SINTEF

SINTEF Building and Infrastructure
P.O.Box 124 Blindern
N-0314 Oslo
Tel. 47 22 96 55 55
Fax 47 22 69 54 38
e-mail: byggforsk@sintef.no

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

Member of EOTA

www.eota.eu

European Technical Assessment

ETA 10/0082
of 03.09.2014

Section I: General Part

Technical Assessment Body issuing the ETA:	SINTEF
Trade name of the construction product	Monokote® MK-6
Product family to which the construction product belongs	Fire Protective Products – Rendering kit intended for fire resisting applications.
Manufacturer	Grace Produits de Construction SAS ZA Les FOULLETONS 39140 LARNAUD France
Manufacturing plant	GRACE Performance Chemical-Irondale, USA. AVI-Dammam, Kingdom of Saudi Arabia.
This European Technical Assessment contains	32 pages including 5 annexes which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of	ETAG 018-1, edition April 2013 and ETAG 018-3, edition May 2012, both used as EAD.
This version replaces	ETA 10/0082 issued on 17.06.2013.

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Section II: Specific parts

1. Technical description of the product and intended use

Monokote® MK-6 is a product of light density, with a hydraulic gypsum based binder and synthetic aggregates. Mixed with water, it gives a light density rendering. The product is delivered in two versions:

- Monokote® MK-6/HY: Quick setting rendering
- Monokote® MK-6/S: Normal setting rendering

Complementary products are:

- Monokote® Accelerator (Aluminium sulphate): accelerator set additive to be used only with MK-6/HY.
- Primer FirebondTM, which optimises the adhesion to anticorrosion primers when compatibility tests are not available, and to old concrete. Optional use as a fixative applied on MK 6 surface.
- Spatterkote® SK3 which optimises adhesion on composite and cellular decks *(this product is not applied in connection with type 3 and type 4 use categories)*

The rendering kit comprising Monokote® MK-6 plus the complementary products mentioned above correspond to “Option 2” (direct application) as described in the foreword of EAD ETAG 018 Fire Protective Products - Part 3 Renderings and rendering kits intended for fire resisting applications.

The basic composition is identical for both Monokote® MK-6/HY and Monokote® MK-6/S:

- Monokote® MK-6/HY is a rendering kit including Monokote® Accelerator, Spatterkote® SK3 and the bonding primer Firebond TM
- Monokote® MK-6/S is a rendering kit including Spatterkote® SK3 and the bonding primer Firebond TM

The dry mix is delivered in bags, and is mixed with water in a mechanical mixer to produce a mortar. The fresh mortar is applied by machine spraying, except for small areas and areas of repair, where the rendering may be applied by trowel. The fresh mortar may be applied in one or several layers.

Only for Monokote® MK-6/HY an accelerator additive is injected into the product. There are two options for injection of the accelerator additive; at the nozzle or in-line. The injection of this additive gives an immediate expansion of the fresh mortar and the product will typically set within 15 minutes (quick setting rendering). Monokote® MK-6/S is not used with Monokote® Accelerator (normal setting rendering).

The total thickness of the rendering (hardened mortar) ranges typically from 10 to 90 mm, depending on the required fire resistance. The hardened mortar is light grey in colour for Monokote® MK-6/HY and can be off-white or light grey for Monokote® MK-6/S.

The rendering has a textured surface due to the method of application. Other properties for identification are given in clause 3.7.3.

2. Specification of the intended use

Related to environmental conditions the rendering system is intended for internal and semi-exposed environmental conditions; use category Type Y as defined in ETAG 018-Part 3 (used as EAD). This includes temperatures below 0 °C, but no exposure to rain and limited exposure to UV (effects of UV exposure are not assessed).

Table 1 below shows the possible intended uses of the fire protective product. Not all the possible intended uses have been assessed within the framework of this ETA concerning fire resistance performance. This ETA covers the fire protective product Monokote® MK-6 when applied according to intended use type 1, type 3, type 4 and type 5 (see right column in table 1), and installed in assemblies in accordance with the provisions respectively given in Annex 1, Annex 2, Annex 3 and Annex 4 .

Table 1 Intended use

Protection of	**ETAG 018-1 reference**	**Use covered by this ETA**
Horizontal membrane protection	Type 1	X
Vertical membrane protection	Type 2	
Load-bearing concrete elements	Type 3	X
Load-bearing steel elements	Type 4	X
Load-bearing flat concrete profiled sheet composite elements	Type 5	X
Load-bearing concrete filled hollow steel columns	Type 6	
Load-bearing timber elements	Type 7	
Fire separating assemblies with no load- bearing requirements	Type 8	
Technical services assemblies in buildings	Type 9	
Uses not covered by types 1-9	Type 10	

The provisions made in this ETA are based on an assumed intended working life of the product of 25 years, provided that the assembled product is subject to appropriate use and maintenance in accordance with this ETA. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works. The user of the product must ensure, that the durability assessment made, is relevant to the local conditions of use.

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

3.0 Summary of the performance of the product

The assessment of fitness for use has been made in accordance with ETAG 018 - Part 3, date of EC endorsement 27-06-2013, and is summarized as follows (BR = Basic Requirement according to ANNEX I in the Construction Product Regulation):

ETAG § no. (part 3)	Characteristics	Assessment of characteristics (references to clauses in the ETA)
4.1	**Mechanical resistance and stability (BR 1)**	Not relevant. See clause 3.1.
4.2	**Safety in case of fire (BR 2)**	
	Reaction to fire *(see ETAG 018-1, § 4.2.1)*	Fire class A1. See clause 3.2.
	Resistance to fire *(see ETAG 018-1, § 4.2.2)*	According to EN 13501-2. See clause 3.2.2, and Annex 1 to Annex 4.
4.3	**Hygiene, Health and the Environment (BR 3)**	
	Air and/or water permeability *(see ETAG 018-1, § 4.3.1)*	No performance determined
	Release of dangerous substances *(see ETAG 018-1, § 4.3.2)*	See clause 3.3.2
4.4	**Safety and accessibility in use (BR 4)**	
	Mechanical resistance and stability *(see ETAG 018-1, § 4.4.1)*	Se clause 3.4.1.
	Resistance to impact / movement *(see ETAG 018-1, § 4.4.2)*	No performance determined.
	Adhesion (bond strength) *(see ETAG 018-1, § 4.4.3)*	Satisfactory tensile bond strength has been proved by the *durability* testing. See clause 3.7.2.6, and the site test method described in Annex 5.
4.5	**Protection against noise (BR 5)**	No performance determined
4.6	**Energy, Economy and Heat Retention (BR 6)**	No performance determined
4.7	**Aspects of durability, serviceability and identification**	
4.7.1	Durability	Satisfactory *durability and serviceability* characteristics has been proved for environmental use category type Y, according to ETAG 018-3, § 2.2.2. See clause 3.7.
4.7.2	Serviceability	
4.7.3	Identification	See clause 3.7.3, table 3 – table 6

3.1 Mechanical resistance and stability

Not relevant to fire protective products, when referring to Basic Requirement no. 1 given in in the Construction Products Regulation (CPR), Annex I.

3.2 Safety in case of fire

3.2.1 Reaction to fire
The renderings have a reaction to fire classification A1 according to EN 13501-1.

3.2.2 Fire resistance
The fire resistance classified according to EN 13501-2 for various thicknesses and type use categories is presented in Annex 1 – Annex 4, and has been determined on the basis of tests according to the relevant parts of EN 13381 and the provisions given in the relevant parts of ETAG 018 used as EAD.

In addition, satisfactory fire *insulation efficiency* has been proved by specified exposures with following fire testing according to ETAG 018 – Part 3 (used as EAD), Annex E.

