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Designated according to Article 29 of Regulation (EU) No 305/2011

Member of EOTA

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European Technical Assessment

ETA 11/0185 of 23.04.2021

General part

Technical Assessment Body issuing the ETA: ITeC ITeC has been designated according to Article 29 of Regulation (EU) No 305/2011 and is member of EOTA (European Organisation for Technical Assessment).	
Trade name of the construction product	**TECWOOL F®**
Product family to which the construction product belongs	Rendering intended for fire resisting applications.
Manufacturer	**TECRESA Protección Pasiva SL** Parque Leganés Tecnológico Margarita Salas 6 ES-28919 Leganés (Madrid) Spain
Manufacturing plant(s)	According to Annex N kept by ITeC.
This European Technical Assessment contains	34 pages including 3 annexes which form an integral part of this assessment and Annex N, which contains confidential information and is not included in the European Technical Assessment when that assessment is publicly available.
This European Technical Assessment is issued in accordance with Regulation (EU) 305/2011, on the basis of	European Assessment Document EAD 350140-00-1106.
This version replaces	ETA 11/0185, issued on 05.08.2019.

General Comments

Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document.

Communication of this European Technical Assessment, including transmission by electronic means, shall be in full (excepted the confidential Annex(es)).

Specific parts of the European Technical Assessment

1 Technical description of the product

TECWOOL F® is a spray-applied fire protective rendering made of mineral wool mixed with white cement and additives, with the binder included as part of the dry mix. TECWOOL F® is sprayed dry and mixed with water at the nozzle.

The rendering considered in this ETA does not require any additional product for its installation (ETA under option 1 as described in the scope of EAD 350140-00-1106).

Properties of the applied rendering such as thickness range, density, adhesion values, etc., are described in Annexes 2 and 3.

2 Specification of the intended use(s) in accordance with the applicable EAD

TECWOOL F® is intended for the fire protection uses as described in table 1, which also shows the related environmental use conditions.

Table 1: Intended use categories related to the protected element and the environmental conditions.

Fire protection uses		**Environmental conditions**
EAD 350140-00-1106 reference	**Element intended to be protected**	**EAD 350140-00-1106 reference**
Type 3	Loadbearing concrete elements	Type Z_2
Type 4	Loadbearing steel elements	Type Z_2

The environmental use categories are specified in EAD 350140-00-1106, section 1.2.3:

- Type Z_2: internal conditions with temperature of at least 0 °C and humidity lower than 85 % RH.

The provisions made in this ETA are based on a working life of TECWOOL F® of at least 25 years, provided that the conditions laid down in the manufacturer's instructions for the installation, use and maintenance are met. These provisions are based upon the current state of the art and the available knowledge and experience.

The indications given as to the working life cannot be interpreted as a guarantee given by the producer or Assessment Body, but are to be regarded only as a means for choosing the appropriate product(s) in relation to the expected economically reasonable working life of the works.

3 Performance of the product and reference to the methods used for its assessment

3.1 Performance of the product

The assessment of the TECWOOL F® has been performed in accordance with EAD 350140-00-1106 *Renderings and rendering kits intended for fire resisting applications (September 2017)*.

Table 2: Performance of TECWOOL F®.

Product: TECWOOL F®			**Intended use:** Fire resisting applications
Basic requirement	**Essential characteristic**		**Performance**
BWR 2 Safety in case of fire	Reaction to fire		A1
	Resistance to fire		See Annexes
	Durability		Type Z_2
BWR 4 Safety and accessibility in use	Adhesion (bond strength)		See 3.2.4 and Annex 2 and 3
BWR 5 Protection against noise	Sound absorption	Thickness 17 mm	α_w = 0,60; Class C
		Thickness 26 mm	α_w = 0,80; Class B
BWR 6 Energy economy and heat retention	Thermal conductivity	$\lambda_{U,90/90(23/50)}$	0,075 W/(m·K)
		$\lambda_{U,90/90(23/80)}$	0,080 W/(m·K)
	Water vapour permeability (μ)		2,1

The rest of characteristics included in EAD 350140-00-1106 have not been assessed in this ETA.

3.2 Methods used for the assessment

3.2.1 Reaction to fire

The performance of TECWOOL F® has been tested according to EN ISO 1182[1] and EN ISO 1716[2].

Classification is given in accordance with EN 13501-1[3] and Regulation (EU) 2016/364.

3.2.2 Resistance to fire

Resistance to fire performance, classified in accordance with EN 13501-2[4], has been determined following the test and evaluation methods given in the annexes.

[1] EN ISO 1182 Reaction to fire tests for products. Non-combustibility test.

[2] EN ISO 1716 Reaction to fire tests for products. Determination of the gross heat of combustion (calorific value).

[3] EN 13501-1 Fire classification of construction products and building elements. Part 1: Classification using data from reaction to fire tests.

[4] EN 13501-2 Fire classification of construction products and building elements. Part 2: Classification using data from fire resistance tests, excluding ventilation services implemented.

3.2.3 Durability

Durability of the rendering has been assessed according to EAD 350140-00-1106, section 2.2.12, in relation to its fire protective intended uses as defined in table 1.

3.2.4 Adhesion (bond strength)

Adhesion (bond strength) has been determined in accordance with EAD 350140-00-1106, section 2.2.7, and EGOLF EA 05[5]. The adhesion of the rendering depends on the installed thickness and the preparation of the substrate. Bond strength guidance values of the rendering and the conditions under which they were achieved are given in Annexes 2 and 3.

3.2.5 Sound absorption

The sound absorption of assemblies installed according to Annex 2 has been tested according to EN ISO 354[6]. The weighted sound absorption coefficient (α_w) and rating have been determined in accordance with EN ISO 11654[7].

3.2.6 Thermal insulation

Thermal conductivity has been tested according to EN 12667 [8] and the declared values have been determined according to EN ISO 10456 [9].

Table 3: Thermal characteristics.

$\lambda_{10,dry,90/90}$	0,061	(W/m·K)	Conductivity fractile value at 10ºC at dry conditions, representing at least 90% of the production with a confidence level of 90%
$\lambda_{U,90/90(23/50)}$	0,075	(W/m·K)	Design value of conductivity at 23ºC and 50% R.H.
$\lambda_{U,90/90(23/80)}$	0,080	(W/m·K)	Design value of conductivity at 23ºC and 80% R.H.

3.2.7 Water vapour permeability

Tested according to EN ISO 12572[10], the declared value of the water vapour diffusion resistance coefficient (μ-value) is given in table 2.

[5] EGOLF EA 05 (SM5:1999): Fire testing. Method for the measurement of bonding properties of fire protection materials applied to steel, concrete and steel/concrete composite structures.

[6] EN ISO 354 Acoustics. Measurement of sound absorption in a reverberation room.

[7] EN ISO 11654 Acoustics. Sound absorbers for use in buildings. Rating of sound absorption.

[8] EN 12667 Thermal performance of building materials and products. Determination of thermal resistance by means of guarded hot plate and heat flow meter methods. Products of high and medium thermal resistance.

[9] EN ISO 10456 Building materials and products. Hygrothermal properties. Tabulated design values and procedures for determining declared and design thermal values.

[10] EN ISO 12572 Hygrothermal performance of building materials and products - Determination of water vapour transmission properties - Cup method

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

According to the Decision 1999/454/EC of the European Commission, the system of AVCP (see EC Delegated Regulation (EU) No 568/2014 amending Annex V to Regulation (EU) 305/2011) given in the following table applies.

Table 4: AVCP System.

Product(s)	Intended use(s)	Level(s) or class(es)	System(s)
Fire protective products	For fire compartmentation and/or fire protection or fire performance	Any	1

5 Technical details necessary for the implementation of the AVCP system, as foreseen in the applicable EAD

All the necessary technical details for the implementation of the AVCP system are laid down in the Control Plan deposited with the ITeC and agreed in accordance with EAD 350140-00-1106, section 3.

The Control Plan is a confidential part of the ETA and only handed over to the notified product certification body involved in the assessment and verification of constancy of performance.

The factory production control operated by the manufacturer shall be in accordance with the above-mentioned Control Plan.

Issued in Barcelona on 23 April 2021

by the Catalonia Institute of Construction Technology.

Institut de Tecnologia de la Construcció de Catalunya

Ferran Bermejo Nualart
Technical Director, ITeC

ANNEX 1. Resistance to fire performance and installation provisions

A.1.1 Overview of the assessed resistance to fire performance

The assessed constructive elements fire protected with TECWOOL F® are shown in table A.1.1.

Table A.1.1: Fire protected constructive elements.

Intended use according to EAD		Test standard	Installation
Type 3	Loadbearing concrete elements	EN 13381-3[11]	Annex 2
Type 4	Loadbearing steel elements	EN 13381-4[12]	Annex 3

A.1.2 Installation provisions related to the elements protected with TECWOOL F®

The installation should be carried out in accordance with the manufacturer's instructions and the provisions given in this ETA.

The product is intended for environmental use category Type Z_2. Special provisions shall be taken for temporary protection of the rendering exposed to outdoor conditions during construction.

Before application the substrate should be inspected and prepared. Surfaces to be sprayed shall be free from oil, grease, primers, sealing agents or of any other substance that will impair adhesion. If dirt is detected on the substrate, it is recommended to clean the substrate by spraying water with a hose.

Clips, hangers, supports, sleeves and other attachments to the substrate can be placed by others prior or after the application of TECWOOL F®. Ducts, piping, conduits or other suspended equipment can be installed after the application of TECWOOL F®, in which case later inspection will be required and, when necessary, reparation of the rendering.

