

AS 7638:2022



Railway earthworks

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Infrastructure Standard



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This Australian Standard® AS 7638 Railway earthworks was prepared by a Rail Industry Safety and Standards Board (RISSB) Development Group consisting of representatives from the following organisations:

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The Standard was approved by the Development Group and the Infrastructure Standing Committee in March, 2022. On March 30, 2022 the RISSB Board approved the Standard for release.

This standard was issued for public consultation and was independently validated before being approved.

Development of the Standard was undertaken in accordance with RISSB's accredited process. As part of the approval process, the Standing Committee verified that proper process was followed in developing the Standard.

RISSB wishes to acknowledge the positive contribution of subject matter experts in the development of this Standard. Their efforts ranged from membership of the Development Group through to individuals providing comment on a draft of the Standard during the open review.

I commend this Standard to the Australasian rail industry as it represents industry good practice and has been developed through a rigorous process.



Deb Spring
Chief Executive Officer
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AS 7638:2022

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Document details

First published as: AS 7638:2022 Railway earthworks

ISBN 978 1 76113 691 7

Document history

Publication Version	Effective Date	Reason for and extent of change(s)
AS 7638:2022	April 27, 2022	New edition 2022
AS 7638:2013	June 05, 2013	Superseded (aged review)

Approval

Name	Date
Rail Industry Safety and Standards Board	April 27, 2022

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This Standard was prepared by the Rail Industry Safety and Standards Board (RISSB) Development Group AS 7638 Railway earthworks. Membership of this Development Group consisted of representatives from the organisations listed on the inside cover of this document.

Objective

This Standard is to describe the requirements for the design, construction and maintenance of earthworks in connection with railway operations in Australia.

Compliance

There are four types of provisions contained within Australian Standards developed by RISSB:

1. Requirements.
2. Recommendations.
3. Permissions.
4. Constraints.

Requirements – it is mandatory to follow all requirements to claim full compliance with the Standard. Requirements are identified within the text by the term 'shall'.

Recommendations – do not mention or exclude other possibilities but do offer the one that is preferred. Recommendations are identified within the text by the term 'should'.

Recommendations recognise that there could be limitations to the universal application of the control, i.e. the identified control is not able to be applied or other controls are more appropriate or better.

Permissions – conveys consent by providing an allowable option. Permissions are identified within the text by the term 'may'.

Constraints – provided by an external source such as legislation. Constraints are identified within the text by the term 'must'.

For compliance purposes, where a recommended control is not applied as written in the standard it could be incumbent on the adopter of the standard to demonstrate their actual method of controlling the risk as part of their WHS or Rail Safety National Law obligations. Similarly, it could also be incumbent on an adopter of the standard to demonstrate their method of controlling the risk to contracting entities, or interfacing organisations where the risk may be shared.

RISSB Standards address known hazards / hazardous events within the railway industry. Where applicable to this Standard, these are listed in Appendix A: Australian Rail Risk Model (ARRM).

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1 Scope and general

1.1 Scope

- 1.1.1 This Standard provides a whole-of-life approach to rail structures, and covers the general management requirements, material composition, manufacturing, construction, maintenance, decommissioning and disposal of rail structures used in Australian rail operations. This includes:
- (a) cuttings and excavations;
 - (b) embankments;
 - (c) sub-ballast / capping layer.
- 1.1.2 This Standard should be used for new earthworks and modifications to existing earthworks. RIMs may also use this Standard when assessing existing earthworks.
- 1.1.3 This Standard covers railways classified in AS 7630 including light rail networks, except for high speed passenger lines.
- 1.1.4 This Standard does not cover ballast, rails, sleepers, or rail jewellery.
- 1.1.5 This Standard is not specifically intended to cover cane railways or heritage railways operating on private reservation, however items from this Standard may be applied to such systems as deemed appropriate by the relevant railway infrastructure manager (RIM).
- 1.1.6 This Standard is also not intended for use in the design of the following:
- (a) Works intended to be of a temporary or emergency nature.
 - (b) Piled foundations.
 - (c) Flood levee banks.

