TEST REPORT FIRES-FR-021-18-AUNE

Loadbearing wall composed of EcoCocon straw modules with clay plaster

Reg. No. 041/S-159

The Experts on Fire Safety

TEST REPORT

FIRES-FR-021-18-AUNE

Tested property:	Fire resistance
Test method:	EN 1365-1: 2012/AC: 2013
Test type:	Accredited and Notified (NB 1396)
Date of issue:	21. 02. 2018
Name of the product:	Loadbearing wall composed of EcoCocon straw modules with clay plaster
Manufacturer:	Ecococon UAB Odminiu street 10-10 Vilnius Lithuania
Sponsor:	Ecococon UAB Odminiu street 10-10 Vilnius Lithuania
Test carried out by:	FIRES, s.r.o., Testing laboratory
Task No.:	PR-18-0027
Specimen received:	18. 12. 2017
Date of the test:	29. 01. 2018

Technician responsible for the technical side of this report: Dávid Šubert

Number of pages: 30
Test reports: 3 Copy No.: 2

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1. INTRODUCTION

This test report contains the results of a test carried out by FIRES, s.r.o., Testing laboratory in Batizovce, accredited for testing by SNAS. Certificate of accreditation No.: S-159. The purpose of the test was to gain information for product classification.

Sponsor's representatives witnessing the test:

Mr. Bjorn Kierulf	Ecococon
test carried out by	Dávid Šubert
operator	Ing. Marek Gorlický

2. MEASURING EQUIPMENT

Identification number	Measuring equipment	Note
F 90 001	Vertical test furnace for fire resistance testing	-
F 69 010	PLC system for data acquisition and control TECOMAT TC 700	-
F 40 019	Visual and calculating software to PLC TECOMAT TC 700	-
F 40 017	Control and communication software to PLC TECOMAT TC 700	-
F 40 018	SW Reliance	-
F 40 020	Driver Tecomat - Reliance (SW)	-
F 71 041, F 71 042	Transducer of differential pressure (–50 to + 150) Pa	measurement of pressure inside the test furnace
F 54 020	Digital calliper (0 to 200) mm	-
F 54 056	Racking meter	-
F 73 002	Suspension load-cell scale	finding out of humidity equilibrium state
F 69 009	PLC system for data acquisition and climate control TECOMAT TC 604	-
F 60 001 - F 60 009	Sensors of temperature and relative air humidity	measurement of climatic conditions
F 15 501 - F 15 508	Plate thermometers	measurement of temperature inside the test furnace according to EN 1363-1
F 15 002 - F 15 200	Unsheathed thermocouples type K 2 x Ø 0,5 mm	measurement of temperatures on the unexposed surface of the specimen
F 15 701	Sheathed thermocouple type K Ø 3 mm	measurement of ambient temperature
F 15 001	Roving thermocouple	-
F 74 007 - F 74 012	Cable position transducers (0 to 1250) mm	measurement of deflection
F 90 005	Gap gauge for fire resistance testing ∅ 25 mm	-
F 90 006	Gap gauge for fire resistance testing ∅ 6 mm	-
F 90 007	Frame for supporting the cotton pad (100 x 100) mm for fire resistance tests	-
F 57 005	Digital stop-watch	-
F 95 004	Hydraulic loading appliance to the loading frame	static loading of the specimen

Identification number	Measuring equipment	Note
F 95 005	Hydraulic loading unit	
F 95 006, F 95 007	Transducers of oil pressure	

3. PREPARATION OF THE SPECIMEN

Testing laboratory noted down production data of the specimen from a certified production.
Test specimen data are listed in following table:

Place of production	Ecococon UAB, Gedimino street 30D, Kybartai, Vilkaviskis district, Lithuania
Production number	4395 - 4401
Date of production	21. 09. 2017
Check-out date	25. 09. 2017
Number of certificate ISO 9001	04-14-007
Issuing Body	UAB Inspekta
Date of issuing	02. 12. 2015

Individual materials (straw modules, wood fibre boards, plasters, etc.) were delivered to the testing laboratory by test sponsor. Assembling of the test specimen from individual modules and application of plasters was carried out by representatives of the sponsor.

4. PREPARATION OF THE TEST

4.1 DESCRIPTION OF THE SPECIMEN STRUCTURE

One specimen of loadbearing wall composed of EcoCocon straw modules with clay plaster was used for fire resistance test.

Dimensions

Overall specimen dimensions	(3000 x 3000 x 250) mm (height x width x thickness)
Dimensions of individual modules	(2900 x 1000 x 250) mm (height x width x thickness)
	(2900 x 1200 x 250) mm (height x width x thickness)
	(2900 x 800 x 250) mm (height x width x thickness)

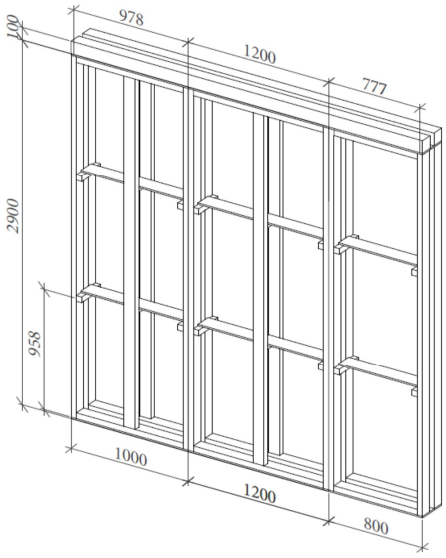
Construction of wall
The wall is assembled of three EcoCocon straw modules 800 mm, 1000 mm and 1200 mm width.

Frame construction of the module
Double frame construction of each module is made of timber profiles with cross-section (45 x 95) mm. Modules with width 1000 mm or more includes two additional vertical timber profiles placed at mid-width. Top and bottom module edge is covered by 12,0 mm thick plywood. Individual components are fixed together by screws (8 x 100) mm and (4,5 x 50) mm.

Modules are reinforced by transverse timber profiles (45 x 45) mm placed on both vertical edges at maximum distances 960 mm. Boards 20,0 mm thick are placed between vertical edges and fixed to transverse profiles by screws (6 x 60) mm and (8 x 80) mm.

Individual modules are fixed together by screws (8 x 100) mm placed in maximum spacing of 470 mm. Two wooden profiles C24 with dimensions (100 x 100) mm are placed on the top wall edge to ensure balanced loading of wall.

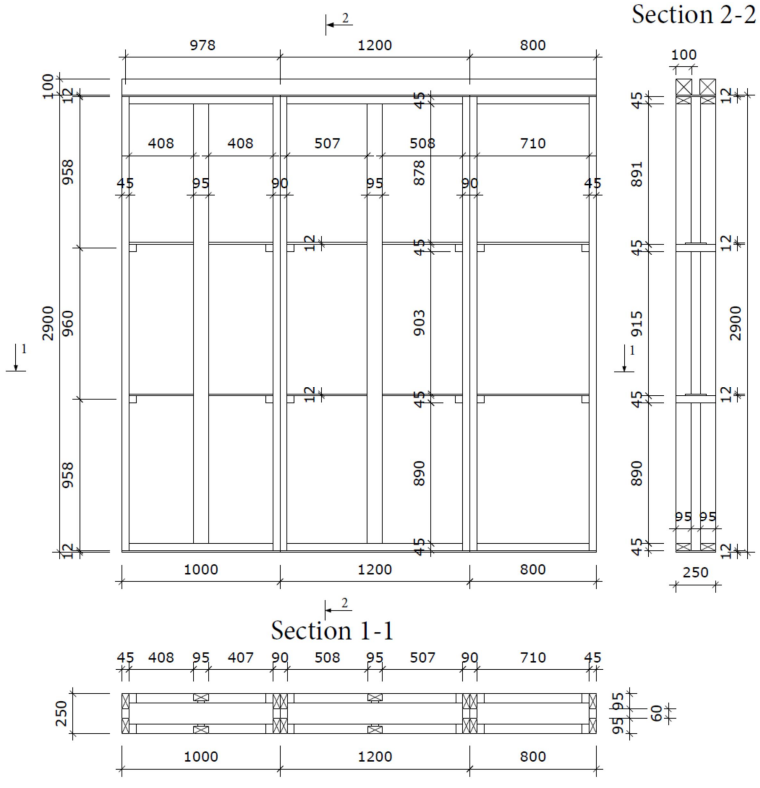
Core of the wall is pressed straw with bulk density 100kg.m^{-3}.



View of the wall module

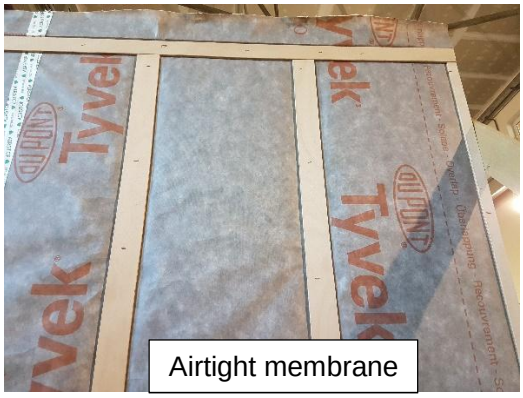
View of fixing of plywood to frame construction

View of assembled wall



Covering of the wall
Timber elements are covered from exterior face by waterproof membrane (producer: Tyvek) fixed to the timber posts by staples 20,0 mm long applied through plywood strips (8 x 45/90) mm. A wood fibre boards Steico Protect H (producer: Steico) with dimensions (535 x 1300 x 60) mm and bulk density of 265 kg.m^{-3} are fixed to wooden construction by steel staples 90,0 mm long spaced each 150 mm. The wood fibre boards are fixed together by tongue-groove joints on edges. No additional plaster used on external face of wall.


Tongue-groove joint of wood fibre boards



Airtight membrane


Covering of the wall by wood fibre boards

Timber elements are covered from interior face by clay base plaster applied two layers (together 20 – 25 mm thick) with a reinforced glass fibre mesh (producer: Vertex). An additional fine clay plaster approx. 5,0 mm thick is added as a finish.

Composition of clay base plaster during the test defined by the sponsor: clay 0,001 – 0,002 mm (5%), silt 0,002 – 0,06 mm (9,4%), sand 0,06 – 2,0 mm (85,5%) and gravel 2,0 – 4,0 mm (0,1%).

The clay plaster is applied directly on the straw surface and timber studs.

More detailed information about the construction of the specimen is shown in the drawings which are a part of this test report. Drawings were delivered by the sponsor.

All the information about technical specifications of used materials and semi-products, information about their type sign were delivered by sponsor. This information was not subject to the specimen verification. Parameters which were verified are quoted in paragraph 4.3.

4.2 DESCRIPTION OF THE SPECIMEN FIXATION

The test specimen is fixed to the loadbearing test frame. Gap between test specimen and test frame is filled with aerated concrete blocks with bulk density of 613 kg/m^3, 250 mm thick.

Both vertical specimen edges are unrestrained (free edges), filled with mineral wool with bulk density 150 kg/m^3, 50 mm thick.

30 minutes before the fire test and during the fire test, the axial load 70,0 kN/m was applied by the set of hydraulic cylinders on the upper specimen edge.

Orientation of the specimen during the test

Internal face of wall exposed to fire – clay plaster exposed to fire

4.3 VERIFICATION OF THE SPECIMEN

The conformity of the drawings and the test specimen was verified before and after the fire resistance test. It was possible to carry out this verification on the test specimen. The specimen corresponded to the drawings which are a part of this test report. The visual review of the test specimen, the used materials as well as the size verification of basic dimensions and the specimen's attachment to the supporting construction were subject to this verification.

4.4 CLIMATIC CONDITIONING OF THE SPECIMEN

Test specimen was stored in the hall of the testing laboratory and was conditioned according to EN 1363-1 under the following climatic conditions:

Ambient air temperature [°C]

mean	25,1
standard deviation	2,0

Relative air humidity [%]

mean	45,1
standard deviation	3,0

5. CARRYING OUT OF THE TEST

5.1 CONDITIONS OF THE TEST

Conditions during the test in the test furnace (temperature – standard temperature/time curve, pressure, O_2 content) as well as in the testing room (ambient temperature) corresponded to EN 1363-1. Detailed information is a part of this test report, or can be found in the test record.

Values characterizing the testing room environment directly before the test:

Ambient air temperature [°C]
15,1

5.2 RESULTS OF THE TEST

Measured values are stated in this test report. Description of the specimen behaviour during the test:

Time [min:s]	**Face of specimen**	**Observation**
30:00	NS	no significant changes are visible;
61:00	ES	creation of a cracks on the specimen surface;
90:00	NS	no significant changes are visible;
120:00	NS	no significant changes are visible;
121:30	termination of the test.	