A.1.3 Verifications on site

The thickness should be measured at sufficient points to determine the mean and minimum thickness. A suitable method for thickness measurement is given in EAD 350140-00-1106, section 2.3.4.

The density of the hardened rendering should be measured within the tolerances specified in the next annexes.

The bond strength of the rendering to the substrate should be tested on site. A suitable method is EGOLF Agreement EA 05, which can be used as a base for the site tests. The person responsible for the works will decide on the adequacy of the site tests results taking into account the reference values given in the next annex. For their acceptability, the recommendations given in EAD, section G.4, or other existing criteria can be applied, under the responsibility of the person responsible for works.

[11] EN 13381-3 Test methods for determining the contribution to the fire resistance of structural members. Part 3: Applied protection to concrete members.

[12] EN 13381-4 Test methods for determining the contribution to the fire resistance of structural members. Part 4: Applied passive protection to steel members.

ANNEX 2. Specification and assessment of fire protection of loadbearing concrete elements protected by TECWOOL F® (intended use Type 3)

A.2.1 Loadbearing concrete beams and columns

A.2.1.1 Classification

The constructive elements described in this annex have been tested and assessed according to EN 13381-3 and classified in accordance with EN 13501-2.

The equivalent thickness of concrete and the insulation performance are given in section A.2.1.3.

A.2.1.2 Installation requirements

The system installation should be carried out in accordance with the provisions in A.1.2 and the following specification.

A.2.1.2.1 Supporting structural element

TECWOOL F® can be applied on concrete beams and columns exposed to fire from more than one side. Specification of the supporting structural element is given in table A.2.1.

Table A.2.1: Specification of the concrete structural element.

Element	Characteristics	Mounting and fixing
Loadbearing concrete beam and column	Height of the section ≥ 450 mm* Width of the section ≥ 150 mm Density: 2400 kg/m^3 ± 15% Compressive strength ≥ 25,0 N/mm^2 Made with any type of aggregate	Reinforced concrete Concrete release from the mould without agent Surface free of oil, grease, dust, etc.

* The height may be decreased provided the section surface remains the same or is higher, by increasing the width.

A.2.1.2.2 Fire protective rendering

TECWOOL F® is directly applied on the apparent sides of the concrete structure to be protected by following their shape. TECWOOL F® is sprayed in coats of regular thickness to reach the requested thickness according to this annex. Hairline cracks in the dry rendering are not accepted.

Specification of the fire protective rendering is given in table A.2.2.

Table A.2.2: Specification of the applied rendering.

Product	Characteristics	Mounting and fixing
TECWOOL F® (Hardened rendering)	Thickness: 12,2 mm to 38,0 mm Density: 351 kg/m^3 ± 15 %	Rendering is kept without finishing after application It is sprayed in layers of approximately 10 mm Spray-applied rendering without: - Primer or bonding agent - Topcoat or sealing coat - Mechanical fixings or reinforcement - Additives out of dry mix

A.2.1.2.3 Bonding properties of TECWOOL F® on concrete beams and columns

Assessment of the bonding properties of TECWOOL F®, when directly applied on concrete structures, has been carried out according to EGOLF EA 05 procedure.

The indicated values are representative of cohesive failure near the rendering surface. These values are guidance values, and they do not reflect a statistical evaluation, nor minimum guaranteed values.

Table A.2.3: Tensile bond strength on concrete substrates.

Surface	Thickness of TECWOOL F® (mm)	Mean tensile bond strength (MPa)	Failure mode
Concrete substrate according EGOLF EA 05	12,0	0,0390	Cohesive
	37,0	0,0204	Cohesive

A.2.1.3 Assessment of the fire performance of TECWOOL F® on concrete beams and columns

A.2.1.3.1 General

The assessment method used to assess the fire protection performance of TECWOOL F® when applied on concrete elements is according to clause 13 of EN 13381-3.

A.2.1.3.2 Insulation performance

The average temperature of the 12,2 mm protected concrete beam unexposed surface exceeded 140ºC the initial temperature at minute 129.

Insulation criteria were maintained for the 38,0 mm protected concrete beam over the entire test duration (360 minutes).

A.2.1.3.3 Stickability performance

The stickability of TECWOOL F® when applied on concrete beams and columns is determined according to the requirements of clause 13.5 of EN 13381-3.

At no time the maximum recorded temperatures of the exposed surface of the 12,2 mm protected concrete were more than 50% above the mean value of the recorded temperatures of the concrete exposed surface (no stickability failure occurs).

At no time the maximum recorded temperatures of the exposed surface of the 38,0 mm protected concrete were more than 50% above the mean value of the recorded temperatures of the concrete exposed surface (no stickability failure occurs).

A.2.1.3.4 Protection of concrete beams and columns

The insulation efficiency of the 12,2 mm and 38,0 mm thickness protective material when applied on concrete beams and columns as specified in table A.2.1, subject to the thermal exposure under the standard time-temperature curve as defined in paragraph 5.1.1 of EN 1363-1, is given in the next tables in a range of concrete temperatures within 350 ºC – 650 ºC.

Table A.2.4: Concrete depth vs critical temperature for 12,2 mm thickness of TECWOOL F®.

Temperature (°C)	Depth of critical temperatures inside the concrete (mm)							
	30 min	60 min	90 min	120 min	150 min	180 min	210 min	240 min
350	--	--	--	--	40	64	--	--
400	--	--	--	--	--	53	70	--
450	--	--	--	--	--	33	60	74
500	--	--	--	--	--	--	44	64
550	--	--	--	--	--	--	--	51
600	--	--	--	--	--	--	--	28
650	--	--	--	--	--	--	--	--

Table A.2.5: Concrete depth vs critical temperature for 38,0 mm thickness of TECWOOL F®.

Temperature (°C)	Depth of critical temperatures inside the concrete (mm)							
	30 min	60 min	90 min	120 min	150 min	180 min	210 min	240 min
350	--	--	--	--	--	--	--	--
400	--	--	--	--	--	--	--	--
450	--	--	--	--	--	--	--	--
500	--	--	--	--	--	--	--	--
550	--	--	--	--	--	--	--	--
600	--	--	--	--	--	--	--	--
650	--	--	--	--	--	--	--	--

A.2.1.3.5 Equivalent thickness of concrete

The equivalent thickness of concrete induced by the protective rendering TECWOOL F®, applied at 12,2 mm and 38,0 mm on concrete beams or columns, is determined according to Annex C of EN 13381-3 and given in the table A.2.6.

Table A.2.6: Equivalent thickness of concrete induced by TECWOOL F®.

Time period (minutes)		30	60	90	120	180	240
Equivalent thickness of concrete (mm)	Tecwool F® at 12,2 mm	56	71	75	72	65	--
	Tecwool F® at 38,0 mm	97	100	114	117	123	116

The equivalent thickness of concrete H_{eq} in function of the thickness of TECWOOL F® is given in figures A.2.1, A.2.2, A.2.3, A.2.4 and A.2.5 for a time period of 30, 60, 90, 120 and 180 minutes respectively.

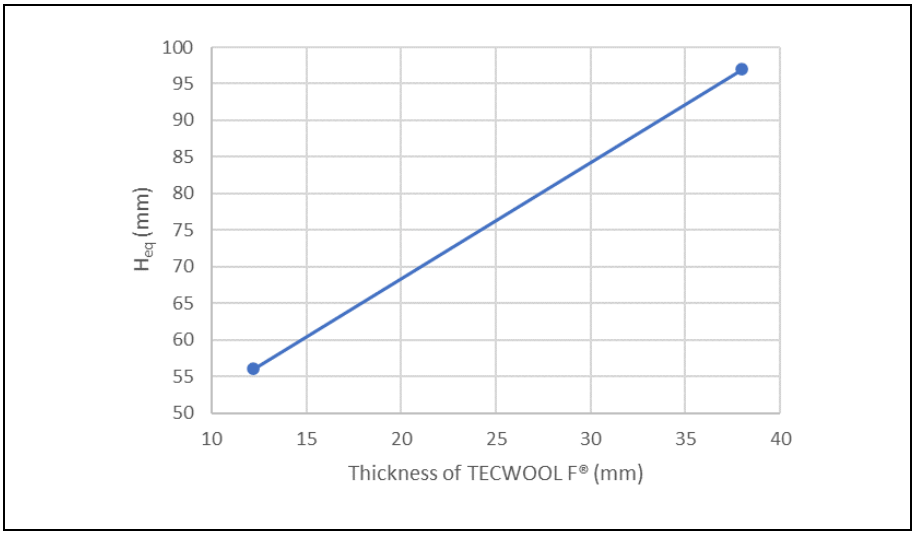

Figure A.2.1: Equivalent thickness of concrete (30 minutes).

