Kivimiehentie 4,
FI-02150 Espoo, FINLAND
www.eurofins.fi/expertservices

Designated according to Article 29 of Regulation (EU) No 305/2011

Member of EOTA
www.eota.eu

European Technical Assessment ETA 23/0176 of 18/04/2023

I General Part

Technical Assessment Body issuing the ETA	**Eurofins Expert Services Oy**
Trade name of the construction product	**Lett-Tak wood (LTW) roof elements**
Product family to which the construction product belongs	Wood based panels and elements
Manufacturer	**Lett-Tak Systemer AS** Hegdalsveien 139 3261 Larvik, Norway
Manufacturing plant	**Annex N**
This European Technical Assessment contains	**25 pages including 3 Annexes which form an integral part of this assessment. Separate Annex 3.**
This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of	**EAD 140022-00-0304 Prefabricated wood-based loadbearing stressed skin panels**

II Specific Part

1. Technical description of the product

Lett-Tak wood (LTW) roof elements are composite slab elements made of structural laminated veneer lumber Kerto LVL. The adhesive is of type I (full exposure to the weather) polyurethane adhesive as defined in EN 15425. Lett-Tak wood (LTW) roof elements contain thermal insulation inside the cavities, roofing for watertightness and optional fire protective gypsum plasterboards. The elements have a bottom slab. The materials, dimensions and tolerances are given in Annex 1.

Lett-Tak wood (LTW) roof elements are intended to be used as structural elements in buildings. Lett-Tak wood (LTW) roof elements may function as directly load bearing as well as structural stiffening members.

The products are shaped according to the customer's specification. The maximum length of the elements is 25 m and the height varies from 150 to 1200 mm. Top and bottom slabs may be jointed at a rib. Typical lengths are from 4 to 24 m and width 2 400 mm. The panels may have one-sided tapered ribs; maximum taper is 10°.

Lett-Tak wood (LTW) roof elements can be painted or stained. The suitability of the treatment shall be checked with the manufacturer of it. Surface treatments of the elements are not covered by this ETA.

2. Specification of the intended uses in accordance with the applicable EAD

2.1. Intended uses

Lett-Tak wood (LTW) roof elements are intended to be used as directly load bearing parts of building constructions. They may also function as structural bracing members. Lett-Tak wood (LTW) roof elements can be supported below the ribs.

With regard to moisture behaviour of the product, the use is limited to service classes 1 and 2 as defined in EN 1995-1-1. The product shall not be used in service class 3 / use class 3 (3.1 exterior, above ground, protected; occasionally wet). Lett-Tak wood (LTW) roof elements are intended to be a part of the external envelope of the building and they are protected adequately with roofing.

Lett-Tak wood (LTW) roof elements can be used in seismic areas, when designed adequately. The panels are intended to be used subject to static or quasi-static actions only. In seismic areas the behavior factor of LVL rib panels used for the design is limited to non-dissipative or low-dissipative structures ($q \leq 1{,}5$), defined according to Eurocode 8 (EN 1998-1:2004 clauses 1.5.2 and 8.1.3 b) and applicable national rules on construction works of the Member States (MS).

Holes in Lett-Tak wood (LTW) roof elements to provide openings for ducts, pipes etc. or modification or repair of the construction may only be made after consultation with the person responsible for the design as described in 2.3.

2.2. Working life

The provisions made in this European Technical Assessment are based on an assumed intended working life of Lett-Tak wood (LTW) roof elements of 50 years when installed in the works, provided that the elements are subjected to appropriate installation, use and maintenance. These provisions are based upon the current state of the art and the available knowledge and experience. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[1].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA nor by the Technical Assessment Body, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

2.3. Design of works

For each individual building project, a specific structural design shall be made according to the instructions of the ETA holder by a person responsible for the task according to the laws of the Member States (MS). The design also shall take into account any aspects regarding installation of the elements, as any temporary bracing and supporting.

Lett-Tak AS provides design instructions of the Lett-Tak wood (LTW) roof elements. When the instructions are updated, the updated version shall be assessed by Eurofins Expert Services Oy.

2.4. Manufacturing

Gluing of slabs to ribs shall be performed according to the ETA holder's instructions assessed by Eurofins Expert Services Oy. Gluing pressure may be achieved by screws or nails as specified in detail in the instructions of the ETA holder. When the instructions are updated, the updated version shall be approved by Eurofins Expert Services Oy

2.5. Packaging, transport, storage, maintenance, replacement and repair

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

2.6. Installation

Lett-Tak wood (LTW) roof elements shall be installed by appropriately qualified personnel, following the installation plan. Lett-Tak wood (LTW) roof elements shall be protected against moisture from the supporting main structure by a damp-proof membrane, when relevant. The completed building (the works) shall comply with the building regulations (regulations on the works) applicable in the Member States in which the building is to be constructed. The procedures foreseen in the Member State for demonstrating compliance with the building regulations shall also be followed by the entity held responsible for this act. The ETA for Lett-Tak wood (LTW) roof elements does not amend this process in any way.

---

[1] The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

3. Performance of the product and references to the methods used for its assessment

Table 1. Basic requirements for construction works and essential characteristics

Basic requirement and essential characteristics	Performance
BWR 1. Mechanical resistance and stability	
Mechanical resistance and stiffness Dimensional stability	Clause 3.1.1 Clause 3.1.2
BWR 2. Safety in case of fire	
Reaction to fire Resistance to fire	Clause 3.2.1 Clause 3.2.2
BWR 3. Hygiene, health and the environment	
Water vapour permeability and moisture resistance Content, emission and/or release of dangerous substances	Clause 3.3.1 Clause 3.3.2
BWR 4 Safety and accessibility in use	
Impact resistance	Clause 3.4.1
BWR 5 Protection against noise	
Airborne sound insulation Impact sound insulation	No performance assessed No performance assessed
BWR 6 Energy economy and heat retention	
Thermal conductivity Air permeability	Clause 3.5.1 Clause 3.5.2
Aspects of durability	
Natural durability	Clause 3.6.1

3.1. Mechanical resistance and stability, BWR 1

3.1.1. Mechanical resistance and stiffness as well as serviceability

The intention of the manufacturer is to declare the performance of the kit by reference to the production documents[2]. Thus, the mechanical resistance and deformations for Lett-Tak wood (LTW) roof elements is given by the Method 3b: Reference to design documents produced and held by the manufacturer according to the order for the works.

The structural performance of Lett-Tak wood (LTW) roof elements is considered in accordance with the limit state design principles specified in Eurocodes and is described in detail in the manufacturer's instructions for design. Both ultimate limit state and serviceability limit state are considered. Calculation methods follow EN 1995-1-1:2004.

Structural design shall be documented. Strength values of Kerto LVL to be used in design together with information of the dimensions of the components are given in Annex 1.

[2] This is specified in Delegated Regulation (EU) No 574/2014 of 21 February 2014 amending Annex III to Regulation (EU) No 305/2011.

Eurofins Expert Services Oy has assessed the design instructions of the manufacturer. In case of updating, the new versions shall be assessed by Eurofins Expert Services Oy.

3.1.2. Dimensional stability

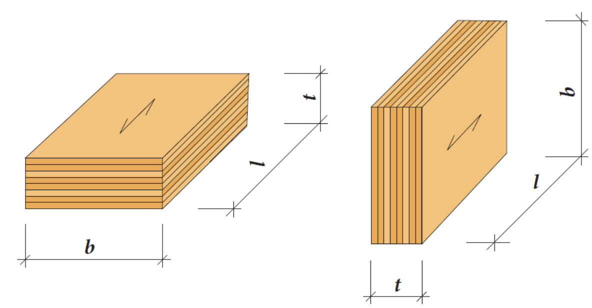
In normal conditions, harmful deformations due to moisture changes of the Lett-Tak wood (LTW) roof elements are not expected. When necessary, the dimensional change ΔL of a Kerto LVL product due to change of moisture content can be calculated as follows:

$$\Delta L = \Delta\omega \cdot \alpha_H \cdot L$$

where $\Delta\omega$ is change of moisture content [%] from the equilibrium moisture content, α_H dimensional variation coefficient and L dimension [mm]. The dimensional variation coefficients are presented in Table 2.

