For queries regarding this document
standards@transport.nsw.gov.au
www.transport.nsw.gov.au

Technical Direction – TD 00005:2025

Issue date: 10 March 2025

Effective date: 10 March 2025

Title: Update to material selection testing – Amendment to T HR TR 00192 ST (TS 03609:0.0) *Ballast*, V2.0

This technical direction is issued by the Asset Management Branch (AMB) as an update to T HR TR 00192 ST (TS 03609:0.0) *Ballast*, version 2.0.

1 Background

This technical direction includes the following updates to material selection testing in T HR TR 00192 ST (TS 03609:0.0):

- introduction of an alternative ballast material grading option
- changes regarding bulk density
- new sections related to ballast material testing.

2 Amendments to T HR TR 00192 ST (TS 03609:0.0)

The sections in T HR TR 00192 ST (TS 03609:0.0) *Ballast,* V2.0 are to be amended as follows:

3 Reference documents

Add the following after the last Australian standard:

AS 1141.6.1 *Methods for sampling and testing aggregates – Method 6.1: Particle density and water absorption of coarse aggregate – Weighing-in-water method*

AS 1141.23 *Methods for sampling and testing aggregates – Method 23: Los Angeles value*

4 Terms and definitions

Add the following after the last defined term:

RIM rail infrastructure manager; In relation to rail infrastructure of a railway, means the person who has effective control and management of the rail infrastructure, whether or not the person –

(a) owns the rail infrastructure; or

(b) has a statutory or contractual right to use the rail infrastructure or to control, or provide, access to it.

9.1 Material and grading

Add the following paragraph after Table 1:

The ballast material grading in Table 1.1 may be used as an alternative to the 'standard' grading when there are issues with the availability and sourcing of ballast material through the usual supply sources (for example from Bombo quarry or Chullora ballast recycling centre) at the discretion of the RIM.

Table 1.1 – Ballast 60 – percentage passing by mass

Sieve size (mm)	Ballast 60 – nominal size (mm)
63.0	100%
53.0	85% to 100%
37.5	20% to 65%
26.5	0% to 20%
19.0	0% to 5%
13.2	0% to 2%
9.5	N/A
4.75	0% to 1%
1.18	N/A
0.075	0% to 1%

9.3 Bulk density

Add the following after the last paragraph:

Ballast material with a compacted bulk density of not less than 1350 kg/m^3 may be used when there are issues with the availability and sourcing of ballast material through the usual supply sources (for example from Bombo quarry or Chullora ballast recycling centre) at the discretion of the RIM.

Add the following new sections after Section 9.9:

9.10 Particle density

The particle density on a dry basis of the ballast material shall be not less than 2500 kg/m^3 when determined in accordance with AS 1141.6.1.

9.11 Los Angeles value

The Los Angeles value of the ballast material shall not exceed 25% for F or G grading when determined in accordance with AS 1141.23.

9.12 Water absorption

The water absorption of ballast material shall not exceed 2% when determined in accordance with AS 1141.6.1.

Authorisation:

Approved by	Director Corridor Infrastructure and Engineering Asset Management Branch Passenger, Planning and Integration

Transport Asset Standards Authority

T HR TR 00192 ST

Standard

Ballast

Version 2.0

Issue date: 03 July 2018

Important message

This document is one of a set of standards developed solely and specifically for use on Transport Assets (as defined in the Asset Standards Authority Charter). It is not suitable for any other purpose.

This document may not be current and is uncontrolled when printed or downloaded. Standards may be accessed from the Transport for NSW website at www.transport.nsw.gov.au

For queries regarding this document, please email the ASA at standards@transport.nsw.gov.au or visit www.transport.nsw.gov.au

Standard governance

Owner: Lead Track Engineer, Asset Standards Authority

Authoriser: Chief Engineer, Asset Standards Authority

Approver: Executive Director, Asset Standards Authority on behalf of the ASA Configuration Control Board

Document history

Version	Summary of changes
1.0	First issue 6 October 2015
2.0	Significant change to Section 11.6 with reference to provision and specification of ballast mats. All other changes are of a minor nature for clarification or grammar correction. New document template applied.

Preface

The Asset Standards Authority (ASA) is a key strategic branch of Transport for NSW (TfNSW). As the network design and standards authority for NSW Transport Assets, as specified in the *ASA Charter*, the ASA identifies, selects, develops, publishes, maintains and controls a suite of requirements documents on behalf of TfNSW, the asset owner.

