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CRN CS 330

Standard

Engineering Standards - Miscellaneous Structures

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Document history

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1.1	30 January 2022	TfNSW template applied.
2.0	30 January 2022	First full UGLRL issue

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1. Purpose, scope and application

This document specifies the design and configuration requirements for miscellaneous structures on or interfacing with the Country Regional Network (CRN).

Miscellaneous structures include:

- Retaining walls
- Station platforms. It covers the structural design of the platform. It does not cover the design of the platform surface, except the coping, or the building and architectural design of elements associated with platforms. It specifies requirements for both permanent and temporary structures
- Buffer stops. It applies to all terminal roads and sidings
- Track slabs. It includes requirements for both rigid and floating slabs, the interface with track, the transition between rigid and floating slabs, and the transition to other forms of track support. It covers track slabs where the track is fixed directly to a concrete slab. It does not address the design requirements for floating slabs supporting ballasted track.
- Noise barrier walls
- Rockfall shelters
- Signal gantries
- Lighting and Communications towers.
- Overhead service crossings
- Overhead loading structures
- Unloading bins
- Tunnels.
- Structures over and adjacent to tunnels
- Cranes,
- Storage dams,
- Turntables,
- Water columns and tanks,
- Weighbridges (excluding in-motion types)
- Cattle grids associated with fencing

Air space developments are not included in this standard. These developments are not approved in the CRN.

2. References

2.1. Australian and International Standards

AS 1170	Structural design actions
AS 1657	Fixed platforms, walkways, stairway and ladders – Design, construction and installation
AS 1726	Geotechnical site investigations
AS 2700 Set	Colour standards for general purposes
AS 2159	Piling – Design and installation
AS 3600	Concrete structures
AS 4100	Steel structures
AS 4678	Earth-retaining structures
AS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS 5100	Bridge design

Unless otherwise specified, all references relate to the latest standard versions, including amendments and relevant superseding standards.

2.2. CRN documents

CRN CS 100	Civil Technical Maintenance Plan
CRN CS 200	Track System
CRN CS 210	Track Geometry and Stability
CRN CS 215	Transit Space
CRN CS 220	Rail and Rail Joints
CRN CS 310	Underbridges
CRN CS 320	Overbridges and Footbridges
CRN CS 420	Track Drainage
CRN CM 203	Track Inspection
CRN CM 302	Structures Examination
CRN CP 236	Resilient Fastenings
CRN CP 237	Resilient Baseplates
CRN CP 301	Structures Construction

Drawings:

CV 0255592 (205A-326)	Standard Buffer Stop for Terminal Roads
190-211	Cattle Stop Standard Movable
CC0015-01	Standard Stop Block – Maintenance Siding

2.3. Other references

SafeWork (formerly WorkCover) NSW Code of Practice	Tunnels under Construction
Roads & Maritime Services RMS Specification R57	Design of Reinforced Soil Walls
Roads & Maritime Services RMS Specification R271	Design and Construction of Noise Walls

2.4. Definitions

Services:	Underground and aboveground pipelines and cables carrying utilities such as electricity, water, gas, telecommunications and signalling etc.
Trackform:	The type of track structure. May be ballasted or non-ballasted. Ballasted trackform consists of ballast, sleepers, rail fastening assemblies and rails. Non-ballasted trackform consists of concrete slab(s), rail fastening assemblies and rails.
Track Slab:	Concrete slab or slabs with directly fixed track
Rigid Track Slab:	Track slab which is directly fixed to the ground or supporting structure.
Floating Track Slab:	Track slab which is isolated from the ground or supporting structure using resilient bearings.

3. Engineering authority

Design and selection of infrastructure detailed in this standard for use on the CRN may only be undertaken by persons who have been granted appropriate Engineering Authority by the Principal Track and Civil Engineer.

4. General requirements

4.1. Clearances

Horizontal and vertical clearances for structures detailed in this standard shall comply with CRN Engineering Standard CRN CS 215 “Transit Space”.

The area extending one metre below design rail level of Normal Structure Gauge as detailed in CRN CS 215 shall be kept clear of structures and structure footings.

Horizontal and vertical clearances from the track to a signal gantry shall be determined at each location to suit the requirements of signal design for signal cage position, signal sighting and access to the structure.

The design of structures shall, where required, also provide clearances for safe places as detailed in Section 19 of this standard.

4.2. Clearances to electrical services and equipment

Electrical services within the rail corridor may include aerial lines and exposed low voltage equipment.

Miscellaneous structures shall be designed and constructed to ensure that minimum clearances are observed to all electrical power lines and electrical equipment, as laid down within the Australian Standards and the regulations of the relevant electrical authorities.

Where high voltage aerial lines are located above a structure, measures shall be taken to ensure that the risk of transferred potential associated with fallen conductors is mitigated.

4.3. Safety

The design of all new miscellaneous structures including the refurbishment of 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 or gain access to the structure.

The following special requirements apply:

- Where access is required for personnel to maintain signalling or other services attached to signal gantries safe access shall be provided. This may include access steps, ladders, cages, walkways and fixing points.
- Access & egress shall be designed so that personnel have an unobstructed view of the danger zone and approaching rail traffic.
- Tunnel designs shall comply with the requirements of SafeWork NSW (formerly WorkCover NSW) Code of Practice “Tunnels under Construction”.

- Provision shall be made for a safety handrail on top of a retaining wall where the wall height exceeds 2 metres.

4.4. Security

At locations where there is a risk of unauthorised persons gaining access to a structure and endangering themselves or others, security shall be provided by way of fencing or other appropriate means.

4.5. Protection of the environment

The design of all new miscellaneous structures including the refurbishment of existing structures shall take into account environmental impacts during construction and maintenance activities, with a view to minimising any such impacts.

4.6. Heritage

Heritage considerations and classifications must be observed in all designs. This may have particular application in circumstances where an existing structure is being refurbished or modified, or where a new structure is being proposed in the vicinity of existing heritage items.

4.7. Design procedure – new or infrequently used products

If any products specified in the design documentation can reasonably be deemed to be new or infrequently used, these must be identified by the designer and referred to the Principal Track and Civil Engineer for approval. The designer must be satisfied that the manufacturer/constructor/maintainer understands any special requirements/practices relating to the product prior to release of the design documentation.