Table 2. Dimensional variation coefficients.

Dimension	Kerto LVL S-beam	Kerto LVL Q-panel
Thickness *t*	0.0024	0.0024
Width *b*	0.0032	0.0003
Length *l*	0.0001	0.0001



3.2. Safety in case of fire, BWR 2

3.2.1. Reaction to fire

Untreated Kerto LVL is classified to have reaction to fire class D-s1, d0. If thermal insulation is used inside the elements, it shall be classified to have reaction to fire class A1 as a default. Other options for completing materials are specified in Annex 2.

Reaction to fire class of Lett-Tak wood (LTW) roof elements can be improved by chemical treatments or other protective means designed appropriately. These kinds of improvements are not covered by this ETA.

For roofing, reaction to fire is B_{ROOF}(t2) on a wood underlay.

3.2.2. Resistance to fire

Lett-Tak wood (LTW) roof elements have been tested according to relevant standards to be classified according to EN 13501-2. Annex 2 (informative) is based on these tests and the calculation methods in EN 1995-1-2:2004. A roof construction made of Lett-Tak wood (LTW) roof elements may have resistance to fire class REI 30, REI 60 or REI 90 provided that the conditions in Annex 2 are fulfilled. Load-bearing performance (class R) can be determined as a part of design of works (see also clause 2.3 – Design of works) taking into account the charring rates and limitations given in Annex 2. Resistance to fire is strongly influenced by the structure of the element, insulation in the cavities and optional use of gypsum plasterboards, see Annex 2.

Passage of fire to the gap between the end of the element and a supporting edge has to be prevented. Neither may the bottom slab have such holes that might act as passages for fire to the cavity inside the Lett-Tak wood (LTW) roof element.

3.3. Hygiene, health and environment, BWR 3

3.3.1. Water vapour permeability and moisture resistance

Lett-Tak wood (LTW) roof elements have a closed unventilated structure (warm roof). Bottom panel is Kerto LVL Q-panel which forms the vapour barrier of the structure. The cavities are filled with thermal insulation. The top panel under roof membrane is Kerto LVL Q-panel. Any possible moisture coming into the cavities is removed by diffusion.

The resistance to moisture has been assessed based on calculations according to EN ISO 13788. Main intended use is in such climatic conditions, where the tendency of moisture flow is from inside out for the most time of the year, as in Northern part of Europe. Indoor moisture load is 0…2 or 2…4 g/m^3 which are typical for e.g. day-care centres, schools or other similar facilities. In such conditions, the function of roof elements fulfil the common requirements to prevent indoor moisture from damaging the structures. The assessed structures of the roof structures, including the air tightness of the relevant building details (Annex 3), have been assessed to provide adequate moisture control for the intended use. In Tables 3 - 5 are given the alternative structures of the roof elements for different U-values, outside climate and internal moisture excess conditions.

Table 3. Alternatives of the structural layers of the roof elements with U-value 0.09 [W/(m^{2}K)] in different outside climate and internal moisture excesses conditions.

Layer	Alternatives	Outside climate			
		North Finland - Sodankylä		South Finland – Helsinki	
		Internal moisture excess [g/m^3]		Internal moisture excess [g/m^3]	
		0-2	2-4	0-2	2-4
LVL	Bottom plate 21 mm			x	x
	Bottom plate 39 mm	x		x	x
	Top plate 21 mm	x		x	x
Insulation material	Mineral wool	x		x	x
	Wood Fiber plate	x		x	x
Roof membrane	Asphalt layer Sd=135 [m]	x		x	x
	PVC membrane Sd=27 [m]	x		x	x

Table 4. Alternatives of the structural layers of the roof elements with U-value 0.13 [W/(m²K)] in different outside climate and internal moisture excesses conditions.

Layer	Alternatives	Outside climate			
		North Finland - Sodankylä		South Finland – Helsinki	
		Internal moisture excess [g/m³]		Internal moisture excess [g/m³]	
		0-2	2-4	0-2	2-4
LVL	Bottom plate 21 mm	x	x	x	x
	Bottom plate 39 mm	x	x	x	x
	Top plate 21 mm	x	x	x	x
Insulation material	Mineral wool	x	x	x	x
	Wood Fiber plate			x	
Roof membrane	Asphalt layer Sd=135 [m]	x	x	x	x
	PVC membrane Sd=27 [m]	x	x	x	x

Table 5. Alternatives of the structural layers of the roof elements with U-value 0.18 [W/(m²K)] in different outside climate and internal moisture excesses conditions.

Layer	Alternatives	Outside climate			
		North Finland - Sodankylä		South Finland – Helsinki	
		Internal moisture excess [g/m³]		Internal moisture excess [g/m³]	
		0-2	2-4	0-2	2-4
LVL	Bottom plate 21 mm	x	x	x	x
	Bottom plate 39 mm	x	x	x	x
	Top plate 21 mm	x	x	x	x
Insulation material	Mineral wool	x	x	x	x
	Wood fiber plate			x	
Roof membrane	Asphalt layer Sd=135 [m]	x		x	x
	PVC membrane Sd=27 [m]	x	x	x	x

In other climatic conditions, or if the use of building provide for that, the function of the envelope shall be separately assessed with regard to moisture diffusion and condensation as a part of the design of works. When the performance shall be calculated, the water vapour resistance factors μ given in Table 3 may be used.

Table 6. Water vapour resistance factors μ and diffusion coefficients δ_p.

	Conditions	μ (-)		δ_p (kg/Pa s m)	
		Kerto LVL S-beam	Kerto LVL Q-panel	Kerto LVL S-beam	Kerto LVL Q-panel
Thickness direction	Dry Cup[1]	200	200	$1{,}0\cdot10^{-12}$	$1{,}0\cdot10^{-12}$
	Wet Cup[2]	70	70	$2{,}7\cdot10^{-12}$	$2{,}7\cdot10^{-12}$
	20°C-50/75RH%	80	62	$2{,}4\cdot10^{-12}$	$3{,}0\cdot10^{-12}$
Width direction	20°C-50/75RH%	82	9,5	$2{,}3\cdot10^{-12}$	$20\cdot10^{-12}$
Length direction	20°C-50/75RH%	3,9	4,7	$49\cdot10^{-12}$	$40\cdot10^{-12}$

[1] Dry cup values tested in 23°C - 0/50 RH% conditions.
[2] Wet cup values tested in 23°C - 50/93 RH% conditions.

3.3.2. Content, emission and/or release of dangerous substances

Dangerous substances

Based on the declaration of the manufacturer and the assessment of the Assessment Body, Lett-Tak wood (LTW) roof elements do not contain harmful or dangerous substances as defined in the EU database, with exception of formaldehyde. The formaldehyde release class of the LVL is E1 in accordance with EN 14374. The product does not contain pentachlorophenol, or recycled wood. Kerto LVL products manufactured by Metsä Wood have formaldehyde releases less than 0,030 ppm which is 30% of E1 class requirement 0,10 ppm when determined in accordance with EN 717-1.

High relative humidity conditions may cause mould growth on the surface of Lett-Tak wood (LTW) roof elements. If these kinds of conditions are expected during erection, a brushable or sprayable surface treatment should be used. These kinds of treatment have no adverse effects to the structural properties of Lett-Tak wood (LTW) roof elements. If, due to excessive wetting, there is mould growth on the surface of Lett-Tak wood (LTW) roof elements, this can be removed by sanding.

Lett-Tak wood (LTW) roof elements treated against biological attack are not covered by this ETA.

In addition to the specific clauses relating to dangerous substances contained in this European Technical Assessment, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need to also be complied with, when and where they apply.

