

MASTER DESIGN

TECHNICAL SPECIFICATIONS FOR CONSTRUCTION

RBCN-RBR-SPC-R-00001

Revision: 4.0

Date: 2023-07-27

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1. SECTION 01.- GENERAL TECHNICAL SPECIFICATIONS

1.1 INTRODUCTION

- A. These Technical Specifications shall be read in conjunction with the General and Particular Conditions of Contract written in accordance with the FIDIC Red Book (*Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer, Second Edition 2017*), and the other relevant documents of the Contract.

1.1.1 PROVISIONS

- A. These Technical Specifications contain general requirements relating to the Works as a whole; where the requirements contained herein conflict with the particular requirements contained in other sections of the technical specification and/or on drawings, the priority of the documents shall be according to the priority sequence stated in the Contract.
- B. These Technical specifications follows the requirements set by Rail Baltica Design guidelines. In the case of contradiction between these documents the priority is for Rail Baltica Design guidelines documents. In the case of change of Rail Baltica Design guidelines, the Rail Baltica Design guidelines override related requirements set in these Technical specifications.
- C. The scope of these Technical Specifications document is limited to 1435 gauge railway-related structures and road bridges/underpasses. RBTSC does not include the requirements for service/access roads and also does not include structures, utilities, or networks owned/administrated by third parties.
- D. These Technical Specifications do not specify requirements for 1520 mm gauge structure. The construction works of 1520 mm gauge elements, also conditions and requirements when works are performed in the protection zone of existing railways and their equipment and shall be separately specified in the Technical design, following local regulations on 1520 mm gauge railways, rules, conditions and requirements of infrastructure owner.
- E. In the scope described in clause C above, in the event of contradictions between these Technical Specifications documents and other Technical Design Specification documents, the Employer shall have the responsibility to determine the priority between the documents for the specific contradicting requirements. Additionally, the Employer shall take all necessary actions to ensure compliance with CC and applicable Legislation.
- F. The Contractor shall obtain written instructions from the Engineer, or the Employer in the cases where the Engineer shall seek the Employer's approval in line with sub-clause 1.3 [Notices and Other Communications] of the CC, before proceeding with the works affected by any omissions or discrepancies.
- G. The Contractor is responsible for following and implementing all of the requirements towards BIM, GIS and AIM according to the specified LoG and LoI levels mentioned in DG BIM EIR (but not limited) and "RBDG-MAN-040 Digital information requirements for construction and handover stages" documents.
- H. Geodetic site supervision requirements shall be according to RBR "RBDG-MAN-039 - Geodetic network establishment for Construction stage of Rail Baltica high speed railway and RBDG-MAN-038 - Geodetic network establishment for Design stage of Rail Baltica high speed railway" documents.

1.1.2 TERMS AND DEFINITIONS

Term	Definition
As-built information and/or as-built data	Accurate record for all sections and structures showing complete Works as real executed, aligned with the requirements stated in the in DG documents such as BIM EIR (but not limited) and "RBDG-MAN-040- Digital information requirements for construction and handover stages", and in the format agreed with the Engineer.
BIM	Set of technologies, processes and policies multiple stakeholders to collaboratively design, construct and operate a Facility in virtual space. Including PIM (project information model) and AIM (asset information model).
BIM Model	3D models information (PIM & AIM).

Term	Definition
Bill of Quantities	An itemised list of classified materials, parts, and labour together with their unit cost and description what is basis for cost calculation, required to construct, install, maintain, and/or repair the infrastructure, specifically extracted from Rail Baltica BIM models.
CC	Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer, Second Edition 2017 (Red Book, FIDIC).
Drawings	The drawings of the Works included in the Technical Design, in the Contract, and any additional and modified drawings issued by (or on behalf of) the Employer.
Employer	The entity named as the Employer in the Contract Data and the legal successors in title to this person. Also "Contracting Authority". Also "Client".
Engineer	The entity and/or the person named in the Contract Data appointed by the Employer to act as the Engineer for the purposes of the Contract, or any replacement appointed under sub-Clause 3.6 [Replacement of the Engineer]. Also "Engineer's Representative".
Implementing Body	The Employer.
Notice	A written communication identified as a Notice and issued in accordance with FIDIC Red Book (<i>Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer, Second Edition 2017</i>),
Official national language	An official language according to the Employer and the Contract.
PCC	Particular Conditions of the Contract including Contract Data and Specific Provisions.
Party	The Employer or the Contractor, as the context requires. "Parties" means both the Employer and the Contractor.
Technical design	Refers to the Master design in general, or to Detailed technical design if these two are executed in the one phase.
Designer / Consultant	Means the entity who prepared and is the author of the Technical design.
Author supervision	Means the Designer's supervising activities during construction in order to ensure that the construction comply with the design.
shall / must	Indicates an obligation or a mandatory requirement.
recommended / preferred	Indicates preferred course of action, which is not mandatory, there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.
Design chainage	Is the railway alignment chainage used in Technical design and on which basis building permit is obtained.
Operational chainage	Is the railway alignment chainage for usage in operation period of the Rail Baltica line.
RB Rail Supplier	Means consolidate material supplier from RB Rail AS Global project coordinator side for project implementation.

1.1.3 ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
AHJ	Authority Having Jurisdiction
ASTM	American Society of Testing Material Standard
BoD	Basis of Design
BoQ	Bill of Quantities
DoC	Declaration of Conformity
DoP	Declaration of Performance
DWL	Design Working Life
EIA	Environmental Impact Assessment included in the Contract

Abbreviation	Definition
EN	European Standard
EMP	Environmental Management Plan
EPP	Emergency Procedures and Contingency Plan
FPC	Factory Production Control Certificate
HSMP	Health and Safety Management Plan
ISO	International Standard
LARP	Land Acquisition and Resettlement Plan
LoG	Level of Geometry
LoI	Level of Information
PIM	Project Information Model
PQP	Project Quality Plan
QAP	Quality Assurance Plan
ITP	Inspection & Test Plan
QA/QC	Quality Assurance and Quality Control
QCP	Quality Control Plan
QM	Quality Management
RBR	RB Rail AS
SI	International System of Units
TMP	Traffic Management Plan

1.1.4 RULING LANGUAGE

A. The ruling language shall be that stated in the Contract Particular Conditions as Official National Language.

1.1.5 SYSTEM OF UNITS

A. The SI system of units shall be used throughout the Contract.

1.1.6 WORK DURING ADVERSE CLIMATIC CONDITION

- A. Contractor is required to continue all works despite any non-exceptionally adverse climatic condition.
- B. Difficulties due to low temperature, snow, heat, drought or rain shall not make the Contractor eligible to claim for extension of construction time unless the conditions stated at sub-clause 8.5 [Extension of Time for Completion] of the CC are met.

1.1.7 PRIORITY OF DOCUMENTS

- A. The documents forming the Contract are to be taken as mutually explanatory of one another.
- B. These Technical specifications follows the requirements set by Rail Baltica Design guidelines. In the case of contradiction between these Technical specifications document the priority is for Rail Baltica Design guidelines documents. In the case of change of Rail Baltica Design guidelines, the Rail Baltica Design guidelines override related requirements set in these Technical specifications.
- C. If there is any conflict, ambiguity or discrepancy, the priority of the documents shall be in accordance with the sequence stated in the Contract.
- D. If a Party finds an ambiguity or discrepancy in the documents, prior to proceeding with the works containing the discrepancy, that Party shall give a Notice in writing to the Engineer, describing the ambiguity or discrepancy. After receiving such Notice, the Engineer shall issue the necessary clarification or instruction.

1.1.8 OBLIGATIONS AND RESPONSIBILITIES OF THE PARTIES

- A. The obligations and responsibilities of each Party and the relations between them shall be according to the CC, unless stated otherwise in the Contract or in these Technical Specifications.
- B. Contractor's obligations and responsibilities relate to works and/or movement in construction site of other Parties contracted by Employer/RBR are set in RBR "RBGL-SOD-SPC-R-00004 - RAILWAY SYSTEMS REQUIREMENTS on Mainline Works Contractor", "RBGL-SEA-SPC-R-00001 - System assurance requirements on Mainline Works Contractor" and the CC.
- C. The Engineer may issue instructions to the Contractor (at any time) which may be necessary for the execution of the Works, in accordance with the Contract and the Technical Specifications.
- D. The Contractor shall comply with the instructions given by the Engineer, subjected to the provisions in sub-Clause 3.5 of the CC, the Contract and the Technical Specifications.
- E. The Contractor shall execute the Works in accordance with the Contract and the Technical Specifications. The Contractor shall be responsible for the adequacy, stability and safety of all the Contractor's operations and activities, of all methods of construction and of all the Temporary Works.
- F. The Contractor shall submit details of the arrangements and methods which the Contractor proposes to adopt for the execution of the Works prior to the commencement of the Works.
- G. The Contractor shall prepare and submit all documents required in the Contract, in the Technical Specifications, and those stated in sub-section 4.4 [Contractor's Documents] of the CC.
- H. Among others, the Contractors' documents shall comprise the documents required to satisfy permits, permissions, licenses and any other regulatory approvals which are the Contractor's responsibility under sub-Clause 1.13 [Compliance with Laws] of the CC.
- I. When required by the Contract, by Technical Specifications and/or by the Engineer, Contractor's documents shall be submitted to the Engineer for Reviewing, together with a Notice from the Contractor stating they are ready for Review. The Engineer shall give a Notice to the Contractor within the time period stated in the Contract. If the period is not stated in the contract, the time period shall be considered to be 21 working days, The Notice shall conclude of:
 - a. of No-objection (which may include comments concerning minor matters which will not substantially affect the Works); or
 - b. that the Contractor's Document fails (to the extent stated) to comply with the Particular Contract Conditions, with reasons. In this case, the Contractor shall revise the Contractor's Document and resubmit it to the Engineer for Review in accordance with this sub-clause and the period of 21 working days for Review shall be calculated from the date that the Engineer receives it.
- J. Approvals (e.g. verbal or written) from the Engineer, the Employer or their representatives do not relieve the Contractor from his obligations or responsibilities under the Contract.
- K. All obligations of the Contractor provided in this Technical Specification do not revoke or amend obligations of the Contractor under the Contract, including provisions regarding liability, work reception and other. If such differences exist, it subjected to the approval of the Engineer and/or Employer.
- L. All obligations provided in this Technical Specification that concern Materials, execution of Works, including, obligations to ensure testing and acquire appropriate materials, are obligations of the Contractor, excluding cases when other responsible party for an obligation is clearly named in these Technical Specifications.
- M. The Contractor is responsible to select manufacturers/suppliers, and conclude the contracts with, ensuring that requirements and/or obligations referring to manufacturer/supplier (except cases when supplier is RB Rail Supplier) in this Technical specification will be fulfilled. Without prejudice to the manufacturer/supplier liability under applicable law, Contractor shall be held liable for all claims regarding manufacturer/supplier compliance with requirements of this Technical specification.

1.1.9 ANNEXES AND APPENDIXES

- A. The annexes and annexes listed below shall be considered integral components in conjunction with these Technical Specifications. It is important to note that this list is not exhaustive and does not encompass all references required to be followed within these Technical Specifications:

No.	Document ^(a)
APPENDIX 1	RBCN-RBR-BOQ-R-00001 - Rail Baltica BoQ Master table
APPENDIX 2	RBCN-RBR-SPC-R-00002 - Acceptance related QC&QA Requirements
ANNEX 1	RBDL-PCR-PLN-Z-00001 - Schedule Management Plan
ANNEX 2	Common Client's minimum requirements for construction sites
ANNEX 3	RBGP-HSD-STN-Z-00001 - Construction Health and Safety Standard in Rail Baltica global project
ANNEX 4	RBGL-SOD-SPC-R-00004 - Railway systems requirements on Mainline works contractor
ANNEX 5	RBGL-SEA-SPC-R-00001 - System assurance requirements on Mainline track and Civil works contractor
ANNEX 6	RBCN-RWM-SPC-R-00004 - TS Fence Components
ANNEX 7	RBCN-RWM-SPC-R-00005 - TS Noise Barrier Elements
ANNEX 8 ^(b)	RBCN-CMS-SPC-R-00001 - TS Railway Ballast material requirements for construction of Rail Baltica Railway line
ANNEX 9 ^(b)	RBCN-CMS-SPC-R-00002 - TS Sleepers and Bearers with fastening system and under sleeper pad material requirements for construction of Rail Baltica Railway line
ANNEX 10 ^(b)	RBCN-CMS-SPC-R-00003 - TS Rails material requirements for construction of Rail Baltica Railway line
ANNEX 11 ^(b)	RBGL-SOD-SPC-R-00003 - TS Turnout integrated system and Rail expansion joint system
ANNEX 12 ^(b)	RBCN-CMS-SPC-R-00005 - TS Multi-ducts, Cable ducts, Manholes and Cable channels material requirements for construction of Rail Baltica Railway line
Notes: a) Appendixes and annexes will be issued to the Contractor by Employer b) The version of ANNEX document shall be updated after end of corresponding Centralized material procurement tender	

1.2 MEASUREMENT AND VALUATION

1.2.1 GENERAL

- A. The Works shall be measured and valued for payment in accordance with sub-clause 12 [Measurement and Valuation] of the CC, unless otherwise stated in the Particular Contract Conditions and these Technical specifications. Works exceeding the volumes and quantities indicated in the Technical Design and Bill of Quantities shall not be paid if not clearly stated otherwise in the Contract.
- B. Requirements for geodetic measurements accuracy and geodetic reference system to be used is described in "RBDG-MAN-039 - Geodetic network establishment for Construction stage of Rail Baltica high speed railway" and "RBDG-MAN-038 - Geodetic network establishment for Design stage of Rail Baltica high speed railway" documents.
- C. The Contractor is directly responsible for following and implementing all of the requirements towards BIM, GIS and AIM according to the specified LoG and LoI levels mentioned in DG documents such as BIM EIR (but not limited) and "RBDG-MAN-040- Digital information requirements for construction and handover stages" document.

1.2.2 WORKS TO BE MEASURED

- A. The Contractor shall make the measurements of the Works for Engineer's approval.
- B. The Contractor shall develop 3D models for measurements. Such models shall be prepared by the Contractor, unless agreed otherwise between the Parties. Any part of Permanent Works that is to be measured from models shall be agreed between the Engineer and the Contractor.
- C. If, for any part of the Works, the Contractor attends the measurement on Site or examines the measurement records but the Engineer and the Contractor are unable to agree the measurement, then the Contractor shall give a Notice to the Engineer setting out the reasons why the Contractor considers the measurement on Site or records are inaccurate. Until such time as the measurement is agreed or determined, the Engineer shall assess a provisional measurement for the purposes of Interim Payment Certificates.

1.2.3 METHOD OF MEASUREMENT

- A. The method of measurement of completed Works for Payment shall be as stated in the Contract Conditions and these Technical Specifications, and in accordance with the method adopted in the Bill of Quantities and under the items as therein set forth.
- B. Measurement shall be made of the net actual quantity of each item of the Permanent Works and no allowance shall be made for bulking, shrinkage or waste.
- C. All temporary works, auxiliary means and construction costs shall be included in the work related BoQ items. Only those items considered in the List of Quantities for each object shall be applied in term of measurement and valuation.
- D. Works exceeding the volumes and quantities indicated in the Technical Design and Bill of Quantities shall not be paid if not clearly stated otherwise in the Contract.
- E. Payments will be made for only those materials which are specified and permanently installed in the Works to the approval of the Engineer.
- F. Construction materials supplied and delivered to the site by the Contractor which become surplus to the requirements of the Works shall become the property of the Contractor who shall reimburse the Employer any money that was paid to the Contractor for the supply and delivery to site of the surplus materials.
- G. Unless stated otherwise, measurements for structures shall be in accordance with dimensions shown on plans or as directed by the Engineer in writing.

1.2.4 VALUATION OF THE WORKS

- A. The Engineer shall value each item of work based on method of measurement determined in accordance with sub-clauses 1.2.1 [Works to be Measured] and 1.2.2 [Method of Measurement] of the CC, and the appropriate unit price for the item. If the particular method of measurement is not defined in these Technical specifications or CC, or is defined as several alternative methods, the specific method of measurement shall be agreed in between Contractor and Engineer and used for valuation of particular work.
- B. For each item of work, the appropriate unit price for the item shall be the unit price specified for such item in the Bill of Quantities.

1.2.5 UNIT PRICES

- A. The unit prices for each item of work shall include all services to be accomplished which are foreseen in the unit.
- B. All items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the contract and shall include, but not be limited to:
 - a. All payments necessary to ensure compliance with the project documentation requirements;
 - b. Salaries and all related costs (including taxes);
 - c. Materials, goods, their delivery, storage and costs related to their delivery to the construction site, as well as all other costs related to delivery. If the materials are supplied by another company, the costs of unloading and storing the materials, as well as all other related costs, shall also be included;
 - d. Labour, machinery and all associated costs;
 - e. Assembly, incorporation or placement of materials or elements in the designed location.
 - f. Provision of plant and laboratory testing;
 - g. Temporary Works, including necessary designing, etc.;
 - h. Expenses, which may increase the total amount of work, incurred by dividing the work into separate stages (parts) situated by the nature of the technological implementation of the technical design solutions in specific circumstances, needed approvals or permits, but not counting the cases modulated by Employer not foreseen in the Contract;
 - i. Expenses that will be incurred to produce control materials and perform necessary testing of construction materials and structures, which will be performed by Contractor;
 - j. Expenditure incurred in carrying out the work quality assurance and for inspections confirming its implementation;

- k. Expenses that will be incurred in developing the required detailed working drawing;
 - l. The main liabilities, responsibilities and risks associated with the performance of the work;
 - m. Expenses of all necessary permits, utilization expenses and state fees;
- C. Administrative expenses, establishment charges, other expenses, overheads and profit.

1.3 CONTROL AT WORKS

1.3.1 IMPACTED UTILITIES

- A. Known existing utilities are indicated on Drawings. For these, Contractor shall follow design solutions and relevant requirements from Utility Owner.
- B. For unknown utilities, Contractor shall study location, request technical conditions for relocation from Utility Owner and propose appropriate technical solution and variation order.
- C. The Contractor shall provide temporary support for any surface and underground facilities affected by the works also undertake all necessary measures to protect the existing facilities during the progress of the works.
- D. The Contractor shall be responsible for the diversion (temporary or permanent) of any existing utilities, in agreement with the owner and according to their requirements and procedures, obtaining required permissions and approvals, all in accordance with the provisions of the CC, the Contract Conditions and subject to the approval of the Engineer.

1.3.2 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

- A. The Contractor shall assume full responsibility for the protection of all buildings, structures, roads, surface and/or underground facilities such as cables and pipes, existing in the area of the construction site, public or private, whether they are shown on the drawings or not.
- B. The Contractor shall adopt the necessary protection measures during the progress of the works according to the requirements of the owner.
- C. Any damage resulting from the Contractor's operations shall be repaired at his expense.
- D. The Contractor shall not interfere unnecessarily or improperly with the convenience of the public or the access to and use and occupation of all roads and footpaths, irrespective of whether they are public or in the possession of the Employer or others.
- E. The Contractor shall indemnify and hold the Employer harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from any such unnecessary or improper interference.

1.3.3 PROTECTION OF THE ENVIRONMENT DURING WORKS

- A. The Contractor shall ensure sustainable construction approach and ensure that good practices are followed in order to reduce the Project impact on the environment.
- B. The Contractor shall identify the environmental obligations, risks and responsibilities and implement the requirements and conditions set in EIA and Environmental protection part of the Technical design.
- C. The Contractor shall undertake reasonable steps to protect the environment (both on and off the Site) and to limit damage and nuisance to people and property resulting from pollution, noise and other results of his operations.
- D. The Contractor shall ensure that emissions, surface discharges and effluent from the Contractor's activities shall not exceed the values stated in this Specifications or prescribed by the Local Legislation and Regulations in force governing this issue and the Law of the country where the Works are being performed.
- E. The Contractor shall act in full compliance of the national environmental legislation of the country where the Works are being performed, EIA and Environmental protection part of the Technical design requirements.

1.3.4 HEALTH AND SAFETY ON THE SITE

- A. The Contractor shall comply with applicable regulations and directives in respect of health and safety, and those obligations specified in the CC, "RBGL-SOD-SPC-R-00004 - RAILWAY SYSTEMS REQUIREMENTS on Mainline Works

Contractor” , “RBGL-SEA-SPC-R-00001 - System assurance requirements on Mainline Works Contractor” and “RBGP-HSD-STN-Z-00001 – Construction Health and Safety standard in Rail Baltica Global Project”.

- B. The Contractor shall take care of the health and safety of all persons entitled to be on the Site and other places (if any) where the Works are being executed and keep the Site and Works in a proper manner to avoid danger to all persons entitled to be on Site. Contractor shall also take all the actions necessary to prevent public access on Site.
- C. The Contractor shall submit to the Engineer with a copy of the written safety policy specifically prepared for the Works, and any revisions thereof which the Contractor has prepared as a supervisor and which relate to the execution of the Works.
- D. Prior to commencement of work on the Site, the Contractor shall inform the Engineer of the name and location of his appointed safety supervisor(s).
- E. The Contractor shall appoint necessary certified persons responsible for safety with an obligation to visit and support each site regarding work safety matters under his responsibility at least once a day in the 10 km section.

1.4 REQUIREMENTS FOR CONSTRUCTION SITES

1.4.1 GENERAL

- A. The Contractor shall comply with the RBR document “Common Client’s Minimum Requirements for Construction Sites”, with the CC, these Technical Specifications, “RBGL-SOD-SPC-R-00004 - RAILWAY SYSTEMS REQUIREMENTS on Mainline Works Contractor”, “RBGL-SEA-SPC-R-00001 - System assurance requirements on Mainline Works Contractor” and “RBGP-HSD-STN-Z-00001 – Construction Health and Safety standard in Rail Baltica Global Project”.

1.4.2 PLANNING OF LINEAR CONSTRUCTION PROJECTS

- A. Based on the developed Work Organisation project, which is developed under each Design Sections as separate part, the Contractor shall prepare the Work Execution Project according to actual specific requirements in each country.
- B. Content of Work Execution Project before submission shall be agreed with the Engineer/Employer and respective AHJ which is responsible for issuance of a building permit. The Work Execution Project shall be submitted to Engineer and Employer and respective AHJ, if required by respective AHJ.
- C. Initially it is needed that Contractor assesses the volumes of the works indicated in the project, variety of works, requested technologies and availability of the materials for certain section.
- D. The input data for developing the Work Execution Project will be, at least, the following:
 - a. Location of the different construction sites and different sections,
 - b. Volume of the construction works of different sections,
 - c. Length of the linear construction site,
 - d. Local availability of the raw materials and potential delivery options,
 - e. Time schedule for execution of construction works in each section following availability of Land alienated (acquired) by Employer,
 - f. Available and necessary list of machinery for performance of construction works,
 - g. Developed parts of technical design.
- E. As main requirement for this document is conformity with the Employer’s requirements expressed in Design documentation and respect of requirements of Building Authority which is responsible for issuance of the building permit for respective planning of the construction works, Contractor of linear construction shall follow recommended content of Work Execution project and establish his own Work execution project including:
 - a. Calendar of construction works to respect milestones indicated in Works execution project and contract,
 - b. General layout of construction works;
 - c. Description of the necessary preparatory works, works according to contractor necessities to perform before starting construction work;

- d. Technological schemes and indication of execution areas for non-traditional and complex types of construction works;
 - e. The work schedule of usage of the main construction machinery;
 - f. Minimum list of specialists required by the Employer to perform work on the construction site;
 - g. Necessary demolition works of structures (if there is such necessity);
 - h. Reasonable solutions for temporary structures;
 - i. Technical solutions for labour protection, safety equipment, industrial hygiene and fire safety measures;
 - j. List of construction machinery, technological and assembly equipment will be necessary during construction with relevant mobilization dates;
 - k. Explanatory description of works;
 - l. Forecast charts of workforce mobilization (weekly workload),
 - m. Conditions of transportation of construction materials and temporary storage places in the construction site.
- F. Additionally, to the above mentioned:
- a. Contractor needs to provide forecasted daily production rate for main activity that justify respect of contractual milestones in each work section,
 - b. Contractor shall forecast and identify the need for additional Geological information regarding soil conditions under main railway line.
 - c. Contractor shall forecast additional geological information along main line, for optimize number and location of the temporary structures (temporary pumping stations, temporary roads, temporary material storage, etc.)
 - d. Contractor shall investigate potential flood risks in the design section, so to avoid unforeseeable or unexpected washouts of materials or machinery
 - e. Contractor needs to get necessary agreements with neighbour territories to avoid disturbance and conflict with owner of property on the border of new railway.

1.4.3 SITE ACCESS/SECURITY

- A. The Contractor shall comply with the RBR "Common Client's Minimum Requirements for Construction Sites" document.

1.4.4 CONTRACTOR'S SITE FACILITIES

- A. The Contractor shall provide and maintain Site offices, equipment, furniture, and facilities for the Engineer as stated in the Particular Contract Conditions and described (but not limited to) in the Technical Specifications, and during the entire duration of the Contract.
- B. All those temporary facilities, furniture and equipment to be provided by the Contractor are to be approved by the Engineer.
- C. All expenses associated with services installations, water, electricity, sewerage, air conditioning, and heating etc., removal and reinstatement at the end of the maintenance period shall be at Contractor's costs.
- D. All offices, furniture and equipment provided by the Contractor for the Engineer shall be insured by the Contractor against any loss or damage by accident, fire or theft for the duration of the Contract.
- E. On completion of the Contract, the ownership of all offices, furniture, and equipment for the Engineer shall revert to the Contractor on completion of the Contract.

1.4.4.1 OFFICES, ACCOMMODATION AND EQUIPMENT FOR ENGINEER/EMPLOYER

- A. Offices, accommodation and equipment for the Engineer/Employer shall be provided by the Contractor as stated herein and in the Contract.
- B. For every section of 25 km the Contractor shall establish the following:
 - a. One (1) office for Contractor's team,

- b. One (1) office for each subcontractor for which approval will be requested,
- c. One (1) meeting room not less than 50 m² equipped with chairs, projector, internet connection,
- d. One (1) office for the Employer not less than 50 m² equipped with printer, internet connection, four (4) tables, four (4) shelves, and four (4) chairs,
- e. One (1) office for Engineer not less than 50 m² equipped with printer, internet connection, four (4) tables, four (4) shelves, and four (4) chairs
- f. One (1) kitchen with microwave, two (2) electric plates, one (1) sink and one (1) small fridge,
- g. One (1) separate toilette.
- C. If not stated in the CC otherwise, the Contractor shall establish for every section of 60 km a main office facility for the Employer with at least the following:
 - a. One (1) office for Contractor direction team,
 - b. One (1) meeting room not less than 100 m² equipped with chairs, projector,
 - c. One (1) office for the Employer not less than 100 m² equipped with printer, internet connection, eight (8) tables, eight (8) shelves, and sixteen (16) chairs,
 - d. One (1) kitchen with microwave, two (2) electric plates, one (1) sink and one (1) small fridge,
 - e. One (1) separate toilette.
 - f. One (1) archive room not less than 30 m²,
 - g. If there is not any emergency authority closer than 50 km, then one (1) emergency car shall be placed close to construction site with emergency staff at disposal.

1.4.5 SITE LAYOUT PLAN

- A. Actual, accurate Site layout plans shall be prepared by Contractor as part of their mobilisation activities before work on site will be started.
- B. Such Site layout plans shall be developed on the bases of the developed Technical Design and approved by the Engineer.
- C. Site layout plan shall be prepared for all relevant sections showing:
- D. Site layout for each of the site
- E. Position of workers facilities sites.
- F. Position of office facility site.
- G. Site layout planning will solve four basic processes:
- H. Identifying the site facilities that shall be required.
- I. Determining the sizes, and other constraints of those facilities.
- J. Establishing the inter-relationships between the facilities.
- K. Optimising the layout of the facilities on the site.
- L. Site layout plans shall include, but not limited to, locations for and sizes of:
 - a. Zones for construction works.
 - b. Cranes (including radius and capacities of them and where necessary plan of installation of anti-interference device).
 - c. Temporary site offices.
 - d. Welfare facilities.
 - e. Off-loading, temporary storage and storage areas (laydown area).
 - f. Sub-contractor facilities.
 - g. Car parking area.
 - h. Emergency routes and muster (assembly) points.
 - i. Access, entrances, security and access controls, temporary roads and separate pedestrian routes.

- j. Vehicle wheel washing facilities at each access from/to public road.
 - k. Waste management and recycling areas.
 - l. Planned construction site boundaries.
 - m. Protection for trees, existing buildings, neighbouring buildings.
 - n. Necessary signage for construction site.
 - o. Temporary services (including electrical power, lighting, water distribution, drainage, information and communications technology, site security systems).
 - p. Temporary works (such as propping solutions to retained structures, sheet piling details).
 - q. Areas for the construction of mock-ups for testing.
 - r. Necessary fabrication facilities (concrete plants etc.).
 - s. Proposed template of construction site.
- M. Specifically, layout plans for linear construction sites are to:
- a. Nominate dangerous and working area in each stage of works.
 - b. To nominate specific conditions of each working area, so everybody which is involved could recognise the respective area of works.
 - c. Responsible personnel and number of such personnel for observations of the site.
 - d. Respective measures in case of any emergency.
- N. As construction sites will change during the construction works, Contractor shall forecast that layout plans include section where are described different organization of site layout for different construction phases, in a form of developed sequences plan.

1.4.6 MANDATORY DOCUMENTATION IN THE SITE OFFICE

- A. Requirements may vary from country to country; here below is list of most important documents which shall be in each construction site office:
- a. Copy of Authorized building permit according to local national norms.
 - b. Copy of Civil liability insurance policy.
 - c. Commitment acts of each responsible site construction manager.
 - d. Commitment acts of each responsible site construction supervisor.
 - e. Certificates of the Contractors which are working on the construction site, as well as copy of subcontractor approval form accepted by Employer.
 - f. Order to appointed author supervision team.
 - g. Author's supervision journal (or other journal according to local national norms).
 - h. Building journal prepared and registered according to local constructions norms.
 - i. Original of the design according to which construction works will be done.
 - j. IT station accessible for Employer where access to BIM Model shall be available.
 - k. Approved work organization project (as part of design).
 - l. Building panel mounted according to requirements of local authorities and approved by Employer.
 - m. Developed quality control plan for construction works.
 - n. Approved Health and Safety plan.
 - o. Registration journal of work safety instructions.
 - p. Elaborated and approved Work Protection Plan.
 - q. Acceptance acts of covered works.
 - r. Documentation certifying the conformity of construction materials.
 - s. List of delivered materials to the construction site.

- t. Additionally, necessary permits for specific works (water, gas, sewage connections etc.).

1.4.7 SITE / WORKING AREA

- A. The **Contract Work Site , Site or Working Area** shall be defined as that area that is affected by all the Works as shown on the Technical Design.
- B. That area may include land types such as, but not limited to, roads, road reserves, nature strips or footpaths, watercourses and private property. The Contractor shall not work or occupy areas outside of the designated areas. In the case of private property, the Contractor shall not enter the property until given a written direction to enter by the Engineer.
- C. Where necessary according to the Engineer, respective Local Legislation and Regulations and norms, the Contractor shall erect the appropriate warning and safety signs in prominent locations around the Construction Site. Such signs shall include, but are not limited to: " Danger, Construction Site, No Unauthorised Access" and personal protective equipment signs as necessary.
- D. As much as possible by logic of execution of works, the Contractor shall start by installation of fences and gates around the construction site to permit execution of works in area which shall not be accessible by public and unauthorized persons.
- E. Locations, where constructions works are performed and locations where the mobile construction site offices are located, shall be equipped with CCTV cameras (for linear construction sites each 150 m) which could be used also for night-time vision and which could be available for Employer's necessities.
- F. Contractor is responsible for delivery and installation of necessary equipment and personnel to guarantee safety and security of areas where construction works are performed.
- G. Contractor shall provide evidence with respective procedures how security and safety issues will be solved in the construction area and FIDIC Engineer must approve this proposal.

1.4.8 SIGNALS

- A. In order to receive a permit to commence construction works, the Contractor shall develop and co-ordinate the transport scheme for actual construction site in accordance with the existing requirements.
- B. For information of construction works participants contractor is obliged to use safety signs. Safety signs shall be:
 - a. used to draw attention to the imminent danger, to alert the employees at risk, and to provide them with the necessary information, prohibit certain activities and orientate and correct direct their behaviour in any risk situation;
 - b. for assisting employees in locating and identifying protective equipment, evacuation or emergency exits, and location of first aid points;
 - c. considered as an additional or temporary alternative to labour protection, but safety signs can never eliminate the risk factors.
- C. The following safety signs shall be used at the workplace, as appropriate to the situation:
 - a. Prohibition sign - a sign that prohibits activities that may create a dangerous situation.
 - b. Warning sign - a sign that warns of a risk or danger.
 - c. Order sign - a sign indicating a specific requested action.
 - d. Emergency, evacuation and emergency exit sign - a sign that provides information on first aid sites, escape routes and auxiliary escape routes.
 - e. Fire safety sign - a sign that provides information regarding fire-fighting equipment and facilities and their locations, as well as information regarding signs in evacuation plans or fire, rescue and civil protection plans.
 - f. Information sign - a sign that provides additional information.
 - g. Signal colouring - a colour with a specific meaning.
 - h. Acoustic signal - an encoded (predetermined) sound signal transmitted by an appropriate device without the use of a human voice or an artificially created voice imitating it.
 - i. Verbal communication - communication that provides encrypted (predefined) security information with a human voice or an artificially created voice simulating it using a suitable device.

- j. Hand signal - A signal that provides encoded (predefined) safety information with the movements or positions of hands and wrists to persons who perform dangerous manoeuvres or are within the range of these manoeuvres.
- D. Warning signs shall not substitute technical or other collective labour protection measures, they shall be used in cases where the risk cannot be eliminated or sufficiently reduced by other measures.
- E. Safety signs are only a complement to other workplace safety measures that may be used and means of protection, such as emergency exits, shelters, other safety equipment, personal protective equipment, etc. The usage of safety signs in any way in this case, will not be exempted from other appropriate labour protection measures.
- F. Safety signs and devices shall always be kept clean and shall be regularly inspected and, if need, to be repaired or replaced with others so that at any time safety signs shall do function properly.

1.4.9 INSPECTIONS OF CONSTRUCTION SITES

- A. During the construction works, the Contractor shall be prepared and accept any type of inspection which could be done in accordance:
 - a. Local Legislation and Regulations, or
 - b. Based on Engineer/Employer request or requirement.
- B. As potential examples for inspections of authorities is the following list:
 - a. Inspection of Construction board representative.
 - b. Inspection of State Revenue Service.
 - c. Inspection of State labour inspection.
 - d. Inspection of Border Guard (regarding existence of work permits for personnel).
 - e. Inspection of National Bureau of Construction Control.
 - f. Etc.
- C. The Engineer/Employer shall require the inspection of the works, or the construction products delivered or made on the site. All construction works shall be recorded daily. All records shall be done in accordance with national legislation.
- D. If the quality of the Works or the materials supplied do not meet the requirements of the quality control criteria, the responsible site manager shall stop the construction works related with the defected Works or materials.
- E. The Engineer can require showing the covered works, certificates, the declaration of conformity to the customer, who decides the conformity of the documents related with the performed works or the incorporated materials.
- F. Contractor shall be ready to present required documentation of the works and/or materials to the nominated personnel of the Employer.

1.4.9.1 INSPECTIONS OF THE PREVIOUS WORK STAGES

- A. Inspections of executed works can be divided in the following sections:
 - a. Inspection according to applicable regulations,
 - b. Inspection for quality approval – Acceptance testing,
 - c. Extraordinary inspection (due to any reason).
- B. One important inspection is checking the correctness of design elevation marks for new structures.
- C. If any of the characteristics does not comply with the applicable requirements, then the responsible work manager shall propose new time when such inspection could be done and necessary design parameters will be presented. The proposed new time should be proposed while taking into account the foreseen works implementation schedule.
- D. If the conclusion of the checks carried out complies with the applicable requirements, the responsible work manager and construction supervisor (Engineer) sign common acceptance act of respective works.

- E. Requirements regarding Environmental aspects (including noise, dust and vibrations control) shall comply with relevant Local Regulations governing these issues.

1.4.10 SETTING OUT

- A. As states the sub-clause 4.7 [Setting Out] of the CC, the Contractor shall set out the Works in relation to original survey control points, lines and levels of reference specified on the Drawings and/or in the Contract and/or issued to the Contractor by the Engineer.
- B. The setting out includes, but is not limited to follow the horizontal alignment, staking and setting levels (survey beacons) and the general site clearance, stripping of topsoil and removal of bushes and trees, structures and other obstructions.
- C. Before starting any geodetic or surveying works, the Contractor shall submit a plan of actions / Method Statement to the Engineer/Employer and RBR for approval, and the works must not be started until approval is received.

1.4.10.1 BASIC SURVEY

- A. The Technical Design includes information to enable the Contractor to set out the Works and the Contractor shall be responsible for setting out all necessary reference points and for the maintenance thereof.
- B. If the Contractor discovers any error in line level, or dimension in the basic survey information, the Contractor shall notify the Engineer immediately. If the information is confirmed to be incorrect, then the Contractor will issue amended drawings for the approval of the Engineer.
- C. Also the following actions shall be taken by the Contractor:
- Take-over of Rail Baltica existing geodetic network;
 - Submission of all surveying/geodetic works Method Statement for approval by the Employer and RBR;
 - Checking of 0-level surface and comparison with design and topographic data;
 - In case of difference in location and/or in height, the 0-level surface must be re-measured and all volume calculations performed from the new 0-level surface;
 - Submission of new 0-level surface and comparison results with existing design and topographic data for approval by the Employer and RBR;
 - For any other geodetic works, the steps and methodology described in "RBDG-MAN-039 - Geodetic network establishment for Construction stage of Rail Baltica high speed railway".

1.4.10.2 DETAILED SETTING OUT

- A. The Contractor shall set out the line and level of the Works at intervals of not more than 25m or such lesser intervals as are required to construct the Works.
- B. Reference pegs clearly and indelibly marked with all relevant information shall be provided clear of the road and at right angles to it from which the centre line and level can be re-established at any time.
- C. Reference pegs shall be maintained by the Contractor for as long as they are needed by the Engineer to check the Works.

1.4.10.3 LEVELS

- A. After completion of setting-out and site clearance, the Contractor shall take ground cross-sections at intervals of 25m, or such intervals as the Engineer will require, and these shall be plotted and submitted to the Engineer for agreement.

1.4.10.4 SURVEY BEACONS (DATUM POINTS)

- A. The Contractor shall not remove, damage, alter or destroy in any way any plot beacons, survey beacons of the National Survey of the country where the Works are being performed or those reference beacons positioned by the Design Consultants for this project.
- B. Should the Contractor consider that any beacon will be interfered with by the works he shall notify the Engineer who, if he considers necessary, shall make arrangements for the removal and replacement of the beacon.
- C. If the Contractor removes or disturbs a beacon without permission of the Engineer, he shall be liable for the full cost of its replacement and as appropriate, a fine under the Survey Ordinance in force.

1.4.10.5 ENVIRONMENTAL REQUIREMENTS

- A. The Contractor shall have 1 (one) specialist with a degree in ecology, environmental science or biology participating during the installation of construction sites near protected territories.
- B. For more detailed environmental requirements regards site organization and management, please refer to Section 7 in these Technical Specifications.

1.4.11 ACCESS ROUTE

- A. In line with sub-clause 4.15 [Access Route] of the CC, the Contractor shall provide the necessary means and measures to prevent any existing road or bridge from being damaged by the Contractor's traffic and/or by the Contractor's Personnel. These measures shall include the proper use of appropriate vehicles (conforming to legal load and width limits (if any) and any other restrictions) and routes. The Contractor shall be responsible for enhancing and maintaining any existing road when used as an access and material supply route.
- B. The Contractor shall be responsible for maintaining the pavement and asphalt roads, and for repairing any damage during the construction period, providing any transversal drainage pipes where necessary.
- C. The Contractor shall provide all necessary signs or directions along access routes and shall obtain permission from the relevant authorities for the Contractor's use of routes, signs and directions.
- D. The Employer shall not be responsible for any Third-Party claims which may arise from the Contractor's use of any access route. The Employer does not guarantee the suitability or availability of particular access routes.
- E. All costs arisen from the non-suitability and/or non-availability of access routes shall be covered by the Contractor.
- F. The performance of any work related to access routes shall be agreed with the Engineer prior to the commencement of the works.

1.4.12 TRAFFIC MANAGEMENT

- A. The Contractor shall provide traffic safety and management and cover all costs associated with it.
- B. The works shall be carried out while the Contractor maintains the traffic throughout the Works, and until issuance of the Taking-over Certificate by the Employer.
- C. All diversion roads, temporary roads and road lengths subject to traffic restrictions shall always be maintained in a good condition.
- D. The Contractor shall, based on due consultation with and requirements of the Police and AHJ, submit a Traffic Management Plan for the Engineer's approval at least 28 working days prior to the commencement of any works affecting public or private rights of way. Traffic Management Plan has to be approved by the Authorities and Affected Parties.
- E. The Traffic Management Plan shall indicate the details of the proposed scheme of traffic safety and management measures including all construction details, temporary lighting and signing, and programme of works. The Contractor shall provide further details as necessitated by the Works or required by the Engineer.
- F. At all times the public traffic adjacent to and within the work site shall be controlled and protected by the Contractor according to the active traffic rules and regulations in the country where the Works are being performed.

- G. The Work will be accepted providing that it has been built in conformance to the drawings and specifications pertaining to the segment involved and is accepted by the Engineer.

1.4.13 ACCOMMODATING TRAFFIC DURING WORK

- A. The Contractor shall provide safe movement of vehicles and pedestrians through the Site in accordance to AHJ's procedures (Municipality or Local Road Administration).
- B. The Contractor shall submit traffic control implementation drawings and alternate traffic control proposals including the following:
- A detailed diagram, which shows the location of all traffic control devices, including advance construction signs and speed limit signs, method, length and time duration for lane closures; and location of flaggers and time duration of flagging operation.
 - A tabulation of all traffic control devices shown in the detail diagram.
 - An access maintenance plan for all properties requiring access during construction. This plan shall also indicate the areas where equipment will be stored, vehicles parked, construction signs and materials stored, if within the construction site limits. The Contractor shall also indicate ingress and egress to the construction site unless otherwise approved.
 - A pedestrian traffic control plan.
- C. The work should be performed in a manner that assures the safety and convenience of the public and protects the residents and property adjacent to the works.
- D. The Contractor shall accommodate public traffic on roads within the project until the work is accepted.

1.4.14 MAINTAINING ROADWAYS DURING WORK

- A. The Contractor shall perform roadway maintenance as follows:
- Maintain intersections with trails, roads, streets, enterprises, parking lots, residences, businesses, farms, and other objects.
 - Remove accumulations of soil and other material from travelled way.
- B. The Contractor shall maintain the roadway in a safe and acceptable condition. If corrective action is requested and the corrective action is not taken immediately, the condition may be corrected, and the Contractor will be charged for the cost of the corrective action.

1.5 ADMINISTRATIVE SPECIFICATIONS

1.5.1 CONTRACTOR'S QUALITY MANAGEMENT SYSTEM

- A. Subject to the provisions of sub-clause 4.9 [Quality Management and Compliance Verification System] of the CC, the Contractor shall prepare and implement a Quality Management (QM) system to demonstrate compliance with the requirements of the Contract.
- B. The QM system shall be ISO 9001 certified or equivalent to ISO 9001 (verified by a certified third party), specifically prepared for the Works, and a Quality management plan submitted to the Engineer and Employer within the time agreed between the Parties before commencement of works. The organization of the Quality Management shall be clearly defined (and provided adequate resources to successfully perform roles and responsibilities).
- C. The Personnel involved with quality assurance and quality control shall have demonstrable experience or qualification and have well-defined responsibilities and organizational freedom to identify and evaluate quality problems.
- D. The Certification and competency of personnel shall be demonstrated by virtue of those skills which are obtained by qualification, experience or training.
- E. The Personnel who are found not to be suitably competent or effective in the implementation of the quality plan may be removed after evaluation of the performance by Employer.
- F. The Contractor personnel performing inspections and tests shall be qualified for such work and have to be approved by Employer and Engineer.

- G. The Employer and Engineer reserves the right to reject material or products manufactured by personnel not qualified.
- H. The Contractor's quality manager shall lead quality assurance personnel involved in audits. The quality audits shall be aligned with ISO 19011 – guidelines for auditing management systems.
- I. The Contractor's quality manager shall be certified for internal / external auditing and QA personnel shall have auditing experience applicable to their responsibilities.
- J. All Contractor's staff shall have position descriptions with their roles and responsibilities defined including those responsibilities specific to quality, safety and environmental matters.
- K. The Contractor shall define Process, Template, KPI according the Employer's QM plan.
- L. Whenever the QM system is updated or revised, a copy shall promptly be submitted to the Engineer.
- M. The QM system shall be in accordance with the details and requirements/specifications stated in the Contract and the Technical Specifications and in accordance with the Technical Design.
- N. The QM system shall clearly describe the Contractor's systems, procedures and methods that will be used to deliver and monitor the Contract, in particular the compliance of the Works with the requirements of these Technical Specifications and the PCC:
 - a. to ensure that all Notices and any other communications under sub-clause 1.3 [Notices and Other Communications] of the CC, Contractor's Documents, as-built records, operation and maintenance manuals, and contemporary records can be traced, with full certainty, to the Works, Goods, work, workmanship or test to which they relate;
 - b. to ensure proper coordination and management of interfaces between the stages of execution of the Works, and between Subcontractors;
 - c. for the submission of Contractor's Documents to the Engineer for Review.
- O. The Employer and/or the Engineer shall be entitled to audit any aspect of the QM system.
- P. The QM system shall include a full description of the systems, procedures and methods that will be used to develop the assignment and the documented Contractor's procedures for at least the following:
 - a. QM system implementation and internal audits.
 - b. Compliance Verification, according to the CC, to demonstrate that materials, works and workmanship comply in all aspects of the Contract. The Compliance Verification System shall include a method for reporting the results of all inspections and tests carried out by the Contractor. In the event that any inspection or test identifies a non-compliance with the Contract, Sub-Clause 7.5 [Rejection] shall apply.
 - c. Procedures for monitoring and measurement (inspection and/or testing) the work specifying:
 - i. Process and output monitoring and measurements to be applied;
 - ii. the stages at which they are to be applied;
 - iii. the characteristics to be monitored and measured at each stage;
 - iv. the acceptance criteria to be used;
 - v. and statistical process control method to be applied;
 - vi. where inspections or tests are required to be witnessed or performed by interested parties;
 - vii. where, when and how the organisation intends to use external providers to perform inspections and tests;
 - viii. the criteria for release of products services and or other outputs.
 - d. Specify the controls to be used for monitoring and measuring resources intended for use for the specific case, including requirements for calibration or verification, or reference to relevant documented information.
 - e.
 - f. Evidence of all testing or measuring apparatus being recently calibrated.
 - g. Materials supply and delivery processes.
 - h. Program presentation, monitoring and updating.
 - i. Recording, reporting and analysis of Data.

- j. Control of documented information and management of contract administration documents.
 - k. Emergency procedures and incident response plan.
 - l. Record of non-conformities, their causes and mitigation measures to amend those non-conformities and to avoid future non-conformities.
 - m. Internal audits and responsibilities for addressing non-compliance.
 - n. Staff training.
- Q. In particular, the standard EN 16907-5:2018 - "Earthworks - Part 5: Quality control" shall be followed for drafting the QM system related to earthworks.
- R. The QM system shall consider the Quality Requirements detailed in sub-section 1.7 [Quality Requirements] of these Technical Specifications.
- S. The QM system shall also integrate the Contract work requirements with the Contractor's quality, health and safety, environmental and social management systems to deliver the Works.
- T. The Contractor shall prepare and submit the draft QM system (including the three supplementary plans: Health & Safety Management, Emergency Procedures & Contingency, and Traffic Management) for the approval of the Engineer at the same time as the submission of the Programme (refer to sub-section 1.5.6 hereinafter). The final QM system shall be submitted for approval not later than 14 days after the receipt of the Employer's comments.

1.5.1.1 QUALITY MANAGEMENT PLAN

- A. The Contractor shall provide a QM Plan to Engineer and Employer.
- B. The Contractor's QM Plan shall be aligned with ISO 10005 – Guidelines for quality management plans, and Employer's QM Plan.
- C. The Contractor shall update and maintain the Contractor QM Plan.
- D. The Contractor's QM Plan shall be regularly reviewed and updated to reflect improvements, changes to work practices and/or changes to policy and legislation. The proposed changes are to be submitted to Engineer for review prior to inclusion and implementation.
- E. The regularly updated of the Contractor's QM Plan shall be agree in the Implementation phase with Engineer.
- F. The update of Contractor QM Plan may be requested and initiated by Contractor, Engineer or Employer.
- G. The Contractor QM Plan shall constitute the written policies and procedures setting forth the Contractor QM system.
- H. The Contractor QM Plan shall encompass all aspects of the ENE Deployment, including but not limited to:
 - a. Management commitment, policy and implementation review process;
 - b. Objectives;
 - c. Schedule of all KPI's required to measure and monitor the QM system;
 - d. Design quality management including workflows and quality records;
 - e. Quality control of all deliverables;
 - f. Procurement procedures, including analysis of prequalification and factory evaluation;
 - g. Material approval procedures;
 - h. Quality audit programs;
 - i. Scheduled quality record reviews related to lifecycle stage and review of improvement actions undertaken;
 - j. Corrective and preventive action;
 - k. Management Reviews;
 - l. Continual improvement;

1.5.1.2 QUALITY MANAGEMENT SYSTEM DOCUMENTS (ITP, REPORTS OF INSPECTIONS ETC.)

- A. The Contractor shall produce quality control plans / ITP(s) for all activities requiring test, monitoring and/or inspection, and provide for review by the Engineer.
- B. Each ITP shall identify the quality objectives and include, without limitation:
 - a. The personnel responsible for undertaking and certifying the inspection and/or testing;
 - b. The procedure or instructions for the inspection and/or testing;
 - c. The test method or a reference to the relevant standard of testing;
 - d. The inspection and/or testing required prior to commencement of an activity;
 - e. The inspection and/or testing during an activity and its frequency;
 - f. The inspection and/or testing required to complete an activity;
 - g. All hold points;
 - h. All witness points;
 - i. Any notices or other documents to be given to the Engineer in relation to witness points and hold points;
 - j. The compliance criteria;
 - k. The method of analysis of test data;
 - l. The procedure for correction or disposal of any work which fails the compliance criteria;
 - m. The procedure for the distribution, filing and storage of inspection reports, test reports and reports on analysis of test data;
 - n. The verifying documentation.

1.5.1.3 NON-CONFORMITY MANAGEMENT

- A. The Contractor shall establish, document, and maintain an effective system, for identifying and controlling non-compliance.

1.5.1.4 AUDIT (INTERNAL & EXTERNAL)

- A. The CONTRACTOR shall continuously monitor the performance of the QM System and shall specifically include in each Monthly Progress Report:
 - a. The status of all QM system documentation;
 - b. An up-to-date audit schedule and status;
 - c. An up-to-date non-conformity register providing the status of all nonconformities identified by the Engineer, Employer and the Contractor;
 - d. And any other items as instructed by the Engineer.
- B. The Contractor shall have clear and approved non-conformity identification and reporting (NCR) processes, and effective corrective actions.
- C. The Effective Corrective Actions shall be implemented, monitored and closed out in an agreed time.
- D. The Contractor shall ensure that audits of all the activities in quality plan are carried out according to the approved audit schedule, or at such other intervals as the Engineer may require, ensuring the continuing suitability and effectiveness of the quality system.
- E. All the Reports of each audit shall be submitted within 7 days to the Engineer.
- F. Upon receipt of Corrective Action Request (CAR), Non-Conformance Report (NCR), or similar as a result of a quality audit, the Contractor shall submit to the Engineer for review and approval proposed corrective and preventative action plan as required.

1.5.1.5 TESTS AND TRIALS

- A. A pre-test briefing involving the Contractor testing staff and the Engineer representatives shall be held prior to each test.
- B. At the pre-test briefing meeting, the Contractor shall distribute approved test procedures and shall discuss the test with the Engineer.
- C. Following each test, a post-test briefing including both the Contractor's testing staff and the Engineer, shall be held to discuss the results of the test and obtain agreement upon whether it was successful or if there is a need for additional tests (according to the Pass-Criteria defined in the ITP).
- D. The Contractor Test Reports shall be submitted to the Engineer following each test and/or demonstration.
- E. The Contractor Test Reports shall include the test procedures, prevailing weather data (if applicable), unusual conditions or events, complete test data, and pass/fail disposition.
- F. The Contractor Test Reports shall include any failures which occurred during the test/demonstration, whether or not related to the equipment under test, as well as ITP, all referenced and completed documentation.

1.5.1.6 QUALITY TRAINING

- A. The Contractor shall submit the material for the quality induction training to the Engineer for review, 42 days prior to conducting quality training sessions.
- B. The Contractor's staff shall receive quality training to ensure competency (the ability to apply knowledge and skills to achieve intended results).
- C. The specific training needs shall be identified on a training needs register and individual personal development plans.

1.5.1.7 QUALITY TEMPLATE, REGISTER, MONITOR, REVIEW REPORT, MEETING

- A. The Contractor shall provide (editable format) and maintain at all stages of the Work a Quality Control Register to identify the status of inspections, sampling and testing of the Work, and all certificates.
- B. The Quality Control Register shall be maintained as current at all times.
- C. The Contractor shall implement / utilise Employer's Electronic Document Management System, and best practice hard copy filing system to collect and maintain all Quality Documentation.
- D. The Contractor shall submit on a Monthly Basis Summaries based on approved project template of Quality Control Register to the Engineer.
- E. All Quality Control Documentation shall be managed, controlled and securely maintained as per the approved Document Management Plan.
- F. The Records shall include but not limited to results of audits, non-conformance records, inspections, tests, process controls, certification of processes and personnel, nonconforming material (including records of disposition), and other verification, test and acceptance requirements.
- G. The Records shall be maintained, completed and made available upon request at all times during the performance of the Contract and shall be issued with the "As-built" Documentation Package.
- H. The Contractor shall make available the record documentation including but not limited to:
 - a. Minutes of the previous meeting/review of pending actions and decisions;
 - b. Quality key issues;
 - c. Project status;
 - d. Project documentation and reporting;
 - e. Inspection and testing;
 - f. Surveillance;
 - g. Non-conformities and improvement;

- h. Audits.

1.5.2 HEALTH AND SAFETY MANAGEMENT PLANS

- A. The Contractor shall respect the Health and Safety rules and regulations of the country where the Works are being performed. Furthermore, the Contractor shall always take all the reasonable precautions to maintain the health and safety of the Contractor's personnel as well as its subcontractors' personnel.
- B. Contractor shall comply with Employer's provided "RBGP-HSD-STN-Z-00001 – Construction Health and Safety standard in Rail Baltica Global Project".
- C. Contractor shall comply with safety requirements of infrastructure manager's shall contracted operations come into restricted area of infrastructure (e.g. 1520 mm railway line, power supply (overhead or belowground), gas lines, water pipes, but not limited to).

1.5.3 EMERGENCY PROCEDURES AND CONTINGENCY PLAN

- A. The Contractor, in line with sub-clause 6.7 [Health and Safety of the Personnel] of the CC, shall ensure that medical staff, first aid facilities, sick bay and ambulance service are available at all times in reasonable distance from Construction site. Accommodation for the Contractor's and Employer's personnel, and suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of sickness.
- B. The Contractor shall include in the QM system an Emergency Procedures and Contingency Plan (EPP), which shall establish the roles, practices and procedures during specific types of emergency events identified in the plans. The EPP shall be developed by the Contractor and agreed with the Engineer and any other stakeholders the Engineer may identify.
- C. The purpose of the EPP is to ensure the safety of the Contractor's personnel and road users in the case of emergency and/or road closure. It should include:
 - a. An effective communication and event recording system.
 - b. Name, contact telephone number, and specific duties of the Contractor's personnel nominated to respond to an emergency event. The contact for Emergency Calls will be the Engineer or alternative delegated personnel and the Contractor's Contract Manager.
 - c. The contact number of other Parties who need to be notified in cases of emergency events, e.g. police.
 - d. Detailed response procedures for all emergency events.
 - e. Possible detour routes in the event of road closures.
- D. The EPP shall be submitted with the draft QM system and, when approved, shall become a part of the QM system.

1.5.4 SITE TRAFFIC MANAGEMENT PLAN

- A. The Contractor shall include a Traffic Management Plan (TMP) in the QM system.
- B. The TMP shall establish the practices for traffic management at work sites, both day and night, and shall define and establish procedures appropriate to the types of road and traffic levels under consideration.
- C. The TMP shall be developed by the Contractor and agreed with the Engineer.
- D. The objectives of the TMP are to:
 - a. Clearly define and document the responsibilities and chain of command for the development, implementation and management of traffic control measures and systems.
 - b. Establish the minimum requirements for temporary traffic control.
 - c. Establish the minimum geometric, cross section and surfacing standards for temporary works.
 - d. Establish the minimum traffic management levels including any reviews necessary as a result of changing traffic conditions over the duration of the contract.
 - e. Provide appropriate transitions and enable safe and efficient traffic flow into, through and out of work sites.
 - f. Always protect the public.
 - g. Protect the Contractor's personnel at all times.
 - h. Protect the Asset and the Contractor's resources at all times.

- i. Meet the operational requirements for the road.
- E. The TMP shall include at least the following:
 - a. A documented process for preparation, review and approval of the traffic management measures.
 - b. Layout diagrams, method statements etc. for implementation of traffic control while undertaking each aspect of the Services (including site specific layout diagrams and method statements if the Services require traffic control measures not covered by standard codes of practice).
 - c. Steps to deal with excessive traffic delays which shall be implemented once the traffic delay exceeds 10 (ten) minutes. The Contractor shall be responsible for the monitoring of traffic delay.
 - d. A document tracking and control system to ensure that only the latest operative copy of the Traffic Management Plan is in circulation Contact details for Contractor, Engineer, any relevant representative(s) of the Employer's Personnel, emergency services and other stakeholders.
 - e. The Contractor's strategy for informing the general public and adjacent landowners about the nature of the planned work activities or events, the implications of the traffic plan (e.g. detours) and their role in maintaining the overall safety of the site.
 - f. Parties with Access Affected shall be advised as necessary. Specific attention shall be given to Schools, Hospitals, Emergency Services, Police and other institutions or businesses located within the work zone or directly affected by the Works.
- F. The Contractor shall program Works such that contract activities affecting traffic flow are not carried out on-site in urban zones during periods of peak traffic flow, other than emergency or emergency maintenance work and then only with the approval of the Engineer. Specific plans requiring either partial (single lane) or full road closure (with detour) shall be submitted to the Engineer and Employer for approval at least 2 weeks in advance of the programmed closure and should be agreed with traffic police. These plans shall stipulate the duration of the proposed closure. Specific Plans not requiring closure shall be registered with the Engineer at least 5 days prior to the work taking place.
- G. The TMP shall be submitted with the draft QM system and, when approved, shall become a part of the QM system.
- H. The TMP shall consider the Traffic Management Requirements detailed in sub-section 1.4.6 [Traffic Management] of these Technical Specifications.

1.5.5 SITE DIARY

- A. The Contractor shall keep a Site Diary of the Works. The diary shall be readily accessible in the office of the Contractor to the Engineer, in the format agreed with the Engineer and according to Local Legislation and Regulations governing this issue.
- B. The Site Diary shall be aligned with the relevant requirements stated in the document "RBDG-MAN-040- Digital information requirements for construction and handover stages" and other DG BIM documents.
- C. The Site Diary shall be drafted in accordance with the following requirements:
 - a. An entry shall be made in the Site Diary for each day of construction. The entries shall describe, in chronological order for each day of construction, the construction work and the work supporting it.
 - b. If the information provided below in points (3) iii) to v) has not changed, an additional entry in the Site Diary is not necessary, the entry shall be supplemented with continuing dates.
 - c. At least the following data shall be entered in the Site Diary:
 - i. the date of the entry;
 - ii. the name of the person who drafts the entry;
 - iii. a description of the condition of the Works and/or construction site and the conditions affecting them;
 - iv. a description of the work performed;
 - v. used construction materials and products;
 - vi. a notation concerning the preparation of the report on the work;
 - vii. the date on which the waste was removed;
 - viii. a remark or recommendation of the Engineer, if any;

- ix. a precept of the state supervisory Authority, if any;
 - x. the name of the person performing the construction work;
 - xi. the name of the Engineer.
- D. The diary shall be used to record any observations, instructions, changes, or other relevant matters, in official national language and in English if agreed with the Engineer. The Contractor shall arrange and pay for the English translation.

1.5.6 PROGRAMME

- A. In line with sub-clause 8.3 [Programme] of the CC the Contractor shall submit a detailed Programme to the Engineer within 28 days after receiving the notice under sub-clause 8.1 [Commencement of Works] of the CC.
- B. The programme shall be a Gantt diagram produced with Primavera P6 software.
- C. The programme shall be formulated and managed according to the requirements of the by the principles compatible with Rail Baltica "Schedule Management Plan".
- D. The following Gant diagrams shall be produced:
 - a. Summary of the Gantt diagram of the main activities in ONE DIN A3 PDF format.
 - b. The complete and detailed Gantt diagram including all work items, activities and sub-activities issued in both a PDF and softcopy format.
 - c. The level of detail required is to be equivalent to the AACE International level 4 definition.
- E. In both presentations, the Contractual and key milestones including the performance-completion rate or output shall be shown with a comparison made between the planned and actual performance.
- F. The programme shall represent the full scope of the Contractor's works showing the timings and durations for each activity and be sequenced in the order of works prepared.
- G. The programme shall represent any activities that are required to be undertaken by other organisations that affect or may affect the Contractor's works. These are to include but not limited to third party approvals, interfacing works by other contractors, review periods from authorising bodies, receipt of key information from the Engineer etc.
- H. The dates and durations specified by the Contractor shall be reasonable and not contain an exaggerated quantity of float.
- I. The Programme shall include linkages to activities prior and following each activity.
- J. The Programme shall be in logic linked Critical Path Method (CPM) network format clearly showing the critical paths to each contractual or key milestone, and the overall critical path of the project.
- K. The time floats (both total and free float) for each activity shall be listed.
- L. The Programme shall follow and be developed taking in consideration the highest industry standards of scheduling, including but not limited to:
 - a. Widely accepted 14-point DMCA guidelines.
 - b. AACE International Recommended Practices.
 - c. "Planning, Scheduling, Monitoring and Control Guide (2015)" published by the sociation for Project Management – APM.
- M. The Programme shall include the description of the organization of the Work based on the technical documentation and the constraints identified by the Contractor to determine a rational sequence of activities in order to ensure completion of the Works on the Time of Completion stipulated in the Contract.
- N. The Programme shall cover all activities from the Commencement Date until Completion of the Work subject to the Contract Conditions.
- O. The Contractor shall identify the main milestones of the Work and agree with the Engineer.
- P. The Contractor shall include the list and sequence of the activities in which is possible to break down the Work; and the list of activities necessary to be completed or started prior to each activity.

- Q. Any activities requiring special working arrangements (e.g.) 24h working shall be highlighted and included in the Contractor's Programme.

1.5.6.1 IDENTIFICATION OF RISK TO THE PROGRAMME

- A. The Contractor shall continually identify and highlight activities in the Programme that are at risk of being delayed. A list of any events causing delay or likely to cause delay is to be maintained including the proposed mitigating measures which may be performed by the Contractor for consideration by the Engineer.
- B. The Contractor shall stipulate and justify the planned duration for each of the activities, according to the foreseen assignment of the equipment, materials and personnel.
- C. For the determination of the duration, the Contractor shall detail and justify the performance rate for each activity.

1.5.6.2 PROGRAMME REPORTING

- A. After the Programme has been agreed by the Engineer it shall be baselined and the reporting period programme is to show any variance to the planned dates as a result of the update.
- B. The Programme shall not be baselined or re-baselined without an agreement of the Engineer.
- C. The Programme shall be reported against on at least a monthly basis (or at less intervals if requested by the Engineer).
- D. Before each Monthly Progress Meeting, the Contractor shall submit an updated Programme (including the progress to date and any changes to the planned dates) for approval showing the progress, remaining duration, actual dates, physical percentage complete and expected completion dates.
- E. The reporting date of the regular monthly update shall be the 01st of each month.

1.5.6.3 PROGRAMME LOADING

- A. The Contractor shall resource load the Programme (Prices, Labour, etc.) and be submitted for acceptance to the Engineer. This will facilitate an additional assessment of progress, cost and performance.

1.5.6.4 MODIFICATION AND REVISION OF THE PROGRAMME

- A. The Programme shall remain a relevant document capable of accurate reporting on an ongoing basis and able to be relied upon when other associated Parties are planning their works.
- B. If it becomes apparent that the programme is not as reliable, the Contractor shall revise and re-submit the programme for approval by the Engineer.
- C. If it is evident that the rate of progress is insufficient to ensure timely completion as per the contractual milestones and time periods, the Contractor shall revise their programme demonstrating the intended plan to recover including a list of associated mitigating measures.
- D. If the Contractor requests an extension of time to the dates specified in the Contract, justification shall be provided as the Engineer deems necessary.
- E. The supporting information used for justification shall include a cause-and-effect type programme using a recognised delay analysis method (e.g. Time Impact Analysis) so the impact of the delay to the activities in question can be demonstrated.

1.5.7 RISK ANALYSIS

- A. The Contractor shall carry out a Risk Analysis for the Time of Completion, considering at least the following aspects:
 - a. Identification of the risks.
 - b. Quantitative and qualitative evaluation of the risks.

- c. Contingency plan in case delay in the programme occurs.
- d. Evaluation of the residual risks.

1.5.8 BIM, GIS AND AIM METHODOLOGY

- A. The BIM (Building Information Management), GIS (Geographic Information System) and AIM (Asset Information Management) methodology is an integral part of the Construction works. For data (reports, documents, schedules, spreadsheets, etc.), models (BIM, 3D, 4D, 5D, 6D) and drawings management platform the General Contractor shall use Employer's/RBR established CDE (Common Data Environment).
- B. The General Contractor must set up and maintain IT (hardware and software) infrastructure for the to carry out the required tasks. The General Contractor is directly responsible for following and implementing all of the requirements towards BIM, GIS and AIM according to the specified LoG and LoI levels in DG BIM and "RBDG-MAN-040- Digital information requirements for construction and handover stages" documents.

1.6 PROGRESS REPORTS

- A. Progress Reports shall be drafted and submitted as stated in sub-clause 4.20 [Progress Reports] of CC, unless otherwise stated in the Contract and in these Technical Specifications. Progress Reports shall also be aligned with the relevant requirements stated in the RBR document "RBDG-MAN-040- Digital information requirements for construction and handover stages".
- B. Monthly Progress Reports, in the format(s) agreed with the Engineer, shall be prepared by the Contractor and submitted to the Engineer.
- C. The first report shall cover the period up to the end of the first month following the Commencement Date. Reports shall be submitted monthly thereafter, each within 7 days after the last day of the month to which it relates, unless otherwise agreed with the Engineer.
- D. Reporting shall continue until the Date of Completion of the Works.
- E. Unless agreed otherwise with the Engineer, each progress report shall include as a minimum but not limited to:
 - a. the details described in sub-clause 6.10 [Records of Contractor's Personnel and Equipment] of the CC;
 - b. charts, diagrams and detailed descriptions of progress, including each stage of Contractor's Documents, procurement, manufacture, delivery to Site, construction, erection and testing;
 - c. BIM models with as-built data, laser scanning/photogrammetry data according to "RBDG-MAN-040- Digital information requirements for construction and handover stages", photographs and/or video recordings showing the status of manufacture and of progress on and off the Site;
 - d. for the manufacture of each main item of Materials, the name of the manufacturer, manufacture location, percentage progress, and the actual or expected dates of:
 - i. commencement of manufacture,
 - ii. Contractor's inspections,
 - iii. tests,
 - iv. shipment and arrival at the Site;
 - e. Risk assessment.
 - f. copies of quality management documents, inspection reports, test results, and compliance verification documentation (including certificates of Materials);
 - g. a list of Variations, and any Notices given (by either Party) under sub-clause 20.2.1 [Notice of Claim] of the CC;
 - h. health and safety statistics, including details of any hazardous incidents and activities relating to environmental aspects and public relations; and
 - i. comparisons of actual and planned progress, with details of any events or circumstances which may adversely affect the completion of the Works in accordance with the Programme and the Time for Completion, and the measures being (or to be) adopted to overcome delays.

- F. Nothing stated in any Progress Report shall constitute a Notice (as per sub-clause 1.3 [Notices and Other Communications] of the CC).

1.6.1 AS-BUILT DOCUMENTS

- A. The Contractor shall prepare, keep up to date and deliver to the Engineer a complete set of as-built information of the execution of the Works. As-built information shall also be aligned with the relevant requirements stated in the document RBR "RBDG-MAN-040- Digital information requirements for construction and handover stages" and Local Legislation and Regulation for as built documents.
- B. In addition, the Contractor shall supply to the Engineer as-built drawings and BIM models of the Works, showing all Works as executed, and submit them to the Engineer for review. As-built drawings and BIM models shall show the exact as-built locations, size and details of the Works.
- C. The BIM models must contain detailed as-built data according to the specified LoG (and Lol levels in RBR "RBDG-MAN-040- Digital information requirements for construction and handover stages". As-built BIM models shall be created and/or updated by developing PIM models from the Technical Design accompanied with laser scanning/photogrammetry data according to RBDG-MAN-40.
- D. These records and as-built and BIM models, drawings shall be kept on the Site and shall be used exclusively for the purposes of this sub-clause. The record drawings shall show all significant features of the new works so as to form a complete pictorial record of the finished Works. The drawings shall show details of all utilities affected by the Works.
- E. The Contractor shall prepare all record drawings to provide accurate and complete record drawings acceptable to the Engineer. During the work, the Engineer shall have the right to call for record drawings at any time so that he may check them for accuracy and completeness. The Contractor shall provide a minimum of two prints of each record drawing for this purpose. The Contractor shall finish the record drawings as specified within five days of the date of the request to submit in writing by the Engineer.
- F. Drawings shall be dated and signed by the Contractor's representative and, if approved, by the Engineer.
- G. Contractor shall include and the Operational chainage into final as-built drawings and as-built BIM models, if detailed information about Operational chainage from Employer is provided not later than 6 (six) months before final submittal of as-built drawings and as-built BIM models. In this case the final as-built drawings and as-built BIM models shall contain as the Design chainage. as the Operational chainage within.

1.6.2 FINAL SUBMITTAL

- A. In addition to any record drawings required by the Engineer during the course of work, as it is described in the section above, the Contractor shall supply to the Engineer, as-built drawings as follows:
 - a. Local legal acts,
 - b. BIM models according to the document "RBDG-MAN-040- Digital information requirements for construction and handover stages".
- B. Prior to the issue of any Performance Certificate or the commencement of the Test on Completion, the Contractor shall supply the Engineer with as-built records and drawings plus the data in digital format on hard drives or equivalent. The Works shall not be considered to be completed for the purposes of taking-over until the Engineer has received these documents and data.

1.7 QUALITY REQUIREMENTS

1.7.1 GENERAL

- A. The Contractor shall draft a QM system as stated in sub-section 1.5.1 "CONTRACTOR'S QUALITY MANAGEMENT SYSTEM". This sub-section includes requirements for Quality Assurance and Quality Control (QA/QC) management. Testing and inspecting are required to verify compliance with Conditions of the Contract and these Technical Specifications
- B. Mandatory but not exhaustive list of requirements related to QA&QC are listed in "RBCN-RBR-SPC-R-00002 - Construction requirements related to QC&QA" document, which shall be taken into account preparing the Plans for Inspection and Test and QA/QC.

- C. The Contractor shall establish and maintain a QA/QC Plan, with project quality requirements extending to all Subcontractors and suppliers, to ensure that compliance with the Contract is satisfied.
- D. Compliance with the QA/QC requirements shall not relieve the Contractor of any of his duties, obligations or responsibilities under the Contract.
- E. The Contractor shall institute a QA/QC system to demonstrate compliance with the requirements of the Contract. The Engineer shall be entitled to audit any aspect of the QA/QC system.
- F. "Quality Assurance system" implies activities, actions, and procedures performed before and during execution of the Works to comply with the Contract and provide assurance against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- G. "Quality Control system" implies tests, inspections, procedures, and related actions during and after execution of the Works to evaluate, that actual products are incorporated into the Works and completed construction comply with requirements.
- H. QA/QC Plan shall comply with ISO 9001, or equivalent to ISO 9001 (verified by a certified third party).

1.7.2 QUALITY CONTROL PLAN

- I. Quality Control Plan shall cover following items as a minimum:
 - a. Sampling and testing procedures, including:
 - i. Testing locations;
 - ii. Sampling procedure and applicable standards;
 - iii. Test methodology and standards;
 - iv. Testing frequency;
 - v. Information about data to be collected;
 - vi. Methods and criteria for acceptance;
 - b. Organization chart identifying all relevant personnel and key tasks; in particular who is responsible for quality overall and for individual elements such as testing.
 - c. Procedures for reviewing samples, certificates, etc.
 - d. Continuous visual observations and inspections.
 - e. Document control procedures.
 - f. Procedures for recording non-conformance and what corrective actions are to be undertaken.
 - g. Submittal procedure.
- J. The Contractor shall maintain testing and inspection reports including log of approved and rejected results.
- K. For every detected non-conformance, following information shall be registered and stored:
 - a. Description.
 - b. Action taken to identify the cause(s) of non-conformance.
 - c. Description of corrective actions to prevent recurrence.
 - d. Corrective actions taken to bring non-conforming work into compliance with requirements.
- L. All works shall be checked, tested and monitored as appropriate with records being fully documented and maintained throughout the construction period and after completion of works, if required. This documentation shall be submitted to the Employer after completion of works or upon request.

1.7.3 SAMPLING AND TESTING

A. Testing is divided into three categories, as per table below.

Table 1. Testing categories with responsibilities

Testing category	Responsibility
Verification testing	Contractor
Internal control testing	Contractor
Acceptance testing	Employer

- B. Sampling and testing shall be done in accordance with applicable standard and methodologies.
- C. Equipment and personnel for sampling shall be provided by the Contractor, if requested by Engineer. Sampling shall be done by the Contractor if requested by Engineer.
- D. The Contractor shall inform Engineer at least 24h prior to sampling.
- E. Sample shall be divided into three separate samples – samples A, B and C. Sampling and reduction shall be done in accordance with EN 932-1, EN 932-2, EN 13286-1 or EN 13450. Sample size depends on the testing scope and shall be sufficient for intended testing. Sample A shall be handed over to the Contractor. Sample B and C shall be handed over to the Engineer and shall be tested if needed.
- F. Testing shall be done in laboratories accredited in accordance with EN ISO/IEC 17025. For acceptance testing all tests to be done in the laboratory shall also be accredited.
- G. A daily record of samples and materials taken shall be maintained. Records shall provide information about the nature and source of the materials and shall identify the location, means of selection and sampling. Where appropriate, a copy of daily records shall be provided for retention.
- H. Test reports shall be submitted to the Engineer prior to proceeding with the works.

1.7.4 VERIFICATION TESTING

- A. Verification test shall be done by the Contractor to demonstrate that the materials are suitable for intended use (i.e. meeting the requirements stated in the Technical Design). These tests shall be done, and results submitted to Engineer for approval prior to works, including Declaration of Conformity and/or Declaration of Performance together with Factory Production Control (FPC) certificates. Works are not allowed to be performed without approval from by Engineer/Employer.
- B. The Contractor shall provide sample of each material with required quantity (determined by the Engineer) if requested by the Engineer.
- C. All costs associated with verification testing shall be included in the unit price of the work item and shall not be paid separately.

1.7.5 INTERNAL CONTROL TESTING

- A. Internal control tests shall be carried out by the Contractor to ensure that the materials and works meet the predetermined requirements.
- B. The Contractor shall carry out internal control tests with described frequency. All sampling and testing shall be done in accordance with applicable standards and methodologies.
- C. All internal control testing results shall be provided to the Engineer if requested.
- D. All internal control testing results shall be part of the handover documentation.
- E. All costs associated with internal control testing shall be included in the unit price of the work item and shall not be paid separately.

1.7.6 ACCEPTANCE TESTING

- A. Acceptance testing shall be carried out by the Engineer/Employer to determine if the materials and work meet the prescribed requirements and properties.

- B. This testing shall be usually carried out randomly but can be also done in specific cases and locations (e.g. visually defective areas, etc.).
- C. Contractor shall provide sampling together with necessary equipment and labour for sampling. Testing carried out by Engineer/Employer shall be paid by the Employer unless stated otherwise in the contract.

1.7.7 DELIVERY TICKET

- A. For each lot of material delivered to site shall come with a delivery ticket. Delivery ticket shall provide overview about following information as minimum:
 - a. Ticket serial number;
 - b. Source of the material (producer, quarry, etc.);
 - c. Destination (site);
 - d. Material type, designation;
 - e. Quantity;
 - f. Reference to Declaration of Performance or Declaration of Conformity with reference to applicable product specification;
 - g. Date of dispatch.
- B. Delivery Ticket shall ensure that each batch can be linked with the producer.
- C. Delivery Tickets shall be submitted and checked by Engineer.

1.7.8 QUALITY ASSURANCE PLAN

1.7.8.1 IDENTIFICATION AND INSPECTION STATUS

- A. The Contractor shall maintain a system for identifying the progressive inspection status of materials, components, sub-assemblies and assemblies as to their acceptance, rejection, or non-inspection.
- B. The system shall provide for ensuring that required inspections and tests are performed and that the status of items with regard to inspections and test performance is known throughout manufacturing, installation, and testing.
- C. Nonconforming items shall be identified by physical segregation and status indicators such as tags, serialization, markings, stamps, and inspection records.
- D. The identification system shall ensure that only items that have passed the required inspection and tests are used or installed.

1.7.8.2 CORRECTIVE ACTION

- A. The Contractor shall establish, maintain, and document procedures to ensure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, and defects in material and equipment, shall be promptly identified and corrected.
- B. In the case of conditions adverse to quality, the measure shall ensure that the cause of the condition is determined, and corrective action is immediately taken to preclude repetition of such conditions.
- A. Corrective action and related information shall be documented and made available to the Employer upon request.
- B. Corrective action shall extend to the performance of all Subcontractors.

1.7.8.3 FACTORY TEST

- A. All materials and/or equipment provided under this Contract shall be factory tested in accordance with the requirements of the Contract. Test schedules shall be so arranged as to permit monitoring by the Engineer.

- B. The Contractor shall ensure proper handling, storing, preserving, packaging, packing, marking, and shipping to protect the quality of products as required by the contract.

1.7.9 TESTING BY THE CONTRACTOR

- A. The Contractor shall carry out the testing of materials and Works during the execution of the Works, in accordance with sub-clause 7.4 [Testing by the Contractor] of the CC. Testing shall be performed in the manner specified in the Contract and Quality Control Plan, in accordance with applicable standards and recognised good practice.
- B. The Contractor shall give a Notice to the Engineer, stating the time and place for the specified testing of any Materials and other parts of the Works. This Notice shall be given in reasonable time agreed with the Engineer, having regard to the location of the testing, for the Engineer to attend. The Engineer has authority to propose new time for testing which shall be followed by the Contractor.
- C. All samples and records shall be preserved as long as the Engineer may direct. All samples shall be properly labelled.
- D. The Contractor shall perform tests on materials as specified in the Contract and in the Technical Specifications and shall promptly supply the Engineer with two copies reports of every test, in the form agreed with the Engineer and/or Employer.
- E. No payment shall be made for any item of the Contract unless testing proves the Work is acceptable and the element can be used.
- F. Sub-clause 7.5 [Defects and Rejection] of the CC shall apply if any Materials and other parts of the Works fails to pass a specified test, unless otherwise stated in the Technical Specification.
- G. The Contractor shall carry out the Test on Completion in accordance with the sub-clause 9 [Test on Completion] of the CC, unless otherwise stated in the Contract and in these Technical Specifications.

1.7.10 TESTING BY THE ENGINEER/EMPLOYER

- A. During the construction process, the Engineer or Employer has full authority to conduct random or targeted¹ sampling and testing to assess the properties of the materials and Works.
- B. If requested by the Engineer or Employer, the Contractor shall provide necessary equipment and personnel for sampling and the sample(s) shall be handed over to the Engineer or Employer.

1.7.11 CONTRACTOR'S QUALITY-CONTROL (QC) PLAN

1.7.11.1 GENERAL

- A. The Contractor shall submit a Quality Control Plan, identifying the Contractor's personnel, execution procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities.
- B. The QC Plan shall be coordinated with the Contractor's construction schedule.

1.7.11.2 SUBMITTAL PROCEDURE

- A. The Contractor shall describe procedures for ensuring compliance with requirements through review and management of submittal process. The Contractor shall indicate qualifications of personnel responsible for submittal review.

¹ Targeted sampling and testing – QC procedure where sampling and testing are aimed at specific location, area, stockpile, etc. This is usually done in cases where the material, product, etc. has variable organoleptic properties (e.g. appearance).

1.7.11.3 TESTING AND INSPECTION

- A. In Quality-Control Plan, the Contractor shall include a schedule of Works requiring testing or inspection, including the following:
 - a. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections;
 - b. Employer-performed tests and inspections indicated in the Contract Documents.

1.7.11.4 CONTINUOUS INSPECTION OF WORKMANSHIP

- A. The Contractor shall describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mock-ups.

1.7.11.5 MONITORING AND DOCUMENTATION

- A. The Contractor shall maintain testing and inspection reports including log of approved and rejected results.
- B. The Contractor shall include work Engineer has indicated as non-conforming or defective.
- C. The Contractor shall indicate corrective actions taken to bring nonconforming work into compliance with requirements.
- D. The Contractor shall comply with requirements of AHJ.
- E. The Contractor shall ensure monitoring of the required environmental aspects as stated in Section 07 ENVIRONMENT in these Technical Specifications.

1.7.12 CONTRACTOR'S QUALITY-ASSURANCE (QA) PLAN

1.7.12.1 IDENTIFICATION AND INSPECTION STATUS

- A. The Contractor shall maintain a system for identifying the progressive inspection status of materials, components, sub-assemblies and assemblies as to their acceptance, rejection, or non-inspection.
- B. The system shall provide for ensuring that required inspections and tests are performed and that the status of items regarding inspections and test performance is known throughout manufacturing, installation, and testing.
- C. Nonconforming items shall be identified by physical segregation and status indicators such as tags, serialization, markings, stamps, and inspection records.
- D. The identification system shall ensure that only items that have passed the required inspection and tests are used or installed.

1.7.12.2 CORRECTIVE ACTION

- A. The Contractor shall establish, maintain, and document procedures to ensure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, and defects in material and equipment shall be promptly identified and corrected.
- B. In the case of conditions adverse to quality, the measure shall ensure that the cause of the condition is determined, and corrective action is immediately taken to preclude repetition of such conditions.
- C. Corrective action and related information shall be documented and made available to the Employer upon request.
- D. Corrective action shall extend to the performance of all Subcontractors.

1.7.12.3 EVIDENCE OF COMPLIANCE

- A. The Contractor shall give evidence of compliance subject to the provisions of sub-clause 4.9 [Quality Management and Compliance Verification System] of the CC and sub-section 1.5.1 “Contractor’s Quality Management system” in this Technical Specification.
- B. The Contractor shall establish and maintain objective, verifiable evidence of compliance with all requirements of the Contract.
 - a. The Contractor may use certificates of compliance from its Subcontractor for certain materials and products in lieu of the specified sampling and testing procedures as approved by the Employer. The Contractor shall submit the certificates required for demonstrating proof of compliance of materials delivered to the work. The submission shall clearly identify the lot certified through the relevant certificate. An authorized representative of the producer and/or manufacturer shall sign the certificates, stating that the material complies in all respect with contract requirements.
 - b. The certificate of compliance shall be accompanied with a certified copy of test results or state that such test results are on file with the producer or manufacturer and will be furnished to the Employer on request. On the certificate, the Contractor shall give the information specified for samples, the name and address of the organization performing the tests, the date of the tests, and the quantity of materials shipped.

1.7.12.4 NON-CONFORMING MATERIALS

- A. The Contractor shall establish and maintain documented procedure (system) for controlling nonconforming material, including procedures for its identification, segregation and disposition. In case a non-conforming materials or products have been identified, investigations shall be initiated by the Contractor to determine the reasons for non-conformity and effective corrective action plan shall be implemented to prevent recurrence in accordance with procedures outlined in the Quality Plan. For every nonconforming incident, cause and mitigation measure shall be recorded. The Engineer shall be informed of every non-conformance, including cause and mitigation measures. Dispositions for the use or repair of nonconforming material shall require the Engineer’s approval. All nonconforming material shall be positively identified to prevent unauthorized use, shipment or intermingling with conforming material. Holding areas and procedures mutually agreeable to the Contractor and the Engineer shall be established by the Contractor.

1.7.13 INFORMATIONAL SUBMITTALS

- A. The Contractor shall submit the accreditation as per EN ISO/IEC 17025 of the Contractor’s laboratory. The Contractor shall submit to the Engineer Qualification Data for Contractor’s quality-control personnel.
- B. The Contractor shall submit Testing Agency Qualifications to the Engineer, to demonstrate their capabilities and experience. Proof of qualifications shall be included in the form of a recent report on the inspection of the testing agency by a National Accreditation Authority
- C. The Contractor shall submit schedules of tests and inspections as required, prepared in tabular form and including the following:
 - a. Specification: Section number and title;
 - b. Entity responsible for performing tests and inspections;
 - c. Description of test and inspection;
 - d. Identification of applicable standards;
 - e. Identification of test and inspection methods;
 - f. Number of tests and inspections required;
 - g. Time schedule or time span for tests and inspections;
 - h. Requirements for obtaining samples;
 - i. Unique characteristics of each quality-control service.

1.7.14 REPORTS AND DOCUMENTS

1.7.14.1 TESTING AND INSPECTION REPORTS

- A. The Contractor shall apply to all test the conditions of sub-clause 7.4 [Testing by the Contractor] of the CC and sub-section 1.4.8.3 in these Technical Specifications.
- B. The Contractor shall prepare and submit certified written reports, including the following:
 - a. Date of issue;
 - b. Name, address, and telephone number of testing agency;
 - c. Dates and locations of samples and tests or inspections;
 - d. Names of individuals making tests and inspections;
 - e. Description of the Work and test and inspection method;
 - f. Identification of product and Specification Section;
 - g. Complete test or inspection data;
 - h. Test and inspection results and an interpretation of test results;
 - i. Record of temperature and weather conditions at time of sample taking and testing and inspecting;
 - j. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements;
 - k. Name and signature of laboratory inspector;
 - l. Recommendations on retesting and re-inspecting.

1.7.14.2 MANUFACTURER'S TECHNICAL REPRESENTATIVE'S FIELD REPORTS

- A. The Contractor shall prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
 - a. Name, address, and telephone number of technical representative making the report;
 - b. Statement on condition of substrates and their acceptability for installation of product;
 - c. Statement that products at Project site comply with requirements;
 - d. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken;
 - e. Results of operational and other tests and a statement of whether observed performance complies with requirements;
 - f. Statement whether conditions, products, and installation will affect warranty;
 - g. Other required items indicated in individual Specification Sections.

1.7.14.3 FACTORY-AUTHORIZED SERVICE REPRESENTATIVE'S REPORTS

- A. Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
 - a. Name, address, and telephone number of factory-authorized service representative making report;
 - b. Statement that equipment complies with requirements;
 - c. Results of operational and other tests and a statement of whether observed performance complies with requirements;
 - d. Statement whether conditions, products, and installation will affect warranty;
 - e. Other required items indicated in individual Specification Sections.

1.7.15 PERMITS, LICENSES, AND CERTIFICATES

- A. For Employer's records, the Contractor shall submit copies of permits, licenses, certifications, declarations, inspection reports, releases, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Works.

1.7.16 APPROVAL OF SOURCES AND MATERIALS

- A. The Contractor shall select the sources of Materials and submit applicable declaration(s)² and Contractor's testing results with applicable results for approval prior to use in the works. The test results shall not be older than 6 months. The Contractor shall not use Materials from sources which are not approved by the Engineer. Materials which are not approved shall be removed immediately at Contractor's expenses.
- B. Approval of a source does not mean that any material of this source is approved. The Contractor has to ascertain, by continuous Quality Control measurements, that only material which complies with the requirements specified in the various clauses of these specifications will be used for the works.

1.8 MATERIALS

1.8.1 SAMPLES

- A. The Contractor shall provide the samples as set out in sub-clause 7.2 [Samples] of CC and complying with the Contractor's QM system. Sampling shall be done in accordance with applicable standard. If requested by the Engineer or Employer, the sampling shall be done by the Contractor by valid means (equipment, trained personnel, etc.).

1.8.2 INSPECTION

- A. Refer to sub-clause 7.3 [Inspection] of CC.

1.8.3 TESTING

- A. Refer to sub-clause 7.4 [Testing by the Contractor] of CC.

1.8.4 REJECTION

- A. Refer to sub-clause 7.5 [Defects and Rejection] of CC.

1.8.5 TESTS ON COMPLETION

- A. Refer to sub-clause 9 [Tests of Completion] of CC.

1.9 DEFECTS NOTIFICATION PERIOD (DNP)

- A. Refer to sub-clause 11 [Defects after Taking Over] of CC.

1.10 WARRANTY PERIOD

1.10.1 DESCRIPTION OF WORKS

- A. The warranty period for the Works shall be defined in Contract Conditions; if not defined in Contract, Local Legislation and Regulations shall be followed.
- B. The warranty period starts from the day when the commencement of finished construction is signed by respective state Authorities unless stated otherwise in the contract.

² Declarations – If the construction product is within the scope of harmonized product specification, then Declaration of Performance (DoP) shall be submitted. In case the product is covered by non-harmonized product specification, Declaration of Conformity (DoC) shall be submitted. Interoperability constituents must be covered by EC declarations of conformity or suitability for use.

- C. If the Employer issues a notice of the discovered defect during the warranty period, Contractor is obliged to correct the defect mentioned in the notice with its own expenses. The maintenance works shall be completed in the time specified in the Employer's notice.
- D. If the Employer notifies the Contractor of the discovered defect just before the end of the warranty period, the Parties shall agree that the warranty period is extended until the defects are eliminated.
- E. If the Contractor has not eliminated the defect within the term specified in the Employer's notice, the Employer will ensure the elimination of the defect, but the Contractor shall be obliged to cover the costs of elimination of the defect in double amount.

1.10.1.1 REQUIREMENTS FOR MATERIALS

- A. The requirements for materials to be used for warranty period maintenance works shall be in accordance with requirements stated in the Maintenance manual.
- B. The materials shall be supplied only with the manufacturer's certificate stipulating a compulsory production standard, product use, quality of materials and components certificates.

1.10.1.2 REQUIREMENTS FOR PERFORMING WORKS

- A. The requirements for performing the warranty period maintenance works shall follow Technical Design or requirements of Maintenance manual.

1.10.1.3 REQUIREMENTS FOR COMPLETED WORKS

- A. The requirements for completed the warranty period maintenance works shall follow Detailed Technical design or requirements of Maintenance manual.

1.10.1.4 MEASUREMENTS AND QUALITY ASSESSMENT

- A. The measurements and quality assessment of performed warranty period maintenance works should follow Technical Design or requirements of Maintenance manual.
- B. The commissioning of performed warranty period maintenance related to the elimination of defects described in the notice shall take place in the presence of the representatives from the Employer and Contractor.

2. SECTION 02.- EARTHWORKS

2.1 SCOPE OF WORKS

- A. The technical specifications related to earthworks are covered under this section, which includes the requirements for the following:
- a. Archaeological supervision;
 - b. Unexploded ordnance (UXO) unexploded bombs (UXBs), or explosive remnants of war (ERW) hazard assessment and mitigation.
 - c. Demolition.
 - d. Site clearing.
 - e. Topsoil stripping.
 - f. Earthworks:
 - i. Track bed layers (frost protection, prepared subgrade, sub-ballast layers), except ballast layer, which is in the scope of Section 03 – Railway superstructure;
 - ii. General filling, railway embankment;
 - iii. Filter/graded filling;
 - iv. backfilling at special locations;
 - v. Excavations.
 - g. Temporary support measures.
 - h. Slope protection.
 - i. Soil treatments.
 - j. Geosynthetics/geotextiles/geogrids
 - k. Technical blocks.
 - l. Dewatering systems.
 - m. Geotechnical instrumentation and monitoring.
 - n. Precast driven piles for soil reinforcement (Peat treatment).
 - o. Quality Assurance and Quality Control (QA/QC).
- B. The Contractor shall prepare Method Statements for works under this section and submit them for Engineer's approval. Each Method of Statement shall be adapted to each type of work and shall define the proposed procedures, materials and workmanship ensuring compliance with conditions of Contract, Technical Design and Technical Specification. Minimum content shall be as follows:
- a. Description of Works; site planning.
 - b. Site Survey.
 - c. Resources (equipment, work force, etc.).
 - d. Materials, if apply.
 - e. Methodology (e.g. method and sequence of excavations, method of temporary supports, means for keeping excavations free of water, disposal of surplus material, method of spreading and compacting fill and testing procedure, etc.).
 - f. Quality Assurance and Quality Control (QA/QC) Plan.
 - g. Permit Requirements.
 - h. Drawings and Survey Data.
 - i. Health and Safety requirements.
 - j. Supervision and Monitoring.
 - k. Environment and Quality requirements.

- I. Risk Assessment.
- C. This section provides a needed but non-exhaustive list of labour, temporary works, drainage measures, materials, equipment, transport, testing and services necessary to furnish, deliver and install all work of this section as shown on the drawings and BIM models, as specified herein and/or as required by job conditions.
- D. Works shall comply with the construction Environmental Management Plan (EMP).

2.2 GENERAL

- A. Earthworks shall be executed in accordance with the Technical Design, Technical Specifications and the Contract.
- B. Rail Baltica railway earthworks have a Design Working Life (DWL) of 100 years which shall be considered by the Contractors when choosing construction materials, equipment, soil improvement methods, technology, etc.
- C. The Contractor shall follow relevant Local Construction Regulations, including environmental regulations (noise, dust, contamination, water course protection, vibrations, etc.)
- D. The BIM models shall contain detailed as-built data according to the specified LoG and Lol levels in DG BIM EIR (but not limited) and "RBDG-MAN-040- Digital information requirements for construction and handover stages" document requirements. As-built BIM models shall be created by the Contractor and/or updated by developing PIM (Project Information Model) models from the Technical Design accompanied with laser scanning/photogrammetry data according to RBGL-VDC-INS-R-00001.

2.3 TERMS AND DEFINITIONS

- A. The following definitions of earthworks shall apply to this Technical Specification:
 - a. **"Topsoil"** means the top layer of soil that can support vegetation, as per BS 3882 – Specification for topsoil.
 - b. **"Cuttings"** refers to both the earthwork structure itself (i.e. railway line beneath the natural ground level) and the material excavated. The earthwork structure is considered to be a cutting when the Point P (Zp) is below ground level.
 - c. **"Embankments"** refer to earthworks raised above the natural ground level. Different terms related to the embankment height (height is measured between the top of the sub-ballast layer and ground level) are as follows:
 - i. low rise embankment, for which the height is:
 - <1.5m, measured between the Point P (Zp) and the ground level;
 - <1.2m, measured between the top edge of the sub-ballast layer and the ground level.
 - ii. level cuttings for which the height is measured between track bed thickness and ground level.
 - iii. high embankments for which the height is 12m at the lowest point.
 - iv. medium height embankments include all other embankment heights.
 - d. **"Methodically compacted embankments"** means those embankments designed to support the railway tracks or roadway. These include the embankment and the upper part.
 - e. **"Technical blocks"** refers to those embankments in the transition area adjacent to structures (e.g. bridges, hydraulic structures, etc.).
 - f. All other embankments are classed as **"ordinary"** (e.g. berms, depots).
 - g. **"Reinforced embankment"** means embankment earthworks made up of a solid embankment block, stabilised by means of reinforcement (e.g. inclusions, aggregate columns, bracings, coverings, facings, etc.).
 - h. **"Supporting soil"** means the ground on which earthwork rests. A distinction is made between stable and unstable supporting soil (e.g. compressible, collapsible, liquefying, disturbed, expansive, etc.).
 - i. **"Drainage layer"** means a layer made up with a material that ensure the drainage through it.
 - j. **"Filter layer"** means a layer made up with a material that ensure the drainage through it and provide filtering function.
 - k. **"Point P (Zp)"** corresponds to the top of the sub-ballast layer at the centreline.

- l. **"Slope"**: xH/yV: x for Horizontal and y for Vertical
- m. **"Formation level"** means the level (surface) on which the track bed layers are laid.
- n. **"Surplus materials"** means those materials suitable for use but their volume is in excess.
- o. **"Imported Material/imported soil"** means material from sources outside the Site.
- p. **"Suitable material"** means that material acceptable to be used in a specific work and capable of being compacted in accordance with the requirements of this Specification.
- q. **"Unsuitable material"** means other than suitable material.

2.4 ARCHAEOLOGICAL SUPERVISION

2.4.1 SCOPE OF WORKS

- A. The works include archaeological research and supervision of the relocation of the cultural heritage according to the instructions of the AHJ and relevant Local Regulations governing this issue.

2.4.2 WORK EXECUTION

- A. The Contractor is responsible for meeting the relevant requirements.
- B. The Contractor is responsible for getting any permits on time from the AHJ.
- C. All necessary information for the Works shall be taken by the Contractor from the AHJ to ensure the Works are performed in a manner that shall not cause a hazard to labour and third parties.
- D. Archaeological supervision and relocation work of objects of cultural heritage shall be in conformity with Engineer's instructions and order of relevant AHJ.
- E. The Contractor shall get the approval of the Engineer and from the AHJ prior of the commencement of the Works.

2.4.3 MEASUREMENT AND PAYMENT - ARCHAEOLOGICAL SUPERVISION

- A. The following units of measurement are defined:

Table 2. Units of measurement - Archaeological supervision

Uniclass code	Type number	Work item	Unit	Work item includes
Co_32_20_22	000101	ARCHAEOLOGICAL SUPERVISION	ha	Archaeological supervision consists of archaeological research and supervision of the relocation of the cultural heritage according to the Technical Specifications; includes all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permits, etc.) and transportation (incl. fuel, insurance, etc.).

2.5 UXO, UXBS, AND ERW HAZARD ASSESSMENT AND MITIGATION

2.5.1 SCOPE OF WORKS.

- A. The Works include a research of Unexploded Ordnance (UXO), Unexploded Bombs (UXBS) and Explosive Remnants of War (ERW) for the Site and draft the representative risk assessment and mitigation measures about those hazards.
- B. Any ground investigations are considered to be included in the Works.

2.5.2 WORK EXECUTION.

- A. Works shall be performed according to Local Regulations. The Contractor shall be responsible for meeting the relevant requirements.
- B. Contractor must assess and identify high risk specific areas and shall decide the areas to be investigated according to its experience and agreed with the Engineer before the commencement of the works.

- C. All necessary information for the Works shall be taken by the Contractor from the AHJ to ensure the Works are performed in a manner that shall not cause a hazard to labour and third parties.
- D. Detection Methods shall be proposed to the Engineer for approval prior to the commencement of the Works. Risk management recommendations shall be addressed and considered during the Works.
- E. Detection Methods, in any case, shall filter and eliminate any erroneous point measurement values generated by the existence of anthropogenic elements.
- F. The Contractor shall give notice to the Engineer about the work programme and results before the commencement of any ground investigation.
- G. Any measure to be adopted to eliminate these hazards is to be in accordance with Local Regulations and relevant AHJ.
- H. The Contractor shall be responsible for getting any permits on time from the AHJ.

2.5.3 RISK MITIGATION MEASURES

- A. In case of appearance of suspicious object/smell the work will be stopped immediately and personnel will leave the site. Afterwards the local emergency service (phone number 112) will be informed and personnel will follow their instructions.

2.5.4 MEASUREMENT AND PAYMENT - UXO, UXBS, AND ERW HAZARD ASSESSMENT AND MITIGATION

- A. The following units of measurement are defined:

Table 3. Units of measurement - UXO, UXBS and ERW hazard assessment and mitigation

Uniclass code	Type number	Work item	Unit	Work item includes
PM_30_40_92	000101	UXO, UXBS AND ERW HAZARD ASSESSMENT AND MITIGATION	ha	UXO, UXBS and ERW hazard assessment and mitigation include a research of Unexploded Ordnance (UXO), Unexploded Bombs (UXBS) and Explosive Remnants of War (ERW) for the Site and draft the representative risk assessment and mitigation measures about those hazards. Any ground investigations are considered to be included in the works, including all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permits, etc.) and transportation (incl. fuel, insurance, etc.).

2.6 DEMOLITION

2.6.1 SCOPE OF WORKS

- A. This section includes demolition works as specified hereinafter, and as shown in Drawings.
 - a. Demolition of existing building or structure, of any material.
- B. This section provides a needed but non-exhaustive list of labour, materials, equipment and services necessary to prepare, furnish, deliver and install all Works of this section as shown on the drawing, as specified herein and/or as required by job conditions.

2.6.2 GENERAL

- A. Before commencing of the Works, the Contractor shall obtain the necessary approval from AHJ.
- B. No demolition of any existing building or structure shall be carried out until it has been approved by the Engineer in writing.
- C. The Contractor shall take all necessary steps during demolition to protect adjoining properties, fences, roadways, footpaths, etc. and shall be responsible for making good any damage, or the replacement by an acceptable equivalent should the material be no longer obtainable in the market.

- D. Demolition shall be carried out in such a manner as to cause as little inconvenience as possible to adjoining properties occupier and general public and to safeguard public safety at all time. The Contractor shall be held responsible for any claims arising there from.
- E. The Contractor shall take all necessary precautions during demolition and site clearance not to disturb existing electricity supply cables, drains, gas pipes, water supply pipes, ducts, telephone cables, radio and television relay lines, hydraulic pressure mains and other service pipes and fittings across the site. Where necessary, the above service lines and fittings shall be supported and protected.

2.6.3 *NORMATIVE REFERENCES*

- A. BS 6187:2011 - Code of practice for full and partial demolition.
- B. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

2.6.4 *EXECUTION OF WORKS*

- A. Demolition Works shall comply with procedures and requirements in BS 6187, and shall be in accordance with current Local Regulations.
- B. The Contractor shall submit the Demolition Method Statement to the Engineer for acceptance prior to the commencement of the works.
- C. The Contractor shall provide, maintain and dismantle all support to safety protect any properties adjoining the element to be demolished. Should any subsidence or any damage result from the inadequacy or inefficiency of the provided support, the damage shall be made good by the Contractor at his own expense.

2.6.5 *DISPOSAL OF MATERIAL*

- A. The Contractor shall comply with all Local Regulations governing the disposal of debris and any other material waste.
- B. If not indicated by the Employer, all unsuitable and surplus material from demolition works carried out in accordance with these Specifications shall become the property of the Contractor and shall be removed from site and disposed of in an appropriate manner by the Contractor.

2.6.6 *HAZARDOUS MATERIALS*

- A. The treatment of hazardous materials encountered shall comply with any specific requirements stated in contract as well as relevant legislation and any other health and safety measures and shall be subjected to the Engineer's approval and the permission of AHJ.

2.6.7 *MEASUREMENT AND PAYMENT - DEMOLITION*

- A. Demolition of structures shall be measured as the volume of precast or cast in-situ concrete or other material required to be removed.
- B. The demolition of pavements, footways and traffic islands shall be measured as the area of material required to be removed.
- C. The items for demolition of buildings and structures shall include for:
 - a. Demolition study, if necessary.
 - b. total or partial demolition of buildings, structures, pavements, footways, traffic islands; breaking up and removal;
 - c. cutting and trimming;
 - d. cutting through reinforcement, removal, disposal, protecting cut ends with treatment, de-bonding existing reinforcement;
 - e. excavation of acceptable and unacceptable material;
 - f. excavation in hard material;

- g. transport and handling;
 - h. working between and behind reinforcement and other obstructions;
 - i. measures in respect of specialist demolition techniques;
 - j. protection of unaffected parts of the structure;
 - k. disposal of material;
 - l. disconnecting, removing and sealing services and supplies;
 - m. disposal of hazardous materials at tips approved by the Engineer;
 - n. filling of all basements and other excavations made;
 - o. replacing items damaged during the foregoing operations.
 - p. Health & Safety measures associated to the works.
 - q. Temporary works.
- D. In all cases the removal of the products resulting from the demolition and their transport to a place of use, stockpile or authorised landfill are included in these units.
- E. The following units of measurement are defined:

Table 4. Units of measurement – Demolitions

Uniclass code	Type number	Work item	Unit	Work item includes
Ac_10_10_20	000101	DECONSTRUCTION	m3	Deconstruction consists of all works and expenses necessary to achieve the end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.).
Ac_10_10_25	000101	STRUCTURE DEMOLITION	m3	Structure demolition consists of all works and expenses necessary to achieve the end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.).
Ac_10_10_25	000102	DEMOLITION OF EXISTING PAVEMENT, OF ANY TYPE OR THICKNESS	m2	Demolition of existing pavement, of any type or thickness, consists of all works and expenses necessary to achieve the end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). Including low working efficiency by vehicle traffic, demolition of sidewalks, traffic island, kerbstones and all kinds of special parts for paving.
Ac_10_10_25	000103	BUILDING DEMOLITION	m3	Building demolition consists of all works and expenses necessary to achieve the end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for demolition of volume occupied by existing building, including demolition of the foundation, debris removal, loading and disposed off site.

2.7 SITE CLEARING AND GRUBBING

2.7.1 SCOPE OF WORKS

- A. This section includes site clearance works as specified hereinafter, including the removal from the site of all trees, stumps (parts above ground), logs, boulders/rocks up to 1.0m in size which are exposed or lying on the surface,

saplings, bushes, scrub or similar growth, levelling of obsolete terraces, ditches, windrows, minor manmade structures, obstructions and property improvements (e.g. fences and livestock yards) and any surface feature that is considered unsuitable for incorporation into the works.

- B. This section includes grubbing works as specified herein, including the removal of the base of stumps, roots, buried logs, the underground parts of structures and other obstructions that obtrude, encroach upon or otherwise obstruct the work and other subsurface material considered unsuitable by the Engineer for incorporation in the Works.
- C. This section provides a needed but non-exhaustive list of labour, materials, equipment and services necessary to furnish, deliver and install all work of this section as shown on the drawing, as specified herein and/or as required by job conditions.

2.7.2 EXECUTION OF WORKS

- A. Before commencing of the Works, the Contractor shall obtain the necessary approval from AHJ.
- B. The Contractor shall submit the Site Clearing and Grubbing Method Statement to the Engineer for acceptance prior to the commencement of the works.
- C. The Contractor shall plan and carry out clearing operations to avoid erosion, contamination and sedimentation of the site, surrounding areas, watercourses, streams and other drainage systems.
- D. Works related to tree removal comprise shall be carried out in accordance with Section 7. ENVIRONMENTAL in these Technical Specifications.
- E. The Contractor shall provide adequate protection to all trees, bushes, etc., to be preserved as requested by the AHJ and/or as directed by the Engineer.
- F. No trees shall be felled, removed or cut without the prior approval of the AHJ and only when directed by the Engineer.
- G. The stump and root of felled trees shall be grubbed up immediately and removed from the site. All empty tree holes or cavities shall be filled to the existing ground level and compacted to the satisfaction of the Engineer.
- H. All shrubs, roots, etc. shall be removed by cutting and/or digging and removed from site.

2.7.3 DISPOSAL OF MATERIAL

- A. The Contractor shall observe all Local Regulations governing the disposal of debris and any other material waste.
- B. All material cleared and/or grubbed in accordance with these Specifications shall become the property of the Contractor and shall be removed from site and disposed of in an appropriate manner.
- C. Burning tree, shrub, and other vegetation waste might be permitted according to requirements of AHJ and subjected to the Engineer's approval and the permission of AHJ. The Contractor shall control such burning to produce the least smoke or air pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris shall not be permitted under any circumstances.

2.7.4 MEASUREMENT AND PAYMENT – SITE CLEARING AND GRUBBING

- A. The following work items are defined:

Table 5. Units of measurement – Site clearing and grubbing

Uniclass code	Type number	Work item	Unit	Work item includes
Ac_10_30_90	000101	TREE REMOVAL	pc	Tree removal consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.).

Uniclass code	Type number	Work item	Unit	Work item includes
Ac_10_30_10	000101	BUSH AND SCRUB REMOVAL	m2	Bush and scrub removal consist of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.).
Ac_10_30_80	000101	CLEARING AND SURFACE SOIL REMOVAL	m2	Clearing and surface soil removal consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.).

- B. The item shall include full compensation for all work necessary for removal of trees and shrubs and uprooting.
- C. Wood logs are property of the Employer and shall be temporary stored. Small branches and other unusable materials shall be disposed outside the Site as directed by the Engineer, and in accordance with Local Legislation and Regulations.
- D. The items shall include for:
- a. Basic Survey and Detailed Setting Out, including
 - i. scheduling, coordination and provision of all construction surveying;
 - ii. fixing coordinates, levelling and staking-out;
 - iii. tying the points into the national survey network;
 - iv. calculations essential to complete the project and properly control the work;
 - v. appropriate traffic control measures for all survey activities;
 - vi. marking of all survey stakes with station and offset reference;
 - vii. conducting a detailed cross section survey of the existing road for the purpose of measurement and preparing working drawings;
 - viii. provision and maintaining of reference stakes;
 - ix. renewing of illegible stakes;
 - x. relocation of initial horizontal and vertical control points, if necessary;
 - xi. protection of benchmarks;
 - xii. cooperation with utility companies and staking of control lines to relocate utilities;
 - b. herbicide;
 - c. drilling and frill girdling;
 - d. treating re-growth;
 - e. stump grinding;
 - f. reinstatement of paved areas;
 - g. grubbing up stumps;
 - h. dealing with infected timber arising;
 - i. cutting and shredding;
 - j. temporary storage of logs;
 - k. disposal of material;
 - l. means to protect the vegetation and property and services regarded as permanent;
 - m. sterilising tools and the like;
 - n. inspections and reports;
 - o. auxiliary means.

2.8 TOPSOIL STRIPPING

2.8.1 SCOPE OF WORKS

- A. This section includes topsoil stripping (including turf) works and stockpiling as specified hereinafter.
- B. This section provides a needed but non-exhaustive list of labour, materials, equipment and services necessary to furnish, deliver and install all work of this section as shown on the drawing, as specified herein and/or as required by job conditions.

2.8.2 GENERAL REQUIREMENTS

- A. Topsoil stockpiles shall be free from subsoil, other excavated materials, remains of logs and branches, contaminated materials, refuse, clay lumps and stones, timber or other rubbish.
- B. Topsoil stockpiles shall be carried out in the chosen places, so that the normal development of the works does not interfere with them.
- C. Topsoil shall not be mixed with other materials stockpiles.
- D. The Contractor shall ensure that stripped topsoil properties are preserved.

2.8.3 EXECUTION OF WORKS

- A. Before commencing of the Works, the Contractor shall obtain the necessary approval from the AHJ.
- B. The Contractor shall submit the Topsoil stripping Method Statement to the Engineer for acceptance prior to the commencement of the works.
- C. Existing topsoil material (including turf) shall be stripped prior earthworks to a depth as defined on the Technical Design Drawings, or as directed by the Engineer.
- D. Stripping is obligatory on slopes and underneath all level embankments.
- E. Where topsoil stripping may be inappropriate (e.g. in very soft soils, marshy areas) and, in accordance with the Engineer or the Technical Design, the maintenance of this layer is beneficial, this shall not be removed.
- F. As a rule, topsoil stripping shall only commence in areas where earthworks are to occur within one week.
- G. Topsoil shall, wherever practicable be used immediately after its stripping and if not shall be stored in stockpiles of heights not exceeding 2m. The Contractor shall make own arrangements for stockpiling and the provision of appropriate areas for the purpose.
- H. Topsoil shall not be stockpiled for more than two years. Any case, the Contractor shall take measures against erosion and fines washing.
- I. Traffic shall not run unnecessarily on the topsoil either before stripping or when in a stockpile. The Contractor shall take measures to prevent the topsoil from becoming mud.
- J. Topsoil stockpiles shall not be compacted or surcharged with additional weight, etc.

2.8.4 DISPOSAL OF MATERIAL

- A. The Contractor shall observe all Local Regulations governing the disposal of surplus topsoil.

2.8.5 MEASUREMENT AND PAYMENT – TOPSOIL STRIPPING

- A. The following units are defined:

Table 6. Units of measurement – Topsoil stripping

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_31_26_90	000101	TOPSOIL REMOVAL FOR REUSING [RE-VEGETATION, SLOPE PROTECTION, DISPOSAL TEMPORARY OR PERMANENT, ETC]	m3	Topsoil removal consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for topsoil that is re-used during the construction phase without needing any prior processing or can be disposed on site (e.g. false cuttings, etc.).
Pr_15_31_26_90	000102	TOPSOIL REMOVAL FOR DISPOSING OFF SITE	m3	Topsoil removal consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for topsoil that can't be re-used on site and shall be disposed.

B. The items shall include for:

- a. Basic Survey and Detailed Setting Out, including
 - i. scheduling, coordination and provision of all construction surveying;
 - ii. fixing coordinates, levelling and staking;
 - iii. tying the points into the national survey network;
 - iv. calculations essential to complete the project and properly control the work;
 - v. appropriate traffic control measures for all survey activities;
 - vi. marking of all survey stakes with station and offset reference;
 - vii. conducting a detailed cross section survey of the existing road for the purpose of measurement and preparing working drawings;
 - viii. provision and maintaining of reference stakes;
 - ix. renewing of illegible stakes;
 - x. relocation of initial horizontal and vertical control points, if necessary;
 - xi. protection of benchmarks;
 - xii. cooperation with utility companies and staking of control lines to relocate utilities,
- b. herbicide;
- c. drilling and frill girdling;
- d. treating re-growth;
- e. stump grinding;
- f. reinstatement of paved areas;
- g. cutting and shredding;
- h. disposal of material;
- i. means to protect the vegetation and property and services regarded as permanent;
- j. sterilising tools and the like;
- k. inspections and reports;
- l. auxiliary means.

2.9 EARTHWORKS

2.9.1 SCOPE OF WORKS

- A. Earthworks include excavation, loading, transporting (movement of excavated material or fill material, etc), transforming/improving, placing (installing), planning, stabilizing and compacting natural materials (soils, rock), recycled materials to achieve stable and durable earth-structures with predetermined Design Working Life and having prescribed properties stated in the Detailed Technical Design (hereinafter the Technical Design) and this Technical Specification.
- B. All earthworks shall be executed in accordance with the Technical Design and Technical Specifications.
- C. The Contractor shall submit Method of Statements for earthworks for the Engineer's approval prior to the commencement of the works.

2.9.2 NORMATIVE REFERENCES

- A. Earthworks shall comply with the following non-exhaustive list of standards and regulations:
 - a. EN 1997-1 Eurocode 7: Geotechnical design – Part 1: General rules.
 - b. EN 1997-2 Eurocode 7: Geotechnical design – Part 2: Ground investigation and testing.
 - c. EN 16907 – EARTHWORKS
 - i. EN 16907-1 Earthworks - Part 1: Principles and general rules.
 - ii. EN 16907-2 Earthworks - Part 2: Classification of materials.
 - iii. EN 16907-3 Earthworks - Part 3: Construction procedures.
 - iv. EN 16907-4 Earthworks - Part 4: Soil treatment with lime and/or hydraulic binders.
 - v. EN 16907-5 Earthworks - Part 5: Quality control.
 - vi. EN 16907-6 Earthworks - Part 6: Land reclamation earthworks using dredged hydraulic fill.
 - vii. EN 16907-7 Earthworks – Part 7: Hydraulic placement of extractive waste.
 - d. EN 14199 Execution of special geotechnical works – Micropiles
 - e. EN 14475 Execution of special geotechnical works - Reinforced fill
 - f. EN 1536 Execution of special geotechnical works - Bored piles
 - g. EN 1537 Execution of special geotechnical works - Ground anchors
 - h. EN 12063 Execution of special geotechnical works - Sheet-pile Walls
 - i. EN 12699 Execution of special geotechnical works - Displacement piles
 - j. EN 14679 Execution of special geotechnical works – Deep mixing
 - k. EN 1538 Execution of special geotechnical works – Diaphragm Walls
 - l. EN 15237 Execution of special geotechnical works – Vertical drainage
 - m. EN 12715 Execution of special geotechnical works – Grouting
 - n. EN 14490 Execution of special geotechnical works - Soil nailing
 - o. EN 13383-1 Armourstone - Part 1: Specification
 - p. EN 13383-2 Armourstone - Part 2: Test methods
 - q. EN 10223-8 Steel wire and wire products for fencing and netting - Part 8: Welded mesh gabion products.
 - r. EN ISO 14688 – GEOTECHNICAL INVESTIGATION AND TESTING – IDENTIFICATION AND CLASSIFICATION OF SOIL
 - i. EN ISO 14688-1: Geotechnical investigation and testing - Identification and classification of soil - Part 1: Identification and description
 - ii. EN ISO 14688-2 Geotechnical investigation and testing - Identification and classification of soil - Part 2: Principles for a classification.
 - s. UIC 719R – Earthworks and track bed for railway lines.
 - t. EN 13055: Lightweight aggregates in general (not only expanded clay aggregates).
 - u. EN 14063: Expanded clay aggregates as thermal insulation in buildings.

- v. EN 15732: Expanded clay aggregates in civil engineering applications.
- B. Test standards:
 - a. ASTM D1556 / D1556M – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
 - b. DIN 18125-2 – Soil investigation and testing - Determination of density of soil - Part 2: Field tests.
 - c. ASTM D1883 – Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils.
 - d. ASTM D4644 – Standard Test Method for Slake Durability of Shales and Similar Weak Rocks.
 - e. ASTM D6938 – Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
 - f. ASTM E2835 – Standard Test Method for Measuring Deflections using a Portable Impulse Plate Load Test Device.
 - g. ASTM D4542-Standard Test Method for Pore Water Extraction and Determination of the Soluble Salt Content of Soils by Refractometre.
 - h. ASTM D4546-Standard Test Methods for One-Dimensional Swell or Collapse of Soils.
 - i. DIN 18134 – Determining the deformation and strength characteristics of soil by the plate loading test.
 - j. EN 1097-1 – Tests for mechanical and physical properties of aggregates - Part 1: Determination of the resistance to wear (micro-Deval).
 - k. EN 1097-2 – Tests for mechanical and physical properties of aggregates - Part 2: Methods for the determination of resistance to fragmentation.
 - l. EN 13242 – Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction.
 - m. EN 13285 – Unbound mixtures - Specifications.
 - n. EN 13286-1 – Unbound and hydraulically bound mixtures – Part 1: Test methods for laboratory reference density and water content – Introduction, general requirements and sampling.
 - o. EN 13286-2 – Unbound and hydraulically bound mixtures - Part 2: Test methods for laboratory reference density and water content - Proctor compaction.
 - p. DIN 18127 – Soil, investigation and testing - Proctor-test.
 - q. EN 1367-2 – Tests for thermal and weathering properties of aggregates - Part 2: Magnesium sulphate test.
 - r. EN 932-1 – Tests for general properties of aggregates - Part 1: Methods for sampling.
 - s. EN 932-2 – Tests for general properties of aggregates - Part 2: Methods for reducing laboratory samples.
 - t. EN 933-8 – Tests for geometrical properties of aggregates - Part 8: Assessment of fines - Sand equivalent test.
 - u. EN 933-9 – Tests for geometrical properties of aggregates - Part 9: Assessment of fines - Methylene blue test.
 - v. EN ISO 10693 – Soil quality - Determination of carbonate content - Volumetric method.
 - w. EN ISO 17892-4 – Geotechnical investigation and testing - Laboratory testing of soil - Part 4: Determination of particle size distribution (ISO 17892-4).
 - x. EN ISO 17892-5 – Geotechnical investigation and testing - Laboratory testing of soil - Part 5: Incremental loading oedometer test.
 - y. EN ISO 17892-12 – Geotechnical investigation and testing - Laboratory testing of soil - Part 12: Determination of liquid and plastic limits.
 - z. EN ISO 22475 – Geotechnical investigation and testing – Sampling methods and groundwater measurements – Part 1: Technical principles for execution.
 - aa. ISO 10390 – Soil quality. Determination of pH.
 - bb. ISO 11048 – Soil quality — Determination of water-soluble and acid-soluble sulphate.
 - cc. ISO 11265 – Soil quality — Determination of the specific electrical conductivity.
 - dd. ISO 14235 – Soil quality — Determination of organic carbon by sulfochromic oxidation.

- ee. ISO 20290-3 – Aggregates for concrete — Test methods for mechanical and physical properties — Part 3: Determination of aggregate crushing value (ACV).
- C. Quality standards
 - a. ISO 9001:2015 – Quality management systems – Requirements.
- D. Latest edition of the referenced standards (including any amendments) applies.
- E. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

2.9.3 GENERAL REQUIREMENTS

- A. All soils and materials used for earthworks shall have equal or better properties (including geotechnical properties, e.g. friction angle, cohesion, etc.) than described in the Technical Design.
- B. Only natural materials shall be used for construction. Industrial by-products or recycled materials shall be used only if accepted by the Engineer and the requirements according to this Technical Specification, article 2.9.3.3 before, are met.
- C. Materials excavated on site shall be re-used as much as possible but shall be discussed with and accepted by the Engineer. Re-used materials shall meet the same requirements as virgin materials.
- D. The Contractor shall verify and ensure that the properties of the excavated materials meet the requirements stated in the Technical Design and Technical Specification before being re-used.
- E. Where excavation is done where layers of suitable and unsuitable materials are encountered, the excavation shall be done in layers and materials stored separately to maximize the amount of re-use. The Contractor shall ensure that suitable materials shall not mix with unsuitable materials.
- F. Prior earthworks, the Contractor shall ensure that the excavation surface, formation level, etc. is prepared in accordance with the Technical Design and Technical Specifications requirements. This may require additional levelling, excavation, compaction, etc. Surfaces shall be accepted by the Engineer prior proceeding with the works.
- G. All materials, items and devices which are not compliant with Technical Design and Technical Specifications shall be removed to extent indicated by Engineer. Costs associated with testing, measuring, calculations necessary to determine the volumes and quantities shall be covered by the Contractor.
- H. As-built BIM models shall be created by the Contractor and/or updated by developing PIM (Project Information Model) models from the Technical Design accompanied with laser scanning/photogrammetry data according to "RBDG-MAN-040- Digital information requirements for construction and handover stages".
- I. During construction the Contractor shall provide for the effective diversion of surface water from the Works. The Contractor shall provide efficient pumping equipment on site and shall always keep trenches and excavations dewatered during construction.
- J. Water is not permitted to pond on or adjacent to an embankment unless stated otherwise on the Drawings or authorised by the Engineer.

2.9.3.1 CONSTRUCTION WATER

- A. Construction water quality shall not compromise the design life of rail infrastructure in contact with earthworks (including via leachates or runoff).
- B. The Contractor shall evaluate the suitability of non-potable water by field and laboratory testing at the discretion of the Engineer. This includes but is not limited to ensuring the chemical composition of the water does not contribute to an environment exceeding any adjoining structure's design exposure classification as specified on the Technical Design Drawings or does not affect the establishment of vegetation.

2.9.3.2 CLIMATIC CONDITIONS

- A. During periods of rainfall, consideration shall be given to suspending earthworks operations in wet sensitive materials. When necessary, the earth surfaces shall be sealed to prevent the ingress of water.

- B. In dry climatic conditions, consideration shall be given to preventing evaporative losses by covering the exposed earth surfaces with material(s) which is not sensitive to moisture.
- C. Earthworks during the winter period are allowed if the air temperature is above 0°C and base of the fill (e.g. subgrade) is not frozen. Earthworks below 0°C are allowed if the base of the fill meets all applicable requirements, soil/material used for filling is not frozen, and the fill/material is planned and compacted immediately. Earthworks shall be organized to have no interruptions. In cases where interruptions are expected or encountered, the works are not allowed to continue.
- D. Excavations shall be conducted below 0°C if frozen layer of soil is excavated to a depth which is at least or greater than the frost penetration depth (to be verified by Engineer) and backfill layers are constructed immediately.
- E. Frozen soil, snow and ice shall not be used for filling or placed/installed into the earth-structures. Frozen soil which is considered to be suitable for earthworks shall be deposited for thawing prior installation.

2.9.3.3 USE OF SECONDARY MANUFACTURED MATERIALS AND RECYCLED MATERIALS

- A. Recycled materials shall be used only if accepted by the Engineer. Prior to acceptance, the materials submitted for approval shall have applicable Declaration of Performance or Declaration of Conformity to verify the properties and suitability. Additionally, full compliance with applicable local and European regulations shall be ensured, e.g. the content of dangerous substances, etc.
- B. Anthropogenic material suitable for using in earthworks shall be classified in accordance with EN 16907-2 table 5, including tables 2 to 4.
- C. Materials used for frost protection layer and prepared subgrade shall be in accordance with EN 13285 and/or EN 13242 which contain additional requirements for recycled materials.
- D. These materials and Works done with these materials shall meet the requirements stated in the Technical Design and the Technical Specifications based on intended use.

2.9.3.4 PROTECTION OF THE WORKS

- A. The Contractor shall be responsible for the protection of earthworks and structures, specifically:
 - a. Installation and maintenance of erosion and sedimentation control measures in accordance with the EMP.
 - b. Permanent erosion and sediment controls (e.g. topsoiling, grassing or hydroseeding and hydromulching) shall be carried out as specified at the earliest practicable date.
 - c. Providing and maintaining drainage of the working areas without causing erosion. Water is not permitted to pond in the working areas resulting in wetting of the existing pavement, formation, foundation material, etc. except where ponding forms part of a planned erosion and sedimentation control system.
 - d. The Contractor shall ensure that grade earthworks and particularly the formation surface is always drained without ponding.
 - e. The Contractor shall apply all means to minimise ingress of any excess water into earthworks material. Ripped material remaining in cuttings and material placed on embankments shall be sealed off by adequate compaction to provide a smooth tight surface.
 - f. If stockpiled material becomes too wet (above the optimum moisture content used for compaction) because the Contractor did not provide adequate protection, the Contractor shall replace and/or dry the material to the optimum moisture content and shall be responsible for any consequent delays to the Works.
 - g. The Contractor shall not allow earthworks material in embankments to dry out to the point where excessive shrinkage occurs, and the surface is pulverised by traffic, generating dust pollution.
 - h. No excavation shall be undertaken affecting the stability or integrity of any structure without prior approval by the Engineer.
 - i. Temporary and permanent works shall be limited to safe heights and slopes in accordance with the Technical Design and the Technical Specifications.
- B. The Contractor shall cover costs and delays associated with the repairs to damaged earthworks resulting from failure to comply with the requirements.

2.9.3.5 NEW ACCESSES

- A. If the Contractor requires access to a part of the Site where no access has been provided, the Contractor shall supply to the Engineer all plans for obtaining such access and shall not commence works until approval has been given.
- B. The completed formation track shall be used as an access road only where approved by the Engineer. Where approved, it shall be used in such a manner to afford minimum damage to the sub-ballast layer, formation, ditches, shoulders and slopes.
- C. All repairs required to restore the sub-ballast material or the formation to its original condition shall be at the Contractor's expense.

2.9.3.6 TRANSPORT

- A. Transportation shall be undertaken within the earthwork footprint. When transporting on public roads, only permitted equipment shall be used, and in accordance with relevant Local Regulation. Requirements for cleaning public roads shall be met. Each of these cases shall require appropriate pre planning and organisation.
- B. Dust generated by transportation shall be controlled and minimized, complying with environmental and safety Local Regulation governing this issue.
- C. Buried utilities, existing structures or roads and structures constructed as part of the works shall be protected from traffic above them.

2.9.3.7 MATERIAL MANAGEMENT

- A. The Contractor shall be responsible for:
 - a. Any assumptions made in relation to the nature and types of the materials, excavated or imported, and the bulking and compaction characteristics of all such materials which are then incorporated in the Works;
 - b. Determining suitable sources of material and any processing needed to satisfy the requirements of the Technical Design and the Technical Specification;
 - c. The design, and the cost of construction and maintenance of all tracks, roads, haul roads, pads and other earthworks structures required for the proper execution of the Works;
 - d. Managing procurement of materials to ensure sufficiency of materials of the specified quality;
 - e. Achieving a high utilisation of prepared subgrade and sub-ballast material from excavations, unless otherwise proven uneconomical.
 - f. If the Contractor causes a deficiency of fill material by electing not to use acceptable material from excavations in the embankments and formation or by constructing embankments with dimensions other than those shown on the Technical Design Drawings or authorised by the Engineer, the Contractor shall make good that deficiency from sources of material meeting the quality requirements specified in the Technical Design and the Technical Specification.

2.9.4 STOCKPILES

2.9.4.1 STOCKPILES AREAS

- A. Stockpiles shall be located at the areas nominated in the Drawings or Specifications. Those areas shall not adversely impact the track and formation, drainage, the surrounding environment, existing infrastructure, utilities and operational access.
- B. Where no such areas are nominated, or if the Contractor proposes other areas, a proposal shall be submitted with details of the maximum dimensions of the proposed stockpiles, for approval by the Engineer at least 10 working days before stockpiling is due to commence. The Contractor shall obtain all the necessary approvals and consents from AHJ, including environmental approvals.
- C. Stockpiles shall be provided with temporary drainage measures.

- D. Stockpile sites in Private Property shall be restored following completion of the Works in accordance with landowner agreements and to the satisfaction of the Engineer.

2.9.4.2 STOCKPILE MANAGEMENT

- A. Materials assigned to be stockpiled shall be segregated, stored separately and protected to prevent mixing, cross contamination and loss of material.
- B. Stockpiles shall be clearly labelled for quality control.
- C. Stockpile areas shall be secured, and access controlled to prevent illegal dumping and the public from entering the site.
- D. Surface erosion and dust generation shall be prevented.

2.9.5 EXCAVATIONS

2.9.5.1 SCOPE OF WORK

- A. This section deals (after site clearing and grubbing, and topsoil stripping) with the excavations including cuttings, trenches, shafts, foundations and borrow pits.
- B. Excavations shall be carried out to the dimensions, lines, levels, profiles and slopes as indicated in the Technical Design Drawings, or to such other dimensions, lines, levels, profiles and slopes as the Engineer directs or approves.
- C. This section provides a needed but non-exhaustive list of labour, materials, equipment, transport and services necessary to furnish, deliver and install all work of this section as shown on the drawings and BIM models, as specified herein and/or as required by job conditions.

2.9.5.2 GENERAL REQUIREMENTS

- D. Before starting the excavation works, a detailed method of statement for the excavations shall be submitted to the Engineer for approval, including methods of excavation, drainage means, etc.
- E. Excavation includes disposal of soil materials and transportation costs within the boundaries of the construction site and, if necessary, utilization costs.
- F. Decision on what to do with surplus material which is suitable for re-using shall be made by the Engineer and/or Employer.
- G. Unsuitable and surplus material shall be removed to appropriate landfill, following the Local Regulations governing this issue.
- H. Excavations shall be carried out safely, and according to Local Regulations, ensuring that excavation formation/subgrade and the surrounding area is undamaged by the excavation process.
- I. All excavation surfaces and volumes shall be inspected and accepted or rejected by the Engineer prior proceeding with the works.
- J. Areas where excavations are executed shall clearly marked and access to these areas shall be restricted via fence. Excavated pits shall be filled as soon as possible in accordance with Technical Design and Technical Specification.
- K. In cases where potentially contaminated/harmful soils or other items are encountered, the Contractor shall use all means necessary to handle and utilize them according to the Technical Specifications.
 - a. This includes communicating with local emergency, health and safety, environmental and other AHJ and following the guidance given by these authorities and applicable regulations.
- L. Earthworks and soil usage shall be aligned with the landowner prior execution.
- M. Over-excavation or formation of temporary steep unstable slopes shall be avoided.
- N. Process of excavation shall be documented in the site records (see EN 16907-3).

- O. If excavations are carried out beyond their true line and level other than those in the Technical Design or directed by the Engineer, the Contractor shall at his own cost make good to the required line and level with approved material and/or deal with the matter in such a manner as the Engineer directs.
- P. Materials shall be classified according to the construction procedures necessary to achieve the excavation as follows (as per EN 16907-3):
 - a. strong to intermediate rocks (blasting, pre-splitting);
 - b. intermediate to weak rocks (ripping, excavation);
 - c. soil (excavation by conventional plant alone).

2.9.5.3 CONSTRUCTION REQUIREMENTS

2.9.5.3.1 GENERAL

- A. The Contractor shall ensure the stability of the excavations. Where required, the excavations shall be stabilized during the construction by appropriate means.
- B. Temporary retaining remedies shall be removed, unless it is not clearly specified by the Technical Design or directed by the Engineer.
- C. Standing water is not permitted in the excavation, except in cases foreseen in the Technical Design (e.g. in cases where the embankment is to be constructed into the waterbody, etc.):
 - a. The Contractor shall ensure working drainage system with sufficient capacity throughout the construction phase;
 - b. All surfaces shall be graded/planned to divert and guide rainwater and melting snow (i.e. having suitable longitudinal and/or transverse gradients or drainage systems, etc);
 - c. All uneven surfaces which may cause water to accumulate shall be filled with material meeting the applicable requirements and compacted immediately;
 - d. If unforeseen aquifer levels are found, corrective measures shall be taken in accordance with the Engineer's criterion.
- D. In cases where temporary excavations are done in sandy soils (fines content, % material passing 0.063 sieve, <35% according to EN 13285) and high groundwater level is expected to affect the excavation, the Contractor shall provide a temporary dewatering system (e.g., well-point, ...) to lower and control groundwater, complying with the following requirements:
 - a. Maintain piezometric water level a minimum 1.5m below bottom of excavation, exceptionally 1.0m with the Engineer's approval.
 - b. Open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability is not permitted.
 - c. Dewatering system shall be placed into operation to lower water to specified levels before excavating below groundwater level.
 - d. The Contractor shall provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.
- E. Pressure relief wells shall be installed at the bottom of excavations to relief excess hydrostatic pressures in pervious strata (granular soil) overlain by more impervious top strata (clayey soil).
 - a. Pressure relief wells only to be executed where required, and where shown on Technical Drawings. It is recommended to drill the holes for relief wells from the surface, before excavation.
 - b. The hole shall be drilled large enough to provide a minimum diameter of 4" to 6", depending on the gradation of the filter material proposed by the Contractor for the pressure relief wells to work properly and the minimum length in the granular stratum will be 2 m.
- F. The wells shall be fill in with granular material. Excavations shall be constructed as per Technical Design. Any temporary changes to geometry are only allowed if it is also foreseen by the Technical Design or approved by the

Engineer after Contractor's justification. To ensure safety and stability of the earth-structures, these changes shall be restored as soon as possible.

- G. In cases where excavation is done in locations where layers of suitable and unsuitable materials are expected to be encountered (as per Technical Design site investigation information), the excavation shall be done in layers and stored separately to maximize the amount of re-use.
- H. All excavation phases shall be carried out with accurate topographical references according to this Technical Specification.
- I. Soils/materials shall not be accumulated on the edges of slopes.
- J. The floor of the excavation shall be maintained. Vehicles shall be able to circulate in safety conditions.
- K. The occurrence of low strength shear zones, relict soil horizons and seepage zones in excavations may require localised support as directed by the Engineer. Such works shall be based on site specific geotechnical design.
- L. Loading operations and transportation shall be carried out in safety conditions and avoiding muddling of public roads.
- M. Dust pollution and losses of material shall be avoided while transporting.
- N. Excavations shall follow this issue governing Local Regulations, requirements set in the EIA, and in Section 7 ENVIRONMENTAL in these Technical Specifications.
- O. Disposal of surplus suitable fill to an authorised landfill shall be at the approval of the Engineer.
- P. Open excavations shall be maintained in approved conditions. The Contractor shall provide dewatering and drainage systems necessities.
- Q. Excavated surface shall have a uniform aspect. The excavation floor shall be free of either loosen material, loose rocks or fragmented.

2.9.5.3.2 CUTTINGS

- A. Cuttings shall be constructed as per Technical Design, except for temporary changes allowed according to this Technical Specification.
- B. If the evident risk of slips or falls during construction works is identified, the Engineer may require modify the slopes defined in the project, without involving a change in this work unit.
- C. Drainage in the slope shall not provoke risk of destabilisation, erosion or infiltrations into the cutting.
- D. The slope gradient changes of the cuttings and their intersection with the ground shall be rounded.
- E. Cut faces shall be cleared of any overhanging, loose or unstable material as the excavation proceeds, and so the final surface.
- F. The final surface shall be free of rills, have no signs of traces or damages caused by construction equipment and shall be flat and even.
- G. Unsuitable material on slopes shall be replaced with suitable material to a predetermined depth and compacted.
- H. In cold weather, if the material in the cutting is sensitive to frost heave and if the frost shall penetrate more than 0.5m in the material in the final profile, boulders shall be removed.
- I. The Contractor shall be responsible for the repairment of the damages that may occur in the slopes during the time elapsed from its execution to the reception of the work.

2.9.5.3.3 EXCAVATION OF TRENCHES, SHAFTS AND FOUNDATIONS

- A. Trenches, shafts and foundations shall be excavated to the lines and levels shown on the Drawings.
- B. Excavation shall be performed in such a manner to minimize disturbance of the sides and bottom of the excavation.
- C. Material shall not be stockpiled to a distance from the upper excavation edge lower than 2m.
- D. Protection and signalling measures shall be arranged surrounding the open excavation area.
- E. Trenches and shafts:

- a. Sides of the excavation shall be stable and adequately supported, in accordance with Local Regulation governing this issue;
 - b. Trenches for pipes shall be excavated to a sufficient depth and width to enable the pipe and the specified joint, bedding, haunching and surrounding to be accommodated.
- F. Foundations:
- a. The quality of the excavation floor requires the explicit approval of the Engineer;
 - b. When material suitable for founding is encountered above the designed founding level, excavation to final grade shall not be made until the Engineer has inspected the excavation and before any working blinding layer is placed;
 - c. Where in the opinion of the Engineer material unsuitable for foundation is encountered at designed founding level such material shall be removed and replaced with approved by Engineer compacted granular fill;
 - d. If the ground floor is made of rock, the excavation floor shall be flatten correcting any peaks or irregularities in its surface;
 - e. When the excavation floor is not rocky, the excavation of the last 30cm shall not be performed until just before the placement of the blinding concrete layer;
 - f. No concrete shall be placed before the excavation has been cleaned, inspected and approved by the Engineer. A concrete working floor [blinding layer] shall be placed underneath all bases, with the width shown on Drawings and following the requirements in Section 05 STRUCTURES governing this issue.

2.9.5.3.4 EXCAVATION BY BLASTING

- A. Blasting shall be in accordance with Local Regulations in force and with the approval of the AHJ and the Engineer.
- B. The Contractor shall submit a Blasting Management Plan according to Local Regulations to the Engineer, to obtain the approval for the commencement of the Works.
- C. The execution of the authorised Blasting Management Plan, the permits obtention and the compliance with regulations in force are responsibility of the Contractor.
- D. The procurement, transport, storage, conservation, manipulation and the use of ignitors and explosives shall comply with all the regulations in force.
- E. The Contractor shall take precautions relating to the safety of persons and animals. The Contractor shall place the appropriate signs in accordance with AHJ.
- F. A vibration study according to Local Regulations shall be carried out by the Contractor if required for protecting any structure.
- G. The Contractor shall maintain accurate records of each blast including the details listed below:
 - a. Date, identification number and time of blast;
 - b. Location, number and diameter of blast holes loaded;
 - c. Site plan showing locations and identification numbers;
 - d. Depth of each drill hole loaded;
 - e. Inclination of drill holes;
 - f. Burden(s) and spacing(s);
 - g. Types and amounts of explosives used;
 - h. Maximum instantaneous charge;
 - i. Initiation Plan;
 - j. Length and type of stemming in each blast hole;
 - k. Ground vibration and noise levels at measuring locations;
 - l. Regulatory notifications;
 - m. Details and all relevant documentation relating to all breaches which have occurred.

2.9.5.3.5 DISPOSAL OF SPOIL

- A. Non-contaminated surplus soil and unacceptable materials shall be taken to the approved landfills, according to the relevant requirements of Local Regulations governing this issue.
- B. Where spoil materials are found to be contaminated at levels that are unsuitable for reuse, the management of the materials shall be undertaken to ensure that risk of harm to human health and the environment is avoided. All management of contaminated material shall be done in accordance with the relevant Local Regulation in force and after getting approvals/permits.
- C. The Contractor is responsible for determine the methods and locations for management and disposal of the non-contaminated and contaminated material and obtain relevant approvals from the AHJ.

2.9.5.4 QUALITY CONTROL - ACCEPTANCE TESTING FOR EXCAVATION FLOOR

- A. The Contractor shall obtain approval of excavations prior to placing fill, concrete, etc.
- B. The excavation floor shall present homogeneity in visual inspection and when tested, with no points showing defective behaviour.
- C. The Contractor shall conduct compaction testing in accordance with methods and frequencies stated in this Technical Specification (Internal Control Testing). Acceptance testing shall be arranged by the Engineer and/or Employer with not more than 5 times the frequency stated in this Technical Specification, i.e. plate loading test shall be conducted at least once per 500 m and compaction degree at least once per 100 m. Acceptance testing shall be done at the locations selected by the Engineer and/or Employer. The Contractor shall provide equipment and personnel to conduct acceptance testing, if necessary, to the Engineer and/or Employer. Internal Control Testing reports shall be submitted to Engineer and/or Employer.
- D. The requirements demanded at the bottom of the excavation are different depending on the type of ground where the embankment is proposed to be executed:
 - a. QS2 and QS3 at the bottom of the excavation: no replacement is necessary. The excavation surface, below the replacement, shall be compacted to 95% D_{Pr} .
 - b. QS0 and QS1 at the bottom of the excavation: It is necessary a soil replacement at least of 35 cm, ensuring 1 meter of QS2 measured from the bottom of the prepared subgrade.
 - c. The material may be treated with hydraulic binder and possibly pre-treated with quicklime to obtain the required bearing capacity.
- E. The target degree of compaction (D_{Pr}) and the bearing capacity (E_{v2}) measured on the excavation floor shall be:

Table 7. Compaction requirements - Excavation floors

Layer	E_{v2} (DIN 18134)		Field density (ASTM D1556 / D1556M or ASTM D6938 or DIN 18125-2)	
	Target value	Testing frequency	Target value	Testing frequency
Excavated surface/floor of the excavation	≥ 45 MPa for fine soils ≥ 60 MPa for sandy or gravelly soils ≥ 80 MPa (treated material) Additionally, $E_{v2}/E_{v1} < 2.2$ if E_{v1} less than $0.6E_{v2}$	Once per 100 m, 2 locations – beneath the railway and near the edge	$\geq 97\%$ of the D_{Pr} (EN 13286-2 Standard Proctor compaction)	Once per 20 m, 2 locations - beneath the railway and near the edge (≤ 1 m)

- F. If the results obtained do not reach the minimum values stated herein, the surface shall be moistened and re-compacted until the required values are reached. If the required degree of performance is not obtained, the layer shall be removed and re-built at the Contractor expense.
- G. During the construction phase, different direct/indirect test methods (e.g. continuous compaction control (CCC) method, deflectometers (LWD, FWD), E_{v2}/E_{v1} , Troxler, etc. can be used if the correlation with the reference methods stated above (DIN 18134 and EN 13286-2) is documented and verified with on trial section(s). In case CCC method is used, E_{v2} measurements are done only for “soft spots” to check the compatibility of these locations

with the requirements. Roller compactor must be equipped with GPS and the results shall be recorded with an accuracy of ≤ 0.2 m. The Contractor shall include in the proposed method of statement which test methods is proposed and their methodology. The application of the test methods shall be subject to the approval of the Engineer and/or Employer. Engineer and/or Employer has authority to initiate new correlation/verification tests to be conducted at any time. These costs shall be covered by the Contractor.

2.9.5.5 ALLOWABLE GEOMETRICAL TOLERANCES

- A. Allowable geometrical tolerances for excavations and fills with respect to the geometry established in the Technical Design are stated in chapter 2.9.7.7.4 "Geometrical tolerances" in these Technical specifications.
- B. Where these tolerances are exceeded, the Contractor shall correct them, at its expense. The Contractor shall scarify in a minimum depth of 150 mm, adding or removing the necessary material, re-compacting, and controlling in accordance with this section.

2.9.5.6 BORROW PITS

- A. Borrow material shall be suitable for any earthwork and shall receive the approval of the Engineer before use. The material from borrow pits can be used in frost protection layer only if it's subjected to Factory Production Control (AVCP level 4) in accordance with EN 13242 and/or EN 13285. The material from borrow pits can be used in prepared subgrade layer only if it's subjected to applicable Factory Production (AVCP level 2+) in accordance with EN 13242 and/or EN 13285. The material and declared properties shall be in accordance with requirements stated in this Technical Specification.
- B. Borrow pits shall comply with Local Regulation governing this issue and Technical design and Section 7 ENVIRONMENTAL in this Technical Specification.
- C. The Contractor shall be responsible for obtaining all the permissions and comply the environmental requirements.
- D. The borrow pits shall be run according to the Technical Specification, and on completion of the Works, they shall be left in an appropriate state according to Local Regulation.
- E. Borrow pits shall not a danger to health or a nuisance to the neighbourhood, either during the operation or after completion of the works.

The Contractor shall obtain the Engineers approval for the sites of borrow pits.

