EUROPEAN ASSESSMENT DOCUMENT

EAD 260001-00-0303

April 2016

STRUCTURAL SECTIONS MADE FROM FIBER REINFORCED POLYMERS (FRP/GLASSFIBER COMPOSITES)

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) No 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

Contents

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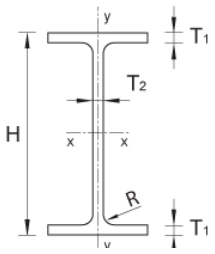
1 SCOPE OF THE EAD

1.1 Description of the construction product

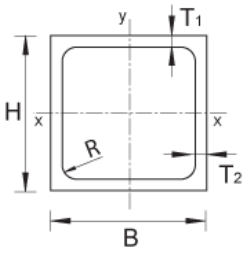
Structural sections made from fibre reinforced polymers (FRP/Glassfiber Composites). The profiles can be made as closed web based elements or as open elements. The range of products spans from shapes that are equivalent to steel sections for construction such as square tube- I-, and U-sections to profile shapes for use as deck elements. The structural sections are engineered according to the requirements of EN13706 parts 1 to 3.

The sections are made with unidirectional reinforcement in several layers

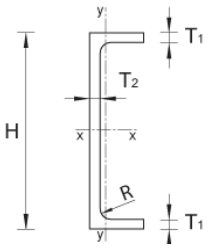
Cross sections, structural profiles:



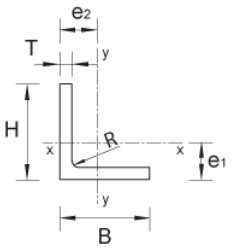
I-section



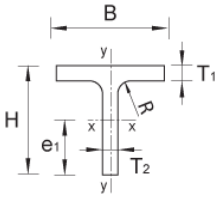
Square hollow section (SHS)



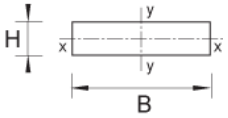
U-section



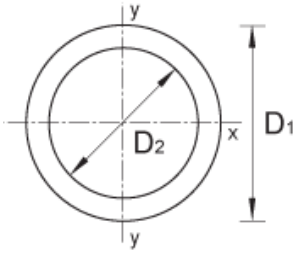
Angle section



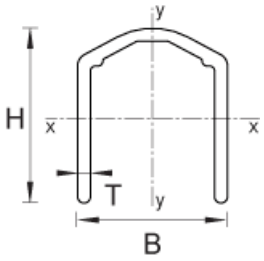
T-section



Flat sheets/plates

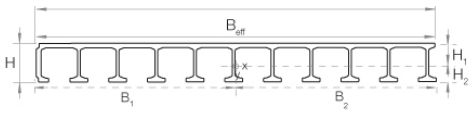


Circular hollow sections (CHS)

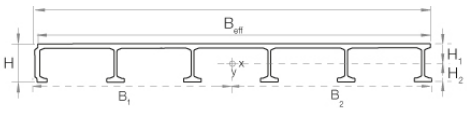


Handrail sections

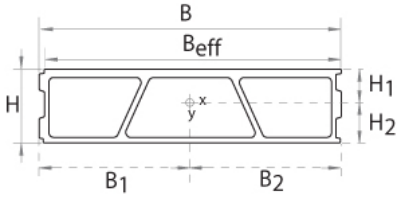
Cross sections, Deck profiles:



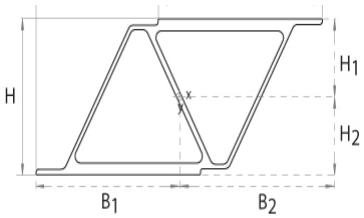
Plank HD



Plank MD



FBD300



FBD450/600

Figure 1 Drawings of cross sections

Figure 2: Examples of FRP profile build-up and application as beams, columns and decks

Dimensions minimum and maximum of the different element types:

Element type	Minimum, mm	Maximum, mm	Wall thickness, mm
Structural Profiles			
Square hollow sections	**50 x 50**	**240 x 240**	**5 - 12**
I-sections	**120 x 60**	**360 x 180**	**5 - 18**
U-sections	**100 x 30**	**360 x 108**	**5 - 18**
Angle sections	**50 x 50**	**150 x 150**	**6 - 12**
Flat sheets/plates	**30 x 6**	**500 x 10**	**6 - 10**
T-sections	**60 x 60**	**72 x 90**	**6 -11**
Circular hollow sections	**40 x 34**	**90 x 80**	**3 -5**
Handrail sections	**70 x 60**	**120 x 180**	**5 - 8**
Deck Profiles			
Plank MD	**40 x 500**	**40 x 505**	**3-5**
Plank HD	**40 x 500**	**40 x 505**	**3-5**
Deck FB 300	**80 x 339**	**80 x 500**	**6-10**
Deck FB 450	**130 x 310,7**	**130 x 500**	**4-10**
Deck FB 600	**225 x 500**	**225 x 521**	**7-16**

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

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 structural profiles and deck profiles are intended to be used as a structural element (beams, columns and decks) where the load bearing characteristic is the major criterion of design and where the product is part of a load bearing system.

The performance of the structural profiles and deck profiles are given on the basis of short term loads, at room temperature and without any environmental influences.

Properties of composites, as any other material, change in elevated temperatures, over time and depending on the environment. Testing is recommended in unusual exposures and extra attention shall be shown in the design when elements are subject to torsional loads, in risk of lateral-torsional buckling, fatigue loads and or long term exposure – experimental proof can be required.

Within a roof construction, the deck element will not contribute to the water tightness, but will receive a suitable waterproofing or roof covering. Waterproofing and roof covering are not covered by this EAD.

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 elements and profiles for the intended use of 50 years when installed in the works (provided that the elements and profiles are subject to appropriate installation (see 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 works[1].

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] 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 1 shows how the performance of structural sections made from fibre reinforced polymers is assessed in relation to the essential characteristics.

Table 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
Basic Works Requirement 1: Mechanical resistance and stability			
1	Full-section effective modulus of elasticity	2.2.1 describes for each characteristic the appropriate assessment method	Level
2	Flexural strength – Axial/Transverse		
3	Tensile strength – Axial/Transverse		
4	Tensile modulus of elasticity – Axial/Transverse		
5	Compressive strength – Axial/Transverse		
6	Compressive modulus of elasticity – Axial/Transverse		
7	Shear strength (perpendicular to plane)		
8	Shear modulus (perpendicular to plane)		
9	Inter-laminar (in-plane) shear strength – Axial		
10	Inter-laminar (in-plane) Shear Modulus		
11	Pin-bearing strength – axial/transverse		
12	Poisson's ratio – Axial/Transverse		
13	Thermal expansion – Axial/Transverse		
14	Fibre content by weight		
15	Degree of cure - Differential scanning calorimetry (DSC)		
16	Creep		
17	Reduction factors for stability and serviceability related to aging/ environmental influence		
18	effect of temperature		
19	long term loads		
20	repeated loads		

No	Essential characteristic	Method of verification and assessment	Expression of product performance
Basic Works Requirement 2: Safety in case of fire			
21	Reaction to fire	2.2.2	Class
22	Resistance to fire	2.2.3	Class
Basic Works Requirement 4: Safety and accessibility in use			
23	Impact resistance	2.2.4	Level
24	Definition of geometry and tolerances	2.2.5	Level

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

2.2.1 Mechanical resistance and stability

Characterisation of products to be assessed shall be done in accordance with available specifications, notably the mechanical properties (characteristics) of the cross sections.

Characteristic values for properties can be specified for a group of profiles, if it can be shown that the characteristic values determined are the least beneficiary values possibly present in the group of profiles (e.g. by Determination of textile-glass content acc. to EN ISO 1172) – Each characteristic value in the ETA document must, in other words, be the lowest common denominator for the group of profiles.

