2013-04-20

Managing moisture - the key to healthy internal wall insulation retrofits of solid walls

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Poster - Managing moisture - the key to healthy internal wall insulation retrofits of solid walls

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RESEARCH AND DEVELOPMENT

17TH INTERNATIONAL PASSIVE HOUSE CONFERENCE 2013
20 April 2013, Frankfurt am Main

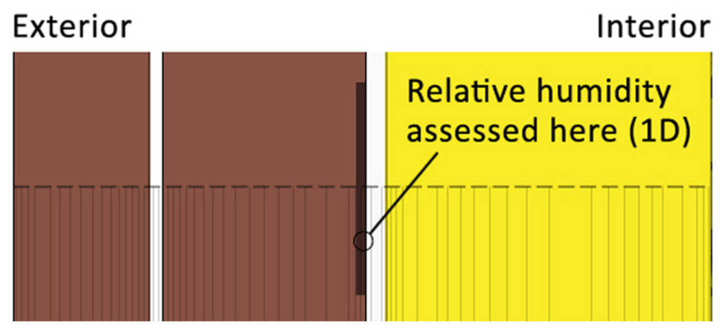
Managing moisture – the key to healthy internal wall insulation retrofits of solid walls

Scope and methodology

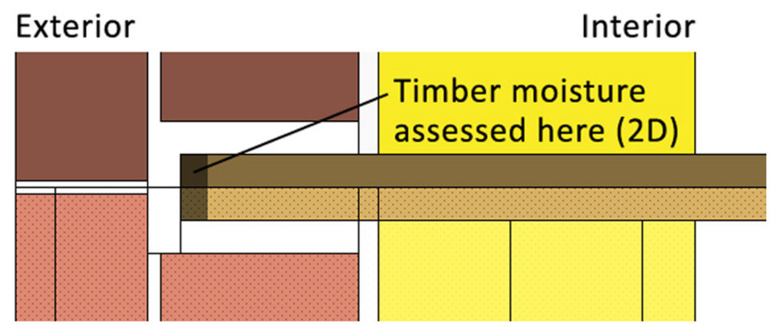
This study investigates the appropriateness of internally insulating solid walls to the Passivhaus standard. A number of variables are assessed using numerical hygrothermal simulation (under EN 15026). These cover variables such as exposure to driving rain, brick characteristics, type and amount of internal insulation.

We deliberately focused on lower cost internal insulation options:

- Cellulose blown through a gauze ('low-carbon' approach)
- Cellulose with an AVCL ('best practice' approach)
- PIR with foil face taped ('commercial' approach)