4.8. Drawing standards

Construction drawings shall comply with UGL Regional Linx Pty Ltd (UGLRL) CRN's standard procedures and formats, and shall detail the design criteria and any other information that is relevant to ensuring that the new structure is constructed and maintained in accordance with the design.

4.9. Construction

In accordance with UGLRL CRN's Design Procedures, design documentation shall identify standards for construction, including construction methods, processes and materials.

UGLRL CRN has a suite of technical specifications for construction of structures. The specifications are detailed in CRN Engineering Specification CRN CP 301 "Structures

Construction" and shall be incorporated in the design and construction documentation for new and refurbished structures.

The design shall take into account construction constraints, particularly live operating conditions and track possession constraints.

Design documentation shall identify standards for construction including construction methods, processes and materials.

4.10. Maintenance

The design of all new miscellaneous structures shall take into account the ability to access components for inspection and maintenance purposes.

Components, materials and finishes should be chosen to minimise future maintenance due to the close proximity of the structure to the tracks.

Maintenance requirements shall be specified in all design documentation for structures. Requirements shall include examination tasks and frequencies, damage limits, and repair standards. In most cases, the requirements of CRN Engineering Standard CRN CS 100 "Civil Technical Maintenance Plan" and CRN Engineering Manual CRN CM 302 "Structures Examination" will apply. However site specific maintenance requirements may need to be provided.

The following special requirements apply:

- Track slab design shall also consider provision for safe egress from maintenance plant and vehicles from the track onto the track slab.
- Spare components, especially consumables, shall be readily available for buffer stops.

4.11. Mechanical and chemical anchors

Mechanical and chemical anchors may be used to attach minor structures to bridges, tunnels and other structures.

The design documentation shall specify the relevant design and installation criteria.

As the load carrying capacity for these types of anchor is normally based on concrete strength, account must be taken of the age and condition of the concrete or brick structures into which these anchors are to be installed (e.g. fractured concrete or brickwork), in order that the manufacturers' specifications and installation instructions are met.

5. Retaining walls and platforms

5.1. Design standards

Retaining walls and station platforms shall be designed in accordance with AS 4678 - Earth-retaining structures, AS 5100 - Bridge design, other relevant Australian Standards and the requirements of this Standard.

The design of station platforms shall take into account requirements for services and utilities, drainage, public safety and disabled access.

When replacing or refurbishing an existing retaining wall or station platform, the design shall comply with the requirements above and provide for the current and proposed future line usage and business requirements.

Platform reconstruction or refurbishment work shall consider the requirements of all stakeholders. Design options shall consider the following requirements:

- track geometry
- potential impact of track renewal activities (e.g. track re-conditioning)
- clearances to overbridges, footbridges, overhead wiring structures
- current and future rolling stock types
- platform height
- platform length
- platform cross fall (slope away from track)
- building levels
- drainage
- end of platform access stairs
- lighting
- station furniture
- platform fencing
- service conduits
- removal of trees
- heritage issues
- potential impact on existing buildings, structures, entrances, riser height to bridge stairs

- potential impact on signal sighting or signal positioning.

5.2. Approved materials

Approved construction materials for main structural elements are steel and concrete. With the exception of retaining walls less than 900mm high, timber materials shall not be used as structural elements in the design of platforms and retaining walls.

Masonry is approved for existing structures and for cladding of new structures where this is required in special circumstances such as for heritage reasons.

5.3. Formwork

Permanent formwork may be used in the design of retaining walls and platforms, but shall not be structurally significant. The design of steel permanent formwork shall include the mitigation of the effects of stray currents.

5.4. Surface finishes

Designers shall consider aesthetic factors when selecting the form and finishes for retaining walls and should provide a feature finish to large expanses of plain concrete.

At locations where vandalism may be an issue, walls shall have an anti-graffitti coating applied.

Where shotcrete is used in refuges, the shotcrete surface shall be steel-floated.

5.5. Earthworks

Earthworks associated with the backfill of retaining walls and station platforms shall be designed in accordance with AS 4678 for compaction and drainage.

5.6. Design requirements

5.6.1. Retaining walls

All retaining walls over 900 mm high shall be designed by structural engineer with UGLRL CRN Engineering Authority or shall comply with an approved standard design.

Design of retaining walls and soil-reinforced structures shall comply with AS 4678 and RMS Specification R57 “Design of Reinforced Soil Walls”. The deformation limits in R57 are not necessarily appropriate for rail embankments. The requirements for deformation limits for walls subject to rail loading shall be assessed and the limits in R57 modified appropriately.

Design of soil-supporting structures for bridges shall comply with AS 5100.

Retaining walls shall also be designed for horizontal and vertical surcharge due to derailment loads. The design shall be based on the derailment load cases in AS 5100 and shall consider the worst load case for a structure.

Designs shall take into account site-specific geotechnical parameters.

Retaining walls greater than 2 metres high and any retaining wall supporting rail embankments shall have a design life of 100 years.

Gabion walls shall only be used to support rail embankments where the height of the wall is one metre or less.

The effect of the top one metre of passive fill in front of retaining walls shall be ignored in the design of retaining walls. The passive resistance of shear keys however may be included.

For cantilevered piled walls, the effect of the passive fill in front of the wall to a depth of 1.5 times the pile diameter shall be ignored.

For retaining walls within 3 metres of a track centreline, the top of the footings shall be located at least 1 metre below rail level. This will permit the proper functioning of cess drainage and future ballast cleaning and track reconditioning activities.

Designs shall include appropriate provision for back of wall drainage (e.g. drainage layer, collector pipes and weep holes).

5.6.2. Platforms

Retaining type platform walls shall be designed in accordance with AS 4678.

5.6.2.1 Design loads

Permanent platforms

Permanent station platforms shall be designed for the following loading:

- Vertical: 10 kPa live load
- Lateral: 200 kN ultimate load at any point along the platform
- Longitudinal: 200 kN ultimate load resisted by the end 20 metres of platform (concurrent with lateral load).

Temporary platforms

The provision of temporary station platforms may be required during new construction works or as part of major maintenance work.

If a temporary platform is required to be in service for twelve months or more, it shall be designed for full loading as specified above for permanent platforms.

