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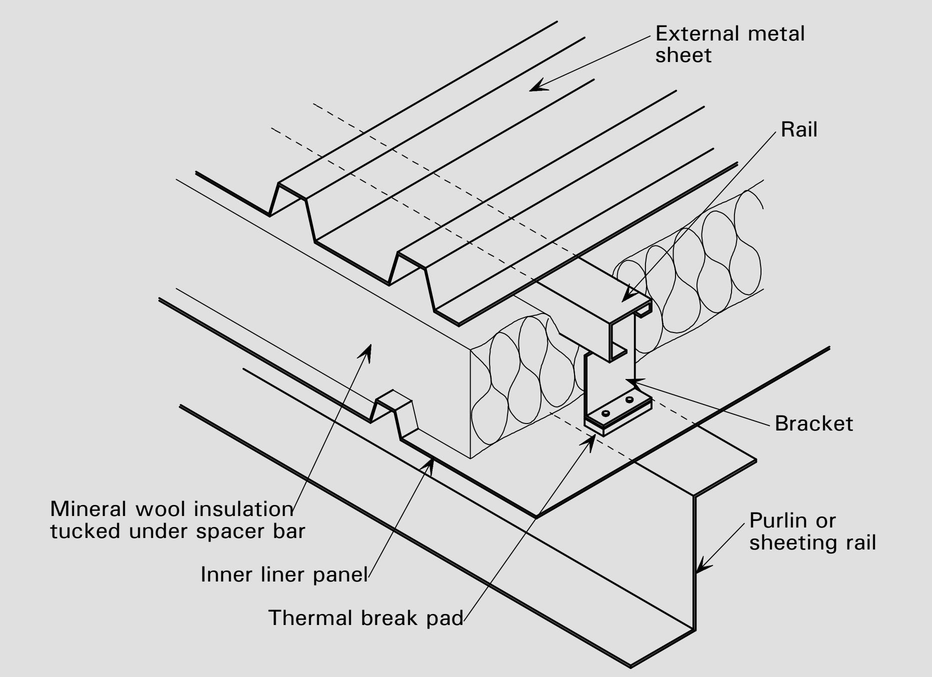
Metal cladding: U-value calculation

Assessing thermal performance of built-up metal roof and wall cladding systems using rail and bracket spacers

Technical Information Sheet



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- This Information Sheet sets out a simple method for determining U-values for built-up metal roof and wall cladding that uses rail and bracket spacers.
- The method can be used to demonstrate compliance with the 2002 editions of Approved Documents L1 and L2.
- It enables U-values for the relevant constructions to be calculated easily using simple algorithms.
- Software is available, incorporating these simple algorithms, that can be used to carry out the U-value calculations.
- As an alternative to using software, graphs are presented that can be used to determine U-values for typical specifications.
- The method is similar to that given in BS EN ISO 6946 for other constructions but with some important differences to account for the effect of the linear and point thermal bridges.
- Designers, suppliers, builders and enforcers of the regulations can easily calculate U-values for such cladding without the need for complex numerical analysis software (as previously required).
- The method has been validated using BS EN ISO 10211-1.

INSIDE

Built-up metal cladding with rail and bracket fixings

This leaflet deals with twin skin metal roof and wall cladding that is built-up on site and which consists of:

- A metal inner liner panel, usually between 0.4 and 0.6 mm thick and with a shallow profile.
- A rail and bracket spacer system that creates a cavity between the inner liner panel and the external sheeting. The rails are galvanized steel L- or C-sections, typically attached to the outer sheet at 1200 mm to 2400 mm centres. The rails are attached to the inner panel galvanized steel brackets, typically between 100 mm and 250 mm high, spaced at 500 mm to 1000 mm centres along the rails, depending on wind loads. The brackets incorporate some form of thermal break to reduce heat transfer across the bracket.
- Thermal insulation placed in the cavity. This material is typically a low-density mineral wool quilt (10 to 24 kg/m^3).
- An outer metal sheet, typically 0.5 mm to 0.9 mm thick, usually with a deep profile.

The metal sheets are either galvanized steel or aluminium and can be coated to give a variety of finishes. An air and vapour barrier is achieved by sealing the joints of the inner liner panel or by incorporating an impermeable membrane on top of the liner.

The brackets and rails are structural components that transfer loads from the external metal sheeting to the purlins or sheeting rails.

The thermal insulation is compressed by the rails, creating linear thermal bridges. The brackets and fasteners also produce small point-thermal bridges but this effect is reduced by the thermal break reducing heat flow through the bracket (see Figure 1). The thermal break is often in the form of a pad of thermally resistant material at the base of the bracket, but can be achieved in other ways. The thermal bridging effects may be accounted for by the U-value calculation method set out in this information sheet.

With this system, the thickness of mineral wool insulation needed to satisfy the requirements of Part L will normally be about 110 mm to 130 mm for walls and 160 mm to 200 mm for roofs. The exact thickness needed will depend on the spacing, thickness and shape of elements, and the thermal conductivity of the insulation.

