A Short Paper on the Conventions and Standards that govern the understanding of heat loss in traditional buildings.

Heat Loss

Conventions for U-value calculations (BR 443) & RdSAP Appendix S

BR 443 sets out the calculations that should be used for the estimation of heat loss (U-value) in building elements in order to demonstrate compliance with the building regulations for the conservation of fuel and power. Its use is referred to in Approved Document Part L for England and Wales, the Technical Handbooks for Scotland and Technical Booklets for Northern Ireland. It is also the basis for U-value calculating software used throughout the building industry. Where whole building assessments are required BR443 is used as part of SAP or SBEM calculations. The calculation methods are based on International and European Standards published as British Standards, the principle method being ISO EN BS 6946:2007 known as the Combined Method.

U-values are used as the basis of energy performance estimates for individual elements, whole buildings and whole stocks of buildings (through SAP, RdSAP and SBEM calculations). They are also, therefore, the basis for decisions regarding energy saving interventions in buildings.

When, in particular, the solid walls of traditional pre-1919 buildings are measured there is often a significant discrepancy between the measured U-value and the one provided by a calculation following BR 443. The calculated U-value shows a much greater degree of heat loss than that established by a U-value measured in situ.[1] This means that the thermal resistance of the solid wall is underestimated by the standard means of calculation, and because of this estimates of energy savings made via the insulation of these walls may be overestimated. The discrepancy between measured and calculated U-values originates from the rationale that underpins the calculation procedure which assumes that all elements of a wall can be properly defined and given their correct thermal attributes. This is straightforward with a cavity wall where the different leaves are easily identified and the material conductivities of modern building materials well known. However, it is difficult to deduce in an existing stone wall the exact types and quantities of materials, including masonry and voids, involved in its build up, and there is very little thermal conductivity data for historic UK building materials. The U-value calculation procedure as currently configured requires a degree of definition which is inappropriate for existing solid walls. Furthermore, as a steady state method a calculated U-value is also unable to take account of the positive contribution that can be made by thermal mass, a principal characteristic of many of the walls of traditional buildings.

In view of the significance of, in particular, wall U-values for the basis of much retrofit decision-making and the risks raised by the misapprehension of heat loss through pre-1919 solid walls, BR 443 needs to be amended. The Convention should be amended in light of its limitations with regard to the estimation of heat loss for traditionally built solid walls and offer guidance to aid the creation of more representative U-values.

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[1] The comparison of measured and calculated U-values was first carried out in 2010 by Dr Caroline Rye on behalf of the Society for the Protection of Ancient Buildings (SPAB). The findings of a discrepancy between measured and calculated U-values were further confirmed by Dr Paul Baker who had undertaken measurements of solid stone walls in Scotland on behalf of Historic Scotland. English Heritage are due to publish similar findings concerning solid brick walls this Autumn from research again carried out by Dr Baker.

Whilst providing additional information within BR 443 will improve current understanding of heat loss from older walls equally important is the amendment of default U-value tables used in RdSAP calculations for existing buildings (Appendix S). The revision of this document published in April this year has made some improvements in that there is now an imperative to use a measured wall width for the estimation of a U-value, if such data is available. If it is not, however, a formula is provided based on a nominal wall width for pre-1919 buildings. This formula results in U-values of 2.3 W/m2K and 2.0 W/m2k for stone walls (1.9 and 1.6 W/m2K for stone walls in Scotland) and a U-value of 2.1 W/m2k is given for pre-1919 brick walls in both countries. These U-values are higher that averages for similar walls established from measured in situ U-values (Rye finds 1.51 W/m2k to be the average U-value for solid stone walls, Baker finds U-values between 1.1-1.5 W/m2K for solid stone walls in Scotland and an average of 1.4 W/m2k for solid brick walls in England.) The inflation of U-values in RdSAP default tables is similar in its effect to the overestimation of U-values of individual wall elements derived from BR 443.

Consequences:

The overestimation of the U-values of solid walls by BR 443 and RdSAP leads to a misunderstanding of the actual degree of heat loss from these walls, possible inaccuracies in energy and cost saving calculations for retrofit and encourages the deployment of inappropriate solutions to mitigate heat loss. By indicating a high degree of heat loss for a solid wall a calculated U-value may encourage the over insulation of these elements leading, perhaps, to a loss of habitable space but more seriously to an accumulation of moisture in the wall, either via the excessive cooling of masonry or due to the use of high performing vapour closed insulation materials. The incorrect analysis of heat loss in solid wall buildings also potentially distorts policy and funding, and wastes resources that might be deployed elsewhere. It may also bring energy policy into unnecessary conflict with heritage, economic and health priorities. Ultimately it leads to the misapprehension of the energy performance characteristics of a quarter of UK existing building stock.

Conclusion:

The document BR 443 and the default U-values derived from Appendix S of the current RdSAP 2009 version 9.91 require urgent amendment.

References:

Baker, P., 2011; Technical Paper 10 - U-values and Traditional Buildings, Historic Scotland, Edinburgh.

Rye, C., 2010; The SPAB Research Report 1: The U-value Report, the Society for the Protection of Ancient Buildings, London.

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