2.9.5.7 MEASUREMENT AND PAYMENT - EXCAVATION

- A. The following work items are defined:

Table 8. Units of measurement – Excavation

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_31_26_26	000101	EXCAVATION FOR REUSING IN CONSTRUCTION AFTER PROCESSING (SOFT SOIL EXCAVATION)	m3	Soft soil excavation consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.), and transportation (incl. fuel, insurance, etc.). This item is meant for granular soil that can be re-used after processing.
Pr_15_31_26_26	000102	EXCAVATION FOR REUSING IN CONSTRUCTION (SOFT SOIL EXCAVATION)	m3	Soft soil excavation consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for granular soil that can be re-used without prior processing.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_31_26_26	000106	EXCAVATION AND DISPOSING OFF SITE - PEAT	m3	Peat excavation for disposing off site consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excess material from excavation and material that is unsuitable for construction even after processing or which's processing is deemed to be too costly and shall be disposed off site, in accordance with the work methodology defined in the technical specifications.
Pr_15_31_26_26	000107	LEVELING OF THE BOTTOM OF ROCK EXCAVATIONS	m3	Leveling of the bottom of rock excavations consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for levelling of the bottom of excavations in rock with blind concrete C16/20. The excesses of measurement will not be payable, neither the possible diversions due to defects during the excavation.
Pr_15_31_26_36	000101	EXCAVATION FOR REUSING IN CONSTRUCTION (HARD SOIL EXCAVATION)	m3	Hard soil excavation consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for hard soil that can be re-used without prior processing.
Pr_15_31_26_36	000102	EXCAVATION FOR REUSING IN CONSTRUCTION (RIPPABLE)	m3	Rippable excavation consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for rippable soil that can be re-used without prior processing.
Pr_15_31_26_36	000105	EXCAVATION FOR REUSING IN CONSTRUCTION (BLASTING)	m3	Blasting excavation consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for blasted soil that can be re-used without prior processing.
Pr_15_31_26_26	000103	EXCAVATION AND DISPOSING OFF SITE - SOFT SOIL EXCAVATION	m3	Excavating soft soil consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excess material from excavation and material that is unsuitable for construction even after processing or which's processing is deemed to be too costly (e.g. certain type of clays, silts, clayey/silty soils, peat, swelling/shrinking soils, etc.) and shall be disposed off site.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_31_26_36	000103	EXCAVATION AND DISPOSING OFF SITE - HARD SOIL EXCAVATION	m3	Excavating hard soil consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excess material from excavation and material that is unsuitable for re-use even after processing or which's processing is deemed to be too costly (e.g. certain type of clays, silts, clayey/silty soils, peat, swelling/shrinking soils, etc.) and shall be disposed off site.
Pr_15_31_26_36	000104	EXCAVATION AND DISPOSING OFF SITE - RIPPABLE	m3	Excavating rippable consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excess material from excavation and material that is unsuitable for re-use even after processing or which's processing is deemed to be too costly (e.g. certain type of clays, silts, clayey/silty soils, peat, swelling/shrinking soils, etc.) and shall be disposed off site.
Pr_15_31_26_36	000106	EXCAVATION AND DISPOSING OFF SITE - BLASTING	m3	Blasting excavation consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excess material from excavation and material that is unsuitable for re-use even after processing or which's processing is deemed to be too costly (e.g. certain type of clays, silts, clayey/silty soils, peat, swelling/shrinking soils, etc.) and shall be disposed off site.
Pr_15_31_26_26	000104	EXCAVATION FOR REUSING IN CONSTRUCTION (ALL TYPES OF SOIL EXCAVATION)	m3	Soil (all types) excavation for reusing in construction consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for all types of soil that can be re-used without prior processing.
Pr_15_31_26_26	000105	EXCAVATION AND DISPOSING OFF SITE - SOIL (ALL TYPES) EXCAVATION	m3	Soil (all types) excavation for disposing off site consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excess material from excavation and material that is unsuitable for construction even after processing or which's processing is deemed to be too costly and shall be disposed off site.
Pr_15_31_26_26	000301	EXCAVATION FOR STRUCTURES FOUNDATIONS	m3	Localized excavation for structure foundations consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the excavation necessary for the execution of the foundations in structures

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_31_26_26	000302	EXCAVATION INSIDE COFFERDAM FOR STRUCTURE FOUNDATIONS	m3	Localized excavation inside cofferdam for structure foundations consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the excavation necessary for the execution of the foundations in structures localized inside a cofferdam
Ss_15_10_76_21	000301	DEWATERING OF EXCAVATION COFFERDAM INSIDE FOR FOUNDATION PITS	m3	Dewatering of excavation inside cofferdam for foundation pits consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). Measurement per m3 of water. Including pumps, staff, auxiliary equipment, and all means necessary for the execution of the works
Pr_15_31_26_26	000601	EXCAVATION IN TRENCHES WITH MECHANICAL MEANS IN ALL TYPES OF GROUND	m3	Excavation in trenches consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the excavation necessary for the execution of the trenches in all type of ground.
Pr_15_31_26_26	000602	DICHT EXCAVATION WITH MECHANICAL MEANS IN ALL TYPES OF GROUND	m3	Ditch excavation consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the excavation, by mechanical systems, of new ditches, of any geometry and slopes. Including shores.
Pr_15_31_26_26	000603	EXCAVATION OF TRIAL PIT FOR DRAINAGE PIPES SEARCH	m3	Excavation of trial pit for drainage pipes search consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the excavation necessary for the execution of trial pits in all types of soil.
Pr_15_31_26_26	000303	RIVERBED EXCAVATION FOR REUSING	m3	Localized excavation of natural soil in riverbed for reusing consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavation of natural soil in riverbed that can be re-used without prior processing
Pr_15_31_26_26	000304	EXCAVATION BETWEEN DIAPHRAGM WALLS OR CONCRETE WALLS IN ANY TYPE OF UNCOVERED TERRAIN	m3	Excavation between diaphragm walls or concrete walls in any type of uncovered terrain , consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavation of materials between diaphragm walls including load and transportation.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_31_26_26	000305	EXCAVATION BETWEEN DIAPHRAGM WALLS OR CONCRETE WALLS UNDER TOP SLAB	m3	Excavation between diaphragm walls or concrete walls under top slab , consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavation of materials between diaphragm walls under top slab including load and transportation.
Ss_20_60_30_70	000301	EXCAVATION OF DIAPHRAGM WALL BY MEANS OF GRABS, FROM 80 CM TO 100 CM THICK UP TO 30 M DEPTH	m2	Excavation of diaphragm wall by means of grabs, from 80 cm to 100 cm thick, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavation of diaphragm wall by means of grabs, from 80 cm to 100 cm thick up to 30 m deep including the total execution and and subsequent demolition of guide walls with non-structural concrete C16/20, excavation, thixotropic or bentonite slurry, cleaning of walls and p.p. of transport of mechanical equipment.
Ss_20_60_30_70	000302	EXCAVATION OF DIAPHRAGM WALL BY MEANS OF GRABS, UP TO 60 CM THICK UP TO 30 M DEPTH	m2	Excavation of diaphragm wall by means of grabs, up to 60 cm thick, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavation of diaphragm wall by means of grabs, up to 60 cm thick up to 30 m deep including the total execution and and subsequent demolition of guide walls with non-structural concrete C16/20, excavation, thixotropic or bentonite slurry, cleaning of walls and p.p. of transport of mechanical equipment.

B. The measurement of items related to excavation shall be for:

- a. Basic Survey and Detailed Setting Out, including:
 - i. scheduling, coordination and provision of all construction surveying;
 - ii. fixing coordinates, levelling and staking;
 - iii. tying the points into the national survey network;
 - iv. calculations essential to complete the project and properly control the work;
 - v. appropriate traffic control measures for all survey activities;
 - vi. marking of all survey stakes with station and offset reference;
 - vii. conducting a detailed cross section survey of the existing road for the purpose of measurement and preparing working drawings;
 - viii. provision and maintaining of reference stakes;
 - ix. renewing of illegible stakes;
 - x. relocation of initial horizontal and vertical control points, if necessary;
 - xi. protection of benchmarks;
 - xii. cooperation with utility companies and staking of control lines to relocate utilities.
- b. archaeological supervision.
- c. UXO, UXBS, and ERW hazard assessment and mitigation.

- d. Cuttings, trenches and other excavations;
- e. Removal of both unsuitable and surplus materials, including selection and separation of materials, multiple handling of material, loading into transport, haulage and deposition including the provision of sites for deposit,
- f. Foundations for structures – the volume of the void to accommodate the structure and bedding.
- g. New and enlarged watercourses, intercepting ditches; clearing abandoned watercourses.
- h. Auxiliary means.

2.9.6 TEMPORARY SUPPORT MEASURES

2.9.6.1 SCOPE OF WORKS

- A. This sub-section covers temporary support measures composed of steel sheet piles or metal props with steel panels - to be used where required by the works (i.e shoring), where specified by Technical Design or directed by the Engineer.
- B. This work includes all materials, machinery, equipment and labour, as necessary to carry out the work related to this part of the material, according to the Technical Design and Technical Specification.

2.9.6.2 NORMATIVE REFERENCES

- A. EN 10248-1 - Hot rolled sheet piling of non-alloy steels. Technical delivery conditions.
- B. EN 10248-2 - Hot rolled sheet piling of non-alloy steels. Tolerances on shape and dimensions.
- C. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

2.9.6.3 GENERAL REQUIREMENTS

- A. Steel sheets piles as temporary support measures shall be designed and executed according to relevant Local Regulation.
- B. The Contractor shall submit to the Engineer the Drawings and the stability calculations of the shoring and of any other type of support for approval. The Contractor shall be responsible for the design. The Contractor shall be responsible, in any case, for the damages derived from the lack of propping, support, and its incorrect execution.
- C. The Contractor shall keep a permanent surveillance on the behaviour of the shoring and supports, and to reinforce or replace them if necessary.

2.9.6.4 MATERIALS

- A. Steel sheet shall comply with the requirements of EN 10248-1 "Hot rolled sheet piling of non-alloy steels. Technical delivery conditions".
- B. Steel sheet shall meet the tolerances allowance demanded in EN 10248-2. "Hot rolled sheet piling of non-alloy steels. Tolerances on shape and dimensions".
- C. Steel sheet piles and accessories shall be transported and stored in accordance with the manufacturer's instructions.

2.9.6.5 CONSTRUCTION REQUIREMENTS

- A. Temporary support measures shall be included in the earthwork's method of statement and need the Engineer's approval prior the commencement of the works.
- B. The construction method shall fit the soil conditions and the Technical Design.

2.9.6.6 MEASUREMENT AND PAYMENT – TEMPORARY SUPPORT MEASURES

A. The following units are defined:

Table 9. Units of measurement – Temporary support measures

Uniclass code	Type Number	Work item	Unit	Work item includes
Ss_20_60_30_85	000301	SHEET PILES	t	Sheet pile consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the execution of provisional sheet piles driven into the ground for provide earth retention and excavation support.
Ss_20_60_30_85	000302	DISMANTLING SHEET PILES	t	Dismantling sheet piles consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the dismantling of provisional sheet piles driven into the ground for providing earth retention and excavation support.
Pr_20_85_62_10	000301	KING POST PILE	t	King post pile consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the execution of provisional steel piles driven into the ground for provide earth retention and excavation support. Including the dismantling of steel piles.
Pr_20_85_86_90	000301	SHORING EXCAVATION. AT	m2	Shoring at excavation consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for temporal earth supports through bracing the walls of excavation to prevent collapse and cave-ins.

2.9.7 FILLS AND TRACK BEDS

2.9.7.1 SCOPE OF WORKS

A. This sub-section covers the requirements for the following works:

- a. Sub-ballast layer;
- b. Frost protection layer;
- c. Prepared subgrade;
- d. Railway embankment;
- e. General fillings/embankment;
- f. Filter/graded material;
- g. Backfilling at special locations;
- h. Localised fillings;

- i. Non-structural fill associated to ecoducts;
 - j. Pavement for intermediate berms;
 - k. Rip-Rap material in river diversions;
 - l. Clay liner as impermeable layer;
 - m. Landfill formation.
- B. Fillings shall be carried out to the dimensions, lines, levels, profiles and slopes as indicated in the Technical Design Drawings, or to such other dimensions, lines, levels, profiles and slopes as the Engineer directs or approves.
- C. This section provides a needed but non-exhaustive list of labour, materials, equipment, transport and services necessary to furnish, deliver and install all work of this section as shown on the drawings and BIM models, as specified herein and/or as required by job conditions.

2.9.7.2 GENERAL REQUIREMENTS

- D. Soils and construction materials used for constructing the embankments and the track bed layers shall meet all the requirements described in the Technical Design (e.g. soil classification according to EN 14688-1, EN 14688-2, UIC 719R, or other method stated in the Technical Design and Technical Specification).
- E. Materials excavated on site can be used for constructing embankment and frost protection layer only after verifying the required properties and proving the suitability for intended use. Contractor shall have appropriate Factory Production Control and issue Declaration of Performance (or Declaration of Conformity, if applicable) in accordance with applicable standard's requirements. As a minimum, AVCP³ level 4 shall be adopted by the Contractor processing the materials for embankment and frost protection layers and therefore taking full responsibility of the declared properties of the material.
- F. The Contractor shall ensure that all materials, including materials excavated on site, maintain their properties during the excavation, loading, transportation, intermediate storing, prior and after installation
- G. The Contractor shall ensure that suitable materials shall not mix with unsuitable materials.
- H. The Contractor shall organize the storing of suitable and unsuitable material.
- I. Unsuitable material shall not be used for constructing before processing. Unsuitable material shall be utilized by the Contractor according to applicable local regulations.
- J. The Contractor shall prepare the foundation ground to the appropriate grade before placing fill over it.
- K. The Contractor shall be responsible for the location of suitable base layer material and selected material fill to meet the specified requirements.
- L. Material for fillings shall be obtained from approved sources or selected from excavations containing no vegetable or perishable matter, graded to ensure a dense, stable and homogeneous fill when compacted. The use of any necessary borrow pits shall be subject to the approval of the Engineer.
- M. Prior to commencement of filling, the Contractor shall submit to the Engineer the proposed method of statement for the works for approval. No filling shall be carried out until the Engineer approves the proposal and the material intended to be used.
- N. Embankment construction shall be done simultaneously with embankment slopes. In case slopes are constructed later, this shall be done by creating steps with up to 1 to 3m wide and 0.3 to 0.6 m high.
- O. The Contractor shall conduct compaction testing in accordance with methods and frequencies stated in this Technical Specification (Internal Control Testing). Acceptance testing shall be arranged by the Engineer and/or Employer with not more than 5 times the frequency stated in this Technical Specification, i.e. plate loading test shall be conducted at least once per 500 m and compaction degree at least once per 100 m. Acceptance testing shall be done at the locations selected by the Engineer and/or Employer. The Contractor shall provide equipment and personnel to conduct acceptance testing, if necessary, to the Engineer and/or Employer. Internal Control Testing reports shall be submitted to Engineer and/or Employer.

³ AVCP - The Assessment and Verification of Constancy of Performance (AVCP) is a harmonised system defining how to assess products and control the constancy of the assessment results. This system safeguards the reliability and accuracy of the Declaration of Performance [European Commission]

- P. During the construction phase, different direct/indirect test methods (e.g. continuous compaction control (CCC) method, deflectometers (LWD, FWD, E_{v2}/E_{v1} , Troxler, etc.) can be used if the correlation with the reference method is documented and/or verified with trial section. The Contractor shall include in the proposed method of statement which test methods is proposing and their methodology. The application of the test methods shall be subject to the approval of the Engineer.
- Q. The Contractor shall take all necessary measures to prevent any damage or defects to the Works, which may be caused by settlements, slips or falls of embankments. And if such occurs The Contractor shall fix the damage and restore affected elements to their normal state in the way agreed with the Engineer.
- R. Any instability of any adjacent excavation resulting from the embankment not being formed to the lines, levels and profile shown in the Drawings or as ordered by the Engineer shall be the responsibility of the Contractor.
- S. Where double handling of excavated material is necessary, the Contractor shall be responsible for the temporary disposition of the material such that it does not endanger the stability of the excavation.

2.9.7.3 CLASSIFICATION OF MATERIALS

- A. The suitability of a soil for being used as railway embankment and bed layer is determined according to UIC-719R (2008) - Earthworks and track bed construction for railway lines", according to the following Table 10 and
- B. Table 11.

Table 10. Soil quality classes according to UIC-719 R

Soil Type (geotechnical classification)		Soil quality class
0.1	High-organic soils	QS0
0.2	Soft soils containing more than 15% of fines ^a , with a high moisture content, unsuitable for compaction	
0.3	Thixotropic soils ^b (f.e. quick-clay)	
0.4	Soils containing soluble material (e.g. rock salt or gypsum)	
0.5	Contaminated ground (f.e. industrial waste)	
0.6	Medium-organic soils ^b	
0.7	High plasticity soils with more than 15% of fines, collapsible soils ^c or expansive soils ^d	
1.1	Soils containing more than 40% of fines ^a (except for soils classified under 0.2 or 0.7)	QS1
1.2	Rocks which are very susceptible to weathering E.g.: Chalks with $\rho_d < 1.7 \text{ t/m}^3$ and high friability Marl Weathered shale	
1.3	Soils containing more than 15 to 40% of fines ^a (except for soils classified under 0.2 or 0.7)	
1.4	Rocks which are moderately susceptible to weathering E.g.: Chalks with $\rho_d < 1.7 \text{ t/m}^3$ and low friability Unweathered shale	QS1 ^e
1.5	Soft rock E.g.: Microdeval wet (MED) > 40 and Los Angeles (LA) > 40	
2.1	Soils containing from 5 to 15% of fines ^a except collapsible soils ^c	
2.2	Uniform soils containing less than 5% of fines ^a ($CU \leq 6$) except collapsible soils ^d	QS2 ^f
2.3	Moderately hard rock E.g.: If $25 < MDE \leq 40$ and $30 < LA \leq 40$	

Soil Type (geotechnical classification)		Soil quality class
3.1	Well graded soils containing less than 5% of fines ^a	QS3
3.2	Hard rock E.g.: If $MDE \leq 25$ and $LA \leq 30$	
Notes: <div>a) These percentages are calculated from particle size distribution analysis undertaken on material passing a 63 mm sieve. The percentages indicated here have been rounded down; they may be increased by up to 5% if a sufficiently representative number of samples is taken.</div> <div>b) Certain railways sometimes include these soils in quality class QS1.</div> <div>c) Collapse settlement higher than 1% for undisturbed samples or for remoulded samples with the standard Proctor Density and a normal pressure of 0.2 MPa.</div> <div>d) Free swelling higher than 3% for undisturbed samples or for remoulded samples with the standard Proctor density.</div> <div>e) These soils can come under class QS2 if the hydrogeological and hydrological conditions are good.</div> <div>f) These soils can come under quality class QS3 if the hydrogeological and hydrological conditions are good.</div>		

Table 11. QSi Quality Classes for Soils a (as per UIC 719R)

QSi Quality Classes for Soils a (as per UIC 719R)	
QS0	'Unsuitable' soils which do not form a suitable subgrade and therefore require improvement. These soils are not considered for dimensioning the track bed layers.
QS1	'Poor' soils which are acceptable in their natural condition subject to adequate drainage being provided and maintained in good order. These soils could be considered for upgrading by means of the appropriate treatment (e.g. stabilization binding agents).
QS2	'Average' soils
QS3	'Good' soils

C. UIC 719R Soil QS classes related with EN 16907-2 soil groups is described in Table 12.

Table 12. QS soil classes and EN 16907-2 soil groups

Parameter	QS quality class			
	QS0	QS1	QS2	QS3
Group name according to EN 16907-2	F4 - FV	I1 - IL- I2- IM F1 - FL- F2 FM - F3 – FH	G2 – S2 G4 – S4	G1 – S1 G3 – S3

2.9.7.4 SUB-BALLAST

2.9.7.4.1 MATERIALS

- A. Sub-ballast layer shall be built with unbound mixture (produced in accordance with EN 13242 and EN 13285, AVCP level 2+).
- B. The material shall meet the minimum requirements described in the Table 13 below:

Table 13. Minimum requirements - Material for sub-ballast layer

Property	Requirement	Reference
Mixture designation Maximum aggregate D	0/32, 0/45, 0/56	EN 13285

Property	Requirement	Reference
Fines content category (passing 0.063 sieve)	UF ₅ (≤5%)	EN 13285
Content of particles below 0.02mm	<3%	EN 14688-2
Oversize	OC ₉₀	EN 13285
Grading category	G ₈	EN 13285
Percentage of crushed or broken particles and totally rounded particles	C _{50/30}	EN 13242
Resistance to fragmentation	LA ₃₀	EN 13242
Resistance to frost category	F ₂	EN 13242
Content of harmful fines (MB _F value) ^(a)	≤10g/kg	EN 13242
Organic content (C _{OM})	LOI<1%	LOI ^(b)
Notes: a) Applicable if fines content is above 3%, see EN 13242 Annex A. b) Accreditation for compliant European harmonized standard for LOI test. The conditions of test shall be tested in accordance with EN 1997-2 Annex N, Clause N.2. Test shall be conducted on the material that is passing 2 mm sieve. The minimum ignition temperature shall be 440 °C +/-25°C. Other temperatures may be considered, depending on the type of material. Nevertheless, any deviations from shall be agreed separately with Engineer and/or Employer.		

- C. The properties of the material shall be checked prior to installation (verification testing) by the Contractor. Verification testing for gradation related properties shall be carried out by the Contractor at least once per 1000m³ (per source/quarry). If applicable, other geometric, physical, chemical and durability-related properties (resistance to fragmentation, frost resistance, etc.) shall be assessed at least once per 5000 m³ (per source/quarry). The Engineer shall conduct acceptance testing at a minimum frequency of once per volume that is three times the volume stated above.
- D. The material to be used in the formation of the sidewalks along the route shall comply the requirements in Table 13.

2.9.7.4.2 CONSTRUCTION REQUIREMENTS

- A. Sub-ballast layer dimensions (thickness, cross slope, slope) shall be those shown on Technical Design Drawings.
- B. Sub-ballast layer shall only be placed on completely thawed substructure which shall meet the properties stated in the Technical Design and Technical Specification. If requested by the Engineer, this shall be proven by the Contractor via control excavations on site.
- C. Weather conditions during the works shall not produce alterations in the material's moisture so that it exceeds by more than 2% the optimum moisture content.
- D. Spreading shall be carried out avoiding segregation and contamination of the material, in two layers.
- E. Once the sub-ballast layer is finished and refined to its geometrical shape and levels, it shall be protected. The Contractor shall be responsible for ensuring that traffic on top of the sub-ballast layer is not allowed.
- F. If technically applicable, the sub-ballast layer shall be constructed after installing catenary foundations.

2.9.7.4.3 COMPACTION REQUIREMENTS

- A. Sub-ballast layer minimum compaction degree and stiffness requirements with testing frequency shall be as following table:

Table 14. Compaction requirements - Sub-ballast layer

Property	Minimum requirement	Reference	Testing frequency
In-situ density (D_{pr})	$\geq 103\%$ of D_{pr} determined by EN 13286 Standard Proctor Compaction	Field density (ASTM D1556 / D1556M or ASTM D6938 or DIN 18125-2)	Once per 20m, 2 locations – under the railway and near the edge
Strain modulus after second loading, E_{V2}	$\geq 120\text{MPa}$ $E_{V2}/E_{V1} \leq 2.2$	DIN 18134	Once per 100m, 2 locations – under the railway and near the edge

- B. If the results obtained do not reach the minimum values stated herein, the surface shall be moistened and re-compacted until the required values are reached. If the required degree of performance is not obtained, the layer shall be removed and re-built at the Contractor expense.
- C. During the construction phase, different direct/indirect test methods (e.g. continuous compaction control (CCC) method, deflectometers (LWD, FWD, E_{V2}/E_{V1} , Troxler, etc.) can be used if the correlation with the reference method is documented and/or verified with trial section. The Contractor shall include in the proposed method of statement which test methods is proposing and their methodology. The application of the test methods shall be subject to the approval of the Engineer.
- D. The compacted layer shall present homogeneity in visual inspection and when tested, with no points showing defective behaviour.

2.9.7.4.4 GEOMETRICAL TOLERANCES

- A. Sub-ballast layer shall fulfil the geometrical requirements stated in the following table:

Table 15. Geometrical tolerances - Sub-ballast layer

Geometric property	Allowable deviation, single measurement	Allowable deviation, average (5 measurements)	Method	Testing frequency
Height	$\pm 50\text{ mm}$	$\pm 20\text{ mm}$	Geodetic	20 m
Width	$+ 50\text{ mm}$ $- 0\text{ mm}$		Geodetic	20 m
Crossfall	$\pm 0,5\%$		Geodetic	20 m
			3 m straightedge	In case of suspicion
Alignment	$\pm 100\text{ mm}$		Geodetic	20 m
Evenness	$\pm 20\text{ mm}$		3 m straightedge	In case of suspicion

- B. Where these tolerances are exceeded, the Contractor shall correct them, at its expense. The Contractor shall scarify in a minimum depth of 150mm, adding or removing the necessary material, re-compacting, and controlling in accordance with this section.

2.9.7.4.5 MEASUREMENT AND PAYMENT. SUB-BALLAST

- A. The following work items are defined:

Table 16. Units of measurement – Sub-ballast layer

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_31_04_06	000101	SUB-BALLAST FROM IMPORTED MATERIAL	m3	Sub-ballast fill consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported materials that are suitable for constructing sub-ballast layer.

B. The items shall include for:

- a. Basic Survey and Detailed Setting Out, including:
 - i. scheduling, coordination and provision of all construction surveying;
 - ii. fixing coordinates, levelling and staking;
 - iii. tying the points into the national survey network;
 - iv. calculations essential to complete the project and properly control the work;
 - v. appropriate traffic control measures for all survey activities;
 - vi. marking of all survey stakes with station and offset reference;
 - vii. conducting a detailed cross section survey of the existing road for the purpose of measurement and preparing working drawings;
 - viii. provision and maintaining of reference stakes;
 - ix. renewing of illegible stakes;
 - x. relocation of initial horizontal and vertical control points, if necessary;
 - xi. protection of benchmarks;
 - xii. cooperation with utility companies and staking of control lines to relocate utilities.
- b. fill provided by the Contractor from sources outside the Site or excavations in the Site, meeting the requirement in the Specification
- c. protection of subgrade;
- d. multiple handling of material;
- e. keeping earthworks free of water;
- f. complying with requirements and constraints on the sequence, timing and rate of deposition and filling, and equalisation of earth pressures;
- g. complying with the particular requirements and constraints with regard to soil stabilisation, reinforced earth structures, strengthened embankments, anchored earth structures, corrugated steel buried structures and the like;
- h. taking precautions to avoid damage to property, structures, drains, services, instrumentation and the like;
- i. replacing acceptable material rendered unacceptable;
- j. selection of material and layering or depositing in locations stated in the Contract;
- k. depositing fill to slope away from vertical drainage layers and measures to prevent surface water entering such layers;
- l. trimming and shaping to levels and contours;
- m. trial areas, trials and demonstrations;
- n. making good after sampling and testing;
- o. forming and trimming side slopes, benching and beams;
- p. treatment of side slopes and berms;

- q. watering or drying to adjust moisture content;
- r. compaction of fill;
- s. blinding;
- t. special measures for dealing with processed material;
- u. Auxiliary means;
- v. Temporary works.

2.9.7.5 PREPARED SUBGRADE

2.9.7.5.1 MATERIALS

- A. Prepared subgrade materials shall meet the requirements stated in the Technical Design.
- B. Prepared subgrade materials shall be produced in accordance with EN 13285 (AVCP level 2+), meeting the QS3 soil quality class requirements and this Technical Specification.
- C. The material to be used for prepared subgrade shall meet the minimum requirements described in the Table 17 below:

Table 17. Minimum requirements - Material for prepared subgrade

Property	Requirement	Reference
Mixture designation Maximum aggregate D ^(a)	$D \leq 63\text{mm}$	EN 13285
Fines content category (passing 0.063 sieve)	UF ₅ ($\leq 5\%$)	EN 13285
Content of particles below 0.02mm	$< 3\%$	EN 14688-2
Oversize	OC ₉₀	EN 13285
Grading category	Gv	EN 13285
Resistance to frost category ^(b)	F ₄	EN 13242
Content of harmful fines (MB _F value) ^(c)	$\leq 10\text{g/kg}$	EN 13242
Organic content (C _{OM})	LOI $< 1\%$	LOI ^(d)
Notes: c) Upper size D shall be selected based on the requirement for Coefficient of Uniformity $C_u \geq 6$; d) Applicable to unbound mixtures produced from gravel and crushed rock. Not applicable to natural sand (Sa), gravelly sand (grSa) or sandy gravel (saGr). Gravel and crushed rock is only allowed if the gravel or crushed rock mixture complies with the requirements described in Clause 2.9.7.5.1, sub-clause F of this Technical Specification; e) Applicable if fines content is above 3%, see EN 13242 Annex A. f) Accreditation for compliant European harmonized standard for LOI test. The conditions of test shall be tested in accordance with EN 1997-2 Annex N, Clause N.2. Test shall be conducted on the material that is passing 2 mm sieve. The minimum ignition temperature shall be 440 °C +/- 25°C. Other temperatures may be considered, depending on the type of material. Nevertheless, any deviations from shall be agreed separately with Engineer and/or Employer.		

- D. The properties of the material shall be checked prior to installation (verification testing) by the Contractor. Verification testing for gradation related properties shall be carried out by the Contractor at least once per 1000m³ (per source/quarry). If applicable, other geometric, physical, chemical and durability-related properties (resistance to fragmentation, frost resistance, etc.) shall be assessed at least once per 5000 m³ (per source/quarry). The Engineer shall conduct acceptance testing at a minimum frequency of once per volume that is three times the volume stated above.

2.9.7.5.2 CONSTRUCTION REQUIREMENTS

- A. Prepared subgrade layer thickness shall be that shown on Technical Design Drawings.
- B. Any layer shall not be spread until the support surface has been verified by the Engineer (levels, degree of compaction). Any defects or irregularities exceeding the tolerances shall be corrected. The surface shall be scarified to a minimum depth of 150mm, adding or removing the necessary material and re-compacting and refining.
- C. The material shall be spread in layers of thickness between 0.20m and 0.30m, avoiding segregations and contamination.
- D. Weather conditions during the works shall not produce alterations in the material's moisture so that it exceeds by more than 2% the optimum moisture content.
- E. Wetting of the material shall be made before compaction. Wetting after compaction is only allowable for the preparation of the surface for lying next layer to be compacted.
- F. Compaction shall be carried out longitudinally, starting at the outer edges, and progressing towards the centre to overlap each compaction path by a width not less than one third (1/3) of the compacting element.
- G. In areas where, due to their small size, slope gradient or proximity to road works or drains or structures, the use of the usual equipment is not possible, the material shall be compacted with the appropriate means to achieve the required reference density.
- H. Railway substructure may be subject to hold period to facilitate settlements or keeping over the winter period. The Contractor is responsible to ensure that prepared subgrade properties will meet the geometrical tolerances and compaction degree after the hold period/winter. The acceptance of works will be done after hold period/winter by Engineer.

2.9.7.5.3 COMPACTION REQUIREMENTS

- A. Prepared subgrade layer minimum compaction degree and stiffness requirements with testing frequency shall be as following Table 18:

Table 18. Compaction requirements - Prepared subgrade

Property	Minimum requirement	Method	Testing frequency
In-situ density D_{pr}	$\geq 100\%$ of D_{pr} determined by EN 13286 Standard Proctor Compaction	Field density (ASTM D1556 / D1556M or ASTM D6938 or DIN 18125-2)	Once per 20m, 2 locations – under the railway and near the edge ($\leq 1.0m$)
Strain modulus after second loading E_{v2}	$\geq 80MPa$ – untreated materials $E_{v2}/E_{v1} \leq 2.2$	DIN 18134	Once per 100m, 2 locations – under the railway and near the edge ($\leq 1.0m$)
	$\geq 120MPa$ – treated materials $E_{v2}/E_{v1} \leq 2.2$		

- B. If the results obtained do not reach the minimum values stated herein, the surface shall be moistened and re-compacted until the required values are reached. If the required degree of performance is not obtained, the layer shall be removed and re-built at the Contractor expense.
- C. The compacted layer shall present homogeneity in visual inspection and when tested, with no points showing defective behaviour.
- D. During the construction phase, different direct/indirect test methods (e.g. continuous compaction control (CCC) method, deflectometers (LWD, FWD, E_{v2}/E_{v1} , Troxler, etc.) can be used if the correlation with the reference method is documented and/or verified with trial section. The Contractor shall include in the proposed method of statement which test methods is proposing and their methodology. The application of the test methods shall be subject to the approval of the Engineer.

2.9.7.5.4 GEOMETRICAL TOLERANCES

A. Prepared subgrade layer shall fulfil the geometry tolerances stated in following table:

Table 19. Geometrical tolerances - Prepared subgrade

Geometric property	Allowable deviation, single measurement	Allowable deviation, average (5 measurements)	Method	Frequency
Height	± 50 mm	+ 20 mm - 50 mm	Geodetic	20 m
Width	+ 150 mm - 0 mm		Geodetic	20 m
Slopes	Not steeper than designed		Geodetic	In case of suspicion
Crossfall	± 1,0 %		Geodetic	20 m
			3 m straightedge	In case of suspicion
Alignment	± 100 mm		Geodetic	20 m
Evenness	± 30 mm		3 m straightedge	In case of suspicion

B. Where these tolerances are exceeded, the Contractor shall correct them, at its expense. The Contractor shall scarify in a minimum depth of 150mm, adding or removing the necessary material, re-compacting, and controlling in accordance with this section.

2.9.7.5.5 MEASUREMENT AND PAYMENT. PREPARED SUBGRADE

A. The following work items are defined:

Table 20. Units of measurement - Prepared Subgrade

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_31_04_06	000102	PREPARED SUBGRADE FROM IMPORTED MATERIAL	m3	Prepared subgrade fill consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported materials that are suitable for constructing prepared subgrade.
Pr_20_31_04_06	000103	PREPARED SUBGRADE FROM EXCAVATED MATERIAL	m3	Prepared subgrade fill consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated materials that are suitable for constructing prepared subgrade.

B. The items shall include for:

- a. Basic Survey and Detailed Setting Out, including
 - i. scheduling, coordination and provision of all construction surveying;
 - ii. fixing coordinates, levelling and staking;

- iii. tying the points into the national survey network;
- iv. calculations essential to complete the project and properly control the work;
- v. appropriate traffic control measures for all survey activities;
- vi. marking of all survey stakes with station and offset reference;
- vii. conducting a detailed cross section survey of the existing road for the purpose of measurement and preparing working drawings;
- viii. provision and maintaining of reference stakes;
- ix. renewing of illegible stakes;
- x. relocation of initial horizontal and vertical control points, if necessary;
- xi. protection of benchmarks;
- xii. cooperation with utility companies and staking of control lines to relocate utilities.
- b. fill provided by the Contractor from sources outside the Site or excavations in the Site, meeting the requirement in the Specification
- c. protection of subgrade;
- d. multiple handling of material;
- e. keeping earthworks free of water;
- f. complying with requirements and constraints on the sequence, timing and rate of deposition and filling, and equalisation of earth pressures;
- g. complying with the particular requirements and constraints with regard to soil stabilisation, reinforced earth structures, strengthened embankments, anchored earth structures, corrugated steel buried structures and the like;
- h. taking precautions to avoid damage to property, structures, drains, services, instrumentation and the like;
- i. replacing acceptable material rendered unacceptable;
- j. selection of material and layering or depositing in locations stated in the Contract;
- k. depositing fill to slope away from vertical drainage layers and measures to prevent surface water entering such layers;
- l. trimming and shaping to levels and contours;
- m. trial areas, trials and demonstrations;
- n. making good after sampling and testing;
- o. forming and trimming side slopes, benching and beams;
- p. treatment of side slopes and berms;
- q. watering or drying to adjust moisture content;
- r. compaction of fill;
- s. blinding;
- t. special measures for dealing with processed material;
- u. Auxiliary means;
- v. Temporary works.

2.9.7.6 FROST PROTECTION LAYER

2.9.7.6.1 MATERIALS

- A. Frost protection layer materials shall meet the requirements stated in the Technical Design.
- B. Frost protection layer materials shall be produced in accordance with EN 13285 (AVCP level 4).

- C. Materials to be used in frost protection layer shall be similar to those used for the general embankment, complying the following additional requirements in Table 21.

Table 21. Minimum requirements - Material for frost protection layer

Property	Requirement	Reference
Mixture designation	$D \leq 63\text{mm}$	EN 13285
Maximum aggregate D		
Fines content category (passing 0.063 sieve)	$UF_5 (\leq 5\%)$	EN 13285
Content of particles below 0.02mm	$< 3\%$	EN 14688-2
Oversize	OC_{90}	EN 13285
Grading category	G_v	EN 13285
Resistance to frost category ^(a)	F4	EN 13242
Content of harmful fines (MB_F value) ^(b)	$\leq 10\text{g/kg}$	EN 13242
Organic content (C_{OM})	$LOI < 1\%$	$LOI^{(c)}$
Notes: a) Only applicable to unbound mixtures produced from gravel and crushed rock. Not applicable to natural sand (sa), gravelly sand (grSa) or sandy gravel (saGr). Gravel and crushed rock is only allowed if the gravel or crushed rock mixture complies with the requirements described in Clause 2.9.7.5.1, sub-clause f of this Technical Specification; b) Only applicable if fines content is above 3% (see EN 13242 Annex 5) c) Accreditation for compliant European harmonized standard for LOI test. The conditions of test shall be tested in accordance with EN 1997-2 Annex N, Clause N.2. Test shall be conducted on the material that is passing 2 mm sieve. The minimum ignition temperature shall be $440^\circ\text{C} \pm 25^\circ\text{C}$. Other temperatures may be considered, depending on the type of material. Nevertheless, any deviations from shall be agreed separately with Engineer and/or Employer.		

- D. In addition to UIC 719 soil quality class requirements, frost protection layer material shall also meet the frost susceptibility criteria described in next Figure:

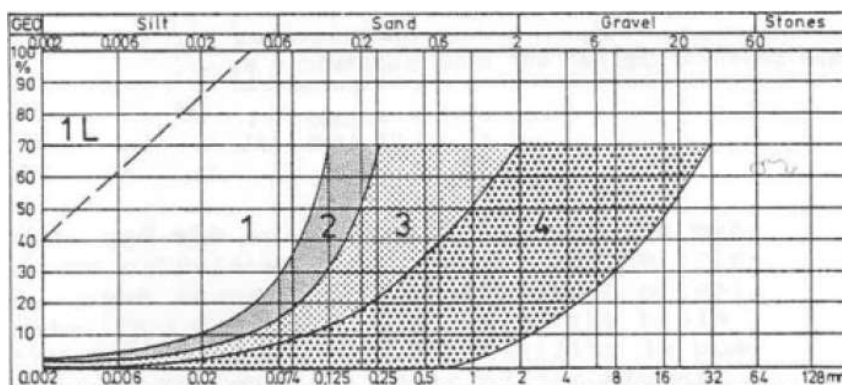


Figure 1. Frost susceptibility assessment criteria. Gradation limits for frost non-susceptible soils (according to "DETERMINATION OF FROST-SUSCEPTIBILITY OF SOILS", Slunga, E., Saarelainen, S., 1989)

Note to Figure:

If the gradation lies completely within the region 1, the soil is always frost susceptible, in the region 1L, the frost-susceptibility of a soil is low;

If the gradation falls completely inside the regions 2, 3 or 4, the soil is not susceptible to frost;

If the lower part of the gradation permanently passes the boundary of the next region on the finer side (upper limit), the soil is frost susceptible.

- E. The properties of the material shall be checked prior to installation (verification testing) by the Contractor. Verification testing for gradation related properties shall be carried out by the Contractor at least once per 1000 m^3 (per source/quarry). If applicable, other geometric, physical, chemical and durability-related properties (resistance to fragmentation, frost resistance, etc.) shall be assessed at least once per 5000 m^3 (per source/quarry).

The Engineer shall conduct acceptance testing at a minimum frequency of once per volume that is three times the volume stated above.

2.9.7.6.2 CONSTRUCTION REQUIREMENTS

- A. Frost protection layer thickness shall be as shown on Drawings.
- B. Frost protection layer construction is only allowed on surfaces that are controlled, meet the requirements and are acceptable.
- C. Frost protection layer shall be compacted in layers with appropriate thickness described in Table 34.

2.9.7.6.3 COMPACTION REQUIREMENTS

- A. Frost protection layer minimum compaction degree and stiffness requirements with testing frequency shall be as following Table 22.

Table 22. Compaction requirements - Frost protection layer

Property	Minimum requirement	Reference method	Testing frequency
In-situ density D_{pr}	$\geq 97\%$ of D_{pr} determined by EN 13286 Standard Proctor Compaction	Field density (ASTM D1556 / D1556M or ASTM D6938 or DIN 18125-2)	Once per 20 m, 2 locations – under the railway and near the edge
Strain modulus after second loading E_{v2}	≥ 45 MPa – fine materials $E_{v2}/E_{v1} \leq 2.2$	DIN 18134	Once per 100 m, 2 locations – under the railway and near the edge
	≥ 60 MPa – sandy or gravelly materials $E_{v2}/E_{v1} \leq 2.2$		
	≥ 80 MPa – treated materials $E_{v2}/E_{v1} \leq 2.2$		

- B. If the results obtained do not reach the minimum values stated herein, the surface shall be moistened and re-compacted until the required values are reached. If the required degree of performance is not obtained, the layer shall be removed and re-built at the Contractor expense.
- C. The compacted layer shall present homogeneity in visual inspection and when tested, with no points showing defective behaviour.
- D. During the construction phase, different direct/indirect test methods (e.g. continuous compaction control (CCC) method, deflectometers (LWD, FWD, E_{v2}/E_{v1} , Troxler, etc.) can be used if the correlation with the reference method is documented and/or verified with trial section. The Contractor shall include in the proposed method of statement which test methods is proposing and their methodology. The application of the test methods shall be subject to the approval of the Engineer

2.9.7.6.4 GEOMETRICAL TOLERANCES

- A. Frost protection layer shall fulfil the geometry tolerances stated in following

- B. Table 23.
- C. Where these tolerances are exceeded, the Contractor shall correct them, at its expense. The Contractor shall scarify in a minimum depth of 150mm, adding or removing the necessary material, re-compacting, and controlling in accordance with this section.

Table 23. Geometrical tolerances - Frost protection layer

Geometric property	Allowable deviation, single measurement	Allowable deviation, average (5 measurements)	Method	Frequency
Height	± 50 mm	+ 20 mm - 50 mm	Geodetic	20 m
Width	+ 150 mm - 50 mm		Geodetic	20 m
Slopes	Not steeper than designed		Geodetic	In case of suspicion
Crossfall	± 1,0 %		Geodetic	20 m
			3 m straightedge	In case of suspicion
Alignment	± 100 mm		Geodetic	20 m
Evenness	± 50 mm		3 m straightedge	In case of suspicion

2.9.7.6.5 MEASUREMENT AND PAYMENT. FROST PROTECTION LAYER

A. The following work items are defined:

Table 24. Units of measurement –Frost protection layer

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_31_04_06	000104	FROST PROTECTION LAYER FROM IMPORTED MATERIAL	m3	Frost protection layer fill consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported materials that are suitable for constructing frost protection layer.
Pr_20_31_04_06	000105	FROST PROTECTION LAYER EXCAVATED MATERIAL	m3	Frost protection layer fill consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated materials that are suitable for constructing frost protection layer.

B. The items shall include for:

- a. Basic Survey and Detailed Setting Out, including:
 - i. scheduling, coordination and provision of all construction surveying;
 - ii. fixing coordinates, levelling and staking;
 - iii. tying the points into the national survey network;
 - iv. calculations essential to complete the project and properly control the work;
 - v. appropriate traffic control measures for all survey activities;
 - vi. marking of all survey stakes with station and offset reference;

- vii. conducting a detailed cross section survey of the existing road for the purpose of measurement and preparing working drawings;
- viii. provision and maintaining of reference stakes;
- ix. renewing of illegible stakes;
- x. relocation of initial horizontal and vertical control points, if necessary;
- xi. protection of benchmarks;
- xii. cooperation with utility companies and staking of control lines to relocate utilities.
- b. fill provided by the Contractor from sources outside the Site or excavations in the Site, meeting the requirement in the Specification
- c. protection of subgrade;
- d. multiple handling of material;
- e. keeping earthworks free of water;
- f. complying with requirements and constraints on the sequence, timing and rate of deposition and filling, and equalisation of earth pressures;
- g. complying with the particular requirements and constraints with regard to soil stabilisation, reinforced earth structures, strengthened embankments, anchored earth structures, corrugated steel buried structures and the like;
- h. taking precautions to avoid damage to property, structures, drains, services, instrumentation and the like;
- i. replacing acceptable material rendered unacceptable;
- j. selection of material and layering or depositing in locations stated in the Contract;
- k. depositing fill to slope away from vertical drainage layers and measures to prevent surface water entering such layers;
- l. trimming and shaping to levels and contours;
- m. trial areas, trials and demonstrations;
- n. making good after sampling and testing;
- o. forming and trimming side slopes, benching and beams;
- p. treatment of side slopes and berms;
- q. watering or drying to adjust moisture content;
- r. compaction of fill;
- s. blinding;
- t. special measures for dealing with processed material;
- u. Auxiliary means;
- v. Temporary works.

2.9.7.7 EMBANKMENT

2.9.7.7.1 MATERIALS

- A. Embankment material quality classes are defined in the Technical Design in accordance with Table 10 and
- B. Table 11.

Table 11. QSi Quality Classes for Soils a (as per UIC 719R)

- C. The properties of the fill material shall be checked prior to installation (verification testing) by the Contractor. Verification testing for gradation related properties shall be carried out by the Contractor at least once per 2000 m³ (per source/quarry). If applicable, other geometric, physical, chemical and durability-related properties (resistance to fragmentation, frost resistance, etc.) shall be assessed at least once per 10000 m³ (per

source/quarry). The Engineer shall conduct acceptance testing at a minimum frequency of once per volume that is three times the volume stated above.

D. EMBANKMENT CORE

- a. The material to be used in the core of the embankment shall be QS1 (sandwich layer structure) or QS2.

E. EMBANKMENT BASE

a. EMBANKMENT BASE IN NORMAL CONDITIONS

- i. The material to be used in the base of the embankment in normal conditions shall be QS2. Normal conditions are different from those described herein below.

b. EMBANKMENT BASE IN FLOOD RISK AREAS

- i. Materials to be used in embankment in temporarily flooded areas shall be permeable, and similar to those used for the general embankment, complying the following additional, more restrictive requirements:

Table 25. Minimum requirements - Material for embankment base in flood areas

Property	Requirement	Reference
Granular materials or rocks insensitive to water and washout of infill material and to frost		
Maximum aggregate size D	$D \leq 630\text{mm}$	EN 13285
Fines content (% material passing 0.063 sieve)	$UF_5 (\leq 5\%)$	EN 13285
Resistance to fragmentation	LA_{35}	EN 13242
Not sensitive to water Content of harmful fines (MB_F value) ^(a)	$\leq 10\text{g/kg}$	EN 13242
(a) - Only applicable if fines content is above 3% (see EN 13242 Annex 5)		

- ii. Embankment base material shall prevent fine migrations through it when the supporting ground is silty or clayey. Where shown on the Technical Design Drawings, the base shall consist of filter material, composed of gravel or crushed rock. It shall be verified that between two (2) successive layers the following conditions are accomplished:

$$\bullet \quad (I_{15}/S_{85}) < 5; \quad (I_{50}/S_{50}) < 25; \quad (I_{15}/S_{15}) < 20$$

where:

I_x is the sieve opening through which passes the x% in weight of the material of the lower layer

S_y is the sieve opening through which passes the y% in weight of the material of the upper layer.

c. EMBANKMENT BASE IN DAMP AREAS

- i. This sub-clause shall apply for embankments located in hydromorphic areas (areas where the soil is saturated with water for at least part of the year, and water can cause structural disturbances – low bearing capacity, frost heave, swelling, ...), according to the Technical Design, or where directed by the Engineer due to the course of the works.
- ii. Materials to be used in embankment bases in damp areas (when conditions of possible saturation due to high groundwater table or damp areas are present) shall be similar to those used for the general embankment, complying the following additional requirements:

Table 26. Minimum requirements - Material for embankment base in damp areas

Property	Requirement	Reference
Granular materials or rocks insensitive to water and washout of infill material and to frost		
Maximum aggregate size D	$D \leq 630\text{mm}$	EN 13285
Fines content (% material passing 0.063 sieve) ^(a)	$UF_{15} (\leq 15\%)$	EN 13285
(a) - extending this requirement in embankment core up to a height of 2m above the natural ground surface (or stripping fill if any)		

- iii. Embankment bases in damp areas built with materials treated with hydraulic binders on compressible supporting soils are not allowed.
- d. EMBANKMENT BASE IN MARSHLAND AREAS
 - i. Materials to be used in embankment base fills in marshland areas shall be similar to those used for the general embankment, complying the following additional requirements:

Table 27. Minimum requirements - Material for embankment base in marshland areas

Property	Requirement	Reference
Granular materials or rocks insensitive to water and washout of infill material and to frost		
Maximum aggregate size D	$D \leq 630\text{mm}$	EN 13285
Fines content (% material passing 0.063 sieve)	$UF_5 (\leq 5\%)$	EN 13285
Not sensitive to water Content of harmful fines (MB_F value) ^(a)	$\leq 10\text{g/kg}$	EN 13242
a) Only applicable if fines content is above 3% (see EN 13242 Annex 5)		

- ii. Embankment bases in marshland areas built with hydraulically bound materials are not allowed due to the risk of induced cracking.
- e. EMBANKMENT BASE UNDERWATER
 - i. Materials to be used in embankment base fills below water level or in permanently flooded areas shall be similar to those used for the general embankment, complying the following additional requirements:

Table 28. Minimum requirements - Material for embankment base underwater

Property	Requirement	Reference
Maximum aggregate size D	$D \leq 630\text{mm}$	EN 13285
Material passing 5mm sieve	$\leq 10\%$	EN 13285
Material passing 50mm sieve	$\geq 60\%$	EN 13285
Not sensitive to water Content of harmful fines (MB_F value) ^(a)	$\leq 10\text{g/kg}$	EN 13242
a) Only applicable if fines content is above 3% (see EN 13242 Annex 5)		

- ii. Embankment bases underwater built with hydraulically bound materials are not allowed due to the risk of induced cracking.
- f. EMBANKMENT BUILT USING CRUSHED ROCK
 - i. If embankment is built using unbound mixtures produced out of crushed rock, then material requirements stated in this Chapter shall be followed.
 - Unbound mixture shall be produced in accordance with EN 13242 and EN 13285 (AVCP level 2+)
 - Maximum aggregate LA category shall be ≤ 40 (LA_{40})
 - Maximum aggregate frost resistance shall be ≤ 4 (F_4). In case the frost resistance of the aggregate is inferior ($F > 4$), then Sub-clause 2) requirements need to be met.
 - Unbound mixture gradation shall meet the requirements stated in this document, e.g. depending on frost susceptibility, etc.
 - ii. If the aggregate does not meet the frost resistance requirement, i.e. the declared frost resistance is > 4 , then the requirements described in this sub-clause shall be followed:
 - Unbound mixture shall be produced in accordance with EN 13242 and EN 13285 (AVCP level 2+) using coarse aggregates mixed with fine or all-in aggregates meeting the requirements described in this sub-clause. Resultant unbound mixture shall meet the requirements stated in sub-clause iv of this Chapter.

- Coarse aggregate requirements shall be produced in accordance with EN 13242 (AVCP level 2+) and shall meet the requirements described in Table 29.
- Fine or all-in aggregate shall be produced in accordance with EN 13242 and/or EN 13285 and shall meet the requirements described in Table 30. Using fine or all-in aggregate which is produced by rock crushing (e.g. tailings) is not allowed. Fine or all-in aggregate shall be free of humus (EN 1744-1 NaOH assessment).

Table 29. Minimum requirements - Coarse aggregate

Property	Requirement
Gradation category	G _C 80/20
minimum aggregate size	d ≥ 4 mm
Resistance to fragmentation	LA ₄₀
Frost resistance	F _{declared} 12

Table 30. Minimum requirements - Fine or all-in aggregate

Property	Requirement
Petrographic description (EN 932-3)	quartzose sand
Maximum aggregate size	D ≤ 8 mm
Gradation category	G _F 80 in case of fine aggregate (EN 13242) G _A 80 in case of all-in aggregate (EN 13242) OC80 in case of unbound mixture (EN 13285)
Maximum fines content	f ₅ in case on EN 13242 UF ₅ in case of EN 13285

- Unbound mixture shall be produced in accordance with EN 13285 (AVCP level 2+) by mixing coarse aggregate with fine or all-in aggregate to meet the requirements described in Table 31.

Table 31. Minimum requirements - Unbound mixture for using in embankments

Property	Requirement
Minimum content of quartzose sand (fine or all-in aggregate) in the mix ^(a)	≥ 15%
Gradation category	G _V
Maximum fines content	UF ₅ – in case the material is used within frost penetration depth (within frost protection zone) UF ₇ – in case the material is used below frost penetration depth (below frost protection zone)
Organic content C _{OM} ^{(b) (c)}	LOI ≤ 2%
Note <ul style="list-style-type: none"> (a) – the content of quartzose sand depends on the voids between coarse aggregate which shall be determined based on laboratory testing. If coarse aggregate to be used has D/d ratio 2, then the voids between the coarse aggregates is approximately 35-40% and this shall be filled with fine or all-in aggregate (quartzose sand). If more than one coarse aggregate size fraction is used for producing the unbound mixture, or the mixture is inherently well-graded, then the voids content will decrease. However, the content of quartzose sand shall not be less than 15%. (b) – accreditation for compliant European harmonized standard for LOI test. The conditions of test shall be tested in accordance with EN 1997-2 Annex N, Clause N.2. Test shall be conducted on the material that is passing 2 mm sieve. The minimum ignition temperature shall be 440 °C +/-25°C. Other temperatures may be considered, depending on the type of material. Nevertheless, any deviations from shall be agreed separately with Engineer and/or Employer. (c) – If the LOI is above 2%, it's important to ensure that the material is free of humus (EN 1744-1 NaOH assessment). In this case, the material can still be considered to be suitable. Nevertheless, the LOI should not exceed 6%. 	

- The Contractor shall submit all certificates and necessary documentation of the constituent materials of the unbound mixture to Engineer and/or Employer for approval. In addition, the producer shall submit mix recipe to Engineer and/or Employer for approval. Mix recipe shall list all constituent materials and content of these in the unbound mixture. Mix recipe shall also provide typical grading declared by the producer together with production tolerances.
- iii. Unbound mixture shall be transported and installed while avoiding segregation. All materials, which show signs of segregation shall be removed from the structure and replaced with material meeting the requirements.
- Segregation shall be assessed visually by Contractor and Engineer and/or Employer. In case of disputes, a sample shall be taken from the layer in accordance with EN 932-1, sub-clause 8.8, which describes sampling from flat stockpiles. In case the material does not meet the gradation requirements stated in this document, the material shall be removed from the structure. The extent and quantity of the material which shall be removed from the structure will be determined by the Engineer and/or Employer. If additional tests need to be done in order to determine the extent and quantities, then these the expenses of these tests shall be covered by the Contractor.
- iv. Unbound mixture shall be installed in layers with maximum thickness of 50 cm. Every layer shall be compacted to meet the compaction requirements. Dynamic compaction (e.g. vibratory compactor) shall be used.
- v. In case the layer exhibits surface defects which refer to insufficient content of fine or all-in aggregate in the mixture (voids between coarse aggregate particles are not filled with quartzose sand), then the producer of the unbound mixture shall be informed in order to amend the mix recipe and the compacted layer shall be covered with sufficient amount of fine or all-in aggregate (quartzose sand) which shall meet the requirements stated in Table 30. This approach is only applicable if the depth of defects is not more than 10 cm. In case the thickness of the defected zone is more than 10 cm, then the material shall be removed from the structure to depth indicated by Engineer and/or Employer.
- vi. The properties of the unbound mixture shall be checked prior to installation (verification testing) by the Contractor. Verification testing for gradation related properties shall be carried out by the Contractor at least once per 1000 m³ (per source/quarry). If applicable, other geometric, physical, chemical and durability-related properties (resistance to fragmentation, frost resistance, etc.) shall be assessed at least once per 5000 m³ (per source/quarry). The Engineer shall conduct acceptance testing at a minimum frequency of once per volume that is three times the volume stated above.
- F. FILTER (GRADED MATERIAL)
- a. Material to be used for filter function shall be natural granular or crushed aggregate, having the required gradation to satisfy the following criteria:

Table 32. Minimum requirements - Filter / Graded material

Property	Requirement	Reference
Gradation	$D_{15f}/D_{85b} < 5$ $5 < D_{50f} < 20 - 60$ $D_{20f}/D_{20b} > 5$	EN 13285
Material passing 0.063 sieve	$\leq 5\%$	EN 13285
Plasticity index I_p of the material	$\leq 7\%$	EN 17892-12

- b. When used around perforated pipes, the filter shall satisfy the requirements for slot dimension of the pipe.

2.9.7.7.2 CONSTRUCTION REQUIREMENTS

- A. Soils and materials with higher stiffness and better load bearing properties shall be used in the upper parts of the fill, unless these soils/materials are intended to be improved via mechanical or chemical stabilization methods.
- B. The Contractor shall ensure the stability of the fills with suitable measures.
- C. Embankment construction and backfill shall be done in horizontal layers.

- D. It is not allowed to use and compact different materials in one single layer, unless it is technically reasonable and justified, and approved by the Engineer.
- E. Embankment construction shall be done simultaneously with embankment slopes. In case slopes have to be constructed later, this shall be done by creating steps with up to 1 to 3 m wide and 0.3 to 0.6 m high.
- F. Embankment construction works shall be supervised and inspected in accordance with EN 1997-1 Ch. 12.7.
- G. Embankment construction includes:
 - a. Preparation of foundation areas over which fill material is to be placed and backfilling of excavations undertaken for foundation treatments;
 - b. Placement and compaction of suitable fill material, also in areas from which unsuitable material has been removed, and in areas where material below the subgrade level has been removed in cut/fill transitions;
- H. SOIL REMOVAL AND REPLACEMENT FOR EMBANKMENT
 - a. According to Technical Design, there will be certain areas along the alignment with natural soils that are not suitable for embankment foundation since they could present large consolidation settlements. Those areas are shown on Technical Design Drawings and Geotechnical Design Reports (GDR).
 - b. In those areas, the excavation depth of the layer shall be carried out as shown on Technical Design before embankment construction.
 - c. The replacement of excavated material in each area shall be performed in accordance with the Technical Design and these Technical Specifications.
- I. BACKFILLING NEAR STRUCTURES
 - a. Near structures
 - i. During the construction process, the Contractor shall protect all structures against damage. Any damage to structures shall be repaired at the expense of the Contractor.
 - ii. Light weight compaction equipment shall be used within 3m of structures to avoid damage and where directed by the Engineer.
 - iii. Filling around structures shall ensure that the difference in levels of fill on either side of the structure is no greater than 1.0m at any time
 - iv. Materials shall be placed and compacted in successive horizontal layers, with a compacted layer thickness no greater than 150 mm,

2.9.7.7.3 COMPACTION REQUIREMENTS

- A. Embankment minimum compaction degree and stiffness requirements with testing frequency are stated in the following table.

Table 33. Compaction requirements - Embankment

Property	Minimum requirement	Method	Testing frequency
In-situ density D_{pr}	$\geq 97\%$ of D_{pr} determined by EN 13286-2 Standard Proctor	Field density (ASTM D1556 / D1556M or ASTM D6938 or DIN 18125-2)	Once per 20 m, 2 locations – under the railway and near the edge
Strain modulus after second loading E_{v2}	≥ 45 MPa – fine materials	DIN 18134	Once per 100 m, 2 locations – under the railway and near the edge
	≥ 60 MPa – sandy or gravelly materials		
	≥ 80 MPa – treated materials		

- a. If the results obtained do not reach the minimum values stated herein, the surface shall be moistened and re-compacted until the required values are reached. If the required degree of performance is not obtained, the layer shall be removed and re-built at the Contractor expense.
- b. During the construction phase, different direct/indirect test methods (e.g. continuous compaction control (CCC) method, deflectometers (LWD, FWD), E_{v2}/E_{v1} , Troxler, etc. can be used if the correlation with the

reference method stated above is documented and verified with on trial section(s). The Contractor shall include in the proposed method of statement which test methods is proposed and their methodology. The application of the test methods shall be subject to the approval of the Engineer and/or Employer. Engineer and/or Employer has authority to initiate new correlation/verification tests to be conducted at any time. These costs shall be covered by the Contractor.

- c. The compacted layer shall present homogeneity in visual inspection and when tested, with no points showing defective behaviour.
- B. Layer to be compacted shall not be greater described in Table 34. Upper aggregate size (D) shall not be greater than 2/3 of the layer within 4m below the bottom of the sub-ballast layer. Below 4m from the sub-ballast layer, D shall be less than the thickness of the layer to be compacted.

Table 34. Minimum requirements - Compaction thickness compared with soil type and equipment

Equipment	Material			
	Crushed rock and rockfill	Sand	Silty of clayey sands and gravels or clayey soils	Soil with variable grading with silt and/or clay
Single roller, dynamic compaction Static linear load:				
≥ 15 kN/m ² (approx. 2 t)	N/A	0,30	0,25	0,20
≥ 30 kN/m ² (approx. 6 t)	1,0	0,60	0,50	0,30
≥ 45 kN/m ² (approx. 10 t)	2,0	0,80	0,60	0,40
≥ 65 kN/m ² (approx. 15 t)	3,0	1,20	0,80	0,60
Dual roller, dynamic compaction Static linear load:				
≥ 5 kN/m ² (approx. 1 t)	N/A	0,15	0,10	-
≥ 10 kN/m ² (approx. 2 t)		0,25	0,20	0,15
≥ 20 kN/m ² (approx. 6 t)		0,40	0,35	0,20
≥ 30 kN/m ² (approx. 10 t)		0,60	0,50	0,30
Triple roller, static linear load: ≥ 50 kN/m ² (approx. 10 t)	N/A	0,25	0,20	0,20
Static sheepfoot roller ≥ 45 kN/m ² (approx. 20 t)	N/A	0,25	0,25	0,25
Pneumatic roller, Load/wheel: ≥ 15 kN/m ² ≥ 25 kN/m ²	N/A	0,20 0,25	0,20 0,25	0,20 0,25

- C. Backfill of structures (abutments, retaining walls, etc.) shall be done with layers having maximum thickness of 30cm, depending on soil type (see Table 34).
- D. Each layer shall be compacted to a predetermined compaction degree prior laying, planning and compacting next layer.
- E. The moisture content of the soil to be compacted shall have optimum moisture content. Optimum moisture content shall be determined according to EN 132862.
- F. Optimum moisture content and maximum density shall be determined according to Standard Proctor procedures.
- G. Moisture content tolerance shall be ±2% from the determined optimum moisture content.

- H. During the works it may be necessary to increase or decrease the soil's moisture content. Water pouring machinery shall be able to provide required amount of water quickly and efficiently without delaying compaction.
- I. If the strain modulus after second loading (E_{v2}) is not met, following measures shall be considered, apart from others, with the approval of the Engineer:
 - a. Soil improvement or stabilization.
 - b. Increasing the thickness of layer with material with higher stiffness.
 - c. Soil replacement.
- J. Compaction on layers of structural lightweight aggregates fill for ecoducts (LWA):
 - a. Generally, embankments with LWA are used in areas with soft and compressible subsoil. It may be difficult to obtain a sufficient compaction of fill materials on this type of soil conditions due to the lack of response from the subsoil. The compaction of LWA fill in the embankment and the pavement should be considered carefully to obtain a good result.
 - b. For the most commonly used round LWA materials the contractor should be aiming at a compaction of about 10 - 12 % in relation to the loose fill state. When installing the material by blowing the material automatically compacts, and initial compaction of maximum 5% is achievable, depending on the blowing pressure and the installation procedure. Hence, the need for additional mechanical compaction is reduced.
 - c. Over-compaction of the material (because it leads to extensive crushing) should be avoided, especially if the material is used as frost insulation. This will increase the required volume and reduce the frost insulation properties.
 - d. Over-compaction will also reduce the volume of the material and increase the need for material on site compared to the calculated volume.
 - e. Compaction of lightweight materials requires less energy than conventional material, ordinary requirements for compaction equipment and recommendations for layer thickness to achieve a proper compaction is not similar to conventional materials.
 - f. Compaction of the LWA fill is done in layers with a maximum thickness of 50 cm. Proper compaction of the edge of the fill requires proper lateral support.
 - g. This can be achieved either by a slope capping or by a geotextile wraparound of the edge.
 - h. The equipment and procedure for compaction should be related to the type of structure.
 - i. Compaction of small areas and close to structures will require smaller and lighter equipment as well as smaller layer thicknesses compared to the compaction of large areas e.g. for a road or railway embankment.
 - j. As the required energy is less than conventional materials, it is not recommended to use heavy equipment or equipment with high contact stress levels. Generally, the contact stress (belt pressure) should be less than 50 kN/m². Conventional compaction equipment (e.g. vibrating rollers) should not be used to compact directly on the LWA-fill as this cause the machinery to sink into the fill.
 - k. As a general rule, compaction of LWA materials should be done in layers of no more than 0.15 – 0.50 m, taking into account the compaction equipment. Typically, compaction of the material is done with a tracked excavator by overdriving directly on top of the LWA at least 6 overruns depending on the working weight of the used machine.
 - l. The compaction procedure should be determined on experimental sections and the minimal requirements must be confirmed by in situ tests or other means necessary.
- K. Final compaction of capping layer on top of LWA fill
 - a. It is of high importance for the quality of the final structure to obtain a proper compaction of the capping layer on top of the LWA.
 - b. The compaction of unbound layers on top of LWA should preferably be carried out with a vibrating oscillating roller with adjustable amplitude and/or frequency. The roller weight and compaction energy should be carefully considered towards the basis of material type thickness of the base layer.

- c. Compaction of the capping layer is commonly performed with vibrating roller equipment, typically weight 15-50kN. It is recommended to use vibrating equipment with the possibility to modify amplitude and the frequency to perform the compaction in 3 steps:
 - i. Compaction of the sub-base layer with high amplitude and high frequency
 - ii. Compaction of base layer with low amplitude and high frequency
 - iii. Additional compaction with low amplitude and low frequency followed by a levelling compaction (without vibration).
- L. Structural quality control before installation of LWA capping layer
 - a. The structural quality control is intended to verify that the material was installed in a proper way and is fulfilling its intended function in the structure.
 - b. The surface of the LWA should be inspected visually to check for possible deviations from the project description and plan, e.g. visible alteration of the theoretical profile, excessive crushing of materials etc. If clear indications of deviations are observed, samples should be taken to control the material in the laboratory.
 - c. The installed thickness and variations should be according to the project specifications and national requirements. Installed thickness is controlled by surface levelling, test pit etc.
 - d. The degree of compaction can be controlled by levelling, by relative volume control or by installed density measurements. Levelling should be performed on top of the LWA layer and the degree of compaction should be estimated as the average deformation from at least 5 measuring points for each 1000 m² surface. It should be noted that possible changes in the fill profile should be evaluated as this will influence the measurements of compaction based on levelling only.
 - e. Static or dynamic plate load tests directly on the LWA layer should be evaluated based on national experience with correlation with the bearing capacity of LWA from field experience with similar structures.

2.9.7.7.4 GEOMETRICAL TOLERANCES

- A. Embankments, and excavation floors shall fulfil the geometry requirements stated in following table. Embankment geometry shall be measured by the Contractor. The Engineer and/or Employer has authority to conduct random or targeted measurements at any time and location during the Works.

Table 35. Geometrical tolerances – Embankment fills & Cuttings

Geometric property	Allowable deviation, single measurement	Allowable deviation, average (5 measurements)	Method	Frequency
Height	± 50 mm ^(a)	+ 20 mm - 50 mm	Geodetic	20 m
Width	+ 150 mm -50 mm ^(b)		Geodetic	20 m
Slopes	Not steeper than designed		Geodetic	In case of suspicion
Crossfall	± 1,0 %		Geodetic	20 m
			3 m straightedge	In case of suspicion
Alignment	± 100 mm		Geodetic	20 m
Evenness	± 50 mm		3 m straightedge	In case of suspicion
a) For rockfill embankments the allowable deviation is ± 100 mm b) For rockfill embankments the allowable deviation is – 100 mm				

2.9.7.8 LOCALISED FILLINGS

2.9.7.8.1 BACKFILLING DIRECTLY IN CONTACT WITH ABUTMENTS OF RAILWAY BRIDGES, FRAMEWORKS, CULVERTS AND RETAINING WALLS ASSOCIATED TO THE RAILWAY ALIGNMENT.

- A. Suitable soil groups according to EN ISO 14688-2 are Sa, grSa, saGr, Gr. Suitable soil groups according to EN 16907-2 are G1/G2/S1/S2 or G3/G4/S3/S4. In addition, crushed rock mixed with sand as described in Clause 2.9.7.7.1. subclause f "EMBANKMENT BUILT USING CRUSHED ROCK" can be used as a fill, if fines content of the mixture is less than 15%.
- B. The material shall have fines content (particles passing sieve <0.063 mm) $\leq 15\%$. If the fines content is more than 5%, the material shall not exhibit any plasticity ($I_p \leq 0$, $W_L \leq 0$, determined in accordance with EN ISO 17892-12). If the structure is located in hydrologically and hydrogeologically difficult areas (e.g. cuttings slopes, flood zones, marshland areas), the fines content in weight shall be limited to 5%, therefore suitable soil groups according to EN ISO 14688-2 are Sa, grSa, saGr, Gr and according to EN 16907-2 are G1, G2, S1, S2. The material shall be insensitive to water and washout of infill material and not susceptible to frost (as per ISSMFE-TC 8, 1989). The organic content (loss on ignition) shall be $\leq 1\%$ ($C_{OM} \leq 1\%$).
- C. accreditation for compliant European harmonized standard for LOI test. The conditions of test shall be tested in accordance with EN 1997-2 Annex N, Clause N.2. Test shall be conducted on the material that is passing 2 mm sieve. The minimum ignition temperature shall be $440\text{ }^{\circ}\text{C} \pm 25^{\circ}\text{C}$. Other temperatures may be considered, depending on the type of material. Nevertheless, any deviations from shall be agreed separately with Engineer and/or Employer.
- D. Maximum aggregate size (D) shall not exceed 90 mm.
- E. In order to avoid the contamination of different backfill materials by soil particles which may migrate from one layer to another, it is required that the adjacent materials comply with applicable filter criteria. If the filter criteria are not met, the materials need to be separated by appropriate, fit for purpose geosynthetics.
- F. Material free of plant material (no roots, trunks, or grasses).
- G. The properties of the fill material shall be checked prior to installation (verification testing) by the Contractor. Verification testing for gradation related properties shall be carried out by the Contractor at least once per 1000 m^3 (per source/quarry). If applicable, other geometric, physical, chemical and durability-related properties (resistance to fragmentation, frost resistance, etc.) shall be assessed at least once per 5000 m^3 (per source/quarry). The Engineer shall conduct acceptance testing at a minimum frequency of once per volume that is three times the volume stated above.

2.9.7.8.2 BACKFILLING RELATED TO ABUTMENTS OF OVERPASSES & UNDERPASSES, CULVERTS AND RETAINING WALLS ASSOCIATED TO ROADS AND ALSO STRUCTURAL FILL IN ECODUCTS.

- A. Suitable soil groups according to EN ISO 14688-2 are Sa, grSa, saGr, Gr. Suitable soil groups according to EN 16907-2 are G1/G2/S1/S2 or G3/G4/S3/S4. In addition, crushed rock mixed with sand as described in Clause 2.9.7.5 subclause f "EMBANKMENT BUILT USING CRUSHED ROCK" can be used as a fill, if fines content of the mixture is less than 15%.
- B. The material shall have fines content (particles passing sieve <0.063 mm) $\leq 15\%$. If the fines content is more than 5%, the material shall comply with following plasticity requirements - $I_p \leq 7$, $W_L \leq 25$ (determined in accordance with EN ISO 17892-12). If the structure is located in hydrologically and hydrogeologically difficult areas (e.g. cuttings slopes, flood zones, marshland areas), the fines content in weight shall be limited to 5%, therefore suitable soil groups according to EN ISO 14688-2 are Sa, grSa, saGr, Gr and according to EN 16907-2 are G1, G2, S1, S2. The material shall be insensitive to water and washout of infill material and not susceptible to frost (as per ISSMFE-TC 8, 1989).
- C. The organic content shall be $\leq 1,0\%$ (loss on ignition).
- D. accreditation for compliant European harmonized standard for LOI test. The conditions of test shall be tested in accordance with EN 1997-2 Annex N, Clause N.2. Test shall be conducted on the material that is passing 2 mm sieve. The minimum ignition temperature shall be $440\text{ }^{\circ}\text{C} \pm 25^{\circ}\text{C}$. Other temperatures may be considered,

depending on the type of material. Nevertheless, any deviations from shall be agreed separately with Engineer and/or Employer.

- E. Maximum aggregate size (D) shall not exceed 90 mm.
- F. In order to avoid the contamination of different backfill materials by soil particles which may migrate from one layer to another, it is required that the adjacent materials comply with applicable filter criteria. If the filter criteria are not met, the materials need to be separated by appropriate, fit for purpose geosynthetics.
- G. Material free of plant material (no roots, trunks, or grasses).
- H. The properties of the fill material shall be checked prior to installation (verification testing) by the Contractor. Verification testing for gradation related properties shall be carried out by the Contractor at least once per 1000 m³ (per source/quarry). If applicable, other geometric, physical, chemical and durability-related properties (resistance to fragmentation, frost resistance, etc.) shall be assessed at least once per 5000 m³ (per source/quarry). The Engineer shall conduct acceptance testing at a minimum frequency of once per volume that is three times the volume stated above.

2.9.7.8.3 STRUCTURAL LIGHTWEIGHT FILL FOR ECODEUCTS.

A. Physical properties of LWA

Table 36. Physical properties - LWA

Properties	Symbol	Grain size 10 - 20mm	Grain size 0 - 32mm
Dry bulk density before compaction	pd	250 - 300 kg/m ³	300 - 350 kg/m ³
Dry density after compaction	pd,f	300 - 350 kg/m ³	350 - 400 kg/m ³
Volume reduction after compaction	P	5 - 15 %	5 - 15 %
Porosity of the fill	n	50 - 55 %	45 - 50 %
Unit weight	γ	3.50 - 4.00 kN/m ³	4.00 - 5.00 kN/m ³

B. Mechanical properties:

- a. The laboratory testing of the proposed LWA mechanical properties should include tests for preparation and compaction, triaxial tests, cyclic triaxial tests, and large scale oedometer tests. The results should be checked through large scale model tests and instrumented field tests.
- b. Based on laboratory test results the following minimum strength parameters of expanded clay LWA should be assured:
- c. friction angle (constant volume) $\phi_{cv} = 41^\circ$
- d. friction angle (peak) $\phi_p = 45^\circ$
- e. cohesion $c = 1 \text{ kPa}$
- f. typical elastic stiffness $E > 30 - 80 \text{ MPa}$
- g. Design recommended values

Table 37. Design recommended values - LWA

Parameters	γ_{unsat}	γ_{sat}	c'	ϕ'	ψ	E_{50}^{ref}	E_{oed}^{ref}	E_{ur}^{ref}	ν_{ur}	m	p^{ref}	K_0^{NC}
LWA	6	10	1	36	0	40	40	120	0.2	0.5	100	0.4

C. Material quality requirements

- a. The LWA material quality should be compliant with EN 15732:2012 – “Light weight fill and thermal insulation products for civil engineering applications (CEA) - Expanded clay lightweight aggregate products (LWA)” standard which describes the product characteristics and includes procedures for testing, marking and labelling.

- b. The standard covers the use of expanded clay LWA as lightweight fill and insulation materials in embankments for roads, railways and other trafficked areas and as lightweight backfill for structures.
- D. Construction works requirements
 - a. LWA in an embankment is commonly covered with a capping layer of granular materials as lateral support. For embankments subject to traffic loads there is also a pavement layer on top typically consisting of a sub-base and a top layer.
- E. Delivery control
 - a. The purpose of the delivery control is to verify that the LWA material delivered on site is in accordance with these Technical specifications. The normal delivery control may include checking if the property of the delivered product is in accordance with the Declaration of Performance document (DoP) and CE-marking.
- F. Handling and storage
 - a. Handling of the LWA materials can be done using normal construction equipment, but care should be taken to avoid excessive impact on the material that may cause crushing of the aggregates (unnecessary traffic with heavy equipment).
 - b. From the point of view of material handling and storage, it must be made in spaces properly arranged for granular materials, in order to avoid contamination.
- G. Preparatory works
 - a. The preparation of the sub formation for LWA fills includes the specific stages of earthworks normal cleaning of the construction site (removal of e.g. tree roots, shrubs and other obstacles), stripping and removal of topsoil or other unsuitable materials, levelling and compaction of the sub formation (as much as possible). If construction is taking place under winter conditions all snow and ice should be removed from the base layer. When prescribed, a geotextile should be installed as a separator and filter between the subgrade and the LWA-fill. Selection of geotextile should be done in accordance with national recommendations.
 - b. Excess water in the excavation pit should be avoided and pumped out to acceptable levels.
 - c. A high-water level could cause problems with uplift and reduce the effect of compaction.
 - d. High water levels can impact the stability of the LWA filling. Access restrictions (machines or workers) should be imposed until stability is evaluated.
 - e. The LWA should be installed in layers of maximum 50 cm after the execution of lateral support (supporting embankment or wrap around geotextile before compaction). Truck driving directly on top of the LWA should be avoided. For the first layer, material can be spread directly from the truck starting at one end of the lightly filled area and ending at the other end. For the other layers when backfilling, spreading can be done with an excavator, bulldozer or other similar equipment. It is often convenient to combine the spreading of the material and the compaction procedure.
 - f. Traffic directly on top the LWA should be avoided with vehicles having a belt or tire pressure higher than 50 kN/m². Traffic ability for the construction equipment on the LWA fill can be achieved by establishing an access road on top of the LWA embankment.
 - g. A separating geotextile shall be used between the LWA fill and the access road base layer. Provided the use of conventional trucks (axle load less than 150 kN), the access roads can be designed according to conventional recommendations. A general recommendation for total road base thickness for the access road is 300 mm unbound material above the LWA. This is sufficient to provide required bearing capacity and avoid crushing of the LWA.
 - h. Access for construction equipment may also be possible by using of temporary measures like steel plate, wooden lodge elements etc.

2.9.7.8.4 NON-STRUCTURAL FILL ASSOCIATED TO ECODUCTS.

- A. For the non-structural fills to be performed within Ecoduct structures, the requirements are not as stringent as for structural fill. Fills with fines content higher than 35% (material passing through sieve #0.063 mm) can be considered suitable, if following conditions are met:

- a. The soil has low or medium plasticity, i.e $W_L \leq 50\%$, rejecting CIH, SiH, CIV, SiV materials according to EN ISO 14688-2 plasticity chart).
 - b. The soil exhibits expansive and/or collapsive behaviour.
 - c. The soil has low organic content (loss on ignition), i.e. $\leq 6\%$ ($C_{OM} \leq 3\%$).
 - d. The soil is suitable to be compacted to required density.
 - e. Material free of plant material (no roots, trunks, or grasses).
- B. The properties of the fill material shall be checked prior to installation (verification testing) by the Contractor. Verification testing for gradation related properties shall be carried out by the Contractor at least once per 2000 m³ (per source/quarry). If applicable, other geometric, physical, chemical and durability-related properties (resistance to fragmentation, frost resistance, etc.) shall be assessed at least once per 10000 m³ (per source/quarry). The Engineer shall conduct acceptance testing at a minimum frequency of once per volume that is three times the volume stated above.

2.9.7.8.5 DRAINAGE MATERIAL TO BE USED IN DRAINAGE TRENCHES (RAILWAY PLATFORM, ROADS OR AROUND ANY SLOTTED/PERFORATED DRAINAGE PIPE)

- A. Suitable soil groups according to EN ISO 14688-2 are Sa, grSa, saGr, Gr. Suitable soil groups according to EN 16907-2 are G1/G2/S1/S2.
- B. The material shall have fines content (particles passing sieve <0.063 mm) $\leq 5\%$. The material shall be insensitive to water and washout of infill material and not susceptible to frost (as per ISSMFE-TC 8, 1989).
- C. The organic content (loss on ignition) shall be $\leq 2\%$ ($C_{OM} \leq 2\%$).
- D. accreditation for compliant European harmonized standard for LOI test. The conditions of test shall be tested in accordance with EN 1997-2 Annex N, Clause N.2. Test shall be conducted on the material that is passing 2 mm sieve. The minimum ignition temperature shall be 440 °C \pm 25°C. Other temperatures may be considered, depending on the type of material. Nevertheless, any deviations from shall be agreed separately with Engineer and/or Employer.
- E. Maximum aggregate size (D) shall not exceed 63 mm.
- F. In order to avoid the contamination of different backfill materials by soil particles which may migrate from one layer to another, it is required that the adjacent materials comply with applicable filter criteria. If the filter criteria are not met, the materials need to be separated by appropriate, fit for purpose geosynthetics.
- G. In addition, all the following filter conditions shall be met:
 - a. $D_{15(F)}/D_{85(B)} < 5$
 - b. $D_{15(F)}/D_{15(B)} > 5$
 - c. $D_{50(F)}/D_{50(B)} < 25$
 - d. $C_u = D_{60(F)}/D_{10(F)} < 20$
 - e. where $D_{x(F)}$ is the mass of particles with size greater than x% of the drainage material (filter) and $D_{x(B)}$ is the mass of particles greater than x% of the ground to be drained (base).
- H. If the drainage system is designed to drain water through drainage pipes, the drainage material placed around the pipes shall also meet the following condition:
 - a. $D_{85(F)}/(\text{Diameter of the slotted pipe holes or pipe joint opening size}) > 1,2$. When this cannot be met with selected materials, the filter conditions established in g and h shall be used in multi-layer granular filter. One of the layers, that has the largest aggregate size, shall be placed in contact with the drainage pipe and filter conditions with the next layer, considered as ground, and so on, up to reach the fill or the natural ground. Also, instead of adopting the aforementioned solution, a geotextile with the functions of separation and filtering can be used around the drainage pipe.
 - b. Regarding compliance with the previous conditions, when the natural ground is composed of boulders, cobbles or gravels, it will be assessed only the part of the granulometric curve of the fraction below twenty-five millimetres (25 mm).

- c. If the natural ground is non-cohesive sandy/silty soils with fine sands and silts, the drainage material shall also meet the following filter condition:
- d. $D_{15(F)} > 1 \text{ mm}$
- e. If the natural ground consists of cohesive soils, consistent and homogeneous, without interbedded fine sands and silts, the filter conditions i) and ii) indicated in subchapter g will be superseded by the next one:
- f. $0,1 \text{ mm} > D_{15(F)} > 0,4 \text{ mm}$
- g. Material free of plant material (no roots, trunks, or grasses).
- l. The properties of the fill material shall be checked prior to installation (verification testing) by the Contractor. Verification testing for gradation related properties shall be carried out by the Contractor at least once per 2000 m³ (per source/quarry). If applicable, other geometric, physical, chemical and durability-related properties (resistance to fragmentation, frost resistance, etc.) shall be assessed at least once per 10000 m³ (per source/quarry). The Engineer shall conduct acceptance testing at a minimum frequency of once per volume that is three times the volume stated above.

2.9.7.8.6 GEOTEXTILES WITH FUNCTIONS OF SEPARATION AND FILTERING.

- A. Retention criterion. Geotextile opening size (O_{90}), as per EN ISO 12956, shall meet the following conditions:
 - a. $O_{90} > 0,05 \text{ mm}$
 - b. $O_{90} < 0,20 \text{ mm}$
 - c. $O_{90} < d_{90}$
 - d. If $d_{40} < 0,06 \text{ mm} \rightarrow O_{90} < 10d_{50}$
 - e. If $d_{40} \geq 0,06 \text{ mm} \rightarrow O_{90} < 5(d_{10} \cdot d_{60})^{1/2}$
 - f. where:
 - g. O_{90} : size of opening which is equal to the particle of size d_{90} of the material which passes through the geotextile or geotextile-related product.
 - h. d_n : particle size for which n% mass fraction is smaller than the mass of measured particles.
- B. Hydraulic criterion. The geotextile permeability in the direction perpendicular to its plane (K_g), as per EN ISO 11058, with regard to the permeability of the less permeable material (K_s) shall be:
 - a. Laminar unidirectional flow: $K_g > 10 \cdot K_s$;
 - b. Rapidly changing flow (alternate or turbulent): $K_g > 100 \cdot K_s$.
- C. Otherwise, instead of geotextile separator it could be placed a transition layer to avoid the contamination by fines always that be well justified that the drainage properties of the structural filling be ensured avoiding the mixture of the existing fines of the non-structural fill with the structural fill material, and it shall be approved by the Engineer.
- D. Installation criterion:
 - a. The geotextile is spread over the lower layer, taking care of the continuity between sheets, sewing them, welding them, placing staples or overlaps (they will not be less than 50 cm);
 - b. While the geotextile is being placed, care should be taken not to step on it during its extension and compaction. Progress is always made by spreading and compacting without affecting the joint area.

2.9.7.9 EARTHWORKS IN WINTER

- A. Earthworks during the winter period are allowed if the air temperature is above 0°C and base ground of the fill is not frozen, unless otherwise directed by the Engineer.
- B. Earthworks below 0°C are allowed if the base of the fill meets the prescribed requirements, soil/material used for filling is not frozen, and the fill/material is planned and compacted immediately.

- C. The Contractor shall be required to organize the earthworks to have no interruptions. In cases where interruptions, which will situate not compliance to technological process and quality requirements, are expected or encountered, the works are not allowed to be continued.
- D. Frozen soil, snow and ice shall not be placed/installed into the earth-structures. Frozen soil suitable for earthworks shall be deposited for thawing prior installation.
- E. Earthworks with hydraulically bound soils/materials (treated soils) shall only allowed if the air temperature is above 5°C. Additionally, it shall be ensured that the installed fill/layer shall not freeze within 28 days after the stabilization works.

2.9.7.10 PAVEMENT FOR INTERMEDIATE BERMS

- A. To ensure accessibility for cutting slopes maintenance, berms of 5 m width shall be prepared to be suitable for motor vehicles. Pavement structure thicknesses and material type shall be formed by two different layers:
 - a. Gravel base layer of unbound mixture 0/32 - 0.15 m,
 - b. Top layer of gravel cover from unbound mixture 0/16 - 0.05 m.
- B. The materials of the base layers of unbound mixtures shall comply with EN 13285 and following requirements:

Table 38. Requirements- Pavement for Intermediate Berms in Cutting Slopes

Material	Thickness	Mixture designation	Fines content
Gravel base	15cm	0/32	Max 5%
Gravel cover	5cm	0/16	Max 5%

2.9.7.11 RIP-RAP MATERIAL

- A. Where required in Technical Design or in Drawings, rip-rap to be used in river diversions, earthworks and structures shall meet the requirements given in the Table 39. The armourstone stone sizes for specific places and geometry of the rip-rap layers shall correspond to the information given in the Drawings.

Table 39. Minimum requirements - Rip-rap material

Property	Requirement	Reference
Gradings	CP _{45/125} to CP _{90/180} LMA _{5/40} to LMA _{15/300} LMB _{300/1000}	EN 13383-1
Shape	≤ LT ₂₀ (Coarse and light gradings) ≤ LT ₅ (Heavy gradings)	EN 13383-1
Particle density	>2.65Mg/m ³	EN 13383-1
Resistance to breakage (excluding fragments)	CS60	EN 13383-1
Resistance to wear (excluding fragments)	MDE ≤ 30	EN 13383-1
Crushed or broken surfaces	≤ RO 5	EN 13383-1
Water absorption	≤ WA _{CM} 0,5	EN 13383-1
Chemical	Testing and properties shall be limited according to the application at end use or origin of the aggregate	EN 13383-1
Durability	Full saturation with fresh water in severe Atlantic and Continental climate	EN 13383-1
Durability	Petrographic examination confirming intrusive igneous rock origin	EN 13383-1

Property	Requirement	Reference
Durability	FT _a and MS ₂₅	EN 13383-1

2.9.7.12 CLAYLINER

- A. Cohesive materials for constructing an impermeable clay layer where required and as shown on Drawings shall meet the following requirements:

Table 40. Minimum requirements - Clay liner

Property	Requirement	Reference
Permeability	$\leq 10^{-7}$ cm/s	BS 1377, Part 6, Method 6
Remoulded undrained shear strength	≥ 50 kN/m ²	BS 1377, Part 7, Method 8
Plasticity Index I _p	$10\% \leq I_p \leq 65\%$	BS 1377, Part 2, Methods 4.3 and 5.3
Liquid Limit LL	$\leq 90\%$	
Percentage fines (<0,063mm)	8% / $\geq 20\%$, with a minimum clay content (particles <2 μ m) of 8%	BS 1377, Part 2, Methods 9.2 and 9.5
Percentage gravel (>5mm)	$\leq 30\%$	
Maximum particle (stone) size	2/3 rd compacted layer thickness, but must not prejudice the liner by particles sticking together to form larger lumps	

2.9.7.13 LANDFILL FORMATION

- A. Landfill design, drainage and execution shall be in accordance with Local Regulation governing this issue. The Contractor shall be the responsible for the landfills.
- B. Landfills shall be stable, with no stability problems.
- C. Unsuitable and surplus materials shall be spread by layers, in such way that the thicker materials shall be placed at the bottom and deeper than 2m from the final ground surface, to achieve a low water table and avoid flooding.
- D. Works and material arrangement shall be in accordance with Section 02 in this Technical Specification.
- E. A shallow drainage system to channel the water inflow, impeding its accumulation on surface shall be designed provided.
- F. It shall be performed the rounding of the crests and a softening of the slope foot. After spreading the last layer, the Contractor shall round the landfill shapes to integrate into the surrounding environment.
- G. Landscaping works (topsoil restoration, vegetation, etc.) shall be as stated in Section 07 ENVIRONMENTAL in this Technical Specification.

2.9.7.14 FILLING FOR PLATFORM FORMATION

- A. Works shall be comprised of laying and compacting of granular materials for the formation of an artificial platform in the riverbed, including a perimeter rip-rap fill and a final surface of concrete C16/20 to have a stable work platform, as well as the demolition, excavation and removal of all these elements to restore the initial situation.
- B. Platform shall be as shown on Technical Drawings.
- C. Concrete works shall be according to Section 05.
- D. The granular material to be used in the platform shall be QS2

2.9.7.15 GRANULAR MATERIAL ON WORK BASES

- A. Works shall be comprised of laying and compacting of granular materials for the formation of a work base, reinforced with a geogrid plus a non-woven geotextile.
- B. Granular material:
 - a. Gravelly soils with fines content (material passing 0.063 sieve, EN 13285) $\geq 10\%$ and $< 35\%$, and non-clayey fines and coarse elements.
 - b. CBR > 5 ,
 - c. compacted to 95% of the Standard Proctor density (EN 13286-2),

- d. $E_{v2} > 60$ MPa.
- C. The reinforcing geogrid and geotextile shall meet the requirements of the Manufacturer and the following:
 - a. biaxial geogrid of polyvinyl alcohol (PVA) yarns and a polymeric protective coating and a non-woven polypropylene geotextile adhered to.

2.9.7.16 LOCAL FILLING WITH NATURAL SOIL FROM EXCAVATED MATERIAL

- A. In situ excavated material which may consist of topsoil, surplus of soil excavation (neither rippable nor blasting), or a mixture of both, depending on the material available in each area, suitable for use as a natural pavement for animal paths and escape systems.
- B. Natural soil will be the excavated material leftover from backfilling and landscaping works.

2.9.7.17 SUBSOIL MATERIAL

- A. In situ excavated material, which served similar purpose before excavation and its characteristics are within the range presented in Table 41, can be re-used for subsoil layer.
- B. In case the excavated material characteristics are not within the range presented in Table 41 or served other purpose (due to excavation depth), the subsoil material shall be imported.
- C. The characteristics of the imported subsoil material shall be as similar as possible to the ones determined at site.
- D. Characteristics of the excavated subsoil material shall be determined by the contractor.

Table 41. Recommended limits - Physical and chemical properties of the soil suitable for planting of vegetation

Property	Minimum value	Maximum value
Total carbonates (%)	-	60
pH	5,5	8,7
Organic matter (%)	1,0	20
Total nitrogen (%)	0,05	0,3
Phosphorus absorbable (mg/kg)	10	50
Potassium absorbable (mg/kg)	50	-
Salinity, EC (dS/m at 25 °C)	-	4
Soil granulometry:		
250-75 mm	-	25
75-2 mm	-	75
2-0,002 mm	15	80
<0,002 mm	5	55
Note: The Contractor shall analyse the content of Heavy metals and conclude, that they are within the acceptable range for vegetation. Ecological restoration of the areas affected by the transport infrastructure Fundación Biodiversidad, 2011 or alternative local instruction/regulation can be used as reference.		

2.9.7.18 MEASUREMENT AND PAYMENT – FILLS

A. The following work items are defined:

Table 42. Units of measurement – Fills

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_31_26_90	000103	TOPSOIL FILL FROM EXCAVATED MATERIAL FOR RE-VEGETATION, SLOPE PROTECTION, DISPOSAL TEMPORARY OR PERMANENT, ETC	m3	Topsoil fill consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated topsoil that is re-used during the construction phase without needing any prior processing (re-vegetation, slope protection, etc) or can be disposed on site (e.g. false cuttings, etc.).
Pr_15_31_26_90	000104	TOPSOIL FILL FROM IMPORTED MATERIAL FOR RE-VEGETATION, SLOPE PROTECTION, DISPOSAL TEMPORARY OR PERMANENT, ETC	m3	Topsoil fill consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported topsoil material that are suitable for re-vegetation, slope protection, etc, or can be disposed on site (e.g. false cuttings, etc.).
Pr_15_31_26_34	000101	EMBANKMENT FILL FROM IMPORTED MATERIAL	m3	Embankment fill consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that are suitable for constructing embankment fill.
Pr_15_31_26_34	000102	EMBANKMENT FILL FROM EXCAVATED MATERIAL	m3	Embankment fill consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated material that are suitable for constructing embankment fill.
Pr_15_31_26_34	000103	EMBANKMENT FILL FROM EXCAVATED MATERIAL AFTER PROCESSING	m3	Embankment fill consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.), processing (sieving, washing, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated material that are suitable for constructing embankment fill after processing.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_57_33_36	000105	GEOGRID AND NON-WOVEN GEOTEXTILE IN REINFORCEMENT OF WORK BASES DESIGN AXIAL STIFFNESS ≥ 710 kN/m	m2	Geogrid and non-woven geotextile in reinforcement of work bases consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of reinforcement on work bases a geogrid of polyvinyl alcohol (PVA) yarns with a low creep tendency and a polymeric protective coating and a non-woven polypropylene geotextile adhered to it. Design axial stiffness ≥ 710 kN/m. This item includes overlaps and surplus material.
Pr_15_31_26_34	000112	EMBANKMENT FILL FOR DAMP AREA FROM IMPORTED MATERIAL	m3	Embankment fill for damp area from imported material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that are suitable for constructing embankment fill in damp areas.
Pr_15_31_26_34	000113	EMBANKMENT FILL FOR DAMP AREA FROM EXCAVATED MATERIAL	m3	Embankment fill for damp area from excavated material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated material that are suitable for constructing embankment fill in damp areas.
Pr_15_31_26_34	000114	EMBANKMENT FILL FOR FLOOD AREA FROM IMPORTED MATERIAL	m3	Embankment fill for flood area from imported material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that are suitable for constructing embankment fill in flood areas.
Pr_15_31_26_34	000115	LOCAL FILLING WITH NATURAL SOIL FROM EXCAVATED MATERIAL	m3	Local filling with natural soil from excavated material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated material that can be used for local filling for animals paths.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_31_26_34	000116	GRAVEL SURFACE ON PATHS FROM IMPORTED MATERIAL	m2	Local filling with gravel on paths from imported material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that can be used for local filling for paths with an average thickness of 20 cm
Pr_15_31_26_34	000118	EMBANKMENT FILL FOR FLOOD AREA FROM EXCAVATED MATERIAL	m3	Embankment fill for flood area from excavated material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated material that are suitable for constructing embankment fill in flood areas.
Pr_15_31_26_34	000121	CLAY LINER	m3	Clay liner consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated material that are suitable for constructing a cohesive impermeable clay layer.
Pr_15_31_26_34	000122	FILLING FOR PLATFORM FORMATION	m3	Filling for platform formation consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for laying and compacting of granular materials for the formation of an artificial platform in the riverbed, including a perimeter rip-rap fill and a final surface of concrete C16/20 to have a stable work platform. As well as the demolition, excavation and removal of all these elements to restore the initial situation
Pr_15_31_26_34	000123	EMBANKMENT FILL FOR UNDERWATER AREA FROM IMPORTED SELF-COMPACTING MATERIAL	m3	Embankment fill for underwater area from imported self-compacting material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported self-compacting material that are suitable for constructing embankment fill in underwater areas.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_31_26_34	000148	EMBANKMENT FILL FOR UNDERWATER AREA FROM EXCAVATED SELF-COMPACTING MATERIAL	m3	Embankment fill for underwater area from excavated self-compacting material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated self-compacting material that are suitable for constructing embankment fill in underwater areas.
Pr_15_31_26_34	000124	GRAVEL BASE LAYER OF UNBOUND MIXTURE 0/32	m3	Local filling with gravel on paths from imported material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that can be used as base layer for paths
Pr_15_31_26_34	000125	GRAVEL COVER FROM UNBOUND MIXTURE 0/16	m3	Local filling with gravel on paths from imported material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that can be used as coating layer for paths
Pr_15_31_26_34	000126	LOCALISED FILL FOR RAILWAY STRUCTURES FROM IMPORTED MATERIAL	m3	Localised fill for railway structures from imported material consists of all the works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that are suitable for localised fill in contact with abutments of railway bridge, frameworks, underpasses, culverts, retaining walls, etc. associated to the railway.
Pr_15_31_26_34	000127	LOCALISED FILL FOR RAILWAY STRUCTURES FROM EXCAVATED MATERIAL	m3	Localised fill for railway structures from excavated material consists of all the works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated material that are suitable for localised fill in contact with abutments of railway bridge, frameworks, underpasses, culverts, retaining walls, etc. associated to the railway.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_31_26_34	000128	LOCALISED FILL FOR ROAD STRUCTURES AND BACKFILL FOR ECODUCTS FROM IMPORTED MATERIAL	m3	Localised fill for road structures and backfill for ecoducts from imported material consists of all the works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that are suitable for localised fill in contact with overpasses & underpasses, culverts and retaining walls associated to the roads and for the backfill in contact with ecoducts.
Pr_15_31_26_34	000129	LOCALISED FILL FOR ROAD STRUCTURES AND BACKFILL FOR ECODUCTS FROM EXCAVATED MATERIAL	m3	Localised fill for road structures and backfill for ecoducts from excavated material consists of all the works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated material that are suitable for localised fill in contact with overpasses & underpasses, culverts and retaining walls associated to the roads and for the backfill in contact with ecoducts.
Pr_15_31_26_33	010101	STRUCTURAL LIGHTWEIGHT FILL FOR ECODUCTS FROM IMPORTED MATERIAL	m3	Structural lightweight fill for ecoducts consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported materials that are suitable for constructing structural lightweight fill for ecoducts.
Pr_15_31_26_34	000130	NON STRUCTURAL FILL FOR ECODUCTS FROM IMPORTED MATERIAL	m3	Non structural fill for ecoducts from imported material consists of all the works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that are suitable for ecoduct slopes and general fill distant from the structure.
Pr_15_31_26_34	000131	NON STRUCTURAL FILL FOR ECODUCTS FROM EXCAVATED MATERIAL	m3	Non structural fill for ecoducts from excavated material consists of all the works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated material that are suitable for ecoduct slopes and general fill distant from the structure.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_31_26_34	000132	LOCAL FILLING WITH FILTERING MATERIAL FROM IMPORTED MATERIAL	m3	Local filling with filtering material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that can be used for local filling with filtering function.
Pr_15_31_26_34	000137	GRAVEL FILTER 3/8" SIZE IN DEEP WELLS	m3	Local filling with gravel filter 3/8" size in deep wells consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that can be used for local filling in deep wells.
Pr_15_31_26_34	000138	STRUCTURAL FILL FOR ECODUCTS FROM IMPORTED MATERIAL	m3	Structural fill for ecoducts from imported material consists of all the works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that are suitable for localised fill in contact with ecoducts.
Pr_15_31_26_34	000139	STRUCTURAL FILL FOR ECODUCTS FROM EXCAVATED MATERIAL	m3	Structural fill for ecoducts from excavated material consists of all the works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated material that are suitable for localised fill in contact with ecoducts.
Pr_15_31_26_34	000301	LOCAL FILLING IN FOUNDATIONS, TRENCHES, BACKFILLING WALLS AND ABUTMENTS WITH MATERIAL FROM QUARRY.	m3	Local filling in foundations, trenches, backfilling walls and abutments consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that can be used for local filling.
Pr_15_31_26_34	000305	LOCAL FILLING IN BACK OF STRUCTURE WITH FILTERING MATERIAL FROM IMPORTED MATERIAL	m3	Local filling in back of structure with filtering material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported material that can be used for local filling in back of structures for drainage.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_31_26_34	000307	LOCAL FILLING IN RIVERBED WITH NATURAL SOIL FROM EXCAVATED RIVERBED MATERIAL	m3	Local filling in riverbed from excavated riverbed material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated riverbed material that can be used for replacement of the riverbed.
Pr_15_31_26_34	000601	LOCAL FILLING IN TRENCHES WITH FILTER MATERIAL FROM QUARRY	m3	Local filling in trenches with filter material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported filter material that can be used for local filling in trenches.
Pr_15_31_26_34	000602	LOCAL FILLING IN TRENCHES WITH SAND FROM IMPORTED MATERIAL	m3	Local filling in trenches with sand consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported sand material that can be used for local filling in trenches.
Pr_15_31_26_34	000603	LOCAL FILLING WITH SAND FROM IMPORTED MATERIAL	m3	Local filling with sand consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported sand material that can be used for local filling.
Pr_15_31_26_34	000604	LOCAL FILLING IN TRENCHES WITH EXISTING MATERIAL	m3	Local filling in trenches with existing material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant from material excavated from the existing area and reused
Pr_15_31_26_90	000105	SUBSOIL FILL FROM EXCAVATED MATERIAL	m3	Subsoil fill from excavated material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for excavated subsoil material that is suitable for Landscaping and will compose the second layer of the Planting Bed.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_15_31_26_90	000106	SUBSOIL FILL FROM IMPORTED MATERIAL	m3	Subsoil fill from imported material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported subsoil material that is suitable for Landscaping and will compose the second layer of the Planting Bed.
Pr_20_31_04_06	000106	PROTECTIVE LAYER FILL FROM IMPORTED MATERIAL	m3	Protective layer fill consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported materials that are suitable for constructing prepared subgrade.

- B. The measurement shall be the volume of compacted fill in embankments, topsoil fill and local fillings.
- C. The measurement for gravel surface on paths shall be the area with the width shown on Drawings (Technical Design).
- D. The items shall include for:
- a. Basic Survey and Detailed Setting Out, including:
 - i. scheduling, coordination and provision of all construction surveying;
 - ii. fixing coordinates, levelling and staking;
 - iii. tying the points into the national survey network;
 - iv. calculations essential to complete the project and properly control the work;
 - v. appropriate traffic control measures for all survey activities;
 - vi. marking of all survey stakes with station and offset reference;
 - vii. conducting a detailed cross section survey of the existing road for the purpose of measurement and preparing working drawings;
 - viii. provision and maintaining of reference stakes;
 - ix. renewing of illegible stakes;
 - x. relocation of initial horizontal and vertical control points, if necessary;
 - xi. protection of benchmarks;
 - xii. cooperation with utility companies and staking of control lines to relocate utilities.
 - b. fill provided by the Contractor from excavations in the Site;
 - c. fill provided by the Contractor from sources outside the Site.
 - d. protection of subgrade;
 - e. multiple handling of material;
 - f. keeping earthworks free of water;
 - g. complying with requirements and constraints on the sequence, timing and rate of deposition and filling, and equalisation of earth pressures;
 - h. fill material shall meet the requirement in the Specification.
 - i. complying with the particular requirements and constraints with regard to soil stabilisation, reinforced earth structures, strengthened embankments, anchored earth structures, corrugated steel buried structures and the like;

- j. taking precautions to avoid damage to property, structures, drains, services, instrumentation and the like;
- k. replacing acceptable material rendered unacceptable;
- l. selection of material and layering or depositing in locations stated in the Contract;
- m. depositing fill to slope away from vertical drainage layers and measures to prevent surface water entering such layers;
- n. trimming and shaping to levels and contours;
- o. trial areas, trials and demonstrations;
- p. making good after sampling and testing;
- q. forming and trimming side slopes, benching and beams;
- r. treatment of side slopes and berms;
- s. watering or drying to adjust moisture content;
- t. compaction of fill;
- u. blinding;
- v. special measures for dealing with processed material.
- w. Temporary works.
- x. Auxiliary means.

2.9.8 TEMPORARY ACCESS PATHS FOR CONSTRUCTION WORKS

2.9.8.1 REQUIREMENTS

- A. Temporary access paths for construction shall consist of all works necessary to achieve the specified result:
 - a. This item is meant for all previous works like temporary access roads for construction, allocation of the warning signs, construction site area, etc, with all the necessary materials and activities (tree cutting, bush cutting, vegetation layer removal and storing at site, demolitions, etc.), storage compounds and return to previous state.
- B. Site clearing and grubbing shall be done in accordance with subsection 2.7 of these Technical Specifications.
- C. The stripping of topsoil area shall be done in accordance with subsection 2.8 of these Technical Specifications.
- D. Earthworks shall be done in accordance with the relevant requirements in Section 02 – EARTHWORKS.
- E. Where required for the execution of the works the Contractor shall provide temporary lighting.
- F. The Contractor shall provide and suitably sign points of entry to and exit from the construction site, for vehicles engaged on the works.
- G. Temporary access paths and compound areas shall be restored to their original condition prior to withdrawal from the area.
 - a. The Contractor shall determine the measures that are appropriate for restoring the construction site, minimizing the impact, and submit a report with an appropriate management plan to the Engineer for approval.

2.9.8.2 MEASUREMENT AND PAYMENT – TEMPORARY ACCESS PATHS FOR CONSTRUCTION WORKS

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 43. Unit of measurement - Temporary access paths for construction works

Uniclass code	Type number	Work item	Unit	Work item includes
En_80_40	000001	ACCESS PATH FOR CONSTRUCTION WORKS	Metre (m)	Access path for construction works consists of all works and expenses necessary to achieve the specified end result, e.g., workforce, equipment, applicable fees (e.g., disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for all works necessary to build a pathway access to worksite.
Ss_15_95_15	000003	TEMPORARY ACCESS ROADS FOR CONSTRUCTION WITH ALL THE NECESSARY MATERIALS	Metre (m)	Temporary access roads consist of all works and expenses necessary to achieve the specified end result, e.g., workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for all works necessary to build a road access to worksite including removal and return to its initial state.

2.10 SLOPE PROTECTION

2.10.1 SCOPE OF WORKS

A. This section covers the following elements:

- a. Blanket Layer:
 - i. Permanent protection layer, composed of fragments of sound, hard and weather resistant rock, placed on the slope of an embankment or on the final surface at cut slope in soils or soft rocks, to protect them against erosion.
 - ii. Biodegradable Erosion Control Blankets (ECBs) provide effective and all-natural erosion control, soil stabilization, and vegetation establishment in an environmentally and wildlife-friendly manner. The erosion control blanket product is made of organic, biodegradable materials for bioengineering applications, environmentally sensitive sites, shaded areas, stream banks and shorelines.
- b. Gabions basket retaining wall: Casing or box made of hexagonal double twisted galvanized steel wire mesh, and later filled with stones on site. To be placed as protective elements against erosion at the foot of the cut slopes or embankments.
- c. Soil nailing wall: Soil nail system (reinforcing bars, facing, and drainage system). It shall be used to enhance/maintain the stability of a soil mass which is dimensioned at profiles steeper than the stable angle of repose.

B. Slope protection measures to be used where required by the works, where specified by Technical Design or directed by the Engineer.

2.10.2 NORMATIVE REFERENCE

A. Slope protection measures shall comply with following standards:

- a. EN 13383-1 - Armourstone. Specification.
- b. EN 13383-2 – Armourstone. Test methods.
- c. EN 10244-2 - Steel wire and wire products. Non-ferrous metallic coatings on steel wire. Zinc or zinc alloy coatings.
- d. EN 10245-1 - Steel wire and wire products - Organic coatings on steel wire - Part 1: General rule.
- e. EN 10080 - Steel for the reinforcement of concrete. Weldable reinforcing steel. General.
- f. EN ISO 1461 - Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods.
- g. EN 10223-3 - Steel wire and wire products for fencing and netting. Hexagonal steel wire mesh products for civil engineering purposes

- h. EN ISO 6988 - Metallic and Other Non-Organic Coatings - Sulfur Dioxide Test with General Condensation of Moisture.
 - i. EN ISO 9227 - Corrosion tests in artificial atmospheres - Salt spray tests.
 - j. EN 14490 - Execution of special geotechnical works. Soil nailing.
- B. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

2.10.3 BLANKET LAYER

2.10.3.1 MATERIALS

- A. Stones for blanket layer shall be produced in accordance with EN 13383-1 and EN 13383-2. The type of armourstone shall be natural armourstone.
- B. The produced armourstone shall comply to AVCP level 2+. Declared properties shall meet the requirements stated in Table below. Employer/Engineer has authority to initiate sampling and testing of the material delivered to site to verify the properties. The Contractor has to verify declared properties at least once per source.

Table 44. Minimum requirements - Armourstone for blanket layer

Property	Requirement	Reference
Gradation	CP 90/250	EN 13383-1
Shape	LT 20	EN 13383-1
Crushed or broken surfaces	RO 5	EN 13383-1
Resistance to breakage	CS 60	EN 13383-1
Resistance to wear ^(a)	M _{DE} 30	EN 13383-1
Water absorption	W _{ACM} 0,5	EN 13383-1
Signs of Sonnenbrand	SB A	EN 13383-1
(a) - Category M _{DE} 30: Moderately abrasive environment, e.g. occasional significant wave or current action of suspended sediment load.		

- C. In case blanket layer needs rest on a base layer that serves as a transition between it and the underlying material, this base layer shall be more permeable than the underlying material and shall prevent fine migrations through it. The filter material shall be formed with gravel or crushed rock. It shall be verified that between two (2) successive layers the following conditions are accomplished:
 - a. $(I_{15}/S_{85}) < 5$; $(I_{50}/S_{50}) < 25$; $(I_{15}/S_{15}) < 20$

where:

I_x is the sieve opening through which passes the x% in weight of the material of the lower layer

S_y is the sieve opening through which passes the y% in weight of the material of the upper layer.
- D. If a single filter layer cannot meet the criteria at both interfaces, two or more layers may be required.
- E. The filter criterion is imposed at the interfaces between the underlying material and the filter, and between the filter and the overlying blanket layer.
- F. As matrix for Biodegradable Erosion Control Blankets will be used only Biodegradable materials as coconut fibre, jute netting and Leno woven.

Table 45. Minimum requirements - ECB blanket layer

Property	Requirement	Reference
Longevity (for long term durability)	Up to 24 months	Supplier Guarantee
Slope application	Up 1:1 (H:V)	EN 13383-1
Woven biodegradable jute top and bottom net, 100% coconut fiber matrix	N/A	N/A
Manufacturing method	Woven type	N/A
Raw material	100% natural (biodegradable)	N/A
Thickness	≥ 5 mm	N/A
Mass per unit area	≥ 400g/m ²	N/A
Tensile strength long.	≥ 8.00 kN/m	N/A
Tensile strength trans.	≥ 5.00 kN/m	N/A
Elongation long.	≤ 25 %	N/A
Elongation trans.	≤ 25 %	N/A

2.10.3.2 CONSTRUCTION REQUIREMENTS

- A. Clearing and grubbing requirements shall be met, with slopes left free of brush, trees, stumps or other objectionable materials and dressed to a smooth surface.
- B. Banks are to be trimmed uniform slope, as indicated on Drawings.
- C. Loose, soft or spongy material, and large rocks projecting through the slope shall be previously removed.

2.10.4 GABIONS BASKET RETAINING WALL

2.10.4.1 MATERIALS

- A. GABIONS BASKET
 - a. Gabions basket units for retaining structures shall be made of hexagonal double twisted steel wire mesh (EN 10223-3). Steel wire mesh shall be type 8x10, wire diameter 2.70/3.70mm (int/ext) as per EN 10223-3. Steel wire mesh shall be coated (galvanized) with Zn 95%/Al 5% and covered with polymer protective coating. A polymer coating shall be in accordance with EN 10245-1 and a nominal thickness of 0.50 mm is then applied to provide added protection.
 - b. The design working life of the gabions basket made of hexagonal double twisted steel wire mesh (galvanized and covered with polymer protective coating) shall be 100 years.
 - c. The tensile strength of the wire mesh shall be not less than 50kN/m (EN 10223-3). When the mesh is tested at 50% of the nominal tensile strength in accordance to EN 10223-3, the wires shall not show cracks in the organic coating within the double twists region.
 - d. The placement of the fill shall be conducted in a manner as not to damage, scratch or break the outer polymeric corrosion protection coating hence leaving the inner wire not exposed to the elements.
 - e. The resistance of the wire mesh to corrosion in sulphur dioxide environment (EN ISO 6988) shall be such that after 28 cycles of discontinuous test the mesh shall not show more than 5% of DBR (Dark Brown Rust). The resistance of the wire mesh to corrosion in neutral salt spray tests (EN ISO 9227) shall be such that after 6000 hours of exposure the mesh shall not show more than 5% of DBR (Dark Brown Rust).
 - f. Lacing shall be made by means of lacing wire in accordance with EN 10223-3 Clause 6.8 or Clause 6.9.
- B. GEOTEXTILE

- a. A nonwoven geotextile recommended by the Manufacturer specifically for gabion related applications shall be placed at the soil-gabion interface for separation/filtration purposes.

C. STONES

- a. Rocks for filling the system shall be hard, angular to round, durable and of such quality that they do not lose their integrity on exposure to water or weathering during the life of the structure. Rocks shall fulfil frost resistance category F_{NaCl4} (EN 1367-6)
- b. Rocks shall range between 100 and 200mm. The range in sizes may allow for a variation of $\pm 5\%$, provided it is not placed on the exposed surface. In all cases, the oversize rock shall not be larger than 250mm and the undersize rock shall not be smaller than 50mm.

2.10.4.2 CONSTRUCTION REQUIREMENTS

A. FOUNDATION PREPARATION

- a. The foundation on which the gabion units are to be placed shall be levelled and graded to the elevations according to the Technical Design Drawings.
- b. Where required, natural soil shall be removed, and soil improvement treatment shall be performed for the foundation of the wall. Soil improvement shall consist of a mix of well compacted (D_{pr} \geq 97% EN 13286-3 Standard Proctor) sand and gravel, material passing 0.063 sieve <15%, and coefficient of uniformity C_u>3.
- c. The outer alignment of the wall shall then be marked on the foundation in accordance to the Technical Design Drawings.

B. DRAINAGE

- a. Behind the gabion retaining structure, a slotted drainpipe at least DN200, or whatever shown on the Technical Design Drawings, shall be placed for drainage of groundwater.
- b. Around the pipe, drainage filter granular material (16-45 mm) and geotextile shall be placed.

C. ASSEMBLING AND LACING THE INDIVIDUAL UNITS

- a. Operations for assembling and lacing the boxes shall be in accordance with Manufacturer's instructions.

D. PLACING THE SYSTEM UNITS AND STONE FILLING

- a. In accordance with Manufacturer's instructions.

2.10.5 SOIL NAILING WALL

2.10.5.1 MATERIALS

- A. The soil nailing system shall be composed of a reinforcing element (steel bars solid or hollow), rigid (shotcrete) and/or flexible (reinforced geomat) facing, double electrowelded wire mesh and subhorizontal drains.

B. REINFORCING ELEMENT

- a. Fully grouted steel bars, diameters 25mm and 32mm, unless otherwise shown on drawings or agreed with the Engineer due to work requirements. Bars shall be self-drilling, or similar approved by the Engineer.
- b. Steel bars and steel plate seat shall conform to EN 10080.
- c. Grout shall be compatible with the reinforcing element and comply with relevant requirements of Section 05 STRUCTURES in these Technical Specifications.

C. SHOTCRETE C25/30 (RIGID FACING)

- a. Shotcrete shall be C25/30 (characteristic strength. Characteristic strength values (no less than 25MPa (cylinder test)/30MPa (cube test)) represent the medium value of three tests at 28 days and no test result may be lower than 75% of mentioned value.
- b. Components (water, cement, aggregates, any admixture) of shotcrete shall be in accordance with relevant requirements in Section 05 STRUCTURES.

- c. Shotcrete shall be capable of being applied in layers of up to 100mm in thickness with good adhesion to the natural soil or previous layers of shotcrete.
 - d. In visual inspection shotcrete shall be dense and homogeneous without segregation of aggregates or other visible imperfections.
 - e. Shotcrete shall be left as sprayed. The surface shall not be worked by float or any other means.
 - f. The minimum thickness of shotcrete shall be in accordance with Technical Design.
 - g. Appropriate thickness markers, acceptable to the Engineer, shall be used to provide a means of determining the thickness of shotcrete applied.
- D. REINFORCED GEOMAT (FLEXIBLE FACING)
- a. Reinforced geocomposite made by a polypropylene three-dimensional matrix extruded onto a double twisted hexagonal steel wire mesh (reinforcement element) during the production.
 - b. The double twisted wire mesh shall be highly galvanized (Class A according to EN 10244-2).
 - c. The reinforced geomat shall have CE mark.
 - d. The Design Working Life shall be 100 years.
 - e. The punch resistance of the geomat shall not be less than 67kN (UNI 11437), with a maximum ultimate punching displacement of 520mm.
 - f. The longitudinal tensile strength shall not be less than 50 kN/m according to EN 10223-3. When the geocomposite is tested at the ultimate tensile strength (EN 10223-3) the elongation shall not be less than 8%.
 - g. The resistance of the wire mesh to corrosion in neutral salt spray tests (EN ISO 9227) shall be such that after 6000 hours of exposure the mesh shall not show more than 5% of DBR (Dark Brown Rust).
 - h. The double twisted mesh shall be 8x10 hexagonal mesh and the wire diameter shall be 2.70/3.70mm, all the dimensions are according to EN 10223-3.
 - i. The geocomposite shall have a minimum thickness of 12 mm (EN ISO 9863-1) and the polypropylene mat shall have a minimum mass per unit area equal to 450 g/m² (EN ISO 9864); the voids index of the mat shall not be lower than 90%.
 - j. The flexible facing shall be transported, stored and installed following the Manufacturer's instructions.
 - k. The geocomposite shall be produced in an approved, quality controlled factory with the CE certificate.
- E. DOUBLE ELECTROWELDED WIRE MESH (150x150x6mm)
- a. The standard mesh grid shall be 150x150mm made up of 6mm diameter steel bars B500B.
 - b. If not specified otherwise on the Technical Design drawings, the overlap of wire mesh shall be 50mm.
 - c. Steel mesh shall be in accordance with EN 10080, and galvanized complying with EN ISO 1461.
 - d. The reinforcement mesh shall be cleaned of any previously deposited material, which might prevent a proper bond.
 - e. Reinforcement mesh shall be securely fixed in place. Ties, anchors and supports for the mesh shall be made of steel and suitable spacers shall be provided where necessary. Timber packings shall not be used. The method of fixing the mesh shall be such that shotcrete can be compacted soundly behind the reinforcement at all points. Laps shall be a minimum of two pitches. Additional fixings shall be installed as necessary to fit the mesh to the excavation profile.
- F. SUB-HORIZONTAL DRAINS
- a. Sub-horizontal drains shall allow to drain water that may circulate through soil mass and could accumulate behind shotcrete slope protection.
 - b. Drain tubes shall be perforated pipes made of PVC or similar material of a minimum nominal diameter of 50mm are installed in the holes.
 - c. Drain tubes shall have a slotted length (variable, as shown on drawings) and a non-perforated length (0.6m).
 - d. Holes shall be drilled with a 5 to 10° inclination.
 - e. Tubes shall be wrapped in geotextile 80N/cm (150gr/m²). Geotextile shall comply with sub-section 2.12.

- f. PVC pipes shall comply with requirements in sub-section 4.3 PIPELINES herein.

2.10.5.2 CONSTRUCTION REQUIREMENTS

- A. The sequence of soil nail construction includes five main processes:
- preliminary work;
 - excavation / face preparation;
 - nail installation;
 - drainage installation;
 - facing installation and connection with nail heads.
- B. Tolerances:
- Excavation of cut slopes should start within 50mm of the design crest.
 - The excavation should be cut to within 2.5° of the design slope angle.
 - Deviation from the design slope between nails should not exceed the lesser of either the nail spacing divided by 20 mm or 50 mm.
 - Local bumps and indentations are permitted, provided they do not affect the integrity of the facing.
 - The nail location on the face should generally not be specified as less than ± 100 mm and the nail orientation to less than $\pm 5^\circ$. Potential clashing of soil nails should be considered.
- C. Acceptance and design assumptions for verification testing shall be in accordance with EN 14490 Annex C. Optional for geotechnical category 1 structures; cat 2 or 3 structures are as follows:
- Sacrificial testing cat 2:
 - If no comparable experience of soil type: a minimum of three sacrificial nails with at least one sacrificial nail per soil type. Where direct experience exists then sacrificial nail tests are optional.
 - Production testing cat 2:
 - 2% with a minimum of three tests. These criteria are subject to a minimum of one test per soil type and per excavation stage.
 - Sacrificial testing cat 3:
 - A minimum of five sacrificial nails with at least two sacrificial nails per soil type.
 - Production testing cat 3:
 - 3% with a minimum of five tests. These criteria are subject to a minimum of one test per soil type and per excavation stage.
 - Testing equipment spec to be in accordance with EN-14490 Annex C
- NOTE 1: Test nails should be evenly distributed throughout the structure
- NOTE 2: The frequency of testing outlined in section C a to d, are minimum
- NOTE 3: Where sacrificial nail tests are carried out the number of production nail tests can be reduced on a pro-rata basis
- NOTE 4: For spacing less than 0.8 m, a group test of four nails is recommended
- D. Materials testing:
- Flow testing should be conducted on grout used during execution to check flow suitability in accordance with ISO 1920, with at least 1 test per batch
 - Cube testing as per EN 14490 the minimum characteristic strength of the grout should be at least 5 N/mm² prior to loading of the soil nail and the 28-day strength should be not less than 25 N/mm². Therefore, at least 6 cubes per grouting batch should be taken and cured in a water tank. Tests are

- to be conducted after 1, 7 and 28 days respectively with at least 2 per test (Sampling and testing to be in accordance with ISO 1920)
- c. All test reports should clearly be identified in order to relate to the corresponding nail locations with dates of execution stated
- E. Supervision and monitoring requirements:
 - a. To be in accordance with EN 1997-1 and Section 9 of EN 14490.

2.10.6 RIP-RAP STRUCTURES

- A. Protective structures shall meet the requirements given in the Table 39, armourstone stone sizes for specific places and geometry of the rip-rap layers and placement as shown in the Drawings at:
 - a. Rip-rap on cut for protection of embankment and stabilization of streams.
 - b. River Bank protection for Piers or abutments to safeguard structures against scour action.
 - c. Rip-rap rockery material for reinforcement of foundation
- B. The riprap structure shall achieve the following requirements:
 - a. Stones for this work shall be hard angular quarry stones and have a percentage of wear of not more than 50 at 500 revolutions as determined by EN ISO-13383-2.
 - b. The least dimension of any piece of stone shall be not less than 1/4 its greatest dimension. Rounded boulders or cobbles shall not be used on slopes steeper than 2:1.
 - c. Stones shall meet the following requirement EN 13383-1 to size and specifications.
 - d. Between the riprap and the slope, a filter intended to retain fine materials within the slope; this may be replaced by anti-contaminant geotextile installed in one or two layers depending on the conditions of installation of the riprap,
 - e. A footing block (anchor) to mitigate any general tendency towards the lowering or undercutting of the channel.
 - f. Protection of riverbanks, rocks are not fixed by concrete to move with riverbed deformation.
 - g. Protection of piers, rocks are fixed by concrete.
- C. STONES:
 - a. Rocks material shall be meet the requirements of Rip-rap Material.
 - b. Rocks shall be hard, angular to round, durable and of such quality that they do not lose their integrity on exposure to water or weathering.
 - c. Minimum density of the rock shall be 26.5kN/m³.
 - d. Minimum rock block weight shall be according to size and grading category defined in Technical Design Drawings.
 - e. Rocks shall not be smaller than indicated in the Technical Design Drawings
 - f. Thickness of Rip-rap protection shall be as shown on the Drawings and not less than 2xD50
 - g. Stones shall meet the requirement of standard EN 13383-1 to size and specifications.
- D. This Section provides a needed but non-exhaustive list of works, materials, tools and equipment necessary for furnishing and placing a protective covering of stone, as shown on the Drawings, or as directed by the Engineer.

2.10.7 CONCRETE BLOCK PITCHING

- A. The function of the slope protection in abutments is to protect the slopes from erosion with concrete stone pitching.
 - a. Concrete stones shall meet the requirements of EN 1338. Weather resistance class 3 and breaking strength 3.6 MPa.
- B. Weight loss of concrete stones in freeze/thaw resistance shall be according EN 1338.

- a. Estonia Minister of Economic Affairs and Infrastructure legal act No. 101 "Tee ehitamise kvaliteedi nõuded" is applicable for road bridges located in Estonia also railway structures located in Estonia, in cases where asphalt pavement road is located under the structure.
- C. The base shall be made from cement and sand mixture, ratio shall be proposed by the contractor and agreed with site Engineer. Minimum thickness of the base is 5 cm, joints between the concrete stone pitching shall be filled with cement and sand mixture.
- D. Cement and sand mix shall be installed before the curing process of the mix.
- E. Concrete stone shall not have cracks and/or holes and be inalterable to water and weather.
- F. The contact surfaces of the concrete stones must be clean before laying them.
- G. Concrete stones shall have minimum thickness at least 8 cm. Recommended width and length of the stones are 10x20 cm.
- H. Pattern of the block layout shall be agreed with the Engineer.

2.10.8 SLOPE PROTECTION LAYER

- A. Stones shall conform to the requirements detailed in following table:

Table 46. Requirements – stones for slope protection layer

Property	Requirement	Reference
Mixture designation	EN 13285 Ch. 4.3.1	5/90
Fines content	EN 13285 Ch. 4.3.2	UF ₅
Oversize	EN 13285 Ch. 4.3.3	OC 90
Crushed or broken surfaces	EN 13242 Ch. 4.5	C _{90/3}
Resistance to frost ^(a)	EN 13242 Ch. 7.3.3 (Partial saturation Table B.1)	F2
Magnesium sulphate value ^(a)	EN 13242 Ch. 7.3.3 (Partial saturation Table B.1)	MS ₂₅
Resistance to fragmentation	EN 13242 Ch. 5.2	LA ₄₀
Grading range category	EN 13285 Ch 4.4.1	G _B
Note: (a) One or another requirement is enough		

2.10.9 MEASUREMENT AND PAYMENT – SLOPE PROTECTION

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The supply, loading, transport and installation of the buffer stop shall be measured as stated below provided if they are executed in accordance with project specifications and the indications of the Engineer.
- C. The units of measurement shall be as follows:

Table 47. Units of measurement – Slope protection works

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_15_31_26_34	000133	FOUNDATIONS OF BLANKET LAYER	m3	Foundations of blanket layer consists of all the materials, works and expenses necessary to achieve the specified end results e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of foundation for blanket layer made with granular material and concrete fluid grout.
Pr_15_57_27_33	000101	FLEXIBLE FACING. REINFORCED GEOCOMPOSITE	m2	Flexible facing consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for turf reinforced geocomposite made by a polypropylene three-dimensional matrix extruded onto a double twisted hexagonal steel wire mesh.
Pr_15_93_30	000101	RIP-RAP ON CUT	m3	Rip -rap on cut consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the layer of solid, hard, weather-resistant rock fragments placed on the slope of a fill or on the final surface at the foot of the cutting slope in soils or in soft rocks. Including all materials and operations required for the correct and full execution of the rip-rap on cut layer
Pr_15_93_30	000103	RIP-RAP ROCKERY MATERIAL	m3	Rip-rap rockery material consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the layer of solid, hard, weather-resistant rock fragments placed on fills in riverbeds. Including all materials and operations required for the correct and full execution of the rip-rap layer
Pr_20_31_16_84	000101	SHOTCRETE C25/30 IN RIGID FACING FOR SOIL NAILING	m3	Shotcrete C25/30 in rigid facing for soil nailing consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of shotcrete C25/30 layer in soil nailing for a rigid facing of slopes. It will be carried out once the excavation has been cleaned up to guarantee the stability of the section in the short term.
Pr_20_85_28_75	000101	RIVER BANK CONTAINMENT BY SAND BAGS	m3	River bank containment by sand bags consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of sand bags placed on the river or channel banks to water containment. Including all materials and operations required for the correct and full execution of the item

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_25_93_60_17	000301	CONCRETE BLOCK PITCHING	m2	Slope protection in abutments consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing a slope protection in abutments with concrete stone pitching that includes the supply of the material and its placement, the concrete of seat and mortar, as well as all the necessary means for the total completion of works
Pr_15_31_26_34	000145	SLOPE PROTECTION LAYER	m3	Slope protection layer consists of all the materials, works and expenses necessary to achieve the specified end results e.g., volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of a layer of granular material on cutting slopes to increase their stability and verticalize them
Pr_15_31_26_34	000146	FOUNDATIONS OF SLOPE PROTECTION LAYER	m3	Foundations of slope protection layer consists of all the materials, works and expenses necessary to achieve the specified end results e.g., volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of foundation for slope protection layer made with granular material and concrete fluid grout
Pr_25_93_60_17	000302	CONCRETE BLOCK PITCHING, WITH HIGH FROST RESISTANCE	m2	Concrete block pitching, with high frost resistance, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing a slope protection with concrete block pitching with average weight loss of concrete paving blocks in freeze/thaw resistance test shall be within 0,2 – 0,5 kg/m2, accordint to technical specifications. Including the supply of the material and its placement, the concrete of seat and mortar, as well as all the necessary means for the total completion of works
Pr_65_52_07_91	000101	SUBHORIZONTAL DRAIN PIPES	m	Subhorizontal drain pipes consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for drilling holes in the front of a slope into which a grooved PVC pipe wrapped in geotextile is inserted to prevent fines from being carried away. Its function is to drain, preventing water on the surface of the slope.
Ss_15_10_80_33	000301	EROSION CONTROL: CRUSHED LIMESTONE OR DOLOMITE FR 32/64 ON GEOTEXTILE	m2	Erosion control consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and laying of crushed limestone or dolomite with geotextile to protect against erosion at the end of the drainage channels.

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_15_10_80_80	000101	SOIL NAILING	m	Soil nailing consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for slope verticalization using steel bar inclusions that will serve to stabilize it. Includes steel bars, steel plates and resin.
Ss_25_13_30	000101	GABION WALL BASKET	m3	Gabion Basket wall consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for placement of box made of triple torsion mesh, obtained with galvanized steel wire "reinforced" and filled on site later with stones. They will be placed as protective elements at the foot of the cuttings or embankments
Ss_25_13_30	000102	GABION WALL BASE BASKET	m3	Gabion basket wall base consists of all the materials, works and expenses necessary to achieve the specified end result e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the placement of a granular fill on the foundation of the gabion basket wall.
Pr_15_31_26_34	000120	BLANKET LAYER	m3	Blanket layer consists of all the materials, works and expenses necessary to achieve the specified end results e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the placement of a layer of granular material on cutting slopes to increase their stability and verticalize them.
Pr_15_93_30	000301	RIVER BANK PROTECTION FOR PIERS OR ABUTMENTS	m3	River bank protection for piers or abutments consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the layer of solid, hard, weather-resistant rock fragments placed on piers or abutments, with rock armour against scour. Including all materials and operations required for the correct and full execution of the item
Ss_32_46_50_05	000101	THREE TORSION MESH	m2	Steel three-torsion mesh consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for slope protection by supply and placement of three torsion mesh that will serve as protection against rock and stone falls from the slopes attached to the railway or roads, with anchored with concrete strap and fastening with anchor bolts

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_32_46_50_05	000102	ELECTROWELDED WIRE MESH	m2	Steel electrowelded wire mesh 150x150x6mm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for slope protection by supply and placement of electrowelded mesh, with steel reinforcement and size 150x150x6mm, that will serve as protection against rock and stone falls from the slopes attached to the railway or roads

2.11 SOIL STABILIZATION (SOIL TREATMENT)

2.11.1 SCOPE OF WORKS

- A. This section covers the following elements:
- Soil treated with hydraulic binders (stabilised soils).
 - Stone columns. Cylindrical perforations filled with granular material, to be used as reinforcing elements in soft soils and in potentially unstable slopes, in fine saturated soils to improve the permeability and accelerated the consolidation.
 - Sub-horizontal drains. Perforated in the front of a slope, to drain the massif, relieving the hydrostatic pressure in it and avoiding the outcrop of water on the surface of the slope.
 - Rigid inclusions. Soil reinforcement method that increases the stiffness of the treated soil mass by allowing effective load sharing between the soils and the columns.
 - Prefabricated vertical drains (PVDs) or “wick drains”.
 - Preload.
- B. Soil stabilization / soil treatment measures to be used where required by the works, where specified by Technical Design or directed by the Engineer.

2.11.2 MATERIALS

2.11.2.1 SOIL STABILIZATION WITH HYDRAULIC BINDERS

- The binder (e.g. cement, fly ash) shall be mixed with one passing. Maximum period between binder laying and mixing shall be less than declared setting time of the binder (EN 196-3). If this time is exceeded, then additional amount of cement shall be introduced into the material. If this period less than 24h, additional amount shall be at least 50%. If this period is longer than 24h, then entire amount of cement shall be added again.
- With hydraulic binders, it is essential to ensure that sufficient amount of water is added during the mixing process. The water content shall be close to optimum moisture content with allowable deviation of $\pm 1\%$. If the determined water content is insufficient then mixing shall be repeated with or without additional water within the timeframe determined in this specification above.
- When soil is treated with lime, the binder can be mixed with one or two passing. In case the soil is difficult to mix, next mixing could be done 2-3 days later after first mixing.
- Stabilization works shall be inspected continuously. Layer's appearance shall be visually homogenous. The amount of binder shall be measured at least once per day and may not deviate more than $\pm 15\%$ from the prescribed amount for 1 m². Measuring shall be done in accordance with appropriate method, approved by the Engineer. The total amount of binder shall not deviate more than $\pm 5\%$.
- The stabilized layer shall be compacted by spraying small amount of water on top of the stabilized layer and compacting the layer with pneumatic roller. After compaction the layer shall be prevented from rapidly losing

moisture. If necessary, the stabilized layer shall be kept moist by spraying with water regularly. After completion, no traffic is allowed on top of the layer for at least 7 days. This requirement may be waived in case the stabilized layer is covered with next layer with thickness of at least 30cm.

- F. The amount of materials and binders shall be controlled by means of weighing, by geodetic measurements or other applicable surveying methods, approved by the Engineer.
- G. Any added water shall have a sulfate content not exceeding 1400 mg/l as SO_4 , when tested in accordance with EN 1744-1 clause 10.

2.11.2.2 STONE COLUMNS

- A. The aggregates shall be produced in accordance with EN 13242 and shall have following requirements:

Table 48. Requirements - Stone columns aggregate

Property	Requirement
% fines	f ₂
Gradation category	G _c 80/20
Minimum aggregate size	d ≥ 16 mm
Maximum aggregate size	D ≤ 63 mm
Resistance to fragmentation	LA ₄₀
Crushed aggregates, category	C _{90/3}

- B. In case of using gravel natural aggregates the smaller internal friction angle shall be taken into account in the dimensioning.
- C. The stone columns shall be superficially covered with a draining granular layer with the following characteristics, unless otherwise stated in the Technical Design:
 - a. Thickness > 0.50m.
 - b. Maximum aggregate size D ≤ 16 cm.
 - c. % of fines (0.063mm sieve passing) f ≤ 5%.

2.11.2.3 SUB-HORIZONTAL DRAINPIPER

- A. The Engineer shall set the separation, depth and inclination of the drains according to the existing conditions in each slope.
- B. Except special cases, the minimum inclination shall be one (1) vertical: / ten (10) horizontal (1V/10H), towards the exit of the drain.

2.11.2.4 RIGID INCLUSIONS

- A. Fluid concrete, minimum C16/20.
 - a. Concrete shall be pumpable.
 - b. Concrete according to chapter "5.2. CONCRETE WORKS".
- B. Load transfer platform (capping layer between the rigid inclusions head and the structure):
 - a. Gravelly soils with fines content (material passing 0.063 sieve, EN 13285) ≥10% and <35%, and non-clayey fines and coarse elements. Friction angle between 30° and 36° depending on the particle size distribution criteria set forth in EN 14475.
 - b. CBR >10,
 - c. compacted to 100% of the Standard Proctor density (EN 13286-2),
 - d. E_{v2} > 80 MPa.

2.11.2.5 PREFABRICATED VERTICAL DRAINS (PVDs)

- A. Prefabricated Vertical Drains, also known as Wick Drains, are used to accelerate the consolidation of compressible soils.
- B. The consolidation of compressible soils involves the removal of pore water from the soil. This is traditionally done by applying a surcharge of preload to the construction area to "squeeze" the water out. Unfortunately, compressible soils are also often low-permeability soils (peats, silts, clays) with long drainage paths, and as such the pore water is not easily squeezed out resulting in very slow rates of consolidation.
- C. Therefore, to accelerate the dewatering process, it is necessary to install PVDs into the soil to provide a conduit for the pore water to flow easily.
- D. PVDs consist of a specially designed synthetic core extruded into a unique configuration to transmit maximum water flow on both sides of the core. The core is fully wrapped in a durable non-woven geotextile filter that is ultrasonically welded at the edges to maintain effective filtration. The PVD is designed to allow free flow of water in all directions and to ensure the integrity of the drainage system when subjected to tensile, compressive and buckling forces as the compressible soil deforms and consolidates

2.11.2.6 PRELOAD

- A. Unless expressly authorised by the Engineer, the material used in the preload shall comply, as a minimum, with the conditions established for the material usable in the embankment core. In case the material used in the preload is not suitable for embankment core, it shall be removed completely from the structure. The extent and volumes must be recorded prior to installation and these shall match later with the removed material quantities. It is not allowed to use topsoil or inadequate materials.
- B. Unless justified otherwise and approved by the Engineer, the material used in the preload shall be material which shall be used in the embankment or surplus material to be disposed offsite.
- C. The material used in the preload does not require special conditions of compaction. However, to avoid erosions, instabilities, etc., the Engineer may limit the maximum thickness of spreading layer to fifty centimetres (50cm) and prescribe to pass twice over the layer with a smooth roller.
- D. The geometrical properties of the preload shall be in accordance with the Technical Design or that instructed by the Engineer and/or Employer. The thickness of the preload shall in any case provide a weight greater than the set of railway layers (frost protection + prepared subgrade + sub-ballast + ballast) to be laid later.
- E. The material for the preload shall be placed from the theoretical final surface of the embankment fill (i.e. from the underside of the frost protection or prepared subgrade).

2.11.3 CONSTRUCTION REQUIREMENTS

2.11.3.1 STONE COLUMNS

- A. Stone columns shall be arranged with the diameters, separation and depth indicated in the Technical Design.
- B. Before installation, the ground surface shall be cleared and cleaned, proceeding to install external references that allow the correct staking of the project mesh, with an error $\pm 20\text{cm}$.
- C. Stone columns shall be executed by a method appropriated to the soft soil, approved by the Engineer.
- D. Once the columns are completed, the draining layer shall be spread over them, with the dimensions indicated in the Technical Design.
- E. Finally, the embankment shall be extended so that the draining layer is not removed or contaminated, and the lateral outlet of water is maintained.

2.11.3.2 SUB-HORIZONTAL DRAINPIPES

- A. Drainpipes shall be arranged with the diameters, separation and depth indicated in the Technical Design. The minimum diameter of the perforation shall be of 10cm.

- B. Once the drilling is finished, it shall be cleaned, eliminating any obstacle that may hinder the entry of the drainage tube.
- C. If required by the ground conditions, drilling shall be done with tubing. In no case shall slurry be used.
- D. The drainage tube shall be prepared so that its length meets the following terms:
 - a. Leave a maximum of 1.0m at the bottom of the hole devoid of tube.
 - b. Leave at least 1.0m of pipe outside the hole of the drill to allow the connection to the drainage.
- E. The tube shall be grooved along its entire length, except for the last metre located in the interior of the terrain.
- F. The grooved area shall be wrapped with a geotextile. Minimum overlaps longitudinally shall be 20cm and 7cm circumferentially. Geotextile shall comply with sub-section 2.12.
- G. The diameter of the PVC pipe shall be less than that of the drill, between 15 – 40mm less. The diameter shall be approved by the Engineer.
- H. The bottom of the tube shall be plugged.
- I. When placing the tube, it shall be inserted without forcing it, reducing as much as possible the friction against the walls. In case an obstacle is found, the tube shall be removed, the hole re-drilled to eliminate it and, after checking the tube and wrapping the damaged areas in geotextile, the PVC tube shall be inserted again.
- J. The same procedure shall be followed when it is verified, when inserting the tube, that the drill length is more than 50cm less than the specified.
- K. The mouth of the drains shall be sealed with a cement grout or bentonite-cement, to a depth of at least 25cm. Once the installation is finished, it shall be verified that no water comes out of the space between tube and drill.

2.11.3.3 RIGID INCLUSIONS

- A. Rigid inclusions shall be arranged with the diameters, separation and depth indicated in the Technical Design Drawings.
- B. The gravel platform (capping layer) over the rigid inclusions shall be arranged with the dimensions indicated in the Technical Design Drawings.
- C. Previous site preparation:
 - a. Working platform before the rigid inclusions works to allow the drilling equipment works properly, adapted to actual execution conditions.
 - b. Setting out of the rigid inclusion mesh.
- D. Execution phase for rigid inclusions:
 - a. Rigid inclusions shall be installed by means of soil displacement techniques, with no soil extraction, and according to EN 12699 - Execution of special geotechnical works - Displacement pile.
 - b. Drilling parameters shall be registered by the equipment during 100% of the drilling.
 - c. The inclusions shall be installed using a hollow tool that will enable concreting the inclusions by their tip. Concrete shall be continuously pumped through the screw while the tool rises, without interruptions, in a manner that guarantees the continuity of the inclusion (constant flow of concrete and lifting speed, mainly).
 - d. If the inclusion is not continuous, it shall be executed again.
 - e. Stopping the casting operation below the water table is forbidden.
- E. Execution tolerances: Rigid inclusions shall be installed within the following maximum permitted tolerances:

Table 49. Execution tolerances - Rigid inclusions

Property	Tolerance
Position	75 mm in any direction at commencing level
Verticality	1 in 75 deviation from the vertical
Rake	1 in 25 deviation from the specified rake for columns raking up to 1:6 and 1 in 15 for columns raking more than 1:6

Property	Tolerance
Diameter	not less than the specified diameter

- F. Cut-off operation (adjust the level of the inclusion head):
 - a. The heads of concrete columns shall be set to an appropriate elevation while the material is fresh. Hydraulic hammers shall not be used so as not to affect the integrity of the columns.
- G. Capping layer shall be spread and compacted in accordance with the requirements for embankments in Section 02 – EARTHWORKS. These works shall only begin when the tests determine that the concrete has gained a minimum strength of at least 80% of the f_{ck} .

2.11.3.4 PREFABRICATED VERTICAL DRAINS (PVDs)

- A. PVDs are installed into the ground using a hollow mandrel that houses and protects the PVD material. The mandrel is hydraulically driven into the compressible soil to the design depth so that the wick drain anchors in the incompressible materials underlying the compressible soils. The mandrel is then withdrawn leaving the PVD in place.
- B. The pattern and depth of the PVDs are a function of the consolidation properties of the soil and the required time for consolidation to occur. Wick Drains are typically installed at 1.0m to 3.0m centres, with depths ranging from 5m to 45m.
- C. Once the PVDs have been installed, a surcharge load is applied over the area to be consolidated. This surcharge layer combined with the PVDs accelerates the consolidation of the compressible soils so that it occurs over a period of months as opposed to a period of years.

2.11.3.5 PRELOAD

- A. The execution of the preload treatment shall begin once the prepared subgrade of the embankment has been reached, after verifying that the corresponding esplanade meets the requirements of the fillings.
- B. The Engineer may authorise the theoretical embankment prepared subgrade to be left to a height greater than that deduced from the plans, to compensate future settlements during the consolidation process. This additional height shall not exceed 4cm for each metre of embankment height. This additional height shall also be carried out with material suitable for the embankment in those conditions.
- C. The material forming the overload shall be spread in thick layers (<1.0m, unless directed otherwise by the Engineer), covering the entire width of the embankment.
- D. The preload material shall be continuously placed until the prescribed height is reached. Any interruption or waiting period, with incomplete height of the preload, shall require express authorisation from the Engineer.
- E. Throughout the preload process, periodic readings of the auscultation elements shall be carried out, with a periodicity of two readings/week during the placement of the filling and a reading/week thereafter.
- F. The preload crowning shall have a minimum cross slope of 2%, to avoid puddles and infiltrations. The Contractor shall take appropriate measures to prevent erosion, proceeding to the immediate repair of gullies and erosions that may occur.
- G. The removal of the preload material only shall begin once the Engineer give the approval to the degree of consolidation. If the Contractor withdraws material without prior authorisation, it shall be replaced immediately until reaching the previously existing height at Contractor's own expense
- H. Although the preload period shall be defined by the Engineer (based on the settlement tracking), it shall remain in place at any point a minimum of 4 months.
- I. When removing the preload, the necessary precautions shall be taken to avoid damaging the embankment. Upon reaching the height of the planned coronation, a minimum of 20cm shall be scarified, recompacting thereafter.
- J. Prepared subgrade and frost protection shall be placed immediately after removing the preload material, unless directed otherwise by the Engineer.

