

Australian Standard™

Railway track material

Part 17: Steel sleepers

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Australian Industry Group
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STANDARDS AUSTRALIA

RECONFIRMATION

OF

AS 1085.17—2003

Railway Track Material

Part 17: Steel Sleepers

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Technical Committee CE-002 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

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NOTES

Australian Standard™

Railway track material

Part 17: Steel sleepers

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PREFACE

This Standard was prepared by the Standards Australia Committee CE-002, Railway Track Materials, to supersede AS 1085.17—2000, *Railway permanent way materials*, Part 17: *Steel sleepers*.

The objective of this Standard is to provide purchasers and suppliers including owners, operators, designers and manufacturers of railway sleepers with requirements for the specification, manufacture and testing of trough-shaped steel sleepers for use in railway track.

This revision includes only those changes necessary to accompany the publication of the new Standards in the series, AS 1085.18 and AS 1085.19. This implements the separation of the requirements for resilient fasteners from those for the sleepers.

This Standard includes the following changes to the previous edition:

- (a) Change of title of the AS 1085 series (previously *Railway permanent way material*.)
- (b) Requirements for resilient fastenings that are covered in AS 1085.19 have been removed and reference made to that Standard.
- (c) The referenced documents list has been updated.
- (d) Minor editorial changes implemented.
- (e) Appendix numbering has been updated following removal of a number of Appendices.
- (f) The most recent version of the informative Appendix ‘Means of demonstrating compliance with this Standard’ has been included.

Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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FOREWORD

The performance of steel sleepers in track depends on the condition of the rail, the condition and type of rail joints, the ballast support and the rail fastening system. Accordingly, when considering performance, the sleeper and its fastening together with the rail must be regarded as interdependent components of a system.

The limits given in this Standard are based on the current state of knowledge of steel sleeper behaviour in service; however, service conditions are difficult to define and test criteria that are seen as the most appropriate for the current state of knowledge, have been adopted.

A critical design aspect of steel sleepers is the interaction of the fastening and the portion of sleeper around the hole in which the fastening is secured. The rail seat assembly repeated load test cannot be used to predict the expected in-track fatigue life. It does, however, provide a means of acceptance of a design by comparison with existing proven designs on the basis of experience.

The loads used in testing and design should reflect the use of the sleeper. For example, if sleepers are used in an interspersed pattern, a disproportionate amount of the load may be taken by a particular sleeper and early in-service failure may result.

This Standard does not cover sleepers for use in curves with a radius less than 200 m.

Track constructed using sleepers and fastener components meeting the requirements of this Standard is expected to give satisfactory performance when properly installed and under an appropriate maintenance program.

This Standard is intended for use by persons experienced in track design and performance and who have a good knowledge of the duty and environment of the track in which the sleepers are to be used.

Loads and calculation methods given in this Standard are in permissible stress format and are not based on limit states principles.

STANDARDS AUSTRALIA

Australian Standard Railway track material

Part 17: Steel sleepers

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies the performance requirements and gives design and testing methods for trough-shaped steel sleepers and their associated components for use in railway track. It also sets out requirements for the performance of rail-insulating components.

NOTES:

- 1 Sleepers are generally designed to suit a specific rail profile and gauge with a given fastening.
- 2 Guidance on information that should be provided by the purchaser and supplier is given in Appendix A.
- 3 Guidance on means for demonstrating compliance with this Standard is given in Appendix B.
- 4 Guidelines on the design and manufacture of special sleepers and fastenings are given in Appendix C.

1.2 PURPOSE AND CONTEXT OF USE

1.2.1 Function

Sleepers are support members that are part of the structure of railway permanent way. They are embedded into the ballast and support the rails above. They tie the rails together maintaining gauge and rail position and resisting lateral and longitudinal movement of the rail system. Fastenings, as part of the sleeper assembly, secure the rails to the sleeper.

1.2.2 Action

Sleepers are subject to—

- (a) loads imposed by the passage of rolling stock on the rails and during maintenance;
- (b) loads generated by thermal effects on the rail and by ballast movement; and
- (c) fatigue, wear, damage and corrosion.

1.3 TESTING

Testing shall be conducted by a laboratory appropriately qualified to carry out the tests. Testing shall be carried out on sleeper assemblies or elements that have been produced using the processes and the plant, and with the materials that the manufacturer uses or intends to use in mass production. The tests given in this Standard are for the design and acceptance of steel sleepers.