3.4. Safety in use, BWR 4

3.4.1. Impact resistance

Lett-Tak wood (LTW) roof elements are assessed to have acceptable impact resistance for the intended uses.

3.5. Energy economy and heat retention, BWR 6

3.5.1. Thermal conductivity

The thermal conductivity λ for both web and flange material is 0.13 W/(m K) according to EN ISO 10456. The natural density variation of the materials is taken into account in this value.

Table 7. U-values for different roof element thickness

Element thickness [mm]	Insulation [W/mK]	U-value [W/ m^2K]
220	0,037 mineral wool	0,18
300	0,037 mineral wool	0,13
450	0,037 mineral wool	0,09
220	0,038 wood fibre	0,18
300	0,038 wood fibre	0,13
450	0,038 wood fibre	0,09

3.5.2. Air permeability

A construction with Lett-Tak wood (LTW) roof elements, including the joints between the elements (Annex 3), will provide adequate airtightness in relation to the intended use, taking into account both energy economy and heat retention, risk of cold draughts and risk of condensation within the construction.

Table 8. Air tightness of element joints

Joint type	Air leakage per joint at 50 Pa pressure difference
Longitudinal joints	≤ 0,1 $m^3/(h \cdot m)$
Transverse joints – with overlap vapour barrier joints clamped with plywood collar	≤ 0,5 $m^3/(h \cdot m)$

3.6. Aspects of durability

3.6.1. Natural durability

The adhesive of type I can also be used in service class 3 but natural durability class of LVL is 5 according to EN 350-2. Thus, Lett-Tak wood (LTW) roof elements can be used in service classes 1 and 2 according to EN 1995-1-1, and hazard classes 1 and 2 as specified in EN 335. The designer shall pay attention to the details of the construction and to ensure that no water pockets will be formed. During the erection of the building, Lett-Tak wood (LTW) roof elements have good resistance to temporary exposure to water without decay, provided that they are allowed to dry afterwards. Integrity of the bond is maintained in the assigned service classes throughout the expected life of the structure.

Durability may be reduced by attack from insects such as long horn beetle, dry wood termites and anobium in regions where these may be found.

When necessary and required by the local authorities, Lett-Tak wood (LTW) roof elements may be treated against biological attack according to the rules valid within the region. Any adverse effects of the treatment on other properties shall be taken into account. These kinds of treatments are not covered by this ETA.

4. Assessment and verification of constancy of performance (hereinafter AVCP) system applied, with reference to its legal base

According to the Decision 2000/447/EC of the European Commission, the system of assessment and verification of constancy of performance (see Annex V to the regulation (EU) No 305/2011) is System 1.

5. Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD.

Assessment and verification of constancy of performance shall focus on glue bond quality that is provision for the performances given in the ETA. Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Eurofins Expert Services Oy.

5.1. Tasks of the manufacturer

The manufacturer has approved instructions for manufacturing and factory production control for each type of manufacturing method. Integrity of the glue bond shall be tested, as specified in the instructions, with a shear test according to the clause 3.4.1 of the EAD 140022-00-0304.

5.2. Tasks of the notified body

Under continuous production, the notified body shall visit the factory twice a year. Products may not be manufactured continuously. Only one yearly inspection visit may be carried out in case of production stop longer than half a year.

Issued in Espoo on April 18, 2023
by Eurofins Expert Services Oy

Anssi Pekkarinen
Manager, Structures

Jouni Hakkarainen
Leading Expert

ANNEX 1
DESCRIPTION OF LETT-TAK WOOD (LTW) ROOF ELEMENTS

1. Structure of Lett-Tak wood (LTW) roof element

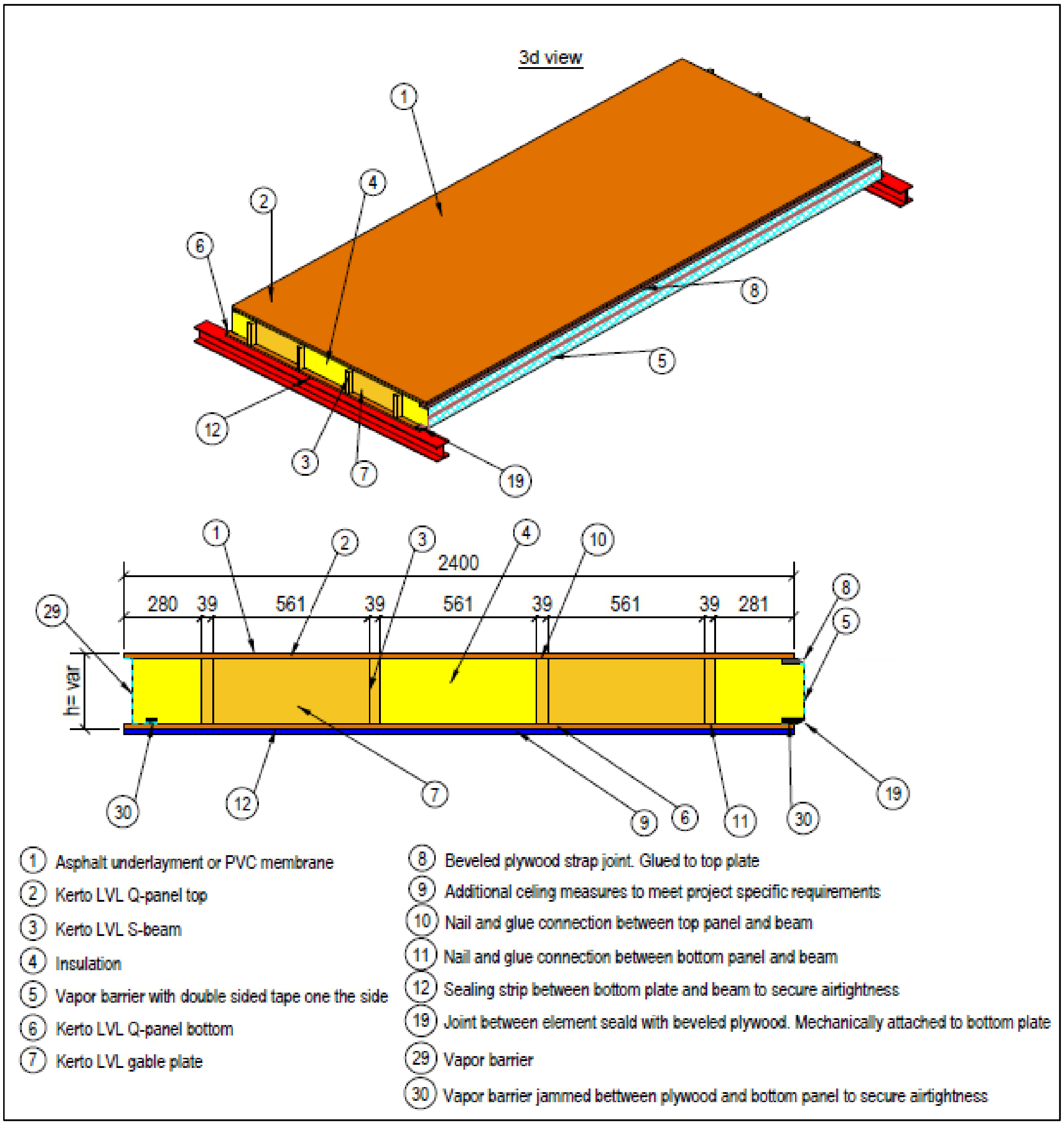


Figure1-1: 3D view and cross section of Lett-Tak wood (LTW) roof element.

Typical cross sections and symbols used are illustrated in Figure 1-1. The products are individually designed based on the specification of the customer. The maximum length of the elements is 25 m and the height varies from 150 to 1200 mm. Top and bottom slabs may be jointed at a rib. If the length of the element is more than 12 m, the handling of the element shall be considered by the designer. The panels may have one-sided tapered ribs; maximum taper is 10°.The ribs may be stiffened, when necessary, with additional stiffeners made of Kerto LVL. Lett-Tak wood (LTW) roof elements have thermal insulation in the cavities.