2.11.4 MEASUREMENT AND PAYMENT – SOIL TREATMENT

A. The following work items are defined:

Table 50. Units of measurement – Soil treatments

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_15_57_27_33	000102	GEOCOMPOSITE FOR DRAINAGE	m2	Geocomposite for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for supply and instalation of thermobonding a 3-dimensional drainage core of extruded monofilaments between two filtering nonwoven geotextiles.
Ss_15_10_35	000101	STONE COLUMNS, DIAMETER OF 0,60 m.	m	Stone columns with diameter 0,60 m consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for cylindrical perforations filled with granular material encased in geotextile, made in the support soil of embankments or foundations of structures in order to increase the shear strength of the soil and reduce its compressibility.
Ss_15_10_35	000103	STONE COLUMNS, DIAMETER OF 0,80 m.	m	Stone columns with diameter 0,80 m consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for cylindrical perforations filled with granular material encased in geotextile, made in the support soil of embankments or foundations of structures in order to increase the shear strength of the soil and reduce its compressibility.
Pr_25_93_50_55	000101	STONE COLUMN CAP	m3	Stone columns cap consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item includes the necessary gravel for the formation of the layer according to the technical specifications.

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_20_05_65_43	000101	RIGID INCLUSIONS, DIAMETER OF 0,40 m	m	Rigid inclusions with diameter 0,40 m consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for cylindrical perforations filled with concrete, without material extraction, made in the support soil of embankments or foundations of structures in order to increase the shear strength of the soil and reduce its compressibility. This unit includes cleaning and disposal of excess material to landfill.
Pr_15_31_26_34	000106	PRELOAD	m3	Preload consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for preloading in fillings. Includes spreading of material in the thickness established in the project, maintenance of the preloading for the time determined, removal of the material and transport to its point of use or offsite.
Pr_25_93_50_55	000102	RIGID INCLUSIONS CAP	m3	Rigid inclusions cap consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item includes the necessary gravel for the formation of the layer according to the technical specifications.
Pr_25_93_50_55	000103	GRANULAR MATERIAL ON WORK BASES	m3	Granular material on work bases consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item includes the necessary gravel for the formation of the layer according to the technical specifications.
Ss_15_10_35	000102	SOIL MIXING	m3	Soil mixing consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.), processing (binder, mixing, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the mixing of the existing material with a binder (e.g. cement, ash). Includes geotextile and soil to make the base for the stabilization equipment.

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_50_70_05_82	000101	PREFABRICATED VERTICAL DRAINS, 100 mm WIDE AND 4 mm THICK	m	Prefabricated vertical drains consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for inserted in the ground a high-density polyethylene or polypropylene plastic core with dimensions 100 mm wide and 4 mm thick, wrapped in geotextile. Its function is to drain the soil and accelerate its consolidation.

2.12 GEOSYNTHETICS / GEOTEXTILES AND GEOCELLS

2.12.1 SCOPE OF WORKS

- A. This section includes geosynthetics/geotextiles and geocell and their related works as specified in the Technical Design and these Technical Specifications.
- B. This section provides a needed but non-exhaustive list of labour, materials, equipment and services necessary to furnish, deliver and install all work of this section as shown on the drawing, as specified herein and/or as required by job conditions.

2.12.2 NORMATIVE REFERENCES

- A. Following list of geosynthetic/geotextiles standards shall be used as a reference:
 - a. EN 13249 Roads and other trafficked areas.
 - b. EN 13250 Railways.
 - c. EN 13251 Earthworks, foundations and retaining structures.
 - d. EN 13252 Drainage systems.
 - e. EN 13253 External erosion control systems.
 - f. EN 13254 Reservoirs and dams.
 - g. EN 13255 Canals.
 - h. EN 13256 Tunnel and underground structures.
 - i. EN 13257 Solid waste disposals.
 - j. EN 13265 Liquid waste containment.
 - k. EN 15381 Pavements and asphalt overlays.
- B. Compliance with construction regulations:
 - a. EN 13253. Geotextiles and geotextile-related products. Prerequisites features for use in erosion control works (coastal protection, bank revetments).
 - b. EN ISO 9864 Geosynthetics. Test method for the determination of mass per unit of geotextiles and geotextile-related products.
 - c. EN ISO 12236 Geosynthetics. Static puncture test (CBR test).
 - d. ISO 13433 - Dynamic perforation test (Cone drop test).
 - e. EN ISO 10058 - Determination of water permeability characteristics normal to the plane, without load.
 - f. EN 14150. Geosynthetic barriers. Determination of permeability to liquids.
 - g. EN 14575. Geosynthetic barriers. Screening test method for determining the resistance to oxidation.
 - h. EN 12224. Geotextiles and geotextile-related products. Determination of the resistance to weathering.

- C. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

2.12.3 GENERAL REQUIREMENTS

- A. Geosynthetics/geotextiles for filter function, embankment and track bed layers shall have DWL greater than structure's DWL, i.e. at least 100 years.
- B. All materials, components and products shall conform to the requirements of relevant standards, Local Regulations and have the CE marking.
- C. Declared properties together with declared allowable deviations shall meet the requirements stated in the Technical Design.
- D. Products shall be suitable for intended use, e.g. separative geosynthetic product shall only be used for this purpose.

2.12.4 TECHNICAL REQUIREMENTS

- A. Geotextiles shall have the following functions according to the Technical Design or as specified on Drawings
- Separation.
 - Filter.
 - Protection.
- B. Geotextiles with a separation function shall meet the following requirements:

Table 51. Minimum requirements - Geotextile for separation

Separation Geotextile Requirements		
EN ISO 10319	Longitudinal tensile strength	≥ 8 kN/m
	Transverse tensile strength	≥ 10 kN/m
EN ISO 10319	Longitudinal elongation	$\geq 50\%$
	Transverse elongation	$\geq 55\%$
Static puncture test (CBR test) (EN ISO 12236)		≥ 1560 N
Dynamic perforation test (Cone drop test) (ISO 13433)		≤ 24 mm
Determination of water permeability characteristics normal to the plane, without load (EN ISO 11058)		≥ 61 l/m ² /s

- C. Geotextiles with a filter function shall meet the following requirements:

Table 52. Minimum requirements - Geotextile for filter

Filter Geotextile Requirements		
EN ISO 10319	Longitudinal tensile strength	≥ 6.5 kN/m
	Transverse tensile strength	≥ 6.5 kN/m
EN ISO 10319	Longitudinal elongation	$\geq 50\%$
	Transverse elongation	$\geq 55\%$
Static puncture test (CBR test) (EN ISO 12236)		≥ 1110 N
Dynamic perforation test (Cone drop test) (ISO 13433)		≤ 33 mm
Determination of water permeability characteristics normal to the plane, without load (EN ISO 11058)		≥ 64 l/m ² /s

- D. Geotextiles with a protection function shall meet the following requirements:

Table 53. Minimum requirements - Geotextile for Protection

Protection Geotextile Requirements		
EN ISO 10319	Longitudinal tensile strength	≥ 21.1 kN/m
	Transverse tensile strength	≥ 24.8 kN/m
EN ISO 10319	Longitudinal elongation	$\geq 60\%$
	Transverse elongation	$\geq 60\%$
Static puncture test (CBR test) (EN ISO 12236)		≥ 3930 N
Dynamic perforation test (Cone drop test) (ISO 13433)		≤ 10 mm
Determination of water permeability characteristics normal to the plane, without load (EN ISO 11058)		≥ 31 l/m ² /s

E. Geocells shall meet the following requirements:

Table 54. Minimum requirements – Geocell

Geocells Requirements	
Type	Perforated
No of cells per square meter	≥ 20 cells/m ²
Cell height	≥ 15 cm
Average density	$\geq 0,950$ g/cm ²
Strength	≥ 16 kN/m
Weld strength	≥ 11 kN/m

- F. The Manufacturer's specifications of the proposed material shall be submitted by the Contractor for the approval of the Engineer.
- G. The proposed material shall only be incorporated in the construction after the confirmation of the material characteristics and the approval of the Engineer.
- H. Durability of the geosynthetics and geotextiles shall be evaluated according to requirements stated in Annex B in EN 13250.

2.12.5 SUPPLY AND STORAGE

- A. Geotextiles shall be supplied in accordance with EN 13250 requirements. The Contractor shall carry out the supply of materials and product verification in accordance with the requirements of the specifications.
- B. During transportation and storing the material shall be protected from damage, contamination, and adverse weather conditions.
- C. Transport and storage shall be done in accordance with manufacturers recommendation. All materials and products for manufacturers / suppliers shall be clearly marked and transported, stored in such a way that this information would not be compromised, it would be easy to check.

2.12.6 INSTALLATION, CONTROL AND REPAIR

- A. Geotextile shall be placed and joined following the written manufacturer's recommendations. The Contractor shall submit method of laying and jointing to the Engineer for acceptance prior to commencement of work.
- B. Depending on the width of the supply roll and manufacturers/suppliers' recommendations shall be installed with different overlaps. Overlaps shall be fastened as indicated by the manufacturers/suppliers. Overlapping at the locations of geotextile sheets splices shall be not less than 100 mm.
- C. Geosynthetics/geotextiles shall be placed in daily work sections so the lap adjustment can be made shall movement of the geotextile occur
- D. Placement of the geotextile shall be performed ensuring its continuous contact with the surface it is laid on, without voids or protrusions. Immediately after placement, the geotextile shall be covered with a protective layer of material, and until completion of such protective layer, no piece of equipment or vehicle likely to damage the geotextile, shall be allowed to circulate on unprotected surfaces.

- E. Fill material placement shall not occur until the Engineer accepts surface preparation and geotextile laps.
- F. At no time shall equipment operate on the unprotected geotextile. Construction equipment shall not make sudden stops, starts, or turns on the over material.

2.12.6.1 FOR DRAINAGE:

- A. The geotextile shall be placed to conform loosely to the shape of the trench.
- B. After placing the filter material, the geotextile shall be folded over the top of the filter material to produce a minimum overlap of 300mm. The geotextile shall then be covered with the subsequent course.

2.12.6.2 FOR PROTECTION:

- A. The geotextile shall be placed and anchored on a prepared surface approved by the Engineer.
- B. The geotextile shall be laid loosely but in intimate contact with the soil so that placement of the overlying materials shall not stretch or tear the geotextile.
- C. Where geotextile is placed above water, the backfill placement shall begin at the toe and proceed up the slope. Where geotextile is placed under water, the long dimension (provided that the width dimension is wider than the channel width) shall be placed parallel to the direction of flow. If the width dimension is not wider than the channel width, the long dimension shall be placed perpendicular to the direction of flow. Successive geotextile sheets shall be overlapped so that the upstream sheet is placed over the downstream sheet. As the geotextile is placed under water, the backfill material shall be placed on it to the required thickness. The geotextile placement shall not progress more than 15m ahead of the backfill placement.
- D. Technical blocks, riprap, stone filling (Heavy) or stone filling (Medium) shall not be dropped onto the geotextile from a height greater than 0.30m. Slope protection and smaller sizes of stone filling shall not be dropped onto the geotextile from a height exceeding 1m.

2.12.6.3 GEOTEXTILE REPAIR

- A. Shall it be determined during or after embankment construction that specified geotextile lap widths have not been achieved, or that the Contractor otherwise damaged the installed geotextile, the Contractor shall correct the geotextile installation.
- B. The Contractor shall expose the geotextile and add additional geotextile extending in all directions to achieve specified laps and anchorage. After correcting the geotextile, the embankment shall be reconstructed in accordance with Technical Design and Technical Specifications.

2.12.7 MEASUREMENT AND PAYMENT – GEOSYNTHETICS/GEOTEXTILES

- A. The following work items are defined:

Table 55. Units of measurement – Geosynthetics/Geotextiles

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_15_57_33_36	000101	GEOGRID SLOPES IN	m2	Geogrid consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for slope treatments using a three-dimensional geogrid and the subsequent placement of vegetation as an element of stabilization and control of erosion, as well as protection against the loss of fines on the slope

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_15_57_33_36	000102	GEOGRID IN FOUNDATION OF EMBANKMENT (100 – 600kN/M)	m2	Geogrid consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the reinforcement of embankment foundations using a geogrid for increasing the soil's bearing capacity, increase the stability of the embankment and reducing the footing settlement.
Pr_15_57_35	000101	GEOTEXTILE IN FOUNDATION OF EMBANKMENT	m2	Geotextile in foundation of embankment consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for application of geotextiles as a separating element between a fill and the ground, in order to prevent contamination or loss of fines, while allowing water to pass through. It has medium resistance to drilling
Pr_15_57_35	000301	GEOTEXTILE, SEPARATING FUNCTION.	m2	Geotextile separating function consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for application of geotextiles as a separating element between a fill and the ground, in order to prevent contamination or loss of fines, while allowing water to pass through. It has medium resistance to drilling
Pr_15_57_35	000302	GEOTEXTILE NON-WOVEN, ANTI PUNCTURE PROTECTION	m2	Geotextile non-woven, anti puncture protection consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for application of geotextiles as a protective element between a fill and impermeabilization materials, in order to prevent damages, while allowing water to pass through, allowing water to pass retaining fines. It has high resistance to drilling
Pr_15_57_35	000303	GEOTEXTILE, FILTERING FUNCTION.	m2	Geotextile filtering function consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for application of geotextiles as a filtering element between a fill and the ground, in order to allowing water to pass through while retaining fines. It has low resistance to drilling.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_15_57_35	000304	GEOCELLS (MIN 15 CM HEIGHT) FILLED WITH VEGETABLE SOIL OR GRANULAR MATERIAL	m2	Slope protection with geocells consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant to protect the slope against erosion and consists of: laying the geocells on the entire surface of the slope to be protected, fixing them with metal anchors or with fasteners specific to each manufacturer, extracting and transporting the backfill material from the temporary site, providing and arranging the access road, filling the geocells with the backfill material in successive layers until total coverage. The backfill material used to fill the geocells can be granular material, or topsoil in which case the soil need to be seeded. A geotextile is provided under the geocells when the subgrade is granular material. Slope protection with geocells will be carried out in accordance with the project details.

2.13 TECHNICAL BLOCKS

2.13.1 SCOPE OF WORKS

- A. This section includes spreading and compaction of materials, treated and untreated with cement, on either side of the viaducts, bridges, underpasses and transverse drainage works of the railway line, according to the Technical Design and these Technical Specifications.
- B. This section provides a needed but non-exhaustive list of labour, materials equipment and services necessary to furnish, deliver and install all work of this section as shown on the drawing, as specified herein and/or as required by job conditions.

2.13.2 GENERAL REQUIREMENTS

- A. Technical blocks are intended to provide a gradual transition of deformability between structures under the railway or abutments of viaducts and bridges, with the adjacent embankment.
- B. Where there is a determined thickness of inadequate material to support the corresponding technical block according to the Technical Design or the Engineer's criterion, it shall be excavated and replaced by a material with the same characteristics as the rest of the technical block, or some type of geotechnical treatment shall be carried out (gravel columns, drains...) with the Engineer's approval.
- C. The Contractor shall present the definition of the road and track layouts, the conditioning of the existing roads and the easements or temporary occupations foreseen for the execution of the technical blocks, for the approval of the Engineer.
- D. The Contractor shall also submit a detailed and chronological sequence of operations, with the program for the exploitation of excavations, landfills and stockpiles and the excavation of the works.
- E. The Contractor shall carry out a detailed survey of the different cuttings and quarries, checking the results of the geotechnical studies of the Project and in view of them proposing the particular treatments or techniques for using the different materials for the different parts of the technical blocks. This plan shall be submitted to the approval of the Engineer, which in view of the same may prescribe the appropriate additional studies or tests.
- F. The use of all types of material and especially those which need a particular technical treatment for the installation, or zoning for its use, shall be carried out after carrying out a large-scale test with the material. This test may consist of the execution and monitoring of the first layers of the corresponding filling.
- G. The compaction prescribed in these Technical Specifications shall be achieved at all points, including at the edge of the theoretical slope. In order to achieve this objective, the filling shall be made with the necessary width and

the excess materials shall be eliminated at the end of the same in order to obtain the geometry of the theoretical slope of the Project.

- H. In all the fillings, the refining of the upper layer shall be carried out, according to the dimensions and slopes of the type sections in the Technical Design, before the laying of the prepared subgrade.
- I. The Contractor shall conduct compaction testing in accordance with methods and frequencies stated in this Technical Specification (Internal Control Testing). Acceptance testing shall be arranged by the Engineer and/or Employer with the same frequency stated in this Technical Specification. Acceptance testing shall be done at the locations selected by the Engineer and/or Employer. The Contractor shall provide equipment and personnel to conduct acceptance testing, if necessary, to the Engineer and/or Employer. Internal Control Testing reports shall be submitted to Engineer and/or Employer.

2.13.3 SPECIAL LOCAL FILLING IN TRANSITION TECHNICAL BLOCK AT ABUTMENTS IN RAIL BRIDGES

2.13.3.1 MATERIALS

- A. The material to be used for this work unit shall meet the minimum requirements described in the table below:

Table 56. Minimum requirements - Special local filling in transition technical block at abutments in rail bridges

Property		Requirement	Reference
Mixture designation	0/20, 0/22.4, 0/31.5, 0/40,	EN 13285	
Maximum aggregate D	0/45, 0/56, 0/63		
Fines content category (passing 0.063 sieve)	UF ₅ (≤5%)	EN 13285	
Oversize	OC 85	EN 13285	
Grading category	GB	EN 13285	
Cu	D60/D10 > 4		
Cc	$1 < D_{30}^2 / (D_{60} * D_{10}) < 4$		
Resistance to fragmentation	LA 30	EN 13242	
Resistance to wear	MDE 25	EN 13242	
Resistance to frost category ^(a)	F ₄	EN 13242	
Content of harmful fines (MB _F value) ^(b)	≤10g/kg	EN 13242	
Organic content (C _{OM})	LOI < 0,2%	LOI ^(c)	
Free of humus	Negative result	EN 1744-1 Ch 15.1	
Notes:			
a) Applicable to unbound mixtures produced from gravel and crushed rock. Not applicable to natural sand (Sa), gravelly sand (grSa) or sandy gravel (saGr);			
b) Applicable if fines content is above 3%, see EN 13242 Annex A.			
c) Accreditation for compliant European harmonized standard for LOI test. The conditions of test shall be tested in accordance with EN 1997-2 Annex N, Clause N.2. Test shall be conducted on the material that is passing 2 mm sieve. The minimum ignition temperature shall be 440 °C +/-25°C. Other temperatures may be considered, depending on the type of material. Nevertheless, any deviations from shall be agreed separately with Engineer and/or Employer.			

- B. The properties of the fill material shall be checked prior to installation (verification testing) by the Contractor. Verification testing shall be carried out by the Contractor at least once per 500 m3 (per source/quarry). The Engineer shall conduct acceptance testing at a minimum frequency of once per volume that is three times the volume stated above.

2.13.3.2 CONSTRUCTION REQUIREMENTS

- A. As a general rule, the embankment adjacent to a structure located under the platform of the railway line shall be executed at the same time as the corresponding technical block, by successive layers, except in the case of

cement-treated technical blocks, in which preferably the embankment adjacent to the structure shall be executed after successive layers of the corresponding technical block.

- B. The execution conditions described for the general case of embankments, in terms of equipment, preparation of the seating surface, extension and compaction of the piles and limitations in execution, are also applicable to this area of the embankment.
- C. The finishing conditions and finishing tolerances shall be the same as in the general case of embankments.

2.13.3.3 COMPACTION REQUIREMENTS

- A. Minimum compaction degree and stiffness requirements with testing frequency shall be as described in the table below.

Table 57. Compaction requirements - Granular fill for technical block at abutments in rail bridges

Property	Minimum requirement	Method	Testing frequency
In-situ density D_{pr}	$\geq 97\%$ of D_{pr} determined by EN 13286 Standard Proctor Compaction	Field density (ASTM D1556 / D1556M or ASTM D6938 or DIN 18125-2)	Twice per side of the structure, 2 locations – under the railway and near the edge ($\leq 1.0\text{m}$) (total 8 tests per structure)
Strain modulus after second loading E_{v2}	$\geq 80\text{MPa}$	DIN 18134	Once per side of the structure, 2 locations – under the railway and near the edge ($\leq 1.0\text{m}$) (total 4 tests per structure)
E_{v2}/E_{v1}	≤ 2.2	DIN 18134	Once per side of the structure, 2 locations – under the railway and near the edge ($\leq 1.0\text{m}$) (total 4 tests per structure)

- B. If the results obtained do not reach the minimum values stated herein, the surface shall be moistened and re-compacted until they are reached. If exceptionally the required degree of performance is not obtained, the layer shall be removed and re-built at the Contractor expense.
- C. The compacted layer shall present homogeneity in visual inspection and when tested, with no points showing defective behaviour.

2.13.4 SPECIAL LOCAL FILLING IN TRANSITION TECHNICAL BLOCK AT ABUTMENTS TREATED WITH CEMENT IN RAIL BRIDGES

2.13.4.1 MATERIALS

- A. Granular material to be used for this work unit shall meet the same minimum requirements and testing frequency as described in the previous section for the special local filling in transition technical block at abutments in rail bridges.
- B. In addition, the cement treated material shall be produced in accordance with EN 14227-1. Minimum cement content shall be declared and shall be $\geq 3\%$.
- C. The optimal dosage for the cement content in the treated material shall be determined in the laboratory to achieve RC class 3/4 as per EN 14227-1.
- D. Cement shall be of 32.5N, as a minimum, resistant to sulphates and with a setting time of > 120 min.
- E. The incorporation of the cement shall be carried out in a mixing plant with water and suitable aggregates, by using dosing devices that allow to meet the dosage of cement and water previously determined in the laboratory.
- F. The cement dosage shall be verified in the mixing plant and approved by the Engineer. On-site mixing with cement, by backhoe loader or any other type of auxiliary machine, is not allowed.

2.13.4.2 CONSTRUCTION REQUIREMENTS

- A. As a general rule, the embankment adjacent to a structure located under the platform of the railway line shall be executed at the same time as the corresponding technical block, by successive layers, except in the case of cement-treated technical blocks, in which preferably the embankment adjacent to the structure shall be executed after successive layers of the corresponding technical block.
- B. Compaction of the cement-treated material shall be started within one hour (1h) after mixing and the 97% density of Standard Proctor shall be reached within four hours (4 hr).
- C. The thickness of each layer, as well as the number of them executed within this period, shall be determined by the need to obtain said density in the entire extended thickness.
- D. The necessary tests shall be carried out to properly size the compaction equipment.
- E. In these tests, it shall be guaranteed that the compacted material reaches a deformation modulus greater than 160MPa, in the second cycle of the load plate, with the condition $E_{v2}/E_{v1} \leq 2.2$.
- F. To this end, and for verification of all the technical means arranged by the Contractor, a test section shall be delimited on site, which the Engineer may, if acceptable, include as part of the definitive work unit of technical block treated with cement.
- G. Particular attention shall be paid to compaction in proximity to the structure, resorting if necessary, to decrease the thickness of layers and the use of small compactors.
- H. On the layers executed in the previous conditions, the spread of new layers shall not be accepted at least until after seventy-two hours (72 h). However, the Engineer can reduce this time, provided a test with different times between the paving spread is carried out and it is verified that the density and compressive strength of the lower paving does not decrease significantly (less than 20%) or it is guaranteed to exceed 4.5MPa.

2.13.4.3 COMPACTION REQUIREMENTS

- A. Minimum compaction degree and stiffness requirements with testing frequency shall be as described in the table below.

Table 58. Compaction requirements - granular fill for technical block at abutments treated with cement in rail bridges

Property	Minimum requirement	Method	Testing frequency
In-situ density D_{pr}	$\geq 97\%$ of D_{pr} determined by EN 13286 Standard Proctor Compaction	Field density (ASTM D1556 / D1556M or ASTM D6938 or DIN 18125-2)	Twice per side of the structure, 2 locations – under the railway and near the edge ($\leq 1.0m$) (total 8 tests per structure) Testing during works no later than 2 hours after compaction.
Strain modulus after second loading E_{v2}	$\geq 160MPa$	DIN 18134	Once per side of the structure, 2 locations – under the railway and near the edge ($\leq 1.0m$) (total 4 tests per structure)
E_{v2}/E_{v1}	≤ 2.2	DIN 18134	Once per side of the structure, 2 locations – under the railway and near the edge ($\leq 1.0m$) (total 4 tests per structure) Testing during works no later than 2 hours after compaction.

- B. If the results obtained do not reach the minimum values stated herein, the surface shall be moistened and re-compacted until they are reached. If exceptionally the required degree of performance is not obtained, the layer shall be removed and re-built at the Contractor expense.
- C. The compacted layer shall present homogeneity in visual inspection and when tested, with no points showing defective behaviour.

2.13.5 TECHNICAL BLOCK SELECTED GRANULAR MATERIAL

2.13.5.1 MATERIALS

A. The material to be used for this work unit shall meet the minimum requirements described in the table below.

Table 59. Minimum requirements - Selected granular material for technical block

Property	Requirement	Reference
Mixture designation Maximum aggregate D	0/20, 0/22.4, 0/31.5, 0/40, 0/45, 0/56, 0/63	EN 13285
Fines content category (passing 0.063 sieve)	UF5 ($\leq 5\%$)	EN 13285
Oversize	OC 85	EN 13285
Grading category	GB	EN 13285
Cu	D60/D10 > 4	
Cc	$1 < D_{30}^2 / (D_{60} \cdot D_{10}) < 4$	
Resistance	LA + MDE ≤ 80	EN 13242
Resistance to frost category ^(a)	F ₂	EN 13242
Content of harmful fines (MB _F value) ^(b)	$\leq 10\text{g/kg}$	EN 13242
Organic content (C _{OM})	LOI < 0,2%	LOI ^(c)
Free of humus	Negative result	EN 1744-1 Ch 15.1
Notes: a) Applicable to unbound mixtures produced from gravel and crushed rock. Not applicable to natural sand (Sa), gravelly sand (grSa) or sandy gravel (saGr); b) Applicable if fines content is above 3%, see EN 13242 Annex A. c) Accreditation for compliant European harmonized standard for LOI test. The conditions of test shall be tested in accordance with EN 1997-2 Annex N, Clause N.2. Test shall be conducted on the material that is passing 2 mm sieve. The minimum ignition temperature shall be 440 °C +/-25°C. Other temperatures may be considered, depending on the type of material. Nevertheless, any deviations from shall be agreed separately with Engineer and/or Employer.		

B. The properties of the material shall be checked prior to installation (verification testing) by the Contractor. Verification testing shall be carried out by the Contractor at least once per 500 m³ (per source/quarry). The Engineer shall conduct acceptance testing at a minimum frequency of once per volume that is three times the volume stated above.

2.13.5.2 CONSTRUCTION REQUIREMENTS

- A. As a general rule, the embankment adjacent to a structure located under the platform of the railway line shall be executed at the same time as the corresponding technical block, by successive layers, except in the case of cement-treated technical blocks, in which preferably the embankment adjacent to the structure shall be executed after successive layers of the corresponding technical block.
- B. The execution conditions described for the general case of embankments, in terms of equipment, preparation of the seating surface, extension and compaction of the piles and limitations in execution, are also applicable to this area of the embankment.
- C. The finishing conditions and finishing tolerances shall be the same as in the general case of embankments.

2.13.5.3 COMPACTION REQUIREMENTS

A. Minimum compaction degree and stiffness requirements with testing frequency shall be as described in the table below.

Table 60. Compaction requirements - Selected granular material for technical block

Property	Minimum requirement	Method	Testing frequency
In-situ density D_{pr}	$\geq 97\%$ of D_{pr} determined by EN 13286 Standard Proctor Compaction	Field density (ASTM D1556 / D1556M or ASTM D6938 or DIN 18125-2)	Twice per side of the structure, 2 locations – under the railway and near the edge ($\leq 1.0\text{m}$) (total 8 tests per structure)
Strain modulus after second loading E_{v2}	$\geq 80\text{MPa}$	DIN 18134	Once per side of the structure, 2 locations – under the railway and near the edge ($\leq 1.0\text{m}$) (total 4 tests per structure)

- B. If the results obtained do not reach the minimum values stated herein, the surface shall be moistened and re-compacted until they are reached. If exceptionally the required degree of performance is not obtained, the layer shall be removed and re-built at the Contractor expense.
- C. The compacted layer shall present homogeneity in visual inspection and when tested, with no points showing defective behaviour.

2.13.6 TECHNICAL BLOCK SELECTED GRANULAR MATERIAL TREATED WITH CEMENT

2.13.6.1 MATERIALS

- A. Granular material to be used for this work unit shall meet the same minimum requirements and testing frequency as described in the previous section for the Technical block selected granular material.
- B. In addition, the cement treated material shall be produced in accordance with EN 14227-1. Minimum cement content shall be declared and shall be $\geq 3\%$.
- C. The optimal dosage for the cement content in the treated material shall be determined in the laboratory to achieve RC class 3/4 as per EN 14227-1..
- D. Cement shall be of 32.5N, as a minimum, resistant to sulphates and with a setting time of > 120 min.
- E. The incorporation of the cement shall be carried out in a mixing plant with water and suitable aggregates, by using dosing devices that allow to meet the dosage of cement and water previously determined in the laboratory.
- F. The cement dosage shall be verified in the mixing plant and approved by the Engineer. On-site mixing with cement, by backhoe loader or any other type of auxiliary machine, is not allowed.

2.13.6.2 CONSTRUCTION REQUIREMENTS

- A. As a general rule, the embankment adjacent to a structure located under the platform of the railway line shall be executed at the same time as the corresponding technical block, by successive layers, except in the case of cement-treated technical blocks, in which preferably the embankment adjacent to the structure shall be executed after successive layers of the corresponding technical block.
- B. Compaction of the cement-treated material shall be started within one hour (1h) after mixing and the 97% density of Standard Proctor shall be reached within four hours (4 hr).
- C. The thickness of each layer, as well as the number of them executed within this period, shall be determined by the need to obtain said density in the entire extended thickness.
- D. The necessary tests shall be carried out to properly size the compaction equipment.
- E. In these tests, it shall be guaranteed that the compacted material reaches a deformation modulus greater than 160MPa, in the second cycle of the load plate, with the condition $E_{v2}/E_{v1} \leq 2.2$.
- F. To this end, and for verification of all the technical means arranged by the Contractor, a test section shall be delimited on site, which the Engineer may, if acceptable, include as part of the definitive work unit of technical block treated with cement.
- G. Particular attention shall be paid to compaction in proximity to the structure, resorting if necessary, to decrease the thickness of layers and the use of small compactors.

- H. On the layers executed in the previous conditions, the spread of new layers shall not be accepted at least until after seventy-two hours (72 h). However, the Engineer can reduce this time, provided a test with different times between the paving spread is carried out and it is verified that the density and compressive strength of the lower paving does not decrease significantly (less than 20%) or it is guaranteed to exceed 4.5MPa.

2.13.6.3 COMPACTION REQUIREMENTS

- A. Minimum compaction degree and stiffness requirements with testing frequency shall be as described in the table below.

Table 61. Compaction requirements - Selected granular material treated with cement for technical block

Property	Minimum requirement	Method	Testing frequency
In-situ density D_{pr}	$\geq 97\%$ of D_{pr} determined by EN 13286 Standard Proctor Compaction	Field density (ASTM D1556 / D1556M or ASTM D6938 or DIN 18125-2)	Twice per side of the structure, 2 locations – under the railway and near the edge ($\leq 1.0\text{m}$) (total 8 tests per structure) Testing during works no later than 2 hours after compaction.
Strain modulus after second loading E_{v2}	$\geq 160\text{MPa}$	DIN 18134	Once per side of the structure, 2 locations – under the railway and near the edge ($\leq 1.0\text{m}$) (total 4 tests per structure)

- B. If the results obtained do not reach the minimum values stated herein, the surface shall be moistened and re-compacted until they are reached. If exceptionally the required degree of performance is not obtained, the layer shall be removed and re-built at the Contractor expense.
- C. The compacted layer shall present homogeneity in visual inspection and when tested, with no points showing defective behaviour.

2.13.7 PREPARED SUBGRADE TREATED WITH CEMENT

2.13.7.1 MATERIALS

- A. Granular material to be used for this work unit shall meet the same minimum requirements and testing frequency as described in the previous section for the Prepared subgrade.
- B. In addition, the cement treated material shall be produced in accordance with EN 14227-1. Minimum cement content shall be declared and shall be $\geq 3\%$.
- C. The optimal dosage for the cement content in the treated material shall be determined in the laboratory to achieve RC class 3/4 as per EN 14227-1..
- D. Cement shall be of 32.5N, as a minimum, resistant to sulphates and with a setting time of > 120 min.
- E. The incorporation of the cement shall be carried out in a mixing plant with water and suitable aggregates, by using dosing devices that allow to meet the dosage of cement and water previously determined in the laboratory.
- F. The cement dosage shall be verified in the mixing plant and approved by the Engineer. On-site mixing with cement, by backhoe loader or any other type of auxiliary machine, is not allowed.

2.13.7.2 CONSTRUCTION REQUIREMENTS

- A. Construction of this work unit shall comply with all the requirements indicated for the construction of the prepared subgrade and the following additional requirements.
- B. Compaction of the cement-treated material shall be started within one hour (1h) after mixing and the 100% density of Standard Proctor shall be reached within four hours (4 hr).

- C. The thickness of each layer, as well as the number of them executed within this period, shall be determined by the need to obtain said density in the entire extended thickness.
- D. The necessary tests shall be carried out to properly size the compaction equipment.
- E. In these tests, it shall be guaranteed that the compacted material reaches a deformation modulus greater than 120MPa, in the second cycle of the load plate, with the condition $E_{v2}/E_{v1} \leq 2.2$.
- F. To this end, and for verification of all the technical means arranged by the Contractor, a test section shall be delimited on site, which the Engineer may, if acceptable, include as part of the definitive work unit of technical block treated with cement.
- G. Particular attention shall be paid to compaction in proximity to the structure, resorting if necessary, to decrease the thickness of layers and the use of small compactors.
- H. On the layers executed in the previous conditions, the spread of new layers shall not be accepted at least until after seventy-two hours (72 h). However, the Engineer can reduce this time, provided a test with different times between the paving spread is carried out and it is verified that the density and compressive strength of the lower paving does not decrease significantly (less than 20%) or it is guaranteed to exceed 4.5MPa.

2.13.7.3 COMPACTION REQUIREMENTS

- A. Prepared subgrade layer minimum compaction degree and stiffness requirements with testing frequency shall be as following table:

Table 62. Compaction requirements - Prepared subgrade treated with cement

Property	Minimum requirement	Method	Testing frequency
In-situ density D_{pr}	$\geq 100\%$ of D_{pr} determined by EN 13286 Standard Proctor Compaction	Field density (ASTM D1556 / D1556M or ASTM D6938 or DIN 18125-2)	Once per 20m, 2 locations – under the railway and near the edge ($\leq 1.0m$) Testing during works no later than 2 hours after compaction.
Strain modulus after second loading E_{v2}	$\geq 120MPa$	DIN 18134	Once per 100m, 2 locations – under the railway and near the edge ($\leq 1.0m$) Testing during works no later than 2 hours after compaction.

- B. If the results obtained do not reach the minimum values stated herein, the surface shall be moistened and re-compacted until they are reached. If exceptionally the required degree of performance is not obtained, the layer shall be removed and re-built at the Contractor expense.
- C. The compacted layer shall present homogeneity in visual inspection and when tested, with no points showing defective behaviour.

2.13.7.4 GEOMETRICAL TOLERANCES

- A. Cement treated prepared subgrade layer shall fulfil the same geometrical tolerances as the indicated for prepared subgrade.

2.13.8 LOCAL FILLING IN TRANSITION TECHNICAL BLOCK AT ABUTMENTS IN ROAD BRIDGES

2.13.8.1 MATERIALS

- A. The material to be used for this work unit shall meet the minimum requirements described in the table below.

Table 63. Minimum requirements - Fill material for technical blocks at the road bridges

Property	Requirement	Reference
Mixture designation (Maximum aggregate D) (a)	$D \leq 63\text{mm}$	EN 13285
Fines content category (passing 0.063 sieve)	$UF_5 (\leq 5\%)$	EN 13285
Content of particles below 0.02mm	$<3\%$	EN 14688-2
Oversize	OC_{90}	EN 13285
Grading category	G_v	EN 13285
Resistance to frost category (b)	F_4	EN 13242
Content of harmful fines (MB_F value) (c)	$\leq 10\text{g/kg}$	EN 13242
Organic content (C_{OM})	$LOI < 1\%$	LOI (d)
a) Upper size D shall be selected based on the requirement for Coefficient of Uniformity $CU \geq 6$; b) Applicable to unbound mixtures produced from gravel and crushed rock. Not applicable to natural sand (Sa), gravelly sand (grSa) or sandy gravel (saGr). Gravel and crushed rock is only allowed if the gravel or crushed rock mixture complies with the requirements described in Clause 2.9.7.5.1, sub-clause F of Technical Specification; c) Applicable to unbound mixtures produced from gravel and crushed rock. Not applicable to natural sand (Sa), gravelly sand (grSa) or sandy gravel (saGr). Gravel and crushed rock is only allowed if the gravel or crushed rock mixture complies with the requirements described in Clause 2.9.7.5.1, sub-clause F of Technical Specification; d) Applicable if fines content is above 3%, see EN 13242 Annex A		

- B. The properties of the material shall be checked prior to installation (verification testing) by the Contractor. Verification testing shall be carried out by the Contractor at least once per 500 m³ (per source/quarry). The Engineer shall conduct acceptance testing at a minimum frequency of once per volume that is three times the volume stated above.
- C. Verification test shall be done by the Contractor to demonstrate that the materials are suitable for the use. These tests shall be done, and results submitted to Engineer for approval prior to works, including Declaration of Performance and/or Declaration of Conformity together with Factory Production Control (FPC) certificates. Works are not allowed to be performed without approval from by Engineer/Employer.
- D. The Contractor shall provide sample of each material with required quantity (determined by the Engineer) if requested by the Engineer.
- E. All costs associated with verification testing shall be included in the unit price of the work item and shall not be paid separately.

2.13.8.2 CONSTRUCTION REQUIREMENTS

- A. As a general rule, the embankment adjacent to a structure located under the platform of the road line shall be executed at the same time as the corresponding technical block, by successive layers.
- B. The execution conditions described for the general case of embankments, in terms of equipment, preparation of the seating surface, extension and compaction of the piles and limitations in execution, are also applicable to this area of the embankment.
- C. The finishing conditions and finishing tolerances shall be the same as in the general case of embankments.

2.13.8.3 COMPACTION REQUIREMENTS

- A. Minimum compaction degree and stiffness requirements with testing frequency shall be as described in the table below.

Table 64. Compaction requirements - Fill material for technical blocks at the road bridges at abutments in road bridges

Property	Minimum requirement	Method	Testing frequency
In-situ density D_{pr}	$\geq 100\%$ of D_{pr} determined by EN 13286-2 Standard Proctor Compaction	Field density (ASTM D1556 / D1556M or ASTM D6938 or DIN 18125-2)	Twice per side of the structure, 2 locations – under the road and near the edge ($\leq 1.0\text{m}$) (total 8 tests per structure)
Strain modulus after second loading E_{V2}	$\geq 80\text{MPa}$	DIN 18134	Once per side of the structure, 2 locations – under the road and near the edge ($\leq 1.0\text{m}$) (total 4 tests per structure)
E_{V2}/E_{V1}	≤ 2.2	DIN 18134	Once per side of the structure, 2 locations – under the road and near the edge ($\leq 1.0\text{m}$) (total 4 tests per structure)

- B. If the results obtained do not reach the minimum values stated herein, the surface shall be moistened and re-compacted until they are reached. If exceptionally the required degree of performance is not obtained, the layer shall be removed and re-built at the Contractor expense.
- C. The compacted layer shall present homogeneity in visual inspection and when tested, with no points showing defective behavior.

2.13.9 FILL MATERIAL ABOVE TRANSITION SLAB IN ROAD BRIDGES

- A. On top of the transition slab, the road superstructure layers shall be installed according to the road design. The materials filled above the transition slab and their installation works must meet the requirements specified in the technical design of the road connecting with the technical block.

2.13.10 MEASUREMENT AND PAYMENT – TECHNICAL BLOCKS

- A. The following work items are defined:

Table 65. Units of measurement – Technical blocks

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_15_31_26_34	000108	SPECIAL LOCAL FILLING IN TRANSITION TECHNICAL BLOCK AT ABUTMENTS IN RAIL BRIDGES	m3	Special local filling in transition technical block in rail bridges consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for laying and compacting of granular materials, on both sides of viaducts, bridges, underpasses and drainage works of the railway line that provide a gradual transition of deformability between works under the railway or abutments of viaducts, bridges, with the adjacent embankment
Pr_15_31_26_34	000109	SPECIAL LOCAL FILLING IN TRANSITION TECHNICAL BLOCK AT ABUTMENTS TREATED WITH CEMENT IN RAIL BRIDGES	m3	Special local filling in transition technical block treated with cement consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for laying and compacting of granular materials treated with cement, on both sides of viaducts, bridges, underpasses and drainage works of the railway line that provide a gradual transition of deformability between works under the railway or abutments of viaducts, bridges, with the adjacent embankment

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_15_31_26_34	000134	TECHNICAL BLOCK SELECTED GRANULAR MATERIAL	m3	Technical block selected granular material consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for laying and compacting of selected granular materials, on both sides of structures of the railway line that provide a gradual transition of stiffness between structures and adjacent embankments.
Pr_15_31_26_34	000135	TECHNICAL BLOCK SELECTED GRANULAR MATERIAL TREATED WITH CEMENT	m3	Technical block selected granular material treated with cement consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for laying and compacting of selected granular materials treated with cement, on both sides of structures of the railway line that provide a gradual transition of stiffness between structures and adjacent embankments.
Pr_15_31_26_34	000136	PREPARED SUBGRADE FROM IMPORTED MATERIAL TREATED WITH CEMENT	m3	Prepared subgrade treated with cement consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for imported materials that are suitable for constructing prepared subgrade treated with cement.
Pr_15_31_26_34	000110	SPECIAL LOCAL FILLING IN TRANSITION TECHNICAL BLOCK AT ABUTMENTS IN ROAD BRIDGES	m3	Special local filling in transition technical block in road bridges consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for laying and compacting of granular materials, on both sides of overpasses that provide a gradual transition of deformability between works under the road or abutments of viaducts, bridges, with the adjacent embankment
Pr_15_31_26_34	000142	PROTECTIVE FROST- RESISTANT LAYER	m3	Protective frost-resistant layer of mix consists of all works and expenses necessary to achieve the end result as per technical specification, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for laying and compacting of frost-resistant layer of mix, on both sides of overpasses that provide a gradual transition of deformability between works under the road or abutments of viaducts, bridges, with the adjacent embankment
Pr_20_31_04_20	001010	CRUSHED STONE BASE LAYER OF UNBOUND MIXTURE 0/45 WITH A THICKNESS H = 0.20 M INSTALLATION	m3	Crushed stone base layer of unbound mixture 0/45 with a thickness h = 0.20 m installation

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_31_04_20	001023	CRUSHED STONE LAYER OF UNBOUND MIXTURE 0/45 WITH USED ASPHALT GRANULES UP TO 20%, WITH A THICKNESS H = 0.20 M INSTALLATION	m3	Crushed stone layer of unbound mixture 0/45 with used asphalt granules up to 20%, with a thickness h = 0.20 m installation

2.14 DEWATERING SYSTEMS

2.14.1 SCOPE OF WORKS

- A. This section covers dewatering systems which shall be implemented for keeping excavations safe against uplift and heave failures due to the presence of confined aquifers under hazardous water pressures.
- B. This section provides a needed but non-exhaustive list of labour, materials, equipment and services necessary to furnish, deliver and install all work of this section as shown on the Technical Design, drawings, as specified herein and/or as required by job conditions.

2.14.2 GENERAL REQUIREMENTS

- A. Dewatering systems shall be able to pump water from the relevant aquifers and drain the water flow until enough low pressures are reached and excavation can be undertaken under safe conditions, according to the Technical Design.
- B. The following elements shall be used, according to according to the Technical Design and these Technical Specifications:
 - a. Submersible pumps;
 - b. Valves.
- C. Pipes and manholes, if required, shall comply with Section 04 – DRAINAGE of this Technical Specification.

2.14.3 SUBMERSIBLE PUMPS

2.14.3.1 GENERAL DESCRIPTION

- D. According to the Technical Design, submersible pumps are projected for deep wells and dewatering systems where it was required to drop the groundwater table.
- E. The submergible pumps of dewatering system shall have the following technical features:
 - a. Steel components are made in stainless steel, EN 1.4301 (AISI 304)
 - b. Pump speed 2900 rpm
 - c. Flow rate 6 – 5 l/s
 - d. Head rate 35 – 20
 - e. Motor diameter 4"
 - f. Rated power 4kW
 - g. Rated voltage 3x380-400-415 V
 - h. Enclosure class IP68
 - i. Insulation class F
 - j. Frequency 50 Hz

2.14.3.2 REQUIREMENTS

- A. Pump shall be defined according the flow and head requirements. The technical features of pump shall be submitted to the Engineer, in advance for approval, before purchasing
- B. The pump shall be compatible with the inner diameter of the well casing.
- C. Pump shall be made completely of stainless steel to DIN W.NR. 1.4301 (AISI 304).
- D. Pump shall be supplied complete with all accessories such as flexible coupling, head gear, valves, power and control cables.
- E. All bearings shall be water - lubricated and have a squared shape enabling sand particles, if any, to leave the pump together with the pumped liquid.
- F. Inlet strainer shall be sized according to manufacturer's recommendations to prevent large soil particles from entering the pump.
- G. Pump shall be equipped with reliable non - return valve in the valve casing preventing back flow in connection with pump stoppage.
- H. Pump shall be fitted with priming screw to prevent the case of dry running and ensure that pump bearings are always lubricated.
- I. Shaft seal shall be of the type providing low friction against the rotor shaft. Material shall provide optimum sealing, wear resistance and long life. It shall also be suitable for use in drinking water.
- J. Pump and motor shall be protected against upthrust by either built-in stop ring or hydraulic balancing.
- K. Pump motor shall be driven by electrical motor (submersible). Submersible motor shall be hermetically enclosed in stainless steel envelop to DIN W. NR. 1.4301 (AISI 304). Motor shall be totally insulated by metallic / non-electric hydraulic oil which will also function as lubricant and coolant. Motor speed shall not exceed 3500 r.p.m. Power and control cables shall be resistant to water
- L. Motors shall be protected against lightning. If motor is not equipped with lightning protection and if well is not housed in a building contractor shall submit a proposal for protecting the motor against lightening sticks for approval by the engineer.
- M. Control Panel shall have as a minimum two circuits:
 - a. Power supply circuit complete with main power breaker, starter (star I delta) indicating lights for the three phases, current I volt meters, operation time counter and phase failure protection.
 - b. Control circuits complete with control switches, on I off switches and the related indicating lights, protection devices, manual I automatic control devices. Control circuit shall also include time delay relay to delay stopping the pump after its start for an adjustable period between 1 - 3 minutes.
- N. Power and control panels shall be weather-proof type NEMA.

2.14.3.3 EXECUTION OF WORKS

- A. Area and conditions under which pumps are to be installed shall be examined prior the installation of the equipment. Installation shall be done in accordance with the instructions of manufacturer, and as specified herein.
- B. The pipe shall be connected to the first galvanized steel pipe before inserting in deep well. The cabling will be fixed to the piping.
- C. The installation level of pump shall be previously defined by the Engineer, based in groundwater investigation of boreholes. The pump shall be submerged in dynamic groundwater level.
 - a. The final installation level shall be fixed once confirmed the stability of dynamic level.
 - b. Strategic piezometers shall be installed in bore holes for the control and optimization of force system.
 - c. The submersible pump shall be protected in the casing.
 - d. The force pipeline shall be fixed with centralizers in casing in order to avoid the clash with casing.
 - e. The dewatering system shall be configured, according to the conditions of hydrogeological investigation.

- f. The test and commissioning shall be performed, following the recommendations of manufacturer.
- g. The manhole shall have a cover over the deep well axis, in order to facilitate the removal of piping and pumps.
- h. The electrical and control panel of pumps shall be centralized.

2.14.4 VALVES

2.14.4.1 GENERAL DESCRIPTION

- A. The hydraulic valves are designed to section, protect and control the flow in pressurized pipelines. The valves shall be conformed EN 736 and 1074.
- B. The valves are classified as following:
 - a. Gate Valves, EN 1171
 - b. Check Valves, EN 16767
 - c. Air release Valves, EN 1074-4
- C. Gate valves are defined for the sectioning of network and diversion of water flow.
- D. Check valves have the main objective of protecting the electromechanical equipment and mitigating the water hammer in pressurized pipelines.
- E. Trifunctional air release valves were projected in high points and downstream gate and check valves, in order to protect the pipeline from vacuum or air bags through the releasing and admission of air. The valves shall be installed with a gate valve of same diameter for maintenance.

2.14.4.2 REQUIREMENTS

- A. The body of valves shall be defined with cast iron body, PN10 and epoxy coating.
- B. The joint shall be defined with flanges and gasket.
- C. GATE VALVES:
 - a. Gate valves shall be designed with PN10.
 - b. All gate valves shall be of non-rising stem.
 - c. Valves shall be the same size as the incoming line size with a clear waterway equal to the full nominal diameter of the valves and shall be opened by turning counter clockwise.
 - d. The operating nut or wheel shall have an arrow cast in valve indicating the direction of opening.
 - e. Valves 75mm and larger shall be cast iron body and shall conform to EN 1171 with flange end connections.
- D. CHECK VALVES:
 - a. 100% non-corrosive.
 - b. The valve shall allow flow in one direction by the action of a spring loaded flap which closes against a rubber seal.
 - c. The valve shall have a pressure rating of 16 bars.
- E. AIR RELEASE VALVES
 - a. Air release valves shall be of the kinetic/automatic type.
 - b. The valve components shall be constructed of 100% corrosion resistant materials to ensure maximum life and minimum water loss due to leaks.
 - c. The Valve shall remain open even when pipeline air pressure reaches 10 psi.
 - d. The air release valve shall employ rolling seal mechanism.

2.14.4.3 EXECUTION OF WORKS

- A. The valves shall be adjusted, according to the **alignment** of pipelines.

2.14.5 PVC CASING

2.14.5.1 GENERAL DESCRIPTION

- A. PVC casing shall be installed in deep wells for dewatering systems.
- B. The casing shall be inserted in bore hole for the stabilization of drilling and protection of force pipeline and submersible pump.
- C. The PVC pipe shall be slotted in bottom of bore hole, presence of groundwater to allow the abstraction of groundwater. In the rest of drilling, the casing might be defined with liner pipe.

2.14.5.2 REQUIREMENTS

- A. Slotted and liner PVC pipes 10" SDR26
- B. Length of pipes 6m.
- C. Achievement of ASTM F 480
- D. Joints and couplings, internal and external thread
- E. Spacing of slots ¼".
- F. Minimum spacing with borehole and force pipeline 5 cm.
- G. Pipes shall be resistant to aggressive substances contained in the water, to possible external and internal mechanical, chemical and microbiological processes.
- H. High-quality couplings and sealing rings shall be used to seal the pipes to ensure complete tightness of the system

2.14.5.3 EXECUTION OF WORKS

- A. The installation of casing shall be installed after completion of bore hole and added approximately 30cm of gravel. The insertion of pipes shall be done progressively till reaching the top of gravel.
- B. The casing will be fixed in the top of bore hole and backfilling the gap between edge of excavation and external face of PVC pipe.

2.14.6 HDPE PIPELINES

2.14.6.1 GENERAL

- A. HDPE pipes are projected for pressurized network of dewatering system. The network is pressurized by the deep wells and transports the extracted water to the discharge point. The pipelines are defined with maximum diameter 400 mm.
- B. Pressurized pipelines shall be installed in trench (buried), EN 13244. The cover shall have at least one meter of cover. Exposed can be exposed for temporary solutions, previous approval of Authority, when the operation will be performed in periods with temperatures higher than 5° C.

2.14.6.2 MATERIAL REQUIREMENTS

- A. HDPE PE100 PN10 SDR
- B. Joints with electro fusion
- C. Fittings of HDPE

- D. The Employer shall request the Contractor the provision of the Manufacturer's Certificates on the characteristics of the supplied pipes as well as carry out the corresponding verification tests.

2.14.6.3 COMPLIANCE CONTROL / COMPLIANCE TESTING

- A. The pipes shall be installed in a trench whose width will be fifty (50) cm greater than the nominal diameter of the pipe, at the level of the upper generatrix.
- B. The connection of the tubes with wells, manholes and pipe nozzles shall be carried out by applying mortar on the pipe, the end of which is flush with the inside of the manhole, well or mouthpiece.

2.14.7 MEASUREMENT AND PAYMENT – DEWATERING SYSTEMS

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 66. Units of measurement –Dewatering systems

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_53_24_86	000101	DEEPWELL SUBMERSIBLE PUMP WITH MOTOR FOR 20,52 M3/H AND HEAD 30 METERS, 380-3 PHASES-50 HZ, STAINLESS STEEL (SS394), 4 KW, IP68, 380V, 2900 RPM, FREQUENCY DRIVER, ELECTRICAL CONTROL PANEL, CONTROL/POWER SUPPLY CABLES AND INSTRUMENTATION,	pc	Deepwell submersible pump with motor for 20,52 m3/h and head 30 meters consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation deepwell submersible pump with motor for 20,52 m3/h and head 30 meters, 380-3 phases-50 Hz, Stainless Steel (SS394), 4 Kw, IP68, 380V, 2900 rpm, frequency driver, electrical control panel, control/power supply cables and instrumentation including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_54_95_12	000103	GATE VALVE D300 MM PN10, CAST IRON AND EPOXY COATING	pc	Gate valve D300 mm PN10, cast iron and epoxy coating consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of gate valve D300 mm PN10, cast iron and epoxy coating including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_54_95_12	000102	GATE VALVE D250 MM PN10, CAST IRON AND EPOXY COATING	pc	Gate valve D250 mm PN10, cast iron and epoxy coating consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of gate valve D250 mm PN10, cast iron and epoxy coating including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_54_95_12	000101	GATE VALVE D100 MM PN10, CAST IRON AND EPOXY COATING	pc	Gate valve D100 mm PN10, cast iron and epoxy coating consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of gate valve D100 mm PN10, cast iron and epoxy coating including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_54_95_12	000105	GATE VALVE D80 MM PN10, CAST IRON AND EPOXY COATING	pc	Gate valve D80 mm PN10, cast iron and epoxy coating consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of gate valve D80 mm PN10, cast iron and epoxy coating including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_54_95_12	000104	GATE VALVE D50 MM PN10, CAST IRON AND EPOXY COATING	pc	Gate valve D50 mm PN10, cast iron and epoxy coating consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of gate valve D50 mm PN10, cast iron and epoxy coating including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_54_40_13	000101	CHECK VALVE D100 MM PN10, CAST IRON AND EPOXY COATING	pc	Check valve D100 mm PN10, cast iron and epoxy coating consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of check valve D100 mm PN10, cast iron and epoxy coating including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_54_40_13	000102	CHECK VALVE D50 MM PN10, CAST IRON AND EPOXY COATING	pc	Check valve D50 mm PN10, cast iron and epoxy coating consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of check valve D50 mm PN10, cast iron and epoxy coating including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_54_40_02	000101	AIR RELEASE D50 MM PN10, CAST IRON AND EPOXY COATING	pc	Air release D50 mm PN10, cast iron and epoxy coating consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of air release D50 mm PN10, cast iron and epoxy coating including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_54_40_02	000102	AIR RELEASE D80 MM PN10, CAST IRON AND EPOXY COATING	pc	Air release D80 mm PN10, cast iron and epoxy coating consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of air release D80 mm PN10, cast iron and epoxy coating including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_03_31	000101	GALVANIZED STEEL PIPE 4" SCH40	m	Galvanized steel pipe 4" SCH40 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of galvanized steel pipe 4" SCH40 including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_07_36	000101	HIGH DENSITY POLYETHYLENE PIPE D250 MM PE100 PN10	m	High density polyethylene pipe D250 mm PE100 PN10 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of high density polyethylene pipe D250 mm PE100 PN10, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_07_36	000102	HIGH DENSITY POLYETHYLENE PIPE D280 MM PE100 PN10	m	High density polyethylene pipe D280 mm PE100 PN10 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of high density polyethylene pipe D280 mm PE100 PN10, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_07_36	000103	HIGH DENSITY POLYETHYLENE PIPE D315 MM PE100 PN10	m	High density polyethylene pipe D315 mm PE100 PN10 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of high density polyethylene pipe D315 mm PE100 PN10, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_07_36	000104	HIGH DENSITY POLYETHYLENE PIPE D400 MM PE100 PN10	m	High density polyethylene pipe D400 mm PE100 PN10 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of high density polyethylene pipe D400 mm PE100 PN10, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_20_05_65	000101	VERTICAL DRILLING 0-50 M IN DIAMETER 400 MM	m	Vertical Drilling 0-50 m in diameter 400 mm consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the execution of drilling for deep shaft
Pr_65_52_63_87	000101	UPVC CASING 10" SDR26, SLOTTED AND LINEAR	m	UPVC Casing 10" SDR26 slotted consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of UPVC Casing 10" SDR26 slotted on a sand bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 25 cm above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Ss_50_35_06_14	000101	PRECAST REINFORCED CONCRETE MANHOLE D 1000 MM HAVG-4,9 M FROM ELEMENTS WITH OVERLAPS, WALL WATERPROOFING, CAST IRON COVER CLASS A15, WITH LOGOS, LOCK, SEALING ELEMENTS, LADDERS	pc	Precast reinforced concrete manhole D 1000 mm havg-4,9 m consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of precast reinforced concrete manhole D 1000 mm havg-4,9 m from elements with overlaps, wall waterproofing, cast iron cover class A15, with logos, lock, sealing elements, ladders

2.15 GEOTECHNICAL INSTRUMENTATION AND MONITORING

2.15.1 SCOPE OF WORKS

- A. this section provides a needed but non-exhaustive list of labor, materials, equipment, and performing all operations related to the geotechnical instrumentation and monitoring of embankments according to the Technical Design and Drawings.
- B. The geotechnical instrumentation and monitoring network shall be composed of:
 - a. Vibrating wire PWP piezometers;
 - b. Settlement plates or magnetic extensometer;
 - c. In-place inclinometers;
 - d. Surveying.
- C. All instrumentation and monitoring works shall be executed in accordance with the Technical Design and Technical Specifications. Minor adjustments to the proposed locations and elevations shown in the Technical Design may be made in the field by the Contractor or the Engineer if job conditions require them.
- D. The Contractor shall submit a Geotechnical Instrumentation and Monitoring Plan for Engineer's approval prior to the commencement of the works. Geotechnical Instrumentation and Monitoring Plan shall take into account the preliminary locations in "Instrumentation and Monitoring plan" in Technical Design and contain, at least, the following data:
 - a. Detailed plan of instrumentation locations;
 - b. Proposed schedule for installing instrumentation;
 - c. Drilling methods, in case of boreholes required, and construction procedures;
 - d. Manufacturer's installation instructions and recommendations for installation of instrumentation;

- e. Operating manuals, specifications, calibration certificates for each instrument, and descriptions of each type of instrument, including read-out devices and appurtenant supplies required for a complete instrumentation installation.
- f. Data collection and analysis procedures.
- g. Reporting and Plan updates.

2.15.2 GENERAL REQUIREMENTS

- A. Attending to EC7-1997-1, the monitoring program shall be applied with the following purposes:
 - a. Check the validity of predictions of performance made during the design;
 - b. Ensure that the structure will continue to perform as required after completion.
- B. The results obtained from monitoring shall always be evaluated and interpreted in a quantitative manner by the Contractor. The frequency of the readings will be daily to monthly and/or as requested by the Engineer.
- C. Since the Geotechnical Design within the framework of Rail Baltica Projects are enclosed within the Category 2 according to EC7-1997-1, the evaluation of the monitoring shall be based on measurements of movements of selected points on the structure. In case that any structure would be involved within the Category 3, the evaluation of the monitoring will be based on the measurement of displacements and analyses, which take account of the sequence of construction operations.
- D. Where there could be an adverse effect on ground or ground-water conditions, the possibility of leakage or of alterations to the pattern of ground-water flow, since granular soils are involved, shall have be taken into account for planning the monitoring programme.
- E. At the beginning of the monitoring activity, the Contractor shall define the range of data that are considered valid within the monitoring at each section that are established. These range of data shall be approved by the Engineer.
- F. The end of the monitoring activity shall be approved by the Engineer when the range of data obtained ensure that does not exist risk further.
- G. Works shall comply with EN ISO 18674 – Geotechnical investigation and testing. Geotechnical monitoring by field investigation.
- H. Monitoring surveys shall be permanent where required and shall require permanently installed instruments with continuous recording facilities.
- I. Instrumentation shall be maintained by the Contractor. Damaged or non-functional installations shall be replaced by the Contractor immediately.
- J. The Contractor shall provide access to monitoring instruments and facilitate monitoring by temporarily stopping or interrupting certain portions of the Work as may be required for monitoring and taking readings.
- K. Monitoring and measuring shall be schedule and performed in a manner that will not delay the work unnecessarily.

2.15.3 INSTALLATION DETAILS

- A. Boreholes for instruments shall be drilled by any method provided that it results in a clean and stable hole of the required diameter to the correct depth. Boreholes shall be cased to their full depth unless strata are sufficiently competent for the hole to stay open under dry conditions. Drilling mud or polymer additives shall be only used with the prior approval of the Engineer.
- B. The method of borehole formation, including the procedure for advancing casing, shall be submitted to the Engineer before the commencement of the works. The works shall not commence until such time as the Supervisor has approved the proposals.
- C. Small, disturbed samples shall be taken during drilling of these boreholes at 1.0m centres and at every change in stratum. A geotechnical log shall be produced from these samples and borehole records for submission the working day after drilling has been completed.
- D. All instruments shall be labelled with their reference number at the location where readings or measurements are to be taken.

2.15.4 VIBRATING WIRE PWP PIEZOMETERS

- A. Vibrating wire PWP piezometers shall be installed in boreholes using the fully grouted method.
- B. Each piezometer shall be assembled and installed so that the tip is at the design depth or complying with the Technical Design criteria.
- C. The porous piezometer filter tip shall be properly saturated before installation into the borehole and set with the tip up and taped to the disposable grout pipe and/or inclinometer casing as appropriate at each borehole location.
- D. Once the vibrating wire tip has been saturated, the Contractor shall assemble the tip, disposable pipe, and cables in a way to prevent the tip from becoming desaturated. If, due to complications during installation, the tip does become desaturated the tip shall be saturated again.
- E. Each piezometer vibrating wire tip shall be calibrated prior to installation.
- F. Grout for backfilling the vibrating wire piezometers shall be placed in the borehole by pumping under pressure through the disposable grout pipe (tremie pipe). The hollow-stem auger shall be withdrawn as necessary during the grouting process. The grout pipe shall permanently remain in the boring.
- G. The protective casing shall be installed according to Manufacturer's instructions, to an approximate depth of 0.5m in the borehole. The exact depth shall be adjusted so that the top of the casing is even with the top of the piezometer casing.
- H. The annulus between the protective casing and the borehole wall shall be filled with concrete grout.
- I. During drilling, the Contractor shall be responsible for the care and maintenance of the piezometers and shall maintain the site in such a condition and protect the piezometers in such a manner that no undesirable materials are spilled, dripped, or introduced into the borehole by any means.
- J. If for any reason a borehole or piezometer cannot be completed, the Contractor shall contact Engineer for permission to abandon it. Borehole abandonment includes removing all casing, and/or tools from the borehole, sealing the borehole as nearly as possible for its full length with cement grout and restoring the site.

2.15.5 SETTLEMENT PLATES AND MAGNETIC EXTENSOMETERS

- A. Settlement plates and magnetic extensometer shall be used for monitoring vertical movements.
- B. The plates shall be placed at the selected strata in the ground prior to embankment construction, according to the Technical Design. The base platform will be a steel plate, with a reference rod (riser pipe), with threaded end connections, attached to it. As fill is placed over the settlement plate additional segments of pipe shall be added. Where high quality readings of the behaviour at the plate elevation are of interest, and/or where extra protection is required, a PVC protection pipe shall be placed around the threaded riser pipe. The plastic pipe shall be of sufficient diameter to accommodate any couplers used to connect the riser rods. Settlement shall be determined by periodically measuring the elevation of the top of the reference rod. The elevation of the base platform elevation shall be measured before the embankment construction begins. Stable benchmarks shall be used for a reference elevation datum and should be located away from all possible vertical movement or other disturbance.
- C. The magnetic extensometer shall consist of an access tube, a steel measuring tape, a tape reel with built in lights and buzzer and a series of magnetic targets, set along the pipe at specified depths, which are free to slide down the tube, together with a datum magnet fixed to the tube near its base. The access tube shall be a rigid PVC pipe with threaded ends. All joints shall be sealed with a suitable PVC solvent cement or similar approved.

2.15.6 IN-PLACE INCLINOMETERS

- A. In-place inclinometers shall be installed for automatic data collection for continuous real-time monitoring according to Technical Design criteria.
- B. Each inclinometer will comprise a casing pipe installed in a borehole, control cable attached to a probe and data reader unit. The system shall consist of one or more sensors permanently installed in the casing pipe and connected to a data logger.
- C. The borehole shall be drilled below the potential movement zone to ensure that the inclinometer is founded and embedded a minimum of 1.0 m into stable ground such as rock or stiff soil beyond the displacement zone. The

length shall be justified by the Contractor in the Monitoring Plan and agreed with the Engineer before installation.

- D. The inclinometer shall be installed in the borehole and grouted in place
- E. The inclinometer shall be constructed such that no more than 1.0m and no less than 0.5m stick up above the ground surface.
- F. Inclinometer grout shall be placed from the base of the inclinometer to the ground surface by pumping under pressure through a tremie pipe/pipe attached to the grout valve gasket at the tip of the inclinometer casing.
- G. The inclinometer shall be installed so that the difference in alignment of any section is no greater than 3% of the depth to that part. If the inclinometer is not installed to meet this tolerance, the Contractor shall abandon the location and install a new inclinometer at a location identified by the Engineer at no additional cost to the Employer. The verification of verticality shall be made after the grout has set and two datasets are collected.
- H. The protective casing shall be installed according to Manufacturer's instructions, to an approximate depth of 1.2m in the borehole. The exact depth shall be adjusted so that the top of the casing is even with the top of the inclinometer casing.
- I. The annulus between the protective casing and the borehole wall shall be filled with concrete grout.
- J. If for any reason a borehole or inclinometer cannot be completed, the Contractor shall contact Engineer for permission to abandon it. Borehole abandonment includes removing all casing, and/or tools from the borehole, sealing the borehole as nearly as possible for its full length with cement grout and restoring the site.

2.15.7 DATA COLLECTION AND ANALYSIS

- A. Instrumentation readings shall be taken with the frequency stated in the Monitoring Plan and agreed with the Engineer for each Work, and according to the Technical Design.
- B. Readings will be collected more frequently during construction activities to guide any real-time adjustment of the construction rate needed to maintain stability. Frequency will be dependent on the rate of construction and will be determined at the time the construction schedule is determined.
- C. The continuous readings shall be recorded using a datalogger and will be downloaded monthly or at an increased frequency if the need arises.
- D. The frequency of ongoing analyses shall be re-evaluated as construction and operation progress.

2.15.8 MEASUREMENT AND PAYMENT – GEOTECHNICAL INSTRUMENTATION AND MONITORING

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 67. Units of measurement –Geotechnical instrumentation and monitoring

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_75_70_85	000101	DOCUMENT PREPARATION. PRODUCTION ON SITE SPECIFIC RISK ASSESSMENTS AND METHOD STATEMENTS (RAMS)	pc	Geotechnical monitoring document preparation. This item is meant for production on site specific Risk Assessments and Method Statements (RAMS)
Ss_75_70_85	000103	PROJECT MANAGEMENT PRIOR TO AND DURING INSTALLATION	pc	Geotechnical monitoring Project Management prior to and during installation. This item is meant for project management of the activities for monitoring prior and during installation

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_75_70_85	000104	PROJECT MANAGEMENT DURING CONSTRUCTION PERIOD	Month	Geotechnical monitoring Project Management during construction period. This item is meant for project management of the activities for monitoring during construction period
Ss_75_70_85	000105	PROJECT MANAGEMENT DURING POST-CONSTRUCTION PERIOD	Month	Geotechnical monitoring Project Management during post-construction period. This item is meant for project management of the activities for monitoring during post-construction period
Ss_75_70_85	000106	PROJECT MANAGEMENT DURING COMMISSIONING	pc	Geotechnical monitoring Project Management during commissioning. This item is meant for project management of the activities for monitoring during commissioning
Ss_75_70_85	000107	VIBRATING WIRE PIEZOMETER. INCLUDES: -SUPPLY OF EQUIPMENT -DRILLING OF BOREHOLES AND INSTALLATION	pc	Vibrating Wire Piezometer consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply of equipment, drilling of boreholes and complete installation.
Ss_75_70_85	000108	MAGNETIC EXTENSOMETER INCLUDES: -SUPPLY OF EQUIPMENT -DRILLING OF BOREHOLES AND INSTALLATION	pc	Magnetic Extensometer consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply of equipment, drilling of boreholes and complete installation.
Ss_75_70_85	000109	INCLINOMETERS INCLUDES: -SUPPLY OF EQUIPMENT -INSTALLATION	pc	Inclinometers consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply of equipment and complete installation.
Ss_75_70_85	000110	SURVEYING INCLUDES: -SUPPLY OF EQUIPMENT -INSTALLATION	pc	Surveying consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply of equipment and complete installation.
Ss_75_70_85	000111	3D PRISM TARGETS (24 MONTHS)	pc	3D prism targets (Retaining walls) consist of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply of equipment and complete installation for prism targets for Monitoring Construction- Manual Data Collection (MDC)
Ss_75_70_85	000120	SETTLEMENT LEVELLING POINTS (24 MONTHS)	pc	Settlement levelling points consist of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply of equipment and complete installation for settlement levelling points for Monitoring Construction- Manual Data Collection (MDC)
Ss_75_70_85	000112	REFLECTIVE POINTS (24 MONTHS)	pc	Reflective points consist of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply of equipment and complete installation for reflective points for Monitoring Construction- Manual Data Collection (MDC)

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_75_70_85	000113	3D PRISM TARGETS (6MONTHS)	pc	3D prism targets (Retaining walls) consist of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply of equipment and complete installation for prism targets for Monitoring Post Construction- Manual Data Collection (MDC)
Ss_75_70_85	000121	SETTLEMENT LEVELLING POINTS (6MONTHS)	pc	Settlement levelling points consist of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply of equipment and complete installation for settlement levelling points for Monitoring Post Construction- Manual Data Collection (MDC)
Ss_75_70_85	000114	REFLECTIVE POINTS (6MONTHS)	pc	Reflective points consist of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply of equipment and complete installation for reflective points for Monitoring Post Construction- Manual Data Collection (MDC)
Ss_75_70_85	000115	DATA COLLECTION (24 MONTHS)	Month	Data collection. This item is meant for Monitoring Construction- Automated Data Collection (ADC)
Ss_75_70_85	000116	DATA COLLECTION (6 MONTHS)	Month	Data collection. This item is meant for Monitoring Post Construction- Automated Data Collection (ADC)
Ss_75_70_85	000117	INSTALLATION REPORT: -PIEZOMETERS -EXTENSOMETERS -INCLINOMETERS -SURVEYING	pc	Data visualisation & report consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for installation report for Piezometers, Extensometers, Inclclinometers and Surveying.
Ss_75_70_85	000118	FACTUAL REPORTING: -PRE-CONSTRUCTION MONITORING- MONTHLY REPORT -CONSTRUCTION WORKS -CLOSE-OUT MONITORING	pc	Factual reporting consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for factual reporting for Pre-construction monitoring-monthly report, construction Works and Close-out Monitoring.
Ss_75_70_85	000119	DECOMMISSIONING (REMOVAL EQUIPMENT)	pc	Decommissioning (removal equipment) consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for activities necessaries to removal equipment used for geotechnical monitoring.

2.16 QUALITY ASSURANCE & QUALITY CONTROL (QA/QC)

- A. The Contractor shall institute a Quality Assurance and Quality Control (QA/QC) system/plan for Earthworks to demonstrate compliance with the requirements of the Technical Design, the Technical Specifications and the Contract.
- B. QC Plan shall comply with EN 16907-5.
- C. The QA/QC plan for Earthworks shall be submitted to the Engineer for approval prior to Works.
- D. Compliance with the QA/QC requirements shall not relieve the Contractor of any duties, obligations or responsibilities under the Technical Specifications and the Contract.

- E. The Contractor shall establish and maintain a QA/QC Plan, with project quality requirements extending to all Subcontractors and Suppliers, to ensure that compliance with the Technical Specifications and the Contract is satisfied.
- F. QA/QC Plan shall comply with ISO 9001/9002.

3. SECTION 03.- RAILWAY SUPERSTRUCTURE

3.1 SCOPE OF WORKS

- A. This Section includes the following sub-sections related to the railway superstructure in the project as it is specified hereinafter:
 - a. Rails, in accordance with RBCN-CMS-SPC-R-00003.
 - b. Sleepers, fastenings and under sleeper pads (USPs), in accordance with RBCN-CMS-SPC-R-00002.
 - c. Ballast layer, in accordance with RBCN-CMS-SPC-R-00001.
 - d. Turnout integrated and rail expansion joints integrated systems, in accordance with the RBGL-SOD-SPC-R-00003.
 - e. Buffer stops in accordance with the RBDG-MAN-014E TS of buffer stops.
 - f. Welding.
 - g. Rail destressing.
 - h. Track tamping, levelling, and stabilization works.
 - i. Rail profiling and grinding.
- B. The above listed materials under sub-points a, b, c, d, e for Rail Baltica global project are supplied in a consolidated way by the Employer. It means that these materials will be supplied in accordance with the technical specifications (please refer to sub-points a, b, c, d, e) to the specified locations.
- C. This section provides a needed but non-exhaustive list of labour, materials, equipment, transport, and services necessary to receive materials, unload, assemble (if applicable), load, deliver, unload, install and commission all work of this section as shown on the drawings and BIM models, as specified herein and/or as required by job conditions.

3.2 GENERAL

- A. Superstructure construction shall be done in accordance with this Technical Specification and the Technical Design.
- B. All the superstructure components shall have a Design Working Life of at least 50 years, in accordance with RBDG-MAN-012 and the RBR technical specification of the component.
- C. All superstructure components shall be compatible with each other, in accordance with RBDG-MAN-014 and the RBR technical specification of the component.
- D. All superstructure components shall be compliant with all items and systems indicated in the European Commission Regulation No 1299/2014 (Technical Specifications of Interoperability – TSI).
- E. All superstructure components shall be compliant with the loads derived from the line classification in accordance with European Commission Regulation No 1299/2014 (Technical Specifications of Interoperability – TSI).
- F. All superstructure components shall be compatible with the use of magnetic braking systems for emergency braking as indicated in the European Commission Regulation No 1299/2014 (Technical Specifications of Interoperability – TSI).
- G. Acceptance of works shall be done in accordance with EN 13231-1 and the RBR technical specification of the component.
- H. Acceptance of reprofiling rails in plain line, switches, crossings and expansion devices in track shall be done in accordance with EN 13231-2.
- I. Procedures described on EN 13231-5 shall be followed regarding reprofiling in plain line, switches, crossings and expansion devices.
- J. Acceptance criteria shall be selected based on design speed of the line in accordance with relevant Rail Baltica Design guidelines and the RBR technical specification of the component.

- K. Absolute track position shall be Class AP 2 as per EN 13231-1, Clause 4.5 and track position measurements shall be carried out based on total station measurements.
- L. Absolute track position measurements shall be carried out after track dynamic stabilization, with track measuring trolleys, measuring coach (wagon) or manually operated devices which are compliant with EN 13848-4.
- M. Standards referred above are considered to be a set of minimum requirements.
- N. Measurements shall be organized and paid by the Contractor in accordance with "RBDG-MAN-039 - Geodetic network establishment for Construction stage of Rail Baltica high speed railway".
- O. For the final acceptance for whole railway section is required relative track geometry measurements and absolute track position measurements with track recording coach (wagon). Service will be organized by the Engineer/Employer.
- P. Despite the results of the initial measurement, all identified non-compliances are the Contractor's responsibility. Final Acceptance shall not be given until the work is completed in accordance with the requirements of the contract and in accordance with the RBR technical specification of the components.
- Q. The BIM models shall contain detailed as-built data according to the specified LoG and LoI levels and "RBDG-MAN-040- Digital information requirements for construction and handover stages". As-built BIM models shall be created by the Contractor and/or updated by developing PIM (Project Information Model) models from the Technical Design accompanied with laser scanning/photogrammetry data according to RBGL-VDC-INS-R-00001.

3.3 BALLAST

3.3.1 SUPPLY OF MATERIAL

- A. Ballast supply will be organized by the RB Rail Supplier according to RBCN-CMS-SPC-R-00001 - TS Railway Ballast material requirements for construction of Rail Baltica Railway line. Supplied materials shall meet requirements to corresponding Technical specification.
- B. Contractor shall organise ballast collection and stockpiling at delivery point if it is not otherwise stated.
- C. The material shall be weighed at the point of delivery.
- D. Delivery points shall be equipped with all necessary infrastructure to provide ballast unloading from railcars or trucks and ballast loading into railcars or trucks.
- E. Delivered ballast shall be stored separately until the quality and quantity of delivery is accepted. Stockpiles shall be separated from each other to avoid contamination of different stockpiles and to provide access to any of stockpiles at the same time. Stockpiles from single source can be merged only after the quality and volume of the stockpiles are accepted and deed of acceptance is signed.
- F. Contractor is responsible to execute all necessary activities, including laboratory tests and, if needed, weighing, to accept or reject delivered material in 10 days after date when materials delivery is completed. In case when Contractor didn't reject delivered materials in 10 days, they shall be assumed as accepted by the Contractor.
- G. Any deliveries which do not meet the requirements described in this Technical specification point A shall be rejected and replaced at the expense of the Supplier.
- H. In case when multiple samples of one delivered batch are tested, all test results shall meet requirements described in the present section of the technical specification, otherwise delivered batch in full amount shall be rejected.
- I. Any necessary reprocessing of the material to meet the requirements described in this Technical specification point A shall be done by the Supplier at their expense. Sampling after reprocessing of the material shall be organized by the Contractor according to standard EN 932-1 and/or EN 13450 requirements. All costs related to sampling and testing after reprocessing of material shall be covered by the Supplier.
- J. When Contractor accepts delivered material, all responsibility of delivered materials quality and quantity is handed over from the Supplier to the Contractor.

3.3.1.1 LOADING, TRANSPORT AND UNLOADING

- A. Particular attention shall be paid to ensure the ballast is not contaminated with other materials from the storage area. Railway ballast from different sources shall be stored in different stockpiles avoiding contamination of railway ballast from different sources.
- B. The Contractor shall initiate internal control testing to assure quality of ballast at the Contractor's expense.
- C. The Contractor shall check all ballast delivery tickets and if necessary, arrange weighting and additional tests at their expense.
- D. The Contractor shall be responsible for setting up storage area, including obtaining the area, preparing the storage area, ensuring suitable accesses to them. Any environmental aspects, including restoration of the storages and access roads shall be the responsibility of the Contractor. Any environmental claims (dust pollution, water contamination and flow restrictions) shall be avoided.
- E. Ballast shall be stored by the Contractor at locations specifically intended for storing bulk material (aggregates, soils). Storage area shall be prepared as follow:
 - a. Area shall be clean of any vegetation or weak soils;
 - b. Area shall be covered with hard pavement (concrete, asphalt or similar) or unbound mixture in necessary depth to provide pavement stability;
 - c. Area shall have sufficient water drainage to avoid water bonding;
 - d. Area shall have sufficient bearing capacity for aggregates storage;
- F. Prior to installation, the ballast aggregate shall be irrigated with appropriate amount of water to avoid dust pollution. However, the amount of water and method of application shall prevent the fines migration (segregation).
- G. Stockpiling shall be done by minimizing the segregation of the ballast material.
- H. The stockpiles place has to be chosen assessing the loads, ensuring the stability of the surrounding slopes if such persist and stability of the slopes of the stock piles itself.
- I. The height of stockpiles shall not exceed 5 meters.
- J. To avoid excessive railway ballast degradation during stockpiling, it is forbidden to drive over the railway ballast with wheels equipped equipment. For stockpiling The Purchaser should use conveyers or crawler excavator or any other equipment, that does not cause material degradation.
- K. All stockpiles shall be marked with identification that allow to identify material and delivery batch.
- L. The settlements or damage to existing ground surface shall be restored after removing the material from the storage place.
- M. If materials are transported to Site by trucks, then Contractor shall indicate the Engineer the storage areas and a material handling quality assurance system.
- N. The Engineer shall request the Contractor to collect samples of materials on Site (Employer can make additional test) according standard EN 932-1 and/or EN 13450, send samples to laboratory and based on laboratory test results approve/reject material with quality assurance system.
- O. If the Contractor will transport ballast by hopper wagons directly to site more than 20km and unload railway ballast directly from hoppers, then the Contractor shall present quality assurance plan to the Engineer for approval.
- P. Ballast material acceptance test on site before installation of ballast and during unloading from hopper wagons shall be paid by Employer.
- Q. Acceptance test frequency average is 5000 t (grading and fines content) material installed to track (Engineer can require more test based on Employer request).
- R. The Contractor shall clean all used territories in the end of construction works and shall landscape based on landowner requirements.

3.3.1.2 QUALITY CONTROL

- A. The Contractor shall carry out tests to ensure the quality of material at delivery point and during construction process. These tests shall be executed and paid by the Contractor.
- B. The minimal sampling and testing frequencies shall be in accordance with the following table below.

Table 68. Sampling and testing - Ballast

Property	Testing method	Testing frequency
Grading	Sampling EN 13450 or EN 932-1 Testing EN 933-1	At least once per 5000 t delivered material
Fines content		
Particle density	Sampling EN 13450 or EN 932-1 Testing EN 1097-5	At least once per 5000 t delivered material
Shape index	Sampling EN 13450 or EN 932-1 Testing EN 933-4	At least once per 5000 t delivered material
Particle length	Sampling EN 13450 or EN 932-1 Testing EN 13450 Ch. 6.7	At least once per 5000 t delivered material
Resistance to fragmentation	Sampling EN 13450 or EN 932-1 Testing EN 1097-2 (Annex A)	At least once per 10000 t delivered material
Resistance to wear	Sampling EN 13450 or EN 932-1 Testing EN 1097-1 (Annex A)	At least once per 10000 t delivered material
Resistance to freezing and thawing (water adsorption)	Sampling EN 13450 or EN 932-1 Testing EN 1097-6 (Annex B)	At least once per 10000 t delivered material
Sonnenbrand	Sampling EN 13450 or EN 932-1 Testing EN 1367-3	Once per source during verification testing by Contractor

- C. All tests shall be documented, and the Contractor shall provide access for the Employer to said documents.
- D. Of each of the delivered batches to the construction site the following information shall be included in the quality control documentation:
- Identification number of the batch and its volume
 - Source of the material
 - Nature and description of the rock
 - Grading
 - Fines content
 - Particle density
 - Shape index
 - Particle length
 - Resistance to fragmentation
 - Resistance to wear
 - Resistance to freezing and thawing
 - Sonnenbrand
 - Declaration of performance with the CE marking of the manufacturer.
- E. Samples shall be taken in accordance with standard EN 932-1 or EN 13450 Annex A.
- F. Regardless of the tests carried out by the Contractor following the Technical Specifications, the Employer can also monitor the characteristics of the materials supplied and can make the inspections and tests it deems appropriate at any time and place, from the materials supply, construction process to the finished product.
- G. This additional surveillance shall not exempt the Supplier nor the Contractor of its responsibility.

- H. The costs of any inspection in site carried out by the Employer that results in the noncompliance with the requirements of the material shall be paid by the Contractor. This will include the cost of the tests, any counter tests associated to said tests, the cost of the technical personnel that have participated in said inspections and/or tests and the personnel to control the subsequent repairing and correcting measures.
- I. All the expenditures associated with said Plan and the tests with the necessary frequencies to guarantee the acceptance of the material and the execution process shall be underwent by the Contractor.
- J. Monthly, the Contractor shall provide a report with all the results of the tests and works carried out in the period and will be obliged to attend any meeting summoned by the Employer to explain or clarify anything about the progress and quality of the supply.
- K. Testing is divided into three categories as in Table 1 in these Technical specifications.
- L. Sampling and testing shall be done in accordance with applicable standard and methodologies. Equipment and personnel for sampling shall be provided by the Contractor, if requested by Engineer/ Employer. Sampling shall be done by the Contractor if requested by Engineer/ Employer. The Contractor shall inform Engineer/ Employer at least 24h prior to sampling. Sample is divided into three separate samples – samples A, B and C. Sampling and reduction shall be done in accordance with EN 932-1, EN 932-2, EN 13286-1 or EN 13450. Sample size depends on the testing scope and shall be sufficient for intended testing. Sample A is handed over to the Contractor. Sample B and C are handed over to the Engineer/ Employer and shall be tested if needed.
- M. Testing shall be done in laboratories accredited in accordance with EN ISO/IEC 17025. For acceptance testing all tests to be done in the laboratory shall also be accredited.
- N. A daily record of samples and materials taken shall be maintained. Records shall provide information about the nature and source of the materials and shall identify the location, means of selection and sampling. Where appropriate, a copy of daily records shall be provided for retention.
- O. Test reports shall be submitted to the Engineer/ Employer prior to proceeding with the works.

3.3.2 EXECUTION PROCESS CONDITIONS

- A. Ballast layer construction can start only after the acceptance of previous layer (e.g. sub-ballast layer).
- B. Before the start of the ballast works the Contractor shall be responsible for checking the condition of the sub-ballast layer in accordance with these Technical Specifications.
- C. If any non-compliance with the sub-ballast tolerances indicated in the sub-ballast section of the present Technical Specification is found, the contractor shall proceed to the repair of the damaged sub-ballast surface.
- D. Trafficking on sub-ballast layer is only allowed for machinery and equipment related with ballast layer construction. Machinery shall avoid making turns on sub-ballast and ballast layers.
- E. Contractor shall conduct additional processing, e.g. crushing, sieving, washing or other suitable method, to improve materials' quality before installing it on the track if material properties do not meet contract requirements.
- F. Ballast layer surface finishing shall be done with construction equipment which does not cause harm to the aggregate (i.e. generate fines, cause aggregate breakdown, cause aggregate segregation, etc.).
- G. Ballast layer shall be constructed in two layers: bottom layer and upper layer. All deviations from this requirement shall be approved by the Engineer.
- H. Ballast layer (ballast bottom layer) shall be compacted with static rollers with smooth steel drum. Dynamic compaction is not allowed. Thickness of ballast bottom layer shall be 13 (0/+2) cm on embankment and 20 (±2) cm on structures.
- I. Ballast surface (ballast upper layer) shall be finished after the installation of sleepers.
- J. Finished ballast layer shall be compacted by compactor or stabilizer. Stabilizer shall apply compactive effort equal to 150000-ton train. Prior to compaction, the sleepers shall be in correct position and supported appropriately. All the preparation work specified by the supplier of the turnout shall be completed before the stabilization of turnout. After stabilization and trafficking, turnouts and fastenings shall be checked and, if necessary, adjusted.
- K. The geometrical shape, thickness, measures of ballast layer shall comply with the requirements of design solutions.

- L. Finished ballast layer shall be free of impurities, aggregate particles that are larger than allowable limits and aggregates, particles, objects, etc. which are not part of the layer.
- M. In curves, the cant of the track will be taken into account up to 110mm.
- N. When pouring the ballast, test sections shall be carried out to adjust to the amount of water and avoid segregation. Test section shall be carried out in straight section with regular geometry at least of 50 meters to determine compaction ratio (compacted ballast layer density).
- O. In a same cross section ballast from different quarries shall never be used, the ballast shall be changed from a specific chainage in order to avoid mixing them as much as possible.
- P. The machinery that circulates on the ballast bed shall have wide crawlers or wheels such a way that the ballast does not fracture, or the surface of the bed is altered.
- Q. Once the track components are installed on the ballast bottom layer it shall be possible to transport the rest of the ballast in hopper cars and unload them onto the track.
- R. Once the upper layer of ballast is installed, the tamping machine shall act to compact and adjust the levelling by means of lifting and tamping.
- S. Contractor is responsible to carry out the necessary number of passes to execute the ballast laying, tamping and levelling to achieve the required rail position (height) and geometry of ballast layer.
- T. The Contractor shall prepare the survey and withdrawal in accordance with the guidelines of the Engineer especially in regard to the removal of ballast.
- U. Ballast layer shall be in accordance with EN 13231-1 Clause 4.6. Acceptable tolerances per EN 13231-1 are described in the table below.

Table 69. Acceptable tolerances - Ballast layer execution (EN 13231-1)

Property	Allowable deviation from design value
Ballast thickness (BT) ^(a)	+ 15 % - 0 %
Distance between the running edge of the rail and the ballast shoulder (RD)	+ 10 cm - 0 cm
Ballast slope inclination (SB)	± 10 %
Ballast shoulder over height (OH)	+ 2 cm - 0 cm
Note: a) Minimum distance between the formation surface (top surface of the sub-ballast layer) and the lower base of the sleeper, measured under the inner rail in curves.	

3.3.3 MEASUREMENT AND PAYMENT - BALLAST LAYER

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. Ballast measurements for ballast supply shall be made per tons (t) transported to delivery points.
- C. In case when railway ballast supply to the Delivery location is made by trucks or railway when railcar scales is available:
 - a. Delivered material shall be weighted before unloading;
 - b. Delivered material shall be sampled in accordance with EN 932-1, EN 932-2 or EN 13450 immediately after unloading. Sample to be used for water content determination shall be packed in waterproof containers;
 - c. Water content in delivered material shall be determined according to EN 1097-5 no later than 24 hours after the sampling;
 - d. Water content determination shall be executed not less than one sample for each 2500 t of delivered material. The Purchaser reserves the rights to execute more frequent sampling in case of doubts;

- e. Water content for the delivered batch shall be calculated as average water content in all samples from one delivery batch;
 - f. Water content in delivered material shall not exceed 3%. Any additional water content in the delivered material shall be eliminated from the delivered quantities to be paid.
- D. In case when railway ballast supply to the Delivery location is made by railway and railcar scales is not available:
- a. Supplier shall provide information about capacity of railcars used for material delivery;
 - b. Supplier shall deliver materials only with fully and properly loaded railcars. Contractor may reject railcars, that are not fully loaded or delivered quantity can't be determined;
 - c. Delivered material shall be sampled in accordance with EN 932-1, EN 932-2 or EN 13450 immediately after unloading. Sample to be used for bulk density and water content determination shall be packed in waterproof containers;
 - d. Bulk density and water content of delivered material shall be determined according to EN 1097-3 no later than 24 hours after the sampling;
 - e. Sampling for water content and bulk density determination shall be executed not less than one sample for each 5000 t of delivered material. The Purchaser reserves the rights to execute more frequent sampling in case of doubts;
 - f. Bulk density and water content for the delivered batch shall be calculated as average bulk density and water content of all samples from one delivery batch.
- E. Ballast measurements for ballast layer construction shall be made per cubic metre (m³). Contractor shall declare ballast usage in tons (t) for the measured constructed section. Measurement shall correspond to the section executed according to the project drawings.
- F. The following work items are defined:

Table 70. Units of measurement – Ballast layer

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_85_88_07	000202	LAYING AND COMPACTING OF BALLAST BOTTOM LAYER	m3	Laying and compaction of ballast bottom layer consists of all necessary activities at the delivery point, transportation of the material from delivery point and all works, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_85_88_07	000203	LAYING OF BALLAST UPPER LAYER	m3	Laying of ballast upper layer consists of all necessary activities at the delivery point, transportation of the material from delivery point and all works, equipment and expenses necessary to achieve the specified result, according to Technical specifications

- G. The unit of measurement includes all the necessary means for handling the ballast in the delivery point and unloading it in the site place, including storage, stockpiling, surveillance, handling, management, maintenance and washing prior to its final incorporation.

3.4 SLEEPERS, FASTENINGS AND USP

3.4.1 SUPPLY OF MATERIAL

- A. Sleepers, fastenings and USP supply will be organized by the RB Rail Supplier according to RBCN-CMS-SPC-R-00002 – "TS Sleepers and Bearers with fastening system and under sleeper pad material requirements for

construction of Rail Baltica Railway line". Supplied materials shall meet requirements to corresponding technical specification.

- B. Contractor shall inspect delivered materials at IMF base or any other delivery place. Inspection shall include acceptance of delivered quantity as well as visual inspections of any damages, deformations, scratches, missing elements of fastening system, and any other compliance to point A of this chapter.
- C. Any deliveries which do not meet the requirements described in point A of this chapter shall be rejected and replaced at the expense of the Supplier.
- D. Contractor shall transport Sleepers, Fastenings and USP from IMF base or any other delivery point to the site (including loading into Contractor's transport at IMF base or any other delivery point and unloading at site).

3.4.2 EXECUTION PROCESS CONDITIONS

- A. Contractor shall place the sleepers along the alignment, transporting them to final location if necessary and disposing of the discarded sleepers.
- B. The packages of sleepers shall be separated from each other with the necessary protection to protect all the parts of the sleeper and fastening system.
- C. During transportation of the sleepers the elastic clips shall be in transportation position:
 - a. Launching or dropping sleepers is prohibited;
 - b. Abrupt manoeuvres should be avoided;
 - c. Special care shall be taken with the sleepers pre-equipped with their fasteners, so as not to damage them. For this, the sleepers will be lifted by their ends, never by the fasteners.
- D. Contractor shall install sleepers on the track according to this Technical specification.
- E. Depending on placement location 5 types are following:
 - a. Type 1 - with elastomeric pad placed on the regular embankment, includes C Category fastening system with rail pad stiffness=70 kN/MM.
 - b. Type 2 - with elastomeric pad placed on the structures without guardrails, includes C Category fastening system with rail pad stiffness=40 kN/MM.
 - c. Type 3 - with elastomeric pad placed on the structures with guardrails, includes C Category fastening system with rail pad stiffness=40 kN/MM.
 - d. Type 4 - with elastomeric pad placed approaching the structures with guardrails, includes C Category fastening system with rail pad stiffness=70 kN/MM.
 - e. Type 5 - the sets with elastomeric pads placed in guardrail transition zone, include C Category fastening system with rail pad stiffness=70 kN/MM.
- F. The types of sleepers shall be placed in accordance to the schemes shown in Figure 2 and Figure 3.

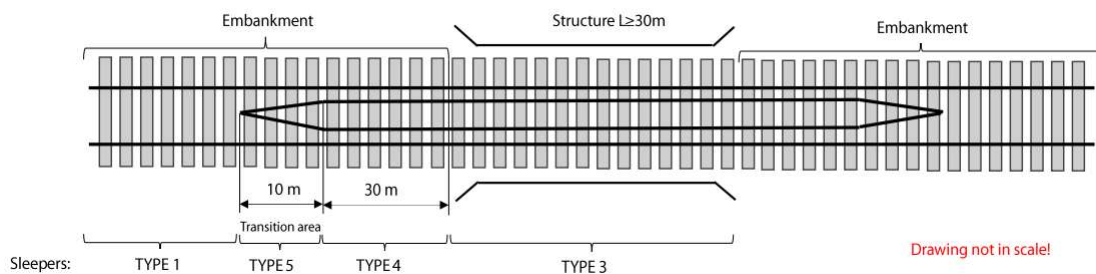


Figure 2. Sleeper types for structure with guard rails

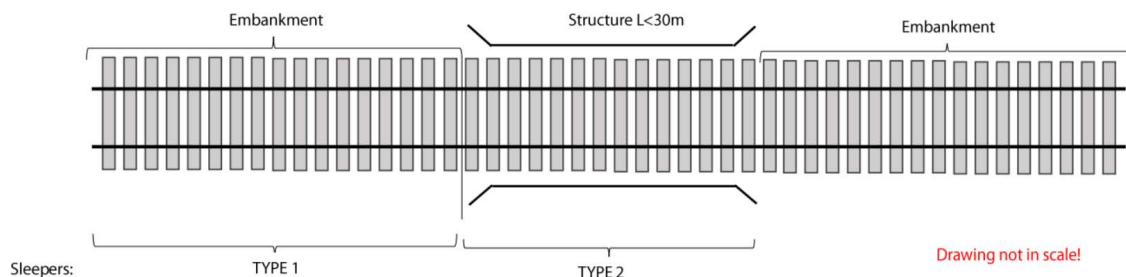


Figure 3. Sleeper types for structure without guard rails

- G. Sleepers shall be placed with spacing 600 mm (from centre to centre).
- H. For the placement of sleepers on the ballast bed the position shall be marked with chalk or with a guiding string to guarantee the tolerances.
- I. The permissible sleeper spacing deviation is $\pm 10\text{mm}$ (except at welds or other justifiable cases) and shall be checked. Checking shall be made at least once per 200 m of laid sleepers/track. The number of sleepers within 1000m shall be within 0,5% of the designed number. Squareness of the sleepers shall be $\pm 10\text{mm}$.
- J. All sleepers shall be fully supported by the underlaying layer (i.e. ballast layer).
- K. All fastening systems shall be complete and correctly fitted.
- L. In the case of viaducts, they cannot be stored above the structure and this operation shall be carried out according to the terms described in the contract specific requirements.

3.4.2.1 SLEEPERS FOR THE TRANSITION BETWEEN TRACK WITH GUARD RAILS AND GENERAL TRACK

- A. Transitions between track with guard rails and general track shall be installed at both ends of the guard rail sections.
- B. Guard rail transitions shall consist of 17 different sleepers (sleepers T1 to T17) with a configuration of positioning of the guard rail fastenings that enable the transition of both guard rails from their position to the centre of the track. The fastening components and details for the transition zone shall be assembled and installed as indicated in Drawings.
- C. Sleepers for guard rail transitions shall have the following dimensional requirements additional to the requirements of the sleepers for general track.

Table 71. Alignment requirements – Sleepers for guard rail transition

Chracteristic	Values
Height in guard rail seat section	$\leq 220 \text{ mm}$
Guard rail	EN 60E2

Characteristic	Values
Distance between running and guard rail measured between rail running edges (Different for each sleeper of the transition)	T1 → 0.369m
	T2 → 0.383m
	T3 → 0.397m
	T4 → 0.411m
	T5 → 0.425m
	T6 → 0.439m
	T7 → 0.453m
	T8 → 0.467m
	T9 → 0.481m
	T10 → 0.495m
	T11 → 0.509m
	T12 → 0.523m
	T13 → 0.537m
	T14 → 0.551m
	T15 → 0.565m
	T16 → 0.579m
	T17 → 0.593m
Guard rail inclination	Vertical

- D. As the guard rail transition sleepers need to be supplied and positioned as a set of 17 sleepers they shall be measured as a joint work unit.

3.4.3 QUALITY ASSURANCE AND QUALITY CONTROL OF SUPPLIED MATERIALS

- A. Quality assurance shall be ensured by supplier, as supplier shall implement and operate Quality System described in standard EN 13230-1 clause 8. All testing shall be done by manufacturer of sleepers. Design approval testing and routine testing in accordance with EN 13230-1, EN 13230-2. Manufacturer shall provide 0,5% of total produced sleepers for additional testing done by 3rd party.
- B. Quality control before signing the deed of acceptance shall be performed by Contractor. Quality control means:
- visual inspection for any damages of sleeper and fastening system, missing components of fastening system, missing marking, labelling.
 - dimensional inspection. In dimensional inspection main dimensions shall be checked: overall length, width at bottom, height at rail seat, track gauge, rail inclination, thickness of under sleeper pad. Inspection sheet of dimensional testing shall be prepared indicating nominal value, tolerances and measurement results. For facilitation and speed-up of dimensional inspection process special testing gauges can be used.

Visual inspection shall be done for at least 1 of 100 sleepers, dimensional inspection for at least 1 of 1000 sleepers. Checked sleepers shall be marked. In case of material non-conformity Contractor shall contact supplier and principal immediately.

3.4.4 MEASUREMENT AND PAYMENT - SLEEPERS

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The supply, loading, transport and placement of the sleepers will be measured per unit (pc) provided if they are executed in accordance with project specifications and the indications of the Engineer.
- C. The units of measurement shall be as follows:

Table 72. Units of measurement - Sleepers

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_85_72_21	000210	PLACEMENT OF CONCRETE MONOBLOCK SLEEPER ON EMBANKMENT INCLUDING FASTENING SYSTEM (CATEGORY C, RAIL PAD STIFFNESS=70 kN/MM) AND ELASTOMERIC PAD (TYPE 1)	pc	The item consists of transportation of the material from delivery point and all works, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_85_72_21	000212	PLACEMENT OF CONCRETE MONOBLOCK SLEEPER ON STRUCTURE INCLUDING FASTENING SYSTEM (CATEGORY C, RAIL PAD STIFFNESS=40kN/MM) AND ELASTOMERIC PAD (TYPE 2)	pc	The item consists of transportation of the material from delivery point and all works, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_85_72_21	000214	PLACEMENT OF CONCRETE MONOBLOCK SLEEPER ON STRUCTURE FOR TRACK WITH GUARD RAILS INCLUDING FASTENING SYSTEM (CATEGORY C, RAIL PAD STIFFNESS=40kN/MM) AND ELASTOMERIC PAD (TYPE 3)	pc	The item consists of transportation of the material from delivery point and all works, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_85_72_21	000216	PLACEMENT OF CONCRETE MONOBLOCK SLEEPER ON EMBANKMENT FOR TRACK WITH GUARD RAILS INCLUDING FASTENING SYSTEM (CATEGORY C, RAIL PAD STIFFNESS=70kN/MM) AND ELASTOMERIC PAD (TYPE 4)	pc	The item consists of transportation of the material from delivery point and all works, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_85_72_21	000218	PLACEMENT OF CONCRETE MONOBLOCK SLEEPERS FOR THE TRANSITION (FROM SET OF 17 SLEEPERS) OF GUARD RAILS INCLUDING FASTENING SYSTEM (CATEGORY C, RAIL PAD STIFFNESS=70kN/MM) AND ELASTOMERIC PAD (TYPE 5)	Set of 17 (Set)	The item consists of transportation of the material from delivery point and all works, equipment and expenses necessary to achieve the specified result, according to Technical specifications

3.5 RAIL

3.5.1 SUPPLY OF MATERIAL

- A. Rails supply will be organized by the RB Rail Supplier according to RBCN-CMS-SPC-R-00003 – “TS Rails material requirements for construction of Rail Baltica Railway line”. Supplied materials shall meet requirements to corresponding Technical specification.
- B. Contractor shall inspect delivered materials at IMF base or any other delivery point. Inspection shall include acceptance of delivered quantity as well as visual inspections of any damages, deformations, scratches, and other compliance to point A of this chapter.
- C. Any deliveries which do not meet the requirements described in point A of this chapter shall be rejected and replaced at the expense of the Supplier.

3.5.2 EXECUTION PROCESS CONDITIONS

- A. Delivered rail shall be welded for minimum 150 m long rails and transported to construction site. 120 m rail from producers can be transported to construction site.
- B. Contractor shall transport welded rails from IMF base or any other delivery point to the site (including loading into Contractor's transport at IMF base or any other delivery point and unloading at site).
- C. To provide continuous welded rail, Flash-but welding on site shall be used in running rails according to this Technical specification 3.6. "WELDING".
- D. To provide continuous welded rail, aluminothermic welding on site shall be used with turnout and rail expansion joints according to this Technical specification 3.6. "WELDING".
- E. Contractor shall distress rails according to this Technical specification 3.7. "RAIL DESTRESSING".

3.5.2.1 UNLOADING OF RAILS ON THE TRACK

- A. For the unloading of the rails from the rail train, the Contractor shall provide long rail unloading and rail installation technology for the acceptance to the Engineer before material deliveries can start. Rails shall be unloaded by means of mechanical extension arms that will place the rails parallel to the track.
- B. Any damage to the rails during the unloading process shall be avoided, also avoiding excessive flexing that may cause permanent deformations.
- C. When two long bars shall overlap the second bar that is unloaded shall not be supported on the head of the first.
- D. Partial discharge should be done so that the remaining load is distributed as symmetrically as possible with respect to the axis of the wagons.
- E. During the unloading process damage to the rest of the infrastructure construction and facilities should be avoided.

3.5.2.1.1 POSITIONING OF RAILS

- A. Once the sleepers are positioned, the rails are placed on them, without damaging the rails, the sleepers, or their fasteners, ensuring the perpendicularity of the sleepers to the rail.
- B. The rails will be positioned so that the joints are centred between sleepers, to be able to weld the bars without having to move them.
- C. Once the rails are in place, the position of the sleepers will be checked according EN 13231-1 requirements.
- D. After checking the correct positioning of the sleepers and once the clips have been placed in their correct position they will be fastened.
- E. The track width will then be checked, and any defects that may occur shall be corrected.
- F. The tolerance in the horizontal position will be ± 10 mm.
- G. For the circulation of work trains and track machinery, the rails may be clamped with fishplates that allow the tamping of the joint. It is not allowed to drill holes on the rail neck to fix the fishplates.
- H. The joints shall be facing each other and located in the centre of the sleeper separation.

3.5.3 QUALITY ASSURANCE AND QUALITY CONTROL OF SUPPLIED MATERIALS

- A. Quality assurance shall be ensured by supplier, as it is defined in standard of TRACK - RAILS EN 13674-1. Rails shall be delivered with certificates of testing, which confirms rails conformity to EN 13674-1 standard. Furthermore, EC declaration of conformity to TSI requirements shall be submitted by supplier confirming rails conformity to interoperability requirements.
- I. Quality control before signing the deed of acceptance shall be performed by Contractor. Quality control includes visual inspection of delivered materials and checking of quality assurance documentation described in paragraph A. Visual inspection shall be performed for at least 1 of 10 delivered rails paying attention to any damages, presence of marking, labelling. Profile geometry shall be checked using master sample (verified profile cut).

Checked rails shall be labelled at the end of the rail. In case of material non-compliance found, contractor shall contact supplier, principal immediately.

3.5.4 MEASUREMENT AND PAYMENT - RAIL

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The supply, loading, transport, distribution and assembly of the rail will be measured per metre (m) of rail supplied and assembled and in the same way will be paid at the following work items.
- C. The units of measurement shall be as follows:

Table 73. Units of measurement – Rail

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_76_70_30	000211	DELIVERY AND PLACEMENT OF FLAT BOTTOMED VIGNOLE RAIL PROFILE EN 60 E2 STEEL GRADE R260 AS RUNNING RAIL	m	Delivery and placement of flat bottomed vignole rail profile EN 60 E2 steel grade R260 as running rail consists of transportation of the material from delivery point and all works, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_70_30	000214	DELIVERY AND PLACEMENT OF FLAT BOTTOMED VIGNOLE RAIL PROFILE EN 60 E2 STEEL GRADE R350HT AS RUNNING RAIL	m	Delivery and placement of flat bottomed vignole rail profile EN 60 E2 steel grade R350HT As running rail consists of transportation of the material from delivery point and all works, equipment and expenses necessary to achieve the specified result, according to Technical specifications

3.6 WELDING

3.6.1 DEFINITION AND GENERAL REQUIREMENTS

3.6.1.1 ALUMINOTHERMIC RAIL WELDING

- A. Aluminothermic welding is the only allowed on switches and crossings and rail expansion joints.
- B. This operation will consist of grading, cutting the rail if necessary (with a rail cutting machine), leaving the regulatory cleat, placement of jaws to maintain the cleat, alignment and levelling at least 15 m on each side of the weld, placement of moulds and preheating apparatus, putting the crucible for single use and removing it after the melted material has fallen. Elimination of moulds and burrs with wire cutter, jaw removal and profile reconstruction with a grinder.
- C. The Contractor will take the necessary precautions in order to avoid any deterioration or burn in rails, sleepers and accessories made of synthetic materials. Items that suffer deterioration due to the welding works will be replaced by the Contractor, at his own expense and always following the directions of the Engineer. In case of rain or snow, the Contractor shall ensure effective protection of the place where the welding shall be carried out.
- D. In order to carry out the welding process, the welder shall have the corresponding approvals and permits from the Engineer/Employer as per EN standard, approvals that will not exempt in any case the Contractor from his responsibility in the case of a poor execution of work.
- E. Prior to the execution of the welds, the Contractor shall present to the Engineer the list of homologated welders from aluminothermic producers who will work on the section as well as the list of aluminothermic cargo lots to

be used. The purpose of both listings is to check if the welders and aluminothermic charge are authorized to weld and be used, respectively, in high-speed tracks. Additionally, track welders shall fulfil local qualification requirements.

- F. At the start of each welder's work on site, he shall perform a first test weld in order to verify that all the operations, procedures and tools used are suitable. All testing works shall be monitored by Engineer and tested by Engineer appointed laboratory. All test related material, labour, transportation and laboratory cost shall be covered by Contractor.
- G. In case the welder fails repeatedly in the execution of welds, being considered defective welding one that does not meet the appearance conditions, penetrating liquid geometry and ultrasounds, the Engineer may determine the replacement of said welder.
- H. Contractor shall provide aluminothermic track welding technology and track welding report format for acceptance to Engineer prior welding works can start.

3.6.1.2 FLASH BUTT WELDING

- A. Only flash butt welding is accepted for main line and station tracks rails. Contractor shall provide Flash butt welding technology and track welding report format for acceptance to Engineer prior welding works can start.
- B. Contractor shall test machines and welders according EN 14587 standard. For fatigue test Contractor shall make past the post test. All testing works shall be monitored by Engineer and tested by Engineer appointed laboratory. All test related material, labour, transportation and laboratory cost shall be covered by Contractor.

3.6.2 EXECUTION PROCESS CONDITIONS

- A. Rail welding will take place in different phases of the track works. The rails will be manufactured in bars with the maximum feasible length for transportation constraints. After positioning the rails on the sleepers, and prior to the rail destressing the long strings can be welded together to form larger strings up to the length permitted to carry out the rail destressing.
- B. Finally, after rail destressing all the corresponding joints will be welded obtaining a continuously welded track.

3.6.2.1 ALUMINOTHERMIC RAIL WELDING:

- A. All the operations necessary to carry out the welding process shall be done in accordance with standard EN 14730-1 and EN 14730-2.
- B. In situ aluminothermic welding of rails shall be done in accordance with requirements described in EN 147301.
- C. Requirements described in the following Table 74 to be used as a basis.

Table 74. Requirements - Aluminothermic weld

Property	Reference	Requirement
Pre-heating requirement	EN 14730-1 Ch. 4, sub-clause a).	
Width level of heat-softened zone	EN 14730-1 Ch. 7.4.4	≤ 30 mm
Fatigue test	EN 14730-1 Ch. 7.5 and Annex J	≥ 5×10 ⁶ cycles (past-the-post method)

- D. Welders and Contractors shall have required qualification as per EN 14730-2, Clause 5. Prior to welding, the welders shall have valid Permit to Weld issued by the local Railway Authority or the Employer.
- E. Contractor's quality management system shall be aligned with EN 14730-2, Clause 5.
- F. The Contractor shall provide evidence that they have the necessary experience for the type of work to be carried out. Contractor shall also fulfil the country's' specific track welder qualification requirements.
- G. Contractor shall perform ultrasonic control for every aluminothermic weld and add report to every welding report.
- H. Marking of welds shall be agreed with Employer before welding works.

- I. All date and documentations shall be added to BIM-AIM system before final approval by Engineer.
- J. When aluminothermic welding is carried out in tunnels and other confined spaces, the welding process shall be equipped with fumes extraction system to remove most of the fumes during the reaction.
- K. For the execution of the welds the rail quality of the turnout shall be considered. In cases where rails of different qualities are welded, the material to be used will be that corresponding to the highest quality.
- L. Acceptance of welds shall be done in accordance with EN 14730-2, Clause 6.
- M. Acceptance criteria shall be according ch.6.4.3.5 Table 1 Category D and Table 2 Category Z.

3.6.2.2 *FLASH BUTT WELDING*

- A. Flash butt welding shall be done in accordance with EN 14587-1 (fixed plant) or EN 14587-2 (in situ) using automatic, programmed welding sequence.
- B. Welding in association with crossing construction shall be done in accordance with EN 14587-3.
- C. During welding procedure, suppliers' guidance and requirements shall be followed.
- D. Mobile Flash-Butt Welding machine shall be approved by the Employer prior to works as described in EN 14587-2, Clause 5.
- E. Contractor shall also fulfil the country's' specific track welder qualification requirements.
- F. Flash butt welding will be the preferred method of welding, only recurring to aluminothermic welding when necessary (switches and crossings).
- G. All the operations necessary to carry out the welding process shall be done in accordance with standard EN 14587-1, EN 14587-2 and EN 14587-3.
- H. All of the welds and rails shall be inspected visually for welding, trimming, pressing, clamping and profile finishing imperfections. The finished weld shall be inspected using ultrasonic and X-Ray inspection methods. The variation in hardness shall be measured across the heat affected zone of each of the finished welds in accordance with EN 14587-1.
- I. Requirements according EN 14587-2 shall be the following:
 - a. 8.1.e) According 8.9 Table 3 Class 2.
 - b. 8.1 f) Marking shall be agreed with Employer before welding works. All dates and documentations shall be added to BIM-AIM system before final approval by Engineer.
 - c. 8.1.g) production bend test frequency – 1 bending test after every 50 production welds. Min bend test force 1520kN according to Table A.2

3.6.3 *MEASUREMENT AND PAYMENT - WELDING*

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The welds will be measured and paid according to the unit (pc) of fully executed welding, die-cut and with the corresponding part approved by the Engineer according to the following Table work items.
- C. The units of measurement shall be as follows:

Table 75. Units of measurement - Welding

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_29_96_03	000201	RAIL WELDING BY ALUMINO-THERMIC PROCESS	pc	Rail welding by alumino-thermic process consists of all works and expenses necessary to achieve the specified end result based on agreed welding technology with Engineer prior welding works.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_29_96	000201	RAIL WELDING BY FLASH BUTT PROCESS (FIXED PLANT)	pc	Rail welding by flash butt process consists of all works and expenses necessary to achieve the specified end result based on agreed welding technology with Engineer prior welding works.
Pr_20_29_96	000202	RAIL WELDING BY FLASH BUTT PROCESS (IN SITU)	pc	Rail welding by flash butt process consists of all works and expenses necessary to achieve the specified end result based on agreed welding technology with Engineer prior welding works.

3.7 RAIL DESTRESSING

3.7.1 DEFINITION AND GENERAL CONDITIONS

- A. Rail destressing consists of fixing the rail homogeneously stressed at a temperature of neutralization so that at neutralization temperature there are no thermal stresses.
- B. The process consists of cutting the rail or utilize an existing joint, unclamping the rail to be released, placing of rollers between rail and sleeper, release of tension by hitting the rail (homogenization) with rubber or wooden mallets, never metallic ones, creating the initial cleat, use of hydraulic tensioners if required (low temperatures), and finally weld the joint with Flash-but welding technology.
- C. Rail Baltica track neutral temperature is 23 °C +/- 3 °C.
- D. Contractor shall provide rail destressing technology, destressing report format and qualified site welding engineer for acceptance to Engineer prior destressing works can start.
- E. Based on described technology description the Contractor shall arrange test work and prove to Engineer that contractor can reach the required neutral temperature.
- F. All test related material, labour, machines, transportation and laboratory cost shall be covered by Contractor if Contractor fails the test.

3.7.2 EXECUTION PROCESS CONDITIONS

- A. The Contractor shall follow the agreed technology.
- B. Contractor site welding engineer is responsible for the quality of track destressing works and shall supervise on site total process (track works and welding works) and keep all records on agreed report form.
- C. Contractor welding engineer shall sign all welding and destressing reports. All welding and destressing reports shall be presented to Engineer for acceptance of welds and destressing works. Final documents shall be delivered to the Engineer/Employer.
- D. A series of precautions shall be taken when destressing the track:
 - a. It is prohibited to make new cuts in the middle of the bar to execute the destressing of the rail;
 - b. The destressing operation will be carried out in a way that does not interfere with other work. Contractor shall assess all safety hazards before destressing works.
- E. All the data referring to the neutralization operations will be documented and shared with the Employer.

3.7.2.1 DESTRESSING IN TURNOUTS

- A. The contractor shall create the distressing of the turnout procedure based on the information provided by supplier.

- B. The turnout destressing process has a series of points that differ from that described for the usual track.
- C. Some of the fasteners will not loosen, so the operations will be executed in the rest.
- D. The indications in the turnout section of the present Specifications will always be followed.
- E. Contractor shall follow turnout supplier instruction before preparation of turnouts destressing technology.

3.7.3 MEASUREMENT AND PAYMENT – RAIL DESTRESSING

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. Rail destressing will be measured and paid per metre (m) actually executed and fully finished meeting the specifications established in the project:
- C. The units of measurement shall be as follows:

Table 76. Units of measurement – Rail destressing

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_80_70_70_06	000203	RAIL DESTRESSING	Linear metre (m) (track)	Rail destressing consists of all works and expenses necessary to achieve the specified end result based on agreed rail destressing technology with Engineer

3.8 TURNOUTS AND RAIL EXPANSION JOINTS INTEGRATED SYSTEMS

3.8.1 DEFINITION AND GENERAL CONDITIONS

- A. Turnout integrated system - it is an integrated system that includes turnout and all necessary elements and subsystems required for the optimal operation and maintenance of the turnout.
- B. Rail expansion joint (REJ) system - it is an integrated system including rail expansion joint and all necessary elements and subsystems required for optimal operation and maintenance of the rail expansion joints.

3.8.2 SUPPLY AND DELIVERY

- A. Turnouts and rail expansion joints integrated system supply will be organized by the RB Rail Supplier according to actual Technical Specifications of Turnout integrated system and Rail expansion joints RBGL-SOD-SPC-R-00003 as part of consolidated material procurement process. Supplied materials shall meet requirements to corresponding technical specification.
- B. Contractor shall inspect delivered materials at IMF base or any other delivery point. Inspection shall include acceptance of delivered quantity as well as visual inspections of any damages, deformations, scratches, and other compliance to point A of this chapter.
- C. Any deliveries which do not meet the requirements described in point A of this chapter shall be rejected and replaced at the expense of the Supplier.

3.8.3 REQUIREMENTS

3.8.3.1 GENERAL REQUIREMENTS

- A. Turnouts and rail expansion joints integrated systems shall comply with the following requirements:
 - a. Standard gauge 1435mm,
 - b. Inclined 1:40.
 - c. Axle load 25t,
 - d. Main track speed 160km/h to 300km/h.

- e. Diverging track speed 40km/h to 230km/h.
- f. and others indicated in technical specification.

B. There will be 11 types of the turnouts integrated systems:

Table 77. Types list - Turnouts

Number	Turnout types	Crossing type	
1	60E-7350-1/65 SN	Swing nose	High Speed <250
2	60E-3550-1/46 SN	Swing nose	
3	60E-2500-1/26.5 SN	Swing nose	
4	60E-1200-1/18.5 SN	Swing nose	
5	60E-760-1/15 SN	Swing nose	
6	60E-760-1/14 SN	Swing nose	
7	60E-2500-1/26.5	Fixed	Conventional <200
8	60E-1200-1/18.5	Fixed	
9	60E-760-1/14	Fixed	
10	60E-300-1/9	Fixed	
11	60E-190-1/9	Fixed	

C. . There will be 4 sizes of single type of Rail expansion joints:

Table 78. Types list – Rail expansion joints

Number	Expansion Capacity C, mm	Expansion from M mean position, mm
1	300	±150
2	600	±300
3	1000	±500
4	1200	±600

D. The supplier of turnout integrated system or rail expansion joint integrated system shall provide the valid RB Rail Product acceptance certificate for each type of integrated system which to be installed on Rail Baltica line.

3.8.4 EXECUTION PROCESS CONDITIONS

3.8.4.1 TURNOUTS

- A. The supplier of the turnout integrated system shall provide to the Contactor, all the Assembly manuals which include the information about handling, regulation and assembly, the drawings for the device and the receipt checklist.
- B. At the time of hand-over on Rail Baltica track, all Turnout components must be present, tested and inspected in accordance with the requirements of the RBGL-SOD-SPC-R-00003.
- C. As turnouts is a complex system, there are multiple parties involved in its acceptance, delivery, installation and hand-over. Their main responsibilities are as following:
 - a. The Supplier is responsible for the supply of the approved / certified, completed, assembled, and commissioned Turnout as well as hand-over of the Turnout on its installation site on the Rail Baltica track.
 - b. The Contractor is responsible for:
 - i. Unloading supplied turnouts at delivery point;

- ii. Assembly of turnouts at delivery point (with assistance of the Supplier);
 - iii. Disassembly of turnouts at delivery point (for long turnouts);
 - iv. Loading turnouts at delivery point and transporting to site;
 - v. Unloading turnouts at site;
 - vi. Assembling turnouts in case if turnouts was disassembled for transportation;
 - vii. Installation of the track part of Turnout on the Rail Baltica track.
- c. The CCS Contractor is responsible for installation and integration of actuation, locking, detection, heating, and condition monitoring sub-systems into the Turnout at installation site on the Rail Baltica track and its integration to the track-side CCS system.
- d. RB Rail is responsible for implementing the product acceptance process. RB Rail is responsible for approval of commissioning and hand-over certification of the Turnout on its installation sites on the Rail Baltica track.
- e. Care shall be taken when handling the rails to avoid deformation of the rail, such as hogging, sagging and etc.
- D. Due to large number of the sub-systems of the Turnout, RB Rail implemented a process with the purpose to obtain the Turnout integrated system in the best condition from the Supplier. The process is described and schematically depicted below. It consists of two workflows:
- E. The first workflow is the Product acceptance process of the Turnout which shall be performed during Phase 1 and Phase 2 once per each type of Turnout:
 - a. The Supplier, Contractor and CCS Contractor shall take part in the RAM program plan provided in the Turnout Technical specifications RBGL-SOD-SPC-R-00003 to successfully complete system development process.
 - b. FAT of turnout integrated system shall be done according RBGL-SOD-SPC-R-00003 TS at the Supplier's factory. The supplier shall provide equipment (simulator) for operating and checking the condition of the point machines as in the interlocking system.
 - c. SAT shall be done according the RBGL-SOD-SPC-R-00003 TS at IMF or at the installation site if it is agreed with RBR. The supplier shall provide equipment (simulator) for operating and checking the condition of the point machines as in the interlocking system.
 - d. When all stages, phases, all test of RAM program plan are complete, results are reviewed and found to be positive, and other documentation listed in RBGL-SOD-SPC-R-00003 TS is submitted and complete, RBR will issue a product acceptance certificate.
- F. The Product acceptance process of the REJ systems shall be the same as for the turnouts.
- G. The second workflow is the delivery of the Turnout with already granted Product acceptance certificate.
 - a. The Contactor, CCS Contractor and the Supplier shall create the Installation Plan for each delivery option of the Turnout. Installation Plan shall describe a clear line of responsibility between the Supplier, CCS Contractor and Contractor related to delivery of the Turnout which shall be approved by RBR. Short Turnout types which can fit on the road vehicles shall be supplied pre-assembled.
 - b. Referring to the diagram below, the turnout delivery process shall take place in 4 phases. The diagram below shows both workflows described above.

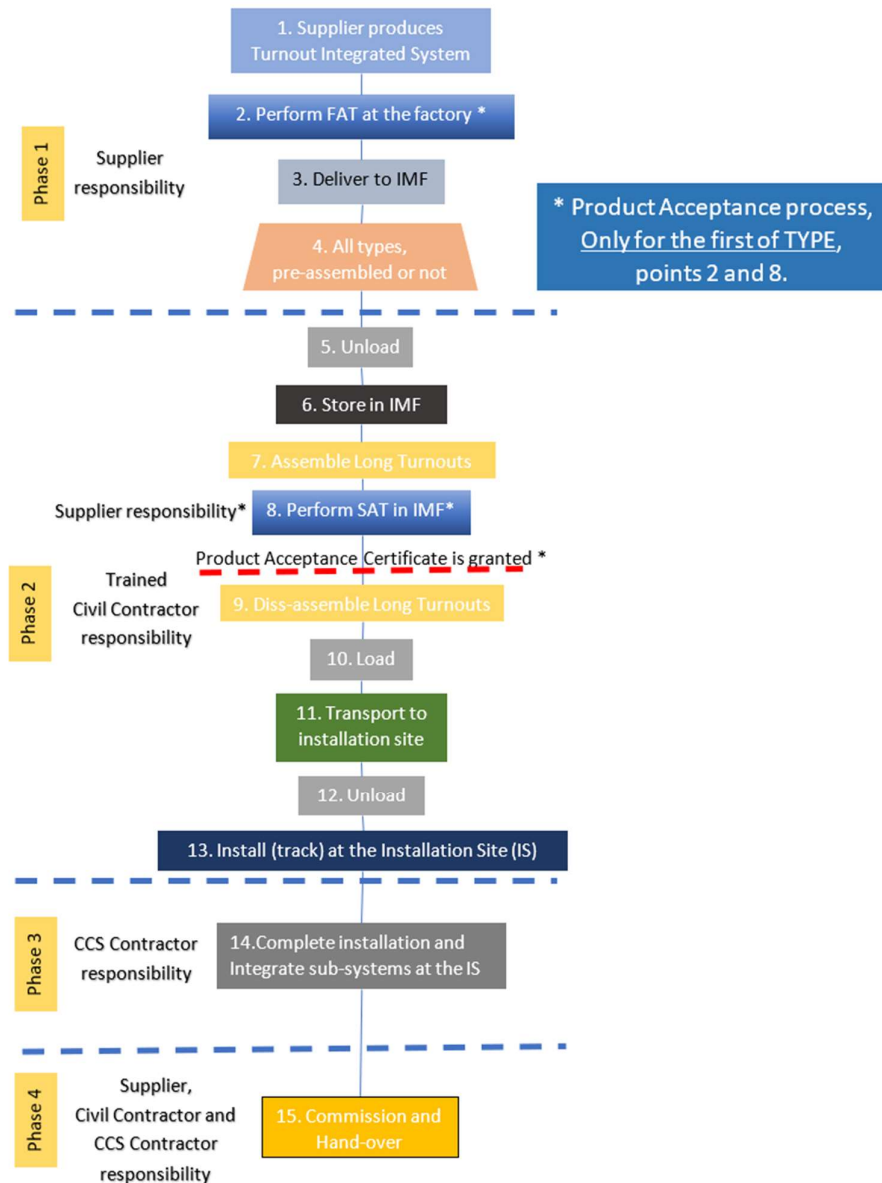


Figure 4. Turnout delivery workflows

- c. During phase 1: The Supplier is responsible for:
 - i. Supply of special unloading / loading tools, beams, or extension bars.
 - ii. Supply of the short Turnout types as pre-assembled to the IMF.
 - iii. Supply of the long Turnout types as diss-assembled to the IMF.
 - iv. Provide support and formal training to Contractors.
- d. During phase 2: The Contractor is responsible for:
 - i. Provision of access roads till material unload place at IMF and installation site on Rail Baltica track. As per Civil design, the access road is provided till each Turnout installation site. Including a temporary rail track to the installation site.
 - ii. Acquiring the necessary tools for transportation.
 - iii. Unloading and storing of pre- or diss-assembled track, actuation, locking, detection, heating, and condition monitoring sub-systems of the Turnout at the IMF.

- iv. Assembling, checking, and dis-assembling long turnouts.
- v. Assisting the Supplier during the SAT.
- vi. Preparation of the final, levelled, and compacted ballast layer on which the turnout shall be supported in the final position at the installation site.
- vii. Loading the track part and transporting to the installation site.
- viii. Unloading at the installation site.
- ix. Provision of the required tools for installation.
- x. Installation at the installation site.
- xi. Supply of ballast, lifts, and stabilization.
- xii. Final levelling to reach accepted tolerances. Shall be kept to minimum by good preparation of the ballast layer.
- xiii. Welding and destressing.
- e. During phase 3: The CCS Contractor is responsible for:
 - i. completion of installation of all sub-systems of the Turnout at the installation site.
 - ii. integration of sub-systems of the Turnout into CCS system on the Rail Baltica track.
- f. During phase 4: Commissioning and hand-over according to the Installation Plan:
 - i. The Supplier is responsible for commissioning and hand-over of the operational and functional parameters of delivered Turnout at the installation site.
 - ii. The Civil Contractor is responsible for commissioning and hand-over of the installation work of track part of the Turnout at the installation site.
 - iii. The CCS Contractor is responsible for commissioning and hand-over of the CCS installation and integration work at the installation site.
 - iv. All three parties shall make the Turnout available for a final test conducted by the tester assigned by RBR. At the end of this phase the hand-over certificate shall be obtained to allow further use of the Turnout for rail traffic.
- H. The Rail expansion joints integrated systems shall be delivered the same way as the short turnouts.
- I. During the assembling procedure the Contractor shall follow the supplier's instruction, and manuals and the main phases are as follows:
 - a. Preparation of ballast bottom layer as per track drawing in both directions, straight track and diverging track.
 - b. Assembly of turnout and laying on the top of prepared ballast layer. Measuring and inspection of assembled turnout according to RBGL-SOD-SPC-R-00003 TS and supplier's instructions.
 - c. Laying of upper ballast layer shall be finalized according EN 13231-1 requirements
 - d. Tamping, and levelling, stabilization of turnout to achieve design position in vertical and horizontal. This activity shall cover whole curve to diverging (side) direction, to achieve smooth transition to side-track. If tamping machinery cannot properly compact ballast under the hollow sleeper, then the Contractor shall tamp in those areas additionally, to achieve the desired result.
 - e. Welding of rail joints shall be performed according to this Technical specification chapter 3.6.
 - f. It is essential to use turnout tamping machines to guarantee a homogeneous and simultaneous lifting of the main track with the diverging track, thus avoiding unacceptable solicitations on the sleepers and diverging rail.
 - g. Note: The turnout tamping machine to be used has as its main characteristic that when tamping the main track, it can lift and tamp the furthest rail from the diverging track with concrete sleepers. This prevents the turnout from swinging transversely when the diverging track is being lifted and tamped in the crossing and intermediate track area.
- J. Particular attention shall be paid to the length of the tamping tools for the insertions and tamping to be carried out to the depth required by the height difference from the rail head with respect to the general track due to possible increased section of the bearers in turnouts.

3.8.4.2 RAIL EXPANSION JOINTS

- A. The Product acceptance process of the REJ systems shall be the same as the turnouts according to RBGL-SOD-SPC-R-00003.
- B. The REJ systems shall be delivered the same way as the short turnouts.
- C. The supplier of the rail expansion joint (REJ) will provide to the Contractor with the Assembly manuals, which includes all the instructions for handling, regulation and assembly, the drawings for the device and the receipt checklist for these devices.
- D. Contractor shall prepare REJ installation plan and Contractor shall ask approval from RBR prior installation works
- E. No more than 15 days shall pass between the placement of the devices and the welding.
- F. For the execution of the welds the rail quality of the expansion joint shall be considered. In cases where rails of different qualities are welded, the material to be used will be that corresponding to the highest quality.

3.8.5 MEASUREMENT AND PAYMENT – TURNOUTS AND EXPANSION JOINTS

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract. Employer will arrange supply to delivery points which will be described in Employer CC Particular conditions.
- B. Turnouts and expansion joints will be measured unit (pc) actually executed and fully finished meeting the specifications established in the Rail Baltica project and as ordered by the Engineer:
- C. The units of measurement shall be as follows:

Table 79. Units of measurement – Turnouts and expansion joints

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_76_71_84	000285	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND TURNOUT 60E-1200-1/18.5 WITH SWING NOSE	pc	Delivery and installation of complete right-hand turnout 60E-1200-1/18.5 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000286	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND TURNOUT 60E-1200-1/18.5 WITH SWING NOSE	pc	Delivery and installation of complete left-hand turnout 60E-1200-1/18.5 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000223	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND TURNOUT 60E-1200-1/18.5	pc	Delivery and installation of complete right-hand turnout 60E-1200-1/18.5 consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000224	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND TURNOUT 60E-1200-1/18.5	pc	Delivery and installation of complete left-hand turnout 60E-1200-1/18.5 consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000277	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND TURNOUT 60E-760-1/14 WITH SWING NOSE	pc	Delivery and installation of complete right-hand turnout 60E-760-1/14 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_76_71_84	000278	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND TURNOUT 60E-760-1/14 WITH SWING NOSE	pc	Delivery and installation of complete left-hand turnout 60E-760-1/14 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000227	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND TURNOUT 60E-760-1/14	pc	Delivery and installation of complete right-hand turnout 60E-760-1/14 consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000228	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND TURNOUT 60E-760-1/14	pc	Delivery and installation of complete left-hand turnout 60E-760-1/14 consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000231	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND TURNOUT 60E-300-1/9	pc	Delivery and installation of complete right-hand turnout 60E-300-1/9 consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000232	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND TURNOUT 60E-300-1/9	pc	Delivery and installation of complete left-hand turnout 60E-300-1/9 consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000235	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND TURNOUT 60E-190-1/9	pc	Delivery and installation of complete right-hand turnout 60E-190-1/9 consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000236	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND TURNOUT 60E-190-1/9	pc	Delivery and installation of complete left-hand turnout 60E-190-1/9 consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000239	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND TURNOUT 60E-760-1/15 WITH SWING NOSE	pc	Delivery and installation of complete right-hand turnout 60E-760-1/15 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000240	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND TURNOUT 60E-760-1/15 WITH SWING NOSE	pc	Delivery and installation of complete left-hand turnout 60E-760-1/15 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000243	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND TURNOUT 60E-7350-1/65 WITH SWING NOSE	pc	Delivery and installation of complete right-hand turnout 60E-7350-1/65 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000244	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND TURNOUT 60E-7350-1/65 WITH SWING NOSE	pc	Delivery and installation of complete left-hand turnout 60E-7350-1/65 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_76_71_84	000247	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND TURNOUT 60E-3550-1/46 WITH SWING NOSE	pc	Delivery and installation of complete right-hand turnout 60E-3550-1/46 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000248	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND TURNOUT 60E-3550-1/46 WITH SWING NOSE	pc	Delivery and installation of complete left-hand turnout 60E-3550-1/46 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000281	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND TURNOUT 60E-2500-1/26.5 WITH SWING NOSE	pc	Delivery and installation of complete right-hand turnout 60E-2500-1/26.5 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000282	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND TURNOUT 60E-2500-1/26.5 WITH SWING NOSE	pc	Delivery and installation of complete left-hand turnout 60E-2500-1/26.5 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000251	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND TURNOUT 60E-2500-1/26.5	pc	Delivery and installation of complete right-hand turnout 60E-2500-1/26.5 consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000252	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND TURNOUT 60E-2500-1/26.5	pc	Delivery and installation of complete left-hand turnout 60E-2500-1/26.5 consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000289	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND CROSSOVER 60E-1200-1/18.5 WITH SWING NOSE	pc	Delivery and installation of complete right-hand crossover 60E-1200-1/18.5 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000290	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND CROSSOVER 60E-1200-1/18.5 WITH SWING NOSE	pc	Delivery and installation of complete left-hand crossover 60E-1200-1/18.5 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000255	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND CROSSOVER 60E-1200-1/18.5	pc	Delivery and installation of complete right-hand crossover 60E-1200-1/18.5 consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000256	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND CROSSOVER 60E-1200-1/18.5	pc	Delivery and installation of complete left-hand crossover 60E-1200-1/18.5 consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_71_84	000259	DELIVERY AND INSTALLATION OF COMPLETE RIGHT-HAND CROSSOVER 60E-760-1/15 WITH SWING NOSE	pc	Delivery and installation of complete right-hand crossover 60E-760-1/15 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_76_71_84	000260	DELIVERY AND INSTALLATION OF COMPLETE LEFT-HAND CROSSOVER 60E-760-1/15 WITH SWING NOSE	pc	Delivery and installation of complete left-hand crossover 60E-760-1/15 with swing nose consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specifications
Pr_20_76_70_28	000204	DELIVERY AND INSTALLATION OF RAIL EXPANSION JOINT WITH MAXIMUM DISPLACEMENT OF 300mm	pc	Delivery and installation of rail expansion joint with maximum displacement of 300mm consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specification and technical specification RBGL-SOD-SPC-R-00003
Pr_20_76_70_28	000205	DELIVERY AND INSTALLATION OF RAIL EXPANSION JOINT WITH MAXIMUM DISPLACEMENT OF 600mm	pc	Delivery and installation of rail expansion joint with maximum displacement of 600mm consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specification and technical specification RBGL-SOD-SPC-R-00003
Pr_20_76_70_28	000206	DELIVERY AND INSTALLATION OF RAIL EXPANSION JOINT WITH MAXIMUM DISPLACEMENT OF 1000mm	pc	Delivery and installation of rail expansion joint with maximum displacement of 1000mm consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specification and technical specification RBGL-SOD-SPC-R-00003
Pr_20_76_70_28	000210	DELIVERY AND INSTALLATION OF RAIL EXPANSION JOINT WITH MAXIMUM DISPLACEMENT OF 1200mm	pc	Delivery and installation of rail expansion joint with maximum displacement of 1200mm consists of all works, materials, equipment and expenses necessary to achieve the specified result, according to Technical specification and technical specification RBGL-SOD-SPC-R-00003

3.9 BUFFER STOPS

3.9.1 DEFINITION AND GENERAL CONDITIONS

- A. Buffer stops are elements at the end of sidetracks. They signal the end of the track equipped with elements that can stop trains impacting at low speeds. Buffer stops prevent railway vehicles from going past the end of a physical section of track and prevent for derailments. The purpose of the buffer stop is to absorb the kinetic energy of the train in case of collision caused by inaccurate braking and avoid or minimize (when the designed absorbing capacity of the buffer stop is exceeded) the damage to passengers, rolling stock and infrastructure.
- B. Buffer stops shall comply the requirements set in "RBDG-MAN-014E - TECHNICAL SPECIFICATION. BUFFER STOPS"

3.9.2 EXECUTION PROCESS CONDITIONS

- A. Buffer stops shall be assembled as indicated by the manufacturer and positioned in the position indicated in Drawings. Buffer Stop manufacturer shall provide detail BIM models with required operational information as input for as built models.

3.9.3 MEASUREMENT AND PAYMENT – BUFFER STOPS

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.

- B. The design, supply, loading, transport and installation of the buffer stop will be measured per unit (pc) provided if they are executed in accordance with project specifications and the indications of the Engineer.
- C. The units of measurement shall be as follows:

Table 80. Units of measurement – Buffer stops

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_40_70_73_73	000201	SUPPLY AND PLACEMENT OF SLIDING FRICTION BUFFER STOP FOR EN 60 E2 RAIL	pc	Supply and placement of Sliding Friction buffer stop for EN 60 E2 rail consists of all works, materials, equipment and expenses necessary to supply, deliver and install a buffer stop according to Technical specifications
Pr_40_70_73_73	000202	SUPPLY AND PLACEMENT OF FIXED BUFFER STOP WITH HYDRAULIC DAMPERS	pc	Supply and placement of fixed buffer stop with hydraulic dampers consists of all works, materials, equipment and expenses necessary to supply, deliver and install a buffer stop according to Technical specifications

3.10 TRACK TAMPING, LEVELLING AND STABILIZATION

3.10.1 DEFINITION AND GENERAL CONDITIONS

- A. Track tamping, levelling and stabilization consists of performing the ballast discharges and lifts necessary obtain the vertical and horizontal geometry of the track complying with the indications of standard EN 13231-1 and stabilizing the track.

3.10.2 EXECUTION PROCESS CONDITIONS

- A. The ballast necessary to carry out the track lifting will reach the works in the manner indicated in the section corresponding to the ballast in these Technical specifications.
- B. The elevation of the track will be carried out in successive phases, taking into account that the maximum lift per rail shall not exceed eighty-four (84) millimetres each lift.
- C. The Contractor shall provide track levelling technology for acceptance to the Engineer prior to the start of the works.
- D. The Contractor shall execute the successive lifts according to the tables approved by the Engineer before the start of the works. These tables will indicate, for each lifting:
- Kant variation in each pass.
 - For the low rail and the high rail, the height at each pass and the cumulative lift.
- E. The reference points in each lift shall also take into account, the data necessary to be able to make the transitions between grade lines, provisional levelling and alignment, starting values for lifting to the finish of the levelling.
- F. To carry out the work with the required quality, the Contractor shall use tamping machines that have the equipment necessary to measure the tamping parameters.
- G. Stabilization shall a ballast compaction effect equivalent to that obtained by the passing through the tracks of about 150,000 gross tons.
- H. This operation will be carried out in two phases:
- Between each lift with a frequency of 30-35 Hz.
 - After raising the track to the required tolerances and at a constant load of 100 BAR and a frequency of 30-35 Hz.
- I. The machinery utilized will consist of a "Dynamic Stabilizer" capable of administering a vertical force of 240kN, translated into 120kN per rail line, requiring that the range of application frequencies have a maximum limit of 45 Hz.

- J. The dynamic stabilizer shall be equipped with a recording system for the following parameters: arrow on 4 and 6 m base, twist on 3 m base, kant, longitudinal levelling on base 2.6 and 6 m.
- K. After each tamping operation, the regulation and sweeping of the ballast surface will be carried out, leaving the appropriate geometry to perform the next lift, taking special care that there is no ballast on the sleeper.
- L. The Contractor is obliged to deliver the records of the tamping machine to the Engineer.
- M. It will be the Contractor's obligation to carry out corrective tamping, levelling and stabilization after 1 million brute tons of operational capacity to restore horizontal and vertical geometry of the track.
- N. The measures and verifications to be carried out and the documentation to be presented for the acceptance of the track by the Employer will be those indicated in the standard EN 13231.
- O. All the requirements established in the standard EN 13231-1 shall be fulfilled in order for the track works to be considered in acceptance state, as well as all the tolerances indicated in said standards. Longitudinal levelling and alignment, cross levelling, absolute railway track location shall be checked according to EN 13231-1 requirements.
- P. For the longitudinal levelling and alignment, the results of the D1, D2 and D3 measurements will be considered. There will be no requirement for the value of D3 measurement.
- Q. Squareness of the sleepers shall be ± 10 mm.
- R. All sleepers shall be fully supported by the underlying layer (i.e. ballast layer).

3.10.3 MEASUREMENT AND PAYMENT - TRACK LEVELLING AND STABILIZATION

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. Track lifts will be measured and paid per metre (m) tamped and paid according to following work items when levelling and stabilization is finalized during construction works:
- C. The units of measurement shall be as follows:

Table 81. Units of measurement – Track levelling and stabilization

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_80_70_70_06	000201	TRACK TAMPING, LEVELLING AND STABILIZATION	m (of track)	Track tamping, levelling and stabilization consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for all operations necessary to position the track within the permitted tolerances, as shown in the drawings. It includes levelling with heavy ballast tamping machine equipped with plan and elevation records and final dynamic stabilization with the specified load and frequency. Work item includes Contractor's obligation to carry out corrective tamping, levelling and stabilization after 1 million brute tons of operational capacity to restore horizontal and vertical geometry of the track

3.11 RAIL PROFILING AND GRINDING

3.11.1 DEFINITION AND GENERAL CONDITIONS

3.11.1.1 DEFINITION

- A. The demands of High-Speed operation require optimal wheel/rail interaction with maximum levels of rolling quality to guarantee passenger comfort and optimize railway operation by reducing maintenance and energy costs.
- B. For this, and once the track assembly and acceptance are completed, a rail grinding treatment is carried out to remove the decarburized steel surface film that is produced in the rail laminating process and that has lower mechanical characteristics than the deeper layers. In addition, it is possible to eliminate the possible defects of its active surfaces inherent in its manufacture together with the superficial defects caused in the track assembly. Additionally, the formation of long-wave wave wear is delayed, and the inclination of the rail is improved together with the continuity of the running surface.

3.11.1.2 GENERAL CONDITIONS

- A. This operation shall be carried out in accordance with EN 13231-2.
- B. The profiling (to achieve Anti Head Check profile) and preventive grinding will be carried out with a grinding train, equipped with the necessary personnel and adequate training for its operation. The grinding train shall be perfectly autonomous and be able to move and perform its function in both directions of travel.
- C. The grinding of the rail will be carried out by a single pass, or successive passes of the grinding train, moving in both directions within the area in which the work is carried out.
- D. The treatment of the two rails will be carried out simultaneously, although the personnel will be trained to perform asymmetric grinding.

3.11.2 EXECUTION PROCESS CONDITIONS

- A. The rail grinder shall be self-propelled, equipped with at least 40 grinding stones, controlled by electric motors.
- B. The grinding units have two functionalities:
 - a. Grinding units mounted in groups of four on a rigid frame and movable along vertical axes that can tilt 10°-15° outward or inward of the rail and can sweep the centre portion of its running surface.
 - b. Reprofiting units mounted equally in groups of four on a frame, tilting from the vertical, 30° to the outside of the rail and 90° to the inside, allowing the grinding wheels to act on the entire active part of the rail. Usually, the inclination of 15° towards the outside and 70° towards the interior is not exceeded, for clearance reasons.
- C. During the first passes, the grinding wheels work freely following the surface of the rail to remove the surface film. In the following passes, the grinding wheels work locked two by two, fixed on their axis at a certain height and without following the surface of the rail to eliminate the protruding parts of the long waves until they are completely flattened. In the last pass, the grinding wheels are no longer locked and finish the grinding of the entire active surface.
- D. For the execution and control of the works, the following actions will be undertaken:

3.11.2.1 RAIL STATE MEASUREMENTS

- A. Measurements of the condition of the rail shall be made before and after the profile treatment and the rail grinder shall be equipped with on-board longitudinal and transverse profile measuring system and on-board head check scanner.
- B. Measurements of the condition of the rail shall be made before and after the profile treatment and preventive grinding with the following characteristics:
- C.

