

Fire resistance test on a non-loadbearing uninsulated external wall construction covered with a single layer of Cembrit Multi Force boards on the unexposed side and Cembrit Construction façade boards on the exposed side

Test method: Standard EN 1364-1:2015 "Fire resistance tests for non-loadbearing elements – Part 1: Walls"



Requested by: Cembrit Production Oy

Test Date: January 22, 2016

Requested by Cembrit Production Oy
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02601 ESPOO
Finland
Order by e-mail on October 30, 2015 / Sampsa Tikkala

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Fire resistance test on a non-loadbearing uninsulated external wall construction covered with a single layer of Cembrit Multi Force boards on the unexposed side and Cembrit Construction façade boards on the exposed side

Test specimen Test specimen was a non-loadbearing external wall construction comprising of six vertical 45 x 66 mm timber studs c/c 600 mm and 45 x 66 mm timber studs as the head and floor tracks and behind the horizontal joint between the vertical studs. One layer of 12 mm Cembrit Multi Force fibre cement boards was mounted on the unexposed side and a layer of 4.5 mm Cembrit Windstopper Extreme boards was fixed to the timber studs on the exposed side. Timber battens 20 x 95 mm and 20 x 45 mm were fixed over the vertical joints of the Windstopper boards and 8 mm Cembrit Construction facade boards were fixed to the battens.

The size of the specimen was $b \times h = 3000 \text{ mm} \times 4000 \text{ mm}$ and thickness 112 mm.

Detailed information about the structure and materials of the specimen are presented in Appendix 7

Client's drawings are presented in Appendix 1

Date of delivery of materials December 22, 2015, January 14 and 19, 2016

Date of assembly by the client January 19, 2016

Manufacturer had selected all the materials for the wall construction.

Date of test January 22, 2016

Test method	<i>Standard EN 1364-1:2015 "Fire resistance tests for non-loadbearing elements - Part 1: Walls".</i>						
Witnesses	The test was witnessed by Mr Kalle Kekarainen and Mr Matti Onkamo representing Cembrit Production Oy and Mr Sampsa Tikkala, Mr Esben Moos and Mr Frank Brøndum representing Cembrit Holding A/S.						
Test	<p>The fire resistance test was carried out in the vertical furnace of the testing laboratory. The wall was installed to the opening of the testing frame.</p> <p>Location of measuring points for temperatures of the furnace and the test specimen as well as deflections: Appendix 2</p> <p>Test conditions in the furnace (furnace temperature and pressure difference between the furnace and test hall): Appendices 3a and 3b</p> <p>The ambient temperature in the test hall was 17 °C in the beginning of the fire resistance test.</p> <p>The test was terminated 34 min after the start of the fire test by a request from the customer.</p>						
Test results	<p>Measured temperatures and deflections as well as observations and photographs are presented in the following appendices:</p> <table><tr><td>Temperatures of the test specimen</td><td>Appendix 4</td></tr><tr><td>Observations and deflections</td><td>Appendix 5</td></tr><tr><td>Photographs</td><td>Appendix 6</td></tr></table> <p>Test results with respect to the performance criteria imposed by the standard EN 13501-2:2007+A1:2009 complemented with EN 1364-1:2015 and EN 1363-1:2012 are presented in table 1.</p>	Temperatures of the test specimen	Appendix 4	Observations and deflections	Appendix 5	Photographs	Appendix 6
Temperatures of the test specimen	Appendix 4						
Observations and deflections	Appendix 5						
Photographs	Appendix 6						

Table 1. Test results with respect to the criteria

Property	Test result		
Integrity E			
Occurrence of flames: (criterion: no sustained flaming in excess of 10 s duration)	No sustained flaming		
Cotton pad test: (criterion: no ignition)	Not done		
Gap gauge test: (criterion: through-going Ø 6 mm can be moved less than 150 mm along the gap; Ø 25 mm can be passed through the test specimen)	Not done, no gaps		
Insulation I	Test time [min]		
	15 min	30 min	34 min
	$\Delta T_{(\text{number of } t_c)}$		
Average temperature rise: (criterion: $\Delta T \leq 140\text{ }^{\circ}\text{C}$), tc1...tc5	28 °C	83 °C	90 °C
Highest temperature rise: (criterion: $\Delta T \leq 180\text{ }^{\circ}\text{C}$), tc1...tc12	39 °C (7)	90 °C (3)	103 °C (3)

Summary

The test specimen comprised of 45 x 66 mm vertical timber studs, head and floor tracks and horizontal studs. A layer of 12 mm Cembrit Multi Force boards was mounted on the unexposed side and a single layer of Cembrit Windstopper Extreme and Cembrit Construction façade boards as the outer layer was mounted on the exposed side.

The wall met the fire resistance test performance criteria imposed by the standards EN 13501-2:2007+A1:2009 complemented with EN 1364-1:2015 and EN 1363-1:2012 as follows:

Integrity E

-sustained flaming	34 minutes*
-gap gauge	34 minutes*
-cotton pad	34 minutes*

Insulation I

34 minutes*

*) Test was terminated 34 min after the start of the test

This report details 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 1364-1:2015 and where appropriate EN 1363-1:2012. Any significant deviation with respect to size, constructional

details, loads, stresses and 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.

Because of the nature of the 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 on the result.

Application of test results

Certain modifications mentioned in the chapter 13 of standard EN 1364-1:2015 can be allowed on the basis of the test results. These modifications can be done without a separate assessment or approval on the fire resistance. Field of direct application of test results is presented in Appendix 8.

VTT Expert Services Ltd is notified body No. 0809 under the Construction Products Regulation (CPR).

