

AS 7636: 2013



RAIL INDUSTRY SAFETY AND STANDARDS BOARD

ABN: 58 105 001 465

Australian Railway Infrastructure

Accredited Australian Standards
Development Organisation

AS 7636 Railway Structures

STANDARD



 rissb.com.au

Search



Documents

Document Sharing Hub

This Australian Railway Standard *AS 7636 Railway Structures* was prepared by the RISSB *Railway Structures Development Group*. It was signed off by the RISSB *Railway Structures Development Group* and *Infrastructure Standing Committee* in *May 2013* and subsequently by the Development Advisory Board (DAB) in *May 2013*. The DAB confirmed that the process used to develop the standard was in accordance with the RISSB accredited development process. On the *04 June 2013* the RISSB Board approved the Standard for release. This Standard was published on the RISSB website (www.rissb.com.au) on the *15 August 2013*.



Kevin Taylor

Chief Executive Officer
Rail Industry Safety and Standards Board

The following organisations were represented on the RISSB *Railway Structures Development Group* :

Brookfield	Rail Corp
PTA WA	Rio Tinto
RTBU	ARTC
Trans Adelaide	Queensland Rail
Transport Victoria	Pacific National

This Standard was issued on Two occasions for open review was independently validated before being signed off and the approvals were granted.

RISSB wish to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the committees and through the open review periods.

Keeping Standards up-to-date

Australian Standards developed by RISSB are living documents that reflect progress in science, technology and systems. To maintain their currency, all Standards are reviewed every five years, and new editions are published. Between editions, amendments may be issued.

Australian Standards developed by RISSB may also be withdrawn. It is important that readers assure themselves they are using a current RISSB Standard, which should include any amendments that may have been published since the Standard was published.

Information about Australian Standards to be developed by RISSB, drafts, amendments, and new projects can be found by visiting www.rissb.com.au

RISSB welcomes suggestions for improvements, and encourages readers to notify it immediately of any apparent inaccuracies or ambiguities. Contact us via email at rissb@rissb.com.au or write to Rail Industry Safety and Standards Board, PO Box 4608, Kingston, ACT 2604

As 7636: 2013

Australian Standards® developed by RISSB

AS 7636: 2013

Australian Railway Infrastructure – Railway Structures

First published as AS 7636:2013

Copyright

RISSB

All rights are reserved. No part of this work may be replaced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of RISSB.

Published by Rail Industry Safety and Standards Board (RISSB) ABN: 5810-5001-465

P O Box 4608, Kingston, ACT, Australia 2604

ISBN 978-1-74342-571-8

Important Notice and Disclaimer

The Rail Industry Safety & Standards Board ('RISSB') provides a range of template products, collectively called the 'RISSB Products', including:

- Standards;
- Codes of Practice;
- Rules;
- Guidelines; and
- Handbooks.

The purpose of RISSB's Products is to provide general good practice guidance for use by organisations engaged in, or providing services to those engaged in, railway operations in Australia (the 'Users').

RISSB Products have not been tailored to fit or address the individual circumstances of any organisation. They are adopted by Users at their own risk.

Responsibility rests with the User, should it choose to adopt a RISSB Product, to ensure that the RISSB Product is safe for use in the specific User's operations.

This will include undertaking a risk assessment. Reliance must be placed on the User's own enquiries and assessment rather than the RISSB Product.

RISSB and all persons acting for RISSB in preparing a RISSB Product disclaim any and all liability or responsibility to any person for any consequences arising directly or indirectly from the use by Users of the RISSB Product in whole or in part, and whether or not in conjunction with, or as a supplement to, the guidelines which the Users currently use.

Adherence to the RISSB Products does not ensure compliance with any relevant law, national guidelines, standards and codes of practice.

Due to the diverse operating environments within the rail industry, strict and technical compliance with RISSB Products may not always be possible by organisations.

Users are responsible for making their own enquiries in relation to compliance with national standards, guidelines and codes of practice.

While all reasonable care has been taken in the preparation of RISSB Products, RISSB is an industry association, not a legal practitioner, and therefore it makes no representation that, and gives no warranty or guarantee that, RISSB Products are an accurate representation of the law or fit for any individual circumstances. RISSB (including all persons acting for, or on behalf of, RISSB in preparing and/or publishing RISSB Products) does not take any responsibility for loss or damage suffered by any person resulting in any way from the use of, or reliance on, RISSB Products.

© Rail Industry Safety and Standards Board

Document Control

Identification

Document Title	Number	Version	Date
Railway Structures	AS 7636	1	2013

Document History

Publication Version	Effective Date	Page(s) Affected	Reason for and Extent of Change(s)

Authoring & Approval

Name	Date
CMT Solutions & Evans & Peck	RISSB Board Approval 5 June 2013

Code Change Procedures

The RISSB maintains the master for this document and publishes the current version on the RISSB website.

Any changes to the content of this publication require the version number to be updated.

Changes to this publication must be approved according to the procedure for developing management system documents.

The RISSB will identify and communicate changes to this publication.

Contents

1	PREFACE	1
1	INTRODUCTION.....	2
1.1	DISCLAIMER.....	2
1.2	DOCUMENT CONTROL	2
1.3	CONTENT	3
1.4	PURPOSE: AS 7636 RAILWAY STRUCTURES.....	4
1.5	SCOPE	5
1.6	COMPLIANCE	5
1.7	REFERENCED DOCUMENTS.....	6
1.8	DEFINITIONS	7
2	GENERAL REQUIREMENTS FOR MANAGEMENT OF RAILWAY STRUCTURES	7
2.1	GENERAL.....	7
2.2	SAFETY.....	8
2.3	COMPETENCY MANAGEMENT.....	8
2.4	CHANGE MANAGEMENT.....	8
2.5	INTERFACE COORDINATION	8
2.6	STRUCTURES OWNED BY OTHERS.....	9
2.7	CLEARANCES	9
2.8	DOCUMENTATION AND RECORD MANAGEMENT	10
2.9	RISK MANAGEMENT.....	10
3	DESIGN.....	11
3.1	FUNCTION	11
3.2	GENERAL.....	11
3.3	DESIGN MANAGEMENT	12
3.4	DESIGN.....	12
3.5	DESIGN CRITERIA	18
3.6	SIGNAGE	21
3.7	WALKWAYS/REFUGES/HANDRAILS	21
3.8	GUARDRAIL SYSTEM	21
4	MANUFACTURING.....	21
4.1	GENERAL.....	21
4.2	NON-STANDARD STRUCTURAL COMPONENTS.....	22
4.3	STANDARD PORTABLE PREFABRICATED STRUCTURES	23
5	CONSTRUCTION AND COMMISSIONING.....	23
5.1	CONSTRUCTION.....	23
5.2	CONSTRUCTION PROCEDURES	25
5.3	WORKING RESTRICTIONS	29
5.4	STRUCTURAL BOLTS AND ANCHORS	30

5.5	AS-BUILT DRAWINGS	31
5.6	COMMISSIONING REQUIREMENTS	31
6	MONITORING AND MAINTENANCE	32
6.1	MONITORING	32
6.2	RATING AND ASSESSMENT OF EXISTING BRIDGES	35
6.3	MAINTENANCE	38
6.4	REHABILITATION	39
7	DECOMMISSIONING AND DISPOSAL	39
7.1	DECOMMISSIONING	39
7.2	DISPOSAL	40

Appendix Contents

A	DEFINITIONS	41
B	STRUCTURE TYPE CLASSIFICATION	44
B.1	BRIDGE SECTIONS (DIAGRAMATIC EXAMPLES AND TERMINOLOGY)	53
C	LOADING DIAGRAMS (EXAMPLES ONLY)	56
D	DESIGN PARAMETERS (FOR CONSIDERATION)	59
E	RECOMMENDED FREQUENCIES OF INSPECTIONS	65
E.1	TABLE 1: RECOMMENDED INSPECTION FREQUENCIES	65
E.2	TABLE 2: INSPECTION LATITUDE AND SUBMISSION TIMEFRAME	68
F	ASSESSMENT METHODS	69
G	EXAMPLE CATEGORY TABLES (EXAMPLE FOR POSSIBLE GUIDANCE ONLY)	75
H	STRUCTURALLY CRITICAL MEMBERS	98
I	STEEL MATERIAL PROPERTIES	101
J	SPECIFICATION FOR STEEL FABRICATION OF SECTIONS	102

1 PREFACE

The aim of this Standard is to outline requirements that encourage rail organisations to utilise a whole-of-life approach to rail structures, and cover the general management requirements, material composition, manufacturing, construction, maintenance, decommissioning and disposal of rail structures used in Australian rail operations.

