Module 3.7

Thermal bridging

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Learning Outcomes

- On successful completion of this module learners will be able to
- Describe construction details which influence thermal bridging.

Introduction to thermal bridging.

- Thermal bridging occurs in building envelopes when materials with high thermal conductivity, such as steel timber and concrete, create pathways for heat loss that bypass thermal insulation.
- When these poor insulating materials provide an uninterrupted “short circuit” between the interior and exterior of a building, the thermal bridge can result in

  a) accelerated heat loss through that area,

  b) localised cold spots on the interior of a wall that may cause a risk of condensation.
- This effect is most significant in cold climates during the winter when the indoor-outdoor temperature difference is greatest. Reference: http://wiki.aia.org/WikiPages/ThermalBridging.aspx

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- Thermal bridging can also occurs in building envelopes when gaps or breaks in the insulation envelope create pathways for heat loss that bypass thermal insulation.
- The reduced or missing insulation can allow warm inside air make contact with cold external surfaces.
- This bypass of the insulation will also cause accelerated heat loss through that area, and localised cold spots on the interior.

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Examples of construction details which contribute to thermal bridging.

- Only a small number examples will be shown in this module.
- Examples shown here may not represent all possible relevant examples in all European countries.
- Additional examples and information may be found in a free online presentation at

  www.asiepi.eu/fileadmin/files/PPT-ON-DEMAND/PPT_4.1/player.html
- Also in two documents available at www.asiepi.eu/information-papers.html
- P188_Thermal_bridge_guidance_principles_ASIEPI-WP4[1].pdf
- P189_Thermal_bridge_guidance_examples_ASIEPI-WP4[1].pdf

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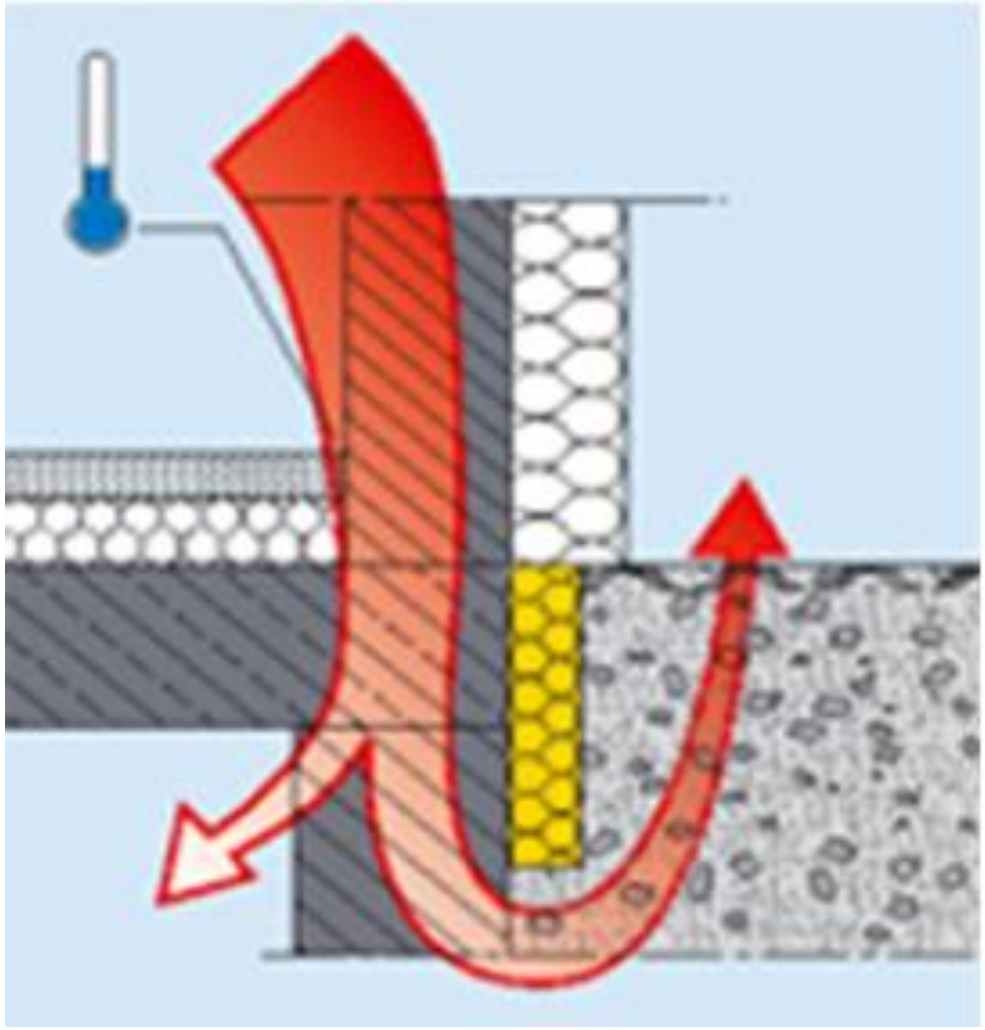
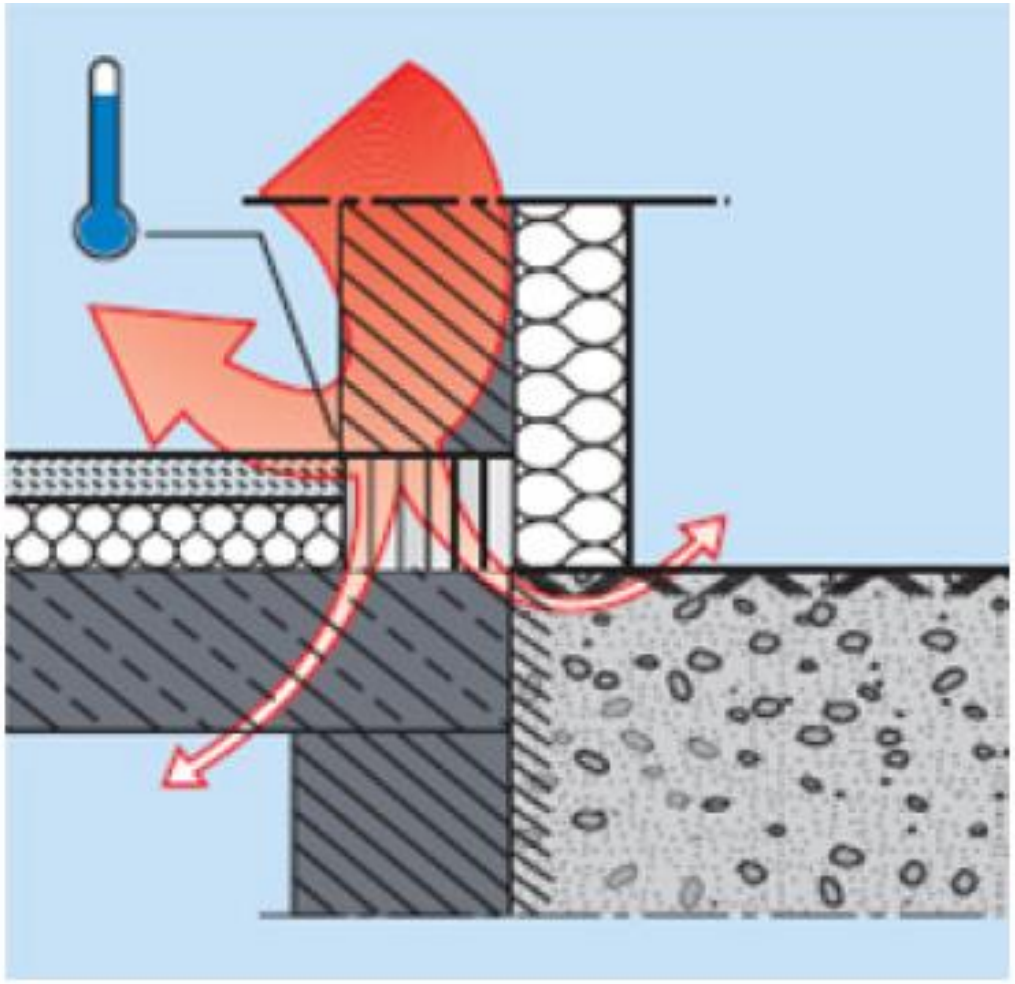
Example of construction detail which contributes to thermal bridging.