Typical dimensions of the members to be glued together are
b_w = 39 to 75 mm
h_w = 100 to 900 mm (h_w< 15.4x thickness of rib b_w)
h_f = 19 to 73 mm

2. Tolerances of dimensions

Tolerances of dimensions at the reference moisture content of 10 ± 2% are presented in Table 1-1.

Table 1-1. Tolerances of Lett-Tak wood (LTW) roof elements.

Dimension	Tolerance, mm or %
Depth	± 5,0 mm or 1,5 %**
Width	± 0,5 %
Length	± 5,0 mm

** which one is smaller

The thickness of sanded Kerto LVL slabs is the nominal thickness decreased by 1mm for each sanded surface. Kerto LVL slabs used in Lett-Tak wood (LTW) roof elements shall be sanded at least from that side which is glued to the ribs. The effect of sanding to the thickness shall be taken into account in the structural calculations of Lett-Tak wood (LTW) roof elements.

3. Specifications of components

The components are made of Kerto LVL produced by Metsä Wood Lohja LVL Mill or Punkaharju LVL Mill or corresponding Kerto LVL mill. Orientation of the Kerto LVL material is given in Figure 1-2. The material properties comply with EN 14374. The characteristic strength values of the Kerto LVL shall be at least as given in Table 1-2.

The adhesive used in manufacturing of Lett-Tak wood (LTW) roof elements is of type I (full exposure to the weather) polyurethane adhesive as defined in EN 15425. The adhesives used shall be approved for gluing of load-bearing structures and suitable for gluing of Kerto LVL.

Table 1-2 The characteristic values of Kerto LVL S-beam and Kerto LVL Q-panel to be used in the design of Lett-Tak wood (LTW) roof elements.

Property	Symbol	Figure 1-2	Characteristic value, N/mm² or kg/m³			
			Kerto LVL S-beam thickness	Kerto LVL Q-panel thickness		
			27 – 75 mm	19-20 mm*	19 - 23 mm**	25 – 73 mm**
Characteristic values						
Bending strength:						
Edgewise (depth 300 mm)	$f_{m,0,edge,k}$	A	44.0	28.0	28.0	32.0
Size effect parameter	s	-	0.12	0.12	0.12	0.12
Flatwise, parallel to grain	$f_{m,0,flat,k}$	B	50.0	28.0	32.0	36.0
Flatwise, perpendicular to grain	$f_{m,90,flat,k}$	C	-	14,0	7.0	8.0
Tensile strength:						
Parallel to grain (length 3000 mm)	$f_{t,0,k}$	D	35.0	19.0	19.0	26.0
Perpendicular to grain, edgewise	$f_{t,90,edge,k}$	E	0.8	6.0	6.0	6.0
Perpendicular to grain, flatwise	$f_{t,90,flat,k}$	F	-	-	-	-
Compressive strength:						
Parallel to grain	$f_{c,0,k}$	G	35.0	19.0	19.0	26.0
Perpendicular to grain, edgewise	$f_{c,90,edge,k}$	H	6.0	9.0	9.0	9.0
Perpendicular to grain, flatwise	$f_{c,90,flat,k}$	I	2,2	2,2	2,2	2,2
Shear strength:						
Edgewise	$f_{v,0,edge,k}$	J	4.2	4.5	4.5	4.5
Flatwise, parallel to grain	$f_{v,0,flat,k}$	K	2.3	1.3	1.3	1.3
Flatwise, perpendicular to grain	$f_{v,90,flat,k}$	L	-	0.6	0.6	0.6
Modulus of elasticity:						
Parallel to grain, along	$E_{0,k}$	ABDG	11600	8300	8300	8800
Parallel to grain, across	$E_{90,k}$	C	-	2900	1000	1700
Perpendicular to grain, edgewise	$E_{90,edge,k}$	H	350	2000	2000	2000
Perpendicular to grain, flatwise	$E_{90,flat,k}$	I	100	100	100	100
Shear modulus:						
Edgewise	$G_{0,edge,k}$	J	400	400	400	400
Flatwise, parallel to grain	$G_{0,flat,k}$	K	270	60	60	100
Flatwise, perpendicular to grain	$G_{90,flat,k}$	L	-	16	16	16
Density	ρ_k	-	480	480	480	480
Mean values						
Modulus of elasticity:						
Parallel to grain, along	$E_{0,mean/}$	ABDG	13800	10000	10000	10500
Parallel to grain, across	$E_{90,mean}$	C	-	3300	1200	2000
Perpendicular to grain, edgewise	$E_{90,edge,mean}$	H	430	2400	2400	2400
Perpendicular to grain, flatwise	$E_{90,flat,mean}$	I	130	130	130	130
Shear modulus:						
Edgewise	$G_{0,edge,mean}$	J	600	600	600	600
Flatwise, parallel to grain	$G_{0,flat,mean}$	K	380	80	80	120
Flatwise, perpendicular to grain	$G_{90,flat,mean}$	L	-	22	22	22
Density	ρ_{mean}	-	510	510	510	510

* For Kerto LVL Q-panel with lay-up |—| | |—|

** For Kerto LVL Q-panel with two parallel surface veneers

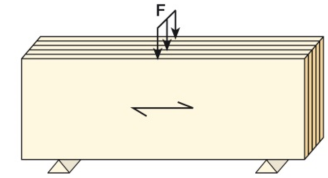
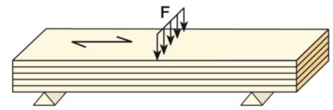
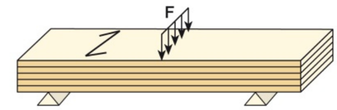
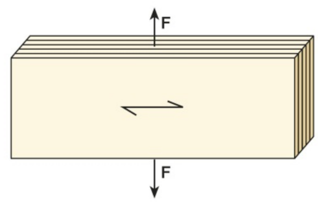
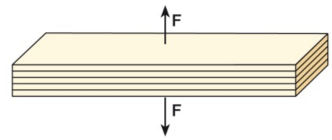
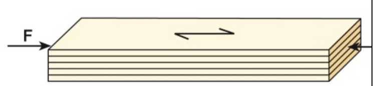
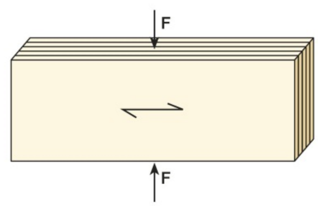
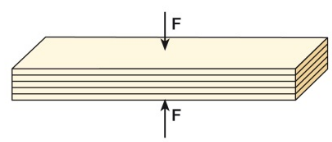
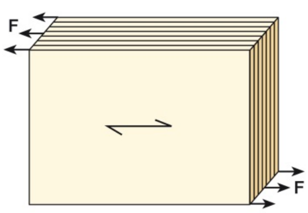
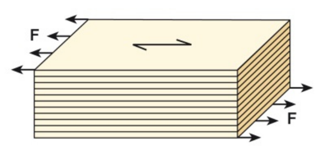
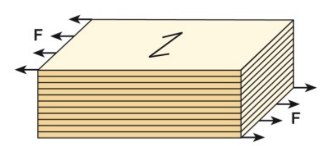
 A. Edgewise bending, parallel to grain (m,0,edge)	 B. Flatwise bending, parallel to grain (m,0,flat)	 C. Flatwise bending, perpendicular to grain (m,90,flat)
 D. Tension, parallel to grain (t,0)	 E. Edgewise tension, perpendicular to grain (t,90, edge)	 F. Flatwise tension, perpendicular to grain (t,90,flat)
 G. Compression, parallel to grain (c,0)	 H. Edgewise compression, perpendicular to grain (c,90,edge)	 I. Flatwise compression, perpendicular to grain (c,90,flat)
 J. Edgewise shear, parallel to grain (v,0,edge)	 K. Flatwise shear, parallel to grain (v,0,flat)	 L. Flatwise shear, perpendicular to grain (v,90,flat)

Figure 1-2. Definitions of the strength and stiffness properties in different orientations.

