Sustainable Warmth Cumbria

Retrofitting for flood and weather resilience

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Towards Zero Carbon Cumbria
CAfS
Cumbria Action for Sustainability

CARLISLE CITY COUNCIL
www.carlisle.gov.uk

Programme

Session 1

09.30 - Introduction and Context and Introduction

09.50 - The need to understand the potential flood risk and building performance

10.30 - Short workshop – factors affecting decisions / end users priorities

10.40 - Break

10.50 - Options for flood resistance and flood resilience measures

11.15 - Sustainable options for energy efficiency measures in flood risk areas

11.40 - Q&A

Session 2

09.30 - Review and questions from previous session

09.40 - Retro-fitting options and the Building Regulations

10.00 - Break

10.10 – Workshop in break out groups – house types, options and issues to consider

10.50 - Guidance and case studies.

11.30 - Q &A

Introduction and Context

Towards Zero Carbon Cumbria
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Context

In 2005 Carlisle suffered severe flooding; and in 2009 Appleby, Keswick and Cockermouth as well as other communities across the County were also hit.

These events were considered to be once in a generation events, so following storm Desmond the flooding experienced by the same communities in 2015, with the addition of Kendal and the severe damage to the infrastructure across the County came as a shock. Since then there have been further storms in 2018

With the impacts of climate change in the form of extreme weather events becoming more common across the world, we need therefore need to assume that these communities will flood again.

Context

BBC Report 11/10/16

Hundreds of thousands of householders in flood risk areas have failed to install basic protection against rising waters, insurers say.

The insurers, the Environment Agency says, should not simply re-instate flooded homes to their original state - they should ensure properties are resistant or resilient to future floods.

Emma Howard Boyd, who chairs the agency, says: "There is a disconnect between insurance reinstatement and resilient repair of property.
"Loss adjustors and builders do not understand the benefits of resilient measures.
"It is not clear that the insurance industry value property-level resilience or incentivising people to have it.“

That is despite research suggesting that precautionary measures are extremely good value. The report's main author, Sir Peter Bonfield, says: "The typical range of [flood-proofing] measures have a cost-benefit ratio in excess of £5 for every £1 invested in terms of reduced damages.
"However, there is still relatively low uptake in England - people at high flood risk aren't routinely installing resilience measures in their homes and businesses."

What does energy efficiency and sustainability mean in the context of flood resilience?

Climate change is blamed on several human activities, but the biggest contributor to climate change is the increase in greenhouse effect produced by carbon dioxide (CO2).

Most of the carbon dioxide emissions come from fossil-fuel burning and the main reason we burn fossil fuels is for energy. So to reduce the impacts of climate change, we need to use less energy and sort out a new way of getting energy that leaves fossil fuels in the ground. The climate problem is mostly an energy problem.

What does energy efficiency and sustainability mean in the context of flood resilience?

Work to improve the flood resilience of a property could be carried out at the same time as energy efficiency measures minimising cost and disruption.

Reducing levels of damp can significantly reduce the energy used to heat a property as drier walls reduce heat loss through the walls and prevent mould, rot and damage to the building and improve the health and comfort of the occupants.

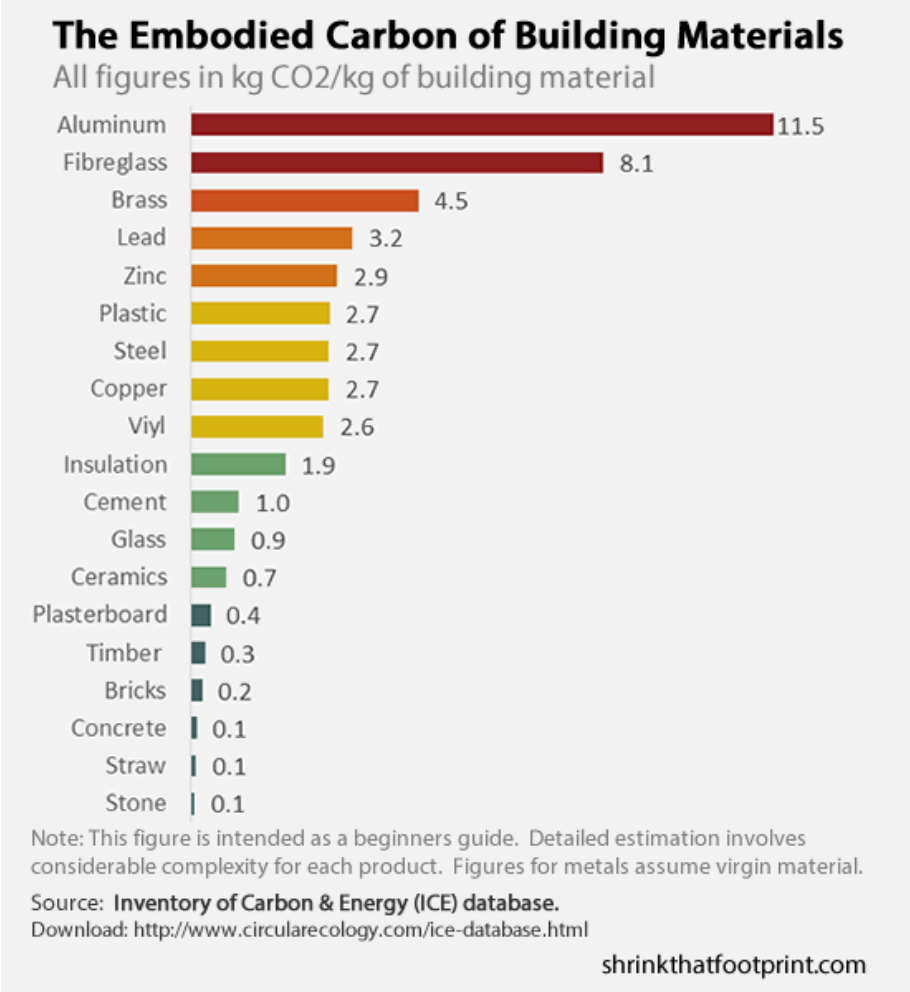
Carrying out flood resilience measures and choosing building and insulation materials that dry out more quickly will also reduces the need for stripping out saving resources.

Sustainability and embodied energy

The ‘embodied energy’ of building includes the energy used to extract, manufacture, and transport all the materials used.

Once the energy needed in the day-to-day life of a building has been minimised, then the energy used in construction becomes a bigger energy use.

Different building methods use differing amounts of materials, so it’s a matter of balancing the benefits of a particular method against its impact.



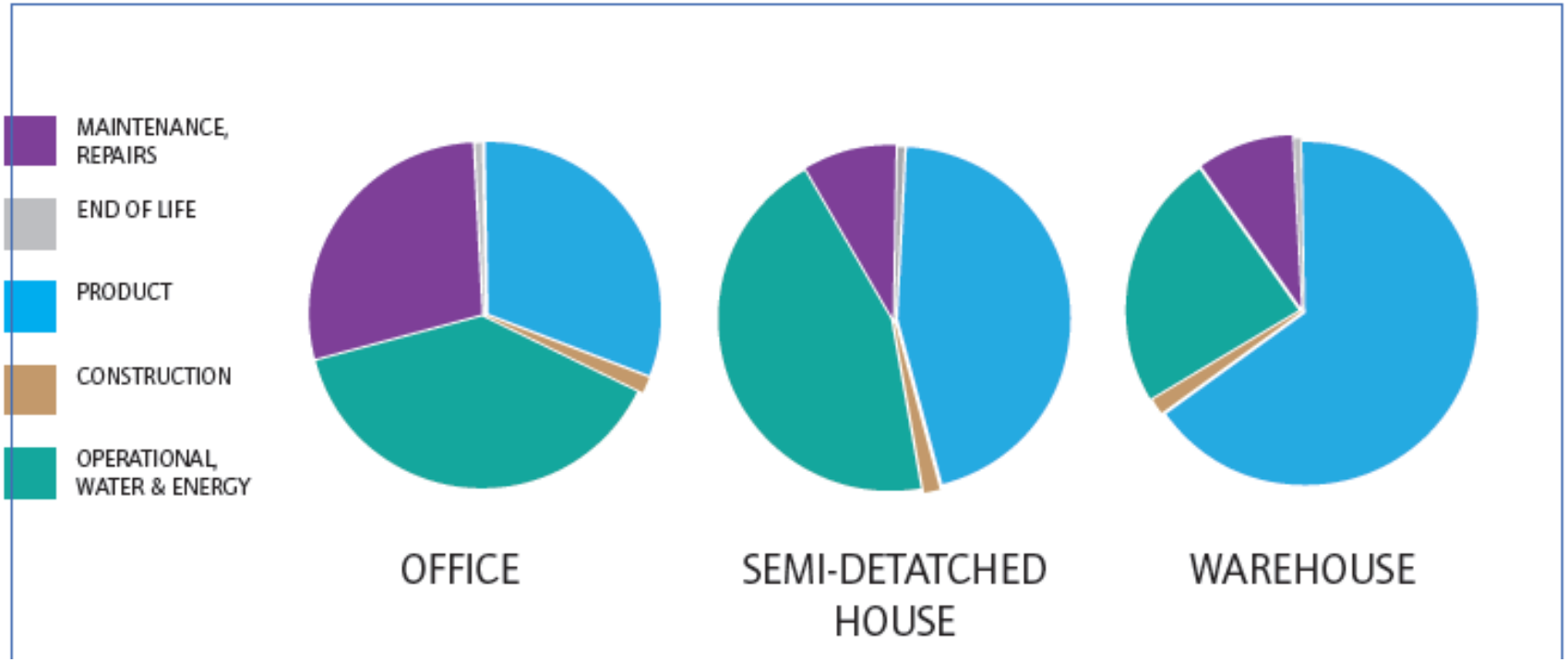
A free database of building materials, giving data for embodied energy and embodied carbon

https://circularecology.com/embodied-carbon-footprint-database.html

Embodied energy and payback

The environmental impact of retrofit work

Retrofit is commonly measured in terms of its effect on the energy consumption and CO_2 emissions from buildings ***in use***. For responsible retrofit the 'embodied' impact of construction and materials should also be taken into consideration wherever possible. This can be substantial and sometimes even outweigh any savings in use. Retrofit materials require energy for manufacture and transport to site, and in many cases they are made from increasingly scarce resources such as oil, or are taken from vulnerable habitats. Unfortunately good information and standards are also lacking.



Increases in:

- Standard of Flood Protection
- Scheme Cost
- Peace of Mind
- Insurance Options
- Property Value

Traditional Flood Defence Schemes

Temporary Flood Barrier Schemes

Property Level Protection

Sandbags

Do Nothing

Flood risk and building construction

Two Approaches to flood resilience

Flood resistance or **Water exclusion strategy**
Measures to stop water entering a building where emphasis is placed on minimising water entry whilst maintaining structural integrity, and on using materials and construction techniques to facilitate drying and cleaning. This strategy is favoured when low flood water depths are involved (not more than 0.3m).

Flood resilience or **Water entry strategy**
Measures to adapt a building to limit the damage caused once water has entered, where emphasis is placed on allowing water into the building, facilitating draining and consequent drying. Standard masonry buildings are at risk of structural damage if there is a water level difference between outside and inside of about 0.6m or more. This strategy is therefore favoured when high flood water depths are involved (greater than 0.6m).

To decide which strategy to take you need to:
Understand the flood risk or where the water is coming from.
How the building is constructed.

