



AUSTRALIAN RAIL TRACK CORPORATION LTD

Discipline: Engineering (Track & Civil)

Category: Standard

# Steel Sleeper Specification

## ETA-02-03

### Applicability

New South Wales	✓	CRIA (NSW CRN)	
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### Primary Source

ARTC NSW Standard TDS 05
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### Document Status

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### Amendment Record

Version	Date Reviewed	Clause	Description of Amendment
1.0	01 Dec 09		Implementation draft. Supersedes NSW Standard TDS 05 v1.2
1.1	18 Jun 10		Banner added regarding mandatory requirements in other documents and alternative interpretations.
1.2	05 Apr 11	3 and 4	Track classification A,B,C and D amended to show "Heavy Haul Lines", "Interstate lines", "Intrastate Lines", and "Light Weight Lines".. Deleted reference to Class E Lines

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**Mandatory requirements also exist in other documents.**

**Where alternative interpretations occur, the Manager Standards shall be informed so the ambiguity can be removed. Pending removal of the ambiguity the interpretation with the safest outcome shall be adopted.**

## 1 Scope

This specification sets out requirements for the design, manufacture, testing and delivery of steel sleepers and their associated fastening components for use in standard gauge railway track.

## 2 Performance Requirements

The nominal maximum axle loads and speeds shall be as stated in Table 1. Faster passenger trains with lower track loading may also use the steel sleeper track.

The design life of the sleeper and fastening system shall be at least 50 years. The expected total tonnage for the design life will be as specified in Table 1.

A maximum track gradient of 1 in 40 and a minimum radius curve specified for the particular track need be considered concurrently.

## 3 Track Details

Steel sleepers may be used in standard gauge [Interstate](#), [Intrastate](#) and [Light Weight lines](#) as shown in Table 1. Steel sleepers are not utilized in heavy haul lines with 30 tonne axle load.

	Interstate Lines	Intrastate Lines	Light Weight Lines
Nominal Ballast Depth	250 to 300 mm	200 to 250 mm	150 to 200mm
Nominal Track Modulus	25 Mpa	20 MPa	15 Mpa
Nominal Track Condition	TCI = 40 to 45	TCI = 45 to 50	TCI = 50 to 60
Equiv Eisenmann Factor	0.20 to 0.25	0.25 to 0.30	0.30 to 0.40
Minimum Curve Radius	300 m	240 m	240 m
Maximum Axle Load	25 t	25 t	20 t (-)
Maximum Speed	@ 115 km/h	@ 60 km/h	@ 80 km/h
Total Life	500 MGT	200 MGT	200 MGT

*Note: Interstate Lines steel sleepers are limited to a minimum of 300 m radius curves. Intrastate and Light Weight Lines steel sleepers may be used in curves of less than 240 m radius but a reduced total life would be expected. Intrastate and Light Weight Lines may also have a small proportion of 22t axle load traffic @ 40km/h.*

Table 1

Rails to be used are canted 1 in 20 to centre of track. The following rail sizes may be used:

Rail No	Rail Size	Rail Foot width	Rail Head Width	Rail Height	Assumed Rail Height for Gauge	See Figure
1	60 kg/m	146mm	70mm	170mm	164mm	5
2	53 kg/m	146mm	70mm	157mm	164mm	6
3	50kg/m	127mm	70mm	154mm	144mm	7

4	47 kg/m	127mm	70mm	141 mm	144mm	8
5	80 AS "A" (1900)	127mm	63.5mm	127mm	132mm	9
6	41 kg/m (new)	127mm	63.5mm	136.5mm	132mm	10
7	80 "B" (1928)	127mm	63.5mm	136.5mm	132mm	11
8	80 "AA " (1907)	127mm	63.5mm	128.5mm	132mm	12
9	60 AS "B" (1928)	108mm	63.5mm	117.5mm	115mm	13
10	60 AS "A" (1928)	108mm	63.5mm	114.3mm	115mm	14
11	60 AS "BA" (1907)	102mm	57.9mm	111.1mm	115mm	15

Table 2

Details of rail sections are shown in Appendix 3.

Insulators are to be provided if specified.

Standard track gauge for all rails shall be adjusted to assumed rail heights as shown in Table 2.

## 4 Design Requirements

	Intersate Lines	Intrastate and Light Weight Lines
Max. Vertical Rail Seat Force	100 kN (Static + Quasistatic)	80 kN (Static + Quasistatic)
Max. Rail Seat Moment	11 kNm (Static + Quasistatic)	9 kNm (Static + Quasistatic)
Lateral to Vertical Force Ratio	0.75 (Calculated for Rail Seat)	0.75 (Calculated for Rail Seat)
Min. Rail Clamping Force	20 kN (at each Rail Seat)	18 kN (at each Rail Seat)
Min. Longitudinal Restraint	10 kN (at each Rail Seat)	9 kN (at each Rail Seat)
Design Life of Sleeper and Fastenings	50 years at 10 million gross tonnes/annum	50 years at 4 million gross tonnes/annum

Table 3

If rail sections smaller than 60 or 53 kg/m are used in conjunction with spacers or alternative holes, then smaller forces as specified in Table 3 may be approved by the Responsible Manager.

The design requirements given in Table 3 shall be used in sleeper and fastening design. The requirements shall also be used in the laboratory tests of Section 8.4.

## 5 Sleeper Dimensions (nominal)

### 5.1 Overall dimensions

1	Length	2500 mm
2	Width (at base)	250 mm to 260 mm
3	Width (at seat)	150 mm to 160 mm
4	Depth	95 mm to 100 mm
5	Thickness (at shoulder)	7.5 mm to 10 mm

Sleepers are made to fit at least two different rail sizes as listed under Section 3, Table 2. They are made as single fastening sleepers or multi-fastening sleepers as shown in Figures 16 & 17 in Appendix 4.

Single fastening sleepers allow the direct fitting of one rail size only. Spacers can be provided for the fitting of smaller rail sizes until replacement with larger rail sizes takes place. Multi-fastening sleepers allow the alternative fitting of two different rail sizes without the use of spacers. Where more than two rail sizes are to be used during the life of a sleeper, spacers must be provided for the smaller rail size.

Where two rail sizes are used, spacers are needed for smaller rails in the same sleeper shoulder size (e.g. from 146 mm to 127 mm or 127 mm to 108/102 mm). For larger differences in rail foot dimensions, the fastening assembly with its spacers must pass the "Uplift Test of Fastening" after subjecting the fastening assembly to a "Fatigue Test for Fastening and Sleeper" (3 million cycles).

Insulators may be used in conjunction with single fastening and multi-fastening insulated sleepers, but not in sleepers with spacers. Where two rail sizes are used, special insulators are needed for the smaller rail. The fastening assembly with its special insulator must pass the "Uplift Test of Fastening" after subjecting the fastening assembly to a "Fatigue Test for Fastening and Sleeper" (3 million cycles).

## 5.2 Sleeper Types

### 5.2.1 Option 1 — Single Fastening Sleeper

This sleeper fits one rail size without spacers and has four 36 mm diameter holes for lock-in shoulders and four 30 mm diameter inspection holes.

Holes shall be located at centre line of sleeper top section, inspection holes spaced along centre line at 90 to 100 mm from lock-in shoulder holes (away from seat).

