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European Technical Assessment

ETA 18/1087
of 21.03.2019

General part

Trade name of the construction product	**Biofire**
Product family to which the construction product belongs	Rendering intended for fire resisting applications.
Manufacturer	**TRIA – Serviços, Materiais e Equipamentos SA** Parque Industrial Manuel Lourenço Ferreira 43 PT-3450-232 Mortágua (Viseu) Portugal
Manufacturing plant(s)	According to annex N kept by ITeC.
This European Technical Assessment contains	46 pages including 7 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.

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

Biofire is a wet-mix spray-applied fire protective rendering made of lightweight, expanded perlite and vermiculite aggregates. The binder is included as part of the dry mix in the bag.

The rendering considered in this ETA is applied in conjunction with the additional components as specified in the Annexes – ETA under option 3 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 to 7.

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

Biofire 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	Load-bearing concrete elements	Type Z_2
Type 4	Load-bearing steel elements	Type Y
Type 5	Load-bearing flat concrete profiled sheet composite elements	Type Y
Type 7	Load-bearing timber elements	Type Z_2
Type 9	Technical services assemblies in buildings	Type Y
Type 10	Load-bearing floor of timber joists and concrete slab	Type Z_2

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

- Type Y: semi-exposed conditions, which includes temperatures below 0ºC, but no exposure to rain and limited exposure to UV (effects of UV exposure are not assessed). This category includes Type Z_1 and Type Z_2.
- Type Z_1: internal conditions with humidity equal to or higher than 85% RH, excluding temperatures below 0°C. This category includes Type Z_2.
- Type Z_2: internal conditions excluding temperatures below 0°C, with humidity lower than 85% RH.

The provisions made in this ETA are based on a working life of Biofire 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 Biofire was performed according to EAD 350140-00-1106 *Renderings and rendering kits intended for fire resisting applications (September 2017)*.

Table 2: Performance of Biofire.

Product: Biofire		**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 2 to 7
General aspects relating to the performance of the product	Durability	Type Y, Z_1 and Z_2. (see 3.2.3)
	Resistance to corrosion of the fixings	No corrosion
	Resistance to corrosion of steel substrate induced by the rendering	No corrosion
	Resistance to hard body impact	Compliance with EAD 350140-00-1106
	Adhesion (bond strength)	See 3.2.3 and Annexes 2 to 7

3.2 Methods used for the assessment

3.2.1 Reaction to fire

The performance of the rendering has been determined according to EN 13501-1 [1].

3.2.2 Fire resistance

Fire resistance performance, classified in accordance with EN 13501-2 [2] and EN 13501-3 [3], has been determined following the test and evaluation methods given in Annexes 2 to 7.

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

[2] 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] EN 13501-3 Fire classification of construction products and building elements. Part 3: Classification using data from fire resistance tests on products and elements used in building service installations: fire resisting ducts and fire dampers.

3.2.3 General aspects relating to the performance of the product

Durability of the rendering has been assessed according to EAD 350140-00-1106, section 2.2.12.1, in relation to its fire protective intended uses as defined in Table 1, verifying the:

- Resistance to deterioration caused by high humidity
- Resistance to deterioration caused by heat and cold
- Resistance to deterioration caused by freezing and thawing

Corrosion protection primers for use on load-bearing steel elements (Type 4) have been assessed to be compatible, in accordance with EAD 350140-00-1106, section 2.2.14.4, for the primer families as specified in Annex 2, section A.2.2.2, of this ETA.

The rendering has also been assessed for direct application onto the steel substrate (without primer) in accordance with EAD 350140-00-1106, section 2.2.14.4, by means of the insulation efficiency test.

Assessment of the steel substrate corrosion induced by the rendering was carried out in accordance with EAD 350140-00-1106, section 2.2.14.4 and Annex B. The rendering does not show a corrosive effect on the assessed substrates. Test results are given in Table 3.

Table 3: Resistance to corrosion induced by the rendering.

Substrate	Test conditions	Loss of mass
Bare steel	23 ºC / R.H. ≤ 60 %	3,75 x 10^{-6} g/mm^2
	35 ºC / 95 % R.H.	10^{-5} g/mm^2
Primed steel	35 ºC / 95 % R.H.	5,5 x 10^{-6} g/mm^2

Regarding resistance to corrosion of the fixings, the expanded galvanised steel mesh as specified in Annex 5, 6 and 7 is compatible with Biofire.

Regarding the resistance to functional failure from hard body impact (0,5 kg steel ball), Biofire has been assessed to be resistant, in accordance with EAD 350140-00-1106, section 2.2.6.1.

Adhesion (bond strength) has been determined in accordance with EAD 350140-00-1106, section 2.2.7 and EGOLF Agreement EA 05[4]. The adhesion/cohesion 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 the Annexes when relevant.

The ETA is issued for Biofire on the basis of agreed data/information, deposited with the ITeC, which confirm, according to EAD 350140-00-1106, section 2.3.2, that the product under assessment conforms to its declared characteristics.

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

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 (including coatings)	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 [5] and the factory production control shall be in accordance with it. The following table specifies the cornerstones for the factory production control.

Table 5: FPC test plan for Biofire.

Product	Property control	Minimum frequency
Dry mix	Incoming materials	1 per batch supplied
	Bulk density of dry mix	5 times per day[6] at regular intervals
Fresh mortar	Apparent density	1 per batch
	Consistence	1 per batch
Hardened rendering	Density	1 per month
	Adhesion	1 per month
	Insulation efficiency	1 per month

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Institut de Tecnologia de la Construcció de Catalunya

Ferran Bermejo Nualart
Technical Director, ITeC

[5] 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.

[6] A day represents a 24 hour time period in which production is considered to be “normal”.

ANNEX 1. Fire resistance performances and installation provisions for the assemblies related to the intended uses of Biofire

A.1.1 Overview of fire resistance performances for assemblies protected with Biofire

The fire protective assemblies in Table A.1.1 have been assessed within the framework of this ETA.

Table A.1.1: Fire protective assemblies.

Assembly assessed within the framework of this ETA	Classification	Test standards	Intended use type according to EAD 350140-00-1106	Installation details
Load-bearing steel elements	EN 13501-2, see Annex 2	ENV 13381-4	Type 4	Annex 2
Load-bearing flat concrete profiled sheet composite elements	EN 13501-2, see Annex 3	ENV 13381-5	Type 5	Annex 3
Load-bearing concrete elements	EN 13501-2, see Annex 4	ENV 13381-3	Type 3	Annex 4
Load-bearing timber elements	EN 13501-2, see Annex 5	EN 1365-2	Type 7	Annex 5
Technical services assemblies in buildings	EN 13501-3, see Annex 6	EN 1366-1	Type 9	Annex 6
Load-bearing floor of timber joists and concrete slab	EN 13501-2, see Annex 7	EN 1365-2	Type 10	Annex 7

A.1.2 Installation and design provisions related to the assemblies protected with Biofire

The system installation should be carried out in accordance with the manufacturer's instructions and the provisions given in the following Annexes.

A.1.2.1 Tools and equipment

Typical machines used to spray Biofire are those suitable for all pumpable ready-mixed dry mortar, usually comprising an electric motor, storage hopper, conical mixing tube, integrated water pump, compressor and flow meter for modifying the water quantity, among others. For example, a typical spraying machine is the MP 25, supplied by Putzmeister.

A.1.2.2 Substrate

Before application the substrate should be inspected and prepared. Surfaces to be sprayed shall be free from oil, grease, primers, lock down 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 Biofire. Ducts, piping, conduits or other suspended equipment can be installed

after the application of Biofire, in which case later inspection of the applied Biofire will be required and, when necessary, reparation of the rendering. See next Annexes for substrate specifications.

A.1.2.3 Environmental conditions during application and construction

The air and substrate temperature shall be over 0 ºC during the rendering application and for a minimum of 24 hours after application. In open areas, wind speed should not be higher than 8 m/s. When air temperature is higher than 30 ºC, it is necessary to spray the rendering with water every 12 hours during the first 48 hours.

Adequate ventilation must be envisaged to allow the product to dry out after being sprayed. In closed areas where the ventilation is not adequate, it may be necessary to install a ventilation and air circulation device sufficient to obtain a renovation of air at least 4 times per hour. During winter time special considerations must be taken according to the recommendations of the manufacturer. Depending on the temperature and the relative humidity on the jobsite, Biofire will set in about 18 to 36 hours.

As shown in section 2, the product is intended for environmental use categories Type Y, Z_1 and Z_2. Special provisions shall be taken for temporary protection of the rendering exposed to outdoor conditions during construction.

A.1.2.4 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 relevant Annex.

The bond strength of the rendering to the substrate should be tested on site, except in the case of assemblies according to Annex 5 in which a reinforcement mesh is installed. 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 relevant Annex. For their acceptability, the recommendations given in EAD 350140-00-1106, section G.4, or other existing criteria can be applied, under the responsibility of the person responsible for works.

A.1.2.5 Storage

The bags of Biofire must be stored in a dry and well ventilated place until use, under shelter and away from oozing wall or any other wet surface, unless the package (pallet) is properly protected. Do not store the bags in direct contact with the floor. Biofire can be stored up to 1 year from date of manufacture under dry conditions. Material damaged by moisture (open or damaged bags) should not be used.

A.1.2.6 Repair

Limited damages of Biofire can be repaired. The damaged area shall be carefully cleaned with a knife, cutter or trowel through the whole applied thickness, down to the support. An additional zone of 250 mm all around the damaged area shall be cut at a right angle. Dust and particles generated by this operation shall be carefully eliminated. Biofire shall be sprayed in such a way that the opening is completely filled up and the surface of the repaired area is levelled with the surrounding Biofire. Rendering shall be sprayed with water once Biofire has been applied.

ANNEX 2. Specification and assessment of fire protection of load bearing steel elements protected by Biofire (intended use Type 4)

A.2.1 Classification

The assembly described in this Annex has been tested according to ENV 13381-4 and classified in accordance with EN 13501-2.

The maximum duration of the exposure to the standard time temperature curve defined in EN 1363-1, 5.1.1, is 140 min, depending on the section factor of the load bearing steel element and the thickness of Biofire.

The assessment of the required thickness of Biofire at the design temperature in the range of 350 ºC to 600 ºC, in function of the section factor and the exposure time, is given in section A.2.3.

A.2.2 Installation requirements

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

A.2.2.1 Supporting structure

Biofire was applied to steel substrates with C-THERM protection corrosion primer.

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

- 'H' or 'I' shaped beam and column sections with section factors (A_m/V) between 65 m^{-1} and 295 m^{-1}.
- steel grades according to ENV 13381-4.
- three-sided and four-sided fire exposure for beams and columns.

Specifications for the components are given in Table A.2.1.

Table A.2.1: Specifications for the components.

Element	Identification	Characteristics	Mounting and fixing
Load bearing steel sections	Steel grade according to EN 10025 with the restrictions given in ENV 13381-4	Section factor from 65[(1)] m^{-1} to 295 m^{-1} I/H sections Hollow sections[(2)]	Steel sections blast cleaned to ISO 8501-1 SA2½ or equivalent. Surface shall be bare, clean, dry and free of dust. Steel substrates coated with a corrosion protective alkyd primer.

[(1)] A steel member with section factor ≤ 65 m^{-1} shall be protected with the thickness of Biofire determined for the steel member with section factor equal to 65 m^{-1}.

[(2)] Sections other than I/H sections, according to Annex B of ENV 13381-4.

A.2.2.2 Surface of steel members

Prior to the application of Biofire, the steel members should be coated with an corrosion protective alkyd primer (e.g. C-THERM). Other possible primers assessed to be compatible with the rendering are:

- Alkyd primer
- Two component epoxy primer
- Zinc rich epoxy primer (containing about 85 % by weight of metallic zinc powder)
- Zinc silicate primer

No bonding primer was applied prior to application of Biofire.

A.2.2.3 Fire protective rendering

Biofire is applied on the apparent sides of the steel member to be protected, by following its shape.

Biofire is continuously applied with a spraying machine. During the application, the thickness of the protective material is regularly controlled with a pin caliper. Any part of the structural element exposed to fire shall be covered with Biofire rendering at the required thickness. After spraying, Biofire is smoothed to homogenize the thickness.

Hairline cracks in the dry rendering are not accepted.