The characteristic strength values are given at an equilibrium moisture content resulting from a temperature of 20 °C and a relative humidity of 65 % exposed to duration of load of 5 minutes. The characteristic values given in Table 1-2 can be used without any modifications for temperatures below or equal to 50 °C for a prolonged period of time.

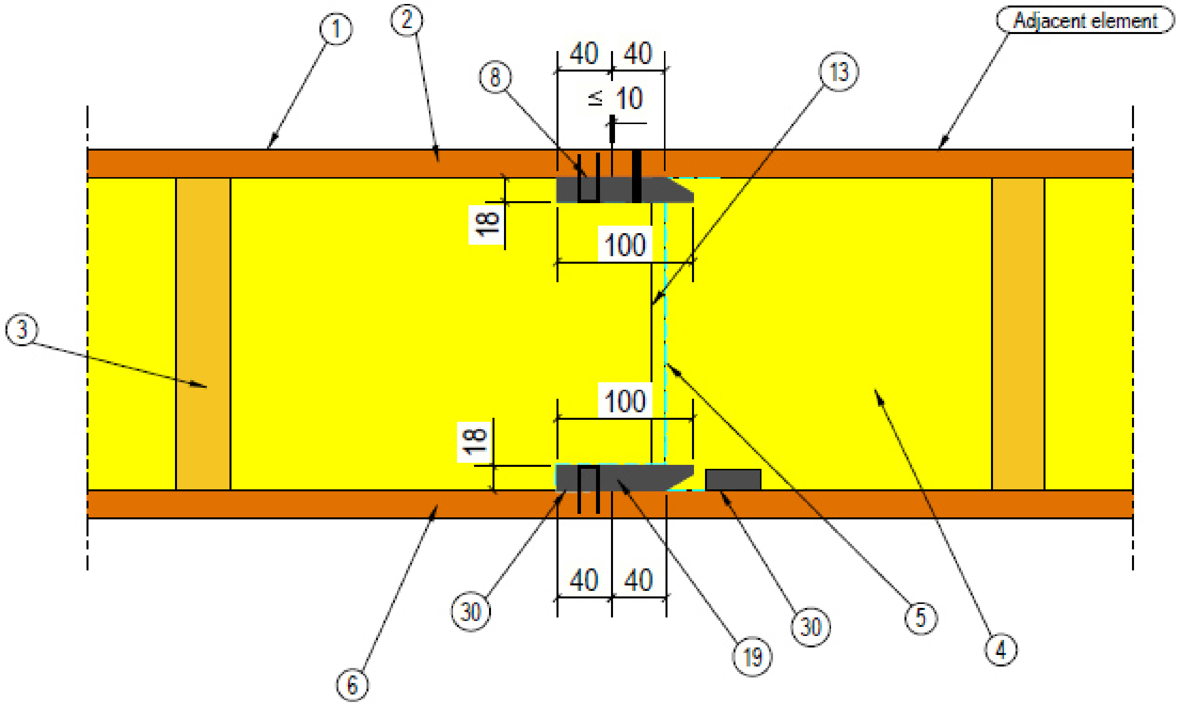
Furthermore, the reference width (depth of the beam) in edgewise bending is 300 while the reference length in tensile parallel to grain is 3000 mm. The effect of member size on edgewise bending and tensile strength values shall be taken into account. This is made by the factors k_h and k_l given in Eurocode 5 for which the *s*-values are given in Table 1-2. This also applies for the effective width of the tension flange.

The modification factors k_{mod} and k_{def} for LVL, as defined in Eurocode 5, shall be used in the design of Lett-Tak wood (LTW) roof elements. Partial safety factor γ_m is defined in National annex of 1995-1-1:2004. γ_m for LVL shall be used for the composite cross section of the elements.

Since the dimensions of Lett-Tak wood (LTW) roof elements remain quite stable during temperature changes, it is not usually necessary to consider any effects of temperature variations on the structural design.

4. Typical connections between Lett-Tak wood (LTW) roof elements

Lett-Tak wood (LTW) roof elements normally connected to each other with mechanical fasteners, see Figure 1-3. Lett-Tak wood (LTW) roof elements shall be designed in such a way that width and thickness changes due to moisture content variation do not cause harmful stresses in the structures. Special attention shall be paid to the design of joints.



(1) Asphalt underlayment or PVC membrane

(2) Kerto LVL Q-panel top

(3) Kerto LVL S-beam

(4) Insulation

(5) Vapor barrier with double sided tape one the side

(6) Kerto LVL Q-panel bottom

(8) Beveled plywood strap joint width 100 mm, thickness 18 mm, stampled and glued to top plate. Adjacent element connected to beveled plywood with screw type CE marked according to EN 14592. Minimum size of screws Ø = 4,0 mm, L = 40 mm with maximum spacing c/c 150 mm. Maximum spacing between elements ≤ 10 mm

(13) Pinched joint due to extra 30-40mm width insulation

(19) Joint between element seald with beveled plywood. Stampled and glued to bottom plate. Width 100 mm, thickness 18 mm.

(30) Vapor barrier jammed bettween plywood and bottom panel to secure airtightmess

Figure1-3: Principal drawing of joints between Lett-Tak wood (LTW) roof elements.

ANNEX 2 (INFORMATIVE)
RESISTANCE TO FIRE OF LETT-TAK WOOD (LTW) ROOF ELEMENTS

Structure of Lett-Tak wood (LTW) roof element is a closed box element presented in Annex 1, Figure 1-1, type 2. The roof construction made of Lett-Tak wood (LTW) roof elements with a continuous bottom slab may have resistance to fire class REI 15, REI 30, REI 60 or REI 90, if the thickness of the bottom slab is at least 19mm, 22 mm, 37 mm or 61 mm, respectively.

In fire resistance class REI 30, the bottom slab may alternatively be comprised of at least 19 mm thick Kerto LVL Q-panel and one or more layers of gypsum plasterboard of type A or type F or combinations of them according to the Table 2-2. In fire class REI 60 or REI 90, the bottom slab may alternatively be comprised of at least 25 mm thick Kerto LVL Q-panel and one or two layers of gypsum plasterboard of type A or type F or a combination of them. The thickness of board type A[3] is at least 13 mm and weight 8.2 kg/m^2 and of type F at least 15 mm and weight 12.5 kg/m^2. Gypsum plasterboards type A and F are defined in product standard EN 520.

Further provisions for the classification above:

The thickness of the ribs shall be at least 39 mm and the spacing of the ribs shall not exceed 1250 mm. The cavities may contain insulation or not. The height of the ribs shall not exceed 350 mm added by the height of the insulation layer when the whole bottom slab is charring during the required fire resistance time. When the fire does not proceed into the cavity of the insulated closed box element, or the closed box element is uninsulated, the height of the ribs is not restricted. The elements shall be glued with polyurethane glue Purbond HB 110 or other glue with corresponding strength properties at elevated temperatures.

To have an effect on resistance to fire, insulation in the cavities shall be rock wool installed tightly against the ribs and the thickness of it shall be at least 100 mm and the density of it at least 27 kg/m^3. If the thickness exceeds 100 mm, rock wool shall be fixed in the ribs so that it remains at place during the fire or if rock wool is not fixed it has to be supported with the bottom slab during the whole fire resistance time.

If the spacing of the ribs exceeds 600 mm, the start of charring of the ribs shall be at least the required fire resistance time R.

Insulation in the cavities may also be glass wool or insulation of class B – F according to EN13501-1. If the insulation is glass wool, then fire design may be performed as fire design of a box element without insulation. If the insulation is of class B – F, then residual thickness of the bottom slab should be at least 10 mm at the time of required fire resistance time R. The values of Table 2-3 may be used to calculate loadbearing capacity and deflection of the Lett-Tak wood (LTW) roof element construction with insulation materials specified above. See Table 2-1 for the minimum thicknesses of bottom slab Kerto-Q panel for fire resistance time t = 15 – 90 min with different types of cavity insulations.

