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 report on a fire wall solidly attached to an unprotected steel structure

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WP3: Fire behaviour of a hybrid fire wall solution associated with unprotected steel structure

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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 FISHWALL 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 results of a fire test carried out at the Testing Laboratory of PAVUS according to EN 1363-1 [1] on a partition fire wall made of steel-faced sandwich panels solidly attached to an unprotected steel structure and penetrated by two steel purlins supporting steel decks with insulation. The detailed fire test report is provided in Annex of the report.

1 INTRODUCTION

Partition fire walls can be solidly attached to the supporting steel structure of buildings, which remains continuous at the position of walls. In such situation, adequate measures must be implemented to avoid the collapse of fire walls as a result of significant fire-induced movements of the steel structure. These measures mainly concern the fire protection of steel members (columns, portal frames) supporting the fire walls. In addition, the positioning of fire walls throughout the buildings means that roof members such as purlin and rafters pass through the tops of the walls. Consequently, structural members penetrating the walls also have to be partially fire protected. This protection has to allow the fire-induced plastic hinges in members to form away from the walls and thus to prevent damage to walls because of the collapse of the heated steel members. Sandwich panels forming the partition fire wall could also be used as a fire protection system of steel members penetrating the walls, as alternative to common passive fire protections.

In this context, a fire test was carried out at the Testing Laboratory of PAVUS according to EN 1363-1 [1] on a partition fire wall made of steel-faced sandwich panels solidly attached to an unprotected steel structure and penetrated by two steel purlins supporting a steel roof with insulation. The main objective was:

- Firstly, to investigate the interaction of deforming purlins with the partition fire wall and to check that a sandwich panel-based fire protection along an appropriate length of purlins allows, as expected, preventing wall damage.
- Secondly, to confirm that the temperature rise of penetrating members on the unexposed side of the fire wall is limited and fulfils the insulation performance criteria.

The present report aims at summing up the results of this fire test. The detailed fire test report is reported in Annexe. A detailed analysis and interpretation of the test results will be provided later during the validation work of three-dimensional FE numerical models developed in WP3 for the thermal-mechanical analysis of steel members traversing fire walls made of sandwich panels.

2 TESTS SPECIMENS AND TESTS ARRANGEMENT

Only a short description of both test specimen and test arrangement is given hereafter. More detailed information are given in Appendix A, which contains the fire test report provided by PAVUS.

It should be noted that the originally proposed test programme envisaged one test on a partition fire wall made of sandwich panels penetrated by a single steel purlin supporting a flat roof with steel decking [4]. However, further to discussions held during project progress meetings, the test setup was slightly modified to test a wall penetrated by two purlins partially fire protected with encasement systems.

Figure 1 shows the schematic of the final test arrangement. The test specimen consisted of two steel purlins in IPE 200 penetrating a fire wall made of lightweight sandwich panels with 175 mm thick and providing a 120-minutes fire resistance (EI 120). The purlins were single span members having cantilever ends. A horizontal supporting steel frame placed around the furnace supported them. On the fire-exposed side, each purlin was simply supported by means of a fork support allowing a free axially thermal expansion of purlins along 60 mm. On the fire-unexposed side, the purlins were bolted to a beam as part of the horizontal supporting frame placed around the furnace and running along the wall. A steel beam to take account of purlin continuity effects also prevented the possible uplift of the free end of purlins located on the fire-unexposed side. The purlin span was 6.25 m, while the cantilevers length was 1 m approximately. The purlins were spaced at 1.5m and supported a continuous steel roof decking (type JI 40-190-950 roof steel sheet) being 1.5 m wide and 1 mm thick, covered with one layer of 100 mm thick mineral wool insulation.

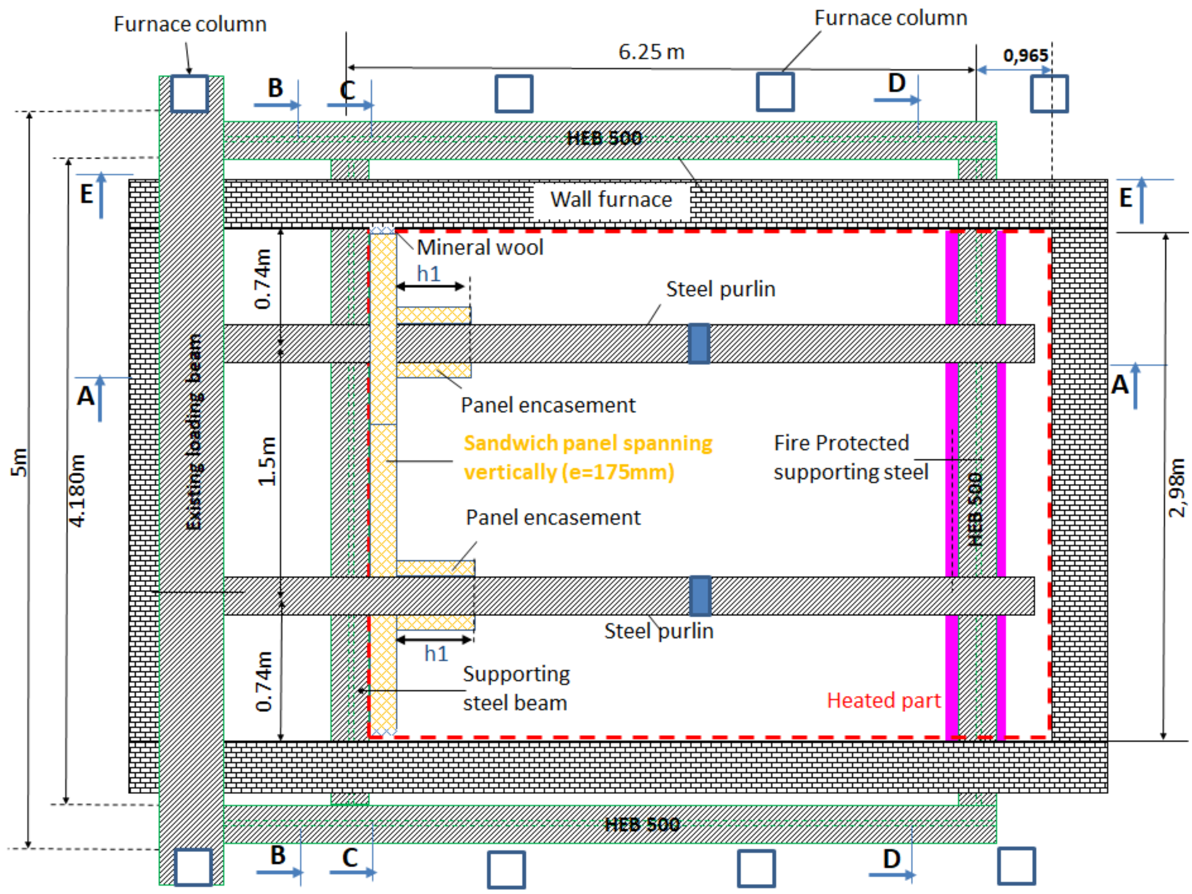
The wall had overall dimensions of 3.2m high by 3m wide. Eurobond Rockspan Extra panels produced by Euroclad were used. The wall was mounted according to the current practice. The sandwich panels were installed vertically and arranged so that the first purlin crossed the wall at the junction between two panels, while the second one crossed the wall at a panel mid-width. On the fire exposed side, the purlins were fire protected by an encasement system over 50 cm length from the fire wall, leaving unfilled the voids formed between the ribs of the steel decks and the top flange of steel purlins (see Figure 2). The encasement system was made from sandwich panels 175 mm thick. The voids inside the encasement system (between the purlin flanges) were fully filled with mineral wool for one purlin. Finally, wall openings managed at the level of purlins were also filled with mineral wool. The same mineral wool as the one constituting the core of sandwich panels was used everywhere.

Examples of the different stages of the specimen manufacture and preparation are shown in Figure 4. Photos of the test specimen taken just before the test are given in Figure 5.

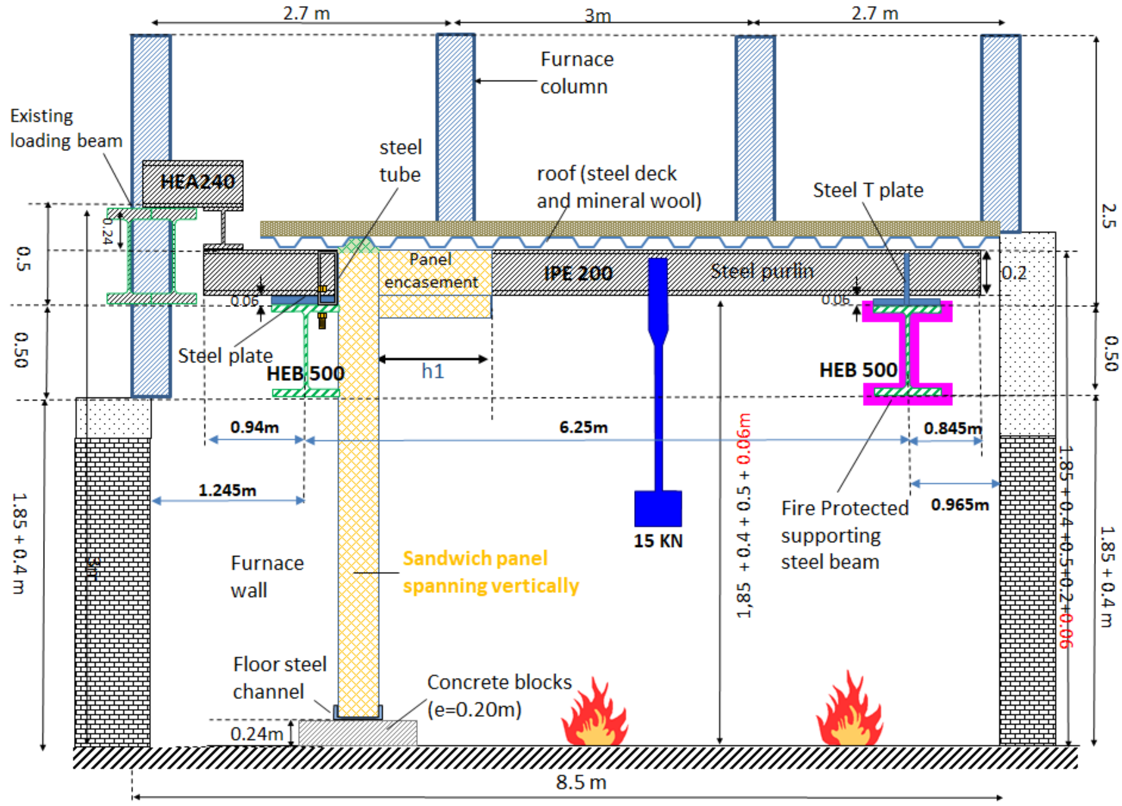
In addition to the self-weight of the test specimen (steel profiles, steel decks and mineral wool insulation), purlins were loaded with dead weights of 15 kN, applied at the purlins mid-span. Adequate fixation providing hinges was used between the dead weights and the purlins to prevent as far as possible unwanted additional moments in the purlins, as illustrated in Figure 3. One side of the wall and the roof system, from below, were exposed to fire. The temperature rise in the furnace was controlled to follow as close as possible the ISO-834 standard fire curve.

During the test, the furnace temperatures, temperatures at different locations along the steel purlins and the temperatures of the unexposed side of the wall were recorded. Since displacement sensors cannot be installed inside the furnace due to the high temperatures, draw-wire displacement sensors were installed above the steel roof decking (so outside the furnace), then attached to the test specimen using stainless steel rods to measure the vertical displacement at different locations along the heated purlins: at the level of encasement systems and at purlin's mid-span. Unfortunately, it was not possible to record purlin inclination. Some examples of data recorded during the test are given in Figure 6 to Figure 8.

The overall behaviour of the test specimen was monitored visually. Also, the failure and collapse of the test specimen was monitored and documented.



a) Top view of the test arrangement



b) Side view of the test arrangement

Figure 1: Schematic of the test arrangement

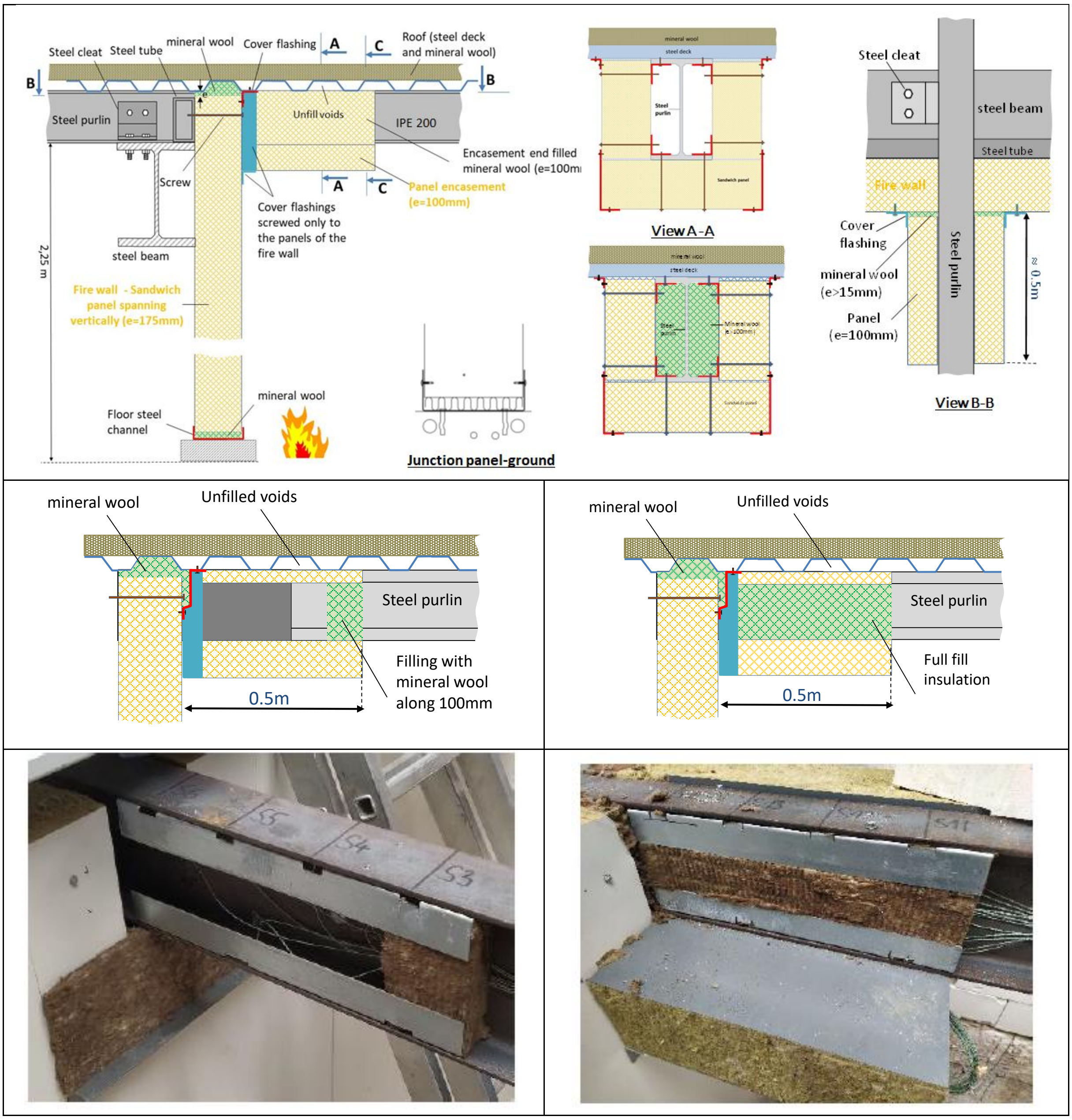


Figure 2: View of some detailing

Figure 3: Loading system

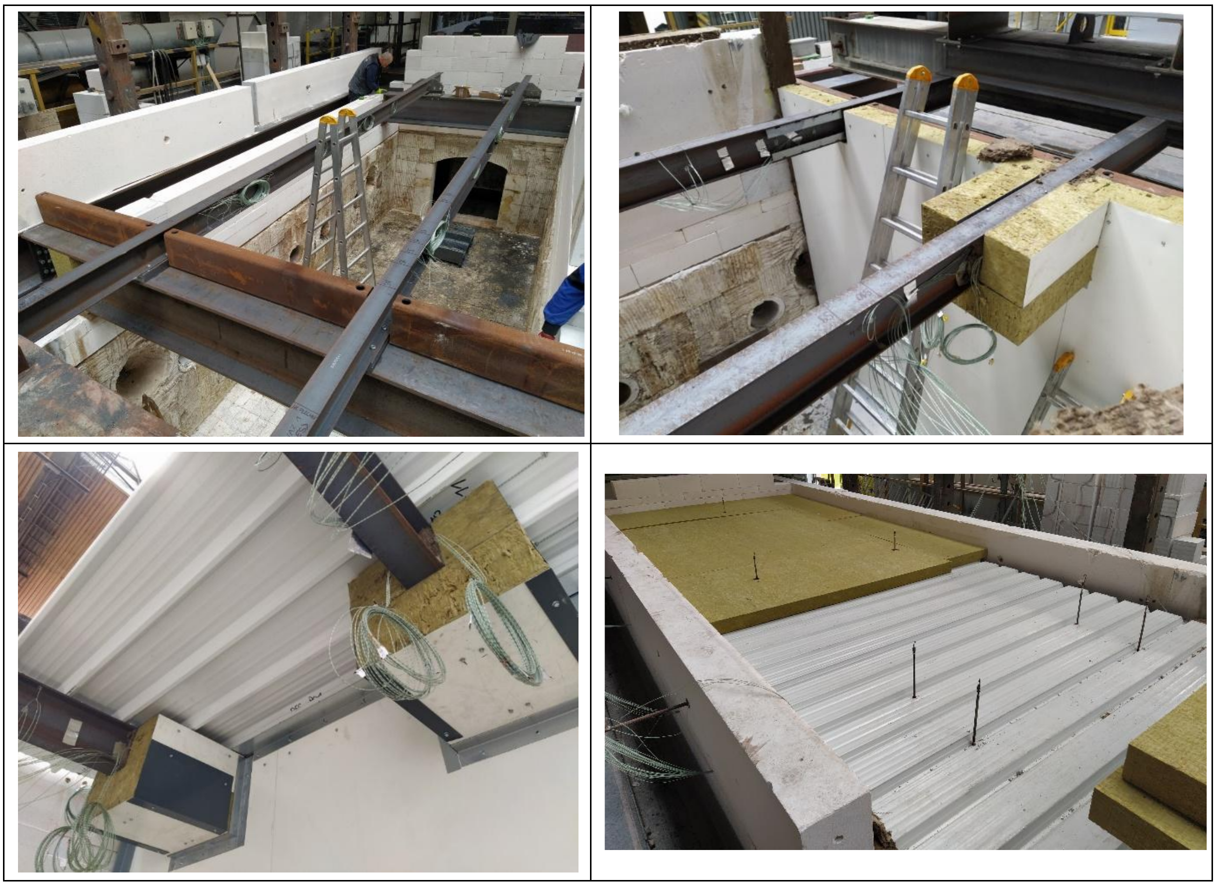


Figure 4: Manufacture and preparation of the test specimen

Figure 5: View of the test specimen before the test

3 TEST RESULTS AND MAIN OBSERVATIONS

Only brief some results and observations are given here. Detailed test results are reported in Appendix A.

Some examples of data recorded during the test are illustrated from Figure 6 to Figure 10.

With regard to the structural behaviour of purlins, it can be noted that no lateral torsional buckling was observed during the test, which leads to the conclusion that the purlins failed mainly by flexural bending (see Figure 11). The purlins were restrained in the lateral direction by the steel decks forming the roof, so that they were unable to move laterally. Some local buckling of purlin flanges in compression was observed at the end of encasement systems placed around the purlins. However, purlins deformation at the wall level remained very limited and the purlin encasements made of sandwich panels were undamaged (see Figure 12). Indeed, observations after the test showed that the part of purlins fire-protected by panels still appeared to be straight, in spite of the large bending of the heated parts of purlins.

Moreover, delamination of steel sheets at elevated temperature was observed for sandwich panels. The temperature criteria related to the insulation performance of the wall was reached at the 23rd minute on a thermocouple placed in the upper corner of the wall. At the 58th minute of the test there was integrity failure of the wall due to sustained flaming and ignition of the cotton pad in a vertical joint below the supporting steel beam. Next, strong flaming appeared below the steel decks at the junction with the wall, forcing to stop the test long before the targeted time, namely 120 minutes, due to staff safety and impending damage to the equipment. This is probably due to imperfect filling of the wall openings managed at the level of purlins and the void formed between the wall top and the rib of the steel deck placed above. To avoid this, a solution could be to use a harder mineral wool with the higher density. Maybe using of some intumescent product (for example together with mineral wool) could be also solution.

