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ASSESSMENT REPORT

An assessment of the fire performance of I- and H-section steel beams and columns protected with Rockwool FireProTM BeamClad, installed using the glued joint method, in accordance with the ASFP Yellow Book, 5th Edition

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Table of Contents

1. Introduction 4
2. Scope 4
3. Supporting data 4
4. Description of the proposed fire protection system 4
4.1 General 4
4.2 Installation method using noggins and nails or pigtail screws 4
4.3 Installation method using noggins and stud welded pins 4
5. Assessment 5
5.1 General 5
5.2 Assessment parameters 5
5.3 Multiple linear regression method 5
5.4 Maximum fire resistance period 6
5.5 Criteria for acceptability 6
5.6 Permitted extensions 7
5.6.1. Section factor 7
5.6.2. Protection thickness 7
5.6.3. Other sections with re-entrant details 7
5.6.4. Method of fixing and support 7
5.6.5. Deep web sections 7
5.6.6. Beams with protection on all sides 7
5.6.7. Cellular beams 7
6. Conclusion 7
7. Validity of the assessment 7
7.1 Declaration by applicant 7
7.2 BRE Global declaration 8
Appendix A – Results of analysis 9
Appendix B – Supporting data 15
B.1 ITB test report no. LP01-1984/14/R63NP 15
B.2 ITB test report no. LP02-1984/14/R63NP 15
B.3 ITB test report no. LP03-1984/14/R63NP 15
Appendix C – Measured densities of tested Rockwool FirePro™ BeamClad 17
Appendix D – Actual and predicted times for sections to reach each design temperature 18

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1.Introduction

A relationship between protection thickness, section factor and fire resistance for I- and H-section steel beams and columns protected with Rockwool FirePro™ BeamClad has been established using the multiple linear regression method defined in section 2.3.4.7 of the ASFP Yellow Book, *Fire protection for structural steel in buildings, 5th Edition,* using test data generated in accordance with EN 13381-4:2013.

The results of this analysis are summarised in appendix A for I- and H-section beams and columns at design temperatures of 350°C, 400°C, 450°C, 500°C, 550°C, 600°C, 620°C, 650°C, 700°C, 750°C and 800°C and for fire resistance periods of 30, 60, 90, 120, 180 and 240 minutes.

2.Scope

To determine the relationship between protection thickness, section factor and fire resistance for I- and H-section steel beams and columns protected with Rockwool FirePro™ BeamClad, installed using the glued joint method, using the multiple linear regression method defined in section 2.3.4.7 of the ASFP Yellow Book, *Fire protection for structural steel in buildings, 5th Edition.*

3.Supporting data

This assessment is based on supporting test data which is more than five years old. This supporting data has therefore been reviewed against current test procedures.

Details of the supporting data used in the preparation of this assessment are given in appendix B.

4.Description of the proposed fire protection system

4.1 General

Rockwool FirePro™ BeamClad is a stone wool insulation board supplied in slabs 2000mm long x 1200mm wide with a nominal density of 165kg/m^3. The insulation can also be foil or tissue faced. The measured densities for the various board thicknesses are given in appendix C.

4.2 Installation method using noggins and nails or pigtail screws

The insulation is applied to the steel sections as a box protection system. Before applying the protection, as a minimum, the steel is cleaned in the areas where the noggings are to be installed. The noggings are glued between the flanges using Rockwool FirePro™ Glue at nominal 1000mm centres. The boards across the web are glued to the noggings using the same adhesive, ensuring any transverse board joints are coincident with the noggings. All longitudinal and transverse board-to-board joints are also coated with adhesive. Round-head nails, with a length at least twice the thickness of the board being installed, are fixed through the side boards into the noggings (minimum two fixings) and into the board across the flanges (at nominal 400mm centres). As an alternative pigtail screws can also be used in lieu of the nails provided that they are the same length and fitted at the same locations.

4.3 Installation method using noggins and stud welded pins

The insulation is applied to the steel sections as a box protection system. The system is installed using 2.7mm-diameter stud-welded pins fitted with 28mm-diameter spring washers. The pins are supplied in various lengths, the length being used dependent on board thickness.

