

A\_Shell construction

The information below provides an example of Stora Enso's construction proposals

## **A Shell construction**

- Plinth/Wall anchorage
- Wall joint
- Lintel
- Ceiling
- "Ground floor wall – ceiling – top floor wall" connecting nodes
- Roof
- Cantilever/coat

## **B Layer structure**

- External walls
- Internal walls
- Floor structure
- Slab (underside)
- Roof
- Party wall
- Building partition wall

## **C Details**

- Plinth/Wall anchorage
- Window connection
- Door joint
- Cantilever
- Pitched roof
- Flat roof
- Electric installation
- Sanitary installation
- Fireplace
- Stairs

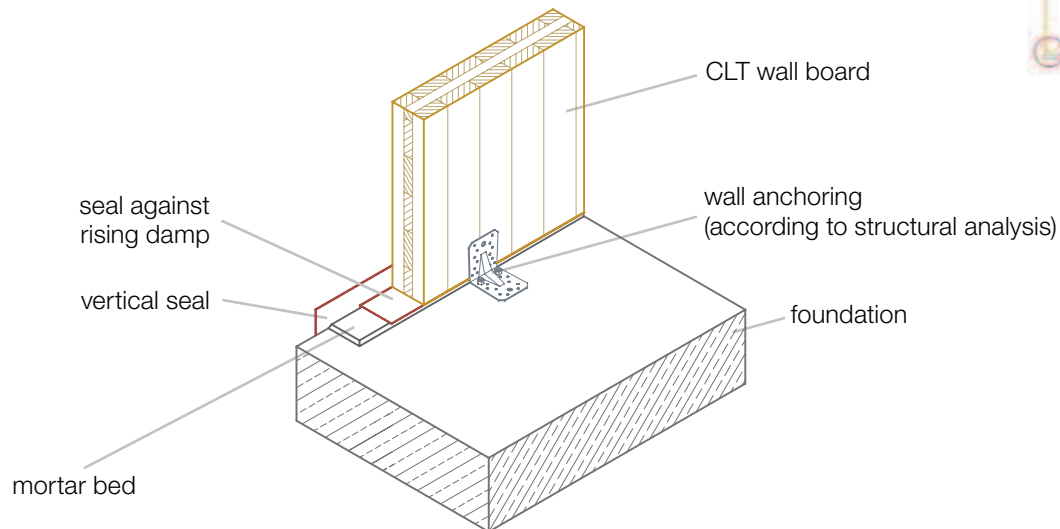
## **D Other applications**

- Industrial and commercial buildings
- Multi-storey residential buildings
- Building extensions
- Structural engineering

**Constructions or structures must be tested separately and calculated on a case by case basis with regard to the structural analysis, building physics and feasibility. The actual professional implementation is the responsibility of the crews authorised to perform the work.**

## 1 Base and wall anchoring

### 1.1 Base with mortar bed



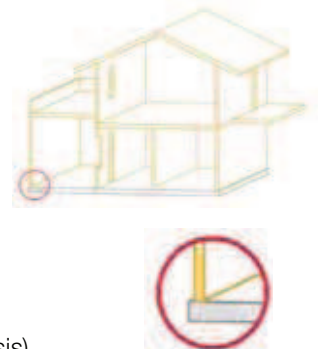
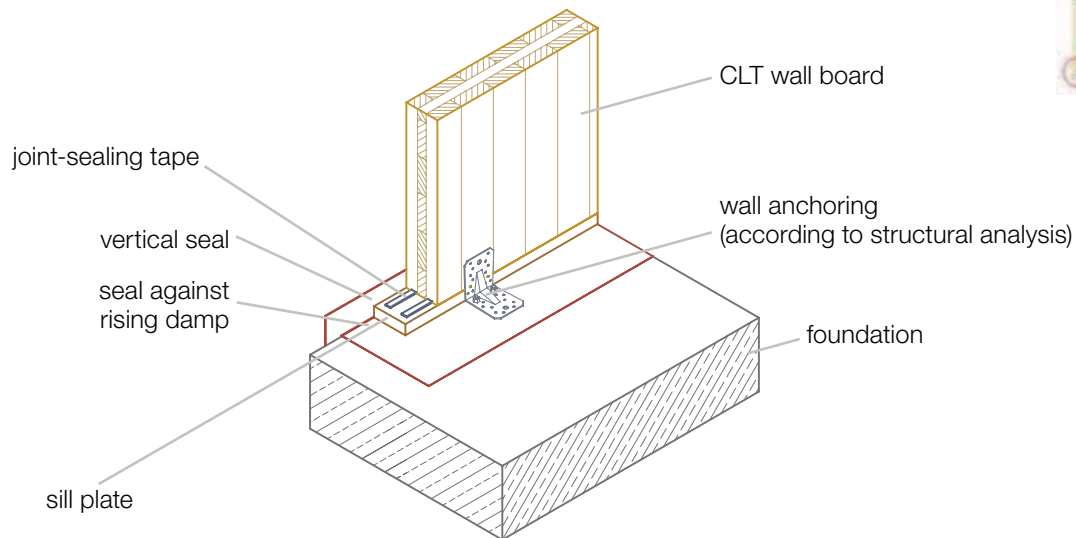
#### Execution

- 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



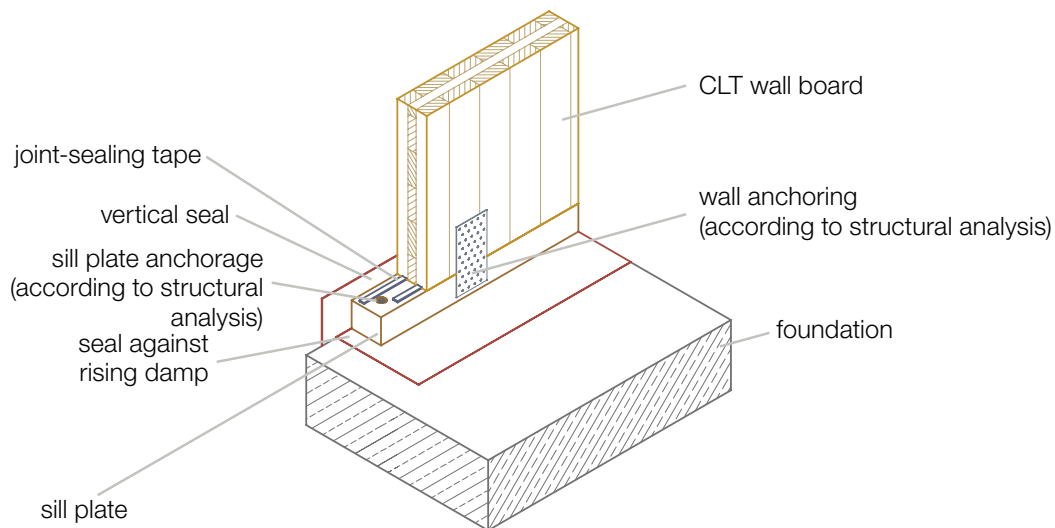
### Execution

- 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



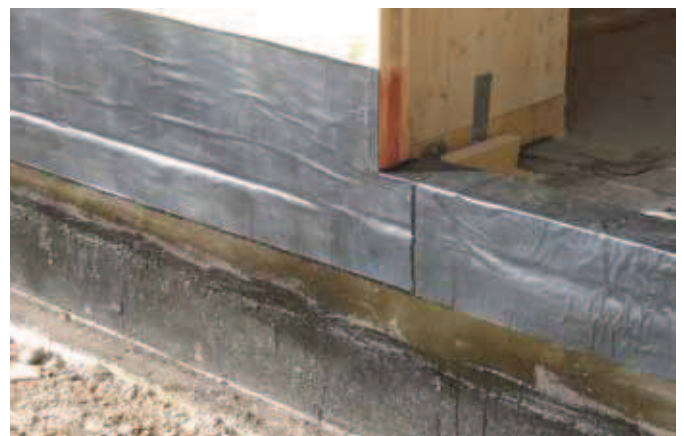
## 1.3 Base with raised sill plate



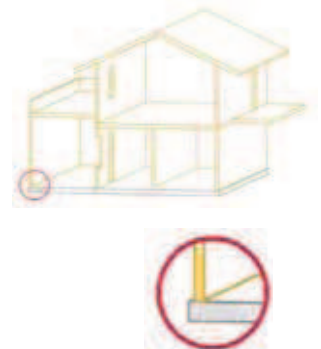
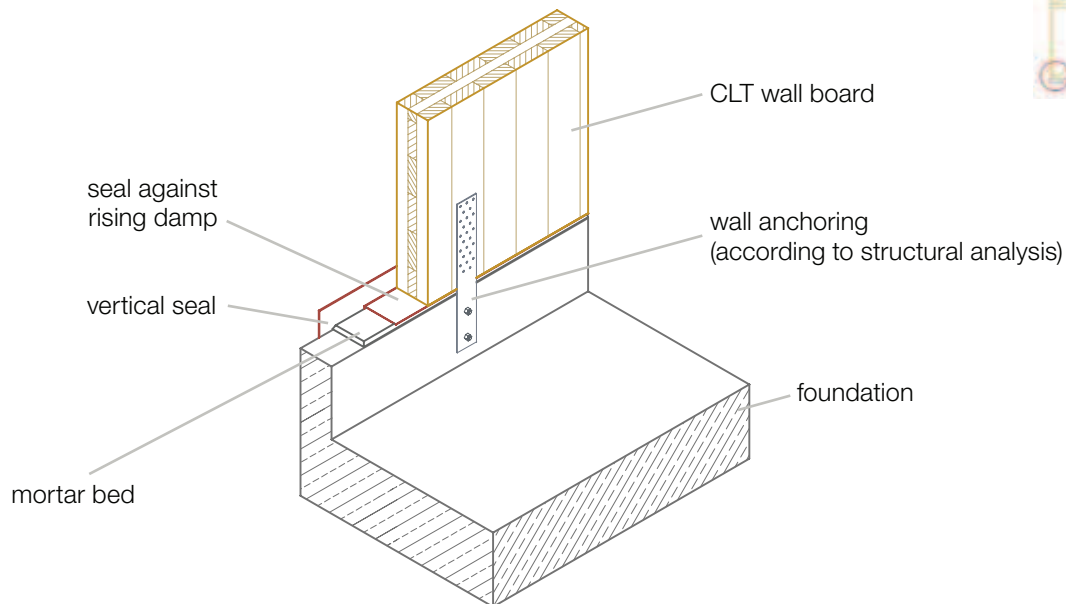
### Execution

- 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



## 1.4 Concrete base (mortar bed)



### Execution

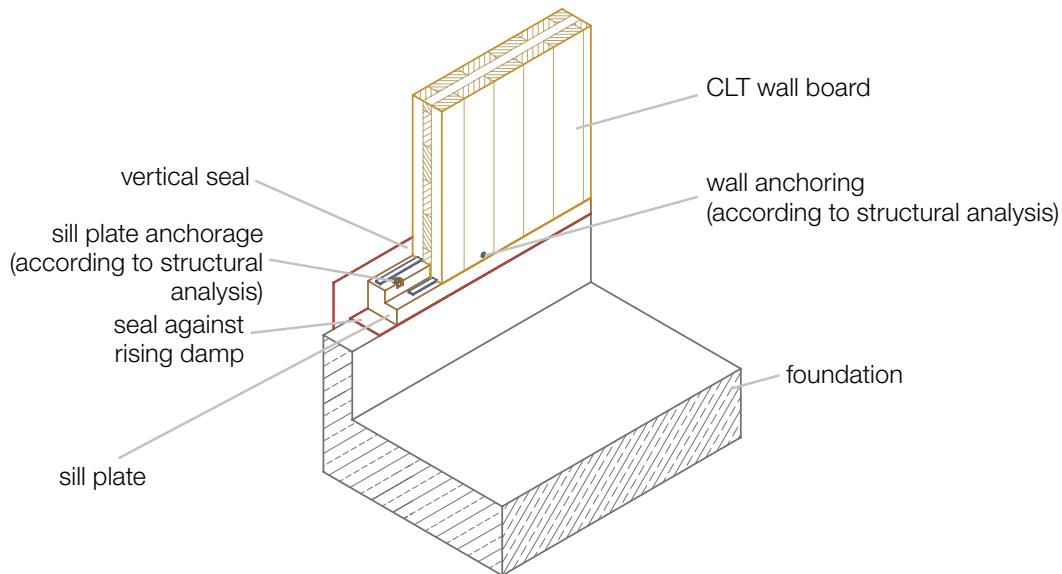
- The CLT board can be installed on a dry or wet mortar bed for tolerance compensation (full surface contact). The CLT must be protected against rising damp using a suitable damp-proof seal.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- When fitting the wall anchoring (tensile and shear forces), the permissible edge distances for the connectors must be observed.