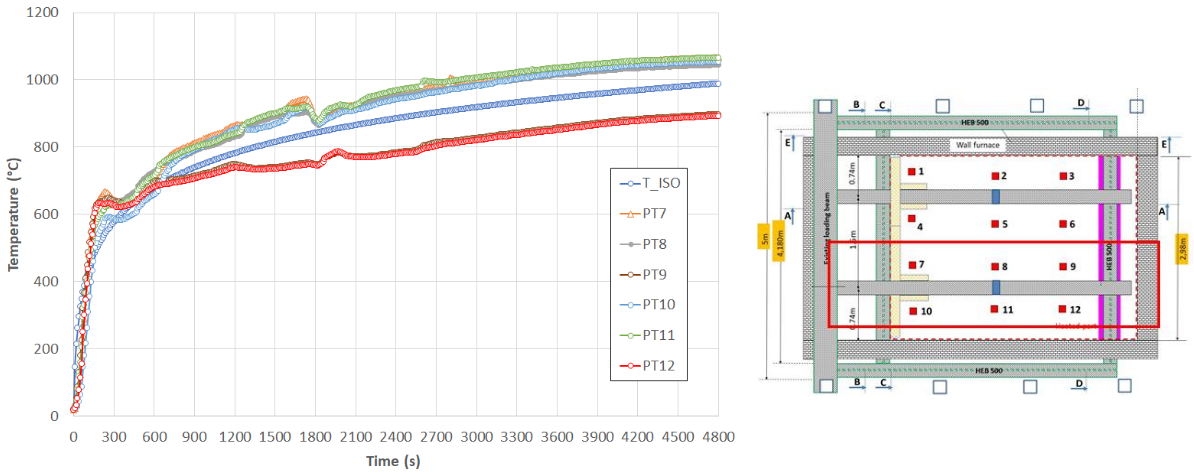


Figure 6: Example of hot gas temperature-time curves recorded during the test

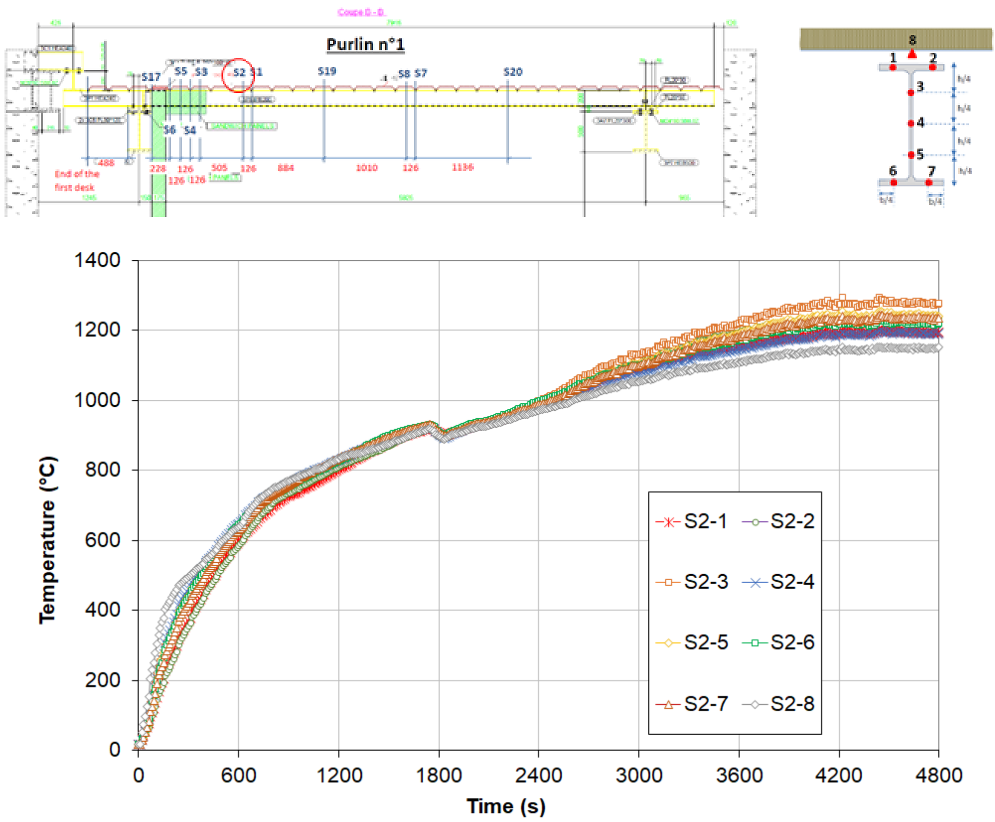


Figure 7: Example of temperature-time curves recorded in the fire-exposed part of the first purlin

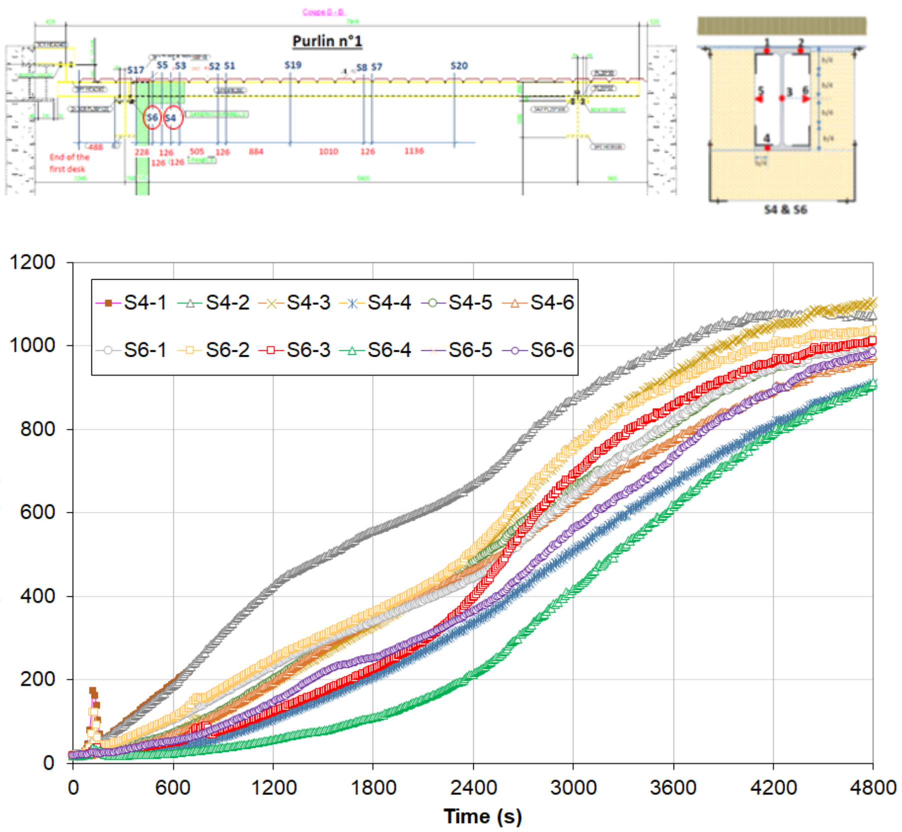


Figure 8: Example of temperature-time curves recorded in the encased part of the first purlin

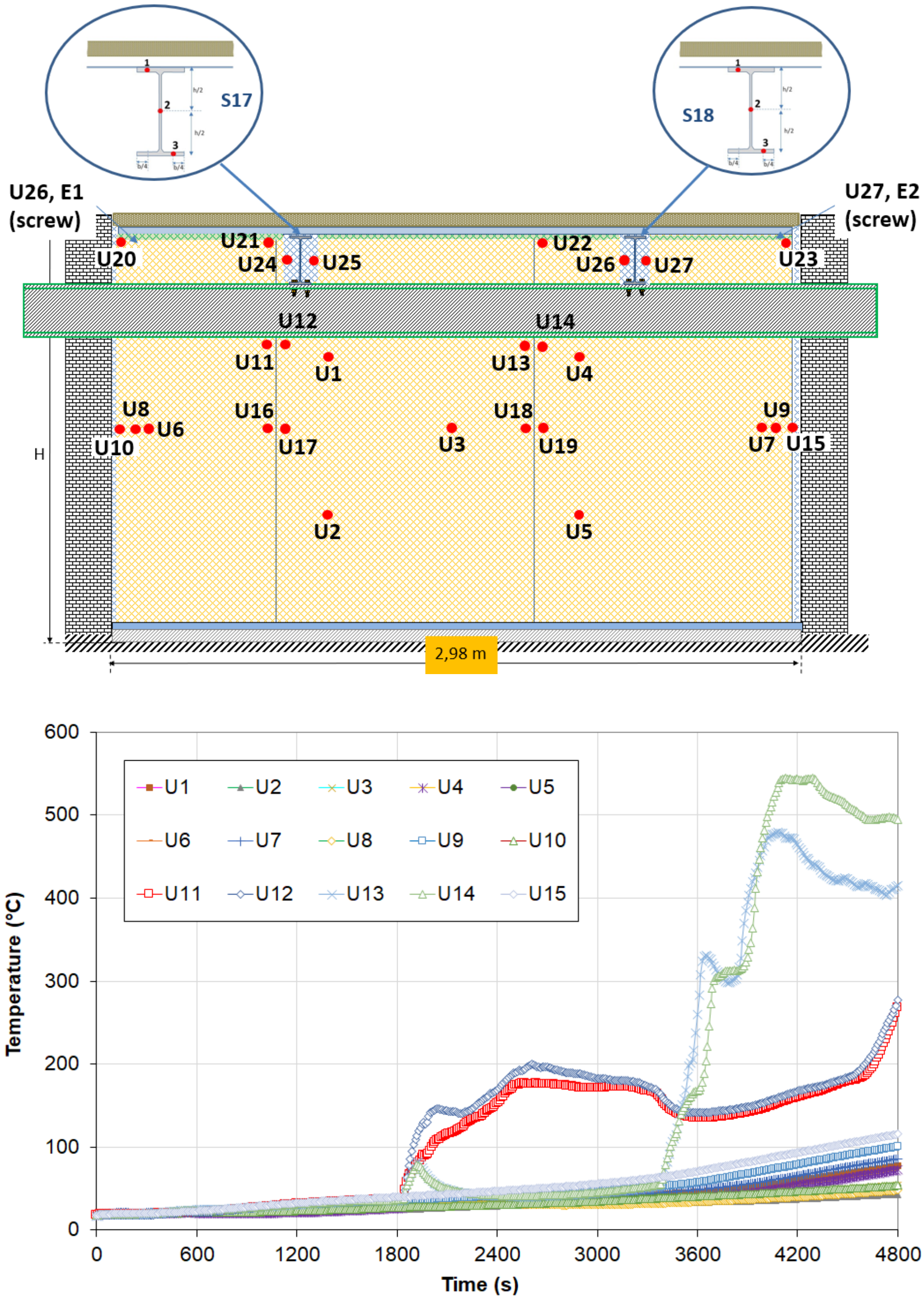


Figure 9: Example of temperature-time curves recorded on the fire-unexposed side of the wall

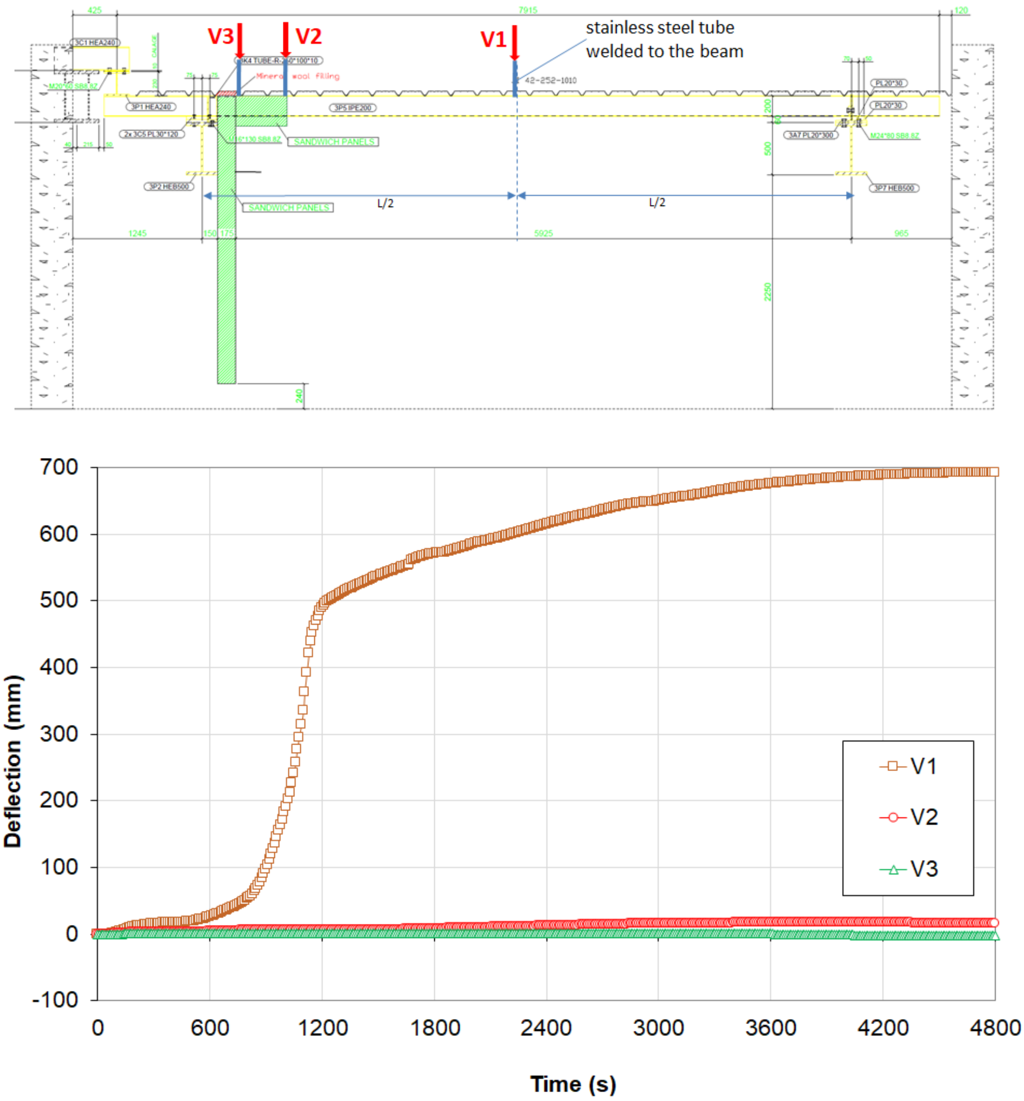


Figure 10: Example of vertical displacement-time curves recorded along the purlin n°1

a) Furnace inside

b) Unexposed wall side

Figure 11: View of the test specimen during the test

	
a) Furnace outside	b) Furnace inside

Figure 12: View of the test specimen after the test

4 CONCLUSIONS

This report aimed at summing up results of the fire test carried out at the Testing Laboratory of PAVUS on a partition fire wall made of steel-faced sandwich panels solidly attached to an unprotected steel structure and penetrated by two steel purlins supporting a steel roof with insulation. For testing, the purlins were partially fire-protected at the wall level with an encasement system made of sandwich panels. This protection had to allow the fire-induced plastic hinges in purlins to form away from the wall and thus to prevent damage to wall. Eurobond Rockspan Extra panels with 175mm thick produced by Euroclad were used for both wall and encasement systems. Two sets of data were recorded during tests, including the temperatures of fire, steel purlins and fire-unexposed wall side and the deflection of steel purlins. All measured values were recorded in Excel sheets to provide data easily to use. The overall behaviour of the test specimen was also monitored visually.

The test results showed that the tested encasement system placed around purlins remained undamaged and was enable to avoid large wall damage in spite of the collapse of the heated steel purlins, as expected. However, after 60 minutes approximately, there was an integrity failure of the wall due to sustained flaming appearing at the wall-roof junction and at some joints between panels.

Regarding the wall-roof junction, the integrity failure is believed to be due to imperfect filling of the wall openings managed at the level of purlins and the void formed between the wall top and the rib of the steel deck placed above. One possible solution to easily avoid this problem may be the use of harder, higher-density mineral wool . Some intumescent product (for example together with mineral wool) could be also a solution.

The integrity failure observed due to flaming in some joints between panels can easily be solved. This type of issue has previously been observed in standard fire tests conducted on firewalls made of sandwich panels, and solutions are available. The most popular solutions are securing the panels to each other at the junction using stitching screws or adding intumescent seals to the joint. When exposed to temperatures typically above 180°C, the intumescent seal expands many times its original size, sealing the gaps between the panels and slowing the passage of fire, smoke, and hot gases. It should be also noted that the test conducted did not fully adhere to the standard procedure. Due to the wall sides being unable to be fixed in the furnace, two vertical free edges were used instead of one, as is standard in fire resistance tests. This could have had an adverse effect on the behaviour of the panels, particularly with regard to their deflection and joint opening.
A detailed analysis and interpretation of the test results will be provided later during the validation work of three-dimensional FE numerical models developed in WP3 for the thermal-mechanical analysis of steel members traversing fire walls made of sandwich panels.

5 REFERENCES

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

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

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

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

[5] Fire resistance test report n° Pr 23-2.086-En on a partition fire wall made of sandwich panels solidly attached to an unprotected steel structure and penetrated by steel purlins, 18-10-2023, PAVUS.

APPPENDIX A. FIRE TEST REPORT N°PR-23-2.086-EN

PAVUS
FIRE TESTING INSTITUTE
Order No.: Z210220040

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

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-23-2.086-En

issued on 2023-10-18

For product

Fire wall connected to an unprotected steel structure and penetrated by steel purlins (Task 3.2)

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

Test method:

ČSN EN 1363-1
» Fire resistance tests - Part 1: General requirements «

Test Report includes 44 pages
(7 pages of text + 4 Annexes)

Number of copies: 2
Copy number: 1

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1 INTRODUCTION

The fire resistance test of a fire wall made of steel-faced sandwich panels solidly attached to an unprotected steel structure and penetrated by two steel purlins supporting steel decks with insulation 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 requirements

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

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

[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 fire test aimed mainly to investigate the interaction of deforming steel purlins with a non-loadbearing fire wall made of sandwich panels and to check that a panel-based fire protection system along an appropriate length of purlins allows, as expected, preventing wall damage and subsequent spread of fire.

3 TEST SPECIMEN

The test specimen consisted of two steel purlins penetrating a non-loadbearing fire wall made of sandwich panels spanning vertically between concrete panel at the bottom and steel decks at the top, solidly fixed to a supporting steel structure.

Description of steel structures:

The steel structure consisted of single span steel purlins (IPE 200) having cantilever ends. On EF, each purlin was simply supported at its end by means of a fork support (allowing the free axially thermal expansion of the purlin along 60 mm) fixed to an HEB 500 beam as part of an horizontal supporting frame placed around the furnace. The part of the HEB 500 located inside the furnace was adequately fire protected with mineral wool th. 50 mm, density 100 kg/m^3, wrapped with ceramic blanket insulation Cerablanket 1430, th. 13 mm, density 128 kg/m^3.

On UF, purlins were bolted (flange to flange connection using 4 pcs of M16x50 bolts) to another HEB 500 beam as part of the horizontal supporting frame placed aroung the furnace and running along the wall. The possible uplift of the free end of purlins located on the fire-unexposed side was prevented by a steel beam, to take account of some purlin continuity effects. The purlin span was 6.25 m, while the cantilevers length was 1 m approximately. The purlins were spaced at 1.5 m.

The grade of steel was S275 for steel members and steel plates and 8.8 for bolts.

Description of the purlin encasement system:

On EF, the purlins were fire protected by an encasement system over 50 cm length from the fire wall, leaving unfilled the voids formed between the ribs of the steel decks and the top flange of steel purlins. The voids inside the encasement system (between the purlin flanges) were fully filled with mineral wool for one purlin (Purlin No. 2). Finally, wall openings managed at the level of purlins were also filled with mineral wool.

The purlin encasement system was made of 3 cut pieces of length 500 mm (2x width of 200 mm, 1x width of 450 mm) of the sandwich panels Eurobond Rainspan Extra, th. 175 mm. From the inner side of purlin flanges, there were fixed supporting steel angles 50x50x2 with screws RPK12-SS-5.5 x 38 (producer Fixfast Ltd) in spacing of 250 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 300 mm, on two vertical sides with washers Fixfast SP-40-DD (producer Fixfast Ltd). On the corners of the fire protection, there were fixed covering steel sheets, th. 0.35 mm.

A mineral wool strip with 15 mm thick was placed between the wall and the encasement systems, with cover flashings 30x30x2 fixed to the wall panels with screws RPK12-SS-5.5 x 38 (producer Fixfast Ltd) in spacing of 200 mm.

Description of roof structure:

The roof consisted of trapezoidal metal sheets JRI-JI-42-252-1010 (producer JORIS IDE N.V.), with 1.0 mm thickness and 2800 mm length. The sheets were in steel grade S320 GD. On the top, there was polyester coating, th. 15 μm. The sheets were fixed to steel purlins IPE 200 in each bottom wave by 2 pcs of screws DrillFast DF12-SSA4-5.5 x 40 (producer Fixfast Ltd). On the top, there was freely laid insulation, without anchoring, made of mineral wool boards SPANROCK XL 9570 GR (producer ROCKWOOL), th. 105 mm, density 120 kg/m^3. Perimeter of the structure was sealed by Cerablanket 1430 mechanically fixed to the masonry above the furnace.

Description of the wall construction:

The wall was a non-loadbearing wall measuring 3 000 mm wide × 3 000 mm high × 175 mm thick. It was made of sandwich panels vertically oriented and consisting of 3 pcs of Eurobond Rainspan Extra panels with mineral wool as an insulation core. The nominal density of mineral wool was 120 kg/m^3. Each panel had dimensions of 1 200 mm (stock width) × 2 800 mm (length) x 175 mm (thickness). One panel was reduced to 580 mm in width and it was mounted to right edge of the wall (view from UF), both vertical edges were free, without fixing. 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 wall, L-profiles 100x50x2 were mounted on both sides of the wall (on EF and also on UF in the end of the assembly). The profiles were anchored to the bottom aerated concrete panel of thickness 150 mm using carbon steel screws TutFast HTF-6.3 x 57 (producer Fixfast Ltd) in spacing of 350 mm. On the sides and the top of the wall these profiles were anchored only to the sandwich panels using screws DrillFast DF2-SS-LS-A15-6.3 x 25 (producer Fixfast Ltd) in spacing of 300 mm, without fixing to the wall of the furnace.

Panels were anchored to steel tubes 250x100x10 using stainless screws DrillFast DF12-SS-HT-5.5 x 200 (producer Fixfast Ltd) in the direction from EF, in spacing of 250 mm. These tubes were fixed to the upper flange of the HEB 500 beam running along the wall.

The gaps between the test specimen and the rigid construction (concrete panel, roof structure, furnace walls) were simply filled up with mineral wool POWER-TEK BD 660 (manufacturer Knauf Insulation, spol. s r.o.), without the use of glue. The wall openings managed at the level of purlins were also filled with mineral wool, nominal density 100 kg/m^3. The width of the gap was between 20 and 30 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 steel elements were delivered by company Briand CM on 3th April 2023, they were mounted by PAVUS Fire testing laboratory from 19th to 22nd May 2023. The specimen of the wall was manufactured and assembled by company Euroclad Group Ltd from 23rd to 24th May 2023.

The parts of the test specimen were delivered to the test laboratory without any defects and in accordance with the delivered documentation.

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

4 TEST PERFORMANCE

4.1 General

The fire resistance test was performed as per [2] on 31st May 2023 in Testing hall PO 1 in horizontal furnace with inner dimensions of 3 000 mm (width) × 8 460 mm (length) × 3 000 mm (height).

Used testing and gauging equipment is stated in Annex A.

4.2 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 the region of the loaded beams according to request of the sponsor and [4] cl. 9.2.2, i. e. 500 mm below the soffit of the furnace and 100 mm from the side of the steel beams.

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.

4.3 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.

K-type thermocouples, the diameter of each wire of 0.5 mm, were used for a measurement of the steel temperature following the consultation between the laboratory and the test sponsor regarding their suitability, see [4]: C.2. Hot junctions of the thermocouples were located according to request of the sponsor and [2]: 9.3, the thermocouples were fixed to the surface by welding and routed according to [4]: Annex C.

The rate of vertical deflections was measured by deflectometers spaced according to request of the sponsor. Since displacement sensors cannot be installed inside the furnace due to the high temperatures, draw-wire displacement sensors were installed outside the furnace, then attached to the test specimen by means stainless steel rods welded to the upper flange of beams to measure horizontal displacements at different locations along the purlins: at the purlin-to-wall connections, at the encasement ends and at purlins mid-span. Total length of stainless-steel rods was 350 mm, of which approximately 50 mm was directly in the heated space in the furnace (wave height of the trapezoidal sheet).

