



Test Report

Loadbearing roof

Name of sponsor: Nordic Build A/S
Product name: Loadbearing roof
File no.: PGA11454A **Revision no.:** 0
Test date: 07-06-2019 **Date:** 03-07-2019
Pages: 11 **Encl.:** 56
Ref: RBI / NOL

Client information

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Date of test

The test was conducted on 07-06-2019.

Purpose of test

Examination of the fire-resistance of a loadbearing and separating roof.

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

DS/EN 1363-1:2012 Fire resistance tests – General requirements

in conjunction with

EN 1365-2:2014 Fire resistance test for loadbearing elements – Part 2: Floors and roofs

Test specimen

The trade name and sponsors identification mark is stated below:

Trade name:	Loadbearing roof
Identification mark:	None

The components for the test specimen were delivered and mounted by the sponsor.

The sponsor delivered one test specimen for fire testing.

The process of verification was carried out by DBI - Danish Institute of Fire and Security Technology. The laboratory oversaw the fabrication of the test specimen, material for verification of density, thickness, moisture and organic content were sampled during the inspection.

Drawings and description

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

Type	Drawing No.	Dated	Subject
Drawing	1	01.06.2019	Tagelement monteret på DBI betonramme
Drawing	2	20.05.2019	Tagelement uden brandbeskyttende beklædning
Drawing	3	06.06.2019	Hatteprofiler
Drawing	4	06.06.2019	Tagelement med 1. lag 15 mm brandgips
Drawing	5	06.06.2019	Tagelement med 2. lag 15 mm brandgips
Drawing	6	20.05.2019	Tagelement
Drawing	7	20.05.2019	Tagelement vederlagsdetalje
Drawing	8	20.05.2019	Tagelement vederlagsdetalje
Drawing	9	20.05.2019	Tagelement
Drawing	10	20.05.2019	Tagelement uden brandbeskyttende beklædning
Drawing	11	20.05.2019	Tagelement tværsnit
Data sheet			M4 composite board (2 pages)
Data sheet			Stone wool (2 pages)
Data sheet			Adhesive
Data sheet			Steel (2 pages)
Data sheet			Gypsum boards

The documentation is supplied by the sponsor and it is stamped 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 assembly, the test and after the test.

The sponsor carried out the mounting of the test specimen.

Test specimen

External measures: Full length: 6170 mm Width: 2900 mm Thickness: 472 mm

The test specimen was a loadbearing roof construction made of elements of steel, M4 composite boards and stone wool. The test specimen consisted of 12 elements – further documentation see drawing 6, 7, 9 and 11.

The test specimen was built of individual elements with a width of 250 mm – further documentation see drawing 11.

The elements at free edge had a width of 200 mm.

On the exposed side of the test specimen, two layers of 15 mm gypsum plasterboards were mounted on steel hat profiles.

Each individual element consisted of two 0.9 mm profiled flanges of steel. The two flanges of steel were connected through a M4 composite board – the M4 composite boards were glued with 140 g/m to the flanges of steel. The vertical joints in the M4 composite boards were not glued. Stone wool was installed between the two flanges of steel – there was no glue used to bond the stone wool to the flanges of steel. Each individual element formed an insulated beam. The individual elements were connected in an airtight tongue and groove lock – further documentation see drawing 9.

The test specimen was symmetrical – to leave out of account the gypsum plasterboards.

Components

Boards:	15 mm M4 composite boards designated Cantona M4 komposit with a nominal density of 1.100 kg/m ³ . The M4 composite boards had a height of 470 mm and were installed with two joints in the longitudinal direction of the test specimen – 1850 mm / 2400 mm / 1850 mm.
Insulation:	420 mm stone wool insulation designated Rockwool Flexibatts 34 with a nominal density of 42 kg/m ³ . The nominal density is not indicated. The stone wool was installed in full length of the test specimen – 6100 mm – with a plural number of joints.
Adhesive:	A two component adhesive designated PKI ProFect 41176 + 91102 with a nominal density of 1.6 kg/L + 1.2 kg/L.
Steel:	Exterior side of the test specimen was formed with steel plates designated Aluzinc with a bulk density of 3750 kg/m ³ .
Hat profile:	Steel hat profiles with dimension 25 x 85 mm was mounted cc 400 mm on the exposed side of the test specimen. The hat profiles were mounted with screws designated BYGMA T/STÅL gipsskruer m/borspids 3.5x25 mm. The screws were placed cc 250 mm – corresponding to the width of each insulated beam. Further documentation – see drawing 3. A 50 x 50 mm steel profile was mounted on each side of the test specimen as support for the gypsum plaster boards. See photo no. 10.
Gypsum plaster boards:	Two layers of 15 mm gypsum plaster boards designated Siniat GKF SCAN 15 was mounted on the exposed side of the test specimen. The dimension of the gypsum plaster boards before cutting into size was 3000 x 1200 x 15 mm. The first layer of gypsum plaster boards consisted of four boards in full width and two boards cut into size with width 400/800 mm. The two boards cut into size were mounted at each end of the test specimen. One full width board had a joint placed 500 mm from the edge of the test specimen. The second layer of gypsum plaster boards consisted of five boards in full width. One full width board had a joint placed 500 mm from the edge of the test specimen – opposite edge side as the joint in first layer of gypsum plaster boards. The first layer of gypsum plaster boards were mounted with screws designated P-SCREW S 3.5x35 mm. The screws were placed cc 200 mm along the edges and cc 300 mm at mid width of the gypsum plaster boards.

The second layer of gypsum plaster boards were mounted with screws designated BYGMA T/STÅL 3.5x51 mm. The screws were placed cc 200 mm along the edges and cc 300 mm at mid width of the gypsum plaster boards.

Further documentation – see drawing 4 and 5.

Measured by DBI

Product		Flexibatts 34	M4 Composite	GKF SCAN 15
Density	kg/m ³	41	978	896
Thickness	mm		14.7	15.5
Moisture content	%	0.3	14.8	0.4
Organic content	%	2.5	-	-
Sampling method		Extra material	Extra material	Extra material
Drying temperature		105 °C	105 °C	55 °C

Test conditions

Conditioning

The test specimen was delivered on the 03-06-2019 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

The test specimen was mounted simple supported in a test frame suitable for loaded tests with a clear opening length and width of 6000 x 3070 mm (exposed area). The loadbearing roof element was supported 50 mm in from the furnace edges resulting in a total loaded roof span of 6100 mm.

The two layer of 15 mm gypsum boards were mounted after the test specimen was mounted in the test frame.

Free edges between the roof and the furnace frame were established along both vertical edges of the test specimen (2 x 25 mm stone wool in each side) to allow for unrestrained deformation of the test specimen.

Loading

The test specimen was loaded with a total applied load of 45.2 kN (2.60 kN/m²) placed as two line loads in the two quarter sections each on 22.6 kN.

The maximum moment in the deck from the applied load during the fire test was 11.7 kNm/m.
The maximum shear force in the deck from the applied load during the fire test was 7.8 kN/m.

The total applied load of 45.2 kN corresponds to a load of 4608 kg. With a total weight of the loading equipment of 295 kg, the load delivered from the piston was set to 4313 kg.

Prior to the uploading, the applied load was verified by placing the piston under a calibrated load cell. The oil pressure needed to obtain the required load 4313 kg was determined. This pressure was controlled during the test.

The load was applied as a downward oriented point load in the quarter sections of the deck, e.g. there was no eccentricity in the loading conditions.

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. The fully applied load was kept during the full extent of the fire test.

