CENTRAL RAILWAY PROJECT

Appendix D - Construction Quality Requirements

November 2017

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REFERENCE DATA

All standards that are referred to in the TSIs are mandatory for the purposes of the Railway Project and must be complied with, including the following specific standards:

1. EN 13450:2002+AC:2004
   Aggregates for railway ballast.
2. EN 13848-1:2009+A1 A1 Railway applications. Track. Follow up of geometry quality. Part 1: Characterisation of track geometry.
3. EN 13848-2:2006 Railway applications. Path. Follow up of geometry quality. Part 2: Measuring systems. Follow up of vehicles' recording.
4. EN 13848-3:2009 Railway applications. Track. Follow up of geometry quality. Measuring systems. Machines for track construction and maintenance.
5. EN 13848-4:2011 Railway applications. Track. Follow up of geometry quality. Measuring systems. Manual and lightweight devices.
6. EN 13848-5:2014 Railway applications. Track. Follow up of geometry quality. Part 5: Geometric quality levels. Electric power, switches and crossings.
7. EN 13848-6:2014 Railway applications. Track. Follow up of geometry quality. Characterisation of the track geometric quality.
8. EN 13231-1:2013 Railway applications. Track. Acceptance of works. Part 1: Works on ballasted path. Electric power, switches and crossings.
9. EN 14730-1:2017 Railway applications. Track. Aluminothermic welding of rails. Approval of welding processes.
10. EN 14730-2:2006 Railway applications. Track. Aluminothermic welding of rails. Qualifications of aluminothermic welders, approval of contractors and acceptance of welds
11. EN 14587-1:2007 Railway applications. Track. Butt welding of rails. New R220, R260, R260Mn and R350HT grade rails in fixed plant.
12. EN 14587-2:2009 Railway applications. Track. Butt welding of rails. New R220, R260, R260Mn and R350HT grade rails made by mobile welding machines at sites other than fixed plant.
13. EN 14587-3:2012 Railway applications. Track. Butt welding of rails. Welding in association with construction of crossings.
14. EN 932-1: 1997 Tests for general properties of aggregates. Part 1: Method for sampling.
15. EN 932-2: 1999 Tests for general properties of aggregates. Part 2: Methods for reducing laboratory samples.
16. EN 932-3 + A1: 2003 Tests for general properties of aggregates. Part 3: Procedure and terminology for simplified petrographic description.
17. EN 932-5: 2012 Tests for general properties of aggregates. Part 5: Common equipment and calibration.
18. EN 932-5/AC: 2014 Tests for general properties of aggregates. Part 5: Common equipment and calibration.
19. EN 932-6: 1999 Tests for general properties of aggregates. Part 6: Definitions of repeatability and reproducibility.
20. EN 933-1:2012 Tests for geometrical properties of aggregates. Part 1: Determination of particle size. Sieving method.
21. EN 933-2:2012 Tests for geometrical properties of aggregates. Part 2: Determination of particle size. Sieves, nominal size of apertures.
22. EN 933-3:2012 Tests for geometrical properties of aggregates. Part 3: Determination of particle shape. Flakiness index.
23. EN 933-4:2008 Tests for geometrical properties of aggregates. Part 4: Determination of particle shape. Shape index.

24. EN 933-5:2005 Tests for geometrical properties of aggregates. Part 5: Determination of percentage of crushed and broken surface in coarse aggregate particles.
25. EN 933-6:2014 Tests for geometrical properties of aggregates. Part 6: Assessment of surface characteristics. Flow coefficient of aggregates.
26. EN 933-7:1998 Tests for geometrical properties of aggregates. Part 7: Determination of shell content. Percentage of shells in coarse aggregates.
27. EN 933-8:2015 Tests for geometrical properties of aggregates. Part 8: Assessment of fines. Sand equivalent test
28. EN 933-9:2013 Tests for geometrical properties of aggregates. Part 9: Assessment of fines. Methylene blue test.
29. EN 933-10:2009 Tests for geometrical properties of aggregates. Part 10: Assessment of fines. Grading of filler aggregates (airjet sieving).
30. EN 12407:2009 Natural stone test methods. Petrographic examination.
31. EN 13242 + A1: 2008 Aggregates for unbound and hydraulically bound materials for use in civil engineering works and road construction.
32. EN 13598-2:2016: Plastic piping systems for non-pressure underground drainage and sewers. Non-laminated poly (vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE). Part 2: Specifications for manholes and inspection chambers.
33. EN ISO 10147: 2013 Pipes and fittings made of crosslinked polyethylene (PE-X). Estimation of the crosslinking degree by determination of gel content (ISO 10147:2011)
34. EN 13251:2016: Geotextiles and geotextile-related products. Characteristics required for use in earthworks, foundations and retaining structures.
35. EN 10025 EN 10025-1:2004 Hot rolled products of structural steels. Part 1: General conditions for technical delivery.
36. EN 10025-2:2004 Hot rolled products of structural steels. Part 2: Conditions for technical delivery of non-alloy structural steels
37. EN 10025-3:2004 Hot rolled products of structural steels. Part 3: Conditions for technical delivery of normalized/normalized rolled weldable fine grain structural steels.
38. EN 10025-4:2005 Hot rolled products of structural steels. Part 4: Conditions for technical delivery of thermomechanical rolled weldable fine grain structural steels
39. EN 10025-5:2005 Hot rolled products of structural steels. Part 5: Conditions for technical delivery of structural steels with improved atmospheric corrosion resistance.
40. EN 10025-6 + A1:2009 Hot rolled products of structural steels. Part 6: Conditions for technical delivery of flat products of high yield strength structural steels at quenched and tempered condition.
41. EN 10346 Continuously hot-dip coated steel flat products for cold forming. Technical delivery conditions.
42. EN 13476-3 + A1:2009 Plastics piping systems for non-pressure underground drainage and sewers. Structured-wall piping systems of non-laminated poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE). General requirements and performance characteristics.
43. EN 10080 Steel for concrete reinforcing. Weldable reinforcing steel. General.
44. EN 10138-1:2000 Pretressing steels - Part 1: General Requirements
45. EN 13369 Common rules for precast concrete products.
46. EN 13670 Execution of concrete structures.
47. EN 124-1:2015 Gully tops and sewer lids for vehicular and pedestrian areas. Definitions, classification, general principles of design, performance requirements and test methods.
48. EN 508-1:2014 Roofing and cladding products, in metal sheet. Specification for self-supporting structures in steel, aluminium or stainless steel sheet.
49. EN 1916:2002 Concrete pipes and fittings, non reinforced, steel fibre and reinforced.
50. EN 1917:2002 Concrete manholes and inspection chambers, non reinforced, steel fibre and reinforced.