Espoo, 1 June 2016



Markus Taipale
Product Manager



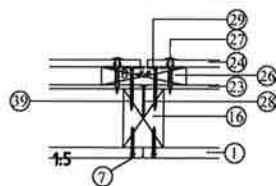
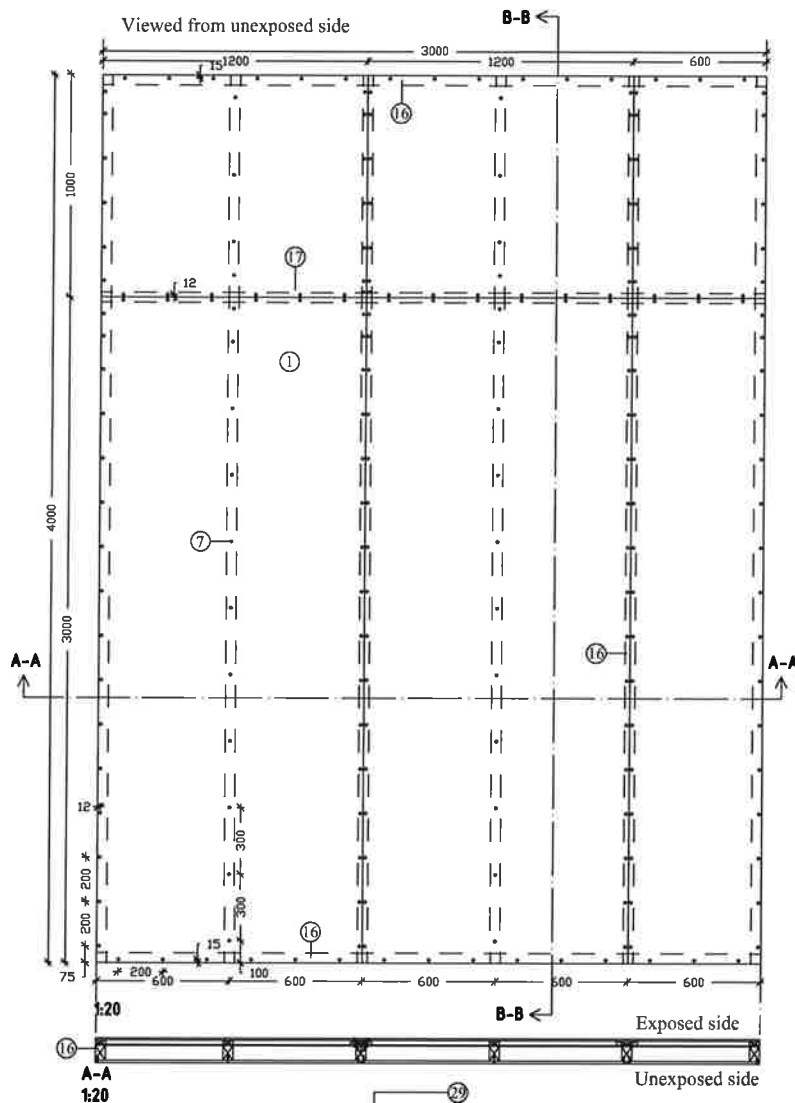
Jens Pedersen
Expert

APPENDICES

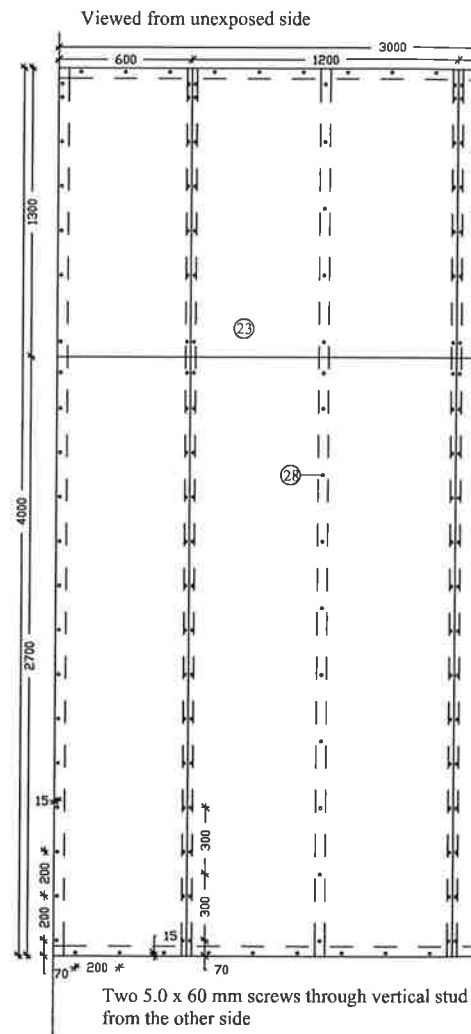
Appendix 1	Clients drawings of the structure
Appendix 2	Location of measuring points for temperatures and deformations
Appendix 3a and 3b	Furnace temperature and pressure difference
Appendix 4	Temperatures of the test specimen
Appendix 5	Observations and deformations
Appendix 6	Photographs
Appendix 7	Information of construction and determined material properties
Appendix 8	Field of direct application of test results

DISTRIBUTION

Client	Original (2 pcs)
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Screw/nail principle for joints solution (unexposed and exposed side)

