SLOVENSKI STANDARD
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Vlakna za beton – 1. del: Jeklena vlakna – Definicija, specifikacije in skladnost

Fibres for concrete - Part 1: Steel fibres - Definitions, specifications and conformity

Fasern für Beton - Teil 1: Stahlfasern - Begriffe, Festlegungen und Konformität

Fibres pour béton - Partie 1 : Fibres d'acier - Définitions, spécifications et conformité

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Fibres for concrete - Part 1: Steel fibres - Definitions, specifications and conformity

Fibres pour béton - Partie 1 : Fibres d'acier - Définitions, spécifications et conformité

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This European Standard was approved by CEN on 26 June 2006.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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Foreword

This document (EN 14889-1:2006) has been prepared by Technical Committee CEN/TC 104 “Concrete and related products”, the secretariat of which is held by DIN. It has been developed by working group 11, “Fibres for concrete”, the secretariat of which is held by BSI.

This standard comprises two parts:

Part 1 dealing with steel fibres for concrete;

Part 2 dealing with polymer fibres.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2007, and conflicting national standards shall be withdrawn at the latest by May 2008.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of the Construction Products Directive.

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

This European Standard should be given the status of a national standard.

No existing European Standard is superseded.

Not all fibre characteristics that may be relevant to the performance of a fibre concrete, structural or non-structural, such as early age effects, creep and chemical attack, have been addressed in this standard due to the difficulties of formulating meaningful and reproducible standardised test methods.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This Part 1 of EN 14889 specifies requirements for steel fibres for structural or non-structural use in concrete, mortar and grout.

NOTE Structural use of fibres is where the addition of fibres is designed to contribute to the load bearing capacity of a concrete element. This standard covers fibres intended for use in all types of concrete and mortar, including sprayed concrete, flooring, precast, in-situ and repair concretes.

2 Normative references

The following referenced documents are indispensable for the application 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.

EN 10002-1, *Metallic materials – Tensile testing – Part 1: Method of test at ambient temperature*

EN 10218-1, *Steel wire and wire products - General – Part 1: Test methods*

EN 12350-3, *Testing fresh concrete - Part 3: Vebe test*

prEN 14845-1, *Test methods for fibres in concrete – Part 1: Reference concretes*

EN 14845-2, *Test methods for fibres in concrete - Part 2: Effect on concrete*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
steel fibres
straight or deformed pieces of cold-drawn steel wire, straight or deformed cut sheet fibres, melt extracted fibres, shaved cold drawn wire fibres and fibres milled from steel blocks which are suitable to be homogeneously mixed into concrete or mortar

3.2
length
distance between the outer ends of the fibre

3.2.1

developed length (for deformed fibres with irregular cross section)
length of the deformed fibres after straightening the fibre without deforming the cross section

3.3
equivalent diameter
diameter of a circle with an area equal to the mean cross sectional area of the fibre. For circular fibres, the equivalent diameter is equal to the diameter of the fibres

3.4
aspect ratio
ratio of length (l) to equivalent diameter of the fibre

3.5
fibre shape
specific outer configuration of the fibres, both in the longitudinal direction and in the shape of the cross section and also the possible surface coatings and/or bundling of fibres

3.6
tensile strength of fibre
stress corresponding to the maximum force a fibre can resist. The tensile strength is calculated by dividing the maximum force a fibre can resist by the mean cross sectional area of the fibre

3.7
residual flexural strength
notional stress at the tip of the notch which is assumed to act in an uncracked mid-span section, with linear stress distribution, of a prism subjected to the centre-point load F_j corresponding to $CMOD_j$ where $CMOD_j > CMOD_{FL}$; or to δ_j where $\delta_j > \delta_{FL}$ (j = 1,2,3,4)

3.8
crack mouth opening displacement (CMOD)
linear displacement measured by a transducer installed on a prism subjected to a centre-point load F

3.9
elastic modulus
initial slope of the tensile stress versus tensile strain curve

3.10
declared value
value for a product property, determined in accordance with this standard, that a manufacturer is confident of achieving within the given tolerances taking into account the variability of the manufacturing process

4 Symbols

Symbols used in this part of this standard are defined as follows:

A area of the cross section of the fibre, in mm^2;

d diameter or equivalent diameter of the fibre, in mm;

R_m tensile strength of the fibre, in MPa;

l length of the fibre, in mm;

l_d developed length of the fibre in mm;

m mass of the fibre in g;

λ = l / d and is the aspect ratio of the fibre;

ρ density of steel in kg/m^3.

