itecons

Rua Pedro Hispano, s/n
3030-289 Coimbra

Tel: (+351) 239 79 89 49
itecons@itecons.uc.pt
www.itecons.uc.pt

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European Technical Assessment

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General Part

Technical Assessment Body issuing the European Technical Assessment: Itecons - Instituto de Investigação e Desenvolvimento Tecnológico para a Construção, Energia, Ambiente e Sustentabilidade	
Trade name of the construction product	LTS – Laminated Timber System
Product family to which the construction product belongs	Building kits, Units and Prefabricated Elements Product area code: 34
Manufacturer	Rusticasa – Construções, Lda. Zona Industrial de Campos, Polo 1 4920-909 Vila Nova de Cerveira Portugal
Manufacturing plant	Zona Industrial de Campos, Polo 1 4920-909 Vila Nova de Cerveira Portugal
This European Technical Assessment contains	41 pages including 2 Annexes which forms integral part of this ETA
This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of	EAD 340308-00-0203 - *Timber Building Kits*

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Specific parts

1. Technical description of the product

The LTS – Laminated Timber System, hereinafter referred to as LTS, is a predesigned timber building kit prepared in the factory for each individual building, and delivered as a package to be assembled on site. The kit includes the main building parts such as external walls, internal walls, intermediate floor and roof panels. Further components are described in Annex A. The essential construction details, including their joints, are also described in Annex A. The maximum number of storeys of the kit is two (ground floor + 1st floor).

The external walls are load-bearing and are formed by LTS 160 panels, which are 160 mm thick and can be either straight (LTS 160 R) or rounded (LTS 160 B), or LTS 180 panels, which are 180 mm thick. The maximum dimensions of these panels are 10.0 x 3.0 m^2. The composition of the wall panels is as follows:

- LTS 160 R and LTS 160B – laminated logs essentially composed of 4 glued wooden lamellae made of resinous wood, arranged vertically. Between each log, a strip of linen insulation is inserted;
- LTS 180 – laminated logs essentially composed of 3 to 5 lamellas made of resinous wood, arranged vertically. Between each log, two expansive bands are inserted.

The mechanical resistance of the wood that comprises the logs is C14 or higher according to EN 14081-1. In the case of logs made of *Cryptomeria japonica*, the mechanical resistance is classified as CYS II according to NP 4544. In both systems, the logs are milled longitudinally with a male-female type profile to interlock with each other.

To build up the panels, the logs are mechanically fixed 1 meter apart using fasteners with an 8 mm diameter. The panels are reinforced with studs at the edges made of *Pinus radiata* or *Pinus sylvestris* or LVL, which enable longitudinal and corner connections between panels. The panels finish is in varnish at the inner side and in stain at the outer side.

The internal walls are constructed using logs that are 80 mm thick (comprising 2 glued lamellae). The maximum dimensions of these panels are 10.0 x 3.0 m^2. Between each log, an expansion strip is inserted. Similar to the exterior wall panels, these panels are also reinforced with studs at the edges. The panels are finished with varnish on both sides.

The roof is composed of glued laminated beams, which are placed directly on the wall panels, and prefabricated panels with a maximum dimension of 10.0 x 2.5 m^2. These panels may be panels named NATURLAM R230 ISOL 160 or roof panels composed of linear wooden structural elements made of *Cryptomeria japonica or Pinus radiata or Pinus Sylvestris or Picea abies*. The insulation, which is 160 mm thick in the case of NATURLAM R230 ISOL 160, or varies between 150 to 200 mm in the case of the roof panels composed of linear wooden structural elements, may consist of wood fiber (WF), mineral wool (MW), or cork insulation (ICB). On the inner side, a vapor barrier is inserted, and the panels are finished with a 20 mm thick wooden layer or with gypsum boards. This wooden layer is fastened to a subframe of wooden slats with a thickness of 32 mm. The panels outside may be composed of moisture-resistant chipboard or OSB board with a thickness of 18 mm for flat roofs or 12 mm for pitched roofs, coated with a sub-tile waterproof membrane. Over this membrane, battens with a section of 45 x 45 mm^2 are screwed into alignment with the structural battens of the panel, thus creating a ventilated air gap. The edges are constructed using 150 to 200 x 25 mm^2 pieces of wood. Panel joints are covered with an appropriate adhesive tape. A ventilation grille, embedded in the lower end of each panel, spans the entire perimeter of the roof.

For flat roofs, the panel receives on its upper face a substructure with ramped battens to create a 3% slope for proper drainage of rainwater. The 18 mm thick bracing panel is nailed onto these ramped battens. The attachment of the ramped battens to the structural battens of the panel is carried out to create a 'single body' ensuring complete diaphragm efficiency with the 18 mm bracing panels.

In buildings with a flat roof, a parapet is constructed along the entire perimeter of the roof, varied based on the presence of projecting eaves or not. As waterproofing element for the flat roof, a waterproofing membrane is installed. A layer of expanded clay may provide additional protection against UV radiation. In order to prevent condensation in the inner face of the bracing element, ventilation system is applied.

The roof panels conclude their production in the factory with the application of varnish and stain finishes, according to the location of the elements on-site.

When the building has a 1st floor, the slab between floors is formed by CRIPTOLAM F210 panels (0.5 x 8.0 m^2) built in glued laminated solid wood with 210 mm of thickness, assembled side-by-side with nailed joint covers in the upper-face, or, alternatively, the slab between floors is formed by panels (2.5 x 8.0 m^2) composed of linear wooden structural elements made of *Cryptomeria japonica* or *Pinus radiata* or *Pinus sylvestris* or *Picea abies* connected together by a wood-based board (OSB or particleboard 18 mm thickness). Both types of floor panels are covered by mineral wool (45 mm) and wooden floor or multi-layered floor, 15 mm thick, with solid wood on the surface, featuring tongue and groove locking mechanism. The floor panels are directly placed on the walls.

The kit is intended to be assembled on a rigid ground slab, for example a concrete slab that is covered by mineral wool or cork insulation (ICB) and a wooden floor.

The insulation products that may be incorporated in the LTS system, as described, do not contribute to the loadbearing capacity and stability of the works.

Other accessories complete the LTS kit, such as:

- Columns on the exterior building corners. They are screwed to the walls and, beyond an aesthetic function, they support the cantilever beams by anchoring for hold the roof panels who compose the eaves in the gable wall;
- Anchorages to assemble the façade panels and interior wall partitions into the concrete slab;
- External joint-covers;
- Exterior roof claddings;
- Roof eaves wood boards;
- Windows, skylights and doors.

The kit is manufactured in accordance with the provisions of this European Technical Assessment and as laid down in the technical documentation deposited at the Itecons.

2. Specification of the intended use(s) in accordance with the applicable European Assessment Document (hereinafter EAD)

2.1. Intended use

Timber building kit LTS is intended, mainly, to be used as a residential building. It can be produced as ground floor buildings or can have one additional storey. The LTS kit is suitable for various climatic conditions.

The external envelope was evaluated as sufficient watertight under normal climatic conditions.

Concerning the vapour permeability and moisture resistance, the LTS timber building kit is intended to be used for buildings with a humidity flow (diffusion) from inside towards outside. The kit should be assessed in case of application under different climatic conditions.

The use of the kit in areas where termite attack can occur is extremely inadvisable without additional chemical treatment. This kind of treatments are not part of this assessment.

The provisions made in this European Technical Assessment are based on an assumed working life of 50 years, as minimum according to the EAD, for the load-bearing structure and non-accessible components and materials, and 25 years for repairable or replaceable components and materials like claddings, roofing materials, exteriors trims, and integrated components like windows and doors, provided that the conditions lay down for the installation, packaging, transport and storage as well as appropriate use, maintenance and repair are met. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a mean for choosing the right product in relation to the expected economically reasonable working life of the works.

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

The assessment of the LTS according to the Basic Work Requirements (BWR) was carried out in compliance with EAD 340308-00-0203. The characteristics of the components shall correspond to the respective values laid down in the technical documentation of this ETA, checked by Itecons.

3.1. Mechanical resistance and stability (BWR 1)

The components of the kit, which are necessary for the mechanical resistance, stiffness and stability, are listed in Annex A and described regarding to their composition and geometry.

If the kit is intended to be used in areas where seismic actions are predictable, the response of the structure should be studied case-by-case, taking into account national regulations, if needed.

The foundations are not part of the kit. The individual loads and conditions of each kit should be taken in account for the structural design of the foundations or design of constructions that the kit will be fitted on.

3.1.1. Resistance, stability and stiffness of wall, floor and roof structures and their connections against vertical and horizontal loads

Indication of geometrical data of the components and elements and their properties related to mechanical resistance and stability are used as an expression of resistance, stability and stiffness of wall, floor and roof elements against vertical and horizontal loads.

The wall, floor and roof elements, including relevant fasteners for their assembling, are presented in Annex A.

Information given are used case by case calculations according to EN 1990, EN 1991, EN 1995-1-1 and EN 1998-1 taking into consideration respective requirements of the Member States regarding ultimate limit state and serviceability limit state.

Additionally, numerical calculations are presented in Annex B for CRIPTOLAM F210.

3.1.2. Shear resistance in plane direction against horizontal loads

No performance assessed.

3.1.3. Compression resistance – log walls

The compression resistance of the log walls of the LTS system can be determined according to the

procedure presented following.

According to section 2.2.3 of the EAD 340308-00-0203 the compressive resistance $F_{C,k}$ against vertical loads is $F_{W,k} + n * F_{CC,k}$

Where:

- Characteristic compression capacity $F_{W,k}$ of the wall for an eccentric vertical load $F_{W,k} = min(L;4000\ mm) * b_{ef} * 1.0\ N/mm^2$ [kN]*;*
- b_{ef} = ¾ nominal thickness of laminated logs [mm];
- L = length of the wall [mm]*;*
- The characteristic compression capacity $F_{CC,k}$, with each corner type / other bracing elements $F_{CC,k} = 600\ mm * b_{ef} * 1.0\ N/mm^2$ [kN]*;*
- n = number of bracing cross corners.

Given that the LTS system does not include cross corners as bracing elements, it was considered that the studs installed at the edges of the LTS panels do not contribute to the compression resistance, although these elements are essential for the stability of the wall panels. Thus, the term of the formula $n * F_{CC,k}$ shall be 0. Therefore, the compressive resistance of the wall panels of the LTS system is represented by: $F_{C,k} = F_{W,k}$.

The use of the equations is limited to the condition of the height of the wall does not exceed 3 m.

The dowelling system needs to be taken into consideration, including aspects such as wood dowels, steel pipes, threaded bars or screws, sizes, holes, max. spacing, etc. For the LTS system, it shall be considered that the logs are mechanically fixed 1 m apart using fasteners with an 8 mm diameter, in accordance with the manufacturer's instructions.

3.1.4. Settling of construction – log walls

Log house walls are settling in vertical direction after construction due to drying the logs. The amount of the settling is influenced by the way of installation and the final moisture content (MC%) of the structure compared with the moisture content during installation.

The settling of a log house shall be taken into account in the assessment of at least the following detailing:

- Sliding supports on the walls for roof beams;
- Door and window openings;
- The settling must not be prohibited by any construction even if they are not a part of the kit;
- Adjustable screw foot connections for columns, removal of possible adjustments bits, etc. They shall be used as described in the construction manual.

The expected settling of the LTS walls is 15 mm/m (laminated logs) and needs to be taken in account in the kit design.

3.1.5. Corrosion protection of metal fasteners

The corrosion protection of metal fasteners of the LTS kit is presented in Table 1.

Table 1: Corrosion protection of metal fasteners

Corrosion protection of metal fasteners	
Screws and threaded rods	Corrosion protection in service class 1 and 2 acc. ETA 11/0030
Clip connectors	Corrosion protection in service class 1, 2 and 3 acc. ETA 10/0189

3.2. Safety in case of fire (BWR 2)

3.2.1. Reaction to fire

No performance assessed.

3.2.2. Resistance to fire

No performance assessed.

3.2.3. External fire performance of roofs

No performance assessed.

3.3. Hygiene, health and the environment (BWR 3)

3.3.1. Water vapour resistance

The assessment interstitial or internal surface condensation risk shall be based on the assumption that growth of micro-organisms is avoided if humidity in the timber structures inside the external sheeting or breather membrane only exceeds 80% RH for limited periods of time at design climatic conditions.

The risk of condensation can normally be verified on the basis of hygrothermal characteristics of the products used in each component and construction details.

The water vapour resistance of the relevant layers is presented in Annex A based on design values given in EN ISO 10456 or declared in the DoP in accordance with harmonised technical specifications.

3.3.2. Watertightness

3.3.2.1. External envelope

The watertightness of the façade was assessed according to EN 1027. The test specimens were composed by a log straight wall and a log corner wall of LTS 160 B and LTS 180.

The log straight wall specimens consisted of 5 logs and 4 joints (LTS 160 B) and 4 logs and 3 joints (LTS 180). The total dimensions of the test specimens were 1200 mm x 800 mm. The total length of the joints was 4.8 m (LTS 160 B) and 3.6 m (LTS 180).

The log corner wall specimens consisted of 2 straight log walls with a corner connection. The dimensions of the test specimens were 1200 mm x 1000 mm, totalizing 10 logs and 8 joints (LTS 160 B) and 8 logs, 6 joints and 10 logs (LTS 180). The total length of the joints was 8.16 m (LTS 160 B) and 6.12 m (LTS 180).

The results are presented in Table 2.

Table 2: Watertightness class according EN 12208

Type of wall	Test specimen	Watertightness class
LTS 160 B	Log straight wall	Class E750
	Log corner wall	Class 8A
LTS 180	Log straight wall	Class E1350
	Log corner wall	Class 7A

No performance assessed regarding the watertightness of the LTS 160 R panels.

3.3.2.2. Internal surfaces

Internal surfaces in wet areas are not part of the kit.

3.3.3. Durability class/use class

The LTS kit is designed in compliance with durability requirements according to the intended working life of 50 years for the load-bearing structure and non-accessible components and materials, and 25 years for repairable or replaceable components and materials like claddings, roofing materials, exteriors trims, and integrated components like windows and doors provided.

The adequacy of the use classes according to EN 335 for wood and wood-based products used in the kit is presented in the Table 3.

Table 3: Use classes according to EN 335

Type of component	Use classes
External components	2, 3
Internal components	1

The natural durability according EN 350 is presented in Table 4.

Table 4: Natural durability according EN 350

Species	Fungi	Hylotrupes	Anobium	Termites
Cryptomeria Japonica *(Cryptomeria japonica D. Don)*	5	D	n/a	S
Fir *(Abies alba Mill)*	4	S	S	S
Maritime pine *(Pinus pinaster Ait.)*	3-4	D	D	S
Scots pine redwood *(Pinus sylvestris L.)*	3-4	D	D	S
Southern blue gum *(Eucalyptus globulus Labill)*	5	---	n/a	S

The use of the kit in regions where termite attack may occur is impermissible without additional chemical treatment. The chemical treatment shall be done according to local regulations for such use. This European Technical Assessment does not involve methods of chemical treatment of the kit.

Additional measures of the works shall be taken to provide adequate durability if the kit will be used in climate condition with often incidence of driving rain and snow.

The assumed intended working life requires regular maintenance as specified by the manufacturer instructions.

The adequacy of the service classes according to EN 1995-1-1 for the fasteners used in the kit is given in Annex A.

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

No performance assessed.

3.4. Safety and accessibility in use (BWR 4)

3.4.1. Impact resistance

No performance assessed.

3.5. Protection against noise (BWR 5)

The acoustical performance of the components was carried out in accordance with EN ISO 10140-1, EN ISO 10140-2, 3 and EN ISO 10140-4 and EN ISO 717-1 and EN ISO 717-2.

3.5.1. Airborne sound insulation of walls, floors and roof structures

The airborne sound insulation of the LTS 160B wall panel was tested. The test specimen nominal dimensions were 3140 x 3140 mm^2. The perimeter of the test specimen was sealed with mineral wool. The test area had the standardized value of 10 m^2 (3160 x 3160 mm^2).