Specifications for the components are given in Table A.2.2.

Table A.2.2: Specifications for the components.

Element	Identification	Characteristics	Mounting and fixing
Rendering	Biofire	Thickness: from 10 to 63 mm, according to the assessment rules Density: 870 kg/m^3 ± 15 %	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.

A.2.2.4 Bonding properties of Biofire on steel elements

Assessment of the bonding properties of Biofire product when applied on primed steel plates has been carried out according to EGOLF SM5 procedure.

The indicated values are representative of cohesive failure through the applied thickness of protective sprayed product Biofire. 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 steel plates.

Surface	Thickness of Biofire	Mean tensile bond strength	Failure mode
Primed steel plates according to EGOLF SM5	10 mm	0,15 MPa	Cohesive failure
	50 mm	0,12 MPa	

A.2.3 Assessment of the fire performance of Biofire on steel structures

The assessment of the fire protection performance of Biofire when applied on steel structures has been done according to ENV 13381-4, Annex H Numerical Regression Analysis.

The resistance to fire assessment of I/H sections is given in tables A.2.4 to A.2.9.

The resistance to fire assessment of hollow sections is given in tables A.2.10 to A.2.15, calculated in accordance with Annex B of ENV 13381-4.

Table A.2.4: Resistance to fire of I/H sections for design steel temperature 350 ºC.

Section factor A_m/V (m^{-1})	Fire resistance classification							
	R15	R30	R45	R60	R90	R120	R180	R240
	Minimum thickness (mm) for a design temperature of 350 ºC							
65	10	10	10	13	18	24	25	47
70	10	10	10	13	19	25	37	48
75	10	10	11	14	20	26	38	50
80	10	10	11	14	20	26	39	51
85	10	10	11	14	21	27	40	53
90	10	10	11	15	21	28	41	54
95	10	10	12	15	22	28	42	55
100	10	10	12	15	22	29	42	56
105	10	10	12	15	22	29	43	57
110	10	10	12	16	23	30	44	58
115	10	10	12	16	23	30	44	59
120	10	10	13	16	23	31	45	60
125	10	10	13	16	24	31	46	60
130	10	10	13	17	24	31	46	61
135	10	10	13	17	24	32	47	62
140	10	10	13	17	25	32	47	62
145	10	10	13	17	25	32	48	63
150	10	10	13	17	25	33	48	-
155	10	10	14	17	25	33	49	-
160	10	10	14	18	25	33	49	-
165	10	10	14	18	26	34	49	-
170	10	10	14	18	26	34	50	-
175	10	10	14	18	26	34	50	-
180	10	10	14	18	26	34	50	-
185	10	10	14	18	26	35	51	-
190	10	10	14	18	27	35	51	-
195	10	10	14	18	27	35	51	-
200	10	10	14	19	27	35	52	-
205	10	10	14	19	27	35	52	-
210	10	10	15	19	27	35	52	-
215	10	10	15	19	27	36	53	-
220	10	10	15	19	27	36	53	-
225	10	11	15	19	28	36	53	-
230	10	11	15	19	28	36	53	-
235	10	11	15	19	28	36	53	-
240	10	11	15	19	28	36	54	-
245	10	11	15	19	28	37	54	-
250	10	11	15	19	28	37	54	-
255	10	11	15	19	28	37	54	-
260	10	11	15	20	28	37	54	-
265	10	11	15	20	28	37	55	-
270	10	11	15	20	28	37	55	-
275	10	11	15	20	29	37	55	-
280	10	11	15	20	29	37	55	-
285	10	11	15	20	29	38	55	-
290	10	11	15	20	29	38	55	-
295	10	11	16	20	29	38	55	-

Table A.2.5: Resistance to fire of I/H sections for design steel temperature 400 ºC.

Section factor A_m/V (m^{-1})	Fire resistance classification							
	R15	R30	R45	R60	R90	R120	R180	R240
	Minimum thickness (mm) for a design temperature of 400 ºC							
65	10	10	10	11	16	22	32	43
70	10	10	10	11	17	22	34	45
75	10	10	10	12	18	23	35	46
80	10	10	10	12	18	24	36	47
85	10	10	10	13	19	25	37	49
90	10	10	10	13	19	25	37	50
95	10	10	10	13	20	26	38	51
100	10	10	10	14	20	26	39	52
105	10	10	11	14	20	27	40	53
110	10	10	11	14	21	27	40	54
115	10	10	11	14	21	28	41	54
120	10	10	11	15	21	28	42	55
125	10	10	11	15	22	29	42	56
130	10	10	12	15	22	29	43	57
135	10	10	12	15	22	29	43	57
140	10	10	12	15	22	30	44	58
145	10	10	12	16	23	30	44	59
150	10	10	12	16	23	30	45	59
155	10	10	12	16	23	31	45	60
160	10	10	12	16	23	31	46	60
165	10	10	12	16	24	31	46	61
170	10	10	13	16	24	31	46	61
175	10	10	13	16	24	32	47	62
180	10	10	13	17	24	32	47	62
185	10	10	13	17	24	32	47	63
190	10	10	13	17	25	32	48	63
195	10	10	13	17	25	32	48	63
200	10	10	13	17	25	33	48	-
205	10	10	13	17	25	33	48	-
210	10	10	13	17	25	33	49	-
215	10	10	13	17	25	33	49	-
220	10	10	13	17	25	33	49	-
225	10	10	14	18	25	33	49	-
230	10	10	14	18	26	34	50	-
235	10	10	14	18	26	34	50	-
240	10	10	14	18	26	34	50	-
245	10	10	14	18	26	34	50	-
250	10	10	14	18	26	34	51	-
255	10	10	14	18	26	34	51	-
260	10	10	14	18	26	34	51	-
265	10	10	14	18	26	35	51	-
270	10	10	14	18	26	35	51	-
275	10	10	14	18	27	35	51	-
280	10	10	14	18	27	35	52	-
285	10	10	14	18	27	35	52	-
290	10	10	14	18	27	35	52	-
295	10	10	14	18	27	35	52	-

Table A.2.6: Resistance to fire of I/H sections for design steel temperature 450 ºC.

Section factor A_m/V (m^{-1})	Fire resistance classification							
	R15	R30	R45	R60	R90	R120	R180	R240
	Minimum thickness (mm) for a design temperature of 450 ºC							
65	10	10	10	10	14	19	29	39
70	10	10	10	10	15	20	30	41
75	10	10	10	10	16	21	31	42
80	10	10	10	11	16	22	32	43
85	10	10	10	11	17	22	33	45
90	10	10	10	11	17	23	34	46
95	10	10	10	12	17	23	35	47
100	10	10	10	12	18	24	36	48
105	10	10	10	12	18	24	36	49
110	10	10	10	12	19	25	37	49
115	10	10	10	13	19	25	38	50
120	10	10	10	13	19	26	38	51
125	10	10	10	13	20	26	39	52
130	10	10	10	13	20	26	39	52
135	10	10	10	14	20	27	40	53
140	10	10	10	14	20	27	40	54
145	10	10	11	14	21	27	41	54
150	10	10	11	14	21	28	41	55
155	10	10	11	14	21	28	42	55
160	10	10	11	14	21	28	42	56
165	10	10	11	15	22	29	42	56
170	10	10	11	15	22	29	43	57
175	10	10	11	15	22	29	43	57
180	10	10	11	15	22	29	43	58
185	10	10	12	15	22	29	44	58
190	10	10	12	15	22	30	44	58
195	10	10	12	15	23	30	44	59
200	10	10	12	15	23	30	45	59
205	10	10	12	16	23	30	45	60
210	10	10	12	16	23	30	45	60
215	10	10	12	16	23	31	45	60
220	10	10	12	16	23	31	46	60
225	10	10	12	16	23	31	46	61
230	10	10	12	16	24	31	46	61
235	10	10	12	16	24	31	46	61
240	10	10	12	16	24	31	46	62
245	10	10	13	16	24	32	47	62
250	10	10	13	16	24	32	47	62
255	10	10	13	16	24	32	47	62
260	10	10	13	17	24	32	47	63
265	10	10	13	17	24	32	47	63
270	10	10	13	17	24	32	48	63
275	10	10	13	17	25	32	48	63
280	10	10	13	17	25	32	48	63
285	10	10	13	17	25	32	48	-
290	10	10	13	17	25	33	48	-
295	10	10	13	17	25	33	48	-

Table A.2.7: Resistance to fire of I/H sections for design steel temperature 500 ºC.

Section factor A_m/V (m^{-1})	Fire resistance classification							
	R15	R30	R45	R60	R90	R120	R180	R240
	Minimum thickness (mm) for a design temperature of 500 ºC							
65	10	10	10	10	13	18	27	37
70	10	10	10	10	14	19	28	38
75	10	10	10	10	14	19	30	40
80	10	10	10	10	15	20	31	41
85	10	10	10	10	15	21	31	42
90	10	10	10	10	16	21	32	43
95	10	10	10	11	16	22	33	44
100	10	10	10	11	17	22	34	45
105	10	10	10	11	17	23	35	46
110	10	10	10	11	17	23	35	47
115	10	10	10	12	18	24	36	48
120	10	10	10	12	18	24	36	49
125	10	10	10	12	18	25	37	49
130	10	10	10	12	19	25	38	50
135	10	10	10	13	19	25	38	51
140	10	10	10	13	19	26	38	51
145	10	10	10	13	19	26	39	52
150	10	10	10	13	20	26	39	52
155	10	10	10	13	20	27	40	53
160	10	10	10	13	20	27	40	54
165	10	10	10	14	20	27	41	54
170	10	10	10	14	21	27	41	54
175	10	10	11	14	21	28	41	55
180	10	10	11	14	21	28	42	55
185	10	10	11	14	21	28	42	56
190	10	10	11	14	21	28	42	56
195	10	10	11	14	21	28	42	56
200	10	10	11	15	22	29	43	57
205	10	10	11	15	22	29	43	57
210	10	10	11	15	22	29	43	58
215	10	10	11	15	22	29	44	58
220	10	10	11	15	22	29	44	58
225	10	10	11	15	22	30	44	58
230	10	10	12	15	22	30	44	59
235	10	10	12	15	23	30	44	59
240	10	10	12	15	23	30	45	59
245	10	10	12	15	23	30	45	60
250	10	10	12	16	23	30	45	60
255	10	10	12	16	23	30	45	60
260	10	10	12	16	23	31	45	60
265	10	10	12	16	23	31	46	61
270	10	10	12	16	23	31	46	61
275	10	10	12	16	23	31	46	61
280	10	10	12	16	23	31	46	61
285	10	10	12	16	24	31	46	61
290	10	10	12	16	24	31	46	62
295	10	10	12	16	24	31	47	62

Table A.2.8: Resistance to fire of I/H sections for design steel temperature 550 ºC.

Section factor A_m/V (m^{-1})	Fire resistance classification							
	R15	R30	R45	R60	R90	R120	R180	R240
	Minimum thickness (mm) for a design temperature of 550 ºC							
65	10	10	10	10	12	17	26	36
70	10	10	10	10	13	18	27	37
75	10	10	10	10	13	18	28	38
80	10	10	10	10	14	19	29	40
85	10	10	10	10	14	20	30	41
90	10	10	10	10	15	20	31	42
95	10	10	10	10	15	21	32	43
100	10	10	10	10	16	21	33	44
105	10	10	10	10	16	22	33	45
110	10	10	10	11	17	22	34	46
115	10	10	10	11	17	23	35	47
120	10	10	10	11	17	23	35	47
125	10	10	10	11	18	24	36	48
130	10	10	10	12	18	24	36	49
135	10	10	10	12	18	24	37	50
140	10	10	10	12	18	25	37	50
145	10	10	10	12	19	25	38	51
150	10	10	10	12	19	25	38	51
155	10	10	10	13	19	26	39	52
160	10	10	10	13	19	26	39	52
165	10	10	10	13	20	26	40	53
170	10	10	10	13	20	27	40	53
175	10	10	10	13	20	27	40	54
180	10	10	10	13	20	27	41	54
185	10	10	10	14	20	27	41	55
190	10	10	10	14	21	27	41	55
195	10	10	10	14	21	28	42	55
200	10	10	10	14	21	28	42	56
205	10	10	11	14	21	28	42	56
210	10	10	11	14	21	28	42	56
215	10	10	11	14	21	28	43	57
220	10	10	11	14	22	29	43	57
225	10	10	11	15	22	29	43	57
230	10	10	11	15	22	29	43	58
235	10	10	11	15	22	29	44	58
240	10	10	11	15	22	29	44	58
245	10	10	11	15	22	29	44	59
250	10	10	11	15	22	30	44	59
255	10	10	11	15	22	30	44	59
260	10	10	11	15	22	30	45	59
265	10	10	12	15	23	30	45	59
270	10	10	12	15	23	30	45	60
275	10	10	12	15	23	30	45	60
280	10	10	12	15	23	30	45	60
285	10	10	12	15	23	30	45	60
290	10	10	12	16	23	31	46	61
295	10	10	12	16	23	31	46	61

Table A.2.9: Resistance to fire of I/H sections for design steel temperature 600 ºC.