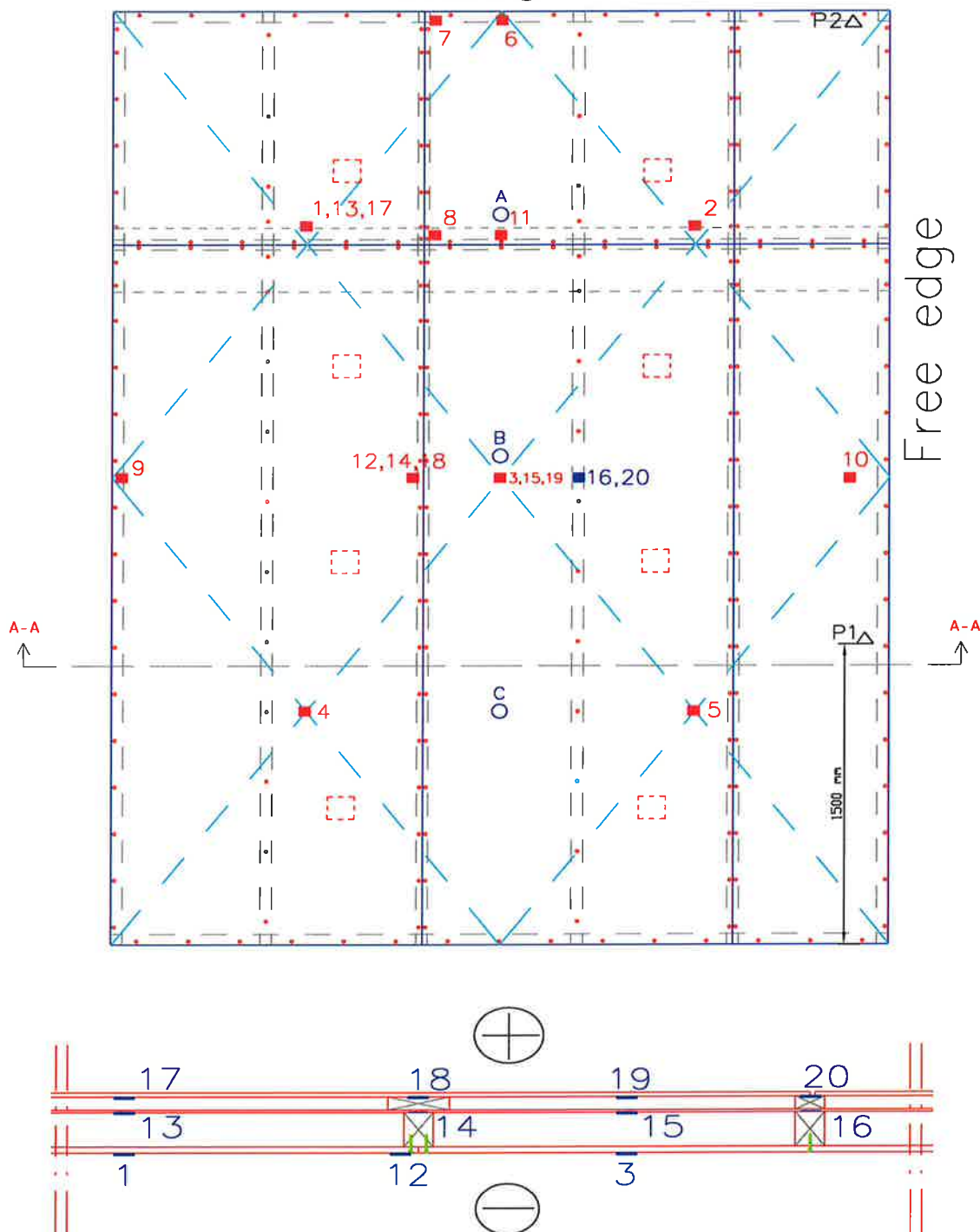


Two 5.0 x 60 mm screws through vertical stud from the other side

Description:

- ① 12 x 3000 x 1200mm Multi Force, long sides of the board are rec
- ⑦ Steelscrew Li-SW/S 4,2x35 mm.
- ⑬ Woodframe 45 x 66 mm.
- ⑰ Horizontal transoms between vertical woodframes, 45 x 66 mm
- ⑲ Cembrit Windstopper Extreme 4,5 x 1200 x 2700 mm.
- ⑳ Cembrit Construction 8 x 1200 x 3050 mm.
- ㉑ Wood plank 20 x 95 - 20 x 45 mm

Test arrangement



Measuring points:

- tc1...tc5 Average temperature of the unexposed surface
- tc1...tc12 Max temperatures on the surface of the test specimen
- tc13-16, 18-20 Temperature inside the test specimen (informative)
- Deflection of the test specimen
- Furnace temperature
- △ P1, P2 Pressure difference between the furnace and the test hall
- Horizontal joints behind the first layer on the unexposed side

The test results relate only to the sample tested.

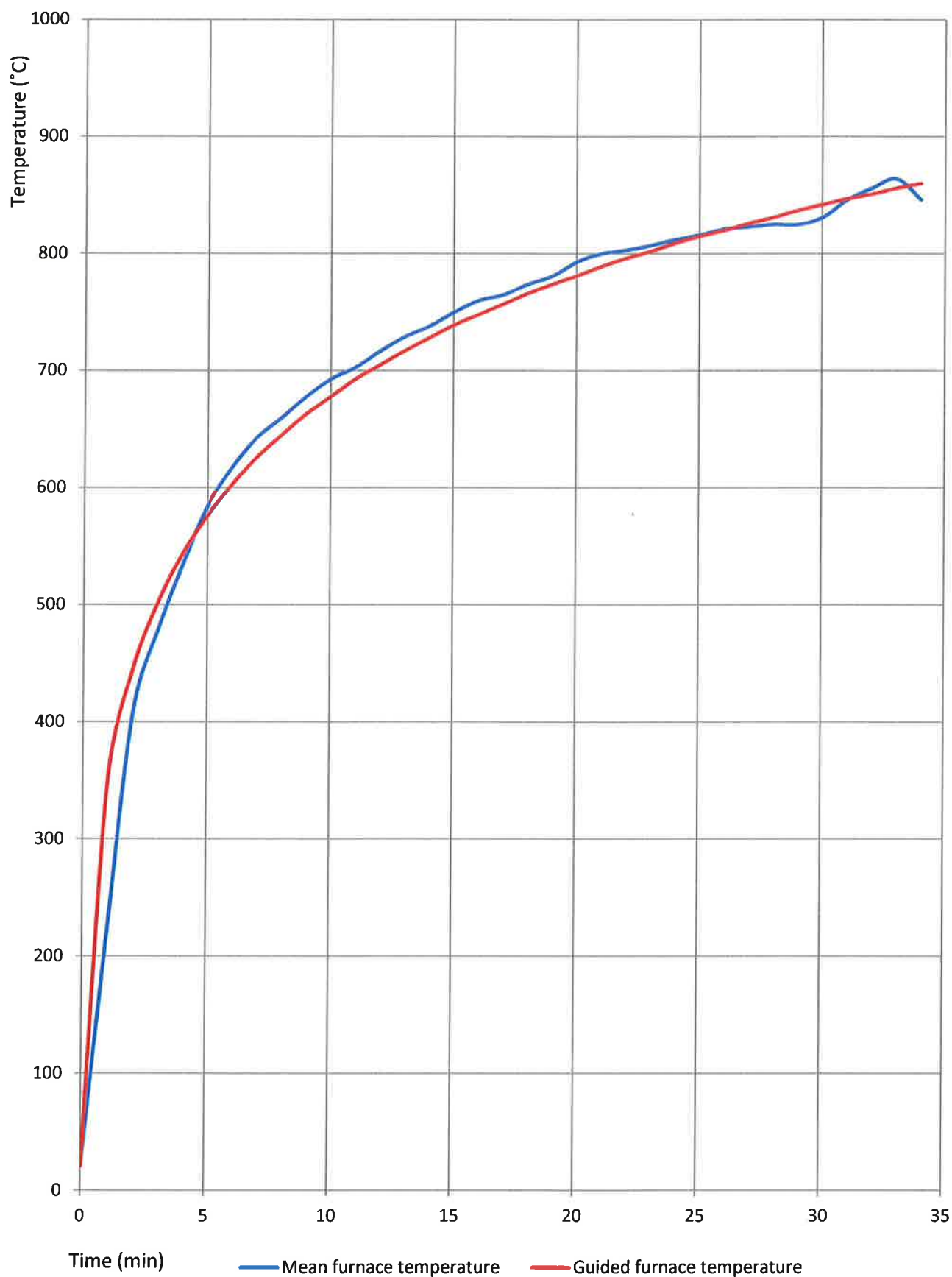


Figure 1. Furnace temperature

The test results relate only to the sample tested.

