

EUROPEAN ASSESSMENT DOCUMENT

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POINT CONNECTOR MADE OF GLASS FIBRE REINFORCED POLYMER FOR SANDWICH WALLS

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1 SCOPE OF THE EAD

1.1 Description of the construction product

The point connector for sandwich walls is made of glass fibre reinforced polymer (GFRP) made by pultrusion. The point connector consists of multi axial glass fibre reinforced layers. For the shape of the connector see Figure 1. The shape of the connector defines a straight type and an inclined type of point connector.

NOTE Sandwich walls are wall elements that consist of a base panel, a thermal insulation layer, a possible air space, and a facing panel. These sandwich walls are standardised in EN 14992, however, that does not imply the point connectors of GFRP are intended to be exclusively used in sandwich panels according to that standard.

One end of the connector is fastened to the reinforcement of the facing panel before concreting, the other end is embedded into the concrete of the base panel, see Figure 2. The installation of the connector can be carried out in horizontal and vertical direction.

Minimum embedment depth of the point connector, as well as minimum centre spacing and edge distance shall be defined.

The length of the point connector is depending on the thickness of the thermal insulation layer and is in a range of 20 to 35 cm.

The minimum embedment depth of the connector in the facing panels is 37 mm and 80 mm in the base panel.

The point connector is intended to transfer the actions on the facing panel into the base panel. The facing panel can be installed unsupported or supported. The facing panel is always non-loadbearing whereas the structural use of the base panel is depending on the requirements of the specific project. However, the facing panel and the base panel of the sandwich wall are not part of this EAD.

The concrete layers shall have a minimum concrete strength of C30/37 and maximum concrete strength of C50/60.

The insulation material of the thermal insulation layer is limited to soft insulation material e.g. EPS, mineral wool etc.

Sandwich walls composed by the point connectors of GFRP are delivered as a whole piece to the construction site.

The product is not covered by a harmonised European standard (hEN).

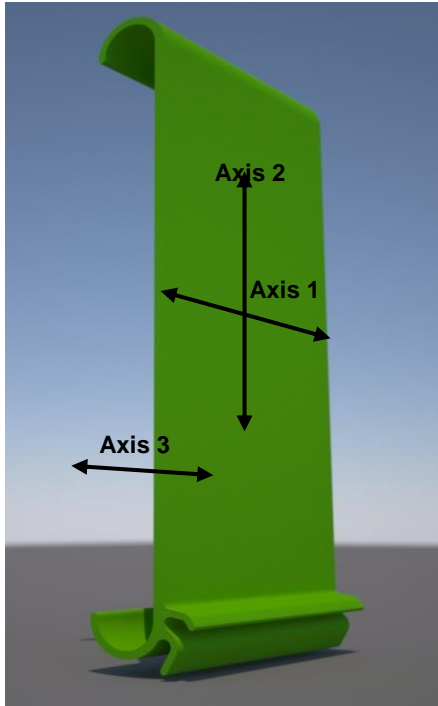


Figure 1 Point connector made of fibre glass reinforced polymer with defined axis

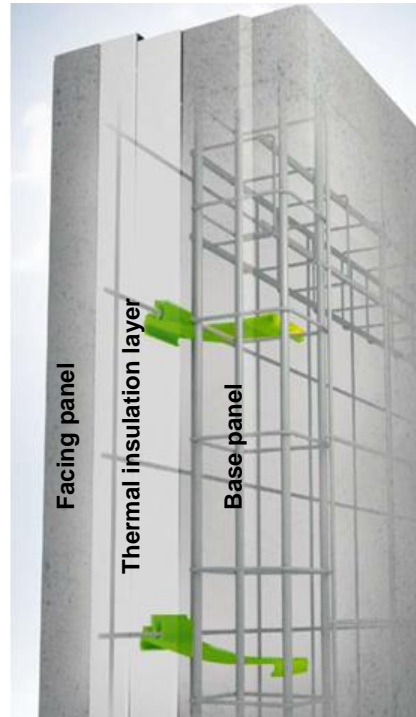


Figure 2 Installation of the point connector – Example

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 of the construction product

1.2.1 Intended use

The point connector of GFRP for sandwich walls is used to join base panel and facing panel, with a thermal insulation layer in between, see Figure 2. The sandwich wall is subject to predominantly static and quasi-static loads only.

Three applications are distinguished:

- 1 Sandwich walls with structural base panel and non-structural facing panel

Building with a structure independent from the sandwich wall:

- 2 Sandwich wall fastened as facade to the structure of the building. Horizontal loads perpendicular to the panel are carried by the base panel only.
- 3 Sandwich wall fastened as facade to the structure of the building. Horizontal loads perpendicular to the panel are carried as a composite system of base panel and facing panel. In that case the maximum dimensions of the sandwich wall are approx. 3.3 m × 14 m

Application 2 and 3 are non-structural sandwich walls.

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 point connector of glass fibre reinforced polymer for sandwich walls for the intended use of 50 years when installed in the works provided that the is subject to appropriate installation, see Clause 1.1. These provisions are based upon the current state of the art and the available knowledge and experience.

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 works¹.

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

1.3.1 Lot

Lot refers to the quantity of point connectors manufactured in a single production run and the whole quantity is made with the same parent material, i.e. all parent materials are themselves of the same batch.

1.3.2 Characteristic value

Value of a product characteristic having a prescribed probability of not being attained nor exceeded. This value corresponds to a specific fractile of the assumed statistical distribution of the particular property. For strength characteristics a 5 %-fractile and for all other characteristics a 10 %-fractile apply.

¹ 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 the working life referred to above.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 1 shows how the performance of the point connector of GFRP for sandwich walls is assessed in relation to the essential characteristics.