ES: exposed face of specimen; NS: unexposed face of specimen

6. CLOSING

Evaluation of the test:

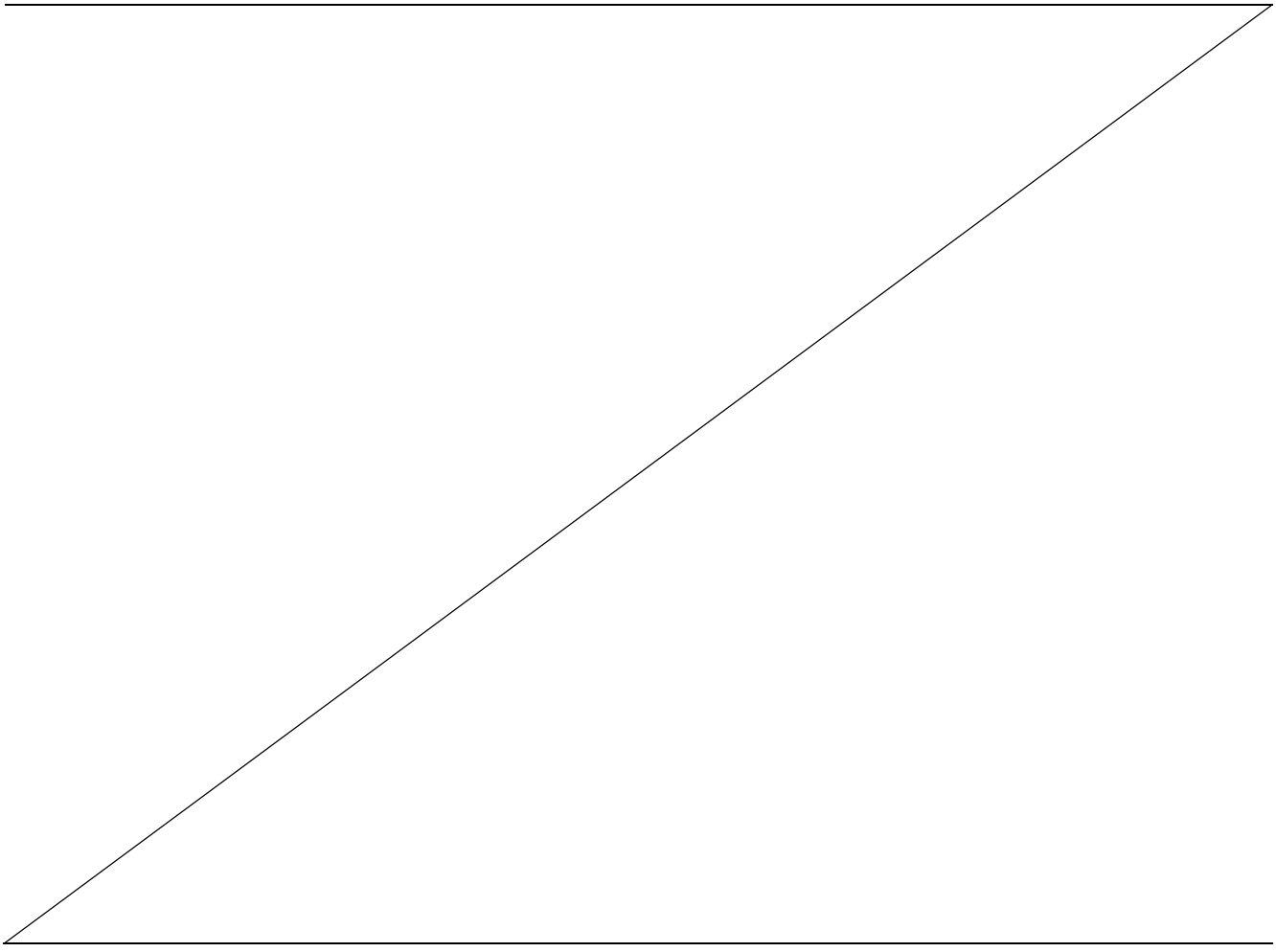
Performance criterion	Time till the performance criterion is achieved
load-bearing capacity – vertical contraction [mm]	121 minutes no failure
load-bearing capacity – rate of vertical contraction [mm/min]	121 minutes no failure
integrity – sustained flaming	121 minutes no failure
integrity – gap gauges ∅ 6 mm and ∅ 25 mm	121 minutes no failure
integrity – cotton pad	121 minutes no failure
insulation – average temperature (140 K)	121 minutes no failure
insulation – maximal temperature (180 K)	121 minutes no failure
radiation 15 $kW.m^{-2}$	121 minutes no failure [1)]

1) Regarding to low temperatures on unexposed specimen surface below 300°C the performance criteria of radiation is to be complied as satisfied.

The fire test was terminated in the 122nd minute upon request of test sponsor.

7. DIRECT APPLICATION OF TEST RESULTS

Direct field of application is valid in accordance with clause 13 of EN 1365-1: 2012/AC: 2013. Validity of individual items of field of direct application shall be determined in classification process.

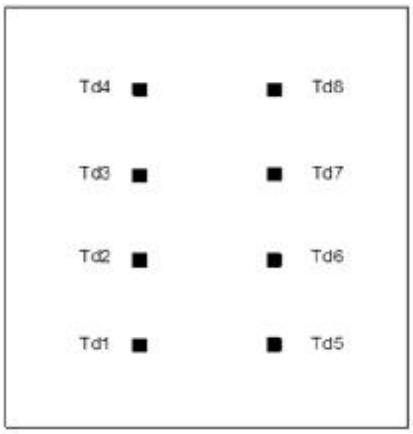


Measured values inside the test furnace

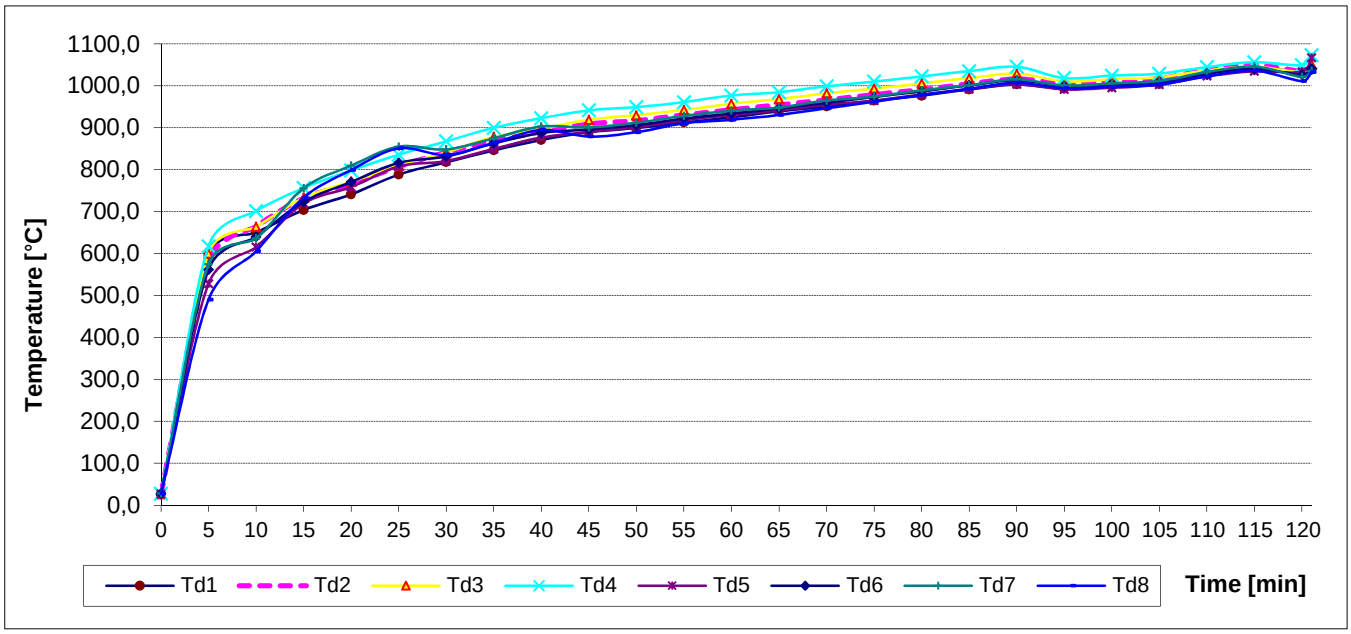
Time	Temperature [°C]											Deviation	Pressure [Pa]	
t [min]	Td1	Td2	Td3	Td4	Td5	Td6	Td7	Td8	Tave	Tn	To	d_e [%]	p1	p2
0	26,3	27,1	27,0	27,7	26,4	27,2	27,9	28,3	27,2	20,0	15,1	0,0	3,4	1,3
5	595,9	581,3	600,2	617,6	527,9	562,1	574,8	490,1	568,7	576,0	15,1	-0,3	18,1	-1,1
10	650,1	664,6	663,9	701,1	615,5	639,8	636,2	605,3	647,1	678,0	15,1	-1,7	17,5	-1,7
15	703,8	732,3	733,2	756,4	719,5	723,5	755,9	733,6	732,3	739,0	15,1	-1,6	17,9	-1,3
20	741,3	765,9	771,6	798,1	758,7	770,7	809,7	799,2	776,9	781,0	15,1	-1,2	18,6	-0,6
25	788,3	807,3	809,8	835,7	807,7	816,4	855,0	851,1	821,4	815,0	15,2	-0,9	18,9	-0,3
30	818,0	841,6	841,2	867,8	820,7	831,5	848,3	835,3	838,1	842,0	15,3	-0,9	18,6	-0,6
35	846,0	868,7	878,3	900,0	849,6	862,8	875,0	864,1	868,1	865,0	15,4	-0,8	19,6	0,4
40	870,9	890,1	897,1	922,8	876,7	887,6	903,0	894,9	892,9	885,0	15,3	-0,6	18,7	-0,5
45	889,7	909,1	919,2	941,6	890,0	896,0	900,8	879,0	903,2	902,0	15,4	-0,3	19,1	-0,1
50	899,3	917,0	929,9	949,2	902,0	906,2	912,0	889,3	913,1	918,0	15,4	-0,4	18,6	-0,6
55	912,6	930,8	942,6	961,2	917,4	921,9	928,2	910,6	928,2	932,0	15,5	-0,4	17,6	-1,6
60	925,1	943,0	957,2	976,9	931,1	933,7	940,6	918,9	940,8	945,0	15,5	-0,4	19,7	0,5
65	939,2	954,6	968,4	984,7	941,0	946,0	948,4	930,5	951,6	957,0	15,5	-0,4	19,6	0,4
70	950,7	966,6	982,1	998,9	955,3	959,8	964,8	946,5	965,6	968,0	15,6	-0,4	19,3	0,1
75	964,6	979,1	993,5	1010,4	964,4	973,4	974,5	962,1	977,8	979,0	15,5	-0,4	19,3	0,1
80	976,3	990,9	1005,6	1022,5	979,5	986,7	989,4	978,1	991,1	988,0	15,5	-0,4	19,6	0,4
85	991,2	1004,8	1018,3	1034,9	992,0	1000,9	1001,5	993,2	1004,6	997,0	15,5	-0,3	19,5	0,3
90	1003,2	1016,2	1029,1	1045,3	1003,6	1013,1	1015,5	1007,1	1016,6	1006,0	15,5	-0,2	18,2	-1,0
95	993,4	1006,3	1010,8	1018,5	991,5	999,5	1000,8	994,2	1001,9	1014,0	15,6	-0,2	19,1	-0,1
100	998,7	1011,3	1015,7	1024,5	995,4	1004,0	1005,8	997,5	1006,6	1022,0	15,7	-0,3	18,6	-0,6
105	1004,6	1017,3	1020,3	1029,1	1002,6	1009,4	1011,6	1003,2	1012,3	1029,0	15,7	-0,4	17,9	-1,3
110	1029,2	1038,4	1036,5	1044,7	1023,2	1029,3	1032,7	1022,2	1032,0	1036,0	15,7	-0,4	18,4	-0,8
115	1040,1	1050,0	1045,4	1056,2	1034,6	1040,6	1045,6	1036,2	1043,6	1043,0	15,7	-0,4	19,4	0,2
120	1035,1	1034,9	1032,8	1049,5	1033,6	1026,4	1021,1	1011,4	1030,6	1049,0	15,8	-0,4	18,5	-0,7
121	1039,0	1049,2	1050,9	1073,0	1067,1	1040,8	1035,8	1032,5	1048,5	1050,0	15,8	-0,4	19,0	-0,2

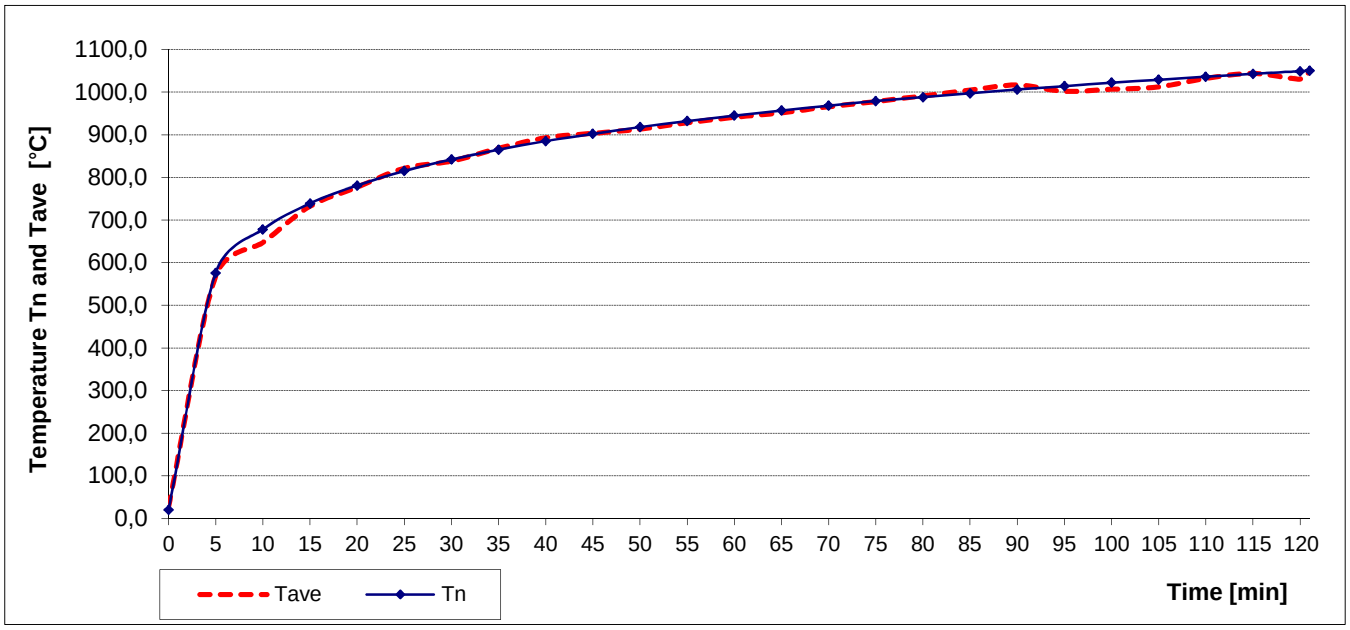
Tave Average temperature in the test furnace calculated from individual thermometers
Tn Standard temperature in the test furnace laid down according to test guideline
d_e Deviation of the average temperature from the standard temperature calc. acc. to test guideline
To Ambient temperature
p1 Pressure inside the test furnace measured under the ceiling of test furnace
p2 Pressure inside the test furnace at the height of neutral pressure level 500 mm above test furnace floor

