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Fibres for concrete - Part 2: Polymer fibres - Definition, specifications and conformity

Fasern für Beton - Teil 2: Polymerfasern - Begriffe, Festlegungen und Konformität

Fibres pour béton - Partie 2: Fibres polymère - Définition, spécifications et conformité

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Fibres pour béton - Partie 2: Fibres polymère - Définition, spécifications et conformité

Fasern für Beton - Teil 2: Polymerfasern - Begriffe, Festlegungen und Konformität

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European foreword

This document (prEN 14889-2:2018) has been prepared by Technical Committee CEN/TC 104 “Concrete and related products”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 14889-2:2006.

This document has been prepared under a standardization request given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

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

This standard comprises two parts:

— Part 1 dealing with steel fibres for concrete;

— Part 2 dealing with polymer fibres for mortar and concrete.

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.

1 Scope

This document specifies requirements for polymer fibres for structural or non-structural use in concrete, mortar and grout. It covers fibres intended for use in all types of concrete and mortar, including sprayed concrete, flooring, precast, in-situ and repair concretes.

Provisions governing the application of polymer fibres in the production of fibre reinforced concrete or mortar elements, i. e. requirements concerning fibre content, structural design, mixing, placing, etc. of concrete including polymer fibres are not part of this standard.

NOTE Structural use of fibres is where the addition of fibres is designed to contribute to the load bearing capacity of a concrete or mortar element, see 3.18.

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.

EN 12226, *Geosynthetics — General tests for evaluation following durability testing*

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

EN 12390-3, *Testing hardened concrete — Part 3: Compressive strength of test specimens*

EN 14030, *Geotextiles and geotextile-related products — Screening test method for determining the resistance to acid and alkaline liquids (ISO/TR 12960:1998, modified)*

EN 14649, *Precast concrete products — Test method for strength retention of glass fibres in cement and concrete (SIC TEST)*

EN 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*

EN ISO 1973, *Textile fibres — Determination of linear density — Gravimetric method and vibroscope method (ISO 1973)*

EN ISO 2062, *Textiles — Yarns from packages — Determination of single-end breaking force and elongation at break using constant rate of extension (CRE) tester (ISO 2062)*

EN ISO 5079, *Textiles — Fibres — Determination of breaking force and elongation at break of individual fibres (ISO 5079)*

EN ISO 11357-3, *Plastics — Differential scanning calorimetry (DSC) — Part 3: Determination of temperature and enthalpy of melting and crystallization (ISO 11357-3)*

EN ISO 11358-1, *Plastics — Thermogravimetry (TG) of polymers — Part 1: General principles (ISO 11358-1)*

ISO 10406-1, *Fibre-reinforced polymer (FRP) reinforcement of concrete — Test methods — Part 1: FRP bars and grids*

3 Terms and definitions

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

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

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

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

3.1a
polymer (with known resistance to deterioration when in contact with the moisture and alkalis present in cement paste)
polymeric material such as polypropylene, polyethylene and blends of them

3.1b
polymer (with unknown resistance to deterioration when in contact with the moisture and alkalis present in cement paste)
polymeric material such as polyester, nylon, aramids, polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyacrylic, vinylal (PVA/vinylon) or other

3.2
polymer fibres
straight or deformed pieces of extruded, orientated and cut material which are suitable to be homogeneously mixed into concrete or mortar

3.3
filament
material after embossing (if applicable) before crimping (if applicable) and cutting to the specified length of the fibres

3.4
length
distance between the outer ends of the fibre

3.5
equivalent diameter
diameter of a circle with an area equal to the mean cross sectional area of the fibre or, in the case of fibrillated fibres, slit filament. For circular fibres, the equivalent diameter is equal to the diameter of the fibres

3.6
aspect ratio
ratio of length to equivalent diameter of the fibre

3.7
fibre shape
specific outer configuration of the fibre, both in the longitudinal direction and in the shape of the cross section and also the possible surface coatings and/or bundling of the fibres

3.8
tensile strength of the filament
stress corresponding to the maximum force a filament can resist. The tensile strength is calculated by dividing the maximum force a filament can resist by the cross sectional area of the filament, derived from the (equivalent) diameter

3.9
elongation of the filament
elongation of the filament is defined as the ratio of the length change of the filament to the initial length expressed as a percentage

3.10
secant modulus of elasticity of the filament
slope derived from the tensile test from a straight line between the stress-strain coordinates at 5 % and 25 % of the maximum strength of the filament

3.11
density of the fibre
density of the fibre expressed in g/cm^3

3.12
linear density
mass per unit length of a yarn or filament expressed in tex or its multiples or submultiples

Note 1 to entry: 1 tex = 1 g/1 000 m.

3.13
tenacity
breaking force of a filament divided by its linear density

3.14
melting point
temperature (range) as defined in EN ISO 11357-3

3.15
fibrillated fibre
slit film fibre where sections of the fibre peel away, forming branching fibrils

3.16
residual flexural strength
nominal 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)

3.17
crack mouth opening displacement (CMOD)
linear displacement measured by a transducer installed on a prism subjected to a centre-point load F

3.18
declared value
value for a product property, determined in accordance with this standard, that a manufacturer is confident of achieving within the given tolerances bearing in mind the variability of the manufacturing process

3.19
structural use
structural use of fibres is where the addition of fibres is designed to contribute to the load bearing capacity of a concrete or mortar element

4 Symbols

Symbols used in this standard are defined as follows:

A	area of the cross section of the fibre, in mm^2;
d	diameter of a fibre with a circular cross section, in mm;
d_e	equivalent diameter of the fibre, in mm;
l	measured length of the fibre, in mm;
l_d	measured length of the filament, in mm;
λ	$= l / d_e$ and is the aspect ratio of the fibre;
m	mass of the fibre, in g;
ρ	density of the fibre, in g/cm^3;
ρ_L	linear density of the fibre, in tex (or g/km);
T_s	melting point of the polymer, in °C;
Pmax	maximum tensile load carrying capacity of the filament, in N;
R_m	tensile strength of the filament, in MPa;
Ten	tenacity of the filament, in cN/tex;
ε	elongation of the filament, in %;
E	Secant modulus of elasticity of the filament, in MPa.