Table 1. Furnace temperatures

Time (min)	Mean furnace temp. (°C)	Guiding furnace temp. (°C)	Min (°C)	Max (°C)	A (°C · min)	As (°C · min)	d (%)	Max d (%)
0	20	20	20	20	0	0	0	-
1	222	349	152	264	121	184	-34,3	-
2	409	445	310	459	436	581	-24,9	-
3	479	502	387	527	881	1055	-16,4	-
4	535	544	446	588	1388	1578	-12	-
5	585	576	501	634	1949	2138	-8,8	-
6	618	603	534	670	2551	2727	-6,5	15
7	643	626	567	692	3182	3342	-4,8	15
8	660	645	586	709	3833	3977	-3,6	15
9	678	663	606	725	4503	4631	-2,8	15
10	693	678	622	738	5188	5302	-2,1	15
11	703	693	636	745	5887	5987	-1,7	15
12	717	705	651	757	6597	6686	-1,3	14,5
13	729	717	665	766	7320	7397	-1	14
14	738	728	674	775	8055	8120	-0,8	13,5
15	750	739	686	785	8799	8853	-0,6	13
16	760	748	697	794	9555	9597	-0,4	12,5
17	765	757	705	800	10318	10349	-0,3	12
18	774	766	717	804	11088	11111	-0,2	11,5
19	781	774	725	814	11866	11881	-0,1	11
20	793	781	737	823	12653	12658	0	10,5
21	800	789	748	829	13450	13443	0,1	10
22	803	796	752	829	14252	14236	0,1	9,5
23	807	802	761	830	15057	15035	0,2	9
24	812	809	765	835	15868	15840	0,2	8,5
25	816	815	771	834	16682	16652	0,2	8
26	821	820	776	842	17501	17470	0,2	7,5
27	823	826	780	844	18324	18293	0,2	7
28	825	831	785	844	19148	19121	0,1	6,5
29	825	837	787	848	19974	19955	0,1	6
30	831	842	791	856	20802	20795	0	5,5
31	846	847	803	873	21641	21639	0	5
32	856	851	813	883	22492	22488	0	4,9
33	864	856	822	894	23353	23342	0	4,8
34	846	860	760	882	24208	24200	0	4,8

Where

A is area under the actual average furnace time-temperature curve

As is the area under the standard (guiding) time-temperature curve

d is deviation

Max d is highest acceptable deviation

The test results relate only to the sample tested.

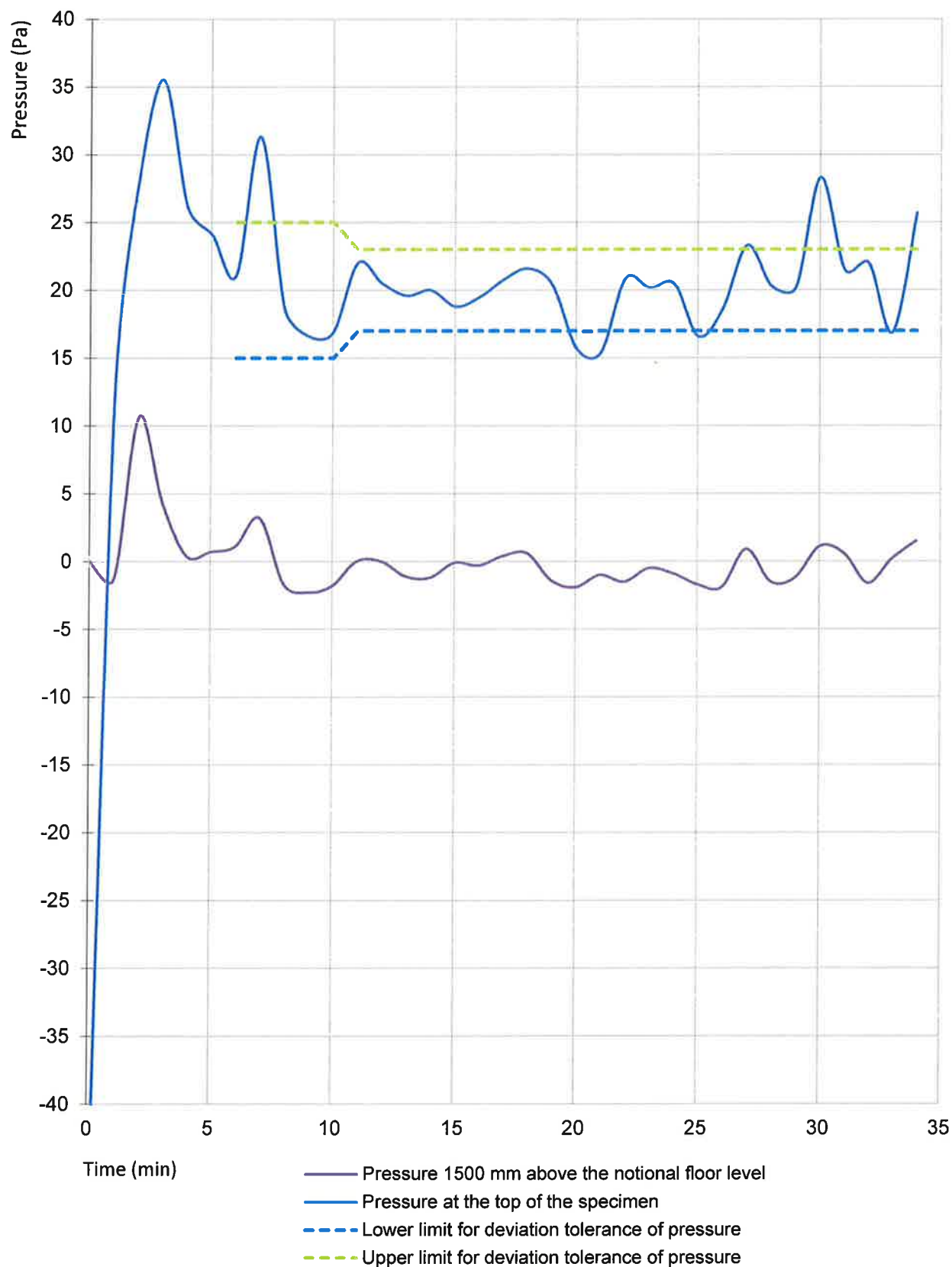


Figure 1. Pressure difference

The test results relate only to the sample tested.