51. EN 206:2013+A1:2016 Concrete. Specification, performance, production and conformity.
52. EN 9969:2016 Thermoplastic pipes. Determination of ring stiffness. Eurocodes for bridges and structures.
53. EN 1990 Eurocode: Bases for structural design.
54. EN 1991 Eurocode 1: Actions on structures (Part 2: Traffic loads on bridges).
55. EN 1992 Eurocode 2: Design of concrete structures.
56. EN 1993 Eurocode 3: Design of steel structures.
57. EN 1994 Eurocode 4: Design of composite steel and concrete structures.
58. EN 1995 Eurocode 5: Design of timber structures.
59. EN 1996 Eurocode 6: Design of masonry structures.
60. EN 1997 Eurocode 7: Geotechnical design.
61. EN 1998 Eurocode 8: Design of structures for seismic resistance.
62. EN 1999 Eurocode 9: Design of aluminium structures.

1. QUALITY MANAGEMENT

This document sets out quality requirements for the Construction Phase of the Railway Project. In a quality Plan (the "**Quality Plan**"), the Railway Contractor shall describe all the quality assurance actions that shall be performed during construction and Commissioning of the Railway Project.

The aforementioned actions shall include, but shall not be limited to, the tests and surveys mentioned in this Appendix and other necessary actions, tests, surveys and documentation required to be performed so as to ensure the quality of construction of Railway Project. The Quality Plan shall be approved by the Infrastructure Manager who can request modifications, additions or clarifications to the document at any point during construction and commissioning.

2. QUALITY CONTROL AND QUALITY ASSURANCE

The Infrastructure Manager shall check and approve the quality and technical compliance of the construction throughout all its phases. For the purpose of the Approval granted by the Infrastructure manager, every track shall be inspected by the experts as appointed by the Infrastructure Manager. The Railway Contractor shall perform the measurements and quality control reports. Quality controls and documents shall be constantly available for the Infrastructure Manager in real time. Measurements or checks shall be carried out as defined in this Appendix; the Infrastructure Manager may request additional documented measurements or checks, or restrict the choice of measuring devices. Approval shall not be given until the work is completed in accordance with the requirements set out herein.

All construction materials shall be approved by the Infrastructure Manager prior to construction.

2.1 Preliminary Procedure to Approval

After completion of the construction works, the Railway Contractor shall inform the Infrastructure Manager in writing that the Preliminary Procedure to Approval can be carried out. The Infrastructure Manager shall carry out the preliminary procedure to approve the works. The Preliminary Procedure to Approval shall consist of the following:

- checking of the list and quantification of the works carried out;
- checking of the records for measurements and tests;
- checking of documents according to the contract (e.g. drawings, notes of calculations, certificates, quality control, etc.);
- listing of works not performed although agreed in the contract;
- listing of non-conformities.

The Railway Contractor shall furnish the personnel and equipment requested by the Infrastructure Manager to allow the execution of the Preliminary Procedure.

2.2 Granting of Approval

The results of the Preliminary Procedure shall be as follows:

- Approval is granted; or
- Approval is granted, with reservations.

If the Approval is granted, the decision shall be notified to the Railway Contractor.

If the Approval is granted with reservations, the Railway Contractor shall be notified of the decision and shall have the opportunity to submit a proposal with corrective actions to the Infrastructure Manager. Once the corrective actions are approved by the Infrastructure Manager, the Railway Contractor shall carry out the necessary actions to correct the defects. Once these actions are carried out, the Preliminary Procedure shall be applied again to verify that the defects were duly corrected.

3. TRACK GEOMETRY

EN 13231-1 Regulation specifies the minimum technical requirements and the tolerances for the approval of works on tracks, including requirements and tolerances for a standard gauge track measuring 1,435 mm, either for construction sections of a new track and/or track renewal. More specifically, EN 13231-1 states the requirements for the documentation of work parameters, for the tolerances for track geometry and track position as well as for the Approval procedures. Track geometry shall be in accordance with EN 13231-1.