Table 1: Essential characteristics of the point connector of GFRP for sandwich walls 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 (Level, class, description)
Basic requirement for construction works 2: Safety in case of fire			
1	Reaction to fire	2.2.1	Class
Basic requirement for construction works 4: Safety and accessibility in use			
2	Shape	2.2.2	Description
3	Dimensions and tolerances	2.2.3	Description
4	Fibre content	2.2.4	Level
5	Density	2.2.5	Level
6	Tensile strength (Axis 1)	2.2.6	Level
7	Tensile strength (Axis 2)		Level
8	Tensile modulus of elasticity (Axis 1)		Level
9	Tensile modulus of elasticity (Axis 2)		Level
10	Compression strength (Axis 1)	2.2.7	Level
11	Compression strength (Axis 2)		Level
12	Compressive modulus of elasticity (Axis 1)		Level
13	Compressive modulus of elasticity (Axis 2)		Level
14	Tensile strain at tensile strength	2.2.8	Level
15	Axial, inter-laminar shear strength (Axis 2,3)	2.2.9	Level
16	In-plane shear strength (Axis 1,2)	2.2.10	Level
17	In-plane shear modulus (Axis 1,2)	2.2.11	Level
18	Tensile strength under high temperature (Axis 1)	2.2.12	Level
19	Tensile strength under high temperature (Axis 2)		Level
20	Tensile modulus of elasticity under high temperature (Axis 1)		Level
21	Tensile modulus of elasticity under high temperature (Axis 2)		Level
22	Compression strength under high temperature (Axis 1)	2.2.13	Level
23	Compression strength under high temperature (Axis 2)		Level

No	Essential characteristic	Assessment method	Type of expression of product performance (Level, class, description)
24	Compressive modulus of elasticity under high temperature (Axis 1)		Level
25	Compressive modulus of elasticity under high temperature (Axis 2)		Level
26	In-plane shear strength under high temperature (Axis 1,2)	2.2.14	Level
27	Alkali resistance in high pH solution	2.2.15	Level
28	Alkali resistance in high pH solution under load	2.2.16	Level
29	Creep deformation	2.2.17	Description
30	Thermal actions - Cyclic test in concrete	2.2.18	Description
31	Coefficient of thermal expansion (Axis 1 and Axis 2)	2.2.19	Level
32	Voids content	2.2.20	Level
33	Cure ratio	2.2.21	Level
34	Water absorption	2.2.22	Level
35	Thermogravimetry	2.2.23	Description
36	Glass transition temperature	2.2.24	Level
37	Connector embedded in concrete – Resistance to tension	2.2.25	Level
38	Connector embedded in concrete – Resistance to shear	2.2.26	Level
39	Edge distance	2.2.27	Description
40	Centre spacing	2.2.28	Description
Basic requirement for construction works 6: Energy economy and heat retention			
41	Thermal conductivity	2.2.29	Level

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

Characterisation of products to be assessed shall be done in accordance with available specifications, notably with dimensions, fibre content, layers and orientation of fibres, infrared spectrum of the resin, microscopic examinations and fibre composition.

2.2.1 Reaction to fire

Testing of the reaction to fire of the point connector of GFRP for sandwich walls in order to be classified is according to Commission delegated regulation (EU) 2016/364.

2.2.2 Shape

Description of the shape of the point connector of GFRP.

Figures of the shape shall be stated in the ETA.

2.2.3 Dimensions and tolerances

The relevant dimensions of the point connector of GFRP shall be determined. Dimensions shall be in accordance with the component's specification.

Dimensions of the point connector of GFRP shall be stated in the ETA.

2.2.4 Fibre content

Determination of fibre content shall be carried out according to EN ISO 1172.

- For glass fibre reinforced polymer (GFRP) without mineral fillers method A of EN ISO 1172 applies.
- For glass fibre reinforced polymer (GFRP) with mineral fillers method B of EN ISO 1172 applies.

The fibre content and content of mineral fillers shall be stated in the ETA.

2.2.5 Density

The density shall be determined according to EN ISO 1183-1, method A, i.e. immersion method.

Testing shall be carried out on 1 lot with 3 specimens.

The density shall be stated in the ETA.

2.2.6 Tensile strength and tensile modulus of elasticity

The tensile strength as well as the tensile modulus of elasticity of the point connector of GFRP in axis 1 and axis 2 (see Figure 1) shall be determined according to EN ISO 527-4 at $23\text{ °C} \pm 2\text{ °C}$.

The specimens are of rectangular shape, 150 mm long, 40 mm wide, and with full thickness of the point connector of GFRP.

Testing shall be carried out on 3 lots with 5 specimens per lot.

The characteristic values of tensile strength and tensile modulus of elasticity of the point connector of GFRP in axis 1 and axis 2 shall be stated in the ETA.

2.2.7 Compression strength and compression modulus of elasticity

The compression strength as well as the compression modulus of elasticity of the point connector of GFRP in axis 1 and axis 2 (see Figure 1) shall be determined according to EN ISO 14126. The test parameters are

- The specimens are of rectangular shape, 110 mm long, 10 mm wide, and with full thickness of the point connector of GFRP
- Testing is in Method 1 according to EN ISO 14126, where the test force is applied to the specimen by shear loading
- The ends of the specimens are reinforced with end tabs, obtained from the point connector of GFRP in full thickness and bonded to the specimens according to method 1.
- Temperature at testing is $23\text{ °C} \pm 2\text{ °C}$

Testing shall be carried out on 3 lots with 5 specimens per lot.

The characteristic values of compression strength and compression modulus of elasticity of the point connector of GFRP in axis 1 and axis 2 shall be stated in the ETA.

2.2.8 Tensile strain at tensile strength

Tensile strain at tensile strength of the point connector of GFRP shall be determined along axis 1 and axis 2 according to EN ISO 527-4 at $23\text{ °C} \pm 2\text{ °C}$.

The specimens are of rectangular shape, 150 mm long, 40 mm wide, and with full thickness of the point connector of GFRP.

Testing shall be carried out on 3 lots with 5 specimens per lot.

The characteristic value shall be stated in the ETA.

2.2.9 Axial, inter-laminar shear strength

The axial, inter-laminar shear strength of the point connector of GFRP shall be determined according to EN ISO 14130 at $23\text{ °C} \pm 2\text{ °C}$.

The specimens are of rectangular shape, with full thickness of the point connector of GFRP and 10 mm width.

Testing shall be carried out on 3 lots with 5 specimens per lot.

The characteristic value shall be stated in the ETA.

2.2.10 In-plane shear strength

The in-plane shear strength in axis 1, 2 (see Figure 1) of the point connector of GFRP shall be determined by the v-notched beam test method according to ASTM D7078 at $23\text{ °C} \pm 2\text{ °C}$.