If a temporary platform will be required for less than 12 months, relaxation of the loading requirements may be allowed as follows:

- Vertical: 5 kPa live load, subject to the platform being used for passengers only and no heavy equipment
- Lateral: 100 kN ultimate load at any point along the platform
- Longitudinal: 100 kN ultimate load resisted by the end 20 metres of platform (concurrent with lateral load).

5.6.2.2 General configuration and drainage

Concrete platform structures are preferred. Steel platform support structures may be used, but they shall comply with the requirements of Section 5.6.2.3. Platform slabs shall be concrete.

Platform ends shall be finished vertically; ramped ends are not permitted as they facilitate the mounting of the platform by a derailed train.

The length of platforms shall be determined on the basis of operating requirements and likely future requirements for passenger train consists.

The height of platforms shall be in accordance with CRN CS 215.

The width of platforms shall be determined on the basis of usage requirements.

Platform surfaces (including temporary platforms) shall be constructed in durable and impermeable materials that will resist warping, slipping and tripping.

Unrestrained earth slopes beneath open platforms shall be designed to prevent spillage of material onto the track.

Vertical platform walls or piers adjacent to the track shall be placed no closer than 750mm to the edge of the cantilevered coping, to allow for adequate ballast profile and drainage.

Track drainage shall be specifically designed at platforms, particularly in cases where natural run-off from the track structure is interrupted by the platform wall.

The top of footings shall be located a minimum of 1 metre below rail level, to facilitate future ballast cleaning and track reconditioning and to ensure that the platform is not undermined during such activities. If shallow or strip footings are proposed, the footing shall be sufficiently deep below the capping layer to protect against platform instability during track reconditioning works.

The slope of the platform surface shall be designed so that run-off is directed away from the track. A positive drainage system shall be provided to collect and dispose of all stormwater.

5.6.2.3 Steel platforms

The design of steel platforms shall ensure a minimum life to first maintenance of 40 years.

The design shall provide for ease of access for inspection and maintenance of steelwork.

The steel shall have protective coatings in accordance with CRN CP 301.

5.6.2.4 Platform copings

The lateral and vertical placement of platform copings in relation to the track shall be in accordance with CRN CS 215.

When refurbishing an existing platform coping, a steel edge may be used.

The use of materials such as fibreglass is subject to the approval of the Principal Track and Civil Engineer.

5.6.2.5 Services

For new structures, services shall be located within utility ducts within the platform.

For existing structures, service cables and ducting may be attached to the platform wall under the coping. Services shall be located no lower than 500 mm from the underside of the coping and extend laterally no more than 300 mm from the platform wall towards the track. Track clearance requirements documented in CRN CS 215 shall maintained

5.6.3. Movement joints

Provision shall be made in new concrete retaining walls, platform walls and platform slabs for control of cracking caused by shrinkage and thermal effects.

Movement joints shall be designed to accommodate both contraction and expansion. Design shall be in accordance with AS 3600- Concrete Structures.

Horizontal construction joints are not allowed in walls.

Movement joints shall be provided around fixed objects located in slabs, e.g. structure footings, to prevent damage to the slab.

Movement joints in brickwork / blockwork facing shall be designed to suit facing material.

5.6.4. Ground anchors

Ground anchors shall have a design life of 100 years.

Ground anchors shall comply with the requirements of AS 4678 and Technical Specification S38 “Permanent Rock Anchors” in CRN CP 301.

The designer shall specify requirements for testing. Test procedures shall comply with Technical Specification S38.

The designer shall specify requirements for long term monitoring, if any.

Anchor heads shall be protected so as not to be an obstruction. They shall be recessed or protected by a continuous smooth surface of shotcrete, concrete etc.

Ground anchors shall not extend under private property without the approval of the Principal Track and Civil Engineer.

5.6.5. Soil nailing

Soil nailing shall comply with the requirements of AS 4678 and Technical Specifications S45 “Reinforced Soil Retaining Walls” and S46 “Soil Nailing” in CRN CP 301.

6. Buffer stops

6.1. Design standards

New buffer stops shall be designed in accordance with this Standard.

Buffer stops shall be designed for a life of 40 years.

Designs shall be suitably robust using proven structural arrangements.

Where existing buffer stops are to be refurbished or fully replaced, the replacement/ refurbished structure shall be designed in accordance with this Standard.

6.2. Approved materials

Approved construction materials for main structural elements are timber, steel and concrete.

Masonry is not approved for buffer stops.

6.3. Location criteria

Buffer stops or lower order protection devices shall be provided on all sidings where trains operate, and on engineering maintenance sidings.

Buffer stops shall not be located on curved track with a radius less than 800 metres without the approval of the Principal Track and Civil Engineer.

6.4. Approved configurations

Approved configurations of buffer stop are:

- Energy absorbing
- Fixed.

6.4.1. Energy absorbing

Energy absorbing buffer stops may be friction, hydraulic or combination friction/hydraulic type.

Energy absorbing buffer stops shall either be type approved by UGLRL CRN from an approved supplier or to an approved design.

6.4.2. Fixed

Fixed buffer stops shall be the timber type.

Timber buffer stops shall be in accordance with CRN Plan No. CV 0255592 “Standard Buffer Stop for Terminal Roads”.

In locations where “modern” passenger rollingstock (e.g. Xplorers) may operate, buffer stops shall have a cut-out at the bottom for the Scharfenberg guiding horn. The size of the cut-out shall be 400 mm wide (200 mm either side of the track centreline) and 50mm high. The height above rail to the underside of the beam in the cut-out area shall be 750mm.

Where passenger trains, with passengers on-board, operate, fixed buffer stops shall only be used when space constraints exist and it is not economically feasible to reconfigure the location to provide for an energy absorbing type. At such locations, a risk assessment shall be carried out to ensure the residual risk is acceptable.

6.4.3. Lower order protection devices

On sidings where no passenger trains operate, lower order protection devices may be used in lieu of buffer stops, subject to a documented risk assessment approved by the Principal Track and Civil Engineer.

Approved configurations are stop blocks and earth or ballast run-off areas.

Stop blocks shall be a 300mm x 300mm timber bearer secured to the rails in accordance with CRN Plan No. CC0015-01 “Standard Stop Block – Maintenance Siding”. Concrete sleepers may be used in lieu of timber bearers.

The length of over-run area shall be based on the requirements of Section 6.6. The minimum length shall be 5 metres.

6.5. Design requirements

The following design criteria shall be applied in the design of new buffer stops on the CRN network.

