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European Assessment Document for

# Polymer macro fibres reinforced with alkali resistant glass fibre for the use in concrete



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This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

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# 1 SCOPE OF THE EAD

## 1.1 Description of the construction product

The polymer macro fibres reinforced with alkali-resistant glass fibre for the use in concrete (in the following referred to as polymer macro fibres reinforced with alkali-resistant glass fibre) are made of a polymeric matrix coating a glass thread containing zirconium dioxide to achieve a high alkali resistance. The zirconium dioxide content ( $ZrO_2$ ) of the alkali-resistant (AR) glass is  $\geq 16$  % by mass. The moisture content of the AR glass thread with sizing is  $\leq 0,50$  % by mass. The strand-in-cement-strength (SIC strength) of the AR glass thread with sizing is  $\geq 250$  N/mm<sup>2</sup> (cf. EAD 260002-00-0301). The glass fibres are twisted using a sacrificial thread and saturated and coated with a vinyl ester resin. Thereby the macro fibres possess a helix structure. The fibres are manufactured from specified constituents in a production plant and produced as chopped strands in different lengths.

The polymer macro fibres reinforced with alkali-resistant glass fibre are not fully covered by EN 14889-2<sup>1</sup> for the following reasons: EN 14889-2 covers polymer fibres that consist exclusively of one polymer or a mixture of polymers. Although the polymer macro fibres reinforced with alkali-resistant glass fibre are assessed similarly to polymer macro fibres according to EN 14889-2, they are not covered by the scope of the EN. Also, the assessment method for density as of EN 14889-2, clause 5.3.4, is not suitable for the multi-component polymer macro fibres reinforced with alkali-resistant glass fibre.

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer's stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

## 1.2 Information on the intended use(s) of the construction product

### 1.2.1 Intended use(s)

The polymer macro fibres reinforced with alkali-resistant glass fibre are intended to be used for preparation of concrete, mortar and other mixes for construction and for the manufacturing of precast construction products for structural use.

### 1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the concrete incorporating the polymer macro fibres reinforced with alkali-resistant glass fibre for the intended use of 50 years when installed in the works (provided that the concrete incorporating the polymer macro fibres reinforced with alkali-resistant glass fibre is subject to appropriate installation (see 1.1)). These provisions are based upon the current state of the art and the available knowledge and experience.

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<sup>1</sup> All undated references to standards or to EADs in the text of this document are to be understood as references to the dated versions listed in chapter 4.

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works<sup>2</sup>.

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

### **1.3 Specific terms used in this EAD**

Unless stated otherwise the terms used in EN 14889-2 and EN 15422 apply.

CMOD = Crack Mouth Opening Displacement

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<sup>2</sup> The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

## 2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

### 2.1 Essential characteristics of the product

Table 2.1.1 shows how the performance of the polymer macro fibres reinforced with alkali-resistant glass fibre is assessed in relation to the essential characteristics.

**Table 2.1.1 Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics**

No	Essential characteristic	Assessment method	Type of expression of product performance
<b>Basic Works Requirement 1: Mechanical resistance and stability</b>			
1	Shape/cross section	2.2.1	Description
2	(Equivalent) diameter	2.2.2	Level
3	Length	2.2.3	Level
4	Density	2.2.4	Level
5	Content of resin (coating)	2.2.5	Level
6	Tensile strength	2.2.6	Level
7	Modulus of elasticity	2.2.7	Level
8	Softening temperature (Melting point)	2.2.8	Level
9	Point of ignition (Decomposition point)	2.2.9	Level
10	IR analysis of coating	2.2.10	Description
11	Effect on the consistency of concrete	2.2.11	Description
12	Effect on the strength of concrete (Residual flexural tensile strength)	2.2.12	Description
<b>Basic Works Requirement 3: Hygiene, health and the environment</b>			
13	Content, emission and/or release of dangerous substances	2.2.13	Level

## 2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

This chapter is intended to provide instructions for TABs. Therefore, the use of wordings such as “shall be stated in the ETA” or “it has to be given in the ETA” shall be understood only as such instructions for TABs on how results of assessments shall be presented in the ETA. Such wordings do not impose any obligations for the manufacturer and the TAB shall not carry out the assessment of the performance in relation to a given essential characteristic when the manufacturer does not wish to declare this performance in the Declaration of Performance.

### 2.2.1 Shape/cross section

The longitudinal (e.g., straight/ deformed) and cross-sectional (e.g., circular/ elliptical/ rectangular/ irregular) shape shall be determined on at least 10 specimens using a magnifying glass (3x) and described in the ETA by wording and sketch or photo.