Section factor A_m/V (m^{-1})	Fire resistance classification							
	R15	R30	R45	R60	R90	R120	R180	R240
	Minimum thickness (mm) for a design temperature of 600 ºC							
65	10	10	10	10	11	16	25	34
70	10	10	10	10	12	16	26	36
75	10	10	10	10	12	17	27	37
80	10	10	10	10	13	18	28	38
85	10	10	10	10	13	19	29	40
90	10	10	10	10	14	19	30	41
95	10	10	10	10	14	20	31	42
100	10	10	10	10	15	20	32	43
105	10	10	10	10	15	21	32	44
110	10	10	10	10	16	21	33	45
115	10	10	10	10	16	22	34	45
120	10	10	10	10	16	22	34	46
125	10	10	10	11	17	23	35	47
130	10	10	10	11	17	23	35	48
135	10	10	10	11	17	24	36	48
140	10	10	10	11	18	24	36	49
145	10	10	10	12	18	24	37	50
150	10	10	10	12	18	25	37	50
155	10	10	10	12	18	25	38	51
160	10	10	10	12	19	25	38	51
165	10	10	10	12	19	25	39	52
170	10	10	10	12	19	26	39	52
175	10	10	10	13	19	26	39	53
180	10	10	10	13	20	26	40	53
185	10	10	10	13	20	26	40	53
190	10	10	10	13	20	27	40	54
195	10	10	10	13	20	27	41	54
200	10	10	10	13	20	27	41	56
205	10	10	10	13	20	27	41	56
210	10	10	10	14	21	27	41	55
215	10	10	10	14	21	28	42	56
220	10	10	10	14	21	28	42	56
225	10	10	10	14	21	28	42	56
230	10	10	10	14	21	28	42	57
235	10	10	11	14	21	28	43	57
240	10	10	11	14	21	29	43	57
245	10	10	11	14	21	29	43	57
250	10	10	11	14	22	29	43	58
255	10	10	11	14	22	29	43	58
260	10	10	11	15	22	29	44	58
265	10	10	11	15	22	29	44	58
270	10	10	11	15	22	29	44	59
275	10	10	11	15	22	29	44	59
280	10	10	11	15	22	30	44	59
285	10	10	11	15	22	30	44	59
290	10	10	11	15	22	30	45	59
295	10	10	11	15	23	30	45	60

Table A.2.10: Resistance to fire of hollow sections for design steel temperature 350 ºC.

Section factor A_m/V (m^{-1})	Fire resistance classification							
	R15	R30	R45	R60	R90	R120	R180	R240
	Minimum thickness (mm) for a design temperature of 350 ºC							
65	11	11	11	14	19	26	27	50
70	11	11	11	14	20	27	40	51
75	11	11	12	15	22	28	41	54
80	11	11	12	15	22	28	42	55
85	11	11	12	15	23	29	43	58
90	11	11	12	16	23	31	45	59
95	11	11	13	16	24	31	46	60
100	11	11	13	17	24	32	46	62
105	11	11	13	17	24	32	48	63
110	11	11	13	18	26	33	49	-
115	11	11	13	18	26	33	49	-
120	11	11	15	18	26	35	50	-
125	11	11	15	18	27	35	52	-
130	11	11	15	19	27	35	52	-
135	11	11	15	19	27	36	53	-
140	11	11	15	19	29	36	54	-
145	11	11	15	19	29	37	55	-
150	12	12	15	20	29	38	55	-
155	12	12	16	20	29	38	57	-
160	12	12	16	21	29	38	57	-
165	12	12	16	21	30	40	57	-
170	12	12	16	21	30	40	59	-
175	12	12	16	21	31	40	59	-
180	12	12	17	21	31	40	59	-
185	12	12	17	21	31	41	60	-
190	12	12	17	21	32	42	61	-
195	12	12	17	22	32	42	61	-
200	12	12	17	23	32	42	62	-
205	12	12	17	23	33	42	63	-
210	12	12	18	23	33	42	63	-
215	12	12	18	23	33	44	-	-
220	12	12	18	23	33	44	-	-
225	12	13	18	23	34	44	-	-
230	12	14	18	23	34	44	-	-
235	12	14	19	23	35	44	-	-
240	12	14	19	24	35	45	-	-
245	12	14	19	24	35	46	-	-
250	13	14	19	24	35	46	-	-
255	13	14	19	24	35	46	-	-
260	13	14	19	25	35	46	-	-
265	13	14	19	25	35	46	-	-
270	13	14	19	25	35	46	-	-
275	13	14	19	25	36	46	-	-
280	13	14	19	25	36	46	-	-
285	13	14	19	25	36	48	-	-
290	13	14	19	25	36	48	-	-
295	13	14	20	25	36	48	-	-

Table A.2.11: Resistance to fire of hollow sections for design steel temperature 400 ºC.

Section factor A_m/V (m^{-1})	Fire resistance classification							
	R15	R30	R45	R60	R90	R120	R180	R240
	Minimum thickness (mm) for a design temperature of 400 ºC							
65	11	11	11	12	17	23	34	46
70	11	11	11	12	18	24	36	48
75	11	11	11	13	19	25	38	49
80	11	11	11	13	19	26	39	51
85	11	11	11	14	21	27	40	53
90	11	11	11	14	21	27	40	55
95	11	11	11	14	22	28	42	56
100	11	11	11	15	22	29	43	57
105	11	11	12	15	22	30	44	59
110	11	11	12	16	23	30	44	60
115	11	11	12	16	23	31	46	60
120	11	11	12	17	24	31	47	62
125	11	11	12	17	25	33	47	63
130	11	11	14	17	25	33	49	-
135	11	11	14	17	25	33	49	-
140	11	11	14	17	25	34	50	-
145	11	11	14	18	26	34	50	-
150	12	12	14	18	26	35	52	-
155	12	12	14	18	27	36	52	-
160	12	12	14	19	27	36	53	-
165	12	12	14	19	28	36	54	-
170	12	12	15	19	28	36	54	-
175	12	12	15	19	28	38	55	-
180	12	12	15	20	28	38	55	-
185	12	12	15	20	28	38	56	-
190	12	12	15	20	30	38	57	-
195	12	12	16	20	30	38	57	-
200	12	12	16	20	30	40	58	-
205	12	12	16	20	30	40	58	-
210	12	12	16	21	30	40	59	-
215	12	12	16	21	30	40	60	-
220	12	12	16	21	31	40	60	-
225	12	12	17	22	31	40	60	-
230	12	12	17	22	32	42	62	-
235	12	12	17	22	32	42	62	-
240	12	12	17	22	32	42	62	-
245	12	12	17	22	32	42	62	-
250	13	13	18	23	33	43	-	-
255	13	13	18	23	33	43	-	-
260	13	13	18	23	33	43	-	-
265	13	13	18	23	33	44	-	-
270	13	13	18	23	33	44	-	-
275	13	13	18	23	34	44	-	-
280	13	13	18	23	34	44	-	-
285	13	13	18	23	34	44	-	-
290	13	13	18	23	34	44	-	-
295	13	13	18	23	34	44	-	-

Table A.2.12: Resistance to fire of hollow sections for design steel temperature 450 ºC.

Section factor A_m/V (m^{-1})	Fire resistance classification							
	R15	R30	R45	R60	R90	R120	R180	R240
	Minimum thickness (mm) for a design temperature of 450 ºC							
65	11	11	11	11	15	20	31	42
70	11	11	11	11	16	21	32	44
75	11	11	11	11	17	23	33	45
80	11	11	11	12	17	24	35	46
85	11	11	11	12	18	24	36	49
90	11	11	11	12	19	25	37	50
95	11	11	11	13	19	25	38	51
100	11	11	11	13	20	26	40	53
105	11	11	11	13	20	27	40	54
110	11	11	11	13	21	28	41	54
115	11	11	11	14	21	28	42	56
120	11	11	11	15	21	29	43	57
125	11	11	11	15	23	29	44	59
130	11	11	11	15	23	29	44	59
135	11	11	11	16	23	31	45	60
140	11	11	11	16	23	31	46	62
145	11	11	13	16	24	31	47	62
150	12	12	13	16	24	32	47	63
155	12	12	13	16	24	32	49	-
160	12	12	13	16	24	32	49	-
165	12	12	13	17	26	34	49	-
170	12	12	13	18	26	34	50	-
175	12	12	13	18	26	34	51	-
180	12	12	13	18	26	34	51	-
185	12	12	14	18	26	34	52	-
190	12	12	14	18	26	36	52	-
195	12	12	14	18	27	36	53	-
200	12	12	14	18	28	36	54	-
205	12	12	14	19	28	36	54	-
210	12	12	15	19	28	36	54	-
215	12	12	15	19	28	38	55	-
220	12	12	15	20	28	38	56	-
225	12	12	15	20	28	38	56	-
230	12	12	15	20	30	38	57	-
235	12	12	15	20	30	38	57	-
240	12	12	15	20	30	38	57	-
245	12	12	16	20	30	40	59	-
250	13	13	16	20	30	40	59	-
255	13	13	16	20	30	40	59	-
260	13	13	16	21	30	40	59	-
265	13	13	16	21	30	40	59	-
270	13	13	16	21	30	40	60	-
275	13	13	16	21	31	40	60	-
280	13	13	16	21	31	40	60	-
285	13	13	16	21	31	40	60	-
290	13	13	16	21	31	41	60	-
295	13	13	16	21	31	41	60	-

Table A.2.13: Resistance to fire of hollow sections for design steel temperature 500 ºC.

Section factor A_m/V (m^{-1})	Fire resistance classification							
	R15	R30	R45	R60	R90	R120	R180	R240
	Minimum thickness (mm) for a design temperature of 500 ºC							
65	11	11	11	11	14	19	29	39
70	11	11	11	11	15	20	30	41
75	11	11	11	11	15	20	32	43
80	11	11	11	11	16	22	33	44
85	11	11	11	11	16	23	34	46
90	11	11	11	11	17	23	35	47
95	11	11	11	12	18	24	36	48
100	11	11	11	12	19	24	37	50
105	11	11	11	12	19	25	39	51
110	11	11	11	12	19	26	39	52
115	11	11	11	13	20	27	40	54
120	11	11	11	13	20	27	40	55
125	11	11	11	14	20	28	42	55
130	11	11	11	14	21	28	43	57
135	11	11	11	15	22	28	43	58
140	11	11	11	15	22	30	43	58
145	11	11	11	15	22	30	45	60
150	12	12	12	15	23	30	45	60
155	12	12	12	15	23	31	46	61
160	12	12	12	15	23	31	46	63
165	12	12	12	16	23	31	48	63
170	12	12	12	16	25	32	48	63
175	12	12	13	16	25	33	48	-
180	12	12	13	17	25	33	50	-
185	12	12	13	17	25	33	50	-
190	12	12	13	17	25	33	50	-
195	12	12	13	17	25	33	50	-
200	12	12	13	18	26	35	52	-
205	12	12	13	18	27	35	52	-
210	12	12	13	18	27	35	52	-
215	12	12	13	18	27	35	53	-
220	12	12	13	18	27	35	54	-
225	12	12	13	18	27	37	54	-
230	12	12	15	18	27	37	54	-
235	12	12	15	19	28	37	54	-
240	12	12	15	19	29	37	56	-
245	12	12	15	19	29	37	56	-
250	13	13	15	20	29	38	56	-
255	13	13	15	20	29	38	56	-
260	13	13	15	20	29	39	56	-
265	13	13	15	20	29	39	58	-
270	13	13	15	20	29	39	58	-
275	13	13	15	20	29	39	58	-
280	13	13	15	20	29	39	58	-
285	13	13	15	20	30	39	58	-
290	13	13	15	20	30	39	58	-
295	13	13	15	20	30	39	59	-

Table A.2.14: Resistance to fire of hollow sections for design steel temperature 550 ºC.