Temperatures of the test specimen

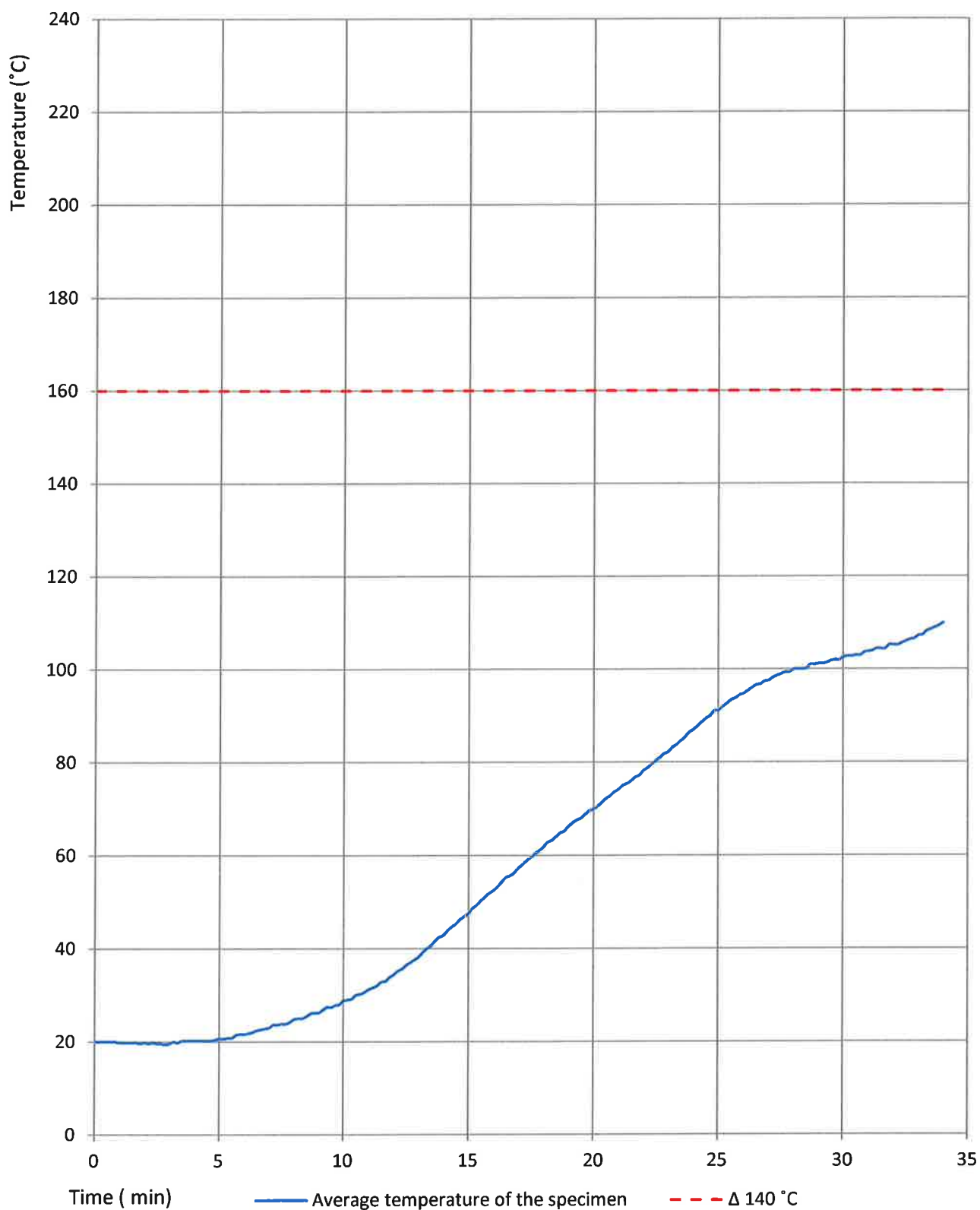


Figure 1. Measured specimen temperature. Mean of thermocouples tc1...tc5

The test results relate only to the sample tested.

