

LapWall Oy
Yrittäjätie 7
36600 Pälkäne

LAUSUNTO KATTOELEMENTIN
PALONKESTÄVYYDESTÄ

Laadittu 26.1.2018



SISÄLLYSLUETTELO

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1 JOHDANTO

Tässä lausunnossa tarkastellaan Lapwall Oy:n puurakenteisen kattoelementin palonkestoa. Tarkasteltava rakenne on esitetty Liitteessä 1. Tässä lausunnossa otetaan kantaa rakenteen palonkestoon (REI-vaatimus). Lausunto perustuu vastaavantapaisen kattoelementin polttokokeeseen ja rakenteen simulointiin.

2 RAKENTEEN PALONKESTON TARKASTELU

Rakenteen palonkestoa arvioidaan VTT:n vastaavantapaiselle rakenteelle tekemän polttokokeen perusteella. Kyseisen polttokokeen raportti on esitetty Liitteessä 2. Polttokokeessa testattu rakenne täytti standardipalossa kantavuus- (R), tiiviys- (E) ja osastoivuusvaatimuksen 35 minuutin ajan. Näin ollen koepoltettu rakenne täytti vaatimuksen REI30.

Koepoltetun ja lausunnossa tarkasteltavan rakenteen palonkestävyyteen vaikuttavat erot sekä niistä aiheutuvat vaikutukset rakenteen palonkestoon on kirjattu Taulukkoon 1.

Taulukko 1. Koepoltetun ja tarkasteltavan rakenteen palonkestävyyteen vaikuttavat erot ja niiden merkitys.

VTT:n polttokokeen mukainen rakenne	Lausunnossa tarkasteltava rakenne	Vaikutus palonkestoon	Perustelu
Kipsilevyn takana ilmarako	Kipsilevyn takana eriste	Parantaa palonkestävyyttä hieman	Kipsilevy saattaa lämmitä hieman nopeammin, mutta toisaalta palo ei pääse kipsilevyn halkeillessa suoraan kantaviin rakenteisiin vaan eristeet suojaavat niitä vielä, kunnes kipsilevy tippuu kokonaan
Alin koolauspuu 51*50	Alin koolauspuu 48*98	Parantaa palonkestävyyttä hieman	Suuremman koolauksen hiiltyminen kestää kauemmin ja näin ollen sen yläpuoliset eristeet pysyvät paikallaan pitempään ja suojaavat kantavien palkkien sivuja

Taulukossa 1 esitettyjen arviointien perusteella voidaan todeta, että tässä lausunnossa tarkasteltavalla rakenteella arvioidaan olevan parempi palonkesto kuin VTT:n testaamalla rakenteella.

Lähteessä [1] on esitetty rakenteen simuloinnit, jotka tukevat kyseisiä johtopäätöksiä. Myös simulointien perusteella elementin paloluokka on vähintään REI30. Simulointimalli validoitiin VTT:n polttokokeen tulosten avulla siten, että sen tuloksia voidaan pitää luotettavina.

3 YHTEENVETO JA JOHTOPÄÄTÖKSET

Tässä raportissa tarkasteltiin LapWall Oy:n puurakenteisen kattoelementin palonkestoa.

Polttokoetuloksien ja simulointien perusteella voidaan arvioida, että kyseinen rakenne täyttää paloluokan REI30-vaatimuksen.

Tampereella 26.1.2018

PALOTEKNINEN INSINÖÖRITOIMISTO
MARKKU KAURIALA Oy

Lausunnon ovat laatineet



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Johtava asiantuntija
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Timo Jokinen
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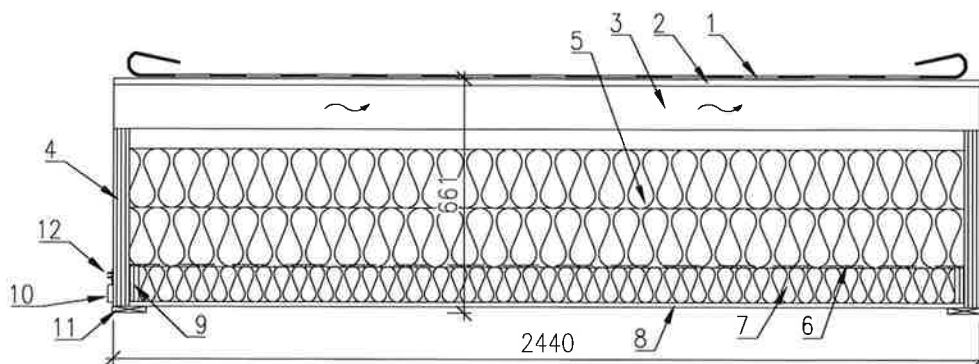
LIITTEET

Liite 1: Tarkasteltavan kattoelementin rakennetyyppiirustus

Liite 2: VTT:n polttokoeraportti

KIRJALLISUUSLÄHTEET

1. LapWall Oy. Kattoelementin palonkestävyyden laskennallinen tarkastelu. Palotekninen insinööritoimisto Markku Kauriala Oy. 2018.