The CRIPTOLAM F210 were also tested. The test specimen area was 3540 x 3540 mm^2 and the test area had ≈ 10 m^2 (3160 x 3160 mm^2). The perimeter of the test specimens was sealed with mineral wool.

The weighted apparent sound reduction index of the components tested is shown in the Table 5.

Table 5: Weighted apparent sound reduction index

Component	Acoustical performance
LTS 160 R	No performance assessed
LTS 160 B	R_w = 35 dB
LTS 180	No performance assessed
CRIPTOLAM F210 with mineral wool (45mm) and wooden floor	R_w = 53 dB
Floor panels made of linear wooden structural elements	No performance assessed
Roof panels	No performance assessed

3.5.2. Impact sound insulation of floors

The CRIPTOLAM F210 with mineral wool (45 mm) and wooden floor was tested. The specimen tested was the same used in the determination of airborne sound insulation. The result is shown in the Table 6.

Table 6: Impact sound insulation for the CRIPTOLAM F210 panels

Component	Acoustical performance
CRIPTOLAM F210 with mineral wool (45mm) and wooden floor	Weighted apparent sound reduction index $L_{n,w}$ = 59 dB
Floor panels made of linear wooden structural elements	No performance assessed

3.5.3. Sound absorption

No performance assessed.

3.6. Energy economy and heat retention (BWR 6)

3.6.1. Thermal resistance and thermal transmittance

The thermal resistance, R_T, of the components was determined according to EN ISO 6946 and EN ISO 10211. The results are shown in Table 7.

Table 7: Thermal resistance of the components

Component	R_T [m^2K/W]
LTS 160 B	1.93
LTS 160 R	No performance assessed
LTS 180	2.12
NATURLAM R230 ISOL 160	Ascendent flow: $R_{TNATURLAM\ R230\ composed\ by\ OSB\ and\ MW}$ = 4.62 $R_{TNATURLAM\ R230\ composed\ by\ OSB\ and\ WF}$ = 4.41 $R_{TNATURLAM\ R230\ composed\ by\ OSB\ and\ ICB}$ = 4.36 $R_{TNATURLAM\ R230\ composed\ by\ moisture\text{-}resistant\ multifunctional\ construction\ board\ and\ MW}$ = 4.61 $R_{TNATURLAM\ R230\ composed\ by\ moisture\text{-}resistant\ multifunctional\ construction\ board\ and\ WF}$ = 4.40 $R_{TNATURLAM\ R230\ composed\ by\ moisture\text{-}resistant\ multifunctional\ construction\ board\ and\ ICB}$ = 4.35 Descendent flow: $R_{TNATURLAM\ R230\ composed\ by\ OSB\ and\ MW}$ = 4.69 $R_{TNATURLAM\ R230\ composed\ by\ OSB\ and\ WF}$ = 4.58 $R_{TNATURLAM\ R230\ composed\ by\ OSB\ and\ ICB}$ = 4.43 $R_{TNATURLAM\ R230\ composed\ by\ moisture\text{-}resistant\ multifunctional\ construction\ board\ and\ MW}$ = 4.68 $R_{TNATURLAM\ R230\ composed\ by\ moisture\text{-}resistant\ multifunctional\ construction\ board\ and\ WF}$ = 4.47 $R_{TNATURLAM\ R230\ composed\ by\ moisture\text{-}resistant\ multifunctional\ construction\ board\ and\ ICB}$ = 4.42
Roof panels made of linear wooden structural elements	No performance assessed
Roof panels for flat roofs	No performance assessed
CRIPTOLAM F210 covered with mineral wool (45 mm) and wooden floor	Ascendent flow: R_{tot} = 4.15 Descendent flow: R_{tot} = 4.32

3.6.2. Air permeability of log walls

The air permeability of the LTS 160 B and LTS 180 was assessed according to EN 1026. The test specimens were composed by a log straight wall and a log corner wall.

The log straight wall specimens consisted of 5 logs and 4 joints (LTS 160 B) and 4 logs and 3 joints (LTS 180). The total dimensions of the test specimens were 1200 mm x 800 mm. The total length of the joints was 4.8 m (LTS 160 B) and 3.6 m (LTS 180).

The log corner wall specimens consisted of 2 straight log walls with a corner connection. The dimensions of the test specimens were 1200 mm x 1000 mm, totalizing 10 logs and 8 joints (LTS 160 B) and 8 logs and 6 joints (LTS 180). The total length of the joints was 8.16 m (LTS 160 B) and 6.12 m (LTS 180).

The test results are shown in the Table 8.

Table 8: Air permeability test results of the LTS 160 B and LTS 180

Test specimen	Pressure P (Pa)	Airflow / join meter V_L (m^3/h.m) – positive test pressure	Airflow / join meter V_L (m^3/h.m) – negative test pressure	Classification acc. EN 12207
LTS 160 B Log straight wall	50	0.00	0.00	Class 4
	100	0.00	0.00	
	150	0.00	0.00	
	200	0.18	0.00	
	250	0.51	0.021	
	300	0.83	0.13	
	450	1.10	0.34	
	600	1.30	0.99	

Test specimen	Pressure P (Pa)	Airflow / join meter V_L (m^3/h.m) – positive test pressure	Airflow / join meter V_L (m^3/h.m) – negative test pressure	Classification acc. EN 12207
LTS 160 B Log corner wall	50	0.071	0.0051	Class 4
	100	0.65	0.34	
	150	0.88	0.71	
	200	1.10	0.87	
	250	1.20	1.00	
	300	1.40	1.20	
	450	1.70	1.50	
	600	2.10	1.80	
LTS 180 Log straight wall	50	0.00	0.00	Class 4
	100	0.00	0.00	
	150	0.45	0.26	
	200	1.10	0.79	
	250	1.50	1.30	
	300	1.50	1.30	
	450	1.80	1.60	
	600	2.00	1.80	
LTS 180 Log corner wall	50	0.00	0.00	Class 4
	100	0.13	0.063	
	150	0.39	0.25	
	200	0.72	0.46	
	250	0.88	0.77	
	300	0.96	0.90	
	450	1.20	1.20	
	600	1.40	1.30	

No performance assessed regarding the air permeability of the LTS 160 R panels.

3.6.3. Thermal inertia

Specific heat capacities and material densities are listed in Annex A. These values were obtained from EN ISO 10456:2007 and declarations of performance of the kit components.

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

According to the Decision 1999/455/EU of European Commission the system of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) applicable is 1.

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

The ETA is issued on the basis of agreed data/information, deposited at Itecons, which identifies the product that has been assessed and judged. It is the manufacturer's responsibility to make sure that all those who use the kit are appropriately informed of specific conditions laid down in this ETA.

Changes to the kit or the components or their production process should be notified to the Itecons before the changes are introduced. Itecons will decide whether or not such changes affect the ETA and if so whether further assessment or alterations to the ETA shall be necessary.

Issued in Coimbra on 24.05.2024

By

Technical Assessment Unit of

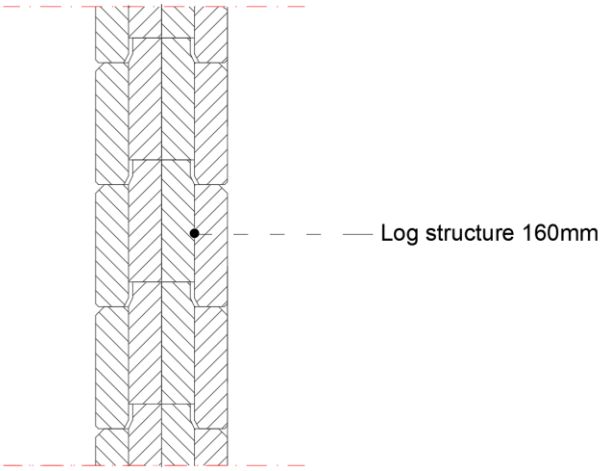
Itecons – Instituto de Investigação e Desenvolvimento Tecnológico para a Construção, Energia, Ambiente e Sustentabilidade

(*Technical Assessment Unit Coordinator*) (Administration)

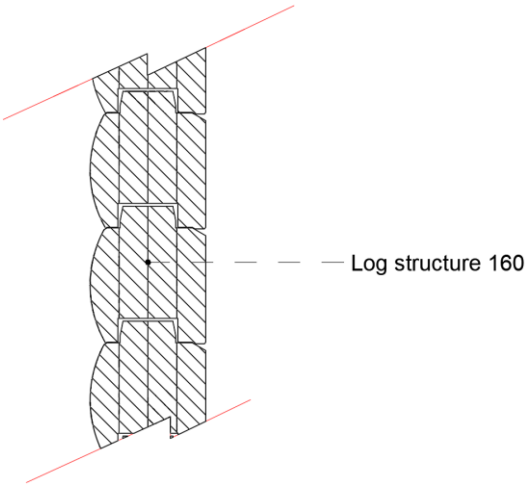
ANNEX A – Index of building elements

The list of relevant drawings of the kit build-up and construction details
External walls
1. LTS 160 R and LTS 160 B
2. LTS 180 (3 and 5vertical layers)
Internal Walls
3. LTS 80
Roof
4. Roof panel (slopped roof) – longitudinal cross section
5. Roof panel (flat roof) – longitudinal cross section
Floor
6. CRIPTOLAM F210
7. Floor longitudinal cross section
Connection between kit elements
8. LTS – ground floor
9. LTS – intermediate floor
10. LTS – roof panels
11. LTS – window (vertical cross section)
12. LTS – window (horizontal cross section)
13. Integration of the PMR sill
14. Projected corner connection detail – projected trim
15. Projected corner connection detail – pillar
16. Recessed corner connection detail – projected trim
17. Recessed corner connection detail – pillar
18. Recessed corner connection detail – trim
19. Recessed corner connection detail – trim + internal wall
20. Projected corner connection detail – pillar
21. Exterior wall panel/Exterior wall panel connection detail – pillar
22. Exterior wall panel/Exterior wall panel connection detail – trim
23. Interior wall panel/External wall panel connection detail – pillar
24. Interior wall panel/Exterior wall panel connection detail – trim
25. Interior wall panel/Exterior wall panel connection detail
26. Detail of the starting point of the 1st panel on-site
27. Projected corner connection detail – false exterior intersection

1 – LTS 160 R and LTS 160 B

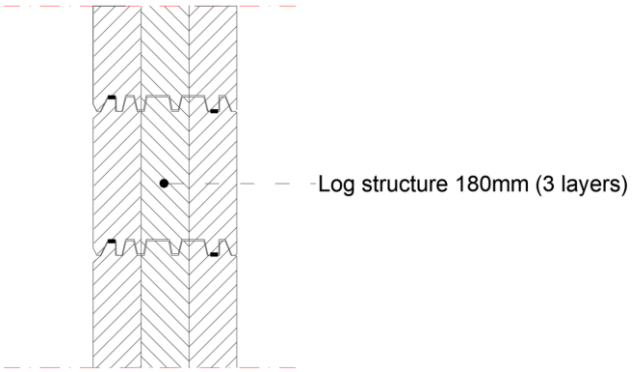


a) LTS 160 R

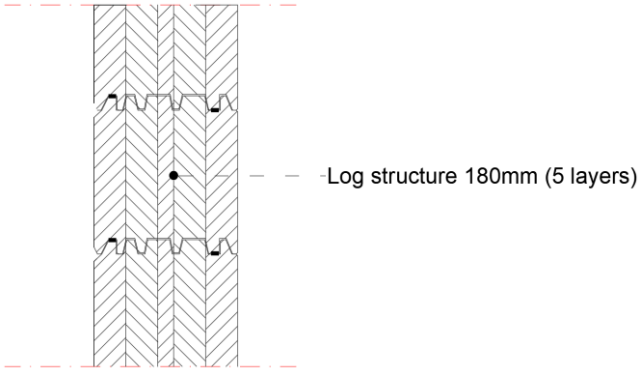


b) LTS 180 B

2 – LTS 180 (3 and 5 vertical layers)

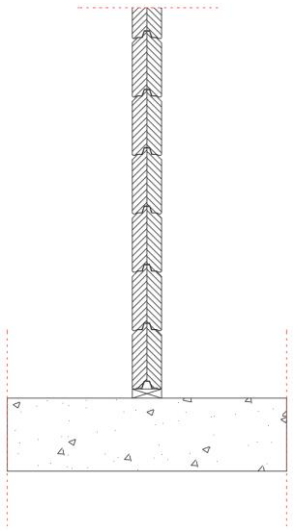


a) LTS 180 (3 vertical layers)

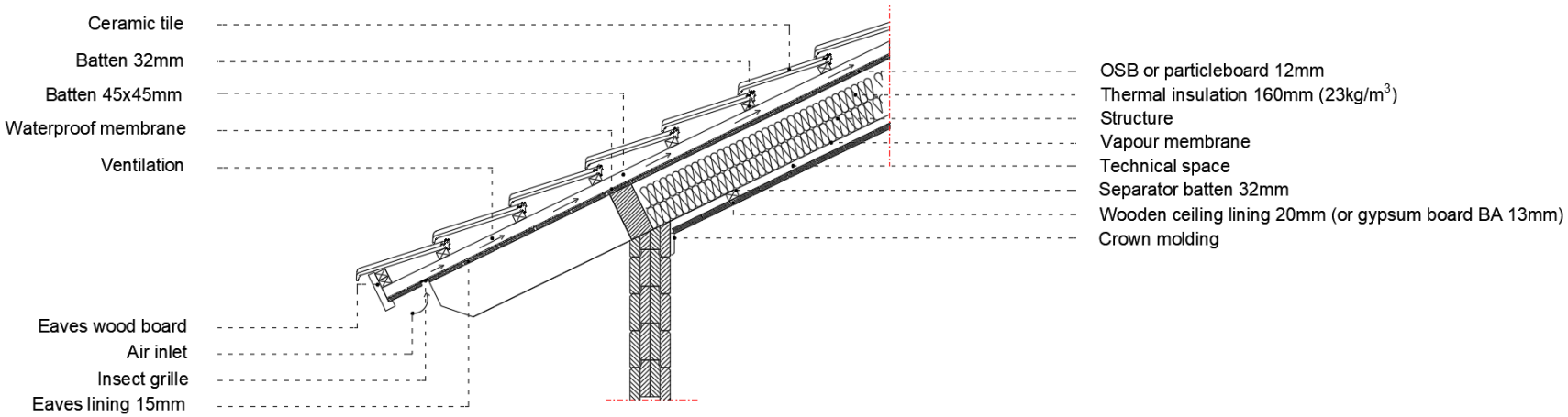


b) LTS 180 (5 vertical layers)

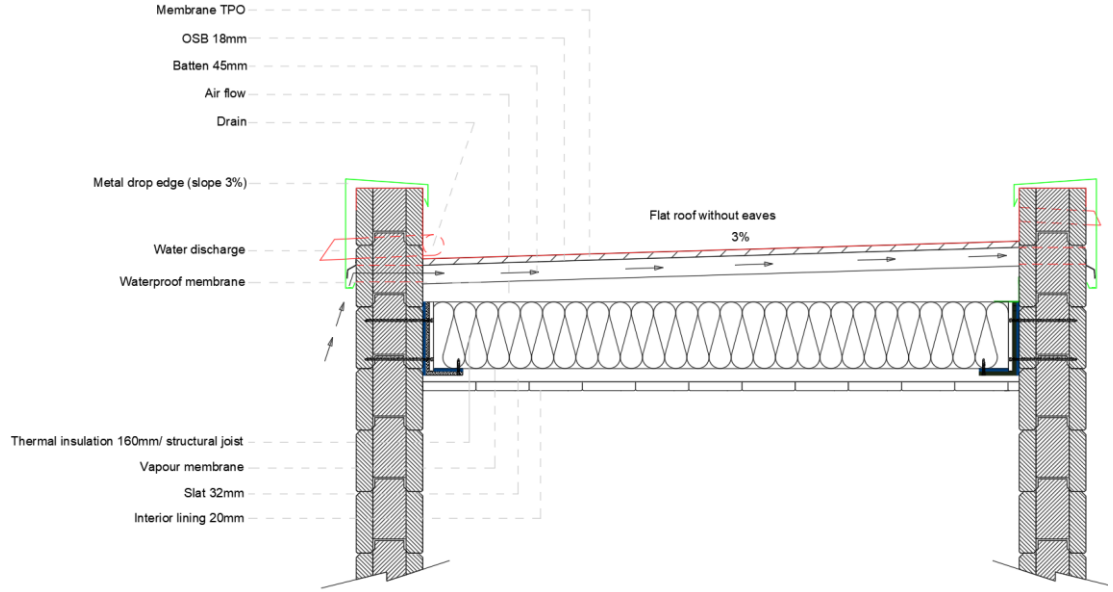
3 – LTS 80 (used in all systems)