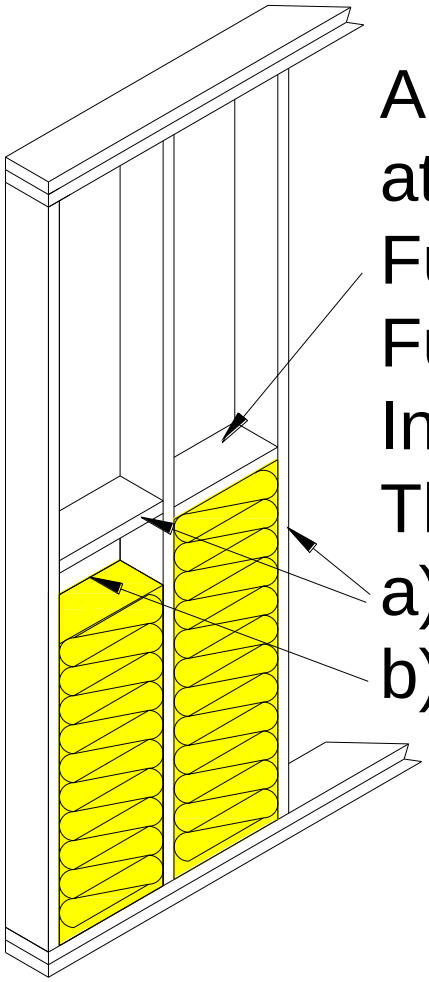
Heat loss through an external wall at a suspended floor.

Example of construction detail which reduces thermal bridging.



Reduced heat loss with an alternative construction detail.

Examples of thermal bridging.



All timbers in wall 150mm X 38mm
at 400mm centres
Full depth noggings
Full depth insulation
Insulation omitted at high level for clarity
Thermal bridge of insulation layer due to
a) Full depth timber studs and noggings
b) Gap in insulation under nogging

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- Take any heat loss surface, i.e. floor, wall, roof, etc.
- Thermal bridging must be considered if there is more than one possible heat flow path through that surface.
- If the thermal bridge allows for two or more possible heat flow paths, in the main body of the floor, wall, roof. etc. then its effect must be considered.

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- Typically construction details are broken down into two parts when considering thermal bridging.
- Part 1.

  When the thermal bridge is part of the main structure of the floor, wall, roof, etc. In this case the effect of the thermal bridge is included in the calculation of the U-value for that element.

  Such calculations were outlined in module 3.4

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- Part 2.

  When the thermal bridge occurs around doors, windows and other penetrations of the insulation envelope. These are typically grouped together as one major contributor to heat loss from the building.

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Calculation of heat loss due to thermal bridging.

- European countries have different ways of calculating heat loss due to thermal bridging.
- This is highlighted in an free presentation at www.asiepi.eu/fileadmin/files/PPT-ON-DEMAND/PPT_4.1/player.html
- These various methods used are also highlighted by two documents available at www.asiepi.eu/information-papers.html
- P188_Thermal_bridge_guidance_principles_ASIEPI-WP4[1].pdf
- P189_Thermal_bridge_guidance_examples_ASIEPI-WP4[1].pdf

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When the thermal bridge is part of the main structure of the floor, wall, rood, etc.

- Take heat loss through the timber frame construction show on the next page.
- One resistance layer is made up of two very different materials, timber and mineral wool insulation.
- The poor insulator, timber, provides an uninterrupted “short circuit” through the insulation, between the interior and exterior of a building.
- The timber create a pathway (or bridge) for heat loss that bypass the insulation.
- This reduces the effectiveness of the insulation.