For the purposes of this Standard, all clauses containing the term 'shall' are considered mandatory requirements; all clauses containing the term 'should' are considered recommendations; and all other clauses are explanatory statements. This Standard also highlights recommended and mandatory sections with (R) and (M) respectively alongside the paragraph number.

All RISSB standards provide controls for hazards contained in RISSB's hazard guideline. In this particular Standard, the reference number of the hazard being addressed is identified in brackets at the end of each sentence (where appropriate). RISSB's hazard guideline can be found on the RISSB website at www.rissb.com.au.

1 INTRODUCTION

1.1 DISCLAIMER

- 1.1.1 This Rail Industry Safety and Standards Board (RISSB) Australian Infrastructure Standard has been drafted for use by rail operators and the rail industry in Australia.
- 1.1.2 RISSB and all persons acting for the RISSB in preparing the Standard disclaim any liability or responsibility to any person for any consequences arising directly or indirectly from the use by the rail industry or organisations of the Standard in whole or in part, and whether or not in conjunction with, or as a supplement to, the standards which the rail industry already use.
- 1.1.3 Users of the Standard should be aware that, while using the Standard, they must also comply with any relevant Commonwealth, State or Territory legislation relevant to their operations.
- 1.1.4 Adherence to the Standard does not replace or exclude the application of such legislative requirements.
- 1.1.5 Users are responsible for making their own enquiries in relation to the application of legislation, and the framers of the Standard accept no responsibility in this regard.
- 1.1.6 Adherence to the Standard does not necessarily ensure compliance with any relevant national standards and codes of practice.
- 1.1.7 Users are responsible for making their own enquiries in relation to compliance with national standards and codes of practice.
- 1.1.8 While all reasonable care has been taken in the preparation of this Standard, it is provided to rail operators without any legal liability on the part of RISSB, and RISSB [publisher, authors, consultants and editors each] takes no responsibility for loss suffered by any person resulting in any way from the use of, or reliance on, this publication.
- 1.1.9 Responsibility rests with the rail organisation to ensure that all aspects of the Standard are safe.
- 1.1.10 © Rail Industry Safety and Standards Board

1.2 DOCUMENT CONTROL

1.2.1 Identification

- 1.2.1.1 Document title: Railway Structures
- 1.2.1.2 Number: 7636
- 1.2.1.3 Version: 1 for publication
- 1.2.1.4 Publication date:

1.2.2 Preparation and Approval

- 1.2.2.1 Prepared by: CMT Solutions & Evans & Peck Pty Ltd
- 1.2.2.2 RISSB Board approval date: 5 June 2013

1.2.3 Distribution and Change

- 1.2.3.1 The current version of the Standard is available from the RISSB website at www.rissb.com.au
- 1.2.3.2 RISSB standards are subject to review at a period not exceeding five years from their date of publication.

1.2.4 Document History

1.2.4.1 Previous Published Versions

- 1. None

1.3 CONTENT

1.3.1 Table of Contents

1. INTRODUCTION

- 1.1 Disclaimer
- 1.2 Document Control
- 1.3 Content
- 1.4 Purpose
- 1.5 Scope
- 1.6 Compliance
- 1.7 Referenced Documents
- 1.8 Definitions

2. GENERAL REQUIREMENTS FOR THE MANAGEMENT OF RAILWAY STRUCTURES

- 2.1 General
- 2.2 Safety
- 2.3 Competency Management
- 2.4 Change Management
- 2.5 Interface Coordination
- 2.6 Structures Owned by Others
- 2.7 Clearances
- 2.8 Documentation and Record Management
- 2.9 Risk Management

3. DESIGN

- 3.1 Function
- 3.2 General
- 3.3 Design Management
- 3.4 Design Parameters
- 3.5 Design Criteria

- 3.6 Signage
- 3.7 Walkways/Refuges/Handrails
- 3.8 Guardrail System
- 4. MANUFACTURING
 - 4.1 General
 - 4.2 Non-Standard Structural Components
 - 4.3 Standard Portable Pre-fabricated Structures
- 5. CONSTRUCTION AND COMMISSIONING
 - 5.1 Construction
 - 5.2 Construction Procedures
 - 5.3 Working Restrictions
 - 5.4 Structural Bolts and Anchors
 - 5.5 As-built Drawings
 - 5.6 Commissioning Requirements
- 6. MONITORING AND MAINTENANCE
 - 6.1 Monitoring
 - 6.2 Rating and Assessment of Existing Bridges
 - 6.3 Maintenance
 - 6.4 Rehabilitation
- 7 DECOMMISSIONING AND DISPOSAL
 - 7.1 Decommissioning
 - 7.2 Disposal

1.3.2 Document Layout

- 1.3.2.1 The section and clause numbers provide a unique identifier for each sentence, recommendation or mandatory item in the document (e.g. this is sentence 1.3.2.1).
- 1.3.2.2 Mandatory items are identified with the symbol **(M)** at the left hand side of the text and are highlighted with the colour shown here.
- 1.3.2.3 Recommendations are identified with the symbol **(R)** at the left hand side of the text, but in this case no highlighting is used.
- 1.3.2.4 The numbers in parentheses at the end of a particular clause show the hazard number, taken from the Track and Civil Hazard Trees, for the hazard(s) being controlled by each requirement.

1.4 PURPOSE: AS 7636 RAILWAY STRUCTURES

- 1.4.1 This Standard describes a set of mandatory and recommended requirements for the nomenclature, design, manufacturing, construction, commissioning, inspection, monitoring, maintenance and decommissioning of rail structures in Australia.

1.4.2 The main purpose of the requirements are to:

- (a) provide a uniform basis for compliance with AS 4292.1
- (b) clearly and accurately describe each of the essential requirements (functions, performance, design constraints, quality and risk attributes) of rail structures and their external interfaces
- (c) promote a consistent treatment of rail structures across the Australian rail industry.

1.5 SCOPE

1.5.1 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.

1.5.2 This Standard applies to all gauges; however, the core knowledge on which this Standard has been developed is based upon the following principal gauges (as measured between the running faces of the rails at a point 16mm below the rail head):

- (a) narrow gauge of 1067mm
- (b) standard gauge of 1435mm
- (c) broad gauge of 1600mm.

1.5.3 This Standard applies to all structures intended to support the railway track or house railway operations, including:

- (a) all structures within the corridor
- (b) all structures adjacent to, below and above railway track.

1.5.4 Tram tracks, cane railways and monorail networks are not included.

1.5.5 This Standard provides the minimum requirements for the design, supply, construction, maintenance, decommissioning and disposal of rail structures, but is not intended to supplant higher performance standards based on local experience and good engineering practice, which may be contained in structural and material standards, codes, guidelines and procedures of individual rail organisations.

1.5.6 Railway structures addressed in this Standard include the following asset classes and structure types, as defined in Appendix A:

- (a) bridges
- (b) culverts
- (c) tunnels
- (d) miscellaneous structures.

1.5.7 Typical railway structure material types that are addressed in this Standard include:

- (a) timber
- (b) steel (including wrought and cast iron)
- (c) concrete
- (d) brick and masonry
- (e) other miscellaneous materials (e.g. Fibre Reinforced Plastics).

1.6 COMPLIANCE

1.6.1 There are two types of controls contained within the RISSB Australian Infrastructure Standards: 1) mandatory (**M**) requirements; and 2) recommended (**R**) requirements.