Testing shall be carried out on 3 lots with 5 specimens per lot.

The characteristic value shall be stated in the ETA.

2.2.11 In-plane shear modulus

The in-plane shear modulus of the point connector of GFRP in axis 1,2, see Figure 1 shall be determined according to EN ISO 15310 at $23\text{ °C} \pm 2\text{ °C}$.

The specimens are of square shape, side length $\geq 35 \cdot h$, with full thickness of the point connector of GFRP.

Where

hthickness of the point connector of GFRP, i.e. dimension in axis 3, see Figure 1.

Testing shall be carried out on 3 lots with 5 specimens per lot.

The characteristic value shall be stated in the ETA.

2.2.12 Tensile strength and tensile modulus of elasticity under high temperature

Testing of tensile strength and tensile modulus of elasticity under high temperature in axis 1 and axis 2 (see Figure 1) shall be carried out on 3 lots with 5 specimens per lot. The specimens shall be conditioned to a temperature of $+ 80\text{ °C} \pm 2\text{ °C}$ for 4 h and then tested in a tensile test analogue to EN ISO 527-4 at this temperature.

The specimens are of rectangular shape, 150 mm long, 40 mm wide, and with full thickness of the point connector of GFRP.

In this test tensile strength and tensile modulus of elasticity at $+ 80\text{ °C} \pm 2\text{ °C}$ will be determined.

The modulus of elasticity shall be determined between approximately 25 and 50 % of the ultimate force.

The characteristic values of the tensile strength and tensile modulus of elasticity under high temperature in axis 1 and axis 2 shall be stated in the ETA.

2.2.13 Compression strength and compressive modulus of elasticity under high temperature

Testing of compression strength and compressive modulus of elasticity under high temperature in axis 1 and axis 2 (see Figure 1) shall be carried out on 3 lots with 5 specimens per lot. The specimens shall be conditioned to a temperature of $+ 80\text{ °C} \pm 2\text{ °C}$ for 4 h and then tested in a compression test analogue to EN ISO 14126 at this temperature. The test parameters are

- The specimens are of rectangular shape, 110 mm long, 10 mm wide, and with full thickness of the point connector of GFRP
- Testing is in Method 1 according to EN ISO 14126 where the test force is applied to the specimen by shear loading
- The ends of the specimens are reinforced with end tabs obtained from the point connector of GFRP in full thickness and bonded to the specimens according to method 1.
- In this test compression strength and compressive modulus of elasticity at $+ 80\text{ °C} \pm 2\text{ °C}$ will be determined.

The modulus of elasticity shall be determined between approximately 25 and 50 % of the ultimate force.

The characteristic values of the compression strength and compressive modulus of elasticity under high temperature in axis 1 and axis 2 shall be stated in the ETA.

2.2.14 In-plane shear strength under high temperature

Testing of in-plane shear strength in axis 1, 2 (see Figure 1) shall be carried out on 3 lots with 5 specimens per lot. The specimens shall be conditioned to a temperature of $+ 80\text{ °C} \pm 2\text{ °C}$ for 4 h and then tested in an in-plane shear strength by the v-notched beam test method analogue to ASTM D7078 at this temperature.

In this test in-plane shear strength at $+ 80\text{ °C} \pm 2\text{ °C}$ will be determined.

The characteristic value of the in-plane shear strength under high temperature in axis 1, 2 shall be stated in the ETA.

2.2.15 Alkali resistance in high pH solution

The intended working life of the point connector of GFRP especially depends on the chemical resistance of the resin components themselves and a suitable process.

This test determines the development of the point connector of GFRP under attack of alkaline ions, similar to the attack the point connector of GFRP experience in concrete.

Specimens of 3 lots (see Table 2 for detailed number of specimens per lot) shall be conditioned in an alkaline solution with 118.5 g Ca(OH)_2 , 0.9 g NaOH, and 4.2 g KOH in 1 l deionised water. For simulate testing of salt water resistance 0.5 g NaCl should be added to the solution. The pH value of the solution should be 12.6 to 13. The specimens should not be subjected to mechanical stress during the immersion².

The immersion shall last for up to 32 weeks, with intervals at 2 weeks, 4 weeks, 8 weeks and 16 weeks, duration at three different temperatures, preferable at room temperature ($23\text{ °C} \pm 2\text{ °C}$), $40\text{ °C} \pm 2\text{ °C}$ and $80\text{ °C} \pm 2\text{ °C}$. During the immersion the solution shall not be exposed to air.

Afterwards a tensile test shall be conducted according to EN ISO 527-4 at $23\text{ °C} \pm 2\text{ °C}$ and the decrease of tensile strength and modulus of elasticity is determined. Additionally the difference in mass shall be determined by weighting the specimens prior and after the immersion, reduction by loss of material, increase by absorption.

For intermediate times at 2 and 8 weeks only one sample per time and temperature may be tested, provided that the values form a straight line on logarithmic scale. Times of 4, and 32 weeks shall be tested with minimum 3 samples. Time of 16 weeks shall be tested with minimum 2 samples.

² Avoiding uncontrolled overlap of influences from mechanical stress and alkali resistance.

The second and third lot may be tested only at 80 °C.

Table 2: Samples for accelerate aging test in alkaline solution

first lot

t in weeks	0	2	4	8	16	32
Temperature	Samples					
23 °C ± 2 °C	5 ¹⁾	1	3	1	2	3
40 °C ± 2 °C	5 ¹⁾	1	3	1	2	3
80 °C ± 2 °C	5 ¹⁾	1	3	1	2	3

¹⁾ Reference from tensile test at least 35 specimens

second lot

t in weeks	0	2	4	8	16	32
Temperature	Samples					
23 °C ± 2 °C	—	—	—	—	—	—
40 °C ± 2 °C	—	—	—	—	—	—
80 °C ± 2 °C	5 ¹⁾	1	3	1	2	3

¹⁾ Reference from tensile test at least 10 specimens

third lot

t in weeks	0	2	4	8	16	32
Temperature	Samples					
23 °C ± 2 °C	—	—	—	—	—	—
40 °C ± 2 °C	—	—	—	—	—	—
80 °C ± 2 °C	5 ¹⁾⁾	1	3	1	2	3

¹⁾ Reference from tensile test at least 10 specimens

Tensile strength versus time of immersion shall be plotted. The test results shall be interpreted for 50 years lifetime prediction.

