

# TEST REPORT LOADBEARING WALL

<b>Name of sponsor:</b>	Wood:UpHigh		
<b>Product name:</b>	Loadbearing wall		
<b>File no.:</b>	PGA12233A	<b>Revision no.:</b>	1
<b>Test date:</b>	2023-01-11	<b>Date:</b>	12-07-2023
<b>Pages:</b>	11	<b>Encl.:</b>	55
<b>Ref:</b>	JBK / CHB		

## Client information

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Client: Wood:UpHigh  
Address: Jernholmen 12  
2650 Hvidovre  
Denmark

The test is part of the project Wood:UpHigh. The project is partly sponsored by Uddannelses- og Forskningsstyrelsen through DBI's performance contract, Realdania and Grundejernes Investeringsfond. The project is headed by DBI, except for the construction of test specimens for the fire tests, which is headed by LOGIK&CO.

The results relate only to the items tested. The report should only be reproduced in extenso - in extracts only with a written agreement with this institute.

Revision chronology				
Rev. no.	Date	Description	Author	Approved
0	21-06-2023		JBK	CHB
1	12-07-2023	Changed description of materials in tables and graphs to more generic.	JBK	CHB

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## 1 Date of test

The test was conducted on 2023-01-11

## 2 Purpose of test

The test specimen has been subjected to a standard fire test in accordance with the following standards:

DS/EN 1363-1:2020 Fire resistance tests – General requirements

in conjunction with

EN 1365-1:2012 Fire resistance tests for loadbearing elements — Part 1: Walls

## 3 Test specimen

The trade name and sponsors identification mark are stated below:

Trade name: None

Identification mark: None

The components for the test specimen were delivered and mounted by LOGIK&CO.

## 4 Drawings and description

Details of the construction are shown in the enclosed documentation as stated below:

Type	Drawing No.	Dated	Subject
Drawing	01	08/05/21	Snit ydervæg
Drawing	02	08/02/21	Skelet + indvendig
Drawing	03	08/02/21	Udvendig
Drawing	04	08/02/21	Indvendig
Drawing	05	08/05/21	Udvendig

The documentation is supplied by DBI - Danish Institute of Fire and Security Technology

### Description

The test specimen consisted of the components described in the following. DBI inspected the components during mounting, the test and after the test.

LOGIK&CO carried out the selection of the products for the test specimen as well as the mounting.

#### Test specimen

External measures:	Height: 3000 mm	Width: 2930 mm	Thickness: 311 mm
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The construction consisted of a straw insulated loadbearing wooden element. On one side a layer of wooden fiber board and a fiber gypsum board was added. On the other side a vapor barrier was fixed and made tight with fillets.

The test specimen was asymmetrical.

**Straw elements** The elements are produced by [REDACTED] and 5 standard elements were used. 4 elements of 3000x600x300 mm and 3000x530x300 mm (height x width x depth).

**Straw** Straw insulation made with multidirectional press technology. The straw is a byproduct of wheat production.

The nominal density of the straw is 110 kg/m<sup>3</sup>. The total weight of a 600 mm wide straw elements was 85.2 kg.

**Load bearing studs:** A total of 5 load bearing elements were used in the wall construction, all 3000 mm tall. Each element had a load-bearing twin stud frame. The studs are 44 x 93 mm dry graded C24 construction spruce wood with a nominal density of 450 kg/m<sup>3</sup>. 4 studs were placed in each corner of the element.

The elements were fixed to each other with 8 x 100 mm screws designated [REDACTED]. The c/c distance between the screws were 500 mm. At the top and bottom of the frames 2 wooden dowels were placed.

Due to the construction of the elements, it was not possible to keep the loadbearing studs away from the DBI-frame edges to avoid edge effects.

See sponsor drawing no. 2 and photo no. 1-3.

Travers beams	Along the front and back side of the element a 44 x 93 mm dry graded C24 construction spruce wood beam with a nominal density of 450 kg/m <sup>3</sup> was placed at the top and the bottom. These were fixed to the loadbearing studs with one screw in top and bottom to create a front frame and a back frame.
Bottom and top plate	<p>A top and bottom plywood board with the thickness of 12 mm were cut to size of the element. The front and back frame were fixed to the top and bottom plate along the edge.</p> <p>Two counter sunk screws were used in each loadbearing stud 2 [REDACTED] 8,0 X 160 mm and three screws were fixed into the travers beams on the frames.</p>
Spacers	44 x 44 mm spruce wood with a nominal density of 450 kg/m <sup>3</sup> . The spacers were placed with c/c 1000 mm in the height of the element and ensured a higher stability between the front and back frame.
<b>Inner layers (exposed side)</b>	A 22 mm thick wood fiber board, designated [REDACTED] (nominal density 220 kg/m <sup>3</sup> , EN 13171) was mounted on the exposed side to the straw elements with 2.8 x 75 mm screws, designated [REDACTED]. For each stud behind the board two screws were fixed, for the maximum dimension 10 nails were used. A full-size wood fiber board had the dimensions of 750 x 2500 mm with the tongue and groove. The vertical board joints were backed by the wooden studs.
Wood fiber board	See sponsor drawing no. 2 and photo no. 6.
Fibre gypsum boards	<p>Two layers of 12.5 mm thick gypsum fibre boards designated [REDACTED] (type EN 15283-2, ETA-03/0050) with a nominal density of 1150 kg/m<sup>3</sup> were fixed with designated [REDACTED] 30 mm at a c/c of 200 mm. The staples were fixed 10 mm from the board edges and 50 mm from the board corners. A full-size board measured 900 x 1200 mm.</p> <p>Approximately 2 mm thick layer of spackle was applied to the joints on the gypsum boards. The designated spackle was [REDACTED].</p> <p>See sponsor drawing no. 4 and photos no. 9 - 10.</p>
<b>Outer layers (unexposed side)</b>	Sarking and roofing felt with monolithic TEEE-Membrane were fixed to the unexposed side of the straw elements with staples. The felt was designated [REDACTED]. The felt consisted of 3 layers and was highly diffusion open $s_d = 0.05$ m and $g$ -value = 0.25 MNs/g.
Wood spacers	18 x 46 mm pine wood spacers (nominal density 450 kg/m <sup>3</sup> ) were fixed to exposed side on the wood fibre board and the load bearing studs with 2.8 x 75 mm strip nails, designated [REDACTED] at c/c of 200 mm. See sponsor drawing no. 5.

### Measured by DBI

Product		[REDACTED] Fiber gypsum	Wood fiber board [REDACTED]	Wood spacers	Construction wood
Moisture content	%	0.9	7.0	6.5	11.1
Sampling method		Extra material	Extra material	Extra material	Extra material
Drying temperature	°C	55	55	105	105

## 5 Test conditions

### Conditioning

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The test specimen was delivered on the 09-01-2023 to the DBI laboratory and stored under room temperature. On the day of the fire testing the condition of the test specimen was similar with respect to its moisture content as the test specimen would be in normal service.

### Mounting

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The test specimen was mounted simple supported in a test frame suitable for loaded tests with a clear opening of 3000 x 3000 mm.

Free edge was established along both vertical edges of the test specimen (2 x 25 mm stone wool with alu-foil in each side) to allow for unrestrained deformation of the test specimen.

### Loading

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The test specimen was loaded with a total applied load of 10 kN per loadbearing stud or 34,1 kN/m with element width of 600 mm during the test, corresponding to a total load of 100 kN (10189 kg).

The load was applied centrally on the horizontal top beam, e.g. there was no eccentricity in the loading conditions.

The loading conditions correspond to example d) in figure 1 in EN 1365-1:2012. The figure describes the load transfer system at head with loading from above. The wall was simple supported at the bottom.

The load was applied in 10 steps prior to the fire test. The fire test was commenced approx. 30 minutes after reaching the final load on the test specimen.

### Fire test

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Observations were made during the test on the general behavior of the test specimen.

Temperature observations were taken continually during the entire testing time.

The surface temperatures were measured on the unexposed surface of the test specimen as indicated on DBI drawing no. 1.0.

The furnace temperature was determined by means of plate thermocouples uniformly distributed at a distance of approximately 100 mm from the exposed side of the test specimen. The furnace temperature was continuously controlled so as to follow the standard time temperature curve within the accuracy specified in EN 1363-1:2020.

The thermocouples were constructed according to the description in EN 1363-1:2020.

The pressure was controlled at 20 Pa in the top of the wall.

## 6 Test results

Duration of the test was 114 minutes.

## Measurements

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The enclosed graphs and tables show:

Enclosures 2.0 and 2.1	<b>Furnace temperatures</b> The actual minimum-, average- and maximum furnace temperature in relation to the standard temperature. The table also shows the area under the actual time-temperature curve as well as the area under the standard time-temperature curve
Enclosures 3.0 and 3.1	<b>Vertical furnace pressure</b> The differential pressure in the furnace during the test, measured 1,16 m above notional floor level
Enclosures 4.0 and 4.1	<b>Ambient temperature</b> The ambient temperature in the laboratory during the test
Enclosures 5.0 and 5.1	<b>Average temperature rise</b> Measured with 5 thermocouples on the unexposed side
Enclosures 6.0 and 6.1	<b>Maximum temperature rise</b> Maximum temperatures on the unexposed side
Enclosures 7.0 and 7.1	<b>Horizontal deformation</b> Negative values indicate movement towards the furnace
Enclosures 8.0 and 8.1	<b>Vertical deformation</b> Negative values indicate downwards movement
Enclosures 9.0 and 9.1	<b>Vertical deformation rate</b>
Enclosures 10.0 and 10.1	<b>Load per cylinder</b> Load per cylinder during test
Enclosures 11.0 and 11.1	<b>Internal temperature - between studs and windbreaker</b> 1 on second element, 2 on center element seen from unexposed side
Enclosures 12.0 and 12.1	<b>Internal temperature - Center of studs</b> 1 on second stud, 2 on center stud seen from unexposed side
Enclosures 13.0 and 13.1	<b>Internal temperature - between studs and chipboard</b> Measured in each quarter section and at the center, and 6.6 on mid height of stud.
Enclosures 14.0 and 14.1	<b>Internal temperature - between chipboard and fiber gypsum boards</b> Measured in each quarter section, and 6.5 and 6.6 at mid height.
Enclosures 15.0 and 15.1	<b>Internal temperature - between fiber gypsum boards</b> mid height of studs. 1 on 2nd stud from the right and 2 on center stud seen from unexposed side
Enclosures 16.0 and 16.1	<b>Temperature development through the construction</b> Each thermocouple represents the maximum temperature in all measured layers
Enclosures 17.0 and 17.1	<b>Horizontal deformation</b>

Negative values indicate movement towards the furnace

Enclosures 18.0 and 18.1 Vertical deformation  
Negative values indicate downwards movement

Enclosures 19.0 and 19.1 Load per cylinder  
Load per cylinder during test

### Visual observations:

Time / Minutes	Visual observations:	U = Unexposed side E = Exposed side
0	Start	
13	Cracks in the plaster are visible around the edge.	E
20	Cracks are larger on the exposed side between boards	E
28	Faint smoke from the free edge	E
31	Boards are loosening a little along the edge; they are still attached.	E
35	No changes on unexposed side.	U
38	Large vertical cracks in the board along the centerline	E
50	Smoke form right free edge, smoke from left free edge is stopped.	U
51	Both layers of gypsum are cracked with large vertical cracks.	E
53	Outer layer is falling, small pieces of the inner layer is falling down.	E
59	No critical place for cotton	U
60	Cracks in the wood fiber board	E
63	Slight increase in smoke from both the free edges	U
64	The smoke decreased from both free edges	U
69	Straw elements are exposed in places	U
71	No change on unexposed	U
78	Liquid is running down the construction	U
79	Very faint smoke from the bottom right panel	U
81	Small vertical gab between wood and straw exposed	U
89	No critical place for cotton pad test.	U
90	Most boards have fallen down.	E
97	More liquids are running down the construction	U
98	More smoke from bottom of construction right side	U
105	Slightly more smoke from unexposed	U
106	Smoke from small hole in element from the right	U
107	Cotton pad test: over small hole. Faint discoloration, no ignition.	U

109	Bottom right side, stick flame at free edge	U
110	New holes 2 and 3 elements	U
111	Cotton pad test: slight discoloration, no ignition, original hole	U
113	Cotton pad test top hole:	U
114	Test is stopped	

The photographs on the attached photo sheets show the test specimen during the mounting, testing and after the test. See the description at each photo.

## 7 Conclusion

Fire resistance testing according to EN 1365-1:2012 of the construction described in this test report showed that failure according to the performance criteria stated in the test method occurred at the following time:

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**Load-bearing capacity (R):** **113 minutes**

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- The load on the test specimen was maintained for 114 minutes
- The measured vertical deflection did not exceed the criteria of  $C = h/100 = 30$  mm during the test.
- The measured rate of vertical deflection did exceed the criteria of  $dC/dt = 3h/1000 = 9$  mm/min after 113 minutes of testing.

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**Integrity (E):** **114 minutes**

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- Sustained flaming occurred after 114 minutes of testing
- The cotton pad was not ignited during the test.
- No through-going openings in the test specimen were created during the test.

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**Insulation (I):** **114 minutes**

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- Failure of insulation occurred after 114 minutes of testing due to failure of integrity.
- The average temperature rise on the unexposed surface of the test specimen did not exceed 140°C during the test.
- The maximum temperature rise on the unexposed surface of the test specimen did not exceed 180°C during the test.

## 8 Remarks

The field of direct application of the test results appears from EN 1365-1:2012, clause 13.

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 EN 1363-1:2020, and where appropriate

EN 1363-2:1999. 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 test method is not covered by this report.

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 to provide a stated degree of accuracy of the result.

This report has only been printed in a pdf-version. DBI has not issued a hard copy version.

All values mentioned in this report are nominal values, production tolerances are not considered.

**Danish Institute of Fire and Security Technology**



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M.Sc. (Eng)



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**Christian Basbøll**  
Resistance to Fire Engineer

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**DBI**

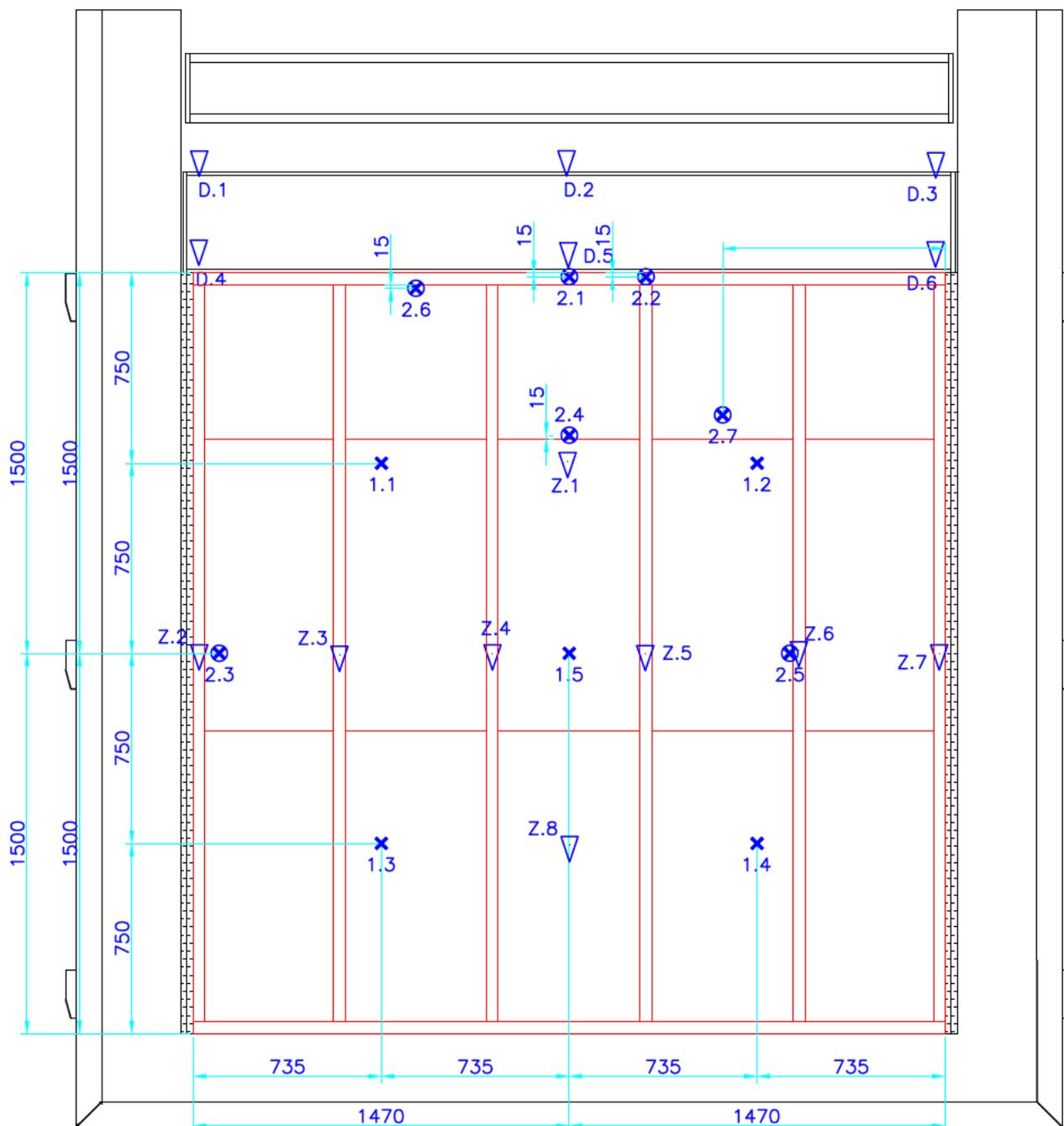
Jernholmen 12  
2650 Hvidovre  
Denmark

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**Enclosures:**

**55**

DBI drawings:	1
DBI graphs and tables:	36
Photo sheets:	11
Sponsors drawings:	7



- ✕ Thermocouple placed on the unexposed surface (average)
- ⊗ Thermocouple placed on the unexposed surface (maximum)
- ▽ Deflection measuring point

