ZCSP Report – Buildings

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MATERIAL CONSIDERATIONS

James Smith December 2020

Generally, the ideal is a complete unbroken thermal envelope around your home - cold bridging must be eradicated if at all possible, as must unmanaged air ingress/egress. This is very tricky when refurbishing a house especially if the insulation is internal, or a mixture of internal and external.

However, it is also important to consider the effects that the improvement of one element may have on another – insulating the walls well may cause greater condensation problems elsewhere, on cold windows for example, or on the underside of the roof which may now become the cool element.

It is also important to point out that if a thermal element is renovated, it must be brought up to the current Part L1B building regulation u-value for that element – although if physically and financially possible/viable, it is always worth aiming higher.

Consideration of thermal comfort is equally important, which has both physical and psychological aspects. For example although the cottage floor costs little in terms of energy and money, it will feel cold to the feet, cooling the body and making the whole room *feel* colder. This is one reason why underfloor heating is more efficient – having warm feet is psychologically very comforting, and means that the ambient room temperature can be set much lower.

It is also true that drafts or air movement cool the body further than the ambient room temperature – and air movement may be the result of warm air moving toward a cold surface.

It is important that wherever possible we minimise the environmental impact of building materials.

Environmental costs of manufacture include:

- Toxic pollution from Manufacturing and combustion
- Primary Energy used in extraction, production and transport
- Natural Resources use

The environmental costs of disposal include:

- Landfill requirement
- Loss of potential resource for re-use and recycling
- Irrecoverable Energy from waste

Breathability, Hygroscopicity, and other issues..

Breathability/Vapour Permeability and hygroscopicity are generally speaking qualities that organic materials have but man-made materials do not (which act instead as vapour barriers).

Hygroscopic materials will readily absorb available moisture from the atmosphere, and let it out again when the atmosphere is drier. This helps greatly in maintaining a comfortable and balanced internal environment without resorting to energy intensive humidifiers or de-humidifiers.

Breathable materials are also called ‘vapour permeable’ – they are not necessarily hygroscopic, but allow the passage of vapour, and thus moist, stale air.

A wall built with lime mortar, a natural insulation material, and a lime or clay-based plaster will be able to absorb moisture (and heat) when the internal environment becomes too hot and humid, and then let it out again when the internal environment cools/dries. Brick walls with cement plasters/renders/mortars are unable to do this, and as the heat is absorbed the moisture is dumped causing damp problems internally (or interstitially), leading to mould, mildew and potential ill-health.

Old breathable walls that have subsequently been treated with cement plasters/renders/mortars for the sake of ‘weather-proofing’ or ‘thermal improvements’ will invariably have damp issues leading to potential structural issues – it is therefore really important to use breathable materials on old structures, particularly if they have lime mortar or plaster.

Many natural materials such as lime and timber also have inherent anti-bacterial properties that have positive benefits for building and occupant health.

Ordinary Portland Cement has become ubiquitous in the construction industry because it is cheap and strong. However its strength requires vast quantities of energy to make and is responsible for damaging materials around it/negating the ability of materials to be re-used. Its use should be eliminated if possible or minimised – limecrete and lime plasters/renders are to be favoured instead.

Hemp or cork for example may be added to lime plaster to improve its insulation properties whilst not increasing costs. Indeed rather than insulating walls internally, it is possible to apply a very thick insulative plaster instead.

Insulation

Insulation materials can be broadly separated into two – those that breathe, based on natural materials, and those that don’t, which are oil based. As above, breathable insulation materials are able to deal better with humid conditions and thus maintain more steady internal atmospheres, and in so doing also deal with issues relating to interstitial condensation which can lead to fungal and structural issues. Oil-based materials are cheaper and generally have better k-values (heat conductivity), but have a high embodied energy.

Insulation is measured by its thermal conductivity or k-value, measured as Watts per m^2 Kelvin (W/m^2K) - the lower the number the better. The u-value of insulation is achieved by multiplying its k-value by its thickness in millimetres.