### 5.2.2 Option 2 — Multi Fastening Sleeper

This sleeper fits two rail sizes without spacers and has eight 36 mm diameter holes for lock-in shoulders (four holes are used for lock-in shoulders at any time).

Holes shall be located at sleeper top section. For alternative fastening of different rail sizes, holes are arranged diagonally at each seat with a mirror-image arrangement on the second rail seat of sleeper, unused holes may serve as inspection holes.

### 5.2.3 Rail seat

The rail seats shall be inclined at 1 in 20 towards centre. The incline is to be achieved by bending sleeper section, but not by pressing out steel at rail seat area.

### 5.2.4 End section

The end sections of the sleeper shall be bent down from the seat area, so that end sections of sleeper are not above level of sleeper centre.

### 5.2.5 End spade

The top surface of the sleeper shall be bent down at both ends to provide "spades" for lateral stability. The angle of spades shall be approximately 25° from vertical with bottom edge approx. level with lower sleeper edge and the gap at corners (from metal distortion) of no more than 30 mm.

### 5.2.6 Sleeper section

Sleepers shall be manufactured either from pressed hot rolled steel strip or from pre-formed steel section

### 5.2.7 Shipment and Handling

Sleepers must be nestable for shipment and be free of burrs and sharp edges for efficient stacking and safe handling.

### 5.2.8 Manufacturing tolerances

Refer to Appendix 1

## 6 Rail Fastenings and Spacers

Rail fastenings shall be of the elastic type consisting of two lock-in shoulders and two elastic clips per rail seat. Fastenings shall be removable for ease of installation in existing track when performing partial re-sleepering.

Insulators or spacers are to be provided if required. Lock-in shoulders must be suitable for installation when sleeper is in situ with rail in place. Elastic clip must also be suitable for fishplated joints (alternatively two types may be provided). Rails to be fastened are those specified in Table 2. Rails are generally welded to lengths of 110m to 250m. These lengths may be joined by thermit welding or non-slip fishplating (with bolts or swage fasteners).

Fastenings must meet the design requirements of Section 4 and be of a proven design with the specified rail clamping force with or without insulators or spacers.

## 7 Manufacture of Sleepers

### 7.1 Deemed to Comply

The following details a design solution, which is deemed to comply with the above requirements. Alternative solutions will be required to demonstrate compliance with the above requirements.

### 7.2 General

Steel sleepers are manufactured from either pre-formed section (hot rolled sections or cold formed strip profiles) or hot rolled strip. The properties shall comply with the requirements of this specification and Australian Standards referenced in the following Clauses.

### 7.3 Pre-Formed Sections

The sleepers section shall be manufactured to quality assurance procedures in accordance with AS/NZS ISO 9001 Quality Management Systems - Requirements.

The sleepers shall be free from defects, which are likely to initiate fatigue failure in service, e.g. pipe, non-metallic inclusions and visible surface damage.

#### 7.3.1 Chemical Composition

The chemical composition of the steel shall be within the following limits:

Phosphorous	0.04 (max) %
Sulphur	0.04 (max) %
Manganese	1.50 (max) %
Silicon	0.50 (max) %

Carbon	0.16 - 0.25 %
Carbon Equivalent	0.41 - 0.49 %

The method of determining the chemical composition of the steel shall be in accordance with AS/NZS 1050.1 Sampling Iron and Steel for Chemical Analysis.

### 7.3.2 Mechanical Properties

Adequate tensile testing shall be conducted by the Contractor to control the manufacturing process and to maintain the 95% characteristic yield strength of at least 250 MPa.

### 7.3.3 Certification

- 1) Certification shall be by chemical analysis only.
- 2) The Contractor shall supply a Certificate of Compliance.

## 7.4 Hot Rolled Strip

### 7.4.1 General

Where the steel sleeper is manufactured from hot rolled strip, the material shall conform to the requirements of the following:

- 1) AS 1594 Hot Rolled Steel Flat Products
- 2) AS/NZS 1365 Tolerances for Flat Rolled Steel Products
- 3) AS 3678 Structural Steel - Hot-Rolled Plates, Floor Plates and Slabs
- 4) AS 3679.1 Structural Steel - Hot Rolled Bars and Sections
- 5) AS/NZS ISO 9001 Quality Management Systems - Requirements.

### 7.4.2 Chemical Composition

The chemical composition and tensile properties for slit strip shall generally conform with the grade 240 fully killed (HA240) requirements of AS 1594 Hot Rolled Steel Flat Products. In particular levels of potentially deleterious elements shall be limited to the levels as follows:

Phosphorous	0.04% Max
Sulphur	0.03% Max

### 7.4.3 Dimensional Tolerances

Hot rolled strip should be supplied according to tolerances set out in AS/NZS 1365 Tolerances for Flat-Rolled Steel Products and as shown in table:

1	Thickness	+0.27 mm	-0.00 mm
2	Width	+2.50 mm	-0.00 mm



## 8 Fastenings

### 8.1 Method

The method of fastening the rails to the sleeper shall be a resilient fastening system. The method shall be subject to approval by the Responsible Manager. Where applicable all components shall be manufactured to the relevant Australian Standards. The rail fastening clip shall be manufactured from hot rolled spring steels complying with AS 1447 Hot Rolled Spring Steels.

Fastenings may be proven products, for which track performance data shall be supplied. Data may contain axle load, total gross tonnage, train speed and track details with relevant site information. For new designs, design data and laboratory test results shall be submitted. Laboratory tests must simulate in-track situations.

### 8.2 Insulation

Where insulated track has been specified, insulation components are to be included as part of the fastening system. The insulation components supplied shall ensure sufficient insulation between the rail and the sleeper, making due allowance for a maximum current of 3 amps and a maximum voltage of 3 volts. Insulation pads are to be subject to approval by the Responsible Manager.

The manufacturer shall advise the level of electrical resistivity achieved per sleeper, in place, with insulators fitted.

### 8.3 Fastening at Fishplated Joints

Where necessary the fastening system design shall make special provision at fishplated joints to ensure effective fastening of the rail to the sleeper. Refer to AS 1085.2 Railway Track Material Part 2: Fishplates.

The fastening system shall be designed to take into account the following joint parameters:

- 1) Rail length, as specified in Section 6.
- 2) Joints that are square (ie at the same location on each rail) and joints that are staggered (offset from the square position).

### 8.4 Test of Fastening Systems

#### 8.4.1 General

The following tests shall be carried out by a recognised laboratory on samples of the fastenings and sleeper in assembled condition. The laboratory shall be registered with NATA, for mechanical tests of this type. Samples are to be fully representative of the production run.

#### 8.4.2 Uplift Testing of Fastening

When tested in accordance with Section 14.1, the measured toe load shall exceed the design requirements set out in Section 4, the fastening system shall maintain geometry, no component of the fastening system shall fracture and the rail shall not be released.

#### 8.4.3 Longitudinal Restraint Test of Fastening

When tested in accordance with Section 14.2, the rail shall not move more than 5 mm during the initial 3 minutes' period, and there shall be no more than 0.25 mm movement of the rail after the initial 3 minutes. The fastenings shall be capable of meeting the requirements of the test in either direction. The maximum loading to be used in the testing shall reflect the track standard and shall be specified by the Responsible Manager (Section 4).

#### 8.4.4 Lateral Restraint Test of Fastening

When tested in accordance with Section 14.3:

- the fastening shall be able to carry a load as specified in accordance with design requirements in Section 4 within 3 mm or less of rail translation; and
- the rail rotation at an applied load as specified in accordance with design requirements in Section 4 shall be equal to or less than 6mm.