6.5.1. Rolling stock mass

Minimum and maximum mass to be specified based on the range of trains and rolling stock, including maintenance vehicles, which use the siding.

6.5.2. Rolling stock speed

The design speed shall be the “probable worst case speed”.

The “probable worst case speed” shall address the causal mechanisms of driver error, rolling stock problems (e.g. brake failure) and/or loss of wheel/rail adhesion. It is not expected to

address deliberate mal-intent of the driver, driver incapacitation, or a runaway train. The exception is that for yards and sidings a runaway of a stabled train shall be included in the determination of “probable worst case speed”.

When determining the probable worst case speed the factors shall include:

- The route approaching the buffer stop
- The advertised speed
- Track gradient
- The speed of the train following the negotiation of points
- Any wheel/rail adhesion issues

The minimum determined design speed shall be 10 km/hr.

6.5.3. Retardation/ deceleration rates

For the range of train masses specified, trains shall be brought to a stop from the maximum speed at a deceleration rate 2.5 m/s2.

6.5.4. Maximum force to minimise train damage

To prevent damage to the rolling stock, the buffer stop shall exert a maximum force of 1,000 kN on the rolling stock.

6.5.5. Coupling capability

Buffer stops shall be designed to suit the range of train and rolling stock that uses the siding, but nominally 865 mm +25/-12 mm above rail.

6.6. Over-run area

A clear length of over-run area shall be provided behind fixed buffer stops and lower order protection devices to manage the risk of trains failing to be stopped by the device.

The length of over-run shall be based on:

- Train mass
- Train speed
- Deceleration rate
- Maximum force on rolling stock
- Track grade
- Safety factor to mitigate variability in friction values.

The normal minimum requirement at locations where the normal operating speed of vehicles is ≤ 25km/h shall be 2 vehicle lengths (40m) beyond the buffer stop or stop block.

6.7. Additional over-run protection

Where the risk assessment determines that additional over-run protection is required, it shall be provided for the mitigation of the consequences of a train hitting the buffer stop at speeds in excess of the “probable worst case speed”.

Options for the design of suitable over-run protection include:

- Provision of space free from structures, other tracks and people
- A speed-arresting device such as a ballast or sand trap beyond the buffer stop
- End impact walls

Where over-run protection cannot be provided, a safety assessment shall be prepared and a waiver obtained. In this situation the buffer stop shall be designed to provide the best risk mitigation reasonably possible within the local constraints.

6.8. Protective coatings

6.8.1. Steel buffer stops

Steel buffer stops shall have protective coatings applied in accordance with CRN CP 301. They shall be either painted or galvanised.

6.8.1.1 Painted

The paint system shall be in accordance with CRN CP 301 Specification S24 “Protective Paint Coating of Steelwork – System P”.

The buffer stop shall be painted white, except for a section of the front, as below.

The section of the horizontal front beam / buffer beam between the running rails shall be painted black. Only the front face of the beam needs to be black.

White paint colour shall be N14 White of AS 2700.

Black paint colour shall be N61 Black of AS 2700.

Paint plaques are not required.

6.8.1.2 Galvanised

Galvanising shall be in accordance with CRN CP 301 Specification S25 “Protective Galvanised Coating of Steelwork – System G”.

6.8.2. Timber buffer stops

6.8.2.1 Timber

Timber components shall be painted with a pink wood primer, an all purpose undercoat and a white alkyd gloss enamel finishing coat.

The minimum dry film thickness shall be 40 micrometres per coat.

The colour shall be N14 White of AS 2700S.

All paints shall be paints approved by the Australian Paint Approval Scheme (APAS).

6.8.2.2 Steel plate

Steel sections shall be in accordance with CRN CP 301 Specification S22 “Miscellaneous Steelwork”.

They shall be painted in accordance with S24 “Protective Paint Coating of Steelwork – System P”.

Paint colour shall be N61 Black of AS 2700.

6.8.3. Stop blocks

Timber stop blocks shall be painted in accordance with Section 6.8.2.1.

6.9. Track requirements

This section specifies the track requirements for the installation of sliding friction buffer stops.

The extent of buffer stop track shall be from 20 metres in front of the buffer stop to the end of the designed length of track required for the buffer to stop a train at the design speed.

The track configuration shall comply with relevant CRN track standards.

The rail configuration shall be in accordance with the requirements in CRN Engineering Standard CRN CS 220 “Rail and Rail Joints”.

- Where timber sleepers are used, the minimum requirements are:
- all sleepers in the buffer stop track area assessed as “good” in accordance with the definition in CRN Engineering Manual CRN CM 203 “Track Inspection”
- resilient fastening assemblies
- sleeper plates shall be secured with screw spikes
- full ballast profile

6.10. Type approval requirements

The following information shall be submitted when requesting type approval of a buffer stop design:

- Design calculations
- Drawings
- Range of couplers and coupler heights allowed for in the design
- Compatible rail types and sizes
- Test results from impact trials
- Performance under specific design criteria
- Assembly and installation procedures
- Resetting procedures
- Spares list and availability
- Maintenance plan including details of failure modes, inspections (routine and post incident) and procedures manual
- Protective coating specification.

7. Track slabs

7.1. Use of track slabs

- The use of track slabs may be necessary in the following situations:
- locations with limited vertical clearance
- existing tunnels where clearances to the track need to be increased to allow the use of larger rolling stock
- new tunnels where the use of non-ballasted track may enable a smaller tunnel profile to be used, ongoing maintenance requirements to be minimised or where the attenuation of noise and vibration is critical.

7.2. Design standards

Designs shall comply with the requirements of the relevant Australian Standards, specific site geotechnical parameters and the requirements of this standard.

Relevant standards and documents include:

- AS 1170 “Structural design actions”

- AS 2159 “Piling – Design and installation”
- AS 3600 “Concrete structures”
- AS 5100 “Bridge design”
- AS 1726 “Geotechnical site investigations”

The design life of track slabs shall be 100 years.

7.3. Integrated designs

The design of each track slab shall be integrated taking into account all associated requirements such as drainage, track, signalling infrastructure and communications services.

7.4. Approved materials

Approved construction material for main structural elements is concrete.

The use of polymer concrete sleepers embedded into track slabs is approved.

Fibre reinforced concrete shall not to be used without the approval of the Principal Track and Civil Engineer.

