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BRE Client Report

Keylite: Condensation Risk Analysis of Roof Window Frame and Thermal Collar

Prepared for: Colin Wells
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Executive Summary

The Senior Technical Sales Manager for Keylite, Colin Wells, approached BRE to demonstrate the impact that the Keylite roof window thermal collar has on the risk of internal surface condensation on the frame.

The condensation risk analysis compared two jamb/roof window variation details as described:

- Left hand side of roof window/jamb detail with Keylite Thermal Collar
- Left hand side of roof window/jamb detail without Keylite Thermal Collar
- Right hand side of roof window/jamb detail with Keylite Thermal Collar
- Right hand side of roof window/jamb detail without Keylite Thermal Collar

This study shows that for this detail design the thermal collar would be necessary to prevent condensation and mould growth. The results in this report indicate that the addition of an expanding thermal collar limits the risk of internal surface condensation and mould growth on the area of interest in accordance with BRE IP 1/06. BRE IP 1/06 gives minimum recommended temperature factors for various types of buildings.

The calculated *surface temperature factor* (*f*) before and after the addition of the expanding thermal collar to both the left and right hand side of the roof window was 0.68 and 0.75 respectively. This shows that the expanding thermal collar leads to a significant improvement in the frame's thermal performance, which in turn will limit the risk of condensation.

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Background

About BRE

BRE is the world's largest research and technology organisation offering expertise in every aspect of the built environment and associated industries. We help clients create better, safer and more sustainable products, buildings, communities and businesses - and we support the innovation needed to achieve this.

BRE are recognised experts in the area of thermal performance of building fabric, and have consistently delivered for both public and private sector organisations in this area. BRE staff, who will directly deliver on this project, have also developed the following publications to help to ensure accuracy and consistency across the industry when assessing thermal performance:

- BR 497 - Conventions for Calculating Linear Thermal Transmittance and Temperature Factors
- BR 443 - Conventions for U-values
- BRE IP 1/06 - Assessing the effects of thermal bridging at junctions and around openings

BRE have also supported local Government, and a wide range of industry clients, to develop or assess the thermal performance of junction details, products or elements.

Thermal bridges

A thermal bridge, often called a cold bridge, is an area of a building construction which has a significantly higher heat transfer than the surrounding construction materials. This is typically where there is either a break in the insulation, reduced level of insulation or the insulation is penetrated by an element with a higher thermal conductivity. This will result in additional heat loss at these thermal bridges.

As more stringent legislation and energy awareness lead to increased insulation levels in walls, roofs and floors, heat losses due to thermal bridging become increasingly important.

Temperature factors

The temperature factor (*f*) is used to assess the risk of surface condensation or mould growth and is calculated under steady state conditions. To avoid problems of surface condensation or mould growth, the f_{Rsi} should not be less than a critical temperature factor (f_{CRsi}). A range of appropriate critical temperature factors are identified in BRE Information Paper IP 1/06, and are listed below in Table 1.

Type of Building	Critical Temperature Factor (f_{CRsi})
Storage Buildings	0.30
Offices, retail premises	0.50
Dwellings, residential buildings, schools	0.75
Sports halls, kitchens, canteens	0.80
Swimming pools, laundries, breweries	0.90

Table 1 - Critical Temperature Factors

For the purposes of analysis in this report a critical temperature factor of 0.75 has been selected as the critical temperature factor for most building types. Office and retail premises usually have a lower indoor relative humidity than residential buildings and therefore the risk of condensation and mould growth in these types of buildings could be less. Conversely in buildings where there is likely to be a higher indoor relative humidity such as large commercial kitchens, swimming pools, sports changing rooms with showers and laundries have a higher risk of internal surface condensation and mould growth.

Description of the project

The Senior Technical Sales Manager for Keylite, Colin Wells, approached BRE to demonstrate the impact that the inclusion of the Keylite roof window thermal collar has on reducing internal surface condensation risk on the frame. The area of interest for the thermal collar has been highlighted on the detail drawings within this section. The frame, together with the neighbouring roof construction, sash and glazing, are shown in Figure 1.

