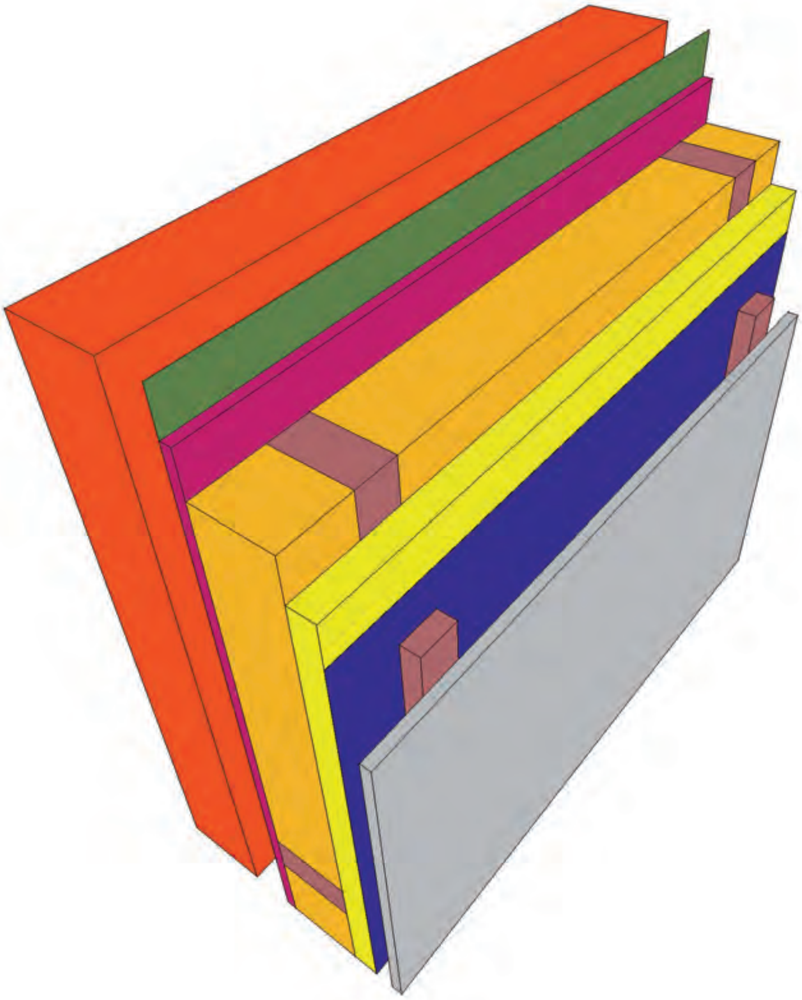
U-VALUE CONVENTIONS IN PRACTICE

Worked examples using BR 443

Sean Doran

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- Aircrete Products Association
- Steel Construction Institute.

1 INTRODUCTION

With the development of energy calculation tools such as the Standard Assessment Procedure (SAP)[1] and the Simplified Building Energy Model (SBEM together with its user interface iSBEM)[2], which support the national building regulations for conservation of fuel and power[3–5], as well as the production of Energy Performance Certificates, there is a need for the industry to calculate U-values and thermal mass values reliably for a range of construction types.

The U-value or thermal transmittance of a building element or component is a measure of its ability to conduct heat from a warmer environment to a cooler environment. It is expressed as:

the quantity of heat (in watts) that will flow through one square metre of area divided by the difference in temperature (in degrees K) between the internal and external environment, and the unit is W/m²K.

For example, if a square metre of area allows 1 watt of heat to pass through it when the difference in temperature is 1 °C, then the U-value of that element is equal to 1 W/m²K.

However, the calculation of a U-value is often complicated by the presence of repeating thermal bridges, which effectively allow some of the heat to bypass the insulation. Among the more common types of repeating thermal bridges are the following:

- timber joists or rafters bridging the insulation in a roof
- mortar joints between lightweight concrete blocks in a wall
- timber studwork bridging insulation in a wall
- steel studs penetrating the insulating layer in a steel-framed construction
- metal spacers or brackets within a non-structural insulated cladding system*
- windposts bridging the thermal insulation in a wall cavity†.

Other factors that can affect the U-value of a construction include:

- air gaps between and around sections of insulation (such air gaps are not normally shown on architectural drawings but can arise from dimensional variations in materials)
- metal fasteners such as wall ties, roof fixings or screws which penetrate all, or a significant part, of the insulation
- embedded light fittings penetrating the insulation above a ceiling
- gaps between sections of external roof insulation through which rain water may percolate layers in an inverted roof.

* This type of thermal bridge is not covered in this report.

† This type of thermal bridge is not covered in this report but the method of treating these is given in BR 443.

Conventions for calculating U-values, taking the above into account, are given in BRE report BR 443[6].

Most wall and roof constructions, as well as most types of floor decks, may be assessed using the method for calculating U-values given in BS EN ISO 6946[7] and CIBSE Guide A3[8]. These documents describe the ‘combined method’ for repeating thermal bridges and give correction procedures for the effects of metal fixings, air gaps, rainwater percolation and unconditioned buffer spaces.