- 1.6.2** Both types of controls address hazards that are deemed to require controls on the basis of existing Australian and international infrastructure practices and standards.
- 1.6.3** A mandatory requirement is one that the Standard recognises as the only way of treating the hazard.
- 1.6.4** A recommended requirement is one where the Standard recognises that there are limitations to the universal application of the requirement, and that there may be circumstances where the control cannot be applied or where other controls may be appropriate or satisfactory, subject to agreement with the Railway Infrastructure Manager and/or Rail Safety Regulator.

1.7 REFERENCED DOCUMENTS

- 1.7.1** Referenced Australian standards shall mean the current edition of the Standard, including any amendments.

- 1.7.2** The following standards, guidelines and/or codes of practice are referred to in this Standard:

- (a) AS 5100: Bridge Design
- (b) AS 4100: Steel Structures
- (c) AS 1170: Structural Design Actions
- (d) AS 1391: Metallic Materials – Tensile Testing at Ambient Temperature
- (e) AS 1597.1 Precast reinforced concrete box culverts
- (f) AS 3600: Concrete Structures
- (g) Building Code of Australia (BCA)
- (h) AS 4678: Earth Retaining Structures
- (i) AS 2327.1: Composite Structures – Simply Supported Beams
- (j) AS 2159: Piling – Design and Installation
- (k) AS 4292: Rail Safety Management
- (l) AS 2601: The Demolition of Structures
- (m) AS 1428.1: Design for Access and Mobility
- (n) AS/NZS 2041.1 Buried corrugated metal structures
- (o) AS/NZS 15288: Systems Engineering
- (p) AS 2312: Guide to the Protection of Structural Steel Against Atmospheric Corrosion by the Use of Protective Coatings
- (q) AS 7633: Railway Infrastructure – Track Clearances
- (r) AS 7637: Railway Infrastructure – Hydrology and Hydraulics
- (s) AS 4680: Hot-dip Galvanised (Zinc) Coatings on Fabricated Ferrous Articles
- (t) AS 1657: Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction and Installation
- (u) AS 3725: Design for Installation of Buried Concrete Pipes
- (v) AS 4058: Precast Concrete Pipes (Pressure and Non-pressure)
- (w) AS 7638: Railway Infrastructure – Earthworks
- (x) AS ISO 13822: Basis for Design of Structures – Assessment of Existing Structures
- (y) AS 1252: High-strength Steel Bolts with Associated Nuts and Washers for Structural Engineering
- (z) AS 1289: Method of Testing Soils for Engineering Purposes
- (aa) AS 3703: Long-span Corrugated Steel Structures
- (bb) AS 4676: Structural Design Requirements for Utility Services Poles

1.7.3 The following standards, guidelines and/or codes of practice are listed here for information only:

- (a) AS 4600: Cold-formed Steel Structures
- (b) AS/NZS 4671: Steel Reinforcing Materials
- (c) EN 10168: Steel Products – Inspection Documents – List of Information and Description
- (d) EN 10204: Metallic Products – Types of Inspection Documents
- (e) AS/NZS 1050: Methods for the Analysis of Iron and Steel Series
- (f) AS 3735: Concrete Structures Retaining Liquids
- (g) AS 2870: Residential Slabs and Footings
- (h) AS 1012: Methods of Testing Concrete Series
- (i) AS 1379: Specification and Supply of Concrete
- (j) AS 3700: Masonry Structures
- (k) AS/NZS 4455.3, Masonry Units, Pavers, Flags and Segmental Retaining Wall Units – Segmental Retaining Wall Units
- (l) AS 1720.1: Timber Structures – Design Methods
- (m) AS 1684: Residential Timber Series
- (n) AS/NZS 4063: Characterisation of Structural Timber Series
- (o) AS/NZS 1080: Timber – Methods of Testing Series
- (p) AS 1604: Specification for Preservative Treatment Series
- (q) AS 5604: Natural Durability Ratings
- (r) AS 4997: Guidelines for the Design of Maritime Structures
- (s) AS 7640: Rail Management
- (t) AS 1726: Geotechnical Site Investigations.

1.8 DEFINITIONS

1.8.1 General railway technical terms extracted from the RISSB National Guideline – Glossary of Railway Terminology can be found in Appendix A

(a) Specific terms used in this Standard are defined below.

1.8.2 **Certification:** The process by which an independent competent person confirms/attests the compliance of a product/products to required safety, quality and purpose parameters within Commonwealth, State or Territory legislation relevant to their operations.

1.8.3 **Load rating:** A calculation of the load carrying capacity of a structure within the stress limits of design code requirements, assessed against a specific reference load or against design load.

2 GENERAL REQUIREMENTS FOR MANAGEMENT OF RAILWAY STRUCTURES

2.1 GENERAL

2.1.1 **(M)** All rail structures shall be managed by the Railway Infrastructure Manager as part of an integrated track and civil infrastructure management system that ensures all track and civil infrastructure is safe.

2.1.2 (M) All rail structures shall be designed to the relevant Australian standards and requirements specified in this Standard.

2.1.3 (M) The Railway Infrastructure Manager shall establish a safety management system for railway operations pertaining to track and civil infrastructure, incorporating all structures on, adjacent, under and/or over track, which complies with rail safety regulations and Occupational Health & Safety (OH&S) legislation in the applicable State or Territory.

2.1.4 (R) The development and implementation of the structure life cycle processes should include tailored conformance with AS/NZS 15288, which provides a common framework for describing the life cycle of systems created by humans, and a set of well-defined processes and associated terminology.

2.2 SAFETY

2.2.1 (M) All railway structures shall be designed, constructed, installed and maintained in a condition appropriate to safely meet both operational and functional requirements in the applicable State or Territory, giving due consideration to the age and condition of adjacent infrastructure, the operating regime, traffic tasks and seasonal climatic conditions.

2.2.2 (M) The management of railway structures, including the design, construction, maintenance and refurbishment of all new and existing structures, shall take into account safety considerations for construction and maintenance personnel and any other parties, including operations personnel who may be required to use the structure.

2.3 COMPETENCY MANAGEMENT

2.3.1 (M) Competency management procedures shall be established by Railway Infrastructure Managers to ensure all works, inclusive of design, construction, monitoring and maintenance on railway structures, are carried out by staff deemed competent and suitably qualified to undertake that work.

2.3.2 (R) Rail organisations should document each training requirement and associated competency certification relevant to perform each type of work on all railway structures.

2.4 CHANGE MANAGEMENT

2.4.1 (M) The Railway Infrastructure Manager shall ensure that change management procedures for structures are established by all relevant stakeholders, to ensure proper identification and control of the safety risks associated with changes to the structures.

2.5 INTERFACE COORDINATION

1. The major stakeholder, which will always be involved in the management of structures, is the Railway Infrastructure Manager. However, for bridges, tunnels and other structures which may support road or infrastructure other than rail, major stakeholders may also include the road manager, the municipal council, and private and/or corporate property developers (including lessors where applicable) and owners.
2. (R) The design of each structure should be integrated taking into account all associated requirements, such as track alignments and clearances, service routes, overhead wiring and signalling infrastructure, drainage, bonding, and architectural treatments.

3. **(M)** For structures owned by others, the Railway Infrastructure Manager shall ensure there is an Interface Coordination Plan and agreement covering the responsibilities of each party in relation to the management of the structure.

2.5.1 Operational Parameters

1. **(R)** The permissible parameters of operation for each train should be compatible with limitations identified within the track and civil infrastructure, including any limitations identified for railway structures.
2. **(R)** An Interface Coordination Plan should be developed and should include practices for the communication of the permissible parameters of operation to all relevant persons and organisations.
3. **(R)** The attention of train operators should be specifically drawn to infrastructure locations that do not meet the standards established for the nominally defined Interstate, State or Territory operating regimes.