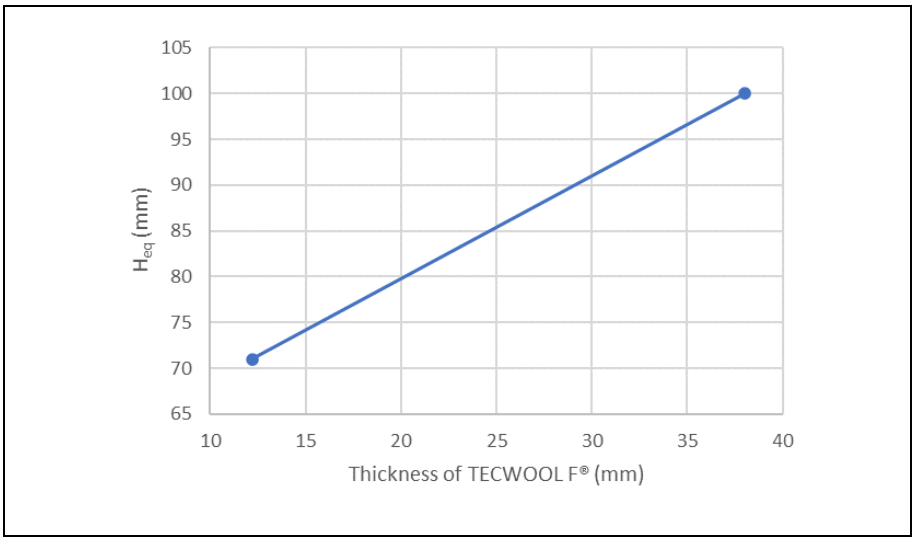

Figure A.2.2: Equivalent thickness of concrete (60 minutes).

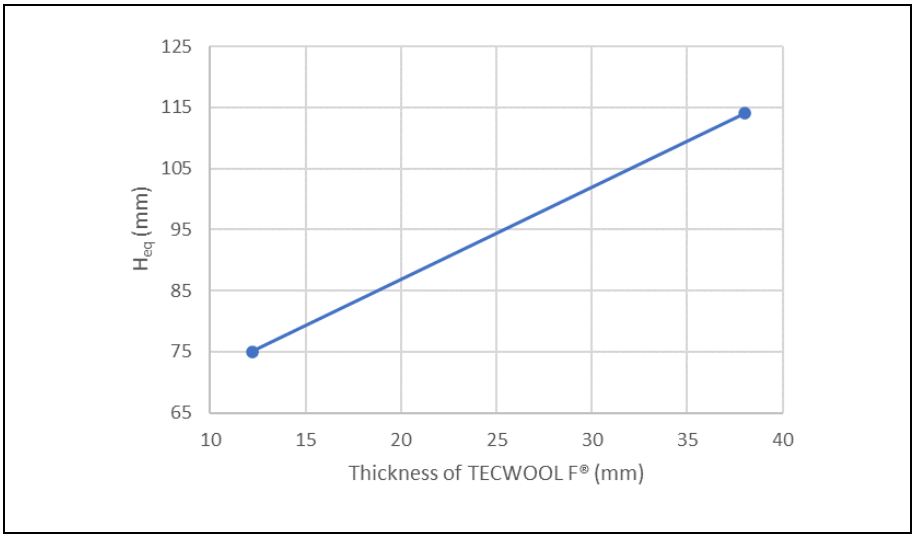

Figure A.2.3: Equivalent thickness of concrete (90 minutes).

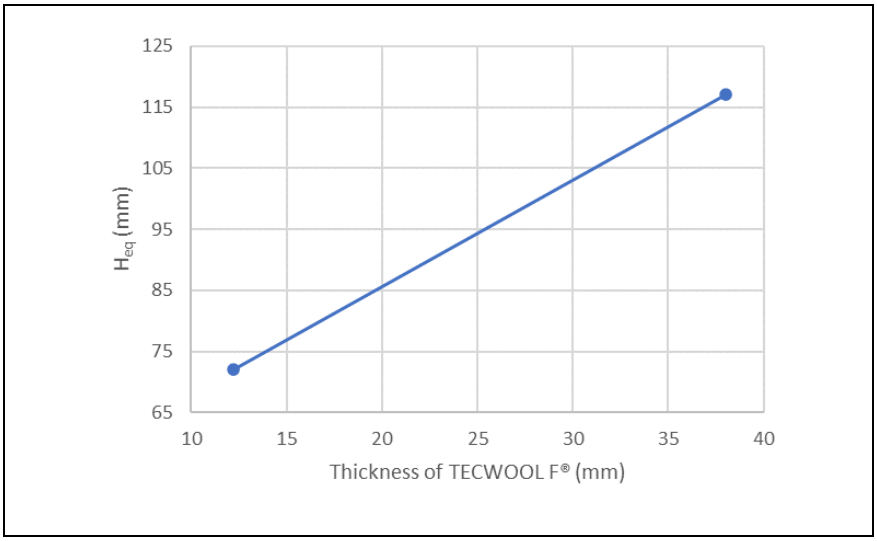

Figure A.2.4: Equivalent thickness of concrete (120 minutes).

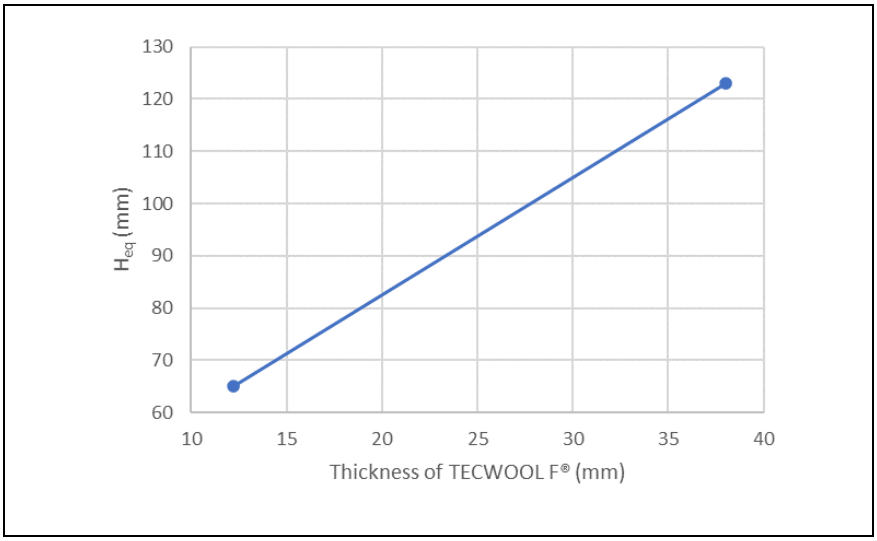

Figure A.2.5: Equivalent thickness of concrete (180 minutes).

A.2.2 Loadbearing concrete slabs and walls

A.2.2.1 Classification

The constructive elements described in this annex has been tested and assessed according to EN 13381-3 and classified in accordance with EN 13501-2.

The equivalent thickness of concrete and the insulation performance are given in section A.2.2.3.

A.2.2.2 Installation requirements

The system installation should be carried out in accordance with the provisions in A.1.2 and the following specification.

A.2.2.2.1 Supporting structural element

TECWOOL F® can be applied on concrete slabs exposed to fire from one side, both in horizontal (floors) and vertical (walls) orientation. Specification of the supporting structural element is given in table A.2.7.

Table A.2.7: Specification of the concrete structural element.

Element	Characteristics	Mounting and fixing
Loadbearing concrete slab and wall	Thickness of the slab/wall ≥ 140 mm Density: 2400 kg/m^3 ± 15 % Compressive strength ≥ 25 N/mm^2 Made with any type of aggregate	Reinforced concrete. Concrete released from the mould without agent. Surface free of oil, grease, dust, etc.

A.2.2.2.2 Fire protective rendering

TECWOOL F® is directly applied on the concrete structure in coats of regular thickness to reach the requested thickness according to this annex. Hairline cracks in the dry rendering are not accepted.

Specification of the fire protective rendering is given in table A.2.8.

Table A.2.8. Specification of the applied rendering.

Product	Characteristics	Mounting and fixing
TECWOOL F® (Hardened rendering)	Thickness: 12,1 mm to 35,2 mm Density: 351 kg/m^3 ± 15 %	Rendering is kept without finishing after application It is sprayed in layers of 10 mm Spray-applied rendering without: - Primer or bonding agent - Topcoat or sealing coat - Mechanical fixings or reinforcement - Additives out of dry mix

A.2.2.2.3 Bonding properties of TECWOOL F® on concrete slabs and walls

Assessment of the bonding properties of TECWOOL F®, when directly applied on concrete structures, has been carried out according to EGOLF EA 05 procedure.

The indicated values are representative of cohesive failure near the rendering surface. These values are guidance values, and they do not reflect a statistical evaluation, nor minimum guaranteed values.

Table A.2.9. Tensile bond strength on concrete substrates.

Surface	Thickness of TECWOOL F® (mm)	Mean tensile bond strength (MPa)	Failure mode
Concrete substrate according EGOLF EA 05	12,0	0,0390	Cohesive
	37,0	0,0204	Cohesive

A.2.2.3 Assessment of the fire performance of TECWOOL F® on concrete slabs and walls

A.2.2.3.1 General

The assessment method used to assess the fire protection performance of TECWOOL F® when applied on concrete elements is according to clause 13 of EN 13381-3.

A.2.2.3.2 Insulation performance

Insulation criteria were maintained for the 12,1 mm protected concrete slab over the entire test duration (306 minutes).

Insulation criteria were maintained for the 35,2 mm protected concrete slab over the entire test duration (360 minutes).

A.2.2.3.3 Stickability performance

The stickability of TECWOOL F® when applied on concrete slabs and walls is determined according to the requirements of paragraph 13.5 of EN 13381-3.

A.2.2.3.3.1 Stickability criteria for slab with TECWOOL F® 12,1 mm

At no time the maximum recorded temperatures of the concrete exposed surface were more than 50% above the mean value of the recorded temperatures of the concrete exposed surface (no stickability failure occurs).

