BUILDING FABRIC 1 - THERMAL PERFORMANCE

From FIRST IN ARCHITECTURE

Achieving good thermal performance of a building fabric will reduce the heat loss from a building, which in turn will reduce the space heating requirements along with carbon emissions and make for improved thermal comfort of the occupants. There are many factors involved when designing for thermal performance, along with a number of variables. Here we will look at an array of factors relating to thermal elements in building design.

Heat Transfer

First we will look at how heat can be transferred.

Heat transfer can occur in three main processes:

- Conduction
- Convection
- Radiation

Conduction transfers heat by molecular collision, and is the most common form of heat transfer that occurs via physical contact. An example of conduction would be placing metal into an open flame, even the parts of the metal not in contact with the flame become hot.

Convection is the transfer of heat through a material by the body movement of particles. This occurs with fluids and gases but not in solids. An example of convection heat transfer is a space heater, the heater heats the air surrounding it, the air will increase in temperature, expand and rise to the top of the room. This forces the cooler air down so it becomes heated. This creates a convection current.

Radiation is the transfer of heat energy through electromagnetic waves. The sun is a good example of heat radiation that transfers heat across the solar system.

k-values, r-values and u-values

In order to measure the effectiveness of the materials we specify and the suitably of a building assembly we need to look to a series of factors.

K-Value

> The k-value or lambda(λ) value (W/mK) measures the thermal conductivity of a material. **The lower the k value, the better the insulation property of a material.**

Some examples of thermal conductivity would be:

Thermal conductivity of materials

Material	Thermal Conductivity (W/m K)
Brickwork	0.77
Concrete - high density	1.93
Concrete block - lightweight aggregate	0.57
Glass	1.022
Plaster lightweight	0.18
Insulation mineral wool batt	0.038
Insulation polyurethane board	0.025
Steel - mild structural	60
Timber - softwood	0.13
Tiles - clay roof	1.0

R-Value

> The r-value (m^2K/W) measures the thermal resistance of a material or construction, and is simply the thickness of a material divided by its k-value.

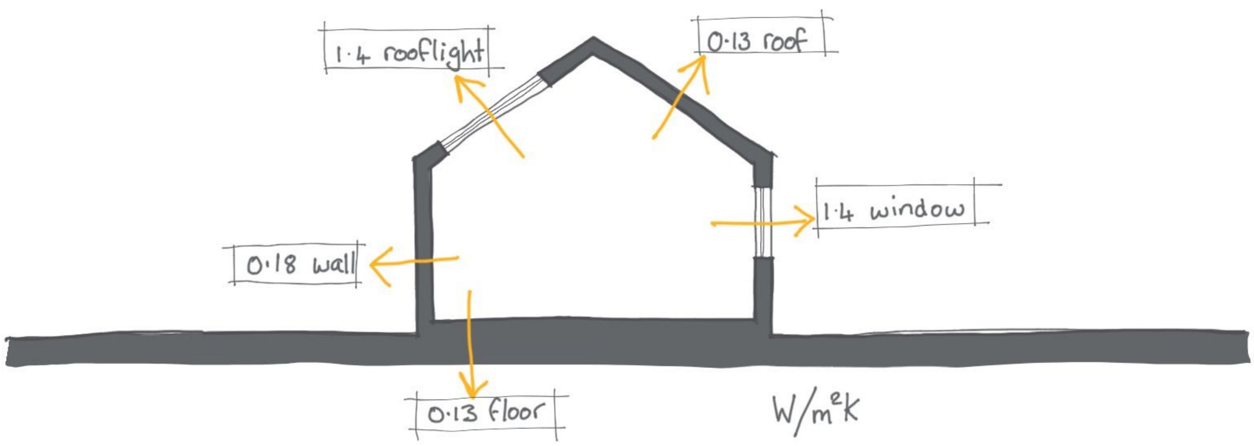
The thickness and conductivity of a material contribute to the overall thermal resistance of a construction. In a building assembly, the thermal resistance is measured for each material to get the overall thermal resistance of the composite.

The higher the thermal resistance, the better the insulator. Rock wool insulation has a high thermal resistance, concrete has a low thermal resistance and is a bad insulator.

U-Value

> A u-value is the measure of the overall rate of heat transfer, by all mechanisms under standard conditions, through a particular section of construction.

In the UK, the lower the u-value the better thermal performance by keeping the heat flow through the structure to a minimum.



You can read more about U-values and look at some supporting documentation and workings by going to our U value guide.