- a. Longitudinal profile. The longitudinal profile of the rail to be treated will be verified continuously by means of the machine-register integrated in the grinding work equipment. The moving average peak-to-peak method shall be used.
- b. Transverse profile. The transversal profile of the rail will be verified continuously by means of the machine-register integrated in the work equipment. The number of minimum measurements to be made, longitudinal and transverse, will be one record per thread to be treated.
- c. Detecting hairline cracks (head checking). The scanner system shall detect the number and depth of the defects located between 0.1mm and 0.3mm deep and angular position between 0° and 30° and provide real-time data to the operator.

3.11.2.2 CONTROL OF THE GRINDING WORKS

- A. The grinding train shall provide the profile treatment and preventive grinding equipment, suitable to complete the specifications of the work detailed below:
- B. LONGITUDINAL PROFILE
 - a. The longitudinal profile of the running surface will be completely rectified, affecting the areas that present deteriorations of admissible dimensions. In the case of profile treatment and preventive grinding, the removal of 0.3mm of the decarburized surface layer in running surface will be guaranteed. In the profile treatment and final grinding of the track, the acceptance criterion for the peak-to-peak limits shall be in accordance with what is indicated in the following table, according to each of the wavelengths.

Table 82. Moving average peak-to-peak amplitude limits

Wavelength range (mm)	10 to 30	30 to 100	100 to 300	300 to 1000
Limit of peak-to-peak amplitude (mm)	± 0.010	± 0.010	± 0.015	± 0.075

- g. Class 1 will be considered in the criterion of acceptance of the longitudinal profile according to EN 13231-2, expressed in admissible percentages as indicated in the following table.

Table 83. Acceptance criteria for longitudinal profile in terms of allowable percentages

Wavelength range (mm)	10 to 30	30 to 100	100 to 300	300 to 1000
Class 1	5%	5%	5%	5%

- h. The longitudinal profile measurements shall be made at a lateral distance of 15mm maximum from the centre of the rail.
- C. TRAVERSE PROFILE
 - i. The rail profile in the rail-wheel contact area will be restored with a deviation range indicated in EN 13231-2 Table 3 Class Q
- D. ROUGHNESS
 - a. Rail surface roughness shall be measured as indicated in section 7 of EN 13231-2.
 - b. Quality index shall be $QI \leq 3$, to obtain a quality class 1 in accordance with section 7 of EN 13231-2.
- E. COLOURING AND FACETS
 - c. In the fully finished works, no continuous bluish traces of coloration should be observed on the profile. The facets that appear on the rail, after grinding, shall comply with the dimensions established in section 8 of EN 13231-2.

3.11.2.3 EXECUTION OF WORKS

- A. The execution of the works will be carried out in accordance with the following requirements:
 - a. SPEED: Profile treatment and grinding work may be carried out from a speed of 3 km/h. The maximum authorized speed of movement of the track work vehicle/s shall be 80 km/h.

- b. MINIMUM EFFICIENCY OF THE RAIL PROFILING AND GRINDING WORKS: In accordance with the tolerances required for track grinding and profile treatment work, its work completion systems will be designed to allow the removal of 0.2 to 0.3mm of rail thickness for preventive or initial grinding, with a maximum of 5 passes.

3.11.3 MEASUREMENT AND PAYMENT – RAIL PROFILING AND GRINDING

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items (including automatic reports) shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract. Contractor shall agree with Engineer/Employer timing of described works based on RB testing and operational plans prior planning of works.
- B. Rail grinding shall be measured by metre of track executed in accordance to the indicated technical specifications.
- C. The units of measurement shall be as follows:

Table 84. Units of measurement – Rail profiling and grinding

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_80_70_70_06	000202	TRACK GRINDING	m (of track)	Track grinding consists of all works and expenses necessary to achieve the specified result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for the longitudinal and transversal rectification of the rails that make up the track. The necessary equipment will be a grinding train. Including the necessary passes until the longitudinal and transversal tolerances of the rail are obtained.

3.12 TRACK REMOVAL

- A. The work shall consist of dismantling and removing the existing track structure consisting of the rail fastening system, bolts, nuts, washers and joint bars of the rail mechanical connexions, removal of rails by cuts or mechanical connection, sleepers and lowering and removal of the ballast layer.
- B. The materials removed shall become or remain the property of the Infrastructure Manager unless it is specified.

3.12.1 DESCRIPTION

- A. The Contractor shall dismantle the track in an efficient and workmanlike manner. Care shall be taken so as not to damage any other track structure not designated for removal.
- B. Materials dismantled under this item that is indicated as remaining the property of the Infrastructure Manager shall be loaded, transported and unloaded in a stockpile of the raised materials in a place indicated.
- C. Materials dismantled under this item that is not indicated as remaining the property of the Infrastructure Manager shall become the property of the Contractor and be disposed of property off the project site.

3.12.2 MEASUREMENT AND PAYMENT – TRACK REMOVAL

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. Track removal shall be measured by a meter of track executed in accordance with the indicated technical specifications.
- C. The units of measurement shall be as follows.

Table 85. Units of measurement – Track removal

Uniclass code	Type number	Work item	Unit	Work item includes
Ac_10_10_20	000201	REMOVAL OF ANY TYPE OF TRACK	m (of track)	Removal of any type of track, including the uncoupling of rails, cutting of rails and unblocking, removal of rails with cuts that allow their later use, sleepers and small material, lowering and removal of ballast, collection, loading, transport and unloading in stockpile of the raised materials in a place indicated., including complementary elements, and auxiliary means.

3.13 REPAIRING AND LEVELLING OF DAMAGED SUB-BALLAST SURFACE

3.13.1 DEFINITION AND GENERAL CONDITIONS

- A. Before the start of the ballast works the contractor shall be responsible for checking the condition of the sub-ballast layer in accordance with these Technical Specifications.
- B. If any non-compliance with the sub-ballast tolerances indicated in Technical specifications chapter “2.9.7.4. Sub-ballast” is found, the contractor shall proceed to the repair of the damaged sub-ballast surface.
- C. The execution of this work unit includes the following operations:
 - a. Scarification of the existing layer;
 - b. Supply of needed material;
 - c. Laying, moistening and compaction of the layer;
 - d. Trimming and shaping to levels and contours.
- D. The material to be used for the reparation of the damaged sub-ballast surface shall comply with all the requirements indicated for the sub-ballast layer in the corresponding section of the present technical specifications.

3.13.2 EXECUTION PROCESS CONDITIONS

- A. The execution of the repair shall comply with the same requirements as for the construction of the sub-ballast layer.
- B. The minimum thickness to be scarified and compacted is of 150mm.
- C. Compaction of the layer shall follow the same requirements as for the compaction of the sub-ballast layer.
- D. The materials used shall be subject to the same quality control as the materials used in the sub-ballast layer.
- E. The tolerances for the finished work shall be the same as the ones indicated for the sub-ballast layer.

3.13.3 MEASUREMENT AND PAYMENT – REPAIRING AND LEVELLING OF DAMAGED SUB-BALLAST SURFACE

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. Repairing of damaged sub-ballast layer measurements shall be made per square metre (m²) of surface to be repaired at the beginning of the works. Prior to the execution of the sub-ballast repair, the Contractor shall present to the Engineer the quantity of the work item to be executed and will only begin the works once this quantity is approved by the Engineer.
- C. The following work items are defined:

Table 86. Units of measurement - Repairing and levelling of damaged sub-ballast surface

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_85_88_07	000204	REPAIRING AND LEVELLING OF DAMAGED SUB-BALLAST SURFACE	m2	Repairing and levelling of damaged sub-ballast surface consists of all works and expenses necessary to achieve the specified result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for the scarification, supply laying and compaction of the material needed to return damaged sub-ballast surface to acceptable state for the execution of the ballast.

3.14 OTHERS

3.14.1 GUARD RAILS

3.14.1.1 GUARD RAIL INSTALLATION

3.14.1.1.1 GUARD RAILS SHALL MEET ALL THE REQUIREMENTS STIPULATED FOR RUNNING RAILS WITH THE FOLLOWING EXCEPTIONS:

- A. Guard rail steel grade shall be of R260 independently of the alignment and traffic of the section.
- B. Guard rail bars shall have a maximum length of 36m.
- C. Guard rail ends (finishing element) that are to be placed at the end of the guard section shall have a 45° angle bevel cut.
- D. The end of guard rail bars that are to be joined to a subsequent guard rail bar, shall be drilled in accordance with EN 13674 to admit bolted fishplate joints.
- E. The responsibility split between the parties presented in the table below:

Table 87. Responsibility matrix - Guard rail installation

No.	Responsibility	Supplier of rails (consolidated procurement)	Supplier of sleepers with fastening system and USP (consolidated procurement)	Contractor (Construction company)	Principal (RB Rail AS)
1	Supply of guard rails	R		C+A	I
2	Supply of sleepers with fastening system and under sleeper pad, and with additional provision for guard rails		R	C+A	I
3	Supply of sleeper set (T1 to T17) for guard rail transition area		R	C+A	I
4	Supply and installation of guard rail finishing element			R	I

No.	Responsibility	Supplier of rails (consolidated procurement)	Supplier of sleepers with fastening system and USP (consolidated procurement)	Contractor (Construction company)	Principal (RB Rail AS)
5	Installation of sleepers and guard rails in guard rail area (including transition). All works and materials related with guard rail installation (machining, bending, drillings for jointing, fishplates, fastening material etc.)			R	I
Markings: R – responsible; C+A – contributes and approves; I - informed					

3.14.1.2 MEASUREMENT AND PAYMENT

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The assembly, supply, loading, transport and installation of the guard rail finishing element will be measured per unit (pc) provided if they are executed in accordance with project specifications and the indications of the Engineer.

The units of measurement shall be as follows: Table 88. Units of measurement - Guard rails

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_76_70_30	000212	DELIVERY AND PLACEMENT OF FLAT BOTTOMED VIGNOLE RAIL PROFILE EN 60 E2 STEEL GRADE R260 AS GUARD RAIL	m	Delivery and placement of flat bottomed vignole rail profile EN 60 E2 steel grade R260 as guard rail consists of transportation of the material from delivery point and all works, equipment and expenses necessary to achieve the specified result, according to Technical specifications

3.14.2 GUARD RAIL FINISHING ELEMENT

3.14.2.1 DEFINITION AND GENERAL CONDITIONS

- A. Guard rails ends shall be equipped with a finishing element with smoothed top. This element shall be connected to the guard rail ends that are joined at the center of the track after their transition from their regular position.
- B. The geometry and position of this finishing element shall be as indicated in the project documents.

3.14.2.2 MEASUREMENT AND PAYMENT

- C. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- D. The assembly, supply, loading, transport and installation of the guard rail finishing element will be measured per unit (pc) provided if they are executed in accordance with project specifications and the indications of the Engineer.
- E. The units of measurement shall be as follows:

Table 89. Units of measurement - Guard rail finishing element

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_76_70_22	000201	SUPPLY AND INSTALLATION OF GUARD RAIL FINISHING ELEMENT SET (L=10 m)	Set of 2	The item consists of all works, materials, equipment and necessary to supply, produce, deliver and install the finishing element at the end of the guard rail transition

3.14.3 MECHANICAL RAIL JOINTS

3.14.3.1 DEFINITION AND GENERAL CONDITIONS

- A. The scope of this specification is to cover the design, supply manufacture, testing and installation of mechanical rail joints between guardrails when these are not welded together forming a continuously welded rail (CWR).

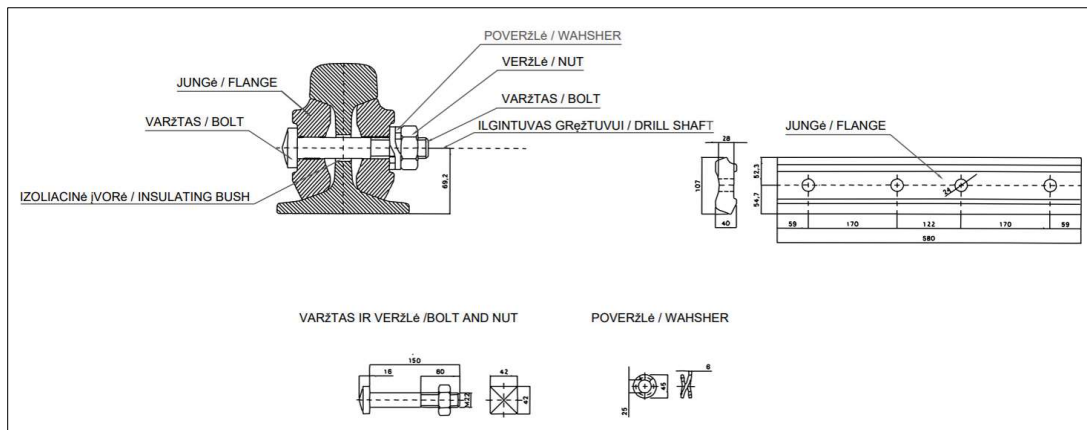


Figure 5. Mechanical connection set materials

- B. This specification does not cover any temporary rail joints that may be needed during the delivery or installation process of the track components.
- C. These joints are conformed of fishplates bolted using fishplate bolts through a series of drills at both ends of the joint rails.
- D. Guard rails shall ensure their continuity by use of mechanical rail joints with fishplates bolted connections.
- E. Mechanical rail joints shall be designed, supplied, manufactured, tested, and installed in accordance with standard DIN EN 16843:2019-12.
- F. The rail temperatures to be considered shall range from +40°C to -35°C unless otherwise indicated by the Contract or the Engineer.
- G. The mechanical connection set materials shall fulfil the following requirements:

- a. The steel fishplates shall be manufactured from a hot-rolled section. The steel for the manufacture shall be S355JR.
- b. Square head bolt M22x150 and steel grade 8.8 according to standards EN ISO6305-4, EN ISO 898-1 and EN 898-2; hot dip galvanized coated to conform to the requirements of ISO10684.
- c. Hexagon nuts with collar M22 with a width across flats of 39 mm, steel grade 8.8 according to standards EN ISO6305-4, EN ISO 898-1 and EN 898-2; hot dip galvanized coated to conform to the requirements of ISO10684.
- d. Wedge lock washers shall:
 - i. It shall be manufactured from carbon steel, through hardened.
 - ii. The minimum tensile strength shall be equal to or higher than 580 MPa.
 - iii. The minimum hardness shall be equal to or higher than 465 HV.
 - iv. The inner dimension shall fit to be fastened with the square head bolts M22; the outer dimension shall not be larger than the dimension of the square head bolt.
 - v. It shall comply with the standard EN 10204, Type 3.1; or Type 3.2.

3.14.3.2 MEASUREMENT AND PAYMENT – MECHANICAL RAIL JOINTS

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The supply, loading, transport and installation of the mechanical rail joints will be measured per unit (pc) provided if they are executed in accordance with project specifications and the indications of the Engineer.
- C. The units of measurement shall be as follows:

Table 90. Units of measurement - Mechanical rail joints

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_29_31_08	000201	SUPPLY AND INSTALLATION OF MECHANICAL RAIL JOINT	pc	Supply and installation of mechanical rail joint consists of all works, materials, equipment and expenses necessary to supply, deliver and install the mechanical rail joint according to Technical specifications

3.15 NORMATIVE REFERENCES

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.
 - a. EN 13146-1 Railway applications – track – test methods for fastening systems – part 1: determination of longitudinal rail restraint
 - b. EN 13146-2 Railway applications – track – test methods for fastening systems – part 2: determination of torsional resistance
 - c. EN 13146-3 Railway applications – track – test methods for fastening systems – part 3: determination of attenuation of impact loads
 - d. EN 13146-4 Railway applications – track – test methods for fastening systems – part 4: effect of repeated loading
 - e. EN 13146-5 Railway applications – track – test methods for fastening systems – part 5: determination of electrical resistance
 - f. EN 13146-6 Railway applications – track – test methods for fastening systems – part 6: effect of severe environmental conditions

- g. EN 13146-7 Railway applications – track – test methods for fastening systems – part 7: determination of clamping force
- h. EN 13146-8 Railway applications – track – test methods for fastening systems – part 8: service testing
- i. EN 13146-9 Railway applications – track – test methods for fastening systems – part 9: determination of stiffness
- j. EN 13230-1 Railway applications – track – concrete sleepers and bearers – part 1: general requirements
- k. EN 13230-2 Railway applications – track – concrete sleepers and bearers – part 2: prestressed monobloc sleepers
- l. EN 13230-6 Railway applications – track – concrete sleepers and bearers – part 6: design
- m. EN 13230-4 Railway applications – track – concrete sleepers and bearers – part 4: prestressed bearers for switches and crossings
- n. EN 13230-5 Railway applications – track – concrete sleepers and bearers – part 5: special elements
- o. EN 13231-1 Railway applications - track - acceptance of works - part 1: works on ballasted tracks - Plain line, switches and crossings
- p. EN 13231-2 Railway applications - track - acceptance of works - part 2: Acceptance of reprofiling rails in plain line, switches, crossings and expansion devices
- q. EN 13232-1 Railway applications - track switching and crossings - part 1 definitions
- r. EN 13232-2 Railway applications- track switching and crossings - part 2 requirements for geometric design
- s. EN 13232-3 Railway applications- track switching and crossings - part 3 requirements for wheel/rail interaction
- t. EN 13232-4 Railway applications - track switching and crossings - part 4 actuation, locking and detection
- u. EN 13232-5 Railway applications - track switching and crossings - part 5 switches
- v. EN 13232-6 Railway applications - track switching and crossings - part 6 fixed common and obtuse crossings
- w. EN 13232-7 Railway applications - track switching and crossings - part 7 crossing with moveable parts
- x. EN 13232-8 Railway applications - track switching and crossings - part 8 expansion devices
- y. EN 13232-9 Railway applications - track switching and crossings - part 9 layouts
- z. EN 13450 Aggregates for railway ballast
- aa. EN 13481-1 Railway applications - track- performance requirements for fastening systems - part 1: definitions
- bb. EN 13481-2 Railway applications - track - performance requirements for fastening systems - part 2: fastening systems for concrete sleepers
- cc. EN 13481-5 Railway applications - track - performance requirements for fastening systems - part 5: fastening systems for slab track
- dd. EN 13481-6 Railway applications - track - performance requirements for fastening systems - part 6: special fastening systems for attenuation of vibration
- ee. EN 13481-7 Railway applications - track- performance requirements for fastening systems - part 7: special fastening systems for switches and crossing and check rails
- ff. EN 13674-1 Railway applications - track - rail - part 1: Vignole railway rails 46 kg/m and above
- gg. EN 13674-2 Railway applications - track - rail - part 2: switch and crossing rails used in conjunction with Vignole railway rails 46 kg/m and above
- hh. EN 13674-3 Railway applications - track - rail - part 3: check rails
- ii. EN 13803-1 Railway applications - track - track alignment design parameters - track gauges 1435 mm and wider - part 1: plain line
- jj. EN 13803-2 Railway applications - track - track alignment design parameters - track gauges 1435 mm and wider - part 2: switches and crossings and comparable alignment design situations with abrupt changes of curvature
- kk. EN 13848-1 Railway applications – track - track geometry quality - part 1: characterisation of track geometry

- ll. EN 13848-2 Railway applications - track - track geometry quality - part 2: measuring systems - track recording vehicles
 - mm. EN 13848-3 Railway applications - track - track geometry quality - part 3: measuring systems - track construction and maintenance machines
 - nn. EN 13848-5 Railway applications - track - track geometry quality - part 5: geometric quality levels - plain line
 - oo. EN 14587-1 Railway applications - track - flash butt welding of rails - part 1: new r220, r260, r260mn and r350ht grade rails in a fixed plant
 - pp. EN 14587-2 Railway applications - track - flash butt welding of rails - part 2: new r220, r260, r260mn and r350ht grade rails by mobile welding machines at sites other than a fixed plant
 - qq. EN 14587-3 Railway applications - track- flash butt welding of rails - part 3: welding in association with crossing construction
 - rr. EN 16273 Railway applications - track - forged rail transitions
 - ss. EN 14730-1 Railway applications - track - aluminothermic welding of rails - part 1: approval of welding processes
 - tt. EN 14730-2 Railway applications - track - aluminothermic welding of rails - part 2: qualification of aluminothermic welders, approval of contractors and acceptance of welds
 - uu. EN 14969 Railway applications - track - qualification system for railway trackwork contractors
 - vv. EN 15689 Railway applications - track - switches and crossings - crossing components made of cast austenitic manganese steel
 - ww. EN 13848-4 Railway applications - track- track geometry quality - part 4: measuring systems - manual and lightweight devices
 - xx. EN 16028 Railway applications - wheel/rail friction management - lubricants for trainborne and trackside applications
 - yy. UIC 713 Design of monobloc concrete sleepers
 - zz. UIC 717-2 Laying of track on a reinforced concrete deck
 - aaa. UIC-719 Earthworks and track-bed layers for railways lines
 - bbb. UIC 720 Laying and maintenance of tracks made up of continuous welded rails
 - ccc. UIC 721 Recommendations for the use of hard quality and extra hard quality rails
 - ddd. UIC 774 Track-Bridge interaction
 - eee. UIC 779-9 Safety in railway tunnels
 - fff. UIC 864-1 Technical specification for the supply of sleeper screws
 - ggg. UIC 864-2 Technical specification for the supply of steel track bolts
 - hhh. UIC 864-3 Technical specification for the supply of spring steel washers for use in the permanent way
 - iii. UIC 864-4 Technical specification for the supply of fishplates or sections for fishplates made of rolled steel
 - jjj. UIC 864-5 Technical specification for the supply of rail seat pads
 - kkk. UIC 864-6 Technical specification for the supply of baseplates made of rolled steel
 - lll. UIC 864-7 Rolled profiles for base-plates for UIC rails
 - mmm. UIC 864-8 Rolled profiles for fishplates for 54kg/m and 60kg/m rails
 - nnn. UIC 864-9 Rolled profile for fishplates for UIC 71 rails
 - ooo. UIC 866 Technical specification for the supply of cast manganese steel crossings for switch and crossing work.
- B. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

4. SECTION 04.- DRAINAGE

4.1 SCOPE OF WORKS

- A. This section covers the following items and works:
 - a. Ditches;
 - b. Pipelines;
 - c. Manholes;
 - d. Protection measures;
 - e. Geotextiles;
 - f. Bridge drainage system;
 - g. Oil separators and water tanks as specified hereinafter, and as shown in Technical Design Drawings.
- B. This section provides a needed but non-exhaustive list of labour, materials, equipment, transport and services necessary to furnish, deliver and install all work of this section as shown on the drawing, as specified herein and/or as required by job conditions.
- C. As-built BIM models shall be created by the Contractor and/or updated by developing PIM (Project Information Model) models from the Technical Design accompanied with laser scanning/photogrammetry data according to "RBDG-MAN-040- Digital information requirements for construction and handover stages".

4.2 GENERAL

- A. Drainage construction shall be done in accordance with this Technical Specification and the Technical Design.
- B. Components shall have the following DWL:

Table 91. Drainage components – Design Work Life

Element	Design life (years)
Reinforced concrete structures	100
Piping (RC, PVC, PP, HDPE, GRP)	50
Stone pitching / riprap	100
Treatment and control devices (oil and flow)	50
Geotextile	100
Scuppers	50
Anchors	50
Valves	50
Pumps	50
Drainage water treatment system	50

4.3 DITCHES

- A. The purpose of ditches is to protect and/or drain:
 - a. Run-off from the track bed into the drainage structure,
 - b. Run-off water from slopes and watersheds,
 - c. Water seepage from the foundation structures,

- d. Internal water, as appropriate with a view to achieving its downwash (water table, capillary upwelling).
- e. Execution tolerances:

Table 92. Allowable geometrical deviations - Ditches

Element	Property	Allowable deviation, single measurement	Allowable deviation, average (%)	Method	Frequency
Ditch	Slope	-	According to national requirements but no more than +/- 10% of defined slope	Geodetic	20m
	Elevation	According to national requirements but no more than +/- 5 cm		Geodetic	50m
	Alignment	According to national requirements but no more than +/-20 cm		Geodetic	20m
	Side slope	+/- 10% of defined slope		Geodetic	20m
	Bottom width	According to national requirements but no more than (+15) ÷ (-0)%		Geodetic	20m

4.3.1 LINED DITCHES

4.3.1.1 GENERAL DESCRIPTION

- A. Lined ditches shall be implemented, according to the following conditions:
 - a. Recommended longitudinal slope for open drainage is 0.004 m/m. Minimum longitudinal slope for open drainage is 0.002 m/m, and exceptional – 0.001 m/m.
 - b. Intercepting cutting ditches
 - c. Minimum width = 0.5 m
 - d. Minimum height: = 0.50 meters
 - i. Type 1: 0.50 meters
 - ii. Type 2: 0.30 meters
 - e. Internal slopes
 - i. Type 1: 1.5H/1V
 - ii. Type 2: 1H/2V
- B. The ditch lining shall be defined with the following materials.
 - a. Grassing,
 - b. Turf reinforcement mats,
 - c. Erosion control blankets
 - d. Mass of concrete C20/25 or higher, velocity up to 4 m/s
 - e. Concrete riprap, velocity >4 m/s
 - f. Other suitable solution proposed by designer.
- C. Dry expansion joint for concrete lined ditch shall be defined every 6 meters and 1 cm expansion joint shall be implement every 30 meters. The equidistance of expansion joint shall be reduced at ditches in wet areas every 18 meters (cuttings and shallow groundwater). The filling material of joint shall be thermostable, extended long life (50 years), and durable to climatic changes.
- D. To limit risk of uprising of the concrete in case of presence of water:
 - a. A layer of sand, or other no water sensitive materials, could be set under concrete, according to drawings,
 - b. The number of expansion joint could be increased or weep holes to be installed, according to the Technical Design Drawings,

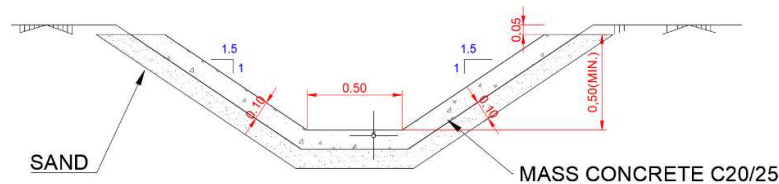


Figure 6. Typical section of concrete lined ditch

- E. The implementation of ditch typology shall be accorded to the Technical Design Drawings.
- F. This item includes lining concrete, formworks, floated (smooth) finishing and joints.
- G. NOTE: Technical Design Drawings may refer to other dimensions, typologies and types of lining, if specific requirements apply (e.g. due to environmental requirements, etc.), The Contractor is obliged to follow the dimensions, typologies and types of lining given on these drawings.

4.3.1.2 MATERIAL REQUIREMENTS FOR CONCRETE LINED DITCHES

- A. Concrete and concreting works:
 - a. Included in sub-section 5.2.3 of these Technical Specifications.

4.3.1.3 EXECUTION OF WORKS

- A. Ditches shall be constructed at a uniform grade, with no low sections to prevent the track or other equipment from being submerged and water to be accumulated in puddles.

4.3.1.4 COMPLIANCE CONTROL / COMPLIANCE TESTING FOR CONCRETE LINED DITCHES

- A. The encounter with the natural terrain shall be without irregularities or discontinuities, with the most rounded shapes possible.
 - a. Concrete thickness ≥ 10 cm
 - b. Mass concrete C20/25 (MPa) or higher
 - c. Execution tolerances:
 - i. Surface flatness according to EN 13670:2010 table G.10.7
 - ii. Horizontal and vertical positioning ± 10 mm/m
 - iii. Dimensions according to EN 13670:2010 table G.10.6.
- B. The slopes shall be those indicated in the project drawings or, failing that, shall be aligned with the Engineer. Any difference from the established values shall be corrected by the Contractor at its expense.
- C. The mass concrete shall cover the geometry coating of drawings, it shall be resistant to aggressive waters, (if necessary) and type C20/25 (20/25 MPa). Resistance to frost shall be according to Table 118. Water impermeability of concrete shall be $\geq W6$.
- D. The coating will take joints every six (6.0) meters; Its execution will comply with the conditions imposed on the concrete unit "5.2. CONCRETE WORKS" of this Technical Specifications.
- E. Ditches shall comply the projected alignment and equidistance conditions to adjacent infrastructure.
- F. The connections of the gutters with the manholes or wells will be made at the levels indicated in the Technical Design drawings.

4.3.1.5 MEASUREMENT AND PAYMENT – CONCRETE FOR LONGITUDINAL LINED DITCHES

- A. Units of measurement include staking, assembly and disassembly of the formwork, supply and concrete placement, execution of joints, machinery, material and auxiliaries means necessary for the correct and total execution of the work unit. Connections with manholes, pits or other drainage elements are also included.
- B. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- C. The units of measurement shall be as follows:

Table 93. Units of measurement - Concrete for longitudinal lined ditches

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_25_93_60_14	000601	MASS CONCRETE C20/25 TO FORM DITCHES	m3	Mass concrete C20/25 to form ditches consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of all materials to the construction of new ditches lining with concrete, including formworks, floated finishing and joints.
Pr_25_93_60_14	000602	REINFORCED CONCRETE C25/30 TO FORM RITCHIE DITCHES	m3	Reinforced concrete C25/30 to form Ritchie ditches consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of all materials to the construction of new ritchie ditches lining with concrete, including formworks, floated finishing and joints.
Pr_25_93_60_14	000603	REINFORCED CONCRETE C30/37 TO FORM RITCHIE DITCHES	m3	Reinforced concrete C30/37 to form ditches consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of all materials to the construction of new ditches lining with concrete, including formworks, floated finishing and joints.

4.3.2 EARTH DITCHES

4.3.2.1 GENERAL DESCRIPTION

- A. Earth ditches shall be implemented, according to the following conditions:
- Recommended longitudinal slope for open drainage is 0.004 m/m. Minimum longitudinal slope for open drainage is 0.002 m/m, and exceptional – 0.001 m/m
 - Minimum width ≥ 0.5 m
 - Minimum height ≥ 0.5 m
 - Internal slopes, 1.5H/1V



Figure 7. Typical earth ditch

- B. Excavation of longitudinal ditches shall be in accordance with relevant requirements in Section 02 – EARTHWORKS.

4.3.2.2 MATERIAL REQUIREMENTS

- A. Not applicable.

4.3.2.3 EXECUTION OF WORKS

- A. Ditches shall be constructed at a uniform grade, with no low sections to prevent the track or other equipment from being submerged and water to be accumulated in puddles.

4.3.2.4 COMPLIANCE CONTROL / COMPLIANCE TESTING

- A. The encounter with the natural terrain shall take place without jumps or discontinuities, with the most rounded shapes possible.
- B. Execution tolerances shall meet requirements and:
 - a. Geometrical sizing: $\leq \pm 20\%$
 - b. Gutter elevation: $\leq \pm 5$ cm
 - c. Grass sprouted and rooted in all area.
- C. The slopes shall be those indicated in the project drawings or, failing that, those shall be aligned with the Engineer. Any difference from the established values shall be corrected by the Contractor at its expense.
- D. Ditches shall comply the projected alignment and equidistance conditions to adjacent infrastructure.
- E. The connections of the gutters with the manholes or wells will be made at the levels indicated in the Drawings.

4.3.2.5 MEASUREMENT AND PAYMENT - EARTH DITCHES

- A. Units of measurement include staking, machinery, material and auxiliaries means necessary for the correct and total execution of the work unit. Connections with manholes, pits or other drainage elements are also included.
- B. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- C. The units of measurement shall be as follows:

Table 94. Units of measurement - Excavation for longitudinal earth ditches

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_15_31_26_26	000602	DITCH EXCAVATION WITH MECHANICAL MEANS IN ALL TYPES OF GROUND	m3	Ditch excavation consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the excavation, by mechanical systems, of new ditches, of any geometry and slopes. Including shores.

4.3.3 "U" SHAPE DITCHES

4.3.3.1 GENERAL DESCRIPTION

- A. "U" shape ditches are used in areas with limited space, as platforms and narrow corridors between infrastructures:
 - a. Recommended longitudinal slope for open drainage is 0.004 m/m. Minimum longitudinal slope for open drainage is 0.002 m/m, and exceptional – 0.001 m/m
 - b. Minimum width - 0.5 m
 - c. Minimum height - 0.50 m
 - d. Vertical or subvertical walls:
 - i. Freeboard ≥ 10 cm/edge of the ditch
 - ii. Bedding ≥ 10 cm of lean concrete C15
- B. U ditch shall be wrapped in draining aggregates and geotextile shall be >250 g/m². The walls shall have to be pierced with weep holes. They shall incorporate cross braces and possibly additional prefabricated units where significant depths shall be achieved. The drainage level shall be the lowest level of the weep hole.
- C. The installation shall achieve the recommendations of manufacturer, drawings and technical specifications.
- D. To limit risk of uprising of the concrete in case of presence of water:
 - a. A layer of sand, or other no water sensitive materials, could be set under concrete, according to drawings,

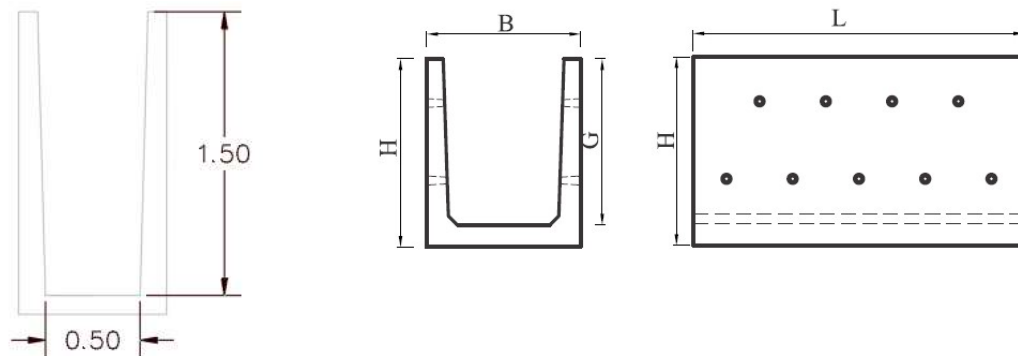


Figure 8. Typical section of "U" shape ditch.

- E. This item includes lining concrete, formworks, floated finishing and joints.

4.3.3.2 MATERIAL REQUIREMENTS

- A. Concrete and concreting works:
 - a. Included in sub-section 5.2.3 of these Technical Specifications.

4.3.3.3 COMPLIANCE CONTROL / COMPLIANCE TESTING

- A. The encounter with the natural terrain will take place without jumps or discontinuities, with the most rounded shapes possible.
- B. Reinforced concrete \geq C25/30 (MPa)
- C. Execution tolerances:
 - a. Flatness \pm 4mm/m
 - b. Horizontal and vertical positioning \pm 10 mm/m
 - c. Dimensions \pm 5mm
- D. The slopes shall be those indicated in the project drawings or, failing that, those shall be aligned with the Engineer. Any difference from the established values shall be corrected by the Contractor at its expense.
- E. Ditches shall comply the projected alignment and equidistance conditions to adjacent infrastructure.
- F. The connections of the gutters with the manholes or wells shall be made at the levels indicated in the drawings.

4.3.3.4 MEASUREMENT AND PAYMENT – “U” SHAPE LONGITUDINAL DITCHES

- A. Prices include staking, assembly and disassembly of the formwork, supply and concrete placement, execution of joints, machinery, material and auxiliaries means necessary for the correct and total execution of the work unit. Connections with manholes, pits or other drainage elements are also included.
- B. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- C. The units of measurement shall be as follows:

Table 95. Units of measurement – “U” shape longitudinal ditches

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_24_26	000601	PRECAST CONCRETE "U" DITCH UP TO 0,5m INCLUDING EXTENDERS AND SLOTTED COVER	m	Precast concrete "U" ditch up to 0,5m high consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete U ditch up to 0,5 m , including extenders and slotted cover, levelling concrete, geogrid layer, geotextile layer and filter material, supply and transport of the prefabricated element to the site, assembly, grouted of joints and perfect levelling.
Pr_65_52_24_26	000602	PRECAST CONCRETE "U" DITCH UP TO 1,0 m INCLUDING EXTENDERS AND SLOTTED COVER	m	Precast concrete "U" ditch up to 1,0 m high consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete U ditch up to 1,0 m , including extenders and slotted cover, levelling concrete, geogrid layer, geotextile layer and filter material, supply and transport of the prefabricated element to the site, assembly, grouted of joints and perfect levelling.
Pr_65_52_24_26	000603	PRECAST CONCRETE "U" DITCH UP TO 1,5 m INCLUDING EXTENDERS AND SLOTTED COVER	m	Precast concrete "U" ditch up to 1,5 m high consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete U ditch up to 1,5 m , including extenders and slotted cover, levelling concrete, geogrid layer, geotextile layer and filter material, supply and transport of the prefabricated element to the site, assembly, grouted of joints and perfect levelling.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_24_26	000604	PRECAST CONCRETE "U" DITCH UP TO 2,0 m INCLUDING EXTENDERS AND SLOTTED COVER	m	Precast concrete "U" ditch up to 2,0 m high consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete U ditch up to 2,0 m , including extenders and slotted cover, levelling concrete, geogrid layer, geotextile layer and filter material, supply and transport of the prefabricated element to the site, assembly, grouted of joints and perfect levelling.
Pr_65_52_24_26	000605	PRECAST CONCRETE "U" DITCH 2,0 m FOR PLATFORM INCLUDING EXTENDERS AND COVER	m	Precast concrete "U" ditch up to 2m for platform consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of prefabricated U ditch, including extenders and cover, levelling concrete, geogrid layer, geotextile layer and filter material, supply and transport of the prefabricated element to the site, assembly, grouted of joints and perfect levelling.
Pr_65_52_24_26	000606	PRECAST CONCRETE DITCH 0,50 m FOR PLATFORM INCLUDING EXTENDERS AND COVER	m	Precast concrete ditch 0,50 m width consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of prefabricated ditch, including extenders and cover, leveling concrete, geogrid layer, geotextil layer and filter material, supply and transport of the prefabricated element to the site, assembly, grouted of joints and perfect levelling.
Pr_65_52_24_26	000607	DUCTS ENCLOSURE WITH REINFORCED CONCRETE SLABS 750x700 mm	m	Ducts enclosure with reinforced concrete slabs 750x700 mm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of prefabricated reinforced concrete slabs 750x700 mm for ducts enclosure.
Pr_65_52_24_26	000608	PRECAST CONCRETE "U" DITCH UP TO 0,5m INCLUDING EXTENDERS	m	Precast concrete "U" ditch no covered up to 0,5m for platform consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of prefabricated U ditch, including extenders, levelling concrete, geogrid layer, geotextile layer and filter material, supply and transport of the prefabricated element to the site, assembly, grouted of joints and perfect levelling.
Pr_65_52_24_26	000609	PRECAST CONCRETE "U" DITCH UP TO 1,0 m INCLUDING EXTENDERS	m	Precast concrete "U" ditch no covered up to 1m for platform consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of prefabricated U ditch, including extenders, levelling concrete, geogrid layer, geotextile layer and filter material, supply and transport of the prefabricated element to the site, assembly, grouted of joints and perfect levelling.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_24_26	000610	PRECAST CONCRETE "U" DITCH UP TO 1,5 m INCLUDING EXTENDERS	m	Precast concrete "U" ditch no covered up to 1,5m for platform consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of prefabricated U ditch, including extenders, levelling concrete, geogrid layer, geotextile layer and filter material, supply and transport of the prefabricated element to the site, assembly, grouted of joints and perfect levelling.
Pr_65_52_24_26	000611	PRECAST CONCRETE "U" DITCH UP TO 2,0 m INCLUDING EXTENDERS	m	Precast concrete "U" ditch no covered up to 2m for platform consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of prefabricated U ditch, including extenders, levelling concrete, geogrid layer, geotextile layer and filter material, supply and transport of the prefabricated element to the site, assembly, grouted of joints and perfect levelling.
Pr_65_52_24_26	000612	PRECAST CONCRETE DITCH 0,50 M WIDTH	m	Precast concrete ditch 0,50 m width consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of prefabricated ditch, including levelling concrete, supply and transport of the prefabricated element to the site, assembly, grouted of joints and perfect levelling.

4.3.4 RECTANGULAR DITCHES

- A. Rectangular ditches were projected with variable geometry depending of required hydraulic capacity, alignment, interface with other infrastructures, available land plot and limited corridor conditions.
- B. The dimension shall follow the geometry of drawings.
 - a. Longitudinal slope of ditches $\geq 0.1\%$
 - b. Minimum width = 0.5 m
 - c. Minimum height = 0.5 m
 - d. Vertical or subvertical walls
 - e. Minimum thickness = 0.2 m
 - f. Freeboard = 10 cm/edge of the ditch
 - g. Minimum bedding = 10 cm of lean concrete C15 or sand.
- C. Rectangular ditch shall be wrapped in geotextile. The walls shall have to be pierced with weep holes. The drainage level shall be the lowest level of the weep hole.
- D. Dry expansion joint shall be defined every 6 meters and 1 cm expansion joint shall be implemented every 30 meters. The filling material of joint shall be thermostable, extended long life (50 years), and durable to climatic changes.
- E. To limit risk of uprising of the concrete in case of presence of water:
 - a. A layer of sand, or other no water sensitive materials, could be set under concrete, according to drawings,
- F. The number of expansion joint could be increased, according to drawings and structural requirements.
- G. The reinforced concrete ditches shall be formed by Concrete C30/37.
- H. Concrete surfaces shall meet A4 category.
- I. Ducts are perforated to collect water from surrounded ground.

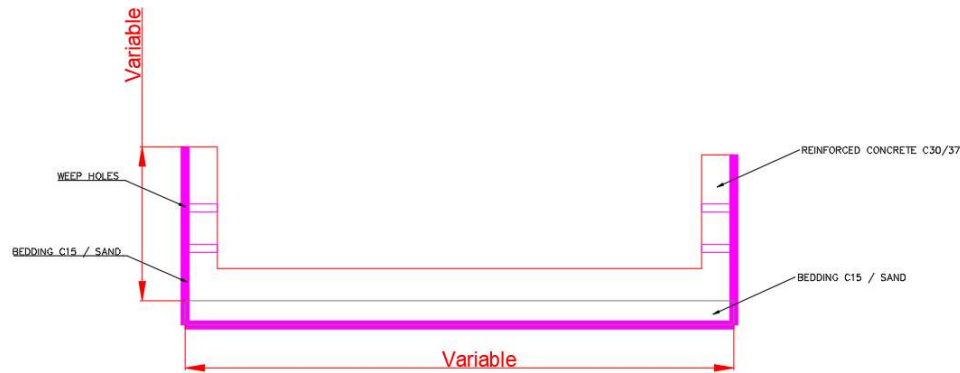


Figure 9. Concept design of rectangular ditch

4.3.4.1 MATERIAL REQUIREMENTS

- A. Concrete and concreting works:
 - a. Included in sub-section 5.2.3 of these Technical Specifications.
 - b. The surfaces of the duct blocks that are in contact with the ground surface are coated twice with hot bitumen. Also filtering geotextile is applied at the outer side of duct. The bottom is concreted in the required places with hydrotechnical class C16 / 20 concrete by forming a slope.
 - c. Ducts are installed on 15 cm layer of sand.
 - d. Lubricated waterproofing consists of two layers of hot or cold bituminous mastic, which is applied on the bituminous primer. The joints between the blocks are plugged on the outside with impregnated bitumen tows.

4.3.4.2 COMPLIANCE CONTROL / COMPLIANCE TESTING

- A. The encounter with the natural terrain shall take place without jumps or discontinuities, with the most rounded shapes possible.
- B. Reinforced concrete \geq C30/37 (MPa)
- C. Execution tolerances:
 - a. Flatness ± 4 mm/m
 - b. Horizontal and vertical positioning ± 10 mm/m
 - c. Dimensions ± 5 mm
- D. The slopes shall be those indicated in the project drawings or, failing that, those shall be aligned with the Engineer. Any difference from the established values shall be corrected by the Contractor at its expense.
- E. Ditches shall comply the projected alignment and equidistance conditions to adjacent infrastructure.
- F. The connections of the gutters with the manholes or wells shall be made at the levels indicated in the Drawings.

4.4 PIPELINES

- A. The pipelines were defined, as buried hydraulic infrastructure to transport, collect, discharge, connect and conform transition elements for drainage system.
- B. Gravity drainage and stormwater systems used in pipes and fittings shall meet:
 - a. PVC pipes – EN 1401, ISO 4435, EN 13476 standards requirements.
 - b. PP pipes – EN 1852, EN 13476 standards. Pipe connections shall be flexible with sealing rings.

- c. PE pipes - EN 12666, EN 13476, EN 13244 standards.
 - d. GRP pipes – EN ISO 23856 CEN/TS 14578 standards.
 - e. RC pipes - EN 1916.
 - f. PVC/PP perforated pipes - DIN 4262-1 or equivalent.
- C. The pipelines were defined according to the functionality and materials:
- a. PVC = step discharges, connections and drains (SN8).
 - b. PVC = infiltration drains at walls of structures (SN4, R1, TP / SN8, R2, TP).
 - c. PP = drains (SN8/16).
 - d. PP = infiltration drains (SN8, R2, LP 220° / SN16, R2, LP 220°).
 - e. PE: sleeves pressurized (PE100 PN10 and 16).
 - f. PE and GRP = downspouts, bridge drainage and step discharges.
 - g. Reinforced concrete pipes = step discharges, transitions and connections.
- D. According to RBDG-MAN-016-0105, *Railway Substructure, Part 2, Hydraulic, Drainage and Culvert Guidelines*, pipelines shall comply the following requirements, but not limited to:
- a. The minimum class of resistance for reinforced concrete pipes is 135 (in line with European standards);
 - b. The minimum longitudinal slope for longitudinal pipes is 0.002m/m;
 - c. Maximum permissible velocity 5m/s.
- E. The geotextile of pipelines shall be > 250 g/m², wrapping the typical section of drawings.
- F. The gravel of drains shall have maximum size of 63 mm and fines content (<0,063 mm particles) shall be ≤ 5%. The coefficient of uniformity Cu shall be lower than 20. The fines shall be non-cohesive.
- G. The quality control certificates of pipelines shall be submitted and approved for validation of the material.
- H. The leakage test shall be performed according to EN 1610 section 13.
- I. This part of the TS includes pipelines including materials and products, the supply, transportation and storage, performance, tolerances.

J. Tolerances:

Table 96. Allowable geometrical deviations – Pipelines

Element	Property	Allowable deviation, single measurement between manholes	Method	Frequency
Pipelines	Invert elevation	According to national requirements but no more than +/- 2 cm	Geodetic	100%
	Line and level	according to design as stated in EN 1610:2016 section 8.6.2, but not greater than allowed by manufacturer (according to CEN/TR 1046:2021 section 7.2.6.4 But no more than 20 cm	Geodetic/ CCTV	100%
Thrust boring process ^(a)	Alignment	Vertical $\pm 200\text{mm} < \varnothing 1.500\text{ m}$ and $\pm 400\text{mm} \varnothing \geq 1.500\text{ mm}$ Horizontal $\pm 300\text{mm} < \varnothing 1.500\text{ m}$ and $\pm 500\text{mm} \varnothing \geq 1.500\text{ mm}$	Boring protocol.	100%
Note: a) Other, less strict, tolerances for trenchless construction (incl. casing pipes) are acceptable in the case if the utility location has enough clearance reserve, ensuring a principle - do not violate: <ul style="list-style-type: none"> requirements of legal acts and regulations regarding distances to buildings, structures, engineering networks, utilities, facilities and other objects and their protection zones or land plots; the interests of third parties by the conditions stipulated in contracts or written consents if such exist, etc. 				

4.4.1 POLYVINYL CHLORIDE PIPELINES

4.4.1.1 GENERAL

- A. PVC was projected for wet utilities, infiltration drains and transitions pipes. The infiltration drains shall be defined by perforated pipes and transition pipes.
- B. The infiltration drains shall be backfilled with granular material, cover by geotextile. The discharge point was projected, most of cases, in longitudinal ditches of railway. The bed of drains shall be 10.
- C. Drainage PVC pipes and fittings must be resistant to surface and groundwater, acids, alkalis, petroleum products, and class correspond the stiffness class indicated in the Technical Design Drawings.
- D. Self-contained PVC drainage pipes used for the installation of the drainage system are installed from a pressure-free SN4 R1 type profiled external and internal surface or SN8 R2 type profiled external and smooth internal surface, TP perforation, stiffness class indicated in the Technical Design Drawings.
- E. The PVC pipelines shall not be used for exposed pipes.

4.4.1.2 COMPLIANCE CONTROL / COMPLIANCE TESTING

- A. The pipes will be installed in a trench whose width will be fifty (50) cm greater than the nominal diameter of the pipe, at the level of the upper generatrix.
- B. The connection of the tubes with wells, manholes and pipe nozzles shall be carried out by applying mortar on the protection socket and inserting pipe in the socket, the end of which is flush with the inside of the manhole, well or mouthpiece.
- C. Pipes shall be visually inspected and cleaned of dirt, snow, ice, grease and other contaminants before laying into trench. The inside of installing pipes shall be clean and dry. At the end of workday or when installation work is not carried out, the ends of the pipes shall be properly sealed.
- D. The pipes are connected to each other by means of a double-sided coupling.
- E. The drain trench shall be filled after inspecting the pipe and removing any damage found so that they do not change their position. The soil in which the drainage trenches are filled shall not contain particles with size larger than 16mm.

- F. Drainpipes shall be wound in a filtering geotextile filter.
- G. Drainpipes shall be laid on a 10 cm concrete layer or according to design solution. Drainage trenches shall be filled with filtering materials. Trenches shall be compacted. The perforated part of the pipes shall face upwards.
- H. The deviation of pipes between adjacent manholes in the horizontal direction may be up to ¼ pipe diameter, but not more than 50 mm in each direction. Slope deviation in the vertical direction is not permitted.
- I. Casing pipes shall be ended before the manhole and sealed with rubber sealants. Protected pipe shall be centred inside the casing pipe with centring rings.
- J. Under roads pipes shall be installed with trenchless method.

4.4.1.3 MEASUREMENT AND PAYMENT – PVC PIPELINES

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 97. Units of measurement - PVC pipelines

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_07_91	000301	PVC DRAIN PIPE, SLOTTED, DIAMETER 160 mm.	m	PVC drain pipe slotted 160 mm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing PVC pipe slotted including transport, assembly, tests, necessary protections and as much equipment and labor as necessary for their final placement, as well as the material and the setting up of the seat material.
Pr_65_52_63_87	000601	PVC PIPE OF DIAMETER 100 mm SLOTTED	m	PVC pipe of diameter 100 mm slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a sand bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 25 cm above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_87	000602	PVC PIPE OF DIAMETER 150 mm SLOTTED	m	PVC pipe of diameter 150 mm slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a sand bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 25 cm above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_63_87	000618	PVC PIPE OF DIAMETER 200 mm SLOTTED	m	PVC pipe of diameter 200 mm slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a sand bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 25 cm above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_87	000603	PVC PIPE OF DIAMETER 250 mm SLOTTED	m	PVC pipe of diameter 250 mm slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a sand bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 25 cm above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_87	000604	PVC PIPE OF DIAMETER 300 mm SLOTTED, SAND BED	m	PVC pipe of diameter 300 mm slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a sand bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 25 cm above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_87	000617	PVC PIPE OF DIAMETER 300 mm SLOTTED, CONCRETE BED, FILTER GRAVEL UP TO 25 cm	m	PVC pipe of diameter 300 mm slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a concrete bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 25 cm above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_87	000623	PVC PIPE OF DIAMETER 300 mm SLOTTED, CONCRETE BED, FILTER GRAVEL UP TO 1,8 m	m	PVC pipe of diameter 300 mm slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a concrete bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 1,8 m above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_63_87	000611	PVC PIPE OF DIAMETER 400 mm SLOTTED	m	PVC pipe of diameter 400 mm slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a sand bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 25 cm above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_87	000614	PVC PIPE OF DIAMETER 500 mm SLOTTED	m	PVC pipe of diameter 500 mm slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a sand bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 25 cm above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_87	000615	PVC PIPE OF DIAMETER 600 mm SLOTTED	m	PVC pipe of diameter 600 mm slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a sand bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 25 cm above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_87	000622	PVC PIPE OF DIAMETER 160 mm	m	PVC pipe of diameter 160 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe placed on non-structural concrete bed, including transport, assembly, testing, concrete bed, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_87	000616	PVC PIPE OF DIAMETER 200 mm	m	PVC pipe of diameter 200 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a sand bed of 10 cm thickness, filled with sand up to 25 cm above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_63_87	000610	PVC PIPE OF DIAMETER 250 mm	m	PVC pipe of diameter 250 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a sand bed of 10 cm thickness, filled with sand up to 25 cm above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_87	000612	PVC PIPE OF DIAMETER 400 mm	m	PVC pipe of diameter 400 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a sand bed of 10 cm thickness, filled with sand up to 25 cm above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_87	000619	PVC PIPE OF DIAMETER 315 mm	m	PVC pipe of diameter 315 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a sand bed of 10 cm thickness, filled with sand up to 25 cm above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_87	000620	PVC PIPE OF DIAMETER 500 mm	m	PVC pipe of diameter 500 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipe on a sand bed of 10 cm thickness, filled with sand up to 25 cm above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_87	000621	FRAME/COVER UPVC d=110mm	pc	Frame/cover UPVC d=110mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC piece, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

- C. The measurement shall be made on the length of the tube actually placed, according to the instructions of the Employer.
- D. The pipes that are the object of measurement for the purposes of their measurement, after compliance tests, shall be fully installed, with their fasteners, coatings and other elements that integrate them and have been successfully subjected to pressure.
- E. The Employer shall demand from the Contractor the guarantee certificate that satisfactorily carried out the tests and that the materials used in the manufacturing met the corresponding specifications. This certificate may be replaced by an officially recognized quality certificate.

- F. The special pieces are included in the work items, and shall be placed by the Contractor, without being measurable in any other way than the one established herein and therefore payable more than for their length along their axis. The unit price includes the different connections to be made with manholes, connections or existing works.
- G. Work items include the manufacture of the tubes and auxiliary elements, their transportation, assembly, tests, necessary protections and as many equipment and labour as is necessary for their final placement, including the seat material.

4.4.2 POLYPROPYLENE PIPELINES

4.4.2.1 GENERAL DESCRIPTION

- H. Drainage polypropylene pipes and fittings must be resistant to surface and groundwater, acids, alkalis, petroleum products, and class correspond the stiffness class indicated in the Technical Design Drawings.
- I. Self-contained polypropylene drainage pipes used for the installation of the drainage system are installed from a pressure-free R2 type profiled external and smooth internal surface, LP 220° perforation, stiffness class indicated in the Technical Design Drawings.
- J. The resistance class of PP pipes must be suitable for use under railway loads.

4.4.2.2 EXECUTION OF WORKS

- A. Pipes shall be visually inspected and cleaned of dirt, snow, ice, grease and other contaminants before laying into trench. The inside of installing pipes shall be clean and dry. At the end of workday or when installation work is not carried out, the ends of the pipes shall be properly sealed.
- B. The pipes shall be connected to each other by means of a double-sided coupling. Couplings can be supplied separately or shall be already fitted at the end of the pipe at the factory. The nozzle shall be mounted in the same way as the coupling.
- C. The drainage trench shall be filled after inspecting the drains and removing any damage found so that they do not change their position. The soil in which the drainage trenches are filled shall be not contain particles with size larger than 16mm.
- D. Drainage pipes shall be wound in a filtering geotextile filter.
- E. Drainage pipes are laid on a 10 cm concrete layer. Drainage trenches shall be filled with filtering materials. Trenches shall be compacted. The perforated part of the pipes shall face upwards.

4.4.2.3 COMPLIANCE CONTROL / COMPLIANCE TESTING

- A. The deviation of pipes between adjacent manholes in the horizontal direction may be up to ¼ pipe diameter, but not more than 50 mm in each direction. Slope deviation in the vertical direction is not permitted.

4.4.2.4 MEASUREMENT AND PAYMENT - POLYPROPYLENE PIPELINES

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 98. Units of measurement - PP pipelines

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_07_66	000601	POLYPROPYLENE (PP) PIPE OF DIAMETER 315 mm SN8 SLOTTED	m	Polypropylene (PP) SN8 drain pipe slotted 315 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a sand bed of 5 cm thickness, coated with geotextile and fill with filter gravel above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_07_66	000602	POLYPROPYLENE (PP) PIPE OF DIAMETER 315 mm SN16 SLOTTED	m	Polypropylene (PP) SN16 drain pipe slotted 315 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a sand bed of 5 cm thickness, coated with geotextile and fill with filter gravel above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_07_66	000603	POLYPROPYLENE (PP) PIPE OF DIAMETER 110 mm SN 8 SLOTTED	m	Polypropylene (PP) SN8 drain pipe slotted 110 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a sand bed of 5 cm thickness, coated with geotextile and fill with filter gravel above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_07_66	000604	POLYPROPYLENE (PP) PIPE OF DIAMETER 200 mm SLOTTED, CONCRETE BED	m	Polypropylene (PP) pipe of diameter 200 mm slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a concrete bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 30 cm above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_07_66	000605	POLYPROPYLENE (PP) PIPE OF DIAMETER 400 mm SLOTTED, CONCRETE BED	m	Polypropylene (PP) pipe of diameter 400 mm slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a concrete bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 30 cm above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_07_66	000606	POLYPROPYLENE (PP) PIPE OF DIAMETER 315 mm SN8 SLOTTED, CONCRETE BED, FILTER GRAVEL UP TO 1,8 m	m	Polypropylene (PP) pipe of diameter 315 mm SN8 slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a concrete bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 1,8 m above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_07_66	000607	POLYPROPYLENE (PP) PIPE OF DIAMETER 500 mm SLOTTED, CONCRETE BED	m	Polypropylene (PP) pipe of diameter 500 mm slotted for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a concrete bed of 10 cm thickness, coated with geotextile and fill with filter gravel up to 30 cm above the pipe and dual closure flap of the filtration packet done with the geotextile and auxiliary for the evacuation of water, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_07_64	000601	POLYPROPYLENE (PP) PIPE OF DIAMETER 400 mm	m	Polypropylene (PP) pipe 400 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a sand bed of 10 cm thickness, fill with filter gravel above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_07_64	000602	POLYPROPYLENE (PP) PIPE OF DIAMETER 600 mm	m	Polypropylene (PP) pipe 600 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a sand bed of 10 cm thickness, fill with filter gravel above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_07_64	000606	POLYPROPYLENE (PP) PIPE OF DIAMETER 630 mm	m	Polypropylene (PP) pipe 630 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a sand bed of 10 cm thickness, fill with filter gravel above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_07_64	000603	POLYPROPYLENE (PP) PIPE OF DIAMETER 800 mm	m	Polypropylene (PP) pipe 800 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a sand bed of 10 cm thickness, fill with filter gravel above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_07_64	000604	POLYPROPYLENE (PP) PIPE OF DIAMETER 315 mm	m	Polypropylene (PP) pipe 315 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a sand bed of 10 cm thickness, fill with filter gravel above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_07_64	000605	POLYPROPYLENE (PP) PIPE OF DIAMETER 500 mm	m	Polypropylene (PP) pipe 500 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a sand bed of 10 cm thickness, fill with filter gravel above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

- C. The measurement shall be made on the length of the tube actually placed, according to the instructions of the Employer.
- D. The pipes that are the object of measurement for the purposes of their payment, after compliance tests, shall be fully installed, with their fasteners, coatings and other elements that integrate them and have been successfully subjected to pressure. The Employer will demand from the Contractor the guarantee certificate that satisfactorily carried out the tests and that the materials used in the manufacturing met the corresponding specifications. This certificate may be replaced by an officially recognized quality certificate.
- E. The special pieces are included in the unit prices, and shall be placed by the Contractor, without being measurable in any other way than the one established herein and therefore payable more than for their length along their axis. The unit rate includes the different connections to be made with manholes, connections or existing works.
- F. Work items therefore include the manufacture of the tubes and auxiliary elements, their transportation, assembly, tests, necessary protections and as many equipment and labour as is necessary for their final placement, including the seat material.

4.4.3 GRP PIPELINES

4.4.3.1 GENERAL DESCRIPTION

- A. This part of the TS includes GRP pipelines including materials and products, compliance control and measurement.
- B. Gravity drainage and stormwater systems used in pipes and fittings shall meet:
 - a. GRP pipes - EN ISO 23856, CEN/TS 14578 standards.
- C. Fiberglass pipe and fittings shall be reinforced thermosetting resin pipe (RTRP) systems meeting the requirements of EN ISO 23856 standards.
 - a. They shall qualify for a 207MPa minimum short time rupture strength hoops tensile stress.

- b. Pipe shall be reinforced thermosetting resin fiberglass pipe meeting the requirements of – EN ISO 23856 4 standards
- c. Pipe Fittings (e.g. elbows, tees, couplings, etc.) shall be reinforced thermosetting resin fiberglass pipe meeting the requirements of EN ISO 23856.
- d. Adhesive: The adhesive used for joining the fiberglass pipes and pipe fittings shall meet the requirements of EN ISO 23856.
- e. Pipe Brackets and Supports: Pipe brackets and supports shall conform to the requirements of EN 12095 and ASTM A-575, Grade 1015 and 1020.

4.4.3.2 MATERIAL REQUIREMENTS

- A. The manufacturer GRP will use high elongation (5-6%) isophthalic polyester in liner and isophthalic polyester (3-5% elongation) in structure of the pipe as iso resin is suitable to resist chemical attack by Sulphuric acid which is the main constituent of any sewer water.
- B. The reinforcing glass fibres used in the manufacture of the components shall be of highest quality commercial grade E glass filaments suitably treated with binder and sizing compatible with impregnating resins.
- C. Silica sand or other suitable materials (size range between 0.05 mm to 0.5 mm) may be used as fillers/aggregates in the laminates.
- D. Elastomeric Sealing rings shall be supplied by recognized, acceptable quality manufacturers. The large diameter (DN600 and above) pipe shall be field connected with GRP sleeve coupling that utilizes EPDM elastomeric Sealing rings to maintain joint water tightness. Below DN 600 pipe may be jointed with double "O" ring bell and spigot joint.
- E. The Employer will request the Contractor the provision of the Manufacturer's Certificates on the characteristics of the supplied pipes as well as carry out the corresponding verification tests.

4.4.3.3 TRANSPORTATION AND STORAGE ON SITE

- A. While transporting, moving, loading & unloading pipes and fittings at jobsite, maximum care should be exercised to avoid any structural damage.
- B. Loading and unloading operations are critical issues, therefore, techniques which will be used during these operations should be determined based on-site conditions. While loading or unloading and placing pipes on the ground, prevent any impact with rigid objects to avoid structural damage.
- C. Pipes can be lifted either with one or two lifting straps, however, for an easier balancing control while lifting, two lifting straps usage is recommended.
- D. The storage area should be flat, levelled and clear of objects such as rocks, stones, sharp edges, etc. Pipes can be stored in piles to minimize the storage area within the allowed limits. Maximum piling height is around 2,5 meters. It is not recommended to store pipes as piles for diameters bigger than DN 1200 mm.
- E. Transportation vehicle should never be loaded over capacity while transporting pipes. To prevent any structural damage due to the movement and vibration during transportation, pipes should be detached from each other. To keep the stability and to prevent movement, pipes should be tightly packaged and supported with wooden wedges.

4.4.3.4 COMPLIANCE CONTROL AND TESTING

- A. The pipes will be installed in a trench whose width will be fifty (50) cm greater than the nominal diameter of the pipe, at the level of the upper generatrix.
- B. Pipes shall be visually inspected and cleaned of dirt, snow, ice, grease and other contaminants before laying into trench. The inside of installing pipes must be clean and dry. At the end of workday or when installation work is not carried out, the ends of the pipes must be properly sealed.
- C. The deviation of pipes between adjacent manholes in the horizontal direction may be up to ¼ pipe diameter, but not more than 50 mm in each direction. Slope deviation in the vertical direction is not permitted.

- D. The pipes are connected to each other by means of a double-sided coupling. Couplings can be supplied separately or are already fitted at the end of the pipe at the factory. The nozzle is mounted in the same way as the coupling.
- E. The connection of the tubes with wells, manholes and pipe nozzles shall be carried out by applying mortar on the pipe, the end of which is flush with the inside of the manhole, well or mouthpiece.

4.4.3.5 MEASUREMENT AND PAYMENT – GRP PIPELINES

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 99. Units of measurement - GRP pipelines

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_63_34	000301	GRP PIPE 150 mm FOR DECK DRAINAGE	m	GRP pipe 150 mm for deck drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of GRP pipes fixed to piles or walls for the evacuation of water in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_63_34	000302	GRP PIPE 250 mm FOR DECK DRAINAGE	m	GRP pipe 250 mm for deck drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of GRP pipes fixed to piles or walls for the evacuation of water in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_63_34	000303	GRP PIPE 300 mm FOR DECK DRAINAGE	m	GRP pipe 300 mm for deck drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of GRP pipes fixed to piles or walls for the evacuation of water in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_63_34	000304	GRP PIPE 90 mm FOR DECK DRAINAGE	m	GRP pipe 90 mm for joint drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of GRP pipes fixed to piles or walls for the evacuation of water in bridge decks joints, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_63_34	000305	GRP PIPE 200 mm FOR DECK DRAINAGE	m	GRP pipe 200 mm for deck drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of GRP pipes fixed to piles or walls for the evacuation of water in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_63_34	000306	GRP PIPE 50 mm FOR DECK DRAINAGE	m	GRP pipe 50 mm for deck drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of GRP pipes fixed to piles or walls for the evacuation of water in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_63_34	000307	RODDING EYES GRP "Y" SHAPE 300-110mm AND 250-110mm	m	GRP "Y" SHAPE 300-110mm and 250-110 mm for deck drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of GRP pipes fixed to piles or walls for the evacuation of water in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_34	000601	GLASS FIBER REINFORCED (GRP) PIPE OF DIAMETER 800 mm	m	Glass fiber reinforced (GRP) pipe of diameter 800 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of GRP pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_63_34	000602	GLASS FIBER REINFORCED (GRP) PIPE OF DIAMETER 1000 mm	m	Glass fiber reinforced (GRP) pipes of diameter 1000 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of GRP pipe, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

- C. GRP pipes can be substituted with HDPE pipes. Changes shall be also indicated in the required as-built documentation and BIM information.
- D. The measurement shall be made on the length of the tube actually placed, according to the instructions of the Employer.
- E. The pipes that are the object of measurement for the purposes of their payment, after compliance tests, shall be fully installed, with their fasteners, coatings and other elements that integrate them and have been successfully subjected to pressure.
- F. The Employer will demand from the Contractor the guarantee certificate that satisfactorily carried out the tests and that the materials used in the manufacturing met the corresponding specifications. This certificate may be replaced by an officially recognized quality certificate.
- G. The special pieces are included in the unit prices, and shall be placed by the Contractor, without being measurable in any other way than the one established herein and therefore payable more than for their length

along their axis. The unit price includes the different connections to be made with manholes, connections or existing works.

- H. Work items therefore include the manufacture of the tubes and auxiliary elements, their transportation, assembly, tests, necessary protections and as many equipment and labour as is necessary for their final placement, including the seat material.

4.4.4 PRECAST CONCRETE PIPELINES

4.4.4.1 GENERAL DESCRIPTION.

- A. Precast reinforced vibro-pressed and porous concrete pipes shall be used in the drainage works transverse to the trace, such as collectors under ditches and conduction to natural channels or as drains in order to collect seepage on the platform.
- B. The minimum class of resistance for pipes shall be as indicated in project documentation (Calculation Note, drawings) and comply with EN 1916.
- C. The pipelines shall be laid over a mass concrete bedding C20/25 with projection to 120°, according to typical section of drawings.

4.4.4.2 MATERIAL REQUIREMENTS

- A. The precast reinforced, vibrated and porous concrete pipes will be manufactured by spinning or another process that guarantees a high compactness, with a controlled curing process.
- B. The Contractor shall install pipes with respective materials according to the information set in the Design. The Contractor will be obliged to structurally justify the pipes based on the Predictable actions in each section of pipe. At the same time, the Contractor shall guarantee to the Engineer that the tube supplier manufacturer has the certificate or seal of quality of your product, in accordance with the provisions of the EN 1916 - "Concrete pipes and fittings, unreinforced, steel fibre and reinforced. Finally, the Contractor shall install pipes according the specifications developed on Design Solutions.
- C. The inner surface will be smooth and waterproof enough and the tubes will be strong, durable, free of defects, cracks or deformations.
- D. The tests that shall have to be carried out are:
 - a. Visual examination of the general appearance of pipes and joint parts and checking of dimensions and thickness.
- E. Notwithstanding the existence of the aforementioned quality certificate, the Employer reserves the right to carry out in the factory, through its representatives, as many manufacturing verifications and material tests as it deems necessary for the control of the various manufacturing stages, according to the requirements of this specification.
- F. The Employer shall demand from the Contractor the guarantee certificate that satisfactorily carried out the tests and that the materials used in the manufacturing met the corresponding specifications. This certificate may be replaced by an officially recognized quality certificate.
- G. The Employer shall require the Contractor the guarantee certificate that satisfactorily carried out the tests and that the materials used in the manufacturing met the corresponding specifications. This certificate may be replaced by an officially recognized quality seal.
- H. The reception tests, in the event that the Employer considers it, may be replaced by a certificate in which the results are expressed satisfactory tests for sealing, crushing and longitudinal flexing of the lot to which the tubes belong or the systematic self-control tests of manufacturing that guarantees the above properties.
- I. Regarding the type of joints proposed, the Engineer may order tests of sealing of joint types. In this case, the test will be done analogously to that of the tubes, arranging two pieces of tube, one after the other, joined by their gasket, closing the free ends with appropriate devices and following the same procedure that for the tubes, it will be verified that there is no loss.

- J. The tolerance for the inside diameter of the tube is set to one percent (1%) of its nominal diameter, not exceeding fifteen millimetres (15mm). Also, the average of the minimum diameters in the five sections resulting from dividing the length of the tube in four equal parts, shall not be less than its nominal diameter.
- K. The tolerance for tube thickness is set to five percent (5%) of its nominal thickness. This same tolerance is established for the core of the tubes prestressed.
- L. The ovalization in the joint area shall be such that the difference between its diameters maximum and minimum interiors do not exceed zero with five percent (0.5%) of the tube nominal diameter.
- M. Regarding the tolerance for the diameters of the sheet metal jacket or the reinforcements, it is established that the difference between their maximum internal diameters and minimum does not exceed one percent (1%) of the nominal diameters corresponding.
- N. The tolerance for tube length is set to one percent (1%) of its nominal length.
- O. All the elements of the pipe will be indelibly engraved with the distinctive and following marks:
 - a. Factory badge.
 - b. Nominal diameter, in mm.
 - c. Ring pressure, in kPa.
 - d. Identification number, which allows knowing the history of its manufacture.
 - e. Completion date of tube manufacturing.

4.4.4.3 EXECUTION OF WORKS

- A. Before proceeding with the installation of the tubes the following conditions shall be verified:
 - a. The bottom material of the trench shall not be regular (not deviate from the design elevation by more than plus or minus two percent (+/- 2%) of the pipe size being installed, or one inch (1"), whichever is greater). If modified, the originally planned bearing capacity shall be preserved.
 - b. In the case of having an inconsistent soil layer at the bottom of the trench, that it shall be removed and replaced with a suitable material, depending of bearing test.
 - c. When low temperatures require it, it will be necessary to protect the trench bottom so that the frozen layers are not left under or on the sides of the pipes.
- B. The installation of pipelines shall be sequential, avoiding open trenches for extended time.
- C. The material from the excavation shall be stacked far enough away from the edge of the trenches to avoid crumbling of the ditches or landslides that could endanger workers.
- D. In the event that the excavations affect pavements, the materials that can be used in their restoration shall be separated from the general material of the excavation.
- E. In the case of trench or ditches for pipes installations, the extracted material is frequently used for subsequent filling, so it is convenient to collect it along the trench at a suitable distance from one of its edges.
- F. The pipes shall be installed in a trench, following typical section of drawings.
- G. The connection of the tubes with wells, or manholes, shall be carried out by applying mortar on the pipe, its end being flush with the inside face of the manhole or well.
- H. The tubes shall be laid on a non-structural concrete bed of two hundred kilopond per square centimetre (200 kp / cm²) of resistance characteristic.
- I. When pipe laying is interrupted, the free ends shall be covered to prevent the entry of water or foreign bodies, proceeding to examine with all take care of the inside of the pipe when resuming work.
- J. The pipes and trenches shall be kept free of water, draining with pumps or leaving drains in the excavation if necessary.
- K. No more than one hundred metres (100 m) of collector shall be placed without filling, least partial of the ditch. At least six (6) tubes will be placed in front of each put together before completely finished.
- L. The two supports of the same tube shall always be built with the same materials.

- M. The headwalls at the inlets and outlets of the tubes will be executed in accordance with the habitual practice of this type of works, respecting the conditions of the plans, and the present Specification regarding installation, dimensions, formwork, concrete, laying on site and concrete curing, stripping, etc.

4.4.4.4 SAFETY MEASURE

- A. Safety at work shall be priority, follow security measurements shall be take in account, but not limited to:
- The personnel who will be working inside the trenches will know the risks to which they may be subject.
 - The access and exit of a trench will be carried out by means of a solid ladder, anchored at the top edge of the trench and it will be supported on a solid load-sharing surface. The ladder will exceed the edge of the trench by 1.0 m.
 - Stockpiling (land, materials, etc.) at a distance of less than 2m, as a general rule, from the trench edge is prohibited.
 - When the depth of a trench is equal to or greater than 2m, the crown edges will be protected by means of a regulatory railing (handrail, intermediate strip and baseboard) located at a minimum distance of 2m from the edge.
 - If the works require lighting, it will be carried out by means of insulated turrets with grounding, in which weatherproof projectors will be installed, fed through a general electrical panel on site.
 - The state of cuts or slopes shall be reviewed at regular intervals in those cases in which they can receive exogenous thrusts due to the proximity of roads, streets, highways, etc. This will be done especially if in the vicinity are established pits with the use of pneumatic hammers, compaction by vibration or the passage of machinery for earthmoving. Shoring shall be used for the stabilization of trench, following safety conditions for trenches.
 - The shoring will be reviewed after the interruption of the works before resuming them again.
 - Trenches and ditches should be surrounded by baseboards to prevent materials from falling onto personnel working at the bottom of the excavation.
 - Step ladders shall be used to access or exit the bottom of a trench. It should not be done by climbing the shoring props.
 - To walk over a trench, suitable walkways shall be installed. It should never be passed over the shoring props.

4.4.4.5 MEASUREMENT AND PAYMENT – PRECAST CONCRETE PIPELINES

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 100. Units of measurement - Precast concrete pipelines

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_63_16	000601	PRECAST CONCRETE PIPE OF DIAMETER 1500 mm	m	Precast concrete pipe of diameter 1500 mm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete pipes with rubber joints, including checking of the support on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_63_16	000602	PRECAST CONCRETE PIPE OF DIAMETER 400 mm ON NON-STRUCTURAL CONCRETE BED	m	Precast concrete pipe of diameter 400 mm on non-structural concrete bed consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete pipes with rubber joints placed on non-structural concrete bed, including checking of the support on site, supply and transport of the prefabricated element to the site, concrete bed, assembly and perfect levelling.
Pr_65_52_63_16	000603	PRECAST CONCRETE PIPE OF DIAMETER 500 mm ON NON-STRUCTURAL CONCRETE BED	m	Precast concrete pipe of diameter 500 mm on non-structural concrete bed consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete pipes with rubber joints placed on non-structural concrete bed, including checking of the support on site, supply and transport of the prefabricated element to the site, concrete bed, assembly and perfect levelling.
Pr_65_52_63_16	000604	PRECAST CONCRETE PIPE OF DIAMETER 1600 mm	m	Precast concrete pipe of diameter 1600 mm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete pipes with rubber joints, including checking of the support on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling.
Pr_65_52_63_16	000605	PRECAST CONCRETE PIPE OF DIAMETER 300 mm ON NON-STRUCTURAL CONCRETE BED	m	Precast concrete pipe of diameter 300 mm on non-structural concrete bed consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete pipes with rubber joints placed on non-structural concrete bed, including checking of the support on site, supply and transport of the prefabricated element to the site, concrete bed, assembly and perfect levelling.
Pr_65_52_63_16	000606	PRECAST CONCRETE PIPE OF DIAMETER 350 mm ON NON-STRUCTURAL CONCRETE BED	m	Precast concrete pipe of diameter 350 mm on non-structural concrete bed consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete pipes with rubber joints placed on non-structural concrete bed, including checking of the support on site, supply and transport of the prefabricated element to the site, concrete bed, assembly and perfect levelling.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_63_16	000607	PRECAST CONCRETE PIPE OF DIAMETER 600 mm ON NON-STRUCTURAL CONCRETE BED	m	Precast concrete pipe of diameter 600 mm on non-structural concrete bed consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete pipes with rubber joints placed on non-structural concrete bed, including checking of the support on site, supply and transport of the prefabricated element to the site, concrete bed, assembly and perfect levelling.
Pr_65_52_63_16	000608	PRECAST CONCRETE PIPE OF DIAMETER 700 mm ON NON-STRUCTURAL CONCRETE BED	m	Precast concrete pipe of diameter 700 mm on non-structural concrete bed consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete pipes with rubber joints placed on non-structural concrete bed, including checking of the support on site, supply and transport of the prefabricated element to the site, concrete bed, assembly and perfect levelling.
Pr_65_52_63_16	000609	PRECAST CONCRETE PIPE OF DIAMETER 800 mm ON NON-STRUCTURAL CONCRETE BED	m	Precast concrete pipe of diameter 800 mm on non-structural concrete bed consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete pipes with rubber joints placed on non-structural concrete bed, including checking of the support on site, supply and transport of the prefabricated element to the site, concrete bed, assembly and perfect levelling.
Pr_65_52_63_16	000610	PRECAST CONCRETE PIPE OF DIAMETER 900 mm ON NON-STRUCTURAL CONCRETE BED	m	Precast concrete pipe of diameter 900 mm on non-structural concrete bed consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete pipes with rubber joints placed on non-structural concrete bed, including checking of the support on site, supply and transport of the prefabricated element to the site, concrete bed, assembly and perfect levelling.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_63_16	000611	PRECAST CONCRETE PIPE OF DIAMETER 1000 mm ON NON-STRUCTURAL CONCRETE BED	m	Precast concrete pipe of diameter 1000 mm on non-structural concrete bed consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete pipes with rubber joints placed on non-structural concrete bed, including checking of the support on site, supply and transport of the prefabricated element to the site, concrete bed, assembly and perfect levelling.
Pr_65_52_63_16	000612	PRECAST CONCRETE PIPE OF DIAMETER 1200 mm ON NON-STRUCTURAL CONCRETE BED	m	Precast concrete pipe of diameter 1200 mm on non-structural concrete bed consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete pipes with rubber joints placed on non-structural concrete bed, including checking of the support on site, supply and transport of the prefabricated element to the site, concrete bed, assembly and perfect levelling.
Pr_65_52_63_16	000613	PRECAST CONCRETE PIPE OF DIAMETER 1200 mm	m	Precast concrete pipe of diameter 1200 mm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete pipes with rubber joints, including checking of the support on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling.

C. In the units of the precast concrete pipes previously mentioned, the following shall be taken into account:

- The pipes that are the object of measurement for the purposes of their payment, shall be fully placed, with their fasteners, coatings and other elements that integrate them and have successfully undergone pressure tests and / or tightness. This criterion includes the loss of material due to cuts and the joints that have been affected.
- Also, it is included in the unit unions with manholes, pits or other elements of sewer system.
- In facilities with a specified degree of difficulty, it also includes the repercussion of the special pieces to place.

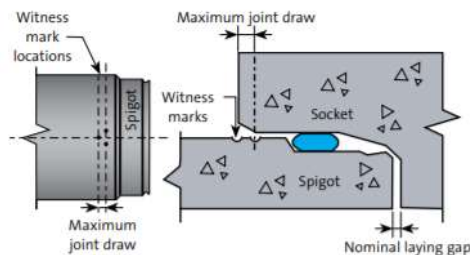
4.4.5 QUALITY CONTROL OF INSTALLATION

A. The quality control of installation and reception of pipelines elements shall meet the following requirements:

- The personnel involved in handling, mounting or, in general, handling of the pipeline during any phase of its installation shall be as experienced as possible and have the proper training.
- Reception: Pipes and manholes shall have CE mark, under achievement of EN-1916 and EN-1917 and test of regulation.
- Visual inspection: Once the pipelines were received, and prior to their installation, they shall be subjected to a visual inspection in order to check that they were not damaged during transport. In this respect, those elements that they do not pass the inspection shall be rejected. Likewise, once the pipe has been installed, a

new visual inspection shall be carried out in order to check its correct assembly and adopting same criteria of rejection.

- d. Dimensional verification of trenches and alignments (horizontal and alignment). The alignment definition and verification shall be performed by topographic procedure, supported by complementary manual measurements. The dimensional verification shall achieve drawings definition and specifications of material and works.
- e. Trench. The geometry, cleaning, stability, and compaction of trench shall be verified before proceeding with bed execution. The bottom of trench shall be compacted and verified >95% Standard Proctor test (randomly), for conforming a solid foundation of piping. Sharp material shall be removed of trench and soft material shall be replaced by granular or selected material for stabilization of foundation.
- f. Piping. Pipes shall be laid on bed (granular or concrete), previous verification of grading, thickness and alignment. The inspection of pipes shall cover the alignment, deflection, and tightness.
- g. Control of assembly and joints. The joints between modules shall incorporate an elastomeric gasket for sealing. The elastomeric gaskets shall achieve the specification of EN 681.



- h. Quality control of fillings and beds.
 - i. The quality control test shall be carried out according to the following ratio:
 - Daily production
 - Backfilling every 300 meters of trench
 - Every change of material and layer
 - ii. The following test shall be done, randomly distributed in the installation:
 - Two complete identification of backfilling material:
 - (a) Atterberg limits
 - (b) Granulometry
 - (c) Modified Proctor
 - (d) Sulphates analysis
 - Six density and humidity tests by nuclear method.
 - Concrete test.

4.4.5.1 INSPECTION OF PIPES AND CONNECTING PARTS OF PIPELINES

- A. Each pipe shall be visually inspected before installation. The pipe shall be solid and the fittings free of damage.
- B. The inspection shall be performed once installed the pipelines, manholes and previous completion of backfilling and keeping uncovered joints.
- C. Testing of pipe connections and joints is performed at the expense of the Contractor. If the required level of pipeline tightness is not achieved during the test, the Contractor shall eliminate the causes of the leak and repeat the test.

4.4.5.2 TESTING

- A. All manifold pipes shall be well cleaned and tested. The Contractor shall give due notice of his intention to test the pipes.
- B. Even if the test is successful, when water flows from any pipe or connection is observed, the pipe is replaced and the connection is reconnected in the prescribed manner, the test being repeated until the flow is stopped.

4.4.5.3 INSPECTION OF WELLS

- A. All completed wells shall be tested with water after all pipes are closed and the well is filled with water to 0.5 m below the lid level. Tightness tests should be performed in accordance with EN 1610.

4.4.5.4 TELEVISION DIAGNOSTICS OF SELF - WAY PIPELINES

- A. Before the Contractor puts the drainage network into operation, it is necessary to perform a television inspection of the pipelines for all self-contained drainage networks. Mobile equipment shall be used to inspect pipelines from the inside. During the inspection, diagnostic protocols shall include photographs of the defects, the defects have been assessed by a laser measuring system, a graphic diagram of the pipeline has been drawn and the slope has been checked. Present the footage on DVD. The diagnostic report shall be submitted to the Engineer.

4.5 MANHOLES

4.5.1 CONCRETE MANHOLES

- A. Concrete manholes shall be according to EN 1917:2003.
- B. All drainage devices should be accessible for maintenance.
- C. Buried drainage shall include an inspection manhole every 80 m at a maximum distance. When it is practically unreasonable to ensure 80m maximum values, then:
 - a. Exceptional value of up to 120m maximum distance between manholes could be applied for buried drainage.
 - b. Exceptional value of up to 120m maximum distance could be applied for third party buried melioration when it is practically unreasonable to ensure 80m maximum values, without foreseeing manholes in railway infrastructure land plots for third party manholes.
- D. The manholes shall be laid over a lean concrete bedding ≥ 10 cm. The bottom of manhole shall be surrounded by filter material, providing continuity to the layers of trench.

4.5.1.1 CONCRETE FOR MANHOLES AND SHAFTS:

- A. This involves the formation of manholes for connecting and unloading the gutters to the collectors or between different sections of pipes or collectors, or changes in the direction of them.

4.5.1.2 STAIRCASE:

- A. The function of polypropylene-lined ladders and metal ladders with protection rings is to facilitate the descent into the underground chambers or tanks, as well as to protect the operators and facilitate their rapid evacuation.

4.5.2 MATERIAL REQUIREMENTS

4.5.2.1 CONCRETE FOR MANHOLES AND SHAFTS

- A. The manholes shall be built in the shape and dimensions indicated in the Technical Design Drawings using reinforced concrete C25/30 according to the design for the different depths.

- B. Reinforced concrete shall comply with the specifications of Section 05. Structures of these Technical Specifications.

4.5.2.2 STAIRCASE

- A. This unit is defined as the supply and placement of the staircase (of circular section) or the steels forming stairs with protection rings (galvanized)
- B. The dimensions of these elements are indicated in the Technical Design Drawings, as well as the location within the corresponding structures.
- C. The protective covering of the staircase shall be a thermoplastic polymeric material belonging to the group of Polyolefins (polypropylene). This material shall meet the conditions of wear resistance, inalterability to the environment in which it is placed, be rot-proof and compatible with the materials that affect it (concrete and steel).

4.5.3 EXECUTION OF WORKS

4.5.3.1 CONCRETE FOR MANHOLES AND SHAFTS

- A. The connections of the gutters and tubes with the manholes will be made respecting the dimensions that result from the plans, so that the ends of the tubes coincide with the interior facing of the manhole.
- B. Exceptionally, when the manhole is not located in the platform gutter, the Engineer may authorize the use of brick, plastered internally with cement mortar.
- C. The manholes shall be provided with a concrete cover or grid and steel feet, when this is decided by the Engineer.
- D. The concrete manholes shall be executed in accordance with the specifications contained in Section 05 STRUCTURES
- E. The elastomeric joints of manholes shall comply EN 681-1 Elastomeric seals - Materials requirements for pipe joint seals used in water and drainage.
- F. Tolerances:

Table 101. Allowable geometrical deviations – Manholes

Property	Allowable deviation, single measurement	Method	Frequency
Bottom elevation	According to national requirements but no more than +/- 2 cm	Geodetic	100%
Horizontal (plan) view	According to national requirements but no more than +/-20 cm	Geodetic	100%

4.5.3.2 STAIRCASE

- A. The staircases will be placed according to EN 1917 standard on site by inserting their anchor in the holes previously opened and sealed by injecting a special high-resistance mortar based on epoxy resins. The injection shall stop when the mortar overflows outside the hole.
- B. These elements cannot be used until seven days (7 days) after their final placement. The anchors of the ladders shall be of the appropriate length as specified by the manufacturer. Prior to their placement, they will be degreased and cleaned to avoid subsequent oxidation.

4.5.4 MEASUREMENT AND PAYMENT - MANHOLES (DRAINAGE)

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 102. Units of measurement – Manholes (drainage)

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_37_50_80_71	000602	REINFORCED CONCRETE C25/30 TO FORM SHAFTS AND MANHOLES, AMOUNT OF STEEL MORE THAN 40 Kg/m3	m3	Reinforcement concrete C25/30 to form shafts and manholes consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of all materials to the construction of shafts and manholes with reinforcement concrete, "in situ" and prefabricated, with an amount of steel more than 40 kg/m ³ , including seat material with mass concrete, formwork, finishing, joints, frame and cover.
Ss_37_50_80_71	000603	REINFORCED CONCRETE C25/30 TO FORM SHAFTS AND MANHOLES, AMOUNT OF STEEL UP TO 40 kg/m3	m3	Reinforcement concrete C25/30 to form shafts and manholes consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of all materials to the construction of shafts and manholes with reinforcement concrete, "in situ" and prefabricated, with an amount of steel up to 40 kg/m ³ , including seat material with mass concrete, formwork, finishing, joints, frame and cover.
Ss_37_50_80_71	000604	REINFORCED CONCRETE C35/45 TO FORM SHAFTS AND MANHOLES, AMOUNT OF STEEL UP TO 20 kg/m3	m3	Reinforcement concrete C35/45 to form shafts and manholes consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of all materials to the construction of shafts and manholes with reinforcement concrete, "in situ" and prefabricated, with an amount of steel up to 20 kg/m ³ , including seat material with mass concrete, formwork, finishing, joints, frame and cover.
Ss_37_50_80_71	000605	REINFORCED CONCRETE C35/45 TO FORM SHAFTS AND MANHOLES, AMOUNT OF STEEL MORE THAN 40 kg/m3	m3	Reinforcement concrete C35/45 to form shafts and manholes consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of all materials to the construction of shafts and manholes with reinforcement concrete, "in situ" and prefabricated, with an amount of steel more than 40 kg/m ³ , including seat material with mass concrete, formwork, finishing, joints, frame and cover.
Pr_25_30_85_23	000601	POLYPROPYLENE COATED STEEL STAIRCASE	pc	Polypropylene coated steel staircase consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of staircase inside manhole including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_20_76_63_35	000601	GLASS FIBER REINFORCED POLYESTER (GRP) MANHOLE DN 2000 mm AND HEIGHT 3,3 m	pc	Glass fiber reinforced polyester (GRP) manhole DN 2000 mm and height 3,3 m consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of glass fibre reinforced manhole, including cast iron cover class A15, logos, lock, sealing elements, ladders and bottom of manhole, checking of the support on site, supply and transport of element to the site, assembly and perfect levelling.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_76_63_35	000601	GLASS FIBER REINFORCED POLYESTER (GRP) MANHOLE DN 1000 mm	pc	Glass fiber reinforced polyester (GRP) manhole DN 1000 mm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of glass fiber reinforced manhole, including cast iron cover class A15, logos, lock, sealing elements, ladders and bottom of manhole, checking of the support on site, supply and transport of element to the site, assembly and perfect levelling.
Pr_65_52_01_61	000601	POLYPROPYLENE (PP) MANHOLE OF DIAMETER 425 mm AND HEIGHT 2,6 m	pc	Polypropylene (PP) manhole of diameter 425 mm h-2,6 m with consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of polypropylene manhole, including cast iron cover class A15, logos, lock, sealing elements, kinetics at the bottom for D315 pipe, checking of the support on site, supply and transport of element to the site, assembly and perfect levelling.
Pr_20_76_63_35	000602	POLYPROPYLENE (PP) MANHOLE OF DIAMETER 600 mm	pc	Polypropylene (PP) manhole of diameter 600 mm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of polypropylene manhole, including cast iron cover class A15, logos, lock, sealing elements, kinetics at the bottom for D315 pipe, checking of the support on site, supply and transport of element to the site, assembly and perfect levelling.

4.6 PRECAST CONCRETE BOX CULVERTS

4.6.1 GENERAL DESCRIPTION

- A. Precast reinforced vibro-pressed and porous precast concrete culverts shall be used in the drainage works transverse to the trace, such as collectors under ditches and conduction to natural channels or as drains in order to collect seepage on the platform.
- B. Where required Precast concrete culverts shall be adapted to allow the transit of animals through the platform.
- C. $A \geq 3\text{cm}$ sand base shall be placed between the precast frame and the lean concrete to allow a proper distribution of stresses along the base of the culverts.
- D. The culverts shall be laid over a lean concrete bedding $\geq 10\text{ cm}$ or over a granular bedding conforming to the following requirements:
 - a. $EV_2 \geq 60\text{ Mpa}$, according to DIN 18134 and
 - b. $D_{pr} \geq 97\%$ according to EN 13286-2 standard Proctor
- E. The bottom of culvert shall be surrounded by filter material, providing continuity to the layers of trench.
- F. The materials used for producing the culverts shall be selected according to EN 14844 requirements and this Technical Specification. Special attention shall be paid to frost resistance of the concrete and resistance to alkali-silica reaction (ASR).

4.6.2 MATERIAL REQUIREMENTS

4.6.2.1 CONCRETE FOR PRECAST CONCRETE FRAMES

- A. Cement used for producing the concrete for culverts shall be produced in accordance with EN 197-1. The Assessment and Verification of Constancy of Performance (AVCP) level of the cement production shall be 1+. Cement minimum strength-grade class shall be $\geq 42,5N$ according to classification in EN 197-1. Sulfur trioxide content of the cement % by mass shall be $\leq 3,5$ %. Tricalcium aluminate (C_3A) amount $\leq 5,0$ %.
- B. Two approaches are adopted to mitigate ASR which are equally applicable:
 - a. Use of low alkali cement, stated as Na_2O equivalent amount in cement $\leq 0,60$ %;
 - b. Limiting the alkalinity of concrete itself. Limiting the alkali content in the concrete to 3.0 kg per m3 of concrete of Na_2O equivalent. The amount of alkali is calculated from alkali content in cement + alkali content from additions such as fly ash or slag, alkali content from admixtures and other alkali sources, but not including potential alkali amount from aggregates. If this method is used, aggregate manufacturer must declare the reactivity of the aggregates as non-reactive to ASTM C1260 – 14, or RILEM TC219-ACS: AAR-0, AR-1.1, AAR-2
- C. Aggregates shall be produced in accordance with EN 12620. The Assessment and Verification of Constancy of Performance (AVCP) level of the aggregate production shall be 2+. Minimum requirements for aggregates strength $LA \leq 50$, frost resistance $F \leq 4$.
- D. Concrete elements have to comply with the relevant requirements listed in 'Section 5.2. Concrete Works'. If necessary, the structural reinforcement steel has to comply with the requirements indicated in 'Section 5.3. Passive Structural Reinforcement'. Concrete used for concrete elements shall be produced according to EN 206 and this Technical Specification. If not indicated otherwise in design documentation, Applicable exposure classes are XC4, XF3, XA1, XD1. Concrete Resistance to freezing and thawing according to CEN/TS 12390-9 (without de-icing salts) shall be $S56 \leq 0,10$ kg/m2 or $S56 \leq 0,20$ kg/m2 if $S56/S28$ is ≤ 2 .
- E. If the culvert will be foreseen for usage under roads and if not indicated otherwise in design documentation, then concrete applicable exposure classes are XC4, XF4, XA1, XD1 and resistance to freezing and thawing according to CEN/TS 12390-9 (with de-icing salts) shall be $S56 \leq 0,20$ kg/m2 or $S56 \leq 0,50$ kg/m2 if $S56/S28$ is ≤ 2 .
- F. The precast reinforced, vibrated and porous concrete frames will be manufactured by spinning or another process that guarantees a high compactness, with a controlled curing process.
- G. The Contractor shall install culverts with respective materials according to the information set in the Design documentation. Contractor shall guarantee to the Engineer that the culvert supplier manufacturer has the certificate or seal of quality in accordance with EN 14844 "Precast concrete products - Box culverts".
- H. The inner surface shall be smooth and free of defects, cracks or deformations.
- I. The tests that shall have to be carried out are:
 - a. Visual examination of the general appearance of culvert elements and joint parts, and checking of dimensions and thickness
- J. Notwithstanding the existence of the aforementioned quality certificate, the Employer reserves the right to carry out in the factory, through its representatives, as many manufacturing verifications and material tests as it deems necessary for the control of the various manufacturing stages, according to the requirements of this specification.
- K. The Employer can demand from the Contractor the guarantee certificate that satisfactorily carried out the tests and that the materials used in the manufacturing met the corresponding specifications. This certificate may be replaced by an officially recognized quality certificate.
- L. The reception tests, in the event that the Employer considers it, may be replaced by a certificate in which the results are expressed satisfactory tests for sealing, crushing and longitudinal flexing of the lot to which the tubes belong or the systematic self-control tests of manufacturing that guarantees the above properties.
- M. The tolerance for the inside dimensions of the frame is set to one percent (1%) of its nominal width, not exceeding fifteen millimetres (15mm). The minimum thickness of the frame shall be according to design documentation.
- N. The tolerance for frame thickness is set to five percent (5%) of its nominal thickness.

- O. Regarding the tolerance for the diameters of the steel bar reinforcements, it is established that the difference between their maximum internal diameters and minimum does not exceed one percent (1%) of the nominal diameters corresponding.
- P. The tolerance for frame length is set to one percent (1%) of its nominal length.
- Q. All the elements of the culvert shall be indelibly engraved with the distinctive and following marks:
 - a. Factory badge.
 - b. Nominal internal dimensions, in mm.
 - c. Maximum allowable pressure, in kPa.
 - d. Identification number, which allows knowing the history of its manufacture.
 - e. Completion date of frame manufacturing.

4.6.2.2 CONCRETE WING WALLS

- A. Concrete elements have to comply with the requirements listed in 'Section 5.2. Concrete Works'. If necessary, the structural reinforcement steel has to comply with the requirements indicated in 'Section 5.3. Passive Structural Reinforcement'
- B. This unit is defined as the in-situ casting and placement of the wingwalls located at the ends of the culverts.
- C. The dimensions of these elements are indicated in the Technical Design Drawings, as well as the location within the corresponding structural elements.

4.6.2.3 EXPANSION JOINTS

- A. Devices that link sections as contiguous precast frames, in order to allow the movements caused by temperature changes and rheological effects.
- B. At the same time, the devices shall provide a continuous surface and prevent the ingress of ballast, water or soil between adjacent structural elements.
- C. The dimensions of these elements are indicated in the Technical Design Drawings, as well as the location within the corresponding structural elements. A detailed drawing is included in the culvert detail drawings to allow a proper understanding of the joint shape and materials placed.
- D. The Engineer may order tests of sealing of joint types. In this case, the test will be done analogously to that of the frames, arranging two pieces of culvert, one after the other, joined by their gasket, closing the free ends with appropriate devices and following the same procedure that for the frames, it will be verified that there is no loss.
- E. The Contractor shall submit to the Engineer the precise characteristics of the joint for the proposed use.
- F. The joints are constituted by bands of elastomeric materials and should be able to absorb deformations in three mutually perpendicular directions, but its main function is to collect the movements imposed by temperature and rheological actions when they affect the frames and to provide a continuous structural behaviour of the whole culvert.
- G. The elastomeric joints of manholes shall comply EN 681-1 Elastomeric seals - Materials requirements for frame joint seals used in water and drainage.
- H. The basic characteristics that these joints shall meet, are:
 - a. Elasticity to follow the movements without cracking or introduce unacceptable efforts on the structure. The total allowable movement will be indicated in the drawings.
 - b. Tightness in case of rain, snow, strong condensations, floods, etc., preventing any leakage.
 - c. Sliding capacity of any edge in the three basic fundamental directions relative to the axes of symmetry of the joints.
 - d. Resistance to wear from movements in the structure due to thermal variations or live loads.
 - e. Conservation of elastic mechanical characteristics of seal materials and edges within the extreme temperatures to which they will be subjected.

- f. Not resulting in any work situation, projections or depressions that result in annoying knocking at the passing vehicles.
- l. The expansion joint span life shall be 25 years as minimum, and they shall be accessible for maintenance or application of joint sealant.

4.6.3 EXECUTION OF WORKS

4.6.3.1 PRECAST CONCRETE FRAMES

- A. The connections of the wingwalls with the culverts shall be made respecting the dimensions that result from the plans, so that the ends of the wing walls coincide with the starting of the frames.
- B. The elastomeric joints of manholes shall comply EN 681-1 Elastomeric seals - Materials requirements for frame joint seals used in water and drainage.
- C. Before proceeding with the installation of the frames the following conditions shall be verified:
 - a. The bottom material of the trench shall not be regular (not deviate from the design elevation by more than plus or minus two percent (+/- 2%) of the pipe size being installed, or one inch (1"), whichever is greater). If modified, the originally planned bearing capacity shall be preserved.
 - b. In the case of having an inconsistent soil layer at the bottom of the trench, that it shall be removed and replaced with a suitable material, depending on bearing test.
 - c. When low temperatures require it, it will be necessary to protect the trench bottom so that the frozen layers are not left under or on the sides of the frames.
- D. The installation of frames shall be sequential, avoiding open trenches for extended time.
- E. The material from the excavation shall be stacked far enough away from the edge of the trenches to avoid crumbling of the ditches or landslides that could endanger workers.
- F. In the event that the excavations affect pavements, the materials that can be used in their restoration shall be separated from the general material of the excavation.
- G. In the case of trench or ditches for frames installations, the extracted material is frequently used for subsequent filling, so it is convenient to collect it along the trench at a suitable distance from one of its edges.
- H. The frames shall be installed in a trench, following typical section of drawings.
- I. The frames shall be laid over a lean concrete bedding ≥ 10 cm. The bottom of culvert shall be surrounded by filter material, providing continuity to the layers of trench. A 3cm sand base shall be placed between the precast frame and the lean concrete to allow a proper distribution of stresses along the base of the culverts.
- J. When frame laying is interrupted, the free ends shall be covered to prevent the entry of water or foreign bodies, proceeding to examine with all take care of the inside of the frame when resuming work.
- K. The frames and trenches shall be kept free of water, draining with pumps or leaving drains in the excavation if necessary.
- L. The two supports of the same frame shall always be built with the same materials.
- M. The wing walls at the inlets and outlets of the culverts will be executed in accordance with the habitual practice of this type of works, respecting the Drawings and these Technical specifications regarding installation, dimensions, formwork, concrete, laying on site and concrete curing, stripping, etc.

4.6.4 COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS

- A. Materials proposed have to comply with the Standards and Regulations listed in chapter "5.2.6. COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS" in these Technical specifications. Referred documents, in whole or in part, are normatively referenced in mentioned section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.
- B. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

4.6.5 WORK RECEPTION

- A. Required control and testing procedures are indicated in these Technical specifications, chapter "5.2.5. WORK RECEPTION". Regarding the prefabricated concrete frames chapter "5.2.5.1. Prefabricated and Reinforced Concrete Structures" in these Technical specifications specifies all necessary information for the production, storage and installation of these elements at site. All listed requirements have to be provided to ensure a proper work procedure.
- B. The Contractor can provide any additional test that may be relevant during the installation or reception process.

4.6.6 MEASUREMENT AND PAYMENT – PRECAST CONCRETE CULVERTS (DRAINAGE)

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 103. Units of measurement – Precast Concrete Culverts (drainage)

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_65_52_20_16	000301	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 1,50x1,50 m	m	Precast reinforcement concrete box culvert, internal dimensions 1,50x1,50 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000302	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 3,00x2,00 m	m	Precast reinforcement concrete box culvert, internal dimensions 3,00x2,00 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000303	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 3,00x2,50 m	m	Precast reinforcement concrete box culvert, internal dimensions 3,00x2,50 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_65_52_20_16	000304	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 4,00x2,50 m	m	Precast reinforcement concrete box culvert, internal dimensions 4,00x2,50 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000305	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 5,00x2,50 m	m	Precast reinforcement concrete box culvert, internal dimensions 5,00x2,50 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000306	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 2,00x2,00 m	m	Precast reinforcement concrete box culvert, internal dimensions 2,00x2,00 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000307	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 4,00x3,00 m	m	Precast reinforcement concrete box culvert, internal dimensions 4,00x3,00 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000308	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 4,00x3,50 m	m	Precast reinforcement concrete box culvert, internal dimensions 4,00x3,50 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_65_52_20_16	000309	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 1,50x1,00 m	m	Precast reinforcement concrete box culvert, internal dimensions 1,50x1,00 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000310	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 4,00x2,00 m	m	Precast reinforcement concrete box culvert, internal dimensions 4,00x2,00 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000311	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 5,00x3,00 m	m	Precast reinforcement concrete box culvert, internal dimensions 5,00x3,00 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000312	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 2,00x1,50 m	m	Precast reinforcement concrete box culvert, internal dimensions 2,00x1,50 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000313	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 2,50x1,50 m	m	Precast reinforcement concrete box culvert, internal dimensions 2,50x1,50 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_65_52_20_16	000314	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 2,50x2,00 m	m	Precast reinforcement concrete box culvert, internal dimensions 2,50x2,00 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000315	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 1,75x1,25 m	m	Precast reinforcement concrete box culvert, internal dimensions 1,75x1,25 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000316	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 2,50x2,50 m	m	Precast reinforcement concrete box culvert, internal dimensions 2,50x2,50 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000317	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 4,00x4,00 m	m	Precast reinforcement concrete box culvert, internal dimensions 4,00x4,00 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_65_52_20_16	000318	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 1,50x1,10 m	m	Precast reinforcement concrete box culvert, internal dimensions 1,50x1,10 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_65_52_20_16	000319	PRECAST REINFORCED CONCRETE BOX CULVERT, INTERNAL DIMENSIONS 1,80x1,80 m	m	Precast reinforcement concrete box culvert, internal dimensions 1,80x1,80 m, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete box, including checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, joints and its sealing with bituminous seal at backfill side and polyurethane elastic seal inside.
Pr_25_30_85_23	000601	POLYPROPYLENE COATED STEEL STAIRCASE	pc	Polypropylene coated steel staircase consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of staircase inside manhole including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

4.7 PROTECTION MEASURES

4.7.1 STONE PITCHING

4.7.1.1 GENERAL DESCRIPTION

- A. A. The function of the stone pitching is to protect inlets, outlets, and transitions from erosion by water and design ditches for $V > 4$ m/s.

4.7.1.2 MATERIAL REQUIREMENTS

- A. Protection of drainage inlets, outlets and transitions
- This unit is defined as the supply and placement, in the form of surface plating with a thickness greater than twenty (20) cm, of crushed stones Fr. >64, with average dimensions of not less than fifteen (15) cm.
 - Geotextile >250 g/m².
 - Concrete C15/20 for seat and grouting of pieces.
- B. Ditches:
- This unit is defined as the supply and placement, in the form of surface plating with a thickness of 10 cm of crushed stones Fr. 32/64.
 - Geotextile >250 g/m².
 - Concrete C15/20 for seat and grouting of pieces.
- C. Crushed stones shall achieve fraction and following conditions, as per EN 12522 Aggregates:
- Density: 2 ton/m³
 - Category - G90/3
 - Maximum fines content – f₂
 - Coefficient LA – LA₄₀
 - Maximum sulphate content – SS_{0,2}
 - Freezing resistance – F₂

4.7.1.3 COMPLIANCE CONTROL / COMPLIANCE TESTING

- A. The stone shall meet the following conditions:
- Be homogeneous, fine-grained and uniform, with a compact texture, and capable of withstanding, without damage, a pressure of four hundred kilograms of force per square centimetre (400kgf/cm²).
 - Lack of cracks, holes, nodules and organic remains. It will give a clear sound to the hammer blow.
 - Be inalterable to water and weather.
 - Have sufficient adherence to mortars.
- B. The base shall be made on a sand bed, although the Employer may establish his seat on a mass concrete bed, and even the mortar joints at points where the stones can be removed by the flow of water.

4.7.1.4 MEASUREMENT AND PAYMENT

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 104. Units of measurement - Stone pitching

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_25_25_85_55	000601	STONE PITCHING IN DITCHES (CRUSHED STONE 32/64)	m2	Stone pitching with crushed stone 32/64 in ditches consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing a stone pitching for protection against water erosion that includes the supply of the material and its placement, the concrete of seat and grouting of pieces, geotextile with separating function and expansion joints as well as all the necessary means for the total completion of works.
Ss_25_25_85_55	000602	STONE PITCHING IN CULVERTS (CRUSHED STONE >64)	m2	Stone pitching with crushed stone >64 in culverts consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing a stone pitching for protection against water erosion that includes the supply of the material and its placement, the concrete of seat and grouting of pieces, geotextile with separating function and expansion joints as well as all the necessary means for the total completion of works.

- C. It will be measured according to the surface actually executed following the instructions of the Employer
- D. Work item includes the contribution of the material and its placement, the concrete and the gripping mortar, as well as all the necessary means for the complete completion of the work unit.

4.7.2 RIPRAP STRUCTURES

- A. Works, materials and requirements related to riprap structures shall be in accordance with sub-section 2.10.6. herein

4.8 GEOSYNTHETICS/GEOTEXTILES

4.8.1 GENERAL

- A. Works, materials and requirements related to geotextiles shall be in accordance with sub-section 2.12 GEOSYNTHETICS / GEOTEXTILES AND GEOCELLS.

4.8.2 DRAINAGE BLANKET

- A. Drainage blanket is a geocomposite strip drain which consists of a drainage core and a filtration geotextile attached to or encapsulating the core.
- B. The drainage core is manufactured from synthetic polymers composed of polypropylene, polyester, polyamine, PVC, polyolefin, or polystyrene; and shall have a minimum compressive strength of 300 kPa when tested in accordance with EN 826. The drainage core with the geotextile fully encapsulating the core shall have a minimum flow rate of 12.5 litres per second per meter of strip width, when tested in accordance with ISO 12958.
- C. Strip drains shall be placed against the excavation face with the geotextile filter side against the soil.

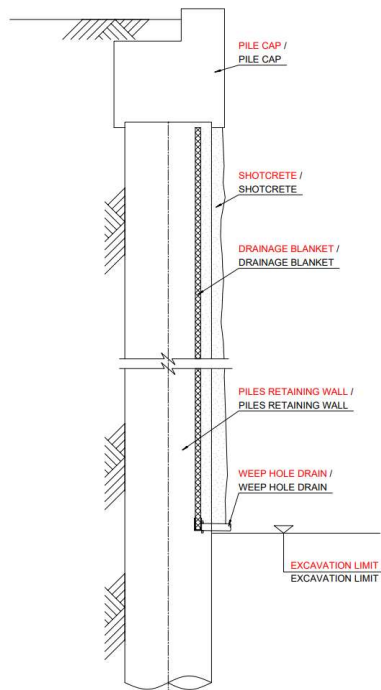


Figure 10. Typical Wall Section with Drainage Blanket

- D. If the strip drain is packaged in rolls, the rolls shall be protected while shotcrete is applied to each lift and then rolled down to be continuous. If the strip drains are panel-type, they shall be spliced at the bottom of each excavation lift and generally should have a minimum 30.5 cm overlap of both the core and the geotextile filter such that the water flow and filtration are not impeded. The bottom drainage cap and exit pipe are connected to the strip drains and affixed to the shotcrete reinforcement. During shotcrete placement, the exit pipe must be adequately covered to prevent penetration of shotcrete into the system. Once the shotcrete operation is complete, the exit pipe can be connected to the underdrain system, if applicable.

4.8.3 MEASUREMENT AND PAYMENT – DRAINAGE BLANKET

Table 105. Units of measurement - drainage blanket

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_25_57_53_65	000302	DRAINAGE BLANKET	m2	Drainage blanket consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing of drainage blanket including placing and fixing the drainage sheet to the wall or cutting including PVC connectors d=100 mm.

4.9 DRAINAGE OF BRIDGE DECK

4.9.1 GENERAL DESCRIPTION

- A. This part of the TS includes storm water system for the structure including materials and products, the supply, transportation and storage, performance, tolerances.

4.9.2 MATERIALS

4.9.2.1 SCUPPERS OF BRIDGE

- A. The objective of scuppers is the abstraction of runoff from the deck and transport the water to the piping. The bridge drains shall satisfy the following criteria.
- Railway bridge scuppers shall comply with class C250 pursuant to EN 124.
 - Road overpass scuppers shall comply with class D400 pursuant to EN 124 or with requirements defined by road owner.
 - The grating shall be firmly attached to the frame by a hinge.
 - The gratings shall be locked to prevent unauthorised opening.
 - Lateral seepage openings shall guarantee proper drainage of the sealing and protective layer.
- B. The nominal dimension of scuppers shall comply with technical drawings. Cast iron, stainless steel or GRP scuppers shall be used.
- C. The technical features of scuppers are the following:
- Captive damping inserts in the frame, rust due to maintenance-free, self-locking, screwless locking and hinge secured,
 - Drain body with adhesive flange according to EN 1253 with drain socket DN 150 vertical,
 - Clamping ring screwed to the drain body,
 - Clamping ring with seepage openings, upper part with grate and all-round closed frame,
 - Construction time drainage can be opened if required,
 - Continuously height-adjustable from 85-160 mm,
 - Side and tilt adjustable, rotatable,
- D. The scuppers consist of a lower part and an upper part with a grating, bucket and tension ring. The upper part can be eccentrically rotated in every direction and is laterally adjustable by 10 mm with respect to the lower part. The lower part is concreted in the structure of the bridge. The broad adhesive flange in the lower part is designed for safe and secure gluing to the sealing membrane.



Figure 11. Indicative example of the scupper

4.9.2.2 PIPES FOR DRAINAGE SYSTEM

- A. The stormwater system will be defined by transversal and longitudinal GRP collectors which discharge at downspouts adjacent to the piers.
- B. Gravity drainage and stormwater systems used in pipes and fittings shall meet:
 - a. GRP pipes EN ISO 23856-, CEN/TS 14578 standards.
 - b. PVC pipes - 1401, ISO 4435, EN 13476 standards requirements.
 - c. PE pipes - EN 12666, EN 13476 standards.
 - d. PP pipes – EN 1852, EN 13476 standards. Pipe connections have to be flexible with sealing rings.
- C. Fiberglass pipe and fittings shall be reinforced thermosetting resin pipe (RTRP) systems meeting the requirements of EN ISO 23856 standards.
 - a. They shall qualify for a 207 MPa minimum short time rupture strength hoops tensile stress.
 - b. The final colour of the reinforced pipe and fittings shall be pigmented sage green. Paint will not be accepted.
 - c. Pipe shall be reinforced thermosetting resin fiberglass pipe meeting the requirements of – EN ISO 23856standards
 - d. Pipe Fittings (e.g. elbows, tees, couplings, etc.) shall be reinforced thermosetting resin fiberglass pipe meeting the requirements of EN ISO 23856.
 - e. Adhesive: The adhesive used for joining the fiberglass pipes and pipe fittings shall meet the requirements of EN ISO 23856.
 - f. Pipe Brackets and Supports: Pipe brackets and supports shall conform to the requirements of EN 12095 and ASTM A-575, Grade 1015 and 1020.

4.9.2.3 HANGERS AND SUPPORTS

- A. Runs of pipe shall be supported at spacing not greater than the lesser of those recommended by the manufacturer of the pipe or as shown on the bridge plans.
- B. Supports that have point contact or narrow supporting areas shall be avoided. Standard sling, clamp and clevis hangers for use with steel pipe can be used.
- C. Straps shall have 120 degrees of contact with the pipe.
- D. Hanger thickness shall be 5mm.

Table 106. Min. Strap Width

Nominal ID	Min. Strap Width
163 mm	38 mm
213 mm	38 mm
267 mm	38 mm

Nominal ID	Min. Strap Width
303 mm	51 mm

- E. All reinforced fiberglass pipe, fittings and expansion joints shall be handled and installed in accordance with guidelines and procedures recommended by the manufacturer of the material.
- F. Fasteners shall be covered with weather-resistant coating (e.g. galvanized) or made of corrosion-resistant materials (stainless steel, plastic)
- G. Fastener points selected according to the supplier / manufacturer's recommendations and to ensure durable and resistant to external influences assertion.

4.9.2.4 EMBANKMENT CHANNEL

- A. The channel shall be constructed with the slope of embankment.
- B. The embankment channel type and dimensions shall be according to the project documentation. The elements shall be laid over a bed of selected material and geotextile.
- C. All used materials need to be transported and stored according to the manufacturer instructions. Embankment channel shall be constructed according to the Technical Specification of "Concrete works" defined in the chapter 5.2.

4.9.3 MEASUREMENT AND PAYMENT – BRIDGE DRAINAGE

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 107. Units of measurement – Bridge Drainage

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_25	000301	BRIDGE SCUPPER	pc	Bridge scupper consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for the drainage system, protected by a grate, which serves to drain rainwater from the decks. Includes the supply of all necessary materials, and their placement
Pr_25_93_60_14	000301	PRECAST CONCRETE CHANNEL	m	Precast concrete channel consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing precast concrete channel including preparation of the base surface, placing the channel, filling with cement mortar and placing the concrete cover if necessary.
Pr_65_50_35_27	000301	GALVANIZED STEEL GUTTERS AND VERTICAL DOWNSPOUT SECTIONS	m	Gutter for joint drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of GRP pipes fixed to piles or walls for the evacuation of water in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_63_88	000301	PVC PIPE, DIAMETER 150 mm. FOR DECK DRAINAGE	m	PVC drainpipe 150 mm for deck drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipes fixed to piles or walls for the evacuation of water in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_63_88	000301	PVC PIPE, DIAMETER 160 mm. FOR DECK DRAINAGE	m	PVC drainpipe 160 mm for deck drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipes fixed to piles or walls for the evacuation of water in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_63_88	000302	PVC PIPE, DIAMETER 200 mm. FOR DECK DRAINAGE	m	PVC drainpipe 200 mm for deck drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipes fixed to piles or walls for the evacuation of water in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_63_88	000304	PVC PIPE, DIAMETER 250 mm. FOR DECK DRAINAGE	m	PVC drainpipe 250 mm for deck drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipes fixed to piles or walls for the evacuation of water in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_63_88	000305	PVC PIPE, DIAMETER 315 mm. FOR DECK DRAINAGE	m	PVC drain pipe 315mm for deck drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVC pipes fixed to piles or walls for the evacuation of water in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_65_52_07_66	000601	PP PIPE OF DIAMETER 315 mm SN8 SLOTTED	m	PP SN8 drainpipe slotted 315 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a sand bed of 5 cm thickness, coated with geotextile and fill with filter gravel above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_07_66	000602	PP PIPE OF DIAMETER 315 mm SN16 SLOTTED	m	PP SN16 drainpipe slotted 315 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PP pipe on a sand bed of 5 cm thickness, coated with geotextile and fill with filter gravel above the pipe, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_63_82	000601	STEEL PIPE OF DIAMETER 630 mm	m	Steel pipe of diameter 630 mm for drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). Steel pipe must have stiffness rating of at least 30 kN/m ² , minimum yield strength of 250 MPa and with thickness of wall at least 10 mm. This item is meant for supply and installation of steel pipe on a sand bed of 5 cm thickness, filled with sand above the pipe, including transport, assembly, testing, protective coating, corrosion evaluation monitoring system and as much equipment and labour as necessary for their final placement.
Pr_65_52_63_88	000303	SUBSURFACE DRAIN: FUNNEL, MESH AND DOWNPIPE	pc	Subsurface drain: funnel, mesh and downpipe consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of pipes, funnel and steel mesh through deck for the evacuation of water in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_15_31_26_34	000306	SUBSURFACE DRAIN: CRUSHED GRANITE FR 8/16 MIXED WITH EPOXY	m	Subsurface drain: crushed granite fr 8/16 mixed with epoxy consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and laying of fill at the edge of deck with epoxy-mixed granite rock fragments fr8/16 for subsurface drain, under pavement layers.

C. Work items include the contribution of the material and its placement, the concrete and the gripping mortar, as well as all the necessary means for the complete completion of the work unit.

4.10 REGULATION AND TREATMENT TANKS

4.10.1 OIL SEPARATOR

4.10.1.1 GENERAL DESCRIPTION

- A. Oil separator tanks shall be built to manage flow and separate oil, with the rate capacity, according to Technical Design.
- B. They shall be built to separate oil of runoff, collected and transported in drainage system of railway, before discharging the water in the protected waterbodies.

4.10.1.2 GENERAL REQUIREMENTS

- A. Oil separators shall be produced according to EN 858 and shall be certified. Oil separators shall comply with the declaration of conformity issued.
- B. Oil separators shall be made of steel S235JR (standard NF EN 10025). On the inside and outside they shall be covered by two component epoxy resin.
- C. Oil separators shall be resistant to aggressive substances contained in the water, to possible external and internal mechanical, chemical and microbiological processes
- D. Oil separators shall have a removable coalescence filter.
- E. Oil separators shall be designed with 2 shafts and automatic valve.
- F. Oil separators shall be provided with alarm system.

4.10.1.3 EXECUTION OF WORKS

- A. Oil separators shall be installed according to Drawings, on sand-gravel mixture and shall be anchored to reinforced concrete plate. The trench bottom must have a deformation modulus EV2 of at least 45 MN/m². The soil in which the trenches are filled shall not contain stones larger than 32mm in diameter.

4.10.1.4 MEASUREMENT AND PAYMENT – OIL SEPARATOR TANKS

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 108. Units of measurement – Oil separator tanks

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_55_76_59	000601	DECANTER + OIL SEPARATOR 3,00x1,74x1,53 m FOR STRUCTURE DRAINAGE	pc	Decanter and oil separator 3,00x1,74x1,53 m for structure drainage consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of all materials to the construction of decanter + oil separator, including excavations, fillings and C16/20 concrete levelling base.
Pr_65_55_76_59	000602	OIL SEPARATOR 100 l/s	pc	Oil separator 100 l/s performance consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing an oil separator for protection of waterbodies against pollutants that includes the supply of the material and its placement, the sand gravel mixture seat, as well as all the necessary means for the total completion of works

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_55_76_59	000603	OIL SEPARATOR 340 l/s	pc	Oil separator 340 l/s performance consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing an oil separator for protection of waterbodies against pollutants that includes the supply of the material and its placement, the sand gravel mixture seat, as well as all the necessary means for the total completion of works
Pr_65_55_76_59	000604 ??	OIL SEPARATOR 30 l/s	pc	Oil separator 30 l/s performance consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing an oil separator for protection of waterbodies against pollutants that includes the supply of the material and its placement, the sand gravel mixture seat, as well as all the necessary means for the total completion of works
Pr_65_55_76_59	000605	OIL SEPARATOR 60 l/s	pc	Oil separator 60 l/s performance consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing an oil separator for protection of waterbodies against pollutants that includes the supply of the material and its placement, the sand gravel mixture seat, as well as all the necessary means for the total completion of works
Pr_65_52_25_62	000601	GLASS PLASTIC SAND TRAP OF DIAMETER 1,8 m AND OF DEPTH 5,8 m	pc	Glass plastic sand trap of diameter 1,8 m and depth of 5,8 m consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of all materials to the construction of prefabricated glass plastic sand trap, including service hatches, finishings, joints, hydroisolation and covers.

- C. Work item includes the contribution of the material and its placement, the sand gravel mixture, as well as all the necessary means for the complete completion of the work unit.

4.10.2 FLOW REGULATION MANHOLE

4.10.2.1 GENERAL DESCRIPTION

- A. The Flow regulation manholes have the objective of diverting the first flush of runoff, which have the higher load of pollutants, into the water treatment process (pond / oil separator). The excess of water will be bypassed.
- B. The Flow regulation manholes shall be according to the Technical Design.

4.10.2.2 GENERAL REQUIREMENTS

- A. Flow regulation manhole shall be certified and comply with the certificates of conformity issued.

- B. Manholes shall be made of steel S235JR (standard EN 10025). On the inside and outside they shall be covered by two component epoxy resin.
- C. Flow regulation manholes shall be resistant to aggressive substances contained in the water, to possible external and internal mechanical, chemical and microbiological processes

4.10.2.3 EXECUTION OF WORKS

- A. Manholes shall be installed on sand-gravel mixture and shall be anchored to reinforced concrete plate, according to Drawings. The trench bottom shall have a deformation modulus EV2 of at least 45MN/m2. The soil in which the trenches are filled shall not contain stones larger than 32mm in diameter.

4.10.2.4 MEASUREMENT AND PAYMENT – FLOW CONTROL MANHOLE

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 109. Units of measurement – Flow Control Manhole

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_40_70_96_31	000601	FLOW REGULATION MANHOLE 100l/s	pc	Flow control manhole with cleaned flow 100 l/s and maximum flow 700 l/s performance, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing a flow control manhole for regulating the inflows in the water treatment process that includes the supply of the material and its placement, the sand gravel mixture seat, as well as all the necessary means for the total completion of works
Pr_40_70_96_31	000602	FLOW REGULATION MANHOLE 340l/s	pc	Flow control manhole with cleaned flow 340 l/s and maximum flow 700 l/s performance, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing a flow control manhole for regulating the inflows in the water treatment process that includes the supply of the material and its placement, the sand gravel mixture seat, as well as all the necessary means for the total completion of works

- C. Work item includes the contribution of the material and its placement, the sand gravel mixture, as well as all the necessary means for the complete completion of the work unit.

4.10.3 WATER TANK

4.10.3.1 GENERAL DESCRIPTION

- A. Water tank shall be designed to regulate the runoff inflow/outflow and mitigate the peak flow in areas with limited discharge capacity and available land plot, according to the Technical Design.

4.10.3.2 MATERIAL REQUIREMENTS

- A. Double wall polyethylene (PE).
- B. Underground installation.

- C. Diameters of Inlet 400mm and outlet 200mm.
- D. Two shaft manholes with cast iron cover Class A15.

4.10.3.3 EXECUTION OF WORKS

- A. Water tank shall be installed on sand-gravel mixture and shall be anchored to reinforced concrete plate, according to Drawings. The trench bottom shall have a deformation modulus EV2 of at least 45 MN/m².
- B. The water tank shall be installed once completed the excavation, levelling of foundation and laying of sand gravel bed. The precast water tank shall follow the technical procedure of manufacturer.
- C. The minimum cover shall have 0.50 meters.
- D. The soil in which the trenches are filled shall not contain stones.

4.10.3.4 MEASUREMENT AND PAYMENT – WATER TANK

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 110. Units of measurement – Water Tank

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_60_50_96	000601	WATER TANK WITH DIAMETER 3300 mm, LENGTH 12,0 m, VOLUME ≥80 m ³	pc	Water tank consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of underground tank with diameter 3300 mm, length 12,0 m, volume ≥80 m ³ with 2 shafts, logos, cast iron cover class A15, lock, sealing elements, ladders, assembly, finishing and perfect levelling

- C. Work item includes the contribution of the material and its placement, the sand gravel mixture, as well as all the necessary means for the complete completion of the work unit.

4.11 CASING PIPES

4.11.1 STEEL CASING

4.11.1.1 GENERAL DESCRIPTION

- A. A steel casing shall be installed at the places given in Technical design.
- B. The casing will be installed with trenchless process in order to avoid the disturbance of traffic.

4.11.1.2 MATERIAL REQUIREMENTS

- A. Steel pipe, the diameter and wall thickness indicated in the drawings .
- B. Epoxy coating, anticorrosion.
- C. Rubber and sealings.
- D. Centering rings.

4.11.1.3 EXECUTION OF WORKS

- A. The launching pits shall be installed at both sides of road, following conditions of road department (to be consulted).
- B. The launching force and velocity shall be controlled to avoid affections to the steel casing and road. The levelling of casing shall be defined for the achievement of vertical alignment of GRP pipe.
- C. The steel casing shall be launched with centralizers and the casing sealed after insertion.

4.11.1.4 MEASUREMENT AND PAYMENT – STEEL CASING

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 111. Units of measurement – Steel Casing

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_63_82	000601	STEEL CASING 630 mm	m	Steel casing 630 mm with trenchless method, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing of steel casing for crossing of road that includes the supply of the material, equipment and its placement, centralizers, sealing, pits, joints, as well as all the necessary means for the total completion of works
Pr_65_52_63_82	000602	STEEL CASING 1370 mm	m	Steel casing 1370 mm with trenchless method, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing of steel casing for crossing of road that includes the supply of the material, equipment and its placement, centralizers, sealing, pits, joints, as well as all the necessary means for the total completion of works

- C. Work item includes the contribution of the material, equipment and its placement, as well as all the necessary means for the complete completion of the work unit.

4.11.2 HDPE CASING

4.11.2.1 GENERAL DESCRIPTION

- A. HDPE casing shall be installed in crossings of railway for small diameters of projected utilities.
- B. The HDPE pipe shall be casted with mass concrete to reinforce the trench.

4.11.2.2 GENERAL REQUIREMENTS

- A. There has been designed 2 types of casing pipes in the Technical Design– steel casing pipes and PE100 PN16 SDR 11. Nominal stiffness of casing pipe shall be at least 100 kN/m².
- B. Casing pipes diameter shall be at least 200 mm wider than the protected pipe diameter when it is installed in trench.

- C. Pipes shall be resistant to aggressive substances contained in the water, to possible external and internal mechanical, chemical and microbiological processes. High-quality couplings and sealing rings shall be used to seal the pipes to ensure complete tightness of the system.

4.11.2.3 EXECUTION OF WORKS

- A. Casing pipes shall be ended before the manhole and sealed with rubber sealants. Protected pipe is centred inside the casing pipe with centring rings.
- B. Under roads pipes shall be installed with trenchless method.
- C. Pipes shall be visually inspected and cleaned of dirt, snow, ice, grease and other contaminants before laying into trench.
- D. The inside of installing pipes shall be clean and dry.

4.11.2.4 MEASUREMENT AND PAYMENT

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 112. Units of measurement – HDPE Casing

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_52_03_61	000601	POLYETHYLENE CASING 630 MM	m	Polyethylene (PE) pipe of diameter 630 mm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PE pipe, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

- C. Work item includes the contribution of the material, equipment and its placement, as well as all the necessary means for the complete completion of the work unit.

4.12 PONDS

4.12.1 GENERAL DESCRIPTION

- A. The ponds were projected, as treatment and retention solution of longitudinal drainage, before releasing the runoff at protected waterbodies or receptor. They were designed in ponds surface to facilitate sediments cleaning process in the ponds.
- B. The ponds were defined with concrete pads, sand base and separative geotextile. The slabs will facilitate the progressive infiltration in subsoil and removal of sediments. The sand and geotextile will conform the permeable layer for improving the underground infiltration.
- C. The ponds will have a minimum useful depth of 60 cm and slopes 1V:1,5H.
- D. The rest of surface shall be covered by grass, for environmental integration.

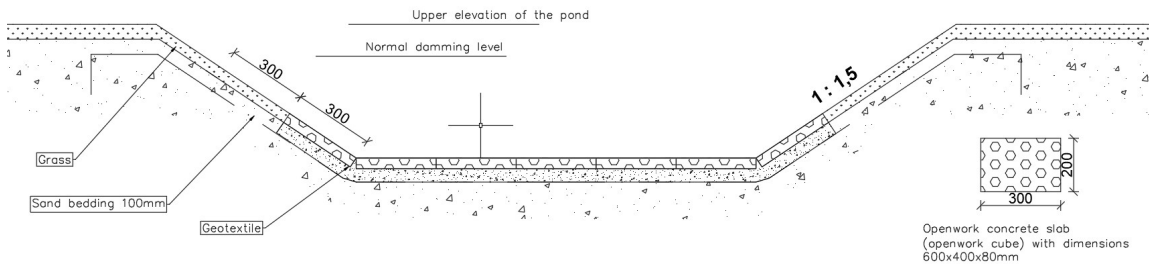


Figure 12. Concept design of Ponds

4.12.2 MATERIAL REQUIREMENTS

- A. Openwork concrete slab dimensions are 600x400x80 mm. Slabs are with holes for water to drain. Concrete slabs shall meet the requirements in EN 13198. Concrete class C 25/30, water absorption < 6 %, frost resistance <1,0 kg/m².
- B. Sand aggregate
- C. Geotextile ≥ 150 gr/m²
- D. Draining soil fr. 8/16 mm.

4.12.3 EXECUTION OF WORKS

- A. Precast concrete slabs are installed on 20 cm layer of draining soil fr. 8/16 and filtrating geotextile. Bottom of cutting must have a deformation modulus EV2 of at least 45 MN/m².

4.12.4 MEASUREMENT AND PAYMENT – EVAPORATING PONDS

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 113. Units of measurement – Evaporating pond

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_50_70_85_64	000601	EVAPORATING POND	m3	Evaporating pond consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of evaporating pond, consisting of openwork concrete pads, sand base and separate geotextile, including checking of the support on site, supply and transport of the element to the site, assembly and perfect levelling.
Pr_20_85_14_16	000601	PRECAST CONCRETE SLABS AT PONDS	m2	Precast concrete slabs at ponds consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing of precast concrete slabs at ponds to cover, that includes the supply of the material, equipment and its placement, leveling, as well as all the necessary means for the total completion of works

- C. Work item includes the contribution of the material, equipment and its placement, as well as all the necessary means for the complete completion of the work unit.

4.13 GENERAL TECHNICAL CONDITIONS

- A. Special drainage system instruments / devices (filters, pumps, etc.), If any, required parameters indicated in the Technical Design.

4.13.1 SUPPLY, TRANSPORT AND STORAGE

- A. The Contractor shall ensure that all pipes are properly constructed, without defects, correctly assembled, made of high-quality materials and not leaks, fractures or faults. Introducing pipes shall be cleaned and prepared for installation at the site.
- B. Pipes and accessories shall be properly packed for transport and, if necessary, the storage facility. All technical specifications not described in detail as bolts, washers, etc., required for the start of completion and should be included in the proposal and delivered.
- C. All pipes and materials shall be new and not to use the products.
- D. Water drainage system elements shall be specified in the manufacturer's label, diameter, pressure class, production date and other relevant information according to the Local Legislation and Regulation governing this issue.
- E. The unloading of goods, shipping, handling, transportation, storage operations, the contractor shall use the following methods and equipment in order to avoid their damage.
- F. Temporary packaging, envelope, packaging elements should be removed.
- G. Storage and transportation shall follow the manufacturer's/supplier's instructions and guidelines.

4.13.2 WORK EXECUTION

- A. External mounting: external (non-ground) water drainage system components and assembly takes place in accordance with the supplier / manufacturer's recommendations. Mandatory protection of pipes, valves and fittings from dirt, water and other foreign substances entering the product interior.
- B. Connections are carried out in strict accordance with the manufacturer's instructions. Before making the connections, all the mating surfaces well cleaned and dried, so their condition is maintained until the installation is completed the connections. If the pipe manufacturer recommends using connections lubricant.
- C. The deflection at the joints cannot exceed 50% of the manufacturer's recommended maximum size. If you need to be fitted with compensators to compensate for axial displacements.
- D. Plow the soil open way: water drainage system construction elements in soil in accordance with EN 1610 and STR 1:06:01, the TS part "Earth Works" and the supplier / manufacturer's recommendations. Pipe-laying method is freely chosen by the contractor building the project if not specified otherwise. Hand excavation of the trench can be played only minor and small diameters (100 - 300mm) pipe. In other cases, the use of special equipment (cranes, tripods, etc.). Lowering shall be a jolt, without bumps on the edge of the trench, mechanisms, without prejudice to the pipe coating layer. The pipes shall be laid on the bottom unmoved. The lowered pipe is adapted to the longitudinal axis, and its position in the vertical plane determined by the levelled visor decks nailed vizor. Pipe joints widening of the trench and deepened,
- E. Pipelines laid on the trench shall be installed in accordance with the Technical Design gradients bottom. Pipes on it should lean the same way. After the installation of tubes cast in soil up to 100mm above the pipe above the ground flat compacted with a vibrator or foot, so that the pipes do not move it sideways.
- F. Smoothing and filler materials used shall meet the following criteria:
 - a. The particle size shall not exceed 63 mm;
 - b. 8/16 mm particles should not exceed 16mm;
 - c. The frozen material shall be removed;
 - d. Do not use sharp debris containing materials.
- G. Above the filler pipe located shall meet the requirements for the structure above the pipeline.

- H. Pipe coupling and cutting pipes shall be cut in such a way as to produce a clean surface profile and do not favour breaking the wall of the tube and which presents the least risk of the protective coating. Where necessary, to cut the pipe ends are rounded to fit connector used type.
- I. Pipe installation: pipes and fittings are connected by inserting the other end equal to the pipe end with the sleeve. The coupling shall be factory installed and attached rubber rings, lubricated with the grease. To protect the pipe interior from contamination after getting stuck them into the trench both ends of the pipe shall be closed sealed plastic covers. Pipes installed by hand or using additional equipment recommended by the manufacturer.
- J. Well installation: Wells installed in accordance with the STR 1:06:01 and the supplier / manufacturer's recommendations. Carriageway (including footpaths) manholes covers are mounted flush with the roadway surface. Well hatches lawns shall be lifted above the ground: built-up area - 5cm; vacant areas - 20cm.
- K. Stormwater drainage: piping, scuppers, downspouts and hangers shall be installed in accordance with the manufacturers' instructions, specifications and drawings.
- L. Hollows at beams for scuppers and piping shall be previously coordinated and executed with suitable dimensions for correct installation. Demolitions at beam will not be allowed. The hollows will be properly sealed.

4.13.3 TOLERANCES

- A. The installation shall achieve the following tolerances:

Table 114. Tolerances – Non pressure drainage

Control values,	Tolerances
excavations bottom altitude	±50mm
levelling the sand (gravel, crushed stone) layer and altitude	±15mm
the upper part of the well deviation from the vertical axis	±12 mm
the well axis deviation from the design position	±8 mm
the well bottom altitude	±5mm

4.13.4 NON-PRESSURE TEST FOR STORMWATER SYSTEM

- A. Non-pressure stormwater system testing before commissioning shall be performed.
- B. Non-pressure test and visual inspection shall be done during and after installation and mounting.

4.13.4.1 AIR TEST

- A. The pipeline section shall be effectively sealed, and air pumped in until a stable pressure of 100mm head of water is indicated in a 'U' tube connected to the system
- B. The pipeline shall have passed the test if the pressure has not fallen below 75mm head of water during a five-minute period without further pumping, following a period for stabilization.
- C. Pipelines failing to pass the test, defects shall be eliminated, and be re-tested.
- D. In the event of failure to pass the air test, the pipeline may be subjected to the water test.

4.13.4.2 WATER TEST

- A. For the water test, the pipe shall be filled in a manner approved by the Engineer to a head not less than 1.2m above the crown of the pipe at the high end and not more than 6m above the crown of the pipe at the low end.
- B. Steeply graded pipelines shall be tested in sections so that the above maximum head is not exceeded.
- C. The test shall commence two hours after completion of filling the test section at which time the level of water at the vertical feed pipe is to be made up to produce the required 1.2m minimum test head.

- D. The loss of water over a 30-minute period shall be measured by adding water from a measuring vessel at regular 5-minute intervals to maintain the original water level and the amounts so added recorded.
- E. The pipeline shall have passed the test if the volume of water added over the 30-minute period does not exceed 0.5 litres per linear metre of pipeline per meter of nominal internal diameter.
- F. Pipelines failing to pass the test, defects shall be eliminated, and be re-tested.

4.14 COMPLIANCE WITH CONSTRUCTION REGULATIONS

- G. EN 1916- Concrete pipes and fittings, unreinforced, steel fibre and reinforced.
- H. EN ISO 1183-2- Plastics - Methods for determining the density of non-cellular plastics - Part 2: Density gradient column method.
- I. EN ISO 306 – Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST).
- J. EN 1452 - Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly (vinyl chloride) (PVC-U)
- K. TR 2.01 Design of roads and railway bridges and tunnels.
- L. 2:07:01 STR Water supply and wastewater disposal. Building engineering systems.
- M. Outside engineering networks (Official Gazette., 2003, Nr. 83-3804, the amendment Official Gazette., 2009, Nr. 35-1348)
- N. EN ISO 23856 Plastics piping systems for pressure and non-pressure water supply, drainage or sewerage — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin.
- O. CEN/TS 14578. Plastics piping systems for water supply or drainage and sewerage - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP) - Recommended practice for installation.
- P. CEN/T 14632. Plastics piping systems for drainage, sewerage and water supply, pressure and non-pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP) - Guidance for the assessment of conformity.
- Q. EN 206 Concrete. Specification, performance, production and compliance.
- R. EN 12390. Tests of hardened concrete
- S. EN 752 Outdoor sewers. Sewage management
- T. EN 124-1, EN 124-2, EN 124-3, EN 124-4, EN 124-5, EN 124-6. Hatches and inspection well hatches in traffic and pedestrian areas. Design requirements, testing, marking, quality control
- U. EN 681-1 + A1: 2001/A3:2005 applies. Elastomeric gaskets. Requirements for gasket materials for water and drainage pipe joints. Part 1. Gum
- V. EN 1401-1 Plastics piping systems for non - pressure underground drainage and sewerage. Unplasticized polyvinyl chloride (PVC-U). Part 1. Technical requirements for pipes, fittings and the system
- W. CEN / TR 1046 Pressure underground drainage and sewerage pipeline systems. Polypropylene with mineral modifiers (PP-MD). 3. Installation Manual
- X. ISO 21138. Plastics piping systems for non-pressure underground drainage and sewerage -- Structured-wall piping systems of unplasticized poly (vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) Material specification and performance criteria for pipes, fittings and systems
- Y. EN 14758-1 Plastics piping systems for non - pressure underground drainage and sewerage. Polypropylene with mineral modifiers (PP-MD). Part 1. Technical requirements for pipes, fittings and the system
- Z. EN ISO 1452. Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure -- Unplasticized poly (vinyl chloride) (PVC-U)
- AA. EN 13476. Plastics piping systems for non-pressure underground drainage and sewerage - Structured-wall piping systems of unplasticized poly (vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) - Part 1: General requirements and performance characteristics
- BB. ISO 4435. Plastics piping systems for non - pressure underground drainage and sewerage. Unplasticized polyvinyl chloride (PVC-U) (ISO 4435: 2003)

- CC. EN 1917: 2003 / AC: 2008 Concrete, steel fiber concrete and reinforced concrete manholes and inspection wells
- DD. EN 1253. Building inlets.
- EE. EN 13253:2007. Geotextiles and geotextile-related products - Characteristics required for use in erosion control works (coastal protection, bank revetments)
- FF. EN ISO 1183 Plastics. Methods for determining the density of non-cellular plastics.
- GG. EN ISO 9969 Thermoplastics pipes – Determination of ring stiffness.
- HH. EN ISO 527 Plastics - Determination of tensile properties Test conditions for moulding and extrusion plastics.
- II. VDE 0304-1 Testing of Solid Insulating Materials for Assessment of Their Thermal Stability; Determination of Thermal Properties of Solid Insulating Materials - GERMAN ONLY
- JJ. DIN 52612-2 Testing of thermal insulating materials; determination of thermal conductivity by MEANS of the guarded hot plate apparatus; conversion of the Measured values for building applications
- KK. EN 1610 Construction and testing of drains and sewers.
- LL. EN 1796 The pressure or non-pressure water supply plastic pipe systems Thermosetting unsaturated polyester resin (UP) Glass (GRP)
- MM. ISO 4435 Pressure underground drainage and sewerage pipeline systems. Non-plasticised polyvinyl chloride (PVC-U)
- NN. EN 13598-2 Pressure underground drainage and sewerage pipeline systems. Unplasticized polyvinylchloride (PVC-U), polypropylene (PP) and polyethylene (PE). 2 part. Traffic areas and deep underground network of wells and survey wells technical requirements.
- OO. EN 13383-1. Armoustone. Part 1: Specification
- PP. EN 13383-2. Armoustone. - Part 2: Test methods.
- QQ. EN 13253 Geotextiles and geotextile-related products. Prerequisites features for use in erosion control works (coastal protection, bank revetments)
- RR. ASTM A-575 Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
- SS. EN 12095. Plastics piping systems - Brackets for rainwater piping systems - Test method for bracket strength.
- TT. EN 858. Separator system for light liquids (e.g. oil and petrol)
- UU. EN 15383: 2012 + A1:2014. Plastics piping systems for drainage and sewerage - Glass-reinforced thermosetting plastics (GRP) based on polyester resin (UP) - Manholes and inspection chambers.
- VV. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

4.15 QUALITY ASSURANCE & QUALITY CONTROL (QA/QC)

- WW. The Contractor shall institute a Quality Assurance and Quality Control (QA/QC) system/plan for Drainage to demonstrate compliance with the requirements of the Technical Design, the Technical Specifications and the Contract.
- XX. Plan shall comply with standards mentioned in the 04.-Drainage subchapters
- YY. The QA/QC plan for Drainage shall be submitted to the Engineer for approval prior to Works.
- ZZ. Compliance with the QA/QC requirements shall not relieve the Contractor of any duties, obligations or responsibilities under the Technical Specifications and the Contract.
- AAA. The Contractor shall establish and maintain a QA/QC Plan, with project quality requirements extending to all Subcontractors and Suppliers, to ensure that compliance with the Technical Specifications and the Contract is satisfied.
- BBB. QA/QC Plan shall comply with ISO 9001/9002.

5. SECTION 05.- STRUCTURES

5.1 SCOPE OF WORKS

- A. This Section includes the following sub-sections related to the structures in the project as it is specified hereinafter:
 - a. Concrete works;
 - b. Passive structural reinforcement;
 - c. Reinforced Concrete piles;
 - d. Concrete repair and waterproofing of surfaces;
 - e. Steel works;
 - f. Bridge bearings;
 - g. Expansion Joints;
 - h. Prestressing Tendons and Bars;
 - i. Falsework and Movable Scaffolding;
 - j. Cantilever Formwork Traveller;
 - k. Load test on railway and road bridges;
 - l. Railway bridges, road bridges and ecoducts miscellaneous;
 - m. Grounding of metallic elements and reinforcement in structures;
 - n. Shock Transmission Units.
- B. and as shown in Drawings and/or BIM models.
- C. The design working life (DWL) of the parts of the structure shall be 100 years except where specified otherwise.
- D. This section provides a needed but non-exhaustive list of labour, materials, equipment, transport and services necessary to furnish, deliver and install all work of this section as shown on the drawings and/or BIM models, as specified herein and/or as required by job conditions.
- E. The BIM models must contain detailed as-built data according to the specified LoG and LoI levels in "RBDG-MAN-040- Digital information requirements for construction and handover stages". As-built BIM models shall be created and/or updated by developing PIM (Project Information Model) models from the Technical Design accompanied with laser scanning/photogrammetry data according to RBGL-VDC-INS-R-00001.

