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PRODUCT CERTIFICATION No. 3041

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CLASSIFICATION OF FIRE RESISTANCE

The object of
classification:

*System for protecting of steel members in accordance
with EN 13501-2:2016: 7.4.6.5*

Identification number:

PK2-16-14-001-A-1

Product name and type:

*steel members with applied passive protection:
single-layer fire protection system, and
multilayer fire protection system (two- and three-layer systems)
with boards **FERMACELL Firepanel A1***

Sponsor:

*James Hardie Europe GmbH
Bennigsen-Platz 1
40474 Düsseldorf
Germany*

Issuing organization:

*PAVUS, a.s.
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1 Introduction

- 1.1 This classification report defines the resistance to fire classification assigned to elements, *steel members with applied passive protection*

*single-layer fire protection system, and
multilayer fire protection system (two- and three-layer systems)
from boards **FERMACELL Firepanel A1***

in accordance with the procedures given in EN 13501-2.

- 1.2 This classification report consists of 59 pages and may only be used or reproduced in its entirety.
- 1.3 This classification report replaces and cancels the Classification Report No. PK2-16-14-001-A-0 of 29 April 2014.

2 Details of classified element

2.1 Type of function

The classified element is defined as a system for protecting of steel members.

2.2 Description of the product

The classified element is fully described in the test report provided in support of this classification listed in 3.1.

The passive fire protection material is FERMACELL Firepanel A1 – fibre-reinforced gypsum-bound panel with paper fibres and added non-combustible fibres, made water-repellent at the factory. The producer of the panels was/is

- Fermacell GmbH (XELLA group) – material for test specimens in 2013,
- James Hardie Europe GmbH – since April 3, 2018.

Material/board properties (nominal values according to the producer data sheet):

- labelling in accordance with EN 15283-2 GF-I-W2-C1;
- reaction to fire classification according to EN 13501-1 A1
- density (1 200 ± 50) kg/m³;
- balancing humidity at 65 % RH and 20 °C air temperature 1.3 %;
- thickness
 - (12.5, 15.0, 18.0) mm – in 2013 when the tests were performed
 - (10, 12.5, 15, 18) mm actually;
- thickness tolerance ± 0.2 mm.

The supporting system (method of fixing of the boards to steel sections) is shown in the drawings listed in Annex A.

Steel grade of tested sections was S235JR+AR according to EN 10025-2. The surface of the steel was not specially prepared.

2.3 Specification of the standard specimens tested

Test Package 3 according to EN 13381-4: Table 1 was selected by the sponsor and adopted for the single-layer system and one for the multilayer system (the two- and three-layer systems combined.), see EN 13381-4: 6.6.1.

3 Test reports / assessment reports and test results in support of the classification

3.1 Test reports / assessment reports

Name of laboratory Address Accreditation	Name of sponsor	Report No Date of issue	Test/assessment method
PAVUS, a.s. Veselí nad Lužnicí AZL č. 1026	Fermacell GmbH ^{a)} Düsseldorfer Landstraße 395 D-47259 Duisburg Germany	Test report Pr-14-2.022-En 2014-03-16	EN 13381-4:2013 (E)
PAVUS, a.s. Veselí nad Lužnicí AZL č. 1026		Assessment report PV-14-2.001-En 2014-03-17	EN 13381-4:2013 (E)
a) Fermacell GmbH has been part of James Hardie Group since April 3, 2018.			

3.2 Test conditions and test results

Test method, Test report No Date of issue	Parameter	Details
EN 13381-4 Pr-14-2.022-En 2014-03-16	Fire scenario Direction of exposure Load Support and restrain conditions	standard temperature/time curve beams – exposed on three sides (length of loaded beam exposed to heating of 4 200 mm) columns – exposed on four sides (height of loaded hollow column exposed to heating of 3000 mm) according to EN 13381-4: 5.3 according to EN 13381-4: 7 loaded beam <ul style="list-style-type: none"> length between supports: 4500 mm length of specimen: 4700 mm length exposed to heating: 4 200 mm

3.3 Characterisation data

3.3.1 Specification of the standard elements tested according to EN 13501-2: B.4 f)

Test Package 3 according to EN 13381-4: Table 1 was selected by the sponsor and adopted for the single-layer system and one for the multilayer system (the two- and three-layer systems combined.), see EN 13381-4: 6.6.1.

3.3.2 Presentation of test data according to EN 13501-2: B.4 g)

Data according to EN 13501-2: B.4 g) are given in reports mentioned in part 3.1 of this report.

3.3.3 Presentation of characterisation data according to EN 13501-2: B.4 j)

The thermal analysis produced a series of tables relating to fire resistance periods appropriate to the performance of the protection material, see Annex A of this report. Each table shows the minimum thicknesses of fire protection material required to maintain the design temperature. As required by the sponsor, the multiple linear numerical regression analysis according to EN 13381-4: E.5 was performed for the section factor of the unprotected steel section (A_{m}/V), see A.2 as well as for the section factor of the boxed protected steel section (A_{p}/V), see A.3.

Further presentation of characterisation data depends upon the assessment procedure used (a numerical regression analysis method) is given in Annex B of this report.

4 Classification and field of application

4.1 Reference of classification

This classification has been carried out in accordance with clauses 7.4.6.5 of EN 13501-2.

4.2 Classification

Classification of protected steel element, including its protection, can be reached using the characterisation data, as given in Annex A and Annex B.

Generally R *tt* classes are available according to EN 13501-2: 7.4.5, 7.2.4 and 7.2.5, whereas the actual class depends on actual parameters of classified element (section factor, thickness of protection material, design steel temperature) – see Annex A.

4.3 Field of application

This classification is valid for the following end use applications according to EN 13501-2: B.4 k) and ENV 13381-4: 15:

- Fire protection period is limited to
 - for the single-layer system 60 min
 - for the multilayer system 120 min

The loaded sections protected with the maximum protection thickness (i.e. 12.5 mm for the single-layer system, and 37.5 mm for the multilayer system) achieved a load bearing capacity performance as defined in EN 13381-4: 10.3.1 and 10.3.2 within 85 % of these periods.
- Design temperatures (350 to 750) °C
- Thicknesses of the protection material
 - I, H beams exposed on three sides
 - single-layer system (11.9 to 13.1) mm
 - multilayer system (23.8 to 39.4) mm
 - I, H columns exposed on four sides
 - single-layer system 12.5 mm
 - multilayer system (25.0 to 37.5) mm
- Section factor
 - I, H beams exposed on three sides
 - single-layer system
 - (63.6 to 487.3) m⁻¹ section factor of unprotected steel section (A_m/V)
 - (46.0 to 364.7) m⁻¹ section factor of boxed protected steel section (A_p/V)
 - multilayer system
 - (63.2 to 497.8) m⁻¹ section factor of unprotected steel section (A_m/V)
 - (45.7 to 372.2) m⁻¹ section factor of boxed protected steel section (A_p/V)
 - I, H columns exposed on four sides
 - single-layer system
 - (57.2 to 487.3) m⁻¹ section factor of unprotected steel section (A_m/V)
 - (41.4 to 364.7) m⁻¹ section factor of boxed protected steel section (A_p/V)
 - multilayer system
 - (56.9 to 497.8) m⁻¹ section factor of unprotected steel section (A_m/V)
 - (41.4 to 372.2) m⁻¹ section factor of boxed protected steel section (A_p/V)

For section factors below the extended minimum, the same protection thickness as that applied to the extended minimum section factor shall be applied.

- Section shape
 - I, H beams
 - I, H columns
 - structural hollow sections (SHS)

The results of the analysis for columns can be applied to beams exposed on all four sides up to the maximum (fire) protection thickness predicted from the appropriate loaded beam test, i.e. 13.1 mm for the single-layer system, and 39.4 mm for the multilayer system.

The maximum beam web depth shall be limited to the web depth of the loaded beam plus 50 %, i.e. 600 mm. The maximum depth of a column shall be limited to 600 mm for boxed fire protection systems.

Results from analysis of I or H sections are directly applicable to angles, channels and T-sections for the same section factor, whether used as individual elements or as bracing. EN 13381-4 does not apply to solid bar or rod. (See EN 13381-4: 1.)

Where thicknesses of the fire protection material have been assessed from 'I' or 'H' sections with boxed protection, no change in thickness is required, i.e. the thickness for a SHS of a given A_p/V value is equal to that for the 'I' or 'H' section of the same 'box' A_p/V value. The maximum thickness that can be applied to structural hollow sections shall not exceed the maximum assessed for 'I' or 'H' sections. The rules outlined in this annex may be used providing that the different section shape does not require new fixing techniques and does not affect the physical performance of the fire protection system. (See EN 13381-4: Annex A.)

- The results of the assessment are applicable to all structural grades of steel given in EN 10025-1 (S designation excluding S185). The results of the assessment may also be applicable to fabricated sections.
- The assessment is applicable to the method of application used in the test specimen preparation.
- The distance of boards of the fire protection system from steel members shall be as follows;

the tested distance -5mm / +50 mm with no change of fixing

where the tested distance is

(0 to 1) mm from column sections;

≈ 2 mm from beam sections in horizontal direction,

≈ 8 mm from beam bottom flanges in vertical direction.

The method of fixing boards is confined to the method used for the test specimens since it may not be suitable for other situations.

5 Limitations

This classification was extended on client statements that did not change the production technology and the individual components of the product, or their suppliers and the fact that there was no change of test method by which the tests used for this classification were carried out.