A.2.2.3.3.2 Stickability criteria for slab with TECWOOL F® 35,2 mm

At no time the maximum recorded temperatures of the concrete exposed surface were more than 50% above the mean value of the recorded temperatures of the concrete exposed surface (no stickability failure occurs).

A.2.2.3.4 Protection of concrete slabs and walls

The insulation efficiency of the 12,1 mm and 35,2 mm thicknesses protective material when applied on concrete slabs and walls as specified in table A.2.7, subject to the thermal exposure under the standard time-temperature curve as defined in clause 5.1.1 of EN 1363-1, is given in the next tables in a range of concrete temperatures within 350 ºC – 650 ºC.

Table A.2.10: Concrete depth vs critical temperature for 12,1 mm thickness of TECWOOL F®.

Temperature (°C)	Depth of critical temperatures inside the concrete (mm)									
	30min	60min	90min	120min	150min	180min	210min	240min	270min	300min
350	--	--	--	--	--	28	42	52	58	63
400	--	--	--	--	--	21	30	41	49	56
450	--	--	--	--	--	--	24	30	41	47
500	--	--	--	--	--	--	19	26	32	40
550	--	--	--	--	--	--	--	22	27	33
600	--	--	--	--	--	--	--	18	24	28
650	--	--	--	--	--	--	--	--	20	25

Table A.2.11: Concrete depth vs critical temperature for 35,2 mm thickness of TECWOOL F®.

Temperature (°C)	Depth of critical temperatures inside the concrete (mm)									
	30min	60min	90min	120min	150min	180min	210min	240min	270min	300min
350	--	--	--	--	--	--	--	--	--	--
400	--	--	--	--	--	--	--	--	--	--
450	--	--	--	--	--	--	--	--	--	--
500	--	--	--	--	--	--	--	--	--	--
550	--	--	--	--	--	--	--	--	--	--
600	--	--	--	--	--	--	--	--	--	--
650	--	--	--	--	--	--	--	--	--	--

A.2.2.3.5 Equivalent thickness of concrete

The equivalent thickness of concrete induced by the protective rendering TECWOOL F®, applied at 12,1 mm and 35,2 mm on concrete slabs and walls, is determined according to Annex C of EN 13381-3 and given in table A.2.12.

Table A.2.12: Equivalent thickness of concrete induced by TECWOOL F®.

Time period (minutes)		30	60	90	120	180	240
Equivalent thickness of concrete (mm)	Tecwool F® at 12,1 mm	40	50	53	52	42	27
	Tecwool F® at 35,2 mm	85	100	114	121	126	132

The equivalent thickness of concrete H_{eq} in function of the thickness of TECWOOL F® is given in figures A.2.6, A.2.7, A.2.8, A.2.9, A.2.10 and A.2.11 for a time period of 30, 60, 90, 120, 180 and 240 minutes respectively.

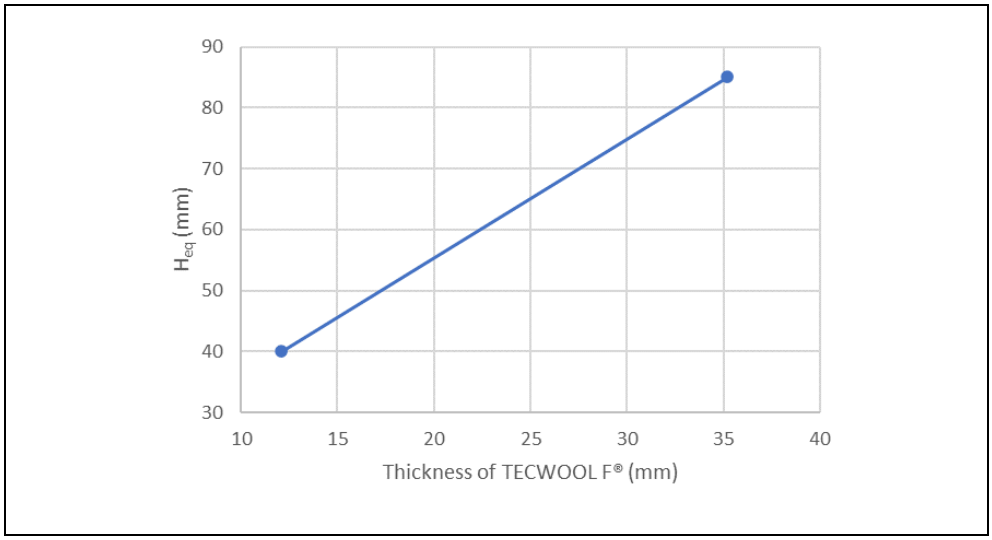

Figure A.2.6: Equivalent thickness of concrete (30 minutes).

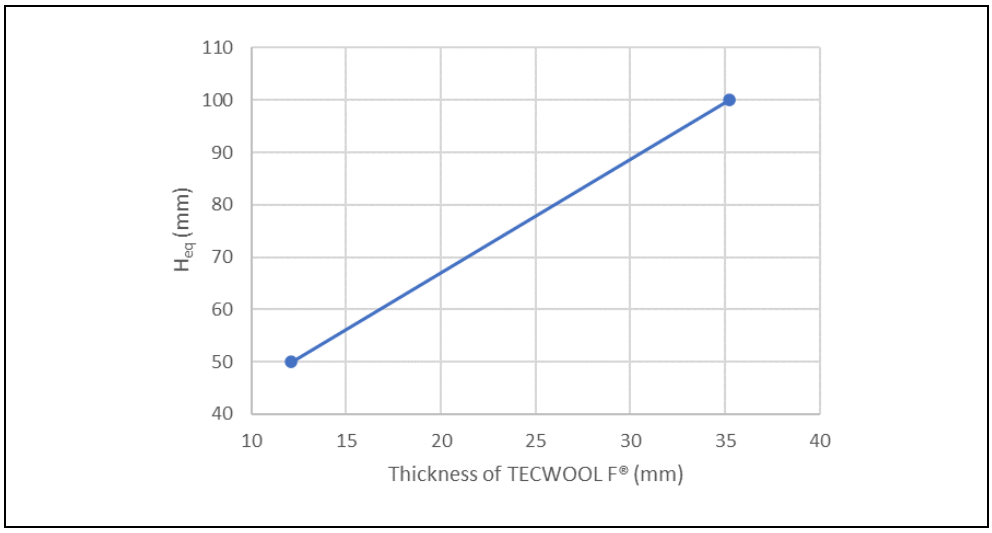

Figure A.2.7: Equivalent thickness of concrete (60 minutes).

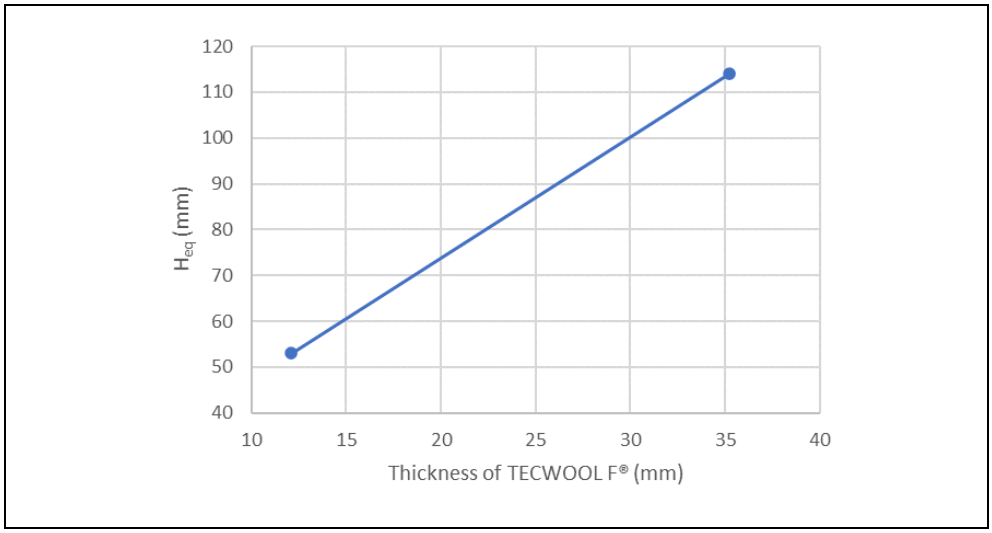

Figure A.2.8: Equivalent thickness of concrete (90 minutes).

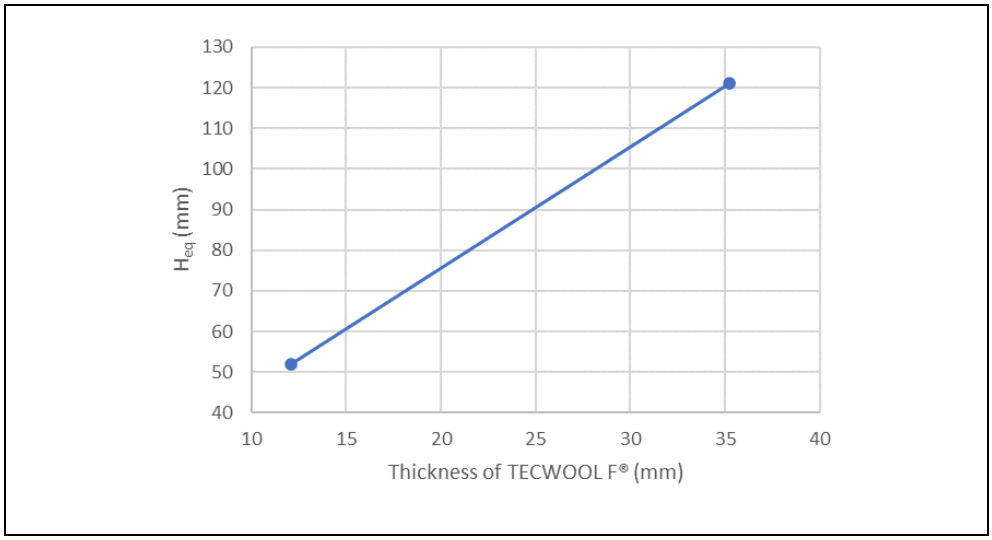

Figure A.2.9: Equivalent thickness of concrete (120 minutes).