### Illustration





## 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

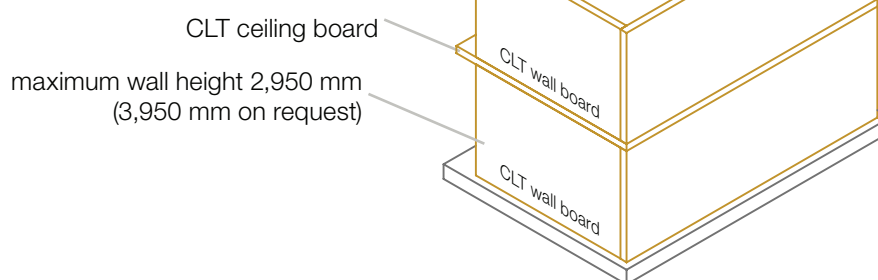


## 2 Wall joints

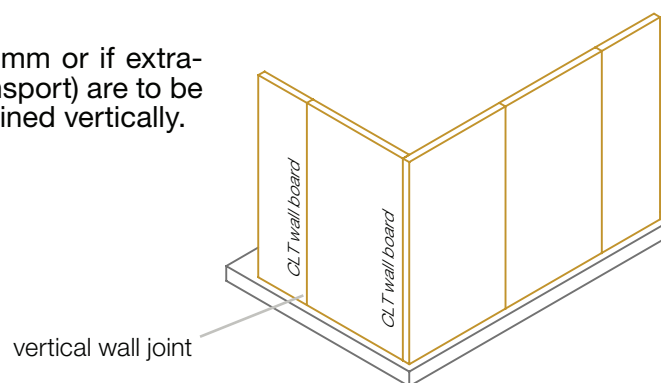
### Basic design rules

#### WALL JOINTS:

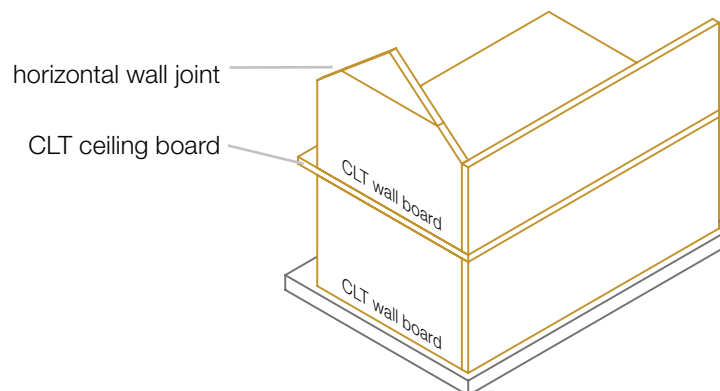
1. CLT wall boards should preferably be full-storey height (no joints).



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)

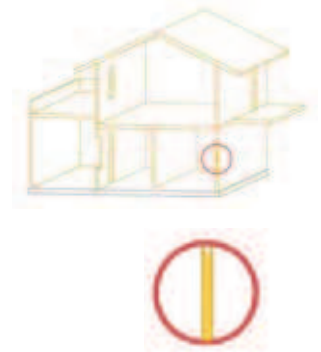
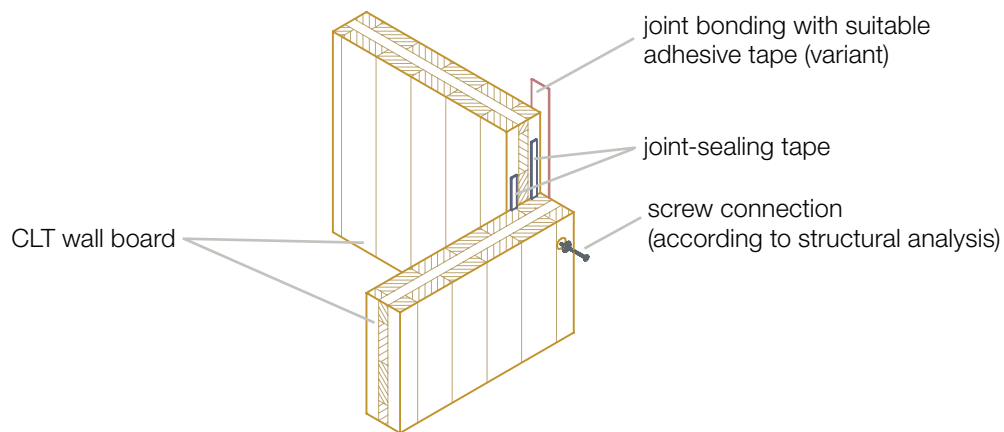


3. If alternatives 1 and 2 cannot be used, the boards must be joined horizontally. (see details under 2.3, 2.4 and 2.5)





## 2.1 Corner joint



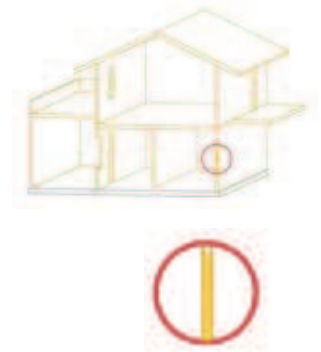
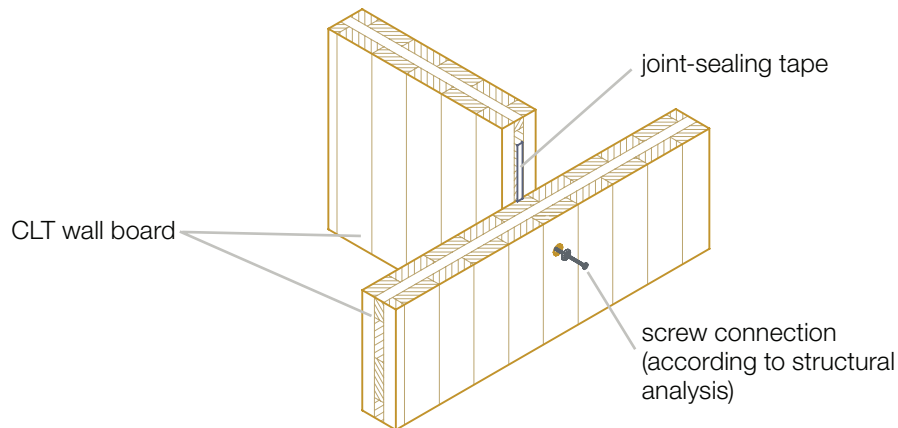
### Execution

- 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



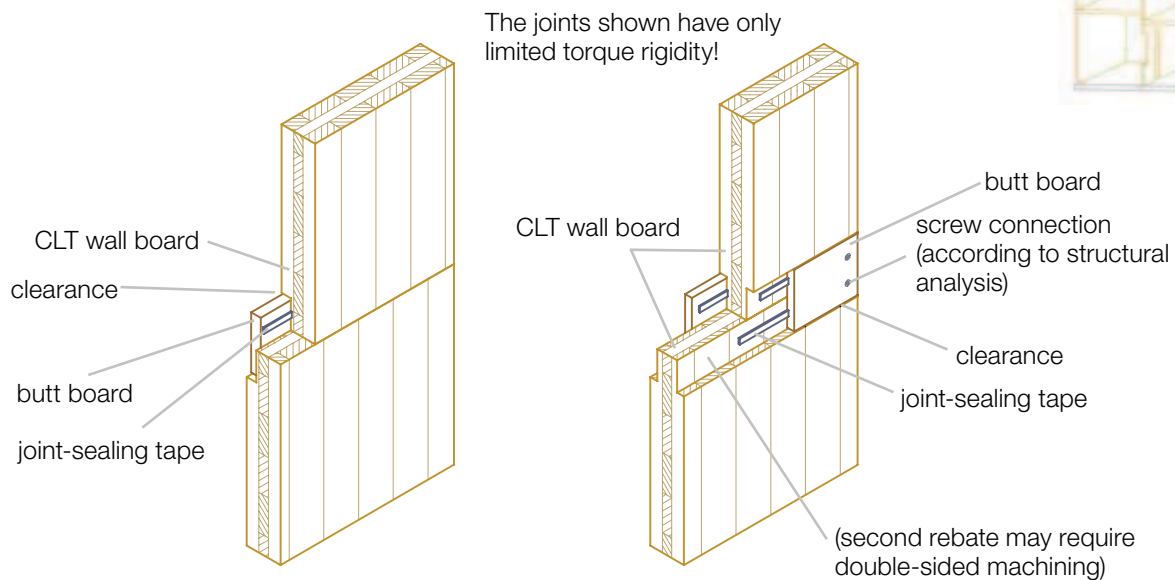
### Execution

- 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)



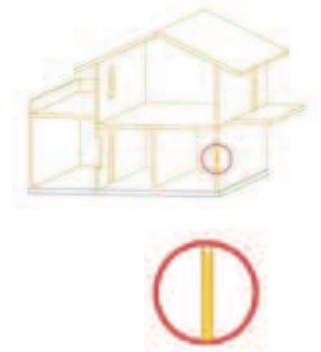
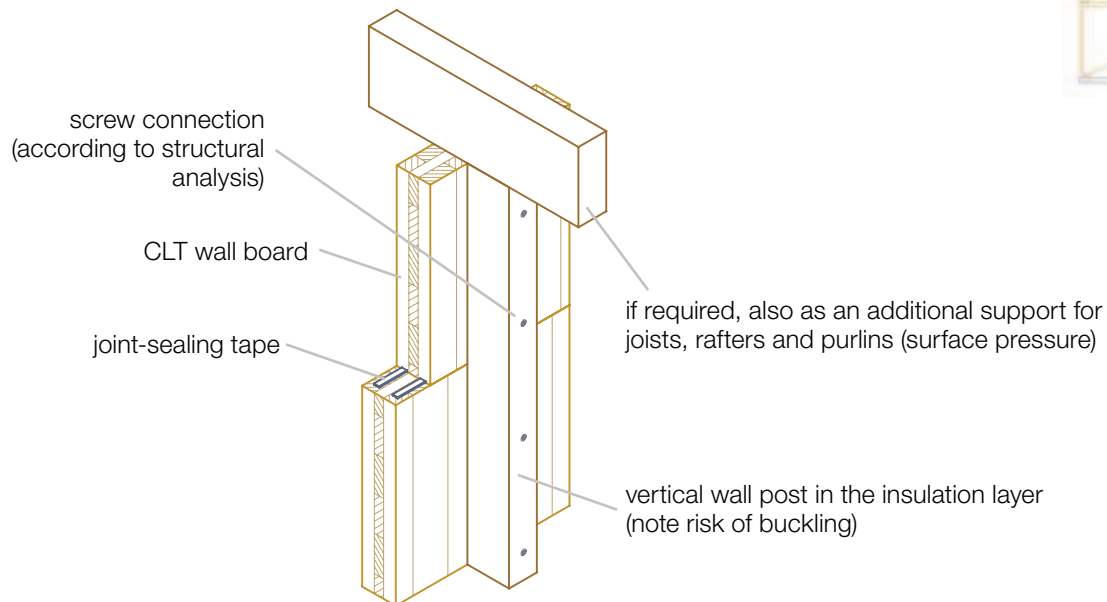
### Execution

- 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.
- 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)