This classification is valid, unless the conditions, under which it was issued, have been changed. The customer may request the issuing authority to review the influence of changes to the classification validity.

The duration of the validity of this classification report is five years from the date of issue.

This classification report does not represent type approval or certification of the product.

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Annex A

Characterisation data of the classified system – tabulated data

A.1 General

According to EN 13381-4: 6.6.1 the results of the assessment are given separately for the single-layer system – see C.2 of this report, and for the multilayer system (the two- and three-layer systems combined) – see C.3 of this report.

The design temperatures of (350, 400 ... 750) °C are considered.

The fire protection thicknesses used within this annex are considered according to EN 13381-4: 3.1.7, i.e.

- thickness of the single-layer fire protection system; or
- combined thickness of all layers of a multilayer fire protection system

excluding the thickness of the supporting system.

The section factors used within this annex are considered according to EN 13381-4: 3.1.9, 3.2, and Figure 1, i.e.

- section factor of the unprotected steel section (A_m/V), see A.2 of this report;
- section factor of the boxed fire protection system (A_p/V), see A.3 of this report.

As required by the sponsor, the multiple linear numerical regression analysis according to EN 13381-4: E.5 was conducted for both section factors A_m/V and A_p/V .

Interpolation is only allowed over a maximum range of 50 °C and 10 m⁻¹.

A.2.1.1 I, H Beams exposed on three sides

[illegible]

Fire Resistance Period	20 min
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Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
64	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
70	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
80	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
90	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
100	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
110	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
120	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
130	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
140	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
150	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
160	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
170	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
180	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
190	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
200	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
210	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
220	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
230	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
240	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
250	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
260	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
270	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
280	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
290	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
300	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
310	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
320	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
330	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
340	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
350	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
360	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
370	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
380	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
390	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
400	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
410	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
420	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
430	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
440	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
450	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
460	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
470	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
480	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
487	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9

Fire Resistance Period 30 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
64	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
70	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
80	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
90	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
100	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
110	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
120	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
130	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
140	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
150	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
160	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
170	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
180	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
190	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
200	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
210	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
220	12.0	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
230	12.4	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
240	12.7	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
250	13.1	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
260		11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
270		12.1	11.9	11.9	11.9	11.9	11.9	11.9	11.9
280		12.3	11.9	11.9	11.9	11.9	11.9	11.9	11.9
290		12.6	11.9	11.9	11.9	11.9	11.9	11.9	11.9
300		12.8	11.9	11.9	11.9	11.9	11.9	11.9	11.9
310		13.1	11.9	11.9	11.9	11.9	11.9	11.9	11.9
320			11.9	11.9	11.9	11.9	11.9	11.9	11.9
330			11.9	11.9	11.9	11.9	11.9	11.9	11.9
340			12.0	11.9	11.9	11.9	11.9	11.9	11.9
350			12.2	11.9	11.9	11.9	11.9	11.9	11.9
360			12.4	11.9	11.9	11.9	11.9	11.9	11.9
370			12.5	11.9	11.9	11.9	11.9	11.9	11.9
380			12.7	11.9	11.9	11.9	11.9	11.9	11.9
390			12.8	11.9	11.9	11.9	11.9	11.9	11.9
400			13.0	11.9	11.9	11.9	11.9	11.9	11.9
410			13.1	11.9	11.9	11.9	11.9	11.9	11.9
420				11.9	11.9	11.9	11.9	11.9	11.9
430				11.9	11.9	11.9	11.9	11.9	11.9
440				11.9	11.9	11.9	11.9	11.9	11.9
450				11.9	11.9	11.9	11.9	11.9	11.9
460				11.9	11.9	11.9	11.9	11.9	11.9
470				12.0	11.9	11.9	11.9	11.9	11.9
480				12.1	11.9	11.9	11.9	11.9	11.9
487				12.2	11.9	11.9	11.9	11.9	11.9

Fire Resistance Period	45 min
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[illegible]

Fire Resistance Period	60 min
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[illegible]

[illegible]

Fire Resistance Period	20 min
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[illegible]

Fire Resistance Period 30 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
57	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
60	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
70	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
80	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
90	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
100	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
110	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
120	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
130	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
140	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
150	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
160	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
170	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
180	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
190	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
200	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
210	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
220	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
230	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
240		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
250		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
260		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
270		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
280		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
290			12.5	12.5	12.5	12.5	12.5	12.5	12.5
300			12.5	12.5	12.5	12.5	12.5	12.5	12.5
310			12.5	12.5	12.5	12.5	12.5	12.5	12.5
320			12.5	12.5	12.5	12.5	12.5	12.5	12.5
330			12.5	12.5	12.5	12.5	12.5	12.5	12.5
340			12.5	12.5	12.5	12.5	12.5	12.5	12.5
350			12.5	12.5	12.5	12.5	12.5	12.5	12.5
360			12.5	12.5	12.5	12.5	12.5	12.5	12.5
370				12.5	12.5	12.5	12.5	12.5	12.5
380				12.5	12.5	12.5	12.5	12.5	12.5
390				12.5	12.5	12.5	12.5	12.5	12.5
400				12.5	12.5	12.5	12.5	12.5	12.5
410				12.5	12.5	12.5	12.5	12.5	12.5
420				12.5	12.5	12.5	12.5	12.5	12.5
430				12.5	12.5	12.5	12.5	12.5	12.5
440				12.5	12.5	12.5	12.5	12.5	12.5
450				12.5	12.5	12.5	12.5	12.5	12.5
460				12.5	12.5	12.5	12.5	12.5	12.5
470				12.5	12.5	12.5	12.5	12.5	12.5
480				12.5	12.5	12.5	12.5	12.5	12.5
487				12.5	12.5	12.5	12.5	12.5	12.5

Fire Resistance Period	45 min
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[illegible]

Fire Resistance Period	60 min
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[illegible]

[illegible]

Fire Resistance Period	20 min
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[illegible]

Fire Resistance Period	30 min
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Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
63	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
70	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
80	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
90	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
100	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
110	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
120	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
130	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
140	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
150	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
160	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
170	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
180	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
190	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
200	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
210	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
220	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
230	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
240	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
250	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
260	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
270	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
280	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
290	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
300	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
310	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
320	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
330	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
340	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
350	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
360	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
370	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
380	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
390	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
400	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
410	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
420	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
430	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
440	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
450	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
460	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
470	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
480	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
498	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8

Fire Resistance Period 45 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
63	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
70	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
80	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
90	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
100	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
110	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
120	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
130	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
140	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
150	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
160	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
170	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
180	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
190	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
200	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
210	24.0	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
220	24.1	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
230	24.2	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
240	24.3	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
250	24.4	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
260	24.5	23.9	23.8	23.8	23.8	23.8	23.8	23.8	23.8
270	24.6	24.0	23.8	23.8	23.8	23.8	23.8	23.8	23.8
280	24.6	24.1	23.8	23.8	23.8	23.8	23.8	23.8	23.8
290	24.7	24.1	23.8	23.8	23.8	23.8	23.8	23.8	23.8
300	24.8	24.2	23.8	23.8	23.8	23.8	23.8	23.8	23.8
310	24.8	24.3	23.8	23.8	23.8	23.8	23.8	23.8	23.8
320	24.9	24.3	23.8	23.8	23.8	23.8	23.8	23.8	23.8
330	24.9	24.4	23.8	23.8	23.8	23.8	23.8	23.8	23.8
340	25.0	24.4	23.9	23.8	23.8	23.8	23.8	23.8	23.8
350	25.0	24.5	23.9	23.8	23.8	23.8	23.8	23.8	23.8
360	25.1	24.5	23.9	23.8	23.8	23.8	23.8	23.8	23.8
370	25.1	24.5	24.0	23.8	23.8	23.8	23.8	23.8	23.8
380	25.2	24.6	24.0	23.8	23.8	23.8	23.8	23.8	23.8
390	25.2	24.6	24.1	23.8	23.8	23.8	23.8	23.8	23.8
400	25.2	24.7	24.1	23.8	23.8	23.8	23.8	23.8	23.8
410	25.3	24.7	24.1	23.8	23.8	23.8	23.8	23.8	23.8
420	25.3	24.7	24.2	23.8	23.8	23.8	23.8	23.8	23.8
430	25.3	24.8	24.2	23.8	23.8	23.8	23.8	23.8	23.8
440	25.4	24.8	24.2	23.8	23.8	23.8	23.8	23.8	23.8
450	25.4	24.8	24.2	23.8	23.8	23.8	23.8	23.8	23.8
460	25.4	24.8	24.3	23.8	23.8	23.8	23.8	23.8	23.8
470	25.4	24.9	24.3	23.8	23.8	23.8	23.8	23.8	23.8
480	25.5	24.9	24.3	23.8	23.8	23.8	23.8	23.8	23.8
498	25.5	24.9	24.4	23.8	23.8	23.8	23.8	23.8	23.8