The ASA deploys TfNSW requirements for asset and safety assurance by creating and managing TfNSW's governance models, documents and processes. To achieve this, the ASA focuses on four primary tasks:

- publishing and managing TfNSW's process and requirements documents including TfNSW plans, standards, manuals and guides
- deploying TfNSW's Authorised Engineering Organisation (AEO) framework
- continuously improving TfNSW's Asset Management Framework
- collaborating with the Transport cluster and industry through open engagement

The AEO framework authorises engineering organisations to supply and provide asset related products and services to TfNSW. It works to assure the safety, quality and fitness for purpose of those products and services over the asset's whole-of-life. AEOs are expected to demonstrate how they have applied the requirements of ASA documents, including TfNSW plans, standards and guides, when delivering assets and related services for TfNSW.

Compliance with ASA requirements by itself is not sufficient to ensure satisfactory outcomes for NSW Transport Assets. The ASA expects that professional judgement be used by competent personnel when using ASA requirements to produce those outcomes.

About this document

This document sets out the requirements for railway ballast for use on the TfNSW heavy rail network. It provides approved ballast configurations, installation, exceedance limits, procurement requirements, recycled ballast and additional testing requirements.

This standard is the second issue. The change from the previous version includes changes to the reference to provision and specification of ballast mats and other minor changes made for clarification or grammar correction.

Table of contents

1. Introduction

Ballast properties and configuration can affect the performance and safety of the rail network. This standard provides minimum requirements for the testing, delivery and configuration of ballast used in the TfNSW heavy rail network.

2. Purpose

This standard sets the design, maintenance and performance requirements for ballast.

2.1. Scope

This standard establishes functional and design requirements, approved configurations, acceptance standards and exceedance limits for rail ballast.

ESC 200 *Track System* contains the overarching requirements for track infrastructure, which is not covered by this standard. ESC 200 should be read in conjunction with this standard.

2.2. Application

This standard is intended for use by Authorised Engineering Organisations (AEOs) and is applicable to all TfNSW main line and siding tracks. This standard applies to the design of new track work and track renewal works, including reconditioning and ballast cleaning.

This standard is intended to be used by competent personnel engaged in the provision of services relating to the railway infrastructure. Compliance with the standard will not in itself be sufficient to ensure that satisfactory outcomes are produced. Personnel providing services based on the requirements of this standard shall bring appropriate expertise to the matters under consideration. This standard is not specifically intended to cover light rail systems; however, the principles of this standard may be applicable to the light rail environment.

3. Reference documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

International standards

DIN 45673-5 Mechanical vibration – Resilient elements used in railway tracks – Part 5: Laboratory test procedures for under-ballast mats

Australian standards

AS 1141.4 Methods of sampling and testing aggregates, Method 4: Bulk density of aggregate

AS 1141.11.1 Methods for sampling and testing aggregates, Method 11.1: Particle size distribution – Sieving method

AS 1141.12 Methods for sampling and testing aggregates, Method 12: Materials finer than 75 µm in aggregates (by washing)

AS 1141.15 Methods for sampling and testing aggregates, Method 15: Flakiness index

AS 1141.21 Methods for sampling and testing aggregates, Method 21: Aggregate crushing value

AS 1141.30.1 Methods for sampling and testing aggregates, Method 30.1: Coarse aggregate quality by visual comparison

AS 1289.4.4.1 Methods of testing soils for engineering purposes, Method 4.4.1: Soil chemical tests - Determination of the electrical resistivity of a soil - Method for sands and granular materials

AS 2758.7 Aggregates and rock for engineering purposes, Part 7: Railway ballast

AS 4482.1 Guide to investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds

Transport for NSW standards

ESC 200 Track System

ESC 310 Underbridges

T HR CI 12110 ST Earthworks and Formation

T MU MD 00011 ST Concessions to ASA Requirements

Legislation

Contaminated Land Management Act 1997

Protection of the Environment Operations Act 1997

National Environment Protection (Assessment of Site Contamination) Measure 1999

Other reference documents

NSW Environment Protection Authority (EPA) 2014, Waste Classification Guidelines

4. Terms and definitions

The following terms and definitions apply in this document:

AEO Authorised Engineering Organisation; means a legal entity (which may include a Transport Agency as applicable) to whom the ASA has issued an ASA Authorisation