1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document:

- (a) AS 1141 Methods for sampling and testing aggregates
- (b) AS 1170 Structural design actions, Part 4: Earthquake actions in Australia
- (c) AS 1289 Methods of testing soils for engineering purposes
- (d) AS 1726 Geotechnical site investigations
- (e) AS 2187 Explosives – Storage, transport and use
- (f) AS 3706 Geotextiles - Methods of test Determination of durability series
- (g) AS 4799 Installation of underground utility services and pipelines within railway boundaries
- (h) AS 5100 Bridge design series
- (i) AS 7630 Railway infrastructure – Track classification
- (j) AS 7664 Railway signalling cable routes, cable pits, and foundations

- (k) AS ISO 11453 Statistical interpretation of data – Tests and confidence intervals relating to proportions

NOTE: Additional documents for informative purposes are listed in Appendix O.

1.3 Terms and definitions

For the purposes of this document, the terms and definitions given in RISSB Glossary: <https://www.rissb.com.au/products/glossary/> and the following apply.

1.3.1

batter

constructed slope (cut or fill) commonly of uniform gradient usually expressed as a ratio of horizontal to vertical

1.3.2

borrow pit

excavation where material can be removed and obtained for use in earthworks/construction

1.3.3

capping

material generally consisting of well-graded, well-mixed natural or artificially coarse-grained material with sufficient fines that is intended to seal the earthworks.

1.3.4

clearing

removal and disposal of all trees, logs, timber, scrub, vegetation, minor structures, refuse and other material unsuitable for incorporation in the work

1.3.5

collapsible soil

unsaturated soil that is stable in the natural state that suffers a sudden decrease of volume after wetting, loading or a combination of both

1.3.6

compaction

process whereby the dry density of soil is increased by mechanical or other means

1.3.7

contaminated materials

material containing a chemical or biological substance(s) at above background levels and posing, or potentially posing, a risk of harm to human health, the environment, water supply or agriculture, based on applicable legislation and standards

1.3.8

cutting

cut

earth and/or rock excavation that is made below an existing surface

1.3.9

defined event

events such as earth movement, rainstorm, earthquake, blasting or inundation, as defined by the RIM

1.3.10

dispersive soil

soil that has the ability to pass into suspension in the presence of water

1.3.11

earth

soil

all materials such as clay, sand, gravel, weathered or loose rock

1.3.12

embankments

fill

earth and / or rockfill structure constructed above an existing and/or excavated surface

1.3.13

expansive soil

soil that exhibits a great amount of volume change as a direct result of a change in soil moisture

1.3.14

drainage blanket

discrete layer of free-draining material to promote drainage at areas of seepage

1.3.15

formation

earthworks structure including all foundation, structural treatments and capping layer, on which ballast is laid

1.3.16

formation layers

any layer within the formation structure. Includes sub-ballast / capping and structural layers

1.3.17

formation level

finished level at the top of capping at the centre of the formation preparatory to laying ballast

1.3.18

foundation treatment

special layer or treated zone within the foundation for the purpose of strengthening, stiffening, managing settlement, aid construction, drainage, etc.

1.3.19

free-draining material

hard, strong and durable particles containing a low percentage of fines that provides a high level of permeability

1.3.20

geosynthetics

range of polymeric products which can include geotextiles, geogrids, geonets, geomembranes, geosynthetic clay liners, geocells and geocomposites

1.3.21

graded filter

layer of material used to prevent fine soil particles washing from the body of the structure, embankment, etc.