Fire Resistance Period 60 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
63	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
70	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
80	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
90	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
100	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
110	24.4	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
120	24.8	24.2	23.8	23.8	23.8	23.8	23.8	23.8	23.8
130	25.2	24.6	24.0	23.8	23.8	23.8	23.8	23.8	23.8
140	25.5	24.9	24.3	23.8	23.8	23.8	23.8	23.8	23.8
150	25.8	25.2	24.6	24.0	23.8	23.8	23.8	23.8	23.8
160	26.0	25.4	24.8	24.2	23.8	23.8	23.8	23.8	23.8
170	26.2	25.6	25.0	24.4	23.9	23.8	23.8	23.8	23.8
180	26.4	25.8	25.2	24.6	24.0	23.8	23.8	23.8	23.8
190	26.6	26.0	25.4	24.8	24.2	23.8	23.8	23.8	23.8
200	26.7	26.1	25.5	24.9	24.4	23.8	23.8	23.8	23.8
210	26.8	26.2	25.6	25.1	24.5	23.9	23.8	23.8	23.8
220	27.0	26.3	25.8	25.2	24.6	24.0	23.8	23.8	23.8
230	27.1	26.5	25.9	25.3	24.7	24.2	23.8	23.8	23.8
240	27.2	26.6	26.0	25.4	24.8	24.3	23.8	23.8	23.8
250	27.3	26.6	26.0	25.5	24.9	24.3	23.8	23.8	23.8
260	27.3	26.7	26.1	25.5	25.0	24.4	23.9	23.8	23.8
270	27.4	26.8	26.2	25.6	25.1	24.5	24.0	23.8	23.8
280	27.5	26.9	26.3	25.7	25.1	24.6	24.0	23.8	23.8
290	27.6	26.9	26.3	25.8	25.2	24.6	24.1	23.8	23.8
300	27.6	27.0	26.4	25.8	25.2	24.7	24.2	23.8	23.8
310	27.7	27.1	26.5	25.9	25.3	24.8	24.2	23.8	23.8
320	27.7	27.1	26.5	25.9	25.4	24.8	24.3	23.8	23.8
330	27.8	27.2	26.6	26.0	25.4	24.9	24.3	23.8	23.8
340	27.8	27.2	26.6	26.0	25.4	24.9	24.4	23.8	23.8
350	27.9	27.3	26.6	26.1	25.5	24.9	24.4	23.9	23.8
360	27.9	27.3	26.7	26.1	25.5	25.0	24.4	23.9	23.8
370	28.0	27.3	26.7	26.1	25.6	25.0	24.5	24.0	23.8
380	28.0	27.4	26.8	26.2	25.6	25.1	24.5	24.0	23.8
390	28.0	27.4	26.8	26.2	25.6	25.1	24.6	24.0	23.8
400	28.1	27.4	26.8	26.2	25.7	25.1	24.6	24.1	23.8
410	28.1	27.5	26.9	26.3	25.7	25.2	24.6	24.1	23.8
420	28.1	27.5	26.9	26.3	25.7	25.2	24.6	24.1	23.8
430	28.2	27.5	26.9	26.3	25.8	25.2	24.7	24.2	23.8
440	28.2	27.6	26.9	26.4	25.8	25.2	24.7	24.2	23.8
450	28.2	27.6	27.0	26.4	25.8	25.3	24.7	24.2	23.8
460	28.2	27.6	27.0	26.4	25.8	25.3	24.8	24.2	23.8
470	28.3	27.6	27.0	26.4	25.9	25.3	24.8	24.3	23.8
480	28.3	27.7	27.0	26.4	25.9	25.3	24.8	24.3	23.8
498	28.3	27.7	27.1	26.5	25.9	25.4	24.8	24.3	23.8

Fire Resistance Period 90 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
63	26.4	25.8	25.2	24.5	23.8	23.8	23.8	23.8	23.8
70	27.3	26.8	26.2	25.6	24.9	24.2	23.8	23.8	23.8
80	28.3	27.8	27.3	26.7	26.1	25.4	24.7	24.0	23.8
90	29.1	28.6	28.1	27.5	26.9	26.3	25.6	24.9	24.2
100	29.8	29.2	28.7	28.1	27.5	26.9	26.3	25.6	25.0
110	30.3	29.7	29.1	28.6	28.0	27.4	26.8	26.2	25.5
120	30.7	30.1	29.5	29.0	28.4	27.8	27.2	26.6	26.0
130	31.0	30.4	29.9	29.3	28.7	28.1	27.5	26.9	26.3
140	31.3	30.7	30.1	29.6	29.0	28.4	27.8	27.2	26.6
150	31.6	31.0	30.4	29.8	29.2	28.6	28.0	27.4	26.8
160	31.8	31.2	30.6	30.0	29.4	28.8	28.2	27.6	27.0
170	32.0	31.4	30.8	30.1	29.5	28.9	28.4	27.8	27.2
180	32.2	31.5	30.9	30.3	29.7	29.1	28.5	27.9	27.3
190	32.3	31.7	31.0	30.4	29.8	29.2	28.6	28.0	27.5
200	32.4	31.8	31.2	30.5	29.9	29.3	28.7	28.1	27.6
210	32.6	31.9	31.3	30.7	30.0	29.4	28.8	28.2	27.7
220	32.7	32.0	31.4	30.7	30.1	29.5	28.9	28.3	27.8
230	32.8	32.1	31.5	30.8	30.2	29.6	29.0	28.4	27.8
240	32.9	32.2	31.6	30.9	30.3	29.7	29.1	28.5	27.9
250	33.0	32.3	31.6	31.0	30.4	29.7	29.1	28.5	28.0
260	33.0	32.4	31.7	31.0	30.4	29.8	29.2	28.6	28.0
270	33.1	32.4	31.8	31.1	30.5	29.9	29.2	28.7	28.1
280	33.2	32.5	31.8	31.2	30.5	29.9	29.3	28.7	28.1
290	33.3	32.6	31.9	31.2	30.6	30.0	29.3	28.8	28.2
300	33.3	32.6	31.9	31.3	30.6	30.0	29.4	28.8	28.2
310	33.4	32.7	32.0	31.3	30.7	30.0	29.4	28.8	28.3
320	33.4	32.7	32.0	31.4	30.7	30.1	29.5	28.9	28.3
330	33.5	32.8	32.1	31.4	30.7	30.1	29.5	28.9	28.3
340	33.5	32.8	32.1	31.4	30.8	30.1	29.5	28.9	28.4
350	33.6	32.8	32.1	31.5	30.8	30.2	29.6	29.0	28.4
360	33.6	32.9	32.2	31.5	30.8	30.2	29.6	29.0	28.4
370	33.6	32.9	32.2	31.5	30.9	30.2	29.6	29.0	28.4
380	33.7	32.9	32.2	31.6	30.9	30.3	29.6	29.0	28.5
390	33.7	33.0	32.3	31.6	30.9	30.3	29.7	29.1	28.5
400	33.7	33.0	32.3	31.6	30.9	30.3	29.7	29.1	28.5
410	33.8	33.0	32.3	31.6	31.0	30.3	29.7	29.1	28.5
420	33.8	33.1	32.3	31.7	31.0	30.4	29.7	29.1	28.6
430	33.8	33.1	32.4	31.7	31.0	30.4	29.8	29.2	28.6
440	33.9	33.1	32.4	31.7	31.0	30.4	29.8	29.2	28.6
450	33.9	33.1	32.4	31.7	31.1	30.4	29.8	29.2	28.6
460	33.9	33.2	32.4	31.7	31.1	30.4	29.8	29.2	28.6
470	33.9	33.2	32.5	31.8	31.1	30.4	29.8	29.2	28.6
480	34.0	33.2	32.5	31.8	31.1	30.5	29.8	29.2	28.7
498	34.0	33.2	32.5	31.8	31.1	30.5	29.9	29.3	28.7

Fire Resistance Period 120 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
63	32.5	32.2	31.9	31.5	31.1	30.7	30.2	29.7	29.1
70	33.4	33.1	32.7	32.3	31.9	31.5	31.0	30.5	29.9
80	34.3	34.0	33.6	33.2	32.8	32.3	31.8	31.3	30.8
90	35.1	34.7	34.3	33.8	33.3	32.9	32.4	31.8	31.3
100	35.7	35.2	34.8	34.3	33.8	33.3	32.8	32.2	31.7
110	36.1	35.7	35.2	34.6	34.1	33.6	33.1	32.5	31.9
120	36.5	36.0	35.5	34.9	34.4	33.9	33.3	32.7	32.2
130	36.9	36.3	35.8	35.2	34.6	34.1	33.5	32.9	32.3
140	37.1	36.6	36.0	35.4	34.8	34.2	33.7	33.1	32.5
150	37.4	36.8	36.2	35.6	35.0	34.4	33.8	33.2	32.6
160	37.6	37.0	36.3	35.7	35.1	34.5	33.9	33.3	32.7
170	37.8	37.1	36.5	35.9	35.2	34.6	34.0	33.4	32.8
180	37.9	37.3	36.6	36.0	35.3	34.7	34.1	33.5	32.9
190	38.1	37.4	36.7	36.1	35.4	34.8	34.2	33.5	32.9
200	38.2	37.5	36.8	36.2	35.5	34.9	34.2	33.6	33.0
210	38.3	37.6	36.9	36.2	35.6	34.9	34.3	33.6	33.0
220	38.4	37.7	37.0	36.3	35.6	35.0	34.3	33.7	33.1
230	38.5	37.8	37.1	36.4	35.7	35.0	34.4	33.7	33.1
240	38.6	37.9	37.1	36.4	35.8	35.1	34.4	33.8	33.1
250	38.7	37.9	37.2	36.5	35.8	35.1	34.5	33.8	33.2
260	38.8	38.0	37.3	36.6	35.8	35.2	34.5	33.8	33.2
270	38.8	38.1	37.3	36.6	35.9	35.2	34.5	33.9	33.2
280	38.9	38.1	37.4	36.6	35.9	35.2	34.6	33.9	33.3
290	39.0	38.2	37.4	36.7	36.0	35.3	34.6	33.9	33.3
300	39.0	38.2	37.5	36.7	36.0	35.3	34.6	34.0	33.3
310	39.1	38.3	37.5	36.8	36.0	35.3	34.6	34.0	33.3
320	39.1	38.3	37.5	36.8	36.1	35.3	34.7	34.0	33.3
330	39.2	38.3	37.6	36.8	36.1	35.4	34.7	34.0	33.4
340	39.2	38.4	37.6	36.8	36.1	35.4	34.7	34.0	33.4
350	39.2	38.4	37.6	36.9	36.1	35.4	34.7	34.0	33.4
360	39.3	38.5	37.7	36.9	36.2	35.4	34.7	34.1	33.4
370	39.3	38.5	37.7	36.9	36.2	35.5	34.8	34.1	33.4
380	39.3	38.5	37.7	36.9	36.2	35.5	34.8	34.1	33.4
390	39.4	38.5	37.7	37.0	36.2	35.5	34.8	34.1	33.4
400		38.6	37.8	37.0	36.2	35.5	34.8	34.1	33.5
410		38.6	37.8	37.0	36.2	35.5	34.8	34.1	33.5
420		38.6	37.8	37.0	36.3	35.5	34.8	34.1	33.5
430		38.6	37.8	37.0	36.3	35.5	34.8	34.2	33.5
440		38.7	37.8	37.1	36.3	35.6	34.8	34.2	33.5
450		38.7	37.9	37.1	36.3	35.6	34.9	34.2	33.5
460		38.7	37.9	37.1	36.3	35.6	34.9	34.2	33.5
470		38.7	37.9	37.1	36.3	35.6	34.9	34.2	33.5
480		38.7	37.9	37.1	36.3	35.6	34.9	34.2	33.5
498		38.8	37.9	37.1	36.4	35.6	34.9	34.2	33.5