A group of profiles is defined by the principal build-up of the reinforcement layers, the production process and the components. They must be the same for the group of profiles – the weakest in longitudinal direction is then found as the lowest longitudinal reinforcement percentage (global) and the weakest in transverse direction is then found as the profile with the lowest transverse reinforcement percentage (least favorable cross section).

The production process, components, dimensions, the reinforcement drawings and the longitudinal and transverse glass fibre content of the cross sections must at all times be known by the issuing TAB and laid down for every ETA.

A load table must be included in the ETA specifying at least the maximum allowed load at varying spans relevant to the intended application of the section.

Sampling and preparation of the samples for the profiles and elements shall be done in accordance with the criteria given in the relevant part of EN 13706-2.

The following characteristics of the profiles and elements shall be determined in accordance with the specified methods below:

Full-section effective modulus of elasticity

The full-section effective modulus of elasticity shall be determined in accordance with EN 13706-2 Annex D.

Flexural strength – Axial/Transverse

The flexural strength shall be determined in accordance with EN ISO 14125. Three point loading system is to be used with specimen class 4.

Tensile strength – Axial/Transverse

The tensile strength shall be determined in accordance with EN ISO 527-5. The test specimen is type 2. For calculation of stress EN ISO 527-1/10.1 is to be used. For calculation of modulus of elasticity EN ISO 527-1/10.3 is to be used.

Tensile modulus of elasticity – Axial/Transverse

The tensile modulus of elasticity shall be done in accordance with EN ISO 527-4.

Compressive strength – Axial/Transverse

The compressive strength shall be done in accordance with EN ISO 14126. Method 1 is to be used and specimen type B2

Pin-bearing strength – axial/transverse

The pin-bearing strength shall be done in accordance with EN 13706-2 Annex E

Poisson's ratio – Axial/Transverse

Poisson's ratio shall be done in accordance with EN ISO 527-4.

Thermal expansion – Axial/Transverse

Thermal expansion shall be done in accordance with ISO 11359-2.

Fibre content by weight

Fibre content shall be done in accordance with EN ISO 1172.

The remaining specified characteristics of the profiles and elements shall be determined in accordance with the following standards:

Compressive modulus of elasticity – Axial/Transverse

The Compressive modulus of elasticity shall be determined in accordance with EN ISO 14126

Shear strength and shear modulus (perpendicular to plane)

The shear strength and shear modulus shall be determined in accordance with ASTM D7078. See also figure 3.

Figure 3: Principle of shear perpendicular to the plane

Inter-laminar (in-plane) Shear strength

The inter-laminar (in-plane) shear strength shall be determined in accordance with EN ISO 14130. See figure 4

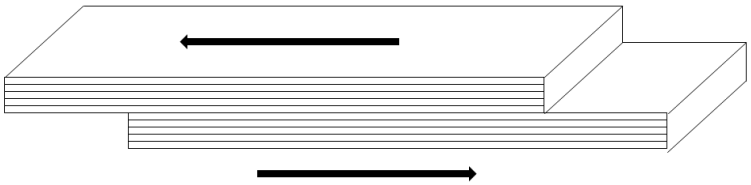


Figure 4: Principle of Inter-laminar Shear

Inter-laminar (in-plane) Shear Modulus

The inter-laminar (in-plane) shear modulus shall be determined in accordance with EN ISO 15310. See figure 4

Degree of cure - Differential scanning calorimetry

The differential scanning calorimetry shall be determined in accordance with EN ISO 11357-3

Creep

The creep properties of the profiles shall be determined in accordance with Annex 1 of this EAD

NOTE: The following characteristics may be considered to be relevant for the products and may be regulated at member state level, but at this time, assessment methods for the characteristics are not given in this EAD:

- *Determination of reduction factors for,*
  - *Aging/ environmental influence*
  - *Effect of temperature*
  - *Long term loads*
  - *Repeated loads*
- *Calculation of internal forces for decks (maximal mid-span moment and moment at support, punching)*

Pull through of screws

The pull through resistance of the screws is calculated in the individual cases based on the size of the screw washer and on the shear strength of the laminate

The values for the individual characteristics shall be stated on the basis of the test results as described in table 2.

