STA Advice Note 14

Robustness of CLT Structures

STRUCTURAL TIMBER ASSOCIATION
Building solutions in timber

No. 14 - Part 3, March 2017

Part 3 - Key principles for good practice detailing for the external envelope of CLT

The purpose of advice note 14

This series of STA advice notes provides good practice design principles to reduce errors and to provide installation guidance to deliver durable, robust panelised CLT buildings. Refer to Advice Note 14, Part 1 for the introduction and general key principles.

Part 3 provides good practice guidance for the design and concept detailing for the external envelope of panelised Cross Laminated Timber (CLT) building structures.

Introduction

CLT is manufactured using quality controlled softwood material which has no natural defence against decay caused by sustained high levels of moisture; typically above the design threshold of 20% moisture content. Correctly designed CLT structures will not be subjected to high moisture, but incorrect installation may create conditions for moisture to become trapped. It is essential that the design team, installation team and follow on trades understand the building materials being adopted. This series of advice notes provides good practice design principles to reduce installation mistakes and includes guidance on installation to deliver durable, robust CLT buildings. The advice note is set out in five parts for ease of reference and application by the building team involved in a project.

The four key design principles are:

- CLT is not positioned on the external envelope cold side, i.e. insulation is on the outside face
- Breathable walls to allow internal moisture to defuse
- Warm roofs to be appropriately designed to avoid moisture traps in service; consult specific warm roof design guidance
- Avoid water traps during installation and in service where leaks can occur.

The three key installation principles are:

- The installers understand and have knowledge of timber as a construction material
- Poor workmanship and interference by follow on trades can occur if not checked (supervision of the works is part of the durability risk mitigation process; for which the STA have provided a check list for site works contained in Part 4)
- Temporary protection of CLT end grain that can be subjected to exposure to wetting during construction.

Acknowledgements

Written by STA Technical with support and review from TRADA and the sponsors' steering group.
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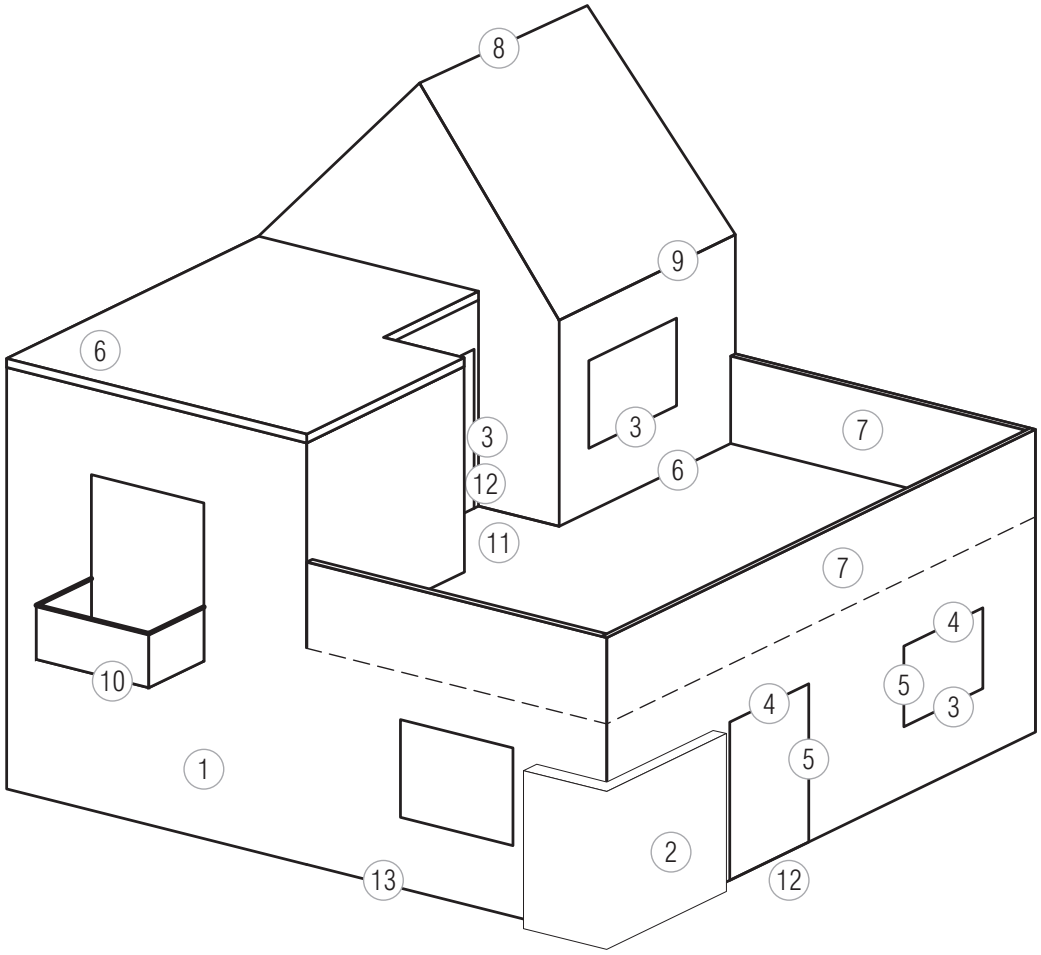
Kind thanks to our sponsors

Details covered in this document

Key principles details are indicated in the following good practice details:



Key to numbers on drawing

1. External walls
2. Cladding (only partially shown for clarity)
3. Window and door cills
4. Window and door head
5. Window and door side reveal
6. Flat roof and eaves
7. Parapet
8. Roof ridge - ventilated warm roof
9. Roof eaves - ventilated warm roof
10. Balconies
11. Inset terrace
12. Threshold*
13. Foundation interface*

* See Advice Note 14, Part 2

Fig 3.0 Key to details within this advice note

Over-arching principles

The good practice details are provided to indicate strategies for controlling heat, air and moisture and to provide indicative detailing for ensuring durability of the CLT structure. The overarching strategies are to:

- Prevent moisture build up and wetting of CLT panels by the provision of a drained wall cavity, protection from external weather by a breather membrane and from internal moisture through hydrothermal design.
- To place a breathable insulation to the exterior of the CLT panels so that the structure is effectively in Service Class 1 conditions throughout and no preservative treatment will be required.
- For CLT in both Service Class 1&2 conditions, design detailing is to be adopted as indicated in the details.
- Check that the CLT walls, roofs and junctions are designed to be in Service Class 1 to EN1995-1-1 and use Class 1 conditions to BS 8417.

For detailing to suit fire resistance, requirements for cavity barriers, differential movement and cladding detailing, reference to third party warranty provider standards and project specific architect's and engineer's details are required.

For estimates of differential movement allowances to be made due to the shrinkage of the CLT structure, specialist advice from the CLT manufacturer and project engineer should be sought - refer also TRADA guidance document GD10(27).

These details are not intended to substitute project-specific details where the input of an architect and specialist designer is required.

Membranes - notes and key to advice note drawings

Membranes are required to control moisture and air flow in the roof and wall assemblies.

Designers should determine the performance standard requirement for all membranes in any given situation and ensure that the specified membrane will meet that standard over the life of the building.

In order to form an effective membrane, side and end joints should be kept to a minimum. Joints in flexible membranes should be formed over solid backing members or a rigid substrate, should be lapped and, where relevant, be sealed. For breather membranes 100mm horizontal and 150mm vertical laps are required. Any damage should be repaired using matching material and jointing techniques.

Penetrations through membranes by pipes and services should preferably be eliminated at design stage. If that is not possible they should be adequately taped - and where airtight or damp proof membranes are involved - be sealed by means of proprietary seals and collars or liquid-applied sealants which should be able to accommodate thermal and other movements likely to occur during the service life of the building.