1.3.22

grubbing

removal of the base of stumps, roots, perishable material, underground parts of redundant structures, and other minor obstructions

1.3.23

poor ground

soil and/or rock which does not provide adequate foundation strength or support for the placement and compaction of fills or support for railway ballast and track

1.3.24

relative compaction

ratio of the as-compacted field dry density to a laboratory maximum dry density, expressed as a percentage

1.3.25

rip rap

cobble sized rock placed on the surface for the protection of the underlying material to prevent erosion, scour or sloughing of a structure or surface such as on an embankment or cut slope

1.3.26

rock

mineral matter of variable composition, consolidated or unconsolidated, assembled in masses in nature. Naturally occurring solid mass or aggregate of minerals

1.3.27

rock armour

revetment made of typically large rocks used to provide erosion protection against tidal, flood or wave action

1.3.28

root jacking

process of roots penetrating joints and defects in the rock and movement of rock masses due to pressure generated by growing roots

1.3.29

select fill

material for use adjacent to structures or in other distinct applications that require specific properties defined for that purpose

1.3.30

special location

location prone to or with a history of earthworks instability

1.3.31

sub-ballast

permeable layer which is more appropriate than the impermeable capping under certain circumstances where the foundation consists of free draining materials such as rockfill or sand

1.3.32

ULX

under line crossing

The passage of pipes, cables, etc. below a railway line. Also known as UTX (under track crossing)

1.3.33

uncontrolled fill

material that is placed without adequate compaction to assure a bearing capacity without undue settlement

1.3.34

unsuitable material

material considered unsuitable for earthworks due to its adverse characteristics

1.4 Abbreviations

1.4.1

H

Height

1.4.2

V

Vertical

1.4.3

MPa

Megapascal

1.4.4

t

tonne

1.4.5

kPa

kilopascal

1.4.6

RIM

rail infrastructure manager

2 Design

2.1 General

- 2.1.1 Design and rating of earthworks should include a geotechnical report covering the geotechnical investigation of, and specialist geotechnical advice on, the site and materials. Further guidance regarding geotechnical reports is available in AS 1726 and other relevant Australian Standards.
- 2.1.2 Design of light rail earthworks must comply with other legislative requirements and Standards, such as those applicable to road construction, where operating within a shared corridor.
- 2.1.3 Design should include checks with other relevant disciplines associated with the same works or projects.
- 2.1.4 All earthworks subject to rolling stock loading should be designed for rolling stock wheel loading in accordance with AS 5100 and/or other relevant standards.
- 2.1.5 Example design drawings are provided for information as below:
- (a) Appendix G – Earthworks cross section.
 - (b) Appendix H – Earthworks at cut/fill interface.
 - (c) Appendix I – Widening of existing embankment.
 - (d) Appendix J – Embankments.
 - (e) Appendix K – Cuttings.
 - (f) Appendix L – Centre Drains.
 - (g) Appendix M – Special width requirements.

2.2 Design

- 2.2.1 The following factors should be assessed, as appropriate to individual sites, when designing the rail earthworks structure:
- (a) Proposed current and likely future loading patterns (refer AS 7630), such as traffic type, axle load, speed, track geometry.
 - (b) Topography.
 - (c) Local geology, including subsurface bedrock topography, pre-existing failure planes and weathering patterns.
 - (d) Soil type, consistency and lithological characteristics.
 - (e) Areas of engineered or uncontrolled filling.
 - (f) Geotechnical hazards, including seismic events and liquefaction
 - (g) Poor ground and problematic soils requiring special consideration, including expansive soils, dispersive soils, collapsible soils, soluble soils, compressible soils and potential/actual acid sulphate soils, and other soil types.
 - (h) Landfill.
 - (i) Groundwater and surface water regime.
 - (j) Hydrological and hydrogeological impacts, including flooding.