Testing shall be carried out using the rail profile (or part of the rail profile, as appropriate) and the sleeper assembly, including rail fastening, which is intended to be used. This includes the use of spacers or other variation in configuration (e.g., multiple sets of holes).

1.4 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- 1085 Railway track material
- 1085.19 Part 19: Resilient fastening assemblies
- 1171 Non-destructive magnetic testing—Magnetic particle testing of ferromagnetic products, components and structures
- 1199 Sampling procedures and tables for inspection by attributes
- 1365 Tolerances for flat-rolled steel products
- 1399 Guide to AS 1199
- 1594 Hot-rolled steel flat products
- 2312 Guide to the protection of iron and steel against atmospheric corrosion by the use of protective coatings
- 2758 Aggregates and rock for engineering purposes
- 2758.7 Part 7: Railway ballast

AS/NZS

- 1100 Technical drawing
- 1100.101 General principles
- 3678 Structural steel—Hot-rolled plates, floorplates and slabs
- ISO 9001 Quality management systems—Requirements
- ISO 9004 Quality management systems—Guidelines for performance improvements

SAI

- HB18 Guidelines
- HB18.28 Guide 28—General rules for a model third-party certification scheme for products

Australasian Railways Association

Review of Track Design Procedures Volumes 1 and 2, 1991
(ISBN 0 909582 01 7)

HETENYI, M. *Beams on elastic foundation*. The University of Michigan Press: Ann Arbor, 1967

1.5 DEFINITIONS

For the purpose of this Standard, the definitions given below and those shown in Figure 1 apply.

1.5.1 Cant

The inward tilt of the rails with respect to the sleeper.

1.5.2 End spade

The turned-down end of the sleeper, which provides lateral resistance and stability.

1.5.3 Fastening

The component or group of components of a steel sleeper system, which fastens the rail to the sleeper.

1.5.4 Gauge corner

Transition surface separating the rail running surface from the rail side.

1.5.5 Gauge point

The point on the side of the rail head 16 mm beneath the top surface of the rail at which track gauge is measured.

1.5.6 In-face

Where sleepers are installed in every position rather than interspersed with other sleepers in between.

1.5.7 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 longitudinal axis of the rail.

1.5.8 Longitudinal load

A load along the longitudinal axis of a rail.

1.5.9 Pod

Volume enclosed by the top, end spades and sides of the sleeper.

1.5.10 Rail insulation pad

A component of a steel sleeper system that electrically insulates the rail from the sleeper.

1.5.11 Rail seat

The area on the top of the sleeper on which the rail sits extending between the field and gauge shoulders.

1.5.12 Shoulder

A component that is attached to, fitted to or forms part of a steel sleeper, to prevent lateral movement of the rail.

1.5.13 Side

Side of the sleeper projecting into the ballast layer (see Figure 1).

1.5.14 Sleeper design life

The intended period during which fatigue cracking or bending failure does not occur when the sleeper is subjected to the specified loading and environmental conditions.

NOTE: Actual in-service sleeper life may vary from the sleeper design life depending on actual loading and environmental conditions applied to the sleeper. Actual in-service life may also depend on the extent to which minor deterioration (e.g., cracking, corrosion) may be tolerated using appropriate risk management techniques.

1.5.15 Toe

Section at the tip of the side of a steel sleeper (see Figure 1(c)).

1.5.16 Top

Top section of the sleeper (see Figure 1(c)).

1.5.17 Track gauge

The distance between the gauge points of the rails.

1.5.18 Vertical load

A load or vector component of a load, perpendicular to a line joining the midpoint of the rail seats of the sleeper and perpendicular to the longitudinal axis of the rail.