In the case of beams, the pins are welded to the steel section along the flange tips and in two rows along the face of the bottom flange, nominally 50mm in from each edge; all pins are located at maximum 320mm centres.

Before applying the protection, as a minimum, the steel is cleaned in the areas where the noggings are to be installed. The noggings are glued between the flanges using Rockwool FirePro™ Glue at nominal 1000mm centres.

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The boards are pushed over the pins and glued to the noggings. They are secured in position using the washers so that the boards covering the flange are fitted between those covering the web; the boards are also fixed to the noggings using round-head nails with a length at least twice the thickness of the board being installed. Transverse joints in the boards fixed to the webs and offset with respect to those fixed to the flange by a minimum of 100mm. Prior to installation, all longitudinal and transverse board edges are coated with Rockwool FirePro™ Glue.

The fixing system for columns is the same except that only a single row of pins is used down the centre of the flange where the flange width is less than 120mm and the protection thickness 30mm or greater.

5.Assessment

5.1 General

This assessment has been carried out using thermal data generated by the testing of short unloaded sections and loaded beams and relates to a range of design temperatures for both beams and columns.

The assessment method used in the multiple linear regression method detailed in section 2.3.4.7 of the ASFP Yellow Book, *Fire protection for structural steel in buildings, 5th Edition.*

5.2 Assessment parameters

The following parameters are used in the assessment protocol:

a) The average thickness of the board/slab.

b) The calculated section factor using the measured dimensions of each section.

c) The mean temperature calculated as follows:

I-section beams: The average of the temperatures recorded by the thermocouples attached to the lower flange plus the average of the temperatures recorded by the thermocouples attached to the web divided by 2.

I-section columns: The average of the temperatures recorded by the thermocouples attached to the flanges plus the average of the temperatures recorded by the thermocouples attached to the web divided by 2.

d) At least the minimum data set in accordance with section 2.3.2.3 of the ASFP Yellow Book.

e) The maximum fire resistance period.

5.3 Multiple linear regression method

The data from the sections has been analysed using the multiple linear regression method detailed in section 2.3.4.7 of the ASFP Yellow Book, *Fire protection for structural steel in buildings, 5th Edition*, using the following equation:

$$\text{Fire resistance time (minutes) } t = a_0 + a_1 d_p V/A + a_2 d_p$$

Details of the calculated regression coefficients and the linear modification factors applied are detailed in table 1.

Table 1 Regression coefficients and linear modification factors for I- and H-section beams

Design temperature (°C)	Regression coefficients			Linear modification factor
	a_0	a_1	a_2	
350	35.658	105.472	0.391	0.91
400	40.979	124.999	0.359	0.92
450	46.436	144.627	0.329	0.93

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Design temperature (°C)	Regression coefficients			Linear modification factor
	a_0	a_1	a_2	
500	53.346	164.829	0.302	0.95
550	59.594	172.173	0.340	0.96
600	64.344	242.693	0.103	0.97
620	67.462	252.009	0.082	0.97
650	72.596	264.161	0.053	0.97
700	82.940	277.199	0.006	0.97
750	96.445	286.005	-0.080	0.95
800	108.667	286.050	-0.143	0.94

Details of the actual and predicted times for each section are detailed in appendix D.

5.4 Maximum fire resistance period

The maximum fire resistance period is determined by the loaded sections.

The loaded beam protected with the maximum protection thickness, LB-17, satisfied the loadbearing capacity criteria for 330 minutes. The maximum fire resistance period covered by this assessment is therefore 240 minutes as the protection system remained intact during the overrun period.

