A Shell construction
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1 Base and wall anchoring

1.1 Base with mortar bed

Execution

- The CLT board can be installed on a dry or wet mortar bed for tolerance compensation (full surface contact). The CLT must be protected against rising damp using a suitable damp-proof seal.

- The choice and rating of the connectors and all structural components depend on the structural requirements.

- When fitting the wall anchoring (tensile and shear forces), the permissible edge distances for the connectors must be observed.

Illustration
1.2 Base with sill plate

Execution

- The CLT wall board must be sealed to the previously installed sill plate (e.g., larch) with joint-sealing tape. The sill plate in turn must be protected against damp rising from the foundation.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- When fitting the wall anchoring (tensile and shear forces), the permissible edge distances for the connectors must be observed.

Illustration
1.3 Base with raised sill plate

**Execution**

- The CLT wall board must be sealed to the previously installed sill plate (e.g. larch) with joint-sealing tape. The sill plate in turn must be protected against damp rising from the foundation.
- A raised sill plate enables a small but often necessary increase in the wall height from 2,950 mm to approx. 3,050 mm.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- When fitting the wall anchoring (tensile and shear forces), the permissible edge distances for the connectors must be observed.

**Illustration**

![Illustration of a base with a raised sill plate](image)
### 1.4 Concrete base (mortar bed)

**Execution**

- The CLT board can be installed on a dry or wet mortar bed for tolerance compensation (full surface contact). The CLT must be protected against rising damp using a suitable damp-proof seal.

- The choice and rating of the connectors and all structural components depend on the structural requirements.

- When fitting the wall anchoring (tensile and shear forces), the permissible edge distances for the connectors must be observed.

**Illustration**

![Concrete base (mortar bed) illustration]
1.5 Concrete base (sill plate)

Execution

- The CLT wall board must be sealed to the previously installed sill plate (e.g., larch) with joint-sealing tape. The sill plate in turn must be protected against damp rising from the foundation.
- In the case of wall anchorings, as shown in the picture on the left, please note that costs will be higher because of the horizontal and vertical loads that have to be absorbed.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- When screwing the CLT board to the sill plate, the permissible edge distances for the connectors must be observed.

Illustration
2 Wall joints
Basic design rules

WALL JOINTS:

1. CLT wall boards should preferably be full-storey height (no joints).

![Diagram of CLT wall boards joined horizontally.]

2. If the walls are higher than 2,950 mm or if extra-wide boards (requiring special transport) are to be avoided, the wall boards can be joined vertically. (see details under 2.6 and 2.7)

![Diagram of CLT wall boards joined vertically.]

3. If alternatives 1 and 2 cannot be used, the boards must be joined horizontally. (see details under 2.3, 2.4 and 2.5)

![Diagram of CLT wall boards joined horizontally.]
2.1 Corner joint

Execution

- To achieve the required airtightness in a building, the joints of the CLT boards can, apart from joint-sealing tape, alternatively be sealed with suitable adhesive tape on the inside and outside of the boards.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- The screw connection at the corner joint must be made either purely constructionally (screw at 90°) or in a structurally effective way (slanted end-grain screwing).

Illustration
2.2 T-joint

Execution

- If the individual rooms in the building are required to be airtight, the joints of the CLT boards must be sealed with joint-sealing tape.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- The screw connection at the T-joint must be made either purely constructionally (screw at 90°) or in a structurally effective way (slanted end-grain screwing).

Illustration
2.3 Horizontal wall joint (butt board)

The joints shown have only limited torque rigidity!

Execution

- When using butt boards (e.g. 3-layer board or laminated veneer lumber), the standard rebate dimensions of $27 \times 80 \text{ mm}$ should preferably be ensured.
- Joint-sealing tape must be used to make the structure airtight.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- In the case of wall joints with rebated butt boards please note that the end-grain surface of the CLT boards becomes smaller as a result of the rebate (surface pressure).