1. PVC-yksikerroskate 1,2
2. OSB-levy 18 mm
3. Koolaus 123x42 C24 k/k 610 / tuuletusväli
4. Kerto-S reunapalkit 45x500
5. Mineraalivilla 0,037 W/mK (165+165) 330mm, T2, A2-s1,d0, yläpinnan luokitus B-s1,d0
6. Höyrinsulkumuovi
7. Koolaus ST C24 48x98 k/k 600 + mineraalivilla 0,037 W/mK 100mm, A2-s1,d0, yläpinnan luokitus B-s1,d0
8. Kipsilevy 13 mm (Tyyppi A)
9. Kerto-T reunarima 27x100
10. Vaneririma 15x50
11. Saumalauta ST 18x95
12. EPDM

Lämmöneristävyys: $U=0,09 \text{ W/m}^2\text{K}$
 Palonkesto: REI30
 Kuormitukset: Kattoelementin omapaino $0,6 \text{ kN/m}^2$, ripustukset $0,2 \text{ kN/m}^2$
 Ripustukset: Kattoelementin pääpalkkien syrjäpintaan porakärkisin puuruuvein (R6x120)

LapWall 
 Element System

Työn nro	Mittakaava	YP1
Päiväys	Suunnittelija	
26.1.2018	LapWall Oy	
Tekijä		
RiBo		
Sisältö		
RAKENNETTYYPPI		
Elementtityyppi		
LapWall LEKO -kattoelementti		

Rakennuskohde



Fire resistance test on a wooden roof construction, Kerto-S beams used as loadbearing structures

Test method: Standard EN 1365-2:2014 "Fire resistance tests for
loadbearing elements – Part 2: Floors and roofs



FINAS
Finnish Accreditation Service
T001 (EN ISO/IEC 17026)

Requested by: Metsä Wood

Test Date: 5 June 2015

Requested by Metsä Wood
Henri Salonen
Askonkatu 9 E
215100 LAHTI
Finland
Order by e-mail on 23 April 2015 / Henri Salonen

Testing laboratory VTT Expert Services Ltd
Fire Safety
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Fire resistance test on a wooden roof construction, Kerto-S beams used as loadbearing structures

Test specimen The test specimen was a wooden roof construction which consisted of two elements with loadbearing Kerto-S beams on the long sides. The two elements were connected together and to glued laminated timber beams on the short ends.

The size of the elements was 2440 x 5290 mm² (width x length) and 543 x 5290 mm² and the thickness was 666 mm. Loadbearing Kerto-S beams were 45 x 500 mm² (width x height) and length 5260 mm. Plastic foil as a vapour barrier, Kerto-S joists (51 x 50 mm² c/c 400 mm) and a layer of 12.5 mm thick Pregyplat Deco YK gypsum boards type A (manufactured by Siniat B.V, nominal density 9.1 kg/m²) were fixed under the loadbearing beams. Cavity between the loadbearing beams was insulated with two layers of 150 mm thick and one layer of 125 mm thick Isover KT37 glass wool (nominal density 15 kg/m³).

Timber joists (42 x 148 mm² c/c 815 mm, grade C24), 18 mm thick plywood and Protan roof covering were fixed on top of the loadbearing beams. The joints were sealed with EPDM gasket and Polyurethan foam.

The size of the specimen was 3000 mm x 5470 mm (width x length) and the span was 5195 mm.

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

Drawings of the test specimen delivered by the client **Appendix 1**

Date of delivery of materials **25 May 2015**

Date of assembly by the client 26 May 2015

Manufacturer had selected all the materials for the floor construction.

Date of test 5 June 2015

Test method *Standard EN 1365-2:2014 "Fire resistance tests for loadbearing elements - Part 2: Floors and roofs".*

Deviations from the test method:

Furnace pressure (item 5.2 of the standard SFS-EN 1363-1:2012)

The furnace pressure shall be monitored and controlled. 5 min after the commencement of the test the furnace pressure shall be ± 5 Pa of the nominal pressure specified for the particular element under test; from 10 min onwards it shall be ± 3 Pa of the nominal pressure specified for the particular element under test.

Pressure 100 mm below the roof fluctuated more than ± 5 Pa during test time of 6 – 10 minutes (lowest measured 13.9 Pa and highest measured 35.9 Pa).

Pressure 100 mm below the roof fluctuated more than ± 3 Pa at test time of 11 - 34 minutes (lowest measured 12.0 Pa and highest measured 30.8 Pa).

