Research Programme of the Research Fund for Coal and Steel

FIre and Seismic performances of Hybrid fire WALLs in case of single-storey industrial and commercial steel buildings (FISHWALL)

Fire test reports on partition fire walls made of sandwich panels with large spans

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PAVUS

WP2: Fire performance of lightweight sandwich panels for partition walls and fire protection

Deliverable: D2.6

Contributing partners		
	CTICM	France
	JORIS	Belgium
	EMB	France
	EFR	France

Grant agreement No: 101034083

Version	Issue	Purpose	Author	Reviewer	Approved
A	D2.6	first version (14/02/2023)	Jiří Vaněk	All partners	Christophe RENAUD
B	D2.6	revised version following comments from EC (06/10/2023)	Jiří Vaněk	All partners	Christophe RENAUD

TABLE OF CONTENTS

ABSTRACT

It is well known that the intrinsic fire resistance of single-storey unprotected steel-framed buildings is largely sufficient to guarantee the evacuation of occupants in the event of fire. In consequence, for this type of building, the main concern of national fire regulations in Europe is how to prevent the spread of fire to the whole building. To achieve this objective, two performances shall be usually satisfied, namely, the appropriateness of constructive systems to ensure that there is no progressive collapse between fire compartments, and the efficiency of fire walls to stop the fire inside the initial compartment regardless of the state of structures exposed to fire. In practice, many constructional solutions can be implemented in order to preserve the integrity of the fire walls, while accepting that the fire exposed part of the structure may collapse. One of the most common solutions is to place a non-load bearing wall between two independent steel structures and to connect it to them by means of "fusible" links. In fire situation, these fusible links have to allow the wall to be disconnected from the structure affected by fire without endangering the separating function of the wall, which shall remain fixed to the steel structure on the other side of the wall and therefore not exposed to fire. However, due to the lack of corresponding scientific evidence, questions are being very often raised about the real efficiency of such systems in fire situation, which, in certain cases, have also to provide an adequate seismic resistance, if they are used in seismic areas.

Today, concrete or masonry wall solutions are frequently used for the compartmentation of buildings, predominately for low-rise commercial and industrial steel buildings. However, as an alternative, lightweight sandwich panels (comprising two thin flat metal faces and an insulated core) could become an appropriate steel fire wall solution, offering numerous benefits in comparison to other solutions, including fire resistance, durability, flexibility, easy dismounting and fast construction times. But, there is an evident lack of technical information about the adequate fire performance of such type of wall solutions when they are implemented in single-storey buildings with unprotected steel structure, which constitutes a major obstacle for their large use.

In this context, the overall goal of the FISWHALL project is to develop a design guidance and recommendations for an innovative hybrid fire wall solution based on lightweight steel-faced sandwich panels associated with unprotected steel structure under both fire and seismic actions, but considered individually. This will be achieved through the following specific tasks: i) Establishing of a full range of experimental evidence about the fire and seismic behaviour of the investigated hybrid fire wall solution by carrying out a number of tests; ii) Investigating intensively the fire and seismic performances of the above hybrid fire wall solution in combination with unprotected single-storey steel structures through a variety of parametric numerical studies by means of validated FE numerical models; iii) Developing both cost-effective and innovative "fusible" connection systems for fire walls to be used in combination with unprotected steel structures of single-storey buildings; and iv) Developing a design guidance and practical recommendations for the studied hybrid fire wall and fusible links solutions, on the basis of above studies, from which engineers can carry out very efficient design.

The present report aims at summing up the main results of fire tests carried out at the Testing Laboratory of PAVUS according to EN 1364-1 [1] on partition fire walls made of sandwich panels with panel span ranging from 4.5 to 6m. Detailed fire test reports are provided in Annexes of this report. The gained test data will be use in a subsequent task dedicated to the assessment of rules currently proposed in Annex B of EN 15254-5 to extend the span length of sandwich panels beyond 4 m from standard fire tests.

1 INTRODUCTION

The fire resistance of partition fire walls is usually determined by standard fire resistance tests according to EN 1364-1 [1] . Since the test furnaces have limited dimensions, standard fire tests are usually performed on small-sized 3x3m or 3x4m wall specimens only. Then, extension rules have to be used to design partition fire walls with larger span in real buildings. The large spanning capacities of sandwich panels should limit the supporting members to be used for high partition fire walls, leading to economize from both construction material and assembly time. However, due to the lack of background information regarding the existing extension rules for extending the span length of sandwich panels from results of standard fire tests, such as the one given in Annex B of European standard EN 15254-5 [2] accredited fire laboratories or relevant designers deny currently to apply them. They estimate that the span of panels cannot be extended beyond 4 m to achieve the same fire resistance to that the specimen tested in standard fire test. This restraint leads evidently to additional supporting members (such as columns, purlins or side rides according to the vertical or horizontal orientation of panels) which increases tremendously the construction cost and reduce drastically the competitiveness of lightweight sandwich panels.

In this context, a set of four standard fire tests was carried out to investigate the fire performance of partition fire walls made of lightweight sandwich panels with span larger than the usually 3m fire-tested span. This report contains all results of fire tests carried out at the Testing Laboratory of PAVUS on partition fire walls made of sandwich panels with panel span ranging from 4.5 to 6m. Detailed fire test reports are provided in Annexes. The gained test data will be used in a subsequent task of the project to assess the existing rules for the extension in span length of fire walls made of sandwich panels from standard fire resistance tests.

2 WALL SPECIMENS AND TESTS ARRANGEMENT

As already mentioned in deliverable D1.4 [4], during the process of finalizing the design of tests, project partners expressed concern about the success of the two fire tests initially planned in a horizontal furnace (the panels having to carry their own weight), as well as the possibility to compare the results from such tests to those of the reference fire tests (conducted on 3×3m walls). Consequently, all partners agreed to update the initial test programme, performing all the planned wall tests in the vertical furnace only.

Only a short description of wall specimens and tests arrangement is given hereafter. More detailed information are provided in Annexes containing the test report of each tested wall.

Erreur ! Source du renvoi introuvable. lists the main characteristics of the non-loadbearing walls tested. All walls had overall dimensions of 6m high, by 5m wide and 175 mm thick. Eurobond Rockspan Extra panels produced by Euroclad were used. The walls were mounted according to current practice. They were formed from five or six sandwich panels, according to the panel orientation (vertical or horizontal). They were mounted into a steel frame specifically designed for testing, placed in the front of the vertical furnace. Thus, walls were exposed to fire on one side only. Wall panels were installed either vertically or either horizontally to test both configurations. For each test, one wall edge was left unrestrained to incorporate a free edge (with a gap of 25 mm to 50 mm between the free edge of the wall and the test frame). This free edge was filled with mineral insulation. In two tests, additional steel members (beam or column) were fixed to the steel frame supporting the walls, allowing to reduce the panel span lengths to the fixed values. These steel members were fire-protected with a panel encasement fabricated with the same sandwich panels as the ones constituting the walls.

Table 1: List of fire tests carried out on walls

Test	Wall configuration			Test report
	Panel type	Panel arrangement	Panel span (m)	
1	Eurobond Rockspan Extra (175 mm thick)	Horizontal	5	Pr-22-2.084-En (appendix A)
2			4.5+0.5	Pr-22-2.086-En (appendix B)
3		Vertical	6	Pr-22-2.085-En (appendix C)
4			5.5+0.5	Pr-22-2.231-En (appendix D)

The tests were conducted according to EN 1364-1 [1]. During the tests, integrity, thermal insulation and radiation performances of walls were checked. For this purpose, deflection of walls (deflection difference at mid-span between the joint and the centers of the adjoining panels) as well as the temperature rise at different locations on the fire-unexposed side were recorded according to the standard provisions. In addition, the occurrence of openings or sustained flaming on the fire-unexposed side as well as the ignition of a cotton pad placed against the wall surface were continuously controlled. The failure and collapse of the walls was thus visually monitored and documented.

All measured values were recorded in Excel sheets to provide data to be easily used for the assessment of the extended application rules of test results existing for sandwich panels, planned in a subsequent task of the project.

Some photos of the testing setup and test specimens are shown in Figure 1.

a) Outside view of the furnace

b) View of the steel frame used as support of test specimens

c) View of the wall specimen n°2 – fire-unexposed side

d) View of the wall specimen n°2 – fire-exposed side

Figure 1: Views of the testing setup and test specimens

3 TEST RESULTS AND MAIN OBSERVATIONS

Only brief results and observations are given here. Detailed results of all tests are reported in Annexes.

An example of wall failure due to the occurrence of large openings at panel junctions (allowing gap gauge passage through the wall) is shown in Figure 2. As expected, during tests, the exposed side steel facing delaminated from the insulated core (phenomenon well known with sandwich panels). All walls and panels buckled progressively towards the fire because of the temperature gradient occurring through the wall thickness during the fire exposure. More or less large openings and sustained flaming were then observed on the fire-unexposed side of walls, on joints between sandwich panels. These openings appeared at different locations along joints, resulting in the loss of the integrity criterion and large variations in the recorded temperature rises on the unexposed surface.

Test results, namely the fire performance of walls expressed in terms of Integrity, Insulation and Radiation, are summarised in Table 2. It can be noted that the fire resistance times obtained for walls made of vertically installed sandwich panels are significantly lower than the fire resistance times for walls made of horizontally installed sandwich panels.

Table 2: Main test results

Test	Wall configuration			Test results		
	Panel type	Panel arrangement	Panel span (m)	Integrity	Insulation	Radiation
1	Eurobond Rockspan Extra (175 mm thick)	Horizontal	5	126	126	126
2			4.5+0.5	163	122	163
3		Vertical	6	94	94	94
4			5.5+0.5	141	104	141

a) Test n°1

b) Test n°2

c) Test n°3

d) Test n°4

Figure 2: Views of two wall specimens during tests

4 CONCLUSIONS

This report aimed at summing up all results of tests carried out at the Testing Laboratory of PAVUS on partition fire walls made of lightweight sandwich panels with span larger than the usually tested 3m span. For testing, Eurobond Rockspan Extra panels with 175mm thick produced by Euroclad were used.

During tests, deflection of walls as well as the temperature rise at different locations on the fire-unexposed side were recorded. The overall behaviour of walls was also monitored visually. All measured values were recorded in Excel sheets to provide data easily to use for the assessment of existing rules for the span extension of fire walls made of sandwich panels from standard fire test results, planned in a subsequent task of the project. A more detailed analysis and discussion of test results will be provided in deliverable related to the assessment of existing rules.

5 REFERENCES

[1] EN 1364-1, Fire resistance tests for non-loadbearing elements - Part 1: Walls, 2017.

[2] EN 15254-5:2019 Extended application of results from fire resistance tests - Non-loadbearing walls - Part 5: Metal sandwich panel construction, 2019.

[3] EN 1363-1: Fire resistance tests - Part 1: General requirement, 2021.

[4] Deliverable D1.4: Design of tests, RFSC project FISHWALL, 2020.

[5] Fire resistance test report n° Pr-22-2.085-En on non-loadbearing wall 5m×6m - External wall made of sandwich panels Eurobond Rockspan Extra (vertical cladding), 13-06-2022 and classification report of fire n° PK2-06-22-010-E-0, 28-09-2022.

[6] Fire resistance test report n° Pr-22-2.084-En on non-loadbearing wall 5m×6m - External wall made of sandwich panels Eurobond Rockspan Extra (horizontal cladding), 13-06-2022 and classification report of fire n° PK2-06-22-009-E-0, 28-09-2022.

[7] Fire resistance test report n° Pr-22-2.231-En on non-loadbearing wall 5m×6m - External wall made of sandwich panels Eurobond Rockspan Extra (vertical cladding with steel beam), 17-01-2023 and classification report of fire n° PK2-06-22-016-E-0, 24-01-2023.

[8] Fire resistance test report n° Pr-22-2.086-En on non-loadbearing wall 5m×6m - External wall made of sandwich panels Eurobond Rockspan Extra (horizontal cladding with steel column), 13-06-2022 and classification report of fire n° PK2-06-22-011-E-0, 28-09-2022.

APPPENDIX A. REPORT N°PR-22-2.084-EN FOR TEST N°1

PAVUS
FIRE TESTING INSTITUTE

Order No.: Z210220039

PAVUS, a.s.
AUTHORIZED BODY 216
NOTIFIED BODY 1391
ACCREDITED TESTING LABORATORY
EGOLF MEMBER

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L 1026

FIRE TESTING LABORATORY VESELÍ NAD LUŽNICÍ
Testing Laboratory No. 1026 accredited by ČIA
Notified Testing Laboratory
workplace Veselí nad Lužnicí

FIRE RESISTANCE TEST REPORT

No. Pr-22-2.084-En

issued on 2022-06-13

For product

Non-loadbearing wall 5 x 6 m

External wall made of sandwich panels Eurobond Rockspan Extra (horizontal cladding)

Sponsor: Consortium of the RFCS project FISHWALL

cticm · UNIVERSITÀ DI TRENTO · CTU · JORISIDE THE STEEL FUTURE · BRIAND CONSTRUCTION METALLIQUE · PAVUS FIRE TESTING INSTITUTE · L'ENVELOPPE MÉTALLIQUE DU BÂTIMENT · Efectis · euroclad group

Test method:

ČSN EN 1364-1
» Fire resistance tests for non-loadbearing elements - Part 1: Walls «

Test Report includes 28 pages
(6 pages of text + 4 Annexes)

Number of copies: 2
Copy number: 1

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1 INTRODUCTION

The fire resistance test of the non-loadbearing wall was performed based on the order of Consortium of the RFCS project FISHWALL in Fire Testing Laboratory PAVUS, a.s. in Veselí nad Lužnicí.

The test was prepared, performed and assessed on the base of following documents:

[1] ČSN EN 1364-1:2017 Fire resistance tests for non-loadbearing elements - Part 1: Walls

[2] ČSN EN 1363-1:2021 Fire resistance tests - Part 1: General requirement

[3] ČSN EN 1363-2:2000 Fire resistance tests - Part 2: Alternative and supplementary procedures

[4] ČSN EN 15254-5:2019 Extended application of results from fire resistance tests - Non-loadbearing walls - Part 5: Metal sandwich panel construction

[5] ČSN EN 13501-2:2017 Fire classification of construction products and building elements - Part 2: Classification using test data from resistance fire tests, excluding ventilation services

[6] ILAC-G17:01/2021 Guidelines for Measurement Uncertainty in Testing

[7] JCGM 100:2008 GUM 1995 with minor corrections, Evaluation of measurement data - Guide to the expression of uncertainty in measurement (Available from www.BIPM.org)

[8] Specimen-related technical documentation delivered by the test sponsor

For the purposes of this document, definitions given in [1] ÷ [7] together with following abbreviations apply:

ČIA	Český institut pro akreditaci, o.p.s. (Czech Institute for Accreditation)
ATL	accredited testing laboratory
TC	thermocouple
TM	thermometer (sheathed TC)
PTM	plate thermometer fit with a TM ∅ 2 mm
EF	exposed specimen face
UF	unexposed specimen face
RTC	roving thermocouple

2 TEST SUBJECT

The subject matter of the test was represented by a specimen of prebuilt non-loadbearing wall with total dimensions of 5 035 mm (width) × 6 000 mm (height) × 175 mm (thickness) of sandwich panels Eurobond Rockspan Extra horizontally oriented.

The specimen in test frame was mounted to rigid construction with low density, thickness 250 mm, density 550 kg/m^3.

Description of the construction:

Non-loadbearing external wall consisted of 6 pcs of sandwich panels Eurobond Rockspan Extra with mineral wool as an insulation core, nominal density of mineral wool was 120 kg/m^3. Each panel had dimensions of 1 200 mm (stock width) × 4 995 mm (length) x 175 mm (thickness). One panel was reduced to ½ in width and it was mounted to the upper edge of the wall, so that the horizontal contact of panels was 500 ± 150 mm far from the upper edge. Another ½ of panel was mounted to the lower edge of the wall. On EF, the panels had metal sheet, th. 0.5 mm (interior side) and on UF, they had metal sheet, th. 0.5 mm (exterior side), both sheets were galvanized and coated.

On both vertical sides and on the bottom part of the rigid construction, L-profiles 100x50x2 were mounted on EF (and also on UF in the end of the assembly), aligned with the edge of the rigid construction. The profiles were anchored to the rigid construction using carbon steel screws TutFast HTF-6.3 x 57 (producer Fixfast Ltd) in spacing of 450 mm. The top part of the specimen was without mechanical fixing.

Particular panels were anchored to the L-profiles using stainless screws DrillFast DF2-SS-LS-A15-6.3 x 25 (producer Fixfast Ltd) in the direction from EF, in spacing of 300 mm.

The structural gaps between the test specimen and the rigid construction were filled up with mineral wool POWER-TEK BD 660 (manufacturer Knauf Insulation, spol. s r.o.), nominal density 100 kg/m^3, width of the gap between 20 and 30 mm.

The upper horizontal edge was left unrestrained in order to enable free specimen moving. The gap between the specimen and the rigid construction of width 50 mm was filled up with mineral wool.

Test specimen related technical documentation delivered by the test sponsor is documented in Annex C.

The specimen was mounted as per [1] cl. 7 and Annex C of this Test Report.

The tested specimen was manufactured by company Euroclad Group Ltd.

The Testing Laboratory did not participate in extracting elements used for test specimen assembly.

The parts of the test specimen were delivered to the test laboratory on 11th March 2022 without any defects and mounted from 14th to 16th March 2022 to the test frame by company Euroclad Group Ltd in accordance with the delivered documentation.

3 TEST PERFORMANCE

3.1 General

The fire resistance test was performed as per [1] on 18th March 2022 in Testing hall PO 1 in vertical wall furnace with inner dimensions of 5 000 mm (width) × 6 000 mm (height) × 1 500 mm (depth).

Direction of fire exposure from interior side.

Used testing and gauging equipment is stated in Annex A.

3.2 Furnace control

The test furnace was heated with a set of oil burners. In-furnace temperatures were measured by the help of PTMs and recorded at minute intervals. The measuring wires of PTM were distributed uniformly in a distance of 100 mm from the exposed specimen face according to [1] cl. 9.1.1.

In-furnace temperatures for standard heating curve according to [2] were controlled so that they conformed to the relation according to [2] cl. 5.1.1, within the specified limits (see [2] cl. 5.1.2):

$$T = 345 \log (8t + 1) + 20$$

where T (°C) = required in-furnace temperature in time °C
t (min) = time since the test beginning

The test furnace positive pressure was measured and controlled so that the values correspond to the conditions of [1] cl. 9.2 and [2] cl. 5.2.1 and 9.2.1.

3.3 Specimen measuring

The specimen unexposed face temperatures were taken using K-type disc TCs and recorded at minute intervals. The TCs were fixed on the specimen surface according to [1] cl. 9.1.2.2, 9.1.2.3 and B.3.

The rate of the horizontal deflection was measured by deflectometers spaced according to [1] cl. 9.3.

One RTC (see [2] cl. 4.5.1.3) was available to measure points where higher temperatures were expected.

The measured points of deflections and the TC positions are described and figured in Annex B.

The initial test conditions met the standard values as per [2] cl. 10.3.

3.4 Ambient temperature

During the test, the ambient temperature was measured using one K-type TM (see [2] cl. 4.5.1.5) according to the conditions of [2] cl. 5.6.

3.5 Conditioning

From the specimen delivery to the Fire Testing Laboratory until the test performance, the specimen was stored in the enclosed ambient of test hall at the air temperature of (15 ± 5) °C and at relative air humidity of (50 ± 5) %.

4 TEST COURSE

Time (min)	Test observation
2.	audible crackling in the panels
15.	EF - metal sheets are strongly bent nearby the joints, especially in the half of the specimen's height
70.	UF - darkening of the bottom joint (measured point c_5)
75.	UF - opening of the joint by measured point c_4, visible light from the furnace
90.	UF - cotton pad test by measured point c_4 - without failure
94.	UF - 6 mm gap gauge can't pass through the specimen by measured point c_4, the joint is closed due to bent sheets on EF - without failure
125.	UF - opening of the joint by measured point c_3
127.	UF - 6 mm gap gauge passes through the specimen by measured point c_4 in distance longer than 150 mm - **integrity failure**
128.	UF - cotton pad test by measured point c_4 - without failure
136.	UF - sustained flaming in the half of the specimen's height (measured point c_3) - **integrity failure**
138.	UF - cotton pad test by measured point c_3 - without failure
145.	end of the test at request of the Sponsor

Layout of TC described in Annex B. Deflections are described in Annex B.

The in-furnace temperatures and pressures met the requirements of [2]. Time relations to the measured temperatures and pressures are specified in Annex B.

5 TEST RESULTS

5.1 Limit state attainment criteria

+ **Integrity** (according to [2] cl. 11.2). This criterion means the time in completed minutes for which the test specimen continues to maintain its separating function during the test without either:
  a) causing the ignition of a cotton pad applied in accordance with [2] cl. 10.4.5.2; or
  b) permitting the penetration of a gap gauge as specified in [2] cl. 10.4.5.3; or
  c) resulting in sustained flaming.

+ **Insulation** (according to [2] cl. 11.3). This criterion means the time in completed minutes for which the test specimen continues to maintain its separating function during the test without developing temperatures on its unexposed surface which either:
  a) increase the average temperature above the initial average temperature by more than 140 K; or
  b) increase the temperature at any location (incl. RTC) above the initial average temperature by more than 180 K.

+ **Radiation** (according to [1] cl. 9.4 and [3] cl. 8). The criterion of radiation is deemed to be observed until the measured radiation does not exceed the value of 15 $kW.m^{-2}$. The time for the measured radiation to exceed the value of 5, 10, 15, 20 and 25 $kW.m^{-2}$ is reported.

5.2 Expression of test results

Criterion	Partial criterion	Measured value	Evaluation
Integrity	Cotton pad ignition	144 min, no failure	144 min
	Gap gauge passage	126 min	126 min
	Sustained flaming	135 min	135 min
Insulation	Average temperature	144 min, no failure	126 min [1)]
	Maximum temperature	135 min	126 min [1)]
Radiation	6 kW.m^{-2} (not measured) [2)]	126 min [3)]	

Notes:

[1)] The performance criteria "insulation" shall automatically be assumed not to be satisfied when the "integrity" criterion ceases to be satisfied (see [2] cl. 11.4.2).

[2)] There is no requirement to measure the radiation from a surface with a temperature below 300 °C because the radiation from such a surface is low (see [3] cl. 8.1). Average temperature on the UF of the specimen didn't exceed 300 °C.

[3)] Failure of integrity under the cracks or openings in excess of given dimensions criteria means automatically failure of the radiation criterion. (see [5] cl. 5.2.4).

5.3 Field of direct application

The results of the fire test are directly applicable to similar constructions where one or more of the changes listed below are made and the construction continues to comply with the appropriate design code for its stiffness and stability:

- decrease in height and/or width of the wall;
- increase in the number of horizontal joints, of the type tested;
- decrease in distance of fixing centres;
- increase in the thickness of the wall;
- decrease in linear dimensions of boards or panels but not thickness;
- the width of the construction may be increased by 1.0 m under the maximum deflection of the test specimen was not in excess of 100 mm and the expansion allowances are increased pro-rata;
- the height of the construction with the same element height as tested may be increased by up to a third of the tested height.

The results are applicable to high density rigid supporting constructions with at least the same fire resistance as the test specimen.

5.4 Application of test results

- The test results refer only to the tested specimen including the way of its mounting into the construction (see part 2 of this Report).
- This report details the method of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outlined in ČSN EN 1363-1, ČSN EN 1363-2 and ČSN EN 1364-1. Any significant deviation with respect to size, constructional details, loads, stresses, edge or end conditions other than those allowed under the field of direct application in the relevant test method is not covered by this report.

The Report and Annex sheets are valid with the embossed stamp only.

Elaborated by: ..... Jiří VANĚK, Technical Officer

Approved by: ..... Jiří KÁPL, ATL Manager

ANNEX A: TESTING AND GAUGING DEVICES, MEASUREMENT UNCERTAINTY

Test equipment:	**Device registration number:**
Vertical wall furnace PO 1 supplemented by modules increasing the size of the furnace to 5 m x 6 m (+ equipment for temperature and pressure control)	0127
Furnace pressure probe	0011
Test frame	0129/1
Gap gauge ∅ 6 mm	0112
Gap gauge ∅ 25 mm	0113
Cotton pad frame	0014
Gauging equipment:	**Metrological registration number:**
Differential pressure gauge AMR DPS	3 09 29
Datalogger Almemo 5990-2	3 10 85
PTM – in-furnace temperature (TM K ∅ 2 mm)	3 10 10
TC (K) – specimen UF temperature	3 10 14, 3 10 15
TM K ∅ 3 mm – ambient temperature	3 10 09
THERM 2260 + RTC (K)	3 10 13
Winding tape measure	3 01 29
Deflectometer Huggenberger	3 01 39÷42, 55÷58, 60÷62
Stop-watch	3 05 12
Thermo-hygro-barograph	3 13 06
Calliper	3 01 52

Measurement traceability of all measurement equipment is reported in the metrological registration card of the equipment; identified by the same metrological registration number as the equipment.

Quantity measured			**Extended**
Name	Symbol	Unit	**measurement uncertainty**
Time since the test beginning	t	(min)	3,4 10^{-2}min, for t ≤ 240 min
Integrity disruption time		(min)	< 0,5 min
Temperature: TC or K-type PTM + compensation cable (both of the 2nd tolerance class) + Almemo 5990-2	T	(°C)	$\sqrt{(6{,}40.10^{-6}.T^2 + 1{,}57.10^{1}°C^2)}$, for 40°C ≤ T < 375°C $\sqrt{(8{,}04.10^{-5}.T^2 + 7{,}84°C^2)}$, for 375°C ≤ T ≤ 1000°C
Ambient-to-in-furnace pressure difference	p	(Pa)	$\sqrt{(5.3.10^{-4}.p^2+1{,}1.10^{-5}Pa^2)}$
Weight		(g)	1 g
Deflection (horizontal distortion)		(mm)	1,8 mm

The reported expanded measurement uncertainty is stated as the combined standard measurement uncertainty multiplied by the coverage factor $k = 2$ such that the coverage probability corresponds to approximately 95 %.", see [6] and [7].

The measurement uncertainty arising from sampling is not included in the expanded measurement uncertainty. "Because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance, it is not possible stated a degree of accuracy of the result", see EN 1363-1: 12.1 w).

ANNEX B: MEASUREMENT

TEMPERATURE AND PRESSURE IN FURNACE, AMBIENT TEMPERATURE

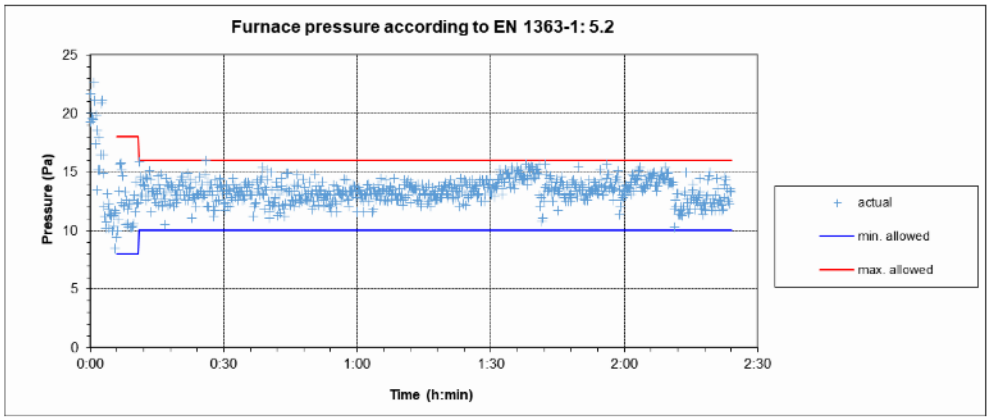
Test conditions according to EN 1363-1: 5

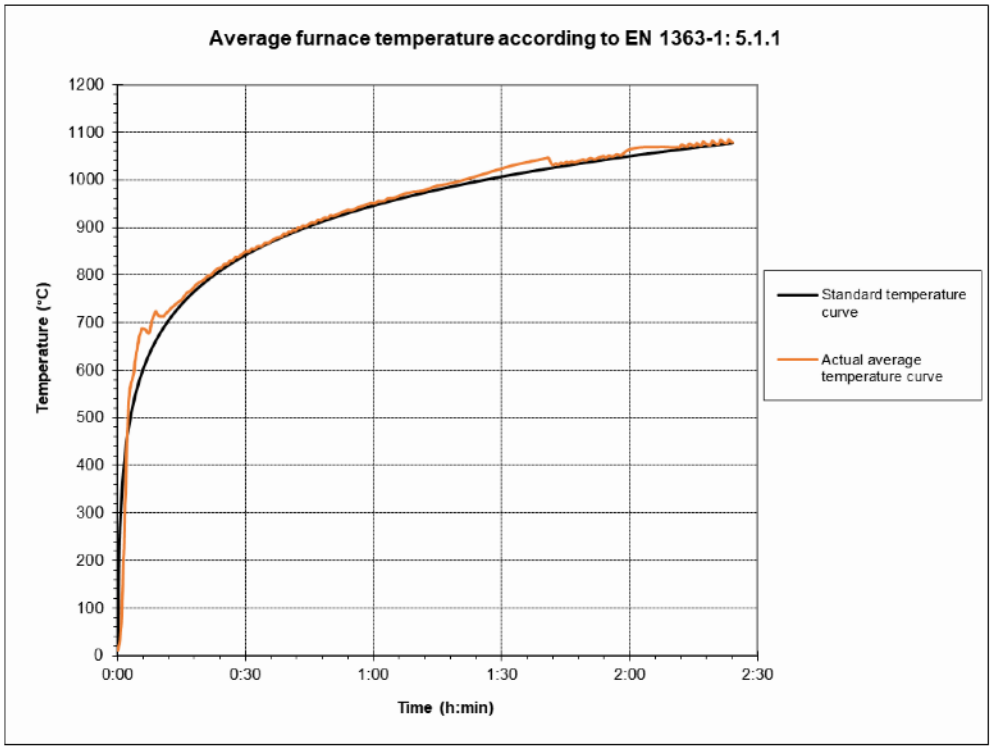
Time	Furnace temperatures																							Deviation d_e			Deviation from T		Probe pressure			Ambient
	T	58	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	avg	shall be within		actual	min	max	shall be within		actual	temperature
(h:min:s)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(%)	(%)	(%)	(°C)	(°C)	(Pa)	(Pa)	(Pa)	(°C)
0:00:00	20	12	11	11	11	11	11	11	11	12	12	12	11	11	12	11	11	11	10	12	12	12	11								21.7	11
0:05:00	576	654	663	663	663	680	681	685	692	702	688	672	644	674	629	638	680	671	676	687	681	644	670			-7.6					10.0	11
0:10:00	678	691	713	717	723	715	719	735	707	710	701	704	716	732	711	714	728	717	725	708	709	688	713	-15	15	2.8	10	57	8.0	18.0	13.0	11
0:15:00	739	741	743	744	753	742	744	774	739	754	740	754	746	757	741	749	763	761	756	740	759	734	749	-12.5	12.5	2.8	-4	35	10.0	16.0	13.2	11
0:30:00	842	852	839	838	848	838	845	865	847	860	847	857	847	849	842	847	853	853	858	853	864	849	850	-5.0	5.0	1.8	-4	24	10.0	16.0	12.3	11
0:45:00	902	905	899	898	907	901	904	912	905	921	909	915	909	906	905	907	910	910	922	905	922	906	908	-3.8	3.8	1.3	-5	20	10.0	16.0	12.2	11
1:00:00	945	942	944	944	953	951	949	952	945	956	948	954	954	950	953	952	953	951	966	945	960	948	951	-2.5	2.5	1.1	-3	20	10.0	16.0	11.6	11
1:15:00	979	979	980	983	990	982	987	991	983	992	985	991	991	985	990	989	990	989	1014	982	996	986	988	-2.5	2.5	1.0	0	35	10.0	16.0	13.5	12
1:30:00	1006	1014	1017	1019	1026	1019	1023	1024	1017	1026	1017	1027	1025	1021	1027	1024	1026	1023	1072	1013	1029	1023	1024	-2.5	2.5	1.1	7	66	10.0	16.0	13.3	12
1:45:00	1029	1025	1031	1031	1038	1031	1034	1034	1031	1042	1037	1036	1043	1036	1041	1036	1036	1035	1093	1028	1041	1032	1038	-2.5	2.5	1.2	-4	63	10.0	16.0	13.4	12
2:00:00	1049	1054	1053	1054	1060	1054	1062	1055	1059	1084	1057	1097	1061	1059	1061	1059	1057	1055	1138	1047	1072	1068	1065	-2.5	2.5	1.1	-2	89	10.0	16.0	13.3	13
2:15:00	1067	1058	1059	1060	1066	1061	1070	1061	1067	1094	1072	1090	1065	1063	1064	1063	1062	1061	1154	1056	1081	1078	1072	-2.5	2.5	1.1	-11	87	10.0	16.0	12.7	13
2:24:00	1076	1061	1068	1069	1074	1069	1077	1071	1074	1100	1079	1092	1074	1072	1072	1072	1071	1069	1170	1063	1088	1079	1079	-2.5	2.5	1.1	-15	94	10.0	16.0	13.3	13

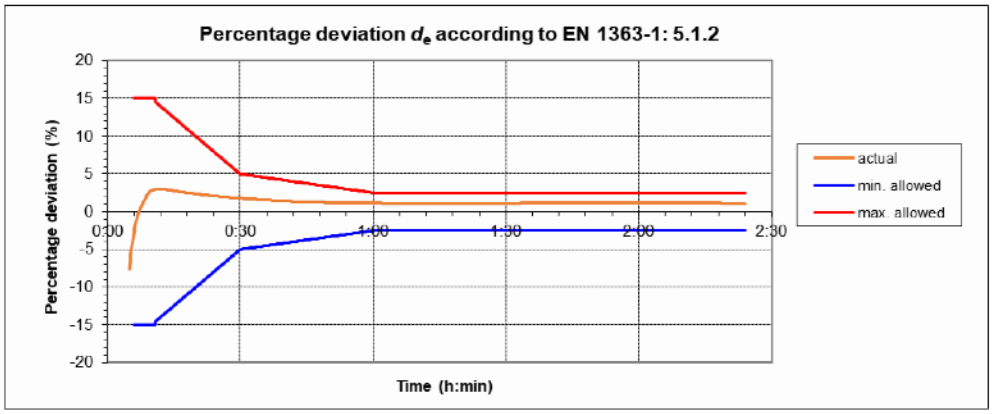
Key

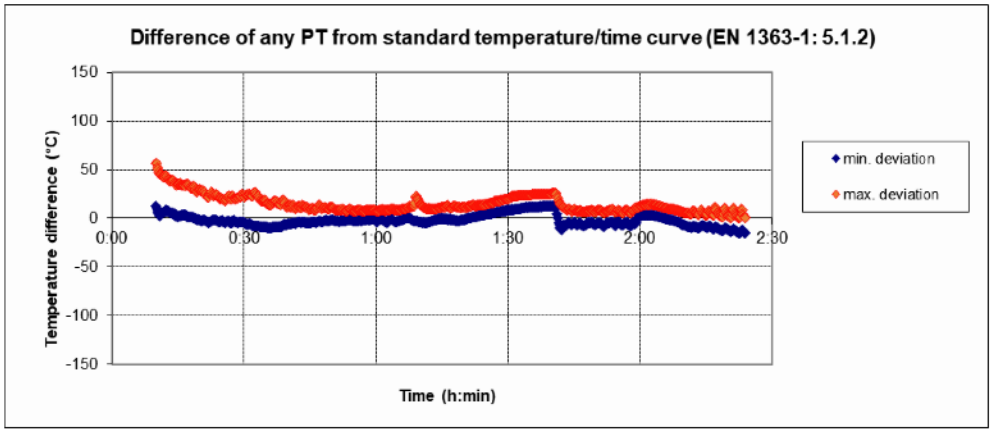
t is the time, in min;
T is the standard average furnace temperature, in °C, $\{T\} = 345.\log_{10}(8\{t\}+1) + 20$;
avg is the actual average furnace temperature, in °C;
d_e is the percentage deviation in the area of he actual average temperature/time curve from the area of the standard temperature/time curve;