3.3 Hygiene, health and environment

3.3.1 Water absorption
No performance determined.

3.3.2 Release of dangerous substances
The holder of the Assessment has submitted a written declaration stating that Monokote® MK6, Firebond™ (the bonding primer), Spatterkote SK3 and Monokote accelerator contains no dangerous substances according to EC-database, as known at the date of issue.

In addition to the specific clauses relating to dangerous substances contained in this European Technical Assessment, there may be other requirements applicable to the product (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Regulation (EU) No. 305/2011 (CPR), these requirements also need to be complied with, when and wherever they apply.

3.4 Safety and accessibility in use in use

3.4.1 Mechanical resistance and stability
The fire protective product have sufficient mechanical resistance to sustain static and/or dynamic loads that can be expected under normal conditions of handling, during installation and its end use conditions.

3.4.2 Resistance to impact / movement
No performance determined.

3.4.3 Adhesion (bond strength)
The adhesion/cohesion characteristic of the Monokote® MK6 fire protective product depends on the installed thickness and on the preparation of the substrate. Typical values, determined in accordance with ETAG 018-3 (used as EAD) and EGOLF method SM/5, are listed in clause 3.7.2.6 below.

3.5 Protection against noise

No performance determined.

3.6 Energy economy and heat retention

No performance determined.

3.7 Aspects of durability, serviceability and identification

3.7.1 Aspects of durability

3.7.1.1 General aspects of durability
Based on the results from the durability testing according to ETAG 018-Part 3 (used as EAD), ANNEX E, the fire protective rendering Monokote® MK6 will not deteriorate during its assumed intended working life so as the product performance is significantly affected.

In case of physical damages the fire protective rendering shall be repaired according to the manufacturer's instruction.

3.7.1.2 Resistance to UV-exposure and deterioration caused by heat and rain
No performance determined. (Not relevant for the intended use; semi-exposed type Y).

3.7.1.3 Resistance to deterioration caused by high humidity
Monokote® MK6 renderings are resistant to high humidity as defined in ETAG 018-Part 3, which was used as an EAD.

3.7.1.4 Resistance to deterioration caused by heat and cold
Monokote® MK6 renderings are resistant to heat/cold cycles as defined in ETAG 018-Part 3, which was used as an EAD.

3.7.1.5 Resistance to deterioration caused by freezing and thawing
Monokote® MK6 renderings are resistant to freeze/thaw cycles as defined in ETAG 018 - Part 3, which was used as an EAD.

3.7.1.6 Resistance to corrosion of a steel substrate by the rendering
The renderings are compatible with and provide protective ability as defined in ETAG 018-Part 3 (used as EAD), Annex C for the following steel substrates; bare steel, galvanized steel, and primers of the four generic families (oil alkyd, epoxy, zinc rich epoxy, zinc silicate).

3.7.1.7 Resistance to corrosion of the fixings by the rendering

No performance determined.

3.7.2 Aspects of serviceability

3.7.2.1 Mechanical resistance and stability

No performance determined. However, see clause *3.7.2.6 Adhesion* and clause 3.2.2 Fire resistance. No significant detachment, delamination or cracking were reported for the fire insulation efficiency testing.

3.7.2.2 Resistance to impact/movement

No performance determined.

3.7.2.3 Air erosion

No performance determined.

3.7.2.4 Water vapour permeability

No performance determined.

3.7.2.5 Water absorption

No performance determined.

3.7.2.6 Adhesion

The tensile bond strength has been assessed in accordance with ETAG 018-3 (used as EAD) and EGOLF method SM/5. The adhesion/cohesion characteristic of the Monokote® MK6 fire protective product depends on the installed thickness and on the preparation of the substrate. Typical values are listed in the following table 2 below.

Table 2 Adhesion expressed by tensile bond strength values

Surface preparation	**Thickness of MK6 (mm)**	**Tensile bond strength** [*)] **(N/mm²)**	
		Average	**Standard deviation**
Bare steel	10	0.07128	0.00463
	80	0.03732	0.00593
Galvanized steel	10	0.05974	0.00799
	80	0.03749	0.00257
Primed with alkyd primer on steel	10	0.04422	0.00717
	80	0.02956	0.00432
Primed with epoxy primer on steel	10	0.04824	0.00492
	80	0.02673	0.00474
Primed with SPATTERKOTE® SK3	10	0.05335	0.02613
	80	0.02153	0.01130
Bare concrete, release agent: emulsion	13	0.074805	0.015361
	59	0.043241	0.007389
Bare concrete, release agent: mineral oil	13	0.091831	0.016496
	59	0.041936	0.003686

[*)] The tensile bond strengths apply to both Monokote MK6/HY and MK6/S

3.7.3 Identification

Table 3 – 6 shows the main material properties used for product identification.

Table 3 Dry mix identification of Monokote® MK-6

Property	MK-6/HY	MK-6s	Test method
Description / colour	Light grey	Off-white/light grey	Visual
Formulation	Formulation declared	Formulation declared	
Density (kg/m^3)	240 +/- 3.2 kg/m^3		

Table 4 Fresh mortar identification of Monokote® MK-6

Property	MK-6/HY	MK-6s	Test method
Mixing ratio	23 - 32 litres	23 - 32 litres	
Bulk density at mixer*)	640 – 795 g/l	600 – 700 g/l	by weighing 1,0 litre
Bulk density at Nozzle*)	≥ 500g/l	≥ 620 g/l	by weighing 1,0 litre
pH value	8	8	

*) In case of continuous mixer machine the weight is checked at nozzle

Table 5 Rendering identification of Monokote® MK-6

Property	MK-6/HY	MK-6s	Test method
Description / colour	Light grey	Off-white/light grey	Visual
Average Density; hardened mortar	255 kg/m^3	312 kg/m^3	EN 1015-10
Flexural and compressive strength; hardened mortar	NPD	NPD	EN 1015-11

Table 6 Identification of additives, i.e. complementary products

a) Additives identification: Accelerator and primer

Properties	Monokote® Accelerator	Primer FIREBOND	Test method
Description / colour	Aluminium Sulphate powder / white	Water based acrylic liquid / white	
Volatile	/	water	
Volatile organic components (VOC)	/	14.3 g/l +/- 10 g	
Weight per litre at 25°C	/	1054 g/l	by weighing 1,0 litre
Odor	/	Similar to latex house paint	
Density	(Dry bulk) 993 to 1137 Kg/m3	/	

b) The identification of the additive product Spatterkote SK3

Properties	SPATTERKOTE SK3	Test method
Description / colour	Mill-mixed Portland cement based powder / grey	
Density Fresh mortar	700-880 g/l	by weighing 1,0 litre
Mixing ratio	31 - 33 litres	
Covering	80 m²/bag	

4. Assessment and verification of constancy of performance system (AVCP)

According to the decision 1999/454/EC of the European Commission, as amended, the system(s) of assessment and verification of constancy of performance (see Annex V of Regulation (EU) No 305/2011) is given in the following table:

Product	Intended use	Resistance to fire Level(s) or class(es)	AVCP-system
Fire Protective Products *See section I: General Part*	Renderings and Rendering Kits intended for Fire Resisting Applications, as given in *section II, clause 2*	*See clause 3.2, and Annex 1 - 4*	1

Note! References given in the table are made to this ETA document only.

5. Technical details necessary for the implementation of the AVCP-system, as provided for in the applicable ETAG used as EAD

Technical details necessary for the implementation of the AVCP-system are laid down in the control plan deposited at SINTEF.