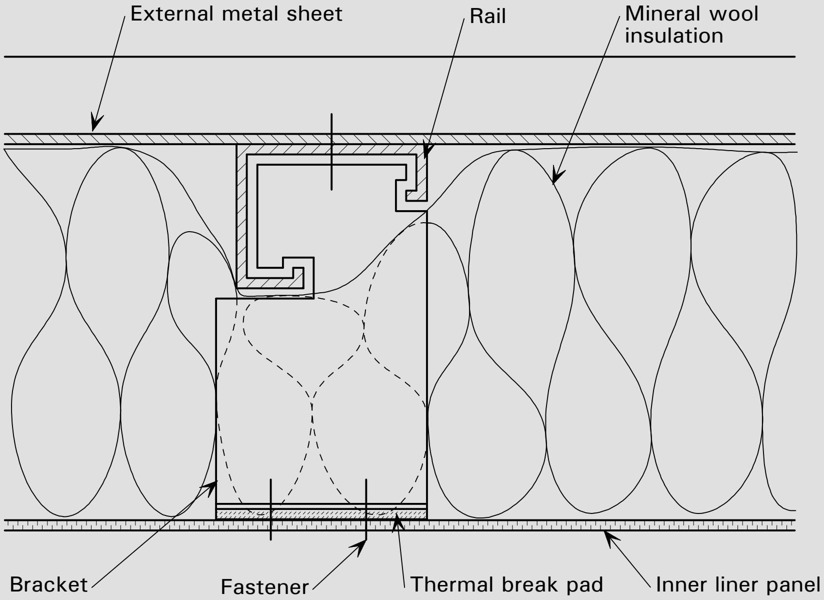

Figure 1 Section through a typical rail and bracket spacer system

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Requirements of Part L of the Building Regulations

Requirements for control of heat flow

The 2001 Amendments to Part L of Schedule 1 of the Building Regulations impose more demanding requirements for the control of heat flow in buildings. The intention of the new requirements is to reduce carbon dioxide emissions from buildings by up to 25%. The requirements are given in Part L1 for dwellings and Part L2 for buildings other than dwellings.

The new Approved Documents that provide guidance on how the requirements can be met came into force in April 2002. To comply with Part L, a minimum level of thermal performance should be achieved in each of the elements of a building.

To show compliance, the thermal performance of the elements must be no worse than standard U-values tabulated in the Approved Document. Standard U-values are given here in Table 1.

For most envelope constructions, to demonstrate compliance, it is acceptable to use the simplified calculation method in BS EN ISO 6946 to calculate U-values. However, this method is inappropriate for constructions such as metal cladding where linear metal components (such as the rails) bridge part, or all, of the insulation.

For built-up metal cladding with a Z-spacer fixing system, the methodology set out in BRE Information Paper IP 10/02 may be used to calculate U-values. However, until now there has been no approved, simplified method available for calculating U-values for built-up cladding with a rail and bracket spacer system. This Technical Information Sheet sets out an approved methodology that may be used for such systems.

Table 1 Standard U-values (maximum values to achieve compliance), taken from Approved Document L2

Element	W/m^2K
Walls	0.35
Floors	0.25
Pitched roof: insulation between joists	0.16
Pitched roof: insulation between rafters	0.20
Flat roof or roofs with integral insulation	0.25
Roof lights	2.20
Windows (metal/wood or PVC glazing)	2.20 / 2.00

Methods of demonstrating compliance

There are three ways of using the information given in this document to calculate the U-values necessary to check for compliance of the thermal performance of a built-up metal roof or wall cladding system that uses rails and bracket spacers:

1) Use simple algorithms

This requires knowledge of the upper and lower limits to the thermal resistance of the basic panel (see page 4). These values are then used to determine a U-value, to which adjustments are made for the effects of fixing brackets, air gaps and liner profiles (see pages 5 and 6). An example of the use of this method is given on pages 7 and 8.

2) Use software based on the algorithms

Software is available from BRE that can be used to carry out the calculation process described in this information sheet.

Visit http://projects.bre.co.uk/uvalues.

3) Use graphical information

For more common specifications for built-up claddings using rail and bracket spacers, U-values may be obtained by interpolating between the graphs given and pages 9 and 10.

Calculating thermal resistance

BS EN ISO 6946 method

BS EN ISO 6946 sets out a method of calculation of U-values (thermal transmittance) that may be used where no metal components create linear thermal bridges through the insulation. It is, therefore, not strictly applicable to built-up metal cladding constructions. However, the methods given in BS EN ISO 6946 for calculating thermal resistance can be used as a basis for the calculation for built-up metal roof and wall cladding, as shown in this Information Sheet.

The BS EN ISO 6946 method involves the calculation of R_{max} and R_{min}, the theoretical upper and lower limits of thermal resistance. The upper limit of thermal resistance (R_{max}) is calculated by combining in parallel the total resistance of the heat-flow paths (or sections) through the building element. The lower limit of thermal resistance (R_{min}) is calculated by combining in parallel the resistance of the heat flow paths of each layer separately, and then summing the resistance of all layers of the building element.

