An Introduction To

Passivhaus Building Technology

By

Phil Hammett

Wilhams Insulation Far East
Who Is Wilhams?
What Is Passivhaus Building Technology?

Current Building Technology
What Is Passivhaus Building Technology?

Passivhaus Technology

Thermos Flask - Invented by Scottish scientist Sir James Dewar in 1892
What Is Passivhaus Building Technology?

- Super insulated building envelope
- Air-tight building envelope
- High performance windows
- Reduced thermal bridging
- Comfort ventilation with coolth recovery
Super insulated building envelope
Super insulated building envelope

The low energy requirement for heating of a passive buildings requires a thermal insulation level that is considerably higher than normal.

Minimum values for the thermal transmittance coefficients of the exterior shell components:

- exterior wall and roof: 0.15 W/m² K
- floor: 0.25 W/m² K
- window: 0.80 W/m² K
- Window installed: 0.85 W/m² K
Super insulated building envelope
Air-tight building envelope

Airtightness
Typical air leakage rates for different buildings:

- Passive building $n_{50} = 0.6$
- Tight building $n_{50} = 1$
- New buildings (Finland) $n_{50} = 3 - 4$
- Normal tightness $n_{50} = 5...10$ (Malaysia house)
- Leaking construction $n_{50} = 15$
Air Tightness Of The Building Envelope

If air moves within insulation it substantially affects the thermal performance.

When it is protected with an airtightness barrier it performs to its optimum level.

Energy consumption (model house)

MWh/year

Heating energy

Tightness of the house $n_{50}$
Air Tightness Of The Building Envelope

The air tight barrier must be continuous over the thermal insulation and tightly sealed around any penetrations over the entire area of the exterior shell.
Air Tightness Of The Building Envelope

Standardised pressure test EN 13829, by subjecting the building to 50 Pa overpressure and evaluating the air exchange rate of the building. The air leakage rate in the building should not exceed 1 per hour.
High performance windows
High performance windows
High performance windows

Zertifikat
Passivhaus geeignete Komponente

Kategorie: Fensterrahmen
Hersteller: Paula Passiv GmbH
Produkt: Passiv X plus

Folgende Behaglichkeitskriterien wurden für die Zuerkennung des Zertifikates geprüft:

Mit $U_w = 0.79 \text{ W/(m²K)}$ und bei einem Fenstermaß von $1.33 \text{ m} \times 1.48 \text{ m}$ ergibt sich:

$U_n = 0.80 \text{ W/(m²K)} \leq 0.89 \text{ W/(m²K)}$

Einschließlich der Einbauverkleidungen und des Fensters folgende Bedingung, vorausgegeben der Einbauverkleidung von innen. Dabei eine höhere oder gleiche Wärmedämmungsleistung

$U_{nc, eingebaut} \leq 0.85 \text{ W/(m²K)}$

Folgende Rahmenkennwerte wurden ermittelt:

<table>
<thead>
<tr>
<th>$U_n$-Wert</th>
<th>Breite</th>
<th>$\psi_n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>[W/(m²K)]</td>
<td>[mm]</td>
<td>[W/(m²K)]</td>
</tr>
<tr>
<td>Abstandshalter</td>
<td>0.70</td>
<td>0.19</td>
</tr>
<tr>
<td>Unten</td>
<td>0.70</td>
<td>0.19</td>
</tr>
<tr>
<td>Seitenkanten</td>
<td>0.70</td>
<td>0.19</td>
</tr>
</tbody>
</table>

*Thermisch hochwertiger Abstandshalter, insbesondere solche aus Aluminium, führen zu hohen Wärmeverlusten am Glaseinsatz und zu geringen Temperaturunterschieden.

Weitere Informationen siehe Produktblatt

www.passiv.de
Reduced thermal bridging
# Green Building Index

U-value calculation  
by BRE U-value Calculator version 2.03  
Printed on 18 Jul 2014 at 11:33

**Element type: Roof - Flat roof - insulation between steel joints**

**Calculation Method:** BRE Digest 465

<table>
<thead>
<tr>
<th>Layer</th>
<th>d (mm)</th>
<th>h, layer</th>
<th>h,.bridge</th>
<th>Fraction</th>
<th>R,layer</th>
<th>R,bridge</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.8</td>
<td>50.0</td>
<td></td>
<td></td>
<td>0.050</td>
<td></td>
<td>Ri</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Steel</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>0.038</td>
<td>60.0</td>
<td>0.100</td>
<td>2.632</td>
<td>0.0017</td>
<td>Vapour control layer</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mineral wool insulation / steel</td>
</tr>
<tr>
<td>5</td>
<td>0.4</td>
<td>50.0</td>
<td></td>
<td></td>
<td>0.100</td>
<td></td>
<td>Vapour control layer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.4</td>
<td>Nuis</td>
</tr>
</tbody>
</table>

Total roof thickness: 2.632 mm

- **Note:** this resistance substitutes for Rs and the resistance of layers 4-5 because of the ventilated air layer (layer 4).