Issued in Trondheim on 03.09.2014

By

SINTEF Building and Infrastructure

Hans Boye Skogstad

Approval Manager

ANNEX 1

Type 1: Horizontal membrane protection - REI 30 to REI 240

The results of the assessment are valid only according to the following conditions:

- Protective materials MONOKOTE MK6-HY / MONOKOTE MK6-S composition and application conditions identical as those noted during reference fire tests;
- A metallic lath type NERGALTO NG1 (LE METAL DEPLOYE) was fixed directly on the bottom sides of steel runners F530 with screws TTPC 25 at 100 mm centres.

Building material of beam and joist	Building material of supporting floor	Minimal thickness of MONOKOTE MK6-HY/ MONOKOTE MK6-S to be applied (mm)				
		REI 30	REI 60	REI 90	REI 120	REI 180
Reinforced concrete	Aerated concrete	25	33	33	33	40
Reinforced concrete	Reinforced concrete	25	33	33	33	40
Steel	Aerated concrete	25	33	33	33	48
Steel	Reinforced concrete	25	33	33	33	48
Steel	Steel	25	33	33	33	48
Reinforced concrete Steel	Pan joist concrete floor	25	33	33	41	59
Cold formed steel	Reinforced concrete Aerated concrete Pan joist concrete floor	25	33	34	43	60
Wood	Aerated concrete	25**	33	40	48	66*
Wood	Reinforced concrete	25**	33	40	48	66*
Reinforced concrete	Wood	25**	33	40	48	66*
Steel	Wood	25**	33	40	48	66*
Wood	Wood	25**	33	40	48	66*

*: Value obtained by extrapolation

**: Plenum height at least equal to 220 mm

Building material of beam and joist	Building material of supporting floor	Minimal thickness of MONOKOTE MK6-HY to be applied (mm)				
		REI 30	REI 60	REI 90	REI 120	REI 180
Steel	Steel	25	33	33	33	48

Type 3: Protection of load-bearing concrete elements – REI 30 to REI 240

The results of the assessment are valid only according to the following conditions:

- Protective materials MONOKOTE MK6-HY and MONOKOTE MK6-S composition and application conditions identical as those noted during reference fire tests;
- Nominal density of applied protective material MONOKOTE MK6-HY included in [219,297] (kg/m^3) range;
- Nominal density of applied protective material MONOKOTE MK6-S included in [280,345] (kg/m^3) range;
- Applied thicknesses of protective materials MONOKOTE MK6-HY and MONOKOTE MK6-S included in [10, 55] (mm) range;
- Protective materials MONOKOTE MK6-HY and MONOKOTE MK6-S applied on bare concrete structures cast with following release agents:
    - Mineral oil;
    - Emulsion
- Protective materials MONOKOTE MK6-HY and MONOKOTE MK6-S can be applied on bare concrete structures preliminary treated with bonding primer FIREBOND;
- Protective materials MONOKOTE MK6-HY and MONOKOTE MK6-S applied on:
    - Slabs;
    - Beams;
    - Walls exposed on one side only.
- Density of concrete equal to 2330 kg/m^3 ± 15%;
- Thickness of slabs or walls greater or equal to 120 mm;
- Width of beams greater or equal to 150 mm;
- Maximum duration of the exposure to the conventional thermal program as prescribed byEN 1363-1 equal to 5 hours at maximum for application on beams and to 6 hours for application on walls or slabs, depending on the type of concrete structures and the thickness of MONOKOTE MK6-HY and MONOKOTE MK6-S applied.

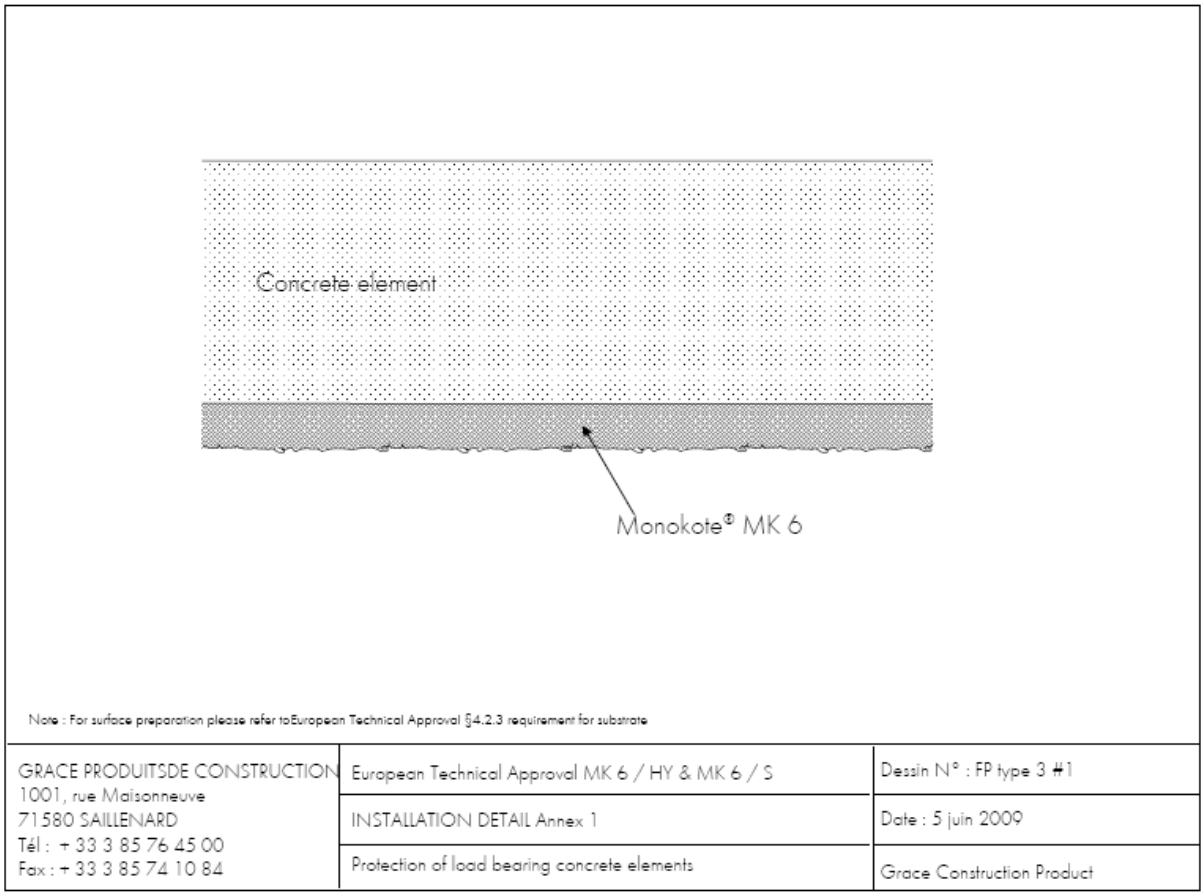


Figure A1.1
Installation details on concrete slabs

Table A1.1 shows the equivalent thickness of concrete induced by Monokote® MK-6, determined according to EN 13381-3 Annex C and EN 1992-1-2 Annex A.

Table A1.1

Type of concrete structure	Thickness of Monokote MK-6/HY – MK-6S (mm)	Solid concrete element thickness (mm)						
		Fire resistance						
		30 min.	60 min.	90 min.	120 min.	180 min.	240 min.	360 min.
Slab	11	38	50	53	53	49	40	*
	32	63	78	85	92	99	97	*
	55	84	104	113	124	131	140	133
Beam	10	22	38	45	45	*	*	*
	41	56	72	81	92	104	104	*

*: Exposure duration not covered

Table A1.2 and A1.3 show the thickness of Monokote in regard of the equivalent thickness of concrete based on linear interpolation.