"Pressure" is the difference of the pressure in the furnace and the ambient pressure at the same hight level:
The pressure of 20 Pa is required in height of 6 m
Then the pressure of 13 Pa is expected in pressure sensor 5.2 m

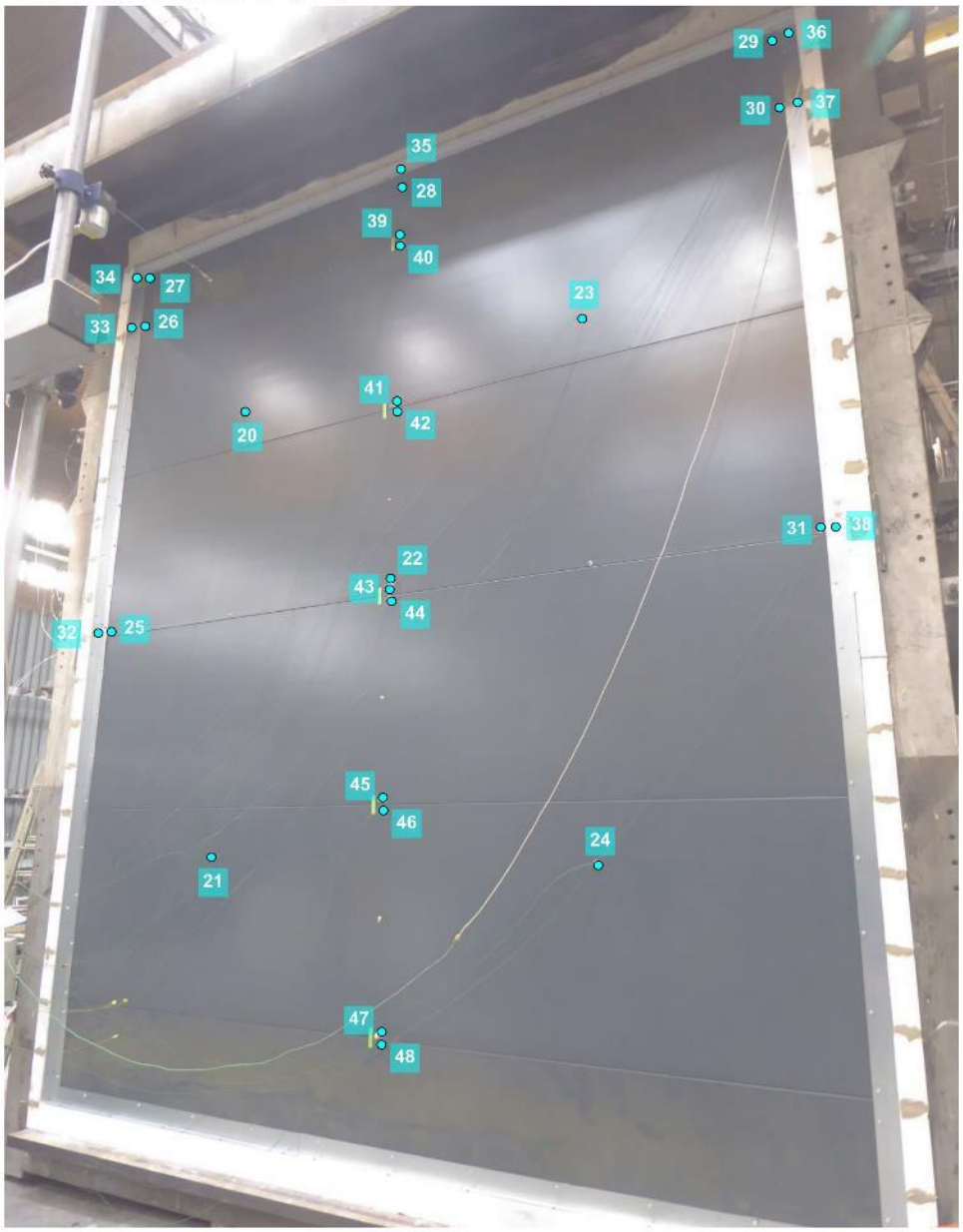

Furnace pressure according to EN 1363-1: 5.2
Pressure (Pa)
25
20
15
10
5
0
0:00
0:30
1:00
1:30
2:00
2:30
Time (h:min)
actual
min. allowed
max. allowed


Average furnace temperature according to EN 1363-1: 5.1.1
Temperature (°C)
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0:00
0:30
1:00
1:30
2:00
2:30
Time (h:min)
Standard temperature curve
Actual average temperature curve


Percentage deviation d_e according to EN 1363-1: 5.1.2
Percentage deviation (%)
20
15
10
5
0
-5
-10
-15
-20
0:00
0:30
1:00
1:30
2:00
2:30
Time (h:min)
actual
min. allowed
max. allowed


Difference of any PT from standard temperature/time curve (EN 1363-1: 5.1.2)
Temperature difference (°C)
150
100
50
0
-50
-100
-150
0:00
0:30
1:00
1:30
2:00
2:30
Time (h:min)
min. deviation
max. deviation

LAYOUT OF TC ON UF OF SPECIMEN



Key:

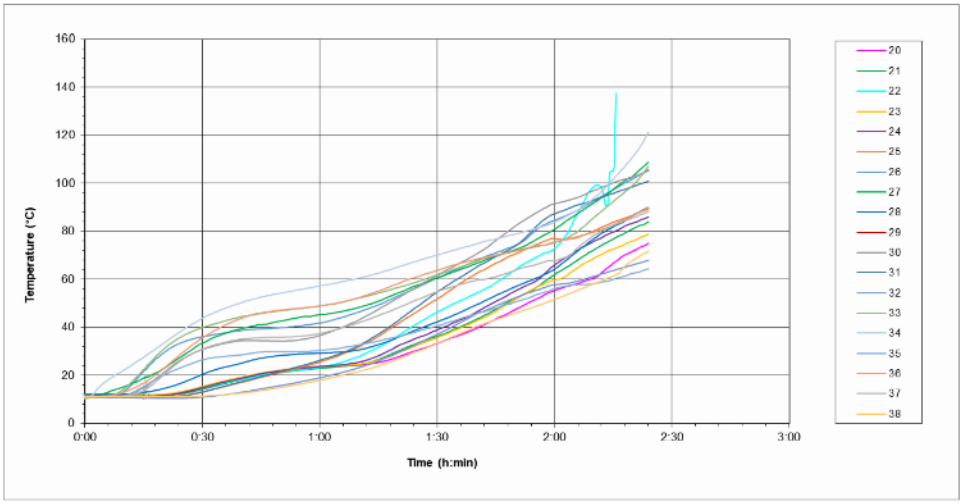
20 ÷ 24 - TC for T_{aver} and T_{max}

25 ÷ 48 - TC for T_{max}

Time	Temperature on the unexposed face of the specimen (°C)																				
	T_{aver}											T_{max}									
(h:min:s)	T_{aver}	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	T_{max}
0:00:00	**12**	12	11	12	12	11	11	12	11	12		11	11	11	11	10	11	11	11	11	**12**
0:05:00	**12**	12	11	12	12	11	11	12	13	12		11	11	11	11	17	11	11	11	11	**17**
0:10:00	**12**	12	12	12	12	11	11	13	15	12		11	11	11	14	22	12	13	11	11	**22**
0:15:00	**12**	12	12	12	12	12	11	22	19	13		15	11	10	23	27	16	17	14	11	**27**
0:30:00	**15**	14	14	15	15	15	13	36	33	20		31	13	11	40	44	26	36	31	11	**44**
0:45:00	**20**	21	20	20	21	21	19	39	41	27		34	20	14	46	53	30	46	36	14	**53**
1:00:00	**23**	24	23	23	24	24	26	42	45	29		37	26	19	49	57	30	49	37	18	**57**
1:15:00	**28**	25	27	32	26	28	36	49	51	33		48	37	26	54	63	34	55	45	24	**63**
1:30:00	**38**	33	36	46	36	39	52	61	61	42		62	55	37	62	70	41	64	55	34	**70**
1:45:00	**49**	44	48	59	47	51	67	71	70	53		76	70	49	70	77	48	70	61	43	**77**
2:00:00	**63**	55	62	73	60	66	77	85	81	64		92	87	58	75	84	56	76	68	52	**92**
2:15:00	**80**	67	77	105	73	80	84	97	98	82		100	96	64	92	102	60	83	83	61	**105**
2:24:00	**81**	75	84		79	86	89	106	109	90		105	101	68	107	121	64	90	88	72	**121**

Temperature recorded at 10 s intervals. In the table, they figure in 15 minute intervals

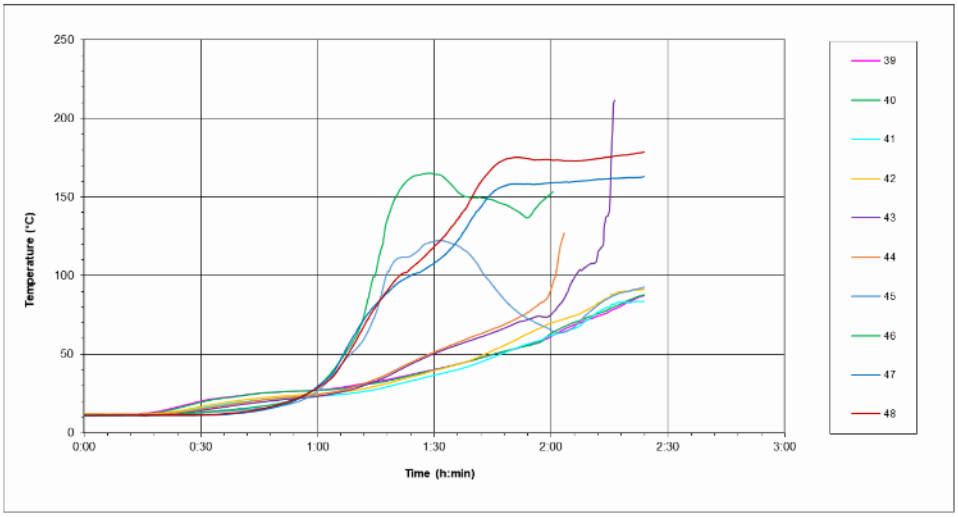
XX	Designation of measuring joint of TC as figured in Annex B
XX	Time and temperature when the insulation criterion has been exceeded
	TC fell down
	Failure of TC

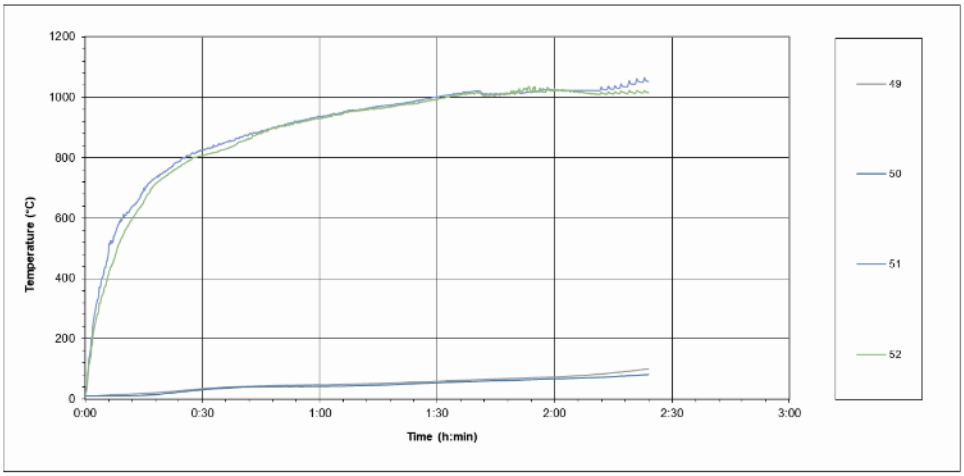


Time	Temperature on the unexposed face / fixing of the specimen (°C)														
		T_{max}										T_{fixing}			
(h:min:s)	T_{max}	39	40	41	42	43	44	45	46	47	48	49	50	51	52
0:00:00	**12**	12	12	12	12	12	12	11	12	11	11	11	11	10	11
0:05:00	**12**	12	12	12	12	12	12	11	12	11	11	13	11	434	373
0:10:00	**12**	12	12	12	12	12	12	11	12	11	11	16	11	604	551
0:15:00	**13**	13	12	12	12	12	12	11	11	11	11	20	13	698	657
0:30:00	**20**	20	20	16	17	15	15	13	13	11	12	35	31	825	808
0:45:00	**25**	25	25	21	22	20	21	16	17	14	15	44	41	889	881
1:00:00	**30**	27	27	24	25	24	24	27	30	30	29	48	42	936	931
1:15:00	**102**	33	32	28	30	33	34	76	102	82	80	52	46	971	966
1:30:00	**165**	40	40	37	40	51	52	122	165	108	119	59	54	1002	995
1:45:00	**168**	50	50	48	52	64	66	94	148	153	168	66	60	1013	1007
2:00:00	**174**	62	63	62	70	75	92	65	153	159	174	73	66	1025	1031
2:15:00	**175**	77	79	80	86	141		86		162	175	87	74	1027	1013
2:15:50	**192**	78	80	82	88	192		87		162	176	88	74	1033	1017
2:24:00	**179**	87	88	84	91			93		163	179	100	81	1053	1017

Temperature recorded at 10 s intervals. In the table, they figure in 15 minute intervals

XX	Designation of measuring joint of TC as figured in Annex B
XX	Time and temperature when the insulation criterion has been exceeded
	TC fell down

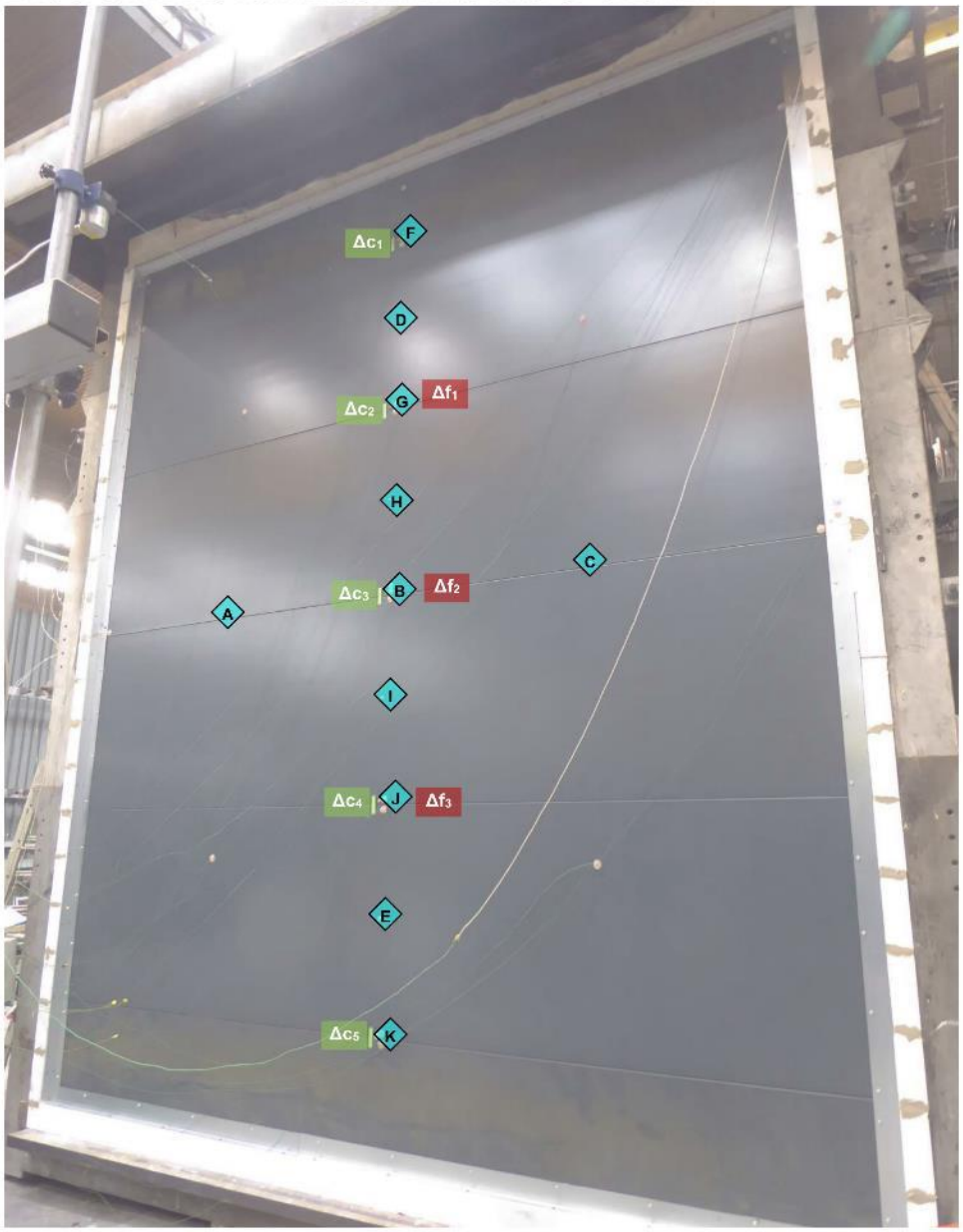




Key:

49, 50	- TC on UF of the screw
51, 52	- TC on EF of the screw

LAYOUT OF DEFLECTION MEASUREMENTS ON UF OF SPECIMEN



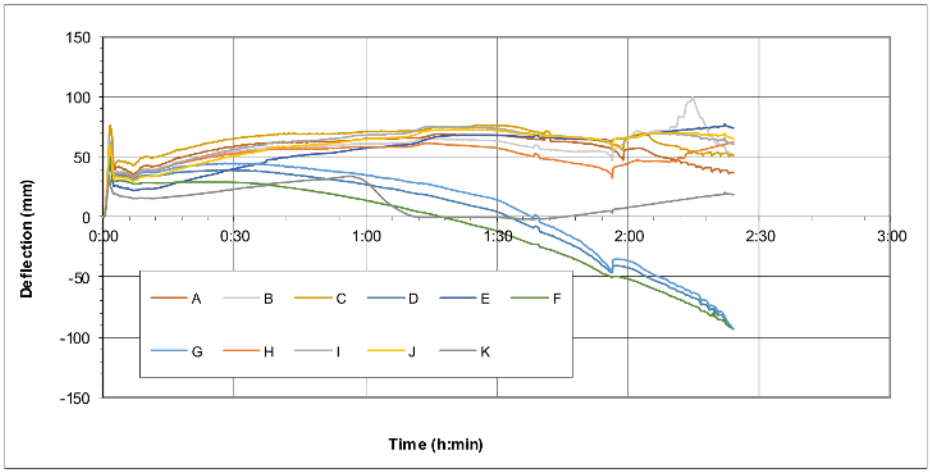
Key:

A ÷ K - points of measurement of horizontal deflection

Δf_x - deflection difference according to EN 15254-5, Figure B.1

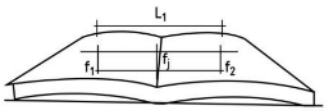
Δc_x - deflection difference according to EN 15254-5, Figure B.2

Time	Deflection (mm)										
(h:min:s)	A	B	C	D	E	F	G	H	I	J	K
0:00:00	0	0	0	0	0	0	0	0	0	0	0
0:05:00	40	37	46	34	24	30	37	37	37	33	17
0:10:00	42	40	50	34	23	28	38	39	39	34	16
0:15:00	46	42	53	35	26	28	40	42	42	37	17
0:30:00	59	54	65	38	40	29	45	53	56	51	23
0:45:00	62	59	69	34	51	23	42	57	64	59	30
1:00:00	65	61	71	26	57	14	35	59	68	65	30
1:15:00	68	65	74	17	66	2	27	62	76	72	-1
1:30:00	68	63	76	4	68	-12	14	58	74	72	-1
1:45:00	63	55	67	-20	65	-31	-13	47	68	67	0
2:00:00	57	64	66	-43	66	-52	-37	45	66	66	8
2:15:00	44	97	55	-68	73	-74	-64	55	68	70	16
2:24:00	37	51	52	-94	74	-93	-94	63	61	65	19



Values "+" - deflection in furnace
Values "-" - deflection away from furnace

Measurement according to EN 15254-5, Annex B:

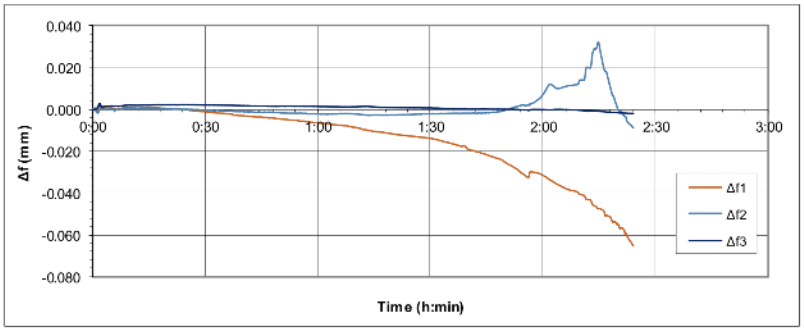


$$\Delta f = (f_j - 0{,}5x(f_1 + f_2))/L_1$$

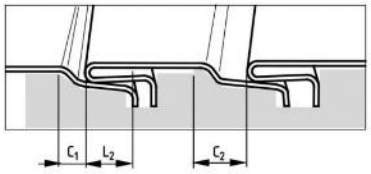
Figure B.1 — Calculation of Δf in midspan section

L_1 = 1200 mm

Time (h:min:s)	Deflection difference (mm) Δf_1	Δf_2	Δf_3
0:00:00	0.000	0.000	0.000
0:05:00	0.001	0.000	0.002
0:10:00	0.001	0.001	0.002
0:15:00	0.001	0.000	0.002
0:30:00	-0.001	0.000	0.002
0:45:00	-0.004	-0.001	0.002
1:00:00	-0.006	-0.002	0.002
1:15:00	-0.010	-0.003	0.001
1:30:00	-0.014	-0.002	0.001
1:45:00	-0.022	-0.002	0.000
2:00:00	-0.032	0.007	0.000
2:15:00	-0.047	0.030	-0.001
2:24:00	-0.065	-0.009	-0.002



Measurement according to EN 15254-5, Annex B:



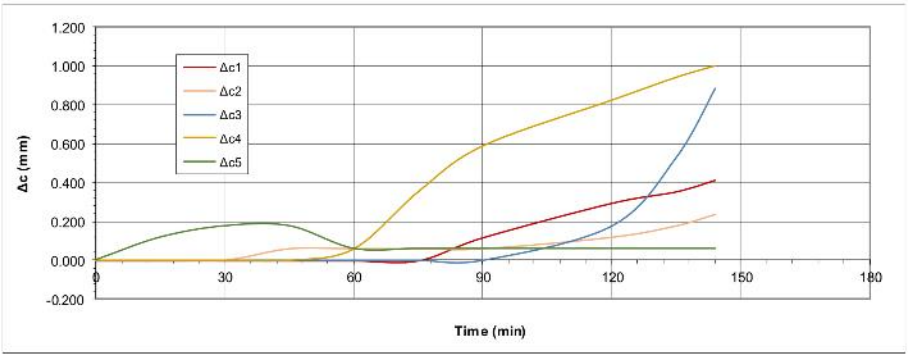
$\Delta c = (c_2 - c_1)/L_2$

Figure B.2 — Calculation of Δc

L_2 = 17 mm

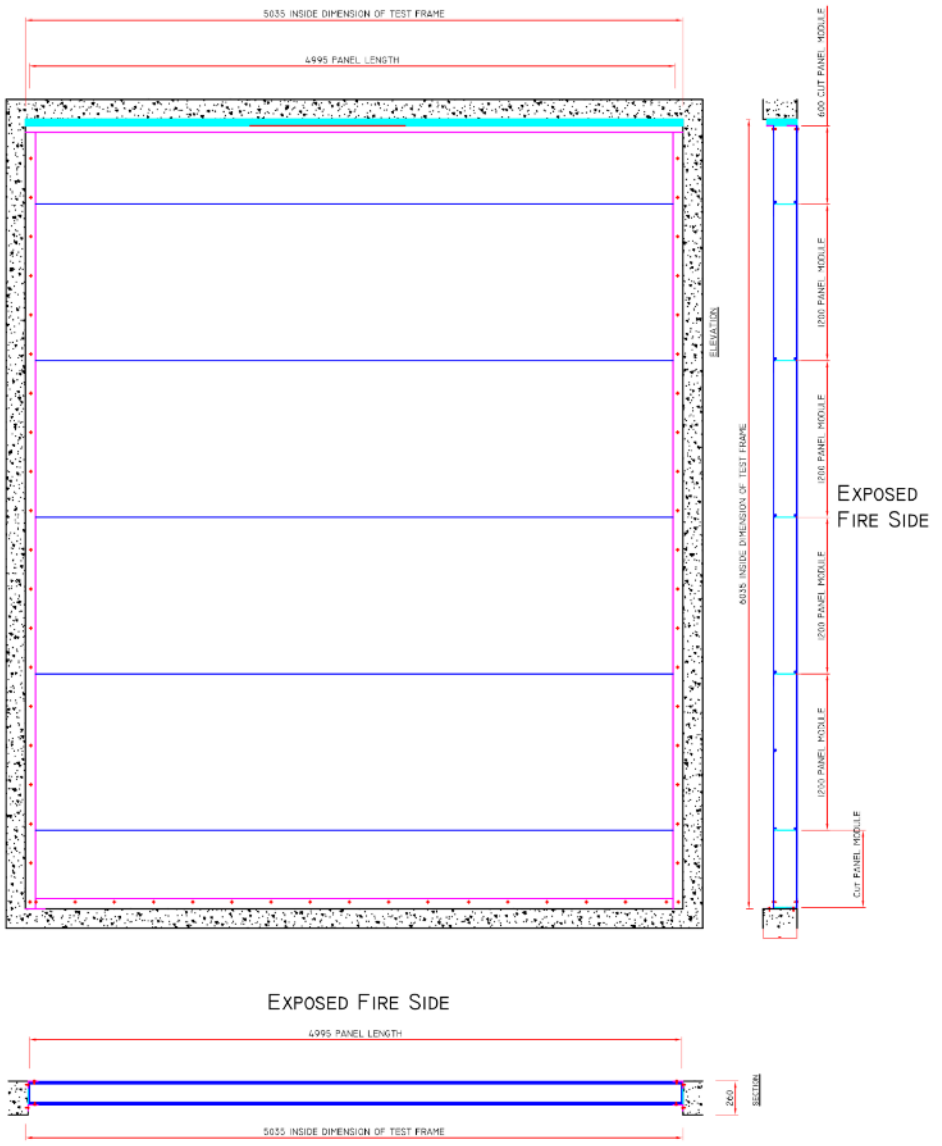
c_0 = 2 mm (before the test)

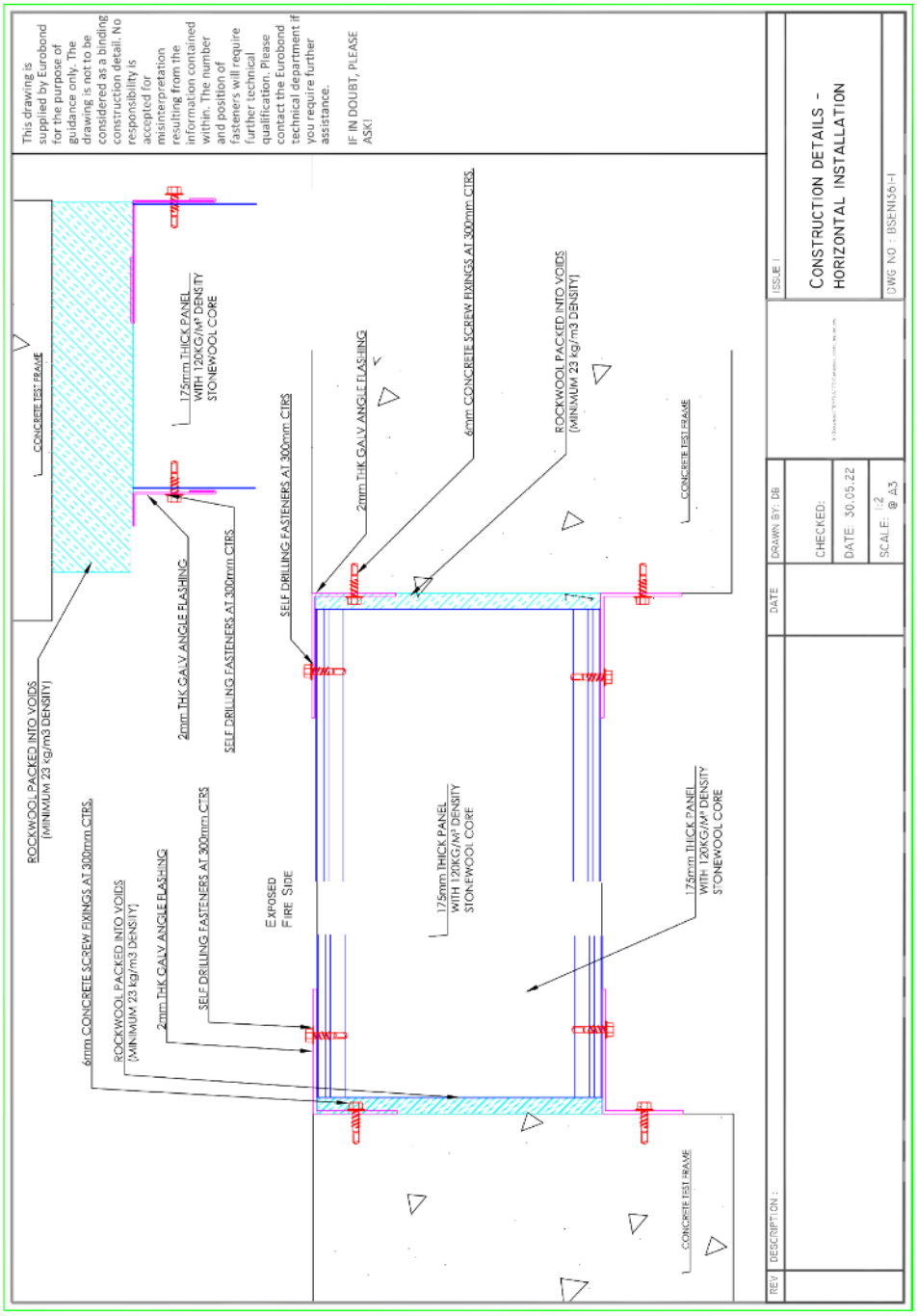
Time (min)	Deflection difference (mm)				
	Δc_1	Δc_2	Δc_3	Δc_4	Δc_5
0	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.118
30	0.000	0.000	0.000	0.000	0.176
45	0.000	0.059	0.000	0.000	0.176
60	0.000	0.059	0.000	0.059	0.059
75	0.000	0.059	0.000	0.353	0.059
90	0.118	0.059	0.000	0.588	0.059
120	0.294	0.118	0.176	0.824	0.059
135	0.353	0.176	0.529	0.941	0.059
144	0.412	0.235	0.882	1.000	0.059



ANNEX C: DOCUMENTATION

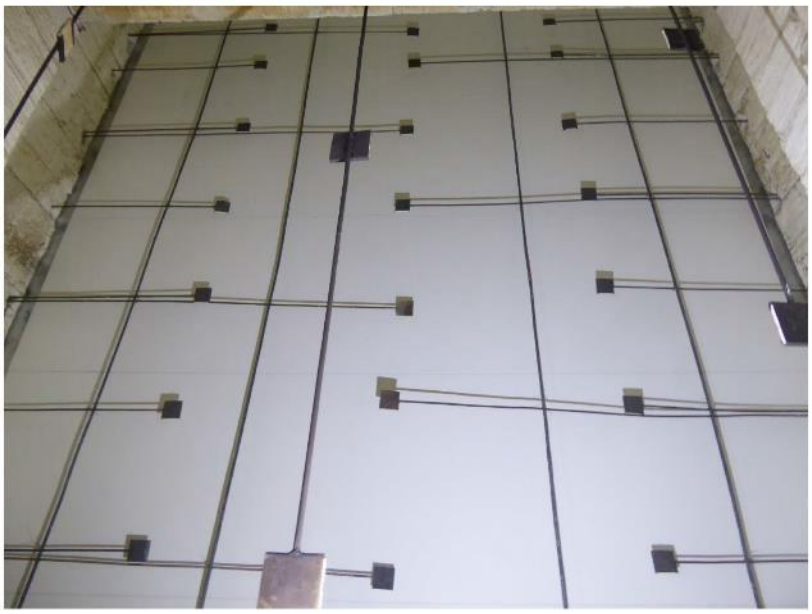
Specimen-related documentation delivered by the test sponsor.