5.5 Criteria for acceptability

The acceptability of the analysis within the range of steel section temperatures and duration of the test has been judged up to the maximum temperature tested on the following basis:

a) for each short section the predicted time in minutes to reach the design temperature calculated to one decimal place shall not exceed the corrected time by more than 15%;

b) the mean value of all percentage differences as calculated in a) shall be less than zero;

c) a maximum of 30% of individual values of all percentage differences as calculated in a) shall be more than zero;

d) the results of the analysis which satisfy (a) to (c) above shall also comply with the following rules provided all other parameters remain constant:

   1) the thickness of the fire protection material increases with fire resistance time;

   2) as the section factor increases the fire resistance time decreases;

   3) as the fire resistance time increases the temperature increases;

   4) as thickness increases temperature decreases;

   5) as section factor increases the temperature increases;

   6) as section factor increases thickness increases.

e) Using the regression coefficients derived from the short section data the predicted time to reach the design temperature for each loaded section shall not be greater than the measured time.

Table 2 details the compliance with criteria (a) to (c) at each design temperature.

Table 2 Compliance with criteria for acceptability for I- and H-section beams

Criterion	Design temperature (°C)										
	350	400	450	500	550	600	620	650	700	750	800
a)	7.7	9.8	11.1	14.5	15.0	13.2	13.2	13.5	14.6	15.0	15.0
b)	-8.2	-6.8	-5.7	-3.7	-3.0	-2.0	-2.0	-1.9	-2.1	-3.6	-5.2
c)	7.7	15.4	15.4	15.4	25.0	27.3	27.3	27.3	27.3	18.2	18.2

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5.6 Permitted extensions

5.6.1. Section factor

The assessment is valid for section factors between 46m^{-1} and 350m^{-1}.

5.6.2. Protection thickness

The assessment is valid for thicknesses of Rockwool FirePro™ BeamClad between 20mm and 105mm.

5.6.3. Other sections with re-entrant details

The results of the assessment are directly applicable to angles, channels and T-sections for the same section factor.

5.6.4. Method of fixing and support

The assessment only applies to the method of fixing and support for the protection system used for the tested sections and the alternatives using pigtail screws and stud-welded pins (see section 4). The latter fixing systems are considered more robust than the tested nails when used in conjunction with the glued joints, and it is therefore reasonable to expect the same level of fire resistance.

5.6.5. Deep web sections

The maximum beam web depth is limited to 604mm.

The maximum depth of a column is limited to 600mm.

5.6.6. Beams with protection on all sides

The results of the analysis can be applied to beams exposed on all four sides.

5.6.7. Cellular beams

Where a limiting temperature of 450°C has been provided or one associated with a particular design of cellular beam provided by a qualified structural engineer in accordance with the principles of section 4 of the ASFP Yellow Book, *Fire protection for structural steel in buildings, 5th Edition,* the section factor for that beam shall be determined as the highest value derived from the following:

a) The section factor of the "I" section above the opening.
b) The section factor of the "I" section below the opening.
c) The section factor derived from $1400/t_w$ where t_w is the thickness of the web in mm.

In all cases the thickness of protection obtained based on the section factor and temperature as derived above shall be increased by 20%. The applied thickness shall not exceed the maximum assessed, as detailed in section 5.6.2, for the product for beam protection.

6.Conclusion

The thicknesses of Rockwool FirePro™ BeamClad required for various periods of fire resistance, when applied to I- and H-section steel beams and columns having various section factors has been predicted using the multiple linear regression method detailed in section 2.3.4.7 of the ASFP Yellow Book, *Fire protection for structural steel in buildings, 5th Edition*, using test data generated in accordance with EN 13381-4:2013.

The results of this analysis are summarised in appendix A for I- and H-section beams and columns. The analysis has been carried out at design temperatures of 350°C, 400°C, 450°C, 500°C, 550°C, 600°C, 620°C, 650°C, 700°C, 750°C and 800°C, for fire resistance periods of 30, 60, 90, 120, 180 and 240 minutes.

7.Validity of the assessment

7.1 Declaration by applicant

We the undersigned confirm that we have read and complied with the obligations placed on us by the Passive Fire Protection Forum (PFPF) Guide to undertaking technical assessments and engineering evaluations based on fire test evidence 2021 Industry Standard Procedure.

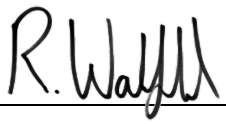
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We confirm that any changes which are the subject of this assessment, has not to our knowledge been tested to the standard against which this assessment has been made.