Before the approval of track geometry, the following measurements or checks shall be carried out, recorded and documented, as follows:

- relative track geometry of single track, switches and crossings as specified in paragraph 4.4 of EN 13231 1; and
- absolute track position of single track, switches and crossings as specified in paragraph 4.5 of EN 13231-1.

Other measuring mechanisms different to the ones proposed can be applied, provided measurements are performed with certified devices and that the meet International Technical Regulations are approved by the Infrastructure Manager.

3.1 Relative Track Geometry

Relative track geometry measurements shall be taken as defined in EN 13848-1.

Track geometry shall be measured by a track recording vehicle, or by a track construction and maintenance machine fitted with measuring equipment, both in accordance with EN 13848. Measurements with lightweight or manual devices can also be used, according to EN 13848.

The measuring of the layout, as per EN 13848, shall be carried out before the railway project is completed.

3.2 Track Gauge and Crossing Level

Measurements for track gauge and crossing level shall be made:

- by a track recording vehicle according to the requirements of EN 13848-2; or
- by track construction and maintenance machines according to the requirements of EN 13848-3; or
- by manually operated track measuring trolleys or devices, according to the requirements of EN 13848-4, with a minimum of 10 measurements on successive sleepers, every one hundred (100) metres.

3.3 Longitudinal Leveling and Alignment

Measurements for the longitudinal leveling shall be undertaken on both rails. The measurement for alignment shall be undertaken for both rails on the straight track, and on the outer rail in curves:

- by a track recording vehicle according to the requirements of EN 13848-2; or
- by track construction and maintenance machines according to the requirements of EN 13848-3; or
- by manually operated track measuring trolleys or devices, according to the requirements of EN 13848-4.

3.4 Twists

Twist measurements shall be made:

- by a track recording vehicle, according to the requirements of EN 13848-2; or
- by track construction and maintenance machines according to the requirements of EN 13848-3; or
- by manually operated track measuring trolleys or devices, according to the requirements of EN 13848-4; measurings shall be taken at least every three (3) meters.

3.5 Tolerances

Requirements for the approval of track geometry are shown in EN 13231-1. The approved track shall comply with the tolerances shown in Table 1 of EN 13231-1. The type class used shall be number two. Tolerances shall apply for the loaded track measurements.

All measurements shall be sampled at constant distance-based intervals not larger than 0.5 metres, or as determined by the Infrastructure Manager. In the case of using track construction machines that move non-continuously and measure track geometry while working, the sampling interval may be extended by up to 1.5 meters, or as determined by the Infrastructure Manager.

The track gauge between any two adjacent sleepers shall not vary by more than 1 millimeter (mm). For measurements made by track recording vehicles, track construction and maintenance machines or track measuring trolleys, the track gauge shall not vary by more than 3 millimeters (mm) per every 1.5 meters.

As regards longitudinal level and plain tracks alignment:

a) measurements shall be made using wavelength range D1, in accordance with EN 13848-1;
b) the analysis method shall be "mean-to-peak"; and
c) for chord measurements, the following shall apply:
    1) at chord measurement results, the sliding mean for each point shall be taken in a length not longer than 40 meters considering a symmetric interval;
    2) for alignment, the corridor as defined by the mean and the tolerances shall include the design value; otherwise the defect between the design value and the peak shall be considered;
    3) chord measurements made by recording vehicles or track construction and maintenance machines shall be performed with an asymmetrical chord having a ratio of 40 % to 60 %, which should be 10 meters long; for measurements made by manually operated trolleys or devices, a symmetrical chord with 10 meters (in curves) and 20 meters (in straight tracks) may be allowed;
    4) recording vehicles and track construction and maintenance machines manufactured before to the issuing of this standard may use a symmetrical chord; and
    5) for measurements made by a chord system with base lengths other than 10 meters, the results shall be converted to a 10 meters' asymmetrical chord (40 % to

60 %).

The twist base length shall normally be 3 meters, and the analysis method shall be "zero-to-peak". In transition curves with a design twist, the tolerances shall be considered as from the design twist, but not from the zero line, without exceeding the intervention limit values set out in EN 13848-5.

The Infrastructure Manager can approve alternative methods based on authorized Technical Regulations.

3.6 Absolute Track Position

3.6.1 Tolerances

The accepted track shall comply with class AP3 (EN 13231-1 Table 3), which defines tolerances for the deviation from the design track position, or as determined by the Infrastructure Manager.

3.6.2 Compliance Measurements

Compliance measurements shall refer to a defined reference point in the track, and the reference point shall define the precise track position. The requirements for compliance measurement are described in more detail in Appendix B3 (Geodetic Reference System, Geodetic Control Network and Railroad Construction Measurements).

4. SUPERSTRUCTURE

EN 13231-1 specifies the minimum technical requirements and tolerances for the approval of works on ballasted tracks located on a plain track and on switches, crossings and rail expansion devices, as part of the track, for 1,435 mm track gauge railways, with respect to both the construction of a new track and to track renewal.
The Infrastructure Manager can approve alternative methods based on authorized Technical Regulations.