Light steel-frame constructions, where steel framework partly or wholly penetrates the insulating layer, are outside of the scope of BS EN ISO 6946, and for such constructions BRE Digest 465[9] provides a simplified method for calculating U-values. Similarly, a publication by the Steel Construction Institute[10] gives guidance for rail and bracket cladding systems. For some types of construction involving bridging of the insulation by metal, simplified methods cannot be used and it may be necessary to use other approaches, such as finite element thermal modelling calculations using BRE report BR 497[11] and BS EN ISO 10211[12].

Thermal conductivity values for common building materials can be obtained from the CIBSE Guide A3[8] and from BS EN ISO 10456[13]. For specific products, however, data should be obtained from manufacturers’ declared values.

Air spaces

An important aspect of U-value calculations is assessing the effect of air spaces, such as cavities or voids. The effect of air spaces on a U-value depends on:

- the size and shape of the air space
- the emissivity of the surfaces bounding the air space
- the level of ventilation in the air space.

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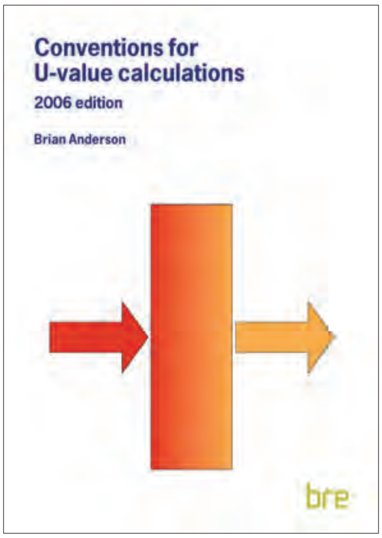
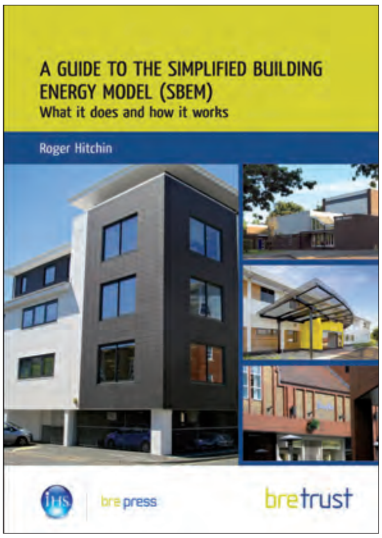


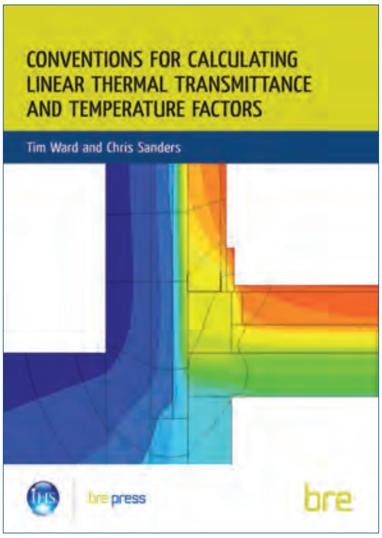
Learn how to calculate U-values for different construction elements: roofs, walls, floors, basements, windows and doors using data relevant to typical UK constructions. Particular guidance is given on thermal conductivity of materials, and on various issues commonly arising when calculating U-values and how they apply to different construction types.

Ref. BR 443, 2006



Understand how SBEM calculates the energy used by buildings and gain a practical insight into the processes and assumptions within the model. This guide for building services engineers and architects describes SBEM in words rather than equations.

Ref. FB 24, 2010



Confirm the adequacy of junction details with this guidance on using numerical modelling to calculate heat loss by thermal bridging. Advice is also given on developing novel solutions to improve the thermal performance of junctions.

Ref. BR 497, 2007

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Ref. SD 4, 2007

Through 17 examples of timber frame wall, roof and floor constructions, learn the principles behind achieving U-values that meet the requirements of building regulations. Align your designs with the regulations simply and effectively.

Ref. SD 2, 2007

Learn a simplified method developed by BRE and SCI for assessing U-values of light steel-frame constructions which has been validated using the procedures in BS EN ISO 10211-1. The method can easily be incorporated into the software tools used by designers for calculation of U-values.

Ref. DG 465, 2002

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This publication will assist designers who need a better understanding of how to calculate U-values and kappa-values for use in calculation tools. It aims to:

- support the implementation of building regulations on conservation of fuel and power and legislation on the energy performance of buildings
- help raise awareness and understanding of U-values (thermal transmittances) and kappa-values (thermal mass values)
- encourage a unified, consistent and up-to-date approach to calculating U-values and kappa-values.

The calculation methods are explained using worked examples for wall, roof and floor designs encompassing the main construction types in BR 443. The examples can be used to support training programmes for practitioners carrying out energy assessments and using U-value calculation software. Information is given about calculating U-values using standard simplified methods.

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