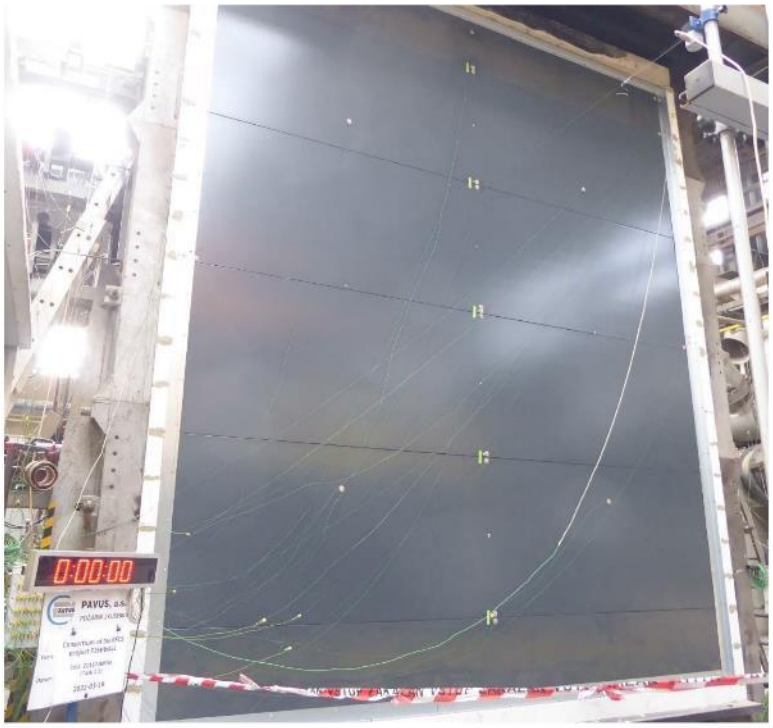

This drawing is supplied by Eurobond for the purpose of guidance only. The drawing is not to be considered as a binding construction detail. No responsibility is accepted for misinterpretation resulting from the information contained within. The number and position of fasteners will require further technical qualification. Please contact the Eurobond technical department if you require further assistance.
IF IN DOUBT, PLEASE ASK!
CONCRETE TEST FRAME
175mm THICK PANEL WITH 120KG/M³ DENSITY STONEWOOL CORE
ROCKWOOL PACKED INTO VOIDS (MINIMUM 23 kg/m3 DENSITY)
2mm THK GALV ANGLE FLASHING
SELF DRILLING FASTENERS AT 300mm CTRS
6mm CONCRETE SCREW FIXINGS AT 300mm CTRS
EXPOSED FIRE SIDE
CONSTRUCTION DETAILS - HORIZONTAL INSTALLATION
ISSUE 1
DRAWN BY: DB
CHECKED:
DATE: 30.05.22
SCALE: 1:2 @ A3
DWG NO : BSEN1364-1
REV
DESCRIPTION :
DATE

ANNEX D: PHOTOS

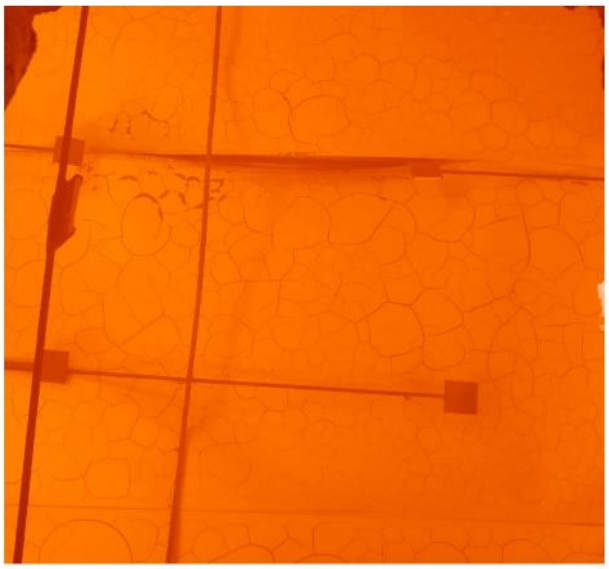
Assembly of the specimen



EF before the test

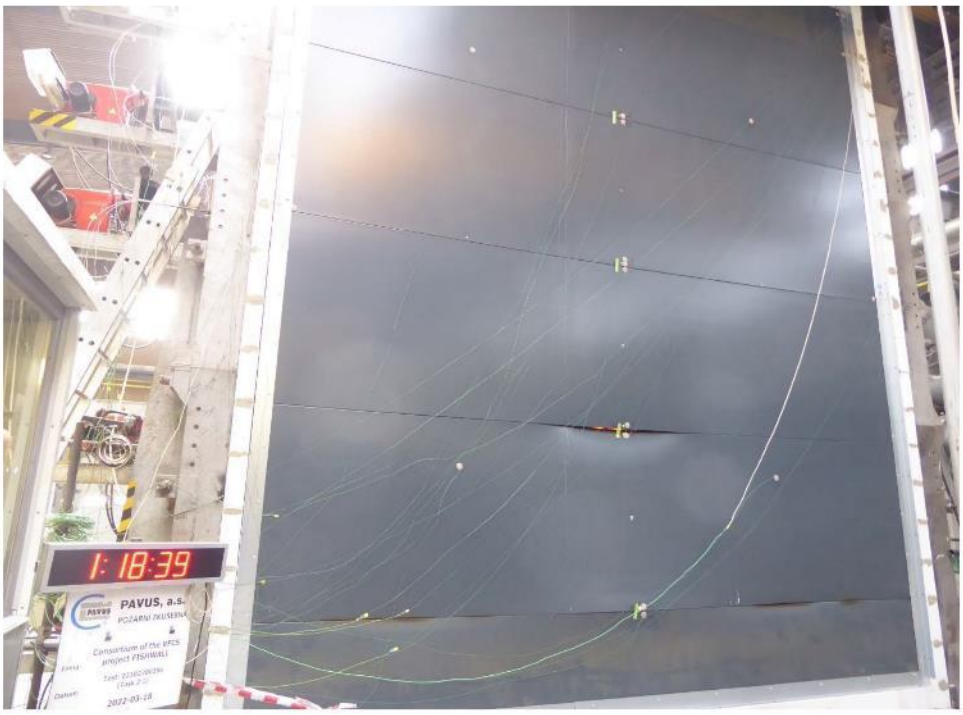


UF before the test

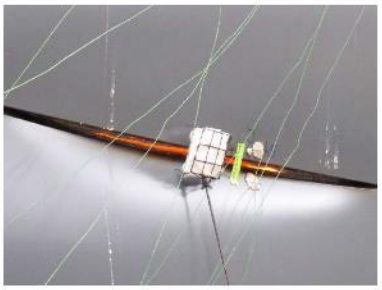


EF after 30 minutes of the test

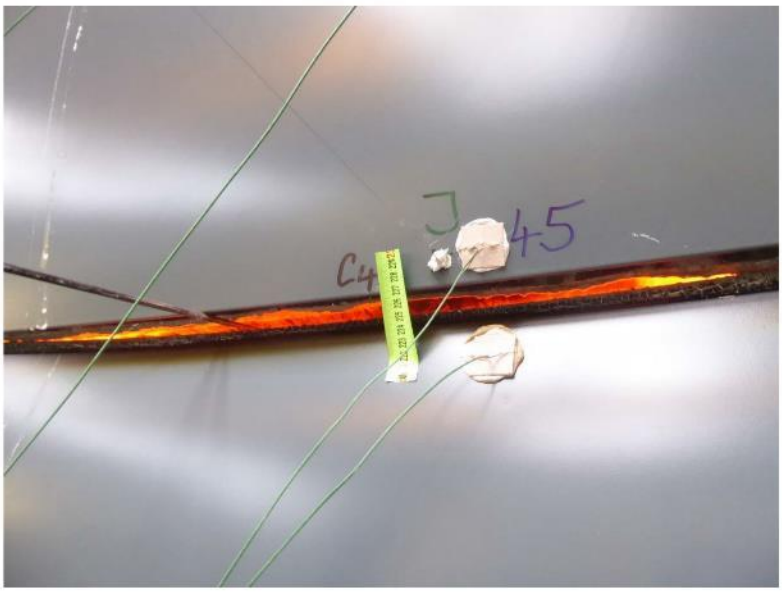
UF after 60 minutes of the test



UF after 78 minutes of the test



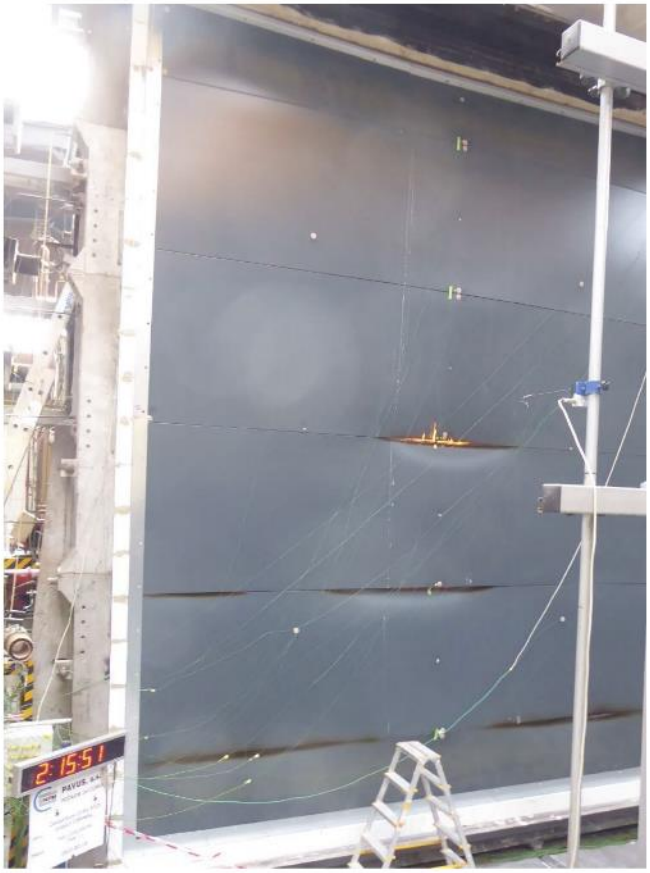
UF in 90th minute of the test - cotton pad test - without integrity failure



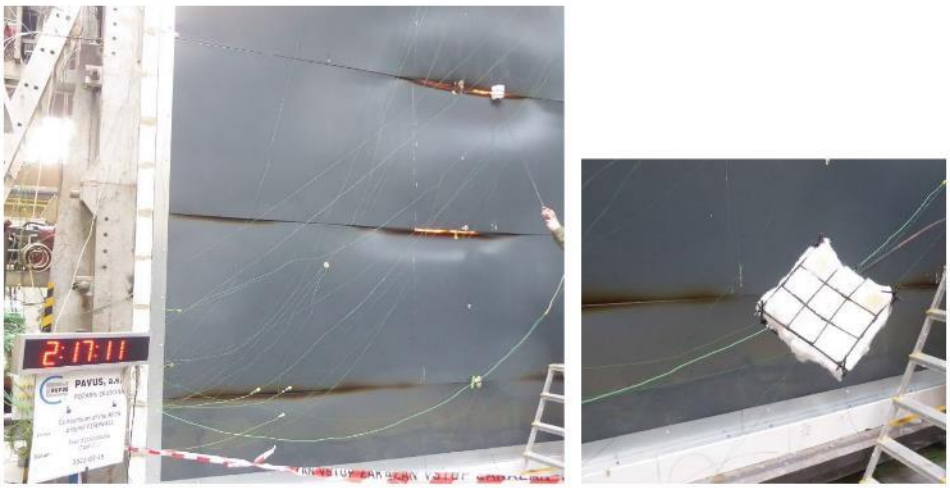
UF in 94th minute of the test - 6 mm gap gauge can't pass through the specimen - without integrity failure

UF in 127th minute of the test - 6 mm gap gauge passed through the specimen in distance longer than 150 mm along the gap - integrity failure

UF in 128th minute of the test - cotton pad test - without integrity failure



UF after 135 minutes of the test - sustained flaming in the middle part of the specimen



UF in 138th minute of the test - cotton pad test - without integrity failure

UF after 144 minutes - end of the test

EF the second day after the test

APPPENDIX B. REPORT N°PR-22-2.086-EN FOR TEST N°2

PAVUS
FIRE TESTING INSTITUTE

Order No.: Z210220039

PAVUS, a.s.
AUTHORIZED BODY 216
NOTIFIED BODY 1391
ACCREDITED TESTING LABORATORY
EGOLF MEMBER

ilac-MRA

L 1026

FIRE TESTING LABORATORY VESELÍ NAD LUŽNICÍ
Testing Laboratory No. 1026 accredited by ČIA
Notified Testing Laboratory
workplace Veselí nad Lužnicí

FIRE RESISTANCE TEST REPORT

No. Pr-22-2.086-En

issued on 2022-06-13

For product

Non-loadbearing wall 5 x 6 m

External wall made of sandwich panels Eurobond Rockspan Extra (horizontal cladding with steel column)

Sponsor: **Consortium of the RFCS project FISHWALL**

cticm · UNIVERSITÀ DI TRENTO · CTU · JORISIDE THE STEEL FUTURE · BRIAND CONSTRUCTION METALLIQUE · PAVUS FIRE TESTING INSTITUTE · L'ENVELOPPE MÉTALLIQUE DU BÂTIMENT · Efectis · euroclad group

Test method:

ČSN EN 1364-1
» Fire resistance tests for non-loadbearing elements - Part 1: Walls «

Test Report includes 31 pages
(6 pages of text + 4 Annexes)

Number of copies: 2
Copy number: 1

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1 INTRODUCTION

The fire resistance test of the non-loadbearing wall was performed based on the order of Consortium of the RFCS project FISHWALL in Fire Testing Laboratory PAVUS, a.s. in Veselí nad Lužnicí.

The test was prepared, performed and assessed on the base of following documents:

[1] ČSN EN 1364-1:2017 Fire resistance tests for non-loadbearing elements - Part 1: Walls

[2] ČSN EN 1363-1:2021 Fire resistance tests - Part 1: General requirement

[3] ČSN EN 1363-2:2000 Fire resistance tests - Part 2: Alternative and supplementary procedures

[4] ČSN EN 15254-5:2019 Extended application of results from fire resistance tests - Non-loadbearing walls - Part 5: Metal sandwich panel construction

[5] ČSN EN 13501-2:2017 Fire classification of construction products and building elements - Part 2: Classification using test data from resistance fire tests, excluding ventilation services

[6] ČSN EN 1366-4 Fire resistance tests for service installations - Part 4: Linear joint seals

[7] ČSN EN 13381-4:2018 Test methods for determining the contribution to the fire resistance of structural members - Part 4: Applied passive protection to steel members

[8] ILAC-G17:01/2021 Guidelines for Measurement Uncertainty in Testing

[9] JCGM 100:2008 GUM 1995 with minor corrections, Evaluation of measurement data - Guide to the expression of uncertainty in measurement (Available from www.BIPM.org)

[10] Specimen-related technical documentation delivered by the test sponsor

For the purposes of this document, definitions given in [1] ÷ [9] together with following abbreviations apply:

ČIA	Český institut pro akreditaci, o.p.s. (Czech Institute for Accreditation)
ATL	accredited testing laboratory
TC	thermocouple
TM	thermometer (sheathed TC)
PTM	plate thermometer fit with a TM ∅ 2 mm
EF	exposed specimen face
UF	unexposed specimen face
RTC	roving thermocouple

2 TEST SUBJECT

The subject matter of the test was represented by a specimen of prebuilt non-loadbearing wall with total dimensions of 5 035 mm (width) × 6 000 mm (height) x 175 mm (thickness) of sandwich panels Eurobond Rockspan Extra horizontally oriented. The specimen in test frame was mounted to rigid construction with low density, thickness 250 mm, density 550 kg/m^3.

Description of the construction:

Non-loadbearing external wall consisted of 12 pcs of sandwich panels Eurobond Rockspan Extra with mineral wool as an insulation core, nominal density of mineral wool was 120 kg/m^3. Each panel had dimensions of 1 200 mm (stock width) × 175 mm (thickness), length of 4 400 mm (6 panels), resp. 545 mm (6 panels), forming the joint with the steel column of width approx 15 mm, filled in full depth with mineral wool Knauf POWER-TEK BD 660, nominal density 100 kg/m^3. One panel was reduced to ½ in width and it was mounted to the upper edge of the wall, so that the horizontal contact of panels was 500 ± 150 mm far from the upper edge. Another ½ of panel was mounted to the lower edge of the wall. On EF, the panels had profiled metal sheet, th. 0.5 mm (interior side) and on UF, they had metal sheet, th. 0.5 mm (exterior side), both sheets were galvanized and coated.

On both vertical sides and on the bottom part of the rigid construction, L-profiles 100x50x2 were mounted on EF (and also on UF in the end of the assembly), aligned with the edge of the rigid construction. The profiles were anchored to the rigid construction using carbon steel screws TutFast HTF-6.3 x 57 (producer Fixfast Ltd) in spacing of 450 mm. The top part of the specimen was without mechanical fixing.

Particular panels were anchored to the L-profiles using stainless screws DrillFast DF2-SS-LS-A15-6.3 x 25 (producer Fixfast Ltd) in the direction from EF, in spacing of 300 mm. On one side, the panels were anchored to the steel column with stainless screws DrillFast DF3-SS-HT-A15-5.5 x 225 (producer Fixfast Ltd) in spacing of 500 mm.

The structural gaps between the test specimen and the rigid construction were filled up with mineral wool, width of the gap between 20 and 30 mm.

The upper horizontal edge was left unrestrained in order to enable free specimen moving. The gap between the specimen and the rigid construction of width 50 mm was filled up with mineral wool.

Description of the steel column and its fire protection:

In distance 577 mm from the rigid construction, there was mounted steel column, section IPE 240, in length of 6 140 mm. The column was screwed with one bolt M20 through two steel angles L 160x160x16 on both ends. On the bottom end, the steel angles were welded to the testing frame, on the top end, the steel angles were fixed to the concrete lintel with screws M12x140 (4 pieces / 1 angle). Slotted hole was drilled in the top end of the steel column for possibility of the thermal movement of the section.

From the inner side of the flanges, there were fixed supporting steel angles 50x50x2 with screws RPK12-SS-5.5 x 38 (producer Fixfast Ltd) in spacing of 500 mm. Boxed fire protection of the steel column was made of 3 cut pieces of length 6 000 mm (2x width of 240 mm, 1x width of 470 mm) of the sandwich panels Eurobond Rockspan Extra, th. 175 mm. Panels were fixed to the supporting steel angles using stainless screws DrillFast DF3-SS-HT-A15-5.5 x 225 (producer Fixfast Ltd) in spacing of 500 mm, on two vertical sides with washers Fixfast SP-40-DD (producer Fixfast Ltd).

On the corners of the fire protection and on the joint of the panels with steel column, there were fixed covering steel sheets, th. 0.35 mm.

Test specimen related technical documentation delivered by the test sponsor is documented in Annex C.

The specimen was mounted as per [1] cl. 7 and Annex C of this Test Report.

The tested specimen was manufactured by company Euroclad Group Ltd.

The Testing Laboratory did not participate in extracting elements used for test specimen assembly.

The parts of the test specimen were delivered to the test laboratory on 11th March 2022 without any defects and mounted from 5th to 7th April 2022 to the test frame by company Euroclad Group Ltd in accordance with the delivered documentation.

3 TEST PERFORMANCE

3.1 General

The fire resistance test was performed as per [1] on 12th April 2022 in Testing hall PO 1 in vertical wall furnace with inner dimensions of 5 000 mm (width) × 6 000 mm (height) × 1 500 mm (depth).

Direction of fire exposure from interior side (with the steel column).

Used testing and gauging equipment is stated in Annex A.

3.2 Furnace control

The test furnace was heated with a set of oil burners. In-furnace temperatures were measured by the help of PTMs and recorded at minute intervals. The measuring wires of PTM were distributed uniformly in a distance of 100 mm from the exposed face of fire protection of the steel column according to [1] cl. 9.1.1.

In-furnace temperatures for standard heating curve according to [2] were controlled so that they conformed to the relation according to [2] cl. 5.1.1, within the specified limits (see [2] cl. 5.1.2):

$$T = 345 \log (8t + 1) + 20$$

where T (°C) = required in-furnace temperature in time °C
t (min) = time since the test beginning

The test furnace positive pressure was measured and controlled so that the values correspond to the conditions of [1] cl. 9.2 and [2] cl. 5.2.1 and 9.2.1.

3.3 Specimen measuring

The specimen unexposed face and inner temperatures were taken using K-type disc TCs and recorded at minute intervals. The TCs were fixed on the specimen surface and according to [1] cl. 9.1.2.2, 9.1.2.3, B.3 and with respect to [6] cl. 9.2.2, on the surface of the steel column with respect to [7] cl. 9.3.

The rate of the horizontal deflection was measured by deflectometers spaced according to [1] cl. 9.3.

One RTC (see [2] cl. 4.5.1.3) was available to measure points where higher temperatures were expected.

The measured points of deflections and the TC positions are described and figured in Annex B.

The initial test conditions met the standard values as per [2] cl. 10.3.

3.4 Ambient temperature

During the test, the ambient temperature was measured using one K-type TM (see [2] cl. 4.5.1.5) according to the conditions of [2] cl. 5.6.

3.5 Conditioning

From the specimen delivery to the Fire Testing Laboratory until the test performance, the specimen was stored in the enclosed ambient of test hall at the air temperature of (15 ± 5) °C and at relative air humidity of (50 ± 5) %.

4 TEST COURSE

Time (min)	Test observation
2.	audible crackling in the panels
15.	EF - metal sheets are strongly bent nearby the joints of the panels and angles on the fire protection of the steel column
65.	UF - strong smoke from the upper part of the vertical joint (connection column-panels)
105.	UF - opening of the joint by measured point c_4
135.	UF - larger opening of the joint by measured point c_4, visible light from the furnace
153.	UF - cotton pad test by measured point c_4 - without failure
164.	UF - 6 mm gap gauge passes through the specimen by measured point c_4 in distance longer than 150 mm - **integrity failure**
167.	UF - darkening and opening of the joint by measured point c_5
181.	end of the test at request of the Sponsor

Layout of TC described in Annex B. Deflections are described in Annex B.

The in-furnace temperatures and pressures met the requirements of [2]. Time relations to the measured temperatures and pressures are specified in Annex B.

5 TEST RESULTS

5.1 Limit state attainment criteria

+ **Integrity** (according to [2] cl. 11.2). This criterion means the time in completed minutes for which the test specimen continues to maintain its separating function during the test without either:
  a) causing the ignition of a cotton pad applied in accordance with [2] cl. 10.4.5.2; or
  b) permitting the penetration of a gap gauge as specified in [2] cl. 10.4.5.3; or
  c) resulting in sustained flaming.

- **Insulation** (according to [2] cl. 11.3). This criterion means the time in completed minutes for which the test specimen continues to maintain its separating function during the test without developing temperatures on its unexposed surface which either:
  a) increase the average temperature above the initial average temperature by more than 140 K; or
  b) increase the temperature at any location (incl. RTC) above the initial average temperature by more than 180 K.

- **Radiation** (according to [1] cl. 9.4 and [3] cl. 8). The criterion of radiation is deemed to be observed until the measured radiation does not exceed the value of 15 kW.m^{-2}. The time for the measured radiation to exceed the value of 5, 10, 15, 20 and 25 kW.m^{-2} is reported.

5.2 Expression of test results

Criterion	Partial criterion	Measured value	Evaluation
Integrity	Cotton pad ignition	180 min, no failure	180 min
	Gap gauge passage	163 min	163 min
	Sustained flaming	180 min, no failure	180 min
Insulation	Average temperature	180 min, no failure	163 min [1]
	Maximum temperature	122 min	122 min
Radiation	6 kW.m^{-2} (not measured) [2]	163 min [3]	

Notes:

[1] The performance criteria "insulation" shall automatically be assumed not to be satisfied when the "integrity" criterion ceases to be satisfied (see [2] cl. 11.4.2).

[2] There is no requirement to measure the radiation from a surface with a temperature below 300 °C because the radiation from such a surface is low (see [3] cl. 8.1). Average temperature on the UF of the specimen didn't exceed 300 °C.

[3] Failure of integrity under the cracks or openings in excess of given dimensions criteria means automatically failure of the radiation criterion. (see [5] cl. 5.2.4).

5.3 Field of direct application

The results of the fire test are directly applicable to similar constructions where one or more of the changes listed below are made and the construction continues to comply with the appropriate design code for its stiffness and stability:

- decrease in height and/or width of the wall;
- increase in the number of horizontal joints, of the type tested;
- decrease in distance of fixing centres;
- increase in the thickness of the wall;
- decrease in linear dimensions of boards or panels but not thickness;
- the width of the construction may be increased by 1.0 m under the maximum deflection of the test specimen was not in excess of 100 mm and the expansion allowances are increased pro-rata;
- the height of the construction with the same element height as tested may be increased by up to a third of the tested height.

The results are applicable to high density rigid supporting constructions with at least the same fire resistance as the test specimen.

5.4 Application of test results

- The test results refer only to the tested specimen including the way of its mounting into the construction (see part 2 of this Report).
- This report details the method of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outlined in ČSN EN 1363-1, ČSN EN 1363-2 and ČSN EN 1364-1. Any significant deviation with respect to size, constructional details, loads, stresses, edge or end conditions other than those allowed under the field of direct application in the relevant test method is not covered by this report.

The Report and Annex sheets are valid with the embossed stamp only.

Elaborated by: ..... Jiří VANĚK, Technical Officer

Approved by: ..... Jiří KÁPL, ATL Manager

ANNEX A: TESTING AND GAUGING DEVICES, MEASUREMENT UNCERTAINTY

Test equipment:	**Device registration number:**
Vertical wall furnace PO 1 supplemented by modules increasing the size of the furnace to 5 m x 6 m (+ equipment for temperature and pressure control)	0127
Furnace pressure probe	0011
Test frame	0129/1
Gap gauge ∅ 6 mm	0112
Gap gauge ∅ 25 mm	0113
Cotton pad frame	0014
Gauging equipment:	**Metrological registration number:**
Differential pressure gauge AMR DPS	3 09 29
Datalogger Almemo 5990-2	3 10 85
PTM – in-furnace temperature (TM K ∅ 2 mm)	3 10 10
TC (K) – specimen UF temperature	3 10 14, 3 10 15
TM K ∅ 3 mm – ambient temperature	3 10 09
THERM 2260 + RTC (K)	3 10 13
Winding tape measure	3 01 29
Deflectometer Huggenberger	3 01 32, 33, 39÷42, 55÷58, 60÷62
Stop-watch	3 05 12
Thermo-hygro-barograph	3 13 06
Calliper	3 01 52

Measurement traceability of all measurement equipment is reported in the metrological registration card of the equipment; identified by the same metrological registration number as the equipment.

Quantity measured			**Extended measurement uncertainty**
Name	Symbol	Unit	
Time since the test beginning	t	(min)	$3{,}4\ 10^{-2}$min, for $t \leq 240$ min
Integrity disruption time		(min)	< 0,5 min
Temperature: TC or K-type PTM + compensation cable (both of the 2nd tolerance class) + Almemo 5990-2	T	(°C)	$\sqrt{(6{,}40.10^{-6}.T^2 + 1{,}57.10^{1}°C^2)}$, for 40°C ≤ T < 375°C $\sqrt{(8{,}04.10^{-5}.T^2 + 7{,}84°C^2)}$, for 375°C ≤ T ≤ 1000°C
Ambient-to-in-furnace pressure difference	p	(Pa)	$\sqrt{(5.3.10^{-4}.p^2+1{,}1.10^{-5}Pa^2)}$
Weight		(g)	1 g
Deflection (horizontal distortion)		(mm)	1,8 mm

The reported expanded measurement uncertainty is stated as the combined standard measurement uncertainty multiplied by the coverage factor $k = 2$ such that the coverage probability corresponds to approximately 95 %.", see [8] and [9].

The measurement uncertainty arising from sampling is not included in the expanded measurement uncertainty. "Because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance, it is not possible stated a degree of accuracy of the result", see EN 1363-1: 12.1 w).

ANNEX B: MEASUREMENT

TEMPERATURE AND PRESSURE IN FURNACE, AMBIENT TEMPERATURE

Test conditions according to EN 1363-1: 5

Time	Furnace temperatures																							Deviation d_e			Deviation from T		Probe pressure			Ambient
	T	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	82	avg	shall be within		actual	min	max	shall be within		actual	temperature
(h:min:s)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(%)	(%)	(%)	(°C)	(°C)	(Pa)	(Pa)	(Pa)	(°C)
0:00:00	20	11	11	11	11	11	11	11	11	11	11	10	10	11	11	11	11	11	11	11	11	11	11								8.7	12
0:05:00	576	586	603	599	610	617	629	640	618	624	569	590	595	612	605	605	621	604	608	609	608	628	609			-16.1					10.1	12
0:10:00	678	672	678	670	681	679	691	698	669	688	644	667	667	680	664	662	674	661	669	669	676	686	673	-15	15	-5.8	-35	19	8.0	18.0	17.5	12
0:15:00	739	717	726	717	732	739	751	768	760	771	722	720	726	737	735	742	755	745	753	756	751	765	742	-12.5	12.5	-3.3	-22	33	10.0	16.0	12.6	12
0:30:00	842	832	828	827	825	831	832	851	854	854	823	828	830	831	836	849	840	858	857	854	853	848	840	-5.0	5.0	-1.4	-18	16	10.0	16.0	13.4	13
0:45:00	902	894	891	891	892	896	898	915	916	915	891	886	891	896	898	910	905	916	915	911	918	911	903	-3.8	3.8	-0.8	-16	15	10.0	16.0	13.1	13
1:00:00	945	938	935	935	938	940	942	958	957	959	937	931	936	941	941	952	948	956	957	954	964	955	946	-2.5	2.5	-0.6	-15	18	10.0	16.0	12.8	13
1:15:00	979	982	976	979	980	981	984	999	998	1000	979	974	977	981	980	990	990	994	997	993	1007	996	987	-2.5	2.5	-0.3	-5	29	10.0	16.0	12.7	14
1:30:00	1006	1005	999	1001	1002	1002	1006	1019	1017	1018	999	997	999	1003	1002	1011	1011	1012	1015	1011	1025	1016	1008	-2.5	2.5	-0.1	-9	19	10.0	16.0	12.1	14
1:45:00	1029	1027	1023	1024	1024	1025	1026	1038	1037	1038	1021	1021	1023	1026	1025	1034	1032	1035	1037	1033	1047	1036	1030	-2.5	2.5	-0.1	-8	18	10.0	16.0	12.8	15
2:00:00	1049	1046	1044	1043	1045	1047	1050	1063	1061	1063	1045	1042	1044	1048	1045	1054	1055	1056	1059	1054	1070	1060	1052	-2.5	2.5	0.0	-7	21	10.0	16.0	12.6	15
2:15:00	1067	1067	1070	1067	1077	1078	1075	1090	1088	1089	1072	1071	1075	1092	1082	1089	1094	1089	1086	1083	1098	1091	1082	-2.5	2.5	0.1	0	31	10.0	16.0	13.2	16
2:30:00	1082	1084	1101	1083	1097	1091	1090	1104	1103	1105	1088	1089	1092	1110	1098	1108	1106	1103	1104	1098	1114	1105	1099	-2.5	2.5	0.2	0	31	10.0	16.0	13.2	16
2:45:00	1097	1097	1116	1096	1114	1114	1105	1117	1108	1115	1105	1105	1104	1119	1115	1122	1119	1113	1116	1106	1126	1117	1112	-2.5	2.5	0.4	-1	29	10.0	16.0	14.9	17
3:00:00	1110	1108	1126	1107	1125	1124	1117	1127	1117	1124	1112	1115	1113	1128	1124	1134	1126	1127	1133	1085	1149	1126	1121	-2.5	2.5	0.4	-25	40	10.0	16.0	14.5	18

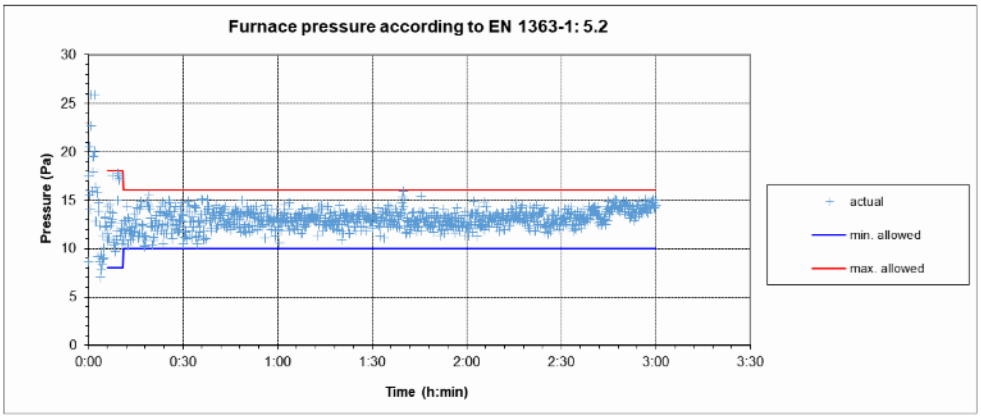
Key

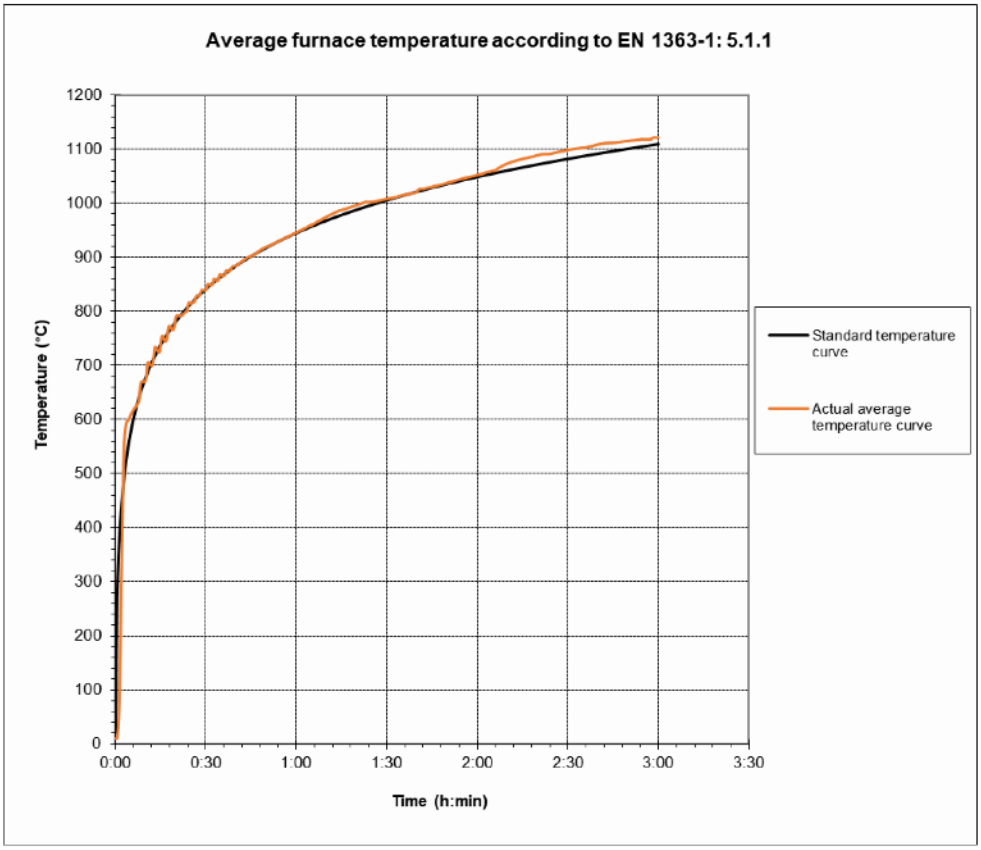
- t is the time, in min;
- T is the standard average furnace temperature, in °C, $\{T\} = 345.\log_{10}(8\{t\}+1) + 20$;
- avg is the actual average furnace temperature, in °C;
- d_e is the percentage deviation in the area of he actual average temperature/time curve from the area of the standard temperature/time curve;

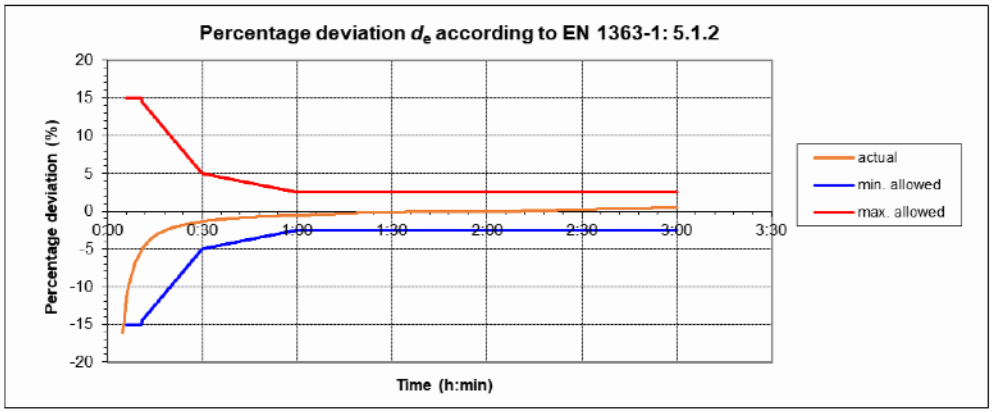
"Pressure" is the difference of the pressure in the furnace and the ambient pressure at the same hight level:

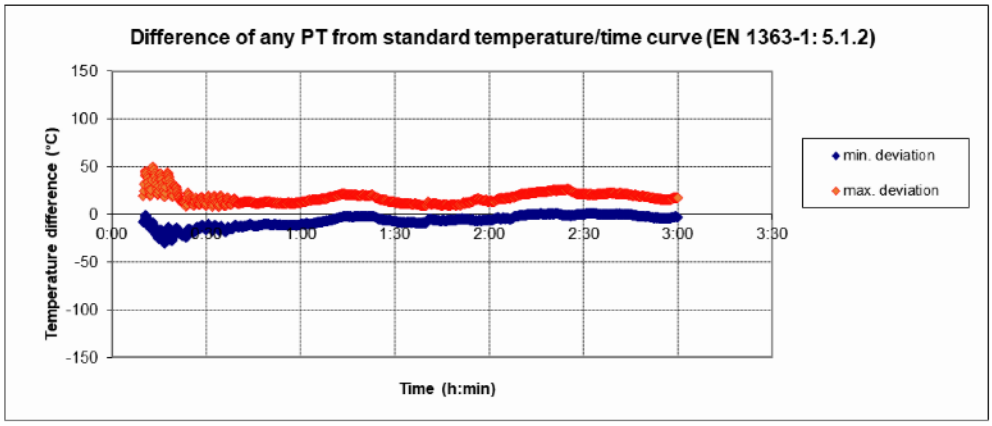
The pressure of 20 Pa is required in height of 6 m

Then the pressure of 13 Pa is expected in pressure sensor 5.2 m

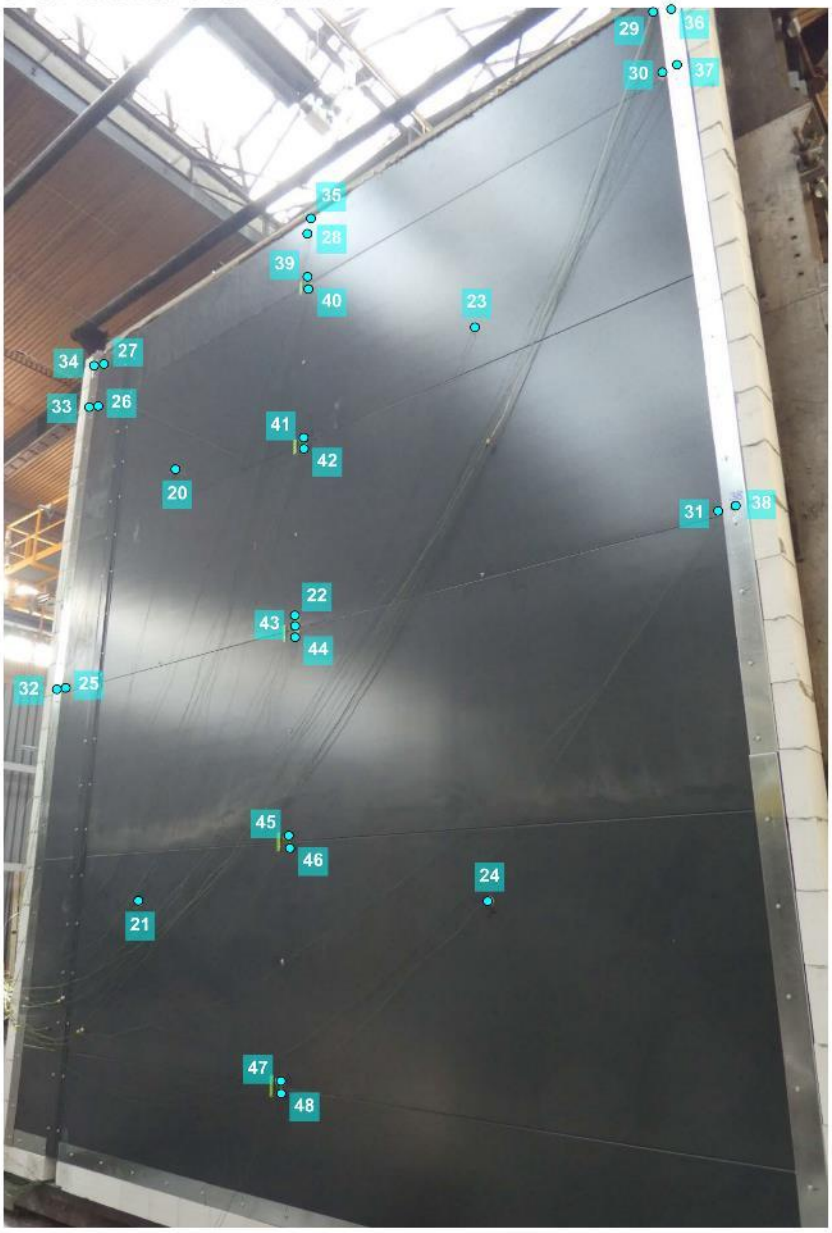

Furnace pressure according to EN 1363-1: 5.2
Pressure (Pa)
0
5
10
15
20
25
30
0:00
0:30
1:00
1:30
2:00
2:30
3:00
3:30
Time (h:min)
actual
min. allowed
max. allowed


Average furnace temperature according to EN 1363-1: 5.1.1
Temperature (°C)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
0:00
0:30
1:00
1:30
2:00
2:30
3:00
3:30
Time (h:min)
Standard temperature curve
Actual average temperature curve


Percentage deviation d_e according to EN 1363-1: 5.1.2
Percentage deviation (%)
20
15
10
5
0
-5
-10
-15
-20
0:00
0:30
1:00
1:30
2:00
2:30
3:00
3:30
Time (h:min)
actual
min. allowed
max. allowed


Difference of any PT from standard temperature/time curve (EN 1363-1: 5.1.2)
Temperature difference (°C)
150
100
50
0
-50
-100
-150
0:00
1:00
1:30
2:00
2:30
3:00
3:30
Time (h:min)
min. deviation
max. deviation

LAYOUT OF TC ON UF OF SPECIMEN



Key:

20 ÷ 24 - TC for T_{aver} and T_{max}

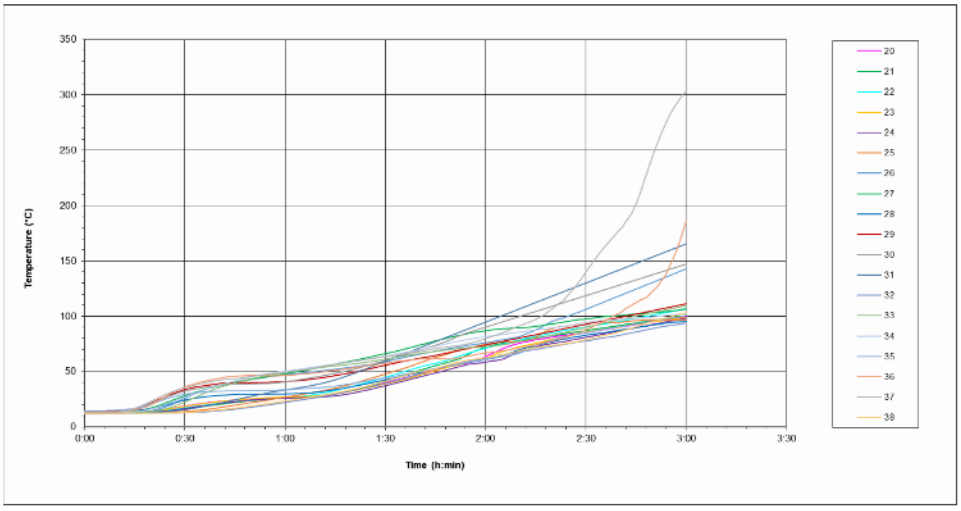
25 ÷ 48 - TC for T_{max}

Time	Temperature on the unexposed face of the specimen (°C)																				
	T_{aver}						T_{max}														
(h:min:s)	T_{aver}	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	T_{max}
0:00:00	**13**	13	12	13	14	12	12	13	14	14	14	13	12	12	13	13	14	13	13	12	**14**
0:05:00	**13**	14	13	13	14	13	12	13	14	15	14	13	13	12	13	13	15	13	13	12	**15**
0:10:00	**13**	14	13	13	14	13	12	13	14	15	14	14	13	12	13	13	15	14	14	12	**15**
0:15:00	**14**	14	13	14	14	13	13	14	15	15	16	16	13	12	13	14	17	15	17	12	**17**
0:30:00	**18**	19	16	17	19	17	14	26	28	24	34	32	16	13	23	27	30	36	36	13	**36**
0:45:00	**23**	24	22	23	24	23	20	41	40	29	40	39	24	16	40	42	33	46	44	17	**46**
1:00:00	**26**	26	26	26	27	26	27	47	48	30	41	41	33	22	50	50	34	47	49	23	**50**
1:15:00	**30**	30	30	33	30	28	35	52	57	34	46	48	43	30	55	57	37	51	57	31	**57**
1:30:00	**41**	40	41	45	39	37	48	59	66	43	56	60	60	40	61	64	44	58	63	41	**66**
1:45:00	**53**	52	55	57	51	49	63	69	78	53	65	74	77	53	68	73	53	62	71	52	**78**
2:00:00	**66**	64	72	71	62	59	75	76	87	61	74	90	95	62	73	82	61	67	80	63	**95**
2:15:00	**78**	79	80	82	76	72	81	88	91	74	83	104	113	70	80	88	74	74	97	72	**113**
2:30:00	**86**	85	87	90	86	81	94	106	98	83	93	119	130	78	90	94	85	88	140	79	**140**
2:43:40	**93**	92	93	97	92	89	96	123	102	89	101	132	146	85	100	98	92	110	193	89	**193**
2:45:00	**93**	93	94	98	93	90	96	125	102	90	102	133	148	86	100	98	93	112	202	91	**202**
3:00:00	**101**	100	101	107	99	98	97	143	107	96	111	147	166	94	110	103	101	187	304	103	**304**

Temperature recorded at 10 s intervals. In the table, they figure in 15 minute intervals

XX Designation of measuring joint of TC as figured in Annex B

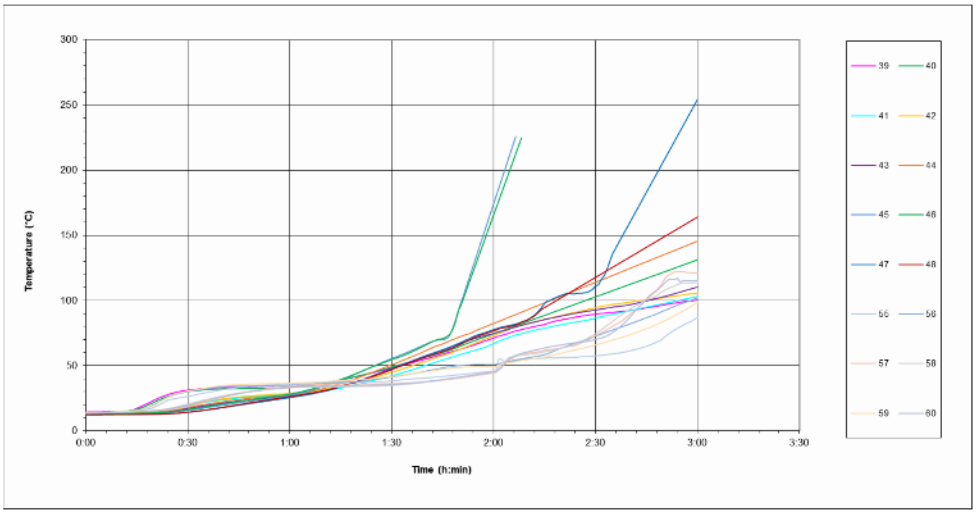
XX Time and temperature when the insulation criterion has been exceeded

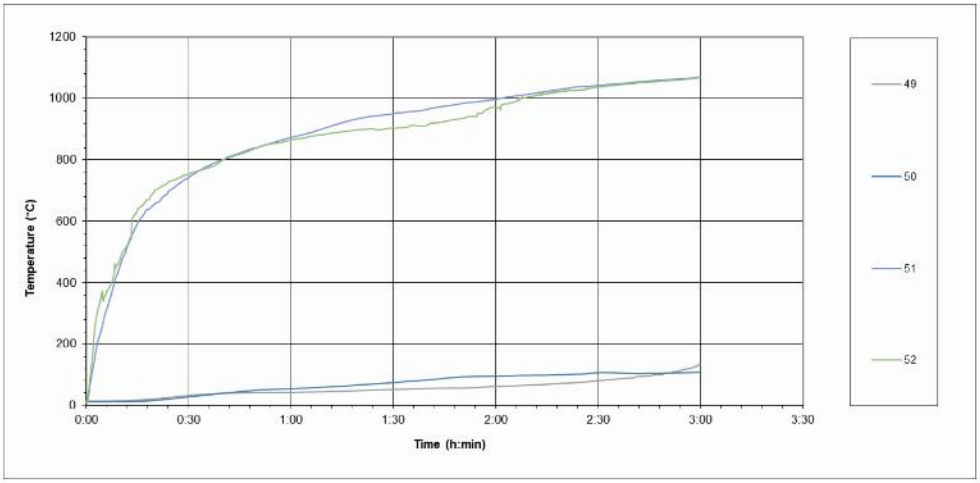


Time	Temperature on the unexposed face / fixing of the specimen (°C)																				
		T_{max}										T_{fixing}				T_{joint}					
(h:min:s)	T_{max}	39	40	41	42	43	44	45	46	47	48	49	50	51	52	55	56	57	58	59	60
0:00:00	**14**	14	14	14	14	13	13	13	13	12	12	14	13	10	10	14	14	14	14	14	14
0:05:00	**15**	15	14	14	14	13	13	13	13	12	12	14	13	276	342	14	14	14	14	14	14
0:10:00	**15**	15	15	14	14	14	14	13	13	12	13	15	13	460	482	15	15	14	14	15	14
0:15:00	**17**	17	16	14	14	14	14	13	13	13	13	17	14	595	638	15	16	15	15	16	15
0:30:00	**31**	31	30	19	20	17	18	16	16	14	14	33	29	743	754	26	30	19	21	31	20
0:45:00	**33**	33	32	25	26	23	24	22	23	20	20	41	46	819	823	33	34	29	29	35	29
1:00:00	**34**	34	33	28	29	27	28	27	28	26	26	43	55	872	865	36	35	34	33	37	33
1:15:00	**39**	39	39	33	34	34	36	39	39	34	34	46	64	921	892	37	37	36	34	39	35
1:30:00	**56**	48	49	42	45	48	51	56	55	47	47	52	75	950	904	38	41	36	35	42	36
1:45:00	**71**	59	60	54	58	62	67	70	71	62	61	56	89	975	925	42	48	39	39	47	39
2:00:00	**174**	71	75	67	73	75	82	174	166	78	77	62	97	996	972	46	51	45	45	49	45
2:02:30	194	73	77	70	76	77	85	194	184	80	79	63	97	1001	983	54	52	49	51	51	49
2:15:00	**98**	82	89	79	86	85	98			98	95	69	99	1022	1016	56	59	62	61	57	64
2:30:00	**118**	89	103	87	95	93	114			111	118	82	107	1041	1036	58	73	73	75	66	70
2:45:00	**183**	94	117	95	100	100	130			183	141	97	105	1055	1053	65	87	102	100	78	101
3:00:00	254	101	131	103	106	110	146			254	164	134	109	1068	1067	87	102	121	114	99	115

Temperature recorded at 10 s intervals. In the table, they figure in 15 minute intervals

XX	Designation of measuring joint of TC as figured in Annex B
XX	Time and temperature when the insulation criterion has been exceeded
	TC fell down

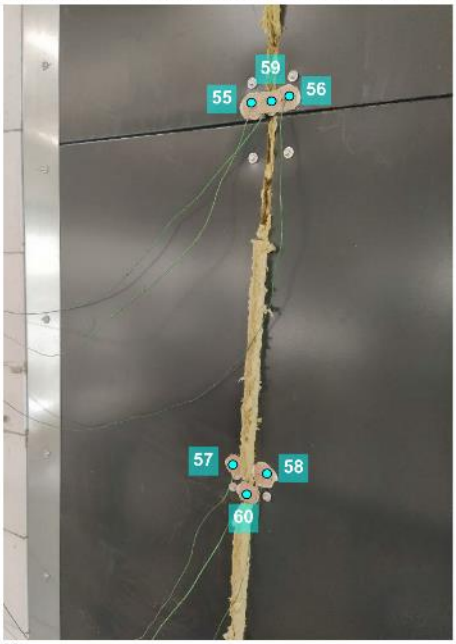




Key:

49, 50	- TC on UF of the screw
51, 52	- TC on EF of the screw

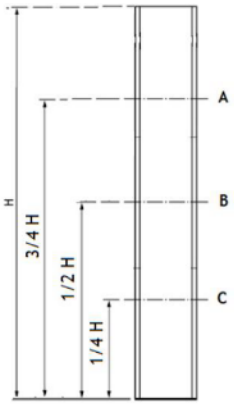
LAYOUT OF TC ON UF OF LINEAR JOINT SEAL OF SPECIMEN

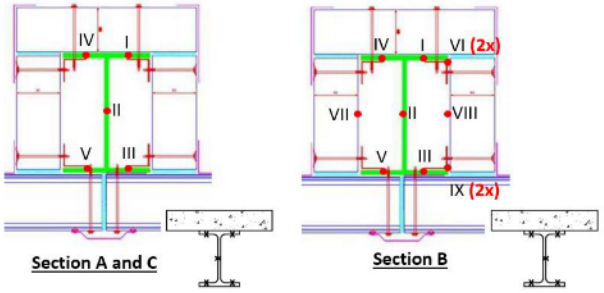


Key:

55 ÷ 58	- junction TC for T_{max}
59 ÷ 60	- joint seal TC for T_{max}

LAYOUT OF TC ON THE SURFACE OF THE STEEL COLUMN





Thermocouples :

- I, II, III, IV and V to record the temperature of the steel profile
- VI, VII, VIII and IX to record the temperature at the surface of sandwich panels

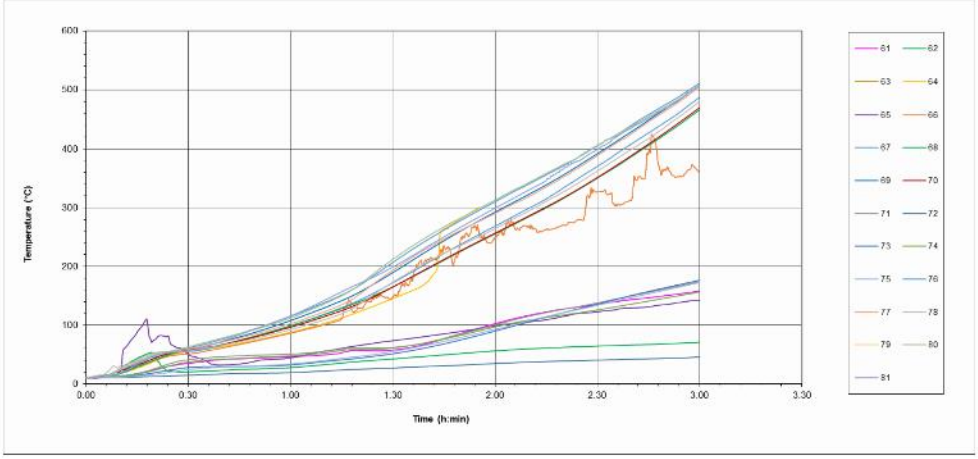
Key:

Section/TC	Datalogger	Section/TC	Datalogger	Section/TC	Datalogger	Section/TC	Datalogger
A - I	*61*	B - I	*66*	C - I	*71*	B - VI	*76, 77*
A - II	*62*	B - II	*67*	C - II	*72*	B - VII	*80*
A - III	*63*	B - III	*68*	C - III	*73*	B - VIII	*81*
A - IV	*64*	B - IV	*69*	C - IV	*74*	B - IX	*78, 79*
A - V	*65*	B - V	*70*	C - V	*75*		

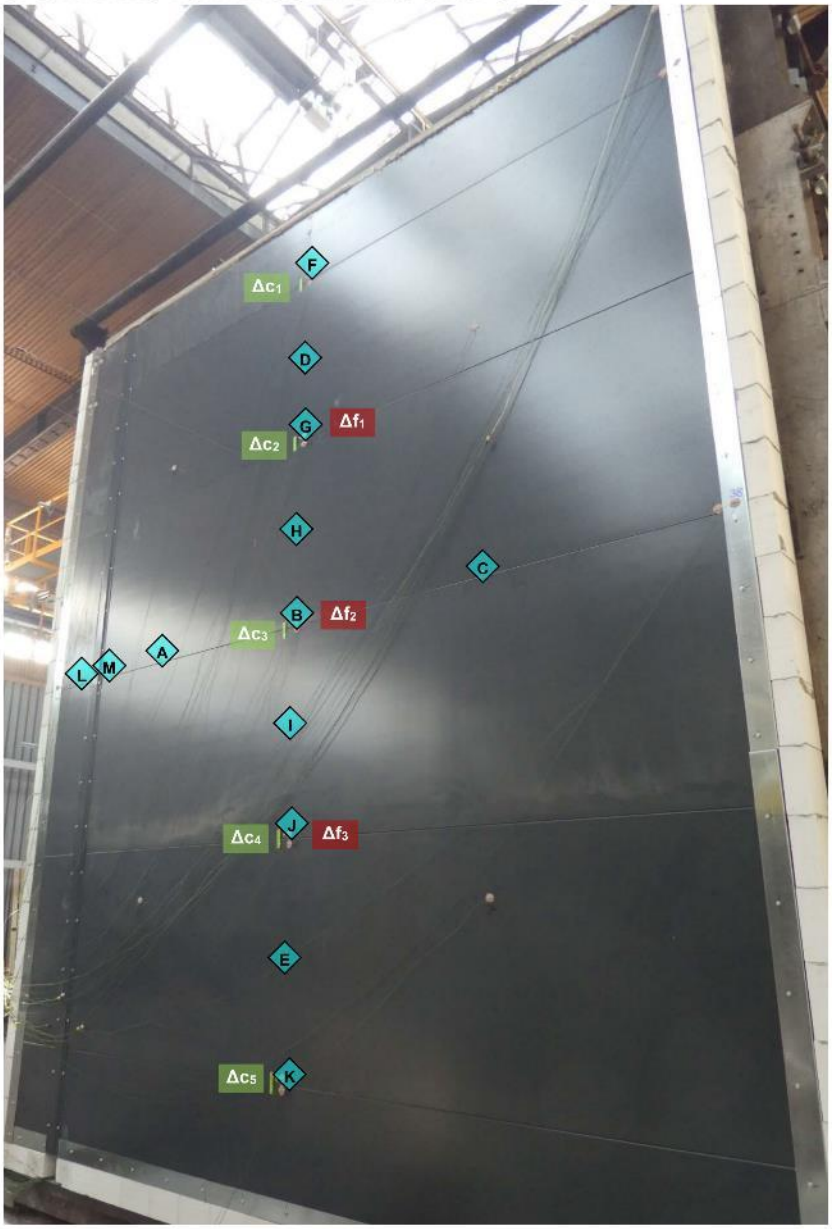
Time	Temperature on the steel section / angle / sandwich panel (°C)																				
	T_{steel}															T_{angle}				T_{panel}	
(h:min:s)	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
0:00:00	11	11		10	11	10	11	11	11	10	11	10	11	11	11	10	11	11		10	10
0:05:00	11	13		11	11	12	11	12	14	13	11	11	11	12	11	13	13	16		13	12
0:10:00	13	26		18	23	19	17	18	22	22	14	11	12	13	12	23	24	31		26	19
0:15:00	18	44		27	88	29	30	29	34	33	18	12	15	17	13	37	38	41		42	34
0:30:00	35	21		55	51	51	55	57	59	58	41	15	28	37	24	61	59	57		63	55
0:45:00	43	25		69	34	67	73	74	80	73	48	18	29	44	30	85	78	72		86	84
1:00:00	46	28		88	45	86	99	99	108	97	51	19	32	48	34	115	103	93		112	116
1:15:00	53	36		112	61	111	130	128	142	125	59	24	41	57	44	151	135	120		150	157
1:30:00	58	43		145	74	147	172	165	190	165	62	27	51	61	55	207	194	173		212	199
1:45:00	77	50		264	85	232	222	211	244	212	77	31	68	76	72	262	246	222		267	250
2:00:00	103	56			99	250	269	255	292	256	101	35	90	97	93	310	290	264		313	299
2:15:00	123	61			109	263	315	300	339	301	122	38	114	113	115	356	335	311		358	346
2:30:00	135	64			123	327	370	350	392	351	138	40	136	126	134	405	388	362		406	399
2:45:00	147	67			131	390	427	406	449	408	156	43	157	141	153	458	446	417		455	452
3:00:00	158	71			143	359	488	467	508	470	174	46	177	157	173	511	505	481		507	508

Temperature recorded at 10 s intervals. In the table, they figure in 15 minute intervals

XX	Designation of measuring joint of TC as figured in Annex B
	Failure of TC



LAYOUT OF DEFLECTION MEASUREMENTS ON UF OF SPECIMEN



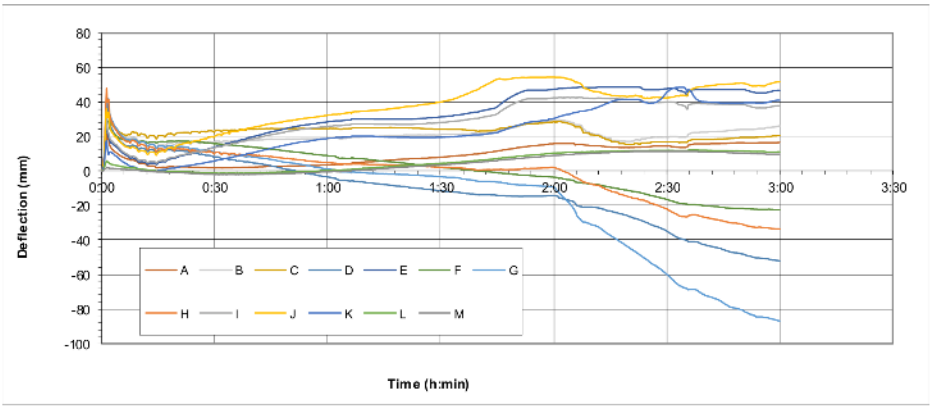
Key:

A ÷ M - points of measurement of horizontal deflection

Δf_x - deflection difference according to EN 15254-5, Figure B.1

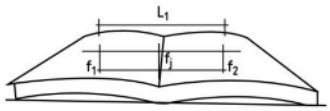
Δc_x - deflection difference according to EN 15254-5, Figure B.2

Time	Deflection (mm)												
(h:min:s)	A	B	C	D	E	F	G	H	I	J	K	L	M
0:00:00	0	0	0	0	0	0	0	0	0	0	0	0	0
0:05:00	9	22	22	17	12	19	21	20	13	17	7	3	1
0:10:00	5	17	21	13	5	17	16	15	6	11	1	1	0
0:15:00	2	15	20	12	5	17	14	13	6	11	0	0	-1
0:30:00	2	16	23	8	14	16	11	10	13	20	6	-1	-2
0:45:00	3	18	25	3	23	13	7	8	21	28	13	-1	-2
1:00:00	4	19	25	-4	29	9	1	5	26	32	19	0	-1
1:15:00	6	20	25	-8	30	6	-2	4	27	36	20	2	2
1:30:00	8	21	24	-12	31	2	-3	2	28	40	20	4	4
1:45:00	12	23	24	-14	37	-1	-6	1	33	53	22	7	6
2:00:00	16	29	29	-14	47	-4	-9	2	42	54	30	10	9
2:15:00	14	19	18	-23	49	-9	-37	-11	42	44	40	11	11
2:30:00	14	20	17	-35	48	-17	-60	-22	40	42	46	12	11
2:45:00	16	23	19	-46	47	-21	-76	-29	39	50	39	12	11
3:00:00	17	26	21	-52	47	-22	-87	-34	38	52	41	11	10



Values "+" - deflection in furnace
Values "-" - deflection away from furnace

Measurement according to EN 15254-5, Annex B:

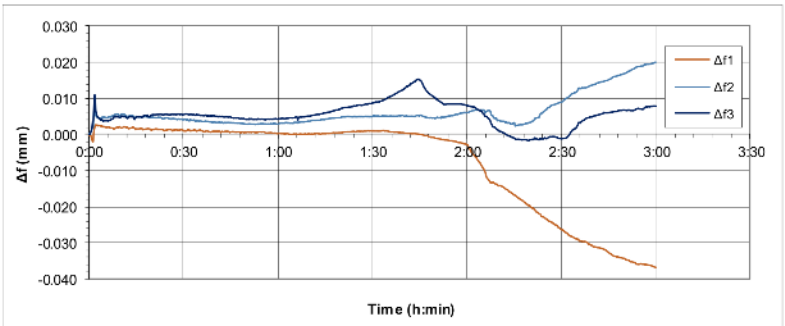


$$\Delta f = (f_j - 0{,}5x(f_1 + f_2))/L_1$$

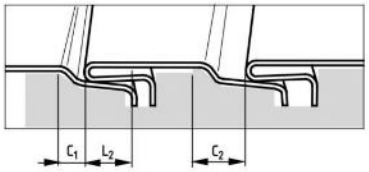
Figure B.1 — Calculation of Δf in midspan section

L_1 = 1200 mm

Time (h:min:s)	Deflection difference (mm) Δf_1	Δf_2	Δf_3
0:00:00	0.000	0.000	0.000
0:05:00	0.002	0.005	0.004
0:10:00	0.002	0.005	0.005
0:15:00	0.002	0.005	0.005
0:30:00	0.001	0.004	0.005
0:45:00	0.001	0.003	0.005
1:00:00	0.000	0.003	0.004
1:15:00	0.000	0.004	0.006
1:30:00	0.001	0.005	0.009
1:45:00	0.000	0.005	0.015
2:00:00	-0.003	0.006	0.008
2:15:00	-0.017	0.003	-0.001
2:30:00	-0.026	0.009	-0.001
2:45:00	-0.033	0.015	0.006
3:00:00	-0.037	0.020	0.008



Measurement according to EN 15254-5, Annex B:



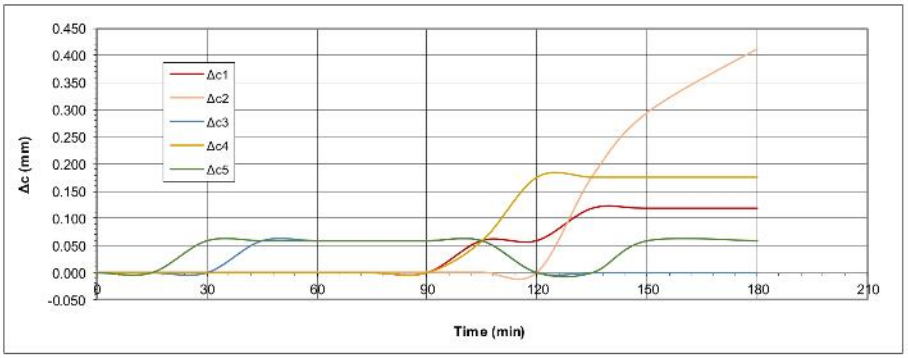
$\Delta c = (c_2 - c_1)/L_2$

Figure B.2 — Calculation of Δc

L_2 = 17 mm

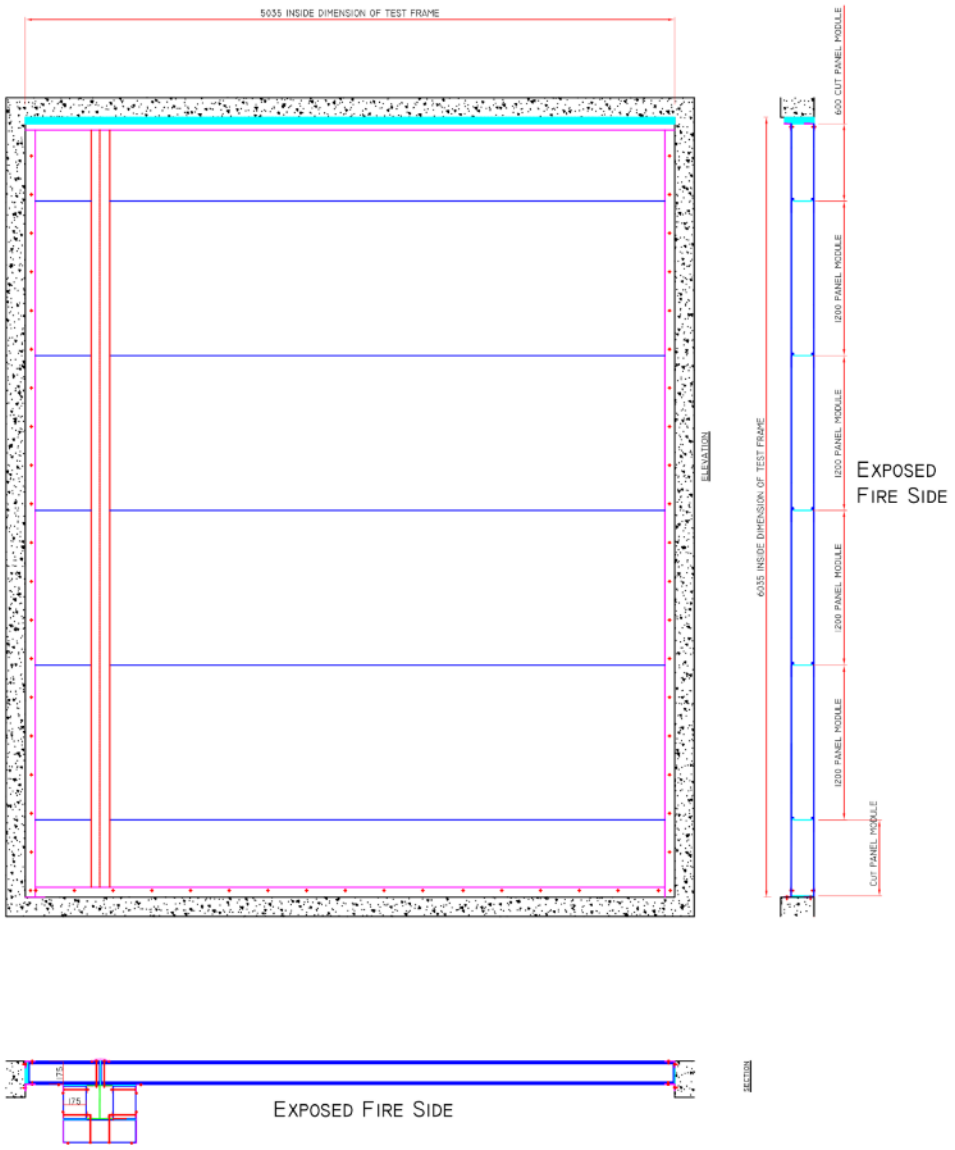
c_0 = 2 mm (before the test)