Understanding where the water is coming from

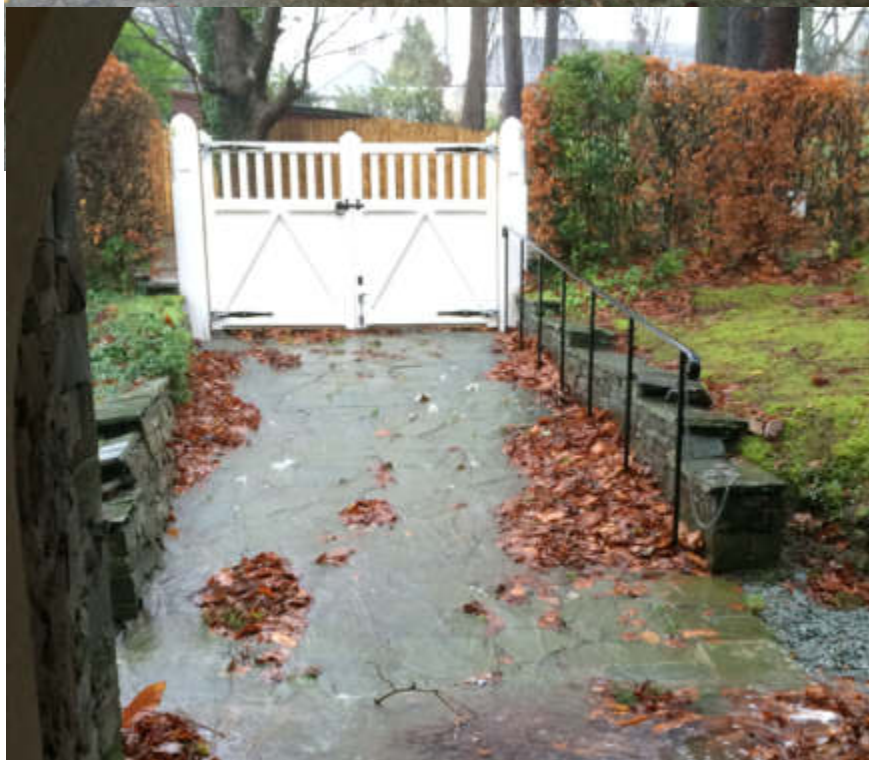
….and how it may enter a property and how it will it be drained away

Understanding where the water is coming from

- From rivers or becks that have burst their banks, with the potential for contaminated water.
- May enter through doors or external air bricks and rise up through the floor.
- For terraced or semi-detached properties it may even seep through from the adjoining property.

Understanding where the water is coming from

- From surface water run off including roads, fields and paths. Some risk of contamination.
- May enter through doors or external air brick bricks and rise up through the floor.
- Impact of increased hard surfacing, reduced natural drainage (1/4 London gardens paved over)



Understanding where the water is coming from

- From overflowing land and foul drains, with the risk of contaminated water

- May enter through doors or air brick vents

- From backing up sewers, with associated contamination

Understanding where the water is coming from

- From rising ground water levels, either through the door or more likely coming up through the floor.

Severity of ground water flooding will depend on;

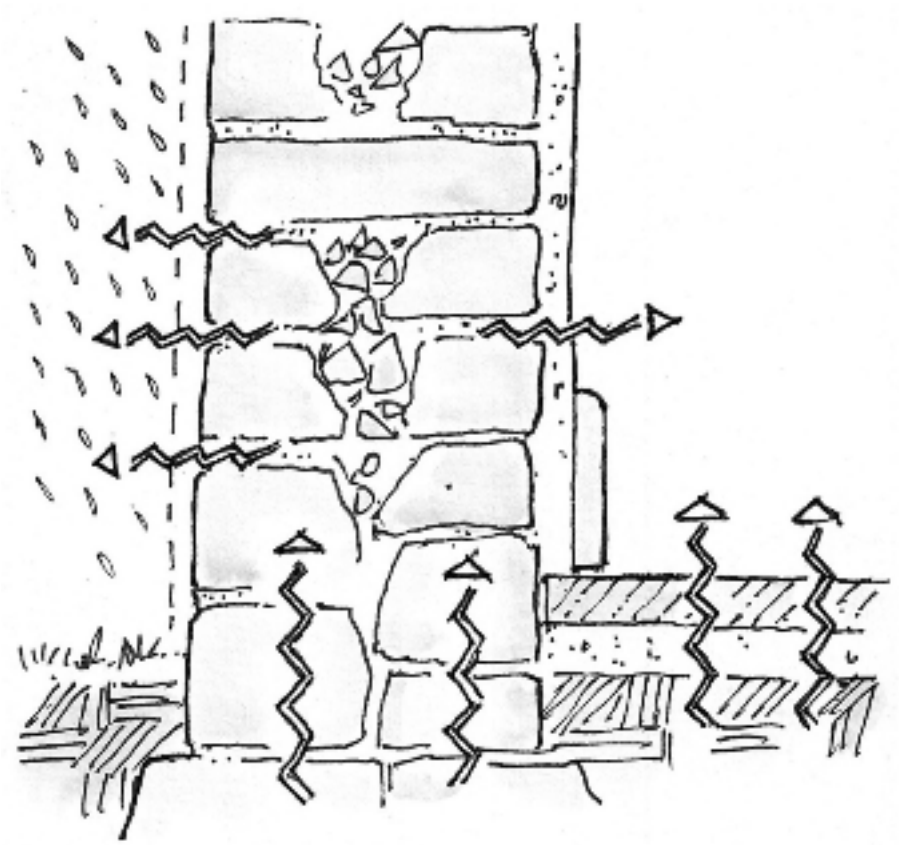
- The height of floodwater
- The length of time the floodwater is present
- The type of soil or ground around and beneath the house.

Understanding where the water is coming from

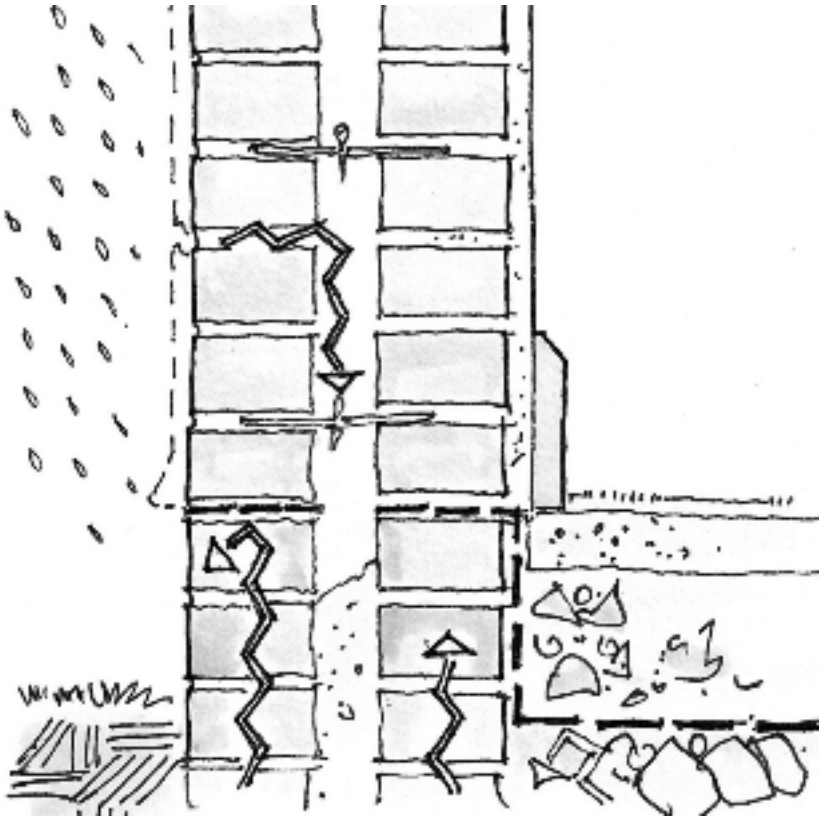
- From leaking and/or badly maintained roofs and windows and rainwater goods.

Building Construction

How moisture flows through the fabric and how it dries out



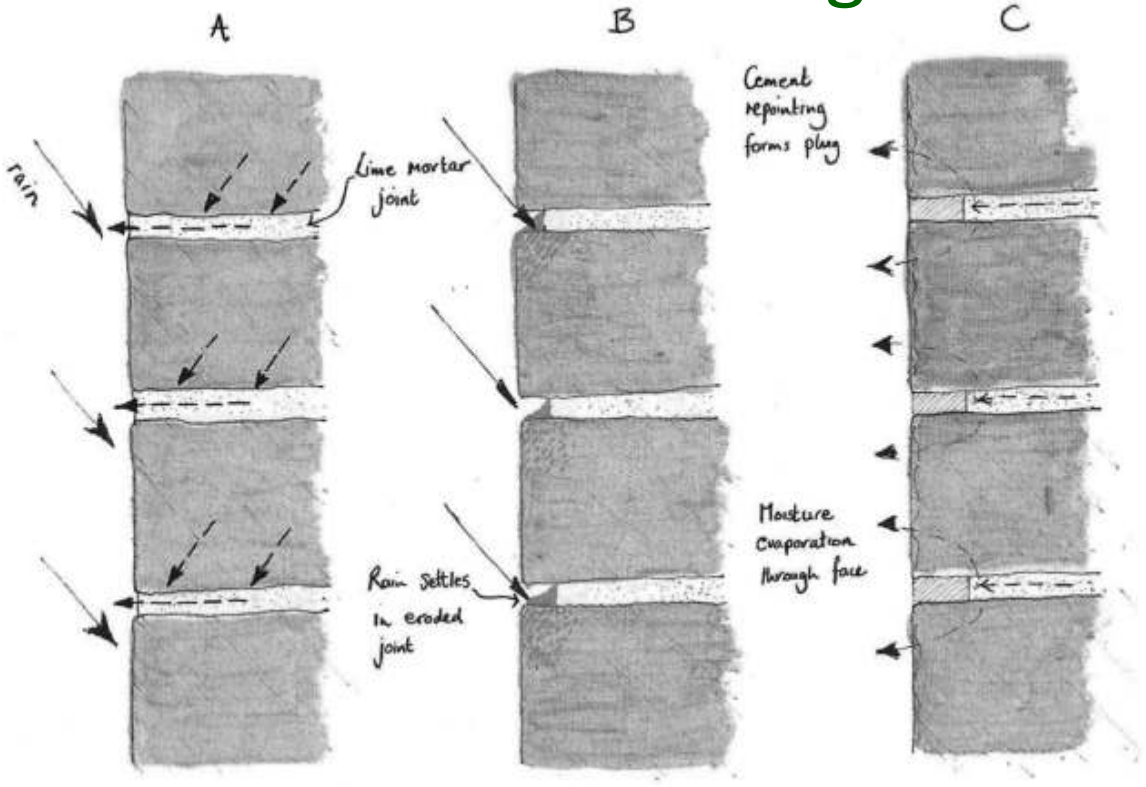
Traditional solid wall construction - soft breathable, pervious, flexible materials – moisture evaporates out



Modern cavity wall construction – hard, waterproof, impervious, inflexible materials – barriers to moisture until cracks develop