Fire test

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 and deflection were measured on the unexposed surface of the test specimen as indicated on DBI enclosure 1.0.

The internal temperatures were measured at mid height and 25 mm above lower visible edge of M4 composite boards of the test specimen as indicated on DBI enclosure 1.1.

The surface temperatures were measured on the exposed side of the test specimen placed between the test specimen and the 2x15 mm gypsum boards as indicated on DBI enclosure 1.2.

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 1363-1:2012.

The thermocouples were constructed according to the description in EN 1363-1:2012.

The pressure was kept at 20 Pa just below the aerated concrete deck. The pressure differential was measured 100 mm below the loaded deck, which gives a pressure set point of approximately 20 Pa at the height of the measuring device.

Test results

Duration of the test was 87 minutes.

Measurements

The enclosed graphs and tables show:

Enclosures 2.0 and 2.1	Furnace temperatures 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	Horizontal furnace pressure The differential pressure in the furnace during the test, measured 100 mm below the test specimen
Enclosures 4.0 and 4.1	Ambient temperature The ambient temperature in the laboratory during the test



Enclosures 5.0 and 5.1	Average temperature Temperature rise on the unexposed side
Enclosures 6.0 and 6.1	Maximum temperatures Temperature rise on the unexposed side
Enclosures 7.0 and 7.1	Internal indicative temperatures Temperature rise inside the test specimen
Enclosures 8.0 and 8.1	Internal indicative temperatures Temperature rise inside the test specimen
Enclosures 9.0 and 9.1	Load The load on the deck from the hydraulic jack
Enclosures 10.0 and 10.1	Deformation The vertical deflection measured on the unexposed side (positive values indicates movement towards the furnace)
Enclosures 11.0 and 11.1	Deformation rate per minute D1, D3: at the edges, D2: in the center
Enclosures 12.0 and 12.1	Load during loading phase Total load prior to the test
Enclosures 13.0 and 13.1	Deformation during loading phase The vertical deflection measured prior to the test on the unexposed side (positive values indicates movement towards the furnace)

Visual observations:

Time / Minutes	Visual observations:	U = Unexposed side E = Exposed side
0	Test commences	
15	No changes	U
20	Smoke development from edges of test frame	U
30	No changes	U
40	No changes	U
48	Joints in gypsum boards are opening a bit	E
62	Cracks in 1. layer gypsum boards, more openings from joints in gypsum boards	E
67	Opening up in joints – visible deflection	E
70	Gypsum boards are hanging loose in one side	E
72	Gypsum boards are falling down in medium size pieces	E
74	Cracks in 2. layer of gypsum boards	E
76	2. layer of gypsum boards are falling down on one side of the furnace	E
77	Further gypsum boards from 2. layer falls down	E

79	Visible flames on exposed side of the test specimen	E
82	Approximately 70 % of exposed side of the test specimen is not covered by gypsum boards	E
84	Deflection measuring D1 falls of	U
85	Approximately 90 % of exposed side of the test specimen is not covered by gypsum boards	E
87	Test stopped due to safety reasons	

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.

Conclusion

Fire resistance testing according to 1365-2:2014 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:

Load-bearing capacity (R): 81 minutes

- The load on the test specimen was maintained during the entire test
- The measured vertical deflection did not exceed the criteria of $C = L^2/(h \times 400) = 190.7$ mm during the test. The maximum deflection was 176.1 mm.
- The measured rate of vertical deflection exceeded the criteria of $dC/dt = L^2/(h \times 9000) = 8.5$ mm/min after 81 minutes of testing.

Note: according to EN 1363-1:2012 §11.1 the criteria for rate of deflection does not apply in the first 10 minutes of the fire test.

Integrity (E): 87 minutes

- Sustained flaming did not occur during the test
- The cotton pad was not ignited during the test
- No through-going openings in the test specimen were created during the test

Insulation (I): 68 minutes

- During the test no failure of insulation occurred 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
-

Remarks

The field of direct application of the test results appears from 1365-2:2014, 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, and where appropriate EN 1363-2. 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.

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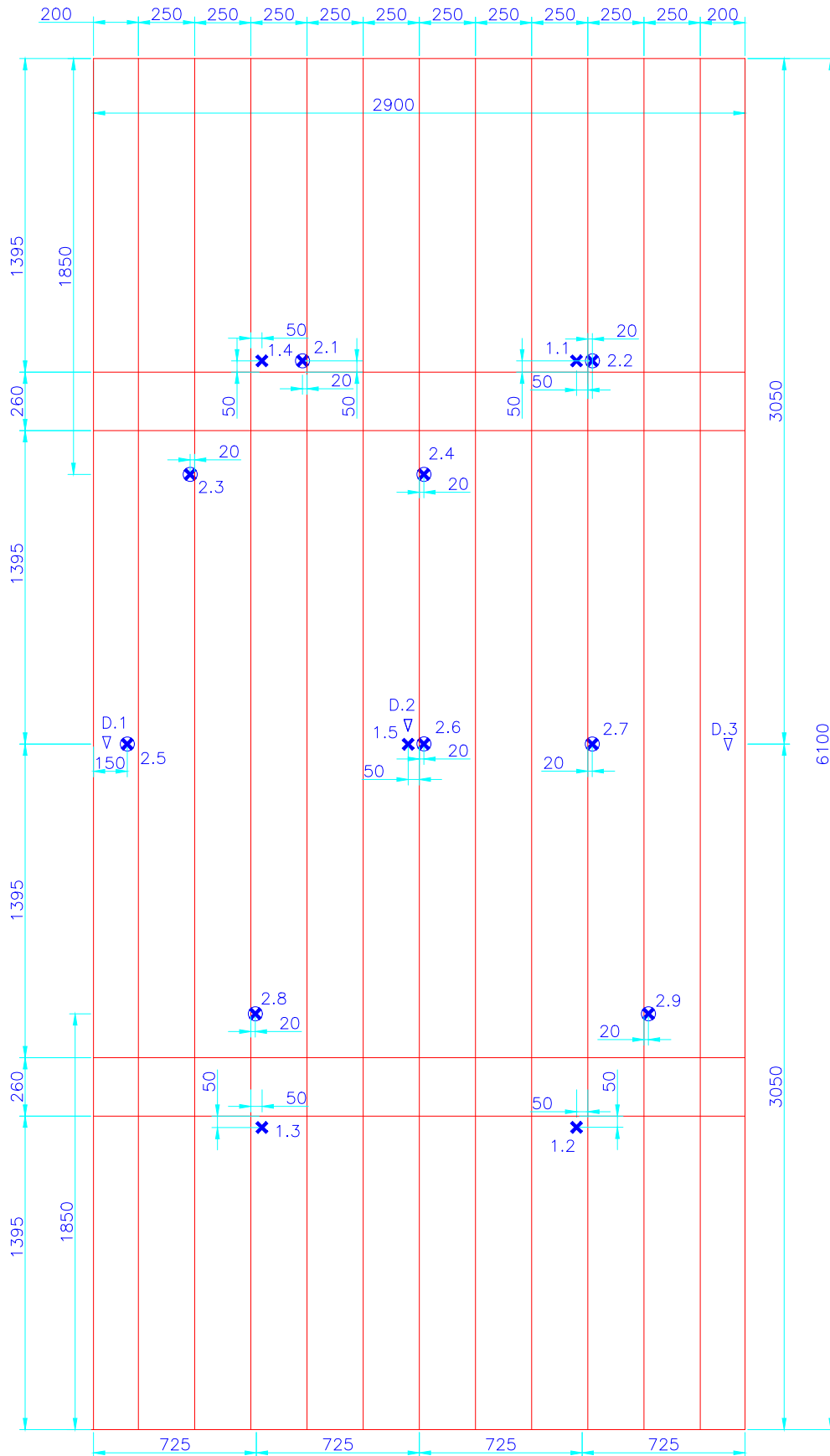
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Enclosures:

