Engineering Standard

Track

OTCS 240

BALLAST

Version 1.0

Issued August 2018

Approved by:

.

Document control

Revision	Date of Approval	Summary of change
1.0	August 2018	First Issue. Includes content from the following former RIC standards: TS 3101, TS 3402, RTS.3430, TS 3104 and CRN CS 240 Ver 1.1

Summary of changes from previous version

Section	Summary of change

Contents

1 Scope and application

This Standard establishes functional and design requirements, approved configurations, acceptance standards, damage limits and repair standards for rail ballast.

It is applicable to all main line and siding tracks and shall be applied to the design of new trackwork, track renewal, reconditioning and ballast cleaning.

2 References

2.1 Australian and International standards

AS 2758.7-1996: Aggregate and rock for engineering purposes Part 7: Railway Ballast

2.2 OTHR documents

OTCS 200 - Track System

2.3 Other references

CRN CP 241 - Ballast Specification

2.4 Definitions

Ballast:	Ballast is a free draining coarse aggregate or metallurgical slag used to support railway tracks.
Nominal Size:	The designation of an aggregate which gives an indication of the largest size particle present.

3 Engineering authority

Design and selection of infrastructure detailed in this standard may only be undertaken by persons who have been granted appropriate Engineering Authority by the Engineering Manager.

4 Design & performance criteria

4.1 Track configuration

The configuration of track elements, including ballast, is specified in OTCS 200 “Track System”.

4.2 Ballast design criteria

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

4.2.1 Loading

- Service loads including effects of track alignment, maintenance standards, and traffic task.

4.2.2 Materials

- Ballast consolidation requirements.

4.2.3 Interfaces with other rail infrastructure

- Sleeper material, type and spacing.
- Electrical properties in track circuited areas.

4.2.4 Support requirements

- Required track modulus.
- Track support conditions and deflection criteria.
- Track formation material and condition.

4.2.5 Performance requirements

- The need to interlock sufficiently, provide resistance against excessive vertical, lateral (buckling of the track) and longitudinal movement of sleepers and bearers.
- The need to reduce excessive loading and failure of the track formation.
- The need to provide adequate drainage of the track structure to the cess and allow fines to migrate out.
- The need to be durable enough to resist crushing when subjected to design axle loadings specified for the relevant track class in OTCS 200.

5 Approved configurations

5.1 Ballast material and grading

For existing applications, detailed in OTCS 200, all ballast shall meet the material and grading requirements of Specification CRN CP 241.

Ballast grading shall be selected in accordance with the track class detailed in OTCS 200 and as detailed in Table 2.

Track Class	Ballast Grading
Main Line	
1	Standard
2	Standard
3	Standard
3G	Standard
5	Standard
Sidings	
1	Standard
2	Fine
3	Fine

Table 1 - Ballast Selection

The ballast gradings are detailed in Table 2.

Sieve size (mm)	Ballast Grade			
	Enhanced (Note 3)	Standard	Medium (Note 2)	Fine (Note 1)
	Nominal size (mm)			
	60 (RailCorp Graded Ballast)	60 (Uniformly graded ballast)	60 (steel sleepers)	50 (graded aggregate)
	% passing by mass			
63.0	100	100	100	–
53.0	85 – 100	85 – 100	95 – 100	100
37.5	50 – 70	20 –- 65	35 – 70	70 – 100
26.5	20 – 35	0 – 20	15 – 30	–
19.0	10 – 20	0 –- 5	5 – 15	40 – 60
13.2	2 – 10	0 – 2	0 – 10	–
9.50	0 – 5	–	0 – 1	20 – 30
4.75	0 – 2	0 – 1	–	10 – 20
2.36	–	–	–	–
1.18	–	–	–	5 - 10
0.075	–	0 – 1	0 – 1	0 –- 5

Table 2 - Ballast grading

Note 1: Fine graded Ballast is not for general use.

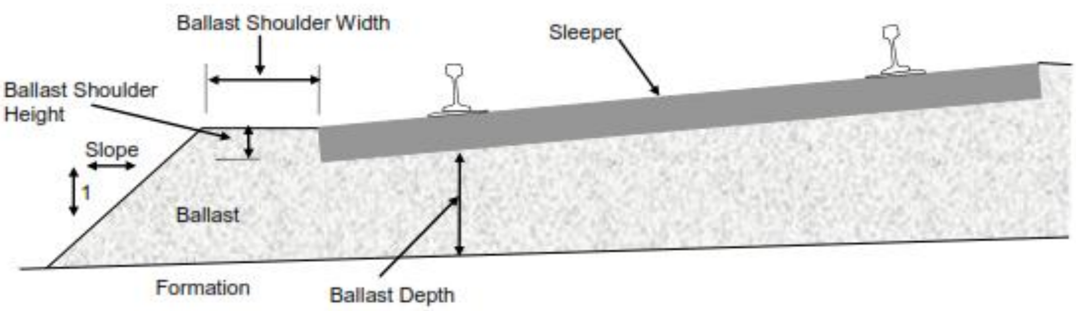
Note 2: Medium grade ballast may be used in lieu of Standard grade when used on lines which are or are intended to be fully steel sleepered.