Illustration
2.4 Horizontal wall joint (butt jointing)

Execution

- Joint-sealing tape must be used to make the structure airtight.
- If positioned appropriately, an interior wall can also assume the function of the wall post shown in the drawing.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- The vertical wall post can serve as an additional support for, for example, joists or purlins (higher surface pressure).

Illustration
2.5 Horizontal wall joint (external butt boards)

Execution

- When external butt boards are used (e.g. 3-layer plate or laminated veneer lumber), the subsequent layer structure must be adapted to them.
- Joint-sealing tape must be used to make the structure airtight.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- With this type of CLT wall board connection in particular the danger of buckling must be taken into account.
- The joint can also be adhesively bonded to enhance its rigidity.
2.6 Vertical wall joint (lap)

- Joint-sealing tape must be used to make the structure airtight.
- The design must provide sufficient clearance (on one side), depending on the installation situation.
- Make allowance for joint-sealing tape in the rebate height, if necessary.

- The choice and rating of the connectors and all structural components depend on the structural requirements.
- If high shear force transmission at the joint cannot be avoided, the connectors must be specifically dimensioned and positioned as these forces require.

Illustration
### 2.7 Vertical wall joint (butt board)

- When using butt boards (e.g., 3-layer board or laminated veneer lumber), the standard rebate dimensions of 27 × 80 mm should preferably be ensured.
- Joint-sealing tape must be used to make the structure airtight.
- Instead of using screws, the butt board can be connected to the CLT wall boards with suitable glue which improves the transmission of the shear forces.

### Illustration

- The choice and rating of the connectors and all structural components depend on the structural requirements.
3 Lintels

3.1 Continuous lintel

Execution

- If the lintel height is not sufficient from a structural engineering standpoint, there must be an appropriately dimensioned upstand from which the lintel can be suspended. If a wall above the lintel is used as an upstand, it is essential to take account of the sill height of any window openings.

- The choice and rating of the connectors and all structural components depend on the structural requirements.

- The lintel can be connected to the upstand (upper wall) with, for example, perforated metal plates or screws (end-grain screwing should be avoided in this case).
3.2 Engaged lintel

Execution

- An engaged lintel must be dimensioned according to the loads and forces acting on it.
- Attention must be paid to the surface pressure in the lintel support area.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- CLT lintels absorb and transmit shear forces significantly better than glulam lintels. This is because of the lack of transverse layers in glulam.
4 Ceiling
4.1 Ceiling joint (butt board)

Execution

- When using butt boards at ceiling joints (e.g. OSB, 3-layer board or laminated veneer lumber), the standard rebate dimensions of 27 × 80 mm should preferably be ensured.
- Joint-sealing tape must be used if necessary to make the connection airtight.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- Appropriately sized nails, screws or staples can be used as connectors (note permissible minimum diameter).

Illustration
4.2 Ceiling joint (lap)

- Joint-sealing tape must be used if necessary to make the connection airtight.
- The design must provide sufficient clearance (on one side), depending on the installation situation.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- If high shear flow can be expected at the joint, the connectors must be dimensioned and positioned accordingly.

**Illustration**

![Joint-sealing tape joint-sealing tape](image1)

CLT ceiling board CLT ceiling board

Clarity clearance

CLT ceiling board CLT ceiling board

Joint-sealing tape Joint-sealing tape

Screw connection (according to structural analysis)

Screw connection under high shear flow (according to structural analysis)
4.3 Ceiling joint (structural analysis, transverse tension)

- Joint-sealing tape
- Screw connection for shear force transmission at the joint (according to structural analysis)

Static system:

- CLT ceiling board
- Clearance
- CLT ceiling board
- Screw connection to increase transverse tension (according to structural analysis)
- Screw connection for shear force transmission at the joint (according to structural analysis)

Static system:
Execution

- Joint-sealing tape must be used if necessary to make the connection airtight.
- The design must provide sufficient clearance, depending on the installation situation.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- Depending on the static system, fully threaded screws must be used in order to secure effective lateral force connections at the joint and the point of support.

