AUSTRALIAN RAIL TRACK CORPORATION LTD

Discipline
Engineering Standard

Category
Track & Civil - Design

Resilient Rail Fastenings for Heavy Duty Concrete Sleepers - Design

ETD-02-04

Applicability

ARTC Network wide	✓
New South Wales	
Western Jurisdiction	
Victoria	

Primary Source
(ARTC Standard ETD-02-02 Resilient Rail Fastenings for Medium Duty Concrete Sleepers)

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Contents

1. General Description

This Standard specifies requirements for the design of resilient rail fastenings for Heavy Duty concrete sleepers designed in accordance with ARTC Standard ETD-02-03 for use on track having nominal 30t axle load or less. Fastenings supplied for use in Australian Rail Track Corporation track shall meet these design requirements

Resilient fastening assemblies for special applications including multi-gauge tracks and turnout bearers are not covered by this Standard.

2. Definitions

Concrete sleeper	Concrete sleeper consisting of appropriately formed reinforced concrete which, when prestressed, includes the deformed reinforcing bars (tendons) which are stressed before casting the concrete.
Cast in shoulder	A component that prevents lateral movement of the rail foot and provides anchorage for the resilient fastening system.
Resilient Fastenings	Elastic steel clips, insulators and pads attached to sleeper cast in shoulders and designed to engage rail foot flanges. The arrangement fastens rails to sleepers generating toe load at the rail flange providing resistance to longitudinal movement and to rail roll and lateral shift.
Clip	Spring steel component having an appropriate stiffness that, when installed, provides for sleeper and fastening assembly dimensional tolerances while providing a particular load upon the foot of the rail. Clips are installed in pairs, located each side of each rail on a sleeper.
Spacers	Components added to either or both sides of the rail above or below the insulators to provide for the difference in rail foot width and rail location to provide for rail of a lesser size than the maximum allowed by the cast in shoulders.
Assembly clamping force	The total force perpendicular to the rail seat exerted by a resilient fastening assembly on the foot of the rail.
Toe load	The force in kN applied on the rail foot flange by one clip of a pair acting through the insulator and any spacer.
Insulator	The component that fits between the cast in shoulder, the foot of the rail and the clip. Insulators are installed in pairs. Insulators may include metal inserts.
Pad	The component that is located between the foot of the rail and the sleeper. Pads may include multiple layers of material.

Monoblock sleeper	Standard concrete sleeper cast in a single piece.
Medium Duty	Pertains to track having traffic not exceeding nominal 25t axle loads and/or 25 MGT annual traffic.
Heavy Duty	Pertains to track having traffic not exceeding nominal 30t axle loads and/or 100 MGT annual traffic.

3. References

The design shall be based on relevant Australian Standards and Codes of Practice and/or the referenced standards specified in this document.

Referenced Standards include:

AS 1085.14 – Prestressed Concrete Sleepers

AS 1085.19 – Resilient fastening assemblies

AS 1085.1 – Rails

ARTC Standard ETD-02-02 – Resilient Rail Fastenings for Medium DutyConcreete Sleepers – Design

ARTC Standard ETD-02-03 – Concrete Sleepers (Heavy Duty) – Design

NSW Standard TDS 09 – Mainline Track Geometry.

NSW Standard TDS 13 – Base Operating Condition Standards of Track Geometry

NSW Standard TEP 01 – Evaluation & Approval of Track Components

Other internationally accepted and proven standards providing these are at least equivalent to AS 1085.19.

All references relate to the latest Standard versions, including amendments and relevant superseding Standards.

4. Fastenings - General

4.1. Type

The fastening shall be an elastic resilient fastening of a type that is internationally proven under operating conditions on a major railway system for more than five years, or alternatively sound research information must be presented prepared by an independent recognised institution indicating that the fastening system will meet all the requirements of this specification under simulated railway conditions as detailed herein.

The fastening shall be capable of withstanding repeated loading within the service conditions nominated, without fatigue or excessive maintenance of the fastening components including the “cast in’ components.