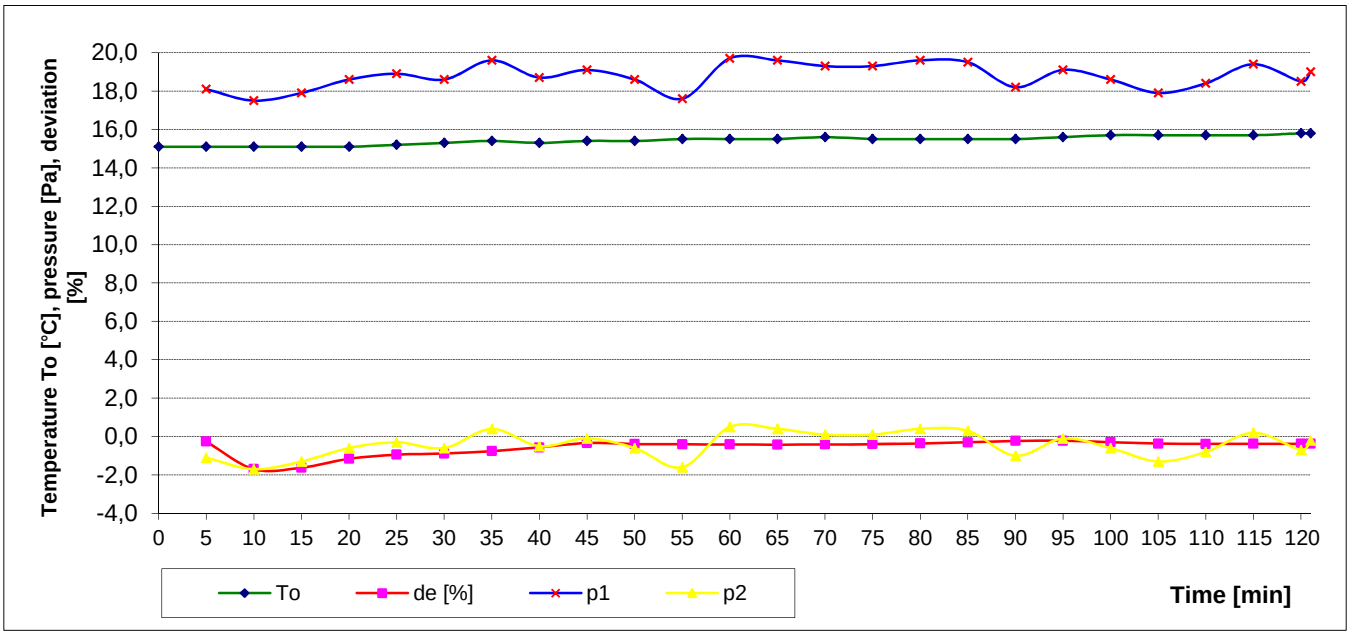
Layout of measuring points in the test furnace:



Measured values inside the test furnace /graph







Measured values on the unexposed surface of the test specimen /part1

The initial average temperature of the unexposed specimen surface: 14,4 °C

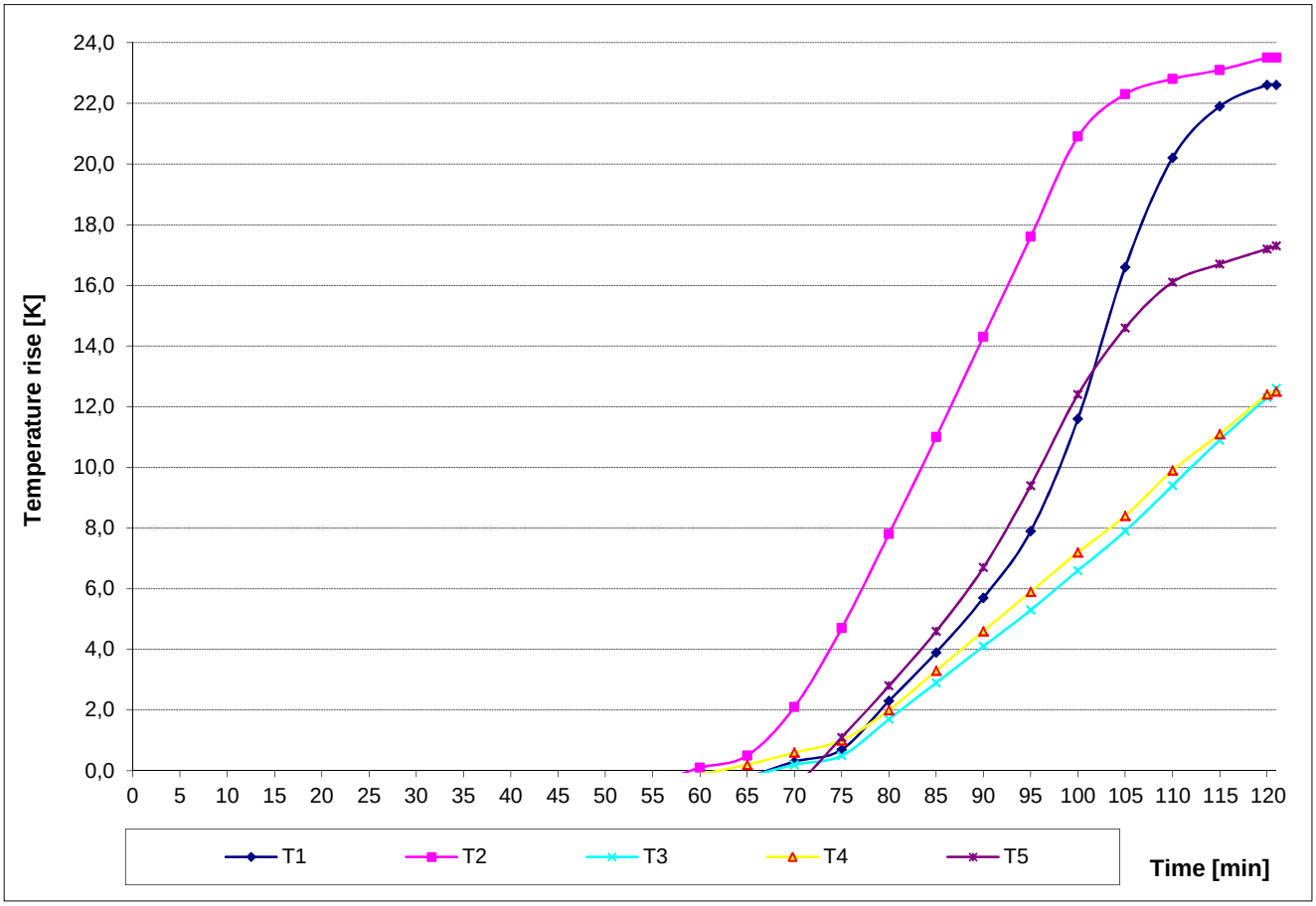
Time	Temperature rise [K]												
t [min]	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13
0	-1,6	-1,3	-1,5	-0,9	-2,8	1,8	0,5	0,0	-0,1	-0,6	0,1	1,1	1,6
5	-1,5	-1,2	-1,4	-0,8	-2,6	2,0	0,6	0,1	0,0	-0,1	0,2	1,2	1,7
10	-1,4	-1,1	-1,3	-0,6	-2,4	2,0	0,7	0,1	0,1	0,1	0,3	1,2	1,8
15	-1,4	-1,0	-1,2	-0,5	-2,1	2,0	0,7	0,2	0,1	0,1	0,5	1,4	1,8
20	-1,3	-1,0	-1,1	-0,4	-2,1	2,0	0,8	0,3	0,2	0,1	0,6	1,5	1,8
25	-1,3	-1,0	-1,1	-0,4	-2,0	2,1	0,9	0,4	0,3	0,1	0,7	1,6	1,8
30	-1,2	-0,9	-1,0	-0,3	-2,0	2,1	1,0	0,6	0,5	0,2	0,7	1,6	1,9
35	-1,2	-0,9	-1,0	-0,3	-2,0	2,1	1,1	0,8	0,6	0,2	0,8	1,6	1,9
40	-1,2	-0,9	-1,0	-0,3	-2,0	2,2	1,3	1,0	0,9	0,2	0,8	1,6	1,9
45	-1,1	-0,8	-1,0	-0,3	-2,0	2,3	1,5	1,3	1,2	0,3	0,8	1,7	2,0
50	-1,0	-0,6	-0,9	-0,3	-1,9	2,4	1,9	1,6	1,6	0,4	0,8	1,7	2,2
55	-0,8	-0,4	-0,7	-0,2	-1,9	2,6	2,1	1,6	1,6	0,5	0,9	1,7	2,4
60	-0,5	0,1	-0,5	-0,1	-1,6	3,0	2,1	1,7	1,6	0,6	0,9	1,8	2,8
65	-0,2	0,5	-0,2	0,2	-1,3	3,3	2,2	1,7	1,7	0,8	1,1	1,9	3,5
70	0,3	2,1	0,2	0,6	-0,5	4,6	2,2	1,7	1,7	1,3	1,3	2,2	5,1
75	0,7	4,7	0,5	1,0	1,1	6,0	2,2	1,8	1,7	1,6	1,6	2,5	6,8
80	2,3	7,8	1,7	2,0	2,8	7,6	2,3	1,8	1,8	3,0	2,1	2,9	8,9
85	3,9	11,0	2,9	3,3	4,6	9,3	2,3	1,8	1,8	4,5	2,7	3,3	10,7
90	5,7	14,3	4,1	4,6	6,7	10,8	2,4	1,9	1,8	6,2	3,8	4,3	12,5
95	7,9	17,6	5,3	5,9	9,4	12,3	2,4	1,9	2,0	7,7	4,9	5,2	14,0
100	11,6	20,9	6,6	7,2	12,4	13,3	2,5	2,2	2,1	9,2	5,8	6,4	18,2
105	16,6	22,3	7,9	8,4	14,6	14,1	2,8	2,3	2,5	10,2	7,1	7,8	25,0
110	20,2	22,8	9,4	9,9	16,1	15,1	3,1	2,7	2,8	11,8	8,5	9,4	30,4
115	21,9	23,1	10,9	11,1	16,7	16,1	3,6	3,2	3,7	12,7	10,5	11,2	32,9
120	22,6	23,5	12,3	12,4	17,2	16,8	4,4	3,8	4,3	13,6	12,2	12,9	34,0
121	22,6	23,5	12,6	12,5	17,3	17,0	4,5	3,9	4,3	13,7	12,4	13,3	34,1

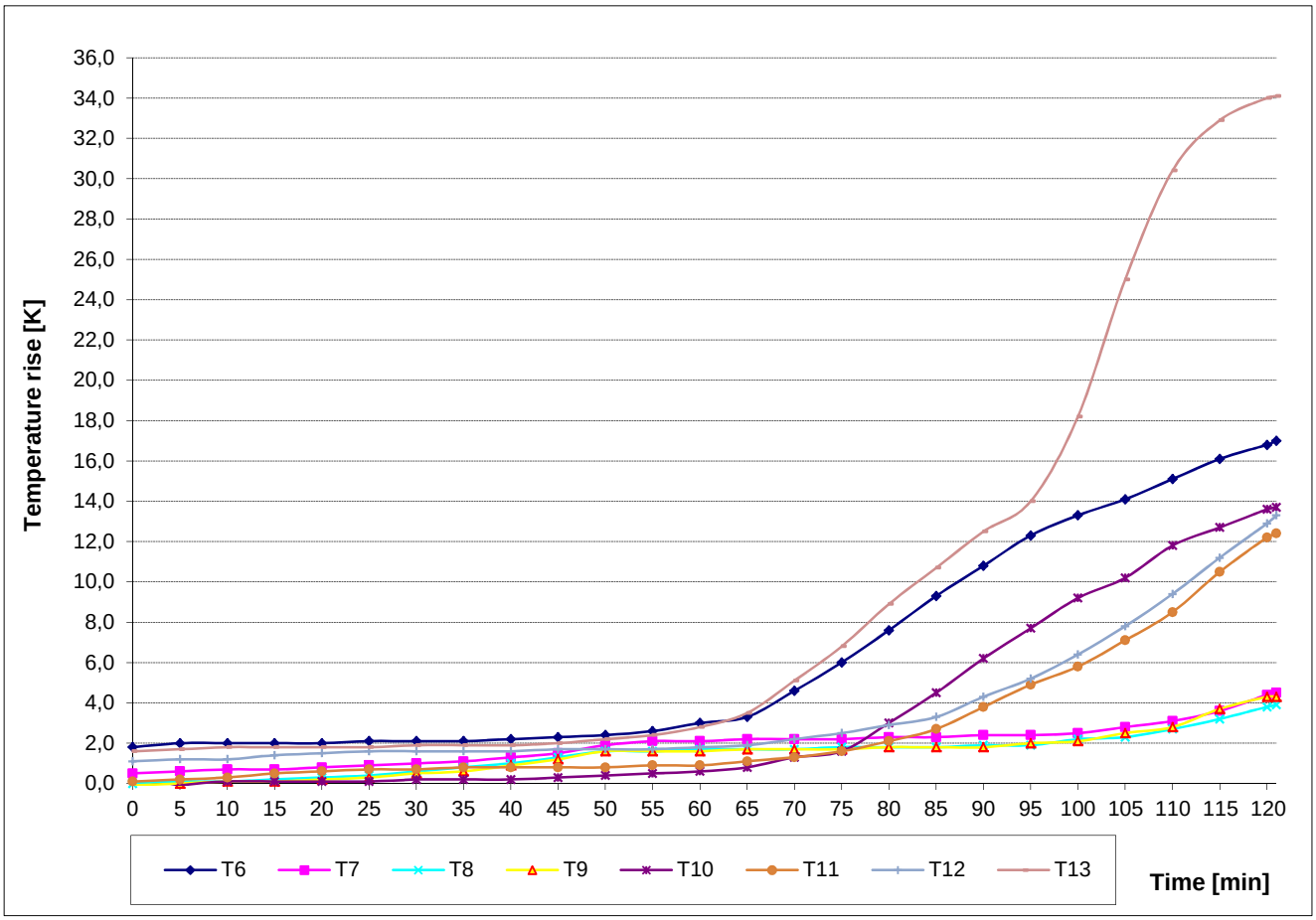
Negative values are quoted because temperature rises are calculated from the initial average temperature of the specimen surface.