Building Construction

Moisture flow through solid walls - mortars

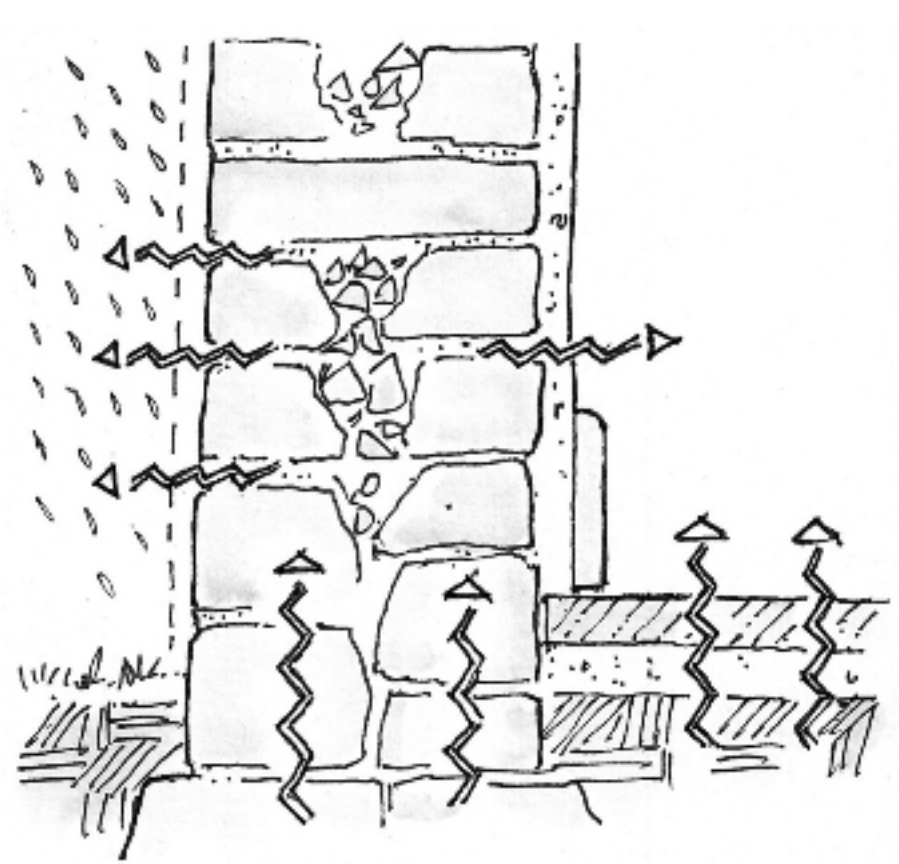


80% evaporation
through the joint zone

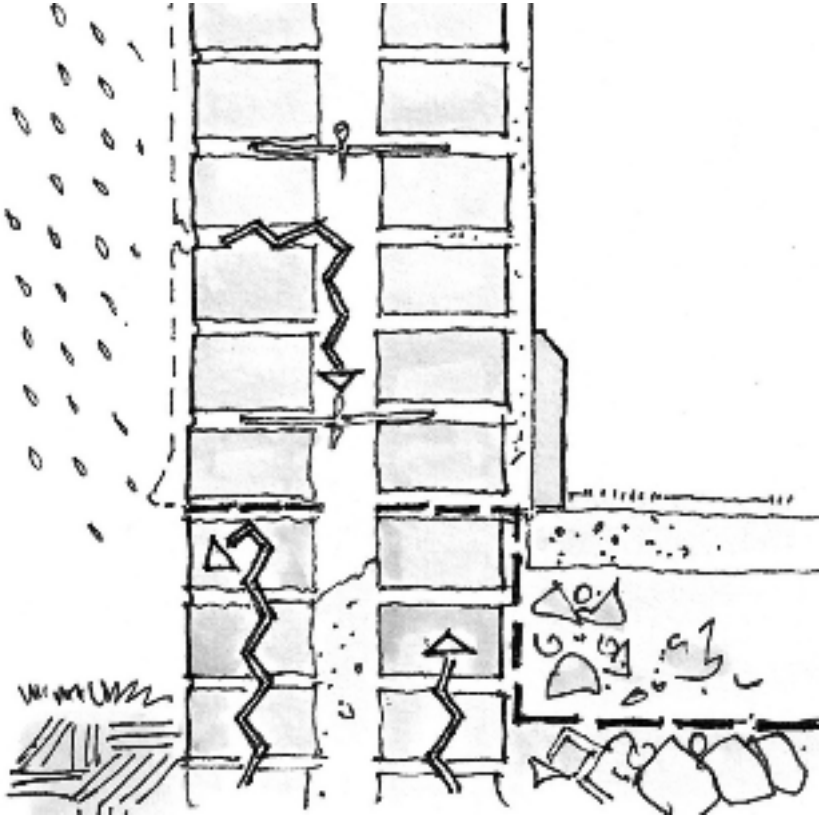
Moisture concentration = accelerated decay through freeze thaw & salt activity.

Building Construction

Moisture flows through floors



Traditional flagged floor no dpm – permeable material allowing ground moisture to evaporate.



Modern construction – impervious concrete floor with dpm linked to dpc preventing ground moisture from rising up.

Building Construction

Moisture flows through floors with hybrid construction

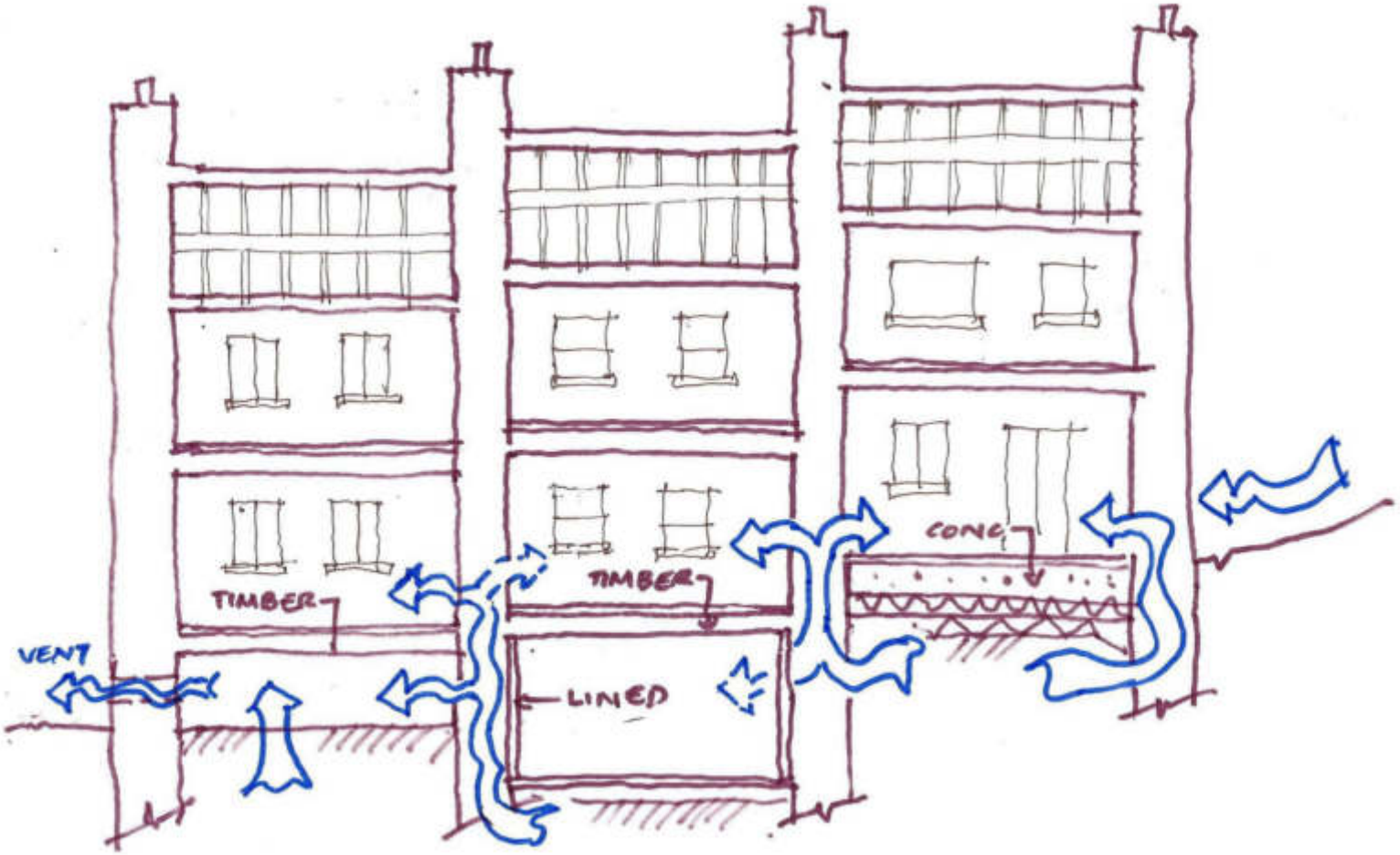
Upward moisture movement by capillary action, caused by:

Below ground moisture pushed to the base of the walls causing rising damp.

Other factors including neglected drains

Building Construction

Moisture flow, hybrid construction



- Solid floor with dpc / where is that water going

Building Construction

performance of materials

•Water affects different materials in different ways. The key issues for resilient buildings is the ability of building materials to withstand wetting and drying and to minimise the extent of any stripping out after the water has subsided.

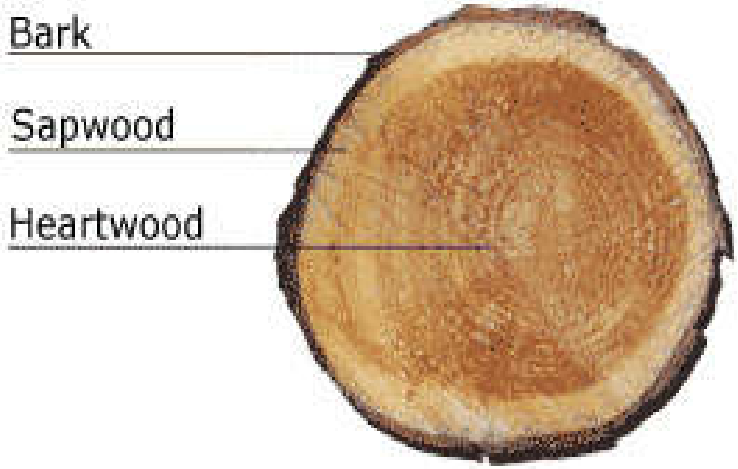
•When choosing a material it is therefore important to understand how wetting and drying effects the performance of the material either positively or negatively depending on whether it is a breathable/vapour open or barriered / vapour closed form of construction.

•This is important as the wrong choice can lead to problems with entrapment of moisture, which will also makes the buildings feel colder. This is because heat transfers through water much faster than through dry materials. Damp may also lead to the deterioration of plaster and stonework, promote timber decay and create unhealthy conditions for occupants due to mould and rot.

Building Construction

Performance of materials – timber decay

Beetle Attack:
Below 15% moisture content
difficult for insects to thrive



Fungal decay:

Water content 28% - 30%
(22% no growth, spores can live for years)

Spores settle on timber

(food source) and if wet/ unventilated

Hyphae develop to form mycelium (white and cotton wool like). When threatened forms fruiting body which stores spores.