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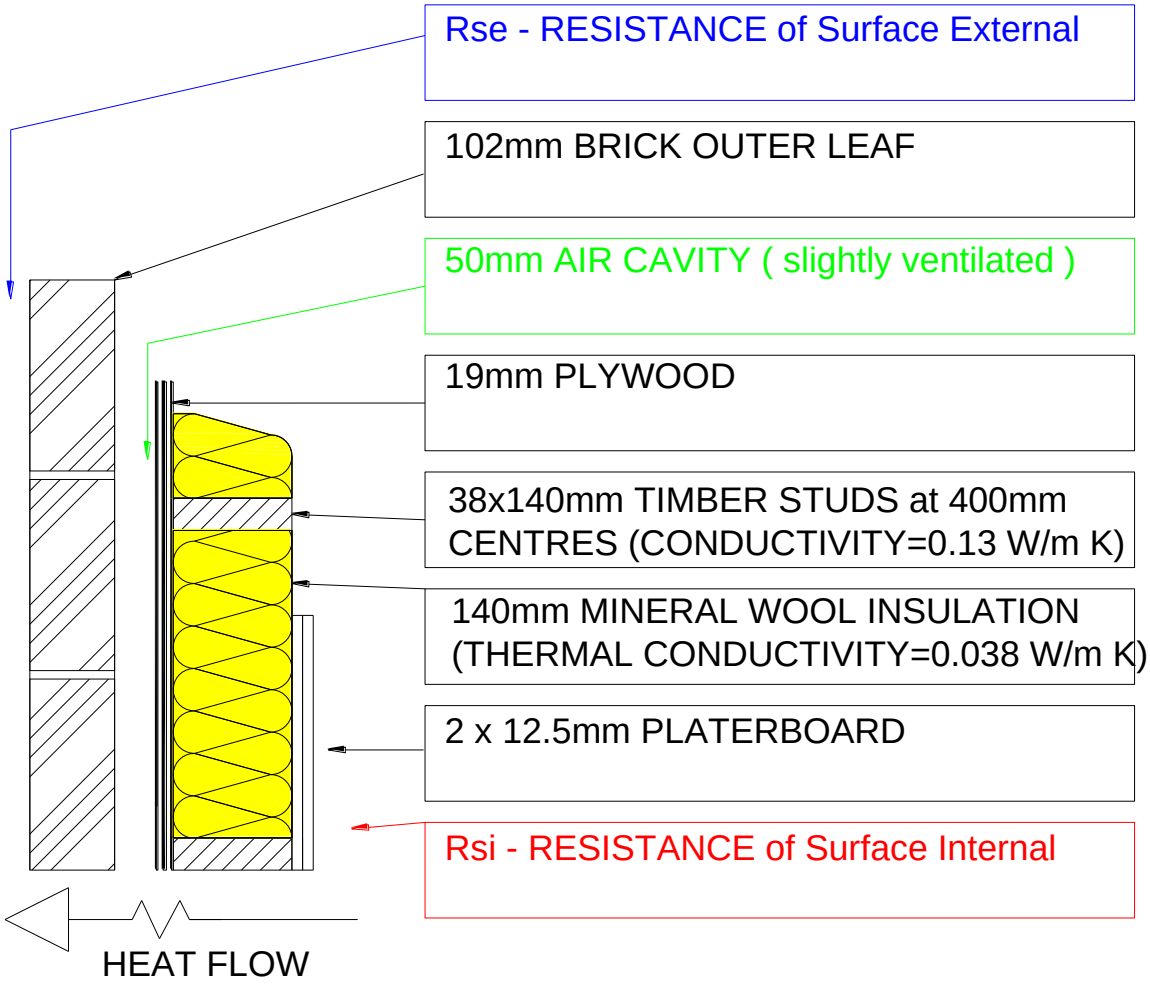
TIMBER FRAMED WALL (Plan view)



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- For this construction detail – the timber frame is critical for structural support.
- However a large area of timber will create a larger thermal bridge and so increase heat loss through this wall.
- To minimise the area of the thermal bridge the designer must minimise the area of timber exposed to the warm air inside the heated space, however this should not weaken the structure.

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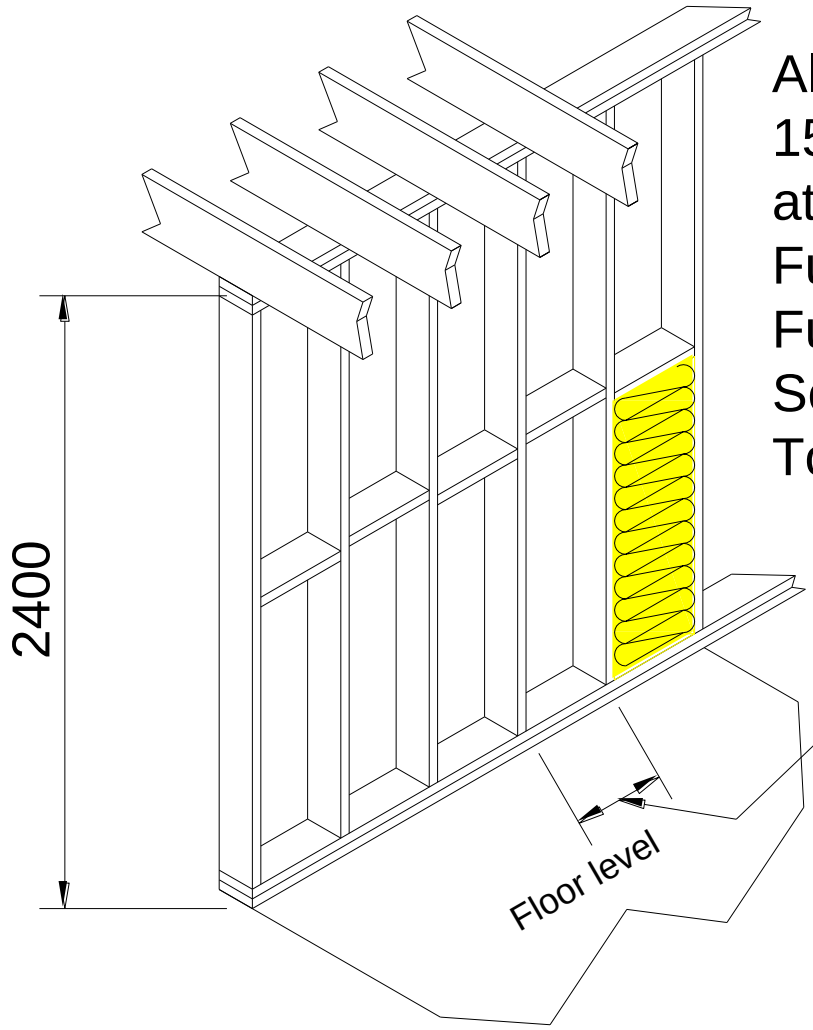
Possible timber frame detail



All timbers in wall
150mm x 38mm
at 400mm centres
Full depth noggings
Full depth insulation
Sole plate above floor level
Top plate below ceiling level

400 - 38 = 362mm

Fractional area of timber – possible detail.