All measurements are in mm

**Danish Institute of Fire and security Technology**

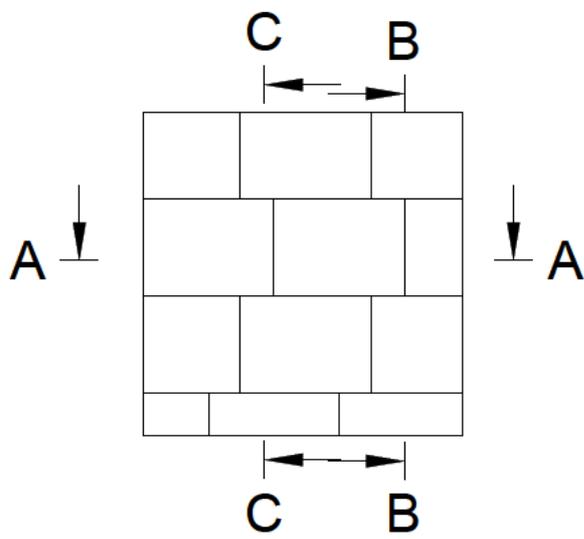
Sponsor: Wood:UpHigh

Subject: Load bearing wall

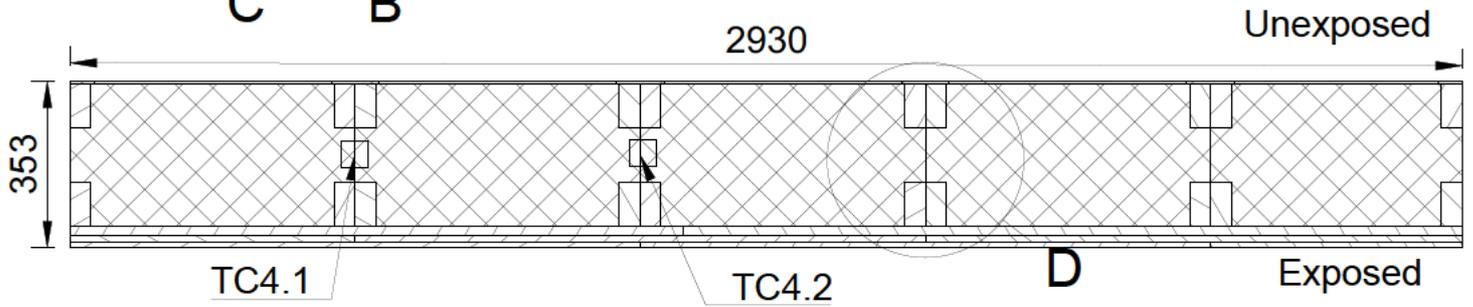
**File No.: PGA12233A**

Test date: 10-01-2023

Enclosure: 1.0

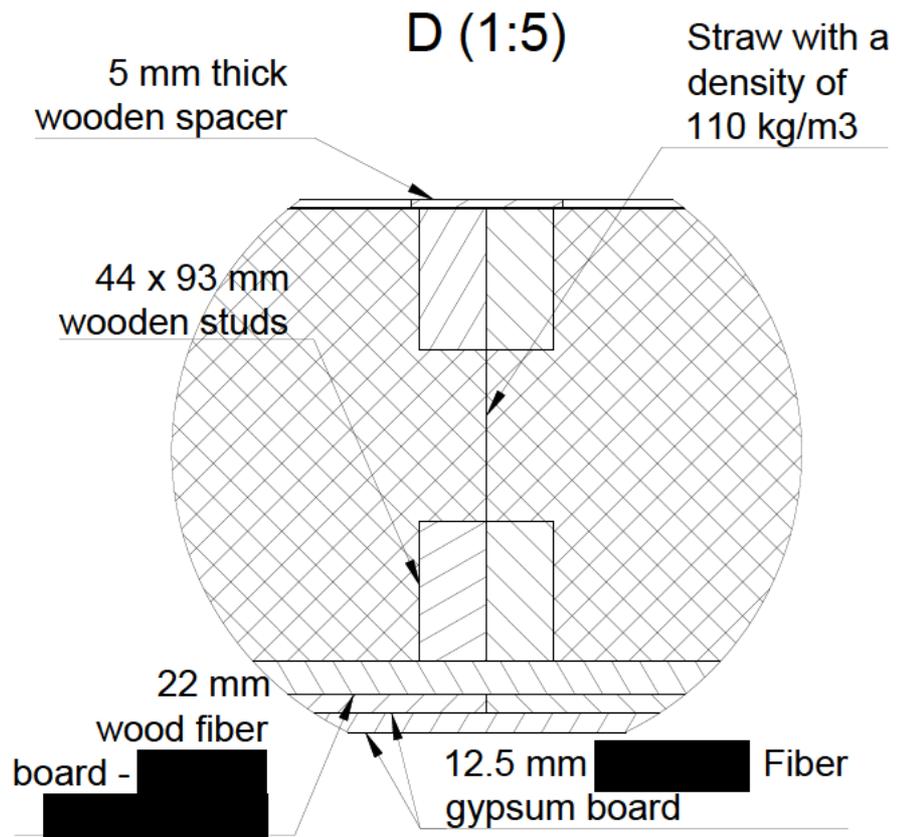
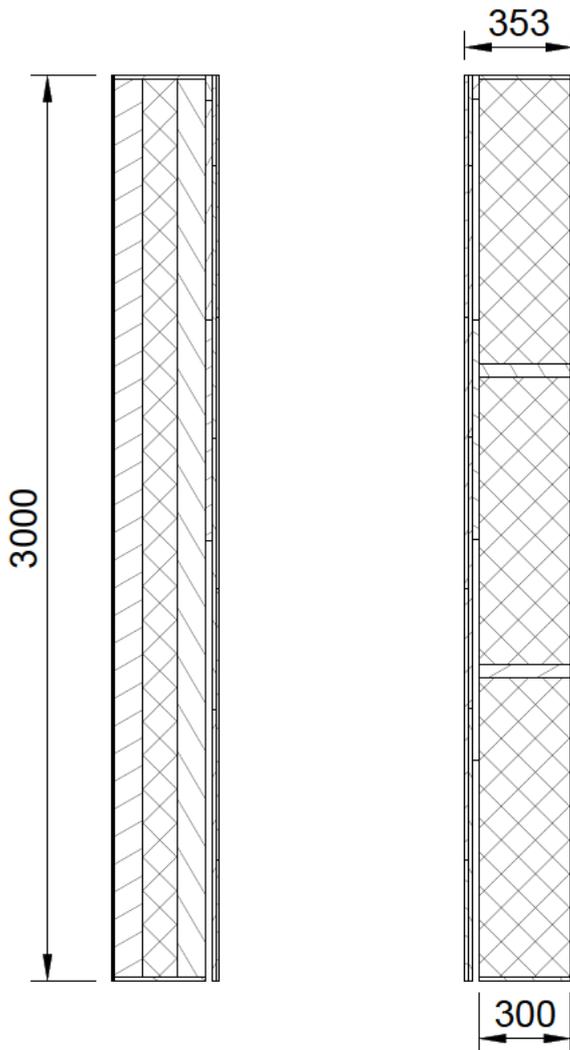


A-A (1:16)



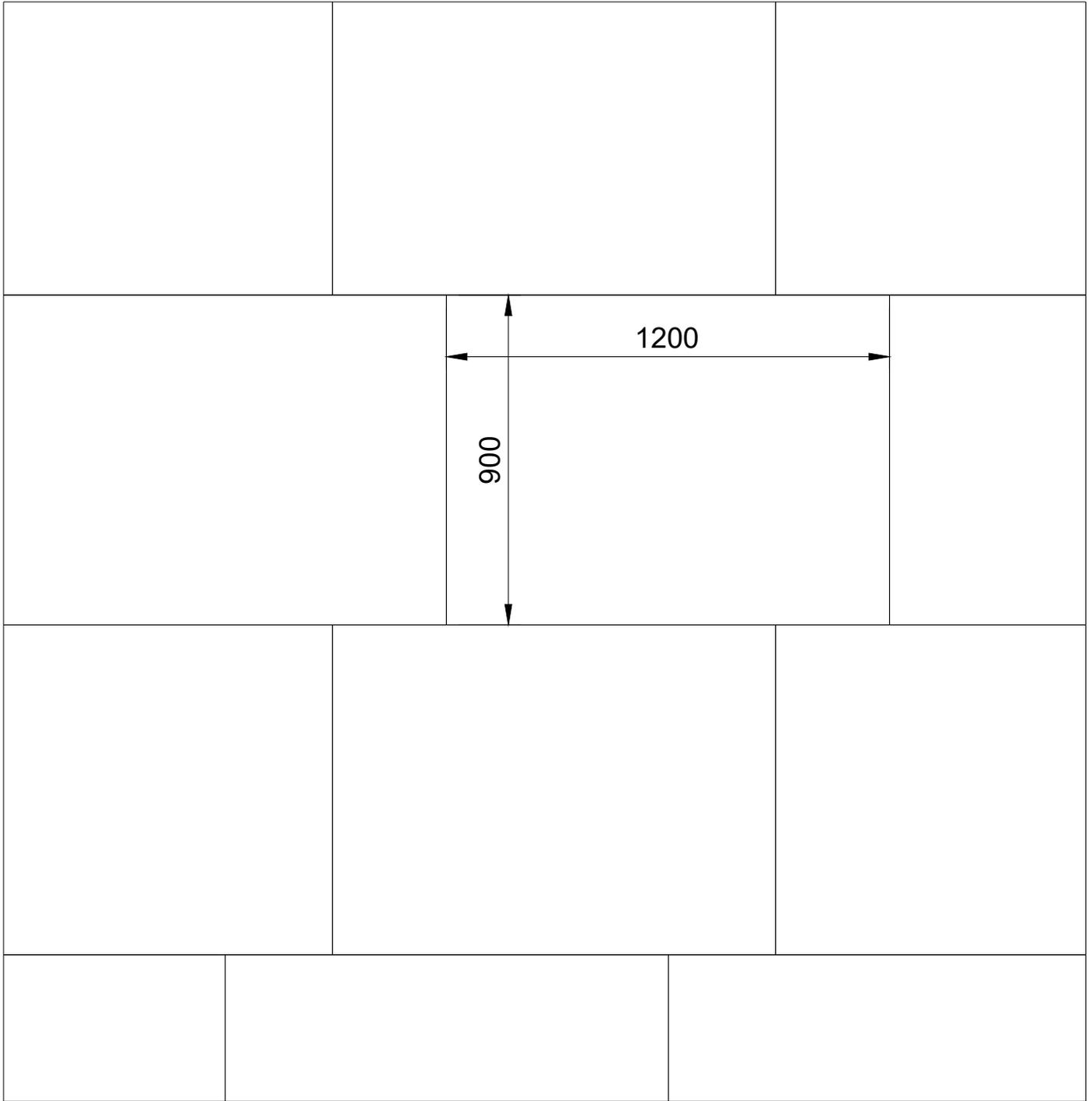
B-B (1:25)

C-C (1:25)



All measurements are in mm





All measurements are in mm



**Danish Institute of Fire and Security Technology**

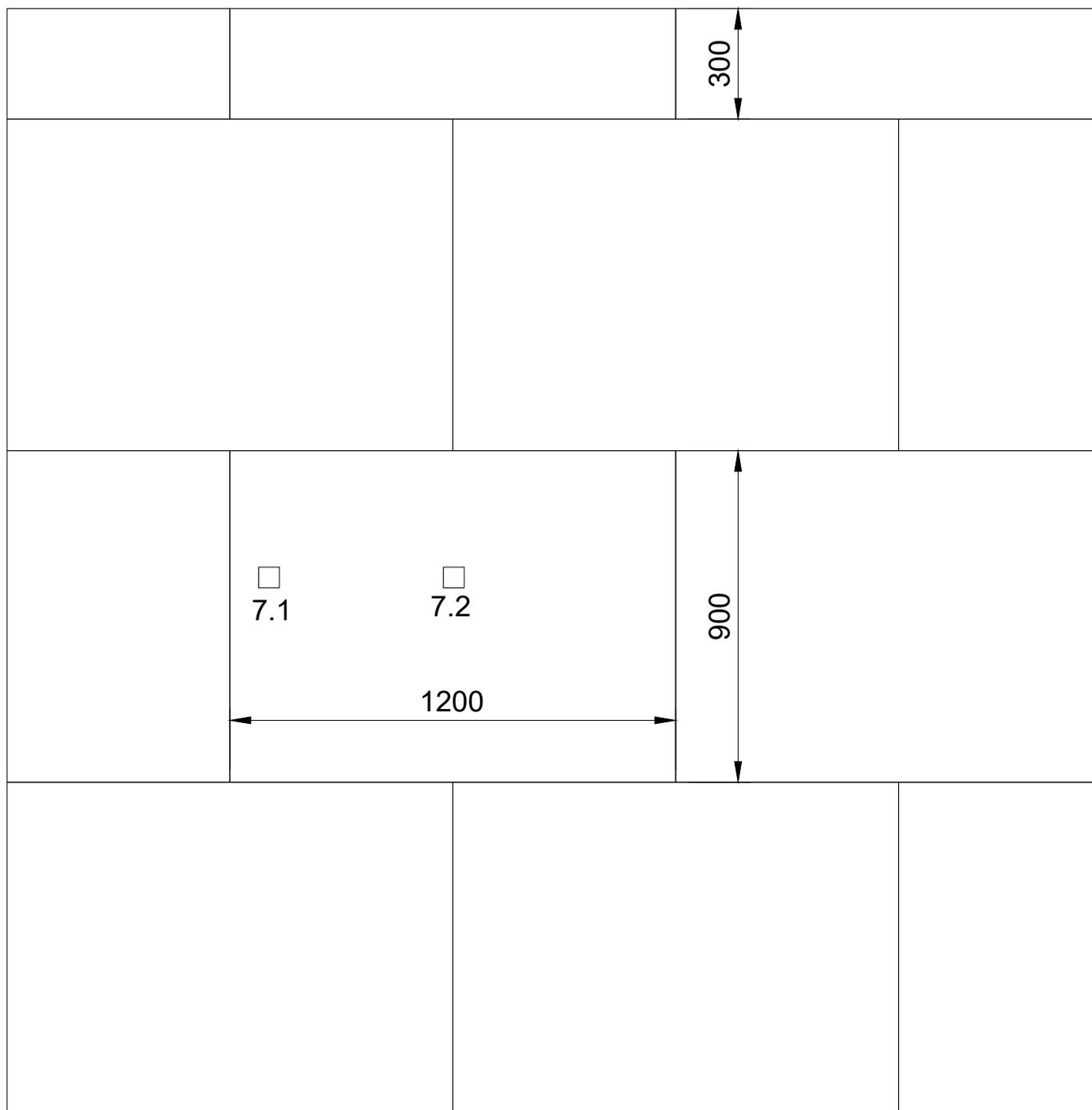
Sponsor: Wood:UpHigh

Subject: Loadbearing wall - Outer layer of fiber gypsum on exposed side

**File No.:** PGA12233A

**Test date:** 11-01-2023

**Enclosure:** 1.2



All measurements are in mm



**Danish Institute of Fire and Security Technology**

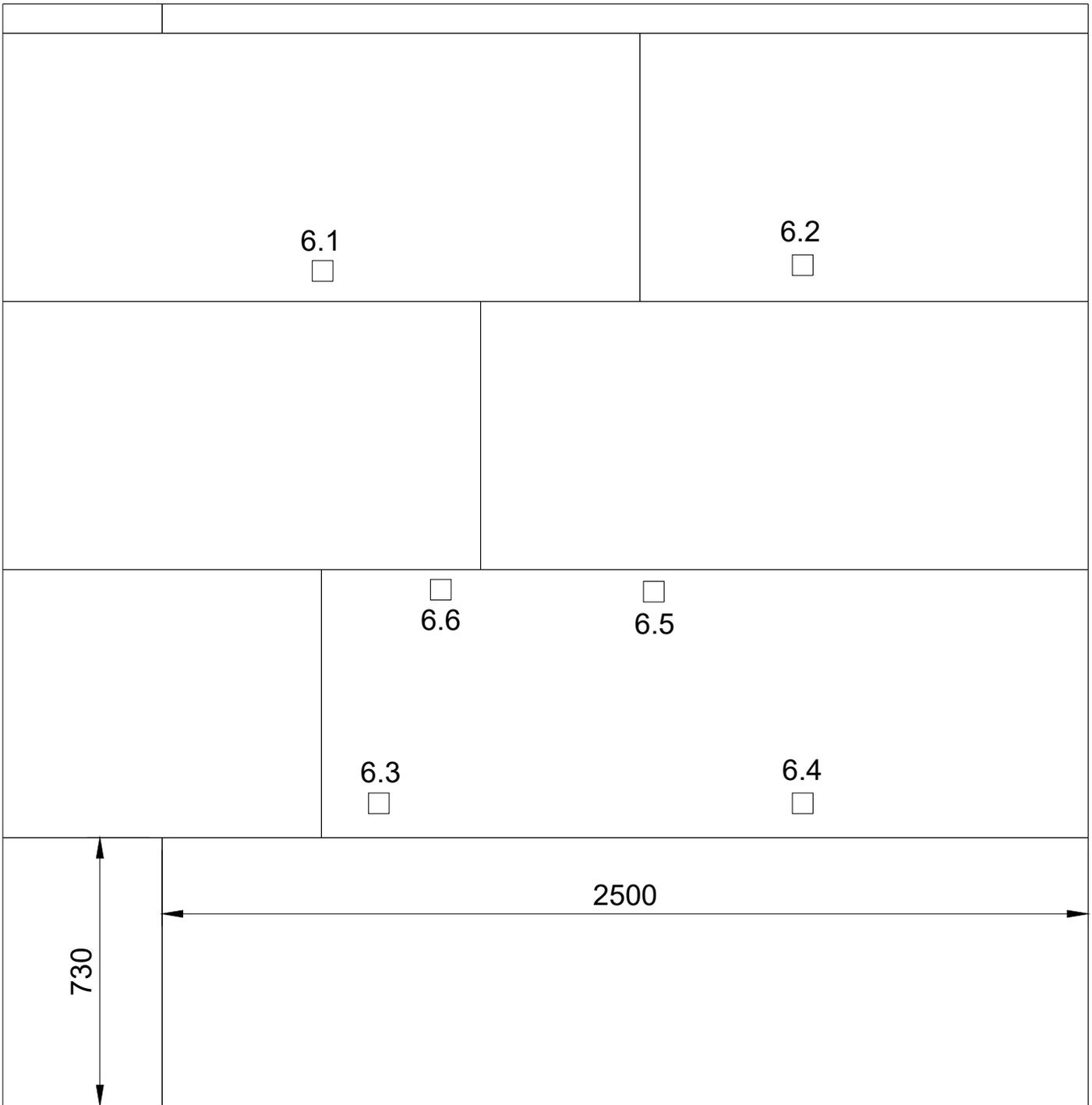
Sponsor: Wood:UpHigh

Subject: Loadbearing wall - Inner layer of fiber gypsum on exposed side

**File No.:** PGA12233A

**Test date:** 11-01-2023

**Enclosure:** 1.3



The wood fiber boards with tongue and groove have maximum dimensions of 750 x 2500 mm.