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*Note: Rail rotation is gauge widening less rail translation.*

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#### 8.4.5 Fatigue Test for Fastening and Sleepers Assembly

When tested in accordance with Section 14.4, rupture failure of any component of the fastening system including sleeper shall constitute failure of this test. The residual toe load of the fastening shall be measured as in Clause 8.4.2 and any reduction below the design minimum will constitute failure unless otherwise approved by the Responsible Manager.

Sleeper/fastening system passing this test is deemed to have satisfied the requirement of a 50 year fatigue life.

## 9 Spacers and Insulators

### 9.1 Method of Fitting Spacers and Insulators

The method of fitting spacers and insulators is subject to approval and detail drawings shall be submitted with the Tender to the Responsible Manager for approval.

The manufacture of all specified spacer and insulator components shall be to the Contractor's specification and detail drawings, which shall be subject to approval by the Responsible Manager.

### 9.2 Testing of Spacers

The combination of the spacer system, fastening system and rail specified shall satisfy all requirements of the fastening system as set out in Clauses 8.4.2, 8.4.3, 8.4.4 and 8.4.5. Testing shall be carried out in accordance with Clauses listed at 8.4.

## 10 Identification

The following markings shall be incorporated in the sleepers by raised or indented letters not less than 25mm high, nor more than 3mm raised or indented:

- a) The Purchaser's logo
- b) Supplier's identification
- c) Year of Manufacture
- d) Nominal Rail Size(s) without spacers
- e) Marking for insulated sleeper system (eg "I")
- f) Fastener identification number

Spacers shall be identified for original size of sleeper and reduced rail fitting. An identification is required for gauge side or field side as well as insulated or non-insulated (e.g. 60kg/80lb-GI represents 60kg sleeper holes, 80lb reduced rail fitting for gauge side and insulated).

The marking specified in this Section:

- Shall be such as to induce no inherent fatigue weakness zones.

- Shall be located on the top surface of the sleeper and between the rail seats, and in the spacer such that it can be identified when in place.
- Shall be sufficient to remain visible for the sleeper design life specified in Section 2.

## 11 Inspection Frequency

Inspection procedures should be in accordance with AS/NZS ISO 9001 Quality Management Systems - Requirements, except as indicated below: The first sleeper produced following any shutdown or delay in production (for more than 30 minutes) shall be examined.

If the sleeper is rejected the batch from which the sleeper was selected shall be subjected to detailed examination. Initially 10 sleepers shall be selected at random from the batch and submitted for inspection. If all 10 sleepers are found satisfactory the batch shall be accepted, otherwise the batch will be rejected.

Batches found unacceptable shall be resubmitted for inspection only after all items or units or product are re-examined and all defective items or units of product are removed.

## 12 Drawings and Working Gauges

The Responsible Manager will return a copy of the approved drawings to the Contractor with notification of approval of the design.

The Contractor shall make up two sets of working gauges to measure the specified dimensional tolerances before starting the production. After approval by the Responsible Manager the Contractor shall stamp the working gauges, which then become valid for checking purposes.

One set of working gauges provided at the Contractor's expenses, shall be made available to the Responsible Manager for the period of acceptance testing.

Working gauges approved by the Responsible Manager or by an outside testing agency, shall be used for other relevant purchases wherever possible.

## 13 Corrosion Allowance

The Contractor shall demonstrate to the satisfaction of the Responsible Manager that adequate allowance has been made for the affects of corrosion during the life of the sleeper.

Most sleepers will be used in areas not affected by seawater spray or high humidity in tunnels. Some proposal for the protection of sleepers in a highly corrosive environment (e.g. painting or galvanising) should be considered.

## 14 Fastening and Sleeper Test Procedure

The tests specified in Section 8.4.2, 8.4.3, 8.4.4, 8.4.5 and 9.2 shall be carried out in accordance with the following procedure:

### 14.1 Uplift Test of Fastening (Normative)

#### 14.1.1 Apparatus:

The following apparatus is required:

- 1) A piece of the specified rail section, at least 450 mm long
- 2) Rail-fastening assembly (including pads and spacers if required)
- 3) Two 0.25 mm thick feeler gauges
- 4) Test assembly as shown in Figure 1 (Appendix 2)

#### 14.1.2 Procedure:

The procedure shall be as follows:

- 1) Secure the piece of rail section to one rail seat using a complete rail-fastening assembly (including pads if required), clips and associated hardware as shown in Figure 1.
- 2) Apply a load incrementally to the loading frame until separation of the rail from the sleeper takes place. Load deflection should be monitored in the form of an X-Y plot.
- 3) Determine the separation of the rail from the sleeper by using the two feeler gauges placed under opposite sides of the rail.
- 4) Determine the measured load as the average of the loads at which each feeler gauge becomes free.
- 5) Record the toe load, which is the measured load plus unsupported sleeper weight plus frame weight.
- 6) Release the load completely.
- 7) Apply a load of 1.5 times the toe load which should not exceed 45 kN.
- 8) Release the load completely.

#### 14.1.3 Report:

The following shall be reported:

- 1) The toe load.
- 2) Fracture of any component of the fastening system.
- 3) Release of the rail.

### 14.2 Longitudinal Restraint Tests of Fastening (Normative)

#### 14.2.1 Apparatus:

The following apparatus is required:

- 1) A piece of the specified rail section.
- 2) Wire brush.
- 3) Two dial gauges with an accuracy of 0.025 mm.
- 4) Test assembly as shown in Figure 2. (Appendix 2).

### 14.2.2 Procedure:

The procedure shall be as follows:

- 1) Wire brush the piece of rail section to be tested to remove all loose mill scale and foreign matter.
- 2) Set up the test assembly as shown in Figure 2 (Appendix 2).
- 3) Apply a longitudinal load in increments of 2 kN until the maximum load (as specified in Section 3) is reached and held for not less than 15min.
- 4) Record the time and readings of longitudinal rail displacement after each load increment from the two dial gauge indicators placed one on each side of the rail.

### 14.2.3 Report:

The following shall be reported:

- 1) The longitudinal movement of the rail during the initial 3 minutes period in millimetres.
- 2) The longitudinal movement of the rail after initial 3 minutes in millimetres.

## 14.3 Lateral Restraint Tests of Fastening (Normative)

### 14.3.1 Apparatus:

The following apparatus is required:

- 1) A piece of the specified rail section.
- 2) Rail-fastening assembly, including pads if required.
- 3) Two dial gauges.
- 4) Flat wooden block 250 x 250 x 20 mm exterior grade plywood to AS 2271.
- 5) Test assembly as shown in Figure 3. (Appendix 2)

### 14.3.2 Procedure:

The procedure shall be as follows:

- 1) Secure the specified rail section to the sleeper using the approved fastening system, as shown in Figure 3.
- 2) Ensure that the loading head is fixed against translation and rotation.
- 3) Apply a pre-load equal to half the required load (as specified in Section 4) to the rail, so it will seat in the fastening. The lateral to vertical force ratio to be used is specified in Section 4.
- 4) Upon release of the pre-load, set the dial gauges to zero for measuring translation.
- 5) Apply load at a rate not exceeding 20 kN/min until either the load (as specified in Section 4) has been reached or the rail base has translated 3mm, whichever occurs first.
- 6) Record the dial gauge reading for translation and the applied load.
- 7) Release the load from the rail.
- 8) Install a roller nest between the fixed loading head and the wooden block on the rail head.
- 9) Ensure that the roller nest does not offer resistance to lateral movement of the rail head.
- 10) Set the dial gauges to zero for reading gauge widening.
- 11) Apply a load equal to half the required load (as specified in Section 4) at a rate not exceeding 20kN/min.
- 12) Record the dial gauge reading for gauge widening.