Note 3: Enhanced grade ballast is the preferred grading on Class 1 and Class 2 main line track

Alternative gradings (either as specified in AS 2758.7, or specifically designed) to meet special requirements (eg special gradings necessary in conjunction with reduced ballast depth) must be approved by the Engineering Manager.

5.2 Ballast profile

A typical track cross-section illustrating ballast profile is shown in Figure 1.



5.2.1 Shoulder height

Ballast shoulder height (the distance from sleeper soffit (bottom of the sleeper) to the underside of the rail) is determined by the sleeper design. The ballast shall be profiled to the top of the end of the sleepers. Depending on the sleeper design, the rail seat area may be higher than the centre and ends.

5.2.2 Crib height

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

5.2.3 Shoulder slope

For freestanding ballast, the slope of the ballast shoulder is assumed to be 1:1.5 (height: width)

5.2.4 Shoulder width

The minimum shoulder distance is determined by the track stability requirements of rail length. The requirements for current applications are detailed in Table 3.

Track Class	Rail Length	Design Ballast shoulder width (mm)	
		Minimum	Maximum
Main line			
1	CWR / LWR	400	700
2	CWR / LWR	400	700
3/3G	CWR / LWR	400	700
3	Loose	250	700
5	Loose	250	700
Siding			
1	CWR / LWR	400	700
2	CWR / LWR	400	700
3	CWR / LWR	400	700
3	Loose	250	700

Table 3 - Ballast Shoulder widths

Ballast Shoulder width is measured from the extreme end of the sleeper, not the visible end when the track is fully ballasted.

The ballast shoulder should extend horizontally from the sleeper end. It is, however, acceptable for the ballast shoulder to be profiled in the plane of the sleeper for a normal ballast shoulder width (nominally 400mm) to suit ballast regulators. Any extended shoulders, such as on bridges, should be horizontal.

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

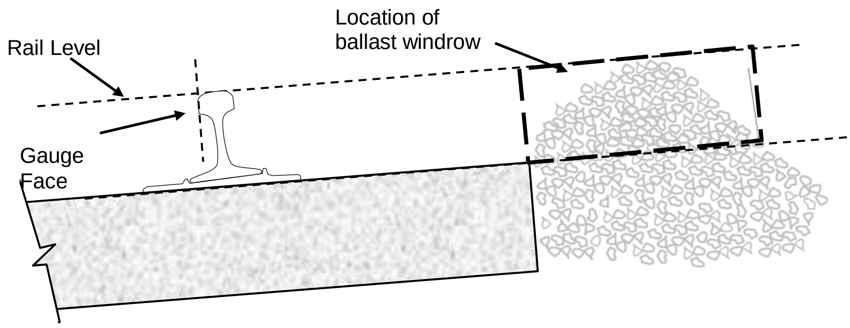


Figure 2 Location of ballast windrow

5.2.5 Ballast depth

Ballast depth is the distance from the underside of the sleeper to the top of the finished formation. It does not include the capping layer.

Note: Ballast depth below steel sleepers is measured from the bottom of the sleeper and does not include the depth of ballast in the pod

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

Design ballast depth shall be selected in accordance with the Track class detailed in OTCS 200. Some variations are required when alternative sleeper type and rail size are used. Approved ballast depths for each Track class and for alternative sleeper type and rail size are detailed in Table 4.

Track Class	Sleeper / rail type	Design Ballast Depth	
		Minimum	Maximum
Main Line			
1	Concrete – 60kg rail	300	500
	Concrete – 53kg rail	270	500
	Steel	270	500
	Timber – 60kg rail	300	500
	Timber – 53kg rail	270	500
2	Timber/Steel	270	500
3	Timber/Steel	200	500
3G	Timber/Steel	150	500
5	Timber/Steel	150	500
Sidings			
1	Timber/Steel	250	500
2	Timber/Steel	200	500
3	Timber/Steel	150	500

Table 4 - Ballast depth

Note 1: Full ballast depth in existing track includes ballast that is not free draining

Free draining ballast may include ballast with fines such as sand, brake dust and other fine material that does not restrict water flow.

Note 2: Existing track may not necessarily achieve the target ballast depth.