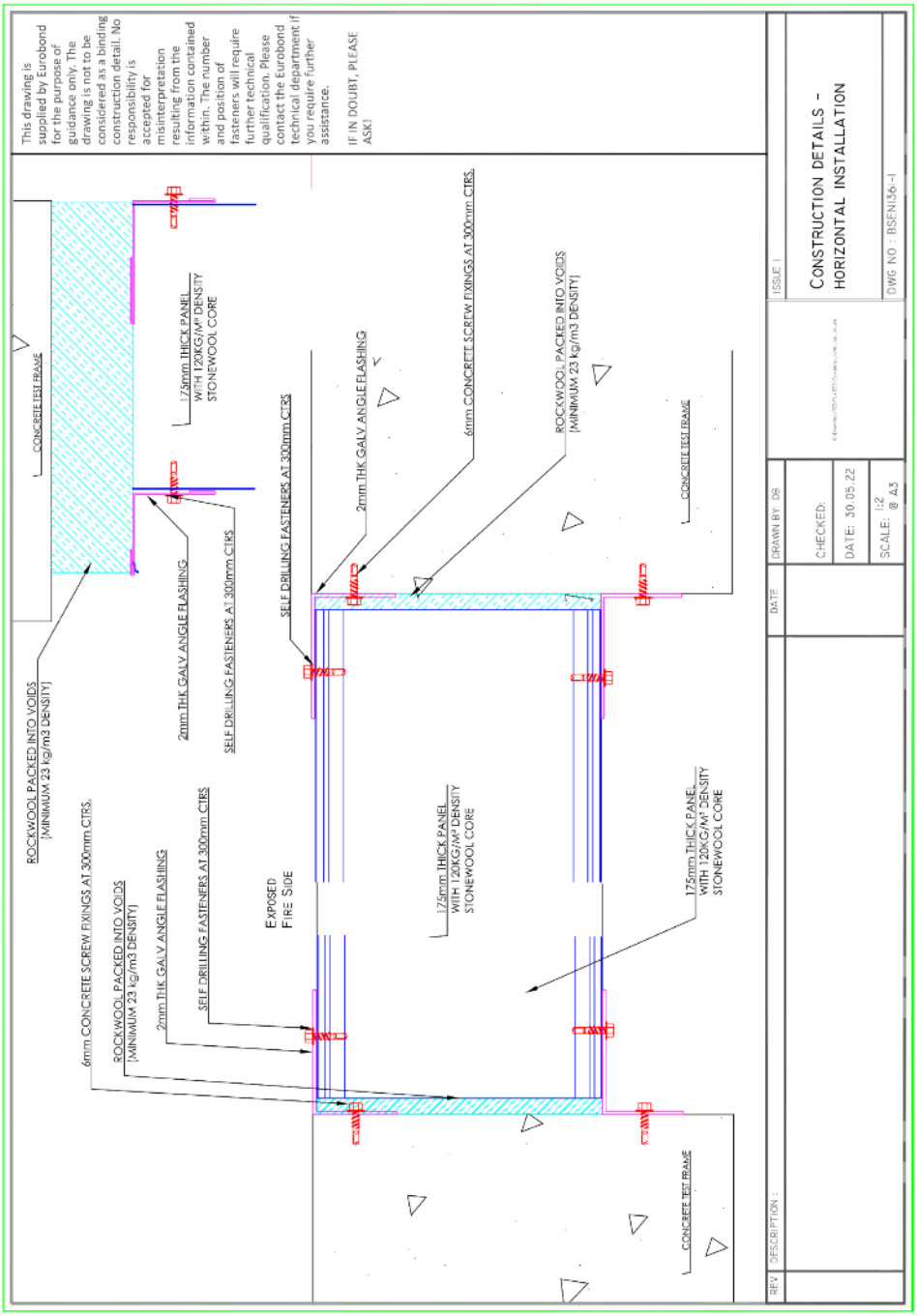
Time	Deflection difference (mm)				
(min)	Δc_1	Δc_2	Δc_3	Δc_4	Δc_5
0	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.059
45	0.000	0.000	0.059	0.000	0.059
60	0.000	0.000	0.059	0.000	0.059
75	0.000	0.000	0.059	0.000	0.059
90	0.000	0.000	0.059	0.000	0.059
105	0.059	0.000	0.059	0.059	0.059
120	0.059	0.000	0.000	0.176	0.000
135	0.118	0.176	0.000	0.176	0.000
150	0.118	0.294	0.000	0.176	0.059
180	0.118	0.412	0.000	0.176	0.059

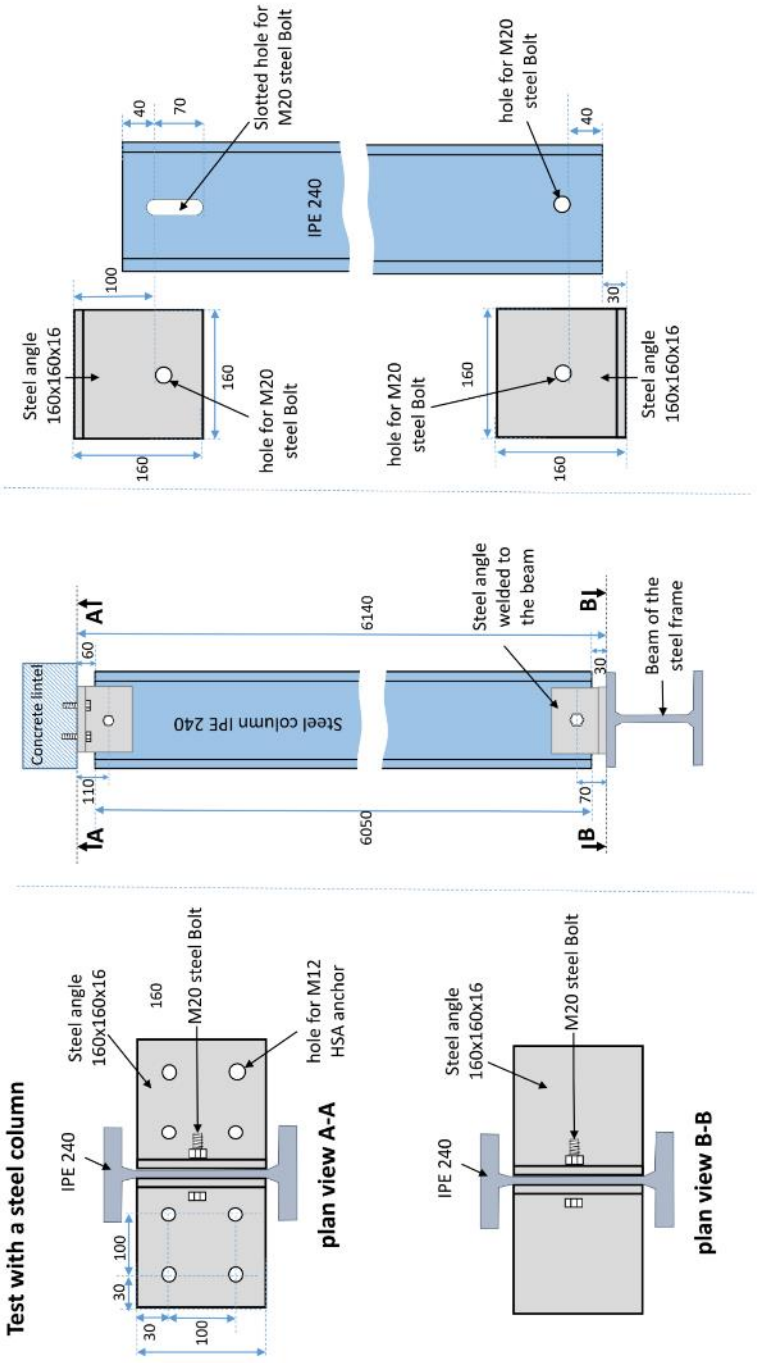


ANNEX C: DOCUMENTATION

Specimen-related documentation delivered by the test sponsor.




This drawing is supplied by Eurobond for the purpose of guidance only. The drawing is not to be considered as a binding construction detail. No responsibility is accepted for misinterpretation resulting from the information contained within. The number and position of fasteners will require further technical qualification. Please contact the Eurobond technical department if you require further assistance.
IF IN DOUBT, PLEASE ASK!
CONCRETE TEST FRAME
175mm THICK PANEL WITH 120KG/M³ DENSITY STONEWOOL CORE
2mm THK GALV ANGLE FLASHING
SELF DRILLING FASTENERS AT 300mm CTRS
ROCKWOOL PACKED INTO VOIDS (MINIMUM 23 kg/m3 DENSITY)
6mm CONCRETE SCREW FIXINGS AT 300mm CTRS
EXPOSED FIRE SIDE
CONSTRUCTION DETAILS - HORIZONTAL INSTALLATION
ISSUE 1
DRAWN BY: DR
CHECKED:
DATE: 30.05.22
SCALE: 1:2 @ A3
DWG NO : BSEN1366-1
REV
DESCRIPTION :
DATE


Slotted hole for M20 steel Bolt
hole for M20 steel Bolt
IPE 240
40
70
40
100
30
Steel angle 160x160x16
160
hole for M20 steel Bolt
hole for M20 steel Bolt
160
Steel angle 160x160x16
160
160
A
B
6140
Steel angle welded to the beam
Beam of the steel frame
Concrete lintel
Steel column IPE 240
60
30
110
70
A
B
6050
Test with a steel column
Steel angle 160x160x16
160
M20 steel Bolt
hole for M12 HSA anchor
IPE 240
plan view A-A
100
30
30
100
Steel angle 160x160x16
M20 steel Bolt
IPE 240
plan view B-B

ANNEX D: PHOTOS

Assembly of the steel column

Assembly of the specimen

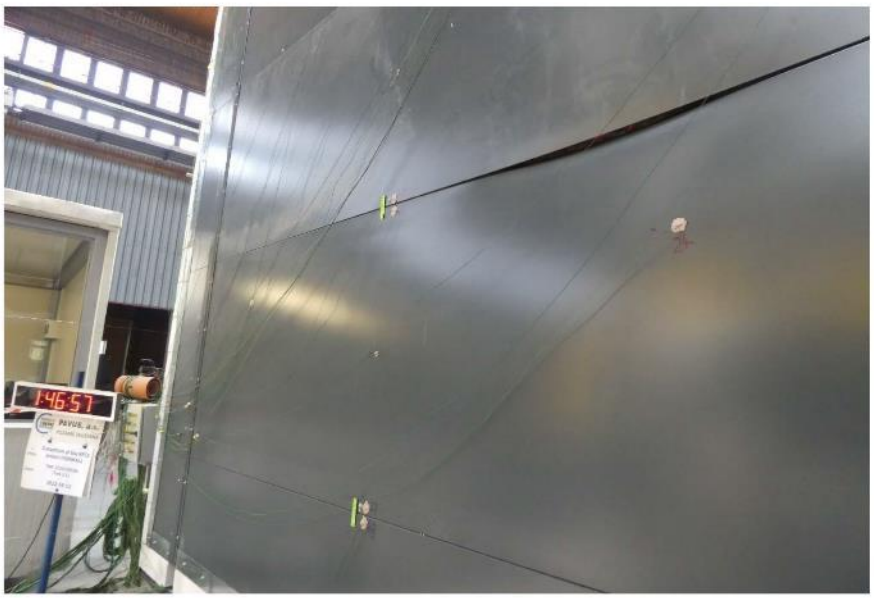
EF before the test

UF before the test

EF after 30 minutes of the test

UF after 60 minutes of the test

UF after 90 minutes of the test



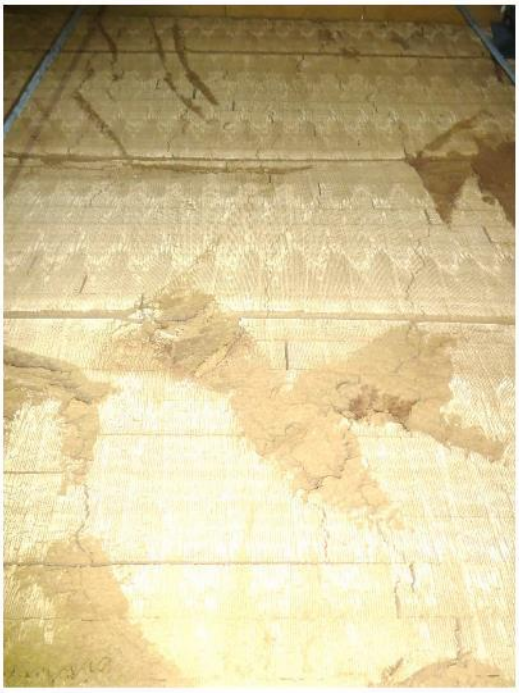
UF after 106 minutes of the test

UF after 121 minutes of the test

UF in 153th minute of the test - cotton pad test - without integrity failure

UF in 164th minute of the test - 6 mm gap gauge passed through the specimen in distance longer than 150 mm along the gap - integrity failure

UF after 180 minutes - end of the test



EF the second day after the test

APPPENDIX C. REPORT N°PR-22-2.085-EN FOR TEST N°3

PAVUS
FIRE TESTING INSTITUTE

Order No.: Z210220039

PAVUS, a.s.
AUTHORIZED BODY 216
NOTIFIED BODY 1391
ACCREDITED TESTING LABORATORY
EGOLF MEMBER

ilac-MRA

L 1026

FIRE TESTING LABORATORY VESELÍ NAD LUŽNICÍ
Testing Laboratory No. 1026 accredited by ČIA
Notified Testing Laboratory
workplace Veselí nad Lužnicí

FIRE RESISTANCE TEST REPORT

No. Pr-22-2.085-En

issued on 2022-06-13

For product

Non-loadbearing wall 5 x 6 m

External wall made of sandwich panels Eurobond Rockspan Extra (vertical cladding)

Sponsor: **Consortium of the RFCS project FISHWALL**

cticm · UNIVERSITÀ DI TRENTO · CTU · JORISIDE THE STEEL FUTURE · BRIAND CONSTRUCTION METALLIQUE · PAVUS FIRE TESTING INSTITUTE · L'ENVELOPPE MÉTALLIQUE DU BÂTIMENT · Efectis · euroclad group

Test method:

ČSN EN 1364-1
» Fire resistance tests for non-loadbearing elements - Part 1: Walls «

Test Report includes 28 pages
(6 pages of text + 4 Annexes)

Number of copies: 2
Copy number: 1

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ID: 60193174, VAT: CZ60193174, in Commercial Register of the Municipal Court in Prague, Sec. B, File no. 2309
Phone: +420 286 019 587

Veselí nad Lužnicí Branch
Čtvrť J. Hybeše 879, 391 81 Veselí nad Lužnicí, Czech Republic, e-mail: veseli@pavus.cz
Phone: +420 381 477 418

1 INTRODUCTION

The fire resistance test of the non-loadbearing wall was performed based on the order of Consortium of the RFCS project FISHWALL in Fire Testing Laboratory PAVUS, a.s. in Veselí nad Lužnicí.

The test was prepared, performed and assessed on the base of following documents:

[1] ČSN EN 1364-1:2017 Fire resistance tests for non-loadbearing elements - Part 1: Walls

[2] ČSN EN 1363-1:2021 Fire resistance tests - Part 1: General requirement

[3] ČSN EN 1363-2:2000 Fire resistance tests - Part 2: Alternative and supplementary procedures

[4] ČSN EN 15254-5:2019 Extended application of results from fire resistance tests - Non-loadbearing walls - Part 5: Metal sandwich panel construction

[5] ČSN EN 13501-2:2017 Fire classification of construction products and building elements - Part 2: Classification using test data from resistance fire tests, excluding ventilation services

[6] ILAC-G17:01/2021 Guidelines for Measurement Uncertainty in Testing

[7] JCGM 100:2008 GUM 1995 with minor corrections, Evaluation of measurement data - Guide to the expression of uncertainty in measurement (Available from www.BIPM.org)

[8] Specimen-related technical documentation delivered by the test sponsor

For the purposes of this document, definitions given in [1] ÷ [7] together with following abbreviations apply:

ČIA	Český institut pro akreditaci, o.p.s. (Czech Institute for Accreditation)
ATL	accredited testing laboratory
TC	thermocouple
TM	thermometer (sheathed TC)
PTM	plate thermometer fit with a TM ∅ 2 mm
EF	exposed specimen face
UF	unexposed specimen face
RTC	roving thermocouple

2 TEST SUBJECT

The subject matter of the test was represented by a specimen of prebuilt non-loadbearing wall with total dimensions of 5 000 mm (width) × 6 035 mm (height) × 175 mm (thickness) of sandwich panels Eurobond Rockspan Extra vertically oriented.

The specimen in test frame was mounted to rigid construction with low density, thickness 250 mm, density 550 kg/m^3.

Description of the construction:

Non-loadbearing external wall consisted of 5 pcs of sandwich panels Eurobond Rockspan Extra with mineral wool as an insulation core, nominal density of mineral wool was 120 kg/m^3. Each panel had dimensions of 1 200 mm (stock width) × 5 995 mm (length) x 175 mm (thickness). One panel was reduced to width 200 mm and it was mounted to the fixed vertical edge of the wall. On EF, the panels had profiled metal sheet, th. 0.5 mm (interior side) and on UF, they had metal sheet, th. 0.5 mm (exterior side), both sheets were galvanized and coated.

On both horizontal sides and on left vertical edge of the rigid construction, L-profiles 100x50x2 were mounted on EF (and also on UF in the end of the assembly), aligned with the edge of the rigid construction. The profiles were anchored to the rigid construction using carbon steel screws TutFast HTF-6.3 x 57 (producer Fixfast Ltd) in spacing of 450 mm. The right vertical edge of the specimen was without mechanical fixing.

Particular panels were anchored to the L-profiles using stainless screws DrillFast DF2-SS-LS-A15-6.3 x 25 (producer Fixfast Ltd) in the direction from EF, in spacing of 300 mm.

The structural gaps between the test specimen and the rigid construction were filled up with mineral wool POWER-TEK BD 660 (manufacturer Knauf Insulation, spol. s r.o.), nominal density 100 kg/m^3, width of the gap between 20 and 30 mm.

The right vertical edge was left unrestrained in order to enable free specimen moving. The gap between the specimen and the rigid construction of width 50 mm was filled up with mineral wool.

Test specimen related technical documentation delivered by the test sponsor is documented in Annex C.

The specimen was mounted as per [1] cl. 7 and Annex C of this Test Report.

The tested specimen was manufactured by company Euroclad Group Ltd.

The Testing Laboratory did not participate in extracting elements used for test specimen assembly.

The parts of the test specimen were delivered to the test laboratory on 11th March 2022 without any defects and mounted from 14th to 16th March 2022 to the test frame by company Euroclad Group Ltd in accordance with the delivered documentation.

3 TEST PERFORMANCE

3.1 General

The fire resistance test was performed as per [1] on 30th March 2022 in Testing hall PO 1 in vertical wall furnace with inner dimensions of 5 000 mm (width) × 6 000 mm (height) × 1 500 mm (depth).

Direction of fire exposure from interior side.

Used testing and gauging equipment is stated in Annex A.

3.2 Furnace control

The test furnace was heated with a set of oil burners. In-furnace temperatures were measured by the help of PTMs and recorded at minute intervals. The measuring wires of PTM were distributed uniformly in a distance of 100 mm from the exposed specimen face according to [1] cl. 9.1.1.

In-furnace temperatures for standard heating curve according to [2] were controlled so that they conformed to the relation according to [2] cl. 5.1.1, within the specified limits (see [2] cl. 5.1.2):

$$T = 345 \log (8t + 1) + 20$$

where T (°C) = required in-furnace temperature in time °C
t (min) = time since the test beginning

The test furnace positive pressure was measured and controlled so that the values correspond to the conditions of [1] cl. 9.2 and [2] cl. 5.2.1 and 9.2.1.

3.3 Specimen measuring

The specimen unexposed face temperatures were taken using K-type disc TCs and recorded at minute intervals. The TCs were fixed on the specimen surface according to [1] cl. 9.1.2.2, 9.1.2.3.

The rate of the horizontal deflection was measured by deflectometers spaced according to [1] cl. 9.3.

One RTC (see [2] cl. 4.5.1.3) was available to measure points where higher temperatures were expected.

The measured points of deflections and the TC positions are described and figured in Annex B.

The initial test conditions met the standard values as per [2] cl. 10.3.

3.4 Ambient temperature

During the test, the ambient temperature was measured using one K-type TM (see [2] cl. 4.5.1.5) according to the conditions of [2] cl. 5.6.

3.5 Conditioning

From the specimen delivery to the Fire Testing Laboratory until the test performance, the specimen was stored in the enclosed ambient of test hall at the air temperature of (15 ± 5) °C and at relative air humidity of (50 ± 5) %.

4 TEST COURSE

Time (min)	Test observation
1.	a few parts of aerated concrete on the perimeter fell down
15.	EF - mild bending of the flashing on the perimeter of the specimen, darkening of the joints between the panels
20.	UF - visible distribution of the lamellas of mineral wool on the surface of the steel sheets
30.	EF - paint on the steel sheets fell down almost in whole area of the specimen
63.	UF - opening of the joint by measured point c_2 in the bottom part
76.	UF - 6 mm gap gauge can't pass through the specimen by measured point c_4, the joint is closed due to bent sheets on EF - without failure
88.	UF - opening of the joint by measured point c_4, darkening of the next joints in the bottom part
95.	UF - 6 mm gap gauge passes through the specimen by measured point c_2 in distance longer than 150 mm - **integrity failure**
105.	UF - cotton pad test by measured point c_2 - without failure
106.	UF - cotton pad test by measured point c_2 - without failure, sustained flaming under the cotton pad - **integrity failure**
107.	UF - cotton pad test by measured point c_2 - **integrity failure**
108.	end of the test at request of the Sponsor

Layout of TC described in Annex B. Deflections are described in Annex B.

The in-furnace temperatures and pressures met the requirements of [2]. Time relations to the measured temperatures and pressures are specified in Annex B.

5 TEST RESULTS

5.1 Limit state attainment criteria

+ **Integrity** (according to [2] cl. 11.2). This criterion means the time in completed minutes for which the test specimen continues to maintain its separating function during the test without either:
  a) causing the ignition of a cotton pad applied in accordance with [2] cl. 10.4.5.2; or
  b) permitting the penetration of a gap gauge as specified in [2] cl. 10.4.5.3; or
  c) resulting in sustained flaming.

+ **Insulation** (according to [2] cl. 11.3). This criterion means the time in completed minutes for which the test specimen continues to maintain its separating function during the test without developing temperatures on its unexposed surface which either:
  a) increase the average temperature above the initial average temperature by more than 140 K; or
  b) increase the temperature at any location (incl. RTC) above the initial average temperature by more than 180 K.

+ **Radiation** (according to [1] cl. 9.4 and [3] cl. 8). The criterion of radiation is deemed to be observed until the measured radiation does not exceed the value of 15 $kW.m^{-2}$. The time for the measured radiation to exceed the value of 5, 10, 15, 20 and 25 $kW.m^{-2}$ is reported.

5.2 Expression of test results

Criterion	Partial criterion	Measured value	Evaluation
Integrity	Cotton pad ignition	106 min	106 min
	Gap gauge passage	94 min	94 min
	Sustained flaming	105 min	105 min
Insulation	Average temperature	107 min, no failure	94 min [1)]
	Maximum temperature	98 min	94 min [1)]
Radiation	6 kW.m^{-2} (not measured) [2)]	94 min [3)]	

Notes:

[1)] The performance criteria "insulation" shall automatically be assumed not to be satisfied when the "integrity" criterion ceases to be satisfied (see [2] cl. 11.4.2).

[2)] There is no requirement to measure the radiation from a surface with a temperature below 300 °C because the radiation from such a surface is low (see [3] cl. 8.1). Average temperature on the UF of the specimen didn't exceed 300 °C.

[3)] Failure of integrity under the cracks or openings in excess of given dimensions criteria means automatically failure of the radiation criterion. (see [5] cl. 5.2.4).

5.3 Field of direct application

The results of the fire test are directly applicable to similar constructions where one or more of the changes listed below are made and the construction continues to comply with the appropriate design code for its stiffness and stability:

- decrease in height;
- increase in the thickness of the wall;
- increase in the thickness of component materials;
- decrease in linear dimensions of boards or panels but not thickness;
- decrease in distance of fixing centres;
- increase in the number of vertical joints, of the type tested;
- the width of the construction may be increased;
- the height of the construction may be increased by 1.0 m under the maximum deflection of the test specimen was not in excess of 100 mm and the expansion allowances are increased pro-rata.

The results are applicable to high density rigid supporting constructions with at least the same fire resistance as the test specimen.

5.4 Application of test results

- The test results refer only to the tested specimen including the way of its mounting into the construction (see part 2 of this Report).
- This report details the method of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outlined in ČSN EN 1363-1, ČSN EN 1363-2 and ČSN EN 1364-1. Any significant deviation with respect to size, constructional details, loads, stresses, edge or end conditions other than those allowed under the field of direct application in the relevant test method is not covered by this report.

The Report and Annex sheets are valid with the embossed stamp only.

Elaborated by: ..... Jiří VANĚK, Technical Officer

Approved by: ..... Jiří KÁPL, ATL Manager

ANNEX A: TESTING AND GAUGING DEVICES, MEASUREMENT UNCERTAINTY

Test equipment:	**Device registration number:**
Vertical wall furnace PO 1 supplemented by modules increasing the size of the furnace to 5 m x 6 m (+ equipment for temperature and pressure control)	0127
Furnace pressure probe	0011
Test frame	0129/2
Gap gauge ∅ 6 mm	0112
Gap gauge ∅ 25 mm	0113
Cotton pad frame	0014
Gauging equipment:	**Metrological registration number:**
Differential pressure gauge AMR DPS	3 09 29
Datalogger Almemo 5990-2	3 10 85
PTM – in-furnace temperature (TM K ∅ 2 mm)	3 10 10
TC (K) – specimen UF temperature	3 10 14, 3 10 15
TM K ∅ 3 mm – ambient temperature	3 10 09
THERM 2260 + RTC (K)	3 10 13
Winding tape measure	3 01 29
Deflectometer Huggenberger	3 01 39÷42, 55÷58, 60÷62
Stop-watch	3 05 12
Thermo-hygro-barograph	3 13 06
Calliper	3 01 52

Measurement traceability of all measurement equipment is reported in the metrological registration card of the equipment; identified by the same metrological registration number as the equipment.

Quantity measured			**Extended**
Name	Symbol	Unit	**measurement uncertainty**
Time since the test beginning	t	(min)	3,4 10^{-2}min, for $t \leq 240$ min
Integrity disruption time		(min)	< 0,5 min
Temperature: TC or K-type PTM + compensation cable (both of the 2nd tolerance class) + Almemo 5990-2	T	(°C)	$\sqrt{(6{,}40.10^{-6}.T^2 + 1{,}57.10^{1}°C^2)}$, for 40°C ≤ T < 375°C $\sqrt{(8{,}04.10^{-5}.T^2 + 7{,}84°C^2)}$, for 375°C ≤ T ≤ 1000°C
Ambient-to-in-furnace pressure difference	p	(Pa)	$\sqrt{(5.3.10^{-4}.p^2+1{,}1.10^{-5}Pa^2)}$
Weight		(g)	1 g
Deflection (horizontal distortion)		(mm)	1,8 mm

The reported expanded measurement uncertainty is stated as the combined standard measurement uncertainty multiplied by the coverage factor $k = 2$ such that the coverage probability corresponds to approximately 95 %.", see [6] and [7].

The measurement uncertainty arising from sampling is not included in the expanded measurement uncertainty. "Because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance, it is not possible stated a degree of accuracy of the result", see EN 1363-1: 12.1 w).

ANNEX B: MEASUREMENT

TEMPERATURE AND PRESSURE IN FURNACE, AMBIENT TEMPERATURE

Test conditions according to EN 1363-1: 5

Time	Furnace temperatures											
	T	48	50	51	52	53	54	55	56	57	58	59
(h:min:s)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)
0:00:00	20	18	20	17	26	23	28	15	22	22	20	23
0:05:00	576	613	610	608	635	613	607	618	615	649	635	647
0:10:00	678	693	651	654	673	664	678	696	694	714	707	717
0:15:00	739	757	711	716	731	724	728	750	740	765	765	775
0:30:00	842	843	825	816	821	813	818	828	830	853	848	862
0:45:00	902	909	891	881	889	883	886	893	896	917	912	926
1:00:00	945	952	935	928	937	930	933	938	939	959	951	970
1:15:00	979	981	958	954	961	953	962	964	975	988	984	996
1:30:00	1006	1011	988	989	994	991	1007	1005	1018	1021	1018	1029
1:45:00	1029	1036	1004	1007	1012	1005	1019	1022	1028	1035	1040	1051
1:47:20	1032	1045	1023	1026	1034	1023	1031	1023	1040	1058	1061	1069

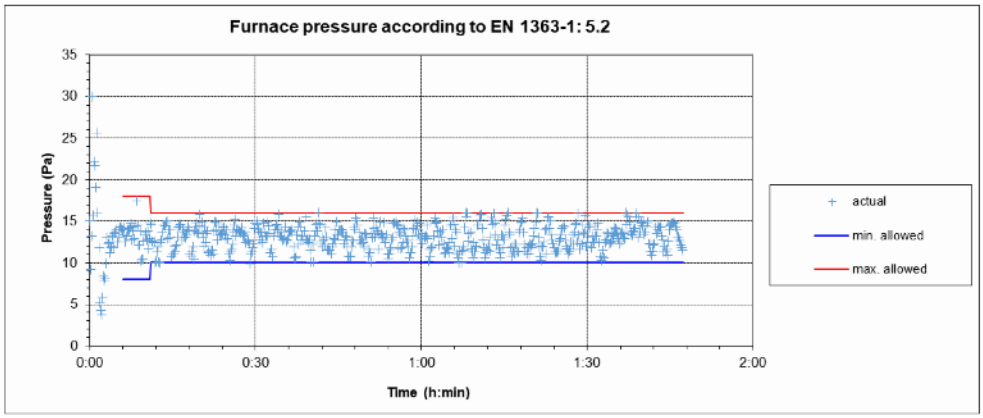
Time	Furnace temperatures											Deviation d_e			Deviation from T		Probe pressure			Ambient
	60	61	62	63	64	65	66	67	68	69	avg	shall be within		actual	min	max	shall be within		actual	temperature
(h:min:s)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(%)	(%)	(%)	(°C)	(°C)	(Pa)	(Pa)	(Pa)	(°C)
0:00:00	20	23	23	22	25	41	19	24	35	18	23								15.0	12
0:05:00	595	623	603	621	638	640	660	619	657	592	624			11.3					12.5	12
0:10:00	647	664	652	667	685	692	722	699	718	684	684	-15	15	6.3	-32	43	8.0	18.0	13.3	12
0:15:00	710	719	718	735	748	761	788	747	782	750	744	-12.5	12.5	3.9	-29	49	10.0	16.0	11.1	12
0:30:00	812	815	817	828	831	845	863	830	865	846	834	-5.0	5.0	1.6	-29	24	10.0	16.0	14.7	12
0:45:00	882	882	888	900	899	914	926	895	929	910	900	-3.8	3.8	0.9	-22	27	10.0	16.0	13.3	12
1:00:00	941	930	940	945	945	956	968	937	969	955	945	-2.5	2.5	0.6	-18	24	10.0	16.0	13.1	12
1:15:00	964	957	965	965	962	971	989	973	992	981	971	-2.5	2.5	0.4	-26	18	10.0	16.0	12.8	13
1:30:00	993	991	995	994	994	1001	1020	1022	1024	999	1005	-2.5	2.5	0.3	-18	23	10.0	16.0	12.4	13
1:45:00	1011	1009	1012	1010	1010	1018	1035	1039	1042	1032	1023	-2.5	2.5	0.2	-25	22	10.0	16.0	14.4	13
1:47:20	1036	1030	1036	1038	1031	1039	1045	1054	1054	1050	1040	-2.5	2.5	0.2	-9	37	10.0	16.0	11.5	14

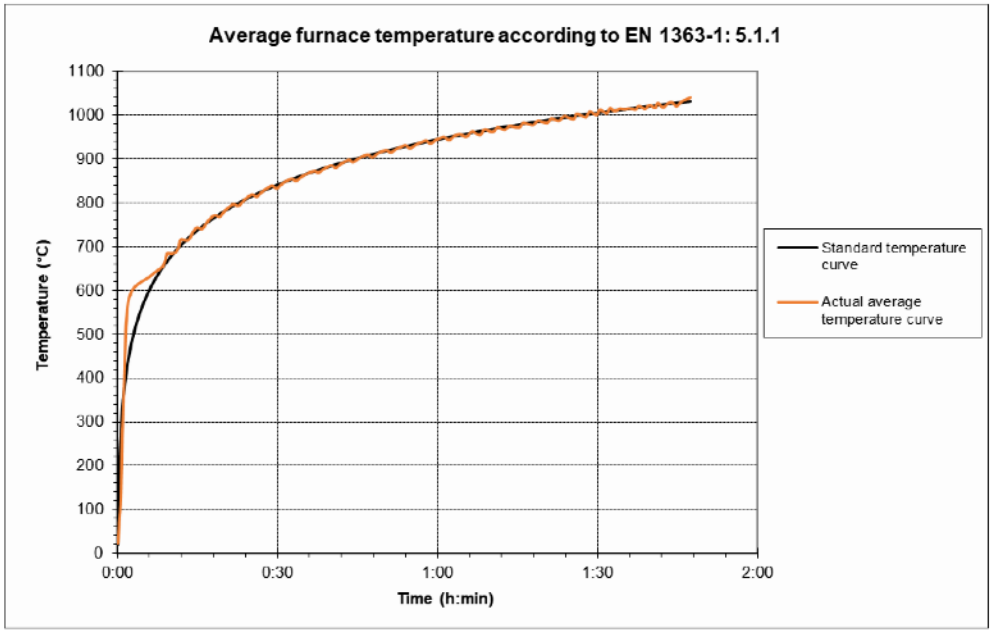
Key

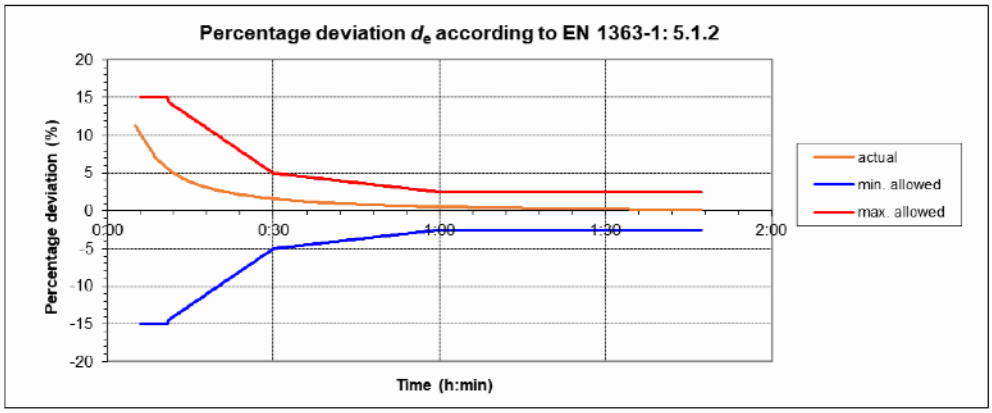
- t is the time, in min;
- T is the standard average furnace temperature, in °C, $\{T\} = 345.\log_{10}(8\{t\}+1) + 20$;
- avg is the actual average furnace temperature, in °C;
- d_e is the percentage deviation in the area of he actual average temperature/time curve from the area of the standard temperature/time curve;

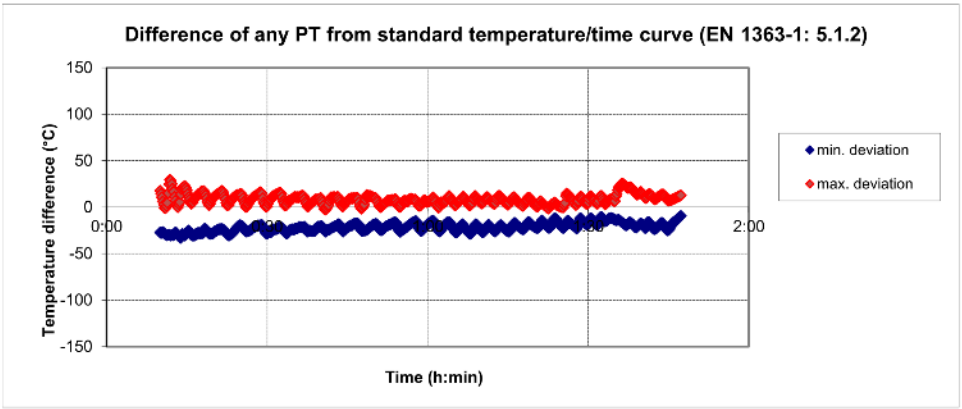
"Pressure" is the difference of the pressure in the furnace and the ambient pressure at the same hight level:

The pressure of	20 Pa	is required in height of	6 m
Then the pressure of	13 Pa	is expected in pressure sensor	5.2 m

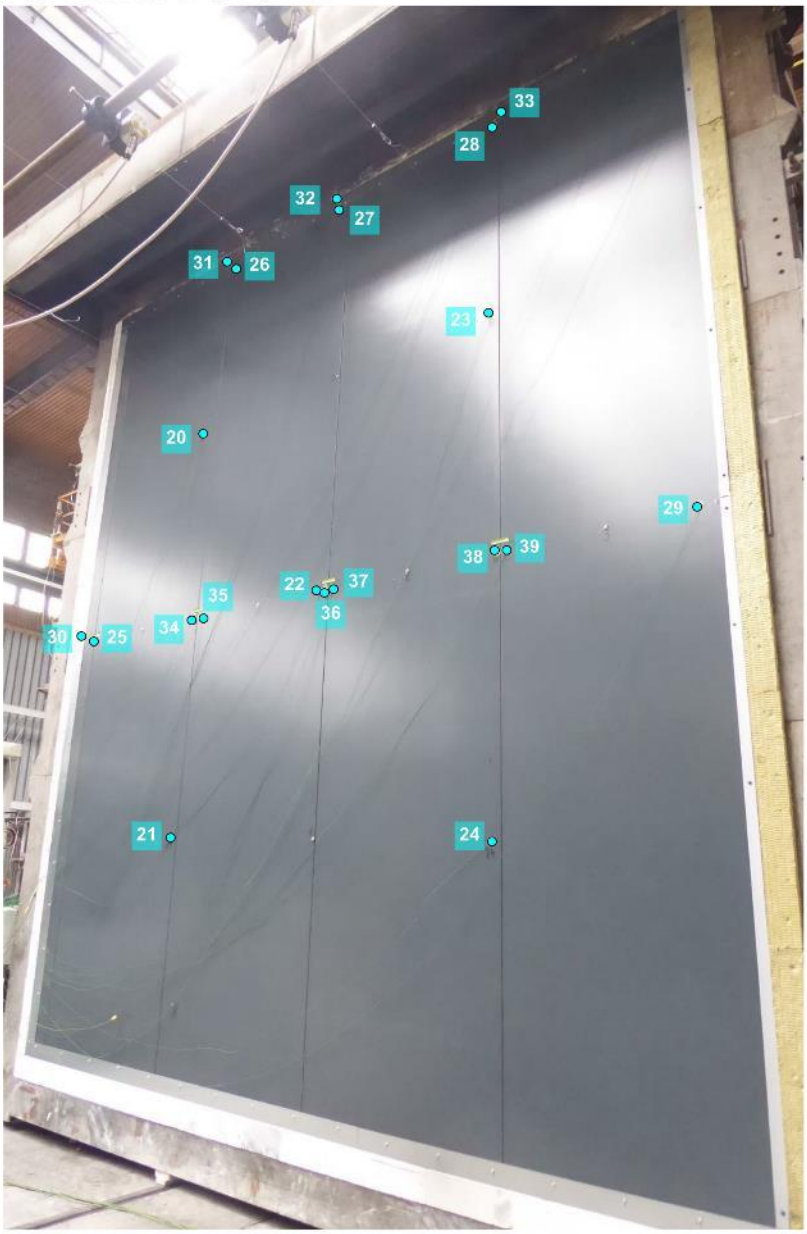

Furnace pressure according to EN 1363-1: 5.2
Pressure (Pa)
35
30
25
20
15
10
5
0
0:00
0:30
1:00
1:30
2:00
Time (h:min)
actual
min. allowed
max. allowed


Average furnace temperature according to EN 1363-1: 5.1.1
Temperature (°C)
1100
1000
900
800
700
600
500
400
300
200
100
0
0:00
0:30
1:00
1:30
2:00
Time (h:min)
Standard temperature curve
Actual average temperature curve


Percentage deviation d_e according to EN 1363-1: 5.1.2
Percentage deviation (%)
20
15
10
5
0
-5
-10
-15
-20
0:00
0:30
1:00
1:30
2:00
Time (h:min)
actual
min. allowed
max. allowed


Difference of any PT from standard temperature/time curve (EN 1363-1: 5.1.2)
Temperature difference (°C)
150
100
50
0
-50
-100
-150
0:00
2:00
Time (h:min)
min. deviation
max. deviation

LAYOUT OF TC ON UF OF SPECIMEN



Key:

20 ÷ 24 - TC for T_{aver} and T_{max}

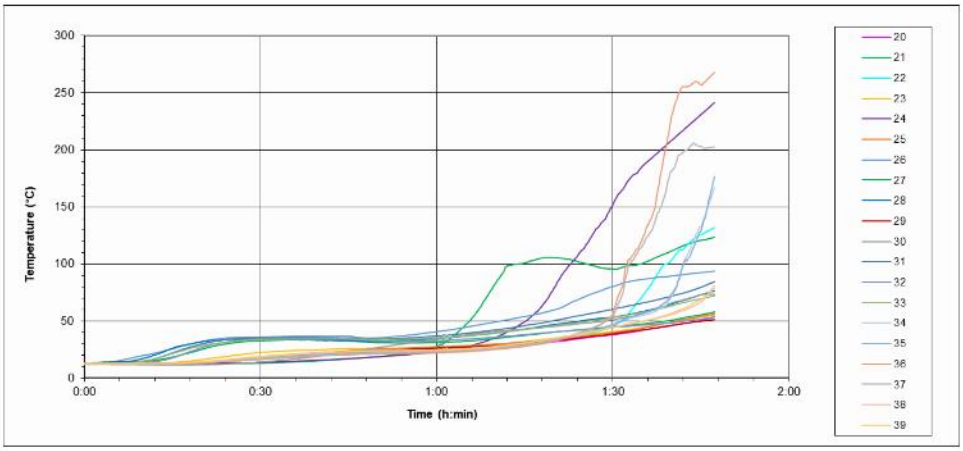
25 ÷ 39 - TC for T_{max}

Time	Temperature on the unexposed face of the specimen (°C)																				
	T_{aver}						T_{max}														
(h:min:s)	T_{aver}	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	T_{max}
0:00:00	**12**	13	12	13	13	13	13	12	12	12	13	12	12	12	12	12	12	12	12	13	**13**
0:05:00	**13**	13	12	13	13	13	13	14	14	14	13	12	13	13	13	12	12	12	13	13	13	**14**
0:10:00	**13**	13	12	13	13	13	13	20	14	17	13	12	15	13	15	12	12	12	13	13	13	**20**
0:15:00	**13**	13	12	13	14	13	13	26	18	26	13	12	22	18	21	13	12	13	13	13	13	**26**
0:30:00	**17**	19	13	16	22	14	18	36	33	34	17	14	35	34	33	17	17	16	17	19	18	**36**
0:45:00	**21**	24	17	21	26	17	24	37	33	33	22	23	35	34	34	22	22	20	21	23	23	**37**
1:00:00	**25**	26	28	23	26	23	27	40	31	35	26	34	37	33	35	24	25	22	23	24	25	**40**
1:15:00	**48**	29	101	28	32	49	32	54	37	43	30	43	46	38	42	29	30	28	29	31	31	**101**
1:30:00	**74**	38	96	45	41	152	40	80	45	53	39	51	60	44	53	46	47	56	54	44	44	**152**
1:38:40	**100**	45	109	99	48	202	48	89	50	63	45	63	70	48	62	63	65	193	157	54	54	**202**
1:45:00	**116**	50	121	126	53	231	54	92	55	73	50	73	80	52	69	133	129	258	203	67	69	**258**
1:47:20	**121**	54	123	132	55	242	56	94	58	77	51	73	85	53	72	167	177	268	203	81	79	**268**

Temperature recorded at 10 s intervals. In the table, they figure in 15 minute intervals

XX Designation of measuring joint of TC as figured in Annex B

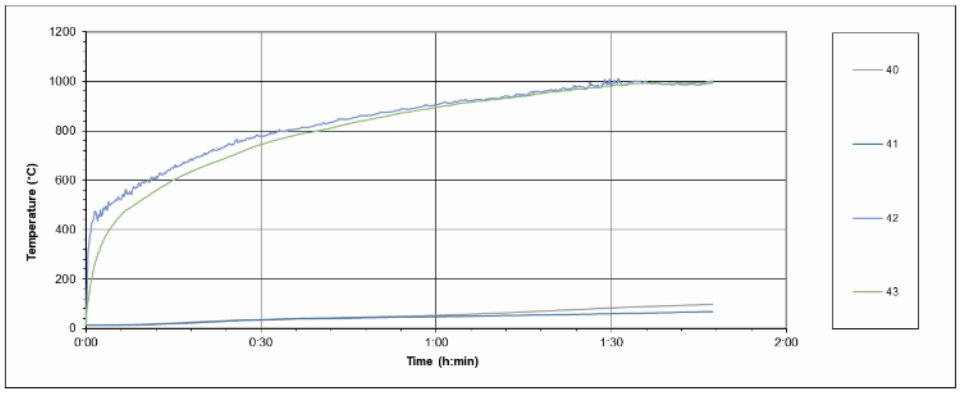
XX Time and temperature when the insulation criterion has been exceeded



Time	Temperature on the fixing of the specimen (°C)					
	T_{fixing}					
(h:min:s)	40	41	42	43		
0:00:00	12	12	12	12		
0:05:00	14	13	517	431		
0:10:00	17	15	590	528		
0:15:00	22	19	650	601		
0:30:00	36	35	779	745		
0:45:00	44	43	849	830		
1:00:00	53	48	907	896		
1:15:00	67	54	947	941		
1:30:00	83	60	982	980		
1:45:00	96	68	986	994		
1:47:20	98	69	995	1001		

Temperature recorded at 10 s intervals. In the table, they figure in 15 minute intervals

XX Designation of measuring joint of TC as figured in Annex B

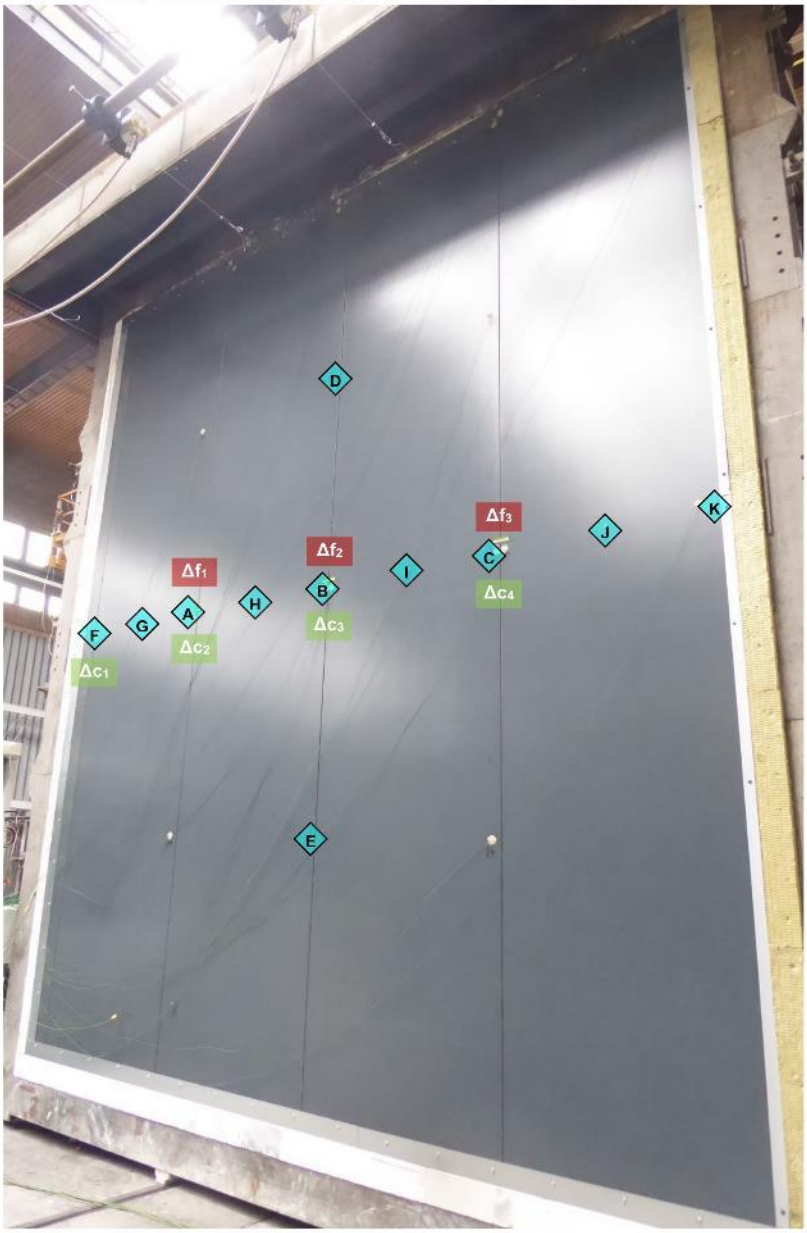


Key:

40, 41 - TC on UF of the screw

42, 43 - TC on EF of the screw

LAYOUT OF DEFLECTION MEASUREMENTS ON UF OF SPECIMEN



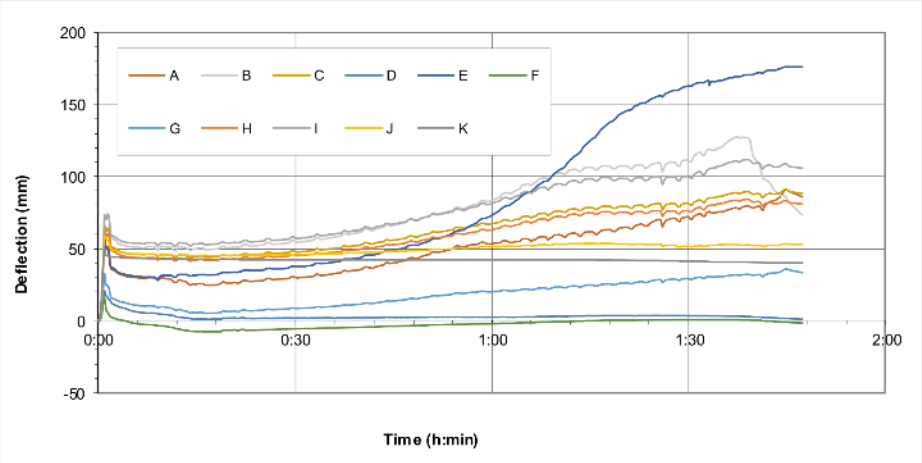
Key:

A ÷ K - points of measurement of horizontal deflection

Δf_x - deflection difference according to EN 15254-5, Figure B.1

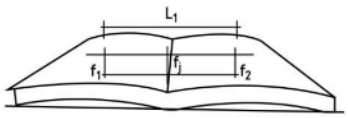
Δc_x - deflection difference according to EN 15254-5, Figure B.2

Time	Deflection (mm)										
(h:min:s)	A	B	C	D	E	F	G	H	I	J	K
0:00:00	0	0	0	0	0	0	0	0	0	0	0
0:05:00	30	51	46	7	32	-2	11	44	54	46	43
0:10:00	29	51	46	4	32	-4	9	43	54	45	42
0:15:00	25	50	44	1	32	-8	5	42	53	45	42
0:30:00	30	55	48	2	38	-6	8	45	57	46	42
0:45:00	40	66	55	2	49	-4	13	52	67	48	42
1:00:00	53	83	67	2	73	-3	20	63	81	51	42
1:15:00	62	106	78	3	125	0	25	75	98	53	42
1:30:00	72	110	81	3	163	0	29	76	100	51	41
1:45:00	91	84	90	1	176	-1	36	83	109	53	40
1:47:20	86	73	88	1	176	-2	33	81	106	53	40



Values "+" - deflection in furnace
Values "-" - deflection away from furnace

Measurement according to EN 15254-5, Annex B:

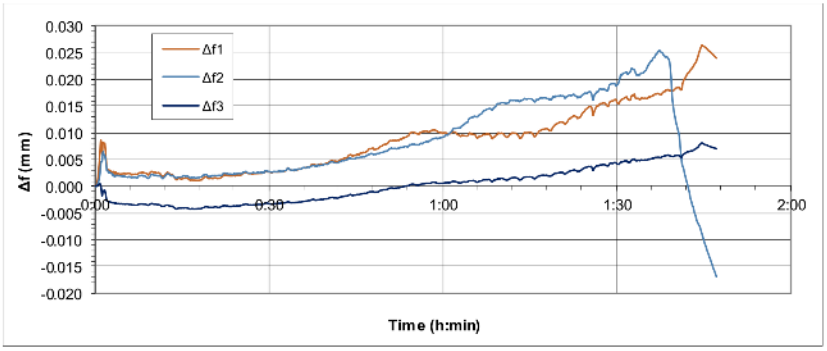


$$\Delta f = (f_j - 0{,}5x(f_1 + f_2))/L_1$$

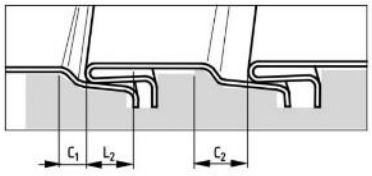
Figure B.1 — Calculation of Δf in midspan section

L_1 = 1200 mm

Time (h:min:s)	Deflection difference (mm) Δf_1	Δf_2	Δf_3
0:00:00	0.000	0.000	0.000
0:05:00	0.002	0.002	-0.003
0:10:00	0.003	0.002	-0.003
0:15:00	0.001	0.002	-0.004
0:30:00	0.003	0.003	-0.003
0:45:00	0.006	0.005	-0.002
1:00:00	0.010	0.009	0.001
1:15:00	0.010	0.016	0.002
1:30:00	0.016	0.019	0.004
1:45:00	0.026	-0.009	0.008
1:47:20	0.024	-0.017	0.007



Measurement according to EN 15254-5, Annex B:

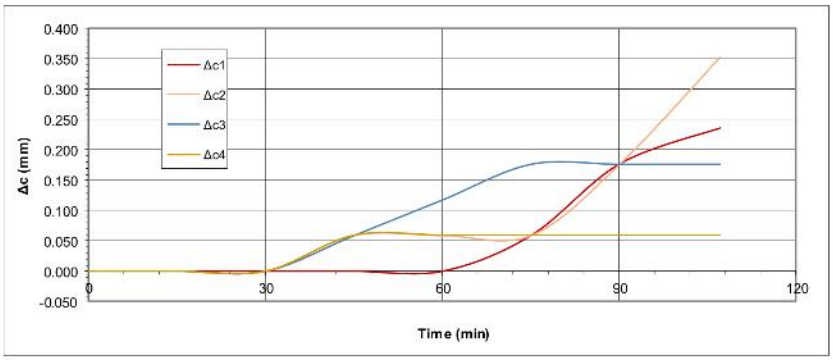


$\Delta c = (c_2 - c_1)/L_2$

Figure B.2 — Calculation of Δc

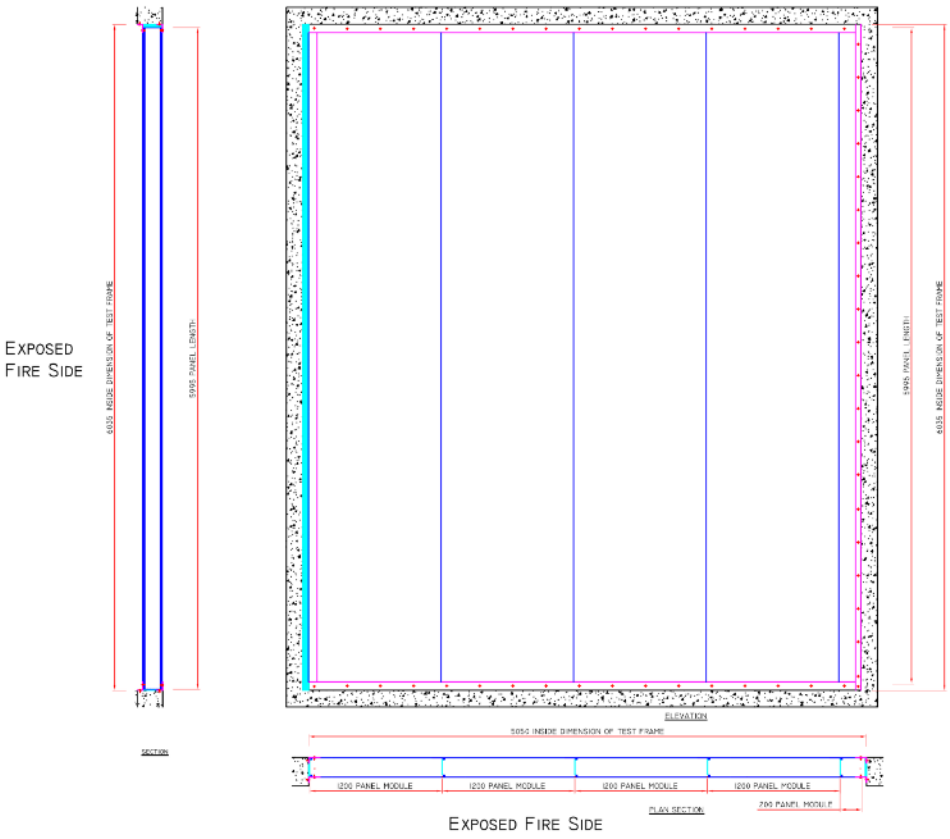
L_2 = 17 mm
c_0 = 2 mm (before the test)

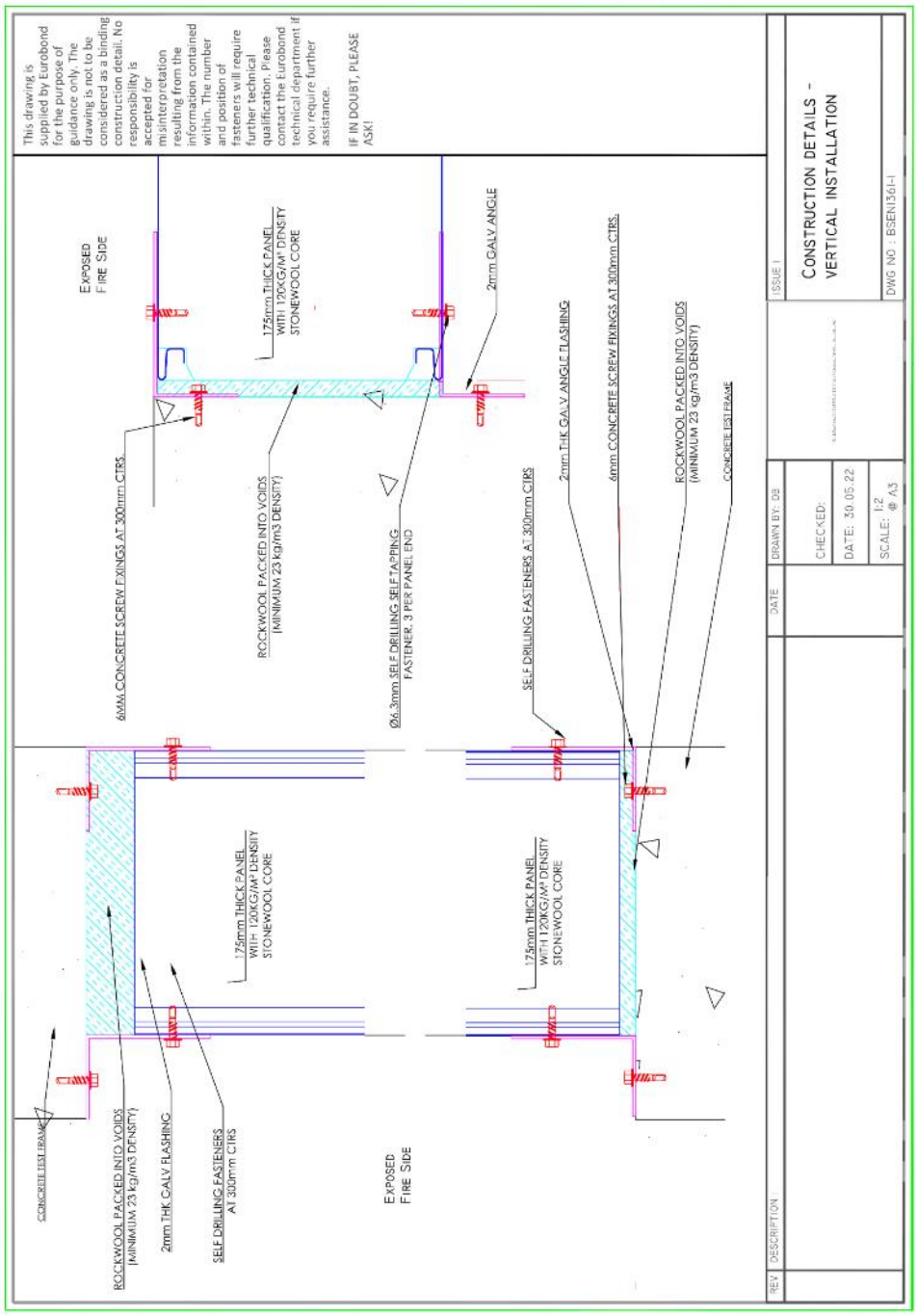
Time (min)	Deflection difference (mm)			
	Δc_1	Δc_2	Δc_3	Δc_4
0	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000
45	0.000	0.059	0.059	0.059
60	0.000	0.059	0.118	0.059
75	0.059	0.059	0.176	0.059
90	0.176	0.176	0.176	0.059
107	0.235	0.353	0.176	0.059



ANNEX C: DOCUMENTATION

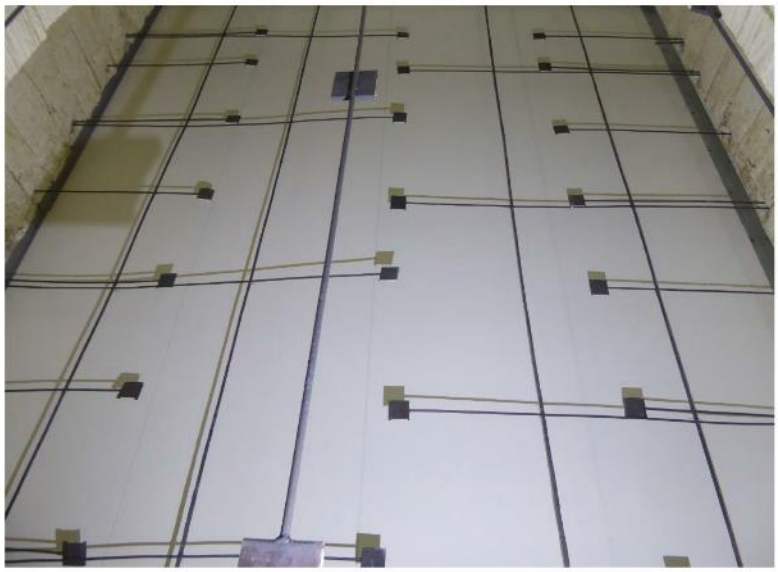
Specimen-related documentation delivered by the test sponsor.



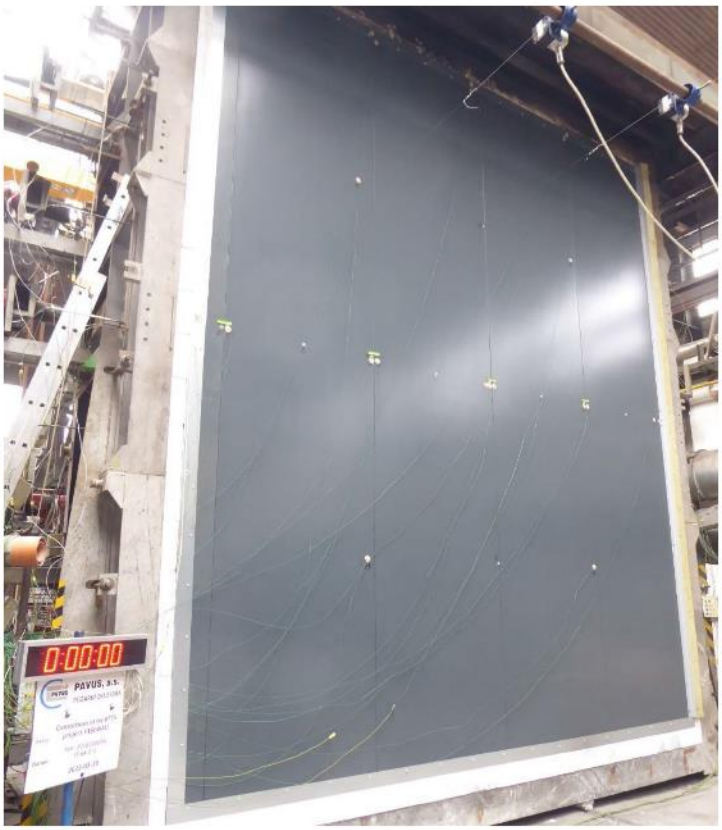

This drawing is supplied by Eurobond for the purpose of guidance only. The drawing is not to be considered as a binding construction detail. No responsibility is accepted for misinterpretation resulting from the information contained within. The number and position of fasteners will require further technical qualification. Please contact the Eurobond technical department if you require further assistance.
IF IN DOUBT, PLEASE ASK!
EXPOSED FIRE SIDE
175mm THICK PANEL WITH 120KG/M³ DENSITY STONEWOOL CORE
2mm GALV ANGLE
6MM CONCRETE SCREW FIXINGS AT 300mm CTRS
ROCKWOOL PACKED INTO VOIDS (MINIMUM 23 kg/m3 DENSITY)
Ø6.3mm SELF DRILLING SELF TAPPING FASTENER, 3 PER PANEL END
SELF DRILLING FASTENERS AT 300mm CTRS
2mm THK GALV ANGLE FLASHING
6mm CONCRETE SCREW FIXINGS AT 300mm CTRS.
ROCKWOOL PACKED INTO VOIDS (MINIMUM 23 kg/m3 DENSITY)
CONCRETE TEST FRAME
175mm THICK PANEL WITH 120KG/M³ DENSITY STONEWOOL CORE
175mm THICK PANEL WITH 120KG/M³ DENSITY STONEWOOL CORE
CONCRETE TEST FRAME
ROCKWOOL PACKED INTO VOIDS (MINIMUM 23 kg/m3 DENSITY)
2mm THK GALV FLASHING
SELF DRILLING FASTENERS AT 300mm CTRS
EXPOSED FIRE SIDE
REV
DESCRIPTION
DATE
DRAWN BY: DB
CHECKED:
DATE: 30.05.22
SCALE: 1:2 @ A3
ISSUE 1
CONSTRUCTION DETAILS - VERTICAL INSTALLATION
DWG NO : BSEN1364-1

ANNEX D: PHOTOS

Assembly of the specimen



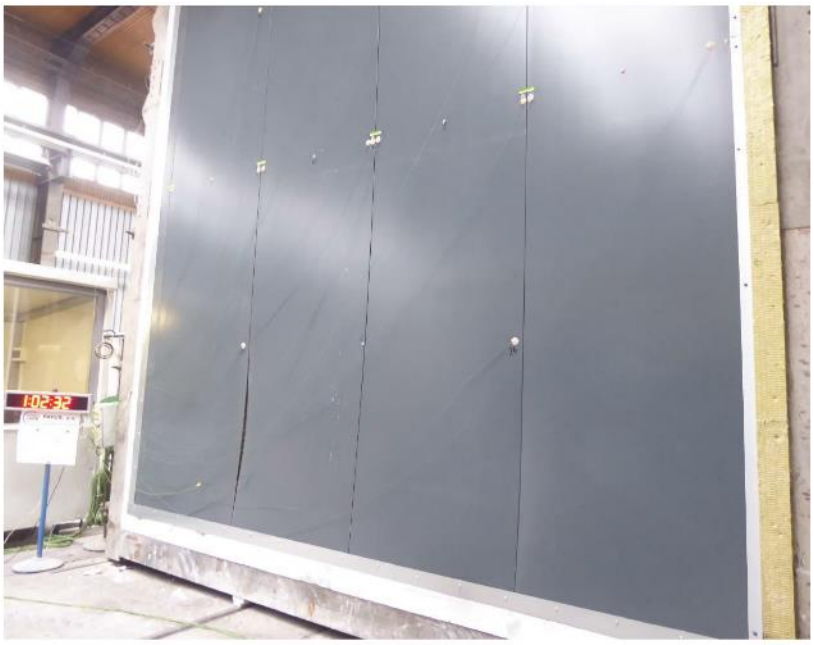
EF before the test



UF before the test

EF after 30 minutes of the test

UF after 45 minutes of the test



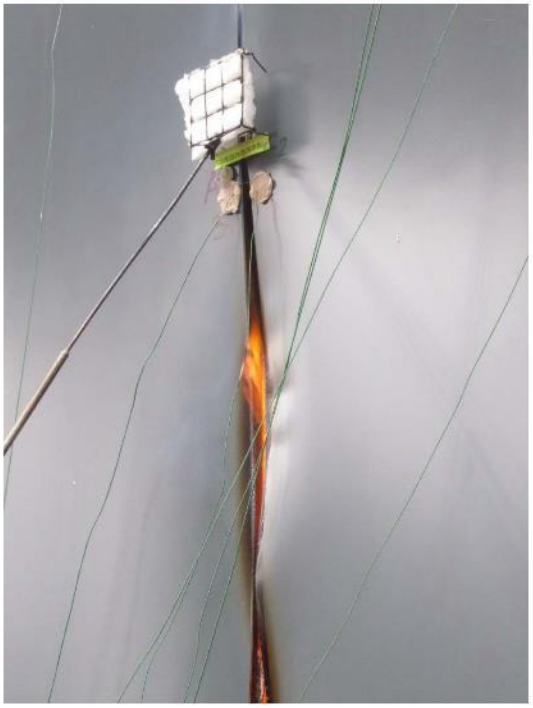
UF after 62 minutes of the test

UF in 76th minute of the test - 6 mm gap gauge can't pass through the specimen - without integrity failure

UF after 90 minutes of the test

UF in 95th minute of the test - 6 mm gap gauge passed through the specimen in distance longer than 150 mm along the gap - integrity failure

UF in 105th minute of the test - cotton pad test - without integrity failure



UF in 106th minute of the test - cotton pad test - without failure, sustained flaming - integrity failure

UF in 107th minute of the test - cotton pad test - integrity failure

UF after 108 minutes - end of the test

EF the second day after the test

APPPENDIX D. REPORT PR-N°22-2.231-EN FOR TEST N°4

PAVUS
FIRE TESTING INSTITUTE

Order No.: Z210220039

PAVUS, a.s.
AUTHORIZED BODY 216
NOTIFIED BODY 1391
ACCREDITED TESTING LABORATORY
EGOLF MEMBER

ilac-MRA

L 1026

FIRE TESTING LABORATORY VESELÍ NAD LUŽNICÍ
Testing Laboratory No. 1026 accredited by ČIA
Notified Testing Laboratory
workplace Veselí nad Lužnicí

FIRE RESISTANCE TEST REPORT

No. Pr-22-2.231-En

issued on 2023-01-17

For product

Non-loadbearing wall 5 x 6 m

External wall made of sandwich panels Eurobond Rockspan Extra (vertical cladding with steel beam)

Sponsor: **Consortium of the RFCS project FISHWALL**

cticm · UNIVERSITÀ DI TRENTO · CTU · JORISIDE THE STEEL FUTURE · BRIAND CONSTRUCTION METALLIQUE · PAVUS FIRE TESTING INSTITUTE · L'ENVELOPPE METALLIQUE DU BÂTIMENT · Efectis · euroclad group

Test method:

ČSN EN 1364-1
» Fire resistance tests for non-loadbearing elements - Part 1: Walls «

Test Report includes 33 pages
(6 pages of text + 4 Annexes)

Number of copies: 2
Copy number: 1

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Phone: +420 286 019 587

Veselí nad Lužnicí Branch
Čtvrť J. Hybeše 879, 391 81 Veselí nad Lužnicí, Czech Republic, e-mail: veseli@pavus.cz
Phone: +420 381 477 418

1 INTRODUCTION

The fire resistance test of the non-loadbearing wall was performed based on the order of Consortium of the RFCS project FISHWALL in Fire Testing Laboratory PAVUS, a.s. in Veselí nad Lužnicí.