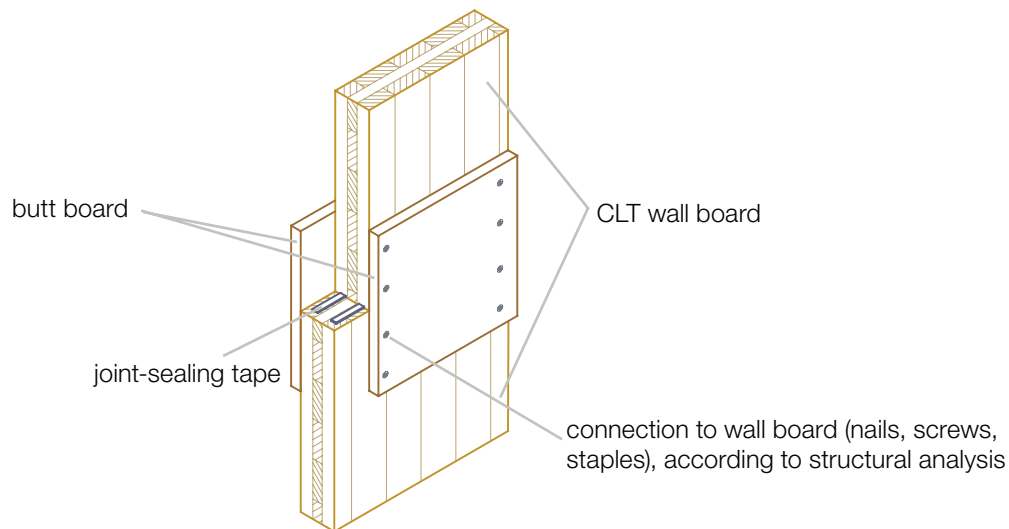
### Execution

- 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



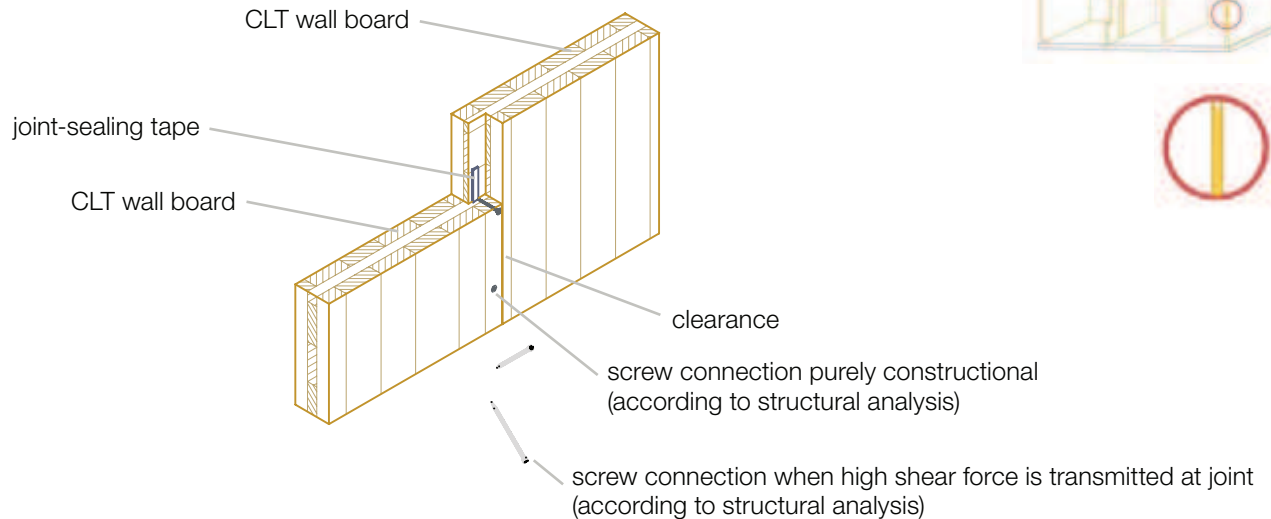
## 2.5 Horizontal wall joint (external butt boards)



### 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)



### Execution

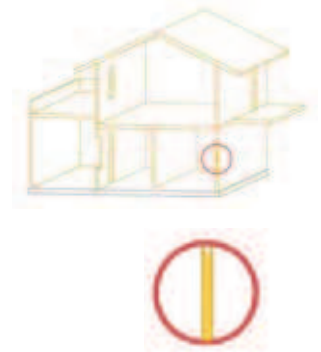
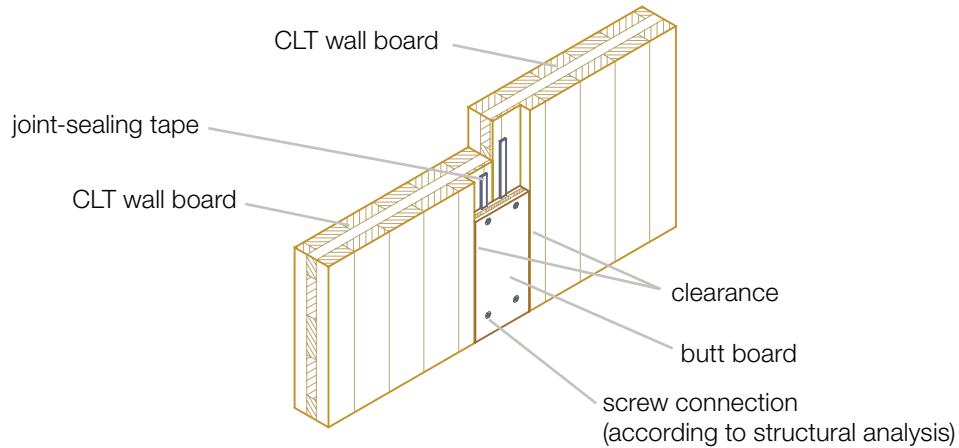
- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>• Joint-sealing tape must be used to make the structure airtight.</li> <li>• The design must provide sufficient clearance (on one side), depending on the installation situation.</li> <li>• Make allowance for joint-sealing tape in the rebate height, if necessary.</li> </ul> | <ul style="list-style-type: none"> <li>• The choice and rating of the connectors and all structural components depend on the structural requirements.</li> <li>• If high shear force transmission at the joint cannot be avoided, the connectors must be specifically dimensioned and positioned as these forces require.</li> </ul> |
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### Illustration





## 2.7 Vertical wall joint (butt board)



### Execution

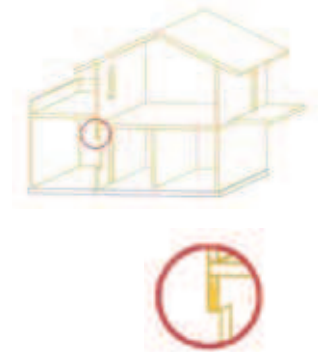
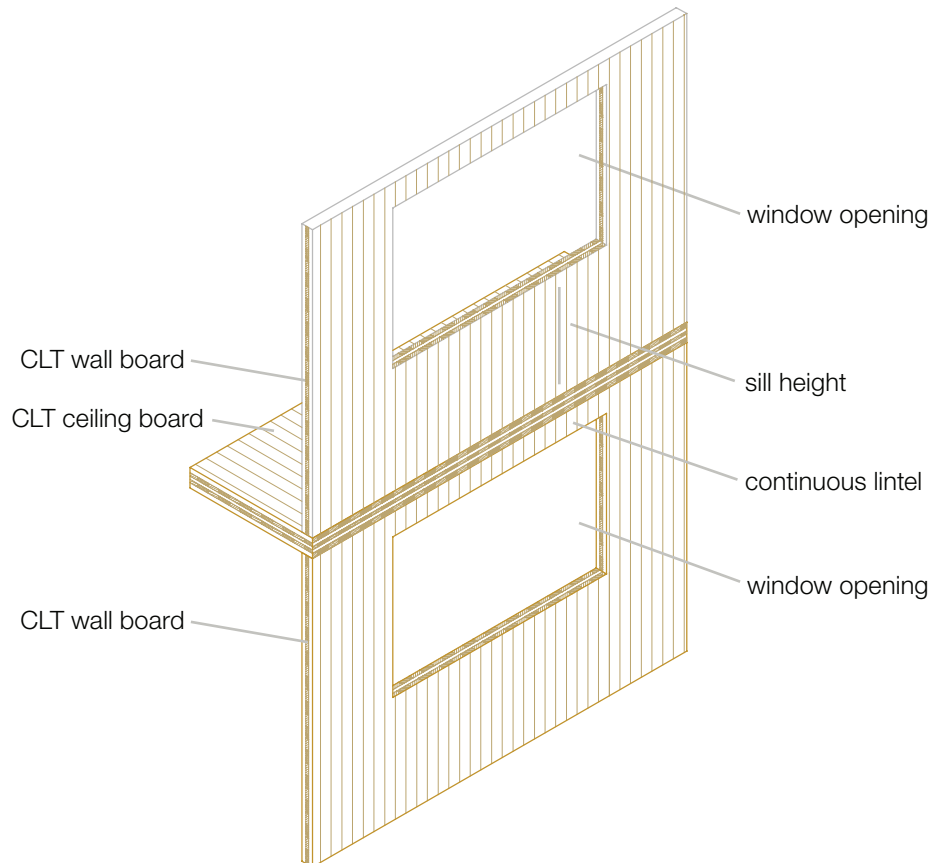
- When using butt boards (e.g. 3-layer board or laminated veneer lumber), the standard rebate dimensions of  $27 \times 80$  mm should preferably be ensured.
- Joint-sealing tape must be used to make the structure airtight.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- 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



## 3 Lintels

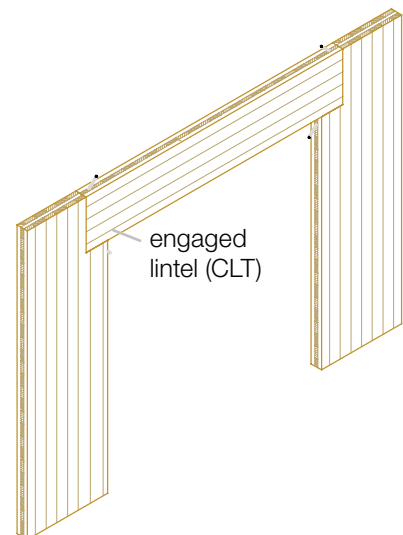
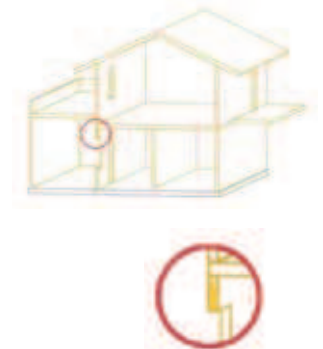
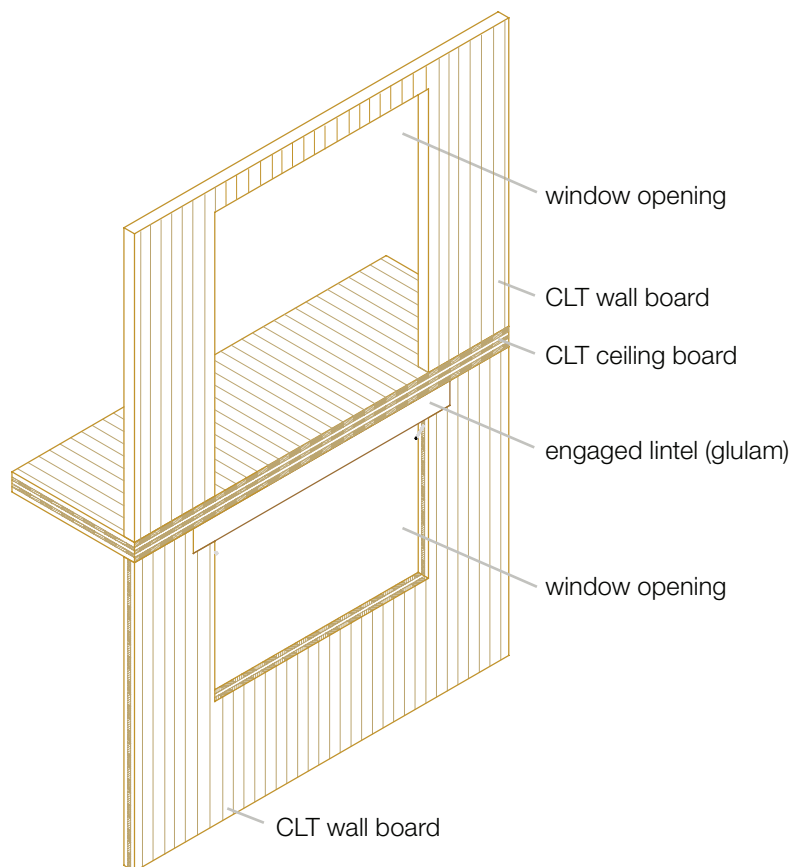
### 3.1 Continuous lintel