All measurements are in mm



**Danish Institute of Fire and Security Technology**

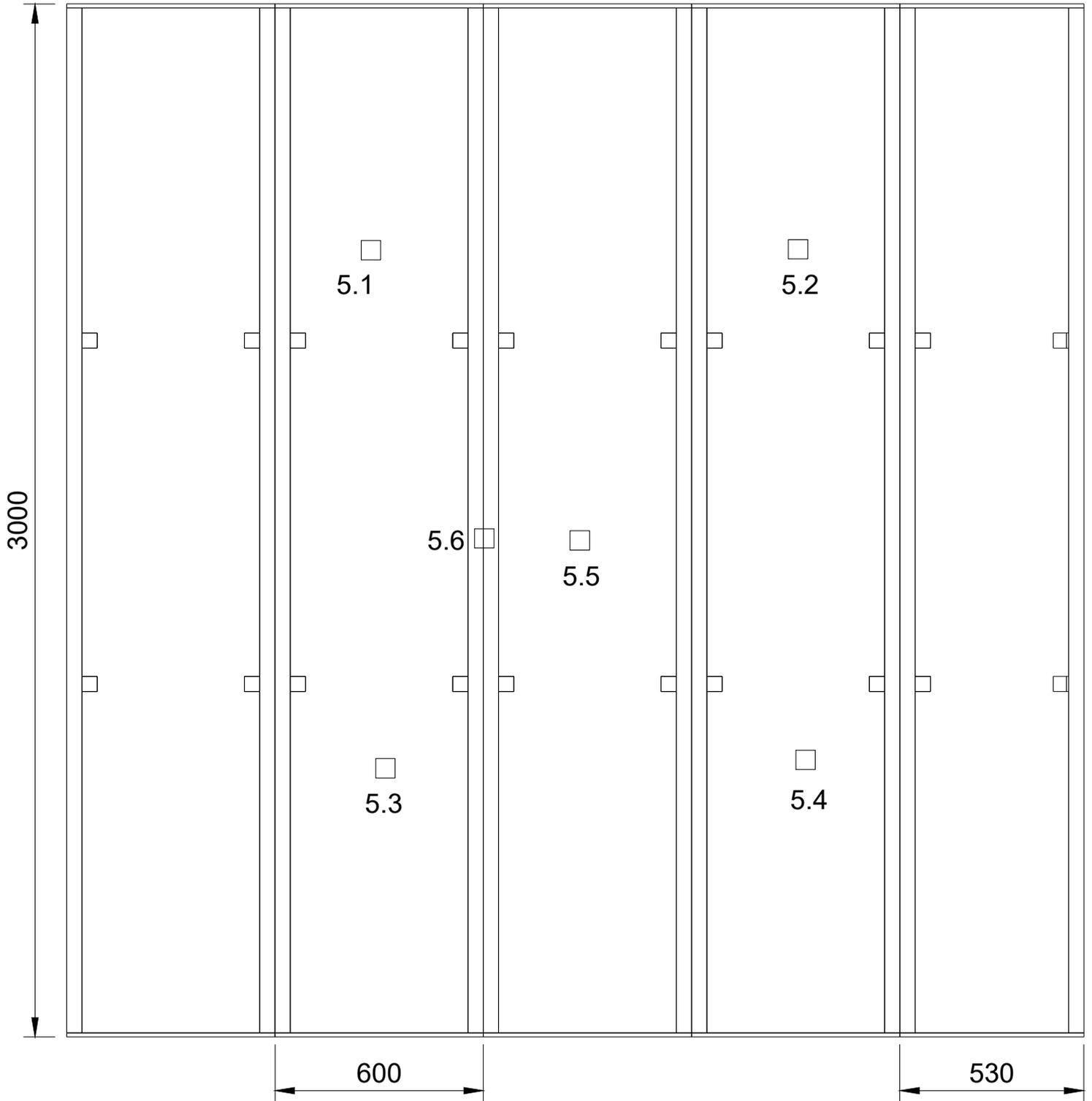
Sponsor: Wood:UpHigh

Subject: Loadbearing wall - wood fiber board behind fiber gypsum boards on exposed side