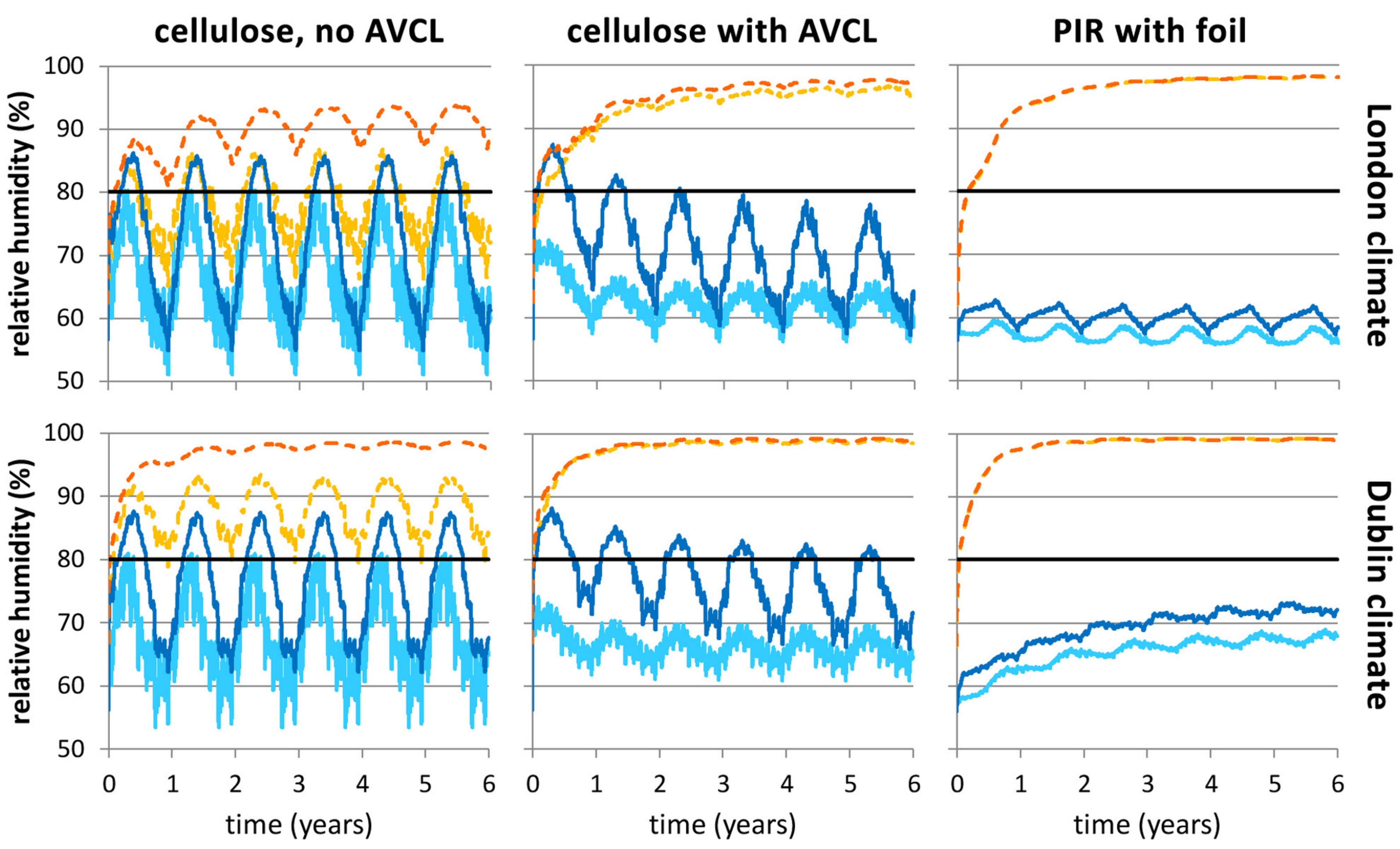
48 variations of a solid brick wall build-up (using WUFI Pro) to check risk of mould growth on original substrate



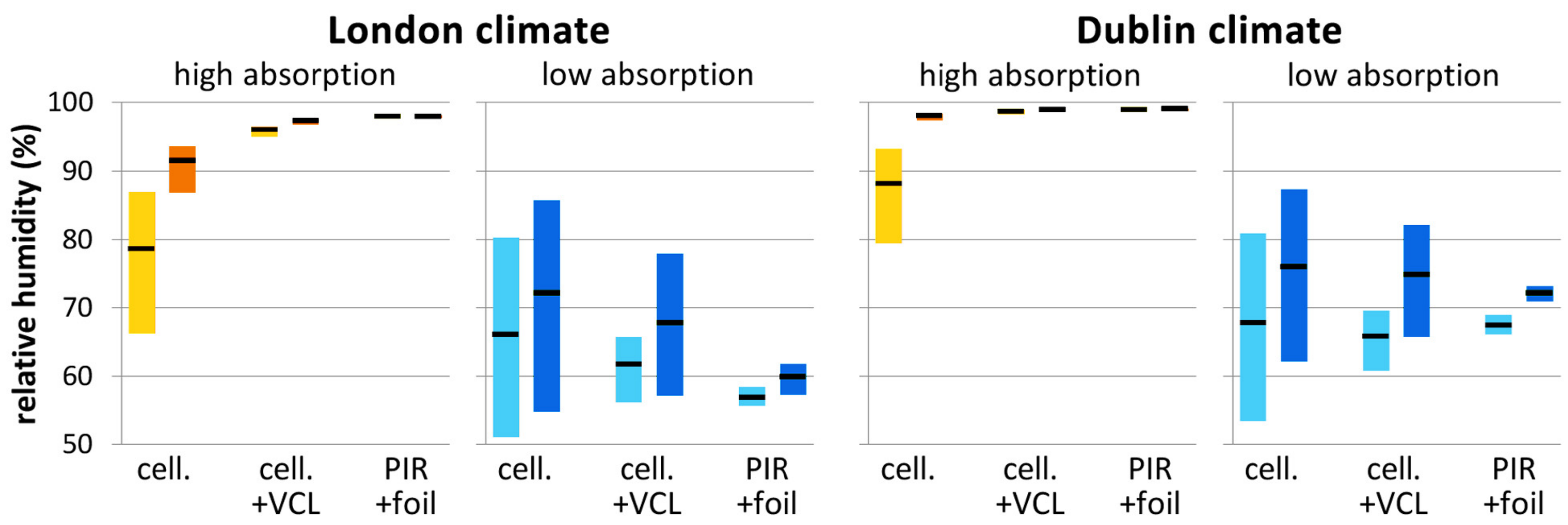
18 variations of a built-in joist end detail (using WUFI 2D) to check risk of timber decay at built-in joist ends