The effect of the deviation on the test results can be neglected.

Witnesses The test was witnessed by Mr Henri Salonen and Mr Jussi Björman representing Metsä Wood.

Test The fire resistance test was carried out in the horizontal furnace of the testing laboratory. The test specimen was connected to glued laminated beams at the short ends on the furnace. Both long edges of the specimen were free to deflect.

During the test each beam was loaded with eight point loads (2.6 kN/point) which were applied with the aid of steel weights, steel beams and hydraulic jacks. The load was determined so that the maximum moment in the middle of the span of the specimen was 15.68 kNm which corresponds to the moment produced by self weight of 0.51 kN/m² and an imposed load of 2.0 kN/m² with a span of 6400 m. The load was applied at least 15 minutes before the beginning of the test and it was defined by the client (Appendix 7b).

Location of measuring points for temperatures of the furnace and the test specimen as well as deflections: Appendix 2

Test conditions in the furnace (furnace temperature and pressure difference between the furnace and test hall): Appendices 3a and 3b

The ambient temperature in the test hall was 26 °C in the beginning of the fire resistance test.

The test was terminated 35 min 50 s after the start of the fire test due to structural failure.

Test results

Measured temperatures, deflections, observations and photographs are presented in the following appendices:

Temperatures of the test specimen	Appendix 4
Observations and deflections	Appendix 5
Photographs	Appendix 6

Test results with respect to the performance criteria imposed by the standard EN 13501-2:2007+A1:2009 complemented with EN 1365-2:2014 and EN 1363-1:2012 are presented in the following table 1.

Table 1. Test results with respect to the criteria.

Property	Test result		
Loadbearing capacity R			
Deflection (<i>criterion: $\leq L^2/400d$ mm = 135 mm when $d=500$ mm</i>)	Not exceeded. - maximum deflection D = 114 mm at the time of 35 min 50 s		
Rate of deflection (<i>criterion: $\leq L^2/9000d$ mm/min = 6.0 mm/min when $d=500$ mm and the value $L/30 = 173$ mm has been exceeded</i>)	Not exceeded. - dD/dt exceeded 34 min 40 s but L/30 did not exceed		
Integrity E			
Occurrence of flames: (<i>criterion: no sustained flaming in excess of 10 s duration</i>)	Not done		
Cotton pad test: (<i>criterion: no ignition</i>)	Not done		
Gap gauge test: (<i>criterion: through-going \varnothing 6 mm can be moved less than 150 mm along the gap; \varnothing 25 mm can be passed through the test specimen</i>)	Not done, no gaps		
Insulation I	Test time [min]		
	15 min	30 min	35 min
	ΔT (number of tc)		
Average temperature rise: (<i>criterion: $\Delta T \leq 140$ °C), tc78...tc82</i>)	2 °C	9 °C	15 °C
Highest temperature rise: (<i>criterion: $\Delta T \leq 180$ °C), tc78...tc84</i>)	10 °C (84)	47 °C (84)	67 °C (84)

Summary

The test specimen was a wooden roof construction (width x length = 3000 mm x 5470 mm) which consisted of two elements with loadbearing Kerto-S beams (45 x 500 mm²) and 425 mm thick glass wool insulation Isover KT37 (nominal density 15 kg/m³) between the beams. Plastic foil, Kerto-S joists and a layer of 12.5 mm thick Pregyplat Deco YK gypsum boards type A (manufactured by Siniat B.V., nominal density 9.1 kg/m²) were installed on the exposed side and timber joists, 18 mm thick plywood and Protan roof covering on the unexposed side.

During the test each beam was loaded with eight point loads (2.6 kN/point) which caused the maximum moment of 15.68 kNm in the middle of the span. This moment corresponds to the moment produced by self weight of 0.51 kN/m² and an imposed load of 2.0 kN/m² with a span of 6400 m.

The roof construction met the fire resistance test performance criteria imposed by the standards EN 13501-2:2007+A1:2009 complemented with EN 1365-2:2014 and EN 1363-1:2012 as follows:

Loadbearing capacity R 35 minutes^{*)}

Integrity E

-sustained flaming 35 minutes^{*)}
-gap gauge 35 minutes^{*)}
-cotton pad 35 minutes^{*)}

Insulation I 35 minutes^{*)}

^{*)} The test was terminated 35 min 50 s after the start of the test due to structural failure

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 1365-2:2014 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 1365-2:2014 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, 30 October 2015