ASA Asset Standards Authority

ballast is a free draining coarse aggregate or metallurgical slag used to support railway tracks

ballast mat is a sheeting placed beneath track ballast to augment formation stiffness or the protection of rigid structures

ballast shoulder ballast placed outside the end of sleepers

ballast shoulder height is the distance from sleeper soffit to the underside of the rail and is determined by the sleeper design

ballast shoulder width is the distance of the shoulder ballast as measured from the sleeper end to the edge of the shoulder

capping layer a layer of compacted material that provides a sealing layer to the earthworks

CCB Configuration Control Board

Crib is the track ballast located between adjacent sleepers

CWR continuous welded rail; track where the rail is joined by welding (and other non-moveable joints such as glued insulated joints) in continuous lengths between fixed points or in lengths greater than 220 m, and where adjustment controls are in place

formation the earthworks structure including all foundation, structural treatment and capping layer, on which ballast is laid

LWR long welded rail; rails which are individually longer than 27.4 m and less than or equal to 220 m. Rail adjustment can be calculated from gap measurement. Rail fastenings comprise dog spikes and anchors or a mixture of dog spikes and resilient fastenings no greater than 1 resilient fastening in 3

windrow the build-up of material on the edge of newly graded ballast

5. Asset life cycle

AEO service providers shall demonstrate to TfNSW that physical assets are managed safely and effectively and that those assets will support project and service outcomes in the long-term.

The application of this document will supplement asset life cycle considerations for ballast by an AEO.

6. Environmental

All ballast activities shall consider environmental impacts and optimise sustainability opportunities during all life cycle phases. Ballast activities shall conform to contemporary good practice in environmental and sustainability considerations and implementation.

Ballast disposal depends on the degree of the ballast contamination. The level of the contamination shall be considered when determining the appropriate receiving facility for its final disposal to ensure compliance with the relevant environmental legislation and guidelines, which can include the following:

- *Contaminated Land Management Act 1997*
- *Protection of the Environment Operations Act 1997*
- *National Environment Protection (Assessment of Site Contamination) Measure 1999*
- the NSW Environment Protection Authority's (EPA) *Waste Classification Guidelines*

Opportunities to recycle used ballast while still meeting the requirements of this standard shall be optimised.

7. Track performance requirements

The performance requirements of track elements, including ballast, are specified in ESC 200 *Track System*.

8. Track structure

The ballast material requirements and track cross-sectional ballast profile in this standard have been developed in consideration of the following criteria:

- loading
    - service loads including effects of track alignment, maintenance standards and traffic tasks
- material
    - ballast consolidation requirements

- interfaces with other rail infrastructure
    - sleeper material, type and spacing
    - electrical properties in track circuited areas
- support requirements
    - required track modulus
    - track support conditions and deflection criteria
    - rigid support structures
    - track formation material and condition
- performance requirements
    - the need to interlock sufficiently to provide resistance against excessive vertical and lateral (buckling of the track) and longitudinal movement of sleepers and bearers
    - the need to reduce excessive loading and failure of the track formation
    - the need to provide adequate drainage of the track structure to the cess and allow fines to migrate out
    - sufficiently durable enough to resist crushing when subjected to normal loading

9. Material selection testing

The supply of railway ballast shall be tested in accordance with AS 2758.7 *Aggregates and rock for engineering purposes, Part 7: Railway ballast*, unless otherwise specified in this document.

The requirements contained within Section 9.1 to Section 9.9 shall apply.

> *Note the sieve sizes, where required for testing from Section 9.2 to Section 9.9 are independent tests and should not be associated with similar sieve sizes listed in Table 1 for ballast grading.*

9.1. Material and grading

Ballast grading shall be either Standard or Fine, in accordance with the existing or proposed track structure classification detailed in standard ESC 200.

Table 1 specifies ballast gradings for the TfNSW heavy rail network. Alternative gradings, either as specified in AS 2758.7 or gradings that are specifically designed to meet special requirements, shall be approved by the Lead Track Engineer, ASA. The nominal graded ballast, shown in the table below, is the designation of the largest size particle present.