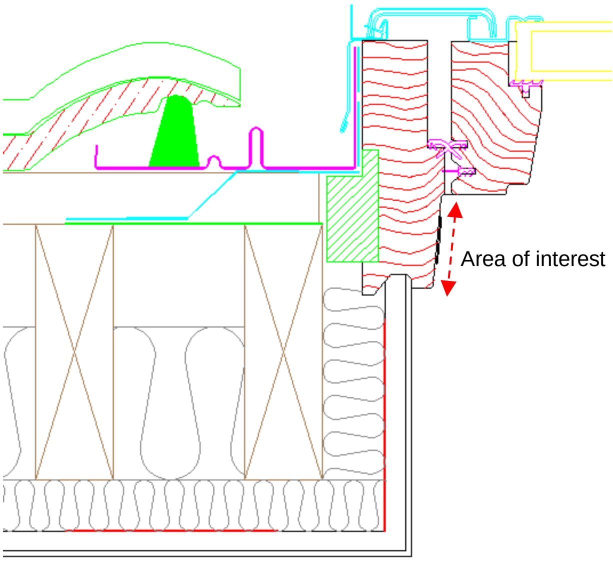

Figure 1. The frame, together with the neighbouring roof construction, sash and glazing.

The condensation risk analysis compared two jamb/roof window variation details as described below and illustrated in:

- Left hand side of roof window/jamb detail with Keylite Thermal Collar (Figure 2)
- Left hand side of roof window/jamb detail without Keylite Thermal Collar (Figure 3)
- Right hand side of roof window/jamb detail with Keylite Thermal Collar (Figure 4)
- Right hand side of roof window/jamb detail without Keylite Thermal Collar (Figure 5)

The left hand and right hand side of the roof window detailed differed only in the positioning of the roof tiles and the flanking softwood timber studs as can be identified by the following figures.

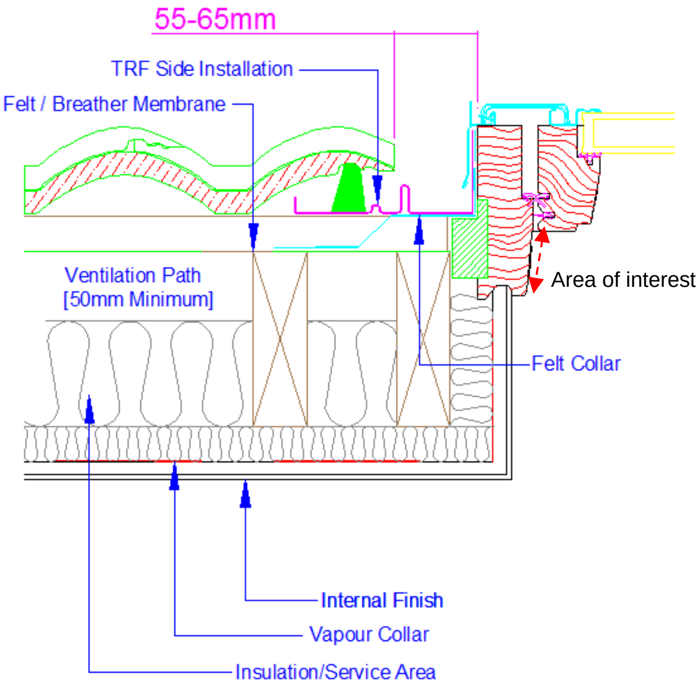

Figure 2. Left hand side of roof window/jamb detail with Keylite Thermal Collar.