- (k) Design gradients and the proposed extent of cutting and filling.
- (l) Existing and resultant drainage patterns.
- (m) Erosion and siltation.
- (n) Sinkholes and washaways.
- (o) Measures to mitigate animal damage.
- (p) In situ and design moisture contents.
- (q) Locally available material types, including site won, borrowed, and import materials.
- (r) Location and type of structures (bridges, culverts, tunnels, subways, underpasses, etc.) and slope surcharges, including the effects of local changes in soil stiffness.
- (s) Existing vegetation, including that requiring protection (environmental) or specialist disposal during earthworks.
- (t) Pre-existing formation construction and performance, including available records.
- (u) Proximity to and potential impact on adjoining properties and infrastructure.
- (v) Rehabilitation of worksites, haul routes, borrow pits, etc.
- (w) The availability and suitability of the use of geosynthetics.
- (x) The impacts of vibration and the mitigation measures.
- (y) Outside influences, such as dewatering and blasting.
- (z) Calculation of quantities.
- (aa) Bulking and compaction factors.
- (bb) Sources and quality of water for compaction.
- (cc) Existing underground structures and services.
- (dd) Historical records and cultural heritage, including heritage documentation, overlays and registrations.
- (ee) Soil and rock settlement including creep conditions.
- (ff) The short-term and long-term stability of the structure.
- (gg) Benching and subsurface drainage details at cut-fill interfaces.
- (hh) Track stiffness, modulus and uniformity thereof.
- (ii) Other applicable policies, such as environmental policies.

2.2.2 Design inputs should include:

- (a) design requirements for flood immunity and overtopping;
- (b) instrumented monitoring data;
- (c) data regarding relevant historical events;
- (d) earthquake loading factors as per AS 1170.4;
- (e) potential for liquefaction or other undesirable consequences of earthquakes or other vibration events.

- 2.2.3 The design shall state the requirement for instrumentation and monitoring to assist construction to evaluate performance, and to improve understanding for long term management and maintenance of the asset.
- 2.2.4 The design should state the deformation allowance for earthworks, including the time frames at which the deformation is to be measured. For example this measurement may occur at 4 weeks, 6 months and 12 months following construction.
- 2.2.5 Design by observation may be used where detailed design is not practical or appropriate.

2.3 Track classification

This Standard is prescribed for railway earthworks in the track classifications detailed in AS 7630.

2.4 Investigation and planning

2.4.1 General

Before work activity is undertaken which may affect earthworks, an assessment and/or investigation should be carried out to provide the minimum data for satisfactory design of the earthworks, including but not limited to those listed in Section 2.2.1, and in accordance with RIM requirements.

2.4.2 Design Investigation

- 2.4.2.1 Approvals from local statutory bodies and consent from affected landowners should be obtained prior to commencing the investigative works.
- 2.4.2.2 A review of the site history (which could include previous geotechnical failures or mining activities) and an assessment of potential for contaminated materials, including acid sulphate soils, should be undertaken.
- 2.4.2.3 Geotechnical investigation should be undertaken to provide input into the design, construction and maintenance of the proposed works, as determined by the RIM.
- 2.4.2.4 Geotechnical investigations should be conducted in accordance with AS 1726.
- 2.4.2.5 Where the surface has been disturbed during the investigation process, these areas should be backfilled, compacted and otherwise reinstated where appropriate, such that they do not reduce the performance of the existing or proposed railway, or pose a risk to public safety.
- 2.4.2.6 The results of any contamination investigations/studies should be compared with the limits for contaminants provided by legislation then managed in accordance with legislation and RIM policies.

2.5 Drainage

The design of the formation shall assess the requirements for drainage. This may include the incorporation of surface and subsurface drainage systems appropriate to their relative position on embankments, cuttings, etc.

Further information on surface drainage is provided in AS 7637.

2.6 Capping layer

- 2.6.1 Well compacted capping with material strength suitable for track superstructure and rolling stock load should be placed immediately beneath the track ballast layer, with sufficient cross-fall to drain pluvial flow clear of the formation or into the track drainage system.
- 2.6.2 The form and construction of the sub-ballast or capping layer should be as determined and specified by the RIM.
- 2.6.3 Where there are multiple tracks (three or more), consideration should be given to providing drainage systems which have the sub-ballast or capping layer cross-fall oriented, such that each track is drained separately.