Kai Renholm
Business Manager



Tuuli Oksanen
Leading Expert

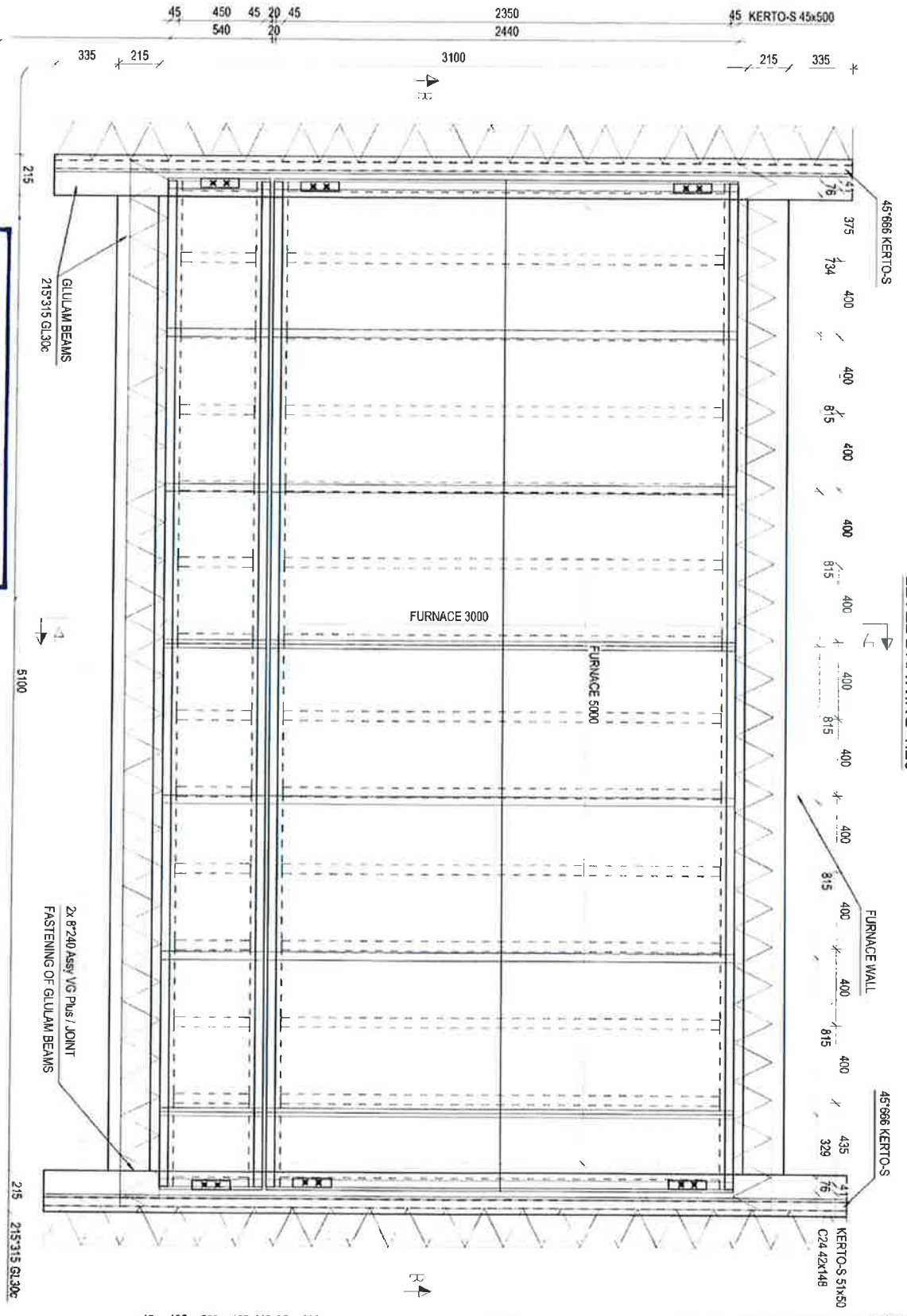
APPENDICES

Appendix 1	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 7a	Information of construction and determined material properties
Appendix 7b	Defining of test load
Appendix 8	Field of direct application of test results

DISTRIBUTION

Client	Original (2 pcs)
VTT Expert Services Ltd/Archive	Original (1 pcs)