Membranes are typically indicated as follows:

DPC membranes or waterproofing layers which are intended to resist the passage of moisture and which are resistant to standing water and vapour impermeable

Airtightness membranes or localised sealing tapes (if required by design with laps no less than 50mm)

Breather membranes comprising a high degree of wet strength and water resistance with very low vapour resistance e.g LR membranes to BS5250(5)

1. External wall details

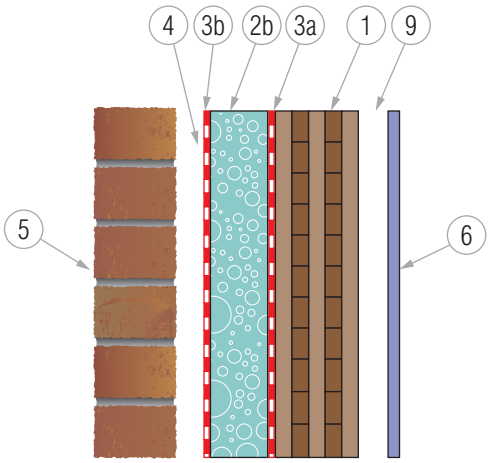


Fig 3.1 External walls (warm wall construction - rigid foam) ***Service Class 1 for both sides of the CLT***

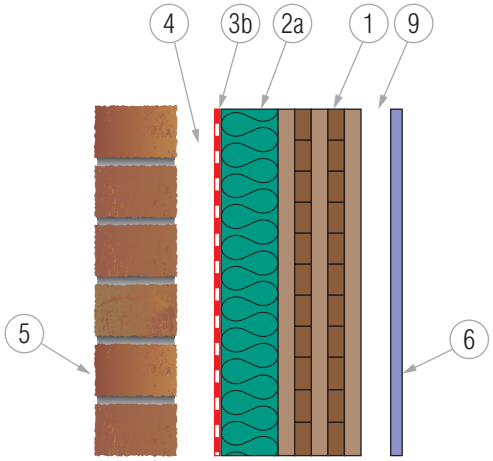


Fig 3.2 External walls (warm wall construction - breathable insulation) ***Service Class 1 for both sides of the CLT***

Key to Figs 3.1 - 3.2

1. CLT
2. 2a Breathable thermal insulation (see page 5 **Part 3 - Key Design Principle 6**)
3. 2b Tight-jointed rigid foam insulation
4. 3a Breather membrane to CLT face; subject to condensation and site wetting risk analysis
5. 3b Breather membrane to insulation face; subject to insulation type and jointing techniques (always required on breathable insulation)
6. 4 Drained and vented cavity
7. 5 Cladding spaced off the insulation
8. 6 Optional drylining and battened service zone
9. 9 Hydrothermal checks will typically demonstrate that a vapour control layer is not required

NOTES:

- The advice note will refer to the approach given in Fig 3.2a for the remainder of the guidance and the designer shall follow similar functional requirements for insulation details as given in Fig 3.2b
- See Advice Note 14, Part 1 (page 5) relating to non-breathable rigid insulation.
- Hydrothermal checks will typically demonstrate that a vapour control layer is not required.

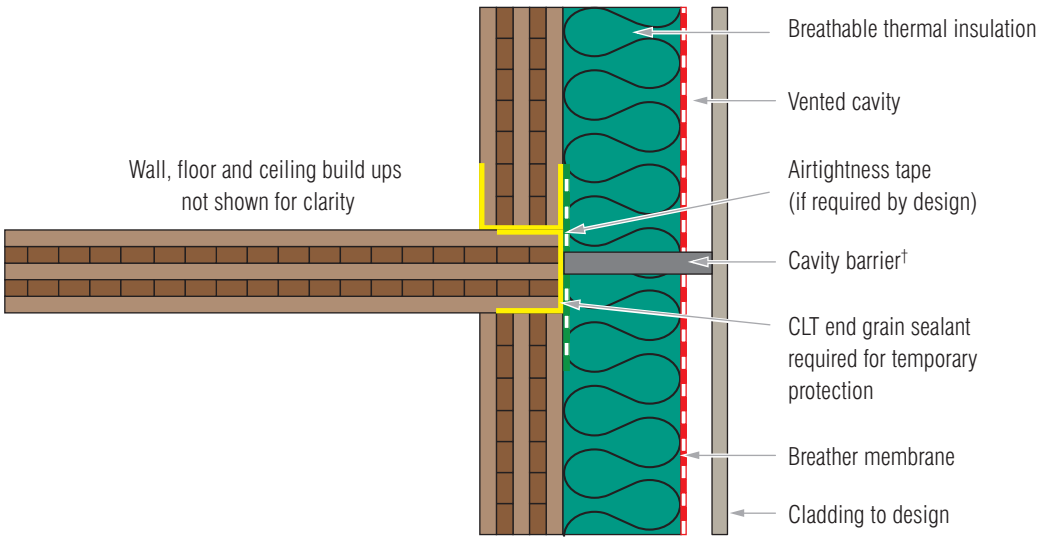


Fig 3.3 Typical CLT platform frame external wall-floor junction (cladding not shown)

† Cavity barrier through insulation where insulation is combustible. Cavity space between cladding to have an appropriate fire barrier to the technical standards or Building Regulations. Where a non-venting intumescent barrier is not appropriate a cavity tray is included with drain vents.

Key principles

Service class

1. CLT wall panels are in service class 1 conditions to EN1995-1-1. This is a warm frame in that the CLT is on the internal side of the envelope insulation.

Airtightness (CLT superstructure only)

1. CLT panels are airtight, external envelope panel joints to be taped and interfaces with windows/doors etc to be designed appropriately.

Breather membranes

1. A breather membrane should be provided for temporary and permanent moisture protection and fixed to the outside face of the thermal insulation.
2. Breather membranes should be a high performance type (Type 1) to BS 4016 Specification for flexible building membranes and ones that do not propagate spread of fire.
3. Where provided, the breather membrane should be continuous and lapped such that it drains moisture away from the CLT. The vapour permeability of the breather membrane and insulation should allow for outward passage of moisture.
4. Fit breather membranes from the lowest level upwards so that the upper membranes overlap the lower membranes to prevent water running down behind the joints.
5. Horizontal laps should be at least 100mm, vertical laps 150mm. Breather membranes must lap over any cavity trays or cavity battens provided at the heads of openings.
6. External insulation and breather membranes should be installed as quickly as possible after the erection of the CLT to provide construction stage weather protection.
7. Where a significant delay is anticipated, a temporary weatherproof membrane should be applied to the CLT.
8. Note additional breather membrane may be required on the CLT before the insulation to protect the CLT during construction and on account of the condensation risk assessment of non-breathable insulation products at joints.

Insulation

1. Insulation shall be located on the outside face of the CLT and should be of a breathable type. Foil faced products may not be breathable and require special attention to check the vapour resistivity of the interface between CLT and insulation within the interstitial condensation check. In addition a further breather membrane may be required between the CLT and insulation to avoid condensation issues at the board joints.
2. The joints of rigid insulation built up in layers should be staggered and taped.

Cavity barriers

1. Cavity barriers are to be installed in positions detailed in the relevant Building Regulations Parts B1 and B2 (or Technical Standards) and are to occupy the full depth of the cavity plus extend into combustible insulation zones.
2. Cavity barriers can be either of a rigid or flexible type (some insulation types can act as cavity barriers).
3. Cavity barriers that are in the cavity are to be provided with a DPC to shed moisture away from the structure.

Drylining

1. CLT may be left exposed subject to in-service fire spread and resistant design.
2. Drylining or flame retardant applications may be needed to satisfy Building Regulations (or Technical Standards) requirements - reference to be made to manufacturer's literature or specific application test evidence.
3. Acoustic design may determine if additional layers of drylining and other board types are required.
4. Service cavities can be included but the fire resistance and acoustic performance to be considered.

Key principles cont/…

Resistance to fire

1. CLT can provide resistance to fire by charring using charring rates declared by the CLT manufacturer in accordance with the CLT Product Standard. This will allow for increased char ratings on the board types and calculations undertaken using the reduced cross-section method in accordance with BS EN 1995-1-2:2004.

3. Cross-reference to the building regulations or standards relating to heights of buildings and the use of combustible insulation materials in an external wall shall be included in the design process.

Reaction to fire

1. The reaction to fire performance of the CLT product is taken as the reaction to fire of the surface and is taken as standard timber Euro class D unless test evidence provides evidence to improve this.

2. Refer to STA Advice Note 7, Part 1 (www.structuraltimber.co.uk) for further information relating to the 'reaction to fire' as it applies to timber structures.

Fire robustness during the construction process

1. STA 16 Steps and Separation Distance Guidance, Part 4 is to be followed to comply with CDM 2015 and HSG 168 (HSE publication - avoiding construction site fires).

2. STA member's Site Safe policy.

Erectors

1. Temporary bracing to be engineered specifically for the project and checked.

2. End grain sealer shall be applied to to protect the relevant areas of CLT during the construction process.

3. Follow the member's manual on their CLT system.

Builders work holes and penetrations

1. STA recommend sleeved joints and correctly taped junctions for weather tightness at service penetrations.

2. Check requirement for site-cut holes for external envelope penetrations such as flues and extractor ducts are to have site-applied end grain sealer applied to cut surfaces.