5.1.1 WARRANTY PERIOD

- A. The warranty period for the structure shall be defined in Contract, if not defined in Contract the Local Legislation and Regulations shall be followed. The warranty period starts from the day when the commencement of finished construction is signed by respective state Authorities.
- B. Section 01 of this Technical Specification is applicable for warranty.

5.2 CONCRETE WORKS

5.2.1 SCOPE

- A. This Technical specifications section includes concrete materials, manufacture, supply, laying, testing and adoption of concrete and reinforced concrete structural and non-structural elements, their production, transportation, and installation tolerances.
- B. The design working life of concrete works shall be 100 years.

5.2.2 INTRODUCTION

- A. Concrete, its production, placing and test and evaluation of test results, shall be as per EN 206 requirements.

- B. Concrete shall be produced according to AVCP level 2+.
- C. General terms and definitions are:
 - a. **Admixture**: material added during the mixing process of concrete in small quantities related to the mass of cement to modify the properties of fresh or hardened concrete.
 - b. **Batch**: quantity of fresh concrete produced in one cycle of operations of a mixer or the quantity discharged during 1 min from a continuous mixer.
 - c. **Characteristic strength** : value of strength below which 5% of the population of all possible strength determinations of the volume of concrete under consideration, are expected to fall.
 - d. **Cement content**: mass of cement contained in a cubic metre of fresh, fully compacted concrete, expressed in kilograms per cubic metre (kg/m³).
 - e. **Combination** : restricted range of Portland cements and additions which, having been combined in the concrete mixer, count fully towards the cement content and water/cement ratio in concrete.
 - f. **Compressive strength class**: classification comprising the type of concrete (normal-weight or lightweight), the minimum characteristic 150 mm diameter by 300 mm cylinder strength and the minimum characteristic 150 mm cube strength).
 - g. **Conformity test** : test performed by the producer to assess conformity of the concrete.
 - h. **Fresh concrete**: concrete which is fully mixed and still in a condition that is capable of being compacted by the chosen method.
 - i. **Identity test**: test to determine whether selected batches or loads come from a conforming population.
 - j. **Hardened concrete**: concrete which is in a solid state and which has developed a certain strength.
 - k. **High strength concrete**: concrete with a compressive strength class higher than C50/60 in the cases of normal-weight or heavy-weight concrete and LC50/55 in the case of light-weight concrete
 - l. **Maximum aggregate size**: largest aggregate size used in the concrete.
 - m. **Minimum cover**: depth of cover to reinforcement assumed for the purposes of durability design.
 - n. **Normal-weight concrete** : concrete having an oven-dry density greater than 2 000 kg/m³ but not exceeding 2 600 kg/m³.
 - o. **Light-weight concrete** : concrete having an oven dry density of not less than 800 kg/m³ and not more than 2000 kg/m³.
 - p. **Precast concrete product** : concrete product cast and cured in a place other than the final location of use.
 - q. **Recycled aggregate (RA)**: aggregate resulting from the reprocessing of inorganic material previously used in construction.
 - r. **Recycled concrete aggregate (RCA)** : recycled aggregate principally comprising crushed concrete.
 - s. **w/c**: water/cement or combination.

5.2.3 MATERIALS AND PRODUCTS

5.2.3.1 CEMENT

- A. In structures, CEM I cement type shall be used in accordance with EN 197-1. Other cements may be used if they are necessary to obtain certain concrete properties and their use is based on experiments approved, and certified concrete mixtures recipe.
- B. The project can adopt low heat release (LH according to EN 197-1) cement use of massive structure or structures of cracking caused by hydration of the concrete temperature release shall be limited. In this case, the concrete manufacturer based on the design required concrete strength class and resistance to the environment class has to choose the appropriate type and brand of cement.
- C. Cements and combinations shall conform to EN 197-1. Evidence of compliance with the harmonized part of EN 197-1 with respect to product performance shall be demonstrated by CE marking and a Declaration of

Performance where the declared performance for the essential characteristics given in Annex ZA of that Standard is equal or greater than the performance level required for the intended use of the cement.

- D. Ground granulated blast furnace slag, fly ash and silica fume shall conform to EN 15167-1, EN 450-1 and EN 13263-1, respectively. Evidence of compliance with the harmonized part of those Standards with respect to product performance shall be demonstrated by CE marking and a Declaration of Performance where the declared performance for the essential characteristics given in Annex ZA of those Standards is equal or greater than the performance level required for the intended use of the constituent.
- E. The cement shall be able to provide the concrete with the characteristics set out for the different types of concretes.
- F. In order to avoid ASR, one of the following conditions shall be met while deciding the final concrete mixture recipe:
 - a. Limiting the total alkali content of the cement, stated as Na₂O equivalent to $\leq 0,60\%$, or;
 - b. Limiting the total mass of reactive alkalis in the concrete to $\leq 3,0 \text{ kg/m}^3$. If this method is used, aggregate manufacturer must declare the reactivity of the aggregates as non-reactive to ASTM C1260 – 14, or RILEM TC219-ACS: AAR-0, AR-1.1, AAR-2.
- G. Cements with a strength class of 32.5N shall be deemed to be slow-hardening cements; those of classes 32.5R and 42.5R and 52.5R shall be deemed to be rapid-hardening cements. Cements that satisfy the following requirements shall be used:
 - a. Are in conformity with the specific regulations in force,
 - b. Satisfy the limitations set out in Table 115.
 - c. Belong to a strength class of 32.5 or above.

Table 115. Requirements - Types of cement

Type of concrete	Type of cement
Mass concrete	Ordinary cements except types CEM II/A-Q, CEM II/B-Q, CEM II/A-W, CEM II/B-W, CEM II/A-T, CEM II/B-T and CEM III/C ESP VI-1 cements for special purposes
Reinforced concrete	Ordinary cements except types CEM II/A-Q, CEM II/B-Q, CEM II/A-W, CEM II/B-W, CEM II/A-T, CEM II/B-T, CEM III/C and CEM V/B
Prestressed concrete	Ordinary cements of types CEM I and CEM II/A-D, CEM II/A-V, CEM I/A-V, CEM II/A-P and CEM II/A-M(V,P)

5.2.3.2 AGGREGATES

- A. Aggregates shall conform to EN 12620 (for normal and heavy weight aggregates) and EN 13055-1 (for lightweight aggregates).
- B. Where the use of RCA or RA is proposed, it shall be subject to the approval of the Engineer. Aggregates for the concrete to be fractionated and clean, meeting the purpose of the concrete production and class. Building usable concrete mixtures to be used in dense aggregates for concrete. Dense aggregates texture, grain shape, strength, frost resistance, the emissions and composition of the clay, dust and sludge particles, organic, swollen and fine dispersed materials and concrete harden interfering substances, they contain sulphur compounds, the alkali-soluble silicic acid and metal corrosive materials shall meet the standard EN 12620 requirements.
- C. Aggregates shall be of such coarseness that concrete mix can freely enter between rebar and cover these well. The largest filler particles should not exceed:
 - a. 1.4 minimum dimensions of the structure;
 - b. minimum distance between adjacent reinforcing bars minus 5 mm;
 - c. 0.7 times the thickness of the protective concrete layer. Fillers shall be suitable properties and satisfy:
 - d. EN 12620 requirements;

- e. sanitary and hygienic regulations and shall be harmless to human health and the environment.

5.2.3.3 CONCRETE ADDITIVES

- A. Technological, hydraulic (pozzolanic), latent hydraulic mineral additives can be selected for the project or concrete technologists depending on environmental conditions and requirements for concrete and concrete mixture.
- B. Technological additives shall have suitable properties and comply with EN 934-2. Admixtures which are not within the scope of EN 934-2 shall conform to EN 934-1 general requirements. Hydraulic, including the SiO₂ fume and latent hydraulic (ash, blast furnace slag) annexes shall be suitable properties and meet the design standards. Mineral fillers and other additives (hydraulic) can be used only if it is based on the recommendations for their use. They shall not be aggressive to concrete without causing corrosion of reinforcement. Pigments used shall comply with EN 12878 and mineral accessory requirements.
- C. The project may involve concrete shrinkage reducing additives as a percentage indicating the shrinkage deformation reduction value, without diminishing the concrete resistance.
- D. Additives with chloride catalyst cannot be used. If the concrete mixture uses two or more chemical additives, they shall be compatible with each other.

5.2.3.4 WATER

- A. Water used for concrete production shall comply with EN 1008.

5.2.3.5 CONCRETE MIX

- A. Selection of concrete mix concrete production technology shall consider the concrete construction methods, environmental effects, the type of construction, etc. Concrete mix shall be such that the mixture fills well the formwork, never layered in order to create the required slope on bare surfaces.
- B. Carrying structures of concrete mix, if not otherwise stated in the project shall meet the EN 206 Annex F, table F.1, requirements.
- C. Concrete mixtures shall be produced in concrete mixers or come from a stationary plant. Concrete mixers are used to guarantee an adequate component mixing duration and mixing quality. Car mixers shall be installed in such a way that they place uniformly blended mixture. They shall have the proper metering equipment, where necessary, to add water and additives.
- D. The Contractor shall record, prior to the supply of any designed concrete, the following information which shall be subsequently supplied to the Engineer:
 - a. the nature and source of each material;
 - b. either:
 - i. appropriate existing data as evidence of satisfactory previous performance for target mean strength, current margin, consistence and water/cement ratio; or
 - ii. full details of initial tests carried out in accordance with Annex A of EN 206-1;
 - c. the quantities of each constituent material per cubic metre of fully compacted concrete.
- E. Assessment of the concrete in accordance with this sub-Clause shall be carried out for each different source of material and for any change in the quantities of each constituent material (except for changes in cement content of not more than 20kg/m³ and pro-rata changes in aggregate contents where a single assessment is required).

5.2.3.6 CONCRETE CLASSIFICATION

- A. The specific design of concrete strength class and environmental resistance class shall be according to EN 206, as well as additional requirements for concrete or concrete mixture indicated in the project. Concrete element definition shall be as indicated in the drawings and technical reports of each structure.

- B. As reference, the main concrete structural elements if not indicated otherwise in the drawings and technical reports of each structure shall comply with the following table:

Table 116. Requirements - Concrete for main structural elements

CONCRETE SPECIFICATION ACCORDING TO EN-1992-1-1:2004, EN 206-1:2000 and EVS-EN 206						
	Element type	Exposure class	fck	Min. Cement	Max. w/c	max. aggregate size
			(MPa)	(kg/m ³)		(mm)
Lean Concrete	N/A	N/A	C16/20	N/A	N/A	20
Foundations	Spread Footings	XC2 ⁽¹⁾	C30/37 ⁽¹⁾	280 ⁽¹⁾	0.60 ⁽¹⁾	20
	Piles Caps	XC2 ⁽¹⁾	C30/37 ⁽¹⁾	280 ⁽¹⁾	0.60 ⁽¹⁾	20
	Piles	XC2 ⁽¹⁾	C30/37 ⁽¹⁾	280 ⁽¹⁾	0.60 ⁽¹⁾	20
Superstructure	Abutments & Walls	XC4/XD1/XF2	C35/45	340	0.5	20
		XS1/XD1/XF2 ⁽²⁾		"	"	
		XC4/XD3/XF4 ⁽³⁾		380	0.4	
		XS1/XD3/XF4 ^{(2)&(3)}		"	"	
	Piers	XC4/XD1/XF2	C40/50	360	0.45	20
		XS1/XD1/XF2 ⁽²⁾		"	"	
		XC4/XD3/XF4 ⁽³⁾		380	0.4	
		XS1/XD3/XF4 ^{(2)&(3)}		"	"	
	Prefabricated vault	XC4/XD1/XF2	C45/55	380	0.4	20
		XS1/XD1/XF2 ⁽²⁾				
	Cast In situ vault	XC4/XD1/XF2	C45/55	360	0.45	20
		XS1/XD1/XF2 ⁽²⁾				
	Bridge Decks and Top Slab in Underpasses	XC4/XD3/XF4	C45/55	380	0.35	20
		XS1/XD3/XF4 ⁽²⁾				
Details	Pedestrian Path, Ballast Wall...	XC4/XD3/XF4	C35/45	380	0.4	20
		XS1/XD3/XF4 ⁽²⁾				
	Edge Beam Precast	XC4/XD3/XF4	C35/45	380	0.4	10
		XS1/XD3/XF4 ⁽²⁾				
(1) Non-Aggressive conditions for the soil and water to be confirmed.						
(2) Located at distances less than 5 km from the coast.						
(3) Piers, abutments and walls in close proximity of salted roads. (in the case of pathways shall be assessed by Rail Baltica when a change of usage is expected in the future)						

- C.

5.2.3.7 REINFORCEMENT

- A. See sub-section 5.3 "Passive structural reinforcement" herein.

5.2.3.8 CYCLOPEAN CONCRETE

- A. Concrete shall be proportioned to 200 kg of cement per 1 m³. Minimum compressive strength (28 days): 20MPa.
- B. Stones with a maximum size of 20 cm and covered with concrete shall be added to fresh concrete.
- C. The proportion of concrete shall not be less than 60% of the total volume. Stones shall not be in contact with one another, nor with the formworks or trenches sides.
- D. Stones shall be wetted and cleaned prior to batching.
- E. WORK EXECUTION:
- Reinforced concrete and concrete structures manufactured in a precast yard (precast) or generated by a plant / site (in situ) shall be in accordance with the project, technical specifications, instructions and EN 13670 requirements. Reinforced concrete structures are subjected to production requirements, scope and methods defined by the production performance of the class according to EN 13670.
 - In this project, unless stated otherwise, structures are classified as reliability class RC2 (EN 1990 tables B1 and B2). Therefore, the execution class shall be under EXC2 as per EN 13670.
 - The materials of the concrete mix for the preparation, transportation and storage
 - Materials shall be transported and stored in such a way as to avoid mix-ups, contamination or failure:
 - cement and fillers shall be protected from moisture and dirt.
 - cements and fillers shall be clearly labelled and stored in such a way that their operation shall not cause any possibility of confusion;
 - cement bags shall be stored so as to be used for the delivery sequence;

- iv. if the different strains of fillers can be delivered separately, mix them - is not allowed;
- e. accessories shall be transported in such a way that the physical and chemical influences (cold, high temperature, etc.) do not suffer quality. They shall be clearly labelled and stored in such a way that their operation shall not cause any possibility of confusion.

5.2.3.9 COVER LAYER

- A. Concrete protective layer of reinforced concrete structures shall be as follows, unless noted otherwise in drawings.

Table 117. Requirements - Concrete cover for main structural elements

CONCRETE SPECIFICATION ACCORDING TO EN-1992-1-1:2004, EN 206-1:2000 and EVS-EN 206						
	Element type	Exposure class	Structural class	Cover	Min. Air content	Other requirements
				(mm)	(%)	
Lean Concrete	N/A	N/A	N/A	N/A	-	-
Foundations	Spread Footings	XC2 ⁽¹⁾	S6	50 ⁽¹⁾	-	-
	Piles Caps	XC2 ⁽¹⁾	S6	50 ⁽¹⁾	-	-
	Piles	XC2 ⁽¹⁾	S6	75	-	-
Superstructure	Abutments & Walls	XC4/XD1/XF2	S5	50	-	-
		XS1/XD1/XF2 ⁽²⁾		"	-	-
		XC4/XD3/XF4 ⁽³⁾		60	3.5	Freeze-thaw resisting aggregates
		XS1/XD3/XF4 ^{(2)&(3)}		"	"	"
	Piers	XC4/XD1/XF2	S4	40	-	-
		XS1/XD1/XF2 ⁽²⁾	"	"		-
		XC4/XD3/XF4 ⁽³⁾	S5	55		Freeze-thaw resisting aggregates
		XS1/XD3/XF4 ^{(2)&(3)}	"	"		"
	Prefabricated vault	XC4/XD1/XF2	S3	35	-	-
		XS1/XD1/XF2 ⁽²⁾				
	Cast In situ vault	XC4/XD1/XF2	S4	40	-	-
		XS1/XD1/XF2 ⁽²⁾				
	Bridge Decks and Top Slab in Underpasses	XC4/XD3/XF4	S4	50	-	Freeze-thaw resisting aggregates
		XS1/XD3/XF4 ⁽²⁾				
Details	Pedestrian Path, Ballast Wall...	XC4/XD3/XF4	S4	50	3.5	Freeze-thaw resisting aggregates
		XS1/XD3/XF4 ⁽²⁾				
	Edge Beam Precast	XC4/XD3/XF4	S4	45	3.5	Freeze-thaw resisting aggregates
		XS1/XD3/XF4 ⁽²⁾				
(1) Non-Aggressive conditions for the soil and water to be confirmed.						
(2) Located at distances less than 5 km from the coast.						
(3) Piers, abutments and walls in close proximity of salted roads. (in the case of pathways shall be assessed by Rail Baltica when a change of usage is expected in the future)						

- B. In addition, it shall be considered by Contractor that the minimum cover for concrete cast against prepared (including blinding) shall be 50 mm and for concrete cast directly against soil 75 mm.
- C. The above table is based in a special quality control of the production in the superstructure in order to determine the structural classification. Only special quality control shall be allowed in superstructure.
- D. The special quality control of concrete production shall be ensured according EN 1992-1-1 and EN 206, for example by certification of the production control according to EN 206, Annex C.
- E. Certification of the production control according to EN 206, Annex C.
- F. Test as per CEN/TS 12390-9 shall also be performed on concrete in order to assess the required exposure class. Thresholds for each exposure class shall be as per the following table. (Design working life to be considered 100 years).

Table 118. Requirements - CEN/TS 12390-9 freeze and thaw testing thresholds

Exposure Class	Design Working Life of the structure / component	Testing medium and requirements based on design working life and exposure class	
		Water	3% NaCl
XF1	50 years	$S_{56} \leq 0,50 \text{ kg/m}^2$ or $S_{56} \leq 1,00 \text{ kg/m}^2$ if $S_{56} / S_{28} \leq 2$	-
	100 years	$S_{56} \leq 0,20 \text{ kg/m}^2$ or $S_{56} \leq 0,50 \text{ kg/m}^2$ if $S_{56} / S_{28} \leq 2$	-
XF2	50 years	-	$S_{56} \leq 0,65 \text{ kg/m}^2$ or $S_{56} \leq 1,30 \text{ kg/m}^2$ if $S_{56} / S_{28} \leq 2$
	100 years	-	$S_{56} \leq 0,50 \text{ kg/m}^2$ or $S_{56} \leq 1,00 \text{ kg/m}^2$ if $S_{56} / S_{28} \leq 2$
XF3	50 years	$S_{56} \leq 0,20 \text{ kg/m}^2$ or $S_{56} \leq 0,50 \text{ kg/m}^2$ if $S_{56} / S_{28} \leq 2$	-
	100 years	$S_{56} \leq 0,10 \text{ kg/m}^2$ or $S_{56} \leq 0,20 \text{ kg/m}^2$ if $S_{56} / S_{28} \leq 2$	-
XF4	50 years	-	$S_{56} \leq 0,35 \text{ kg/m}^2$ or $S_{56} \leq 0,70 \text{ kg/m}^2$ if $S_{56} / S_{28} \leq 2$
	100 years	-	$S_{56} \leq 0,20 \text{ kg/m}^2$ or $S_{56} \leq 0,50 \text{ kg/m}^2$ if $S_{56} / S_{28} \leq 2$
S_{56} – loss of mass after 56 freeze/thaw cycles (test method CEN/TS 12390-9) S_{28} – loss of mass after 28 freeze/thaw cycles (test method CEN/TS 12390-9)			

5.2.3.10 CONCRETE TRANSPORTATION

- A. The concrete shall be transported to the installation location quickly and to such methods in order to avoid the separation, segregation and deterioration of concrete performance. The consistency and the amount of air shall be measured in laying location.

5.2.3.11 PRECAST REINFORCED CONCRETE PRODUCTS TRANSPORTATION AND STORAGE

- A. The vehicle used to transport the precast pieces shall be provided with bracing devices that allow a safe and secure delivery, preventing damage and permanent deformation of the pieces; surfaces shall be protected from damage and properly storage.
- B. Contractor shall clearly define the de-shuttering time, the hoisting points, the handling operations and the stacking points at precast yard and at site, prior to proceed with the precast element manufacturing for Engineer approval.
- C. For storage at construction site, the following conditions are required:
 - a. area free of obstacles shall be provided in the discharge area;
 - b. protruding reinforcement in the precast elements shall be protected in order to be damaged and to not harm workers.
- D. Precast elements are prohibited to be stacked bearing on their hoisting points. Wooden shims shall be used to avoid direct contact among precast pieces.

5.2.3.12 CONCRETE LAYING AND COMPACTION

- A. Concrete mix is laid in 10 to 40 cm layers and compacted by vibratory methods. The mixture is to be installed on the bottom for starting of binding layer.
- B. Mass concrete or reinforced concrete structures have to be poured without interruption, but the assessment of possible technological and organizational reasons can provide concrete working joints. The Contractor shall tune the situation of working joints concrete in advance of the concreting structures. Working joints should be prepared to ensure a good concrete layer surface, clean of laitance and intentionally roughed to an amplitude of 1.5 cm, previously to pour the new freshly layer. Different phases of connecting concrete surfaces shall be secured with covering materials at different stages of the concrete adhesion if required due to environmental conditions.
- C. Concreting massive structures shall apply measures to prevent the temperature and concrete shrinkage cracks, wetting it properly, controlling the hydration heat, and sectoring the element into casting blocks, if required. Maximum concrete element dimension and pouring in order to control the hydration heat shall be coordinated by the Contractor with the Engineer on site. Environmental and concrete surface temperature difference shall not exceed 20°C. The mixture temperature and the air temperature at pouring shall not exceed + 30°C (unless indicated otherwise), and not be less than + 5°C.
- D. Fresh concrete shall not be placed against in situ concrete that has been in position for more than 30 minutes unless a construction joint is formed.
- E. Where lightweight aggregate concrete is to be pumped, the Contractor shall demonstrate to the satisfaction of the Engineer that pumping shall have no significant effect on the strength of the hardened concrete.
- F. No concrete shall be placed in flowing water. Underwater concrete shall be placed in position by tremies or by pipelines using methods to ensure the requirements of this Specification are met.
- G. When concreting bridge decks of substantial thickness to avoid layering of concrete, the whole thickness shall be placed in one pass. In deck slabs where void formers are used, adequate means to prevent flotation shall be employed and care taken to ensure adequate compaction of the concrete placed beneath the void formers.
- H. Where the minimum dimension of a concrete section to be placed at a single time is greater than 600 mm measures shall be taken to reduce the adverse effects of high temperatures in the concrete or to reduce the temperature of concrete to prevent high temperatures having an adverse effect on the finished concrete.
- I. Concreting operations shall not displace reinforcement, tendon ducts, tendon anchorages or formwork, or damage the faces of formwork.
- J. Concrete shall be thoroughly compacted by vibration during the operation of placing, and thoroughly worked around the reinforcement, tendons or duct formers, around embedded fixtures and into corners of the formwork to form a solid mass free from voids. When vibrators are used to compact the concrete, vibration shall be applied continuously during the placing of each batch of concrete until the expulsion of air has practically ceased. A sufficient number of vibrators in serviceable condition shall be on site. Contractor shall ensure that spare equipment is always available in the event of breakdowns.

- K. Vibration shall not be applied acting on the reinforcement. Where vibrators of the immersion type are used, contact with reinforcement and inserts shall be avoided as far as is practicable.
- L. Concrete shall not be subjected to disturbance between 4 hours and 24 hours after compaction except that re-compaction of the upper layers of deep lifts to prevent or anneal settlement cracking may be carried out. Whenever vibration has to be applied externally, the design of formwork and disposition and operation of vibrators shall ensure efficient compaction and the avoidance of surface blemishes.
- M. There shall be no excess water on the top surface on completion of compaction.
- N. Slip-forming shall be performed with appropriate equipment using methods to ensure that the requirements of this Specification are met.

5.2.3.13 CONCRETE PROTECTION AND MAINTENANCE OF CURING

A. GENERAL

- a. Concrete shall be protected from rain, wind and the drying effects of the sun and high or low temperatures.
- b. Along curing time, no structure shall heat up above 60°C and temperature differences between any section throughout the curing period should not exceed 20°C.
- c. Details of curing methods used shall be subject to the acceptance of the Engineer.
- d. Curing Class 3 in accordance with sub-Clause 8.5 of EN 13670 shall be used, unless otherwise directed by the Engineer.
- e. Immediately after compaction and thereafter for the duration of applied curing, except where elevated temperature curing is used, concrete shall be protected against harmful effects of weather, including rain, rapid temperature changes, frost, and from drying out. The method of curing shall provide a suitable environment for the concrete to mature and prevent loss of moisture harmful to the quality of the concrete.
- f. Where the Contractor proposes to use a curing liquid, compound or membrane on surfaces on which a waterproofing system is to be laid, it shall be completely removable. The Contractor shall keep records of all curing liquids, compounds and membranes and the areas of subsequent removal; such records shall be subsequently supplied to the Engineer for approval.

B. ACCELERATED CURING

- a. Elevated-temperature curing as described below may be used only for concrete made with Portland cement (CEM I) or sulphate-resisting Portland cements (CEM I-SR 0 or CEM I-SR 3).
- b. The formwork may be generally heated to no more than 20°C prior to the placing of concrete.
- c. Once placing is complete, the concrete shall be left for 4 hours without additional heating. The concrete temperature can then be raised at a maximum rate of 10°C per ½hour.
- d. The concrete temperature shall at no time exceed 70°C.
- e. The rate of subsequent cooling shall not exceed the rate of heating.
- f. Cubes shall be manufactured and cured under identical conditions to those to which the concrete is subjected.
- g.
- h. The use of accelerated curing methods for concrete containing other types of cement or any admixture shall not be used.

5.2.3.14 CONCRETING DURING THE COLD SEASON

- A. The ambient air temperature when pouring concrete shall not be less than + 5 ° C.
- B. During the cold period it shall be ensured that the solidification of the concrete binding develops at positive temperature.
- C. After the concrete construction formwork and loose surfaces will be covered with thermal insulation materials.
- D. When concrete is placed at air temperatures below 2°C, the following requirements shall be met:

- a. The aggregates and water used in the mix shall be free from snow, ice and frost.
- b. The surface temperature of the concrete at the time of placing shall be at least 5°C. Where the concrete is made using CEM I or a CEM II/A cement, the concrete temperature shall not be more than 30°C. Where the concrete is made using a CEM II/B or a CEM III cement, or equivalent combination, the concrete temperature shall not be more than 35°C.
- c. The surface temperature of the concrete shall be maintained at not less than 5°C until the concrete reaches a strength of 5N/mm² as determined by tests on cubes that were cured under identical conditions to the structural concrete.
- d. Before placing concrete, the formwork, reinforcement, prestressing steel and any surface with which the fresh concrete will be in contact shall be free from snow, ice and frost.
- e. Cement shall not be allowed to come into contact with water at a temperature greater than 60°C.
- f. Ice-free concrete additives are only possible in agreement with the project authors.

5.2.3.15 CONCRETING IN HOT ENVIRONMENTS

- A. In concrete, when the ambient temperature is above 25 °C and a relative humidity lower than 50% is needed to provide to the concrete mix and its components the cooling capabilities of cement with low hydration heat. It is necessary to ensure the protection of concrete surfaces from too rapid loss of moisture.
- B. Use of concrete retarders is only possible in agreement with the Employer.
- C. During hot weather the Contractor shall ensure that the constituent materials of the concrete are sufficiently cool to prevent the concrete from stiffening in the interval between its discharge from the mixer and compaction in its final position. Contractor shall propose for approval to the Engineer the measures adopted in order to control the hydration heat.
- D. Cement shall not be allowed to come into contact with water at a temperature greater than 60°C.

5.2.4 TOLERANCES

- A. Structural elements and their geometric deviations shall be as per EN 13670 (Annex G), excepting clauses 10.4 to 10.6, as they are specifically for buildings and shall not be applied to railway and road bridges.
- B. Tolerance Class 1 and Execution Class 3 shall be considered to be normal tolerance as set out in EN 13670, unless noted otherwise in project drawings.

5.2.4.1 CAST IN PLACE ELEMENTS

- A. Main tolerances for cast in place elements shall be as stated in Tables Table 119 to Table 122, as per EHE-08, Annex 11.
- B. Base dimensions are those indicated in the project drawings:
- C. SPREAD FOUNDATIONS AND PILE CAPS

Table 119. Execution tolerances - Spread foundations and pile caps

Deviation	Parameter	Tolerance
In plan deviation (see figures below 10)	centre of gravity of isolated spread footings and pile caps	Lesser of 2% or 50 mm
Elevations (see figures below)	Top of lean concrete	+20 mm / -50 mm
	Top of spread footing or pile cap	+20 mm / -50 mm
	Lean concrete thickness	-30 mm
In plan dimensions	Spread footing or pile cap casted with formwork	+40 mm / -20 mm
	Spread footing or pile cap casted against soil	
	Minimum dimension lesser than 1 m	+80 mm / -20 mm

Deviation	Parameter	Tolerance
	Minimum dimension between 1 m and 2.5 m	+120 mm / -20 mm
	Minimum dimension greater than 2.5 m	+200 mm / -20 mm
	$D > 30$ cm	+16 mm / -12 mm
	Hollow dimensions	± 12 mm
Cross sectional dimensions	-	+ 5% ≤ 120 mm
	-	- 5% ≥ 20 mm
Flatness: Deviations measured after concrete hardening but 72 hours before concrete pouring. A 2 metres rule shall be used, placed randomly on top of footing or pile cap bearing on two points. This procedure is only valid for elements with dimensions greater than 2 m	Lean concrete	± 16 mm
	Top of footing	± 16 mm
	Lateral footing face (only when formwork is used)	± 16 mm

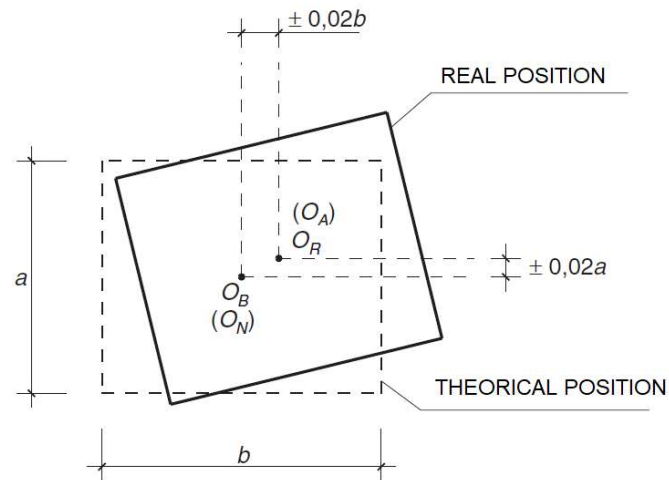


Figure 13. In plan deviation for spread footings

- a. In plan dimensions (a_1 -a or b_1 -b)

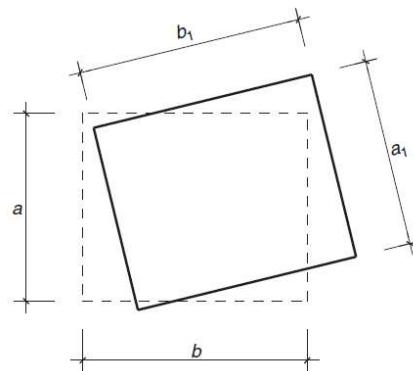


Figure 14. Dimensions in plan view

D. PILES

- a. See chapter: 5.4

E. PIERS AND STRUCTURAL ELEMENTS POURED USING CLIMBING FORMWORKS

- a. In case of contradiction between this chapter and 5.10, the most restrictive shall apply:

Table 120. Execution tolerance - Elements poured using climbing formworks

Deviation	Tolerance (mm)
Vertical deviation Horizontal shift from the basic position of any reference point at the base of the element, as a function of height H	
H ≤ 30 m	• = ±1.5H with a maximum value of 12 mm Where • in mm and H in metres
Lateral deviation	
Between adjacent elements	±50 mm
Wall thickness (t) in abutments and hollow piers	
t ≤ 25 cm	+12 mm / -10mm
t > 25 cm	+16 mm / -10mm
Flat formwork surfaces	
Maximum allowed deviation	± 6 mm in 3 m

F. RETAINING WALLS

Table 121. Execution tolerances - Retaining walls

Deviation	Parameter	Tolerance (mm)
Vertical deviation Lateral displacement of any point of the wall stem from a reference point in the top of the foundation.		
H ≤ 6 m	Exposed surface	±30 mm
	Intrados	±20 mm
H > 6 m	Exposed surface	±40 mm
	Intrados	±24 mm
Thickness (t):		
t ≤ 50 cm		+16 mm / -10mm
t > 50 cm		+20 mm / -16mm
Flatness on wall stem surfaces		
Maximum allowed deviation	Exposed surface	± 6 mm in 3 m
	Intrados	± 6 mm in 3 m
Intrados top edge in exposed walls		
	Intrados	±12 mm
Flatness on wall top surface		
	Top surface	±12 mm with 3 m rule bearing in two random points once the concrete has hardened

G. BRIDGE STRUCTURAL ELEMENTS

Table 122. Execution tolerances - Bridge structural elements

H. Deviation	I. Parameter	J. Tolerance
Vertical deviation	Visible surfaces	±20 mm
	Hidden surfaces	±40 mm
Lateral deviation:	Axis	±24 mm
Concrete flatness	Longitudinal direction	3 mm with 3 m rule bearing on two random points after concrete hardening but 72 hours before concrete pouring
	Transversal direction	6 mm with 3 m rule bearing on two random points after concrete hardening but 72 hours before concrete pouring
Sidewalks	All directions	6 mm with 3 m rule bearing on two random points after concrete hardening but 72 hours before concrete pouring
Cross section dimensions (t= thickness)	Top Slab	
	e ≤ 25 cm	+10 mm / -8 mm
	e > 25 cm	+12 mm / -10 mm
	Transversal dimensions D for piers, walls, abutments, etc	
	D ≤ 30 cm	+10 mm / -8 mm
	30 cm < D ≤ 100 cm	+12 mm / -10 mm
	D > 30 cm	+16 mm / -12 mm
	Hollow dimensions	±12 mm
Relative deviation	Hollow position	±12 mm
	Plan concrete surfaces using formwork regarding the reference plane. Deviation within 3 m	
	Visible surfaces	±12 mm
	Hidden surfaces	±24 mm
	Concrete surfaces built without formwork, apart from pavements and sidewalks, regarding the reference plane. using formwork. Deviations	
	In 3 m	±6 mm
	In 6 m	±10 mm

5.2.4.2 PRECAST ELEMENTS

- A. As a general rule, for prefabricated elements with CE mark, the tolerances required are those laid down in the corresponding harmonised European product standard: EN 14844, EN 15258 and EN 15050 "Precast concrete products. Bridges elements".

B. The tolerances set out in the followings clauses below apply only in the case of elements not bearing the CE marking. These tolerances in Tables Table 123 to Table 125 are as per EHE-08, Annex 11.

C. Always, the base dimensions are those indicated in the Technical Design Drawings:

Table 123. Execution tolerances - Linear precast elements

Deviation	Parameter	Tolerance
Linear structural elements		
Element length (L)	General	$\pm 0.001L$ (m)
	$L \leq 1.0$ m	< 5 mm
	$L > 1.0$ m	< 20 mm or general
Transversal dimensions (D):	$D \leq 150$ mm	± 3 mm
	$150 \text{ mm} < D \leq 500$ mm	± 5 mm
	$500 \text{ mm} < D \leq 1000$ mm	± 6 mm
	$D > 1000$ mm	± 10 mm
Lateral sag, measured from the vertical plan that contains the concrete piece axis, being lesser than $L/750$. L is the piece span	$L \leq 6$ m	± 6 mm
	$6 \text{ m} < L \leq 12$ m	± 10 mm
	$L > 12$ m	± 12 mm
Camber deviation from that specified in the project drawings, measured when the precast element is assembled on site	General elements	$\pm L/750$ and ≤ 16 mm
	Pieces to be assemble one after other	$\pm L/1000$ and ≤ 12 mm
	Being L the piece Length. The explicit values (16 mm and 12 mm) are only mandatory when the aesthetical appearance of the precast elements is compromised.	
Flatness of top face	If cast in place slab is not intended	± 6 mm
	If cast in place slab is intended	± 12 mm
	Deviation measured with 3 m rule bearing on two random points when assembled	

Table 124. Execution tolerances - Plate precast elements

Deviation	Parameter	Tolerance
Length, being L the basic dimension	$L \leq 6$ m	± 8 mm
	$6 \text{ m} < L \leq 12$ m	+12 mm / -16 mm
	$L > 12$ m	+16 mm / -20 mm
Cross section:	$D \leq 60$ cm	± 6 mm
	$60 \text{ cm} < D \leq 100$ cm	± 8 mm
	$D > 1000$ mm	± 10 mm
Openings in plate elements	Opening position	± 6 mm
	Opening relative position	± 6 mm
Embedded elements	Bolts	± 6 mm
	Welded plates	± 24 mm
	Fixation anchorages	± 12 mm

Deviation	Parameter	Tolerance
Wrap when assembly		± 5 mm per linear metre to the closer corner, but not greater than ± 24 mm
Camber (being D [m] the plate diagonal length)		$\pm 0.003D$ with a maximum value of 24 mm

D. ASSEMBLY OF PRECAST ELEMENTS

Table 125. Assembly tolerances - Precast elements

Deviation	Parameter	Tolerance
Vertical deviation		As per cast in place elements
Lateral deviation		As per cast in place elements
Precast walls	Joint width in exposed surfaces	± 6 mm
	Joint width variation along the joint in exposed surfaces	+2 mm per metre, and as minimum ± 1.5 mm between two random points along the joint, being always lesser than ± 6 mm
	Joint between adjacent panels	
	$L \leq 6$ m	± 6 mm
	$6\text{ m} < L \leq 9$ m	± 12 mm
	$9\text{ m} < L \leq 12$ m	± 24 mm
Level deviation between edges or top faces on contiguous pieces	With top slab	± 6 mm
	Without top slab	± 16 mm
Embedded elements	Bolts	± 6 mm
	Welded plates	± 24 mm
	Elements used as guidelines	± 2 mm
Wrap when assembly		± 5 mm per linear metre to the closer corner, but not greater than ± 24 mm
Camber (being D [m] the plate diagonal length)		$\pm 0.003D$ with a maximum value of 24 mm

5.2.5 WORK RECEPTION

- Quality of the concrete needs to be controlled during the mixture production and when the mixture is hardened. This is the responsibility of the Contractor and shall be clearly indicated in the Contractor's QA/QC plan approved by Engineer.
- Special quality control of concrete production shall be ensured according EN 1992-1-1 and EN 206, for example, by certification of the production control according to EN 206, Annex C.
- Identified compacted concrete properties - plasticity (cone sedimentation) mobility and compaction, density, consistency and air content, compressive strength, water permeability index, frost resistance – shall be into conformity.
- Where conformity testing is applied to a concrete family (see EN 206 clause 3.1.1.2), a reference concrete is selected which is either that most commonly produced or one from the mid-range of the concrete family.

Relationships are established between each individual concrete composition of the family and the reference concrete in order to be able to transpose test results for compressive strength from each individual concrete test result to the reference concrete. The relationships shall be reviewed on the basis of original compressive strength test data at every assessment period and when there are appreciable changes in the production conditions. In addition, when assessing conformity for the family, it has to be confirmed that each individual member belongs to the family.

- E. In the sampling and testing plan and the conformity criteria of individual concrete compositions or concrete families, distinction is made between initial production and continuous production.
- F. Initial production covers the production until at least 35 test results are available.
- G. Continuous production is achieved when at least 35 test results are obtained over a period not exceeding 12 months.
- H. If the production of an individual concrete composition, or a concrete family, has been suspended more than 12 months, the producer shall adopt the criteria, sampling and testing plan given for initial production.
- I. During continuous production, the producer may adopt the sampling and testing plan and the criteria for initial production. If the strength is specified for a different age, the conformity is assessed on specimens tested at the specified age. Where identity of a defined volume of concrete with a population verified as conforming to the characteristic strength requirements is to be assessed, e.g. if there is doubt about the quality of a batch or load or if in special cases required by the project specification, this shall be in accordance with EN 206, Annex B.
- J. Samples of concrete shall be randomly selected and taken in accordance with EN 12350-1. Sampling shall be carried out on each family of concrete produced under conditions that are deemed to be uniform. The minimum rate of sampling and testing of concrete shall be in accordance with Table below at the rate that gives the highest number of samples for initial or continuous production, as appropriate.
- K. The samples shall be taken after any water or admixtures are added to the concrete under the responsibility of the producer, but sampling before adding plasticizer or superplasticizer to adjust the consistence is permitted where there is proof by initial testing that the plasticizer or superplasticizer in the quantity to be used has no negative effect on the strength of the concrete.
- L. The test result shall be obtained from an individual specimen or the average of the results when two or more specimens made from one sample are tested at the same age.
- M. Where two or more specimens are made from one sample and the range of the test values is more than 15 % of the mean then the results shall be disregarded unless an investigation reveals an acceptable reason to justify disregarding an individual test value
- N. The test results shall be kept in appropriate records, which checks the technical supervisor, if necessary, by taking samples of controls.
- O. Samples sequences checking monolithic concrete strength has to be carried out for the laid concrete sites.

Table 126. Minimum requirements - Concrete sampling rate for concrete structures

Production	Minimum rate of sampling		
	First 50 m ³ of production	Subsequent to first 50 m ³ of production ^(a)	
		Concrete with production control certification	Concrete without production control certification
Initial (until at least 35 tests results are obtained)	3 samples	1 per 200 m ³ or 1 per 3 production days ^(d)	1 per 150 m ³ or 1 per production day ^(d)
Continuous ^(b) (when at least 35 test results are available)	N/A	1 per 400 m ³ or 1 per 5 production days ^{(c),(d)} or 1 per calendar month	

Production	Minimum rate of sampling		
	First 50 m ³ of production	Subsequent to first 50 m ³ of production ^(a)	
		Concrete with production control certification	Concrete without production control certification

Notes:

- Sampling shall be distributed throughout the production and should not be more than 1 sample within each 25 m³
- Where the standard deviation of the last 15 test results exceeds the upper limits for s_n according to Table 19 in EN 206:2016, the sampling rate shall be increased to that required for initial production for the next 35 test results.
- Or if there are more than 5 production days within 7 consecutive calendar days, once per calendar week.
- The definition of a "production day" shall be stated in provisions valid in the place of use.

- Conformity criteria for compressive strength shall be as per EN 206 clause 8.2.1.3, while conformity control for tensile splitting strength shall be as per EN 206 clause 8.2.2. Acceptance testing of concrete mixture shall be done in accordance with Table 126 and will be carried out by Engineer and/or Employer. The samples for acceptance testing shall be provided by the Contractor in the presence of Engineer and/or Employer, i.e. the Contractor is responsible for proper equipment, workforce and sampling procedure. The Contractor's internal quality testing frequency shall be in accordance with Table 126 and shall be indicated in the Contractor's QA/QC plan.
- In a case of doubt Engineer and/or Employer can request Contractor the testing of the compressive strength of the concrete in structures or precast concrete components in accordance with EN 13791.
- All works not meeting the requirements shall be rejected and will be amended on the expense of the Contractor.

5.2.5.1 *PREFABRICATED AND REINFORCED CONCRETE STRUCTURES*

- Prefabricated concrete and reinforced concrete constructions (parts thereof) that are produced by the project documentation subject to Technical specifications chapters "5.2 CONCRETE WORKS", "5.3 PASSIVE STRUCTURAL REINFORCEMENT" and shall comply with requirements of EN 13369.
- Building products and construction supply shall come from manufacturers whose products are certified or meets the specifications.

5.2.5.1.1 PREFABRICATED CONCRETE AND REINFORCED CONCRETE STRUCTURES TRANSPORTATION

- Prefabricated concrete and reinforced concrete products are transported to building sites in working position (except for columns and some of the other products unless otherwise stated). The Contractor shall check the delivered to the construction site design / product brand, quantity, quality, technical control of seals.
- The Contractor shall be responsible for designing all methods and equipment for handling, lifting and installation of the precast concrete elements. Regions in which the precast elements are to be lifted or supported shall be indicated on the Drawings and the units shall not be lifted or supported at any other points without the prior acceptance of the Employer.
- The contractor shall prepare working drawings describing everything necessary for complete performance of the construction work and coordinate it with the Engineer.
- Where lifting devices are to be cast permanently into the concrete, they shall either:
 - be detailed to provide at least 35mm cover, between the lifting point and the finished concrete surface in the complete works in which case non-corrosion-resistant materials may be used, or
 - be constructed from an accepted grade of stainless steel if they are to be exposed, or provided with not less than 35mm cover, in the completed works.
- The making good of all temporary penetrations for, and/or coverings to, lifting devices shall be carried out by the Contractor in accordance with the requirements of the Employer.

5.2.5.1.2 PREFABRICATED CONCRETE AND REINFORCED CONCRETE STRUCTURES STORAGE

- A. Construction products, in compliance with the storage regulations or manufacturer's recommendations, shall be stored in designated areas.
- B. Part of building / product may be stored in stacks (if allowed by the manufacturer or construction project author).
- C. Precast elements shall be stacked using wooden beams. However, Contractor shall propose the stacking procedure to the Engineer for approval.

5.2.5.1.3 PREFABRICATED CONCRETE AND REINFORCED CONCRETE CONSTRUCTIONS

- A. When assembling prefabricated structures, the stability of the already installed parts of the structure shall be ensured at all the stages of the construction sequence.
- B. When installing individual elements, it is necessary to temporarily secure them before uncoupling them from the hoisting point.
- C. Temporary anchoring shall be such that, if required, the position of the structure can be adjusted in the joints in order to fit the design requirements.

5.2.5.2 CONCRETE SURFACES

- A. For all visible concrete, uniformity of colour and texture are important, and all materials shall be obtained from single consistent source. The aggregates shall be durable and free of any impurities, which may cause staining. The mix proportions and the grading, particularly of the fine aggregate, shall be maintained constant. Any partial replacement of individual plywood sheets or sections of timber in large panels shall be avoided.
- B. Where formwork ties or other embedded ferrous metal parts are built into the concrete, the whole or part of any such supports shall be capable of removal so that any part that remain embedded in the concrete shall be at less 50 mm away from the surface. Holes left after the removal of such parts shall be neatly filled with well-rammed, colour matched, dry-pack mortar.
- C. Curing methods and conditions including the time of removal of formwork shall receive careful consideration. Components that are intended to have the same surface finish shall receive the same treatment and the same curing regime. Where the surface is to receive an applied finish, the Contractor shall ensure the compatibility of any sprayed-on curing membrane with the finish to be applied.
- D. The formwork shall be capable of producing the following finishes where required in the works:
- E. Rough finish. A dense finish with no grout or mortar loss with the specified cover to embedded metal and achieving the specified dimensional tolerances.
- F. Fair finish. As the requirements of rough finish and the resulting finish shall be smooth and of uniform texture and appearance. The formwork lining shall leave no stain on the concrete and shall be so joined and fixed to its backing that it imparts no blemishes. It shall be of the same type and obtained from only one source throughout any one structure. The Contractor shall make good any imperfections, such as discoloration and fins, in the finish. Provision for the embedment of metal parts in the permanent works on a regular spacing, shall be allowed
- G. Permanently exposed concrete surfaces to all Classes of finish other than rough finish shall be protected from rust marks and stains of all kinds.
- H. Unless otherwise stated by the Engineer, all formwork joints for all classes of finish other than rough finish shall form a regular pattern with horizontal and vertical lines continuous throughout each structure and all construction joints shall coincide with these horizontal or vertical lines.

5.2.6 COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.
 - a. EN 1992: Eurocode 2 - Design of concrete structures.
 - b. EN 206+A1: Concrete - Specification, performance, production, and conformity.

- c. EN 196-1 Methods of testing cement. Part 1. Strength determination
- d. EN 196-2 Methods of testing cement. Part 2. Cement chemical analysis
- e. EN 197-1 Cement. Part 1. Composition, specifications and conformity criteria for common cements
- f. EN 197-2 Cement. Part 2. Assessment and verification of constancy of performance.
- g. EN 480-1 Concrete, mortar and grout. Test methods. Part 1. Reference concrete and reference mortar for testing.
- h. EN 932-1 For general properties of aggregates. Part 1. Sampling methods.
- i. EN 932-3 Methods for Determining the Basic Properties of Aggregates Part 3. Petrographic analysis and simplified terms
- j. EN 933-1 Tests for geometrical properties. Part 1. Determination of particle size. Sifting method.
- k. EN 933-3 Tests for geometrical properties. 3. Determination of particle shape. Flatness index.
- l. EN 933-4 For geometrical properties of aggregates. 4. Determination of particle shape. Shape index.
- m. EN 934-1 Concrete, mortar and grout. Part 1. general requirements
- n. EN 934-2 Concrete, mortar and grout. 2 part. Concrete Admixtures accessories. Definitions, requirements, conformity, marking and labelling
- o. EN 1008. Water concrete. Technical water sampling, testing and eligibility requirements, including the return of the concrete production industry, water for reuse in the preparation of concrete mixture
- p. EN 1097-3. For mechanical and physical properties of aggregates. 3. Bulk density and voids.
- q. EN 1367-4. For thermal properties and resistance to weathering methods. 4. Determination of the drying shrinkage.
- r. EN 1744-1. Tests for chemical properties. Part 1. Chemical analysis
- s. EN 12350-1. Concrete mixture tests. Part 1. Sampling taking.
- t. EN 12350-2. Concrete mixture tests. 2 part. Slump testing
- u. EN 12350-3. Concrete mixture tests. 3. Vebe testing.
- v. EN 12350-4. Concrete mixture tests. 4. Degree of compactability
- w. EN 12350-5. Concrete mixture of 5 tests. Flow table test
- x. EN 12350-6. Concrete mixture of 6 tests. Density.
- y. EN 12350-7. Testing fresh concrete — Part 7: Air content of fresh concrete — Pressure methods.
- z. EN 12390-1. Testing hardened concrete — Part 1: Shape, dimensions and other requirements for test specimens and moulds.
- aa. EN 12390-2. Testing hardened concrete — Part 2: Making and curing specimens for strength tests
- bb. EN 12390-3. Testing hardened concrete — Part 3: Compressive strength of test specimens
- cc. EN 12390-6. Testing hardened concrete — Part 6: Tensile splitting strength of test specimens
- dd. EN 12390-7. Testing hardened concrete — Part 7: Density of hardened concrete
- ee. EN 12390-8. Hardened concrete tests. 8. Water penetration depth under pressure
- ff. CEN / TS 12390-9 Hardened Concrete testing. 9 parts. Resistance to cyclical freezing and thawing. Shearing.
- gg. 12504-1. Concrete testing structures. Part 1. Kerns. Sampling, inspection and testing in compression.
- hh. EN 12504-2. Concrete testing structures. 2 part. Non-destructive testing. Rebound rate.
- ii. EN 12878. Pigments for building materials and cement (or) lime. Technical requirements and test methods
- jj. EN 13055-1. Lightweight aggregates. Part 1. Concrete, mortar and grout lightweight aggregates.
- kk. 13369. Common rules for precast concrete products
- ll. EN 13670. Execution of concrete structures.
- mm. EN 15050. Precast concrete products - Bridge elements.
- nn. EN 14844. Precast concrete products - Box culverts.

oo. EN 15258. Precast concrete products - Retaining wall elements.

pp. EHE-08 Code on Structural Concrete.

- B. Where differences exist between standards, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

5.2.7 MEASUREMENT AND PAYMENT – CONCRETE WORKS

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.

- B. The units of measurement shall be as follows:

Table 127. Units of measurement - Concrete works

Uniclass code	Type Number	Work item	Unit	Work item includes
Ss_20_05_15	000301	CAST IN-SITU BLINDING CONCRETE C15 IN FOUNDATIONS	m3	Blinding concrete C15 in foundations consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply, testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_05_15	000302	NON-STRUCTURAL CONCRETE C16/20 FOR FILLING AND LEVELING LAYERS	m3	Concrete C16/20 for filling and leveling layers consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply, testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_05_15	000303	CAST IN-SITU BLINDING CONCRETE C16/20 IN FOUNDATIONS	m3	Blinding concrete C16/20 in foundations consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply, testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_05_15	000305	NON-STRUCTURAL CONCRETE C20/25 FOR FILLING AND LEVELING LAYERS	m3	Concrete C20/25 for filling and leveling layers consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply, testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests

Uniclass code	Type Number	Work item	Unit	Work item includes
Ss_20_05_15	000304	CONCRETE C30/37. FOUNDATIONS. EXPOSURE CLASS XC2	m3	Concrete C30/37 for foundations EXPOSURE CLASS XC2 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply, testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_05_15	000310	CONCRETE C30/37. FOUNDATIONS. EXPOSURE CLASS XC2/XA1	m3	Concrete C30/37 for foundations EXPOSURE CLASS XC2/XA1 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply, testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_05_15	000306	CONCRETE C25/30. FOUNDATIONS. EXPOSURE CLASS XC3 XF2	m3	Concrete C25/30 for foundations EXPOSURE CLASS XC3 XF2 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply, testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_05_15	000307	CONCRETE C35/45. FOUNDATIONS. EXPOSURE CLASS XC4/XD1/XF2	m3	Concrete C35/45 for foundations EXPOSURE CLASS XC4/XD1/XF2 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply, testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_05_15	000308	CYCLOPEAN CONCRETE	m3	Cyclopean concrete in fillings of foundations consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply, testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_50_10_70	000301	CONCRETE C35/45. UNDERPASS STRUCTURE, ABUTMENTS AND WALLS. EXPOSURE CLASS XC4/XD1/XF2	m3	Concrete C35/45 for underpass structure, abutments and walls EXPOSURE CLASS XC4/XD1/XF2 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests

Uniclass code	Type Number	Work item	Unit	Work item includes
Ss_20_50_10_70	000302	CONCRETE C35/45. UNDERPASS STRUCTURE, ABUTMENTS AND WALLS. EXPOSURE CLASS XC4/XD3/XF4	m3	Concrete C35/45 for underpass structure, abutments and walls EXPOSURE CLASS XC4/XD3/XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_50_10_70	000303	CONCRETE C35/45. UNDERPASS STRUCTURE, ABUTMENTS AND WALLS. EXPOSURE CLASS XS1/XD1/XF2	m3	Concrete C35/45 for underpass structure, abutments and walls EXPOSURE CLASS XS1/XD1/XF2 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_50_10_70	000304	CONCRETE C35/45. UNDERPASS STRUCTURE, ABUTMENTS AND WALLS. EXPOSURE CLASS XS1/XD3/XF4	m3	Concrete C35/45 for underpass structure, abutments and walls EXPOSURE CLASS XS1/XD3/XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_50_10_70	000306	CONCRETE C35/45. UNDERPASS STRUCTURE, ABUTMENTS AND WALLS. EXPOSURE CLASS XC4/XD1/XF3	m3	Concrete C35/45 for underpass structure, abutments and walls EXPOSURE CLASS XC4/XD1/XF3 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_50_10_70	000305	CONCRETE C35/40. UNDERPASS STRUCTURE, ABUTMENTS AND WALLS. EXPOSURE CLASS XC4/XD1/XF2	m3	Concrete C35/40 for underpass structure, abutments and walls EXPOSURE CLASS XC4/XD1/XF2 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_50_10_70	000307	CONCRETE C20/25. UNDERPASS STRUCTURE, ABUTMENTS AND WALLS. EXPOSURE CLASS XC4/XD1/XF3	m3	Concrete C20/25 for underpass structure, abutments and walls EXPOSURE CLASS XC4/XD1/XF3 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests

Uniclass code	Type Number	Work item	Unit	Work item includes
Ss_20_50_10_70	000308	CONCRETE C45/55. UNDERPASS STRUCTURE, ABUTMENTS AND WALLS. EXPOSURE CLASS XC4/XD1/XF2	m3	Concrete C45/55 for underpass structure, abutments and walls EXPOSURE CLASS XC4/XD1/XF2 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_50_10_70	000309	CONCRETE C45/55. UNDERPASS STRUCTURE, ABUTMENTS AND WALLS. EXPOSURE CLASS XC4/XD3/XF4	m3	Concrete C45/55 for underpass structure, abutments and walls EXPOSURE CLASS XC4/XD3/XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_50_10_70	000310	CONCRETE C45/55. UNDERPASS STRUCTURE, ABUTMENTS AND WALLS. EXPOSURE CLASS XC4/XD1/XF4	m3	Concrete C45/55 for underpass structure, abutments and walls EXPOSURE CLASS XC4/XD1/XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_50_20_70	000301	CONCRETE C40/50. PIERS. EXPOSURE CLASS XC4/XD1/XF2	m3	Concrete C40/50 for piers EXPOSURE CLASS XC4/XD1/XF2 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_50_20_70	000302	CONCRETE C40/50. PIERS. EXPOSURE CLASS XC4/XD3/XF4	m3	Concrete C40/50 for piers EXPOSURE CLASS XC4/XD3/XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_50_20_70	000303	CONCRETE C40/50. PIERS. EXPOSURE CLASS XS1/XD1/XF2	m3	Concrete C40/50 for piers EXPOSURE CLASS XS1/XD1/XF2 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests

Uniclass code	Type Number	Work item	Unit	Work item includes
Ss_20_50_20_70	000304	CONCRETE C40/50. PIERS. EXPOSURE CLASS XS1/XD3/XF4	m3	Concrete C40/50 for piers EXPOSURE CLASS XS1/XD3/XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_20_50_20_70	000305	CONCRETE C45/55. PIERS. EXPOSURE CLASS XC4/XD3/XF4	m3	Concrete C45/55 for piers EXPOSURE CLASS XC4/XD3/XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_30_16_10	000301	CONCRETE C45/55. DECK. EXPOSURE CLASS XC4/XD3/XF4	m3	Concrete C45/55 for decks EXPOSURE CLASS XC4/XD3/XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_30_16_10	000302	CONCRETE C45/55. DECK. EXPOSURE CLASS XS1/XD3/XF4	m3	Concrete C45/55 for decks EXPOSURE CLASS XS1/XD3/XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_30_16_10	000307	CONCRETE C45/55. DECK. EXPOSURE CLASS XC4/XD1/XF2	m3	Concrete C45/55 for decks EXPOSURE CLASS XC4/XD1/XF2 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_30_16_10	000305	CONCRETE C45/55. VAULT. EXPOSURE CLASS XC4/XD1/XF2	m3	Concrete C45/55 for vaults EXPOSURE CLASS XC4/XD1/XF2 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests

Uniclass code	Type Number	Work item	Unit	Work item includes
Ss_30_16_10	000303	CONCRETE C30/37. DECK. PEDESTRIAN PATH, BALLAST WALLS EXPOSURE CLASS XC4/XD3/XF4	m3	Concrete C30/37 for elements above deck (pedestrian path, ballast wall, etc.) EXPOSURE CLASS XC4-XD3-XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_30_16_10	000304	CONCRETE C35/45. DECK. PEDESTRIAN PATH, BALLAST WALLS EXPOSURE CLASS XC4/XD3/XF4	m3	Concrete C35/45 for elements above deck (pedestrian path, ballast wall, etc.) EXPOSURE CLASS XC4/XD3/XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_30_16_10	000308	CONCRETE C45/55. DECK. PEDESTRIAN PATH, BALLAST WALLS EXPOSURE CLASS XC4/XD3/XF4	m3	Concrete C45/55 for elements above deck (pedestrian path, ballast wall, etc.) EXPOSURE CLASS XC4/XD3/XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_30_16_10	000306	WATERTIGHT CONCRETE C35/45. DECK. PEDESTRIAN PATH, BALLAST WALLS EXPOSURE CLASS XC4/XD3/XF4	m3	Watertight concrete C35/45 for elements above deck (pedestrian path, ballast wall, etc.) EXPOSURE CLASS XC4/XD3/XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), watertight powder (providing a concrete with reduced permeability that protects the resulting concrete against water ingress via hydrostatic pressure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests
Ss_30_16_10	000309	WATERTIGHT CONCRETE C45/55. DECK. PEDESTRIAN PATH, BALLAST WALLS EXPOSURE CLASS XC4/XD3/XF4	m3	Watertight concrete C45/55 for elements above deck (pedestrian path, ballast wall, etc.) EXPOSURE CLASS XC4/XD3/XF4 consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant concrete supply (for the specified exposure), watertight powder (providing a concrete with reduced permeability that protects the resulting concrete against water ingress via hydrostatic pressure), testing of the concrete's plasticity, preparation of the concrete joints with the materials to be use, pouring and compacting the concrete, curing of the concrete and necessary tests

Uniclass code	Type Number	Work item	Unit	Work item includes
Ss_20_05_15	000309	REINFORCED CONCRETE C30/37 FOR MAINTENANCE SLABS, AMOUNT OF STEEL UP TO 65 kg/m ³	m ²	Reinforcement concrete C30/37 for maintenance slabs consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of all materials for the construction of maintenance slabs with reinforcement concrete, 'in situ' and prefabricated, with an amount of steel up to 65 kg/m ³ and exposure class XC4/XD3/XF4 including formwork, concreting and finishing.
Pr_20_76_92_65	000302	TWO-HINGED PRECAST VAULT 15.14m wide	m	Two-hinged precast vault 15.14 m wide consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast vaults, including preparation and checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, neoprene pads for support, filling and sealing with no shrinkage high strength cement mortar, fast setting, and high adherence, "grout" type or similar, for the joining of prefabricated parts, where appropriate, according to drawings.
Ss_25_11_16_65	000301	PRECAST WALLS	m ²	Precast walls consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast walls, including preparation and checking of the support surfaces on site, supply and transport of the prefabricated element to the site, assembly and perfect levelling, filling and sealing, fast setting, and high adherence, "grout" type or similar, for the joining of prefabricated parts, where appropriate

C. Lean (mass) concrete under structures meant for levelling and filling can be substituted with coarse aggregate produced in accordance with EN 13242 and conforming to following requirements:

- Minimum aggregate size $d \geq 4$ mm
- Maximum aggregate size $D \leq 63$ mm
- $G_{c80/20}$
- Fines content f_4
- Flakiness index FI_{50}
- $C_{50/30}$
- Resistance to fragmentation LA_{40}
- Frost resistance:
 - F_{NR} – if the bottom of the foundation structure's foundation is below frost penetration depth;
 - F_4 if the bottom of the foundation is within the frost penetration depth.

5.3 PASSIVE STRUCTURAL REINFORCEMENT

5.3.1 SCOPE

- This Technical Specification section covers passive structural reinforcement products for concrete reinforcement, including handling, transportation, placing in the formwork, tolerances, testing and quality assurance.
- The design working life for steel reinforcement shall be 100 years.

5.3.2 INTRODUCTION

- A. Reinforcing steel bars that are intended to be used for reinforcement of concrete structures, manufacture of anchor bolts, and so on, shall be obtained by hot rolling process with subsequent superficial hardening by heat treatment, being ribbed, in weldable steel grade S500 according to EN 10080.
- B. Reinforcement used in concrete structures shall not be less than B class tensile reinforcing steel whose ductility $k = (f_t / f_y) k \geq 1.08$. In other reinforced concrete structures can be used for class A tensile reinforcing steel whose ductility $k = (f_t / f_y) k \geq 1.05$, with the approval of the Employer

Table 128. Mechanical requirements - Reinforcing Steel

Reinforcing Steel	
Mechanical Requirements	B500C - Minimum values
Ultimate Tensile strength	550 N/mm ²
Yield strength, f_y	500 N/mm ²
Elongation at maximum load	>5%

- C. The maximum carbon content shall be of 0.3%.
- D. The bar schedules are based on the dimensions of the concrete and the nominal cover to the reinforcement shown on the drawings. The reinforcement shall be cut and bent as per EN 1992-1-1, being based on bar diameter:

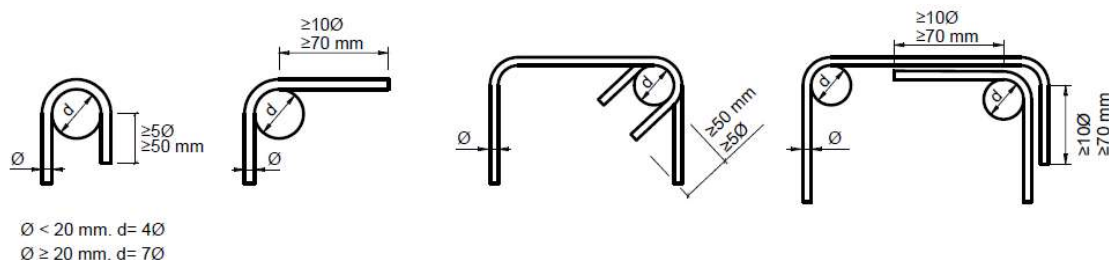


Figure 15. Detailing of transversal reinforcement

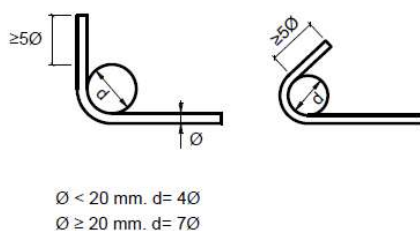


Figure 16. Detailing of longitudinal reinforcement

5.3.3 MATERIALS AND PRODUCTS

- A. Structural reinforcement elements (single rod, bent elements, networks, spatial latticework) produced on site or produced in specialized workshops to be placed in concrete will be according to the design drawings and within tolerances.
- B. Rebar minimum bending diameter (according to EN 1992-1-1) clause 8.3.

Table 129. Requirements - Mandrel diameter

Bar diameter	Minimum mandrel diameter for bends, hooks and loops
$d \leq 16 \text{ mm}$	$4d$

Bar diameter	Minimum mandrel diameter for bends, hooks and loops
d > 16 mm	7d

- A. Bending of reinforcement at temperatures below 5°C or in excess of 100°C shall not be carried out.
- B. Re-bending of carbon steel bars and fabric reinforcement shall not be permitted.
- C. Site storage of reinforcement shall be ensured to be clean and covered with a waterproof sheeting or fixed cover, in order to reduce contamination and excess corrosion prior to placement.

5.3.4 WORK EXECUTION

5.3.4.1 FIXING

5.3.4.1.1 WIRE-ON SPACERS AND CHAIRS

- A. Reinforcement shall be secured against displacement and tied together. Projecting ends of ties or clips shall not encroach into the concrete cover.
- B. The assembly of the reinforcement can be carried out in an industrial facility outside the site or as part of the assembly of the reinforcement on site and shall be carried out by means of wire tying procedures or by application of non-resistant welding.
- C. In any case, the maintenance of the reinforcement shall be guaranteed during the normal operations of its assembly in the formworks as well as during the pouring and compacting of the concrete. In the case of reinforcement bars in a facility outside the work, it shall also be guaranteed that the reinforcement shall be maintained during its transport to site.
- D. Tying shall be done with steel wire using hand tools or mechanical tying machines. Both non-resistant welding and wire tying may be carried out by means of cross or overlapping joints.
- E. In general, the main reinforcement bars shall pass through the interior of the shear reinforcement, unless otherwise indicated in the project plans.
- F. The arrangement of the tying points shall comply with the following conditions depending on the type of element:
 - a. SLABS:
 - i. All bar crossings on the perimeter of the reinforcement shall be tied;
 - ii. When the bars of the main reinforcement have a diameter not exceeding 12 mm, the bar crosses shall be tied alternatively in the rest of the panel, in a staggered manner. Where the diameter of the main reinforcement is greater than 12 mm, the tied crosses shall not be more than 50 times the diameter and shall be evenly arranged at random.
 - b. PIERS AND GIRDERS
 - i. All corner crossings of the stirrups shall be tied to the main reinforcement,
 - ii. When using electrowelded mesh bent into the stirrups or pre-assembly reinforcement for automatic stirrup arrangement, the main reinforcement shall be tied at the corners at a distance of no more than 50 times the diameter of the main reinforcement;
 - iii. Main reinforcement bars not located at the corners of the stirrups shall be tied to the stirrups at distances not exceeding 50 times the diameter of the main reinforcement;
 - iv. In the case of multiple stirrups consisting of other single stirrups, they shall be tied together.
 - c. WALLS:
 - i. The bars shall be tied at their intersections alternately, in a staggered manner.
- G. Bars in inner layers shall be located as shown on the drawings.

5.3.4.1.2 CLIP-ON SPACERS

- A. Fixity of clip-on spacers shall be verified by observing whether they prevent $0.5 \text{ kg} \pm 0.01 \text{ kg}$ commercially ground, unrusted, degreased, silver steel bar, of the smallest bar size (in the size range produced by the manufacturer) from sliding vertically through the spacer as shown in the figure below
- B. In addition, clip-on spacers shall not require more than 150 N force to place them on the largest bar size in the size range produced by the manufacturer (at $20 \text{ }^{\circ}\text{C} \pm 2^{\circ}\text{C}$)

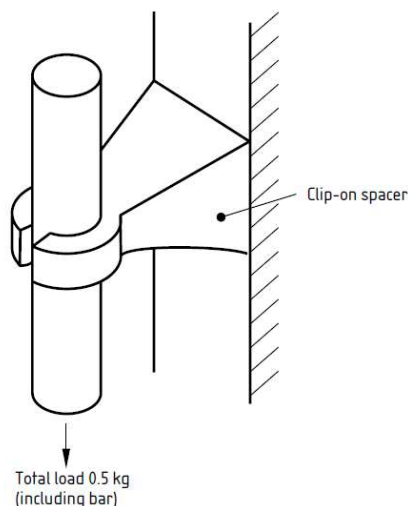


Figure 17. Isometric view of the fixity test for clip-on spacers

5.3.4.2 COVER

- A. Cover shall be achieved by using spacers and chairs which meet the performance requirements of BS 7973-1. They shall be designed so that they will not overturn or be displaced when the concrete is placed.
- B. The spacers shall be used with the following criteria:

Table 130. BS 7973-1. Table 1. Applications for spacers and chairs in terms of category

Spacer and chair category	Application
Light (L)	To provide cover in vertical members to the reinforcement nearest the surface of the concrete or to horizontal reinforcement in small sections not subject to any foot traffic. Not suitable for reinforcement greater than 16 mm in size.
Normal (N)	To provide cover to reinforcement where the size of reinforcement is 20 mm or less.
Heavy (H)	To provide cover to reinforcement where the size of reinforcement is greater than 20 mm.
Chairs (C)	To support the top reinforcement in slabs, so as to provide the required top cover or to separate layers of reinforcement.

- C. The Contractor shall provide access and carry out a cover measurement survey of all reinforced concrete surfaces within the 24-hour period following the removal of formwork. The cover measurement survey shall be carried out on a 500 mm grid over the whole structure. A record of the survey shall be kept and subsequently supplied to the Engineer.
- D. Spacers and chairs shall be manufactured from three basic materials: plastics, cementitious material or steel wire.
- E. The material of manufacture shall have an equivalent durability when it is in place to that of the concrete itself. The spacers or chairs will not cause deterioration to the reinforcement or the concrete, including not allowing free passage of water to the reinforcement nor causing spalling of the finished face.
- F. REQUIREMENTS FOR NON-CEMENTITIOUS SPACERS

- a. Non-cementitious spacers shall satisfy the condition that any cross-section perpendicular to the bar has at least 25% voids within the enclosed perimeter.
- G. REQUIREMENTS FOR CEMENTITIOUS SPACERS
 - a. The mix used for cementitious spacers shall have a cube strength of at least 50 N/mm² at 28 days. Concrete spacers shall not be made on construction site.
- H. REQUIREMENTS FOR STEEL CHAIRS
 - a. When steel chairs are required to support reinforcement off and exposed face, the ends of each chair leg shall be encased in a protective tip, such as a closed plastics sleeve, for a distance of at least 40 mm.
- I. Continuous and circular chairs shall comprise top and bottom wires of equal size and quality to which shall be welded transverse or lattice wires to space them.

5.3.4.3 SURFACE CONDITION

- A. Immediately before concrete is placed around it, reinforcement shall be free from mud, oil, paint, retarder, release agent, loose rust, loose mill scale, snow, ice, grease or any other substance that can be shown to have an adverse chemical effect on the steel or concrete, or to reduce the bond between the steel and the concrete.

5.3.4.4 LAPS AND JOINTS

- A. Laps and joints shall be made only where shown on the drawings, except in the case where additional laps or splice bars are required, and the Engineer's approval has been obtained. Anchoring and overlapping shall be done according to EN 1992-1-1.
- B. Development and lap lengths shall be as in following tables, based on bar size and concrete grade.

Table 131. Lap length

C25/30										
BAR SIZE Ø [mm]	GOOD BOND CONDITIONS					POOR BOND CONDITIONS				
	ANCHORANGE LENGTH [mm]		LAP LENGTH [mm]			ANCHORANGE LENGTH [mm]		LAP LENGTH [mm]		
			% OF LAPPED BARS					% OF LAPPED BARS		
	STRAIGHT	HOOK	≤33%	50%	>50%	STRAIGHT	HOOK	≤33%	50%	>50%
8	350	250	400	500	500	500	350	550	650	700
10	450	300	500	600	650	600	450	700	850	900
12	500	350	600	750	750	700	500	800	1000	1050
16	650	500	750	950	1000	950	650	1100	1300	1400
20	850	600	950	1150	1250	1200	850	1350	1650	1750
25	1050	750	1200	1450	1550	1450	1050	1700	2050	2200
32	1300	950	1500	1850	1950	1850	1300	2150	2600	2800

C30/37										
BAR SIZE Ø [mm]	GOOD BOND CONDITIONS					POOR BOND CONDITIONS				
	ANCHORANGE LENGTH [mm]		LAP LENGTH [mm]			ANCHORANGE LENGTH [mm]		LAP LENGTH [mm]		
			% OF LAPPED BARS					% OF LAPPED BARS		
	STRAIGHT	HOOK	≤33%	50%	>50%	STRAIGHT	HOOK	≤33%	50%	>50%
8	300	250	350	450	450	450	300	500	600	650
10	400	300	450	550	550	550	400	600	750	800
12	450	350	500	650	650	650	450	750	900	950
16	600	450	700	850	900	850	600	950	1150	1250
20	750	550	850	1050	1100	1050	750	1200	1450	1550
25	900	650	1050	1300	1350	1300	900	1500	1800	1950
32	1150	850	1350	1650	1750	1650	1150	1900	2300	2500

C35/45										
BAR SIZE Ø [mm]	GOOD BOND CONDITIONS					POOR BOND CONDITIONS				
	ANCHORANGE LENGTH [mm]		LAP LENGTH [mm]			ANCHORANGE LENGTH [mm]		LAP LENGTH [mm]		
			% OF LAPPED BARS					% OF LAPPED BARS		
	STRAIGHT	HOOK	≤33%	50%	>50%	STRAIGHT	HOOK	≤33%	50%	>50%
8	300	200	300	400	400	400	300	450	550	600
10	350	250	400	500	500	500	350	550	650	700
12	400	300	450	550	600	600	400	650	800	850
16	550	400	600	750	800	750	550	850	1050	1150
20	650	500	750	950	1000	950	650	1000	1300	1400
25	850	600	950	1150	1250	1200	850	1350	1650	1750
32	1050	750	1200	1450	1550	1500	1050	1700	2100	2250

C40/50										
BAR SIZE Ø [mm]	GOOD BOND CONDITIONS					POOR BOND CONDITIONS				
	ANCHORANGE LENGTH [mm]		LAP LENGTH [mm]			ANCHORANGE LENGTH [mm]		LAP LENGTH [mm]		
			% OF LAPPED BARS					% OF LAPPED BARS		
	STRAIGHT	HOOK	≤33%	50%	>50%	STRAIGHT	HOOK	≤33%	50%	>50%
8	250	200	300	350	400	350	250	400	500	550
10	300	250	350	450	450	450	300	500	600	650
12	400	250	450	500	550	550	400	600	750	800
16	500	350	550	700	750	700	500	800	950	1050
20	600	450	700	850	900	850	600	1000	1200	1300
25	750	550	850	1050	1150	1100	750	1250	1500	1600
32	950	700	1100	1350	1450	1350	950	1600	1900	2050

C45/55										
BAR SIZE Ø [mm]	GOOD BOND CONDITIONS					POOR BOND CONDITIONS				
	ANCHORANGE LENGTH [mm]		LAP LENGTH [mm]			ANCHORANGE LENGTH [mm]		LAP LENGTH [mm]		
			% OF LAPPED BARS					% OF LAPPED BARS		
	STRAIGHT	HOOK	≤33%	50%	>50%	STRAIGHT	HOOK	≤33%	50%	>50%
8	250	200	300	350	350	350	250	400	450	500
10	300	200	350	400	450	400	300	450	550	600
12	350	250	400	500	500	500	350	550	700	750
16	450	350	550	650	700	650	450	750	900	950
20	550	400	650	800	850	800	550	900	1100	1200
25	700	500	800	1000	1050	1000	700	1150	1400	1500
32	900	650	1050	1250	1350	1250	900	1450	1750	1900

- C. Where reinforcing bars are required to be coupled, the coupling system shall have a current product acceptance scheme Certificate of Product and shall be sourced, applied and processed from organizations holding relevant valid certificate of approval.
- D. Couplers shall comply with cover requirements of sub-Clause Reinforcement – Fixing and ISO 15835-1.
- E. Welded joints shall be carried out according to section Reinforcement-Welding and EN ISO 17660-1.

5.3.4.5 WELDING

- A. Welded reinforcement, other than steel fabric reinforcement, shall not be incorporated in the permanent works unless permitted by the Engineer.
- B. When required, welding of reinforcing bars shall comply with the requirements of Clause 3.2.5 of EN 1992-1-1 and shall be carried out in accordance with EN ISO 17660 and be subject to the demonstration of the satisfactory performance of trial joints.

- C. The Contractor shall demonstrate that at each location the fatigue life, durability and other properties of the member are not adversely affected by the proposal.
- D. The allowed welding methods are stated herein after.
- E. BUTT JOINTS WELDED BY WELDING PROCESSES 111, 114, 135 AND 136
 - a. Examples of butt joint preparation for load-bearing welded joints are given in following figure from 1a) to 1d).
 - b. Other joint preparations or types permanent backing may also be used under Engineer approval.
 - c. The prepared joint shall be bevelled.
 - d. The joint preparation should be carried out by grinding or flame cutting.

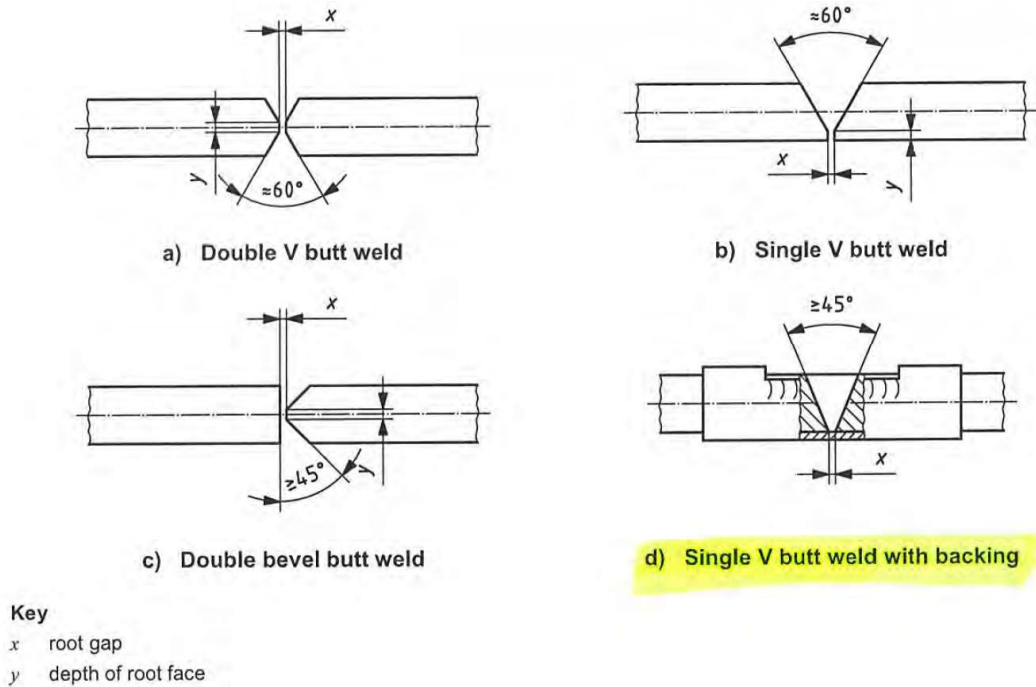
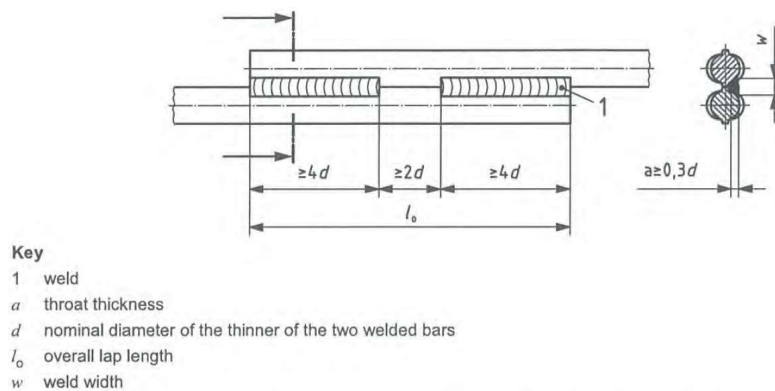


Figure 18. Butt joints as per EN ISO 17660. Clause 6.2.1

F. LAP JOINTS

- a. Lap joints using single-sided intermittent lap welds (asymmetric force flow) shall be welded in accordance with the following figure.

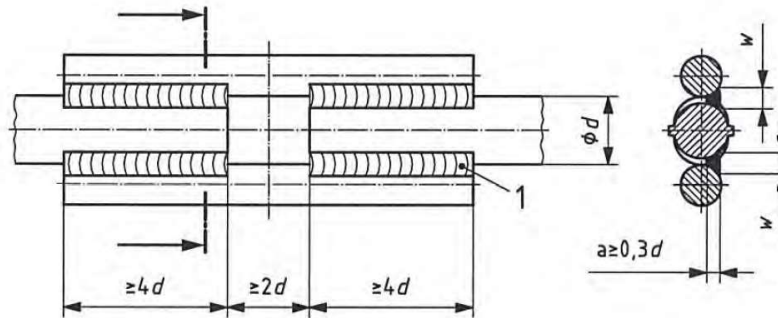


NOTE Welding is also possible on both sides with minimum weld length of $2,5 d$. A conservative estimate of the effective throat thickness can be taken as $a \approx 0,5 w$.

Figure 19. Lap joints as per EN ISO 17660. Clause 6.3

G. STRAP JOINTS

- Strap joints with single-sided lap welds shall be welded in accordance with the following figure.
- Where the straps and the bars have the same mechanical properties, the combined cross-sectional area of the two straps shall be equal to or greater than the cross-sectional area of the bars to be joined.
- Where the straps and the bars do not have the same mechanical properties, the cross-sectional area of the straps shall be adapted on the basis of the ratio of their individual nominal yield stresses.



Key

- 1 weld
- a throat thickness
- d nominal diameter of the thinner of the two welded bars
- w weld width

NOTE Welding is also possible on both sides with minimum weld length of $2,5 d$. A conservative estimate of the effective throat thickness can be taken as $a \approx 0,4 w$.

Figure 20. Strap joint as per EN ISO 17660. Clause 6.4

H. CROSS JOINTS FOR WELDING PROCESSES 111, 114, 135 AND 136

- Cross joints shall be welded in accordance with the following figure. The joint shall be welded, whenever possible, from at least two sides with two equal welds (see figure a).
- If only one single-sided weld is used, the shear strength of the welded joint shall be verified with the force applied as shown in figure b).
- To avoid cracks in the weld, the following conditions shall be fulfilled:

Table 132. Conditions - Bar welding

Condition	Requirement
minimum throat thickness	$a \geq 0,3 d_{\min}$
minimum length of the weld	$l \geq 0,3 d_{\min}$

- If more than one transverse bar is used on the same side of the longitudinal bar, the spacing of the transverse bars shall be at least three times the nominal diameter of the transverse bar.

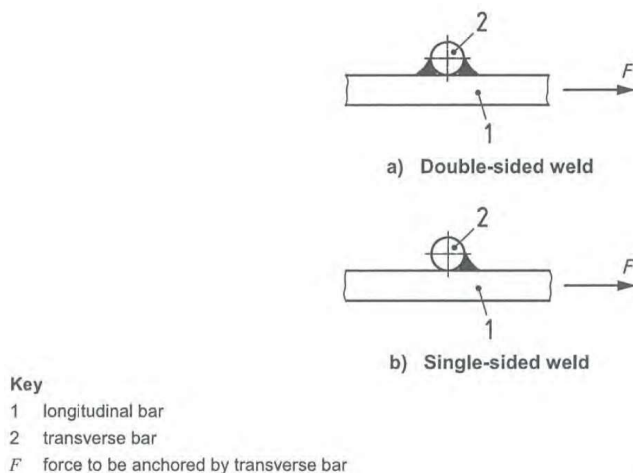


Figure 21. Cross joint welded by welding processes 111, 114, 135 and 136 as per EN ISO 17660. Clause 6.5.2

I. WELDING PROCESSES

- a. The following welding processes, said before, shall be in accordance with ISO 4063, as per the following image.

Table 133. List of processes - Welding (and reference numbers in accordance with ISO 4063. EN ISO 17660)

Welding process	English term	American term
111	manual metal arc welding (metal arc welding with covered electrode)	shielded metal arc welding
114	self-shielded tubular cored arc welding	
135	metal active gas welding (MAG-welding)	gas metal arc welding
136	tubular cored metal arc welding with active gas shield	flux cored arc welding
21	resistance spot welding	
23	projection welding	
24	flash welding	
25	resistance butt welding	
42	friction welding	
47	oxy-fuel gas pressure welding	pressure gas welding

J. COMMON RANGES OF BAR DIAMETERS FOR WELDED JOINTS

- a. A summary of common ranges of bar diameters for welded joints, depending on the welding process, is given in the following table.

Table 134. Common ranges - Bar diameters for welded joints. EN ISO 17660. Clause 6.1

Welding processes	Type of welded joint	Range of bar diameters for load-bearing welded joint mm
21 23	cross joint ^a	4 to 20
24 25	butt joint	5 to 50 5 to 25
42	butt joint joint to other steel component	6 to 50 6 to 50
47	butt joint	6 to 50
111	butt joint without backing butt joint with permanent backing	≥ 16 ≥ 12
114	lap joint	6 to 32
135	strap joint	6 to 50
136	cross joint ^a joint to other steel components	6 to 50 6 to 50

^a d_{min}/d_{max} should be $\geq 0,4$.

5.3.5 TOLERANCES

- A. Inspection of structures and components shall be in accordance with EN 13670. The documentation of inspection shall be in accordance with EN 13670 and this Specification.

Table 135. Production tolerances - Rebar

Verification sizes	Tolerances, mm
When clipping individual rods	± 10
Hoops and stirrups $\varnothing \leq 25$ mm; $\varnothing > 25$ mm	± 16 -24 and +20
Rods folding seats deviation (rod diameter d-)	$\pm 2d$
Angular deviation in hooks and curved bars	$\Delta = \pm 5^\circ$
Flat welded networks: length and width; the distances between the rod centres the longitudinal and transverse directions;	max (± 25 ; 0.5%) max (± 15 , 7.5%)
Flat net curvature in the horizontal plane of the rod diameter: ≤ 12 mm; > 12 mm to ≤ 25 mm; > 25 mm of ≤ 40 mm;	10 15 20
Spatial reinforcement cage length: $5.0 \leq m$; > 5.0 m;	± 40 $\pm 0.8\%$
The distance between the main reinforcement in spatial reinforcement cage, where the bar diameter $d \leq 40$ mm	$\pm 0,5d$
The distances between the transverse rods (clamps) in welded spatial frames	± 10

Verification sizes	Tolerances, mm
Bars (d- bar diameter) and length of lining in welded joints	$\pm 0,5d$
Rod (d- bar diameter) axes are shifted, when welded: butt; using circular lining; by contact	0,05d 0,1d 0,1d
Dimensions of the side seams of the joints (d- rod diameter) length; width;	$\pm 0,5d$ $\pm 0,15d$
Non-weld depth in welded bars (d- rod diameter) when their diameter ≤ 40 mm or when multilayer butt welded is used	0,1d
The distance between the main reinforcement bars: pillars, beams, arches; slabs, walls and foundation in frame structures; Massive construction;	± 10 ± 20 ± 30
The distance between hoops and stirrups	$\pm b/12$

- B. The tolerance on the space dimension providing the cover shall be ± 1 mm for covers/heights up to 75 mm and ± 2 mm for larger cover/heights over 75 mm.
- C. The tolerance on the chair dimensions providing the cover or the specified height shall be ± 2 mm. For continuous and circular chairs where the nominal cover dimension is provided by a longitudinal element any side-supporting element shall not protrude beyond the longitudinal element by more than 3 mm.
- D. Reinforcing steel and reinforcing steel products shall be protected from damage during transport, storage, stacking in the formwork before the concrete pouring. Construction site shall be protected from contamination, damage, and random diameter and bar shape storage.

5.3.5.1 TRACEABILITY AND IDENTIFICATION

- A. Any product acceptance scheme shall ensure that materials used in reinforcing bars are traceable from their initial production casts, through rolling and other treatments to delivery on site of straight bar or cut and bent steel.
- B. The marking system on reinforcement shall be secured, clear and unambiguous. Marking shall also identify the grade of a reinforcement bar both in terms of strength and ductility. Steel for passive reinforcement shall be supplied in accordance with any relevant product acceptance scheme. It shall be deemed to meet the requirements for traceability and identification of materials described above.
- C. If the Contractor does not supply this information, the reinforcement used for Works shall be tested prior to the commencement of the reinforcing works. The Contractor shall possess manufacturer's test certificates for each produced and delivered material. The control tests of the steel reinforcement shall be carried out for each delivery and for each type of reinforcement by appropriate diameters.

5.3.5.2 TESTING AND QUALITY ASSURANCE

5.3.5.2.1 TEST METHODS

- A. Rebar conformity assessment shall be carried out in accordance with standard EN 10080 requirements.
- B. Reinforcing bars and their products shall be tested in accordance with standard EN ISO 15630-1 requirements. Welded reinforcing products shall be tested in accordance with the relevant standards ISO 15630-2, EN ISO 17660-1 and / or EN ISO 17660-2 requirements.

5.3.5.2.2 TEST RESULTS

- A. Utilization of products that do not meet the requirements of rebar or products is prohibited.

5.3.5.2.3 QUALITY ASSURANCE

- A. Visually checking the quality of the reinforcing steel shall not present:
- cracks, overstrain or profiling marks, breakage, local damage at edges, local and general curvature, deviations from design dimensions;
 - damaged by corrosion more than the 5% cross-sectional area
- B. Reinforcing steel, and / or the product quality will be confirmed by a document, in accordance with the visual inspection of reinforced steel and a declaration of performance, which shall meet the performance required in the relevant standards.

5.3.6 COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.
- EN 10080 Reinforcing steel. Weldable reinforcing steel. General specifications.
 - EN ISO 15630-1. Steel concrete reinforcement and prestressing. Test methods. Part 1. The reinforcement bars, wire rod and wire (ISO 15630-1)
 - EN ISO 15630-2. Steel concrete reinforcement and prestressing. Test methods. 2 part. Welded Products (ISO 15630-2)
 - EN 15835-1. Steels for concrete reinforcement. REINFORCING the coupling rod mechanical splice. Part 1. Requirements (ISO 1535-1)
 - EN ISO 17660-1. Welding of reinforcing steel. Part 1. Load bearing welded joints (ISO 17660-1)
 - EN ISO 17660-2. Welding of reinforcing steel. Part 2. Non-load bearing welded joints (ISO 17660-2).
- B. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

5.3.7 MEASUREMENT AND PAYMENT – PASSIVE STRUCTURAL REINFORCEMENT

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 136. Units of measurement - Passive Structural Reinforcement

Uniclass code	Type number	Work item		Unit	Work item includes
Pr_20_96_71_14	000301	REINFORCEMENT STEEL 500 MPA CLASS B or C	kg		Reinforcement steel 500MPa Class B or C consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for steel bars used to reinforce concrete, and includes supply of all materials, cutting and bending of the bars, placing of separators, placing of the bars and tying or welding of the armatures, if applicable.

Uniclass code	Type number	Work item		Unit	Work item includes
Pr_20_96_71_51	000301	REINFORCEMENT COUPLINGS	pc		Reinforcement couplings consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for rebar connection

5.4 REINFORCED CONCRETE PILES

5.4.1 SCOPE

- This Technical specification chapter covers the reinforced concrete piles bored for deep foundation in structures, its materials, installation, testing, tolerances and reception.
- The structures designed are based on bored piles.
- The design working life considered for reinforced concrete piles shall be 100 years.

5.4.2 INTRODUCTION

- The Contractor shall install reinforced concrete cast in situ piles as detailed herein and as shown on the project drawings or as directed by the Engineer.

5.4.2.1 APPROVAL OF PROPOSALS

- Before any piling is started, the Contractor shall familiarize with the information provided in the site investigation report which forms a part of the contract document.
- The Contractor shall submit to the Engineer a complete detailed work execution project and the method of construction he proposes for approval.
- This shall include the method proposed by the Contractor to adopt for excavating/boring, stabilising the hole, any dewatering, placing of concrete, testing of piles, load testing of working piles, the plant, machinery and equipment he proposes to use and comprehensive programme of work.

5.4.2.2 LABOUR

- The Contractor shall maintain at the site a specially qualified and experienced supervisor together with the necessary workforce of trained labour experienced in casting of piles. Qualifications for the personnel shall be indicated in work execution project and approved by Engineer.

5.4.3 MATERIALS AND PRODUCTS

5.4.3.1 REINFORCEMENT

- Qualifying fixtures and reinforcing products shall comply with Technical specifications chapter "5.3 PASSIVE STRUCTURAL REINFORCEMENT". Minimum longitudinal reinforcement bars shall comply with the requirements of EN 1536 +A1.
- The number of splices in longitudinal steel bars shall be kept to a minimum. Splices in steel reinforcement shall be such that the full strength of each bar is effective across the splice and shall be made so that there is no detrimental displacement of the reinforcement during the construction of the pile. Reinforcement shall be maintained in its correct position during concreting of the pile, to allow a vertical tolerance of +150/-50 mm on the level of the reinforcement projecting above the final cut off level. Where reinforcement is made up into cages,

they shall be sufficiently rigid to enable them to be handled, placed and concreted without damage. If the cage is to be welded together, welding shall be carried out to the requirements of EN ISO 17660.

- C. Unless otherwise specified, reinforcement shall extend to the base of the pile.
- D. Spacers shall be designed and manufactured using durable materials which shall not lead to corrosion of the reinforcement or spalling of the concrete cover. Details of the means by which the Contractor plans to ensure the correct cover and position of the reinforcement shall be submitted for Engineer's approval.

5.4.3.2 CONCRETE

- A. Requirements for concrete, concrete mix and concreting will be according TS section "Concrete works". Piles concrete mixture, its preparation, sampling and testing shall meet the standard EN 1536 requirements of paragraph 6.3. Pile concrete shall meet the standard EN 1536 requirements of paragraph 8.3.
- B. The consistence and method of placing of the concrete shall be such that a continuous monolithic concrete or grout shaft of the full cross-section is formed. Concrete shall be transported from the mixer to the position of the pile in such a manner that segregation of the concrete constituents does not occur.
- C. The concrete shall be placed without such interruption as would allow the previously placed batch to have achieved a stiffness which prevents proper amalgamation of the two concrete batches.
- D. The Contractor shall take all precautions in the design of the concrete mix and placing of the concrete to avoid arching of the concrete. No soil, liquid, or other foreign matter shall be permitted to contaminate the concrete.

5.4.3.3 DRILLING FLUID

5.4.3.3.1 SUPPLY AND MIXING

- A. Drilling Fluid, Bentonite, if used shall be in accordance with specification DFCP 4 of the Oil Companies Materials Association or equivalent.
- B. A certificate shall be obtained by the Contractor from the manufacturer/supplier and shall be forwarded to the Engineer and Environmental Authorities for approval.
- C. Bentonite shall be mixed thoroughly with clean fresh water to make a suspension which will maintain the stability of the pile bore for the period necessary to place concrete and complete construction.

5.4.3.3.2 TEST

- A. Contractor shall carry out tests indicated in this chapter and as indicated in Quality control plan.
- B. Control tests shall be carried out on the bentonite suspension, using suitable apparatus. Density of freshly mixed bentonite suspension shall be checked daily.
- C. Tests to determine density, viscosity, shear strength and pH value shall be applied to bentonite supplied to the pile bore.
- D. The results shall be within the range indicated below:

Table 137. Minimum testing requirements - On drilling fluid

Property to be Measured	Range of Results at 20°C	Test Method
Density	Less than 1.10 g/ml	Mud density balance
Viscosity	30-90 s or lesser than 20 cp.	Marsh cone method Fann viscometer
Shear Strength (10 minutes gel strength)	1.4 – 10 N/mm ² or 4 – 40 N/mm ²	Shearometer Fann viscometer
pH	9.5-12	pH indicator paper or electrical pH meter

- E. The frequency of testing shall be as specified in Quality control plan by the Contractor. When the results show consistent behaviour, the test for shear strength and pH value may be discontinued with the approval of the Engineer.

5.4.4 *WORK EXECUTION*

- A. Pile drilling, concrete reinforcement composition and conducted in accordance with EN 1536 the methods and requirements. Drilling equipment shall meet the requirements of EN 16228-1.
- B. Piles shall be bored in an order and in such a manner that no damage is sustained by previously formed piles.

5.4.4.1 *CASING*

- A. Temporary casings shall be of quality material, length and thickness adequate for the purpose of preventing water and unstable soil from entering the pile excavations. A short length of temporary casing shall be provided for all piles to provide an upstand of at least 1.0 m above surrounding ground level for safety and to prevent contamination of the concrete in the bore.
- B. Temporary casings shall be used to support overburden soils during drilled shaft construction in those sites where those conditions exist unless differently specified.
- C. Temporary casings shall maintain the excavations to their full dimensions and ensure that piles are completed to their full cross-sectional dimensions.
- D. Temporary casings shall be free from significant distortion. They shall be of uniform cross-section throughout each continuous length. During concreting, they shall be free from internal projections and encrusted concrete which might adversely affect the proper formation of piles.
- E. Where piles are bored under water or support fluid in an unlined state, the insertion of a full-length loosely fitting casing to the bottom of the bore prior to placing concrete will not be permitted.

5.4.4.2 *STABILITY OF PILE BORE*

- A. Where boring takes place through unstable water-bearing strata, the process of excavation and the support fluid and depth of temporary casing where employed shall be such that soil from outside the area of the pile is not drawn into the pile section and cavities are not created outside the temporary casing as it is advanced.
- B. Where a support fluid is used for maintaining the stability of a bore, an adequate temporary casing shall be used in conjunction with the support fluid so as to ensure stability of the strata near ground level until concrete has been placed. During construction the level of drilling fluid in the pile excavation shall be maintained within the cased or stable bore so that it is not less than 2.0 m above the level of external standing groundwater at all times, unless stated otherwise by the Engineer. In addition, when fluid is used, the tremie will be always introduced 5 m inside the concrete previously poured.
- C. In the event of a rapid loss of drilling fluid from a pile excavation, the bore shall be backfilled without delay and instructions of the Engineer shall be obtained before boring at the location is resumed.
- D. The Contractor shall avoid contamination of the environment, keeping fluids controlled within an enclosure around the pile and removing them to landfill for treatment.
- E. Contractor shall prepare a detailed Environmental Plan within the scope of the Construction Contract, which shall be approved by the Engineer and Environmental Authorities, explaining clearly how the drilling fluids are treated and where they will be disposed. The bentonite slurry may be dehydrated on site or at an outside waste management company facility. In both cases press filters are used for drying out and separating end product from water. The result of this separation is an end product made up on the one hand of dry bentonite with solids from the excavation and on the other of water with little or no contamination.
- F. Contractor shall propose for Engineer and Environmental Authorities approval the filter cloth to be used for bentonite slurry. The most suitable, Polyamide or polypropylene in its multifilament, monofilament or mono-multifilament forms, with different permeability ratings cloth, for wasting dump facility shall be provided by Contractor. This shall be approved by Engineer and Environmental Authorities.

- G. Thermal-mechanical treatment shall be applied. It shall be heat setting or calendaring, applied as many times as is necessary and at different pressures to achieve greater or lesser permeability in the cloth.

5.4.4.3 PUMPING FROM PILE BORES

- A. Pumping from pile bores shall not be permitted unless the bore has been sealed against further water entry by casing or unless the soil is stable and will allow pumping to take place without ground disturbance below or around the pile. It is to say, the soil ground shall not be disturbed at all.

5.4.4.4 CONTINUITY OF CONSTRUCTION

- A. The pile shall be bored, and the concrete shall be placed without such delay as would lead to impairment of the performance of the pile.
- B. The time period during which each pile is excavated, and the concrete is placed shall not exceed 12 hours. The time period shall start when excavation below the temporary lining tubes commences.
- C. Where the construction sequence is such that the time period of 12 hours will be exceeded even if no delays are taken into account, a realistic time period during which the pile is excavated and concrete placed shall be stated in the Contractor's method statement.
- D. The Contractor shall advise on the likely effect of this extended pile construction period on the performance and capacity of the pile.

5.4.4.5 CLEANING OF PILE BASES

- A. On completion of boring loose, disturbed or softened soil shall be removed from the bore using appropriate methods, which shall be designed to clean while at the same time minimizing ground disturbance below the pile bases.
- B. Water or support fluid shall be maintained at such levels throughout and following the cleaning operation that stability of the bore is preserved.
- C. At all times when the pile head is unattended, the bore shall be clearly marked and fenced off so as not to cause a safety hazard.

5.4.4.6 EXTRACTION OF CASING

- A. Temporary casings shall be extracted while the concrete within them remains sufficient consistence to ensure that the concrete is not lifted.
- B. During extraction the motion of the casing shall be maintained in an axial direction relative to the pile.
- C. When the casing is being extracted, a sufficient quantity of concrete shall be maintained within it to ensure that pressure from external water, support fluid or soil is exceeded and that the pile is neither reduced in section nor contaminated.
- D. The concrete level within a temporary casing in a dry bore may be topped up where necessary during the course of casing extraction so that the base of the casing is always below the concrete surface until the casting of the pile has been completed.
- E. Adequate precautions shall be taken in all cases where excess heads of water or support fluid could occur as the casing is withdrawn because of the displacement of water or fluid by the concrete as it flows into its final position against the walls of the pile bore.
- F. Where two or more discontinuous lengths of casing (double casing) are used in the construction the Contractor's method of working shall produce piles to their full designed cross-sections.
- G. The depth to the average levels of the concrete surface of the pile shall be measured before and after each temporary casing is removed.
- H. These measurements shall be recorded on the pile record.

5.4.4.7 PILE CUTTING OFF

- A. The piles shall be cast to a level above the specified cut-off so that, after trimming to remove all debris and contaminated concrete, a sound concrete connection with the pile can be made.
- B. When cutting off and trimming piles to the specified cut-off level, the Contractor shall take care to avoid shattering or otherwise damaging the rest of the pile.
- C. Any cracked or defective concrete shall be cut away and the pile repaired in a manner to provide a full and sound section at the cut-off level

5.4.5 TOLERANCES

- A. Piles shall be installed, for all kind of structures, within the following maximum permitted tolerances:

Table 138. Execution tolerances - Piles

Property	Tolerance
Position	lesser of 10% pile diameter or 75 mm in any direction at commencing level
Verticality	1 in 75 deviation from the vertical
Bore depth	± 1% Pile length
Rake	1 in 25 deviation from the specified rake for piles raking up to 1:6 and 1 in 15 for piles raking more than 1:6
Diameter	not less than the specified diameter

- B. No method of forcible correction will be permitted unless it can be proved that the integrity, durability and performance of the piles will not be adversely affected

5.4.6 WORK RECEPTION

- A. The following studies and alternative tests are envisaged to be performed in piles by Contractor:
 - a. Pile bearing capacity tests according to EN 1997-1, Clause 7.5; EN 1536, Clause 9 and EN 12699, Clause 9 requirements:
 - i. Static load method in accordance with EN ISO 22477-1.
 - ii. Dynamic load method in accordance with EN ISO 22477-4.
 - iii. Pseudo static "Statnamic" method according to EN ISO 22477-10 or ASTM D 7383-08 under Engineer Approval.
 - b. Pile integrity tests shall be according to EN 1536 and EN 1997-1 requirements. Cross hole logging method tests according to ASTM D6760.
 - c. Impact integrity test for small deformations according to ASTM D5882, AFNOR NF P94-160-2, CUR Aanbevelingen 109 or DGGT EA-Pfähle, in case of being performed, shall be approved by Engineer.
- B. At least one load bearing test shall be executed for each pile type and for each zone of homogeneous subsoil conditions. If the outcome of these tests leads to unclear or doubtful results, then further load tests are necessary. The number of piles to be tested for load-bearing capacity shall be at least 1% of the number of piles in case for foundation with a large number of piles. In case one load-bearing capacity test result is rejected, the number of tests to be performed shall be increased to at least 4% (rounded up to the whole number if needed).
- C. The piles to be tested shall be proposed by Contractor and/or Engineer before starting the piling operations and be approved by the Engineer. Foundations of most important structures shall be chosen to be pile-tested in any case, always under the number of test piles to be performed and stated before.
- D. The bearing capacity test method, as default, shall be the static load method carried out in design final piles, however dynamic load or pseudo static load "Statnamic" could be performed if proposed by the contractor and accepted by the Engineer. Dynamic load or pseudo static load "Statnamic" could be requested by Engineer if necessary.
- E. Otherwise, pile integrity tests, shall be carried out for 100% of the pile.

5.4.6.1 ADDITIONAL TEST ON VICINITY PILES TO REQUIRED FOUNDATIONS

- A. If load-bearing capacity tests are performed by Contractor in additional, non-design piles, these piles shall be installed after capacity tests have been performed in the designed piles. The static test loads on design piles shall be at least equal to ultimate design loads for the piles or 1.5 times the service load of the piles. In the case of non-design piles the test shall be continued up to failure or excessive deformation.
- B. These non-design piles shall be in the vicinity of the design ones. Depending on the results of the pile tests, length, diameter, reinforcement and number of piles may be adjusted in the design under Engineer approval.
- C. In exceptional cases, the pile type even might be modified, always under Engineer approval.
- D. Regardless of stated above, the design of piles based on pile test, shall be always as per country local or EN 1997-1 requirements.
- E. The Contractor shall assess any additional materials and mechanisms according to the selected test technology needed to carry out the test piles and submit them to the Engineer for approval.

5.4.6.2 INTEGRITY TESTING OF PILES

- A. Where integrity testing is called for, the method to be adopted shall be one of the following, as specified:
 - a. Impulse method; (PIT)
 - b. Sonic Echo, Frequency Response or Transient Dynamic steady state vibration method;
 - c. Cross hole Sonic logging method. (CSL) according to ASTM D6760.
 - d. Test methodology and procedure is to be presented by the contractor and approved by the Engineer.
- B. For sonic testing, metallic tubes shall be installed, embedded in the concrete and attached to the reinforcement. The number of tubes will be three (3) for diameters less than 1 m, four (4) for diameters from 1 m to 1.4 m, and six (6) tubes for diameters between 1.5 and 2.10 m. Tube diameter recommended is 50 mm, and minimum 40 mm. CSL tests are recommend as integrity tests for piles with diameter of 1 m or more.
- C. In the case of cast-in-place concrete piles, integrity tests shall not be carried out until 28 days have elapsed since pile casting, unless otherwise directed or approved by the Engineer.
- D. Where the method of testing requires the positioning of sensing equipment on the pile head, the head shall be broken down to expose sound concrete and shall be clean, free from water, grout, loose concrete, over spilled concrete and blinding concrete and shall be readily accessible for the purpose of testing.
- E. The testing shall be carried out by a specialist firm, which has experience on other similar contracts before the commencement of testing. The Contractor shall submit the name of the specialist integrity testing firm, a description of the test equipment, a test method statement and a program for executing the specified tests prior to commencement of the Works.
- F. The Contractor shall give all available details of the ground conditions, pile dimensions and construction method to the specialist firm before the commencement of integrity testing in order to facilitate interpretation of the tests.
- G. Preliminary results of the tests shall be made available within 24 hours of carrying out the tests. The test results and findings shall be recorded and made available within 10 days of the completion of each phase of testing. The report shall contain a summary of the method of interpretation including all assumptions, calibrations, corrections, algorithms and derivations used in the analyses. If the results are presented in a graphical form, the same scales shall be used consistently throughout the report. The units on all scales shall be clearly marked.
- H. In the event that any anomaly in the acoustic signal is found in the results indicating a possible defect in the pile the Contractor shall demonstrate that the pile is satisfactory for its intended use or shall carry out remedial works to make it so. Sonic logging tubes shall be grouted up after the Contractor has demonstrated that the pile is satisfactory.

5.4.6.3 STATIC PILE LOAD TEST

- A. Static pile load tests are proposed according to the test procedure described in EN 1997-2 (Section 7.5.2) and in accordance with EN ISO 22477-1 or as alternative, if approved by the Engineer, the "ISSMFE Subcommittee on Field and Laboratory Testing, Axial Pile Loading Test, Suggested Method. ASTM Journal, June 1985, pp. 79-90."
- B. Dynamic load tests Method shall be calibrated against static load tests on the same type of pile, or similar length and cross-section, and in comparable soil conditions according to EN 1997-1 (Section 7.5.3) and in accordance with EN ISO 22477-4 or as alternative, if approved by the Engineer, the "ASTM Designation D 4945, Standard Test Method for High-Strain Dynamic Testing of Piles".
- C. As aforementioned, the Contractor shall include all relevant details of the method of testing as part of Contractor's Documents to the Engineer for approval.
- D. The Contractor shall submit the records of the testing to the Engineer, and the records shall be filed along the bridge span life by the Engineer's Office.

5.4.6.4 REJECTION OF PILES

- A. ADDITIONAL PILES
 - a. If any pile is rejected, either due to its incorrect position, poor workmanship or materials or due to any other cause, the Engineer may order an additional or if necessary, two additional piles, to be installed and incorporated in the pile cap re-designed to the approval of the Engineer.
- B. PAYMENT
 - a. If at the direction of the Engineer, the Contractor installs an additional pile, or if necessary two additional piles, the Contractor shall not be paid for the rejected pile, but he shall be paid for one additional pile.
 - b. The Contractor shall himself bear the costs of the second pile if two are ordered, plus the additional cost of the pile cap over the amount for the designed pile cap allowed under the contract, and plus also all costs involved in amendments necessary to the supported structure a result of the altered positions of the pile and the special design of the pile cap.

5.4.7 CONTINUOUS FLIGHT AUGER (CFA) PILES

5.4.7.1 GENERAL REQUIREMENTS

- A. This clause covers the requirements for the construction of reinforced cast-in-place concrete injected piles using continuous flight augers (CFA). They are used as foundation for noise barriers.
- B. Dimensions shall be as shown on Technical Design and Drawings. The diameter of a pile shall not be less than the specified diameter.

5.4.7.2 MATERIAL

- A. Concrete shall be as shown on Technical Design Drawings and complying with relevant clauses of Section 05 in this Technical Specification.
- B. Steel reinforcement shall be as shown on Technical Design Drawings and complying with with relevant clauses of Section 05 in this Technical Specification.

5.4.7.3 EXECUTION REQUIREMENTS

5.4.7.3.1 BORING

- A. Removal of augers from the ground:
 - a. The auger shall not be extracted from the ground during the boring or construction of a pile in such a way that an open unsupported bore or inflow of water into the pile section would result.

- b. As the auger is withdrawn from the ground it shall be cleaned of all rising.
- B. Suitability of boring equipment:
 - a. The piles shall be bored using equipment capable of penetrating the ground without drawing surrounding soils laterally into the pile bore.
 - b. The Contractor shall record the fact if flighting of soil up the auger is excessive.
 - c. The verticality of the auger shall be checked at the commencement of boring. Should it deviate during boring so that the pile verticality is outside the specified tolerance the fact shall be recorded on the pile record.
- C. Sealing the base of the auger: The base of the auger stem shall be fitted with a suitable means of sealing it against ingress of water and soil during boring.

5.4.7.3.2 PLACING OF CONCRETE

- A. Equipment for supply of concrete to piles:
 - a. concrete shall be supplied to the pile through suitable concrete pump, tubing and the hollow auger stem.
 - b. All pipe fitments and connections shall be so constructed that grout does not leak during the injection process.
- B. Rate of supply of concrete or grout:
 - a. The concrete shall be supplied to the pile at a sufficient rate during auger withdrawal to ensure that a continuous monolithic shaft of at least the full specified cross-section is formed, free from debris or any segregated concrete or grout.
- C. Completion of concreting or grouting of piles:
 - a. If the concrete placing in any pile cannot be completed in the normal manner, then the pile shall be re-bored to a safe level below the position of interruption in supply before the concrete has achieved initial set and before further concrete is injected. The method statement submitted by the Contractor shall set out the procedure.
- D. Casting level of pile head:
 - a. Concrete shall be cast to the commencing surface level in all cases.
 - b. The pile position shall be clearly marked and fenced off so as not to cause a safety hazard.

5.4.7.3.3 REINFORCEMENT

- A. All reinforcement shall be placed right after the completion of the concreting operation.
- B. It shall be fabricated in cages or bundles of bars fixed securely to permit it to be placed in the correct position and to the depth specified through the concrete of the pile.
- C. Suitable spacers shall be provided to maintain the specified concrete cover to steel.
- D. The transverse reinforcement of any reinforcing cage shall meet the design requirements and shall maintain the longitudinal bars in position when the cage is inserted into the wet concrete.
- E. Longitudinal main steel reinforcement shall be continuous over the specified length. Where joints are necessary, no more than one joint shall be used and then only if the reinforcement cage length exceeds 12m. Joints in steel reinforcement shall be such that the full strength of each bar is effective across the joint and shall be made so that there is no detrimental displacement of the reinforcement during placing in the pile.
- F. Reinforcement shall be placed and maintained in position to provide the specified projection of reinforcement above the final cut-off level. A vertical tolerance of +150/-50 mm on the level of reinforcement projecting above the final cut-off level shall be met.

5.4.7.3.4 CUTTING OFF PILE HEADS

- A. When cutting off and trimming piles to the specified cut-off level, the Contractor shall take care to avoid shattering or otherwise damaging the rest of the pile.

- B. Any laitance, or contaminated, cracked or defective concrete shall be cut away and the pile made good in a manner to provide a full and sound section up to the cut-off level.

5.4.8 COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.
- a. EN 1536 Special geotechnical works. Bored piles
 - b. EN 12699 Special geotechnical works. Driven piles
 - c. EN 16228-1 Drilling and foundation equipment. Safety. Part 1. General requirements
 - d. EN 1997-1 Eurocode 7. Geotechnical design. Part 1. General rules
 - e. BS 8008 – “Safety precautions and procedures for the construction and descent of machine-bored shafts for piling and other purposes”.
 - f. ISO 13500 Drilling fluid materials. Specifications and tests
 - g. ISO 10414-1 Field testing of drilling fluids – Part 1: water-based fluids
 - h. ASTM D6760 Standard Test Method for Integrity Testing of Concrete Deep Foundations by Ultrasonic Cross hole Testing.
- B. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

5.4.9 MEASUREMENT AND PAYMENT – REINFORCED CONCRETED PILES

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract. The tubes for the cross hole sonic logging test are included in the price of the pile drilling.
- B. The units of measurement shall be as follows:

Table 139. Units of measurement - Reinforced Concreted Piles

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_20_05_65_41	000301	PILE DRILLING, DIAMETER OF 1.00 M. RECOVERING THE CASING PIPE	m	Pile drilling diameter 1.00 m consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the execution of pile drilling for deep foundations or retaining structures, including placement and removal of casing pipe
Ss_20_05_65_41	000302	PILE DRILLING, DIAMETER OF 1.20 M. RECOVERING THE CASING PIPE	m	Pile drilling diameter 1.20 m consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the execution of pile drilling for deep foundations or retaining structures, including placement and removal of casing pipe
Ss_20_05_65_41	000303	PILE DRILLING, DIAMETER OF 1.50 M. RECOVERING THE CASING PIPE	m	Pile drilling diameter 1.50 m consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the execution of pile drilling for deep foundations or retaining structures, including placement and removal of casing pipe

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_20_05_65_41	000304	PILE DRILLING, DIAMETER OF 1.80 M. RECOVERING THE CASING PIPE	m	Pile drilling diameter 1.80 m consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the execution of pile drilling for deep foundations or retaining structures, including placement and removal of casing pipe
Ss_20_05_65_41	000305	PILE DRILLING, DIAMETER OF 0.80 M. RECOVERING THE CASING PIPE	m	Pile drilling diameter 0.80 m consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the execution of pile drilling for deep foundations or retaining structures, including placement and removal of casing pipe
Ss_20_05_65_41	000306	PILE DRILLING, DIAMETER OF 0.50 M, CFA DRILLING SYSTEM	m	Pile drilling CFA system diameter 0.50 m consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the execution of pile drilling for deep foundations or retaining structures with CFA (Continuous Flight Auger) system
Ss_20_05_65_41	000307	PILE DRILLING, DIAMETER OF 0.50 M. RECOVERING THE CASING PIPE	m	Pile drilling diameter 0.50 m consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the execution of pile drilling for deep foundations or retaining structures, including placement and removal of casing pipe
Ss_20_05_65_41	000308	PILE DRILLING, DIAMETER OF 1.00 M. WITHOUT CASING PIPE	m	Pile drilling diameter 1.00 m (without casing pipe) consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the execution of pile drilling for deep foundations or retaining structures.
Ss_20_05_65_41	000309	PILE DRILLING, DIAMETER OF 0.60 M. WITHOUT CASING PIPE	m	Pile drilling diameter 0.60 m (without casing pipe) consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for the execution of pile drilling for deep foundations or retaining structures.
Ac_25_30_50	000301	SONIC TESTING ON PILES	pc	Sonic testing on piles consists of all works to check the integrity and compactness of the piles by means of the "sonic transparency" procedure (diagraphy) that consists of obtaining sonic cross sections (between pairs of tubes) of the state and continuity of the concrete.

Uniclass code	Type number	Work item	Unit	Work item includes
Ac_25_30_50	000302	PILE TESTING WITH STATIC LOAD	pc	Static testing on piles consists of all works and expenses necessary to achieve the end result as per technical specification, and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for check the behaviour of deep foundations with service load. It consists of the application of a load and the study of the deformations caused by that load in the pile.
Ac_25_30_50	000303	LOW-STRAIN TESTING ON PILES	pc	Low-strain testing on piles consists of all works to check the integrity and compactness of the piles by means of the Low Strain Integrity Test method that consists of obtaining the response of the pile to the impact on the head and analyzing the state and continuity of the concrete.

C. The measurement of items related to pile drilling shall be for metallic tubes installed for sonic testing.

5.5 REPAIR, PROTECTION AND WATERPROOFING OF CONCRETE SURFACES

5.5.1 SCOPE

- A. This Technical specifications chapter concrete and reinforced concrete structures preparatory work, repair and surface coating of protective coatings, as well as waterproofing for structures, including decks, abutment, walls and underground elements
- B. The design working life of these elements shall be at least 25 years unless specified otherwise.

5.5.2 MATERIALS AND PRODUCTS

5.5.2.1 CONCRETE REPAIR

5.5.2.1.1 ANCHORING MATERIAL

- A. Anchoring material will be used in case of any construction defect which compromise the anchor (including rebars) bonding.
- B. Anchoring materials shall be certified in accordance with standard EN 1504-6 requirements, have a manufacturer's declaration of performance - the original copy and translation of the national language.
- C. EN 1504-6 defines the anchoring products as hydraulic binders, synthetic resins or a mixture of these, installed at a fluid or paste consistency, to grout ribbed steel bars (rebars) in concrete structures.
- D. The declaration shall include the compliance of performance characteristics of anchoring products which are required for anchoring of reinforcing steel bars (rebars) according to EN 1504-6 table 1, product identification according to EN 1504-6 table 2 and anchoring product performance rates according to EN 1504-6 table 3.
- E. For steel anchor bolts, method 4.2 covered in EN 1504-6 and EN 1992-4 shall be followed.

5.5.2.1.2 REPAIR MORTARS

- A. Concrete repair mortars shall be certified in accordance with standard EN 1504-3 requirements, have a manufacturer's declaration of performance - the original copy and translation of the official national language.
- B. The declaration shall include the repair mortar conformity with EN 1504-3 Table 3 requirements and include the compliance for at least one of the following repair methods: 3.1, 3.2, 3.3, 4.4, 7.1, 7.2.
- C. in case defects occur during the construction process, the repair method shall be proposed by the Contractor to the Engineer for approval. The proposed method shall consider performance class R4 according to the EN 1504-3.

5.5.2.2 PROTECTION OF CONCRETE SURFACES

5.5.2.2.1 CONCRETE PROTECTIVE COATING – SIDEWALK SURFACE

- A. Concrete protective coating shall be certified in accordance with standard EN 1504-2 requirements, having a manufacturer's declaration of performance - the original copy and translation of the official national language.
- B. Sidewalk coating shall be executed with polyurethane coating, including non-slip particles. This treatment is additional and independent to the hydrophobic impregnation.
- C. The declaration shall include material conformity with the following requirements:

Table 140. Minimum requirements - Concrete protective coatings at upper surface of sidewalks

Binding properties	Value	Test method
Resistance to abrasion	≤3000mg	EN ISO 5470-1
Resistance to carbonation (CO ₂)	Sd ≥50m	EN 1062-6
Water vapor permeability	Class II	EN ISO 7783
Capillary water absorption and water permeability	≤0,1kg / m ² H ^{-0.5}	EN 1062-3
The adhesion after thermal compatibility	a) no bubbles, cracks or delamination b) pull-off-test: ≥ 1,5 (1,0) MPa	EN 1542
Pull-off-test	≥ 1,5 (1,0) MPa	EN 1542
Crack bridging ability	Class A1 (-30 °C) Class B1 (-30 °C)	EN 1062-7
Impact resistance	Class III	EN ISO 6272-1
Slip/skid resistance	Class III	EN 13036-4
Artificial weathering	After 2000h of artificial weathering: - no blistering - no cracking - no flaking	EN 1062-11

5.5.2.2.2 CONCRETE PROTECTIVE COATING (C) – GENERAL

- A. Concrete protective coating (c) shall be certified in accordance with standard EN 1504-2 requirements, have a manufacturer's declaration of performance - the original copy and translation of the official national language.
- B. The declaration shall include material conformity with the following requirements:

Table 141. Minimum requirements - Concrete protective coatings in general (C)

Binding properties	Value	Test method
Resistance to carbonation (CO ₂)	Sd ≥50m	EN 1062-6
Water vapor permeability	Class II	EN ISO 7783
Capillary water absorption and water permeability	≤0,1kg / m ² H ^{-0.5}	EN 1062-3
The adhesion after thermal compatibility	a) no bubbles, cracks or delamination b) pull-off-test: ≥ 0,8 (0,5) MPa	EN 1542
Pull-off-test	≥ 0,8 (0,5) MPa	EN 1542
Crack bridging ability	Class A1 (-30 °C) Class B1 (-30 °C)	EN 1062-7

Binding properties	Value	Test method
Artificial weathering	After 2000h of artificial weathering: - no blistering - no cracking - no flaking	EN 1062-11

5.5.2.2.3 CONCRETE IMPREGNATION

- A. Concrete protective coating impregnation shall be certified in accordance with standard EN 1504-2 requirements, have a manufacturer's declaration of performance - the original copy and translation into the official national language.
- B. The declaration shall meet the binding properties and their values as follows:

Table 142. Minimum requirements - Concrete impregnation (I)

Binding properties	Value	Test method
Capillary water absorption and water permeability	$w \leq 0,1 \text{ kg / M}^2\text{H-}0.5$	EN 1062-3
Penetration depth	$\geq 5 \text{ mm}$	According to EN 1504-2 table 4 (19)
Adhesion after Thermal compatibility (with de-icing salt influence)	a) no bubbles, cracks or delamination b) pull-off-test: $\geq 0.8 (0.5) \text{ MPa}$	EN 13687

- C. Concrete impregnation shall not change the concrete texture. Impregnation shall be chemically compatible with the "anti-graffiti" means, and applied in locations indicated in project drawings
- D. Impregnation may be used in conjunction with pigments, in order to give the desired shade to the surface of concrete. Implementation of pigmented impregnation shall be agreed with the site engineer in advance.

5.5.2.2.4 HYDROPHOBIC IMPREGNATION– CORNICE AND SIDEWALKS

- A. Concrete protective coating for hydrophobization, applied in those elements indicated in project drawings, shall be certified in accordance with standard EN 1504-2 requirements, have a manufacturer's declaration of performance - the original copy and translation of the national language.
- B. The declaration shall meet the binding properties and their values as follows:

Table 143. Minimum requirements – Concrete Hydrophobic impregnation (H)

Binding properties	Value	Test method
penetration depth	class I	According to EN 1504-2 table 3 (19)
Water absorption and resistance to alkali	$<10\%$	EN 13580
Drying rate coefficient	class I	EN 13579
Loss of mass after freeze-thaw-salt stress	According to EN 1504-2 table 3 (17)	EN 13581

5.5.2.3 WATERPROOFING OF CONCRETE SURFACES

5.5.2.3.1 ELASTIC (PRESSURIZED) MASTIC

- A. Elastic (pressurized) mastic, applied in pedestrian and other non-traffic areas as indicated on project drawings, shall be certified according to the standard EN 15651-4, have a manufacturer's declaration of performance - the original copy and the translation of the national language.
- B. The declaration shall declare the mastic suitability for pedestrian traffic in warm and cold outdoor conditions: Type PW-EXT-INT-CC, 20HM class according to EN 15651-4.

5.5.2.3.2 HAND OR SPRAYED BITUMEN-BASED WATERPROOFING OF CONCRETE SURFACE

- A. Bitumen-based waterproofing shall apply as indicated in the structural drawings of the Technical Design.
- B. Hand or sprayed waterproofing (bitumen-based) shall be certified in accordance with standard EN 15814 requirements, material properties which need to be met are presented in . Coating system shall have a manufacturer's declaration of performance - the original copy and translation of the official national language.
- C. The surfaces on which the coating is to be applied shall be clean and prepared in accordance with manufacturer's instructions or EN 1504-2. prior to application of the coating:
 - a. The Contractor shall use adequate methods to remove dirt, dust, oil and all other contaminants that could interfere with adhesion of the coating.
 - b. Bituminous coating shall not be applied to surfaces unacceptable to manufacturer.
 - c. Penetrations, small cracks, or minor honeycomb in surfaces shall be sealed prior the appliance of the coating.
- D. Two (2) layers of approved waterproofing bituminous coating shall be applied, with a final dry thickness of at least 3mm. This system shall apply to underground and invisible faces of concrete structures.
- E. Bitumen shall be applied at a temperature limited by manufacturer's instructions.
- F. Any item passing through waterproofing surface shall be sealed watertight.

Table 144. Material requirements - Waterproofing Bituminous coating

Parameter	Requirements according to EN 15814 for Final Performance	Test method
Resistance to Water	No discolouring of water No detachment of reinforcement if dry thickness ≥ 4 mm No change to the material according to EN 15817	EN 15817
Dimensional stability at high temperatures (70 °C)	No slumping or dripping	EN 15818
Reduction in thickness when dry	$\leq 50\%$	EN 15819
Reaction to fire	Class E	EN 13501-1
Impermeability to water in pressure on a 1 mm open crack	Class W1: ≥ 24 h at 0.0075 N/mm^2 , dry thickness without reinforcement ≥ 3 mm	EN 15820
Compressive strength	Class C1: 0.06 MN/m^2 , with dry thickness ≥ 3 mm	EN 15815

5.5.2.3.3 RAILWAY DECK WATERPROOFING

- A. Waterproofing shall include bituminous membrane which can be formed from one (monolayer) or two layers of elastomer bitumen sheets.
- B. Bitumen sheets shall be welded to the subsurface in the entire extent of the structure's deck. The membrane longitudinal and transversal overlapping shall be done according to the Manufacturer's instructions.
- C. Waterproofing system for railway structures have been defined as two separate cases.

- D. CASE I applies to the area of the deck, which is covered with protection layer, between the ballast walls, and shall be formed (from bottom to top):
- Primer: shall be chemically compatible with the elastomer bitumen membrane. The Manufacturer of the bitumen membrane shall propose an appropriate primer. It shall be applied under a minimum ratio of 350 g/m², unless Manufacturer instructions state otherwise.
 - Membrane: waterproofing sheets shall follow the requirements in and EN 14695. Membrane shall be applied on the dry primer surface and have a manufacturer's declaration of performance - the original copy and translation of the official national language.
 - Protection: if not indicated otherwise in project documentation, protection layer Above the elastomer bitumen membrane, shall be applied with 30mm layer of asphalt mixture. The asphalt mixture shall be AC 12 surf S type, as per EN 13108-1.
- E. CASE II applies to the area of the deck, which is not covered with protection layer and is exposed to the direct sunlight and shall be formed (from bottom to top):
- Primer: shall be chemically compatible with the elastomer bitumen membrane. The Manufacturer of the bitumen membrane shall propose an appropriate primer. It shall be applied under a minimum ratio of 350 g/m², unless Manufacturer instructions state otherwise.
 - Membrane: waterproofing sheets shall follow the requirements in and EN 14695. Membrane shall be applied on the dry primer surface and have a manufacturer's declaration of performance – the original copy and translation to the official national language.
 - Protection: protection layer is not mandatory for case II.
- F. For both cases I and II, joint sealants shall be applied between ballast wall and elastomer bitumen membrane and between concrete channel for cables and elastomer bitumen membrane. These epoxy joint sealants are included in the price per m² of the work item.
- A. Bittuminous waterproofing sheet material requirements for railway bridges shall meet the minimum requirements described in the table below:

Table 145. Minimum requirements - Waterproofing sheets for railway deck

Parameter	Method	Units	One-layer system	Top coat of 2 layer system	Lower layer of 2 layer system
Visible defects	EN 1850-1	-	No defects	No defects	No defects
Thickness (Total thickness in case of two-layer system)	EN 1849-1	mm	≥ 5,0	≥ 7,5	
Tensile properties: maximum tensile force (longitudinal) maximum tensile force (transversal)	EN 12311-1	N/50 mm N/50 mm	≥ 900 ≥ 800	≥ 900 ≥ 800	≥ 700 ≥ 600
Tensile properties: elongation (longitudinal) elongation (transversal)	EN 12311-1	% %	≥ 30 ≥ 30	≥ 30 ≥ 30	≥ 30 ≥ 30
Water absorption	EN 14223	%	< 1%	< 1%	< 1%
Flexibility at low temperature	EN 1109	°C	≤ -20	≤ -20	≤ -20
Flow resistance at elevated temperature	EN 1110	°C	≥ 115	≥ 115	≥ 115
Dimensional stability	EN 1107-1 or Annex B of EN 14695	%	≤ 0,5	≤ 0,5	≤ 0,5
Thermal ageing by long term exposure to elevated temperature - Pliability - Flow resistance	EN 1296 EN 1109 EN 1110	°C °C	≤ 5 ≥ 100	≤ 5 ≥ 100	≤ 5 ≥ 100

Parameter	Method	Units	One-layer system	Top coat of 2 layer system	Lower layer of 2 layer system
Bond strength	EN 13596	N/mm ²	≥ 0,5	≥ 0,5	≥ 0,5
Shear strength	EN 13653	N/mm ²	≥ 0,2	≥ 0,2	≥ 0,2
Crack bridging ability	EN 14224	°C	-20	-20	-20
Resistance to compaction of an asphalt layer ^(a)	EN 14692	-	Pass	Pass	Pass
Watertightness	EN 14694	-	Pass	Pass	Pass
Static load resistance ^(b)	EN 12730	kg	≥ 15	≥ 15	≥ 15
Impact resistance ^(b)	EN 12691	mm	≥ 1000	≥ 1000	≥ 1000
Joints strength to shear ^(b)	EN 12317-1	N/50 mm	≥ 650	≥ 650	≥ 450
Artificial ageing by long term exposure to the combination of UV radiation, elevated temperature and water ^(b)	EN 1297	-	No defects	No defects	No defects
Notes: a) Not applicable for case II; b) Material without permanent surface protection (case II).					

5.5.2.3.4 ROAD AND PEDESTRIAN BRIDGE/OVERPASS DECK WATERPROOFING

- B. Road bridges/overpasses shall fulfil this technical specification and requirements of the Country's Road Authority.
- C. Waterproofing system (primer+membrane+protective layer) according to the local Road Authority's Technical Specification can be used as an alternative to the one included in this Technical Specification.
- D. Waterproofing shall include bituminous membrane which can be formed from one (monolayer) or two layers of elastomer bitumen sheets.
- E. Bitumen sheets shall be welded to the subsurface in the entire extent of the structure's deck. The membrane longitudinal and transversal overlapping shall be done according to the Manufacturer's instructions.
- F. Waterproofing system for road bridges/overpasses shall be formed (from bottom to top)::
- G. Primer: shall be chemically compatible with the elastomer bitumen membrane. The Manufacturer of the bitumen membrane shall propose an appropriate primer. It shall be applied under a minimum ratio of 500 g/m², unless Manufacturer instructions state otherwise.
- H. Membrane: waterproofing sheets shall follow the requirements in Table 147 and EN 14695. Membrane shall be applied on the dry primer surface and have a manufacturer's declaration of performance – the original copy and translation to the official national language.
- I. Protection: if not indicated otherwise in project documentation, protection layer above the elastomer bitumen membrane, shall be applied with asphalt mixture. Protection layer shall fulfil the requirements described in the Table below.

Table 146. Material requirements – Protection above waterproofing sheet

Country	Type of mixture	Reference	Minimum thickness
Estonia	MA8	EN 13108-6	30 mm
	AC8bin	EVS 901-3	
Latvia	MA 8	EN 13108-6	15±3mm
Lithuania	SMA 8S / SMA 5S	EN 13108-6	20 mm

- J. Waterproofing membrane on top of transition slab shall be protected by a protection panel board in the extent presented in the drawings.
- K. Protection board shall comply with the performance requirements and tolerance level of UEAtc (European Union Technical Agreement).
- L. Joint sealant shall be applied between edge beam and pavement layers.
- M. Bituminous waterproofing sheet for road and pedestrian overpasses shall meet the requirements described in the table below:

Table 147. Minimum requirements - Waterproofing sheets for road and pedestrian bridges/overpasses

Parameter	Method	Units	One-layer system	Top coat of 2 layer system	Lower layer of 2 layer system
Visible defects	EN 1850-1	-	No defects	No defects	No defects
Thickness (Total thickness in case of two-layer system)	EN 1849-1	mm	≥ 5,0	≥ 7,5	
Tensile properties: maximum tensile force (longitudinal) maximum tensile force (transversal)	EN 12311-1	N/50 mm N/50 mm	≥ 900 ≥ 800	≥ 900 ≥ 800	≥ 700 ≥ 600
Tensile properties: elongation (longitudinal) elongation (transversal)	EN 12311-1	% %	≥ 30 ≥ 30	≥ 30 ≥ 30	≥ 30 ≥ 30
Water absorption	EN 14223	%	< 1%	< 1%	< 1%
Flexibility at low temperature	EN 1109	°C	≤ -20	≤ -20	≤ -20
Flow resistance at elevated temperature	EN 1110	°C	≥ 115	≥ 115	≥ 115
Dimensional stability	EN 1107-1 or Annex B of EN 14695	%	≤ 0,5	≤ 0,5	≤ 0,5
Thermal ageing by long term exposure to elevated temperature - Pliability - Flow resistance	EN 1296 EN 1109 EN 1110	°C °C	≤ 5 ≥ 100	≤ 5 ≥ 100	≤ 5 ≥ 100
Bond strength	EN 13596	N/mm ²	≥ 0,5	≥ 0,5	≥ 0,5
Shear strength	EN 13653	N/mm ²	≥ 0,2	≥ 0,2	≥ 0,2
Crack bridging ability	EN 14224	°C	-20	-20	-20
Compatibility by heat conditioning ^(a)	EN 14691	%	≥ 5	≥ 5	≥ 5
Resistance to compaction of an asphalt layer	EN 14692	-	Pass	Pass	Pass
Behaviour of bitumen sheets during application of mastic asphalt ^(a)	EN 14693	mm	≤ 2	≤ 2	≤ 2
Watertightness	EN 14694	-	Pass	Pass	Pass
Softening point ^(b)	EN 1427	°C	120	120	120
Thickness of weldable bituminous layer (below reinforcement) for two-layer system ^(b)		mm	-	≥ 2,5	≥ 2,5
Thickness of weldable bituminous layer (below reinforcement) for one-layer system ^(b)		mm	≥ 3,0	-	-

Parameter	Method	Units	One-layer system	Top coat of 2 layer system	Lower layer of 2 layer system
Notes: a) Country specific requirement only applicable in Lithuania; b) Country specific requirement only applicable in Estonia.					

5.5.2.3.5 ECODECT WATERPROOFING

- a. Ecodects shall have continuous protection with waterproofing membrane in all the vault surface and overlapping with the vertical walls on the side.
 - b. Waterproofing shall be formed from one (monolayer) or two layers of waterproofing membrane with reinforcement. Longitudinal and transversal overlapping shall be done according to the Manufacturer's instructions.
 - c. Preparation of the subsurface shall be done according to the Manufacturer's instructions.
 - d. Waterproofing membrane shall follow the requirements in and have a manufacturer's declaration of performance – the original copy and translation to the official national language.
 - e. Waterproofing shall be manufactured according to EN 13969 and/or EN 14695.
- A. Bituminous waterproofing sheet for ecodects shall meet the minimum requirements described in the table below:

Table . Minimum requirements - Waterproofing sheets for ecodects

Parameter	Method	Units	One-layer system	Top coat of 2 layer system	Lower layer of 2 layer system
Visible defects	EN 1850-1	-	No defects	No defects	No defects
Mass per unit area	EN 1849-1	kg/m ²	≥ 5,0	≥ 5,0	
Tensile properties: maximum tensile force (longitudinal) maximum tensile force (transversal)	EN 12311-1	N/50 mm N/50 mm	≥ 900 ≥ 800	≥ 900 ≥ 800	≥ 700 ≥ 600
Tensile properties: elongation (longitudinal) elongation (transversal)	EN 12311-1	% %	≥ 30 ≥ 30	≥ 30 ≥ 30	≥ 30 ≥ 30
Water absorption	EN 14223	%	< 1%	< 1%	< 1%
Flexibility at low temperature	EN 1109	°C	≤ -20	≤ -20	≤ -20
Shear strength	EN 13653	N/mm ²	≥ 0,2	≥ 0,2	≥ 0,2
Crack bridging ability	EN 14224	°C	-20	-20	-20
Watertightness	EN 14694	-	Pass	Pass	Pass

5.5.2.4 DIMPLE DRAINAGE COMPOSITE SHEET

- A. This kind of composite drainage boards shall be placed in the intrados of retaining walls, abutments, vaults or any other buried element in order to ensure drainage of the interface in contact with the soil or embankment and where shown on Drawings.

5.5.2.4.1 GENERAL REQUIREMENTS

- A. Service temperature range -40 - +80 °C.
- B. Physiological properties: resistant to a wide range of chemicals, resistant to fungus and bacteria attack, impervious to root penetration, rot proof.

5.5.2.4.2 MATERIALS

- A. The composite sheets are formed of a core element of HDPE black resin with dimples that allows passage of water and a geotextile to separate from the soil fill. Minimum dimple height is 10 mm.
- B. Minimum requirements for the dimple drainage boards are:
 - a. Core Product:
 - i. Resin: HDPE
 - ii. Area weight: 600 g/m² EN 12127
 - iii. Compressive strength: 420 kN/m² EN 25619-2
 - b. Geotextile:
 - i. Resin: PP
 - ii. Area weight: 136 g/m² EN 12127
 - iii. Tensile strength: 9.0 kN/m EN 10319
 - iv. Puncture (CBR): 1,250 N EN 12236
 - v. Dynamic cone puncture: 29 mm EN 918
 - vi. Opening size: 120 µm EN 12956
 - vii. Permeability: 50x10⁻³ m/s EN 11058
 - c. Geocomposite:
 - i. Area weight 740 g/m² EN 12127
 - ii. Drainage capacity 3.5 l/(ms) EN 12958, i=1, 20 kPa
 - iii. Tensile strength 15.4 kN/m EN 10319
 - iv. Strain at maximum load 50 % EN 10319
 - v. CE certificate EN 13252

5.5.2.4.3 INSTALLATION INSTRUCTIONS

- A. Storage: protect from UV radiation .
- B. Geotextile fabric wraps behind the core material on top.
- C. The vertical splicing shall be done with the top part overlapping the bottom part, both for core material and geotextile.
- D. Unrolling Panels: Starting along edge of horizontal area, unroll panel while folding fabric over edge adjacent to starting edge. On sloped surfaces, unroll in direction of slope. Filter fabric faces top side. Adjacent panels should be unrolled and splices should be performed in vertical.
- E. All factory edges and/or cut edges must be covered with filter fabric to prevent intrusion of cover material (soil, sand, concrete, etc.)
- F. Do not leave exposed to intensive sunlight for extended periods of time (5-7 days)
- G. Attachment Method: On concrete substrates, use mechanical fasteners, i.e., Nailing or powder actuated fasteners. On waterproofing substrates, use construction adhesives that are compatible with the waterproofing membrane.
- H. Dimples & filter fabric always shall face backfill.

- I. Backfill as soon as possible, not exceeding 5 – 7 days. Backfill in layers and compact each layer. Backfill should extend over top of panels

5.5.3 WORK EXECUTION

5.5.3.1 CONCRETE REPAIR PRODUCTS

- A. Concrete repair products shall be applied, if required, as stated by supplier in the product technical sheet.
- B. The application shall, in any case, require the Engineer's approval.

5.5.3.2 ELASTIC (PRESSURIZED) MASTIC

- A. Elastic (pressurized) mastic shall be applied under the conditions noted by the supplier and approved by Engineer.
- B. This sealant shall provide a span life of 25 years.

5.5.3.3 PROTECTIVE COATINGS

- A. Concrete protective coatings and impregnations are installed, if not otherwise stated in the project, in accordance with the manufacturer's instructions.

5.5.3.4 MATERIAL TRANSPORT AND STORAGE

- A. Concrete repair, protective and waterproofing coatings materials shall be transported and stored in accordance with the transport and storage instructions provided by the manufacturers.

5.5.3.5 SURFACE PREPARATION OF PROTECTIVE COATINGS

- A. The surface of the concrete to be coated shall be clean and dry. Cleaning method is selected according to the protective coating's rules and instructions.
- B. The surface shall be smooth and free of dirt, dust and other contaminants. In case if poor surface quality, repair works shall be performed by Contractor until Engineer's approval.

5.5.3.6 SURFACE PREPARATION FOR OVERLAY WATERPROOFING

- A. The transverse and longitudinal slopes of the concrete surface covered with bituminous waterproofing sheet shall correspond to the design. irregularities (glare under a 4 m long control ruler) in both the transverse and longitudinal directions shall not exceed 5 mm.
- B. Concrete surface should be slightly rough texture, measured according to EN 13036-1, clean and dry. The surface roughness of concrete shall be lesser than 1.5 mm on the surface once it is primed. Otherwise, the following procedure shall be applied:
 - a. Larger unevenness and cracks before priming shall receive a puttying monolithic treatment > C25/30 class concrete mixture
 - b. Priming and filling will be performed on reactive resins.
 - c. When primed, the filler is sprinkled with 0.2/0.7 Group quartz sand.
 - d. The reconstituted concrete average strength shall be $\geq 1,5$ MPa according to EN 13596.
- C. The concrete surface shall be verified by the Engineer after the curing of concrete. Surface shall not have cavities or protrusions that may damage the waterproofing membrane.
- D. After the preparation of the surface primer shall be applied. The used primer shall be agreed with the manufacturer of the waterproofing membrane.

- E. The application of the primer is carried out on entire surface of the area to be waterproofed as per system. The application and drying are performed at an ambient temperature with a minimum value of five degrees (5 °C).
- F. It is recommended not to make waterproofing works when the outside temperature is lower than minus five degrees Celsius (-5 °C).

5.5.3.7 WATERPROOFING MEMBRANE ON RAILWAY BRIDGES

- A. primer coating shall be applied. After drying, waterproofing membrane shall be placed on top of the primer, always starting from the lowest points.
- B. The movement of machinery and vehicles work on the membranes without any protection of the waterproofing is prohibited.
- C. On top of waterproofing membrane protection layer shall be installed according to the manufacturer's instructions.
- D. Paving the agglomerate is made with pneumatic wheels paver. The machinery used for the laying of the agglomerate will not perform manoeuvres on the membrane small radius. The speed of trucks strives to be slow, resulting in no acceleration or sudden braking.
- E. The membrane longitudinal and transversal overlapping shall be done according to the Manufacturer's instructions.

5.5.3.8 WATERPROOFING MEMBRANE ON ROAD DECK BRIDGES

- A. It shall be verified that the concrete surface of the deck is clean and perfectly dry, without any loose element; otherwise, approved procedures by the Engineer shall be carried out.
- B. It shall not present gaps or projections of more than 20 mm. Otherwise, the irregularities shall be corrected with the corresponding material/product for this work. Exact material/product shall be proposed by the Contractor to the Engineer for approval.
- C. The surfacing layer of the waterproofing system shall be fully bonded to the system.
- D. The smoothness of the subsurface shall follow elastomer membrane Manufacturer instructions.