Track fastening systems shall be approved by the Principal Track and Civil Engineer.

Timber and masonry materials shall not be used.

7.5. Services

Provision shall be made in the design and installation of track slabs for services as required, e.g. signalling, electrical, communications.

Services shall be positioned in accordance with the following requirements:

- Transit space standard CRN CS 215;
- Clear of any walking areas where they might present a trip hazard;
- Not to obstruct access to or reduce the capacity of refuge areas:
- Not to obstruct drainage
- Not to obstruct Track Control Marks.

The location of any services shall also to be selected so that future access for maintenance of the services is facilitated.

7.6. Construction

Construction methods include top down, bottom up or a combination of both.

Top down construction involves setting the rails in place with temporary supports and casting the concrete slab in situ.

Bottom up involves installing a slab(s) and attaching the rails.

Fastening systems that enable rail removal without damage to slab shall be used.

Track slab configurations include:

- monolithic slab
- base slab and top slab
- sleepers embedded in a slab
- base slab with kerb walls and an infill slab
- concrete monoblocks embedded in concrete.

7.7. Design requirements

7.7.1. General

Track slab design is a system design taking into account the stiffness of the:

- sub-base
- slab(s)
- rail fastening assemblies
- rail

The sub-base shall be designed based on the results of a geotechnical investigation to ensure it provides a continuous uniform support of the track structure. The sub-base shall be designed to prevent the infiltration of water under the track slab and to mitigate against the adverse effects of high water tables.

Track slab designs shall:

- Include materials, components and design with proven service history. However, this does not preclude the use of improved track technology that may become available over time,
- Minimise the risk of derailment owing to track irregularities;
- Provide uniform transmission of all rail borne forces to the trackform;
- Incorporate continuous rail with no mechanical joints;
- Incorporate rail lubrication systems where maintenance requirements dictate;
- Provide for future track maintenance, including rail replacement, in-situ rail welding and emergency rail clamping.

The trackbed vibration isolation systems shall be optimised for operation with the rolling stock that is to operate on the track.

The maximum height of grout bed under the rail fixings shall be 60mm. Packers shall not be used.

High impact epoxy grouts/mortars or specially developed grouts shall be used under the rails to accommodate the high dynamic effects and movement of the slab. There shall be no metallic elements in the epoxy. Standard cementitious grouts shall not be used.

The grout bed shall provide sufficient edge distance to the bolt to avoid cracking of the grout.

Where different trackforms are used on a particular project, the geometric tolerances specified at the wheel/ rail interface should be the same. Different slab trackforms shall be effectively bonded at the interface.

Non-resilient fastening assemblies shall not be used on track slabs.

Where the track slab consists of a base slab and a top slab, the top slab shall be tied to the base slab with anchors.

7.7.2. Design loads

Track slabs shall be designed to accommodate the train loadings as specified in Table 1 below:

Table 1 – Design loading for track slabs

Track Class	Design Load configuration
Main Lines	
Heavy Haul Coal Operations	350-LA plus DLA
Class 1 and 2 lines	300-LA plus DLA
Class 3 and 5 lines	280-LA plus DLA

The loading is based on the railway traffic load in AS 5100 “Bridge design”. The ‘Reference Load’ is 300LA. For the other loadings, all axles shall be proportioned by the ratio of the nominated LA load divided by 300.

Track Classes are defined in CRN Engineering Standard CRN CS 200 “Track System”.

For loadings less than 300LA, future loading requirements need to be considered. Final approval of the design loads shall be obtained from the Principal Track and Civil Engineer.

The impact factor shall be in accordance with the dynamic load allowance in AS 5100 with the characteristic length based on either deck slabs or direct rail fixation.

Track slabs shall also be designed for the derailment load requirements of AS 5100.

Track slabs shall be designed for earthquake forces in accordance with AS 5100. The earthquake design category shall be Type III i.e. essential to post-earthquake recovery unless otherwise approved by the Principal Track and Civil Engineer.

7.7.3. Infill slabs

Where track slabs are constructed using ‘top down’ methods in which a concrete infill section is provided to connect the track fixings to the base slab, the concrete infill shall be designed and detailed to ensure structural adequacy and durability to give a 100 year design life to AS 5100.

In particular the construction joint between the infill concrete and track slab shall be prepared by removing laitance to expose the aggregate using appropriate mechanical equipment or by using an approved bonding system.

The reinforcement provided in the infill shall be designed to limit cracking due to early thermal and shrinkage effects. Cracks shall not exceed 0.2 mm in width.

The infill slab shall be adequately tied down to the main track slab to ensure that de-bonding does not occur due to dynamic effects or thermal/shrinkage effects. The maximum spacing of the bars shall be 500mm in any direction.

The minimum thickness of the concrete infill shall be 250 mm.

7.7.4. Width of track slab

The track slab shall extend a minimum width of 500 mm beyond the fasteners on each side of the running rails at the level of the slab under the rails. The maximum vertical drop at the edges of the track slab shall be 150mm, unless guard rails are provided.

7.7.5. Allowable movements

The design of the track slab shall provide for allowable movements of the slab that do not adversely affect the integrity of other infrastructure such as track and signalling. Movements shall not result in the track geometry being outside the limits as specified in CRN Engineering Standard CRN CS 210 “Track Geometry and Stability”.

The design shall provide for construction, expansion and contraction joints as appropriate.

7.7.6. Drainage

Provision shall be made for adequate surface drainage by efficiently directing water into the track drainage system. The track drainage system shall be cleanable as specified in CRN Engineering Standard CRN CS 420 “Track Drainage”.

Baseplates and fastenings must remain above water at all times.

Ponding must not occur on slabs. The drainage design shall ensure that depth of run-off water on track slabs does not interfere with signalling equipment.

7.7.7. Track interface

7.7.7.1 General

The design of the track slab shall take account of the interaction with the track including longitudinal effects, thermal effects, concrete shrinkage and traction/braking loads. The design shall consider the effect on both the track and the track slab, including interaction of slab expansion and rail expansion.

Track fastenings shall be approved resilient fastenings in accordance with CRN Engineering Specifications CRN CP 236 “Resilient Fastenings” and CRN CP 237 “Resilient Baseplates” and shall provide gauge adjustment.