2.2.16 Alkali resistance in high pH solution under load

Alkali resistance in high pH solution under load is tested by subjecting the axis 2,3 of the point connector of GFRP under a defined bending stress to an aqueous alkaline environment.

The point connectors of GFRP are immersed in the alkaline solution under sustained bending stress. The test parameters are

- the mechanical stress under sustained load
- the pH value of the alkaline solution
- the temperature of the alkaline solution
- the immersion time

Reference tests for determining the characteristic flexural strength in axis 2, 3 of the point connector of GFRP shall be carried out according to EN ISO 14125 at 23 °C ± 2 °C.

The specimens are of rectangular shape, 60 mm long, 15 mm wide, and with full thickness of the point connector of GFRP.

The characteristic flexural strength shall be determined by evaluating statistically the 5 % fractile at 95 % confidence level of the test results.

Additionally specimens shall be immersed in an alkaline solution with 118.5 g Ca(OH)₂, 0.9 g NaOH and 4.2 g KOH in 1 l of deionised water. For simulate testing of salt water resistance 0.5 g NaCl should be added to this solution. The pH value of the solution should be 12.6 to 13.

The immersion under sustained load shall

- last for up to 16 weeks, 3 000 h
- with intervals at 0, 2, 4, 8, 16 week
- at two different temperatures, i.e. at room temperature, 23 °C ± 2 °C, and at 60 °C ± 2 °C. During the immersion the solution shall not be exposed to air.
- 30 % of the characteristic flexural strength assessed in the reference test.

Specimens of 3 lots shall be tested. For detailed number of specimens per lot see Table 3.

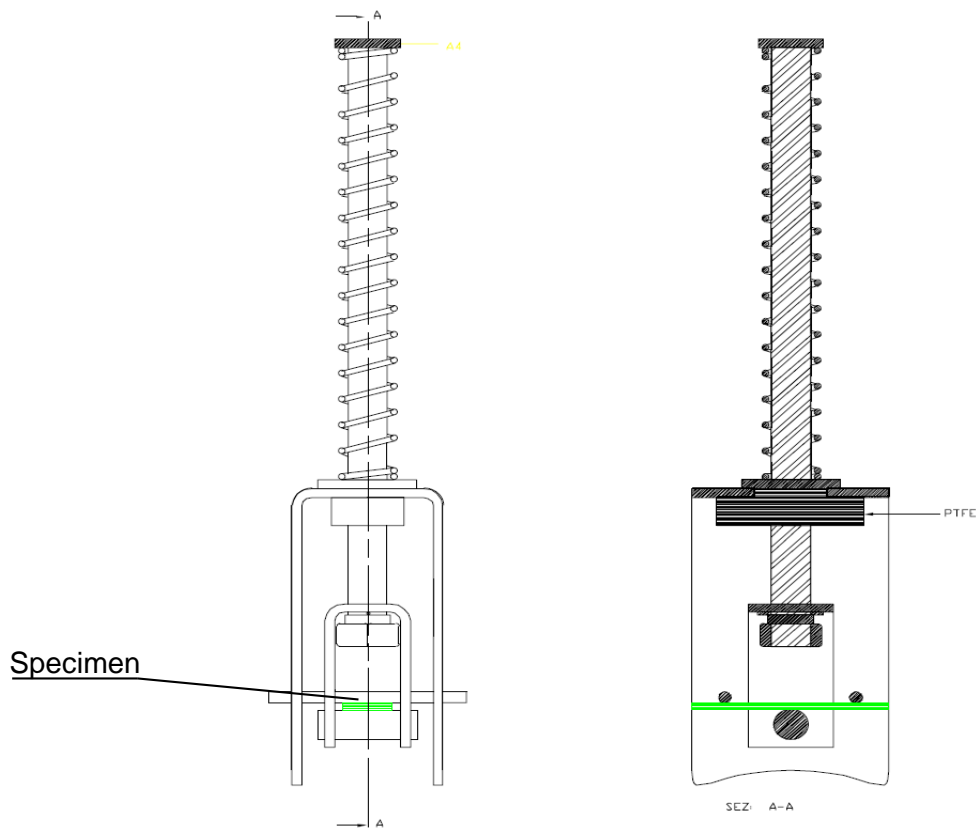


Figure 3: Test rig alkali resistance in high pH solution under load

Table 3: Samples for alkali resistance in high pH solution under load

first lot

t in weeks	0	2	4	8	16
Temp.	Samples				
23 °C ± 2 °C	5 ¹⁾	1	3	1	5
60 °C ± 2 °C	5 ¹⁾	1	3	1	5

¹⁾ Reference from bending test

at least 20 specimens

second lot

t in weeks	0	2	4	8	16
Temp.	Samples				
23 °C ± 2 °C	—	—	—	—	—
60 °C ± 2 °C	5 ¹⁾	1	3	1	5

¹⁾ Reference from bending test at least 10 specimens

third lot

t in weeks	0	2	4	8	16
Temp.	Samples				
23 °C ± 2 °C	—	—	—	—	—
60 °C ± 2 °C	5 ¹⁾	1	3	1	5

¹⁾ Reference from bending test at least 10 specimens

After the immersion in alkaline solution the flexural strength of the specimens shall be tested according to EN ISO 14125 and the decrease of flexural strength shall be determined.

Flexural strength versus time of immersion shall be plotted and shall be extrapolated to 50 years.