Table 2: Expression of performance

Characteristic	Unit	Value
Full-section effective modulus of elasticity	GPa	Average
Flexural strength – Axial/Transverse	MPa	Characteristic (EN 1990, Annex D)
Tensile strength – Axial/Transverse	MPa	Characteristic (EN 1990, Annex D)
Tensile modulus of elasticity – Axial/Transverse	GPa	Average
Compressive strength – Axial/Transverse	MPa	Characteristic (EN 1990, Annex D)
Compressive modulus of elasticity – Axial/Transverse	GPa	Average
Shear strength (perpendicular to plane)	MPa	Characteristic (EN 1990, Annex D)
Shear modulus (perpendicular to plane)	GPa	Average
Inter-laminar (in-plane) shear strength – Axial	MPa	Characteristic (EN 1990, Annex D)
Interlaminar (in-plane) Shear Modulus	GPa	Average
Pin-bearing strength – axial/transverse	MPa	Characteristic (EN 1990, Annex D)
Poisson's ratio – Axial/Transverse	-	Average
Thermal expansion – Axial/Transverse	K^{-1}	Average
Fibre content by weight	%	Average
Degree of cure - Differential scanning calorimetry (DSC)	%	Average

The standard deviation and the variation coefficient shall be given in conjunction with the characteristic value and stated in the ETA.

2.2.2 Reaction to fire

The structural profiles and deck profiles shall be tested and classified in accordance with EC Delegated Regulation 2016/364/EU and EN 13501-1. The class is given in the ETA

When the above provisions require testing in accordance with EN 13823, the provisions and conditions in the standard shall be followed. The specimen for the test according to EN 13823 shall have a maximum thickness of 200 mm. On the trolley the specimen shall be installed without any backing.

2.2.3 Resistance to fire

The resistance to fire performance shall be tested with the test required methods in order to be classified according to EN 13501-2.

The product classification in accordance to EN 13501-2 shall be given in the ETA.

2.2.4 Impact resistance

Decks shall have sufficient strength to withstand impacts to the surface and to ensure retention of their performance and consequently to protect persons from injury by brittle material or falling through.

Based on EN 477, at a temperature of -10 ºC deck profiles without any surface treatment are subjected to a blow from falling mass of 1 kg with hemispherical striking surface of 25 (±0,5) mm.

The impact tests and corresponding damages to the surface of deck elements are worst case scenarios, since installed decks will always be coated with anti-slip surface.

The results of tests, fall height and the total impact energy shall be stated in the ETA.

2.2.5 Definition of geometry and tolerances

The geometry and tolerances of the profiles and elements shall be determined in accordance with annex B of EN 13706-2

The geometry and tolerances of the profiles and elements shall be declared in conformity with annex B of EN 13706-2

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: Decision 1997/597/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.

Table 3 Control plan for the manufacturer; cornerstones

No	Subject/type of control *(product, raw/constituent material, component - indicating characteristic concerned)*	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC)					
1	Incoming materials The components (resin, glassfibre and surface protection layer) shall be delivered with certificates 3.1 according to EN 10204	The manufactures shall document the date of delivery and the date of the manufacture of the components		Every delivery	Every delivery
2	Dimensions	With Caliper	According to profile list and tolerances acc. to EN13706-2 App B	1 sample per relevant criteria	At start-up and thereafter every 4 hours of production
3	Weight per meter	-	According to profile list ± 2%	1 sample	At start-up and thereafter every 7 production days
4	Creep	3 point bending test according to appendix 1	As initial test, but maximum ≤6%	1 sample	At start-up and thereafter every 7 production days
5	Modulus of elasticity	EN ISO 14125	≥ initial test at start up	1 sample cut in longitudinal direction	At start-up and thereafter every 7 production days
6	Fibre content	EN ISO 1172	must be determined with the initial tests	1 sample	At start-up and thereafter every 7 production days
7	Residual enthalpy of reaction	EN 11357-3	≤6% residual enthalpy	1 sample	At start-up and thereafter every 7 production days

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 for the structural elements and profiles are laid down in Table 4.