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.

4.4 Loading

A vertical loading of 15 kN was applied at the beam's mid-span using dead weights made from steel elements, according to request of the sponsor. The loads were applied on the upper flange of purlins.

4.5 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.

4.6 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) %.

5 TEST COURSE

Time (min)	Test observation
ca 15.	increase of the deflection of both purlins and consequential collapse (purlin No. 2 collapsed a little earlier)
18.	UF - opening of the joints between mineral wool boards located on the roof due to the excessive deflection of purlins
40.	UF - small flame appears occasionally from the vertical joint in the space between TC U11 and U16
58.	UF - ignition of the cotton pad and subsequent sustained flaming on the top of the wall in one vertical joint - **integrity failure**, sustained flaming also on the top of the wall in the connection with the roof structure, almost in whole width of the wall
81.	end of the test due to safety reasons - sustained flaming of the specimen still going on

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

6 TEST RESULTS

6.1 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.

6.2 Expression of test results - wall made of sandwich panels

Criterion	Partial criterion	Measured value	Evaluation
Integrity	Cotton pad ignition	57 min	57 min
	Gap gauge passage	80 min, no failure	80 min
	Sustained flaming	57 min	57 min
Insulation	Average temperature	80 min, no failure	57 min [1)]
	Maximum temperature	22 min	22 min

Note:

[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).

6.3 Field of direct application

The results of this fire test have no field of direct application.

6.4 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, ČSN EN 1364-1 and ČSN EN 13381-4. 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.

POŽÁRNÍ ZKUŠEBNA VESELÍ NAD LUŽNICÍ AKREDITOVANÁ ZKUŠEBNÍ LABORATOŘ č. 1026 PAVUS FIRE TESTING INSTITUTE PAVUS, a.s.

NOTIFIED BODY 1391 PAVUS FIRE TESTING INSTITUTE PAVUS, a.s.

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:**
Horizontal furnace (+ equipment pressure and temperature control inside the furnace)	0007
Furnace pressure probe	0011
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
Dataloggers Almemo 5990-2	3 10 66, 85
PTM – in-furnace temperature (TM K ∅ 2 mm)	3 10 10
TC (K) – specimen 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 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 $40°C \leq T < 375°C$ $\sqrt{(8,04.10^{-5}.T^2 + 7,84°C^2)}$, for $375°C \leq T \leq 1000°C$
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	63	64	65	66	67	68	70	71	72	73	74	75	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)	(Pa)	(Pa)	(Pa)	(°C)
0:00:00	20	19	19	20	19	19	19	19	19	19	19	20	19	16								9.3	22
0:05:00	576	642	634	641	587	625	626	620	627	630	615	635	664	613			-9.7					10.8	22
0:10:00	678	718	728	695	658	715	680	693	756	708	693	686	716	692	-15	15	-2.8	-27	78	5.7	15.7	13.6	22
0:15:00	739	813	788	714	792	799	706	770	731	722	768	750	736	747	-12.5	12.5	-1.0	-32	74	7.7	13.7	9.2	22
0:30:00	842	890	872	749	882	886	746	864	819	749	877	844	772	837	-5.0	5.0	0.1	-96	48	7.7	13.7	11.3	24
0:45:00	902	981	970	815	963	992	803	956	876	825	965	909	842	906	-3.8	3.8	0.0	-99	89	7.7	13.7	10.8	25
1:00:00	945	1032	1014	857	1018	1035	851	1006	912	864	1017	952	885	949	-2.5	2.5	0.1	-95	89	7.7	13.7	11.5	27
1:15:00	979	1062	1040	890	1050	1061	885	1037	942	899	1048	974	920	982	-2.5	2.5	0.2	-93	83	7.7	13.7	10.7	28
1:20:20	989	1067	1044	898	1054	1065	892	1043	949	906	1052	985	927	990	-2.5	2.5	0.2	-97	78	7.7	13.7	11.2	32

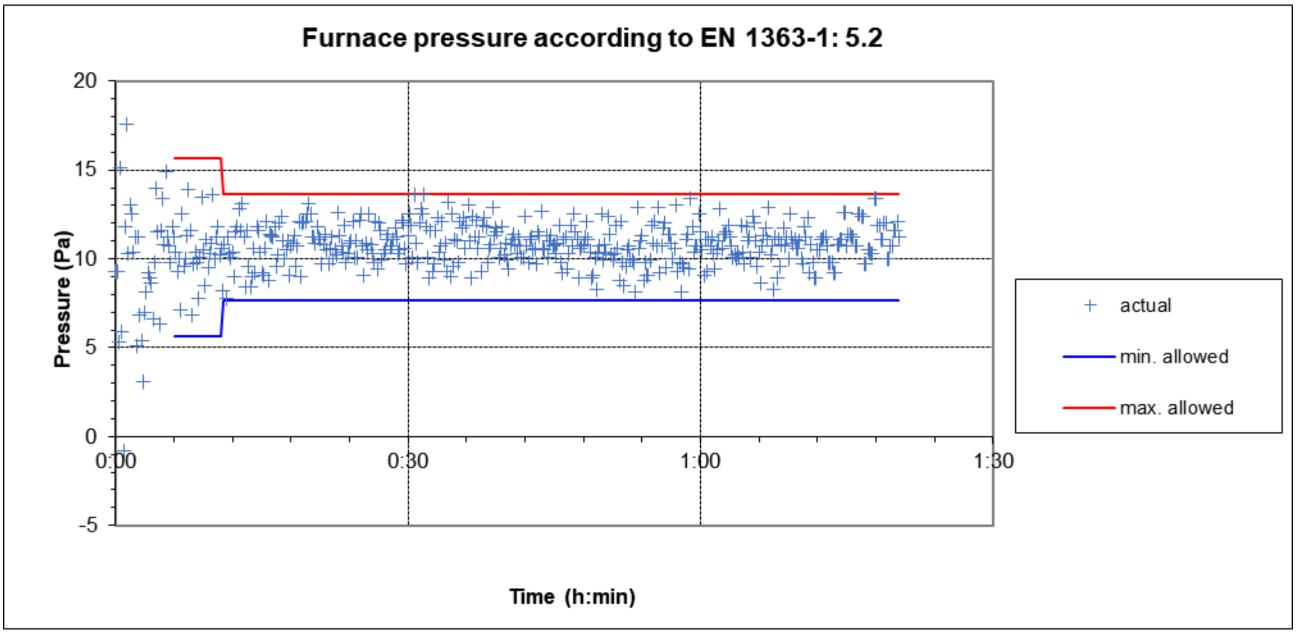
Key

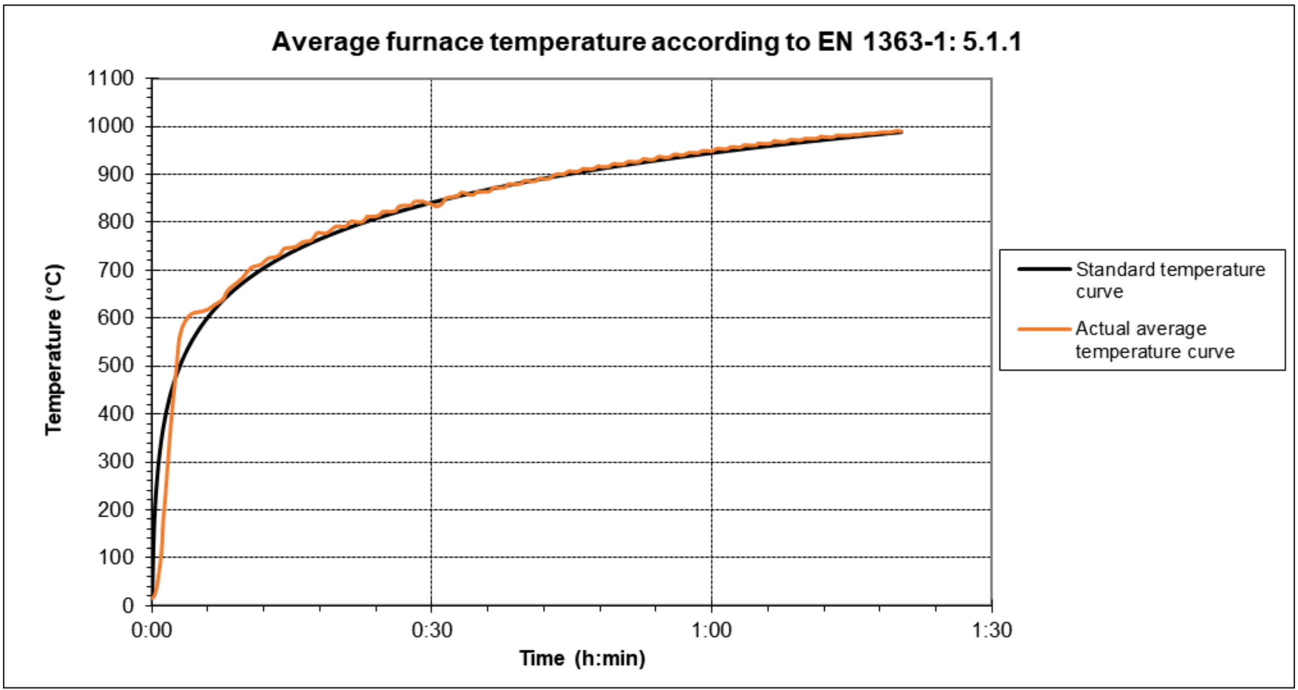
- t is the time, in min;
- T is the standard average furnace temperature, in °C, $\{T\} = 345.\log_{10}(8\{t\}+1) + 20$;
- avg is the actual average furnace temperature, in °C;
- d_e is the percentage deviation in the area of he actual average temperature/time curve from the area of the standard temperature/time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

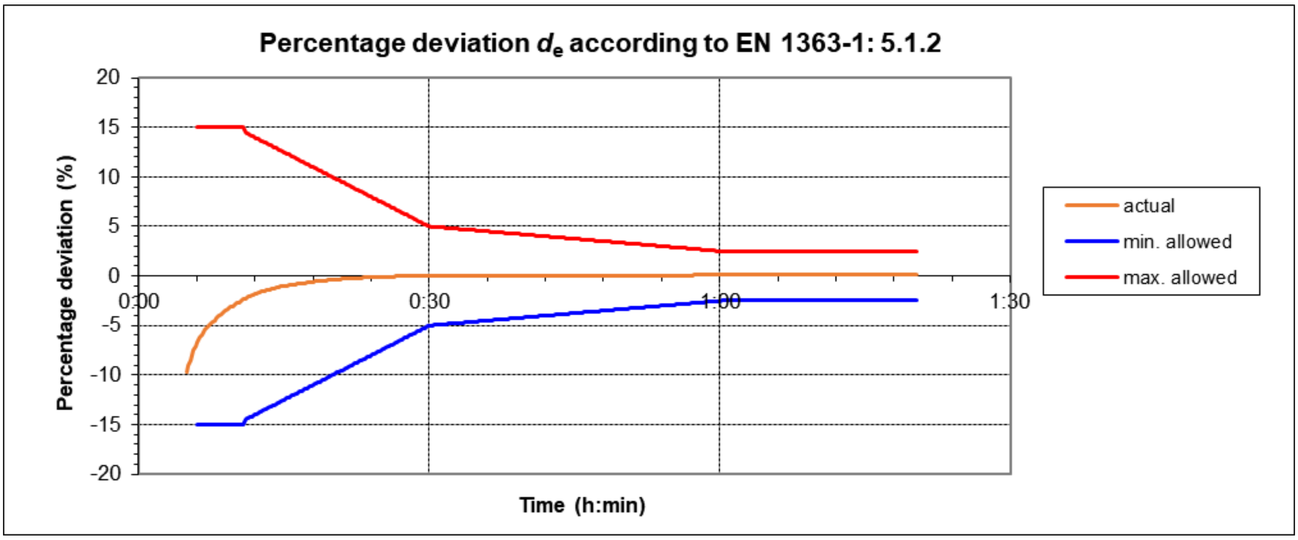
"Pressure" is the difference of the pressure in the furnace and the ambient pressure at the same hight level:

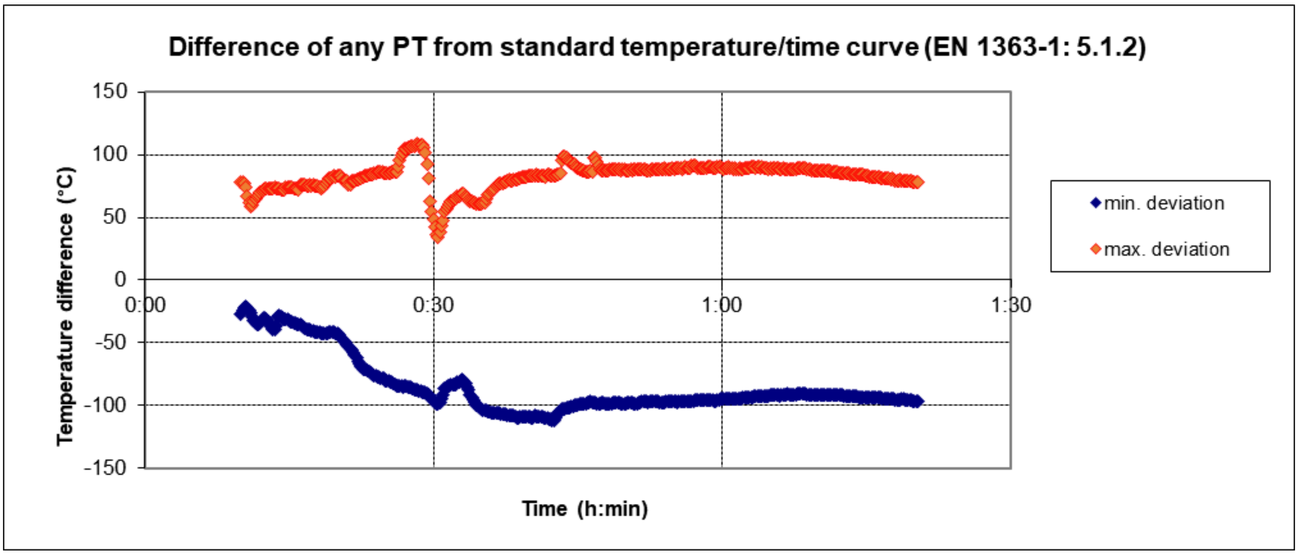
The pressure of 20.0 Pa is required 100 mm below underside of the separating element

Then the pressure of 10.7 Pa is expected in pressure sensor 1200 mm below underside of the separating element


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

Measuring points

Purlin 1		
Drawing		Datalogger
S1-	1	00
	2	01
	3	02
S2-	1	03
	2	04
	3	05
	4	06
	5	07
	6	08
	7	09
	8	10
S3-	1	11
	2	12
	3	13
	4	14
	5	15
	6	16
	7	17
	8	18
	9	19
	10	20
	11	21
S4-	1	22
	2	23
	3	24
	4	25
	5	26
	6	27
S5-	1	28
	2	29
	3	30
	4	31
	5	32
	6	33
	7	34
	8	35
	9	36
	10	37
	11	38
S6-	1	39
	2	40
	3	41
	4	42
	5	43
	6	44
S7-	1	45
	2	46
	3	47
S8-	1	48
	2	49
	3	50
	4	51
	5	52
	6	53
	7	54
	8	55
S17-	1	31
	2	32
	3	33
S19-	1	56
	2	57
	3	58
S20-	1	59
	2	60
	3	61

Purlin 2		
Drawing		Datalogger
S9-	1	20
	2	21
	3	22
S10-	1	23
	2	24
	3	25
	4	26
	5	27
	6	28
	7	29
	8	30
S11-	1	31
	2	32
	3	33
	4	34
	5	35
	6	36
	7	37
	8	38
	9	39
	10	40
	11	41
S12-	1	42
	2	43
	3	44
	4	45
	5	46
	6	47
S13-	1	48
	2	49
	3	50
	4	51
	5	52
	6	53
	7	54
	8	55
	9	56
	10	57
	11	58
S14-	1	59
	2	60
	3	61
	4	62
	5	63
	6	64
S15-	1	65
	2	66
	3	67
S16-	1	68
	2	69
	3	70
	4	71
	5	72
	6	73
	7	74
	8	75
S18-	1	34
	2	35
	3	36
S21-	1	76
	2	77
	3	78
S22-	1	79
	2	80
	3	81

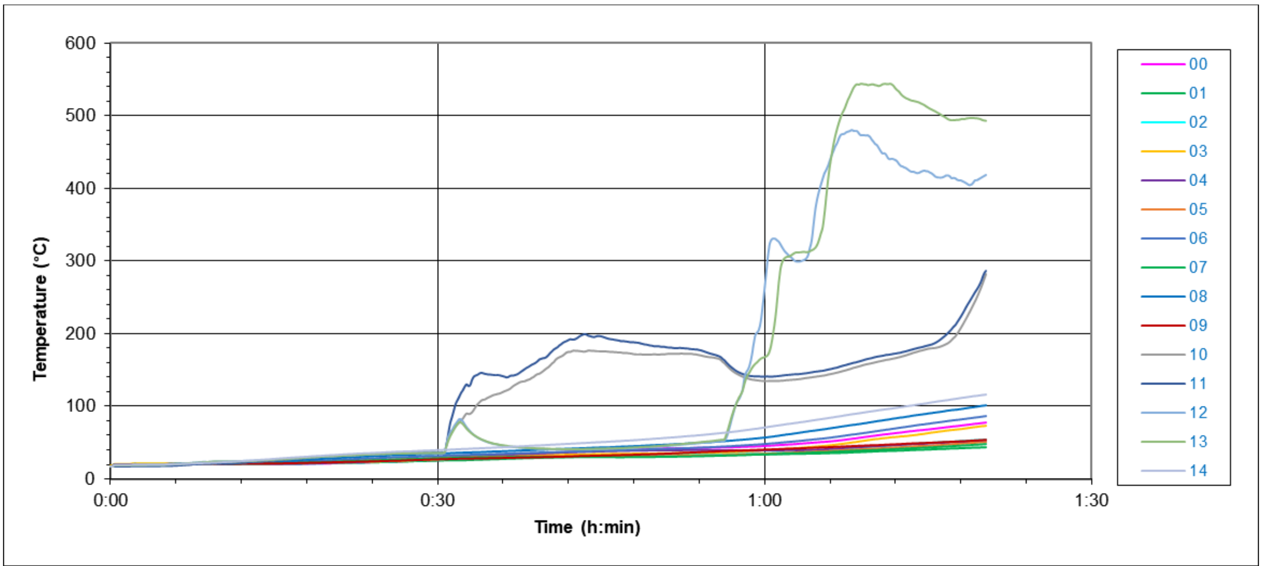
Wall	
Drawing	Datalogger
U1	00
U2	01
U3	02
U4	03
U5	04
U6	05
U7	06
U8	07
U9	08
U10	09
U11	10
U12	11
U13	12
U14	13
U15	14
U16	15
U17	16
U18	17
U19	18
U20	19
U21	20
U22	21
U23	22
U24	23
U25	24
U26	25
U27	26
U28 (screw on US)	27
U29 (screw on US)	28
E1 (screw on ES)	29
E2 (screw on ES)	30

Note: drawings with all measuring points are in Annex C

Time (h:min:s)	Temperature on the unexposed face of the wall (°C)															
	T_{aver}						T_{max}									
	T_{aver}	U1 00	U2 01	U3 02	U4 03	U5 04	U6 05	U7 06	U8 07	U9 08	U10 09	U11 10	U12 11	U13 12	U14 13	U15 14	T_{max}
0:00:00	**18**	18	17	18	18	18	18	18	18	18	18	18	18	17	18	18	**18**
0:05:00	**20**	20	21	20	21	21	21	21	20	21	20	20	18	20	20	20	**21**
0:10:00	**21**	21	22	21	21	21	22	22	21	22	21	21	21	25	24	23	**25**
0:15:00	**21**	21	21	21	21	22	22	24	22	25	22	26	26	27	27	28	**28**
0:30:00	**27**	26	25	27	26	30	29	32	29	35	27	36	37	36	36	40	**40**
0:45:00	**35**	39	31	33	34	39	32	39	30	44	33	176	197	41	42	51	**197**
0:59:10	**38**	45	34	35	38	40	35	48	34	56	40	136	142	198	159	69	**198**
1:00:00	**39**	46	34	35	39	40	35	49	34	57	41	135	141	260	168	71	**260**
1:15:00	**54**	68	40	50	63	50	46	76	44	90	50	179	184	423	512	105	**512**
1:20:20	**60**	78	43	54	73	53	51	87	49	101	54	282	287	418	494	116	**494**

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

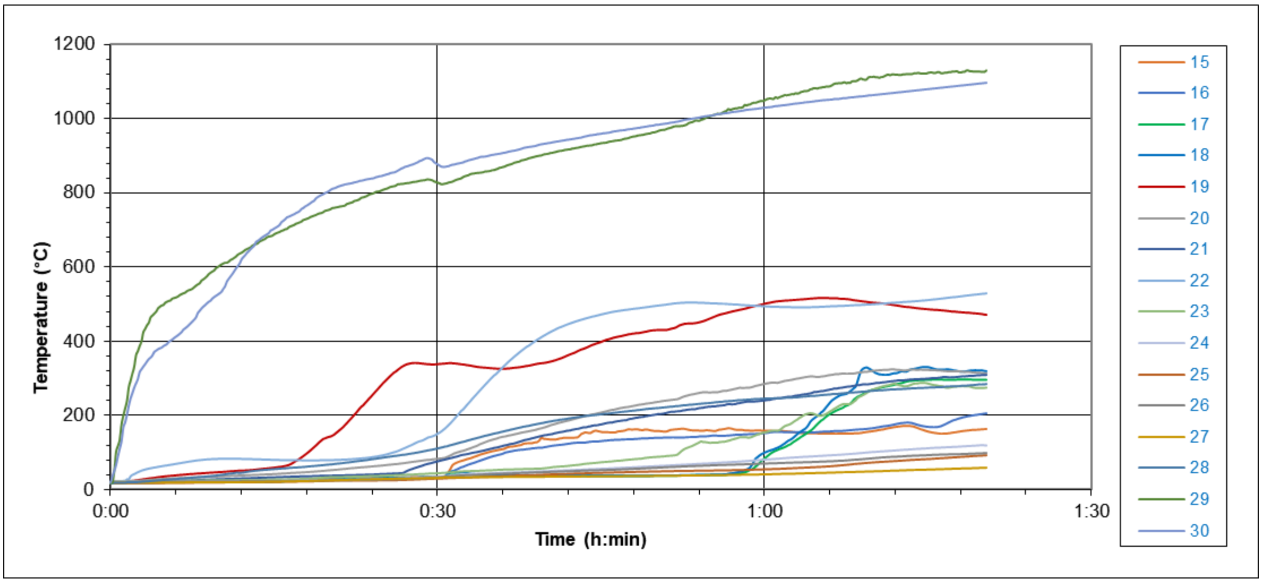
XX	Designation of measuring joint of TC as figured in Annex C
XX	Time and temperature when the insulation criterion has been exceeded