[3] Nominal board thickness of type A is 13 mm which corresponds real thickness of 12,5 mm.

Table 2-1. Minimum thicknesses of bottom slab Kerto-Q panel for fire resistance time t = 15 – 90 min with different types of cavity insulations when there is no additional gypsum plasterboard protection.

Required fire resistance time *t*	Minimum thickness of Kerto-Q bottom panel	
	Rock wool or glass wool cavity insulation	EN13501-1 class B - F cavity insulation
15 min	19 mm	19 mm
30 min	22 mm	31 mm
60 min	37 mm	49 mm
90 min	61 mm	72 mm

Gypsum plasterboards, if any, shall be fixed to the bottom slab of the element at least with 32 mm long gypsum plasterboard screws for one layer and 52 mm long screws for two layers. Maximum spacing of the screws is c/c 200 mm at the edge and end of the board and 300 x 400 mm^2 squares at the centre of the board. In case of two layers of gypsum plasterboards, the joints of the boards shall be staggered.

The elements shall be fixed together by joint type presented in Figure 1-3 of Annex 1. The elements shall be fixed together with EN 14592 screws, Ø = min 4,0 mm, l = 40 mm, c/c max. 150 mm from the top slab, the penetration length of the screw tip is at least the spline thickness.

Lett-Tak wood (LTW) roof elements are supported so that whole bottom slab rests on the underlay.

Loadbearing capacity (for class R) and deflection of the Lett-Tak wood (LTW) roof element construction in case of fire may be calculated according to EN 1995-1-2:2004/AC Annex C (insulation in the cavity) or D (no insulation in the cavity) taking into account the charring rates, factors and notes given in Tables 2-2 and 2-3. Notional charring rate β_n or β_{n3} of the ribs and top slab shall be determined according to expressions in Tables 2-2 and 2-3 when required fire resistance time $t \geq t_f$ where t_f is failure time of cladding.

Table 2-2. Factors and expressions used in fire design according to EN 1995-1-2:2004/AC Annex C for roofs with rock wool insulation in the cavities.

Lett-Tak wood (LTW) roof element with continuous bottom slab with rock wool insulation in the cavities

Bottom slab	Kerto LVL Q-panel	Kerto LVL Q-panel and gypsum plasterboard type A	Kerto LVL Q-panel and gypsum plasterboard type F	Kerto LVL Q-panel and gypsum plasterboards type 2 x A	Kerto LVL Q-panel and gypsum plasterboards type A + F	Kerto LVL Q-panel and gypsum plasterboards type 2 x F
Charring rate of the bottom slab β_0	β_0 = 0.75 mm/min	-	-	-	-	-
Start of charring t_{ch} of the bottom edge of the ribs and failure time of cladding t_f	$t_{ch} = t_f = h_p/\beta_0 - 4$	$t_{ch} = t_f$ = 50 min when h_{f2} = 25 mm[2)]	$t_{ch} = t_f$ = 60 min when h_{f2} = 25 mm[3)]	$t_{ch} = t_f$ = 60 min when h_{f2} = 25 mm[3)]	$t_{ch} = t_f$ = 70 min when h_{f2} = 25 mm[4)]	$t_{ch} = t_f$ = 75 min when h_{f2} = 25 mm[5)]
Notional charring rate β_n of the bottom edge of the ribs	$\beta_n = k_s\, k_3\, k_n\, \beta_0$ k_s = [1)] k_3 = 3.5 k_n = 1.5 β_0 = 0.65 mm/min	$\beta_n = k_s\, k_3\, k_n\, \beta_0$ k_s = [1)] k_3 = 3.5 k_n = 1.5 β_0 = 0.65 mm/min	$\beta_n = k_s\, k_3\, k_n\, \beta_0$ k_s = [1)] k_3 = 3.5 k_n = 1.5 β_0 = 0.65 mm/min	$\beta_n = k_s\, k_3\, k_n\, \beta_0$ k_s = [1)] k_3 = 3.5 k_n = 1.5 β_0 = 0.65 mm/min	$\beta_n = k_s\, k_3\, k_n\, \beta_0$ k_s = [1)] k_3 = 3.5 k_n = 1.5 β_0 = 0.65 mm/min	$\beta_n = k_s\, k_3\, k_n\, \beta_0$ k_s = [1)] k_3 = 3.5 k_n = 1.5 β_0 = 0.65 mm/min
Start of charring of the vertical edges of the ribs $t_{ch,vertical}$ and the top slab $t_{ch,top}$	$t_{ch,vertical} = t_{ch,top} = t_{ch}$ + 10 min	$t_{ch,vertical} = t_{ch,top} = t_{ch}$ + 10 min	$t_{ch,vertical} = t_{ch,top} = t_{ch}$ + 10 min	$t_{ch,vertical} = t_{ch,top} = t_{ch}$ + 10 min	$t_{ch,vertical} = t_{ch,top} = t_{ch}$ + 10 min	$t_{ch,vertical} = t_{ch,top} = t_{ch}$ + 10 min
Notional charring rate β_n of the vertical edges of the ribs and the top slab	$\beta_n = k_s\, k_3\, k_n\, \beta_0$ k_s = [1)] k_3 = 3.5 k_n = 1.0 β_0 = 0.65 mm/min	$\beta_n = k_s\, k_3\, k_n\, \beta_0$ k_s = [1)] k_3 = 3.5 k_n = 1.0 β_0 = 0.65 mm/min	$\beta_n = k_s\, k_3\, k_n\, \beta_0$ k_s = [1)] k_3 = 3.5 k_n = 1.0 β_0 = 0.65 mm/min	$\beta_n = k_s\, k_3\, k_n\, \beta_0$ k_s = [1)] k_3 = 3.5 k_n = 1.0 β_0 = 0.65 mm/min	$\beta_n = k_s\, k_3\, k_n\, \beta_0$ k_s = [1)] k_3 = 3.5 k_n = 1.0 β_0 = 0.65 mm/min	$\beta_n = k_s\, k_3\, k_n\, \beta_0$ k_s = [1)] k_3 = 3.5 k_n = 1.0 β_0 = 0.65 mm/min
Design of the residual cross section as a composite structure after charring of the bottom slab	always	always	always	always	always	always

[1)] according to EN 1995-1-2:2004 Table C1 for the bottom and vertical edges of the ribs and k_s = 1.0 for the bottom slab
[2)] if $h_{f2} \neq$ 25 mm $t_{ch} = 50 + (h_{f2} - 25)/0.65$ [min] when charring rate of the bottom slab β_0 = 0.65 mm/min
[3)] if $h_{f2} \neq$ 25 mm $t_{ch} = 60 + (h_{f2} - 25)/0.65$ [min] when charring rate of the bottom slab β_0 = 0.65 mm/min
[4)] if $h_{f2} \neq$ 25 mm $t_{ch} = 70 + (h_{f2} - 25)/0.65$ [min] when charring rate of the bottom slab β_0 = 0.65 mm/min
[5)] if $h_{f2} \neq$ 25 mm $t_{ch} = 75 + (h_{f2} - 25)/0.65$ [min] when charring rate of the bottom slab β_0 = 0.65 mm/min

Required thickness of the bottom slab h_{f2} may be calculated as follows:

$h_{f2} \geq (t_{req} - t_{ch,25})*0.65 + 25 + h_{B-F}$ [mm]

where

t_{req} is the required fire resistance time [min]
$t_{ch,25}$ is the time of start of charring for the ribs when 25 mm thick board as the bottom flange (according to Table 1) [min]
h_{B-F} is required residual thickness of the bottom slab [mm]

The nominal board thickness of type A is at least 13 mm which corresponds real thickness of 12,5 mm and the nominal board thickness of type F is at least 15mm.

