Understanding 'k' values (Design Thermal Conductivity) and U-values

The **Code for Sustainable Homes** has outlined requirements for achieving zero carbon homes by 2016. As a consequence the Zero Carbon Hub has set benchmarks for fabric performance and published their recommendations in a document which defines a Fabric Energy Efficiency Standard for Zero Carbon Homes giving indicative U-values for the fabric of the building (as well as air permeability and thermal bridging targets). Currently target U-values for cavity walls are in the region of 0.2 to 0.25 dependent on other variables.
Often Designers are left with the task of selecting materials to meet these targets whilst trying to keep the over-all wall thickness to a minimum so not taking up a larger plot footprint or reducing living space.

In calculating U-values the materials ability to conduct or resist the conductance of heat need to be established and for bricks the density (m^3) and dimensions(mm) are used to calculate its thermal conductivity ('k' value) and resistivity ('r' value). The results are expressed in watts per metre degrees kelvin or Celsius (W/m°K) or (W/m°C)

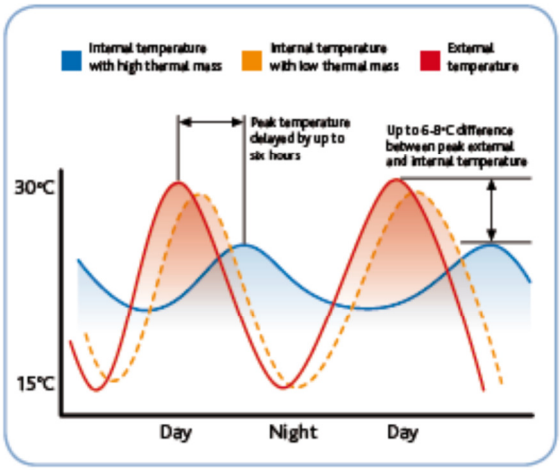
Design thermal conductivity ('k') values for common building materials can be obtained from the CIBSE Guide section A3. The 'k' value is related to the products nett dry bulk density and expected moisture content in service.
(The nett density is calculated by dividing the dry weight of the product by the volume and subtracting the volume of any voids).
Two standard values of moisture content in service are listed in CIBSE, 1% assumes the material will be protected either by being used internally or by other cladding materials, 5% assumes it will be exposed and used externally.

Once the design 'k' value has been ascertained by obtaining the nett density or quoted 'k' value from the manufacturer, the reciprocal 'r' value can be calculated by dividing the thickness of the leaf by the 'k' value. (i.e. Brick with a quoted nett density of 1710kg/m³ expected to be used externally will have a 'k' value of 0.77W/mk. A single leaf of brickwork is normally 102mm therefore 0.102mm ÷ 0.77W/m°K = 'r' value 0.13W/m°K).

With masonry outer leaf construction the density of the product is often taken to be an indicator of how effective the insulative properties will be. Specifiers sometimes mistakenly feel that a relatively lower density masonry product is a better option to achieve a lower U-value.
The density of the masonry outer leaf makes very little difference to the overall U-value of a cavity wall.

To see how little masonry affects the over-all U-value of the fabric, the examples on the following page of facing bricks at extreme ends of the range of densities currently available illustrate their effect on the U-value calculations when used with a popular brand of cavity fill insulation. Stock bricks with a net density typically 1400kg/m3 and Engineering grade typically 2000kg/m3 are compared to illustrate that both are equally effective as a wall cladding.

Furthermore the thermal mass achieved from using brick helps regulate temperature within the home. Fluctuations in external temperature are evened out effectively when dense materials such as brick are used to clad a building. The diagram shows the peaks and troughs of daily temperature, the external and internal temperatures are similar when low density materials have been used and are much more evenly distributed when high density material has been utilised combatting the need for mechanical means of conditioning air.



U-value calculations using bricks of different density.

Brick nett density ***1400kg/m^3***

	Thickness mm	Converted to metres	'k' value	resistivity	'r' value
Outer surface – from CIBSE	-	-	-	-	0.020
Outer leaf – assume brick density of 1400kg/m3	**102**	**0.102**	**0.60**		**0.169**
Cavity	5	0.005	-	-	0.109
Insulation material	95	0.095	0.021		4.520
Inner leaf – aerated block density 600kg/m3	100	0.100	0.19		0.526
Plasterboard – from CIBSE	13	0.013	0.16		0.080
Inner surface – from CIBSE	-	-	-	-	0.130
				total	5.554
				÷ 1	0.180
				U-value	**0.18**

. *Brick nett density* ***2000kg/m^3***

	Thickness mm	Converted to metres	'k' value	resistivity	'r' value
Outer surface – from CIBSE	-	-	-	-	0.020
Outer leaf – assume brick density of 2000kg/m3	**102**	**0.102**	**0.96**		**0.106**
Cavity	5	0.005	-	-	0.109
Insulation material	95	0.095	0.021		4.520
Inner leaf – aerated block density 600kg/m3	100	0.100	0.19		0.526
Plasterboard – from CIBSE	13	0.013	0.16		0.080
Inner surface – from CIBSE	-	-	-	-	0.130
				total	5.491
				÷ 1	0.182
				U-value	**0.18**

For further information or advice regarding this topic please contact Ibstock's Design & Technical Helpline on 0844 800 4576 or email technical@ibstock.co.uk