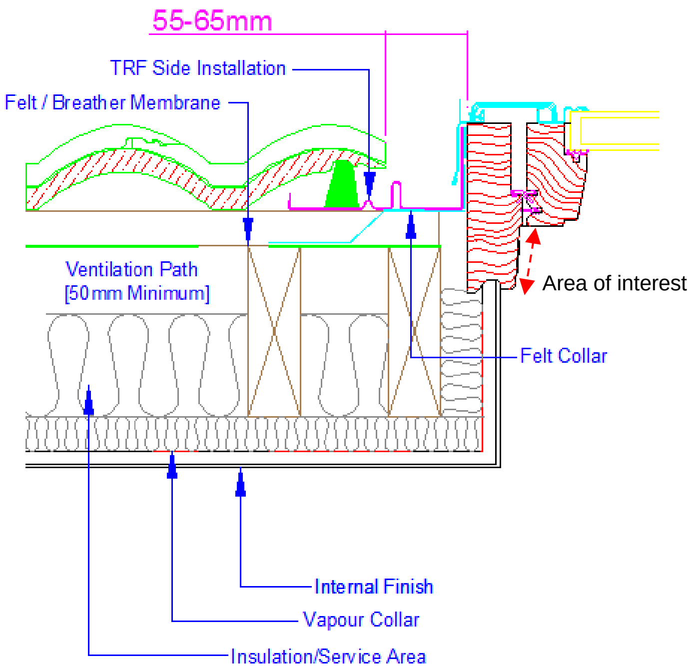

Figure 3. Left hand side of roof window/jamb detail without Keylite Thermal Collar. Area of interest indicated by dashed red arrows.

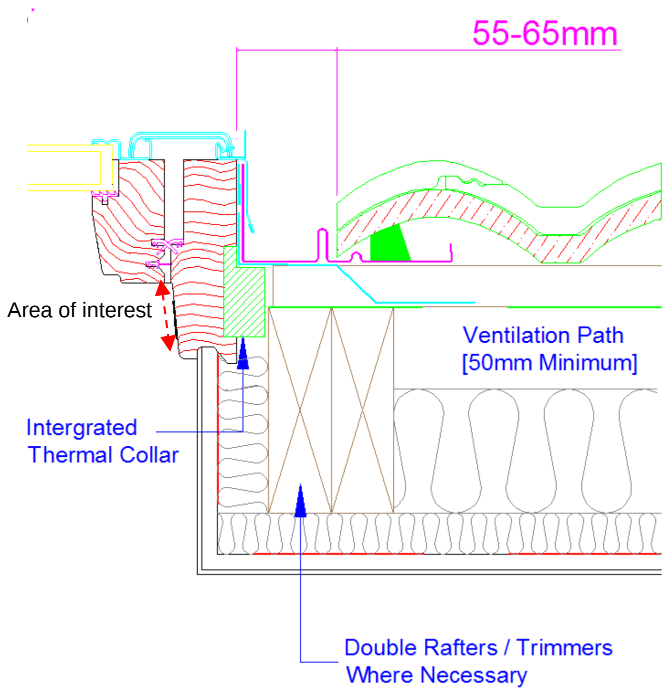

Figure 4. Right hand side of roof window/jamb detail with Keylite Thermal Collar. Area of interest indicated by dashed red arrows.