#### 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

- |  |   |
|--|---|
| <ul style="list-style-type: none"><li>• An engaged lintel must be dimensioned according to the loads and forces acting on it.</li><li>• Attention must be paid to the surface pressure in the lintel support area.</li></ul> | <ul style="list-style-type: none"><li>• The choice and rating of the connectors and all structural components depend on the structural requirements.</li><li>• CLT lintels absorb and transmit shear forces significantly better than glulam lintels. This is because of the lack of transverse layers in glulam.</li></ul> |
|--|---|

# Construction

FRAME CONSTRUCTION

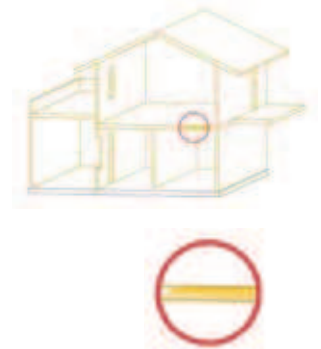
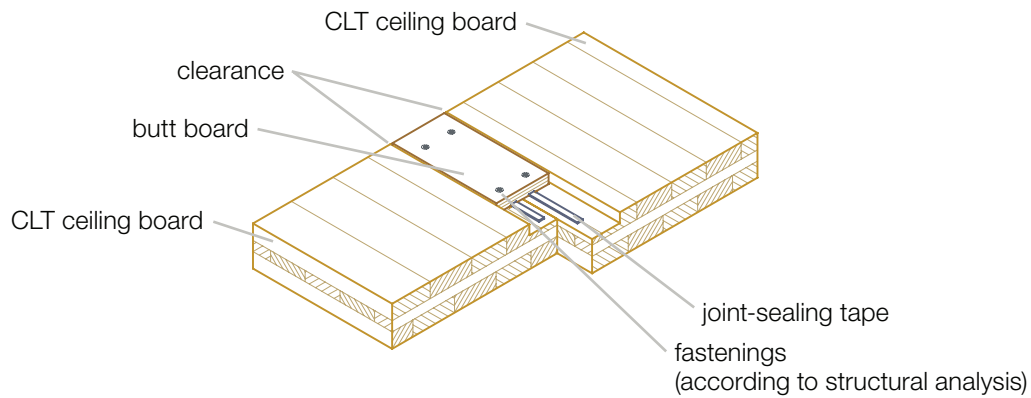
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Illustration



## 4 Ceiling

### 4.1 Ceiling joint (butt board)



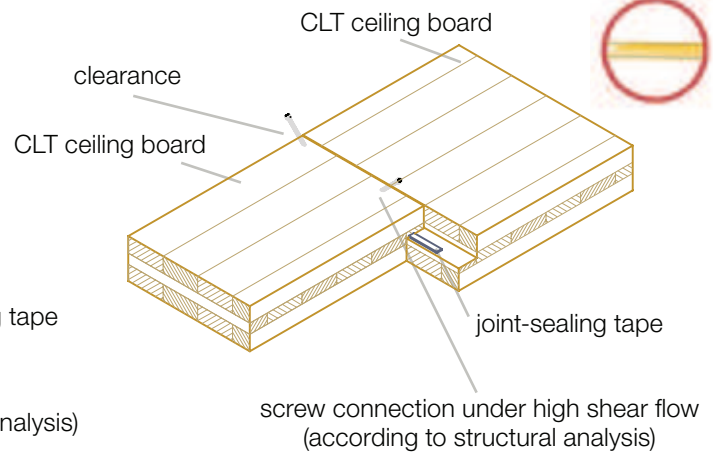
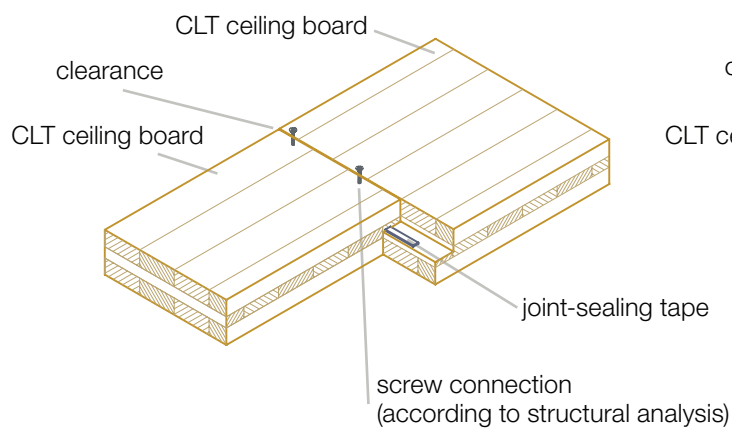
#### Execution

- 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)



### Execution

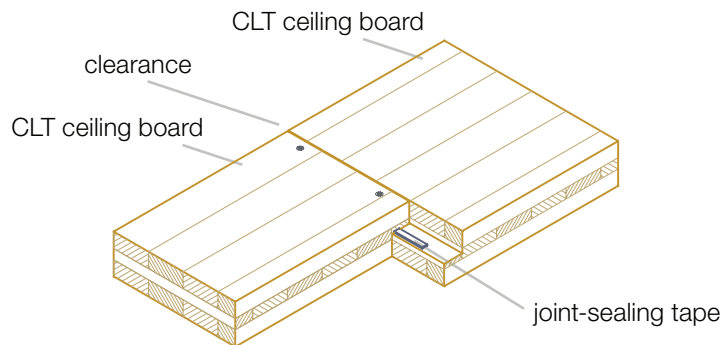
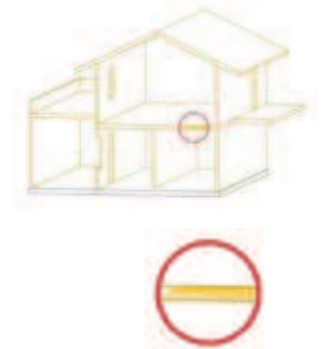
- Joint-sealing tape must be used if necessary to make the connection airtight.
- The design must provide sufficient clearance (on one side), depending on the installation situation.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- If high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

### Illustration

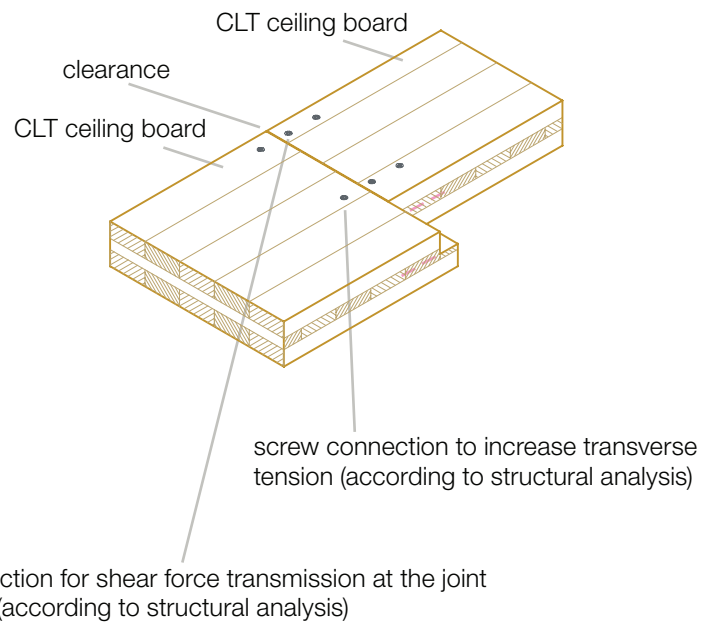
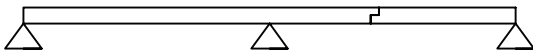




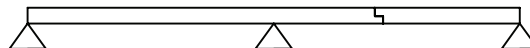
## 4.3 Ceiling joint (structural analysis, transverse tension)

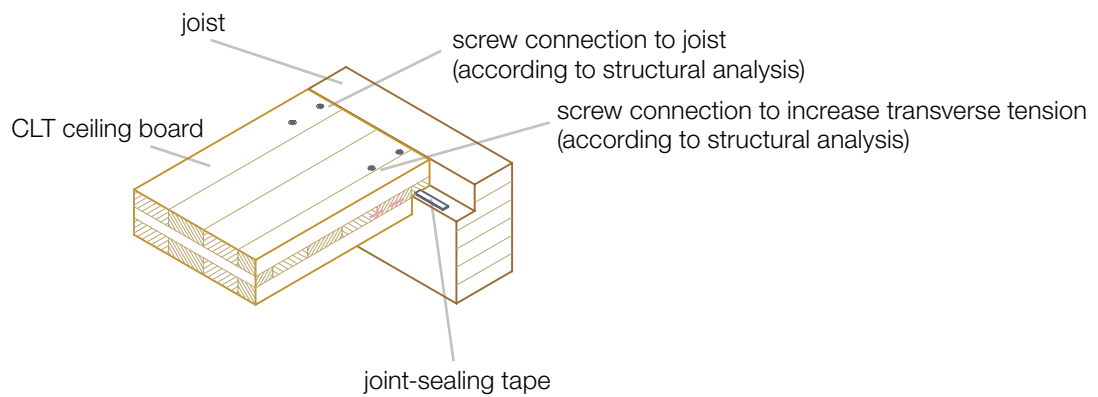


static system:



static system:





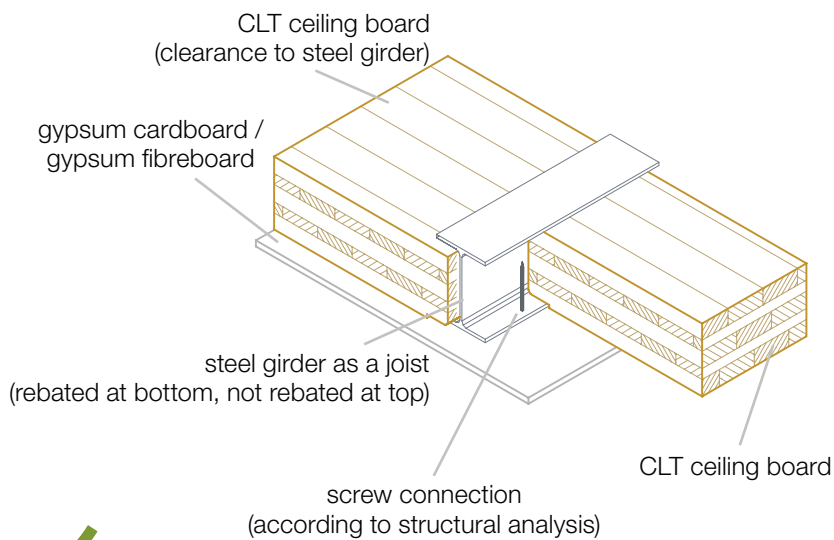
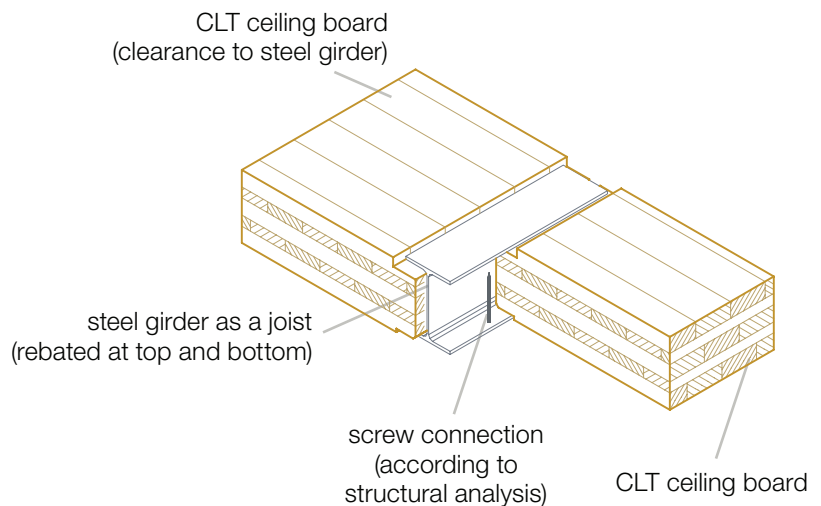
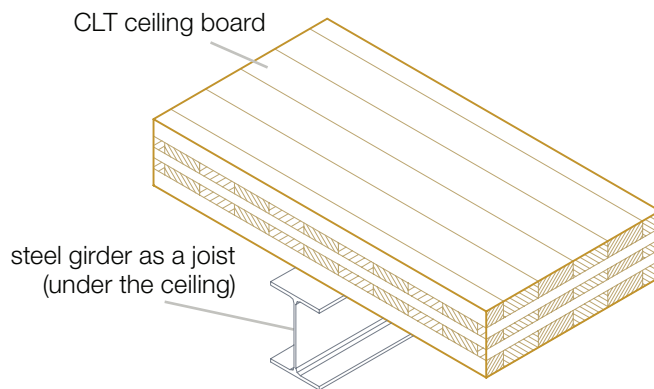
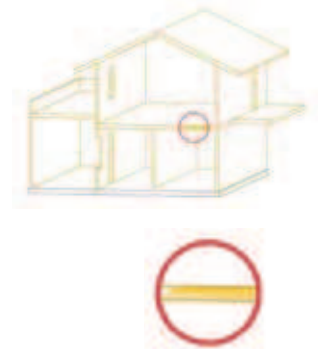
## Execution