Table A1.2

SLAB	Equivalent thickness of concrete (mm)					
Thickness of MONOKOTE (mm)	Fire resistance					
	30 min.	60 min.	90 min.	120 min.	180 min.	240 min.
11	38	50	53	53	49	40
12	39	51	55	55	51	43
13	40	53	56	57	54	45
14	42	54	58	59	56	48
15	43	55	59	60	59	51
16	44	57	61	62	61	54
17	45	58	62	64	63	56
18	46	59	64	66	66	59
19	48	61	65	68	68	62
20	49	62	67	70	70	64
21	50	63	68	72	73	67
22	51	65	70	73	75	70
23	52	66	71	75	78	73
24	53	67	73	77	80	75
25	55	69	74	79	82	78
26	56	70	76	81	85	81
27	57	71	77	83	87	83
28	58	73	79	85	89	86
29	59	74	80	86	92	89
30	61	75	82	88	94	92
31	62	77	83	90	97	94
32	63	78	85	92	99	97
33	64	79	86	93	100	99
34	65	80	87	95	102	101
35	66	81	89	96	103	103
36	67	83	90	98	105	104
37	68	84	91	99	106	106
38	68	85	92	100	107	108
39	69	86	94	102	109	110
40	70	87	95	103	110	112
41	71	88	96	105	112	114
42	72	89	97	106	113	116
43	73	90	98	107	114	118
44	74	92	100	109	116	119
45	75	93	101	110	117	121
46	76	94	102	111	118	123
47	77	95	103	113	120	125
48	78	96	104	114	121	127
49	79	97	106	116	123	129
50	79	98	107	117	124	131
51	80	99	108	118	125	133
52	81	101	109	120	127	134
53	82	102	111	121	128	136
54	83	103	112	123	130	138
55	84	104	113	124	131	140

Table A1.3

BEAM	Equivalent thickness of concrete (mm			
thickness of MONOKOTE (mm)	Fire resistance			
	30 min.	60 min.	90 min.	120 min.
10	22	38	45	45
11	23	39	46	47
12	24	40	47	48
13	25	41	48	50
14	26	42	50	51
15	27	43	51	53
16	29	45	52	54
17	30	46	53	56
18	31	47	54	57
19	32	48	55	59
20	33	49	57	60
21	34	50	58	62
22	35	51	59	63
23	36	52	60	65
24	37	53	61	66
25	38	54	62	68
26	40	56	64	69
27	41	57	65	71
28	42	58	66	72
29	43	59	67	74
30	44	60	68	75
31	45	61	69	77
32	46	62	71	78
33	47	63	72	80
34	48	64	73	81
35	49	65	74	83
36	51	67	75	84
37	52	68	76	86
38	53	69	78	87
39	54	70	79	89
40	55	71	80	90
41	56	72	81	92

ANNEX 3

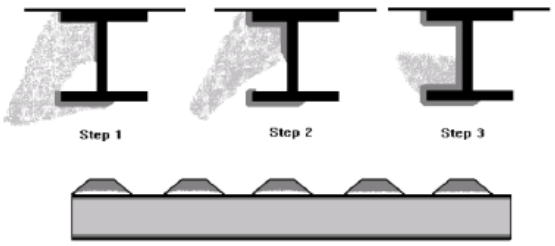
Type 4: Protection of load-bearing steel elements – R15 to R240

The results of the assessment are valid only according to the following conditions:

- Protective materials MONOKOTE MK6-HY / MONOKOTE MK6-S composition and application conditions identical as those noted during reference fire tests;
- Protective material MONOKOTE MK6-HY / MONOKOTE MK6-S applied on bare or galvanized steel or steel members painted with a primer belonging to following chemical families:
  - Alkyd;
  - Epoxy;
  - Epoxy rich in zinc;
  - Silicate of zinc
- Density of applied protective material MONOKOTE MK6-HY included in [219, 291] (kg/m^3) range;
- Density of applied protective material MONOKOTE MK6-S included in [280, 345] (kg/m^3) range;
- Applied thicknesses of protective material MONOKOTE MK6-HY / MONOKOTE MK6-S included in [10, 90] (mm) range;
- Shape factors of steel members protected by MONOKOTE MK6-HY / MONOKOTE MK6-S included in [50, 410] (m^{-1}) range;
- Maximum duration of the exposure to the conventional thermal program as prescribed by EN 1363-1 equal to 4 hours;
- Assessment results valid for both loaded beams and columns exposed on 3 or 4 sides;
- Assessment results valid for only « H » or « I » sections;
- Assessment results valid for steel hollow sections (SHS) (rectangular, square or circular sections) if protective material required thicknesses are corrected as indicated in paragraph B.1.1.3. - Annex B of EN 13381-4;
- Steel members with shape factors inferior to 50 m^{-1} can be protected with the thickness of protective material MONOKOTE MK6-HY / MONOKOTE MK6-S determined for steel members with shape factors equal to 50 m^{-1};
- Assessment results valid for steel limit temperature included in [350, 750] (°C) range.

REPEAT steps 1– 4 on the opposite side of the beam paying particular attention to the underside of the beam for potential light areas down the center of the beam where the material meets.

Note: In some cases an additional pass on the center of the web may be required when larger beams are being sprayed.



Step 4

Repeat Steps 1 - 4 on the opposite side of the beam

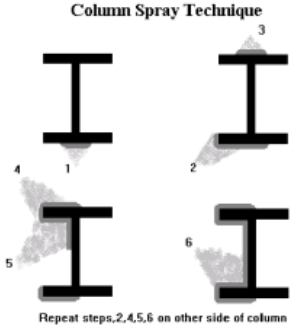
Example of Beam application

Note : For surface preparation please refer toEuropean Technical Approval §4.2.3 requirement for substrate

GRACE PRODUITSDE CONSTRUCTION 1001, rue Maisonneuve 71580 SAILLENARD Tél : + 33 3 85 76 45 00 Fax : + 33 3 85 74 10 84	European Technical Approval MK 6 / HY & MK 6 / S	Dessin N° : FP type 4 #1
	INSTALLATION DETAIL Annex 2	Date : 5 juin 2009
	Protection of load bearing steel elements	Grace Construction Product

Figure A1.2: Beam application

Column Spray Technique



Repeat steps,2,4,5,6 on other side of column

The opposite side of the column is complete in the same application technique with the exception of steps 1 and 3

On some wider columns an additional pass down the center of the inside column web may be necessary to achieve a uniform application.

Example of column application

Note : For surface preparation please refer toEuropean Technical Approval §4.2.3 requirement for substrate

GRACE PRODUITSDE CONSTRUCTION 1001, rue Maisonneuve 71580 SAILLENARD Tél : + 33 3 85 76 45 00 Fax : + 33 3 85 74 10 84	European Technical Approval MK 6 / HY & MK 6 / S	Dessin N° : FP type 4 #2
	INSTALLATION DETAIL Annex 2	Date : 5 juin 2009
	Protection of load bearing steel elements	Grace Construction Product

Figure A1.3: Column application

Required thicknesses of Monokote® MK-6/HY and Monokote® MK-6/S

The required thickness of Monokote® MK-6/HY and S in order to obtain the declared fire resistances based on the duration of the thermal exposure under the conventional thermal program is as follows:

Fire resistance R 15
A thickness of **10 mm** is sufficient to obtain R 15 fire resistance for all combinations of shape factors S/V of the steel members up to 410 m^{-1} and standard steel temperatures up to 750 ºC.

Fire resistance R 30 – R 240
Table A2.1 – A2.7 show the required minimum thickness.
The minimum required thickness of protective material is determined in function of :

- the shape factor S/V (m^{-1}) of the steel members ;
- the standard steel limit temperature comprised between [350,750] (°C)
- the duration of the thermal exposure under the conventional thermal program.