2.7 Embankments

2.7.1 General

- 2.7.1.1 The composition and grading of embankment materials shall comply with the requirements set by the RIM.
- 2.7.1.2 Embankment design should consider:
 - (a) benching requirements to suit asset maintenance criteria;
 - (b) acceptable embankment foundation treatments, including foundations on unsuitable subgrade material;
 - (c) the total and differential allowable movements over a specific period and over the design life of the structures, at areas close to (and remote from) structures.
- 2.7.1.3 Embankment fill shall consist of engineered material, with specified zone thickness and properties. This may include:
 - (a) adopting suitable methods for grading of layers to avoid particle mixing of adjacent layers, in particular in the upper layers of the formation to avoid pumping of fines under traffic;
 - (b) zoning of engineered fill materials to minimize risk and shrink swell effects;
 - (c) confinement/encapsulation of contaminated materials, potential acid sulphate soil and rock, etc.;
 - (d) zoning of engineered fills to optimize use/reuse of site won materials.

2.7.2 Drainage blanket

- 2.7.2.1 Where specified in the design, or directed by the RIM during construction, a layer of free-draining material shall be provided, such as in embankment fill or in areas where the adjacent geology or the terrain is likely to produce seepage.
- 2.7.2.2 The designer should determine the typical composition of any drainage blanket. The composition may include:
- (a) a suitably thick layer of free-draining material, according to the local area conditions;
 - (b) a geotextile layer encapsulating the free-draining material to reduce the ingress of fines;
 - (c) scour protection at the outfall.
- 2.7.2.3 The position of any drainage blanket should consider potential interaction with surface drainage systems.

2.7.3 Embankment protection

- 2.7.3.1 Scour protection should be considered for embankments, with the type and extent of the embankment protection noted on the design drawings.
- 2.7.3.2 Embankment scour protection should be determined by the designer, but in general should be provided in the following ways:
- (a) Rock armour protection placed against the embankment face.
 - (b) Rip rap (rock facing), which should be separated by a graded filter or geosynthetic.
 - (c) Topsoiling, grassing and seeding.
 - (d) Collecting the runoff and directing the flow to lined channels and drop down structures (e.g. trapezoidal concrete or rock lined channel) down the batter.
 - (e) Directing the runoff to drainage pits and piping the flow down the batter in buried pipes.
 - (f) Providing scour protection in the form of endwalls, rip rap and/or energy dissipaters at the outlets of steep pipes and open drains.
- 2.7.3.3 Scour protection of embankments from water courses should be provided, including wave action on causeways.

2.7.4 Physical separation of dissimilar materials

Filters (comprising material of selected particle size distribution and/or geosynthetics) may be used in the design to avoid the mixing of materials after placement. For example:

- (a) softer materials being forced into voids of granular material;
- (b) erosion and migration of fine particles into adjacent granular material.

2.8 Cuttings

The design of cuttings should specify the following:

- (a) Batter slope dimensions including the treatment, location and width of benches.
- (b) Preparation of batter surfaces and finishing treatments (e.g. shotcrete, gabion baskets).
- (c) Details of soil nailing / rock bolting required.
- (d) Treatment of cutting floors, drainage and floor stabilisation.
- (e) The placement of drainage along and down the sloping face of cuttings, top drain / catch drain, as well as access to drains or drainage for maintenance.
- (f) Buffer zone at the toe of cuttings to accommodate fallen soil or rock.
- (g) The inclusion of benching for cuttings e.g. for erosion control, access to maintain the cut face.
- (h) Collection, control and erosion protection for discharge from cess drains at the ends of cuttings.

2.9 Slope stability

2.9.1 General

2.9.1.1 Cuttings and embankments shall provide a stable, safe foundation to the track and associated structures.

2.9.1.2 The design stability of batters should take into account drainage, material properties, height, foundation conditions, presence of services and utilities, static and dynamic loading, potential seepage, earthquake loading, pre-existing failure planes, long-term settlement, and maintenance access. Design criteria should be specified by the RIM.

2.9.2 Cut and fill batters

2.9.2.1 Batters should be no steeper than those determined by the RIM.

2.9.2.2 Batter design should take into consideration maintenance and access requirements.

2.9.2.3 Slopes for rock cuttings should be constructed as determined by geotechnical assessment.

2.9.3 Other slopes

An assessment of the impact of the works on existing slopes, including those outside the rail corridor, should be undertaken as part of the design and investigation phase (e.g. the impact of additional ground surcharging and dewatering).