Section factor A_m/V (m^{-1})	Fire resistance classification							
	R15	R30	R45	R60	R90	R120	R180	R240
	Minimum thickness (mm) for a design temperature of 550 ºC							
65	11	11	11	11	13	18	28	38
70	11	11	11	11	14	19	29	40
75	11	11	11	11	14	19	30	41
80	11	11	11	11	15	21	31	43
85	11	11	11	11	15	22	33	44
90	11	11	11	11	16	22	34	46
95	11	11	11	11	16	23	35	47
100	11	11	11	11	18	23	36	48
105	11	11	11	11	18	24	36	50
110	11	11	11	12	19	24	38	51
115	11	11	11	12	19	26	39	52
120	11	11	11	12	19	26	39	53
125	11	11	11	12	20	27	41	54
130	11	11	11	14	20	27	41	55
135	11	11	11	14	20	27	42	57
140	11	11	11	14	21	29	42	57
145	11	11	11	14	22	29	44	58
150	12	12	12	14	22	29	44	59
155	12	12	12	15	22	30	45	60
160	12	12	12	15	22	30	45	60
165	12	12	12	15	23	30	47	62
170	12	12	12	15	23	32	47	62
175	12	12	12	15	24	32	47	63
180	12	12	12	15	24	32	48	-
185	12	12	12	17	24	32	49	-
190	12	12	12	17	25	32	49	-
195	12	12	12	17	25	33	50	-
200	12	12	12	17	25	34	50	-
205	12	12	13	17	25	34	51	-
210	12	12	13	17	25	34	51	-
215	12	12	13	17	26	34	52	-
220	12	12	13	17	27	35	52	-
225	12	12	13	18	27	36	53	-
230	12	12	14	18	27	36	53	-
235	12	12	14	19	27	36	54	-
240	12	12	14	19	27	36	55	-
245	12	12	14	19	27	36	55	-
250	13	13	14	19	28	38	55	-
255	13	13	14	19	28	38	55	-
260	13	13	14	19	28	38	56	-
265	13	13	15	19	29	38	56	-
270	13	13	15	19	29	38	56	-
275	13	13	15	19	29	38	56	-
280	13	13	15	19	29	38	56	-
285	13	13	15	19	29	38	56	-
290	13	13	15	20	29	39	58	-
295	13	13	15	20	29	39	58	-

Table A.2.15: Resistance to fire of hollow sections for design steel temperature 600 ºC.

Section factor A_m/V (m^{-1})	Fire resistance classification							
	R15	R30	R45	R60	R90	R120	R180	R240
	Minimum thickness (mm) for a design temperature of 600 ºC							
65	11	11	11	11	12	17	27	36
70	11	11	11	11	13	17	28	39
75	11	11	11	11	13	18	29	40
80	11	11	11	11	14	19	30	41
85	11	11	11	11	14	21	31	43
90	11	11	11	11	15	21	33	45
95	11	11	11	11	15	22	34	46
100	11	11	11	11	17	22	35	47
105	11	11	11	11	17	23	35	49
110	11	11	11	11	18	23	37	50
115	11	11	11	11	18	25	38	50
120	11	11	11	11	18	25	38	52
125	11	11	11	12	19	26	39	53
130	11	11	11	12	19	26	40	54
135	11	11	11	12	19	27	41	54
140	11	11	11	13	21	27	41	56
145	11	11	11	14	21	27	42	57
150	12	12	12	14	21	29	43	58
155	12	12	12	14	21	29	44	59
160	12	12	12	14	22	29	44	59
165	12	12	12	14	22	29	45	61
170	12	12	12	14	22	30	46	61
175	12	12	12	15	22	31	46	62
180	12	12	12	15	24	31	47	63
185	12	12	12	15	24	31	47	63
190	12	12	12	15	24	32	48	-
195	12	12	12	16	24	32	49	-
200	12	12	12	16	24	32	49	-
205	12	12	12	16	24	33	49	-
210	12	12	12	17	25	33	50	-
215	12	12	12	17	26	34	51	-
220	12	12	12	17	26	34	51	-
225	12	12	12	17	26	34	51	-
230	12	12	12	17	26	34	52	-
235	12	12	14	17	26	35	53	-
240	12	12	14	17	26	36	53	-
245	12	12	14	17	26	36	54	-
250	13	13	14	18	28	36	54	-
255	13	13	14	18	28	36	54	-
260	13	13	14	19	28	36	55	-
265	13	13	14	19	28	36	55	-
270	13	13	14	19	28	36	55	-
275	13	13	14	19	28	36	55	-
280	13	13	14	19	28	38	55	-
285	13	13	14	19	28	38	55	-
290	13	13	14	19	28	38	56	-
295	13	13	14	19	29	38	56	-

ANNEX 3. Specification and assessment of fire protection of load bearing composite concrete/profiled steel sheet elements protected by Biofire (intended use Type 5)

A.3.1 Classification

The assemblies described in this Annex have been tested and assessed according to ENV 13381-5 and classified in accordance with EN 13501-2.

The maximum duration of the exposure to the standard time temperature curve defined in EN 1363-1, clause 5.1.1, is 169 minutes.

The assessment of the required thickness of Biofire in function of the type of profiled steel sheet and the exposure time, for the characteristic steel sheet temperature rise to 350 ºC, the equivalent thickness of concrete and the insulation performance, are given in section A.3.3.

A.3.2 Installation requirements

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

A.3.2.1 Supporting structure

Biofire is applied directly on profiled steel sheets of composite slabs cast with normal weight concrete.

The type of steel sheet to be protected is trapezoidal.

The substrate must be rigid, free of deformations or excessive vibrations before Biofire is applied. Mid span deflection of deck spans should not be greater than L/250.

Specifications for the components are given in Table A.3.1.

Table A.3.1: Specification of the components.

Component	Identification	Characteristics	Mounting and fixing
Trapezoidal profiled galvanized steel sheet	See Figure A.3.1.	Thickness ≥ 1,0 mm Width of the ribs ≤ 181 mm Depth of the ribs ≤ 90 mm S320GD steel with galvanized Z275	Surface shall be bare, free of dust, oil and grease.
Concrete	Concrete strength class 25 N/mm^2 Siliceous aggregates	Concrete with the same strength class or better. Density: 2240 kg/m^3 ± 15 %.	The concrete may or may not contain additional reinforcing bars for load bearing purposes. Without release agent.

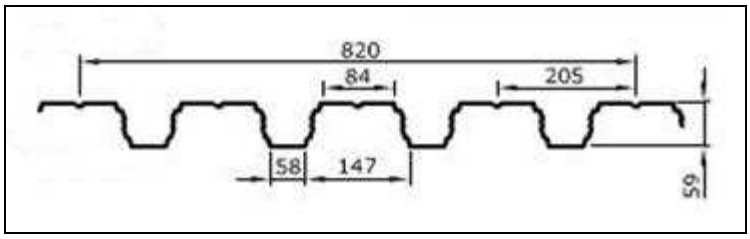


Figure A.3.1: Geometry of the tested trapezoidal profiled galvanized steel sheet.

A.3.2.2 Surface of steel members

No specific preliminary preparation of the profiled steel sheets to be protected by Biofire is required. However, they must be bare, free of dust, oil and grease (attention must be paid to the fact that the steel sheets are normally supplied covered by a grease protective layer).

No bonding primer is applied before application of Biofire.

A.3.2.3 Fire protective rendering

Biofire is applied on the apparent side of the profiled steel sheet to be protected, by following its corrugation, for exposure to fire from the steel side of the composite slab.

Biofire is sprayed in one coat of regular thickness to reach the requested thickness according to this Annex. During the application, the thickness of the protective material is regularly controlled with a pin caliper.

Hairline cracks in the dry rendering are not accepted.

Specifications for the components are given in Table A.3.2.

Table A.3.2: Rendering specifications for fire resistance test.

Component	Identification	Characteristics	Mounting and fixing
Rendering	Biofire applied on trapezoidal profiled steel sheet	Thicknesses from 13,1 to 26,3 mm, according to the assessment rules Hardened density: 863 ± 15 % kg/m^3	Rendering is kept without finishing after application. Spray applied rendering with: - No bonding agents - No top coats or sealing coats - No mechanical fixings - No additives out of dry mix

A.3.2.4 Bonding properties of Biofire on concrete/profiled steel sheet elements

Assessment of the bonding properties of Biofire, when applied on trapezoidal profiled steel sheets of composite slabs cast with normal weight concrete, has been carried out according to EGOLF SM5 procedure.

The indicated values are representative of cohesive / adhesive failure through the applied thickness of protective sprayed product Biofire. These values are guidance values, and they do not reflect a statistical evaluation, nor minimum guaranteed values.

Table A.3.3: Tensile bond strength on profiled steel sheets of composite concrete slabs.

Surface	Thickness of Biofire	Mean tensile bond strength	Failure mode
Trapezoidal profiled galvanized steel sheet	13 mm	0,10 MPa	Cohesive / adhesive failure
	23 mm	0,09 MPa	

Samples have been taken from the flat area of the ribs (see figure A.3.2).

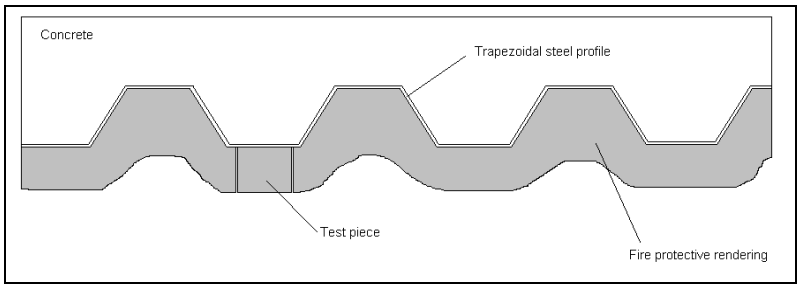


Figure A.3.2. Test specimen.

A.3.3 Assessment of the fire performance of Biofire on composite concrete/profiled steel sheet elements

A.3.3.1 General

The assessment method used to assess the fire protection performances of Biofire when applied on composite concrete/profiled steel sheet elements is according to ENV 13381-5.

A.3.3.2 Temperature of the profiled steel sheet

The time to reach 350 ºC in the profiled steel sheets has been determined according to provisions of standard ENV 13381-5, section 13.2 and they are given in Table A.3.4 for minimum and maximum thickness and within the thickness range in figure A.3.3.

Table A.3.4: Time to reach 350 ºC.

Description	Thickness of Biofire (mm)	Time to reach 350 ºC (minutes)
Trapezoidal profiled galvanized steel sheet	13,1	62
	26,3	134

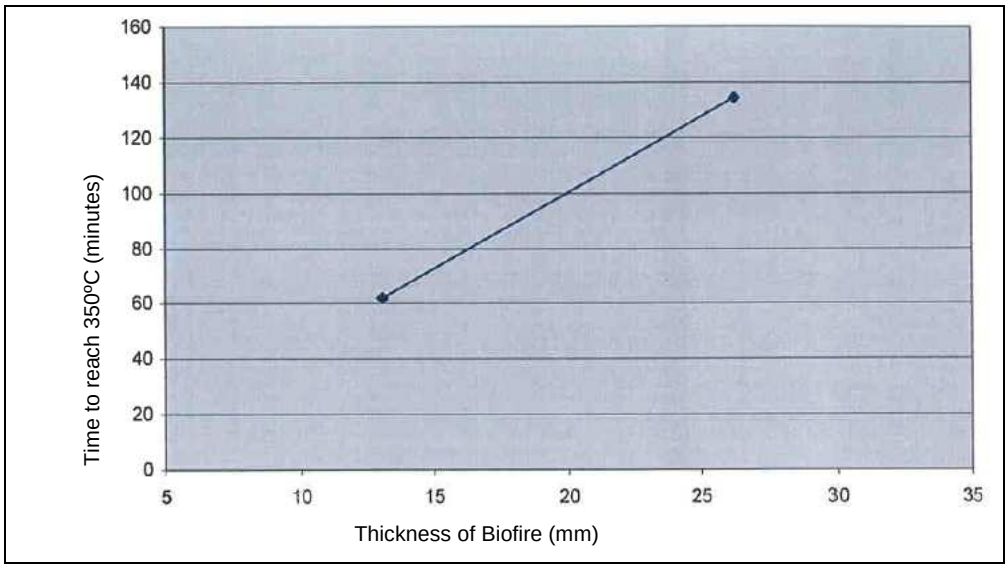


Figure A.3.3. Time to reach 350 ºC in the profiled steel sheets.