2.2.17 Creep deformation

The creep deformation of the point connector of GFRP shall be determined according to EN ISO 899-1. The test parameters are

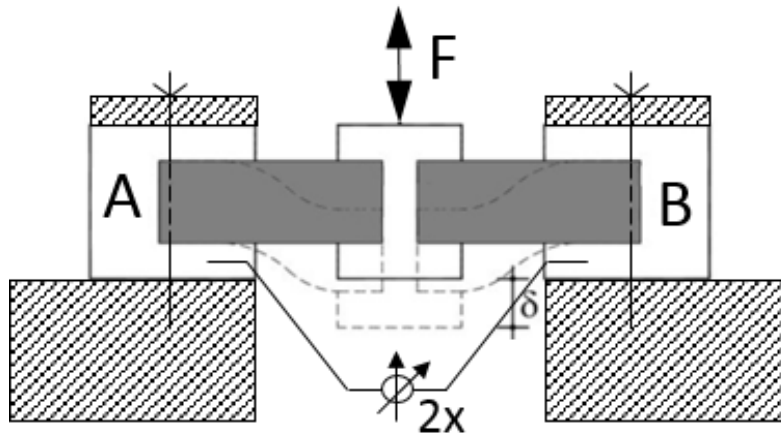
- at 23 °C ± 2 °C
- at ambient atmosphere
- specimens similar to shape 1BA according to EN ISO 527-2, however with larger shoulders to facilitate clamping
- the mechanical stress under sustained load
- the time under load

Testing shall be carried out on 3 lots with 5 specimens per lot.

Creep deformations versus time shall be plotted and shall be extrapolated to 50 years.

2.2.18 Thermal actions – Cyclic test in concrete

To simulate the actions caused by temperature changes on the concrete layers and therefore on the two types of point connector of GFRP a continuously alternating mechanical load or applied displacement is applied at constant frequency to a test specimen.



NOTE The horizontal movements (translation) of the concrete members A and B shall be allowed. The rotation shall be locked.

Figure 4: Test rig of the cyclic test in concrete of the straight connector (The test rig applies for the inclined connector accordingly)

The test members and concrete specimens (cylinders, cubes) shall be cured and stored indoors for seven days. Thereafter they may be stored outside provided they are protected such that frost, rain and direct sun does not cause a deterioration of the concrete compression and tension strength. The concrete members shall correspond to the maximum concrete strength of the panels. The concrete members A and B represent the base panel. The concrete member joint to A and B by the point connector represents the facing panel of the sandwich wall. The embedment depth of the connector in the base panel depends on the length of the connector to be tested and the spacing between base panel and facing panel represents the thickness of the thermal insulation.

Each type of point connector shall be assessed individually. For the test the shortest connector of each type of point connector shall be used. Testing is carried out at minimum embedment depth of the connector in the facing panel, minimum thermal insulation thickness of the sandwich wall intended to be assembled by the point connector of GFRP and the resulting embedment depth of the connector in the base panel, which in any case shall correspond to the minimum embedment depth of the connector in the base panel.

The height, width and thickness of the three concrete members shall be chosen in such a way that represents the conditions of use and delivers satisfactory results. The minimum edge distance of the point connector of GFRP shall be observed.

The load shall induce a defined cyclic displacement of the concrete member which is connected to the concrete members A and B by point connectors of GFRP. The testing machine shall be capable of repeating the displacement amplitude at the defined frequency. The testing machine shall be fitted with a counter capable of recording the number of cycles. The accuracy of the displacement shall be within 1% of the displacement range.

The concrete member is subject to cyclic displacement corresponding to the temperature spectrum of Table 4 and Figure 3.

The displacements resulting from these temperatures are calculated as follows.

$$v_h = \pm \frac{c \cdot \alpha_c \cdot \Delta T}{4}$$

Where

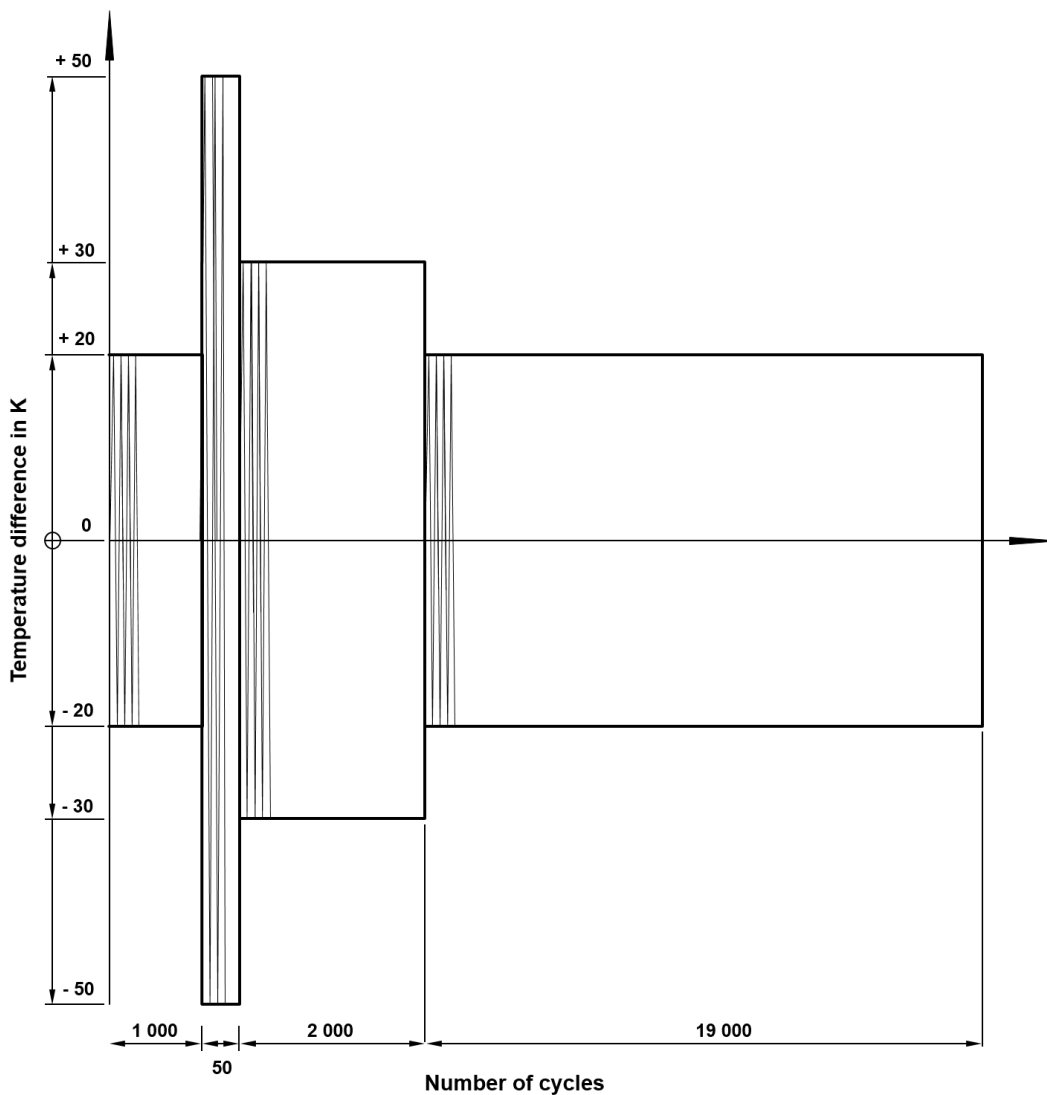
α_c linear coefficient of thermal expansion, i.e. $\alpha_c = 10 \cdot 10^{-6} \text{ K}^{-1}$ linear coefficient of thermal expansion for concrete

