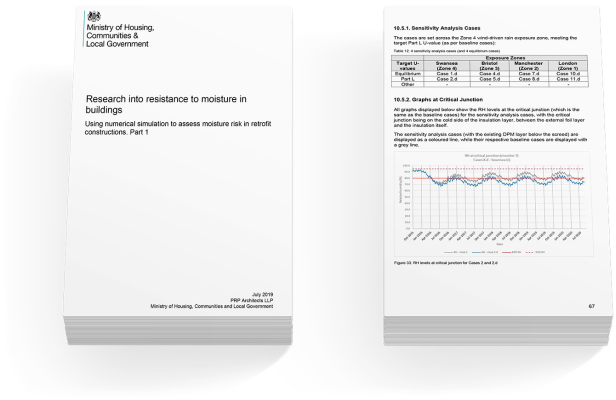
Solid Masonry Wall with Internal Wall Insulation – WUFI Modelling



Installing retrofit insulation measures into existing buildings can introduce unintended consequences in terms of moisture flow or condensation. The classic example of this is how cavity wall insulation can become wet from penetrating rain and cause internal damp and mould to occur where previously there were no problems. Similar issues can occur with internal wall insulation. Because of this, the Ministry of Housing, Communities & Local Government (MHCLG) has recently commissioned a research paper titled 'Research into Resistance to Moisture in Buildings'[1].

As part of this research, a paper subtitled 'Using Numerical Simulation to Assess Moisture Risk in Retrofit Constructions'[2] was produced. This used computer modelling software known as WUFI[3] to analyse the moisture risk present in various standard retrofit scenarios (internal wall insulation, external wall insulation, floor insulation etc). This article is a summary of the research into internal wall insulation (hereafter referred to as IWI) on solid masonry walls treated with **Stormdry Masonry Protection Cream**.

WUFI is a computer modelling program that can tell how moisture and heat flow affect building materials over time, it will predict what the water content of each component will be over time and if mould is likely to grow. In the MHCLG paper, each retrofit insulation scenario was modelled to achieve Part L of the building regulations, which requires a U value of 0.28 W/m²K to be reached.

The U value is a measure of the rate of heat transfer through a building element, such as a wall. Achieving a very low U value means that a wall will be highly insulating and greatly reduce heat loss. However, this extreme change can also affect how moisture behaves, especially at the colder side of the insulation. Typically, if the relative humidity is above 80% RH then mould has the conditions to grow and so 80% RH is set as the pass/fail criteria.

Solid Walls

When modelled with WUFI, a solid wall with retrofit IWI (installed to the Part L target U value) was found exceed the 80% RH threshold in all cases and therefore was deemed as failing in all simulated cases. This was shown to be 'mainly due to the wind-driven rain reaching the external surface and penetrating through to the brick'. For this typology, the focus is given on RH levels and moisture content at the interface between the retrofitted insulation and the existing plastered solid wall.

Sensitivity analysis was performed to see what the effect of brick cream was on each case. Stormdry was chosen as the product to model as, "this product is by far the main product used in the industry."

1 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/815953/R1_M10_Research_Summary.pdf

2 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/815957/R5_M7_Numerical_sim_retro1.pdf

3 https://www.greenbuildingadvisor.com/article/a-brief-introduction-to-wufi-in-5-easy-pieces

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Brick Cream WUFI Input Data

In each case, the solid wall with IWI was modelled with and without **Stormdry Masonry Protection Cream**. Several different types of brick were modelled, both high absorption and low absorption types were included. Modelling input data included water absorption coefficient and vapour resistance of the bricks. The modelling data for the **Stormdry Masonry Protection Cream** was taken from laboratory reports which were based on measured results. The data used are listed below:

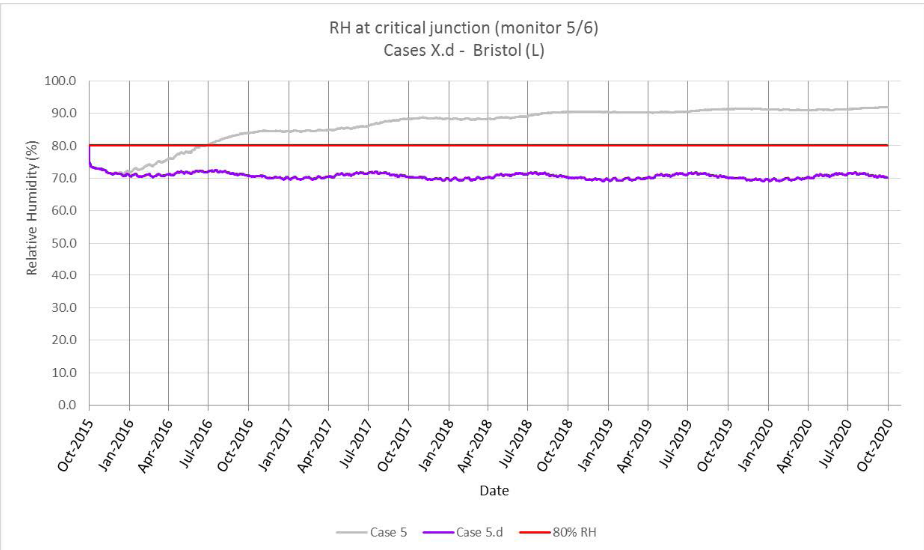
- 10 mm brick cream penetration into the brick (so 10 mm external layer modelled with different characteristics compared to the rest of the brick)
- Reduction in water absorption coefficient (A-value) by 95%
- Increase in water vapour diffusion resistance factor (μ) by 10%

Lower Absorption Brick (Solid Brick Masonry)

The analysis was done for each wind-driven rain exposure zone 1 to 4 (4 being most severe).