Where epoxy grouts are used under the rail seat pad, the minimum thickness of the pad shall be 7.5 mm.

7.7.7.2 Slab construction

Where rails are to be fixed to the completed slab, the finished surface of the slab shall be constructed to a tolerance of + 0mm, - 5mm from the design level.

Where top down construction is used, the construction method shall ensure track fastenings are fully supported with no voids under the track fastenings. This is especially important on superelevated track.

7.7.7.3 Guard rails

Guard rails may be required along track slabs where it is determined to be appropriate for providing protection to adjacent structures.

The approved configurations and design standards for guard rails are documented in CRN CS 310 “Underbridges”

Concrete upstands may be provided as an alternative to standard guard rail sections. Upstands shall be installed in the four foot, not on the outside of the track. The upstands shall be designed for a 80kN lateral load.

7.7.8. Transition section trackforms

Transition section trackforms shall be provided in locations where two differing trackforms abut. The transition section shall be designed to:

Provide a progressive change in track stiffness;

- Provide an easily maintained trackform transition, which will not be prone to differential settlement;
- Provide accurate matching of track alignment under all load conditions, in order to avoid stress concentrations in components or uneven ride characteristics;
- Minimise the number of transition sections.
- Where track slabs abut ballasted track, a transition slab shall be provided to achieve a progressive change in track stiffness. The ballasted track on the transition slab shall be designed and installed in accordance with CRN's track standards.
- The minimum length of transition section trackform shall be 4.5 m.
- Transition section trackforms shall be designed for the same loads as the track slab.

7.8. Prohibited configurations

The following track slab configurations are prohibited:

- Embedded rail systems.

8. Noise barrier walls

8.1. Design standards

Noise Walls shall be designed to the relevant Australian Standards and the requirements specified in this standard.

8.2. Approved materials

Approved construction materials for main structural elements are steel and concrete. Timber materials shall not be used as structural elements in the design.

8.3. Design requirements

Noise barrier walls are structural elements erected for the purpose of attenuating the transmission of train noise to adjacent properties. They may be installed adjacent to the rail lines or along the rail corridor boundary.

The barriers shall be designed and constructed in accordance with RMS Specification R271 "Design and Construction of Noise Walls". Due consideration shall be given during the design to access for maintenance and also general access to other rail infrastructure.

The design shall be integrated taking into account all associated requirements such as drainage, bonding, architectural treatments and access for maintenance. Where appropriate, aesthetics shall be taken into account including proportions, details and finishes.

Anti-graffiti coatings should be specified in areas where there is a high risk of graffiti.

Noise barrier walls shall not be painted in safeworking colours of red, orange and green.

Where noise barrier walls are installed adjacent to the track, the minimum clearances shall be observed in accordance with CRN CS 215.

Where applicable, provision shall made for safe areas for authorised staff to gain refuge from a passing train in accordance with Section 19 of this document.

9. Rockfall shelters

9.1. Design standards

Rockfall shelters shall be designed to the relevant Australian Standards and the requirements specified in this section.

9.2. Approved materials

Approved construction materials for main structural elements are steel and concrete. Timber materials shall not be used as structural elements in the design.

9.3. Design requirements

Rockfall shelters protect the track from falling rocks. The need to provide a rockfall shelter shall be determined by a geotechnical risk assessment.

Rockfall shelters and supporting elements such as columns shall be designed to resist impact loads from falling rocks. The design loads shall be determined on a site specific basis.

Where rockfall shelters are to be constructed, the vertical clearance between the design rail level and underside of structure, and lateral clearance beside the tracks, shall be as specified in CRN CS 215.

Where applicable, provision shall be made for ‘safe areas’ for authorised staff to gain refuge from a passing train in accordance with Section 19 of this document.

The design shall consider the future maintenance of the rockfall structure and the roof shall be designed for any temporary plant and equipment required for maintaining the roof.

10. Signal gantries

10.1. Design standards

The components of signal gantries shall be designed in accordance with this document and to the following Australian Standards.

- Steel structures shall be designed to AS 4100 and hot-dip galvanized in accordance with AS 4680.
- Concrete footings shall be designed to AS 3600 and AS 2159.

Where existing signal gantries require refurbishment or replacement, the design of the replacement/ refurbished structure shall be in accordance with the current and proposed future line usage and business requirements.

Refurbished structures shall comply with design standards listed above.

10.2. Design loads

Signal gantries shall be designed to support signal equipment at the specific locations nominated. Loads imposed on signal gantries from the signal equipment shall be determined using the weight of the equipment and the placement position of the equipment determined by the signal design requirements for the signal gantry.

Permanent actions for use in designing signal gantries structure shall be in accordance with AS 1170.1.

Imposed actions for use in the design of signal gantries shall be in accordance with AS 1170.1 and AS 1657.

Wind loading on signal gantries shall be determined in accordance with AS 1170.0 and AS 1170.2. The ultimate regional wind speed shall be determined using an appropriate average recurrence interval using importance levels and design working life chosen from Table 2below:

Table 2 – Signal Gantry Design Life

Signal Gantry Condition and Usage	Importance Level	Design Working Life (Years)
New Gantries Supporting Signals, Cages and Maintenance Personnel	2	50
Existing Gantries (25 years or older) Supporting Signals, Cages and Maintenance Personnel	2	25

The serviceability regional wind speed shall be determined using an average recurrence interval of 25 years.

Deflection of signal gantries under full serviceability loading - permanent action, wind and live load - shall be limited so that the aesthetic appearance of the structure is acceptable. Deflection limits in Table 3 below should be used as a minimum:

Table 3 – Signal Gantry Deflection Limits

Structure Type	Maximum Vertical Deflection	Maximum Horizontal Deflection (In and Out of Plane)
Portals	Span/ 250	Height / 125
Cantilever	Length/ 125 (+ve) Length/ 500 (-ve)	Height / 125
Signal Cage	-	Length of cage / 75 (Out of plane only)

These limits are applied to the final deflected shape, which must take into account any mast rake on cantilever structures and bridge or boom pre-camber on portals and cantilever structures.

10.3. Design requirements

10.3.1. General

To minimise maintenance, signal gantries shall be configured using smooth, clean faced structures without a proliferation of small members, fittings and metal to metal interfaces.

