Technical Update No 9

Specification and verification of thermal performance of curtain walling in accordance with Part L2 of the Building Regulations (England and Wales)

CENTRE FOR WINDOW AND CLADDING TECHNOLOGY

Introduction

The UK Building Regulations changed on 1 April 2002 with the implementation of the new Part L. Approved Documents L1 – Dwellings and L2 – Buildings other than dwellings set tougher standards for thermal performance of buildings and require both better-insulated and more airtight construction. They are also more complicated to interpret due to possible trade offs between different elements of the structure and the efficiency of the heating system. As the requirements become more stringent analysis techniques must become more sophisticated to include all possible heat flow paths. These developments have resulted in some confusion by specifiers and curtain wall providers. This Update attempts to clarify a number of issues that have arisen.

Requirements of Part L

Curtain walling is only covered in Part L2 of the Building Regulations. Where curtain walling is used on dwellings such as apartments then Part L2 may be used. Part L1 is concerned principally with low-rise housing and is not appropriate for larger buildings comprising curtain wall facades and large areas of glazing.

Approved Document L2 offers three methods for demonstrating compliance:

- An elemental method
- A whole building method
- A carbon emissions calculation method

Whichever method is adopted by the building design team for design of the building as a whole, the curtain wall contractor needs to know the required U value for the curtain wall. The elemental method is the simplest method however even when using the elemental method the required U value for a section of curtain walling will depend on factors outside the control of the curtain wall contractor such as U values of other parts of the building envelope, possibly including other types of wall construction.

The specification to the curtain wall contractor should state the required U value. This will depend on the method of assessing building compliance. In the elemental method areas of U-value greater than the standard U-values may be balanced by areas of lower U-value. In the whole building method and carbon emissions calculation method U-values higher than the standard value may be allowable depending on other aspects of the building including type of heating/cooling plant and the effect of solar gain.

In the absence of a specified value, the curtain wall designer could assume that the required U value for the curtain wall is 1.1 W/m^2K. This value is based on the elemental values for windows and walls and a window area of 40% of the façade. This may be increased to 1.2 W/m^2K if the detailed calculation procedure given below is adopted. The derivation of these values and the justification for the increase are given in CWCT Technical Update 5. The specification should not limit the curtain wall contractor by specifying U values for components of the curtain wall such as framing members, infill panels and glazing units.

The required U value relates to the whole thickness of the facade. If the facade consists of a curtain wall with an internal lining, the effect of the lining may be included. This may cause difficulties where the lining is to be provided by a different sub-contractor and the curtain wall contractor does not know the details of the lining. An internal lining will normally reduce heat loss and ignoring its effect may require slightly more insulation in the curtain wall but the complete wall will still meet the required U value. Addition of a dry lining could increase the risk of condensation on parts of the curtain wall. It is therefore important that any condensation risk assessment should include the effect of the lining. If this is not possible because details of the lining are not known, a condensation risk assessment carried out without including the dry lining should be qualified.

Calculation of U values

There are currently no standards applicable to the assessment of thermal performance of curtain walling, although there are European Standards under development. Approved Document L2 refers to the CWCT publication 'Guide to good practice for assessing glazing frame U-values' and 'Guide to good practice for assessing heat transfer and condensation risk for a curtain wall'. These are two of a quartet of documents describing thermal performance of curtain walling. The second edition of these was published in 2002.

The amount of heat flowing through a curtain wall-framing member depends on the design of infill panel or glazing it supports. This is because heat will flow laterally along the surface layer of an insulated panel or glazing unit and through the cold bridge where it meets the framing member. The U value of a curtain wall therefore depends on the properties of the individual components (framing members, glazing units and infill panels), their relative areas in the assembled wall and interactions between the components. It follows that a curtain wall system supplier can only give indicative U-values for a system used with commonly used glazing and infill panels and of typical layout and dimensions. They cannot state that a system meets any particular U value requirement unless the spacing of framing members and types and sizes of infill and glazing units are known.

There are two stages to the calculation of the U value of a curtain wall: calculation of the U values of the components and calculation of the U value of the assembled wall from these component values.

