U VALUE TABLE

SIP BUILDING SYSTEMS

Construction	100mm SIP	125mm SIP	150mm SIP	175mm SIP	200mm SIP	225mm SIP	250mm SIP
Blank SIP	0.35	0.26	0.21	0.17	0.15	0.13	0.12
Build-up (1)	0.3*	0.24	0.19	0.16	0.14	0.13	0.11
Build-up (2)	0.30	0.23	0.19	0.16	0.14	0.12	0.11
Build-up (3)	0.26	0.21	0.17	0.15	0.13	0.12	0.11
Build-up (4)	0.25	0.20	0.17	0.15	0.13	0.12	0.11
Build-up (5)	0.26	0.21	0.17	0.15	0.13	0.12	0.11
Build-up (6)	0.25	0.20	0.17	0.15	0.13	0.12	0.11
Build-up (7)	0.23	0.19	0.16	0.14	0.12	0.11	0.10
Build-up (8)	0.22	0.18	0.15	0.14	0.12	0.11	0.10

Note: The above figures exclude thermal bridging from edge timbers and connections.

(1) - 103mm outer brick, 50mm cavity, breather membrane, SBS SIP, 12.5mm Plasterboard - FR30

(2) - 103mm outer brick, 50mm cavity, breather membrane, SBS SIP, 19mm Plasterboard, 12.5mm Plasterboard - FR60

(3) - 103mm outer brick, 50mm cavity (low emissivity), TF200 thermo breather membrane, SBS SIP, 12.5mm Plasterboard - FR30

(4) - 103mm outer brick, 50mm cavity (low emissivity), TF200 thermo breather membrane, SBS SIP, 19mm Plasterboard, 12.5mm Plasterboard - FR60

(5) - 103mm outer brick, 50mm cavity, breather membrane, SBS SIP, Foil VCL, 25mm Service cavity** (low emissivity), 12.5mm Plasterboard - FR30

(5) - 103mm outer brick, 50mm cavity, breather membrane, SBS SIP, Foil VCL, 25mm Service cavity** (low emissivity), 19mm Plasterboard, 12.5mm Plasterboard - FR60

(7) - 103mm outer brick, 50mm cavity (low emissivity), TF200 thermo breather membrane, SBS SIP, Foil VCL, 25mm Service Cavity** (low emissivity), 12.5mm Plasterboard - FR30

(8) - 103mm outer brick, 50mm cavity (low-E), TF200 thermo breather membrane, SBS SIP, Foil VCL, 25mm Service Cavity** (low-E), 19mm plasterboard, 12.5mm Plasterboard - FR60

*to achieve 0.3 with 100mm panel and build-up 1, use 15mm plasterboard in leiu of 12.5mm

**Service cavity includes 12% Timber fraction for Plasterboard Battens

REV 1 - 12.12.11/TB004

UKSIPS

4 Technical Bulletin
Thermal

This Technical Bulletin has been commissioned by the UK SIP Association in conjunction with TRADA Technology and is intended to provide the reader with introductory information on using **structural insulated panels** for construction.

Structural insulated panels (SIPs) are prefabricated, high performance, lightweight, building panels that can be used in floors, walls and roofs for residential and commercial buildings. A SIP consists of two high density facings, typically Orientated Strand Board (OSB) which are bonded on both sides of a low density, cellular foam core.

The panels are typically made by sandwiching a core of rigid foam plastic insulation which is bonded to the two structural skins. A strong, structural bond between the three layers is essential to the load bearing ability of the SIP so that high loads can be transmitted by the relatively light units reducing the use of internal studding. SIP walls can bear considerable vertical and horizontal loads with reduced internal studding. The load carried by the SIP is transferred to ground by the OSB skins, held in position by the fully bonded insulation core.

In the UK structural insulated panels are available with a number of different insulation cores; expanded polystyrene (EPS), extruded polystyrene (XPS), polyisocyanate (PIR) and polyurethane (PUR). In all cases the skins are typically OSB although there is increasing research into other forms of load bearing materials.

SIPs are manufactured under closely controlled factory conditions and can be custom designed for each application. The result is a building system that is extremely strong, energy efficient and cost effective. Strict quality control procedures are implemented in the manufacture of SIPs to ensure quality and consistency of panels.

In terms of strength and resistance to fire there is little difference between the different core materials. Both forms of manufacture will comply with the Building Regulations and all Manufacturers in the UKSIPS Association are third party accredited.

In all cases it is the insulation core that provides excellent thermal properties due to the limited amount of timber studs required. Equally air permeability due to the large format nature of the supplied panels is much lower than traditional construction due to the small number of joints in the structure.