**File No.:** PGA12233A

**Test date:** 11-01-2023

**Enclosure:** 1.4



All measurements are in mm



**Danish Institute of Fire and Security Technology**

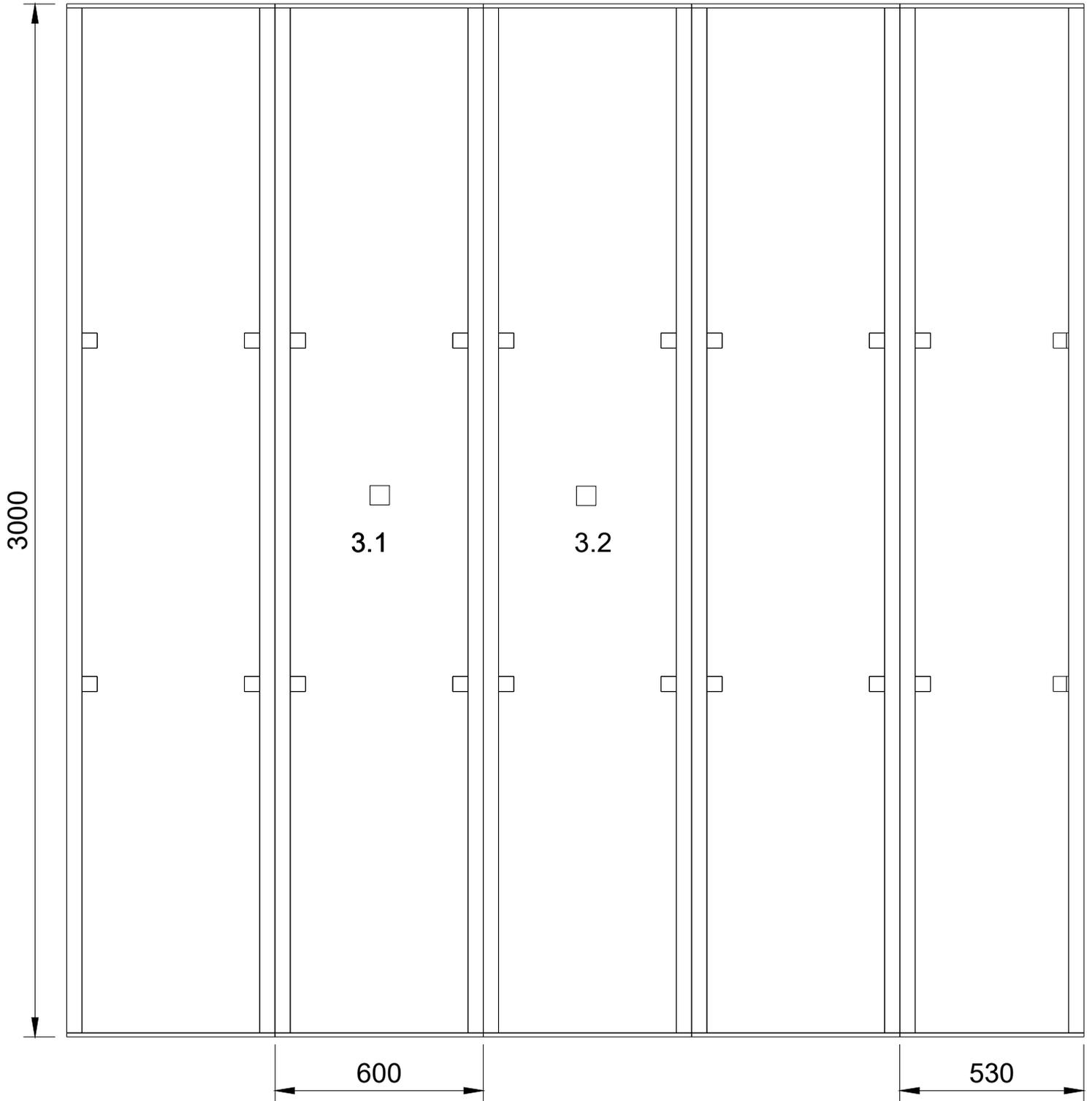
Sponsor: Wood:UpHigh

Subject: Loadbearing wall - Straw elements seen from exposed side

**File No.:** PGA12233A

**Test date:** 11-01-2023

**Enclosure:** 1.5



All measurements are in mm



**Danish Institute of Fire and Security Technology**

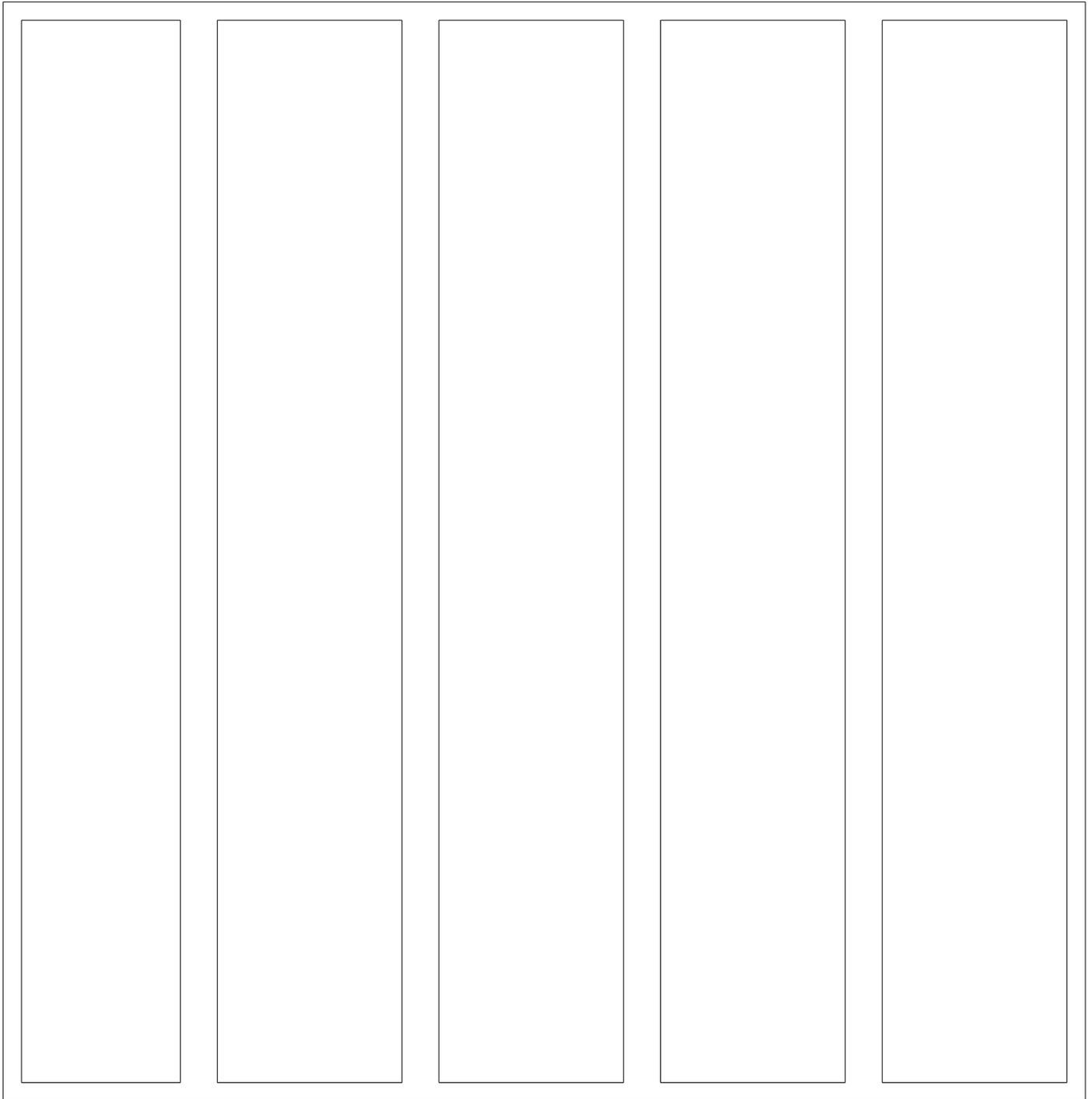
Sponsor: Wood:UpHigh

Subject: Loadbearing wall - Straw elements seen from unexposed side

**File No.:** PGA12233A

**Test date:** 11-01-2023

**Enclosure:** 1.6



Under the wooden spacers a sarking and roofing felt is applied

All measurements are in mm

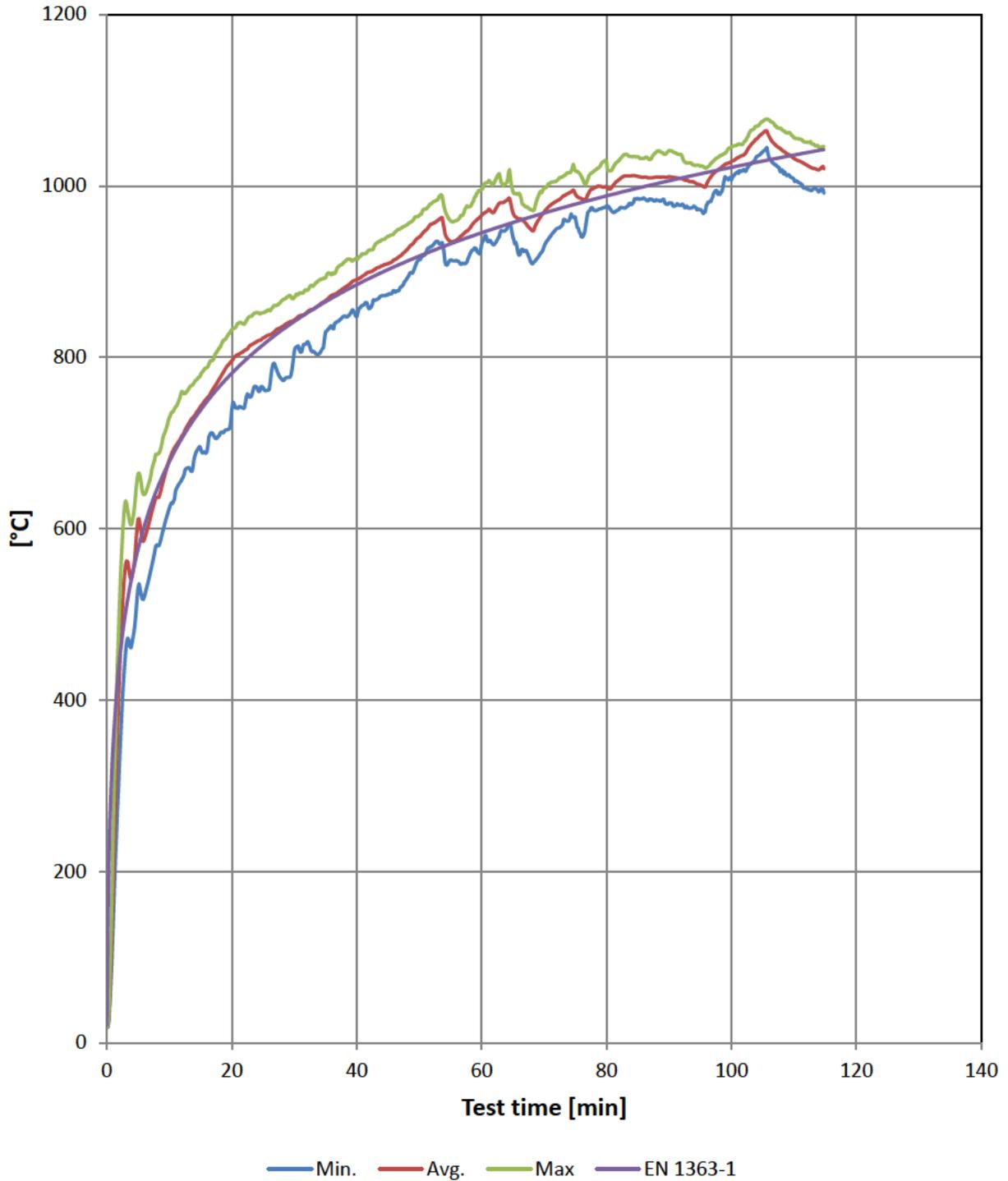


**Danish Institute of Fire and Security Technology**  
Sponsor: Wood:UpHigh  
Subject: Loadbearing wall - Unexposed side

**File No.:** PGA12233A  
**Test date:** 11-01-2023  
**Enclosure:** 1.7

## Furnace temperature

*Furnace temperature*



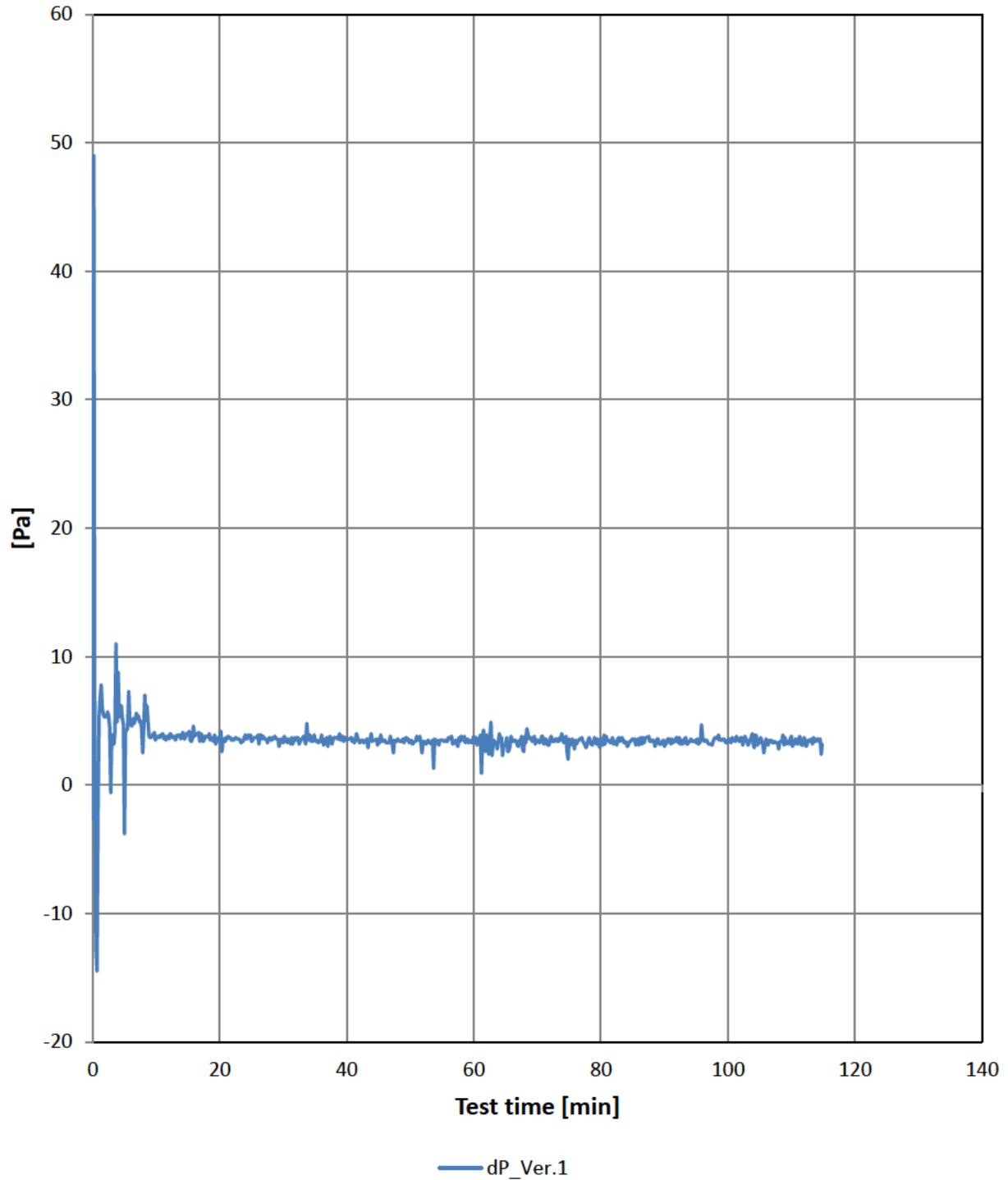
## Furnace temperature

### *Furnace temperature*

Time Minutes	Measured			Norm EN 1363-1	Area under curve		Dev. [%]	Limit [%]
	Minimum	Average	Maximum		Measured	EN 1363-1		
0	18	18	18	20	0	0	0.0	
5	531	611	664	576	2022	2200	-8.1	
10	623	680	729	678	5157	5366	-3.9	15
15	694	743	780	739	8727	8918	-2.1	13
20	740	796	833	781	12572	12723	-1.2	10
25	764	823	852	815	16625	16716	-0.5	8
30	807	844	870	842	20791	20859	-0.3	5
35	830	866	893	865	25064	25127	-0.3	5
40	847	891	916	885	29458	29502	-0.2	4
45	873	909	941	902	33962	33971	0.0	4
50	914	940	965	918	38576	38522	0.1	3
55	914	936	960	932	43330	43149	0.4	3
60	931	965	996	945	48069	47844	0.5	3
65	941	969	994	957	52946	52601	0.7	3
70	929	970	997	968	57739	57415	0.6	3
75	964	991	1018	979	62660	62283	0.6	3
80	977	999	1028	988	67625	67201	0.6	3
85	986	1011	1034	997	72661	72166	0.7	3
90	981	1011	1042	1006	77712	77175	0.7	3
95	973	1001	1023	1014	82746	82225	0.6	3
100	1007	1028	1045	1022	87820	87315	0.6	3
105	1039	1062	1075	1029	93035	92442	0.6	3
110	1008	1032	1056	1036	98271	97605	0.7	3
114	993	1019	1045	1041	102370	101760	0.6	3

## Vertical furnace pressure

*The differential pressure in the furnace during the test, measured 1,16 m above notional floor level*



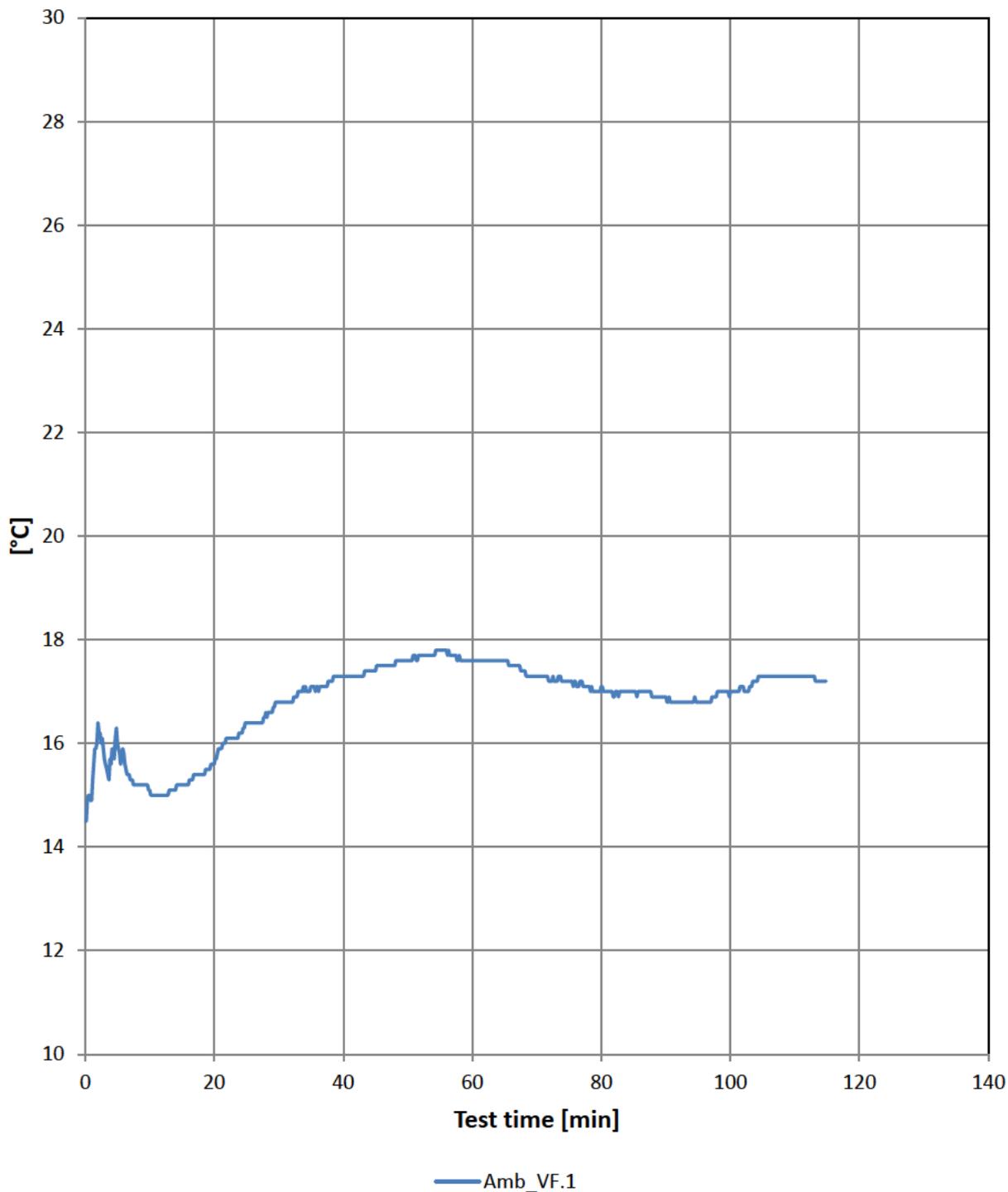
## Vertical furnace pressure

*The differential pressure in the furnace during the test, measured 1,16 m above notional floor level*

Min. / Pa	dP_Ver.1
0	-2.6
5	-3.8
10	3.8
15	3.9
20	3.6
25	3.4
30	3.3
35	3.5
40	3.5
45	3.6
50	3.4
55	3.5
60	3.8
65	3.2
70	3.5
75	3.6
80	3.6
85	3.6
90	3.0
95	3.3
100	3.5
105	3.3
110	3.8
114	3.6

## Ambient temperature

*The ambient temperature in the laboratory during the test*



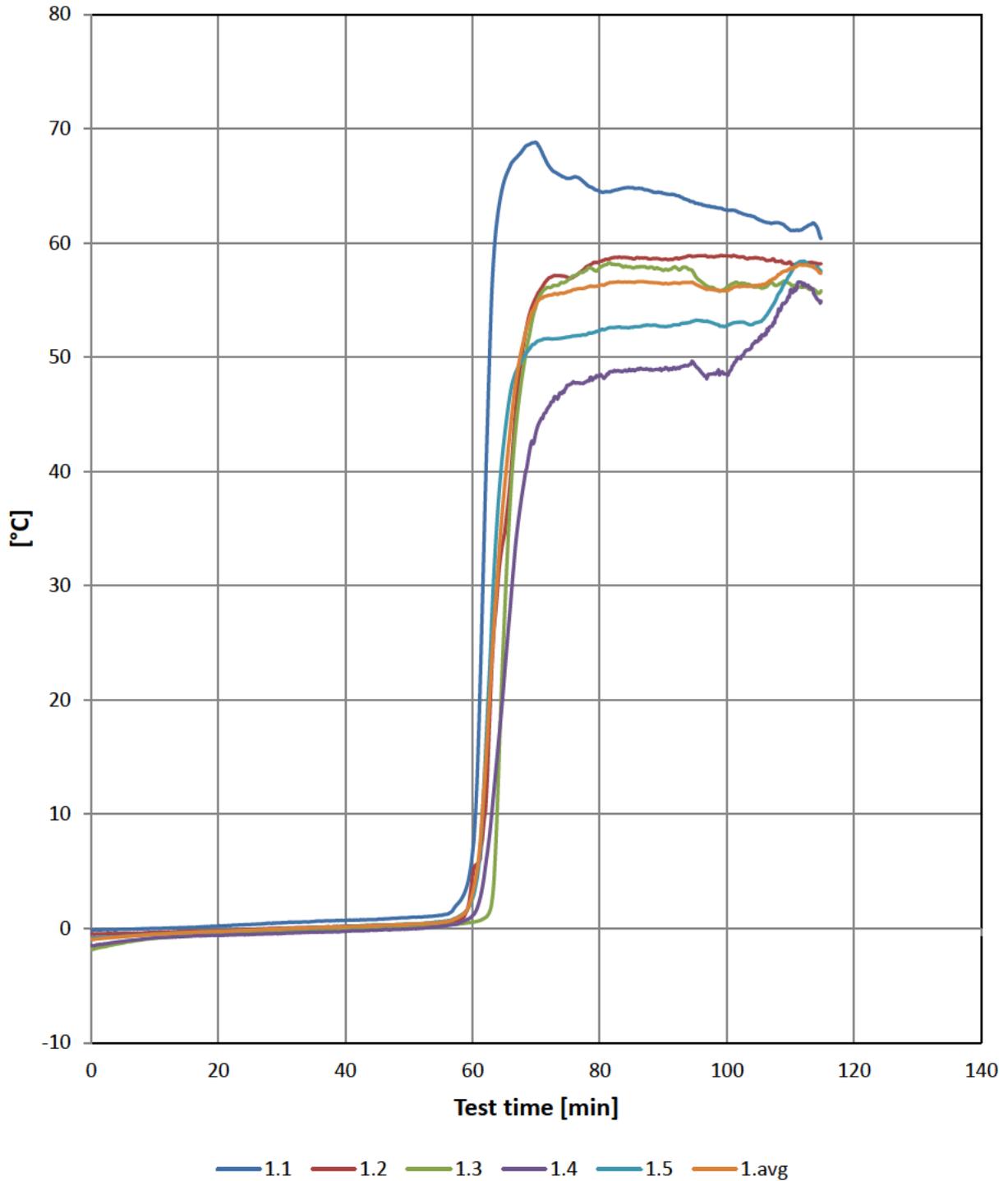
## Ambient temperature

*The ambient temperature in the laboratory during the test*

Min. / °C	Amb VF.1
0	14.5
5	16.0
10	15.1
15	15.2
20	15.6
25	16.4
30	16.8
35	17.1
40	17.3
45	17.4
50	17.6
55	17.8
60	17.6
65	17.6
70	17.3
75	17.2
80	17.1
85	17.0
90	16.9
95	16.8
100	17.0
105	17.3
110	17.3
114	17.2

### Average temperature rise

Measured with 5 thermocouples on the unexposed side



## Average temperature rise

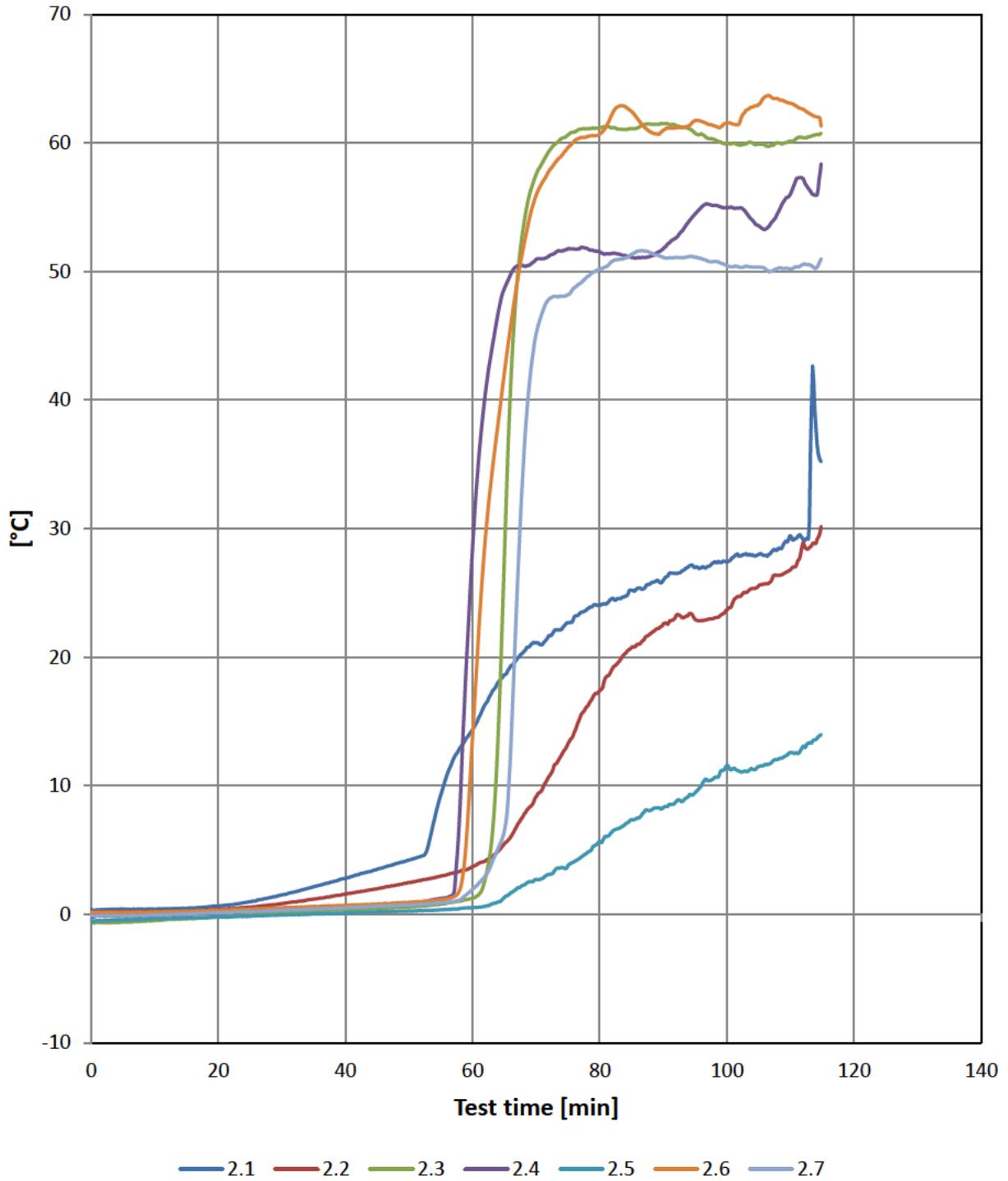
Measured with 5 thermocouples on the unexposed side

Min. / °C	1.1	1.2	1.3	1.4	1.5	1.Avg	1.Max
0	0	0	-2	-1	-1	-1	0
5	0	0	-1	-1	-1	-1	0
10	0	0	-1	-1	0	0	0
15	0	0	-1	-1	0	0	0
20	0	0	-1	-1	0	0	0
25	0	0	0	-1	0	0	0
30	1	0	0	0	0	0	1
35	1	0	0	0	0	0	1
40	1	0	0	0	0	0	1
45	1	0	0	0	0	0	1
50	1	0	0	0	0	0	1
55	1	0	0	0	1	1	1
60	7	5	1	1	3	3	7
65	66	35	27	22	43	39	66
70	69	55	55	44	51	55	69
75	66	57	57	48	52	56	66
80	65	58	58	48	52	56	65
85	65	59	58	49	53	57	65
90	64	59	58	49	53	56	64
95	63	59	57	49	53	56	63
100	63	59	56	49	53	56	63
105	62	59	56	52	53	56	62
110	61	58	56	56	57	58	61
114	62	58	56	55	58	58	62

