TRACK AND CIVIL INFRASTRUCTURE

CODE OF PRACTICE

VOLUME THREE - TRAM SYSTEM [CP3]

TRACK SUPPORT SYSTEMS

TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE

1.1 PURPOSE

The purpose of this part is to set standards to ensure that track support systems are safe and fit for purpose.

1.2 PRINCIPLES

This part complies with the principles set out in the "Code of Practice for the Defined Interstate Rail Network", volume 4, part 2, sections 2 and 4.

1.3 SCOPE

1.3.1 Ballasted track

This part specifies general procedures for the design/rating, monitoring and maintenance of:

a) sleepers;
b) plain track sleeper plates;
c) points and crossings bearer plates;
d) trackspikes i.e. dogspikes, spring fastening spikes and screw spikes;
e) lock-in shoulders ("F & Gs");
f) resilient rail clips;
g) insulation pads and rail insulators ("biscuits");
h) rail anchors; and
i) ballast.

1.3.2 In-street track

This part also specifies general procedures for the design/rating, monitoring and maintenance of in-street track.

1.4 REFERENCES

1.4.1 Australian Standards;

AS 1085.3 Railway permanent way material Part 3: Sleeper plates
AS 1085.8 Railway permanent way material Part 8: Dogspikes
AS 1085.9 Railway permanent way material Part 9: Rolled steel clip fastening sleeper plates
AS 1085.10 Railway permanent way material Part 10: Rail anchors
AS 1085.13 Railway permanent way material Part 13: Spring fastening spikes for sleeper plates
AS 1085.14 Railway permanent way material Part 14: Prestressed concrete sleepers
AS 1085.16 Railway permanent way material Part 16: Cast steel sleeper plates
AS 2758.7 Aggregates and rock for engineering purposes Part 7: Railway ballast
AS 3818.1 Timber - Heavy structural products - Visually graded Part 1: General requirements
AS 3818.2 Timber - Heavy structural products - Visually graded Part 2: Railway track timbers
AS 4799 Installation of underground utility services and pipelines within railway boundaries.

1.4.2 **Industry codes of practice**

a) Code of Practice for the Defined Interstate Rail Network, volume 4 (Track, Civil and Electrical Infrastructure), part 2 (Infrastructure Principles), sections 2 (Sleepers and fastenings) and 4 (Ballast).

b) TransportSA specification PM21:

1.4.3 **TransAdelaide documents**

a) **CP3**

CP-TS-972: Part 2, Structure and application
CP-TS-973: Part 3, Infrastructure management and principles
CP-TS-976: Part 6, Track geometry
CP-TS-979; Part 9, Earthworks
CP-TS-981: Part 11, Rails and rail joints
CP-TS-982; Part 12, Guard/check rails and buffer stops
CP-TS-983: Part 13, Points and crossings
CP-TS-984: Part 14, Rail stress control
CPRD/PRC/046 Records Management

b) **Infrastructure Services Management System Procedure Manual**
QP-IS-501: Document and Data Control

1.4.4 **TransAdelaide drawings**

304-A3-83-1650: Design standard: track anchor patterns for C.W.R.
304-A4-80-367: Design standard: spiking patterns on curves

Note: The following drawing is not referred to in this document but needs to be actioned as shown:
304-A3-83-917: Design standard: ballast cross-sections
TO BE REVISED IN ACCORDANCE WITH INCREASED BALLAST DEPTH VIDE TABLE 4.1

2.0 TRACK DESIGN FOR BALLASTED TRACK

2.1 TRACK SUPPORT SYSTEMS

a) This section describes the various track configuration systems for standard gauge tram track.
b) Components used on TransAdelaide ballasted tram tracks are described in section 3.0.
c) Formation and ballast are described in section 4.0.
d) In-street slab track is described in section 7.0.

2.2 AXLE LOADS AND SPEEDS

Tram tracks shall be designed for the axle loads and speeds shown in CP-TS-972 (Structure and application)

2.3 INSULATION OF TRAM TRACK RAILS

All rails, which are embedded in level crossings, pedestrian crossings (where the rails are embedded) or in-street track, shall be insulated against stray electric currents leaking into the ground with an approved insulating material of sufficient durability to remain effective until rails are renewed or reconditioned.

2.4 TRACK CONFIGURATIONS

The track configurations to be used on TransAdelaide standard gauge tram tracks shall comply with table 2.1, except where varied to suit the position of insulated joints or other influences:

Table 2.1: Track configurations for standard gauge tram tracks

Rail type	Length of rails	Sleepers	Joints	Fastening system	For fastening systems refer to table 3.1, line:-
Jointed track and short welded rail	12-35m	Timber	Square	Trackspikes	1
		Timber	Square	Resilient fastenings	2
Long welded rail	35-75m	Timber	Square	Trackspikes	1
		Timber	Square	Resilient fastenings	2
Continuously welded rail (CWR)	> 75m	Timber	Nil	Trackspikes	1
		Timber	Nil	Resilient fastenings	2
		Concrete [see note]	Nil	Resilient fastenings	3

Notes: Continuously welded rail laid on concrete sleepers is the preferred configuration for new work.