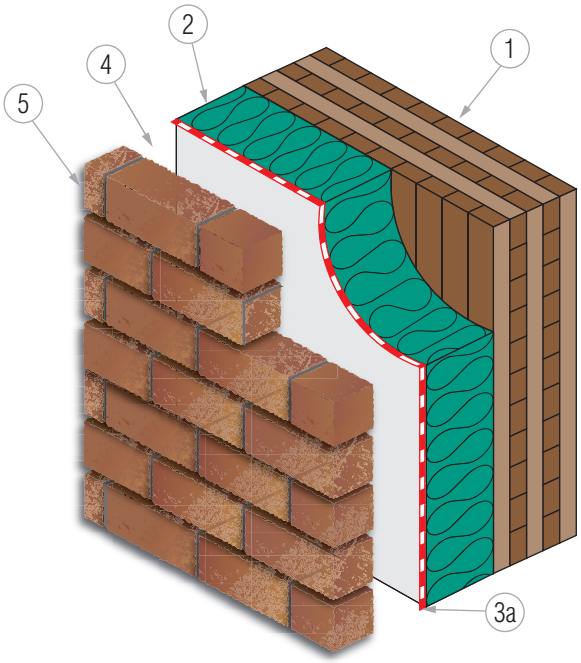
3. In the free cavity area a DPC cavity tray is to be provided at head of openings and cavity barriers are to be provided around openings.

2. Cladding

Cladding should be designed and installed in accordance with relevant authoritative guidance, for example third party approved details for the external envelope of the CLT structure shall be designed to avoid moisture and water ingress. It is recommend that workmanship is checked on site particularly at openings and interfaces. See STA members check list in Advice Note 14, Part 4.

External walls should always include a drained and vented cavity. Achieving a dry environment adjacent to the timber is of paramount importance. Fixings should be compatible and take account of type and material. Hot works associated with fixing of membranes should be avoided.

Fig 4 CLT structure during construction before cladding and insulation is installed



Key

1. CLT wall panel
2. Breathable thermal insulation
3a. Breather membrane over insulation (see Advice Note 14, Part 1)
4. Vented cavity - vent and weep holes to design
5. Cladding spaced off the insulation

Fig 3.5 CLT external wall with rain screen cladding (general principle)

Key principles

1. Cladding systems should be of a type to provide a first line of defence against moisture from penetrating the cavity
2. The first priority is for cladding systems to deflect as much rainwater away from the building as possible
3. A drained cavity should be provided behind the rain screen cladding system to direct any water that does penetrate away from the insulation and CLT (the assembly). Battens in the cavity should be arranged vertically and not block the drainage paths
4. A vented cavity is to be provided in all designs
5. Cladding battens are to be treated timber or other durable material
6. Cladding batten fixings are to be of appropriate corrosion resistance (stainless steel A4 recommended) and designed for vertical load and wind suction by engineer
7. Cladding is to be detailed with suitable movement joints to accommodate any differential movement between cladding system and CLT structure. Refer to TRADA guidance document GD10 for further advice on differential movement of CLT
8. Remember cavity barriers; detail cavity trays, drainage and ventilation to each relevant cavity compartment. Cavity barriers need to penetrate through the combustible insulation layer.

3. Window and door sill

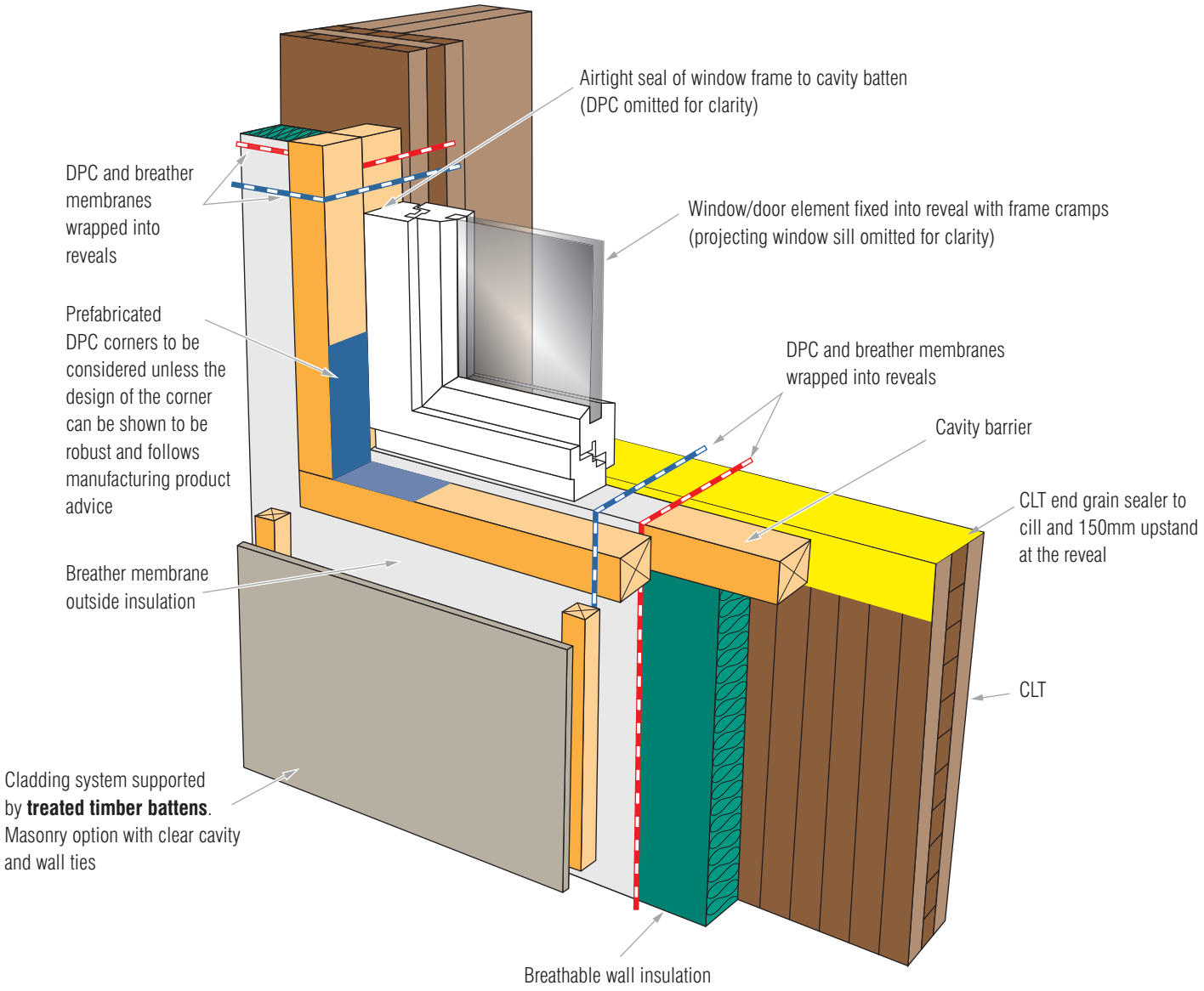


Fig 3.6 Typical external wall with ventilated façade showing window supported by timber batten

NOTE: Thermal bridging checks as part of the design for cladding battens, frame window support and cavity barriers.

