An assessment report of the loadbearing capacity of horizontal protective membrane made of Gyproc GK system with double layer of GN 13 gypsum plasterboards

Requested by: Saint-Gobain Finland Oy, Aulis Lundell Oy

Date April 20, 2021

Requested by

Saint-Gobain Finland Oy
Harri Kemppainen
Ojangontie 23
FI-02401 Kirkkonummi
Finland
Harri.Kemppainen@saint-gobain.com

Aulis Lundell Oy
Leena Lundell
Nummenpääntie 6
FI-09430 SAUKKOLA
FINLAND
leena.lundell@aulislundell.fi

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Testing laboratory

Eurofins Expert Services Oy
Kivimiehentie 4
FI-02150 Espoo
Finland
Contact information:
Tel +358 40 631 1311, E-mail: ForenameSurname@eurofins.fi

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Task

An assessment report of the loadbearing capacity of horizontal protective membrane made of Gyproc GK system with double layer of GN 13 gypsum plasterboards is made according to standard EN 13381-1:2020 and using the test results presented in test report EUFI29- 20006483-T1.

Fire protection of Gyproc GK system with double layer of GN 13 gypsum plasterboards is manufactured by Saint-Gobain Finland Oy.

Test specimen

Test specimen was roof construction, which consisted of standard loadbearing timber structure and underneath of the timber structure suspended ceiling structure made of Gyproc GK system with double layer of Gyproc GN 13 gypsum plasterboards.

The size of the six loadbearing timber beams was 75 x 220 mm c/c 585 mm. 18 mm thick particleboard was fixed on the top of the beams. Gyproc GK 26-01+M-wire hangers were fixed under the timber beams (c/c 900 mm / 585 mm) with Wurth 6,0x50/46 screws. Upper Gyproc GK1 steel profiles were installed at the timber beams (c/c 585 mm) and lower Gyproc GK1 steel profiles (c/c 400 mm) were installed to the upper GK1 steel profiles with cross connection bracket Gyproc GK 22. Two layers of Gyproc GN 13 gypsum plasterboards were installed under the lower GK1 steel profile with H&H 25x3,5 mm and 40x4,2 mm screws. The dimension between the bottom of the loadbearing timber beam and the top surface of the first gypsum plasterboard layer was 155 mm.

The size of the construction was 5287 x 3000 mm and the span was 5191 mm. The size of the specimen was 5000 mm x 3000 mm.

The materials were conditioned in a conditioning room. Timber frame and covering was built by Eurofins Expert Services Oy and fire protection Gyproc GK system with double layer of GN 13 gypsum plasterboards was mounted by Saint-Gobain Finland Oy.

Detailed information about the fire protection system of Gyproc GK system with double layer of GN 13 gypsum plasterboards are presented in Appendix 1

Detailed information about the structure and materials of the floor construction are presented in Appendix 2

Material properties of the test specimen Appendix 3

Test

The fire resistance test was carried out in the horizontal furnace of the testing laboratory. The floor specimen was simply supported at the ends of the beams and the long edges of the floor construction were free to deflect.

During the test the structure was loaded with two line loads which were applied with the aid of four hydraulic jacks. The load was determined so that it corresponded together with self weight a maximum moment of 45.6 kNm when the span L = 5.191 m. The load was determined so that the maximum effect produced by the total applied load at mid-span of the specimen was 60 % of the bending resistance at normal temperature according to EN 1995-1-1 using γm = 1.25 and kmod = 1.0.

Test results

The measured specimen temperatures and deflections as well as photographs are presented in test report EUFI29- 20006483-T1.

Observations Appendix 4

Test arrangement and temperatures of the test specimen Appendix 5

Assessment

Assessment of the loadbearing capacity is made by determination from the characteristic temperature curves. Limiting temperature for building members made of timber is 300 °C at the cavity and the surface (Chapter 13-15, EN 13381-1:2020). Temperatures and temperature curves are shown in appendix 5.

Failure time of the protection is defined on the basis of temperature measurements according to chapter 13 standard EN 13381-1:2020. The results are presented in Tables 1 and 2. According to observations, the failure time of the protection was 36 min 40 s in the cavity and 36 min 50 s on the surface. **So the failure time of the protection is 36 min**.

Table 1. Position of failure and failure time in the cavity on the basis of temperature measurements.

Temperature in the air cavity	
Limiting cavity temperature for timber constructions: *(criterion: T ≤ 300 °C),* tc1...tc33	***T ≤ 300 °C = 36 min 40 s*** **(tc2, tc7)**

Table 2. Position of failure and failure time on the surface on the basis of temperature measurements.

Temperature on the surface	
Limiting surface temperature for timber constructions: *(criterion: T ≤ 300 °C),* tc1...tc33	***T ≤ 300 °C = 36 min 50 s*** **(tc17, tc18)**

Summary

Assessment of the loadbearing capacity is made by determination from the characteristic temperature curves. Limiting temperature for building members made of timber is 300 °C at the cavity and the surface (Chapter 13-15, EN 13381-1:2020). The test results of the fire protected horizontal protective member presented in test report EUFI29-20006483-T1 are used for the assessment.

Gyproc GK 26-01+M-wire hangers were fixed under the timber beams (c/c 900 mm / 585 mm) with Wurth 6,0x50/46 screws. Upper Gyproc GK1 steel profiles were installed at the timber beams (c/c 585 mm) and lower Gyproc GK1 steel profiles (c/c 400 mm) were installed to the upper GK1 steel profiles with cross connection bracket Gyproc GK 22. Two layers of Gyproc GN 13 gypsum plasterboards were installed under the lower GK1 steel profile with H&H 25x3,5 mm and 40x4,2 mm screws. The dimension between the bottom of the loadbearing timber beam and the top surface of the first gypsum plasterboard layer was 155 mm.

The results of the assessment are as follows in table 3:

Table 3. Presentation of loadbearing capacity results

For application to the following contruction material	Limiting cavity temperature	Loadbearing capacity from elapsed time
Timber	300 °C	36 min

Limits of applicability of the results of the assessment

1. Type of structural building member

The results obtained may be applied to other combinations of beams or joists and floors in accordance with table 4:

Table 4. Application of results from tests to other materials

Standard structural member tested	Results applicaple to structural building members comprising, slabs constructed from alternative material types, provided from 15.2 to 15.5 (EN 13381-1:2020), are satisfied			
	Aerated concrete	Normal concrete	Steel/concrete composite	Timber
Timber boards on timber beams	YES[a]	YES[a]	YES[a]	YES[a]

[a] Only for the duration to get 300 °C inside the cavity during the test of the timber floor protected by the same horizontal membrane.

2. Type of timber structure

Fire resistance obtained from the testing of a timber structural building member or the standard aerated concrete floor shall be directly applicable to timber building members provided that:

- the thickness of timber particle board/cover is equal or greater than 21 mm;
- the particle board which are laid perpendicular to the joists, shall be connected with tongue and groove joints;
- the butt joints shall only be located above the joist;

- the requirements of EN 1995-1-1 and the provisions with respect to the cavity specified in “Height of the cavity” are both maintained.

3. Height of the cavity

Fire resistance obtained by direct application shall be applicable to cavities with equal or greater height than that tested.

4. Exposed width of test specimen

The results are applicable to structures of width greater than that tested.

5. Properties of the horizontal protective membrane

The result of the assessment is only applicable to the horizontal protective membrane construction tested and at the density and thickness tested ± 5 %.

Components of supporting steel frame and installation conditions shall be the same as those tested.

6. Gaps between grid members and test frame or walls

Test results obtained with no expansion gap between grid members and the test frame or furnace walls shall be applicable to practical situations where such gaps are used, providing these are no greater than 5 mm in size.

