SPOORNET

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TECHNOLOGY MANAGEMENT
TRACK TECHNOLOGY

TECHNICAL SPECIFICATION

SPECIFICATION FOR RAILWAY EARTHWORKS
S410

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Specification for Railway Earthworks, S410

(March 2006)

Contents

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1 GENERAL

1.1 This specification covers railway earthworks and service roads as well as other earthworks that may be specified in the project specification. Specifications SABS 1200 C, SABS 1200 D, and SABS 1200 DN shall apply in addition to this specification unless in conflict herewith.

1.2 All tests and terminology referred to herein are in terms of Technical Methods for Highways 1 (TMH1) published by the Department of Transport or Stabilisation Manual (M5) published by the Department of Transport.

2 DEFINITIONS

2.1 *Catchwater Drain:* an open drain to intercept water and to lead it to suitable discharge points.

2.2 *Catchwater Mound:* a mound formed to intercept stormwater.

2.3 *Modified AASHTO Density:* the maximum dry density obtained when testing a sample of soil or granular material in accordance with THM1 Test method A7.

2.4 *Non-Cohensive Soil:* a non-plastic material with not less that 93% passing a 4,75mm sieve and not more than 10% passing a 0,075mm sieve.

2.5 *Pedogenic Material:* a soil, which has become strongly, cemented e.g. ferricrete, calcrete and silcrete.

2.6 *Right-Of-Way:* the strip of land reserved by statute for a railway.

2.7 *Service Road:* a road alongside the railway line for maintenance purposes.

2.8 *Table Drain:* a shallow drain on the side of the formation to carry surface water.

3 ORDER OF WORK

3.1 The Contractor shall carry out the work in the order specified, or as directed by the Engineer.

4 DRAINAGE

4.1 The prevailing drainage pattern and flow of water shall be maintained but, if temporarily altered, the original conditions shall be restored.

5 TABLE DRAINS, CATHWATER DRAINS AND MOUNDS

5.1 Table drains shall be constructed true to line and level along the length of all cuttings on both sides of the formation and elsewhere if ordered, to dimensions specified.

5.2 Catchwater drains shall be constructed to dimensions and levels as specified. Material excavated shall be deposited on the low side of the drain to form a catchwater mound.

5.3 Where the crossfall at right angles to the track does not generally exceed 1 in 6, and unless otherwise directed by the Engineer, a catchwater drain and mound shall be formed by cutting at a slope of 1 in 3 against the natural slope as indicated in Figure 1.

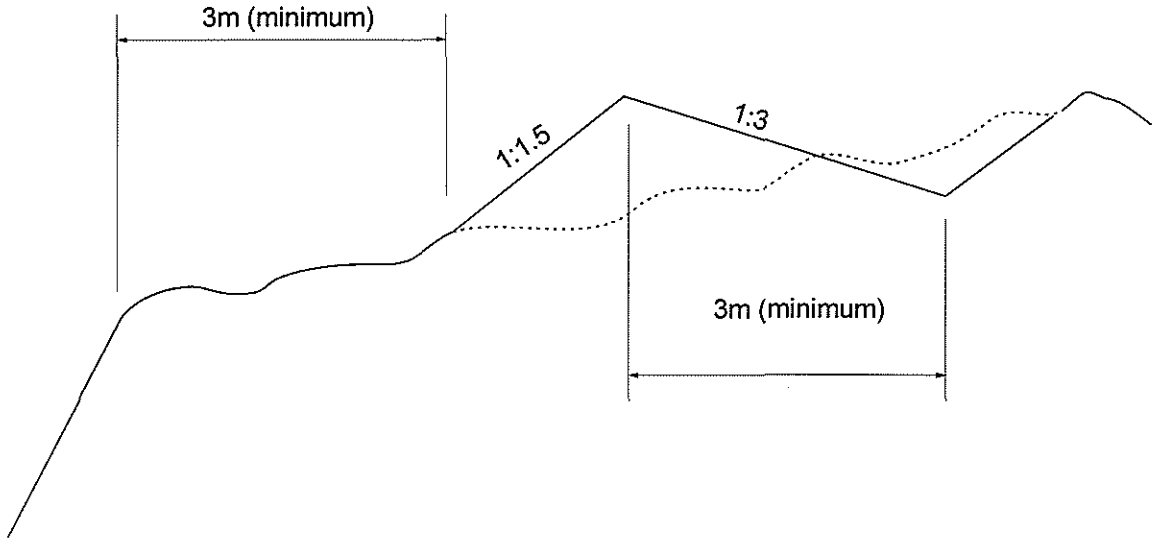


Figure 1: Catchwater drain geometry

5.4 Where the ground conditions are such that the economic excavation of a drain is not possible, a catchwater mound 3m at a slope of 1 in 3 on the waterside shall be constructed of top soil or other selected material.