Table 1 – Ballast grade – Percentage passing by mass

Sieve size (mm)	Standard - nominal 60 mm graded ballast	Fine - nominal 50 mm graded ballast
63.0	100%	n/a
53.0	85% to 100%	100%
37.5	50% to 70%	70% to 100%
26.5	20% to 35%	n/a
19.0	10% to 20%	40% to 60%
13.2	2% to 10%	n/a
9.50	0% to 5%	20% to 30%
4.75	0% to 2%	10% to 20%
2.36	n/a	5% to 10%

9.1.1. Particle size distribution

The particle size distribution grading of ballast aggregates shall conform to the requirements set out in Table 1 when determined in accordance with the following standards:

- AS 1141.11.1 *Methods for sampling and testing aggregates, Method 11.1: Particle size distribution – Sieving method*
- AS 1141.12 *Methods for sampling and testing aggregates, Method 12: Materials finer than 75µm in aggregates (by washing) Material finer than 75 µm*

The percentage of materials finer than 75 µm, when tested according to the procedure set out in AS 1141.12, shall not be greater than 1%.

9.2. Particle shape

The particle shape of the ballast material shall meet the requirements of AS 2758.7.

9.3. Bulk density

When determined in accordance with AS 1141.4 *Methods of sampling and testing aggregates, Method 4: Bulk density of aggregate*, the compacted bulk density of ballast material shall not be less than 1400 kg/m^3.

9.4. Flakiness index

When determined in accordance with AS 1141.15 *Methods for sampling and testing aggregates, Method 15: Flakiness index* the proportion of flaky particles in the ballast material retained on the 6.70 mm test sieve shall not exceed 30%.

9.5. Aggregate crushing value

The aggregate crushing value of the ballast material, when determined in accordance with AS 1141.21 *Methods for sampling and testing aggregates, Method 21: Aggregate crushing value* for the fraction of material passing the 53.0 mm test sieve and retained on 37.5 mm test sieve, shall have a result no greater than 30%.

9.6. Wet attrition value

The wet attrition value of the ballast material shall meet the requirements of AS 2758.7.

9.7. Weak particles

The ballast shall meet the requirements of AS 2758.7 for weak particles (contaminant test).

9.8. River gravels

As required in AS 2758.7, river gravel or crushed river gravel shall not be used as railway ballast.

9.9. Ballast electrical resistivity

To meet electrical resistance requirements necessary for the satisfactory operation of signalling track circuits, ballast shall demonstrate an electrical resistivity of greater than 60 ohms when tested in accordance with AS 1289.4.4.1 *Methods of testing soils for engineering purposes, Method 4.4.1: Soil chemical tests - Determination of the electrical resistivity of a soil - Method for sands and granular materials*.

10. Ballast treatment and testing

The ballast material shall be managed and controlled as described in Section 10.1 to Section 10.5.

10.1. Ballast delivery and disposal

Graded ballast material shall be handled at the producing plant in a manner such that it is kept clean and free from segregation. Vehicles used for transportation shall be clean and free from rubbish and substances that can foul or damage the ballast.

Discharge from plant, loading of trucks, delivery, and building and maintaining stockpiles shall also be carried out in a manner that effectively avoids segregation and contamination with other materials. A strategy to minimise dust generation and sediment run off from any ballast stockpile should also be developed to ensure no water or air pollution occurs.

Any ballast delivered directly from quarry stockpiles shall have been accepted according to the requirements of this standard prior to delivery to railway wagons.

Redundant ballast, including spoil, should not be left on site or in the rail corridor. Ballast spoil should be transported and disposed of at an appropriate waste facility in accordance with the NSW waste regulations.

10.2. Recycled ballast

Recycled ballast shall be tested for contamination. The determination of its reusability shall be dependent on the level of contamination as prescribed in the relevant environmental legislation.

Contaminated ballast may require cleaning and remediation in order to meet the contamination threshold levels that make it suitable for reuse and recycling, and to ensure compliance with Section 6 of this standard and AS 4482.1 *Guide to investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds*.

The use of recycled ballast is permitted if, as a minimum, one of the following conditions is met:

- the reuse is approved by the Lead Track Engineer, ASA and the ballast is cleaned to remove fines and contaminants
- ballast material meets the testing requirements of Section 9.1 to Section 9.9
- the ballast is only to be used below the depth specified for free draining ballast

10.3. Product testing

Sampling and testing shall be carried out in accordance with the requirements of AS 2758.7 and the AS 1141 series.

Sample testing shall be undertaken from the point of delivery or at the source of the ballast supply. Requirements for testing and type approval from new suppliers or material sources shall be directed by the Lead Track Engineer, ASA. Requirements for testing during normal production are provided in Section 10.3.1.