Time (h:min:s)	Temperature on the unexposed face / fixing of the wall (°C)																
		T_{max}												T_{fixing}			
		U16	U17	U18	U19	U20	U21	U22	U23	U24	U25	U26	U27	U28	U29	E1	E2
	T_{max}	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0:00:00	**19**	18	18	18	18	19	18	18	19	18	19	16	19	18	18	19	19
0:05:00	**64**	21	21	20	20	35	28	21	64	22	21	17	21	20	28	504	389
0:10:00	**82**	23	22	21	21	46	34	27	82	24	22	19	21	21	41	605	529
0:15:00	**79**	26	25	23	23	58	41	32	79	26	23	20	22	22	57	689	703
0:22:20	**200**	31	31	29	29	200	57	38	82	34	26	24	25	27	77	779	827
0:30:00	**338**	35	35	34	34	338	82	75	150	43	34	29	33	32	112	829	876
0:45:00	**473**	154	130	37	38	398	208	176	473	73	55	45	52	36	204	935	959
1:00:00	**501**	157	152	86	101	501	286	241	495	153	80	54	71	41	246	1051	1029
1:15:00	**512**	155	168	297	331	486	324	300	512	285	112	82	94	54	276	1125	1079
1:20:20	**530**	162	204	297	320	471	314	310	530	274	119	93	100	59	286	1131	1096

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

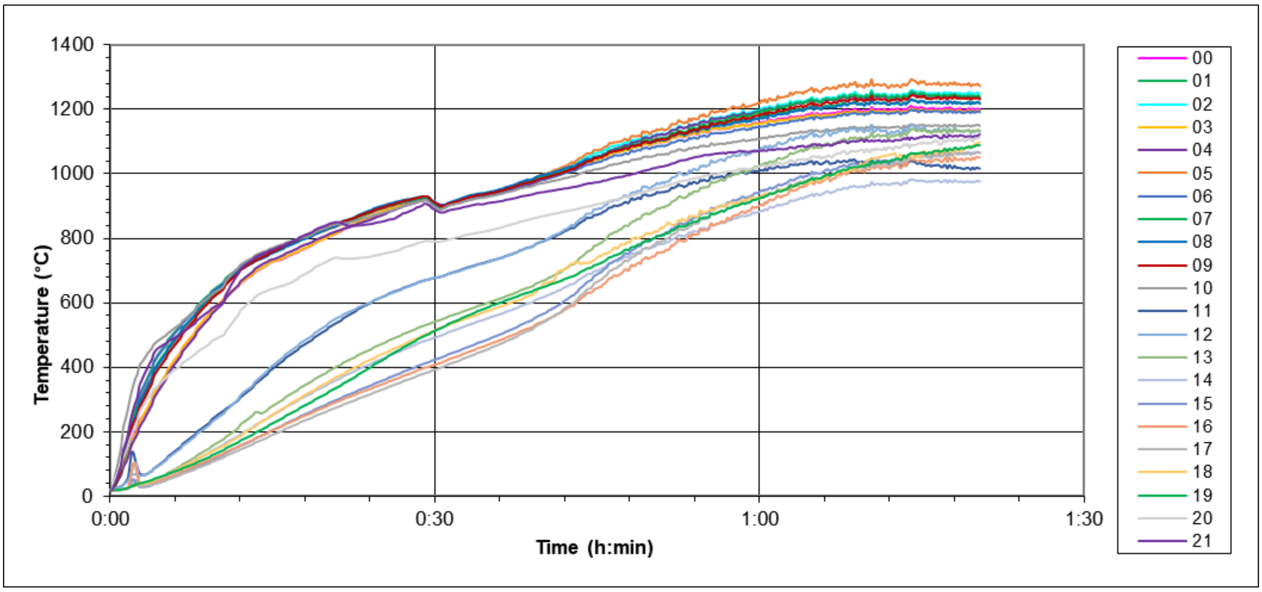
XX	Designation of measuring joint of TC as figured in Annex C
XX	Time and temperature when the insulation criterion has been exceeded



Time	Section	S1-			S2-								S3-										
		1	2	3	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	9	10	11
(h:min:s)	TC No.	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
0:00:00		19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
0:05:00		369	467	424	371	356	436	462	443	437	421	496	111	107	65	61	48	54	47	64	65	363	472
0:10:00		596	652	636	597	586	633	649	639	644	631	640	255	246	168	152	122	126	115	149	136	493	595
0:15:00		728	766	761	728	736	756	763	756	755	758	770	396	406	280	253	206	205	191	251	227	644	765
0:30:00		909	903	913	908	911	903	904	908	910	910	897	678	678	542	493	424	408	393	514	514	790	889
0:45:00		1045	1047	1064	1044	1051	1074	1036	1054	1052	1050	1014	873	890	780	700	689	645	666	742	719	906	974
1:00:00		1159	1173	1198	1157	1193	1220	1146	1191	1172	1182	1109	1011	1075	1025	885	945	903	928	921	925	1025	1073
1:15:00		1206	1224	1253	1200	1245	1283	1197	1248	1225	1237	1151	1030	1137	1133	978	1058	1040	1052	1062	1065	1093	1114
1:20:20		1200	1217	1247	1194	1236	1272	1192	1238	1219	1231	1150	1017	1130	1134	977	1066	1051	1065	1099	1089	1114	1122

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 C

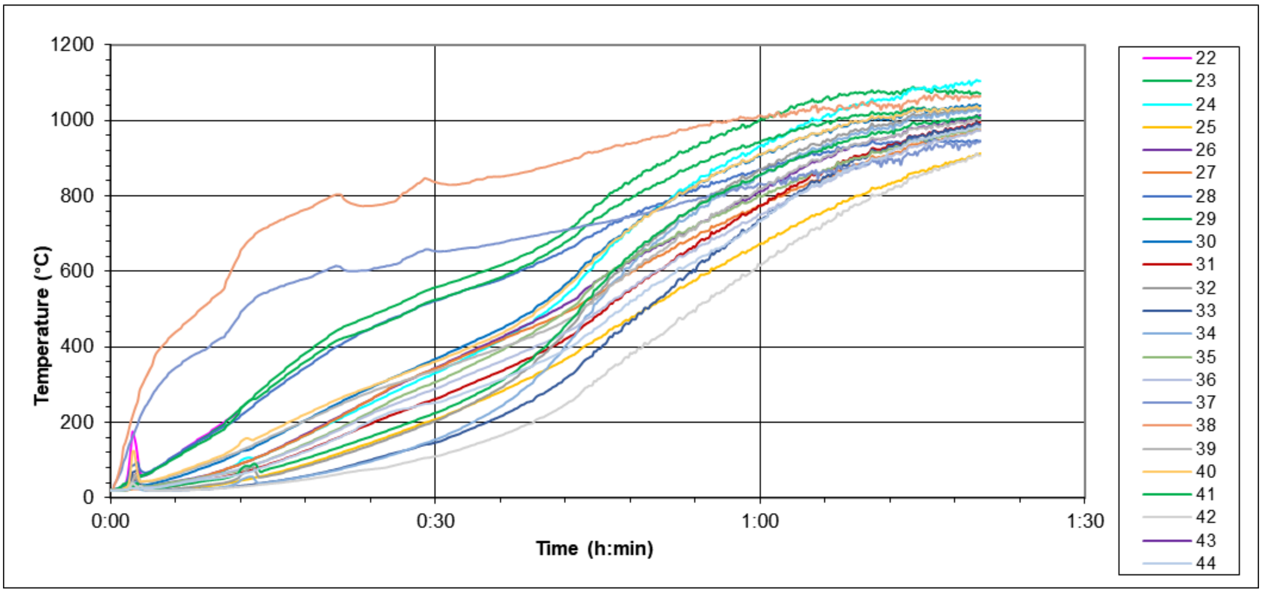


Time	Section	S4-						S5-											S6-					
		1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
(h:min:s)	TC No.	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
0:00:00		19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19		19
0:05:00		91	91	30	21	38	32	93	88	45	27	22	20	20	37	32	316	409	52	55	28	19		30
0:10:00		191	186	66	35	70	69	182	174	94	53	37	25	26	62	62	420	542	102	109	49	24		53
0:15:00			315	125	65	126	125	285	298	160	92	60	43	43	106	105	552	726	165	180	79	38		90
0:30:00			558	331	208	344	343	522	525	368	262	203	146	154	306	289	654	837	337	361	225	110		252
0:45:00			778	627	422	576	539	704	742	649	485	543	394	521	577	494	727	917	532	642	557	315		453
1:00:00			1002	933	674	813	775	871	944	907	775	869	736	853	798	750	832	1013	819	909	856	615		732
1:15:00			1084	1086	868	984	942	951	1034	1030	964	1018	963	1011	952	937	923	1060	981	1027	993	857		951
1:20:20			1071	1105	913	1014	975	946	1029	1040	996	1031	989	1026	983	973	944	1065	1002	1033	1008	908		982

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 C

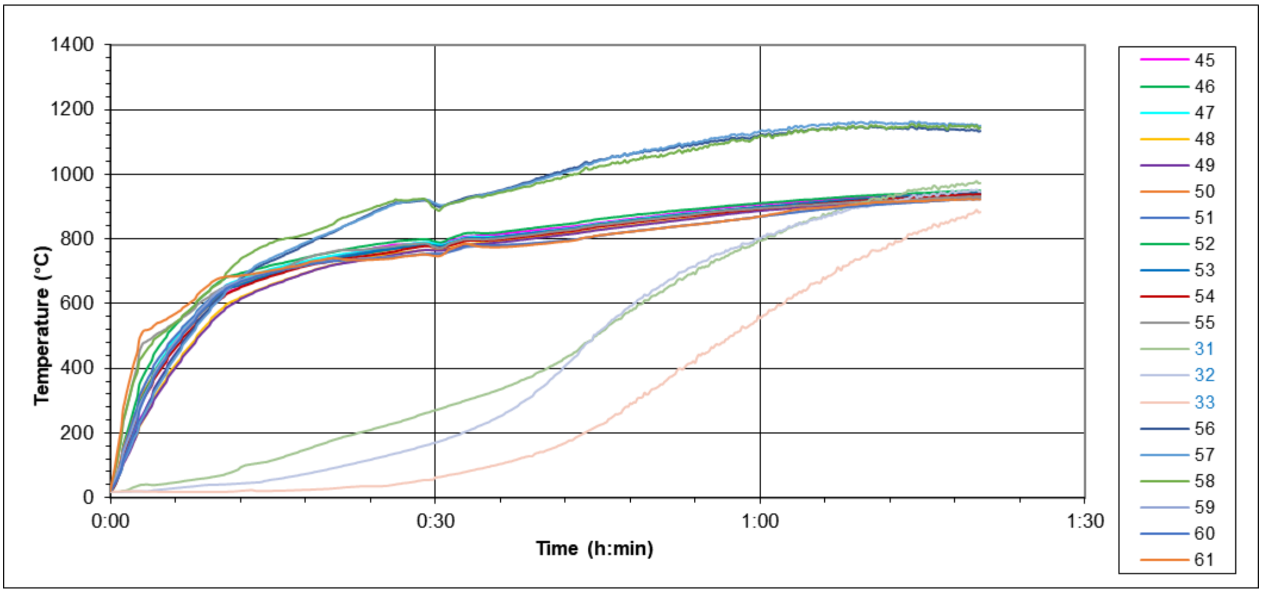
Failure of TC



Time	Section	S7-			S8-								S17-			S19-			S20-		
		1	2	3	1	2	3	4	5	6	7	8	1	2	3	1	2	3	1	2	3
(h:min:s)	TC No.	45	46	47	48	49	50	51	52	53	54	55	31	32	33	56	57	58	59	60	61
0:00:00		19	19	19	19	19	19	19	19	19	19	20	19	19	19	19	19	20	19	19	19
0:05:00		388	489	441	357	350	431	456	434	428	413	518	44	27	19	388	375	512	433	422	548
0:10:00		610	665	639	574	565	623	641	626	628	610	640	69	42	18	618	608	661	638	627	677
0:15:00		692	719	709	660	658	690	700	692	691	687	696	118	57	22	735	742	788	699	696	703
0:30:00		787	791	785	765	765	774	779	779	779	774	774	272	172	63	906	910	893	753	753	746
0:45:00		849	860	847	829	828	841	846	844	844	838	841	508	512	222	1045	1040	1023	810	809	810
1:00:00		906	910	899	889	888	895	898	899	898	893	893	796	802	555	1123	1133	1118	870	868	869
1:15:00		937	941	931	925	923	929	932	933	933	930	922	958	934	827	1144	1158	1149	916	914	916
1:20:20		945	949	939	934	932	938	940	942	942	939	930	974	948	883	1136	1150	1144	924	923	922

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

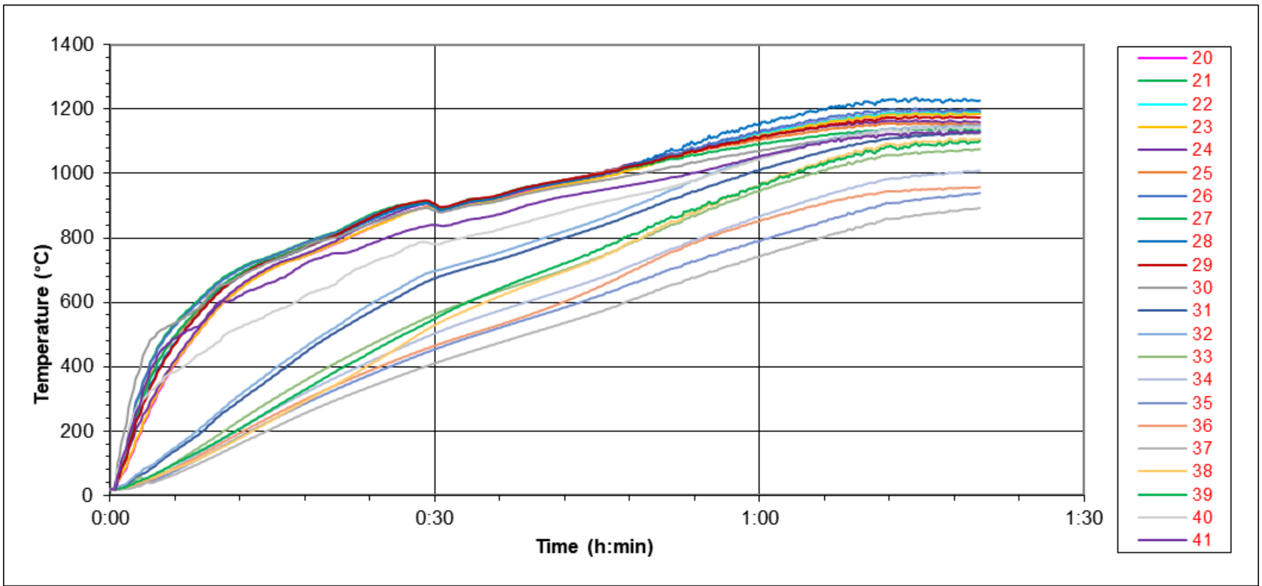
XX Designation of measuring joint of TC as figured in Annex C



Time	*Section*	*S9-*			*S10-*								*S11-*										
		1	*2*	*3*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
(h:min:s)	*TC No.*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*	*31*	*32*	*33*	*34*	*35*	*36*	*37*	*38*	*39*	*40*	*41*
0:00:00		19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
0:05:00		358	495	449	363	372	450	489	452	429	422	519	117	126	81	70	61	70	54	70	83	368	461
0:10:00		584	665	638	584	591	638	660	642	632	629	649	245	257	188	167	146	157	128	144	169	478	599
0:15:00		707	747	734	706	715	736	744	736	730	731	729	370	391	299	266	237	249	209	236	270	572	663
0:30:00		896	898	897	894	900	896	896	900	896	905	885	675	697	563	503	454	466	411	529	549	781	840
0:45:00		992	998	996	986	1002	1001	995	997	995	999	977	834	856	739	673	619	647	569	737	764	909	947
1:00:00		1123	1119	1120	1114	1112	1103	1127	1090	1150	1110	1069	1010	1048	945	865	790	851	741	962	960	1044	1053
1:15:00		1192	1188	1189	1186	1163	1155	1199	1138	1232	1176	1126	1119	1144	1066	996	921	952	873	1101	1092	1143	1128
1:20:20		1191	1186	1188	1185	1160	1152	1196	1136	1228	1175	1126	1130	1150	1076	1009	940	958	893	1108	1102	1144	1129

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 C

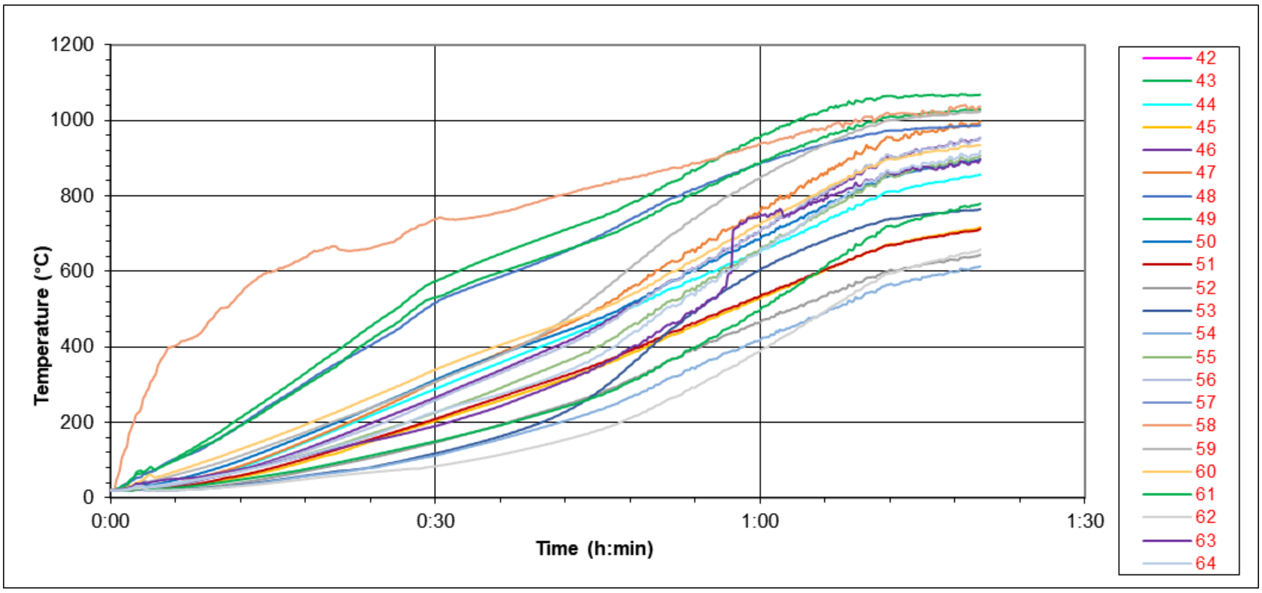


Time	Section	S12-						S13-											S14-					
		1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
(h:min:s)	TC No.	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
0:00:00			19	19	19	19	19	19	19	19	19	19	19	19	19	19		19	19	19	19	19	19	19
0:05:00			89	27	23	30	31	90	87	41	25	21	20	20	34	31		381	53	61	24	20	48	36
0:10:00			173	61	44	58	67	157	155	79	48	32	28	27	59	58		497	92	108	40	27	64	60
0:15:00			272	113	73	100	116	251	246	132	80	54	46	44	91	96		601	143	161	61	39	92	91
0:30:00			574	288	203	265	307	517	531	312	209	146	117	111	226	258		739	308	340	149	84	190	227
0:45:00			742	463	347	457	503	693	687	475	355	277	281	232	402	448		827	540	498	271	179	349	376
1:00:00			955	652	529	706	759	885	886	686	535	464	604	417	658	707		939	847	724	498	388	747	652
1:15:00			1065	829	690	925	972	980	1019	871	688	619	751	585	876	925		1026	1011	913	744	620	877	888
1:20:20			1069	857	717	955	997	988	1030	896	713	644	765	613	907	955		1037	1024	935	780	659	898	919

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 C

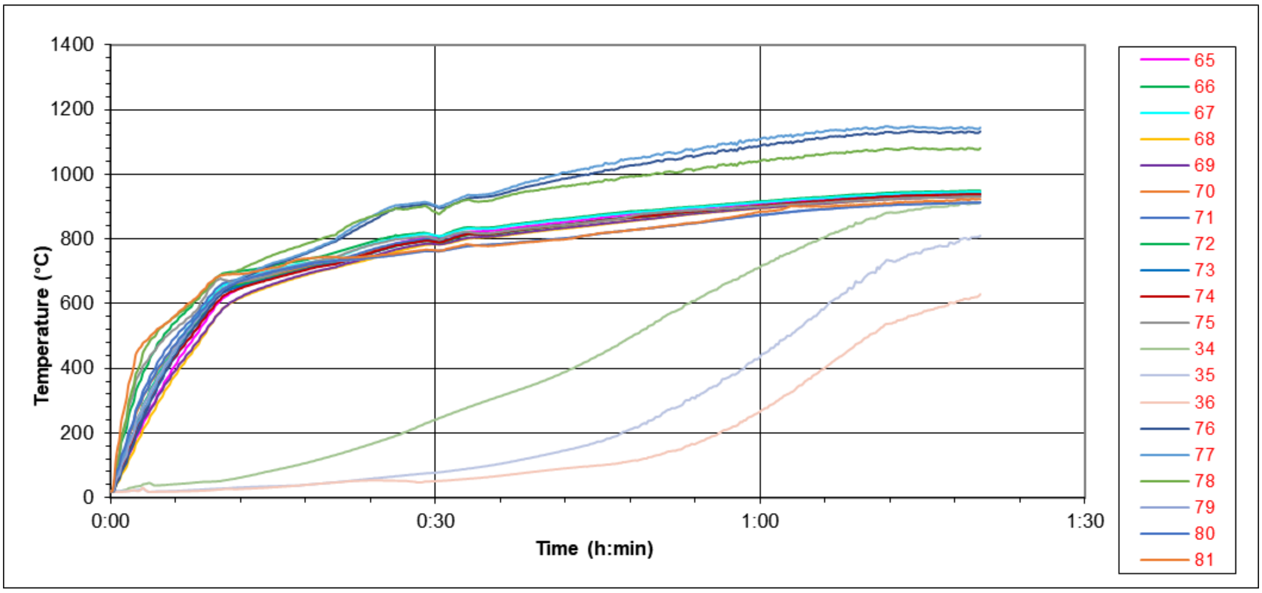
Failure of TC



Time	Section	S15-			S16-								S18-			S21-			S22-		
		1	2	3	1	2	3	4	5	6	7	8	1	2	3	1	2	3	1	2	3
(h:min:s)	TC No.	65	66	67	68	69	70	71	72	73	74	75	34	35	36	76	77	78	79	80	81
0:00:00		19	19	19	19	19	19	19	19	19	19	20	19	19	19	19	19	19	19	19	19
0:05:00		358	507	425	330	349	429	454	415	386	392	495	41	18	20	390	404	537	412	431	536
0:10:00		603	686	644	570	570	635	652	628	623	609	675	53	27	26	624	630	686	633	633	685
0:15:00		686	718	705	656	662	688	695	684	680	677	692	86	34	34	723	727	752	703	699	712
0:30:00		805	811	812	783	785	790	794	792	795	791	800	242	76	53	902	906	885	765	761	766
0:45:00		864	876	873	843	847	854	856	856	856	856	854	442	172	101	1007	1027	979	817	815	818
1:00:00		908	917	915	894	897	900	902	903	901	902	900	715	434	266	1089	1110	1043	874	873	885
1:15:00		938	947	944	926	928	933	933	935	934	934	927	896	762	572	1133	1148	1082	909	908	916
1:20:20		941	950	947	930	932	937	937	939	938	938	930	914	808	628	1134	1146	1082	914	912	924