5.5 Catchwater mounds and drains shall be not closer that 3m from the top edges of cuttings or toes of fills and shall be completed as soon as possible to encourage the growth of vegetation transported with the material.

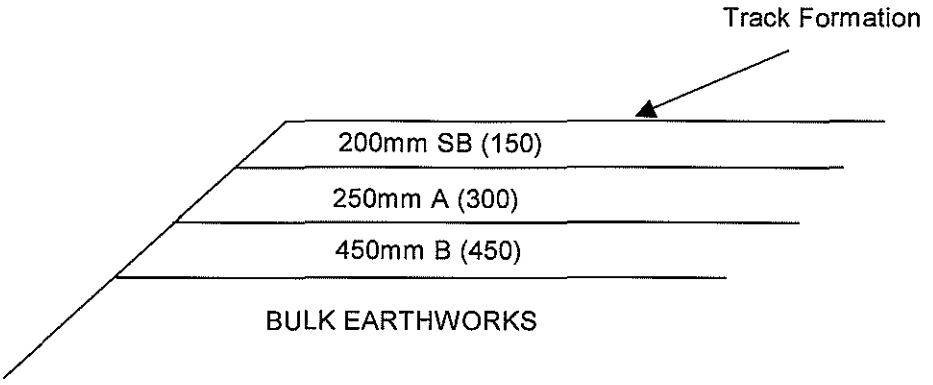
6 PROPERTIES AND CLASSIFICATION OF MATERIALS FOR PLACING PURPOSES

6.1 Material that consists of soil with rock not larger than two-thirds of the loose layer thickness is classified as soil. All other material is classified as rock.

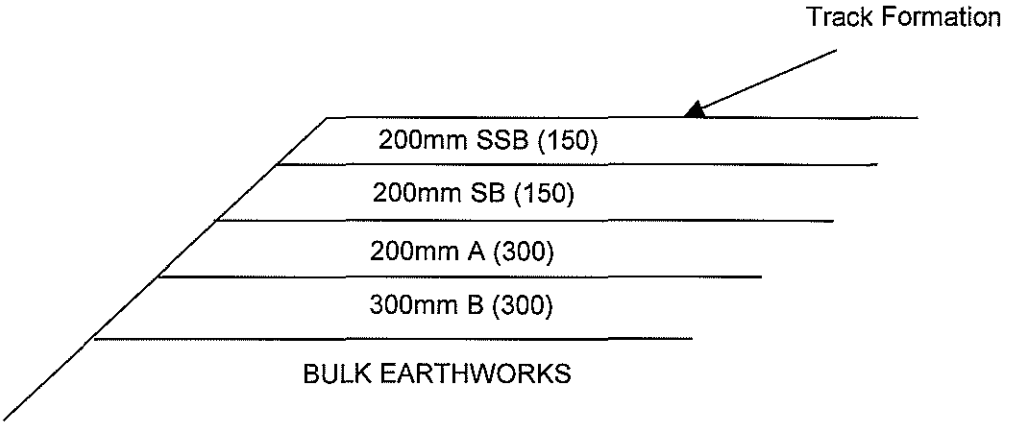
6.2 Rock shall not be used within 900mm of the formation except with the permission of the Engineer.

6.3 The properties of the soil in the bulk earthworks and in the structural layers indicated in Figure 2 shall, subject to the requirements of 6.5 to 6.7, be as shown in Table 1.