Failure [min]	-	-	-	-	-	-	-
Failure °C	180	180	180	180	180	140	180

## Maximum temperature rise

Maximum temperatures on the unexposed side



## Maximum temperature rise

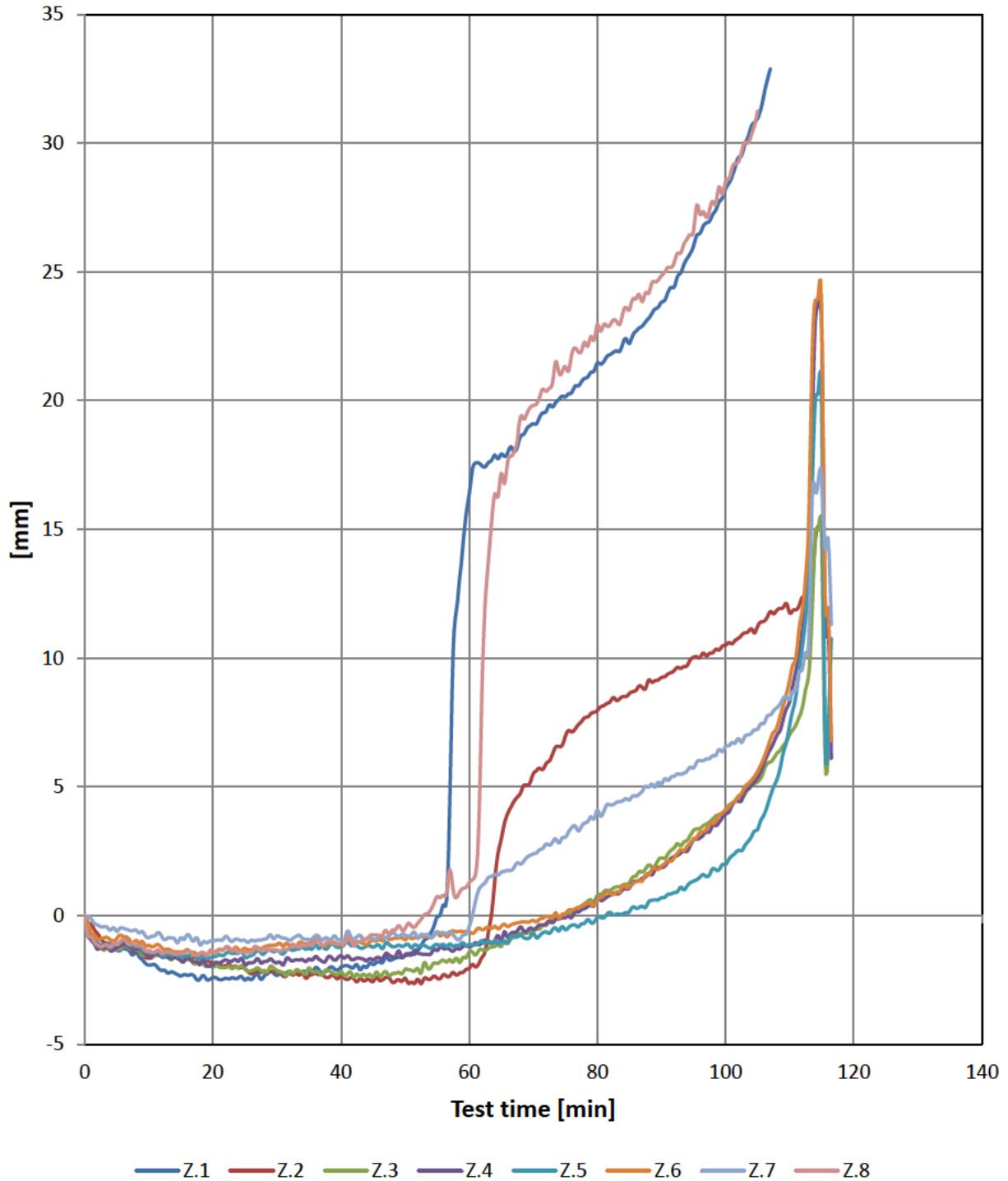
*Maximum temperatures on the unexposed side*

Min. / °C	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.Max
0	0	0	-1	0	0	0	0	0
5	0	0	-1	0	0	0	0	0
10	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
20	1	0	0	0	0	0	0	1
25	1	1	0	0	0	0	0	1
30	2	1	0	0	0	1	0	2
35	2	1	0	1	0	1	0	2
40	3	2	0	1	0	1	1	3
45	4	2	0	1	0	1	1	4
50	4	2	1	1	0	1	1	4
55	9	3	1	1	0	1	1	9
60	14	4	1	29	1	14	2	29
65	19	6	28	49	1	42	6	49
70	21	9	58	51	3	56	45	58
75	23	13	61	52	4	60	48	61
80	24	17	61	52	6	61	50	61
85	25	21	61	51	7	62	51	62
90	26	23	62	52	8	61	51	62
95	27	23	61	54	9	62	51	62
100	27	24	60	55	12	62	50	62
105	28	26	60	54	12	63	50	63
110	29	27	60	56	13	63	50	63
114	38	29	61	56	14	62	50	62

Failure [min]	-	-	-	-	-	-	-	-
Failure °C	180	180	180	180	180	180	180	180

## Horizontal deformation

*Negative values indicate movement towards the furnace*



## Horizontal deformation

*Negative values indicate movement towards the furnace*

Min. / mm	Z.1	Z.2	Z.3	Z.4	Z.5	Z.6	Z.7	Z.8
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	-1.3	-1.2	-1.3	-1.2	-1.1	-0.9	-0.6	-1.1
10	-1.9	-1.6	-1.5	-1.6	-1.4	-1.1	-0.9	-1.4
15	-2.3	-1.7	-1.6	-1.8	-1.6	-1.4	-0.9	-1.5
20	-2.4	-1.9	-2.0	-1.9	-1.6	-1.4	-1.0	-1.4
25	-2.5	-2.1	-2.1	-1.9	-1.6	-1.3	-1.0	-1.4
30	-2.3	-2.2	-2.1	-1.8	-1.3	-1.1	-0.8	-1.3
35	-2.2	-2.3	-2.0	-1.7	-1.3	-1.1	-0.9	-1.1
40	-2.0	-2.3	-2.2	-1.6	-1.2	-1.1	-0.9	-1.1
45	-1.9	-2.6	-2.4	-1.7	-1.2	-1.0	-0.9	-0.7
50	-1.6	-2.4	-2.1	-1.5	-1.1	-0.9	-0.8	-0.5
55	0.0	-2.4	-1.9	-1.4	-1.1	-0.6	-0.6	0.7
60	16.4	-2.1	-1.4	-1.2	-1.1	-0.6	-0.4	1.3
65	17.9	2.9	-1.2	-1.0	-1.0	-0.4	1.7	17.2
70	19.1	5.5	-0.6	-0.5	-0.7	-0.2	2.4	19.8
75	20.1	7.0	0.1	-0.1	-0.6	0.0	3.0	21.3
80	21.5	8.0	0.8	0.7	-0.1	0.6	4.1	23.0
85	22.2	8.6	1.3	1.1	0.1	1.1	4.5	23.5
90	23.8	9.2	2.2	1.9	0.7	1.9	5.1	24.9
95	26.0	10.0	3.3	3.0	1.3	3.0	5.7	26.6
100	28.2	10.5	4.1	4.0	2.0	4.1	6.6	28.5
105	31.0	11.2	5.2	5.4	3.4	5.6	7.2	31.3
110	0.0	11.7	7.0	8.3	7.4	9.1	8.4	0.0
115	0.0	15.3	14.6	22.8	19.7	23.3	17.0	0.0
116	0.0	0.0	6.2	11.1	7.0	12.0	14.7	0.0



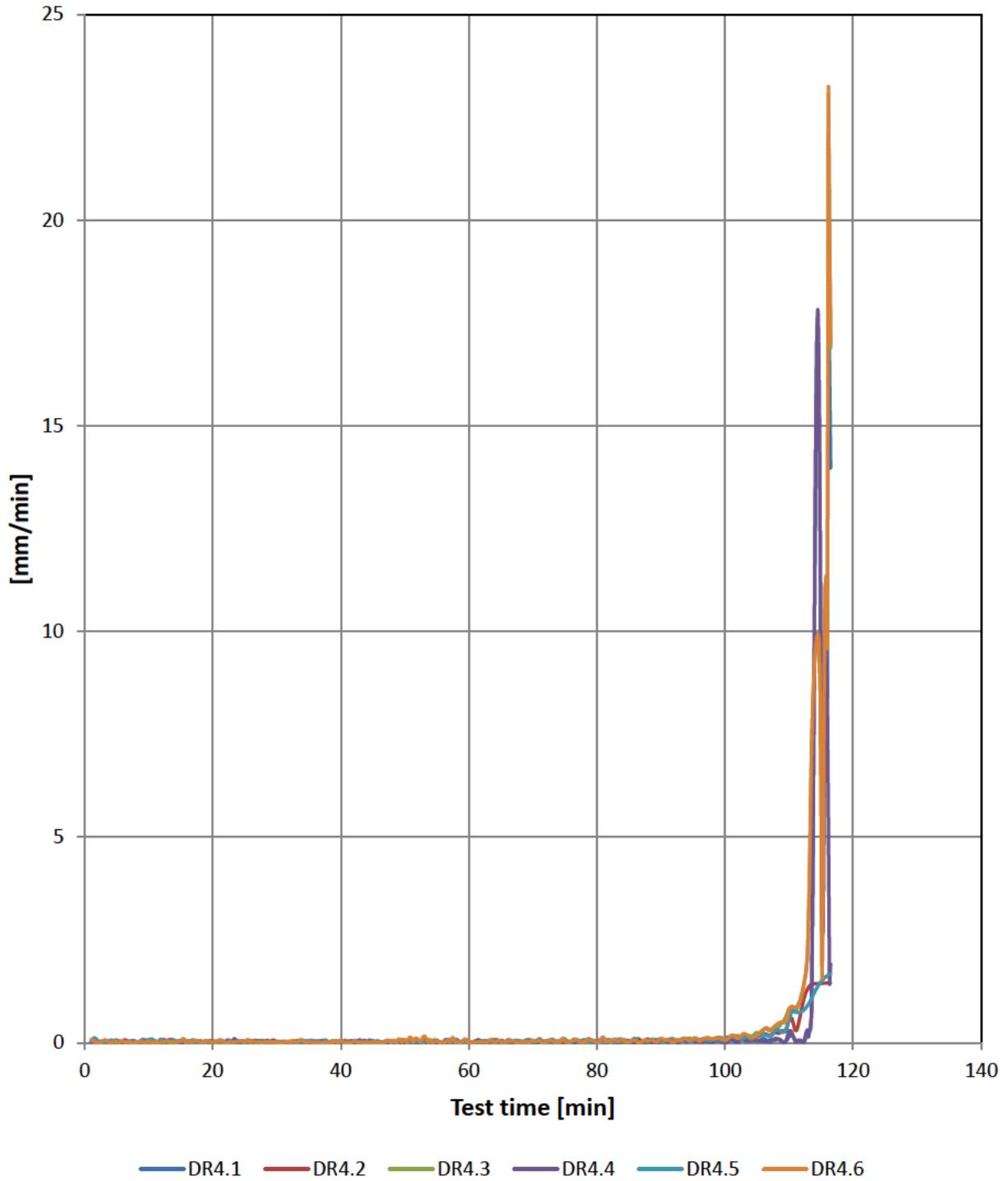
## Vertical deformation

*Negative values indicate downwards movement*

Min. / mm	D.1	D.2	D.3	D.4	D.5	D.6	D.Max
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	-0.2	-0.1	-0.1	-0.1	-0.1	-0.2	0.0
10	-0.2	-0.3	-0.2	-0.2	-0.3	-0.3	0.0
15	-0.3	-0.5	-0.3	-0.3	-0.5	-0.4	0.0
20	-0.4	-0.6	-0.4	-0.3	-0.6	-0.4	0.0
25	-0.4	-0.7	-0.5	-0.4	-0.7	-0.5	0.0
30	-0.4	-0.7	-0.5	-0.4	-0.8	-0.6	0.0
35	-0.4	-0.8	-0.6	-0.4	-0.9	-0.6	0.0
40	-0.4	-0.9	-0.5	-0.4	-1.0	-0.6	0.0
45	-0.5	-1.0	-0.6	-0.4	-1.1	-0.6	0.0
50	-0.5	-1.1	-0.6	-0.5	-1.2	-0.7	0.0
55	-0.6	-1.3	-0.7	-0.5	-1.3	-0.8	0.0
60	-0.6	-1.4	-0.7	-0.6	-1.5	-0.8	0.0
65	-0.8	-1.6	-0.8	-0.7	-1.6	-0.9	0.0
70	-0.8	-1.8	-0.8	-0.8	-1.8	-1.0	0.0
75	-0.9	-2.0	-1.0	-0.9	-2.0	-1.1	0.0
80	-1.0	-2.1	-1.1	-1.0	-2.2	-1.2	0.0
85	-1.1	-2.4	-1.3	-1.1	-2.4	-1.5	0.0
90	-1.3	-2.6	-1.6	-1.3	-2.7	-1.8	0.0
95	-1.5	-3.0	-1.9	-1.5	-3.0	-2.1	0.0
100	-1.7	-3.4	-2.4	-1.7	-3.5	-2.6	0.0
105	-2.0	-4.1	-3.3	-2.0	-4.1	-3.4	0.0
110	-2.4	-5.5	-5.6	-2.5	-5.6	-5.7	0.0
115	-21.9	-10.9	-25.8	-22.0	-10.8	-26.0	0.0
116	-13.5	-12.4	-16.3	-13.6	-12.4	-16.4	0.0

Failure [min]	-	-	-	-	-	-	-
Failuremm	30.0	30.0	30.0	30.0	30.0	30.0	30.0

### Vertical deformation rate



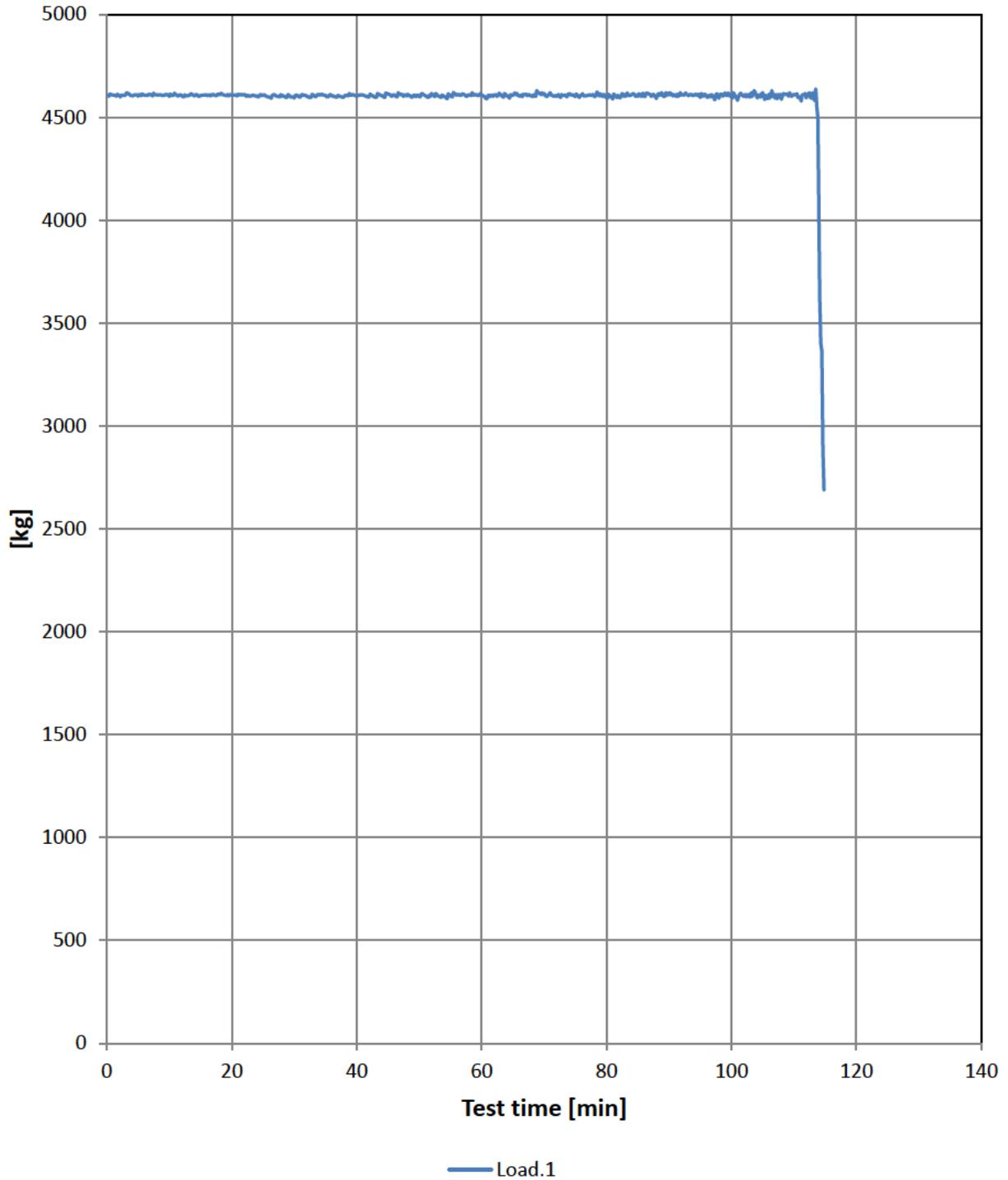
## Vertical deformation rate

Min. / mm/min	DR4.1	DR4.2	DR4.3	DR4.4	DR4.5	DR4.6	DR4.Max
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.07	0.02	0.05	0.03	0.00	0.02	0.00
10	0.03	0.05	0.04	0.07	0.07	0.04	0.00
15	0.05	0.05	0.05	0.00	0.05	0.04	0.00
20	0.00	0.04	0.04	0.00	0.03	0.03	0.00
25	0.02	0.02	0.03	0.02	0.01	0.01	0.00
30	0.04	0.01	0.03	0.00	0.01	0.00	0.00
35	0.02	0.00	0.02	0.00	0.04	0.03	0.00
40	0.02	0.02	0.01	0.00	0.01	0.06	0.00
45	0.04	0.04	0.02	0.00	0.04	0.02	0.00
50	0.00	0.01	0.03	0.00	0.04	0.08	0.00
55	0.03	0.06	0.03	0.00	0.05	0.04	0.00
60	0.02	0.02	0.02	0.00	0.01	0.00	0.00
65	0.03	0.02	0.02	0.05	0.05	0.03	0.00
70	0.01	0.01	0.02	0.03	0.00	0.06	0.00
75	0.02	0.04	0.10	0.02	0.06	0.05	0.00
80	0.01	0.03	0.01	0.02	0.06	0.01	0.00
85	0.04	0.05	0.01	0.02	0.02	0.02	0.00
90	0.02	0.05	0.04	0.06	0.08	0.11	0.00
95	0.08	0.09	0.08	0.03	0.05	0.10	0.00
100	0.02	0.08	0.11	0.03	0.09	0.06	0.00
105	0.04	0.16	0.25	0.07	0.17	0.19	0.00
110	0.15	0.56	0.83	0.28	0.58	0.79	0.00
115	8.19	1.45	6.19	8.21	1.49	6.20	0.00
116	8.39	1.45	9.57	8.37	1.64	9.58	0.00