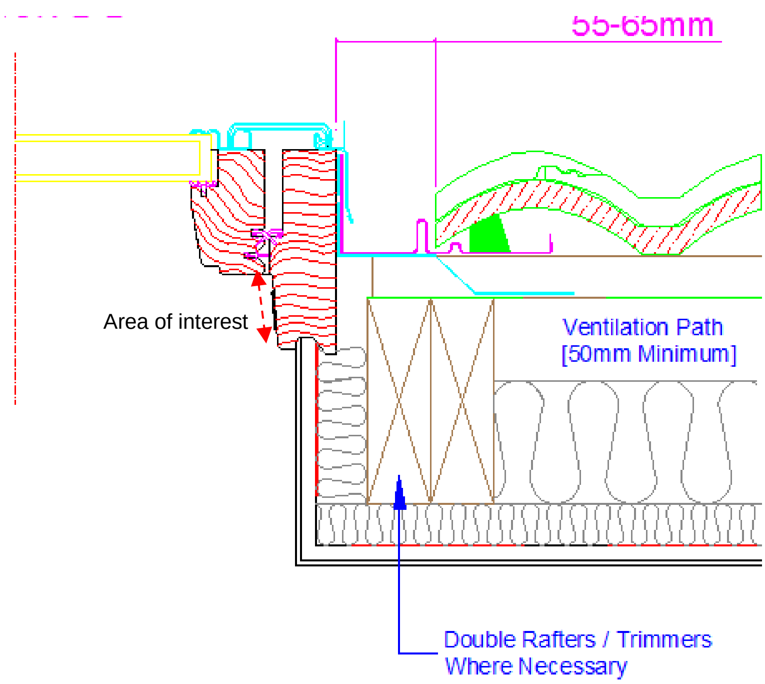

Figure 5. Right hand side of roof window/jamb detail without Keylite Thermal Collar. Area of interest indicated by dashed red arrows.

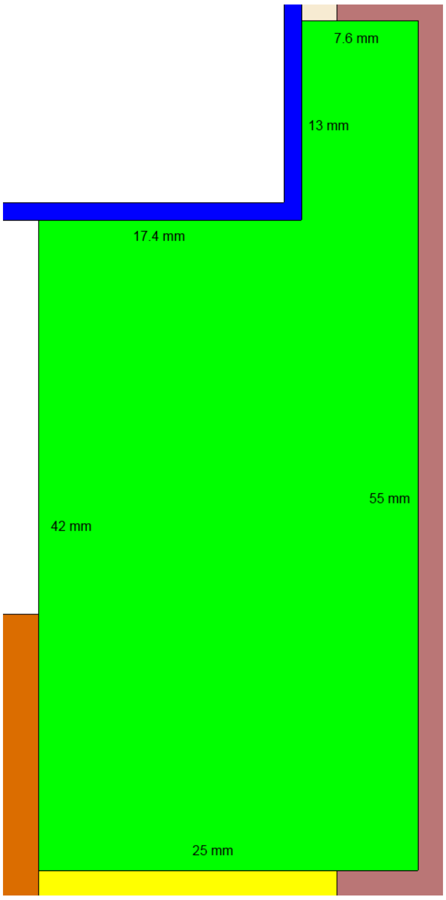

Figure 6. An expanded view of the thermal collar, showing the dimensions of the collar in mm. This figure refers to the left collar, however the right collar has the same dimensions and is a mirror image of the left collar.

Thermal Assessment

Numerical assessment

Thermal bridges occur within the building fabric where, because of the geometry or the presence of high conductivity materials, heat flows are two or three dimensional. For many situations, simple calculations are no longer sufficient to determine thermal performance correctly and it is necessary to analyse the construction using numerical modelling.

The current BRE BR 497 publication (Conventions for calculating linear thermal transmittance and temperature factors) details the conventions that should be followed by thermal modellers to produce consistent, reproducible results and so help the push towards ambitious energy improvements and healthier buildings. The conventions relate to the use of thermal modelling software to assess the 'as designed' thermal performance of building junction details, products or elements.

Thermal assessment models of frame details were created for each of the details. These were developed on the basis of information provided by the client, with representative thermal conductivities assumed for each material.

The thermal assessment models were utilised to obtain the temperature factor:

> The minimum temperature factor (f) is used to assess the risk of surface condensation or mould growth, and is the ratio of the minimum internal temperature identified at the internal surfaces of the model and the 'internal' boundary condition temperature (20°C) under steady state conditions. To avoid problems of surface condensation or mould growth, f_{Rsi} should not be less than the critical temperature factor (f_{CRsi}).

Conventions

The assessments were undertaken in compliance with:

- BR 497 - Conventions for calculating linear thermal transmittance and temperature factors
- IP 1/06 – Assessing the effects of thermal bridging at junctions and around openings

Software

The assessment was undertaken using:

- Physibel TRISCO (v 12.0) thermal modelling software.