There are two fundamental applications for SIPs; full structural and infill for a concrete, steel or engineered timber frame. In all cases the product will be engineered for load bearing capability, racking resistance and wind loading in accordance with the test results obtained by UK SIPs members

For more information please visit www.uksips.org or scan the QR code

Written by

TRADA TECHNOLOGY

‘Fabric First’ is a popular ethos that has grown from the German Passivhaus standard. This is where energy efficient buildings are created by focusing on the performance of the external envelope of the building, before looking to renewable energy sources or ‘bolt on’ technologies.

With the fabric first approach, elemental U-Values and heat loss are driven down to very low levels, so the building consumes a minimal amount of energy staying warm or cool. With SIP structures, because part of the structure of the building is insulation, excellent U-Values can be achieved for a minimal wall thickness.

Energy efficiency of buildings is generally broken down into three key areas of performance:

- U-Values of building elements
- Ψ-Values (thermal bridging) of element junctions
- Air permeability of the building envelope

U-Values of building elements deal with the heat loss through the walls, floors, roof, windows and external doors.

Ψ-Values (thermal bridging) of element junctions deal with the additional heat loss at junctions in elements, e.g. wall/foundation junction, or at corners.

Air permeability of the building envelope deals with the additional heat loss through unplanned air infiltration e.g. around windows or external doors, or air infiltration at service penetrations.

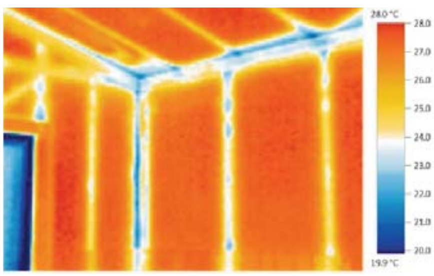
In order to achieve an energy efficient building, each of these areas of heat loss needs to be addressed. It is worth noting, at this point, that with each of these measures of performance the smaller the number the better the building is performing.

The energy efficiency of a building is calculated in SAP. This is the Government's ‘Standard Assessment Procedure’ for Energy Rating of Dwellings and is used to calculate the heat loss and carbon emissions from dwellings.

U-Values

A U-Value is the amount of heat energy in Watts that can pass through a square metre of element per degree Kelvin of temperature difference (W/m^2K).

Building Regulations specify minimum U-Value performance criteria for building elements. In reality the performance required for walls, floors and roofs is normally much better. As already discussed, SIP external walls can achieve good U-Values for a given wall thickness because the insulation is part of the structure.



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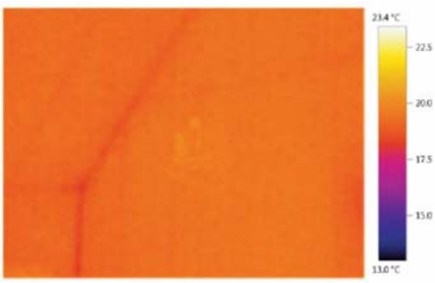


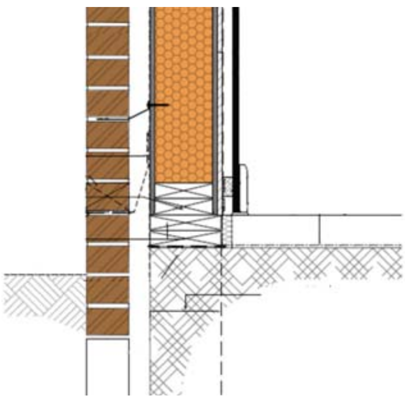
SIP

Walls

SIP wall panels can be of any thickness, although most manufacturers will make panels between 100 mm and 250 mm thick. Most new build developments will have external wall U-Value targets of between 0.1 W/m^{2}K and 0.2 W/m^{2}K, which SIPs can easily achieve.

External walls will generally consist of the following layers:

- External cladding
- Drained and ventilated cavity
- Breather membrane
- SIP of the required thickness
- Vapour control layer (if required)
- Battens forming a service void (this void may contain additional insulation)
- Internal linings



The SIP itself provides the greatest contribution to the overall U-Value of the external wall. In most instances U-Value targets will dictate the overall thickness of the SIP, rather than structural or any other requirement. Reflective breather membranes and vapour control layers can also provide a worthwhile contribution to the overall U-Value of the external wall. Reflective membranes, coupled with an adjoining air gap create a low emissivity void can enhance U-Values by as much as 0.02 W/m^{2}K.

The SIP manufacturer should be able to conduct U-Value calculations based on their system and client specifications.

If U-Values better than those achievable with the SIP alone are required, additional insulation could be installed to the inside or outside of the SIP. The thickness and type of insulation would need to be considered, and condensation risk calculations conducted. A drained and vented cavity should be maintained behind the external cladding.