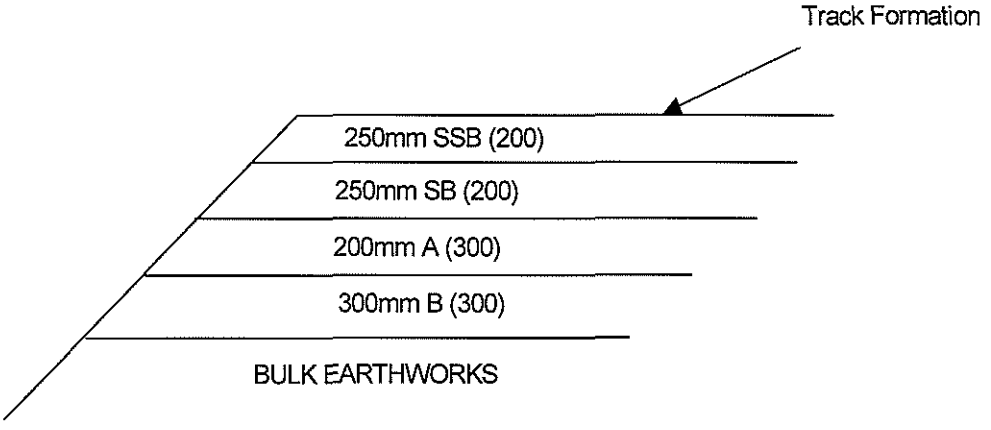
6.4 Stabilisation of the sub-ballast Layers shall be performed only when suitable natural soils is not available and when directed by the Engineer.



2.1 Structural layers for 20t axle loading



2.2 Structural layers for 26t axle loading



2.3 Structural layers for 30t axle loading

Notes: 1. Dimensions in brackets apply when layers SB and SSB are stabilised.

2. Table 1 gives material properties, compaction and strength required.

Figure 2: Structural layers between bulk earthworks and formation

Table 1: Material properties for earthworks construction

LAYER		MATERIAL PROPERTIES									Minimum compaction % of modified AASHTO Density	Minimum strength after compaction CBR
		SAR Index	Min. Grading Modulus	% BY MASS PASSING SIEVE (sieve size in mm) 75	13.2	2.0	0.425	0.075	PI	Max. CBR Swell %		
SUB LAYERS	SSB	<50	2.0	100	60-85	20-50	10-30	5-15	3-10	0.5	98	60 **(o)** (1.5-3 MPa)
	SB	<80	1.8	100	70-100	20-60	10-40	5-20	3-10	0.5	95	+ 30 **(o)** (1.5-3 MPa)
A		<110	1.0					<40	<12		95 100*	20
B		<155	0.5					<70	<17		93 98*	10
Bulk earth works									<25	2	90 95*	5

* These densities apply to non-cohesive soils
(o) Strengths in brackets apply in place of CBR values where sub-ballast is stabilised
+ Increase to 45 in the absence of Layer SSB unless otherwise specified (Increase not normally required in dry areas.)

Note:- See Appendix A for comparable road materials. The classifications shown may be used by the Contractor at his discretion when preparing preliminary assessments of availability of materials for use in the listed layers.

6.5 In Table 1

6.5.1 the SAR Index is the sum of the Liquid Limit, the Plastic Limit and the percentage passing the 0.075mm sieve, expressed as a number (the sum of Liquid Limit and Plastic Limit shall be taken as 45 if tests for these limits cannot be performed buy virtue of the nature of the material);

6.5.2 the grading modulus is the sum of the cumulative percentages of material retained on the 2.00; 0.425 and 0.075mm sieves divided by 100;

6.5.3 the maximum CBR swell is determined at 100% of modified AASHTO density;

6.5.4 the strength after compaction of stabilised layers is the unconfined compressive strength (UCS) determined when applying the curing times and methods as shown in Table 2.

Table 2: Recommended stabilising procedures

Stabilising Agent	Type of Cure	Curing time	Reference
Cement or cement/slag	Normal	7 d	TMH1 method A14
Lime or lime/slag	Accelerated	48 h	Appendix C of M5, except that curing temperatures shall be 50°C

6.6 Where pedogenic materials are used and accepted as such by the Engineer, the requirements given in Table 1 are modified as follows to allow for their anomalous behaviour.

6.6.1 The SAR Index and grading modulus requirements shall not apply.

6.6.2 The maximum passing the 0.075mm sieve for sub-ballast is increased to 25%.

6.6.3 The maximum PI for all materials is increased by 25%.

6.6.4 The compaction and CBR requirements remain unaltered.

6.7 Where the sub-ballast layers are stabilised, the requirements given in Table 1 are modified as follows:-

6.7.1 For Material to be stabilised:-

6.7.1.1 the SAR Index, minimum grading modulus, PI and maximum CBR swell requirements shall not apply;

6.7.1.2 if the stabilising agent is cement, the upper limit of the percentage by mass passing the 0.075mm sieve is increased to 25;

6.7.1.3 in earthworks for 26t axle loads, the minimum grading modulus and grain size distribution requirements for the Layer SB material may be as given for Layers A material provided that the percentage by mass passing the 0.075mm sieve does not exceed 30.