2.5.2 Provision for Services

1. **(R)** Provision should be made when designing and constructing structures for services for which the Railway Infrastructure Manager is accountable and which are owned by other authorities and utilities.
2. **(R)** Coordination with the relevant owners should be undertaken to ensure that the location and fixing of service ducts is, wherever possible, designed so that future access to the structure and to service ducts for inspection and maintenance is safe and unimpeded.

2.6 STRUCTURES OWNED BY OTHERS

2.6.1 (M) Where structures are owned by other persons or organisations, and are subject to agreements whereby the Railway Infrastructure Manager can require that person or organisation to rate the functional capacity of the structure, it shall be so rated and certified as per the relevant standards and applicable regulatory requirements.

2.6.2 (M) Where a structure owned by another person or organisation is considered to present an unacceptable risk to the safe passage of trains, the Railway Infrastructure Manager shall:

- (a) **(M)** notify the relevant person or organisation in writing, requesting appropriate action be taken to reduce the risk to acceptable levels
- (b) **(M)** consider the need to impose operational restrictions or other means to reduce any immediate risk
- (c) **(M)** consider reporting the situation to the appropriate regulatory authorities for resolution, where the risk has not been satisfactorily addressed.

2.7 CLEARANCES

2.7.1 (M) Horizontal and vertical clearances for bridges, structures and services shall comply with the requirements and recommendations in AS 7633 and other local operational requirements and guidelines.

2.8 DOCUMENTATION AND RECORD MANAGEMENT

2.8.1 (M) The Railway Infrastructure Manager shall maintain relevant documentation on all railway structures, so that the capacity of the infrastructure to perform its required function is recorded, and any change to that capacity is documented.

2.8.2 (M) The Railway Infrastructure Manager shall establish and maintain local policies and procedures for the maintenance of records, ensuring compliance with the requirements of the Safety Act and State and/or Territory legislation.

2.8.3 (M) Documentation shall be maintained during the operational life and until all components of the structure have been completely removed, for all railway structures.

2.8.4 (M) Documentation shall be available for audit purposes, in accordance with national standards and the relevant Commonwealth, State and/or Territory legislation.

2.8.5 (R) At a minimum, documentation on railway structures should include:

- (a) **(R)** a register providing a description of all structures to be inspected – this description should be in terms of primary material of construction and should define each structural category and member accordingly
- (b) **(R)** a system for defining their location on the network
- (c) **(R)** governing standards, procedures and work instructions applicable to their management through each life cycle stage
- (d) **(R)** design and rating records, including digital analysis data where appropriate, required to achieve the specified functional capability
- (e) **(R)** engineering drawings detailing design layout configurations, component manufacturing details and as-built construction
- (f) **(R)** hazard locations that have the potential to impact on defined functional capacity
- (g) **(R)** inspection and assessment requirements, including details from visual inspections, commissioned detailed engineering inspections, investigations and analysis when required, and records of the inspections and assessments carried out and when results of recommendations will be actioned
- (h) **(R)** engineering drawings detailing layouts of any modification, repair or renewal works conducted on the infrastructure.

2.9 RISK MANAGEMENT

2.9.1 (M) The Railway Infrastructure Manager shall ensure that appropriate risk management processes are implemented and/or undertaken to ensure that health and safety is qualified by what is reasonably practical.

2.9.2 (M) Reasonably practical requires consideration of, at a minimum, the following relevant matters:

- (a) **(M)** the likelihood of the hazard or the risk occurring
- (b) **(M)** the degree of harm that might result from the hazard or the risk
- (c) **(M)** knowledge about the hazard or the risk, and ways of eliminating or minimising the risk
- (d) **(M)** the availability and suitability of ways to eliminate or minimise the risk, including engineering, administrative and behavioural strategies.
- (e) **(M)** after assessing the extent of the risk and the available ways of eliminating or minimising it, the cost associated with eliminating or minimising it, including whether the cost is grossly disproportionate to the risk.

2.9.3 (M) Where additional stakeholders (refer Clause 2.5.3) may have a duty for the same matter in relation to the structure, the Railway Infrastructure Manager shall retain responsibility for their duty where:

- (a) **(M)** The Railway Infrastructure Manager shall discharge it to the extent to which the other stakeholder has the capacity to influence or control the matter.
- (b) **(M)** If there is an agreement or arrangement in place claiming to limit or remove that capacity, then the Railway Infrastructure Manager is also limited by the terms and conditions of that agreement or arrangement.

2.9.4 Structures risk management entails an assessment of all risks to maintenance and repair staff, adjacent roads and rail infrastructure, pedestrian, and livestock traffic, with reference to the structure, the layout of adjacent infrastructure, site characteristics, climatic hazards, signage, design and maintenance access requirements.

2.9.5 The purpose of the risk management process is to assess and quantify the identified risks, and to specify or recommend measures aimed at mitigating those risks.

2.9.6 (R) Risk management should involve conducting risk reviews throughout the life of the structure, particularly when significant changes to an as-designed structure's configuration or structurally critical elements occur, either rapidly or progressively throughout its life cycle.

3 DESIGN

3.1 FUNCTION

3.1.1 The function of this section is to provide guidelines and set standards to ensure that railway structures:

- (a) built adjacent to, on or over, or to support the railway (e.g. underbridges) are safe and fit for purpose
- (b) owned by others on, or adjacent to, the railway corridor comply with the relevant standards, and are sound, of safe construction, and maintained in safe condition.

3.1.2 Design, in relation to a structure, includes the design of all or part of the structure, and the redesign or modification of a design.

3.2 GENERAL

3.2.1 (M) The structure shall be designed to comply with safe design requirements in accordance with the relevant standards, and: (6.7)

- (a) **(M)** in such a manner that it shall be capable of carrying and transferring the loads, within the allowable stresses, including its self-weight applied during its intended life. (6.7)

3.2.2 (M) The structure shall be designed so that there is at least one safe and feasible method for its execution and for its subsequent decommissioning.

3.2.3 (M) Where this Standard is silent, design shall comply with good practice, Australian standards and the general requirements of the 'AREMA' Manual of Railway Engineering, and other relevant international codes, standards and guidelines.

3.2.4 (M) The design of all structures shall take into account construction constraints particularly under live road and rail operation conditions and track possession constraints.

3.2.5 (M) The structure shall be designed in such a manner that it will not affect the safety of railway operations, or the safety of persons whose duties take them on or near the line, including, where relevant: (1.3)

- (a) (M) groundwater (particularly in tunnels)
- (b) (M) potential arching of electric power equipment
- (c) (M) sighting for train drivers
- (d) (M) sighting for track staff
- (e) (M) provision of positions of safety
- (f) (M) provision of emergency access
- (g) (M) provision of maintenance access.

3.2.6 (R) Where relevant, consideration should be given so that the design allows the structure to be executed in such a way that it may not be damaged by accidental events or vandalism.

3.2.7 Safe design of the structure includes the integration of control measures early in the design process to eliminate or, if this is not reasonably practical, to minimise risks to health and safety through the life of the structure being designed.

3.2.8 General definitions and diagrammatic examples of structural components are provided in Appendix A and Appendix B of this Standard.

3.3 DESIGN MANAGEMENT

3.3.1 (R) Where appropriate, a Design Management Plan should be developed that clearly details the design requirements and constraints, strategy, planning, resource requirements, and financial management of the design project.

3.4 DESIGN

1. (M) The design of all new or replacement structures shall consider and, where relevant, take into account the following:

- (a) (M) safety in design
- (b) (M) service loads (and dynamic response) for current and known future operating requirements
- (c) (M) intended life and use (12.7, 12.21)
- (d) (M) clearances
- (e) (M) suitability of materials
- (f) (M) services and utilities
- (g) (M) constructability and construction methodology
- (h) (M) whole-of-life considerations
- (i) (M) environment and heritage
- (j) (M) accessibility
- (k) (M) aesthetics of the structure
- (l) (M) drainage and waterway requirements

- (m) **(M)** geometry – alignment and approaches
- (n) **(M)** impact and derailment protection
- (o) **(M)** earthquake.