Table 6.1 Flood resilience characteristics of building materials (based on laboratory testing)			
Material	Resilience characteristics*		
	Water penetration	Drying ability	Retention of pre-flood dimensions, integrity
Bricks			
Engineering bricks (Classes A and B)	Good	Good	Good
Facing bricks (pressed)	Medium	Medium	Good
Facing bricks (handmade)	Poor	Poor	Poor
Blocks			
Concrete (3.5N, 7N)	Poor	Medium	Good
Aircrete	Medium	Poor	Good
Timber board			
OSB2, 11mm thick	Medium	Poor	Poor
OSB3, 18mm thick	Medium	Poor	Poor
Gypsum plasterboard			
Gypsum Plasterboard, 9mm thick	Poor	Not assessed	Poor
Mortars			
Below d.p.c. 1:3(cement:sand)	Good	Good	Good
Above d.p.c. 1:6(cement:sand)	Good	Good	Good
* Resilience characteristics are related to the testing carried out and exclude aspects such as ability to withstand freeze/thaw cycles, cleanability and mould growth			

Improving the Flood Performance of New Buildings Flood Resilient Construction

Table 6.2 Flood resilience characteristics of walls (based on laboratory testing)			
Material	Resilience characteristics*		
	Water penetration	Drying Ability	Retention of pre-flood dimensions, integrity
External face			
Engineering bricks (Classes A and B)	Good	Good	Good
Facing bricks (pressed)	Medium	Medium	Good
Internal face			
Concrete blocks	Poor	Medium	Good
Aircrete	Medium	Poor	Good
Cavity insulation			
Mineral fibre	Poor	Poor	Poor
Blown-in expanded mica	Poor	Poor	Poor
Rigid PU foam	Medium	Medium	Good
Renders/Plaster			
Cement render – external	Good	Good	Good
Cement/lime render – external	Good	Good	Good
Gypsum Plasterboard	Poor	Not assessed	Poor
Lime plaster (young)	Poor	Not assessed	Poor
* Resilience characteristics are related to the testing carried out and exclude aspects such as ability to withstand freeze/thaw cycles, cleanability and mould growth			

Improving the Flood Performance of New Buildings Flood Resilient Construction

Building Construction, performance of materials

Building materials:	
Concrete	Very resistant to water damage / Not breathable and can lead to concentration of water elsewhere.
Stone and Brick	Resistant to water damage; porous & breathable, will dry out; Long term water penetration in conjunction with non-porous mortars can cause serious damage and surface erosion during drying out.
Timber (wood)	Can be resistant to short term wetting, but suffer from rot if allowed to remain wet. Should be dried out steadily (not too fast) as soon as possible.
Cement render	Dense material, retains little water but dries slowly. Prevents wall 'breathing' and traps moisture that gets in through hairline cracks.
Cement /gypsum plaster	Dense material, retains little water but dries slowly. Not breathable. Will tend to crumble or disintegrate when wet and will need to be removed anyway to allow wall to dry out.
Plaster - board	Porous, but not breathable. Plaster will tend to crumble or disintegrate when wet. If backed with foam insulation will absorb moisture and will not dry out so will have to be disposed of and replaced.
Lime plaster	Resists water damage. Porous and breathable, can retain large amounts of water and will often dry out relatively quickly. Can be retained if allowed to dry out.

Building Construction

Drying out and material compatibility

•As indicated earlier traditional buildings perform best when they are allowed to ‘breathe’ therefore maintaining and/or re-instating these materials will allow the building to perform at its most efficient and allow the building dry out quicker if flooded again.

•Introducing energy efficiency measure in the form of insulation should therefore be compatible with this approach. Many of these materials are also not heavily processed as this will further reduce the carbon footprint and environmental impact.

•A number of these materials are NOT though compatible with being soaked in water.

Building Construction

Impact on Hygro-Thermal Behaviour

Relative Humidy

The behaviour of water vapour is directly linked to temperature, because warm air can carry considerably more moisture than cold air.
This is generally expressed as ***relative humidity*** **(RH)** – the amount of water vapour in air as a percentage of the total amount that could be carried at that particular temperature.

Latent heat

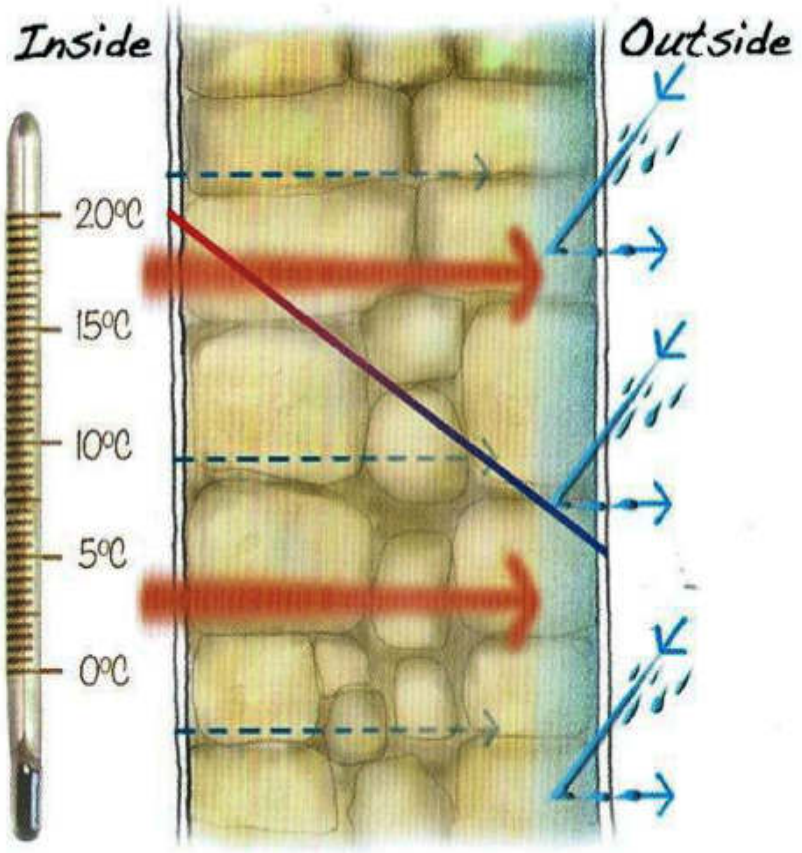
In addition the evaporation and condensation of water influences material temperature through the effects of latent heat. It takes energy to evaporate water and this energy must be obtained from somewhere, and is typically taken from the body of the permeable material the water is evaporating from, thus cooling it. Conversely, when that water then condenses on a surface, that latent energy is released back into the material.

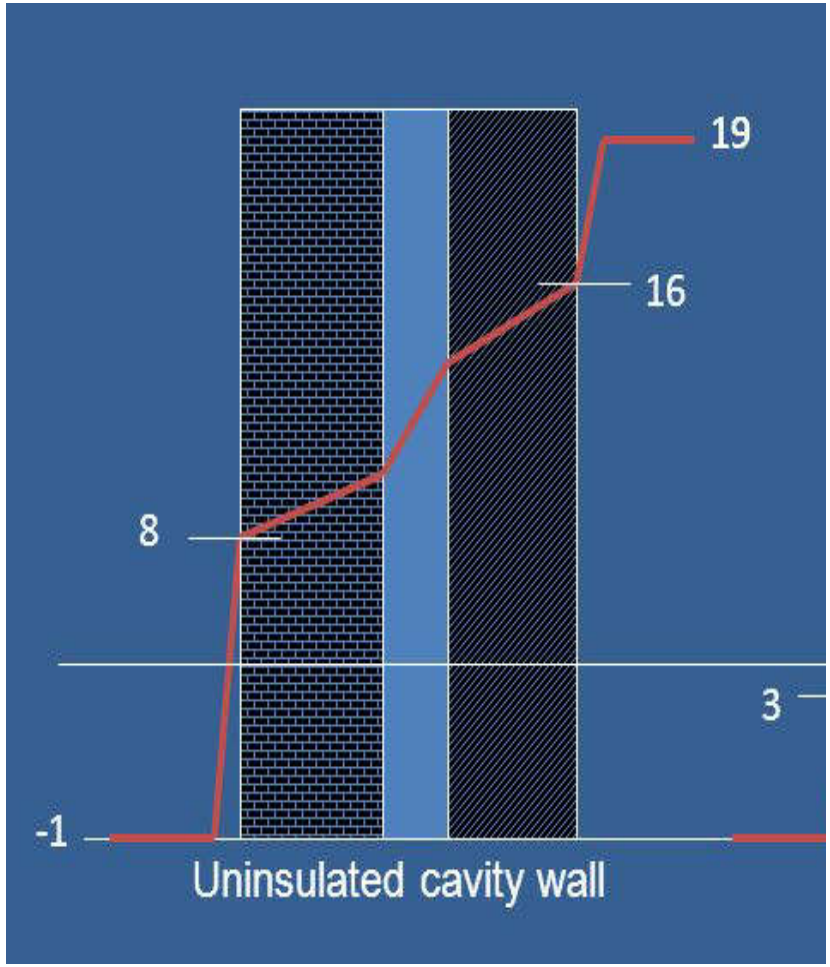
Impact on the hygro-thermal behaviour

The impact of an insulation layer can therefore affect the hydro-thermal behaviour of the wall.

Hygro-Thermal Behaviour.

Temperature gradient across the wall





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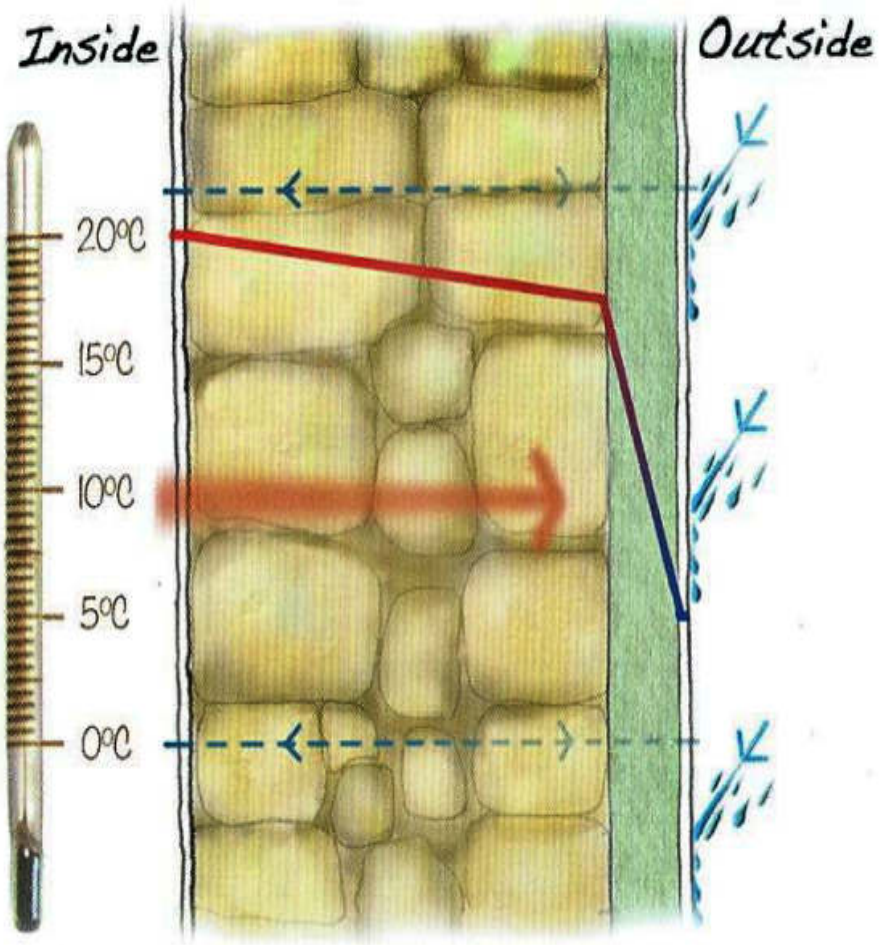
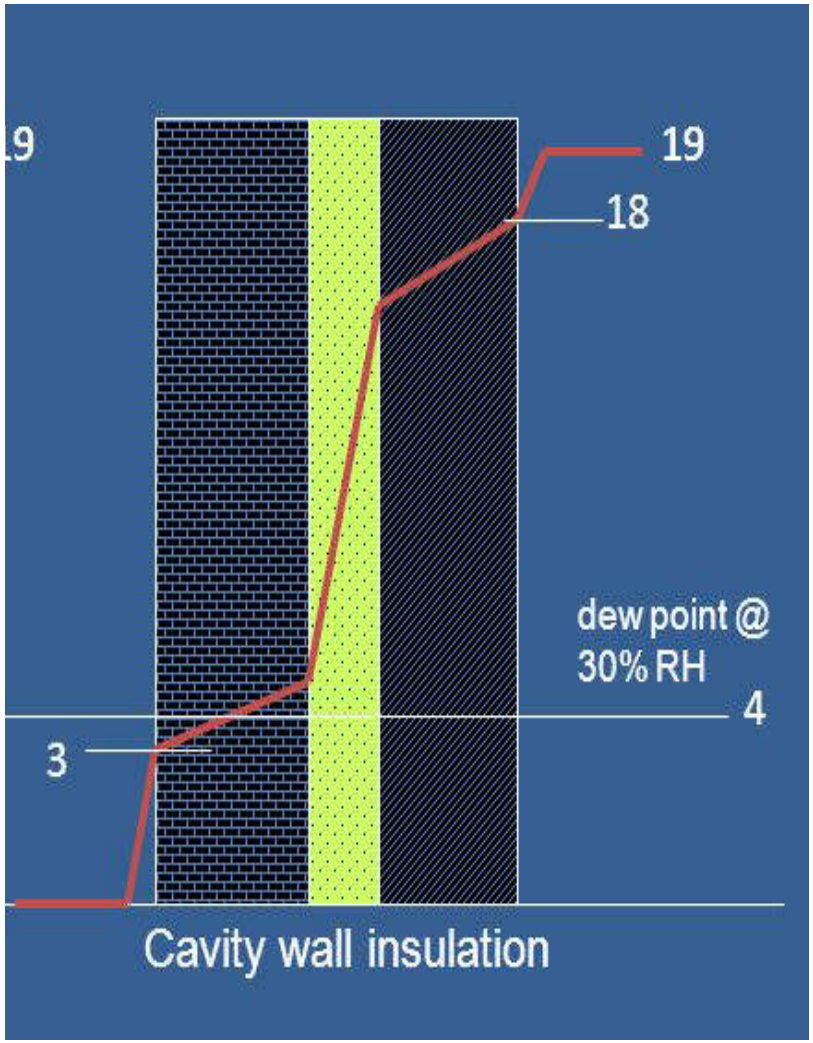
Hygro-Thermal Behaviour.