DBI drawings:	3
DBI graphs and tables:	24
Photo sheets:	10
Sponsors drawings:	19

56



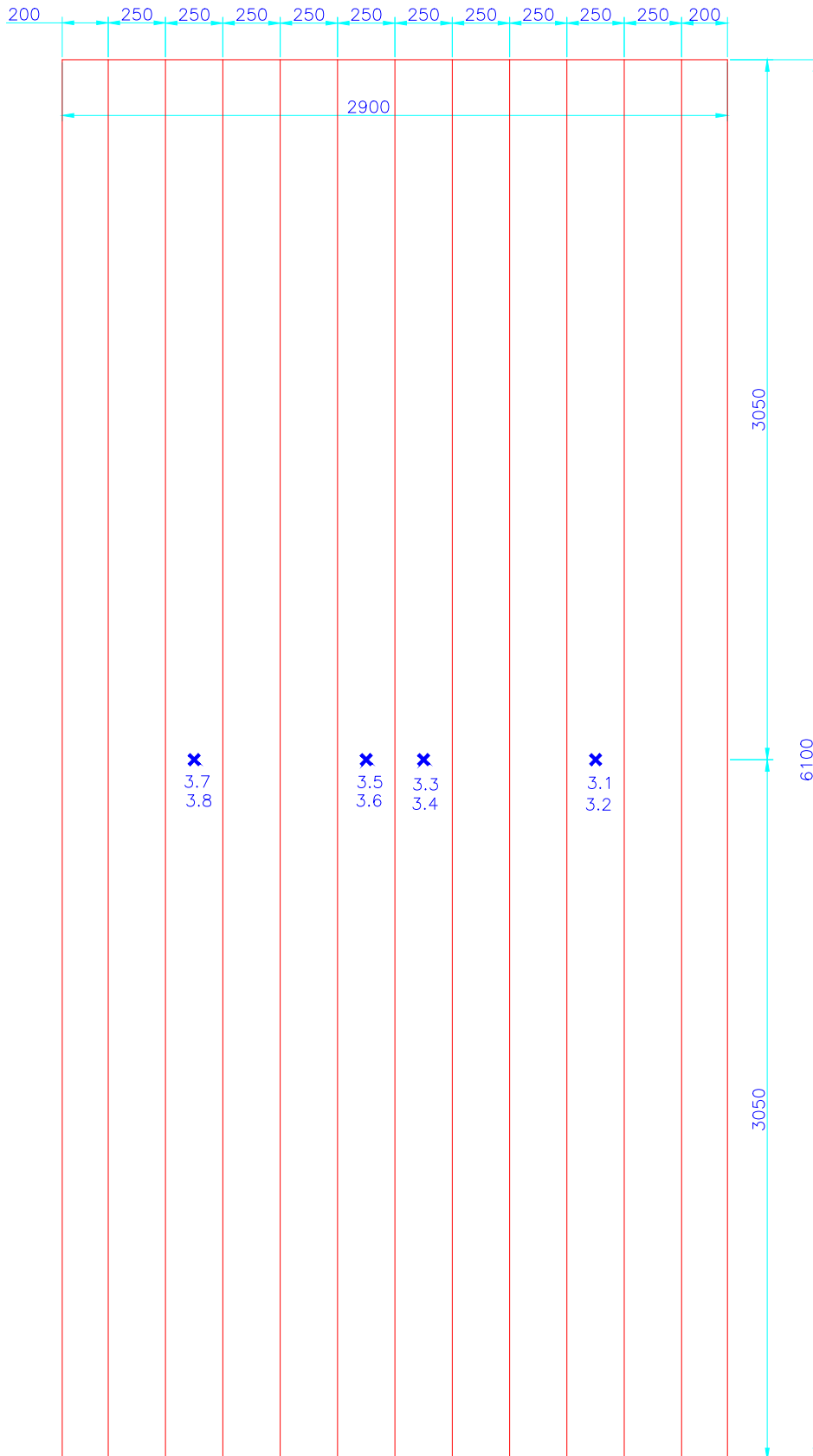
- ✕ Thermocouple placed on the unexposed surface (average)
- ⊗ Thermocouple placed on the unexposed surface (maximum)
- ∇ Deflection measuring point

All measurements are in mm

Danish Institute of Fire and security Technology

Sponsor: Nordic Build A/S
 Subject: Loadbearing roof

File No.: PGA11454A
 Test date: 07-06-2019
 Enclosure: 1.0



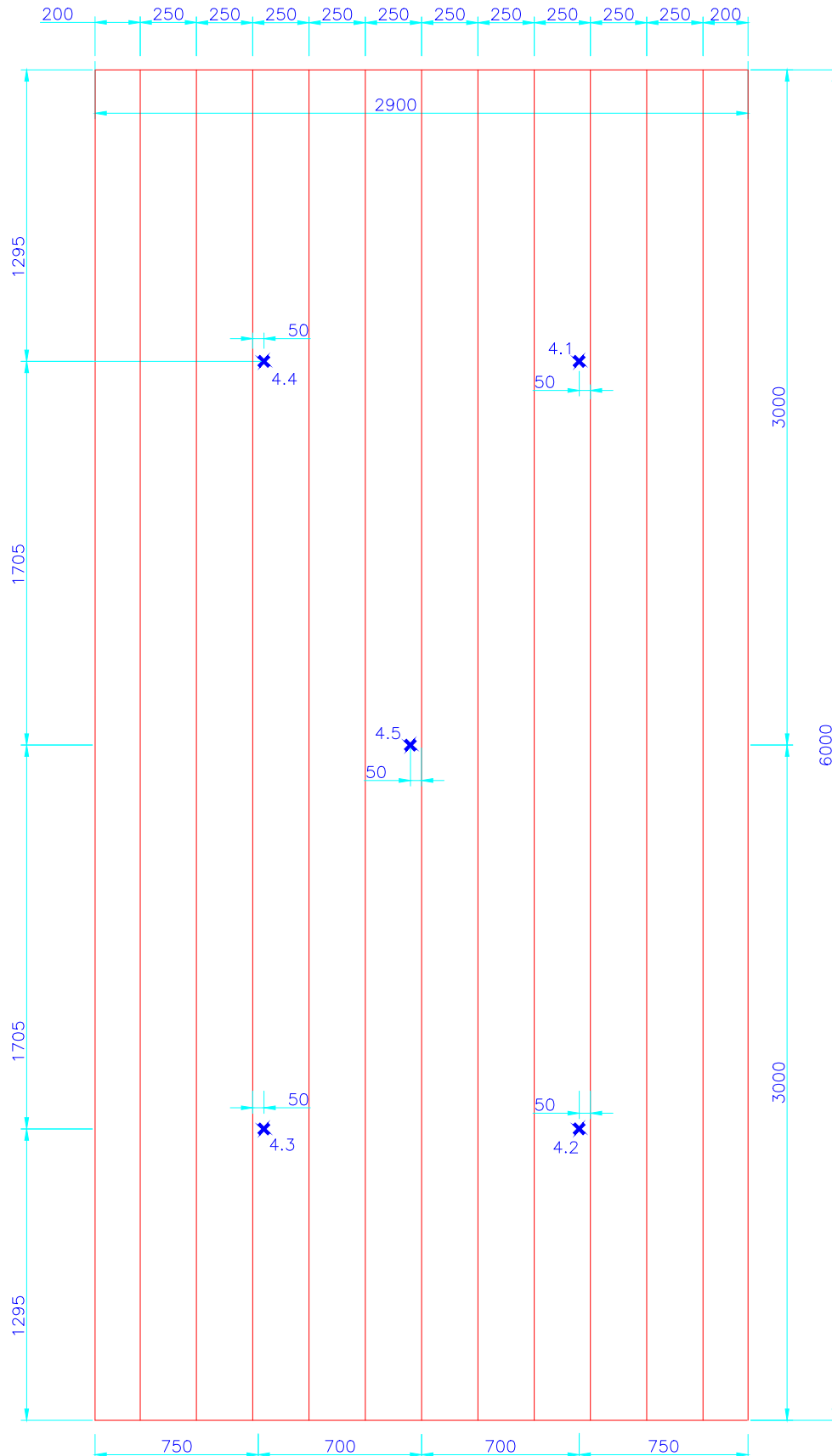
- ✘ Thermocouple placed inside the test specimen
A3.1, A3.3, A3.5, A3.7 placed 25 mm above lower visible edge of M4 composite board
A3.2, A3.4, A3.6, A3.8 placed mid height M4 composite board