3.0 DESIGN OF SLEEPER FASTENING SYSTEMS, RAILS, SLEEPERS AND FASTENINGS

3.1 DESIGN OF SLEEPER FASTENING SYSTEMS

The sleeper fastenings and fittings for the various track configurations shall comprise compatible individual components in accordance with table 3.1:

Table 3.1: Fastening systems

General track system configuration	Fastening components	No. per sleeper	Refer to table 3.2; line:
1. Timber sleepers & bearers with trackspikes and rail anchors [see note 1]	Sleeper plates	2 no.	1
	Trackspikes	[see note 2]	2, 3 or 4
	Rail anchors	[see note 3]	10
2. Timber sleepers & bearers with spring fastening spikes or screw spikes (plate fixing); resilient fastenings (rail fixing)	Sleeper plates	2 no.	1
	Spring fastening spikes	4 No.	2
	Lock-in shoulders (“F & G”s)	[see note 4]	5
	Resilient rail clips	4 No.	6
3. Concrete sleepers & bearers with resilient fastenings	Lock-in shoulders	[see note 4]	5
	Resilient rail clips	4 no.	6
	Rail insulators (“biscuits”)	4 no.	8
	Rail pads	2 no.	7

Notes:

[1] Sleepers using resilient rail clips i.e. “F and G”s are not to be randomly mixed with sleepers using trackspikes and rail anchors but must strictly only be used in place of box anchored sleepers as defined in note 2.

[2] Normally 4 no. but the number of dogspikes or spring fastening spikes may be varied in accordance with drg 304-A4-80-367.

[3] Timber sleepers only - The minimum number of anchors used on CWR shall be in accordance with drg 304-A3-83-1650. On other configurations (i.e. where rail lengths are 75m or less) the following rule shall apply to the minimum number of anchors required:

a) Determine the number of sleepers per rail length;
b) Divide the number of sleepers by 4;
c) Round up this figure to the next highest even number;
d) This answer shall then be the number of sleepers to be box anchored (half one side and half the other side of the joint) on each alternate sleeper, starting with the second sleeper from the joint.

EXAMPLE:

a) If the rail lengths are 12m, the number of sleepers = 18 No.
b) Divide by 4 = 4.5.
c) Round up to next even number = 6 No. (i.e. 3 No. each side of the joint).
d) Therefore: box anchor the 2nd, 4th and 6th sleeper from each side of every joint.

[4] Lock-in shoulders are to be used with proprietary resilient rail clips as required, i.e. the number of lock-in shoulders shall be the same number as the resilient rail clips when used.

3.2 MANUFACTURE AND INSTALLATION OF RAILS, RAIL JOINTS AND RAIL ASSEMBLIES

3.2.1 Rails, rail joints and rail assemblies

For details of:

a) rail and rail joints refer to CP-TS-981(Rails and rail joints);

b) rail assemblies for points and crossings refer to CP-TS-983 (Points and crossings);

3.2.2 Rail cant

Rails in plain track shall be laid with either an inward 1 in 20 cant or zero cant. A transition rail should be used between rail with a 1 in 20 cant and rail with zero cant particularly between plain track on concrete sleepers and turnouts.

3.3 MANUFACTURE AND INSTALLATION OF SLEEPERS AND FASTENINGS

Tables 3.2 and 3.3 prescribe for each type of sleeper, the requirements for its manufacture, materials and material testing, design or specification, component testing, compliance and installation:

Table 3.2: Component manufacture and installation – sleepers

SLEEPERS						
Sleeper type	**Manufacture shall comply with the requirements of:**	**Nominal sleeper sizes (in mm)**				
1. Timber	AS 3818.1 & AS 3818.2	225 x 125 x 2 450 (minimum) up to 2 600 long				
2. Concrete	AS 1085.14 [see also note 1]	[see note 1]				
SLEEPER SPACING (in mm.)						
Sleeper type	**Current**	**Spot re-Sleepering**	**Reconstruction**			**Points & crossings**
			Plain track	**Level crossings**	**Pedestrian crossings [see note 2]**	
3. Timber	760	as existing	670	600	515	As per
4. Concrete	N/A	N/A	670	600	*TO BE DEVELOPED*	timbering diagrams

Notes:

[1] Concrete sleepers for tram tracks or for special uses shall be manufactured in accordance with the following or similar drawings:

Drawing No.	Title
xxx-xx-xxxx-xxx	To be designed when required

[2] Pedestrian crossings with concrete units (4 sleepers). On other pedestrian crossings the existing spacing shall remain unaltered.

Table 3.3: Component manufacture and installation - fastenings and fittings

Component	Manufacture shall comply with the requirements of:	Installation shall be in accordance with
1. Sleeper plates see notes [1], [2] and [3]	AS 1085.3, AS 1085.9 or AS 1085.16 as applicable to type of system used	See note [4]
2. Spring fastening spikes	AS 1085.13	See note [4] and drg. 304-A4-80-367 (for curved track only)
3. Screw spikes	See note [2]	See note [4] and drg. 304-A4-80-367 (for curved track only)
4. Dogspikes	AS 1085.8	See note [4] and drg. 304-A4-80-367 (for curved track only)
5. Lock-in shoulders	See note [2]	See note [4]
6. Resilient rail clips	AS 1085.14 (concrete), for timber see note [2]	See note [4]
7. Rail/Insulation pads	See note [2]	See note [4]
8. Rail insulators (“biscuits”)	See note [2]	See note [4]
9. Rail spacers	See note [2]	See note [4]
10. Rail anchors	AS 1085.10	See table 3.1, notes [2] and [3]

Notes:

[1] Sleeper plates shall include the following:

a) Sleeper plates with a nominal rail cant of 1 in 20 towards the centre of the track or level plates for use in turnouts and some level crossings.

b) Sleeper plates for use with dogspikes, spring fastening spikes or screw spikes.

