NON-REPEATING THERMAL BRIDGES

1. Introduction

Thermal bridging occurs around openings, at conjunctions of building elements and anywhere where the insulation of the building is interrupted by a less insulating fabric. Repeating thermal bridges occur at regular intervals throughout the fabric and are accounted for in the U-value of the element.

Non-repeating thermal bridges are represented by their psi value, Ψ, the heat loss per unit length and degree of temperature difference between internal and external conditions (W/mK). Multiplying each psi value by the total length of the respective bridge gives heat loss (W/K), the sum of these being the total bridging heat loss. Division of total bridging heat loss by the total internal heat loss area of the building gives the y-value, overall heat loss from thermal bridging per unit area and degree of temperature difference (W/m^2K).

Under SAP2009 a variety of simpler approaches based on the overall dwelling y-value can be used. Use of Accredited Construction Details (ACD) allows use of a y-value of 0.08, providing that the company register with a quality assurance scheme approved by the Secretary of State and submit to testing of a sample of details on site, in lieu of such registration a penalty of 0.02W/mK must be added to the value. Alternately a very conservative default y-value of 0.15 $W/(m^2K)$ may be added to the overall heat loss of the building, Table 1.

Table 1. Psi- and y-values of various standards

	Psi value (W/mK)	y value (W/mK)
SAP default	Int	0.15
SAP Accredited Construction Details with ACD	0.00 - 0.24[1] internal	0.08
SAP Accredited Construction Details no ACD		0.1
Passivhaus "thermal bridge free"	<0.01W/m²K external	-

[1] (DECC, 2013)

Y-values, by their very universal nature are a crude method of estimating heat loss. By using system-specific psi-values, calculated using finite element heat flow methods, accuracy is increased and allow good design is more accurately represented.

2. Notes on Method

The numerical thermal modelling calculations using *THERM 6.3* are in compliance with EN ISO 10211-2007 (British Standards) and IP 1/06 & BR497 (BRE Press) and use reference to EN ISO 6946 (British Standards) and BR443 (BRE Press). Values used for thermal conductivity of building elements are taken from literature or are generic values in *THERM* software defaults (Eugen Decker, 2014), (Hunton, 2014).

3. Discussion and Conclusions

Error! Reference source not found. shows the collected psi values found from *THERM* modelling of ecofab building junctions, along with psi values and lengths from an example three storey house[2] [3]. Detailing in wool construction outperforms the example in just over half of the cases. In half of these cases the improvement is by a considerable margin. Underperforming junctions are only marginally inferior, with the exception of the eaves junction. Straw construction detailing outperforms the example in just under half of the cases, with a similar pattern to the wool construction.

In particular ecofab's suspended floor has a psi value of just a quarter (wool) or an eighth (straw) of that of the example used, the door lintel installation is around an eighth (wool) or a sixth (wool) of the example used. For two of the most significant junctions, ground floor perimeter and vertical wall corners ecofab junctions represent less than half of the example heat loss per metre. The window jambs however, at a significant length of 22m, are slightly

[2] Using steel lintels with perforated base plate, insulation at ceiling level for gable and eaves, full details available from (NHBC, 2011)

worse in the case of the straw build. The case in which ecofab building details significantly underperform is in the eaves with psi values two and a half times that of the example.

Table 2. Modelled psi values and anticipated heat loss from thermal bridges in example house

	Psi example (W/mK)	Psi wool (W/mK)	Psi straw (W/mK)	Length (m)	Heat loss example (W/K)	Heat loss wool (W/K)	Heat loss straw (W/K)
Window lintel	0.50	0.04	0.08	10.42	5.79	0.42	0.83
Door lintel	0.50	0.06	0.08	1.16	5.79	0.07	0.09
Window sill	0.04	0.05	0.06	10.42	0.46	0.52	0.63
Door sill	0.04	0.06	0.06	1.16	0.46	0.07	0.07
Window jamb	0.05	0.04	0.08	22.08	1.38	0.88	1.77
Door jamb	0.05	0.06	0.08	5.52	1.38	0.32	0.45
Ground floor	0.16	0.04	0.02	17.67	2.83	0.71	0.42
Eaves	0.06	0.15	0.15	8.00	0.48	1.20	1.20
Gable[3]	0.24	0.24	0.24	9.67	2.32	2.32	2.32
Wall corner - fitted	0.09	0.04	0.04	14.80	1.33	0.52	0.59
Wall corner - wool packed	-	-	0.03		-		

[3] Gable end not modelled so values kept consistent with example

Table 3 shows the results of basic modelling of an example house on the y-value and heat loss for each building type. A typical house fabric heat loss of 100W/K is used and the length of each junction type and the total internal area for heat loss are kept the same.

ecofab building details here contribute between four and or six percent additional heat loss to the building, around one sixth of the SAP default value, or one quarter of the ACD value.

Table 3. Comparison of total heat loss from non-repeating thermal bridges for example house

	ecofab wool	ecofab straw	Example house	SAP default	SAP accredited details (no q.a.)
Total bridging heat loss (W/K)	4.39	5.74	17.51	-	-
Equivalent y-value (W/m^2K)	0.022	0.028	0.090	0.150	0.100
Total heat loss (W/K)	104	106	118	130	120
Additional loss (% of orig.)	4.4	5.7	17.5	30.5	20.3

An improvement, addition of an extra 10mm of Bitroc layer, was modelled for one of the junctions and result is shown below, Table 4. A considerable improvement is achieved.

Table 4. Potential improvement by use of 25mm Bitroc

	Psi example (W/mK)	Psi wool (W/mK	Psi wool new (W/mK)	Length (m)	Heat loss e.g. (W/K)	Heat loss wool (W/K)	Heat loss wool new (W/K)
Window lintel	0.500	0.040	0.001	10.42	5.79	0.42	0.01

4. Further Work

Modelling results show that ecofab junction detailing can outperform a conventional build by some margin and that heat loss from thermal bridging can be significantly reduced. Results have also shown that performance is not consistent across all design and that significant improvement is possible through simple material choice.

Further quantification of this improvement would be useful, in terms of SAP results, energy savings and cost. A more complete bank of building details is may also be required in order that all details used by ecofab can be used in SAP reports.

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