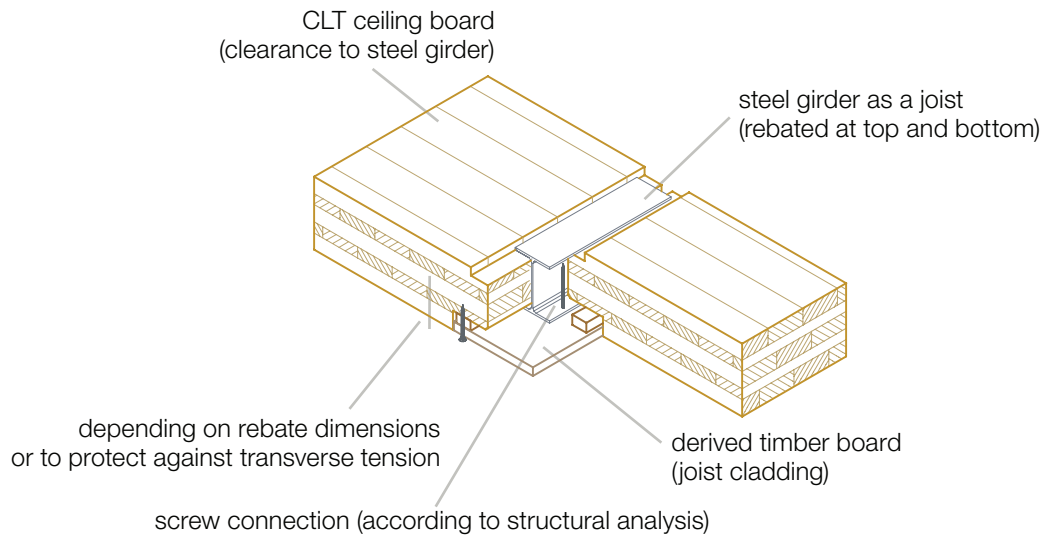
- Joint-sealing tape must be used if necessary to make the connection airtight.
- The design must provide sufficient clearance, depending on the installation situation.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- Depending on the static 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





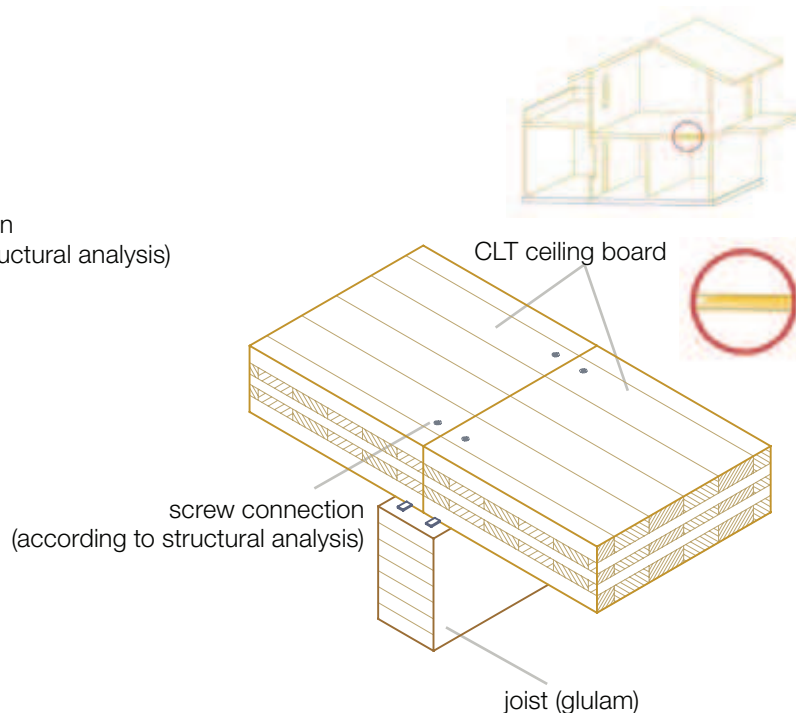
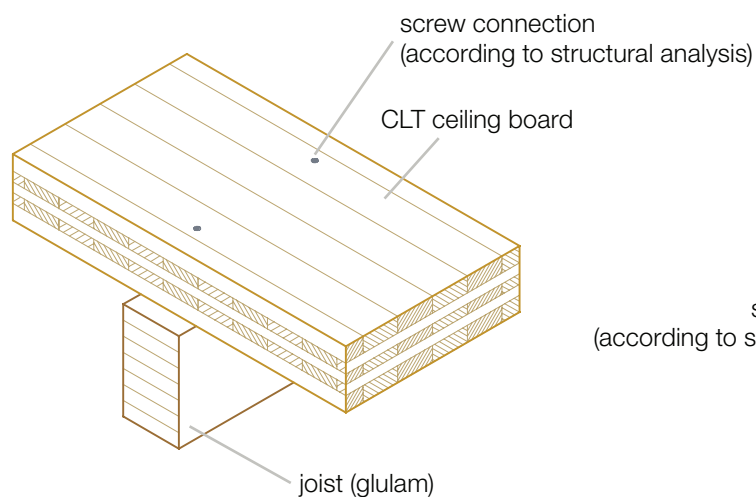
## Execution

- 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



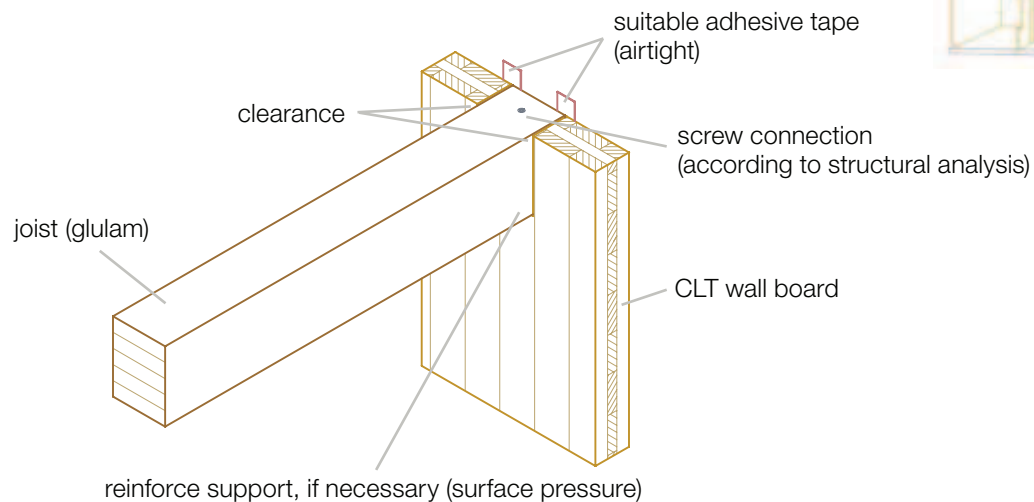
### Execution

- 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

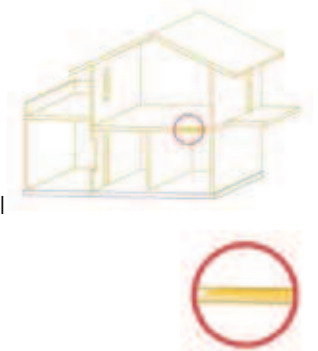
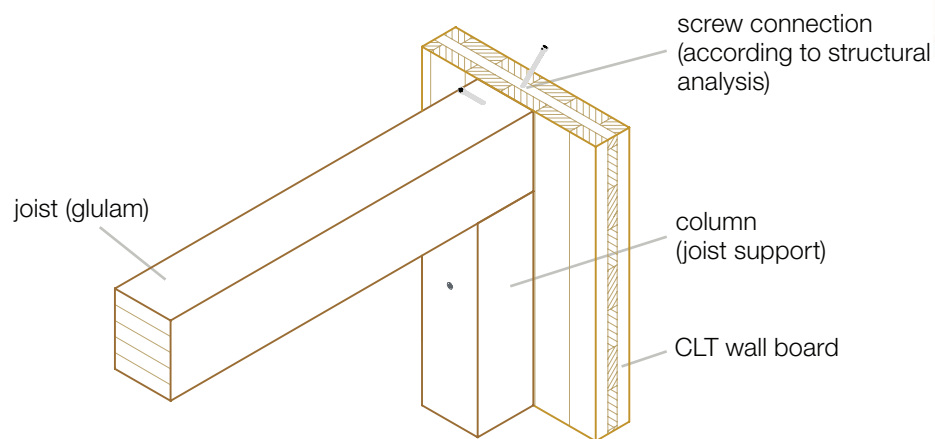
- A suitable adhesive tape (joint bonding) must be used if necessary to make the structure airtight.
- The design must provide sufficient clearance, depending on the installation situation.
- The choice and rating of the connectors and all structural components depend on the structural requirements.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

### Illustration





## 4.7 Joist (column)



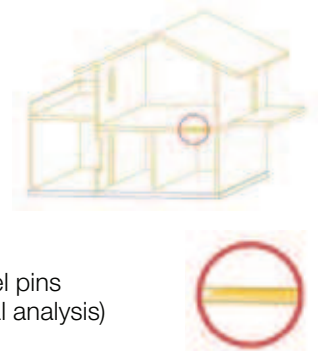
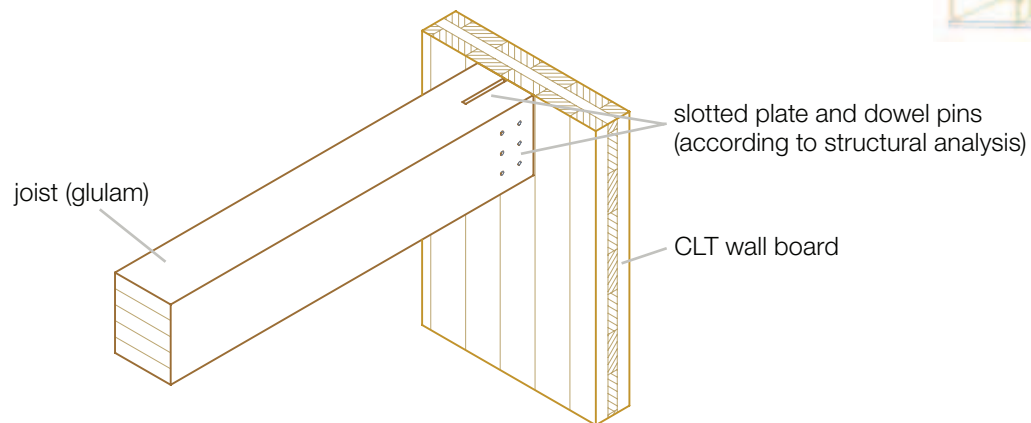
### Execution