Failure [min]	113.83	-	113.83	113.83	-	113.83	-
Failuremm/mi	9.00	9.00	9.00	9.00	9.00	9.00	9.00

## Load per cylinder

*Load per cylinder during test*



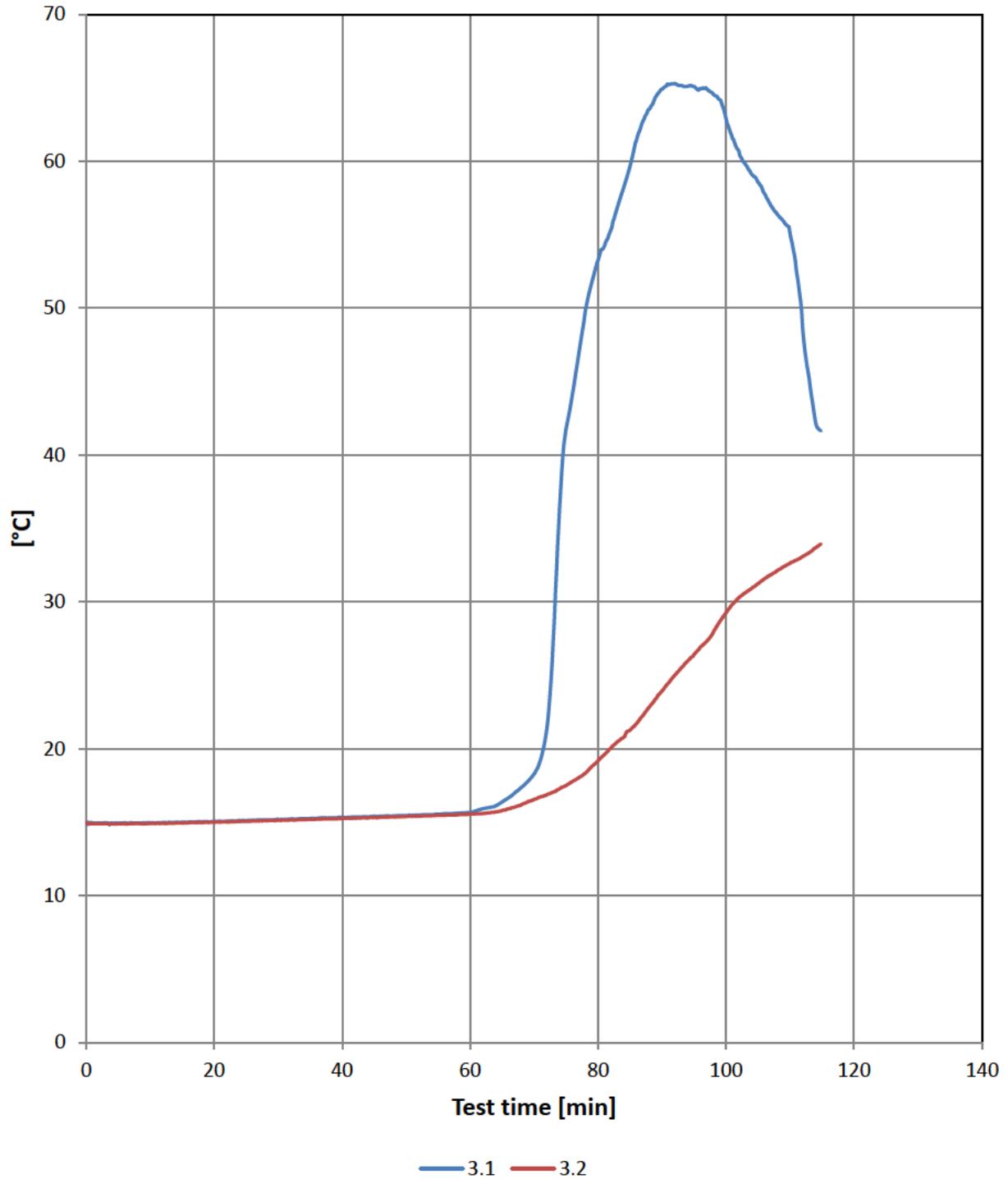
## Load per cylinder

*Load per cylinder during test*

Min. / kg	Load.1
0	4609
5	4604
10	4603
15	4606
20	4608
25	4609
30	4595
35	4608
40	4602
45	4614
50	4603
55	4607
60	4610
65	4607
70	4616
75	4601
80	4596
85	4603
90	4610
95	4598
100	4611
105	4621
110	4610
114	4152

## Internal temperature - between studs and windbreaker

*1 on second element, 2 on center element seen from unexposed side*



## Internal temperature - between studs and windbreaker

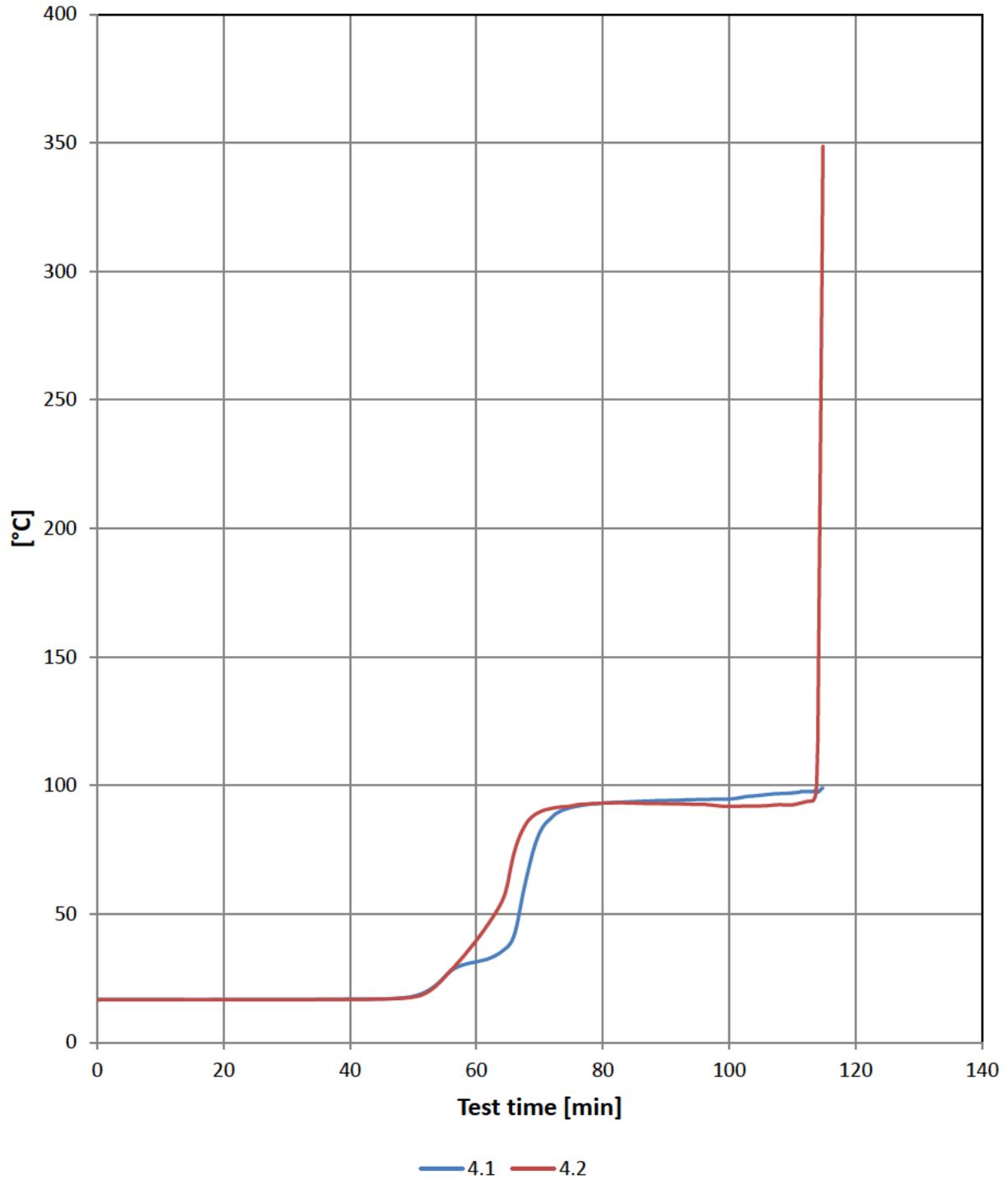
*1 on second element, 2 on center element seen from unexposed side*

Min. / °C	3.1	3.2	3.Max
0	15	15	15
5	15	15	15
10	15	15	15
15	15	15	15
20	15	15	15
25	15	15	15
30	15	15	15
35	15	15	15
40	15	15	15
45	15	15	15
50	15	15	15
55	16	15	16
60	16	16	16
65	16	16	16
70	18	17	18
75	42	18	42
80	53	19	53
85	60	21	60
90	65	24	65
95	65	26	65
100	63	29	63
105	59	31	59
110	55	33	55
114	42	34	42

Failure [min]	-	-	-
Failure °C	270	270	270

## Internal temperature - Center of studs

1 on second stud, 2 on center stud seen from unexposed side



## Internal temperature - Center of studs

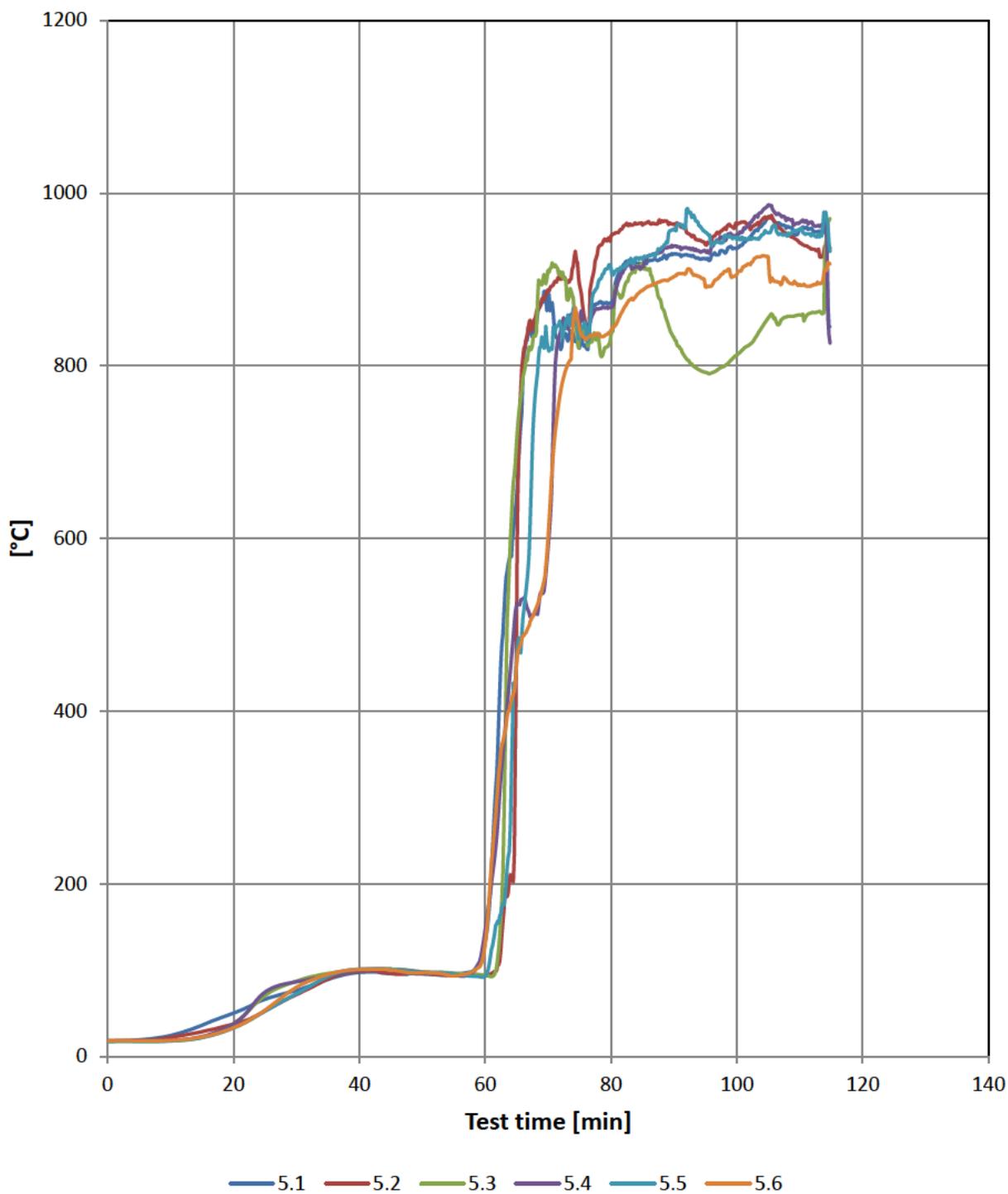
*1 on second stud, 2 on center stud seen from unexposed side*

Min. / °C	4.1	4.2	4.Max
0	17	17	17
5	17	17	17
10	17	17	17
15	17	17	17
20	17	17	17
25	17	17	17
30	17	17	17
35	17	17	17
40	17	17	17
45	17	17	17
50	18	18	18
55	26	26	26
60	31	40	40
65	37	63	63
70	82	90	90
75	91	92	92
80	93	93	93
85	94	93	94
90	94	93	94
95	95	93	95
100	95	92	95
105	96	92	96
110	97	92	97
114	97	117	117

Failure [min]	-	114.50	114.50
Failure °C	270	270	270

## Internal temperature - between studs and chipboard

Measured in each quarter section and at the center, and 6.6 on mid height of stud.



## Internal temperature - between studs and chipboard

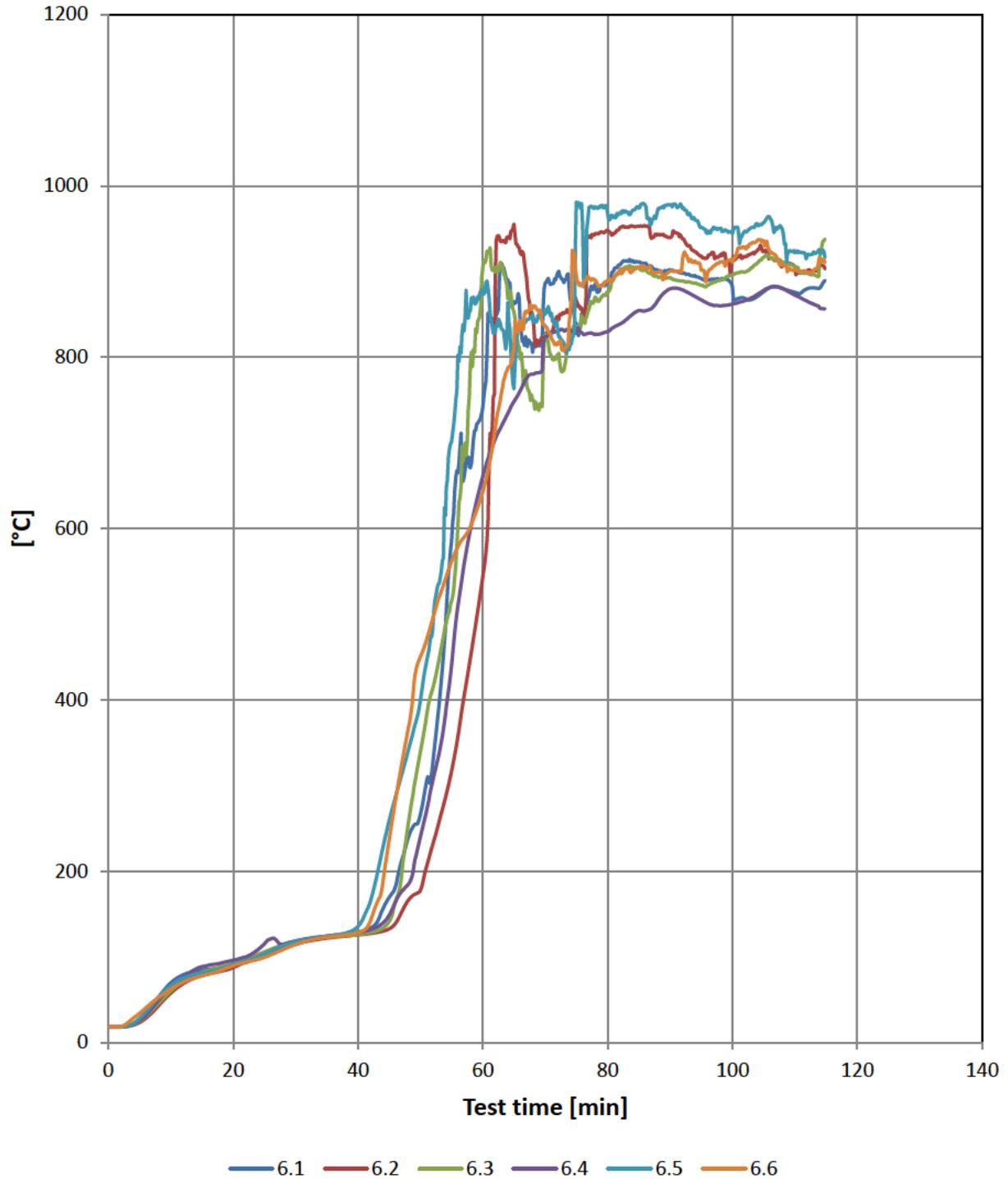
Measured in each quarter section and at the center, and 6.6 on mid height of stud.

