**Q.9 Thermal bridge free design - three locations**

9. It is proposed to design the external envelope of a dwelling house to be thermal bridge free. The drawing shows an outline section through a two-storey house having a 450 mm external concrete block wall with a 250 mm full-fill insulated cavity. The roof is a traditional cut roof, the first floor has tongue-and-groove flooring on timber joists and the ground floor is an insulated solid concrete floor.

(a) Select any three locations from those circled on the drawing and, using notes and freehand sketches, show best practice design detailing that will prevent the formation of a thermal bridge at each location selected.

(b) Discuss the importance of designing a building envelope that is thermal bridge free.

**Floor detail – such as**

- a thermal/cold bridge is an area of a building that has a higher heat transfer than the surrounding materials, resulting in a reduction in thermal insulation of the building

- thermal bridging reduces energy efficiency and thermal comfort

- thermal bridging is prevented by careful design - to achieve uniform thermal resistance, with no thermal breaks, and continuous insulation

- best practice - a perimeter 80 mm insulation strip installed up to floor level

- ensure wall insulation is carried down at least 225mm below the top of the finished floor.

**Head of window opening - such as**

- 250mm full-fill cavity insulation

- 60mm cavity closer
• internal concrete lintel 25mm above external lintel to allow for insulation wrapping the window frame
  • 15mm insulation overlapping window frame
  • insulated plasterboard finish to reveal.

**Window sill - such as**

• insulation at back of sill to prevent cold bridge
• high density proprietary cavity closer for fireproofing
• sill does not bridge cavity
• triple-glazed window to Passive House standard - 0.8W/m2 K or equivalent
  • 60 mm cavity closer
  • 250mm full-fill cavity insulation
  • airtightness tape to window frame.

**Ground floors abutting external walls - such as**

• cavity insulation
  • 80 mm insulation between concrete floor slab and inner leaf of wall
  • 150 – 300 mm insulation between floor slab and subfloor
  • 100 mm aac – autoclaved aerated concrete – blocks below ground level.

**Junction of upper floors and external walls - such as**

• joist to hang on inside leaf, no penetration of leaf and cavity
• wall plastered to increase airtightness
• resin anchored bolts to support floor joists – see sketch
• joists supported on metal hangers .

**Junction of roof and wall at eaves – such as**

• 60 mm rigid insulation board
• 400 fibreglass insulation
• 60 mm cavity closer
• 250 mm full-fill cavity insulation.
(b) Thermal bridge free envelope

A number of problems arise when instances of thermal bridging occur in the envelope of a domestic building. These problems can be very serious and can impact on the health and wellbeing of those living in the building as well as causing unsightly deterioration of the building fabric.

- thermal bridging occurs as a result of localized variations in insulation - where the insulation is less effective the envelope is a more efficient conductor of heat

- where thermal bridging is present, a higher proportion of heat energy passes through the affected part of the building envelope to the outside - where the temperature is lower, the heat loss is uneven resulting in relatively hotter and colder surface areas inside the building

- this causes variations in the temperature differential where warm air comes into contact with the colder materials of the inner surface of the building envelope

- the damaging effects of thermal bridging arise from warmer air coming into contact with the colder surface areas where it is cooled to its dew point depositing the released water as moisture on the surface

- the resulting damp patches support the growth of moulds which are unsightly, produce odours, cause staining and rapid deterioration of materials and finishes and can adversely affect human health when airborne spores are inhaled

- in extreme cases building materials and components such as plaster, wood and steel can be compromised and fail

- the heat loss also needs to be made good to maintain the comfort and health of residents - this increases the overall energy demand and the use of resources for heating making the building less sustainable.

Homework: 2011 Question 9

9. Careful design detailing is necessary in order to design a building envelope which is free of thermal/cold bridges. The drawing shows an outline section through a single storey house having a 350 mm external concrete block wall with an insulated cavity. The ground floor is an insulated solid concrete floor.

(a) Select any three locations from those circled on the sketch, and show clearly, using notes and annotated freehand sketches, the typical design detailing which will prevent the formation of thermal bridges at each location selected.

(b) Discuss in detail two advantages of designing a building envelope which is free of thermal bridges.
• A thermal/cold bridge occurs where a portion of a structure has a high thermal conductivity resulting in pathways through which significant heat is lost. This lowers the overall thermal insulation properties of the structure.

• Thermal Bridging may be due to poor design detailing, poor workmanship or a lack of adequate insulation.

• In the sketch a proprietary cavity closer or block of insulation is used behind the sill. This separates the outer leaf from the inner leaf and provides a thermal break between the two structures.

• In the next sketch you will see a fireproof, high density block of insulation is used to close the cavity and eliminate thermal bridging.

• All gaps should be sealed with a flexible sealant or tape to increase air tightness.

• Walls should have a minimum airspace of 40 mm.

• Double/triple glazed, low-e argon filled, thermally broken windows.

• A proprietary cavity closer or block of high density fireproof insulation is used to eliminate cold bridging.

• Gap between wall plate and eaves vent to be completely filled with insulation.

• 450 mm of insulation between and over the ceiling joists.

• Fig 9.3. Block with a minimum thermal conductivity of 0.20 W/m K is used.

Floor insulation

• Perimeter insulation with a minimum R-value of 0.75m2 K/W.

• Ensure wall insulation is installed at least 225mm below the top of the floor.

• All junctions to be sealed with a flexible sealant or taped airtight.

• Fig 9.5 shows an insulated steel lintel.

• Internal insulation and insulation in the lintel eliminates thermal bridging.
9(b) Advantages of eliminating thermal bridges

- Prevents heat loss through fabric at critical junctions
- Improves the thermal comfort of the house
- Saves money as less heat is required
- Reduces the amount of fossil fuels - oil/gas - needed to heat home
- Reduces carbon footprint and CO2 emissions of the building
- Thermal bridging can cause condensation, which can cause dampness and mould growth, therefore no thermal bridging results in more healthy building