[2] Sleeper plates shall be used for all timber re-sleepering.

[3] In points and crossings, acceptable fittings include strap plates and crossing plates for use with resilient rail fastenings.

[4] Acceptable proprietary fittings are to be manufactured and installed in accordance with drawings and specifications approved by TransAdelaide and supplied by the manufacturer or his agent.

3.4 NON-CONFORMING CONFIGURATIONS

Although this part prescribes standard track support configurations and components to be used on TransAdelaide tracks, where it is necessary to deviate from these prescribed standards, the suitability of the non-conforming configurations or components shall be analyzed in accordance with CP-TS-973 (Infrastructure management and principles).

4.0 DESIGN OF FORMATION AND BALLAST

4.1 FORMATION

4.1.1 Formation types

a) The formation is the surface on which the track (including ballast) is laid. Traditionally, it was the finished surface of the earthworks. However, present day practice requires the material in the finished earthworks to be analyzed for its ability to satisfactorily support the track whether wet or dry and if necessary carry out one of the following procedures to ensure the track is properly supported and drained:

i. cap the formation with 200mm to 300mm of selected material in accordance with Transport SA specification PM21;

ii. cement stabilize the top 200mm layer of the earthworks in accordance with geotechnical design; or

iii. finish the earthworks with a layer of geofabric or similar laid on the surface and covered with a 150mm layer of sand as protection from puncturing.

b) Track built before the adoption of the present day methods in sub-clause (a) may shows signs of stress and necessitate the undertaking of remedial work.

4.1.2 Construction of the formation

a) **Width:** The shape of the earthworks and particularly the width of embankments and cuttings shall be in accordance with CP-TS-979 (Earthworks).

b) **Cross-fall:** The finished formation for double track shall be graded to fall towards the sides of the track as shown in figure 4.1. On single track, the fall will be all to one side (whichever is the most convenient to accommodate drainage). The degree of cross-fall shall range from 1 in 20 (preferred) to 1 in 45 depending on other influences (such as cuttings in solid rock, overbridges, etc.).

c) **Formation drainage:** The drainage of the formation and track takes the following forms:

i. Primary drainage of the track is through the ballast and fed to the sides of the track by the slope on the formation as shown in figure 4.1.

ii. On embankments where erosion is critical and in cuttings, longitudinal drains are to be constructed in the cess.

iii. To avoid the cess drains being subject to excessive silting, tops of cuttings shall also be drained with longitudinal drains parallel with and sufficiently distant from the edge of the cutting not to be undermined by subsequent erosion.

iv. On large embankments it may be necessary to construct drains of earthenware or concrete down the sides of the embankment to protect against erosion.

d) **Drainage design:** The location of drains and the type of drain shall be determined for each location in accordance with the characteristics of the site, soil conditions and potential erosion. The installation of drains and underground pipes shall comply with the requirements of AS 4799.The following paragraphs are guidelines for the selection of appropriate designs:

i. Ditches and open channels are the preferred design where the site characteristics are favourable as they are easy to inspect and clean.

ii. Concrete half pipes are preferred where open earth drains would be subject to erosion or rapid silting as they provide more rapid drainage.

iii. Pipe drains as shown in figure 4.1. Open jointed pipes or agricultural pipes are used to allow water to enter the pipe over its full length. The drainage trench is to be filled over the pipe with suitable granular material – gravel, broken stone, track ballast or other similar available material. If required, pipes to be half-jointed and bedded in concrete (“haunching”);

iv. French drains, (non-preferred).

4.2 BALLAST

4.2.1 The manufacture, materials and material testing, design or specification, testing and compliance of ballast shall comply with the requirements of AS 2758.7.

4.2.2 Ballast profiles shall be installed and ultimately finished in accordance with table 4.1 and figure 4.1:

Table 4.1: Ballast profiles

Sleeper type	Minimum ballast depth from sleeper soffit [see note 1]	Maximum shoulder slope	Sleeper spacing	Minimum ballast shoulder width from sleeper end
Timber	150mm	1 in 1.5	760mm	400mm
			670mm	350mm
Concrete	150mm *TO BE ASSESSED*	1 in 1.5	670mm	300mm

Note for table 4.1 and figure 4.1:

[1] The depth of ballast is measured vertically under the rail seat.