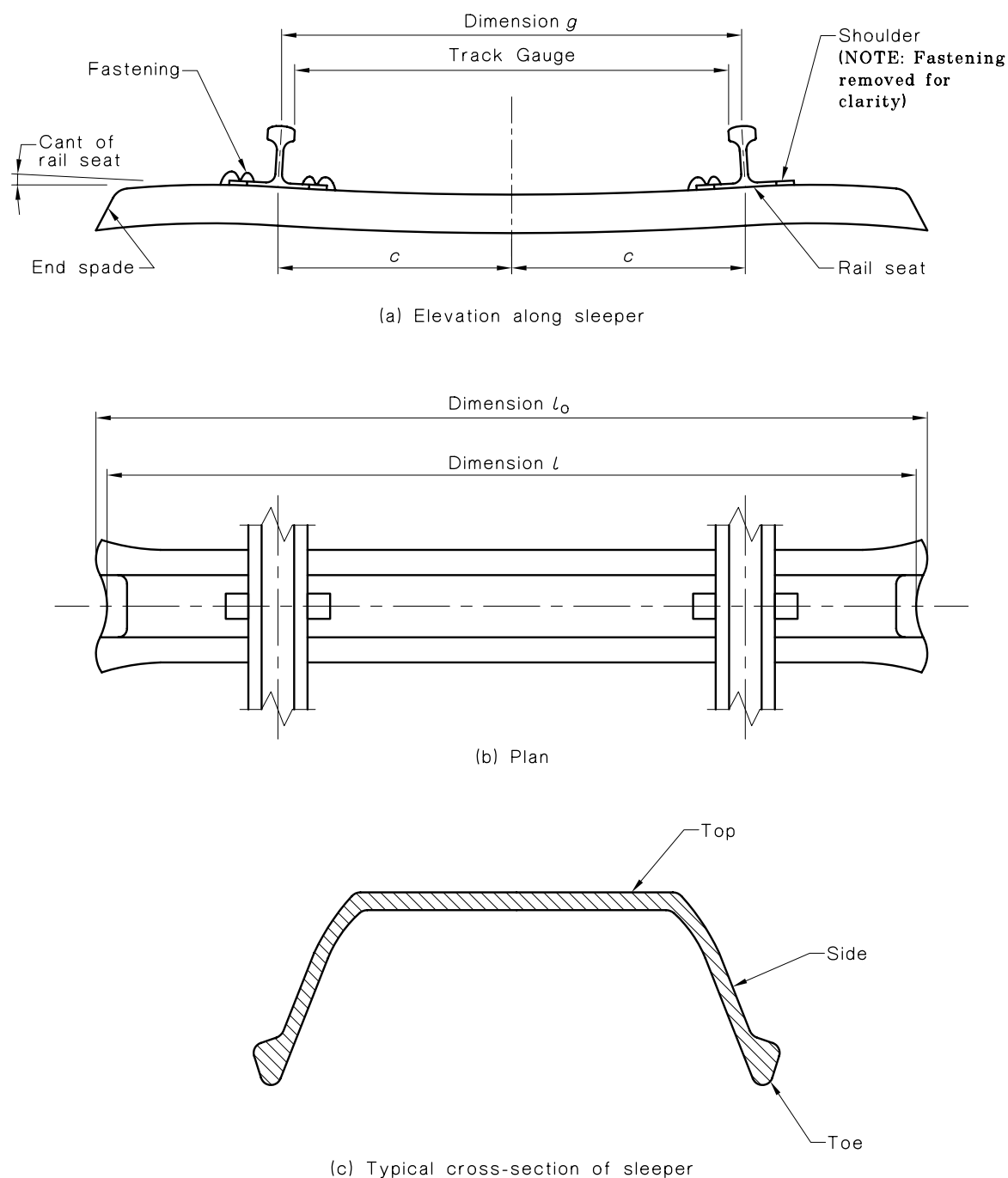


FIGURE 1 SCHEMATIC REPRESENTATION OF STEEL SLEEPER SHOWING PRINCIPAL DEFINITIONS

1.6 NOTATION

For the purpose of this Standard, the following symbols apply:

- a = length of pressure distribution (ballast support) beneath each rail seat, in metres
- B = maximum internal width of the sleeper section (see Figures D1 and D2), in millimetres
- C_{BM} = sleeper bending moment coefficient
- $C_{BM(n)}$ = bending moment coefficient at the field side edge of the sleeper housing
- $C_{BM(max.)}$ = maximum sleeper bending moment coefficient (maximum of $C_{BM(0)}$ and $C_{BM(n)}$)