Results of one-dimensional simulations – Risk of mould growth on original substrate

BS 5250 states that mould growth is likely to occur if relative humidity (RH) at a surface exceeds 80% for a prolonged period. The graphs below show relative humidity (RH) at the inner surface of the original wall (behind the internal insulation) for 6 years.



The bar graphs below display the RH range at that same position for the sixth year of the simulation.

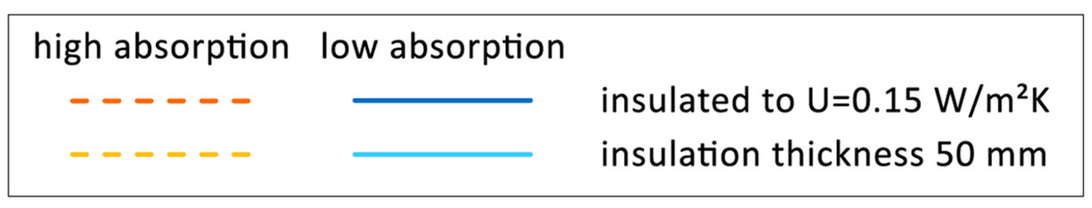


According to the one-dimensional simulations, the variables that cannot be changed (masonry thickness and external climate) appear to be the least significant (see table below).

Variations	Cases assessed	Max. ΔRH
Masonry thickness	275 mm / 447 mm	3%
Amount of driving rain	London climate / Dublin climate	9%
Water absorption of masonry	0.0011 / 0.11 kg/m²√s	41%
Internal insulation type	cellulose / cellulose + AVCL / PIR + foil	17%
Insulation thickness	50 mm / up to U-value of 0.15 W/m²K	13%

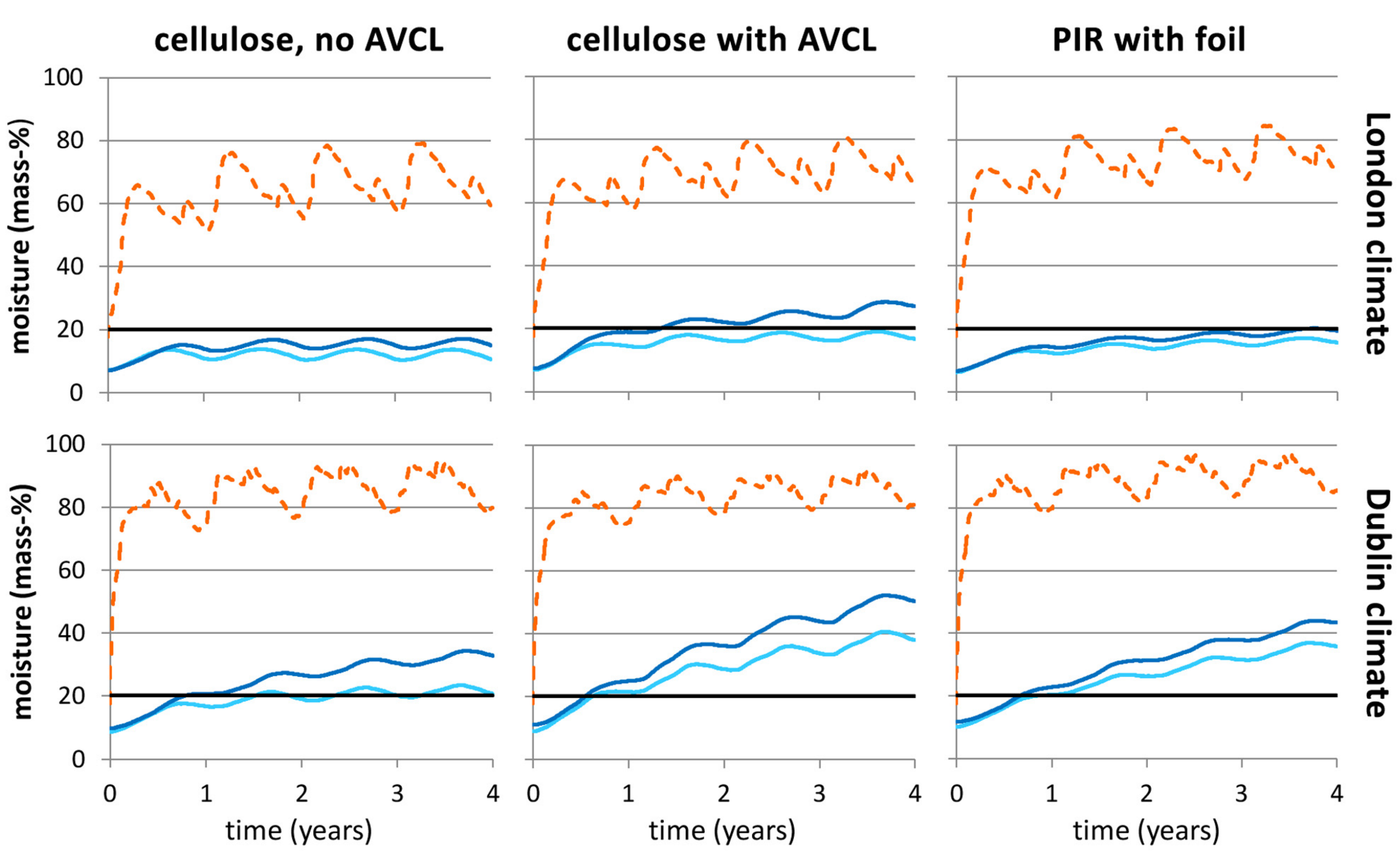
When internally insulating solid walls, dealing with moisture uptake from driving rain is the most critical issue: all build-ups with high absorption external surfaces (yellow & orange) fail unless the water uptake is reduced (e.g. by means of an external render, rain-screen or impregnation). The impact of the water absorption (orange vs. blue shades) is dramatic for vapour-closed strategies; smaller, yet still very significant, for a vapour-open strategy.