4.2. Installation

The fastening shall be composed of a minimum number of parts. Component parts shall be easily identifiable.

The fastening shall be such as to require minimum labour for insertion and removal. Mechanical insertion and/or withdrawal should be practical and preference will be given to those fastenings for which a proven clip installation and removal machine is available.

5. Design Requirements

5.1. General

Fastening design shall be in accordance with AS 1085.19 unless otherwise specified in this document.

Cast in components shall be designed and manufactured to provide a minimum service life of fifty years and the clips shall provide a minimum service life of 25 years, based on annual tonnage of 100 MGT, nominal axle load of 30 t and nominal 667 mm sleeper centres

Sleepers shall be Monoblock type cast as pretensioned concrete designated “Heavy Duty” for use with axle loads up to 30 tonne. Sleeper design shall comply with ARTC Common Standard ETD-02-03.

5.2. Track Details

The fastenings will be used on mainline track of 1435mm rail gauge (measured 16 mm from the top of rail when assembled), assuming AS 1085, 47, 50, 53 or 60 kg/m or UIC 60 or UIC 54 rails. All running rails shall slope towards the track centre-line at 1 in 20.

The railways on which the fastenings will be used include extensive lengths of sharp curves and steep gradients where sanding is applied for improved traction. Concrete sleepers are to be designed to minimise potential for soffit abrasion and rail seat erosion in the operating environment.

Track configuration is detailed in NSW Standard TDS 09, Class 1XC track, with geometry maintained as per NSW Standard TDS 13.

Sleepers will be installed in track both with and without signalling circuits and with and without electrification at 1.5 kV DC and may in future be electrified at 25 kV AC.

Nominal maximum train speeds and axle loads may apply as detailed in Table 1.

30t Freight	25t Freight	23 t Freight	21t Freight	19t Passenger
80km/h	80 km/h	110 km/h	115 km/h	160 km/h

Table 1 – Maximum Speeds in km/h

Track geometry assumptions (curvature, gradient, superelevation, cant deficiency etc) are to be in accord with Table 2, NSW Standard TDS 09 “Mainline Track Geometry” for Class 1XC track, except Max E_a may be 150 mm and Max D for Heavy Freight lines may be 100 mm.

Other relevant track data includes:

Electrical Insulation - fastening assemblies and sleepers shall ensure a minimum electrical resistance between the running rails of 10 Ohms per track kilometre.

5.3. Design Parameters

The rail fastening assemblies shall be designed to clamp the rail to the sleeper with sufficient force to contain the temperature stresses which may develop in the rail and to maintain the correct gauge of the track under the service conditions detailed herein.

Toe load should not be less that 10 KN, that is, not less than 20 kN per rail seat. In addition, the toe load shall be such that it provides zero rail displacement when tested in accordance with AS 1085.19 Appendix E, section E2. The minimum toe load shall apply throughout the service life while accommodating all component tolerances and service deflections.

The pad shall be so designed that it is self locating on the sleeper. The pad shall be capable of transmitting the rail's load to the sleeper and shall be designed to suit the clip, insulator, spacer (where required) and concrete sleeper accepted for use. The pad and insulators shall be designed such that they remain correctly located on the sleeper throughout their service life. The pad shall achieve 50% attenuation when tested in accordance with AS 1085.19, Appendix J, utilising the Aggregate Support Method.

6. Materials

6.1. Cast-in Components

Cast-in components shall be manufactured only from proven and approved materials, including malleable iron or spring steel.

Where cast in components are used, they shall be designed for the full life of the sleeper. They shall be suitably resistant to corrosion and able to withstand the required repeated loads without fatigue failure. Sleeper cribs will be filled with ballast to the top of sleeper level. Components in contact with the ballast shall be suitably treated to prevent corrosion. Details of corrosion protection shall be supplied. Cast in components shall be maintenance free.

6.2. Clips

All clips shall be manufactured from spring steel, hardened and tempered as required to provide specified performance.

6.3. Pads

Bearing pads shall be manufactured from materials providing performance meeting the requirements of this standard.

The performance of the material shall be stable throughout the range +60°C and -10°C.

