

## FIRE TEST OF BUILDING ELEMENTS

According to EN 13381-4

## ASSESSMENT REPORT 07 - U - 198 A

Reference test reports :

**07 - U - 197**      **07 - U - 199**  
**07 - U - 198**      **07 - F - 218**

Scope

**Sprayed products MONOKOTE MK6-HY / MONOKOTE MK6-S applied on steel structures**

**Applied thicknesses : 10 to 90 mm**

**Section factors : 50 to 410 m<sup>-1</sup>**

Sponsor :

**GRACE PRODUITS DE CONSTRUCTION SAS  
MAISON NEUVE  
F - 71580 SAILLENARD**

*This assessment report consists 52 pages. Only a full copy of this assessment report permits a normal utilization of the results.*

## 1. SCOPE OF THIS TEST REPORT

Determination, according to the characterization methodology of protective materials as indicated by the european standard EN 13381-4 "TEST METHOD FOR DETERMINING THE CONTRIBUTION TO THE FIRE RESISTANCE OF STRUCTURAL MEMBERS : BY APPLIED PROTECTION TO STEEL MEMBERS", of the temperatures of steel members exposed to the conventionnal fire in function of their section factors, the thickness of protective material and the duration of the exposure.

## 2. TEST LABORATORY

Name : EFECTIS France  
Address : EFECTIS France  
Voie Romaine  
F - 57280 MAIZIERES-lès-METZ

## 3. SPONSOR OF THE FIRE TEST

Name : GRACE PRODUITS DE CONSTRUCTION SAS  
Address : MAISON NEUVE  
F - 71 580 SAILLENARD

## 4. REFERENCE FIRE TEST REPORTS

Reference fire tests reports : 07-U-197 / 07-U-198 / 07-U-199 / 07-F-218

Date of tests : July, 19, 12 and 25<sup>th</sup>, 2007

## 5. REFERENCES AND MANUFACTURER OF PROTECTIVE MATERIALS

References : MONOKOTE MK6-HY / MONOKOTE MK6-S  
Manufacturer : GRACE  
DAMMAN (SAUDI ARABIA)

## 6. DESCRIPTION OF THE PROTECTIVE MATERIALS

### 6.1 GENERAL

The steel members are protected by a cementeous product sprayed directly on the steel members.

These ones can be kept bare, painted with a primer against corrosion or galvanized.

### 6.2 COMPONENTS LIST

Name	Trade reference	Characteristics	Supplier
Accelerator	MONOKOTE Accelerator	Aluminium sulphate	GRACE
Protective material	MONOKOTE MK6-HY	d = 219 to 291 kg/m <sup>3</sup> th = 10 to 90mm	GRACE
Protective material	MONOKOTE MK6-S	d = 280 to 345 kg/m <sup>3</sup> th = 10 to 90mm	GRACE
Primer 1		Alkyd	
Primer 2		Epoxy	
Primer 3		Epoxy rich in zinc	
Primer 4		Silicate of zinc	

d = density / th = thickness

### 6.3 APPLICATION OF THE PROTECTIVE MATERIAL

#### 6.3.1 Steel members

MONOKOTE MK6-HY / MONOKOTE MK6-S sprayed products can be applied directly on I/H shaped steel members, with shape factors between 50 and 410 m<sup>-1</sup>.

#### 6.3.2 Preliminary surface preparation of members

MONOKOTE MK6-HY / MONOKOTE MK6-S sprayed products can be applied directly on steel members with following premature surface preparations :

- Bare steel ;
- Steel members painted with a primer against corrosion ;
- Galvanized steel.

In case of protection with a primer against corrosion, steel members are grit-blasted (finition grade Sa 2.5) and then painted with a primer.

Usable primers must have following characteristics :

Primer	Type	Chemical family*	Average applied thickness ** (µm)
1	Alkyd	Family I - Class 4a	80
2	Epoxy	Family I - Class 6b/7a1	120
3	Epoxy rich in zinc	Family I - Class 6b	80
4	Silicate of zinc	Family I - Class 10b2	135

\* : According to NFT 36005 \*\* : DFT (Dry Film Thickness)

In case of galvanized steel, thickness of zinc must not exceed 85 µm.