6.7.2 For stabilised material:-

6.7.2.1 the PI after stabilisation shall not exceed 6;

6.7.2.2 after compaction to the specified in situ density, the percentage loss shall not exceed 14 when tested in accordance with THM1 method A19. Samples of the Layers SB material shall be brushed only after the final cycle.

6.8 Where used without stabilisation in the sub-ballast layers, all rock, and especially residual fine-grained sedimentary rock material shall comply with the following 10% FACT requirements when tested in accordance with TMH1 method B2:-

6.8.1 Minimum crushing strength of dry material : 110kN

6.8.2 Minimum ratio of the crushing strengths of wet (24 h soaking) to dry material : 75%

7 PLACING OF MATERIALS

7.1 Structural Layers shall be placed to the dimensions in Fig.2 except that in cuttings or shallow fills. Layers other than the top structural layer or portions thereof shall be omitted if the in situ material complies with the requirements specified for the omitted material, subject to confirmation by the Engineer.

7.2 The top structural layer shall be constructed in every case

7.3 In hard cuttings, where excavation to the underside of the sub-ballast Layer within the tolerances specified in 16 is not possible, the cutting shall be over-excavated, backfilled and compacted to the underside of that Layer with material complying with the requirements for the Layer immediately below. If any sub-ballast Layer(s) has (have) to be stabilised, the over-excavation and backfilling shall be done to the underside of the lowest stabilised Layer.

8 COMPACTION

8.1 The standard of compaction shall be as shown in Table 1. The contractor shall be solely responsible for attaining the minimum densities and strengths specified. In addition to the tests referred to in 10.4.1 and 10.4.2, the Contractor shall make use of the dynamic cone penetrometer as often as may be necessary to ensure that a uniformly high standard of compaction is achieved.

8.2 Irrespective of density requirements, each Layer shall be rolled at optimum moisture content with a minimum of 3 passes of a suitable roller.

8.3 Acceptable in situ material below undercuts and at the base of fills shall be compacted to the density specified for the relevant Layer to a depth of 150mm.

9 STABILISATION

9.1 Stabilisation shall be in accordance with specification S413 using approved equipment to produce thorough and uniform mixing to the full depth of each Layer.

9.2 Mix designs shall be submitted for approval by the Engineer prior to commencement of construction.

9.3 If required by the Engineer, samples of the material to be stabilised and the proposed stabilising agents shall be submitted together with the mix design.

9.4 Trail strips shall be laid for approval of the Engineer before work on stabilised Layers proceeds.

9.5 Payment will be made for approved final strips forming part of the Works.

10 TESTING OF MATERIALS

10.1 General

10.1.1 The contractor shall erect field laboratories as necessary for testing materials and determining standards of compaction. The equipment provided by the Contractor shall be adequate for all the necessary tests in accordance with the procedures laid down in TMH1.

10.1.2 The Contractor shall provide full-time competent staff to carry out the tests, and shall maintain a record, in approved form, of all tests carried out. Copies of such records shall be submitted to the Engineer within 2 working days of completion of each test.

10.1.3 The costs of carrying out all tests except check tests ordered by the Engineer, shall be borne by the Contractor and shall be included in the scheduled rates for earthworks.

10.2 Check tests

10.2.1 The Engineer may order check tests to confirm the Contractor's test results, which determine material classification or standard of compaction. These check tests shall be undertaken by the Contractor under conditions decided by the Engineer.

10.3 Material properties

10.3.1 Although Transnet may supply information concerning the classification of the soil likely to be encountered during the course of the contract, the onus nevertheless rests on the Contractor to carry out, as the work proceeds, such tests as are necessary to ensure that the soils used are in accordance with the standards specified.

10.4 Control Tests

10.4.1 The standard of compaction shall be established by field density determination using the sand replacement method. Nuclear instruments for control of density and moisture content will be permitted, provided that:-

10.4.1.1 only instruments approved by the Engineer are used;

10.4.1.2 the instruments are in a state of proper calibration and wet density bias is not introduced;

10.4.1.3 the dry density as determined by the use of the instrument does not vary by more that 3% from that determined by the sand replacement method;

10.4.1.4 the equipment for field density tests by the sand replacement method is available on the site at all times.

10.4.2 Unless otherwise permitted by the Engineer, the number of tests performed by the Contractor to determine compliance with the requirements in Table 1 shall be:-

10.4.2.1 at least one set of test to determine the material properties for every 5000m² of competed layer below the sub0ballast layer and at least one set of tests per 2000m² of completed sub-ballast layer;

10.4.2.2 at least 3 density test per completed layer for each day's production, subject to a minimum of one test for every 1000m² of completed layer;

10.4.2.3 at least one CBR test per 5000m² of completed sub-ballast layer.