All measurements are in mm

Danish Institute of Fire and security Technology

Sponsor: Nordic Build A/S
Subject: Loadbearing roof

File No.: PGA11454A
Test date: 07-06-2019
Enclosure: 1.1



✘ Thermocouple placed on exposed side of the test specimen between the test specimen and the 2x15 mm gypsum boards

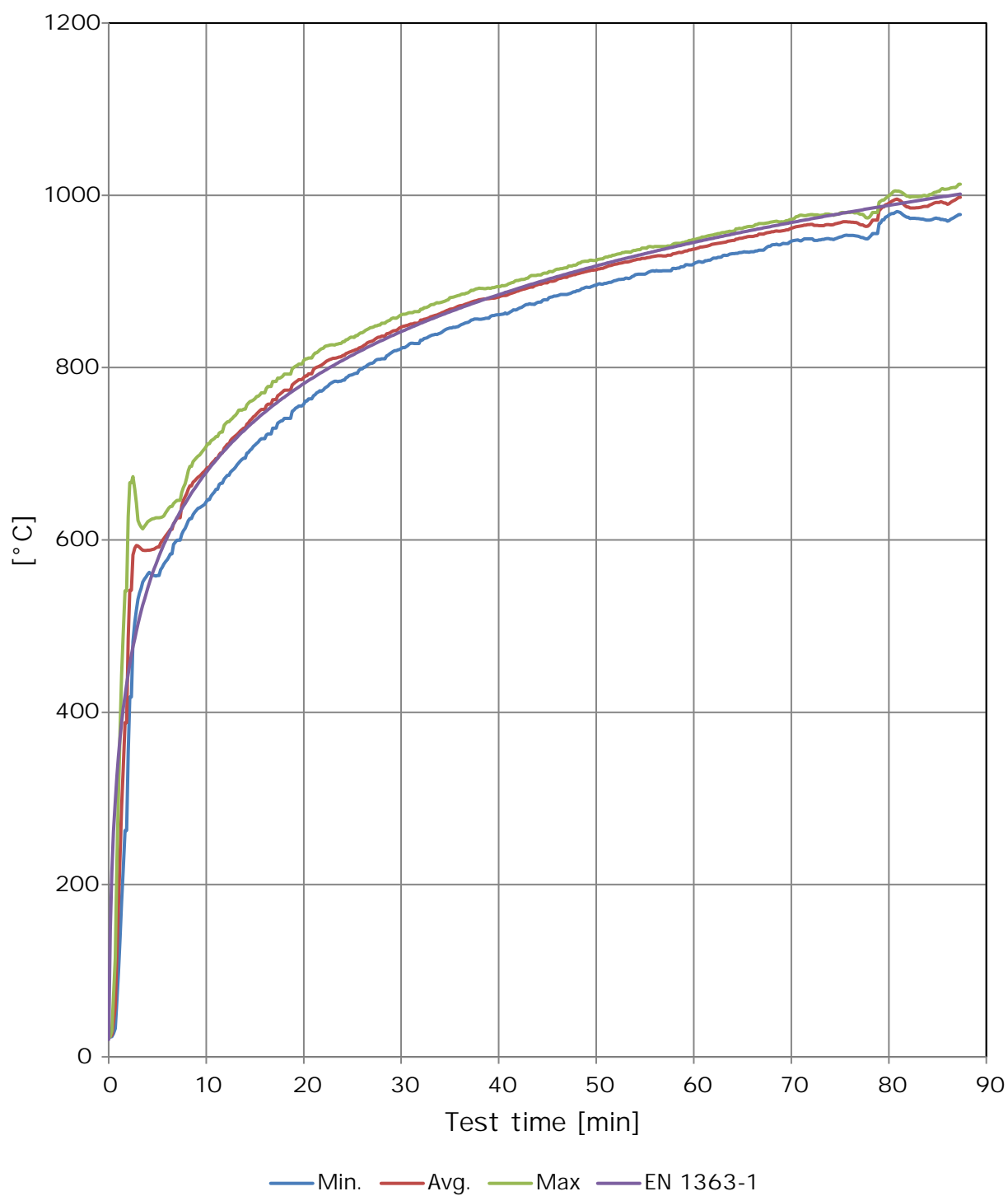
All measurements are in mm

Danish Institute of Fire and security Technology

Sponsor: Nordic Build A/S
Subject: Loadbearing roof

File No.: **PGA11454A**
Test date: 07-06-2019
Enclosure: 1.2

Furnace temperatures

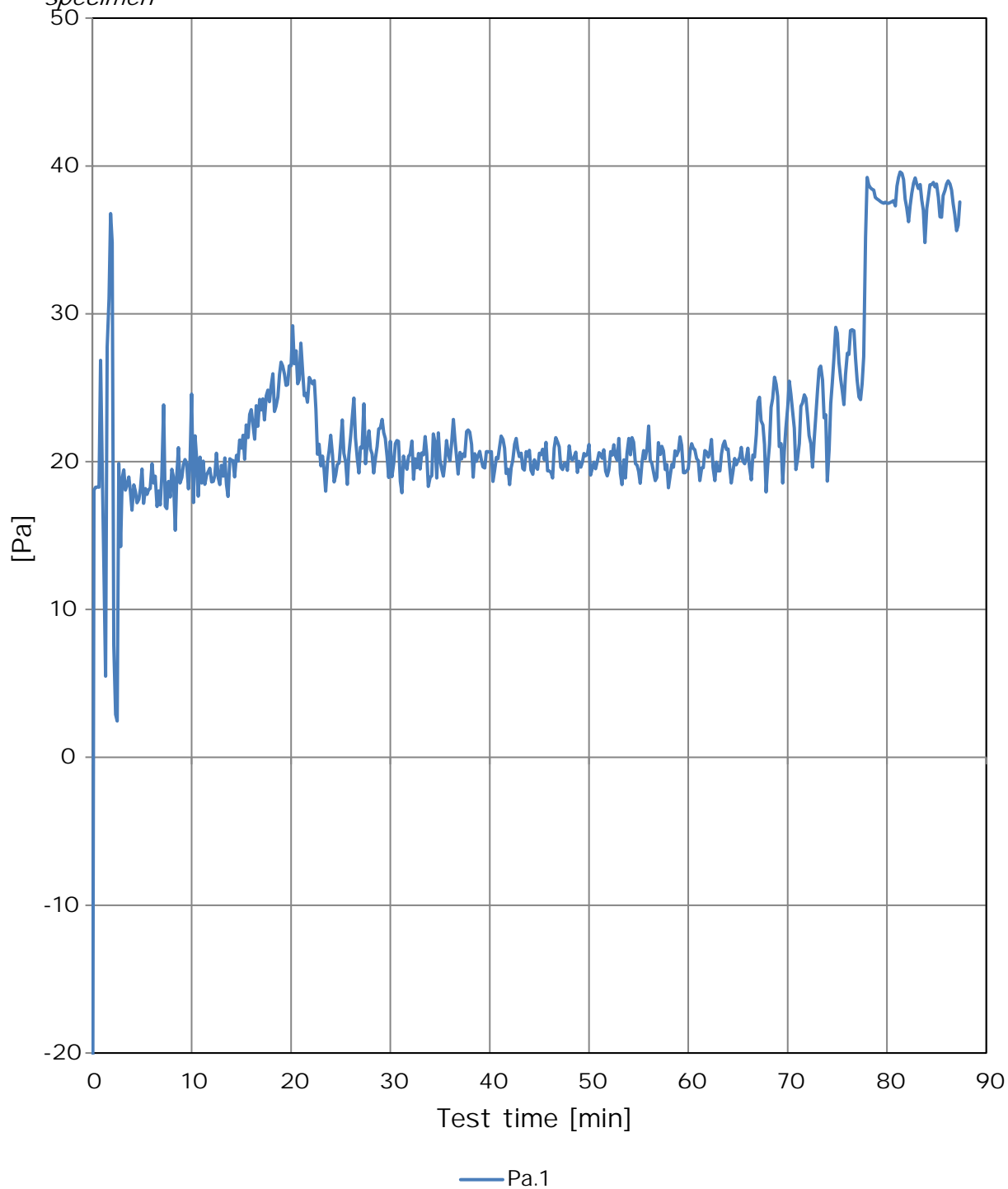


Furnace temperatures

Time Minutes	Measured			Norm EN 1363-1	Area under curve		Dev. [%]	Limit [%]
	Minimum	Average	Maximum		Measured	EN 1363-1		
0	23	23	24	20	0	0	0,0	
3	531	593	623	502	953	1115	-14,5	
6	577	607	634	603	2731	2790	-2,1	15
9	635	671	696	663	4647	4695	-1,0	15
12	673	709	735	705	6712	6750	-0,6	14
15	710	744	764	739	8891	8918	-0,3	13
18	741	774	792	766	11166	11176	-0,1	11
21	767	798	815	789	13519	13508	0,1	10
24	785	814	830	809	15940	15904	0,2	8