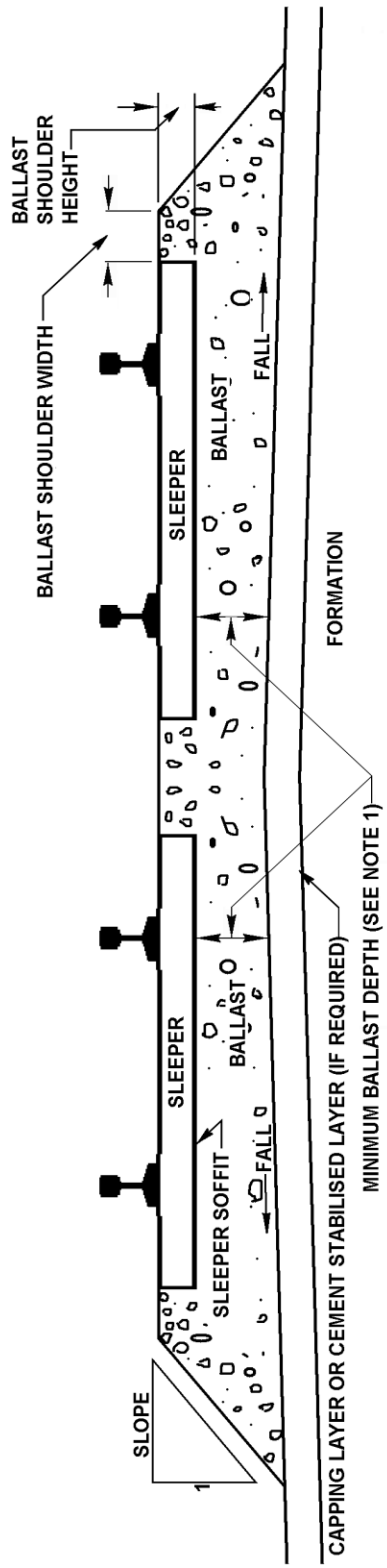
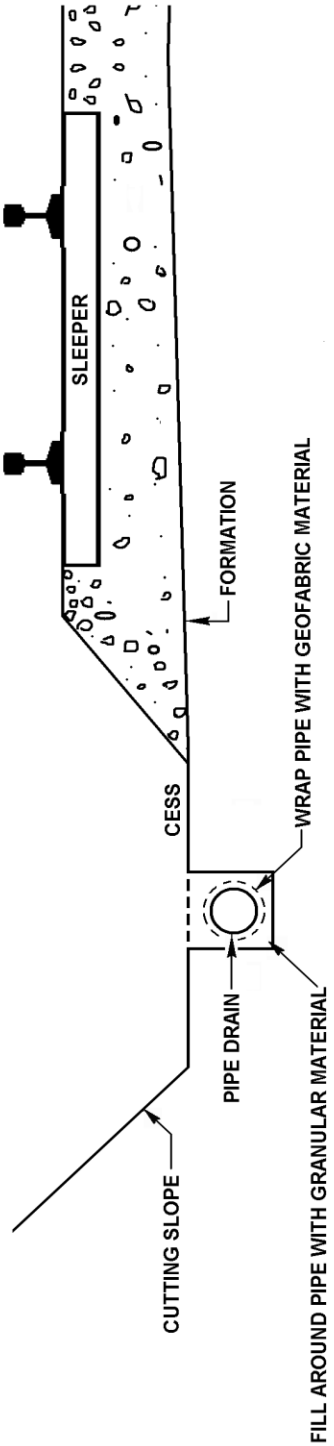


Figure 4.1: Ballast profile for double track
CROSS-SECTION THROUGH TRACK



CROSS-SECTION OF DRAIN IN CESS IN CUTTING

5.0 MONITORING AND MAINTENANCE OF SLEEPERS AND FASTENINGS

5.1 INSPECTION, ASSESSMENT AND MAINTENANCE ACTIONS

5.1.1 This section prescribes the requirements for inspection and response to sleeper and fastening assembly conditions. For the purposes of this section, “sleepers” shall include the following.

a) Sleepers designed and manufactured from timber or concrete in accordance with section 3.0;

b) Points and crossing bearers. Refer to CP-TS-983 (Points and crossings) for bearers in critical areas of points and crossings; and

c) Bridge timbers.

5.1.2 Fastening assembly condition for guard rails and continuous check rails [see CP-TS-982 (Guard/check rails and buffer stops)] should be assessed in accordance with this section.

Table 5.1: Inspection of sleepers and fastening systems

Type of inspection	Specific actions or conditions to look for
Scheduled inspections	
Walking inspections	a) Identify visually, and report, obvious sleeper and fastening conditions which indicate degradation. b) Intervals between walking inspections shall not exceed 31 days.
General inspections	a) Ineffective sleepers as defined in sub-section 5.2 shall be identified and the number of ineffective sleepers per half kilometre reported. b) To be carried out visually in a manner and at an interval appropriate to the sleeper and fastening type, condition, rates of deterioration and other local and seasonal factors, however shall be at intervals not greater than 1 year for timber sleepered track or 2 years for concrete sleepered track
Detailed inspections	An inspection of a particular component for a specific defect arising from the walking or general inspection, e.g. length of cracks in concrete sleepers and shall include reporting and marking of sleepers as appropriate.
Unscheduled inspections	To be justified and undertaken in accordance with “unscheduled inspections” as defined in CP-TS-973 (Infrastructure management and principles).
Assessment and method of assessment	The assessment of sleeper and fastening assembly condition and response criteria shall be in accordance with sub-sections 5.3, 5.4 and 5.5. Sub-section 5.5 shows the assessments in diagram form.

