Advanced Details Ltd

EFFECT OF VENTILATION ON THE CALCULATED PSI-VALUE IN ANALYSIS OF THERMAL BRIDGING IN BUILDINGS

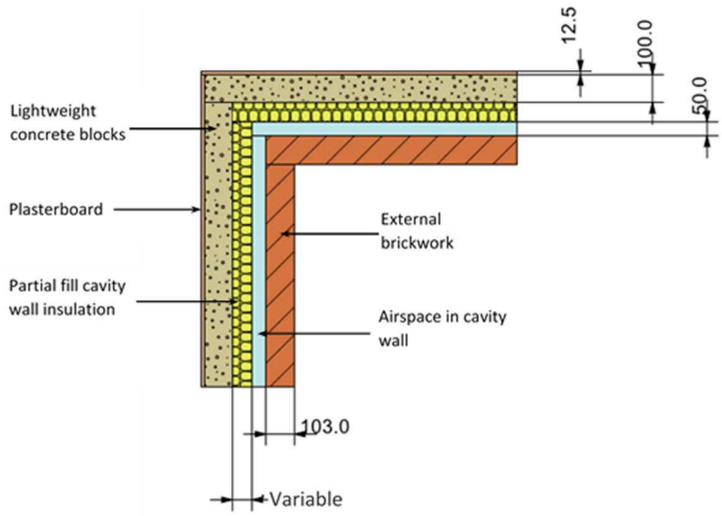
SUMMARY

Partial fill masonry walls can be ventilated, unventilated or slightly ventilated. Under BS EN 6946, unventilated walls take full account of the thermal resistance of the nominally still air space, whereas ventilated walls effectively ignore the thermal resistance of the cavity and brick. Slightly ventilated airspaces take a U-value found by linear interpolation between unventilated and fully ventilated, according to the open ventilator area. This difference has an impact on the psi values of junctions in a partial fill cavity due to a difference in geometrical thermal bridging. The difference between slightly, and unventilated constructions is negligible; at less than 1% it is less significant than numerical error allowable under BS EN 10022. However the difference between slightly/unventilated constructions, and ventilated constructions is more significant, around 10% for the case considered here. The trend indicates that the difference is more profound for thicker insulation. It is therefore acceptable to take the same psi vales for a slightly and unventilated construction, but a different value should be used if the construction is ventilated. This finding is reflected in the Advanced Details database.

Psi-values were calculated for a range of variants on a cavity masonry inverted corner junction (SAP code E17). A normal corner will be analysed in a future paper.

METHODOLOGY

The following diagram illustrates the junction design selected for analysis. Three different thicknesses of insulation were analysed in order to include a range of U-values in the investigation, these are indicated as "variable" in Figure 2. Insulation thicknesses of 50mm, 70mm and 85mm were modelled in order to give U-values of a range of 0.18 Wm^{-2}K^{-1} to 0.33 Wm^{-2}K^{-1}. For each insulation thickness, the detail was modelled as unventilated; slightly ventilated (with various densities of openings to the external environment); and fully ventilated, this is shown in Table 1. All cases were modelled in accordance with BS EN ISO 6946:2007, and the insulation was assigned a thermal conductivity of 0.022Wm^{-1}K^{-1}.



BS EN 6946 states that the densities of openings to the external environment presented in Table 1 define the terms *fully ventilated*, *unventilated* and *slightly ventilated.*[1] It is important to note that fully ventilated examples are modelled in accordance with the instructions given in section 5.3 of BS EN ISO 6946. This means that the thermal conductivities of the air layer and all layers between this layer and the external environment are disregarded. The following Table lists the types of airspaces investigated here.

Level of Ventilation	*Openings to the External Environment (mm^2 / m^2)*
Unventilated	<500
Slightly Ventilated	750
	1000
	1250
Fully Ventilated	>1500

RESULTS

The key results are presented in the following Table. This shows that between a slightly ventilated and an unventilated model, there is no significant variation in the ψ-value with the level of ventilation. However, there is a much larger variation between unventilated and well ventilated examples.

Width of Cavity Wall Insulation (mm)	*ψ-value (W/mK)*					*Max. % Variation Between Unventilated & Slightly Ventilated*	*Max. % Variation Between Unventilated & Well Ventilated*
	Unventilated (<500mm2 p sq. m)	Slightly Ventilated (750mm2 p sq. m)	Slightly Ventilated (1000mm2 p sq. m)	Slightly Ventilated (1250mm2 p sq. m)	Well Ventilated (>1500mm2 p sq. m)		
50	-0.0764	-0.0766	-0.0764	-0.0763	-0.0721	0.26%	5.63%
70	-0.0846	-0.0843	-0.0844	-0.0842	-0.0793	-0.36%	6.26%
85	-0.1002	-0.1005	-0.1006	-0.1003	-0.0920	0.10%	8.18%

The analysis was repeated with the thermal conductivity of the lightweight concrete block set to 0.11W/mK instead of 0.19W/mK as above. The results are presented in Table 3, and are very similar.

Width of Cavity Wall Insulation (mm)	*ψ-value (W/mK)*					*Max. % Variation Between Unventilated & Slightly Ventilated*	*Max. % Variation Between Unventilated & Well Ventilated*
	Unventilated (<500mm2 p sq. m)	Slightly Ventilated (750mm2 p sq. m)	Slightly Ventilated (1000mm2 p sq. m)	Slightly Ventilated (1250mm2 p sq. m)	Well Ventilated (>1500mm2 p sq. m)		
50	-0.0697	-0.0698	-0.0695	-0.0696	-0.0655	0.43%	6.03%
70	-0.0755	-0.0758	-0.0758	-0.0757	-0.0707	0.40%	6.36%
85	-0.0870	-0.0874	-0.0875	-0.0876	-0.0799	0.68%	8.16%

DISCUSSION

The results indicate that it is valid to treat unventilated and slightly ventilated models as the same. This makes it valid to model junctions simply as either unventilated or well ventilated, as the slightly ventilated case can be assigned the same internal ψ-value as the unventilated case. This has a practical application of simplifying the process of modelling thermal bridges with a minimal introduction of error. It should, however, be noted that U-values must be properly modelled in conjunction with BS EN ISO 6946.

There is no technical specifications of the maximum acceptable error to be associated with a psi-value. However, in BS EN ISO 10211 it is stated that the absolute error on temperature factors should be in the region of 0.5%.[2] However, in "*Conventions for Calculating Linear Thermal Transmittance and Temperature Factors"*, the validation examples for psi-value calculations have errors in the region of approximately 10% associated with them.[3] Taking this as an indicator, an error in the region of 1% which is introduced by treating unventilated and slightly ventilated examples as equivalent is acceptable when quoting psi-values for SAP calculations.

With respect to PHPP assessment, the external psi-values are used. The assumption discussed above is less valid for use with external psi-values as there is a higher error introduced. The largest introduced error was 6.30%, whereas the mean error was 4.97%. This shows that by making these assumptions for external psi-values, the error induced is more significant. This is because when calculating external psi-values, the position at which the heat loss surface is defined is different. This leads to a more significant associated error.

REFERENCES

[1] BS EN ISO 6946, *Building Components & Building Elements – Thermal Resistance and Thermal Transmittance – Calculation Method.* British Standards Institute, 2007. (Pages 4-5)

[2] BS EN ISO 10211, *Thermal Bridges in Building Construction – Heat Flows & Surface Temperatures – Detailed Calculations.* British Standards Institute, 2007. (Page 26)

[3] T. Ward, C. Sanders. *Conventions for Calculating Linear Thermal Transmittance and Temperature Factors*, First Edition. BRE Press, 2007.