Impact of adding an insulating layer





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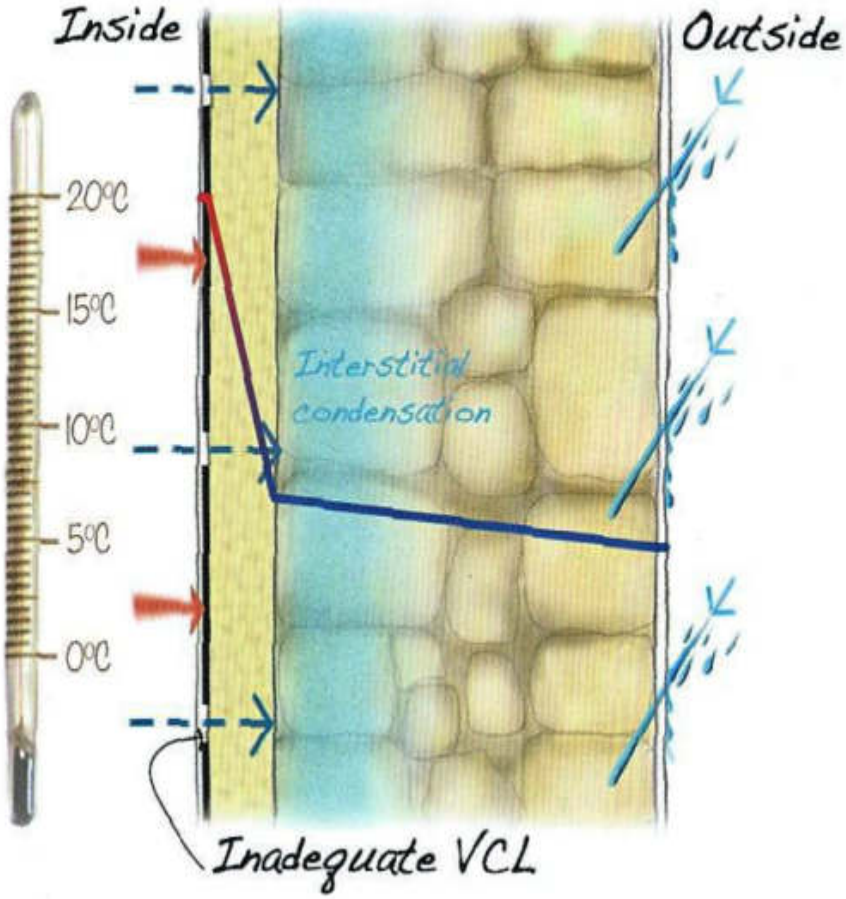
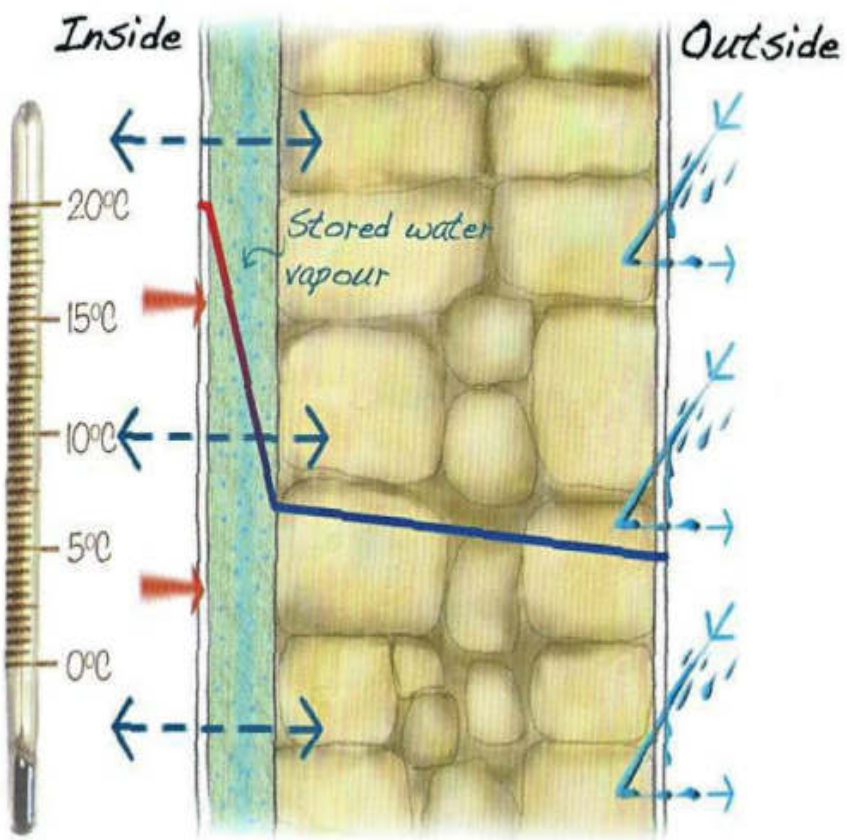
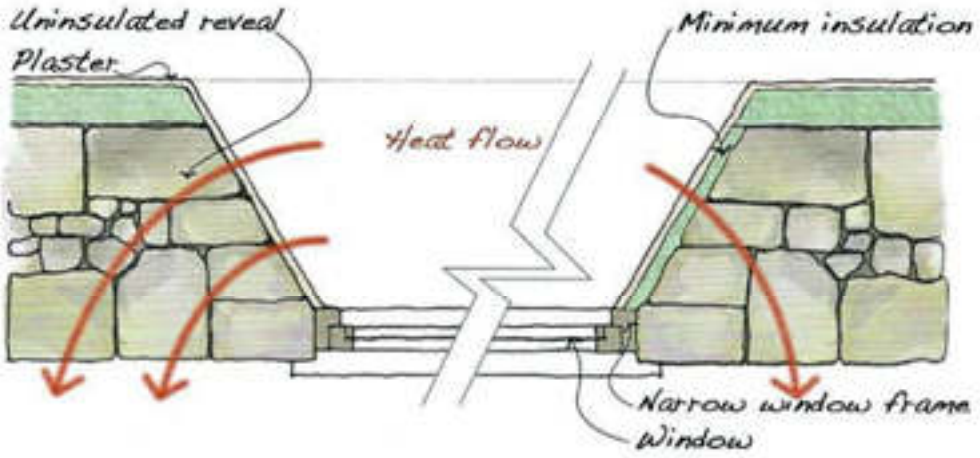
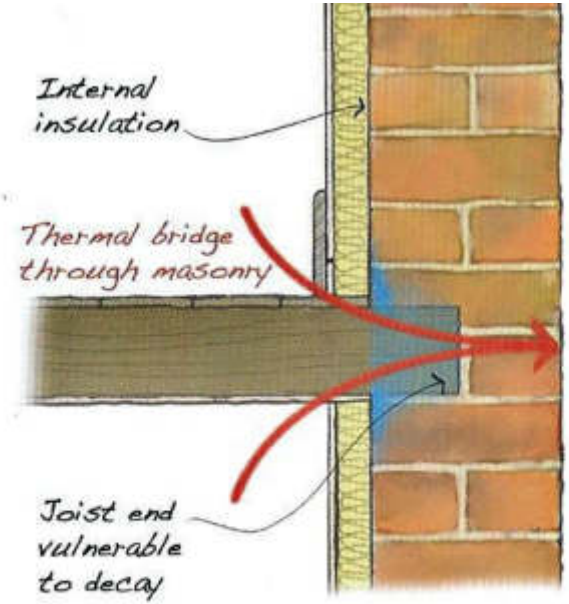
Hygro-hermal Behaviour.