### 2.2.2 (Equivalent) diameter

The (equivalent) diameter  $d_e$  shall be measured in accordance with EN 14889-2, clause 5.3.3, on at least 30 specimens and stated in the ETA (average value in mm).

### 2.2.3 Length

The length shall be measured in accordance with EN 14889-2, clause 5.3.2, on at least 30 specimens and stated in the ETA (average value in mm rounded on one decimal position, accompanied by standard deviation and variation coefficient in %).

The length shall be measured with a Vernier calliper with a resolution of at least of 0,1 mm.

### 2.2.4 Density

The density of the filament shall be measured by helium gas pycnometer method according to EN ISO 1183-3 on at least 10 specimens. The result shall be stated in the ETA (average value in g/cm<sup>3</sup>).

A sample cell with a diameter and height of approximately 25 mm (volume = 12,285 cm<sup>3</sup>) shall be used. The fibres shall be conditioned previously for at least 24 hours at (20±2) °C and (65±5) % relative humidity, then roughly cut to fit well into the sample cell. Samples of (5,00± 0,25) g shall be weighed out.

### 2.2.5 Content of resin (coating)

The content of vinyl ester resin (coating) shall be defined by determination of the loss on ignition in accordance with EN 196-2, clause 5.4, at a temperature of 600°C for 3 hours, on at least 5 specimens and shall be stated in % by mass in the ETA (average value in % by mass).

### 2.2.6 Tensile strength

The tensile strength,  $R_m$ , shall be determined on 30 individual filaments by EN ISO 2062 (method A), and shall be stated in the ETA (average value in N/mm<sup>2</sup>). The distance between the clamping points shall be 250 mm, the strain rate shall be 50 % per minute.

The tensile strength  $R_m$  shall be calculated from the breaking force divided by the cross sectional area  $\pi \cdot d_e^2 / 4$ .

Other methods (e.g., EN ISO 5079 or ISO 3341) than the one indicated may be used provided they give results correlated and equivalent to those obtained with the reference method. This is especially applied if the method above cannot be used due to specific manufacturing conditions of a specific product.

### 2.2.7 Modulus of elasticity

The secant modulus of elasticity shall be calculated from the tensile strength (clause 2.2.6) divided by the elongation at break of the filament (in %) and shall be stated in the ETA (average value in N/mm<sup>2</sup>). The initial distance between the clamping points shall be 250 mm. The strain rate shall be 50 % per minute. The strain rate can be measured by the relative movement of the clamps, provided that slippage is prevented.

Other methods (e.g., EN ISO 5079) than the one indicated may be used provided they give results correlated and equivalent to those obtained with the reference method.

### 2.2.8 Softening temperature (Melting point)

The softening temperature (melting point) shall be determined in accordance with EN ISO 11357-3 (EN ISO 11357-1, clause 4.2) on one specimen and shall be stated in the ETA.

For calibration indium with an accuracy of 0.001°C shall be used. In addition, a sensitivity calibration of both chambers shall be carried out in order to compare them. The measurement shall be carried out in aluminium crucibles, with an empty aluminium crucible being used as a reference in the second chamber. The heating rate shall be 10 K/min (dynamic mode). The sample mass shall be between 5 and 10 mg.

### 2.2.9 Point of ignition (Decomposition point)

The point of ignition (decomposition point) shall be determined in accordance with EN ISO 11358-1 on one specimen and shall be stated in the ETA.

The isothermal method (EN ISO 11358-1, clause 8.4) shall be used, while the sample is kept in a controlled oxidizing atmosphere (20% oxygen and 80% inert gas, flow rate 50 ml/min). The shape, dimensions and mass of the sample depend on crucible. Before testing the sample shall be dried at 40-60°C and cooled in a desiccator with drying gel. The heating rate shall be between 5 and 10 K/min (up to approximately 450°C) and onset shall be determined graphically or by software.

### 2.2.10 IR analysis of coating

The chemical composition of the coating (vinyl ester resin) shall be analysed by infrared analysis (IR analysis) in accordance with EN 1767, clause 7.2, on one specimen (sampling technique ATR - deviating from section 6 and 7.2 the specimen to be examined may stay in solid state and be put on an ATR crystal without further preparation).

### 2.2.11 Effect on the consistency of concrete

The effect of fibres on the consistency (workability) of fresh concrete shall be determined on a reference concrete (mandatory mix according to EN 14845-1, Table 1, footnote a – other mixes according to EN 14845-1, Table 1, may be used provided they give results correlated and equivalent to those obtained with the mandatory mix).