### 14.3.3 Report:

The following shall be reported:

- 1) The applied load and dial gauge reading for translation.
- 2) The applied load and dial gauge reading for gauge widening.

## 14.4 Fatigue Test for Fastening and Sleeper (Normative)

### 14.4.1 Apparatus:

The following apparatus is required:

- 1) A piece of the specified rail section at least 450 mm long and 600 mm long section of the steel sleeper.
- 2) Rail fastening assembly.
- 3) Clips and associated hardware recommended by the manufacture of the rail fastening assembly.
- 4) Wire Brush.
- 5) Test assembly as shown in Figure 4 (Appendix 2).

### 14.4.2 Procedure:

The procedure shall be as follows:

- 1) Wire brush the piece of rail section to be tested to remove all loose mill scale and foreign matter.
- 2) Assemble a new set of fastening clips for use in the repeated load test.
- 3) Set up the test assembly as shown in Figure 4. Note: Sleeper section to be securely clamped at each end to a suitable base.
- 4) Ensure that rail is free to rotate under the applied loads (roller box at the rail head).
- 5) The rail/fastening combination shall be loaded to the values shown in Section 4 at a rate not exceeding 300 cycles per minute for 3,000,000 cycles. Note: One cycle consists of downward load and release of load.
- 6) Perform the fastening uplift test in Section 14.1.

### 14.4.3 Report:

The following shall be reported:

- 1) Rupture failure of any component of the fastening system including sleeper.
- 2) The residual toe load of the fastening system.

## 15 Attachments

### Appendix 1 Sleeper Tolerances

- List of Dimensions

### Appendix 2 Test Assembly

- Figure 1 Uplift test of fastening
- Figure 2 Longitudinal restraint test of fastening
- Figure 3 Lateral restraint test of fastening
- Figure 4 Fatigue test for fastening and sleeper

### Appendix 3 Rail Sections

- Figure 5 AS 60 kg/m rail
- Figure 6 BHP 53 kg/m rail
- Figure 7 AS 50 kg/m rail
- Figure 8 AS 47 kg/m Rail to E22
- Figure 9 AS 41 kg/m rail
- Figure 10 80 lb/yd AS "B" 1928 rail
- Figure 11 80 lb/yd "A" 1907 rail
- Figure 12 80 lb/yd "A" 1900 rail
- Figure 13 60 lb/yd AS "B" 1928
- Figure 14 60 lb/yd AS "A" 1928 (AS 1716)
- Figure 15 60 lb/yd AS "B" <sup>A</sup> 1907

