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Railway applications — Polymeric composite sleepers, bearers and transoms —

Part 1: Material characteristics

Applications ferroviaires — Traverses et supports en matériaux composites à matrice polymère —

Partie 1: Propriétés des matériaux

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 269, *Railway applications*, Subcommittee SC 1, *Infrastructure.*

This second edition cancels and replaces the first edition (ISO 12856-1:2014), which has been technically revised.

The main changes are as follows:

— this document has been updated in accordance with addition of the new ISO 12856-2 (product testing) and ISO 12856-3 (general requirements).

A list of all parts in the ISO 12856 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Railway applications — Polymeric composite sleepers, bearers and transoms —

Part 1: Material characteristics

1 Scope

This document specifies the characteristics of polymeric composite and reinforced polymeric composite materials in the manufacture of polymeric composite railway sleepers. It is applicable to sleepers, bearers and transoms to be installed in all tracks (both heavy and urban rail) with or without ballast.

NOTE In this document, the term "sleeper" refers to "sleeper, bearer and transom".

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4582, *Plastics — Determination of changes in colour and variations in properties after exposure to glass-filtered solar radiation, natural weathering or laboratory radiation sources*

ISO 4892-2:2013, *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*

ISO 12856-2:2020, *Railway applications — Polymeric composite sleepers, bearers and transoms — Part 2: Product testing*

ISO 12856-3, *Railway applications — Polymeric composite sleepers bearers and transoms — Part 3: General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12856-3 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Material characteristics

4.1 Resistance

4.1.1 Chemical compatibility

The material of the polymeric composite sleepers shall be resistant against all chemicals that can regularly contaminate the sleepers in conventional railway traffic, e.g. oils/grease/hydrocarbons

(media dripping from railway vehicles) and possibly de-icing salts and herbicides/fungicides from weed control on the railway track.

The manufacturer shall prove the resistance to chemical media in suitable form, if necessary, through studies and demonstration of transferable knowledge from other application cases.

If the purchaser requests high resistance to specific chemicals (e.g. for use in loading and unloading areas of chemical factories, oil and chemical transhipment ports), the purchaser shall define requirements and the sleeper manufacturer shall prove these requirements/the resistance if necessary.

The purchaser may specify tests if the manufacturer's proof is not satisfactory or plausible according to the generally recognized state of scientific and technical knowledge.

4.1.2 Environmental resistance

4.1.2.1 Weathering resistance

The load bearing capacities of the sleeper until the end of its service life shall remain sufficient for service regardless of weathering effects. 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 changes of properties in accordance with ISO 4582:

  — after an exposure to xenon-arc lamps in accordance with ISO 4892-2:2013, Method A, Cycle 1;

  — and/or after an exposure to carbon-arc lamps in accordance with ISO 4892-4.

4.1.2.2 Resistance to water

The sleepers shall be highly resistant to water absorption, precipitation of water (rain, snow, dew, fog etc.). The purchaser may limit the possible water absorption when reasonably necessary.

The manufacturer may prove the basic non-water absorbing capacity of the material in suitable form, if necessary, through studies and demonstration of transferable knowledge from other application cases.

The purchaser may specify tests if the manufacturer's proof is not satisfactory or plausible according to the generally recognized state of scientific and technical knowledge.

4.1.2.3 Frost in connection with water

The sleepers shall be designed so that any penetrating and freezing water produces no frost damage to the sleepers.

The manufacturer may prove the basic non-water absorbing capacity of the material in suitable form, if necessary, through studies and demonstration of transferable knowledge from other application cases.

The purchaser may specify tests if the manufacturer's proof is not satisfactory or plausible according to the generally recognized state of scientific and technical knowledge.

4.1.2.4 Temperature resistance

4.1.2.4.1 Deformation

The material of the sleepers shall be selected in a way that sleepers subject to normally occurring long term temperature cycles do not deform to any extent (bend, rotate, twist), or do not soften or solidify too

much in order to meet the specific values required by the infrastructure operator in ISO 12856-2:2020, Clause 4.

These limit values are specified and tested in accordance with the relevant standards. For example, thermal-mechanical guiding characteristic values, to be measured on standard test specimens, such as for thermal deformability (e.g. Vicat softening temperature) and modulus of elasticity (tensile testing/bending).

4.1.2.4.2 Embrittlement

The manufacturer shall ensure that, for the plastic material used, the influence of temperature (see above) during the minimum service-life duration specified by the manufacturer does not lead to such embrittlement of the sleeper material that the specific values in accordance with ISO 12856-2:2020, Clause 4, are no longer maintained.

The purchasers shall specify the percentage of the absolute values of the specific values (for the sum of all influences described in 4.1) in accordance with ISO 12856-2:2020, Clause 4, which shall still be present until the end of the minimum service-life specified by the manufacturer.

4.1.2.5 Resistance to biological media

The sleeper material shall be sufficiently inert against any microbiological and macrobiological attack that the product specific values in accordance with ISO 12856-2:2020, Clause 4, are not reduced during the service life by more than a rate to be defined by the purchaser.