LEVEL DRAWING 1:20



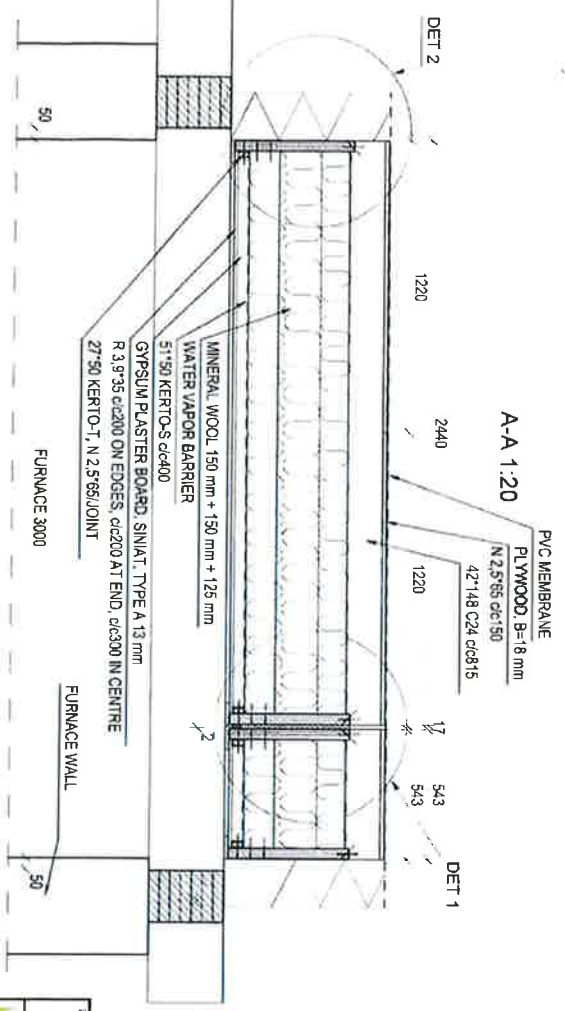
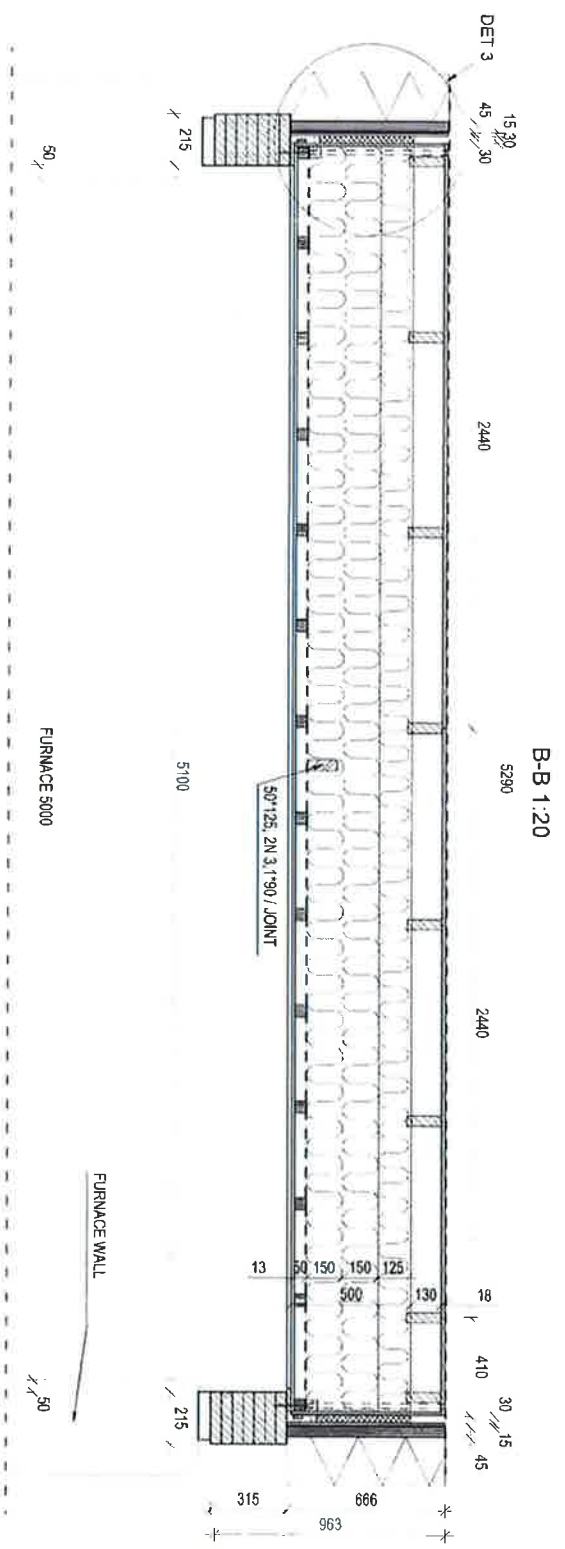
APPENDIX NO. 11(6)
 REPORT NO: VTT-S-02769-15
 SIGNATURE: Jens Perleberg
 VTT EXPERT SERVICES LTD

Rakennusalan nimi		Talon nimi	
Metsä Wood -kattoelementti		Polttokoe R30	
Painajien seaso		Talon numero	
Pohjapiirros		Mittakaava	
		1:20	
		Suunnitella	
		HST	
		Päiväys	
		19.5.2015	
		Mallitus	