- Construction detail repeated every 400mm
- Overall repeatable area

	2.400	x	0.400	=	0.960 m^2

- Area of timber

Vertical	2.400	x	0.038	=	0.091 m^2
Horizontal	0.362	x	0.038 x 5	=	0.069 m^2
			Total		0.160 m^2

- Fractional area of timber (0.160 / 0.960) 0.17
- Fractional area of insulation (1 – 0.17) 0.83

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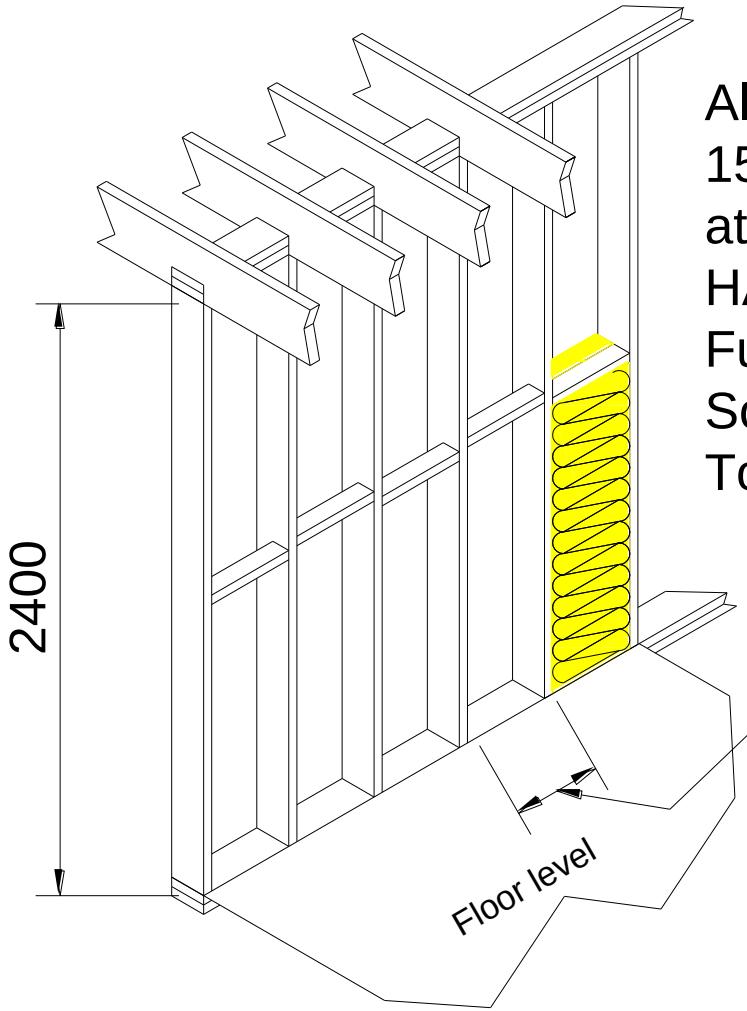
Improved timber frame detail



All timbers in wall
150mm x 38mm
at 400mm centres
HALF DEPTH noggings
Full depth insulation
Sole plate BELOW floor level
Top plate ABOVE ceiling level

400 - 38 = 362mm

Fractional area of timber – improved detail

- Construction detail repeated every 400mm
- Overall repeatable area

	2.400	x	0.400		=	0.960 m^2

- Area of timber

Vertical	2.400	x	0.038		=	0.091 m^2
Horizontal	0.362	x	0.038 x 0		=	0.000 m^2
			Total			0.091 m^2

- Fractional area of timber (0.091 / 0.960) 0.10
- Fractional area of insulation (1 – 0.10) 0.90
- Conclusion – smaller fractional area of timber will reduce thermal bridging and so reduce heat loss. No loss in structural strength.

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One way to reduce thermal bridging in the main structure of the floor, wall, ceiling, etc.

a) Reduce the overall area of thermal bridge penetrating the insulation envelope.

For previous example – move part of the thermal bridge so that it is no longer in contact with the warm air inside the room.

Also, if possible, change the construction detail to place the timber struts at 600mm centres rather than 400mm centres.

How to reduce thermal bridging in the main structure of the floor, wall, ceiling, etc.

b) If possible change the construction detail to eliminate the thermal bridge.

   For the previous example – reduce the depth of the nogging so it does not fully penetrate the insulation layer.

c) Ensure full continuity of insulation.

   For previous example – make sure the insulation is fitted tightly against all timber surfaces, .i.e. make sure there are no gaps in the insulation envelope.

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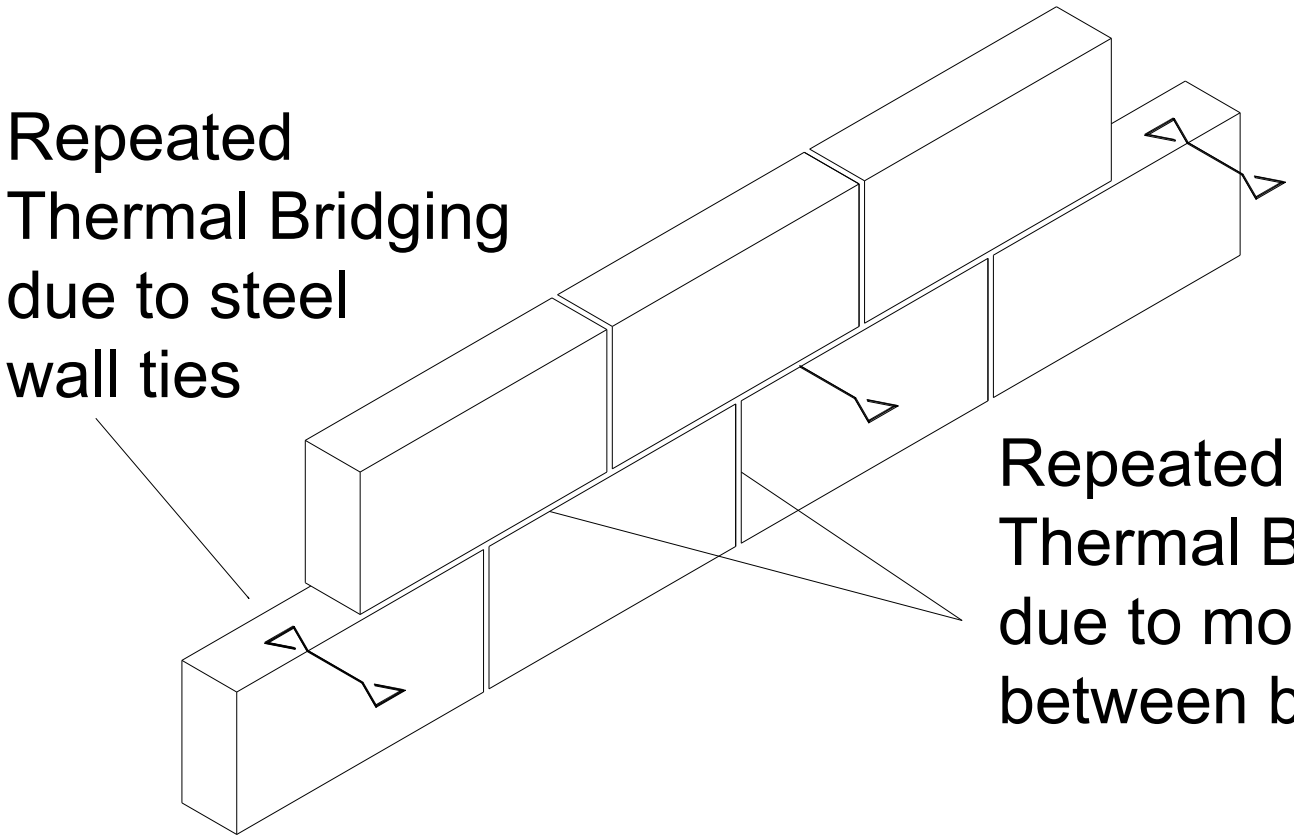
In some cases the thermal bridge is repeated at given intervals across the construction.