- 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

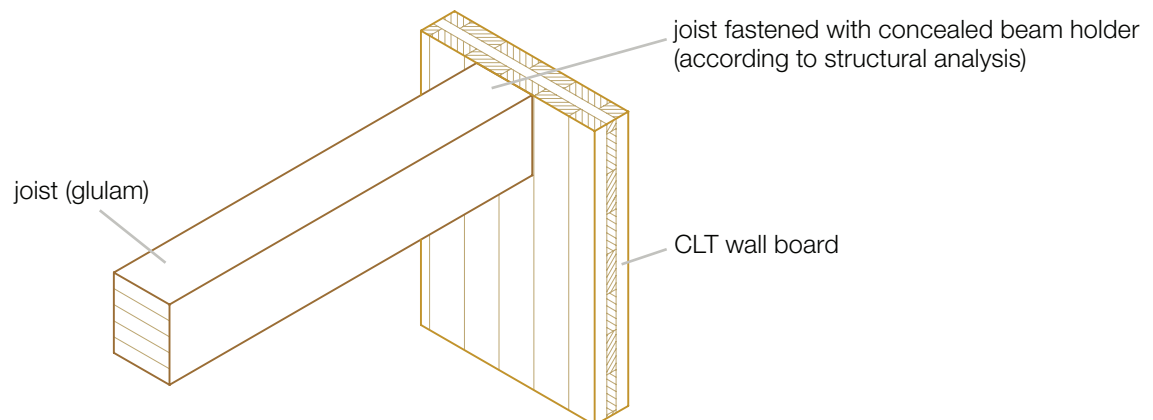


## 4.8 Joist (beam holder)



### 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.



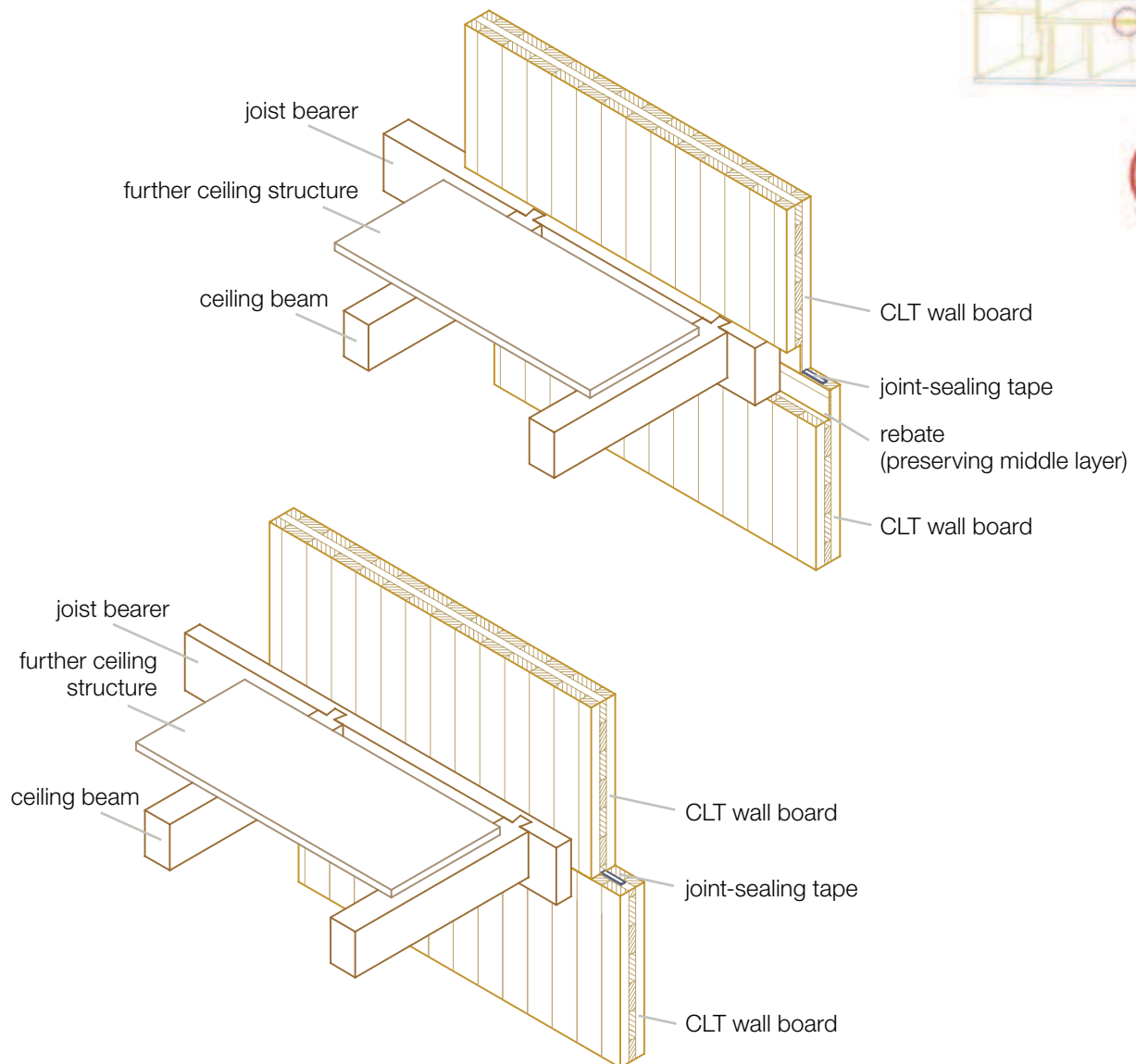
## Execution

- 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).

# Construction

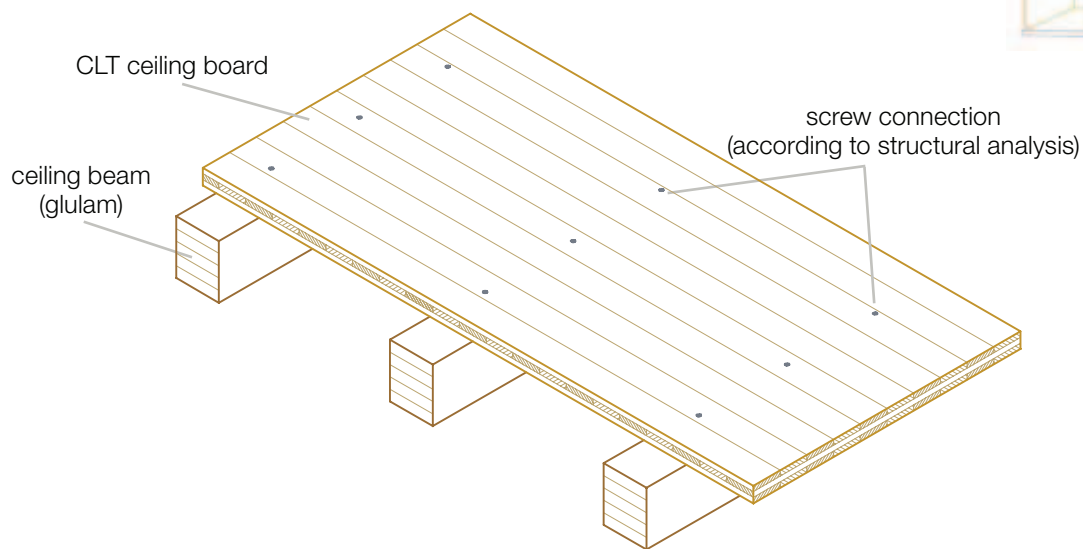
FRAME CONSTRUCTION

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Illustration



## 4.10 Wooden beam ceiling



### Execution

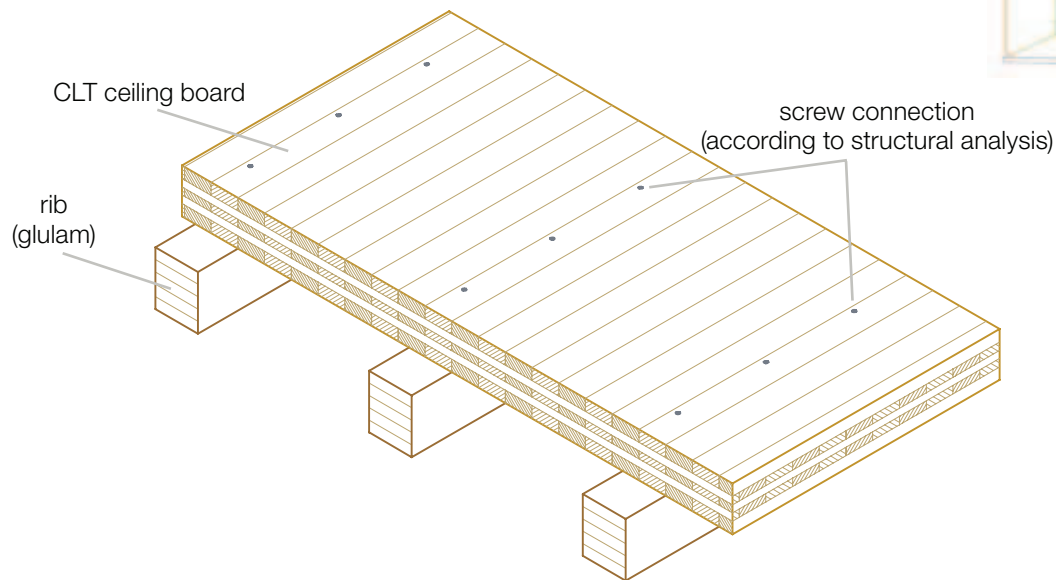
- Deflection (serviceability check) of the ceiling board must be taken into account (centre distance of the beams and dimensions of the ceiling).
- The choice and rating of the connectors and all structural components depend on the structural requirements.

### Illustration





## 4.11 Ribbed ceiling



### Execution

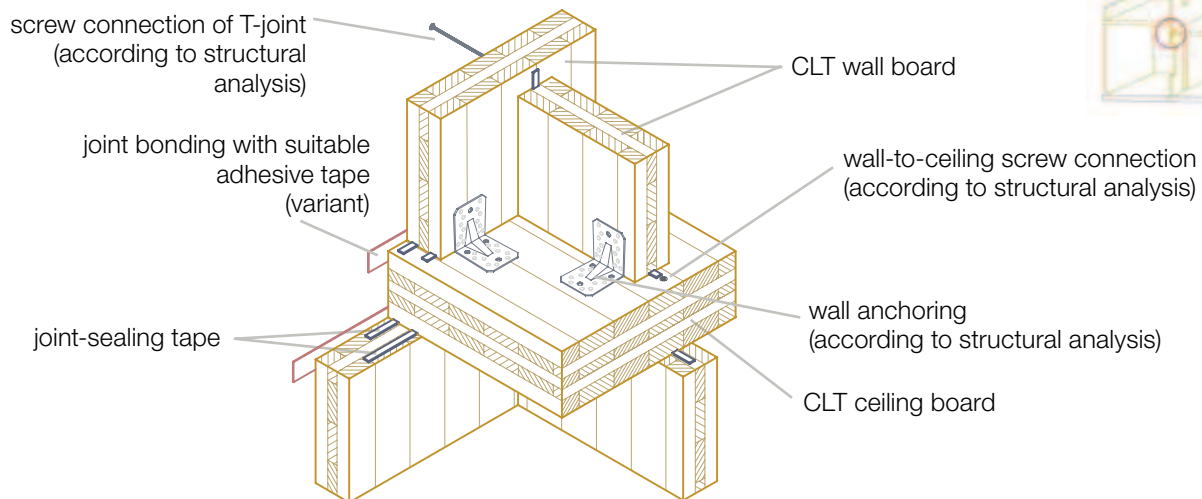
- Deflection (serviceability check) of the ceiling board must be taken into account (centre distance of the ribs and dimensions of the ceiling).
- Structural connection between the ribs and ceiling by means of screwing or gluing.
- The choice and rating of the connectors and all structural components 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