In the calculation, care should be taken to avoid large rounding errors and thermal resistance should not be rounded to less than 3 significant figures. The upper and lower limits, R_{max} and R_{min}, can be easily determined using the software on the BRE web site.

Using the BS EN ISO 6946 method, the Total Thermal Resistance R_T is calculated as follows:

$$R_T = 0.5\ R_{max} + 0.5\ R_{min} \qquad [1]$$

Note that where the liner profile depth is greater than 25 mm, the insulation depth to be used in the determination of R_{min} and R_{max} should not exceed the depth to the top of the liner profile (i.e. as for dimension t_p in Figure 2).

Method for built-up metal cladding

A similar methodology can be used for built-up metal cladding using a rail and bracket spacer system. The values for R_{max} and R_{min} are calculated as in the BS EN ISO 6946 method, but are then combined using a different formula to obtain the total thermal resistance R_T.

To combine R_{max} and R_{min}, a parameter p is used; the value of which depends on the details of the construction. R_T is given by:

$$R_T = p\ R_{max} + (1 - p)\ R_{min} \qquad [2]$$

In effect, the BS EN ISO 6946 method uses a value of $p = 0.5$ in all cases. For built-up metal cladding with rail and bracket spacer systems, a value of 0.5 can exaggerate the effect of the rail when the rail penetrates only part of the total insulation thickness and the rails are reasonably spaced. An appropriate value needs to be calculated.

The value of p is influenced by a number of factors, including the rail width (lateral dimension) and thickness (of metal), the spacing between the rails and the depth of the rail. The following formula may be used to calculate p for built-up cladding using rail and bracket spacers where the metal rail bridges part of the insulation layer:

$$p = 0.8\left[\frac{R_{min}}{R_{max}}\right] + 0.44 + 0.1\left[\frac{w}{40}\right] - 0.2\left[\frac{600}{s}\right] - 0.04\left[\frac{d}{100}\right] \qquad [3]$$

Where:
w = the rail width in mm
s = rail spacing in mm
d = rail depth in mm.

NOTE:

1. If the value of p calculated by equation [3] is greater than 1, set $p = 1$.
2. If there is an air space greater than 5 mm between the outside of the insulation and the outer metal sheet, this should be allowed for in the calculation of R_{max} and R_{min} as an additional air cavity thermal resistance. Appropriate values can be obtained from BS EN ISO 6946. The insulation must be installed such that a continuous cavity is maintained.

Calculating thermal transmittance (U-value)

The U-value

The thermal transmittance, expressed as a U-value, is determined from the thermal resistance R_T and from 'corrections' to allow for the effects of brackets, air gaps and liner profiles.

The U-value is given by:

$$U = (1 / R_T) + \Delta U_f + \Delta U_g + \Delta U_p \qquad [4]$$

Where:

ΔU_f is an adjustment for the effect of the fixing brackets

ΔU_g is an adjustment for the effect of air gaps in the insulation

ΔU_p is an adjustment for the effect of the liner profiles.

The calculation of these is described below.

NOTE: The methodology in BS EN ISO 6946 allows the corrections ΔU to be ignored, provided that they together amount to less than 3% of $(1 / R_T)$. This rule may also be applied for metal cladding.

Metal brackets

In order to take account of additional heat loss caused by the metal bracket penetrating through the insulation layer, a U-value correction ΔU_f should be added. This correction may be calculated using:

$$\Delta U_f = 1.6\, \lambda_f\, A_f\, n_f\, (R_i / R_{ub})^2 / d_i \qquad [5]$$

Where:

R_i Is the thermal resistance of the insulation layer penetrated by the bracket (m^2K/W)

R_{ub} Is the total thermal resistance of the construction ignoring the thermal bridging (m^2K/W)

l_f Is the thermal conductivity of the bracket (W/mK)

A_f Is the cross-sectional area of the bracket (m^2)

n_f Is the number of brackets per square metre of cladding

d_i Is the thickness of insulation penetrated by the bracket (m).

Air gaps

In order to take account of additional heat loss caused by air gaps at junctions between individual pieces of insulation, a U-value correction, ΔU_g, should be calculated. The correction for the air gaps may be determined using an amendment to the method described in Annex D of BS EN ISO 6946, as follows:

$$\Delta U_g = \Delta U'' (R_I / R_{ub})^2 \qquad [6]$$

Where:

R_I Is the thermal resistance of the insulation in the layer containing air gaps (m^2K/W)

R_{ub} Is the total thermal resistance of the construction ignoring thermal bridges (m^2K/W)

$\Delta U''$ Is the air gap correction factor as defined in BS EN ISO 6946 (Annex D). In most cases for built-up metal cladding, $\Delta U'' = 0.01$.

Liner profiles

The degree of thermal bridging due to the liner profile depends on the depth of the profile and the proportion of the area with reduced insulation thickness. If the insulation is accommodated between the liner profile and the outer sheet without being compressed, no adjustment is necessary.