Building regulations and standards often refer to u-values as a target for thermal performance. Currently, in the UK the Building Regulation concurrent notional dwelling requirements for u-values are as follows:

Summary of concurrent notional dwelling U-value specification

Element	Value
Opening areas (windows and doors)	Same as actual dwelling up to a maximum proportion of 25% of floor area
External walls	0.18 W/m^2K
Party walls	0 W/m^2K
Floor	0.13 W/m^2K
Roof	0.13 W/m^2K
Windows, roof windows, roof lights, glazed doors	0.14 W/m^2K
Opaque doors	1.0 W/m^2K

To calculate a u-value of a construction refer to this article.

Building Form

Designing a building to have less and smaller surfaces exposed to the external environment will result in a lower heat loss and therefore less energy used for heating. Research suggests that this compact design will benefit the overall thermal performance of a building. Another thing to consider is the complexity of design. A more complicated building form will most likely have more thermal bridges, whereas a simpler form will avoid some of these thermal bridges that lead to heat loss. Building form must also be considered when designing for daylight and sunlight – we will look at this in another article.

Insulation

Specifying the correct insulation for your project will have a large impact on energy performance, along with environmental benefits.

A well insulated building will not only reduce the heating requirements in the summer, but also help to keep the building cool in summer, as long as ventilation and solar gain are controlled. For larger buildings it is often the case that more energy is used in summer cooling rather than winter heating.

Well designed insulation also reduces the risk of surface condensation because the internal surfaces are kept at room temperature which is above the dew point.

We will focus on insulation materials in a future post.

Thermal bridging and heat loss

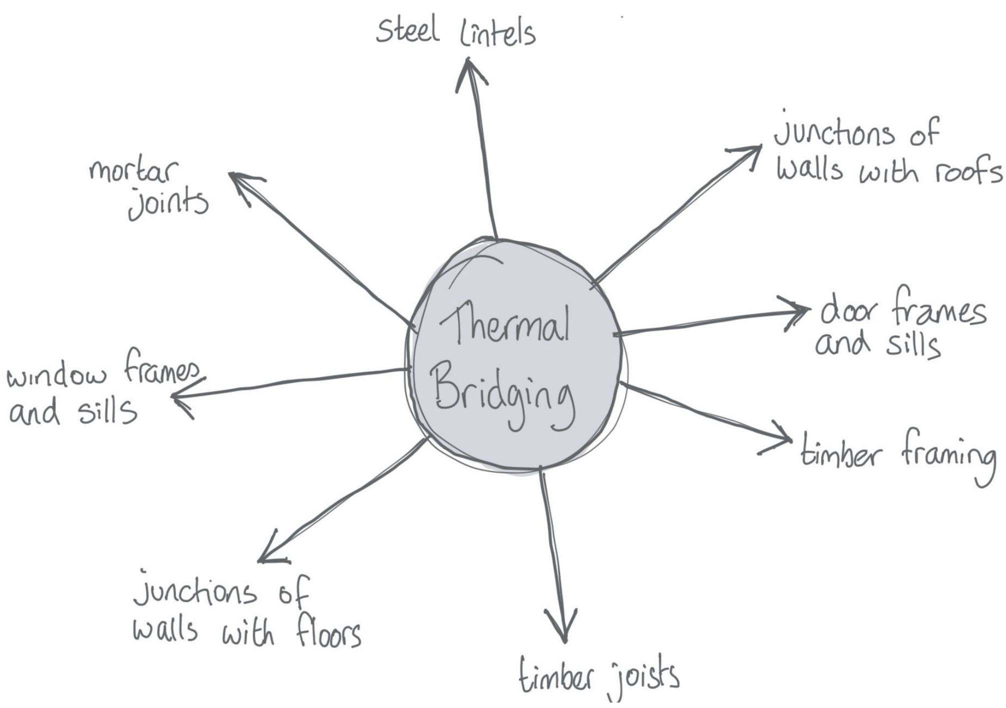
When we consider u-values we assess the building assembly as a whole. It should however also include adjustments for thermal bridges.

A thermal bridge is an area where there is reduced insulation, which results in a higher u-value creating heat loss, potential for condensation and mould. Some research suggests that up to 25% of internal heat loss is through thermal bridges[1].

There are three main types of thermal bridge:

Repeating thermal bridges – which usually are evenly distributed through the thermal envelope – an example being timber frame studs, or steel wall ties.
Non repeating thermal bridges – usually occur around openings or where materials with different thermal conductivity meet.
Geometrical thermal bridges – these are related to the shape of the building envelope usually where planes intercept. An example of this type of thermal bridge could be a junction or corner.