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

Espoo, 20. April 2021

Matias Huusko
Senior Expert

Teemu Vesala
Senior Expert

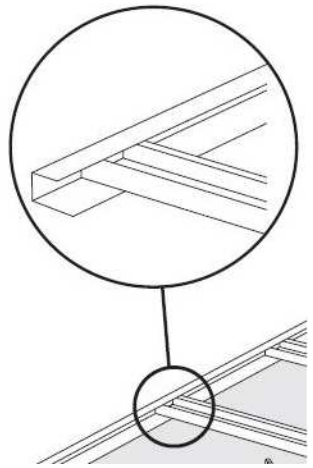
Appendices	Appendix 1	Drawing of the fire protection system
	Appendix 2	Drawing of the timber structure
	Appendix 3	Material properties
	Appendix 4	Observations
	Appendix 5	Test arrangement and temperatures of the test specimen

DISTRIBUTION	Client	Original (1 pcs)
	Eurofins Expert Services Oy/Archive	Original (1 pcs)

KUVA YLÄPUOLELTA KATSOTTUNA

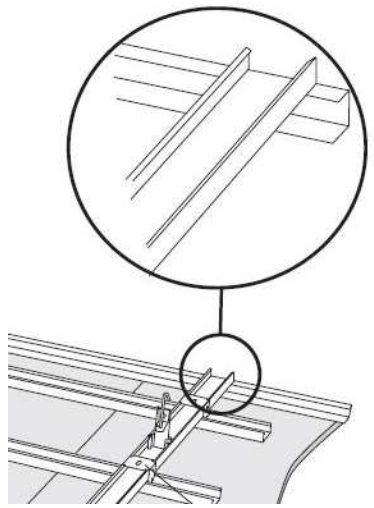
GK -KANNATTIMET JA RIPUSTIMET

Eurofins Expert Services Oy
Teemu Vesala



PITKILLÄ SIVUILLA GK-C -LISTA (ei kiinnitetty seinään!)

PÄÄDYISSÄ GK-C -LISTA (ei kiinnitetty seinään!)



KIVIVILLA REUNOILLA TIIVIISTI KIPSI-LEVYJÄ VASTEN

YHTEENSÄ 36 RIPUSTINTA:
Gyproc GK 26-01 + M-lanka

55 | 567.5 | 585 | 585 | 585 | 567.5 | 55

YLEMMÄT GK1 KANNATTAJAT K/K 585 MM (=puuvasojen kohdilla)

3000 (TESTIRAKENTEEN ÄÄRIMITTA)

Tiivistetään kivivillalla huolelliesti uunimuuriin

250 | 900 | 900 | 900 | 900 | 900 | 900 | 250

YHTEENSÄ 36 RIPUSTINTA: Gyproc GK 26-01 + M-lanka

300 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 300

ALEMMAT GK1 KANNATTAJAT K/K 400 mm

5000 (TESTIRAKENTEEN ÄÄRIMITTA)

Tiivistetään kivivillalla huolelliesti uunimuuriin

MITTAKAAVA 1:20
PIIRTÄJÄ: Janne Inkinen
PVM. 19.01.2020
REV. 03.02.2021

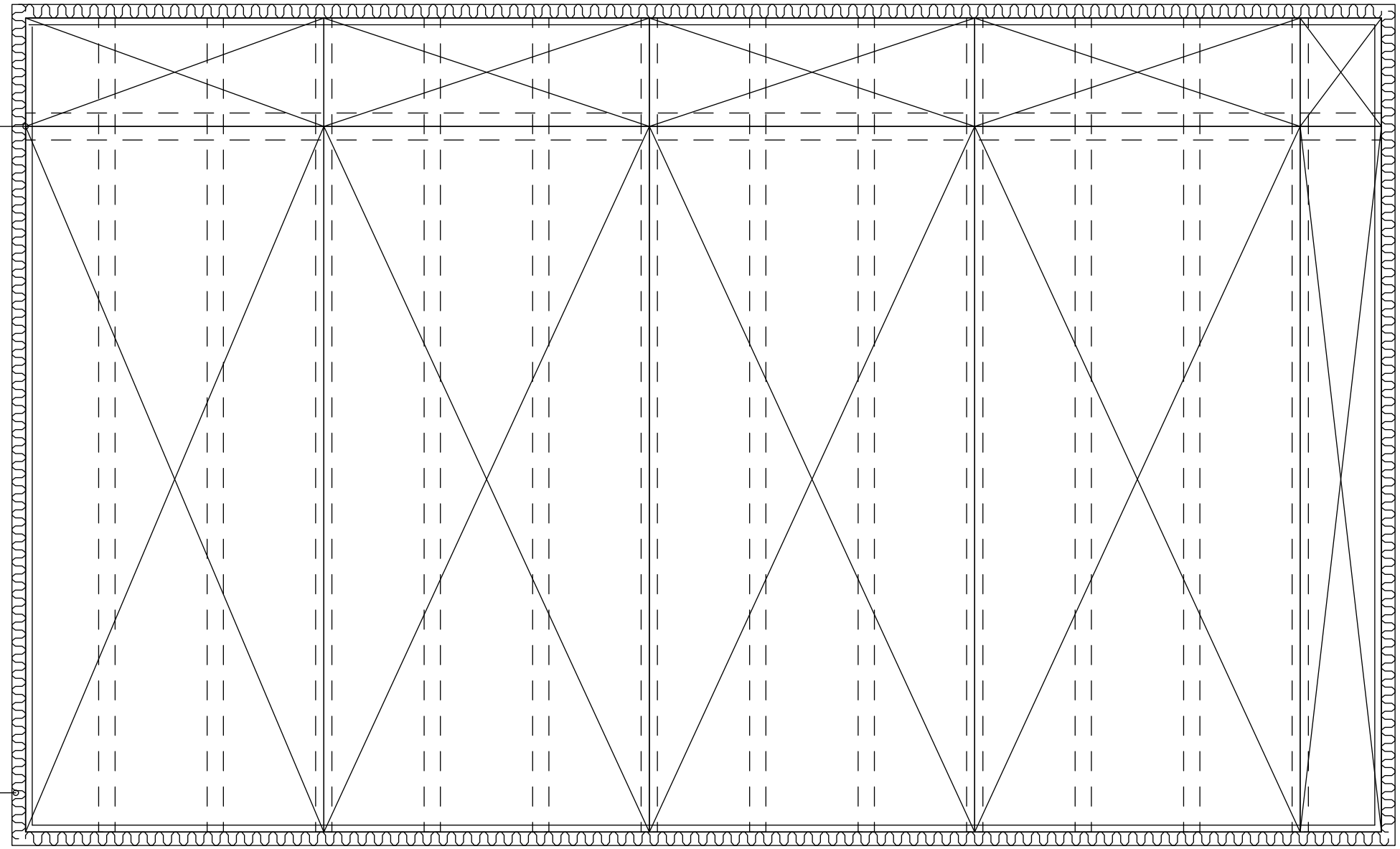
KUVA ALAPUOLELTA KATSOTTUNA

YLEMPI LEVYTYS

LEVYJEN RUUVAUS
- k/k 200 mm levyn reunoilla
- k/k 300 mm levyn keskellä

PITKILLÄ SIVUILLA GK-C -LISTA (ei kiinnitetty seinään!)