Where the liner profile is no more than 25 mm deep, the profile spacing (d_r) is not less than 250 mm and the profile compresses the insulation, an adjustment to the U-value, ΔU_p may be calculated as follows:

$$\Delta U_p = \frac{l}{t_p} \times \frac{d_p}{d_p + d_r} + \frac{l}{t_r} \times \left[\frac{d_r}{d_p + d_r} - 1 \right] \qquad [7]$$

Where:

t_r is the insulation thickness used for the U-value calculation (m)

t_p is the insulation thickness when compressed by the liner profile (m)

d_p is the width of the profile measured at half height (m)

d_r is the distance (in m) between profile ribs (i.e. profile ribs are at centres $d_p + d_r$)

l is the thermal conductivity of the insulation (W/mK).

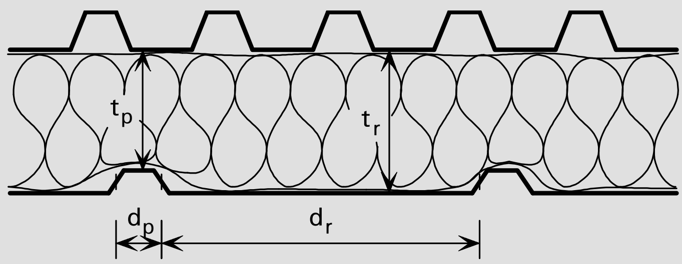

Figure 2 Section through a shallow profile liner tray showing insulation compression

Where the liner panel profile is deeper than 25 mm, the values of R_{min} and R_{max} are based on the lesser of the actual thickness and the compressed thickness of the insulation (see comment on page 4) and no adjustment ΔU_p is necessary.

General guidance on input data for the U-value calculation

1. The steel inner liner panel and outer sheet should be considered as individual layers, each with its relevant thickness and thermal conductivity (l_{steel} = 60 W/mK).
2. The insulation layer should be divided into two separate layers:
   - One layer should correspond to the depth of the rails (see Figure 3). This layer is bridged by the rails and the air gap that is formed around the rails through the compression of the insulation (this may generally be assumed to be twice the width of the rail). This layer should be considered as a thermally bridged layer in the calculation. The relevant bridging fraction for the rails is the thickness of steel* divided by the spacing of the rails. The bridging fraction for the air gap is twice the width of the rail divided by the spacing of the rails
   - The second layer corresponds to the remaining thickness of insulation, with the brackets penetrating through it.
3. The rail width should be taken to be the width across the top of the rail.
4. The rail spacing should be the average spacing across the whole area of the wall or roof

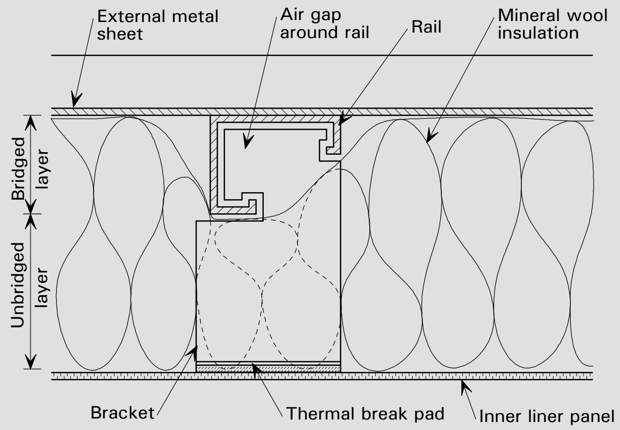

Figure 3 Insulation layers

5. The brackets should be considered as follows:
   - Brackets need only be considered to bridge the second layer of insulation (i.e. the part of the insulation layer that is not bridged by rails).
   - The number of brackets per m^2 should be taken as the average over the whole area of the construction element (i.e. total number / total area)
   - The cross sectional area should be taken as that for the thickest part of the bracket.
   - The thermal conductivity (l) of the bracket should be taken as 60 W/mK for steel brackets.
6. When calculating the air gap correction, ΔU_g, the air gap correction factor, as defined by BS EN ISO 6946, should be taken as for level 1 unless the specific requirements in BS EN ISO 6946 can be satisfied for correction level 0.

* In rail designs such as that in Figure 3, a single thickness of steel penetrates the insulation. In others, such as where the rails are C- or U-shaped, two steel thicknesses may penetrate the insulation. The steel thickness used for the calculation must be chosen accordingly; if two sections penetrate the insulation, double the steel thickness should be used.

LIMITATIONS OF USE AND DEFAULT VALUES

Table 2 gives the range of values for which the method is applicable and the default values to be used when some of the parameters are unknown.

In addition, there must be a thermal break to reduce the thermal bridging through the bracket. The rail must not penetrate the full depth of the insulation; some insulation must be tucked beneath the rail (between the brackets), thus providing a thermal break between the rail and inner liner panel.

Table 2 Data input values

Parameter	Symbol	Default value	Limiting value for method
Rail spacing	s	1200 mm	1000 mm (min)
Rail depth	d	40 mm	150 mm (max)
Rail width	w	40 mm	80 mm (max)
Bracket spacing	n_f	0.8 / m^2	1.3 / m^2 (max)

Example of the calculation method

The following example illustrates the use of the calculation method for a typical built-up metal roof cladding.