5 Requirements

5.1 General

The steel fibres shall conform to one of the groups or one of the shapes listed below:

a) group

Steel fibres shall be classified into one of the following groups, in accordance with the basic material used for the production of the fibres.

Group I : cold-drawn wire

Group II : cut sheet

Group III : melt extracted

Group IV : shaved cold drawn wire

Group V : milled from blocks

b) Shape

Fibres shall be either straight or deformed. The manufacturer shall declare the shape of the fibre. The control and tolerances on the shape shall be specified for each different shape separately, and may be performed using optical equipment.

When applicable, the type of bundling shall be declared.

When steel fibres are supplied with a coating (e.g. zinc coating), the type and characteristic quantity in g/m² shall be declared. The control of the quantity shall be a function of the type of coating and shall be declared by the manufacturer.

5.2 Dimensions and tolerances

5.2.1 General

For fibres of group I and II, the length, equivalent diameter and aspect ratio shall be declared. The tolerances shall be as given in Table 1. Specimens of fibres, when sampled in accordance with 6.2.2 and measured in accordance with 5.2.2 and 5.2.3 shall not deviate from the declared value by more than the tolerances given in Table 1. At least 95 % of the individual specimens shall meet the specified tolerances in both cases.

For fibres of group III, IV and V, the range of lengths, equivalent diameters and aspect ratio's shall be declared. Specimens of fibres, when sampled in accordance with 6.2.2 and measured in accordance with 5.2.2 and 5.2.3 shall be within the specified range. At least 90 % of the individual specimen fibres shall meet the specified tolerances in both cases.

Table 1 — Tolerances on fibre length and diameter

Property	Symbol	**Deviation of the individual value relative to the declared value**	**Deviation of the average value relative to the declared value**
Length and developed length >30 mm ≤ 30 mm	***l*** **,** ***l*****$_d$** **(if applicable)**	± 10 %	 ± 5 % ± 1,5 mm
(Equivalent) diameter >0,30 mm ≤ 0,30 mm	*d*	± 10 %	 ± 5 % ± 0,015 mm
Length/diameter ratio	λ	± 15 %	± 7,5 %

5.2.2 Determination of length

The length shall be measured with a marking gauge (callipers) with an accuracy of 0,1 mm.

In the case of an irregular cross section, the developed length of the fibre shall also be determined to calculate the equivalent diameter. If straightening of the fibre is necessary, it shall be done by hand or, if this is not possible, by hammering on a level of wood, plastic material or copper using a hammer of similar material. During the straightening the cross section should not be changed.

5.2.3 Determination of (equivalent) diameter

5.2.3.1 Round wire fibres

The diameter of the fibre shall be measured with a micrometer, in two directions, approximately at right angles, to an accuracy of 0,01 mm. The fibre diameter shall be the mean of the two diameters.

5.2.3.2 Rectangular fibres

The width (w) and thickness (t) of the fibres shall be measured with a micrometer with an accuracy of 0,01 mm.

The equivalent diameter (d) is calculated as $\sqrt{\frac{4.w.t}{\pi}}$

5.2.3.3 Fibres with irregular cross section

The mass (m) and the developed length (l_d) of the fibre shall be determined. The mass shall be determined to an accuracy of 0,001 g. The equivalent diameter is computed from the mass and the developed length using the following formula:

$$d = \sqrt{\frac{4.m.10^6}{\pi.l_d.\rho}}$$

nominal density ρ of mild steel may be taken as 7850 kg/m³

nominal density ρ of stainless steel may be taken as 7950 kg/m³

5.3 Tensile strength of fibres

The tensile strength (R_m) shall be determined in accordance with EN 10002-1, except as indicated below, and shall be declared.