Min. / °C	5.1	5.2	5.3	5.4	5.5	5.6	5.Max
0	18	18	18	18	18	18	18
5	19	18	18	18	18	18	19
10	24	22	18	19	18	19	24
15	36	29	22	23	22	22	36
20	50	37	38	38	33	33	50
25	66	53	71	75	52	54	75
30	76	72	87	87	72	80	87
35	89	90	96	94	93	95	96
40	97	99	100	100	101	101	101
45	96	96	101	101	101	100	101
50	95	96	98	97	98	97	98
55	95	94	97	94	96	94	97
60	131	94	94	146	93	128	146
65	646	471	711	522	457	452	711
70	868	888	910	586	821	598	910
75	820	895	836	842	840	843	895
80	873	950	836	868	913	841	950
85	919	963	914	914	923	887	963
90	930	965	833	939	959	904	965
95	924	941	792	933	955	891	955
100	936	963	812	951	946	906	963
105	973	973	855	986	954	926	986
110	958	942	859	966	957	894	966
114	962	939	923	975	974	912	975

Failure [min]	61.33	64.67	62.83	61.83	64.00	61.50	61.33
Failure °C	270	270	270	270	270	270	270

## Internal temperature - between chipboard and fiber gypsum boards

Measured in each quarter section, and 6.5 and 6.6 at mid height.



## Internal temperature - between chipboard and fiber gypsum boards

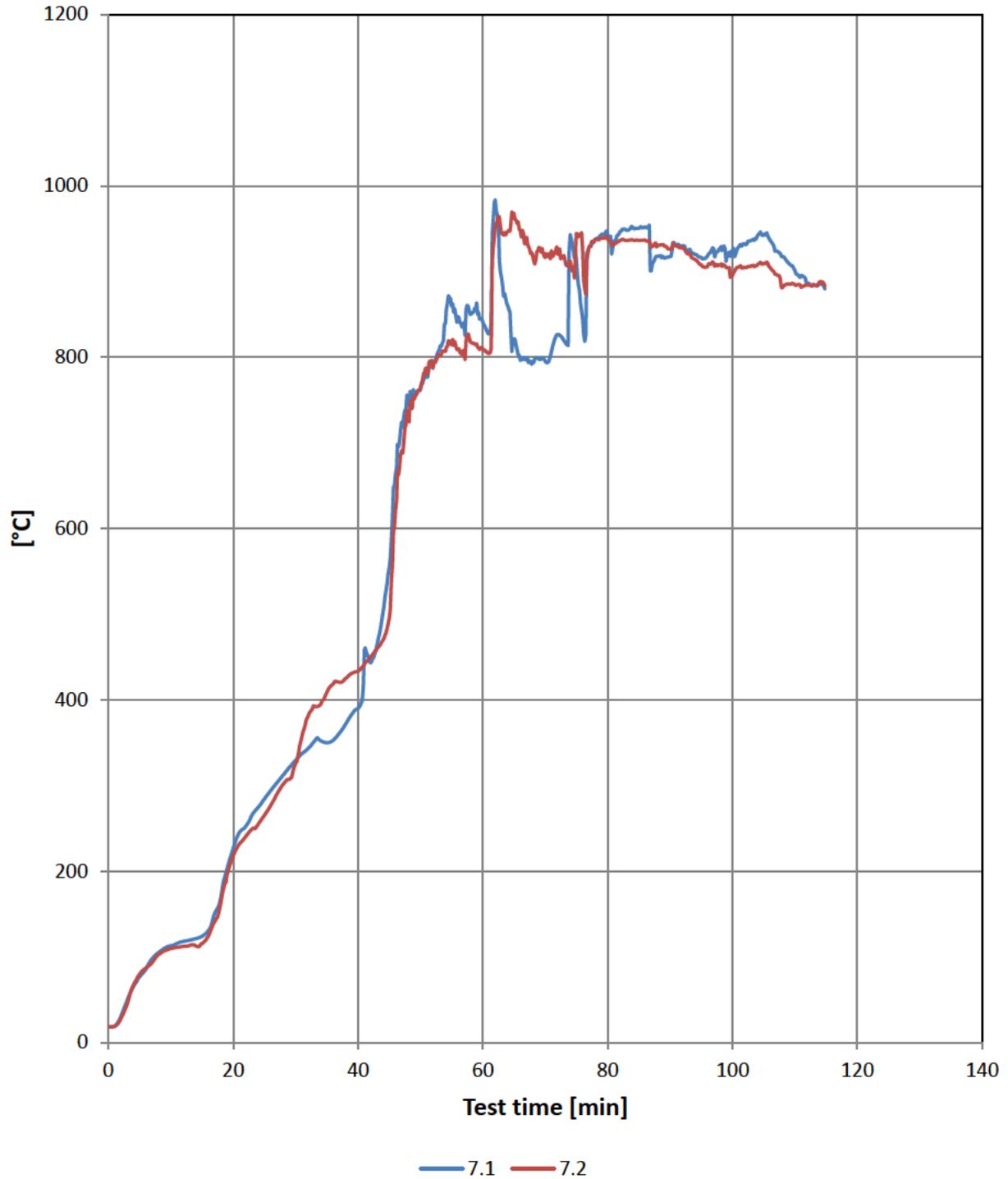
Measured in each quarter section, and 6.5 and 6.6 at mid height.

Min. / °C	6.1	6.2	6.3	6.4	6.5	6.6	6.Max
0	18	18	18	18	18	19	19
5	26	23	25	26	28	34	34
10	70	58	60	64	66	63	70
15	85	78	82	89	81	78	89
20	91	87	92	96	92	90	96
25	103	100	106	115	104	99	115
30	117	115	118	119	118	114	119
35	124	122	123	124	124	123	124
40	129	126	126	129	135	128	135
45	169	133	141	148	259	237	259
50	266	177	339	240	400	450	450
55	586	317	515	440	701	562	701
60	741	544	904	661	875	643	904
65	865	955	853	748	763	809	955
70	886	821	826	824	850	836	886
75	840	866	836	828	981	895	981
80	890	948	877	830	967	889	967
85	911	953	904	854	974	905	974
90	902	940	893	880	978	900	978
95	892	918	884	867	951	901	951
100	882	913	896	862	944	910	944
105	876	923	917	878	957	936	957
110	876	906	906	872	922	902	922
114	881	907	915	857	924	916	924

Failure [min]	50.00	53.33	48.33	50.83	45.33	45.67	45.33
Failure °C	270	270	270	270	270	270	270

## Internal temperature - between fiber gypsum boards

*mid height of studs. 1 on 2nd stud from the right and 2 on center stud seen from unexposed side*



## Internal temperature - between fiber gypsum boards

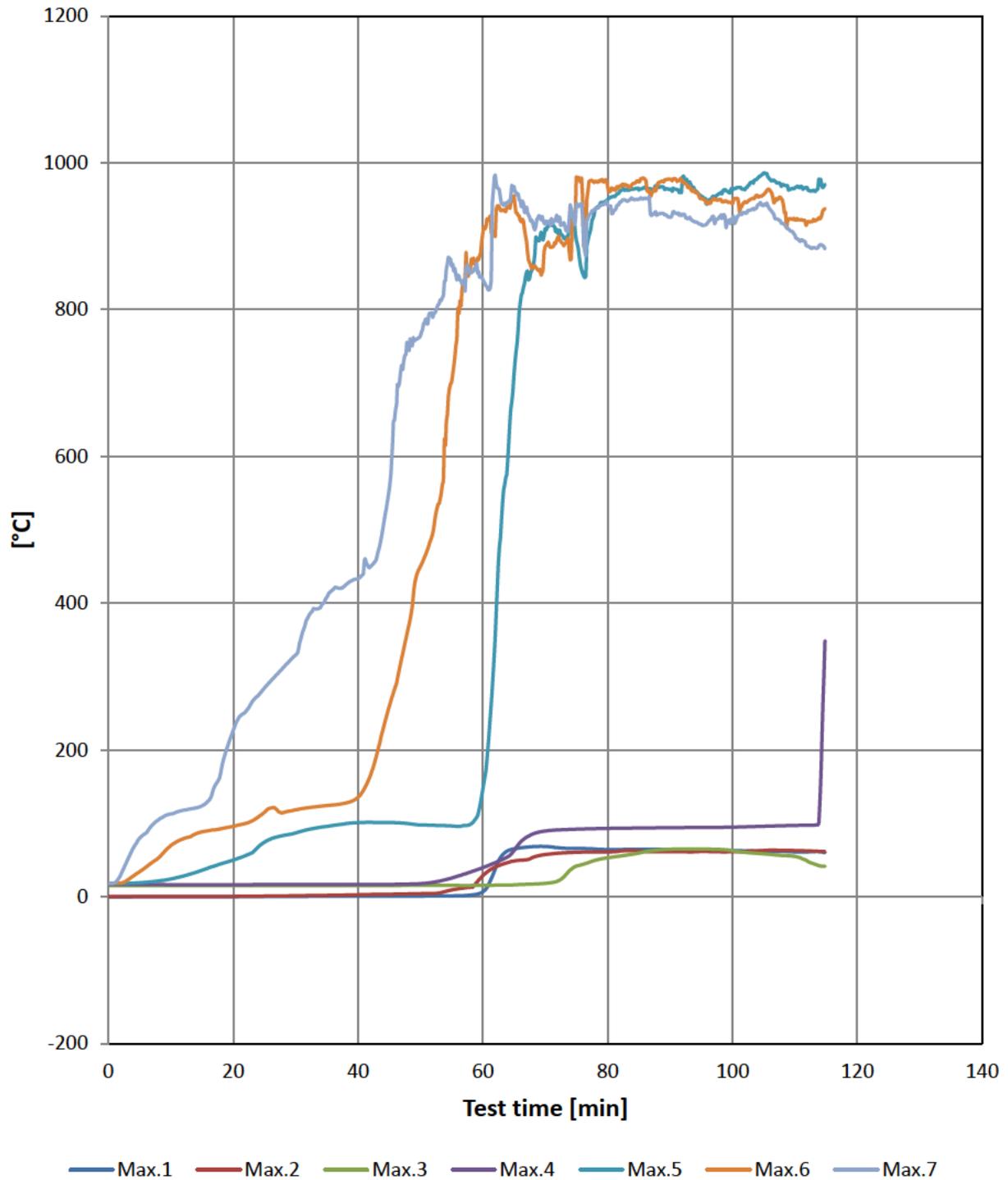
*mid height of studs. 1 on 2nd stud from the right and 2 on center stud seen from unexposed side*

Min. / °C	7.1	7.2	7.Max
0	18	18	18
5	77	80	80
10	113	110	113
15	124	116	124
20	227	218	227
25	285	265	285
30	330	326	330
35	350	408	408
40	390	433	433
45	554	495	554
50	762	764	764
55	859	814	859
60	841	810	841
65	821	968	968
70	796	916	916
75	915	944	944
80	942	938	942
85	951	936	951
90	918	926	926
95	917	908	917
100	924	895	924
105	942	909	942
110	902	885	902
114	885	888	888

Failure [min]	23.50	25.33	23.50
Failure °C	270	270	270

## Temperature development through the construction

Each thermocouple represents the maximum temperature in all measured layers



## Temperature development through the construction

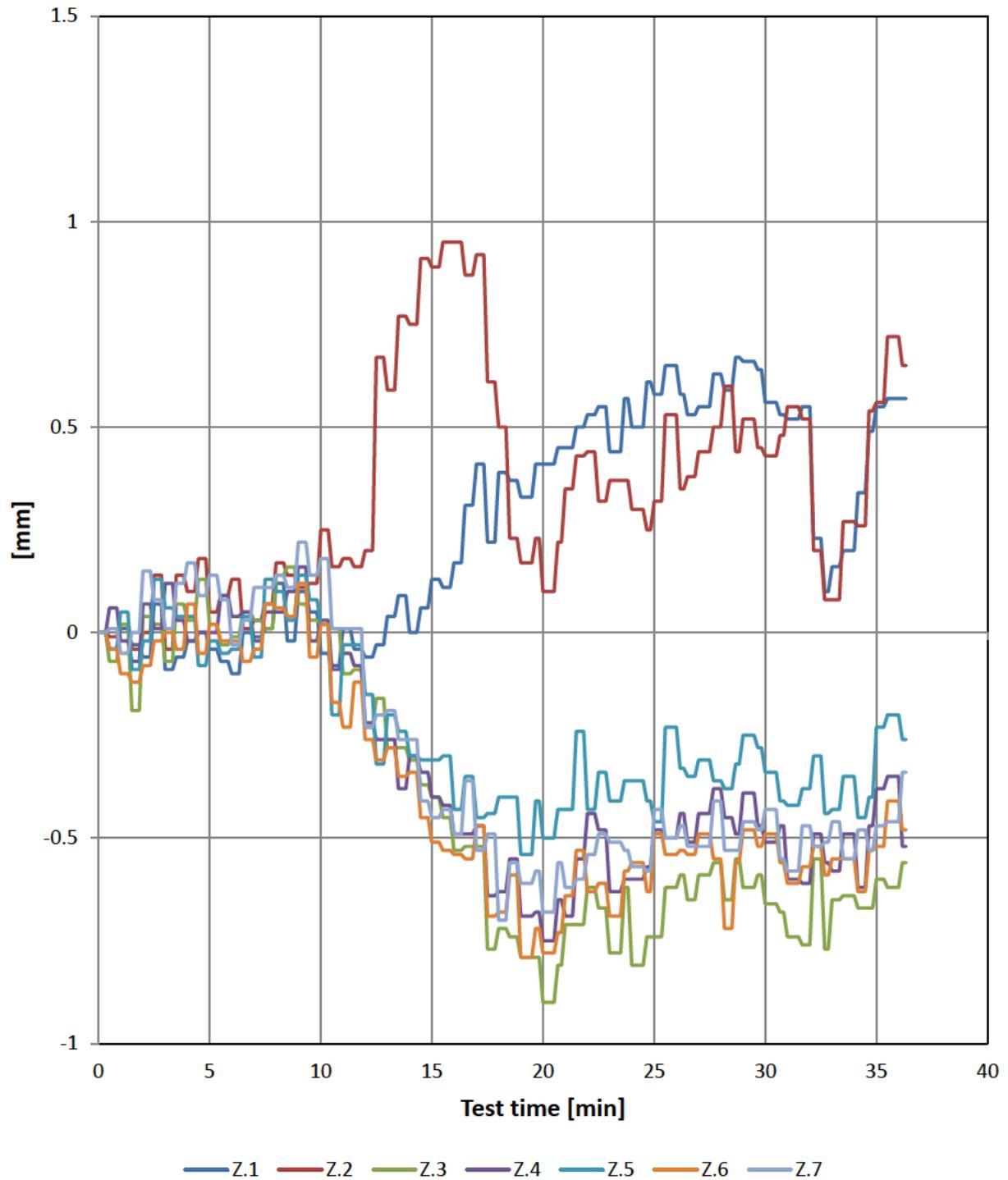
*Each thermocouple represents the maximum temperature in all measured layers*

Min. / °C	Max.1	Max.2	Max.3	Max.4	Max.5	Max.6	Max.7	Max.Max
0	0	0	15	17	18	19	18	0
5	0	0	15	17	19	34	80	0
10	0	0	15	17	24	70	113	0
15	0	0	15	17	36	89	124	0
20	0	1	15	17	50	96	227	0
25	0	1	15	17	75	115	285	0
30	1	2	15	17	87	119	330	0
35	1	2	15	17	96	124	408	0
40	1	3	15	17	101	135	433	0
45	1	4	15	17	101	259	554	0
50	1	4	15	18	98	450	764	0
55	1	9	16	26	97	701	859	0
60	7	29	16	40	146	904	841	0
65	66	49	16	63	711	955	968	0
70	69	58	18	90	910	886	916	0
75	66	61	42	92	895	981	944	0
80	65	61	53	93	950	967	942	0
85	65	62	60	94	963	974	951	0
90	64	62	65	94	965	978	926	0
95	63	62	65	95	955	951	917	0
100	63	62	63	95	963	944	924	0
105	62	63	59	96	986	957	942	0
110	61	63	55	97	966	922	902	0
114	62	62	42	117	975	924	888	0

Failure [min]	-	-	-	114.50	61.33	45.33	23.50	-
Failure °C	270	270	270	270	270	270	270	270