10.3.1. Test requirements

Sample testing shall be undertaken from the point of delivery or at the source of the ballast supply.

Every 5000 tonnes or 1 week, whichever is greater, carry out the following tests:

- flakiness index
- weak particles

- material finer than 75 µm
- particle size distribution

Every 50,000 tonnes or 3 months, whichever is greater, or if there is a change in the material quarried, carry out the following tests:

- bulk density
- aggregate crushing value
- wet attrition value
- ballast electrical resistivity

10.4. Sourcing alternative materials

In addition to meeting the requirements of Section 9 of this standard, material from new sources of supply shall be subject to petrographic and petrological analysis in accordance with the requirements of AS 1141.30.1 *Methods for sampling and testing aggregates, Method 30.1: Coarse aggregate quality by visual comparison* to evaluate for deleterious materials.

Igneous or other rock displaying minerals considered to be harmful to the overall performance of the ballast can be rejected following petrographic analysis or durability testing, even though the rock complies with this standard.

10.5. Additional tests

Additional tests for other properties may be specified by the Lead Track Engineer, ASA for particular requirements.

11. Ballast configuration

All work involved with the laying of ballast as part of new track installation or track renewal shall be in accordance with Section 11.1 to Section 11.6 and shall meet the acceptance criteria detailed in Section 11.7.

11.1. Ballast profile

Figure 1 illustrates a cross-section of a typical track and ballast profile. The profile is further described in Section 11.1.1 to Section 11.4.

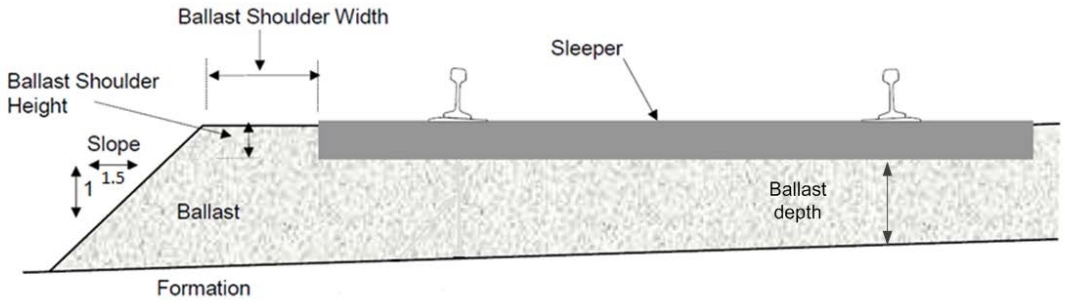

Figure 1 – Typical track cross-section and ballast profile

11.1.1. Shoulder height

Ballast shoulder height shall be profiled level with the top of the sleeper ends. Depending on the sleeper design, the rail seat area may be higher than the centre and ends.

11.1.2. Crib height

The ballast shall be profiled level with the top of sleeper centres.

11.1.3. Shoulder slope

For freestanding ballast, the slope of the ballast shoulder is 1 high : 1.5 wide.

11.2. Shoulder width

The minimum shoulder distance is determined by the track stability requirements of rail length.

The requirements for current applications are detailed in Table 2.

Table 2 – Design ballast shoulder width

Operating class	Minimum	Maximum
Main line – CWR and LWR	400 mm	700 mm
Siding – CWR and LWR	400 mm	700 mm
Siding – Loose rail	300 mm	700 mm

As shown in Figure 2, the ballast shoulder should extend horizontally from top of the sleeper end. It is acceptable for the ballast shoulder to be profiled in the plane of the sleeper for a normal ballast shoulder width to suit ballast regulators. Any extended shoulders, such as on bridges, shall be horizontal.

The design of the ballast shoulder width is a contributing factor to overall track lateral stability. Additional ballast shoulder width above the minimum and a ballast windrow up to rail height outside the sleeper, may be necessary in areas of poor track lateral stability. This is to provide adequate resistance to track buckling on sharp curves where design radius is outside normal limits.