Fire Resistance Period		15 min							
Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
57	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
60	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
70	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
80	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
90	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
100	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
110	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
120	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
130	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
140	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
150	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
160	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
170	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
180	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
190	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
200	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
210	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
220	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
230	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
240	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
250	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
260	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
270	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
280	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
290	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
300	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
310	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
320	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
330	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
340	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
350	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
360	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
370	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
380	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
390	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
400	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
410	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
420	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
430	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
440	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
450	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
460	25.0	25.0	2						

Fire Resistance Period	20 min
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[illegible]

Fire Resistance Period	30 min
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[illegible]

Fire Resistance Period	45 min
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	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
Section factor (m ⁻¹)	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
57	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
60	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
70	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
80	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
90	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
100	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
110	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
120	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
130	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
140	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
150	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
160	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
170	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
180	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
190	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
200	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
210	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
220	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
230	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
240	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
250	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
260	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
270	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
280	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
290	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
300	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
310	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
320	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
330	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
340	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
350	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
360	25.1	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
370	25.1	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
380	25.2	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
390	25.2	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
400	25.2	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
410	25.3	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
420	25.3	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
430	25.3	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
440	25.4	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
450	25.4	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
460	25.4	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
470	25.4	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
480	25.5	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
498	25.5	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0

Fire Resistance Period 60 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature									
57	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
60	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
70	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
80	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
90	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
100	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
110	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
120	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
130	25.2	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
140	25.5	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
150	25.8	25.2	25.0	25.0	25.0	25.0	25.0	25.0	25.0
160	26.0	25.4	25.0	25.0	25.0	25.0	25.0	25.0	25.0
170	26.2	25.6	25.0	25.0	25.0	25.0	25.0	25.0	25.0
180	26.4	25.8	25.2	25.0	25.0	25.0	25.0	25.0	25.0
190	26.6	26.0	25.4	25.0	25.0	25.0	25.0	25.0	25.0
200	26.7	26.1	25.5	25.0	25.0	25.0	25.0	25.0	25.0
210	26.8	26.2	25.6	25.1	25.0	25.0	25.0	25.0	25.0
220	27.0	26.3	25.8	25.2	25.0	25.0	25.0	25.0	25.0
230	27.1	26.5	25.9	25.3	25.0	25.0	25.0	25.0	25.0
240	27.2	26.6	26.0	25.4	25.0	25.0	25.0	25.0	25.0
250	27.3	26.6	26.0	25.5	25.0	25.0	25.0	25.0	25.0
260	27.3	26.7	26.1	25.5	25.0	25.0	25.0	25.0	25.0
270	27.4	26.8	26.2	25.6	25.1	25.0	25.0	25.0	25.0
280	27.5	26.9	26.3	25.7	25.1	25.0	25.0	25.0	25.0
290	27.6	26.9	26.3	25.8	25.2	25.0	25.0	25.0	25.0
300	27.6	27.0	26.4	25.8	25.2	25.0	25.0	25.0	25.0
310	27.7	27.1	26.5	25.9	25.3	25.0	25.0	25.0	25.0
320	27.7	27.1	26.5	25.9	25.4	25.0	25.0	25.0	25.0
330	27.8	27.2	26.6	26.0	25.4	25.0	25.0	25.0	25.0
340	27.8	27.2	26.6	26.0	25.4	25.0	25.0	25.0	25.0
350	27.9	27.3	26.6	26.1	25.5	25.0	25.0	25.0	25.0
360	27.9	27.3	26.7	26.1	25.5	25.0	25.0	25.0	25.0
370	28.0	27.3	26.7	26.1	25.6	25.0	25.0	25.0	25.0
380	28.0	27.4	26.8	26.2	25.6	25.1	25.0	25.0	25.0
390	28.0	27.4	26.8	26.2	25.6	25.1	25.0	25.0	25.0
400	28.1	27.4	26.8	26.2	25.7	25.1	25.0	25.0	25.0
410	28.1	27.5	26.9	26.3	25.7	25.2	25.0	25.0	25.0
420	28.1	27.5	26.9	26.3	25.7	25.2	25.0	25.0	25.0
430	28.2	27.5	26.9	26.3	25.8	25.2	25.0	25.0	25.0
440	28.2	27.6	26.9	26.4	25.8	25.2	25.0	25.0	25.0
450	28.2	27.6	27.0	26.4	25.8	25.3	25.0	25.0	25.0
460	28.2	27.6	27.0	26.4	25.8	25.3	25.0	25.0	25.0
470	28.3	27.6	27.0	26.4	25.9	25.3	25.0	25.0	25.0
480	28.3	27.7	27.0	26.4	25.9	25.3	25.0	25.0	25.0
498	28.3	27.7	27.1	26.5	25.9	25.4	25.0	25.0	25.0

Fire Resistance Period 90 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature									
57	25.3	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
60	25.9	25.3	25.0	25.0	25.0	25.0	25.0	25.0	25.0
70	27.3	26.8	26.2	25.6	25.0	25.0	25.0	25.0	25.0
80	28.3	27.8	27.3	26.7	26.1	25.4	25.0	25.0	25.0
90	29.1	28.6	28.1	27.5	26.9	26.3	25.6	25.0	25.0
100	29.8	29.2	28.7	28.1	27.5	26.9	26.3	25.6	25.0
110	30.3	29.7	29.1	28.6	28.0	27.4	26.8	26.2	25.5
120	30.7	30.1	29.5	29.0	28.4	27.8	27.2	26.6	26.0
130	31.0	30.4	29.9	29.3	28.7	28.1	27.5	26.9	26.3
140	31.3	30.7	30.1	29.6	29.0	28.4	27.8	27.2	26.6
150	31.6	31.0	30.4	29.8	29.2	28.6	28.0	27.4	26.8
160	31.8	31.2	30.6	30.0	29.4	28.8	28.2	27.6	27.0
170	32.0	31.4	30.8	30.1	29.5	28.9	28.4	27.8	27.2
180	32.2	31.5	30.9	30.3	29.7	29.1	28.5	27.9	27.3
190	32.3	31.7	31.0	30.4	29.8	29.2	28.6	28.0	27.5
200	32.4	31.8	31.2	30.5	29.9	29.3	28.7	28.1	27.6
210	32.6	31.9	31.3	30.7	30.0	29.4	28.8	28.2	27.7
220	32.7	32.0	31.4	30.7	30.1	29.5	28.9	28.3	27.8
230	32.8	32.1	31.5	30.8	30.2	29.6	29.0	28.4	27.8
240	32.9	32.2	31.6	30.9	30.3	29.7	29.1	28.5	27.9
250	33.0	32.3	31.6	31.0	30.4	29.7	29.1	28.5	28.0
260	33.0	32.4	31.7	31.0	30.4	29.8	29.2	28.6	28.0
270	33.1	32.4	31.8	31.1	30.5	29.9	29.2	28.7	28.1
280	33.2	32.5	31.8	31.2	30.5	29.9	29.3	28.7	28.1
290	33.3	32.6	31.9	31.2	30.6	30.0	29.3	28.8	28.2
300	33.3	32.6	31.9	31.3	30.6	30.0	29.4	28.8	28.2
310	33.4	32.7	32.0	31.3	30.7	30.0	29.4	28.8	28.3
320	33.4	32.7	32.0	31.4	30.7	30.1	29.5	28.9	28.3
330	33.5	32.8	32.1	31.4	30.7	30.1	29.5	28.9	28.3
340	33.5	32.8	32.1	31.4	30.8	30.1	29.5	28.9	28.4
350	33.6	32.8	32.1	31.5	30.8	30.2	29.6	29.0	28.4
360	33.6	32.9	32.2	31.5	30.8	30.2	29.6	29.0	28.4
370	33.6	32.9	32.2	31.5	30.9	30.2	29.6	29.0	28.4
380	33.7	32.9	32.2	31.6	30.9	30.3	29.6	29.0	28.5
390	33.7	33.0	32.3	31.6	30.9	30.3	29.7	29.1	28.5
400	33.7	33.0	32.3	31.6	30.9	30.3	29.7	29.1	28.5
410	33.8	33.0	32.3	31.6	31.0	30.3	29.7	29.1	28.5
420	33.8	33.1	32.3	31.7	31.0	30.4	29.7	29.1	28.6
430	33.8	33.1	32.4	31.7	31.0	30.4	29.8	29.2	28.6
440	33.9	33.1	32.4	31.7	31.0	30.4	29.8	29.2	28.6
450	33.9	33.1	32.4	31.7	31.1	30.4	29.8	29.2	28.6
460	33.9	33.2	32.4	31.7	31.1	30.4	29.8	29.2	28.6
470	33.9	33.2	32.5	31.8	31.1	30.4	29.8	29.2	28.6
480	34.0	33.2	32.5	31.8	31.1	30.5	29.8	29.2	28.7
498	34.0	33.2	32.5	31.8	31.1	30.5	29.9	29.3	28.7