Illustration
4.4 Steel joist

- CLT ceiling board
- Steel girder as a joist (under the ceiling)
- CLT ceiling board (clearance to steel girder)
- Screw connection (according to structural analysis)
- Steel girder as a joist (rebated at top and bottom)
- CLT ceiling board (clearance to steel girder)
- Screws (according to structural analysis)
- Steel girder as a joist (rebated at bottom, not rebated at top)
- CLT ceiling board (clearance to steel girder)
- Screw connection (according to structural analysis)
- Gypsum cardboard / Gypsum fibreboard

Diagram and text depict the construction details for 4.4 Steel joist, including the use of CLT ceiling boards, steel girder as a joist, and screw connections.
Execution

- Joint-sealing tape must be inserted or other tape bonded if necessary to make the connection airtight.
- To ensure trouble-free assembly, CLT ceiling boards must have sufficient clearance because of the cross-section of steel girders.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- In the case of specific fire protection requirements, metal joists must be clad or coated with special paint.

Illustration
4.5 Wooden joist

Execution

- Joint-sealing tape must be used if necessary to make the connection airtight.
- The choice and rating of the connectors and all structural components depend on the structural requirements.

Illustration
4.6 Joist (wall cut-out)

**Execution**

- A suitable adhesive tape (joint bonding) must be used if necessary to make the structure airtight.
- The design must provide sufficient clearance, depending on the installation situation.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- If necessary, the support surface in the wall board must be reinforced with a metal plate and fully threaded screws (pressure).

**Illustration**

[Images of a wooden interior showing joists and CLT wall board]
4.7 Joist (column)

Execution

- The design must provide sufficient clearance, depending on the installation situation.
- The choice and rating of the connectors and all structural components depend on the structural requirements.

Illustration
4.8 Joist (beam holder)

- The design must provide sufficient clearance, depending on the installation situation.
- The choice and rating of the connectors and all structural components depend on the structural requirements.

<table>
<thead>
<tr>
<th>Execution</th>
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<tbody>
<tr>
<td>- The design must provide sufficient clearance, depending on the installation situation.</td>
<td>- The choice and rating of the connectors and all structural components depend on the structural requirements.</td>
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</table>
Execution

- The design must provide sufficient clearance, depending on the installation situation.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- Appropriate beam holders must be used which correspond to the dimensions of the joists.

Illustration
4.9 Joist bearer

Execution

- Joint-sealing tape must be used if necessary to make the connection airtight.
- To ensure airtightness of the CLT wall board, it is essential to preserve its middle layer (rebate area).
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- Please note: Rebating reduces the support surface at the joint; additionally, the joist bearer can shrink, which would make load transfer impossible (surface pressure).
4.10 Wooden beam ceiling

**Execution**

- Deflection (serviceability check) of the ceiling board must be taken into account (centre distance of the beams and dimensions of the ceiling).

- The choice and rating of the connectors and all structural components depend on the structural requirements.

**Illustration**

- CLT ceiling board
- Ceiling beam (glulam)

Screw connection (according to structural analysis)
4.11 Ribbed ceiling

**Execution**
- Deflection (serviceability check) of the ceiling board must be taken into account (centre distance of the ribs and dimensions of the ceiling).
- Structural connection between the ribs and ceiling by means of screwing or gluing.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- Ceiling (with span direction parallel to that of the ribs) can be included in the structural analysis or can be estimated.

**Illustration**

![Ribbed ceiling illustration](image-url)
5 “Lower floor wall – ceiling – upper floor wall” connection node

5.1 Platform framing

Execution

- To achieve the required airtightness in a building, the joints of the CLT boards can, apart from joint-sealing tape, alternatively be sealed with suitable adhesive tape on the inside and outside of the boards.

- The choice and rating of the connectors and all structural components depend on the structural requirements.

- Wall anchoring for structurally effective connection between wall and ceiling (shear and tensile forces).

- Screw connection of T-joint from inside or outside.