Table A2.1
Required minimum thicknesses of protective material to justify R 15

Shape factor (m^{-1})	Minimum required thickness to justify R15 (mm)								
	Standard steel temperatures (°C)								
	350	400	450	500	550	600	650	700	750
50	10	10	10	10	10	10	10	10	10
60	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	10	10	10	10	10	10	10	10	10
120	10	10	10	10	10	10	10	10	10
130	10	10	10	10	10	10	10	10	10
140	10	10	10	10	10	10	10	10	10
150	10	10	10	10	10	10	10	10	10
160	10	10	10	10	10	10	10	10	10
170	10	10	10	10	10	10	10	10	10
180	10	10	10	10	10	10	10	10	10
190	10	10	10	10	10	10	10	10	10
200	10	10	10	10	10	10	10	10	10
210	10	10	10	10	10	10	10	10	10
220	10	10	10	10	10	10	10	10	10
230	10	10	10	10	10	10	10	10	10
240	10	10	10	10	10	10	10	10	10
250	10	10	10	10	10	10	10	10	10
260	10	10	10	10	10	10	10	10	10
270	10	10	10	10	10	10	10	10	10
280	10	10	10	10	10	10	10	10	10
290	10	10	10	10	10	10	10	10	10
300	10	10	10	10	10	10	10	10	10
310	10	10	10	10	10	10	10	10	10
320	10	10	10	10	10	10	10	10	10
330	10	10	10	10	10	10	10	10	10
340	10	10	10	10	10	10	10	10	10
350	10	10	10	10	10	10	10	10	10
360	10	10	10	10	10	10	10	10	10
370	10	10	10	10	10	10	10	10	10
380	10	10	10	10	10	10	10	10	10
390	10	10	10	10	10	10	10	10	10
400	10	10	10	10	10	10	10	10	10
410	10	10	10	10	10	10	10	10	10

Table A2.2
Required minimum thicknesses of protective material to justify R 30

Shape factor (m^{-1})	Minimum required thickness to justify R30 (mm)								
	Standard steel temperatures (°C)								
	350	400	450	500	550	600	650	700	750
50	10	10	10	10	10	10	10	10	10
60	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	10	10	10	10	10	10	10	10	10
120	10	10	10	10	10	10	10	10	10
130	10	10	10	10	10	10	10	10	10
140	10	10	10	10	10	10	10	10	10
150	10	10	10	10	10	10	10	10	10
160	10	10	10	10	10	10	10	10	10
170	10	10	10	10	10	10	10	10	10
180	10	10	10	10	10	10	10	10	10
190	12	10	10	10	10	10	10	10	10
200	12	10	10	10	10	10	10	10	10
210	12	10	10	10	10	10	10	10	10
220	13	11	10	10	10	10	10	10	10
230	13	11	10	10	10	10	10	10	10
240	14	12	10	10	10	10	10	10	10
250	14	12	11	10	10	10	10	10	10
260	15	13	11	10	10	10	10	10	10
270	15	14	12	10	10	10	10	10	10
280	16	14	12	11	10	10	10	10	10
290	16	14	13	11	10	10	10	10	10
300	16	15	13	12	10	10	10	10	10
310	17	15	14	12	10	10	10	10	10
320	17	15	14	12	11	10	10	10	10
330	17	16	14	13	11	10	10	10	10
340	17	16	15	13	12	10	10	10	10
350	18	16	15	13	12	11	10	10	10
360	18	17	15	14	13	11	10	10	10
370	18	17	15	14	13	11	10	10	10
380	18	17	16	14	13	12	10	10	10
390	19	18	16	15	14	12	11	10	10
400	19	18	16	15	14	12	11	10	10
410	19	18	16	15	14	12	11	10	10

Table A2.3
Required minimum thicknesses of protective material to justify R 60

Shape factor (m^{-1})	Minimum required thickness to justify R60 (mm)								
	Standard steel temperatures (°C)								
	350	400	450	500	550	600	650	700	750
50	10	10	10	10	10	10	10	10	10
60	10	10	10	10	10	10	10	10	10
70	13	11	10	10	10	10	10	10	10
80	15	13	11	10	10	10	10	10	10
90	16	15	13	12	10	10	10	10	10
100	18	16	15	13	12	10	10	10	10
110	18	17	16	14	13	11	10	10	10
120	19	18	16	15	14	12	11	10	10
130	20	18	17	16	14	13	12	10	10
140	21	19	18	16	15	14	12	11	10
150	23	20	19	17	16	14	13	11	10
160	24	22	19	18	16	15	13	12	10
170	25	23	20	18	17	15	14	12	10
180	26	24	22	19	18	16	14	13	11
190	27	25	23	20	19	17	15	14	12
200	28	26	24	22	20	18	16	14	13
210	29	27	25	23	21	19	17	15	13
220	29	27	25	23	22	20	18	16	14
230	30	28	26	24	22	20	18	16	14
240	30	28	27	25	23	21	19	17	15
250	32	29	27	25	24	22	20	18	16
260	32	30	28	26	24	22	21	19	16
270	33	30	28	26	25	23	21	19	17
280	33	31	29	27	25	23	22	20	17
290	34	31	29	27	26	24	22	20	18
300	34	32	29	28	26	24	22	21	18
310	35	32	30	28	26	25	23	21	19
320	35	33	30	28	27	25	23	21	19
330	36	34	31	29	27	25	23	21	19
340	36	34	32	30	28	26	23	21	19
350	37	35	32	30	28	26	24	22	20
360	37	35	33	31	28	26	24	22	20
370	37	35	33	31	29	27	25	22	20
380	38	36	34	32	30	28	25	23	20
390	38	36	34	32	30	28	26	23	21
400	38	37	35	33	31	28	26	24	21
410	39	37	35	33	31	29	26	24	22

Table A2.4

Required minimum thicknesses of protective material to justify R 90

Shape factor (m^{-1})	Minimum required thickness to justify R90 (mm)								
	Standard steel temperatures (°C)								
	350	400	450	500	550	600	650	700	750
50	17	16	14	13	11	10	10	10	10
60	19	18	16	15	13	12	11	10	10
70	21	19	18	16	15	13	12	11	10
80	25	22	20	18	16	15	13	11	10
90	27	25	22	20	18	16	15	13	11
100	29	27	25	22	20	18	16	14	13
110	31	28	26	24	22	20	18	16	14
120	32	29	27	25	24	22	20	18	16
130	34	31	29	27	25	23	21	19	17
140	36	33	31	29	26	24	22	20	18
150	37	35	32	30	28	26	23	21	19
160	38	36	34	32	29	27	24	22	19
170	39	37	35	33	31	28	25	22	20
180	41	38	36	34	32	29	26	23	20
190	42	39	37	35	33	31	28	24	21
200	42	40	38	36	34	32	29	26	22
210	44	41	39	37	35	33	30	27	24
220	45	43	40	38	36	33	31	28	25
230	46	43	41	39	37	34	32	30	26
240	46	44	42	40	37	35	33	30	27
250	47	45	43	41	38	36	33	31	28
260	47	45	43	41	39	37	34	31	29
270	48	46	44	42	40	37	35	32	29
280	48	46	44	42	41	38	35	32	29
290	48	46	45	43	41	39	36	33	29
300	49	47	45	43	41	39	36	33	30
310	49	47	46	44	42	40	37	34	30
320	49	48	46	44	43	41	38	34	31
330	50	48	46	45	43	41	39	35	32
340	50	48	47	45	43	42	40	36	32
350	51	49	47	45	44	42	40	37	33
360	51	49	47	46	44	42	41	38	34
370	52	50	48	46	44	43	41	38	34
380	52	50	48	46	45	43	41	39	35
390	52	50	48	47	45	43	41	39	36
400	53	51	49	47	45	44	42	40	36
410	53	51	49	47	46	44	42	40	37