### 6.3.3 Application of protective material

#### 6.3.3.1 Application by machine

The protective materials MONOKOTE MK6-HY / MONOKOTE MK6-S are sprayed directly on the steel members following their outer perimeters.

They are applied with a spraying machine, in one layer for a goal thickness from 10 up to 25 mm and successive layers for a goal thickness between 25 and 90 mm with no time delay between each one.

Each layer 25/30 mm thick is measured and adjusted continuously during application.

MONOKOTE-MK6-HY is sprayed by using accelerator referenced MONOKOTE Accelerator (Aluminium sulphate) diluted in potable water under the ratio of 1 bag (27.2 kg) / 10 US gallons (37.9 liters).

For MONOKOTE MK6-S, no accelerator is used.

Except this point, the application process is the same for both MONOKOTE MK6-HY and MONOKOTE MK6-S.

Each bag of MONOKOTE MK6-HY / MONOKOTE MK6-S is mixed with potable water in the mixer tank of the spraying machine during 1 to 1 ½ minute.

The ratio between MONOKOTE MK6-HY / MONOKOTE MK6-S and water is 1 bag (20.9 kg) / 23 to 32 liters.

Characteristics of the spray machine :

- Trade reference : S5
- Manufacturer : PUTZMEISTER.

#### 6.3.3.2 Repairing of damages

Some limited damages of MONOKOTE MK6-HY / MONOKOTE MK6-S products already applied on steel members can be repaired manually.

First, the damages areas are carefully cleaned with a knife, cutter or trowel through the whole applied thickness, down to the steel support.

Then dust and particles generated by this operation are carefully eliminated.

For repairs, some quantity of MONOKOTE MK6-HY/ / MONOKOTE MK6-S materials is sampled in a bucket from the mixer tank.

For MONOKOTE MK6-HY only, it is mixed manually with accelerator.

Once it is expanded, it is applied with a trowel, in order to fill completely the damages volumes.

Then, it is flushed to the external surface of MONOKOTE MK6-HY/ / MONOKOTE MK6-S original protection in place with a float.

The dimensions of damages can be up to 260 x 260 mm at maximum.

### 6.3.4 Characteristics of the protective material MONOKOTE MK6-HY

#### 6.3.4.1 Average densities

- **Wet densities**

Type of application	Applied thickness (mm)	Average density (kg/m <sup>3</sup> )
Machine	10	478 ± 72
Trowel	10	470 ± 70
Machine	80	391 ± 59
Trowel	80	451 ± 68

- **Dry densities**

Type of application	Applied thickness (mm)	Average density (kg/m <sup>3</sup> )
Machine	10	291 ± 44
Trowel	10	279 ± 42
Machine	80	219 ± 33
Trowel	80	257 ± 39

#### 6.3.4.2 Average water content after drying at 105°C in a ventilated oven

Type of application	Applied thickness (mm)	Water content (% of dry weight)
Machine	10	19
Trowel	10	21
Machine	80	23.5
Trowel	80	19

#### 6.3.4.3 Applicable thicknesses

Applicable thicknesses : 10 to 90 mm

### 6.3.5 Characteristics of the protective material MONOKOTE MK6-S

#### 6.3.5.1 Average densities

- **Wet densities**

Type of application	Applied thickness (mm)	Average density (kg/m <sup>3</sup> )
Machine	10	527 ± 79
Machine	80	537 ± 81

- **Dry densities**

Type of application	Applied thickness (mm)	Average density (kg/m <sup>3</sup> )
Machine	10	345 ± 52
Machine	80	280 ± 42

#### 6.3.5.2 Average water content after drying at 105°C in a ventilated oven

Type of application	Applied thickness (mm)	Water content (% of dry weight)
Machine	10	18
Machine	80	18

#### 6.3.5.3 Applicable thicknesses

Applicable thicknesses : 10 to 90 mm

## 7. ASSESSMENT METHOD

The assessment method used to assess the protective material is method 1 : « Differential Equation - Variable Thermal Conductivity », as described in Annex F of standard EN 13381-4.