Metal Strip PB-100
levysaumassa



300 400 400 400 400 400 400 400 400 400 400 400 300

GK1 K/K 400 mm

1100 1200 1200 1200 300

YLEMPI LEVYTYS (GN-13)

5000 (TESTIRAKENTEEN ÄÄRIMITTA)

KIVIVILLA REUNOILLA
TIIVIISTI KIPSI-
LEVYJÄ VASTEN

Eurofins Expert Services Oy
Teemu Vesala

MITTAKAAVA 1:20
PIIRTÄJÄ: Janne Inkinen
PVM. 19.01.2020
REV. 03.02.2021

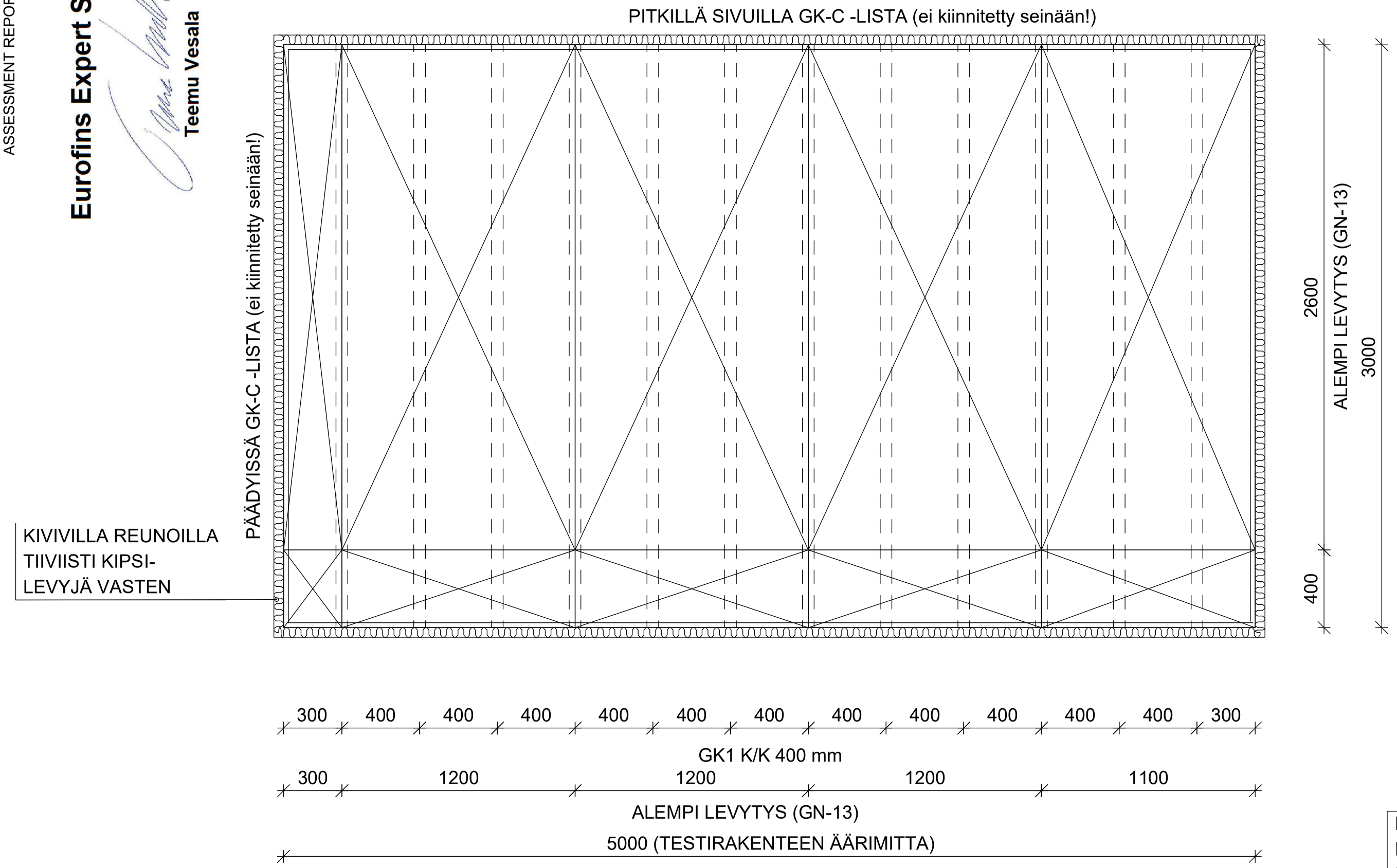
KUVA ALAPUOLELTA KATSOTTUNA

ALEMPI LEVYTYS

Eurofins Expert Services Oy

Teemu Vesala

LEVYJEN RUUVAUS
- k/k 200 mm levyn reunoilla
- k/k 300 mm levyn keskellä



MITTAKAAVA 1:20
PIIRTÄJÄ: Janne Inkinen
PVM. 19.01.2020
REV. 03.02.2021

PIIRUSTUS 3/3

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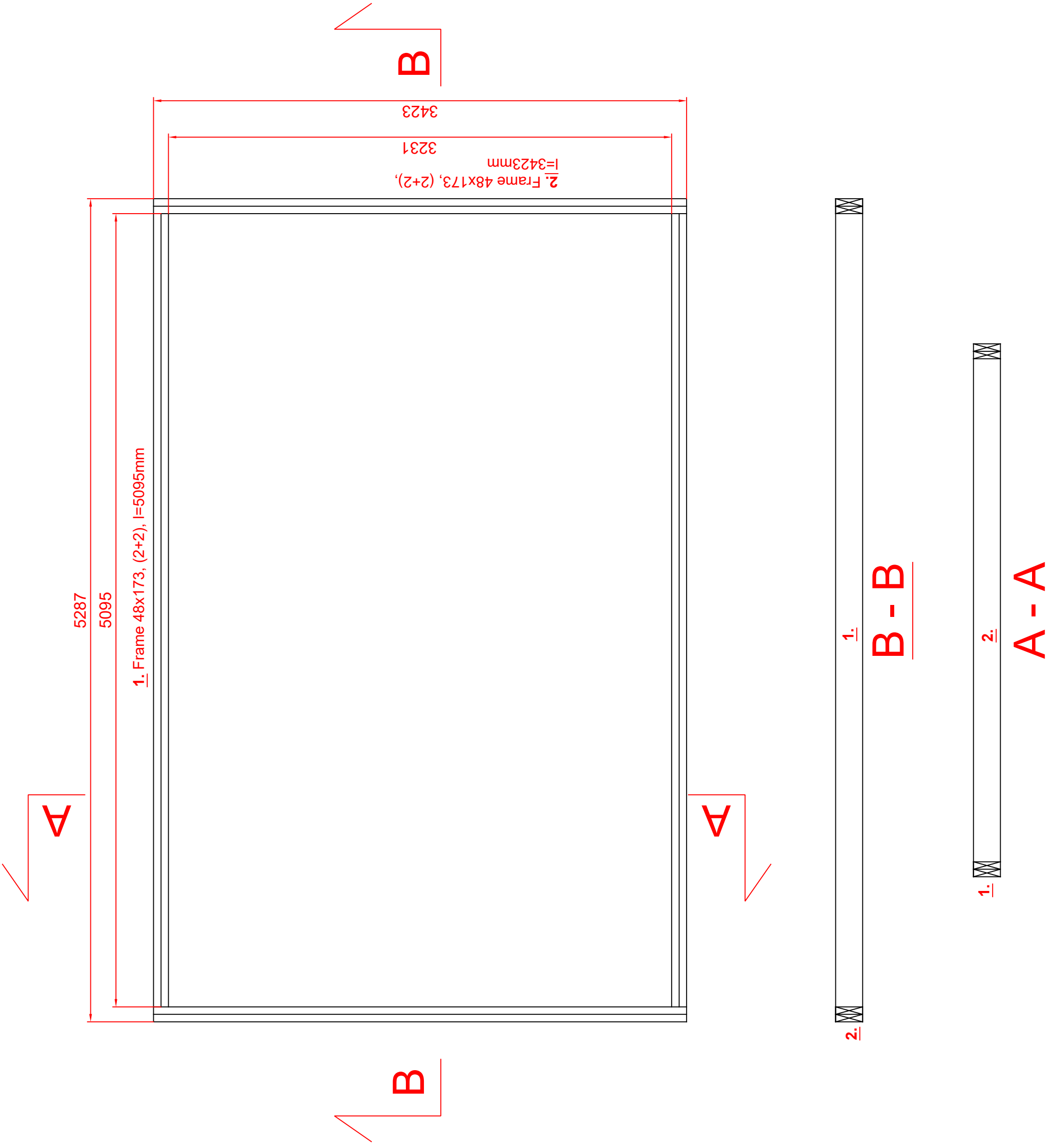