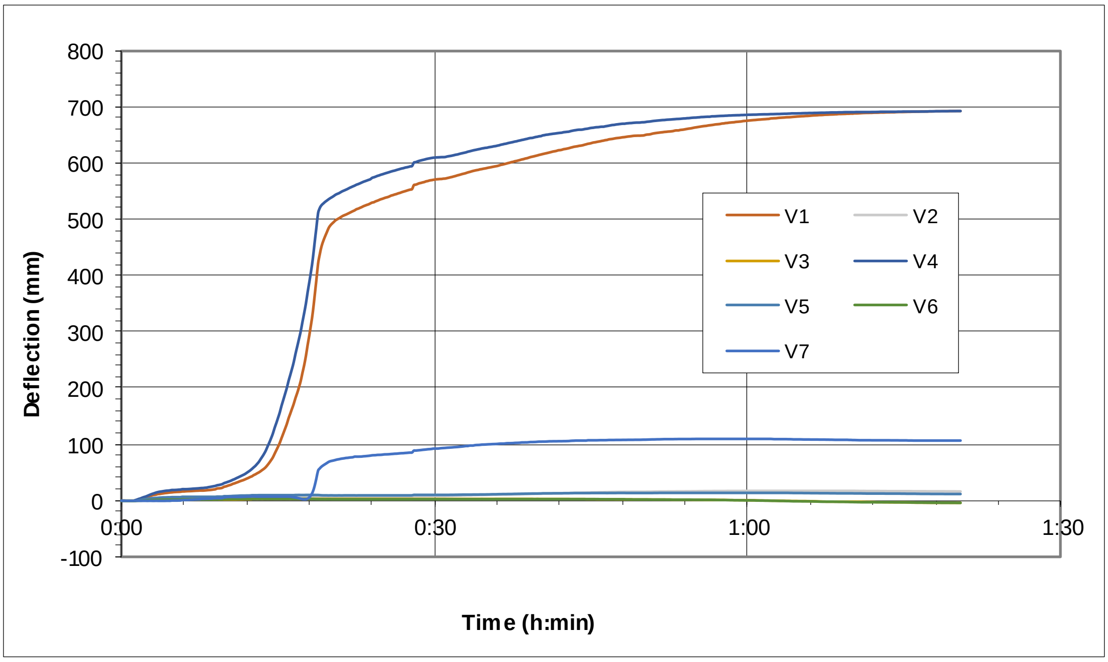
Temperature recorded at 10 s intervals. In the table, they figure in 15 minute intervals

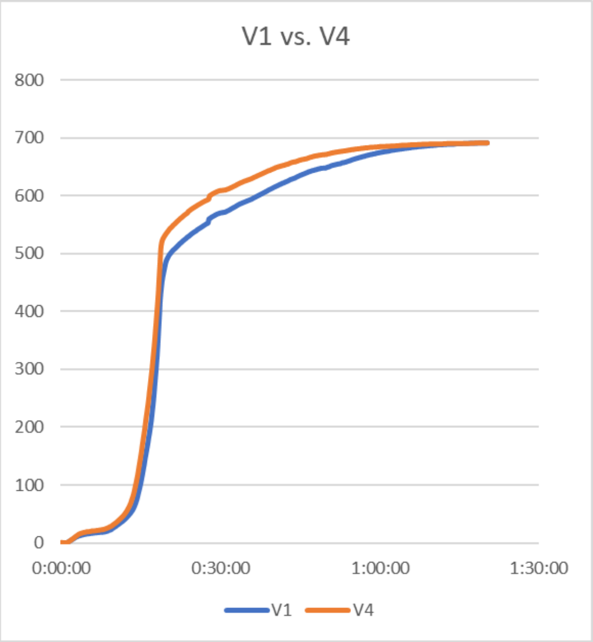
XX Designation of measuring joint of TC as figured in Annex C

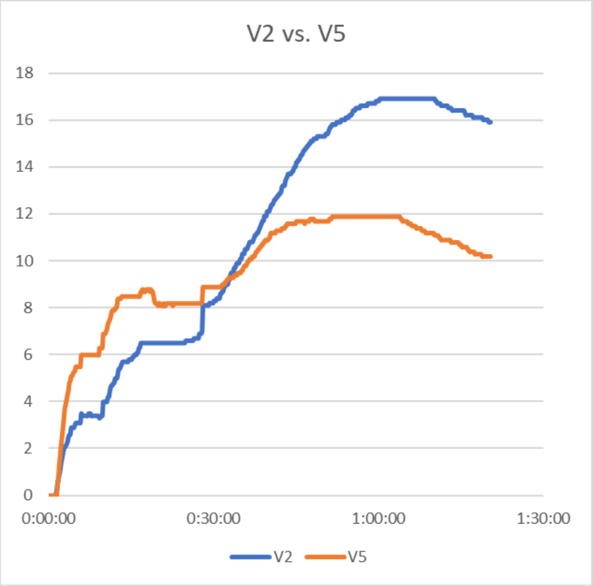


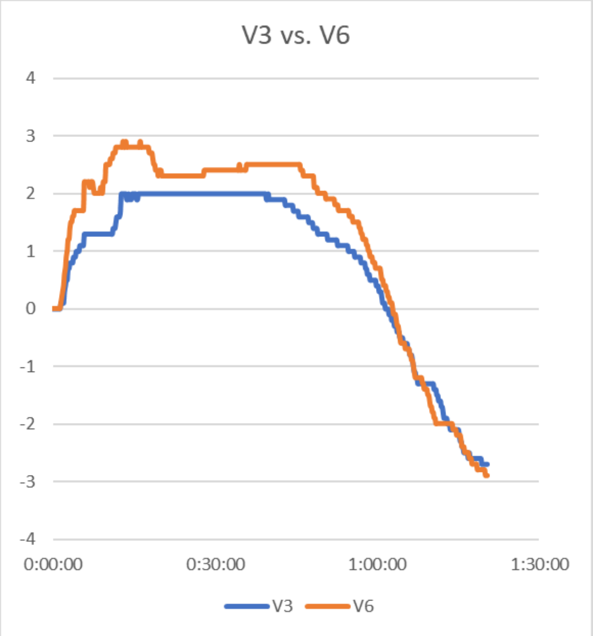
Time (h:min:s)	Deflection (mm) V1	V2	V3	V4	V5	V6	V7
0:00:00	0	0	0	0	0	0	0
0:05:00	15	3	1	19	6	2	0
0:10:00	26	4	1	32	7	3	6
0:15:00	96	6	2	147	9	3	7
0:20:00	489	7	2	537	8	2	69
0:25:00	536	7	2	579	8	2	81
0:30:00	571	8	2	609	9	2	91
0:35:00	591	10	2	626	10	2	98
0:40:00	614	12	2	647	11	3	103
0:45:00	635	14	2	662	12	3	106
0:50:00	649	15	1	672	12	2	107
0:55:00	663	16	1	680	12	2	108
1:00:00	675	17	0	685	12	1	108
1:05:00	683	17	-1	687	12	-1	107
1:10:00	688	17	-1	689	11	-2	106
1:15:00	691	16	-2	691	11	-2	105
1:20:20	692	16	-3	691	10	-3	105

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




V1 vs. V4
800
700
600
500
400
300
200
100
0
0:00:00
0:30:00
1:00:00
1:30:00
V1
V4

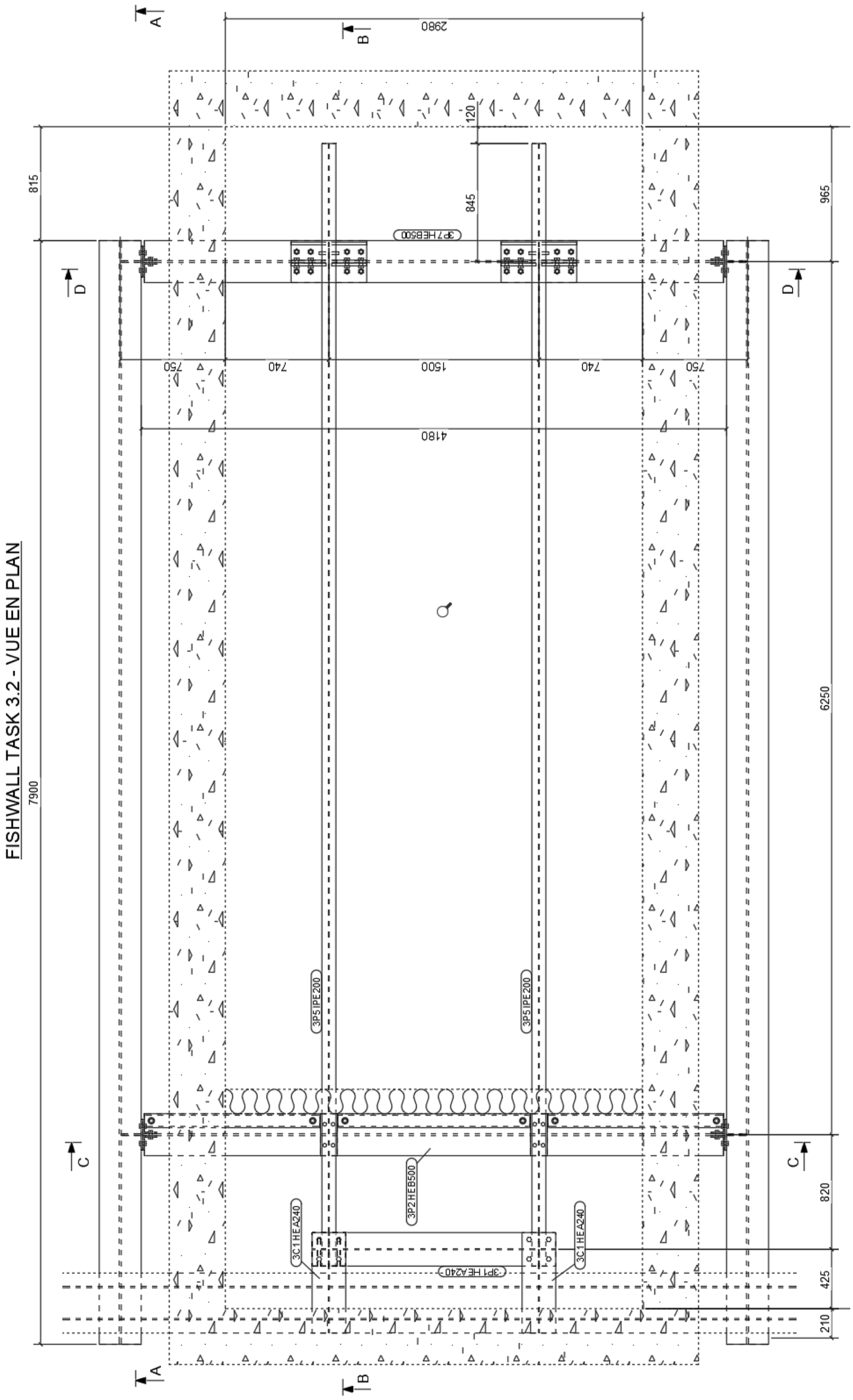

V2 vs. V5
18
16
14
12
10
8
6
4
2
0
0:00:00
0:30:00
1:00:00
1:30:00
V2
V5

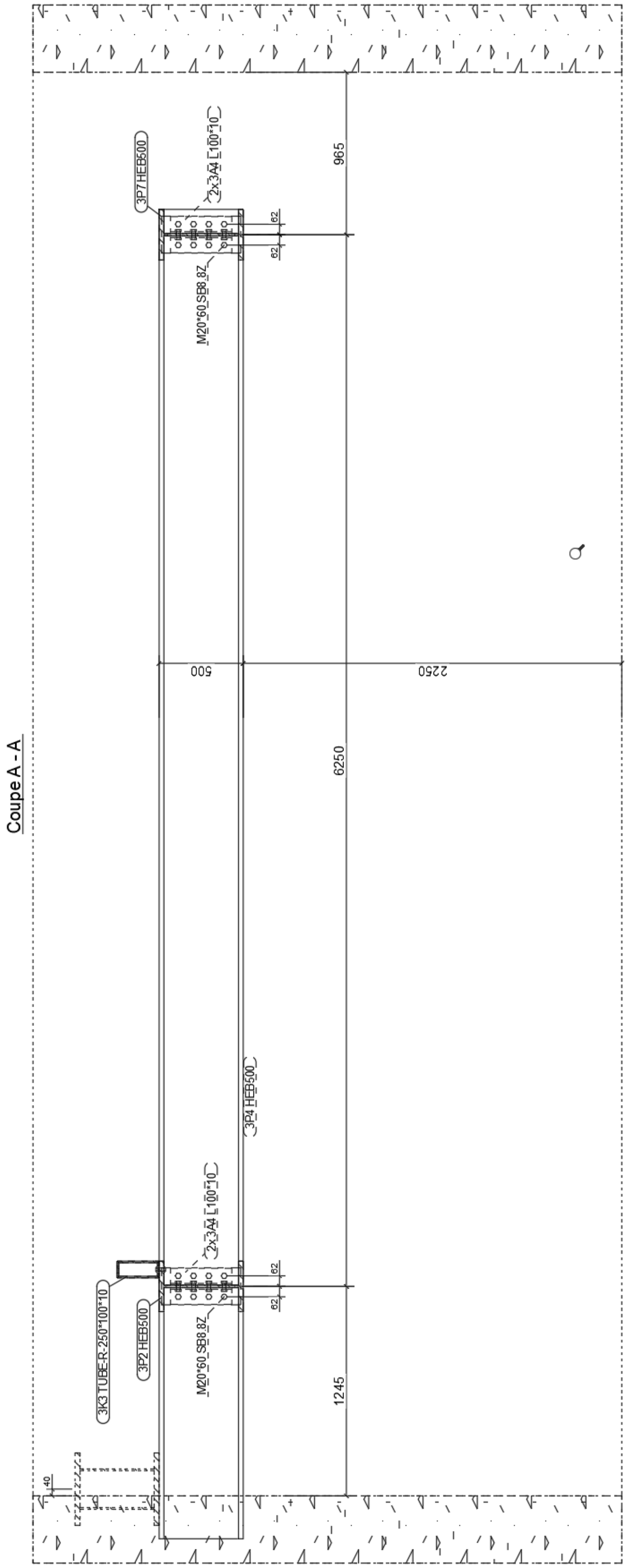

V3 vs. V6
4
3
2
1
0
-1
-2
-3
-4
0:00:00
0:30:00
1:00:00
1:30:00
V3
V6

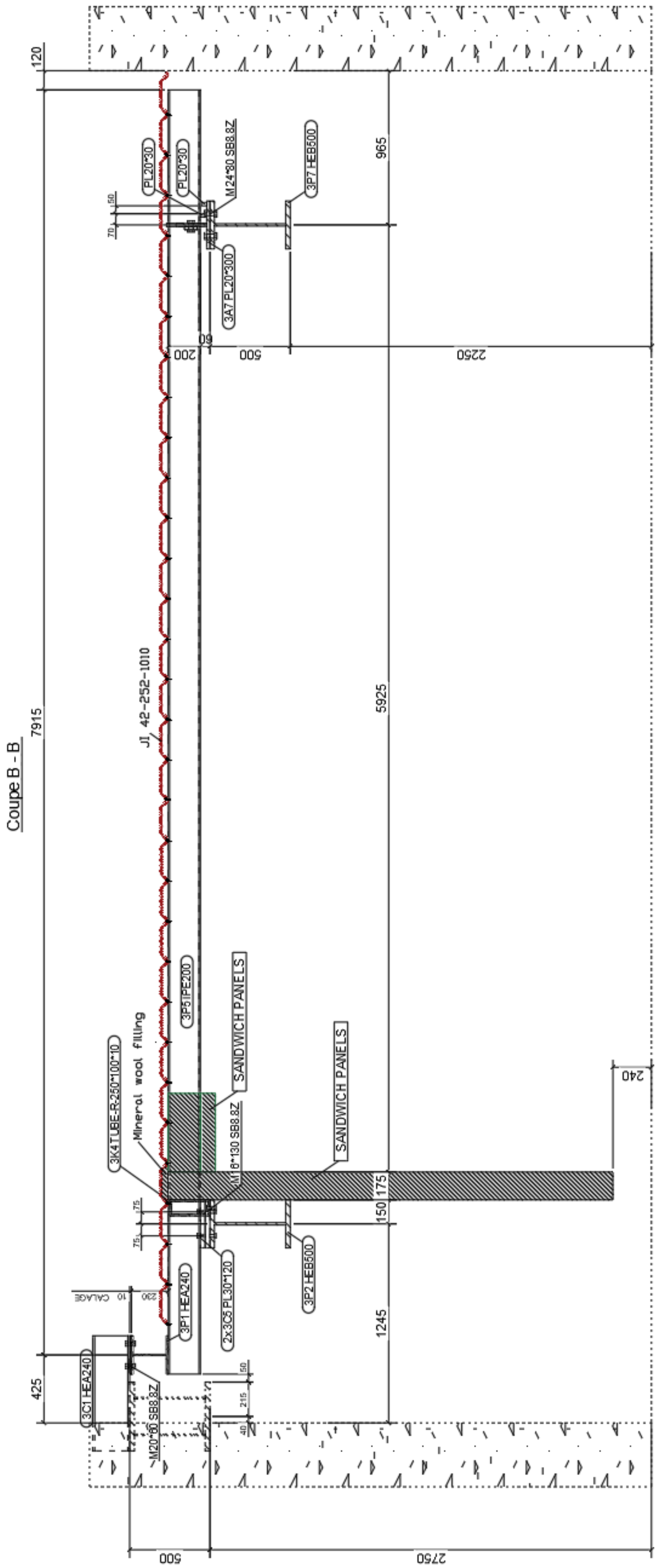
ANNEX C: DOCUMENTATION

Specimen-related documentation delivered by the test sponsor.

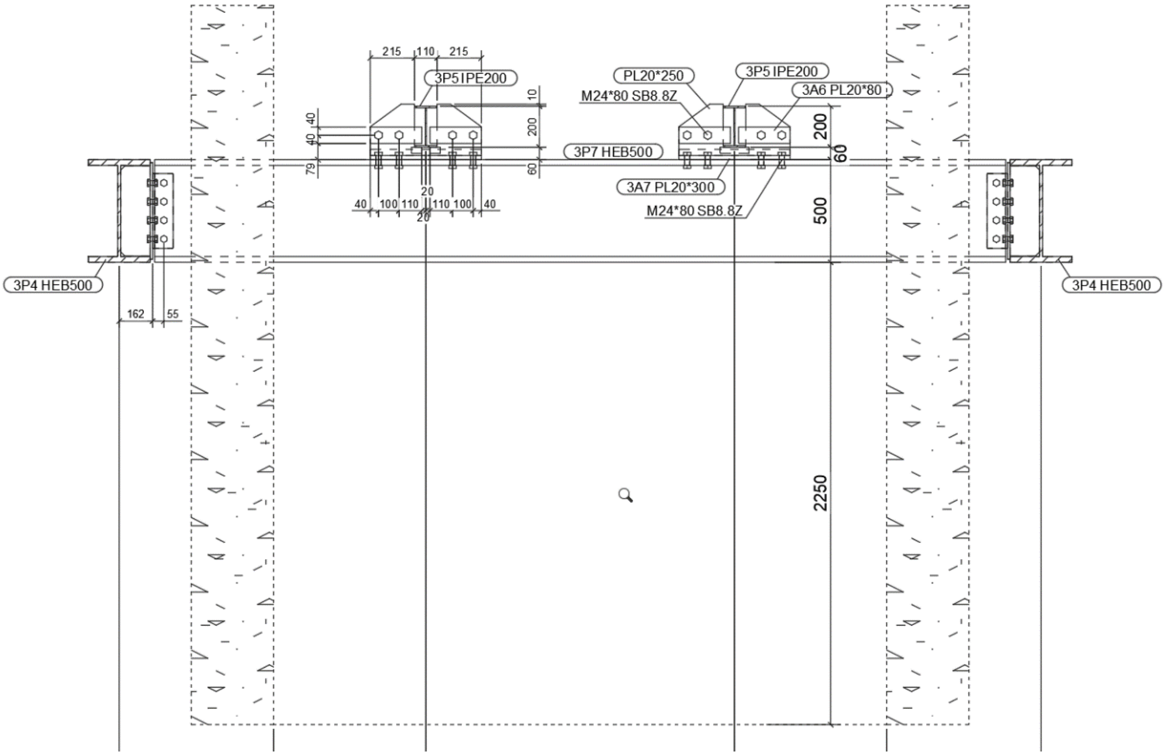
Drawings ot test specimen



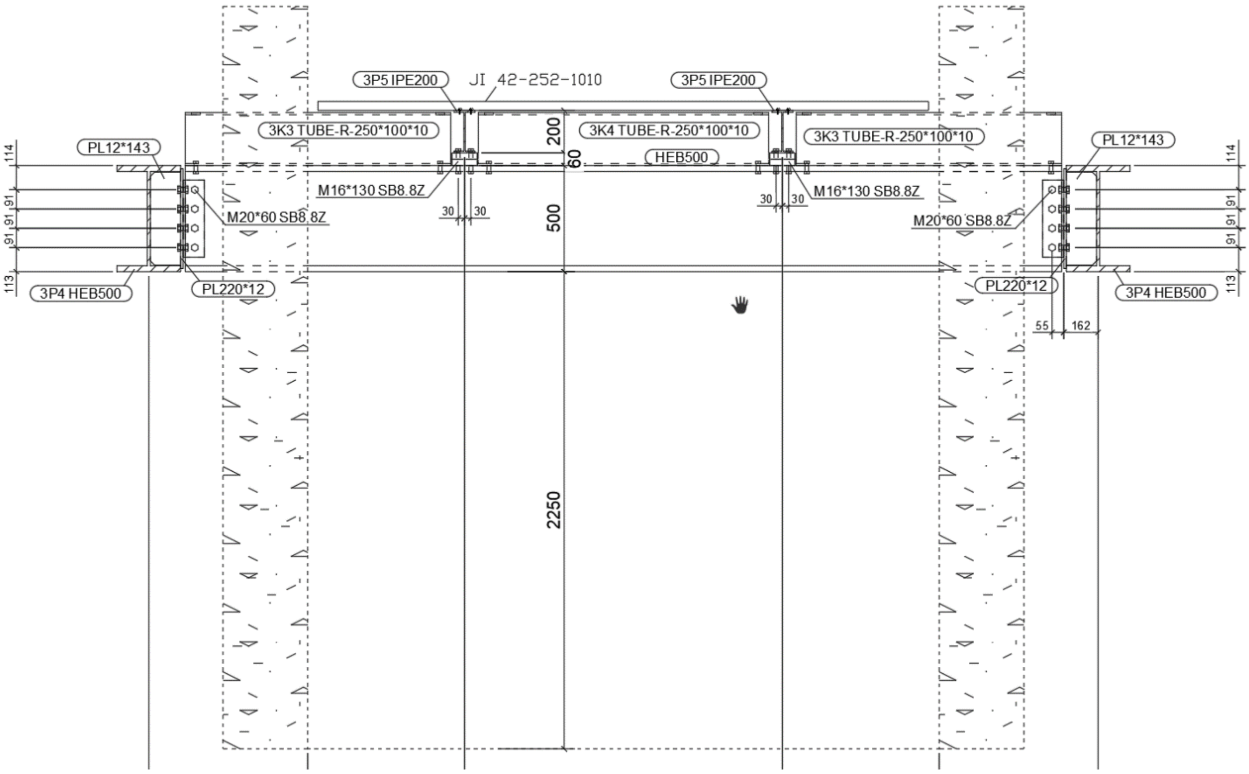

Coupe A - A
3P7 HEB500
2x3A4 L100*10
M20*60 SB8.8Z
965
62
62
500
2250
6250
3P4 HEB500
2x3A4 L100*10
62
62
3K3 TUBE-R-250*100*10
3P2 HEB500
M20*60 SB8.8Z
1245
40