Table 2-3. Factors and expressions used in fire design according to EN 1995-1-2:2004/AC Annex D for roofs without rock wool insulation in the cavities (empty cavities or other insulation than rock wool).

Lett-Tak wood (LTW) roof element with continuous bottom slab without rock wool insulation in the cavities

Bottom slab	Kerto LVL Q-panel	Kerto LVL Q-panel and gypsum plasterboard type A	Kerto LVL Q-panel and gypsum plasterboard type F	Kerto LVL Q-panel and gypsum plasterboards type 2 x A	Kerto LVL Q-panel and gypsum plasterboards type A + F	Kerto LVL Q-panel and gypsum plasterboards type 2 x F
Charring rate of the bottom slab β_0	β_0 = 0.65 mm/min	-	-	-	-	-
Start of charring t_{ch} of the bottom edge of the ribs and failure time of cladding t_f	$t_{ch} = t_f = h_p/\beta_0$-4	$t_{ch} = t_f$ = 50 min when h_{f2} = 25 mm[1)]	$t_{ch} = t_f$ = 60 min when h_{f2} = 25 mm[2)]	$t_{ch} = t_f$ = 60 min when h_{f2} = 25 mm[2)]	$t_{ch} = t_f$ = 70 min when h_{f2} = 25 mm[3)]	$t_{ch} = t_f$ = 75 min when h_{f2} = 25 mm[4)]
Notional charring rate β_{n3} of the bottom edge of the ribs	$\beta_{n3} = k_3\,\beta_n$ k_3 = 2.0 βn = 0.7 mm/min	$\beta_{n3} = k_3\,\beta_n$ k_3 = 2.0 βn = 0.7 mm/min	$\beta_{n3} = k_3\,\beta_n$ k_3 = 2.0 βn = 0.7 mm/min	$\beta_{n3} = k_3\,\beta_n$ k_3 = 2.0 βn = 0.7 mm/min	$\beta_{n3} = k_3\,\beta_n$ k_3 = 2.0 βn = 0.7 mm/min	$\beta_{n3} = k_3\,\beta_n$ k_3 = 2.0 βn = 0.7 mm/min
Start of charring of the vertical edges of the ribs $t_{ch,vertical}$ and the top slab $t_{ch,top}$	$t_{ch,vertical} = t_{ch,top} = t_{ch}$	$t_{ch,vertical} = t_{ch,top} = t_{ch}$	$t_{ch,vertical} = t_{ch,top} = t_{ch}$	$t_{ch,vertical} = t_{ch,top} = t_{ch}$	$t_{ch,vertical} = t_{ch,top} = t_{ch}$	$t_{ch,vertical} = t_{ch,top} = t_{ch}$
Notional charring rate β_{n3} of the vertical edges of the ribs and the top slab	$\beta_{n3} = k_3\,\beta_n$ k_3 = 2.0 βn = 0.7 mm/min	$\beta_{n3} = k_3\,\beta_n$ k_3 = 2.0 βn = 0.7 mm/min	$\beta_{n3} = k_3\,\beta_n$ k_3 = 2.0 βn = 0.7 mm/min	$\beta_{n3} = k_3\,\beta_n$ k_3 = 2.0 βn = 0.7 mm/min	$\beta_{n3} = k_3\,\beta_n$ k_3 = 2.0 βn = 0.7 mm/min	$\beta_{n3} = k_3\,\beta_n$ k_3 = 2.0 βn = 0.7 mm/min
Design of the residual cross section as a composite structure after charring of the bottom slab	if shear stress between the rib and the bottom slab ≤ 1.5 N/mm^2	if shear stress between the rib and the bottom slab ≤ 1.5 N/mm^2	if shear stress between the rib and the bottom slab ≤ 1.5 N/mm^2	if shear stress between the rib and the bottom slab ≤ 1.5 N/mm^2	if shear stress between the rib and the bottom slab ≤ 1.5 N/mm^2	if shear stress between the rib and the bottom slab ≤ 1.5 N/mm^2

[1)] if h_{f2} ≠ 25 mm t_{ch} = 50 + (h_{f2} - 25)/0.65 [min] when charring rate of the bottom slab β_0 = 0.65 mm/min

[2)] if h_{f2} ≠ 25 mm t_{ch} = 60 + (h_{f2} - 25)/0.65 [min] when charring rate of the bottom slab β_0 = 0.65 mm/min

[3)] if h_{f2} ≠ 25 mm t_{ch} = 70 + (h_{f2} - 25)/0.65 [min] when charring rate of the bottom slab β_0 = 0.65 mm/min

[4)] if h_{f2} ≠ 25 mm t_{ch} = 75 + (h_{f2} - 25)/0.65 [min] when charring rate of the bottom slab β_0 = 0.65 mm/min

Required thickness of the bottom slab h_{f2} may be calculated as follows:

$h_{f2} \geq (t_{req} - t_{ch,25})*0.65 + 25 + h_{B\text{-}F}$ [mm]

where

t_{req} is the required fire resistance time [min]

$t_{ch,25}$ is the time of start of charring for the ribs when 25 mm thick board as the bottom flange (according to Table 1) [min]

$h_{B\text{-}F}$ is required residual thickness of the bottom slab [mm]

The nominal board thickness of type A is at least 13 mm which corresponds real thickness of 12,5 mm and the nominal board thickness of type F is at least 15mm.

Modification factor $k_{mod,fm,fi}$ values for bending and axial strength of LVL are given in Table 2-4 *(exposed side in tension)* and Table 2-5 (*exposed side in compression)* when the structure includes insulation in the cavities. $k_{mod,fm,fi}$ value is 1.0 when the structure does not include insulation in the cavities.

In d_{char} / h for the modification factor $k_{mod,fm,fi}$, the depth h is the total depth of the element as the sum of the thicknesses of the bottom and top slab and the height of the rib. Charring depth d_{char} is charring depth of the bottom slab and the bottom edge of the rib added together. Height in case of fire h_{fi} may be used in calculation of the factor k_h (given in EN 1995-1-1 equation (3.3)) for characteristic value for bending strength $f_{m,k}$.

Table 2-4. Modification factor $k_{mod,fm,fi}$ for bending and axial strength of LVL with exposed side in tension when the floor or roof construction includes insulation. Interpolation can be used for the intermediate values.

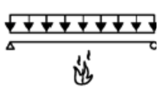
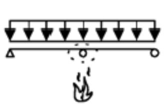
	$k_{mod,fm,fi}$, when d_{char} / h							
	h [mm]	**0**	**0,1**	**0,2**	**0,3**	**0,4**	**0,5**	**0,9**
 Bending strength with exposed side in tension	**95**	0.6	0.55	0.51	0.46	0.42	0.37	0.19
	145	0.68	0.63	0.58	0.53	0.48	0.43	0.24
	195	0.73	0.68	0.63	0.58	0.53	0.48	0.27
	220	0.76	0.71	0.66	0.61	0.56	0.51	0.3
	300	0.84	0.79	0.74	0.69	0.64	0.59	0.38
	400	0.94	0.89	0.84	0.79	0.74	0.69	0.48
	500	1	0.95	0.9	0.85	0.8	0.75	0.54
	600	1.00	1.00	0.96	0.91	0.86	0.81	0.60
	1200	1.00	1.00	1.00				

Table 2-5. Modification factor $k_{mod,fm,fi}$ for bending and axial strength of LVL with exposed side in compression when the floor or roof construction includes insulation. Interpolation can be used for the intermediate values.