3.4.1 Design Loads

3.4.1.1 Live Loads

2. **(M)** Design load shall be as specified in relevant Australian standards, or as specified by the Railway Infrastructure Manager:

- (a) **(M)** Walkways and footbridges shall be designed in accordance with the requirements of AS 5100, and should also consider other possible loads from, for example, light maintenance vehicles.

2. **(M)** All load factors shall be in accordance with AS 5100, except as varied with the approval of the Railway Infrastructure Manager.

3. Refer to Appendix C for details on loading diagrams for specific train consists. These diagrams are provided as an example. Loads shall be calculated as per requirements in AS 5100 for the unique operating requirements on which the structure is to be used.

3.4.1.2 Nosing Loads (Lateral Loads)

1. **(M)** The proportioning of nosing load shall be calculated in accordance with AS 5100.

3.4.1.3 Dead Loads

1. **(R)** Design should take into consideration the possibility of the design loads on the structure being exceeded in future, or to minimise the risk of the design loads being exceeded in future:
 - (a) **(R)** Examples include ensuring adequate drainage of the structure to deter ponding, and allowances for changes in surfacing material where applicable.
 - (b) **(R)** Suitable mitigation measures to minimise any risks of increases to actual dead loads should be implemented.

1. **(M)** All design live loads shall be shown on the General Arrangement drawings of the structure.

3.4.1.4 Environmental Loads

1. **(M)** Earthquake loading for structures shall be undertaken on a risk-based approach in consideration of regional conditions, and comply with AS 1170, AS 5100 and other relevant risk and relevant material standards as appropriate. (12.12)

2. **(R)** The class of bridge for seismic loading, in accordance with AS 5100 Table 14.3.1 Bridge Earthquake Design Category, is recommended as:

- (a) **(R)** bridges on running lines as classified in AS 7630 are Type III (i.e. essential to post-earthquake recovery)

- (b) **(R)** bridges on sidings as classified in AS 7630 are Type I, except for bridges over roadways or railways which are Type II.

1. **(M)** Wind loading for all structures shall be designed in compliance with AS 1170.

3.4.1.5 Dynamic Load Allowance

1. **(M)** The dynamic load allowance (DLA) used in the load rating assessment of railway underbridges shall be in accordance with AS 5100.

3.4.2 Safety in Design

3.4.2.1 **(M)** The Railway Infrastructure Manager shall be responsible for ensuring that the designer of the structure clearly understands their responsibilities and obligations to ensure the design of the structure will not affect the health and safety of persons:

- (a) **(M)** during construction of the structure
- (b) **(M)** when the structure has been constructed and is being used for the purpose it was originally designed for
- (c) **(M)** where the structure has been decommissioned and/or is not being used for the purpose it was originally designed for, yet has not been removed and/or demolished, and either all or partial components remain (i.e. abutments on bridges).

3.4.3 Intended Use and Life

3.4.3.1 **(M)** Bridge structures, including retaining walls and major culverts, shall be designed for a 100-year life in accordance with AS 5100.1, unless a shorter design life to match the life cycle of the other railway infrastructure is intended, and shall be subject to the approval of the Railway Infrastructure Manager.

3.4.3.2 **(M)** Other structures shall be designed for the design life specified in the relevant Australian standards. Any reduction to design life shall be subject to the approval of the Railway Infrastructure Manager.

3.4.3.3 **(R)** The design life of structures should align with the life cycle of the rail infrastructure it supports, and shall be assessed in accordance with the relevant standards and manufacturers' recommendations for the materials and components.

3.4.4 Adequacy of Structure Gauging, Clearances and Dimensions

3.4.4.1 **(M)** The design shall consider the required horizontal, vertical and below rail clearances and dimensions in accordance with AS 7633.

3.4.4.2 **(M)** If the design covers work adjacent to running tracks, then the design shall provide adequate trackside clearances for construction equipment.

- (a) **(R)** The minimum recommended clearance should be the kinetic envelope as defined in AS 7633, plus 200mm.

3.4.5 Suitability of Materials

- 3.4.5.1 **(R)** Approved construction materials for main structural elements are steel and concrete. Notwithstanding that, materials used in the design should be the most appropriate to the function and requirements of the structure.
- 3.4.5.2 **(R)** With the exception of bridge transoms, timber materials should generally not be used as structural elements in the design of new bridges and structures:
 - (a) **(R)** In recommending timber materials, the Railway Infrastructure Manager should consider durability and maintenance, as well as availability in the region of the species and size of members specified.
- 3.4.5.3 **(R)** Where steel structures are preferred because of economic, aesthetic or practical considerations, and component size precludes galvanising, the protection system should adhere to AS 2312:
 - (a) **(R)** Corrosion protection systems, including preparation, should be shown on structural drawings.
- 3.4.5.4 **(R)** Masonry is approved for existing structures, and should only be used for the design of new structures subject to the approval of the Railway Infrastructure Manager.
- 3.4.5.5 **(R)** Fibre composite, engineered timber products and other approved materials may be used, subject to the approval of the Railway Infrastructure Manager.

3.4.6 Services and Utilities

- 3.4.6.1 **(M)** Where provision for services owned by other authorities and utilities is required, the Railway Infrastructure Manager shall:
 - (a) **(M)** consult with the relevant authorities and, where appropriate, make provision for these services in the structure
 - (b) **(M)** design the location and the fixing of such services, so as to allow safe and unimpeded access to the structure for inspection and maintenance.

3.4.7 Constructability

- 3.4.7.1 **(R)** The Railway Infrastructure Manager should equally balance design efficiency with short construction times (specifically to fit in with block possessions) when producing plans and design specifications, taking careful consideration where design efficiency is compromised for shorter construction periods.

3.4.8 Whole-of-life Considerations

- 3.4.8.1 **(M)** Structures shall be designed and detailed to ensure durability for the purpose for which they were required.
- 3.4.8.2 **(R)** Structures should be designed and detailed to:
 - (a) **(R)** minimise maintenance
 - (b) **(R)** safely facilitate inspection and maintenance activities.

- 3.4.8.3 **(R)** Where required, specific maintenance procedures should be documented on the construction drawings.

3.4.9 Environment and Heritage

- 3.4.9.1 **(M)** The design shall take into consideration all potential impacts to environmental and heritage matters, and shall comply with the legal and associated regulatory requirements.
- 3.4.9.2 **(M)** Relevant State and/or Territory registers shall be referenced before planning any changes to structure assets, to ensure that changes comply with the requirements of all relevant heritage acts.
- 3.4.9.3 **(M)** The design process shall accommodate the procedures, timings and commitments associated with obtaining heritage, tenure, environmental and other government approval requirements.

3.4.10 Accessibility

- 3.4.10.1 **(R)** Designs for structures should provide safe access for inspection and maintenance. This may include access steps, ladders, cages, walkways, refuges and fixing points, and:
- (a) **(R)** where possible, jacking points should be provided to facilitate bearing maintenance and replacement as necessary
 - (b) **(R)** where box girder bridges are provided with access hatches to voids in the superstructure, access manholes should be provided outside in a safe accessible area away from rail traffic.
- 3.4.10.2 **(R)** Where elements of a structure are to be accessed by pedestrians, cyclists and/or animals, consideration should be given to the provision of accessibility by all as per the requirements of AS 1428.1.
- 3.4.10.3 **(R)** Structures that are to provide above-ground walkways for pedestrians, cyclists or animals (including equestrian access) must be fit for purpose and in compliance with safety regulations, AS 5100 and State and/or Territory regulatory requirements.
- 3.4.10.4 **(M)** Safe access to and safe working on the structures shall be provided in accordance with the requirements of AS 1657.

3.4.11 Aesthetics of the Structure and Surrounds

- 3.4.11.1 **(R)** All structures in urban areas and visually important sites in rural areas should be given appropriate aesthetic design considerations, where practicable.
- 3.4.11.2 **(R)** In situations where aesthetics are a major consideration in the design, materials adopted may be varied from those specified in other sections of this Standard on the basis of aesthetic assessment. Any such deviation should be subject to the approval of the Railway Infrastructure Manager.