We agree to withdraw this assessment from circulation should the component or element of structure, or any of its component parts be the subject of a failed fire resistance test to the standard against which this assessment is being made.

We understand that this assessment is based on test evidence and will be withdrawn should evidence become available that causes the conclusion to be questioned. In that case, we accept that new test evidence may be required.

We are not aware of any information that could affect the conclusions of this assessment. If we subsequently become aware of any such information, we agree to ask BRE Global to withdraw the assessment.

Signature:	
Name:	Rob Wakefield
Position:	Fire Certification Engineer
Company:	ROCKWOOL UK
Date:	10/06/2025

7.2 BRE Global declaration

This assessment was reviewed on 14 March 2025. We have received written confirmation from Rockwool Limited that there have been no changes in the specification of their Rockwool FirePro™ BeamClad protection system for structural steelwork since the original date of the assessment. There have been no changes in the fire test procedures or methods of assessment, which would adversely affect the fire performance of the system. We are therefore satisfied that the validity of this assessment may be extended for a further five years.

This assessment is issued on the basis of test data and information to hand at the time of issue. If contradictory evidence becomes available to BRE Global the assessment will be unconditionally withdrawn, and the applicant will be notified in writing. Similarly, the assessment should be re-evaluated if the assessed construction is subsequently tested since actual test data is deemed to take precedence.

The assessment is valid for a period of five years after which it is recommended that it be submitted to BRE Global for re-evaluation.

This assessment has been carried out in accordance with the Passive Fire Protection Forum (PFPF) Guide to undertaking technical assessments of the fire performance of construction products based on fire test evidence 2021. It relates to the fire performance of the product and does not cover aspects of quality, durability, maintenance nor service requirements. This assessment relates only to the specimen(s) assessed and does not by itself imply that the product is approved under any Loss Prevention Certification Board approval or certification scheme or any other endorsements, approval or certification scheme.

The assessment report is not valid unless it incorporates the declaration duly signed by the applicant.

Next review date: 07 April 2030

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Appendix A – Results of analysis

Table 3 Required thickness (mm) of Rockwool FirePro™ BeamClad for a design temperature of 350°C

Board thickness (mm)	Limiting section factor (m^{-1}) for a fire resistance of					
	30min	60min	90min	120min	180min	240min
20	350	127	-	-	-	-
25	350	181	59	-	-	-
30	350	250	74	-	-	-
35	350	346	90	52	-	-
40	350	350	109	61	-	-
45	350	350	129	71	-	-
50	350	350	151	81	-	-
55	350	350	176	92	47	-
60	350	350	204	103	52	-
65	350	350	237	116	57	-
70	350	350	273	129	63	-
75	350	350	316	143	68	-
80	350	350	350	159	74	48
85	350	350	350	175	80	52
90	350	350	350	193	86	56
95	350	350	350	212	93	59
100	350	350	350	233	100	63
105	350	350	350	255	107	67

Table 4 Required thickness (mm) of Rockwool FirePro™ BeamClad for a design temperature of 400°C

Board thickness (mm)	Limiting section factor (m^{-1}) for a fire resistance of					
	30min	60min	90min	120min	180min	240min
20	350	211	59	-	-	-
25	350	310	78	-	-	-
30	350	350	98	54	-	-
35	350	350	119	65	-	-
40	350	350	144	77	-	-
45	350	350	171	89	-	-
50	350	350	201	102	51	-
55	350	350	234	115	57	-
60	350	350	272	130	63	-
65	350	350	316	145	70	46
70	350	350	350	162	76	50
75	350	350	350	179	83	54
80	350	350	350	198	90	58
85	350	350	350	218	97	63
90	350	350	350	240	105	67
95	350	350	350	264	113	71
100	350	350	350	289	121	76
105	350	350	350	317	129	81

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Table 5 Required thickness (mm) of Rockwool FirePro™ BeamClad for a design temperature of 450°C