A.3.3.3 Equivalent thickness of concrete

The effective thickness H_{eff}, the equivalent effective thickness H_e and the equivalent thickness of concrete H_{eq} induced by the protective material Biofire applied on trapezoidal profiled steel sheets have been determined according to the provisions of the standard ENV 13381-5, section 13.3 and are given in Table A.3.5.

Table A.3.5. Equivalent thickness of concrete.

Element	Thickness of Biofire (mm)	H_{eff} (mm)	H_e (mm)	H_{eq} (mm)	Limiting time for applicability (min)
Trapezoidal profiled galvanized steel sheet	13,1	81,2	100	19	88
	26,3	86,2	143	57	169

The equivalent thickness of concrete H_{eq} and the limiting time for applicability in function of the thickness of Biofire are given in figure A.3.4 and A.3.5 respectively.

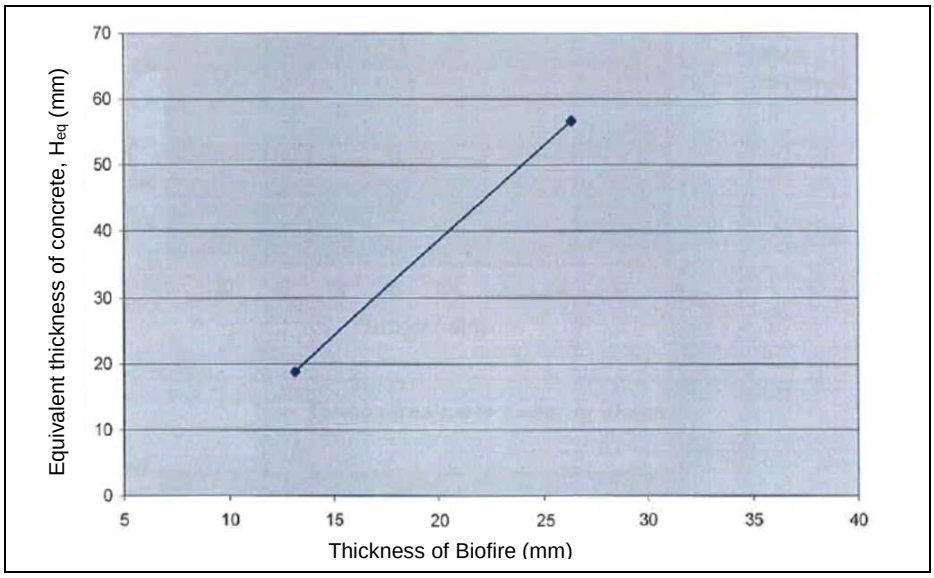


Figure A.3.4. Equivalent thickness (H_{eq}) vs thickness of Biofire for a maximum temperature of 500 ºC of the steel sheet.

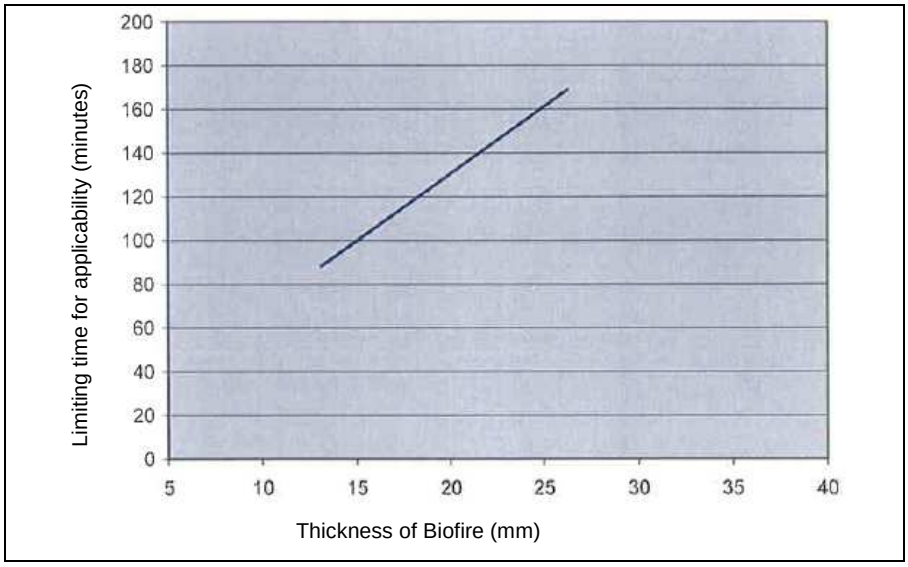


Figure A.3.5. Limiting time for applicability.

A.3.3.4 Insulation performance

The separating function of the composite concrete/profiled steel sheet elements protected with Biofire was maintained during the test in accordance with the criteria established in EN 1363-1.

A.3.3.5 Stickability performance

The time for which the stickability of the protective material Biofire applied on trapezoidal profiled steel sheets is ensured has been determined according to the provisions of the standard ENV 13381-5, section 13.4, and it is given in table A.3.6. However, significant detachment of the protective rendering was noted for the maximum thickness after the test.

Table A.3.6: Stickability of Biofire.

Description	Thickness of Biofire (mm)	Stickability of Biofire (min)
Trapezoidal profiled galvanized steel sheet	13,1	88
	26,3	169

ANNEX 4. Specification and assessment of fire protection of load-bearing concrete elements protected by Biofire (intended use Type 3)

A.4.1 Load-bearing concrete beams and columns

A.4.1.1 Classification

The assemblies described in this Annex have been tested and assessed according to ENV 13381-3 and classified in accordance with EN 13501-2.

The maximum duration of the exposure to the standard time-temperature curve defined in EN 1363-1, clause 5.1.1, is 240 minutes for the applied maximum thickness of the Biofire.

The equivalent thickness of concrete and the insulation performance are given in section A.4.1.3.

A.4.1.2 Installation requirements

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

A.4.1.2.1 Supporting structure

Biofire is applicable to concrete beams and columns exposed to fire from more than one side (3 and 4 sides), both in horizontal and vertical orientation.

No bonding primer is applied before application of Biofire.

Specifications for the components are given in Table A.4.1.

Table A.4.1: Specification of the components.

Component	Identification	Characteristics	Mounting and fixing
Load bearing concrete beam and column	Concrete strength class 25 N/mm^2 Siliceous aggregates	Concrete with the same strength class or better. Density: 2275 kg/m^3 ± 12,5% Width of the beam ≥ 150 mm	Without release agent. Surface free of oil, grease, dust, etc.

A.4.1.2.2 Fire protective rendering

Biofire is applied on the apparent sides of the concrete structures to be protected, by following their shape. Biofire is sprayed in one coat of regular thickness to reach the requested thickness according to this Annex. During the application, the thickness of the protective material is regularly controlled with a pin caliper.

Hairline cracks in the dry rendering are not accepted.

Specifications for the components are given in Table A.4.2.

Table A.4.2: Rendering specifications for fire resistance test.

Component	Identification	Characteristics	Mounting and fixing
Rendering	Biofire applied on a concrete beam	Thickness: 9,7 mm to 22,7 mm Hardened density: 926 kg/m^3 ± 12,5%	Rendering is kept without finishing after application. Spray applied rendering with: - No bonding primers - No topcoats or sealing coats - No mechanical fixings - No additives out of dry mix

A.4.1.2.3 Bonding properties of Biofire on concrete elements

Assessment of the bonding properties of Biofire, when applied on concrete structures, has been carried out according to EGOLF SM5 procedure.

The indicated values are representative of adhesive/cohesive failure through the applied thickness of protective sprayed product Biofire. These values are guidance values, and they do not reflect a statistical evaluation, nor minimum guaranteed values.

Table A.4.3: Tensile bond strength on substrates cast with normal weight concrete.

Surface	Thickness of Biofire	Mean tensile bond strength	Failure mode
Concrete substrate according EGOLF SM5	10 mm	0,10 MPa	Adhesive failure
	22,7 mm	0,14 MPa	Cohesive failure

A.4.1.3 Assessment of the fire performance of Biofire on concrete beams and columns

A.4.1.3.1 General

The assessment method used to assess the fire protection performance of Biofire when applied on concrete elements is according to ENV 13381-3.

A.4.1.3.2 Protection of concrete beams and columns of minimum 150 mm x 150 mm

The insulation efficiency of the protective material when applied on concrete beams or columns of minimum 150 mm x 150 mm section is determined in function of:

- The thickness of protective material applied (mm).
- The standard concrete temperature comprised between [150, 550] (ºC) along a vertical, horizontal and diagonal axis.
- The duration of the thermal exposure under the standard time temperature curve as defined in EN 1363-1, section 5.1.1.

Table A.4.4: Protection with applicable thickness 22,7 mm.

Time (minutes)	Temperatures inside the concrete (ºC)								
	150	200	250	300	350	400	450	500	550
	Concrete depth (mm)								
Along a vertical axis									
30	-	-	-	-	-	-	-	-	-
60	11	-	-	-	-	-	-	-	-
90	60	30	7	-	-	-	-	-	-
120	91	65	43	23	6	-	-	-	-
150	128	89	69	51	33	16	3	-	-
180	-	122	94	74	57	39	23	9	1
210	-	-	125	100	80	61	43	27	12
240	-	-	-	130	107	86	67	47	29
Along a horizontal axis									
30	-	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	-	-
90	14	-	-	-	-	-	-	-	-
120	50	9	-	-	-	-	-	-	-
150	74	36	5	-	-	-	-	-	-
180	-	68	37	9	-	-	-	-	-
210	-	-	72	44	17	1	-	-	-
240	-	-	-	-	50	23	6	-	-
Along a diagonal axis									
30	-	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	-	-
90	65	40	-	-	-	-	-	-	-
120	90	69	50	33	-	-	-	-	-
150	119	89	71	56	42	-	-	-	-
180	-	114	92	76	62	48	33	-	-
210	-	-	117	97	81	66	51	37	-
240	-	-	-	-	103	86	70	55	40

Table A.4.5: Protection with applicable thickness 9,7 mm.

Time (minutes)	Temperatures inside the concrete (ºC)								
	150	200	250	300	350	400	450	500	550
	Concrete depth (mm)								
Along a vertical axis									
30	13	7	1	-	-	-	-	-	-
60	63	49	36	22	12	5	-	-	-
90	140	75	66	57	49	40	31	22	16
Along a horizontal axis									
30	16	12	8	4	-	-	-	-	-
60	30	18	16	14	12	10	8	6	3
90	-	65	51	38	25	19	16	14	12
Along a diagonal axis									
30	-	-	-	-	-	-	-	-	-
60	75	60	45	-	-	-	-	-	-
90	-	106	91	76	65	54	43	-	-

A.4.1.3.3 Equivalent thickness of concrete

The equivalent thickness of concrete induced by the protective material Biofire is determined according to requirements of Annex C of standard ENV 13381-3 and is given in Table A.4.6.

Table A.4.6. Equivalent thickness of concrete (mm).

Component	Thickness of Biofire (mm)	Duration in minutes					
		30	60	90	120	180	240
Load bearing concrete beams or columns	9,7	38	36	30	-	-	-
	22,7	44	60	60	61	57	56

The equivalent thickness of concrete H_{eq} in function of the thickness of Biofire is given in Figures A.4.1, A.4.2 and A.4.3 for a duration of 30, 60 and 90 minutes respectively.