Before the approval of the above-ground railway infrastructure (the "Superstructure"), the following measurements or checks shall be carried out when applicable, either manually or by automatic means. Measurements to be documented include:

- sleeper or bearer position, voiding of sleepers or bearers as specified in paragraphs 4.6.2, 4.6.3, 4.6.4, and 4.6.5 of EN 13231-1;
- proper assembly and integrity of the rail fastenings, pads and insulators as specified in paragraph 4.6.6 of EN 13231-1;
- welds as specified in paragraph 4.6.7 of EN 13231-1 (running surface and running edge);
- ballast cross-section as specified in paragraph 4.6.10 of standard EN 13231-1;
- specific measurements or checks for switches and crossings, and for rail expansion devices as specified in paragraphs 4.7 and 4.8 of standard EN 13231-1;
- tamping work as specified in paragraph 5.2 of EN 13231-1;
- dynamic stabilising work as specified in paragraph 5.3 of EN 13231-1;
- ballast compaction as specified in paragraph 5.4 of EN 13231-1;
- damage caused to rails, sleepers, fastenings, cables and other equipment, or where the work process has displaced the sleepers, the fastenings or the rail pads; and
- all the follow up of the track materials' compliance with the Infrastructure Manager’s relevant approval criteria or specifications, in particular approval of associated works

as well as approval of the material provided by the supplier.

4.1 Sleeper Spacing

The deviation allowed from the spacing designed between the sleepers shall be ±20 mm and shall be checked by sampling at least every 200 m. The number of sleepers within 1.000 meters shall be within 0.5 % of the designed number.

4.2 Bearer Spacing

The deviation allowed from the designed bearer spacing, in individual cases, shall be ±10 mm.

4.3 Sleepers Out-of-Quadrature

The deviation allowed from the quadrature of the sleepers shall be ±10 mm.

4.4 Voiding of Sleepers and Bearers

The quality of the tamping shall be checked by sampling 10 % of the sleepers and fastenings, or by the distance determined by the Infrastructure Manager. All sleepers and fastenings shall be fully supported under the rails:

4.5 Rail Fastenings

All fastening systems shall be complete and correctly fitted.

4.6 Welds

The approval of welding works in conjunction with the track works is covered by EN 14730 and EN 14587, or as determined by the Infrastructure Manager. Non-destructive testing shall be required to verify the integrity of the welds.

4.7 Ballast Cross-Section

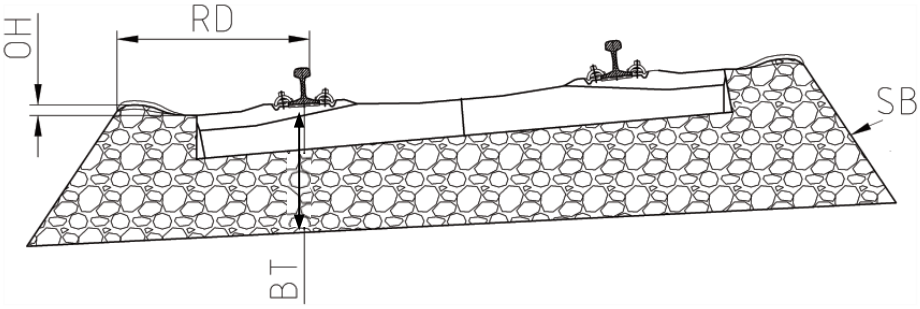
Each type of ballast cross-section shall be checked at each kilometre or at the distance determined by the Infrastructure Manager, and duly documented. The cross-section of the accepted track ballast shall comply with the tolerances stated in Table 1 below. No ballast is allowed on top of sleepers.

Table 1 Tolerances for ballast cross-section

Parameter	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	±10 %
Height over ballast shoulder	+2 cm - 0 cm

a) Ballast thickness (height) shall be measured from below the rail pad, which is installed between the sleeper and the rail.

The parameters of **Table 1** are defined in **Figure 1.**



Indicators

BT: ballast thickness
RD: distance between the running edge of the rail and the ballast shoulder
SB: ballast slope inclination
OH: Height over ballast shoulder

Figure 1 Ballast cross-section

Material requirements for ballast are shown in Appendix B (Technical Specifications); and other requirements for ballast are described in EN 13450 and in EN 932.

4.8 Switches and Crossings

The requirements for specific measurements and quality checks for switches and crossings are described in EN 13231-1.

4.9 Tamping

Requirements for tamping work are described in EN 13231-1. Tamping machines shall be equipped with systems than can measure the tamping working parameters. The quality of the tamping machines' work shall be evaluated and documented by measuring the relative geometry of the track. Information about tolerances and resolution of the working parameters shall be documented in the machine manufacturer's manual. Calibration and validity checks shall be carried out according to the machine manufacturer's manual. The Railway contractor shall submit the following tamping parameters to the Infrastructure Manager for approval. Works shall not be performed before the Infrastructure Manager's approval has been received, with respect to the following:

- Duration of compaction work;
- Frequency of compaction tools; and
- Compaction's dynamic pressure.

Consolidation of the ballast will be necessary after tamping in order to restore the full lateral resistance of the track. This may be achieved naturally by the action of traffic or by other measures, e.g. using a dynamic track stabiliser.

5. TRACK SUBSTRUCTURE, DRAINAGE AND EROSION PROTECTION

Track substructure aggregates, drainage and erosion protection shall be constructed in accordance with Appendix B (Technical Specifications). General properties of aggregates shall be tested according to EN 932. Geometrical properties of aggregates shall be tested according to EN 933. The Infrastructure Manager can approve alternative methods based on authorized Technical Regulations.