T1 - T5 thermocouples distributed for average and maximum temperature rise evaluation
T6 - T16 thermocouples distributed for maximum temperature rise evaluation

Please see figure showing the layout of measuring points on the specimen surface which is a part of this test report

Measured values on the unexposed surface of the test specimen – part 1/graph





Measured values - part 2 and calculated values from measured values on the specimen surface

The initial average temperature of the unexposed specimen surface: 14,4 °C

Time	Temperature rise [K]					Temperature [ºC]				
t [min]	T14	T15	T16	TRave	TRmax	T31	T32	T33	T34	T35
0	1,5	1,0	1,3	-1,6	1,8	14,7	13,6	13,2	12,7	13,0
5	1,5	1,0	1,4	-1,5	2,0	14,6	13,5	13,0	12,7	13,7
10	1,6	1,2	1,6	-1,4	2,0	14,7	13,5	13,0	30,9	86,1
15	1,9	1,3	1,7	-1,2	2,0	14,7	13,6	13,0	90,0	91,7
20	2,0	1,6	1,8	-1,2	2,0	14,6	17,0	12,9	91,1	91,9
25	2,0	1,6	1,8	-1,2	2,1	14,6	66,7	16,4	91,6	101,0
30	2,1	1,7	1,9	-1,1	2,1	14,5	91,4	43,2	93,5	153,6
35	2,1	1,7	1,9	-1,1	2,1	14,7	91,8	88,4	113,4	237,8
40	2,1	1,8	1,9	-1,1	2,2	15,4	93,2	90,4	168,4	340,0
45	2,1	1,8	2,0	-1,0	2,3	27,6	93,6	91,3	240,1	429,5
50	2,1	1,8	2,0	-0,9	2,4	54,4	93,8	91,9	325,3	488,7
55	2,2	1,9	2,3	-0,8	2,6	65,6	93,7	92,4	399,4	533,7
60	2,3	2,0	2,5	-0,5	3,0	71,8	93,6	92,5	453,3	574,1
65	2,5	2,3	2,9	-0,2	3,5	75,7	93,8	92,6	492,3	606,9
70	2,9	2,6	3,6	0,5	5,1	78,3	94,3	92,5	526,9	633,0
75	3,4	3,1	5,2	1,6	6,8	79,8	99,6	92,6	557,2	656,1
80	4,4	3,9	7,4	3,3	8,9	81,2	125,3	92,9	584,2	676,7
85	5,5	5,7	9,7	5,1	11,0	82,4	169,6	94,5	609,1	694,2
90	6,6	15,2	16,0	7,1	16,0	82,7	209,7	114,0	632,7	710,1
95	7,8	24,1	29,6	9,2	29,6	83,8	248,2	163,6	654,5	725,5
100	9,1	25,9	33,8	11,7	33,8	84,2	288,8	234,8	673,2	739,6
105	10,4	26,6	35,2	14,0	35,2	84,5	325,0	315,1	689,7	751,1
110	11,8	26,9	35,5	15,7	35,5	86,4	365,7	378,2	704,3	760,3
115	13,4	27,2	35,9	16,7	35,9	86,3	402,0	418,9	718,0	767,4
120	15,1	28,0	36,2	17,6	36,2	85,9	420,6	443,0	730,7	771,8
121	15,2	28,2	36,3	17,7	36,3	85,6	413,3	443,8	732,5	771,7

Negative values are quoted because temperature rises are calculated from the initial average temperature of the specimen surface.

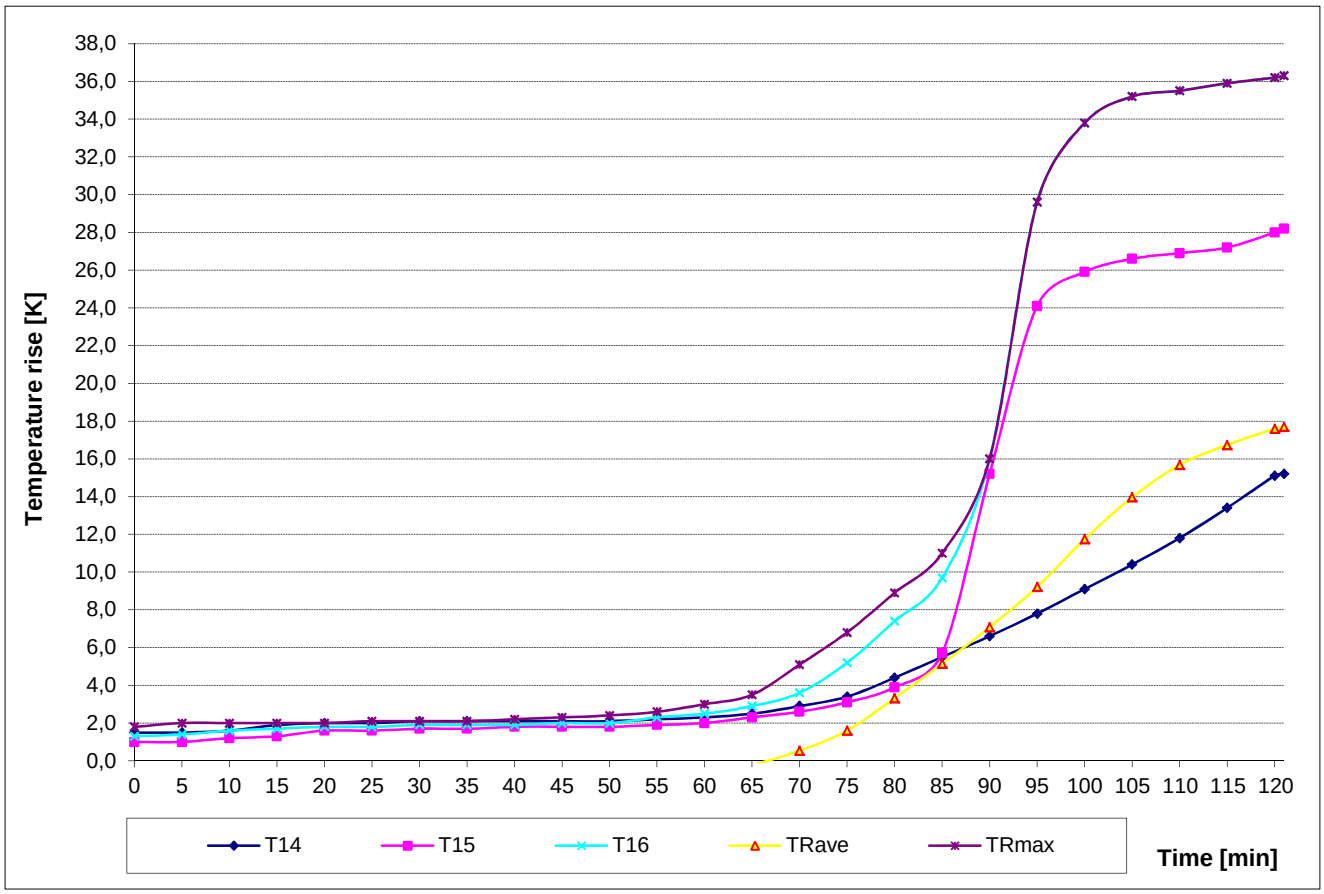
T1 - T5 thermocouples distributed for average and maximum temperature rise evaluation
T6 - T16 thermocouples distributed for maximum temperature rise evaluation

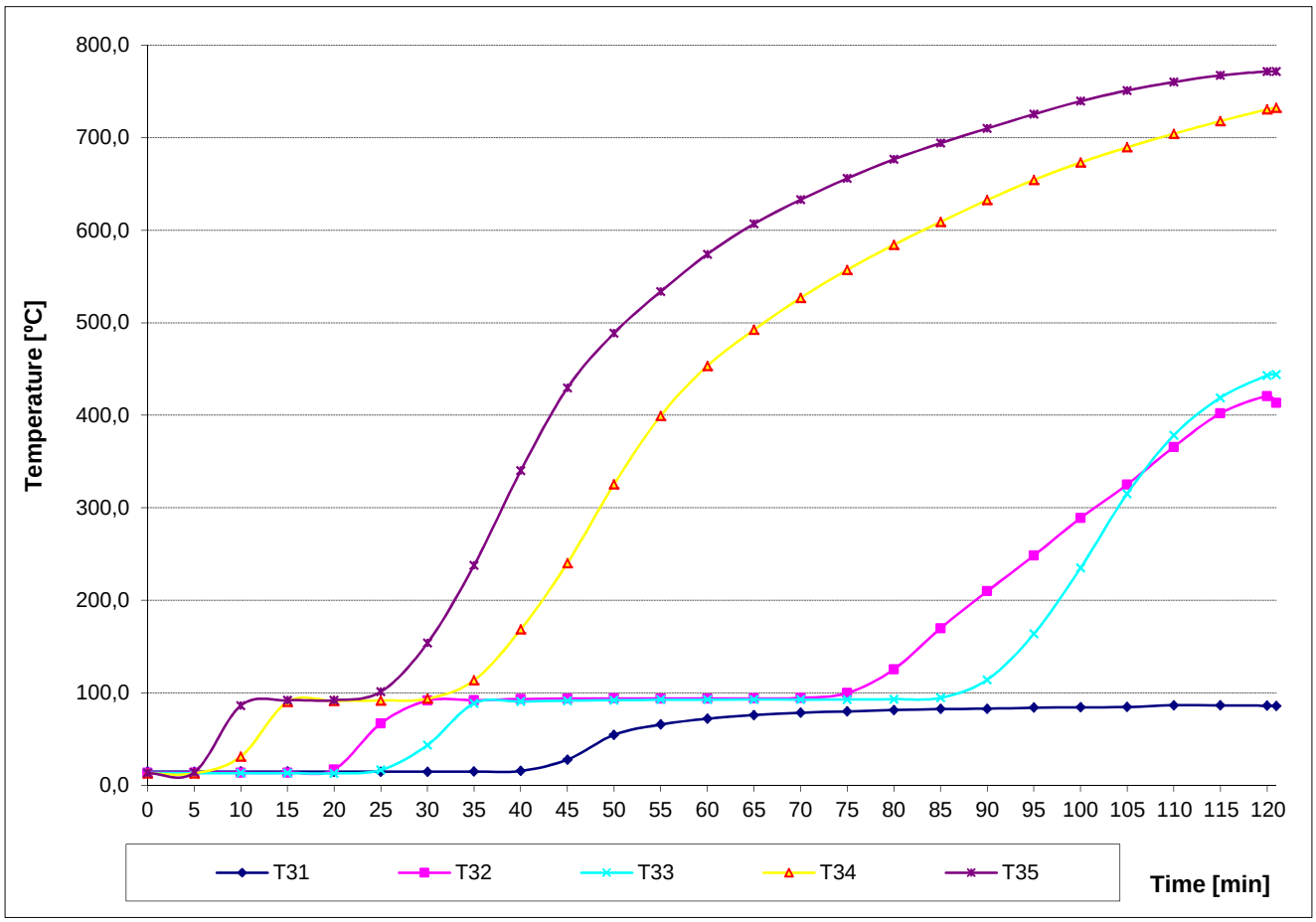
TRave average temperature rise above initial average temperature calculated from T1 - T5
TRmax maximal temperature rise above initial average temperature calculated from T1 - T16

T31 thermocouple placed inside the test specimen insulation in depth 60 mm under the surface
T32, T33 thermocouples placed inside the test specimen insulation in depth 180 mm under the surface
T34, T35 thermocouples placed inside the test specimen insulation in depth 300 mm under the surface

Please see figure showing the layout of measuring points on the specimen surface which is a part of this test report

Measured values - part 2 and calculated values from measured values on the specimen surface /graph





Deflection of the specimen

Time t [min]	Deflection [mm]						
	D1	D2	D3	D4	D5	D	dD/dt
0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
5	0,0	0,0	0,7	0,0	0,0	0,0	0,0
10	0,0	0,0	2,7	0,0	0,1	0,0	0,0
15	0,0	0,0	5,5	0,1	0,4	0,0	0,0
20	0,0	0,0	7,3	0,4	0,6	0,0	0,0
25	0,0	0,0	9,0	0,7	0,7	0,0	0,0
30	0,0	0,0	9,0	0,7	1,0	0,0	0,0
35	0,0	0,0	7,3	0,7	1,3	0,0	0,0
40	0,0	0,0	5,5	0,7	1,3	0,0	0,0
45	0,0	0,0	4,3	0,7	1,4	0,0	0,0
50	0,0	0,0	3,8	0,7	1,6	0,0	0,0
55	0,1	0,0	3,4	0,7	1,6	0,1	0,0
60	0,4	0,1	3,0	0,7	1,6	0,3	0,0
65	0,8	0,4	2,5	0,7	1,6	0,6	0,0
70	1,3	0,8	1,7	0,7	1,6	1,1	0,2
75	1,4	1,0	1,2	0,7	2,8	1,2	0,1
80	2,4	1,7	0,5	0,7	2,2	2,1	0,0
85	2,4	2,0	-0,3	0,7	2,1	2,2	0,1
90	2,4	2,5	-1,2	0,7	2,1	2,5	0,1
95	3,0	3,3	-2,6	0,7	1,8	3,2	0,2
100	3,5	4,1	-3,5	0,7	1,6	3,8	0,1
105	3,9	4,8	-4,0	0,6	1,5	4,4	0,1
110	4,3	5,6	-4,8	0,3	1,5	5,0	0,1
115	4,6	6,5	-5,8	0,3	1,5	5,6	0,1
120	5,0	7,2	-7,1	0,1	1,6	6,1	0,1
121	4,9	7,3	-7,1	0,1	1,9	6,1	0,0

Deflection [mm] deflection of the specimen measured with cable extension positioning transducer

D1, D2 vertical deflection (vertical contraction)

D3 deflection measured in the middle of specimen surface - horizontal deflection

D4, D5 deflection measured 50 mm from the free specimen edgse in the middle of height of specimen - horizontal deflection

Positive values of deflection represent deflection to the heat stress/Negative values of deflection represent deflection from the heat stress.