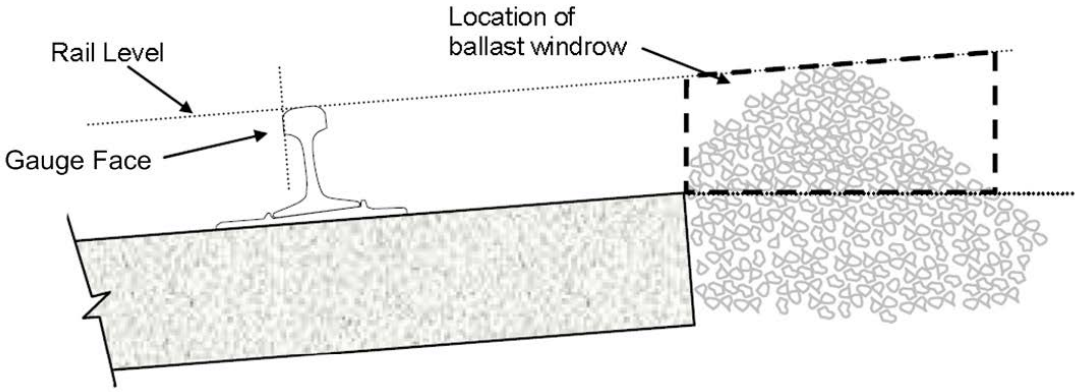

Figure 2 – Location of ballast windrow

11.3. Ballast depth

As shown in Figure 1, ballast depth is the distance from the underside of the sleeper to the top of the finished formation or capping layer.

Formation design for ballast placement shall be to the requirements of T HR CI 12110 ST *Earthworks and Formation*.

On superelevated track, the depth of ballast is measured from under the low rail.

Ballast depth shall be high, medium or low in accordance with the track structure classification detailed in ESC 200, and as detailed in Table 3 to Table 7.

Table 3 – Ballast depth categories

Category	Minimum design depth	Maximum design depth
High - H	350 mm	500 mm
Medium - M	300 mm	500 mm
Low - L	250 mm	500 mm
Low - L (150)	150 mm	500 mm
Low - L (100)	100 mm	500 mm
Low - L (nominal)	nominal	500 mm

Table 4 – New main line ballast height

Operating class	Sleeper type	Ballast depth
Passenger main line	• Medium duty concrete • Heavy duty concrete	L
Mixed passenger and freight main line	• Medium duty concrete • Heavy duty concrete	M
Light line	n/a	n/a
Heavy freight option	Heavy duty concrete	H

Table 5 – Existing main line ballast height

Operating class	Sleeper type	Ballast depth
Passenger main line	Timber	L
Mixed passenger and freight main line	Timber	M
Light line	Timber	L
Heavy freight option	Heavy duty concrete	H

Table 6 – New sidings ballast height

Operating class	Sleeper type	Ballast depth
General yard	Medium duty concrete	L
Passenger operations or maintenance	Medium duty concrete	L
Passenger siding	Timber	L (100)
Engineering maintenance siding	Timber	L (Nominal)

Table 7 – Existing sidings ballast height

Operating class	Sleeper type	Ballast depth
General yard	Timber	L (150)
Passenger operations or maintenance	Timber	L (150)
Passenger siding	Timber	L (100)
Engineering maintenance siding	Timber	L (Nominal)

Full ballast depth in existing track includes ballast that may not be free draining. Free draining ballast can include ballast with fines such as sand, brake dust and other fine material that does not restrict water flow.

Use of the design ballast depths with poor subgrades can still cause the subgrade to be over stressed. A detailed investigation and analysis of the whole track structure including the substructure condition is necessary in these problem situations.

Through turnouts, the minimum ballast depth under turnout bearers shall be maintained by lowering the formation level as required. The change in the level of the formation shall be ramped-off as described in Table 8.

Table 8 – Maximum grade under turnouts

Turnout installation or replacement	Maximum grade relative to track grade
Where adjacent track is also being installed or reconstructed	1 in 200
Where major track reconstruction is not being undertaken	1 in 20

11.4. Formation design model

The basic design model for ballast depth is based on the formation strength. Refer to T HR CI 12110 ST *Earthworks and Formation* for details.

11.5. Alternative ballast profiles

The following alternative ballast profile designs may also be adopted:

- The ballast shoulder width may be reduced to a minimum of 75 mm if a lateral restraint, such as a retaining wall is provided. The lateral restraint shall be at least equivalent to the restraint that would have been provided by the absent shoulder ballast. Arrangements shall also be made for the drainage of water from the formation.
- The ballast shoulder width may be increased, for example in walkways and examination areas, if alternative arrangements are made for the drainage of water from the formation.
- The ballast depth may be reduced if measures are in place to provide track strength and durability that is at least equivalent to the standard configuration and stiffness is no less than the requirement. Examples include the use of special vibration isolation fastenings and ballast matting.