Board thickness (mm)	Limiting section factor (m^{-1}) for a fire resistance of					
	30min	60min	90min	120min	180min	240min
20	350	350	78	-	-	-
25	350	350	102	55	-	-
30	350	350	128	68	-	-
35	350	350	157	81	-	-
40	350	350	190	95	48	-
45	350	350	226	110	54	-
50	350	350	266	126	61	-
55	350	350	312	143	68	-
60	350	350	350	161	76	49
65	350	350	350	180	83	54
70	350	350	350	200	91	59
75	350	350	350	221	99	64
80	350	350	350	244	107	69
85	350	350	350	269	116	74
90	350	350	350	295	125	79
95	350	350	350	324	134	84
100	350	350	350	350	143	90
105	350	350	350	350	153	95

Table 6 Required thickness (mm) of Rockwool FirePro™ BeamClad for a design temperature of 500°C

Board thickness (mm)	Limiting section factor (m^{-1}) for a fire resistance of					
	30min	60min	90min	120min	180min	240min
20	350	350	107	54	-	-
25	350	350	141	69	-	-
30	350	350	179	85	-	-
35	350	350	221	102	49	-
40	350	350	268	120	57	-
45	350	350	321	139	65	-
50	350	350	350	159	73	48
55	350	350	350	181	82	53
60	350	350	350	203	91	58
65	350	350	350	227	100	64
70	350	350	350	253	109	69
75	350	350	350	280	118	75
80	350	350	350	310	128	81
85	350	350	350	341	138	87
90	350	350	350	350	149	93
95	350	350	350	350	159	99
100	350	350	350	350	170	105
105	350	350	350	350	182	111

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Table 7 Required thickness (mm) of Rockwool FirePro™ BeamClad for a design temperature of 550°C

Board thickness (mm)	Limiting section factor (m^{-1}) for a fire resistance of					
	30min	60min	90min	120min	180min	240min
20	350	350	145	64	-	-
25	350	350	196	82	-	-
30	350	350	255	102	46	-
35	350	350	325	124	55	-
40	350	350	350	147	64	-
45	350	350	350	171	73	46
50	350	350	350	198	83	52
55	350	350	350	226	93	58
60	350	350	350	258	103	64
65	350	350	350	292	113	70
70	350	350	350	329	124	76
75	350	350	350	350	136	83
80	350	350	350	350	147	89
85	350	350	350	350	159	96
90	350	350	350	350	172	103
95	350	350	350	350	185	110
100	350	350	350	350	199	117
105	350	350	350	350	213	124

Table 8 Required thickness (mm) of Rockwool FirePro™ BeamClad for a design temperature of 600°C

Board thickness (mm)	Limiting section factor (m^{-1}) for a fire resistance of					
	30min	60min	90min	120min	180min	240min
20	350	350	205	90	-	-
25	350	350	262	114	53	-
30	350	350	322	138	64	-
35	350	350	350	163	75	49
40	350	350	350	188	87	56
45	350	350	350	214	98	63
50	350	350	350	240	109	71
55	350	350	350	267	121	78
60	350	350	350	294	133	85
65	350	350	350	322	144	93
70	350	350	350	350	156	100
75	350	350	350	350	168	108
80	350	350	350	350	180	115
85	350	350	350	350	193	123
90	350	350	350	350	205	131
95	350	350	350	350	217	139
100	350	350	350	350	230	146
105	350	350	350	350	243	154

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Table 9 Required thickness (mm) of Rockwool FirePro™ BeamClad for a design temperature of 620°C

Board thickness (mm)	Limiting section factor (m^{-1}) for a fire resistance of					
	30min	60min	90min	120min	180min	240min
20	350	350	241	99	-	-
25	350	350	307	124	57	-
30	350	350	350	150	68	-
35	350	350	350	177	80	51
40	350	350	350	204	92	59
45	350	350	350	232	104	67
50	350	350	350	260	116	74
55	350	350	350	288	128	82
60	350	350	350	317	140	90
65	350	350	350	346	152	97
70	350	350	350	350	165	105
75	350	350	350	350	177	113
80	350	350	350	350	190	121
85	350	350	350	350	202	129
90	350	350	350	350	215	137
95	350	350	350	350	228	145
100	350	350	350	350	241	153
105	350	350	350	350	254	161