Determine the U-value for the following cladding system, which has an internal depth of 170 mm:

- A profiled steel outer sheet, 0.7 mm thick.
- Mineral wool insulation, 170 mm thick, installed between the inner liner panel and outer sheet.
- C-section steel rails, 1.2 mm thick and 40 mm deep, attached to the outer sheet and spaced at 1800 mm centres.
- Steel brackets at 1000 mm centres along each rail, fixed through thermal break pads to the inner liner panel. The cross section of each bracket is 50 mm by 1.2 mm.
- A steel profiled inner liner panel, 0.4 mm thick, with 25 mm deep and 50 mm wide profiles at 600 mm centres.

For the calculation, the cladding is considered to consist of four basic layers:

Layer 1: The outer sheet
Layer 2: The first layer of insulation, to the depth of the rail
Layer 3: The second layer of insulation
Layer 4: The inner liner panel

The first insulation layer is to be considered in three parts, according to fractional areas:

Layer 2a: The majority of the area, which is filled only with insulation.

Layer 2b: Corresponds to the bridge between the outer sheet and the second layer of insulation that is provided by the web of the steel rail. The area fraction is thus the rail thickness divided by the rail spacing.

Layer 2c: Corresponds to the air gap around the rail caused by compressed insulation. The area fraction is twice the rail width divided by the rail spacing.

The inputs required to calculate the U-value are listed in Table 3. The thickness and thermal conductivity of each layer are shown in Table 4. The internal and external surface resistances correspond to those given in BS EN ISO 6946.

Table 3 Inputs for the calculation

Parameter	Input
Cladding layers	
External sheet thickness (Layer 1)	0.7 mm
External sheet thermal conductivity (steel)	60 W/mK
Depth of bridged insulation layer (Layer 2)	40 mm
Bridging fraction of rail (rail thickness/rail spacing)	0.00067 (1.2/1800)
Bridging fraction of air gap around rail (2 x rail width/rail spacing)	0.044 (2 x 40/1800)
Thickness of remaining insulation (Layer 3)	130 mm (170 – 40)
Insulation thermal conductivity	0.04 W/mK
Inner liner panel thickness (Layer 4)	0.4 mm
Liner thermal conductivity (steel)	60 W/mK
Rails	
Rail depth	40 mm
Rail spacing	1800 mm
Rail width	40 mm
Rail thermal conductivity (steel)	60 W/mK
Brackets	
Number of brackets /m^2	0.56 (1/[1.8x1.0])
Bracket cross sectional area	60 mm^2 (50 x 1.2)
Bracket thermal conductivity (steel)	60 W/mK

Example (continued)

Table 4 Construction layers in example calculation

Layer	Material	Area Fraction	Thickness (mm)	Thermal conductivity (W/mK)	Thermal resistance (m^2K/W)
	External surface				0.04
1	External steel sheet		0.7	60	0.00001
2a	Insulation (bridged by rail)	0.95533	40	0.04	1.00
2b	Rail web	0.00067	40	60	0.00067
2c	Air space around rail caused by compressed insulation	0.044	40		0.215
3	Insulation bridged only by brackets		130	0.04	3.250
4	Inner liner panel		0.4	60	0.000007
	Internal surface				0.13

Using the data in Table 4, the upper and lower limits of thermal resistance, R_{max} and R_{min}, are calculated in accordance with BS EN ISO 6946. This calculation can be done manually but is usually done using simple software.

R_{max} = 4.377 m^2K/W
R_{min} = 3.883 m^2K/W

The value of p is calculated using equation [3]

$$p = 0.8\left[\frac{R_{min}}{R_{max}}\right] + 0.44 - 0.1\left[\frac{w}{40}\right] - 0.2\left[\frac{600}{s}\right] - 0.04\left[\frac{d}{100}\right]$$

$$p = 0.8\left[\frac{3.883}{4.377}\right] + 0.44 - 0.1\left[\frac{40}{40}\right] - 0.2\left[\frac{600}{1800}\right] - 0.04\left[\frac{40}{100}\right]$$

p = 0.9670

The total thermal resistance R_T is calculated using equation [2]:

$$R_T = p\,R_{max} + (1 - p)\,R_{min}$$

$$R_T = (0.9670 \times 4.377) + (1 - 0.9670) \times 3.883$$

$$R_T = 4.3607\ m^2K/W$$

Corrections

The effect of the brackets is calculated using equation [5]:

$$\Delta U_f = 1.6\ l_f\,A_f\,n_f\,(R_i / R_{ub})^2 / d_i$$

$$\Delta U_f = \frac{1.6 \times 60 \times (60 \times 10^{-6}) \times 0.56 \times (3.25 / 4.42)^2}{0.13}$$

$$\Delta U_f = 0.0134$$

The effect of air gaps at the insulation junctions is calculated using equation [6]:

$$\Delta U_g = \Delta U'' (R_I / R_{ub})^2$$

where the value of $\Delta U''$ is taken from Annex D of BS EN ISO 6946, and in this case $\Delta U''$ = 0.01. Thus:

$$\Delta U_g = 0.01\ (4.25 / 4.42)^2$$

$$\Delta U_g = 0.0092$$

The effect of the profiled liner is calculated using equation [7]:

$$\Delta U_p = \frac{l}{t_p} \times \frac{d_p}{d_p + d_r} + \frac{l}{t_r} \times \left[\frac{d_r}{d_p + d_r} - 1\right]$$

$$\Delta U_p = \frac{0.04}{0.145} \times \frac{0.05}{0.05 + 0.55} + \frac{0.04}{0.17} \times \left[\frac{0.55}{0.05 + 0.55} - 1\right]$$

$$\Delta U_p = 0.00338$$

The U-value

The U-value is given by equation [4]:

$$U = 1 / R_T + \Delta U_g + \Delta U_f + \Delta U_p$$

$$= (1 / 4.3607) + 0.0092 + 0.0134 + 0.0034$$

$$= 0.2553\ W/m^2K$$

$$= 0.26\ W/m^2K$$

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Graphical determination of U-value

For built-up metal roof and wall cladding with rail and bracket spacers with the following specification, the graphs given in Figures 4 to 6 can be used to determine the U-value.

- Thermal conductivity of insulation material between 0.035 and 0.045 W/mK
- Cross sectional area of brackets between 50 and 60 mm^2 per metre of rail. A thermal break pad is provided.
- The rails are not bigger than 40 mm deep by 40 mm wide with a steel thickness of 1.2 mm.
- The rails are at a spacing of between 1200 mm and 2400 mm.

The graphs may either be used to determine the U-value for a given insulation thickness and rail spacing, or to select the required insulation thickness to achieve a given U-value.

There are three graphs, for insulation thermal conductivity values of 0.035, 0.040 and 0.045 W/mK respectively (actual values of material can be obtained from manufacturers). Interpolation may be used between Figures 4, 5 and 6, and between the curves on the Figures.

Correction for air spaces

The graphs have been derived ignoring the effect of air cavities between the insulation and the outer metal sheet. Air cavities below 5 mm may be ignored but for larger cavities the U-value should be adjusted for the presence of the cavity, using the following relationship:

$$U' = 1 / (1/U + R_{\text{air space}}) \qquad [8]$$

Where U is the U-value read from (or used as input to) the relevant graph, and $R_{\text{air space}}$ is the thermal resistance of the air space in m^2K/W, which can be obtained from BS EN ISO 6946.

Correction for Liner Profiles

A correction should also be made when profiled liner trays are used.

When using the curves to determine U, add the correction ΔU_p given by equation 7 to the value from the graphs

When using the curves to calculate the thickness of insulation required, add a correction Δt to the value from the graphs, where Δt is given by:

$$\Delta t = t_r - \frac{1}{\frac{1}{t_p} \times \left[\frac{d_p}{d_p + d_r}\right] + \frac{1}{t_r} \times \left[\frac{d_r}{d_p + d_r}\right]} \qquad [9]$$

Where all dimensions are as given on Page 5.

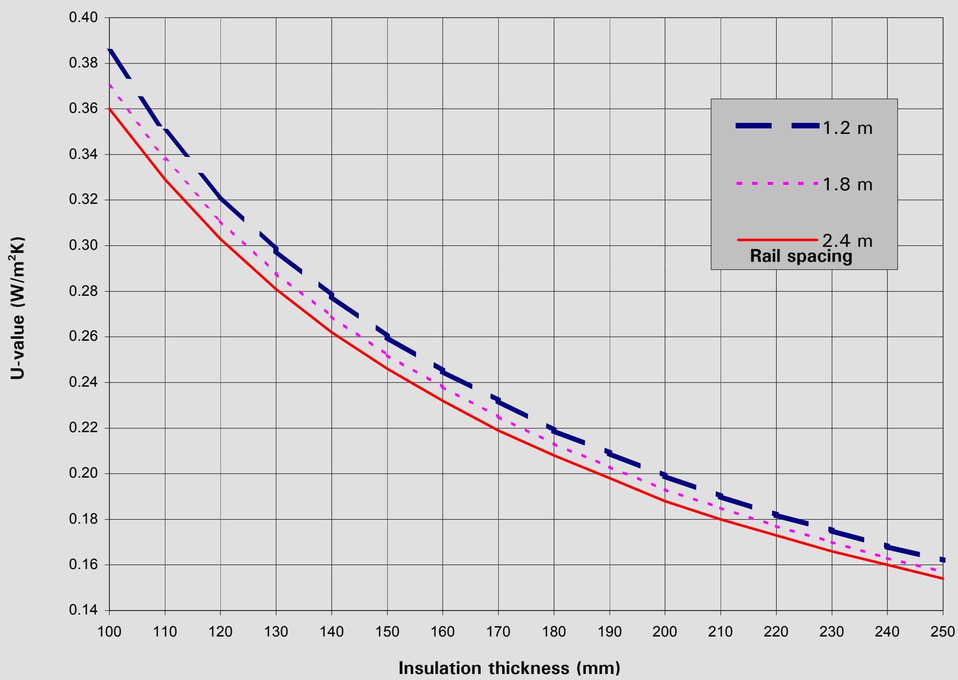

Figure 4 U-values for insulation thermal conductivity l = 0.035 W/mK

Graphical determination of U-value (continued)