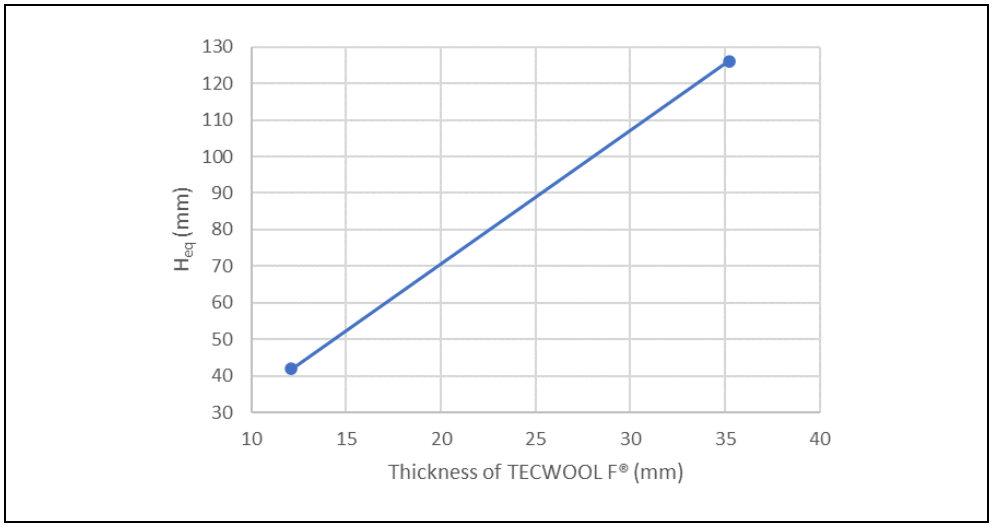

Figure A.2.10: Equivalent thickness of concrete (180 minutes).

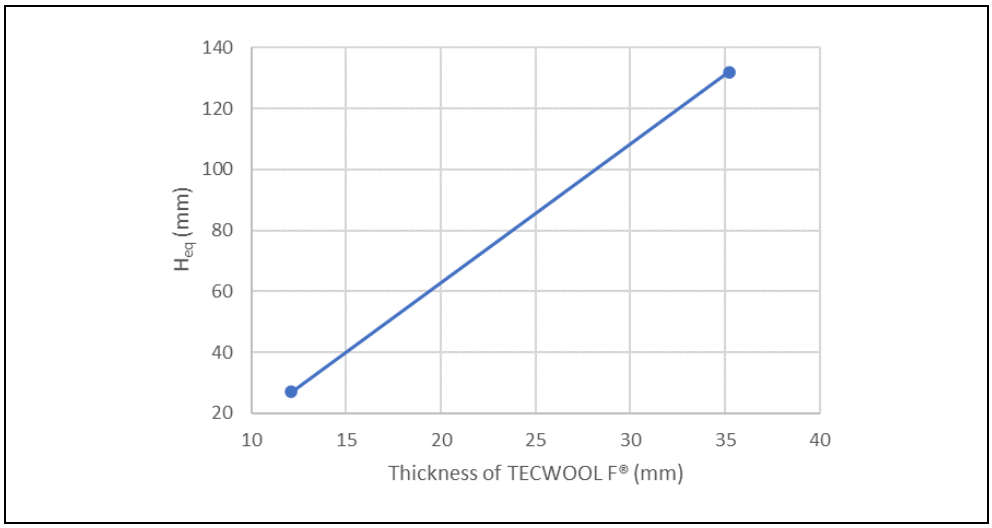

Figure A.2.11: Equivalent thickness of concrete (240 minutes).

ANNEX 3. Specification and assessment of fire protection of loadbearing steel elements protected by TECWOOL F® (intended use Type 4)

A.3.1 Classification

The system described in this annex has been tested and evaluated according to EN 13381-4 and classified in accordance with EN 13501-2.

The assessment of the required thickness of TECWOOL F® rendering for the relevant resistance to fire period, at the design temperature within the range of 300 ºC to 700 ºC and in function of the section factor of the steel element, is given in section A.3.3.

A.3.2 Installation requirements

The product installation should be carried out in accordance with the provisions in A.1.2 and the following specification.

A.3.2.1 Supporting structure

The supporting structure consists of load-bearing steel elements with the following characteristics:

- 'H' or 'I' section beams and columns (table A.3.3 to table A.3.9 of this ETA).

  The maximum beam depth is limited to 450 mm and the maximum column depth to 600 mm.

  Note: The protection thickness given for H/I sections also apply to steel sections of other shapes (e.g. U, L and T-sections) under consideration of the same section factor.

- Hollow section beams and columns (table A.3.10 to table A.3.16 of this ETA).
- Structural steel grades (S designation) in accordance with EN 10025 [13] excluding S185.
- Section factors as given in table A.3.3 to table A.3.16 of this ETA.

  Steel elements with a section factor lower than 67 m^{-1} shall be protected with the thickness of TECWOOL F® rendering given for an element with section factor equal to 67 m^{-1}.

- Three-sided fire exposure for beams and four-sided fire exposure for columns.

  In case of beams or columns with fewer sides exposed to fire, thickness of the rendering can be applied according to table A.3.3 to table A.3.16 under consideration of the section factor calculated for the relevant case.

[13] EN 10025-1 to 6 Hot rolled products of structural steels.

A.3.2.2 Surface of steel elements

The steel sections must be blast cleaned to EN ISO 8501-1[14] SA2½ or equivalent. The surface shall be bare, clean, dry and free of dust.

TECWOOL F® is assessed for direct application on the steel elements.

A.3.2.3 Fire protective rendering

TECWOOL F® is applied on the apparent sides of the steel structural element to be protected by following their shape. TECWOOL F® is sprayed according to table A.3.1 to reach the requested thickness according to this annex. Hairline cracks in the dry rendering are not accepted.

Table A.3.1: Specification of the applied rendering.

Product	Characteristics	Mounting and fixing
TECWOOL F® (Hardened rendering)	Thickness: 10 mm to 69 mm Density: 348 kg/m^3 ± 15 %	Rendering is kept without finishing after application. For minimum thickness application, it is sprayed in one single layer. For medium thickness application, it is sprayed in two layers. For maximum thickness application, it is sprayed in three layers. Spray-applied rendering without: - Bonding agent - Topcoat or sealing coat - Mechanical fixings or reinforcement - Additives out of dry mix

A.3.2.4 Bonding properties of TECWOOL F® on steel elements

Assessment of the bonding properties of TECWOOL F®, when applied on steel structures, has been carried out according to EGOLF EA 05 procedure.

The indicated values are representative of cohesive failure near the rendering surface. These values are guidance values, and they do not reflect a statistical evaluation, nor minimum guaranteed values.

Table A.3.2: Tensile bond strength on steel substrates.

Surface	Thickness of TECWOOL F® (mm)	Mean tensile bond strength (MPa)	Failure mode
Steel substrate according EGOLF EA 05	Minimum	0,0055	Cohesive
	Maximum	0,0028	Cohesive

[14] EN ISO 8501-1 Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.

A.3.3 Assessment of the fire performance of TECWOOL F® on steel structures

The assessment of the fire resistance performance of TECWOOL F® when applied on steel structures has been done according to EN 13381-4, Annex E.5 Numerical Regression Analysis.

The resistance to fire performance of I/H sections beams and columns is given in tables A.3.3 to A.3.9.

The resistance to fire performance of hollow section (HS) beams and columns is given in tables A.3.10 to A.3.16, calculated in accordance with Annex A, section A.3, of EN 13381-4.

Table A.3.3: Resistance to fire of H and I sections.

Section Factor (m^{-1})	Resistance to fire period of 30 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	10	10	10	10	10	10	10	10	10
70	10	10	10	10	10	10	10	10	10
80	10	10	10	10	10	10	10	10	10
90	10	10	10	10	10	10	10	10	10
100	10	10	10	10	10	10	10	10	10
110	11	10	10	10	10	10	10	10	10
120	12	10	10	10	10	10	10	10	10
130	12	10	10	10	10	10	10	10	10
140	13	11	10	10	10	10	10	10	10
150	13	11	10	10	10	10	10	10	10
160	14	12	10	10	10	10	10	10	10
170	14	12	10	10	10	10	10	10	10
180	14	12	11	10	10	10	10	10	10
190	15	13	11	10	10	10	10	10	10
200	15	13	11	10	10	10	10	10	10
210	15	13	12	10	10	10	10	10	10
220	15	13	12	10	10	10	10	10	10
230	15	14	12	11	10	10	10	10	10
240	16	14	12	11	10	10	10	10	10
250	16	14	12	11	10	10	10	10	10
260	16	14	13	11	10	10	10	10	10
270	16	14	13	11	10	10	10	10	10
280	16	14	13	12	10	10	10	10	10
290	16	15	13	12	10	10	10	10	10
300	16	15	13	12	11	10	10	10	10
310	16	15	13	12	11	10	10	10	10
320	16	15	13	12	11	10	10	10	10
330	17	15	14	12	11	10	10	10	10
340	17	15	14	12	11	10	10	10	10
350	17	15	14	12	11	10	10	10	10
360	17	15	14	12	11	10	10	10	10
370	17	15	14	13	11	10	10	10	10
380	17	15	14	13	11	10	10	10	10
390	17	15	14	13	12	10	10	10	10
400	17	16	14	13	12	11	10	10	10
410	17	16	14	13	12	11	10	10	10
420	17	16	14	13	12	11	10	10	10
430	17	16	14	13	12	11	10	10	10
440	17	16	14	13	12	11	10	10	10
495	18	16	15	13	12	11	10	10	10

Table A.3.4: Resistance to fire of H and I sections.