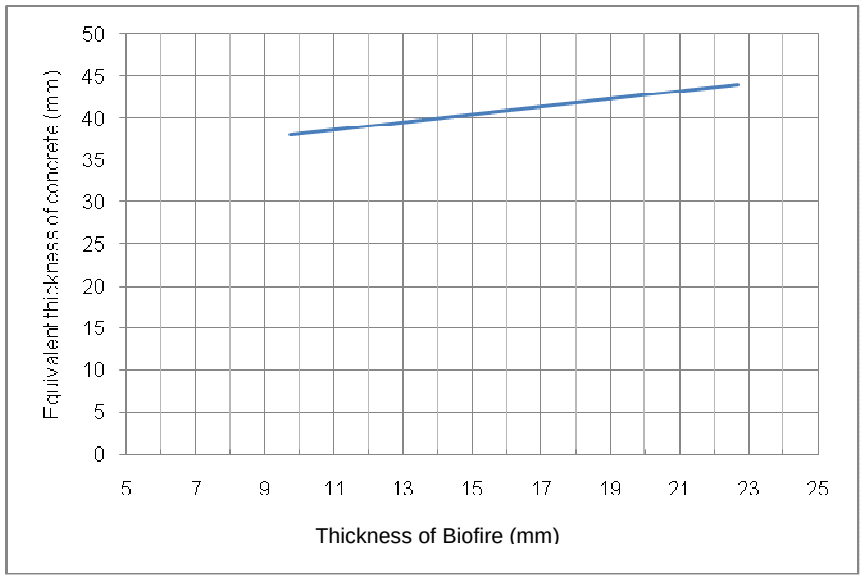


Figure A.4.1: Equivalent thickness of concrete (30 minutes).

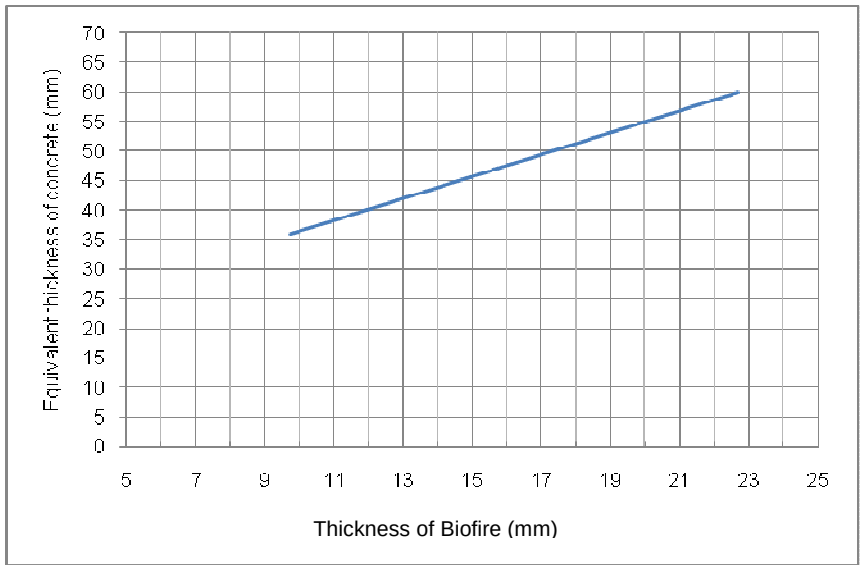


Figure A.4.2: Equivalent thickness of concrete (60 minutes).

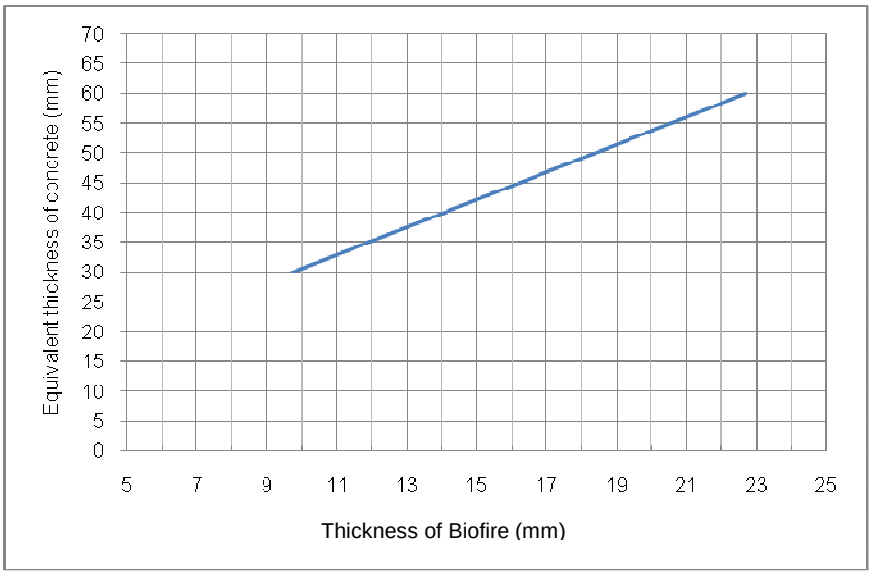


Figure A.4.3: Equivalent thickness of concrete (90 minutes).

A.4.1.3.4 Insulation performance

Mean temperature of the thermocouples placed on the upper side of the concrete beam protected with 22,7 mm exceeded 140ºC the initial temperature at minute 202. Insulation criteria were maintained for the concrete beam protected with 9,7 mm over the test duration, i.e. 97 minutes, time at which the beam collapsed.

A.4.1.3.5 Stickability performance

The stickability of Biofire when applied on concrete structures is determined according to the requirements of paragraph 13.5 of ENV 13381-3.

Stickability criteria for beam with Biofire 9,7 mm:

Between the 47th and the 73rd minute the maximum recorded temperature on the exposed surface of the concrete was more than 50 % above the mean value of all the recorded temperatures on the exposed surface of the concrete.

Significant detachment of protection: 29 min.

Stickability criteria for beam with Biofire 22,7 mm:

Between the 99th and the 194th minute the maximum recorded temperature on the exposed surface of the concrete was more than 50 % above the mean value of all the recorded temperatures on the exposed surface of the concrete.

Significant detachment of protection: 240 min (without failure).

A.4.2 Load-bearing concrete slabs and walls

A.4.2.1 Classification

The assemblies described in this Annex have been tested and assessed according to ENV 13381-3 and classified in accordance with EN 13501-2.

The maximum duration of the exposure to the standard time-temperature curve defined in EN 1363-1, clause 5.1.1, is 180 minutes for the applied thickness of the Biofire.

The equivalent thickness of concrete and the insulation performance are given in section A.4.2.3.

A.4.2.2 Installation requirements

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

A.4.2.2.1 Supporting structure

Biofire is applicable to concrete slabs and walls exposed to fire from one side, both in horizontal and vertical orientation.

Specifications for the components are given in Table A.4.7.

Table A.4.7: Specification of the components.

Component	Identification	Characteristics	Mounting and fixing
Load bearing concrete slab and wall	Concrete strength class 25 N/mm^2 Siliceous aggregates	Concrete with the same strength class or better. Density: 2.300 kg/m^3 ± 15 %. Thickness of the slab ≥ 120 mm	Without release agent. Surface free of oil, grease, dust, etc.

A.4.2.2.2 Bonding primer

The bonding primer Pyrocola is applied before application of Biofire.

Table A.4.8: Specification of the components.

Component	Identification	Characteristics	Mounting and fixing
Pyrocola	Acrylic resin water based single component	Density: 1,04 g/l Applied quantity: ca. 110 g/m^2	Applied directly on the surface by brush or roller.

A.4.2.2.3 Fire protective rendering

Biofire is applied on the concrete structure coated with Pyrocola, approximately 4 hours after the resin application when it is tacky, in one coat of regular thickness to reach the requested thickness according to this annex. During the application, the thickness of the protective material is regularly controlled with a pin caliper.

Hairline cracks in the dry rendering are not accepted.

Specifications for the components are given in Table A.4.9.

Table A.4.9. Rendering specifications for fire resistance test.

Component	Identification	Characteristics	Mounting and fixing
Rendering	Biofire applied on a concrete slab	Thickness: 10 mm Hardened density: 951 kg/m^3 ± 15 %	Rendering is kept without finishing after application. Spray applied rendering with: - No top coats or sealing coats - No mechanical fixings - No additives out of dry mix

A.4.2.2.4 Bonding properties of Biofire on concrete slabs and walls

Assessment of the bonding properties of Biofire, when applied on concrete structures primed with Pyrocola, has been carried out according to EGOLF SM5 procedure.

The indicated values are representative of cohesive failure through the applied thickness of protective sprayed product Biofire. These values are guidance values, and they do not reflect a statistical evaluation, nor minimum guaranteed values.

Table A.4.10. Tensile bond strength on concrete substrates primed with Pyrocola.

Surface	Thickness of Biofire	Mean tensile bond strength	Failure mode
Concrete substrate according EGOLF SM5	10 mm	0,25 MPa	Cohesive failure

A.4.2.3 Assessment of the fire performance of Biofire on concrete slabs and walls

A.4.2.3.1 General

The assessment method used to assess the fire protection performance of Biofire when applied on concrete elements is according to ENV 13381-3.

A.4.2.3.2 Protection of concrete slabs and walls of minimum 120 mm

The insulation efficiency of the protective material when applied on concrete slabs and walls of minimum thickness 120 mm is determined in function of:

- The thickness of protective material applied (mm).
- The standard concrete temperature comprised between [300, 650] (ºC).
- The duration of the thermal exposure under the standard time temperature curve as defined in EN 1363-1, section 5.1.1.

Table A.4.11. Protection with applied thickness 10 mm. Depth of limiting temperatures inside the concrete (mm).

Time (minutes)	Design temperature (ºC)							
	300	350	400	450	500	550	600	650
30	-	-	-	-	-	-	-	-
60	34	27	19	14	13	11	9	7
90	52	46	41	35	30	19	14	12
120	63	57	51	45	40	35	29	18
180	-	74	67	59	53	48	42	36

A.4.2.3.3 Equivalent thickness of concrete

The equivalent thickness of concrete induced by the protective material Biofire is determined according to requirements of Annex C of standard ENV 13381-3 and is given in Table A.4.12.

Table A.4.12. Equivalent thickness of concrete (mm).

Component	Thickness of Biofire (mm)	Duration in minutes					
		30	60	90	120	180	240
Load bearing concrete slabs or walls	10	30	15	13	12	11	-

A.4.2.3.4 Insulation performance

Mean temperature of the thermocouples placed on the upper side of the concrete slab exceeded 140 ºC the initial temperature at minute 167.

Maximum temperature of the thermocouples placed on the upper side of the concrete slab exceeded 180ºC the initial temperature at minute 171.

A.4.2.3.5 Stickability performance

The stickability of Biofire when applied on concrete slabs is determined according to the requirements of paragraph 13.5 of ENV 13381-3.

Between the minute 34 and minute 40 the maximum recorded temperature on the exposed surface of the concrete was more than 50 % above the mean value of all the recorded temperatures on the exposed surface of the concrete.

Significant detachment of protection: minute 33 (without failure).

ANNEX 5 Specification and assessment of fire protection of load-bearing timber elements protected by Biofire (intended use Type 7)

A.5.1 Load-bearing timber floor

A.5.1.1 Classification

The assembly described in this Annex has been tested and assessed according to EN 1365-2:1999 and classified REI 60 in accordance with EN 13501-2. Test method and resistance to fire evaluation are in accordance with requirements in EN 1365-2:2014.

A.5.1.2 Installation requirements

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

A.5.1.2.1 Supporting structure

The supporting structure is a timber floor assembly consisting of wooden joists and a flooring of wooden boards. Joists are placed in parallel at maximum 600 mm centres and boards installed on top, rabbet jointed to each other (joints perpendicular to the joists) and fixed to the joists with 60 mm length screws at maximum 200 mm centres (joist coincident with a longitudinal board joint is fixed with 2 lines of screws, one at each joint side). Additionally, 2 screws of 20 mm length are used to fix the boards at transversal joints between boards. See Table A.5.1 for components specification and Figure A.5.1 for details.

The maximum load-bearing capacity of the floor corresponds to a maximum load per joist of 1700 N per linear metre uniformly distributed along a maximum span of 4000 mm.