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- In this cases the repeated thermal bridging is caused by

a) Steel wall ties in the cavity wall construction.

(Effect can be neglected if using plastic wall ties)

b) Mortar joints in the internal block work leaf.

- The effect of this repeated thermal bridging is included when calculating the overall U-value (thermal transmittance) of the block work wall, following procedures described in I.S. EN ISO 6946.

When the thermal bridge occurs around doors, windows, etc.

- In other cases, thermal bridging can occur around openings in the insulation envelope.
- This thermal bridging does not occur at constant intervals and so cannot easily be calculated as part of the individual wall, roof etc.
- Treatment of this type of thermal bridging varies between European countries. In some cases all thermal bridging around openings are grouped together as one major contributor to heat loss from the building. In such cases an approximate heat loss factor is used to estimate the relevant heat loss.

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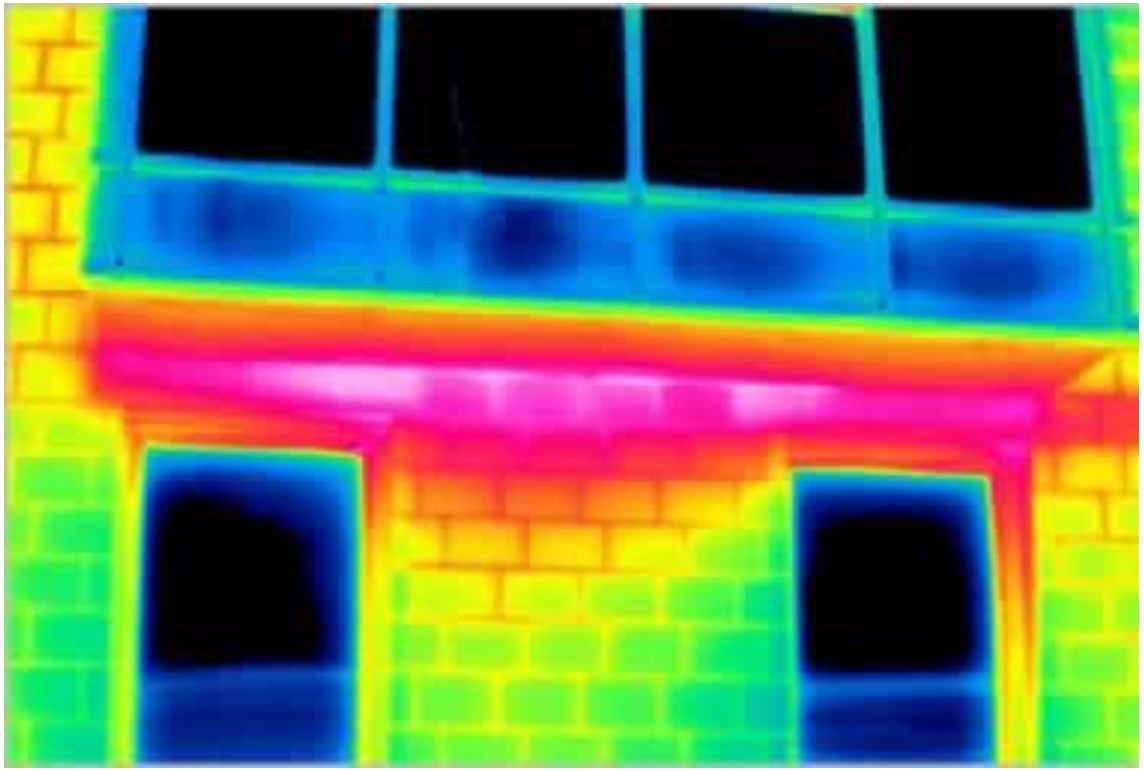
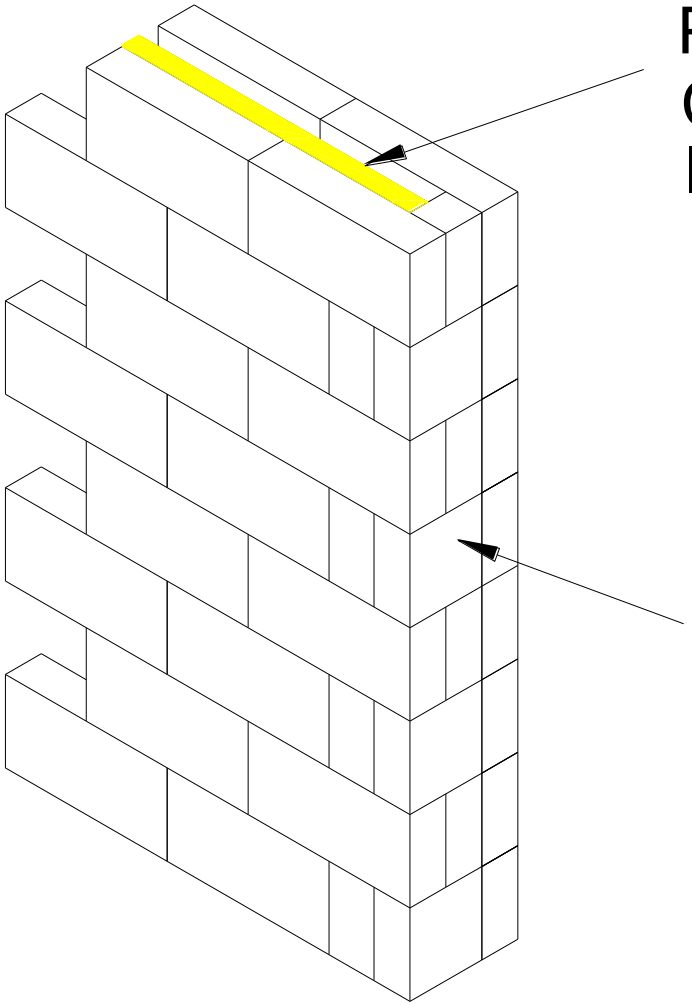
Examples of construction details which contribute to thermal bridging.