Table A2.5

Required minimum thicknesses of protective material to justify R 120

Shape factor (m^{-1})	Minimum required thickness to justify R120 (mm)								
	Standard steel temperatures (°C)								
	350	400	450	500	550	600	650	700	750
50	25	22	20	18	17	15	15	15	15
60	28	26	24	22	20	18	16	15	15
70	32	29	27	25	23	20	18	16	15
80	36	33	30	27	25	23	21	18	15
90	38	35	33	30	28	25	23	21	17
100	40	38	35	33	30	28	25	22	19
110	43	40	37	35	33	30	27	23	20
120	46	43	40	37	34	32	29	25	21
130	47	44	42	39	36	34	31	28	24
140	48	46	43	41	38	35	33	30	26
150	49	47	44	42	39	37	34	31	28
160	50	48	46	43	41	38	35	32	29
170	52	50	47	45	42	40	36	33	29
180	52	50	48	46	44	41	38	34	30
190	53	51	50	47	45	42	40	36	31
200	54	52	50	48	46	43	41	37	33
210	54	53	51	49	47	45	42	39	35
220	55	53	52	50	48	45	43	40	36
230	55	54	52	51	49	46	44	41	38
240	56	54	53	51	50	47	44	42	38
250	56	54	53	52	50	48	45	42	39
260	56	55	53	52	51	48	45	42	39
270	56	55	54	52	51	49	46	43	40
280	57	55	54	53	51	50	47	44	40
290	57	56	54	53	52	50	48	44	41
300	57	56	55	53	52	51	49	45	41
310	57	56	55	54	52	51	50	46	42
320	57	56	55	54	53	51	50	47	43
330	58	56	55	54	53	52	50	48	44
340	58	57	55	54	53	52	51	48	45
350	58	57	56	54	53	52	51	49	46
360	58	57	56	55	53	52	51	50	46
370	58	57	56	55	54	53	51	50	47
380	58	57	56	55	54	53	51	50	48
390	58	57	56	55	54	53	52	51	48
400	59	58	56	55	54	53	52	51	49
410	59	58	56	55	54	53	52	51	49

Table A2.6

Required minimum thicknesses of protective material to justify R 180

Shape factor (m^{-1})	Minimum required thickness to justify R180 (mm)								
	Standard steel temperatures (°C)								
	350	400	450	500	550	600	650	700	750
50	43	39	36	33	30	27	25	25	25
60	48	45	41	38	35	32	28	25	25
70	52	49	46	43	39	36	32	29	25
80	54	52	50	46	43	40	36	32	27
90	55	53	52	50	47	43	39	34	29
100	56	54	53	51	50	46	42	38	33
110	57	55	54	52	51	49	45	41	36
120	58	56	55	53	52	51	47	43	39
130	58	57	55	54	53	51	50	45	39
140	59	57	56	55	53	52	51	47	41
150	60	58	57	55	54	53	51	50	44
160	61	59	58	56	55	53	52	51	47
170	63	60	58	57	55	54	52	51	48
180	64	61	59	57	56	54	53	51	49
190	65	62	59	58	56	55	53	51	50
200	67	63	60	59	57	55	54	52	50
210	68	65	61	59	57	56	54	53	51
220	69	66	63	60	58	56	55	53	51
230	69	66	63	61	59	57	55	54	52
240	71	67	64	61	59	58	56	54	53
250	71	68	65	62	60	58	56	55	53
260	72	69	66	63	60	59	57	55	54
270	73	70	67	64	61	59	57	56	54
280	74	71	68	65	62	59	58	56	55
290	74	71	69	66	63	60	58	57	55
300	75	72	69	66	63	60	59	57	55
310	75	73	70	67	64	61	59	57	56
320	76	73	70	68	65	62	59	58	56
330	76	74	71	68	65	62	60	58	56
340	76	74	72	69	66	63	60	58	57
350	77	74	72	69	66	63	60	59	57
360	77	74	72	70	67	64	61	59	57
370	77	75	73	70	67	64	61	59	58
380	77	75	73	71	68	65	62	59	58
390	78	75	73	71	68	65	62	60	58
400	78	76	73	71	69	66	63	60	58
410	78	76	74	71	69	66	63	60	58

Table A2.7

Required minimum thicknesses of protective material to justify R 240

Shape factor (m^{-1})	**Minimum required thickness to justify R240 (mm)**								
	Standard steel temperatures (°C)								
	350	**400**	**450**	**500**	**550**	**600**	**650**	**700**	**750**
50	54	53	51	48	44	40	36	32	30
60	56	55	53	52	50	46	42	36	30
70	58	56	55	53	52	50	47	42	37
80	60	58	56	55	53	52	50	45	39
90	63	59	58	56	55	53	52	50	43
100	67	62	59	57	56	54	53	51	48
110	70	65	61	58	57	55	53	51	49
120	73	68	64	60	58	56	54	52	51
130	75	71	66	62	59	57	55	53	52
140	78	73	69	64	60	58	56	55	53
150	80	75	71	67	62	59	57	56	54
160	81	77	73	69	65	60	58	57	55
170	83	79	75	71	67	62	59	57	56
180	84	80	76	72	68	64	60	58	57
190	85	81	78	74	70	66	61	59	57
200	86	83	79	75	71	67	63	59	58
210	87	84	80	77	73	69	64	60	58
220	88	85	81	78	74	70	66	61	59
230	89	86	82	79	75	71	67	62	59
240	90	87	83	80	76	72	68	63	59
250	*	87	84	81	77	73	69	64	60
260	*	88	85	82	78	74	70	65	60
270	*	89	85	82	79	75	71	66	60
280	*	89	86	83	80	76	72	67	60
290	*	90	87	84	80	77	73	68	62
300	*	*	88	84	81	77	74	70	63
310	*	*	88	85	82	78	74	71	64
320	*	*	88	85	82	79	75	71	66
330	*	*	89	86	83	79	76	72	67
340	*	*	89	86	83	80	76	72	68
350	*	*	90	87	84	80	76	72	68
360	*	*	*	87	84	81	77	73	68
370	*	*	*	87	84	81	77	73	69
380	*	*	*	88	85	82	78	73	69
390	*	*	*	88	85	82	78	74	69
400	*	*	*	88	85	82	79	74	70
410	*	*	*	89	86	83	80	75	70

ANNEX 4

Type 5: Protection of load-bearing concrete profiled sheet composite elements – REI 60 to REI 180

The results of the assessment are valid only according to the following conditions:

- Protective materials MONOKOTE MK6-HY and MONOKOTE MK6-S composition and application conditions identical as those noted during reference fire tests;
- Bonding layer SPATTERKOTE SK3 applied on profiled steel sheets prior to MONOKOTE MK6-HY and MONOKOTE MK6-S application;
- Nominal density of applied protective material MONOKOTE MK6-HY included in [226, 306] (kg/m^3) range;
- Nominal density of applied protective material MONOKOTE MK6-S included in [280, 345] (kg/m^3) range;
- Applied thicknesses of protective materials MONOKOTE MK6-HY and MONOKOTE MK6-S comprised between:
  - 13 and 46 mm for an application on concrete/steel composite slabs with trapezoidal profiled steel sheets;
  - 12 and 46 mm for an application on concrete/steel composite slabs with re-entrant profiled steel sheets;
- Tests results applicable to concrete/steel composite slabs with profiled steel sheets which may or may not contain additional reinforcing bars for loadbearing purposes;
- Test results applicable to concrete/steel composite slabs with fire exposure from the steel side;
- Thickness of the profiled steel sheets greater or equal to 0.75 mm;
- Width of the rib (L_2) not greater than 187 mm;
- Height of the rib (H_2) not greater than 87 mm;
- Equivalent thicknesses of concrete (H_{eq}) applicable up to:
  - 210 min for an application on concrete/steel composite slabs with trapezoidal profiled steel sheets;
  - 172 min for an application on concrete/steel composite slabs with re-entrant profiled steel sheets;
- Assessment results applicable for both trapezoidal and re-entrant profiled steel sheets
- Test results applicable on concrete/steel composite slabs with a concrete density equal to 2292 kg/m^3 ± 15%;
- Test results applicable on concrete/steel composite slabs with a concrete belonging to C25/30 class or higher

Composite slabs

Table A3.1 shows equivalent thickness of concrete - Monokote MK-6HY & MK-6S. The times to reach 350°C in the profiled steel sheets have been determined according to requirements of standard EN 13381-5 – paragraph 13.2.