Note, Physibel TRISCO has been validated against the detailed test reference cases contained within Annex A of the published standard ISO 10211 "*Thermal bridges in building construction — Heat flows and surface temperatures - Detailed calculations*".

Thermal conductivities

The representative thermal conductivities used in the model were taken from Annex A of BS EN ISO 10077-2, the BRE U-Value Calculator, CIBSE Guide A: Environmental design 8th Edition, and information provided the client, as detailed below in Table 2.

Material	Thermal conductivity (W/m·K)
Roof tile	2.5
Keylite Thermal Collar. Assumed to be PUR of density 21 kg/m^3	0.025
Aluminium	160
Softwood	0.13
Mineral wool insulation	0.04
Plasterboard	0.21
EPDM	0.25
Desiccant	0.3
TGI spacer material	0.25
Glazing 4-16-4, TGI spacer	0.02
Glass	1.0
Rubber seal	0.35

Table 2. Thermal conductivities of materials

Airspaces equivalent thermal conductivities were calculated in accordance with guidance in BS EN ISO 6946 (2007) – *Building components and building elements – thermal resistance and thermal transmittance – Calculation method*.

Glazing specification

Thermal conductivities for the materials which make up the glazing unit are included within Table 2. The makeup of glazing units can vary however in this analysis the glazing has been modelled using a TGI spacer bar containing desiccant, incorporating a thin layer of aluminium on a rubber seal. The gas between the glass panes has been assigned a thermal conductivity of 0.02 W/m·K.

Surface Condensation Risk Analysis Results

A summary of the temperature factor results are presented in Table 3 below. Condensation would be expected to develop where the temperature factor is below the recommended critical temperature factor (0.75). The table demonstrated that the addition of the thermal collar reduces the risk of internal surface condensation on the area of interest.

Detail	Internal temperature	External temperature	Minimum surface temperature	**Temperature factor (f_{Rsi})**
Jamb left **with** thermal collar	20	0	15.0	**0.75**
Jamb left **without** thermal collar	20	0	13.6	**0.68**
Jamb right **with** thermal collar	20	0	15.0	**0.75**
Jamb right **without** thermal collar	20	0	13.6	**0.68**

Table 3. Condensation risk analysis focussing on area adjacent to thermal collar

Results from Table 3 indicate that the risk of internal surface condensation is reduced to an acceptable level on the area of interest with the additional of the expanding thermal collar, in accordance with BRE IP 1/06.

The following thermal and material images illustrate the difference in performance between a window detail which utilises the expanding thermal collar and one which does not.