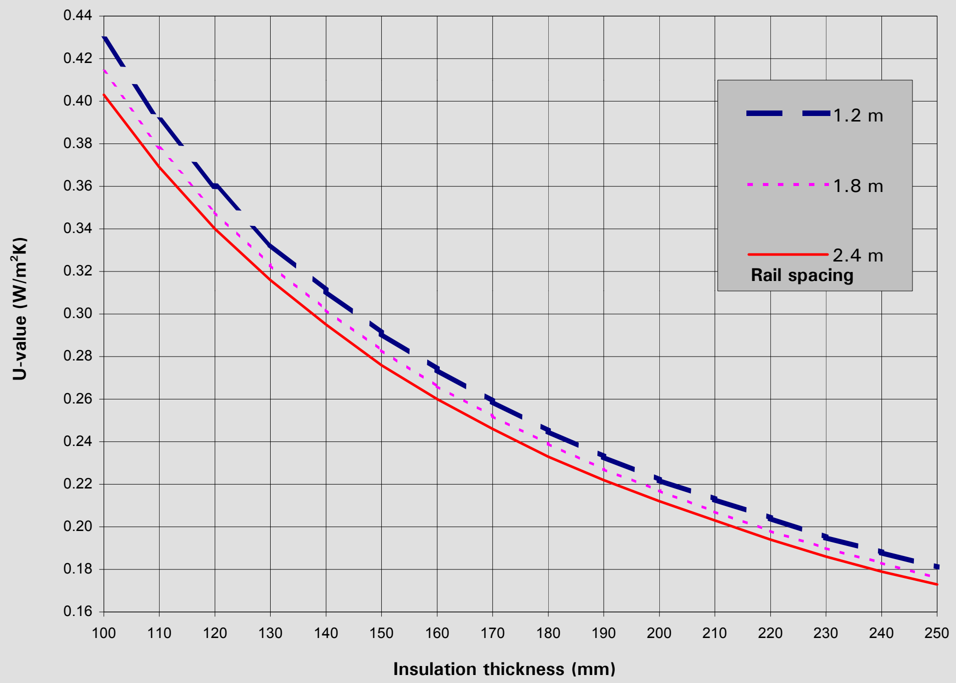

Figure 5 U-values for insulation thermal conductivity l = 0.040 W/mK

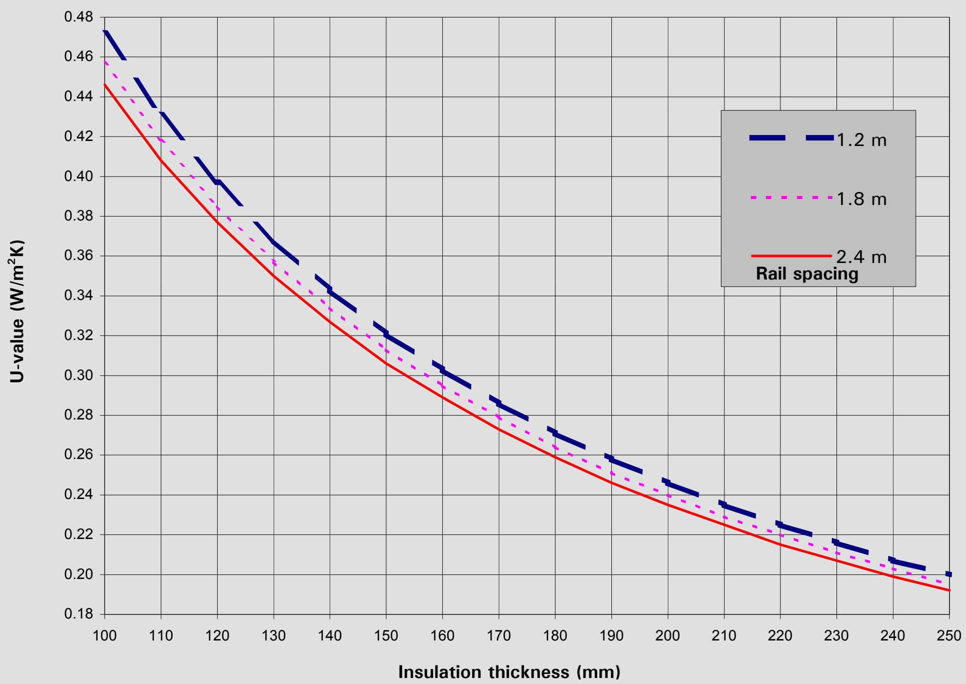

Figure 6 U-values for insulation thermal conductivity l = 0.045 W/mK

Technical Basis

Algorithms for a simplified method of calculating U-values for light steel framing were developed and reported in BRE Digest 465. Further investigations were carried out to assess whether these could also form the basis for U-value calculations for built-up cladding. This is reported in SCI Report RT923.