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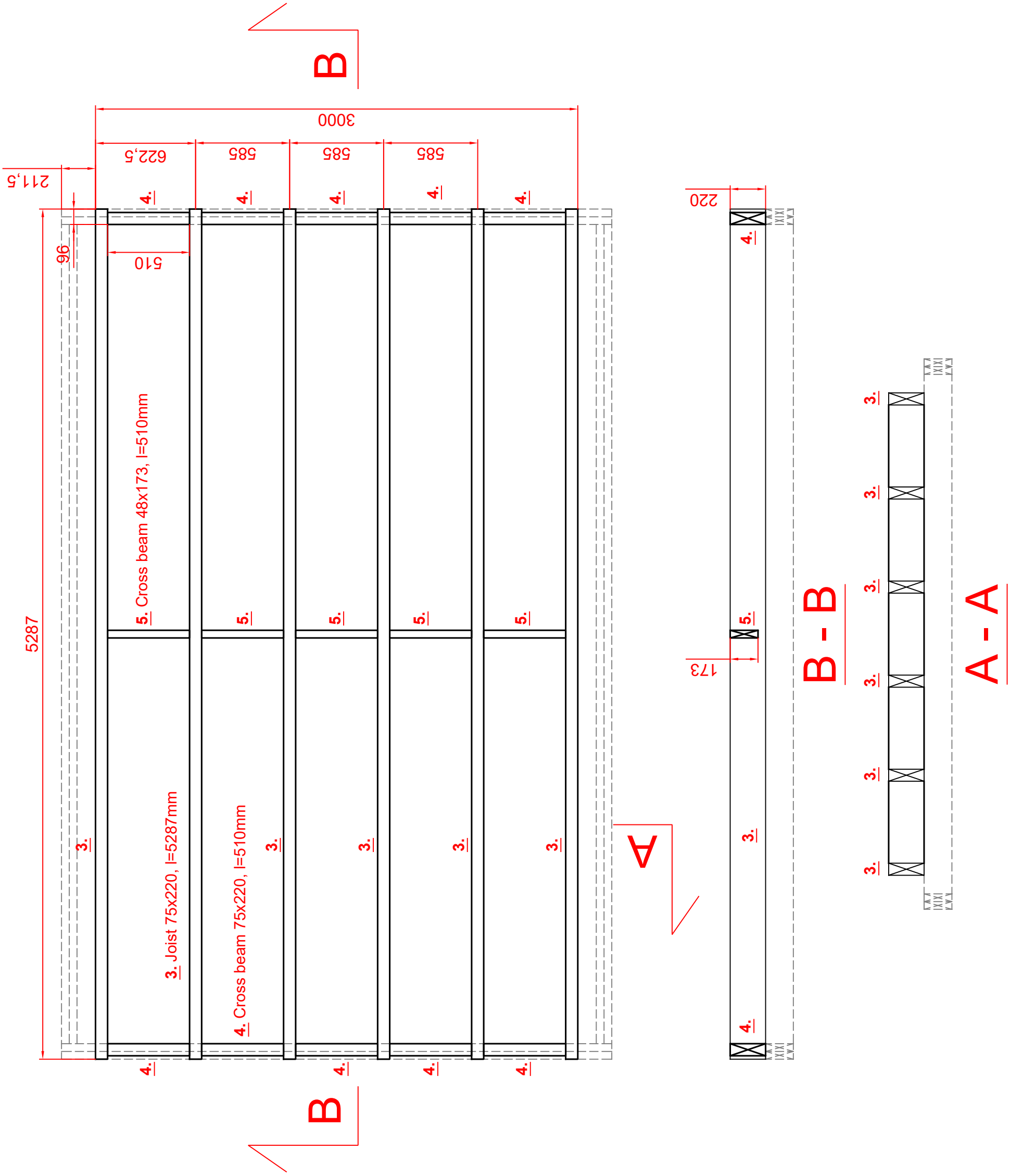

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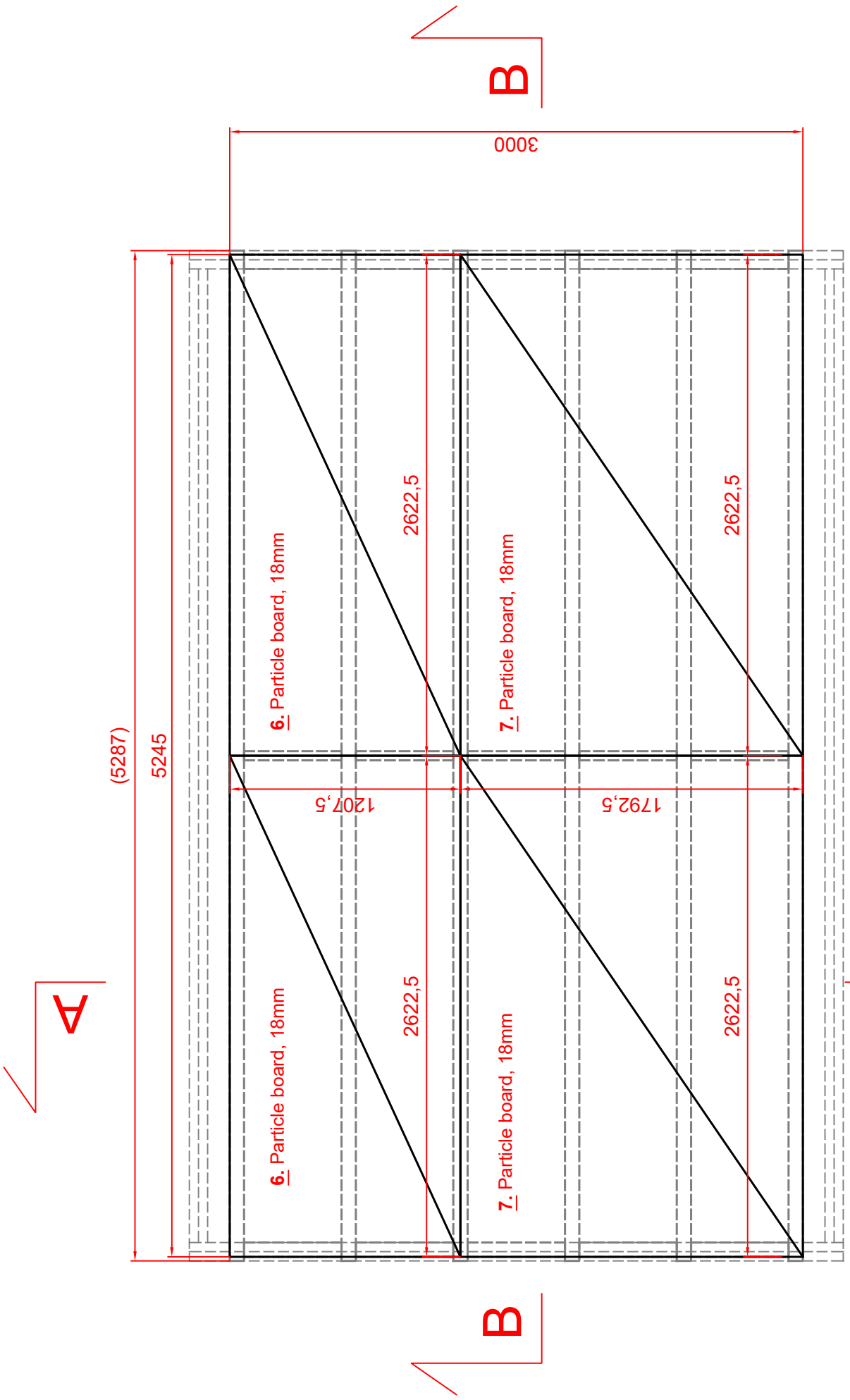
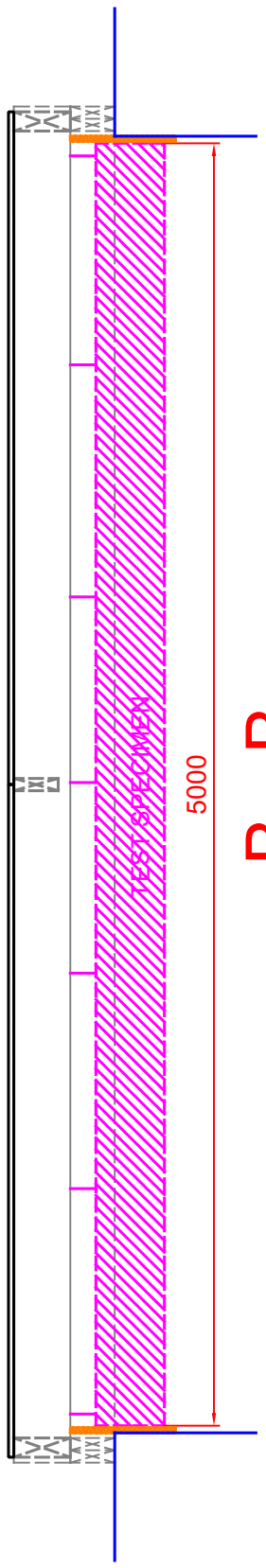
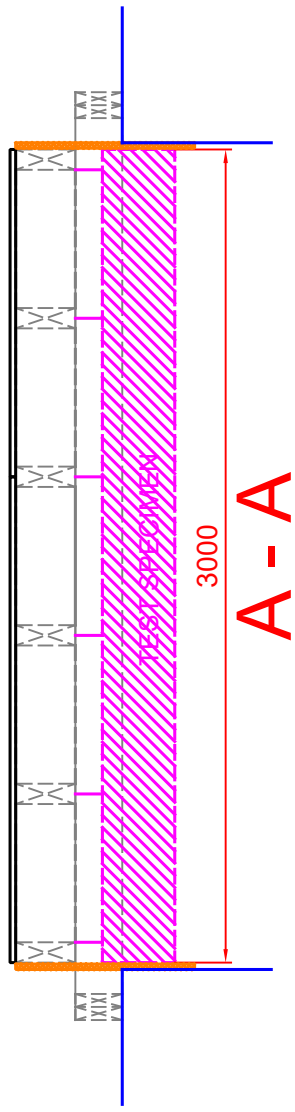