- **Joint spacing:** 600 mm  
- **Joint depth:** 100 mm  
- **Flange width:** 50 mm  
- **p = 0.221** (Digest 465 equation 3)

Total resistance: Upper limit: 1.219  
Lower limit: 0.217  
Weighted average: 0.440 m²K/W

U-value (uncorrected): 2.271

- **U-value corrections:**
  - Air gaps in layer 1: \( u' = 0.009 \) (Level 1)
  - Flanges in layer 1: \( u' = 0.009 \) (2.50 m²/W, 7.5 m² cross-section, \( \lambda = 17.0 \))

Total \( u' \): 0.009

- **U-value (corrected):** 2.380
- **U-value (rounded):** 2.38 W/m²K

**Calculated by:**

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This Information Paper describes a method for determining the thermal performance of insulated double-skin metal roof and wall systems used in the UK that incorporate Z spacers. It can be used to demonstrate compliance with the 2002 edition of these building regulations.

Introduction

The method described in BS EN ISO 6946 (also known as the Combined Method in CIBSE Grade A, Section A3, 1999 edition) is used to calculate the U-value of many types of building elements with insulating thermal bridges such as timber joints, structural and other framing, and metal buildings. However, when applied to double-skin metal-cladding systems, these constructions can be identified as having thermal bridges caused by the metal connecting paths between lower floor and outer sheet. Built-up systems using raft and bracket spacers are dealt with in Metal-cladding U-value calculation – Assessing thermal performance of built-up metal roof and wall cladding systems using raft & bracket spacers published by the Steel Construction Institute. Other metal cladding systems should be assessed by numerical modeling of the specific construction type. This paper replaces IP 1/02.

The method takes account of the thermal bridging caused by the metal connections between lower floor and outer sheet. Built-up systems using raft and brackets are dealt with in Metal-cladding U-value calculation – Assessing thermal performance of built-up metal roof and wall cladding systems using raft & bracket spacers published by the Steel Construction Institute. Other metal cladding systems should be assessed by numerical modeling of the specific construction type. This paper replaces IP 1/02.

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WILHAMS INSULATION FAR EAST SDN BHD
Thermal Bridging - Calculation Standards

U-values for light steel-frame construction

This Digest gives a method for assessing U-values of light steel-frame constructions. The method has been validated using the procedures in BS EN ISO 10211-1 and enables U-values to be calculated by means of a simplified method. It is similar to the one given in BS EN ISO 6946 but with some important differences. It can easily be incorporated into software tools used by designers, builders and assessors of the Building Regulations wishing to calculate U-values of light steel-frame constructions. The method was developed jointly by BRE and The Steel Construction Institute.

With the implementation of the 2002 editions of the Approved Documents L1 and L2 for the Conservation of Fuel and Power [EM], the Proportional Area Method for calculating U-values has been replaced by the method given in BS EN ISO 6946. Although BS EN ISO 6946 may be used for most types of wall, roof and floor deck, including masonry and timber frame constructions, it specifically excludes frame constructions in which insulating layers are bridged by metal elements, as in light steel frame designs. This has resulted in there being no approved simplified method available for calculating U-values of many light steel frame designs.

<p>| Table 1: Thicknesses of layers and thermal conductivities |
| --- | --- | --- | --- | --- |</p>
<table>
<thead>
<tr>
<th>Layer</th>
<th>Material</th>
<th>Area fraction, f</th>
<th>Thickness (mm)</th>
<th>Thermal conductivity (W/m K)</th>
<th>Thermal resistance (m K/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brickwork</td>
<td>—</td>
<td>102</td>
<td>0.77</td>
<td>0.1325</td>
</tr>
<tr>
<td>2</td>
<td>Air cavity</td>
<td>—</td>
<td>50</td>
<td>—</td>
<td>0.1800</td>
</tr>
<tr>
<td>3</td>
<td>Insulation bridged only by fixings</td>
<td>—</td>
<td>50</td>
<td>0.04</td>
<td>1.2500</td>
</tr>
<tr>
<td>4</td>
<td>Plywood or OSB</td>
<td>—</td>
<td>20</td>
<td>0.13</td>
<td>0.1538</td>
</tr>
<tr>
<td>5a</td>
<td>Insulation between webs of steel studs and nogging</td>
<td>0.9972 (99.72%)</td>
<td>100</td>
<td>0.04</td>
<td>2.500</td>
</tr>
<tr>
<td>5b</td>
<td>Webs of steel studs and nogging</td>
<td>0.0028 (0.28%)</td>
<td>100</td>
<td>60</td>
<td>0.00167</td>
</tr>
<tr>
<td>6</td>
<td>Plasterboard</td>
<td>—</td>
<td>15</td>
<td>0.21</td>
<td>0.0714</td>
</tr>
<tr>
<td>7</td>
<td>Internal surface</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0.1300</td>
</tr>
</tbody>
</table>
Comfort ventilation with coolth recovery
Comfort ventilation with coolth recovery

- Low pressure supply fresh air to living rooms and bedrooms
- Extract air from kitchens, bathrooms and toilets
Comfort ventilation with coolth recovery

- Hygienic clean air
- System runs 24 hours a day, 7 days a week, 365 days a year
- Air filtered to ensure no allergies
- No moisture / mould