Table 10 Required thickness (mm) of Rockwool FirePro™ BeamClad for a design temperature of 650°C

Board thickness (mm)	Limiting section factor (m^{-1}) for a fire resistance of					
	30min	60min	90min	120min	180min	240min
20	350	350	323	114	49	-
25	350	350	350	143	62	-
30	350	350	350	173	74	47
35	350	350	350	203	87	55
40	350	350	350	233	100	63
45	350	350	350	264	113	72
50	350	350	350	295	126	80
55	350	350	350	326	139	88
60	350	350	350	350	152	96
65	350	350	350	350	165	104
70	350	350	350	350	178	112
75	350	350	350	350	191	121
80	350	350	350	350	204	129
85	350	350	350	350	218	137
90	350	350	350	350	231	146
95	350	350	350	350	245	154
100	350	350	350	350	258	162
105	350	350	350	350	272	171

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Table 11 Required thickness (mm) of Rockwool FirePro™ BeamClad for a design temperature of 700°C

Board thickness (mm)	Limiting section factor (m^{-1}) for a fire resistance of					
	30min	60min	90min	120min	180min	240min
20	350	350	350	150	57	-
25	350	350	350	187	71	-
30	350	350	350	225	85	53
35	350	350	350	263	100	61
40	350	350	350	301	114	70
45	350	350	350	338	128	79
50	350	350	350	350	143	88
55	350	350	350	350	157	97
60	350	350	350	350	171	106
65	350	350	350	350	186	114
70	350	350	350	350	200	123
75	350	350	350	350	215	132
80	350	350	350	350	229	141
85	350	350	350	350	243	150
90	350	350	350	350	258	159
95	350	350	350	350	272	168
100	350	350	350	350	287	177
105	350	350	350	350	301	186

Table 12 Required thickness (mm) of Rockwool FirePro™ BeamClad for a design temperature of 750°C

Board thickness (mm)	Limiting section factor (m^{-1}) for a fire resistance of					
	30min	60min	90min	120min	180min	240min
20	350	350	350	227	67	-
25	350	350	350	279	83	49
30	350	350	350	330	99	58
35	350	350	350	350	115	68
40	350	350	350	350	131	77
45	350	350	350	350	147	87
50	350	350	350	350	163	96
55	350	350	350	350	178	106
60	350	350	350	350	194	115
65	350	350	350	350	209	124
70	350	350	350	350	224	134
75	350	350	350	350	239	143
80	350	350	350	350	254	152
85	350	350	350	350	269	161
90	350	350	350	350	283	170
95	350	350	350	350	298	179
100	350	350	350	350	312	188
105	350	350	350	350	326	197

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Table 13 Required thickness (mm) of Rockwool FirePro™ BeamClad for a design temperature of 800°C

Board thickness (mm)	Limiting section factor (m^{-1}) for a fire resistance of					
	30min	60min	90min	120min	180min	240min
20	350	350	350	350	77	-
25	350	350	350	350	95	53
30	350	350	350	350	113	63
35	350	350	350	350	131	73
40	350	350	350	350	148	83
45	350	350	350	350	165	93
50	350	350	350	350	182	103
55	350	350	350	350	198	113
60	350	350	350	350	214	122
65	350	350	350	350	230	132
70	350	350	350	350	246	141
75	350	350	350	350	261	151
80	350	350	350	350	276	160
85	350	350	350	350	291	169
90	350	350	350	350	305	178
95	350	350	350	350	320	187
100	350	350	350	350	334	196
105	350	350	350	350	348	205

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Appendix B – Supporting data

B.1 ITB test report no. LP01-1984/14/R63NP

A fire resistance test in accordance with EN 13381-4:2013 was carried out on seven unloaded short I-section columns protected with Rockwool FirePro™ BeamClad on 19 March 2015. The test duration was 361 minutes

Details of the tested specimens relevant to this report are summarised below:

Test specimen	Section type	Measured section factor (m^{-1})	Measured protection thickness (mm)
SIC-3	HEM 280	52	79.9
SIC-5	HEA 300	109	79.9
SIC-6	HEA 300	111	99.4
SIC-10	IPE 200	219	99.4
SIC-13	IPE 100	297	99.4

For full details see ITB test report no. LP01-1984/14/R63NP.