Thermal bridge caused by structural beam below a balcony window

Image source: www.rensolutions.co.uk/images/Thermal%20Bridg



Incorrect detail allowing thermal bridging.



Part fill
Cavity
Insulation

Traditionally, block were used to close the cavity at the jamb, resulting in a solid masonary reveal and so thermal bridging

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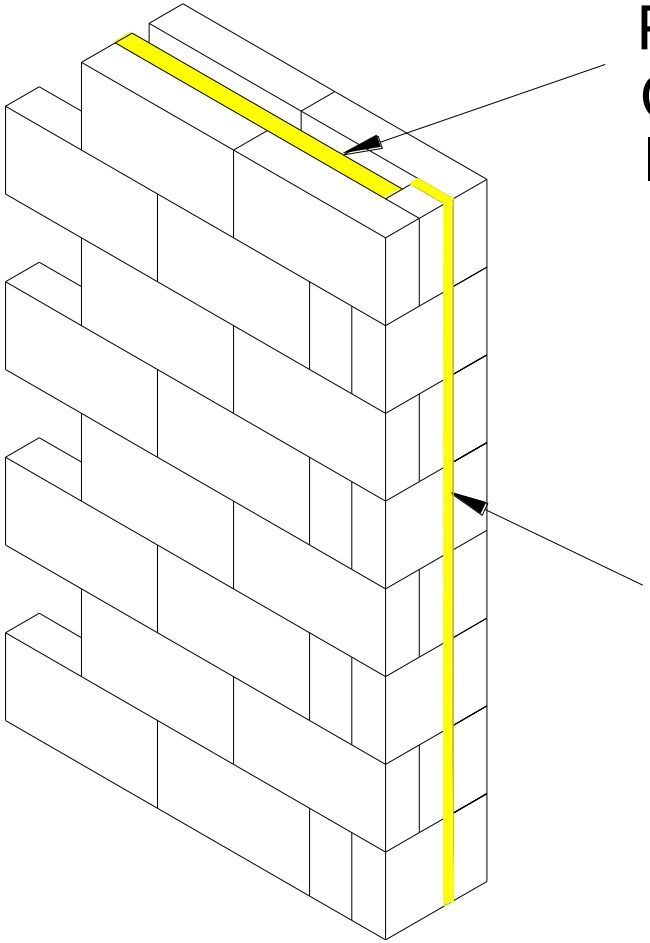
Same detail with a thermal break installed.



Part fill
Cavity
Insulation

The cavity should be closed using a proprietary insulated cavity closer, or by inserting a thin strip of insulation between the masony leafs to form a thermal break.

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Incorrect detail .