ΔT Total temperature difference in K

- cmaximum height of the horizontal sandwich panel or maximal width of the vertical sandwich panel
- v_h lateral displacement in mm

Table 4: Temperature spectrum for cyclic displacement test

Number of displacement cycles	Total temperature difference
1 000 displacement cycles corresponding to	$\Delta T = 40 \text{ K}$
50 displacement cycles corresponding to	$\Delta T = 100 \text{ K}$
2 000 displacement cycles corresponding to	$\Delta T = 60 \text{ K}$
19 000 displacement cycles corresponding to	$\Delta T = 40 \text{ K}$



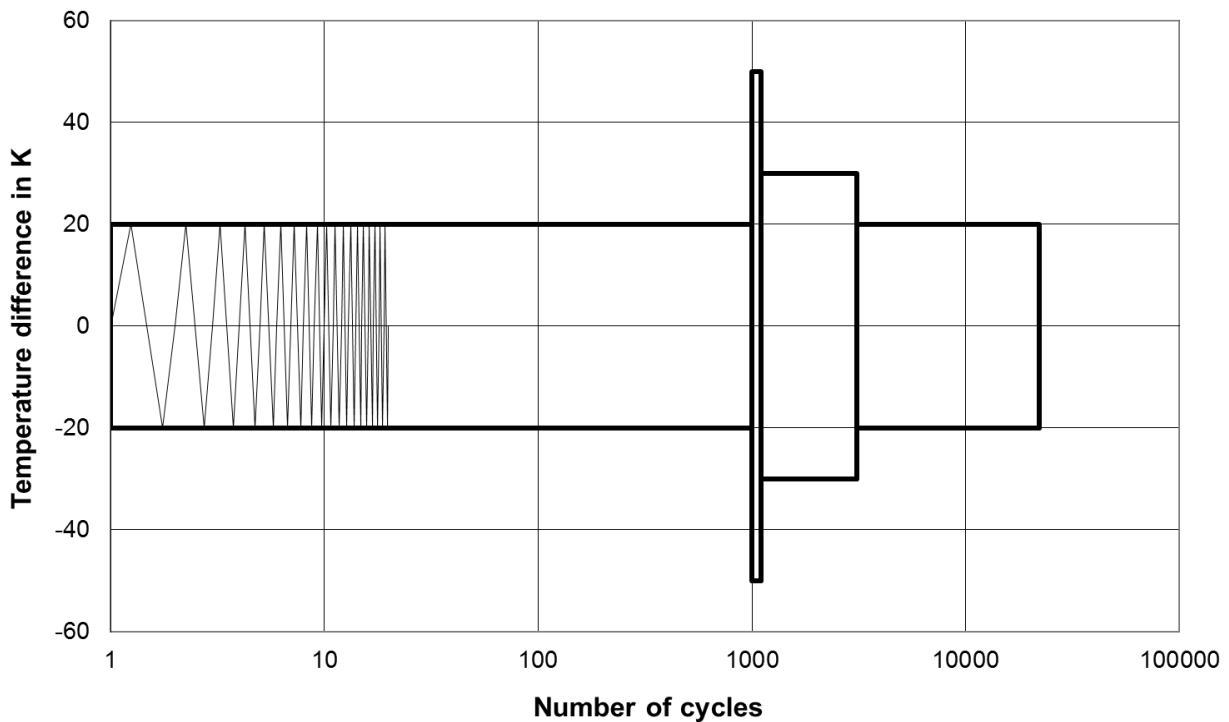


Figure 5: Temperature spectrum for cyclic displacement test – Schematic and in scale

After the cyclic displacement test the point connector of GFRP and the adjacent concrete shall be free of cracks and spalling. At the end of cycles a shear test to failure shall be performed.

The cyclic displacement test should not adversely affect the load bearing capacity of the product to a considerable extend. The value $\frac{V_u}{V_t}$ of the cyclic displacement test is calculated.

Where

V_u ultimate shear force determined in test

V_t characteristic shear force determined in test under Clause 2.2.26

The tested deformation shall be given in the ETA.

2.2.19 Coefficient of thermal expansion

The coefficient of thermal expansion shall be determined in longitudinal and transverse direction according to ISO 11359-2. The temperature range in which the coefficient is to be determined shall be 0.1 to 0.3 of the glass transition temperature T_g .

Where

T_g Glass transition temperature in °C

Test shall be carried out on 3 lots with 3 specimens per lot.

The coefficient of thermal expansion shall be stated in the ETA.

2.2.20 Voids content

The void content shall be determined according to ASTM D2734-09.

Tests shall be carried out on 3 lots with 3 specimens per lot.

The void content shall be stated in the ETA.

2.2.21 Cure ratio

The cure ratio of the point connector of GFRP will be determined by differential scanning calorimetry (DSC) according to CSA-S807-10.

Testing shall be carried out on 3 lots with 5 specimens per lot.

The cured specimens shall display no residual reaction.

2.2.22 Water absorption

The water uptake of the composite material shall be determined according to EN ISO 62. The samples shall be dried, weighted and immersed into water at 50°C until full saturation.

Testing shall be carried out on 3 lots with 5 specimens per lot.

The water content shall be calculated from the mass difference.

$$w = 100 \cdot \frac{P_s - P_d}{P_d}$$

Where

w..... water absorption

P_d dry mass of specimen

P_s..... mass of specimen after immersion

The characteristic value for water absorption shall be stated in the ETA.