### Appendix 4 Sleeper Sections

- Figure 16 Typical Sleeper Section
- Figure 17 Typical Fastening Assembly

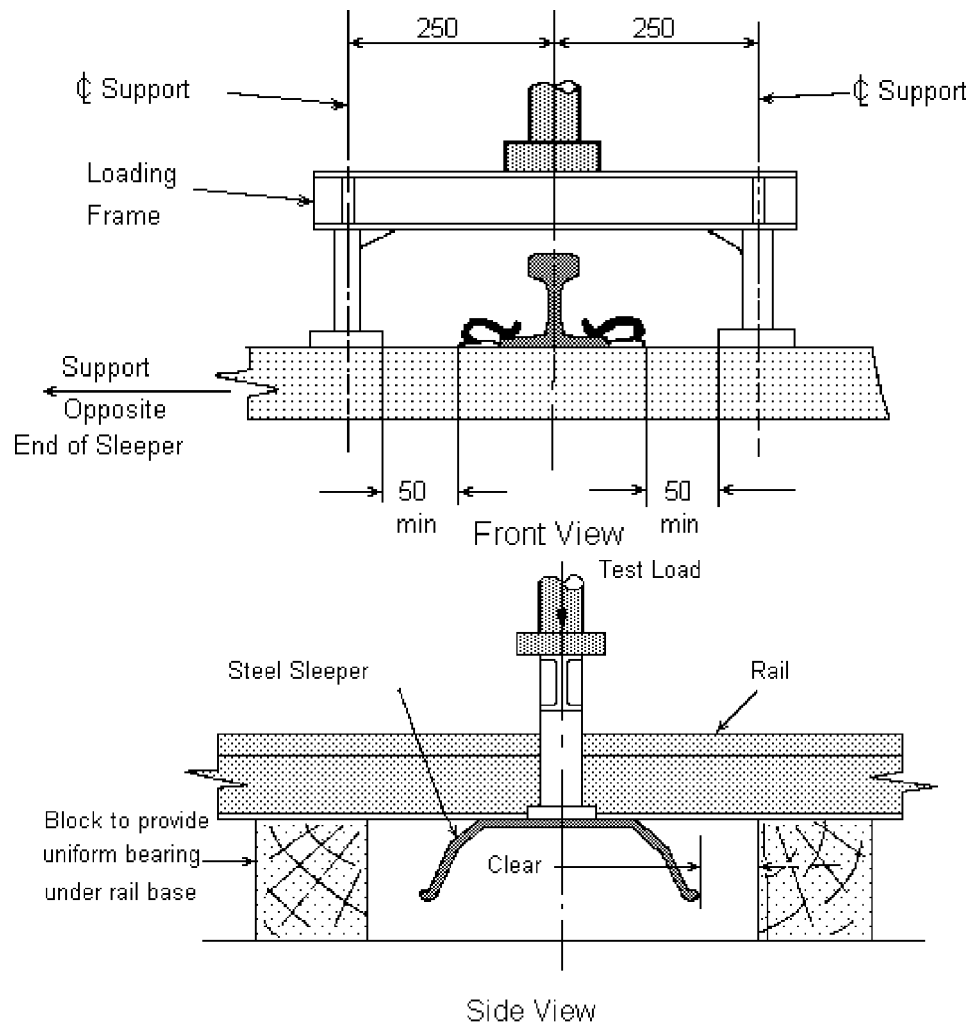
### Appendix 5 Technical Glossary

## 15.1 Appendix 1 - Sleeper Tolerances

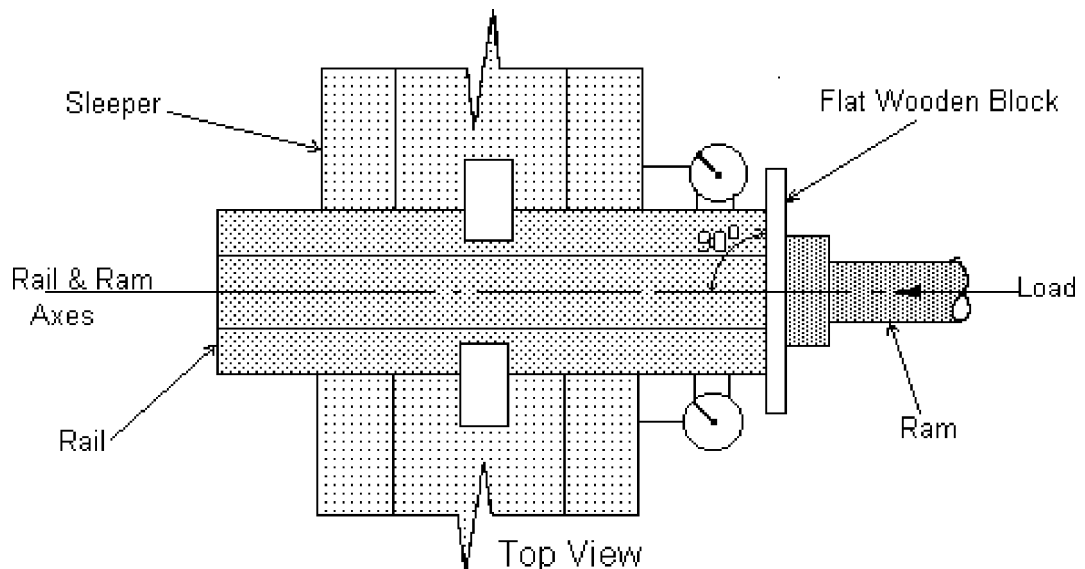
DESCRIPTION	TOLERANCE/RANGE	COMMENTS
Track Gauge	+/- 2.0 mm	Nominal 1435mm
Cant	1:19 to 1:21	Nominal 1:20
Overall length of sleeper	+/-10mm	Measured at the outside edge of the sleeper spaded end
Overall width of sleeper	+/-5mm	
Internal width of sleeper at section toe	+/-5mm	
Thickness of sleeper web	+0.27/-0mm	
Overall depth of sleeper	+/-2mm	
Distance between outer edges of the extreme outside holes or slots	+/-1 mm	Measured at a height of 5mm above rail seat
Distance between outer edges of pair of rail seat holes	+/-0.5mm	Measured at a height of 5mm above rail seat
Diameter of holes	+/-0.5/-0mm	
Rail seat width	+/-0.5mm	Measured at a height of 5mm above rail seat
Rail seat flatness	+0.0/-1.0mm	
Differential tilt angle of rail. Seats in directional of rail	+/-0.6deg	
Height of turndowns at spaded end	0.2D Maximum	
Height of turn up at spaded end	0.3D Maximum	
Width of spaded end	W + 40mm	Measured of outside points of base
Maximum width within 400mm of rail centre line	W + 5mm	
Inside walls of inner and outer housing of each rail to be parallel to longitudinal axis of each rail	+/-0.2 deg	
Straightness (over the nominally straight portion)	3mm/m	
The angle of the end ballast retaining walls of the sleeper including the side walls.	Not greater than 30 degrees from the vertical.	
D = Nominal depth of sleeper	W = Nominal width of sleeper	



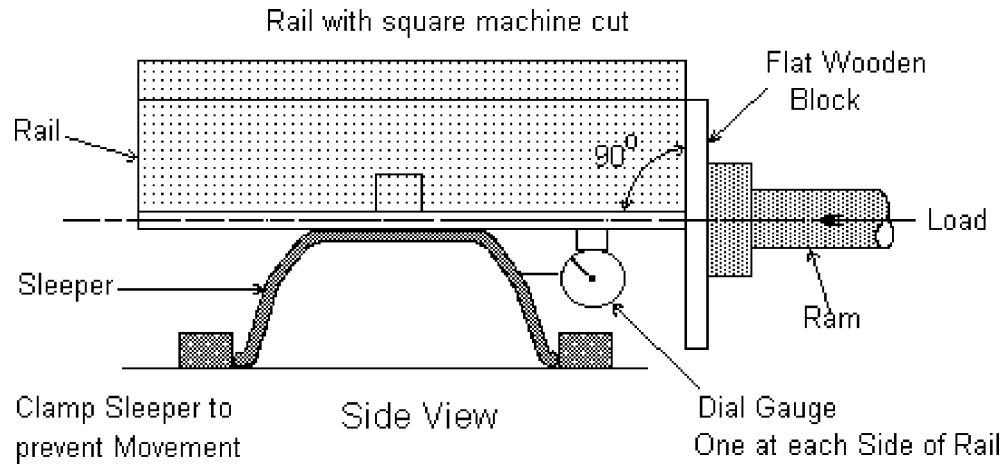
## 15.2 Appendix 2 – Test Assembly



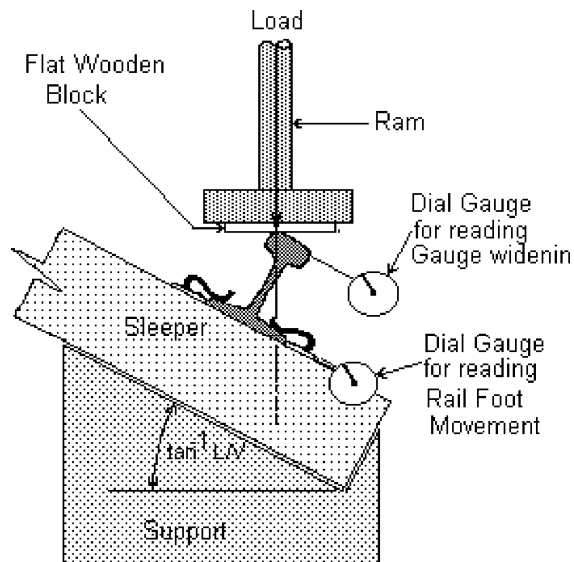
**FIG. 1 UPLIFT TEST OF FASTENING**



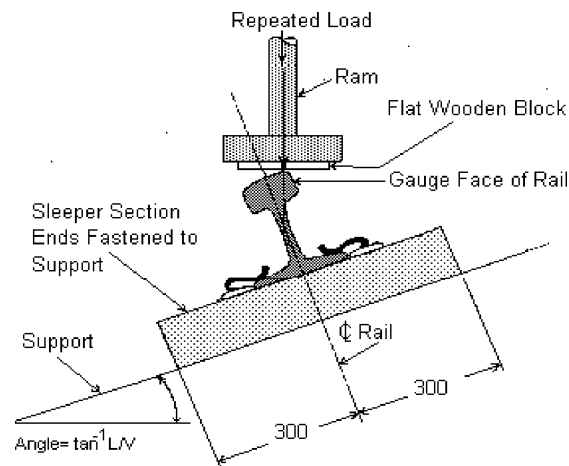
**Appendix 2 – Test Assembly (Continued)**