Microbiological attacks are, for example, attacks by fungi, algae, rotting and fermenting microbes.

Macrobiological attacks are, for example, attacks through the roots of plants and animal gnawing damage (e.g. beetles, ants/termites, rodents).

The manufacturer shall prove the resistance to biological media in suitable form, if necessary, through studies and demonstration of transferable knowledge from other application cases.

The purchaser may specify tests if the manufacturer's proof is not satisfactory or plausible according to the generally recognized state of scientific and technical knowledge.

4.2 Environmental compatibility

The plastic material should not contain any chemical, biological or physical environmental contaminants. No negative environmental impact should emanate from it. The limit values for chemical and biological contaminants shall be defined by the purchaser.

Should raw materials be processed that, from their history, were in contact with chemical or biological substances harmful to the environment, the manufacturer shall prove the absence of hazardous substances or the observance of limit values applied to their intended location. Waste legislation in accordance with the intended location is valid for the admissibility of using recycled raw materials for polymeric composite sleepers.

If sorting, washing or other cleaning processes are used in the raw material production, the manufacturer shall prove the absence of hazardous substances or the observance of limit values in accordance with health and safety regulations applicable to the production location.

If the manufacturer proves the observance of the aforementioned conditions during the use of the raw materials (e.g. through a quality management system accepted by the infrastructure operator or through a certification of the production in accordance with ISO 9001), a final inspection of the behavioural properties of finished sleepers is not necessary.

If the observance of the aforementioned conditions during the use of the raw materials is not provable by the manufacturer of the polymeric composite sleepers, the behavioural properties of all possible environmental contaminants on or in the raw materials and in finished sleepers shall be tested

according to the specifications of the infrastructure operator by a recognized laboratory that is independent of the manufacturer and is accredited for such measurements.

Proof, certificates and analyses that originate at the manufacturer according to the aforementioned regulations are to be archived for the minimum service life of the polymeric composite sleepers, which is forecast by the manufacturer, and are to be presented for tests by the infrastructure operator or environmental and regulatory authorities.

4.3 Mechanical properties

In order to characterize the mechanical properties of the plastic or reinforced plastic materials, the tests given in Table 1 are recommended. The test conditions used, specific tests and processes used to obtain the samples shall be communicated with the results.

Table 1 shows the material characteristics of interest. The characteristics can be demonstrated by the general properties of the original material or by testing.

NOTE 1 The tests are performed on plastic or reinforced plastic materials to be used for the product.

NOTE 2 For reinforcement materials, a data sheet or equivalent is provided.

Table 1 — Test methods for mechanical properties

Material	Characteristics	Test method
Thermoplastic matrix materials	Tensile strength	ISO 527-2
Materials based on long fibre-reinforced (fibre length under 7,5 mm) thermosetting resins	Tensile modulus of elasticity	ISO 527-4
	Tensile fatigue strength	Test method defined by the supplier and based on ISO 527-5
Materials based on long fibre-reinforced (fibre length over 7,5 mm) thermosetting resins	Compressive strength parallel to sleeper axis	ISO 604/ISO 14126
	Compressive modulus of elasticity parallel to sleeper axis	ISO 604/ISO 14126
Materials based on unidirectional fibre-reinforced thermosetting resins	Compressive strength in transverse direction	ISO 604/ISO 14126
	Compressive modulus of elasticity in transverse direction	ISO 604/ISO 14126
	Bending strength[a]	ISO 178/ISO 14125
	Flexural modulus[a]	ISO 178/ISO 14125
	Shear strength[a]	See Clause A.2
	Adhesive shear strength[a]	See Clause A.3
	Coefficient of thermal expansion	ISO 11359
	Glass transition temperature	ISO 11357-2
	Impact strength at different temperatures	ISO 179-1
	Water absorption	ISO 62
	Vicat softening temperature	ISO 306

[a] The bending strength, flexural modulus, shear strength and adhesive shear strength are recommended for materials based on unidirectional fibre-reinforced thermosetting resins.

Table 1 *(continued)*

Material	Characteristics	Test method
Any other plastic material	Tensile strength	To be defined
	Tensile modulus of elasticity	To be defined
	Tensile fatigue strength	To be defined
	Compressive strength parallel to sleeper axis	To be defined
	Compressive modulus of elasticity parallel to sleeper axis	To be defined
	Compressive strength in transverse direction	To be defined
	Compressive modulus of elasticity in transverse direction	To be defined
	Content of fibres	To be defined
	Coefficient of thermal expansion	To be defined
	Glass transition temperature	To be defined
	Impact strength at −20 °C and +23 °C	To be defined
	Water absorption	To be defined
	Vicat softening temperature	To be defined

[a] The bending strength, flexural modulus, shear strength and adhesive shear strength are recommended for materials based on unidirectional fibre-reinforced thermosetting resins.

Annex A
(informative)

Shear strength and adhesive shear strength

A.1 General

A.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.

A.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.

A.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.

A.2 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 A.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 A.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 A.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.

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

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

where

τ is the shear strength (N/mm^2);