STA Advice notes

Structural timber solutions: Thermal performance

STRUCTURAL TIMBER ASSOCIATION
Building solutions in timber

No. 6 - December 2014

Part 1 - Fabric first approach to thermal performance

This advice note covers the structural timber fabric first approach to delivering high performance thermal insulated homes. The guidance is divided into 3 parts:

- Part 1 - Fabric first approach to thermal performance
- Part 2 - Information for house builders addressing Part L 2013 updates for new dwellings
- Part 3 - Closing the performance gap in design to as built (document in development)

This is PART 1 which provides an introduction to structural timber frame techniques to deliver energy efficient homes.

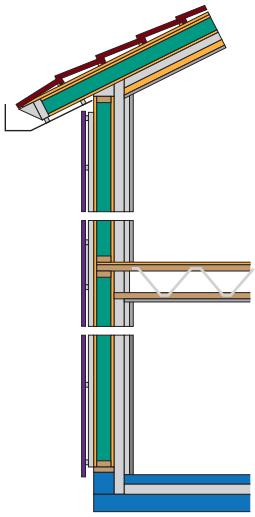
Structural timber solutions for fabric performance

The thermal performance of a structural timber solution addresses airtightness, U-values and thermal bridging. Some members provide windows as part of the package and this is added to the combination of solutions.

The Building Regulations allow freedom to change components in the assessment, provided that the specification meets all other provisions within the appropriate Building Regulation Approved Document, in particular the limiting fabric parameters. These limiting fabric parameters are easily exceeded by structural timber solutions.

STRUCTURAL TIMBER ASSOCIATION
Building solutions in timber

Figure 1 Structural timber frame delivers energy efficient solutions



Design and build structural timber frame offers

- Low embodied carbon
- Choice of insulation performance
- Airtight construction; proven products and details
- Calculated thermal bridging psi-values
- Manufactured off-site in a quality controlled environment, quick to construct on-site with minimal waste
- Solutions without renewables
- Supply chain choice