	$k_{mod,fm,fi}$, when d_{char} / h							
	h [mm]	**0**	**0,1**	**0,2**	**0,3**	**0,4**	**0,5**	**0,9**
 Bending strength with exposed side in compression	**95**	0.46	0.42	0.39	0.35	0.31	0.28	0.13
	145	0.55	0.51	0.47	0.43	0.39	0.35	0.19
	195	0.65	0.60	0.55	0.51	0.46	0.41	0.22
	220	0.67	0.62	0.58	0.53	0.48	0.44	0.25
	300	0.73	0.68	0.64	0.59	0.55	0.50	0.32
	400	0.81	0.76	0.72	0.67	0.63	0.58	0.40
	500	0.89	0.84	0.80	0.75	0.71	0.66	0.48
	600	0.97	0.92	0.88	0.83	0.79	0.74	0.56
	1200	1.00	1.00	1.00				

Alternatively modification factor $k_{mod,fm,fi}$ for bending and axial strength of LVL until element height of 500 mm may be calculated as

$$k_{mod,fm,fi} = a_0 - a_1(d_{char,n}/h)$$

where

a_0 and a_1 are values given in Table 2-6.

When element height > 500 mm the modification factor $k_{mod,fm,fi}$ increases with the same slope a_3 as for element height ≤ 500 mm until the modification factor $k_{mod,fm,fi}$ achieves the value of 1. Thus modification factor $k_{mod,fm,fi}$ for bending and axial strength of LVL when element height > 500 mm may be calculated as

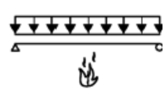
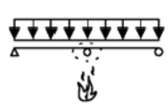
$$k_{mod,fm,fi} = k_{mod,fm,fi,500} + a_3(h\text{-}500)$$

where

$k_{mod,fm,fi,500}$ is modification factor with element height of 500 mm,

a_3 is 0.0006 when exposed side is in tension and 0.0008 when exposed side is in compression.

Table 2-6. Values of a_0 and a_1 for calculation of modification factor $k_{mod,fm,fi}$ when exposed side in tension or exposed side in compression.

<table>
<tr><td rowspan="8">
Bending strength with exposed side in tension</td><td>h [mm]</td><td>a_0</td><td>a_1</td></tr>
<tr><td>95</td><td>0.60</td><td>0.46</td></tr>
<tr><td>145</td><td>0.68</td><td>0.49</td></tr>
<tr><td>195</td><td>0.73</td><td>0.51</td></tr>
<tr><td>220</td><td>0.76</td><td>0.51</td></tr>
<tr><td>300</td><td>0.84</td><td>0.51</td></tr>
<tr><td>400</td><td>0.94</td><td>0.51</td></tr>
<tr><td>500</td><td>1.00</td><td>0.51</td></tr>
<tr><td rowspan="8">
Bending strength with exposed side in compression</td><td>h [mm]</td><td>a_0</td><td>a_1</td></tr>
<tr><td>95</td><td>0.46</td><td>0.37</td></tr>
<tr><td>145</td><td>0.55</td><td>0.40</td></tr>
<tr><td>195</td><td>0.65</td><td>0.48</td></tr>
<tr><td>220</td><td>0.67</td><td>0.47</td></tr>
<tr><td>300</td><td>0.725</td><td>0.45</td></tr>
<tr><td>400</td><td>0.805</td><td>0.45</td></tr>
<tr><td>500</td><td>0.885</td><td>0.45</td></tr>
</table>

If Kerto LVL Q-panel is only partially charred, loadbearing capacity of the element in case of fire may be calculated according to EN 1995-1-2:2004/AC Annex D. Charring rate of the bottom slab β_0 = 0.65 mm/min shall be used together with the values of Table 2-7 for start of charring t_{ch}, failure time of cladding t_f, insulation factor k_2 and post-protection factor k_3 of gypsum plaster boards.

Table 2-7. Factors used in fire design, if Kerto Q-panel at the bottom side is only partially charred.

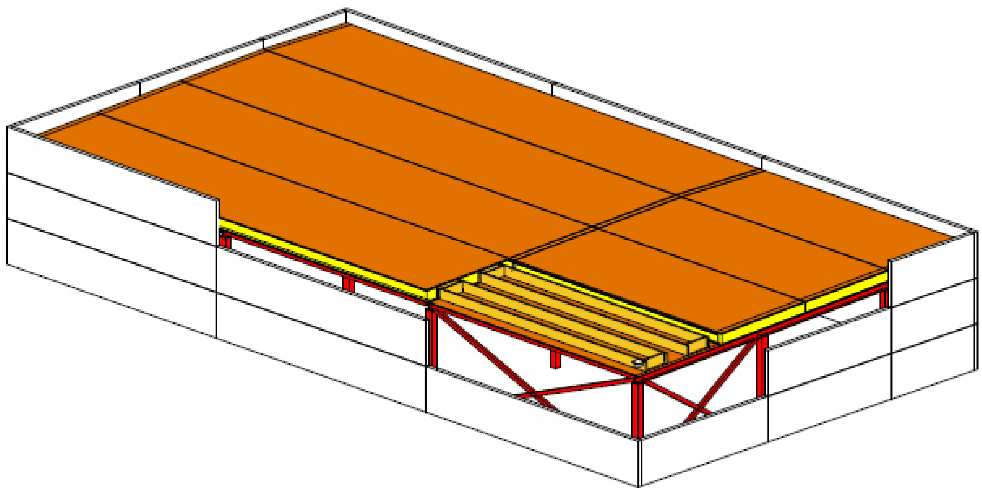
Lett-Tak wood (LTW) roof element covered with gypsum plasterboard at the bottom side					
	type 2 x A	**type A + F**	**type 2 x F**	**type F**	**type A**
Start of charring t_{ch}	30 min	40 min	60 min	20 min	10 min
Failure time of cladding t_f	30 min	45 min	65 min	30 min	10 min
Insulation factor k_2	-	0.85	0.85	0.85	-
Post-protection factor k_3	3	3	3	3	3
The residual cross section is designed as a composite structure after charring of the bottom flange					

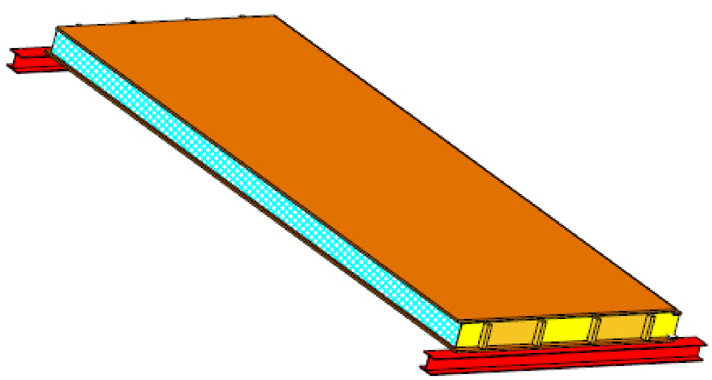
The deflection in the fire situation should not exceed $D = L^2/(2600*d)$ [mm] where L = the span of the element [mm] and $d = h_{f1} + h_w + h_{f2}$ [mm]. Modulus of elasticity at normal temperature may be used when calculating the deflection.

ANNEX 3
CONSTRUCTION DETAILS OF LETT-TAK WOOD (LTW) ROOF ELEMENT (CONFIDENTAL)

Construction details

Lett-Tak Wood (LTW) roof element





Number of detail drawings:

LETT-TAK

+47 33 13 28 00
firmapost@lett-tak.no
www.lett-tak.no

Original date:

Revision date:

Innhold - Content

Drawing nr.	Date	Rev.	Drawing description	Rev. Date
01			Standard roof element	
02			Load bearing cross section	
03			Longitudinal element joint	
04			Ridge longitudinal joint alternativ 1	
05			Ridge longitudinal joint alternativ 2	
06			Elements connected to load bearing beam	
07			Elements connected to load bearing beam by ridge	
08			Elements connected to load bearing beam by valley	
09			Elements connected to end wall rafter	
10			Elements connected to eave strut/purlin altenativ 1	
11			Elements connected to eave strut/purlin altenativ 2	
12			Roof drain cross section	
13			Circular recess cross section	
14			Square recess cross section	
15			Two span continuous element alternativ 1	
16			Two span continuous element alternativ 2	

Rev. description

LETT-TAK

+47 33 13 28 00
firmapost@lett-tak.no
www.lett-tak.no