Fire Resistance Period 120 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature									
57	31.5	31.3	30.9	30.6	30.2	29.7	29.2	28.6	27.9
60	32.1	31.8	31.4	31.1	30.7	30.2	29.7	29.2	28.5
70	33.4	33.1	32.7	32.3	31.9	31.5	31.0	30.5	29.9
80	34.3	34.0	33.6	33.2	32.8	32.3	31.8	31.3	30.8
90	35.1	34.7	34.3	33.8	33.3	32.9	32.4	31.8	31.3
100	35.7	35.2	34.8	34.3	33.8	33.3	32.8	32.2	31.7
110	36.1	35.7	35.2	34.6	34.1	33.6	33.1	32.5	31.9
120	36.5	36.0	35.5	34.9	34.4	33.9	33.3	32.7	32.2
130	36.9	36.3	35.8	35.2	34.6	34.1	33.5	32.9	32.3
140	37.1	36.6	36.0	35.4	34.8	34.2	33.7	33.1	32.5
150	37.4	36.8	36.2	35.6	35.0	34.4	33.8	33.2	32.6
160		37.0	36.3	35.7	35.1	34.5	33.9	33.3	32.7
170		37.1	36.5	35.9	35.2	34.6	34.0	33.4	32.8
180		37.3	36.6	36.0	35.3	34.7	34.1	33.5	32.9
190		37.4	36.7	36.1	35.4	34.8	34.2	33.5	32.9
200			36.8	36.2	35.5	34.9	34.2	33.6	33.0
210			36.9	36.2	35.6	34.9	34.3	33.6	33.0
220			37.0	36.3	35.6	35.0	34.3	33.7	33.1
230			37.1	36.4	35.7	35.0	34.4	33.7	33.1
240			37.1	36.4	35.8	35.1	34.4	33.8	33.1
250			37.2	36.5	35.8	35.1	34.5	33.8	33.2
260			37.3	36.6	35.8	35.2	34.5	33.8	33.2
270			37.3	36.6	35.9	35.2	34.5	33.9	33.2
280			37.4	36.6	35.9	35.2	34.6	33.9	33.3
290			37.4	36.7	36.0	35.3	34.6	33.9	33.3
300			37.5	36.7	36.0	35.3	34.6	34.0	33.3
310			37.5	36.8	36.0	35.3	34.6	34.0	33.3
320				36.8	36.1	35.3	34.7	34.0	33.3
330				36.8	36.1	35.4	34.7	34.0	33.4
340				36.8	36.1	35.4	34.7	34.0	33.4
350				36.9	36.1	35.4	34.7	34.0	33.4
360				36.9	36.2	35.4	34.7	34.1	33.4
370				36.9	36.2	35.5	34.8	34.1	33.4
380				36.9	36.2	35.5	34.8	34.1	33.4
390				37.0	36.2	35.5	34.8	34.1	33.4
400				37.0	36.2	35.5	34.8	34.1	33.5
410				37.0	36.2	35.5	34.8	34.1	33.5
420				37.0	36.3	35.5	34.8	34.1	33.5
430				37.0	36.3	35.5	34.8	34.2	33.5
440				37.1	36.3	35.6	34.8	34.2	33.5
450				37.1	36.3	35.6	34.9	34.2	33.5
460				37.1	36.3	35.6	34.9	34.2	33.5
470				37.1	36.3	35.6	34.9	34.2	33.5
480				37.1	36.3	35.6	34.9	34.2	33.5
498				37.1	36.4	35.6	34.9	34.2	33.5

A.3.1.1 I, H Beams exposed on three sides

[illegible]

Fire Resistance Period	20 min
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[illegible]

Fire Resistance Period 30 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
46	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
50	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
60	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
70	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
80	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
90	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
100	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
110	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
120	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
130	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
140	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
150	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
160	12.1	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
170	12.6	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
180		11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
190		11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
200		12.3	11.9	11.9	11.9	11.9	11.9	11.9	11.9
210		12.7	11.9	11.9	11.9	11.9	11.9	11.9	11.9
220		13.0	11.9	11.9	11.9	11.9	11.9	11.9	11.9
230			11.9	11.9	11.9	11.9	11.9	11.9	11.9
240			11.9	11.9	11.9	11.9	11.9	11.9	11.9
250			12.2	11.9	11.9	11.9	11.9	11.9	11.9
260			12.4	11.9	11.9	11.9	11.9	11.9	11.9
270			12.6	11.9	11.9	11.9	11.9	11.9	11.9
280			12.9	11.9	11.9	11.9	11.9	11.9	11.9
290			13.1	11.9	11.9	11.9	11.9	11.9	11.9
300				11.9	11.9	11.9	11.9	11.9	11.9
310				11.9	11.9	11.9	11.9	11.9	11.9
320				11.9	11.9	11.9	11.9	11.9	11.9
330				12.0	11.9	11.9	11.9	11.9	11.9
340				12.1	11.9	11.9	11.9	11.9	11.9
350				12.3	11.9	11.9	11.9	11.9	11.9
360				12.4	11.9	11.9	11.9	11.9	11.9
365				12.4	11.9	11.9	11.9	11.9	11.9

Fire Resistance Period	45 min
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[illegible]

Fire Resistance Period	60 min
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[illegible]

Fire Resistance Period	15 min
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[illegible]

Fire Resistance Period	20 min
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[illegible]

Fire Resistance Period 30 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
41	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
50	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
60	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
70	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
80	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
90	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
100	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
110	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
120	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
130	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
140	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
150	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
160	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
170		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
180		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
190		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
200		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
210			12.5	12.5	12.5	12.5	12.5	12.5	12.5
220			12.5	12.5	12.5	12.5	12.5	12.5	12.5
230			12.5	12.5	12.5	12.5	12.5	12.5	12.5
240			12.5	12.5	12.5	12.5	12.5	12.5	12.5
250			12.5	12.5	12.5	12.5	12.5	12.5	12.5
260			12.5	12.5	12.5	12.5	12.5	12.5	12.5
270				12.5	12.5	12.5	12.5	12.5	12.5
280				12.5	12.5	12.5	12.5	12.5	12.5
290				12.5	12.5	12.5	12.5	12.5	12.5
300				12.5	12.5	12.5	12.5	12.5	12.5
310				12.5	12.5	12.5	12.5	12.5	12.5
320				12.5	12.5	12.5	12.5	12.5	12.5
330				12.5	12.5	12.5	12.5	12.5	12.5
340				12.5	12.5	12.5	12.5	12.5	12.5
350				12.5	12.5	12.5	12.5	12.5	12.5
360				12.5	12.5	12.5	12.5	12.5	12.5
365				12.5	12.5	12.5	12.5	12.5	12.5

Fire Resistance Period	45 min
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[illegible]

Fire Resistance Period	60 min
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[illegible]

A.3.2 Two- and three-layer fire protection systems combined

A.3.2.1 I, H Beams exposed on three sides

[illegible]

Fire Resistance Period	20 min
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[illegible]

Fire Resistance Period	30 min
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[illegible]