5.5.3.9 ECODUCT AND CULVERT WATERPROOFING

- A. Ecoduct and Culvert Waterproofing shall be carried out according to project drawings.
- B. It shall be verified that the concrete surfaces are clean and perfectly dry, without any loose element, otherwise, approved procedures by the Engineer shall be carried out.
- C. It shall not present gaps or projections of more than 20 mm. Otherwise, the irregularities shall be corrected with the corresponding material/product for this work. Exact material/product shall be proposed by the Contractor to the Engineer for approval.

5.5.4 **TOLERANCES**

- A. All the products for repair, protection and waterproofing of concrete surfaces described in this chapter shall be under the application tolerances specified by the manufactures.

5.5.5 **WORK RECEPTION**

- A. The application of all the products described in this chapter shall be as per supplier recommendations and manuals.
- B. Final acceptance shall be based on inspection tests that could be demanded by Engineer in order to verify the proper functioning of the waterproofing systems.
- C. The Contractor shall conduct evaluation of the bond strength properties of the applied waterproofing sheet system for railway and road deck bridges. The following procedure shall be applied:

- a. Three evenly separated verification tests per each 500 m² shall be performed.
- b. Conformity criteria for bond strength shall be as per stated in the present Technical Specification, Table 146 (railway bridges) and Table 148 (road bridges).
- c. Verification testing of bond strength shall be done in accordance with EN 13596.
- d. The samples for the verification testing shall be performed by the Contractor in the presence of Engineer.
- e. The Contractor is responsible for proper equipment, workforce, and sampling procedure.

5.5.6 COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.
 - a. EN 1504-2. Products and systems for the protection and repair of concrete structures. Definitions, requirements, quality control and evaluation of conformity. Part 2. Surface protection systems for concrete
 - b. EN 1504-3. Products and systems for the protection and repair of concrete structures. Definitions, requirements, quality control and evaluation of conformity. Part 3. Structural and non-structural repair
 - c. EN 1504-7. Products and systems for the protection and repair of concrete structures. Definitions, requirements, quality control and evaluation of conformity. Part 7. Rebar protection from corrosion
 - d. EN 1504-9. Products and systems for the protection and repair of concrete structures. Definitions, requirements, quality control and evaluation of conformity. Part 9. General principles for use of products and systems
 - e. EN 1542. Products and systems for the protection and repair of concrete structures. Test methods. Measurement of bond strength by pull-off
 - f. EN ISO 5470. Rubber- or plastics-coated fabrics. Determination of abrasion resistance. Taber abrader
 - g. EN ISO 6272 Paints and varnishes. Quick deformation (impact resistance) tests. Part 1. Falling test weights with a large area indenter.
 - h. EN ISO 7783. Paints and varnishes. Determination of water-vapour transmission properties. Cup method
 - i. EN ISO 8501-1. Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
 - j. EN ISO 9863 Geosynthetics. Determination of thickness at specified pressure – Part 1: Single layers
 - k. EN ISO 9864 Geosynthetics. Test Method for the determination of mass per unit area of geotextiles and geotextile-related products
 - l. EN ISO 10319 Geosynthetics. Wide-width tensile test
 - m. EN ISO 12190 Products and systems for the protection and repair of concrete structures – test methods – Determination of compressive strength of repair mortar.
 - n. EN ISO 12236 Geosynthetics. Static puncture test (CBR test)
 - o. EN ISO 12944-4. Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 4: Types of surface and surface preparation.
 - p. EN 13108-5. Bituminous mixtures. Material specifications. Part 5: Stone Mastic Asphalt
 - q. EN 13108-6. Bituminous mixtures. Material specifications. Part 5: Stone Mastic Asphalt
 - r. EN 13295. Products and systems for the protection and repair of concrete structures. Test methods. Determination of resistance to carbonation
 - s. EN 13412. Products and systems for the protection and repair of concrete structures. Test methods. Determination of modulus of elasticity in compression.
 - t. EN ISO 13433. Geosynthetics. Dynamic perforation test (cone drop test)
 - u. EN 13501-1. Fire classification of construction products and building elements. Part 1: Classification using data from reaction to fire tests.

- v. EN 13579. Products and systems for the protection and repair of concrete structures. Test methods. Drying test for hydrophobic impregnation
 - w. EN 13580. Products and systems for the protection and repair of concrete structures. Test methods. Water absorption and resistance to alkali for hydrophobic impregnation
 - x. EN 13581. Products and systems for the protection and repair of concrete structures. Test methods. Hydrophobic impregnated concrete mass loss after freeze-thaw salt stress determination
 - y. EN 13687-1. Products and systems for the protection and repair of concrete structures. Test methods. Determination of thermal compatibility. Part 1. Cyclic cooling - heating, immersion in ice thawing salt solution.
 - z. EN 15815. Polymer modified bituminous thick coatings for waterproofing – Resistance to compression.
 - aa. EN 15818. Polymer modified bituminous thick coatings for waterproofing – Determination of dimensional stability at high temperature.
 - bb. EN 15819. Polymer modified bituminous thick coatings for waterproofing. Reduction of the thickness of the layer when fully dried.
 - cc. EN 15820. Polymer modified bituminous thick coatings for waterproofing. Determination of watertightness.
 - dd. EN 15651-4 Sealants for non-structural use in joints in buildings and pedestrian walkways. Sealants for pedestrian walkways.
 - ee. EN 13707. Flexible sheets for waterproofing. Reinforced bitumen sheets for roof waterproofing. Definitions and characteristics
 - ff. EN 12311-1. Flexible sheets for waterproofing. Determination of tensile properties. Bitumen sheets for roof waterproofing
 - gg. EN 13036-1. Road and airfield surface characteristics. Test methods. Measurement of pavement surface macrotexture depth using a volumetric patch technique
 - hh. EN 13596. Flexible sheets for waterproofing. Waterproofing of concrete bridge decks and other concrete surfaces trafficable by vehicles. Determination of bond strength.
- B. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

5.5.7 MEASUREMENT AND PAYMENT – WATERPROOFING AND CONCRETE PROTECTION

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 148. Units of measurement - Waterproofing and concrete protection

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_35_31_68	000301	WATERPROOFING ON ROAD BRIDGE DECKS	m2	Waterproofing on road bridge decks consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.).This item is meant for waterproofing systems applicable to road bridges, and includes all materials and work required for placement, as well as sealing with epoxy at the edges of the membrane in the deck.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_35_31_68	000302	WATERPROOFING ON RAIL STRUCTURES DECKS	m2	Waterproofing on rail structures decks consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for waterproofing systems applicable to bridges, viaducts and underpass structures on whose deck the ballast of the railway tracks is directly supported or has earth filling on top. In these structures, each system will consist of a membrane, formed by one or more layers of heat-welded elastomer bitumen sheets, adhered to the deck, on which a protection will be placed. This protection will be measured separately. Including sealing with epoxy at the edges of the membrane in the deck.
Pr_35_31_68	000303	WATERPROOFING PROTECTION COURSE	m2	Waterproofing protection course consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of a 3.00 cm thick concrete layer to protect the waterproofing system. It includes all the materials and work necessary for its completion
Pr_35_31_68	000304	WATERPROOFING ON PRECAST ECODUCTS VAULTS	m2	Waterproofing on precast ecoduct vaults consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for waterproofing systems applicable to ecoduct vaults, and includes all materials and work required for placement
Pr_35_31_68	000308	WATERPROOFING ASPHALT PROTECTION COURSE	m2	Waterproofing asphalt protection course consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of a 3.00 cm thick asphalt layer to protect the waterproofing system. It includes all the materials and work necessary for its completion
Pr_25_57_53_65	000301	DRAINAGE COMPOSITE BOARD	m2	Drainage composite board consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing of drainage composite board including placing and fixing the drainage sheet to the wall.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_35_31_68	000305	BITUMEN COATING (TWO-HANDED APPLICATION)	m2	Bitumen coating consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for two handed of asphalt products application at the back of the concrete works (walls, abutments, vaults, etc.), including the supply of the waterproofing materials and all necessary works.
Pr_35_31_68	000309	NON-SLIP COATING	m2	Non-slip coating consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for thin layer coating with non-slip particle, application on sidewalks or other places for pedestrian use, including the supply of the materials and all necessary works.
Pr_35_31_68	000306	HYDROPHOBIC IMPREGNATION	m2	Hydrophobic impregnation consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for a surface applied, invisible, non-film forming protection system, penetrate the surface pores and capillaries, so that they are internally lined but not filled.
Pr_35_31_68	000307	WATERPROOFING PROTECTION PANELS AT THE END WALL	m2	Waterproofing protection panels at the end wall consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and laying of drainage waterproofing panel at the endwall including placing and fixing. It runs vertically on the back of the end wall and turns on above the transition slab up to 1.0 m
Ss_15_30_17	000301	CONCRETE SURFACE REPAIR	m2	Concrete surface repair consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for a repair of surface concrete of a structure, including all the materials (e.g. repair mortar, concrete, cementitious mortars, liquid polymer systems, grout mortars, etc) and operations necessary for the correct finish of the surface to be treated.
Pr_25_57_53_65	000302	DRAINAGE BLANKET	m2	Drainage blanket consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing of drainage blanket including placing and fixing the drainage sheet to the wall or cutting including PVC connectors d=100 mm.

5.6 STEEL WORKS

5.6.1 SCOPE

- A. This Technical specifications section includes the performance criteria, materials, design, production, and erection of the structural steel works for the entire project.
- B. This section provides a needed but non-exhaustive list of labour, material, equipment, related services, and supervision required for the manufacture and erection of the structural elements as defined in the Project and shown at the Drawings.
- C. Steel structure shall be designed and built of a design working life (DWL) of 100 years. And anti-corrosion protection systems must have a durability of at least 15 years before repainting is required.

5.6.2 MATERIALS AND PRODUCTS

- A. Materials shall be supplied from a quality assured source, operating a Quality Assurance system in compliance with the relevant part of EN ISO 9001, and those Standards and Regulations related below, in this Technical specification. All steel products shall be supplied with inspection documents "Type 3.1" or "Type 3.2" according to EN 10204.

5.6.2.1 GENERAL

- A. NON-AVAILABILITY OF SPECIFIED MATERIALS
 - a. Obtain approval for any variation required when the specified material is not available and bear any additional cost arising therefrom.
- B. MANUFACTURER'S CERTIFICATES
 - a. Provide the manufacturer's certificates for all steel sections, plates, sheets, bolts, nuts and washers delivered to Site.
- C. MARKINGS
 - a. Clearly mark all steelwork in an approved manner. Individual pieces shall be capable of positive identification at all stages of fabrication.

5.6.2.2 MECHANICAL PROPERTIES AND CHEMICAL COMPOSITION

- A. Except specified otherwise, all structural steel shall be hot-rolled or hot-finished structural steel complying with EN 10025 or EN 10210 respectively.
- B. In general, all structural steel shall be Grade S235J2+N, S275J2+N or S355J2+N complying with EN 10025, except that hot-finished hollow sections shall be Grade S235J2H+N, S275J2H+N or S355J2H+N complying with EN 10210-1.
- C. For the case of stainless steel elements, as plates, profiles or other, unless specified otherwise, the steel used shall be 1.4401 stainless steel according to EN 10088-1 and EN 10088-2

5.6.2.3 EXECUTION CLASSES

- A. According to EN 1090-2, cl 4.1.2 the following execution classes shall be applied. In the following table, it shall be understood:
 - a. Main structure: all the steel elements that plays a relevant role in the structure resistance, relaying on them the structural integrity of the constructions. As main structure, as in example, can be considered elements as: girders, bracings, diaphragms, etc
 - b. Secondary structures: those steel elements that are not required to guarantee the structural integrity of the construction. Such elements are, in example: ladders intended for inspections, gates, auxiliary walkways for maintenance, fences, gratings, checkered plates, etc.

Table 149. Execution classes - Steel works (to EN 1090-29)

Execution classes (to EN 1090-2)			
Structure	Execution class	Structure Class	Traceability
Main structures	EXC4	Primary	Full
Secondary Structures.	EXC2	Secondary	Limited

5.6.2.4 BOLTS, NUTS AND WASHERS

5.6.2.4.1 BOLTS, NUTS AND WASHERS

- A. All bolts, nuts and washer shall comply with EN 1993-1-8 clause 1.2.4 listed Reference Standards. All of them shall be CE marked and approved by the Engineer.
- B. The yield strength and the ultimate tensile strength for bolts are given in table below:

Table 150. Requirements - Bolts, nuts and washers. Yield strength and ultimate tensile strength

Nominal values of the yield strength and the ultimate tensile strength for bolts							
Bolt class	4.6	4.8	5.6	5.8	6.8	8.8	10.9
$f_{yb}(N/mm^2)$	240	320	300	400	480	640	900
$F_{ub}(N/mm^2)$	400	400	500	500	600	800	1000

5.6.2.4.2 DRILL ANCHOR BOLTS

- A. Unless specified otherwise, all drill anchor bolts for external environment shall be in Grade A4 stainless steel to EN ISO 3506, and electroplated anchors and hot-dip galvanized anchors shall not be allowed.

5.6.2.4.3 HOLDING DOWN BOLTS

- A. Unless specified otherwise in the Drawings, grade 10.9 shall be used as holding down bolt. Dacromet coating shall be provided on grade 10.9 holding down bolts.

5.6.2.5 SHEAR STUDS

- A. Proprietary shear studs for composite construction shall be the headed type and shall be in accordance with EN ISO 13918 with the following minimum properties after being formed:
- Yield strength 350 MPa;
 - Ultimate tensile strength 450 MPa; and
 - Elongation of 15% on a gauge length of $5.65 \sqrt{A_0}$, where A_0 is the original cross section area of the test specimen.
- B. The minimum diameter and the minimum depth of the head of a headed stud shall be 1.5d and 0.4d respectively, where d is the nominal shank diameter of the stud.

5.6.2.6 TURNBUCKLES AND OTHER ELEMENTS

- A. The Contractor shall obtain Engineer's approval for turnbuckles and any other specially made elements and components.
- B. The Contractor shall provide to Engineer the turnbuckle or other elements breaking load and the force demand.

- C. The Contractor shall propose to Engineer, for approval, the proper anti-corrosion treatment suitable to the turnbuckle or other elements span life. The anticorrosion treatment shall conform the requirements stated in this Technical specification.

5.6.2.7 MATERIALS FOR GROUTING OF BASE PLATES

- A. Unless specified otherwise, grout around foundation bolts and under column base plates shall be one of the following types. Material will be based on EN 1504-5 Standard or ACI 351.1R or ACI 308.1. In any case, the products will require the Engineer approval.
- Thickness greater than 25 mm: Fluid cement non-shrinkable mortar not leaner than 1:1 cement to fine aggregate by volume and be mixed as thickly as possible consistent with fluidity. The minimum amount of water is to be added to provide a viscosity suitable for the voids to be filled without bleeding or segregation of the fresh grout mix; or
 - Thickness lesser than 25 mm: An approved proprietary non-shrink polymer modified cementitious or resin-based grout.
- B. Grout shall have at least the same grade strength as the surrounding concrete.

5.6.2.8 DOWELS ANCHOR MATERIAL

- A. Material shall comply with the requirements stated for steel structural reinforcement in subsection 5.3 PASSIVE STRUCTURAL REINFORCEMENT.
- B. Dowels anchors shall be hot-dip galvanized, to withstand with environmental class C4 as per EN ISO 12944-2.

5.6.3 WORK EXECUTION

5.6.3.1 FABRICATION SHOP DRAWINGS

- A. SUBMISSION
- B. Prior to construction and fabrication, submit to the Engineer for approval Fabrication Shop Drawings to show all necessary details and dimensions. Fabrication Shop Drawings shall not be reproductions of contract drawings without providing information required.
- C. Acceptance by the Engineer of the Fabrication Shop Drawings shall not relieve the Contractor of his responsibility for accuracy of his detail dimensions on the drawings, nor the general fit-up of parts to be assembled on site.
- D. WELDING
- Requirements on edge preparation for welds shall be indicated on the Fabrication Shop Drawings.
- E. PACKINGS AND CLEARANCE. When preparing Fabrication Shop Drawings, make provision for:
- Packings which may be necessary to ensure proper fit-up of joints.
 - The need for clearances between the fabricated components so that the permitted deviations in fabrication shall not be exceeded.
- F. HOLES SIZES: Holes in steel sections and plates shall be formed to the following sizes:
- For ordinary bolts and high strength friction grip bolts:
 - Not exceeding 24 mm diameter - 2 mm greater than the bolt diameter
 - Greater than 24 mm diameter - 3 mm greater than the bolt diameter
 - For holding down bolts: 6 mm greater than the bolt diameter or with sufficient clearance to ensure that a bolt, whose adjustment may cause it to be out of perpendicular, can be accommodated through the base plate.
 - Details of holes and fittings in components necessary for safety or to provide lifting and erection aids shall be included in the Fabrication Shop Drawings.
- G. HOLDING DOWN BOLT COVERS

- a. Holding down bolt details shall include provision of loose cover plates or washers with holes 3 mm greater than the holding down bolts.

H. MACHINING NOTE

- a. Any machining requirements shall be clearly noted on the Fabrication Shop Drawings.

5.6.3.2 WORKMANSHIP

5.6.3.2.1 HANDLING, TRANSPORTATION AND STORAGE

- A. Bundle, pack, handle and transport steelwork will be performed in a safe manner that shall prevent damage to the steelwork and any protective coating, and to avoid permanent distortion. Particular care shall be taken to stiffen free ends and all machined surfaces.
- B. Take precautions to minimize exposure of steelwork to atmospheric or chemical pollution before and after fabrication. Prior to fabrication, steel shall not be more heavily pitted or rusted than Grade C to DIN 55928 or ISO 8501-1+2.
- C. Store steelwork awaiting erection clear of the ground and keep different members separate. Lay or stack to avoid accumulation of water or dirt on or against any of the surfaces. Provide suitable packings between layers of stacked steelwork. Ventilate covered steelwork sufficiently to preclude condensation. Store and stack steel members in such a manner that markings are clearly visible.

5.6.3.2.2 CUTTING, SAWING, DRILLING AND FORMING HOLES

- A. Cutting, sawing and drilling:
 - a. Cut members to size.
 - b. Guide and control flame cutting, plasma cutting or laser cutting by machine.
 - c. Use hand-held cutting only where it is impracticable to use machine cutting.
 - d. Finish cut edges as follows:
 - i. Remove burrs, sharp arises and slag from edges of all cut members.
 - ii. Dress machine sheared or cropped edges to a neat finish, free from distortion.
- B. Grind stiffeners, plates and the like to fit the profile of the parent member with diagonal cuts to clear the root radius.
- C. Machine stanchion splices and butt joints of compression members true and square.

5.6.3.2.3 FORMING HOLES

- A. Drill round holes for fasteners or pins.
- B. Form slotted holes by drilling two holes and complete by cutting.
- C. Dress holes as required to remove burrs and protruding edges.
- D. Holes or slotted holes can be plasma cut only after satisfactory demonstration and to the approval of the Engineer that the tolerances and distortion control can be met.
 - a. Punching full size shall not be permitted for steel grade with design yield strength greater than 460 MPa. Punching full size shall only be permitted when all the following conditions are satisfied
 - i. The tolerance on distortion of the punched hole does not exceed that stated in this Technical Specifications.
 - ii. The holes are free from burrs that should prevent solid seating of the parts when being tightened.
 - iii. The thickness is less than 25 mm for steel not higher than Grade S355 and not greater than 10 mm for higher grade steel.
 - iv. The thickness is also not greater than the diameter of the hole being punched.

- v. In spliced connections, the holes in mating surfaces shall be punched in one direction in all members.
- b. Punching and reaming: If the conditions stated in (b)(ii) above are not satisfied, punching may be used provided that the holes are punched at least 2 mm less in diameter than the required size and the hole is reamed to the full diameter.
- c. Drifting: Drifting of holes to align the components shall only be permitted with the approval by the Engineer but shall not cause any damage or distortion to the final assembly.
- d. Holes in hollow sections: Seal bolt holes or other holes in hollow sections to prevent the ingress of moisture unless approved otherwise by the Engineer. Show the proposed method on the Fabrication Shop Drawings.

5.6.3.2.4 CURVING, STRAIGHTENING, HEATING, SHAPING AND FORMING

- A. Carry out curving, straightening, heating, shaping or forming only if it does not result in material properties that do not conform to the specified requirements for the as-supplied material.
- B. Submit to the Engineer for approval curving, straightening, heating, shaping or forming procedures before commencement of the work.

5.6.3.2.5 INSTALLATION AND TESTING OF DRILL ANCHOR BOLTS

- A. All drill anchor bolts shall be coordinated such that they do not clash with any reinforcing steel bars of the concrete structure. Any deviation from the specified positions shall be reported to the Engineer before installation.
- B. Installation of drill anchor bolts shall strictly follow the manufacturer's specifications. Any installation procedures or details that deviate from the manufacturer's specifications shall be appended by a written statement from the manufacturer to confirm strength of the anchors.
- C. Where specified, carry out loading test of drill anchor bolts in accordance with BS 5080, Parts 1 and 2 at a sampling rate of at least 1% of the anchors or 5 numbers, whichever is more, of each type and size of the anchors installed. Each sample anchor shall be tested for tensile load by pull-out test and/or shear load by shear load test, as appropriate, to not less than 1.5 times the recommended working load of the anchor as specified by the manufacturer and with a minimum holding time of 60 minutes under maximum test load. The sample anchor shall not show any signs of separation, plastic deformation or deleterious effect, and shall have at least 80% recovery of the total deformation upon removal of the test load.
- D. If the loading test of any sample anchor fails, the failure mode shall be recorded and the cause shall be determined and reported to the Engineer. Propose remedial measures, including justification calculations for any alternate design and method statement, for agreement with the Engineer prior to carrying out any remedial works. The sample anchor shall not be used for permanent work unless agreed by the Engineer.

5.6.3.3 BOLTING

- A. PREPARATION OF JOINTS
 - a. Prepare and prime the contact surfaces at bolted joints.
 - b. If the contact surfaces are specified to be coated or otherwise treated, e.g. machined surface finish, the joint shall be approved before assembly.
- B. BOLTS AND NUTS
 - a. Length of bolts and threads
 - i. For Grade 4.6 and 8.8 bolts, the length of bolts shall be chosen such that, after tightening, at least one clear thread shall show above the nut. For Grade 10.9 bolts, at least five clear threads shall remain.
 - ii. At the same time, except for high strength friction grip bolts, bolt length shall be chosen such that, after tightening, at least one complete thread in addition to the thread run-out shall remain clear between the nut and the unthreaded shank of the bolt, and for Grade 10.9 bolts used other than in shear, at least 5mm shall remain.

- iii. For general grade (Grade 8.8) high strength friction grip bolts, at least three clear threads shall remain. For higher grade (Grade 10.9) high strength friction grip bolts, at least five clear threads shall remain.
 - b. Galvanized nuts
 - i. Nuts shall be checked after being galvanized for free running on the bolt and re-tapped if necessary, to ensure a satisfactory tightening performance.
 - c. Locking of nuts
 - i. Secure nuts used in connections subject to vibration or reversal of stresses to prevent loosening. Show the proposed method in the Fabrication Shop Drawings.
- C. WASHERS
 - a. General
 - i. When the members being connected have a finished surface protective treatment which may be damaged by the nut or bolt head being rotated, place a washer under the rotating part
 - ii. Provide taper washers to give the bolt heads and nuts a satisfactory bearing when the bolt head or nuts is in contact with a surface which is inclined at more than 3° from a plane at right angles to the bolt axis.
 - b. Spring washers
 - i. Tighten bolt assemblies containing spring washers until the spring washer is completely flattened.
- D. FIT-UP WITH ORDINARY BOLT ASSEMBLIES
 - a. Draw parts to be connected firmly together.
 - b. Use shims to adjust the fit, if necessary.
 - c. For thicker gauge material (thicker than 4 mm for plates and 8 mm for sections), leave residual gaps up to 2 mm, if necessary, between contact faces unless full contact bearing is specified.
 - d. Bring each bolt assembly into a snug-tight condition without overloading the bolts.
 - e. In large bolt groups, carry out this process progressively from the middle of the group to the outside.
 - f. Carry out additional cycles of tightening, if necessary, to achieve a uniform snug-tight condition.
 - g. Take sufficient precautions so as not to overload short bolts and M12 or smaller bolts during tightening.
 - h. The snug tight tension in the bolt should not exceed the value at which bolt shear capacity reduces.
- E. HIGH STRENGTH FRICTION GRIP BOLTS
 - a. Preparation of surfaces
 - i. Clean the interface of members to be jointed with high strength friction grip bolts to the specified surface preparation and leave unpainted.
 - ii. Protect the surface before and after bolt assembly from weather so that the slip factor is not adversely affected.
 - iii. Prepare sample surface preparation for the prior approval of the Engineer.
 - b. Slip factor
 - i. The slip factor shall be in accordance with EN 1993-1-8.
 - ii. Remove all mill-scale from the faying surfaces of friction grip bolted connections.
 - iii. The faying surfaces of friction grip joints are to be free of distortion, deformities or contaminants.
 - iv. Use masking to keep the surfaces free of protective treatments.
 - v. Where specified or when slip factor greater than 0.2 is proposed, carry out tests in accordance with EN 1090-2 to determine the slip factor.
 - c. Tightening
 - i. Use high strength friction grip bolts in accordance with EN 1090-2.
 - ii. Plate washers shall be used for connections with long slotted and oversized holes.
- F. Tightening may be by one of the following methods:

- a. The torque-control method using a calibrated power-operated or a hand-operated torque wrench to the minimum preloading force in following table:

Table 151. Minimum preloading force - High strength friction grip bolts

Minimum preloading force		
Nominal size and thread diameter	Minimum preloading force (kN)	
	General grade (Grade 8.8)	Higher grade (Grade 10.9)
M12	47	59
M16	88	110
M20	137	172
M22	170	212
M24	198	247
M27	257	321
M30	314	393
M36	458	572

- b. Calibrate the wrench regularly in accordance as follows:
- At the commencement of each new working day or shift,
 - With each change of bolts diameter, and
 - With each change of bolts grip length in excess of 1/5th of the length used in the calibration of the wrench.
 - Reapply the wrench to bolts previously tightened in a multi-bolt connection to ensure all bolts have the correct torque.
- c. The direct tension indicator method using approved proprietary load indicators, strictly in accordance with the manufacturer's instructions.
- Adopt wrenches of adequate capacity. Maintain the wrenches in a proper working condition in accordance with the manufacturer's recommendations.
- d. Fit-up
- Draw parts to be connected firmly together with all bolts partially tightened.
 - Check if there is any remaining gap which may affect the integrity of the joint.
 - If so, take the joint apart and insert a pack before recommencing the tightening procedure.
 - Where parts cannot be brought together by drifting without distorting the steelwork, rectify by reaming, provided that the design of the connection will allow the use of larger diameter bolts.
 - Submit calculation to demonstrate that the connection remains adequate for the forces in the connection.
- e. Discarded bolt assemblies
- If, after complete tightening, a bolt or nut has to be slackened off, discard the whole bolt assembly.

5.6.3.4 WELDING

A. WELDING

- Welding shall be anarc welding process in accordance with EN 1011-1 together with other clauses contained in this Technical Specification, unless specified otherwise by project documentation.
- Choose welding consumables to ensure that the mechanical properties of the weld metal are not less than those required for the parent metal. Execute welding in a flat or horizontal position wherever possible.

B. WELDERS AND TESTING OF WELDERS

- a. Provide and assign experienced and competent operator, responsible to supervise welding. Welders shall be tested to meet the requirements of ISO 9606-1/EN 287-1 or approved equivalent standards.
- b. Test on welders shall be witnessed by a qualified welding inspector and certificates are to be endorsed by an independent inspection authority. The certification shall remain valid providing it complies with the conditions for re-approval of certification specified in EN 287-1 or approved equivalent standards.

C. WELDING RECORD

- a. The Contractor shall keep a record on Site when specified to identify welders responsible for major welds.

D. PREPARATION OF WELDING PROCEDURE SPECIFICATIONS

- a. Submit preliminary Welding Procedure Specification (pWPS) which shall be prepared in accordance with EN ISO 15609-1 and certified by a qualified welding inspector for the approval of the Engineer.
- b. The approved pWPS shall be qualified in accordance sub-clause 5.5.4.5.5 prior to commencing production welding.
- c. More than one qualified Welding Procedure Specification (WPS) may be needed to cover the scope of the actual production, and each WPS shall at least address:
 - i. Welding process,
 - ii. Parent metal specification, thickness and other relevant dimensions,
 - iii. Classification, type and size of electrodes and other consumables,
 - iv. Welding current, arc voltage and travel speed/ wire feed speed,
 - v. Sketch showing edge preparation, fit-up and approximate number and arrangement of runs in multi-run welds,
 - vi. heather shop or site welding,
 - vii. Welding positions,
 - viii. Welding sequence,
 - ix. minimum preheating temperature and interpass temperature range,
 - x. Post-weld heat treatment if required.
- d. Do not depart from the approved welding procedure without prior agreement of the Engineer.

E. QUALIFICATION TESTING OF WELDING PROCEDURE

- a. Carry out qualification testing of approved pWPS by Welding Procedure test to EN ISO 15607 and EN ISO 15614-1 strictly in accordance with the approved pWPS and using representative samples of the materials. The qualification testing including welding and testing shall be examined by an accredited independent firm approved by the Engineer. Allow for the Engineer's inspection of the qualification testing.
- b. Subject to the approval of the Engineer, qualification testing of pWPS need not be carried out if the same procedures have been tested and approved by an accredited firm acceptable to the Engineer.
- c. Strictly follow the qualified WPS for the works. Carry out further qualification tests if either the material or procedure changes.
- d. Based on the qualified WPS, prepare appropriate work instructions for all sizes of butt welds and fillet weld where leg length equals to or exceeds 10mm. Submit the work instructions for Engineer's approval prior to the commencement of welding. Work instructions shall include cross-reference to the qualified WPS upon which they are based and shall indicate clearly all essential information including their acceptable range for the specific weld size.

F. WELDING CONSUMABLES

- a. Consumables shall be to EN 499, EN 440, EN 756 or EN 758 as appropriate and strictly in accordance with the manufacturer's recommendations.

G. STORAGE OF WELDING CONSUMABLES

- a. Consumables for use in welding (including electrodes) shall be kept and handled in a controlled manner in accordance with EN 1011-1.

- b. Any drying or baking of electrodes before issue shall be carried out in accordance with the manufacturer's recommendations.
- H. DISTORTION CONTROL
 - a. The sequence of welding a joint or a sequence of joints shall be such that distortion is minimized.
- I. PREPARATION OF JOINTS FOR WELDING
 - a. Prepare fusion surfaces to EN ISO 9692-1 and qualified WPS.
 - b. Surfaces shall be dry, clean and free from paint or metal coating.
 - c. Warm the surfaces if required to remove condensation.
 - d. Weld runs that were not performed on the same day shall have the inter-pass surface treated and properly dressed to the approval of the Engineer.
 - e. The first three runs of a welded joint shall be completed within one day.
- J. SLAG
 - a. Remove welding slag by chipping before depositing subsequent runs.
- K. TACK, BUTT, FILLET AND OTHER WELDS
 - a. Tack welds: Tack welding may only be used with express approval by the Engineer, and shall be carried out as follows:
 - i. Tack welds shall be made using the same procedures as for the root runs of main welds. The length of the tack shall be the lesser of 4 times the thickness of the thicker part being joined and at least 50 mm long, unless demonstrated by a weld procedure qualification.
 - ii. Tack welds, which are not defective, may be incorporated into main welds provided that the welder is qualified as in sub-clause B. However, where joints are welded using an automatic or mechanized process, the suitability of the tack weld used for incorporation into automatic processes shall be demonstrated in the weld procedure qualification.
 - iii. Remove all tack welds made in circumstances other than those identified above.
 - b. Butt welds
 - i. Butt welds shall be full penetration welds between prepared fusion faces, unless specified otherwise. Partial penetration butt weld shall be subject to the approval of the Engineer, but the bevel depth shall at least be 70% thickness of the jointing plates.
 - ii. Carry out back chipping, grinding or gouging of the deposited weld as required to obviate imperfections in the root run. Grind butt welds flush without loss of parent metal.
 - c. Fillet welds
 - i. Deposit fillet welds to the required length, throat thickness and with partial or full penetration as specified.
 - d. Temporary attachments
 - i. Do not weld temporary attachments to principal joints.
 - ii. Obtain approval of the position of welds for temporary attachments and time slot for removal and shall be made in accordance with the requirements for a permanent weld.
 - iii. Remove temporary attachments by flame cut or gouged at a point not closer than 3 mm from the surface of the parent material.
 - iv. If affected area deeper than 3mm, remedial proposal shall be submitted to the Engineer for approval and the repaired surface shall be subject to both magnetic particle inspection and ultrasonic examination.
 - v. Ground flush the residual material and visually inspect the affected area. When the base material thickness exceeds 20mm (or carbon equivalent > 0.43%), it shall also in any case be checked by magnetic particle inspection.
 - vi. The standard of acceptance for welds shall be in accordance sub-clause 5.6.5.2.
 - vii. Do not remove attachments by hammering.

e. Shear stud welding

i. Method

- Weld shear studs by automatic stud welding gun strictly in accordance with the manufacturer's recommendations for materials, procedures and equipment unless approved otherwise.
- Provide adequate earth return connections local to area being stud welded.
- The local area around where the stud is to be welded shall be free of standing water before commencement of welding.

ii. Trial Welding

- Before commencement of the work, carry out trial welding of studs on samples of material and studs, representative of those to be used in the work to demonstrate the suitability of the proposed welding system and equipment.
- Test a minimum of ten studs in the trial. During the work, at the commencement of each shift, a minimum of two trial welds is to be undertaken by each welder. Visually inspect all trial welded studs and they shall show a full 360° collar. Subject trial welded studs to a bend test. The stud weld shall not show any signs of cracking or lack of fusion.
- The bend test shall be made by striking the head of the stud with a 6 kg hammer until it is displaced laterally a distance of about one quarter of the height of the stud. Studs subjected to the bend test shall not be straightened.

iii. Test and Inspection

- Visually inspect all stud welds. Subject any stud weld that does not exhibit full 360° collar to a bend test such that the area of 'no flash' is put in tension.
- Under this test the weld is to show no visible signs of cracking.
- Subject a minimum of 5% of the studs, but not less than two studs per beam, which have satisfied the visual inspection to a bend test. Under this test the weld is to show no visible signs of cracking. Studs subjected to the bend test shall not be straightened.
- Where bend testing reveals an unsatisfactory stud weld, test an additional stud on each side of the defective stud. Replace defective stud with new stud in an adjacent location and retest the replacement stud. The defective stud need not be removed.

iv. Removal of Slag

- Remove slag by light hammering, wire brushing or other methods that do not deform the surface of the weld.

5.6.3.5 PAINTING AND CORROSION PROTECTION

A. PAINTING IN GENERAL

- All painting shall be applied in strict compliance with approved paint manufacturer's recommendation and shall be compatible with each other.
- EN ISO 12944 conditions shall apply, with a minimum requirement class C4 (as per EN ISO 12944-2. Table 1), and painting systems as Table C.5 under EN ISO 12944-5.

B. PREPARATION AND PAINTING OF NEW SURFACES: Prepare new surface to receive protective coatings in accordance with ISO EN 12944-4, and in addition, when more restrictive one of the following:

- Manually clean metal surface thoroughly to remove all dirt, weld spatter, grease and the like. Chip, scrape and wire-brush to remove mill scale and rust. The surface so prepared shall not be inferior to DIN 55928 or ISO 8501-1+2 St2.
- Degrease metal surface, mechanically remove all millscale, rust and weld spatter with power driven tools such as carborundum grinding discs, chipping hammers and needle guns. Clean off all loosened particles by wire brushing or vacuum cleaning. The surface so prepared shall not be inferior to DIN 55928 or ISO 8501-1+2 St3. Apply the protective coating within 4 hours to the cleaned surface.

- c. Blast-clean steel so that the prepared surface is not inferior to DIN 55928 or ISO 8501-1+2 Sa 2.5. Unless approved otherwise by the Engineer, blast-cleaning to steelwork shall not be carried out until all welds for steelwork have been completed. Clean the blasted surface by vacuum and do not touch the surface by hand or contaminate it in any other way. Apply the protective coating within 4 hours to the cleaned surface. Submit a sample of blast cleaned steel not less than 150 x 150 x 6 mm adequately protected in sealed clean polythene wrapping for approval before any work is carried out.
 - d. This approved sample shall be retained for comparison with the subsequent prepared steelwork.
- C. REPARATION OF EXISTING PAINTED SURFACES
 - a. For reparation of existing painted surfaces of structural steelwork, clean the existing paint coat with an approved detergent, remove loose and flaking portions with wire brush and grind rusted areas back to bare metal as instructed by the Engineer, care being taken to avoid producing a smooth surface by excessive grinding.
 - b. Where the existing coating is intact after cleaning, apply the proposed paint coating over a trial panel and examine for adherence after the curing period as recommended by the paint manufacturer. Do not use the paint until the trial is passed.
 - c. Where bare metal is exposed, apply primer, undercoat and finishing coat as directed by the Engineer.
 - d. The reparation of existing painted surfaces shall fulfil, in any case, the requirements stated under "Preparation and painting of new surfaces" in the TS.
- D. HOT DIP GALVANIZING
 - a. Unless approved otherwise by the Engineer, galvanizing to steelwork shall not be carried out until all welds for steelwork have been completed.
 - b. Prior to galvanizing, the following requirements have to be satisfied:
 - i. All welding slags and paints on the steel surface shall be removed.
 - ii. All cut surfaces shall be ground smooth.
 - iii. Adequate number of vent and drainage holes in accordance with EN ISO 14713 shall be provided for closed end hollow sections. The position of the holes and any requirements for subsequent sealing shall be agreed by the Engineer.
 - c. Apply hot dip galvanized coatings to EN ISO 1461 and EN ISO 14713-2.
 - d. Exceptionally, and only under Engineer's approval, small areas of galvanized coating damaged by welding, cutting or by rough treatment during transit or erection shall be made good by:
 - i. The use of at least one coat of zinc rich primer to BS 4652. Thoroughly clean all areas affected by welding with abrasives or mechanical driven tools before applying the zinc rich paint; or
 - ii. If specified, by blast cleaning to not inferior to DIN 55928 or ISO 8501-1+2 Sa 2.5 and followed by one coat of 2-packed epoxy-based zinc rich primer to BS 4652.
 - e. Painting to galvanized structural steel shall be per Table in sub-clause 5.5.4.5.18 Type F or Type G as specified in the Contract.
 - f. For galvanized or zinc rich primer coated surface, submit method statement on checking and removal of zinc salt for the Engineer's approval prior to application of painting.
- E. PAINTING, STRIPE COATS TO JOINTS AND SHARP EDGES AND DAMAGED PAINTING
 - a. Unless approved otherwise by the Engineer, painting to steelwork shall not be carried out until all welds for steelwork have been completed.
 - b. Unless as required in sub-clause *Preparation and painting of new surfaces* (iii), there shall be no paint at the time of welding, other than suitable prefabrication primer, within 50 mm of the weld.
 - c. As soon as possible after joints have been completed and approved, the parent and the joint material, exposed parts of bolts, nuts and washers and weld affected areas shall be brought up to the same standard of preparation and painting as the adjoining surfaces.
 - d. All damaged painting shall be brought up to the same standard of preparation and painting as the adjoining surfaces.

- e. Immediately after the primer of the painting system has dried, apply a stripe coat of primer by brush to edges, corners, crevices, exposed parts of bolts, nuts and welds to ensure that all these areas have a similar dry film thickness to that of any adjacent surface.
 - f. Subsequent undercoat and finishing coat of paint shall be applied similarly, but with the stripe coat for the undercoat and finishing coat be applied beforehand.
- F. PAINT: Paint shall be supplied in sealed containers. Each container shall be marked on the side to show the following:
- a. The name of the manufacturer,
 - b. The paint manufacturer's reference number,
 - c. Intended purposes, type of pigment and binder,
 - d. Batch number, date of manufacture, expiry date and pot life, and
 - e. Colour, gloss, drying times and flash point.

Table 152. Painting systems - EN ISO 12944-5 . C.5

Table C.5 — Paint systems for carbon steel for corrosivity category C5

System No.	Priming coat				Subsequent coat(s)	Paint system		Durability			
	Binder type	Type of primer	No. of coats	NDFT in μm	Binder type	Total no. of coats	NDFT in μm	l	m	h	vh
C5.01	EP, PUR, ESI	Misc.	1	80 to 160	EP, PUR, AY	2	180	X			
C5.02	EP, PUR, ESI	Misc.	1	80 to 160	EP, PUR, AY	2-3	240	X	X		
C5.03	EP, PUR, ESI	Misc.	1	80 to 240	EP, PUR, AY	2-4	300	X	X	X	
C5.04	EP, PUR, ESI	Misc.	1	80 to 200	EP, PUR, AY	3-4	360	X	X	X	X
C5.05	EP, PUR, ESI	Zn (R)	1	60 to 80	EP, PUR, AY	2	160	X			
C5.06	EP, PUR, ESI	Zn (R)	1	60 to 80	EP, PUR, AY	2-3	200	X	X		
C5.07	EP, PUR, ESI	Zn (R)	1	60 to 80	EP, PUR, AY	3-4	260	X	X	X	
C5.08	EP, PUR, ESI	Zn (R)	1	60 to 80	EP, PUR, AY	3-4	320	X	X	X	X
NOTE 1 For abbreviations see Table A.1 .											
NOTE 2 In addition to polyurethane technology, other coating technologies may be suitable, e.g. polysiloxanes, polyaspartic and fluoropolymer [fluoroethylene/vinyl ether co-polymer (FEVE)].											

Table 153. Painting systems. EN ISO 12944-5

Surface Preparation	Painting system	Details of Painting System	
As Clause 15.61 (i)	Type A	Primer :	Drying oil based zinc phosphate primer, applied in 1 coat Dry film thickness = 40 µm
		Finishing coat :	Drying oil based finishing coat, applied in 2 coats Dry film thickness = 80 µm
		Minimum overall dry film thickness = 120 µm	
As Clause 15.61 (ii)	Type B	Primer :	2-pack surface tolerant epoxy based aluminium paint Dry film thickness = 80 µm
		Finishing coat :	2-pack recoatable polyurethane finishing paint, applied in 2 coats Dry film thickness = 80 µm
		Minimum overall dry film thickness = 160 µm	
As Clause 15.61 (iii)	Type C	Primer :	2-pack epoxy based zinc rich primer, applied in 1 coat, to BS 4652 (except that the content of zinc metal in the dry film shall not be less than 80% (by weight) of the cured paint film) Dry film thickness = 60 µm
		Undercoat :	2-pack epoxy based micaceous iron oxide paint Dry film thickness = 100 µm
		Finishing coat :	2-pack recoatable polyurethane coats finishing coat, applied in 2 coats Dry film thickness = 100 µm
		Minimum overall dry film thickness = 260 µm	
As Clause 15.61 (iii)	Type D	Primer :	2-pack epoxy based zinc rich primer, applied in 1 coat, to BS 4652 (except that the content of zinc metal in the dry film shall not be less than 80% (by weight) of the cured paint film) Dry film thickness = 60 µm
		Undercoat :	2-pack epoxy based micaceous iron oxide paint Dry film thickness = 100 µm
		Finishing coat :	2-pack epoxy based finishing coat Dry film thickness = 100 µm
		Minimum overall dry film thickness = 260 µm	
	Type E	NOT USED	
Hot dip galvanized to Clause 15.63	Type F	Primer :	Nil
		Pretreatment :	Degrease and rinse. Apply British Rail T-Wash or equivalent. Excess etchant to be thoroughly rinsed.
		Undercoat :	Nil
		Finishing coat :	2-packed recoatable polyurethane finishing paint applied in 2 coats recommended as suitable by paint manufacturer for direct application to etched surface. Etched surface shall be overcoated within 24 hours or the time limit by the manufacturer Dry film thickness = 80 µm
Hot dip galvanized to Clause 15.63	Type G	Primer :	Nil
		Pretreatment :	Degrease and rinse. Apply British Rail T-Wash or equivalent. Excess etchant to be thoroughly rinsed.
		Undercoat :	2-pack epoxy based micaceous iron oxide paint recommended as suitable by paint manufacturer for direct application to etched surface. Etched surface shall be overcoated within 24 hours or the time limit by the manufacturer Dry film thickness = 80 µm
		Finishing coat :	2-packed recoatable polyurethane finishing paint applied in 2 coats Dry film thickness = 80 µm
		Minimum overall dry film thickness = 160 µm	
Note : Drying oils dry (or cure) in the presence of atmospheric oxygen; they include linseed oil, urethane oil, alkyd, modified alkyd, phenolic varnish or epoxy ester.			

G. For Table A.1, Contractor shall refer to EN ISO 12944-5

5.6.4 TOLERANCES

5.6.4.1 DIMENSIONS AND TOLERANCES

- A. HOT-ROLLED OR HOT-FINISHED SECTIONS AND PLATES: Dimensions and tolerances shall comply with the standards shown in the following table:

Table 154. Dimensions and tolerances - Technical delivery requirements, dimensions and tolerances for steel works

Products	Technical delivery requirements	Dimensions	Tolerances
I and H sections	EN 10025-1 and EN 10025-2 EN 10025-3 EN 10025-4 EN 10025-5 EN 10025-6 as relevant	EN 10365	EN 10034
Hot-rolled taper flange I sections		EN 10365	EN 10024
Channels		EN 10365	EN 10279
Equal and unequal leg angles		EN 10056-1	EN 10056-2
T Sections		EN 10355	EN 10355
Plates, flats, wide flats		Not applicable	EN 10029 EN 10051
Bars and rods		EN 10017, EN 10058, EN 10059, EN 10060, EN 10061	EN 10017, EN 10058, EN 10059, EN 10060, EN 10061
Hot finished hollow sections	EN 10210-1	EN 10210-2	EN 10210-2
Cold formed hollow sections	EN 10219-1	EN 10219-2	EN 10219-2

- A. COLD-FORMED OPEN SECTIONS AND PROFILED STEEL SHEETS
- Cold-formed open sections and profiled steel sheets shall comply with EN 1993 1-3 or equivalent.
 - Proprietary products may be used with prior approval of the Engineer.
- B. COLD-FORMED HOLLOW SECTIONS
- The mechanical properties, chemical composition, dimensions and tolerances of cold-formed structural hollow sections shall comply with EN 10219.

5.6.4.2 ACCURACY OF FABRICATION

- A. ROLLED SECTIONS
- Hot rolled, hot finished or cold formed structural products shall conform to the tolerances specified by the relevant product standard. These tolerances continue to apply to components manufactured from such products, unless superseded by more stringent criteria specified in EN 1090-2 Annex B.
- B. WELDED SECTIONS
- Welded components manufactured from plates shall conform to the permitted deviations in EN 1090-2 Table B.1 and Tables B.3 to B.6.
- C. COLD FORMED SECTIONS
- Components cold formed by pressing shall conform to the permitted deviations in EN 1090-2 Table B.2.
- D. STIFFENED PLATING
- Stiffened plating shall conform to the permitted deviations in EN 1090-2 Table B.7.

5.6.4.3 PERMITTED DEVIATIONS

- A. Fabricate all steelwork components to an accuracy that will enable erection within the specified limits to take place without inducing excessive stresses, deflection or distortion into the structure.
- B. Essential and functional tolerances shall be in accordance with EN 1090-2 Annex B and EN 1090-2 Clause 11 requirements.
- C. The permitted deviations do not include elastic deformations induced by the self-weight of the components.
- D. In each case, the requirements are for final acceptance testing. If fabricated components are to form parts of a structure that is to be erected on site, the tolerances specified for the final checking of the erected structure shall be met in addition to those for the fabricated components.
- E. In case of nonconformity, EN 1090-2 instructions shall be followed.

5.6.4.4 ERECTION

- A. Unless approved otherwise by the Engineer, erect fabricated steelwork only after all welded joints and specified protective coatings have been inspected, tested where required, and approved.
- B. Do not load any part of the structure without prior approval of Engineer.
- C. METHOD STATEMENT
 - a. Prepare and submit details of the proposed method of erection for Engineer's approval.
 - b. Details submitted shall include type of plant and equipment to be used and, if necessary, drawings and calculations of any temporary work.
 - c. Approval shall not in any way relieve the Contractor of his responsibility for safe erection of permanent work, or the safe erection and subsequent dismantling of temporary work.
- D. TEMPORARY BRACINGS OR RESTRAINTS
 - a. Design and provide sufficient temporary bracings or restraints to ensure that the structure can withstand all loadings during construction without inducing excessive stresses, deflection or distortion in the structure. Include the design and details of the temporary bracings or restraints in the proposed method of erection.
 - b. Do not remove the temporary bracings or restraints until the fabricated structure has been completed and permanent bracings have been erected to ensure stability in all directions.
 - c. Any connections for the temporary bracings or restraints shall not weaken the permanent structure or impair its serviceability.
- E. LINING AND LEVELLING
 - a. Align each part of structure as soon as practicable after it has been erected. Do not make permanent connections between members until the structure has been aligned, levelled, plumbed and temporarily connected to ensure that members will not be displaced during the subsequent erection or alignment of the remainder of the structure.
 - b. Take due account of the effects of temperature on the structure and measuring equipment when measurements are made for setting-out, during erection, and for dimensional checks carried out subsequently.
- F. PACKINGS AND GROUTING
 - a. Bed column bases or grout anchor bolts only after the steelwork has been plumbed, levelled, aligned, and adequately braced.
 - b. Steel packings and wedges of sufficient strength and stiffness shall be used to plumb and level columns before grouting and shall be of sufficient size to avoid local crushing of the concrete. They shall be placed so that they do not prevent subsequent grouting to completely fill all spaces directly under the base plates.
 - c. Grout shall be poured under a suitable head and tamped or vibrated to remove air pockets.
 - d. Where packings are to be left in position and subsequently grouted, they are to be placed such that they will be totally embedded in the grout with adequate cover.

- e. Immediately before grouting, the space under column base plates shall be clean and free of all extraneous matter.

5.6.5 WORK RECEPTION

5.6.5.1 TESTING OF MATERIALS

5.6.5.1.1 GENERAL

- A. Allow sufficient time for the testing of specimens.
- B. Do not incorporate materials until relevant tests have been carried out and approval obtained.

5.6.5.1.2 TESTING OF SECTIONS AND PLATES

- A. Contractor is responsible to conduct tests and provide one test specimen for every 40 tonnes or part thereof of each section or plate of same thickness from the same cast. For the purpose of this clause "same thickness" means similar sections with a variation in thickness not exceeding + 5 mm. Test specimens shall be taken from sections selected at random on Site by the Engineer.
- B. Prepare the test specimens to EN 10002-1 as directed and appropriately mark and deliver them to Public Works Laboratories, as directed by the Engineer. The test specimens shall be subjected to tensile test in accordance with EN 10002-1.
- C. Subject to the approval of the Engineer, manufacturer's certificates may be accepted as proof of quality in lieu of sampling on site when all steel sections are prefabricated prior to shipment.

5.6.5.1.3 THROUGH THICKNESS PROPERTIES

- A. Ensure that where appropriate the steel material has adequate through thickness properties to satisfy the design, the method of fabrication, welding procedures and non-destructive inspection regime such that the material at, or adjacent to, welds are free of laminations, centreline segregation or other crack like indications on completion of welding.
- B. Any material, which is specified or proposed by the Contractor to have enhanced through thickness properties, shall comply with the requirements of EN 10164. The Contractor shall, not less than three weeks prior to ordering the steel, submit a report to the Engineer which documents the strategy that will be adopted (in terms of material selection, weld procedure, procedure trials, weld sequence, shrinkage control and inspection regime) to ensure that the above criteria are satisfied. If valid test reports issued by the manufacturer are not available, carry out the following additional tests by Public Works Laboratories or an approved independent accredited laboratory:
 - a. Ultrasonic grading to EN 10160, Grade L4; and
 - b. Through-thickness tensile tests to EN 10164.

5.6.5.1.4 SECURITY

- A. Cut test specimens under the direction and supervision of the Engineer who shall put his signature on the specimen in indelible ink.
- B. Keep the specimen with Engineer's signature securely under lock. Keep the key in the Engineer's office before delivery to workshop for grinding preparation to the required shape where necessary.
- C. Take test specimen returned from workshop to the Engineer for verification of signature. Keep section securely under lock. Keep the key in the Engineer's office before delivery to the laboratory for testing.
- D. Deliver samples to the laboratory under the escort of the Engineer.
- E. Submit for approval by the Engineer at the commencement of the Contract a stock management system to preclude unauthorized use of structural steel sections prior to receipt of test results as well as swapping of sections of different testing status.

- F. The following shall be included:
- Provide identification marks to different specimens arriving on Site which are uniquely traceable to the record of each batch.
 - The record of a batch of steel sections shall include date of arrival to Site, quantities delivered of different sections, delivery note, mill certificate and the supplier's certificate.
 - Establish and maintain a record system, such as colour coding or other approved systems, for identifying and showing clearly specimens that are under different testing status (awaiting test results, approved for use, non-compliant, re-test, omitted for testing etc.).
 - Keep separately specimens of different testing status at different locations.

5.6.5.1.5 TESTING OF BOLTS, NUTS AND WASHERS

- Contractor shall perform test specimens and carry out testing of bolts and associated nuts and washers in accordance with the relevant standard when so directed by the Engineer.
- Rate of sampling shall be as the Table 155 unless specified otherwise by the Engineer.
- Contractor shall submit test results as soon as they are available.
- Test specimens for bolts shall be subjected to tests to EN ISO 898-1 to determine their tensile strength and for nuts shall be subjected to tests in Annex A of BS 4190.

Table 155. Testing and sampling requirements - Bolts, nuts and washers

Sampling of bolts	
Diameter of bolts	Rate of sample
Not exceeding 16 mm	1 in 15000 or part thereof
Exceeding 16 mm but not exceeding 24 mm	1 in 5000 or part thereof
Exceeding 24 mm	1 in 2500 or part thereof

5.6.5.1.6 FAILURE OF TESTS

- When result of any test on steel sections or plates specified in previous sub-clauses fail to comply with the relevant standard, two further test specimens shall be taken from the same batch of steel for re-test.
- Provided the results of these further tests both comply with the relevant standard, the batch of steel represented by the specimens shall be deemed to comply with the Specification.
- If the result of either of these additional tests does not comply with the relevant standard, the batch of steel represented by the specimens shall be deemed not to comply with the Specification.
- If the result of any test on bolts or nuts fails to comply with relevant standard, two further test specimens shall be taken respectively from the same batch of bolts or nuts for re-test. Provided the results of these further tests both comply with the relevant standard, the batch of bolts or nuts represented by the specimens shall be deemed to comply with the Specification.
- If the result of either of these additional tests does not comply with relevant standard, the batch of bolts or nuts represented by the specimens shall be deemed not to comply with the Specification.
- Remove non-compliant structural steel, bolts, nuts and washers from Site as soon as possible under the supervision of the Engineer.

5.6.5.2 ACCEPTANCE OF WELDS

- An approved independent accredited testing firm to carry out and interpret the inspection and testing of welds and provide any necessary labour and attendance shall be provided by Contractor.

- B. Evidence proving that operators carrying out the inspection and testing have been trained and assessed for competence in the inspection and testing of welds shall be submitted. In addition, submit certificates of competence from a recognized authority for operators carrying out ultrasonic examination.
- C. Arrange for the independent testing firm to submit a testing programme for the approval of the Engineer. Any welds that shall be rendered inaccessible by subsequent work shall be examined prior to the loss of access.
- D. Visually inspect all welds in accordance with EN 970, and after visual inspection, carry out non-destructive testing in accordance with next table:

Table 156. Testing requirements - Welds

Welds - Frequency of non-destructive testing	
Weld type	Frequency of non-destructive testing
All types of butt welds	100% ultrasonic examination and magnetic particle inspection
Fillet welds with leg length exceeding and including 10 mm	20% ultrasonic examination and magnetic particle inspection
Fillet welds with leg length not exceeding 10 mm	20% magnetic particle inspection
Secondary attachment welds, e.g. for fixing purlings, side rails	5% attachments by magnetic particle inspection and ultrasonic examination if leg exceeds and includes 10 mm

- E. In any case, the number and percentage of non-destructive testing will be in accordance with the execution classes of the elements and to the table 24 of EN 1090-2.
- F. Carry out surface flaw detection by magnetic particle inspection (MPI) in accordance with EN 1290. If MPI is impractical, dye penetration inspection (DPI) may be used, subject to the approval of the Engineer, in accordance with EN 571.
- G. Carry out ultrasonic examination in accordance with EN 1714 Level B. Make printout results available during ultrasonic examination on site at 3 specified locations per weld (such as at both ends and in the middle of the weld) and at positions in question.
- H. The independent testing firm shall submit test reports directly to the Engineer in sealed envelopes within 3 days of the completion of the testing. Tests revealing discontinuity shall be reported separately from the subsequent repair and re-test.
- I. Unless approved otherwise by the Engineer, carry out all non-destructive testing not less than 16 hours from the time of completion of the weld to be inspected, or not less than 40 hours in case of butt welds thicker than 40 mm or any welds to Grade 55 steel. Should test results indicate that welds are below the standard of acceptance, carry out at the Contractor's own expense approved remedial measures and further acceptance tests.

5.6.5.3 ACCEPTANCE OF PAINTING SYSTEMS

- A. Paint system shall be tested and approved under conditions required in EN ISO 12944-6 and EN ISO 12944-7.

5.6.6 COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.
 - a. EN 1993: Eurocode 3. Design of steel structures.
 - b. EN 1504-5 Standard. Products and systems for the protection and repair of concrete structures. Definitions, requirements, quality control and evaluation of conformity. Concrete injection.
 - c. EN 10025: Hot rolled products of structural steels.
 - d. EN 10210: Hot finished structural hollow sections of non-alloy and fine grain steels.
 - e. EN 10056: Structural steel equal and unequal leg angles.

- f. EN 10056-2: Structural steel equal and unequal leg angles part.
- g. EN 10055: Hot rolled steel equal flange tees with radiused root and toes - dimensions and tolerances on shape and dimensions.
- h. EN 10034: Structural steel i and h sections; tolerances on shape and dimensions.
- i. EN 10024: Hot rolled steel taper flange I sections - tolerances on shape and dimensions.
- j. EN 10279: Hot rolled steel channels - tolerances on shape, dimensions and mass.
- k. EN 10029: Hot-rolled steel plates 3 mm thick or above - tolerances on dimensions and shape.
- l. EN 10051: Continuously hot-rolled strip and plate/sheet cut from wide strip of non-alloy and alloy steels - tolerances on dimensions and shape.
- m. EN 10219: Cold formed welded structural hollow sections of non-alloy and fine grain steels.
- n. BS 4320: Specification for metal washers for general engineering purposes. Metric series.
- o. EN 14399: High-strength structural bolting assemblies for preloading.
- p. EN ISO 3506: Mechanical properties of corrosion-resistant stainless steel fasteners.
- q. EN ISO 13918: Welding - studs and ceramic ferrules for arc stud welding.
- r. EN 10002: Metallic materials - tensile testing.
- s. EN 10164: Steel products with improved deformation properties perpendicular to the surface of the product - technical delivery conditions.
- t. EN ISO 898: Mechanical properties of fasteners made of carbon steel and alloy steel.
- u. EN 1090: Execution of steel structures and aluminium structures.
- v. EN 10365: Hot rolled steel channels, I and H sections. Dimensions and masses.
- w. EN 10160: Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflection method).
- x. EN 1011: Welding - recommendations for welding of metallic materials.
- y. EN 287: Qualification test of welders - fusion welding
- z. EN ISO 15609: Specification and qualification of welding procedures for metallic materials - welding procedure specification.
- aa. EN ISO 15607: Specification and qualification of welding procedures for metallic materials - general rules.
- bb. EN ISO 15614: Specification and qualification of welding procedures for metallic materials - welding procedure test.
- cc. EN 499: Welding consumables - covered electrodes for manual metal arc welding of non alloy and fine grain steels – classification.
- dd. EN 440: Welding consumables - wire electrodes and deposits for gas shielded metal arc welding of non-alloy and fine grain steels – classification.
- ee. EN 756: Welding consumables - solid wires, solid wire-flux and tubular cored electrode-flux combinations for submerged arc welding of non alloy and fine grain steels – classification.
- ff. EN 758: Welding consumables - tubular cored electrodes for metal arc welding with and without a gas shield of non-alloy and fine grain steels – classification.
- gg. EN ISO 9692: Welding and allied processes - types of joint preparation.
- hh. EN 970: Non-destructive examination of fusion welds - visual examination.
- ii. EN 1290: Non-destructive testing of welds - magnetic particle testing of welds.
- jj. EN 571: Non-destructive testing - penetrant testing.
- kk. EN 1714: Non-destructive testing of welds - ultrasonic testing of welded joints.
- ll. EN ISO 12944-2: Paints and varnishes. Corrosion protection of steel structures by protective paint systems – Part 2: Classification of environments
- mm. EN ISO 12944-3: Paints and varnishes. Corrosion protection of steel structures by protective paint systems – Part 3: Design considerations

- nn. EN ISO 12944-4: Paints and varnishes. Corrosion protection of steel structures by protective paint systems – Part 4: Types of surface and surface preparation
- oo. EN ISO 12944-5: Paints and varnishes. Corrosion protection of steel structures by protective paint systems – Part 5: Protective paint systems
- pp. EN ISO 12944-6: Paints and varnishes. Corrosion protection of steel structures by protective paint systems – Part 6: Laboratory performance test methods
- qq. EN ISO 12944-7: Paints and varnishes. Corrosion protection of steel structures by protective paint systems – Part 7: Execution and supervision of paint work
- rr. EN ISO 14713: Zinc coatings - guidelines and recommendations for the protection against corrosion of iron and steel in structures.
- ss. EN ISO 1461: Hot dip galvanized coatings on fabricated iron and steel articles - specifications and test methods.
- tt. ASTM E736 / E736M - Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members.
- uu. DIN 55928 - Corrosion Protection Of Steel Structures By Organic, Inorganic And Metallic Coatings; Preparation And Testing Of Surfaces.
- vv. ISO 8501-1– Rust grades and preparation of uncoated steel substrates and steel substrates after overall removal of previous coatings.
- ww. ISO 8501-2 - Preparation grades of previously coated steel substrates after localised removal of previous coatings.
- xx. BS 4190 - ISO metric black hexagon bolts, screws and nuts. Specification.
- yy. BS 5080 - Structural fixings in concrete and masonry.
- zz. BS 4652 - Specification for zinc-rich priming paint (organic media).
- aaa. ACI 351.1R. Report on grouting between foundations and bases for support of equipment and machinery
- bbb. ACI 308.1 specification for curing concrete
- ccc. EN 10088-1 Stainless steels. List of stainless steels
- ddd. EN 10088-2 Stainless steels - Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes
- eee. EN 10088-3 Stainless steels - Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes
- fff. EN 10088-4 Stainless steels - Part 4: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for construction purposes
- ggg. EN 10088-5 Stainless steels - Part 5: Technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes.
- B. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

5.6.7 MEASUREMENT AND PAYMENT – STRUCTURAL STEEL

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 157. Units of measurement – Structural Steel

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_76_51	000301	STRUCTURAL STEEL S355	kg	Structural steel consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant steel sections S355 supply and all operations, materials and equipment necessary for the manufacture, assembly in the workshop, transport, handling, on-site assembly of the metal structure and its placement by means of cranes, including welding and coating, with all the auxiliary means necessary until it is placed in its final position on the construction site.
Pr_20_76_51	000302	STRUCTURAL STEEL S275	kg	Structural steel consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for steel sections S275 supply and all operations, materials and equipment necessary for the manufacture, assembly in the workshop, transport, handling, on-site assembly of the metal structure and its placement by means of cranes, including welding and coating, with all the auxiliary means necessary until it is placed in its final position on the construction site.
Pr_25_30_30_85	000301	STAINLESS STEEL GRATINGS 25 x 2 mm plate (24 x 24 mm mesh)	m2	Stainless steel gratings 25 x 2 mm plate (24 x 24 mm mesh) consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for stainless steel gratings supply and all operations, materials and equipment necessary for the manufacture, assembly in the workshop, transport, handling, on-site assembly of the metal structure and its placement by means of cranes, including welding, with all the auxiliary means necessary until it is placed in its final position on the construction site.
Pr_20_76_51_21	000301	GALVANIZED DOWEL 12 mm. DRILLING OF 20 mm DIAMETER AND INJECTION OF EPOXI RESIN. LENGTH < 0.70 m	pc	Galvanized dowel (12 mm in diameter, length < 0.70 m) consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of galvanized dowel 12 mm in diameter including 20 mm diameter drilling and filling with epoxy resin, with all the auxiliary means necessary until it is placed in its final position on the construction site.

5.7 BRIDGE BEARINGS

5.7.1 SCOPE

- A. These Technical specifications section apply to bridge bearings that are produced according to EN 1337 standards requirements of the group and / or the relevant European technical approvals. The bearings shall be delivered according to the calculations and requirements indicated in the project drawings.
- B. Bridge bearings shall have a design working life of 50 years except in those cases where specified otherwise in this document and accepted by the Engineer and Employer.

5.7.2 MATERIALS AND PRODUCTS

5.7.2.1 SPHERICAL BEARINGS

- A. Spherical bearings shall meet the requirements of EN 1337-7 and satisfy the properties indicated in the project. Bridge bearings are supplied only with the manufacturer's certificate stipulating a compulsory production standard, product use, quality of materials and components certificates. In supporting parts shall be equipped with a displacement metre which allows the control of the movement of the bearing during operation. The load-bearing parts of the delivery suite to be included in each bearing part and bearing parts of the installation and operating instructions.
- B. Spherical bearings shall be provided with PTFE or enhanced PTFE material, depending on supplier. The spherical steel element allows rotation, while the ability to horizontal displacement is ensured by the presence of a stainless-steel plate that slides in contact with one PTFE sheet.
- C. The bearing devices and the stainless-steel sheet will slide for maximum displacement capacity as indicated in drawings.
- D. Spherical bearings shall be laterally guided as specified in drawings.
- E. The spherical bearings are characterized by their ability to vertical load and the maximum displacement allowable and type of motion allowed. Vertical load, horizontal displacements and rotations allowed by bearings shall be greater than those indicated in drawings.
- F. Spherical bearings shall meet the standard series EN-1337, and the manufacturer shall certify a span life greater of fifty years (50 years). The Contractor shall provide the bearing inspection and maintenance bearing manual in order to ensure the scheduled span life.
- G. Loads (free, guided, etc.) types and movements of each real bearing will be submitted by Contractor for Employer's approval.
- H. All supports shall be arranged with horizontal sliding surface.
- I. Likewise, all supports will be arranged with the stainless-steel sheet sliding on PTFE, in conventional position.
- J. Spherical supports shall have a gauge that will be placed in the position as zero (0) to the place on site in their final position, to allow quickly check the relative movement of the stainless steel sheet with respect to the bearing, which it is equivalent to the relative movement between the deck and the pier or abutment.
- K. The bearings shall be manufactured in three (3) pieces. On the one hand, the lower part with the concavity with PTFE, the intermediate part allowing the rotation of the support, and the top plate slides over the topsheet of PTFE. The bearings will be supplied on site with all their elements fixed by clamps that do not allow dismantling the bearing, including a traceability system identifying clearly the support type, its position on the bridge, and the forward direction of chainage stations.
- L. Once placed the bearing and fixed to the deck, when it will be required to allow longitudinal displacement, the clamping plates shall be withdrawn from the bearings parts so as to allow free movement of the same.
- M. The lower part shall be provided with anchors, which shall be calculated by the manufacturer to resist the forces indicated in planes. These anchors will be embedded in the concrete of piers and/or abutments.
- N. The bearings shall be placed at their position, levelled as indicated in the Tolerance Clause inside this Technical specification Chapter, before proceeding to cast the anchors. The design of anchors, for top and bottom connection, shall permit replacement of the bearing if necessary.
- O. The manufacturer shall provide a certificate of having carried out in an official laboratory an endurance test of a complete support of similar type that will be used on site.
- P. In this test, it shall have been subjected to the action of supporting the effect of at least two million (2 mill) alternate charge cycles. The test range will be performed between half and one and a half (0.5-1.5) the rated load of the support, indicated by the manufacturer.

5.7.2.2 ELASTOMERIC BEARINGS

- A. Without prejudice to the application of the technical specifications in this section, Road bridges shall fulfil technical requirements of the Country's road authority.
- B. The elastomeric bearings shall meet the requirements of EN 1337-3 and satisfy the properties indicated in the project. Bridge bearings are supplied only with the manufacturer's certificate stipulating a compulsory production standard, product use, quality of materials and components certificates. In supporting parts shall be equipped with a displacement metre which allows the control of the movement of the bearing during operation. The load-bearing parts of the delivery suite to be included in each bearing part and bearing parts of the installation and operating instructions.
- C. The elastomeric bearings shall meet the standard series EN-1337, and the manufacturer shall certify a span life greater of 30 years. The Contractor shall provide the bearing inspection and maintenance bearing manual in order to ensure the scheduled span life.
- D. Loads, rotations and displacements of each real bearing will be submitted by Contractor for Employer's approval.
- E. The lower part will be provided with anchors, which shall be calculated by the manufacturer to resist the forces indicated in planes. These anchors will be embedded in the concrete of piers and/or abutments.
- F. The bearings will be placed at their position, perfectly levelled, permitting the replacement of the bearing if necessary.

5.7.3 WORK EXECUTION

5.7.3.1 BEARING INSTALLATION

- A. Bridge bearings are installed in accordance with EN 1337-11 and project documentation drawings. During works and controls Contractor must comply to the following points:
 - a. Those bearings which are placed on inclined bases shall be secured to a flat surface which is formed of a plastic or cement grout. Thicker layers of 50 mm will be made of reinforced concrete or reinforced with the support plate. Approval of bearing below ground level is prohibited.
 - b. Bridge span contacting surfaces shall be a parallel bearing surface, it is to say, horizontal. Deviations in contact surface parallelism with bearings can be tolerated in prefabricated structures if the rotation angle does not exceed the maximum permissible values, as deflection caused by loads and creep effects tend to reduce or eliminate the negative deviations.
 - c. The point where concentrated compressive forces are introduced will strictly fit to the drawings mentioned reinforcement,
 - d. Anticipating the possibility of changing of bearings (lifting jack span structure).
 - e. Bridge bearings shall be accessible for maintenance, inspection of their condition and operation monitoring.

5.7.3.2 BEARING ADJUSTMENT

- A. Bearing adjustment during their installation is specified in the project, taking into account the expected ambient temperature during installation. Adjustment work includes the alignment of the spherical bearing upper and lower plates, considering the concrete bridge shrinkage and creep, as well as concrete expansion or contraction due to temperature changes in relation to the temperature installation at site.
- B. Bearing devices will be installed estimating the length corrections, which are calculated based on the actual (temperature) during installation. The calculation method is determined by the design documentation.
- C. Bearing installation and air temperature will be recorded in the site log and be part of the final as built report.

5.7.4 TOLERANCES

- A. Maximum elevation deviation allowance for the levelling pads shall be ± 5 mm per bearing in a group of bearings.
- B. Maximum elevation deviation allowance for one bearing in a group of bearings will be ± 1 mm.

- C. Tolerances for the plan positioning shall be ± 15 mm but not more than 1/20 of the distance between the bearing axis and the nearest edge of the structure (below / above the bearing) edge.
- D. Material and bearing elements dimensions and shape tolerances can be found in EN 1337 standard parts depending on the bearing type. EN 1337 will be followed.

5.7.5 WORK RECEPTION

- A. Work procedure shall be performed by the Contractor with the conditions and according to the following requirements:
 - a. report on examinations upon spherical bearing installation
 - b. report on the spherical bearing testing after installation,
 - c. spherical bearing position measurement report.
- B. Engineer will check the items listed below in order to assess the project documentation, and other necessary standards:
 - a. temperature installing bridge bearings;
 - b. material used below the support part;
 - c. material used over the bridge bearing;
 - d. direction control according to the design documentation;
 - e. displacement of a direction control;
 - f. contacting the surface area of treatment;
 - g. temporary fasteners removal (spherical bearings will be provided on both sides with a temporary connection, or a temporary support, anchoring elements to substructure and superstructure);
 - h. spherical bearing installation equipment;
 - i. corrosion protection status;
 - j. manufacturer data bearing card;
 - k. anchoring bracket designs and quality.

5.7.6 COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.
- B.
 - a. EN 1337-1: 2002 Structural bearings. Part 1. General rules of design
 - b. EN 1337-2: 2004 Structural bearings. Part 2. Sliding elements
 - c. EN 1337-3: 2004 Structural bearings. Part 3. Elastomeric bearings
 - d. EN 1337-7: 2004 Structural bearings. Part 7. Spherical and cylindrical PTFE
 - e. EN 1337-8: 2008 Structural bearings. Part 8. Guided bearings and restrained bearings
 - f. EN 1337-9: 2002 Structural bearings. Part 9. protection
 - g. EN 1337-10: 2004 Structural bearings. Part 10. Technical inspection
 - h. EN 1337-11: 2002 Structural bearings. Part 11. Transport, storage and installation .
- C. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

5.7.7 MEASUREMENT AND PAYMENT – BRIDGE BEARINGS

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 158. Units of measurement - Bridge bearings

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_85_10_65	000301	POT BEARING 600	pc	POT bearings (600) consist of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_65	000302	POT BEARING 800	pc	POT bearings (800) consist of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_65	000303	POT BEARING 1000	pc	POT bearings (1000) consist of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_65	000304	POT BEARING 1200	pc	POT bearings (1200) consist of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_65	000305	POT BEARING 1400	pc	POT bearings (1400) consist of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10	000301	NON-SLIDING VULCANIZED LAMINATED NEOPRENE BEARING	dm3	Non-sliding neoprene bearings consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems composed of alternative layers of elastomeric material and steel, able to absorb the deformations and twists imposed by supporting structure. This item includes the supply of all materials and their placement

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_85_10	000302	SLIDING VULCANIZED LAMINATED NEOPRENE BEARING	dm3	Sliding neoprene bearings consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems composed of alternative layers of elastomeric material and steel, able to absorb the deformations and twists imposed by supporting structure. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000309	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=7.500)	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=7.500), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000310	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=7.500) with anti uplift	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=7.500) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000301	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=15.000)	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=15.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000311	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=16.000) with anti uplift	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=16.000) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000302	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=20.000)	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=20.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_85_10_81	000303	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=30.000)	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=30.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000304	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=40.000)	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=40.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000322	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=12000)	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=12.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000327	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=14000)	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=14.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000318	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=5000)	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=5.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000333	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=5500) with anti uplift	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=5.500) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_85_10_81	000324	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=7.000) with anti uplift	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=7.000) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000328	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=45.000)	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=45.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000330	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=8.000) with anti uplift	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=8.000) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000335	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=10.000) with anti uplift	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=10.000) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000338	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=25.000) with anti uplift	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=25.000) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000339	GUIDED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=5650) with anti uplift	pc	Supply and fixing of a guided sliding spherical bearing (Nmax,ULS (kN)=5650) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_85_10_81	000312	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=7.500)	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=7.500), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000315	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=7.500) with anti uplift	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=7.500) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000331	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=8.000) with anti uplift	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=8.000) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000305	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=15.000)	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=15.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000316	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=16.000) with anti uplift	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=16.000) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000306	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=20.000)	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=20.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_85_10_81	000307	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=30.000)	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=30.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000308	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=40.000)	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=40.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000321	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=12.000)	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=12.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000317	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=5.000)	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=5.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000334	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=5.500) with anti uplift	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=5.500) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000319	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=10.000)	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=10.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_85_10_81	000336	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=10.000) with anti uplift	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=10.000) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000320	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=11.300)	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=11.300), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000325	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=8.000)	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=8.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000326	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=17.000)	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=17.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000323	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=4.750) with anti uplift	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=4.750) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000329	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=45.000)	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=45.000), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_85_10_81	000337	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=25.000) with anti uplift	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=25.000) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000340	FREE SLIDING SPHERICAL bearing (Nmax,ULS (kN)=5650) with anti uplift	pc	Supply and fixing of a free sliding spherical bearing (Nmax,ULS (kN)=5650) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement
Pr_20_85_10_81	000332	FIXED SLIDING SPHERICAL bearing (Nmax,ULS (kN)=8.000) with anti uplift	pc	Supply and fixing of a fixed sliding spherical bearing (Nmax,ULS (kN)=8.000) with anti uplift (up to 10% of Nmax in ALS), consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for support systems in structures in which the capacity of horizontal movement is guaranteed by the presence of a steel plate with a Teflon coating. This item includes the supply of all materials and their placement

5.8 EXPANSION JOINTS

5.8.1 SCOPE

- A. This Technical specification covers the expansion joints used in road and railway bridges superstructures, as well as the expansion joints in walls, frames and underpasses.
- B. The design working life of expansion joints shall be 50 years, except in those elements in which it is specified otherwise in this document and it is accepted by the Employer, and only in the case of expansion joints not directly used on the deck surface and which allow easy maintenance or replacement.

5.8.2 INTRODUCTION

5.8.2.1 EXPANSION JOINT ON A RAILWAY BRIDGE DECK

- A. This Technical specification covers the expansion joints used in railway bridges superstructure.
- B. Deck joints are defined as the expansion devices that link the edges of adjacent deck stretches, or/and a deck and a free abutment, in such a way as to allow movements due to temperature changes and distortions of the structure. They shall allow a continuous rolling surface and avoiding the loss of ballast.
- C. The execution of the work unit includes the following:
 - a. Preparation of the concrete surface in the width occupied by the deck.
 - b. Positioning and anchoring of the elements of the joint.
 - c. Sealing the perimeter of the joint with epoxy resin flush.

5.8.2.2 EXPANSION JOINT IN WALLS, FRAMES AND UNDERPASSES

- A. Devices that link sections as contiguous walls, frames or underpasses, in order to allow the movements caused by temperature changes and rheological effects.
- B. At the same time, the devices shall provide a continuous surface and prevent the ingress of ballast, water or soil between adjacent structural elements.

5.8.2.3 EXPANSION JOINT SYSTEM IN ROAD BRIDGES

- A. This Technical specification also covers the expansion joints used in road bridges.
- B. Without prejudice to the application of the technical specifications in this section, Road bridges shall fulfil technical requirements of the Country's road authority.
- C. The primary function of the modular expansion joint system is to allow vehicle traffic to travel smoothly across large expansion joint openings. It does this by dividing the large expansion joint openings into a series of smaller openings called cells.
- D. The modular expansion joint system also has the secondary function of protecting the surrounding bridge superstructure and substructure. Cells are equipped with watertight sealing elements that prevent debris, water and corrosives such as de-icing chemicals from passing through bridge expansion openings and damaging superstructure and substructure components.
- E. To achieve the appropriate level of functionality in the joints, the following conditions shall be met:
 - a. They shall absorb all the movements transmitted by the structure.
 - b. They shall not transmit significant actions to the structure, unless it has been designed to resist them.
 - c. They shall be waterproof or provide easy drainage, thus preventing the water causes deterioration in the structure or in the joint itself.
 - d. Extraneous solids should not obstruct the right behaviour of the joint.
 - e. They shall be easy to conserve.
 - f. In the case of deterioration or breakage should be easy to replace, even in the presence of traffic.

5.8.2.4 BITUMEN RUBBER EXPANSION JOINT FILLERS

- A. This kind of bitumen rubber expansion joint filler or asphaltic plug joint is used as expansion joint in transversal joint in pavement with cut in top surface at integral abutments of overpasses. The dimensions of the joint are minimum 100 mm width and height equal to the pavement layers (90 mm). This type of joints shall be able to assume displacements in the range of 10-20 mm, according requirement in each structure. The width of the asphalt plug joint shall be adjusted during construction phase depending on the supplier information, material and joint system used, considering the expected movement indicated in the drawings and increasing the 100 mm width dimension if necessary.
- B. The joint matrix shall be stable within the normal temperature ranges for the site condition works on condition that the surrounding surfaces provide sufficient continuous support for the joint. Joints shall be finished nominally flush with the road surface within the tolerance of the asphaltic surfacing specification. Joint material shall be consolidated during installation in accordance with the manufacturer's method statement. The air gap to the bridge expansion joint shall be caulked with heat resistant expanded plastic or rubber which shall be sealed and plated with a bridging plate of appropriate thickness and width.
- C. The joint system shall be approved according ETAG n° 032 Guideline for European Technical Approval of Expansion joints for road bridges. Part 3: Flexible plug expansion joints. Installation shall be in accordance with supplier requirements and guidelines included in this specification.

5.8.3 MATERIALS AND PRODUCTS

5.8.3.1 EXPANSION JOINT ON A RAILWAY BRIDGE DECK

- A. This type of joint is used exclusively in railway bridges and viaducts.
- B. The metallic expansion joint is composed of two (2) angular anchored in the corners of the concrete slab and covered by a welded plate to one of the corners. The dimensions are included in drawings. A neoprene band is arranged in the gap created between the deck and the abutment, fixed to steel plates, to collect the rainwater and discard it in the general drainage network of the bridge.
- C. The steel used is type S275J2+N, according to EN 10025-2, protected by a layer of anticorrosion coating red lead of at least thirty-five microns (35 µm) and a second layer of chlorinated rubber paint of the same thickness. Previously prepared surfaces with brushing degree St-3.
- D. The span life of the expansion joint shall be 50 years or more.

5.8.3.2 EXPANSION JOINT IN WALLS, FRAMES AND UNDERPASSES

- A. The Contractor shall submit to the Engineer the precise characteristics of the joint for the proposed use.
- B. The joints are constituted by bands of elastomeric materials and where appropriate metal profiles and should be able to absorb deformations in three mutually perpendicular directions, but its main function is to collect the movements imposed by temperature and rheological actions when they affect the walls, frames or underpasses.
- C. The basic characteristics that these joints shall meet, are:
 - a. Elasticity to follow the movements without cracking or introduce unacceptable efforts on the structure. The total allowable movement will be indicated in the drawings.
 - b. Tightness in case of rain, snow, strong condensations, floods, etc., preventing any leakage.
 - c. Sliding capacity of any edge in the three basic fundamental directions relative to the axes of symmetry of the joints.
 - d. Resistance to wear from movements in the structure due to thermal variations or live loads.
 - e. Conservation of elastic mechanical characteristics of seal materials and edges within the extreme temperatures to which they will be subjected.
 - f. Not resulting in any work situation, projections or depressions that result in annoying knocking at the passing vehicles.
- D. The expansion joint span life shall be 25 years as minimum, and they shall be accessible for maintenance or application of joint sealant.

5.8.3.3 EXPANSION JOINT ON A ROADWAY BRIDGE DECK

- A. The expansion joints shall consist of steel profiles, arranged in the longitudinal direction of the joint, between which elastomeric sealing bands are placed, with intermediate profiles between the edge profiles, supported on crossed mobile steel beams.
- B. They are joints that use a modular system of crossbeams in battery or single elastomeric profiles with edge steel profiles as defined in drawings.
- C. All the materials used will have an adequate resistance to oils and fats, to thermal cycles and to the action of ultraviolet rays, ozone and weather in general.
- D. The following initial physical properties for neoprene shall be required:
- E.
 - a. Shore hardness equal to or greater than sixty (60).
 - b. Tensile strength not less than seventeen point five Newtons per square millimetre (17.5 N/mm²).
 - c. Elongation at break not less than four hundred and fifty percent (450%).

- d. Modulus of transverse elasticity, for long-term loads, not greater than one Newton per square millimetre (1 N/mm²).
- e. Modulus of transverse elasticity, for instantaneous loads, not less than two Newtons per square millimetre (2 N/mm²).
- F. In addition, after subjecting the material to oven aging at seventy (70) hours to one hundred degrees centigrade (100°C) of temperature, the following conditions shall be met:
 - a. No cracks appear in the ozone test.
 - b. Do not experience a change in hardness greater than fifteen degrees Shore (15).
 - c. Do not experience a breakage tensile strength change greater than fifteen percent ($\pm 15\%$).
 - d. Do not experience a decrease in elongation at break greater than forty percent (40%).
- G. If the material proposed does not meet some of the indicated conditions, whose values are inspired by the ASTM Standards, the Engineer of the work will decide on its acceptance taking into account the guarantees offered by the supplier and in view of other European standards applicable to the case.
- H. The elements that make up this type of modular joints are:
 - a. Supporting elements
 - i. Edge profiles
 - ii. Intermediate profiles between the edge profiles
 - iii. Connection pieces between intermediate profile and crossbeams.
 - iv. Mobile cross beams
 - b. Supports
 - i. Sliding plates (high quality polished stainless steel)
 - ii. Counter support of sliding reinforced neoprene
 - iii. Sliding support of reinforced neoprene
 - c. Control elements
 - i. Control springs (cellular polyurethane with high wear resistance)
 - d. Waterproof elements
 - i. Neoprene bands 80mm wide
 - e. Anchorage elements
 - i. Anchorage type of roadway area (anchor plates on edge profiles rigidly anchored to the structure)
 - ii. Anchor bolt in crossbeam box
 - f. Crossbeam box
 - i. Crossbeam box to accommodate the sliding supports, the sliding counter-supports, the control springs and crossbeams.
 - g. Various
 - i. Sealing elements
 - ii. Treatment against corrosion (two coats of zinc primer and finish with epoxy resin)
- I. Each intermediate profile will be rigidly welded to its assigned crossbeam, resulting in a grillage capable of moving by itself.
- J. The control springs arranged between the crossbeams will control the coherent space between the intermediate profiles as a function of the total width of the opening.
- K. The crossbeams will be aligned in the direction of the movement of the structure. Movements that deviate from this direction will be admissible to a limited degree.
- L. Since each intermediate profile of the joint will be connected to the assigned cross member, the number of intermediate profiles and therefore the number of crossbeams that can be accommodated is limited by the

maximum allowable separation between intermediate profile supports (between two crossbeam boxes) and the increase in width by the ascending number of crossbeams.

- M. Elastic mortar will be used to fill the joint-deck transmission zones.
- N. The neoprene sheets will be supplied by a solvency supplier recognized by the Engineer. Supplier will define and guarantee the technical characteristics of its models, as well as the quality and characteristics of all the materials used for its installation.
- O. The dimensions of the joint shown in the drawings are merely indicative and may be modified upon approval of the Engineer to adapt to the different commercial models, taking into account that the maximum range of movement of the joint is equal to or greater than that specified in the drawings.
- P. The expansion joint span life shall be 50 years as minimum.

5.8.3.4 BITUMEN RUBBER EXPANSION JOINT FILLERS

A. Asphaltic joint types and definitions

a. Asphaltic Plug Joints types

i. Mixed in-situ

- An in-situ joint set into flexible surfacing or a recess in concrete comprising a band of specially formulated flexible, waterproof material, supported over the expansion gap by metal plates or other suitable components. The binder is a plasticised polymer or rubberised bitumen blend with additional modifiers; it is mixed with aggregate during installation of the joint. The joint forms the running surface by replacing the conventional surfacing to its full depth.

ii. Premixed

- An in-situ joint formed at deck level using specially formulated flexible waterproofing materials incorporating deck plates and flashing. A premixed blend of aggregates and binders forming a flexible mass completes the joint up to finished carriageway level and forms part of the surfacing.

b. Caulking

A compressible material used to fill the expansion joint gap to prevent the binder leaking from the joint during the filling of the joint.

c. Bridging Plate

A plate forming part of an expansion joint system at deck level to cover the expansion joint gap and support the jointing material.

d. Deck Joint Gap

The gap between adjacent spans in a bridge deck or between a bridge deck and an abutment curtain wall.

e. Expansion Joint Gap

The continuous gap within an expansion joint system at surfacing level along the line of the joint.

f. Flashing (Optional)

A membrane placed over the top of the bridging plate.

g. Sub-Surface Drainage

A system for draining water from within the interface between the surfacing and Waterproofing.

h. Binder

A polymer modified or rubberised bituminous compound which precoat and binds the aggregate together.

i. Aggregate

A graded and dried crushed rock used in the construction of Asphaltic Plug Joints.

j. Tanking

The application of hot binder to all horizontal and vertical surfaces in the exposed bridge joint recess prior to filling with aggregate/binder mixture.

k. Sealing

The application of hot binder to seal the expansion joint gap above the caulking materials and sub-surface drainage channel (if installed).

B. Typical asphaltic plug joint

- a. Proprietary systems comprising of layers of specially modified binders and aggregate to provide a homogenous expansion medium and smooth-running surface.
- b. Movement ranges for standard grade modified binders up to + 20 mm.
- c. Information to be provided by the supplier.
- d. The supplier shall provide the following information, in a printed form, for each joint system:
 - i. Description or proprietary name of joint.
 - ii. Horizontal movement capacity.
 - iii. Vertical movement capacity.
 - iv. Composition: aggregate, binder, bridging plate, caulking, flashing.

C. Materials: Asphaltic plug joint is a combination of polymer modified binder and selected aggregates.

a. Binder

- i. The binder is a compound blend of bitumen, polymers, fillers and stabilisers that is specifically formulated to give good fluidity, low and high temperature stability and slump control.
- ii. According normative EN 14188-1.
- iii. Density 1.15-1.45 g/cm³ (according EN 13880-1)

Table 159. Requirements - Bitumen rubber joint fillers

Performance Characteristics	Rubberised Binder	Polymer Modified Binder
Cone Penetration @ 25°C	25 – 45 dmm	25 – 90 dmm
Softening Point	70°C minimum	80°C minimum
Flow Resistance	5% @ 45°C maximum	5mm @ 60°C maximum
Extension Test	(3 cycles) (@ 0°C)	(3 cycles) (@ 0 or – 20°C)

- iv. Alternatively, a blend of bitumen and SBR (Styrene Butadiene Rubber), which meets the following requirements, shall be used.

- Penetration > 40 dmm when tested (EN 1426)
- Softening Point > 55° C when tested (according EN 1427)
- Ductility > 600mm at 4° C
- Black colour
- Application temperature 160-180°.

b. Aggregate

- i. Graded granite fractions will be used (6/10 or 10/14)
- ii. The aggregate shall be graded, washed and drained crushed rock from the trade groups basalt, dolerite, gabbro or granite which meets the following requirements when tested in accordance with the relevant parts of EN 1097.
- iii. The aggregate grading shall give a controllable voids content when placed in the joint.

- iv. If the joint filling is mixed on site, the aggregate shall be delivered to the point of installation in pre-weighed sealed bags.
 - v. Grading shall comply with the suppliers stated values when tested in accordance with the following:
 - Flakiness index < 25
 - Polished stone value > 55
 - Aggregate abrasion value < 5
 - Aggregate impact value < 9%
 - Aggregate crushing value > 11
 - vi. Fine aggregate used in premixed binder/aggregate mixes shall meet the following requirements:
 - Blast furnace slag to BS 1047: 1985
 - Steel slag to BS 1047: 1985
 - Crushed igneous rock fines
 - c. Natural sand
 - i. Filler for the modified bitumen binder shall be limestone
 - d. Base bridging plate
 - i. Where required an aluminium or steel plate is placed at the base over the joint gap to prevent aggregate entering the joint gap and assists in the distribution of wheel loads across the joints.
 - ii. These shall be aluminium or mild steel with or without corrosion protection of a thickness and width appropriate to the expansion joint gap so that it will provide support to the joint under the action of heavy goods vehicles.
- D. Material requirements and tests
- a. Materials used in joints shall comply with the European requirements and regulations.
 - b. The material supplier shall operate quality assurance procedures in accordance with ISO 9000:2000 to ensure that the materials, when supplied, satisfy the requirements of this standard and any other requirements for proprietary systems.
 - c. The Contractor shall ensure that the materials are installed in accordance with the requirements of the manufacturer of the proprietary joint.
 - d. Reference standards for testing of materials and requirements are included in the following table.

Table 160. Testing reference -Bitumen rubber joint fillers

Material/Component	Characteristics	Test method(s)
Binder and precoat layer (if necessary)	Density	ISO 3838
	Segregation	Annex 3-P
	Softening point	EN1427
	Elastic recovery	EN 13880-3 or EN 13398
	Ductility at 0 °C (incl. force-deformation-graph)	EN 13589
	Resistance to heating (8 hours at manufacturers heating temperature)	EN 12607-3
	Dynamic viscosity/temperature characteristics	Annex 3-P
	Determination of complex modulus G* vs temperature	
	Flow length at 60 °C	EN 13880-5
	Composition test (Cf. 3-P.1.10) Soluble/insoluble binder & filler content	Annex 3-P
	Composition test (Cf. 3-P.1.11) Gel Permeation Chromatography	-

Material/Component	Characteristics		Test method(s)
	Primer		EN 14188-4
Aggregate and surface dressing	Type (petrographic description) and grain size		EN 932-3
	Particle size distribution		EN 933-1 and -2
	Specific density, water absorption		EN 1097-6
	Bulk density		EN 1097-3
	Particle shape		EN 933-3 or -4
	Resistance to impact stress		EN 1097-2
	Resistance to heating		EN 1367-5
	Cleanliness		EN 933 and Annex 3-P.2.2
Joint filling mixture	Indirect Tensile Test (Strength unconfined) (Joint filling mixture)		EN 12697-23 + additional text Annex 3-P
	Void content		EN 12697-8
	Wheel tracking (A)		EN 12697-22 & additional text in Annex 3-P
Bridging plate	Steel Stainless steel	Yield point, Tensile strength, Elongation at rupture, Chemical composition (C-eq.)	EN 10025 EN 10088
	Aluminium (covers): Plate material: Grade 5xxx Extruded material: Grade 6xxx Excluded: grades given in EN 1999-1-3, cl. 3	Chemical composition, Tensile strength, Yield point, Stress-strain, Elongation at rupture, Ductility, Charpy-V value	EN 1999 Extruded aluminium: EN 755-2
Bolts, screws, nuts, washer, profiles	Metals	Energy absorption	Charpy test
Bonding agents/sealants, sockets	Chemicals/metal	Resistance to low temperatures (Chemicals) Tensile strength resistance (metal)	

5.8.4 WORK EXECUTION

- The expansion joint is mounted according to the manufacturer's instructions, paying special attention to anchoring it to the deck and its drainage with the top of deck.
- Before mounting the joint, the initial opening will be adjusted by cutting and demolishing the zone to be occupied by the plate, depending on the average temperature of the structure at that time and deferred shortenings provided.
- Subsequently, the necessary fasteners are secured and sealed with epoxy resin flush with the surface.
- The placement process is subject to approval of the Engineer, and it will not cause damage, or modify the conditions of the material.

- E. Expansion joints shall be installed in accordance with the project work plans and the manufacturer's installation instructions so that:
 - a. allow the floor of the bridge and the deck free to deform;
 - b. withstand static and dynamic loads;
 - c. any ingress of water and dirt on the floor, supporting bearings and linings;
 - d. it does not lead through the vehicles at impact and noise;
 - e. to traffic safety, convenient inspections and replacements.
- F. Expansion joints shall be protected from damage during the execution of the works.
- G. The positioning of holding down bolts and anchorage systems shall be checked for accuracy before the casting of concrete commences or before drilling, if concrete is already hardened. Templates or shuttering shall be fixed to box out the concrete for the joint and to locate holding down bolts or anchorage pockets. Threaded parts shall be protected, kept clean and free from rust.
- H. Where the surfacing and bridge deck waterproofing are to be removed to accommodate the bridge joint these shall be cut to a clean straight line for the full depth of the surfacing without damage to the concrete substrate.
- I. Before installation of the joint, the concrete surfaces shall be free from laitance, sound, clean and comply with the manufacturer's requirements.
- J. The expansion joint and the bridge deck waterproofing shall be formed so that a watertight seal is provided. Where prefabricated units are used, the seal between each unit shall be made watertight and in addition a secondary waterproofing system in the form of a continuous membrane shall be installed.
- K. The gap width shall be set, in relation to the prevailing deck temperature, with the joint gap sides parallel. Seals which are not held in metal runners shall remain in compression for the full range of joint movement.
- L. Expansion joints shall be of uniform width and straight alignment and shall be accurately set and finished and aligned with the finished surface.
- M. During the placing and hardening of the bedding and bonding materials, movement between the joint and the substrate shall be prevented.
- N. Where it could be required, if any, subsurface and below-joint drainage systems shall be designed, provided and installed in accordance with the requirements therein, and the joint manufacturer's recommendations. The complete drainage system shall be accessible for cleaning and, on completion of the joint, the drainage system shall be checked and cleared of any obstructions.
- O. Before vehicles traffic over the joints, temporary covers capable of withstanding vehicular loading shall be provided over expansion joints during and after their installation as appropriate for protection.

5.8.4.1 BITUMEN RUBBER EXPANSION JOINT FILLERS

- A. Joints shall be finished nominally flush with the road surface within the tolerance of the asphaltic surfacing specification.
- B. Joint material shall be consolidated during installation in accordance with the manufacturer's method statement.
- C. The air gap to the bridge expansion joint shall be caulked with heat resistant expanded plastic or rubber which shall be sealed and plated with a bridging plate of appropriate thickness and width.
- D. The general installation procedure will be as follows:
 - a. Storage and Delivery
 - i. The joint installer shall ensure that the materials are stored correctly and protected from deterioration prior to, and during, delivery to site.
 - b. Setting Out
 - i. The Engineer shall provide sufficient information to establish the line of the joint and full depth of surfacing and structural air gap.
 - c. Cutting and Breaking Out

- i. The saw shall be set to cut vertically through the full depth of surfacing. Variations in thickness of the surfacing may result in small amounts of the surfacing left uncut or small cuts into the deck.
 - ii. Minor contact points between the deck and the saw blade can be expected and any resulting cuts into the deck should be filled with binder during joint installation.
 - iii. The surfacing should be carefully broken out taking reasonable care not to damage the deck.
 - d. Surface Preparation
 - i. All broken-out material and dust shall be removed, and the exposed surface cleaned and dried using a hot compressed air lance.
 - ii. Any damaged concrete shall be brought to the attention of the supervising Engineer.
 - e. Deck Joint Gap Treatment
 - i. The deck joint gap shall be cleared of loose and loosely bound material, and caulked.
 - f. Bridging Plate Selection
 - i. The plate(s) shall span the expansion gap and be fitted in such a manner that the plate(s) bed well on a sound concrete support.
 - ii. The manufacturer shall provide suitable technical advice to enable the selection of the dimensions of the bridging plate appropriate to the joint design.
 - g. Optional In-Joint Drainage
 - i. Drainage may be placed within the joint to act as a pressure relief system against the build-up of water at the vertical joint/surfacing interface. In joint drainage is not intended to replace the sub-surface deck drainage, which is required to effectively manage water at the waterproofing/asphalt interface.
 - ii. If drainage channels are required along the length of the expansion joint then an appropriate drainage outlet (linked to the deck drainage system) must be made available in close proximity to the joint either through the bridge deck or linked to the deck drainage system. The drainage channels may also be placed across the joint, which will allow water to pass from one side of the joint to the other.
 - iii. After the base of the joint recess has been tanked with binder the drainage channels are secured to the asphalt surface. The ends of the channels are terminated into bridge deck drainage system. The cross-drainage channels are placed after the base has been tanked and are located with approximately 30 mm of the channel penetrating into the adjoining asphalt surface. The cross-drainage channel sections must be able to accommodate the stated bridge movement.
- E. The channels shall be sealed to prevent ingress of binder during joint installation.
 - a. Tanking and Bridging Plate Installation
 - i. Binders shall be heated to the supplier's recommended temperature range and applied to all exposed horizontal surfaces and to fill the expansion gap above the caulking. If in joint drainage channels are required, they shall be sealed against binder ingress and installed after horizontal tanking. The bridging plate shall be installed whilst the tanking on the horizontal surface is hot and the remainder of the joint surfaces tanked. All exposed surfaces shall be completely coated with binder.
 - b. Joint Filling
 - i. (a) Materials mixed on site
 - The aggregate shall be heated and coated with binder before placing in the joint in layers with additional binder in accordance with the manufacturer's procedure.
 - ii. (b) Premixed Materials
 - The premixed aggregate and binder shall either be brought to site at installation temperature in insulated vehicles or brought to site cold and heated to installation temperature.
 - It is then placed in layers not exceeding the manufacturer's recommendations and each layer compacted, also in accordance with the manufacturer's recommendations.
 - The installation programme shall take account of the cooling and curing period prior to opening to traffic.

- Note: The installer should be informed by the engineer of any hazards associated with hot lancing of bridge deck waterproofing.
- c. Resistance to passage of water
 - i. When completed the joint shall prevent the passage of water into the joint gap subject to the satisfactory performance of the adjacent materials.
 - ii. Continuing resistance to the passage of water depends upon interaction with the bridge deck and the stability of contiguous surfaces inside the bridge deck.
 - iii. Provision of adequate sub-surface drainage independent of the joint (for example 'Through Deck Drainage'), and proper cleaning and maintenance of such drainage, is essential.

5.8.5 TOLERANCES

- A. An expansion joint shall be installed in such a way that all its parts are properly supported and will not be subjected to any unnecessary forces. The gap width at the time of installation shall be appropriate for the gap width of the structure at that time, considering the prevailing structure temperature, etc., with allowance for the future opening and closing movements that the joint must accommodate.
- B. For rail expansion joints and road expansion joints with total movement more than 80 mm the gap opening theoretical value shall be defined in drawings in the detail design together with the reference temperature of installation and the influence of temperature variation in this value. At installation a tolerance up to 6% of the total displacement will be allowed in this gap opening value. In any case it shall be verified that considering the expected calculated displacements the resulting minimum and maximum gap opening are within the expansion joint allowable dimensions.
- C. For other kind of joints the joint shall be installed with a gap opening equal to the medium gap between maximum and maximum allowable opening, with a tolerance of 6% of the total allowable displacement.
- D. Tolerances of the surfaces shall follow sub-section 5.2.4 of the present specification. The relative tolerance between the concrete surfaces to be joined shall be ± 12 mm for visible surfaces and ± 24 mm for hidden surfaces considering a deviation within 3m including the own expansion joint.

5.8.6 WORK RECEPTION

- A. The expansion joints shall comply with the project technical requirements, fulfil the standards noted in the present TS Chapter and being installed as indicated in the present TS Chapter, assessing the demanded tolerances, and always under the supervision of the manufacturer.
- B. All the bearings proposed by Contractor shall be CE marked and approved by the Engineer

5.8.7 COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.
- B.
 - a. ETAG n° 032 Guideline for European Technical Approval of Expansion Joints for road bridges. Part 8: Modular Expansion Joints.
 - b. ETAG n° 032 Guideline for European Technical Approval of Expansion joints for road bridges. Part 3: Flexible plug expansion joints.
 - c. TRA HS 15 Road Pavement joint sealants technical specification
 - d. EN 14188-1 Joint fillers and sealants. Part 1. Hot applied sealants
 - e. EN 14188-2 Joint fillers and sealants. 2 part. Cold applied sealants
 - f. EN 14188-4 Joint fillers and sealants. 4. Primers to be used with joint sealants.
- C. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

5.8.8 MEASUREMENT AND PAYMENT – EXPANSION JOINTS

A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.

B. The units of measurement shall be as follows:

Table 161. Units of measurement - Expansion joints

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_35_90_27	000301	STRUCTURAL JOINT IN FIXED ABUTMENT FOR RAILWAY BRIDGE	m	Structural joint in fixed abutment on rail bridge consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of structural joints, including cutting and demolition of the pavement in the width occupied by the joint, laying and anchoring of the joint elements, sealing the perimeter of the joint with epoxy resin, making it flat with the pavement
Pr_35_90_27	000302	STRUCTURAL JOINT IN FREE ABUTMENT FOR RAILWAY BRIDGE	m	Structural joint in free abutment on rail bridge consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of structural joints, including cutting and demolition of the pavement in the width occupied by the joint, laying and anchoring of the joint elements, sealing the perimeter of the joint with epoxy resin, making it flat with the pavement and water drainage duct made of neoprene.
Pr_35_90_27	000303	SINGLE SEAL EXPANSIÓN JOINT IN ROAD BRIDGES WITH MAXIMUM MOVEMENT OF 50 mm	m	Single seal expansión joint in road bridges with maximum movement of 50 mm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of structural joints, including cutting and demolition of the pavement in the width occupied by the joint, laying and anchoring of the joint elements, sealing the perimeter of the joint with epoxy resin, making it flat with the pavement
Pr_35_90_27	000304	SINGLE SEAL EXPANSIÓN JOINT IN ROAD BRIDGES WITH MAXIMUM MOVEMENT OF 80 mm	m	Single seal expansión joint in road bridges with maximum movement of 80 mm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of structural joints, including cutting and demolition of the pavement in the width occupied by the joint, laying and anchoring of the joint elements, sealing the perimeter of the joint with epoxy resin, making it flat with the pavement
Pr_25_71_44_08	000301	BITUMEN RUBBER EXPANSION JOINT FILLERS IN ROAD BRIDGES	m	Bitumen rubber expansion joint fillers in road bridges consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for expansion joint in transversal joint in pavement with cut in top surface at integral abutments of overpasses

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_25_71_44_08	000302	BITUMEN RUBBER SEALANT JOINT FILLERS IN ROAD BRIDGES	m	Bitumen rubber sealant joint fillers in road bridges consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for sealant joint in longitudinal joint between pavement and sidewalk or edge beam and sidewalk of overpasses
Pr_35_90_27	000307	MODULAR EXPANSION JOINT DS160 STW SWIVEL JOIST	m	Modular expansion joint DS160 STW swivel joint consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of structural joints, including cutting and demolition of the pavement in the width occupied by the joint, laying and anchoring of the joint elements, sealing the perimeter of the joint with epoxy resin, making it flat with the pavement, and all the operations to its correct placement.
Pr_35_90_27	000305	STRUCTURAL EXPANSION JOINTS IN WALLS AND CONCRETE FRAMES	m	Structural expansion joint in walls and frames consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for systems that connect contiguous sections of walls, frames or underpasses in such a way as to allow movements caused by changes in temperature and rheological effects that include expanded polystyrene fully placed, cut and wide demolition in the area occupied by the joint, fixing and sealing elements with epoxy resin rated to the wall or pavement.
Pr_35_90_27	000306	STRUCTURAL EXPANSION JOINTS IN WALLS AND CONCRETE FRAMES WITH RUBBER SEALING COLLAR	m	Structural expansion joint in walls and frames with rubber sealing collar consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for systems that connect contiguous sections of walls, frames or underpasses in such a way as to allow movements caused by changes in temperature and rheological effects that include expanded polystyrene fully placed, cut and wide demolition in the area occupied by the joint, fixing and sealing elements with epoxy resin rated to the wall or pavement and rubber sealing collar to prevent the way of water and get hydraulic tightness.

5.9 PRESTRESSING TENDONS AND BARS

5.9.1 SCOPE

- A. This Technical specification chapter covers the post-tensioned steel Y1860S7 in strands as per prEN 10138-3 and post-tensioned steel 835/1030MPa in bars as per prEN 10138-4. This item is meant for steel strands or bars for post-tensioning of concrete structures, and includes supply of the steel strands or bars, positioning and fixing of the tubes, placement of the anchors, laying of the steel strands, tensioning, anchoring and injecting the cement grout into the tubes.
- B. Fib 33 bulletin 33 “durability of post-tensioning tendons” requirements shall be considered by Contractor when proposing the post-tensioning system and the inspection and maintenance plan in order to guarantee the 100 years span life required in the Rail Baltica Project.

- C. The Contractor shall submit details of proposed proprietary post-tensioning systems to the Engineer for in-principle acceptance. Once obtaining in-principle acceptance, the Contractor shall submit detail drawings detailing all tendon anchorage areas, reinforcement and other features to the Engineer for checking and acceptance.
- D. The values assumed in the design for friction coefficient, wobble coefficient and draw-in shall be shown in the Drawings and test certificates shall be submitted to the Engineer for acceptance. The Contractor shall demonstrate the validity of these values by testing with a dead-end anchorage assembly. The test shall be carried out to the required load in 6 increments and for each increment the gauge pressure, elongation and load cell force shall be recorded and a test report submitted to the Engineer for acceptance.

5.9.2 MATERIALS AND PRODUCTS

5.9.2.1 STRANDS' FEATURES

- A. The prestressing steel consists of low relaxation seven-wires strands according to PrEN 10138 with the following nominal properties:

Table 162. Requirements - Strands' for Prestressing tendons (7-wires)

Strands' features for Prestressing tendons (7-wires)		
Diameter	15.2 mm	15.7 mm
Cross section	139 mm ²	150 mm ²
Yield Strength	1640 MPa	
Tensile Strength	1860 MPa	
Young Modulus	195 GPa	

- B. Elongation at maximum load measured on a longitudinal base of 500mm or more shall not be less than 3.5%.
- C. The reduction in area at break shall be visible to the naked eye.
- D. The modulus of elasticity shall be the value guaranteed by the manufacture with 7% tolerance.
- E. Relaxation at 1,000 hours at a temperature of 20°C and for an initial tensile stress of 70% of the actual maximum unit load shall not exceed 2.5 %.
- F. The specified number of strands is as noted on the drawings.
- G. The prestressing losses for prestressed precast beams shall not be higher than:
 - a. Wedge draw-in = 5mm.
- H. The prestressing losses for internal posttensioned elements shall not be higher than:
 - a. Wedge draw-in = 6mm.
 - b. Friction factor = 0.19
 - c. Wobble factor = 0.006
- I. All prestressing steel shall carry a mill certificate from the manufacturers or a nominated testing authority. The mill and test certificates shall be submitted to the Engineer prior to cutting for use of any of the steel. Stress relieved wire strand shall comply with the requirements in PrEN 10138-3.
- J. In addition to the testing requirements of the standards, the Contractor shall arrange for one sample of the steel from each coil intended for use in the works to be tested for proof load, breaking load, percentage elongation, relaxation and ductility at an approved independent testing laboratory.
- K. For each coil, the full results of the tests required on material from that coil, including routine production tests, shall be made available to the Engineer prior to the cutting for use of any of the strand in the coil.

5.9.2.1.1 BARS' FEATURES

- A. The post tensioning system consists of high tensile steel bars in diameters from 25mm to 75mm, provided with cold rolled threads for part or full length, together with a range of fittings.
- B. All fittings shall be designed to exceed the failing load of the steel bars.
- C. Bars shall be 835/1030 N/mm² or 950/1050 N/mm² (yield strength/tensile strength) as specified in drawings.
- D. Bars shall comply with the European Standard prEN 10138-4.
- E. The initial prestressing force shall not exceed 70% of the tensile strength.
- F. Relaxation at 1,000 hours at a temperature of 20°C and for an initial tensile stress of 70% of the actual maximum unit load shall not exceed 2.0 %.
- G. Post tensioning bars and their fittings shall not be welded, subjected to high local heating or splashed with weld metal.
- H. Post tensioning bars should never be galvanized.
- I. Permanent bars fitted inside the ducts will be filled by petroleum was or similar to avoid corrosion.

5.9.3 WORK EXECUTION

5.9.3.1 HANDLING AND STORAGE

- A. All prestressing steel shall be protected against physical damage at all times from manufacture to grouting or encasing in concrete.
- B. Prestressing steel that has sustained physical damage at any time shall be rejected. Bars shall be kept and stored straight. They shall be suitably supported to prevent excessive bending stresses and any threaded portions shall be adequately protected.
- C. PACKAGING
 - a. Prestressing steel shall be packaged in containers or shipping forms for the protection against physical damage and corrosion during shipping and storage. A corrosion inhibitor which prevents rust or other results of corrosion shall be placed in the package or form, or shall be incorporated in a corrosion inhibitor carrier type packaging material, or when permitted by the Engineer, may be applied directly to the steel. The corrosion inhibitor shall have no deleterious effect on the steel or concrete or bond strength of steel to concrete.
 - b. Packaging or forms damaged from any cause shall be immediately replaced or restored to original condition. The name and any other information concerning the corrosion inhibitor shall be supplied to the Engineer on request.
 - c. The shipping package or form shall be clearly marked with a statement that the package contains high strength prestressing steel, the care to be used in handling, the type, kind and amount of corrosion inhibitor used (including the date when placed) safety orders and instructions for use.
- D. CORROSION AND DAMAGE: Steel shall be rejected by the Engineer as unsuitable for use in the works, if either one of the two following conditions occur:
 - a. The steel exhibits evidence of corrosion such as may reduce its strength or ductility.
 - b. There is evidence to show that the steel has been in contact with deleterious substances, or subject to splashes from the cutting operation of an oxy-acetylene torch or arc-welding processes in the vicinity, prior to concreting, which may reduce its strength or ductility or bond characteristics in the permanent works.
- E. PROTECTION
 - a. Prestressing steel for post-tensioning which is installed in members prior to placing and curing of the concrete, shall be continuously protected against rust or other corrosion, until grouted, by means of a corrosion inhibitor placed in the ducts or applied to the steel in the duct. The corrosion inhibitor shall conform to the requirements specified above.

- b. Prestressing steel installed as above but not grouted within 10 calendar days shall be subjected to all the requirements in this Section pertaining to corrosion protection and rejection because of rust.
 - c. All prestressing steel shall be stored clear of ground and protected from weather.
- F. Delivery
- G. WIRE
 - a. Unless otherwise accepted by the Engineer, low relaxation and normal relaxation wire shall be in coils of sufficiently large diameter to ensure that the wire can be laid straight.
- H. STRAND
 - a. Prestressing strand, however manufactured, shall be in coils of sufficiently large diameter to ensure that the strand can be laid reasonably straight.
- I. BARS
 - a. Prestressing bars as delivered shall be straight.
 - b. Bars bent in the threaded portion shall be rejected.
 - c. Any straightening of bars shall be carried out cold but at a temperature of not less than 5°C. Any necessary heating shall be by means of steam or hot water.

5.9.3.2 CUTTING

- A. All cutting of wire, strand or bar shall be carried out using a high-speed abrasive cutting wheel, friction saw or any other mechanical method accepted by the Engineer.

5.9.3.3 DUCTS

- A. All ducts used in bonded post-tensioning system shall be manufactured from galvanized steel strip unless otherwise noted. It shall be stored off the ground and protected against the weather.
- B. Joints in the duct for the tendons shall be minimized and, in any event, not closer than 5 metres. The joints between sections of duct and between duct and anchorages shall be properly sealed.
- C. In order that friction losses are kept to a minimum, the Contractor shall exercise care to prevent deformation of the duct cross section during handling and concreting and to ensure that the duct is placed accurately to the required lines and levels. Based on the tendon profile information given on the Drawings, the Contractor shall prepare shop drawings of the tendon profiles for construction purposes. These drawings shall show locating dimensions for each of the tendons at 600 mm centres or less and shall be submitted to the Engineer for checking and acceptance.
- D. The ducts shall be firmly fixed to, or supported from, the steel reinforcement within the forms at 600 mm centres or less. The tolerance in the location of the duct shall be 3 mm from the true position.

5.9.3.4 SHEATHING

- A. All ducts for external prestressing tendons shall be black, smooth, high-density polyethylene (HDPE) pipes.
- B. The pipe material shall be in accordance with ASTM Specification D1248, "Standard specification for Polyethylene Plastics Moulding and Extrusion Materials". The HDPE pipe shall have a standard density of 941 kg/m³ or greater. The requirements and test methods shall be in accordance with ASTM Specification D3035 and ASTM Specification F714.
- C. The HDPE pipe shall be strong enough to prevent deformation when pressurised during grouting and to resist the strand punching effects at deviated positions. The PE plastic extrusion compound shall have sufficient UV stabilizer to protect the pipe from deleterious effects due to continuous outdoors exposed and antioxidants, in accordance with the requirements in ASTM Specification D3350.
- D. The minimum wall thickness of the pipe shall be determined from the average outside diameter of the pipe divided by 17 (DR 17) or 4mm, whichever is greater.

- E. The sheath shall be continuous with no joining sleeves through the saddle.
- F. The ducts shall be protected against crushing, excessive bending, dirt contamination and corrosive elements during transport, storage and handling.
- G. In order that friction losses are kept to a minimum, the Contractor shall exercise care to prevent deformation of the sheathing cross section during handling and concreting. The Contractor shall also ensure that the sheathing is placed accurately to the required lines and levels.
- H. Joints in the tendon sheath shall be minimized. In no case shall the intervals between the joints be less than 5 m. All joints shall be properly sealed including the joints between the sheath and the anchorage.
- I. Based on the tendon profile information given on the Drawings, the Contractor shall prepare shop drawings of the tendon profiles for construction purposes. These drawings shall be submitted to the Engineer for acceptance.
- J. All external posttensioning shall allow replacement and re-tensioning all throughout its design life.

5.9.3.5 TENSIONING JACKS

- A. Both force and extension measurements shall be taken during all tensioning operations. Force measurements shall be required to an accuracy of 2%, extension measurements to an accuracy of 1mm.
- B. The force measurements shall be made by dynamometers or pressure gauges. Where the latter are used, the gauge shall be selected so as to be used at between 40% and 80% of its full capacity when the final load measurements equivalent to 75% of the ultimate strength of the tendons being stressed, are taken on any tendons.
- C. All tensioning equipment shall be accepted by the Engineer prior to use. It is required that the strands in each multi-strand tendon be stressed simultaneously. Certified calibration by an approved laboratory shall be provided for all dynamometers or pressure gauges.
- D. The calibration certificate shall not be more than 4 weeks old at the time the equipment is brought on site.
- E. For the duration of the stressing operations, intermediate tests on equipment will be required every 2 weeks or when the Engineer has cause to believe that the gauge may be giving incorrect readings at stressing, whichever is sooner. This may be done on site by means of calibrated master pressure gauge that is not used in the stressing operation, or by dynamometer.
- F. All stressing components incorporated in the works shall be in accordance with the manufacture's recommendations and specifications. They shall be subjected to acceptance test prior to their actual use on the works and they shall be subjected to the approval by the Engineer.

5.9.3.6 POST-TENSIONING

- A. ANCHORAGES
 - a. All tendon anchorages shall comply with the requirements of BS 4447 and the Engineer may require the Contractor to provide test certificates to demonstrate such compliance.
 - b. No damaged anchorage devices shall be used, and all parts shall be protected from corrosion at all times. Threaded parts shall be protected by greased wrappings and tapped holes by suitable plugs until used.
 - c. Anchorages shall be positioned and maintained during concreting so that the centre line of the duct shall pass through the anchorage assembly and shall be normal to the bearing surface.
- B. DEAD END ANCHORAGES
 - a. The systems used for coupling or providing dead end anchorages for the strands shall be accepted by the Engineer.
 - b. The use of blind end anchorages or anchorages using bonded bulbs is not permitted. Should swaged anchorages be used, special care shall be taken during the swaging operation to ensure that the ends of the strands are not contaminated with oil or any substance likely to affect the integrity of the connection. If the swages incorporate teeth to assist in gripping the strand, it is essential that they be installed in the correct direction, as a reversal of the swage will impair the efficiency of the grip and may result in slippage of the strand under load.

- c. The swaging pressure shall be carefully monitored during each swaging operation and shall not vary by more than $\pm 5\%$. Should a fall-off in swaging pressure be observed, tests shall be immediately carried out to check the gripping efficiency of the swage by means of a mono jack. The procedures to be adopted for testing the gripping efficiency shall be subject to the Engineer's prior acceptance. In addition, the diameter of each swage after installation on the strand shall be checked.
- C. SADDLES AT DEVIATION POINTS FOR EXTERNAL PRESTRESSING
 - a. Steel tube that is used to form the saddle shall be hot-dipped galvanized and degreased.
 - b. The saddle shall be carefully detailed to avoid damage to the sheath or the prestressing steel during stressing. The protective sheathing shall also be jointed properly.
 - c. Minimum radius in accordance with the relevant manufacturer's specifications and standards shall be provided for the saddle. At the Engineer's request, tests shall be performed to verify the feasibility of a particular practical solution.
- D. INSTALLATION OF TENDONS
 - a. The procedure for installation of the strands into the duct shall be subject to the acceptance of the Engineer.
 - b. The Contractor shall ensure that the tendons are not kinked or otherwise damaged during installation. Likewise, care shall be taken to avoid damage to the ducts during tendon installations.
- E. TENSIONING PROCEDURE
 - a. Tensioning shall be carried out only in the presence of the Engineer and by trained crews experienced in this type of work and in the use of the particular equipment involved. No member shall be stressed until the concrete in it has attained the minimum age at which control test cubes have reached the specified strength. The results of the cube tests shall be submitted to the Engineer before acceptance to proceed with tensioning is given.
 - b. Tendons shall be tensioned to the loads given herein and on the Drawings.
 - c. The tendon force shall be raised to the specified maximum value uniformly such that the force is gradually transferred to the concrete. Extension readings shall commence after 10% of the load has been applied in order to ensure that the datum is set after slack cable has been taken up. For each tendon, the strands at the non-stressing end shall be marked with chalk or by other means so that any movement of strands relative to each other during tensioning may be observed. The draw-in at the non-stressing end shall be measured so that the appropriate allowance can be made in the measured extensions.
 - d. A tolerance of $\pm 5\%$ of the required force will then be permitted for individual tendons, provided that the total force in the member is within 2% of the required value. Members which do not comply with these requirements may be rejected.
 - e. The values for the expected tendon extensions shall be determined, by the Contractor. The actual extensions measured on site shall be compared with the calculated extensions as a check, on the loss of force due to friction in the ducts. If the extension measurements indicate that friction is higher than computed using the design friction and wobble factors given on the Drawings, then the Engineer may direct that the tendons be treated with water soluble oil to reduce friction to the level given by the design factors.
 - f. After a tendon has been anchored, the jack pressure shall be released gradually and evenly, so as not to cause any shock to the anchorage or tendon.
 - g. In the event of a tendon breaking or slipping after tensioning, the tendon shall be released, replaced if necessary and prestressed.
 - h. Full records shall be kept of all tensioning operations, including the measured extension, pressure-gauge or load-cell readings, and the amount of draw-in at each anchorage. Copies of these records shall be supplied to the Engineer within 24 hours of each tensioning operation.
 - i. Following acceptance of the tensioning operation by the Engineer, the ends of the tendons shall be cut off with a disc cutter to within 6 mm of the anchorage.
- F. SAFETY PRECAUTIONS DURING TENSIONING
 - a. Care shall be taken during tensioning to ensure the safety of all personnel engaged on the work and of other persons in the vicinity.

- b. Jacks shall be secured in such a manner that they will be restrained should they lose their grip on the tendons. Warning signs shall be positioned to caution that the operation is in progress. No person shall be allowed to stand behind the jacks or in close proximity behind the jacks while tensioning is in progress. The operation of the jacks and associated operations shall be carried out in such a manner and from such positions that the safety of all concerned is ensured.

5.9.3.7 GROUTING OF PRESTRESSING TENDONS

- A. Each prestressing tendon shall be protected against corrosion and bonded to the surrounding concrete by completely filling the void space between the tendon and its duct with cement grout. Unless directed otherwise by the Engineer, grouting of tendons shall take place within one week of final tensioning.
- B. During the course of the works and depending on the nature of the problems encountered (if any), the Engineer may amend the requirements of the following subsections of this Clause in order to ensure that proper grouting of the tendons is achieved.
- C. PROPERTIES OF GROUT: The grout shall have high fluidity and cohesion when plastic, low shrinkage when hardening and adequate strength when hardened.
 - a. Fluidity
 - i. The fluidity shall be sufficiently high for ease of pumping and, if appropriate, for penetration of the grout into the strand but sufficiently low to expel the air in the duct. Increasing the water/cement ratio to improve fluidity is acceptable provided any increase in bleeding of the grout is counteracted by the use of an expanding agent.
 - ii. Fluidity shall be tested by measuring the time for 1 litre of grout to flow from a funnel or flow cone. A flow cone with a 10mm outlet pipe with a water outflow time of 5s shall be used. Water-cement grouts shall have outflow times of 12s to 25s through this cone. The method shall be used to define the fluidity of a grout and to measure the consistency of fresh grout on site and grout emerging at exits from the ducts.
 - iii. The fluidity of highly colloidal grouts and grouts which include admixtures to modify the fluidity shall not be tested by the flow cone method as their characteristics of shear thinning may produce invalid indications of fluidity. The fluidity of such grouts shall be determined by appropriate alternative methods, which shall be proposed by the Contractor and submitted to the Engineer for acceptance.
 - b. Cohesion
 - i. Cohesion as a measure of the resistance to segregation, bleeding and settlement should preferably be improved by the use of admixtures to modify the viscosity and not increased by reducing the water/cement ratio.
 - ii. Tests for bleeding or grout settlement shall be made at 20°C on 100mm deep samples contained in 100mm diameter air-tight vessels. The upper surface of the cement particles shall not settle more than 2 mm after 3 hours or 4 mm maximum. The amount of bleed water after 3 hours shall not exceed 2% and any water separated at the surface shall be re-absorbed within 24 hours. Provided expanding agents are used, the total unrestrained expansion shall not exceed 10%.
 - c. Compressive Strength
 - i. The strength of 100 mm cubes of grout shall not be less than 17 N/mm² at 7 days and 30 N/mm² at 28 days or the concrete strength of the parent structure whichever is greater.
 - d. Composition of grout
 - i. Grout is composed of ordinary Portland cement and water. In addition, an accepted admixture shall be incorporated in the grout mix.
 - e. Admixtures
 - i. Admixtures shall be used as recommended by the manufacturer and shall be free of any chemical liable to promote corrosion of the tendon or cause damage to the grout, e.g. chlorides, nitrates and sulphates.
 - ii. Plasticizing agents, viscosity modifying agents and gas generating admixtures may all be used.
 - f. Chloride Content

- i. Chlorides from all sources, i.e. cement, water, sand, filler and admixture shall not exceed 0.1% by mass of the cement.

D. GROUT TUBES AND DUCTS

- a. Grout tubes shall be provided adjacent to all tendon anchorages. Intermediate vent tubes shall also be provided at the high and low points of the duct, anchorages, major changes in the cross-section of the duct, such as trumpets of couplers and anchorages and in special cases, at the lowest point of a tendon having a small bending radius.
- b. In detailing the grout inlets and outlets, particular attention shall be paid to any location where a significant directional change to the tendon profile or a change in cross-section occurs. Vent tubes shall be placed at not more than 15m apart.
- c. All grout and vent tubes shall be at least 500 mm long, have a minimum internal diameter of 20 mm, and be provided with:
 - i. A threaded connection to the duct at the lower end.
 - ii. A threaded connection for the grout pump line at the upper end.
 - iii. A high-pressure gas tap to permit quick cut-off of the grout flow.
- d. All ducts shall be large enough both to allow the threading of prestressed cable and to facilitate grouting. The cable to duct area ratio is defined as the total area of the strands based on its nominal diameter divided by the internal cross-sectional area of the duct. The following maximum cable to duct ratio shall be used:
 - i. 0.4 for short cables with few directional changes and the tendons are placed by the pull through method.
 - ii. 0.45 for short cables with few directional changes and the tendons are pre-placed in the duct.
- e. All ducts shall be clean and free of deleterious materials that would impair bonding of the grout or interfere with grouting procedures. Before grouting, each duct shall be cleaned out with oil-free compressed air and flushed out with clean water containing 0.01kg/litre quick lime or calcium hydroxide.

E. MIXING OF GROUT

- a. All materials shall be batched by mass.
- b. The water/cement ratio shall not exceed 0.45.
- c. Sufficient material shall be batched to ensure complete grouting of a duct and making due allowance for overflow. The grout shall be mixed in a machine capable of producing a homogeneous colloidal grout. The mixer shall be of the high-speed type such that it is capable of at least 1000 rpm with a full batch of grout. After mixing, the grout shall be kept in slow continuous agitation, until it is ready to be pumped into the duct. Water shall be added to the mixer first, followed by the cement.
- d. The minimum time of mixing will depend upon the type of mixer and the manufacturer's recommendations shall be followed. Generally, the minimum mixing time will be between 0.5 min and 2 min. Mixing shall not normally be continued for more than 4 min. Where admixtures are used, the manufacturer's recommendations shall be followed.

F. GROUTING PROCEDURE

- a. Prior to commencement of grouting application, the Contractor shall submit to the Engineer, the proven track record of the operators.
- b. Where required by the Engineer, the operators shall carry out trial panels to confirm their competence. The Engineer's approval shall be obtained prior to the deployment of the operators on site.
- c. Trials:
 - i. In some circumstances, grouting trials on representative ducts may be required, e.g. when there is doubt about the ability to grout a particular duct successfully.
 - ii. If the trials indicate that it is not possible to fill the ducts by normal grouting procedures, consideration may be given to the possibility of vacuum grouting.
- d. Injection
 - i. The pump shall be of the positive displacement type with a safety valve to prevent the generation of excessive pressure.

- ii. The connection of the pump to the duct shall be positive and the suction circuit of the pump shall be airtight.
 - iii. The pump shall be capable of exerting delivery pressure of at least 0.7N/mm² and shall be fitted with pressure gauge having a full-scale reading of 2N/mm².
 - iv. A pressure gauge shall be provided at the duct inlet or, if this is out of sight of the pump operator, at the pump outlet to enable the flow of the grout to be checked and to give warning of incipient blockage.
 - v. The baffles in the pump shall be fitted with 1.18mm sieve strainers.
 - vi. Piping to the pump shall have a minimum of bends, valves and changes of diameter.
 - vii. A pump for filling horizontal ducts shall be capable of injecting grout at a continuous rate of 6m/min to 12m/min.
- e. Injection Procedure
- i. It will not be allowed the grout injection if frost is expected within two days (2 days), nor when the temperature of the concrete element is less than five degrees centigrade (5 °C). If it is not possible to comply with this prescription, measures such heating the element or the grout shall be taken, previous approval by the Engineer.
 - ii. Prior to start the injection, all the vent pipes shall be opened.
 - iii. Grout shall be used within 30 min of mixing unless it incorporates a retardant. The time limit is particularly important when the grout includes a gas expanding agent.
 - iv. Ducts shall be grouted as soon as possible after the steel is tensioned. If the delay between inserting the tendons and grouting the ducts is likely to permit corrosion of the tendons, the tendons shall be protected by protective soluble oils or water-phase inhibitors on the steel. These materials shall be used in accordance with the recommendations of the manufacturer and it shall be verified that their use will not have an adverse effect upon the properties of the grout or its bond with the tendons.
 - v. The injection procedure shall ensure that ducts are completely filled. Ducts shall be grouted at a continuous and steady rate, which shall be slow enough to prevent segregation of the grout at points where flow is restricted. When grouting undulating ducts, the rate shall also be sufficiently fast to prevent a downward stream of grout breaking and entrapping air when this is flowing downwards. Grouting shall continue until the fluidity of density of the grout flowing from the free ends and the vent openings are the same as that of the injected grout. The vents shall be closed successively as the filling of the ducts continues. After closing the last vent, the pressure shall be held at 0.5 N/mm² for 5 min.
 - vi. After the completion of grouting, loss of grout from the duct shall be prevented. The tendons shall not be subjected to any vibration or shock within 24 hours after grouting.
 - vii. In very long ducts or those with a large duct section, it may be necessary to re-inject after two hours (2 hours) to compensate for any reduction in the volume of the mixture.
- f. Blockages and Breakdown
- i. The Contractor shall provide standby flushing equipment capable of developing a pumping pressure of 2N/mm² and of sufficient capacity to flush out any partially grouted ducts.
 - ii. If blockage occurs, blocked duct shall be cleaned by, pumping water or blowing compressed air through it to remove the grout from the duct and the grouting procedure repeated.
- g. Removal of Vent Tubes
- i. All valves shall remain closed until the grout has set.
 - ii. At this stage, the vent tubes shall be removed to a minimum depth of 40 mm and the holes left in the face of the concrete rammed solid with dry pack mortar or repaired as otherwise accepted by the Engineer.

5.9.4 TOLERANCES

- A. For pre-stressing strands and bars, allowed tolerances, geometrical and required pre-stress, shall be as indicated in this Technical specification under 5.8.4. WORK EXECUTION chapter.

5.9.5 WORK RECEPTION

- A. The Engineer may check the soundness of the grouting by visual inspection and/or by other means and the Contractor shall supply materials and assistance as required.
- B. Where unsatisfactory grouting is discovered, the Contractor shall undertake such remedial measures as instructed by the Engineer.
- C. Complete records shall be kept on all grouting of cable ducts and a copy of the records submitted to the Engineer.

5.9.6 COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.
- B.
 - a. EN 1992: Eurocode 2 - Design of concrete structures.
 - b. EN 206: Concrete - Specification, performance, production, and conformity.
 - c. BS 8500 Concrete – Complementary to EN 206-1.
 - d. EN 10138-3 – Prestressing steel – Part 3: Strand
 - e. EN 10138-4 – Prestressing steel – Part 4: Bars
 - f. EN 13670 – Execution of concrete structures.
 - g. EN 445 - Grout for prestressing tendons - Test methods.
 - h. EN 446 - Grout for prestressing tendons - Grouting procedures.
 - i. EN 447 - Grout for prestressing tendons. Basic requirements.
 - j. EN 1990: Eurocode. Basis of structural design.
- C. Post tensioning system shall be according to the European Technical Approval (ETA) guidelines.
- D. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

5.9.7 MEASUREMENT AND PAYMENT – PRESTRESSING TENDONS

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 163. Units of measurement - Prestressing tendons

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_96_71_16	000301	POST-TENSIONED STEEL Y 1860 S7 IN STRANDS	kg	Post-tensioned steel Y 1860 S7 in strands consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for steel strands for post-tensioning of concrete structures, and includes supply of the steel strands, positioning and fixing of the tubes, placement of the anchors, laying of the steel strands, tensioning of the reinforcement, anchoring of the reinforcement and injecting the cement grout into the tubes

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_96_71_16	000302	POST-TENSIONED STEEL Y 1860 S7 IN STRANDS FOR EXTERNAL POSTTENSIONING	kg	Post-tensioned steel Y 1860 S7 in strands for external posttensioning consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for steel strands for external post-tensioning of concrete structures, and includes supply of the steel strands, positioning and fixing of the tubes, ducts and HDPE sheaths, saddles and deviation points in hot dipped galvanized steel, placement of the anchors, laying of the steel strands, tensioning of the strands, anchoring of the reinforcement and injecting the cement grout into the ducts. All external strands should allow re-tensioning and replacement of individual strands
Pr_20_76_51_11	000301	POST-TENSIONED STEEL 835/1030 MPA IN BARS	kg	Post-tensioned steel 835/1030 MPa in bars consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for steel bars for post-tensioning of concrete structures, and includes supply of the steel bars, positioning and fixing, placement of the anchors, tensioning of the bars, and all materials and auxiliary means

5.10 FORMWORK, FALSEWORK AND MOVABLE SCAFFOLDING

5.10.1 SCOPE

- A. This Technical specification chapter covers the formwork, false work and movable scaffolding.
- B. Formwork are defined as temporary or permanent moulds into which concrete of similar materials are poured.
- C. Falsework is defined as temporary structure which the aims to support the own weigh of the formwork, the fresh concrete and the construction loads ad wind. The falsework can be a continuous support spatial truss structure or a frame falsework which includes passage areas for roads, paths, rivers or other obstacles according to the definition in drawings and the required clearance during construction.
- D. Movable scaffolding is defined as a self-supporting temporary structure, which aims to support the own weight of the formwork, the fresh concrete and the construction loads and wind.
- E. In addition, both temporary structures, also shall withstand the impact, vibrations and occasional forces produced during the execution of the deck it supports.

5.10.2 MATERIALS AND PRODUCTS

5.10.2.1 FORMWORK

- A. Concrete formwork, concrete shuttering structures and their supporting structures are:
 - a. to be stable, rigid and strong;
 - b. withstand the fresh concrete mass and additional loads during concreting;
 - c. to ensure accurate shape and dimensions of concreted structures, following the plane or curved shapes defined in the technical project drawings;
 - d. be easily assembled and disassembled;
- B. Formwork element deflection under loads shall not exceed $L/1000$.
- C. Formwork errors greater than one centimetre (1 cm) shall not be acceptable in leans and alignments.

- D. The formwork elements can be either:
 - a. timber;
 - b. metal;
 - c. waterproof plywood;
 - d. plastic;
 - e. combination of different materials.
- E. Assembly of formworks will be necessary performed observing the manufacturer's instructions for placing and removal.
- F. Sawn wood humidity used in formworks cannot be higher than 25%.
- G. Formwork joints shall be sealed to prevent the egress of cement paste during the concrete pouring. All formworks surfaces shall be of such quality that meet the requirements of the concrete structures, being sufficiently uniform and smooth to ensure that the concrete faces do not show defects, bulges, projections or burrs of more than five millimetres (5 mm).
- H. The sharp edge of the concrete shall be finished by placing angle profiles on the outer edges of the formwork or by any other effective procedure.
- I. The wooden formworks shall be made of boards, either assembled "in situ" or forming panels, if these give a quality similar to the platform made "in situ". They shall be dried in the air, without showing signs of rot, woodworm or fungal attack.
- J. Before pouring the concrete, formworks shall be watered sufficiently to prevent the absorption of water contained in the concrete, and cleaned, especially the bottoms, leaving temporary openings to facilitate this work.
- K. Built formwork shall be inspected by the Engineer. If the installation does not exceed the permitted tolerances stated in this Technical specification, the Engineer shall draw up a statement of acceptance allowing the concrete pouring.
- L. Before concreting works, Contractor shall check the formwork and anchoring functional fitness. Concrete time shall be constantly monitored in order to a possible loose of geometry. In that case as soon as possible the necessary measures to correct the situation will be performed.
- M. To avoid the concrete sticking in the formwork, the surface may be treated using special grease. Grease shall be fluid enough that it can be sufficiently viscous to spread and to firmly in place on the vertical walls. Formwork surface will be in such manner that concrete will result clean, without producing damage in the concrete strength and maintaining the durability. Formwork will be made of harmless and non-hazardous materials.

5.10.2.2 CLIMBING FORMWORK

- A. In this section the climbing or sliding formwork in high piers is included.
- B. The formwork, with its assemblies and supports, will have the rigidity and resistance necessary to support the concreting without movements greater than one thousandth of the height of the pier.
- C. The stability of the formwork system shall be calculated against the load of fresh concrete, construction loads and wind, as well as the force that it introduces into the anchoring cones to the concrete and the resistance required to move the climber.
- D. The supports shall be arranged in such a way that no more than one-third of the resistance will be introduced on the part of the elements already executed.
- E. The Engineer supervising the works will demand from the Contractor all the drawings and calculation of the climbing formwork system to ensure the compliance with these conditions.
- F. The surfaces will be without unevenness or projections greater than one millimetre for the exposed faces of the concrete.
- G. Errors greater than two (2) millimetres will not be allowed in the vertical of the alignments.

- H. Before starting the execution of the pier, the Contractor shall submit to the Engineer in charge of the works drawings with the shape of the formwork and indications about the position of the construction joints for approval.
- I. Start and finish hardening tests of the concrete will be carried out. Those tests will determine the speed and time the change the climbing system to next stage of the construction.
- J. The Engineer reserves the right to demand the demolition of those parts of the piers that, in his judgment, do not have the proper appearance. The Contractor is obliged to repeat the demolished work without any additional payment for it.

5.10.2.3 FALSEWORK

- A. The execution of this work unit includes the following steps:
 - a. False work and formwork shall be designed and executed according to the Local Regulations in force governing these issues. All conditions applicable to both continuous falsework and frame falsework.
 - b. Specific project including calculations of the falsework and formwork and its bearing capacity is to be prepared and presented by the main contractor and its specialized supplier. This is necessary in all the cases: continuous falsework and frame falsework. The project shall be dully signed by certified professional. This project shall be approved by Engineer prior to proceed with the installation on site.
 - c. Preparation of the base support of the ground including soil replacement to allow bearing capacity conditions.
 - d. Preparation and execution of the foundation support of the falsework, including the local foundations for the frame falsework tower supports.
 - e. Assembly of shoring and falsework, including beams, or trusses for the spans of the frame falsework respecting the required clearance. The clearance during construction phase shall be approved by the corresponding administration in charge (road administration, environmental authority, municipality, etc.).
 - f. Covering the joints between pieces, if applicable.
 - g. Levelling of the formwork.
 - h. Load tests results shall be required for the individual linear elements that made the falsework. In case of composed supports, they shall be tested as a complete element. The goal of these load test is verifying the compressive critical buckling load. The test to be performed shall determine the critical load bearing of the falsework elements
 - i. Removal of the formwork and prop and withdrawal of all elements.

5.10.2.4 MOVABLE SCAFFOLDING

- A. The supports shall be arranged in such a way that no more than one-third of the resistance will be introduced on the part of the elements already executed.
- B. The movable scaffolding for the construction of bridge deck usually use the permanent piers of the deck to transmit the load it supports. Temporary towers founded on the ground are also used for this purpose.
- C. The execution of this work unit includes the following steps:
 - a. Specific project of the movable scaffolding including calculations, support capacity and connections to the bridge piers and deck.
 - b. Preparation and execution of the foundation of tower temporary supports when appropriate.
 - c. Assembly of shoring and support structure.
 - d. Painting of the interior surfaces of the formwork, with a release agent, when the formwork acts as formwork.
 - e. Covering the joints between pieces, if applicable.
 - f. Levelling of the movable scaffolding.
 - g. Load tests.

- h. Removal of the formwork and prop and withdrawal of all elements.
- D. Specifically, in addition to the above steps, all those ones required for the kinematic, movement and positioning of the movable scaffolding and its fixation to the deck, piers or auxiliary elements will be included. These operations will be carried out using hydraulic devices.

5.10.3 WORK EXECUTION

5.10.3.1 FORMWORK

5.10.3.1.1 DESIGN AND CONSTRUCTION.

- A. The formwork shall be sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages, as well as for the appropriate method of placing and compacting. The falsework and formwork shall be so arranged as to be readily dismantled and removed from the cast concrete without shock, disturbance or damage.
- B. The formworks, with their assemblies, supports or falsework, will have the necessary rigidity and resistance to withstand the concreting without any overall movement greater than one thousandth of the span.
- C. The supports will be arranged in such a way that at no time will forces exceeding one third of their resistance be produced on the already executed part of the work.
- D. Contractor will submit to the Employer the drawings and calculations of the formworks and falsework that ensure compliance with these conditions.
- E. The formwork system for all kind of structures shall be previously approved by the Employer.
- F. If the component is to be prestressed whilst still resting on the soffit form, provision shall be made to allow for elastic deformation and any variation in weight distribution. Also, particular care shall be taken with the stiffness of the formwork next to the anchorage areas, so that the axes of the tendons are exactly normal to the anchorages.
- G. The soffit formwork of straight or flat elements spanning more than six meters (6 m) will be arranged with the necessary camber so that, once the element is removed and loaded, it retains a slight concavity in the intrados.
- H. The formwork joints shall not leave gaps of more than two millimetres (2 mm) to prevent the loss of grout; but they shall leave the necessary gap to prevent the boards from being compressed and deformed by the effect of moisture during concreting or curing.
- I. In the case of vertical construction joints, the front closure of the joint shall be made by means of a formwork provided with all the holes necessary for the passage of active and passive reinforcements.
- J. Where it is intended to re-use formwork it shall be thoroughly cleaned and made good.
- K. Internal metal ties which require being withdrawn through hardened concrete shall not be used where either face is permanently exposed. Where internal ties are left in, they shall be provided with a mortar cover of at least 50 mm. The jointing faces of the pocket shall be prepared with an exposed aggregate finish and dampened immediately prior to mortar filling.

5.10.3.1.2 CLEANING AND TREATMENT OF FORMS.

- A. The faces of the forms in contact with the concrete shall be clean and treated with a suitable release agent, where applicable.
- B. Immediately before concreting, all forms shall be thoroughly cleaned out. The source of any compressed air used for the clearing of foreign matter from formwork shall be free from oil and other contaminant.

5.10.3.1.3 PROTRUDING REINFORCEMENT AND FIXING DEVICES.

- A. Where holes are needed in forms to accommodate protruding reinforcement or fixing devices, care shall be taken to prevent loss of grout when concreting or damage when striking formworks.

5.10.3.2 FORMWORK REMOVAL

5.10.3.2.1 GENERAL.

- A. Formwork will be removed in a manner that does not damage the concrete, and at times to suit the requirements for its curing and to prevent restraint that may arise from elastic shortening, shrinkage or creep, and always informing the Employer.
- B. Products used to facilitate formwork removal shall be approved by the Employer, without this exempting the Contractor from his responsibility.
- C. The devices used to anchor the formwork shall be removed immediately after striking.
- D. The use of a blowtorch to cut anchorages is not permitted for removal wires and formwork anchors. Anchorage holes shall be cleanly chiselled, or cones of plastic or soft material shall be provided, which can be easily removed after stripping the formwork. These holes shall be filled with concrete of the same colour as that used in the masonry. It is essential, in any case, to arrange the anchors in lines and equidistant. Wherever possible, external props shall be used.

5.10.3.2.2 TIMING OF REMOVAL FOR CAST IN SITU CONCRETE.

- A. Where the concrete compressive strength is confirmed by tests on concrete cubes stored under conditions that simulate the field conditions, formwork supporting concrete in bending may be removed when the cylinder/cube strength is the strength needed by the design and always under Engineer approval.

5.10.3.3 FALSEWORK AND MOVABLE SCAFFOLDING

- A. The following execution conditions will be taken into account:
 - a. The assembly shall be carried out by specialized personnel. Once the falsework and/or the movable scaffolding has been assembled, prior to concreting, the Contractor will check that the support points of the formwork on the lower face of the structure are adjusted in accordance with the calculations of the established tolerances. It will also be verified that the loads at the support points are in accordance with the provisions of the calculations.
 - b. The Engineer may order, if necessary, a load test up to 20% higher than the weight the movable scaffolding will have to support. The overload test shall be carried out in a uniform and paused manner. The deformation under this load test shall be in accordance with the envisaged calculations.
 - c. The removal of the props and formworks will be carried out in accordance with the program defined in the falsework and/or the movable scaffolding project and will be carried out smoothly and uniformly without producing knocks or jolts. It shall not be dismantled without the authorization of the Engineer.
 - d. If it is not contraindicated by the static system of the structure, the descent of the props and formworks have to start at the centre of the section and continue towards the ends.
 - e. The order, the way of the descent of the supports in each phase of the dismantled, the way of execution and the means to be used in each step, have to be adjusted to the envisaged in the drawings and calculation of the falsework and/or the movable scaffolding.
 - f. It shall not be dismantled until the concrete has reached the expected resistance in the calculations. In order to know the time of disengagement of the formwork and prop, the corresponding tests on concrete specimens have to be carried out.
 - g. The falsework and/or the movable scaffolding has to be detached two or three centimetres for 12 hours, before removing them completely.
 - h. In the case of post-tensioned decks, the process of dismantling the formwork shall take into account the phases of tensioning of the elements, preventing the structure, even if only temporarily, to unforeseen harmful stresses.
 - i. In movable scaffoldings, when the structure of the last span executed has reached the resistance requested by the designer of the structure, the formwork is lowered. This manoeuvre will be carried out by

manipulating the support spindles until the formwork detaches sufficiently so that no friction occurs during the advance and the sliding or rolling devices of the self-jacket are correctly supported to carry out the manoeuvre safely.