EN 13242 specifies the properties of aggregates obtained by the processing of natural, manufactured or recycled materials for hydraulically bound and unbound materials, for civil

engineering work and road construction. Evaluation of conformity for the track substructure aggregates shall be made according to EN 13242. The Infrastructure Manager can approve alternative methods based on authorized Technical Regulations.

Mixing of different aggregate materials in ballast and intermediate layers is not allowed. Material shall not be contaminated or contain impurities such as organic materials.

A typical cross-section of the track structures shall be as shown in Figure 2.

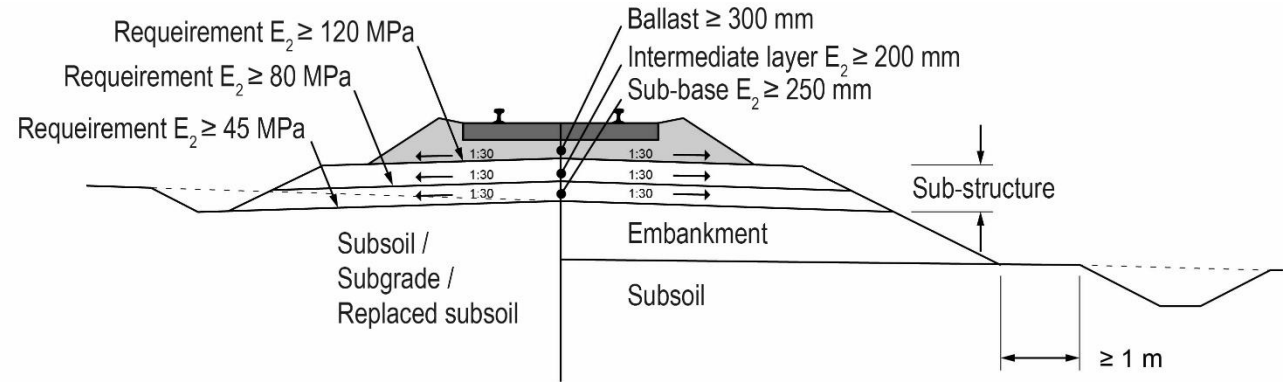


Figure 2 Track layers

5.1 Intermediate Layer

The intermediate layer shall form a flat and supporting substrate for the Superstructure. It will also prevent the support layer from mixing with the underlying structural layers.

5.1.1 Material

The material requirements for aggregate are shown in Appendix B (Technical Specifications).

Total aggregate granularity shall be examined according to EN 933. The minimum testing frequency for granulometry in each individual construction site is once per day, or per 2.000 tonnes, depending on which requirements is met first, or as determined by the Infrastructure Manager. Granularity shall also be tested whenever the source of the material is changed.

5.1.2 Construction

Placement of aggregate layer shall be carried out as shown in Figure 2.

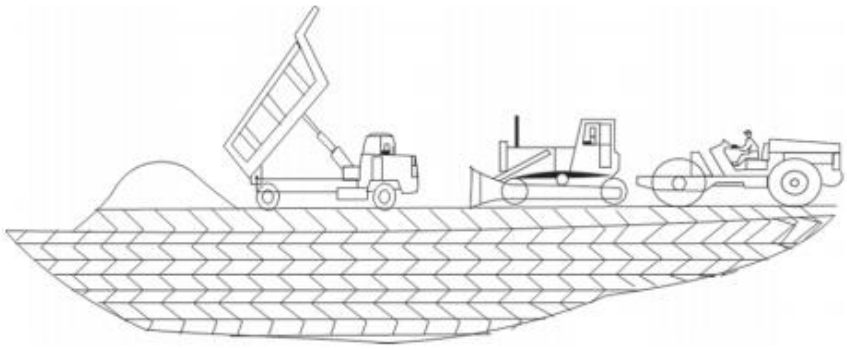


Figure 2 Proper layer placement

An improper layer placement may lead to a non- uniform lift thickness and a non- uniform compactivity effort; thus, this placement method is not allowed (Figure 3).

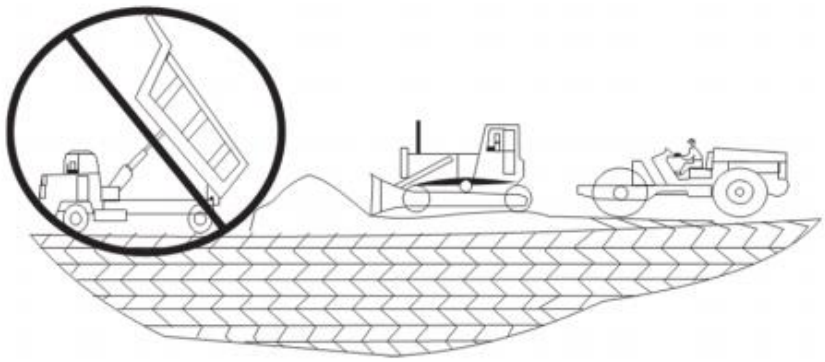


Figure 1 Improper layer placement

Dry aggregate shall be irrigated during compaction.

5.1.3 Dimensions

The profile of the intermediate layer shall be as shown in the "Railway cross-sections" document.