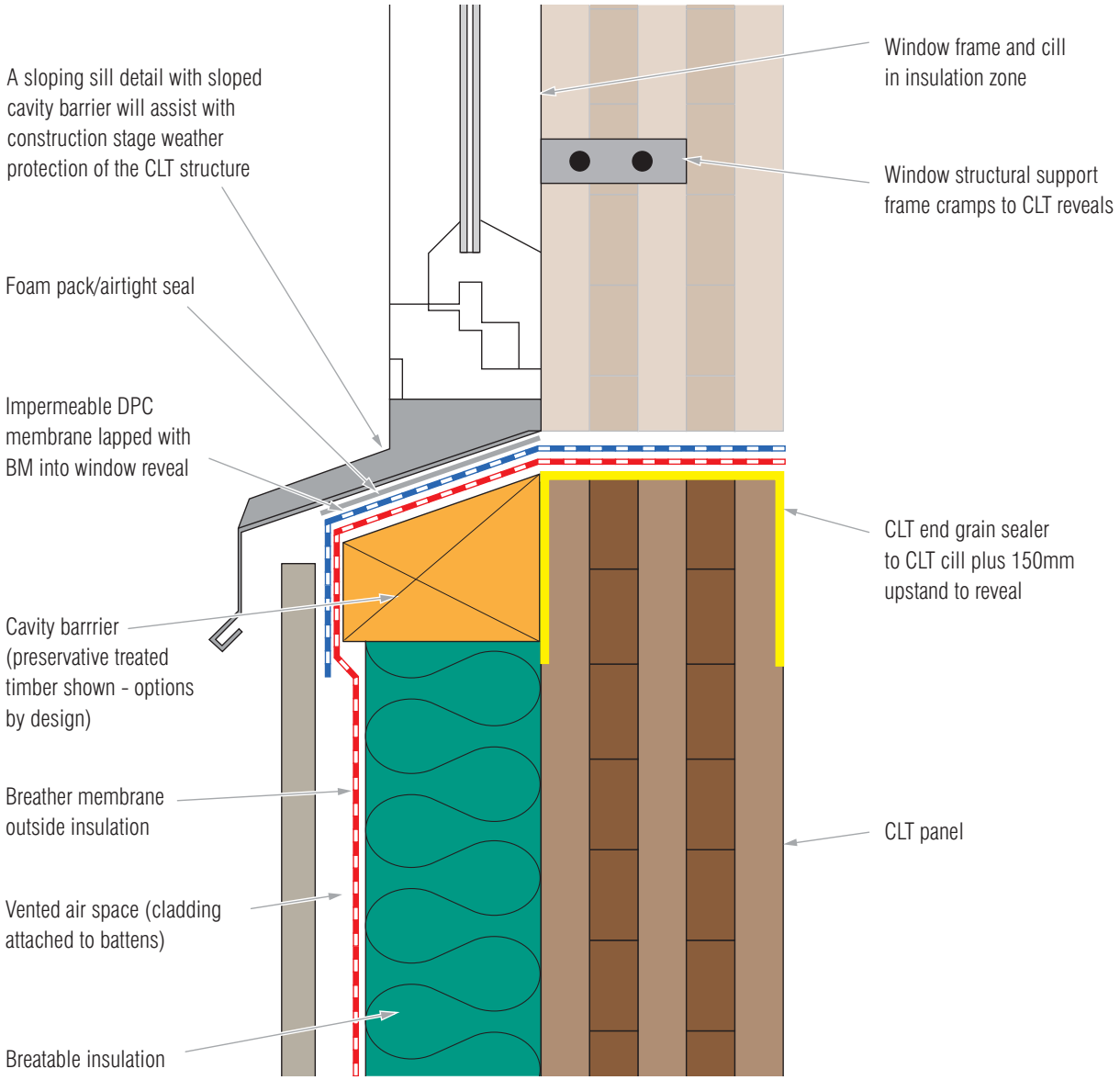


Fig 3.7 Window installation in line with insulation/CLT using sloped sill

4. Window and door head

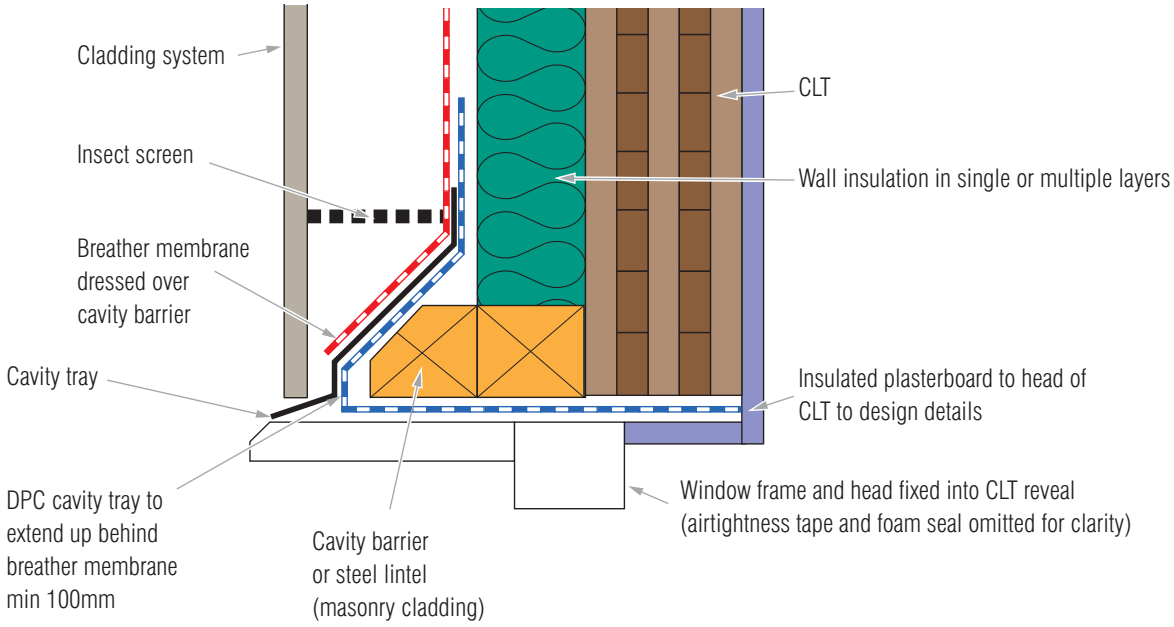


Fig 3.8 Section detail at window and door head

NOTE: Principles shown diagrammatically, with gaps between layers to show make up

5. Window and door side reveal

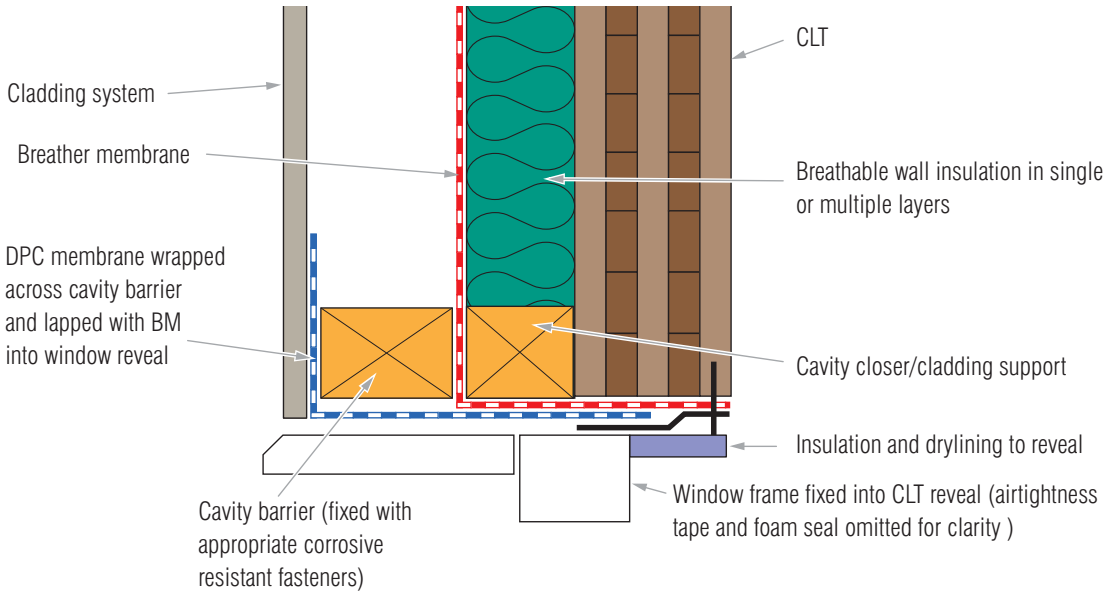


Fig 3.9 Plan detail at window and door reveal

NOTE: Principles shown diagrammatically, with gaps between layers to show make up

Key principles

1. Airtightness continuity must be maintained around the window frame to the design
2. Breather membrane to return into openings and lapped and sealed against window frames
3. The membranes used at the window cill head and jambs should be resistant to standing water and impermeable. All other membranes should be vapour permeable to prevent water from being trapped within the CLT panel
4. Water should be drained to the exterior of the insulation or directly to the exterior where possible
5. Where a window is supported by a structural support other than the reveal clamps, this is to be correctly designed to avoid thermal bridging and protected against moisture ingress