### 10.1.2 Required minimum thicknesses of protective material to justify R 30

Shape factor (m <sup>-1</sup> )	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

### 10.1.3 Required minimum thicknesses of protective material to justify R 60

Shape factor (m <sup>-1</sup> )	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



#### 10.1.4 Required minimum thicknesses of protective material to justify R 90

Shape factor (m <sup>-1</sup> )	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

### 10.1.5 Required minimum thicknesses of protective material to justify R 120

Shape factor (m <sup>-1</sup> )	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

### 10.1.6 Required minimum thicknesses of protective material to justify R 180

Shape factor (m <sup>-1</sup> )	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

### 10.1.7 Required minimum thicknesses of protective material to justify R 240

Shape factor (m <sup>-1</sup> )	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	87	84	81	77	73	69	64	60
260	85	88	85	82	78	74	70	65	60
270	83	89	85	82	79	75	71	66	60
280	81	89	86	83	80	76	72	67	60
290	79	90	87	84	80	77	73	68	62
300	76	87	88	84	81	77	74	70	63
310	75	86	88	85	82	78	74	71	64
320	74	85	88	85	82	79	75	71	66
330	72	83	89	86	83	79	76	72	67
340	72	82	89	86	83	80	76	72	68
350	71	81	90	87	84	80	76	72	68
360	70	80	90	87	84	81	77	73	68
370	69	79	89	87	84	81	77	73	69
380	68	78	88	88	85	82	78	73	69
390	67	77	87	88	85	82	78	74	69
400	67	76	86	88	85	82	79	74	70
410	66	75	85	89	86	83	80	75	70

## 10.2 TEMPERATURES OF STEEL MEMBERS

The steel temperature (°C) is determined in function of :

- the shape factor  $S/V$  ( $m^{-1}$ ) of the steel members ;
- the thickness of applied protective material (mm) ;
- the duration of the thermal exposure under the conventional thermal program.

### 10.2.1 Steel temperatures after 15 min under conventional thermal program

Shape factor ( $m^{-1}$ )	Steel temperatures after 15 min under conventional thermal program (°C)								
	Applied thickness of MONOKOTE MK6-HY / MONOKOTE MK6-S (mm)								
	10	20	30	40	50	60	70	80	90
50	75	44	33	27	24	22	21	20	20
60	85	49	36	29	25	23	21	20	20
70	94	53	39	30	26	23	21	20	20
80	100	58	41	31	26	23	21	20	20
90	111	62	43	32	27	24	21	20	20
100	119	66	46	34	28	24	22	20	20
110	127	70	48	35	28	24	22	20	20
120	136	74	50	36	29	24	22	20	20
130	146	78	52	37	29	24	22	20	20
140	149	81	54	38	30	25	22	20	20
150	160	85	56	39	30	25	22	20	20
160	164	89	58	40	30	25	22	20	20
170	175	92	60	41	31	25	21	20	20
180	179	95	62	41	31	25	21	20	20
190	188	99	63	42	32	25	21	20	20
200	192	100	65	43	32	25	21	20	20
210	186	100	67	44	32	25	21	20	20
220	190	100	68	45	32	25	21	20	20
230	193	100	70	45	33	25	21	20	20
240	197	106	71	46	33	25	21	20	20
250	206	107	73	47	33	25	21	20	20
260	209	107	74	47	33	25	21	20	20
270	213	114	76	48	34	25	21	20	20
280	216	115	77	48	34	25	21	20	20
290	220	115	78	49	34	25	21	20	20
300	229	124	80	50	34	25	21	20	20
310	233	124	81	50	34	25	21	20	20
320	236	125	82	51	34	25	20	20	20
330	239	126	83	51	35	25	20	20	20
340	243	126	85	52	35	24	20	20	20
350	246	135	86	52	35	24	20	20	20
360	249	136	87	53	35	24	20	20	20
370	251	137	88	53	35	24	20	20	20
380	261	138	89	53	35	24	20	20	20
390	264	147	90	54	35	24	20	20	20
400	267	148	91	54	35	24	20	20	20
410	270	149	92	54	35	24	20	20	20

See Annex I, plate 8.