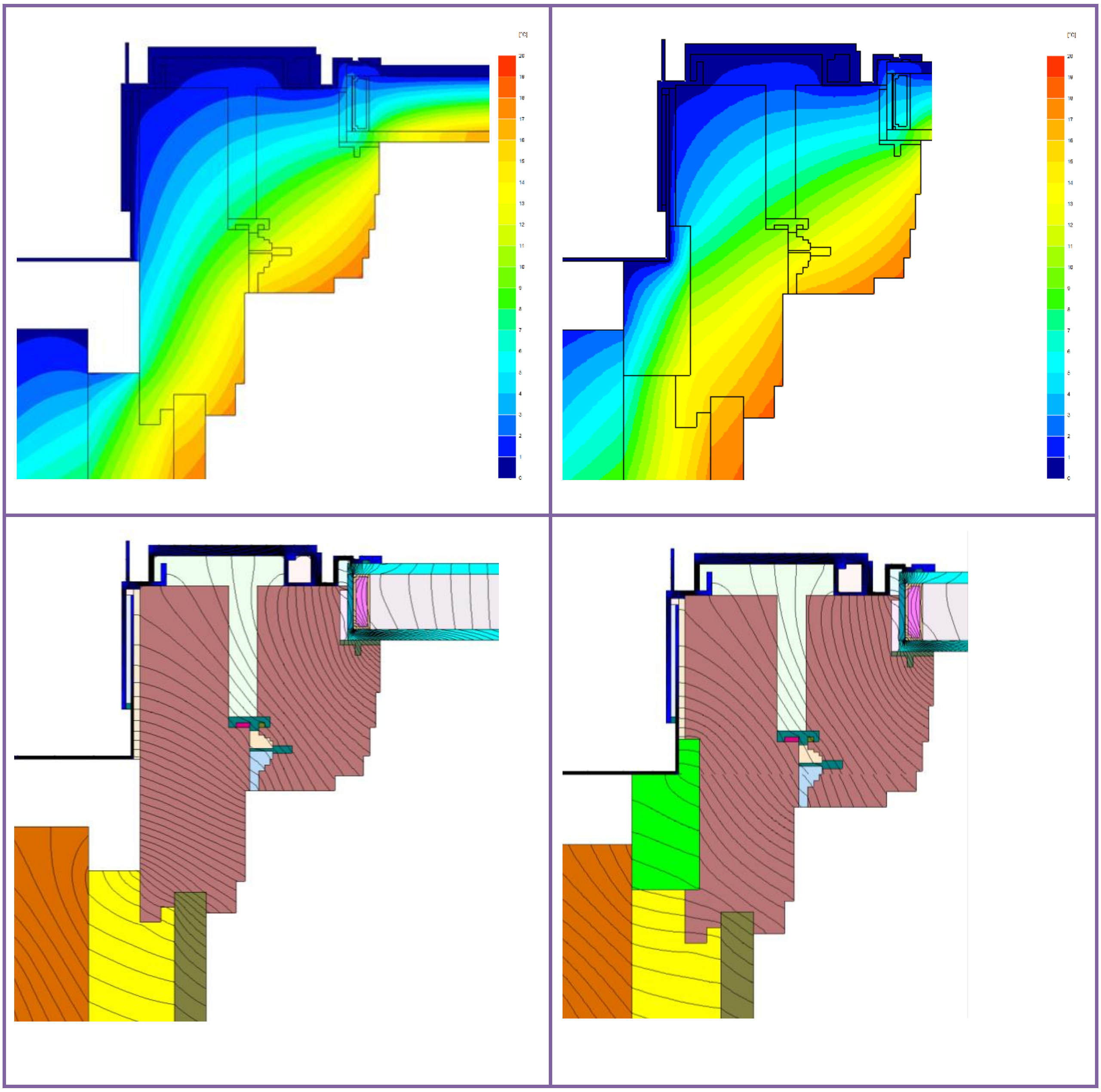

Figure 7. Results for left jamb with thermal collar not present (left) and with thermal collar present (right). Thermal images at the top left and right show the temperature distribution profiles. Material images on the bottom left and right display the heat flow lines. The closer together the black lines the greater the rate of heat flow through that particular area, or the areas of greater thermal bridging.

Figure 7 demonstrates that the addition of the thermal collar reduces heat flow through the area of interest and thereby eliminates the risk of internal surface condensation at this location.

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Conclusions

This study shows that for this typical design detail the thermal collar would be necessary to prevent condensation and mould growth. The results in this report indicate that the addition of an expanding thermal collar limits the risk of internal surface condensation and mould growth on the area of interest in accordance with BRE IP 1/06, as illustrated in figures within the report. BRE IP 1/06 gives minimum recommended temperature factors for various types of buildings, which for this case is 0.75.

The calculated *surface temperature factor* (*f*) before and after the addition of the expanding thermal collar to both the left and right hand side of the roof window was 0.68 and 0.75 respectively. This shows that the expanding thermal collar leads to a significant improvement in the frame's thermal performance, which in turn will limit the risk of condensation.

References

The following documents were referenced:

- BR 497 - Conventions for Calculating Linear Thermal Transmittance and Temperature Factors, BRE
- BS EN ISO 6946 - Building components and building elements. Thermal resistance and thermal transmittance - Calculation methods, BSI, 2007
- BRE Information Paper IP 1/06 – Assessing the effects of thermal bridging at junction and around openings, BRE, 2006

Report Ends