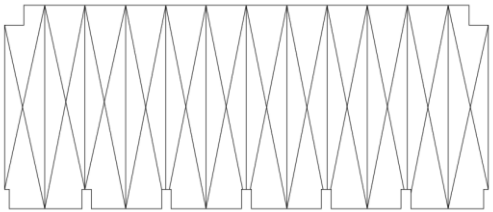
4 – Roof panel (slopped roof) – longitudinal cross section



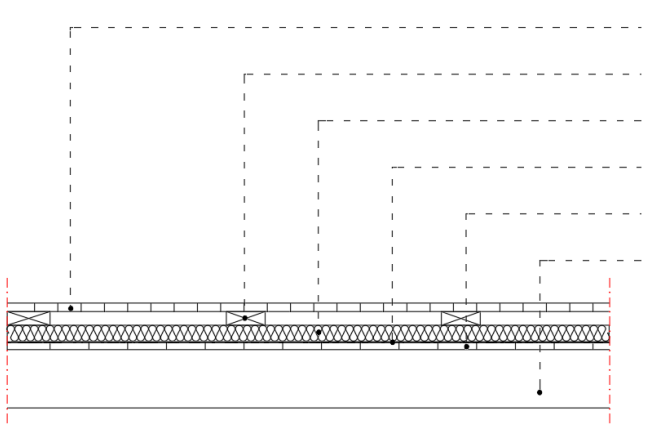
5 – Roof panel (flat roof) – longitudinal cross section



6 – CRITPOLAM F210



7 – Floor longitudinal cross section (with coating layers)



Wooden floor 20mm or Multi-layered wooden floor 15 mm

Wooden slat 35x100 mm (cc 0.33 m)

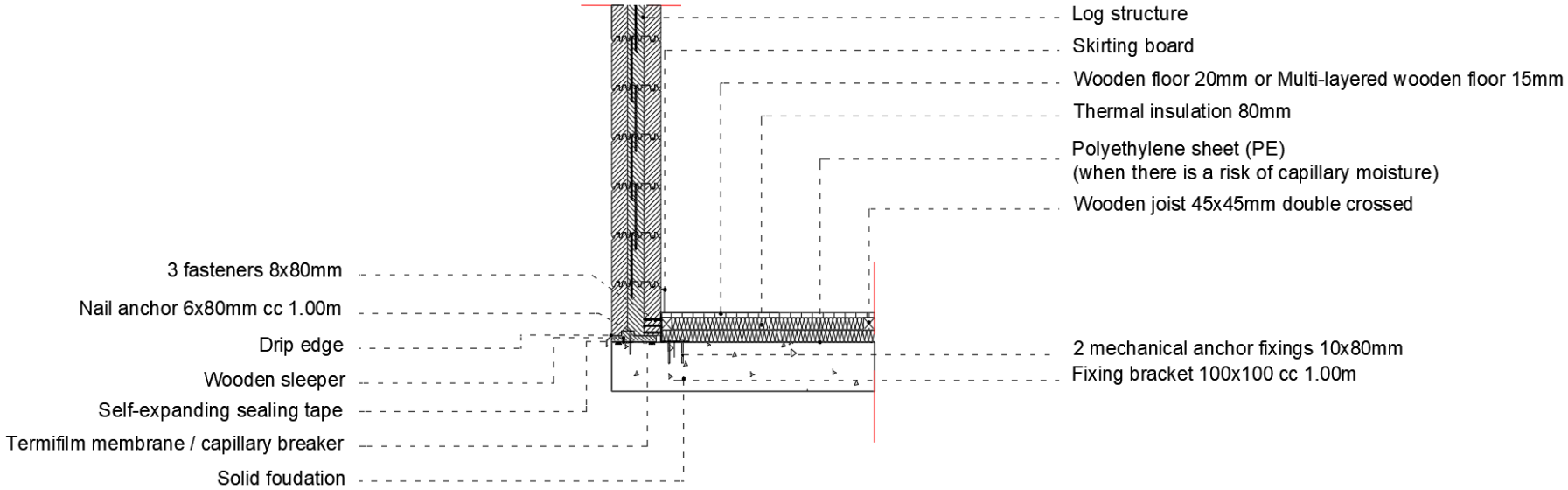
Acoustic insulation 45mm

Polyethilene sheet (PE)

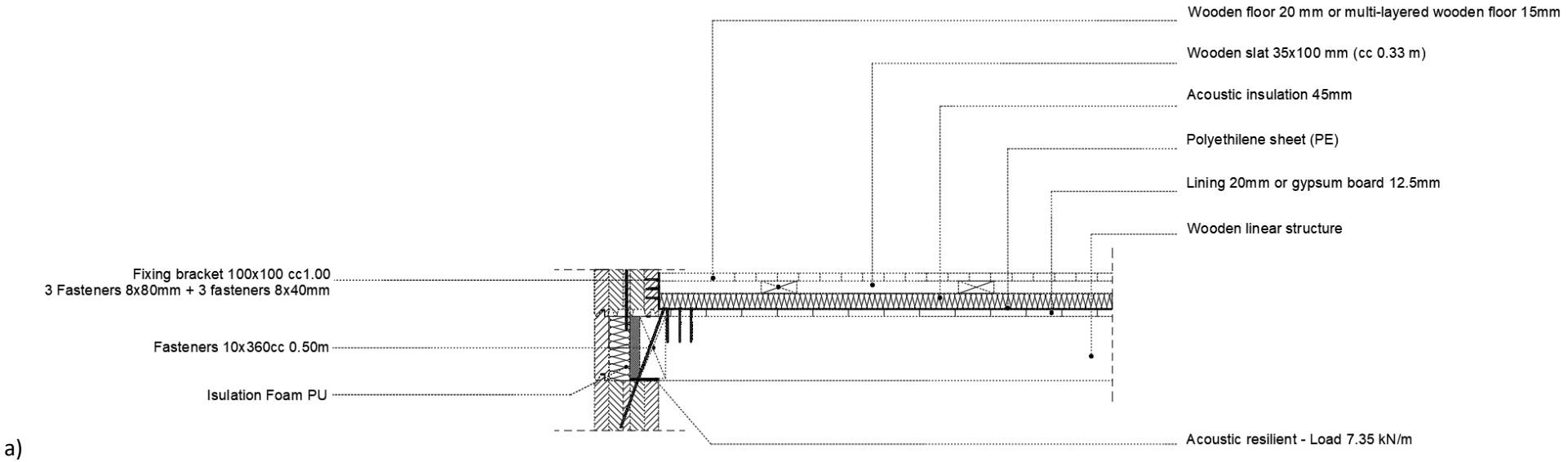
Lining 13mm to 20mm (Only for wooden linear structure)

Criptolam F210 or Wooden linear structure

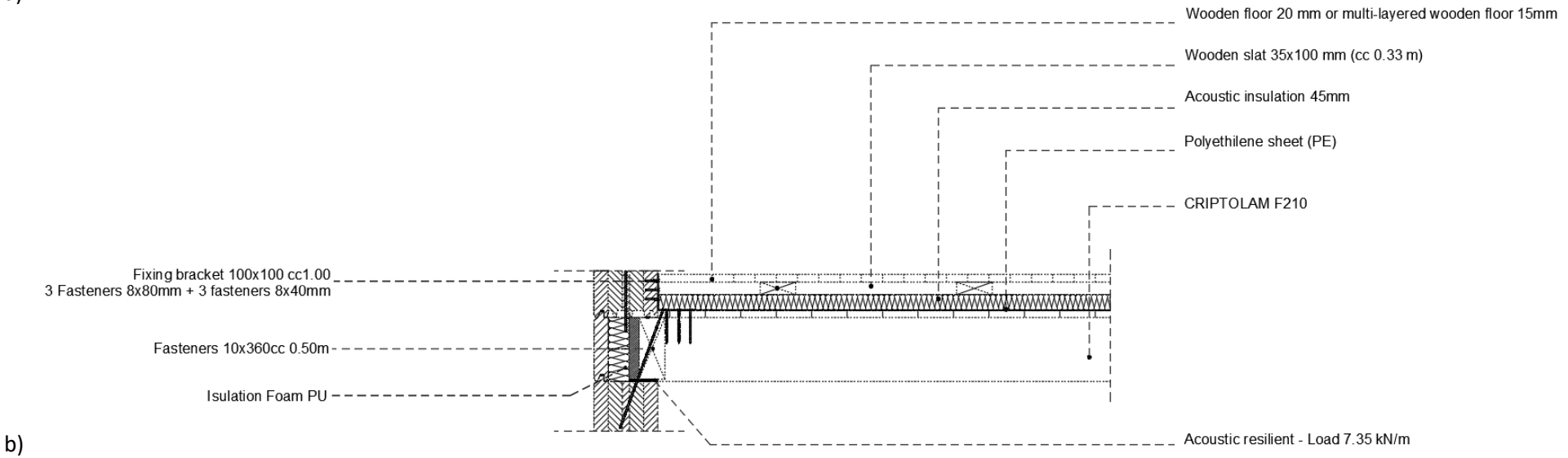
8 – LTS – ground floor (the connection between the various LTS solutions and the ground floor is the same for all solutions)



9 – LTS – intermediate floor (the connection between the various LTS solutions and the intermediate floor panels is the same for all solutions)

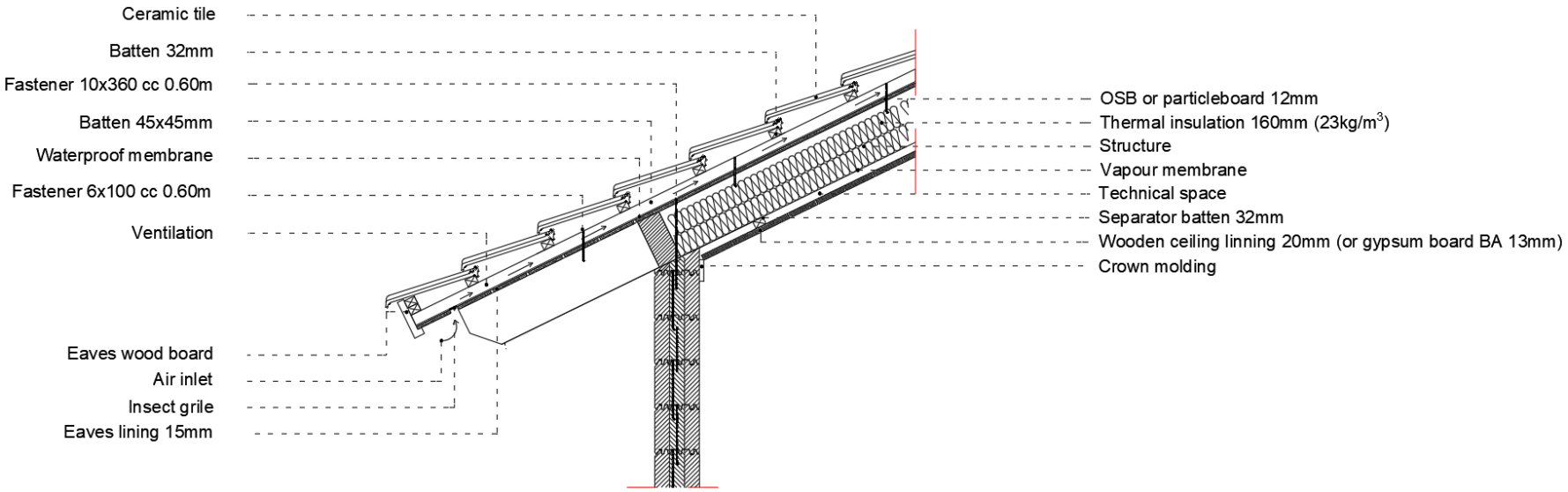


a)

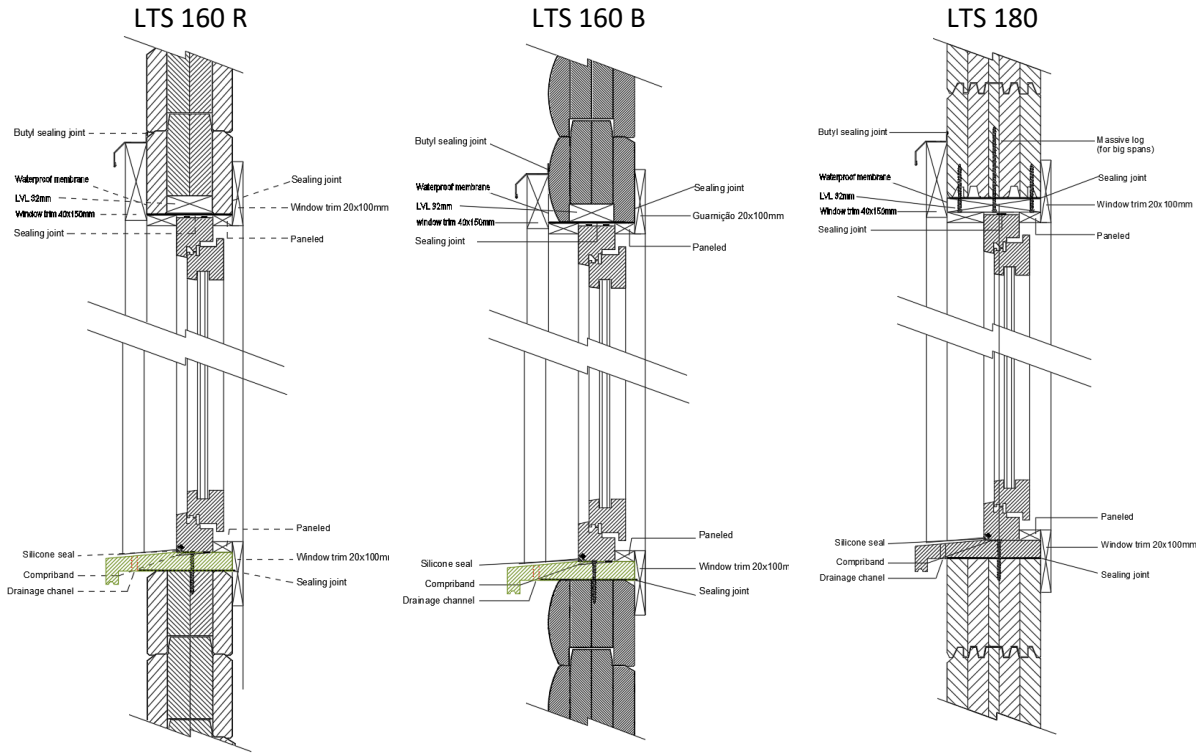


b)

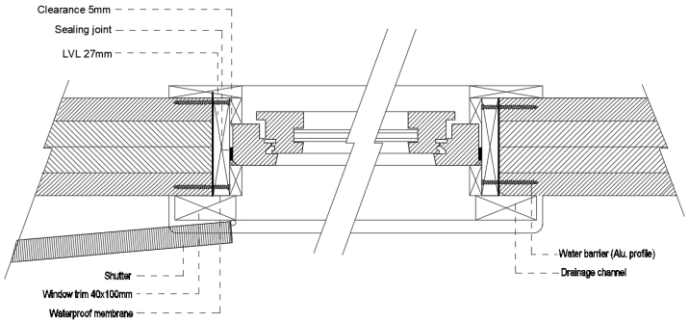
10 – LTS – roof panels (the connection between the various LTS solutions and the roof panels is the same for all solutions)