### 10.2.2 Steel temperatures after 30 min under conventional thermal program

Shape factor (m <sup>-1</sup> )	Steel temperatures after 30 min under conventional thermal program (°C)								
	Applied thickness of MONOKOTE MK6-HY / MONOKOTE MK6-S (mm)								
	10	20	30	40	50	60	70	80	90
50	120	72	53	41	35	30	27	24	23
60	135	81	59	45	37	31	28	25	23
70	147	89	65	49	40	33	29	25	23
80	161	96	70	52	42	34	29	26	24
90	181	100	74	56	45	36	30	26	24
100	203	107	79	59	47	37	31	27	24
110	223	113	83	62	49	38	32	27	24
120	241	120	87	65	51	39	32	27	24
130	260	124	91	68	53	40	33	28	24
140	270	129	96	71	55	41	33	28	24
150	302	135	99	72	56	42	34	28	24
160	316	142	100	75	58	43	34	28	24
170	337	147	100	78	60	44	35	28	24
180	358	155	100	80	61	45	35	28	24
190	387	157	105	81	63	46	35	29	24
200	397	163	107	84	64	46	36	29	24
210	402	166	108	86	65	47	36	29	24
220	421	180	111	88	66	48	36	29	24
230	430	180	116	89	67	48	36	29	24
240	455	195	116	91	68	49	36	28	23
250	466	198	120	93	69	49	37	28	23
260	479	208	120	95	71	50	37	28	23
270	503	214	124	97	72	50	37	28	23
280	515	218	125	98	73	51	37	28	23
290	528	227	125	98	72	51	37	28	23
300	555	237	129	100	73	51	37	28	22
310	562	247	130	100	74	52	37	28	22
320	569	250	131	100	75	52	37	28	22
330	602	252	137	100	76	52	37	27	22
340	612	255	138	100	77	52	37	27	22
350	618	271	139	100	77	53	37	27	22
360	645	275	137	100	78	53	37	27	22
370	650	284	138	100	79	53	37	27	21
380	657	287	145	100	79	53	37	26	21
390	681	307	145	100	80	53	36	26	21
400	686	311	146	100	81	53	36	26	21
410	690	314	147	100	81	53	36	26	21

See Annex I, plate 9.

### 10.2.3 Steel temperatures after 60 min under conventional thermal program

Shape factor (m <sup>-1</sup> )	Steel temperatures after 60 min under conventional thermal program (°C)								
	Applied thickness of MONOKOTE MK6-HY / MONOKOTE MK6-S (mm)								
	10	20	30	40	50	60	70	80	90
50	294	132	90	65	52	48	41	36	32
60	351	156	100	75	57	52	45	39	34
70	413	184	109	85	65	57	48	41	36
80	477	212	123	94	71	61	51	43	38
90	548	240	136	100	77	64	54	46	39
100	603	266	152	100	83	67	57	48	40
110	653	291	170	100	90	70	59	49	42
120	689	320	182	103	96	73	61	51	43
130	717	344	197	111	100	75	63	53	44
140	731	366	214	115	100	78	65	54	45
150	739	401	229	120	100	80	66	55	46
160	748	428	244	130	100	83	68	57	46
170		451	260	138	100	85	69	58	47
180		483	270	148	100	87	71	58	47
190		507	292	155	100	88	72	59	48
200		544	301	162	100	90	73	60	48
210		567	316	179	100	92	75	61	49
220		593	327	189	100	94	75	61	49
230		609	348	192	100	95	76	62	49
240		633	356	199	100	96	77	62	50
250		652	375	210	100	98	78	63	50
260		668	387	215	100	99	79	63	50
270		684	398	226	100	100	79	64	50
280		698	409	231	100	100	80	64	50
290		707	422	237	100	100	81	65	50
300		719	434	240	100	100	81	65	50
310		728	444	252	100	100	82	64	50
320		733	452	257	100	100	83	65	50
330		736	482	260	100	100	83	65	50
340		737	488	274	100	100	84	65	50
350		742	505	277	106	100	83	65	50
360		746	514	288	106	100	84	65	50
370		751	528	289	113	100	84	65	49
380			552	294	113	100	84	65	49
390			557	300	114	100	85	65	49
400			565	312	120	100	85	65	48
410			577	317	121	100	85	65	48