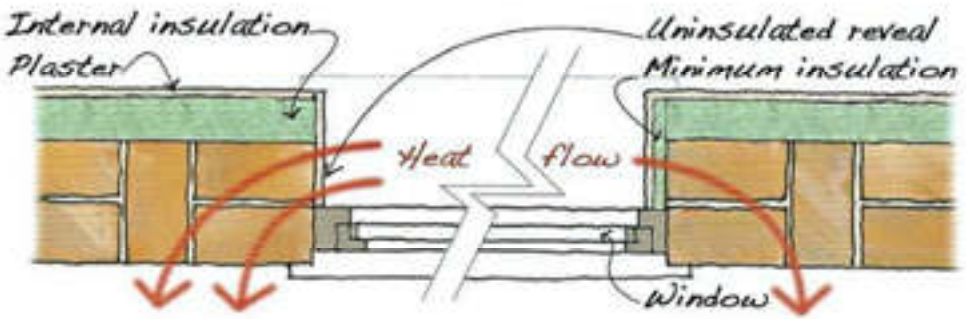
Temperature gradient across the wall

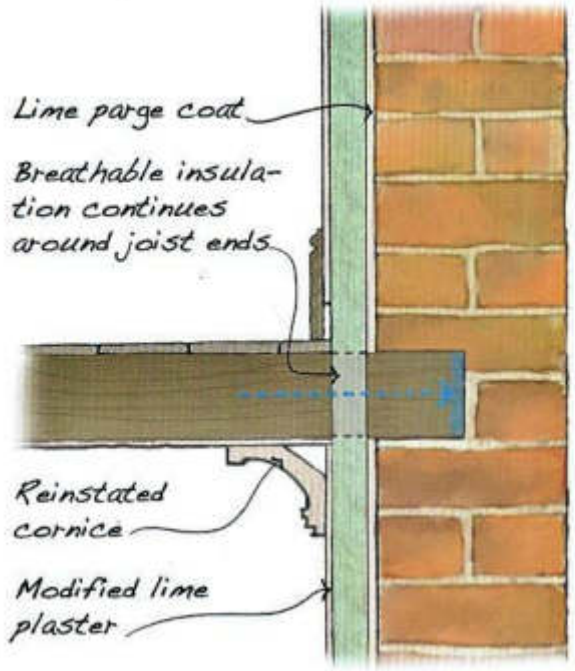












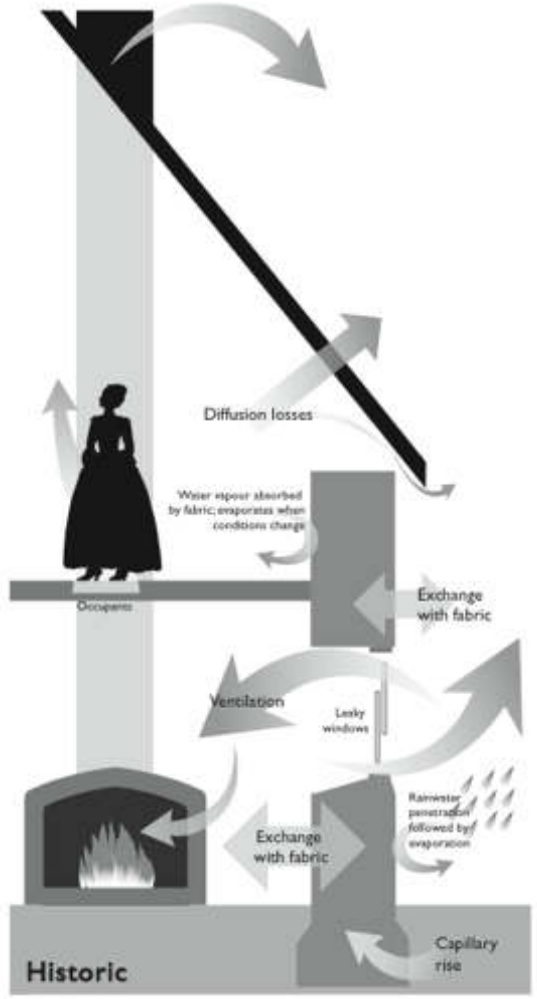
Building Construction

Appropriate levels of ventilation

Ventilation is necessary buildings to help remove moisture and prevent condensation. Successful control of moisture levels and therefore temperature of the fabric depends on adequate ventilation.

However, too much ventilation can lead to a draughty and uncomfortable home. Sources of draughts are also places for floodwater and rainwater to get in.

Controlled ventilation and draughtproofing of windows and doors is therefore important for keeping water out and warmth in (see CAfS Draughtproofing Guide for detailed advice).



Workshop

End users priorities / factors affecting decisions

BBC Report 10-10-16
Comments made to me on trips to flood-hit areas in Devon and Cumbria suggest many reasons why owners of at-risk homes and businesses do not flood-proof their properties. They include:

- distrust of builders
- inability to get grants unless they have already been flooded;
- dislike of form-filling;
- uncertainty about flood protection products;
- complacency about future flooding;
- lack of help from insurance companies
- they can't get round to it.

Any Questions?

Take a break

Options for flood resilience and flood resilience measures

Options for flood resilience and resistance

Flood Resilience

Maintenance of Gutters and Downpipes

Flood Resilience

Maintenance of Gullys and Drains

Flood Resilience

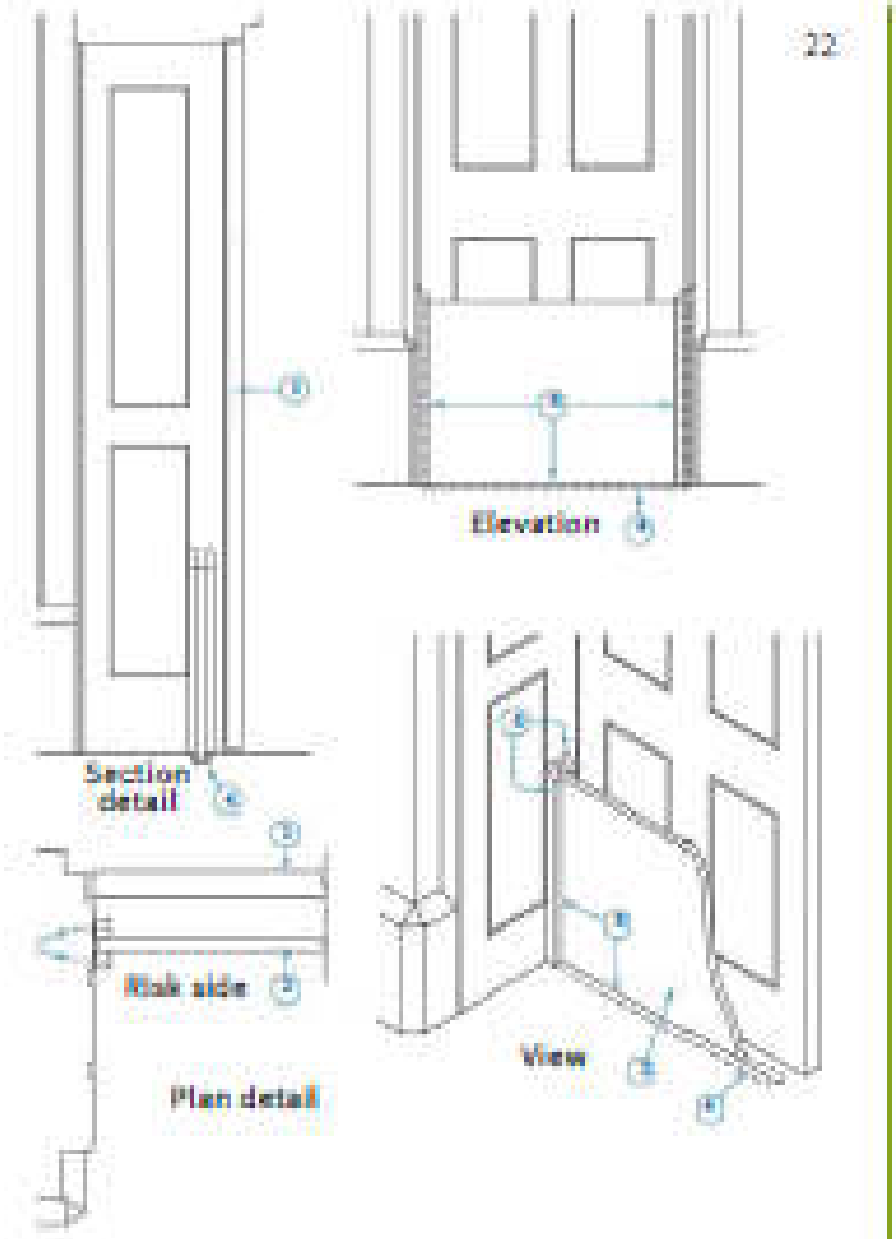
Temporary and permanent flood barriers in the public realm

Do not necessarily address rising ground water issues.

Flood doors and barriers

Flood Doors – Passive Solution
The flood doors are made to measure and can be supplied as UPVC doors or composite doors.
The doors are becoming more popular as once they are shut and locked you are protected in the event of a flood

Flood Barriers – Reactive Solution
The barriers can be a cost effective solution for doorway protection.
Lightweight strong barrier
Bespoke
Various fixings methods
Excellent option for listed buildings, where rails may not be permitted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Elevation
Section
detail
Risk side
Plan detail
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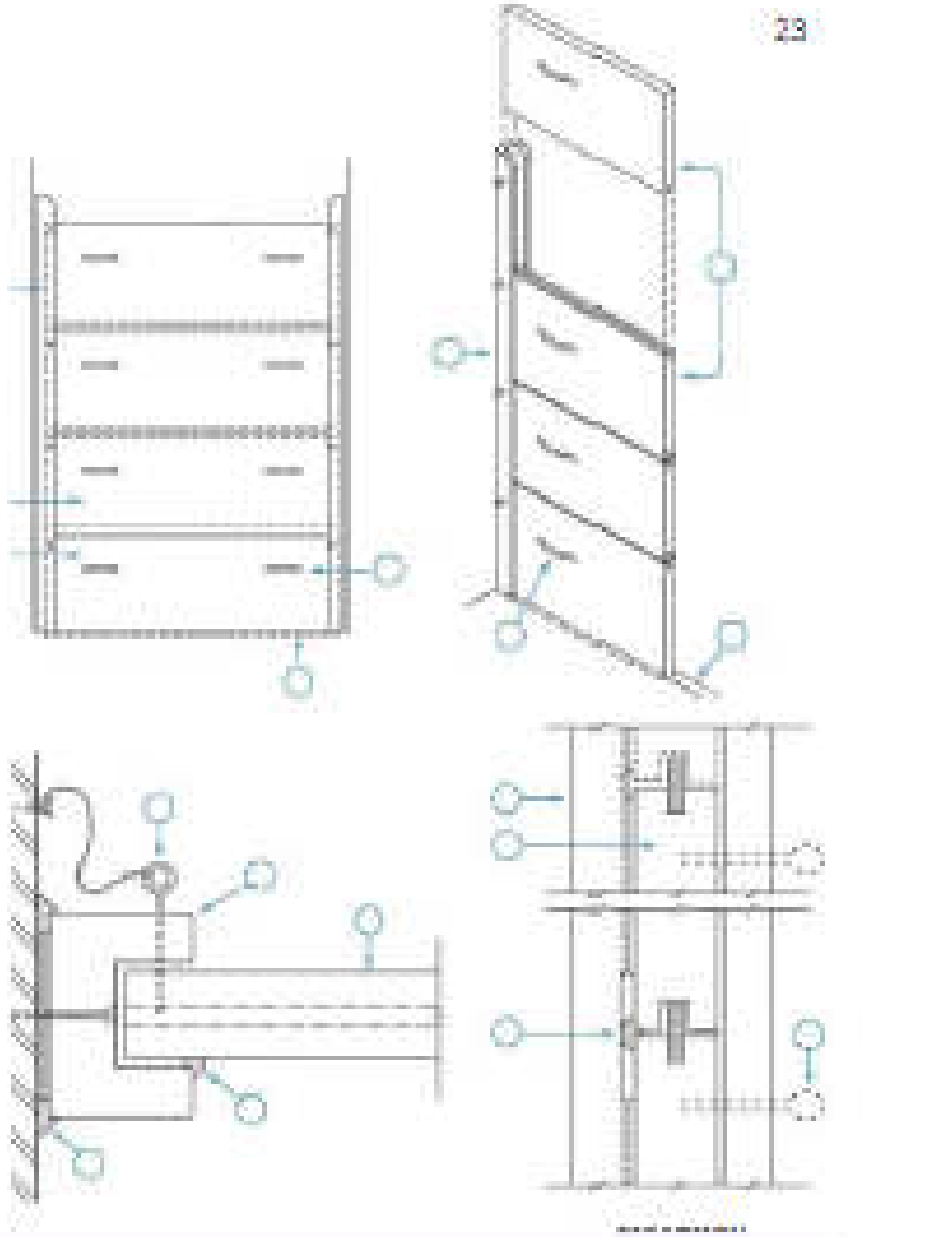
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Flood doors and barriers

FLOODANGEL®

Air bricks

The **SMART AirBrick** has been designed to allow air to pass through freely but not water. As soon as water enters the brick, the valves are forced closed preventing flood water from passing through.

.

Air brick covers

Airbrick covers are a reactive product, i.e. require manual deployment ahead of a flood event.