The rail pad shall be capable of transmitting a wheel load of 300 kN, distributed in accordance with the requirements of AS 1085.14, assuming 667 mm sleeper spacing.

The pad width shall be designed to suit the sleeper.

The minimum thickness of bearing pad shall be 5 mm.

6.4. Insulators

Insulation must be of a proven mechanical capacity and have operated and / or been proven under service conditions similar to section 5.2. The insulation shall be suitable for electrified track of 1500 VDC or 25 KVAC.

6.5. Spacers

Spacers (where required) shall be of proven mechanical capacity and have been proven under service conditions similar to section 5.2.

Spacers shall be designed to remain in position when installed in the track.

The material used shall be resistant to normal levels of ultraviolet radiation, ozone and corrosion.

7. Previous Installation Experience

All components must be equivalent to existing designs that have been proven in track under conditions of service similar to those detailed in this performance specification and referenced documents. This should include corrugation, rail flow, head check, wheel burn and weld dip rail head conditions. Reference site details and contact persons able to objectively discuss sleeper system performance shall be provided.

8. Fastening performance and tests

AS 1085.19 – 2003, Railway track material, Part 19 Resilient fastening assemblies, Appendix A section 1 lists additional information relevant to the standard. The following pertains.

a) Rail size will be as specified in section 5.2.

b) Axle load will be up to 30 t.

c) Minimum curve radius will be 200 m.

d) Speed will be a maximum of 160 km/h for XPT type passenger trains and 115 km/h for freight trains.

e) Track will be concrete sleepers at 667 mm centres.

f) Minimum dynamic clip deflection shall match pad performance requirements.

g) Test criteria shall be:

   (i) Minimum clamping force Fc shall be 20 kN.

   (ii) Minimum resilient clip toe load force Ft shall be 10 kN.

   (iii) Insert pull-out test load Fp shall be as per AS 1085.14.

   (iv) Insert torque test force T shall be as per AS 1085.14.

   (v) Rail translation dtran shall be not greater than 1 mm and rotation drot

shall be not greater than 2 mm.

(vi) Vertical component of the rail seat test load Vt shall be calculated in accordance with AS 1085.14 for a design impact factored wheel load of 300 kN and sleeper spacings of 667 mm.

(vii) Lateral component of rail seat test load Lt shall be 50% of (vi).

(viii) Offset of line of application x shall be in accordance with Table A1 of AS 1085.19.

h) Corrosion protection shall be in accordance with AS 1085.19.

i) Pads shall achieve 50% attenuation.

j) There are no special packaging requirements.

k) (1) Testing shall include the Alternative Repeated Load Test as defined in section G4 of Appendix G to As 1085.19, using two sleeper sections.
(2) The Clip Fatigue Test defined in Appendix I to AS 1085.19 shall include in Procedure I4, section (c), a varying test load producing a clip dynamic deflection determined by the deflection obtained in accordance with Appendix D.
(3) In section (d) of the same procedure, upon completion of specified test, the toe load shall be reported as found by a repeat of the uplift test defined in Appendix F.

In Appendix E to AS 1085.19, Resilient Fastening Assembly Longitudinal Restraint Test, the preferred test is detailed in Section E2, the test load should not cause longitudinal rail movement.

In Appendix J to AS 1085.19, Impact Test For Rail Pad Attenuation For Concrete, the preferred test will utilise the aggregate support method as defined in section J3.3.1. In section J3.4, the length of rail shall be 0.5m.

9. Information to be Supplied

Fully dimensioned drawings showing all the required manufacturing tolerances of assemblies are to be supplied in respect of every component of the assembly and cast in pieces.

Details showing material compositions of the metal, plastic and any other components are to be supplied.

Test results as required by AS 1085.19, modified as detailed in section 8, including details of the testing laboratory or authority shall be provided prior to production.

The following additional information is to be included:

- Availability of small installation and removal tools.
- Minimum period of supply for all components.
- Magnitude of dimensional tolerances allowed.
- Any other test results deemed relevant by the manufacturer.