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Plastics — Plastic railway sleepers for railway applications (railroad ties) —

Part 1: Material characteristics

Plastiques — Traverses en plastique pour les applications ferroviaires (traverses de voie ferrée) —
Partie 1: Propriétés des matériaux

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
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Foreword

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The committee responsible for this document is ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

ISO 12856 consists of the following parts, under the general title *Plastics — Plastic railway sleepers for railway applications (railroad ties)*:

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— *Part 1: Material characteristics*

The following parts are planned:

— *Part 2: Products*

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Introduction

Railway sleepers are manufactured mainly of pre-stressed concrete, wood, or steel. However, based on the development of plastic materials, some plastic sleepers have been installed in recent years.

In view of the facts that the types of plastics and manufacturing processes can have various effects on the in-service performance, this part of ISO 12856 covers the general characteristics of materials which plastic/composite sleepers are made from, in order to specify their performance.

This part of ISO 12856 will be used in conjunction with ISO 12856-2 to be developed in the foreseeable future.

This part of ISO 12856 applies to sleepers made from plastic materials, including reinforced plastic materials.

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Plastics — Plastic railway sleepers for railway applications (railroad ties) —

Part 1: Material characteristics

1 Scope

This part of ISO 12856 specifies the characteristics of plastic and reinforced plastic materials to be used in the manufacturing of railway sleepers.

It is applicable to the sleepers and parts of sleepers to be installed in tracks with or without ballast. Examples of different types of plastic and reinforced sleepers are given in Annex B.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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ISO 62, *Plastics — Determination of water absorption*

ISO 75 (all parts), *Plastics — Determination of temperature of deflection under load*

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ISO 178, *Plastics — Determination of flexural properties*

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 527-4, *Plastics — Determination of tensile properties — Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites*

ISO 604, *Plastics — Determination of compressive properties*

ISO 877-1:2009, *Plastics — Methods of exposure to solar radiation — Part 1: General guidance*

ISO 877-2:2009, *Plastics — Methods of exposure to solar radiation — Part 2: Direct weathering and exposure behind window glass*

ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pyknometer method and titration method*

ISO 2578, *Plastics — Determination of time-temperature limits after prolonged exposure to heat*

ISO 3611, *Geometrical product specifications (GPS) — Dimensional measuring equipment: Micrometers for external measurements — Design and metrological characteristics*

ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 4892-4, *Plastics — Methods of exposure to laboratory light sources — Part 4: Open-flame carbon-arc lamps*

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ISO 8256, *Plastics — Determination of tensile-impact strength*

ISO 10640, *Plastics — Methodology for assessing polymer photoageing by FTIR and UV/visible spectroscopy*

ISO 11357-2, *Plastics — Differential scanning calorimetry (DSC) — Part 2: Determination of glass transition temperature and glass transition step height*

ISO 11357-6, *Plastics — Differential scanning calorimetry (DSC) — Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)*

ISO 11359-2, *Plastics — Thermomechanical analysis (TMA) — Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature*

ISO 13385-1, *Geometrical product specifications (GPS) — Dimensional measuring equipment — Part 1: Callipers; Design and metrological characteristics*

ISO 13385-2, *Geometrical product specifications (GPS) — Dimensional measuring equipment — Part 2: Calliper depth gauges; Design and metrological characteristics*

ISO 14125, *Fibre-reinforced plastic composites — Determination of flexural properties*

ISO/TR 19032, *Plastics — Use of polyethylene reference specimens (PERS) for monitoring laboratory and outdoor weathering conditions*

IEC 60695-11-20:2003, *Fire hazard testing — Part 11-20: Test flames — 500 W flame test methods*

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3 Characteristics

3.1 Material identification

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The manufacturer shall declare the following information:

a) type of polymer(s), e.g. thermoplastic or thermosetting, including the main additives and the materials constituting composite matrix, if any;

b) type, form, structure, and content of reinforcing materials;

c) type, form, and content of filler or increasing-mass materials, if any;

d) description of the manufacturing process.

3.2 Chemical resistance

The material shall not be adversely affected by exposure to chemicals typically found in the railway environment, such as diesel and grease. Chemical compatibility can be demonstrated either by test results or it can be documented.

3.3 Physical, mechanical, and electrical characteristics

The physical, mechanical, and electrical characteristics of materials are listed in Tables 1 and 2. The relevance of assessment on characteristics shall be agreed on between the interested parties. Some of the tests might not be applicable for anisotropic sleepers or sleepers with specific reinforced material.

Examples of typical plastic sleeper properties are given in Annex B.