In addition the following design criteria will apply:

- each structure shall be designed as a stand alone independent structure;
- the minimum thickness of major steel structure components shall be 8mm;
- steel structures and fittings shall be galvanised, unless approval is given by the Principal Track and Civil Engineer to use alternative coatings (e.g. coatings to meet heritage requirements);
- the minimum size of fillet welds shall be 6mm;
- designs shall ensure that moisture and debris collection pockets are not created;
- the top surface of footings and holding down bolts shall be clear of the track ballast, cess and sub grade levels;
- the structures shall be designed for a serviceable life of 100 years.

11. Lighting and communications towers and poles

11.1. Design standards

Lighting and communications towers and poles shall be designed to the relevant Australian Standards and the requirements specified in this document.

11.2. Approved materials

Approved construction materials for main structural elements are steel and concrete.

Lighting poles may be constructed of timber.

11.3. Design requirements

The design loads for lighting and communications towers and poles shall be in accordance with the relevant Australian Standards.

The towers and poles shall be designed and configured to meet the functional and performance requirements specified for each site by the tower owner.

12. Overhead service crossings

12.1. Design standards

Overhead Service Crossings shall be designed to the relevant Australian Standards and the requirements specified in this document.

12.2. Approved materials

Approved construction materials for main structural elements are steel and concrete. Timber materials shall not be used as structural elements in the design.

12.3. Design requirements

Overhead service crossings are free-standing structures carrying utility services such as water or sewer mains.

Designs shall comply with the requirements of the relevant Australian Standards, the collision protection requirements of Section 31 of this standard and clearances specified in CRN CS 215.

Other design criteria shall be applied as follows:

- design of the structure shall be such that the number of elements that are likely to be struck by a derailed train is minimised. Any columns at track level supporting the structure shall comply with the requirements for pier and column protection in accordance with Section 31 of this document;
- access to CRN infrastructure shall be maintained as specified for the particular site.

13. Overhead loading structures

13.1. Design standards

Designs shall comply with the requirements of relevant Australian Standards, the collision protection requirements of Section 20 of this document and clearances specified in CRN CS 215. Additional clearance requirements are specified below.

13.2. Design requirements

Where the loading chute is designed to lower into the rail vehicle, the chute in the raised position shall be a minimum of 5300mm above the designed rail level. The chute in the lowered position shall be suitable for the range of vehicles to be loaded and extend down to a minimum of 3500mm above rail level. The maximum width of the loading chute shall be 1600mm.

The control of the chute must be adequate to ensure that it can be rapidly raised in an emergency.

In areas where the track layout does not provide for a locomotive to pass under the chute, the minimum height of any part of the supporting structure shall be 5000mm above rail. The actual loading chute in the raised position shall be minimum of 5000mm above rail.

14. Unloading bins (track bearing)

14.1. Design standards

To be developed

14.2. Design requirements

The design loads for unloading bins shall be 350LA with appropriate impact factor.

15. Tunnels

15.1. Design standards

Designs shall comply with the requirements of the relevant Australian Standards, specific site geotechnical parameters and the requirements of this Document.

Relevant standards and documents may include:

- AS 1170 “Structural design actions”
- AS 2159 “Piling – Design and installation”
- AS 3600 “Concrete structures”
- AS 4100 “Steel structures”
- AS 4678 “Earth-retaining structures”
- AS 5100 “Bridge design”
- AS 1726 “Geotechnical site investigations”
- SafeWork NSW (formerly WorkCover NSW) Code of Practice “Tunnels under Construction”

The design life of tunnels shall be 100 years.

15.2. Integrated designs

The design of each tunnel shall be integrated, taking into account all associated requirements such as drainage, track, signalling infrastructure and communications services.

15.3. Approved materials

Approved construction materials for main structural elements are steel and concrete.

Masonry is approved for existing tunnels.

Timber materials shall not be used in tunnels.

Materials in tunnels shall generally be non-flammable.

15.4. Provision for services

Provision may be required when designing tunnels for accommodating services managed by UGLRL CRN (e.g. signalling cables) or services owned by other authorities and utilities.

Services shall be positioned in accordance with the following requirements:

- Transit space standard CRN CS 215;

- Clear of any walking areas where they might present a trip hazard;
- Not to obstruct access to or reduce the capacity of refuge areas.

The location of any services shall also be selected so that future access for maintenance of the services is facilitated.

15.5. Specific requirements

15.5.1. Design alternatives

Alternatives for tunnel designs will depend primarily on whether open cut, driven or bored construction methods are adopted to suit the geology and location.

Major design variables will include:

- Track structure type
- Tunnel lining
- Drainage
- Train kinematic clearance requirements (refer to CRN CS 215)
- Infrastructure maintenance and operating practices.

15.5.2. Design requirements

Tunnels located within the rail corridor shall be designed to accommodate the train loadings as specified in Table 4 below:

Table 4 – Design loading for tunnels

Track Class	Design Load configuration
Main Lines	
Heavy Haul Coal Operations	350-LA plus DLA
Class 1 and 2 lines	300-LA plus DLA
Class 3 and 5 lines	280-LA plus DLA

The loading is based on the railway traffic load in AS 5100. The ‘Reference Load’ is 300LA. For the other loadings, all axles shall be proportioned by the ratio of the nominated LA load divided by 300.

Track Classes are defined in CRN CS 200.

For loadings less than 300LA, future loading requirements need to be considered. Final approval of the design loads shall be obtained from the Principal Track and Civil Engineer.

The impact factor shall be in accordance with the dynamic load allowance in AS 5100 with the characteristic length based on either deck slabs or direct rail fixation.

Tunnels shall also be designed for the collision load requirements of AS 5100. Where tunnel walls are not continuous, guard rails or concrete upstands shall be provided in lieu of the collision load requirements at the discontinuity.

Tunnels shall be designed for earthquake forces in accordance with AS 5100. The earthquake design category shall be Type III i.e. essential to post-earthquake recovery.

15.5.3. Configuration

Unless otherwise stated, new rail tunnels shall be designed to accommodate the rolling stock profiles defined in CRN CS 215.

The tunnel shall be sized to accommodate transit space requirements, services, plant and equipment.

In addition, the tunnel shall incorporate niches, where necessary, to accommodate refuges, plant and equipment.