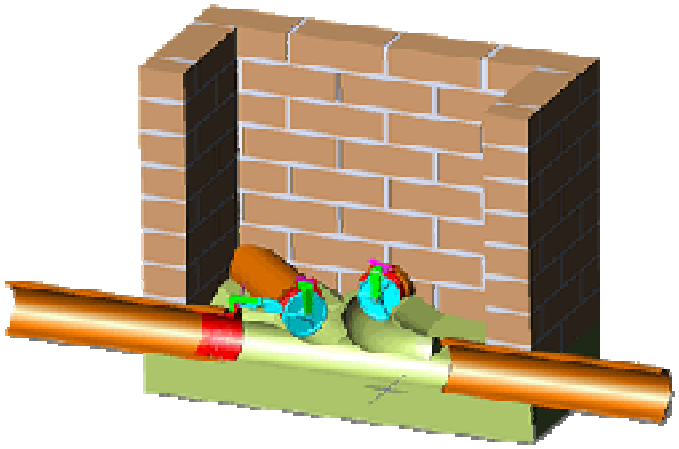
Whole property protection

This solution is basically like putting your building in a boat! These type of system can generally retain up to 1000mm of water, depending on the construction of the building. While it's not in use the skirt folds away into a trough all around the house. When a flood is imminent, the skirt is pulled up in sections, into supports fixed to the walls, and then air seals to the side of each section are inflated.

Valves and pumps

Backflow of sewage can cause major damage in a flood situations.

110mm Non-return Valves - an anti-flood device which can be installed either in the manhole or a valve installed on the discharge pipework from the property, this prevents backflow by automatically closing in flood situations.



Valves and pumps

Backwater Valve
During a flood, water can often enter into the property through waste water pipes such as pipes from kitchen sinks, washing machines, dishwashers etc.
The backwater valve installed on the pipework will prevent this from happening by closing with water rising and opening when the water recedes.

Valves and pumps

Sump and Pump

The sump pump sits below ground level and i designed to pump out water faster than it enters the property, the sump pump can be located inside the property or outside the property.

The pump has a float switch which automatically activates as required.
A must to stop cellars flooding.

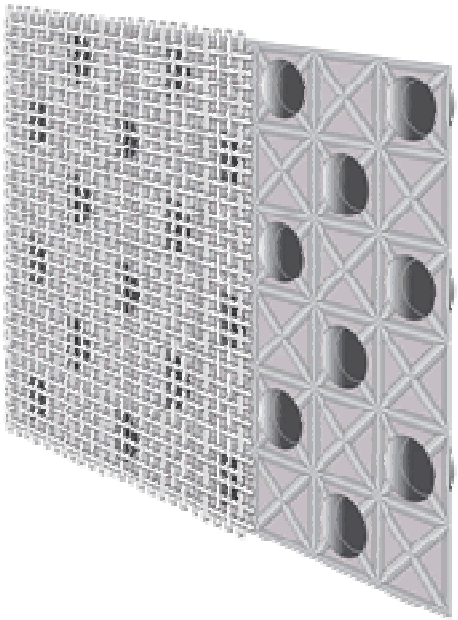
Come in various sizes and can be used in conjunction with membrane systems.

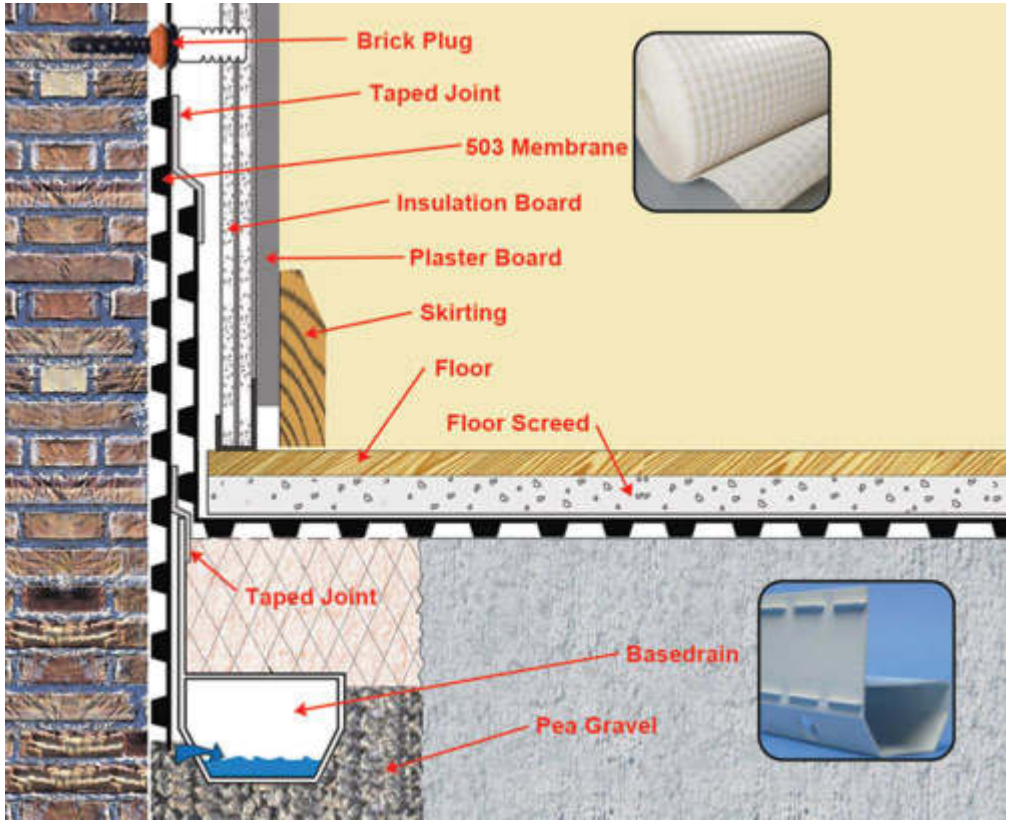
If the surrounding water level is high, pumping could increase the external pressure on foundation walls, which may cause fragile thin-walled structures to collapse inwards.

Membranes and tanking

Avoid tanking or sealants and water repellent coatings that prevent evaporation of moisture, trapping it and allowing it to build up, with potential for failure of the tanking and/or decay of the masonry.

Tanking is usually non-reversible unlike plastic membranes systems that allow some air flow behind and/or are connected to a base drain and sump system.





Membranes and tanking

Newton System 500 being tested in flood conditions

Newton 508 Mesh and Basedrain installation

Electrics, heating and other services

- Position electrical consumer units on the upper floors
- Position any main parts of a heating system, like a boiler, upstairs or raised well above the ground floor
- Run electric cables from ceiling level rather than up from under the floor.
- Position sockets above potential flood levels

Types of insulation / material compatibility

Material compatibility / types of insulation

There are basically three different types of insulation material:

Organic - those derived from natural vegetation or similar renewable sources, which tend to require a low energy use in manufacture (a low 'embodied energy'). Examples are sheep's wool, cellulose, cork, wood fibre, and hemp. Theses are usually vapour permeable and therefore most compatible with breathable construction.

Inorganic - derived from naturally occurring minerals which are non-renewable but plentiful at source. Likely to have a higher embodied energy than organic materials. Examples are mineral/glass fibre, perlite and vermiculite (from volcanic rock) and rigid foamed glass.

Fossil organic - derived by chemical processes from fossilised vegetation (oil) – a finite resource. Fossil organic insulation materials such as expanded polystyrene and polyisocyanurate or phenolic foam are highly processed, resulting in a high embodied energy.

GENERIC PRODUCT	Blown	Boards/batts	Rolls[1]	Pour	Thermal performance	Embodied energy	Cost range	mm thickness required to achieve U-value of 0.25 W	Flat roof over joists	Flat roof between joists	Pitched roof over rafters	Pitched roof between raf	Ceiling level	Cavity wall (full fill)	Cavity wall (partial fill)	Exterior wall	Within structural frame	Suspended timber floors	Solid concrete floor
Natural products																			
cellulose	●		●					150		●		●	●				●	●	
cork (expanded)		●						160	●	●	●	●			[1]	●	●	●	
cotton			●					160		●		●	●				●	●	
flax			●					170		●		●	●				●	●	
hemp			●					175		●		●	●				●	●	
monolithic lime/hemp mix[2]				●		[3]		260								●	●		
reed board		●						220					●				●		
sheep's wool			●					150		●		●	●				●	●	
wood fibreboard[4]		●						150	●	●	●	●	●			●	●	●	
Mineral products																			
aerogel			●					55					●			●	●	●	
calcium silicate board		●						n/a									●		
cellular glass			●					160	●		●			●	●	●			●
glass fibre		●	●					150		●		●	●	●	●	●	●	●	
lightweight expanded clay				●				350											●
stone mineral wool		●	●					150		●		●	●	●	●	●	●	●	
vermiculite				●				250		●			●					●	
Petrochemical																			
expanded polystyrene		●						125	●	●	●	●		●	●	●	●	●	●
extruded polystyrene		●						110	●	●	●	●		●	●	●	●	●	●
phenolic foam boards		●						80			●	●			●		●	●	●
polyurethane		●						80	●	●	●	●			●		●	●	●
recycled plastic fibre wool			●					175			●	●					●	●	
Composites																			
multifoils[5]			●					n/a	●	●	●	●	●						
vacuum insulated panels		●						25		●		●	●			●	●	●	●

Key

Worst → Best

Thermal performance (k-value, W/mK)	Embodied energy (MJ/kg)
> 0.45	> 50
0.36–0.44	30–49
0.3–0.35	20–29
0.26–0.29	10–19
< 0.25	< 9

ROOF

Flood damage is unlikely to be an issue and breathability less important

Organic

- Sheepswool and Hemp Batts
- Woof Fibre
- Blown Cellulose

Breathable

Inorganic

- Glass and Earthwool
- Rock mineral wool

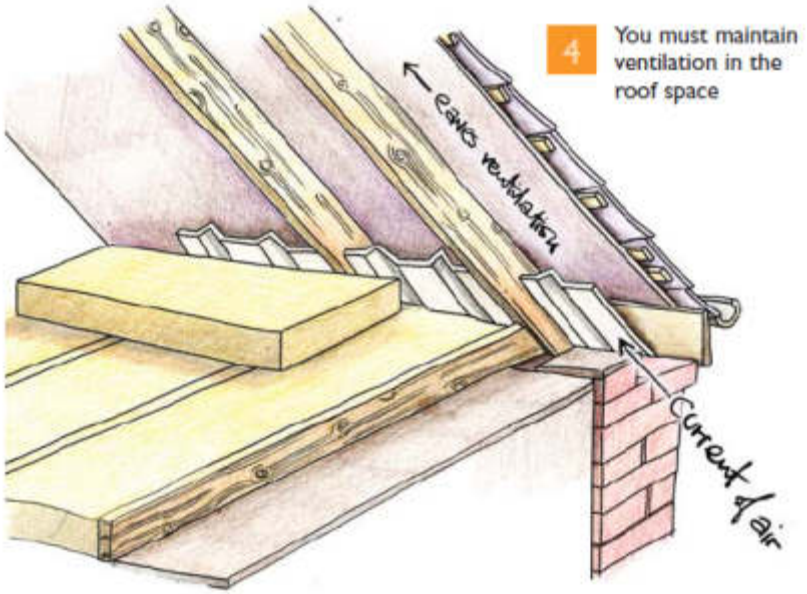
Fossil organic

- Multifoil
- Blown Foam (underside of slates)

Not breathable

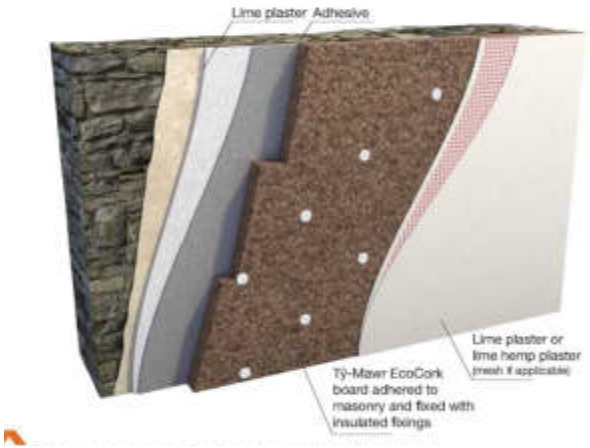
ROOF

Installation



- Remove old insulation
- Good practice 250mm
- Maintain eaves ventilation
- Insulate water tanks and pipes
- Check electrical fittings that could overheat are not covered

WALLS INTERNAL



Organic

- Sheepswool and Hemp
- Blown Cellulose
- Woodfibre boards
- Cork board
- Calsitherm climate board

Breathable, but likely to need to be removed when wet.