**FIG. 2 LONGITUDINAL RESTRAINT TEST OF FASTENING**

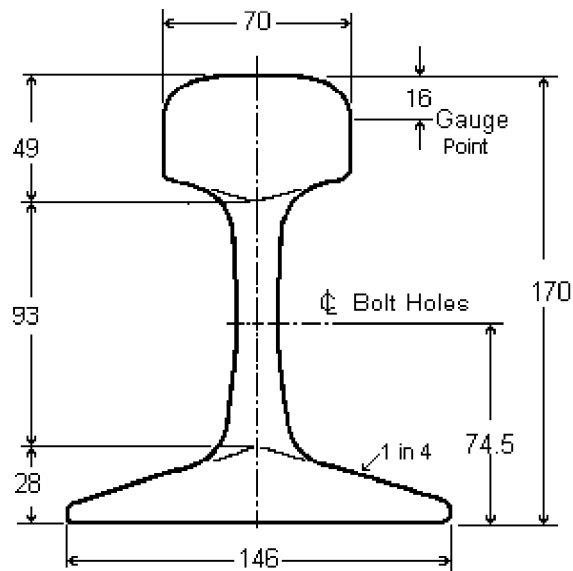


**FIG 3 LATERAL RESTRAINT TESTS OF FASTENING**



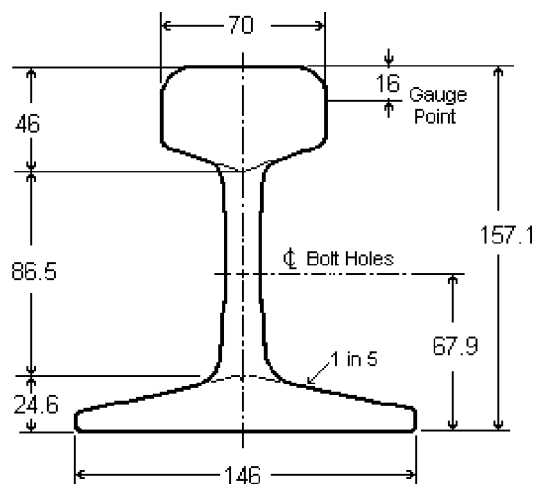
**FIG. 4 FATIGUE TEST FOR FASTENING AND SLEEPER**

### 15.3 Appendix 3 - Rail Sections



Area of Head = 2960 mm <sup>2</sup>	I (xx) = 29.4 * E6 mm <sup>4</sup>
Area of Web = 2040 mm <sup>2</sup>	Z (xx) = 323.2 * E3 mm <sup>3</sup> head
Area of Foot = 2770 mm <sup>2</sup>	Z (xx) = 371.4 * E3 mm <sup>3</sup> foot
Total Area = 7770 mm <sup>2</sup>	I (yy) = 4.9 * E6 mm <sup>4</sup>
Rail Mass = 61.0 kg / m	Z (yy) = 67.1 * E3 mm <sup>3</sup>

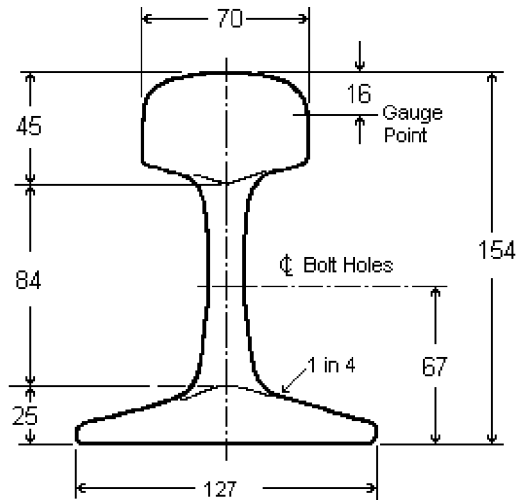
**FIG. 5 AS 60 kg/m RAIL**



Area of Head = 2710 mm <sup>2</sup>	I (xx) = 22.8 * E6 mm <sup>4</sup>
Area of Web = 1529 mm <sup>2</sup>	Z (xx) = 271.2 * E3 mm <sup>3</sup> head
Area of Foot = 2510 mm <sup>2</sup>	Z (XX) = 311.5 * E3 mm <sup>3</sup> foot
Total Area = 6749 mm <sup>2</sup>	I (yy) = 4.54 * E6 mm <sup>4</sup>
Rail Mass = 53.0 kg / m	Z (yy) = 62.2 * E3 mm <sup>3</sup>

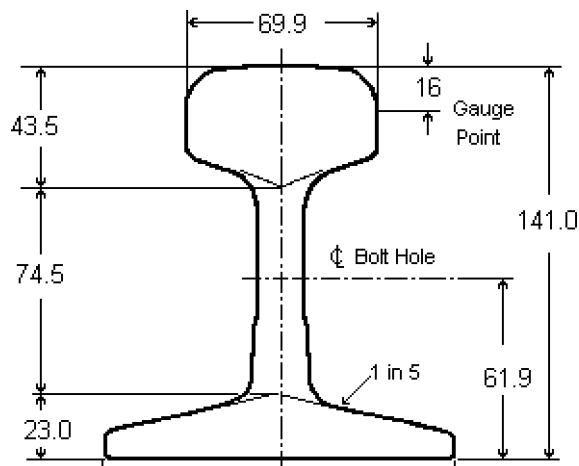
**FIG. 6 BHP 53 kg / m Rail**

**Appendix 3 – Rail Sections (Continued)**



Area of Head = 2680 mm<sup>2</sup>    I (xx) = 20.1 \* E6 mm<sup>4</sup>  
 Area of Web = 1640 mm<sup>2</sup>    Z (xx) = 254.1 \* E3 mm<sup>3</sup> head  
 Area of Foot = 2150 mm<sup>2</sup>    Z (xx) = 269.3 \* E3 mm<sup>3</sup> foot  
 Total Area = 6470 mm<sup>2</sup>    I (yy) = 3.3 \* E6 mm<sup>4</sup>  
 Rail Mass = 50.8 kg / m    Z (yy) = 51.1 \* E3 mm<sup>3</sup>

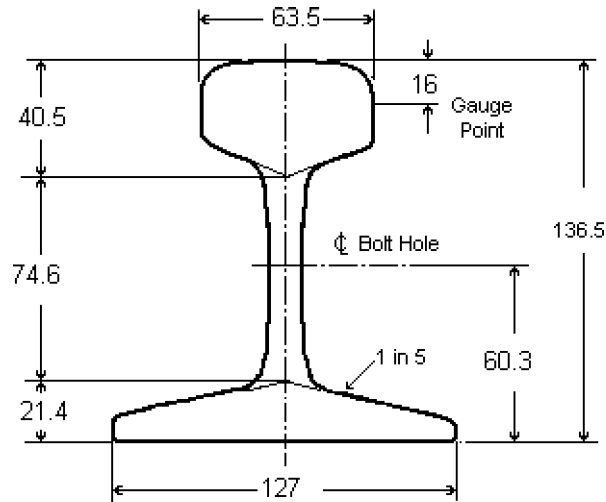
**FIG. 7 AS 50 kg / m RAIL**



Area of Head = 2548 mm<sup>2</sup>    I (xx) = 15.9 \* E6 mm<sup>4</sup>  
 Area of Web = 1277 mm<sup>2</sup>    Z (xx) = 217.8 \* E3 mm<sup>3</sup> head  
 Area of Foot = 2103 mm<sup>2</sup>    Z (xx) = 233.7 \* E3 mm<sup>3</sup> foot  
 Total Area = 5928 mm<sup>2</sup>    Rail Mass = 46.5 kg / m