Illustration
Execution

- To achieve the required airtightness in a building, the joints of the CLT boards can, apart from joint-sealing tape, alternatively be sealed with suitable adhesive tape on the inside and outside of the boards.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- Wall anchoring for structurally effective connection between wall and ceiling (shear forces in wall direction; tensile and compressive forces from wind load).

Illustration
5.2 Balloon framing

- In the case of specific fire protection requirements, the angle bracket on which the ceiling board rests must be clad.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
6 Roof
6.1 CLT roof structure (eaves laths)

Execution

- Joint-sealing tape must be used to make the structure airtight.
- Note edge distances of screw connection.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- The screw connection between the roof and wall boards absorbs shear forces acting in the direction of the point of support and suction forces from the wind load.

Illustration
6.2 CLT roof structure (butted against wall board)

**Execution**
- Joint-sealing tape must be used to make the structure airtight.
- Only the CLT wall board needs a bevelled edge, with the CLT roof board forming the roof projection and soffit.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- The screw connection between the roof and wall boards absorbs shear forces acting in the direction of the point of support and suction forces from the wind load.

**Illustration**
6.3 CLT roof structure (birdsmouth joint)

- Joint-sealing tape must be used to make the structure airtight.
- The CLT wall board has a straight edge requiring a birdsmouth to be machined in the roof board (please note that the birdsmouth must not be too deep, otherwise it might weaken the lower longitudinal layer).
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- The screw connection between the roof and wall boards absorbs shear forces acting in the direction of the point of support and suction forces from the wind load.

Illustration
6.4 Rafter roof (rafter cut-outs in the wall board)

**Execution**

- Sufficient clearance must be provided in the rafter cut-outs in the wall.
- Depending on requirements, joint-sealing tape or exterior adhesive tape must be used to make the structure airtight.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- The screw connection between the rafters and CLT wall board absorbs the suction forces of the wind.

**Illustration**
6.5 Rafter roof (birdsmouth in rafter)

Execution

- When purlin extensions are attached, they must reach at least as far as the first rafter inside the gable wall.
- Depending on requirements, joint-sealing tape or exterior adhesive tape must be used to make the structure airtight.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- The screw connection between the rafters and CLT wall board or purlin extension absorbs the suction forces of the wind.

Illustration
6.6 Ridge (with purlin)

**Execution**

- The prescribed support point widths and areas must be observed.
- Ensure that the birdsmouth is sufficiently deep, based on the structure of the roof board (number of layers).
- Joint-sealing tape must be used to make the structure airtight.
- The choice and rating of the connectors and all structural components depend on the structural requirements.

**Illustration**

![Ridge (with purlin) illustration](image-url)
6.7 Ridge (without purlin) in folded-plate structures

Execution

- Joint-sealing tape must be used to make the structure airtight.
- The roof is fitted with the aid of falsework.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- In this case, the screw connection of the CLT roof boards can mainly absorb and transmit shear forces.

Illustration
Execution

- The screw connection between the ceiling boards and the upstand depends on the forces acting. The choice is between fully threaded screws and partly threaded flat-head screws.
- When using partly threaded flat-head screws ensure that the head is buried.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
7.2 Steel upstand

<table>
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<tbody>
<tr>
<td>• In this case, fully threaded and partly headed screws can be used for the screw connection. As the screwing is carried out from above, steel beams of low cross-sectional height must be provided with holes in the upper flange (through which screws can be inserted).</td>
</tr>
<tr>
<td>• The choice and rating of the connectors and all structural components depend on the structural requirements.</td>
</tr>
</tbody>
</table>
7.3 Wall as an upstand

**Execution**

- When using upper-floor wall boards as upstands (for attaching the ceiling above), window openings and their sill height must be taken into account.
- Use metal plates and fully threaded screws to transmit forces from end grain to end grain (pressure).
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- Cantilever ceilings must be connected to upper wall boards with closely spaced, fully threaded screws.

Please note: If the wall has a window opening in this position, it can no longer be used as a cantilever and a support for other walls.