Fire Resistance Period 45 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
46	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
50	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
60	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
70	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
80	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
90	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
100	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
110	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
120	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
130	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
140	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
150	24.0	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
160	24.2	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
170	24.3	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
180	24.5	23.9	23.8	23.8	23.8	23.8	23.8	23.8	23.8
190	24.6	24.0	23.8	23.8	23.8	23.8	23.8	23.8	23.8
200	24.7	24.1	23.8	23.8	23.8	23.8	23.8	23.8	23.8
210	24.8	24.2	23.8	23.8	23.8	23.8	23.8	23.8	23.8
220	24.9	24.3	23.8	23.8	23.8	23.8	23.8	23.8	23.8
230	25.0	24.4	23.8	23.8	23.8	23.8	23.8	23.8	23.8
240	25.0	24.4	23.9	23.8	23.8	23.8	23.8	23.8	23.8
250	25.1	24.5	24.0	23.8	23.8	23.8	23.8	23.8	23.8
260	25.2	24.6	24.0	23.8	23.8	23.8	23.8	23.8	23.8
270	25.2	24.6	24.1	23.8	23.8	23.8	23.8	23.8	23.8
280	25.3	24.7	24.1	23.8	23.8	23.8	23.8	23.8	23.8
290	25.3	24.7	24.2	23.8	23.8	23.8	23.8	23.8	23.8
300	25.4	24.8	24.2	23.8	23.8	23.8	23.8	23.8	23.8
310	25.4	24.8	24.3	23.8	23.8	23.8	23.8	23.8	23.8
320	25.4	24.9	24.3	23.8	23.8	23.8	23.8	23.8	23.8
330	25.5	24.9	24.3	23.8	23.8	23.8	23.8	23.8	23.8
340	25.5	24.9	24.4	23.8	23.8	23.8	23.8	23.8	23.8
350	25.6	25.0	24.4	23.9	23.8	23.8	23.8	23.8	23.8
360	25.6	25.0	24.4	23.9	23.8	23.8	23.8	23.8	23.8
370	25.6	25.0	24.5	23.9	23.8	23.8	23.8	23.8	23.8
372	25.6	25.0	24.5	23.9	23.8	23.8	23.8	23.8	23.8

Fire Resistance Period 60 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
46	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
50	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
60	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
70	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
80	24.5	23.9	23.8	23.8	23.8	23.8	23.8	23.8	23.8
90	25.1	24.5	23.9	23.8	23.8	23.8	23.8	23.8	23.8
100	25.5	24.9	24.3	23.8	23.8	23.8	23.8	23.8	23.8
110	25.9	25.3	24.7	24.1	23.8	23.8	23.8	23.8	23.8
120	26.2	25.6	25.0	24.4	23.9	23.8	23.8	23.8	23.8
130	26.5	25.9	25.3	24.7	24.1	23.8	23.8	23.8	23.8
140	26.7	26.1	25.5	24.9	24.4	23.8	23.8	23.8	23.8
150	26.9	26.3	25.7	25.1	24.5	24.0	23.8	23.8	23.8
160	27.1	26.4	25.9	25.3	24.7	24.1	23.8	23.8	23.8
170	27.2	26.6	26.0	25.4	24.8	24.3	23.8	23.8	23.8
180	27.3	26.7	26.1	25.5	25.0	24.4	23.9	23.8	23.8
190	27.4	26.8	26.2	25.6	25.1	24.5	24.0	23.8	23.8
200	27.5	26.9	26.3	25.7	25.2	24.6	24.1	23.8	23.8
210	27.6	27.0	26.4	25.8	25.3	24.7	24.2	23.8	23.8
220	27.7	27.1	26.5	25.9	25.4	24.8	24.3	23.8	23.8
230	27.8	27.2	26.6	26.0	25.4	24.9	24.3	23.8	23.8
240	27.9	27.3	26.6	26.1	25.5	24.9	24.4	23.9	23.8
250	27.9	27.3	26.7	26.1	25.6	25.0	24.5	24.0	23.8
260	28.0	27.4	26.8	26.2	25.6	25.1	24.5	24.0	23.8
270	28.1	27.4	26.8	26.2	25.7	25.1	24.6	24.1	23.8
280	28.1	27.5	26.9	26.3	25.7	25.2	24.6	24.1	23.8
290	28.2	27.5	26.9	26.3	25.7	25.2	24.7	24.2	23.8
300	28.2	27.6	27.0	26.4	25.8	25.2	24.7	24.2	23.8
310	28.2	27.6	27.0	26.4	25.8	25.3	24.7	24.2	23.8
320	28.3	27.6	27.0	26.4	25.9	25.3	24.8	24.3	23.8
330	28.3	27.7	27.1	26.5	25.9	25.3	24.8	24.3	23.8
340	28.4	27.7	27.1	26.5	25.9	25.4	24.8	24.3	23.8
350	28.4	27.7	27.1	26.5	26.0	25.4	24.9	24.4	23.9
360	28.4	27.8	27.2	26.6	26.0	25.4	24.9	24.4	23.9
370	28.5	27.8	27.2	26.6	26.0	25.5	24.9	24.4	23.9
372	28.5	27.8	27.2	26.6	26.0	25.5	24.9	24.4	23.9

Fire Resistance Period 90 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
46	26.5	26.0	25.3	24.7	23.9	23.8	23.8	23.8	23.8
50	27.3	26.8	26.2	25.6	24.9	24.2	23.8	23.8	23.8
60	28.7	28.2	27.6	27.1	26.5	25.8	25.1	24.4	23.8
70	29.7	29.1	28.6	28.0	27.4	26.8	26.2	25.6	24.9
80	30.4	29.8	29.3	28.7	28.1	27.5	26.9	26.3	25.7
90	30.9	30.4	29.8	29.2	28.6	28.0	27.4	26.8	26.2
100	31.4	30.8	30.2	29.6	29.0	28.4	27.8	27.2	26.6
110	31.7	31.1	30.5	29.9	29.3	28.7	28.1	27.5	27.0
120	32.0	31.4	30.8	30.2	29.6	29.0	28.4	27.8	27.2
130	32.3	31.6	31.0	30.4	29.8	29.2	28.6	28.0	27.4
140	32.5	31.8	31.2	30.6	29.9	29.3	28.7	28.2	27.6
150	32.6	32.0	31.3	30.7	30.1	29.5	28.9	28.3	27.7
160	32.8	32.1	31.5	30.8	30.2	29.6	29.0	28.4	27.8
170	32.9	32.3	31.6	31.0	30.3	29.7	29.1	28.5	27.9
180	33.1	32.4	31.7	31.1	30.4	29.8	29.2	28.6	28.0
190	33.2	32.5	31.8	31.2	30.5	29.9	29.3	28.7	28.1
200	33.3	32.6	31.9	31.2	30.6	30.0	29.4	28.8	28.2
210	33.4	32.7	32.0	31.3	30.7	30.0	29.4	28.8	28.3
220	33.4	32.7	32.0	31.4	30.7	30.1	29.5	28.9	28.3
230	33.5	32.8	32.1	31.4	30.8	30.1	29.5	28.9	28.4
240	33.6	32.9	32.2	31.5	30.8	30.2	29.6	29.0	28.4
250	33.6	32.9	32.2	31.5	30.9	30.2	29.6	29.0	28.5
260	33.7	33.0	32.3	31.6	30.9	30.3	29.7	29.1	28.5
270	33.8	33.0	32.3	31.6	31.0	30.3	29.7	29.1	28.5
280	33.8	33.1	32.4	31.7	31.0	30.4	29.7	29.1	28.6
290	33.9	33.1	32.4	31.7	31.0	30.4	29.8	29.2	28.6
300	33.9	33.1	32.4	31.7	31.1	30.4	29.8	29.2	28.6
310	33.9	33.2	32.5	31.8	31.1	30.4	29.8	29.2	28.6
320	34.0	33.2	32.5	31.8	31.1	30.5	29.9	29.3	28.7
330	34.0	33.2	32.5	31.8	31.1	30.5	29.9	29.3	28.7
340	34.0	33.3	32.5	31.8	31.2	30.5	29.9	29.3	28.7
350	34.1	33.3	32.6	31.9	31.2	30.5	29.9	29.3	28.7
360	34.1	33.3	32.6	31.9	31.2	30.6	29.9	29.3	28.8
370	34.1	33.4	32.6	31.9	31.2	30.6	30.0	29.4	28.8
372	34.1	33.4	32.6	31.9	31.2	30.6	30.0	29.4	28.8

Fire Resistance Period 120 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
46	32.6	32.3	32.0	31.7	31.3	30.9	30.4	29.9	29.3
50	33.4	33.1	32.7	32.4	32.0	31.5	31.1	30.6	30.0
60	34.7	34.3	33.9	33.5	33.1	32.6	32.1	31.6	31.1
70	35.6	35.2	34.7	34.2	33.8	33.3	32.8	32.2	31.7
80	36.3	35.8	35.3	34.8	34.3	33.7	33.2	32.6	32.1
90	36.8	36.2	35.7	35.2	34.6	34.1	33.5	32.9	32.4
100	37.2	36.6	36.0	35.5	34.9	34.3	33.7	33.1	32.6
110	37.5	36.9	36.3	35.7	35.1	34.5	33.9	33.3	32.7
120	37.8	37.2	36.5	35.9	35.3	34.7	34.1	33.4	32.8
130	38.0	37.4	36.7	36.1	35.4	34.8	34.2	33.5	32.9
140	38.2	37.5	36.9	36.2	35.5	34.9	34.3	33.6	33.0
150	38.4	37.7	37.0	36.3	35.7	35.0	34.4	33.7	33.1
160	38.6	37.8	37.1	36.4	35.7	35.1	34.4	33.8	33.2
170	38.7	37.9	37.2	36.5	35.8	35.1	34.5	33.8	33.2
180	38.8	38.0	37.3	36.6	35.9	35.2	34.5	33.9	33.2
190	38.9	38.1	37.4	36.7	36.0	35.3	34.6	33.9	33.3
200	39.0	38.2	37.5	36.7	36.0	35.3	34.6	34.0	33.3
210	39.1	38.3	37.5	36.8	36.1	35.4	34.7	34.0	33.4
220	39.2	38.4	37.6	36.8	36.1	35.4	34.7	34.0	33.4
230	39.2	38.4	37.6	36.9	36.1	35.4	34.7	34.1	33.4
240	39.3	38.5	37.7	36.9	36.2	35.5	34.8	34.1	33.4
250	39.3	38.5	37.7	37.0	36.2	35.5	34.8	34.1	33.5
260		38.6	37.8	37.0	36.2	35.5	34.8	34.1	33.5
270		38.6	37.8	37.0	36.3	35.5	34.8	34.2	33.5
280		38.7	37.8	37.1	36.3	35.6	34.9	34.2	33.5
290		38.7	37.9	37.1	36.3	35.6	34.9	34.2	33.5
300		38.7	37.9	37.1	36.3	35.6	34.9	34.2	33.5
310		38.8	37.9	37.1	36.4	35.6	34.9	34.2	33.6
320		38.8	38.0	37.2	36.4	35.6	34.9	34.2	33.6
330		38.8	38.0	37.2	36.4	35.7	34.9	34.2	33.6
340		38.8	38.0	37.2	36.4	35.7	34.9	34.3	33.6
350		38.9	38.0	37.2	36.4	35.7	35.0	34.3	33.6
360		38.9	38.0	37.2	36.4	35.7	35.0	34.3	33.6
370		38.9	38.1	37.2	36.5	35.7	35.0	34.3	33.6
372		38.9	38.1	37.3	36.5	35.7	35.0	34.3	33.6