Note 3: Use of the design ballast depths with poor subgrades may still cause the subgrade to be over stressed. Detailed investigation and analysis of the whole track structure including the substructure condition may be necessary in these problem situations. It can equally be demonstrated that in areas with very good subgrades (natural or designed) it is possible to provide adequate support to the track structure with lower ballast depths than those specified in Table 4.

Through turnouts the minimum ballast depth under turnout bearers is to be maintained by lowering the formation level as required. The change in level of the formation shall be ramped off as shown in Table 5. Formation drainage shall be designed to prevent ponding under the turnout

Turnout installation or replacement	**Maximum grade** (relative to the track grade)
where adjacent track is also being installed or reconstructed	1 in 200
where major track reconstruction is not being undertaken	1 in 20

Table 5 – Ramp of formation under turnouts

5.2.6 Alternative ballast profiles

The following alternative ballast profile designs may be adopted:

1. Ballast shoulder width may be reduced to a minimum of 75mm provided that:
   - ~ lateral restraint, such as a retaining wall, is provided. The additional lateral restraint shall be at least equivalent to the restraint provided by the missing shoulder ballast.
   - ~ arrangements are made for drainage of water from the formation.
2. Ballast shoulder width may be Increased (eg for walkways or examination areas) provided that alternative arrangements are made for drainage of water from the formation.
3. Ballast depth may be reduced provided that
   - ~ measures are included to provide strength and durability at least equivalent to the approved design
   - ~ measures are included to provide stiffness no less than the approved design (e.g. use of special vibration isolation fastenings or a ballast mat).
4. Ballast stiffness may be altered at points of transition between differing track stiffness (e.g. ballasted track to transom topped bridges or track slab, timber or steel sleepered track to concrete sleepered track) by use of transition slabs, ballast glue or side walls. All designs for use of alternative methods shall be approved by the Engineering Manager.

6 Acceptance standards

All work involving the laying of ballast as part of new track installation, track renewal or resurfacing shall meet the following acceptance requirements:

6.1 Ballast material and grading

Supplied (new) ballast shall meet an approved design (CRN CP 241 or equivalent approved by the Engineering Manager.)

6.2 Crib and shoulder height

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

6.3 Ballast shoulder width

The ballast shoulder width shall be profiled to meet the minimum and maximum requirements specified in Table 3 to the tolerances detailed in Table 6.

Track Class	Rail Length	Ballast shoulder width (mm)	
		Acceptance	
		Minimum	Maximum
Main line			
1	CWR / LWR	390	700
2	CWR / LWR	390	700
3/3G	CWR / LWR	390	700
3	Loose	240	700
5	Loose	240	700
Siding			
1	CWR / LWR	390	700
2	CWR / LWR	390	700
3	CWR / LWR	390	700
3	Loose	240	700

Table 6 - Ballast shoulder width acceptance limits

6.4 Ballast depth

The ballast depth after track renewal shall meet the minimum and maximum requirements specified in Table 4 to the tolerances detailed in Table 7.

Note: After maintenance resurfacing the minimum requirements may not necessarily be met.

Track Class	Sleeper / rail type	Ballast Depth		
		Acceptance		Minimum Free Draining
		Minimum	Maximum	
Main Line				
1	Concrete – 60kg rail	275	500	75
	Concrete – 53kg rail	245	500	75
	Steel	245	500	75
	Timber – 60kg rail	275	500	75
	Timber – 53kg rail	245	500	75
2	Timber/Steel	245	500	75
3	Timber/Steel	175	500	75
3G	Timber/Steel	125	500	75
5	Timber/Steel	125	500	75
Sidings				
1	Timber/Steel	225	500	75
2	Timber/Steel	175	500	75
3	Timber/Steel	125	500	75

Table 7 - Ballast Depth acceptance limits

7 Damage limits

Ballast repair or replacement shall be undertaken when the ballast has lost its ability to drain surface water from the track to the formation.

8 Repair standards

8.1 Ballast cleaning

Ballast may be cleaned to restore drainage properties by the use of a Track Undercutter or Ballast Cleaner. The ballast returned to the track from the Ballast Cleaner screens is not required to meet the grading specified in this standard however it may only be used below the depth specified for free draining ballast.

8.2 Recycled ballast

Ballast that is recycled by the screening of ballast spoil excavated from the tracks (other than by ballast cleaning) may be used provided that it:

- is cleaned to remove fines and contaminants, AND
- meets an approved design (CRN CP 241 or equivalent approved by the Engineering Manager), OR
- has reinforcement designed to provide strength and durability at least equivalent to the approved design, OR
- is ONLY used below the depth specified for free draining ballast