3.4.12 Hydrology, Drainage and Waterway Requirements

- 3.4.12.1 **(M)** All hydrology, drainage and waterway requirements shall be designed in accordance with *Australian Rainfall and Runoff Guidelines*, *Austroads Waterway Design Manual*, AS 5100, AS 7637 and Australian standards as applicable:

- (a) **(M)** Scour protection shall be provided where there is history of scouring and washaways, and/or where hydraulic assessments indicate a potential problem.

3.4.12.2 Flood discharges are generally to be determined for average return intervals (ARI) of 10 year, 20 year, 50 year, 100 year, 2000 year and probable maximum flood (PMF) events.

3.4.12.3 **(M)** Hydraulic design for a bridge or drainage structure shall conform with the requirements of AS 7637.

3.4.12.4 **(M)** Where the design of the bridge or drainage structure is for a new track alignment that runs parallel to an existing track or road, the waterway of the adjacent drainage structure shall be compared with that of the designed structure, to ensure that there is no adverse hydraulic impact as a result.

- (a) **(R)** In particular, the design of the bridge or drainage structure should be checked for any backwater effect caused by raised floodways or access roads downstream.
- (b) **(R)** Similarly, considerations should be taken to ensure that there are no adverse backwater effects caused by the design of bridge or drainage structures to any adjacent structures or tracks.

3.4.13 Geometry – Alignment and Approaches

3.4.13.1 **(R)** Consideration should be given during preliminary design, to maximise lateral stability and minimise the force of braking loads and impacts on the structure due to alignment approach.

3.4.13.2 **(M)** Careful consideration shall be given to the design of bridge approach embankments to avoid long-term settlement of approaches. Reinforced soil transition approach or other suitable transition approach to an abutment shall be provided for all rail bridges, except where there is a rock foundation at up to 3m depth from rail level.

3.4.14 Impact and Derailment Protection

1. **(M)** All piers and columns supporting elevated structures over roads or railway tracks shall comply with the provisions of collision protection and loading in AS 5100, unless directed otherwise by the Railway Infrastructure Manager. (7.8)
2. **(M)** Bridge spans over roadways with less than the regulated vertical clearance shall be risk assessed for collisions by road traffic, and where deemed necessary, protection barriers shall be installed to protect the bridge spans from collision:

- (a) **(M)** Design of protection beams for bridges with low clearance shall comply with AS 5100.

3.4.15 Impact from falling objects

1. **(R)** Measures should be considered to be implemented to minimise the risk of falling objects (or objects being thrown) from bridge spans onto vehicular, pedestrian or other traffic. (7.4)

3.5 DESIGN CRITERIA

3.5.1 Bridges

3.5.1.1 (M) All bridges shall be designed to AS 5100 and the requirements specified in this document.

3.5.1.2 Further requirements and recommendations relevant to the design of bridges are given in Appendix D of this Standard.

3.5.1.3 (M) The design of metal arch bridges shall comply with the requirements of AS 3703.

3.5.2 Culverts

3.5.2.1 (M) Culverts shall be designed as per the loading effects prescribed in AS 5100, unless otherwise modified and approved by the Railway Infrastructure Manager to suit the track classification and operating environment.

3.5.2.2 Further requirements and recommendations relevant to the design of culverts are given in Appendix D of this Standard.

3.5.2.3 (M) Precast concrete box culverts supporting railway tracks shall be designed as per the loading effects prescribed in AS 5100, unless otherwise modified and approved by the Railway Infrastructure Manager, and shall comply with the requirements in AS 1597.

3.5.2.4 (M) Concrete pipes supporting railway tracks shall be designed as per the loading effects prescribed in AS 5100, unless otherwise modified and approved by the Railway Infrastructure Manager, and shall comply with the requirements in AS 3725 and AS 4058.

3.5.2.5 (M) Buried corrugated metal pipe culverts supporting railway tracks shall be designed as per the loading effects prescribed in AS 5100, unless otherwise modified and approved by the Railway Infrastructure Manager, and shall comply with the requirements of AS 2041.

3.5.3 Tunnels

3.5.3.1 (M) All tunnels shall be designed to comply with the requirements of all relevant Australian standards, specific site geotechnical parameters and the requirements of this Standard.

3.5.3.2 (M) Tunnels shall be designed to accommodate transit space requirements, services, plant and equipment:

- (a) (R) where necessary tunnels should also incorporate niches to accommodate refuges, plant and equipment

3.5.3.3 (M) Tunnel linings and fittings shall be designed to mitigate the effects of stray currents from overhead wiring systems.

3.5.3.4 (M) Drainage systems shall be designed to collect and dispose of any seepage and surface water that enters the tunnel in order that the track infrastructure is kept well drained and that no seepage drips onto the track:

- (a) (M) In addition drainage shall be so configured that in the event of a blockage, any overflow will not effect operations or the reliability of the infrastructure.

- (b) **(M)** Consideration shall also be given to the level of waterproofing required behind the tunnel lining and an assessment made of the possible effects of any build up of water pressure behind the lining against those of allowing some seepage through the lining and onto the track bed.

3.5.3.5 (M) Tunnels and their associated systems shall be designed to allow acceptable noise and vibration during operation:

- (a) **(M)** Operational noise and vibration (inclusive of air-borne and ground-borne noise and vibration) shall be within the relevant State and Federal regulatory requirements.

3.5.3.6 (M) Tunnels shall be designed to comply with acceptable and regulatory levels of fire safety for train crews, rail passengers and all other staff, contractors, emergency services personnel, and, where appropriate, the public. *(6.14)*

3.5.3.7 (M) All overhead wiring, tunnel lighting and all other electrical wiring shall be designed and installed in compliance with the relevant Australian standards.

3.5.3.8 (M) The design life of tunnels shall be 100 years.

3.5.3.9 (M) Structures to be constructed over and/or adjacent to tunnels shall be suitably designed to take into account the interface with the tunnel infrastructure.

3.5.3.10 Further requirements and recommendations relevant to the design of tunnels are given in Appendix D of this Standard.

3.5.4 Platforms

3.5.4.1 (M) Platforms shall be designed to AS 4678, AS 4100, AS 3600 or AS 2327.1, as appropriate.

3.5.5 Air Space Developments

3.5.5.1 (M) All designs of air space developments are to comply with the requirements of AS 1170.4, AS 5100, the Building Code of Australia, other relevant Australian standards, and the requirements of this Standard and the Railway Infrastructure Manager.

3.5.6 Overhead Wiring Structures and Gantry Structures

3.5.6.1 (M) The components of overhead wiring structures and gantry structures shall be designed in accordance with this Standard and other relevant Australian standards, including those listed below:

- (a) **(M)** Steel structures shall be designed to AS 4100, and hot-dip galvanised in accordance with AS 4680.
- (b) **(M)** Concrete footings shall be designed to AS 3600 and AS 2159.
- (c) **(M)** The design of electric components shall be designed to all relevant Australian standards, and in accordance with the operational requirements of the railway.
- (d) **(M)** Pole structures supporting road or railway signalling equipment shall be designed to AS 4676.

3.5.6.2 (M) Overhead wiring structures and gantry structures shall be designed for a serviceable life of 100 years.

3.5.7 Buffer Stops

3.5.7.1 (M) Buffer stops shall be designed in accordance with relevant Australian standards and the requirements in this Standard:

(a) (M) and shall be subject to due consideration of the adequate protection of people and property at or beyond the end of the track.

3.5.7.2 (M) A risk assessment shall be carried out to determine the design criteria, and to:

- (a) (M) determine whether additional overrun protection is required
- (b) (M) determine whether energy absorbing or rigid buffer stop is required.