For the solid brick masonry (sensitivity 1), the cases in zone 4 displays RH levels constantly staying around or above the 80% RH threshold. This means that this case remains a ‘fail’. However, the cases in zones 1, 2 and 3 display equilibrium levels staying below the 80% threshold throughout the year. This means that these cases can be described as a ‘pass’.

This shows that the impact of the measure tested (the use of brick cream) becomes significant enough to change the status of these cases from ‘fail’ to ‘pass’ on most cases (except for the case in zone 4) in these conditions (‘lower’ absorption brick with a low porosity, south-west façade, with this specific build-up in terms of insulation thickness and material, etc.). The graph below shows the case for exposure zone 3 in Bristol – the grey line represents the situation without Stormdry, the purple line is with Stormdry.



The table below summarises the performance of the sensitivity analysis cases:

Table 32: Summary of results

	Exposure Zones			
Target U-values	Swansea (Zone 4)	Bristol (Zone 3)	Manchester (Zone 2)	London (Zone 1)
Equilibrium	-	-	-	-
Part L	Case 2.d Fail	Case 5.d Pass	Case 8.d Pass	Case 11.d Pass
Other	-	-	-	-

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High Absorption Brick

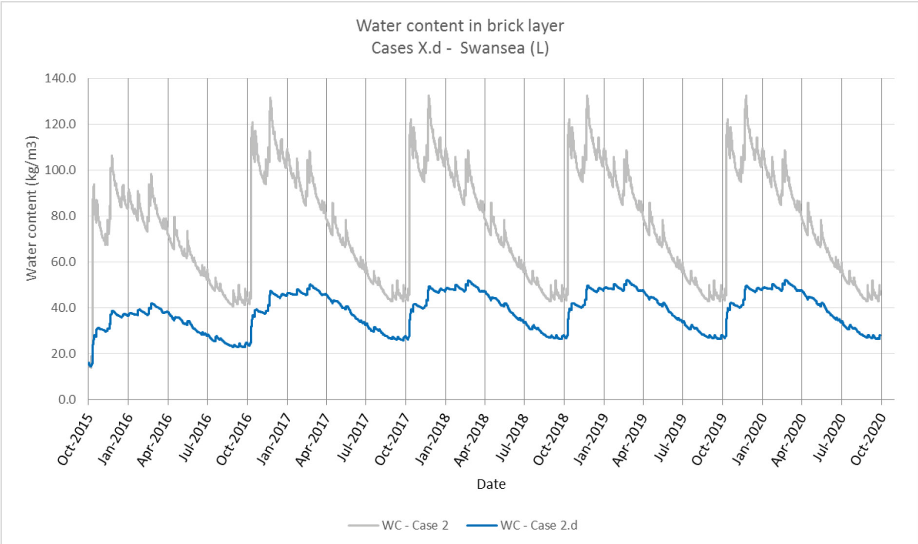
In the report, the authors say: 'These results show that the upgraded build-up with brick cream is made safer in terms of hygrothermal performance, compared to the baseline build-up.'

The table below summarises the performance of the sensitivity analysis cases:

Table 29: Summary of results

	Exposure Zones			
Target U-values	Swansea (Zone 4)	Bristol (Zone 3)	Manchester (Zone 2)	London (Zone 1)
Equilibrium	-	-	-	-
Part L	Case 2.d Fail	Case 5.d Fail	Case 8.d Fail	Case 11.d Fail
Other	-	-	-	-

The graph below displays the water content in the concrete layer for the case in zone 4 (Swansea), as it is the most extreme case (blue is with Stormdry, grey is without Stormdry). The graph shows that the water content throughout the years in the brick layer is significantly reduced with the introduction of the brick cream, which explains the decrease in RH levels at the critical junction and therefore the improvement in the hygrothermal performance of the build-up.



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Sensitivity Analysis – Combined Measures

In order to assess if any combination of measures can be used to pass the risk assessment criteria for this type of build, further analysis cases for variations of the build-up were modelled in different combinations (with varying impacts) to identify the best possible performance. These include combinations of the following:

- The presence / absence of an air gap behind the internal insulation
- The presence of foil layers on either one side or both sides of the insulation layer
- Varying brick types (as investigated in the previous sensitivity analysis)
- The addition of a "brick cream" layer to the build-up
- The reduction of the thickness of the insulation material (and consequently the increase of its U-value

The graphs show that, independently to which of the two 'lower absorption' bricks is used, the impact of these additional measures (as listed below) have a negligible impact:

- The presence / absence of an air gap behind the internal insulation
- The presence of foil layers on either one side or both sides of the insulation layer

The only additional measure that makes a significant enough difference to improve the status of the modelled cases is the addition of the brick cream layer.

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