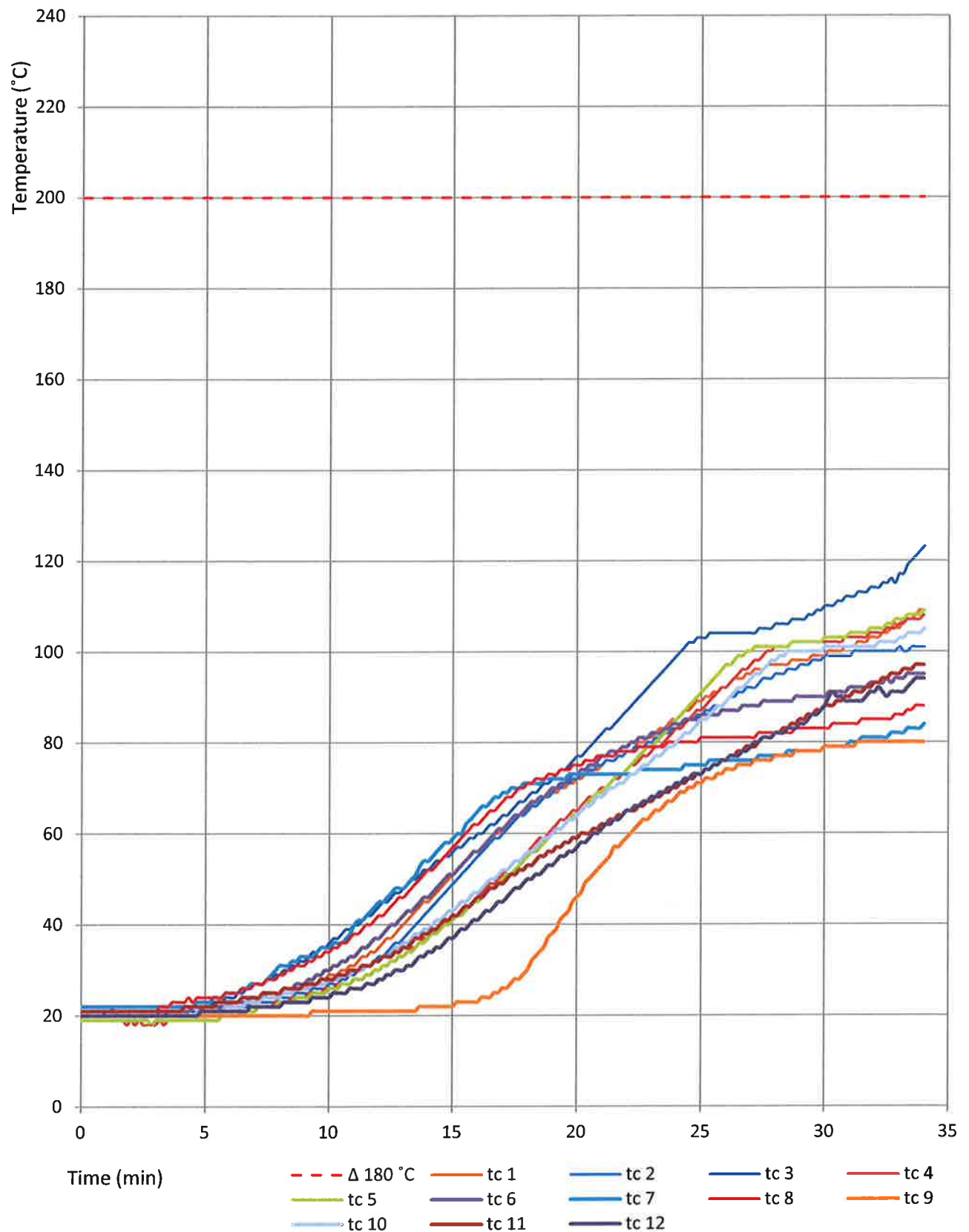


Figure 2. Measured individual specimen surface temperatures

The test results relate only to the sample tested.

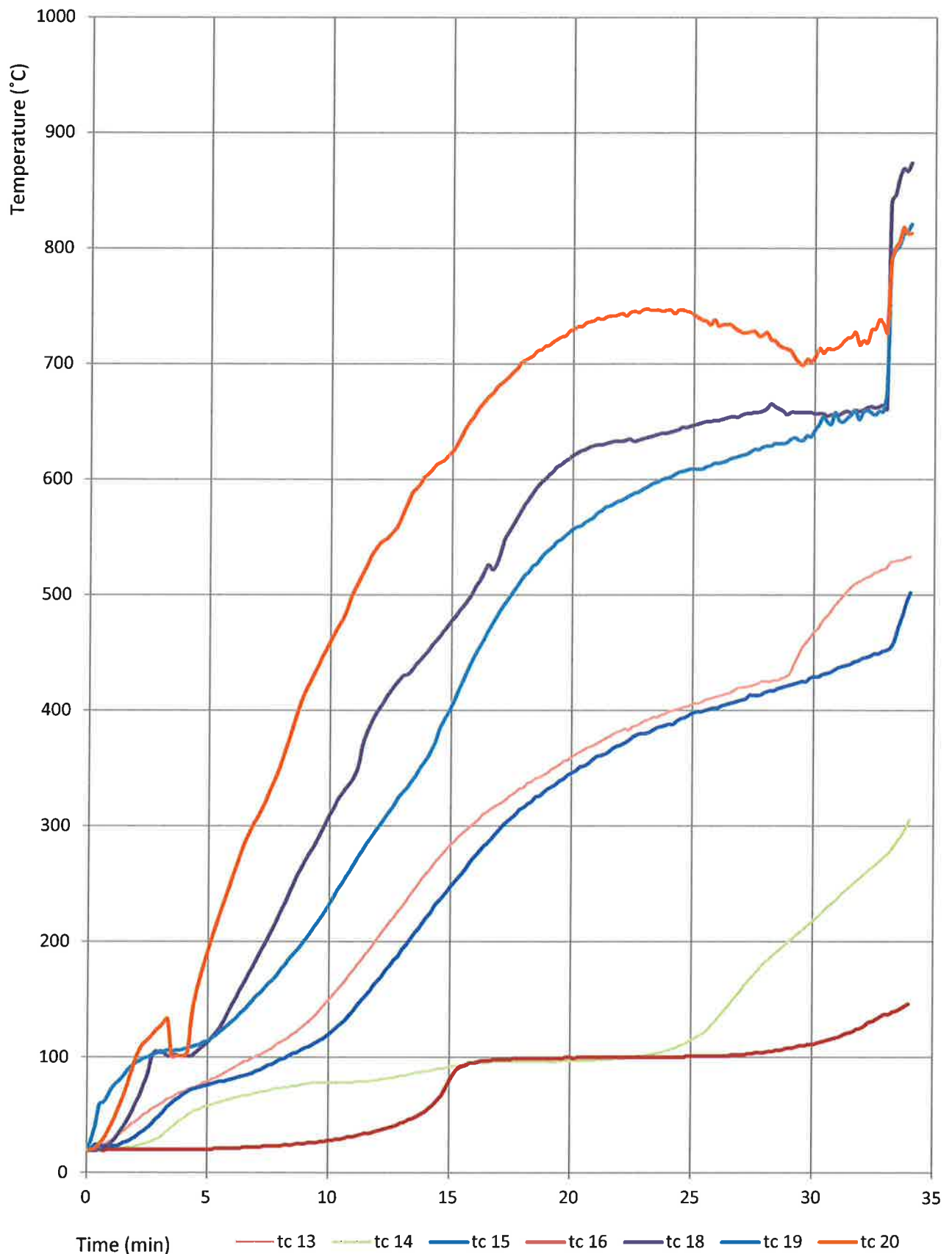


Figure 3. Measured individual specimen temperatures (informative)

The test results relate only to the sample tested.