27	805	831	847	826	18407	18357	0,3	7
30	822	847	861	842	20923	20859	0,3	5
33	837	859	873	856	23480	23406	0,3	5
36	849	872	884	869	26076	25994	0,3	5
39	857	880	892	881	28706	28619	0,3	4
42	869	889	901	892	31357	31279	0,3	4
45	879	898	910	902	34040	33971	0,2	4
48	889	909	919	912	36751	36692	0,2	4
51	898	917	928	921	39489	39442	0,1	3
54	908	925	936	930	42253	42218	0,1	3
57	913	930	941	938	45037	45019	0,0	3
60	920	938	949	945	47838	47844	0,0	3
63	930	945	957	953	50663	50691	-0,1	3
66	935	952	964	960	53510	53559	-0,1	3
69	943	959	969	966	56378	56448	-0,1	3
72	949	966	978	973	59267	59356	-0,2	3
75	952	968	980	979	62165	62283	-0,2	3
78	951	966	975	985	65067	65228	-0,2	3
81	981	995	1005	990	68019	68190	-0,3	3
84	971	987	999	996	70981	71169	-0,3	3
87	976	996	1011	1001	73956	74164	-0,3	3

Horizontal furnace pressure

The differential pressure in the furnace during the test, measured 100 mm below specimen



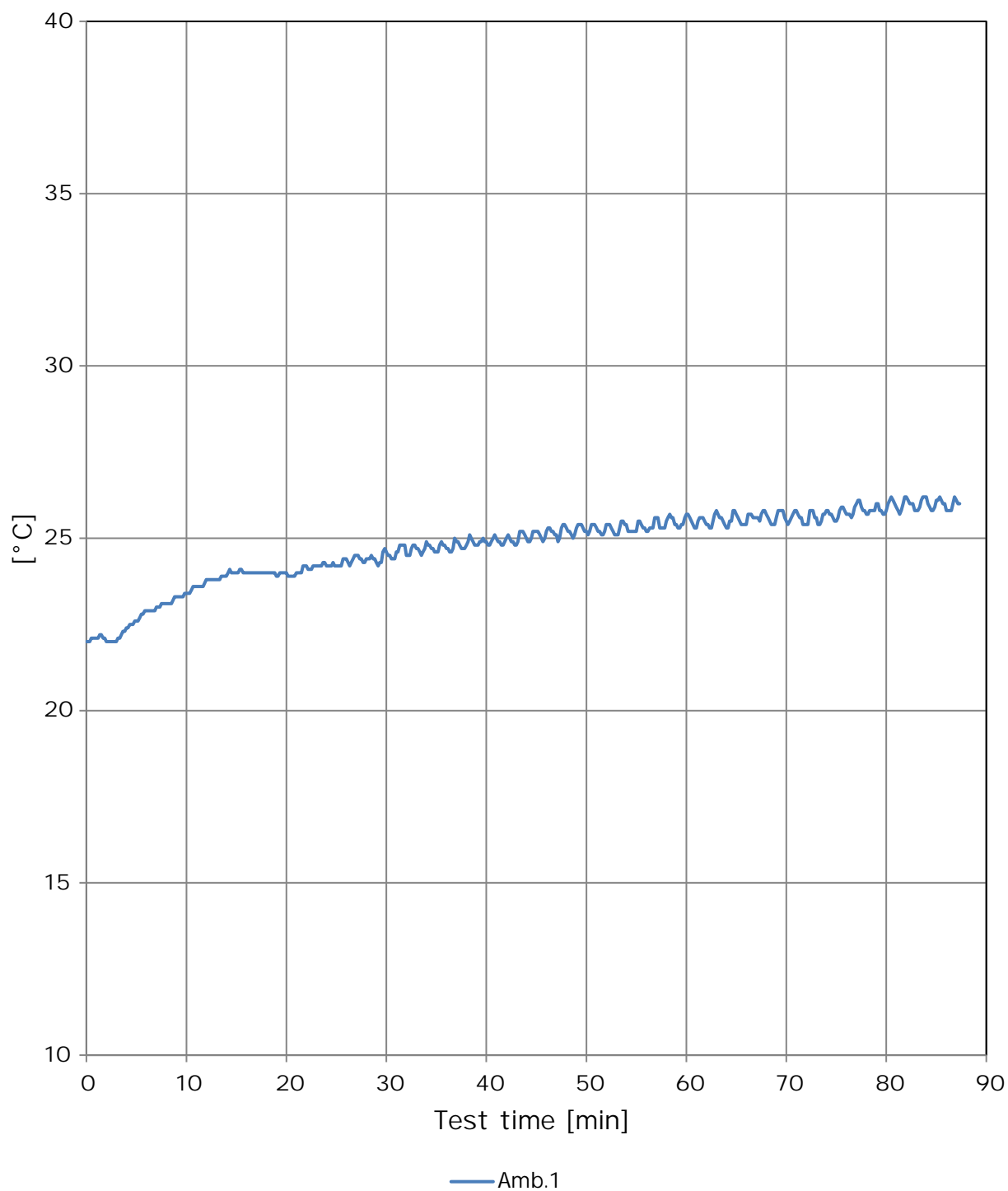
Horizontal furnace pressure

The differential pressure in the furnace during the test, measured 100 mm below specimen