Coupe B - B
7915
120
425
PL20*30
PL20*30
M24*30 SB8.8Z
3P7 HEB500
965
3A7 PL20*300
60
200
500
2250
JI 42-252-1010
5925
3P5 IPE200
SANDWICH PANELS
SANDWICH PANELS
3K4 TUBE-R-250*100*10
Mineral wool filling
M16*130 SB8.8Z
150
175
240
3P2 HEB500
2x3C5 PL30*120
3P1 HEA240
3C1 HEA240
M20*60 SB8.8Z
CALAGE
1245
500
2750

Coupe D - D



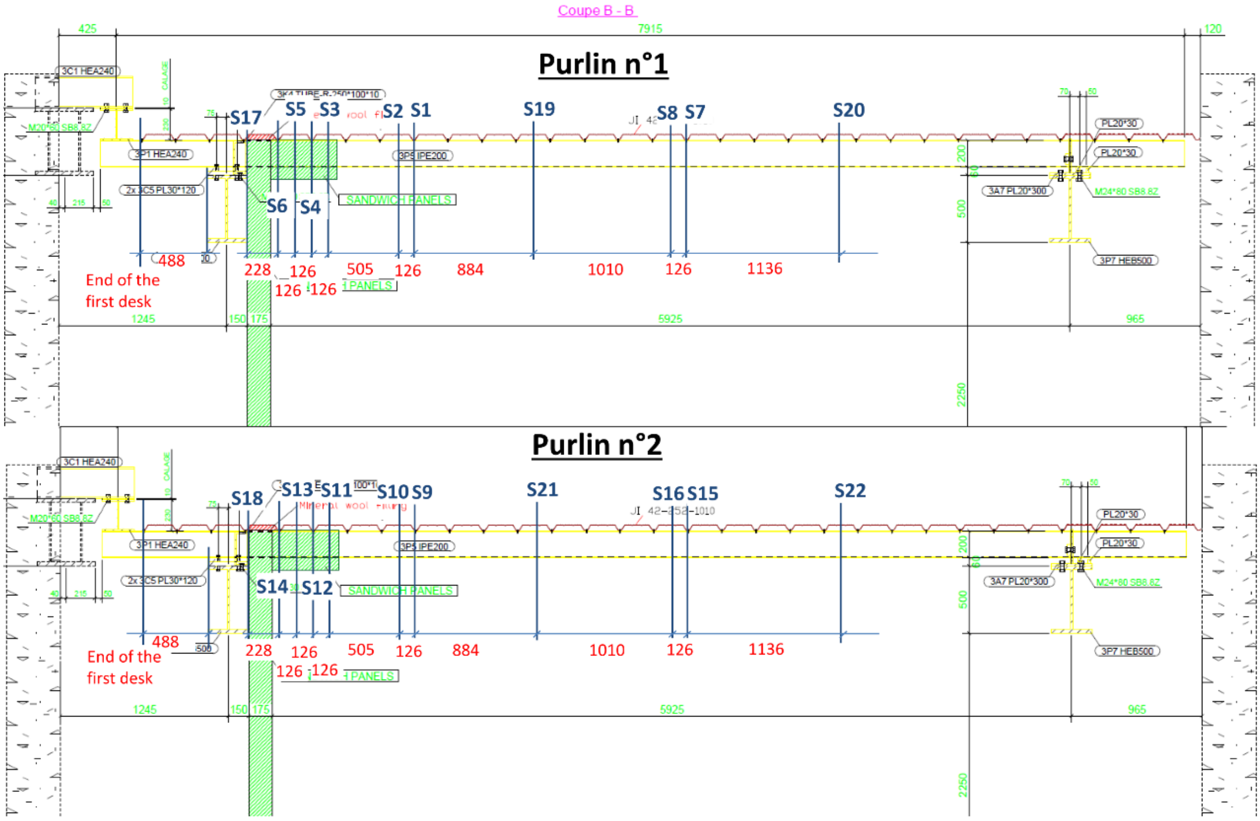
Coupe C - C



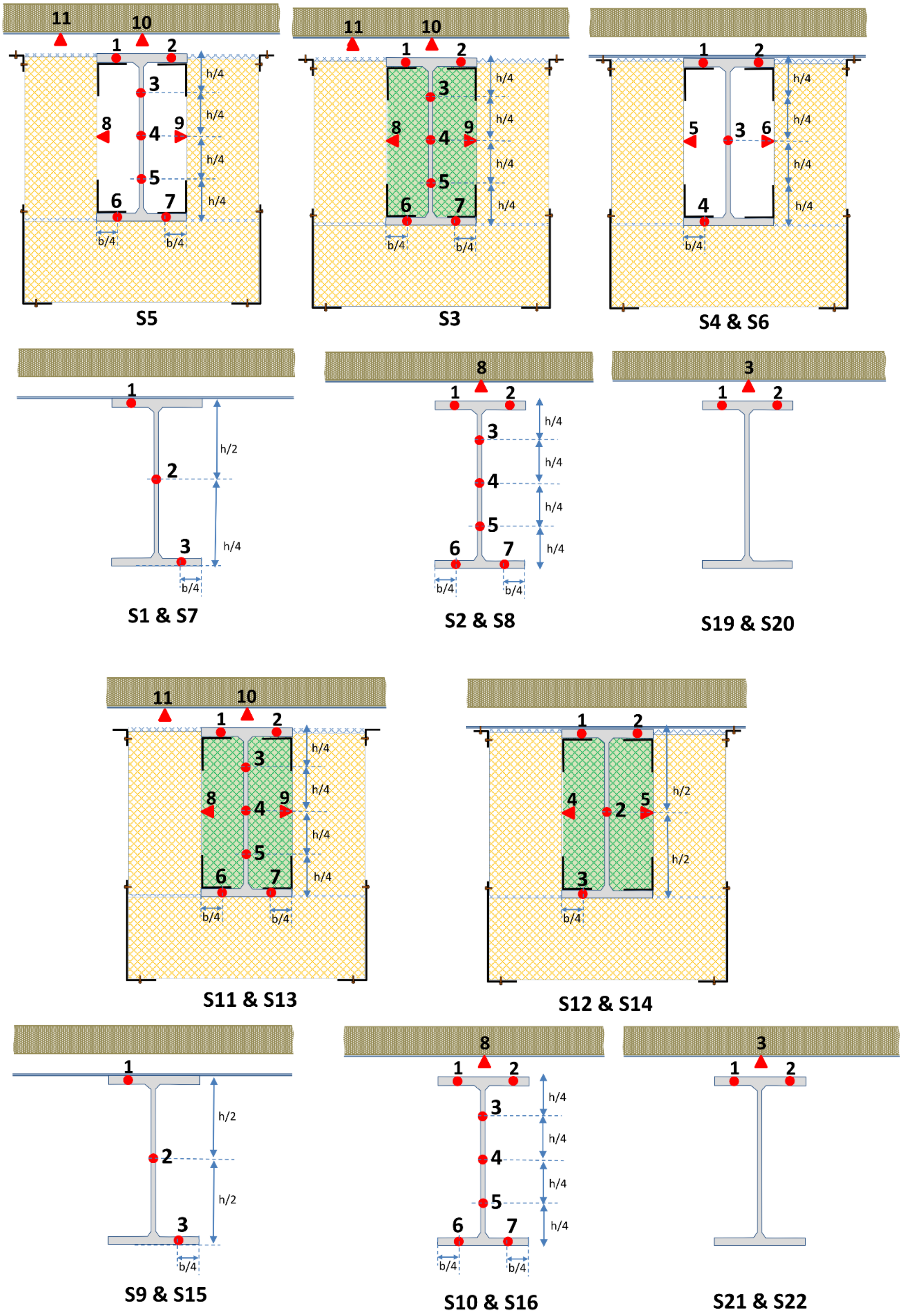
LOCATIONS OF THERMOUCOUPLES

Location of the measuring cross-sections along the purlins

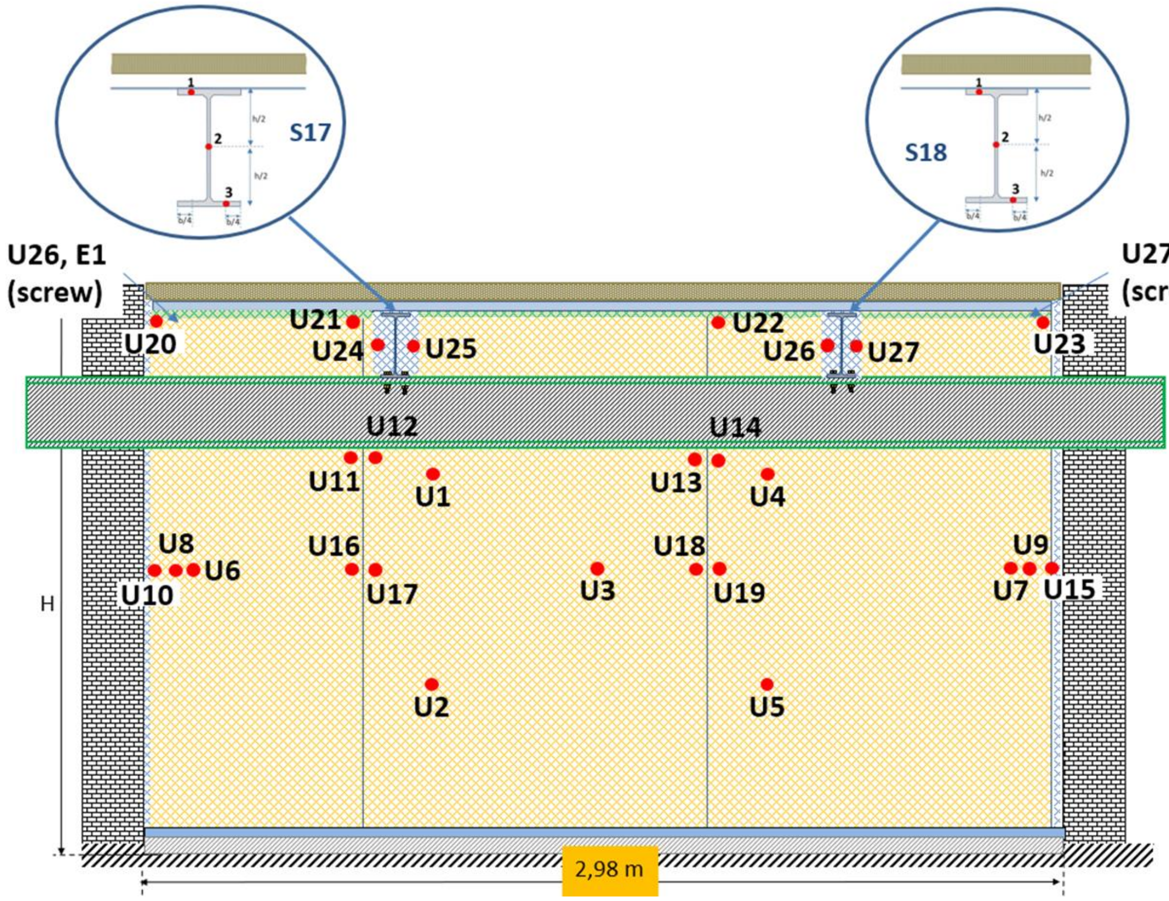
Location of the measuring cross-sections



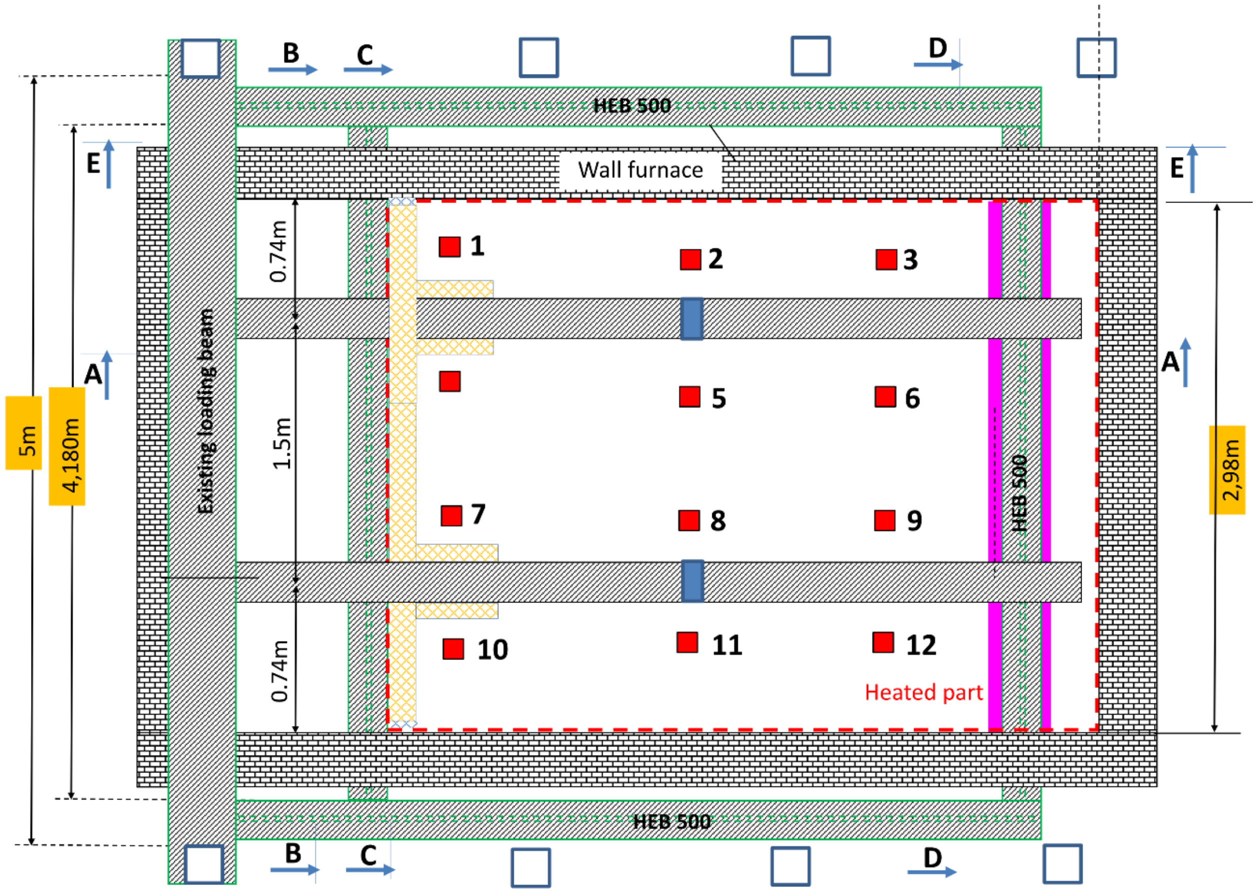
Location of measuring points in cross-sections