[illegible]

Fire Resistance Period	20 min
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[illegible]

Fire Resistance Period	30 min
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[illegible]

Fire Resistance Period	45 min
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[illegible]

Fire Resistance Period 60 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
41	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
50	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
60	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
70	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
80	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
90	25.1	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
100	25.5	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
110	25.9	25.3	25.0	25.0	25.0	25.0	25.0	25.0	25.0
120	26.2	25.6	25.0	25.0	25.0	25.0	25.0	25.0	25.0
130	26.5	25.9	25.3	25.0	25.0	25.0	25.0	25.0	25.0
140	26.7	26.1	25.5	25.0	25.0	25.0	25.0	25.0	25.0
150	26.9	26.3	25.7	25.1	25.0	25.0	25.0	25.0	25.0
160	27.1	26.4	25.9	25.3	25.0	25.0	25.0	25.0	25.0
170	27.2	26.6	26.0	25.4	25.0	25.0	25.0	25.0	25.0
180	27.3	26.7	26.1	25.5	25.0	25.0	25.0	25.0	25.0
190	27.4	26.8	26.2	25.6	25.1	25.0	25.0	25.0	25.0
200	27.5	26.9	26.3	25.7	25.2	25.0	25.0	25.0	25.0
210	27.6	27.0	26.4	25.8	25.3	25.0	25.0	25.0	25.0
220	27.7	27.1	26.5	25.9	25.4	25.0	25.0	25.0	25.0
230	27.8	27.2	26.6	26.0	25.4	25.0	25.0	25.0	25.0
240	27.9	27.3	26.6	26.1	25.5	25.0	25.0	25.0	25.0
250	27.9	27.3	26.7	26.1	25.6	25.0	25.0	25.0	25.0
260	28.0	27.4	26.8	26.2	25.6	25.1	25.0	25.0	25.0
270	28.1	27.4	26.8	26.2	25.7	25.1	25.0	25.0	25.0
280	28.1	27.5	26.9	26.3	25.7	25.2	25.0	25.0	25.0
290	28.2	27.5	26.9	26.3	25.7	25.2	25.0	25.0	25.0
300	28.2	27.6	27.0	26.4	25.8	25.2	25.0	25.0	25.0
310	28.2	27.6	27.0	26.4	25.8	25.3	25.0	25.0	25.0
320	28.3	27.6	27.0	26.4	25.9	25.3	25.0	25.0	25.0
330	28.3	27.7	27.1	26.5	25.9	25.3	25.0	25.0	25.0
340	28.4	27.7	27.1	26.5	25.9	25.4	25.0	25.0	25.0
350	28.4	27.7	27.1	26.5	26.0	25.4	25.0	25.0	25.0
360	28.4	27.8	27.2	26.6	26.0	25.4	25.0	25.0	25.0
370	28.5	27.8	27.2	26.6	26.0	25.5	25.0	25.0	25.0
372	28.5	27.8	27.2	26.6	26.0	25.5	25.0	25.0	25.0

Fire Resistance Period 90 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
41	25.5	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
50	27.3	26.8	26.2	25.6	25.0	25.0	25.0	25.0	25.0
60	28.7	28.2	27.6	27.1	26.5	25.8	25.1	25.0	25.0
70	29.7	29.1	28.6	28.0	27.4	26.8	26.2	25.6	25.0
80	30.4	29.8	29.3	28.7	28.1	27.5	26.9	26.3	25.7
90	30.9	30.4	29.8	29.2	28.6	28.0	27.4	26.8	26.2
100	31.4	30.8	30.2	29.6	29.0	28.4	27.8	27.2	26.6
110	31.7	31.1	30.5	29.9	29.3	28.7	28.1	27.5	27.0
120	32.0	31.4	30.8	30.2	29.6	29.0	28.4	27.8	27.2
130	32.3	31.6	31.0	30.4	29.8	29.2	28.6	28.0	27.4
140	32.5	31.8	31.2	30.6	29.9	29.3	28.7	28.2	27.6
150	32.6	32.0	31.3	30.7	30.1	29.5	28.9	28.3	27.7
160	32.8	32.1	31.5	30.8	30.2	29.6	29.0	28.4	27.8
170	32.9	32.3	31.6	31.0	30.3	29.7	29.1	28.5	27.9
180	33.1	32.4	31.7	31.1	30.4	29.8	29.2	28.6	28.0
190	33.2	32.5	31.8	31.2	30.5	29.9	29.3	28.7	28.1
200	33.3	32.6	31.9	31.2	30.6	30.0	29.4	28.8	28.2
210	33.4	32.7	32.0	31.3	30.7	30.0	29.4	28.8	28.3
220	33.4	32.7	32.0	31.4	30.7	30.1	29.5	28.9	28.3
230	33.5	32.8	32.1	31.4	30.8	30.1	29.5	28.9	28.4
240	33.6	32.9	32.2	31.5	30.8	30.2	29.6	29.0	28.4
250	33.6	32.9	32.2	31.5	30.9	30.2	29.6	29.0	28.5
260	33.7	33.0	32.3	31.6	30.9	30.3	29.7	29.1	28.5
270	33.8	33.0	32.3	31.6	31.0	30.3	29.7	29.1	28.5
280	33.8	33.1	32.4	31.7	31.0	30.4	29.7	29.1	28.6
290	33.9	33.1	32.4	31.7	31.0	30.4	29.8	29.2	28.6
300	33.9	33.1	32.4	31.7	31.1	30.4	29.8	29.2	28.6
310	33.9	33.2	32.5	31.8	31.1	30.4	29.8	29.2	28.6
320	34.0	33.2	32.5	31.8	31.1	30.5	29.9	29.3	28.7
330	34.0	33.2	32.5	31.8	31.1	30.5	29.9	29.3	28.7
340	34.0	33.3	32.5	31.8	31.2	30.5	29.9	29.3	28.7
350	34.1	33.3	32.6	31.9	31.2	30.5	29.9	29.3	28.7
360	34.1	33.3	32.6	31.9	31.2	30.6	29.9	29.3	28.8
370	34.1	33.4	32.6	31.9	31.2	30.6	30.0	29.4	28.8
372	34.1	33.4	32.6	31.9	31.2	30.6	30.0	29.4	28.8

Fire Resistance Period 120 min

Section factor (m ⁻¹)	Design temperature (°C)								
	350	400	450	500	550	600	650	700	750
	Thickness of Fire Protection Material (mm) to Maintain Steel Temperature Below Design Temperature								
41	31.6	31.3	31.0	30.7	30.3	29.9	29.4	28.8	28.1
50	33.4	33.1	32.7	32.4	32.0	31.5	31.1	30.6	30.0
60	34.7	34.3	33.9	33.5	33.1	32.6	32.1	31.6	31.1
70	35.6	35.2	34.7	34.2	33.8	33.3	32.8	32.2	31.7
80	36.3	35.8	35.3	34.8	34.3	33.7	33.2	32.6	32.1
90	36.8	36.2	35.7	35.2	34.6	34.1	33.5	32.9	32.4
100	37.2	36.6	36.0	35.5	34.9	34.3	33.7	33.1	32.6
110		36.9	36.3	35.7	35.1	34.5	33.9	33.3	32.7
120		37.2	36.5	35.9	35.3	34.7	34.1	33.4	32.8
130		37.4	36.7	36.1	35.4	34.8	34.2	33.5	32.9
140			36.9	36.2	35.5	34.9	34.3	33.6	33.0
150			37.0	36.3	35.7	35.0	34.4	33.7	33.1
160			37.1	36.4	35.7	35.1	34.4	33.8	33.2
170			37.2	36.5	35.8	35.1	34.5	33.8	33.2
180			37.3	36.6	35.9	35.2	34.5	33.9	33.2
190			37.4	36.7	36.0	35.3	34.6	33.9	33.3
200			37.5	36.7	36.0	35.3	34.6	34.0	33.3
210				36.8	36.1	35.4	34.7	34.0	33.4
220				36.8	36.1	35.4	34.7	34.0	33.4
230				36.9	36.1	35.4	34.7	34.1	33.4
240				36.9	36.2	35.5	34.8	34.1	33.4
250				37.0	36.2	35.5	34.8	34.1	33.5
260				37.0	36.2	35.5	34.8	34.1	33.5
270				37.0	36.3	35.5	34.8	34.2	33.5
280				37.1	36.3	35.6	34.9	34.2	33.5
290				37.1	36.3	35.6	34.9	34.2	33.5
300				37.1	36.3	35.6	34.9	34.2	33.5
310				37.1	36.4	35.6	34.9	34.2	33.6
320				37.2	36.4	35.6	34.9	34.2	33.6
330				37.2	36.4	35.7	34.9	34.2	33.6
340				37.2	36.4	35.7	34.9	34.3	33.6
350				37.2	36.4	35.7	35.0	34.3	33.6
360				37.2	36.4	35.7	35.0	34.3	33.6
370				37.2	36.5	35.7	35.0	34.3	33.6
372				37.3	36.5	35.7	35.0	34.3	33.6

Annex B

Characterisation data of the classified system – further presentation

B.1 General

This annex gives further presentation of characterisation data depends upon the assessment procedure used (the numerical regression analysis method) according to EN 13501-2: B.4 e) and the judgement of the criteria for acceptability according to EN 13381-4: 13.5.