2.10 Geosynthetics

Appropriate geosynthetics should be selected based on their anticipated service life, considering:

- (a) local conditions;
- (b) design requirements;
- (c) the required puncture and tear strength;
- (d) interlocking characteristics;
- (e) durability;
- (f) fire resistance;
- (g) aggressiveness of the local soils and water;
- (h) water flow conditions e.g. steady-state or dynamic flow conditions;
- (i) inspection and maintenance requirements.

2.11 Poor ground

2.11.1 General

2.11.1.1 The following sections describe the types and suggested treatments to be considered during design for poor ground.

2.11.1.2 Compressible soils within the foundation of embankments, at the base of cuttings or other railway structures shall be managed as per a geotechnical assessment and within the settlement limits as determined by the RIM.

2.11.1.3 The recommended moisture content of expansive soils should take into account the estimated long-term equilibrium moisture content, to ensure the long-term durability and serviceability of the earthworks.

2.11.1.4 The design should specify the foundation treatment techniques to be adopted where expansive soils are present. Suggested approaches to treatment and management are provided in Appendix N.

2.11.2 Existing filled ground

2.11.2.1 Where fill materials are present and no records exist of its construction, it shall be assumed to be uncontrolled fill.

2.11.2.2 Where areas of uncontrolled fill are located within the formation, these shall be accounted for in design.

2.12 UTX/ULX and utilities

2.12.1 The ground conditions at proposed ULX locations should be reviewed by the RIM, and information provided to inform trenching or boring operations.

2.12.2 Where it is necessary to construct a ULX across an existing railway corridor, construction methods shall be accepted by the RIM prior to commencement of the works.

2.12.3 The construction of ULXs and UTXs shall comply with the requirements of AS 7664, AS 4799 and other relevant industry Standards.

2.13 Rail reserve width

2.13.1 New lines should be constructed within a corridor wide enough to accommodate all permanent earthworks.

2.13.2 The width of the rail corridor should take account of the associated earthworks drainage system, communications cables and other services, and allow access for maintenance purposes.

2.14 Retaining wall and ground anchors

Retaining walls and ground anchors shall comply with the relevant sections in AS 5100.3 and other applicable industry Standards.

2.15 Acid sulphate soils and rock

2.15.1 The RIM shall develop plans to manage potential adverse environmental impacts where there is a reasonable likelihood of affecting these materials.

2.15.2 The RIM should arrange for the testing for acid sulphate soils and rock, in areas where there is a reasonable likelihood of affecting these materials.

2.15.3 The relevant environmental authority should be consulted prior to the excavation, handling or use of potential and actual acid sulphate soils, where appropriate.

3 Construction and maintenance

3.1 Site preparation

3.1.1 General

Earthworks construction management should consider as a minimum:

- (a) work methods and plant appropriate to the physical limitations of the site;
- (b) specific measures to avoid or minimize undermining of existing track or structures where earthworks are planned in close proximity to these locations;
- (c) environmental impacts during and after the course of the project;
- (d) management of live rail operations;
- (e) management of underground services;
- (f) management of emergency situations;
- (g) management of sediment generated by the works;
- (h) management of stockpiles;
- (i) locating haul routes to avoid areas of soft or compressible soil, or using ground improvement techniques to improve soil properties in such areas during construction;
- (j) locating haul routes away from the proposed track formation, unless mitigation measures are in place to make good the prepared formation layers prior to the placement of the track ballast layer;
- (k) management of dewatering operations;
- (l) management of temporary drainage and site runoff;
- (m) the potential for nuisance to the public and local residents;
- (n) the potential effects on adjacent infrastructure, such as rail, roads, structures and other earthworks;
- (o) the potential effects on other services, such as emergency services.

3.1.2 Site clearing and grubbing

3.1.2.1 Prior to clearing and grubbing relevant permits required by Federal, State and Local legislation must be obtained.

3.1.2.2 The area to be occupied by the completed works, including ancillary earthworks for drains and diversion levees, plus a suitable clearance from tops of cuttings and toes of embankments, should be cleared and grubbed.