Table 4 Control plan for the notified body; cornerstones

№	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of factory and factory production control (FPC)					
2	The notified body shall ascertain that, in accordance with the control plan, the manufacturing plant of the product manufacturer, in particular personnel and equipment, and the factory production control are suitable to ensure a continuous and orderly manufacturing of the profiles and elements according the European Technical Assessment. See clause 3.2 for particular items regarding BWR1.				As defined in control plan
Continuous surveillance, judgement and assessment of factory production control (FPC)					
3	It shall be verified that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan. See clause 3.2 for particular items regarding BWR1. The notified body shall take out samples for testing of the mechanical properties. Over a 10 year period, all the mechanical properties of all produced profile and deck type shall be tested. Preferably profiles with varying dimensions shall be tested over the years. The notified body prepares a test plan to ensure this				As defined in control plan
Audit-testing of samples taken before placing the product on the market					
4	It shall be verified that the product performance is maintained. See clause 3.2 for particular items regarding BWR1. The notified body shall take out samples for testing of the mechanical properties. Over a 10 year period, all the mechanical properties of all produced profile and deck type shall be tested. Preferably profiles with varying dimensions shall be tested over the years. The notified body prepares a test plan to ensure this				As defined in control plan

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 13706-1:2002	Reinforced plastic composites - Specifications for pultruded profiles - Part 1: Designation
EN 13706-2:2002	Reinforced plastics composites - Specifications for pultruded profiles - Part 2: Methods of test and general requirements
EN 13706-3:2002	Reinforced plastics composites - Specifications for pultruded profiles - Part 3: Specific requirements
EN 1991	Eurocode 1 - Actions on structures
EN 1990	Eurocode - Basis of structural design
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 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
ASTM D7078	Standard Test Method for Shear Properties of Composite Materials by V-Notched Rail Shear Method
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
EN ISO 11357-3	Plastics - Differential scanning calorimetry (DSC) - Part 3: Determination of temperature and enthalpy of melting and crystallization
EN 13501-1	Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests
EN 13823	Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning item
EN 13501-2	Fire classification of construction products and building elements - Part 2: Classification using data from fire resistance tests, excluding ventilation services
EOTA	TR 001 – Determination of impact resistance of panels and panels assemblies
EN ISO 6603-1	Plastics - Determination of puncture impact behaviour of rigid plastics - Part 1: Non-instrumented impact testing
EN ISO 178	Plastics - Determination of flexural properties

ANNEX 1

Method for creep quality control

The sample for the creep test shall be cut from the profile in the longitudinal direction.

The creep is determined by a 24 hour 3 point bending test at a constant stress level, $f_{25\%}$, of 25% of the characteristic ultimate flexural strength at span, L_a,– the load, F_z, is found as:

$$F_z = \frac{4 \cdot f_{25\%} \cdot I}{L_a \cdot e}$$

Where:
$f_{25\%}$ is the stress corresponding to 25% of the characteristic ultimate flexural strength
I is the moment of inertia (as the profile is placed in the machine)
L_a is the span – it is found as 20xH, where H is the vertical length of the profile as it is placed in the test machine
e is the maximum distance between profile edge and neutral axis

The deflection is measured after 1 hour (d_{1h}) and after 24 hours (d_{24h}) and the creep must be ≤ 6% when calculated as:

$$\frac{d_{24h} - d_{1h}}{d_{1h}} \cdot 100\%$$