Min. / Pa	Pa.1
0	-35,8
3	18,9
6	19,9
9	18,9
12	18,6
15	20,9
18	25,1
21	28,0
24	21,8
27	21,0
30	21,4
33	19,5
36	20,1
39	20,7
42	18,4
45	20,6
48	21,1
51	20,6
54	21,6
57	21,3
60	19,5
63	19,4
66	20,9
69	24,4
72	23,1
75	28,7
78	39,2
81	38,6
84	37,1
87	35,6

Ambient temperature

The ambient temperature in the laboratory during the test



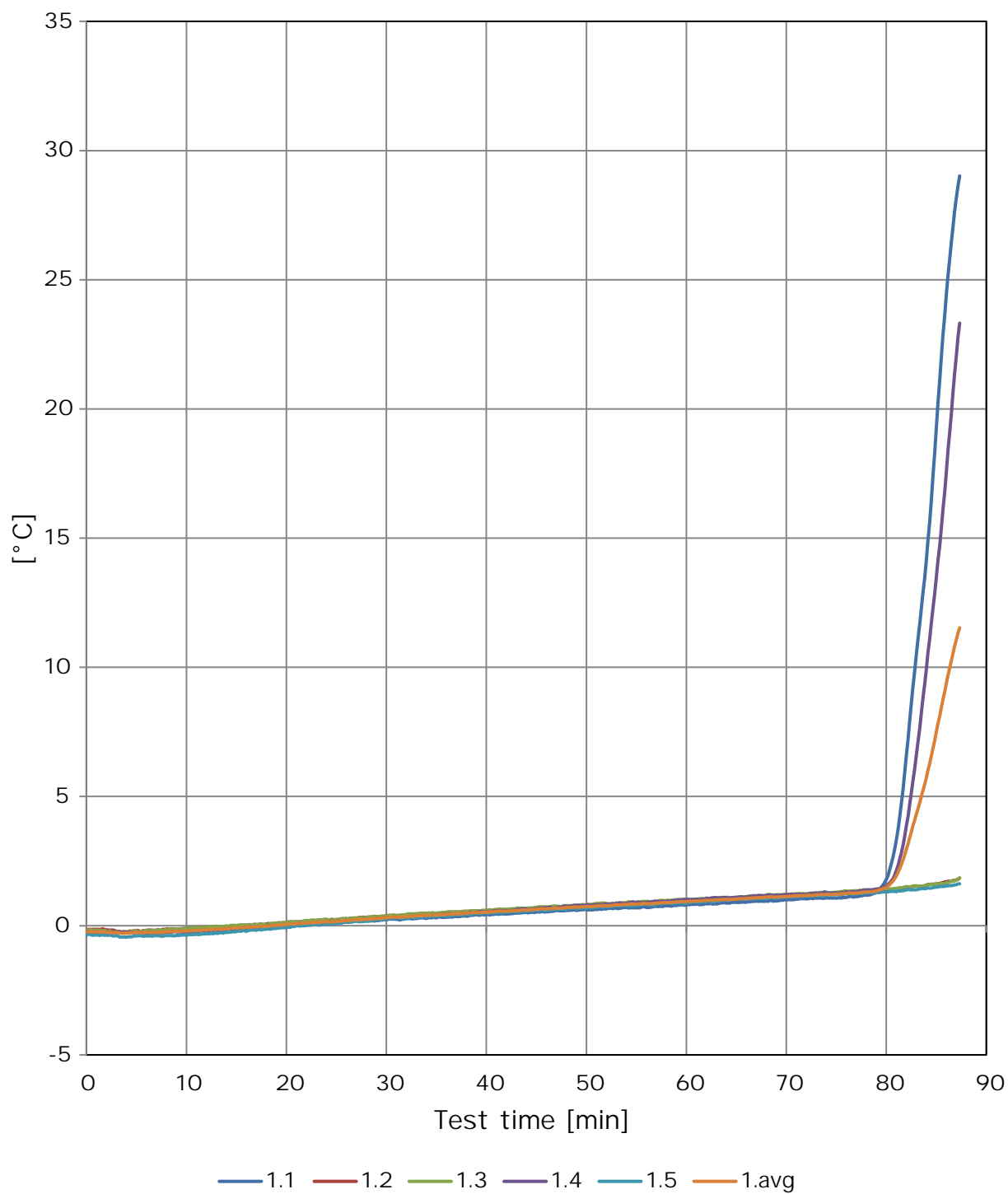
Ambient temperature

The ambient temperature in the laboratory during the test

Min. / °C	Amb.1
0	22,0
3	22,0
6	22,9
9	23,3
12	23,8
15	24,0
18	24,0
21	24,0
24	24,2
27	24,5
30	24,6
33	24,7
36	24,7
39	24,8
42	25,0
45	25,2
48	25,3
51	25,3
54	25,4
57	25,6
60	25,7
63	25,8
66	25,4
69	25,6
72	25,4
75	25,5
78	25,7
81	25,9
84	26,2
87	26,1