Table 1. Measured individual specimen temperatures

Time (min)	tc1 (°C)	tc2 (°C)	tc3 (°C)	tc4 (°C)	tc5 (°C)	Mean (tc1–tc5) (°C)	tc6 (°C)	tc7 (°C)	tc8 (°C)	tc9 (°C)	tc10 (°C)	tc11 (°C)	tc12 (°C)
0	21	21	20	19	19	20	22	22	21	20	20	21	20
1	21	20	20	19	19	20	22	22	21	20	20	21	20
2	21	20	20	19	19	20	21	22	21	20	20	21	20
3	21	20	20	18	19	20	21	22	21	20	20	21	20
4	21	21	21	19	19	20	21	22	23	20	20	21	20
5	22	21	22	19	19	21	22	23	24	20	21	22	21
6	22	22	24	20	20	22	23	25	25	20	22	23	21
7	23	23	27	21	21	23	24	27	27	20	23	24	22
8	25	24	29	23	23	25	25	31	29	20	24	25	22
9	26	25	32	24	24	26	27	33	31	20	26	27	23
10	29	27	36	26	26	29	30	35	34	21	28	28	24
11	31	29	40	28	28	31	33	40	38	21	30	30	26
12	35	33	44	30	30	34	37	45	42	21	32	32	28
13	40	37	48	33	33	38	42	48	46	21	36	35	30
14	45	43	52	37	37	43	46	54	52	22	39	38	34
15	51	49	56	41	41	48	51	59	57	22	43	42	37
16	56	55	60	46	45	52	56	65	62	23	47	46	41
17	61	60	64	51	50	57	61	69	67	26	52	49	45
18	65	65	68	56	55	62	66	71	71	30	56	53	50
19	69	69	72	61	60	66	70	72	73	38	60	56	53
20	72	72	77	65	64	70	73	73	75	46	64	59	57
21	75	75	82	70	69	74	77	73	77	53	68	62	61
22	78	78	87	74	74	78	79	73	78	59	72	65	65
23	81	80	93	78	79	82	82	74	79	64	76	67	68
24	85	83	99	83	85	87	84	74	80	68	80	70	71
25	89	86	103	87	91	91	86	75	81	71	85	73	73
26	92	89	104	92	97	95	87	76	81	74	89	76	76
27	95	92	104	97	100	98	88	76	81	75	94	79	79
28	97	95	106	101	101	100	89	77	82	77	98	82	82
29	98	97	107	102	102	101	90	78	83	78	100	85	84
30	99	99	110	102	103	103	90	79	83	79	101	88	88
31	101	99	112	103	104	104	92	80	84	79	101	90	89
32	103	100	114	104	105	105	93	81	85	80	101	93	91
33	105	101	117	106	107	107	94	82	86	80	103	95	91
34	109	101	123	108	109	110	95	84	88	80	105	97	94

The test results relate only to the sample tested.

Table 2. Measured individual specimen temperatures

Time (min)	tc13 (°C)	tc14 (°C)	tc15 (°C)	tc16 (°C)	tc18 (°C)	tc19 (°C)	tc20 (°C)
0	20	19	20	19	19	20	19
1	28	20	23	20	26	73	42
2	44	23	31	20	60	95	99
3	59	30	49	20	104	105	126
4	70	47	68	20	101	107	101
5	79	58	76	20	113	114	193
6	90	64	81	21	146	131	257
7	101	69	88	22	185	153	307
8	113	73	98	23	227	176	356
9	128	77	108	25	271	202	418
10	150	78	120	28	310	233	460
11	175	78	140	31	343	267	505
12	203	80	166	36	401	299	544
13	230	84	193	43	430	329	572
14	259	88	221	53	451	359	605
15	284	92	248	80	478	404	624
16	303	95	274	95	508	450	659
17	319	96	297	98	536	487	683
18	333	96	316	99	578	517	703
19	346	96	332	99	604	539	716
20	360	97	346	100	621	557	730
21	371	97	360	100	630	571	739
22	382	99	370	100	633	582	743
23	391	101	380	100	636	593	747
24	399	106	388	100	641	602	746
25	406	115	398	101	647	609	742
26	412	132	402	101	651	614	733
27	420	157	409	102	656	621	727
28	425	182	416	104	661	629	727
29	432	200	422	108	658	635	711
30	468	218	429	111	657	643	706
31	494	237	437	117	656	651	715
32	513	256	445	125	660	658	720
33	523	274	452	137	661	678	727
34	533	305	502	146	874	821	813

The test results relate only to the sample tested.

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Observations and measured deformations

Time [min:s]	E/U	Observation (E is fire exposed side, U is unexposed side)
0:00		Test was started.
10:10	U	Steam was rising from all of the joints.
14:30	U	Vertical joint on the left was darkening from the top.
15:50	E	Vertical joint on the right was bending a bit.
16:40	U	Both vertical joints had opened up a little.
15:19	E	Cembrit Construction boards had cracked.
20:00	E	Top corner of the Construction boards had cracked or fallen.
25:30	E	Timber battens had charred and the joints of the boards had opened approximately 15 mm.
28:40	U	Pieces of façade boards had fallen down.
33:01	U	More pieces of the boards fell down.
34:00		The test was terminated.