- j. In movable scaffoldings, once the lowering manoeuvre has been carried out, the actual advance will take place, which shall be done according to the procedure foreseen in the Technical Documentation of the movable scaffolding project prepared by Contractor; in any case, the movement will be carried out by pushing or pulling with hydraulic cylinders or a similar device.
- k. Once the movable scaffolding has definitively reached the next position, it will be brought closer to the height by means of the necessary hydraulic lifting mechanisms located at the ends, in order to continue closing and placing the formwork at height. Once this operation has been completed, the spindles are fixed to move on to the placement of the rebar. Once the rebar operation is finished, the board is concreted.

5.10.4 TOLERANCES

- A. In addition to the prescriptions already mentioned along This Technical specification Chapter regarding the tolerances, the Contractor is obliged to present to the Engineer, at least one month in advance, a specific complete project, with the drawings and calculations justifying the temporary falsework and/or the movable scaffolding system for all the phases of deck execution, as well as the corresponding Quality control plan. Documentation shall also specify the nature, operative technical characteristics, previous recognition of the ground characteristic for foundations, dimensions and resistant capacity of each one of the elements and of the whole. The conservation status of all the elements, at the time of their use and in biweekly review periods, should be satisfactory in the opinion of the Engineer.
- B. The Engineer may order the increase of the resistant capacity or the rigidity of the structure if he deems necessary, without the Contractor being exempted from its own responsibility, and shall take into account the following general conditions:
 - a. The elements that make up the falsework and/or the movable scaffolding, including the screwed or welded joints, shall be sufficiently rigid and resistant to withstand, without deformations greater than the admissible, the static and dynamic actions involved in the concreting and during the Works.
 - b. In post-tensioned concrete works, the falsework and/or the movable scaffolding shall allow the deformations derive from the stress of the post-tensioning steel and shall resist the subsequent redistribution of the weight of the concreted element.
 - c. The definition of the falsework and/or the movable scaffolding shall have the necessary precamber, as well as enough gap to be able to perform the removal of the shoring.
 - d. Bracing shall have a rigidity compatible with the stability of the formwork, and the formwork design will indicate which of these shall be removed before the reinforcement is tensioned, if the structure is to be prestressed.
 - e. The falsework and/or the movable scaffolding project will define the pressures transferred to the ground, proving that there will be no harmful settlements for the planned concreting system and guaranteeing the stability of the supports against sliding, global instability and bearing resistant.
 - f. If the structure can be affected by a water stream, the necessary precautions against the floods shall be foreseen.
 - g. The project of the falsework and/or the movable scaffolding will define the deformation tolerances that, unless justified otherwise, will not be greater than:
 - i. Local movements of the falsework and/or movable scaffolding $\leq 5 \text{ mm}$
 - ii. Movements of the whole ($S = \text{span}$) $\leq S / 1000$
 - h. The Contractor shall be liable, in any case, for the damages arising from the lack/excess of rigidity in the falsework and/or movable scaffolding and its supports, as well as its incorrect execution. He will be obliged to maintain a permanent monitoring of the behaviour of the movable scaffolding and its supports, and to reinforce or replace them if necessary.

5.10.5 WORK RECEPTION

- A. Prior to each concreting phase, an inspection shall be carried out by Contractor, as minimum, of the details specified below:
 - a. Correct positioning of work platforms, with their protections.
 - b. Placement of protection for holes.
 - c. Formwork geometry and correct assembly of the reinforcement.
 - d. Control points during the pouring, vibrating and curing of the concrete.
 - e. Supervision of the mobile supports, tie rods and movable scaffolding thrusters.
 - f. Inspection results must be approved by the Engineer.
- B. The formwork geometry and the movable scaffolding sequences and formwork placement operations shall be supervised by the Contractor in accordance his Quality Control Plan to ensure the correct handling of the different elements in order to avoid the risks of entrapment, friction and falls.

5.10.6 COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies:
 - a. EN 12812 – Falsework – Performance Requirements and General Design
 - b. EN 1991-1-6 – Eurocode 1: Actions on structures – Part 1-6: General actions – Actions during execution.
- B. Where differences exist between standards, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

5.10.7 MEASUREMENT AND PAYMENT – FALSEWORK AND MOVABLE SCAFFOLDING

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 164. Units of measurement - Falsework and movable scaffolding

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_25_71_29	000301	STRAIGHT FORMWORK FOR NON-VISUAL CONCRETE AND FORMWORK REMOVAL.	m2	Straight formwork for non-visual concrete consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for elements designed for the casting of concrete in structures and prefabricated concrete or fibre cement parts, for lost formwork in Prefabricated beam bridge decks. It Includes layout of the formworks, assembly of the formwork with cleaning and preparation of the support surfaces, if necessary. Preparing the interior surfaces of the formwork with release agent. Covering of joints between pieces. Levelling of the formwork. Moistening the formwork. Shoring of the formwork, if necessary. Disassembly and removal of the formwork and all auxiliary material, once the piece the structural design is able to withstand the expected stresses

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_25_71_29	000302	STRAIGHT FORMWORK FOR VISUAL CONCRETE AND FORMWORK REMOVAL.	m2	Straight formwork for visual concrete consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for elements designed for the casting of concrete in structures and prefabricated concrete or fibre cement parts, for lost formwork in Prefabricated beam bridge decks. It Includes layout of the formworks, assembly of the formwork with cleaning and preparation of the support surfaces, if necessary. Preparing the interior surfaces of the formwork with release agent. Covering of joints between pieces. Levelling of the formwork. Moistening the formwork. Shoring of the formwork, if necessary. Disassembly and removal of the formwork and all auxiliary material, once the piece the structural design is able to withstand the expected stresses
Pr_25_71_29	000303	CURVED FORMWORK FOR VISUAL CONCRETE AND FORMWORK REMOVAL.	m2	Curved formwork for visual concrete consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for elements designed for the casting of concrete in structures and prefabricated concrete or fibre cement parts, for lost formwork in Prefabricated beam bridge decks. It Includes layout of the formworks, assembly of the formwork with cleaning and preparation of the support surfaces, if necessary. Preparing the interior surfaces of the formwork with release agent. Covering of joints between pieces. Levelling of the formwork. Moistening the formwork. Shoring of the formwork, if necessary. Disassembly and removal of the formwork and all auxiliary material, once the piece the structural design is able to withstand the expected stresses
Pr_25_71_29	000304	NON-REUSABLE FORMWORK	m2	Non reusable formworks consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for elements designed for the casting of concrete in structures and prefabricated concrete or fibre cement parts, for lost formwork in Prefabricated beam bridge decks. It Includes layout of the formworks, assembly of the formwork with cleaning and preparation of the support surfaces, if necessary. Preparing the interior surfaces of the formwork with release agent. Covering of joints between pieces. Levelling of the formwork. Moistening the formwork. Shoring of the formwork, if necessary. Disassembly and removal of the formwork and all auxiliary material, once the piece the structural design is able to withstand the expected stresses

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_25_71_29	000305	CONVENTIONAL CLIMBING SYSTEM INCLUDING TWO SIDES OF THE FORMWORK.	m2	Conventional climbing system formwork consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for a formwork support structure which, by means of hydraulic and mechanical solutions, can be raised without the need for a crane, lifting the formwork. It includes assembly of the formwork with cleaning and preparation of the support surfaces, if necessary. Preparing the interior surfaces of the formwork with release agent. Covering of joints between pieces. Levelling of the formwork. Moistening the formwork. Shoring of the formwork, if necessary. Disassembly and removal of the formwork and all auxiliary material, once the piece the structural design is able to withstand the expected stresses
Pr_25_71_29_76	000301	CONTINUOUS FALSEWORK SCAFFOLDING	m3	Continuous falsework scaffolding consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for placement and removal of continuous falsework scaffolding including materials, assembly, removal and ground support elements, as well as the preparation of the supporting ground (compaction, levelling, refining). Formwork is not included.
Pr_25_71_29_76	000302	MOVABLE SCAFFOLDING SYSTEM FOR DECK UP TO 14 M WIDTH	m	Movable scaffolding system consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for rental of the movable scaffolding, as well as auxiliary elements, anchors, movement operations, driving personnel, etc. Per meter viaduct deck line. This is a standard movable scaffolding system for spans of up to 50 m of railway viaduct and widths of up to 14 m, with a deck weight of up to 32 ton/m
Pr_25_71_29_76	000303	FIRST INSTALLATION AND TRANSPORT OF MOVABLE SCAFFOLDING SYSTEM	pc	First installation and transport of movable scaffolding system consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for transport, installation and removal of the movable scaffolding system.
Pr_25_71_29_76	000304	FRAME FALSEWORK SCAFFOLDING. DEEP FOUNDATION	m3	Frame falsework scaffolding consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for placement and removal of frame falsework scaffolding including temporary bearings, materials, assembly, removal and ground support elements, including piles, as well as the preparation of the supporting ground (compaction, levelling, refining). Formwork is not included.
Pr_25_71_29_76	000305	FRAME FALSEWORK SCAFFOLDING. SHALLOW FOUNDATION	m3	Frame falsework scaffolding consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for placement and removal of frame falsework scaffolding including temporary bearings, materials, assembly, removal and ground support elements, as well as the preparation of the supporting ground (compaction, levelling, refining). Formwork is not included.

5.11 CANTILEVER FORMWORK TRAVELLER

5.11.1 SCOPE

- A. This Technical specification covers the called cantilever formwork traveller installed in the deck as the auxiliary structure that moves by rails anchored to the deck and hydraulic jacks, used to build the segments of the deck, which is moved from the piers, (segment 1) once this element has hardened to reach the specified resistance, until the next segment and so on.
- B. During the transfer of the formwork traveller, the deck formworks, bottom slab, webs, beams and top slab shall advance together.

5.11.2 MATERIALS AND PRODUCTS

- A. The formwork traveller moves by wheels on the rails until it is positioned in a new phase.
- B. Two formwork travellers will be used at each pier-spans that will be built according to the balance cantilever method.
- C. The shape and structure of the formwork traveller will be defined in drawings and justified in calculations by Contractor, being submitted to Employer for approval.
- D. The formwork traveller in deck will include the following work platforms:
 - a. Side platform
 - b. Front upper platform
 - c. Lower platform in front part.
 - d. Lower platform from the rear part.
 - e. Lateral work platform of the cantilevers.
- E. Installation, usage and maintenance of cantilever formwork traveller shall be followed by supplier's manuals and instructions and approved by Engineer.
- F. If in order to supply the material to build the balanced cantilever are needed crane-towers, the height, arm and capacity of the temporary towers shall be enough to the required tasks in the construction.

5.11.3 WORK EXECUTION

- A. Typical operations for assembly and disassembly of formwork materials inside the traveller formwork shall fulfil the requirements stated in TS Chapter 5.10.

5.11.3.1 CONSTRUCTION AND ASSEMBLY

- A. The cantilever formwork travellers will be able to support its self-weight with all the elements, the fresh concrete and the construction loads and wind. A specific project with drawings and calculation will be provided by the Contractor.
- B. The supports shall be arranged in such a way that no more than one-third of the resistance will be introduced on the part of the elements already executed.
- C. For all the structures it shall be verified that the system has enough gap for the dismantling in order to not damage the structure.
- D. The quality of the elements, steel profiles, bolts, welds and so on will be adequate to the loads and according to the justification provided in the specific project.
- E. In post-tensioned concrete works, the traveller formworks shall allow the deformations derive from the stress of the post-tensioning steel and shall resist the subsequent redistribution of the weight of the concreted element.

5.11.3.2 *DISASSEMBLY*

- A. The dismantling can be carried out when, in view of the temperature conditions and the result of the resistance tests the supported construction element has reached the design concrete strength to withstand the forces that appear when the formwork is removed.
- B. Both the elements that constitute the formwork as the props, will be removed without producing shaking or hitting to the concrete, for which, wedges, sand, jacks or other similar devices will be used to achieve a uniform descent.
- C. In the case of post-tensioned elements, the process of dismantling the formwork shall take into account the phases of tensioning of the elements, preventing the structure, even if only temporarily, to unforeseen harmful stresses.

5.11.4 *TOLERANCES*

- A. All the formwork systems shall have the necessary strength and arrangement so that, at no time the local movements exceed five millimetres (5mm), nor those of the whole thousandth (L/1000) of the span.
- B. Other construction tolerances shall be, but not clashing with the specified above, as stated in This Technical specification Specification chapters 5.2 and 5.10.

5.11.5 *WORK RECEPTION*

- A. The acceptance of the form traveller shall require the approval, by the Engineer, of the following operations:
 - a. Construction and assembly.
 - b. Displacements between execution phases
 - c. Disassembly.
 - d. In the case of the cantilever formwork traveller in the arch the formwork of the concrete surfaces is included in the execution unit.
- B. The cantilever formwork traveller system shall be described in work execution project and approved by the Engineer.
- C. Both the surfaces of the formwork, and the products that may be applied to them, shall not contain substances harmful to the concrete.
- D. In the case of post-tensioned concrete, special care should be taken in the rigidity of the formwork next to the anchoring areas, so that the axes of the tendons are exactly perpendicular to the anchors.
- E. The formwork at the bottom of the straight or flat elements with more than six metres (6 m) of free span will be arranged with the necessary precamber so that, once the element is stripped and loaded, it retains a slight concavity in the intrados.
- F. The joints of the formwork will not leave slits of more than two millimetres (2 mm) to avoid the loss of grout; but they shall leave the gap necessary to prevent the compression and deformation of the panels due to the effect of humidity during concreting or curing.
- G. In the case of vertical construction joints, the frontal closure shall be done by means of a formwork provided with all the necessary holes for the passage of the active and passive reinforcements.
- H. The demoulding should be carried out as soon as possible, without danger to the concrete, and always informing to the Engineer.
- I. The products used to facilitate the demoulding shall be approved by the Engineer, without exempting the Contractor from its responsibility.
- J. The devices used to anchor the formwork shall be removed immediately after the formwork has been removed.
- K. The wires and anchors of the formwork that cannot be easily removed (will be allowed only in exceptional cases and with the authorization of the Engineer) will have to be cut by chisel stroke. It is not allowed to use a torch to cut the protrusions of the anchors. The anchoring holes shall be chiselled cleanly or provided with cones made of plastic or soft material which once the stripping has been carried out, can be easily removed. These holes will be filled with concrete of the same colour as that used in the work. It is essential, in any case, to arrange the anchors in lines and equidistant. Wherever possible, external shoring will be used.

5.11.6 MEASUREMENT AND PAYMENT – CANTILEVER FORMWORK TRAVELLER

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 165. Units of measurement - Cantilever formwork traveller

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_37_17_35_11	000301	SUPPLY OF FORMTRAVELLERS FOR BALANCED CANTILEVER CONSTRUCTION	pc	Supply of formtravellers for balanced cantilever construction consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply of each pair of formwork advance carriages for cantilevered construction for segments up to 5 m long, up to 12 m wide and up to 40 ton/m in weight.
Ss_37_17_35_11	000302	FORMTRAVELLER CONSTRUCTION	m	Formtravellers for balanced cantilever construction consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for the operation, movement, personnel, displacement, use of the formwork feed carriages, as well as the auxiliary means necessary for the execution of the deck by means of balance cantilever advance, per linear metre of deck executed.
Ss_37_17_35_11	000303	SPECIAL STRUCTURE FOR INITIAL SEGMENT OVER PIER	pc	Special structure for initial segment over pier consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for the special initial dowel support structure for the execution of the deck by means of successive cantilever advances. It consists of metal brackets anchored to the pile that serve as a formwork support structure for the first 6 m on each side of each pile
TE_30_10_10_89	000301	TOWER CRANE	pc	Tower crane consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of tower crane and removal at the end of works. This item includes transport, installation and removal of tower crane with 12.5 ton lifting capacity at 80.8 m distance.
TE_30_10_10_89	000302	MONTHLY RENTAL OF TOWER CRANE	Month	Monthly rental of tower crane consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for the monthly rental payment for the lifting crane. This item consists in the rental of a tower crane with 12.5 ton lifting capacity at 80.8 m distance

5.12 LOAD TESTS ON BRIDGES

5.12.1 SCOPE

- A. This Technical Specification section covers the load tests to be carried out in bridges and viaducts, and other types of structures.
- B. Without prejudice to the application of the technical specifications in this section, load testing of bridges shall fulfil Country's local and technical requirements (standards, regulations, Road Authority's guidelines, etc.).
- C. Load test control points and loads to be applied shall be as indicated in the dedicated load test project as part of work execution project.
- D. Contractor shall perform full scale static load test for acceptance of the design and construction before installation of railway track and ballast.

5.12.2 DEFINITION AND GENERAL CONDITIONS

- A. It is defined as load test on bridges, to the set of control operations, whose implementation is mandatory before opening to traffic, in order to check the conception adequate stability and good performance of the work..
- B. The execution of the work unit comprises the following steps:
 - a. Prepare the load test project and report.
 - b. Inspection of all elements of the structure.
 - c. Marking of load positions.
 - d. Placement and levelling of fleximetres and/or other measuring devices.
 - e. Execution of the load phases and deflection measurement.
 - f. Results report.
- C. A proper interpretation of the measurement results requires in general detecting and considering all possible sources of measurement errors, as well as thoroughly evaluating the governing impact parameters and boundary conditions. Special attention must be drawn to the following points:
 - a. Temperature (temperature stress in statically indeterminate structures).
 - b. Statistical spread of individual events.
 - c. Environmental conditions (snow, rain, etc.).
 - d. Support conditions.
- D. The positioning of the sensors is very important for obtaining the right signals for the analysis:
 - a. Fundamentally, the sensors should be positioned at the places, where the expected relevant deformations yield maximum values of the measured quantities.
 - b. Instruments shall be fixed directly on the structure; only in exceptional cases a fixing on secondary construction units (e.g. edge beams) is permissible.
- E. A measurement protocol, including all important facts and parameters, shall be drawn up for every measuring.
- F. Static load tests shall be carried out by Contractor after structure construction works have reached to the required level in order to conduct the load testing, which has to be agreed with the site Engineer.

5.12.3 WORK EXECUTION

- A. Before starting the load test:
 - a. The Contractor shall submit to the Engineer for approval the load test project before carrying out the load test.
 - b. The load test project shall define used loads, a plan sketch of the exact situation of each load position on the deck.
 - c. Inspection of all elements of the structure shall be carried out and documented in the report by Contractor prior load test and submitted for Engineers approval.

- d. The material of load bearing elements of the structure shall have reached to their characteristic resistance values included in the project documentation.
- e. The exact position of the longitudinal and transversal load to be used in the load test shall be marked on the deck prior to the start of the load test.
- f. Measuring devices must be placed and levelled or tared. These elements shall be defined in the Load Test Project, dedicated report for each bridge, included in the work execution project.
- g. Observation and measurement of cracks in the preparation of the test shall be done.
- h. Measurement of displacements on the unloaded deck shall be done.
- i. Temperature and humidity shall be monitored (before and during the test).
- B. While carrying out the load test:
 - a. The load shall be positioned according to the load test project. All the required loading steps shall be indicated in the load test project.
 - b. It shall be verified that the auxiliary elements of access to the control and work areas are correctly adapted in order not to delay or hinder the testing process.
 - c. During this operation, the measuring devices shall be observed at all times.
 - d. Static load shall be increased gradually and gently, in order to avoid any induction of inertia and dynamic effects.
 - e. Once the entire load is placed, measurements shall be made in the sections and points defined in the load test project.
 - f. The following data shall always be recorded:
 - i. Exact time of the successive operations carried out.
 - ii. List and registration of the load (e.g. vehicles used, with their axle weights).
 - iii. Positions of the load in each loading step/ stage.
 - iv. Results in each measurement of each device.
 - v. Compare with calculated displacements and measurements.
 - vi. Start and progression of cracks.
 - vii. Descents (settlements) of the supports
 - viii. Any other data that may seem useful (vibrations, etc.)
- C. Once the test is finished, a report shall be made which will consist of at least:
 - a. Sketch with the location of the loads.
 - b. Sketch with all the measuring devices.
 - c. Sketch with the location of fixed reference points.
 - d. Readings made on all measurement devices in steps or load stages.
 - e. Theoretical expected deflections and those obtained from the load test.
 - f. Displacements that are deduced from the previous readings.
 - g. Diagram of real displacements (both longitudinally and transverse), discounting the descent (settlement) of the supports.
 - h. Maximum rotation at abutments and piers in ballasted track bridges.
 - i. Diagram of the descents (settlement) of the supports.
 - j. Percentages of recovery recorded in displacements.
 - k. Crack records.
 - l. Incidents that occurred during the performance of the test.
 - m. Conclusions. Conclusion shall expressly include the conformity of tested bridge to the assumed theoretical behaviour and deflection. In case necessary, define additional load tests, provisional or definitive commissioning etc.

5.12.4 TOLERANCES

- A. Tolerances in measurement devices (deflections, pier lean, strains, accelerations, etc) shall be as per manufacturer technical specifications.
- B. Contractor shall propose to Engineer the measurement devices for approval, which would be suitable to the bridge dimensions. The measurement range of each device shall allow the assessment for the selected parameters.

5.12.5 WORK RECEPTION

- A. Criteria defined under this point is as per ADIF NAP 2-4-2.0. "Load test on railway bridges" shall be applicable for all type of structures. Contractor can propose other criteria which shall be described in load test project and approved by Engineer.
 - a. Once the bridge is unloaded, the recovered deflection shall be, at least the 80% of the maximum deflection registered in a time not greater than time, the load was kept on the bridge.
 - b. From the theoretical calculation of the displacement due to the loads and the displacement measured, the average coefficient of elasticity of the concrete shall be deducted, verifying if said coefficient has a reasonable value, taking into account the characteristics of the concrete used.
 - c. In a static load test, it shall be verified that the ratio between the obtained deflections in the test and those expected in the load test project are:
 - i. More than 60%
 - ii. and less than:
 - iii. +115% in concrete and composite bridge
 - iv. +110% in post-tensioned concrete bridges or steel bridges.
 - d. A summary table of test results shall be provided.

5.12.6 COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.
 - a. NAP 2-4-2.0. Load test on railway bridges. ADIF (Spanish High-Speed Railway Authority)
 - b. Recommendations for load test on road bridges:
 - i. ST 188710638.10:2005 "Statybos taisyklės. Automobilių kelių tiltų bandymas" (Lithuania)
 - ii. LVS 190-11 "Bridge inspection and load testing" (Latvia)
- B. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

5.12.7 MEASUREMENT AND PAYMENT – LOAD ON ROAD AND RAILWAY BRIDGES

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. Units of measurement shall be as follows:

Table 166. Units of measurement - Load test on road and railway bridges

Uniclass code	Type number	Work item	Unit	Work item includes
Ac_80_94_41	000310	LOAD TESTING OF THE ROAD OVERPASS LENGTH LESS THAN 150 m (Structure No)	pc	Load testing of the road overpass length less than 150 m consists of all the mechanisms, measurements, control, test management, planning, load test project and reports, and all materials, transport, staff and auxiliary means required in accordance with the regulations for road bridges and technical specifications
Ac_80_94_41	000311	LOAD TESTING OF THE ROAD OVERPASS LENGTH MORE THAN 150 m (Structure No)	pc	Load testing of the road overpass length equal or more than 150 m consists of all the mechanisms, measurements, control, test management, planning, load test project and reports, and all materials, transport, staff and auxiliary means required in accordance with the regulations for road bridges and technical specifications
Ac_80_94_41	000312	LOAD TESTING OF THE PEDESTRIAN OVERPASS (Structure No)	pc	Load testing of the pedestrian overpass consists of all the mechanisms, measurements, control, test management, planning, load test project and reports, and all materials, transport, staff and auxiliary means required in accordance with the regulations for road bridges and technical specifications
Ac_80_94_41	000313	LOAD TESTING OF THE RAILWAY BRIDGE WITH SPAN LENGTH LESS THAN 60m (Structure No)	span	Load testing of the railway bridge with length less than 60m consists price for the span of all the mechanisms, measurements, control, test management, planning, load test project and reports, and all materials, transport, staff and auxiliary means required in accordance with the regulations for railway bridges and technical specifications
Ac_80_94_41	000314	LOAD TESTING OF THE RAILWAY BRIDGE WITH SPAN LENGTH MORE LESS THAN 60m (Structure No)	span	Load testing of the railway bridge with span length more than 60m consists price for the span of all the mechanisms, measurements, control, test management, planning, load test project and reports, and all materials, transport, staff and auxiliary means required in accordance with the regulations for railway bridges and technical specifications

5.13 BRIDGE MISCELLANEOUS

5.13.1 SCOPE

- This Technical specification chapter covers elements of the equipment for railway bridges such us precast pigmented cornice, steel railing, anchorage for the posts of the catenary, precast concrete logo, etc.
- This Technical specification chapter also covers elements of bridge equipment for road bridges such us precast pigmented cornice, steel railing, sidewalks, barriers, OCPS, precast concrete logo, etc. Without prejudice to the application of the technical specifications in this section, Road bridges shall fulfill technical requirements of the Country's road authority.
- All bridge equipment shall have a design working life of at least 50 years, unless where specified otherwise. Corrosion protection systems in steel elements shall have a durability of at least 15 years before repainting is required

5.13.2 MATERIALS AND PRODUCTS

- A. All the material required for precast concrete elements, protection and repair of concrete, and steel elements will be according to the inherit clauses of the present TS.
- B. All the steel elements used in the railway bridge shall be grounded as stated in the Section 10 of the present TS.

5.13.2.1 DEFINITIONS

5.13.2.1.1 PRECAST PIGMENTED CORNICE (RAILWAY AND ROAD BRIDGES)

- A. This unit covers the precast concrete elements which are placed at the laterals of the bridge decks (bridge edge beam, as noted in project drawings) and structures, and to which the handrails are fixed to.
- B. Precast cornice shall be supplied by Contractor with the dimensions and material defined in the design project.
- C. These pieces will be provided with holes or reinforcement assembly in order to fix them to the deck by means of bolts or pouring with concrete in second phase as defined in drawings.
- D. The unit covers the starter reinforcement of the anchorages for the railing post, OCPS posts and noise posts as defined in drawings.
- E. The unit covers the sealing with epoxy between modules as defined in drawing.
- F. In those case where the precast cornice has interference with the pedestal of the lighting in overpasses, these special pieces are also cover in this work item.
- G. Technical conditions will follow the requirement of "Prefabricated concrete and reinforcement concrete structures" of this specification.
- H. The execution of the work unit includes the following:
 - a. Previous stakeout.
 - b. Hydrophobic impregnation.
 - c. Placing anchors before the concreting of the deck.
 - d. Placing the pieces on the deck and the final realization of anchors and protection.
 - e. Grouting parts if necessary.
 - f. Removal aids, bracing.
- I. All the previous noted elements are covered in Section 05 of these Technical specifications. Contractor shall refer to the specific chapters and clauses for material conditions, work execution, allowable tolerances and acceptance criteria.
- J. The pigment colour, dosed in 5 % of cement mass shall be synthetic its specifications, (and a minimum of 20 kg of dry or wet pigment per m3 of concrete) according to EN 12878:
 - a. RAL 5014 (BLUE) Estonia. Shall be based on CoAl_2O_4
 - b. RAL 3011 (RED) Latvia. Shall be based on Fe_2O_3
 - c. RAL 6011 (GREEN) Lithuania. Shall be based on Cr_2O_3
- K. Contractor shall provide concrete specimens to the Engineer in order to accept the mixture, as the cornice colour shall be uniform along one country. The colour acceptance shall be based on matching a colour palette previously agreed with the Engineer. Inside one structure, all the precast elements shall use the same concrete mixture in order to avoid changes in colours.
- L. Only type B pigments certified according to EN 12878 are allowed for use in the steel-reinforce concrete.
- M. The manufacturer of the pigmented concrete elements shall take all precautions in order to maintain consistent and uniform colour of the precast elements. The actions shall include following precautions, but are not limited to only these:
 - a. Use a single supplier (producer) and dosage of the pigment
 - b. Avoid significant changes in the raw materials of the concrete and the recipe during all production period. Use the same origin of aggregates with light colour for the concrete production

- c. Use of similar casting and curing conditions and procedures for all produced elements of one colour, including the used form release agent
- d. If any concrete surface sealers, hydrophobic impregnators or other compounds are applied, the same compounds should be applied to all elements in the same manner to avoid different surface colour and appearance of the dry and wet concrete element, or different level of efflorescence.

5.13.2.1.2 STEEL RAILING (RAILWAY AND ROAD BRIDGES)

- A. Handrails joined by bolted connection to the anchor plates on bridge decks or steps and viaducts upper rail. The railing shall conform the dimensions and materials stated in the project design drawings.
- B. The steel elements shall follow what stated in sub-clause 5.6.
- C. The execution of the work unit includes the following:
 - a. Staking and alignment of the elements forming the rail.
 - b. Railing Supply.
 - c. Supply the anchor plate, if any.
 - d. Place anchor bolts if sleeves were embedded in the parapet. Weld post if the plates were poured with the precast cornice.
 - e. Assembly and placement of the railing.
 - f. Cleaning and collection building waste.
 - g. Railing shall be grey, zinc protected (hot-dip galvanized) to withstand with environmental class C4 as per EN ISO 12944-2. Paint shall be provided at steel workshop, being allowed painting on site to amend damages produced during transportation.
 - h. Railing shall be grounded with the criteria defined in Section 10 of the present Specifications.

5.13.2.1.3 LANDMARK RAILING (LANDMARK RAILWAY AND ROAD BRIDGES)

- A. Landmark railing shall be joined by bolted connection to the anchor plates on road bridge decks or steps and viaducts upper rail.
- B. The railing shall conform the dimensions and materials stated in the project design drawings.
- C. The steel elements shall follow what stated in sub-clause 5.5.
- D. The execution of the work unit includes the following:
 - a. Staking and alignment of the elements forming the rail.
 - b. Railing Supply.
 - c. Supply the anchor plate, if any.
 - d. Place anchor bolts if sleeves were embedded in the parapet. Weld post if the plates were poured with the precast cornice.
 - e. Assembly and placement of the railing.
 - f. Cleaning and collection building waste.
 - g. Paint shall be provided at steel workshop, being allowed painting on site to amend damages produced during transportation. Landmark railing colour shall be determined by Engineer, following the RAL Country colour criteria (RAL 5014 Estonia, RAL 3011 Latvia or RAL 6011 Lithuania), fulfilling environmental class C4 as per EN 12944-2. Paint system shall fulfil the requirements of EN 12944-5 for class C4.
 - h. Railing shall be grounded with the criteria defined in Section 10 of the present Specifications.

5.13.2.1.4 ANCHORAGE FOR OVERHEAD CONTACT SYSTEM POST (RAILWAY BRIDGES)

- A. Metallic elements that are anchored to the structure's deck, so that in due course the catenary support posts are attached to them.

- B. These elements are not replaceable, and they are envisaged embedded in the deck of the bridges. To ensure the design life, stainless steel inserts are prescribed and designed, with female end, to be able to screw the subsequent fixing of the post base.

5.13.2.1.5 PRECAST CONCRETE PANEL LOGO (RAILWAY AND ROAD BRIDGES)

- A. The precast concrete panel with the Rail Baltica Logo shall conform the dimensions and materials stated in the project design drawings. The logo will include the country colours.
- B. One panel per abutment shall be placed. The panel shall be placed in the closest position to the direction of travel.
- C. The panel shall be executed using a formwork with a vertically arranged chipped pattern, separated by approximately 24-millimetre-wide depressions.
- D. Concrete shall follow what stated in sub-clause 5.4

5.13.2.1.6 SIDEWALKS (ROAD BRIDGES)

- A. Road bridges sidewalks shall be executed with watertight concrete by adding watertight admixture.
- B. This concrete shall be C35/45 with exposure XC4/XD3/XF4 and maximum aggregate size 20 mm. For watertight concrete in sidewalks measurement and payment refer to sub-section 5.2.8.
- C. Thin layer coating on the area between barriers shall pass over the joint between precast and in situ part. It shall be a polyurethane coating with non-slip particles.
- D. This coating shall be additional to the hydrophobic impregnation.

5.13.2.1.7 BARRIERS

- A. Road bridges shall be provided with steel barriers manufactured under the specifications covered in EN 1337 series; being only allowed those CE marked.
- B. The barrier containment level shall be in accordance with Local Regulations, and shall be as minimum as the following (EN 1317-2 and EN 1317-4):
 - a. Containment level: H2
 - b. Severity Impact Index: B
 - c. Working width: W3 (1.0 m)
 - d. Dynamic Deflection: 0.6 m
- C. The steel shall be hot galvanized and painted according to EN 10025, EN 10235 and EN ISO 1465.

5.13.2.1.8 FIBER REINFORCED CONCRETE STAIRS

- A. In the access to bridges and structures stairs are placed on the embankment slope to access from the upper level to the lower level for maintenance and inspection.
- B. Stairs are made of concrete C35/45 reinforced with stainless steel fibers. Concrete exposure class is XC4, XD3, XF4. Concrete stairs are cast on crushed limestone or dolomite fr 4/16 h=100 mm wrapped in geotextile.
- C. Stainless steel fibers according to requirements in EN 14889-1 to be used in FRC (fiber-reinforced concrete). Amount of fibers 90 kg/m³.
- D. This item includes installation of the steel railing, high 1,10 m, painting and all the necessary operations for its correct placement.

5.13.2.1.9 OVERHEAD CATENARY PROTECTION SYSTEM (OCPs) (ROAD BRIDGES)

- A. This element is formed by a fence placed on the sides of the road overpasses in the spans over the railway line in order to protect the overhead catenary system from falling object or vandalism. This protection system will have a height of at least 1.8m and a robust design in order to avoid that it can be crossed or damaged.
- B. The panel will be composed by a transparent methacrylate panel with anti-bird collision protection with a pattern of grey stripes as per project drawings. The reference wind speed to design the panel will be $v_{b,0}=24$ m/s.
- C. The material of the panel described above will satisfy the requirements of EN 50122-1 Railway applications - Fixed installations - Electrical safety, earthing and the return circuit - Part 1: Protective provisions against electric shock and conforming to a degree of protection IP3X as defined in EN 60529 Degrees of protection provided by enclosures (IP code).
- D. The equivalent dynamic load generated at the snow removal will be 15 kN according to annex E in EN 1794-1. This action does not act in combination with the wind load.
- E. Other ancillaries' elements associated to the OCS shall be as per project detail drawings.
- F. This system is to protect also the users of the road overpass from the electric dangers associated with the overhead catenary system.

5.13.2.1.10 OVERHEAD CATENARY PROTECTION SYSTEM (OCPs). ECODUCTS

- A. This element is formed by a wooden fence placed as defined in ecoduct drawings.
- B. The wooden fence is defined in Section 8.4 Wooden Fence.

5.13.2.1.11 LANDMARK PIERS (RAILWAY AND ROAD BRIDGES)

- A. Landmark piers shall be provided with led lights in the rib hexanal pattern along their shaft.
- B. The LED light colour shall be as per each country.
 - a. RAL 5014: Estonia
 - b. RAL 3011: Latvia
 - c. RAL 6011: Lithuania.

5.13.3 WORK EXECUTION

- A. All the elements noted in the present chapter of the Technical Specification shall be executed as per manufacturer's conditions when not covered in Section 05 of these Technical Specifications.
- B. Contractor shall assure specialist staff of manufacturer, if required by Engineer, to be on site in order to supervise the execution.

5.13.4 TOLERANCES

- A. In addition to the specific tolerance related to main elements (concrete, steel, etc) in these Technical specifications, the following specific tolerances shall apply.

5.13.4.1 PRECAST CORNICE

- A. It will be checked at site and before performing precast cornice final anchors that edges and straight elements present no curvatures or upper arrows beyond a centimetre (1.0 cm) measured with a ruler four metres (4.0 m).
- B. Surfaces will not exhibit voids or burrs slurry and shall have the same pitch as the elements of the concreted structure "in situ".
- C. Those parts on which cracks or fractures and appreciate that do not fit properly with the adjacent parts will be rejected.
- D. Pigments shall match the RAL specified in this document.

- E. Any damage that may occur as a result of the completion of the later works on the structure will be repaired at his expense by the Contractor.

5.13.4.2 STEEL RAILING

- A. Except for those parts of the posts remaining, other recessed surfaces of rail are supplied fitted with two coats of rustproof paint (red lead or lead cyanamide).

5.13.4.3 ANCHORAGE FOR OVERHEAD CONTACT SYSTEM POST

- A. Anchoring will be done according to the drawings, and special care will be taken when staking out of the anchor bolts and during pouring to avoid deviations. These will be embedded in the deck, as detailed in drawings.
- B. The anchor bolts are waiting for the installation of the anchor plate.
- C. Pedestal and base plate of the post will be built during the construction of the catenary.

5.13.4.4 PRECAST CONCRETE PANEL LOGO

- A. The precast concrete panel with the Rail Baltica Logo shall be placed together with the abutment sidewalk formwork. It shall be tied in such a manner that it shall not suffer displacements and damage along the pouring and concrete vibration.

5.13.4.5 OVERHEAD CATENARY SYSTEM PROTECTION SYSTEM (OCPS)

- A. It will be checked that all the fixation anchorages are properly tighten.
- B. As well, in situ welds for posts to cornice embedded base plates shall be checked.

5.13.4.6 MONITORING SYSTEM

- A. Contractor shall monitor the bridge construction, providing all the necessary devices in order to get the acceptance by the Engineer.
- B. The monitoring system, which could consist in topographic survey devices, accelerometers, tilt sensors, strain gauges, etc, shall be proposed by Contractor to Engineer for the approval of the construction monitoring.
- C. Acceptance shall be based on geometrical tolerances, and material properties, with the conditions specified in section 05 of these Technical specifications.

5.13.5 WORK RECEPTION

- A. The elements defined in the present Technical Specification Chapter shall be approved by Engineer. All the conditions related to Section 05 of this Technical specifications shall be valid for the elements covered by sub-section 5.13.

5.13.6 COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.
 - a. EN 12878. Pigments for the colouring of building materials based on cement and/or lime. Specifications and methods of test.
 - b. EN 12944-2. Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 2: Classification of environments.
 - c. EN 12944-5. Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 5: Protective paint systems.

- d. EN 1317-2 Road restraint system. Performance classes, impact test acceptance criteria and test methods for safety barriers including vehicle parapets.
 - e. EN 1317-4 Road restraint system. Performance classes, impact test acceptance criteria and tests methods for terminals and transitions of safety barriers.
 - f. EN 13369. Common rules for precast concrete products.
 - g. EN 13670. Execution of concrete structures.
 - h. EN 15050, Precast concrete products - Bridge elements.
 - i. EN 14889-1:2006. Fibres for concrete – Part 1: Steel fibres – Definitions, specifications and conformity.
- B. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

5.13.7 MEASUREMENT AND PAYMENT

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 167. Units of measurement - Railway bridge equipment

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_93_37_65	000301	CORNICES FOR BRIDGES DECK	m	Cornices for bridge deck consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for precast concrete elements that are placed at the side end of bridge decks and structures, and to which railing uprights are attached. With pigmented colour concrete depending of the country in Rail Baltica according to ALG implementation guidelines, and variable shapes created with the formwork. It includes preliminary setting out, placing the anchors before the deck is concreted, placing the pieces on the deck and making the final anchors and their protection, grouting the pieces if necessary, sealing with epoxy between precast modules and removing the auxiliary elements
Pr_25_30_36_11	000301	STEEL RAILING ON STRUCTURES	m	Steel railing consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for railings attached by welding to anchor plates on bridge decks or overpasses and railway viaducts. It includes layout and alignment of the elements that form the railing, supply of the materials, supply of the anchor plate, assembly and installation of the steel railing and painting
Pr_25_30_36_11	000304	STEEL RAILING ON STRUCTURES WITH SOLID STEEL PLATE	m	Steel railing on structures with solid steel plate consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for railings with a solid steel plate to avoid pollution falling down, attached by welding to anchor plates on bridge decks or overpasses and railway viaducts. It includes layout and alignment of the elements that form the railing, supply of the materials, supply of the anchor plate, assembly and installation of the steel railing and painting

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_25_30_36_11	000302	STEEL HANDRAIL	m	Handrail consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for handrail attached by welding to anchor plates on parapets. It is formed by galvanized steel tube of 100 mm diameter and 3mm thickness with steel anchorage to the parapet. It includes layout and alignment, supply the materials, supply of the anchor plate, assembly and installation of the hanrail and painting.
Pr_25_30_36_11	000303	STEEL RAILING ON STAIRS	m	Steel railing consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for railings attached by welding to anchor plates on stairs. It includes layout and alignment of the elements that form the railing, supply of the materials, supply of the anchor plate, assembly and installation of the steel railing and painting
Pr_20_29_10_13	000301	ANCHORAGE FOR OVERHEAD CONTACT SYSTEM POST	pc	Anchorage for overhead contact system post consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for steel elements that are anchored to the structure's deck, so that the catenary's support posts are attached to them. Includes two embedded stainless steel U bars with threaded socket with a lid to be removed when catenary anchorages are placed and all the work necessary for its placement
Pr_25_71_50_16	000302	FALLING OBJECTS DETECTOR IN OVERPASSES	m	Falling objects detector in overpasses consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for object fall detection system consisting in metal pivoting panels, metal supports, routings and the associated civil works a stainless steel tube on the protection fences.
Ss_25_16_73_05	000301	OVERHEAD CATENARY SYSTEM PROTECTION (OCPS), ACTING AS ANTI-VANDAL FENCE	m	Overhead Catenary system protection (OCPS), acting as Anti-Vandal fence consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for two-meter-high fence (2.0 m) made of transparent methacrylate, fixed to steel bottom frame and posts, the latter being welded to the anchor plates, or indicated place. Includes layout and alignment of the elements that form the fence, posts, handrail, base plates and anchors, supply of materials, and placement of the elements that make up the fence.
Pr_20_85_07	000301	BRIDGE STEEL BARRIER	m	Steel bridge barrier consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of steel barrier with containment level H2 (min.) and working width 1.00 m (max.) on bridge deck
Ss_25_16_94_16	000301	BRIDGE CONCRETE BARRIER	m	Concrete bridge barrier consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of concrete barrier on bridge desk.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_85_07	000302	PARAPET TRANSITION (BARRIER)	pc	Parapet transition (barrier) consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of steel barrier with containment level H2 (min.) and working width 1.00 m (max.) for transition between bridge and road barrier.
Pr_25_93_45_18	000301	KERBSTONES	m	Kerbstone consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of precast concrete kerbstone. Including concrete for bed under the kerb and to grout pieces.
Pr_25_93_45_56	000301	KERBSTONES	m	Kerbstone consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of granite kerbstone. Including concrete for bed under the kerb and to grout pieces.
Pr_25_93_45_18	000302	SUPPORT BEAM OF SLOPE, OF CONCRETE KERBSTONE	m	Support beam of slope consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of precast concrete kerbstone to place at the end of fill cone in abutments slope. Including concrete for bed under the kerb and to grout pieces.
Pr_25_93_45_18	000303	SUPPORT BEAM OF SLOPE, CAST IN-SITU REINFORCED CONCRETE	m	Support beam of slope consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for cast in-situ beam of reinforced concrete to place at the end of fill cone in abutments slope. Including concrete, reinforcement, formwork and all the auxiliary means for its final placement.
Pr_25_71_50_16	000303	SNOW BARRIER	m	Snow barrier consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for fence / barrier on the bridge deck to prevent snowfall on the roads below, made of metal, fixed to frame and posts, the latter being welded to the railing anchor plate, or indicated place. Includes layout and alignment of the elements that form the fence, supply of materials, placement of the elements that make up the fence .
Pr_65_52_63_90	000301	CABLE PROTECTION PIPES	m	Cable protection pipes consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of PVP pipes bedded in the deck for cable protection in bridge decks, including transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_25_71_14_03	000301	MEDIUM SIZE PRECAST CONCRETE PANEL WITH RAIL BALTICA LOGO	pc	Medium size precast concrete Panel with Rail Baltica logo consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). To be placed at abutment wing walls or other elements, with the letters created in the concrete relief by means of the formwork, with the colour logo, and texture created with silicone formwork. Panel dimensions 1.50 x 0.55 m, thickness 8 cm and reinforcing bars for anchoring to the concrete in situ.
Pr_25_71_14_03	000302	LARGE SIZE PRECAST CONCRETE PANEL WITH RAIL BALTICA LOGO	pc	Large size precast concrete Panel with Rail Baltica logo consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). To be placed at abutment wing walls or other elements, with the letters created in the concrete relief by means of the formwork, with the colour logo, and texture created with silicone formwork. Panel dimensions 3.00 x 1.10 m, thickness 8 cm and reinforcing bars for anchoring to the concrete in situ.
EF_35_10	000301	CONCRETE STAIRS WITH RAILING	m	Concrete stairs with railing consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for stairs made with concrete (including concrete C35/45, formwork and stainless steel fiber reinforcement), supported by crushed limestone or dolomite fr 4/16 h=100 mm wrapped in geotextile. This item includes installation of the steel railing, high 1,10 m, painting and all the necessary operations for its correct placement.
Pr_25_93_60_14	000301	PRECAST CONCRETE CHANNEL, WIDE 60 CM	m	Precast concrete channel, wide 60 cm, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing precast concrete channel including preparation of the base surface, placing the channel, filling with cement mortar and placing the concrete cover if necessary.
Pr_25_93_60_14	000304	PRECAST CONCRETE CHANNEL, WIDE 40 CM	m	Precast concrete channel, wide 40 cm, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placing precast concrete channel including preparation of the base surface, placing the channel, filling with cement mortar and placing the concrete cover if necessary.

5.14 SHOCK TRANSMISSION UNITS (STU)

5.14.1 SCOPE

- This Technical specification chapter apply to bridge shock transmission units that are produced according to EN 15129 standard requirements of the group and / or the relevant European technical approvals.
- The shock transmission units (STU) are the devices allocated at bridge or viaduct ends with the intention of transferring the horizontal loads to the substructure.
- STU function as a load transfer path for high velocity inputs in both tension and compression. During low velocity movement (thermal movement and concrete creep and shrinkage) the device is to provide minimal movement resistance. STU transfer forces under quick movements.
- The Contractor shall propose to the Engineer the shock absorber technical sheet, with the following parameter that will at least, be equal than those required in the project drawings:

- a. Maximum allowed forces: fulfilling the project ones in kN/unit.
- b. Maximum allowed displacement: $\pm x$ mm as project condition for slow deformations.
- c. Maximum allowed movement: $\pm x$ mm as project condition for quick loads.
- E. Design working life of STUs elements shall be at least 50 years.

5.14.2 MATERIALS AND PRODUCTS

5.14.2.1 DELIVERY, STORAGE AND HANDLING

- A. Deliver production STU's protective packaging for freight and handling purposes.
- B. Handle STU's to prevent damage, breaking, denting or scoring.
- C. Store STU's in a clean and dry place. Protect from dirt, fumes, construction debris and damage.

5.14.2.2 MATERIALS AND GENERAL CONDITIONS

- A. Shock transmission units shall meet the requirements of EN 15129 and satisfy the properties indicated in the project.
- B. Shock transmission units will be supplied only with the manufacturer's certificate stipulating a compulsory production standard, product use, quality of materials and components certificates.
- C. The main materials involved in the shock absorber manufacturing shall be:
 - a. Outer cylinder: composed by cylinder tubes, cylinder pipes, etc. It will be fabricated in steel S355 according to EN 10025 or equivalent.
 - b. Piston rods: made of special steel 42CrMo4 steel according to EN 10083, or equivalent.
 - c. Hydraulic valves: made of cast steel according to EN 10025, or equivalent.
- D. Steel parts will be treated with the corrosion protection systems according to EN ISO 12944 and fitted to the environmental conditions. Contractor shall propose to the Engineer for approval the corrosion protection system to be applied, which will have a span life of at least 30 years.
- E. The viscous fluid to be used in the shock transmission unit will be protected against aging, in order to guarantee the span life of the device, which will be, at least of 50 years without the requirement of an extensive maintenance. However, Contractor shall provide to the Engineer a maintenance manual, registering the visual inspections to be performed along the regular inspections in the bridge.
- F. Due to the weather conditions at site, the shock absorber will be manufactured to operate in a temperature range of -35 °C to +80°C
- G. In addition, Contractor shall submit the equipment parts list for each STU model to be used in the project for review and approval by the Engineer. Approval will be based on the evaluation of the following documentation as applicable to each STU part:
 - a. Manufacturer part number nomenclatures
 - b. EN, ISO or other applicable specifications
 - c. Source name and part number
 - d. Testing and inspection requirements
- H. The STU shall:
 - a. Provide an output force in either tension or compression that is directly caused by a relative velocity input between the two ends of the unit
 - b. Have output force vary only with velocity
 - c. Be maintenance free for the life of the unit (50 years)
 - d. Provide for length adjustment by ± 5 mm
- I. STU performance shall be:

- a. The axial design load shall be as stated in project drawings in tension or compression with the rod fully extended, retracted or at any intermediate point
- b. Minimum factors of safety for the unit shall be 2.0
- c. Under non-operating conditions and when subjected to proof pressure for two minutes, static seals shall not leak externally
- d. Design unit to withstand relative humidity up to 100%, including condensation due to temperature change.

5.14.3 WORK EXECUTION

5.14.3.1 SUPPLY

5.14.3.1.1 GENERAL

- A. Contractor shall submit to the Engineer a certificate of compliance signed by the manufacturer's Quality Control (QC) representative for each STU. Certificates shall comply with EN 15129.
- B. Contractor shall submit to the Engineer a STU erection work plan. It will include procedures, details and sequences for erecting and fitting each STU. The work plan shall include construction stage deflections and thermal deflections at the time of the installation and be signed by a registered engineer.

5.14.3.1.2 SHOP DRAWINGS

- A. Contractor shall submit to the Engineer for approval the shop drawings for each STU. Shop drawings will include:
 - a. Fabrication drawings
 - b. Installation drawings that consider the bridge construction stage deflections when STU installation is planned, including temperature movements
 - c. Setting diagrams
 - d. Bolting templates and schedules
 - e. All steel mounting and connection hardware which is integral with the STU.

5.14.3.1.3 PRODUCT DATA

- A. Contractor shall submit to the Engineer for approval the product data for each STU. Product data will include:
 - a. Manufacturer's product specifications
 - b. List of production history for STU's

5.14.3.1.4 INSTALLATION INSTRUCTIONS

- A. Contractor shall submit for approval of the Engineer the installation instructions for the STUs including the materials, components and auxiliary means used in the installation

5.14.3.1.5 CERTIFICATIONS

- A. Contractor shall guarantee that the following certifications will be kept on file at the contractor or the manufacturer's facilities, and accessible to the Engineer when required:
 - a. Certification of compliance for all testing equipment to the current revision of ISO 9001 or AS 9100 and to a calibrated measurement standard.
 - b. List of production history for STU's.
 - c. Relevant design specifications to be considered.

- B. The following specifications and requirements shall form the basis for the manufacture, supply and installation of the STUs:
- ISO 1219-1:2006 Fluid power systems and components – Graphic symbols and circuit diagrams - Part 1: Graphic symbols for conventional use and data-processing applications.
 - EN ISO 4413:2010 Hydraulic fluid power - General rules and safety requirements for systems and their components.
 - Machinery Directive 2006/42/EC.
 - EN ISO 13850:2008 edition 2 Safety of machinery – Emergency stop - Principles for design (ISO 13850:2006).
 - EN 13306:2010 Maintenance - Maintenance terminology.
 - ISO/IEC 17011:2005 Conformity assessment – General requirements for accreditation bodies accrediting conformity assessment bodies.
 - CETOP European Fluid Power Committee.

5.14.3.2 SHOCK TRANSMISSION UNIT INSTALLATION

- Shock transmission units will be installed in accordance with EN 15129, project documentation drawings and manufacturers recommendations. Suppliers supervision shall be provided during the installation process to guarantee the correct functioning of the STU.
- Installation temperature will be considered, as well as the concrete aging in order to calibrate it along the installation. Installation temperature shall be as project drawings and supplier recommendations.
- The shock absorber shall be monitored, and remote data will be acquired and transmitted for interpretation of the bridge behaviour.

5.14.3.3 TESTING

- STU quality assurance testing shall include the following:
 - Static proof test
 - An internal pressure shall be applied to each STU that is equivalent to 150% of the maximum STU load and maintained for 180 seconds
 - This test is to verify the pressure vessel integrity of every unit
 - High level proof test
 - One unit shall be tested to an internal pressure of 140 MPa for 180 seconds
 - This test is to verify the pressure vessel integrity of every unit
 - Stroke test
 - Every unit shall be stroked through the entire range of motion to verify the stroke capacity of the unit design
 - Translation test (velocity ≤ 0.125 mm/s)
 - Stroke each unit over a portion of the movement range of the STU in both tension and compression
 - The maximum reaction force shall not exceed 10% of the axial design load in either tension or compression
 - This test is to simulate typical movement of the STU and will be performed on all units.
 - Proof test at high velocity (velocity ≥ 12.5 mm/s)
 - Apply a horizontal load at a rate to simulate a shock load
 - Test STU in both tension and compression
 - The maximum reaction force shall not be lower than the axial design load
 - This test is to simulate the peak load due to high-speed dynamic movement of the STU and shall be performed on all units

- B. Testing acceptance requires no visible leakage, signs of physical deterioration, or degradation in performance at the completion of testing. Each unit shall not display deformation or distress and not require the re-torquing of parts.
- C. A complete test report, including all test results, shall be submitted to the Engineer within two weeks of the completion of the testing.

5.14.4 WORK RECEPTION

- A. Work procedure shall be performed by the Contractor with the conditions and according to the following requirements:
 - a. report on examinations upon shock transmission unit bearing installation
 - b. -report on the shock transmission unit testing after installation,
 - c. shock transmission unit position measurement report.
- B. The Engineer shall check the items listed below compliance project documentation, and other necessary standards:
 - a. temperature installing shock transmission unit and others

5.14.4.1 QUALITY ASSURANCE

5.14.4.1.1 GENERAL

- A. Contractor shall provide the equipment parts list for each STU model to be used on the project to the Engineer at least 30 days before STU production.

5.14.4.1.2 QUALITY CONTROL

- A. Contractor shall submit the Manufacturer's quality control system for manufacturing which will be in accordance with the requirements of the current revision of ISO 9001:2008 and AS 9100 for quality assurance in design, manufacture, test, and repair of STU's.
- B. Contractor shall guarantee that manufacturer will maintain for the project a system of manufacturing process control which includes at a minimum the following:
 - a. Raw material traceability
 - b. Special process certification traceability
 - c. Detailed manufacturing instruction
 - d. Inspection instructions

5.14.5 COMPLIANCE WITH STANDARDS AND CONSTRUCTION REGULATIONS

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.
- B.
 - a. EN 10025-1 Hot rolled products of structural steels. Part 1: General technical delivery conditions
 - b. EN 10083 Steels for quenching and tempering (all the series)
 - c. EN ISO 12944 Paints and varnished (all the series)
 - d. EN 15129 Anti-seismic devices.
- C. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

5.14.6 MEASUREMENT AND PAYMENT – SHOCK TRANSMISSION UNITS

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 168. Unit of measurement - Shock transmission units

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_85_76_09	000301	SHOCK TRANSMISSION UNIT WITH MAXIMUM LOAD 5000 kN	pc	Supply and installation of shock transmission unit with maximum load 5000 kN. consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for devices that allow, under normal traffic loads or climatic fluctuations, relatively slow movements in the structure. Only in the event of shock loads do the shock transmission function as a clamping device that blocks horizontal movements.

5.15 SETTING OUT AND PREPARATORY WORKS FOR BRIDGES

5.15.1 SETTING OUT

- A. Staking, cross-sectioning, and inspecting for structures shall consist of all works and expenses necessary to achieve the specified result, e.g., workforce, equipment, applicable fees, and transportation.
- B. The Contractor shall keep updated schedules and drawings of all benchmarks used in the setting out of the bridge and shall make these available to the Engineer when required.
- C. Requirements for geodetic measurements accuracy and geodetic reference system to be used is described in "Geodetic network construction and supervision services for Rail Baltica Highspeed railway" document.
- D. Reference system (benchmarks, etc.) shall be validated and maintained during the construction process, especially nearby construction activities.

5.15.2 PREPARATORY WORKS

- A. Preparatory works for structures shall consist of all works and expenses necessary to achieve the specified result.
- This item is meant for all previous works like temporary access roads for construction, allocation of the warning signs, construction site area, etc, with all the necessary materials and activities (tree cutting, bush cutting, vegetation layer removal and storing at site, demolitions, etc.) and return to previous state.
- B. Site clearing and grubbing shall be done in accordance with subsection 2.7 of these Technical Specifications.
- C. The stripping of topsoil area shall be done in accordance with subsection 2.8 of these Technical Specifications.
- D. Earthworks shall be done in accordance with the relevant requirements in Section 02 – EARTHWORKS.
- E. Where required for the execution of the works the Contractor shall provide temporary lighting.
- F. The Contractor shall provide and suitably sign points of entry to and exit from the construction site, for vehicles engaged on the works.
- G. Temporary access roads and compound areas shall be restored to their original condition prior to withdrawal from the area.
- The Contractor shall determine the measures that are appropriate for restoring the construction site, minimizing the impact, and submit a report with an appropriate management plan to the Engineer for approval.

5.15.3 MEASUREMENT AND PAYMENT - SETTING OUT AND PREPARATORY WORKS FOR BRIDGES

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 169. Unit of measurement - Setting out and preparatory works for bridges

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_15_95_15	000001	STAKING, CROSS-SECTIONING AND INSPECTING	object / site	Staking, cross-sectioning and inspecting for structure consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.).
Ss_15_95_15	000002	PREPARATORY WORKS	object / site	Preparatory works for structure consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for all previous works like temporary access roads for construction, allocation of the warning signs, construction site area, etc. with all the necessary materials and activities (tree cutting, bush cutting, vegetation layer removal and storing at site, demolitions, etc) and return to previously state.

6. SECTION 06.- RAILWAY CABLE SYSTEM ELEMENTS

6.1 SCOPE OF WORKS

- A. The following items are covered in this Section:
 - a. Precast cable channel incl. straight, turned and elevated elements;
 - b. Cable ducts;
 - c. Manholes, incl. transition elements to cable channel.
- B. This section provides a needed but non-exhaustive list of labour, equipment, transport and services necessary to furnish, deliver and install all work of this section as shown on the drawings and/or BIM models, as specified herein and/or as required by job conditions. And includes the general information about supply of Cable system elements, what will be purchased by Employer in centralized way.
- C. The BIM models must contain detailed as-built data according to the specified LoG and LoI levels in "RBDG-MAN-040- Digital information requirements for construction and handover stages". As-built BIM models shall be created and/or updated by developing PIM (Project Information Model) models from the Technical Design accompanied with laser scanning/photogrammetry data according to RBGL-VDC-INS-R-00001.

6.2 GENERAL REQUIREMENTS

- A. In addition to this Specification, the cable ducts distribution, construction and materials shall be according to:
 - a. Technical Design;
 - b. And actual Rail Baltica technical specification No. RBCN-CMS-SPC-R-00005 for Cable system elements;
 - c. "RBGL-SOD-SPC-R-00004 - RAILWAY SYSTEMS REQUIREMENTS on Mainline Works Contractor";
 - d. "RBGL-SEA-SPC-R-00001 - System assurance requirements on Mainline Works Contractor"
- B. General terms and definitions are:
 - a. **Control-command and signalling - CCS:** Control-Command and Signalling according to the Technical Specifications for Interoperability TSI CCS and EN 50129 standard.
 - b. **CCS Contractor:** The CCS contractor engaged by the RBR (or other stakeholders) responsible for installation of cables and systems.
 - c. **Principal:** RBR or CCS Contractor.
 - d. **Cable channel:** U-shaped Precast concrete element with lid, used for protection of Ducts and cables. Cable channel is installed on surface along the track, on the earthworks or on structures and fitted with lid.
 - e. **Cable system element:** Multiduct; Duct; Manhole incl. transition elements to Cable channel, Cable channel incl. straight, turned and elevated elements.
 - f. **Duct:** Pipe used to protect all types of cables, laid directly under the ground or in Cable channels.
 - g. **Manhole:** Precast modular concrete, vertical watertight structure used to connect pipelines, to change direction and/or level, for pulling, connecting, and dispatching of Ducts, cables, and Cable channels, to permit access for personnel and/or equipment for inspection, maintenance and allow aeration and ventilation.
 - h. **Microducts:** Inner pipes of a multiduct purposed for fibre optic cable installation.
 - i. **Multiduct:** Specific duct for optical cables, aggregating several Microducts of inferior diameter.
 - j. **Cable ducts:** Combinations of several Multiducts and/or Ducts.
 - k. **Transition to Cable channel:** Specific element purposed for cable and Duct transition from Cable channel to Manhole.

6.2.1 CABLE CHANNEL

- A. Cable channel for laying cables along the route consists of prefabricated concrete elements, placed parallel to the tracks and fitted with a reinforced concrete cover lid.
- B. Cable channels are installed in different areas, such as ecoducts, bridges and in those culverts that require it as detailed in the Technical Design. In addition, these elements are also installed in other sections, such as the areas near technical buildings for systems in turnouts, crossovers and block sections and in the central tracks of the depots and passing loops.
- C. The configurations of the Cable channels to be installed by Technical design, the Cable channel types specified in RBCN-CMS-SPC-R-00005.
- D. For each size of the Cable channel Supplier shall provide as well turned and elevated cable channel elements.

6.2.2 CABLE DUCTS

- A. Cable ducts are those that run parallel to the tracks and allow the connection of the different equipment of railway systems along the track.
- B. Longitudinal cable ducts shall be installed in the location indicated in "Cable ducts. General arrangement plan" drawings. The distance to the track at which these elements shall be installed is shown in drawings and in the BIM model.
- C. The number of ducts to be installed by Technical design, depending on the area they serve, the configuration types specified in RBCN-CMS-SPC-R-00005.
- D. At certain points along the route, crossings shall be installed under the tracks that allow cables to cross. These crossings shall connect with their respective manholes. The crossings to be installed by Technical design, the configuration types of crossings specified in RBCN-CMS-SPC-R-00005.

6.2.3 MANHOLES

- A. Manholes consists of prefabricated concrete elements, including cover lid, inlets for different types of Cable ducts and/or or Transitions to Cable channels.
- B. Configuration types and locations of Manholes are installed as detailed in the Technical Design.
- C. The configuration of the Manholes depends on the incoming Cable channel and/or Cable duct types and cable crossing types. The dimensions, configurations and types of manholes and manhole components specified in RBCN-CMS-SPC-R-00005.
- D. Contractor shall take into account that the structure engineering requirements for Goods (EN 206-1, EN 1917) are met for loads of a railway traffic for an installation depth based on the lower edge of the manhole, depending on the manhole type, of a maximum of 4.20 m (from the lower edge of the base plate till top edge terrain).
- E. In case if the actual installation depth of the Goods is higher than 4.20 m, the static load calculation shall be available to the Contractor before installing the Manhole.

6.3 SUPPLY

- A. Cable system elements supply will be organized by the RB Rail Supplier according to procurement technical specification RBCN-CMS-SPC-R-00005.
- B. Any deliveries which do not meet the requirements described in RBCN-CMS-SPC-R-00005 shall be rejected and replaced at the expense of the Supplier.
- C. Contractor is responsible to execute the inspection of the Cable system elements, main check for delivered goods before unloading includes:
 - a. Material volume, labelling, delivery specification check according to Goods order and delivery documentation;
 - b. Check for damaged packaging during transportation.
- D. Additional material quality inspection of Materials after unloading shall include:
 - a. Specific Multiducts check for:

- i. Number of Microducts of each Multiduct drum;
 - ii. Diameter of inner Microducts of Multiduct of each Multiduct drum;
 - iii. Colour of inner Microducts of Multiduct of each Multiduct drum.
- b. Specific Ducts check for:
 - i. Length of one Duct per each Duct package;
 - ii. Outer diameter of one Duct per each Duct package;
 - iii. Wall thickness of one Duct iper each Duct package.
- c. Specific Manhole check for:
 - i. Inner and outer dimensions of one unique element per each delivery;
 - ii. Visual check of all elements for crack and pit detection;
 - iii. Inner diameter of openings of all Duct connection element;
 - iv. Lid slippery surface.
- d. Specific Transitions to Cable channel check for:
 - i. Inner and outer dimensions of one unique element of each delivery;
 - ii. Visual check of all elements for crack and pit detection;
 - iii. Lid slippery surface.
- e. Specific Cable channels check for:
 - i. Inner and outer dimensions of one unique element of each delivery;
 - ii. Visual check of all elements for crack and pit detection;
 - iii. Lid slippery surface.
- f. Material Suppliers will provide detailed material installation instructions which may include additional inspection requirements.
- E. Upon Becoming Aware of Defects. In the event the Contractor observes or otherwise becomes aware of any error, fault, omission, non-conformance, or defect in the delivered Materials the Contractor shall give a notice thereof to the Supplier within five (5) Business Days from the day of becoming aware of a Defect.
- F. Delivery points shall be equipped with all necessary infrastructure and prepared storage places to provide unloading.
- G. Contractor shall organize unloading of supplied Cable system elements delivery point.
- H. When Contractor accept delivered Cable system elements, all responsibility of delivered goods, quality and volume is handed over from the Supplier to the Contractor.

6.4 LOADING, STORAGE AND DELIVERY TO CONSTRUCTION SITE

- A. Contractor is responsible for unloading supplied to delivery point elements, for storage, loading/unloading and transportation to installation place in the construction site.
- B. All manufactured Goods shall be stored in adequate conditions to ensure their conformity with quality requirements and shall follow manufacturer's installation, storage and maintenance manuals.
- C. The storage area shall be flat and even without sharp edges or stones that could damage the Goods.
- D. At temperatures lower than -10 °C, Multiduct becomes inflexible and becomes sensitive to impact forces.
- E. The Multiduct and Duct drums shall be supported to prevent them from rolling.
- F. Cable system elements which must be moved, should never be dragged.
- G. Contractor shall ensure that Cable system elements delivered for installation in construction site are not damaged and in same good condition when was handed over from Supplied.

6.5 MATERIAL REQUIREMENTS

- A. The Cable system elements and auxiliary materials shall meet the requirements specified in RBCN-CMS-SPC-R-00005.
- B. Concrete strength class used for sections of Ducts embedded in concrete shall be C35/45 be according to EN 206.
- C. Material for protection of detection wires and Multiducts in open trench, shall be unbound mixture with fines content (particles passing sieve < 0.063 mm) ≤ 5% and maximum aggregate size $D \leq 6$ mm.
- D. For the installation of Manholes, following assembly equipment and tools shall be applied by Contractor:
 - a. Lifting gear with the lifting force corresponding to the location and the weight of the heaviest individual manhole part,
 - b. 2 double-strand hook ropes with minimum length 1.5 m
 - c. 2 pieces of endless ropes, minimum length 2.5 m, as lifting accessories posed.
 - d. Cement mortar;
 - e. Two-component plastic bitumen thick coating for additional external joint sealing if required.

6.6 EXECUTION CONDITIONS

6.6.1 CABLE CHANNEL

- A. The finished Cable channel shall remain in the form shown in Technical design once the cover has been fitted.
- B. The installation criteria provided by the manufacturer of these elements must be followed for their correct installation.
- C. These Cable channels shall be installed in the positions indicated in 'Cable ducts. General arrangement plan' drawings and staked out with geodetic instruments. The position with respect to the track shall be by Technical design and the BIM Model. In all cases Cable channels placement shall be at distance not less than 3,1 m meters from railway track axis.
- D. In those cases where the channel cover is at ballast level, the execution shall be carried out according to the following steps:
 - a. Firstly, the trench shall be made with the appropriate dimensions according to the Cable channel to be installed. and in accordance with Section 02 herein.
 - b. The minimum thickness of sub-ballast layer under the cable channels shall be 30 cm. This could be achieved by increasing the thickness of the sub-ballast layer at the location of cable channels. In this case, the sub-ballast layer with increased thickness shall be extended to the side of the embankment.
 - c. Subsequently, the trench shall be cleaned, avoiding any elements that could damage the channel.
 - d. Once the trench is made and clean, the channel shall be installed and the remaining spaces between the Cable channel and the trench shall be covered with the same material previously extracted.
 - e. Finally, the interior cleaning of the Cable channel shall be guaranteed, and the cover will be placed.
- E. In cases where the Cable channel is installed on structures (for example, on the deck of viaducts or on culverts), the execution procedure will be as follows
 - a. First, a 2 cm high layer of C35/45 in-situ concrete shall be installed under the Cable channel.
 - b. Then the Cable channel shall be installed, and its interior cleaning shall be guaranteed.
 - c. The cover shall then be installed.

6.6.2 CABLE DUCTS

- A. The ends of the Microducts are closed at the factory with end caps or heat-shrink fittings to prevent dirt (soil, insects, etc.) from entering the tubes. The Duct and Multiduct ends shall also be properly closed with end caps during installation work and during intermediate storage. Problems caused by open-ended or poorly closed ends shall be solved by the Contractor, dirt inside Duct and Multiduct shall not be present.

- B. All of the cableway elements must be staked out with geodetic instruments to avoid deviations from technical design
- C. The Contractor shall install a Cable ducts straight on the bottom of the trench, without horizontal or vertical deviations from a straight direction (waves or bends). A bended system can significantly reduce cable installation length and thus will not allow to perform the testing.
- D. The Contractor shall not pull the Ducts and Multiducts over sharp edges, stretch or crush it during installation.
- E. The Contractor shall always install Multiducts in the same direction so that the ends of Microduct of the same colour meet at a later connection.
- F. The Contractor shall keep the Duct and Multiduct bending radius as large as possible during installation. the Radius shall be at least 1.5 m to ensure the best cable installation lengths.
- G. In the case of under-track crossings, ducts shall be installed following the inclination of the frost protection layer with slightly bend at the crown.
- H. A minimum distance of 1.2 m below the sleepers for cable ducts shall be respected in under-track crossings.
- I. Work tools:
 - a. Contractor shall use suitable tools for work with Cable duct components, and shall follow manufacturer's installation and maintenance manuals;
 - b. A suitable tube cutter must be used by, i.e., scissors that do not crush the tube and allow the tube to be cut at a 90° angle;
 - c. The Contractor shall apply good scissors which have a triangular thin blade that moves like a wedge into the Microduct and leaves a clean cutting surface. If necessary, the inner edge of the Microduct cutting surface must be cleaned but not chamfered;
 - d. The Contractor shall not cut the Microducts with a saw or cutting pliers that crush the tube. It is recommended to cut the sheath of the Multiduct with a so-called "gypsum knife", pushing out the adjustable blade 1-2 mm;
 - e. The Contractor shall remove all cutted Duct, Multiduct and Microduct pieces must be removed from the construction area and shall not be thrown into the excavation.
- J. The Cable duct extensions in the Manholes:
 - a. Whenever the Contractor installs ends of a Multiduct in a manhole, extra length at least of 1,5m of each side is needed to work with the Multiduct. This requirement shall be applied whether a Microduct shall be ended, branched off, or straight jointed, in the Manhole.
 - b. Installed end of Duct, entering the manhole, shall have minimum 0,1 m extra length inside.
- K. The Contractor shall identify each Multiduct, as well as the direction (nearest train following station / switching location) to which they are connected.
- L. All materials supplied by the Contractor must have a service life of at least 50 years and must be suitable for placement in the environment for which they are intended (soil, including wetlands).
- M. The Contractor shall install Ducts in open trench, and Multiducts – in open trench or in installed cable protection Ducts according to Technical design.
- N. Open trench for Cable ducts shall meet following requirements:
 - a. The opening of the trench for the longitudinal Cable ducts shall not be executed until the frost protection layer at the location fixed in 'Cable ducts. General arrangement plan' drawings is finished and approved for compaction.
 - b. The excavation of the trench shall be carried out with light means, avoiding damage to the frost protection layer and in accordance with Section 02 herein.
 - c. Once the trench has been made, thick stones and rubble that could damage the settlement of the Cable ducts shall be removed from the bottom of the trench. The bottom of the trench shall be flat and without irregularities, avoiding rocky edges.
 - d. Cable ducts shall be installed with separating/holding elements, and the initial part of each Multiduct or Duct shall be adjusted with the final part of the previous one.

- e. Cable ducts shall be installed in the positions indicated in 'Cable ducts. General arrangement plan' drawings. The position with respect to the track shall be by Technical design and the BIM Model.
- f. Cable ducts shall be installed at a horizontal distance more than 30 cm from catenary mast foundations, 1,0 m from drainage manhole and more than 3,1 meters from railway track axis. Exceptional cable duct distance value of 2,8 m from track axis and 0,5m from drainage manhole may be applied in case of limited installation space condition for cable ducts, which do not allow to implement the nominal distance of 3,1 m.
- g. First cover backfill around the Multiduct shall be done with at least 10 cm thick unbound sand mixture of maximum aggregate size $D \leq 6$ mm.
- h. The Contractor shall lay a warning tape above the buried Cable ducts:
 - i. On the top of the cover layer 10-20 cm above Multiduct;
 - ii. 10-20 cm above the upper Ducts.
- i. The remained backfill above Ducts or Multiducts cover fill shall be filled with the same material as the frost protection layer or the layer in which installed Cable duct which lays, compacting it with light vibrating means, until the upper part of the layer is compacted, and the surplus earth shall be removed.
- O. The Contractor shall install an detection wire along each buried Cable duct, to locate the installed route later:
 - a. Detection wire shall be insulated copper wire with a cross-section not less than 0.5 mm²;
 - b. The Contractor must check the propagation of the detection wire signal before digging into the ground or before backfilling an open trench;
 - c. The Contractor shall ensure that the installed signal wire is electrically unbroken between two neighbour Manholes;
 - d. The Contractor shall place the signal wire reserve of 1 m in each Manhole on both ends of buried Cable duct.
- P. Cable ducts shall be laid at the minimum depth of 0,8 m from soil surface (for the highest part of the duct). In specific areas indicated in Technical Drawings, ducts can be installed at a depth of 0.5 m or 0,3m embedded in concrete C35/45. Concrete works shall be in accordance with relevant requirements in Section 05 "Structures" in these Technical specifications.

6.6.2.1 GENERAL RULES TO ACHIEVE THE MAXIMUM INSTALLATION LENGTH

- A. Multiducts shall be installed with as few turns as possible.
- B. The largest possible bending radius for Multiduct turns shall be applied.
- C. All fitting connections shall be properly pushed into the Microduct so that the Microduct passes through the fitting seal without damaging it. This presupposes a Microduct cut at a 90 ° angle.
- D. Extension fittings shall be installed only on straight sections of Microduct, not on bend sections.
- E. When extending the Multiduct, installed Microduct extensions must be installed with offset from each other. This prevents the Microduct from becoming squeezing or kinking at the connection point and ensures that the cable passes smoothly later.
- F. The cable outlets from the microtube in Manholes or cabinets shall be stopped using Gasblock with fitting.
- G. Cable installation shall start from higher to lower Multiduct end when there is a difference between the height of the start and end points.
- H. Any dirt shall be removed in the Microduct before installing the cable. Microduct shall be cleaned by blowing air through it, then a sponge ball of the appropriate diameter shall be blown through.
- I. The Contractor shall consider when one Microduct shall be extracted from Multiduct for branch connection, the Microduct extension fitting must be installed so that it does not remain on the bent section. To prevent this, the Contractor shall lock Microduct with connector at Multiduct using cable tie. Unused Microducts end needs to be closed with end cap.

6.6.3 MANHOLES

- A. Excavation for Manholes and Transition to Cable channel elements shall not take place until after the compaction of the sub-ballast layer has been completed and approved. This excavation shall be made with manual or light mechanical means, and in accordance with Section 02 herein.
- B. Manholes shall be installed in the positions indicated in 'Cable ducts. General arrangement plan' drawings. The position with respect to the track shall be by Technical design and the BIM Model.
- C. Manholes shall be installed at a distance more than 5m from catenary mast foundations and more than 3,1 m from railway track axis. Exceptional cable manhole distance value of 2,9 m may be applied in case of limited installation space condition for manhole, which do not allow to implement the nominal distance of 3,1 m. If the distance is less than 5m from catenary pole foundation, designer shall provide calculations of static loads.
- D. Manholes and Transition to Cable channel elements shall be installed according to the procedures established by the manufacturer in the points indicated in 'Cable ducts. General arrangement plan' drawings. Prior to the installation of the Manhole, on the cleaning concrete, the bottom drainage shall be made, in order to evacuate to the platform gutter or embankment slope, the water that can enter through the channel or the Manhole itself. In the case of intermediate Manholes in passing loops or depots, the drainage of the Manholes shall be led to the longitudinal drainage that is projected between the section and general tracks.
- E. Contractor shall check whether the excavation pit is in the prescribed cable duct axis and the base of the excavation pit is levelled at the required depth. If the bottom of the pit is made of in-situ concrete, a 5 cm thick level of sand shall be laid on it.
- F. Contractor shall check before installation whether the prefabricated parts of the Manhole are not damaged. Minor damages of the Manhole prefabricated parts caused during transportation to construction site shall be fixed according to Paragraph 6.6.3.S.
- G. Contractor shall check before installation whether the lead-in frame is prepared for connection of the reinforced concrete entry plates. If it is necessary, Contractor shall open it according to predetermined breaking points and enlarge it. To do it, the contour of the predetermined breaking points shall be cut with a power cutter from inside circularly and outside in the fall area to avoid concrete breaks. Afterwards the hit-out of the blind plates shall be performed only from the outside of the lead-in frame in order not to break out the fold which later shall be used to seal the cable channels. When the blind plate sections are broken out and concrete spalling occurred, use cement mortar to fix it. The removal of other wall parts not intended for this purpose is not permitted
- H. Contractor shall place the manhole base plate in flush and horizontal level on the bottom of the excavation pit. Before lowering the foundation plate, shall be checked if a drainage hole or an opening for connecting a drainage or drainage pipe is located correctly in the excavation pit pump sump. Existing seepage or drainage pipe shall be connected to the pump sump.
- I. Contractor shall clean the bearing surfaces for the intermediate frame on the base plate. Contractor shall moisten the bearing surfaces and apply cement mortar in a way that after placing and aligning the intermediate frame, an approx. 1 cm thick bed joint remains.
- J. Contractor shall clean and moisten the bearing surfaces on the lead-in frame and place the frame centrally on the base plate and align it horizontally.
- K. Contractor shall proceed in the same way when installing the other manhole parts.
- L. Contractor shall peel and rub the horizontal joints inside and outside the manhole to level it with the wall surfaces.
- M. Contractor shall put on the upper plate element as described above.
- N. To make manhole waterproof, Contractor shall apply from outside on horizontal joints, made from the suitable cement mortar, protective coating against soil moisture that is suitable for use on fresh mortar. The protective paint shall go at least 10 cm out onto the reinforced concrete parts.
- O. Contractor shall assemble Manholes waterproof.
- P. When the Manhole is installed, the Cable ducts shall be connected and any joints sealed so that water cannot filter through them, the interior of the Manhole will be cleaned, and the cover will be installed.
- Q. When Transition to Cable channel elements are installed, the Cable channels shall be connected, and any joints sealed so that water cannot filter through them.

- R. After installing the manhole cover, Contractor shall clean the manhole.
- S. Damages in Manhole elements shall be handled following:
 - a. Minor edge damages to the precast reinforced concrete elements that occurred before and/or during installation Contractor shall fix with cement mortar using an adhesive (adhesive emulsions or suitable synthetic resins) as a bridge between the hardened concrete of the precast part and the fresh mortar. The fresh mortar used by the Contractor shall be mixed with an adhesive as specified by the Manhole manufacturer;
 - b. Reinforced concrete parts with:
 - i. damage through which the reinforcing steel reinforcement has been exposed;
 - ii. static cracks.
 - c. shall be examined by Contractor's construction manager to take decision whether the damage is insignificant and may remain untreated or whether (and how) the damage shall be treated, or whether the prefabricated part could not be installed at all.
- T. When backfilling the construction pit, particular attention shall be paid to layers and to achieving of the uniform compacting from all sides of the Manhole. The Manhole or its parts shall not move from their position due to compacting works.
- U. The trench shall be covered with the same material previously removed, so that the cover of the Manhole is at the level of the sub-ballast where it is installed (or at the same level as the surrounding surface if the Manhole is not installed on the sub-ballast).
- V. Contractor shall place an RFID Tag/label shall be placed in each manhole and Transitions to cable channels. The search tag must be attached so that it is legible and can be scanned from the ground without having to go down into the Manhole and in Transitions to cable channels.
- W. Label must follow Principal label standard.

6.6.3.1 FURTHER INTERFACE CONNECTIONS

- A. The creation of a drainage hole and connection of a drainage pipe is possible for all sizes of Manholes. The corresponding preparation of the earth under the base plate shall be carried out by the Contractor before installation of the Manhole.
- B. Manholes consist of precast reinforced concrete parts (base plate, lead-in frame, intermediate frame, and upper plate), which shall be placed by Contractor on top of each other using a suitable cement mortar. As a prevention against displacements of precast reinforced concrete elements, the mortar on shall be fill in the support lock grooves.
- C. Predetermined breaking points in the walls of the lead-in frames shall be opened by the Contractor when needed by knocking out the concrete only for connecting the Cable ducts, Multiducts and Cable channels.
- D. Concrete entry plate, for connection of Cable ducts and Multiducts to Manholes, with inlets for Cable ducts and Multiducts shall be by installed by the Contractor. The reinforced concrete entry plates shall be mortared into the knocked-out openings.
- E. Cable duct and Multiduct entry plate shall be installed with sealant brakers on the upper row.
- F. For connection of Cable channel to Manholes, Contractor shall install Transition to Cable channel element. The cable channel entry plates are struck into the opening with a rubber hammer.

6.7 GEOMETRICAL TOLERANCES

- A. The installed Cable channels, Ducts and Manholes shall fulfil the geometrical position requirements stated in the tables below if not stated otherwise tolerances shall meet tolerance Class 1 in accordance to EN 13670:

Table 170. Geometrical tolerances – Placement of cable system elements

Geometric property ^(a)	Allowable deviation, single measurement	Method	Testing frequency
<u>Manholes:</u>			
Position in vertical	± 20 mm	Geodetic	-
Position in plan: X,Y	± 25 mm	Geodetic	-
<u>Cable channels:</u>			
Height at structures	± 20 mm	Geodetic	20 m
Height at embankment	± 50 mm	Geodetic	20 m
Alignment at structures	± 25 mm	Geodetic	20 m
Alignment at embankment	± 100 mm	Geodetic	20 m
<u>Ducts:</u>			
Height	± 50 mm	Geodetic	20
Alignment	± 100 mm	Geodetic	20
Notes:			
(a) - Tolerances do not override the set minimum clearance requirements from catenary mast foundations, railway track axis, drainage manholes, etc.			

B. Where these tolerances are exceeded, the Contractor shall correct them, at its expense.

6.8 ACCEPTANCE AND HANDOVER

6.8.1 ACCEPTANCE

- A. The Contractor shall install Multiducts in a way that it will allow to blow 2,2 km of cable with 12 bar blowing pressure.
- B. After Engineer inspection of the installed section of Cable system elements, acceptance test shall be performed by Contractor. It shall be done section by section, when the first 10%, but at least 2 km, Cable duct route is installed and connected to associated Manholes:
 - a. Contractor shall pull test cable in each empty Duct (ducts without Multiduct inside by Technical design) between all manhole pairs within the testing section;
 - b. Contractor shall blow Test fibre optic cable through one of Microduct for each Multiduct within the testing section;
 - c. Also Contractor shall blow all Microducts through with a cylindrical test probe on all testing section. The test probe shall have a length of at least 5 times the inner diameter of the Microduct and diameter of 90% from diameter of Microduct.
- C. The Contractor shall ensure and is responsible that the Cable system elements and other equipment is not damaged by blow-tests.

6.8.2 HANDOVER

- A. Principal may require additional control blowing free of charge in case if the test probes performed by the Contractor will not be evidenced by the Principal's representatives.
- B. The Contractor must participate in the handover of the Cable way system to the acceptance of the Principal, when the control blowing for a defined section has been completed with an approved result and before CCS Contractor fibre blowing is started.
- C. 3 month is set aside for the Principal's random checks of the Multiduct system from the end of the control blow. During this period, the Contractor must be available for repair work as well as for additional control blowing,

control excavations, etc. by agreement with the construction manager. After this, the fibre blowing can be started up by the CCS Contractor.

- D. Contractor shall stand for available with one day's notice within for 12 months period for repair work, from the time the test blow is approved and the final fibre blow is done, where the fibre blowing cannot be implemented.
- E. Partial Contractor support can only take place when the fibre blowing has been completed, however, no later than 24 months after approved test blowing.
- F. Cable duct system handover control and assistance with fibre blowing shall be supported by Contractor section by section.

6.9 MEASUREMENT AND PAYMENT

6.9.1 MEASUREMENT AND PAYMENT – PRECAST CABLE CHANNEL

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 171. Units of measurement - Precast cable channel

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_25_93_60_14	000701	PRECAST CONCRETE CHANNEL WITH EXTERNAL DIMENSIONS OF 400x275mm	m	Precast cable channel with integrated cover and external dimensions 400x275 mm, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of precast concrete channel with concrete cover, including trench excavation and backfilling, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_25_93_60_14	000702	PRECAST CONCRETE CHANNEL WITH EXTERNAL DIMENSIONS OF 500X270 mm INSTALLED ON STRUCTURES	m	Precast cable channel with top laid cover and external dimensions 500x270 mm, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of precast concrete channel with concrete cover, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement. This unit also includes the 2 cm high C35/45 in-situ concrete layer installed under the cable channel.
Pr_25_93_60_14	000703	PRECAST CONCRETE CHANNEL WITH EXTERNAL DIMENSIONS OF 500X270 mm INSTALLED IN SUB-BALLAST	m	Precast cable channel with top laid cover and external dimensions 500x270 mm, consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of precast concrete channel with concrete cover, including trench excavation and backfilling, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

Uniclass code	Type Number	Work item	Unit	Work item includes
Pr_25_93_60_14	000704	PRECAST CONCRETE CHANNEL WITH EXTERNAL DIMENSIONS OF 800X270 mm INSTALLED ON STRUCTURES	m	Precast cable channel with top laid cover and external dimensions 800x270 mm, consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of precast concrete channel with concrete cover, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement. This unit also includes the 2 cm high C35/45 in-situ concrete layer installed under the cable channel.
Pr_25_93_60_14	000705	PRECAST CONCRETE CHANNEL WITH EXTERNAL DIMENSIONS OF 800X270 mm INSTALLED IN SUB-BALLAST	m	Precast cable channel with top laid cover and external dimensions 800x270 mm, consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of precast concrete channel with concrete cover, including trench excavation and backfilling, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

- C. The length actually executed according to drawings shall be measured.
- D. The unit includes the supply of the channel and cover on site, as well as all the operations for its placement and total finish.

6.9.2 MEASUREMENT AND PAYMENT – CABLE DUCTS

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement are as follows:

Table 172. Units of measurement - Cable ducts

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_70_11_09	000701	CABLE ROUTING OF 3 HDPE PIPES WITH AN EXTERNAL DIAMETER OF 110 mm AND 3 HDPE PIPES WITH AN EXTERNAL DIAMETER OF 49,5 mm AND 7 MICRODUCTS WITH A DIAMETER OF 16/12 mm INSIDE.	m	Cable routing of 3 HDPE pipes with an external diameter of 110 mm and 3 HDPE pipes with an external diameter of 49,5 mm and 7 microducts with a diameter of 16/12 mm inside, consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of these 3 HDPE pipes for cable ducts with 7 microducts inside, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_70_11_09	000702	CABLE ROUTING OF 6 HDPE PIPES WITH AN EXTERNAL DIAMETER OF 110 mm AND 3 HDPE PIPES WITH AN EXTERNAL DIAMETER OF 49,5 mm AND 7 MICRODUCTS WITH A DIAMETER OF 16/12 mm INSIDE.	m	Cable routing of 6 HDPE pipes with an external diameter of 110 mm and 3 HDPE pipes with an external diameter of 49,5 mm and 7 microducts with a diameter of 16/12 mm inside, consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of these 6 HDPE and 3 HDPE pipes for cable ducts with 7 microducts inside, including trench excavation and backfilling, warning tape and signal wire (when installed buried), transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_70_11_09	000707	CABLE ROUTING OF 3 HDPE PIPES WITH AN EXTERNAL DIAMETER OF 49,5 mm AND 7 MICRODUCTS WITH A DIAMETER OF 16/12 mm INSIDE.	m	Cable routing of 3 HDPE pipes with an external diameter of 49,5 mm and 7 microducts with a diameter of 16/12 mm inside, consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of these 3 HDPE pipes with 7 microducts inside, including trench excavation and backfilling, warning tape and signal wire, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_70_11_09	000703	UNDER-TRACK CABLE CROSSING OF 5 HDPE PIPES WITH AN EXTERNAL DIAMETER OF 110 mm.	m	Under-track cable crossing of 5 HDPE pipes with an external diameter of 110 mm, consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of these 5 HDPE pipes for cable ducts, including trench excavation and backfilling, warning tape and signal wire, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_70_11_09	000704	UNDER-TRACK CABLE CROSSING OF 10 HDPE PIPES WITH AN EXTERNAL DIAMETER OF 110 mm	m	Under-track cable crossing of 10 HDPE pipes with an external diameter of 110 mm, consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of these 10 HDPE for cables ducts, including trench excavation and backfilling, warning tape and signal wire, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_65_70_11_09	000705	UNDER-TRACK CABLE CROSSING OF 15 HDPE PIPES WITH AN EXTERNAL DIAMETER OF 110 mm.	m	Under-track cable crossing of 15 HDPE pipes with an external diameter of 110 mm, consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of these 15 HDPE pipes for cables ducts, including trench excavation and backfilling, warning tape and signal wire, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_70_11_09	000706	UNDER-TRACK CABLE CROSSING OF 5 HDPE PIPES WITH AN EXTERNAL DIAMETER OF 75 mm.	m	Under-track cable crossing of 5 HDPE pipes with an external diameter of 75 mm, consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of these 5 HDPE pipes for cable ducts, including warning tape and signal wire, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_70_11_09	000708	UNDER-TRACK CABLE CROSSING OF 5 HDPE PIPES WITH AN EXTERNAL DIAMETER OF 75 mm. CONCRETE EMBEDDED PIPES	m	Under-track cable crossing of 5 HDPE (concrete embedded pipes) with an external diameter of 75 mm, consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of these 5 HDPE (concrete embedded pipes) for cable ducts, including transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

- C. The useful length placed between manholes shall be measured.
- D. The unit includes the excavation up to the lower level of the pipes, the supply and laying of the HDPE cable ducts, the filling of the trench with the excavation product and it's compacting up to the level of the sub-ballast layer, as well as the removal of the surplus land.

6.9.3 MEASUREMENT AND PAYMENT – CABLE SYSTEM MANHOLES

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 173. Units of measurement – Cable system manholes

Uniclass code	Type Number	Uniclass title	Unit	Work item includes
Pr_65_52_01_20	000701	MANHOLE IV PREFABRICATED IN CONCRETE C30/37. EXTERNAL DIMENSIONS 1,1X1,0X1,3 M (LXWXD)	pc	Manhole IV prefabricated in concrete C30/37 with external dimensions of 1,1x1,0x1,3 m (LxWxD), consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of precast concrete manhole for cables, including excavation, fill, filtering material at the bottom, connection with cable ducts routings, PVC drainage pipe, lid and frames, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_01_20	000702	MANHOLE IV 2 PREFABRICATED IN CONCRETE C30/37. EXTERNAL DIMENSIONS 1,1X1,0X1,5 M (LXWXD)	pc	Manhole IV 2 prefabricated in concrete C30/37 with external dimensions of 1,1x1,0x1,5 m (LxWxD), consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of precast concrete manhole for cables, including excavation, fill, filtering material at the bottom, connection with cable ducts routings, PVC drainage pipe, lid and frames, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_01_20	000705	MANHOLE IV 3 PREFABRICATED IN CONCRETE C30/37. EXTERNAL DIMENSIONS 1,1X1,0X0,48 M (LXWXD)	pc	Manhole IV 3 prefabricated in concrete C30/37 with external dimensions of 1,1x1,0x0,48 m (LxWxD), consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of precast concrete manhole for cables and the transition to the concrete channel, including excavation, fill, filtering material at the bottom, connection with cable ducts routings, PVC drainage pipe lid and frames, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_01_20	000706	MANHOLE V PREFABRICATED IN CONCRETE C30/37. EXTERNAL DIMENSIONS 1,60X1,0X1,5 M (LXWXD)	pc	Manhole V prefabricated in concrete C30/37 with external dimensions of 1,60x1,0x1,5 m (LxWxD), consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of precast concrete manhole for cables, including excavation, fill, filtering material at the bottom, connection with cable ducts routings, PVC drainage pipe lid and frames, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

Uniclass code	Type Number	Uniclass title	Unit	Work item includes
Pr_65_52_01_20	000708	MANHOLE V 2 PREFABRICATED IN CONCRETE C30/37. EXTERNAL DIMENSIONS 1,60X1,0X1,9 M (LXWXD)	pc	Manhole V 2 prefabricated in concrete C30/37 with external dimensions of 1,60x1,0x1,9 m (LxWxD), consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of precast concrete manhole for cables and the transition to the concrete channel, including excavation, fill, filtering material at the bottom, connection with cable ducts routings, PVC drainage pipe lid and frames, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_01_20	000709	MANHOLE VII PREFABRICATED IN CONCRETE C30/37. EXTERNAL DIMENSIONS 1,65X1,4X1,5 M (LXWXD)	pc	Manhole VII prefabricated in concrete C30/37 with external dimensions of 1,65x1,4x1,5 m (LxWxD), consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of precast concrete manhole for cables and the transition to the concrete channel, PVC drainage pipe including excavation, fill, filtering material at the bottom, connection with cable ducts routings, lid and frames, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_01_20	000710	PREFABRICATED ELEMENT FOR TRANSITION TO CABLE CHANNELS (TCC-1).	pc	Element for transition to cable channel (TCC-1) prefabricated in reinforced concrete C30/37 with external dimensions of 0,55 x 0,84 x 0,48 m (LxWxD), consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of precast element for transition to cable channel, including excavation, fill, filtering material at the bottom, connection with cable channel and manhole, lid and frames, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_65_52_01_20	000711	PREFABRICATED ELEMENT FOR TRANSITION TO CABLE CHANNELS (TCC-2).	pc	Element for transition to cable channel (TCC-2) prefabricated in reinforced concrete C30/37 with external dimensions of 1,56 x 0,84 x 1,28 m (LxWxD), consists of all works and expenses necessary to achieve the specified end result (excl. material prise and supply), e.g. workforce, auxiliary materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for unloading at supply delivery point, delivery to construction site and installation of precast element for transition to cable channel, including excavation, fill, filtering material at the bottom, connection with cable channel and manhole, lid and frames, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

C. The units actually executed shall be measured.

- D. The unit includes the excavation up to the level of the manhole's support floor, the installation of the prefabricated manhole, including the cover, as well as the filling of the lateral gaps of the excavation, the reception of the cable ducts in their connection to the manhole, and finally, the execution of the bottom drainage, including materials and completion of the work according to Drawings.

7. SECTION 07.- ENVIRONMENT

7.1 SCOPE OF WORKS

- A. The technical specifications related to environmental measures are covered in the General part - Annex Environmental Protection.
- B. Environmental works shall be in accordance with the General part - Annex Environmental Protection, the Contract conditions and this Technical Specifications where required.
- C. As-built BIM models shall be created by the Contractor and/or updated by developing PIM (Project Information Model) models from the Technical Design accompanied with laser scanning/photogrammetry data according to the specified LoG and LoI levels and "RBDG-MAN-040- Digital information requirements for construction and handover stages".

7.2 GENERAL ENVIRONMENTAL REQUIREMENTS

- A. This Section explains the main environmental requirements for the stages which include the setup of the construction site, chosen location and construction works.

7.2.1 SUSTAINABLE CONSTRUCTION APPROACH

- A. The Contractor shall ensure sustainable construction approach and good practice are followed in order to reduce the Project impact on the environment.
- B. Sustainable approach shall include the following steps, but not be limited to:
 - a. Identify the environmental obligations of the project specific section - this step should include a review of national legislation framework, EIA requirements (including actions required within any environmental action plan produced) or other Employer/designer derived assessment.
 - b. Identify the environmental risks (including potential emergencies) particular to the site specifics – this step includes: development of compile an environmental risk register for the site (ie assess the environmental risks); during site induction, alert and train all site personnel to the risks associated with the construction on site; Discuss and agree potential pollution incident management procedure(s).
 - c. Identify environmental responsibilities – this step includes the procedure of defining the environmental responsibilities of all personnel on site, including those who are involved in implementing and monitoring initiatives, also Contractor shall define lines of communication between site personnel, and those responsible for producing the site environmental plan.
 - d. Establish an environmental management plan (EMP) for construction site - information gathered in Steps above can be used to form the basis of the construction site EMP, important to note - a site waste management plan (SWMP) shall be developed as part of the site EMP.
 - e. Monitoring and follow up – this step includes a robust monitoring system which should be implemented to ensure the requirements of the EMP are met, e.g. weekly site environmental checklists, highlighting any issues, and describing actions taken.
 - f. Energy efficiency – this step includes action plan development for reducing energy consumption and waste generation on site. Also usage of renewable and recyclable resources in construction phase where is possible.
 - g. Creating a healthy working environment – all required health and safety standards and national legislation shall be followed during constructions.
 - h. Usage of more environmentally friendly construction equipment – minimal requirements for construction equipment - shall be technically in order and do not exceed noise, vibration limit values. Innovative technologies with more environmentally friendly fuels are priority.

7.2.2 PREPARATION FOR CONSTRUCTION

7.2.2.1 ACCESS TO CONSTRUCTION SITES

- A. The transport of materials shall be organized in the most sustainable way.
- B. Transport routes to the construction sites and traffic within the construction sites shall be planned so as to use the existing road infrastructure as much as possible.
- C. Railway corridor shall also be used to transport the construction materials as far as possible.
- D. All the necessary measures shall be performed timely to ensure road pavement quality or capacity when required.
- E. Construction works shall be ensured in a way that the access to the construction site is organized using existing roads or prepared railway service right of way.
- F. Owners or operators of the relevant traffic infrastructure shall be informed about any traffic infrastructure disturbances during the project development and construction work organization planning, and during the period of construction works.
- G. Temporary solutions shall be provided during construction to ensure accessibility of territories and objects, especially objects with high public significance. Complete closure of the traffic flow on existing road crossings with Rail Baltica line is not permitted, where it is technically possible. Temporary solutions shall be provided until the completion of construction works.

7.2.3 REQUIREMENTS FOR CONSTRUCTION SITE LOCATIONS

- A. Constructional bases shall be located close to the state roads and in areas where deforestation and large site preparation works are not required.
- B. Construction sites shall be kept as compact as possible; driveways and walkways shall not be obstructed.
- C. It is prohibited to install sites for construction materials, excavated soil storage, construction equipment and waste, parking lots in the following locations: within protected areas, natural habitats of EC importance, forest land, coastal protection strips of surface water bodies, in the vicinity of residential areas without a written consent of all owners of those areas.
- D. A temporary site shall be installed in such a way as not to damage the plants growing in the area that are not intended to be removed and not to contaminate the soil, groundwater and the river.
- E. The work shall be organized in stages. As a result, the land area where the herbaceous cover will be removed during the same period, as well as the time between the removal of the herbaceous cover and open surface stabilization, could be reduced.
- F. Before starting the construction work, hazardous areas on the construction site, where risk factors are either constantly present or may occur, shall be identified. Hazardous areas in which hazardous and/or harmful factors are constantly present shall be fenced by protective enclosures in order to prevent persons not authorized to enter such areas from entering.

7.2.4 CONSTRUCTION WORKS PROCESS

7.2.4.1 CONSTRUCTION SITE AND WORKS ORGANIZATION:

- A. Sites for placing construction materials and machinery shall be possibly located outside the protection zones of watercourses and other objects and in the way that residential or public buildings are not affected.
- B. Whenever possible, movement of construction machinery and equipment shall be only within the construction site boundaries. There shall be activities in place to avoid negative impact of those movements on protected habitats. Temporary sites of construction machinery and materials shall be located respecting the areas of specially protected habitats.
- C. Construction works shall be timely approved with the respective local municipality. Whenever possible, construction works, and transportation of construction materials and waste shall be carried according to country specific EIA requirements.

- D. When carrying out earthworks, pits, trenches and other excavations, where there is motor or pedestrian traffic, shall be fenced in accordance with the established requirements.
- E. Such an engineering solution shall be chosen which will not affect the littoral area and banks of a river.
- F. Construction works shall be carried out only outside bird nesting period in RB sections adjacent to Natura 2000 territories, or inside Natura 2000 territories which have been created for nature protection (including bird protection). This requirement shall follow the conditions set by country specific EIA.
- G. Archaeological supervision of construction works shall be ensured where needed.

7.2.4.2 *CONSTRUCTION MATERIALS AND EQUIPMENT STORAGE*

- A. Storage places shall be selected properly, and the surface of storage area shall be coated with preventive oils spillages measures.
- B. It is forbidden to storage construction materials and equipment in protection zones of natural objects and inside nature protection areas.

7.2.5 *CONSTRUCTION SITE CLEANING AND WASTE MANAGEMENT*

- A. The Contractor shall ensure the daily cleaning and collection of material residues, debris and waste throughout the construction period.
- B. The Contractor shall be responsible for removing all debris on the waste containers each day. In addition, the Contractor maintains all areas and rooms free of dust every day.
- C. The dusty material shall be stored in such a way as to avoid dust-blowing by the wind.
- D. Debris shall not accumulate or endanger safety.
- E. The Engineer shall, if necessary, issue instructions to strengthen the maintenance of cleanliness and order on the construction site.
- F. Each subcontractor shall be responsible for ensuring that all working areas are kept free from obstructions, surplus materials and unused equipment which damage visual views, create obstacles and/or endanger the life of all persons who could at all times be in the appropriate places, but in the event of failure to comply with those requirements, the Contractor shall ensure the proper execution
- G. The Contractor shall provide all containers with lid in such quantity as to be not less than one container in the enclosed work area, debris containers and drainage pipes for the deposit of waste, debris and debris shall be included in the organization plan of the layout of the site.
- H. Containers shall be accessible in each territory in sufficient quantity to ensure selective collection of debris:
 - a. Scrap metal (for recycling purposes);
 - b. Glass (for recycling purposes);
 - c. Paper (for recycling purposes);
 - d. Plastic (for recycling purposes);
 - e. Moist biological waste;
 - f. Hazardous waste;
 - g. Other types of packaging.
- I. Cleaning materials for cleaning of structures and equipment shall be used in accordance with the instructions of the manufacturer of the product and as approved by Employer.
- J. The Contractor shall at all times keep clean from waste, debris and other debris in the building area under the responsibility of the Contractor, including indoor, scaffolding, open areas.
- K. The Contractor shall remove debris and debris from the pipelines' trenches, air collectors, places for wires and other closed or remote spaces before access is closed. The Contractor clean the territory and all standing up every day to ensure suitable working conditions.
- L. During the entire construction period, the Contractor shall ensure snow cleaning in all areas of work.

- M. When working outside the area, the Contractor shall make sure that the site is cleaned every 1/2 days and the public area is free of debris.

7.2.5.1 WASTE MANAGEMENT

- A. Waste sites are prohibited to be installed in protected areas, areas of cultural heritage objects, forest land, habitats of European Community importance, in the coastal protection zone of surface water bodies.
- B. The Contractor shall ensure that waste storage places are protected from weather conditions such as snow, wind, rain, etc.
- C. All solvent waste, oily rags and flammable liquids shall be storage in fire resistant covered containers until removed from the construction site.
- D. Priority-wise, the waste management hierarchy shall be adhered to by managing waste in the following order: preventive waste avoidance, preparation for re-use, recycling, other use (e. g. for energy generation), landfilling with a prior separation of suitable waste for recycling or other type of use.
- E. Waste shall be sorted, temporarily stored, stored, collected, transported and treated in such a way as not to negatively affect public health and the environment. The loading of construction waste into vehicles shall be organized in such a way as to protect the construction site and the adjacent area from dust and noise, and the transportation of the waste from the site shall not pollute the environment, the waste shall be transported in covered vehicles or other means which would ensure that the transported waste or its parts do not enter the environment while being transported shall be employed.
- F. All wastes (incl. hazardous waste) shall be sorted and handled according to the Local Legislation and Regulations governing this issue.
- G. The burning of waste or excess material on the construction site is prohibited.
- H. The Contractor shall export all debris, soil and waste from the construction site and dispose of it in its space and in accordance with the requirements of the applicable law.
- I. The Contractor shall harmonize the waste disposal sites with the responsible authorities and pay all disposal costs.
- J. The Employer shall have the right to require and the Contractor shall, within 24 hours of reception of the request, provide proof that all the waste has been transferred to a municipality approved site.
- K. The Contractor shall comply with the rules of the responsible authorities as regards the control and disposal of the debris.
- L. The Contractor shall ensure the authorization, maintenance and operation of an approved collection of waste, surface water drainage and sewage removal system during the term of the agreement, as well as their removal, deodorization, sterilization and overfilling after Required for execution, as instructed by the Employer.
- M. The Contractor shall have an agreement with certified waste management company for managing and transporting the waste. Upon request, the Contractor will have to provide the Engineer and RBR with waste management invoices, which contain information about the type and the amount of waste managed.
- N. Dismantling materials that are suitable for re-use shall be returned to their owner in accordance with the agreement and by signing the return documents.
- O. The cutting materials shall be handled as follows: logs and firewood are sorted according to tree species, assortments, and the cutting residues are transferred to waste managers and / or taken to a green waste composting site, if not stated differently by national legislation of each country where the Works are being performed.

7.2.6 EROSION AND SLUDGE CONTROL

- A. The works shall be planned and carried out with methods to control water discharge from excavations and mound surfaces. Prevent erosion and deposits.
- B. The amount of soil exposed at the same time should be minimized.
- C. Temporary means such as mound and drainage ditches should be provided to prevent water escaping.
- D. The location of the waste container site should be carefully selected.

- E. Earthworks shall be inspected regularly for signs of erosion and tender. Take corrective action immediately.

7.2.7 WATER DISCHARGE CONTROL

- A. Contaminated wastewater shall not be discharged to the environment from the construction sites. Contractor shall define the most suitable local solution for discharge of the wastewater from each construction site. Wherever it is possible, connection to the centralized sewerage system shall be used.
- B. The Contractor shall ensure construction site alignment and all necessary drainage to prevent the accumulation of stagnant water and to remove surface effluent away from the construction pits, trenches, adjacent properties and public traffic until acceptance of the permanent drainage.
- C. Temporary drainage shall be removed after acceptance of works or as instructed by the Engineer.
- D. Maintain the construction pits and trenches free from water. Ensure and operate the pumping equipment with sufficient power to control the flow of water.
- E. Provide a dewatering system to keep the construction pits dry and free from water supply 24 hours a day.
- F. It is necessary to provide the pipelines for draining off water in such a way as to prevent erosion.
- G. Equipment and installations shall be removed when they are no longer needed in accordance with the instructions given by the Engineer.

7.2.8 WATER PROTECTION

- A. The Contractor shall take all precautionary measures to avoid material, equipment, tools, etc.
- B. The Contractor shall not allow the release of petroleum products and other chemicals, and water which is discharged into water bodies shall be free of harmful substances and chemicals.
- C. The prevention of oil and chemical discharges shall be included in the working methods.
- D. The Contractor shall take all precautionary measures to minimize the impact and pollution of the bodies of water.
- E. The Contractor shall be responsible for promptly notifying each and all incidents to the Engineer and the collection of all objects and materials in the water.
- F. All materials in water tanks shall be collected promptly and disposed of appropriately. If the Contractor is unable to collect any of the materials entering the water, the Engineer may instruct the third party to collect these materials, equipment and tools on the host's means. Such measures shall not relieve the Contractor of his obligations under the agreement. The Contractor shall be responsible for all the consequences which may arise from the materials entering the water.
- G. At the beginning of the construction phase it is necessary to install water supply well farmsteads which are located in the immediate vicinity of the Rail Baltica railway right of way and are using individual water supply (using shallow groundwater).

7.2.9 NOISE REDUCTION

- A. The Contractor shall develop Noise Prevention Plan for construction phase, taking into account construction working hours, equipment noise values and that the work is carried out in a city or near residential area.
- B. By Noise Prevention Plan, the Contractor shall take actions to reduce, prevent and monitor noise generated by equipment, trains and machinery during construction.
- C. Where, in accordance with the studies or other provisions of the EIA, design or during the construction works, there is a requirement for noise reduction, the Contractor shall install temporary noise barriers. The Contractor shall pay all the costs relating to the installation of such mitigation measures.
- D. Within the Contractors detailed noise prevention plan to be implemented on site including:
 - a. To follow all necessary requirements of national legislation related to construction works and noise management.
 - b. To follow all requirements of approved EIA, SEA and other studies related to construction and noise management.
 - c. Action plans shall be developed in case of complaints or when exceedances occurred.

- d. Reduction of noise at source by using electric equipment where feasible and procuring quieter models of equipment e.g. super silenced generators or shall noisy equipment shall be located in the soundproof housing.
- e. Attended noise monitoring of new items of equipment arriving on site.
- f. Extensive use of noise blankets at temporary sites and hoarding at longer term sites and at construction compounds.
- g. Comprehensive investigations of complaints and exceedances and a commitment to continual improvement.
- h. Internal reviews and management meetings were held to discuss noise management performance and where improvements could be made.

7.2.9.1 *NOISE PROTECTION MEASURES FOR WORKERS DURING CONSTRUCTION:*

- A. Only technically sound working equipment which complies with the requirements of the national legal acts of occupational safety and health shall be used in the company.
- B. Noise, vibration or other pollution caused by work equipment shall not exceed the limit values laid down in the legal acts.
- C. Construction workers shall be protected from unwanted noise risk for their ears, in accordance with national legislation.
- D. The sound power levels of outdoor equipment used in construction work shall not exceed the levels specified in the Local Legislation and Regulations governing this issue.
- E. For more detailed noise requirements on noise barriers, please refer to Section b NOISE MITIGATION MEASURES in these Technical Specifications.

7.2.10 *VIBRATION*

- A. The Contractor shall develop Vibration Prevention Plan for construction phase, taking into account construction working equipment and that the work may be carried out in a city or near residential area.
- B. The Contractor shall take actions to reduce and prevent vibration generated by equipment, trains and machinery during construction.
- C. Within the Contractor's detailed Vibration Prevention Plan to be implemented on site it shall be included:
 - a. To follow all necessary requirements of national legislation related to construction works and vibration management.
 - b. To follow all requirements of approved EIA, SEA and other studies related to construction.
 - c. Action plans shall be developed in case of complaints or when exceedances occurred.
 - d. Comprehensive investigations of complaints and exceedances and a commitment to continual improvement.
 - e. Internal reviews and management meetings shall be held to discuss vibration management performance and where improvements could be made.
- D. Vibration protection measures for workers during construction shall be the following:
 - a. Only technically vibration working equipment which complies with the requirements of the national legal acts of occupational safety and health shall be used in the company.
 - b. Vibration, noise or other pollution caused by work equipment shall not exceed the limit values laid down in the legal acts.
 - c. The vibration levels shall not exceed the levels specified in the National Legislation.

7.2.11 *DUST CONTROL*

- A. The Contractor shall carry out works with methods that do not cause dust concentration above the regulatory level.

- B. Work shall be carried out in such a way as to avoid air dispersing of dust into the air. This shall be achieved by:
 - a. Retaining existing vegetation where possible.
 - b. Stripping areas progressively and only where it is necessary for works to occur.
 - c. Employing stabilization methods such as matting, grassing or mulch.
 - d. Dampening the ground with a water spray.
 - e. Covering stockpiles and locating them where they are protected from the wind.
 - f. Restricting vehicle movements.
 - g. Covering the load when transporting material and constructing wind breaks such as wind fences.
- C. When an area of works is completed, the area shall be revegetated immediately to inhibit the generation of dust.

7.2.12 SOIL MANAGEMENT

- A. The Contractor shall remove the fertile soil layer before starting earthworks and with a prior selection of the storage location.
- B. The Contractor shall prepare storage places for construction materials and waste.
- C. The Contractor shall not to use heavy machinery in wet soil conditions in the places where the fertile soil layer has not yet been removed. This could lead to the reduction of soil ability to absorb wastewater.
- D. The Contractor shall minimize the area with open soil during constructions. The quantity of simultaneously maintained non-stabilized areas will be as little as possible.
- E. In order to protect the slopes from erosion and washing off, protective geotextile coverings or temporary seeding shall be used for surface stabilization (temporary slope stabilization measures shall be used when open slopes are planned to be kept for a month or more).
- F. The excavated ground shall be used as much as possible to rebuild the earth surface layer. Soil quality control shall be ensured in areas crossing or near contaminated or potentially contaminated sites. Solutions for use/store of the unused soil shall be developed by the Contractor.
- G. Construction works (including building or rebuilding the necessary utility network and communication lines) shall be planned in the proper manner to avoid extra excavation works after the end of construction works.

7.2.13 VEGETATION MITIGATION MEASURES

- A. Plants that are not planned to be removed (and that may be saved) will be saved during construction works.
- B. The plants that are not planned to be removed will be protected during construction, the protection of plants during construction works is carried out in accordance with the requirements established by Local Legislations and Regulations in force and this Technical Specification.
- C. During construction works, in order to preserve plants left on the construction site and growing in adjacent land plots, the following is mandatory:
 - a. to hoe and fertilize the soil under the tree and shrub crowns that grow on the construction site before the start of construction in order to improve their growing conditions during the construction period;
 - b. to fence trees and shrubs that grow on the construction site and that are located less than 5m from the edge of the carriageway of the entrance or exit of the construction site;
 - c. groups of trees and shrubs – by a continuous at least 2-m-high enclosure not closer than 1.5m from tree trunks and 1m from shrubs; single trees – by a triangular enclosure, whose lower edges shall not be closer than 0.5m from the trunk of the tree, or by boards. to fixate the enclosure with poles driven 0.5m and deeper;
 - d. not to enclose plants that are outside the construction site, when enclosing the entire site;
 - e. to install paths raised above the ground at the distance of at least 1.5m from the tree trunk, when walking close to plants is required during work (under tree crowns);
 - f. to protect lawns and flower beds, unless their reorganization is anticipated in the structure design; to store the soil removed from the part of the land plot that is to be built on in the places designated for that purpose, protecting it from contamination, washing out, wind blowing so as it can be used for landscaping and planting works on the land plot;

- g. to water plants in accordance with the procedure established in the Regulations for Tree and Shrub Care, Protection of Water Bodies Located in Green Plantations, Lawn and Flower Bed Care approved by the order no. D1-45 issued on 18 January 2008 by the Minister of the Environment;
- h. not to store materials and equipment, do not drive, do not park vehicles, do not build temporary structures and equipment less than 1m from projected tree crowns and less than 3m from the trunk and 2m from shrubs. Do not store flammable materials less than 10 metres from tree trunks and shrubs;
- i. not to excavate trenches (for the installation of cable, water supply and sewage pipes and other equipment) less than 3m from a tree trunk with a diameter of more than 15cm, less than 2m from a trunk with a diameter of up to 15cm and less than 1.5m from shrubs, estimating the distance from the far-put trunk;
- j. to fixate the fencing of trenches dug in loose and wet soil at the permitted distance (provided in clause 7.9) to trees and bushes with struts;
- k. to fill the trenches excavated in compliance with the design in the shortest time, but not longer than a month;
- l. to perform works in the undergrowth area of a tree (the projected crown area) below the main skeletal roots (at least 1.5m from the soil surface) without damaging the root system;
- m. not to change the natural soil level by more than 5 cm (either making it higher or lower) in the vicinity of a root collar of the tree and at the distance of up to 2 m to the tree trunk. In case of damage to the root system of a tree during construction works (including the installation or repair of driveways and roads), in order to prevent the roots from drying out, a layer of soil shall be used to cover them or to be poured on top of them, the tree shall be watered to prevent the roots from freezing, they shall be insulated. In case of damage to tree roots, the tree crown may be thinned in accordance with the Regulations for Tree and Shrub Care, Protection of Water Bodies Located in Green Plantations, Lawn and Flower Bed Care.

7.2.14 FAUNA PROTECTION

- D. Construction works shall be carried out according to the approved EIA, SEA and Local Legislations and Regulations in force. In case of not foreseen impact to the protected species – additional mitigation measures shall be adopted immediately.
- E. General requirements are following:
 - a. Environmental monitoring shall be carried out during the construction and operation.
 - b. The Contractor is obliged to have 1 (one) specialist with a degree in ecology, environmental science or biology participate in during the installation of construction sites near protected territories.
 - c. Monitoring of protected species shall be carried out during entire construction phase.

7.2.15 POLLUTION CONTROL

- A. To safely collect oils (lubricants) from mechanisms in order to avoid the contamination of the surface water and soil. To anticipate measures for accidental spillage of the oil (from mechanisms) and fuel. During the construction, oil absorbing material shall be kept (sawdust, sand, sorbents), special containers for the oil collection.
- B. In the case of the accident, the activities shall be planned and implemented immediately to maximally contain the spillage in the environment, including inflow into the underground waters, irrigation drainage channels and surface waters. In an even of a pollution spillage detection, the Contractor shall immediately inform the Contracting Authorities' project contact person for agreeing on further actions.
- C. Such solutions and methods shall be chosen which will not cause the pollution of groundwater horizons. In areas where groundwater needs to be extracted (deep excavations), groundwater volume quantifications shall be completed, and the most appropriate water drainage solutions shall be justified within the technical design. Drainage shall not affect watercourse water quality and hydrological regime. Where necessary, extracted water shall be settled as well as pollution control of the water shall be ensured in contaminated areas.
- D. The Contractor shall provide methods, tools and equipment to prevent pollution of the soil, water and air from the discharges of poisonous, toxic substances and contaminants which are caused by the Works.
- E. The transportation of mechanisms, raw and other materials by heavy transport to the construction site and the removal of waste from the construction site shall be organized and performed without polluting the environment and without exceeding the noise and air pollution norms regarding residents living in the vicinity through whose residential environment the transportation is planned. The transportation routes shall be selected as far away

from residential environments as possible. If an exceeded pollution (especially particulate matter and noise) during the transportation is predicted, temporary protective measures (e. g. noise barriers, irrigation of gravel cover, etc.) shall be employed.

7.2.16 CONSTRUCTION MACHINERY

- A. Movement of heavy construction machinery and equipment shall be avoided in moist forest or grassland areas, where such movement affects micro-relief and the content of vegetation.
- B. Construction machinery shall be well maintained during entire construction phase.

7.2.17 COMPLETION OF CONSTRUCTION WORKS

- A. After the construction works are finalized relevant recultivation measures shall be taken to ensure that the area impacted by the construction process is restored to the condition, which is not worse than it was before the construction started.
- B. soil layer from the same areas shall be used for the recultivation.
- C. Please see more detailed requirements in Section 7.4 LANDSCAPING of this document.

7.2.18 MONITORING OF CONSTRUCTION WORKS

- A. Regular monitoring of air and water and taking of noise measurements is required to determine whether standards, established by the Environmental Management Plan, are being complied with. This shall commence before construction to provide a baseline against which data collected during construction can be compared.
- B. Construction works (starting with construction site cleaning) shall be monitored according national legislation and SEA, EIA and Employer provided requirements.
- C. Monitoring shall provide information on whether standards are being complied with and sensitive sections of the environment protected.
- D. Minimum monitoring requirements relating only to the direct impact of activities in construction site stated in the table below.

Table 174. Environment - Monitoring of construction works

Area of risk	Monitoring activity	Remedial action
Noise	Monitor noise continuously at a representative residence near construction activities according EU, national legislation, EIA, SEA requirements and best practice for construction sites;	Review and enhance noise control measures
Air quality (dusts)	Daily during dry weather for dust deposits at locations that indicate impact on adjacent residents or at site boundary. Monitoring according EU, national legislation, EIA, SEA requirements and best practice for construction sites;	Improve controls on dust emissions
Waste and wastewater management	Monitoring according EU, national legislation, EIA, SEA requirements and best practice for construction sites;	Revise and improve
Energy efficiency	Monitoring according EU, national legislation, EIA, SEA requirements and best practice for construction sites;	Revise and improve
Water management	Monitoring according national legislation, EIA, SEA requirements and best practice for construction sites;	Revise and improve
Interface with External Environment: visual pollution, sensitive territories, protected species	Monitoring according EU, national legislation, EIA, SEA requirements and best practice for construction sites;	Revise and improve
Intrinsic Quality of the Construction Site: Health and Safety Temporary Installations	N/A	Revise and improve

7.3 ESCAPE SYSTEMS FOR ANIMALS

7.3.1 ESCAPE RAMPS

7.3.1.1 DEFINITION

- A. This animal escape device is formed by ground ramps next to the railway fence to allow the animals to get out from inside the railway boundaries.
- B. Animal escape ramp device consists of three slopes leading to a rectangular summit fenceless from which animals may jump outside the railway boundaries. These ramps shall follow the characteristics described below.
- C. The execution of the work item includes the following operations:
 - a. Preparation of the working area.
 - b. Setting out the escape ramp location.
 - c. Supply and transport to the worksite of soil, retaining wall elements, posts, wire mesh and all the necessary accessory elements.
 - d. Excavation of the base of the ramps and wall.
 - e. Ramps construction.
 - f. Reinforcement and formwork placement for the walls, concreting and removal of formwork.
 - g. Positioning of the fence poles, concreting of the foundations and placing and bracing of the wire mesh.

7.3.1.2 GENERAL CONDITIONS

- A. The setting out of the escape devices shall be carried out in accordance with the Technical Design Drawings definition.
- B. The ramps shall be placed in a pocket in the fence to not encroach the free circulation strip inside the fence under no circumstances.
- C. The retaining walls of the escape ramps are divided into single blocks of two metres width (2m) which connect between each other forming a continuous wall.
- D. Retaining wall shall be made of reinforced concrete and must be half buried in the ground.
- E. The shape solutions and dimensions of the mesh shall be as defined for general railway fencing and any modification shall be previously approved by the Engineer.
- F. The upper surface of slopes shall be covered by recommended soil and sown with grass as per details. The backfill of the ramps shall be made of a drainage soil to guarantee the proper water evacuation.
- G. The substrate where animals land after jumping is a critical consideration in the effectiveness of the structure. Landing pad should be relatively flat and surfaced with material such as sand, soil, or similar substrate. Rock, cobble, and other hard surfaces should be avoided. However, the landing area itself has to be kept clear of excessive vegetation.

7.3.1.3 EXECUTION CONDITIONS

- A. The escape devices will be placed in accordance with the Technical Design Drawings or, if required, according to the instructions given by the Engineer.
- B. Before constructing the ramps and the corresponding fence, the ground shall be cleaned of shrubs, stones and any element that obstruct the placement of the escape devices and the mesh.
- C. The base of the ramps shall be excavated fifteen centimetres (15cm) and compacted to generate a proper foundation. Under the retaining walls a layer of at least fifteen centimetres (15cm) of compacted gravel shall be prepared and, over it, the retaining walls of the escape ramps shall be driven in the ground at least one hundred and fifty centimetres (150cm).
- D. The construction of the fence shall follow all the specifications described for the general railway fencing.

- E. Any excavation required shall be performed in accordance with Section 02 – EARTHWORKS in these Technical Specifications.
- F. The products from excavations shall be spread regularly, either "in situ" or in the landfills which the Contractor has agreed under his own responsibility.
- G. In any case, areas where accidental spill has occurred shall be treated in such a way that their final appearance is integrated into the environment.
- H. The Contractor shall always follow the instructions on landfills contained in the Technical Design.
- I. Concrete related works shall be performed in accordance with Section 05 – STRUCTURES in these Technical Specifications.

7.3.1.4 EXECUTION CONTROL

- A. At least, the following parameters shall be controlled:
 - a. Topographic check of the escape device location.
 - b. Visual inspection of the general condition of the ramps and the fence.
 - c. Compaction and stability check of the ramps by means of specific tests, subjected to approval by Works Management.
- B. All materials shall be related to valid quality certificates.

7.3.2 ESCAPE GATES FOR ANIMALS

7.3.2.1 GENERAL REQUIREMENTS

- A. In places where wild animals may enter the carriageway one-way escape gates for animals shall be provided, with screwed ends and a circular rear part.
- B. The setting out of the escape gates will be carried out in accordance with the Drawings definition.

7.3.2.2 DIMENSIONS AND MATERIALS

- A. Gate frame and its steel elements shall be covered with anti-corrosion materials using hot-dip galvanizing. All structural door profiles shall be made of steel S235J0.
- B. The concrete to be used in the foundations of the posts will be at least C20/25. The manufacture, transport, placement and control of the concrete will follow the requirements of Section 05. STRUCTURES in this Technical Specifications and Eurocode 2 Standard; additives that may promote corrosion shall not be used.
- C. The transportation of the frames shall be done by any proper mean to ensure that the struts are protected from free movement.
- D. All exposed metal conductive parts of the one-way gates shall be grounded following Section 10. EARTHING AND BONDING SYSTEM of this Technical Specifications.

7.3.2.3 EXECUTION CONDITIONS AND CONTROL

- A. The pole shall be placed in a pit filled with C20/25 class concrete. Escape gates shall be operated only after 7 days from the day of their installation on the concrete base.
- B. The straightness of the frame position shall be checked with a level.
- C. Any excavation required shall be performed in accordance with Section 02 – EARTHWORKS in these Technical Specifications.
- D. The products from excavations shall be spread regularly, either "in situ" or in the landfills which the Contractor has agreed under his own responsibility.

- E. In any case, areas where accidental spill has occurred shall be treated in such a way that their final appearance is integrated into the environment.
- F. The Contractor shall always follow the instructions on landfills contained in the Technical Design.
- G. Concrete related works shall be performed in accordance with Section 05 – STRUCTURES in these Technical Specifications.

7.3.3 MEASUREMENT AND PAYMENT – ESCAPE SYSTEMS FOR ANIMALS

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 175. Units of measurement - Escape systems for animals

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_45_70_05	000818	ANIMAL ESCAPE DEVICE FORMED BY TWO GROUND RAMPS ATTACHED TO THE INSIDE MARGIN OF THE RAILWAY FENCE	pc	Animal escape device formed by two ground ramps attached to the inside margin of the railway fence consists of all works and expenses necessary to achieve the end result as per technical specification and drawings, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for devices formed by two ground ramps attached to the railway fence to allow the animals exit the railway boundaries. Including excavation, fillings, wooden fence, steel bars, grass covering, plastic strip with reflective function and all the operations and materials necessary for its completion.
Ss_45_70_05	000815	ANIMAL ESCAPE DEVICE FORMED BY ONE GROUND RAMP ATTACHED TO THE INSIDE MARGIN OF THE RAILWAY FENCE	pc	Animal escape device formed by one ground ramp attached to the inside margin of the railway fence consists of all works and expenses necessary to achieve the end result as per technical specification and drawings, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for devices formed by one ground ramp attached to the railway fence to allow the animals exit the railway boundaries. Including excavation, fillings, wooden fence, steel bars, grass covering, plastic strip with reflective function and all the operations and materials necessary for its completion.

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_45_70_05	000802	OPAQUE GUIDANCE WALL	m	Opaque guidance wall consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of a steel piece, hot dip galvanized steel sheet, thickness 1,5 mm, with a minimum height above the ground of 40 cm and buried in the ground 20cm, that will be placed at the external face of the fence. Including necessary material, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Ss_45_70_05	000803	AMPHIBIAN GUIDANCE CONCRETE WALL	m	Amphibian guidance concrete wall consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of a precast concrete wall, type section "C", with a minimum height above the ground of 40 cm. Including trench excavation, sand bed, gravel fill, soil fill, precast concrete element, joints, anchor, reinforcement, levelling, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Ss_45_70_05	000804	FALLING DOWN ELEMENT FOR AMPHIBIAN GUIDANCE, MADE WITH CONCRETE	m	Falling down element for amphibian guidance, made with concrete consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of precast concrete channel with metal grid on top, including trench excavation, concrete base, sand bed, sand filling, soil filling, precast concrete element, joints, anchor, reinforcement, transport, levelling, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Ss_45_70_05	000805	FALLING DOWN ELEMENT FOR AMPHIBIAN GUIDANCE, MADE WITH STRUCTURAL STEEL	m	Falling down element for amphibian guidance, made with structural steel consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of channel made with structural steel profiles, including trench excavation, sand bed, sand filling, soil filling, welding joints, anchor, transport, levelling, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_45_70_05	000807	CATENARY SIGNALING SPIRALS FOR BIRDS.	pc	Catenary signalling spirals for birds consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of sign spirals at the railway catenary to prevent bird crashes increasing the visibility of the line. Including all the operations necessary for its complete finished.
Ss_45_70_05	000808	BIRD FENCING SIGN PLATES.	pc	Bird fencing sign plates consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of sign plates at the railway fence to prevent bird crashes. Plates of rigid plastic and white colour, 30 x 15 cm, to be installed in the own mesh of the fencing, from 1 metre in height, in two alternative rows, locating two of the plates in a lower row and three plates in another upper row. Including all the operations necessary for its complete finished.
Ss_45_70_05	000809	ANIMAL ESCAPE DEVICE FORMED BY ONE WAY DOORS.	pc	Animal escape device formed by one way doors consists of all works and expenses necessary to achieve the end result as per technical specification and drawings, e.g. workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for devices formed by wooden poles and frame, steel nuts, bolts, springs, bars and steel balls at the end of the steel bars, attached railway fence to allow the animals to get out from inside the railway boundaries. Including foundations with rectangular metal tube, excavation, fills, concrete and materials necessary for its complete finished.

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_45_70_05	000810	ANIMAL ESCAPE DEVICE CONSISTING OF GROUND RAMPS ATTACHED TO THE RAILWAY FENCE INNER SIDE AND A RETAINING WALL	pc	Animal escape device formed by ground ramps attached to the inside margin of the railway fence consists of all works and expenses necessary to achieve the end result as per technical specification and drawings, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for devices formed by ground ramps attached to the railway fence to allow the animals exit the railway boundaries. Including excavation, fills, concrete walls, steel fence, steel bars, grass covering, and all the operations and materials necessary for its completion.
Ss_45_70_05	000811	ANIMAL ESCAPE DEVICE FORMED BY ESCAPE GATES	pc	Animal escape device formed by one-way escape gates consists of all works and expenses necessary to achieve the end result as per technical specification and drawings, e.g. workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for devices formed by steel frame, steel nuts, bolts, springs, pipes and steel balls at the end of the steel pipes, attached to the railway fence to allow the animals to leave the railway boundaries. Including foundations with rectangular metal profile, excavation, fills, concrete and materials necessary for its completion.
Ss_45_70_05	000812	ANIMAL ESCAPE DEVICE CONSISTING OF GROUND RAMPS ATTACHED TO THE RAILWAY FENCE INNER SIDE AND A RETAINING WALL. SENSITIVE AREA	pc	Animal escape device formed by ground ramps attached to the inside margin of the railway fence in sensitive areas consists of all works and expenses necessary to achieve the end result as per technical specification and drawings, e.g. volume/quantity, compaction degree/density, geometrical properties, etc. and workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for devices formed by ground ramps attached to the railway fence to allow the animals exit the railway boundaries. Including excavation, fills, concrete walls, steel fence, steel bars, grass covering, and all the operations and materials necessary for its completion.

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_45_70_05	000813	ANIMAL ESCAPE DEVICE FORMED BY ESCAPE GATES. SENSITIVE AREA	pc	Animal escape device formed by one-way escape gates in sensitive areas consists of all works and expenses necessary to achieve the end result as per technical specification and drawings, e.g. workforce, equipment, applicable fees (permissions, taxes, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for devices formed by steel frame, steel nuts, bolts, springs, pipes and steel balls at the end of the steel pipes, attached to the railway fence to allow the animals to leave the railway boundaries. Including foundations with rectangular metal profile, excavation, fills, concrete and materials necessary for its completion.
Pr_20_65_60_89	000301	ANIMAL PROTECTION PANELS OF WOOD POLYMER COMPOSITE	Metre (m)	Animal protection with two panels of wood polymer composite consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of two panels of wood polymer composite with a thickness of 20 mm placed on a steel railing by means of a steel plate support welded to the vertical posts of the railing.

- C. The escape device will be measured by actually executed unit (pc).
- D. Unit of measurement includes all works and expenses necessary to achieve the specified result, e.g. workforce, materials (wooden fence, mesh wire, steel bars, grass covering, plastic strip with reflective function, fills, etc.), equipment, applicable fees (permissions, taxes, etc.) transportation (including fuel, insurance, etc.) and complete installation (including transportation through worksite, excavation, assembly, compaction degree and density testing, etc.) and all the operations and materials necessary for its completion.

7.4 LANDSCAPING

7.4.1 GENERAL CONSTRUCTION REQUIREMENTS

7.4.1.1 REMOVAL OF SOIL, GREEN PLANTATIONS AND WASTE

- A. Grass, vegetation and debris shall be removed from the construction site so that they do not enter the soil of the earth bed or trough and then begin to rot. The grass shall be cut, raked together and removed. Shrubs and trees shall be removed along with stumps. The soil shall be removed completely, throughout the work area, within the limits specified in the work quantities. The removed soil shall be stored in designated areas and then used for re-cultivation of the damaged earth at the end of construction works. The extent of soil, vegetation and debris removal shall be specified in the Technical Design.
- B. Forest cutting, tree cutting, cleaning the territory from shrubs and stumps includes all necessary works, materials or equipment which shall be used or delivered in order to prepare the construction site for construction works.
- C. Equipment for execution of those works shall be selected by the Contractor in order to secure high quality of the works. Equipment shall meet environmental requirements of this Technical specification.
- D. The materials to be disposed shall be stored in a place agreed with the Customer or handed over for recycling. The branches, chips and shavings of pruned off trees shall be taken to the regional green waste composting sites of the waste management point.

E. TREE CUTTING:

- a. Before felling the trees, the boundaries of the wood cutting area shall be clearly marked, which the employees working there shall know.
- b. Warning signs for work safety shall be erected on roads and paths, at a distance of 50-100m from the wood cutting area.
- c. Dangerous trees, hanging branches and tops shall be removed from places intended for the rest of employees, storage of equipment, and loading sites within a radius of at least the height of two trees.
- d. It is forbidden to work at the wood lot in case of heavy rain or snow, thunderstorms, thick fog, smoke, dusk, when visibility is poor, and on slopes - even in the presence of black frost.
- e. It is also forbidden to cut trees in case of strong winds that may affect the direction of tree tumble, cause their early tumble or split.
- f. In a tree cutting area within a radius of at least twice the height of the trees to be felled, first dangerous trees are removed, then those whose direction of lowering coincides with the main direction of lowering, and last shall be cut those whose direction of the lowering coincides with the main direction of lowering.
- g. The main direction of the lowering of trees is determined by the supervisor of hazardous works. The direction of the lowering of trees should be clear-cutting - to the felled area, not clear-cutting - to the gaps of growing trees.
- h. On the slopes, trees are started to be cut at the bottom of the slope and then going upwards. Trees shall be lowered towards the bottom of the slope. The trees are allowed to be lowered across the slope only if it is ensured that they do not slip down. Lowering of trees towards the top of the slope is only allowed in special cases (power and communication lines, ditches, etc.) provided that their stability on the slope is ensured and special cautions are taken.
- i. The glade and undergrowth are first felled around the tree to be cut, the lower branches are pruned off, the snow is cleared and anything that may interfere with this work is removed. In the event of icing, the ice cover around the tree to be cut is crushed. Broken and hanging branches, as well as tops of adjacent trees to be cut, are also removed. When broken and hanging branches and tops cannot be removed, the tree may only be cut only after being absolutely certain that they will not fall and this shall be done under the immediate lead of the supervisor of hazardous works.
- j. When starting to cut a tree, the cutter shall inspect it, assess the condition, shape of the crown, inclination, the influence of adjacent trees and other factors that affect the felling of the tree, and anticipate the direction of the lowering. The direction of the lowering shall be as close as possible to the main direction of the lowering of trees. Particular care should be taken to ensure that the felled tree does not get stuck in others when tumbling. When pruning rotten and dry trees, check that they are stable with a turning fork (barling).
- k. In order to be able to move away from the cut tree as it falls, the retreat paths shall be cleared. There shall be two retreat paths when working in pairs. The direction of the retreat paths shall be at an angle of 45 degrees from the opposite direction of the tree, with a length of not less than 4m, when cutting trees up to 14cm thick at a height of 1.3m - not less than 2m.
- l. Only the workers cutting the tree are allowed to be in the danger area.
- m. In case of necessity, when training of workers by means of demonstrating equipment, controlling work, examining, analysing work methods, other persons may be present. In this case, everyone has to be instructed, retreat paths shall be prepared, a senior person whose instructions shall be followed shall be appointed.
- n. The danger area around the tree to be felled shall be within a radius of twice the height of the tree to be cut, but not less than 10m. On slopes steeper more than 15 degrees, the danger zone is up to the foot of the slope. The dangerous zone of the trapped tree is the side of the circle in the skew direction of the trapped tree and 5 m in the opposite direction.
- o. When the wood cutting area is crossed by two cutters, the distance between them shall be at least the height of 2.5metres the trees to be cut.
- p. It is forbidden to remove trees hanging on power and communication lines without the permission of the services operating those lines.

- q. When other wood preparation works are carried out on slopes, except for felling the trees, there shall be a minimum distance of 30 m between workers across the slope. It is forbidden to work one after the other along the slope if the wood may slip down or roll away.
- r. Trees can be cut by one person and in pairs. When working in pairs, it is necessary to agree in advance who and what operations will perform, to establish the concerted signs for mutual communication.
- s. When lowering trees, tumbling tools shall be used: tumbling levers, wedges, tumbling forks, tumbling pads, etc.
- t. Before cutting the tree, the cutter shall make sure that there are no bystanders in the danger zone. When cutting a tree, the cutter and his assistant shall be at the tree to be cut.
- u. Only a tree cutter is allowed to enter or drive into the danger area. When working, the cutter shall watch that there are no people in the danger zone.
- v. Thickening of the part of the tree near roots can be pruned by starting to cut the tree and felling it. However, in order not to reduce work safety and maintain the desired direction of the lowering, these thickenings cannot be removed from decaying trees before felling. Therefore, pruning is only necessary after making a notch and making sure that the tree is not rotten. When crossing the thickening of the part of the tree near roots, the first cut is made vertically.
- w. For trees thicker than 14 cm at a height of 1.3 m, a notch is made when starting the main cut. It is cut from the side to which the tree is being lowered and as low as possible. Depth of the notch shall be $1/5 - 1/3$ of the diameter of the tree at the cut, depending on the shape of the stem at that place. The notch begins with an oblique cut, proceeding to cut below horizontally to the intersection with the oblique cut. The angle between the two cuts shall be at least 45° . It is allowed to make a notch by two oblique cuts.
- x. The main cut is made perpendicular to the axis of the tree trunk at the level of the intersection of the cuts or up to 5 cm above it. For trees up to 35 cm thick at the cut, an obstruction of at least $1/10$ of the thickness of the cut tree shall be left at the cut when performing the main cut. For trees thicker than 35 cm, the obstruction can be thinner than $1/10$ of the thickness of the cut of the tree to be cut, but not thinner than 3.5 cm. For trees with rot in the stump part, 2 cm thicker obstruction shall be left.
- y. For trees inclined to the side from the direction of the lowering, the wedge-shaped obstruction shall be left so that its thinner end is directed toward the inclination of the tree.
- z. When making the main cut, the turning lever or wedges shall be inserted in time to prevent the cutting belt from being compressed. After cutting to the obstruction, the tree is overturned by lifting the end of the lever upwards, hammering wedges or by other means.
- aa. For trees thicker than twice the length of the saw blade at the cut, it is allowed to cut the middle of the obstruction to half its length with by means of the puncture-type cut before making the main cut. The puncture-type cut starts with the bottom part of the end of the saw blade. The middle of the obstruction is also cut for thick trees, tending to split up as well.
- bb. Before starting to cut the tree, the auxiliary tools are placed in a place within the reach of hand. When placing the saw aside after making the cut, make sure that the saw chain points backwards and the handles towards the tree to be cut.
- cc. When the tree starts falling down, the cutters shall immediately retreat via the pre-prepared paths for at least 4 m. When cutting trees up to 14 cm thick at a height of 1.3, the retreat distance may be shorter, but not less than 2 m. When retreating, workers shall watch the tree falling down.
- dd. Return to the stump is possible only after the tree has completely fallen down, the tops of the adjacent trees have stopped swinging and after making sure that there are no other dangers, such as hanging branches.
- ee. It is forbidden to knock down the tree unfinished to be cut with another lowering tree.
- ff. At wood cutting areas, workers' clothing shall have signalling attributes in orange or yellow colour.
- gg. For tree felling and other hazardous wood preparation (logging) operations, the cutting of standing, broken and overturned trees, including their lowering to the ground and opening of the clod of the overturned tree roots, and when the wood cutting area contains 20 percent or more broken or overturned trees (counting from the total volume of the volume of trees being felled at that wood cutting area) and pruning branches, sawing of stems at the wood cutting area and extraction of wood, shall be supervised by a trained and

certified supervisor of hazardous works possessing a relevant certificate. He is responsible for the occupational safety at the workplace.

- hh. At the beginning of the felling, the supervisor of hazardous works shall inspect the wood cutting area, erect warning and prohibition signs, determine the locations of intermediate warehouses and rest houses, hauling, the main direction of tree lowering, acquaint employees with the organization of works, inform them about possible dangers at that wood cutting area. When the wood cutting area changes, the tree cutter is responsible for moving the warning signs.
 - ii. The supervisor of hazardous works shall ensure that everyone observes the occupational safety requirements and, if necessary, instruct them on-site on how to carry out the works safely.
 - jj. Shrubs, undergrowth, branches, stumps and roots shall be burned, chipped or placed in a landfill, and useful wood shall be taken to the designated place. Ash or wood chips shall be spread or removed.
 - kk. The height of the stumps from the ground surface shall not exceed 1/3 of the stump diameter (if it is not intended to extract the stump) but not higher than 20 cm. If no further excavation of soil in that area is planned, the areas of the extracted stumps should be filled with soil.
 - ll. Shrubs and lower branches should be removed before sawing a single tree.
 - mm. Sawing wood in difficult conditions is done in parts starting from the top using a hoist. If parts of the falling wood can endanger nearby buildings or above-ground utilities, each piece of wood to be cut shall be lifted separately by a mobile crane.
- F. CUTTING OF THIN TREES AND SHRUBS:
- a. Trees up to 8 cm thick at a height of 1.3 m can be cut in one horizontal or sloping cut. When a sloping cut is performed, the inclination shall go in the direction opposite to the lowering of the trees.
 - b. Trees from 9 to 14 cm thick at a height of 1.3 m are cut after making a notch or sloping cut on the side of the lowering. The main cut is made on the opposite side, above or at the level of the notch or the cut.
 - c. Trees up to 14 cm thick at a height of 1.3 m can be lowered without any additional tumbling tools.
 - d. When working with a brush cutter, there may be one person at the wood cutting area.
 - e. When carrying the brush cutter with the engine running, it shall be attached to the belt.
- G. When working with a brush cutter, it is forbidden to:
- a. Cut trees and shrubs without seeing the cutting element of the brush cutter.
 - b. Move from one tree to another with cutting element rotating (moving).
 - c. Clean the cutting element while the engine is running.
 - d. Bend trees and shrubs creating high bending stress.
 - e. Start cutting in very dense places (start from a rarer place).
 - f. Work with a brush cutter with the protective cover removed when fuel leaks.
- H. If shrubs are cut with the tractor it shall be a wheeled tractor with mounted shrub cutter and range of the work for the equipment shall be ≥ 1.2 m. The mower shall meet the following requirements:
- a. be able to cut shoots 10-20 cm above the ground;
 - b. be powerful enough to mow shrubs with a diameter ≤ 5 cm.
- I. Chipping of branches, shrubs and shoots:
- a. Chipping of branches, bushes and shoots is intended to clean up the construction area.
 - b. Chipping shrubs and shoots includes collecting branches, shrubs and shoots, shredding branches, shrubs and shoots, spreading or removing chips.
 - c. The chipper shall be able to process branches, shrubs and shoots with a diameter ≤ 12 cm.
 - d. Cut and shredded shoots, branches and shrubs ≤ 12 cm in diameter shall be collected and chipped.
 - e. The wood chips obtained shall be removed to the designated area or the wood chips may be evenly distributed in the right of way, if agreed so.

7.4.1.2 PROTECTION AND PLANTING OF GREEN PLANTATIONS

A. PROTECTION OF GREEN PLANTATIONS:

- a. Green plantations that are not intended for removal (and which can be preserved) during the construction works shall be preserved.
- b. The green plantations not planned to be removed during the construction shall be protected during the construction, the protection of the green plantations during the construction works shall be carried out.
- c. In forested areas anti-fire lanes shall be created, if needed.

B. PLANTING:

- a. Trees and shrubs should be planted when the area is fully prepared and levelled to design heights. Preparation for planting (i.e. pits, vegetable land with mineral fertilizers) shall be performed no earlier than a month prior.
- b. Plants shall be with a healthy, well-developed root system and above-ground part.