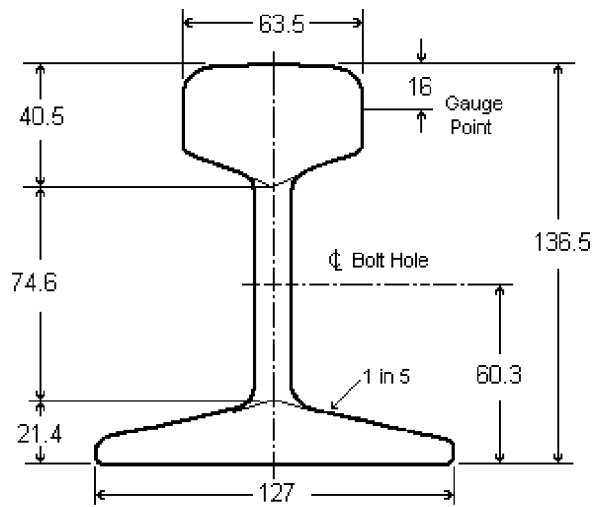
**FIG. 8 AS 47 kg / m Rail to E22**

**Appendix 3 - Rail Sections (Continued)**



Area of Head = 2148 mm<sup>2</sup> I (xx) = 13.24 \* E6 mm<sup>4</sup>  
 Area of Web = 1110 mm<sup>2</sup> Z (xx) = 184.4 \* E3 mm<sup>3</sup> head  
 Area of Foot = 1929 mm<sup>2</sup> Z (xx) = 204.5 \* E3 mm<sup>3</sup> foot  
 Total Area = 5187 mm<sup>2</sup> Rail Mass = 40.7 kg / m

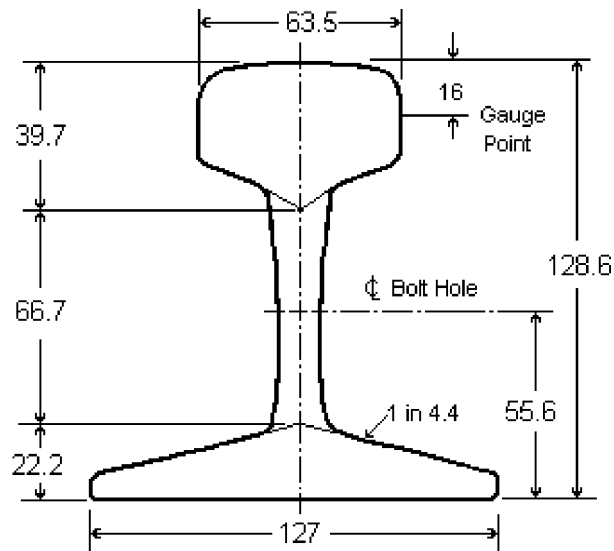
**Fig. 9 AS 41 kg / m Rail**



Area of Head = 2148 mm<sup>2</sup> I (xx) = 13.1 \* E6 mm<sup>4</sup>  
 Area of Web = 1038 mm<sup>2</sup> Z (xx) = 184.6 \* E3 mm<sup>3</sup> head  
 Area of Foot = 1929 mm<sup>2</sup> Z (xx) = 203.4 \* E3 mm<sup>3</sup> foot  
 Total Area = 5116 mm<sup>2</sup> Rail Mass = 40.0 kg / m

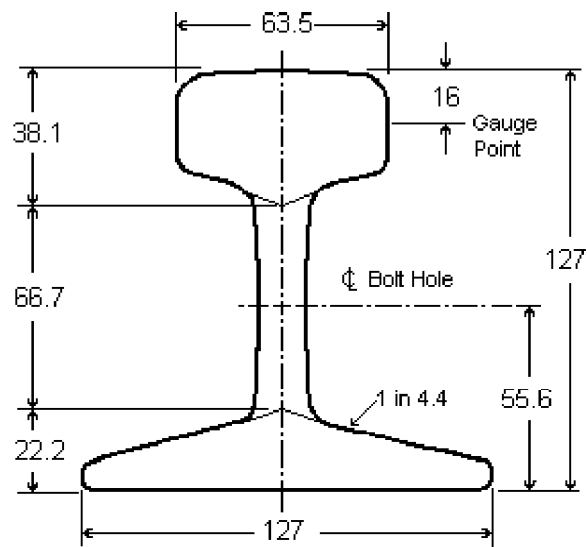
**FIG. 10 80 lb / yd AS "B" 1928 RAIL**

**Appendix 3 - Rail Sections (Continued)**



Area of Head = 2135 mm<sup>2</sup> I (xx) = 11.3 \* E6 mm<sup>4</sup>  
 Area of Web = 1051 mm<sup>2</sup> Z (xx) = ? \* E3 mm<sup>3</sup> head  
 Area of Foot = 1903 mm<sup>2</sup> Z (xx) = ? \* E3 mm<sup>3</sup> foot  
 Total Area = 5090 mm<sup>2</sup> Rail Mass = 40.0 kg / m

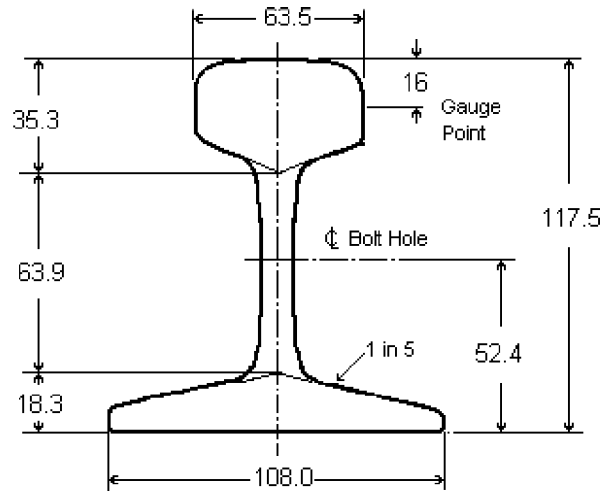
**Fig 11 80 lb / yd "A A" 1907 Rail**



Area of Head = 2135 mm<sup>2</sup> I (xx) = 11.0 \* E6 mm<sup>4</sup>  
 Area of Web = 1032 mm<sup>2</sup> Z (xx) = ? \* E3 mm<sup>3</sup> head  
 Area of Foot = 1825 mm<sup>2</sup> Z (xx) = ? \* E3 mm<sup>3</sup> foot  
 Total Area = 4994 mm<sup>2</sup> Rail Mass = 39.0 kg / m

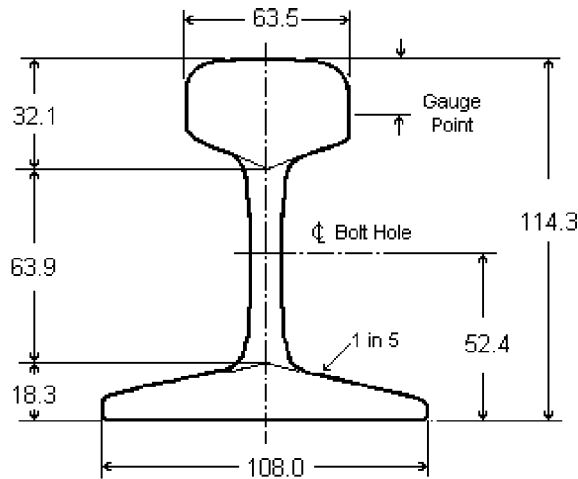
**FIG. 12 80 lb / yd AS "A" 1900 RAIL**

**Appendix 3 - Rail Sections (Continued)**



Area of Head = 1825mm<sup>2</sup>    I (xx) = 7.66 \* E6 mm<sup>4</sup>  
 Area of Web = 793mm<sup>2</sup>    Z (xx) = 130.4 \* E3 mm<sup>3</sup> head  
 Area of Foot = 1394mm<sup>2</sup>    Z (xx) = 130.4 \* E3 mm<sup>3</sup> foot  
 Total Area = 4013mm<sup>2</sup>    Rail Mass = 31.3 kg/m