Average temperature

Temperature rise on the unexposed side





Average temperature

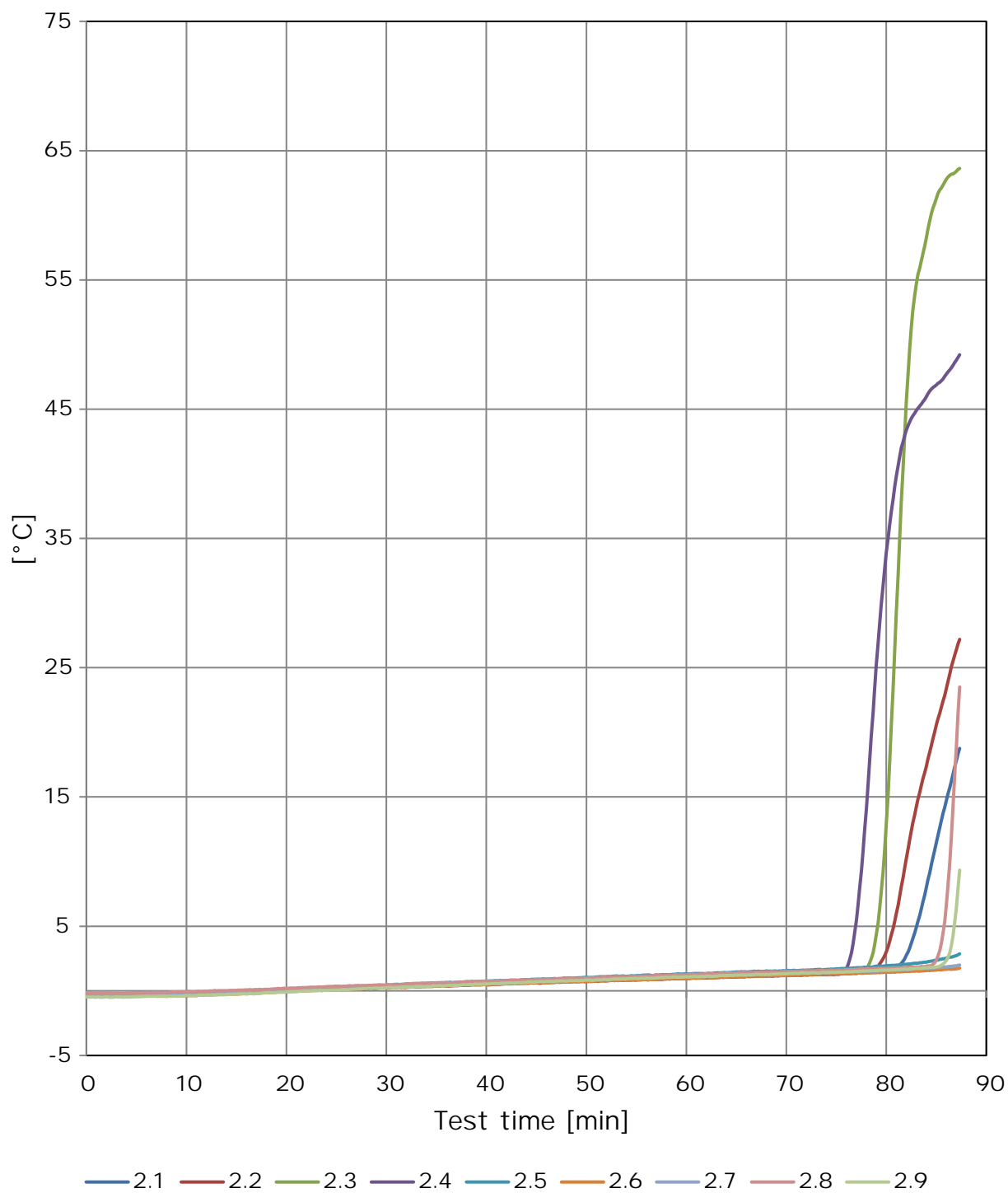
Temperature rise on the unexposed side

Min. / °C	1.1	1.2	1.3	1.4	1.5	1.Avg	1.Max
0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0
36	0	0	1	0	0	0	1
39	0	1	1	1	0	1	1
42	0	1	1	1	1	1	1
45	1	1	1	1	1	1	1
48	1	1	1	1	1	1	1
51	1	1	1	1	1	1	1
54	1	1	1	1	1	1	1
57	1	1	1	1	1	1	1
60	1	1	1	1	1	1	1
63	1	1	1	1	1	1	1
66	1	1	1	1	1	1	1
69	1	1	1	1	1	1	1
72	1	1	1	1	1	1	1
75	1	1	1	1	1	1	1
78	1	1	1	1	1	1	1
81	3	1	1	2	1	2	3
84	14	2	2	10	1	6	14
87	28	2	2	22	2	11	28

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

Maximum temperatures

Temperature rise on the unexposed side





Maximum temperatures

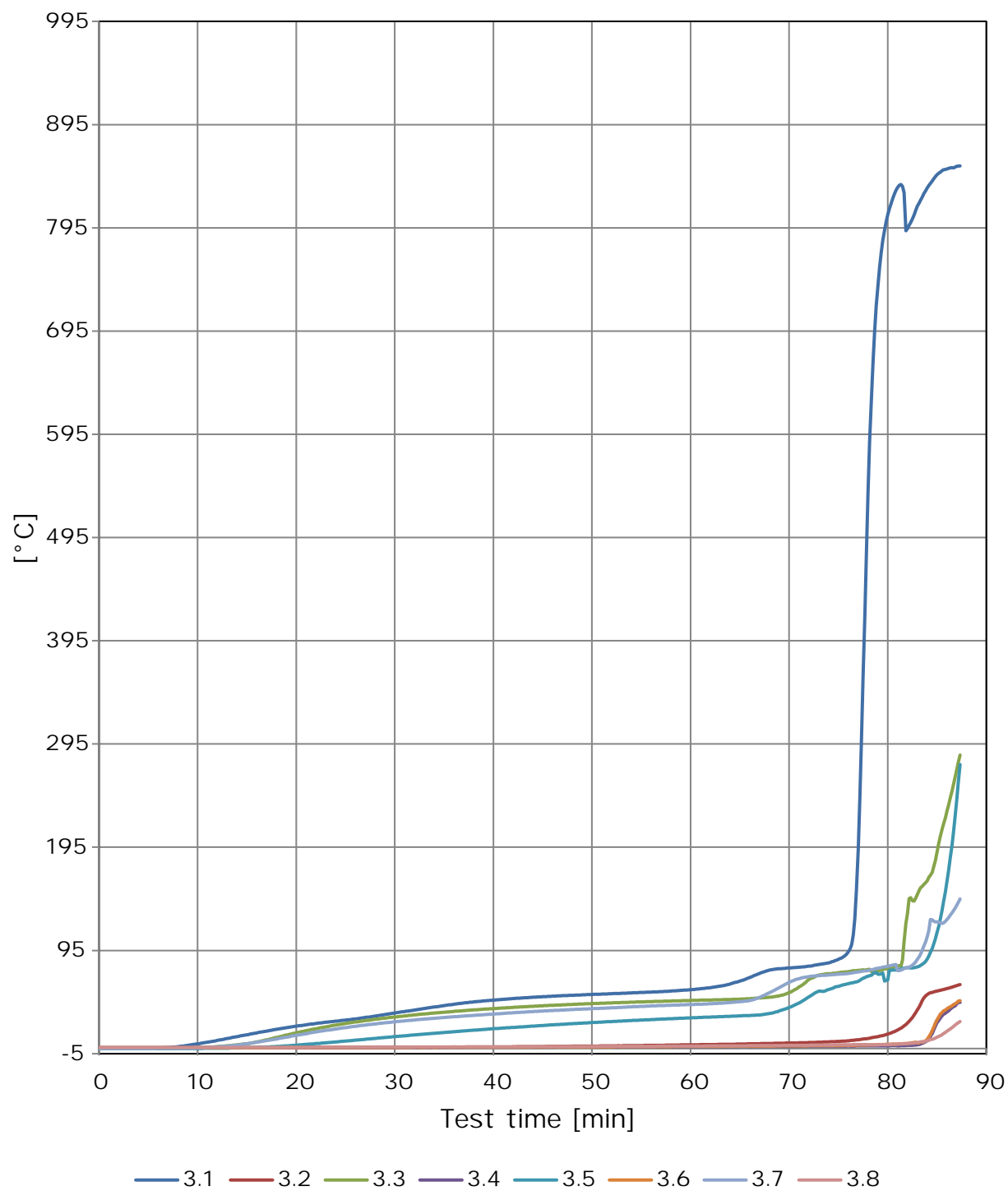
Temperature rise on the unexposed side

Min. / °C	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.Max
0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	1	0	0	1	0	1
36	0	0	1	0	1	0	1	1	0	1
39	1	0	1	1	1	0	1	1	1	1
42	1	1	1	1	1	1	1	1	1	1
45	1	1	1	1	1	1	1	1	1	1
48	1	1	1	1	1	1	1	1	1	1
51	1	1	1	1	1	1	1	1	1	1
54	1	1	1	1	1	1	1	1	1	1
57	1	1	1	1	1	1	1	1	1	1
60	1	1	1	1	1	1	1	1	1	1
63	1	1	1	1	1	1	1	1	1	1
66	1	1	1	1	1	1	1	1	1	1
69	1	1	1	1	2	1	1	1	1	2
72	1	1	1	1	2	1	1	2	1	2
75	1	1	1	1	2	1	1	2	1	2
78	1	1	2	14	2	1	1	2	2	14
81	2	6	29	40	2	1	2	2	2	40
84	8	17	58	46	2	2	2	2	2	58
87	18	26	63	49	3	2	2	19	6	63