For Group I (cold drawn wire), the tensile strength shall be determined from the source wire before deformation. The acceptable tolerance on the declared value of R_m shall be 15 % for individual values and 7,5 % for the mean value. At least 95 % of the individual specimens shall meet the specified tolerance.

For Group II (cut sheet), the tensile strength shall be determined from the source plate before deformation. The acceptable tolerance on the declared value of R_m shall be 15 % for individual values and 7,5 % for the mean value. At least 95 % of the individual specimens shall meet the specified tolerance.

For Group III (melt extracted fibres), Group IV (shaved cold drawn wire) and Group V (milled from steel blocks) the tensile strength shall be determined from fibres with a minimum length of 20 mm clamped within the jaws of the testing machine. These fibre types have irregular cross-section and therefore the fibres will break at the minimum cross-section. The nominal tensile strength shall be determined by dividing the maximum load during the tensile test by the cross-section calculated from the equivalent diameter. The manufacturer may determine the cross-section at the break by an optical method, in which case the tensile strength obtained by dividing the maximum tensile load during the tensile test by the fracture cross-section, may also be declared, giving the precision of the area measurement.

For Groups III, IV and V the manufacturer may instead declare a minimum tensile strength and at least 90 % of the individual specimens of fibres shall then comply with this value.

5.4 Modulus of elasticity

The manufacturer shall declare the modulus of elasticity of the fibres.

The modulus of elasticity may be determined for Groups I and II fibres using the tensile test as described in EN 10002-1. The test shall be done on the basic material before deformation of the fibre and the modulus of elasticity shall be calculated using the stress and the deformation at 10 % and 30 % of R_m.

NOTE The typical modulus of elasticity for normal steel fibres is approximately 200.000 MPa. The typical modulus of elasticity for stainless steel fibres depends on the material composition and is approximately 170.000 MPa.

5.5 Ductility of fibres

If applicable, the manufacturer may declare a value for the ductility which shall be determined according to EN 10218-1 where the test is performed on the end diameter before deformation. The material shall be bent over a cylindrical support with a radius of maximum 2,5 mm. The average number of bends shall be declared.

5.6 Mixing

Mixing instructions shall be supplied by the manufacturer which recommend the mixing sequence to be adopted when introducing the fibre into both a centrally mixed concrete plant and for a dry batch truck mixed plant.

5.7 Effect on consistence of concrete

The effect of fibres on the consistence of a reference concrete conforming to prEN 14845-1 shall be determined.

The consistence according to EN 12350-3 shall be determined on the reference concrete without fibres and then on an identical mix with fibres. The effect on consistence shall be declared.

The amount of fibres added shall be declared by the manufacturer and shall be the minimum amount of fibres needed to obtain the required strength specified in 5.8. If a plasticiser or superplasticer is needed in order to meet the consistence requirements when determining the required addition level of fibres, the amount and type shall also be declared by the manufacturer.

The fibre manufacturer may additionally declare the consistence for the reference concrete with a range of dosages of fibres.

5.8 Effect on strength of concrete

The effect on strength shall be determined according to EN 14845-2 using a reference concrete conforming to prEN 14845-1. The unit volume of fibres in kg/m³ shall be declared by the manufacturer that achieves a residual flexural strength of 1,5 MPa at 0,5 mm CMOD (equivalent to 0,47 mm central deflection) and a residual flexural strength of 1MPa at 3,5 mm CMOD (equivalent to 3,02 mm central deflection).

5.9 Release of dangerous substances

Materials used in products shall not release any dangerous substances in excess of the maximum permitted levels specified in a relevant European Standard for the material or permitted in the national regulations of the member state of destination.

6 Evaluation of conformity

6.1 General

The conformity of a fibre to the requirements of this standard and with the declared values shall be demonstrated by the manufacturer by carrying out both:

- initial type testing of the product (see 6.2.)
- factory production control (see 6.3.)