6. Flat roofs - warm roof construction

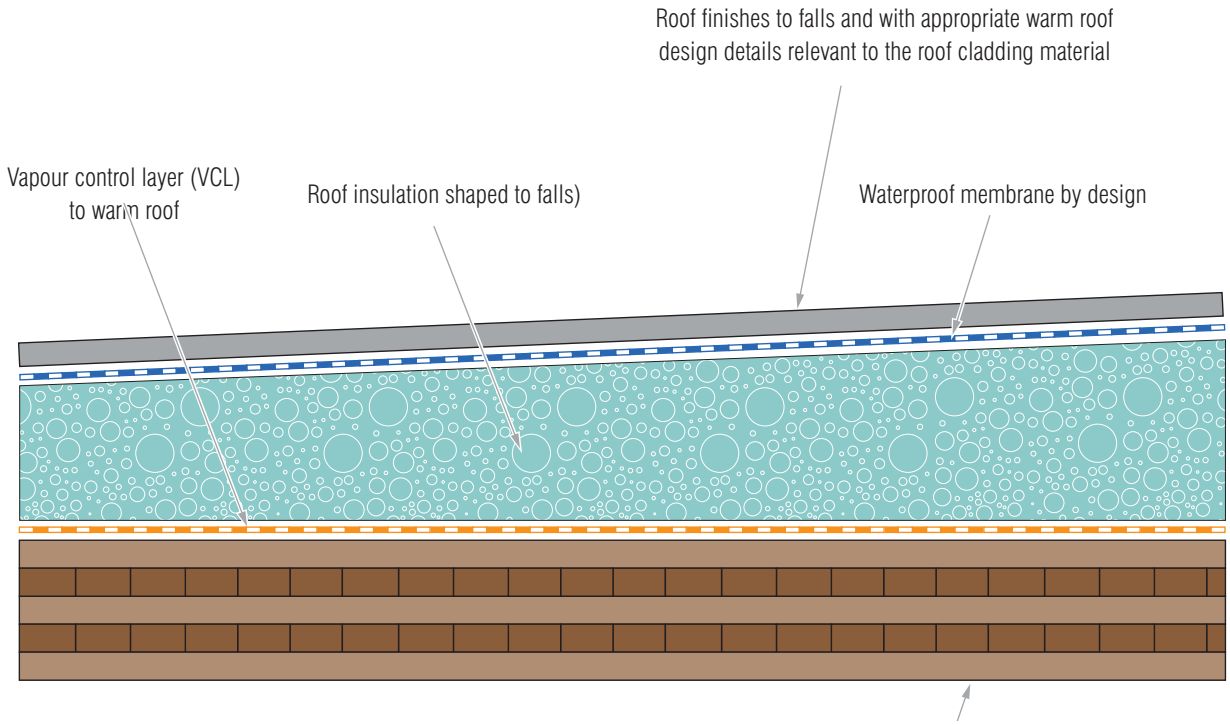


Fig 3.10 Typical warm roof construction

NOTE: Diagrammatic drawing with gaps shown for clarity of layers

Key principles

1. Flat roof detailed as un-ventilated 'warm roof' construction provided with a vapour control layer above the CLT which is to have a moisture vapour resistance at least equal to that of the waterproof covering
2. Cold roof application not recommended and will require specific assessment, with consideration of suitable preservative treatment.

6. Flat roof with upstand at eaves

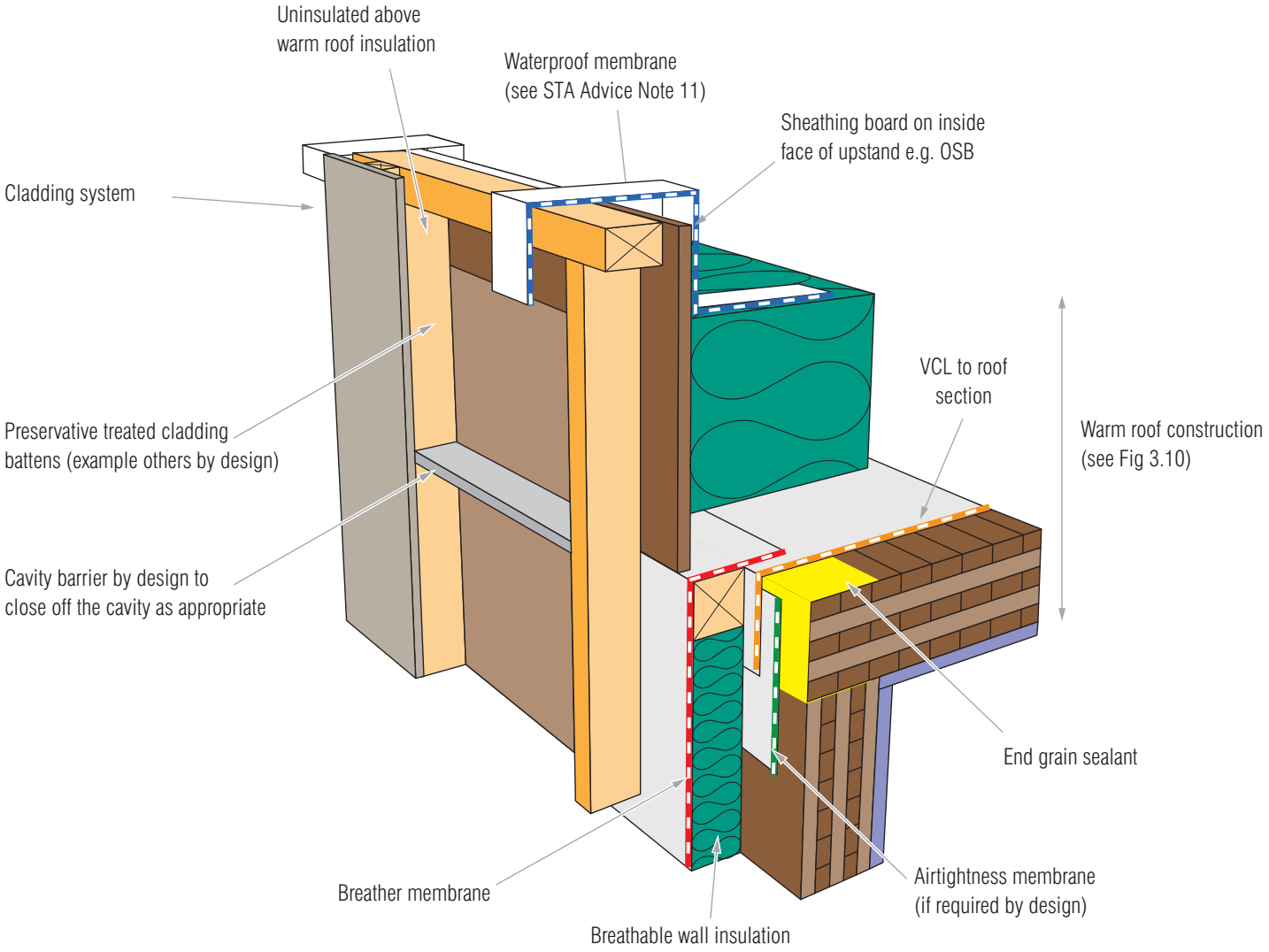


Fig 3.11 Typical flat roof - upstand junction (isometric)

NOTE 1: *This is not a waterproof membrane detail and in such conditions addition membranes may be required by design .*

NOTE 2: *This detail is only suitable where the upstand is not required to provide roof edge protection or to receive handrail fixing - if either of these required, refer to parapet detail 7.*