11 OFF-TRACKING PLATFORMS

11.1 Off tracking platforms for ballast tamping machines shall be constructed at the sites indicated and to the dimensions and levels specified.

11.2 The platforms shall be constructed to the same standards as those of the adjacent earthworks except that layer A material compacted to not less that 95% of modified AASHTO density, shall be used in place of layer SB and SBB.

12 STREAM DIVERSIONS AND INLETS AND OUTLETS OF BRIDGES AND CULVERTS

12.1 The Contractor shall construct the earthworks for stream diversions and for inlets and outlets of bridges and culverts to the lines and levels specified.

13 HAUL ROADS

13.1 The Contractor shall construct and maintain all haul roads necessary for the execution of the works

13.2 Where the route has been designated by the Engineer, the Contractor shall follow such route.

14 HAULAGE

14.1 Where the Contractor, at his own request, is permitted by the Engineer to undertake the work in order other than specified, overhaul and free haul will be calculated as though the work was performed in accordance with the specified order of work.

15 SERVICE ROADS

15.1 The Contractor shall construct a service road as shown on the drawings.

15.2 The road shall be suitable for an unloaded 7 ton flat truck to travel with reasonable ease and safety at a speed of 25 km/h.

15.3 The road shall be graded and handed over in good order on completion of the contract.

15.4 The following geometric standards shall apply:

15.4.1	Minimum width	:	4m
15.4.2	Cross fall	:	1 in 15 to 1 in 40
15.4.3	Maximum local depressions and bumps	:	50mm

15.5 In all cases, effective drainage of the road shall be provided to prevent ponding. Unless otherwise specified, the cross fall shall be in a direction away from the earthworks.

15.6 The road shall have a foundation layer consisting of a 300mm thick layer B over bulk earthworks, both constructed to comply with §6.

15.7 Where specified, a wearing course, complying with the following, shall be provided over the foundation layer:

15.7.1	Thickness (minimum)	:	150mm
15.7.2	Percentage by mass passing the 0.075mm sieve	:	10 to 40
15.7.3	PI	:	8 – 17
15.7.4	Compaction (minimum)	:	93% of modified AASHTO density
15.7.5	Minimum CBR after compaction	:	15

16 TOLERANCES

16.1 Permissible deviations of the finished work shall be as listed in SABS 1200 DN for Degree of accuracy II with the exception of the formation level for which a deviation of ±20mm shall apply. In addition, the plans of the formation when tested with a 3m straightedge shall have no deviation exceeding 20mm, subject to adjustment as necessary for vertical curves.

16.2 The tolerances on the thickness of the layers specified in Table 1 shall be ±20mm for each of the sub-ballast layers SSB and SB and ±50mm for each of the layers A and B. The permissible deviation of the finished level of the bulk earthworks immediately below layer B shall be ±100mm.

16.3 Permissible deviations of moisture content during compaction and of density obtained after compaction shall be as listed in SABS 1200D for Degree of Accuracy II.

17 MEASUREMENT AND PAYMENT

17.1 Measurement and payment for earthworks will be as specified in SABS 1200D and SABS 1200 DN except for the following:-

17.1.1 Excavation and stockpiling of topsoil will be measured in cubic metres in cut computed from depths directed by the Engineer.

17.1.2 Over-excavation, backfilling and compaction described in 7.3 will be measured in square meters of surface treated. Scheduled rates shall include the cost of removal of the non-excavated material to fill or spoil; the provision of suitable backfill material and compaction and finishing within the specified tolerances.

17.1.3 Check tests will be measured by the number of tests confirming the Contractor's results. Scheduled rates shall include the cost of all labour equipment and consumable required to undertake each test.

17.2 The service road will by measured in square meters to the neat dimensions specified. Scheduled rates shall include the cost of forming, shaping and compacting. Cuts and fills exceeding 200mm in depth to form the foundation layer will be paid for separately.

APPENDIX A

COMPARABLE ROAD MATERIALS

This information is provided as a guide only

Layer	CER Range	Unified	AASHTO
SSB	=40	GW GC	A-1-a A-1-b
SB	30 - 60	GP GH SW	A-2-4
A	20-30	SC SP SM	A-2-5 A-3
B	10-20	HL CI CL	A-2-6 A-2-7 A-4 A-5 A-6