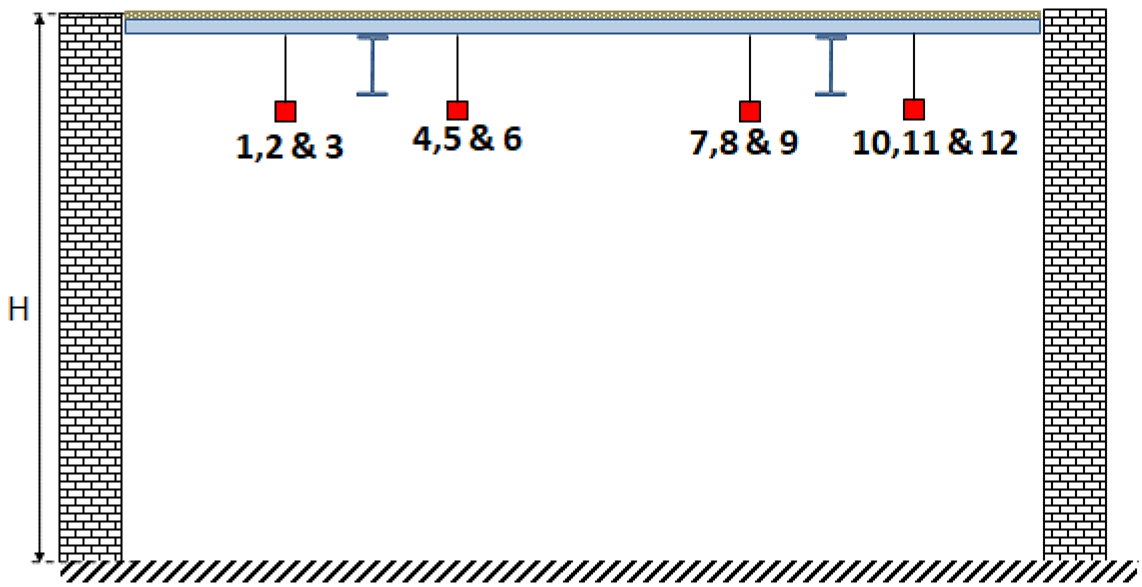


Location of thermocouples on the fire-unexposed side of the wall

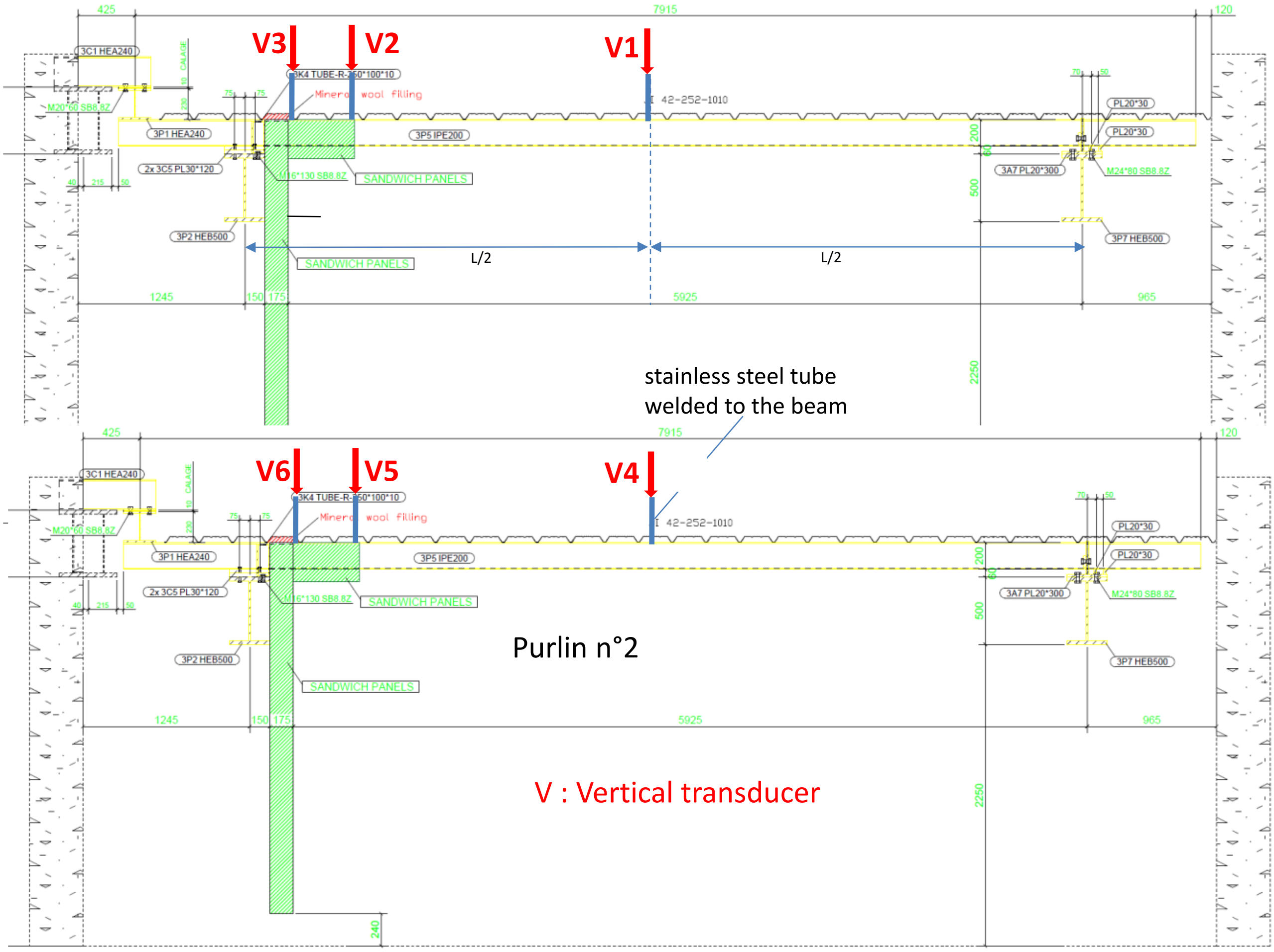


LOCATIONS OF PLATETHERMOTERS INSIDE THE FURNACE



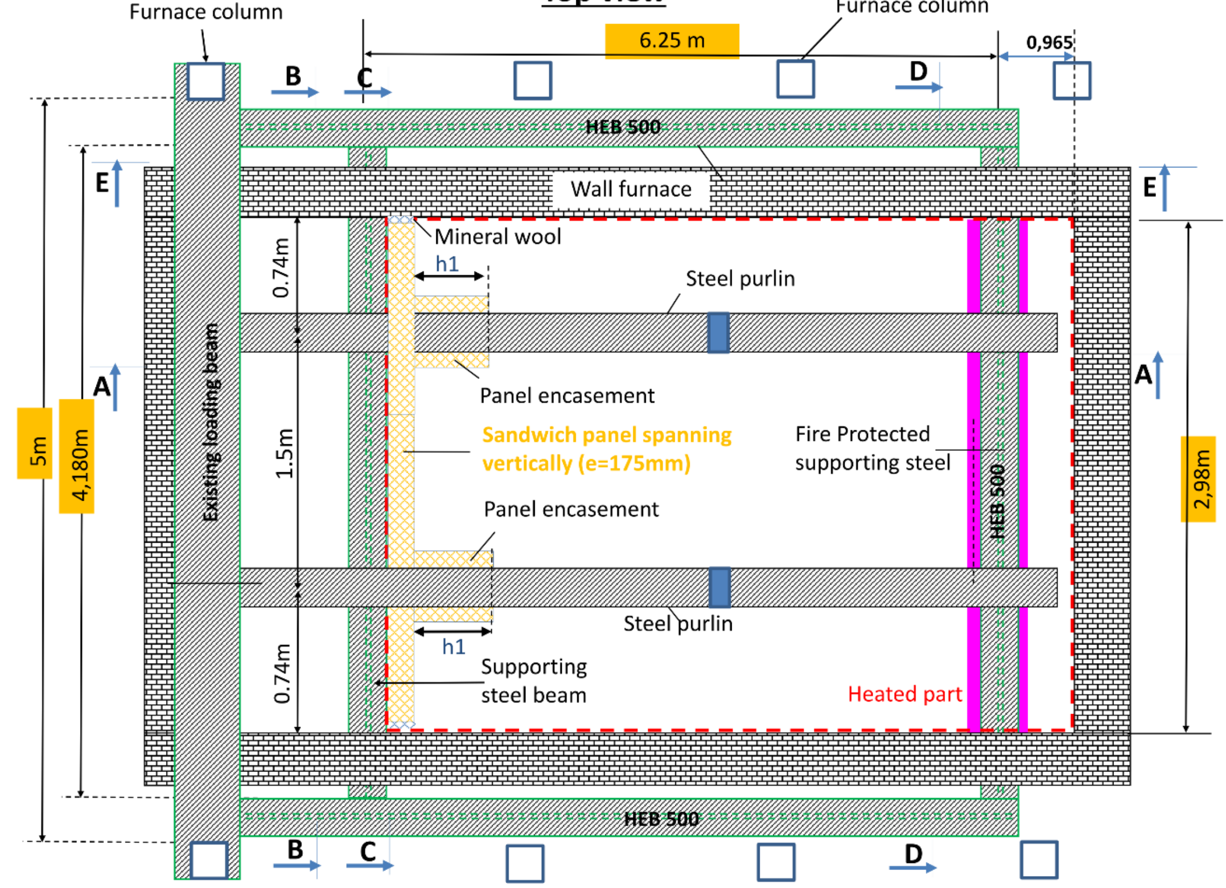


LOCATIONS OF DISPLACEMENT MEASUREMENTS

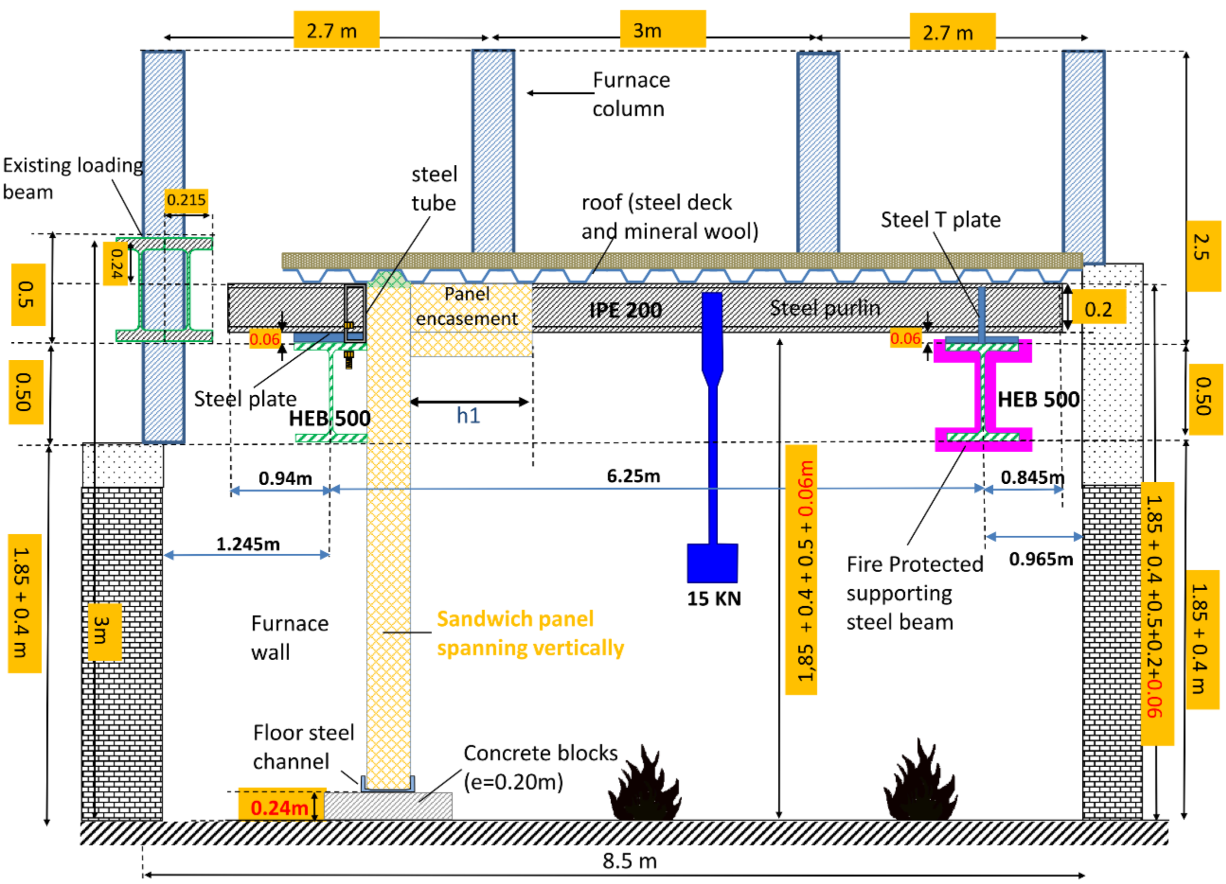


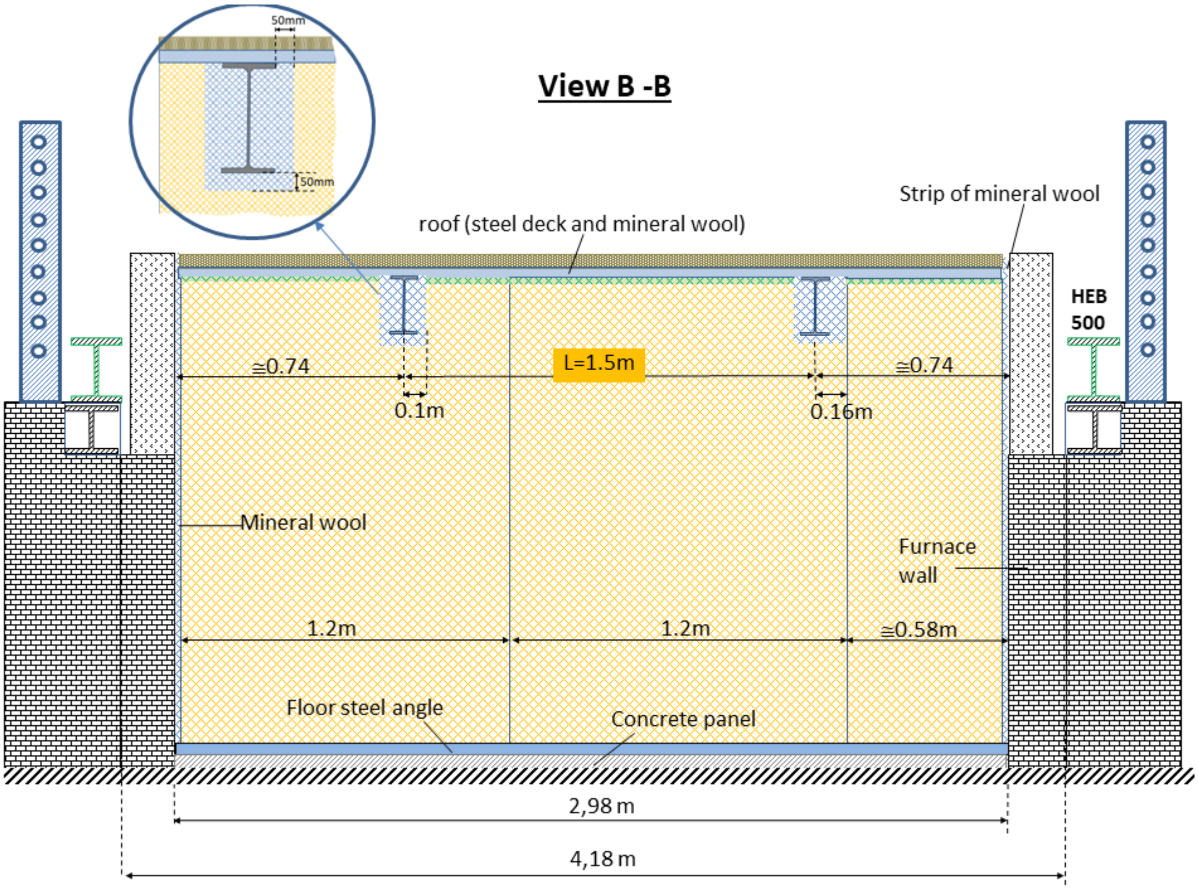
SCHEMATICS OF THE TEST SPECIMEN

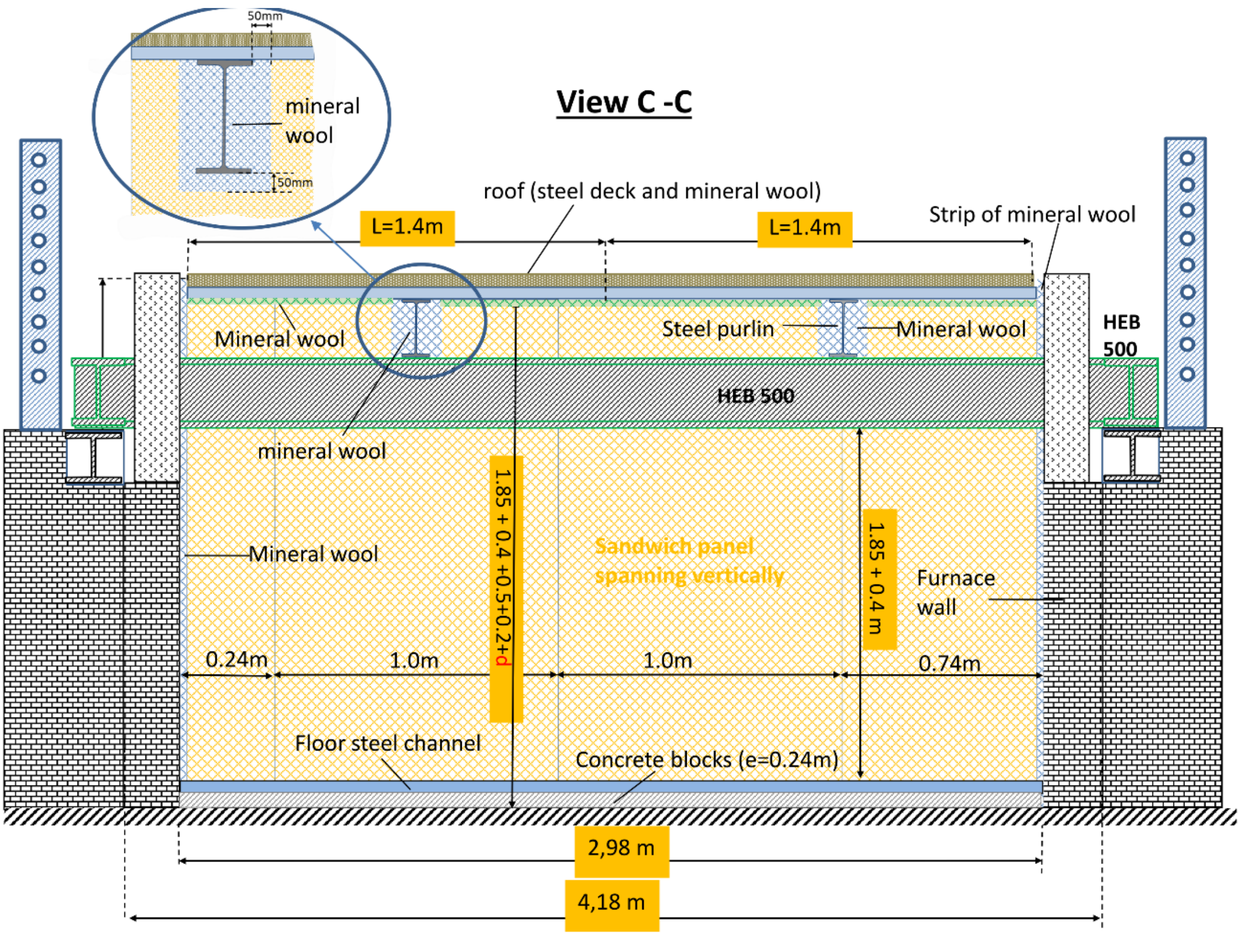
Top view



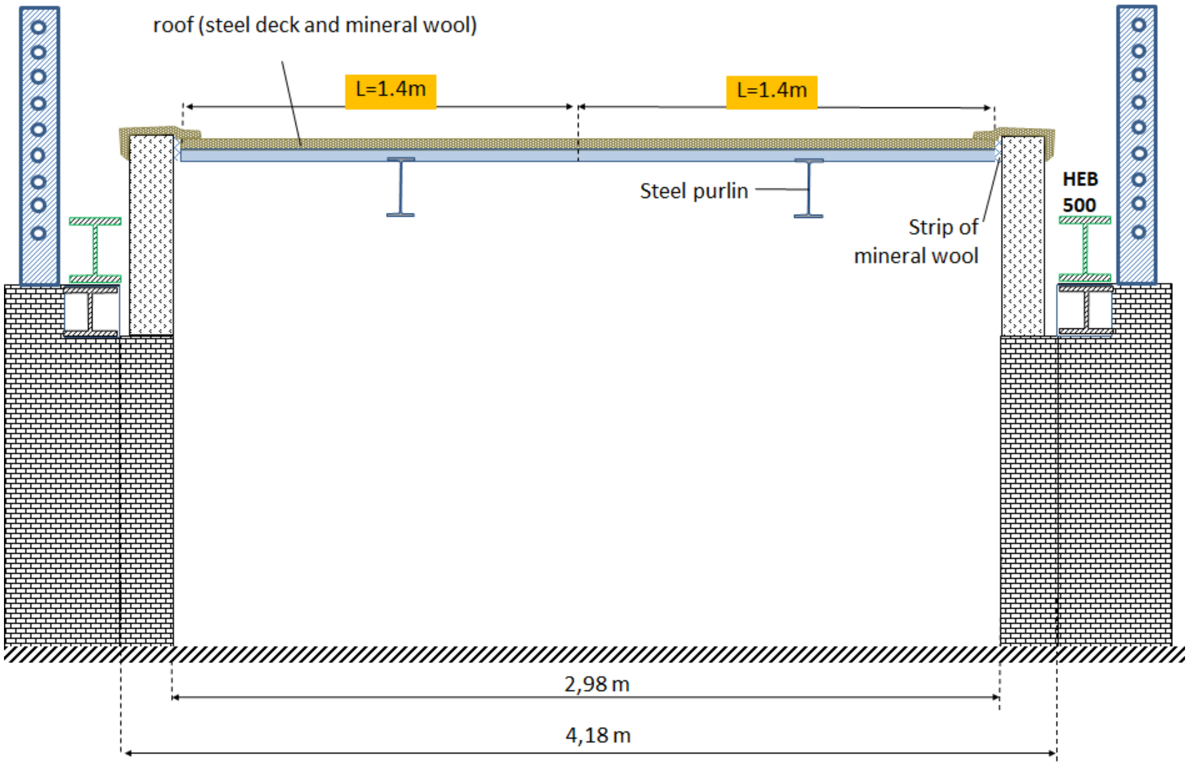
View A -A



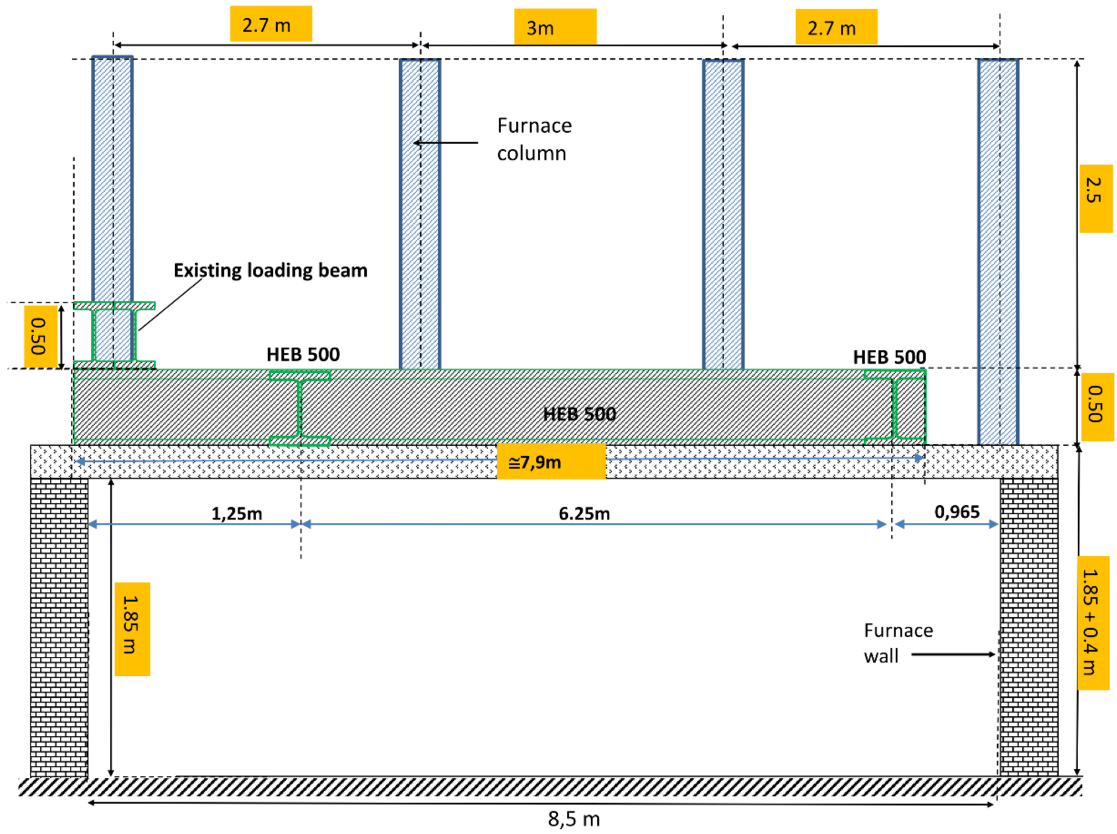

View B -B
50mm
50mm
roof (steel deck and mineral wool)
Strip of mineral wool
HEB
500
≅0.74
L=1.5m
≅0.74
0.1m
0.16m
Mineral wool
Furnace
wall
1.2m
1.2m
≅0.58m
Floor steel angle
Concrete panel
2,98 m
4,18 m


View C -C
50mm
mineral
wool
50mm
roof (steel deck and mineral wool)
L=1.4m
L=1.4m
Strip of mineral wool
Mineral wool
Steel purlin
Mineral wool
HEB
500
HEB 500
mineral wool
Mineral wool
1.85 + 0.4 +0.5+0.2+d
Sandwich panel
spanning vertically
1.85 + 0.4 m
Furnace
wall
0.24m
1.0m
1.0m
0.74m
Floor steel channel
Concrete blocks (e=0.24m)
2,98 m
4,18 m