5.2 DEFINITION OF INEFFECTIVE SLEEPERS

5.2.1 This sub-section defines the meaning of “ineffective sleepers”, “ineffective bearers” and “ineffective bridge timbers.”

5.2.2 These conditions relate primarily but not exclusively to timber sleepers.

5.2.3 For tracks with concrete sleepers, where a higher than expected deterioration in gauge has been detected between inspections, the track should be subjected to an unscheduled detailed inspection of sleeper effectiveness and appropriate action taken.

5.2.4 An individual sleeper and fastening assembly is judged ineffective if it does not provide adequate lateral, longitudinal and vertical support to the rail caused by one or more of the following:

a) sleeper deterioration affecting rail support such as aging or rot;

b) sleeper split, cracked or otherwise deteriorated at or through fastening components rendering the fastening ineffective;

c) sleeper broken through;

d) excessive loss of sleeper cross-section or other properties as specified in the sleeper design;

e) excessive back rail cant; that is negative rail cant (e.g. resulting from sleeper deterioration or loss of fastening toe load);

f) excessive lateral sleeper plate movement relative to the sleeper;

g) loose or missing shoulder inserts;

h) indication of sleeper movement i.e. bunching or skewing;

i) missing sleepers or complete sleeper failure;

j) fastening assembly components not to specification. Examples include inadequate number of dogspikes or lockspikes, or incorrect components;

k) fastening assembly components missing, broken or loose resulting in loss of gauge and/or alignment holding capability or loss of longitudinal rail restraint.

5.3 INEFFECTIVE SLEEPERS – MAINTENANCE ACTION

5.3.1 The actions proposed in this sub-section are based on the sleeper spacing being in accordance with table 3.2 under “current.”

5.3.2 The maximum permissible speeds for consecutive ineffective sleepers or fastenings in an isolated location which have lost gauge holding but still provide bearing are shown in table 5.2:

Table 5.2: Maximum permissible speed responses at isolated locations (see also note [1])

No. of ineffective sleepers or fastenings		Action to be taken
1. 1 or 2 [see note 2]		No action
2. 3 [see note 2		Impose 40km/h or “Notch 2” speed limit or repair
3. 4 [see note 2]	*Tangent* *Curve ≤ 600m*	Impose 40km/h or “Notch 2” speed limit or repair Impose 15km/h or “Notch 1” speed limit or repair
4. >4 [see note 2]		Pilot or repair

Notes on table 5.2:

[1] The criteria in CP-TS-976 (Track geometry) also apply, i.e. where ineffective sleepers or fastening assemblies result in track geometry irregularities.

[2] If two clusters of consecutive ineffective sleepers or fastening assemblies are not separated by a cluster of at least an equal number of consecutive effective sleepers and fastening assemblies, the effective sleepers shall be considered to be ineffective (eg. 3 ineffective followed by 2 effective followed by 2 ineffective shall be considered as one cluster of 7 ineffective, whilst 3 ineffective followed by 3 effective followed by 2 ineffective shall be considered as one cluster of 3 ineffective as the worst case).

5.4 MISSING SLEEPERS – MAINTENANCE ACTION

5.4.1 The actions proposed in this sub-section are based on the sleeper spacing being in accordance with table 3.2 under "current."

5.4.2 The maximum permissible speeds for consecutive missing sleepers in an isolated location i.e. all gauge holding and bearing lost are shown in table 5.3. Note that the criteria in CP-TS-976 (Track geometry) also apply, i.e. where missing sleepers or fastening assemblies result in track geometry irregularities:

Table 5.3: Maximum permissible speed responses at isolated locations

No. of consecutive missing sleepers		Action to be taken
1.	1 [see notes 1 and 2]	No action
2.	2 [see note 1]	Pilot or repair
3.	>2 [see note 1]	Stop all tram movements or immediate repair

Notes on table 5.3:

[1] Missing sleepers do not include sleepers removed during re-sleepering except as described in notes [3] and [4]

[2] If two clusters of missing sleepers are not separated by a cluster of sleepers with at least an equal number plus one of consecutive effective sleepers and fastening assemblies then the effective sleepers shall be considered to be missing (eg. 2 missing followed by 2 effective followed by 2 missing shall be considered as one cluster of 6 missing, whilst 2 missing followed by 3 effective followed by 1 missing shall be considered as one cluster of 2 missing as the worst case).

[3] For re-sleepering on a face only. Alternate single sleepers may be removed from the track while resleepering under traffic, provided:

i) a 15km/h or "Notch 1" speed restriction is imposed while sleepers are out of the track;

ii) the gang is present for all tram movements and track maintenance workers inspect the track for safety after each tram movement; and

iii) the track is fully restored before the gang leaves the site.

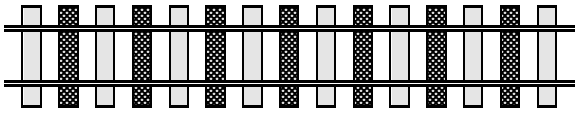
[4] For spot re-sleepering only. Up to two adjacent sleepers may be removed under traffic at a time provided no other sleepers are out of track. A 15km/h or "Notch 1" speed limit is to apply. The gang must be present for all tram movements.