6. Flat roof with projecting eaves

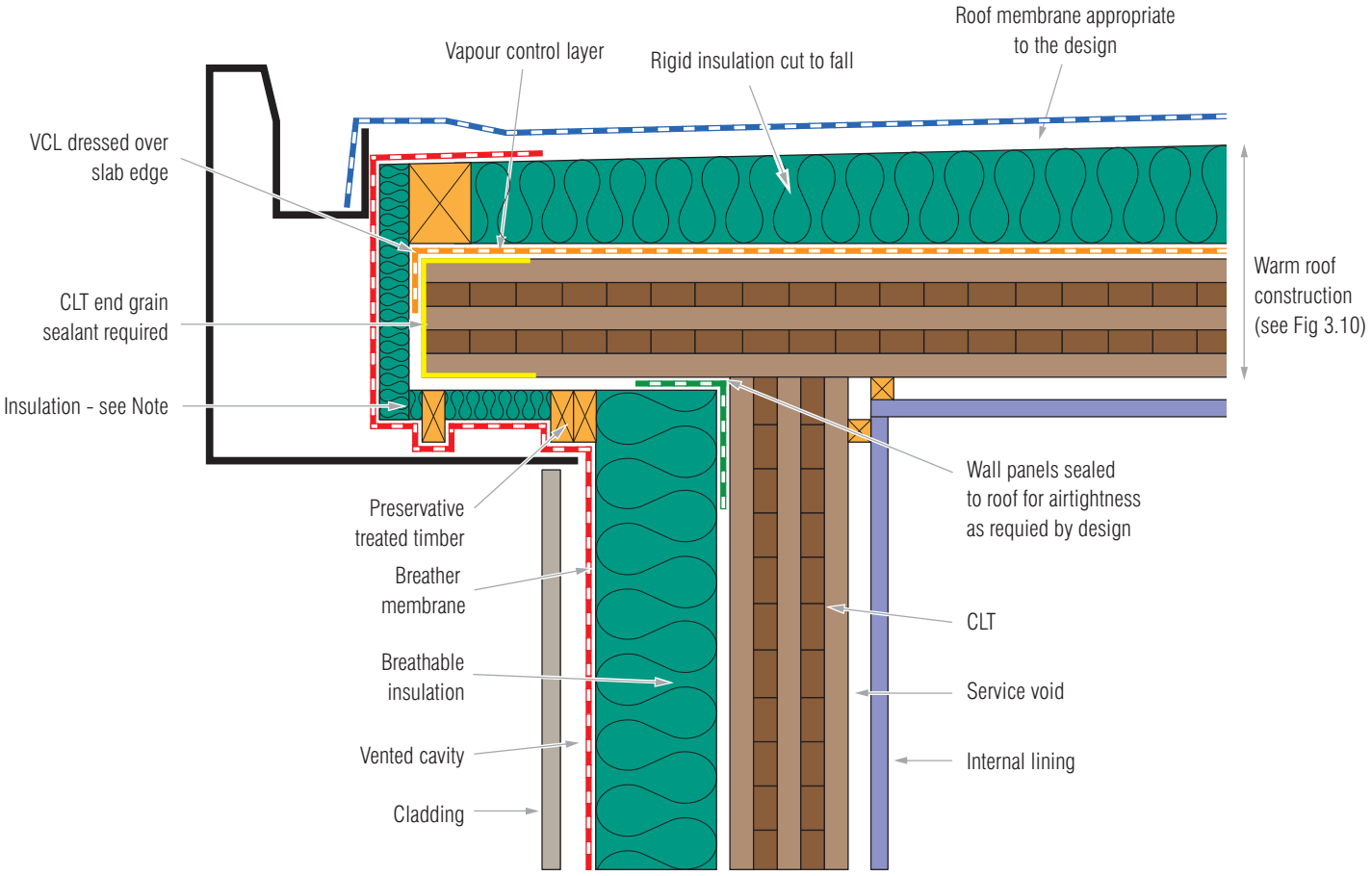


Fig 3.12 Flat roof - sharp eaves

NOTE: *Insulation installed to soffit to ensure CLT is warm side (check needed for condensation)*

Key principles

1. Flat roof detailed as un-ventilated 'warm roof' construction (see Fig 3.10)
2. Effective water management starts with a design that drains water from the roof away from the building
3. Avoid water traps such as abutments, horizontal valleys etc.
4. Flashings at roof/wall intersection are to be correctly lapped with the wall breather membrane
5. Projecting eaves shall be limited to 6 x CLT depth to keep the CLT within user Class 1 conditions. If a greater projection is required then additional review of the following shall be undertaken:
   - Check that the construction moisture levels will not cause moisture build up
   - If no proof can be provided, preservative treatment, that is durable for the construction process, may be required.

7. Parapet details

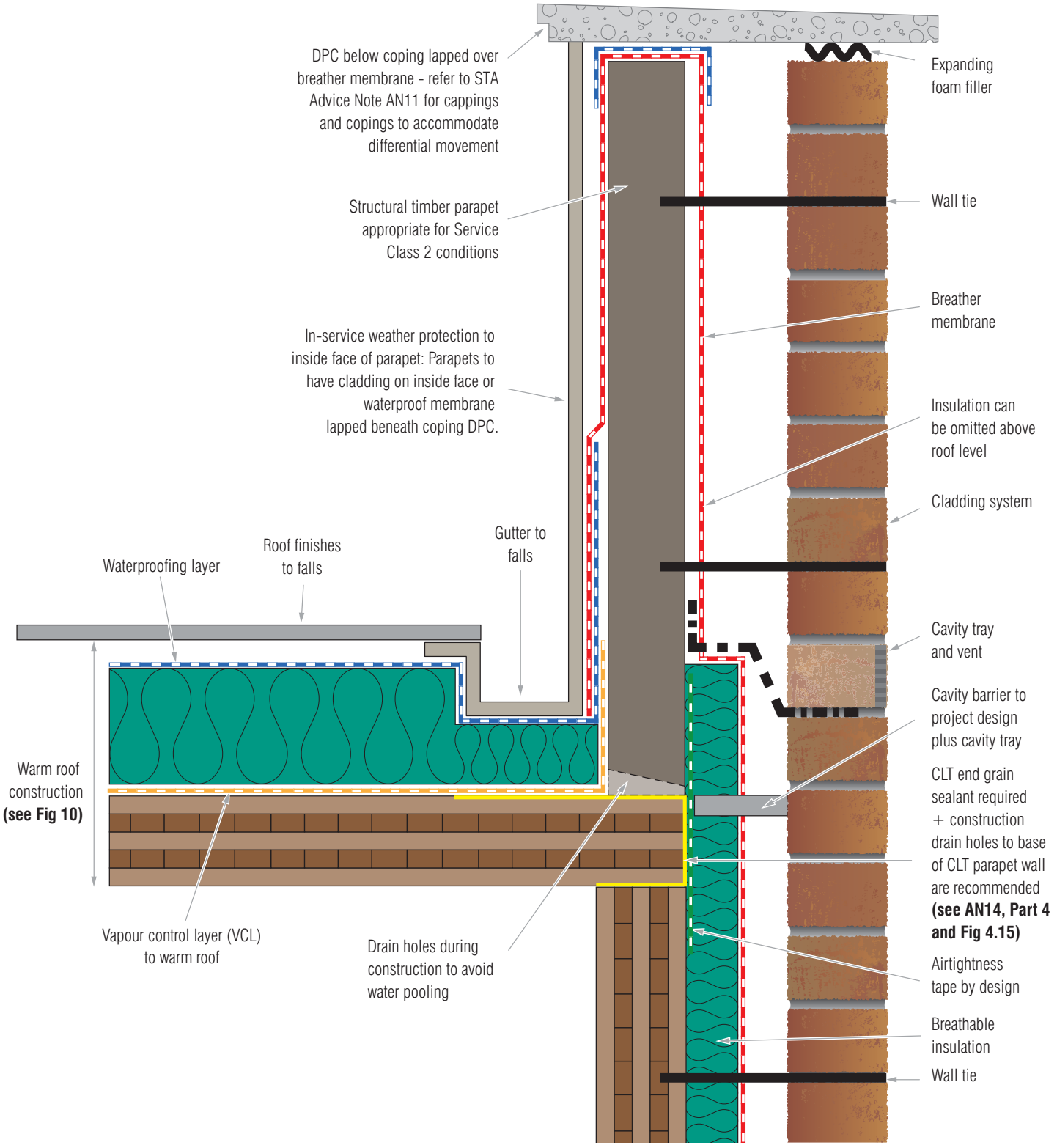


Fig 3.13 Flat roof - cantilevered parapet junction (masonry cladding shown, other cladding types similar)

NOTE: For parapet walls subject to roof edge protection or handrail loading, parapet posts may be required as Engineer's specification