2.2.23 Thermogravimetry

The TG-curve shall be determined according to EN ISO 11358. Testing shall be carried out on 2 lots with 2 specimens per lot.

The TG-chart is obtained by plotting the mass of a specimen, in general as a fraction of its initial mass, as the ordinate and the temperature the specimen is exposed to as the abscissa.

The reference TG-curves for the point connector of GFRP shall be stated in the ETA.

2.2.24 Glass transition temperature

This test determines the glass transition temperature of the composite material by Differential Scanning Calorimetry (DSC) according to EN ISO 11357-2 as T_{1/2, g} i.e. midpoint temperature.

3 lots of resin with 3 specimens per lot shall be tested.

2.2.25 Connector embedded in concrete – Resistance to tension

The reaction of the two types of point connectors of GFRP embedded in concrete during tensile load shall be assessed by pull-out failure tests. Due to the different shape of the ends of the point connector of GFRP both sides shall be embedded in concrete during testing.

For the straight type of point connector of GFRP the test rig consists of 2 concrete members joint by embedding 1 straight connector in the concrete members. The tests shall be carried out at minimum concrete strength and minimum thickness of the facing and base panel, as well as minimum embedment depth of the point connector in the facing and base panel. The minimum edge distance shall be observed.

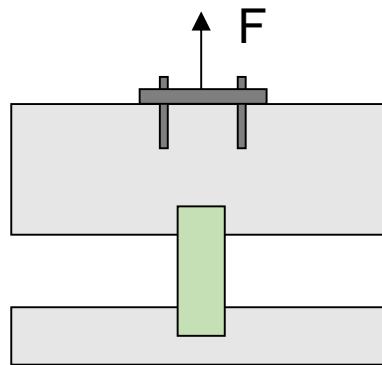


Figure 6: Test rig of the straight connector embedded in concrete subjected to tension

The inclined type of point connector of GFRP shall be tested by joining the 2 concrete members with 2 inclined point connectors of opposite inclination. The interaction of the influence areas of the 2 inclined point connectors embedded in concrete shall be observed. The tests shall be carried out at minimum concrete strength and minimum thickness of the facing and base panel, as well as minimum embedment depth of the point connector in the facing and base panel. The minimum edge distance and centre spacing shall be observed as well.

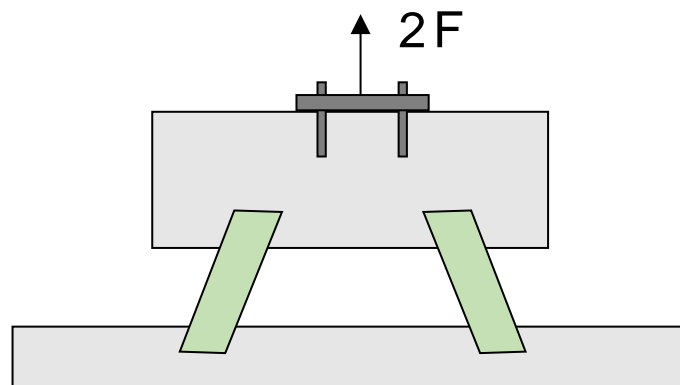


Figure 7: Test rig of the inclined connector embedded in concrete subjected to tension

The test members and concrete specimens (cylinders, cubes) shall be cured and stored indoors for seven days. Thereafter they may be stored outside provided they are protected such that frost, rain and direct sun does not cause a deterioration of the concrete compression and tension strength.

The test rigs shall allow the formation of an unrestricted rupture cone.

For each of the point connector of GFRP, i.e. the straight and the inclined, 5 pull-out failure tests shall be performed. To determine the resistance to tension of the point connector of GFRP the failure load shall be evaluated statistically by determining the 5 % fractile at 90 % confidence level. When evaluating the test results of the inclined connector the failure loads shall be divided by 2 before the statistically evaluation.

The failure mode shall be documented. The characteristic resistance to tension of the straight and inclined point connector of GFRP embedded in concrete and the corresponding boundary conditions shall be stated in the ETA.

2.2.26 Connector embedded in concrete – Resistance to shear

The reaction of the two types of point connector of GFRP embedded in concrete during shear load shall be assessed by shear tests.

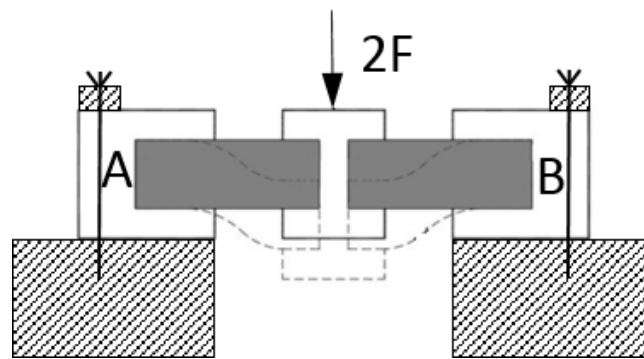


Figure 8: Test rig of the straight connector embedded in concrete subjected to shear load
(The test rig applies for the inclined connector accordingly)

The test members and concrete specimens (cylinders, cubes) shall be cured and stored indoors for seven days. Thereafter they may be stored outside provided they are protected such that frost, rain and direct sun does not cause a deterioration of the concrete compression and tension strength. The concrete members A and B represent the base panel. The concrete member joint to A and B by the point connector represents the facing panel of the sandwich wall.

Each type of point connector shall be assessed individually. The test shall be performed at minimum embedment depth of the connector in the facing panel and base panel. For the test the longest connector of each type of point connector shall be used in order to simulate the maximum thickness of the insulation layer of the sandwich wall intended to be assembled by the point connector of GFRP. The height, width and thickness of the three concrete members shall be chosen in such a way that represents the conditions of use and delivers satisfactory results.

Loading of the specimen shall be carried out until failure. The minimum edge distance of the point connector of GFRP shall be observed.