The allowed deviations of intermediate layer cross-sections shall be as follows:

- individual deviation of upper layer surface: -35 mm … 0 mm;
- mean deviation of upper layer surface: -20 mm … 0 mm; or
- layer width: 0 mm … 50 mm.

Dimensions of intermediate layer shall be checked every 20 meters, or at the distance determined by the Infrastructure Manager.

5.1.4 Load Capacity

The bearing capacity describes the quality of the structure. Each layer of an intermediate layer must have an E-modulus of E2 ≥120 MPa, and the ratio shall be E1/E2 ≤ 2,3. Measurements shall be made using the static plate load test. Tests shall be performed every 100 metres from the centre line of intermediate layer, and every 300 metres from both edges of the intermediate layer, or at the distance determined by the Infrastructure Manager.

If above the established testing sequence, it will always be applied at the minimum over the first kilometer of the constructed layer. In case all measurement results fulfill the set requirements, the Railway Contractor can agree with the Infrastructure Manager that the testing method shall be changed to a method surveying. Method surveying can be applied when there are no changes in the materials, machinery or working methods. Whenever one of the prerequisites for using the method surveying is changed, tests shall be performed again — every 100 meters from the center line of intermediate layer and every 300 meters from both edges of the intermediate layer, at least at a distance of one kilometer before the method, or at the distance determined by the Infrastructure Manager. The surveying can be performed again in case the above described conditions are the same, or the Infrastructure Manager determines so.

When method surveying is applied, the static plate load tests shall be performed every 300 meters from the center line of intermediate layer and every 600 meters in turns, from the edge of the intermediate layer or at the distance determined by the Infrastructure Manager. Requirements for test results remain unchanged.

5.2 Sub-base

5.2.1 Material

Material requirements for aggregate are shown in Appendix B (Technical Specifications).

Total granularity shall be examined according to EN 933. The minimum testing frequency of the granularity for each individual construction site is once per day or per 5000 tonnes depending on which requirement is met first, or at the frequency determined by the Infrastructure Manager. Granularity shall also be always tested when the material source is changed.

5.2.2 Construction

The construction of the sub-base shall be made as described in Figure .

Dry and crushed rock shall be placed during compaction.

5.2.3 Dimensions

The profile of the sub-base shall be as shown in the "Railway cross-sections" document.

Allowed deviations of the sub-base cross-sections shall be as follows:

- individual deviation of upper layer surface: -35 mm … 0 mm;
- mean deviation of upper layer surface: -20 mm … 0 mm; and
- layer width: 0 mm ... 100 mm.

Dimensions of the sub-base shall be checked every 20 meters, or at the distance determined by the Infrastructure Manager.

5.2.4 Bearing Capacity

Bearing capacity describes the quality of the structure. Each layer of sub-base must have an E-modulus of $E2 \geq 80$ MPa, and the ratio shall be $E1/E2 \leq 2{,}5$ DRP, with a proctor density ≥ 96 %. Measurements shall be performed using the static plate load test and modified proctor density test. Tests shall be done every 150 meters from the centre line of each path, and every 300 meters, with a distance of 1.0 meters from both edges of the sub base, or at

the distance determined by the Infrastructure Manager.

If above the established testing sequence, it will always be applied at the minimum over the first kilometer of the constructed layer. In case all measurement results fulfill the set requirements, the Railway Contractor can agree with the Infrastructure Manager that the testing method shall be changed to a method surveying. Method surveying can be applied when there are no changes in the materials, machinery or working methods. Whenever one of the advantages for using the method surveying is changed, tests shall be performed every 100 meters from the centre line of the sub-base, and every 300 meters from both edges of the sub-base, at least at a distance of one kilometer before the method surveying can be applied again.

When method surveying is applied, the static plate load tests shall be performed every 300 meters from the centre line of sub-base and every 600 meters from 1.0 metre from the edge of the sub-base, or at the distance determined by the Infrastructure Manager. Requirements for test results remain unchanged.

5.3 Enbankment Material

5.3.1 Material

Material requirements for the new aggregate are shown in Appendix B (Technical Specifications).

Total aggregate granularity shall be examined according to EN 933. Tests shall be performed:

- for every 4.000 m^3;
- whenever a deviation of granularity can be visually observed; and
- whenever the material source is changing.
- Or at the frequency determined by the Infrastructure Manager.

5.3.2 Construction

For settlement control, all new embankments where the new track elevation must be ≥3.5 meters above the existing ground surface. The embankment shall be constructed first up to the bottom level of the sub-base and then left in place for at least four months before construction of the following layers, or the time determined by the Infrastructure Manager.

The quality of soil and groundwater level shall be constantly monitored and compared to detailed designs. Should changes be detected, work shall be interrupted and necessary additional investigations carried out. Groundwater level shall be reduced to 0.5 meters below cutting surface if the groundwater level is above cutting surface.

Construction of the embankment shall be made as described in Figure 2. The maximum thickness of a layer shall be 500 mm. Topsoil and stones larger than one (1) m^3 shall be completely removed, and the bottom level shall be leveled and compacted. There must be no water-gathering spots on the surface. The bottom of the cutting shall be made according to the "Railway cross-sections". The stones rising above the cutting surface shall be removed.

5.3.3 Dimensions

The profile of the embankment shall be as shown in "Railway cross-sections".