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

Internal indicative temperatures

Temperature rise inside the test specimen





Internal indicative temperatures

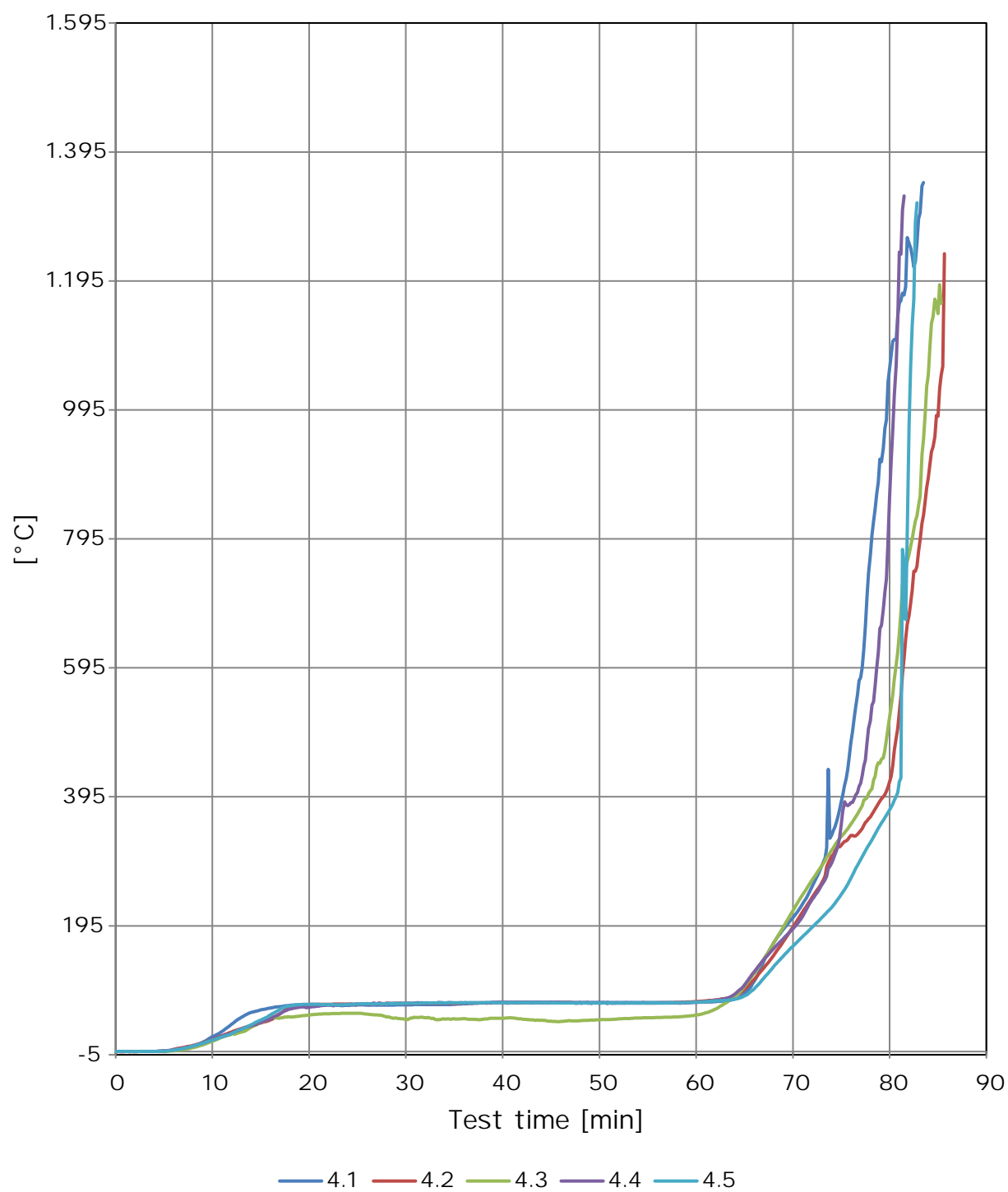
Temperature rise inside the test specimen

Min. / °C	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.Max
0	0	1	0	1	0	1	0	1	1
3	0	1	0	1	0	1	0	1	1
6	0	1	0	1	0	1	0	1	1
9	3	1	0	1	0	1	0	1	3
12	8	1	2	1	0	1	2	1	8
15	13	1	5	1	1	1	5	1	13
18	19	1	11	1	2	1	9	1	19
21	23	1	17	1	4	1	14	1	23
24	27	1	23	1	6	1	19	1	27
27	30	1	27	1	9	1	23	1	30
30	34	1	31	1	12	1	26	1	34
33	39	1	34	1	14	1	29	1	39
36	43	1	36	1	16	1	31	2	43
39	46	2	38	1	18	1	33	2	46
42	48	2	40	1	21	1	35	2	48
45	50	2	41	1	22	1	36	2	50
48	52	2	43	1	24	2	38	2	52
51	53	2	44	2	26	2	39	2	53
54	54	3	45	2	27	2	40	2	54
57	55	3	46	2	29	2	42	2	55
60	57	4	47	2	30	2	43	2	57
63	60	4	47	2	31	2	44	3	60
66	69	5	48	2	32	2	47	3	69
69	77	5	51	2	36	2	59	3	77
72	80	6	67	2	50	3	70	3	80
75	86	7	74	2	60	3	72	4	86
78	538	10	77	3	70	3	76	3	538
81	834	18	80	3	77	4	76	4	834
84	834	52	163	8	87	9	108	7	834
87	854	61	270	43	241	44	139	24	854

Failure [min]	76,83	-	84,67	-	86,17	-	-	-	76,83
Failure [°C]	180	180	180	180	180	180	180	180	180

Internal indicative temperatures

Temperature rise inside the test specimen



Internal indicative temperatures

Temperature rise inside the test specimen

Min. / °C	4.1	4.2	4.3	4.4	4.5	4.Max
0	0	0	0	0	0	0
3	0	0	0	0	0	0
6	2	3	1	3	2	3
9	14	14	10	13	13	14
12	43	30	27	29	28	43
15	65	44	44	45	49	65
18	72	69	54	66	71	72
21	73	73	58	70	73	73
24	72	74	59	73	73	74
27	72	74	57	72	74	74
30	73	75	50	75	75	75
33	73	75	50	75	75	75
36	74	75	51	75	76	76
39	76	76	52	76	76	76
42	77	76	50	76	76	77
45	77	76	47	76	75	77
48	76	76	48	75	75	76
51	76	75	50	76	75	76
54	76	75	52	75	75	76
57	76	76	53	75	75	76
60	76	77	57	77	77	77
63	78	82	75	82	79	82
66	109	112	121	124	97	124
69	189	170	193	175	148	193
72	256	239	266	236	193	266
75	387	320	333	351	243	387
78	770	364	404	513	324	770
81	1161	527	648	1240	418	1240
84	0	889	1049	0	0	1049
87	0	0	0	0	0	0

Failure [min]	68,50	69,33	68,50	69,33	71,00	68,50
Failure [°C]	180	180	180	180	180	180