Deflection

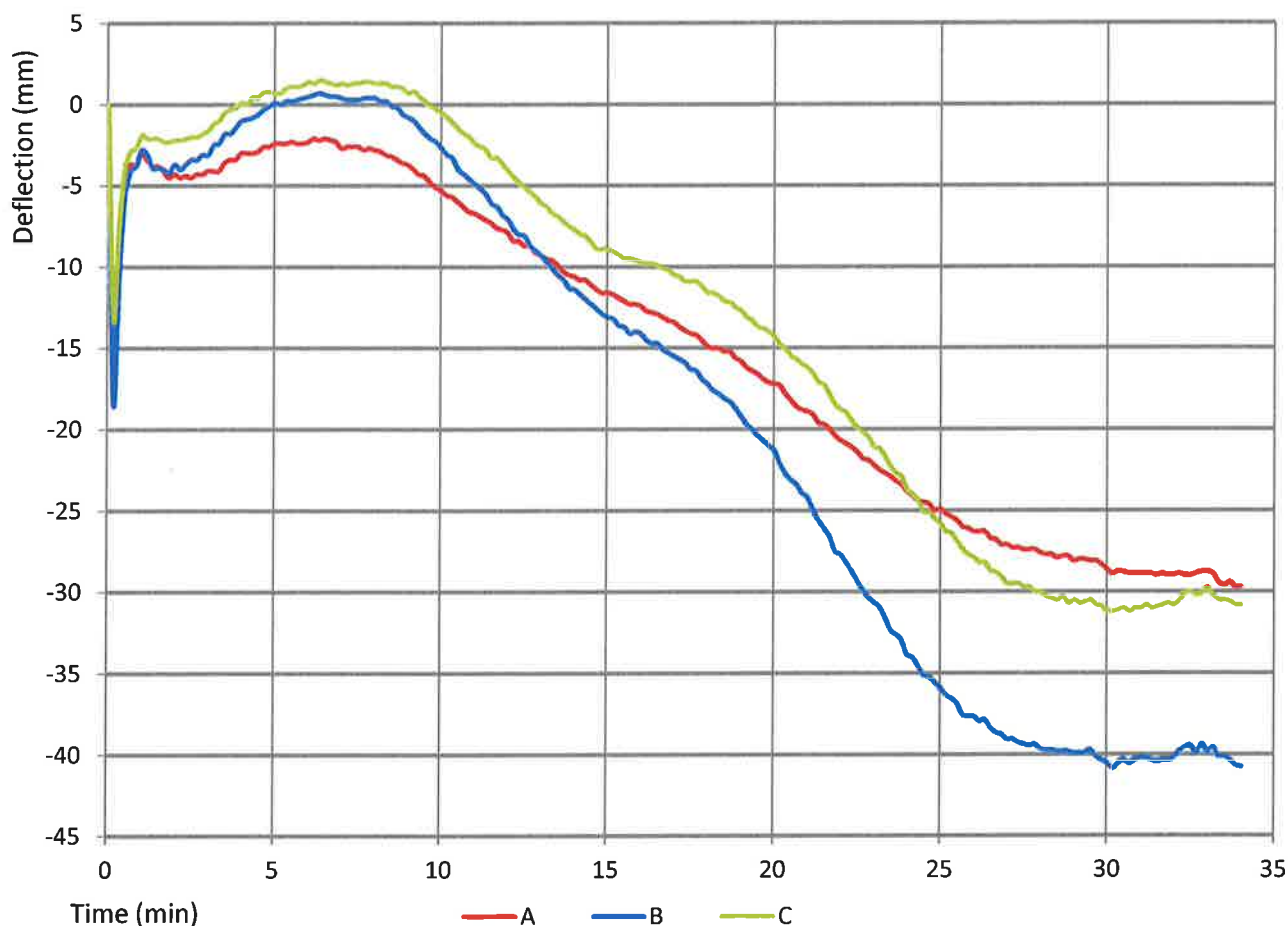


Figure 1. Measured deflections (positive reading is towards the furnace)

The test results relate only to the sample tested.

Photos of the test specimen



Figure 1. Fixing the wind shield boards on the exposed side of the studs



Figure 2. Fixing the façade boards on the exposed side

The test results relate only to the sample tested.



Figure 3. Exposed side of the specimen before the test



Figure 4. Unexposed side of the specimen before the test

The test results relate only to the sample tested.



Figure 5. Test time 10 min



Figure 6. Test time 15 min 30 s

The test results relate only to the sample tested.



Figure 7. Test time 20 min



Figure 8. Test time 21 min 43 s

The test results relate only to the sample tested.

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Figure 9. Test time 30 min



Figure 10. Test time 31 min 20 s

The test results relate only to the sample tested.



Figure 11. Test specimen after the test

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Construction of the test specimen

Test specimen

Test specimen was a non-loadbearing external wall construction (b x h = 3000 x 4000 mm) comprising of six vertical 45 x 66 mm timber studs c/c 600 mm and 45 x 66 mm timber battens as the head and floor tracks and behind the horizontal joint between the vertical studs. The head and floor tracks and one vertical edge stud were fixed to the concrete frame with Gunnebo screws (5.0 x 90 mm). Vertical studs were attached to the head and floor tracks with two 4.2 x 45 mm screws at each end. Horizontal studs were fixed to the vertical studs with two 5.0 x 60 mm screws through the vertical timber stud and one 4.2 x 54 screw diagonally.

One layer of 12 mm thick Cembrit Multi Force fibre cement boards (nominal weight per area 14.0 kg/m², manufactured by Cembrit Holding A/S) was mounted on the unexposed side with 4.2 x 35 mm screws c/c 200 mm at the edges and c/c 300 in the middle of the boards. A layer of 4.5 mm thick Cembrit Windstopper Extreme boards (nominal weight per area 7.2 kg/m², manufactured by Cembrit Holding A/S) was fixed on the exposed side of the timber studs with 2.8 x 30 mm felt nails c/c 200 mm at the edges and c/c 300 mm in the middle. Timber battens 20 x 95 mm and 20 x 45 mm were fixed over the vertical joints of the Windstopper boards with 4.2 x 45 mm screws c/c 400 mm and EPDM rubber strips were attached to the battens with rivets. Cembrit Construction facade boards (nominal thickness 8 mm, nominal weight per area 14.3 kg/m², manufactured by Cembrit Holding A/S) were fixed to the battens with 4.9 x 38 mm Cembrit facade board screws. No plaster was applied over any joints.

The client delivered materials for the test specimen on December 22, 2015 and January 14 and 19, 2016.

Verification

Conformity of the test specimen with the drawings was verified during the mounting before the test and during the demolition after the test.

Mounting of wall

The specimen was mounted into the opening of the testing frame on January 20, 2016. The size of the opening was 3040 x 4020 mm.

Gap between the edge stud and the test frame on one side of the specimen was filled with rock wool so that the edge was free to bend.

Conditioning of the test specimen

The materials were conditioned in a conditioning room from the day of delivery until the construction day.

Determined material properties

Following material properties were determined from samples collected in connection of the mounting of the test specimen:

Material	Weight per area/volume	Moisture content ^{*)} (50 °C)	Moisture content ^{*)} (105 °C)
Cembrit Multi Force fibre cement board 12 mm	14.2 kg/m ²	3.4 %	2.8 %
Cembrit Construction façade board 8 mm	14.9 kg/m ²	1.5 %	2.2 %
Cembrit Windstopper board 4.5 mm	6.8 kg/m ²	1.8 %	2.2 %
Timber batten 20 x 95 mm	436 kg/m ³	-	8.3
Timber batten 20 x 45 mm	392 kg/m ³	-	8.6
Timber stud 45 x 66 mm	506 kg/m ³	-	9.2

^{*)} = moisture content and change of weight are calculated as a percentage of dry weight (equilibrium moisture content of plasterboard in temperature of 50 °C). Values are given as averages of three samples.

The test results relate only to the sample tested.

Field of direct application of test results

In the standard *EN 1364-1:2015 "Fire resistance tests for non-loadbearing elements - Part 1: Walls"*, section 13, the following applications are mentioned:

The results of the fire test are directly applicable to similar constructions where one or more of the changes listed below are made and the construction continues to comply with the appropriate design code for its stiffness and stability, except with respect to the construction types covered in Annex A and Annex B where specific direct field of application rules are given.

- a) Decrease in height
- b) Increase in the thickness of the wall
- c) Increase in the thickness of component materials
- d) Decrease in linear dimensions of boards or panels but not thickness
- e) Decrease in stud spacing
- f) Decrease in distance of fixing centres
- g) Increase in the number of horizontal joints, of the type tested, when tested with one joint not more than (500 ± 150) mm from the edge
- h) Increase in the number of vertical joints, of the type tested
- i) The use of installations such as electrical sockets, switches, etc. when tested as illustrated in figures 9 – 11 with the installations not more than 500 mm from the top edge
- j) Horizontal and/or vertical joints, of the type tested

The test results relate only to the sample tested.