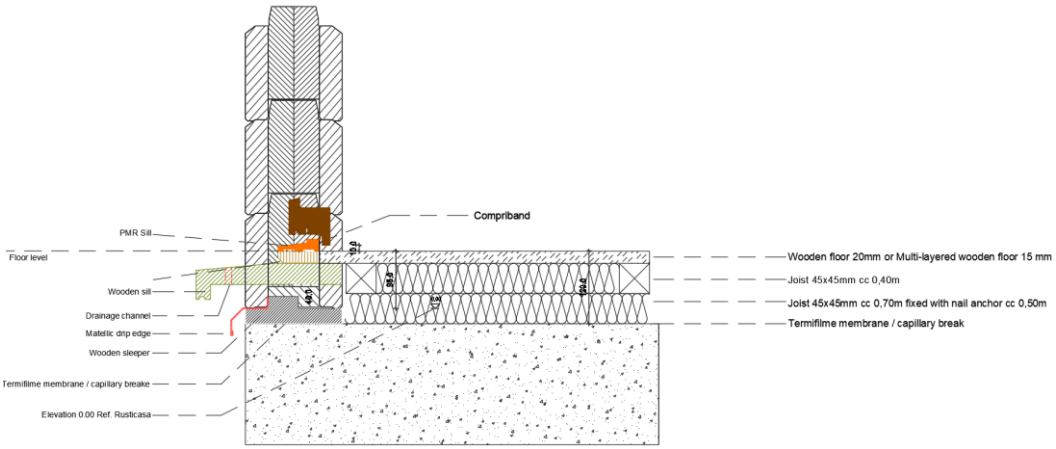
11 – LTS – window (vertical cross section)



12 – LTS – window (horizontal cross section)

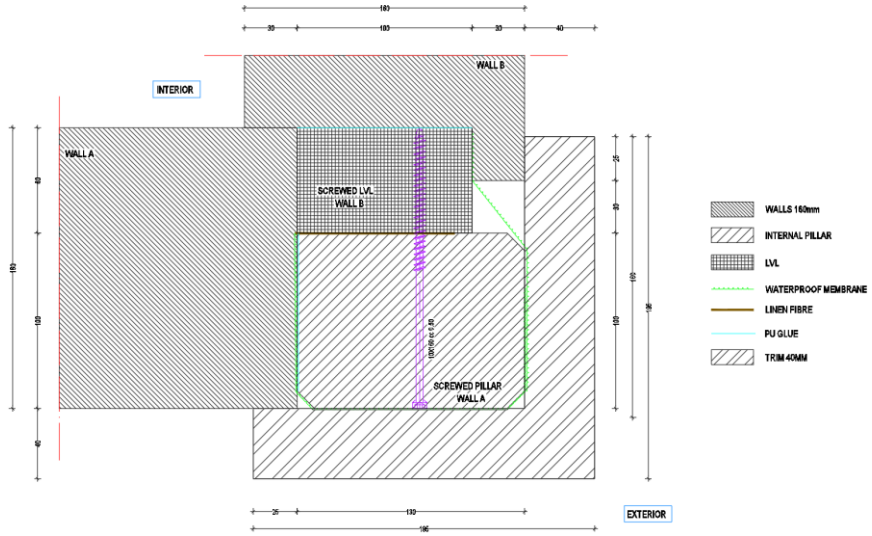


13 – Integration of the PMR sill

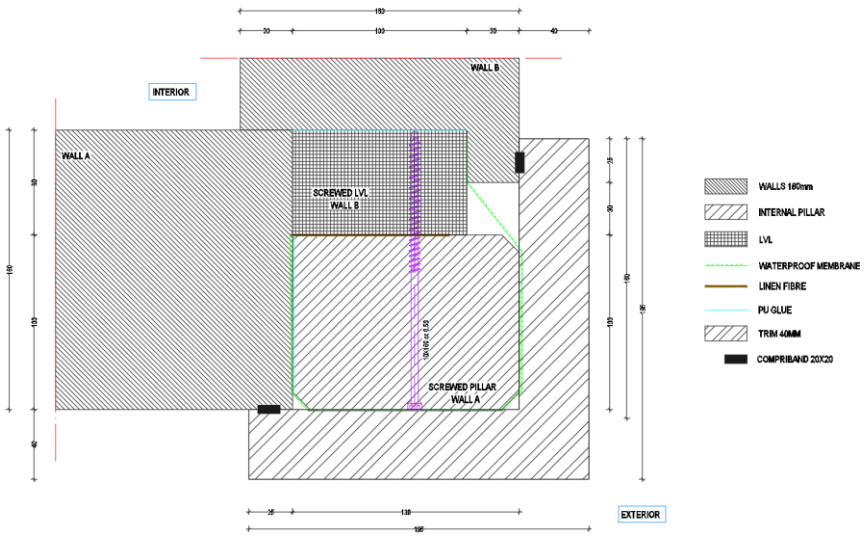


14 – Projected corner connection detail – projected trim

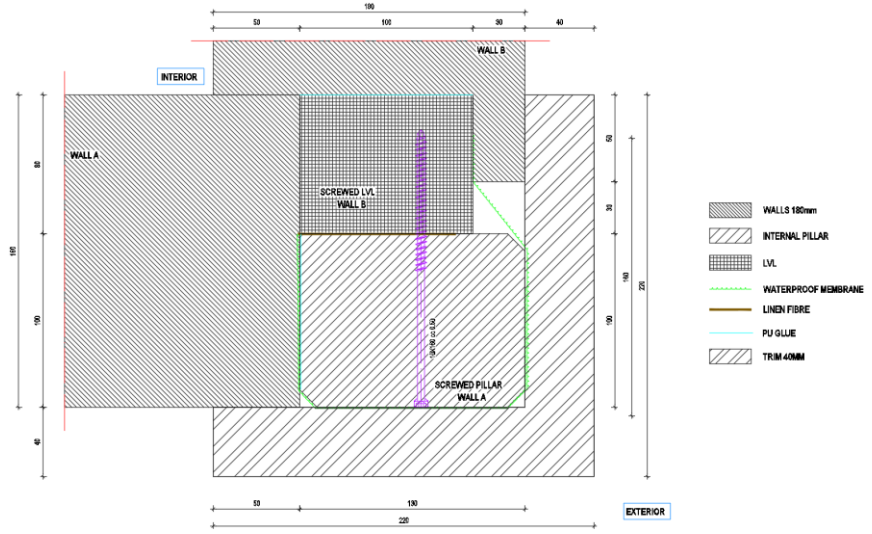
LTS 160 R



LTS 160 B



LTS 180



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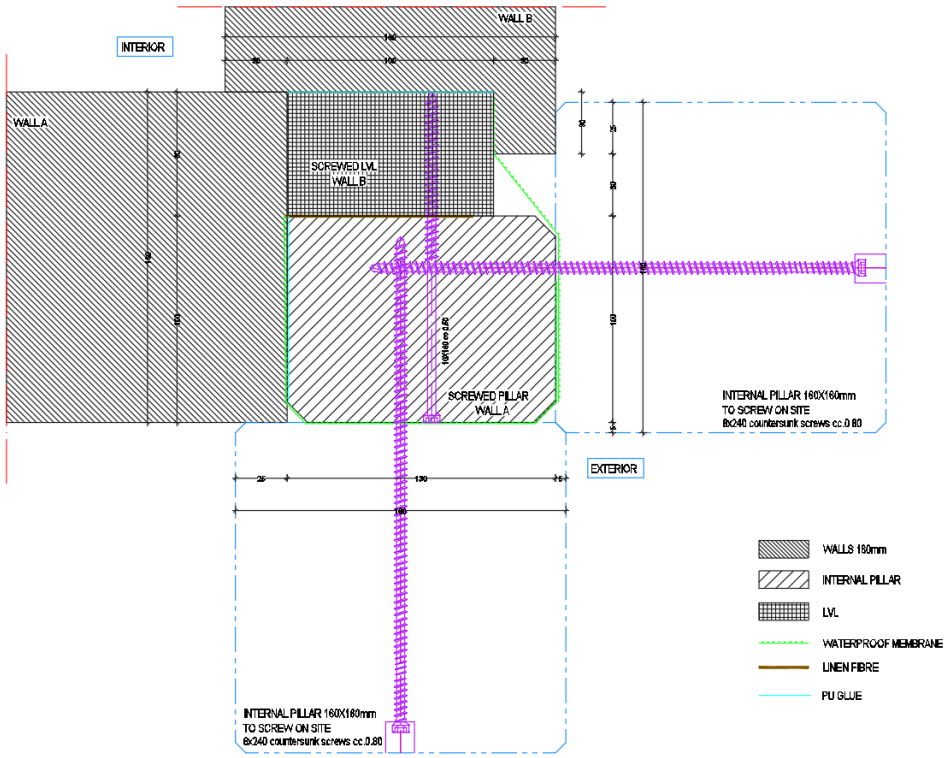
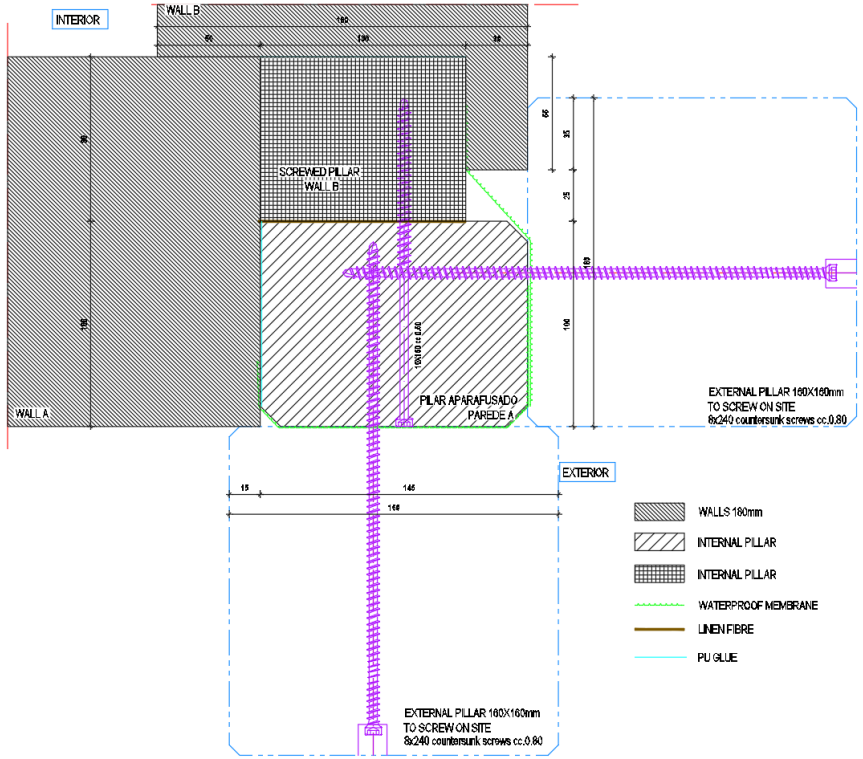
15 – Projected corner connection detail – pillar

LTS 160 R



LTS 180



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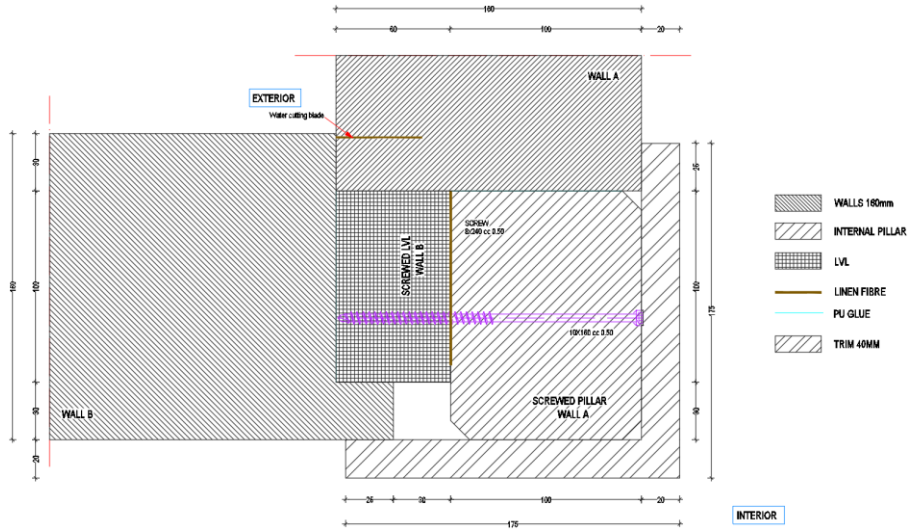
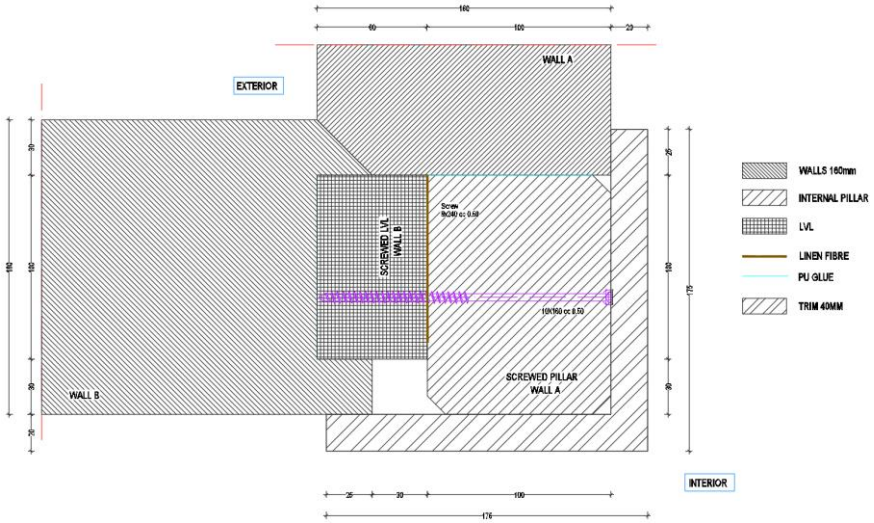
16 – Recessed corner connection detail – projected trim