8. Roof ridge - ventilated warm pitched roof option

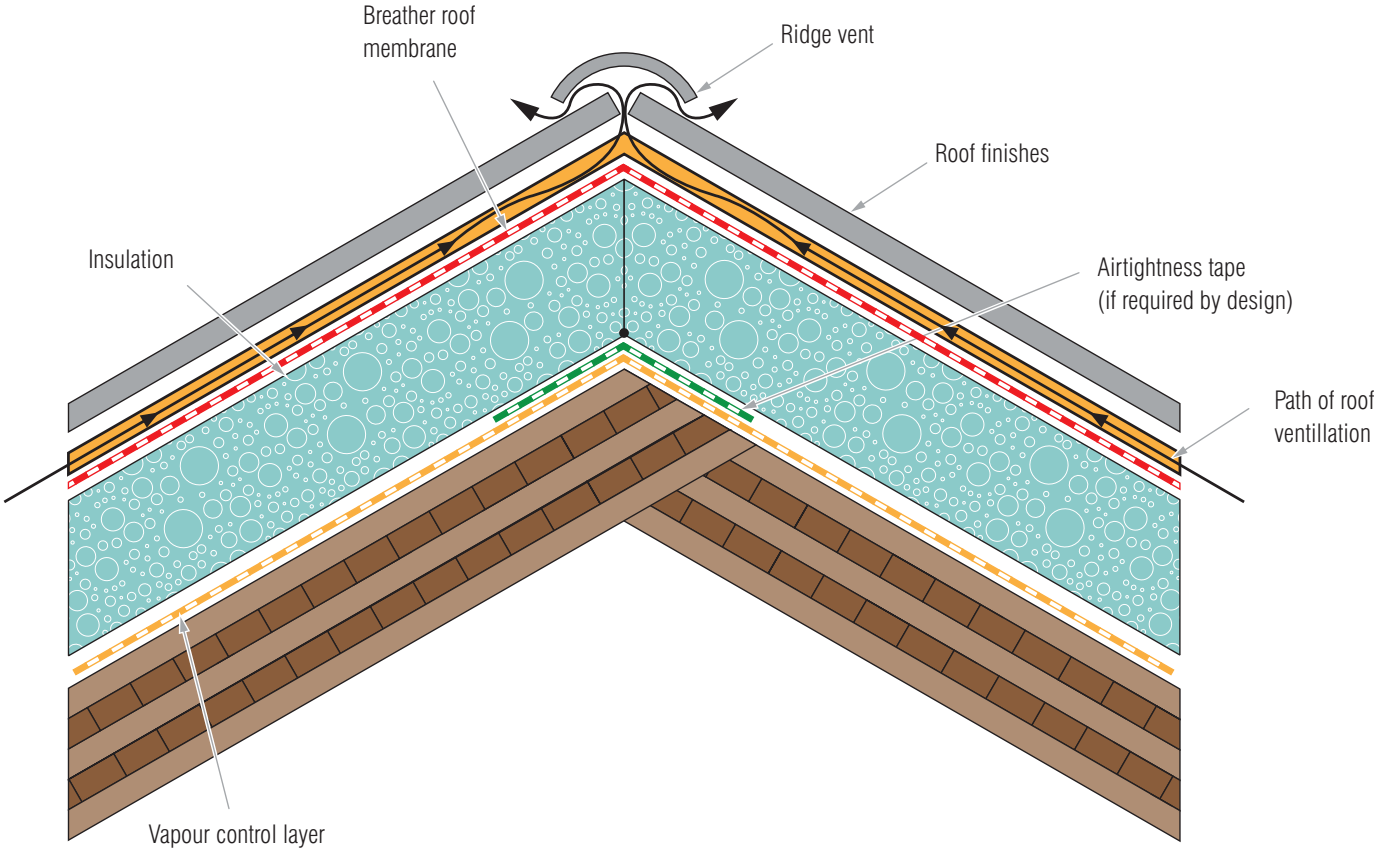


Fig 3.14 CLT pitched roof - ventilated warm roof (ridge)

Key principles

1. Reference should be made to BS 5250 (5) for requirements for membranes in warm pitched roof construction.
2. Breathable roof underlays (Type LR) are recommended for CLT construction combined with a ventilated batten zone with ventilation provided at the eaves and ridge to allow for the possibility of impermeable roof coverings.
3. VCL layer may be required subject to hydrothermal calculation checks.

9a. Roof eaves - ventilated warm pitched roof option

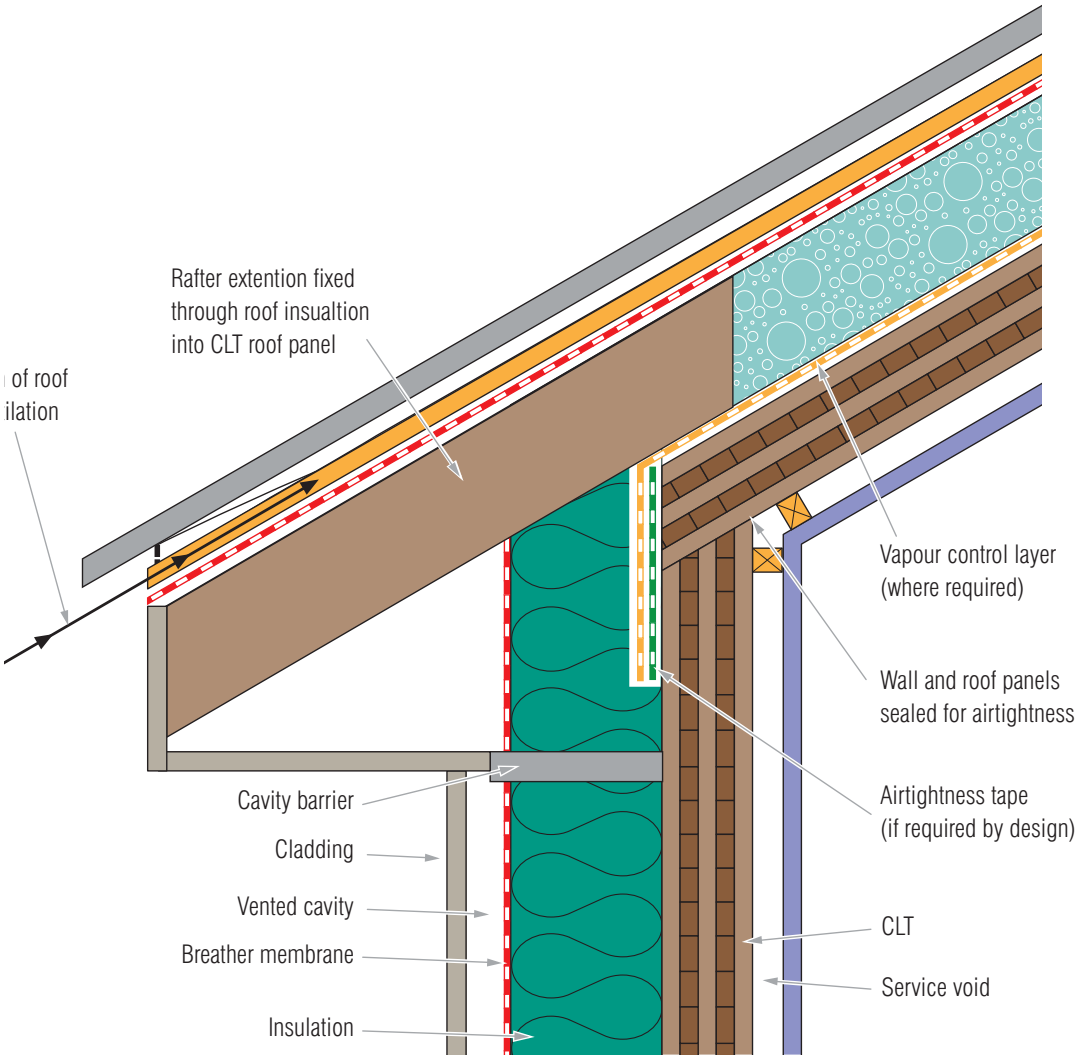


Fig 3.15 CLT Pitched roof - ventilated warm roof (eaves)

NOTE: Gutter omitted for clarity

Key principles

1. Reference should be made to BS 5250 (5) for requirements for membranes in warm pitched roof construction.
2. Breathable roof underlays (Type LR) are recommended for CLT construction combined with a ventilated batten zone with ventilation provided at the eaves and ridge to allow for the possibility of impermeable roof coverings.
3. VCL layer may be required on the internal face of the CLT subject to hydrothermal calculation checks.
4. Tiling battens and rafter extensions to form eaves are to be treated timber.
5. Cavity barrier through insulation where insulation is combustible.

9b. Roof eaves - unventilated warm pitched roof option

Key principles

1. Pitched roofs can be detailed as un-ventilated 'warm roof' construction similar to flat roofs.
2. In this situation a vapour control layer (VCL) is to be provided above the CLT which is to have a moisture vapour resistance at least equal to that of the waterproof covering.

10. Balconies

The use of timber for balconies should be limited to secondary elements which in turn are supported by materials other than timber. Timber can be used in the following situations provided it has the appropriate durability:

a. Cantilevered solid CLT balconies with a waterproof membrane above shall be treated as fig 3.12 and be fully protected to keep the timber insulated and away from moisture; however, construction moisture shall be checked before enclosing.

b. Preservative treated secondary timbers are to be installed regardless of the waterproofing membrane over.

c. Steel balcony solutions should be considered as the standard approach to balcony design.