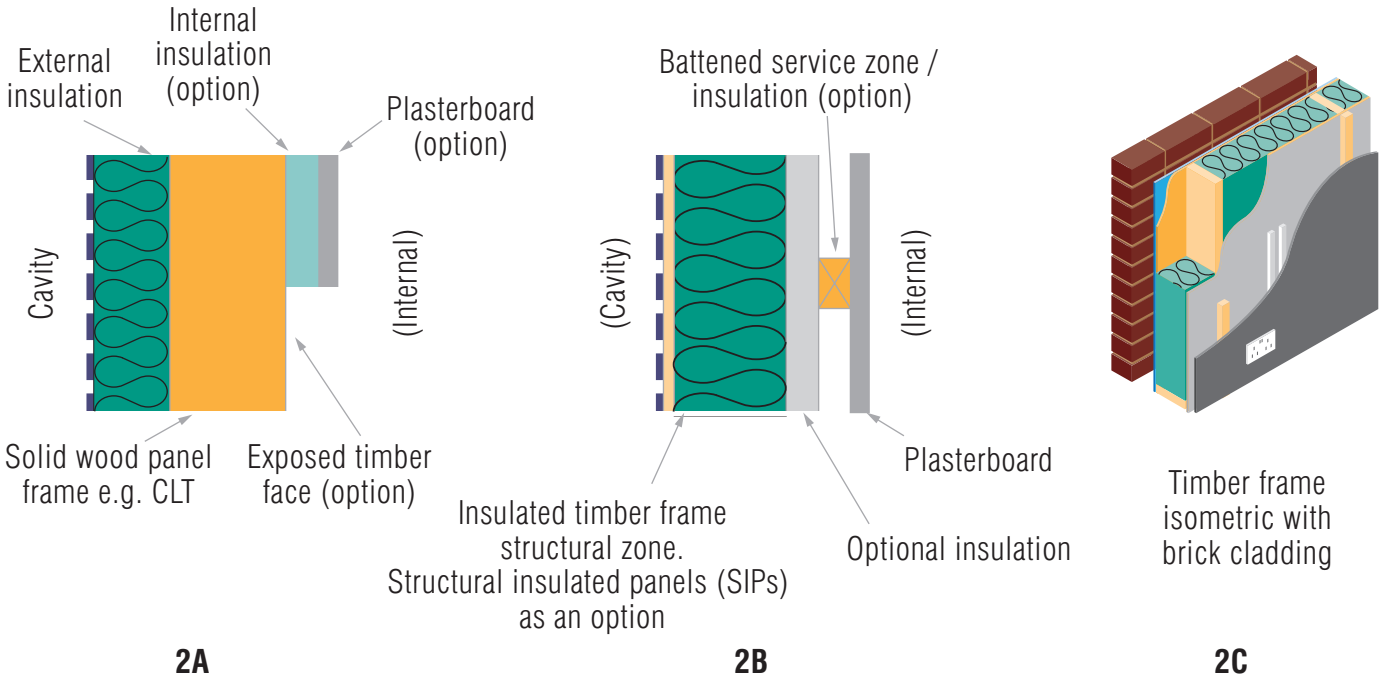


Figure 2 The wall fabric and construction details influence the energy efficiency of the building. Concept ideas shown only.

STRUCTURAL TIMBER ASSOCIATION
Building solutions in timber

Resistance to heat loss through the building envelope

Energy efficiency through the building envelope walls requires the following components to be considered:

Element heat loss resistance

Heat loss through the wall, floor or roof element; thermal transmittance of an element is commonly referred to as a "U-value". This is a through the wall / floor and roof thermal calculation that provides an indication of the resistance to heat loss. U-values are only relevant for whole element assemblies and changing one component in an envelope make up can make differences in the final U-value. The U-value can be specifically tested but to accommodate the large amount of variable options it is common practice for U-values to be calculated using bespoke software packages. The calculations for U-values require a number of inputs including each material's thermal conductivity, called Lambda value. The Lambda value being the rate at which heat is transmitted through a material type.

The lower the value, the better the thermal efficiency of the material

The U-value is not the same as the energy efficiency of the building envelope, which includes other factors as noted below.

Heat loss at junctions

At any junction of a wall to wall, wall to floor, wall to foundation etc. there will be an area of reduced insulation within the construction - a window, roof window or external door. The heat loss may be due to air gaps, thermal bypass or thermal bridging. Thermal bridging is commonly calculated based on specific assemblies and specific junctions and referred to as the .psi (Ψ) value of the construction detail, in W/mK. Air leakage and thermal bypass are tested and cannot be calculated.

Heat loss through openings such as windows and doors. This is the performance of the window and door assembly given as U-values. Door and window frames, or any other form of intrusion into the building envelope, has to be considered for air tightness and thermal bridging.

For the structural timber building system designer, the design of the walls, floors and roofs requires careful consideration of the amount of thermal bridging and lack of insulation being installed due to structural elements.

Fabric energy efficiency for homes

Part 2 of this advice note provides an introduction into the thermal regulations for England, Part L 2014 edition, which introduces the concept of fabric energy efficiency.

Passivhaus

The Passivhaus standard is a high level thermally efficient building approach that considers all aspects of the home and requires very high levels of quality control to achieve very low air leakage, low U-values and absolute minimal thermal bridging. The Passivhaus standard has higher limits on thermal performance than current building regulations. The design solutions include orientation of the building, shading and solar gain issues that can influence the thermal performance of a home.

Structural timber building systems are commonly used as the method of choice to deliver a Passivhaus, but the details are outside the scope of this advice note and consultation with specialist guidance is needed to understand the demanding requirements of the design of a Passivhaus.

Code for Sustainable Homes

The Code for Sustainable Homes is a standard for new dwellings that sets levels of performance for a range of environmental impacts. For privately developed homes the Code is not a legal requirement, but can be used as part of a wider strategic offer by developers. The Code for Sustainable Homes deals with more than energy use and carbon dioxide emissions. Detailed summaries of the Code is outside the scope of this advice note and reference to specialist documents is needed to obtain full understanding of the code.

STRUCTURAL TIMBER ASSOCIATION
Building solutions in timber

Allowable solutions

The term 'allowable solutions' has been used to cover Government drives to deliver the current overall zero carbon target objectives for new building projects. The concept of a provision of allowable solutions is being consulted and investigated as a means to include options for alternative carbon emission schemes outside the homes being built.. There are no published outputs for this as yet.