Twenty-three different constructions were modelled at Oxford Brookes University using the methodology set out in BS EN ISO 10211-1 for numerical modelling techniques. These constructions consisted of variations in the details for built-up metal cladding using bracket and rail fixings. From the overall heat transfer, and the internal and external environmental conditions, the modelled U-value of each construction was determined. The results of the modelling showed that the U-value was sensitive to the ratio R_{min} / R_{max}, with some influence from the rail specification and bracket design.

R_{max} and R_{min}, the upper and lower limits of thermal resistance, were calculated using the method in BS EN ISO 6946, except that the flanges of the steel rails were ignored (so that the rails were represented by their webs only).

Equation 3 in this Information Sheet is based on the equation used for light steel framing. It was found to fit the numerically modelled data for cladding to a good degree of accuracy.

Figure 7 shows the level of agreement that was obtained between the U-values calculated by finite element modelling using BS EN ISO 10211-1 and the method presented in this Information Sheet.

The development of this methodology is reported fully in SCI Report RT923.

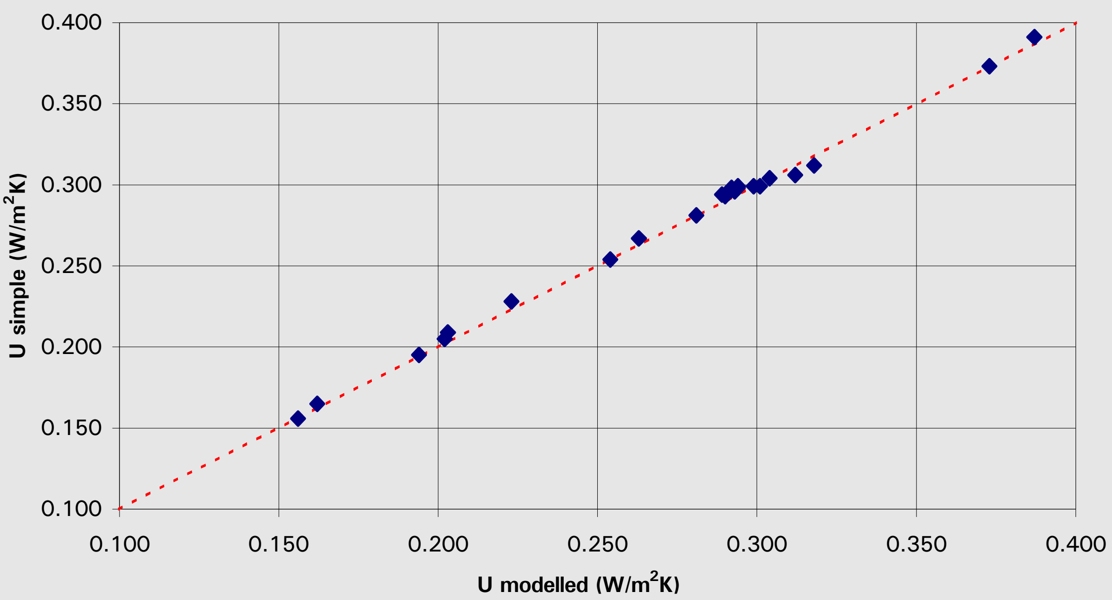

Figure 7 Comparison of modelled and simplified U-values

Relevant publications and reports

Publications

Guidance for the design of metal roofing and cladding to comply with approved document L2:2001 (Technical Paper No. 14)
MCMRA, 2002

WARD, T.
Assessing the effects of thermal bridging at junctions and around openings, (Information Paper IP17/01)
BRE, 2001

WARD, T.
Metal cladding: assessing thermal performance of built-up systems which use "Z" spacers, (Information Paper IP 10/02)
BRE, 2002

ANDERSON, B.
Conventions for U-value calculations, (Report BR 443)
BRE, 2002

DORAN S. and GORGOLEWSKI, M.T.
U-values for light steel frame construction (Digest 465)
BRE 2002

The design of twin skin metal cladding (P311)
SCI, 2002

Reports

Report RT923 U-value calculations for twin skin metal cladding systems using rail and bracket fixings (unpublished report)
SCI, 2002.

Sources of information

The Steel Construction Institute
Silwood Park, Ascot, Berks, SL5 7QN
01344 623345
www.steel-sci.org

Metal Cladding and Roofing Manufacturers Association (MCRMA)
18 Mere Farm Road, Prenton, Wirral,Cheshire, CH43 9TT
Tel 0151 652 3846
Fax 0151 653 4080
www.mcrma.co.uk

National Federation of Roofing Contractors (NFRC)
24 Weymouth Street, London, W1G 7LX
Tel: 020 7436 0387
Fax: 020 7637 5215
www.nfrc.co.uk

Corus Construction Centre
Construction Advisory Service
Tel: 01724 405060
www.corusconstruction.com

Corus Colors
Cladding Advisory Service
Tel 01244 892434
www.colorcoat-online.com

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Web sites:

For information on light steel: www.steel-sci.org/lightsteel

For BRE publications and software: www.brebookshop.com

For 24x7 information on steel construction: www.steelbiz.org

The Steel Construction Institute

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