Steel balcony option

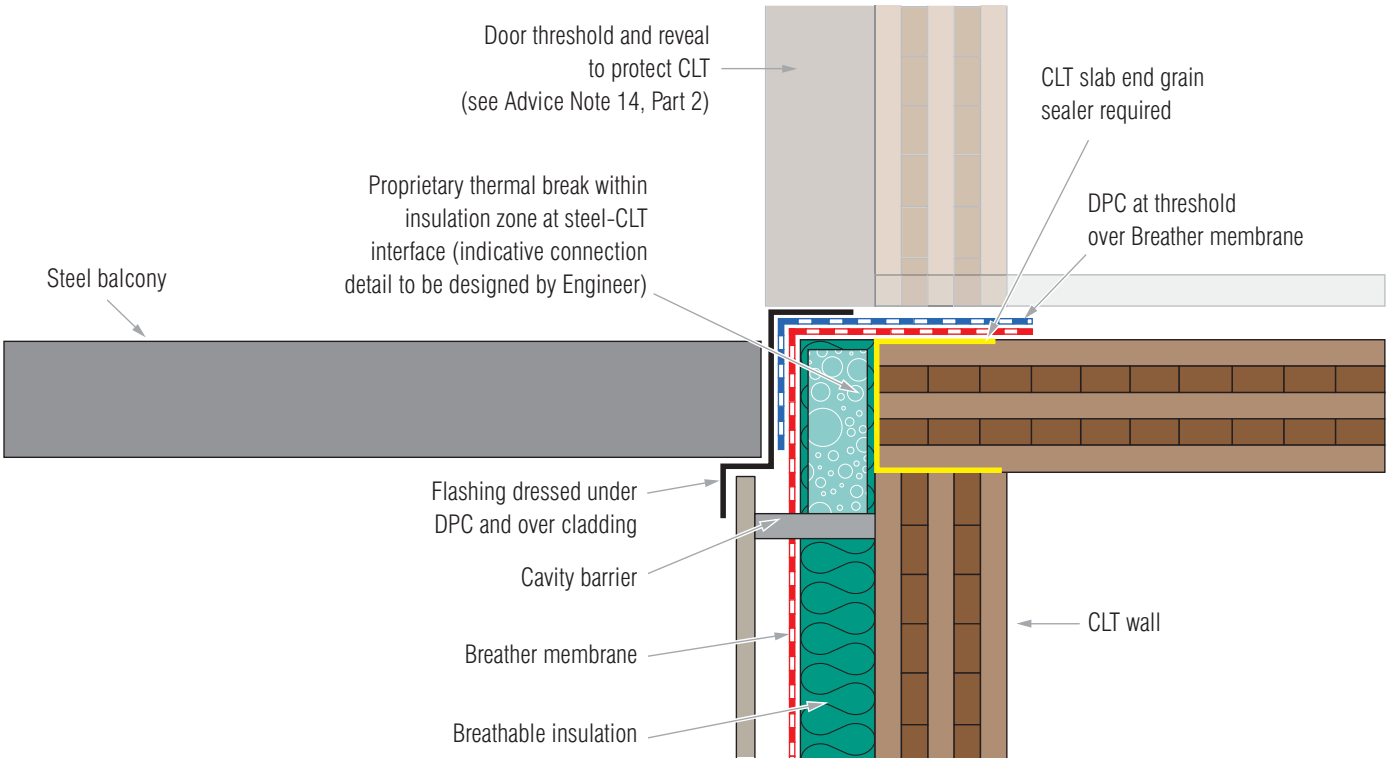


Fig 3.16 Steel balcony option - connected to CLT slab with proprietary thermal break

NOTE: *Notches or chases in the CLT slab to enable connection of the balcony structure must be strictly limited to prevent moisture/water traps and protect steel work and bolts from corrosion.*

11 CLT slab/terrace slab detail

It is recommended that where CLT is to be used as a terrace, the protection measures indicated in Fig 3.17 are adopted together with a waterproof membrane located above the insulation layer.

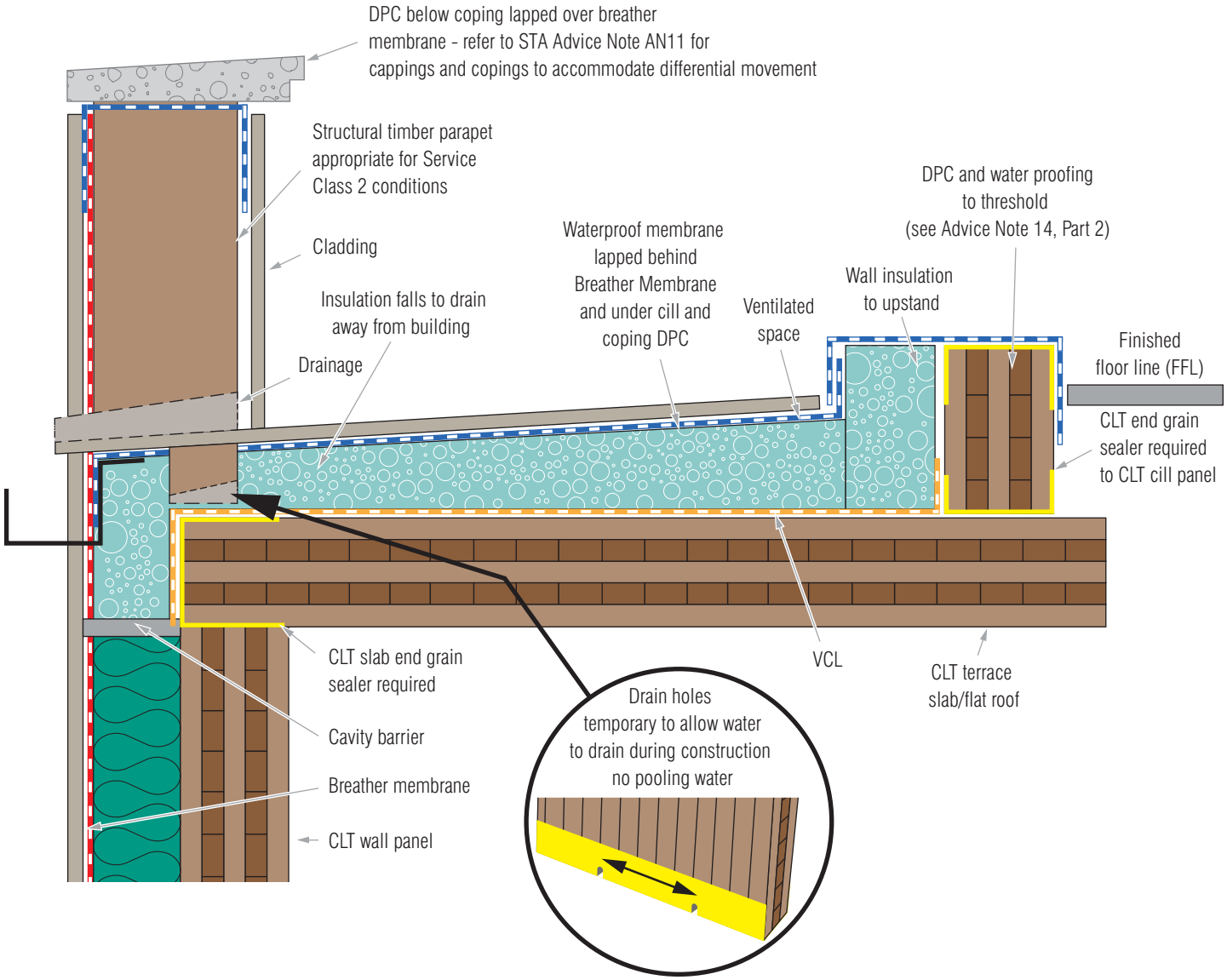


Fig 3.17 CLT inset terrace slab detail

NOTE 1: *Balcony connections to the CLT are to be fire protected by suitable encasement in finishes*

NOTE 2: *The requirements for preservative treatment is to be assessed by the designer for the project-specific detail if there are any concerns relating to water tightness of the terrace detailing*

Key principles

1. The structural application of CLT panels is not suitable for long-term exposure to weather without an applied waterproofing membrane or cladding system. Where CLT is to be used to support an external floor such as a terrace slab, protection of the top surface and exposed edges with a waterproofing membrane will be required in addition to the slab being on the warm side of the fabric.
2. CLT structure is to be protected to Service Class 1 EN1995-1-1 and use Class 1 to BS 8417.
3. For detailing of upstands and parapet walls (see Fig 3.13 and Fig 3.17).
4. For detailing of thresholds (see Advice Note 14, Part 2).
5. For detailing of opening reveals (see Advice Note 14, Part 2).

Steering Group

Sincere thanks for the time and contribution given to this project by members of the CLT steering group.

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David Crawford, CCG OSM
Kay Hartmann, KLH UK
Robin Lancashire - TRADA
Guy Lewis, STA technical consultant
Gareth Mason, Stora Enso
Martin Milner, Milner Associates

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