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# Surface condensation risk pre- and post-retrofit at suspended timber ground floors and external wall junctions

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## Abstract

Insulating below suspended timber ground floors affects heat transfer at the ground floor to external wall junction, which can affect the risk of surface condensation occurring. In this project, we investigate the impact of installing mineral wool insulation, between joists, below suspended timber floors in 3 solid walled homes. TRSICO is used to calculate surface temperature factors at this junction pre- and post-retrofit. Alternative retrofit scenarios of different combinations of suspended floor and solid wall insulation are also modelled to determine which minimises condensation risk. The results suggest the floor and wall junction will have surface condensation risk when uninsulated. Installing suspended floor insulation increases risk, while installing internal or external wall insulation, with or without floor insulation, reduces risk.

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*Keywords:* Suspended timber ground floor; retrofit; insulation; condensation risk; solid wall; thermal bridging

## 1. Introduction

Improving the energy efficiency of homes has been an ambition for many governments for decades and forms a key part of the UK's zero carbon policy [1]. As the remaining potential for conventional retrofit measures, such as loft insulation and cavity wall insulation diminishes, alternative retrofit measures are being sought, one of which is to insulate suspended timber floors. Applying insulation to any fabric element alters how it responds to heat and moisture; thus, suspended timber floor retrofits may affect heat loss and the risk of surface condensation at the wall-to-ground floor junction. Continued condensation at this junction can increase the risk of mould growth and result in moisture build-up on floor timbers, which could increase the risk of rot. Longitudinal monitoring of joist surface temperatures and condensation at junctions, pre- and post-floor retrofits is costly and time consuming; however, modelling may be undertaken to predict the risk of internal surface condensation risk at the ground floor to wall junction.

## 2. Method

A combination of mineral wool insulation below the suspended timber ground floor and solid wall insulation (SWI), both internal (wood fibre), and external (mineral wool), was installed in three solid walled homes across the North of England; 17BG, 56TR and 01BA. The condensation risk at the ground floor to external wall junction was modelled pre- and post-retrofit using TRISCO version 14.0w to extract the surface temperature factors [2]. The internal and external temperatures were assumed to be 20°C and 0°C respectively to extract the surface temperature factors, according to BR497 [3]. The models were validated by comparing the simulated surface temperature factors with the actual measurements taken in the homes [4]. It is important to note that the modelling presented in this study is limited to steady-state conditions.

A sensitivity analysis is undertaken to evaluate the lowest risk retrofit approach and where condensation risk occurs based on the retrofit details described in Table 1.

Table 1. Insulation types and material properties for suspended timber ground floor, external wall, and internal wall insulation in three solid walled homes

	Suspended timber ground floor insulation	External Wall Insulation (EWI)	Internal Wall Insulation (IWI)
17BG	200 mm mineral wool between joists @ 0.044 W/mK	n/a	52 mm Woodfibre board @ 0.043 W/mK
56TR	200 mm mineral wool between joists @ 0.044 W/mK	102 mm mineral wool @ 0.033 W/mK + 10 mm ventilated cavity + 10mm façade)	52 mm Woodfibre board @ 0.043 W/mK
01BA	200 mm mineral wool between joists @ 0.044 W/mK	102 mm mineral wool @ 0.033 W/mK + 10 mm ventilated cavity + 10mm façade)	n/a

## 3. Results

Table 2 presents the results showing in which scenarios risk manifest, i.e., had temperature factors below 0.75.

Table 2. Temperature factor for ground floor to external wall junction (red = condensation risk)

	Pre retrofit	Ground insulation floor only	EWI only	IWI only	EWI and ground floor insulation	IWI and ground floor insulation
17BG perpendicular joists	0.71	0.70	n/a	0.85	n/a	0.83
17BG parallel joists	0.82*	0.77*	n/a	n/a	n/a	0.85
56TR perpendicular joists	0.72	0.71	n/a	0.84	n/a	0.83
56TR parallel joists	0.72	0.71	0.80	n/a	0.78	n/a
01BA perpendicular joists	0.71	0.70	n/a	n/a	0.81	n/a
01BA parallel joists	0.71	0.70	n/a	n/a	0.81	n/a

All homes pre-retrofit there were at risk of surface condensation risk at the external wall to ground floor junction, except 17BG where some thin IWI was already installed pre-retrofit. Installing floor insulation-only, led to a marginal worsening of risk, while installing IWI or EWI, with or without floor insulation, removed risk. No significant difference was observed between perpendicular or parallel joists.

#### 4. Discussion

The appearance of surface condensation risk at the ground floor and external wall junction does not mean there will necessarily be condensation at this location for all homes. Risk will depend on the geometry of suspended timber floors, insulation thickness and thermal resistance, internal and external environmental conditions and presence of ventilation. Furthermore, the presence of internal condensation risk at the ground floor to external wall junction does not imply risk of water accumulation or rot in subfloor timber joists, which is the main concern when insulating suspended timber ground floors. However, it is suggestive that there can be a worsening of conditions post suspended timber ground floor retrofits, and conversely, improvement when solid wall insulation is installed.

Previous research has suggested that the ground floor to external wall junction may experience condensation risk if the EWI is installed and the DPC is left uninsulated in homes with solid concrete slab ground floors [5, 6], leading to best practice guidance for PAS2035 compliance, which suggests that suspended floors should also always be insulated as part of solid wall retrofits [7]. Our findings indicate this may not be the case, i.e., that SWI, installed with or without suspended timber ground floor insulation, may reduce surface condensation risk at the ground floor to external wall junction.

There are relatively few studies undertaken into the condensation risks of installing suspended timber ground floor insulation into solid walled homes, (i.e., without also installing SWI), however, these findings suggest that this may be high risk retrofit option. Only three case studies have been presented here and more research is needed to explore this further. This study did not assess additional moisture criteria considering transient conditions and time, such as moisture accumulation over time, drying potential, and mould growth potential, which is one of the limitations of this work.

#### 5. Conclusion

A balance between improving the thermal performance of homes and minimising condensation risks should be at the core of any retrofit. More research is needed to understand how suspended timber floor retrofits may be installed in homes without increasing the risk of surface condensation at the ground floor and external wall junction.

This research suggests guidance requiring suspended timber floors to be insulated at the same time as installing SWI, may be overly cautious if the intention is to reduce internal condensation risk at the suspended floor and external wall junction.

Importantly, more research is needed to explore longitudinal moisture accumulation and risk of rot in suspended timber floors pre and post retrofits with different retrofit materials in different suspended timber floors and house types.

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\* 20 mm expanded polystyrene installed internally in base case wall