The test was prepared, performed and assessed on the base of following documents:

[1] ČSN EN 1364-1:2017 Fire resistance tests for non-loadbearing elements - Part 1: Walls

[2] ČSN EN 1363-1:2021 Fire resistance tests - Part 1: General requirement

[3] ČSN EN 1363-2:2000 Fire resistance tests - Part 2: Alternative and supplementary procedures

[4] ČSN EN 15254-5:2019 Extended application of results from fire resistance tests - Non-loadbearing walls - Part 5: Metal sandwich panel construction

[5] ČSN EN 13501-2:2017 Fire classification of construction products and building elements - Part 2: Classification using test data from resistance fire tests, excluding ventilation services

[6] ČSN EN 1366-4 Fire resistance tests for service installations - Part 4: Linear joint seals

[7] ČSN EN 13381-4:2018 Test methods for determining the contribution to the fire resistance of structural members - Part 4: Applied passive protection to steel members

[8] ILAC-G17:01/2021 Guidelines for Measurement Uncertainty in Testing

[9] JCGM 100:2008 GUM 1995 with minor corrections, Evaluation of measurement data - Guide to the expression of uncertainty in measurement (Available from www.BIPM.org)

[10] Specimen-related technical documentation delivered by the test sponsor

For the purposes of this document, definitions given in [1] ÷ [9] together with following abbreviations apply:

ČIA	Český institut pro akreditaci, o.p.s. (Czech Institute for Accreditation)
ATL	accredited testing laboratory
TC	thermocouple
TM	thermometer (sheathed TC)
PTM	plate thermometer fit with a TM ∅ 2 mm
EF	exposed specimen face
UF	unexposed specimen face
RTC	roving thermocouple

2 TEST SUBJECT

The subject matter of the test was represented by a specimen of prebuilt non-loadbearing wall with total dimensions of 5 000 mm (width) × 6 035 mm (height) x 175 mm (thickness) of sandwich panels Eurobond Rockspan Extra vertically oriented. The specimen in test frame was mounted to rigid construction with low density, thickness 250 mm, density 550 kg/m^3.

Description of the construction:

Non-loadbearing external wall consisted of 10 pcs of sandwich panels Eurobond Rockspan Extra with mineral wool as an insulation core, nominal density of mineral wool was 120 kg/m^3. Each panel had dimensions of 1 200 mm (stock width) × 175 mm (thickness), length of 4 945 mm (5 panels), resp. 1000 mm (5 panels), forming the joint with the steel beam of width approx 15 mm, filled in full depth with mineral wool Knauf POWER-TEK BD 660, nominal density 100 kg/m^3. One panel was reduced to width 400 mm and it was mounted to the fixed vertical edge of the wall. On EF, the panels had profiled metal sheet, th. 0.5 mm (interior side) and on UF, they had metal sheet, th. 0.5 mm (exterior side), both sheets were galvanized and coated.

On both horizontal sides and on left vertical edge of the rigid construction, L-profiles 100x50x2 were mounted on EF (and also on UF in the end of the assembly), aligned with the edge of the rigid construction. The profiles were anchored to the rigid construction using carbon steel screws TutFast HTF-6.3 x 57 (producer Fixfast Ltd) in spacing of 450 mm. The right vertical edge of the specimen was without mechanical fixing.

Particular panels were anchored to the L-profiles using stainless screws DrillFast DF2-SS-LS-A15-6.3 x 25 (producer Fixfast Ltd) in the direction from EF, in spacing of 300 mm. On one side, the panels were anchored to the steel beam with stainless screws DrillFast DF3-SS-HT-A15-5.5 x 225 (producer Fixfast Ltd) in spacing of 500 mm.

The structural gaps between the test specimen and the rigid construction were filled up with mineral wool POWER-TEK BD 660 (manufacturer Knauf Insulation, spol. s r.o.), nominal density 100 kg/m^3, width of the gap between 20 and 30 mm.

The left vertical edge was left unrestrained in order to enable free specimen moving. The gap between the specimen and the rigid construction of width 50 mm was filled up with mineral wool.

Description of the steel beam and its fire protection:

In distance 1000 mm from the rigid construction, there was mounted steel beam, section IPE 240, in length of 5 400 mm. The beam was fixed at each end with one bolt M20 to the testing frame, one slotted hole was drilled at each end of the beam for possibility of the thermal movement of the section.

From the inner side of the flanges, there were fixed supporting steel angles 50x50x2 with screws RPK12-SS-5.5 x 38 (producer Fixfast Ltd) in spacing of 500 mm. Boxed fire protection of the steel beam was made of 3 cut pieces of length 5 150 mm (2x width of 240 mm, 1x width of 470 mm) of the sandwich panels Eurobond Rockspan Extra, th. 175 mm. Panels were fixed to the supporting steel angles using stainless screws DrillFast DF3-SS-HT-A15-5.5 x 225 (producer Fixfast Ltd) in spacing of 500 mm, on two vertical sides with washers Fixfast SP-40-DD (producer Fixfast Ltd).

On the corners of the fire protection and on the joint of the panels with steel beam, there were fixed covering steel sheets, th. 0.35 mm.

Test specimen related technical documentation delivered by the test sponsor is documented in Annex C.

The specimen was mounted as per [1] cl. 7 and Annex C of this Test Report.

The tested specimen was manufactured by company Euroclad Group Ltd.

The Testing Laboratory did not participate in extracting elements used for test specimen assembly.

The parts of the test specimen were delivered to the test laboratory on 21st November 2022 without any defects and mounted from 29th November to 2nd December 2022 to the test frame by company Euroclad Group Ltd in accordance with the delivered documentation.

3 TEST PERFORMANCE

3.1 General

The fire resistance test was performed as per [1] on 6th December 2022 in Testing hall PO 1 in vertical wall furnace with inner dimensions of 5 000 mm (width) × 6 000 mm (height) × 1 500 mm (depth).

Direction of fire exposure from interior side (with the steel beam).

Used testing and gauging equipment is stated in Annex A.

3.2 Furnace control

The test furnace was heated with a set of oil burners. In-furnace temperatures were measured by the help of PTMs and recorded at minute intervals. The measuring wires of PTM were distributed uniformly in a distance of 100 mm from the exposed face of fire protection of the steel beam according to [1] cl. 9.1.1.

In-furnace temperatures for standard heating curve according to [2] were controlled so that they conformed to the relation according to [2] cl. 5.1.1, within the specified limits (see [2] cl. 5.1.2):

$$T = 345 \log (8t + 1) + 20$$

where T (°C) = required in-furnace temperature in time °C
t (min) = time since the test beginning

The test furnace positive pressure was measured and controlled so that the values correspond to the conditions of [1] cl. 9.2 and [2] cl. 5.2.1 and 9.2.1.

3.3 Specimen measuring

The specimen unexposed face and inner temperatures were taken using K-type disc TCs and recorded at minute intervals. The TCs were fixed on the specimen surface and according to [1] cl. 9.1.2.2, 9.1.2.3, B.3 and with respect to [6] cl. 9.2.2, on the surface of the steel beam with respect to [7] cl. 9.3.

The rate of the horizontal deflection was measured by deflectometers spaced according to [1] cl. 9.3.

One RTC (see [2] cl. 4.5.1.3) was available to measure points where higher temperatures were expected.

The measured points of deflections and the TC positions are described and figured in Annex B.

The initial test conditions met the standard values as per [2] cl. 10.3.

3.4 Ambient temperature

During the test, the ambient temperature was measured using one K-type TM (see [2] cl. 4.5.1.5) according to the conditions of [2] cl. 5.6.

3.5 Conditioning

From the specimen delivery to the Fire Testing Laboratory until the test performance, the specimen was stored in the enclosed ambient of test hall at the air temperature of (15 ± 5) °C and at relative air humidity of (50 ± 5) %.

4 TEST COURSE

Time (min)	Test observation
10.	EF - mild darkening of the vertical joints between the panels
50.	EF - mild bending of the metal sheets in the vertical joints
65.	UF - opening of the joint by measured point c_2, in the bottom part
80.	UF - darkening and mild opening of the joint by measured points c_1 and c_4, in the bottom part
89.	UF - cotton pad test by measured point c_2 - without failure
95.	UF - all joints (c_1 to c_4) are opened in the bottom part EF - flashings on the steel beam are mild bent
114.	UF - cotton pad test by measured point c_3 - without failure
142.	UF - 6 mm gap gauge can't pass through the specimen by measured point c_1 in the bottom part - without failure
142.	UF - sustained flaming and burning flaming of the cotton pad by measured point c_1 in the upper part - **integrity failure**
145.	end of the test at request of the Sponsor

Layout of TC described in Annex B. Deflections are described in Annex B.

The in-furnace temperatures and pressures met the requirements of [2]. Time relations to the measured temperatures and pressures are specified in Annex B.

5 TEST RESULTS

5.1 Limit state attainment criteria

+ **Integrity** (according to [2] cl. 11.2). This criterion means the time in completed minutes for which the test specimen continues to maintain its separating function during the test without either:
  a) causing the ignition of a cotton pad applied in accordance with [2] cl. 10.4.5.2; or
  b) permitting the penetration of a gap gauge as specified in [2] cl. 10.4.5.3; or
  c) resulting in sustained flaming.

- **Insulation** (according to [2] cl. 11.3). This criterion means the time in completed minutes for which the test specimen continues to maintain its separating function during the test without developing temperatures on its unexposed surface which either:
  a) increase the average temperature above the initial average temperature by more than 140 K; or
  b) increase the temperature at any location (incl. RTC) above the initial average temperature by more than 180 K.

- **Radiation** (according to [1] cl. 9.4 and [3] cl. 8). The criterion of radiation is deemed to be observed until the measured radiation does not exceed the value of 15 kW.m^{-2}. The time for the measured radiation to exceed the value of 5, 10, 15, 20 and 25 kW.m^{-2} is reported.

5.2 Expression of test results

Criterion	Partial criterion	Measured value	Evaluation
Integrity	Cotton pad ignition	141 min	141 min
	Gap gauge passage	144 min, no failure	144 min
	Sustained flaming	141 min	141 min
Insulation	Average temperature	144 min, no failure	141 min [1)]
	Maximum temperature	104 min	104 min
Radiation	6 kW.m^{-2} (not measured) [2)]	141 min [3)]	

Notes:

[1)] The performance criteria "insulation" shall automatically be assumed not to be satisfied when the "integrity" criterion ceases to be satisfied (see [2] cl. 11.4.2).

[2)] There is no requirement to measure the radiation from a surface with a temperature below 300 °C because the radiation from such a surface is low (see [3] cl. 8.1). Average temperature on the UF of the specimen didn't exceed 300 °C.

[3)] Failure of integrity under the sustained flaming at unexposed side criteria means automatically failure of the radiation criterion. (see [5] cl. 5.2.4).

5.3 Field of direct application

The results of the fire test are directly applicable to similar constructions where one or more of the changes listed below are made and the construction continues to comply with the appropriate design code for its stiffness and stability:

- decrease in height;
- increase in the thickness of the wall;
- increase in the thickness of component materials;
- decrease in linear dimensions of boards or panels but not thickness;
- decrease in distance of fixing centres;
- increase in the number of vertical joints, of the type tested;
- the width of the construction may be increased;
- the height of the construction may be increased by 1.0 m under the maximum deflection of the test specimen was not in excess of 100 mm and the expansion allowances are increased pro-rata.

The results are applicable to high density rigid supporting constructions with at least the same fire resistance as the test specimen.

5.4 Application of test results

- The test results refer only to the tested specimen including the way of its mounting into the construction (see part 2 of this Report).
- This report details the method of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outlined in ČSN EN 1363-1, ČSN EN 1363-2 and ČSN EN 1364-1. Any significant deviation with respect to size, constructional details, loads, stresses, edge or end conditions other than those allowed under the field of direct application in the relevant test method is not covered by this report.

The Report and Annex sheets are valid with the embossed stamp only.

Elaborated by: ..... Jiří VANĚK, Technical Officer

Approved by: ..... Jiří KÁPL, ATL Manager

ANNEX A: TESTING AND GAUGING DEVICES, MEASUREMENT UNCERTAINTY

Test equipment:	**Device registration number:**
Vertical wall furnace PO 1 supplemented by modules increasing the size of the furnace to 5 m x 6 m (+ equipment for temperature and pressure control)	0127
Furnace pressure probe	0011
Test frame	0129/2
Gap gauge ∅ 6 mm	0112
Gap gauge ∅ 25 mm	0113
Cotton pad frame	0014
Gauging equipment:	**Metrological registration number:**
Differential pressure gauge AMR DPS	3 09 29
Datalogger Almemo 5990-2	3 10 85
PTM – in-furnace temperature (TM K ∅ 2 mm)	3 10 10
TC (K) – specimen UF temperature	3 10 14, 3 10 15
TM K ∅ 3 mm – ambient temperature	3 10 09
THERM 2260 + RTC (K)	3 10 13
Winding tape measure	3 01 29
Deflectometer Huggenberger	3 01 32, 33, 39÷42, 55÷58, 60÷62
Stop-watch	3 05 12
Thermo-hygro-barograph	3 13 06
Calliper	3 01 52

Measurement traceability of all measurement equipment is reported in the metrological registration card of the equipment; identified by the same metrological registration number as the equipment.

Quantity measured			**Extended measurement uncertainty**
Name	Symbol	Unit	
Time since the test beginning	t	(min)	$3{,}4\ 10^{-2}$min, for $t \leq 240$ min
Integrity disruption time		(min)	< 0,5 min
Temperature: TC or K-type PTM + compensation cable (both of the 2nd tolerance class) + Almemo 5990-2	T	(°C)	$\sqrt{(6{,}40.10^{-6}.T^2 + 1{,}57.10^{1}°C^2)}$, for 40°C ≤ T < 375°C $\sqrt{(8{,}04.10^{-5}.T^2 + 7{,}84°C^2)}$, for 375°C ≤ T ≤ 1000°C
Ambient-to-in-furnace pressure difference	p	(Pa)	$\sqrt{(5.3.10^{-4}.p^2+1{,}1.10^{-5}Pa^2)}$
Weight		(g)	1 g
Deflection (horizontal distortion)		(mm)	1,8 mm

The reported expanded measurement uncertainty is stated as the combined standard measurement uncertainty multiplied by the coverage factor $k = 2$ such that the coverage probability corresponds to approximately 95 %.", see [8] and [9].

The measurement uncertainty arising from sampling is not included in the expanded measurement uncertainty. "Because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance, it is not possible stated a degree of accuracy of the result", see EN 1363-1: 12.1 w).

ANNEX B: MEASUREMENT

TEMPERATURE AND PRESSURE IN FURNACE, AMBIENT TEMPERATURE

Test conditions according to EN 1363-1: 5

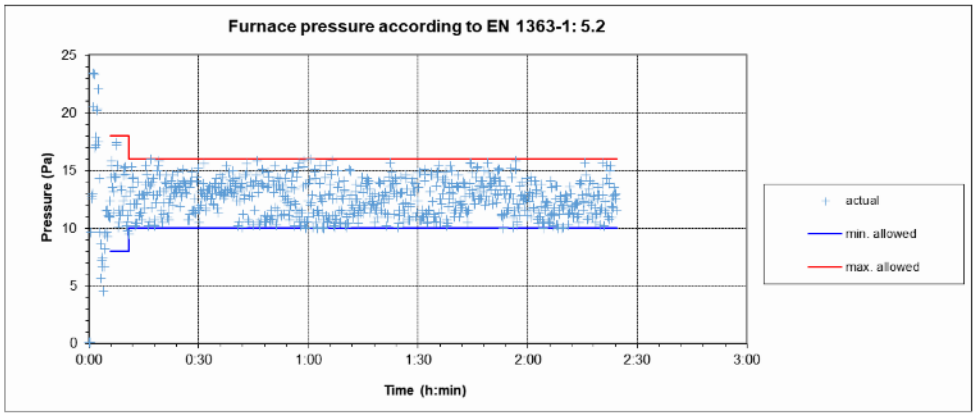
Time	Furnace temperatures																							Deviation d_e			Deviation from T		Probe pressure			Ambient
	T	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	avg	shall be within		actual	min	max	shall be within		actual	temperature
(h:min:s)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(%)	(%)	(%)	(°C)	(°C)	(Pa)	(Pa)	(Pa)	(°C)
0:00:00	20	12	11	11	11	11	11	11	11	11	12	12	11	11	11	11	12	12	11	11	11	12	11								0.1	11
0:05:00	576	551	554	588	578	595	605	607	607	610	598	564	564	583	589	593	600	617	606	587	612	537	588			-26.6					9.3	10
0:10:00	678	647	658	678	676	692	699	679	678	679	677	655	662	671	689	673	672	685	687	683	680	651	675	-15	15	-11.5	-32	20	8.0	18.0	14.7	11
0:15:00	739	719	712	722	721	734	741	743	737	735	740	726	722	725	730	731	737	745	746	745	737	712	731	-12.5	12.5	-7.2	-27	8	10.0	16.0	11.7	10
0:30:00	842	837	834	840	844	856	865	854	847	844	851	840	840	845	849	850	849	856	856	857	831	839	847	-5.0	5.0	-3.4	-11	24	10.0	16.0	11.8	10
0:45:00	902	898	891	895	896	906	911	910	903	898	908	899	897	898	900	902	904	909	910	913	896	900	902	-3.8	3.8	-2.1	-11	11	10.0	16.0	13.8	10
1:00:00	945	939	929	931	932	940	945	945	940	936	946	938	935	934	935	938	942	946	949	953	941	942	940	-2.5	2.5	-1.5	-16	7	10.0	16.0	12.4	10
1:15:00	979	977	966	966	978	979	982	980	976	972	981	978	969	974	972	974	977	981	986	990	981	980	977	-2.5	2.5	-1.2	-13	11	10.0	16.0	11.3	10
1:30:00	1006	1006	995	994	997	1003	1008	1004	1002	999	1009	1004	998	995	999	998	1003	1008	1013	1017	1003	1012	1003	-2.5	2.5	-1.0	-12	11	10.0	16.0	14.8	10
1:45:00	1029	1034	1026	1025	1027	1033	1038	1034	1030	1027	1035	1031	1028	1026	1029	1029	1033	1038	1039	1042	1026	1037	1032	-2.5	2.5	-0.8	-4	13	10.0	16.0	12.7	10
2:00:00	1049	1052	1045	1044	1045	1051	1054	1051	1049	1045	1053	1049	1047	1044	1047	1046	1050	1056	1057	1061	1048	1056	1050	-2.5	2.5	-0.7	-5	12	10.0	16.0	11.1	10
2:15:00	1067	1070	1064	1063	1064	1071	1073	1070	1068	1063	1071	1066	1065	1062	1065	1063	1067	1074	1072	1077	1092	1074	1069	-2.5	2.5	-0.6	-5	26	10.0	16.0	12.9	11
2:24:20	1077	1078	1074	1073	1074	1079	1082	1079	1075	1070	1079	1073	1075	1071	1075	1072	1075	1082	1078	1082	1101	1079	1077	-2.5	2.5	-0.6	-6	25	10.0	16.0	11.6	11

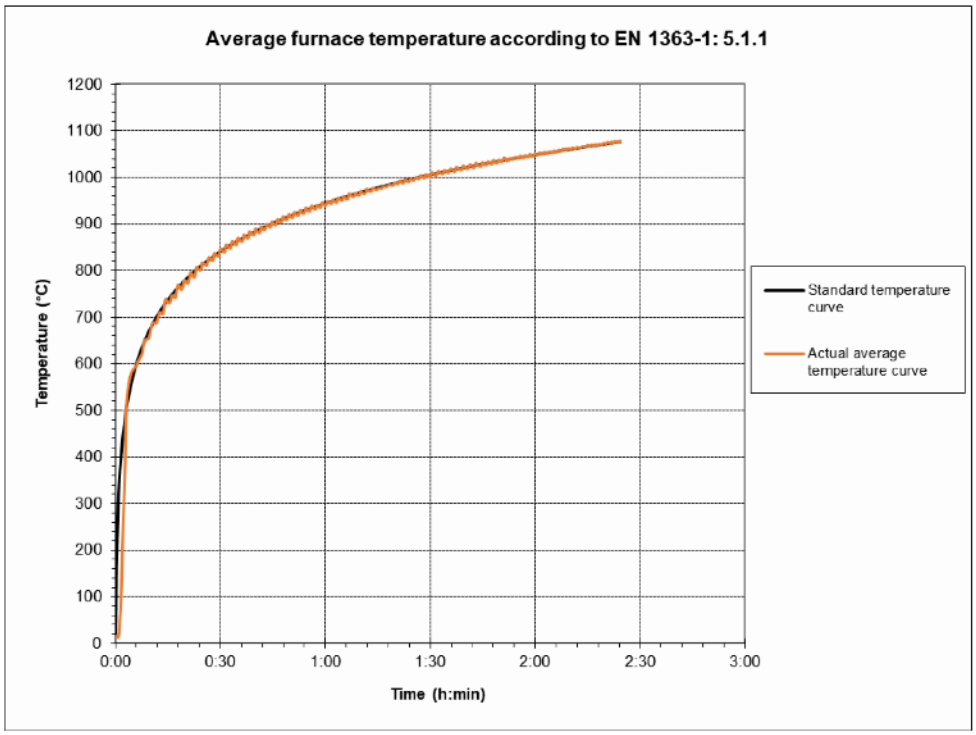
Key

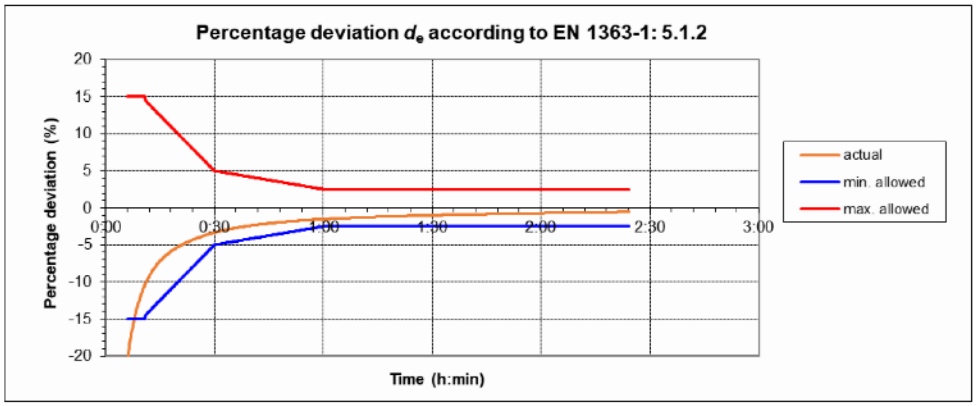
- t is the time, in min;
- T is the standard average furnace temperature, in °C, $\{T\} = 345.\log_{10}(8\{t\}+1) + 20$;
- avg is the actual average furnace temperature, in °C;
- d_e is the percentage deviation in the area of he actual average temperature/time curve from the area of the standard temperature/time curve;

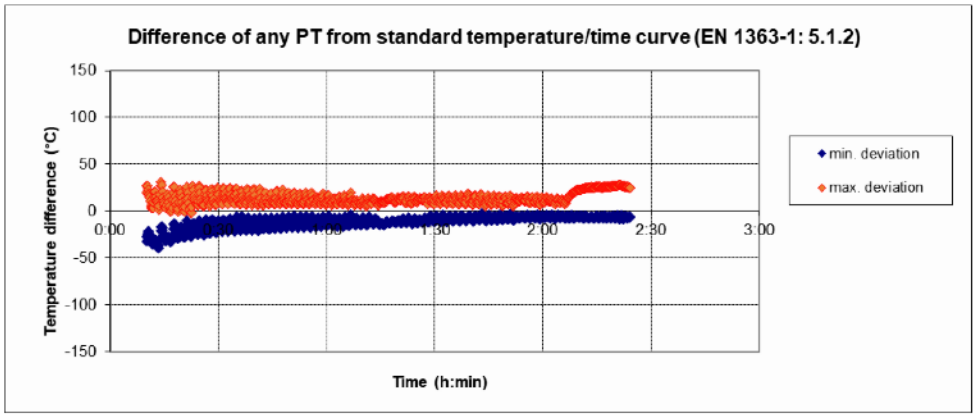
"Pressure" is the difference of the pressure in the furnace and the ambient pressure at the same hight level:

The pressure of	20 Pa	is required in height of	6	m
Then the pressure of	13 Pa	is expected in pressure sensor	5.2	m

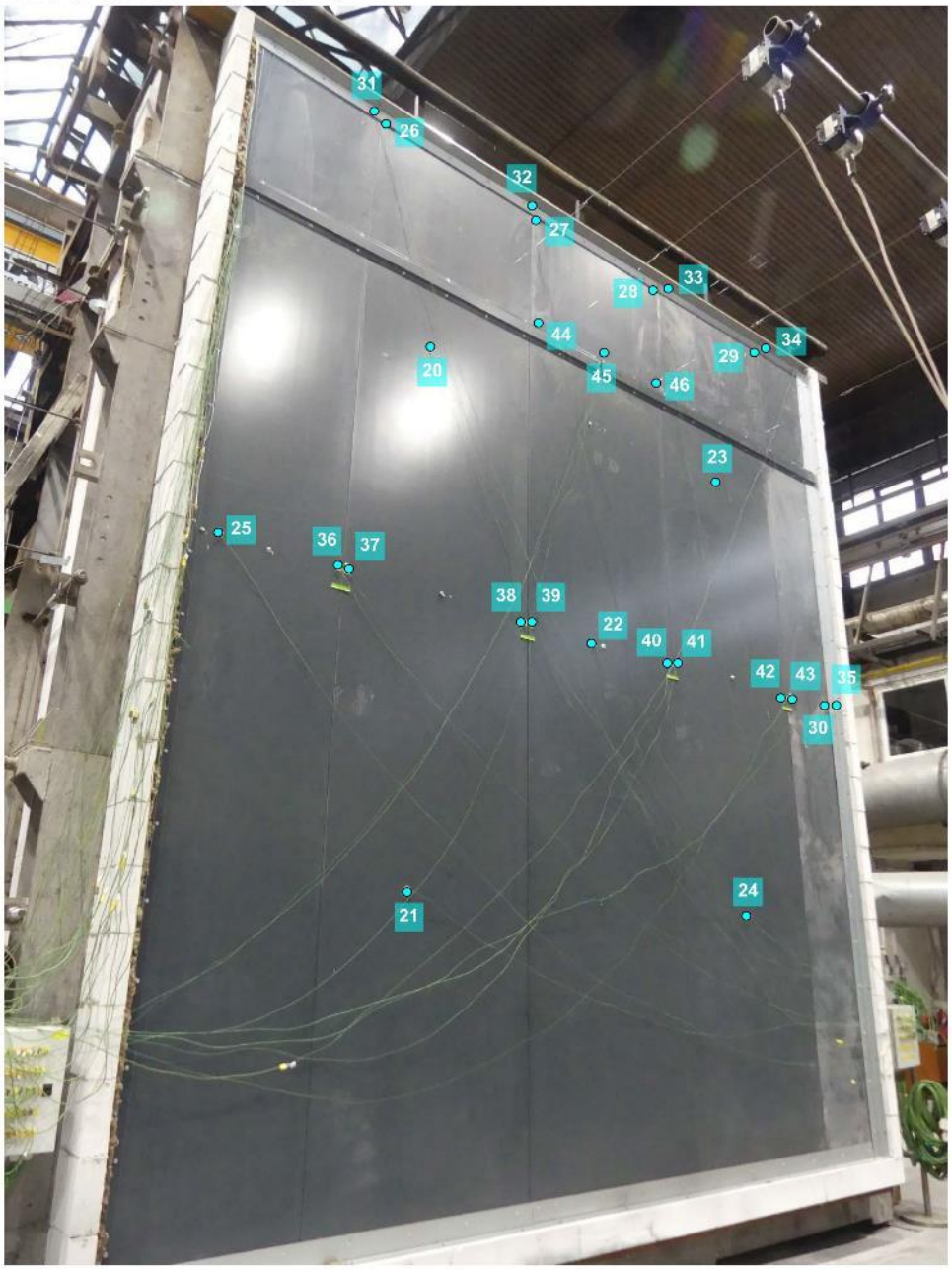

Furnace pressure according to EN 1363-1: 5.2
Pressure (Pa)
25
20
15
10
5
0
0:00
0:30
1:00
1:30
2:00
2:30
3:00
Time (h:min)
actual
min. allowed
max. allowed


Average furnace temperature according to EN 1363-1: 5.1.1
Temperature (°C)
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0:00
0:30
1:00
1:30
2:00
2:30
3:00
Time (h:min)
Standard temperature curve
Actual average temperature curve


Percentage deviation d_e according to EN 1363-1: 5.1.2
Percentage deviation (%)
20
15
10
5
0
-5
-10
-15
-20
0:00
0:30
1:00
1:30
2:00
2:30
3:00
Time (h:min)
actual
min. allowed
max. allowed


Difference of any PT from standard temperature/time curve (EN 1363-1: 5.1.2)
Temperature difference (°C)
150
100
50
0
-50
-100
-150
0:00
0:30
1:00
1:30
2:00
2:30
3:00
Time (h:min)
min. deviation
max. deviation

LAYOUT OF TC ON UF OF SPECIMEN



Key:

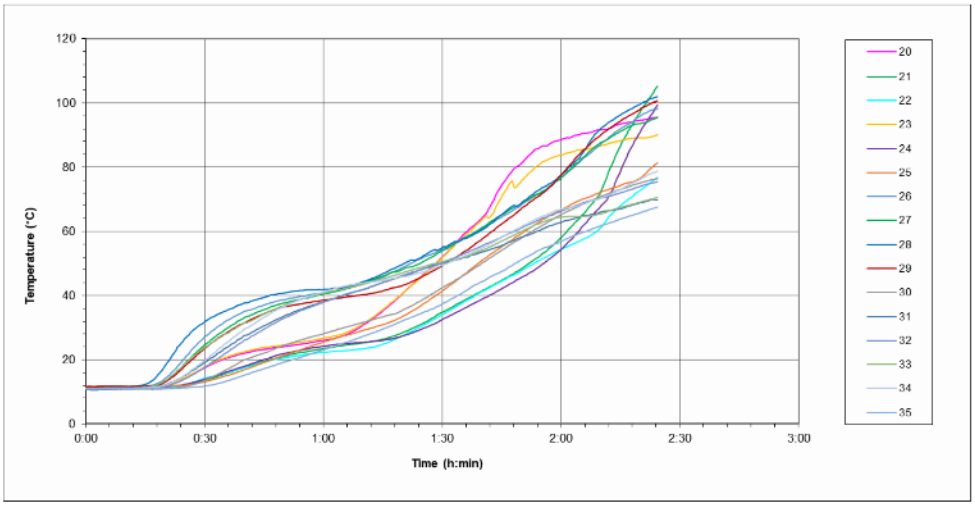
20 ÷ 24 - TC for T_{aver} and T_{max}

25 ÷ 46 - TC for T_{max}

Time	Temperature on the unexposed face of the specimen (°C)																	
	T_{aver}						T_{max}											
(h:min:s)	T_{aver}	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	T_{max}
0:00:00	**11**	11	11	11	12	12	12	11	11	11	12	11	11	11	11	11	11	**12**
0:05:00	**12**	12	11	11	12	12	12	11	11	11	12	11	11	11	11	11	11	**12**
0:10:00	**11**	11	11	11	12	12	12	12	11	12	12	11	11	11	11	11	11	**12**
0:15:00	**11**	11	11	11	12	11	12	12	11	12	12	11	11	11	11	11	11	**12**
0:30:00	**15**	18	14	14	18	14	13	27	25	32	24	14	19	18	24	20	12	**32**
0:45:00	**21**	23	20	19	24	20	19	37	36	40	34	22	31	30	34	33	17	**40**
1:00:00	**25**	26	24	22	27	24	26	41	41	42	39	28	38	38	41	41	23	**42**
1:15:00	**30**	35	26	25	36	26	31	46	46	47	42	33	44	44	45	45	30	**47**
1:30:00	**41**	52	35	34	52	33	42	55	54	55	49	43	50	50	51	50	37	**55**
1:45:00	**55**	75	45	45	71	42	55	65	65	65	62	54	56	58	57	58	48	**75**
2:00:00	**68**	89	58	54	84	55	67	77	77	78	78	65	63	66	64	67	57	**89**
2:15:00	**83**	94	87	68	88	79	74	92	91	96	94	73	67	72	68	73	64	**96**
2:24:20	**93**	96	105	77	90	99	81	98	96	102	101	77	70	76	71	79	68	**105**

Temperature recorded at 10 s intervals. In the table, they figure in 15 minute intervals

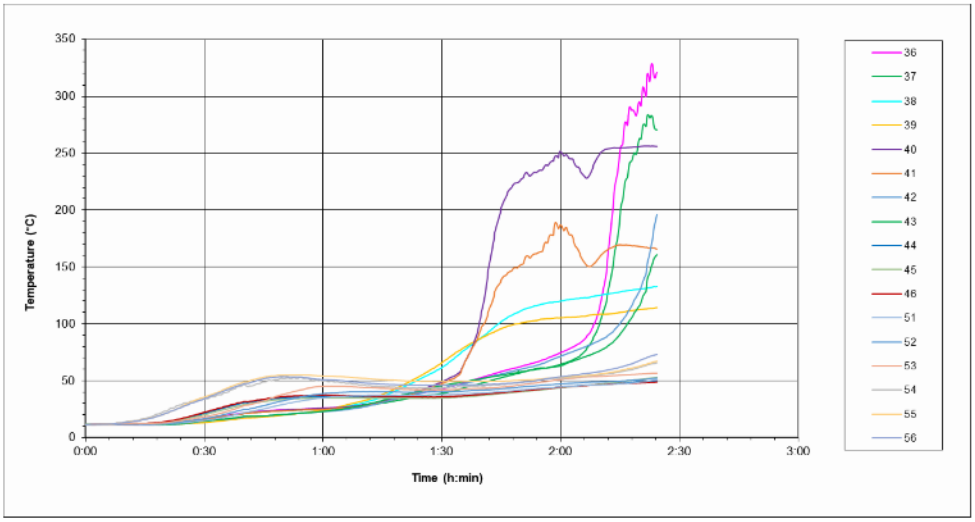
XX	Designation of measuring joint of TC as figured in Annex B
XX	Time and temperature when the insulation criterion has been exceeded