See Annex I, plate 10.

### 10.2.4 Steel temperatures after 90 min under conventional thermal program

Shape factor (m <sup>-1</sup> )	Steel temperatures after 90 min under conventional thermal program (°C)								
	Applied thickness of MONOKOTE MK6-HY / MONOKOTE MK6-S (mm)								
	10	20	30	40	50	60	70	80	90
50	588	259	160	102	93	59	51	45	40
60	668	316	189	123	100	65	56	49	43
70	722	370	222	142	100	71	60	52	45
80	742	435	254	160	100	76	64	55	48
90		503	284	180	105	81	68	58	50
100		556	322	198	118	85	72	61	52
110		600	358	220	130	90	75	63	54
120		639	385	240	139	94	78	66	55
130		674	424	258	150	98	81	67	57
140		700	466	274	161	100	83	70	58
150		724	500	289	172	100	86	71	59
160		735	536	314	180	100	88	73	61
170		740	567	335	193	100	91	75	62
180		751	591	359	197	101	93	76	63
190			619	378	213	105	95	77	63
200			637	393	217	108	97	79	64
210			658	428	234	110	99	80	65
220			674	457	240	113	100	81	65
230			696	473	252	116	100	82	66
240			708	493	263	118	100	83	66
250			720	517	267	120	100	84	67
260			728	534	273	123	100	84	67
270			734	553	285	125	100	85	67
280			736	568	295	128	100	86	67
290			740	583	299	129	100	87	68
300			745	591	313	132	100	87	68
310			752	611	327	134	100	87	68
320				625	334	136	100	87	68
330				632	348	137	100	88	68
340				647	352	138	100	88	68
350				658	366	140	100	88	68
360				671	374	142	100	88	67
370				676	388	143	100	89	67
380				682	392	145	100	89	67
390				692	399	146	100	89	67
400				703	419	148	100	89	66
410				709	423	149	100	89	66

See Annex I, plate 11.



### 10.2.5 Steel temperatures after 120 min under conventional thermal program

Shape factor (m <sup>-1</sup> )	Steel temperatures after 120 min under conventional thermal program (°C)								
	Applied thickness of MONOKOTE MK6-HY / MONOKOTE MK6-S (mm)								
	15	20	30	40	50	60	70	80	90
50	601	444	263	177	118	72	61	53	47
60	679	537	316	213	137	81	68	58	51
70	729	610	375	245	161	90	75	63	55
80	746	669	442	280	185	98	81	68	58
90		713	501	317	208	100	87	73	62
100		734	558	350	231	100	93	77	65
110		746	602	396	252	105	98	81	68
120			636	443	274	110	100	85	70
130			671	479	296	117	100	89	73
140			699	512	318	121	100	92	76
150			719	540	339	128	100	95	78
160			733	575	357	134	100	98	80
170			739	601	392	140	100	100	82
180			748	630	413	146	101	100	84
190				652	441	150	104	100	85
200				669	460	158	107	100	86
210				692	488	164	110	100	88
220				709	504	174	112	100	89
230				720	527	182	113	100	90
240				728	548	188	117	100	92
250				735	561	195	120	100	93
260				738	574	203	122	100	94
270				744	591	210	125	100	94
280				751	606	217	127	100	95
290					617	224	129	100	96
300					631	231	131	100	97
310					649	238	133	100	97
320					656	242	136	100	97
330					670	248	138	100	98
340					679	251	139	100	98
350					691	258	139	100	98
360					700	269	140	100	98
370					710	271	142	100	98
380					715	280	143	100	98
390					722	282	145	100	98
400					729	292	146	100	98
410					732	296	147	100	98

See Annex I, plate 12.