$C_{BM(0)}$	= bending moment coefficient at the sleeper midpoint
$C_{BM(x)}$	= sleeper bending moment coefficient covering the region to the field side of the rail seat
C_x	= distance from horizontal neutral axis to the top surface of the sleeper (see Figures D1 and D2), in millimetres
c	= dimension of sleeper from the centre-line of the rail seat to the centre of the sleeper, in metres (see Figure 1(a))
D	= overall depth of the sleeper section (see Figures D1 and D2) in millimetres
E	= Young's modulus of rail steel, in megapascals
E_s	= Young's modulus of sleeper material, in megapascals
F_y	= yield strength of sleeper material, in megapascals
F_1	= factor applied to the rail seat load to incorporate the effects of the interaction of adjacent wheels to the design wheel load
F_2	= factor depending on the standard of track maintenance
F_3	= distribution factor for lateral loads on the rail seat
G	= track gauge, in millimetres
g	= distance between rail centres measured at the top of the rail, in metres (see Figure 1(a))
g_1	= distance between rail centres for larger of dual gauge measured at the top of the rail, in metres (see Figure C1)
g_2	= distance between rail centres for smaller of dual gauge measured at the top of the rail, in metres
I_s	= sleeper moment of inertia about the horizontal neutral axis, in millimetres ⁴
$I_{s(new)}$	= moment of inertia about the horizontal neutral axis of newly rolled sleeper section, in millimetres ⁴
I_{xx}	= rail moment of inertia about the horizontal neutral axis, in millimetres ⁴
L/V	= ratio of lateral to vertical wheel loads
l	= sleeper length at the centre-line (see Figure 1(b)), in metres
l_0	= overall (maximum) sleeper length (see Figure 1(b)), in metres
M_{C+}	= maximum positive bending moment at the mid-span of the sleeper, in kilonewton metres
M_{C-}	= maximum negative bending moment at the mid-span of the sleeper, in kilonewton metres
M_d	= design sleeper bending moment, in kilonewton metres
M_R	= maximum bending moment at the rail seat, in kilonewton metres
M_{R+}	= maximum positive moment at the rail seat of the sleeper, in kilonewton metres
n	= dimension from end (on centre-line of bottom edge of end spade) to the centre-line of rail seat, in metres
p_{ab}	= average sleeper to ballast bearing pressure, in kilopascals
P_{dL}	= quasi-static lateral wheel load, in kilonewtons
P_{dV}	= quasi-static vertical wheel load, in kilonewtons

Q	= maximum static wheel load, in kilonewtons
R	= design rail seat load, in kilonewtons
R_L	= quasi-static lateral rail seat load, in kilonewtons
R_V	= quasi-static vertical rail seat load, in kilonewtons
r	= radius of curvature of track, in meters
s	= sleeper spacing, in metres
T	= thickness of sleeper top (see Figures D1 and D2), in millimetres
t	= thickness of sleeper side measured 10 mm above the toe (see Figures D1 and D2) in millimetres
t_c	= confidence limit
U	= track modulus (k is used in some publications) in megapascals
U_s	sleeper support modulus, in megapascals
v	= vehicle velocity, in kilometres per hour
W	= a value used in the empirical method, see Clause 5.4.2 and Paragraph C4
w	= maximum external width of sleeper section excluding any localized widening around ends, in millimetres
x	= distance from the sleeper end along centre-line of sleeper, in metres
x_ℓ	= distance (absolute) between load source and point of analysis, in metres
y	= vertical track deflection, in metres
y_i	= vertical track deflection due to a wheel load at a distance ' x_ℓ ' from the point under consideration, in metres
$y_{\max.}$	= maximum sleeper deflection (assumed to occur immediately beneath the rail seat) in metres or millimetres, as appropriate
Z_{toe}	= section modulus of sleeper toe about the horizontal neutral axis, in millimetres ³ (for design purposes, taken at the end of the sleeper design life)
β	= track stiffness parameter, in metres ⁻¹
δ	= track condition factor used in determining the design impact factor/load distribution
η	= velocity factor used in determining the design impact factor/load distribution
λ	= sleeper stiffness parameter, in metres ⁻¹
σ_{all}	= allowable sleeper bending stress (see Clause 2.2.3) in mega pascals
σ_{cont}	= maximum contact pressure at the sleeper/ballast interface (see Clause 5.5.2) in kilopascals
σ_d	= design sleeper bending stress (see Clause 5.3) in megapascals
ϕ	= dynamic impact factor

SECTION 2 PERFORMANCE REQUIREMENTS

2.1 TRACK SYSTEM COMPATIBILITY

Sleeper assemblies shall maintain the track gauge within the tolerance given in Appendix D when tested in accordance with Appendix E.