5.5 DIAGRAMS SHOWING RESPONSES TO SLEEPER CONDITION

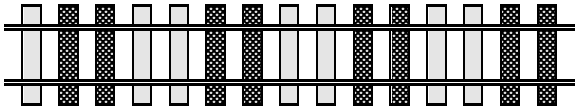
5.5.1 Diagram 5.1: Responses to ineffective sleepers (see table 5.2)

a) One sleeper ineffective, minimum of one effective sleeper either side

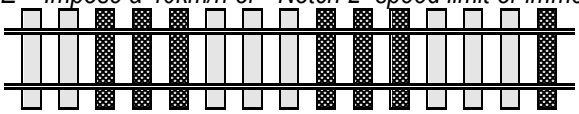
RESPONSE = No action ↓ INEFFECTIVE SLEEPERS



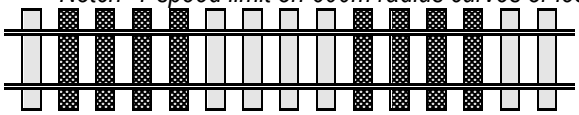
b) Two sleepers ineffective, minimum of two effective sleepers either side
RESPONSE = No action



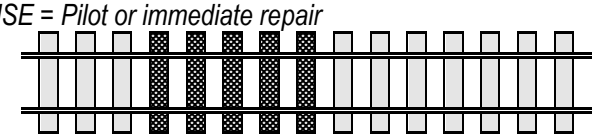
c) Three sleepers ineffective, minimum of three effective sleepers either side
RESPONSE = Impose a 40km/h or "Notch 2" speed limit or immediate repair



d) Four sleepers ineffective, minimum of four effective sleepers either side
RESPONSE = Impose a 40km/h or "Notch 2" speed limit on tangent track, 15km/h or "Notch 1"speed limit on 600m radius curves or less; or immediate repair

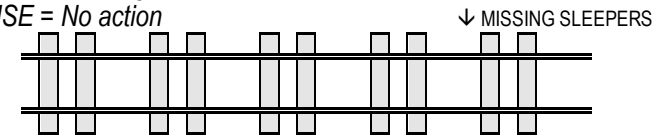


e) More than four sleepers ineffective
RESPONSE = Pilot or immediate repair

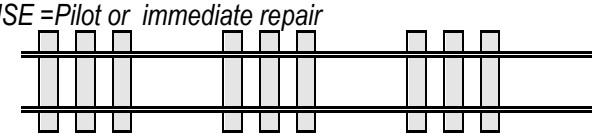


5.5.2 **Diagram 5.2: Responses to missing sleepers (see table 5.3)**

a) One sleeper missing, minimum of two effective sleepers either side
RESPONSE = No action



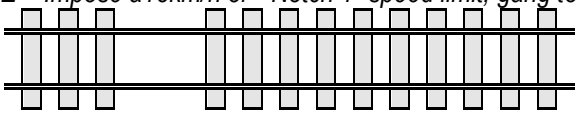
b) Two sleepers missing, minimum of three effective sleepers either side
RESPONSE =Pilot or immediate repair



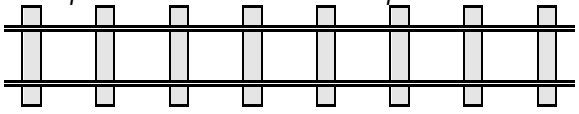
c) If conditions are worse than in (b), *RESPONSE = Stop all tram movements or immediate repair*

5.5.3 **Diagram 5.3: Permissible sleepers removed for resleepering (see table 5.3)**

a) For spot resleepering, two adjacent sleepers may be removed together if no other sleepers are out of track
RESPONSE = Impose a15km/h or "Notch 1" speed limit; gang to be present for all tram movements



b) For resleepering on a face, for each sleeper taken out there shall be one effective sleeper either side
RESPONSE = Impose a 15km/h or "Notch 1" speed limit while work in progress



6.0 MONITORING AND MAINTENANCE OF FORMATION AND BALLAST

6.1 INSPECTION, ASSESSMENT AND MAINTENANCE ACTIONS

Inspections shall include the specific conditions shown in table 6.1:

.**Table 6.1: Inspection, assessment and maintenance actions**

Type of inspection	Specific actions or conditions to observe
Scheduled inspections	
Walking inspections	a) Identify visually and report formation, track drainage and ballast defects and conditions that may affect track stability. This includes ballast profile deficiencies, which may reduce track lateral resistance under temperature induced rail stresses. The conditions shown in sub-section 6.2 and any other defects affecting track support and stability are to be identified and reported. b) Intervals between walking inspections shall not exceed 31 days
Unscheduled inspections	To be justified and undertaken in accordance with "unscheduled inspections" as defined in CP-TS-973 (Infrastructure management and principles).
Assessment, method of assessment, response and maintenance action	a) Degradation of ballast shoulders shall be considered on the basis of the cross-sectional area of ballast shoulder remaining and providing resistance to lateral movement. Table 6.2 shows for various conditions of the ballast shoulder the maximum restricted speed to be imposed. b) Restrictions shall be imposed when the ballast condition in the table 6.2 extends over a length equal to or greater than 10m. c) If the condition of the ballast profile is sub-standard and cannot be rectified immediately, the operating speed shown in table 6.2 shall be compared to the existing speed limit and if less, then a temporary speed restriction shall be imposed no higher than the value shown in table 6.2. Table 6.2 shows for each type of sleeper (timber or concrete) and for different heights and widths of shoulder ballast, the speed limit corresponding to that condition. d) Excess ballast, as defined in clause 6.6, shall not incur a speed restriction but action shall be taken to restore the profile shown in table 4.1 prior to the next inspection. e) The assessment of formation and ballast condition shall be in accordance with sub-section 6.3