B.2 Single-layer system

B.2.1 NRA with section factor of unprotected steel section (A_m/V)

Unmodified regression coefficients
according to EN 13381-4: E.5 step 1

$$A_k =$$

$1.807432 \cdot 10^0$
$0.000000 \cdot 10^0$
$1.977142 \cdot 10^2$
$2.329981 \cdot 10^{-2}$
$1.863985 \cdot 10^{-3}$
$-1.950571 \cdot 10^{-3}$
$-2.438214 \cdot 10^{-2}$
$4.876085 \cdot 10^2$

Modified regression coefficients at the modification factor x
according to [1]: EN 13381-4: E.5 step 1 and 13.5

$$x = 0.9763$$

$$a_k := x \cdot A_k$$

$$a_k =$$

$1.764596 \cdot 10^0$
$0.000000 \cdot 10^0$
$1.930284 \cdot 10^2$
$2.274761 \cdot 10^{-2}$
$1.819809 \cdot 10^{-3}$
$-1.904343 \cdot 10^{-3}$
$-2.380428 \cdot 10^{-2}$
$4.760521 \cdot 10^2$

Judgement of criteria for acceptability according to EN 13381-4: 13.5

The relative difference of the predicted time to reach the design temperature and the corrected time, for each design temperature (indexed by i) and each short section (indexed by j) is denoted by $\Delta t_{d_{r,i,j}}$.

- a) For each short section the predicted time to reach the design temperature shall not exceed the corrected time by more than 15 %:

$$\max(v\Delta t_{d_r}) = 11.8\%$$

PASS

- b) The mean value of all percentage differences as calculated in a) shall be less than zero:

$$\text{mean}(v\Delta t_{d_r}) = -1.9\%$$

PASS

- c) A maximum of 30 % of individual values of all percentage differences as calculated in a) shall be more than zero (n is index of data used for the regression):

$$\frac{\sum_n \text{if}(v\Delta t_{d_{r,n}} \leq 0, 0, 1)}{\sum_n 1} = 28.6\%$$

PASS

- d) The results of the analysis also comply with qualitative criteria acc. to EN 13381-4:13.5 d).

B.2.1 NRA with section factor of boxed protected steel section (A_p/V)

Unmodified regression coefficients
according to EN 13381-4: E.5 step 1

Modified regression coefficients at the modification factor x
according to [1]: EN 13381-4: E.5 step 1 and 13.5

$$A_k =$$

$1.574824 \cdot 10^0$
$0.000000 \cdot 10^0$
$1.253159 \cdot 10^2$
$2.328013 \cdot 10^{-2}$
$1.862410 \cdot 10^{-3}$
$-2.816474 \cdot 10^{-3}$
$-3.520593 \cdot 10^{-2}$
$5.961090 \cdot 10^2$

$$x = 0.9800$$

$$a_k := x \cdot A_k$$

$$a_k =$$

$1.543328 \cdot 10^0$
$0.000000 \cdot 10^0$
$1.228096 \cdot 10^2$
$2.281452 \cdot 10^{-2}$
$1.825162 \cdot 10^{-3}$
$-2.760145 \cdot 10^{-3}$
$-3.450181 \cdot 10^{-2}$
$5.841868 \cdot 10^2$

Judgement of criteria for acceptability according to EN 13381-4: 13.5

The relative difference of the predicted time to reach the design temperature and the corrected time, for each design temperature (indexed by i) and each short section (indexed by j) is denoted by $\Delta t_{d_{r,i,j}}$.

- a) For each short section the predicted time to reach the design temperature shall not exceed the corrected time by more than 15 %:

$$\max(v\Delta t_{d_r}) = 10.6\%$$

PASS

- b) The mean value of all percentage differences as calculated in a) shall be less than zero:

$$\text{mean}(v\Delta t_{d_r}) = -1.7\%$$

PASS

- c) A maximum of 30 % of individual values of all percentage differences as calculated in a) shall be more than zero (n is index of data used for the regression):

$$\frac{\sum_n \text{if}(v\Delta t_{d_{r,n}} \leq 0, 0, 1)}{\sum_n 1} = 28.6\%$$

PASS

- d) The results of the analysis also comply with qualitative criteria acc. to EN 13381-4:13.5 d).

B.3 Multilayer system

B.2.1 NRA with section factor of unprotected steel section (A_m/V)

Unmodified regression coefficients
according to EN 13381-4: E.5 step 1

$$A_k =$$

$-9.511938 \cdot 10^1$
$4.394130 \cdot 10^0$
$1.321972 \cdot 10^2$
$-1.466483 \cdot 10^{-2}$
$3.162641 \cdot 10^{-3}$
$-4.647664 \cdot 10^{-1}$
$1.136885 \cdot 10^1$
$-1.871794 \cdot 10^2$

Modified regression coefficients at the modification factor x
according to [1]: EN 13381-4: E.5 step 1 and 13.5

$$x = 0.9755$$

$$a_k := x \cdot A_k$$

$$a_k =$$

$-9.278895 \cdot 10^1$
$4.286473 \cdot 10^0$
$1.289584 \cdot 10^2$
$-1.430554 \cdot 10^{-2}$
$3.085156 \cdot 10^{-3}$
$-4.533796 \cdot 10^{-1}$
$1.109031 \cdot 10^1$
$-1.825935 \cdot 10^2$

Judgement of criteria for acceptability according to EN 13381-4: 13.5

The relative difference of the predicted time to reach the design temperature and the corrected time, for each design temperature (indexed by i) and each short section (indexed by j) is denoted by $\Delta t_{d_{r,i,j}}$.

- a) For each short section the predicted time to reach the design temperature shall not exceed the corrected time by more than 15 %:

$$\max(v\Delta t_{d_r}) = 7.0\%$$

PASS

- b) The mean value of all percentage differences as calculated in a) shall be less than zero:

$$\text{mean}(v\Delta t_{d_r}) = -2.2\%$$

PASS

- c) A maximum of 30 % of individual values of all percentage differences as calculated in a) shall be more than zero (n is index of data used for the regression):

$$\frac{\sum_n \text{if}(v\Delta t_{d_{r,n}} \leq 0, 0, 1)}{\sum_n 1} = 29.4\%$$

PASS

- d) The results of the analysis also comply with qualitative criteria acc. to EN 13381-4:13.5 d).

B.2.1 NRA with section factor of boxed protected steel section (A_p/V)

Unmodified regression coefficients
according to EN 13381-4: E.5 step 1

Modified regression coefficients at the modification factor x
according to [1]: EN 13381-4: E.5 step 1 and 13.5

$$A_k =$$

$-9.429296 \cdot 10^1$
$4.349085 \cdot 10^0$
$9.990920 \cdot 10^1$
$-1.705370 \cdot 10^{-2}$
$3.260796 \cdot 10^{-3}$
$-3.431871 \cdot 10^{-1}$
$8.393293 \cdot 10^0$
$-2.431851 \cdot 10^2$

$$x = 0.9727$$

$$a_k := x \cdot A_k$$

$$a_k =$$

$-9.171876 \cdot 10^1$
$4.230355 \cdot 10^0$
$9.718168 \cdot 10^1$
$-1.658813 \cdot 10^{-2}$
$3.171776 \cdot 10^{-3}$
$-3.338181 \cdot 10^{-1}$
$8.164156 \cdot 10^0$
$-2.365462 \cdot 10^2$

Judgement of criteria for acceptability according to EN 13381-4: 13.5

The relative difference of the predicted time to reach the design temperature and the corrected time, for each design temperature (indexed by i) and each short section (indexed by j) is denoted by $\Delta t_{d_{r,i,j}}$.

- a) For each short section the predicted time to reach the design temperature shall not exceed the corrected time by more than 15 %:

$$\max(v\Delta t_{d_r}) = 5.5\%$$

PASS

- b) The mean value of all percentage differences as calculated in a) shall be less than zero:

$$\text{mean}(v\Delta t_{d_r}) = -2.5\%$$

PASS

- c) A maximum of 30 % of individual values of all percentage differences as calculated in a) shall be more than zero (n is index of data used for the regression):

$$\frac{\sum_n \text{if}(v\Delta t_{d_{r_n}} \leq 0, 0, 1)}{\sum_n 1} = 28.6\%$$

PASS

- d) The results of the analysis also comply with qualitative criteria acc. to EN 13381-4:13.5 d).