3.5.7.3 (M) A risk assessment shall consider the following factors:

- (a) (M) speed of rail vehicles approaching the line/siding termination
- (b) (M) proximity and criticality of adjacent structures, buildings, facilities and residential/commercial property
- (c) (M) type and mass of rail vehicles
- (d) (M) track usage level
- (e) (M) train patronage level
- (f) (M) potential proximity of personnel/public
- (g) (M) concourse areas (where located at the end of the tracks and/or same ground level)
- (h) (M) any other site specific relevant factors.

3.5.7.4 (M) Buffer stops shall be designed for a life of 40 years.

3.5.7.5 (M) The average grade and length of the dead end track shall be designed appropriately for the speed and type of vehicle approaching the buffer stop.

3.5.7.6 (M) The design of buffer stops shall be suitably robust for the current/future known operations of the railway, and shall be designed using proven structural design methods.

3.5.8 Track Slabs

3.5.8.1 (M) Track slabs in bridge structures shall be designed as one-way slabs in accordance with AS 5100. The design of track slabs on ground shall comply with the requirements of AS 5100 and the specific geotechnical parameters of the site.

3.5.9 Retaining Walls and Rock Shelters

3.5.9.1 (M) Retaining walls and rock shelters shall be designed to AS 4678, AS 7638, AS 5100.3, other relevant Australian standards and the requirements of this Standard.

3.5.10 Miscellaneous Structures

3.5.10.1 (M) All miscellaneous structures shall be designed to the relevant Australian standards for the type of structure, and the requirements specified in this Standard.

3.5.10.2 Description of miscellaneous structures in this Standard is given in Appendix B.

3.6 SIGNAGE

3.6.1 (R) Designers should ensure that provision is made in the design for the location and installation of warning plaques and other relevant signage, including structure identification plaques, limited clearance warnings, refuge locations and details on loading constraints:

- (a) (R) The location of such signage should be clearly visible, and fixing details should not impair the structural integrity of any structural component.

3.6.2 (M) All bridges and other fixed structures included within the scope of this Standard shall have unique identification:

- (a) (M) such identification shall be conspicuous from both road and rail, where appropriate.

3.7 WALKWAYS/REFUGES/HANDRAILS

3.7.1 (M) Appropriate risk assessment shall be carried out to determine the need for walkways/refuges/handrails.

3.7.2 (M) Where walkways/refuges/handrails are required, these shall be designed to comply with current Federal, State and/or Territory standards and requirements.

3.8 GUARDRAIL SYSTEM

3.8.1 (M) The Railway Infrastructure Manager shall be responsible for ensuring guardrails and/or guardrail systems are implemented where Federal, State and/or Territory standards dictate, and/or where appropriate risk assessments have been carried out to determine their requirement.

4 MANUFACTURING

4.1 GENERAL

4.1.1 (M) Railway Infrastructure Managers shall ensure that all manufacturers, subcontractors and suppliers involved in the supply, manufacture and acceptance of structural materials and 'off-the-shelf' components shall be quality assured (5.26)

- (a) (M) and have appropriate procedures in place to guarantee the quality of the materials. (5.26)

4.1.2 (M) The Railway Infrastructure Manager shall ensure that all structural materials and components shall conform to the requirements and test standards of the relevant Australian standards (5.26)

(a) **(M)** and shall be in accordance with the relevant engineering drawings and specifications. (5.26)

4.1.3 (M) The Railway Infrastructure Manager shall check that component materials meet manufacturing standards (5.26)

(a) **(M)** and are within acceptable tolerance limits for the track, its geometry and the operating regimes. (5.26)

4.1.4 (M) Procedures for supervising the testing and acceptance of component materials shall be in place, consistent with the requirements of the rail organisation's quality and safety management systems. (5.26)

4.1.5 (M) The Railway Infrastructure Manager shall obtain all relevant certificates of physical tests and of chemical analysis conducted on component materials from the manufacturers. (5.26)

4.2 NON-STANDARD STRUCTURAL COMPONENTS

4.2.1 Identification

1. Non-standard structural components refer to all structural elements that require some site-specific design requirements. Typical elements include:
 - (a) built-up steel members
 - (b) prestressed concrete members
 - (c) lattice structures
 - (d) footings or foundations
 - (e) ground anchors
 - (f) bridge girders
 - (g) gantries.
2. **(M)** The manufacture of all elements within non-standard structural components shall be in accordance with the design specifications, as detailed in the design and as established in the design process detailed in Section 3 of this Standard.
3. **(M)** Where new or infrequently used products are specified in the structure design documentation, the Railway Infrastructure Manager shall ensure that any special requirements or practices in relation to the product are understood prior to release of the design documentation.

4.2.2 Fabrication of Materials

4.2.2.1 (M) The fabrication of all structural steel girders and other components shall comply with the various Australian standards and other reference documents in the technical and manufacturer's specifications.

(a) **(M)** All fabrication work shall be undertaken in accordance with the relevant approved drawings and specifications.

4.2.2.2 (R) Preferred steel grades should be:

- (a) **(R)** hot rolled sections – grade 300, grade 350
- (b) **(R)** hollow sections – grade C350

- (c) **(R)** flange and web plates – grade 250L 15 (minimum)
- (d) **(R)** other plates and flats – grade 250
- (e) **(R)** welded sections – grade 300, grade 350.

4.2.2.3 Details of relevant standards for reference of manufacturing specifications for steel fabrication sections are shown in Appendix J.

4.3 STANDARD PORTABLE PREFABRICATED STRUCTURES

4.3.1 Standard structures are those that are non-site specific, which can be fabricated off-site and then installed or erected on-site. Typical examples include:

- (a) reinforced box culverts
- (b) pipes
- (c) lighting poles
- (d) portable buildings
- (e) portable bridges.

4.3.2 **(M)** The Railway Infrastructure Manager shall ensure that all off-the-shelf structural elements are fit for purpose for the operational environment and requirements under which they will be used.

4.3.3 **(M)** The Railway Infrastructure Manager shall ensure that the design and manufacturing procedures of standard and portable structures complies with relevant Commonwealth, State and/or Territory certifications.

4.3.4 **(M)** Buried corrugated metal structures shall not be used unless approved by the Railway Infrastructure Manager.

5 CONSTRUCTION AND COMMISSIONING

5.1 CONSTRUCTION

5.1.1 General

5.1.1.1 This section specifies the requirements for the construction and rehabilitation of railway structures.

5.1.1.2 **(M)** Relevant standard construction specifications shall be used for the manufacture, fabrication, erection and installation of structural components, and the construction of associated civil works.

5.1.1.3 **(R)** Construction planning should take into account:

- (a) **(R)** the likely disruption to traffic and the economic consequences of such disruption (2.7)
- (b) **(R)** the effect of the execution on existing infrastructure
- (c) **(R)** the equipment (including backup equipment) required for the construction
- (d) **(R)** any particular requirements to protect road, rail or pedestrian traffic, or infrastructure (inclusive of overhead line equipment (OLE), buried services and requirements when using overhead cranes near operational railway)

- (e) **(R)** the adequacy of any temporary works (including temporary use of permanent works in a completed or uncompleted condition) to ensure adjacent structures are not undermined or de-stabilised (2.4)
- (f) **(R)** the need for any temporary bracing or support to structural elements during the construction process
- (g) **(R)** the disturbance which may be caused to nearby residents
- (h) **(R)** the effect of the works in creating dust or other light pollution to adjacent areas. (2.5)

5.1.1.4 **(M)** All tools, materials and equipment shall be placed and secured in a position so that they cannot fall or be struck by road or railway traffic: (2.8, 3.7)

- (a) **(R)** When not in use, they should either be secured to, or removed from the structure.

5.1.1.5 **(M)** The Railway Infrastructure Manager shall ensure that adequate processes and methods are put in place to:

- (a) **(M)** predict, identify and record change in design, construction materials, methods, etc.
- (b) **(M)** react appropriately and, where required, ensure the effective rescheduling of workflows.

5.1.1.6 **(M)** Where duplication or other civil track construction is being made over existing structures (e.g. culverts), the Railway Infrastructure Manager shall ensure that the necessary inspections and analyses are carried out on the existing structure to ensure it has sufficient capacity to withstand any enhanced live or dead loads that will be imposed both during construction and for future operations.