A default amount of fibres of 10 kg/m<sup>3</sup> concrete shall be used. If additional testing is necessary the amount of fibres shall be adjusted in steps of 0,5 or 1,0 kg depending on the results obtained. Additional testing is necessary if the concrete with fibres does not meet the strength requirements according to clause 2.2.12. As a second option the manufacturer may choose the amount of fibres used.

The consistency according to EN 12350-3 (Vebe test) shall be determined on the reference concrete without fibres and then on an identical mix with fibres. The effect on consistency with and without fibres shall be stated in the ETA.

### 2.2.12 Effect on the strength of concrete (Residual flexural tensile strength)

The effect of fibres on the strength of concrete shall be determined in accordance with EN 14889-2, clause 5.8 (as described in EN 14845-2), on a reference concrete (mandatory mix according to EN 14845-1, Table



1, footnote a – other mixes according to EN 14845-1, Table 1, may be used provided they give results correlated and equivalent to those obtained with the mandatory mix).

A default amount of fibres of 10 kg/m<sup>3</sup> concrete shall be used. If additional testing is necessary the amount of fibres shall be adjusted in steps of 0,5 or 1,0 kg depending on the results obtained. Additional testing is necessary if the concrete with fibres does not meet the strength requirements below. As a second option the manufacturer may choose the amount of fibres used.

The dosage of fibres in kg/m<sup>3</sup> that achieves a residual flexural strength of at least 1,5 MPa at 0,5 mm CMOD (equivalent to 0,47 mm central deflection) and a residual flexural strength of at least 1 MPa at 3,5 mm CMOD (equivalent to 3,02 mm central deflection) shall be determined and stated in the ETA.

## 2.2.13 Content, emission and/or release of dangerous substances

### 2.2.13.1 General

The performance of the polymer macro fibres reinforced with alkali-resistant glass fibre related to the emissions and/or release and, where appropriate, the content of dangerous substances will be assessed on the basis of any information provided by the manufacturer<sup>3</sup> after identifying the release scenarios taking into account the intended use of the product and the Member States where the manufacturer intends his product to be made available on the market.

The identified intended release scenarios for this polymer macro fibres reinforced with alkali-resistant glass fibre and intended use with respect to dangerous substances are:

S/W1: Product with direct contact to soil, ground- and surface water.

S/W2: Product with indirect contact to soil, ground- and surface water.

S/W3: Product with no contact to soil, ground- and surface water

### 2.2.13.2 Test on solids and leaching test

For the intended use covered by the release scenario S/W1 the total content and the leachable substances of the polymer macro fibres reinforced with alkali-resistant glass fibre shall be determined.

For the following parameters, the total content shall be determined on three representative samples after aqua regia digestion in accordance with CEN/TS 17196:

arsenic (As), lead (Pb), cadmium (Ca), total chromium (Cr), copper (Cu), nickel (Ni), mercury (Hg), thallium (TI), zinc (Zn).

The analysis of the parameters shall be in accordance with CEN/TS 17201. The average of the measured values of each parameter shall be expressed in mg/kg and stated in the ETA.

Three representative samples of the polymer macro fibres reinforced with alkali-resistant glass fibre shall be eluted in accordance with EN 12457-4. The following parameters in the eluate shall be determined using the methods for analysis in accordance with CEN/TS 17195:

1. arsenic (As), lead (Pb), cadmium (Ca), total chromium (Cr), copper (Cu), nickel (Ni), mercury (Hg), zinc (Zn) and
2. pH value, electrical conductivity.

The average of the measured values of each substance mentioned in No. 1 shall be expressed in µg/L, or mg/l and stated in the ETA.

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<sup>3</sup> The manufacturer may be asked to provide to the TAB the REACH related information which he must accompany the DoP with (cf. Article 6(5) of Regulation (EU) No 305/2011).

The manufacturer is **not** obliged:

- to provide the chemical constitution and composition of the product (or of constituents of the product) to the TAB, or
  - to provide a written declaration to the TAB stating whether the product (or constituents of the product) contain(s) substances which are classified as dangerous according to Directive 67/548/EEC and Regulation (EC) No 1272/2008 and listed in the "Indicative list on dangerous substances" of the SGDS, taking into account the installation conditions of the construction product and the release scenarios resulting from there.
- Any information provided by the manufacturer regarding the chemical composition of the products may not be distributed to EOTA or to TABs.

### 3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

#### 3.1 System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is Commission Decision 1999/469/EC(EU), as amended by Commission Decision 2001/596/EC.

The system is 1.