## 5 “Lower floor wall – ceiling – upper floor wall” connection node

### 5.1 Platform framing

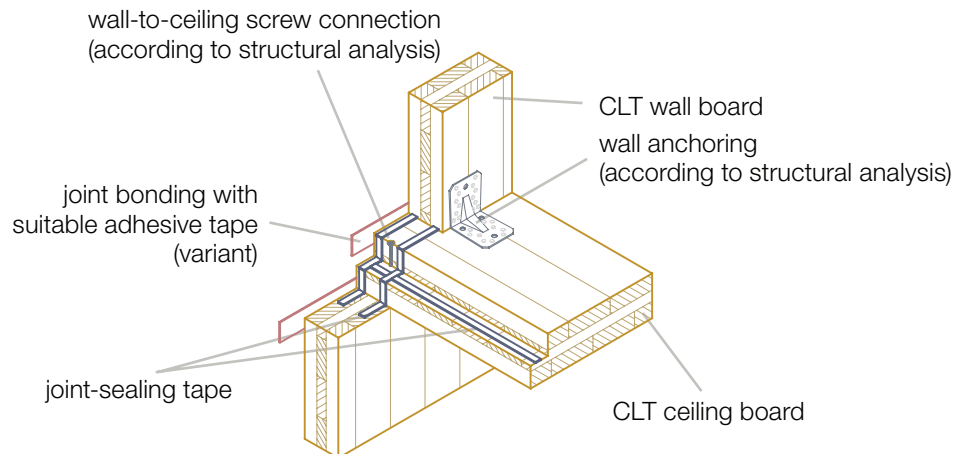


#### Execution

- 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





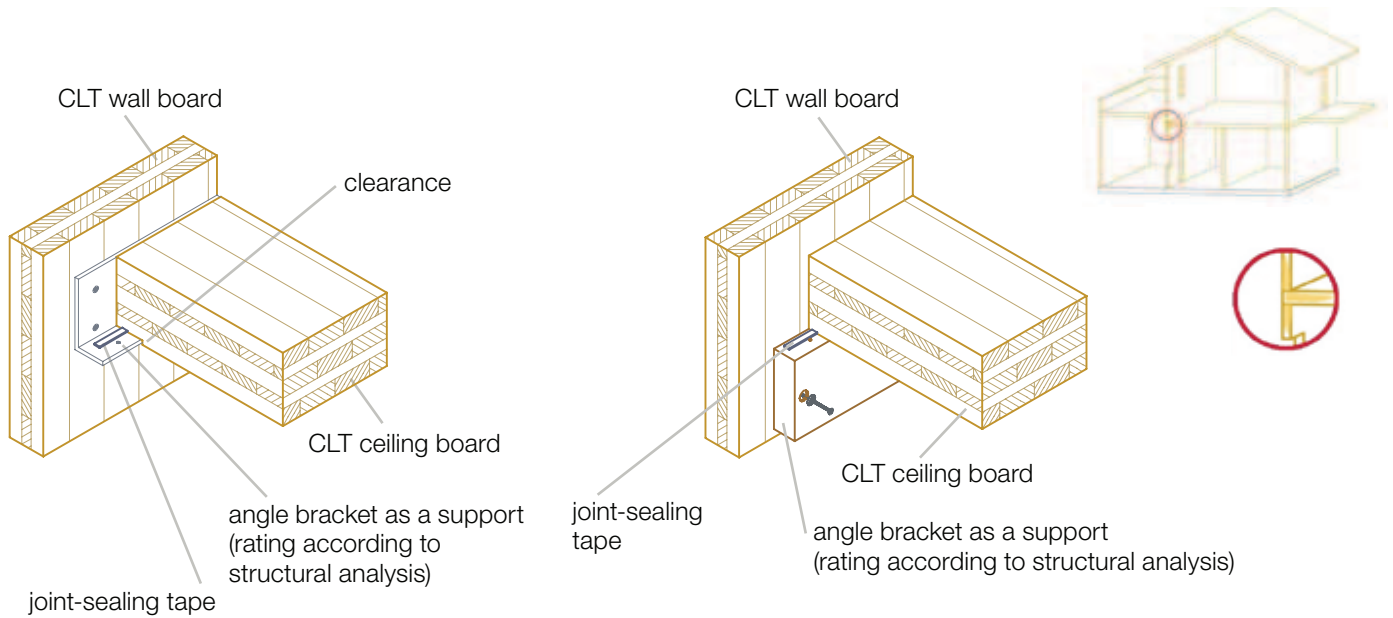
## Execution

- 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

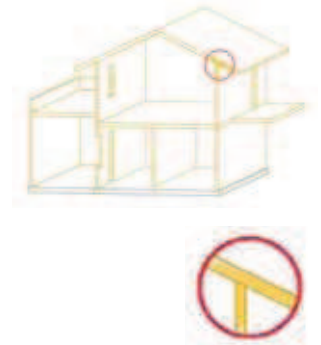
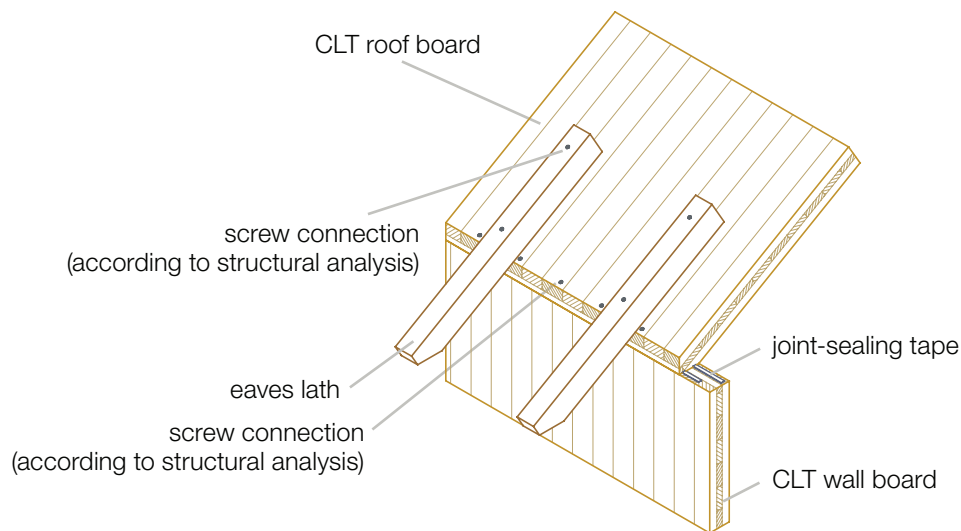


### Execution

- 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)



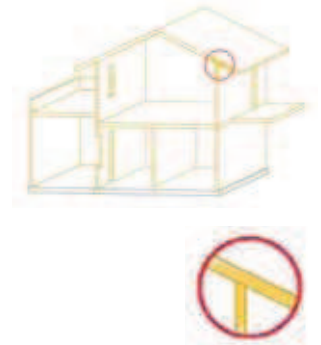
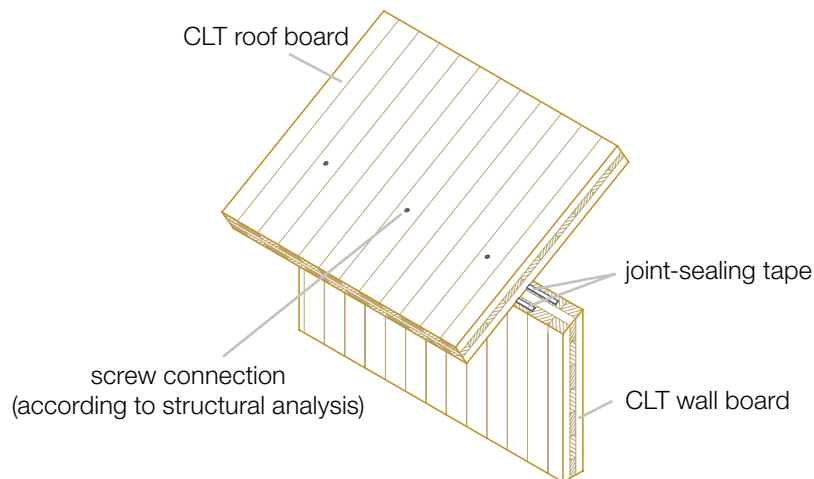
#### Execution

- 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

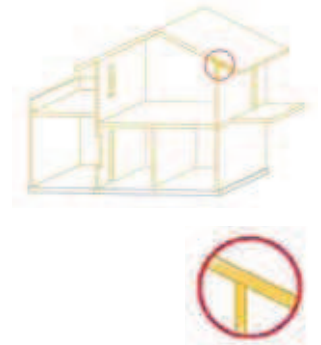
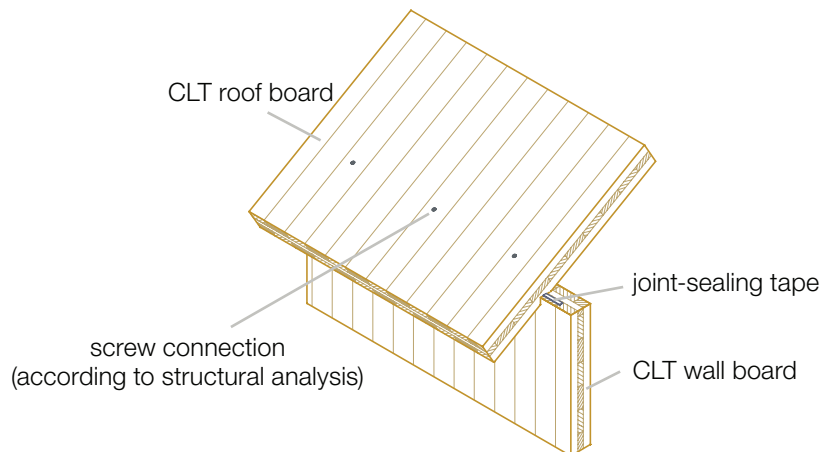
- Joint-sealing tape must be used to make the structure airtight.
- Only the CLT wall board needs a bevelled edge, with the CLT roof board forming the roof projection and soffit.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- The screw 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)



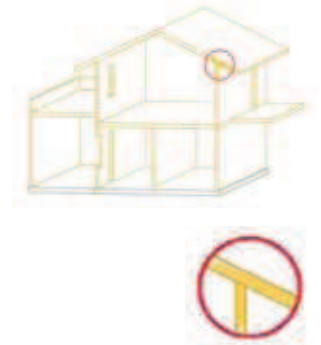
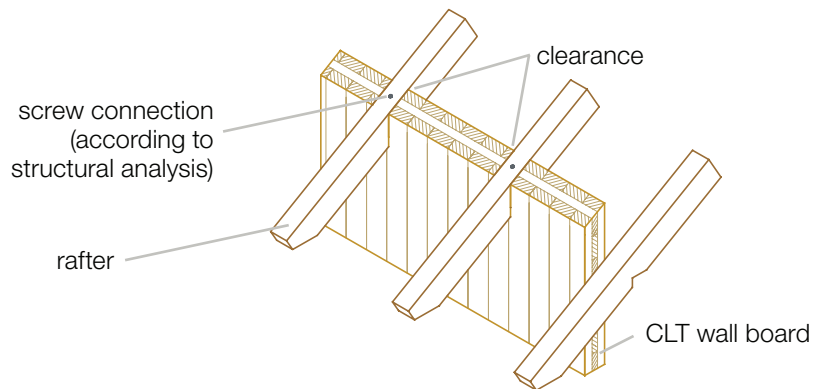
### Execution

- 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)



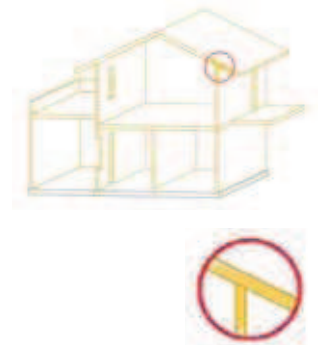
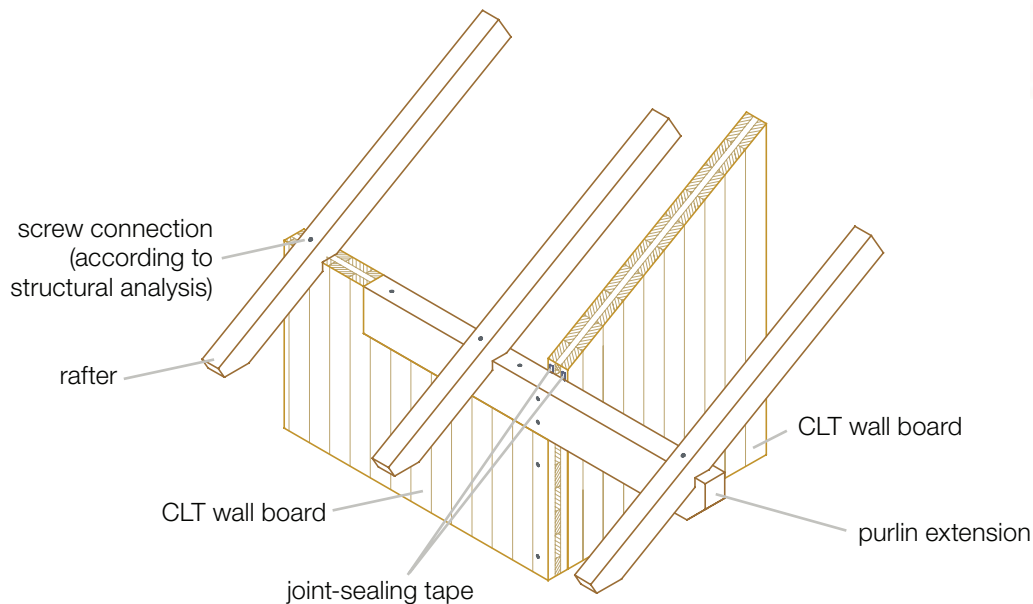
### Execution