6.2 FORMATION AND BALLAST DEFECTS AND CONDITIONS

Ballast defects and conditions that may affect track stability include the following:

a) track sections with inadequate ballast profile;

b) track sections where the ballast profile may foul the operation of infrastructure, eg signals or switches, or rolling stock;

c) mud holes or wet spots that may affect the deterioration rate of the track condition including pumping sleepers;

d) indications of poor sleeper support by ballast, e.g. cracking of sleepers and bearers, excessive vertical sleeper movement;

e) sleeper skewing, lack of crib ballast, heaped ballast or gaps between sleepers indicating longitudinal track movement;

f) heaped ballast or gaps at sleeper ends indicating lateral track movement; or a migration of ballast away from the track;

g) accelerated loss of track geometry, (e.g. following wet or dry weather) that may indicate poor ballast quality;

h) evidence of excessive track vibration (e.g. powdered or rounded ballast);

i) areas and extent of fouled ballast or poor ballast drainage that have resulted or may result in wet spots or mud holes in wet weather;

j) heaving of soil adjacent to the track which may indicate sub-soil failure. Cesses are higher than the formation under the sleepers and ballast. Cesses must always be lower than the formation level below the ballast, and should be lowered where they have been raised by silt or heave of the earthworks;

k) location and extent of narrow formation, that is formation that is too narrow to maintain the design ballast profile;

l) water pockets caused by subsidence of the track and formation under the combined action of traffic and lack of drainage;

m) slips in cuttings or on embankments occur mostly in clay weakened by the presence of excess water;

n) shrinkage cracks in the formation need to be filled in during dry weather;

o) ditches and open channels are to be kept clean and silt removed to another location where it can not re-enter the drains;

p) where drains have been provided down the sides of embankments, these should be checked for condition;

q) open jointed pipe drains – the filling over the pipes should be clear of non-granular material that may prevent the free passage of water. Pipes and pipe sockets should be unobstructed. Catchpits should be free of silt and covers in good order;

r) any obstacles, which may interfere with track drainage;

s) location and extent of substantial weed growth;

t) other defects affecting track stability.

6.3 BALLAST PROFILE DEFICIENCIES

a) Where the ballast profile is assessed to be deficient, it may be necessary to either restore the ballast section immediately or impose a temporary speed restriction.

b) Table 6.2 (over page) shows for each type of sleeper (timber or concrete), the maximum permissible speed for different degrees of deficiency. Figure 6.1 defines the terms used in table 6.2.

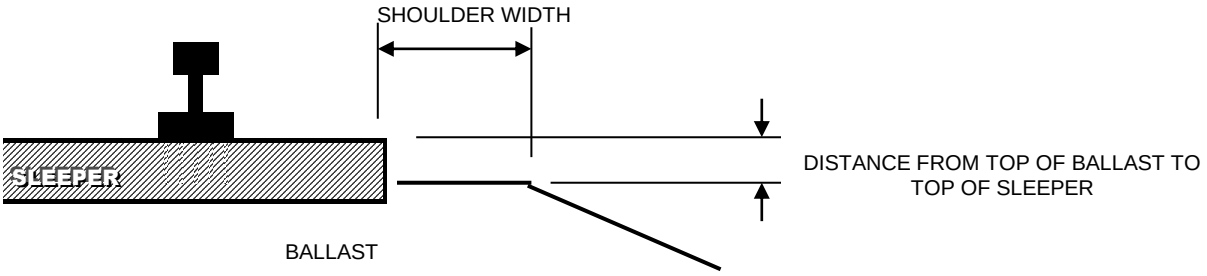
Table 6.2: For each sleeper type the permissible speed (given as "normal", "15km/h or notch 1" or " 40km/h or notch 2") for different combinations of shoulder width and depth are as shown below (note: Speeds applicable on curves ≤ 400m radius are shown in brackets):

TIMBER SLEEPERS (Sleeper depth = 125mm)					
Distance from top of ballast to top of sleeper	**Shoulder width**				
	0mm	100mm	200mm	300mm	400mm
0mm	**Normal speed**				
30mm					
100mm	**15km/h or notch 1***	**40km/h or notch 2 (15km/h or notch 1*)**		**40km/h or notch 2**	
125mm	**15km/h or notch 1***				

CONCRETE SLEEPERS (Sleeper depth = 150mm)				
Distance from top of ballast to top of sleeper	**Shoulder width**			
	0mm	80mm	230mm	300mm
0mm	**Normal**			
60mm	**speed**			
150mm	**40km/h or notch 2 (15km/h or notch 1*)**			

*Note: Where a 15km/h or notch 1 speed limit applies all tram movements are to be piloted until the track is brought up to a standard where a higher speed limit is applicable.