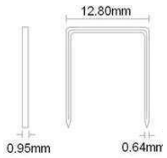
An expanded ribbed metal mesh is fixed to the bottom side of the wooden joists with 35 mm length screws, placed on the main ribs of the mesh, at maximum 200 mm centres along the joists and reinforced with a line of staples every 2 cm. Mesh ribs run perpendicularly to the joists. Sheets shall be placed with an overlapping of at least 200 mm in ribs direction and fit together at the last rib in joists direction.

Pull out resistance of mechanical fixings has been determined in accordance with EAD 350140-00-1106, section 2.2.5.1: 2298 N for the 35 mm length screws and 93 N for the staples. These values are guidance values and they do not reflect a statistical evaluation.

Table A.5.1: Specification of the supporting structure components.

Component	Identification	Characteristics	Mounting and fixing
Flooring wooden boards	Three-layer phenolic glued fir wooden panels	Thickness ≥ 22 mm Density: 650 kg/m^3	Screwed upon the wooden joists. Rabbet joints reinforced with 20 mm screws.
Load-bearing wooden joists	Spruce, softwood	Height ≥ 220 mm Width ≥ 75 mm Density: 470 kg/m^3 Flexural strength ≥ 10 MPa	Installed parallel at ≤ 600 mm centres.
Fixings	Bichromate steel self-tapping screws	Length ≥ 60 mm Diameter ≥ 4 mm	Fixing of boards onto the joists at ≤ 200 mm centres along the joists.
		Length ≥ 20 mm Diameter ≥ 4 mm	Fixing of boards at transversal joints.

Table A.5.1: Specification of the supporting structure components.

Component	Identification	Characteristics	Mounting and fixing
Mesh fixings	Phosphate steel self-tapping screws	Length ≥ 35 mm Diameter ≥ 3,5 mm	Fixing of the metal mesh to the bottom side of the joists at ≤ 200 mm centres.
	Steel wire staples	Height ≥ 14 mm 	Fixing of the metal mesh to the bottom side of the joists every 2 cm.
Expanded ribbed metal mesh	Galvanised steel Z275 GZ200 (2500 x 600) mm	Strength: 38/43 kg/mm^2 (373/421 MPa) Weight: 1,14 kg/m^2 Thickness: 0,5 mm Length opening: 25 mm Width opening: 6 mm	Fixed with screws and staples to the bottom side of the wooden joists along their direction.

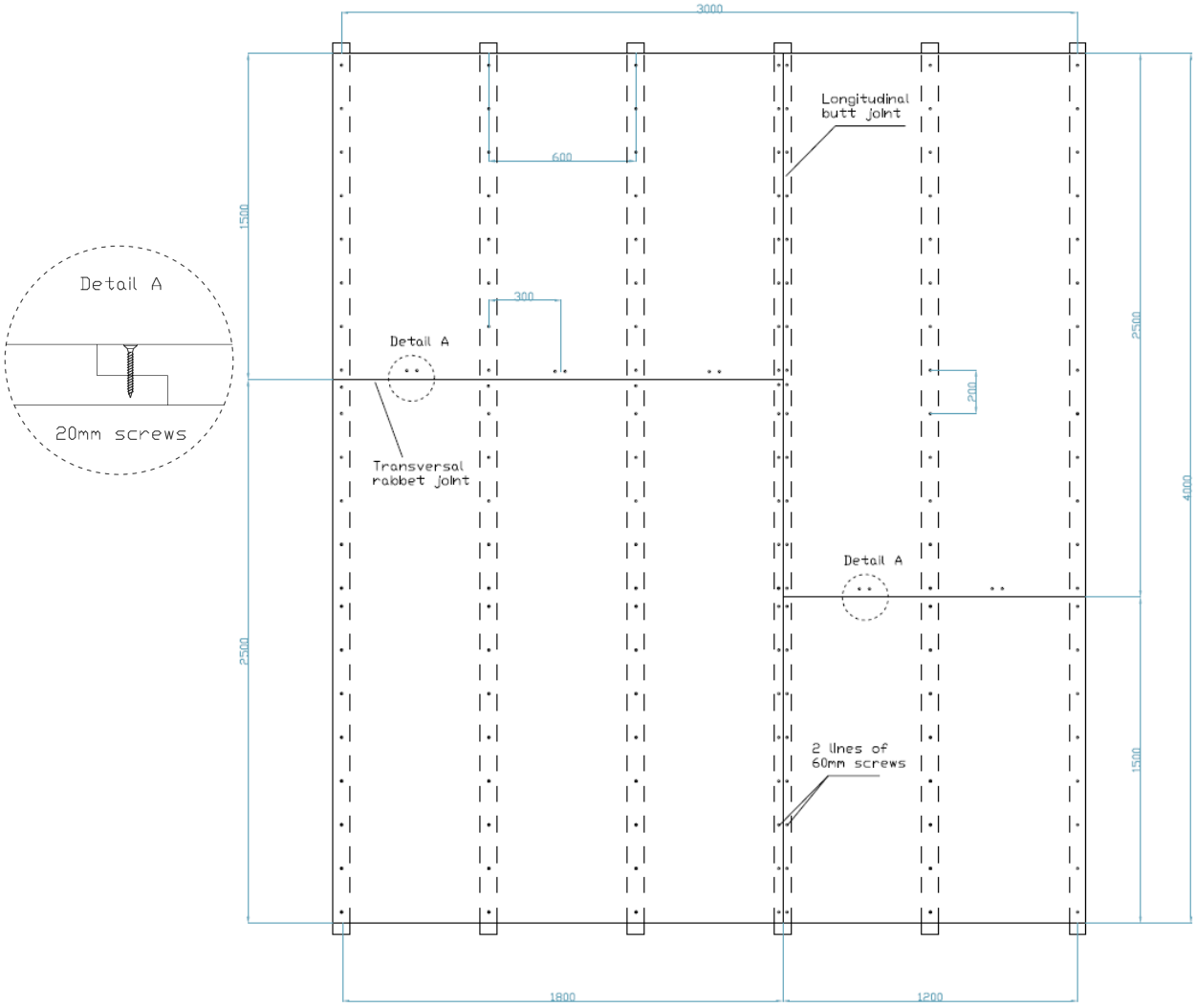


Figure A.5.1: Distribution of wooden joists, board joints and mechanical fixings.

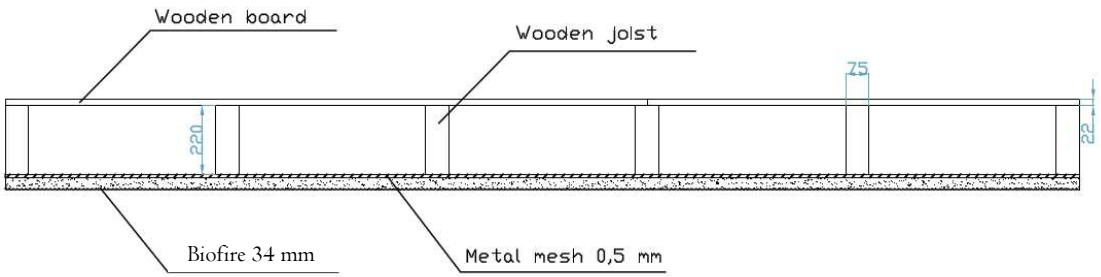


Figure A.5.2: Vertical section of the timber floor.

A.5.1.2.2 Fire protective rendering

Biofire is applied over the expanded mesh entirely covering the surface.

Biofire is sprayed in two coats of regular thickness to reach the requested total thickness of 34 mm, with a 1-2 cm penetration into the mesh. During the application the thickness of the protective material is regularly controlled with a pin caliper.

Hairline cracks in the dry rendering are not accepted.

Table A.5.2: Specification of the rendering.

Component	Identification	Characteristics	Mounting and fixing
Rendering	Biofire	Thickness: 34 mm Hardened density: 819 ± 15 % kg/m^3	Rendering is kept without finishing after application. Spray applied rendering with mechanical reinforcement and: - No bonding primers - No top coats or sealing coats - No additives out of dry mix

ANNEX 6 Specification and assessment of fire protection of technical services assemblies in buildings (intended use Type 9), consisting of a horizontal rectangular ventilation duct protected by Biofire

A.6.1 Classification to external fire of a horizontal rectangular ventilation duct

The assembly described in this Annex has been tested and assessed according to EN 1366-1 and classified EI 120 (ho o→i) in accordance with EN 13501-3.

A.6.2 Installation requirements

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

A.6.2.1 Ductwork

Biofire is applied on a horizontal ventilation duct made of galvanised steel sheets forming a rectangular duct of maximum cross section 1250 mm x 1000 mm. The duct is longitudinally closed using a Pittsburgh joint and every duct segment is connected to the next one by METU-System joints at a maximum distance of 1250 mm.

The ductwork is suspended using steel C-channels under the duct which are hanged with two steel threaded rods, one at each side of the duct. The system is retained with a galvanised steel nut. The maximum distance between suspension elements is 1500 mm.

Table A.6.1: Specification of the ductwork components.

Component	Identification	Characteristics	Mounting and fixing
Metal sheet forming the duct	Galvanised steel sheet S320GD, DX51D+Z275	Thickness: 1,0 mm	Forming a rectangular duct, with longitudinal Pittsburgh joint and transversal METU-System joints
Hangers	Threaded rod of galvanised steel S250 GD+Z275	Diameter: 16 mm	Suspending the C-channels
Fixings	Nut of galvanised steel S250 GD+Z275	Diameter: 16 mm	Fixed with a washer to the rods, to retain the C-channels
Supporting C-channels	HILTI MML-C30 2M, of galvanised steel S250 GD+Z275	See Figure A.6.1	Under the duct, retained to the rods by nuts at both ends of the profile
Transversal joint elements	METU System M30, galvanised steel S250 GD+Z275	See Figure A.6.1	To connect duct sections every 1250 mm, fixed at the framing square with 8 mm diameter screws and along the perimeter with staples at 200 mm

Dimensions of C-channels

A: 30 mm
B: 30 mm
C: 19,5mm
T: 2 mm

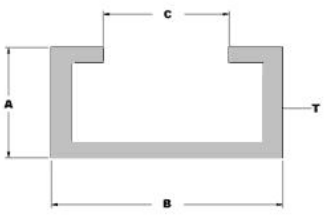


Figure A.6.1: Ductwork hanging system and METU-System transversal joint.

A.6.2.2 Surface of steel sheets

No specific preliminary preparation of the steel sheets forming the duct to be protected by Biofire is required. However, they must be bare, free of dust, oil and grease.

A.6.2.3 Reinforcement mesh

Prior to the rendering application, an expanded ribbed metal mesh is placed around the duct. Each sheet of mesh is folded following the rectangular shape of the duct and fixed with steel wire both longitudinally along the duct to close every reinforcement section and transversally to tie adjacent mesh segments each other.

Table A.6.2: Specification of the reinforcement mesh.

Component	Identification	Characteristics	Mounting and fixing
Expanded metal mesh	Galvanised steel Z275, 20µm (2500 x 600) mm	Strength: 38/43 kg/mm^2 (373/421 MPa) Weight: 1,14 kg/m^2 Thickness: 0,5 mm Length opening: 25 mm Width opening: 6 mm	Installed around the duct, following its rectangular shape, fixed with steel wire

A.6.2.4 Fire protective rendering

Biofire is applied over the expanded mesh entirely covering the 4 sides of the duct, as well as the hangers and the suspension elements.

Biofire is sprayed in two coats of regular thickness to reach the requested total thickness of 60 mm (56 mm outside the mesh and approximately 3-5 mm between the mesh and the duct). During the application the thickness of the protective material is regularly controlled with a pin caliper.

Hairline cracks in the dry rendering are not accepted.

Table A.6.3: Specification of the rendering.

Component	Identification	Characteristics	Mounting and fixing
Rendering	Biofire	Thickness: 60 mm Hardened density: 1160 ± 15 % kg/m^3	Rendering is kept without finishing after application. Spray applied rendering with mechanical reinforcement and: - No bonding primers - No top coats or sealing coats - No additives out of dry mix

A.6.2.5 Penetration seal through the supporting structure

The horizontal ventilation duct penetrates a wall of reinforced concrete blocks of at least 200 mm thickness and 2200 kg/m^3 density. A gap of 50 mm is left between the wall and the rendering surface. The gap is sealed with intumescent cushions as back filling material and mineral wool panels to close the penetration at both ends. A layer of intumescent coating is applied over an area around the protected duct, covering the penetration seal and the wall to a distance of 300 mm from the rendering surface. For details see Figure A.6.2.