- 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)



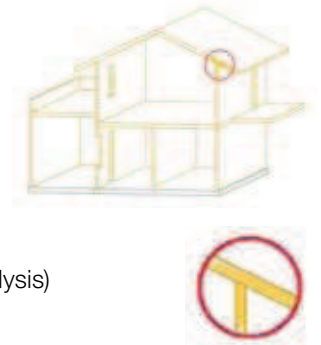
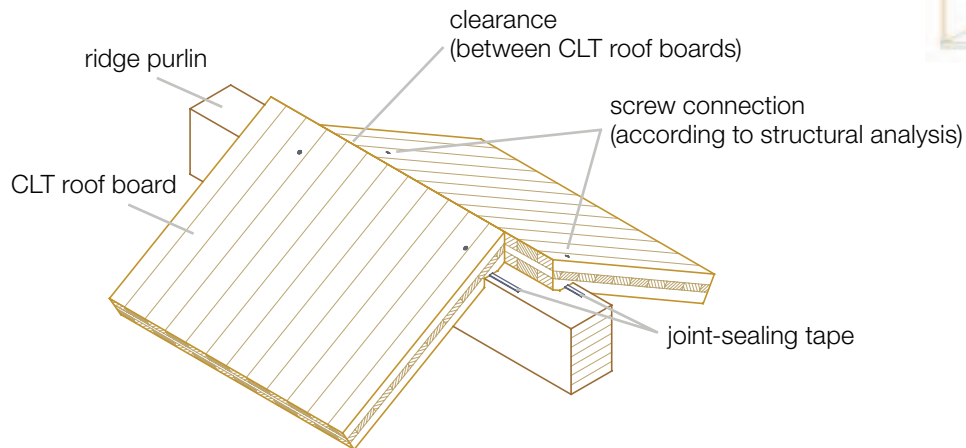
### Execution

- 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

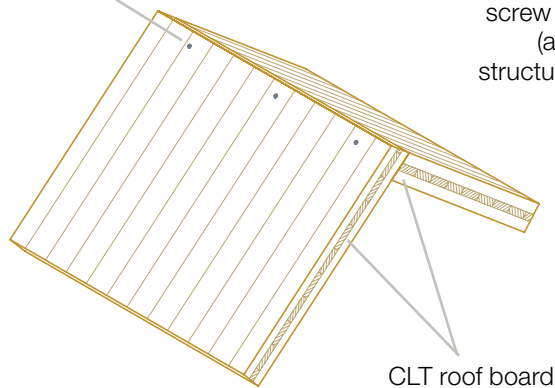
- The prescribed support point widths and areas must be observed.
- Ensure that the birdsmouth is sufficiently deep, based on the structure of the roof board (number of layers).
- Joint-sealing tape must be used to make the structure airtight.
- The choice and rating of the connectors and all structural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

### Illustration

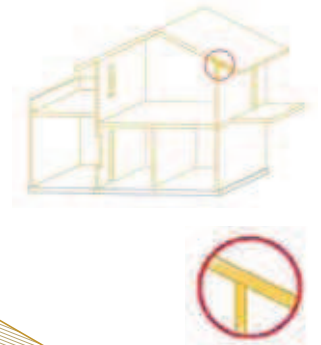
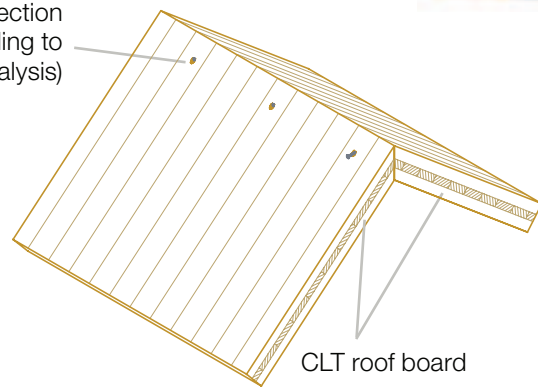


## 6.7 Ridge (without purlin) in folded-plate structures

screw connection  
(according to structural  
analysis)



screw connection  
(according to  
structural analysis)



### Execution

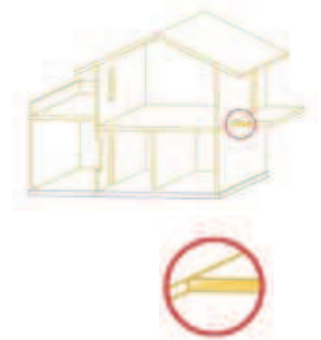
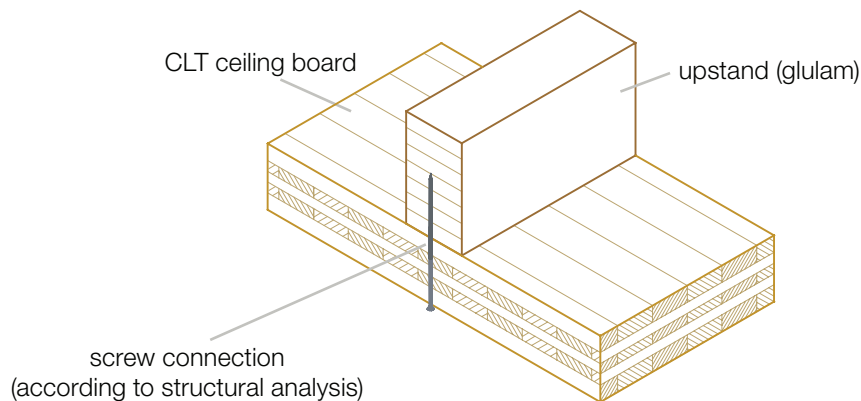
- Joint-sealing tape must be used to make the structure airtight.
- The roof is fitted with the aid of falsework.
- The choice and rating of the connectors and all structural components depend on the structural requirements.
- In this case, the screw connection of the CLT roof boards can mainly absorb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

### Illustration



## 7 Cantilever/upstand

### 7.1 Wooden upstand

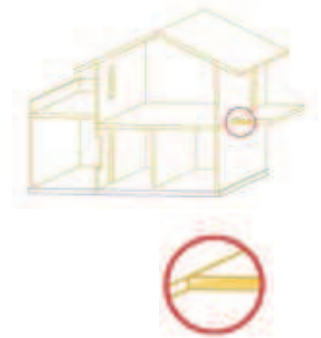
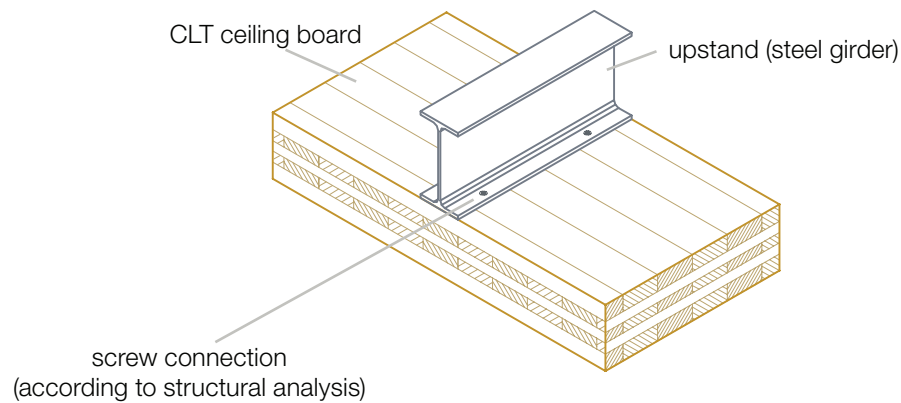


#### Execution

- 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.



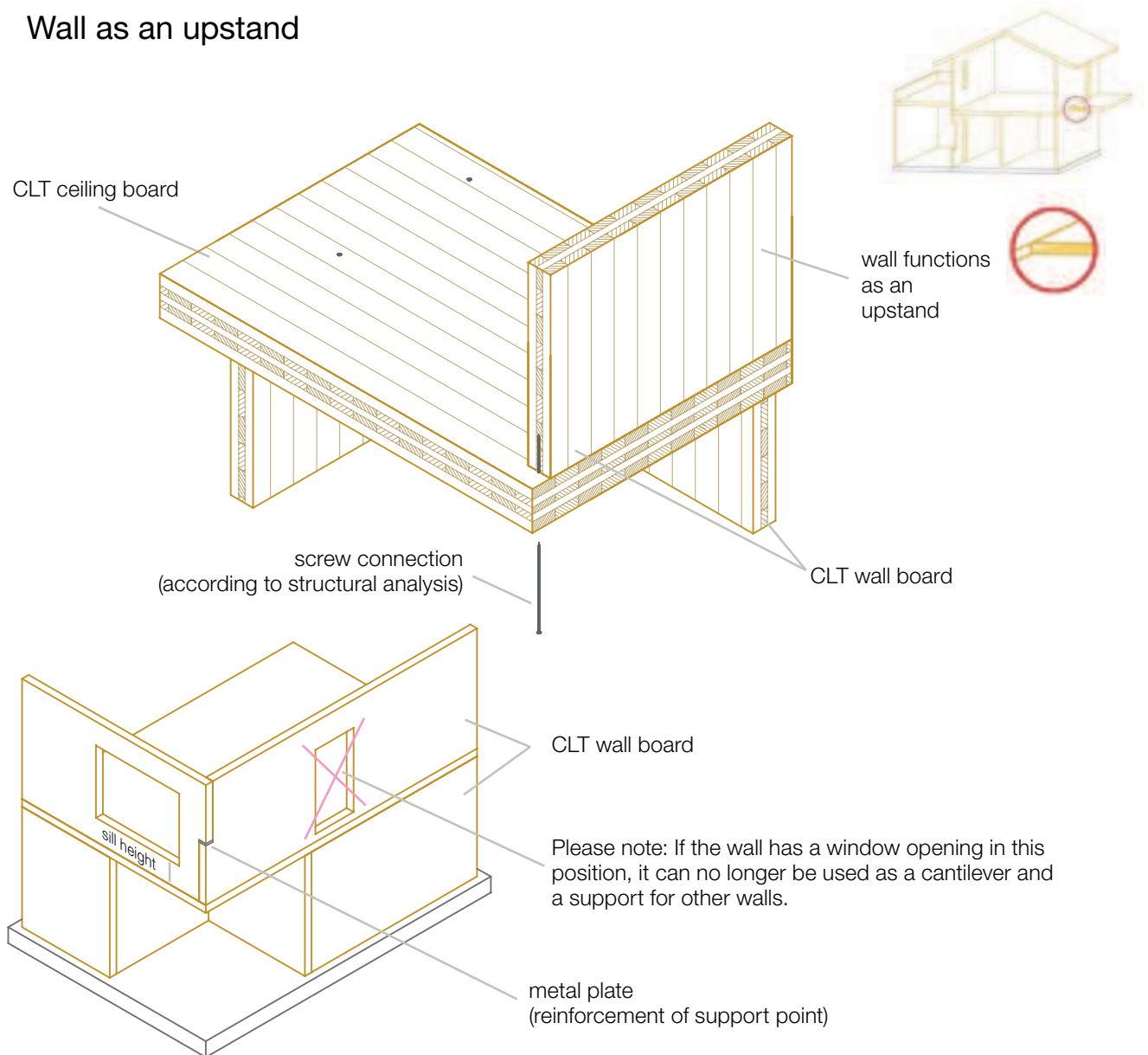
## 7.2 Steel upstand



### Execution

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

## 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.

# Construction

FRAME CONSTRUCTION

04/2012

Illustration