3.1.2.3 Voids left in close proximity to or within the formation boundary after grubbing should be filled with suitable material and compacted in layers.

3.1.2.4 Timber and combustible material should be disposed of as determined by the RIM and in accordance with any relevant regulations.

3.1.3 Stripping of topsoil

- 3.1.3.1 Topsoil covering the area to be occupied by the finished earthworks structure should be removed.
- 3.1.3.2 Topsoil suitable for revegetation should be placed in a stockpile clear of the work to enable its re-use in landscaping and revegetation.
- 3.1.3.3 The area where topsoil has been removed should be inspected by the RIM prior to continuation of earthworks construction.
- 3.1.3.4 The requirement for further removal of topsoil and replacement with suitable material, treatment with additives, etc. should be determined by the RIM.

3.2 Materials

3.2.1 General

- 3.2.1.1 All materials intended for use in the construction of railway earthworks should be clearly specified and meet the requirements of relevant material Standards and RIM specifications.
- 3.2.1.2 All materials shall be transported in a manner which does not affect the physical properties of the material.

3.2.2 Borrow materials

- 3.2.2.1 All permits required by Federal, State and Local legislation must be obtained before commencing excavation at a borrow pit site, with the conditions of the permit followed at all times.
- 3.2.2.2 Where the borrow pit is located within the rail corridor, the borrowing activities should not be detrimental to the stability or performance of the earthworks, adjacent structures or drainage.

3.2.3 Structural fill

- 3.2.3.1 Structural fill material shall be of a quality as defined in the design. The quality specification should consider:
 - (a) particle size distribution;
 - (b) Atterberg limits;
 - (c) maximum dry density;
 - (d) other relevant composition requirements.
- 3.2.3.2 Structural fill shall not contain expansive clays.

3.2.4 Unsuitable materials

3.2.4.1 Unsuitable materials can be defined as either:

- (a) inherently unsuitable – unsuitable due to their composition;
- (b) unsuitable by virtue of their position; or
- (c) unsuitably wet or unsuitably dry.

3.2.4.2 Unsuitable earthworks construction materials may include the following:

- (a) Topsoils, organic soils, peats, logs, etc.
- (b) Materials susceptible to piping, such as fine clean sand, windblown sand and non-cohesive silt.
- (c) Organic silt and clay of low strength.
- (d) Expansive or swelling clays.
- (e) Dispersive soils.
- (f) Dissolvable soils and rock containing substances such as gypsum and sodium chloride.
- (g) Contaminated materials or fill with metals, plastic, hydrocarbons, etc.
- (h) Collapsible materials.
- (i) Chemically aggressive soils.
- (j) Erodible soils.

3.2.4.3 Unsuitable materials should not be used to construct the sub-grade layers or otherwise be present in the formation, except for those made suitable conforming to Clause 3.2.5 below.

3.2.4.4 Materials included in 3.2.4.2(d), (e) and (f) above may be used if treated by additives, or by other suitable controls as approved by the RIM.

3.2.4.5 Unsuitable earthworks construction materials should be reused, treated in accordance with RIM policies and procedures, or removed from site in accordance with relevant statutory requirements.

3.2.4.6 Contaminated or potentially contaminated materials being transported beyond the rail corridor should be tested and managed in accordance with relevant legislation.

3.2.5 Suitable materials

3.2.5.1 Suitable materials comprise of material that meets the design and construction requirements of the formation, such as general fill, structural fill, select fill, capping or sub-ballast material, free-draining material, rock and rock fill, and are generally free from unsuitable materials.

3.2.5.2 The material properties of suitable materials for the layers shown in Appendix G.2 should be defined by the RIM during the design and investigation phase (based upon the general requirements and purpose detailed in this standard).

- 3.2.5.3 The properties of some inferior materials may be improved by artificially blending a selection of materials to provide suitable grading and structural properties, or by chemical stabilisation, subject to appropriate geotechnical advice and laboratory testing.