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Table 1 — Physical, mechanical, and electrical characteristics

Characteristic		Unit	Test method
Material strength	Bending strength	MPa	4.2
	Flexural modulus	MPa	
	Longitudinal compression strength	N/mm^2	4.3
	Lateral compression strength	N/mm^2	4.4
	Shear strength	N/mm^2	4.5
	Adhesive shear strength	N/mm^2	4.6
Electrical characteristic	Alternating-current breakdown voltage	kV	4.7
	Direct-current insulation resistance	Ω	4.8
Water absorption		%[a]	4.9
Mass density		g/cm^3	4.10
Linear expansion coefficient		K^{-1}	4.11

[a] Percentage expressed in mass fraction.

Table 2 — Temperature-dependent mechanical properties

Characteristic		Unit	Test conditions	Test method
Material strength	Bending strength	%[a]	In air for 24 h Test temperatures[b]: −30 °C and 60 °C	4.2
	Flexural modulus	%[a]		
	Longitudinal compression strength	%[a]		4.3
	Shear strength	%[a]		4.5

[a] Percentages indicate the strength retention in comparison with the values determined at an ambient temperature.

[b] Test temperatures can vary in the conditions where sleepers are used (tunnels, extreme weather conditions, excessively exposed locations).

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3.4 Weathering resistance

The sleeper shall be designed to guarantee that at the end of its service life, the load-bearing capacities are sufficient for service even in case of the losses of strength due to weathering.

The requirements for the weathering resistance of the materials shall be agreed on between the interested parties.

The weathering resistance shall be demonstrated either by a documented and substantially proven experience or by assessing the properties in accordance with 4.13.1 or 4.13.2, as applicable.

4 Test methods

4.1 General

4.1.1 Preparation of test specimens

There shall be no damage or faults on the surface of the test specimens in order to prevent notch effects. If there are burrs, they shall be carefully removed without damaging the surface. If necessary, the edges of the surfaces of the test specimens shall be finished using sandpaper.

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4.1.2 Test conditions

Unless otherwise specified in a separate clause, the test shall be carried out in one of the standard atmospheres specified in ISO 291 after the test specimens are conditioned in the same atmosphere for at least 24 h.

4.1.3 Tolerance of test specimens

For each test method, the dimensions of the test specimens should be given with tolerances. The nominal dimension shall be ±1 mm.

4.2 Bending strength and flexural modulus

The test shall be conducted at (23 ± 5) °C using the following method.

The longitudinal direction of the test specimen shall be parallel to the supports and vertical to the load direction. A steel plate of dimensions 3 mm × 50 mm × 50 mm shall be placed on the test specimen and positioned in the middle between the supports.

The dimensions of the test specimen shall be:

— length: (240 ± 2) mm,

— width: (50 ± 1) mm,

— thickness: (20 ± 1) mm,

and the span between supports shall be 160 mm to 200 mm.

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The concentrated load shall be applied in the middle of the span. The average loading speed (stress) shall be less than 15 N/mm^2 per minute.

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The support shall be robust enough and have sufficient area to touch the test specimen. Both supports shall be located on the same distances from the centre of the test specimen in the longitudinal direction.

The other details of test arrangements shall refer to ISO 178.

4.3 Longitudinal compressive strength

The longitudinal compressive strength test shall be conducted at (23 ± 5) °C and using the following method.

The dimensions of the test specimen shall be:

— length: (40 ± 2) mm,

— width: (20 ± 0,5) mm,

— thickness: (20 ± 0,5) mm.

The longitudinal direction of the test specimen is corresponding to the longitudinal direction of the sleeper. The loading direction shall be parallel to the longitudinal direction of the test specimen.

The loading pressure shall be applied to the test specimen where the specimen is located between two flat steel plates. The average loading speed (stress) shall be less than 15 N/mm^2 per minute.

The other details of test arrangements shall be referred to ISO 604.

4.4 Lateral compressive strength

The lateral compressive strength test shall be conducted at (23 ± 5) °C using the following method.

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The test specimen shall be cut with a length between 500 mm and 700 mm and a width 200 mm and thickness 100 mm. The loading direction shall be vertical to the longitudinal direction of test specimen.

The loading pressure shall be applied to the test specimen using the flat steel plates both on its top and bottom sides. The average loading speed (stress) shall be less than 15 N/mm^2 per minute.

The other details of test arrangements shall be referred to ISO 604.

4.5 Shear strength

The shear strength test shall be conducted at (23 ± 5) °C using the following method.

The loading pressure shall be parallel to the longitudinal direction of test specimen. The loading pressure shall be applied by the method illustrated in Figure 1. The average loading speed (stress) shall be less than 5,88 N/mm^2 per minute.

The rectangular test specimen with dimensions 40 mm × 50 mm × 52 mm shall be prepared with a cut portion of 10 mm × 10 mm × 40 mm as shown in Figure 2.

The maximum load refers to the load before the test specimen begins to break (not to deform).