Team work and communication

The research findings from the Zero Carbon Hub have demonstrated that the current average new build (masonry and frame systems) has significantly lower in-service thermal performance than was initially considered in the design of the home. Zero Carbon Hub's work can be summarised as a damming claim that current house building, while having Building Regulation thermal compliance at the design stage, it is not compliant by the time the home is handed over to the occupant; Zero Carbon Hub call this the performance gap. The STA have been involved in the research and can state that structural timber solutions can deliver design-to-completion thermal compliant and better homes, providing that joined up solutions are included throughout the design and construction process. Part 3 of this advice note provides advice on closing the performance gap to address Zero Carbon Homes concerns.

The key details and communications for the project team are:

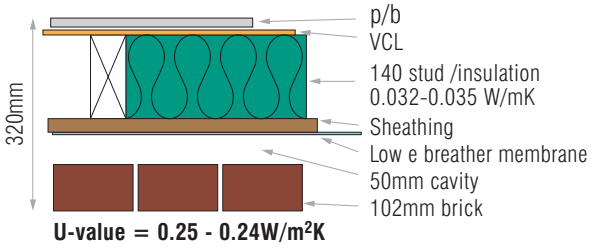
- Continuity of insulation to the entire envelope, which should be included as the standard product delivery for the structural timber frame solution.
- Communication to the construction team via drawings, product specifications and site briefings for all junctions where the structural timber building solutions has a junction with trades outside the product delivered e.g. ground floor slab support junction.
- All parties should appreciate that they cannot make changes to the design or product selection without consideration of the thermal impacts of the changes.
- Simple designs are more likely to be designed and built correctly.
- Minimise the number of different types of construction within the thermal envelope, as problems are most likely to occur where one type of construction meets another. Consider the construction sequence of each detail, and be prepared to modify details if it becomes apparent that they are difficult to achieve, or if the construction team identifies a better method.
- Position windows and door frames to overlap the insulation plane. At openings the insulation layer should be continued to the rear of the window and doorframe. Rebating the frame within the full thickness of the insulation layer will help to reduce the thermal bridge further.
- Overlap insulating layers to reduce the bridging paths. Some construction details include areas that interrupt the insulation layer. These are often at structural junctions. Although these thermal bridges cannot be completely removed, they can be reduced by overlapping the insulating layers of the main elements, even though these will not necessarily in direct contact.

STRUCTURAL TIMBER ASSOCIATION
Building solutions in timber

Concept U-values for structural timber stud work frames

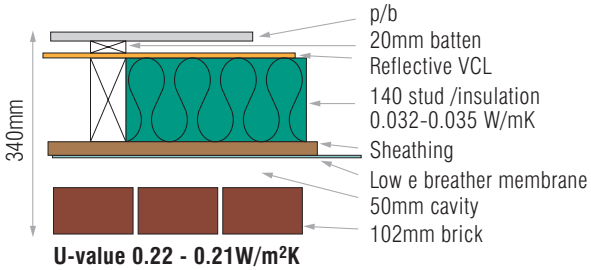
A significant number of thermal performance solutions are available to a developer - too many to provide all the information here. To support the house building industry, the concept U-value frame assemblies in this document can be used as a starting point. However, most STA members have the expertise to provide their own fabric performance data - matched to your requirements - presenting options for enhanced fabric designs. ***For all assemblies please refer to notes 1-6 on the following page.***