Allowed deviations of the embankment cross-sections shall be as follows:

- Cutting level: -100 mm ... 0 mm;
- Horizontal distance from track centre line to the lower edge of slope: 0 mm ... +200 mm;
- Horizontal ditch position: ±150 mm; and
- Height of ditch bottom: 100 mm ... 0 mm.

Dimensions of embankment shall be checked every 20 meters, or at the distance determined by the Infrastructure Manager.

5.3.4 Bearing Capacity

Bearing capacity describes the quality of the structure. Each layer of embankment must have an E-modulus of E2 ≥ 45 MPa, and the ratio shall be E1/E2 ≤ 3.0 DPR of proctor density ≥ 95 %. Measurements shall be made using the proctor density test modified by the static plate load test. Tests shall be done every 150 meters from the centre line of each path, and every 300 meters at a distance of 1.0 meter from both edges of the embankment.

If above the established testing sequence, it will always be applied at the minimum over the first kilometer of the constructed layer. In case all measurement results fulfill the set requirements, the Railway Contractor can agree with the Infrastructure Manager that the testing method shall be changed to a method surveying. Method surveying can be applied when there are no changes in the materials, machinery or working methods. Whenever one of the advantages for using the method surveying is changed, tests shall be performed every 100 meters from the centre line of embankment and every 300 meters from both edges of the embankment, for a distance of at least one kilometer before the method surveying can be applied again, or at the distance determined by the Infrastructure Manager.

When method surveying is applied, the static plate load tests shall be performed every 300 meters from the centre line of the embankment and every 600 meters from 1.0 meter from one edge of the embankment, or at the distance determined by the Infrastructure Manager. Requirements for test results remain unchanged.

5.4 Drainage

The drainage system shall consist of ditches, underdrains, culverts, slopes of embankments, and pumps.

Drainage at different sections of the Railway line must be designed based on land surveys or a land model that is precise enough.

The placement of drainage structures must be measured during the works. A drainage system’s location shall be marked on the "as-built" drawings. When installed under the track, the top of the drainage structure shall be placed under the sub-base layer.

5.4.1 Underground Drainages

The inner diameter of the drainage pipes can be 10 % smaller than the design diameter.

Material requirements for underground drains shall be as follows:

- Road traffic areas and areas next to them: underground drains shall be SN8 grade PE or PP pipes;

- Drainage wastepipe (alternative 1) unperforated at least SN4 PE plastic pipe diameter ≥250 mm; and
- Drainage waste pipe (alternative 2) concrete pipe diameter ≥300 mm.

Excavation of the underground drains' leveling must be ±20 mm. The bottom of the well shall be compacted according to the compaction requirements of the substructure. The thickness of the substrate shall be of at least 150 mm.

Pipes shall be connected to the wells and the inspection pipes tightly to ensure that the ground material cannot get into the well. When connecting the wells, a rigid plastic pipe must be used if the drain pipe is not stiff enough. The protective tube shall be installed so that it extends at least 0.5 meter from the well to the hard ground.

The end of the discharge pipe shall have about 0.3 meter in length; the lower edge shall be at least 200 mm above the bottom of the ditch. The discharge point must be protected against erosion.

The inclination of underground drains must have at least a 0.4 % gradient. The allowed deviation of inclination shall be ±0.2 x the gradient shown in the design documents. The allowed horizontal position deviation from the design documents is ±200 mm. The allowed height deviation from design documents is ±50 mm.

5.4.2 Draining Wells

The drainage wells' inner diameter (DN/ID) shall be at least 600 mm, and the sand trap volume shall be at least 55 L. The DN/ID inspection pipe shall be at least 300 mm.

In traffic areas, the load bearing capacity shall be D400 (400 kN) for of drains and inspection pipes. Elsewhere, the load bearing capacity shall be of at least C250 (250 kN). Thickness of the cover shall be such that it remains firmly in place.

Well lids for the road traffic areas shall be manufactured and tested according to EN 124. Material requirements for tanks and pipes shall be in accordance with EN 13598-2.

The wells and inspection pipes shall be installed on a leveled bottom. The thickness of the backfilling layer under the well shall be 150 mm. The bottom of the excavation shall be compacted according to the substructures' compaction requirements. The wells shall be built at intervals of at least 50 meters, or at the distance determined by the Infrastructure Manager. The depth of the well bottom shall be 500 mm lower than the lowest water surface. The lowest well ring shall be 1 meter high, bottom slab included.

The thickness of the filling material around the wells shall be at least 400 mm and maximum allowed aggregate size is 64 mm. For compaction of filling material, the modified proctor density requirement shall be ≥95 % DPR. The vertical inclination of the well and the inspection pipe shall not exceed 10 mm in the distance of 1 metre. The wells and the horizontal position deviation for the inspection pipes shall not exceed ±100 mm.

5.4.3 Open Ditches

Ditches shall be excavated according to the dimensions stated in the design documents, taking into account the additional excavation required by the erosion protection. The bottom of the ditch width shall be at least 0.5 m, and the inclination of the slopes shall be according

to the design documents. Ditches shall have a minimum inclination of 0.3 %.