Section Factor (m^{-1})	Resistance to fire period of 45 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	11	10	10	10	10	10	10	10	10
70	12	10	10	10	10	10	10	10	10
80	13	11	10	10	10	10	10	10	10
90	14	12	10	10	10	10	10	10	10
100	15	13	11	10	10	10	10	10	10
110	16	14	12	10	10	10	10	10	10
120	17	14	12	11	10	10	10	10	10
130	17	15	13	11	10	10	10	10	10
140	18	16	14	12	10	10	10	10	10
150	18	16	14	12	11	10	10	10	10
160	19	16	15	13	11	10	10	10	10
170	19	17	15	13	12	10	10	10	10
180	19	17	15	14	12	11	10	10	10
190	20	17	16	14	12	11	10	10	10
200	20	18	16	14	13	11	10	10	10
210	20	18	16	15	13	12	10	10	10
220	20	18	16	15	13	12	11	10	10
230	20	18	17	15	14	12	11	10	10
240	21	19	17	15	14	12	11	10	10
250	21	19	17	15	14	13	11	10	10
260	21	19	17	16	14	13	12	10	10
270	21	19	17	16	14	13	12	11	10
280	21	19	18	16	15	13	12	11	10
290	21	19	18	16	15	13	12	11	10
300	21	20	18	16	15	14	12	11	10
310	22	20	18	16	15	14	12	11	10
320	22	20	18	17	15	14	13	11	10
330	22	20	18	17	15	14	13	12	11
340	22	20	18	17	15	14	13	12	11
350	22	20	18	17	15	14	13	12	11
360	22	20	18	17	16	14	13	12	11
370	22	20	19	17	16	14	13	12	11
380	22	20	19	17	16	15	13	12	11
390	22	20	19	17	16	15	13	12	11
400	22	20	19	17	16	15	14	12	11
410	22	20	19	17	16	15	14	13	11
420	22	21	19	17	16	15	14	13	12
430	22	21	19	18	16	15	14	13	12
440	22	21	19	18	16	15	14	13	12
495	23	21	19	18	17	15	14	13	12

Table A.3.5: Resistance to fire of H and I sections.

Section Factor (m^{-1})	Resistance to fire period of 60 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	16	13	10	10	10	10	10	10	10
70	16	13	11	10	10	10	10	10	10
80	18	15	12	10	10	10	10	10	10
90	19	16	14	12	10	10	10	10	10
100	20	17	15	13	11	10	10	10	10
110	21	18	16	14	12	10	10	10	10
120	22	19	17	15	13	11	10	10	10
130	22	20	17	15	13	12	10	10	10
140	23	20	18	16	14	13	11	10	10
150	23	21	18	16	15	13	12	10	10
160	24	21	19	17	15	14	12	11	10
170	24	22	19	17	16	14	13	11	10
180	24	22	20	18	16	15	13	12	11
190	25	22	20	18	16	15	13	12	11
200	25	23	20	19	17	15	14	13	11
210	25	23	21	19	17	16	14	13	12
220	25	23	21	19	17	16	14	13	12
230	26	23	21	19	18	16	15	13	12
240	26	23	21	20	18	16	15	14	13
250	26	24	22	20	18	17	15	14	13
260	26	24	22	20	18	17	15	14	13
270	26	24	22	20	19	17	16	14	13
280	26	24	22	20	19	17	16	15	13
290	26	24	22	21	19	17	16	15	14
300	27	24	22	21	19	18	16	15	14
310	27	25	23	21	19	18	16	15	14
320	27	25	23	21	19	18	17	15	14
330	27	25	23	21	20	18	17	15	14
340	27	25	23	21	20	18	17	16	14
350	27	25	23	21	20	18	17	16	15
360	27	25	23	21	20	18	17	16	15
370	27	25	23	22	20	19	17	16	15
380	27	25	23	22	20	19	17	16	15
390	27	25	23	22	20	19	17	16	15
400	27	25	24	22	20	19	18	16	15
410	27	25	24	22	20	19	18	16	15
420	27	25	24	22	20	19	18	17	15
430	27	26	24	22	21	19	18	17	15
440	28	26	24	22	21	19	18	17	16
495	28	26	24	23	21	20	18	17	16

Table A.3.6: Resistance to fire of H and I sections.

Section Factor (m^{-1})	Resistance to fire period of 90 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	25	21	18	15	13	11	10	10	10
70	26	22	19	16	13	11	10	10	10
80	28	24	21	18	15	13	12	10	10
90	29	25	22	19	17	15	13	11	10
100	30	26	23	21	18	16	14	13	11
110	31	27	24	22	19	17	15	14	12
120	32	28	25	23	20	18	16	15	13
130	32	29	26	23	21	19	17	16	14
140	33	30	27	24	22	20	18	16	15
150	33	30	27	25	23	21	19	17	16
160	34	31	28	25	23	21	19	18	16
170	34	31	28	26	24	22	20	18	17
180	34	31	29	26	24	22	20	19	17
190	35	32	29	27	25	23	21	19	18
200	35	32	29	27	25	23	21	20	18
210	35	32	30	27	25	23	22	20	19
220	35	33	30	28	26	24	22	20	19
230	36	33	30	28	26	24	22	21	19
240	36	33	31	28	26	24	23	21	20
250	36	33	31	29	27	25	23	21	20
260	36	33	31	29	27	25	23	22	20
270	36	34	31	29	27	25	23	22	20
280	36	34	31	29	27	25	24	22	21
290	37	34	32	29	27	26	24	22	21
300	37	34	32	30	28	26	24	23	21
310	37	34	32	30	28	26	24	23	21
320	37	34	32	30	28	26	24	23	21
330	37	34	32	30	28	26	25	23	22
340	37	35	32	30	28	26	25	23	22
350	37	35	32	30	28	27	25	23	22
360	37	35	33	30	29	27	25	24	22
370	37	35	33	31	29	27	25	24	22
380	37	35	33	31	29	27	25	24	22
390	37	35	33	31	29	27	26	24	23
400	38	35	33	31	29	27	26	24	23
410	38	35	33	31	29	27	26	24	23
420	38	35	33	31	29	27	26	24	23
430	38	35	33	31	29	28	26	24	23
440	38	35	33	31	29	28	26	25	23
495	38	36	34	32	30	28	27	25	24

Table A.3.7: Resistance to fire of H and I sections.

Section Factor (m^{-1})	Resistance to fire period of 120 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	35	30	26	22	19	17	15	13	11
70	36	31	27	23	20	18	16	14	12
80	38	33	29	25	22	20	18	16	14
90	39	34	30	27	24	22	19	17	16
100	40	36	32	28	26	23	21	19	17
110	41	37	33	30	27	24	22	20	18
120	42	37	34	31	28	25	23	21	19
130	42	38	35	32	29	26	24	22	20
140	43	39	35	32	30	27	25	23	21
150	43	40	36	33	30	28	26	24	22
160	44	40	37	34	31	29	27	25	23
170	44	41	37	34	32	29	27	25	23
180	45	41	38	35	32	30	28	26	24
190	45	41	38	35	33	30	28	26	25
200	45	42	39	36	33	31	29	27	25
210	45	42	39	36	34	31	29	27	25
220	46	42	39	36	34	32	30	28	26
230	46	42	39	37	34	32	30	28	26
240	46	43	40	37	35	32	30	28	27
250	46	43	40	37	35	33	31	29	27
260	46	43	40	38	35	33	31	29	27
270	47	43	40	38	35	33	31	29	28
280	47	44	41	38	36	33	31	30	28
290	47	44	41	38	36	34	32	30	28
300	47	44	41	38	36	34	32	30	28
310	47	44	41	39	36	34	32	30	29
320	47	44	41	39	36	34	32	31	29
330	47	44	41	39	37	35	33	31	29
340	47	44	42	39	37	35	33	31	29
350	47	44	42	39	37	35	33	31	29
360	48	45	42	39	37	35	33	31	30
370	48	45	42	40	37	35	33	31	30
380	48	45	42	40	37	35	33	32	30
390	48	45	42	40	38	35	34	32	30
400	48	45	42	40	38	36	34	32	30
410	48	45	42	40	38	36	34	32	30
420	48	45	43	40	38	36	34	32	31
430	48	45	43	40	38	36	34	32	31
440	48	45	43	40	38	36	34	32	31
495	48	46	43	41	39	37	35	33	31

Table A.3.8: Resistance to fire of H and I sections.