5 shear tests of each type of point connector with concrete members corresponding to the minimum concrete strength of the panels shall be performed. If failure occurs in the concrete members and not in the connector the test shall be repeated (again 5 shear tests) with concrete members corresponding to maximum concrete strength. To determine the resistance to shear of one point connector of GFRP the failure load shall be divided by 2 and then evaluated statistically by determining the 5 % fractile at 90 % confidence level.

The failure mode shall be documented. The characteristic resistance to shear force of the point connector of GFRP embedded in concrete corresponding to the minimum or/and maximum concrete strength of the panels shall be stated in the ETA.

2.2.27 Edge distance

The minimum edge distance of the point connector of GFRP, see Clauses 2.2.18, 2.2.25, and 2.2.26, shall be stated in the ETA.

2.2.28 Centre spacing

The minimum centre spacing of the point connector of GFRP, at least 2 times the minimum edge distance according to Clause 2.2.27, shall be stated in the ETA.

2.2.29 Thermal conductivity

The design thermal conductivity of the materials is obtained from tabulated values in EN ISO 10456.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is: Decision 97/463/EC³

The system is: 2+.

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 5.

Table 5: Point connector of glass fibre reinforced polymer for sandwich walls – 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
Factory production control (FPC) including testing of samples taken at the factory in accordance with a prescribed test plan					
1	Resin components	Inspection of documents	Conformity with resin specification	100 %	Each delivery
2	Fibre	Inspection of documents	Conformity with fibre specification	100 %	Each delivery
3	Layers and orientation of the fibres	Annex 1.2.1.1	Annex 1.2.1.2	1 per test	Every 2 000 m of finished product, however, once a day
4	Visual inspection	—		100 %	Continuously
5	Dimensions	2.2.3	2)	3 per test	3 per lot
6	Fibre content	2.2.4	2)	3 per test	3 per lot
7	Density Void content	2.2.5	2)	3 per test	3 per lot
8	Modulus of elasticity, tensile strength and tensile strain at tensile strength	2.2.6 2.2.8	2)	3 per test	1 per month
9	Modulus of compressive and compression strength	2.2.7	2)	3 per test	1 per month
10	Axial, inter-laminar shear strength	2.2.9	2)	3 per test	1 per month

³ Official Journal of the European Communities/Union L 198/31 of 25 July 1997, Page 2

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
11	Curing degree of matrix resin	2.2.21	2)	1 per test	1 per lot
12	Water absorption	2.2.22	2)	3 per test	4 per year
13	Glass transition temperature	2.2.24	2)	1 per test	4 per year
2) As defined by the specification of the point connector.					

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment verification of constancy of performance for the point connector of glass fibre reinforced polymer for sandwich walls are laid down in Table 6.

Table 6: Point connector of glass fibre reinforced polymer for sandwich walls – 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
Initial inspection of the manufacturing plant and of factory production control					
1	The notified product certification body shall verify the ability of the manufacturer for a continuous and orderly manufacturing of the product according to the European Technical Assessment. In particular the following items shall be appropriately considered <ul style="list-style-type: none"> – personnel and equipment – the suitability of the factory production control established by the manufacturer – full implementation of the prescribed test plan 				—
Continuing surveillance, assessment and evaluation of factory production control					
2	The notified product certification body shall verify that <ul style="list-style-type: none"> – the manufacturing process – the system of factory production control – the implementation of the prescribed test plan are maintained.				Once per year

4 REFERENCE DOCUMENTS

As far as no edition date is given in the list of standards thereafter, the standard in its current version at the time of issuing the European Technical Assessment, is of relevance.

EN 1767	Products and systems for the protection and repair of concrete structures - Test methods - Infrared analysis
EN 13706-2	Reinforced plastics composites – Specifications for pultruded profiles - Part 2: Methods of test and general requirements
EN 14992	Precast concrete products – Wall elements
EN ISO 62	Plastics – Determination of water absorption
EN ISO 527-4	Plastics - Determination of tensile properties - Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites
EN ISO 899-1	Plastics - Determination of creep behaviour - Part 1: Tensile creep
EN ISO 1172	Textile-glass-reinforced Plastics - Prepregs, moulding compounds and laminates - Determination of the textile-glass and mineral-filler content - Calcination methods
EN ISO 1183-1	Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method
EN ISO 10456	Building materials and products — Hydrothermal properties — Tabulated design values and procedures for determining declared and design thermal values — Technical Corrigendum 1
EN ISO 11357-2	Plastics — Differential scanning calorimetry (DSC) — Part 2: Determination of glass transition temperature and glass transition step height
EN ISO 11358	Plastics -- Thermogravimetry (TG) of polymers -- Part 1: General principles
EN ISO 14125	Fibre-reinforced plastic composites - Determination of flexural properties
EN ISO 14126	Fibre-reinforced plastic composites - Determination of compressive properties in the in-plane direction
EN ISO 14130	Fibre-reinforced plastic composites - Determination of apparent interlaminar shear strength by short-beam method
EN ISO 15310	Fibre-reinforced plastic composites - Determination of the in-plane shear modulus by the plate twist method
ISO 11359-2	Plastics -- Thermomechanical analysis (TMA) Determination of coefficient of linear thermal expansion and glass transition temperature
ASTM D2734	Standard Test Methods for Void Content of Reinforced Plastics
ASTM D7078	Standard Test Method for Shear Properties of Composite Materials by V-Notched Rail Shear Method
CSA-S807-10	Canadian Standards Association, Specification for fibre-reinforced polymers
97/463/EC	Commission Decision 97/463/EC of 27 June 1997 on the procedure for attesting the conformity of construction products pursuant to Article 20 (2) of Council Directive 89/106/EEC as regards plastic anchors for use in concrete and masonry, OJ L 198 of 25 July 1997, p. 31

- 305/2011 Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011, laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, OJ L 88 of 4 April 2011, p. 5, Amended by Commission Delegated Regulation (EU) No 568/2014 of 18 February 2014, OJ L 157 of 27 May 2014, p. 76, and Commission Delegated Regulation (EU) No 574/2014 of 21 February 2014, OJ L 159 of 28 May 2014, p. 41
- 2016/364 Commission delegated regulation (EU) 2016/364 of 1 July 2015 on the classification of the reaction to fire performance of construction products pursuant to Regulation (EU) No 305/2011 of the European Parliament and of the Council, OJ L 68 of 15 March 2016, p. 4