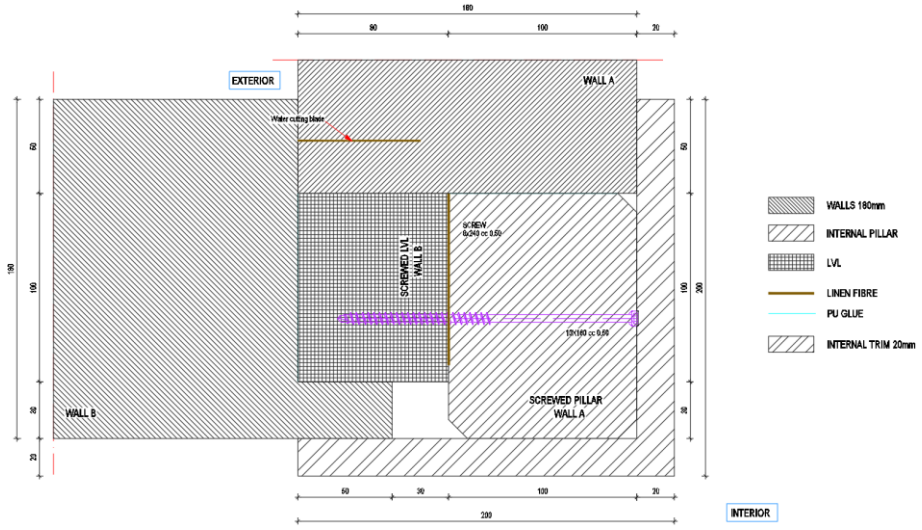
LTS 160 R



LTS 160 B



LTS 180



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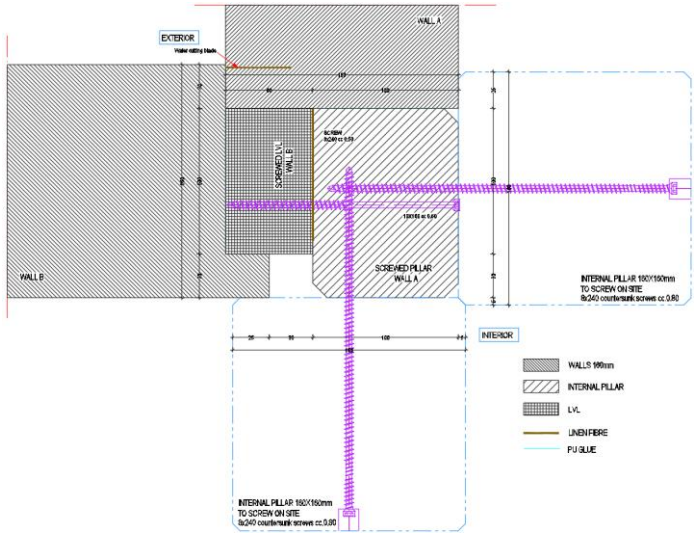
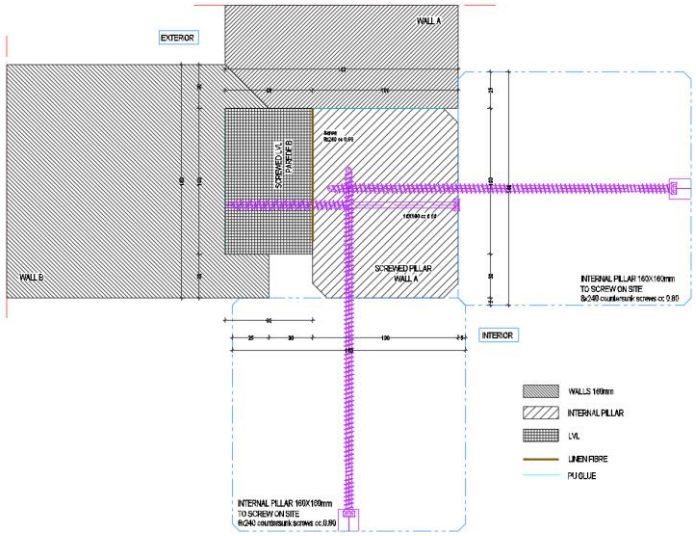
17 – Recessed corner connection detail – pillar

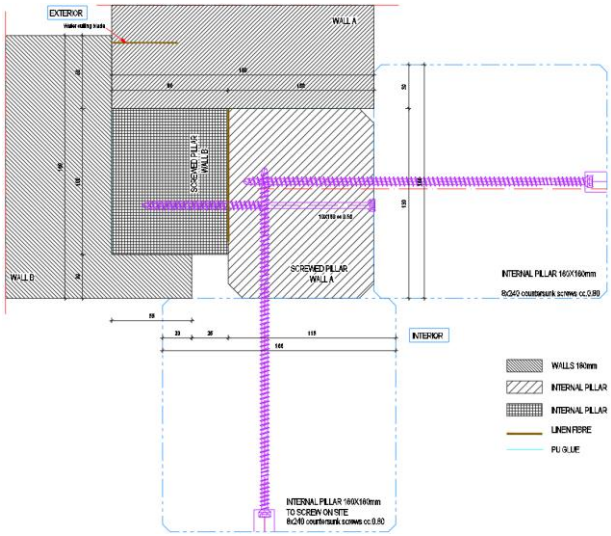
LTS 160 R



LTS 160 B



LTS 180



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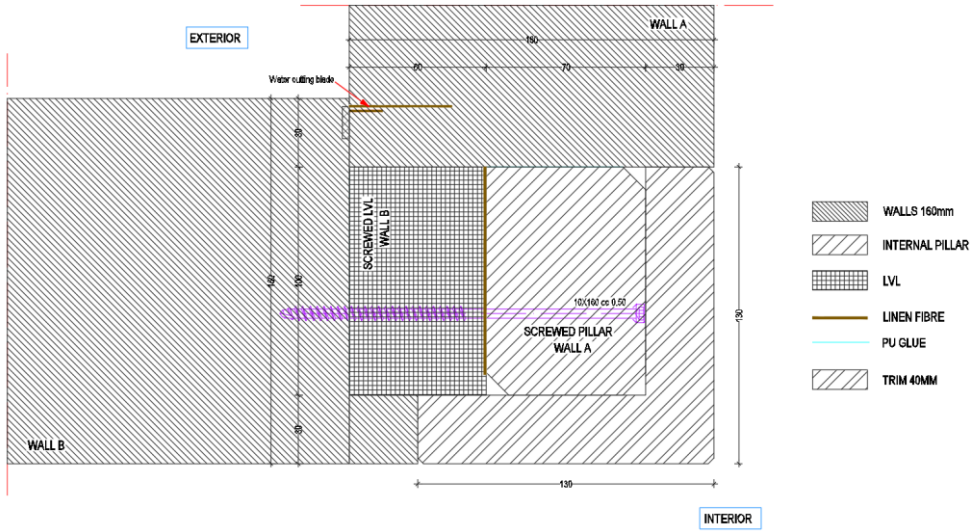
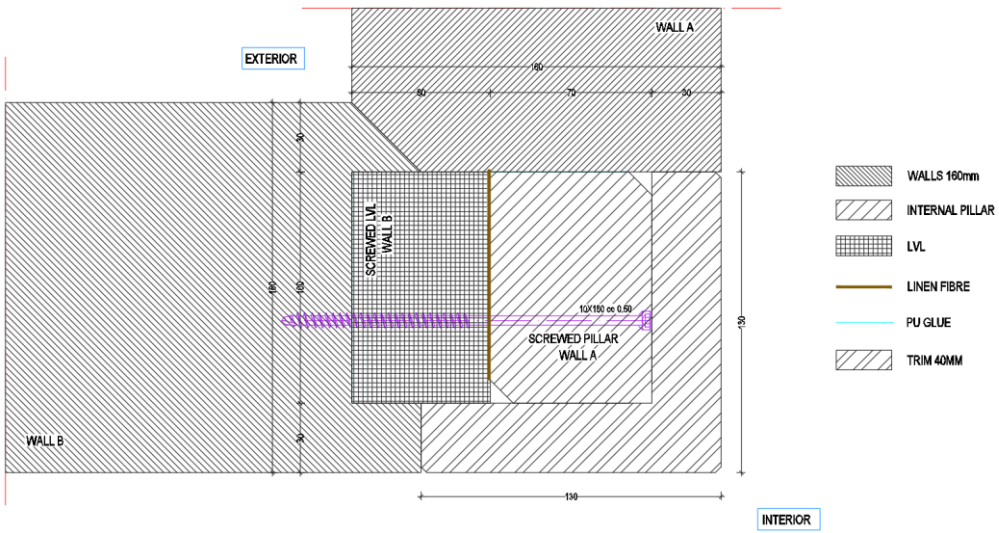
18 – Recessed corner connection detail – trim

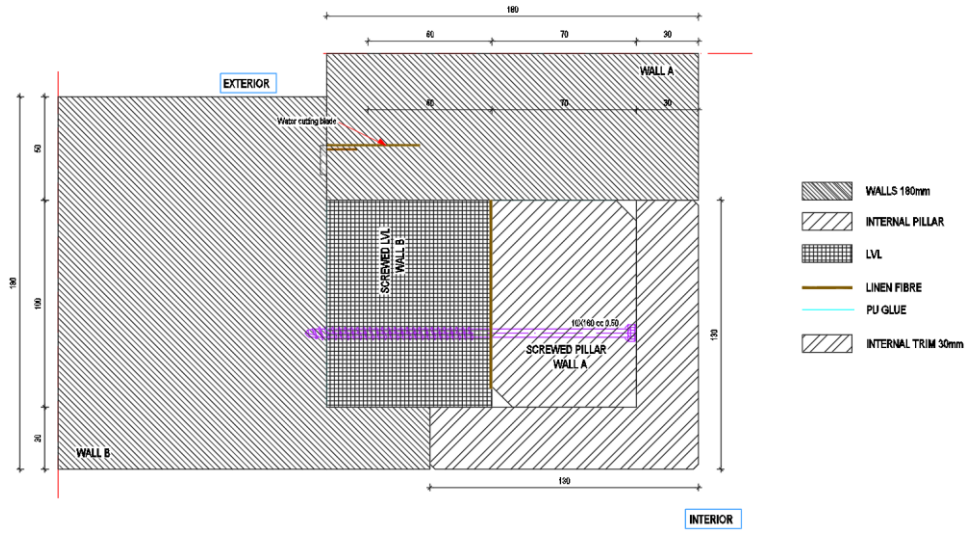
LTS 160 R



LTS 160 B



LTS 180



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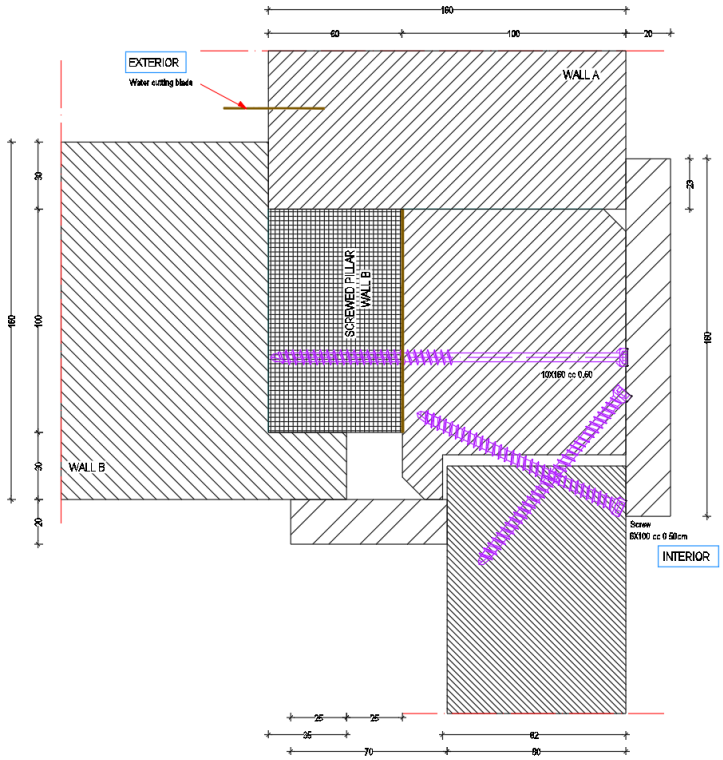
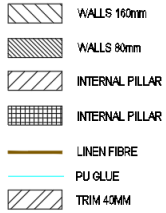
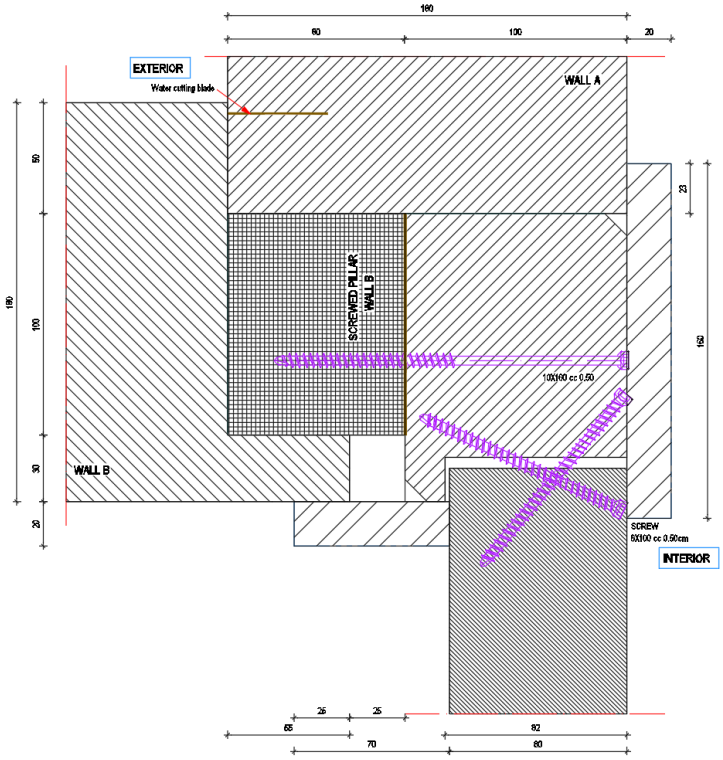
19 – Recessed corner connection detail – trim + internal wall

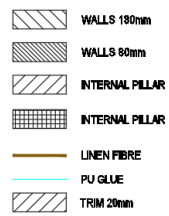
LTS 160 B





LTS 180





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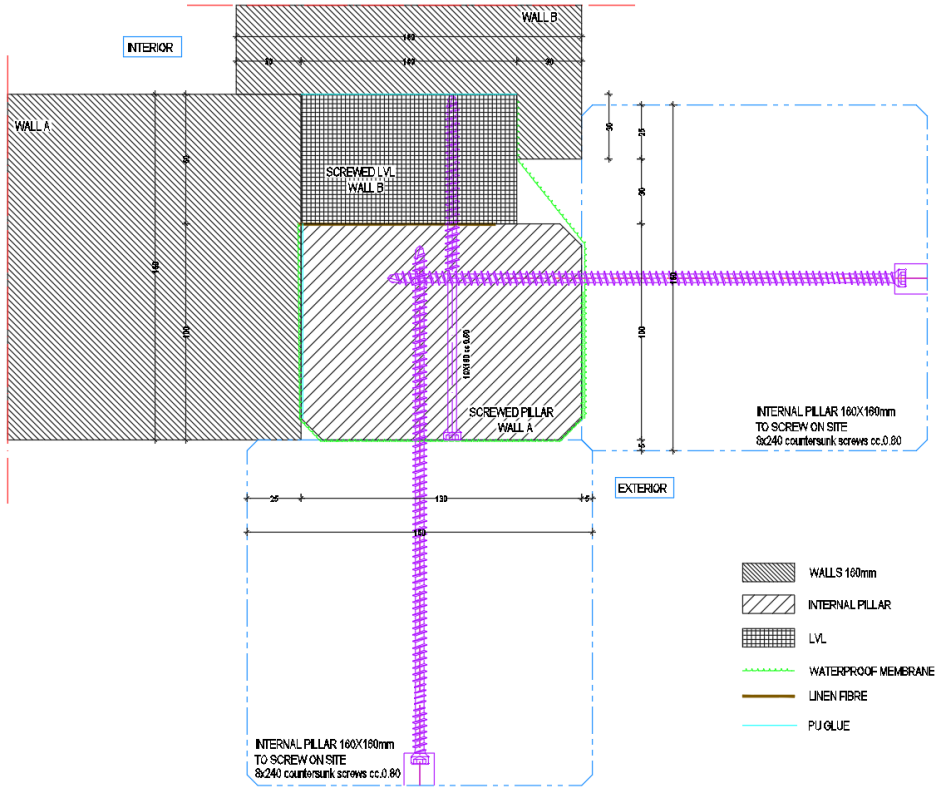
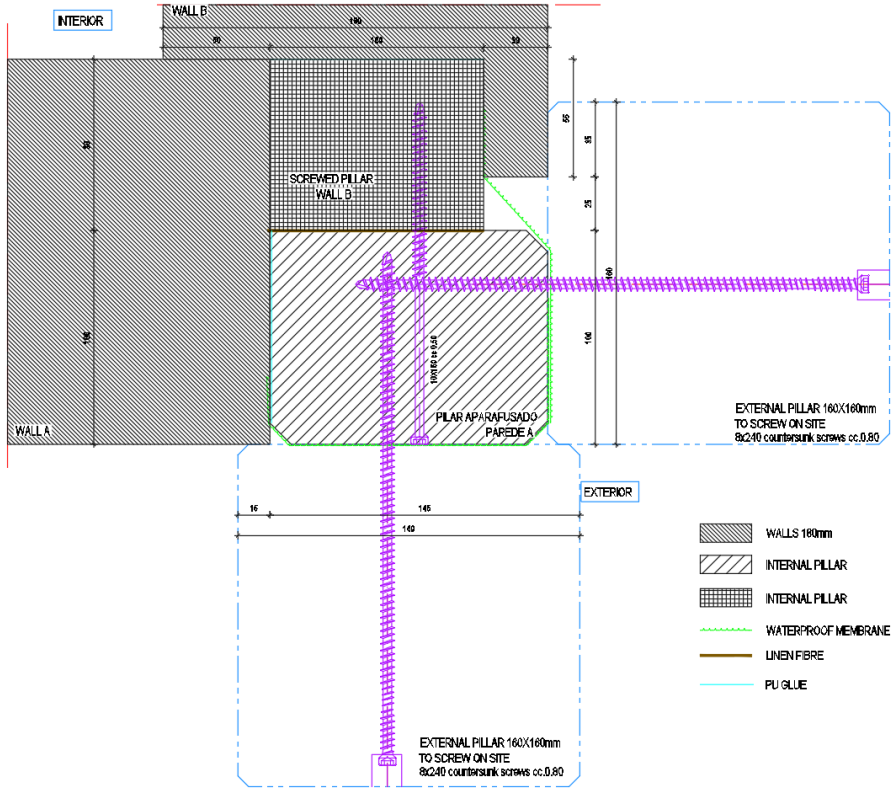
20 – Projected corner connection detail – pillar