Table A.3.1
Time to reach 350°C for given thickness of Monokote MK6-HY

Type	Description	Thickness of Monokote MK6-HY (mm)	Time to reach 350°C (min)
1	Trapezoïdal	46	166
1	Trapezoïdal	13	65
2	Re-entrant	46	172
2	Re-entrant	12	79

Table A3.2 and A3.3 show the effective thicknesses H_{eff}, the equivalent effective thicknesses He and the equivalent thicknesses of concrete H_{eq} induced by the protective material Monokote MK6-HY applied on both types of profiled steel sheets have been determined according to requirements of standard EN 13381-5 – paragraph 13.3.

Table A3.2
Equivalent effective thicknesses H_e

Profiled steel sheets	Type	Thickness of Monokote MK6-HY (mm)	Insulation times (min)			Equivalent effective thickness H_e (mm)
			t_1	t_2	t_{ref}	
COFRAPLUS 60	Trapezoidal	46	256	256	256	180
COFRAPLUS 60	Trapezoidal	13	145	143	143	131
COFRASTRA 40	Re-entrant	46	210	210	210	162
COFRASTRA 40	Re-entrant	12	180	174	174	148

t_1: time to reach an average temperature rise over +140°C, determined with characteristic temperature
t_2: time to reach a temperature over +180°C, determined with maximum temperature
t_{ref}: Minimum $[t_1,t_2]$

Table A3.3
Equivalent thicknesses of concrete H_{eq}

Profiled steel sheets	Type	Thickness of Monokote MK6-HY (mm)	Thicknesses (mm)		
			Effective thickness H_{eff}	Equivalent effective thickness H_e	Equivalent thickness of concrete H_{eq}
COFRAPLUS 60	Trapezoidal	46	83	180	97
COFRAPLUS 60	Trapezoidal	13	73	131	58
COFRASTRA 40	Re-entrant	46	90	162	72
COFRASTRA 40	Re-entrant	12	80	148	68

Stickability times

Table A3.4 shows the times for which the stickability of protective material Monokote MK6-HY applied on both types of profiled steel sheets is ensured. This was determined according to the requirements of standard EN 13381-3, paragraph 13.4.

Table A3.4
Stickability times

TYPE	Description	Thicknes of Monokote MK6-HY (mm)	Stickability of protective material (minutes)
1	Trapezoidal	46	210
1	Trapezoidal	13	148
2	Re-entrant	46	172
2	Re-entrant	12	26

According to the classification standard EN 13501-2 the minimal thickness of the fire protective product to be applied to reach a temperature of 350°C in the profiled steel sheet, have been determined by linear interpolation.

Profiled steel sheet	Minimal thickness of Monokote MK6-HY to reach 350°C on the profiled steel sheet (mm)			
	Exposure duration under the conventional thermal curve EN 1363-1 (min)			
	30	60	90	120
Trapezoidal	13	13	22	31
Re-entrant	12	12	16	27