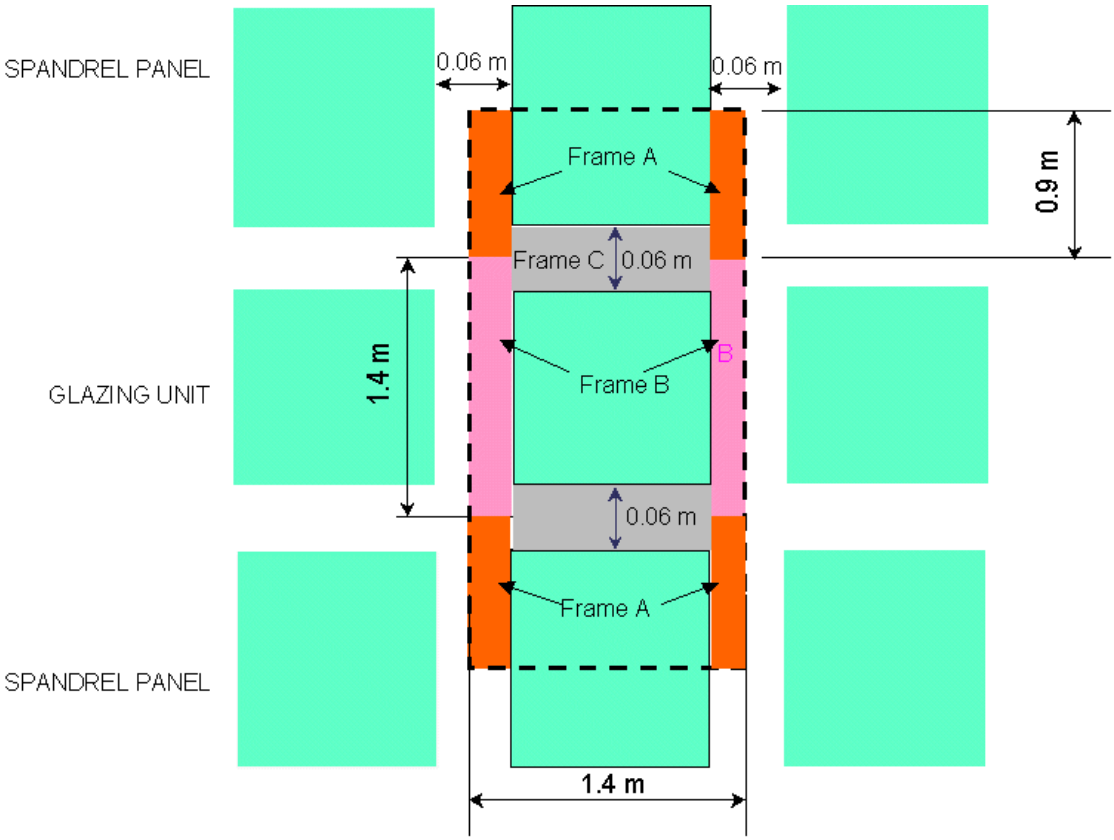
Component U values

The U value of infill panels and glazing units is given as a centre pane/unit value assuming one dimensional heat flow through the unit. The additional heat loss at the edge of the panel due to interaction with the frame (edge effect) may be taken into account by the use of detailed calculation methods as described in the CWCT Standard. This procedure can be used to derive a U value for the framing member that includes the edge effect. The U value of the framing member may be determined by finite element or finite difference techniques and a separate analysis must be done for each combination of framing member and infill. Measurement techniques (eg hot box tests) may be used instead of the calculation methods but these still need to be carried out for the combination of infill and frame.

U values for typical bay

Comparison of systems may be carried out by assessing the U value for a typical bay of curtain wall. The following example shows a section of curtain wall with fixed glazing and opaque spandrel panels. A typical bay may be taken to run from centreline to centreline of adjacent mullions and from centreline to centreline on the opaque panels. The overall U value may be calculated from the overall heat loss divided by the area and the heat loss can be calculated from the U value of each component times its area. It should be noted that when carrying out this calculation the U value for the mullion will be different when there is glazing either side and when there is infill either side. The calculation is shown in the table below.