MM ROOF ELEMENTS

ELEMENTI FASTENING POSITIONS

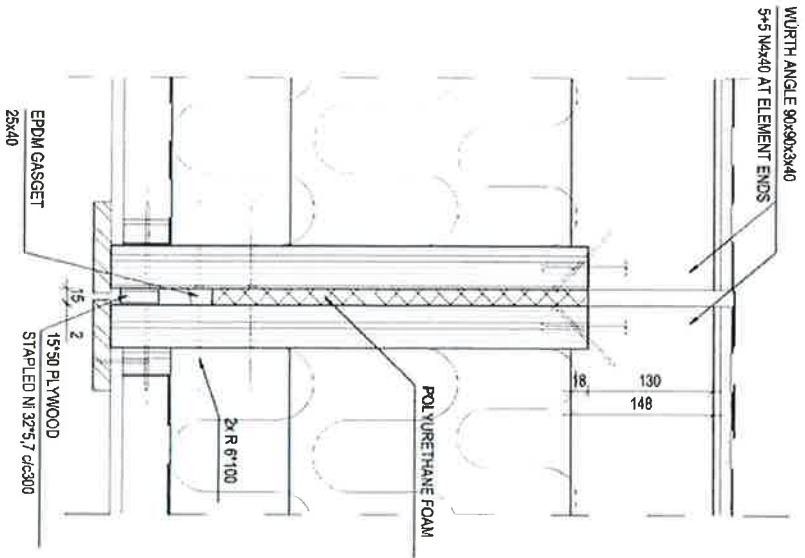


APPENDIX NO. 12(6)
 REPORT NO: VTT-S-02369-15
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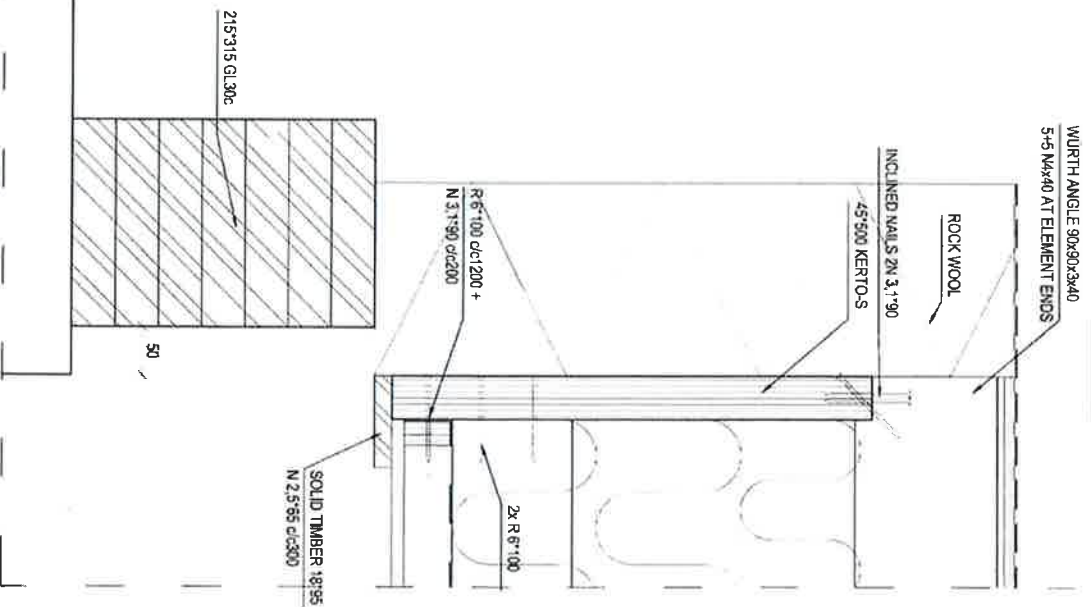
Tutkimuslaitoksen nimi		Tutkimus		Suorittaja		Muuutus	
Metsä Wood -kattoelementti		Polttokoe R30		HST			
Pitkävälisen säätö		1:20		18.5.2015			
Leikkaukset A-A ja B-B							