C. LAWNS:

- a. Before starting greening works, the area or slopes shall be levelled and tamped, if necessary.
- b. All the stones larger than 10cm in diameter, bush roots, as well as other objects shall be removed at the end of the work.

7.4.1.3 MAINTENANCE OF THE GREEN PLANTATIONS

- A. Plants planted during droughts shall be watered until they naturalize well. Initially, they shall be watered every other day, then as needed (watering frequency may vary depending on meteorological conditions).
- B. During the soil preparation stage, before planting trees and shrubs, it is recommended to fertilize the soil with mineral fertilizers. If soil is considered as poor, based on requirements from Table 176, it is obligatory to fertilize the soil with mineral fertilizers.
- C. For at least 5 years, weeds near the planted trees and shrubs shall be grubbed up, the area around should be maintained as well (plants shall be watered during droughts).
- D. The Contractor shall maintain green plantations during the warranty period, but not less than 5 years.

7.4.2 ESTABLISHING PLANTING BED

7.4.2.1 SCOPE OF WORKS

- A. The works include all works and materials necessary for establishing planting bed and execution of all works, including taking of soil samples, mixing of topsoil, spreading, levelling and compacting.
- B. The following concepts refer to current Technical Specifications.
 - a. "Planting bed" means layer or layers of certain dimensions to which the plant could root into.
 - b. "Growing layer" means layer of soil in the Technical specification.
 - c. "Topsoil" means suitable soil for landscaping, which components have been identified by laboratory.
 - d. "Planting surface" means upper soil layer of earth crust containing earth and humus which suitability for landscaping has not been identified by laboratory.

7.4.2.2 MATERIAL REQUIREMENTS

- A. Planting bed shall be made of local turfing, adding soil recovery substances and fertilisers or special topsoil.
- B. Supplier of special topsoil shall submit product description with soil particle size distribution and content of nourishment elements suitable for plants.
- C. Suitability of earth shall be checked according to Table 176 below.

- D. Existing planting surface shall correspond to the same requirements, recommended for use as planting bed or creating a lawn.
- E. Conformity of local soil shall be certified by soil analysis.
- F. Topsoil shall be suitable for plant growth and shall not contain hazardous materials over limits.
- G. Topsoil shall contain neither debris, rocks nor perennial weeds.
- H. Mineral part of topsoil may contain coarse gravel (particles of 6-20mm diameter) up to 10% by weight.
- I. Topsoil of trees and shrubs may contain coarse gravel and small rocks (particles of 6-50mm diameter) up to 15% by weight.
- J. Topsoil shall not be too dense and hardened: it shall easily break up when pressed.
- K. Content of physical clay (particles of less than 0.02 mm) of topsoil for trees, shrubs, perennials as well as I and II class lawn shall be between 10-20%; III class lawn and afforestation 10-50%.
- L. Size of most of mineral parts shall be 0.1 – 0.3mm (see: particle size distribution of soil in Table 176 below).
- M. Sewage sludge can be added as soil amendment or fertilizer if possible.

Table 176. Material requirements - Planting bed.

Optimum limits of content of nutrients of existing soil (source: Põllumajandusuuringute Keskuse Agrokeemia labor)			Specification of limits of content of nutrients necessary for plant growth in the soil applied for landscaping (Min)
Indicators and control method	Unit of measure	Indicator	
Reaction of soil	pHKCl	4,0.....7,5	I and II class lawn, perennials 6,0-6,5; III class lawn 5,5....6,5; deciduous trees 5,5....6,4; conifers 4,5....5,5 (spruce 3,7...4,5); deciduous shrubs 6,0-7.
Soil particle size distribution ^(b) by simple method	L, sl, ls ₁ , ls ₂ , ls ₃ , s	sl-ls ₃	III class soil, forest trees: sl-ls ₃ . trees, shrubs, climbers, perennials, I and II class lawn: sl .
Volume mass	kg/l	0,7....1,6	0,7-1,2
Organic substance	%	1...10	lawn 6<8<12; forest trees (pine) 4<5<6; trees, shrubs, climbers, perennials 8<10<12
P _{Meh3}	mg/kg	10-200	50<80<150
K _{Meh3}	mg/kg	50...360	80<120<170
Mg _{Meh3}	mg/kg	30....200	150-200
Cu _{Meh3}	mg/kg	1....2,5 ^(a)	
Mn _{Meh3}	mg/kg	50....150	
B _{water}	mg/kg	0,5....3 ^(a)	1,5<2<2,5
S _{water}	mg/kg	10....50	
Zn _{Kcl}	mg/kg	0,5...2 ^(a)	

Optimum limits of content of nutrients of existing soil (source: Põllumajandusuuringute Keskuse Agrokeemia labor)			Specification of limits of content of nutrients necessary for plant growth in the soil applied for landscaping (Min)
Indicators and control method	Unit of measure		Indicator
Mo am-oksai	mg/kg	0,05...0,1 (a)	0,05-0,2
Ca	mg/kg	average 2000	1000<2000<3000
a) Targeted figures of hazardous substances in life zone soil, in case of which equal or less value the condition of surface is good, i.e. safe for humans and environment: Heavy metals Cu 100; Zn 200; Mo 10 mg/kg; other anorganic compounds B 30 mg/kg; plant protection products/pesticides 0,5 mg/kg. Targeted and limit figures of all hazardous substances in soil have been enforced by regulation no 38, 11.08.2010 of the Minister of Environment. b) % content of sand (ø 0,02 – 2 mm) and clay particles (ø less than 0,02 mm) in soil. Soil particle size distribution by content of physical clay: L (sand) – less than 10 %, sl (clayey sand) 10-20 %, ls ₁ (light sand clay) 20 - 30 %, ls ₂ (average sand clay) 30 - 40%, ls ₃ (heavy sand clay) 40 - 50 %, s (clay) – over 50 %.			

7.4.2.3 CONSTRUCTION AND WORKMANSHIP

- A. Suitability of local topsoil for creating planting bed, afforestation or sowing III class lawn shall be established by fertility and particle size distribution analysis before sowing or planting works.
- B. The Contractor shall arrange sample taking with the Engineer. Soil samples shall be taken from different spots (at least 1 sample from 5000m³ or 1 sample per 500m², but not less than 2 samples per site) and send to laboratory for determining content of nutrients.
- C. Depending on the results of the sample, soil quality shall be improved by adding improvement substances, by liming and fertilising so that soil shall correspond to table above requirements. The Engineer shall be convinced that necessary substances shall be added to soil. In case the lab did not give any suggestions, the Engineer may require taking new soil samples. Landscaping works may proceed if sample results indicate soil suitability for landscaping.
- D. Planting beds shall be made in required dimensions and volumes: different dimensions and volumes of trees, shrubs, climbers and herbal plants have been indicated in relevant sections, for lawn see table of lawn classes below. Thickness of mulch shall not be deducted from thickness of planting bed.
- E. New planting bed shall not be made by afforestation or creating III class lawn (see table of lawn classes below) if existing planting bed does not situate on limestone (or other rock) and if there is sufficiently suitable humus soil (see Table 176 of optimum limits of content of nutrients of existing soil for requirements) and moraine (or other sediment) for fixing plant roots. Layer thickness for trees shall be 50cm and lawn at least 25cm. It shall be dug over, cleaned from sods, roots and debris and levelled.
- F. By creating new planting bed, material of planting bed shall be spread to previously graded surface by mixing it slightly to avoid sharp transition of different layers. Tree and shrub planting bed may be created on surface in case of dense damp clayey soils to avoid water collecting into planting hole but planting bed shall not be smaller than required.
- G. Uniform planting bed shall be established for trees, dense tree groups and mass planting areas on narrow separating strips (width up to 3.5 m). Planting bed surface shall be levelled. On slopes with gradient larger than 1:2, planting bed shall be supported or binding materials for soil surface shall be used.
- H. The Contractor shall ensure that heavy machinery shall not move around on completed planting bed. In case the planting bed is too compact, it shall be dug over and restored.
- I. Before establishing the planting bed, it shall be controlled whether planting sites have been prepared in proper places (e.g. distance from roads).
- J. Quality of soil shall be controlled before spreading it.

7.4.2.4 CONFORMITY TESTING

- A. Completed planting bed and its volume shall correspond to requirements. Planting bed material shall be of quality and have certified soil analysis.
- B. There shall not be rocks of over 20mm diameter on the surface of planting bed.
- C. Planting bed shall not be too compact. Surfaces shall be even, without hollows.
- D. Height shall correspond to design. Rainwater shall be directed away from planting bed. Permitted surface difference by measuring by 3m board for I class lawn is +/- 30mm, II class lawn +/- 40mm, III class lawn +/- 50mm, IV class lawn +/- 60mm.
- E. Evenness shall be controlled visually by the Engineer and Contractor, by rod every 25m upon requirement of the Engineer.
- F. Surface of planting bed for mass planting area shall be at least 50mm higher in the middle.
- G. Planting bed of lawn or mass planting area shall be even with kerbstone, pavement or any other surrounding layer.
- H. Planting beds of trees and shrubs in the lawn shall be 50-100mm higher than lawn.

7.4.3 SETTING UP A LAWN

7.4.3.1 SCOPE OF WORKS

- A. This section provides a non-exhaustive list of necessary materials and execution of all works necessary for creating lawn, including preparation of planting bed and seeding.

7.4.3.2 MATERIAL REQUIREMENTS

- A. LAWN SEED
 - a. For sowing seeds of local or close-by countries, having good characteristics of sprouting and covering shall be used.
 - b. Seed mix shall consist of at least three species of decorative grasses, one of which shall be Festuca rubra of 55% proportion. Proportion of Lolium perenne in the mix shall not be more than 15% and that of Trifolium repens not more than 5%.
 - c. Advisable typical seed mix is shown in
 - d. Table 177 below.

Table 177. Material requirements - Lawn seed

Typical III class lawn seed mix (<i>Tielahtoksen vakiosiemenseos</i>)		
Proportion		Latin
78%	Red fescue	Festuca rubra rubra
5%	Smooth meadow grass	Poa pratensis
5%	Common bent	Agrostis capillaris
5%	Sheep fescue	Festuca ovina
5%	Rye grass	Lolium perenne
2%	White clover	Trifolium repens

- B. TURF
 - a. Turf shall be a block of at least 0.5m wide with straight edges.

- b. A 0.5m^2 25-35mm thick lawn pane shall not fall apart if lifted from one edge.
- C. SODS
 - a. Sods shall be at least 0.25m^2 , of even size and straight cut edges.

Table 178. Requirements - Lawn classes

Requirements	Lawn classes			
	I	II	III	IV (mowing lawn)
Thickness of planting bed	15	10	5-7 or ^(a)	^(c) or ^(a)
Content of physical clay in soil	10-20% (sl)	10-20% (sl)	10-50% (sl - ls3)	^(c)
Seeding norm of seeds g/ m2	20-25	15-20 On slopes 20-25	10-20 On slopes 20-25	5-10 or ^(c)
Mowing height cm	4-8	6-15	Ca 30	^(c)
Service level 5-1	High (5)	Average (5-4)	Low (3-1)	Low (3-1)
Fertilising kg/ha	^(b)	^(b)	300-4 or ^(b)	^(c)
Notes: a) Only existing, 25 cm loose soil layer suitable for plant growth and fixing of roots (requirements see Table 1) and eg moraine (or other sediment), not on the rock (eg limestone). b) By soil analysis. c) By design. Long term or containing ureaform (long term N) N:P2O5:K2O fertilizer or 17- 23:5-22:5-10 +2MgO+microelements.				

7.4.3.3 CONSTRUCTION AND WORKMANSHIP

- A. Concept "lawn class" means classification of different lawn types as in table above: "Lawn classes". Lawn type will be indicated in design, without design it is permitted to have III class lawn.
- B. Planting bed of lawn (compacted as required) shall be founded according to previous epigraph "Establishing planting bed" and dimensions from "Lawn classes" table. Seeding surface shall be levelled so that it shall be without hollows and the whole earth surface shall be smoothly connected to surrounding surface or buildings.
- C. Levelled surface shall be compacted by rolling it in a way that there shall be no footprints if walked over.
- D. Seeding surface of III class lawn shall be slightly treated before seeding by 2-4cm deep furrows in same direction on steep (steeper than 1:2) and high (>3m) slopes, distance between furrows being ca 5 cm.
- E. SOWING OF LAWN
 - a. Lawn seed shall be sown when planting bed is not frozen and the lawn shall crop up and take root before end of growing period. Advisable period of time is April-May and end of July-beginning of September. Lawn sown at other periods shall be regularly watered or until lawn crops up in period of rains.
 - b. Mix of lawn seed shall be sown in accordance with norm as referred to in table "Lawn classes" above. Mix shall be sown evenly, either manually or by relevant equipment. Seed shall be covered by 1 cm thick layer of earth (e.g to be raked into earth) and rolled. III class seed on slopes shall not be raked.
 - c. Hydroseed may be done not on steeper slopes than 1:1.5. Planting bed of III class lawn shall be prepared for hydroseed if not stated otherwise in design.
 - d. In order to lawn 10-20 mm thick spatial grid which is used for preventing erosion on slopes, seeds shall be sown into installed grid and seeds as well as grid shall be covered by topsoil. In covering slopes by thin nets (e.g. non-reusable biodegradable nets) the seed shall be before installation of erosion barrier. Also, hydroseeding method may be used. Biodegradable nets shall not be covered with earth on top.
- F. LAYING OF TURF
 - a. Planting bed of I class lawn shall be made for turf. Turf may be laid from the period of II half of May until October (or from melting up to freezing of the earth).
 - b. Quality of turf shall be controlled before delivery.
 - c. Lawn shall be kept sufficiently damp and protected from direct sunlight during transportation and storage. Installation shall be done within 48 hours.

- d. Lawn shall not dry out during transportation and installation.
- e. Panes of lawn shall be installed on slopes downwards and fixed afterwards with wooden poles.

G. TURFING

- a. Most suitable time for turfing is end of summer.
- b. Earth shall be watered before cutting of turfs during dry season.
- c. Turfs shall be cut direct before installation. If necessary, upon Engineer's approval, turfs may be stored up to 3 days if kept damp and protected from direct sunlight and wind. In transporting when piling turfs, a plywood board or alike shall be placed between the turfs. If there is no growing layer on the turfed spot, thickness of turfs and planting bed shall be at least 15cm. Turfs shall be placed closely next to each other and pressed against earth.
- d. If necessary, turfs shall be fixed with wooden poles or supported by wooden rack. Material shall be watered after turfing.

7.4.3.4 CONFORMITY CONTROL

- A. Quality of lawn seed and earth improvement substances shall be certified by the supplier.
- B. If lawn is mowed in a correct way and proper frequency, then coverage percentage of lawn shall be at the end of first growing period: I class lawn 70%, II class lawn 60%, III class lawn 50%. Spots of not cropping up in lawn shall be re-sown.
- C. Quality of turfs shall correspond to I class sown lawn by the end of guarantee period.
- D. Distances between panes shall not be visible.
- E. Lawn growing through erosion barrier shall be similar to sown lawn by the end of guarantee period and correspond to lawn class of the design.
- F. Turfs of turfed area shall be fixed and green.

7.4.4 PLANTING OF TREES

7.4.4.1 SCOPE OF WORK

- A. Works shall include planting of all solitary trees, groups of trees and alley trees as well as necessary planting materials, machinery and equipment.

7.4.4.2 MATERIAL REQUIREMENTS

- A. Plants shall be multiplied and grown in the country where works take place.
- B. Supplier of plants shall submit certificate of the origin of plants.
- C. Plants shall correspond to relevant national and local standards.
- D. Species, type and size shall correspond to design. Root ball of the plant shall be thoroughly rooted and shall not break during transportation or planting. Branchless stem of plant shall not be more than 2/3 of the height of tree.
- E. Height of branchless stem of deciduous tree plant shall be at least 1.5m. Deciduous tree plant shall be at least 2m, conifer plant at least 0.6m high. Plant batches shall be even. Planting soil shall not contain weeds with fleshy roots or underground stems.

Table 179. Requirements - Trees

	Thickness of planting bed, mm	Volume of planting bed, m ³	Dimensions of planting bed of solitary plant, mm
High trees with needles (eg spruce, pine) on greenery	800	7,2^(a)	3000 x 3000
High leafy trees (eg. birch, aspen, ash, maple, lime, willow trees, rowan) on greenery	800	7,2 ^(a)	3000 x 3000
Small trees with needles on greenery	600	1,5 ^(a)	1500 x 1500
Small and average trees (eg sorb-apple, cherry, apple) on greenery	600	1,5 ^(a)	1500 x 1500
Large trees (eg. linden, chesnuts, oaks) on greenery	800	3,2 ^(a)	2000 x 2000
High street trees on green ≥3m separating strip btw driveway and light traffic way	800	7,2 ^(a)	3000 x 3000
Small and average trees on limited planting bed (eg. traffic islands, narrow separating strips, parking space greenery)	1000	15	
Large trees on restructured planting bed	1000	25	
Notes: a) Planting bed is in connection with larger green area not situating on rock (eg limestone) and having at least 400mm loose humus and moraine layer (or other sediment) for fixing plant roots. It shall ensure necessary planting bed of 15 m ³ for small trees and 25 m ³ large trees. b) Source: "Viherakentamisen yleinen työselostus VRT'09". Soome 2009			

7.4.4.3 CONSTRUCTION AND WORKMANSHIP

- A. Bare-rooted plants shall be planted in early spring before budding (end April, May) or in autumn, September-mid October before cold season.
- B. Conifers shall be planted in autumn from August up to mid-September and in spring from mid-May up to mid-June.
- C. Container plants and plants with soil ball may be planted when earth is not frozen. Large trees with thick soil ball may be planted up to -10 °C frost.
- D. If plants shall not be planted right after delivery, they shall be stored in transportation package in shadowy place so that upper part of the plant gets light and air. Roots shall be kept damp and protected from sun and wind. Bare-rooted shall not be stored more than 24 hours.
- E. Planting hole shall be at least 20% larger than soil ball or roots of the plant. Bottom of the hole shall be shaped as a bowl in order to prevent water collecting in the bottom of the planting hole. Spot in the bottom of the hole where the root ball is being placed, shall be compacted in order to prevent the plant from further sinking into earth. Planting holes of trees shall be watered before planting (at least 50 l of water per plant).
- F. Plant shall be placed in a way that root collar shall be ca 10-20mm above surrounding earth level. If plant has been placed into hole, open natural material package on top and sides and if possible, remove it from bottom of hole. Manmade material shall be completely removed. Topsoil shall be pressed against roots of plant.
- G. Low watering berm shall be formed around tree for water, with diameter of at least 1 m (ca size of a planting hole). After planting, proceed to water the tree with 50-100l of water. Watering shall be done also during rainy season.
- H. Damaged parts of plants shall be cut during planting. Planted trees shall be straight. Trees which shall be planted in rows shall be in a straight row. Trees at the carriageway or light traffic road shall be planted so that the lowest branch shall not be above the road.
- I. All deciduous trees over 150 cm and conifer trees over 100cm shall be supported right after planting.

- J. Less than 2.5 m deciduous trees shall be supported by 1-2 upright supporting rods, higher trees by 2-4 upright supporting rods, conifers by slanting supporting rods. Rod shall be of a diameter of at least 5 cm.
- K. Rods shall be fixed firmly into subgrade, but not damaging the roots.
- L. Rods shall not be as high as to get into tree crown. Stem shall be firmly fixed to rod. In case of upright support, the highest fixing spot shall be lower than 1/3 of tree height. Fixing material shall not be tight, it shall be preferably belt-shaped. Loop shall not be around stem. Height of rods shall be cut even ca 5-10cm higher than binding spot. Similar supporting rods for trees planted into groups or rows shall be erected in same direction, bands shall be at the same height and rods shall be cut even.
- M. Mulched circle shall be made around the tree which shall be planted into lawn ($d > 1$ m) or stem shall be protected by plastic trimmer protection. Mulch shall not be spread against root collar and stem. In case pine bark is being used, bark layer shall be 5-7cm.

7.4.4.4 CONFORMITY CONTROL

- A. Completed planting shall be in accordance with design. By the end of planting works and guarantee period plants shall be in good condition, typical of species or type concerning form and size, healthy, without damages and pests. Trees shall be planted into correct depth. Planted trees shall not be aslant. Supporting rods shall be firmly fixed into surface. Rod shall be of larger diameter than tree stem.
- B. Supporting material shall not rub against tree stem or branches. Binding material shall not cut into trees.
- C. Mulch cover shall be of even thickness and shall not be mixed with earth.

7.4.5 AFFORESTATION

7.4.5.1 SCOPE OF WORKS

- A. Works shall include all accompanying planting works, necessary materials, machinery and equipment.
- B. Concept "afforestation" means planting of forest for the purpose of landscaping or protective greenery.

7.4.5.2 MATERIAL REQUIREMENTS

- A. Design plants shall be of required species.
- B. Plants shall origin from the country where works take place.
- C. The trees to be used must be presented in the nearby woodlands. Only the tree species native in the country where works take place can be used. For example, spruce (*Picea abies*), pine (*Pinus sylvestris*), aspen (*Populus tremula*), rowan (*Sorbus aucuparia*), birch (*Betula pendula*), maple (*Acer platanoides*), willow (*Salix spp.*), ash (*Fraxinus excelsior*), oak (*Quercus robur*), Lime (*Tilia cordata*) are among the tree species to be selected. Also, other trees species native in the country where works take place flora may be used.
- D. Plants shall correspond to table below requirements.
- E. Plants shall be healthy, vital and suitable for selected growing site.
- F. A plant shall not be suitable in case of having pests or pest damages, mechanical bark damages, if the roots are weak or in case of conifer top bud is damaged, plant has 2 tops (except spruce), plant has not enough buds or thorns.
- G. At least 95% of the batch shall correspond to requirements.

Table 180. Afforestation. Requirements

Tree	Heights of plants
Birch	400-600 mm
Maple	200-400 mm
Oak	200-1000 mm

Tree	Heights of plants
Poplar	600-1250 mm
Ash	1000-1250 mm
Alder	400-800 mm
Willow	400-800 mm
Sorb-apple	400-600 mm
Pine	80-180 mm
Spruce	150-300 mm
Larch	300-600 mm

7.4.5.3 CONSTRUCTION AND WORKMANSHIP

- A. It is not necessary to establish planting bed for plants on area to be afforested unless the area is on rock (e.g. limestone) and if there is at least 500mm mellow layer of humus earth and e.g. moren (or other sediment) for fixing of roots.
- B. Before planting to a clearing stumps, branches shall be cleared, and surface shall be smoothed. Growing layer shall be without compaction, e.g. compacted surface shall be dug out in ca 0.8m deep. In case of planting to sandy soil 10 cm of clay or clayey earth shall be mixed to the bottom of planting hole. Lawn shall not be sown on the area to be afforested.
- C. Deciduous trees shall be planted early spring before budding (end of April, May) or in autumn from September until mid-October before frosts. Conifer plants shall be planted in spring from mid-May until mid-June and in autumn from August until mid-September.
- D. Planting shall not be done in autumn in wet areas.
- E. Plants shall be transported and stored so that they shall not be damaged.
- F. Roots of bare rooted plants shall be protected from the light. If there has been no previous pest control concerning conifer plants, necessary control shall be done. Plants shall be planted in a suitable manner for each species.
- G. Stem of a tree shall be straight when planted on a slope. If not otherwise indicated in the design, planting density shall be 2500 pc/ha, distance between plants being 1.7m.

7.4.5.4 CONFORMITY CONTROL

- A. Afforested area and species shall correspond to the Technical Design.
- B. Planting density shall correspond to requirements. 80% of plants shall fulfil quality requirements at the end of guarantee period and there shall be no visually detected damaged spots. If the number of strong plants is less than 80%, there shall be supplementary planting.

7.4.6 PLANTING OF SPRUCE HEDGE

7.4.6.1 SCOPE OF WORKS

- A. Works shall include all accompanying planting works, necessary materials, machinery and equipment.

7.4.6.2 MATERIAL REQUIREMENTS

- A. Plants shall be multiplied and grown in the project country or neighbouring countries (Baltic region).
- B. Supplier shall submit certificate of origin of plants.

- C. Plants shall correspond to relevant national and local standards.
- D. A plant shall not be suitable in case of having pests or pest damages, mechanical bark damages, if the roots are weak or in case of top bud is damaged, plant has not enough buds or thorns.
- E. Plants of one hedge shall be even. There shall be no weeds with fleshy roots in planting soil.

7.4.6.3 CONSTRUCTION AND WORKMANSHIP

- A. Plants shall be transported and stored in a way that their condition shall not grow worse.
- B. Quality of plants shall be controlled before planting. If plants shall not be planted right after delivery, they shall be stored in transportation package in shadowy place so that upper part of the plant gets light and air. Roots shall be kept damp and protected from sun and wind. Bare rooted plants shall not be stored more than 24 hours.
- C. Bare rooted plants shall be planted in spring from mid-May until mid-June and in autumn from August until mid-September, container plants may be planted also at other time. A ditch of 1m wide and 50-60cm deep shall be excavated for a one-row spruce hedge and it shall be filled with topsoil (see epigraph "Establishing planting bed").
- D. A ditch of 2m wide shall be excavated for a two-row hedge and it shall be filled with topsoil. Surface water shall be directed away from the hedge by slopes.
- E. Distance between plants of a one row spruce hedge shall be 60-80cm, in case of two-row 0.75-1m. Plants shall be planted in the same depth as they were grown. Package shall be removed. Topsoil shall be pressed against roots. There shall be no planting cutting. Plants shall be watered after planting (20-30l/m²) irrespective of the weather. Surface of planting bed shall be covered by mulch. Dry-rotted pine park may be used as mulch (thickness of layer 5-7cm) or special covering material (shall be placed according to instructions).

7.4.6.4 CONFORMITY

- A. Completed planting shall be done in accordance with the referred description if not stated otherwise in design.
- B. Distance between plants shall be correct. At the end of planting works and guarantee period the plants shall be in good condition, typical of species concerning form and size, healthy, without damages and pests. Plants shall be planted in correct depth. Planted items shall not be aslant, stem of the plant planted on slopes shall be also straight. Mulch cover shall be sufficient, of even thickness and shall not be mixed with earth. Weeds shall not be visible through mulch.
- C. All dried and weak (brown thorns more than 2/3 of the plant) plants shall be replaced during guarantee period.

7.4.7 PLANTING OF SHRUBS, CLIMBERS AND PERENNIALS; MASS PLANTING AREA

7.4.7.1 SCOPE OF WORKS

- A. Works include all planting works of single bushes and mass planting areas as well as necessary materials.

7.4.7.2 MATERIAL REQUIREMENTS

- A. Plants shall be multiplied and grown in the project country or neighbouring countries (Baltic region), if not agreed otherwise. Supplier shall submit certificate of origin. Plants shall correspond to relevant national and local standards. Species and sort shall correspond to design. Size of bushes and number of twigs shall correspond to design or it shall be agreed in case there are no design requirements.
- B. The bushes to be used must be present in the nearby woodlands. All species used must be native in the country where works take place. For example, hazel (*Corylus avellana*), juniper (*Juniperus communis*), mountain currant (*Ribes alpinum*), dog rose (*Rosa canina*), common barberry (*Berberis vulgaris*), willow bushes (*Salix spp.*) are among the bush species to be selected. Also, other bush species native in the country where works take place flora may be used.
- C. Quality of plants shall be controlled before planting. Plant batches shall be even.

7.4.7.3 CONSTRUCTION AND WORKMANSHIP

- A. A planting bed shall be established for plants according to design or planting scheme and section "Establishing planting bed". A uniform planting bed shall be made for mass planting area. Thickness of planting bed for solitary shrub and climbers shall be 600 mm and width 700 mm, that of mass planting area (shrubs, perennials, decorative Gramineae) 400 mm.
- B. Planting of bare roots shall be early spring before budding (end April, May or autumn from September until mid-October before frosts). Container plants and soil ball plants may be planted during other periods when earth is not frozen. If plants cannot be planted after delivery, they shall be stored in a shadowy place, protected from sunlight and wind. Roots of plants shall be kept damp. Bare rooted plants shall not be stored more than 3 days.
- C. Plants shall be planted according to design, change in planting spot shall be approved by the Designer. In case of mass planting areas plants shall be planted by even distance, but regular rows shall be avoided.
- D. If a plant has been placed into planting hole, natural package shall be opened from top and sides and, if possible, removed. Manmade material shall be completely removed. Twisted roots shall be dismantled, damaged roots shall be cut back. Plant shall be planted in the same depth as it has been grown. Bare rooted plants shall be planted in 0-50 cm so that fork shall be slightly covered with earth.
- E. Root ball of the plant shall be covered by up to 5 cm earth layer. Topsoil shall be pressed against roots and fixed around the plant.
- F. In order to plant into erosion barrier, jute or coconut matting placed on slopes a hole of size of root ball shall be made into the material. Base shall be previously made under erosion barrier.
- G. Mass area planting shall be watered after planting by 20-30 l/m². Solitary bushes shall be watered depending on the size of the plant, but not less than 10 l per shrub.
- H. Surface of planting bed of mass planting area shall be covered by mulch if not otherwise stated by design.
- I. Several materials can be used for mulch, at the Engineer's approval:
 - a. rotten pine bark (thickness of layer 5-7cm);
 - b. bed carpet (weight of at least 150g/m²) covered by macadam course (btw diameter of 6-16 mm, thickness of layer 2-3cm);
 - c. special covering material (shall be installed according to instructions).
- J. Planting cutting of all plants shall be done depending on species or sort. Bare rooted deciduous plants of minor branching shall be cut back at the height of 15cm in order to thicken the shrubs.
- K. Deciduous plants which have not been cut back in planting nurseries can be cut. Deciduous shrubs planted in autumn shall be cut in spring.
- L. Evergreen shrubs shall not be cut.
- M. All self-fixing climbing plants shall be directed to grades by poles, other climbers shall be fixed to framework.
- N. Plants shall be regularly watered during planting and guarantee period.

7.4.7.4 CONFORMITY

- A. Completed planting shall be in accordance with design or layout and executed according to referred technical description.
- B. Mass planting area shall be even, there shall be no areas without plants.
- C. At the end of planting works and guarantee period the plants shall be in good condition, typical of species and sort by form and size, healthy, without damages and pests.
- D. Height of plants shall be controlled before possible cutting back.
- E. Plants shall be planted in proper depth. Plants shall not be aslant. Necessary cuttings shall be done. Mulch shall be sufficient, of even thickness and shall not be mixed with earth. Weeds shall not be visible through mulch.

7.4.8 RE-PLANTING OF TREES

7.4.8.1 SCOPE OF WORKS

- A. Works include all necessary works for re-planting of trees, materials, machinery and equipment.

7.4.8.2 MATERIAL REQUIREMENTS

- A. Condition of the tree to be re-planted shall be good. Growing conditions in the planting site shall be similar to previous growing site of the tree.

7.4.8.3 CONSTRUCTION AND WORKMANSHIP

- A. Smaller trees may be re-planted without special preparation. Preparatory works for replanting deciduous trees of more than 2.5m and conifer trees of more than 1.7m shall be made by 1-2growing seasons earlier, by digging a narrow ditch around the tree for cutting the roots. Root ball shall be left at least 10 times larger than is the diameter of stem at 1.3m. Depth of ditch shall be lower than horizontal roots. Ditch shall be filled with turf or light gravel. Replanting shall take place during resting period of vegetation when ground is frozen, but the temperature shall not be lower than -15°C.
- B. Surface under the tree to be replanted as well as surface of the new site shall be protected from freezing in autumn, e.g by piling leaves. At the beginning of winter, the tree shall be dug around root ball and let the ball freeze.
- C. Firm cloth or net shall be fixed around root ball for removal of the tree, this shall be removed from the new planting hole. Removal shall be done by lifting by the root ball. Stem and branches shall be protected during removal, crown of the tree shall not be cut smaller. Branches damaged during removal shall be cut up to healthy branch.
- D. Prior stored non-frozen earth shall be pressed against root ball. Re-planted tree higher than 3.5m shall be supported by special cables which are anchored into soil. Planting site shall be finished by arrival of growing period and properly regularly watered.

7.4.8.4 CONFORMITY

- A. Tree shall be vital and planted into correct depth.
- B. There shall be neither bark damages nor broken branches.
- C. Surface around tree shall not be too much compacted.
- D. Planted tree shall not be aslant, shall be firmly fixed.
- E. Supporting material shall not rub against stem or branches.
- F. Binding material shall not get into tree bark.

7.4.9 MEASUREMENT AND PAYMENT – LANDSCAPING RELATED WORKS

- A. Technical specifications above are applicable to the following environmental related work items defined for the Project.
- B. Work items related to site preparation such as tree removal and bush and scrub removal, which are not included in the environmental chapter, shall also meet these technical specifications.
- C. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- D. The units of measurement shall be as follows:

Table 181. Units of measurement - Landscaping related work items

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_45_30_76_39	000801	HYDROSEEDING OF HERBACEOUS LAYER	m2	Hydroseeding of herbaceous layer consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for two-pass of hydroseeding of herbaceous layer with species adapted agroclimatically to the area, including the supply of all necessary components, seeds, mulch or quad, stagilizing, bioactives, bio-activator, fertilizer, rooting watering, as well as the necessary maintenance until the reception of the work.
Ss_45_35_45	000801	SETTING OUT OF PLANTING BED AND SEEDING ON SLOPES	m2	Setting out of planting bed and seeding on slopes consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item includes all necessary materials and execution of all works necessary for creating lawn on slopes (III class)), incl. preparation of planting bed and seeding. Mix of lawn seed shall be sown in accordance with norm. Mix shall be sown evenly, either manually or by relevant equipment. Seed shall be covered by 1 cm thick layer of earth (e.g to be raked into earth) and rolled. III class seed on slopes shall not be raked.
Ss_45_35_05_66	000801	PLANTING OF HIGH CONIFERIOUS TREE	pc	Planting of high coniferious tree consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for plantation of high coniferious tree in root ball, including tree grating, placement of bamboo cane tutor if necessary, mineral fertilizer and irrigation, supply, transport and unloading of the plant.
Ss_45_35_05_66	000802	PLANTING OF HIGH DECIDUOUS TREE	pc	Planting of High deciduous tree consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for plantation of high deciduous tree in root ball, including tree grating, placement of bamboo cane tutor if necessary, mineral fertilizer and irrigation, supply, transport and unloading of the plant.
Ss_45_35_05_67	000801	PLANTING OF SMALL CONIFEROUS TREE	pc	Planting of small coniferious tree consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for plantation of small coniferious tree in forest alveolo of 300 cc, including excavation of a plantation hole of 30 x 30 x 30 cm with manual means and filling of the pit with soil excavation and topsoil, tree grating, placement of bamboo cane tutor, mineral fertilizer and irrigation, supply, transport and unloading of the plant.

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_45_35_30_62	000801	PLANTING HOLE	pc	Planting hole consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for excavation of a plantation hole for high trees with necessary dimensions with manual means and filling of the pit with excavation soil and topsoil.
Ss_45_35_05_67	000802	PLANTING OF BUSHES	m2	Planting of bushes consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for plantation of bushes in forest alveolo of 300 cc, including excavation of a plantation hole of 30 x 30 x 30 cm with manual means and filling of the pit with soil excavation and topsoil, tree grating, placement of bamboo cane tutor, mineral fertilizer and irrigation, supply, transport and unloading of the plant.
Ss_45_35_30_62	000802	GROWING MEDIUM FOR THE TREE	m2	Growing medium for the tree consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for fill with substrate adequate for trees, including all processes and materials to achieve a correct growth of the plantation
Ss_45_35_30_62	000803	GROWING MEDIUM FOR THE BUSH	m2	Growing medium for the bush consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for fill with substrate adequate for bush, including all processes and materials to achieve a correct growth of the plantation
Ss_45_35_30_62	000804	OTHER WORKS (E.G. BOULDERS & STUMPS)	site	Other works (e.g. boulders & stumps) consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for placement other materials different to plantations to complete the landscaping according to drawings and technical specifications, like boulders, stumps, etc for to delimit areas and zones in the landscape for animal crossing
Ss_45_35_30_62	000805	PLANTING OF SPRUCE HEDGE	m	Planting of spruce hedge consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for plantation of spruce hedge in forest alveolo of 300 cc, including excavation of a trench of 1m wide and 50-60 cm deep with manual means and filling of the ditch with soil excavation and topsoil, tree grating, placement of bamboo cane tutor, mineral fertilizer and irrigation, supply, transport and unloading of the plant. Surface water shall be directed away from the hedge by slopes. Distance between plants of a one row spruce hedge shall be 60-80cm.

8. SECTION 08.- FENCING

8.1 SCOPE OF WORKS

- A. The aim of this chapter is to define the technical specifications related to general railway fencing along the high-speed railway line and all their associated elements. This section focuses on the following main points:
 - a. Railway fence;
 - b. Gates for railway fence (Portals, Safety Gates)
 - c. Wooden fence for green bridges, at ecoducts.
- B. This section provides a needed but non-exhaustive list of labour, materials, equipment, transport and services necessary to furnish, deliver and install all work of this section as shown on the drawing, as specified herein and/or as required by job conditions.
- C. The BIM models shall contain detailed as-built data according to the specified LoG and LoI levels and "RBDG-MAN-040- Digital information requirements for construction and handover stages". As-built BIM models shall be created by the Contractor and/or updated by developing PIM (Project Information Model) models from the Technical Design accompanied with laser scanning/photogrammetry data according to RBGL-VDC-INS-R-00001.

8.1.1 SUPPLY OF RAILWAY FENCE AND GATE COMPONENTS

- A. Railway fence components: regular, tension and bracing posts; end posts at gates; tension wires; regular, buried and increased density meshes; barbed arms and barbed wires; other fence components (Turnbuckles and Fasteners) shall conform Rail Baltica Technical specification "RBCN-RWM-SPC-R-00004 - FENCE COMPONENTS" and requirements set in these Technical specifications.
- B. Gates for railway fence components: frames with meshes; leaves; locks; clamping devices and fasteners; excluding materials for fence foundation shall conform Rail Baltica Technical specification "RBCN-RWM-SPC-R-00004 - FENCE COMPONENTS" and requirements set in these Technical specifications.

8.1.2 TRANSPORT AND STORAGE

- A. Contractor is responsible for storage, loading/unloading and transportation to installation place in the construction site.
- B. Railway fence components and gates for railway fence components shall be transported and stored in accordance with the instructions provided by the manufacturer and this Technical specifications.
- C. Railway fence components and gates for railway fence components shall be supplied only with the manufacturer's declaration of performance (with translation into the official national language).

8.2 RAILWAY FENCE

8.2.1 DEFINITION

- A. The railway fence is made up of a grid and tubular steel posts, formed by single torsion mesh wire with the characteristics described below, and as shown on Technical Drawings.
- B. The execution of the work item includes the following operations:
 - a. Preparation of the working area (site clearing, bush and scrub removal and working site levelling);
 - b. Setting out the fence location according to the position set at the drawings;
 - c. Supply and transport to the worksite of posts, wire mesh and all the necessary accessory elements;
 - d. Excavation of the post foundations (Other execution methods for foundations are acceptable);
 - e. Positioning of the posts and concreting of the foundations;
 - f. Placing and bracing of the wire mesh.

8.2.2 GENERAL CONDITIONS

- A. The setting out of the railway fence will be carried out in accordance with the Technical Design Drawings definition, taking as a reference the external edge of the embankment or the cutting zone.
- B. The railway fence and its components shall have a DWL of 50 years.
- C. The distance from the fence to this reference line shall be four metres (4m) in case of embankment section and four and a half metres (4.5m) in case of cutting section, to generate a free service strip.
- D. The shape and dimensions of the posts and the mesh shall be as defined in the Technical Design Drawings.
- E. In those areas where the local environmental assessment so requires, specially where the presence of wild boar and other digging animals is possible, an additional mesh shall be added at the lower part of the fence overlapped with the general mesh and buried as specified in Technical Drawings (at least 25 – 50cm as required).
- F. In the vicinity of animal crossings, if the local environmental assessment so requires (specified in Technical Drawings), the first sixty centimetres (60cm) from the ground shall be covered with a denser mesh.
- G. The total height of the fence may vary depending on its location or following the local environmental recommendations, consisting of a straight stretch and an inclined stretch. In those places where the moose occurrence is possible, as well as other big mammals, the total height of the fence (wire mesh and posts) is increased to minimize the possibility of animals jumping over the fence. Dimensions of the fence elements as indicated in the Technical Drawings. Tension horizontal wires shall be placed in the upper and lower row and also at heights as indicated in the Technical. This point is not applicable for simplified fences.
- H. The posts with an inclined top stretch for the placement of three strands of barbed wire. Additional barbed wires may be added to the main body of the fence as per the specific details included in the Technical Drawings. This point is not applicable for simplified fences.
- I. Where the fence crosses over a ditch, it shall be complemented with a supplementary element placed at the lower part, consisting of a grating made of galvanized tubular steel sections, following the same material requirements for the general fence elements described above. The distance between vertical rods of this supplementary grating shall be as shown in Technical Drawings
- J. In case the fence is installed on a steep surface, distance between posts shall be reduced to three metres (3m). In situations where the fence is to be installed on a concrete surface and foundations are not adequate, posts shall be anchored to the concrete as per Technical Drawings. Steel anchoring elements shall comply with requirements in section 5.6. STEEL WORKS.
- K. All exposed metal conductive parts of the fences shall be grounded following Section 10. EARTHING AND BONDING SYSTEM of this Technical Specifications.

8.2.3 EXECUTION CONDITIONS

- A. The placement of the posts and the metal wire mesh shall be done without producing deformations and there shall be no friction that could remove the zinc layer and with the following execution tolerances:

Table 182. Execution tolerances - Railway fence

Requirement	Execution tolerance
Distance between posts	20mm
Setting out	10mm
Levelling and plumbing	5mm

- B. The railway fence shall be placed in accordance with Technical Design Drawings and/or BIM models.
- C. Before installing the posts, the ground shall be cleaned of shrubs, stones and any element that obstruct the placement of the mesh, whose lower edge shall remain in contact with the ground (maximum exceptional separation of five centimetres (5cm)) preferably buried in its initial 25cm to prevent it from being lifted by animals. Burying of fence lower end shall be mandatory if local environmental recommendations so require (specified in Technical Drawings).

- D. The concrete to be used in the foundations of the posts will be at least C20/25. The manufacture, transport, placement and control of the concrete shall follow the requirements of Section 05. STRUCTURES in this Technical Specifications and Eurocode 2 Standard; additives that may promote corrosion shall not be used.
- E. The foundations of the posts shall be made up of concrete blocks with a dimensions as shown on Technical Drawings and shall be completely buried. Preferably, templates or other elements of verification that guarantee compliance with the minimum dimensions of the foundation block shall be used in the execution of the foundation. Before proceeding with the concreting, the post will be placed checking its verticality. At points where the ground does not present enough consistency, the foundation dimensions shall be increased as necessary to ensure the stability of the fence.
- F. At the points where there is a change in the direction of the fence, the foundation of the tension post and the two diagonal bracing struts shall be executed with a continuous footing with the dimensions shown on Technical Drawings following the alignment of the fence.
- G. The mesh shall not have any areas that are curved or deteriorated due to faulty assembly. It shall not be installed before the Engineer has approved the installation of the posts.
- H. In those areas where the local environmental assessment so requires, specially where protection against digging animals (such as wild boar and lagomorphs) is required by burying the wire mesh, a trench with the necessary depth (25 to 50cm, as shown on Drawings) shall be made between the foundation blocks, where the mesh will be placed with vertical overlaps of forty to sixty centimetres (40 to 60cm) with the fence and horizontal towards the outside at the bottom of the trench, filling it with the material previously excavated. Buried length and overlap shall be as specified in drawings, minimum acceptable overlap is 20 cm. If a transition fence is needed in these areas, it shall present a buried mesh with the same characteristics too.
- I. The fence that ends against the wing walls of structures abutments or that is placed over the wing walls and upper part of frames of the underpasses and transversal culverts shall be adjusted as much as possible, avoiding its vulnerability to people or animals at these points.
- J. Any excavation required shall be performed in accordance with Section 02 – EARTHWORKS in these Technical Specifications. The products from excavations shall be spread regularly, either "in situ" or in the landfills which the Contractor has agreed under his own responsibility. In any case, areas where accidental spill has occurred shall be treated in such a way that their final appearance is integrated into the environment. The Contractor shall always follow the instructions on landfills contained in the Project.

8.2.4 EXECUTION CONTROL

- A. At least, the following parameters shall be followed:
 - a. Topographic check of the fence location.
 - b. Visual inspection of the general condition of the fence.
 - c. Testing of foundation concrete following these Technical Specifications, chapter 5.2.5.
 - d. Manual check of the pull-out resistance in 10% of the posts. The inspection consists of moving manually the fence support without noticing displacement in the foundation base.
 - e. Those identified irregularities in the fence supports shall be corrected by the Contractor and no deficiencies will be admissible. If deficiencies are identified, the execution control will be increase up to 20% of the posts in the first instance, and if irregularities still appear, the totality of the supports shall be checked.
 - f. Tension posts and angle posts shall not suffer top deformation greater than fifteen millimetres (15mm) under the stresses of placing the fence under tension.
- B. All materials shall be related to valid quality certificates.

8.2.5 MEASUREMENT AND PAYMENT – RAILWAY FENCE

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 183. Units of measurement - Railway fence

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_25_71_50_85	000921	DELIVERY AND INSTALLATION OF RAILWAY FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 2,00 m	m	Delivery and installation of Railway Fence built with wire reinforcement single torsion mesh and galvanized posts consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post every 3,50m, 2m height, with barbed wire on top. Including complete concrete foundations(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_25_71_50_85	000922	DELIVERY AND INSTALLATION OF RAILWAY FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 2,00m, WITH BURIED FENCE PROTECTION AT LEAST 50cm	m	Delivery and installation of Railway Fence built with wire reinforcement single torsion mesh and galvanized posts, with buried fence protection at least 50 cm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post every 3,50m, 2m height, with barbed wire on top and buried fence protection at least 50 cm. Including complete concrete foundations(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_25_71_50_85	000923	DELIVERY AND INSTALLATION OF RAILWAY FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 2,50 m, WITH BURIED FENCE PROTECTION AT LEAST 50cm	m	Delivery and installation of Railway Fence built with wire reinforcement single torsion mesh and galvanized posts, with buried fence protection at least 50 cm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post every 3,50m, 2,5m height, with barbed wire on top and buried fence protection at least 50 cm. Including complete concrete foundations(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_25_71_50_85	000924	DELIVERY AND INSTALLATION OF RAILWAY FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 2,20 m, WITH BURIED FENCE PROTECTION AT LEAST 25cm	m	Delivery and installation of Railway Fence built with wire reinforcement single torsion mesh and galvanized posts, with buried fence protection at least 25 cm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post every 3,50m, 2,2m height, with barbed wire and buried fence protection at least 25 cm. Including complete concrete foundations(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_25_71_50_85	000925	DELIVERY AND INSTALLATION OF RAILWAY FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 2,20 m, WITH BURIED FENCE PROTECTION AT LEAST 25cm AND WITH THE FIRST 60 cm ON THE GROUND WITH HIGHER MESH DENSITY	m	Delivery and installation of Railway Fence built with wire reinforcement single torsion mesh and galvanized posts, with buried fence protection at least 25 cm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post every 3,50m, 2,2m height, with barbed wire, with buried fence protection at least 25 cm and with the first 60 cm on the ground with higher mesh density. Including complete concrete foundations(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_25_71_50_85	000926	DELIVERY AND INSTALLATION OF RAILWAY SLOPED FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 2,20 m, WITH BURIED FENCE PROTECTION AT LEAST 25cm	m	Delivery and installation of Railway sloped fence built with wire reinforcement single torsion mesh and galvanized posts, with buried fence protection at least 25 cm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post every 3m, 2,2m height, with barbed wire and buried fence protection at least 25 cm. Including complete concrete foundations(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_25_71_50_85	000927	DELIVERY AND INSTALLATION OF RAILWAY SLOPED FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 2,20 m, ANCHORED TO CONCRETE SURFACE	m	Delivery and installation of Railway sloped Fence built with wire reinforcement single torsion mesh and galvanized posts, anchored to concrete surface consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post every 3m, 2,2m height, with barbed wire and anchored to concrete. Including anchorage elements, transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_25_71_50_85	000928	DELIVERY AND INSTALLATION OF LOWER RAILWAY FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 0,30 m	m	Delivery and installation of Lower Railway fence built with wire reinforcement single torsion mesh and galvanized posts consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post at each end, 2,50 m long and 0,30 m high. Including complete concrete foundations(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_25_71_50_85	000929	DELIVERY AND INSTALLATION OF RAILWAY TRANSITION FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 0,30 m to 1,80 m, WITH BURIED FENCE PROTECTION 50cm DEEP	m	Delivery and installation of Railway transition fence built with wire reinforcement single torsion mesh and galvanized posts, with buried fence protection 50 cm deep, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post at both ends, 0,30 - 1,80 m variable height, with variable length as needed, with buried fence protection 50 cm deep, or until the mesh reaches the culvert. Including complete concrete foundations(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_25_71_50_85	000930	DELIVERY AND INSTALLATION OF RAILWAY FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 1,80 m, WITH BURIED FENCE PROTECTION AT LEAST 25cm	m	Delivery and installation of Railway Fence built with wire reinforcement single torsion mesh and galvanized posts, with buried fence protection at least 25 cm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post every 3,50m, 1,80m height, with barbed wire on top and buried fence protection at least 25 cm. Including complete concrete foundations(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_25_71_50_85	000931	DELIVERY AND INSTALLATION OF RAILWAY FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 2,70 m, WITH BURIED FENCE PROTECTION AT LEAST 25cm	m	Delivery and installation of Railway Fence built with wire reinforcement single torsion mesh and galvanized posts, with buried fence protection at least 25 cm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post every 3,50m, 2,5m height, with barbed wire and buried fence protection at least 25 cm. Including complete concrete foundations(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_25_71_50_85	000932	DELIVERY AND INSTALLATION OF RAILWAY FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 2,70 m, WITH BURIED FENCE PROTECTION AT LEAST 25cm AND WITH THE FIRST 60 cm ON THE GROUND WITH HIGHER MESH DENSITY	m	Delivery and installation of Railway Fence built with wire reinforcement single torsion mesh and galvanized posts, with buried fence protection at least 25 cm consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post every 3,50m, 2,5m height, with barbed wire, with buried fence protection at least 25 cm and with the first 60 cm on the ground with higher mesh density. Including complete concrete foundations(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_25_71_50_85	000933	DELIVERY AND INSTALLATION OF RAILWAY SLOPED FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 2,50 m, ANCHORED TO CONCRETE SURFACE	m	Delivery and installation of Railway sloped Fence built with wire reinforcement single torsion mesh and galvanized posts, anchored to concrete surface consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post every 3,5m, 2,5m height, with barbed wire and anchored to concrete. Including anchorage elements, transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_25_71_50_85	000934	DELIVERY AND INSTALLATION OF SIMPLIFIED FENCE. RAILWAY FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 1,25m.	m	Delivery and installation of Railway Fence built with wire reinforcement single torsion mesh and galvanized posts, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized posts every 3m, 1,25m height. Including complete concrete foundations(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_25_71_50_85	000935	DELIVERY AND INSTALLATION OF SIMPLIFIED FENCE ADAPTED FOR AMPHIBIANS. FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 1,25m, PROTECTION AT LEAST 25cm AND WITH THE FIRST 60 cm ON THE GROUND WITH HIGHER MESH DENSITY	m	Delivery and installation of Fence built with wire reinforcement single torsion mesh and galvanized posts, with buried fence protection at least 25 cm and with the first 60cm on the ground with higher mesh density, consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized posts every 3m, 1,25m height, with buried fence protection at least 25 cm and with the first 60 cm on the ground with higher mesh density. Including complete concrete foundations(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_25_71_50_85	000936	DELIVERY AND INSTALLATION OF RAILWAY SLOPED FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 2,00 m, ANCHORED TO CONCRETE SURFACE	m	Delivery and installation of Railway sloped Fence built with wire reinforcement single torsion mesh and galvanized posts, anchored to concrete surface consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized post every 3m, 2,0m height, with barbed wire and anchored to concrete. Including complete anchorage elements(inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_25_71_50_85	000937	DELIVERY AND INSTALLATION OF SIMPLIFIED FENCE. RAILWAY FENCE BUILT WITH WIRE REINFORCED SINGLE TORSION MESH AND GALVANIZED POSTS, HEIGHT 1,25m, ANCHORED TO CONCRETE SURFACE	m	Delivery and installation of Simplified railway fence built with wire reinforcement single torsion mesh and galvanized posts, anchored to concrete surface consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for delivery from storage place and installation of reinforced simple torsion wire mesh and galvanized posts every 3m, 1,25m height, anchored to concrete. Including complete anchorage elements (inc. materials supply), transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.
Pr_20_76_51_21	000901	SUPPLEMENTARY LOWER RAILWAY FENCE WITH GRATING MADE OF GALVANISED TUBULAR STEEL SECTIONS	m	Supplementary lower railway fence with grating made of galvanised tubular steel sections consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of lower grate in the railway fence to prevent passing through animals when the fence crosses a ditch. It is made by galvanised tubular steel, according with the dimensions of de ditch, with distance between vertical rods of 5 cm maximum. Including all operations, materials and equipment necessary for the manufacture, foundations, transport, assembly, welding, coating, testing, necessary protections and all the auxiliary means necessary until it is placed in its final position on the construction site.
Ss_25_14	000901	SUPPLEMENTARY UPPER RAILWAY FENCE WITH VISIBLE ELEMENTS FOR AVOID BIRDS COLLISIONS	m	Supplementary upper railway fence with visible elements for avoid birds collisions consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of upper part in the railway fence to prevent birds collisions with the fence. It is made by wooden bars, safety netting, metal markers or similar. Including all operations, materials and equipment necessary for the manufacture, anchors, joints, transport, assembly, welding, coating, testing, necessary protections and all the auxiliary means necessary until it is placed in its final position on the construction site.

C. In the above work item for railway fence, the following shall be considered:

- a. The fence will be measured by actually executed linear metres (m).
- b. The work item includes all works and expenses necessary to achieve the specified result, e.g. workforce, materials, equipment, transportation (including fuel, insurance, etc.) and complete installation (including earthworks, complete concrete foundations, transportation through worksite, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement).

8.3 GATES FOR RAILWAY FENCE

8.3.1 DEFINITION

- A. The fence gates for the railway general enclosure are constituted by hot galvanized steel profiles and single torsion mesh, forming one (1) or two (2) door leaves in which the dimensions of the different elements that compose the gates will be those defined in the Drawings and the characteristics will be those indicated in this article.

- B. The execution of the work item includes the following operations:
 - a. Preparation of the work area (site clearing, bush and scrub removal and working site levelling);
 - b. Setting out the gate location according to the position set at the drawings;
 - c. Execution of the foundations;
 - d. Positioning and levelling of gates.

8.3.2 GENERAL CONDITIONS

- C. Fences gates and their components shall have a DWL of 50 years.
- D. Fence gates shall be minimum one metre and eighty centimetres height (1.80m) and shall have a width of at least one metre and twenty centimetres (1.20m) when it is aimed for pedestrian access only, while for vehicle access two leaves are required for a total of four metres (4.0m), with a leaf of two metres and eighty centimetres (2.80m) and another of one metre and twenty centimetres (1.20m). In any case dimensions shall be as shown in the Technical Drawings.
- E. Any modification of the characteristics shall be authorised by the Engineer and shall in no way reduce the strength or functional properties of the gate.
- F. The characteristics of the materials used for the manufacture of the gates shall be analogous to those described in the previous chapter "Railway Fence", for posts, mesh, frames and accessory elements, with the dimensions and composition indicated on the plans.
- G. Gates shall include provisions to block leaves and maintain them in the open position.
- H. Gates shall have a clamping device for leaves on the posts preventing their opening by removal of hinges.
- I. All doors shall be equipped with a double-barrelled safety locking system that shall allow the use of universal keys, in such a way that maintenance staff will be able to move through railway zone only with a master key. Doors shall have also a provision for closure using a padlock and chain. Before installation, the proposed system shall be submitted to the Engineer for approval.
- J. The placement of the gates shall be carried out very carefully to avoid frictions which could remove the zinc layer.
- K. All exposed metal conductive parts of the gates shall be grounded following Section 10. EARTHING AND BONDING SYSTEM of this Technical Specifications.

8.3.3 EXECUTION CONDITIONS

- A. Gates shall be placed as it is defined in the Technical Design Drawings.
- B. Before installing the gates, the ground should be cleared of bushes, stones, and any other unwanted element, as stated in Section 02 – EARTHWORKS and left as horizontal as possible.
- C. The lower edge of the door should be as close to the ground as possible. The permissible separation ranges between two and five centimetres (2 to 5cm).
- D. The concrete to be used in the foundations will be at least C20/25. The manufacture, transport, placement and control of the concrete will follow the requirements of Section 05. STRUCTURES in this Technical Specifications and Eurocode 2 Standard; additives that may promote corrosion shall not be used.
- E. The foundations of the holding posts of the gates shall consist of concrete blocks with a minimum surface area of forty by forty centimetres (40 x 40 cm) and a minimum depth of forty centimetres (40cm) and shall be completely buried. At points where the ground does not present enough consistency, the foundation dimensions shall be increased as necessary to ensure the stability of the fence.
- F. To prevent animal passage under the gates, a continuous footing shall link the foundations.
- G. All materials shall be related to valid quality certificates.

8.3.4 EXECUTION CONTROL

- A. At least, the following parameters shall be followed:
 - a. Visual inspection of the general condition of the gates.
 - b. Testing of foundation concrete following these Technical Specification, chapter 5.2.5.

- c. Manual check of the pull-out resistance the gate posts. The inspection consists of moving manually the gate support without noticing displacement in the foundation base.
 - d. Those identified irregularities in the fence supports shall be corrected by the Contractor and no deficiencies will be admissible.
- B. All materials shall be related to valid quality certificates.

8.3.5 MEASUREMENTS AND PAYMENT – GATES (FOR FENCE)

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 184. Units of measurement - Gates (for fence)

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_30_59_33_78	000901	DOUBLE GATE FOR FENCE	pc	Double gate for fence consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of double gate in fence with steel profiles and single-twist mesh, 1.80 m height and 4.00 m width (leaves of 2.80 m and 1.20 m). Including complete concrete foundations, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_30_59_33_78	000902	SIMPLE GATE FOR FENCE	pc	Simple gate for fence consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of simple gate in fence with steel profiles and single-twist mesh, 1.80 m height and 1.20 m width. Including complete concrete foundations, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_30_59_33_78	000904	DOUBLE GATE FOR FENCE. PORTAL	pc	Double gate for fence consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of double gate in fence with steel profiles and single-twist mesh, 2 m height and 4.00 m width (leaves of 2.80 m and 1.20 m). Including complete concrete foundations, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_30_59_33_78	000903	SIMPLE GATE FOR FENCE. SAFETY GATE	pc	Simple gate for fence consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of simple gate in fence with steel profiles and single-twist mesh, 2 m height and 1.20 m width. Including complete concrete foundations, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.
Pr_30_59_33_78	000905	DOUBLE GATE FOR FENCE. SENSITIVE AREA PORTAL	pc	Double gate for fence consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of double gate in fence with steel profiles and single-twist mesh, 2.30 m height and 4.00 m width (leaves of 2.80 m and 1.20 m). Including complete concrete foundations, transport, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement.

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_30_59_33_78	000906	SIMPLE GATE FOR FENCE (EXTRA HIGH FENCE)	pc	Simple gate for fence consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and installation of simple gate in fence with steel profiles and single-twist mesh, 2.30 m height and 1.20 m width. Including complete concrete foundations, transport, assembly, testing, necessary protections and as much equipment and labor as necessary for their final placement.

- C. In the above work item for gates, the following shall be considered:
- The gates shall be measured by actually executed pieces (pc).
 - The work item includes all works and expenses necessary to achieve the specified result, e.g. workforce, materials, equipment, transportation (including fuel, insurance, etc.) and complete installation (including earthworks, complete concrete foundations, transportation through worksite, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement).

8.4 WOODEN FENCE FOR GREEN BRIDGES, ECODUCTS.

8.4.1 DEFINITION

- A. The wooden fence is a fencing system composed of structural steel posts and wooden boards, with the characteristics described below:
- Wooden fencing components shall be suitably designed to avoid the collection of water at joints, and suitably protected against premature failure due to natural decay, by the use of suitable preservative treatment;
 - The wood shall be impregnated or soaked to safeguard design lifetime of the barriers, following the instructions of the coating manufacturer. CCA coatings shall be avoided. This coating shall be effective against weathering and against vandalism (graffiti);
 - No specific type of wood is specified, unless otherwise required by the Engineer;
 - A protective finish shall be applied on wooden elements to reduce the water ingress and keep the timber wood below the moisture content of 20%;
 - The dimensions of the wooden horizontal boards in the area of the lateral fence and the area of the front fence shall be as shown on Technical Drawings with a cross section in two layers. These dimensions shall be confirmed on site with the real layout of the posts. These wooden boards shall not be directly anchored to the steel posts but through vertical wooden elements with the dimensions as shown on Technical Drawings. All wooden elements shall be treated and coated against weathering and minimum characteristic bending strength $f_{m,k} = 30 \text{ N/mm}^2$.
- B. The execution of the work item includes the following operations:
- Preparation of the working area (site clearing, bush and scrub removal and working site levelling).
 - Setting out the fence location according to the position set at the drawings.
 - Supply and transport to the worksite of posts, wooden boards and all the necessary accessory elements.
 - Execution of the post foundations.
 - Anchoring of posts.
 - Filing of soil and protection of the slope with a stone pitching finishing with a kerbstone.
 - The kerbstone is a piece of in-situ reinforced concrete, C30/37, with the dimensions defined in Drawings.
 - Stone pitching shall be as shown on Drawings and as specified herein in subsection 4.7.1.
 - Placing and bracing of wooden components.

8.4.2 GENERAL CONDITIONS

- A. The setting out of the railway fence will be carried out in accordance with the Technical Drawings definition, placed along the entire perimeter of the green bridges from the level of the outlet to the top of the vault rising along the wingwalls.
- B. The fencing system shall present at least an IP3X level of sealing effectiveness in the Ingress Protection rating, as defined in standard EN 60529 "Degrees of protection provided by enclosures (IP code)". Therefore, the wooden fence shall provide protection to people against access to hazardous parts while handling hand tools with a diameter equal to or greater than two and a half millimetres (2.5mm), and it also shall provide protection to the fence against the ingress of solid foreign objects of the same size (2.5mm). Special protection against the ingress of water is not required.
- C. When the distance between live parts of the catenary system and the standing surface is less than or equal to 3m, the wooden fence shall be installed as an OCPs according to standard EN 50122-1 "Railway applications - Fixed installations - Electrical safety, earthing and the return circuit - Part 1: Protective provisions against electric shock". A total height of two and a half metres (2.5m) meets the requirements of this standard, as it is larger than the minimum of one metre and eighty centimetres (1.80m).
- D. The shape and dimensions of the posts and the wooden boards shall be as defined in the Technical Design Drawings,
- E. The posts shall consist of galvanized steel profiles with HEB 100 or HEB 120 cross section as shown on Technical Drawings, steel quality S355, and height as indicated in Technical Drawings. The connection to the foundation shall be performed by means of an anchoring plate and four galvanized anchor bolts. Steel elements of fences shall be protected against corrosion according to the corrosion class C4. All dimensions as shown on Technical Drawings.
- F. Exposed metal conductive parts of the fences (each of the posts and their foundations) shall be grounded following Section 10. EARTHING AND BONDING SYSTEM of this Technical Specifications.
- G. All wooden elements shall be treated and coated against weathering.
 - a. Deep-impregnated timber, preferred pine or larch, according to the standard EN 335, use class 3, impregnation class AB.
 - b. In contact with ground, water or concrete - use class 4, impregnation class A.
- H. The reinforced concrete foundation shall be executed as shown on Drawings. It consists of a squared footing, with its lower face buried under the ground level. From this foundation, a vertical wall one metre high shall reach the ground level with a squared cross section. The whole foundation shall be buried, if needed, by means of a small embankment. The material characteristics of these elements is shown in the table below. The concrete reinforcement steel shall be S500 (class B) grade.

Table 185. Conditions – Concrete for Wooden fence

Element	Grade	Exposure	C _{nom} (mm)	Min. Cement Content (kg/m ³)	Max. W/C	Max. Aggregate size
Foundation	C30/37	XC2	50	280	0.60	20
Wall	C35/45	XC4/XD1/XF2	50	340	0.45	20

8.4.3 EXECUTION CONDITIONS

- A. The wooden fence shall be placed in accordance with the Technical Drawings, unless otherwise agreed with the Engineer.
- B. The placement of the posts and the wooden elements shall be done without producing deformations and there shall be no friction that could remove the coatings, and with the following execution tolerances:

Table 186. Execution tolerances - Wooden fence

Requirement	Execution tolerance
Distance between posts	20mm
Setting out	10mm
Levelling and plumbing	5mm

- C. Before installing the posts, the ground shall be cleaned of shrubs, stones and any element that obstruct the placement of wooden boards.
- D. The manufacture, transport, placement and control of the concrete will follow the general requirements for concrete set in these Technical Specifications and the manufacturer's instructions. Additives that may promote corrosion shall not be used.
- E. The wooden boards shall not have any areas that are curved or deteriorated due to faulty assembly. They shall not be installed before the Engineer has approved the installation of the posts.
- F. Any excavation required shall be performed in accordance with Section 02 – EARTHWORKS in these Technical Specifications. The products from excavations shall be spread regularly, either "in situ" or in the landfills which the Contractor has agreed under his own responsibility. In any case, areas where accidental spill has occurred shall be treated in such a way that their final appearance is integrated into the environment. The Contractor shall follow the instructions on landfills contained in the Technical Design.

8.4.4 EXECUTION CONTROL

- A. At least, the following parameters shall be followed:
 - a. Topographic check of the wooden fence location;
 - b. Visual inspection of the general condition of the wooden fence;
 - c. Testing of foundation concrete following these Technical Specification, chapter 5.2.5.
- B. All materials shall be related to valid quality certificates.

8.4.5 MEASUREMENT AND PAYMENT – WOODEN FENCE

- A. The unit price shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 187. Units of measurement - Wooden fence

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_25_14_63_95	000301	WOODEN FENCE OVER CUTTING OR EMBANKMENT CROSS SECTIONS	m	Wooden fence over cutting or embankment cross sections consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of wooden fence composed of structural steel posts and wooden boards, including the foundation of the posts with reinforced concrete, the subsequent filling of soil and the protection of the slope with a stone pitching finishing with a kerbstone.

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_25_14_63_95	000302	WOODEN FENCE OVER BRIDGE OR STRUCTURE	m	Wooden fence over bridge or structure consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of wooden fence composed of structural steel posts and wooden boards, including proportional part of type profiles HEA / B and welded metal base plate with galvanized and painted finish, directly anchored to the bridge deck or structure.
Ss_25_14_63_95	000303	WOODEN FENCE OVER THE UPPER FRONT PART OF ECODUCTS	m	Wooden fence over the upper front part of ecoducts consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of wooden fence composed of structural steel posts and wooden boards, including the foundation of the posts with reinforced concrete, the subsequent filling of soil and the protection of the slope with a stone pitching finishing with a kerbstone.

- A. In the above work item for wooden fence, the following shall be considered:
- The fence shall be measured by actually executed linear metres (m);
 - The work item includes all works and expenses necessary to achieve the specified result, e.g. workforce, materials, equipment, transportation (including fuel, insurance, etc.) and complete installation (including earthworks, complete concrete foundations, transportation through worksite, assembly, testing, necessary protections and as much equipment and labour as necessary for their final placement).

9. SECTION 09.- NOISE MITIGATION MEASURES

9.1 SCOPE OF WORKS

- A. This section covers the following items and works:
 - a. Noise barriers;
 - b. Rail dampers;
 - c. as specified hereinafter, and as shown in Technical Drawings.
- B. This section provides a needed but non-exhaustive list of labour, materials, equipment, transport and services necessary to furnish, deliver and install all work of this section as shown on the drawing, as specified herein and/or as required by job conditions.
- C. The BIM models must contain detailed as-built data according to the specified LoG and LoI levels and "RBDG-MAN-040- Digital information requirements for construction and handover stages". As-built BIM models shall be created by the Contractor and/or updated by developing PIM (Project Information Model) models from the Technical Design accompanied with laser scanning/photogrammetry data according to RBGL-VDC-INS-R-00001.

9.2 NOISE BARRIERS

9.2.1 SCOPE AND DEFINITION

- A. Noise barriers or acoustic protection screens are defined as wall-shaped constructions that, placed between the source of noise and the receiver, allow reduce the sound levels at the area to be protected.
- B. The Noise Barrier elements (acoustic panels, steel posts with base plates) including seals and fasteners intended for installation of noise walls shall conform Rail Baltica Technical specification "RBCN-RWM-SPC-R-00005 - NOISE BARRIER ELEMENTS" and these Technical specifications.
- C. This chapter of the Technical Specification includes noise barriers acoustic and non-acoustic properties requirements of the materials, transportation and storage, work execution, the tolerances to provide their full design, the compliance control measures and the consideration regarding its measurement and valuation. The Noise Barrier elements materials shall meet requirements to corresponding Technical specification RBCN-RWM-SPC-R-00005 and these Technical specifications.
- D. In addition to the material performance requirements and other specifications, the noise barrier characteristics shall consider the design Technical Design documents ('Noise barriers. Explanatory letter.' and 'Noise barriers. Details').
- E. The construction of this work unit shall comply with the construction regulation listed herein.
- F. The design life of modular noise barriers for the purpose of stability and resistance calculations is the same than the DWL of the global project, it is 100 years for the concrete foundations with reinforcement steel. The supporting vertical profiles made up by structural steel have a DWL of 50 years, as well as the sealant and gaskets. The acoustic panels have a DWL of 25 years. Other noise barriers than modular, as narrow earth noise barrier, has a different design life, because of its particular design, and it is specified in the subsequent chapters.

9.2.2 GENERAL REQUIREMENTS

9.2.2.1 COMPLIANCE OF RELATED DOCUMENTS

- A. In addition to the specifications of this documents, the noise barriers geometry and the material properties shall be according to the Technical Design (reports 'Noise barriers. Explanatory letter.', 'Noise Impact Assessment Report' and drawings 'Noise barriers. General arrangement plan', 'Noise barriers. Details'), as well as comply with European and Local Legislation and Regulations, and the and the approved Environmental impact assessment (EIA) requirements for noise reduction.

9.2.2.2 NOISE BARRIERS MATERIAL AND CONSTRUCTION CONSIDERATIONS

- A. The installation process of the noise barriers materials shall comply to manufacturer's instructions.
- B. In addition, they shall follow the requirements and recommendations specified in these Technical specifications.
- C. Earth grading and/or paving at the base of the noise barrier panels and posts shall be such that the bottom panels are effectively buried to avoid any gaps.
- D. The earth and/or pavement shall be sloped away from the installation to prevent the washout of soil at the base of the noise barrier.
- E. Sealing elements and gaskets shall be used to guarantee the acoustic tightness of the noise barriers.
- F. The entire barriers shall be constructed in such a way as to avoid water stagnation at all points and, in particular for composite panels, water shall escape easily from the individual panels.
- G. The sound-absorbing material shall be secured in such a way to avoid displacement and bending and shall be protected so that it cannot become impregnated with water. Devices shall be provided to prevent the panels from being easily removed (each supplier shall describe theirs).
- H. The materials constituting the barriers shall be supplied in the colours that are indicated in the Technical Design.

9.2.2.3 ELECTRICAL PROTECTION

- A. The electrical protection for those noise barriers which are close to the electrical elements shall be guaranteed, such as the catenary mast.
- B. Earthing and bonding of the modular and narrow earth noise barriers shall be in accordance with Section 10 EARTHING AND BONDING SYSTEMS in these Technical Specifications.

9.2.2.4 VANDAL RESISTANCE

- A. Noise Barriers are required to be vandal resistant.
- B. Vandal resistant noise barriers shall be constructed out of break-resistant panels that cannot be penetrated by handheld tools e.g. sharp knife, sledgehammer etc.
- C. Where applicable the noise barriers shall contain tamperproof screws.
- D. Protection against damage to the insulation of absorptive noise barriers shall be provided.
- E. Noise barriers shall have an anti-graffiti coating.

9.2.2.5 EMERGENCY EXITS

- A. Emergency exits shall be according to the Technical Design.
- B. In barriers longer than 1000 m emergency exits shall be provided every 500m to give access to both side of the barrier for emergency and maintenance. This guideline is taken from EN-1794-2, which refers to the directive of tunnels. Emergency exits usually consist of gaps with overlapping barriers. Another way to ensure access to the railway line are emergency doors.

9.2.2.6 TRANSPORT AND STORAGE

- A. Contractor is responsible for storage, loading/unloading and transportation to installation place in the construction site.
- B. Noise barriers elements shall be transported and stored in accordance with the instructions provided by the manufacturer and these Technical specifications.
- C. Acoustic elements shall be supplied only with the manufacturer's declaration of performance (with translation into the official national language).

9.2.2.7 INSTALLATION AND MAINTENANCE

- A. The manufacturer shall provide the installation instructions that shall describe the way in which the product (acoustic and non-acoustic elements) is to be installed in order to obtain the behaviour measured in the initial type test.
- B. The Contractor shall provide a report on the maintenance rules to which the work shall be subjected for a period of at least 10 years. This manual shall specify the measures that are necessary, or that should be avoided, to maintain the durability of acoustic behaviour, structural resistance, transparency, etc.
- C. The intended maintenance cycle, as well as any replacement of panels damaged by accidents or vandalism, shall be capable of being carried out by simple means without compromising the static structure and rail traffic. Therefore, this report shall set out in a clear and schematic form the maintenance operations envisaged as well as the operations required for the easy and quick replacement of the panels or other components of the barrier.

9.2.3 MATERIAL REQUIREMENTS

- A. Noise Barrier elements (acoustic panels, steel posts with base plates) including seals and fasteners intended for installation of noise walls shall meet RBCN-RWM-SPC-R-00005 requirements.

9.2.3.1 MODULAR NOISE BARRIERS

- A. These noise barrier types can be placed either above a structure or the ground. If they are located above the ground, its supporting structure includes a foundation. If they lay on a structure, they are anchored to the supporting surface of the structure. The features of structural elements of the noise barriers are defined and justified in the Technical Design reports and drawings.
- B. Noise barriers shall be made up by the following main elements:
 - a. Acoustic panels: the type of acoustic panels depend on the noise barrier type. In all cases, they are the main acoustic elements of the noise barriers.
 - b. Vertical profiles: HE types or similar with a welded baseplate anchored directly to the support surface.
 - c. Ground Beam (if it is foreseen in the Technical design).
 - d. Foundation (if needed): it is composed by piles which support the vertical profiles. They are composed by reinforced concrete. Concrete works shall be according to Section 05 STRUCTURES in these Technical Specifications.
- C. The acoustic tightness of the noise barriers shall be guaranteed using sealant and gaskets.
- D. Earthing and bonding of the modular noise barriers shall be in accordance with Section 10 EARTHING AND BONDING SYSTEMS in these Technical Specifications.
- E. Noise barriers shall have an anti-graffiti coating.
- F. Within the modular noise barriers, there are the following types according to the properties of acoustic panels:
 - a. Metallic absorbing;
 - b. Wooden;
 - c. Transparent.

9.2.3.1.1 ACOUSTIC ELEMENTS

9.2.3.1.1.1 Metallic absorbing noise barriers

- A. In this case, the acoustic panels are metallic absorbing acoustic panels with dimensions as shown on Technical Drawings, composed by steel or aluminium sheets perforated in the inner face and non-perforated in the outer face regarding the noise source, with the inside made up of sound-absorbing material such as mineral wool, glass fibre or other suitable.
- B. The performance requirements related to the acoustic elements are presented in RBCN-RWM-SPC-R-00005.

9.2.3.1.1.2 Transparent noise barriers

- A. Acoustic panels shall be transparent acoustic panels with the dimensions as shown on the Technical Design Drawings.
- B. The performance requirements related to the acoustic elements are presented in RBCN-RWM-SPC-R-00005.

9.2.3.1.1.3 Wooden noise barriers

- A. In this case, the acoustic panels shall be wooden absorbing acoustic panels with dimensions as shown on Technical Design drawings, composed by wooden sheets, with the inside made up of sound-absorbing material such as mineral wool, glass fibre or other suitable.
- B. The performance requirements related to the acoustic elements are presented in RBCN-RWM-SPC-R-00005.

9.2.3.1.2 VERTICAL PROFILES

- A. Steel structural elements shall be provided with the manufacturer's certificate. The requirements related to the steel structural elements of noise barriers are presented in RBCN-RWM-SPC-R-00005.

9.2.3.1.3 SEALANTS AND GASKETS

- A. The requirements related to sealants and gaskets are presented in RBCN-RWM-SPC-R-00005.

9.2.3.1.4 FOUNDATIONS

- A. The general conditions and execution conditions of the drilling method related to the noise barriers foundations shall be according to the related requirements in Section 02 EARTHWORKS of these Technical Specifications.
- B. The Contractor shall guarantee the stability of the shaft during the execution. The Contractor shall apply the CFA as drilling method for the piles of the noise barriers. During the execution, if there is a risk of ground instability or water inlet, the Cased Kelly method shall be applied. Drilled piles shall be installed in accordance with the requirements of EN 1536. Structural class is S6 according to EN 1992-1-1.
- C. A pile cap shall be implemented in the top of the pile after its execution according to the dimension specified in the drawings. The specific design of concrete, its production, transportation, work performance, tolerances and test and evaluation of test results, shall be done according to the relevant parts of Section 05 STRUCTURES herein.
- D. Reinforcing steel bars that are intended to be used for reinforcement of concrete structures, manufacture of anchor bolts, and so on, shall be determined according to the relevant parts of Section 05 STRUCTURES herein.
- E. The concrete and reinforced concrete structures preparatory work, repair and surface coating of protective coatings, as well as waterproofing for structures shall be determined according the relevant parts of Section 05 STRUCTURES herein.
- F. The specific material properties are indicated in the Technical Design documents 'Noise barriers. Explanatory letter' and 'Noise barriers. Details' and "Technical Specification – Noise Barriers elements"
- G. For those noise barriers located out of the railway platform, before the drilling execution, the topsoil and non-competent material shall be excavated and replaced with embankment fill material. These cases are indicated in the drawings and bill of quantities. Drainage systems for noise barriers
- H. The noise barriers present a drainage system which dimensions are as shown on Technical Drawings located on the centre of the base of the lower panels. This element enables the runoff pass through preserving the noise mitigation efficiency of the noise barrier. If the manufacturer proposes another system, it shall specify how its design is compatible and achieve the target of the drainage system of the designed noise barrier.
- I. In addition to this, when necessary, it is designed a parallel ditch of granular material and geotextile with transversal paths to discharge the infiltrated water which allow avoiding the erosion of the sub-ballast surface as a consequence of the runoff flow. The discharge of the infiltrated water through the transversal paths is collected by precast concrete modules. These element enables the runoff pass through preserving the noise mitigation

efficiency of the noise barrier. They are designed according to the specifications of the SECTION 04 - DRAINAGE. These cases are specified in the Technical Design (explanatory note and drawings).

- J. The Manufacturer's specifications of the proposed material shall be submitted by the Contractor for the approval of the Engineer
- K. The proposed material can only be incorporated in the construction after the confirmation of the material characteristics and the approval of the Engineer.
- L. Since May 2007, the obligatory CE marking of noise reduction devices (noise barriers). The CE marking conformity verification system for noise barriers is type 3 of the Construction Products Regulation 305/2011/EU, which requires an initial test of the product in a notified laboratory and a factory production control.

9.2.3.2 NARROW EARTH NOISE BARRIERS

- A. In this case the noise barriers shall consist of gravity walls consisting of a core of filling material confined within a metal structure or cage and geotextile supported on a compacted gravel base. The surface is sown with plant species for the formation of a natural tapestry.
- B. The noise barrier is designed according to the Technical Design documents 'Noise barriers. Explanatory letter. 'Noise barriers. Details'.
- C. The detailed design of its components will depend on each manufacturer specifications, but is mainly composed by the following elements:
 - a. Support structure: steel support structure cage formed by trapezoidal arches of tubular steel profiles, with distance profiles for mounting the structure, pins, horizontal braces and an electro-welded mesh (variable depending on the height);
 - b. Geotextile: woven geotextile which allows contain the fill material within the steel structure cage;
 - c. Core filling material: earth that makes up the barrier itself;
 - d. Base: this type of noise barrier does not need a structural foundation, but it is placed above a compact gravel base that allows the base of noise barriers to be fit to the ground and increases the resistance of the underlying soil;
 - e. Natural tapestry: the surface is sown with plant species. The choice of plant species shall be adapted to their environment as well as fit to them the employed fertilizer. They shall be climate resistant, plants which can survive Baltic winter. Moreover, a maintenance plan shall be provided considering the periodic maintenance of planting, watering, weeding, replacement of failed plants followed by periodic thinning or pruning as necessary. It shall be guaranteeing the proper establishment of the vegetation in the initial period. Plant species shall be consulted and agreed with Employer before implementation;
 - f. Earthing and bonding of the narrow earth noise barriers shall be in accordance with Section 10 EARTHING AND BONDING SYSTEMS in these Technical Specifications.
- D. The noise barriers are supplied only with the manufacturer's declaration of performance (with translation into the official national language). The performance requirements related to the whole noise barrier are presented in the table below:

Table 188. Performance requirements - Narrow earth noise barriers

Performance	Requirement	Test method ^{(a),(d)}
Acoustic features:		
Sound absorption	≥4dB	EN 1793-1 EN 16272-1
Sound insulation	≥ 24dB	EN 1793-2 EN 16272-2
Non acoustic features:		
Dry weight of the acoustic element	>Min. Weight ^(b) <Max. weight ^(b)	EN 1794-1 Annex B EN 16272-1

Performance	Requirement	Test method (a),(d)
Vertical load that the acoustic element can withstand (the load from the upper components)	Withstand its own wet weight and the influence of environmental effects (wind, rain, snow, icing, etc.)	EN 1794-1 Annex B EN 16727-1
Orthogonal (90 °) load which acoustic element can withstand (wind and static load)	> Load project kN/m ² (c)	EN 1794-1 Annex A EN 16727-1
Orthogonal (90 °) load which can withstand the acoustic element (dynamic snow load)	Not required	EN 1794-1 Annex E EN 16727-1
Stones effect: damage caused by the controlled effects	Not required	EN 1794-1 Annex C EN 16727-1
Resistance to fire	Class ≥ 1	EN 1794-2 Annex A EN 16727-3 Annex A
Falling debris risk:	≥ Class 3	EN 1794-2 Annex B EN 16727-3 Annex B
Environmental protection	Not release dangerous substances	EN 1794-2 Annex C EN 16727-3 Annex C
Safety measures: evaluation according to the approved standards	Not required	EN 1794-2 Annex D EN 16727-3 Annex D
Light reflection, reflectance value	Class ≥ 2	EN 1794-2 Annex E EN 16727-3 Annex E
Transparency: Evaluation according to the approved standards	Not required	EN 1794-2 Annex F EN 16727-3 Annex E
Durability:		
Acoustic performance	4k2 >35 years	EN 14389-1 EN 16951-1
Non-acoustic properties	4k2 >35 years	EN 14389-2 EN 16951-2
Notes: a) - the manufacturer shall provide the declaration of performance in accordance with at least one of the two specified regulations in each case. b) - the minimum weight and the maximum weight allowed are indicated in the document 'Noise barriers. Explanatory letter.' c) - the load project is indicated in the document 'Noise barriers. Explanatory letter.' d) - applicable standards shall correspond specific noise barrier assignation - road or railway. If the noise barriers are designed to mitigate noise from both railways and roads sources, both railways and roads standards must be applied.		

E. The design shall comply with all applicable European and local standard and consider the following requirements and recommendations:

- a. The noise barrier detail technical design and structural composition shall guarantee the stability and structural resistance according to the Eurocodes verifications and the Technical Design document 'Noise barriers. Explanatory letter.'
- b. The steel structural cage and all wires and elements which comprise it shall be in accordance with the EN 10080 and EN 10218 series. They shall present tensile strength enough to resist the project loads. The union between different mesh shall comply the respective standard related to the union type and guarantee the proper union along the design life of the noise barrier.
- c. Steel support structure shall present anticorrosion treatment, either hot dip galvanized coatings and powder coated to the steel bars according to EN ISO 1461 and EN 15773 or painted for a high durability class (EN ISO 12944-1), which shall be applied for the project ambient exposure according to EN ISO 12944-2.

- d. For the core filling material, it is recommended the use of a granular material gravel type. It shall be a material with the same properties than the Frost protection layer. The material requirements are presented in Section 02. The angularity of fill should be avoided to protect the geotextile layer.
- e. The topsoil shall be replaced. In addition, usually it shall be applied a deeper and largest replacement to guarantee the compliance to bearing capacity. Those cases where the replacement is necessary are indicated in the documents 'Noise barriers. Explanatory letter.' and 'Noise barriers. Details'. This replacement will consist on:
 - i. A thickness of at least 1.0m shall be cleaned and replaced by suitable granular material that shall be compacted to 100% of the Standard Proctor density (EN 13286-2). The soil replacement depth is specified case by case in the drawings and it is related to the topsoil and non-competent material. The bearing capacity shall be verified during the work construction stage. If there is lower bearing resistance in the location of some noise barrier considering the specified soil replacement depth, the cleaning and replacement treatment should be recalculated, and the soil replacement depth increased if necessary.
 - ii. The bottom of the replacement excavation shall also be compacted.
 - iii. The material to be disposed is the same type than the Prepared Subgrade. The material requirements are presents in Section 02.
 - iv. This replacement shall have a 0.50 m wide width on each side of the base of the noise barrier. In other words, the base of the whole noise barrier is 1m bigger than the base of the trapezoidal section.
- f. The geotextile shall allow the correct growth of the vegetation, guarantee that there is no leakage of the core filling material, present tensile strength enough to resist the acting loads, and have UV resistance. The following properties are stated in the following table:

Table 189. Properties - Geotextile of the narrow earth noise barriers

Performance	Requirement	Test Method
Colour	Green or tan	Visual
Mass/Unit area	≥ 250	ASTM D-6566
Thickness	≥ 6 mm	ASTM D-6525
Light Penetration (% Passing)	35 %	ASTM D-6567
Tensile Strength MD/CD	≥ 29 / 29 kN/m	ASTM D-6818
Elongation	50 %	ASTM D-6818
Resiliency	70%	ASTM D-6524
UV Resistance @ 3000 hours	90 %	ASTM D-4355

- g. Priority shall be given to the use of local vegetation species to cultivate the natural tapestry to ensure proper integration into its environment and its correct conservation. If fertilizers are used, they shall be adapter to the plant species selected. In order to encourage the formation of a natural tapestry cultivation of vegetation shall be carried out from the beginning where that is possible.
 - h. This noise barrier type shall not include an irrigation system, it shall allow the grow thanks to natural precipitation.
- F. If the manufacturers or Technical design instructions differ from the indicated requirements and recommendations, it shall be justified, and they shall guarantee the better practice from a technical point of view.
 - G. The Manufacturer's specifications of the proposed material shall be submitted by the Contractor for the approval of the Engineer.
 - H. The proposed material shall only be incorporated in the construction after the confirmation of the material characteristics and the approval of the Engineer.
 - I. It is compulsory provide the CE marking for the main components of this noise barrier type.

9.2.3.3 EARTH MOUNDS ACTING AS NOISE BARRIERS

- A. In this case the noise barriers consist of gravity walls consisting of an embankment material non confined within a supporting structure. In fact, they are embankments and shall follow the same technical specifications than described in Section 02 for all aspects, both material requirement and work execution process. The surface is cover with topsoil as explained in SECTION 02 – EARTHWORKS. Their geometry is defined in the Technical Design for each case (drawings and reports).
- B. Regarding the acoustic properties, it is considered that if they follow the indications presented in this technical specification and the related drawings and report, they provide the following main acoustic features:

Table 190. Acoustical features - Earth mounds

Performance	Requirement	Test method ^(a)
Acoustic features:		
Sound absorption	≥4dB	EN 1793-1 EN 16272-1
Sound insulation	≥ 34dB	EN 1793-2 EN 16272-2
Note: a) - applicable standards shall correspond specific noise barrier assignation - road or railway. If the noise barriers are designed to mitigate noise from both railways and roads sources, both railways and roads standards must be applied.		

9.2.4 WORK EXECUTION REQUIREMENTS

9.2.4.1 MODULAR NOISE BARRIERS

- A. The assembly of acoustic panels and vertical profiles shall be provided according to manufacturer's instructions. In addition, they shall follow the requirements of the Technical Design.
- B. For those noise barriers located out of the railway platform, before the drilling execution, the topsoil and non-competent material shall be excavated and replaced with embankment fill material. These cases are indicated in the drawings and bill of quantities.
- C. Before installing the noise barrier, the ground shall be cleaned of bushes, stones, etc. that allow the proper laying of foundations and plates and guarantee the correct contact of the lower edge of the panel which shall be in contact with the ground; it shall be done in accordance with relevant part (clearing and grubbing) in Section 02 EARTHWORKS herein.
- D. The drilling of the foundation will be carried out with the presence of a competent technician by the construction company, building a suitable foundation and subsequent supports, with the dimensions indicated in the documents 'Noise barriers. Explanatory letter.' and 'Noise barriers. General Arrangement Plan'.
- E. A pile cap shall be implemented in the top of the pile after its execution according to the dimension specified in the Technical Design Drawings.
- F. In the execution of the foundation, the anchor bolts will be placed leaving them to receive the vertical supports with their corresponding base plate where the vertical profile will be fixed.
- G. The vertical supports will be installed in such a way as to ensure their verticality, allowing the maximum deviation presented in sub-clause 9.2.3.1.2. The distance between the axis of these supports will be adequate to the acoustic panels.
- H. The installation of the modular panels will be carried out taking the necessary precautions to avoid their deterioration. Any scratch or blow to the panels that may affect their mechanical, acoustic characteristics or protection or aesthetic elements may be a cause for the Employer's rejection of the element.
- I. The modular panels will be placed directly between the wings of the HE profiles, adjusting them horizontally and vertically using rubber or high-density foam joints to avoid vibrations.

- J. The panels will be installed in such a way that they fit perfectly between two consecutive posts. It will be ensured that between the ends of the panels and the core of the vertical profiles the same clearance remains at both panel's ends.
- K. The assembly will be carried out using the needed machinery and operators who facilitate the embedding of the upper panel from above, using the vertical profile wings as a rail. Tongue and groove system is highly recommended. If there are different permanent deformations of the panels, the necessary displacement will be applied so that the coupling between them occurs.

9.2.4.2 NARROW EARTH NOISE BARRIERS

- A. The construction of this type of noise barriers depends on manufacturer's instructions and shall comply with applicable local regulation. In addition, they shall follow the requirements of the architectural related documents of the Technical Design.
- B. The topsoil shall be replaced. In addition, usually it shall be applied a deeper and largest replacement to guarantee the compliance to bearing capacity. Those cases where the replacement is necessary are indicated in the Technical Design documents ('Noise barriers. Explanatory letter.' and 'Noise barriers. Details') and the process is explained in the subsection 9.2.3.2.e of the Technical Specifications.
- C. Before installing the noise barrier, the ground shall be cleaned of bushes, stones, etc. that allow the proper laying of noise barrier materials and the let the correct layer replacement execution. It shall be done in accordance with relevant part (clearing and grubbing) in Section 02 EARTHWORKS herein.
- D. Afterwards, the steel structural cage will be performed. This construction procedure will consider the correct assembly of all its elements to guarantee the noise barrier stability along its design life. Moreover, it shall use ground anchors for the work execution if needed to provide stability during this stage.
- E. The geotextile shall be attached to the steel mesh before placing the core filling material. Furthermore, overlapping at the locations of geotextile sheets splices shall be not less than 200 mm. Placement of the geotextile shall be affected in a way ensuring its continuous contact with the structural cage, without voids or protrusions.
- F. The core fill material placement shall not occur until the Engineer accepts steel structural cage preparation and geotextile attachment. When filling operations is carried out, it shall be performed in a way that guarantee the stability of the noise barrier during the work execution.
- G. It is recommended to follow a progressive filling, divide the noise barrier in several series and carry out an iterative process for the whole work execution.
- H. The ground shall be compacted when fall within the structural cage, but it is possible that the compaction increases as days go on as well as its density. In such cases, it shall be added more material to cover the lacking material.

9.2.4.3 EARTH MOUNDS ACTING AS NOISE BARRIERS

- A. Earth mounds acting as noise barriers shall follow the same execution process than stated in the Section 02 EARTHWORKS and Technical design.
- B. Before the embankment execution, the topsoil and non-competent material shall be excavated and replaced with embankment fill material. These cases are indicated in the drawings and bill of quantities.

9.2.5 TESTING AND ACCEPTANCE

9.2.5.1 TOLERANCES

9.2.5.1.1 MODULAR NOISE BARRIERS

- A. Tolerances of modular noise barriers shall be as follows:

- a. Noise Barrier shall be erected along a line or smooth curve as indicated on the drawings in the Contract within a tolerance normal to the plane of the barrier which is set in technical design documentation; in addition, the horizontal deviation from the required positions at adjacent panels or posts shall be taken into account as well from technical design documentation.
- b. The top edge of the barrier shall be at the specified height above the ground surface, existing ground or finished ground level of the earthwork environmental bund within a tolerance and the deviation from the required levels at adjacent panels or posts shall also be taken into account from technical design documentation. The minimum specified height of the noise barrier shall be maintained along the whole noise barrier.
- c. Barriers shall be vertical unless otherwise stated in technical documentation.

B. Tolerances are given in the following table:

Table 191. Tolerances - Modular noise barriers

Element	Criterion	Tolerance
Supporting profiles	Tolerances on shape and dimensions	EN 10034
	Deviation between the bottom and the top of the profile axis	± 10 mm
	The distance between the posts	± 25 mm
Acoustic elements	Element geometric dimensions deviation (length, height, thickness)	± 5 mm
	Squareness (the difference between the diagonals)	± 5 mm
Upper part	At the top of the post, the height difference between the acoustic element and the profile	± 10 mm

C. Concrete Structural elements and their geometric deviations shall be as per EN 13670.

9.2.5.1.2 NARROW EARTH NOISE BARRIERS

A. The minimum specified height of the noise barrier shall be maintained along the whole noise barrier. Tolerances are given in following table:

Table 192. Tolerances - Narrow earth noise barriers

Element	Criterion	Tolerance
Structural cage	Deviation between the bottom and the top of the trapezoidal transversal arches axis	50 mm
	The distance between the trapezoidal transversal arches	50 mm
Geotextile	Overlapping (length, height, thickness)	± 20 mm
Compacted gravel base	Each dimension of the rectangular replacement volume	± 50 mm

9.2.5.1.3 EARTH MOUNDS NOISE BARRIERS

A. The minimum specified height of the noise barrier shall be maintained along the whole noise barrier.

B. Tolerances are given in following table:

Table 193. Tolerances - Earth mounds noise barriers

Element	Criterion	Tolerance
Soil replacement	Geometry (width, depth, length)	± 200 mm
Embankment material	Geometry (width, height, length)	+ 200 mm
	Axis location	± 200 mm

9.2.5.2 COMPLIANCE CONTROL

9.2.5.2.1 MODULAR NOISE BARRIERS

- A. The acceptance phase shall consist of the prior certification of the materials and as far as the acoustic characteristics are concerned, it is divided into three stages. The acceptance – transfer protocol shall be drawn up and signed by the Contractor and the Manufacturer of the noise barrier acoustic panels. A separate acceptance – transfer protocol is drawn up and signed for each type of noise barrier acoustic panel (metal, wood, transparent) and its additional components.
 - a. the first concerning the visual inspection by the Engineer/Employer, for proper dimensions, cracks, voids, surface defects, inconsistency in colour and texture, and any other damage or imperfections;
 - b. the second stage - acoustic characteristics shall be supported by the laboratory tests certificate according to standards EN 1793-1; EN 1793-2; EN 16272-1; EN 16272-2; EN 16272-3. The performance requirements presented in this document shall be provided;
 - c. the third stage- acoustic characteristics shall be supported in open field and in normalized conditions according to standards EN 1793-5; EN 1793-6; EN 16272-5; EN 16272-6. The performance requirements presented in this document shall be provided.
- B. The tests are the responsibility of the manufacturer / supplier who shall certify the acoustic effectiveness of the work by having a series of tests performed by a qualified institute that meet the acoustic acceptance requirements.
- C. The certificates related to the compliance control procedure shall be accompanied by a statement from the Laboratory that certifies that the standard execution methods have been complied with in the relative regulations and prescriptions.
- D. The compliance control of the noise barriers components shall be carried out according to their corresponding specifications included in this document.

9.2.5.2.2 NARROW EARTH NOISE BARRIERS

- A. All materials delivered to the construction site should be visually inspected by the Engineer/Employer, for proper dimensions, cracks, voids, surface defects, inconsistency in colour and texture, and any other damage or imperfections.
- B. The compliance control of the noise barriers components shall be carried out according to their corresponding specifications included in this document.
- C. Acoustic characteristics shall be supported in open field and in normalized conditions according to standards EN 1793-5; EN 1793-6; EN 16272-5; EN 16272-6.

9.2.5.2.3 EARTH MOUNDS

- A. They shall follow the quality control as stated in the SECTION 2 – EARTHWORKS, verifying that the materials meet the requirements before the execution and the construction process is carried out according to the requirements presented in this document.

9.2.6 MEASUREMENT AND PAYMENT – MODULAR NOISE BARRIERS

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless otherwise stated, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement shall be as follows:

Table 194. Units of measurement - Modular noise barriers

Uniclass code	Type Number	Work item	Unit	Work item includes
Ss_25_16_73_03	000508	EARTH-MOUNDS FROM EXCAVATED MATERIAL	m3	Earth mounds as noise barriers consists of all works and expenses necessary to achieve the end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for execution of earth gravity walls without support structure made of excavated material. The slope is specified in drawings, with a typical slope of 2H:1V. Barrier width at top 3m. Width of the base depending on the height and slopes of the barrier.
Ss_25_16_73_03	000512	EARTH-MOUNDS FROM IMPORTED MATERIAL	m3	Earth mounds as noise barriers consists of all works and expenses necessary to achieve the end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for execution of earth gravity walls without support structure made of imported material. The slope is specified in drawings, with a typical slope of 2H:1V. Barrier width at top 3m. Width of the base depending on the height and slopes of the barrier.
Ss_25_16_73_03	000507	NARROW EARTH NOISE BARRIER FILLED WITH IMPORTED MATERIAL	m3	<p>Narrow earth noise barrier consists of all works and expenses necessary to achieve the end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of gravity walls to build noise-reducing acoustic sheet, consisting of a core of filling, made of imported material, confined within a metal structure or cage supported on a gravel or graded aggregate base (not included in this item). The surface is sown with plant species for the formation of a natural tapestry. Technical characteristics: The execution of concrete foundations is not required; The barrier is implemented on a compacted gravel base of prepared subgrade material (not included in this item); Galvanized steel support structure formed by trapezoidal arches of tubular steel profiles, welded and galvanized at the factory with distance profiles for mounting the structure, pins, horizontal braces and 150x150mm galvanized electrowelded mesh (variable depending on the height); Polypropylene woven geotextile blanket with Anti U.V treatment and great durability; Fill material: frost protection layer type made of imported material; Barrier width at the top of 0,6m; Slope 1H:10V, width of the base depending on the height of the barrier.</p> <p>In this item they are not included the following work items: earthing and bonding, the compacted gravel base consisting on prepared subgrade material, the site clearance, and excavation / filling that could be required previous noise barrier execution (if needed).</p>

Uniclass code	Type Number	Work item	Unit	Work item includes
Ss_25_16_73_03	000511	NARROW EARTH NOISE BARRIER FILLED WITH EXCAVATED MATERIAL	m3	<p>Narrow earth noise barrier consists of all works and expenses necessary to achieve the end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for supply and placement of gravity walls to build noise-reducing acoustic sheet, consisting of a core of filling, made of excavated material, confined within a metal structure or cage supported on a gravel or graded aggregate base (not included in this item). The surface is sown with plant species for the formation of a natural tapestry. Technical characteristics: The execution of concrete foundations is not required; The barrier is implemented on a compacted gravel base of prepared subgrade material (not included in this item); Galvanized steel support structure formed by trapezoidal arches of tubular steel profiles, welded and galvanized at the factory with distance profiles for mounting the structure, pins, horizontal braces and 150x150mm galvanized electrowelded mesh (variable depending on the height); Polypropylene woven geotextile blanket with Anti U.V treatment and great durability; Fill material: frost protection layer type made of excavated material; Barrier width at the top of 0,6m; Slope 1H:10V, width of the base depending on the height of the barrier.</p> <p>In this item they are not included the following work items: earthing and bonding, the compacted gravel base consisting on prepared subgrade material, the site clearance, and excavation / filling that could be required previous noise barrier execution (if needed).</p>
Ss_25_16_73_03	000521	DELIVERY AND INSTALLATION OF STEEL NOISE BARRIER OVER CUTTING OR EMBANKMENT CROSS SECTIONS	m2	<p>Delivery and installation of Steel noise barrier over cutting or embankment cross sections consists of all works and expenses necessary to achieve the end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for noise barriers to install over cutting or embankment cross sections and includes delivery from storage place and installation of a metal acoustic barrier consisting of sound-absorbing acoustic panels of dimensions 2000x500x96 mm, without rivets or screws, including all necessary components of the acoustic panels described in the technical specifications (i.e infill material, sealant and gaskets, vandal resistance, etc), the proportional part of type profiles HEA / B and welded metal base plate with galvanized and painted finish, supported on a concrete foundation (inc. materials supply) also included. In this item they are not included the following work items: earthing and bonding, drainage system (if needed), the site clearance (if needed) and excavation / filling that could be required previous noise barrier execution (if needed).</p>

Uniclass code	Type Number	Work item	Unit	Work item includes
Ss_25_16_73_03	000522	DELIVERY AND INSTALLATION OF STEEL NOISE BARRIER OVER BRIDGE OR STRUCTURE	m2	Delivery and installation of Steel noise barrier over bridge or structure consists of all works and expenses necessary to achieve the end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for noise barriers to install over bridge cross sections and includes delivery from storage place and installation of a metal acoustic barrier consisting of sound-absorbing acoustic panels, without rivets or screws, including all necessary components of the acoustic panels described in the technical specifications (i.e. infill material, sealant and gaskets, vandal resistance, etc), the proportional part of type profiles HEA / B and welded metal base plate with galvanized and painted finish, directly anchored to the bridge deck or structure. In this item they are not included the following work items: earthing and bonding.
Ss_25_16_73_03	000523	DELIVERY AND INSTALLATION OF WOODEN NOISE BARRIER OVER CUTTING OR EMBANKMENT CROSS SECTIONS	m2	Delivery and installation of Wooden noise barrier over cutting or embankment cross sections consists of all works and expenses necessary to achieve the result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for noise barriers to install over cutting or embankment cross sections and includes delivery from storage place and installation of wooden acoustic barrier made up of sound absorbing acoustic panels of dimensions 2000x500x95 mm/ 2000x1000x95 mm, including all necessary components of the acoustic panels described in the technical specifications (i.e. infill material, sealant and gaskets, vandal resistance, etc), the proportional part of metal support profiles type HEA/B and welded metal base plate with galvanized finish and optionally painted, supported on a concrete foundation(inc. materials supply) also included. In this item they are not included the following work items: earthing and bonding, drainage system (if needed), the site clearance (if needed) and excavation / filling that could be required previous noise barrier execution (if needed).
Ss_25_16_73_03	000524	DELIVERY AND INSTALLATION OF WOODEN NOISE BARRIER OVER BRIDGE OR STRUCTURE	m2	Delivery and installation of Wooden noise barrier over bridge or structures sections consists of all works and expenses necessary to achieve the end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for noise barriers to install over bridge cross sections and includes delivery from storage place and installation of a wooden acoustic sheet made up of sound absorbing acoustic panels of dimensions 2000x500x95 mm/ 2000x1000x95 mm., including all necessary components of the acoustic panels described in the technical specifications (i.e. infill material, sealant and gaskets, vandal resistance, etc), the proportional part of metal support profiles type HEA/B and welded metal base plate with galvanized finish and optionally painted, directly anchored to the bridge deck. In this item they are not included the following work items: earthing and bonding.

Uniclass code	Type Number	Work item	Unit	Work item includes
Ss_25_16_73_03	000525	DELIVERY AND INSTALLATION OF TRANSPARENT NOISE BARRIER OVER CUTTING OR EMBANKMENT CROSS SECTIONS	m2	Delivery and installation of Transparent noise barrier over cutting or embankment cross sections consists of all works and expenses necessary to achieve the end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for noise barriers to install over cutting or embankment cross sections and includes delivery from storage place and installation of transparent and colourless acoustic barrier consisting of acoustic panels made of polymethacrilate (PMMA), acrylic or similar, metal perimeter frame of at least 2 mm thick of hot dip galvanized steel and optionally painted in RAL colour to choose according to Design Guidelines, including all necessary components of the acoustic panels described in the technical specifications (i.e. sealant and gaskets, vandal resistance, etc), the proportional part of metal support profiles HEA/B type and welded metal base plate with galvanized and painted finish, supported on a concrete foundation(inc. materials supply) also included. In this item they are not included the following work items: earthing and bonding, drainage system (if needed), the site clearance (if needed) and excavation / filling that could be required previous noise barrier execution (if needed).
Ss_25_16_73_03	000526	DELIVERY AND INSTALLATION OF TRANSPARENT NOISE BARRIER OVER BRIDGE OR STRUCTURE	m2	Delivery and installation of Transparent noise barrier over bridge or structure consists of all works and expenses necessary to achieve the end result, e.g. workforce, equipment, applicable fees (e.g. disposal fees, permissions, etc.) and transportation (incl. fuel, insurance, etc.). This item is meant for noise barriers to install over bridge cross sections and includes delivery from storage place and installation of transparent and colourless acoustic barrier consisting of acoustic panels made of polymethacrilate (PMMA), acrylic or similar with dimensions 2000x500 mm/2000x1000 mm in 15 - 20mm thickness, metal perimeter frame of at least 2 mm thick of hot dip galvanized steel and optionally painted in RAL colour to choose, according to Design Guidelines including all necessary components of the acoustic panels described in the technical specifications (i.e. sealant and gaskets, vandal resistance, etc), the proportional part of metal support profiles HEA/B type and welded metal base plate with galvanized and painted finish, directly anchored to the bridge deck or structure. In this item they are not included the following work items: earthing and bonding.

- C. The modular noise barriers will be measured per built square metres (m²), considering the length of the whole noise barrier and its height.
- D. The narrow earth noise barriers will be measured per built cubic metres (m³), considering the total volume of the whole noise barrier placed above the ground.
- E. The earth mounds noise barriers will be measured per built cubic metres (m³), considering the total volume of the whole noise barrier placed above the ground.

9.3 RAIL DAMPERS

9.3.1 SCOPE AND DEFINITION

- A. Rail dampers are defined as absorbers which are designed for the reduction of noise emissions and agitation of the rail. Due to the discontinuous support of the rails on the sleepers and imbalance of the shifting wheel, rails are caused to vibrate.

- B. Based on its weight, the absorber on the rails damps the vibration and therefore reduces the noise. Usually rail dampers are placed in both sides of the rail in the free spaces between sleepers.
- C. This clause of the Technical Specification includes rail dampers acoustic and non-acoustic properties requirements of the materials, transportation and storage, work execution, the tolerances to provide their full design, the compliance control measures and the consideration regarding its measurement and payment. It is worth to clarify that there is not a specific standard regarding the manufacturing and performance of rail dampers. Therefore, the requirements are set considering the efficiency, durability, the integration with other track elements and the compliance with the material standards which compose the final product. The construction of this work unit shall comply with the related construction regulation listed in the sub-clause NORMATIVE REFERENCES.
- D. The rail dampers shall have a DWL of 50 years and provide noise mitigation for a DWL of 50 years.

9.3.2 GENERAL REQUIREMENTS

9.3.2.1 EFFICIENCY AND RELIABILITY

- A. In order to select the rail dampers type to be installed, they shall provide is the following noise reduction performance:
 - a. Freight trains: 3 dB of the global airborne noise emission;
 - b. Regional trains: 2 dB of the global airborne noise emission;
 - c. High speed train: 1.5 dB of the global airborne noise emission.
- B. The compliance of these reduction values shall be proved according to the test presented in sub-clause 9.3.5. In addition to those tests, the manufacturer shall present a reference of other railway project with similar features regarding track and rolling stock where they were used, and they developed the specified performance.
- C. The manufacturer shall be a certified company according to standard ISO 9001.

9.3.2.2 TRANSPORT AND STORAGE

- A. Rail dampers elements shall be transported and stored in accordance with the instructions provided by the manufacturers and shall comply with local regulation.
- B. Rail dampers shall be stored protected from the frost and sun.
- C. Rail dampers shall be supplied only with the manufacturer's declaration of performance (with translation into the official national language).

9.3.2.3 INSTALLATION AND MAINTENANCE

- A. The manufacturer shall provide the installation instructions that shall describe the way in which the product shall be installed in order to obtain the behaviour measured in the initial type test.
- B. Furthermore, the manufacturer shall provide a report on the maintenance rules to which the work shall be subjected for a period of at least 10 years. It shall be considered within the scope of this report the tasks of assembly and disassembly. This manual shall specify the measures that are necessary - or that should be avoided- to maintain the durability of acoustic behaviour, resistance, etc.
- C. The intended maintenance cycle, as well as any replacement of elements damaged by accidents or vandalism, shall be capable of being carried out by simple means without compromising the other element of the track. Therefore, this report shall set out in a clear and schematic form the maintenance operations envisaged as well as the operations required for the easy and quick replacement of the rail dampers.

9.3.3 MATERIAL REQUIREMENTS

- A. The components of the rail dampers depend on the manufacturer's specific design. Usually they consist of a special, heavy elastomer compound as well as a steel insert and are produced in a specialized vulcanizing process. Based on its great mass, the absorbers function as mass dampers. However, they can be also made up of other

materials and present different configurations in the function of the design of each manufacturer. In the same way, the fixation system are usually clamps made of stainless steel connect the absorber with the rail. Anyways, the components shall be certified according to the applicable standard. For example, if they are made up by rubber, vulcanized or thermoplastic materials, the hardness of the material shall be to be determined according to ISO 7619-1. The material characteristics shall guarantee the resistance and durability to the applied load and environmental conditions.

- B. Moreover, they shall present the following features:
- a. Rail dampers shall be designed for the specific track properties, rolling stock features and train speeds. For these boundary conditions, the rail dampers shall provide the efficiency presented in the sub-clause 9.3.2.1.;
 - b. Dampers need to be properly adapted to the shape of a rail;
 - c. It shall be guarantee that the product does not impact on existing EU TSI Infra conformity;
 - d. It shall be guaranteed a damage-free removal for the damper itself and the rail;
 - e. It shall present a coating that provide a high level of corrosion protection for the rail;
 - f. The temperature operating range of the system shall be from - 40° C to + 80° C or higher;
 - g. UV resistant;
 - h. Not susceptible to vandalism;
 - i. Self-draining - no pooling of water, no effect on rail corrosion;
 - j. No influence on ballast maintenance and rail grinding.

9.3.4 WORK EXECUTION REQUIREMENTS

- A. The assembly of the dampers in the rail shall comply to manufacturer's instructions.
- a. Carefully follow the installation instructions from the manufacturer. This guide shall consider both installation and disassembly operations.
 - b. Only use products and components specified by the manufacturer.
 - c. Locally specified Regulations and Site Safety procedures shall be observed, and relevant PPE (Personal Protective Equipment) used.
 - d. Easy-to-handle fixing system: by only a few working steps the prefab-installed rail damper is permanently fixed to the rail. If a rail has to be changed, the rail damper is removed, stored closed to the track and available for re-installation.
 - e. The fixation method or products shall not deteriorate the rail where dampers are placed.
 - f. Guarantee the proper contact between the dampers and the rail.
 - g. Verify that the fixation system of the damper of one side of the rail do not interfere with the damper of the other side.
 - h. The installation can be made either manually with special clamps or using a specific machinery indicated by the manufacturer
 - i. If the installation process involves the removing of a certain quantity of the ballast under the rail, the ballast bed should be replaced and finished to the height defined in the project

9.3.5 TESTING AND ACCEPTANCE

9.3.5.1 TOLERANCES

- A. The product provided by the Manufacturer shall not present any defect in its geometry, composition or manufacturing process which could compromise the required performance and the efficiency stated in the declaration of performance previously provided by the Manufacturer.
- B. The tolerances of the installation shall be specified by the manufacturer. The Contractor shall comply these installation tolerances specified by the product Manufacturer in order to allow reaching the required performance.

- C. In any case the rail dampers shall compromise the correct wheel-rail contact, as well as present any influence on ballast maintenance and rail grinding. They shall not generate any disturbance or interference to other track elements.

9.3.5.2 COMPLIANCE CONTROL

- A. The acceptance phase consists of the prior certification of the materials and as far as the acoustic characteristics are concerned, it is divided into three stages. This acceptance protocol shall be carried out for each combination of Contractor + Manufacturer + dampers model (type, ending materials, etc).
- the first concerning the visual inspection by the Engineer/Employer, for proper dimensions, cracks, voids, surface defects, inconsistency in colour and texture, and any other damage or imperfections;
 - the second stage - the laboratory tests according to the so-called STARDAMP method. The results shall present an efficiency $\geq 3.5\text{dB/m}$ between the frequency range of 1000 – 5000 Hz;
 - the third stage- concerning tests on rail dampers in open field and in normalized conditions by measuring the sound pressure levels before and after installation of the dampers during train pass-by according to ISO 3095 (exterior noise). Further information can be gained from the frequency spectra of the track decay rate according to EN 15461. The efficiency that they shall present shall be equal or higher to the performance specified in the sub-clause 9.3.2.1.
- B. The tests are the responsibility of the manufacturer / supplier who shall certify the acoustic effectiveness of the work by having a series of tests performed by a qualified institution that meet the acoustic acceptance requirements.
- C. The relative certificates shall be accompanied by a statement from the Laboratory that certifies that the standard execution methods have been complied with in the relative regulations and specifications included in this document.

9.3.6 MEASUREMENT AND PAYMENT – RAIL DAMPERS

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The rail dampers will be measured per metre of track where they are placed. The metre of track includes two rails, both sides of the rails.
- C. The units of measurement shall be as follows:

Table 195. Units of measurement – Rail dampers

Uniclass code	Type number	Work item	Unit	Work item includes
Pr_20_76_70_67	000501	Supply and placement of rail dampers in rails along the alignment for any surface in straight alignment and curve.	m	Supply and placement of rail dampers in rails consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, equipment and transportation (incl. fuel, insurance, etc.). This item is meant for absorbers devices placed on the rails for the reduction of noise emissions and vibrations. They are made up by different parts, as the absorber element, the clamps and the coating. Including the supply, transport, loading and unloading and positioning of dampers in the specified rails with the required tolerances, along the alignment for any surface in straight alignment and curve.

9.4 NORMATIVE REFERENCES

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies.

- a. EN 1793-1 Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 1: Intrinsic characteristics of sound absorption under diffuse sound field conditions
- b. EN 1793-2 Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 2: Intrinsic characteristics of airborne sound insulation under diffuse sound field conditions
- c. EN 1793-3 Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 3: Normalized traffic noise spectrum
- d. EN 1793-5 Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 5: Intrinsic characteristics - In situ values of sound reflection under direct sound field conditions
- e. EN 1793-6 Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 6: Intrinsic characteristics - In situ values of airborne sound insulation under direct sound field conditions
- f. EN 1794-1 Road traffic noise reducing devices. Non - acoustic performance. Part 1. Mechanical performance and stability requirements
- g. EN 1794-2 Road traffic noise reducing devices. Non - acoustic performance. 2 part. General safety and environmental requirements
- h. EN 14389-1 Road traffic noise reducing devices - Procedures for assessing long term performance - Part 1: Acoustical characteristics
- i. EN 14389-2 Road traffic noise reducing devices - Procedures for assessing long term performance - Part 2: Non-acoustical characteristics
- j. EN 1317-1 Road barrier systems. Part 1. Terminology and general criteria for test methods
- k. EN 1317-2 Road barrier systems. 2 part. Performance classes of safety barriers, including vehicle parapets, acceptance criteria for impact tests and test methods
- l. EN 16272-1 Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Test method for determining the acoustic performance - Part 1: Intrinsic characteristics - Sound absorption in the laboratory under diffuse sound field conditions
- m. EN 16272-2 Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Test method for determining the acoustic performance - part 2: intrinsic characteristics - Airborne sound insulation in the laboratory under diffuse sound field conditions
- n. EN 16272-5 Railway applications. Track. Noise barriers and related devices acting on airborne sound propagation. Test method for determining the acoustic performance. Intrinsic characteristics. In situ values of sound reflection under direct sound field conditions
- o. EN 16272-6 Railway applications. Track. Noise barriers and related devices acting on airborne sound propagation. Test method for determining the acoustic performance. Intrinsic characteristics. In situ values of airborne sound insulation under direct sound field conditions
- p. EN 16727-1 Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Non-acoustic performance - Part 1: Mechanical performance under static loadings - Calculation and test method
- q. EN 16727-2-1 Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Non acoustic performance - Part 2-1: Mechanical performance under dynamic loadings due to passing trains - Resistance to fatigue
- r. EN 16727-3 Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Non-acoustic performance - Part 3: General safety and environmental requirements.
- s. EN 1992-1-1 Design of concrete structures. General rules and rules for buildings
- t. EN 16951-1 Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Procedures for assessing long term performance - Part 1: Acoustic characteristics
- u. EN 16951-2 Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Procedures for assessing long term performance - Part 2: Non-acoustic characteristics
- v. EN 13501-1 Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests

- w. ISO 1183-1 Plastics — Methods for determining the density of non-cellular plastics - Part 1: Immersion method, liquid pycnometre method and titration method
- x. ISO 527 Plastics - Determination of tensile properties
- y. ISO 178 Plastics — Determination of flexural properties
- z. ASTM D-696 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between –30°C and 30°C with a Vitreous Silica Dilatometre
- aa. ISO 75-2 Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite
- bb. ASTM D-1003 Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics
- cc. ASTM E313-20 Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates
- dd. EN 1993-1-1 Eurocode 3. Design of steel structures. Part 1-1. General and building rules
- ee. EN 10365 Hot rolled steel channels, I and H sections. Dimensions and masses
- ff. EN 10034 Structural steel I and H sections. Tolerances on shape and dimensions
- gg. EN 10025-1:2004(D) Hot rolled products of structural steels
- hh. EN ISO 1461 Hot dip galvanized coatings on fabricated iron and steel articles- Specifications and test methods
- ii. EN ISO 1461 Coatings of cast iron and steel products obtained by hot-dip galvanizing. Technical requirements and test methods (ISO 1461: 2009)
- jj. EN 15773 Industrial application of powder organic coatings to hot dip galvanized or sherardized steel articles [duplex systems]. Specifications, recommendations and guidelines
- kk. EN ISO 12944-1 Paints and varnishes. Corrosion protection of steel structures with protective paint systems. Part 1. General introduction
- ll. EN ISO 12944-2 Paints and varnishes. Corrosion protection of steel structures with protective paint systems. 2 part. Environmental classification
- mm. EN 1011-1 Welding. Recommendations for welding of metallic materials. General guidance for arc welding.
- nn. EN ISO 15609-1 Specification and qualification of welding procedures for metallic materials - Welding procedure specification — Part 1: Arc welding
- oo. EN 13670 Execution of concrete structures
- pp. EN 10080 Steel for the reinforcement of concrete - Weldable reinforcing steel - General
- qq. EN 10218-1 Steel wire and wire products - General - Part 1: Test methods.
- rr. EN 10218-2 Steel wire and wire products - General - Part 2: Wire dimensions and tolerances.
- ss. EN 13286-2 Unbound and hydraulically bound mixtures - Part 2: Test methods for laboratory reference density and water content - Proctor compaction
- tt. ISO 14688-1 Geotechnical investigation and testing — Identification and classification of soil — Part 1: Identification and description
- uu. ASTM D-6566 Standard Test Method for Measuring Mass Per Unit Area of Turf Reinforcement Mats
- vv. ASTM D-6525 Standard Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products
- ww. ASTM D-6567 Standard Test Method for Measuring the Light Penetration of a Rolled Erosion Control Product (RECP)
- xx. ASTM D-6818 Standard Test Method for Ultimate Tensile Properties of Rolled Erosion Control Products
- yy. ASTM D-6524 Standard Test Method for Measuring the Resiliency of Turf Reinforcement Mats (TRMs)
- zz. ASTM D-4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus.
- aaa. EN 1536 Execution of special geotechnical work. Bored piles.
- bbb. EN ISO9223 Corrosion of metals and alloys — Corrosivity of atmospheres — Classification, determination and estimation.

- B. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.

10. SECTION 10.- EARTHING AND BONDING SYSTEM

10.1 SCOPE OF WORKS

- A. This Section defines the technical specifications for the following elements in the project:
 - a. Railway structures (viaducts, overpasses, underpasses, ecoducts, culverts); steel reinforcement;
 - b. Road structures;
 - c. Fencing;
 - d. Railing, posts, signals, steel pipes;
 - e. Any metal works,as shown in Technical Design Drawings and/or BIM models.
- B. This section provides a needed but non-exhaustive list of labour, materials, equipment, transport and services necessary to furnish, deliver and install all work of this section as shown on the drawings and/or BIM models, as specified herein and/or as required by job conditions.
- C. The BIM models must contain detailed as-built data according to the specified LoG and LoI levels in "RBDG-MAN-040- Digital information requirements for construction and handover stages". As-built BIM models shall be created by the Contractor and/or updated by developing PIM (Project Information Model) models from the Technical Design accompanied with laser scanning/photogrammetry data according to RBGL-VDC-INS-R-00001.
- D. The objectives for earthing and bonding of metal elements are the protection of persons and installations against dangerous touch voltages and overheating caused by the traction system for normal operation and under fault conditions (faults, short circuits, lightning etc.).
- E. All metal parts and steel reinforcements of structures will be equipotentially bonded together and connected to the earth and to the return circuit.
- F. All exposed metallic structures such as signals posts, posts, steel pipes, fences, etc. which are liable to become live due to inductive or capacitive coupling with the voltage of the contact line shall be bonded and connected to earth if not directly connected to the return circuit.

10.2 GENERAL REQUIREMENTS

- A. The construction of railway and road structures shall comply with the following requirements:
 - a. The grounding of railway structures shall be integrated into the ENE subsystem earthing and bonding system.
 - b. All metallic components shall be bonded and connected to earthing system, according to EN 50122-1 Standard.
 - c. The earthing system, its components and grounding conductors shall be resistant to short-circuit.
 - d. The grounding and bonding system shall have a resistance of $\leq 25\Omega$.
 - e. The use of chemicals to reduce soil resistivity is not allowed.
 - f. The earthing system shall maintain its integrity for the expected installation lifetime with due allowance for corrosion and mechanical constraints.
 - g. The installation and the grounding connections shall be achieved as shown in the Technical Design Drawings.
 - h. The design for components of the grounding, bonding system embedded within concrete structures shall comply with 100 years DWL.

10.3 CONDITIONS OF THE IMPLEMENTATION PROCESS

10.3.1 VIADUCTS

- A. The earthing and bonding of the reinforcements of the viaduct will be made for all piers and abutments. The electrical continuity will be done connecting the reinforcement of the deck with the reinforcement of the pier or abutment and will be bonded with the foundation's reinforcement, which will be grounded using earth conductors (bare copper conductors) of fifty square millimetres (50mm²) minimum.
- B. In order to measure the resistance of the ground, the earth conductor will be connected to one earth electrode (1 steel-copper rod), which will be installed in an earth pit of forty per forty to sixty centimetres (40 x 40 x 60 cm) filled with sand and accessible for inspection. At the top of the piers or abutments, terminals for connections to the deck reinforcement will be made.
- C. The value of resistance to earth shall be less than or equal to twenty-five Ohms ($\leq 25\Omega$). This value depends on the soil and in order to fulfil this requirement an additional electrode rods can be necessary. It will be defined during catenary construction works according with geotechnical and geoelectrical studies. However, the earthing system, in combination with appropriate measures, shall maintain step, touch and transferred potentials within the voltage limits, according to EN 50122-1 standard.
- D. The deck reinforcement will be bonded, both transversely and longitudinally to achieve electrical continuity and will be connected to the rail and the return wire at each pier and abutment with earth conductor of fifty square millimetres (50 mm²) minimum.
- E. Terminal shall be made on the deck (on both sides of the tracks) at each pier and abutment, providing the following connections:
 - a. With earth;
 - b. With rails;
 - c. With return wires (catenary posts).
- F. The connection to the return wire will be done through the nearest electrification pole, during catenary execution phase.
- G. In the expansion joints shall be fitted the corresponding connections in order to bridge the reinforcement.
- H. All metallic elements located above viaduct (fences, barriers, railings etc.) will be bonded and connected to earthing and bonding system, using earth conductors (Cu) of fifty square millimetres (50mm²) minimum, with screw terminals or welding. All these elements shall be electrically sectioned at the end of the railway influence zone to prevent leakage of the rail potential or return currents.
- I. The installation and the grounding connections shall be achieved as shown in the drawings.
- J. The design for components of the grounding, bonding system embedded within concrete structures shall comply with 100 years DWL.

10.3.2 UNDERPASSES

- A. The slab reinforcement will be bonded, both transversely and longitudinally to achieve electrical continuity. In addition, the reinforcement of the wingwalls shall also be bonded longitudinally and transversely, and will be bonded with the foundation's reinforcement, which will be grounded using earth conductors (bare copper conductors) of fifty square millimetres (50 mm²) minimum.
- B. In order to measure the resistance of the ground, the earth conductor will be connected to one earth electrode (1 steel-copper rod), which will be installed in an earth pit of forty per forty to sixty centimetres (40 x 40 x 60 cm) filled with sand and accessible for inspection.
- C. The value of resistance to earth shall be less than or equal to twenty-five Ohms ($\leq 25\Omega$). This value depends on the soil and in order to fulfil this requirement an additional electrode rods can be necessary. It will be defined during catenary construction works, according with geotechnical and geoelectrical studies. However, the earthing system, in combination with appropriate measures, shall maintain step, touch and transferred potentials within the voltage limits, according to EN 50122-1 standard.
- D. The deck slab reinforcement will be bonded to the reinforcement of the wingwalls which will be connected to the earth and to the rails and return wire with copper wire of fifty square millimetres (50mm²) minimum.

- E. Terminals shall be made on the deck slab and wingwalls, providing the following connections:
 - a. With earth
 - b. With rails
 - c. With return wires (catenary posts).
- F. The connection to the return wire will be done through the nearest electrification pole, during catenary execution phase.
- G. In the expansion joints shall be fitted the corresponding connections in order to bridge the reinforcement.
- H. All metallic elements located above underpass (barriers, railings etc.) will be bonded and connected to earthing and bonding system, using earth conductors (Cu) of fifty square millimetres (50 mm²) minimum, with screw terminals or welding. All these elements shall be electrically sectioned at the end of the railway influence zone to prevent leakage of the rail potential or return currents.
- I. The installation and the grounding connections shall be achieved as shown in the drawings.
- J. The design for components of the grounding, bonding system embedded within concrete structures shall comply with 100 years DWL.

10.3.3 OVERPASSES

- A. The deck reinforcement will be bonded (except prestressing cable), both transversely and longitudinally to achieve electrical continuity. In addition, the reinforcement of the abutments and piers shall also be bonded longitudinally and transversely and will be bonded with the foundation's reinforcement, to achieve electrical continuity, which will be grounded using earth conductors (bare copper conductors) of fifty square millimetres (50 mm²) minimum.
- B. In order to measure the resistance of the ground, the earth conductor will be connected to one earth electrode (1 steel-copper rod), which will be installed in an earth pit of forty per forty to sixty centimetres (40 x 40 x 60 cm) filled with sand and accessible for inspection.
- C. The value of resistance to earth shall be less than or equal to twenty-five Ohms ($\leq 25\Omega$). This value depends on the soil and in order to fulfil this requirement an additional electrode rods can be necessary. It will be defined during catenary construction works, according with geotechnical and geoelectrical studies. However, the earthing system, in combination with appropriate measures, shall maintain step, touch and transferred potentials within the voltage limits, according to EN 50122-1 standard.
- D. The reinforcement of the deck will be bonded to the reinforcement of the abutment and to the reinforcement of the piers, which will be bonded and connected to the rails and return wire with copper wire of fifty square millimetres (50 mm²) minimum.
- E. For this reason, during the construction phase of the overpass, the following terminal shall be prepared:
 - a. Deck Reinforcement – Abutment Reinforcement;
 - b. Deck Reinforcement – Pier Reinforcement;
 - c. Pier Reinforcement – Earth;
 - d. Pier Reinforcement – Rails;
 - e. Pier Reinforcement – Return wires (catenary posts).
- F. The connection to the return wire will be done through the nearest electrification pole, during catenary execution phase.
- G. In the expansion joints shall be fitted the corresponding connections in order to bridge the reinforcement.
- H. All metallic elements located above overpass (fences, barriers, railings etc.) will be bonded and connected to earthing and bonding system, using earth conductors (Cu) of fifty square millimetres (50 mm²) minimum, with screw terminals or welding. All these elements shall be electrically sectioned at the end of the railway influence zone to prevent leakage of the rail potential or return currents.
- I. The design for components of the grounding, bonding system embedded within concrete structures shall comply with 100 years DWL.

10.3.4 ECODUCTS

- A. The precast vault reinforcement of the ecoduct will be bonded, both transversely and longitudinally to achieve electrical continuity. In addition, the reinforcement of the walls of the ecoduct shall also be bonded longitudinally and transversely and will be bonded with the foundation's reinforcement, to achieve electrical continuity, and will be grounded using earth conductors (bare copper conductors) of fifty square millimetres (50 mm²) minimum.
- B. In order to measure the resistance of the ground, the earth conductor will be connected to one earth electrode (1 steel-copper rod), which will be installed in an earth pit of forty per forty to sixty centimetres (40 x 40 x 60 cm) filled with sand and accessible for inspection.
- C. The value of resistance to earth shall be less than or equal to twenty-five Ohms ($\leq 25\Omega$). This value depends on the soil and in order to fulfil this requirement an additional electrode rods can be necessary. It will be defined during catenary construction works, according with geotechnical and geoelectrical studies. However, the earthing system, in combination with appropriate measures, shall maintain step, touch and transferred potentials within the voltage limits, according to EN 50122-1 standard.
- D. The vault reinforcement will be bonded to the reinforcement of the wall and the reinforcement of the foundations, which will be bonded and connected to the rails and return wire with copper wire of fifty square millimetres (50 mm²) minimum.
- E. For this reason, during the construction phase of the ecoduct, the following terminals shall be made:
- F. Precast vault Reinforcement – Wall Reinforcement;
- G. Wall Reinforcement – Earth;
- H. Wall Reinforcement – Rails;
- I. Wall Reinforcement – Return wires (catenary posts);
- J. The connection to the return wire will be done through the nearest electrification pole, during catenary execution phase.
- K. In the expansion joints shall be fitted the corresponding connections in order to bridge the reinforcement.
- L. All metallic elements located above ecoduct (fences, barriers, railings etc.) will be bonded and connected to earthing and bonding system, using earth conductors (Cu) of fifty square millimetres (50 mm²) minimum, with screw terminals or welding. All these elements shall be electrically sectioned at the end of the railway influence zone to prevent leakage of the rail potential or return currents.
- M. The installation and the grounding connections shall be achieved as shown in the drawings.
- N. The design for components of the grounding, bonding system embedded within concrete structures shall comply with 100 years DWL.

10.3.5 CULVERTS

- A. The slab reinforcement will be bonded, both transversely and longitudinally to achieve electrical continuity. In addition, the reinforcement of the wingwalls shall also be bonded longitudinally and transversely, and will be bonded with the foundation's reinforcement, and will be grounded using earth conductors (bare copper conductors) of fifty square millimetres (50 mm²) minimum.
- B. In order to measure the resistance of the ground, the earth conductor will be connected to one earth electrode (1 steel-copper rod), which will be installed in an earth pit of forty per forty to sixty centimetres (40 x 40 x 60 cm) filled with sand and accessible for inspection.
- C. The value of resistance to earth shall be less than or equal to twenty-five Ohms ($\leq 25\Omega$). This value depends on the soil and in order to fulfil this requirement an additional electrode rods can be necessary. It will be defined during catenary construction works, according with geotechnical and geoelectrical studies. However, the earthing system, in combination with appropriate measures, shall maintain step, touch and transferred potentials within the voltage limits, according to EN 50122-1 standard.
- D. The deck slab reinforcement will be bonded to the reinforcement of the wingwalls which will be connected to the earth and to the rails and return wire with copper wire of fifty square millimetres (50 mm²) minimum.
- E. Terminals shall be made at the deck slab and wingwalls, providing the following connections:

- a. With earth
- b. With rails
- c. With return wires (catenary posts).
- F. The connection to the return wire will be done through the nearest electrification pole, during catenary execution phase.
- G. In the expansion joints shall be fitted the corresponding connections in order to bridge the reinforcement.
- H. All metallic elements located above underpass (barriers, railings etc.) will be bonded and connected to earthing and bonding system, using earth conductors (Cu) of fifty square millimetres (50 mm²) minimum, with screw terminals or welding. All these elements shall be electrically sectioned at the end of the railway influence zone to prevent leakage of the rail potential or return currents.
- I. The installation and the grounding connections shall be achieved as shown in the drawings.
- J. The design for components of the grounding, bonding system embedded within concrete structures shall comply with 100 years DWL.

10.3.6 WOODEN FENCE

- A. The metal conductive parts of the wooden fence at the end of the railway influence zone will be sectioned from the earthing and bonding system of the ecoduct.
- B. In case of the wooden fence installed beyond the ecoduct, an earth conductor of fifty square millimetres (50 mm²) buried at a depth of fifty centimetres (50 cm) beneath finished ground level will run along the entire wooden fence, and each wooden fence post will be connected to the earth conductor by a copper conductor with the same characteristics (Cu 50 mm²). The following connection elements will be made:
 - a. Connection to the wooden fence posts using a compression clamp for Cu 50 mm² earth conductor.
 - b. Connection to the buried earth conductor by an aluminothermic "T" welding for Cu 50 mm² conductor.
- C. The installation and the grounding connections shall be achieved as shown in the drawings.
- D. The design for components of the grounding, bonding system embedded within concrete structures shall comply with 100 years DWL.

10.3.7 NOISE BARRIER

- A. In case of modular noise barriers at the end railway structure zone, the metal conductive parts of these noise barriers will be sectioned from the earthing and bonding system of the railway structure. Beyond the railway structure zone, an earth conductor (bare copper conductor) of fifty square millimetres (50mm²) buried at a depth of fifty centimetres (50cm) beneath finished ground level will run along the entire barriers and each vertical steel profile of the barrier will be connected to the earth conductor by a copper conductor with the same characteristics (Cu 50mm²).
- B. Also in case of steel noise barriers, transparent noise barrier over cutting or embankment cross sections including wooden noise barriers and narrow earth noise barrier located above the ground, an earth conductor of fifty square millimetres (50mm²) buried at a depth of fifty centimetres (50cm) beneath finished ground level will run along the entire barriers.
- C. The earth conductor will be connected to each vertical steel profile of the barrier by a copper conductor with the same characteristics (Cu 50mm²).
- D. In case of narrow earth noise barrier, the steel support structure cage will be connected to the buried earth conductor at each 250m. If the length is less than 250m, it shall be connected to the earth conductor at the beginning and at the end of the narrow earth noise barrier.
- E. The following connection elements will be made:
 - a. Connection to the noise barrier steel support using a compression clamp for Cu 50 mm² earth conductor.
 - b. Connection to the buried earth conductor by an aluminothermic "T" welding for Cu 50 mm² conductor.
 - c. The installation and the grounding connections shall be achieved as shown in the drawings.
- F. The design for components of the grounding, bonding system embedded within concrete structures shall comply with 100 years design life.

10.3.8 RAILWAY FENCES

- A. The metal conductive parts of the fences will be grounded using earth conductor (bare copper conductor) of fifty square millimetres (50mm²) buried underneath the mesh at a depth of fifty centimetres (50cm) beneath finished ground level.
- B. This earth conductor will be connected to the fence posts by a copper conductor with the same characteristics (Cu 50mm²) which will be installed in a cable duct Ø50mm in order to avoid vandalism and theft. The connections to the fence must be visible for maintenance inspections.
- C. The maximum distance between the connections to the earth conductor is set at 250m.
- D. The following connection elements will be made:
 - a. Connection to the fence using a compression clamp for Cu 50mm² earth conductor.
 - b. Connection to the buried earth conductor by an aluminothermic "T" welding for Cu 50mm² conductor.
- E. The installation and the grounding connections shall be achieved as shown in the drawings.
- F. The design for components of the grounding, bonding system embedded within concrete structures shall comply with 100 years DWL.

10.3.9 WALLS

- A. The reinforcement of the walls will be grounded using earth conductor (bare copper conductor) of fifty square millimetres (50 mm²) buried at a depth of fifty centimetres (50 cm) beneath finished ground level which will run along the entire wall.
- B. Terminals must be made at the pile caps of the walls or at each module wall which will be connected to the earth conductor by a copper conductor with the same characteristics (Cu 50 mm²).
- C. The maximum distance between the connections to the earth conductor is set at 10m.
- D. The following connection elements will be made:
 - a. Connection to the fence using a compression clamp for Cu 50 mm² earth conductor.
 - b. Connection to the buried earth conductor by an aluminothermic "T" welding for Cu 50 mm² conductor.
- E. All metallic elements located above walls (barriers, railings etc.) will be bonded and connected to earthing and bonding system, using earth conductors (Cu) of fifty square millimetres (50 mm²) minimum, with screw terminals or welding.
- F. The installation and the grounding connections shall be achieved as shown in the drawings.
- G. The design for components of the grounding, bonding system embedded within concrete structures shall comply with 100 years design life.

10.3.10 GABIONS BASKETS

- A. The gabions basket shall be grounded using earth collector conductor of fifty square millimetres (50 mm² Cu) buried underneath the ground. This earth conductor shall be connected to the wire mesh by a copper conductor with the same characteristics (Cu 50 mm²).
- B. The wire mesh of the gabion basket shall be welded to achieve electrical continuity.
- C. The maximum distance between the connections to the buried earth conductor is at 250 m. If the length of the gabions basket is less than 250m, it shall be connected to the earth conductor at the beginning and at the end of the gabions basket.
- D. The connections shall be visible for maintenance inspections.
- E. The following connection elements shall be made:
 - a. Connection to the wire mesh using a compression clamp for Cu 50 mm² earth conductor.
 - b. Connection to the buried earth conductor by an aluminothermic "T" welding for Cu 50 mm² conductor.
- F. The installation and the grounding connections shall be achieved as shown in Technical Drawings.

10.4 MAINTENANCE REQUIREMENTS

- A. Due to the importance of the grounding system, both from the point of view of safety and maintenance of the quality of service of the railway installations, the following periodic operations shall be carried out by the Contractor to control the state of the grounding system.
- Control;
 - Periodic inspection.

10.4.1 CONTROL OF THE GROUNDING SYSTEM

- A. In each installation of the grounding system, the number and the arrangement of the earth conductors and the electrodes shall be inspected, as well as the way in which the interconnection between them has been established, including the connections of the earth conductors between the grounded elements and the electrodes, indicating in each case their path, depth and section.
- B. All measures, incidents and successive treatments of the grounding system shall be registered.

10.4.2 PERIODIC INSPECTION OF THE GROUNDING SYSTEM

10.4.2.1 INSPECTIONS TO BE CARRIED OUT

- A. The following periodic inspections shall be carried out during the maintenance operations:
- Measurement of earth resistance.
 - Inspection of the ground distribution system.
 - Inspection of the ground conductor system.
 - Inspection of the junction points.
 - Irrigation of the facilities in dry periods.

10.4.2.2 MEASUREMENT PERIODICITY

- A. The periodic measurements shall be realised:
- Every year: Measurement of earth resistance.
 - Every 5 years: Inspection of ground conductors, electrodes and junction points.
 - In prolonged dry periods: In the case of very long dry periods, the earth connections that may be defective will be irrigated with water.

10.5 MEASUREMENT AND PAYMENT – EARTHING AND BONDING SYSTEM

- A. The unit prices shall include all services to be accomplished which are foreseen in the unit price. Unless stated otherwise, all items shall be fully inclusive of all that is necessary to fulfil the liabilities and obligations arising out of the Contract.
- B. The units of measurement related to earthing and bonding works shall be as follows:

Table 196. Units of measurement – Earthing and bonding system

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_70_30_25_25	000301	EARTHING AND BONDING OF OVERPASS	pc	Earthing and bonding of overpass consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item includes all materials, preparation and installation of the earthing and bonding system, including earth conductors (Cu 50 mm ²), earth rods (steel-copper rods of 2.5m), earth pits (40 x 40 x 60 cm) and all necessary compression clamps, aluminothermic "T" welding, it includes also the connections with all metallic elements (wooden fences, barriers, railings etc.), according to the specification requirements and drawings of the overpass, fully finished and connected, including at expansion joints.
Ss_70_30_25_25	000302	EARTHING AND BONDING OF VIADUCTS	pc	Earthing and bonding of viaduct consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item includes all materials, preparation and installation of the earthing and bonding system, including earth conductors (Cu 50 mm ²), earth rods (steel-copper rods of 2.5m), earth pits (40 x 40 x 60 cm) and all necessary compression clamps, aluminothermic "T" welding, it includes also the connections with all metallic elements (wooden fences, barriers, railings etc.), according to the specification requirements and drawings of the viaduct, fully finished and connected, including at expansion joints.
Ss_70_30_25_25	000303	EARTHING AND BONDING OF UNDERPASSES	pc	Earthing and bonding of underpass consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item includes all materials, preparation and installation of the earthing and bonding system, including earth conductors (Cu 50 mm ²), earth rods (steel-copper rods of 2.5m), earth pits (40 x 40 x 60 cm) and all compression clamps, aluminothermic "T" welding, it includes also the connections with all metallic elements (barriers, railings etc.), according to the specification and drawings of the underpass, fully finished and connected, including at expansion joints.
Ss_70_30_25_25	000304	EARTHING AND BONDING OF ECODUCTS	pc	Earthing and bonding of ecoduct consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item includes all materials, preparation and installation of the earthing and bonding system, including earth conductors (Cu 50 mm ²), earth rods (steel-copper rods of 2.5m), earth pit (40 x 40 x 60 cm) and all necessary compression clamps, aluminothermic "T" welding, it includes also the connections with all metallic elements (barriers, railings etc.), according to the specification and drawings of the ecoduct, fully finished and connected, including at expansion joints.
Ss_70_30_25_25	000305	EARTHING AND BONDING OF CULVERTS	pc	Earthing and bonding of culverts consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item includes all materials, preparation and installation of the earthing and bonding system, including earth conductors (Cu 50 mm ²), earth rods (steel-copper rods of 2.5m), earth pits (40 x 40 x 60 cm) and all compression clamps, aluminothermic "T" welding, it includes also the connections with all metallic elements (barriers, railings etc.), according to the specification and drawings of the underpass, fully finished and connected, including at expansion joints.

Uniclass code	Type number	Work item	Unit	Work item includes
Ss_70_30_25_25	000306	EARTHING AND BONDING OF RAILWAY FENCE	m	Earthing and bonding of railway fence consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item includes all materials, preparation and installation of the earthing and bonding system, including earth conductor (Cu 50 mm ²) buried at a depth of 50 cm, earth conductor (Cu 50 mm ²) for connections to the fence pots each 250 m, and all necessary compression clamps, aluminothermic "T" welding, according to the specification and drawings of the railway fences, fully finished and connected.
Ss_70_30_25_25	000307	EARTHING AND BONDING OF WOODEN FENCE	m	Earthing and bonding of wooden fence (out of ecoduct zone) consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item includes all materials, preparation and installation of the earthing and bonding system, including earth conductor (Cu 50 mm ²) buried at a depth of 50 cm, earth conductor (Cu 50 mm ²) for connections to each wooden fence pot (each 4.5 m), and all necessary compression clamps, aluminothermic "T" welding, according to the specification and drawings of the wooden fence, fully finished and connected.
Ss_70_30_25_25	000308	EARTHING AND BONDING OF NOISE BARRIER	m	Earthing and bonding of noise barrier (out of railway structure zone) consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item includes all materials, preparation and installation of the earthing and bonding system, including earth conductor (Cu 50 mm ²) buried at a depth of 50 cm, earth conductor (Cu 50 mm ²) for connections to each steel profile or support, and all necessary compression clamps, aluminothermic "T" welding, according to the specification and drawings of the noise barrier, fully finished and connected.
Ss_70_30_25_25	000309	EARTHING AND BONDING OF WALLS	m	Earthing and bonding of walls consists of all works and expenses necessary to achieve the specified end result, e.g. workforce, materials, equipment and transportation (incl. fuel, insurance, etc.). This item includes all materials, preparation and installation of the earthing and bonding system, including earth conductor (Cu 50 mm ²) buried at a depth of 50 cm, earth conductor (Cu 50 mm ²) for connections (each 10 m), and all necessary compression clamps, aluminothermic "T" welding, it includes also the connections with all metallic elements (wooden fences over walls, posts, barriers, railings etc.), according to the specification and drawings of the walls, fully finished and connected.

10.6 NORMATIVE REFERENCES

- A. The following documents, in whole or in part, are normatively referenced in this section of the Technical Specifications and are indispensable for its application. Latest edition of the referenced document (including any amendments) applies:
 - a. EN 50122 -1- Earthing of power installations exceeding 1 kV A.C.
- B. Where differences exist between standards in this Contract, the Contractor shall propose that one which suits the purpose and fits better with his applied construction technology and apply it only after aligning and approval of the Engineer and Consultant.