There are many different insulation products on the market, available as boards, batts (like a quilt), or loose-fill – specification will depend upon what needs insulating, and which material is favoured. They all fall into one of three main categories, Organic, Mineral, or Oil-based.

Organic insulation materials are generally those with the highest k-values (0.037 – 0.040W/m^2K) and cost the most – however costs are falling, and you get what you pay for: they are natural, largely chemical free (no off-gassing!), hygroscopic, breathable, made from renewable materials, and sequester CO_2 within your walls. They are reusable and compostable.

Mineral insulation materials are mid-range options in terms of performance (generally 0.03 – 0.04W/m^{2}K), but often the least expensive. They are natural materials that have been put through energy-intense processes and thus have a higher embodied energy than organic materials. They do not sequester CO_2, and are not hygroscopic, although they are breathable to some extent. They are reusable and recyclable.

Oil-based insulations are often the cheapest and most effective at blocking heat transfer (0.02 – 0.04W/m^{2}K). They are also great at blocking moisture, which can be a benefit in certain applications, but not so good for the internal atmosphere if used on or in your walls. They are made from oil, off-gas toxins, and have a large embodied energy. They are potentially re-useable.

External vs Internal

Solid walls typically allow twice as much heat to escape as uninsulated cavity walls – however they can be insulated either internally (IWI) or externally (EWI).

It is the received wisdom that IWI is cheaper to install than EWI, although in practice once everything has been taken into account the costs are broadly similar.

Generally speaking, EWI is the better option since it can be applied with minimal disruption, does not reduce the internal floor area, keeps the thermal mass inside (thus ensuring a more stable internal temperature and avoiding over-heating in the summer), and because it covers all of the wall it eliminates cold bridging (points which penetrate the insulation) and thus areas inside where condensation is likely to form.

Also, because the insulation is rendered, EWI also enables much better air-tightness.

IWI's main advantages are that it can be carried out piecemeal, as and when rooms are decorated, and that it doesn't affect the external aesthetic of the building.

Whether insulating inside or out, ideally widows and doors should be moved into the insulation pane in order to minimise thermal bridging. If this is not practicably possible, it is important that the insulation returns into the window reveals and butts up against the frame – clearly you are unlikely to get much thickness here, but 25mm is better than nothing.

Cavity Insulation

If the cavity in the wall is over 75mm wide, then cavity fill insulation becomes an option.

However there are other important considerations: the cavity is currently acting as a ventilation gap, allowing both internal and external walls to 'breathe' into it and thus avoid damp issues - filling it may result in an increased dampness inside the house, especially considering that cavity fill materials are generally man-made, oil-based, and not vapour permeable.

It is also difficult to get complete coverage inside the walls and cold-bridging spots may well result.

If damp patches are already present on the inside of external walls, then the cavity should not be filled until the root of the problem has been identified. If practically and financially possible, always consider using external insulation instead.

Floors

The space under suspended floors should be well cross-ventilated via air bricks and this must be maintained to ensure the floor timbers do not rot – this is not so important with concrete beams. It is worth lifting the floors and fitting mineral wool between the joists by either battening and boarding, or simply fixing chicken wire for the batts to lie on. Ventilation below the floor must be maintained or improved, since the floor void will now be cooler and more susceptible to moisture and rot.

Ii is worth contemplating digging up solid floors in order to insulate – this is the perfect situation in which to use an oil-based insulation product, 50mm will make a big difference, 100mm would be best.

Roofs/Lofts

Another quality of natural/organic insulation materials, which is linked to their hygroscopicity, is that they have a certain thermal mass or lag – this is particularly useful in lofts which can get very hot or stuffy if insulated with non-organic materials.

Also, using a breathable construction in the roof negates the need for an air gap between the underside of the tiles and the insulation material – this is specified by building control in order to ensure roof timbers do not rot; an issue that is not relevant if the whole roof construction is breathable.