A



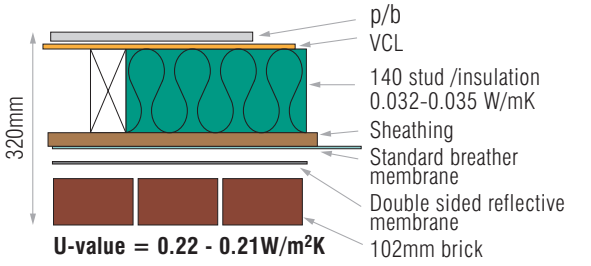
U-value = 0.25 - 0.24W/m²K

B



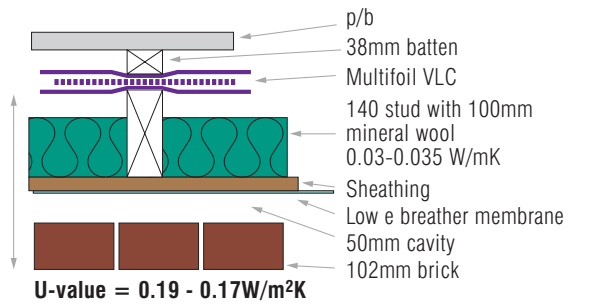
U-value 0.22 - 0.21W/m²K

C



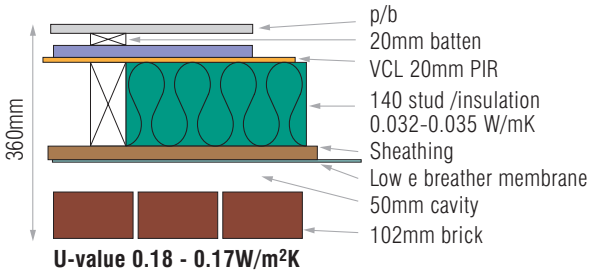
U-value = 0.22 - 0.21W/m²K

D



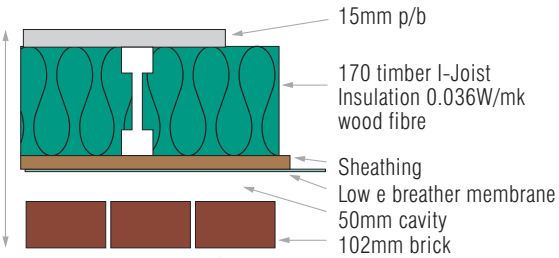
U-value = 0.19 - 0.17W/m²K

E



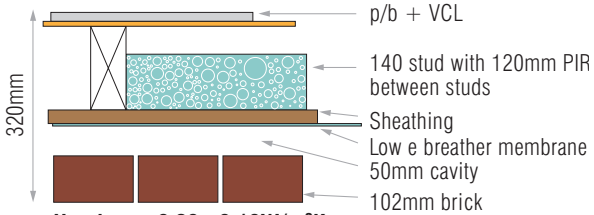
U-value 0.18 - 0.17W/m²K

F



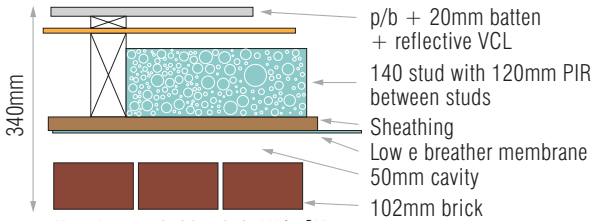
U-value = 0.18W/m²K

G



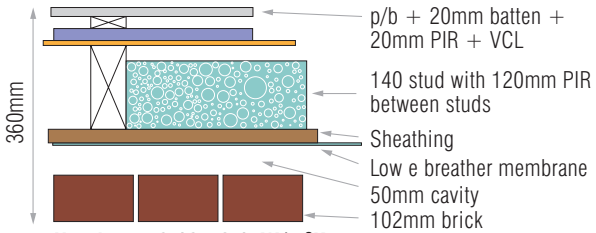
U-value = 0.20 - 0.19W/m²K

H



U-value = 0.18 - 0.17W/m²K

I



U-value = 0.16 - 0.15W/m²K

Figure 3 Concept U-values for standard structural timber wall build-ups (A-I)

STRUCTURAL TIMBER ASSOCIATION
Building solutions in timber

Concept U-values for SIPS and solid wood panel elements

For all assemblies please refer to notes 1-8 below.