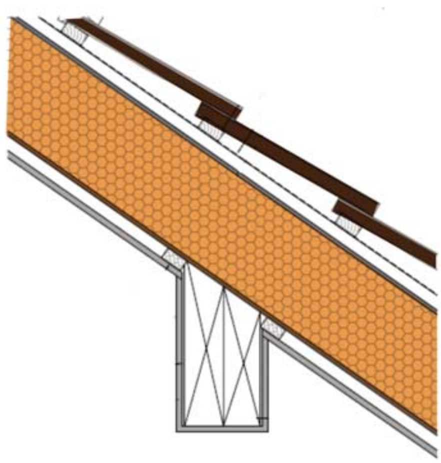
Roofs

Both pitched and flat roofs can be formed using SIPs. These roofs are classified as ‘cold’ roofs, i.e. the structure of the roof passes though the insulation and is subject to a temperature gradient. SIP roofs, whether pitched or flat, will require a ventilation void between the SIP and the roof covering.

SIP roof panels can be of any thickness, although most manufacturers will make panels between 100mm and 250mm thick. Most new build developments will have roof U-Value targets of between 0.1 W/m^{2}K and 0.15 W/m^{2}K which SIPs can easily achieve.

Pitched SIP roofs will generally consist of the following layers:

- Tiles or slates
- Tiling battens
- Counter battens (providing a path for ventilation and water runoff)
- Breathable roofing membrane
- SIP of the required thickness
- Vapour control layer (if required)
- Battens forming a service void
- Internal lining



Flat SIP roofs will generally consist of the following layers:

- Waterproof roofing membrane
- Plywood or similar roof decking
- Furrings to form a runoff and create a ventilation void
- Breathable roofing membrane
- SIP of the required thickness
- Vapour control layer (if required)
- Battens forming a service void
- Internal lining

National regulations and British Standards should be consulted for the size of the ventilation voids required in flat and pitched roofs. These regulations and standards also may pose limits on the size/spans of flat roofs for ventilation requirements.

The SIP manufacturer should be able to conduct U-Value calculations based on their system and client specifications.

As with walls, if U-Values better than those achievable with the SIP alone are required, additional insulation could be installed to the inside or outside of the SIP. The thickness and type of insulation would need to be considered, and condensation risk calculations conducted.

Thermal Bridging & Ψ-Values

Thermal bridging occurs in all construction types and is caused by areas of reduced insulation or where an element passes though the insulation. Timber has a lower thermal resistance than the insulation materials placed between the framing members. Therefore greater heat flow occurs through studs, plates, rails and joists than in other areas of the external wall or roof structures. This increase in thermal conductivity is referred to as thermal bridging. In general, thermal bridges can occur at any junction between building elements or where the building structure changes. There are two categories of thermal bridges:

Repeating thermal bridges
The additional heat flow resulting from repeating thermal bridges is included in the calculation of a particular building element U-value that contains these thermal bridges, such as studs in timber frame walls.

SIP walls and roofs contain solid timber around window and door openings, and may contain solid timber at panel junctions. The proportion of solid timber within a SIP element will be entirely dependent on the building type and size and should be considered on a site by site basis, but the timber content can be as low as 4%, verses an average of 15% for timber framed buildings.

Non-repeating thermal bridges
The additional heat flow resulting from this type of thermal bridge is determined separately, either by the numerical calculation method given in BS EN ISO 10211-1 or by computer modelling using finite element modelling software and is known as a Ψ-Value.

Recent changes to Building Regulations now require that non-repeating thermal bridging is considered when calculating the energy consumption and CO^2 emissions from buildings. Ψ-Values are specific to each building system, as well as each individual building, and so would generally be calculated on a project specific basis.

Air Tightness

Another major aspect of energy efficiency is air tightness. Building Regulations require that un-planned air leakage into, or out of, the building is controlled. Air tightness tests are normally carried out once the building is almost complete, and targets for air tightness are normally set based on the SAP calculations.

SIP buildings are able to provide very good levels of air tightness due to the panelised construction methodology. A SIP building would normally incorporate a vapour control layer onto the warm (inner) side of the external walls. This primarily controls the movement of moisture vapour through the wall, as well as being an effective air barrier.

The vapour control layer/air barrier can be lapped and sealed at wall junctions, as well as lapped and sealed at the junctions with other external elements. As with all construction methods, particular attention should be paid to sealing of windows and doors, as well as service penetrations of the building envelope.

With SIPs it is also normal practise to seal the splines at panel junctions with either mastic or expanding foam products. This, coupled with the vcl/air barrier, is key to the excellent air tightness achievable from SIPs.

It is important to understand that buildings with very low building fabric air leakage rates will require additional ventilation measures. Typically these will take the form of Mechanical Ventilation Heat Recovery (MVHR) units. MVHR units mechanically control the movement of air into and out of a building whilst recovering latent heat in the exhaust air.