2.2 SERVICE LIFE

2.2.1 General

The performance requirements for the design service life of the sleeper assembly shall be deemed to be met when Clauses 2.2.2 to 2.2.8 are satisfied.

2.2.2 Shape

The shape of the sleeper shall be such that it supports the rails and maintains the gauge under the expected conditions for its design service life. The requirements for sleeper shape for service life shall be deemed to be met when the sleeper complies with the minimum geometric section properties and end detail requirements and is within the tolerances given in Appendix D.

2.2.3 Design stresses and ballast contact pressure

When designed in accordance with the service loads and track conditions specified, the calculated sleeper bending stress in tension and compression, calculated in Section 5, shall not exceed the allowable sleeper bending stress, σ_{all} , of $0.66 F_y$.

The average sleeper to ballast contact pressure, calculated in accordance with Clause 5.4 at a position equivalent to the bottom of the sleeper (on a plane intersecting the toes), shall not exceed 500 kPa for high quality, abrasion-resistant ballast. If lower quality ballast materials are used, the allowable ballast pressure shall be reduced accordingly.

Sleeper bending stresses, bending moments and contact pressures shall be calculated in accordance with Sections 4 and 5 and sleeper section properties shall be those assumed for the end of the service life of the sleeper (see Clause 5.2).

Where no other information is available, the value of R shall not be less than R_v as determined in accordance with Section 4.

NOTE: The value of R used for design may be subject to other information requiring engineering judgement

2.2.4 Design of details

Sleeper design shall take into account the stresses induced in the sleeper by the interaction with the fastening system (e.g., stress concentrations).

2.2.5 Sleeper materials

2.2.5.1 Pre-formed sections

Sleepers manufactured from pre-formed section shall be made of steel with a characteristic yield strength of at least 250 MPa. The chemical composition of the steel shall conform to the limits given in Table 2.1. The steel shall not contain defects such as segregation, pipe, or non-metallic inclusions that reduce the expected sleeper life below the design life.

TABLE 2.1
BASIC CHEMICAL COMPOSITION

Element	Percent, max.
Carbon	0.24
Manganese	1.5
Silicon	0.5
Sulfur	0.04
Phosphorous	0.04

2.2.5.2 Strip

Where the steel sleeper is manufactured from strip, the material shall conform to the requirements of AS 1365, AS 1594 or AS/NZS 3678 as appropriate.

2.2.6 Surface finish

The sleeper shall be free of surface defects, cracks, scratches, sharp die marks and sharp tooling marks which are likely to initiate failure in service. Defects may be rectified by grinding, provided that the structural adequacy of the sleeper section is not impaired and tolerances are not exceeded.

2.2.7 Resilient rail fastening assemblies

The performance requirements for the service life of resilient rail fastening assemblies shall be deemed to be met when Clause 2.2.8 and Section 3 are satisfied.

2.2.8 Rail seat assembly repeated load test

When tested in accordance with Appendix F with lateral and vertical rail seat loads as calculated in Section 4, unless the loads are otherwise specified by the purchaser, no fatigue cracking of the sleeper, fastening components or failure of the insulation pad shall occur.

NOTE: This test provides for acceptance of the sleeper on the basis of existing knowledge; however, the test cannot be used to predict the expected in-track fatigue life. Sufficient data is not available on a correlation between the test and in-track performance. In the event of failure under the given loading conditions, full test details should be provided for the consideration of the purchaser.

2.3 RAIL RESTRAINT AND SUPPORT

2.3.1 General

The requirements for rail restraint and support shall be deemed to be met when Clauses 2.3.2 to 2.3.3 are satisfied and the resilient rail fastenings are in accordance with Section 3.

2.3.2 Shape

The requirements for sleeper shape for rail restraint and support shall be deemed to be met when Clause 2.2.2 is satisfied.

2.3.3 Lateral track stability test

When tested in accordance with Appendix G, the maximum load determined shall be not less than the minimum value specified by the purchaser.

NOTE: The ability of the track structure to resist track buckling is also affected by the resistance provided by the fastening system to rotation of the longitudinal rail axis in the horizontal plane. Alternative procedures for the determination of track stability may be used where agreement is reached between the manufacturer and the purchaser (see Appendix A).