The setting jig shall be robust enough and have sufficient areas to touch the test specimen. In addition, as illustrated in Figure 1, the setting jig shall have the necessary capacity to hold the test specimen so as not to be moved even though load is given on the edge of the test specimen.

The tolerance of radius of curvature of the edge of the cut portion and the roughness of contact surface between the loading block and the test specimen can be defined on the agreement between the interested parties.

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The shear strength shall be determined from the test results using Formula (1).

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$$\tau = \frac{P_m}{A} \tag{1}$$

where

τ is the shear strength (N/mm^2);

P_m is the maximum load (N);

A is the cross-sectional area (mm^2).

NOTE Refer to ISO 604 for the definition of “maximum load”.

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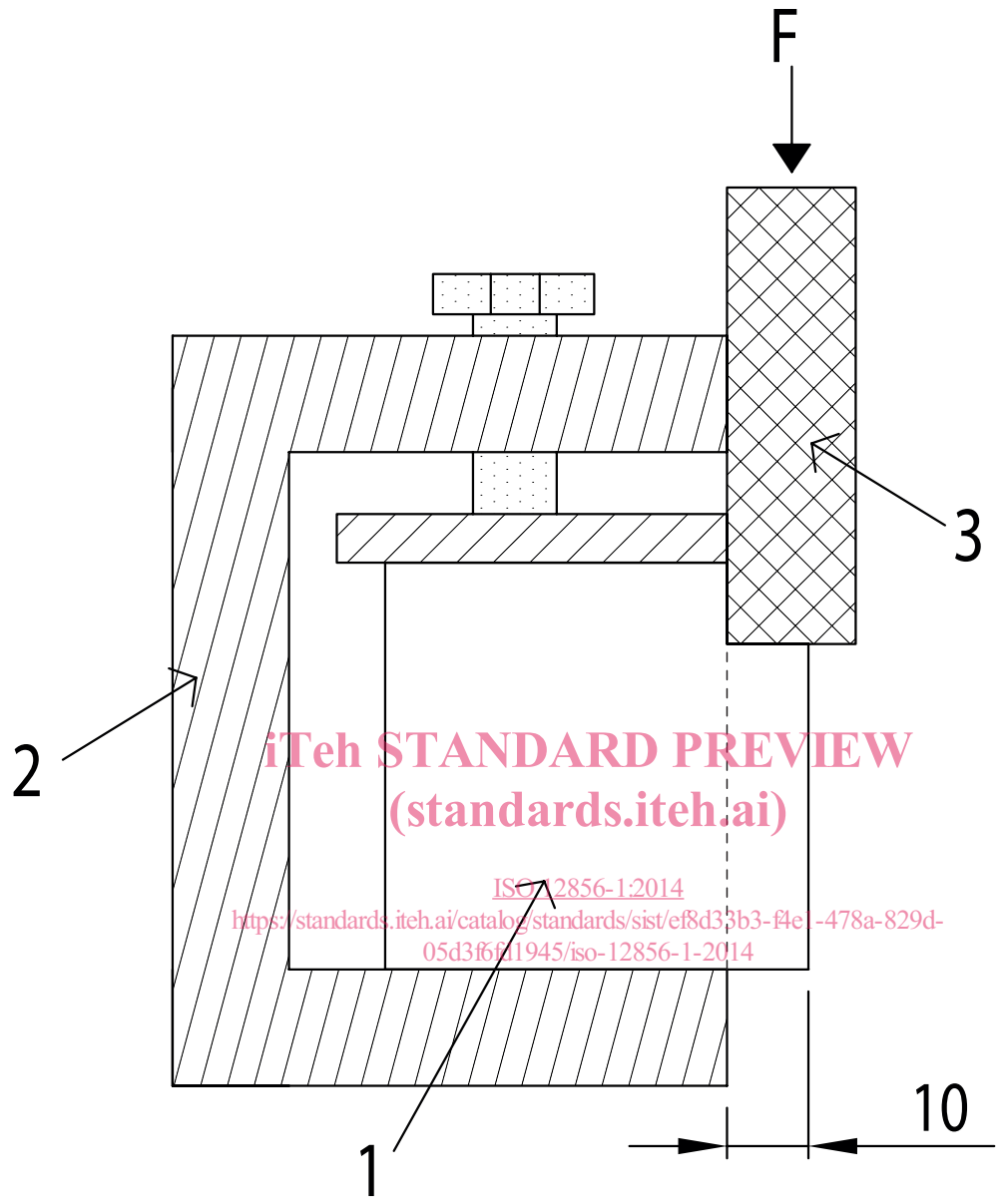
Dimensions in millimetres



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Key

1 specimen
2 setting jig
3 loading block
F load (or force)

Figure 1 — Loading method for shear strength test

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