The ditch shall not have any functional deviation or appearance different from the form shown in the Design Documents. The bottom of the ditch shall not be deeper than 50 mm, and the bottom shall not be above the height specified in the Design Documents:

- Location of fold points: -0.15 m ... +0.15 m;
- Horizontal position: -0.1 m ... 0 m; and
- Bottom level: -0.1 m ... 0 m.

5.4.4 Culverts

Concrete, steel or stone culverts are permitted under the track structures. The permissible corrosion resistance of the steel culvert tubes must be submitted in the construction designs. The use of plastic is only allowed on the side of tracks.

The diameter should not be reduced when located downstream. The uniformity requirement for the culvert installation platform is ±15 mm over 3 m on flat gradients. The level and level of foundation must be ensured before installing the piping. The culvert has a longitudinal inclination of at least 1.0 %. Exceptionally, a 0.5 % slope may be used.

The culvert end shall be made according to designs. If the material for erosion protection is not specified in the Design Documents, the erosion protection shall be made of ballast.

The allowed deviation of the culvert vertical level is +0 ... 50 mm, and horizontal deviation is ±100 mm. The allowed centre line deviation (straightness) of the culvert is ±15 mm over 3 meters.

The difference in level between the ends of the culvert shall not differ by more than ±20 mm from the level difference specified in the Design Documents.

The location and height of each culvert shall be measured during the assembly. The measurement results shall be recorded in the culvert list.

The ballast bedding shall be made in accordance with the Design Documents. Bedding shall be made of gravel or crushed rock of aggregate size 0/32, or with a maximum grain size not larger than 2/3 of the bedding thickness - but not more than 150 mm. When a geotextile is required for the bedding, minimum requirement is a category N4 product. The bedding shall extend beyond the thickness of the bedding at the ends of the culvert.

Excavation must be kept dry during the compaction work. The stone bedding shall be compacted in layers ≤300 mm.

At ground level, the bedding shall be extended to at least 1200 mm beyond the outer edge of the culvert.

The maximum level deviation allowed of the bedding at a distance of 3 meters shall be ±20 mm. The allowed deviation of the bedding thickness shall be +0.1 m, and the width +0.2 m. The strength of the bedding shall be specified in the Design Documents.

Compaction rate shall be ≥95 %DPR. At least two (2) compaction measurements must be done: for structure and layer.

The requirements for concrete pipes shall be submitted in accordance with EN 1916, and

the requirements of the wells in accordance with EN 1917.

The steel culvert material shall be in accordance with EN 10025.

Materials for galvanized and aluminum - galvanized steel tubes shall meet the requirements stated in EN 10346.

The raw material of plastic polyethylene and polypropylene tubes used for the culverts must meet the requirements of EN 13476-3 standard. In accordance with these standards, plastic tubes shall be classified into ring stiffness classes.

Ring stiffness shall be determined in accordance with EN 9969.

In case the Infrastructure Manager considers it convenient, other Technical Regulations can be established for reference purposes.

5.5 Erosion Protection

In the Design Documents, the Railway Contractor shall set out how the erosion protection of track structures shall be implemented, including:

- how to build protection against erosion;
- quality criteria, tolerances and quality documentation.

6. BRIDGES AND STRUCTURES

All bridges and concrete structures shall be designed and built in accordance with the EN standards, as detailed in Figure 5 below. Figure 5 refers only to the main parts of the EN standards; however, the Railway Contractor must find and consider all subparts of the EN Standards for the Construction Phase regarding the Railway Project.

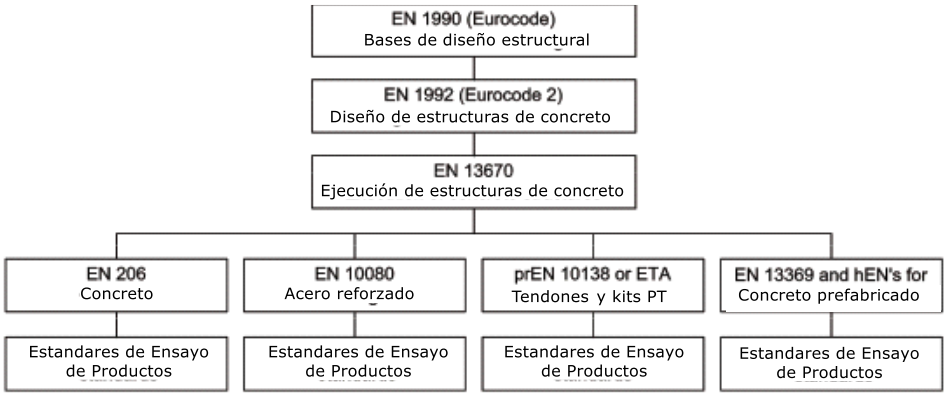


Figure 4 European Standards for Concrete Works

Bridges and structures must be designed according to the Eurocodes 1…9 (Eurocode EN 1990 - 1999).

All the new bridges must be designed with a ballast layer of at least 550 mm, measured from the top of the bed. The load model for new railway bridges and structures shall be LM71-25 (Eurocode EN 1991- Part 2 Loads on bridges). The load model for existing railway bridges and structures shall be LM71-22.5 (Eurocode EN 1991- Part 2 Loads on bridges).

The load model for new road bridges and structures shall be in accordance with the national standards of Uruguay.

Important note: all the verifications must be done according to the quantities and distance established, but could be done additional verifications in case of the Infrastructure Administrator wants it.