3.2.6 Sampling and testing

- 3.2.6.1 Materials proposed for use in the earthworks should be subject to testing, and the results used by the designer to determine the suitability of the material.

- 3.2.6.2 Fill material for laboratory testing should be taken and handled as directed by the RIM.

- 3.2.6.3 Earth and rock materials should be tested in accordance with the requirements of this Standard, AS 1289, AS 1141 and other relevant standards.

- 3.2.6.4 Geosynthetics should be tested in accordance with AS 3706.2, AS 3706.4, AS 3706.5, AS 3706.7, AS 3706.9 and other relevant standards.

3.2.7 Water for compaction

- 3.2.7.1 The suitability of non-potable water to increase the moisture content in fill material should be evaluated by field and laboratory tests.

- 3.2.7.2 Saline water and mineral salts should not be used where they can have an adverse effect. This may include:

- (a) in areas where vegetation could require to be established;
- (b) in fill, where steel elements or steel reinforced concrete are to be buried.

3.2.8 Stockpiles

- 3.2.8.1 Stockpiles shall be maintained in a safe condition.

- 3.2.8.2 Stockpiles should be maintained in a neat and well-shaped state, capable of shedding water.

- 3.2.8.3 Different materials should be stockpiled separately to prevent cross-contamination.

- 3.2.8.4 Consideration should be given to the location of stockpiles, such that they do not overload the edge of embankments or cuttings, interfere with signal and/or level crossing sighting, or present undue risk to nearby water bodies.

3.3 Excavation

3.3.1 General

- 3.3.1.1 The excavated faces should be neatly trimmed to a regular and uniform shape and the top edges of the cuttings neatly rounded.

- 3.3.1.2 The excavated face in cuttings should not have significant rills or undulations in the general plane of the batter.

- 3.3.1.3 The excavated cutting face and floor should be inspected and tested as necessary by the RIM prior to foundation treatment or the placement of formation materials.

3.3.1.4 Filling on the floor of the cutting should be consistent with the construction of subgrades in embankments.

3.3.2 Excavation stability

3.3.2.1 The safety of excavated work faces shall be determined by the designer and site supervisor, subject to the occupational health and safety limitations.

3.3.2.2 Consideration should be given to carrying out excavation in a timely manner to prevent ponding, erosion, undercutting or slips. Where this is not possible the installation of stabilisation measures and temporary drainage may be undertaken.

3.3.2.3 Where there is a possibility of seepage any dewatering requirement shall be determined by the designer.

3.3.2.4 Bench drains should be constructed progressively as each batter face is complete.

3.3.2.5 Overhanging and loose or unstable materials with the potential to slip should be cut back, removed or stabilized.

3.3.2.6 Loose rock particles which cannot be completely removed from the slope face or batter shall be prevented from falling on to the railway. This may be achieved using netting, shotcreting, catch fences, or rockfall catch zones.

3.3.2.7 Loading on excavated slopes and, in particular, the sides of trenches and slopes supported by retaining walls should not exceed design loads unless a risk assessment allows for additional loading.

3.3.3 Use of Explosives

3.3.3.1 Licences from the appropriate authorities shall be obtained prior to the commencement of any excavation work involving the use of explosive substances.

3.3.3.2 Blasting activities must comply with all government legislation regarding the planning, documentation, transport, storage, handling and use of explosives.

3.3.3.3 Blasting activities shall comply with AS 2187 and all other relevant standards and codes for the use of explosives in construction.

3.3.3.4 The RIM shall be responsible for the establishment of third party agreements, to be prepared prior to the commencement of any blasting or related activities.

3.3.3.5 Detailed records should be kept of all excavation work involving the use of explosive substances.

3.3.3.6 The RIM shall assess the impact of explosives on rail assets and operations, and on external receptors. This may include consideration of ground vibrations, flyrock, track disturbance, and air blasts.

3.3.3.7 Detailed inspections / dilapidation surveys should be carried out on railway infrastructure, including track geometry and adjacent third party assets, prior to and following the completion of excavation by use of explosives.