D mean deflection calculated from the deflection D1 and D2 (vertical contraction) [mm]

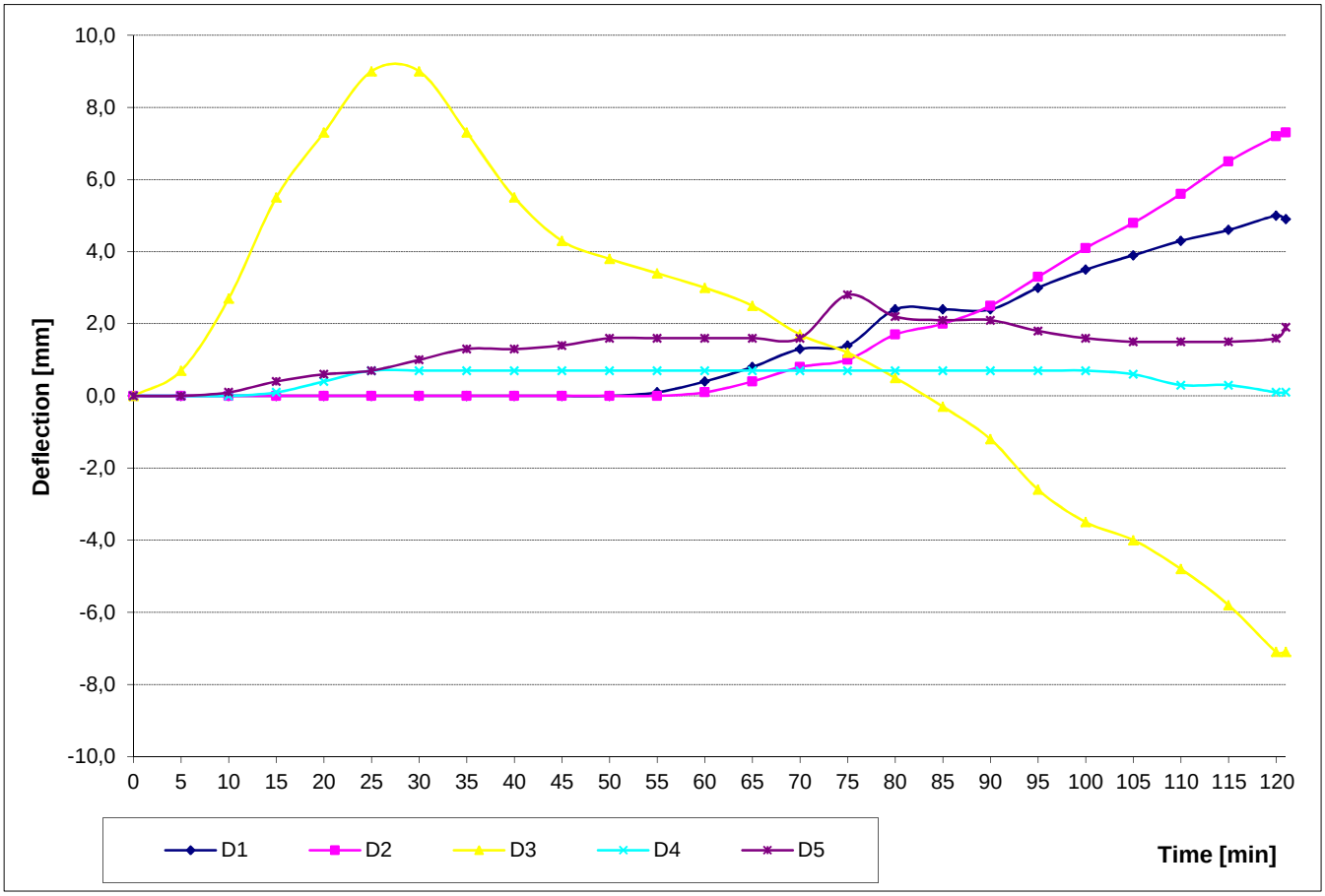
dD/dt rate of vertical contraction D [mm/min]

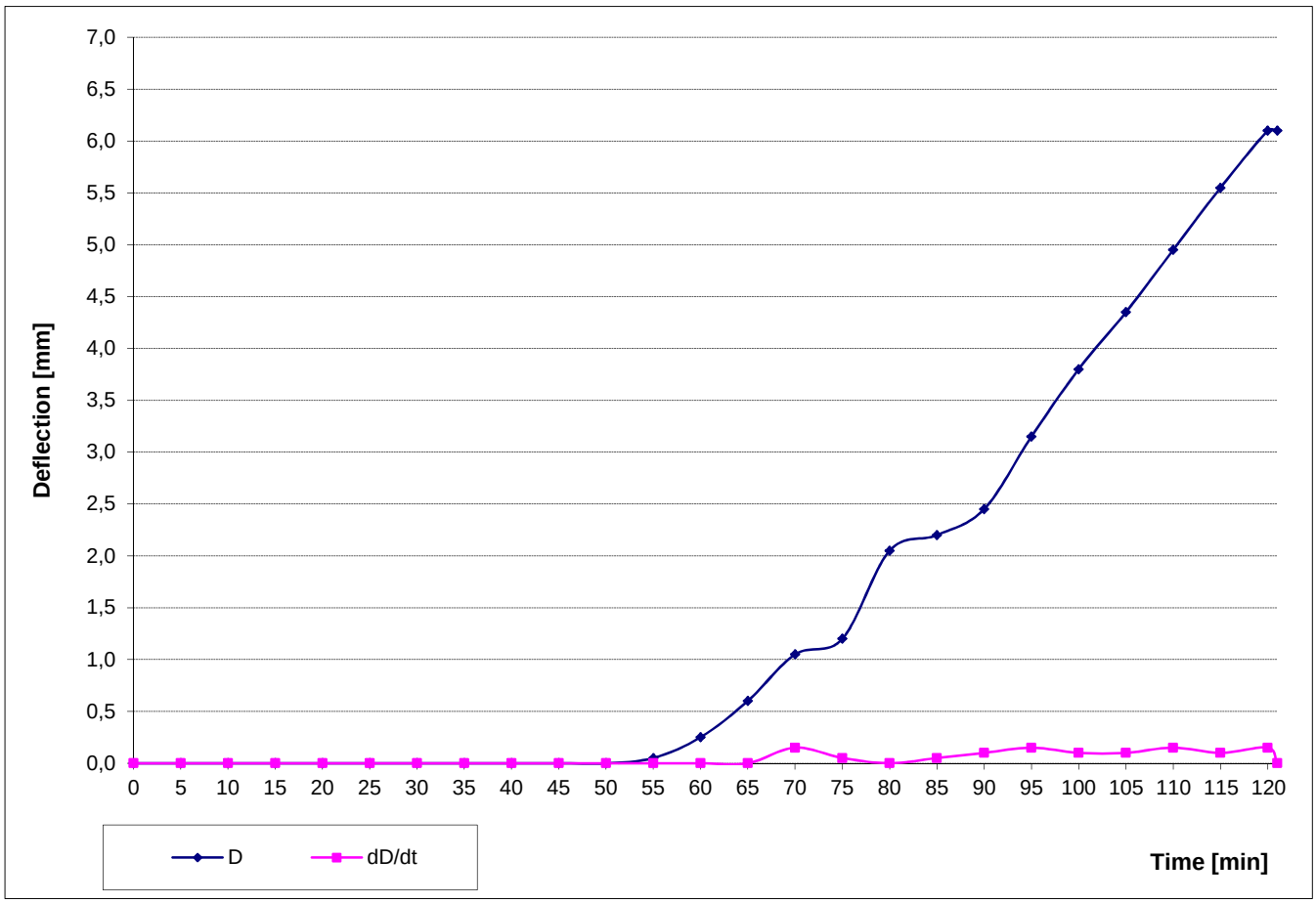
Limit for deflection (vertical contraction) is 30 mm

Limite for rate of vertical deflection (rate of vertical conctraction) is 9 mm/min

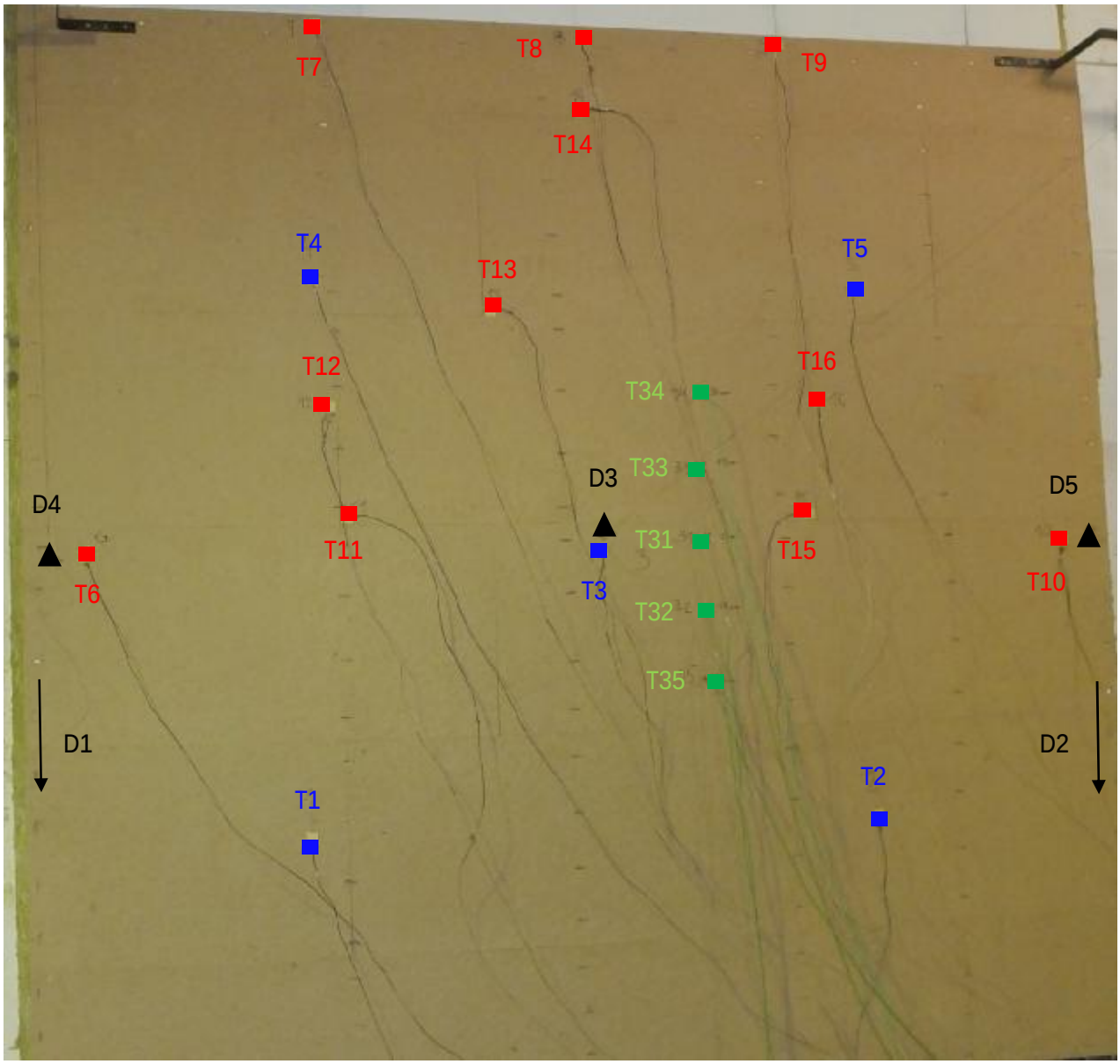
Please see figure showing the layout of measuring points on the specimen surface which is a part of this test report

Deflection of the specimen /graph





Layout of measuring points on the unexposed specimen



Thermocouples attached for the average and maximum temperature rise evaluation
Thermocouples attached for the maximum temperature rise evaluation
Thermocouples placed inside the test specimen insulation

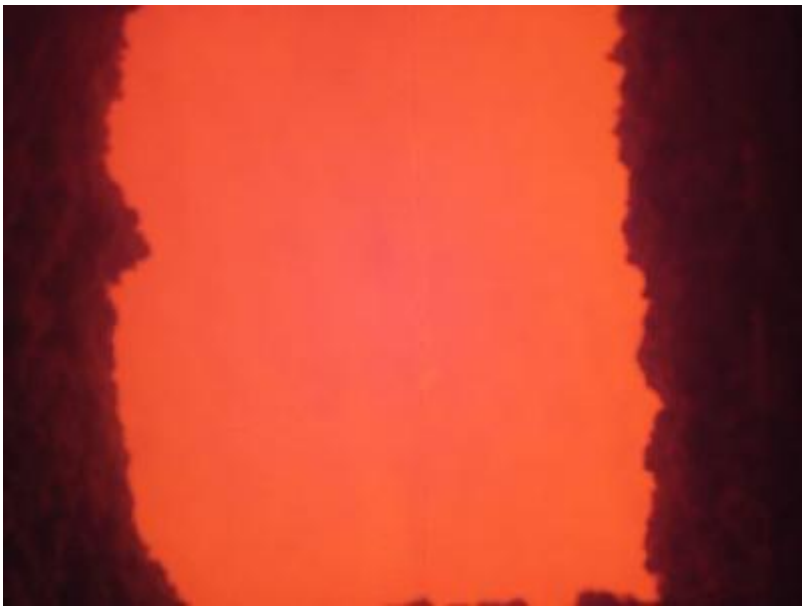
PHOTOS TAKEN DURING THE TEST

View of the specimen before the test commencement.