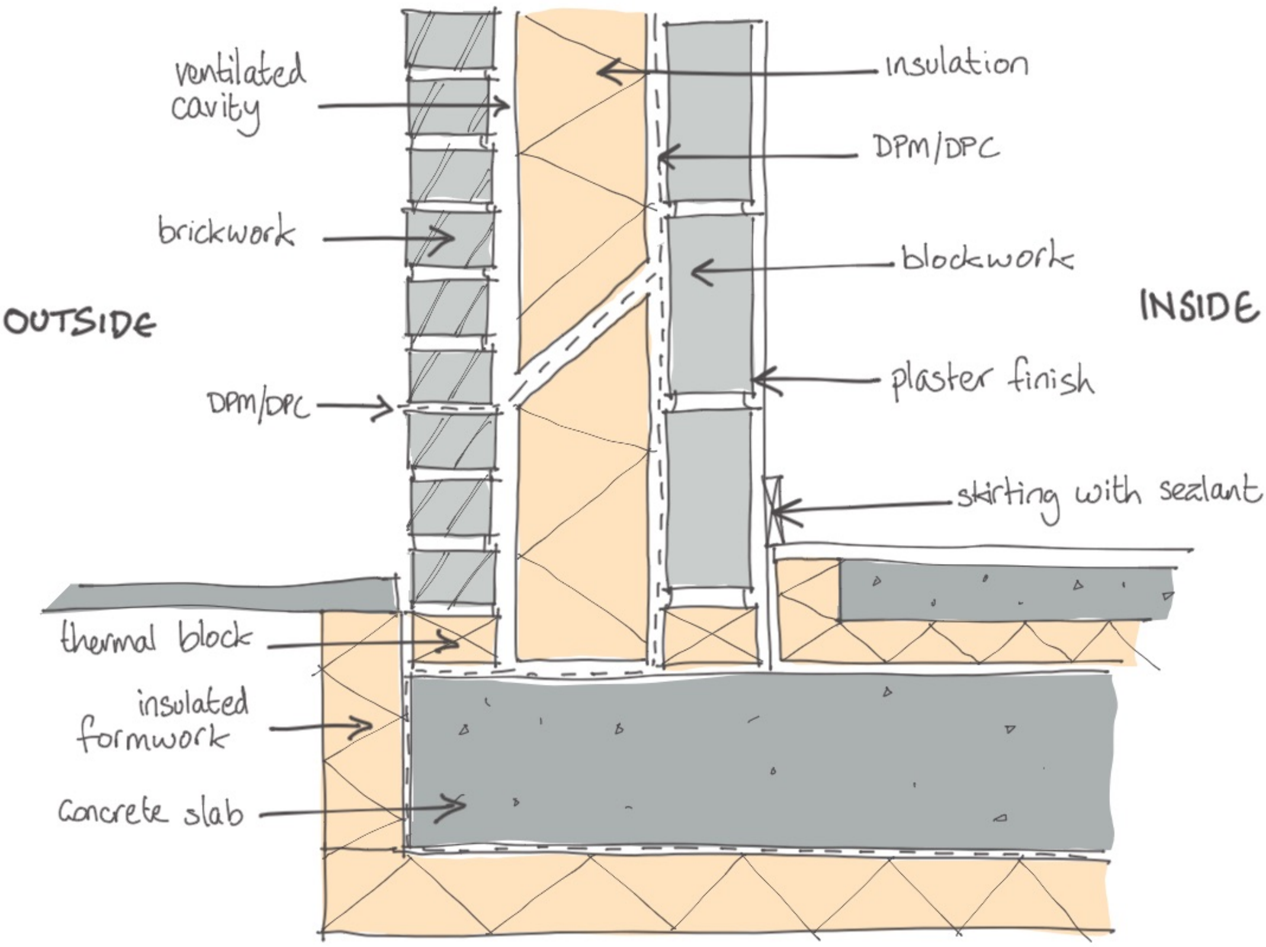
Some areas that thermal bridges occur:



Recommendations for reducing thermal bridging and heat loss:

- Thermal insulation and airtightness barrier should form a continuous line
- No gaps or breaks in the thermal insulation or air barrier
- Extra attention to air tightness membrane at junctions
- Refer to best practice examples (BRE, ECDs, robust details)
- Isolate thermal bridge with insulation
- Change the geometry of the thermal bridge

[1] According to Environmental Design Pocketbook



The detail above demonstrates a floor to wall junction of good practice for insulation placement and minimising thermal bridging.

References:

[Environmental Science in Building – McMullan](#)
[The Environmental Design Pocket Book – Pelsmakers](#)
[Green Building – Guidebook for Sustainable Architecture – Bauer, Mosle, Schwarz](#)

Read the original post here:

https://www.firstinarchitecture.co.uk/building-fabric-01-thermal-performance/

You might also be interested in:

Building Fabric 02 - Insulation Materials
Building Fabric 03 - Sunlight and Solar Gain
Building Fabric 04 - Sound Insulation