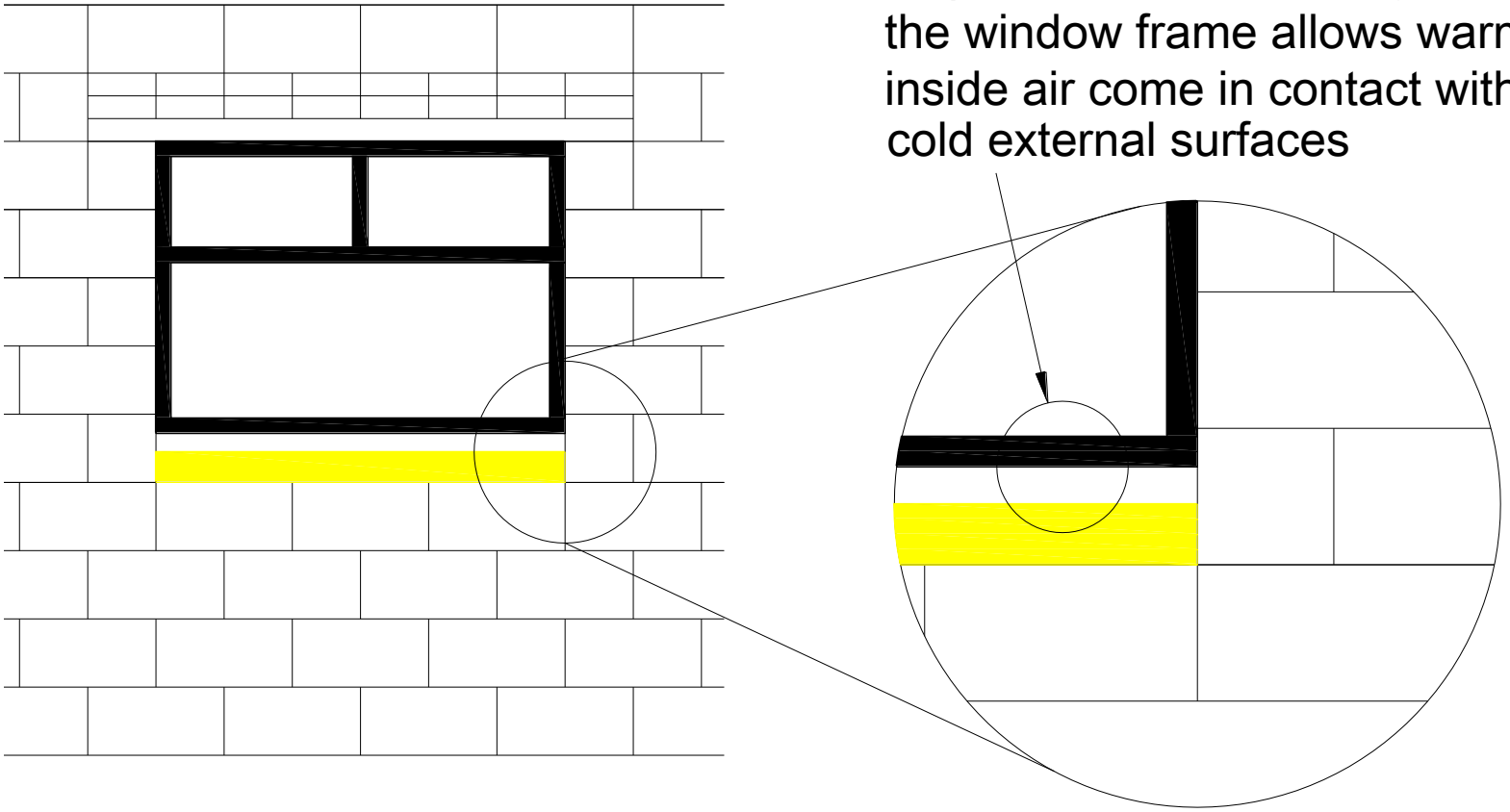

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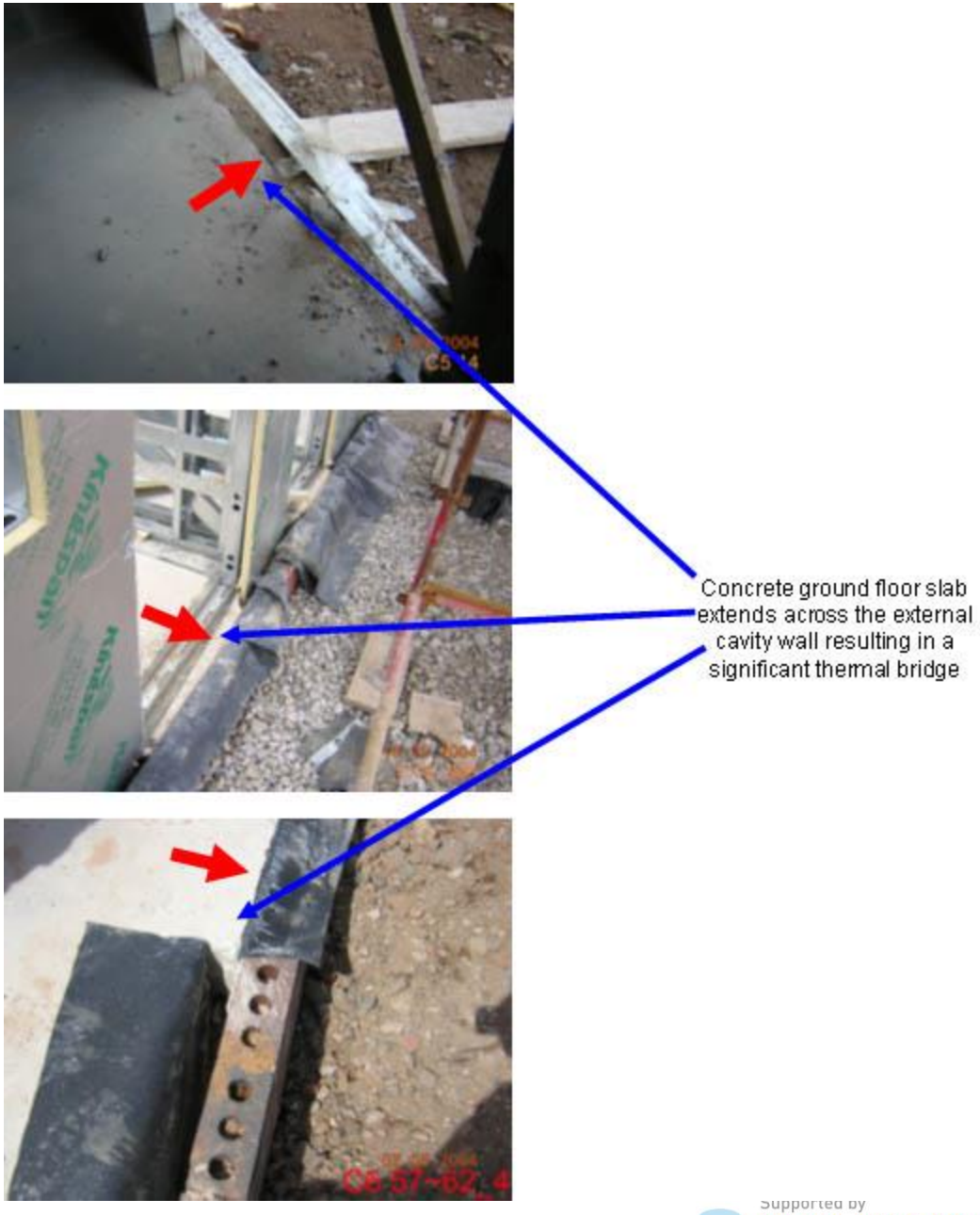
Image source:
www.leedsmet.ac.uk/teaching/vsite/low_carbon_housing/...

All images: Concrete ground floor slab extends across the external cavity wall resulting in a significant thermal bridge.



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Thermal bridging at a Juliet balcony when design detail not followed by the builder.

Image source: www.leedsmet.ac.uk/teaching/vsite/low_carbon_housing/...