24th minute of the test

62nd minute of the test

PHOTOS TAKEN DURING THE TEST



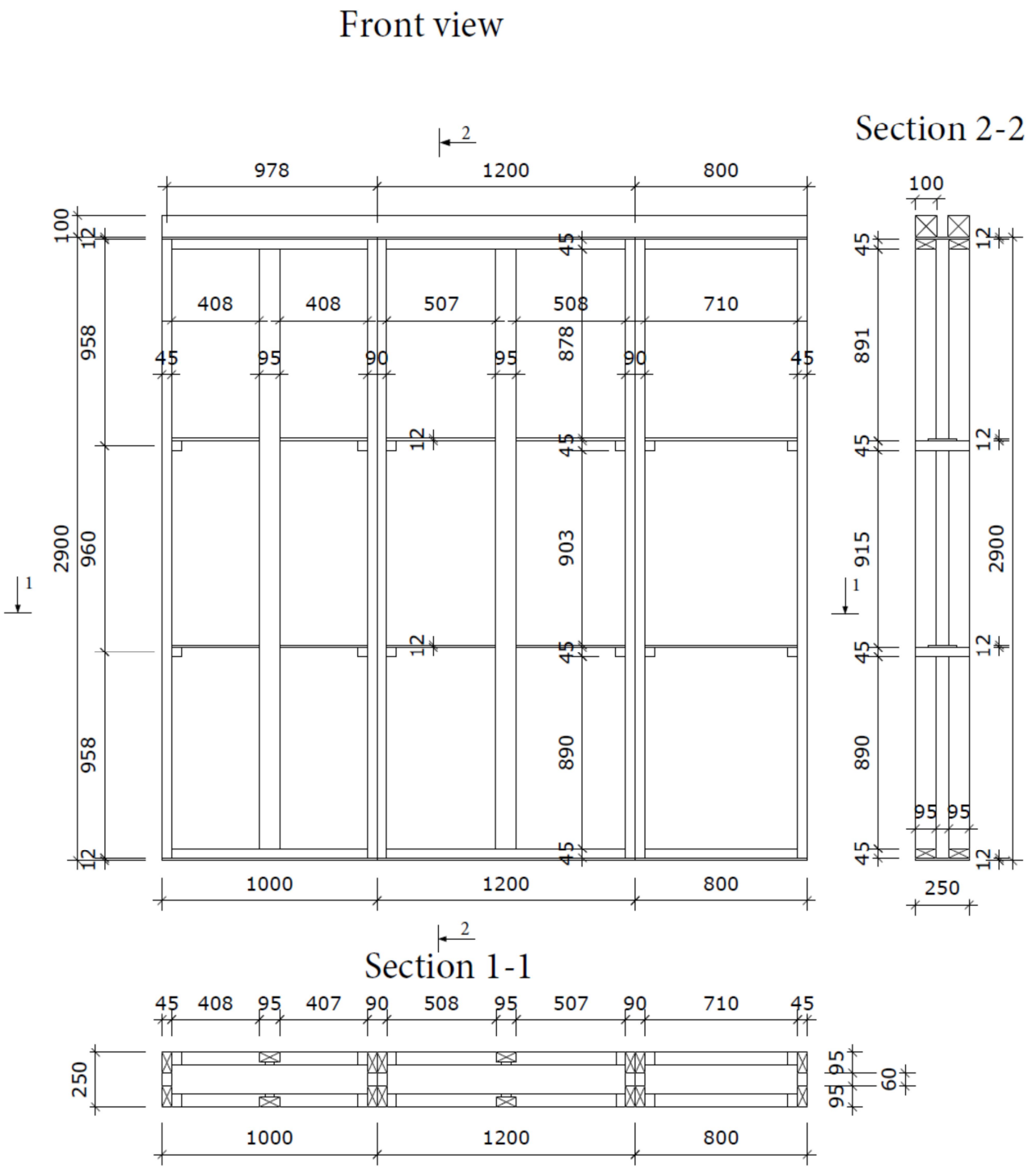
62nd minute of the test

Creation of cracks on the plaster surface.

91st minute of the test

121st minute of the test

DRAWINGS


Front view
Section 2-2
Section 1-1
978
1200
800
100
12
958
960
2900
408
408
507
508
710
45
95
90
878
903
890
891
915
1000
250
407
60

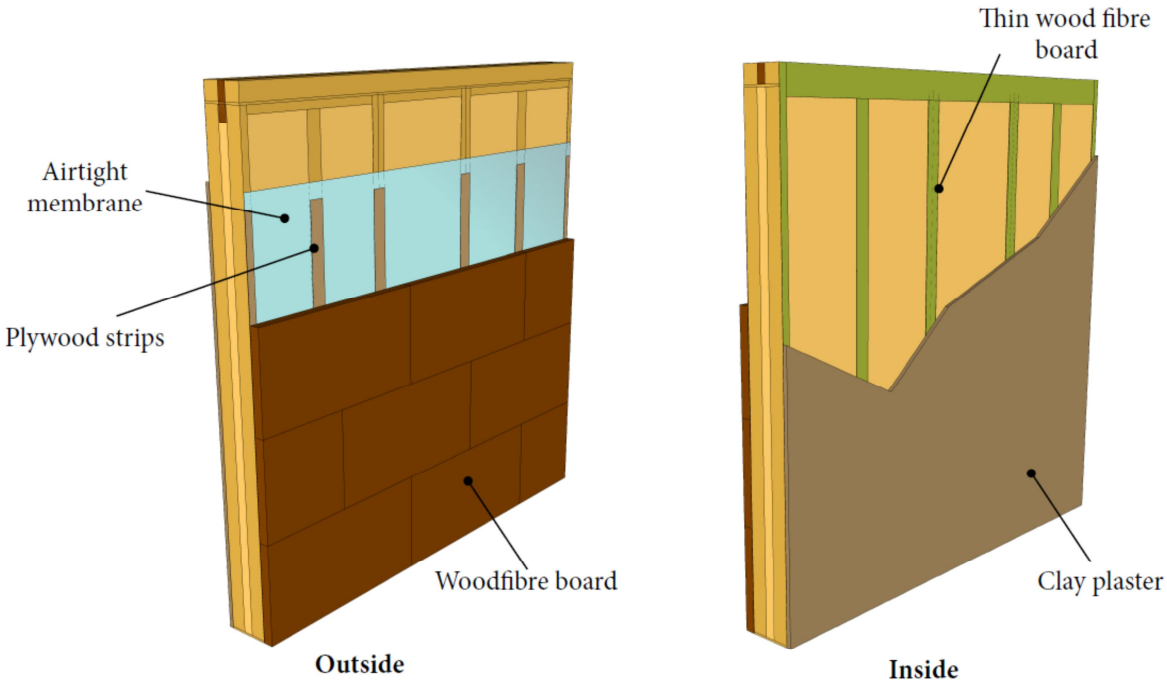
DRAWINGS

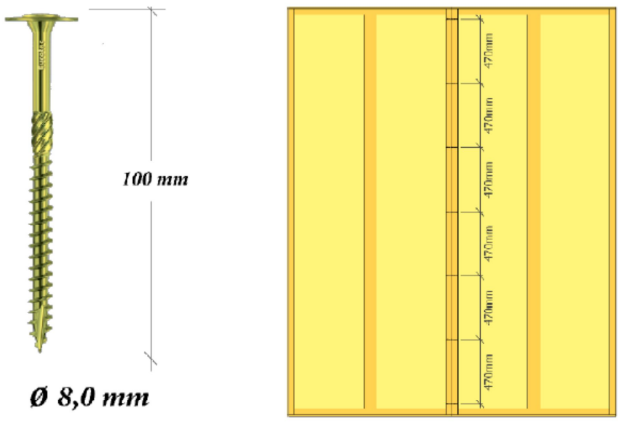
ASSEMBLY DESCRIPTION

The Modules have been screwed together with 8x100mm screws 470mm apart, following the standard assembly guides for EcoCocon

Before plastering, the visible wooden elements on the inside were covered with a 5mm thin wood fibre board that was stapled to the posts. A clay base plaster with a reinforced glass fibre mesh was applied in two layers (together 20-25mm thick) directly on the straw surface and thin wood fibre boards. An additional fine clay plaster (5mm) was added as a finish.

The EcoCocon straw modules are covered on the outside in an airtight but diffusion open membrane Sd<0,2m, held in place with plywood strips (6mm thick) that are stapled to the posts. The entire wall, including load bearing ring-beams, were then covered with 60mm thick Steico Protect wood fibre boards. Standard broad-back staples were used to fix the wood fibre boards to the wooden construction. For the fire resistance test no outside plaster system or wooden cladding was added.





Standard screw connection has been used between panels

DRAWINGS

TESTED LOAD

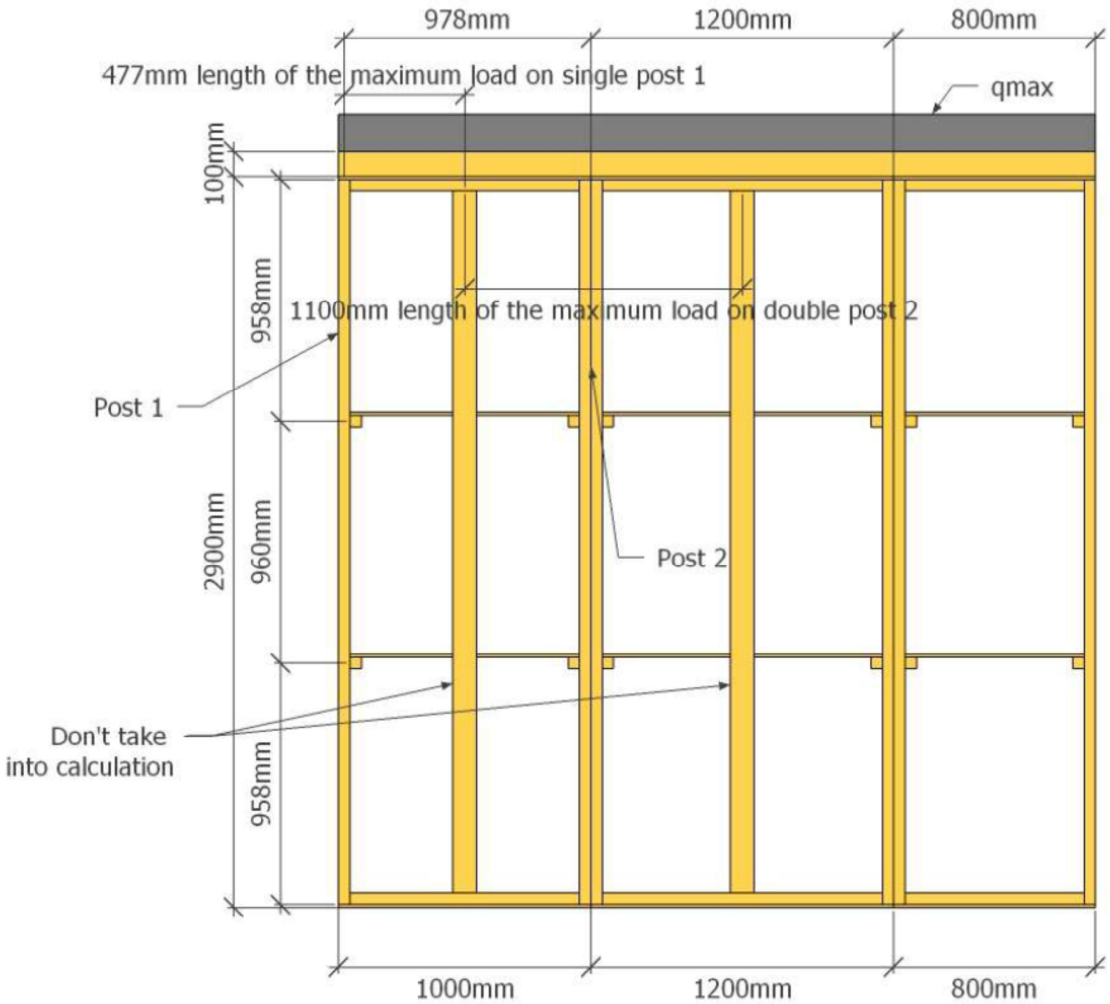
Based on a separate calculation, the walls have been cleared for a load of 70kN/m. This exceeds the loads declared in the National Technical Assessment:

8. Declared performance: The declared performance characteristics are achieved if the straw panel is covered by a 6 cm thick Steico Protect timber fibre panel on the external surface and is plastered with a 3 cm thick layer of clay on the internal surface.