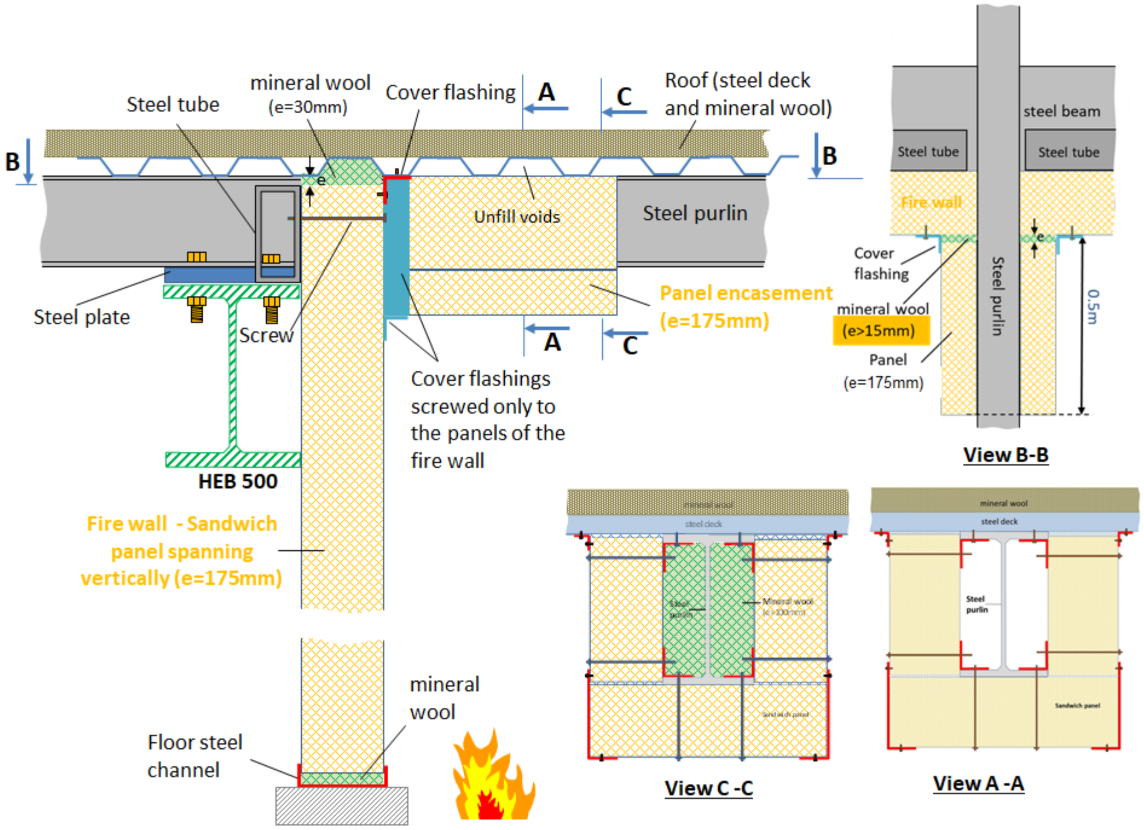
View D -D



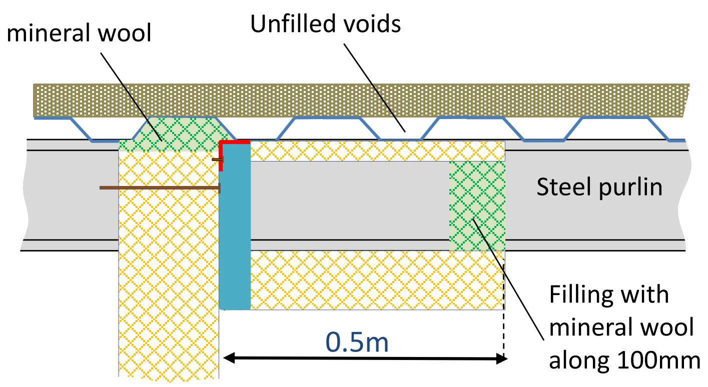
Side view E -E



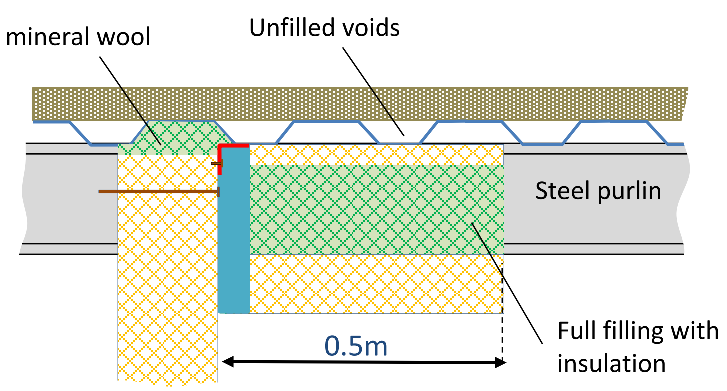
CONSTRUCTIONAL DETAILS

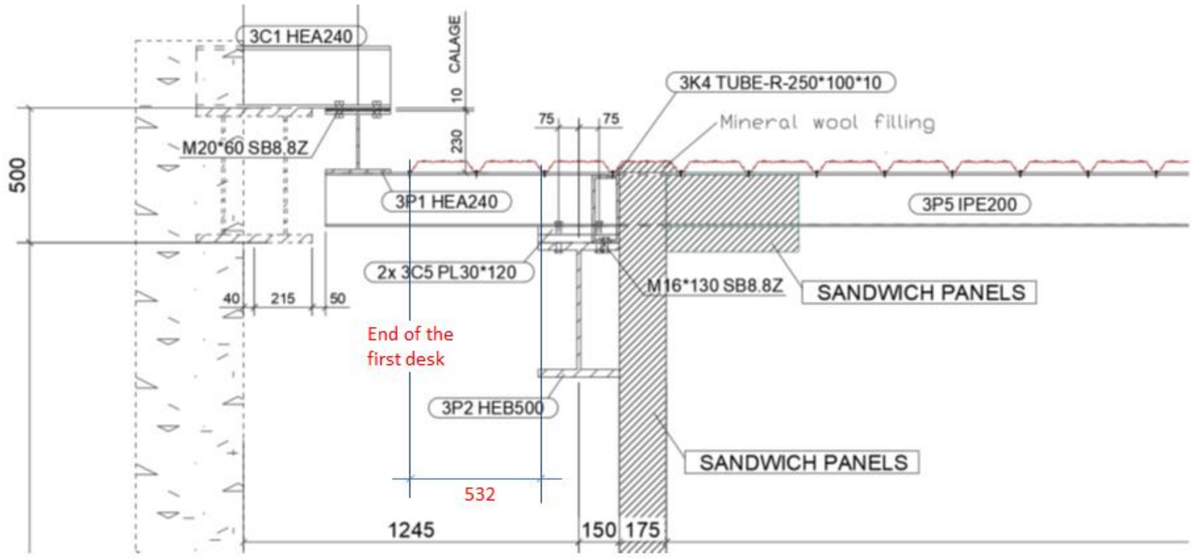


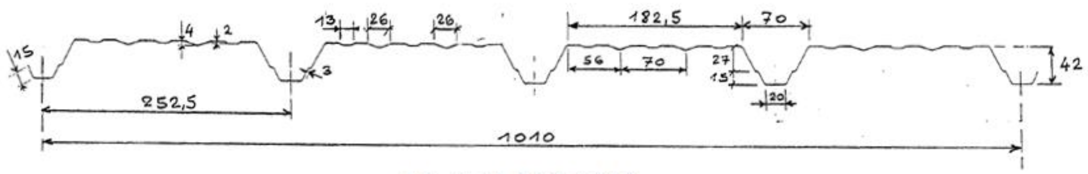
DETAILS ENCASMENT PURLIN n°1



DETAILS ENCASMENT PURLIN n°2







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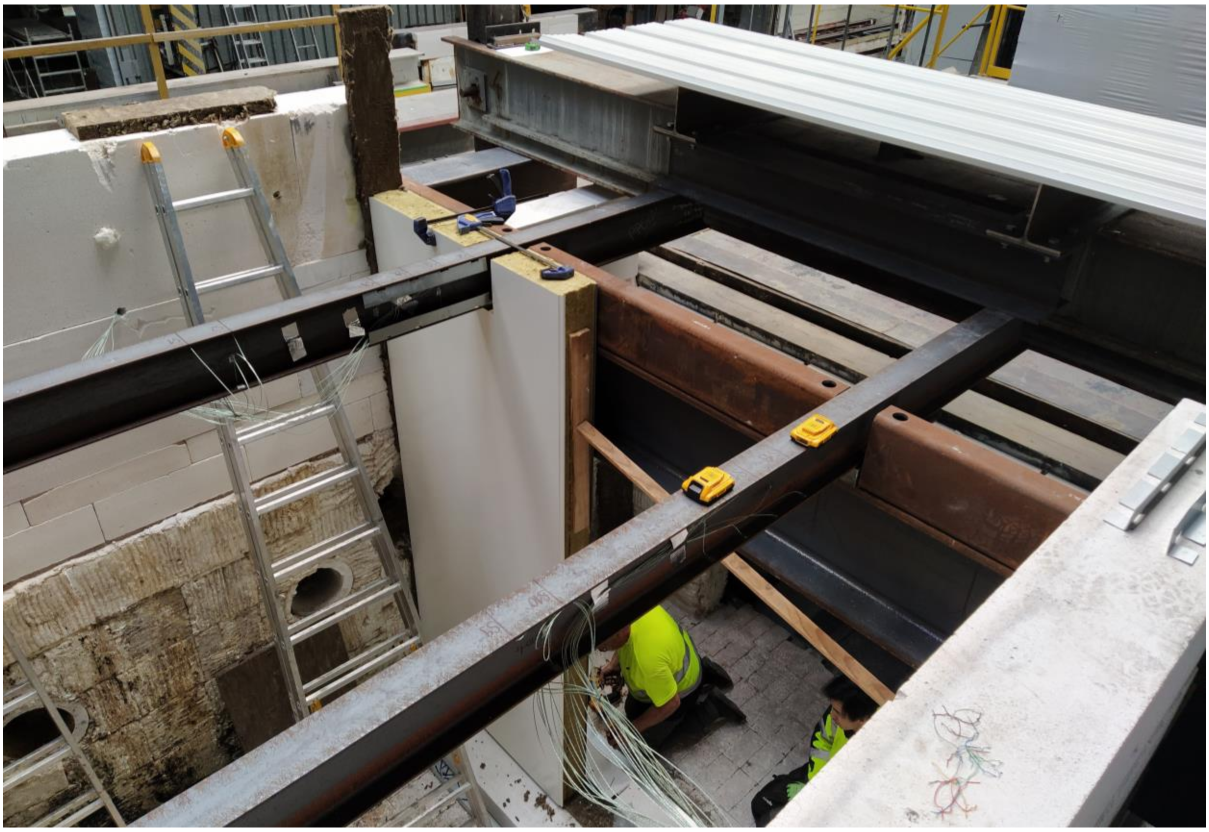
ANNEX D: PHOTOS

Assembly of the steel structure



Assembly of the wall

Detail of the encasements

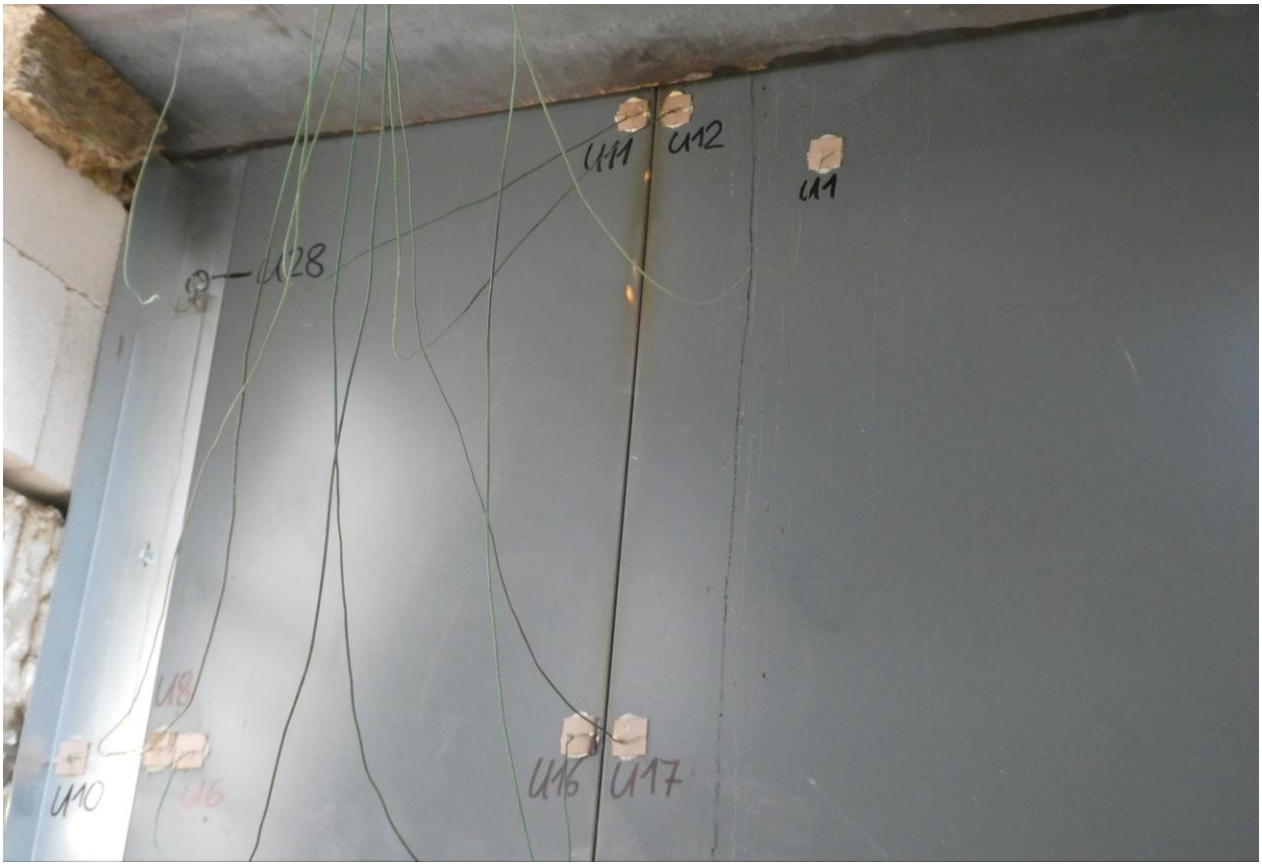
Application of the load and assembly of the roof

EF before the test

UF before the test

EF after 23 minutes of the test

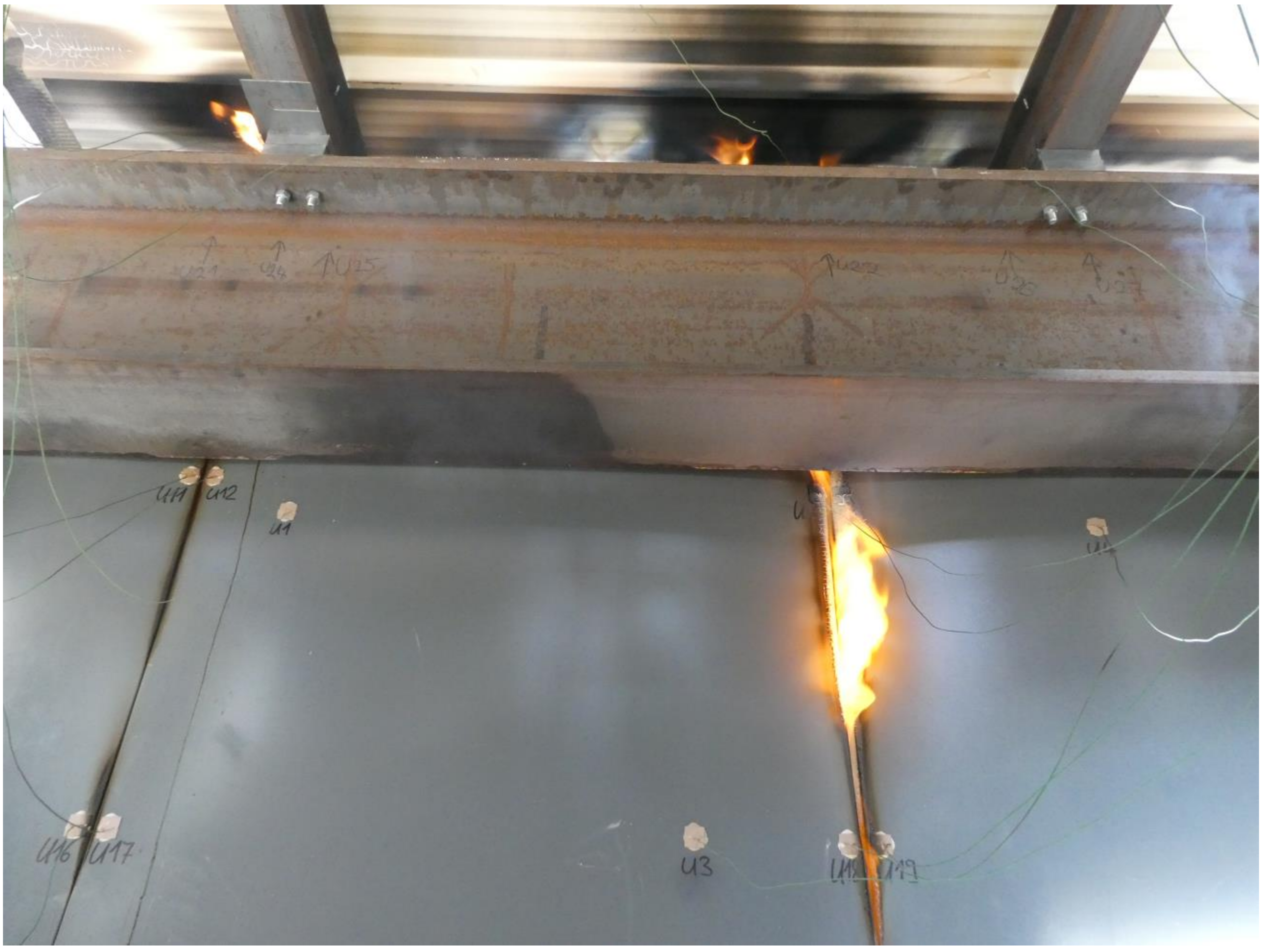
UF after 27 minutes of the test



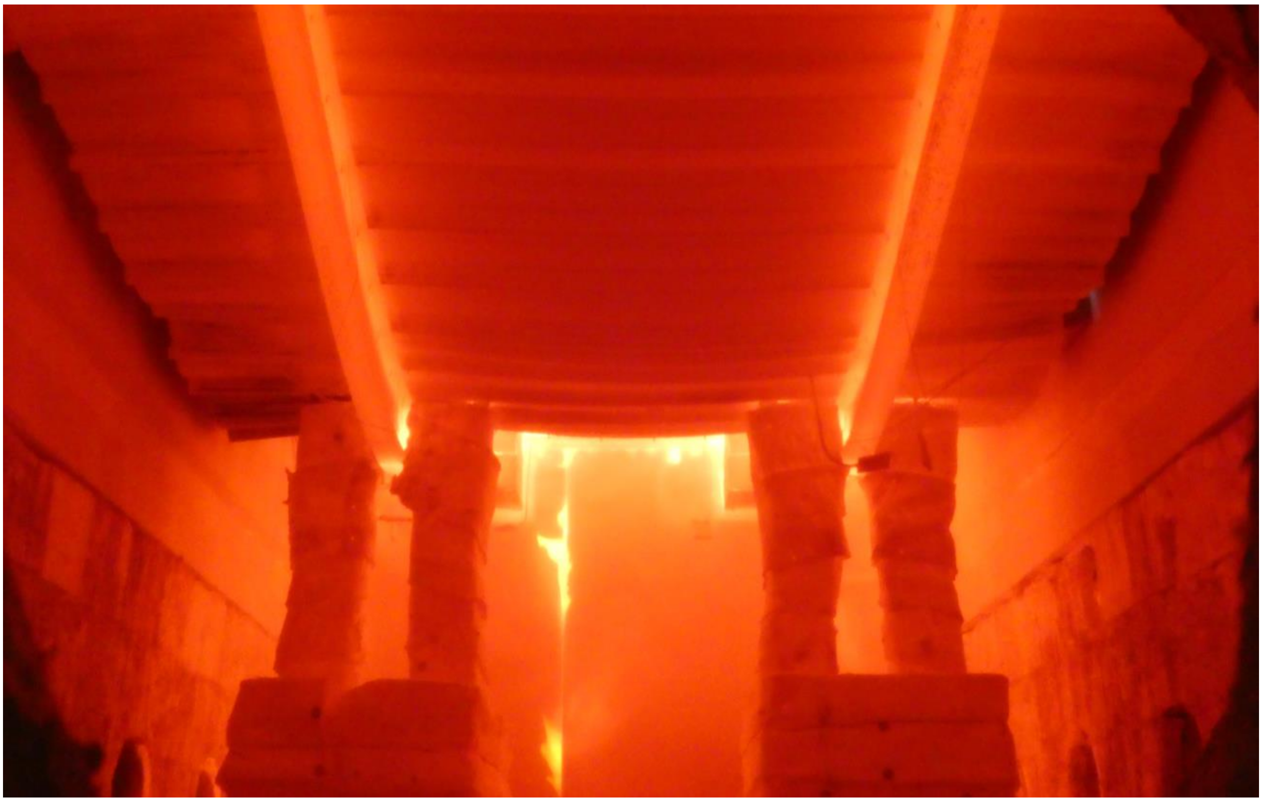
UF in 40th minute of the test - small flames from the vertical joint between sandwich panels

UF after 45 minutes of the test

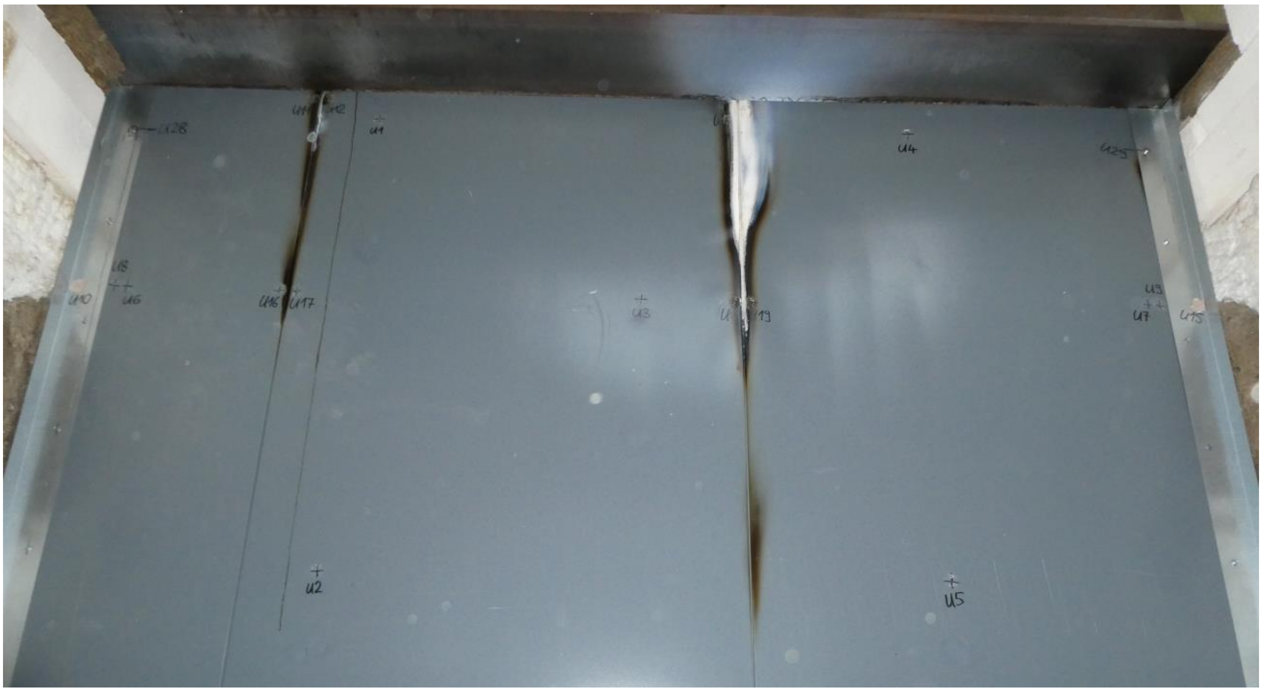
Ignition of the cotton pad and sustained flaming in 58th minute of the test



Continuos flaming of the specimen in 70th minute of the test



EF after 80 minutes of the test and turn off the burners



UF the second day after the test

EF the second day after the test