Section Factor (m^{-1})	Resistance to fire period of 180 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	54	47	41	37	33	29	26	24	21
70	55	48	42	38	34	30	27	24	22
80	57	50	45	40	36	33	30	27	25
90	59	52	47	42	38	35	32	29	27
100	60	54	48	44	40	37	34	31	29
110	61	55	50	46	42	38	35	33	30
120	62	56	51	47	43	40	37	34	32
130	62	57	52	48	44	41	38	35	33
140	63	58	53	49	45	42	39	36	34
150	63	58	54	50	46	43	40	37	35
160	64	59	54	51	47	44	41	38	36
170	64	59	55	51	48	45	42	39	37
180	65	60	56	52	48	45	42	40	37
190	65	60	56	52	49	46	43	40	38
200	65	61	57	53	49	46	44	41	39
210	66	61	57	53	50	47	44	42	39
220	66	61	57	54	50	47	45	42	40
230	66	62	58	54	51	48	45	43	40
240	66	62	58	55	51	48	46	43	41
250	67	62	58	55	52	49	46	44	41
260	67	62	59	55	52	49	46	44	42
270	67	63	59	55	52	49	47	44	42
280	67	63	59	56	53	50	47	45	42
290	67	63	59	56	53	50	47	45	43
300	67	63	60	56	53	50	48	45	43
310	67	63	60	56	53	51	48	46	43
320	68	64	60	57	54	51	48	46	44
330	68	64	60	57	54	51	48	46	44
340	68	64	60	57	54	51	49	46	44
350	68	64	60	57	54	51	49	47	44
360	68	64	61	57	54	52	49	47	45
370	68	64	61	58	55	52	49	47	45
380	68	64	61	58	55	52	49	47	45
390	68	64	61	58	55	52	50	47	45
400	68	65	61	58	55	52	50	47	45
410	68	65	61	58	55	53	50	48	45
420	68	65	61	58	55	53	50	48	46
430	68	65	61	58	55	53	50	48	46
440	69	65	62	58	56	53	50	48	46
495	69	65	62	59	56	54	51	49	47

Table A.3.9: Resistance to fire of H and I sections.

Section Factor (m^{-1})	Resistance to fire period of 240 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	-	65	57	51	46	41	38	34	31
70	-	66	58	52	47	43	39	35	32
80	-	68	61	55	50	46	42	38	35
90	-	-	63	58	53	48	44	41	38
100	-	-	65	60	55	50	47	43	40
110	-	-	67	61	57	52	49	45	42
120	-	-	68	63	58	54	50	47	44
130	-	-	-	64	60	55	52	48	45
140	-	-	-	65	61	57	53	50	47
150	-	-	-	66	62	58	54	51	48
160	-	-	-	67	63	59	55	52	49
170	-	-	-	68	64	60	56	53	50
180	-	-	-	69	64	61	57	54	51
190	-	-	-	-	65	61	58	55	52
200	-	-	-	-	66	62	59	55	52
210	-	-	-	-	66	63	59	56	53
220	-	-	-	-	67	63	60	57	54
230	-	-	-	-	67	64	60	57	54
240	-	-	-	-	68	64	61	58	55
250	-	-	-	-	68	65	61	58	55
260	-	-	-	-	69	65	62	59	56
270	-	-	-	-	69	66	62	59	56
280	-	-	-	-	-	66	63	60	57
290	-	-	-	-	-	66	63	60	57
300	-	-	-	-	-	67	63	60	58
310	-	-	-	-	-	67	64	61	58
320	-	-	-	-	-	67	64	61	58
330	-	-	-	-	-	68	64	61	59
340	-	-	-	-	-	68	65	62	59
350	-	-	-	-	-	68	65	62	59
360	-	-	-	-	-	68	65	62	59
370	-	-	-	-	-	68	65	62	60
380	-	-	-	-	-	69	66	63	60
390	-	-	-	-	-	69	66	63	60
400	-	-	-	-	-	69	66	63	60
410	-	-	-	-	-	69	66	63	61
420	-	-	-	-	-	-	66	63	61
430	-	-	-	-	-	-	67	64	61
440	-	-	-	-	-	-	67	64	61
495	-	-	-	-	-	-	68	65	62

Table A.3.10: Resistance to fire of hollow sections.

Section Factor (m^{-1})	Resistance to fire period of 30 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	10	10	10	10	10	10	10	10	10
70	10	10	10	10	10	10	10	10	10
80	10	10	10	10	10	10	10	10	10
90	10	10	10	10	10	10	10	10	10
100	11	10	10	10	10	10	10	10	10
110	12	11	11	11	11	11	11	11	11
120	13	11	11	11	11	11	11	11	11
130	14	12	11	11	11	11	11	11	11
140	15	12	11	11	11	11	11	11	11
150	15	13	11	11	11	11	11	11	11
160	16	14	12	11	11	11	11	11	11
170	16	14	12	11	11	11	11	11	11
180	17	15	13	11	11	11	11	11	11
190	17	15	13	11	11	11	11	11	11
200	18	16	14	12	11	11	11	11	11
210	18	16	14	12	11	11	11	11	11
220	19	16	14	13	12	12	12	12	12
230	19	17	15	13	12	12	12	12	12
240	19	17	15	13	12	12	12	12	12
250	20	17	16	14	12	12	12	12	12
260	20	18	16	14	12	12	12	12	12
270	20	18	16	14	13	12	12	12	12
280	20	18	16	14	13	12	12	12	12
290	20	18	16	15	13	12	12	12	12
300	20	18	16	15	13	12	12	12	12
310	20	18	17	15	13	12	12	12	12
320	21	19	17	15	14	12	12	12	12
330	21	19	17	15	14	12	12	12	12
340	21	19	17	15	14	12	12	12	12
350	21	19	17	15	14	13	12	12	12
360	21	19	17	16	14	13	12	12	12
370	21	19	17	16	14	13	12	12	12
380	21	19	17	16	14	13	12	12	12
390	21	19	18	16	14	13	12	12	12
400	21	19	18	16	15	13	12	12	12
410	21	19	18	16	15	13	12	12	12
420	21	20	18	16	15	13	12	12	12
430	22	20	18	16	15	13	12	12	12
440	22	20	18	16	15	14	12	12	12
495	22	20	18	17	15	14	13	12	12

Table A.3.11: Resistance to fire of hollow sections.

Section Factor (m^{-1})	Resistance to fire period of 45 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	12	10	10	10	10	10	10	10	10
70	12	10	10	10	10	10	10	10	10
80	14	11	10	10	10	10	10	10	10
90	16	13	11	10	10	10	10	10	10
100	17	14	12	10	10	10	10	10	10
110	18	15	13	11	11	11	11	11	11
120	19	16	14	12	11	11	11	11	11
130	20	17	15	13	11	11	11	11	11
140	20	18	15	13	12	11	11	11	11
150	21	18	16	14	12	11	11	11	11
160	22	19	17	15	13	11	11	11	11
170	22	20	17	15	14	12	11	11	11
180	23	20	18	16	14	13	11	11	11
190	23	21	19	17	15	13	12	11	11
200	24	21	19	17	15	14	12	11	11
210	24	22	20	18	16	14	13	11	11
220	25	22	20	18	16	15	13	12	12
230	25	23	20	18	17	15	13	12	12
240	26	23	21	19	17	15	14	12	12
250	26	24	21	19	17	16	14	13	12
260	26	24	22	20	18	16	15	13	12
270	26	24	22	20	18	16	15	13	12
280	26	24	22	20	18	17	15	14	12
290	27	24	22	20	18	17	15	14	12
300	27	24	22	20	19	17	15	14	13
310	27	25	22	21	19	17	16	14	13
320	27	25	23	21	19	17	16	14	13
330	27	25	23	21	19	17	16	15	13
340	27	25	23	21	19	18	16	15	13
350	27	25	23	21	19	18	16	15	14
360	27	25	23	21	19	18	16	15	14
370	27	25	23	21	20	18	17	15	14
380	28	25	23	21	20	18	17	15	14
390	28	25	23	22	20	18	17	15	14
400	28	26	24	22	20	18	17	16	14
410	28	26	24	22	20	18	17	16	14
420	28	26	24	22	20	19	17	16	14
430	28	26	24	22	20	19	17	16	15
440	28	26	24	22	20	19	17	16	15
495	28	26	24	22	21	19	18	16	15

Table A.3.12: Resistance to fire of hollow sections.

Section Factor (m^{-1})	Resistance to fire period of 60 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	17	13	11	10	10	10	10	10	10
70	18	14	11	10	10	10	10	10	10
80	19	16	13	11	10	10	10	10	10
90	21	18	15	13	11	10	10	10	10
100	22	19	16	14	12	10	10	10	10
110	23	20	18	15	13	11	11	11	11
120	24	21	19	16	14	12	11	11	11
130	25	22	20	17	15	13	12	11	11
140	26	23	20	18	16	14	13	11	11
150	27	24	21	19	17	15	13	12	11
160	28	25	22	20	18	16	14	13	11
170	28	25	23	20	18	16	15	13	12
180	29	26	23	21	19	17	15	14	12
190	29	26	24	22	20	18	16	14	13
200	30	27	25	22	20	18	17	15	14
210	30	28	25	23	21	19	17	16	14
220	31	28	26	23	21	19	18	16	15
230	31	29	26	24	22	20	18	17	15
240	32	29	27	24	22	20	19	17	16
250	32	30	27	25	23	21	19	17	16
260	33	30	27	25	23	21	19	18	16
270	33	30	28	25	23	21	20	18	17
280	33	30	28	25	23	22	20	18	17
290	33	30	28	26	24	22	20	19	17
300	33	30	28	26	24	22	20	19	17
310	33	31	28	26	24	22	21	19	17
320	33	31	28	26	24	22	21	19	18
330	33	31	29	26	24	23	21	19	18
340	34	31	29	27	25	23	21	19	18
350	34	31	29	27	25	23	21	20	18
360	34	31	29	27	25	23	21	20	18
370	34	31	29	27	25	23	22	20	19
380	34	31	29	27	25	23	22	20	19
390	34	32	29	27	25	23	22	20	19
400	34	32	29	27	25	24	22	20	19
410	34	32	30	27	26	24	22	21	19
420	34	32	30	28	26	24	22	21	19
430	34	32	30	28	26	24	22	21	19
440	34	32	30	28	26	24	22	21	19
495	35	32	30	28	26	25	23	21	20

Table A.3.13: Resistance to fire of hollow sections.