5.1.2 Notifications and Other Correspondence

- 5.1.2.1 **(R)** The Railway Infrastructure Manager should record and approve correspondence and coordination letters with local government authorities, agencies and community groups in relation to the construction works.
- 5.1.2.2 **(R)** Where relevant, the construction process should accommodate timings and resources to provide notice and information to adjacent communities, network users and other stakeholders, where they will be adversely affected by the works in any way.

5.1.3 Quality Assurance

5.1.3.1 **(M)** The Railway Infrastructure Manager shall ensure that appropriate quality control processes are implemented, associated with the appropriate on-site evaluation and testing carried out on all construction works:

- (a) **(M)** As part of this quality control process, the Railway Infrastructure Manager shall ensure that any modifications in the design are appropriately approved and shown in the as-built drawings.
- (b) **(M)** The Railway Infrastructure Manager shall ensure an appropriate process is in place for the recording of all as-built drawings, plans, technical queries, test results and other relevant site documentation

5.1.4 Redundant Structures and Fittings

5.1.4.1 (M) Where possible, all redundant structures and fittings shall be removed:

- (a) (M) Where not possible, appropriate processes shall be put in place to make safe the redundant structure and/or fitting, and it shall be inspected and monitored as per the requirements in this Standard until it is removed.

5.2 CONSTRUCTION PROCEDURES

5.2.1 Earthworks and Preparation

5.2.1.1 (M) The preparation and clearing of sites for the construction of structural works shall be in accordance with good engineering and environmental practices, and in compliance with relevant legislation, Australian standards and good practice as specified in this Standard. (2.12, 2.21)

5.2.1.2 Excavation

5.2.1.3 (M) All aspects of the shoring, excavation and backfilling of excavations for structures shall comply with the requirements of AS 7638. (2.9)

5.2.1.4 (M) Prior to any excavations, the Railway Infrastructure Manager shall obtain all underground network information in the construction area. Should the scope of works change or plan validity dates expire, the Railway Infrastructure Manager shall confirm this information prior to works commencing:

- (a) (M) Prior to any railway corridor excavations being undertaken, the relevant railway and/or external telecommunication providers (or other cable providers) shall be contacted to determine the locations and depths of all cables affected by the works.
- (b) (M) If an underground asset is damaged during construction, the Railway Infrastructure Manager shall advise the asset owner immediately.

5.2.1.5 Embankments

5.2.1.6 (M) Embankment batters and slopes shall be designed in accordance with AS 7638, AS 4678, AS 1289 and other relevant standards.

5.2.2 Bridges

5.2.2.1 Foundations

1. (M) Design, testing and installation of piles shall comply with the relevant Australian standards and other referenced documents as prescribed in the specification. All work is to be undertaken in accordance with the project drawings.
2. (R) Where spread footings are placed on rock or other strong layer with an inclined surface, consideration should be given to providing dowels or other equivalent anchorage to provide shear resistance to horizontal forces.

5.2.2.2 Reinforced Concrete (RC) Bridges and Other RC Structures (including Pre-stressed and Post-tensioned Concrete)

1. (M) The methodology and materials required for placing, supporting and stressing of tendons on post-tensioned concrete shall be as specified in the drawings:

- (a) **(M)** Force required (or gauge pressure), anticipated elongation and sequencing for jacking shall be determined by the Railway Infrastructure Manager, and specified on the approved design drawings and/or stressing methodology statement.
- (b) **(M)** The stressing operation shall be monitored by the Railway Infrastructure Manager, who shall be responsible for recording tendon elongations and gauge pressures to ensure that the tendon is stressed to the force required.

2. **(M)** The design of precast concrete elements shall take into consideration the handling stresses which the element will be subject to, and:

- (a) **(M)** shall make provision for suitable lifting points
- (b) **(M)** precast concrete elements shall be stored clear of the ground on adequate supports placed on a plane surface, in a manner that shall avoid damage, twisting or warping
- (c) **(M)** where the ground is of a standard that is not prone to any differential settlement.

3. **(M)** The Railway Infrastructure Manager shall base the acceptability of precast concrete elements on an assurance of:

- (a) **(M)** visual inspection (including the quality of the concrete surface finish)
- (b) **(M)** geometric measurement
- (c) **(M)** measurement of clear cover to reinforcement
- (d) **(M)** specified required design concrete strength
- (e) **(M)** reinforcement spacing and location
- (f) **(M)** and other requirements as specified in AS 3610
- (g) **(M)** The Railway Infrastructure Manager shall reject any precast concrete element which fails to meet the standards specified in AS 3600, the requirements of this Standard and other relevant Australian standards.
- (h) **(M)** For bridges and major concrete structures, AS 5100.5 shall take precedence over AS 3600.

4. **(M)** Concrete incorporated into a structure shall be obtained from a certified concrete plant or, in remote areas, mixed on-site using ingredients from certified suppliers:

- (a) **(M)** Concrete specification, including admixtures, shall be in accordance with the specifications and/or drawings. Changes shall only be implemented under the approval and instructions of the Railway Infrastructure Manager.
- (b) **(M)** Specialised concrete or concrete products that are not available from certified concrete plants shall only be supplied and used in accordance with the instructions of the Railway Infrastructure Manager.
- (c) **(R)** Components of concrete structures defined by the Railway Infrastructure Manager as 'non-structural' may be constructed or repaired with cementitious material that is not from a certified plant, only where the product applied (i.e. approved structural grouts or specialised concrete repair products) is subject to the approval of the Railway Infrastructure Manager.
- (d) **(M)** The use of cementation-based repair materials, epoxy resins, cold galvanising and other similar products in the construction and repair of concrete structures shall be in accordance with the material specifications

and all relevant safety legislation in relation to the management of hazardous substances.

5.2.2.3 Steel Bridges and Other Steel Structures

1. **(M)** Steel (or iron) components shall not be heated, bent or welded, except in accordance with the instructions of the Railway Infrastructure Manager.
2. **(M)** Where drilling/grinding/flame cutting of a painted steel member is to be performed, the paint in the area shall first be removed in such a way that it does not affect the health of the worker or pollute the environment.
3. **(R)** Consideration should be made in the design to ensure that sufficient manoeuvrability is available to position each of the steel components correctly and safely during construction works.
4. **(M)** Any alterations to in-service trusses or other steel existing components for clearance or other purposes shall be conducted in compliance with AS 5100 and other relevant design standards.

5.2.3 Culverts

5.2.3.1 **(M)** When extending existing Culverts

- (a) **(M)** When extending concrete pipe culverts, consideration shall be given to any potential differential settlement between the existing pipe and its extensions, and appropriate measures shall be put in place.
- (b) **(R)** When extending a metal pipe, and there is a gap between the existing pipe and the new pipe, a strip of suitable impervious membrane should be wrapped around the joint of the pipe to prevent loss of embankment material through the joint.

5.2.3.2 During construction of corrugated metal pipe culverts, it should be noted that backfilling is critical, as uneven backfilling will cause deformation and loss of strength in ring compressions.

5.2.3.3 **(M)** Backfilling material for all culvert pipes shall comply with the requirements of AS 7638, AS 3725 and other relevant standards, and pipe manufacturers' specifications for pH and electrical resistivity.

5.2.3.4 **(M)** In the installation of pipe culverts, the width of trenches shall be as wide as necessary to ensure proper installation and compaction, with the width of trench or spacing between structures subject to backfilling procedures and to be in accordance with relevant Australian standards:

- (a) **(R)** with the minimum recommended trench width being the pipe diameter plus 150mm on either side.
- (b) **(M)** Backfill in trenches shall be of a suitable material and compacted as specified by the designer and in accordance with the relevant test methods specified in AS 1289.
- (c) **(M)** Where pipes are laid in two or more lines in the same trench or streambed, they shall be separated enough to allow space for thorough compaction of backfill, while ensuring side support of the culverts to prevent collapse of the pipes due to unequal loading.