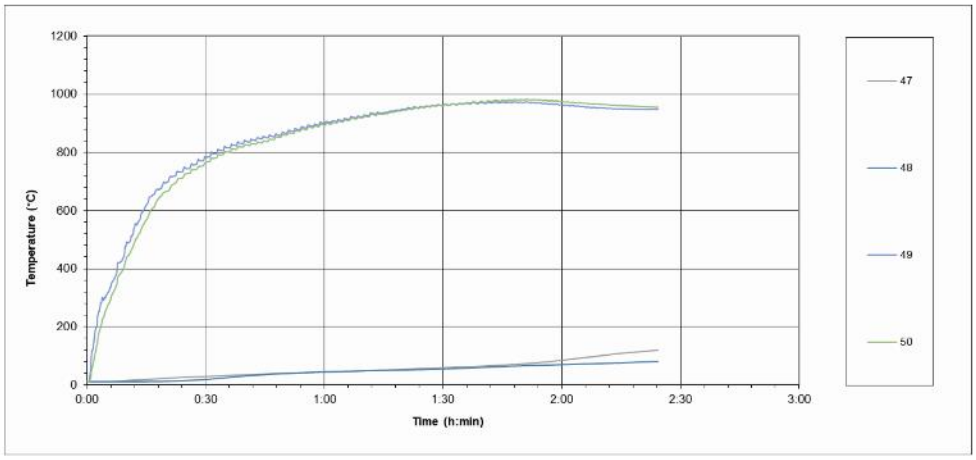


Time	Temperature on the unexposed face / fixing of the specimen (°C)																					
		T_{max}											T_{fixing}				T_{joint}					
(h:min:s)	T_{max}	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
0:00:00	12	12	12	12	12	11	11	12	12	11	12	12	11	11	11	11	11	11	11	12	12	12
0:05:00	12	12	12	12	12	12	12	12	12	12	12	12	11	11	311	264	12	12	12	12	12	12
0:10:00	12	12	12	12	12	11	11	12	12	12	12	12	15	12	492	438	12	12	12	14	13	13
0:15:00	12	12	12	12	12	11	11	12	12	12	12	12	19	12	620	568	12	12	12	17	16	16
0:30:00	22	17	16	14	13	16	16	15	15	21	20	22	29	19	785	765	15	17	18	34	36	34
0:45:00	34	23	23	19	18	23	23	19	19	33	32	34	37	36	854	838	25	28	32	49	53	52
1:00:00	37	26	25	24	24	26	25	23	23	36	35	37	44	45	900	893	35	39	45	50	54	51
1:15:00	38	32	30	36	38	32	31	31	33	35	35	36	51	50	938	933	37	40	43	45	51	47
1:30:00	66	43	39	62	66	49	47	44	46	35	35	36	59	55	962	960	38	40	42	44	49	46
1:44:20	192	57	52	100	95	192	134	55	54	39	38	39	67	63	971	975	40	43	44	46	50	47
1:45:00	202	58	53	102	96	202	139	56	55	40	39	40	68	64	975	979	41	43	44	47	50	47
2:00:00	251	75	64	120	105	251	187	72	63	45	44	44	85	71	965	974	45	47	51	52	53	53
2:15:00	255	251	193	128	110	255	170	100	91	48	49	47	108	76	952	961	47	50	55	58	59	62
2:24:20	321	321	271	133	114	256	166	196	161	50	53	49	119	81	950	956	51	52	57	66	67	73

Temperature recorded at 10 s intervals. In the table, they figure in 15 minute intervals

XX	Designation of measuring joint of TC as figured in Annex B
XX	Time and temperature when the insulation criterion has been exceeded





Key:

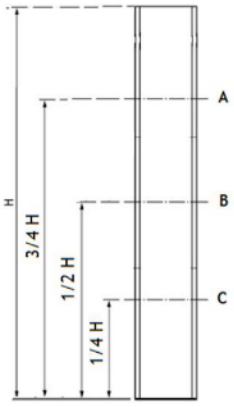
47, 48	- TC on UF of the screw
49, 50	- TC on EF of the screw

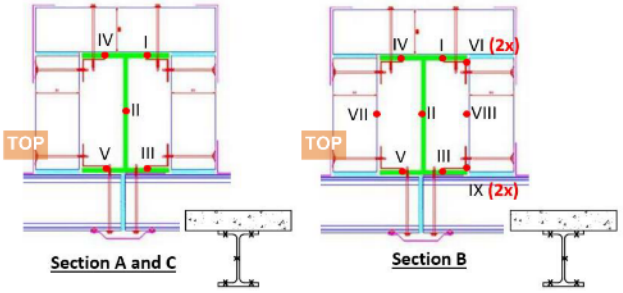
LAYOUT OF TC ON UF OF LINEAR JOINT SEAL OF SPECIMEN

Key:

51, 53, 54, 56	- junction TC for T_{max}
52, 55	- joint seal TC for T_{max}

LAYOUT OF TC ON THE SURFACE OF THE STEEL BEAM





Thermocouples :
- I, II, III, IV and V to record the temperature of the steel profile
- VI, VII, VIII and IX to record the temperature at the surface of sandwich panels

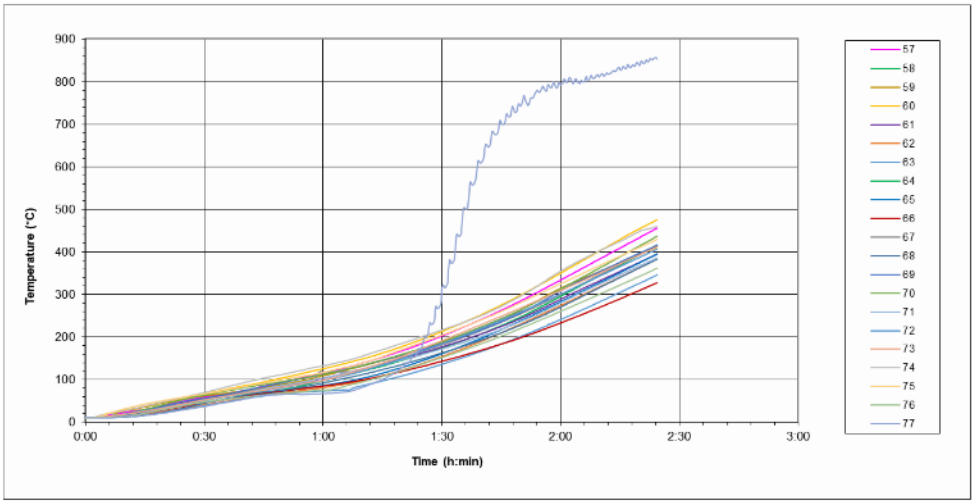
Key:

Section/TC	Datalogger	Section/TC	Datalogger	Section/TC	Datalogger	Section/TC	Datalogger
A - I	*57*	B - I	*62*	C - I	*67*	B - VI	*72, 73*
A - II	*58*	B - II	*63*	C - II	*68*	B - VII	*76*
A - III	*59*	B - III	*64*	C - III	*69*	B - VIII	*77*
A - IV	*60*	B - IV	*65*	C - IV	*70*	B - IX	*74, 75*
A - V	*61*	B - V	*66*	C - V	*71*		

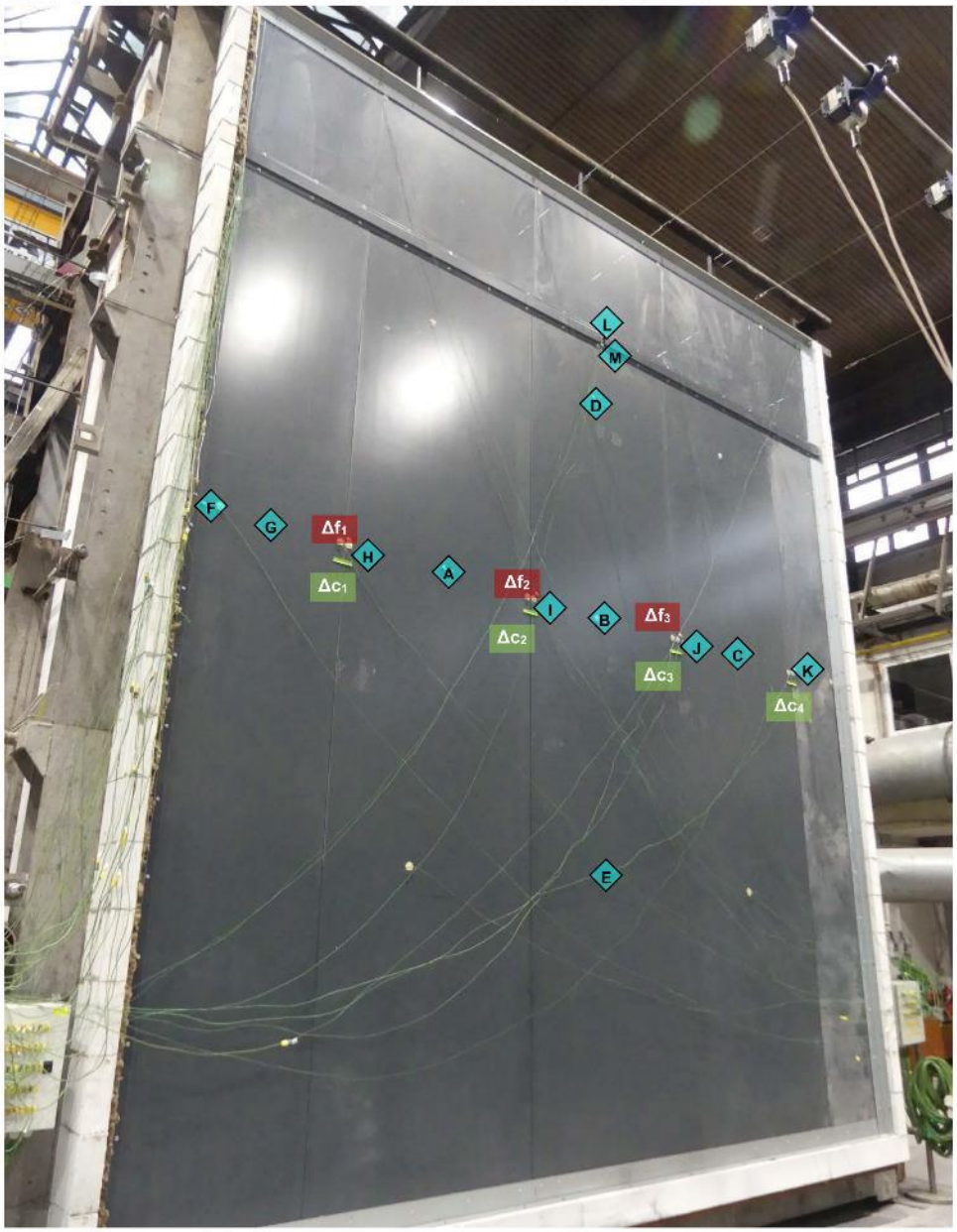
Time	Temperature on the steel section / angle / sandwich panel (°C)																				
	T_{steel}															T_{angle}				T_{panel}	
(h:min:s)	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
0:00:00	11	11	11	11	11	11	11		11	11	11	11	11	11	11	11	11	11	11	11	11
0:05:00	16	12	17	19	11	11	11		12	11	11	11	12	11	11	14	14	19	18	11	11
0:10:00	23	15	27	29	16	13	13		15	14	14	12	18	20	14	20	19	28	32	14	13
0:15:00	31	22	36	38	25	18	16		22	20	22	17	28	31	22	27	26	38	43	21	17
0:30:00	59	51	62	67	55	41	39		47	46	55	45	57	64	51	52	53	70	67	48	37
0:45:00	85	71	82	95	77	64	62		67	68	79	71	84	89	78	75	76	104	92	64	63
1:00:00	116	98	109	126	103	81	74		87	85	119	93	113	113	104	98	99	133	117	76	67
1:15:00	153	132	145	163	137	110	98		116	109	138	124	146	147	135	135	140	171	154	108	101
1:30:00	203	175	187	214	177	155	137		161	144	182	163	185	190	173	185	192	217	205	153	315
1:45:00	264	227	241	276	226	211	184		218	184	236	211	237	244	219	241	250	273	261	203	703
2:00:00	335	296	315	351	290	275	242		284	234	300	271	309	314	281	302	310	356	326	261	793
2:15:00	409	369	374	429	354	341	305		352	290	371	340	376	389	347	366	372	425	390	322	829
2:24:20	456	415	411	476	396	384	347		395	328	417	383	416	437	386	407	413	460	430	362	853

Temperature recorded at 10 s intervals. In the table, they figure in 15 minute intervals

XX	Designation of measuring joint of TC as figured in Annex B
	Failure of TC



LAYOUT OF DEFLECTION MEASUREMENTS ON UF OF SPECIMEN



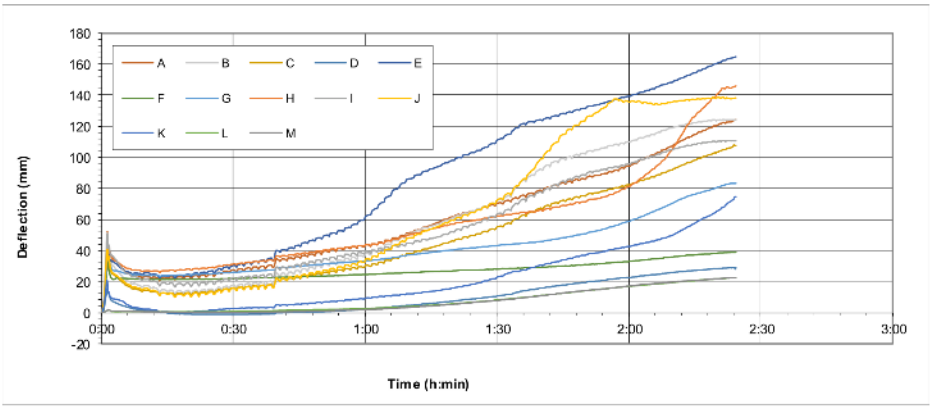
Key:

A ÷ M - points of measurement of horizontal deflection

Δf_x - deflection difference according to EN 15254-5, Figure B.1

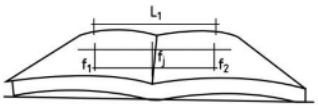
Δc_x - deflection difference according to EN 15254-5, Figure B.2

Time	Deflection (mm)												
(h:min:s)	A	B	C	D	E	F	G	H	I	J	K	L	M
0:00:00	0	0	0	0	0	0	0	0	0	0	0	0	0
0:05:00	28	22	19	4	28	22	26	30	27	20	7	1	1
0:10:00	23	17	14	1	26	21	24	27	21	16	2	1	1
0:15:00	22	14	12	0	23	21	24	27	18	12	1	0	0
0:30:00	28	18	16	-1	30	22	26	31	22	16	3	1	0
0:45:00	36	27	23	0	43	23	30	38	30	23	5	2	1
1:00:00	44	38	30	2	62	25	33	44	39	34	9	3	2
1:15:00	56	56	42	6	93	26	39	54	48	54	14	5	4
1:30:00	70	72	55	11	111	28	43	62	63	72	23	8	8
1:45:00	84	99	72	18	128	30	48	69	85	115	34	13	13
2:00:00	95	110	82	23	139	33	59	81	96	136	43	17	17
2:15:00	115	122	98	27	154	37	76	126	108	137	58	21	21
2:24:20	124	124	108	29	165	39	83	146	111	138	75	22	22



Values "+" - deflection in furnace
Values "-" - deflection away from furnace

Measurement according to EN 15254-5, Annex B:

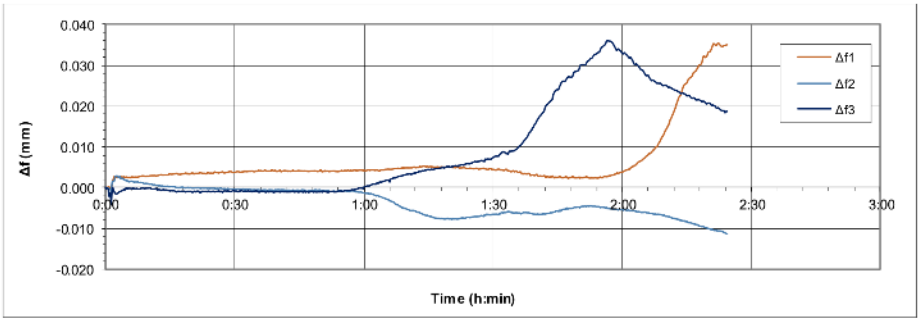


$$\Delta f = (f_j - 0{,}5x(f_1 + f_2))/L_1$$

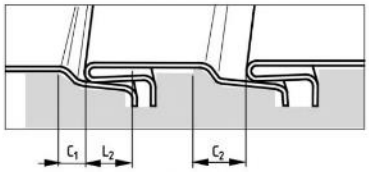
Figure B.1 — Calculation of Δf in midspan section

L_1 = 1200 mm

Time (h:min:s)	Deflection difference (mm) Δf_1	Δf_2	Δf_3
0:00:00	0.000	0.000	0.000
0:05:00	0.003	0.002	0.000
0:10:00	0.003	0.001	0.000
0:15:00	0.003	0.000	-0.001
0:30:00	0.004	0.000	-0.001
0:45:00	0.004	-0.001	-0.001
1:00:00	0.004	-0.001	0.000
1:15:00	0.005	-0.007	0.004
1:30:00	0.005	-0.007	0.007
1:45:00	0.003	-0.006	0.024
2:00:00	0.004	-0.005	0.033
2:15:00	0.026	-0.008	0.022
2:24:20	0.035	-0.011	0.019



Measurement according to EN 15254-5, Annex B:

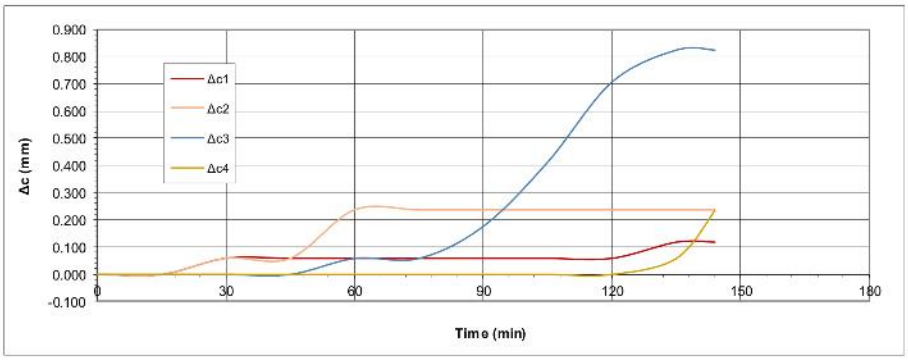


$\Delta c = (c_2 - c_1)/L_2$

Figure B.2 — Calculation of Δc

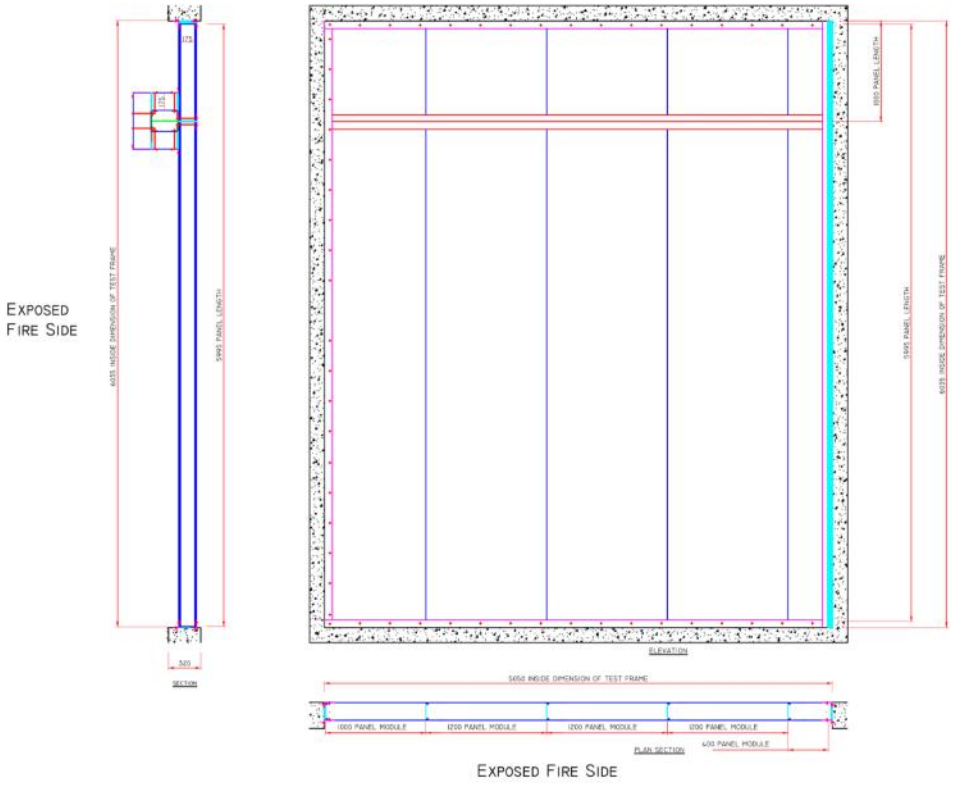
L_2 = 17 mm
c_0 = 2 mm (before the test)

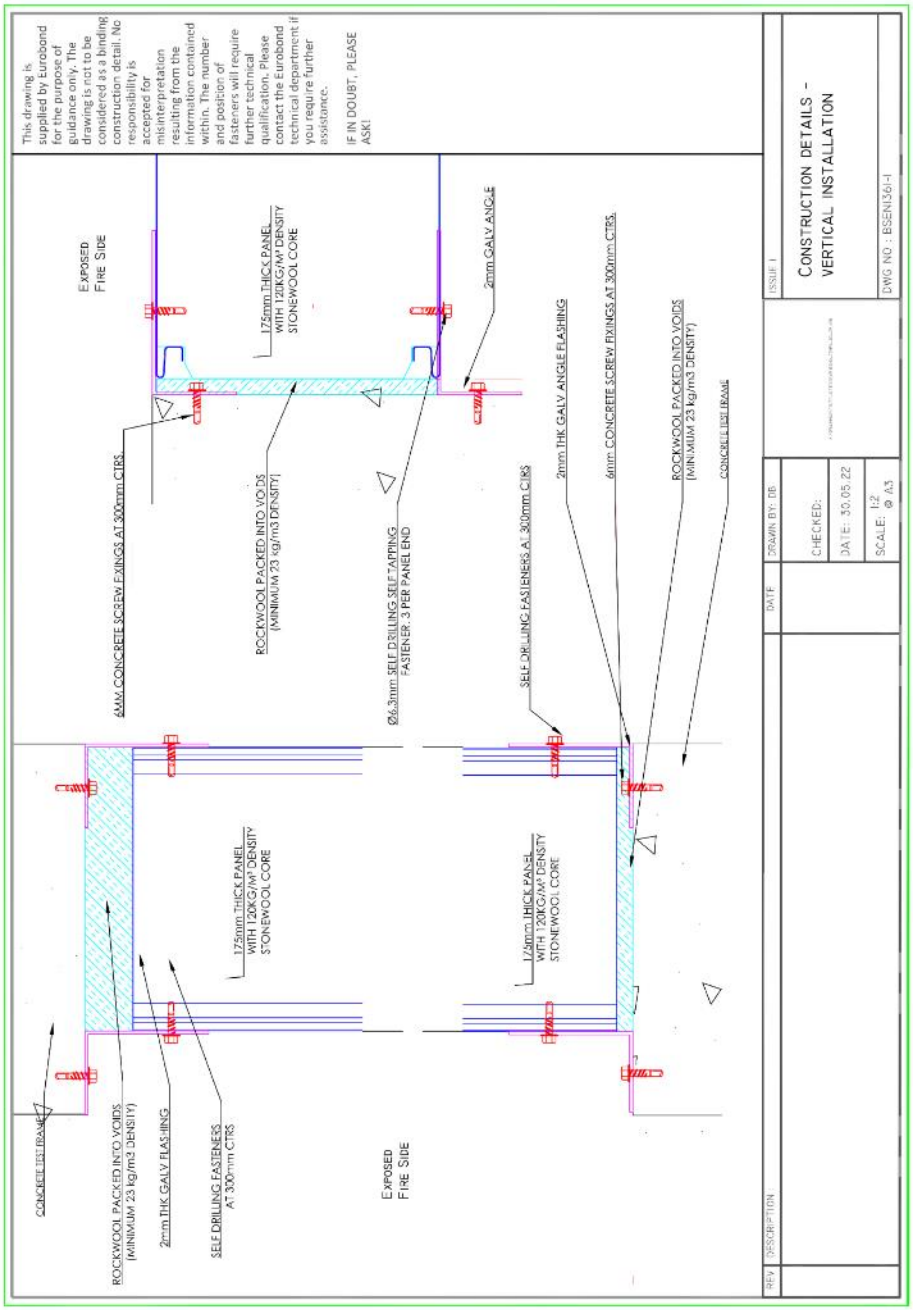
Time (min)	Deflection difference (mm)			
	Δc_1	Δc_2	Δc_3	Δc_4
0	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000
30	0.059	0.059	0.000	0.000
45	0.059	0.059	0.000	0.000
60	0.059	0.235	0.059	0.000
75	0.059	0.235	0.059	0.000
90	0.059	0.235	0.176	0.000
105	0.059	0.235	0.412	0.000
120	0.059	0.235	0.706	0.000
135	0.118	0.235	0.824	0.059
144	0.118	0.235	0.824	0.235



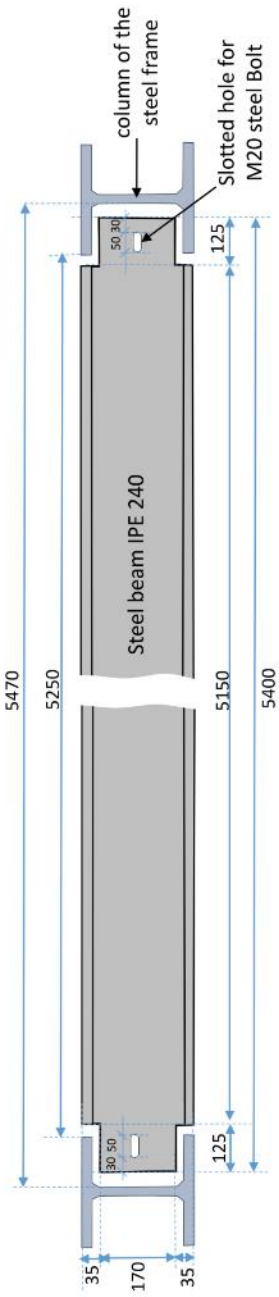
ANNEX C: DOCUMENTATION

Specimen-related documentation delivered by the test sponsor.




This drawing is supplied by Eurobond for the purpose of guidance only. The drawing is not to be considered as a binding construction detail. No responsibility is accepted for misinterpretation resulting from the information contained within. The number and position of fasteners will require further technical qualification. Please contact the Eurobond technical department if you require further assistance.
IF IN DOUBT, PLEASE ASK!
EXPOSED FIRE SIDE
175mm THICK PANEL WITH 120KG/M³ DENSITY STONEWOOL CORE
2mm GALV ANGLE
AMX CONCRETE SCREW FIXINGS AT 300mm CTRS.
ROCKWOOL PACKED INTO VOIDS (MINIMUM 23 kg/m3 DENSITY)
Ø6.3mm SELF DRILLING SELF TAPPING FASTENER. 3 PER PANEL END
SELF DRILLING FASTENERS AT 300mm CTRS
2mm THK GALV ANGLE FLASHING
6mm CONCRETE SCREW FIXINGS AT 300mm CTRS.
ROCKWOOL PACKED INTO VOIDS (MINIMUM 23 kg/m3 DENSITY)
CONCRETE TEST FRAME
175mm THICK PANEL WITH 120KG/M³ DENSITY STONEWOOL CORE
ROCKWOOL PACKED INTO VOIDS (MINIMUM 23 kg/m2 DENSITY)
2mm THK GALV FLASHING
SELF DRILLING FASTENERS AT 300mm CTRS
EXPOSED FIRE SIDE
CONSTRUCTION DETAILS - VERTICAL INSTALLATION
ISSUE 1
DWG NO : BSEN1364-1
DRAWN BY: DB
CHECKED:
DATE: 30.05.22
SCALE: 1:2 @ A3
REV
DESCRIPTION
DATE

Test with a steel beam

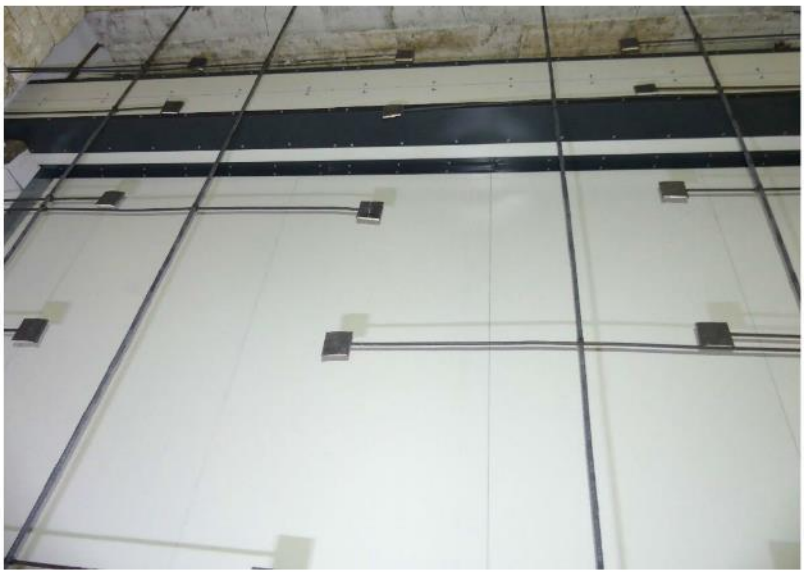


Top view

ANNEX D: PHOTOS

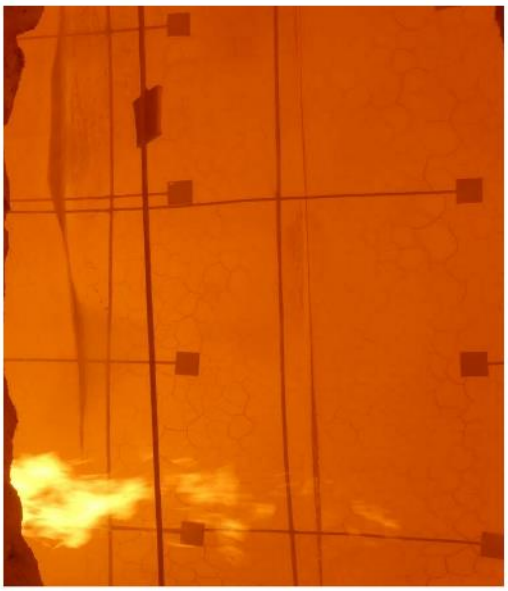
Preparation of the testing frame

Assembly of the specimen



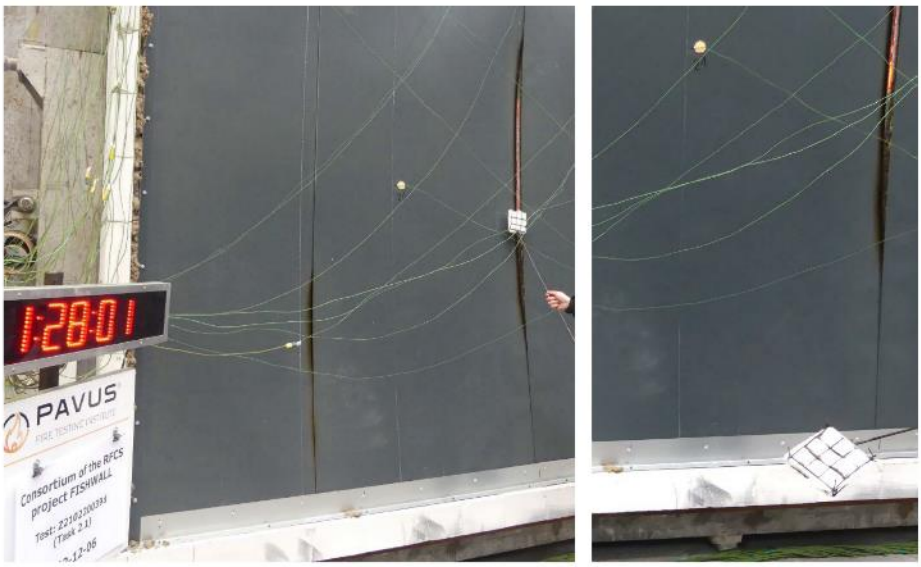
EF before the test

UF before the test

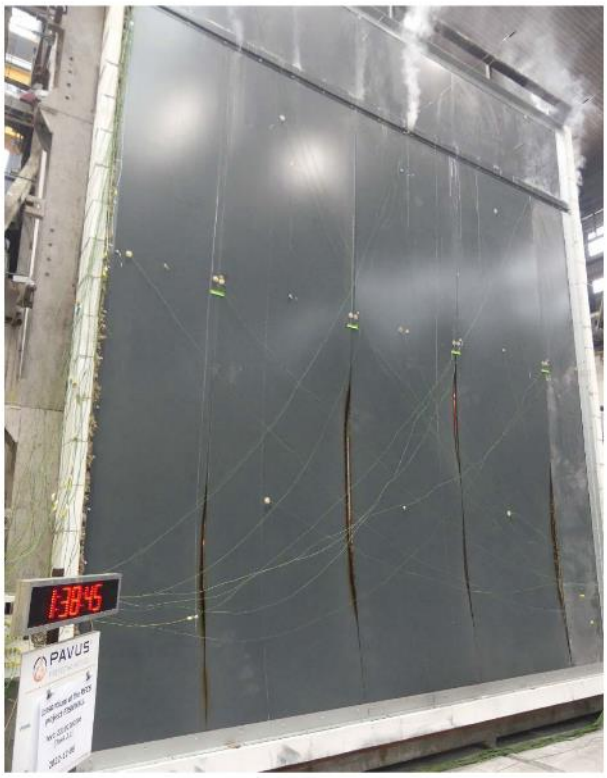


EF after 45 minutes of the test

UF after 60 minutes of the test



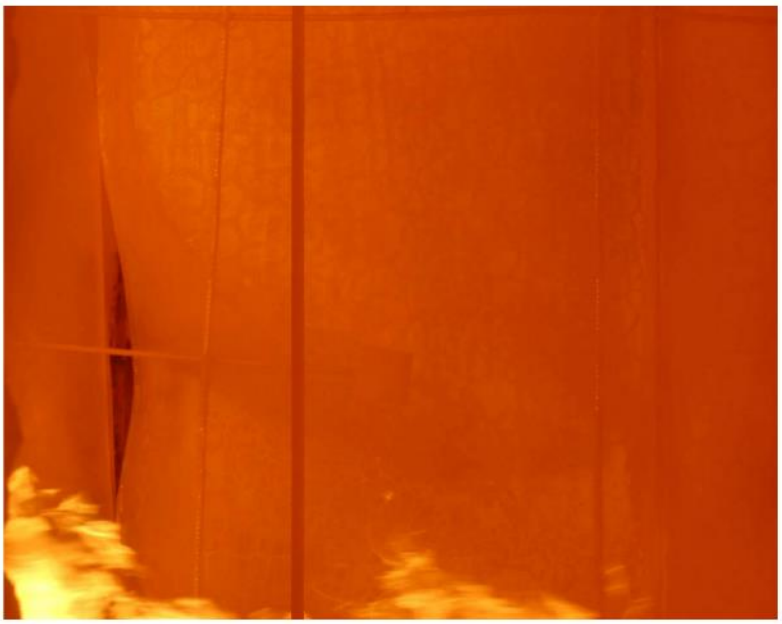
UF in 89th minute of the test - cotton pad test - without integrity failure



UF after 98 minutes of the test

UF in 114th minute of the test - cotton pad test - without integrity failure

UF after 121 minutes of the test



EF after 122 minutes of the test

UF in 142nd minute of the test - 6 mm gap gauge can't pass through the specimen - without integrity failure

UF in 142nd minute of the test - sustained flaming - integrity failure

UF in 142nd minute of the test - cotton pad test - integrity failure

UF after 144 minutes - end of the test

UF after 144 minutes - end of the test