B.2 ITB test report no. LP02-1984/14/R63NP

A fire resistance test in accordance with EN 13381-4:2013 was carried out on one loaded I-section beam, one unloaded short I-section beam, and eight unloaded short I-section columns protected with Rockwool FirePro™ BeamClad on 14 April 2015. The test duration was 249 minutes

Details of the tested specimens relevant to this report are summarised below:

Test specimen	Section type	Measured section factor (m^{-1})	Measured protection thickness (mm)
SIC-1	HEM 280	51	49.7
SIC-2	HEM 280	52	19.6
SIC-4	HEA 300	111	19.6
SIC-7	IPE 200	215	19.6
SIC-8	IPE 200	210	49.7
SIC-9	IPE 200	210	79.6
SIC-11	IPE 100	317	49.7
SIC-12	IPE 100	318	79.6
LB-16	IPE 400	127	19.6

The loaded beam, LB-16, satisfied the criteria of the standard as follows:

Loadbearing capacity: 130 minutes

For full details see ITB test report no. LP02-1984/14/R63NP

B.3 ITB test report no. LP03-1984/14/R63NP

A fire resistance test in accordance with EN 13381-4:2013 was carried out on one loaded I-section beam and one unloaded short I-section beam protected with Rockwool FirePro™ BeamClad on 29 May 2015. The test duration was 341 minutes

Details of the tested specimens relevant to this report are summarised below:

Test specimen	Section type	Measured section factor (m^{-1})	Measured protection thickness (mm)
LB-17	IPE 400	121	99.5

The loaded beam, LB-17, satisfied the criteria of the standard as follows:

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Loadbearing capacity: 330 minutes

For full details see ITB test report no. LP03-1984/14/R63NP.

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Appendix C – Measured densities of tested Rockwool FirePro™ BeamClad

The nominal density of Rockwool FirePro™ BeamClad is stated by Rockwool Limited to be 165kg/m^3. The mean measured densities of samples taken for the different thicknesses of board used in the tests are as follows:

Test report no.	Nominal material thickness	Density (kg/m^3)
LP02-1984/14/R63NP	20mm	139
LP02-1984/14/R63NP	50mm	175
LP01-1984/14/R63NP	80mm	199
LP02-1984/14/R63NP	80mm	141
LP01-1984/14/R63NP	100mm	173
LP03-1984/14/R63NP	100mm	153

In the case of the 80mm-thick samples, the deviation in density is greater than 15%. The maximum density, 199kg/m^3, has therefore been used in the assessment of the results and in the limits of applicability of the assessment.

In the case of the 100mm-thick samples, the deviation in density is less than 15%. The mean density, 163kg/m^3, has therefore been used in the assessment of the results and in the limits of applicability of the assessment.

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Appendix D – Actual and predicted times for sections to reach each design temperature