11.6. Track stiffness and ballast mat

The configurations detailed in Section 11.1 through to Section 11.5 are intended for ballasted track on earth foundations.

Where installed to moderate track stiffness, only ASA type approved ballast mats shall be selected. As a minimum the ballast mats shall meet the requirements of DIN 45673-5 *Mechanical vibration – Resilient elements used in railway tracks – Part 5: Laboratory test procedures for under-ballast mats*.

Ballast mats shall not be constructed from reconstituted or re-cycled materials. Manufacturing design should provide an elastomeric, consistent modulus that may be further augmented by fibre reinforcement.

Ballast mats may be considered for installation in the following circumstances:

- ballast is on a rigid foundation such as a bridge deck
- on a tunnel floor
- where required for noise and vibration attenuation
- where there is insufficient ballast depth (a concession will be required for noncompliant ballast depth)

Approval for installation on rigid structures shall be subject to issue of a concession by the Lead Track Engineer, ASA, in accordance with T MU MD 000011 ST *Concessions to ASA Requirements*. Additional agreement may be required from the Lead Civil Engineer, ASA, where a ballast mat is proposed for installation on a bridge deck, refer to ESC 310 *Underbridges* for additional requirements and details.

Special measures may be required for transitioning between areas of different stiffness such as bridge ends. The selection of a ballast mat shall meet the bridge design requirements including waterproofing, refer to ESC 310 *Underbridges* for details.

Refer to Section 11.3 of this standard, as applicable. To determine the required minimum ballast mat stiffness refer to Table 9.

Table 9 – Ballast mat usage on stiff structures

Ballast category	Sleeper type	Minimum ballast depth (excluding mat)	Recommended ballast mat stiffness
High (H)	Heavy duty concrete	> 300 mm and < 600 mm	0.15 N/mm^3
High (H)	Heavy duty concrete	250 mm to 300 mm	0.10 N/mm^3
High (H)	Heavy duty concrete	< 250 mm but > 200 mm – case by case	0.10 N/mm^3
Medium (M)	Heavy or medium duty concrete	> 250 mm and < 600 mm	0.15 N/mm^3
Medium (M)	Heavy or medium duty concrete	200 mm to 250 mm	0.10 N/mm^3
Medium (M)	Heavy or medium duty concrete	< 200 mm but > 150 mm – case by case	0.10 N/mm^3
Low (L)	Medium duty concrete	> 200 mm and < 600 mm	0.15 N/mm^3
Low (L)	Medium duty concrete	150 mm to 200 mm	0.10 N/mm^3
Low (L)	Medium duty concrete	< 150 mm but > 100 mm – case by case	0.10 N/mm^3

11.7. Acceptance limits

At installation, the width and depths in Table 10 and Table 11 are to be provided.

The ballast height shall be profiled to the top of the centre and end of the sleepers.

11.7.1. Ballast shoulder width

Table 10 shows the maximum and minimum ballast shoulder widths for both the main line and sidings.

Table 10 – Ballast shoulder width acceptance limits

Operating class	Minimum	Maximum
Main line - CWR and LWR	390 mm	700 mm
Siding - CWR and LWR	390 mm	700 mm
Siding - Loose rail	290 mm	700 mm

11.7.2. Ballast depth

Table 11 shows the minimum acceptable ballast depths at installation for each track category.

Where ballast depth is greater than 425 mm, consideration shall be given to the implications for lateral and vertical stability.

Table 11 – Ballast depth minimum acceptance limits for installation

Category	Minimum depth	Minimum free draining
High - H	325 mm	200 mm
Medium - M	275 mm	75 mm
Low - L	225 mm	75 mm
Low - L (150)	125 mm	75 mm
Low - L (100)	100 mm	n/a
Low - L (nominal)	n/a	n/a

11.8. Exceedence limits

Ballast shall be considered to have failed to meet functional requirements when the fouling index is greater than 40.

The fouling index (FI) = P(4) + P(200)

Where P(4) = percentage passing 4.75 mm (No.4) sieve P(200) = percentage passing 0.075 mm (No 200) sieve.

12. Documentation required

All necessary validation documentation for each of the requirements listed in this document and in AS 2758.7 shall be provided or be made available upon request by TfNSW.