#### 3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 3.2.1.

**Table 3.2.1 Control plan for the manufacturer; cornerstones**

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
<b>Factory production control (FPC)</b> [including testing of samples taken at the factory in accordance with a prescribed test plan]					
<b>AR glass fibre</b>					
1	Zirconium dioxide content (ZrO <sub>2</sub> )	According to EAD 260002-00-0301, clause 3.2	See control plan	1	every batch
2	Density			1	every batch
3	Size content			2	every batch
4	Moisture content			2	every batch
5	Average diameter of filaments			2	every batch
6	Linear density of roving (Roving tex)			1	every batch
7	Tensile strength of strands			10	every batch
8	Alkali resistance (SIC strength)			10	every batch
<b>Polymer macro fibres reinforced with alkali-resistant glass fibre</b>					
9	Shape/cross section	2.2.1	See control plan	According to EN 14889-2, clause 6.3	According to EN 14889-2, clause 6.3
10	(Equivalent) diameter	2.2.2	See control plan		
11	Length	2.2.3	See control plan		
12	Content of resin	2.2.5	See control plan		
13	Tensile strength	2.2.6	See control plan		
14	Modulus of elasticity	2.2.7	See control plan		
15	Softening temperature/Melting point	2.2.8	See control plan	1	every batch
16	Point of ignition	2.2.9	See control plan	1	every batch
17	IR analysis of coating	2.2.10	See control plan	1	every batch
18	Density	2.2.4	See control plan	1	every batch

### 3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance of the product are laid down in Table 3.3.1.

**Table 3.3.1 Control plan for the notified body; cornerstones**

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
<b>Initial inspection of the manufacturing plant and of factory production control</b>					
1	Control of the manufacturing plant and of the factory production control carried out by the manufacturer regarding the constancy of performance (according to control plan)	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	According to control plan	According to control plan	When starting the production
<b>Continuous surveillance, assessment and evaluation of factory production control</b>					
2	Continuous surveillance, assessment and evaluation of the factory production control carried out by the manufacturer regarding the constancy of performance (according to control plan)	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in Table 3.2.1	According to control plan	According to control plan	1/year

#### 4 REFERENCE DOCUMENTS

EAD 260002-00-0301:2017	Alkali resistant glass fibres containing zirconium dioxide for the use in concrete (March 2016), OJEU 2017/C 343/06
EN 196-2:2013	Method of testing cement - Part 2: Chemical analysis of cement
EN 1767:1999	Products and systems for the protection and repair of concrete structures - Test methods - Infrared analysis
EN 12457-4:2002	Characterization of waste - Leaching; Compliance test for leaching of granular waste materials and sludges - Part 4: One stage batch test at a liquid to solid ratio of 10 l/kg for materials with particle size below 10 mm (without or with limited size reduction)
EN 14845-1:2007	Test methods for fibres in concrete - Part 1: Reference concretes
EN 14845-2:2006	Test methods for fibres in concrete - Part 2: Effect on concrete
EN 14889-2:2006	Fibres for concrete - Part 2: Polymer fibres - Definitions, specifications and conformity
EN 15422:2008	Precast concrete products - Specification of glassfibres for reinforcement of mortars and concretes
EN ISO 1183-3:1999	Plastics - Methods for determining the density of non-cellular plastics - Part 3: Gas pyknometer method (ISO 1183-3:1999)
EN ISO 2062:2009	Textiles - Yarns from packages - Determination of single-end breaking force and elongation at break using constant rate of extension (CRE) tester (ISO 2062:2009)
EN ISO 5079:2020	Textiles - Fibres - Determination of breaking force and elongation at break of individual fibres (ISO 5079:1979)
EN ISO 11357-3:2018	Plastics - Differential scanning calorimetry (DSC) - Part 3: Determination of temperature and enthalpy of melting and crystallization (ISO 11357-3:2018)
EN ISO 11357-1:2016	Plastics - Differential scanning calorimetry (DSC) - Part 1: General principles (ISO 11357-1:2016)
EN ISO 11358-1:2022	Plastics - Thermogravimetry (TG) of polymers - Part 1: General principles (ISO 11358-1:2022)
ISO 3341:2000	Textile glass - Yarns - Determination of breaking force and breaking elongation
CEN/TS 17195:2018	Construction products: Assessment of release of dangerous substances - Analysis of inorganic substances in eluates
CEN/TS 17196:2018	Construction products - Assessment of release of dangerous substances - Digestion by aqua regia for subsequent analysis of inorganic substances
CEN/TS 17201:2018+AC:2018	Construction products - Assessment of release of dangerous substances - Content of inorganic substances - Methods for analysis of aqua regia digests