Table 14 Actual times for each section to reach each design temperature

Section type	Section reference	Section factor (m^{-1})	Protection thickness (mm)	Time to design temperature (min)										
				350	400	450	500	550	600	620	650	700	750	800
Unloaded	SIC-1	51.0	49.7	179.7	201.8	224.4	248.3	-	-	-	-	-	-	-
Unloaded	SIC-2	52.0	19.6	95.4	108.0	120.8	135.1	150.2	166.2	172.9	183.3	201.7	225.4	247.8
Unloaded	SIC-3	52.0	79.9	244.1	274.5	305.5	333.8	351.6	-	-	-	-	-	-
Unloaded	SIC-4	111.0	19.6	64.8	72.6	80.6	89.0	98.3	108.5	112.8	119.4	131.5	148.5	162.6
Unloaded	SIC-5	109.0	79.9	162.7	180.2	198.7	218.6	239.7	261.2	269.7	280.9	296.7	315.9	327.2
Unloaded	SIC-6	111.0	99.4	187.2	205.9	225.5	246.0	268.4	291.8	301.1	314.3	331.6	345.9	356.1
Unloaded	SIC-7	215.0	19.6	49.1	54.1	59.5	64.9	71.2	78.2	81.3	86.1	94.5	105.1	114.7
Unloaded	SIC-8	210.0	49.7	91.5	99.5	108.1	117.3	127.6	139.3	144.2	151.5	163.4	178.1	190.8
Unloaded	SIC-9	210.0	79.6	124.3	133.6	143.9	154.6	166.8	180.1	185.6	193.9	207.5	223.8	237.7
Unloaded	SIC-10	219.0	99.4	136.5	147.0	158.3	170.3	183.9	195.1	201.0	210.4	225.8	244.2	259.5
Unloaded	SIC-11	317.0	49.7	80.8	86.7	93.0	99.8	107.1	115.7	119.4	125.2	135.8	146.4	156.6
Unloaded	SIC-12	318.0	79.6	102.9	108.7	114.9	121.7	128.8	137.6	141.5	147.3	157.0	167.9	177.9
Unloaded	SIC-13	297.0	99.4	109.9	116.5	123.4	130.5	138.2	146.4	149.9	155.4	165.1	175.0	185.0
Loaded	LB-16	127.0	19.6	59.6	67.3	75.2	84.7	95.3	107.2	112.3	120.3	133.0	144.1	155.9
Loaded	LB-17	121.0	99.5	213.4	233.8	254.4	277.3	301.7	316.4	320.8	326.7	330.7	333.9	339.1

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Table 15 Predicted times for each section to reach each design temperature

Section type	Section reference	Section factor (m^{-1})	Protection thickness (mm)	Time to design temperature (min)										
				350	400	450	500	550	600	620	650	700	750	800
Unloaded	SIC-1	51.0	49.7	157.9	180.6	203.7	229.0	-	-	-	-	-	-	-
Unloaded	SIC-2	52.0	19.6	83.1	95.1	107.4	121.4	131.1	157.8	164.0	173.2	187.5	202.7	213.7
Unloaded	SIC-3	52.0	79.9	229.0	261.7	294.9	330.7	351.3	-	-	-	-	-	-
Unloaded	SIC-4	111.0	19.6	61.9	70.1	78.4	88.4	96.7	109.2	113.6	120.3	132.0	145.4	156.4
Unloaded	SIC-5	109.0	79.9	144.2	161.3	178.7	198.3	213.0	250.5	258.7	270.5	286.6	299.7	307.0
Unloaded	SIC-6	111.0	99.4	169.0	188.6	208.6	230.9	247.5	291.9	301.2	314.4	331.7	344.6	350.6
Unloaded	SIC-7	215.0	19.6	52.9	59.4	66.1	74.3	81.9	88.5	92.0	97.7	108.3	120.9	131.9
Unloaded	SIC-8	210.0	49.7	80.1	88.4	97.0	107.4	117.2	126.9	131.2	137.8	148.8	160.2	169.3
Unloaded	SIC-9	210.0	79.6	106.8	116.9	127.4	139.8	151.9	164.6	169.5	177.0	188.5	198.5	205.7
Unloaded	SIC-10	219.0	99.4	122.4	133.4	144.8	158.2	171.5	184.8	190.0	197.8	209.3	218.3	224.3
Unloaded	SIC-11	317.0	49.7	71.6	78.4	85.4	94.2	103.5	107.5	111.0	116.7	126.7	137.3	146.4
Unloaded	SIC-12	318.0	79.6	93.2	100.8	108.8	118.6	129.7	133.3	137.0	143.0	152.8	161.7	168.9
Unloaded	SIC-13	297.0	99.4	109.8	118.5	127.5	138.5	151.0	155.8	159.9	166.3	176.3	184.2	190.2
Loaded	LB-16	127.0	19.6	59.6	67.3	75.2	84.7	92.8	103.8	108.0	114.4	125.8	139.0	150.0
Loaded	LB-17	121.0	99.5	161.3	179.5	198.1	218.9	235.0	274.2	282.8	295.1	311.5	323.7	329.7

Report Ends

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