### 10.2.6 Steel temperatures after 180 min under conventional thermal program

Shape factor (m <sup>-1</sup> )	Steel temperatures after 180 min under conventional thermal program (°C)							
	Applied thickness of MONOKOTE MK6-HY / MONOKOTE MK6-S (mm)							
	25	30	40	50	60	70	80	90
50	634	549	388	263	100	90	78	68
60	706	624	471	320	125	100	87	76
70	736	687	538	389	147	100	100	83
80		727	594	449	170	121	100	90
90		742	644	501	188	136	100	100
100			684	547	214	151	100	100
110			715	587	238	165	104	100
120			734	621	260	180	118	100
130			742	652	282	194	130	100
140				680	303	209	139	100
150				703	332	223	147	100
160				720	363	238	157	100
170				733	388	255	166	100
180				737	415	267	172	100
190				746	434	281	179	100
200					456	293	188	100
210					472	312	194	100
220					493	327	202	106
230					510	337	211	110
240					525	357	218	116
250					540	372	224	120
260					554	387	235	124
270					568	398	240	124
280					582	412	247	128
290					594	426	251	133
300					605	438	259	137
310					617	449	262	137
320					627	458	265	138
330					637	471	273	142
340					643	481	276	143
350					655	486	279	144
360					665	493	281	144
370					672	505	290	145
380					681	511	293	146
390					686	521	295	146
400					695	526	304	147
410					701	533	309	147

See Annex I, plate 13.

### 10.2.7 Steel temperatures after 240 min under conventional thermal program

Shape factor (m <sup>-1</sup> )	Steel temperatures after 240 min under conventional thermal program (°C)						
	Applied thickness of MONOKOTE MK6-HY / MONOKOTE MK6-S (mm)						
	30	40	50	60	70	80	90
50	722	598	474	189	138	102	100
60	749	671	549	237	169	120	100
70		721	613	285	205	141	100
80		740	665	334	243	160	108
90			707	376	278	187	121
100			732	420	314	216	134
110			742	457	348	241	145
120				491	379	271	162
130				522	410	299	184
140				550	437	323	202
150				577	461	345	215
160				604	484	367	231
170				627	509	388	245
180				650	527	405	259
190				667	549	421	276
200				685	566	442	291
210				699	584	456	307
220				713	599	471	324
230				724	611	486	334
240				731	628	499	351
250				735	641	510	362
260				739	655	526	372
270				745	666	536	379
280				753	677	546	391
290					689	555	401
300					698	567	412
310					707	574	419
320					714	581	425
330					722	593	435
340					728	599	440
350					731	606	446
360					734	611	451
370					736	621	457
380					739	627	461
390					742	632	467
400					745	640	471
410					750	646	477

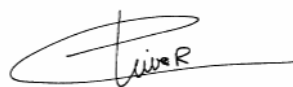
See Annex I, plate 14.

## 11. CONDITIONS of ASSESSMENT RESULTS VALIDITY

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 protective material MONOKOTE MK6-HY included in [219, 291] (kg/m<sup>3</sup>) range ;
- ◆ Density of protective material MONOKOTE MK6-S included in [280, 345] (kg/m<sup>3</sup>) 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<sup>-1</sup>) 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<sup>-1</sup> 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<sup>-1</sup> ;
- ◆ Assessment results valid for steel limit temperature included in [350, 750] (°C) range.

Written at Maizières-lès-Metz, September, 13<sup>th</sup> 2007



**Roman CHIVA**  
Head of the testing department



**Hervé LEBORGNE**  
Director of Project