Determined material properties

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

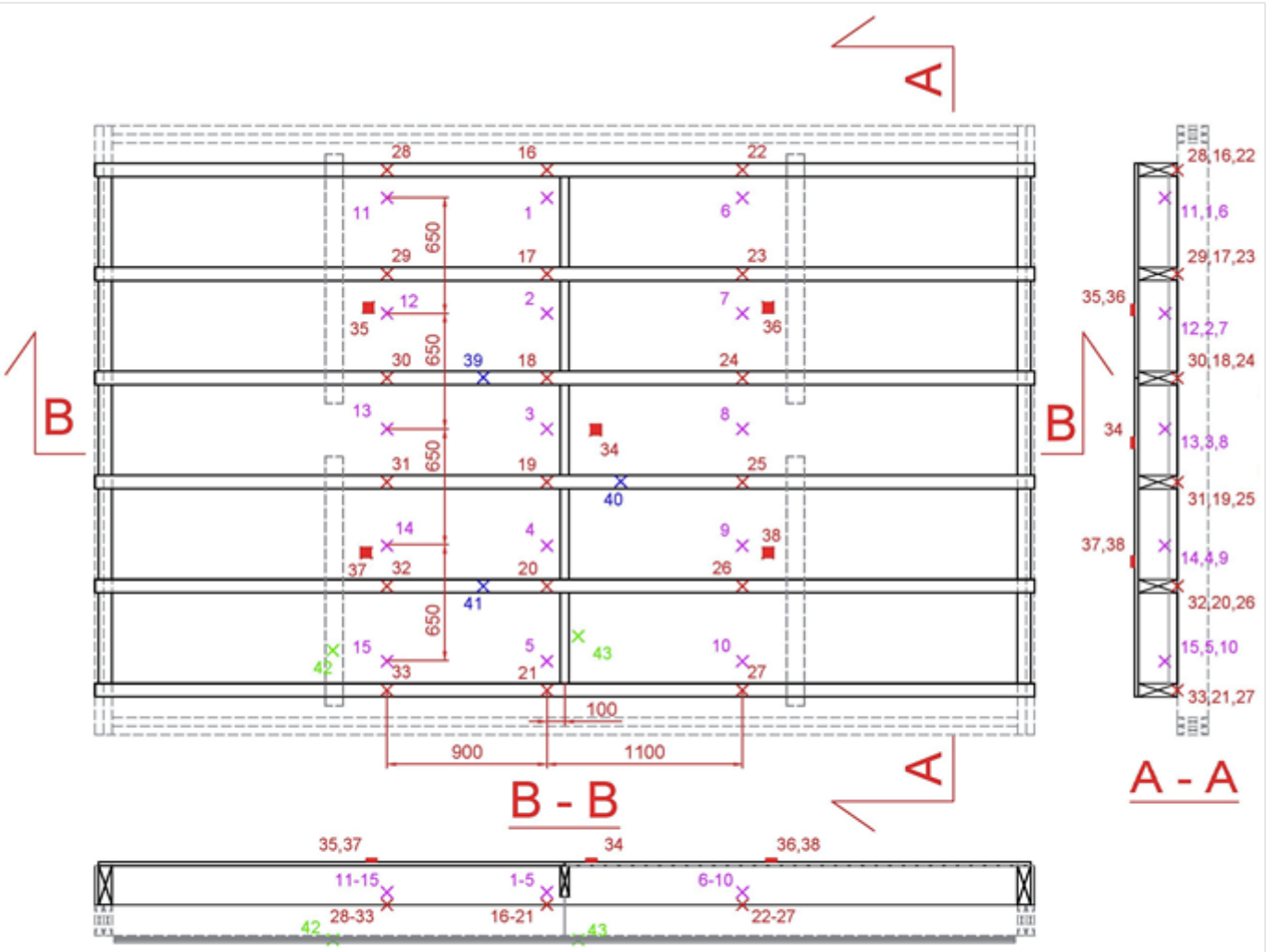
Material	Density / mass per area	Moisture content*) (50 °C)	Moisture content*) (105 °C)
Gyproc GN 13 gypsum board 13 mm	8.3 kg/m^2	0.2 %	17.3 %
Softwood joists 75 mm x 220 mm	523 kg/m^3	-	6.9 %

*) = 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.

Observations

Time [min:s]	**E/U**	**Observation** (E is fire exposed side, U is unexposed side)
0:00		Test was started.
5:40	E	Joint plaster began to fall off.
21:00	E	A crack was observed in a gypsum board in the middle.
22:00	E	A first piece of the first gypsum board layer had fallen off.
26:00	E	About 90% of the first gypsum board layer had fallen off.
36:20	E	Cracks was observed in the middlemost gypsum boards of the inner gypsum board layer.
36:40	U	Over 300 °C temperature was observed in thermocouples 2 and 7.
37:05	U	Over 500 °C temperature was observed in thermocouple 2.
37:30		Test was terminated.