## Horizontal deformation during loading phase

Negative values indicate movement towards the furnace



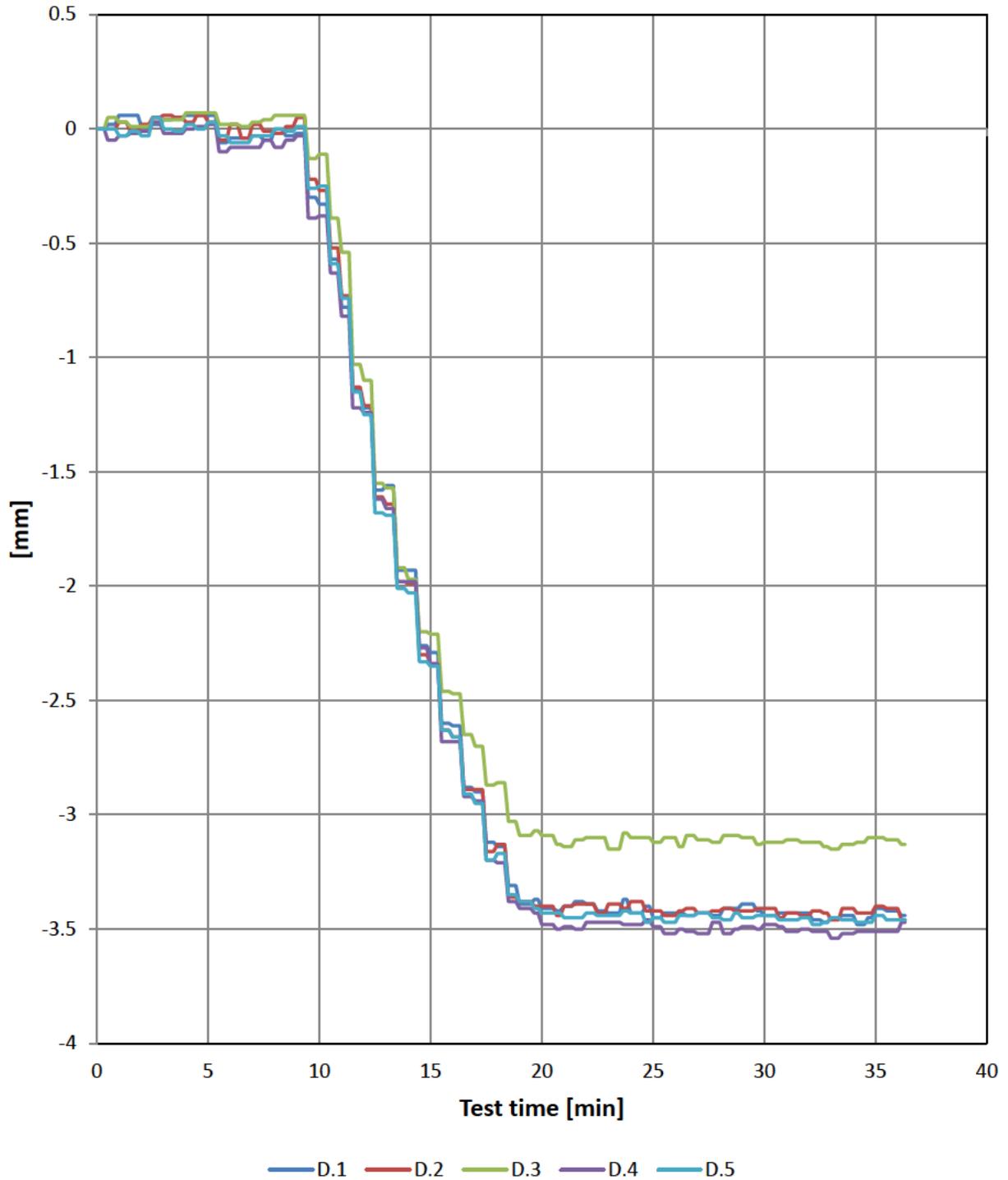
## Horizontal deformation during loading phase

*Negative values indicate movement towards the furnace*

Min. / mm	Z.1	Z.2	Z.3	Z.4	Z.5	Z.6	Z.7
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.1	-0.1	-0.1
2	-0.1	0.0	0.0	0.1	0.0	-0.1	0.2
3	-0.1	0.0	-0.1	0.1	0.1	0.0	0.0
4	0.0	0.1	0.0	0.0	0.0	0.1	0.2
5	0.0	0.1	0.0	0.0	0.0	0.0	0.1
6	-0.1	0.1	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	-0.1	0.0	0.1
8	0.1	0.2	0.1	0.0	0.1	0.1	0.1
9	0.1	0.1	0.1	0.2	0.1	0.1	0.2
10	-0.1	0.3	0.0	0.0	0.0	0.0	0.2
11	0.0	0.2	-0.1	-0.1	0.0	-0.2	0.0
12	-0.1	0.2	-0.2	-0.2	-0.2	-0.3	-0.2
13	0.0	0.6	-0.3	-0.3	-0.2	-0.3	-0.2
14	0.0	0.8	-0.3	-0.3	-0.3	-0.3	-0.3
15	0.1	0.9	-0.4	-0.4	-0.3	-0.5	-0.5
16	0.2	1.0	-0.5	-0.5	-0.4	-0.5	-0.5
17	0.4	0.9	-0.5	-0.5	-0.5	-0.5	-0.5
18	0.4	0.5	-0.7	-0.6	-0.4	-0.7	-0.7
19	0.3	0.2	-0.8	-0.7	-0.5	-0.8	-0.6
20	0.4	0.1	-0.9	-0.8	-0.5	-0.8	-0.7
21	0.5	0.4	-0.7	-0.7	-0.4	-0.6	-0.6
22	0.5	0.4	-0.6	-0.4	-0.4	-0.6	-0.5
23	0.4	0.4	-0.8	-0.6	-0.4	-0.7	-0.5
24	0.5	0.3	-0.8	-0.6	-0.4	-0.6	-0.6
25	0.6	0.3	-0.7	-0.5	-0.5	-0.5	-0.4
26	0.7	0.5	-0.6	-0.5	-0.2	-0.5	-0.5
27	0.6	0.4	-0.6	-0.4	-0.3	-0.5	-0.5
28	0.6	0.5	-0.6	-0.4	-0.4	-0.6	-0.4
29	0.7	0.5	-0.6	-0.4	-0.3	-0.5	-0.5
30	0.6	0.4	-0.7	-0.5	-0.3	-0.5	-0.4
31	0.5	0.6	-0.7	-0.6	-0.4	-0.6	-0.6
32	0.6	0.5	-0.8	-0.6	-0.4	-0.6	-0.5
33	0.2	0.1	-0.7	-0.6	-0.4	-0.6	-0.5
34	0.2	0.3	-0.6	-0.5	-0.4	-0.6	-0.6
35	0.6	0.6	-0.6	-0.4	-0.2	-0.5	-0.5
36	0.6	0.7	-0.6	-0.4	-0.2	-0.4	-0.5

## Vertical deformation during loading phase

*Negative values indicate downwards movement*



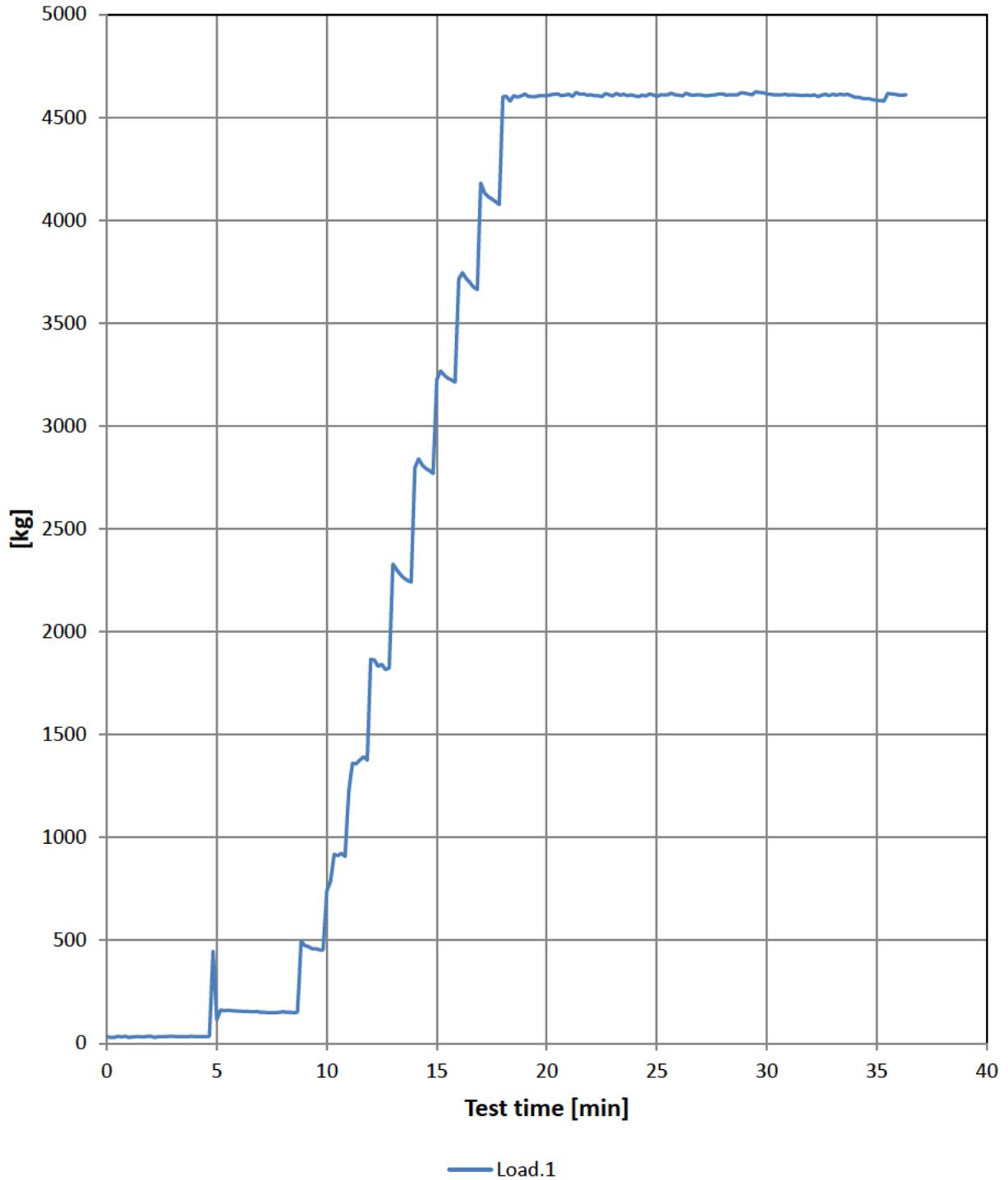
## Vertical deformation during loading phase

*Negative values indicate downwards movement*

Min. / mm	D.1	D.2	D.3	D.4	D.5
0	0.0	0.0	0.0	0.0	0.0
1	0.1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.1	0.0	0.0	0.0
4	0.1	0.0	0.1	0.0	0.0
5	0.1	0.0	0.1	0.0	0.0
6	0.0	0.0	0.0	-0.1	-0.1
7	0.0	0.0	0.0	-0.1	0.0
8	0.0	0.0	0.1	-0.1	0.0
9	0.0	0.1	0.1	0.0	0.0
10	-0.3	-0.3	-0.1	-0.4	-0.3
11	-0.8	-0.7	-0.5	-0.8	-0.7
12	-1.2	-1.2	-1.1	-1.2	-1.3
13	-1.6	-1.6	-1.6	-1.7	-1.7
14	-1.9	-2.0	-2.0	-2.0	-2.0
15	-2.3	-2.3	-2.2	-2.3	-2.4
16	-2.6	-2.7	-2.5	-2.7	-2.7
17	-2.9	-2.9	-2.7	-2.9	-3.0
18	-3.1	-3.1	-2.9	-3.2	-3.2
19	-3.4	-3.4	-3.1	-3.4	-3.4
20	-3.4	-3.4	-3.1	-3.5	-3.4
21	-3.4	-3.4	-3.1	-3.5	-3.5
22	-3.4	-3.4	-3.1	-3.5	-3.4
23	-3.4	-3.4	-3.2	-3.5	-3.4
24	-3.4	-3.4	-3.1	-3.5	-3.4
25	-3.5	-3.4	-3.1	-3.5	-3.5
26	-3.4	-3.4	-3.1	-3.5	-3.5
27	-3.4	-3.4	-3.1	-3.5	-3.4
28	-3.4	-3.4	-3.1	-3.5	-3.5
29	-3.4	-3.4	-3.1	-3.5	-3.5
30	-3.4	-3.4	-3.1	-3.5	-3.4
31	-3.4	-3.4	-3.1	-3.5	-3.5
32	-3.4	-3.4	-3.1	-3.5	-3.5
33	-3.5	-3.5	-3.2	-3.5	-3.5
34	-3.4	-3.4	-3.1	-3.5	-3.5
35	-3.4	-3.4	-3.1	-3.5	-3.4
36	-3.4	-3.4	-3.1	-3.5	-3.5

### Load per cylinder during loading phase

Load per cylinder



## Load per cylinder during loading phase

*Load per cylinder*

Min. / kg	Load.1
0	33
1	29
2	35
3	35
4	33
5	115
6	157
7	151
8	153
9	475
10	740
11	1223
12	1867
13	2329
14	2797
15	3226
16	3715
17	4181
18	4601
19	4614
20	4607
21	4612
22	4610
23	4605
24	4605
25	4603
26	4608
27	4610
28	4614
29	4618
30	4614
31	4608
32	4607
33	4612
34	4599
35	4584
36	4608



Photo No. 1 Mounting of the first part of the wall assembly



Photo No. 2 Straw insulation between the load bearing studs.



Photo No. 3 Wall element assembly finished.



Photo No. 4 Mounting of felt membrane to the unexposed side of the specimen.



Photo No. 5 Unexposed side finished with wood spacers.



Photo No. 6 Mounting of wood fibre board, exposed side.



Photo No. 7 Mounting of gypsum boards, exposed side.



Photo No. 8 Gypsum mounted on exposed side of specimen.



Photo No. 9 Gypsum mounted on exposed side of specimen.



Photo No. 10 Spackle applied over the joints of the gypsum board.



Photo No. 11 Start test.



Photo No. 12 Specimen after 30 minutes of testing.



Photo No. 13 Test specimen after 60 minutes of testing.

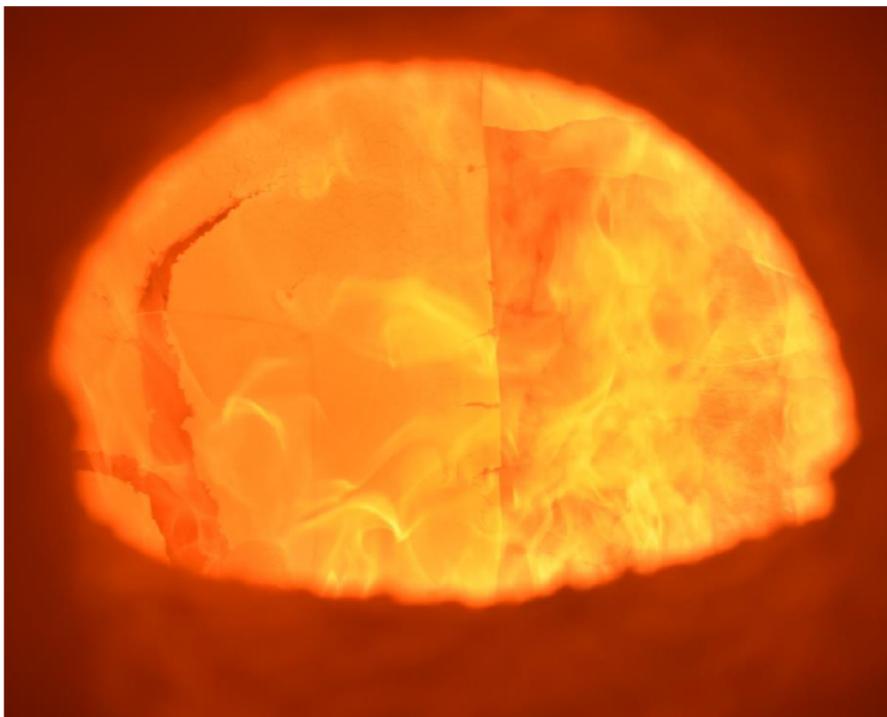


Photo No. 14 Exposed side of specimen after 90 minutes of testing.



Photo No. 15 Unexposed side after 90 minutes of testing. Liquid is starting to run down the bottom of the specimen.



Photo No. 16 Specimen after 104 minutes of testing.



Photo No. 17 Specimen after 105 minutes of testing, starting to smoke form unexposed side of specimen.



Photo No. 18 Specimen after 111 minutes of testing, more smoke form unexposed side of specimen mid and top.

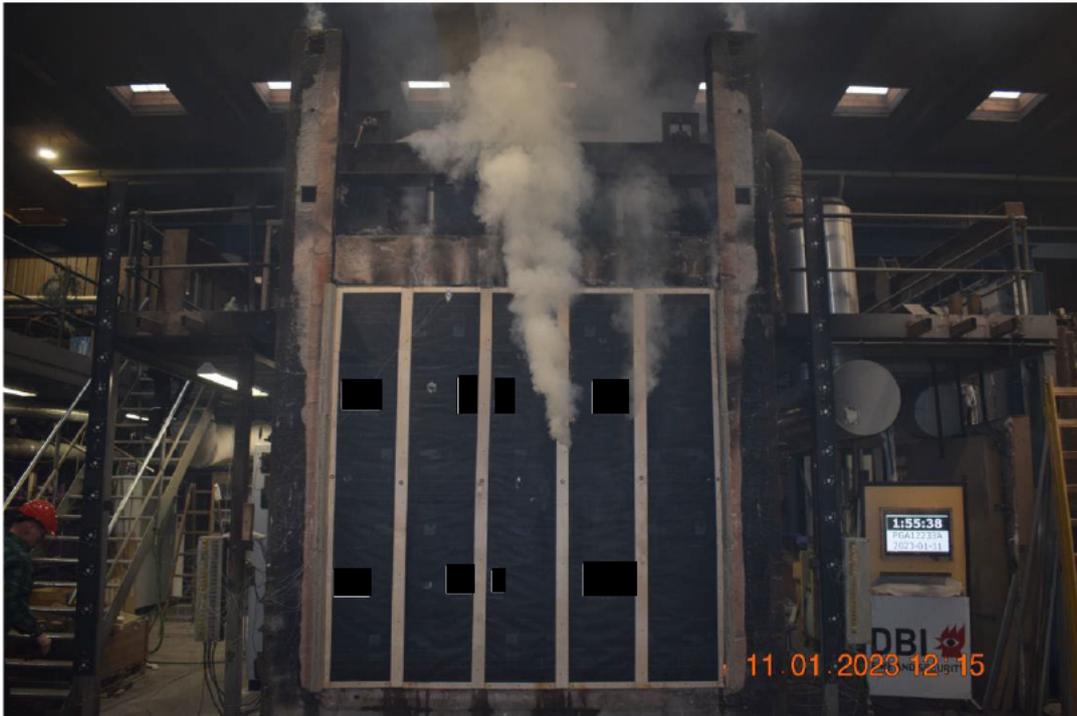


Photo No. 19 Test ended after 114 minutes of testing.



Photo No. 20 Exposed side after test ended.



Photo No. 21 Unexposed side after test ended.