Standard software is available for use in calculation of glazing frame U values however it needs to be used appropriately. Analysts should be able to demonstrate the validity of their results using benchmark calculations on sections with known properties.



Element	Height (m)	Length (m)	Area (m^2)	Total area (m^2)	U value (W/m^2K)	AxU (W/K)
Glass	1.34	1.34	1.796	1.796	1.4	2.514
Spandrel	0.87	1.34	1.66	2.33	0.288	0.672
Frame A	0.03	0.9	0.027	0.108	5.50	0.594
Frame B	0.03	1.4	0.042	0.084	6.44	0.541
Frame C	0.06	1.34	0.080	0.161	5.79	0.931
Total				4.480		5.252

$$U_{facade} = \frac{\sum A \times U}{\sum A} = \frac{5.252}{4.480} = 1.17\ W/m^2K$$

The U value in this case is less than the required value of 1.2W/m^{2}K. Where the calculated U value is above the required value it could be reduced by using components with lower U values, increasing spacing of framing members or reducing the ratio of glazing to infill panel.

The typical bay of curtain walling used in this case is fairly simple. Opening lights would increase the U value as there is a greater area of frame. If all the fixed lights were replaced with opening lights the calculation would be the same except that the frame U values would have to be changed. If alternate fixed lights were replaced with opening lights it would be necessary to calculate the U value of the curtain wall using a double bay width with one opening light and one fixed light.

Additional considerations

The U value calculated for a typical bay is useful for comparison of systems but for checking specification compliance it is necessary to make allowance for additional sources of heat loss as follows

- Junctions at cill and roof
- Corners and interfaces with other types of façade
- Bays of different size
- Doors

The perimeter of the curtain wall will interface with roof, floor and adjacent wall elements. There will be additional heat loss associated with these interfaces due to additional framing members that are ignored in the typical bay. For example the typical bay assumes that there is a spandrel panel running from window cill of one floor to the window head of the floor below. For the ground floor bay there will be a cill at the bottom of the curtain wall. The additional energy loss associated with cold bridging at the perimeter will depend on the detail adopted and the size of the wall. If the wall is extensive and obvious cold bridges have been avoided the additional energy loss will probably small however for a short length of curtain walling two storeys high the additional heat loss could be 20% or more and should be evaluated.

There will be a further additional heat loss due to interaction between the curtain wall and the adjacent construction. This is likely to be less significant and will be more difficult to calculate as it will require detailed knowledge of the adjacent construction. It is reasonable to ignore this effect but the junction should be detailed to avoid obvious cold bridges.

Summary

The specifier should state the required U value for the curtain wall.

In the absence of a specified U value the curtain wall contractor could assume a value of 1.1W/m^{2}K or 1.2W/m^{2}K if following the procedures given in the CWCT guides. These values are derived from the nominal values given for the elemental method.

The curtain wall contractor should qualify his design by stating the assumed U value requirement.

Thermal performance calculations may include the effect of an internal lining behind the curtain wall. In most cases this can be safely ignored for U value calculations. There will be some conservatism in the resulting design but it simplifies the calculations. Ignoring the effect of an inner wall may invalidate condensation risk assessment calculations.

Calculations produced in support of a curtain wall design should show the U values for the major components of the system and how they have been derived. Evidence of benchmark calculations to validate the calculation procedures should also be available. The specifier should be able to check that the U values for the framing members have been derived for the proposed combination of framing members and glazing/infill panels. System suppliers may calculate U-values for their systems using specific glazing and infill panels on a project-by-project basis. Use of indicative U values produced by the system supplier are not acceptable at this stage.

References

Building Regulations 2000, Approved Document Part L1 (Dwellings), Conservation of fuel and power

Building Regulations 2000, Approved Document Part L2 (Buildings other than dwellings), Conservation of fuel and power

CWCT Technical Update 5 - Building Regulations Approved Document L2 (England and Wales) - showing compliance of curtain walls

CWCT Technical Update 1 - *Dynamic watertightness tests for curtain walling*

CWCT Technical Update 2 - Site testing: method statement for the simplified cabinet test

CWCT Technical Update 3 - Condensation on glazing frames

CWCT Technical Update 4 - Standard & guide to good practice for slope glazing systems

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