Test arrangement



1-15 = Cavity temperature measurement points (halfway up the plenum within the cavity)
16-33 = Surface temperature measurement points
34-38 = Unexposed surface temperature measurement points
39-41 = Informative measurement point (bracket)
42-43 = Temperature measurement point between the gypsumboards
P1 = Pressure difference +20Pa (100mm below the surface of the specimen)

Temperatures of the test specimen

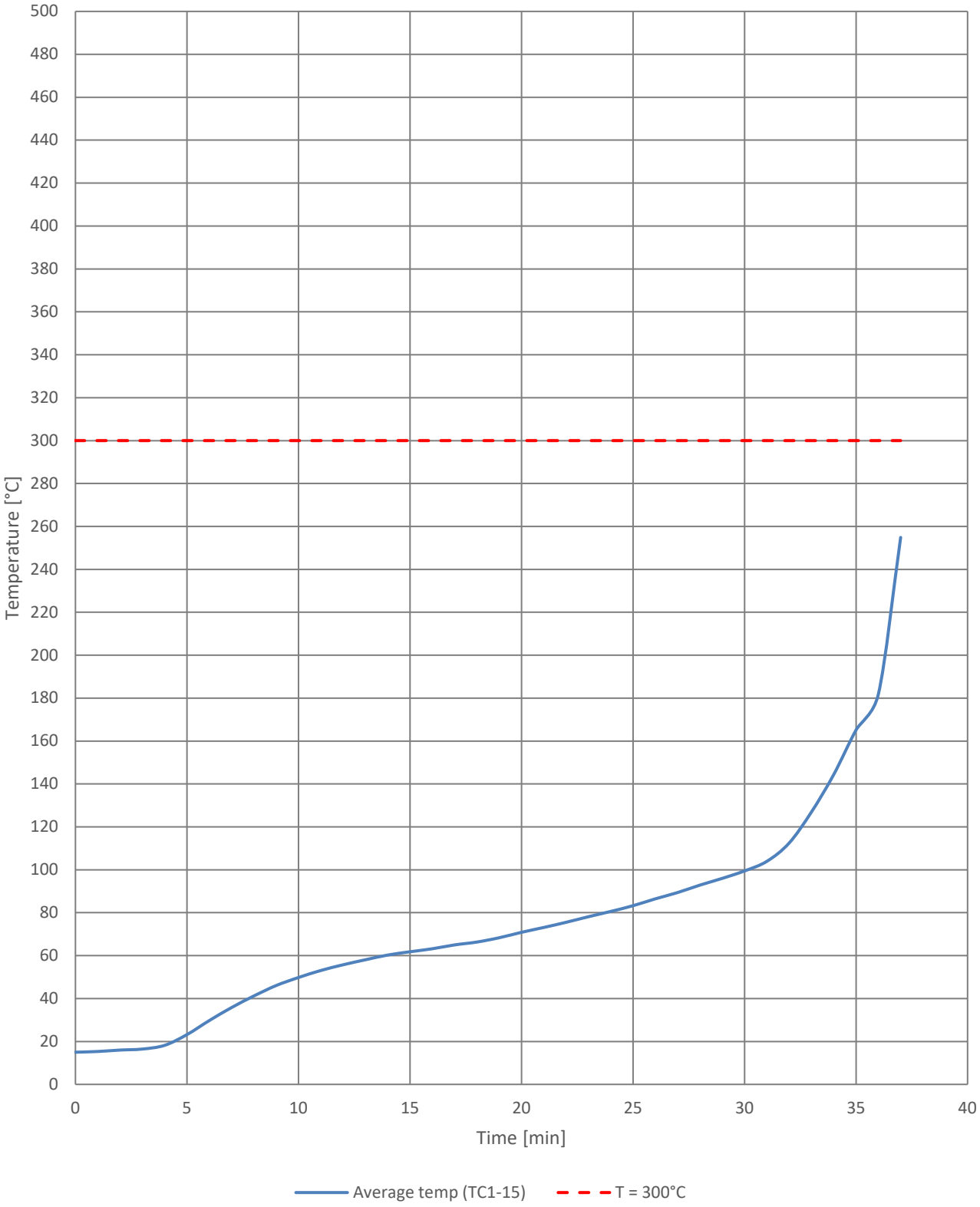


Figure 1. Measured individual cavity temperatures. Mean of thermocouples TC1…TC15.

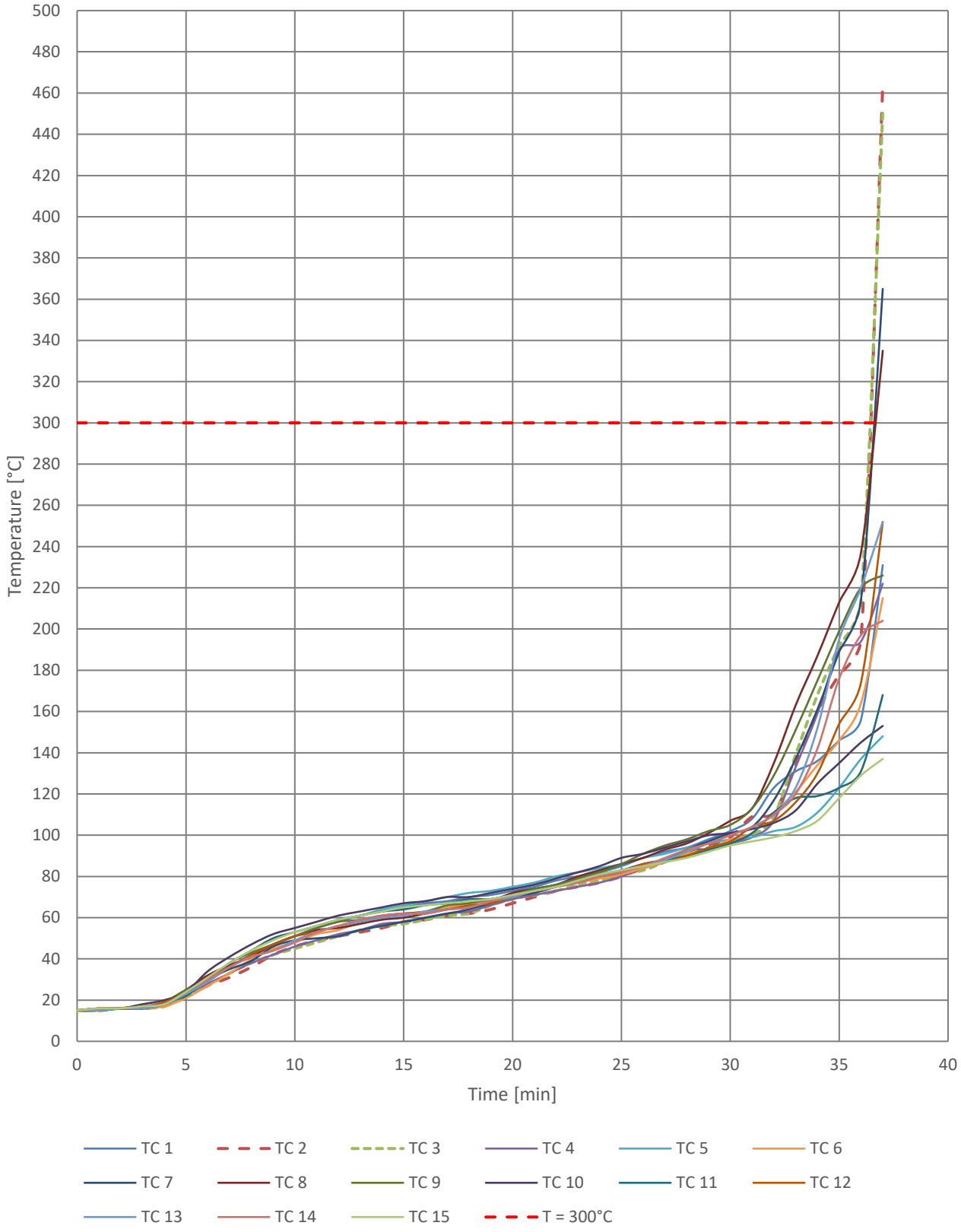


Figure 2. Measured individual cavity temperatures, TC1…TC15.