5 Classification of fibres

Polymer fibres shall be characterised by the manufacturer in accordance with their physical form:

Group Ia:	Micro fibres:	≤ 0,05 mm in (equivalent) diameter; mono-filamented
Group Ib:	Fibrillated fibres:	fibrillated
Group Ic:	Meso fibres:	0,05 mm < (equivalent) diameter ≤ 0,30 mm; mono-filamented
Group II:	Macro fibres:	> 0,30 mm in (equivalent) diameter; mono-filamented

NOTE Classes in the previous version of this standard EN 14889-2:2006 have been re-designated as groups.

6 Requirements

6.1 General

6.1.1 Polymer type

The basic polymer(s) or blends of polymers of the fibre shall be declared.

6.1.2 Shape

Polymer fibres may be either straight or deformed. The longitudinal and cross-sectional shape and type of deformation shall be declared. The control and tolerances on the cross-sectional shape and type of

deformation shall be specified for each different shape separately, and may be performed using optical equipment.

6.1.3 Surface treated, coated or bundled polymer fibres

The type and size of the fibre bundle (e. g. glued, wrapped) shall be declared.

Any surface treatment or coating (type and quantity), and any chemical or physical treatment of polymer fibres shall be defined and controlled.

NOTE Spin finish is a term used to describe the addition of chemical(s) used to coat the fibres that will then help the fibre to disperse in concrete. Without this coating some fibres will not easily disperse in concrete and will tend to ball up. However some types of chemical used to coat the fibres can induce air into the concrete or mortar. It is therefore important that any coating added to the fibre is controlled and is recorded as part of the initial type testing and as part of the factory control procedures.

6.2 Tolerances

Specimens of fibres or filaments, when sampled in accordance with 7.2.2 and measured in accordance with 6.3 and 6.3.3 shall not deviate from the declared value by more than the tolerances given in Table 1.

Within blends of polymer fibres the constituent fibre types shall comply. The proportions of the constituent fibres shall be controlled in the production process and declared.

Table 1 — Tolerance limits for the fibres and filaments

Property	Symbol	Deviation of the individual value relative to the declared value	Deviation of the average value relative to the declared value
All fibres			
Length, l > 20 mm		± 10 %	± 7,5 %
Length, l ≤ 20 mm		± 2,0 mm	± 1,5 mm
Group Ia, Ib fibres			
(equivalent) diameter	d_e	± 30 %	± 10 %
Group Ic fibres			
(equivalent) diameter	d_e	± 25 %	± 7,5 %
tensile strength of the filament	R_m	± 25 %	± 12,5 %
secant modulus of elasticity of the filament	E	± 25 %	± 12,5 %
Group II fibres			
(equivalent) diameter	d_e	± 20 %	± 5 %
length/diameter ratio	λ		± 10 %
tensile strength of the filament	R_m	± 25 %	± 10 %
secant modulus of elasticity of the filament	E	± 25 %	± 10 %
Blends			
Weight tolerance of the individual components in the blend (weight %)			± 5 %

6.3 Dimensions

6.3.1 General

The length, (equivalent) diameter and aspect ratio shall be declared for all fibres.

6.3.2 Length

The length shall be measured with a ruler or Vernier caliper with a resolution of at least 0,5 mm.

6.3.3 Determination of (equivalent) diameter

6.3.3.1 Fibre with circular cross section

For Group Ia fibres, the diameter can be determined by conversion from the linear density ρ_L. The linear density of Group Ia fibres shall be determined in accordance with EN ISO 1973.

For Group Ic, the diameter shall be measured using optical measuring equipment.

The diameter d_e in µm is to be calculated from:

$$d_e = \sqrt{\frac{400 \cdot \rho_L}{\pi \cdot \rho}} \qquad (1)$$

with

ρ in g/cm³ according to 6.3.4;

ρ_L in dtex according to 6.3.5.

For Group II fibres, the diameter of the fibre shall be measured with a micrometer with a resolution of at least 0,005 mm.

6.3.3.2 Fibre with elliptical cross section

The equivalent diameter of Group Ia fibres with elliptical cross section shall be determined according to 6.3.3.1.

The diameter of Group Ic and Group II fibres shall be measured with a micrometer, in two directions, approximately at right angles, with a resolution of at least 0,005 mm. The (equivalent) fibre diameter shall be the mean of the two diameters.

6.3.3.3 Rectangular fibres

The equivalent diameter of Group Ia fibres with rectangular cross section shall be determined according to 6.3.3.1.

The equivalent diameter of Group Ib fibres can be determined on the filament which can be larger than 0,3 mm.

The width (w) and thickness (t) of Group Ic and Group II fibres shall be measured with a resolution of at least 0,005 mm. The equivalent diameter, d_e, is calculated as

$$d_e = \sqrt{\frac{4 \cdot w \cdot t}{\pi}} \qquad (2)$$