Figure 6.1: Definition of terms used in table 6.2



6.4 PUMPING

Where excessive vertical movement of the sleeper occurs i.e. greater than 25mm and generally characterised by the presence of mud or slurry, the condition is defined as "pumping." Track geometry criteria is generally affected in this situation. The method of detection is visual and follow up inspections are to be made once pumping is detected. Action to be taken in response to this condition is shown in table 6.3:

Table 6.3: Track pumping (all sleeper types); maximum speed limits

Track pumping:	Action required
over 3 or less consecutive sleepers	No action
over 3 to 10 consecutive sleepers	Impose 40km/h or notch 2 speed limit or repair
over more than 10 consecutive sleepers	Impose 15km/h or notch 1 speed limit or repair

6.5 UNCONSOLIDATED BALLAST

6.5.1 Unconsolidated ballast results from the tamping and ballast renewal processes and may increase the possibility of track instability with temperature variations if ballast is not consolidated under traffic or by other means (i.e. mechanical ballast stabilization, crib and shoulder compaction).

6.5.2 Where, during any 7 day period, tamping or ballast renewal extends over a section of track exceeding 10m in length, speed restrictions due to unconsolidated ballast shall be imposed as follows:

a) Tamping with minimum lift < 25mm: no speed restriction required;

b) Tamping with lift ≥ 25mm and < 75mm: a 40km/h or notch 2 speed restriction for 3 week days [see note 1] under traffic, after which the track condition is to be re-assessed and restriction lifted or extended;

c) Tamping with lift ≥ 75mm or major track reconditioning with complete ballast renewal:

i. For timber and steel sleepers: a 15km/h or notch 1 speed restriction for 7 week days [see note 1] under traffic;

ii. For concrete sleepers: a 40km/h or notch 2 speed restriction for 3 week days [see note 1] under traffic; after which the track condition is to be re-assessed and restriction lifted or extended.

Note [1]: in clauses (b) and (c), a Saturday, Sunday or Public Holiday shall be considered as equal to half a week day.

d) Restrictions on lifting and other precautions to be taken during hot weather are specified in CP-TS-984 (Rail stress control).

6.6 ELECTROLYSIS – BALLAST LEAKAGE

Ballast should either be kept clear of contact with rails or kept clean to avoid electrical current leakage.

6.7 EXCESS BALLAST

Excess ballast shall be defined as ballast above the profile shown in table 4.1, which has not been put there for some approved purpose (e.g. construction road, access road, etc.). Where excess ballast inhibits effective inspection of sleepers and fastenings it shall be recorded as a defect and shall either (1) be removed prior to the next inspection, or (2) a detailed inspection and assessment shall be carried out to determine the condition of the track. Where excess ballast is in breach of the requirements of sub-sections 6.6 or 7.2, immediate action shall be taken to clear any ballast in contact with rails.

7.0 IN-STREET TRACK

7.1 GENERAL DESIGN / RATING PROCEDURE

a) Design of in-street track shall be undertaken in accordance with CP-TS-973 (Infrastructure management and principles).

b) Track constructed in street shall comply with the relevant Australian Standards.

7.2 INSULATION OF TRAM TRACK RAILS

All rails which are embedded in in-street track shall be insulated to prevent leakage of stray electric currents in accordance with sub-section 2.3.

7.3 TRANSITION BETWEEN DIFFERENT TRACK CONSTRUCTION

Where in-street track, laid as an unyielding configuration, is joined to ballasted track i.e. resilient configuration, if necessary, an approved transition shall be provided for the ballasted track.

7.4 INSPECTION, ASSESSMENT AND MAINTENANCE ACTIONS

Inspections shall include the specific conditions shown in table 7.1:

Table 7.1: Inspection, assessment and maintenance actions

Type of inspection	Specific actions or conditions to look for
Scheduled inspections	
Walking inspections	a) Identify visually, and report, obvious degradation of the track or concrete surface. Identify and report broken concrete, broken rails, corrugations or flangeway not clear. b) Intervals between walking inspections shall not exceed 94 days.
Unscheduled inspections	To be justified and undertaken in accordance with “unscheduled inspections” as defined in CP-TS-973 (Infrastructure management and principles).
Assessment, method of assessment and maintenance action	a) Degradation of concrete road surface shall be assessed and if necessary sections shall be cut out and re-constructed. b) Broken rails shall be assessed and if affecting the track safety or condition of the concrete shall be repaired in accordance with CP-TS-981 (Rails and rail joints). c) Corrugations shall be assessed and if affecting track safety, condition of the concrete or attracting complaints from adjacent property occupiers of excessive noise or vibrations, shall be repaired. d) Flangeways shall be cleared and concrete repaired if the loose material in the flangeway has been the result of degradation of the concrete.

8.0 DOCUMENTATION

8.1 TRACK CONFIGURATION RECORD

The Track Configuration Record shall schedule the various track configurations on TransAdelaide's tram tracks in accordance with QP-IS-501 (Document and Data Control). The Track Configuration Record shall also record data as specified in CP-TS-981 (Rails and rail joints). ***RECORD TO BE DEVELOPED***

8.2 INSPECTION REPORTS

All inspection reports shall be maintained in accordance with CPRD/PRC/046 Records Management.