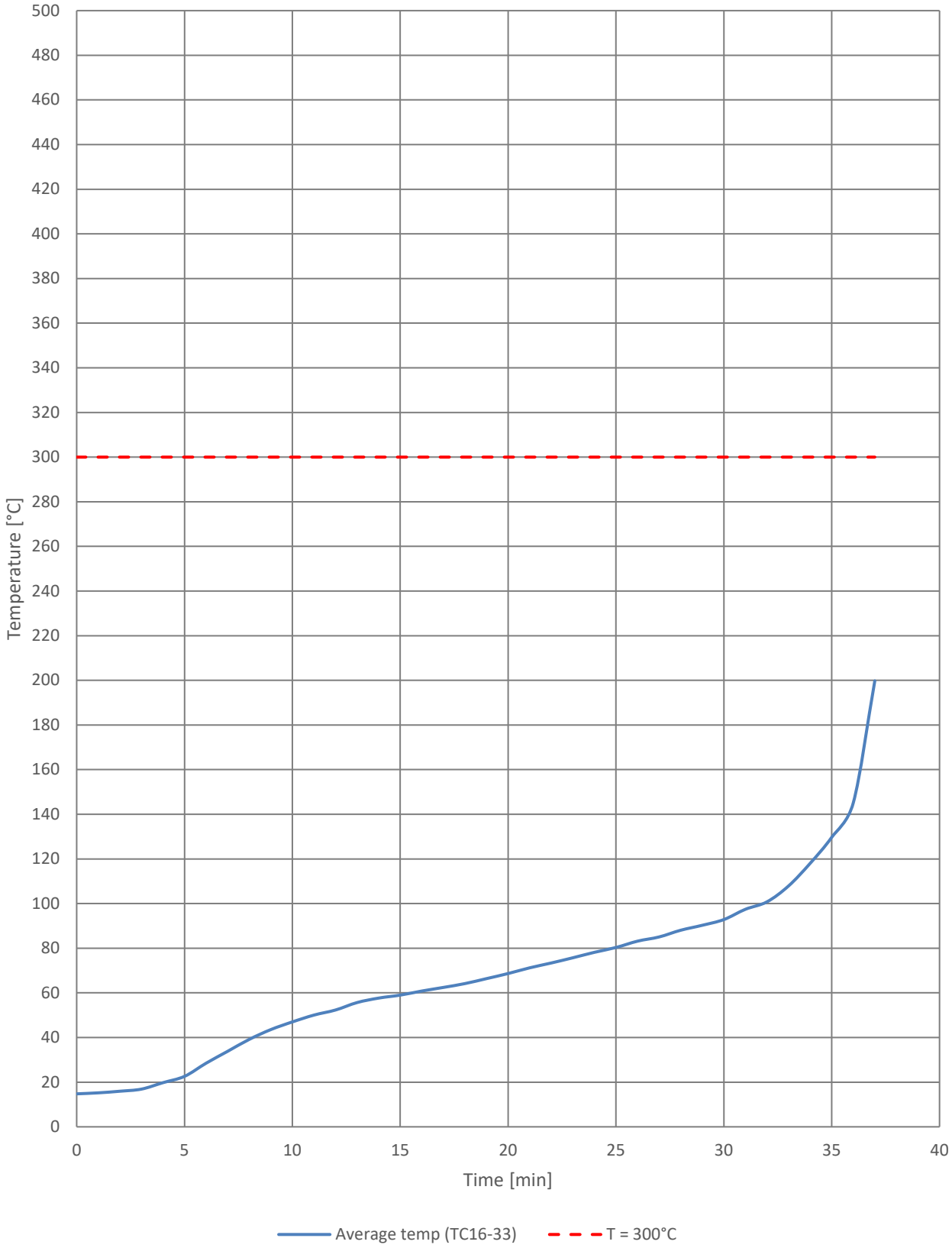


Figure 3. Measured individual surface temperatures. Mean of thermocouples TC16…TC33.

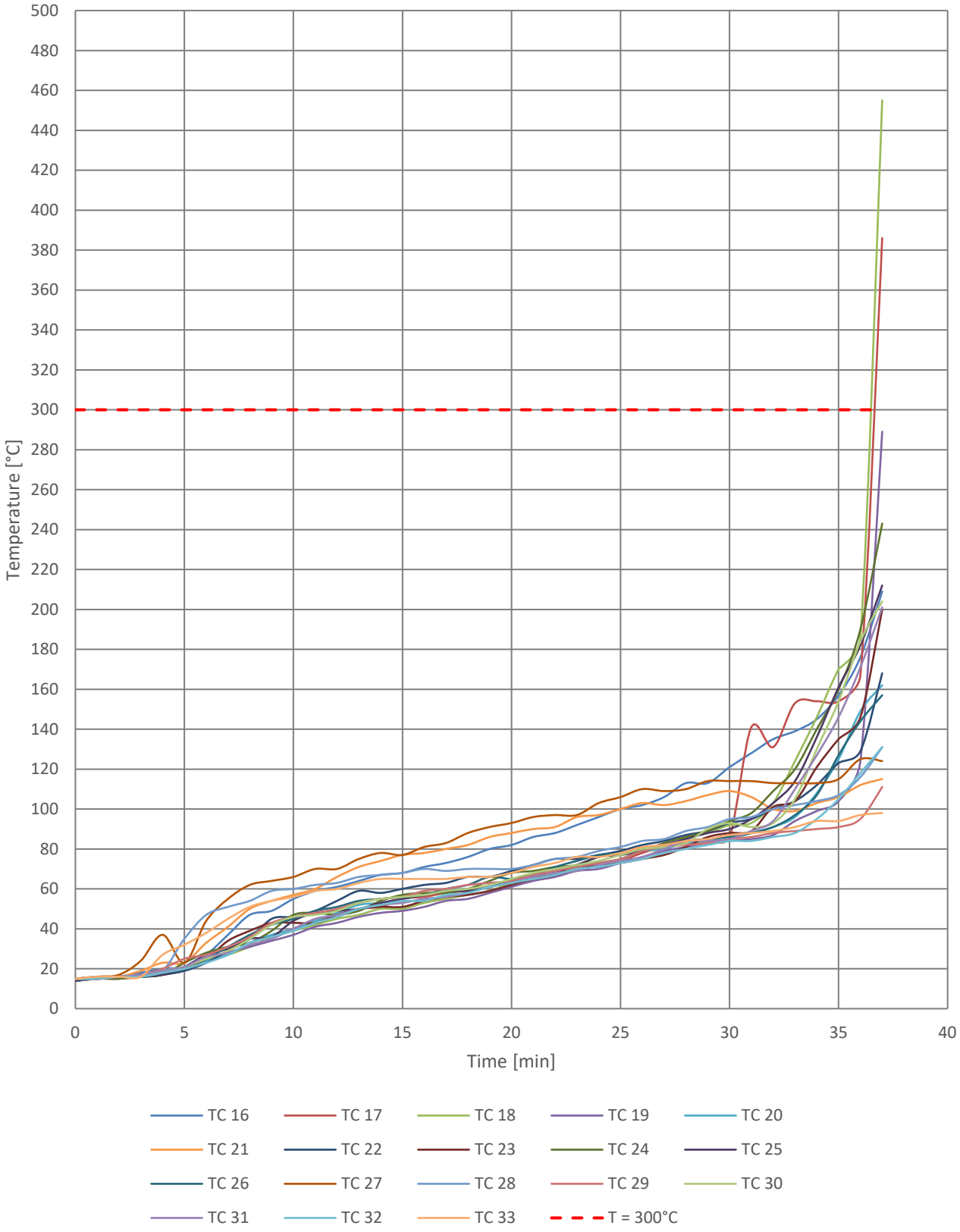


Figure 3. Measured individual surface temperatures. TC16…TC33.