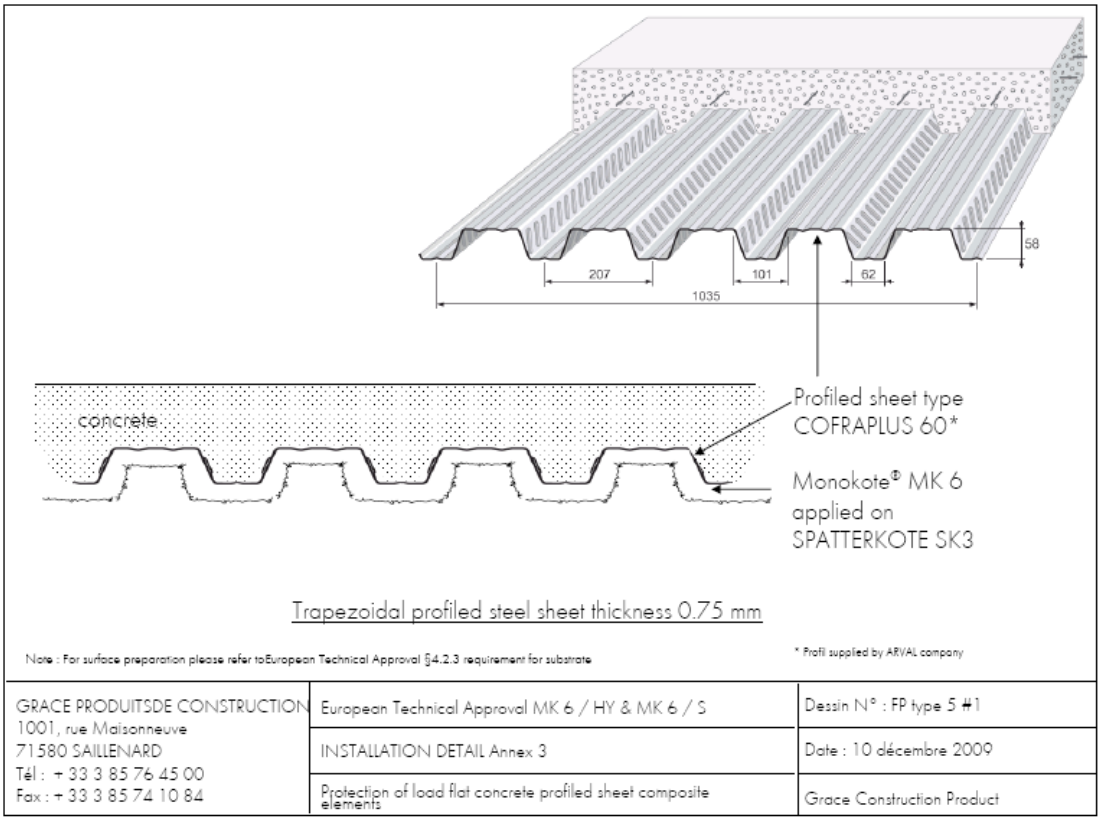


Figure A3.1: Type 1 profile – TRAPEZOIDAL

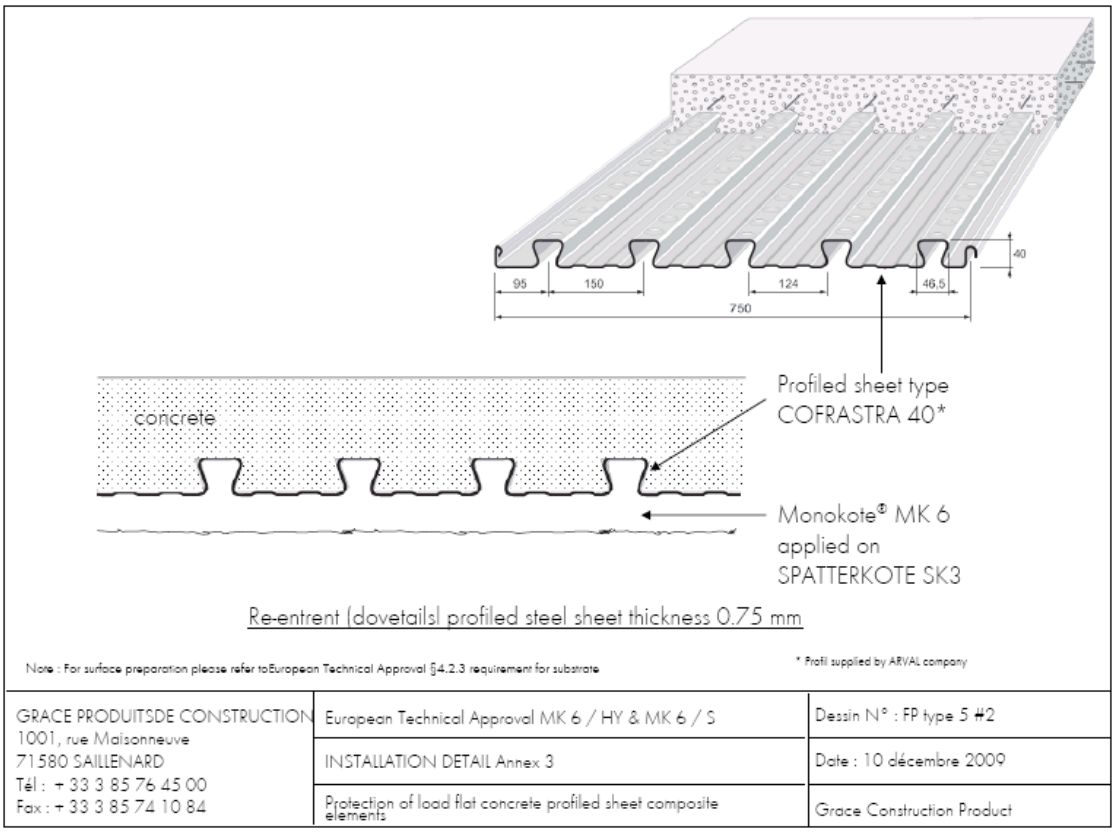


Figure A3.2: Type 2 profile – Re-entrent

ANNEX 5

Site test method for measurements of bonding properties

The site test method to check the bonding properties is described by the manufacturer in the document with title Monokote® site test method Bonding properties (copy below).

See this annex, section 3.5 "Meaning of test" regarding assessments of results.

Date of Issue: 14th of December 2009	**Grace Construction Products**	Control Number: EMEA SBM FP #2
Written By: Fireproofing Department	**Grace Standard Test Method**	Page: 1 of 3
		Supersedes: /
Title: Monokote® site test method Bonding properties		

1 Scope

The purpose of this procedure is to provide a Quality Control of adhesion - cohesion test method on site of sprayed Fire Resistive materials Monokote®, applied to structural members.

This material test procedure is made by Grace Construction Products, based on EGOLF/SM/5 testing method.

2 Responsibilities

QC inspector is responsible for the implementation of this procedure. Record keeping and completing reports reflecting adhesion test results shall fall under the duties of Q.C. inspector.

3 Testing Procedure

3.1 Principle

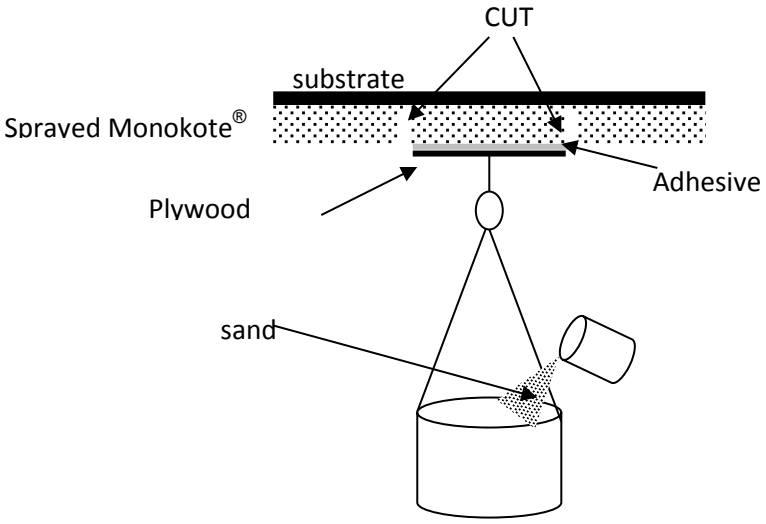
It is a non-destructive test. Tensile bond strength is made perpendicular to the surface. Test runs till maximum load according Monokote® grade specification is reached.

3.2 Apparatus

1. Plywood square of 1 cm thick and 10 cm x 10 cm, with a hook screwed in center,
2. Suitable adhesive that it will be applied on plywood and will cover it's whole surface (100 cm²), i.e. polyurethane adhesive SIKABOND T2,
3. Traction device (tensiometer- weighing scale) or receptacle/container with its mass known (Fig.1), hung to hook, allowing load till 25 kg
4. Scale, accuracy +/- 2 g,
5. Sand,
6. Few containers with a capacity of 1kg minimum

Interpretation of test results

The mean value of adhesion test on site shall not be lower than 80% of the adhesion value specified for the MONOKOTE class: for MK 6 HY and S, (80 % of 16,512 kg correspond to value of 13,210 kg.



3.3 Test Conditions

Sprayed material should be fully dry.
Monokote® requirement is 3 to 4 weeks when datasheet specification for air renewal is respected.

If testing area is not available for the 100 cm² plywood board, such as fluted deck (profiled sheet for composite-slab), size of plywood could be reduced to 5 cm x 5 cm. In that case maximum load must be divided by four.

3.4 Testing Process

1. Let spray material gets dry
2. Bond plywood board on coating according adhesive manufacturer instruction and wait 24 hours
3. Cut down sprayed Monokote® till substrate, following perimeter of plywood board
4. In receptacle/container add progressively sand in steady rate (1kg per 30 seconds) using container capacity of 1 kg*
   The first container must weight :
   (Weight target less its whole number plus one) less (weight of container + string+100 cm² plywood + hook).
5. After each container dropped record the load added
6. re-start to point 4 till total load is reached
7. When total load is reached, wait one minute and stop the test.

* prepared 1kg containers with scale prior to start test.

When using tensiometer tensile force shall be applied manually or automatically at steady rate according to the performance rating of load cell. Force is displayed on tensiometer.

3.4.1. Record

If total load is reached, record the load and “Fully pass”.
If adhesion fails before end of test, record the load reached before failing and “Pass till”.
Tell if adhesion failure or cohesion failure within mortar or any relevant notice.

3.5 Meaning of test

The person responsible for the actual works have to assess the site tests results taking into account the reference values given in the ETA, section 3.7.2.6, table 2. The assessment of the site tests results must be carried out according to recommendations given in ETAG 018-3, §7.3.1. If known, other existing criteria (e.g. ETA applicant’s instructions or information based on experience or testing) can be applied for this assessment. The works, including the mentioned assessment, must be supervised by responsible personnel.

3.6 Report

a. Reference to this method
b. Name of QC inspector and company
c. Date of test
d. Monokote® type , spray cementicious Fireproofing product gypsum or cement base, manufactured by Grace Construction Product, plant.
e. Pump Machine:
f. Estimation of dry density:
g. Cure time:
h. Specification value
i. Type of substrate of structural members protected
j. Apparatus:
   Plywood plate: thickness mm, x mm.
   Weight of empty pulling equipment
   Adhesive:
   Brand Name: Nature: Bonding time
k. Job name & address
l. Applicator
m. Location of test on job
n. People present
o. Individual test record (see § 3.4.1 Record)
p. Average value
q. State if specification is reached or not (see §3.5 meaning of test)

END OF PROCEDURE