LTS 160 R



LTS 180



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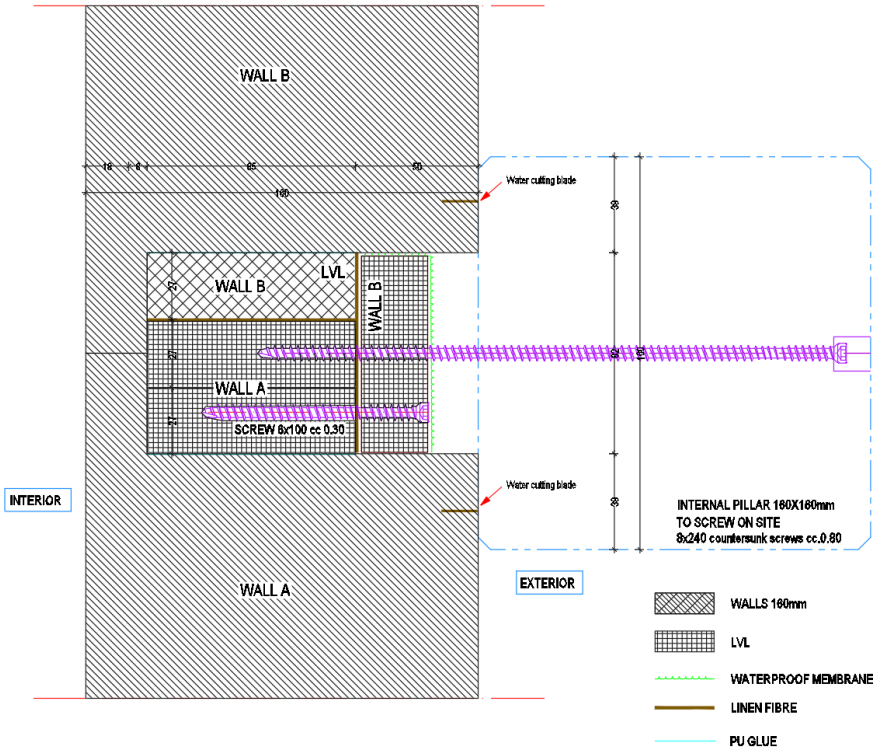
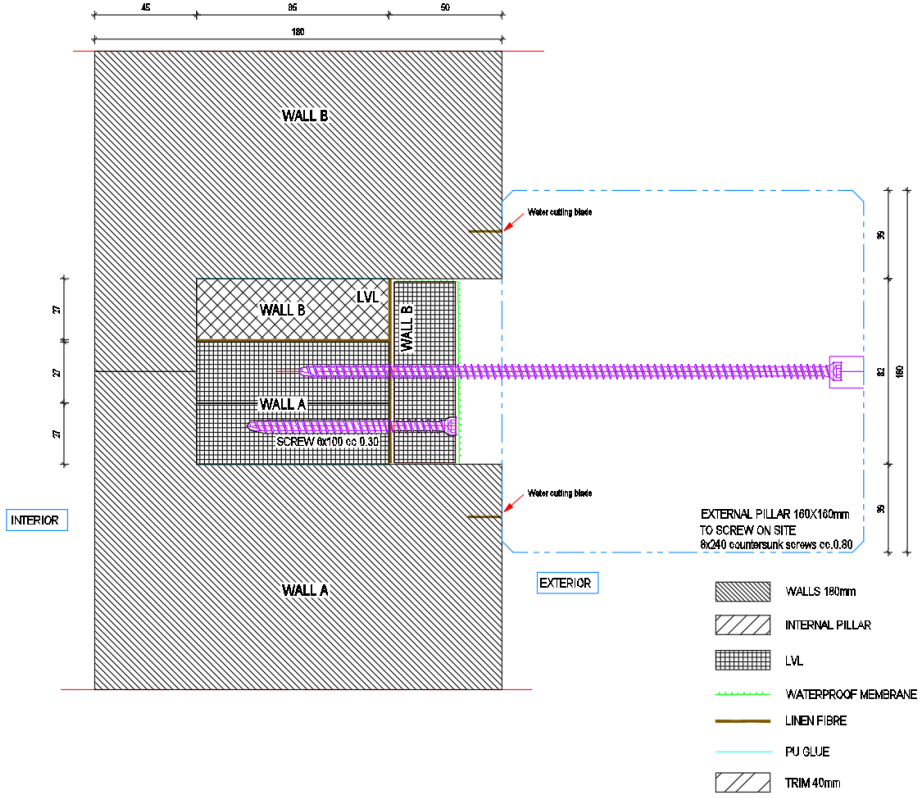
21 – Exterior wall panel/Exterior wall panel connection detail – pillar

LTS 160 R



LTS 180



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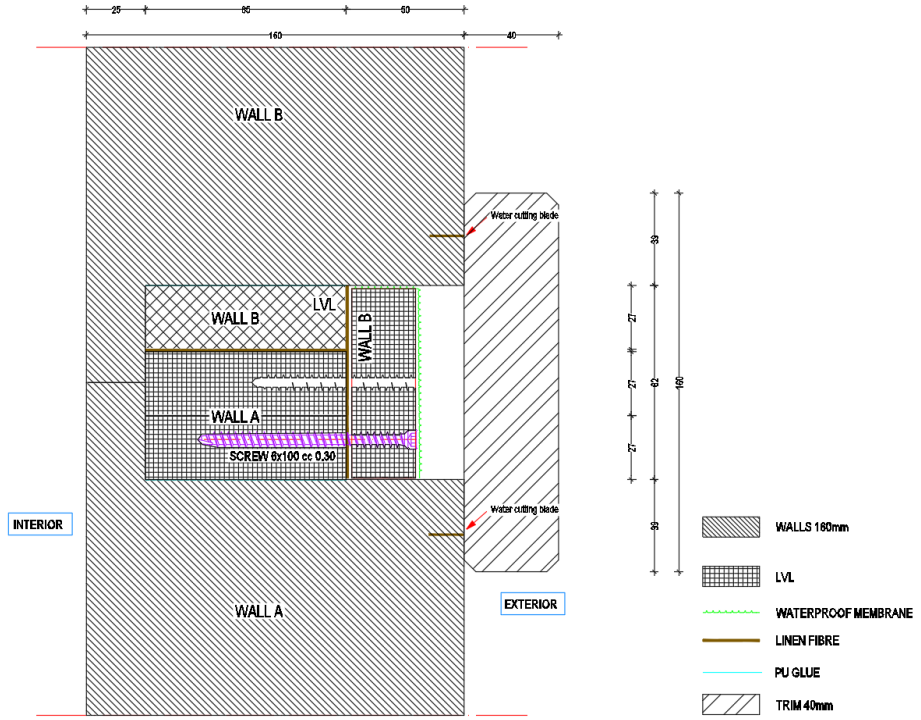
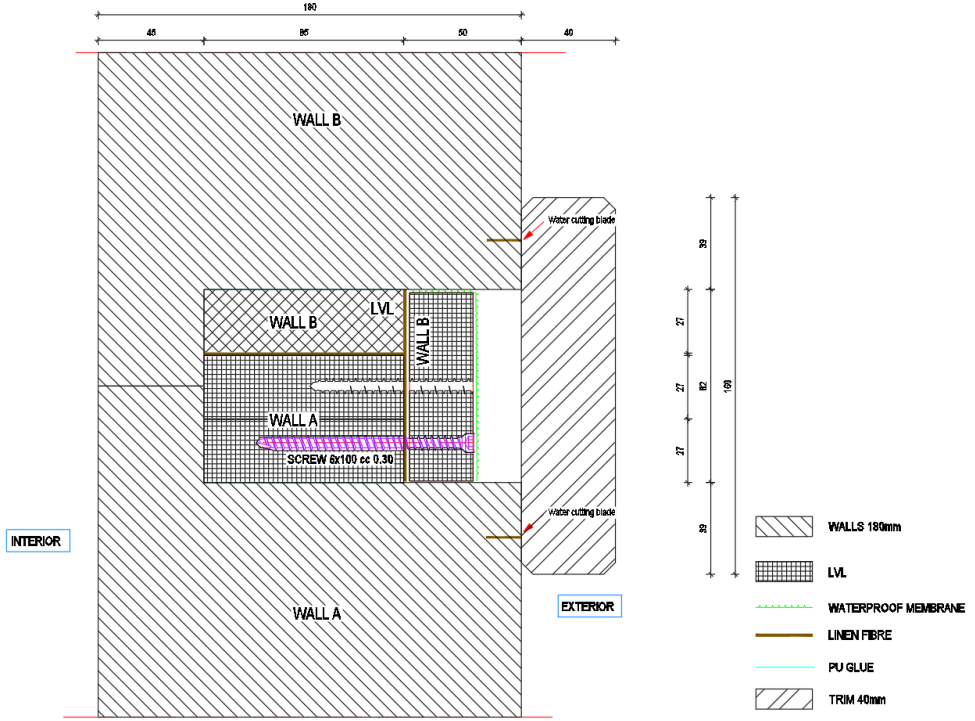
22 – Exterior wall panel/Exterior wall panel connection detail – trim

LTS 160 R



LTS 180



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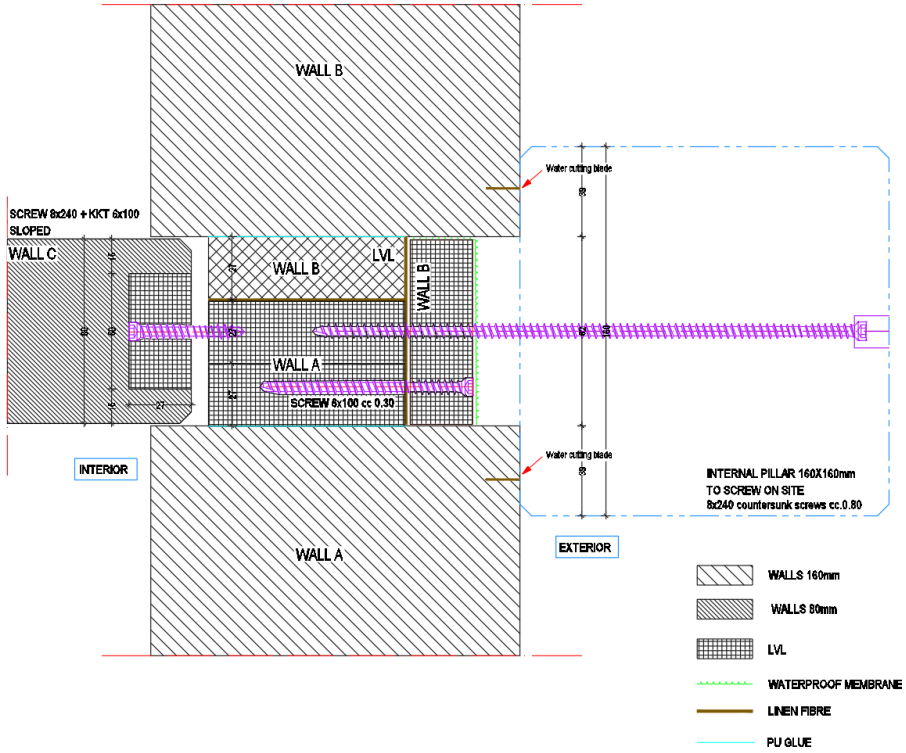
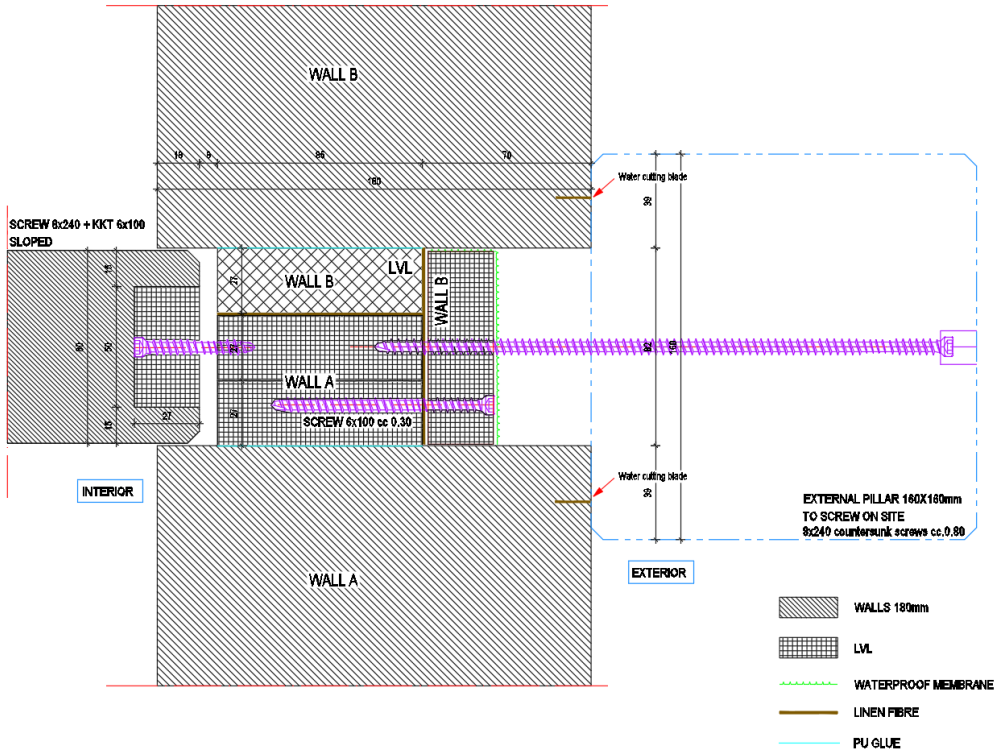
23 – Interior wall panel/Exterior wall panel connection detail – pillar