Performance	Declared value	Technical specification
Load-bearing power: - under a vertical load of medium duration - under a vertical load of short-term duration - under a vertical load of short-term duration and a horizontal load: - 1.8 kN/m² - 2.1 kN/m² - 2.4 kN/m² - under a horizontal load of momentary duration - under short-term or momentary shearing	 36.9 kN/m 41.45 kN/m 29.5 kN/m 25.8 kN/m 22.2 kN/m 5.05 kN/m² 0	LST EN 1990, LST EN 1991-1-1, LST EN 1995-1-1
Reaction-to-fire classification	B-s1,d0	LST EN 13501-1
Thermal resistance R_D	8.1 (m²·K)/W	STR 2.01.03:2009 LST EN ISO 6946

During the tests the loads will be applied as follows:

The testing specimen should be loaded with 70kN/m - Wall is 3 m long, so that is overall load of 210kN. Load can be applied with 2 segments 105kN each, or three segments - 70 kN each; or 5 segments - 42 kN each.



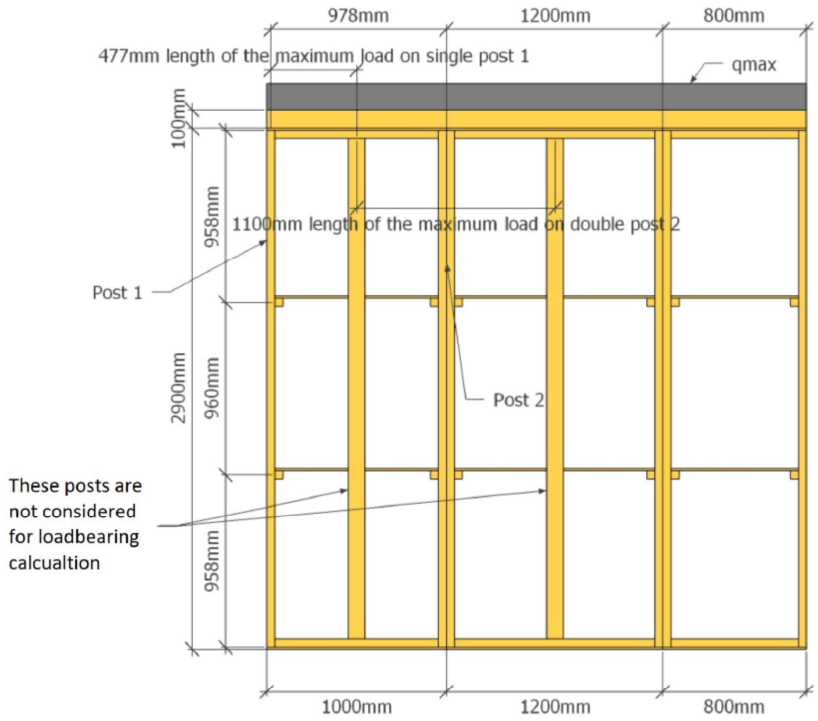
DRAWINGS

MATERIALS USED

- 3 Ecococon Straw Panels 25cm thick, 290cm high and 80cm, 100cm and 120cm wide
- Wood C24 ring beam 100x100
- Screws 8x100mm
- 5mm wood fibre board fixed with staples
- Wood fibre boards Steico Protect 60mm fixed with broad back staples at a distance of approx. 15cm
- Airtight Membrane Sd<0,2m
- Plywood strips 6mm thick (40 and 80mm wide to hold membrane in place)
- Clay plaster 0-4mm as a 20-25mm thick base coat
- Clay plaster 0-2mm as a 5mm surface coat
- Fibre glass mesh 120gr/m2 with mesh size 6,5 x 6,5mm

CALCULATION OF LOADING APPLIED DURING THE TEST

Maximum linear load on the wall when Post 1 and Post 2 are the weakest



Pic1. Loading

Designing Post 2 90x95mm for maximum load:

Rectangular column geometric properties.

Actual column length (see drawing): $L := 0.958\ m$

Effective length for buckling about any axis: $L_{eff} := 1.0 \cdot L = 0.958\ m$

Depth and width of the member 90x95mm but after burning we accept 90x75mm: $a := 90\ mm$ $b := 75\ mm$

Cross-sectional area: $A := a \cdot b = 67.5\ cm^2$

Second moment of area about y and x *axis:* $I_y := \frac{a^3 \cdot b}{12} = 455.625\ cm^4$ $I_x := \frac{a \cdot b^3}{12} = 316.406\ cm^4$

Radius of gyration about y and x axis: $i_y := \sqrt{\frac{I_y}{A}} = 25.981\ mm$ $i_x := \sqrt{\frac{I_x}{A}} = 21.651\ mm$

CALCULATION OF LOADING APPLIED DURING THE TEST

Slenderness ratio about y and x axis: $\lambda_y := \frac{L_{eff}}{i_y} = 36.873$ $\lambda_x := \frac{L_{eff}}{i_x} = 44.248$

Timber properties.

Timber strength class C24.

Characteristic compression strength parallel to the grain: $f_{c.0.k} := 21 \frac{N}{mm^2}$

Fifth-percentile modulus of elasticity parallel to the grain: $E_{0.05} := 7.4 \frac{kN}{mm^2}$

Density: $\rho_k := 350 \frac{kg}{m^3}$

Partial safety factors.

Permanent actions: $\gamma_G := 1.35$

Variable actions: $\gamma_Q := 1.30$

Material factor for solid timber: $\gamma_M := 1.30$

Modification factors.

Factor for permanent-duration loading and service class 1:

$k_{mod} := 0.6$

Compressive strength of column.

Design compression strength: $f_{c.0.d} := \frac{k_{mod} \cdot f_{c.0.k}}{\gamma_M} = 9.692 \frac{N}{mm^2}$

Buckling resistance condition:

Relative slenderness about y and x axis: $\lambda_{rel.y} := \frac{\lambda_y}{\pi} \cdot \sqrt{\frac{f_{c.0.k}}{E_{0.05}}} = 0.625$ $\lambda_{rel.x} := \frac{\lambda_x}{\pi} \cdot \sqrt{\frac{f_{c.0.k}}{E_{0.05}}} = 0.75$

Factor for solid timber: $\beta_c := 0.2$

Instability factor about y axis:

$$k_y := 0.5 \cdot \left(1 + \beta_c \cdot \left(\lambda_{rel.y} - 0.3\right) + \lambda_{rel.y}^{\ 2}\right) = 0.728$$

$$k_{c.y} := \frac{1}{k_y + \sqrt{k_y^{\ 2} - \lambda_{rel.y}^{\ 2}}} = 0.908$$

Instability factor about x axis:

$$k_x := 0.5 \cdot \left(1 + \beta_c \cdot \left(\lambda_{rel.x} - 0.3\right) + \lambda_{rel.x}^{\ 2}\right) = 0.827$$

$$k_{c.x} := \frac{1}{k_x + \sqrt{k_x^{\ 2} - \lambda_{rel.x}^{\ 2}}} = 0.852$$

CALCULATION OF LOADING APPLIED DURING THE TEST

Design buckling strength about y and x axis: $\sigma_{c.0.d.y} := k_{c.y} \cdot f_{c.0.d} = 8.804 \ \frac{N}{mm^2}$

$\sigma_{c.0.d.x} := k_{c.x} \cdot f_{c.0.d} = 8.262 \ \frac{N}{mm^2}$

Maximal design axial load on ONE post about y and x axis:

$N_{max.y} := A \cdot \sigma_{c.0.d.y} = 59.428 \ kN$

$N_{max.x} := A \cdot \sigma_{c.0.d.x} = 55.767 \ kN$

Maximum linear load on whole wall y and x directions:

$q_{max.y} := \frac{N_{max.y} \cdot 2}{1100 \ mm} = 108.052 \ \frac{kN}{m}$ $q_{max.x} := \frac{N_{max.x} \cdot 2}{1100 \ mm} = 101.394 \ \frac{kN}{m}$

Maximum point load on ONE segment x directions when 5 segments are used:

$N_{max} := \frac{q_{max.x} \cdot 3 \ m}{5} = 60.837 \ kN$

Designing single Post 1 45x95mm for maximum load:

Rectangular column geometric properties.

Actual column length (see drawing): $L := 0.958 \ m$

Effective length for buckling about any axis: $L_{eff} := 1.0 \cdot L = 0.958 \ m$

Depth and width of the member 45x95mm but after burning we accept 45x75mm: $a := 45 \ mm$ $b := 75 \ mm$

Cross-sectional area: $A := a \cdot b = 33.75 \ cm^2$

Second moment of area about y and x *axis:* $I_y := \frac{a^3 \cdot b}{12} = 56.953 \ cm^4$ $I_x := \frac{a \cdot b^3}{12} = 158.203 \ cm^4$

Radius of gyration about y and x axis: $i_y := \sqrt{\frac{I_y}{A}} = 12.99 \ mm$ $i_x := \sqrt{\frac{I_x}{A}} = 21.651 \ mm$

Slenderness ratio about y and x axis: $\lambda_y := \frac{L_{eff}}{i_y} = 73.747$ $\lambda_x := \frac{L_{eff}}{i_x} = 44.248$

CALCULATION OF LOADING APPLIED DURING THE TEST

Timber properties.

Timber strength class C24.

Characteristic compression strength parallel to the grain:

$$f_{c.0.k} := 21 \ \frac{N}{mm^2}$$

Fifth-percentile modulus of elasticity parallel to the grain:

$$E_{0.05} := 7.4 \ \frac{kN}{mm^2}$$

Density:

$$\rho_k := 350 \ \frac{kg}{m^3}$$

Partial safety factors.

Permanent actions: $\gamma_G := 1.35$

Variable actions: $\gamma_Q := 1.30$

Material factor for solid timber: $\gamma_M := 1.30$

Modification factors.

Factor for permanent-duration loading and service class 1:

$k_{mod} := 0.6$

Compressive strength of column.

Design compression strength:

$$f_{c.0.d} := \frac{k_{mod} \cdot f_{c.0.k}}{\gamma_M} = 9.692 \ \frac{N}{mm^2}$$

Buckling resistance condition:

Relative slenderness about y and x axis:

$$\lambda_{rel.y} := \frac{\lambda_y}{\pi} \cdot \sqrt{\frac{f_{c.0.k}}{E_{0.05}}} = 1.251 \qquad \lambda_{rel.x} := \frac{\lambda_x}{\pi} \cdot \sqrt{\frac{f_{c.0.k}}{E_{0.05}}} = 0.75$$

Factor for solid timber:

$$\beta_c := 0.2$$

Instability factor about y axis:

$$k_y := 0.5 \cdot \left(1 + \beta_c \cdot \left(\lambda_{rel.y} - 0.3\right) + \lambda_{rel.y}^{\ 2}\right) = 1.377$$

$$k_{c.y} := \frac{1}{k_y + \sqrt{k_y^{\ 2} - \lambda_{rel.y}^{\ 2}}} = 0.512$$

Instability factor about x axis:

$$k_x := 0.5 \cdot \left(1 + \beta_c \cdot \left(\lambda_{rel.x} - 0.3\right) + \lambda_{rel.x}^{\ 2}\right) = 0.827$$

$$k_{c.x} := \frac{1}{k_x + \sqrt{k_x^{\ 2} - \lambda_{rel.x}^{\ 2}}} = 0.852$$

Design buckling strength about y axis:

$$\sigma_{c.0.d.y} := k_{c.y} \cdot f_{c.0.d} = 4.962 \ \frac{N}{mm^2}$$

Design buckling strength about x axis:

$$\sigma_{c.0.d.x} := k_{c.x} \cdot f_{c.0.d} = 8.262 \ \frac{N}{mm^2}$$

Maximal design axial load on ONE post about y and x axis:

$N_{max.y} := A \cdot \sigma_{c.0.d.y} = 16.747 \ kN$

CALCULATION OF LOADING APPLIED DURING THE TEST

$$N_{max.x} := A \cdot \sigma_{c.0.d.x} = 27.883 \ kN$$

Maximum linear load on whole wall y and x directions:

$$q_{max.y} := \frac{N_{max.y} \cdot 2}{477 \ mm} = 70.217 \ \frac{kN}{m} \qquad q_{max.x} := \frac{N_{max.x} \cdot 2}{477 \ mm} = 116.912 \ \frac{kN}{m}$$

Maximum point load on ONE segment y directions if 5 segments are used:

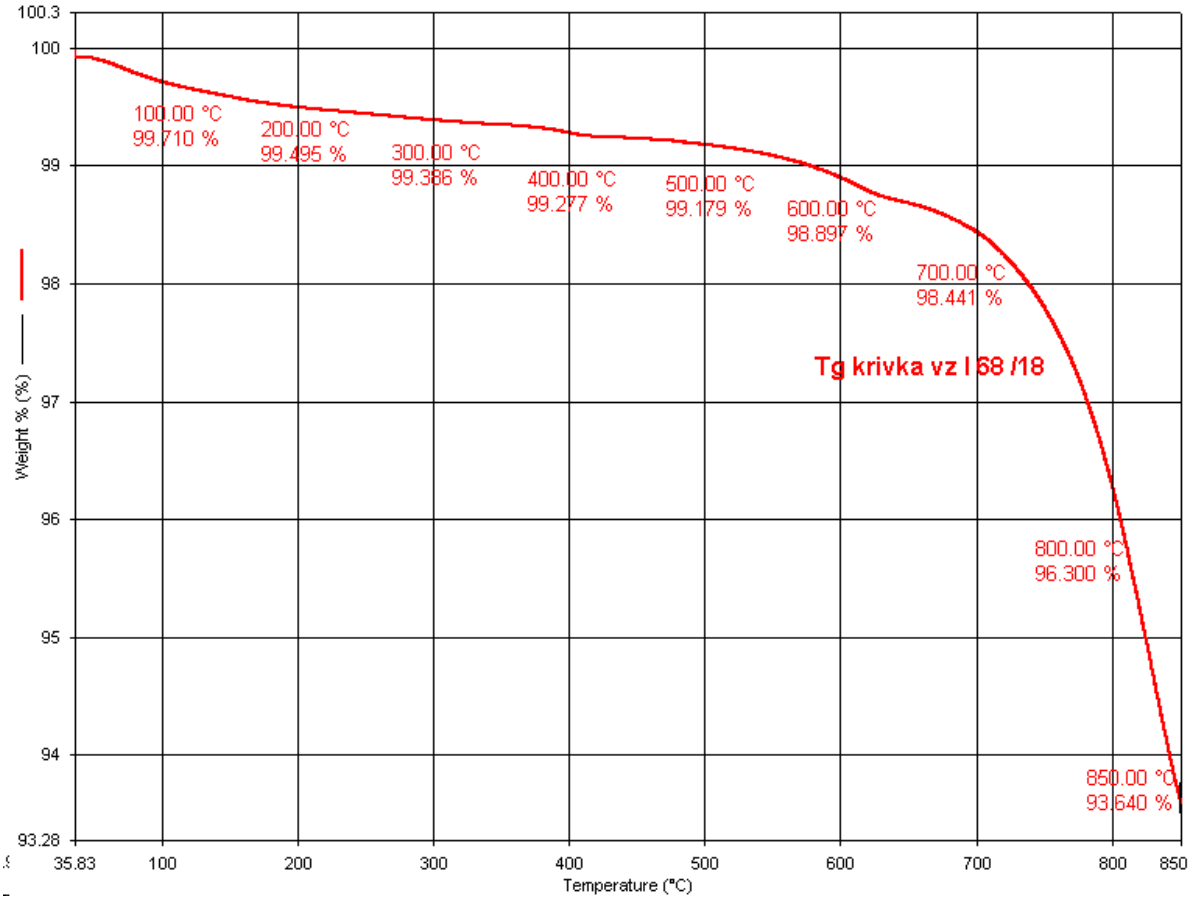
$$N_{max} := \frac{q_{max.y} \cdot 3 \ m}{5} = 42.13 \ kN$$

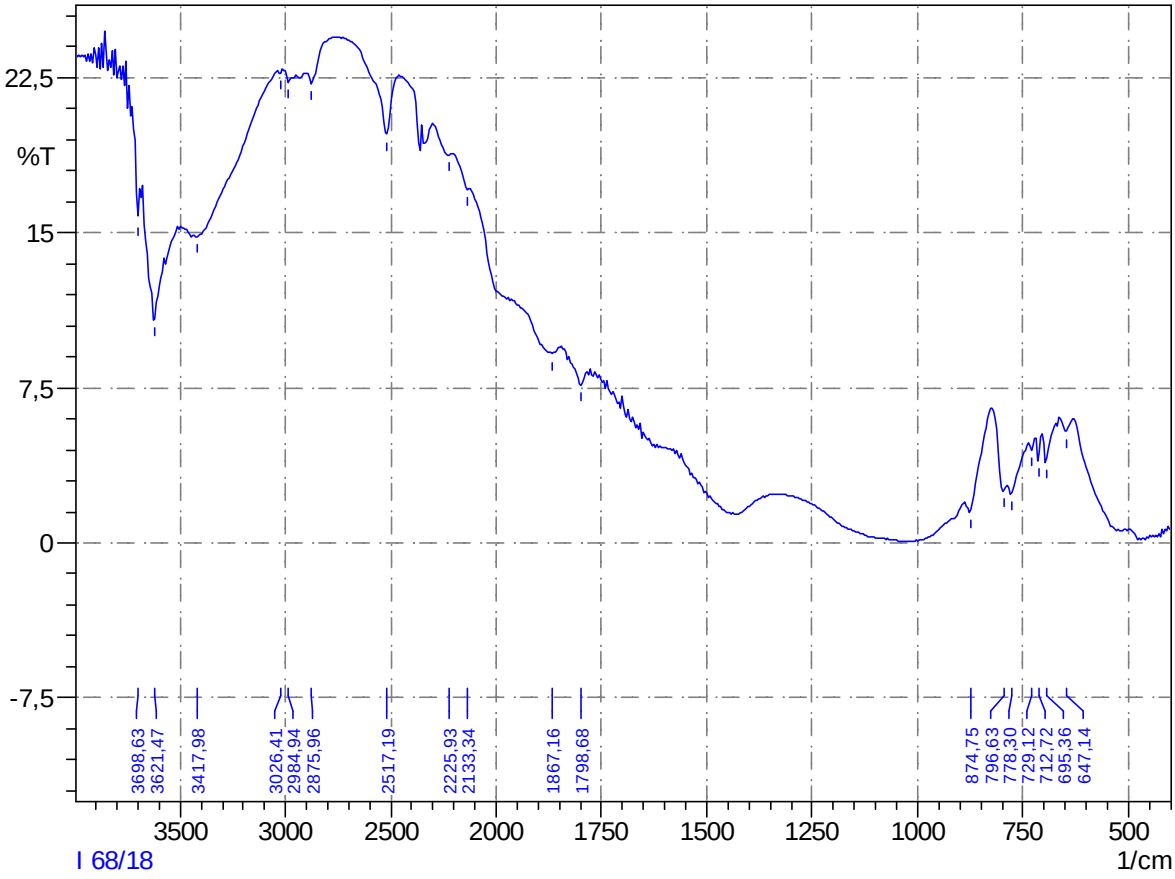
When 5 load elements on the wall are used we recomend to load with 70 kN/m and it correspond with five segments - 42 kN/element.

Calculated by
Vitalij Naruševič
(Structural engineer)

TG analysis and FT-IR analysis of used clay plasters

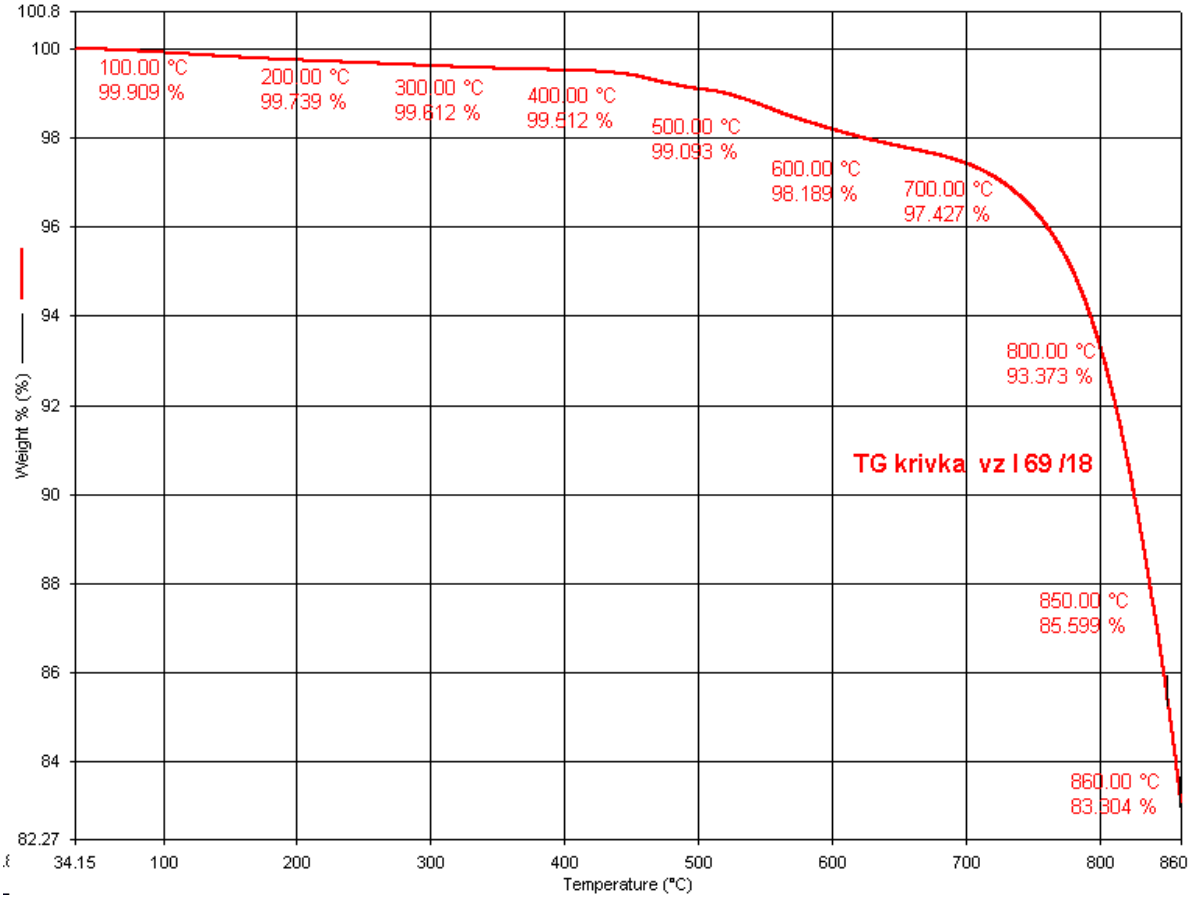
CLAY BASE PLASTER

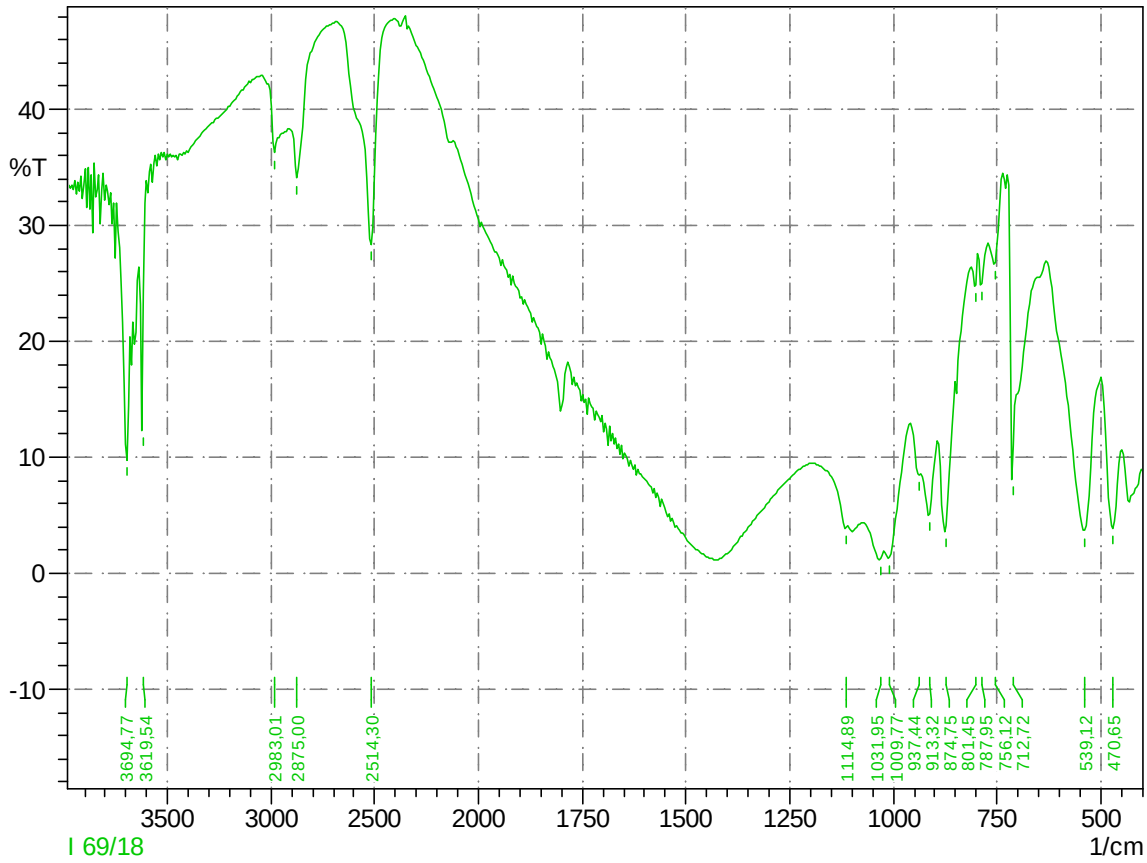




TG analysis and FT-IR analysis of used clay plasters

FINE CLAY PLASTER





8. FINAL PROVISION

§ This report details the method of construction, the test conditions and results obtained when the specific element of construction described herein was 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 relevant test method is not covered by this report.

§ Because of the nature of the fire resistance testing and 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.

§ The test results refer only to the tested subjects. This test report is not an approval of the tested product by the test laboratory or the accreditation body overseeing the laboratory's activities. The test was carried out on testing equipment that is the property of FIRES, s.r.o., Batizovce. Without the written permission of the test laboratory this test report may be copied and/or distributed only as the whole. Any modifications of the test report can be made only by the fire resistance test laboratory FIRES, s.r.o., Batizovce.

Approved by:

Ing. Štefan Rástocký
leader of the testing laboratory

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Prepared by:

Dávid Šubert
technician of the testing laboratory

9. NORMATIVE REFERENCES

EN 1365-1: 2012/AC: 2013	Fire resistance tests for loadbearing elements. Part 1: Walls
EN 1363-1: 2012	Fire resistance tests. Part 1: General requirements
EN 1363-2: 1999	Fire resistance tests. Part 2: Alternative and additional procedures

THE END OF THE TEST REPORT