Inorganic

- Knauf Eco stud
- Glass or Earthwool
- Rock mineral wool

Non or semi breathable, likely to need to be removed when wet.

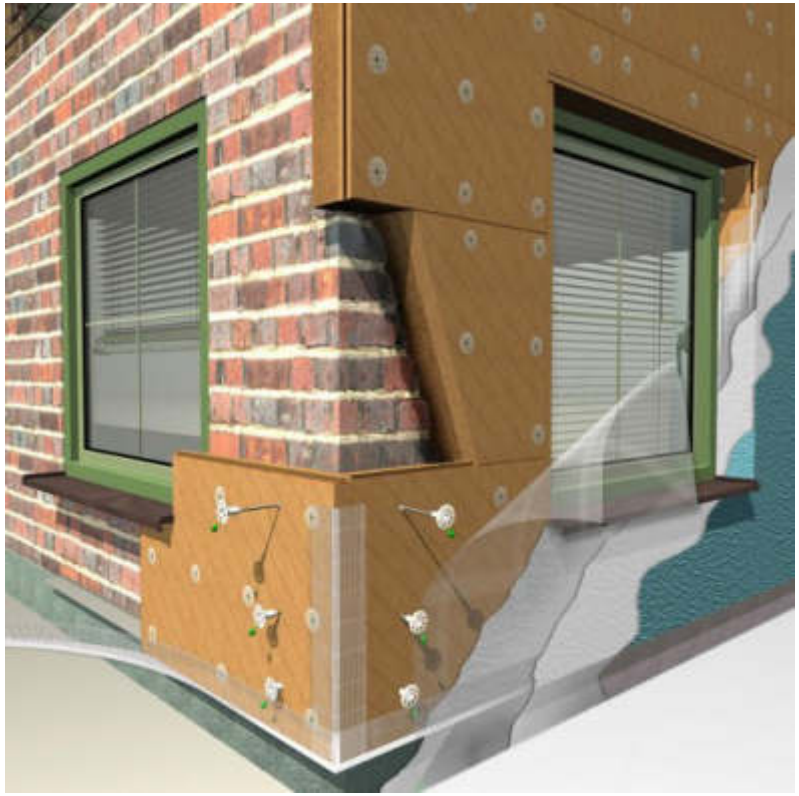
Fossil organic

- Closed cell insulation

Non breathable, absorbs little water so can be retained

WALLS EXTERNAL

As with internal insulation flood damage is only likely where installed at ground floor level, but is more likely to result in the need to strip out and greater consideration needs to be given to the drying out.



Organic

- Woodfibre boards

Breathable, but may not need to be removed when wet.

Fossil organic

- Foam boards (petrochemical based)

Not breathable, but may not need to be removed when wet.

WALLS

Insulating lime plasters

Hemp lime plasters
- Eden Hot Lime
- Ty Mawr Lime
- Womersleys

Cork lime plasters
- Diathonite (through Ecological Building Systems)

Both breathable and will dry out when wetted, but both have potential issues with staining.

Regrettably there are currently no forms breathable wall insulation that can be retained insitu.

Consider how insulation is fitted to minimise loss of material when stripping out.

FLOORS

Most likely to be damaged by flood waters, which may also be contaminated

Suspended timber floors

Between timber floor joists off membrane
Maintain underfloor ventilation

- Sheepswool and Hemp Batts
- Glass and Earthwool
- Rock mineral wool
- Multifoil

All likely to need to be removed

Solid floors

- Concrete with dpm + rigid board

Not breathable and may need removal

- Limecrete
- Hempcrete

Breathable, but will not need to be removed

Windows and Glazing

Windows have limited impact on flooding resilience other than ensuring they are properly maintained with no gaps through which water can leak.

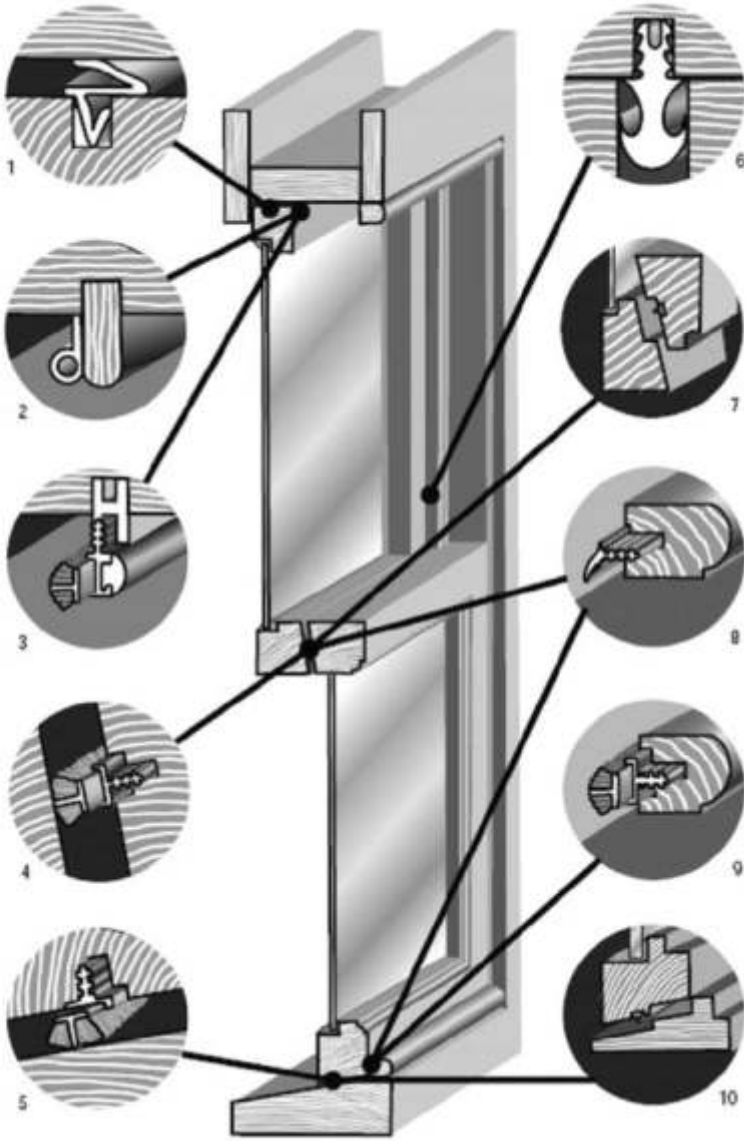
- **Double Glazing**

Fitted as standard in all new homes and generally whenever replacement of a complete window is required other than to listed buildings where consent is required.

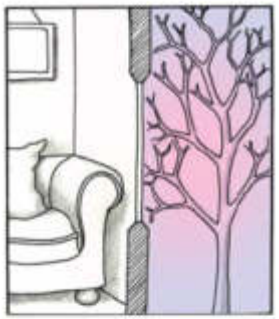
Reduces immediate energy costs and improves comfort level. It will though take many years to return cost of manufacture and installation of new window and the value of the embodied energy.

- Upgrading existing and Curtains and Shutters

1. Plastic or sprung V- or Z-strip
2. Glued or pinned silicone rubber tubing
3. Parting bead (Ventrolla)
4. Meeting rail brush (Ventrolla)
5. Bottom sash or sill brush (Ventrolla)
6. Parting bead weatherstrip (Mighton)
7. Brush for meeting rails (Draughtseal)
8. Standard weatherseal (Mighton)
9. Staff bead or button rod (Ventrolla)
10. Silicone seal (Draughtseal)

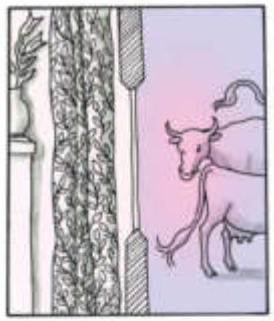


Single Glazed



U value 4.8

Single Glazed with Curtains

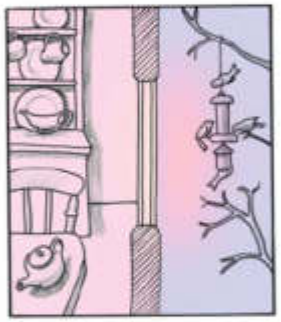


U value 3.6

Single Glazed with Shutters

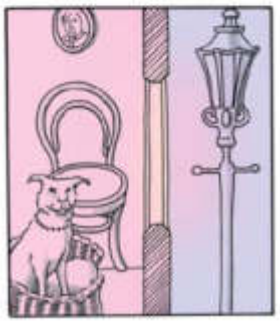
U value 3

Secondary Glazing



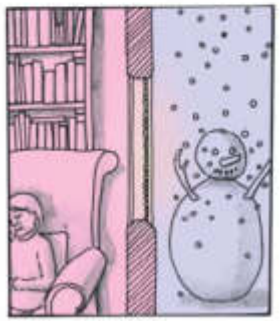
U value 2.9-3.4

Double Glazed with 12mm Gap

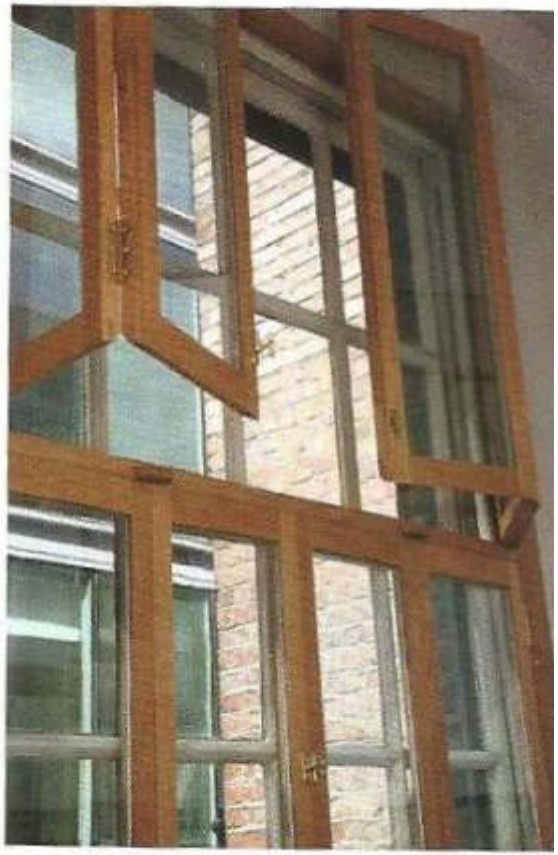


U value 2.8

Double Glazed low E



U value 2



Windows and Glazing - *thermal efficiency*

Secondary Glazing

- Retains existing window and preserves external character and appearance.

- Can achieve close to performance of new double glazed units

Responsible Retro-fit Guidance Wheel

Many Thanks

cafs.org.uk/events

Towards Zero Carbon Cumbria

CAfS

Cumbria Action for Sustainability

CARLISLE CITY COUNCIL

www.carlisle.gov.uk