The presence or absence of an AVCL or foil (preventing vapour getting into the wall but restricting the ability to dry to the room side) appears to be more significant than the insulation material. For high absorption surfaces (yellow & orange), cellulose with no AVCL achieves the best results. **Only** when used with low absorption exterior surfaces light & dark blue) do AVCLs appear useful in reducing risk of mould growth, but **not** useful in preserving built-in joist ends (see results of 2D simulations below).



Results of two-dimensional simulations – Risk of timber decay at built-in joist ends

Moisture content of timber should not exceed 20 mass-% during a prolonged period. The fibre saturation point (~25 – 30 mass% in most timbers) is a clear threshold for decay. The graphs below show water content at end 20 mm of built-in joist ends for 4 years.



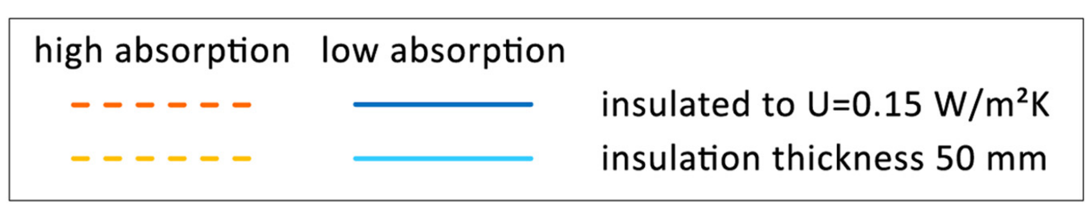
For protecting joist ends, a vapour-open approach (e.g. cellulose with no AVCL) appears to be the best option **in all cases**.

Location plays an essential role: for low-absorption external surfaces (blue shades), moisture content at joist ends doubles in Dublin, compared to the same cases in London.

Build-ups featuring AVCLs and low absorption external surfaces, which looked acceptable in 1D simulations above, can reach critical moisture levels at joist ends (especially in severe climates).

Insulation thickness can be critical (light vs. dark blue), particulaly in wet climates: it often separates failure from success.

The results from this study question the appropriateness of AVCLs where joist ends are built-in: when these are used, moisture levels at joist ends can potentially rise above critical thresholds, even in low absorption walls. This risk is exacerbated in severe climates.



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