Section Factor (m^{-1})	Resistance to fire period of 90 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	27	23	19	16	14	11	10	10	10
70	28	24	20	17	14	12	10	10	10
80	30	26	22	19	17	14	12	11	10
90	32	28	24	21	18	16	14	12	11
100	33	29	26	23	20	18	16	14	12
110	34	30	27	24	21	19	17	15	14
120	36	32	28	25	23	20	18	17	15
130	37	33	29	26	24	22	20	18	16
140	38	34	30	28	25	23	21	19	17
150	38	35	31	29	26	24	22	20	18
160	39	36	32	29	27	25	22	21	19
170	40	36	33	30	28	25	23	21	20
180	41	37	34	31	29	26	24	22	20
190	41	38	35	32	29	27	25	23	21
200	42	39	35	33	30	28	26	24	22
210	43	39	36	33	31	28	26	24	22
220	43	40	37	34	31	29	27	25	23
230	44	40	37	35	32	30	27	26	24
240	44	41	38	35	33	30	28	26	24
250	45	42	39	36	33	31	29	27	25
260	45	42	39	36	33	31	29	27	25
270	45	42	39	36	34	31	29	27	26
280	46	42	39	37	34	32	30	28	26
290	46	42	39	37	34	32	30	28	26
300	46	43	40	37	35	32	30	28	26
310	46	43	40	37	35	32	30	28	27
320	46	43	40	37	35	33	31	29	27
330	46	43	40	38	35	33	31	29	27
340	46	43	40	38	35	33	31	29	27
350	46	43	41	38	35	33	31	29	27
360	47	43	41	38	36	33	31	29	28
370	47	44	41	38	36	34	32	30	28
380	47	44	41	38	36	34	32	30	28
390	47	44	41	38	36	34	32	30	28
400	47	44	41	39	36	34	32	30	28
410	47	44	41	39	36	34	32	30	29
420	47	44	41	39	36	34	32	30	29
430	47	44	41	39	37	34	32	31	29
440	47	44	42	39	37	35	33	31	29
495	48	45	42	40	37	35	33	31	30

Table A.3.14: Resistance to fire of hollow sections.

Section Factor (m^{-1})	Resistance to fire period of 120 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	37	32	27	24	21	18	16	14	12
70	38	33	28	25	22	19	17	15	13
80	41	35	31	27	24	21	19	17	15
90	42	37	33	29	26	23	21	19	17
100	44	39	35	31	28	25	23	21	19
110	45	41	36	33	30	27	25	22	20
120	47	42	38	34	31	28	26	24	22
130	48	43	39	36	33	30	27	25	23
140	49	44	40	37	34	31	29	26	24
150	50	45	42	38	35	32	30	27	25
160	51	46	43	39	36	33	31	29	26
170	52	47	44	40	37	34	32	29	27
180	53	48	44	41	38	35	33	30	28
190	53	49	45	42	39	36	34	31	29
200	54	50	46	43	40	37	34	32	30
210	55	51	47	44	41	38	35	33	31
220	56	52	48	44	41	39	36	34	32
230	56	52	49	45	42	39	37	35	32
240	57	53	49	46	43	40	38	35	33
250	58	54	50	47	44	41	38	36	34
260	58	54	50	47	44	41	39	36	34
270	58	54	51	47	44	42	39	37	35
280	58	54	51	48	45	42	39	37	35
290	58	55	51	48	45	42	40	37	35
300	59	55	51	48	45	42	40	38	35
310	59	55	51	48	45	43	40	38	36
320	59	55	52	49	46	43	40	38	36
330	59	55	52	49	46	43	41	38	36
340	59	55	52	49	46	43	41	39	37
350	59	56	52	49	46	44	41	39	37
360	59	56	52	49	46	44	41	39	37
370	59	56	53	49	47	44	42	39	37
380	60	56	53	50	47	44	42	40	37
390	60	56	53	50	47	44	42	40	38
400	60	56	53	50	47	45	42	40	38
410	60	56	53	50	47	45	42	40	38
420	60	56	53	50	47	45	42	40	38
430	60	56	53	50	48	45	43	40	38
440	60	57	53	50	48	45	43	41	38
495	60	57	54	51	48	46	43	41	39

Table A.3.15: Resistance to fire of hollow sections.

Section Factor (m^{-1})	Resistance to fire period of 180 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	58	50	44	39	35	31	28	25	23
70	59	52	45	40	36	32	29	26	24
80	62	54	48	43	39	35	32	29	27
90	64	57	51	46	42	38	35	32	29
100	66	59	53	48	44	40	37	34	32
110	67	61	55	51	46	43	39	36	34
120	69	63	57	52	48	44	41	38	35
130	-	64	59	54	50	46	43	40	37
140	-	66	60	56	52	48	45	41	39
150	-	67	62	57	53	49	46	43	40
160	-	68	63	59	54	51	47	44	42
170	-	-	64	60	56	52	49	46	43
180	-	-	66	61	57	53	50	47	44
190	-	-	67	62	58	55	51	48	45
200	-	-	68	63	59	56	52	49	46
210	-	-	69	65	60	57	53	50	48
220	-	-	-	66	62	58	55	51	49
230	-	-	-	67	63	59	56	52	50
240	-	-	-	68	64	60	57	53	51
250	-	-	-	69	65	61	58	54	52
260	-	-	-	69	65	61	58	55	52
270	-	-	-	69	65	62	58	55	52
280	-	-	-	-	66	62	59	56	53
290	-	-	-	-	66	63	59	56	53
300	-	-	-	-	66	63	60	57	54
310	-	-	-	-	67	63	60	57	54
320	-	-	-	-	67	63	60	57	54
330	-	-	-	-	67	64	61	58	55
340	-	-	-	-	68	64	61	58	55
350	-	-	-	-	68	64	61	58	55
360	-	-	-	-	68	65	61	58	56
370	-	-	-	-	68	65	62	59	56
380	-	-	-	-	68	65	62	59	56
390	-	-	-	-	69	65	62	59	56
400	-	-	-	-	69	65	62	59	57
410	-	-	-	-	69	66	63	60	57
420	-	-	-	-	69	66	63	60	57
430	-	-	-	-	69	66	63	60	57
440	-	-	-	-	69	66	63	60	57
495	-	-	-	-	-	67	64	61	58

Table A.3.16: Resistance to fire of hollow sections.

Section Factor (m^{-1})	Resistance to fire period of 240 minutes								
	Minimum thickness (mm) of TECWOOL F® at the design temperature								
	300 ºC	350 ºC	400 ºC	450 ºC	500 ºC	550 ºC	600 ºC	650 ºC	700 ºC
67	-	69	61	54	49	44	40	36	33
70	-	-	62	56	50	46	41	38	35
80	-	-	66	60	54	49	45	42	38
90	-	-	69	63	57	53	48	45	41
100	-	-	-	66	60	56	51	48	44
110	-	-	-	68	63	58	54	50	47
120	-	-	-	-	65	60	56	53	49
130	-	-	-	-	67	63	58	55	51
140	-	-	-	-	69	65	60	57	53
150	-	-	-	-	-	67	62	59	55
160	-	-	-	-	-	68	64	60	57
170	-	-	-	-	-	-	66	62	58
180	-	-	-	-	-	-	67	64	60
190	-	-	-	-	-	-	69	65	62
200	-	-	-	-	-	-	-	66	63
210	-	-	-	-	-	-	-	68	64
220	-	-	-	-	-	-	-	69	66
230	-	-	-	-	-	-	-	-	67
240	-	-	-	-	-	-	-	-	68
250	-	-	-	-	-	-	-	-	69
260	-	-	-	-	-	-	-	-	-
270	-	-	-	-	-	-	-	-	-
280	-	-	-	-	-	-	-	-	-
290	-	-	-	-	-	-	-	-	-
300	-	-	-	-	-	-	-	-	-
310	-	-	-	-	-	-	-	-	-
320	-	-	-	-	-	-	-	-	-
330	-	-	-	-	-	-	-	-	-
340	-	-	-	-	-	-	-	-	-
350	-	-	-	-	-	-	-	-	-
360	-	-	-	-	-	-	-	-	-
370	-	-	-	-	-	-	-	-	-
380	-	-	-	-	-	-	-	-	-
390	-	-	-	-	-	-	-	-	-
400	-	-	-	-	-	-	-	-	-
410	-	-	-	-	-	-	-	-	-
420	-	-	-	-	-	-	-	-	-
430	-	-	-	-	-	-	-	-	-
440	-	-	-	-	-	-	-	-	-
495	-	-	-	-	-	-	-	-	-