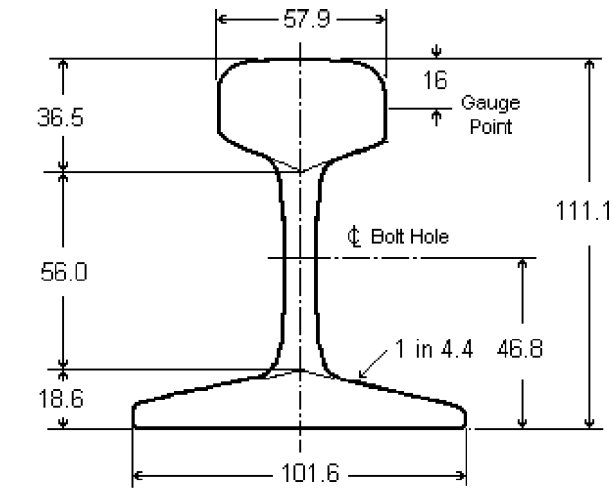
**FIG. 13 60 lb/yd "B" 1928**



Area of Head = 1619 mm<sup>2</sup>    I (xx) = 6.90 \* E6 mm<sup>4</sup>  
 Area of Web = 793 mm<sup>2</sup>    Z (xx) = 117.3 \* E3 mm<sup>3</sup> head  
 Area of Foot = 1393 mm<sup>2</sup>    Z (xx) = 124.2 \* E3 mm<sup>3</sup> foot  
 Total Area = 3806 mm<sup>2</sup>    Rail Mass = 29.7 kg / m

**FIG. 14 60 AS "A" 1928**

**Appendix 3 - Rail Sections (Continued)**



Area of Head = 1555 mm<sup>2</sup>    I (xx) = 6.25 \* E6 mm<sup>4</sup>  
 Area of Web = 742 mm<sup>2</sup>    Z (xx) = \* E3 mm<sup>3</sup> head  
 Area of Foot = 1297 mm<sup>2</sup>    Z (xx) = \* E3 mm<sup>3</sup> foot  
 Total Area = 3794 mm<sup>2</sup>    Rail Mass = 29.6 kg / m

**FIG. 15 60 AS "B" 1907**



### 15.4 Appendix 4 - Sleeper Sections

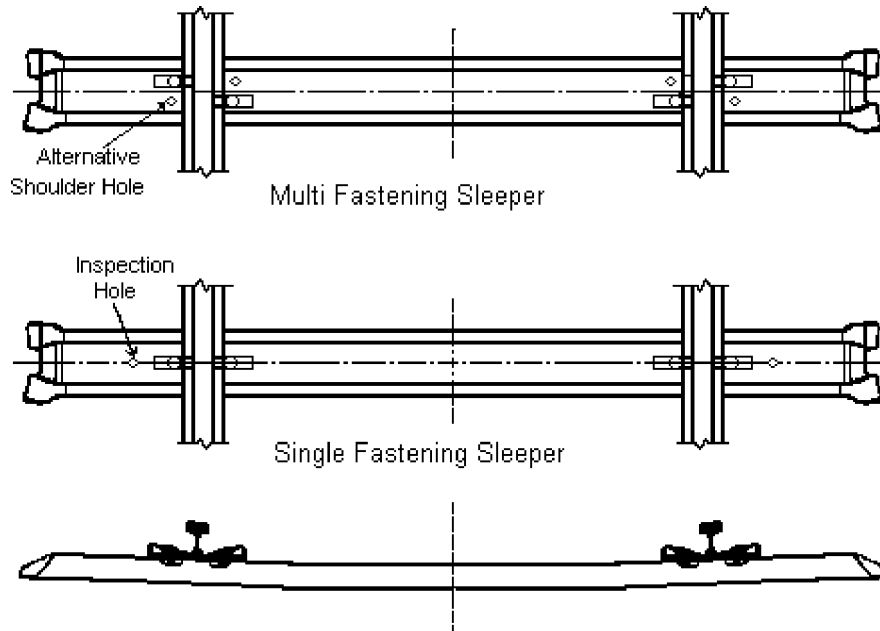


FIG. 16 TYPICAL SLEEPER SECTION

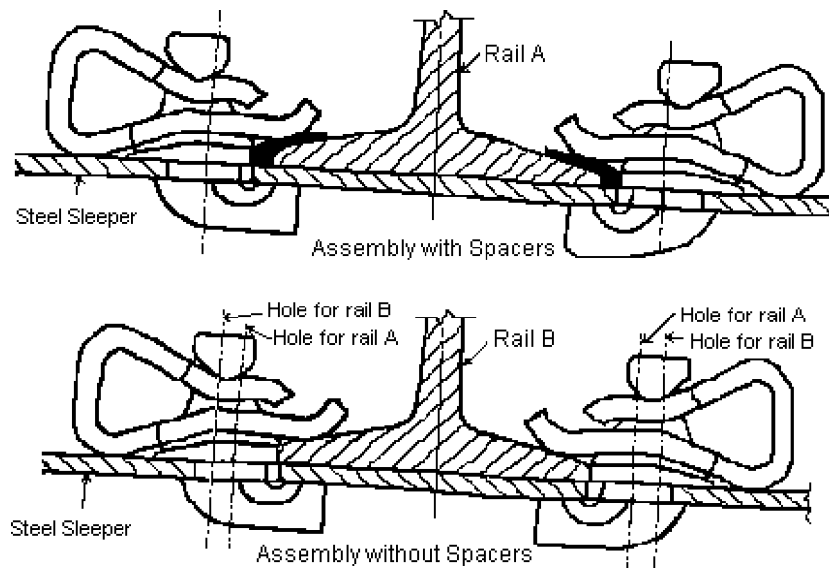


FIG. 17 TYPICAL FASTENING ASSEMBLY

## 15.5 Appendix 5 - Technical Glossary

Term or Acronym	Description
Vertical Load	A load or vector component of a load, at right angles to a line joining the mid points of the rail seats of the sleeper and normal to the longitudinal axis of the rail.
Lateral Load	A load or vector component of a load at the gauge corner of the rail parallel to the longitudinal axis of the sleeper and perpendicular to the rail.
Longitudinal Load	A load along the longitudinal axis of the rail.
Track Gauge	The distance between the gauge points of the rails.
Gauge Corner	Transition surface separating the rail running surface from the rail side.
Gauge Point	The point on the side of the rail head 16mm beneath the top surface of the rail at which the gauge is measured.
Single Fastening Sleeper	Standard steel sleeper with one set of in-line holes for single lock-in shoulder location.
Multi-Fasting Sleeper	Special steel sleeper with two sets of diagonally - placed holes for alternative lock-in shoulder locations.
Fastening	Components of a sleeper system, which fasten the rail to the sleeper.
Lock-in Shoulder	A component that prevents lateral movement of the rail and provides anchorage for the rail clip.
Clip	An elastic component that restrains the movement of the rail by providing a vertical toe load.
Spacers	A set of two components that allow the alternative fitting of a smaller rail size.
Insulation Pad	A component that electrically insulates the rail from the sleeper.
Flange	The sides of the sleeper projecting into the ballast bed.
Rail Seat	The area of the sleeper on which the rail sits (top sleeper surface between the field and gauge shoulders).
Toe of Sleeper	The section at the tip of the flanges (for increased bending strength).
End Spade	Turn-down end of the sleeper top section.