LTS 160 R



LTS 180



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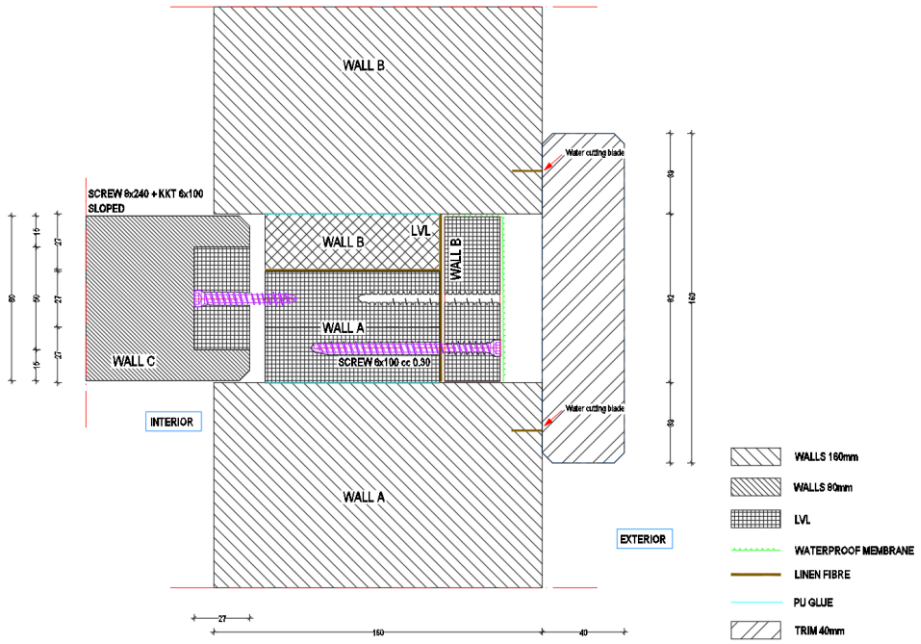
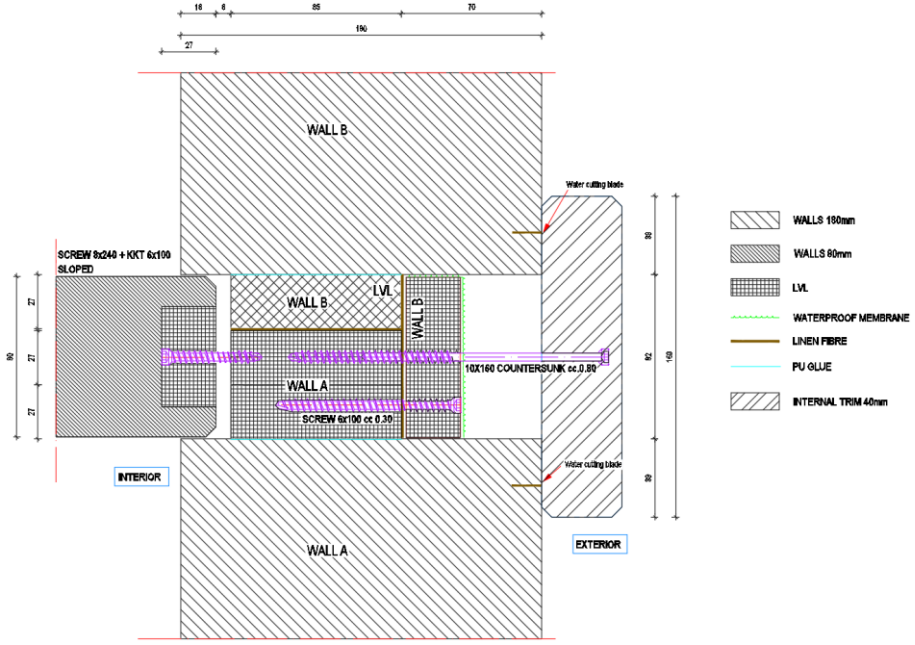
24 – Interior wall panel/Exterior wall panel connection detail – trim

LTS 160 R



LTS 180



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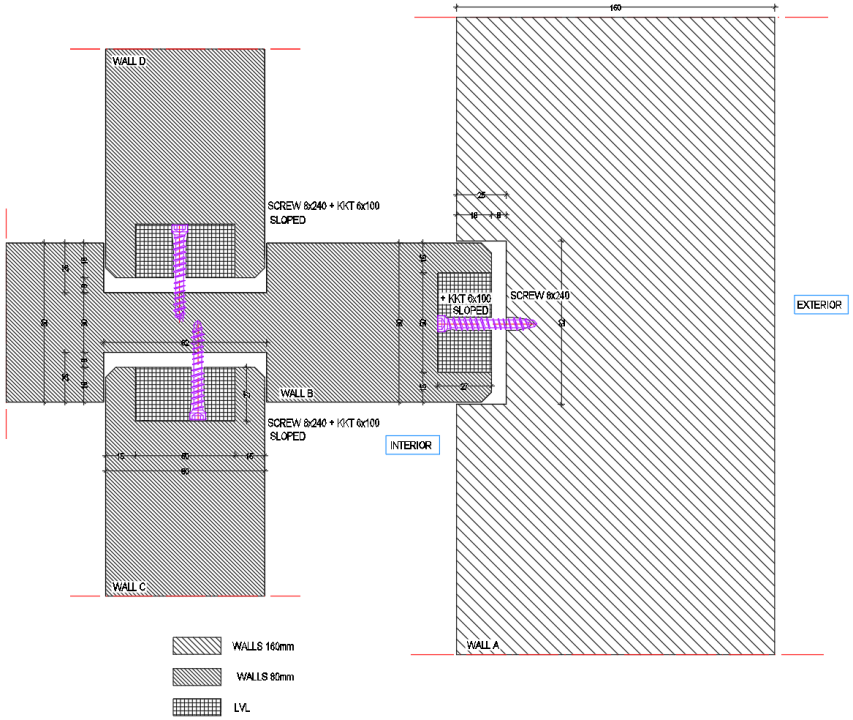
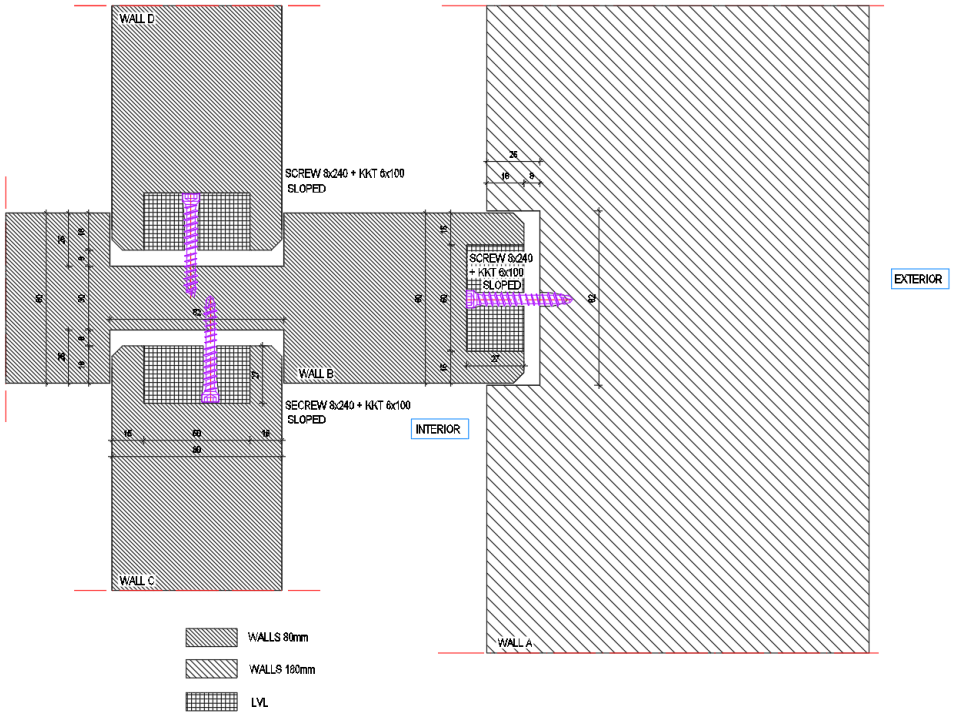
25 – Interior wall panel/Exterior wall panel connection detail

LTS 160 R and LTS 160 B



LTS 180



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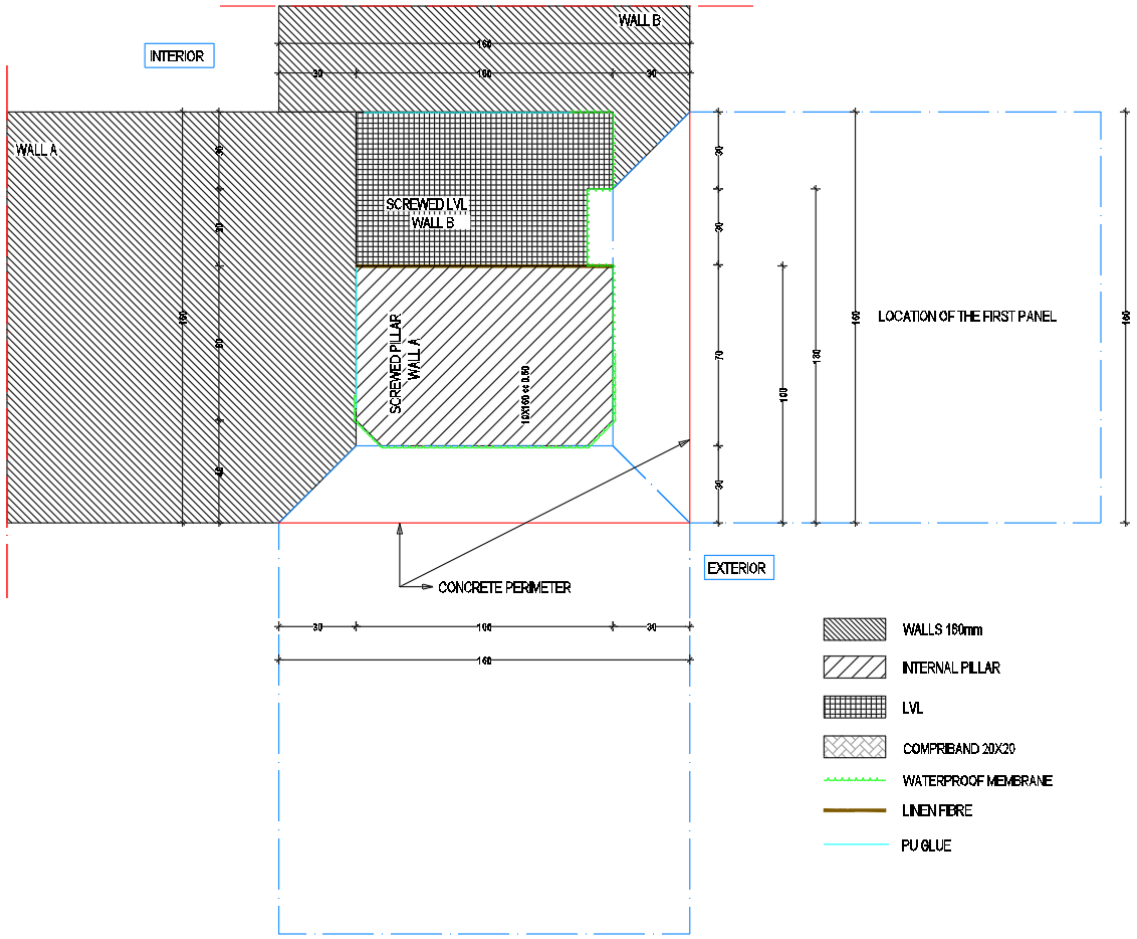
26 – Detail of the starting point of the 1st panel on-site

LTS 160 R



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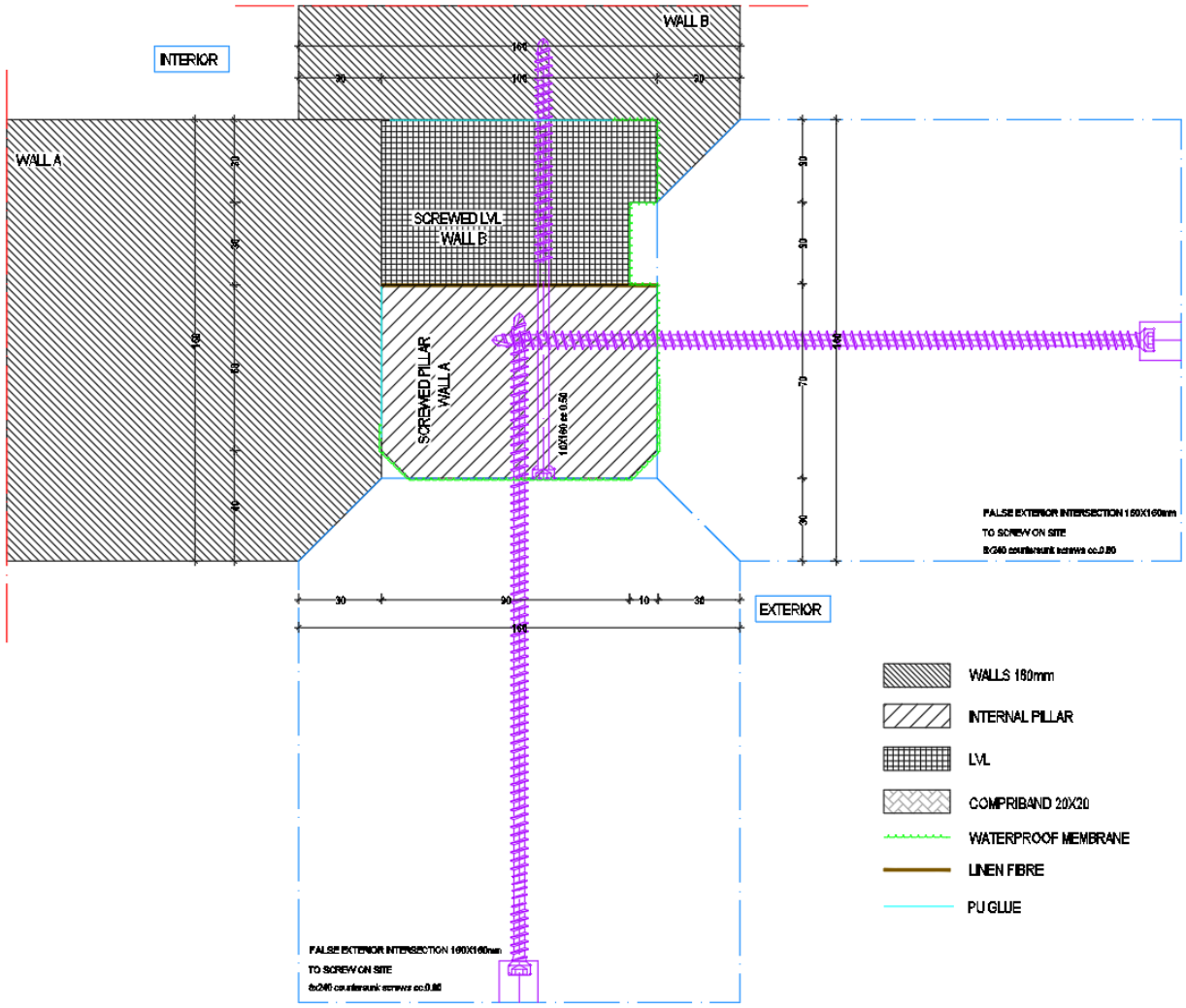
27 – Projected corner connection detail – false exterior intersection



Disclaimer Regarding Settling:
Due to the settling of the log walls, the pillars and trims are only installed at the end of the construction, invariably with the roof already installed. These elements do not serve a structural function and, to avoid issues arising from settling, the pillars and trims have a clearance. Their purpose is architectural and to serve as a barrier to water ingress. Concerning the reinforcing elements installed at the edges of the wall panels, a clearance is foreseen in the studs to anticipate settling and prevent issues related to wall settling.
Additionally, a technical/mechanical review of the building is carried out 18 months after the completion of the construction. If necessary, any element that may have anomalies due to the settling of the logs are corrected.