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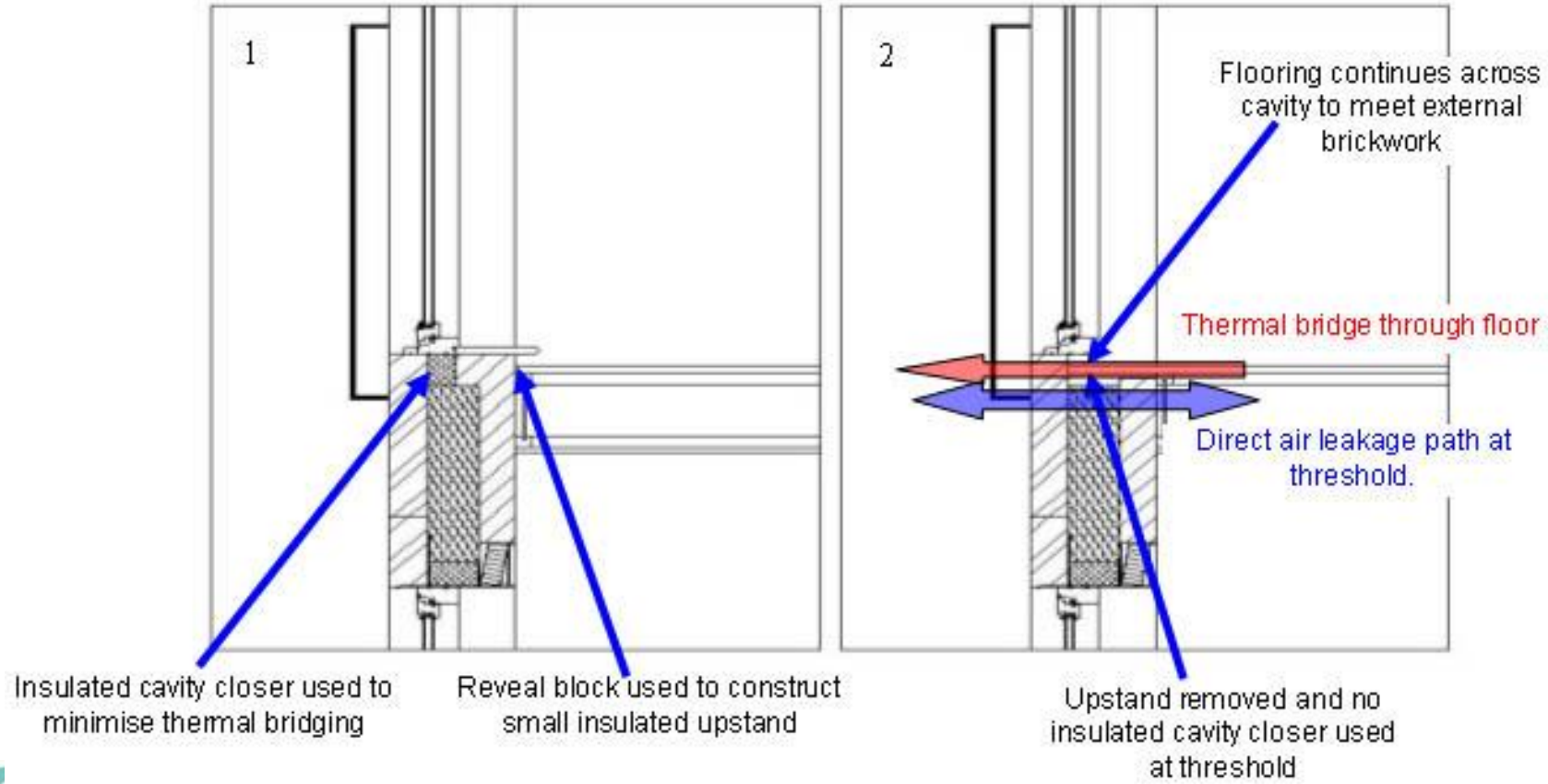
Design detail (1) and actual build(2) for the Juliet Balcony shown on previous page.

Image source: www.leedsmet.ac.uk/teaching/vsite/low_carbon_housing/...



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Thermal bridging due to structural support steel.

Image source: www.leedsmet.ac.uk/teaching/vsite/low_carbon_housing/...

Impact of thermal bridging on overall heat loss.

- As stated previously European countries have different ways of calculating heat loss due to thermal bridging.
- Take an example for Ireland.
- Even when applying best practice details described by Irelands building regulations –

  "Limiting Thermal Bridging and Air Infiltration ---- Acceptable Construction Details" (www.environ.ie)

  heat loss due to thermal bridging may account for more than 10% of the space heating load.

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- When applying typical construction details heat loss due to thermal bridging in Irelands dwellings may account for more than 20% of the space heating load.

  source: Authors calculations performed on worked examples of Irelands Dwelling Energy Assessment Procedure – DEAP – using varying default values for non-repeating thermal bridge.

- This heat loss due to thermal bridging may be much larger if design details are not accurately followed, as in the case of the Juliet balcony described earlier.

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How to reduce heat loss due to thermal bridging.

- Some European countries have developed "Accredited construction details"

  to show designers and builders examples of good practice to

  minimize thermal bridging of insulation layers

  and to achieve air tightness of buildings.
- Some examples are described in Chapter 12.

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Source of accredited construction details.

- Source Denmark - Not found.
- Source France - Not found.
- Source Spain - Not found.
- Source Germany.

  Passivhaus Institut - '*Protokollband #16*'

  reference – ASEIPI P189 Section 4.
- Source Ireland.

  http://www.environ.ie/en/Publications/DevelopmentandHousing/BuildingStandards/

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- Source United Kingdom.

  http://www.planningportal.gov.uk/england/professionals/buildingregs/technicalguidance/bcconsfppartl/bcassociateddocuments9/bcptlaccdet/

- Source Scotland.
  http://www.scotland.gov.uk/Resource/Doc/217736/0088295.pdf

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- Buildings using these details will reduce heat loss by achieving

a) Less thermal bridging.

b) Increased air tightness.

- Details and guidelines developed in Ireland appear to have been adapted from UK guidelines. Both also adopt a checklist approach where tick boxes can be completed to verify checking and correct installation.

Responsibility for reducing thermal bridging.

- Every person involved in construction can help reduce thermal bridging.
- In all cases everyone must try to keep a continuous insulation envelope around the building.
- Designers must specify construction details that minimise thermal bridging. Those details should be as straight forward as possible so that craftsmen do not make mistakes and are not tempted to take short cuts.

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- Builders must complete the building works as specified.
- Craftsmen taking services through the finished insulation envelope must repair and replace any damaged insulation.
- Owners must inspect and approve all construction details, as the work progresses, and before it gets hidden from view by internal or external finished.

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Module Summary.

- Thermal bridging can increase heat loss from buildings.
- Task.

  Explain how thermal bridging can occur.

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Module Summary.

- Traditionally, blocks were used to close the cavity at the jamb around doors and windows, resulting in a solid masonry reveal and thermal bridging.
- Task.

  How can this thermal bridging be reduced / eliminated.

Module Summary.

- On inspecting a concrete floor slab at a door opening, you find that concrete floor extends across the external cavity wall.
- Task.

a) Is this an acceptable construction detail to reduce thermal bridging.

b) Who might be responsible for allowing this occur.

c) What would you suggest to correct the fault.

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Module Summary.

- Some European countries have developed “Accredited construction details” to show designers and builders examples of good practice to minimize thermal bridging of insulation layers and to achieve air tightness of buildings.
- Task.
- Can you list the source of some of those details.

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References:

- http://wiki.aia.org/WikiPages/ThermalBridging.aspx
- www.asiepi.eu/fileadmin/files/PPT-ON-DEMAND/PPT_4.1/player.html
- www.asiepi.eu/information-papers.html
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- www.leedsmet.ac.uk/teaching/vsite/low_carbon_housing/...
- I.S. EN ISO 6946 : 2007 Building components and building elements - Thermal resistance and thermal transmittance - Calculation method
- www.rensolutions.co.uk/images/Thermal%20Bridg

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References – continued.

- http://www.environ.ie/en/Publications/DevelopmentandHousing/BuildingStandards/
- http://www.planningportal.gov.uk/england/professionals/buildingregs/technicalguidance/bcconsfppartl/bcassociateddocuments9/bcptlaccdet/
- http://www.scotland.gov.uk/Resource/Doc/217736/0088295.pdf