DET 1 1:5



DET 2 1:5

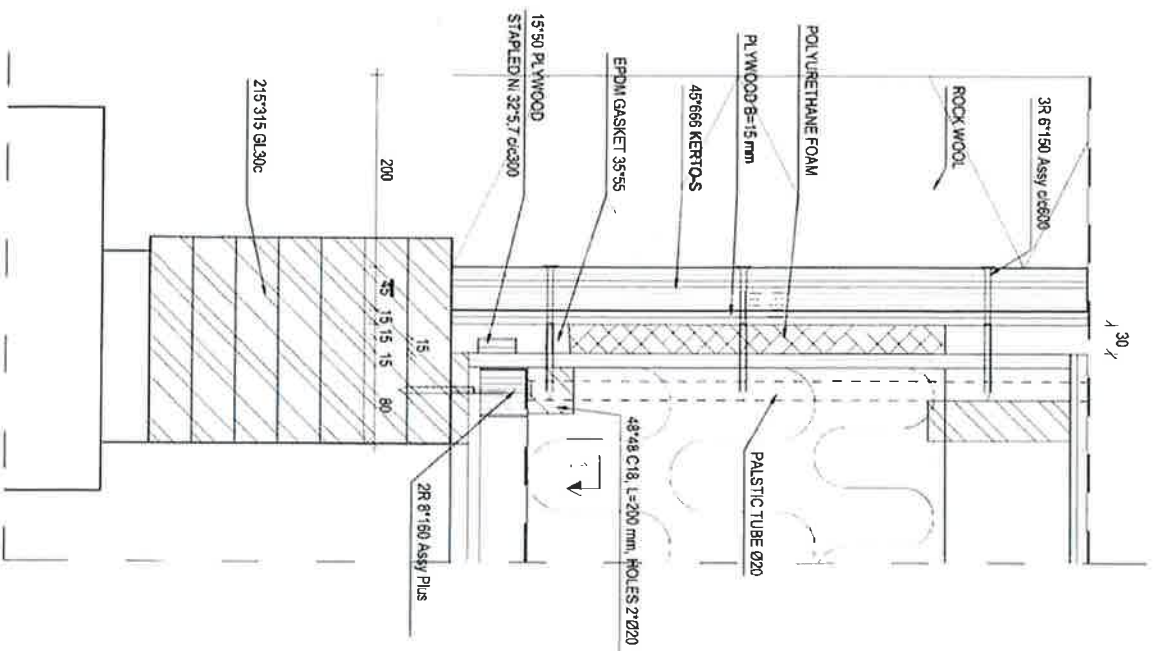


APPENDIX NO. 13(6)
 REPORT NO: VTT-S-02369-15
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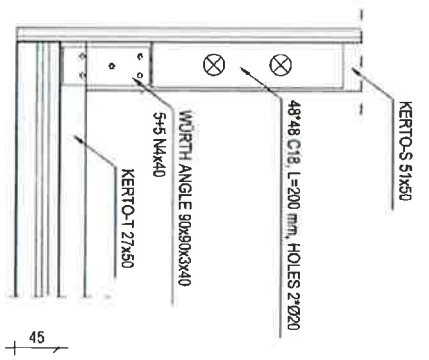
Säveluokotuksen nimi		Tunnus		Työn arvio		Suoritusajalla		Vuos	
Metsä Wood -kattoelementti		Poltokoe R3d		1:5		18.5.2015			
Purkutyön sisältö		Detaljit							