Tunnel services, plant and equipment may include:

- signalling equipment
- communication cables and equipment including emergency telephones
- electrical supply and services cables
- tunnel lighting and small power outlets
- tunnel walkway
- tunnel drainage including pumping stations and sumps
- under track crossings

Allowance shall be made for the operational line speed nominated for the Track Class in CRN CS 200.

The maximum track gradient within the tunnel (after allowances for curve compensation) shall be 3%. The maximum length of continuous track at or close to the maximum grade shall be based on a consideration of the capability of the rolling stock using the tunnel. The design grade profile of the tunnel shall be subject to the approval of the Principal Rolling Stock Engineer.

15.5.4. Tunnel invert

The migration of fines into the tunnel from within the rock mass beneath the tunnel invert must be prevented by appropriate invert treatment.

15.5.5. Seepage and drainage

The rate of inflow of groundwater into the tunnel shall be limited so that surrounding property and infrastructure is not adversely affect by changes to the groundwater level and flow regime.

The rate of inflow into the tunnel must also be controlled to avoid impact to any existing surface water courses.

The seepage rate of water into the tunnel shall be limited to a maximum of 0.1 litres/second per any continuous 100 metre length of single track tunnel.

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 to minimise maintenance.

The drainage system shall be configured so that in the event of a blockage, any overflow will not affect train operations or the reliability of the infrastructure.

All drainage discharge from the tunnel shall be treated to be of such quality as to meet the requirements of the relevant authority for discharge to the stormwater system.

The drainage system design and configuration shall consider the need for authorised staff to access adjacent equipment without having to stand in the drain.

No water seeping through the tunnel structure shall drip onto the track.

15.5.6. Tunnel fittings

Seepage of groundwater can cause corrosion to structural elements of the tunnel. Appropriate measures shall be implemented in the design to protect these components from corrosion.

All fittings and fastenings securing services to the tunnel structure shall be stainless steel.

Mechanical and chemical anchors should be designed and installed taking into account the long-term strength of the natural ground and tunnel linings allowing for deterioration over time.

Equipment such as cabinets and signs shall be mounted clear of tunnel walls to prevent damage by or ingress of seepage water from tunnel walls.

15.5.7. Rock anchors

Rock anchors shall have a design life of 100 years.

Rock anchors shall comply with the requirements of AS 4678 “Earth-retaining structures” and Technical Specification S38 “Permanent Rock Anchors” in CRN CP 301.

The designer shall specify requirements for testing. Test procedures shall comply with Technical Specification S38.

The designer shall specify requirements for long term monitoring, if any.

Anchor heads shall be protected so as not to be an obstruction. They shall be recessed or protected by a continuous smooth surface of shotcrete, concrete etc.

16. Structures over and adjacent to tunnels

Structures to be constructed over and/or adjacent to tunnels shall be suitably designed to take account of the interface with CRN infrastructure. Construction work methods shall be part of the design process.

Work methods shall be designed, staged and monitored to avoid damage to the railway tunnel. Work method statements shall be approved by UGLRL CRN authorised staff with appropriate engineering authority.

Prior to the commencement of works, a dilapidation survey of the tunnel and other rail infrastructure in the vicinity of the proposed works shall be undertaken. The existing condition of the rail infrastructure shall be agreed and recorded.

During construction works, the maximum peak particle velocity in the tunnel lining shall not exceed 20 mm per second.

Before commencing excavation within 5 metres of the tunnel, vibration monitors shall be installed inside the tunnel as close as possible to the point of excavation. Any cracks generated in the tunnel lining shall be monitored during excavation and repaired on completion of the work.

17. Minor miscellaneous structures

The following structures on the CRN network are considered minor structures.

- Cranes,
- Storage dams,
- turntables,
- Water columns and tanks,
- Weighbridges (excluding in-motion types)
- Cattle grids associated with fencing

17.1. Cranes, storage, dams, turntables, water columns, water tanks and weighbridges

These structures commonly exist on disused lines as well as on operating lines. They shall be maintained in a safe and secure condition that protects public safety.

All proposals for renewal or for additional structures shall be approved by the Principal Track and Civil Engineer.

17.2. Cattle grids

Cattle grids are placed in track at level crossings or at locations where the track intersects fenced properties. Their purpose is to prevent livestock straying across the property boundary.

The current configuration of cattle grids is contained in Plan No. 190-211

Older configurations include small girder top timber openings. These are not approved for new installations and shall be replaced with the approved configuration when replacement is required.

It should be noted that some of the older cattle stops function as a waterway. Replacement of these structures with cattle grids may also require installation of appropriately designed culverts or pipes in accordance with CRN Engineering Standard CRN CS 310 “Underbridges”.

18. Guard rails

The prime purpose of guard rails on rail tracks is to keep derailed or derailing bogies/ wheels tracked parallel to and in close proximity to the running rails. In the case of an overhead structure, the guard rails afford a level of protection to an adjacent support.

Where guard rails are determined to be appropriate for providing protection to vulnerable supports of overhead or adjacent structures, they shall be installed in accordance with the requirements specified in Engineering Standard CRN CS 310 “Underbridges”:

19. Provision of safe areas

19.1. Safety refuges and handhold devices

The design of new tunnels, retaining walls, and other wall structures (e.g. rock shelters or sound barriers) shall make provision for a safe area for infrastructure and other authorised staff to stand during the passage of a train.

A safe area shall be provided where the wall structure is longer than 20 metres.

Safe areas may be provided by:

- Refuges, or
- Hand hold devices

The selection, use and configuration of these items shall be in accordance with the requirements of CRN Engineering Standard CRN CS 320 “Overbridges and Footbridges”

Provision for a safe area is not required in the design of platforms

19.2. Locations with limited clearances

Where safe areas (refuges or handhold devices) are not provided, wall structures shall have limited clearance warning signage attached.

The selection, use and configuration of Warning Signs shall also be in accordance with the requirements of CRN CS 320.

20. Collision protection

The design of piers or columns supporting miscellaneous overhead structures within the railway reserve shall comply with the provisions of collision protection and loading in AS 5100 “Bridge Design”.

New structures shall be designed with a clear span between abutments, unless supporting columns are located on platforms.

The prime requirement is to protect the piers and columns against damage from a derailed train, which in turn could result in collapse of the structure onto the train.

Similarly, piers and columns located next to roadways should be protected against impact from road vehicles.

Design and configuration of collision protection shall meet the requirements of CRN CS 320.