The specification of the penetration seal components is given in Table A.6.4.

Table A.6.4: Specification of the penetration seal components.

Component	Identification	Characteristics	Mounting and fixing
Intumescent cushions	Hilti CP 651N-L	According to manufacturer's technical specification	Back-filling the gap between the wall and the protected duct
Mineral wool filling	Panels of 50 mm thickness	Density: 145 kg/m^3 Reaction to fire class: A1	To close the penetration at both ends
Intumescent coating	Water borne intumescent coating	Dry film thickness: 800 µm Specific gravity: 1,41 g/l Reaction to fire class: C-s1,d0	Applied over the penetration seal and the concrete wall around the protected duct

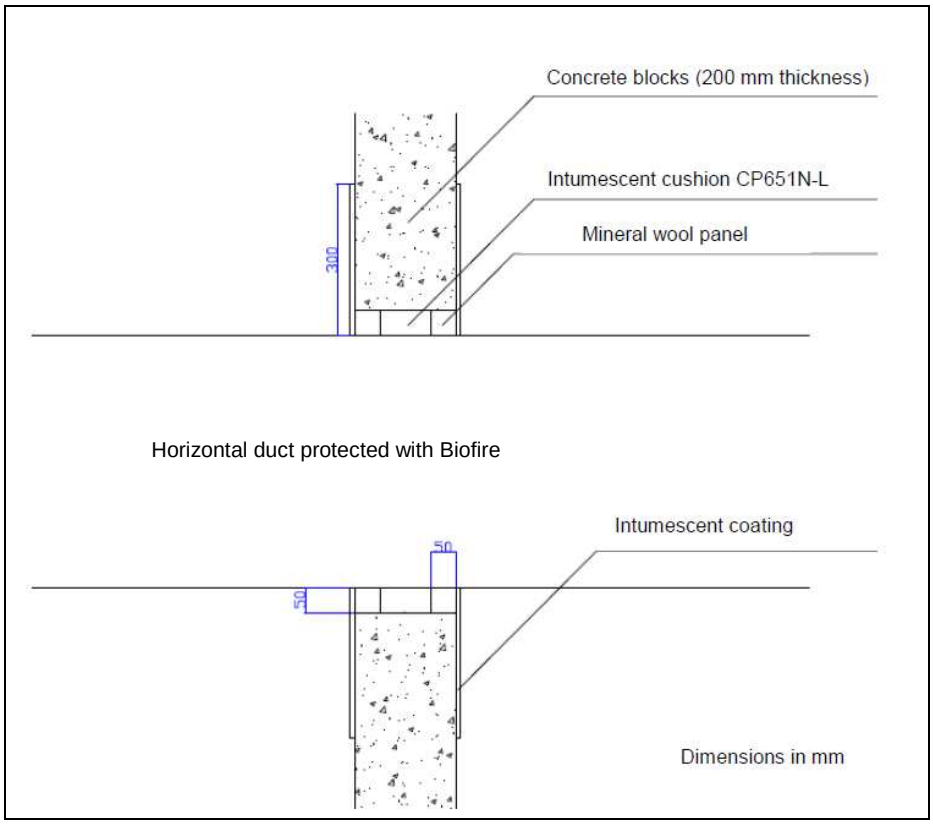


Figure A.6.2: Penetration seal.

ANNEX 7 Specification and assessment of fire protection of load-bearing floors composed of timber joists and concrete slab protected by Biofire (intended use Type 10)

A.7.1 Load-bearing floor

A.7.1.1 Classification

The assembly described in this Annex has been tested and assessed according to EN 1365-2:1999 and classified REI 180 in accordance with EN 13501-2. Test method and resistance to fire evaluation are in accordance with requirements in EN 1365-2:2014.

A.7.1.2 Installation requirements

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

A.7.1.2.1 Supporting structure

The supporting structure is a load-bearing floor composed of timber joists and concrete slab. Joists are placed in parallel at maximum 600 mm centres. A layer of thin tongue and groove ceramic bricks is placed above the joints. Pieces of (600 x 300 x 30) mm rest transversally to the joists direction. On top of the ceramic layer, a concrete slab of 50 mm thickness containing a rebar reinforcement of (150 x 150 x 10) mm completes the floor. See Table A.7.1 for components specification and figures for details.

The maximum load-bearing capacity of the floor corresponds to a maximum load of 250 kg/m^2 uniformly distributed over the concrete slab, with a maximum joists span of 4000 mm.

An expanded ribbed metal mesh is placed following the 3 exposed sides of the wooden joists, fixed with 35 mm length screws (2 screws at the bottom side at maximum 500 mm centres and one screw at each of the lateral sides, at mid distance between bottom screws). Pull out resistance of screws has been determined in accordance with EAD 350140-00-1106, section 2.2.5.1: 2298 N. These values are guidance values and they do not reflect a statistical evaluation.

Table A.7.1: Specification of the components.

Component	Identification	Characteristics	Mounting and fixing
Load-bearing wooden joists	Spruce, softwood	Height ≥ 150 mm Width ≥ 150 mm Strength class C24	Installed parallel at ≤ 600 mm centres.
Thin ceramic layer	LD hollow ceramic bricks of (600 x 300 x 30) mm	Flexural strength ≥ 123 daN	Supported transversally on the joists, installed with tongue and groove joints.

Table A.7.1: Specification of the components.

Component	Identification	Characteristics	Mounting and fixing
Concrete	Concrete strength class 25 N/mm^2 Siliceous aggregates	Concrete with the same strength class or better. Density: 2150 kg/m^3 ± 15 %	The concrete contains additional reinforcing bars for load bearing purposes.
Expanded ribbed metal mesh	Galvanised steel Z275 GZ200 (2500 x 600) mm	Strength: 38/43 kg/mm^2 (373/421 MPa) Weight: 1,14 kg/m^2 Thickness: 0,5 mm Length opening: 25 mm Width opening: 6 mm	Fixed with screws and washers to the bottom and lateral sides of the wooden joists.
Fixings	Phosphate steel self-tapping screws	Length ≥ 35 mm Diameter ≥ 3,5 mm	Fixing of the metal mesh to the joists: – 2 screws every 500 mm on bottom – 2 screws every 500 mm at lateral sides (1 at each side) – 250 mm between lateral and bottom fixings

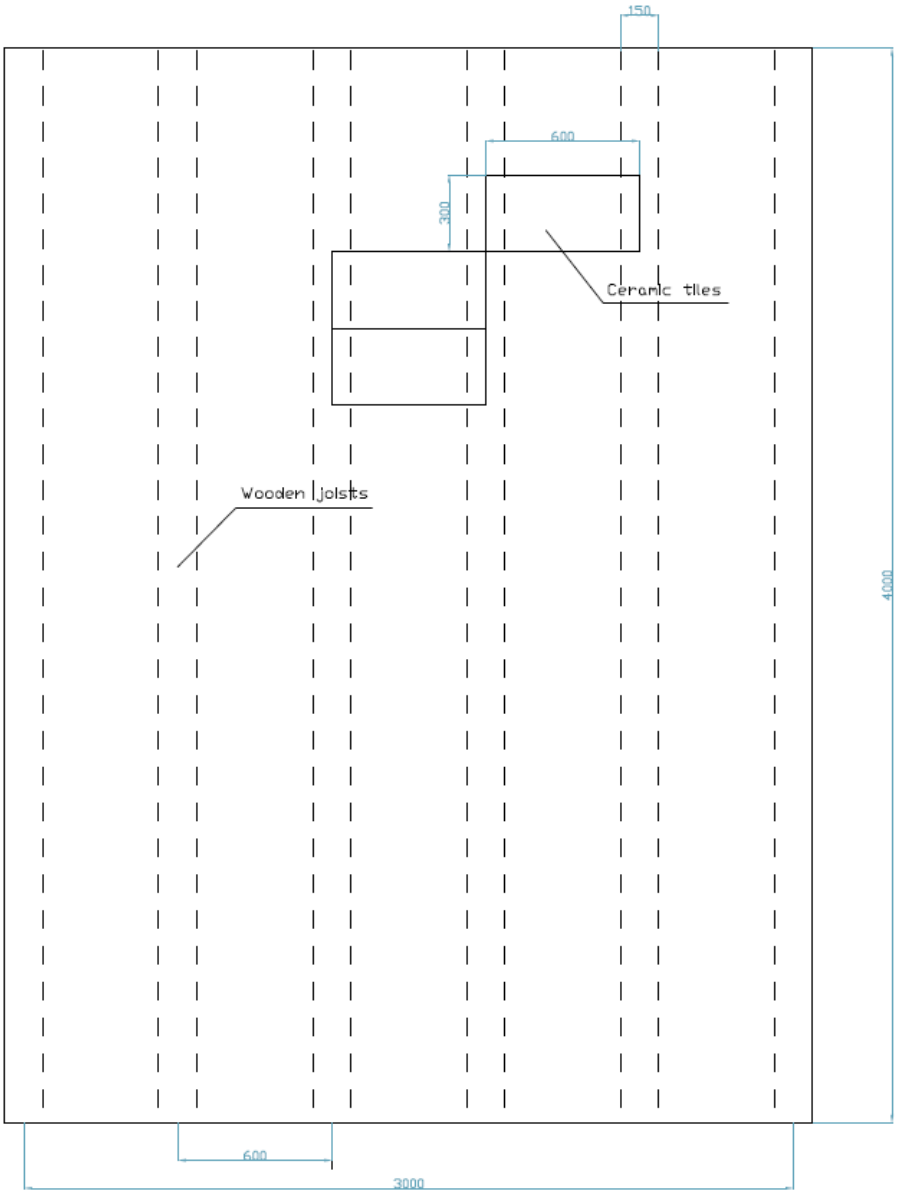


Figure A.7.1: Distribution of wooden joists and thin ceramic bricks.

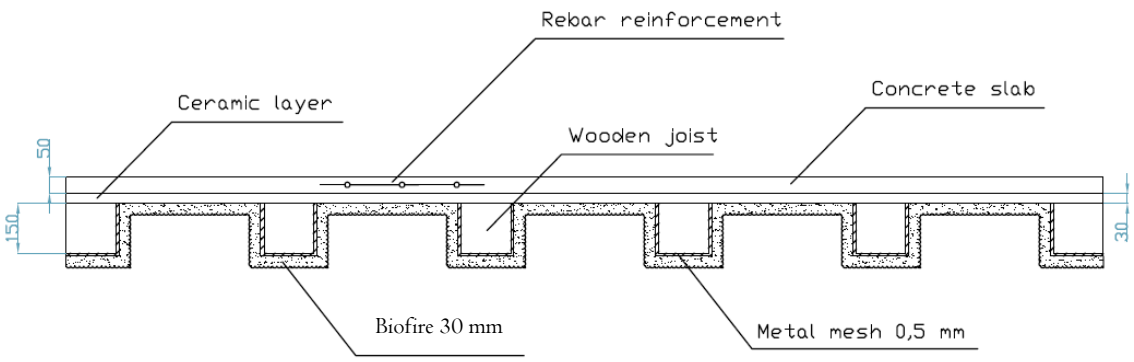


Figure A.7.2: Vertical section of the floor.

Figure A.7.3: Detail of the mesh fixing.

A.7.1.2.2 Fire protective rendering

Biofire is applied over the expanded mesh covering the wooden joists and the bottom side of the ceramic layer, entirely covering the surface.

Biofire is sprayed to reach the requested total thickness of 30 mm. During the application the thickness of the protective material is regularly controlled with a pin caliper. Hairline cracks in the dry rendering, if any, should be filled with intumescent sealant Pyrok®.

Table A.5.2: Specification of the rendering.

Component	Identification	Characteristics	Mounting and fixing
Rendering	Biofire	Thickness: 30 mm Hardened density: 852 ± 15 % kg/m^3	Rendering is kept without finishing after application. Spray applied rendering with mechanical reinforcement and: - No bonding primers - No top coats or sealing coats, apart from the cracks filler - No additives out of dry mix
Intumescent sealant	Pyrok®	Acrylic sealant Density: 1,56 g/cm^3	To fill hairline cracks in the dry rendering, if any.