DET 3 1:5



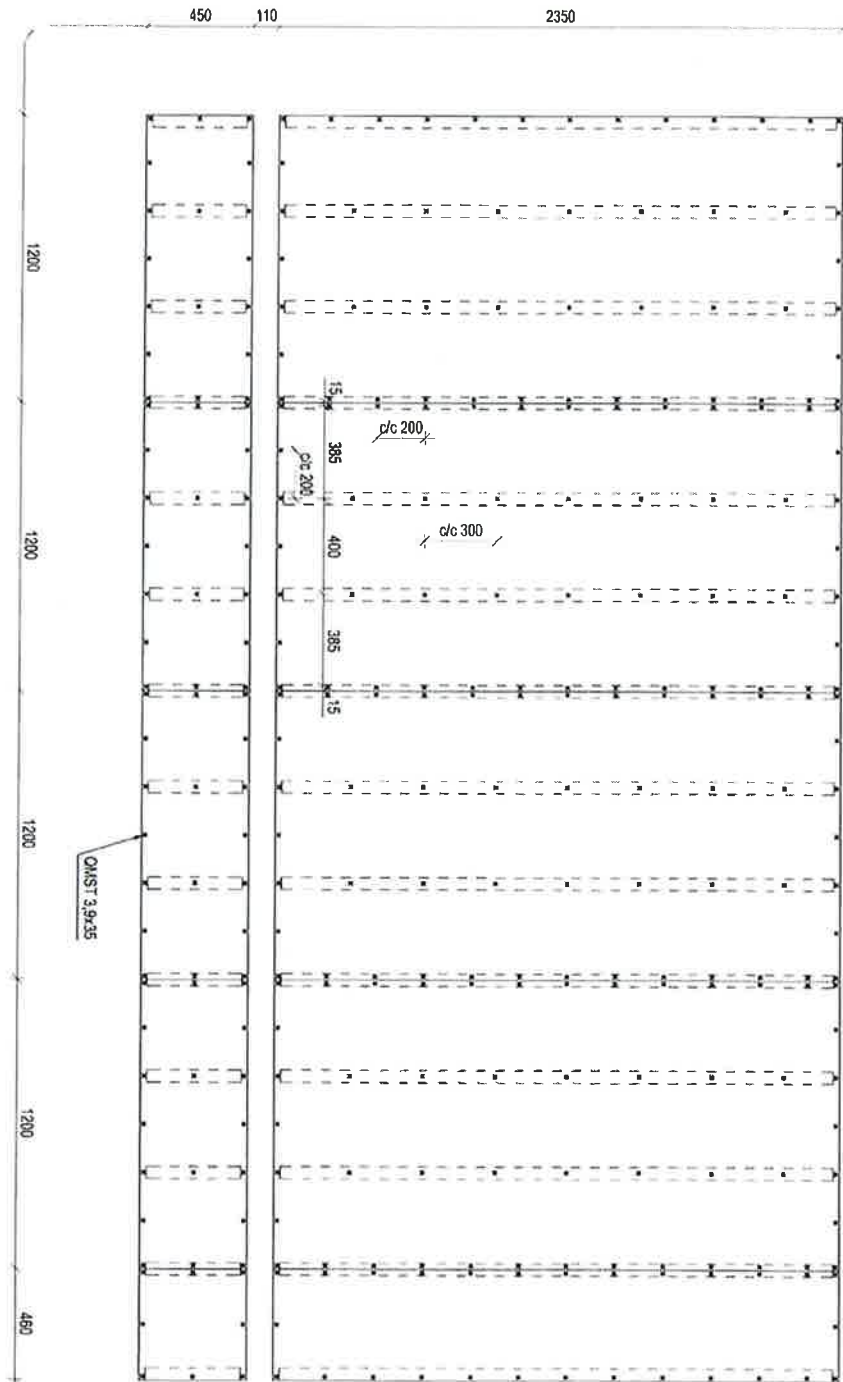
1-1 1:5



APPENDIX NO. 14(6)
 REPORT NO: VTT-5-02769-15
 SIGNATURE Jens Perleberg
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Raportin lausuntoajan nimi		Tunnus		Tytön numero		Suoritusajan alkupäivä		Muuutos	
Metsä Wood -kattoelementti		Polttokoe R30		15		18.5.2015			
MetsäWood		Detailjit							

GYPSUM PLASTER BOARD LAYUP 1:20



APPENDIX NO. 15(6)
 REPORT NO: VT-5-02769-15
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Palomääräysten nro	Tuote	Työn numero	Suunnitelma	Muutos
Metsä Wood -kattoelementti	Polttokoe R30	120	HSN Pääsiäinen 18.5.2015	
Pöytäkirjan sekä		KIPSILEVYKAAVIO		
MetsäWood				

POSITION	TYPE	PRODUCT	MANUFACTURER	STANDARD	OTHER INFO
ROOFING	PVC MEMBRANE		PROTAN	EN 13956	
ROOF PANELING	SPRUCE PLYWOOD	18 mm	METSÄ WOOD	EN 13986	
PURLINS	SOLID TIMBER	42x148 C24	METSÄ WOOD	EN 14081-1	
RAFTERS	KERTO LVL	45x500 KERTO-S	METSÄ WOOD	EN 14374	
WIND PROOF MEMBRANE					NOMINAL DENSITY 15 kg/m ³
INSULATION	GLASS WOOL	KT 37 425 mm	ISOVER	EN 13162	
BLOCKINGS	SOLID TIMBER	50x125			
GUIDANCE PIPE	PLASTIC TUBE	Ø20			
GUIDANCE PIPE HOLDER	SOLID TIMBER	48x48 C18			
WATER VAPOR BARRIER	PLASTIC MEMBER				
GASGETS	EPDM		RANIMOBAR	EN 13984	
EDGE/END BATTEN	SPRUCE PLYWOOD	15x60	FINNPROFILES		
CEILING BATTENS	KERTO LVL	51x60 KERTO-S	METSÄ WOOD	EN 13986	
CEILING EDGE BATTEN	KERTO LVL	27x60 KERTO-T	METSÄ WOOD	EN 14374	
CEILING PANELING	GYPSUM PLASTER BOARD	TYPE A 13	METSÄ WOOD	EN 14374	
CEILING BATTEN	SOLID TIMBER	18x95	SINIAT	EN 520	PREGYPLAT DECO YK 12.5 1200
FASTENERS	NAIL		H&H	EN 14592	
	SCREW		WURTH	ETA-11/0190	
INSULATION FOAM	POLYURETHANE		WURTH		
		WUFOAM GUN			

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Rakennuskauppa Oy		Tunnus		Työn numero		Suunnit. yr.		Muutos	
Metsä Wood -kattoelementti		Polttokoe R30		Vastuu		HSN			
Materiaalit				18.5.2015					