Table 1. Measured individual specimen cavity temperatures

Time (min)	tc1 (°C)	tc2 (°C)	tc3 (°C)	tc4 (°C)	tc5 (°C)	tc6 (°C)	tc7 (°C)	tc8 (°C)	tc9 (°C)	tc10 (°C)	tc11 (°C)	tc12 (°C)	tc13 (°C)	tc14 (°C)	tc15 (°C)	Mean (tc1–tc15) (°C)
0	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
1	15	15	15	15	15	15	15	15	15	16	16	16	15	16	16	15
2	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
3	17	16	16	16	17	16	16	16	16	18	16	17	16	17	17	16
4	18	17	17	18	18	17	18	19	19	20	19	19	18	18	18	18
5	23	22	22	23	23	21	23	25	25	24	22	24	23	24	24	23
6	29	27	27	28	31	27	30	32	30	34	30	31	29	30	31	30
7	36	31	33	33	36	33	35	37	38	41	38	36	36	36	38	36
8	42	36	38	38	42	40	39	41	43	47	44	42	41	41	44	41
9	47	42	42	42	47	45	46	47	47	52	50	47	44	44	49	46
10	51	46	45	46	51	48	49	51	51	55	53	51	49	48	53	50
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12	58	51	51	52	59	54	51	55	58	61	59	56	56	56	59	56
13	61	53	54	54	61	58	54	57	59	63	61	58	58	59	61	58
14	63	55	56	57	64	61	56	59	61	65	63	60	60	61	63	60
15	65	58	57	58	66	62	58	60	62	67	64	62	61	62	65	62
16	67	59	59	60	68	63	60	62	63	68	66	62	63	62	66	63
17	68	61	61	62	70	65	62	64	66	70	67	64	64	64	67	65
18	70	62	62	63	72	67	64	65	67	70	69	66	65	65	68	66
19	71	64	66	66	73	68	67	68	69	72	69	67	68	68	69	68
20	73	67	69	69	75	70	70	72	71	74	71	70	70	71	71	71
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22	78	73	73	73	80	75	75	76	76	79	75	75	75	75	75	76
23	80	75	76	75	82	77	78	80	79	82	78	77	78	77	78	78
24	82	77	78	77	84	79	81	83	82	85	80	80	80	80	81	81
25	85	80	81	80	86	81	83	86	86	89	82	82	83	82	83	83
26	89	84	83	84	89	84	86	89	91	91	86	86	85	85	85	86
27	92	88	87	87	91	87	88	93	95	94	88	87	88	89	87	89
28	94	92	91	93	94	91	93	96	98	97	90	90	92	93	89	93
29	98	95	94	93	96	93	97	101	102	100	93	94	96	96	92	96
30	102	99	97	96	98	98	101	107	105	101	96	97	100	100	95	99
31	108	109	100	99	99	101	104	113	113	103	101	104	104	104	97	104
32	123	111	109	107	102	111	117	135	129	106	111	107	110	110	99	112
33	131	134	139	133	104	121	137	163	151	112	118	116	123	120	102	127
34	136	160	168	159	111	134	161	187	175	125	119	130	152	142	107	144
35	146	178	192	190	123	146	189	213	199	135	123	154	195	176	118	165
36	156	195	214	194	137	164	214	237	220	145	131	174	220	197	129	182
37	231	464	451	222	148	215	365	335	226	153	168	252	252	204	137	255

Table 2. Measured individual surface temperatures

Time (min)	tc16 (°C)	tc17 (°C)	tc18 (°C)	tc19 (°C)	tc20 (°C)	tc21 (°C)	tc22 (°C)	tc23 (°C)	tc24 (°C)	tc25 (°C)	tc26 (°C)	tc27 (°C)	tc28 (°C)	tc29 (°C)
0	15	15	15	15	14	15	15	14	14	14	15	15	15	15
1	15	15	15	15	15	16	15	15	15	15	15	16	16	15
2	16	16	16	16	16	16	16	15	15	16	16	17	16	16
3	18	16	16	16	16	19	16	16	16	16	16	24	17	17
4	20	17	17	17	17	23	17	17	17	17	18	37	19	20
5	21	20	21	19	21	23	19	21	23	21	21	23	35	25
6	27	24	24	23	24	33	23	25	28	27	25	44	47	27
7	37	28	27	28	27	41	29	34	31	30	31	55	51	31
8	47	31	31	31	33	50	35	39	33	35	37	62	54	36
9	49	36	36	34	37	54	45	43	39	36	42	64	59	43
10	55	40	39	37	40	57	46	43	47	44	45	66	60	46
11	59	44	42	41	44	60	49	43	48	48	49	70	62	48
12	61	46	45	43	48	66	54	47	47	49	51	70	63	50
13	64	50	47	46	52	71	59	50	49	50	54	75	66	53
14	67	51	50	48	53	74	58	51	54	53	55	78	67	55
15	68	55	50	49	55	77	60	51	57	55	56	77	68	56
16	71	56	53	51	57	78	62	54	58	57	57	81	70	59
17	73	58	55	54	59	80	63	56	58	59	60	83	69	60
18	76	59	57	55	60	82	66	57	60	59	62	88	70	62
19	80	61	59	58	61	86	66	59	64	61	66	91	70	63
20	82	64	63	61	64	88	69	62	68	64	65	93	70	64
21	86	66	65	64	66	90	72	65	69	67	67	96	72	67
22	88	68	68	66	69	91	75	67	71	68	71	97	75	69
23	92	71	70	69	71	96	75	70	72	72	74	97	76	71
24	96	73	72	70	73	97	77	72	76	76	77	103	79	73
25	100	74	75	73	75	100	79	73	78	77	78	106	81	75
26	102	78	79	76	79	103	82	75	79	79	80	110	84	79
27	106	81	80	79	80	102	84	77	83	82	81	109	85	81
28	113	83	86	81	83	104	87	81	86	85	84	110	89	82
29	113	84	88	83	84	107	89	86	89	88	85	114	91	83
30	121	86	92	84	85	109	93	88	94	90	86	114	95	85
31	128	141	93	85	88	106	95	89	98	95	88	114	96	86
32	135	131	103	87	91	100	100	101	109	103	91	113	100	88
33	139	153	124	94	96	99	104	104	120	114	97	113	102	89
34	145	154	146	99	108	103	112	121	140	136	107	113	104	90
35	157	154	170	104	125	106	123	135	160	161	127	115	107	91
36	176	167	186	124	149	112	129	146	190	182	144	125	116	95
37	209	386	455	289	162	115	168	200	243	212	157	124	131	111

Table 3. Measured individual surface temperatures

Time (min)	tc30 (°C)	tc31 (°C)	tc32 (°C)	tc33 (°C)	Mean (tc16–tc33) (°C)
0	15	15	15	15	15
1	15	15	15	16	15
2	16	16	16	16	16
3	16	17	16	16	17
4	19	19	18	27	20
5	21	21	20	32	23
6	25	26	23	38	29
7	29	28	27	45	34
8	35	32	33	51	39
9	42	35	36	54	44
10	46	40	39	56	47
11	47	45	43	59	50
12	49	47	46	60	52
13	53	50	50	63	56
14	55	52	52	65	58
15	56	53	54	65	59
16	57	55	54	65	61
17	59	56	57	65	62
18	60	58	58	66	64
19	62	61	61	66	66
20	65	63	63	68	69
21	68	66	65	71	71
22	70	68	67	73	73
23	72	69	70	76	76
24	74	72	71	76	78
25	77	74	73	78	80
26	80	76	75	81	83
27	81	80	78	82	85
28	83	84	80	84	88
29	90	84	82	85	90
30	93	85	84	87	93
31	91	89	84	88	97
32	93	94	86	89	101
33	105	110	88	91	108
34	130	127	95	94	118
35	154	146	105	94	130
36	184	171	118	97	145
37	204	201	131	98	200