Table A.1 – Materials and products specifications

Product	Technical Specification	ρ (Kg/m³)	λ (W/mK)	μ (-) or Sd (m)	C (J/kgK)	Reaction to fire EN 13501-1+A1
Particleboard 12 mm (e.g. Durelis Vaporblock)	CE Marking acc. EN 13986+A1:2015	---	0.14	μ = 192 (wet) μ = 510 (dry)	---	D-s2,d0
		Formaldehyde class: E1 Formaldehyde content: ≤ 8 mg/100g Biological durability: class 1 and 2				
Particleboard 18 mm (e.g. Durelis)	CE Marking acc. EN 13986+A1:2015	---	0.14	μ = 16 (wet) μ = 50 (dry)	---	D-s2,d0
		Formaldehyde class: E1 Formaldehyde content: < 8 mg/100g DS Biological durability: class 1 and 2				
Universal single-sided tape without release liner (e.g., SPEEDY BAND)	---	---	---	Sd = 40 m	---	---
OSB (12 mm, e.g. SWISS KRONO OSB 3)	CE Marking acc. EN 13986:2004+A1:2015	650	0.13	μ = 76 (wet) μ = 123 (dry)	---	D-s2, d0
		Formaldehyde class: E1 Biological durability: class 2				
OSB for roof panels (18 mm, e.g., SWISS KRONO OSB 3)	CE Marking acc. EN 13986:2004+A1:2015	605	0.13	μ = 67 (wet) μ = 86 (dry)	---	D-s2, d0
		Formaldehyde class: E1 Biological durability: class 2				
Gypsum Board (e.g., Gyptec – board A – 18 mm)	CE Marking acc. EN 520:2004+A1:2009	---	0.115 (dry)	μ = 10	---	A2-s1, d0
Gypsum Board (e.g., Gyptec – board A – 12.5 mm)	CE Marking acc. EN 520:2004+A1:2009	---	0.100 (dry)	μ = 10	---	A2-s1, d0
Anti-insect net for the air ventilation gap in the roof (e.g., Riwega)	---	Metal or PVC anti-insects Flexible net of the air ventilation gap in the roof				
Mineral wool – walls (e.g., Alpharock 225)	CE Marking acc. EN 13162:2012+A1:2015	70	0.034	μ = 1	---	A1
Mineral wool – roof (e.g., Roulrock Kraft 80)	CE Marking acc. EN 13162:2012+A1:2015	22 to 27	0.040	---	---	---
Mineral wool – roof (e.g., Rocksol 525)	CE Marking acc. EN 13162:2012+A1:2015	150	0.041	μ = 1	---	A1
Flexible sheet for waterproofing – Plastic and rubber vapour control layers (e.g., VAPOR IN 120)	CE Marking acc. EN 13984:2013	290	0.3	Sd = 25 m	---	E
Resilient soundproofing profile (e.g., ALADIN STRIPE)	---	---	---	---	---	E
PE Membrane (e.g. alberplás)	---	920 – 940	---	---	---	---
Bolt for wooden floor (e.g., INEMER – Cavilhas para soalho)	---	Reference: 6 x 80 Zn Amr Dimensions: 6 x 80 mm Material: Steel 200 HV				
Dowel (e.g., WORLDFIX S.A. BUCHA CH)	---	Reference: BUCHA CH Dimensions: 10 x 80 mm				
Linen insulating band (e.g., ISOLINA)	ISO 8301 DIN 52615 EN ISO 12571	---	0.038	μ = 1 – 2	1600	E

Product	Technical Specification	ρ (Kg/m³)	λ (W/mK)	μ (-) or Sd (m)	C (J/kgK)	Reaction to fire EN 13501-1+A1
Angle bracket (e.g., GH Angle Bracket WBR 100)	CE Marking acc. ETAG015	Reference: WBR 100 Dimensions: 100 x 100 x 90 x 3 (mm) Material: Stainless Steel Reaction to fire: A1 Durability: Corrosion protection for class 1 and 2 Characteristic load-carrying capacity: see ETA 09/0323				
Metallic drip edge	---	Material: Stainless Steel				
self-expanding sealing tape	CE Marking acc. EAD 320001-00-0605	---	0.043	Sd < 0.5 m	---	B1
Varnish (e.g., IGUALAK IL-201)	---	Ford viscosity cup Nº4 = 1000 cps Density = 1.04 gr/cm³ Solids = 33% pH = 8				
Waterproof membrane (e.g., TRASPIR ZENIT UV 210)	CE Marking acc. EN 13859-1/2:20114	---	---	Sd = 0.15	---	E
Waterproof anti-termite barrier for foundations	CE Marking acc. EN 13967:2012 + A1:2017	± 1000	0.4	Sd = 232 m	1800	F
TPO membrane (e.g, EverGuard TpO)	CE Marking acc. EN 13956:2012	Fire reaction: class E Watertightness: Pass Longitudinal tensile strength: ≥ 1150 N/50 mm Transversal tensile strength: ≥ 1150 N/50 mm Longitudinal elongation: ≥ 20% Transversal elongation: ≥ 20 Static load resistance (method A): ≥ 20 kg Static load resistance (method B): ≥ 15 kg Impact resistance (method A): ≥ 400 mm Impact resistance (method B): ≥ 1500 mm Longitudinal tear resistance: ≥ 375 mm Transversal tear resistance: ≥ 475 mm Shear resistance of the overlap: ≥ 800 N/50 mm Durability against heat and water: 5000 h UV: Pass Foldability at low temperatures: ≤ - 25ºC				
Structural laminated veneer lumber (e.g., STEICO LVL X)	CE Marking acc. EN 14374:2004	530	---	---	---	D-s1,d0
		Formaldehyde class: E1 Biological durability: 4				
Structural laminated veneer lumber for bridges and buildings (e.g., STEICO LVL R)	CE Marking acc. EN 14374:2004	525	---	---	---	D-s1,d0
		Formaldehyde class: E1 Biological durability: 4				
Glue (e.g., AkzoNobel)	---	Reference: Cola MUF 1247 Viscosity: 10000 – 25000 mPas pH: 9.5 – 10.7 Dry extract: 64 – 69% Density: ± 1270 kg/m³ Formaldehyde content: 0.8%				
Hardener (e.g., AkzoNobel)	---	Reference: Endurecedor 2526 Viscosity: 1700 – 2700 mPas pH: 1.3 – 2.0 Density: ± 1070 kg/m³ Without formaldehyde				
PU Glue (e.g., Soudal Pro 45P)	---	Reference: Pro 45P Total solid content: 95% Temperature resistance: -30°C – 100°C Pressing pressure: 1 kg/cm² – 1.2 kg/cm² Water resistance: D4 Shear strength: > 10MPa				

Product	Technical Specification	ρ (Kg/m³)	λ (W/mK)	μ (-) or Sd (m)	C (J/kgK)	Reaction to fire EN 13501-1+A1
PU Foam (e.g., Soudafoam GUN)	---	Density: 17 kg/m³ Acoustic insulation: 58 dB Compression resistance: Ca. 2.0 N/cm² Shear resistance: Ca. 4.0 N/cm² Temperature resistance: -40°C – 90°C Water absorption: 1% volume				
Clip connectors	CE Marking acc. ETAG 015	Reaction to fire: A1 Durability: Corrosion protection for class 1, 2 and 3 Mechanical resistance: see ETA 10/0189				
Joist bearing for timber/concrete	CE Marking acc. ETAG 015	Reference: Alumidi Reaction to fire: A1 Durability: Corrosion protection for class 1 and 2 Mechanical resistance: see ETA 09/0361				
Support of timber columns and posts as load-bearing elements	CE Marking acc. ETAG 015	Reaction to fire: A1 Durability: Corrosion protection for class 1, 2 and 3 Mechanical resistance: see ETA 10/0422				
Cryptomeria japonica	NP 4544 EN ISO 10456	ρ_m = 350 (Quality class CYS I) ρ_m = 290 (Quality class CYS II)	0.09	50	1600	---
Pinus radiata	EN 1611-1:2010 EN ISO 10456	500	0.13	50	1600	---
Picea abies	EN 1611-1:2010 EN ISO 10456	440 – 480	0.12	50	1600	---
Pinus sylvestris	EN 1611-1:2010 EN ISO 10456	500 – 540	0.13	50	1600	---
Eucalypto globulus L.	EN 1611-1:2010 EN ISO 10456	720 – 850	0.18	200	1600	---
Pinus pinaster	EN 1611-1:2010 EN ISO 10456	550	0.13	50	1600	---
Self-tapping screws and threaded rods	CE Marking acc. EAD 130118-01-0603	Reaction to fire: A1 Durability: Corrosion protection for class 1 and 2 Mechanical resistance: see ETA 11/0030				
Connect band	CE Marking acc. 13984:2010	---	---	---	---	E

Table A.2 – Mechanical characteristics of the structural timber of the LTS kit

Mechanical characteristics	*Cryptomeria japonica* acc. NP 4544		Structural timber C14 acc. EN 14081-1 (EN 338)	Structural timber C18 acc. EN 14081-1 (EN 338)	Structural timber C24 acc. EN 14081-1 (EN 338)
	Quality class CYS I	Quality class CYS II			
Bending strength (N/mm^2)	19	12	14	18	24
Tension strength parallel to grain (N/mm^2)	13	9	7.2	10	14.5
Tension strength perpendicular to grain (N/mm^2)	0.4	0.4	0.4	0.4	0.4
Compression strength parallel to grain (N/mm^2)	20	17	16	18	21
Compression strength perpendicular to grain (N/mm^2)	2.2	1.8	2.0	2.2	2.5
Shear strength (N/mm^2)	3.0	3.0	3.0	3.4	4.0
Modulus of elasticity (kN/mm^2) Parallel to grain: mean value	7.0	5.8	7.0	9.0	11.0
Modulus of elasticity (kN/mm^2) Parallel to grain: characteristic value	4.7	3.9	4.7	6.0	7.4
Modulus of elasticity (kN/mm^2) Perpendicular to grain: mean value	0.24	0.19	0.23	0.30	0.37
Shear modulus (kN/mm^2): mean value	0.44	0.36	0.44	0.56	0.69

Table A.3 – Mechanical characteristics of the structural laminated veneer lumber of the LTS kit according to EN 14374

Mechanical characteristics	Structural laminated veneer lumber (e.g., STEICO LVL X)		Structural laminated veneer lumber for bridges and buildings (e.g., STEICO LVL R)
	Thickness		
	21-24 mm	27-75 mm	
Bending strength – Edgewise, parallel to grain (depth 300 mm) (N/mm^2)	30	32	30
Bending strength – Size effect parameter (N/mm^2)	0.15	0.15	0.15
Bending strength – Edgewise, perpendicular to grain (depth 300 mm) (N/mm^2)	10	8	NPD
Bending strength – Flatwise, parallel to grain (N/mm^2)	32	36	32
Bending strength – Flatwise, perpendicular to grain (N/mm^2)	7	8	NPD
Tensile strength – Flatwise, parallel to grain (length 3000 mm) (N/mm^2)	21	22	NPD
Tensile strength – Edgewise, perpendicular to grain (N/mm^2)	7	5	NPD
Compressive strength – Parallel to grain (length 3000 mm) (N/mm^2)	26	30	38
Compressive strength – Edgewise, perpendicular to grain (N/mm^2)	9	9	7.5
Compressive strength – Flatwise, perpendicular to grain (N/mm^2)	4	4	3.0
Shear strength – Edgewise, parallel to grain (N/mm^2)	4.6	4.6	3.2

Mechanical characteristics	Structural laminated veneer lumber (e.g., STEICO LVL X)		Structural laminated veneer lumber for bridges and buildings (e.g., STEICO LVL R)
	Thickness		
	21-24 mm	27-75 mm	
Shear strength – Edgewise, perpendicular to grain (N/mm²)	4.6	4.6	NPD
Shear strength – Flatwise, parallel to grain (N/mm²)	1.1	1.1	2.6
Shear strength – Flatwise, perpendicular to grain (N/mm²)	1.1	1.1	NPD
Modulus of elasticity – Parallel to grain (mean value) (N/mm²)	10000	10600	11000
Modulus of elasticity – Parallel to grain (characteristic value) (N/mm²)	9000	9000	8900
Modulus of elasticity – Edgewise, perpendicular to grain (mean value) (N/mm²)	3500	3000	NPD
Modulus of elasticity – Edgewise, perpendicular to grain (characteristic value) (N/mm²)	2700	2300	NPD
Modulus of elasticity – Flatwise, perpendicular to grain (mean value) (N/mm²)	1300	2500	NPD
Modulus of elasticity – Flatwise, perpendicular to grain (characteristic value) (N/mm²)	1000	1800	NPD
Shear Modulus – Edgewise, parallel to grain (mean value) (N/mm²)	600	600	500
Shear Modulus – Edgewise, parallel to grain (characteristic value) (N/mm²)	400	400	350
Shear Modulus – Flatwise, parallel to grain (mean value) (N/mm²)	150	150	NPD
Shear Modulus – Flatwise, parallel to grain (characteristic value) (N/mm²)	130	130	NPD
Shear Modulus – Flatwise, perpendicular to grain (mean value) (N/mm²)	150	150	NPD
Shear Modulus – Flatwise, perpendicular to grain (characteristic value) (N/mm²)	130	130	NPD

Table A.4 – Mechanical characteristics of the Particleboards acc. EN 13986+A1:2015

Mechanical characteristics	12 mm	18 mm
Bending strength (N/mm²)	18	16
Modulus of elasticity in bending (N/mm²)	2550	2400
Internal bond (N/mm²)	0.45	0.45
Swelling in thickness, 24h (%)	11	10
Moisture resistance OPTION 1: internal bond (N/mm²)	0.25	0.22
Moisture resistance OPTION 1: swelling in thickness (%)	12	12
Strength – tension f_t (N/mm²)	9.4	8.3
Strength – compression f_c (N/mm²)	12.7	11.8
Strength – bending f_m (N/mm²)	15	13.3

Mechanical characteristics	12 mm	18 mm
Strength – panel shear f_y (N/mm²)	7	6.5
Strength – planar shear f_r (N/mm²)	1.9	1.7
Stiffness – tension E_t (N/mm²)	2000	1900
Stiffness – compression E_c (N/mm²)	2000	1900
Stiffness – bending E_m (N/mm²)	3500	3300
Stiffness – panel shear G_v (N/mm²)	960	930
Linear expansion $\delta l_{30,85}$ (mm/m)	<3	<3

Table A.5 – Mechanical characteristics of the OSB boards acc. EN 13986:2004+A1:2015

Mechanical characteristics	12 mm	18 mm
Bending strength – longitudinal/transversal (N/mm²)	20/10	18/9
Modulus of elasticity in bending – longitudinal/transversal (N/mm²)	3500/1400	
Internal bond (N/mm²)	0.32	0.30
Swelling in thickness, 24h (%)	≤ 15	
Durability (moisture resistance) – Bending strength (N/mm²)	8	7
Strength – bending f_m (N/mm²)	16.4	14.8
Strength – compression $f_{c,0}$ (N/mm²)	15.4	14.8
Strength – compression $f_{c,90}$ (N/mm²)	12.7	12.4
Strength – panel shear f_y (N/mm²)	6.8	
Stiffness – bending $E_{m,0}$ (N/mm²)	4930	
Stiffness – bending $E_{m,90}$ (N/mm²)	1980	
Stiffness – compression $E_{c,0}$ (N/mm²)	3800	
Stiffness – compression $E_{c,90}$ (N/mm²)	3000	
Stiffness – panel shear G_v (N/mm²)	1080	

ANNEX B

The maximum admissible loads and deformation of the panels CRIPTOLAM F210 were determined by numerical simulation based on experimental data.

The results are shown in the Table B.1.

Table B.1: CRIPTOLAM F210 maximum admissible load for a final maximum deformation of L/300 [mm]

Span [m]	**4.0**	**4.5**	**5.0**	**5.5**	**6.0**
Maximum load values [kN/m^2] beyond: panel self-weight + Q = 2.0 kN/m^2	6.50	4.00	2.40	1.30	0.55
Instantaneous deformation | S.L.S. – P_{sd} = G+Q					
Deformation [mm]	7.90	9.14	10.53	12.33	13.98
Maximum deformation (L/360) [mm]	11.11	12.50	13.89	15.28	16.67
Final deformation | S.L.S. P_{sd} = 1.8G+1.24Q					
Deformation [mm]	13.25	14.91	16.62	18.24	19.99
Maximum deformation (L/300) [mm]	13.33	15.00	16.67	18.33	20.00

The resistant capacity of CRIPTOLAM F210 panels, for the service limit state, was calculated using EN 1995-1-2 (Eurocode 5) method. The results are shown in the Table B.2.

Table B.2: Maximum admissible loads for CRIPTOLAM F210 panels beyond panel self-weight + Q = 200 kg/m^2 (P_{sd} = 1.8G+1.24Q)

	Limit [mm]	**Span [m]**				
		4.0	**4.5**	**5.0**	**5.5**	**6.0**
Maximum admissible loads [kg/m^2]	L/300	650	400	240	130	55
	L/200	1000	640	400	235	120