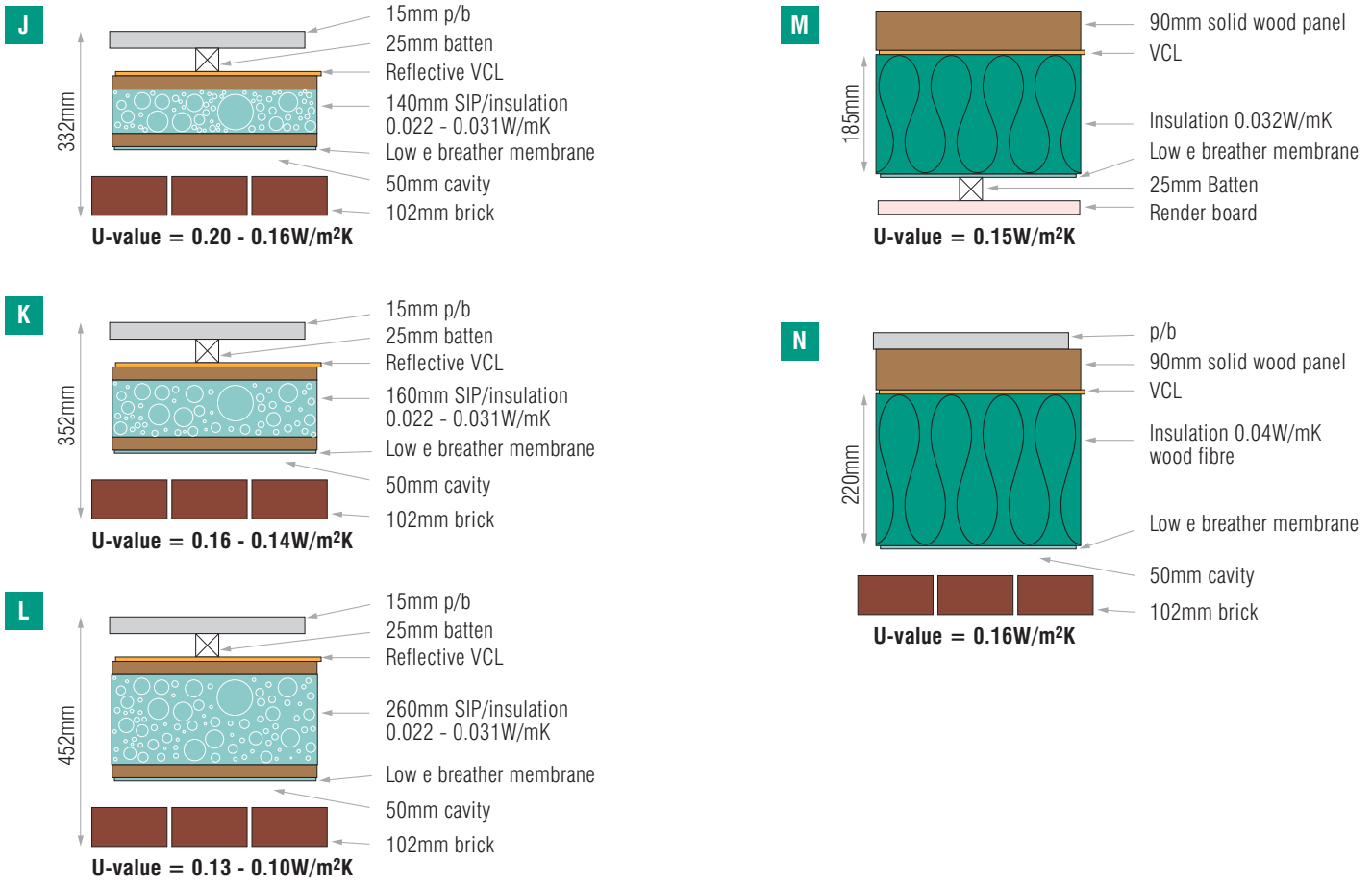


Figure 4 Concept U-values for SIPS (J, K & L) and solid wood panels e.g. CLT (M & N)

NOTE 1: *Limiting fabric standards for each country to be considered for regulation compliance*

NOTE 2: *The calculation for U-values requires inputs for all the materials in the wall make up. Where proprietary materials are adopted in the wall build up, declared thermal performance inputs from the manufacturers of the materials should be audited by competent third party approval bodies or default BR443 values adopted.*

Reference to BS EN ISO 6946 is to be undertaken for clarity on the ventilated cavity condition relevant to the design and U-value calculation inputs.

NOTE 3: *U-value calculations can vary for all types of assemblies and small variances can occur from different assumptions used in the mathematical model. It is for that reason that competent assessor should be employed to determine the U-value of an assembly, using accredited material data and include for the junctions to be modelled for thermal bridging.*

NOTE 4: *Timber fraction; BR 443 advises 15% value is appropriate without robust evidence can demonstrate a reduction in this value.*

NOTE 5: *Where low emissivity membranes are not used the values will be higher.*

NOTE 6: *The values shown for the assemblies do not make allowances for slightly vented air spaces. See BS EN ISO 6946.*

Notes applicable to SIPS and solid wood elements only:

NOTE 7: *The variances in SIP insulation types and depths results in a wide range of U-values.*

NOTE 8: *CLT can be used with other cladding and insulation materials to provide different wall thicknesses and U-values.*

STRUCTURAL TIMBER ASSOCIATION
Building solutions in timber

Useful references

BR443

Conventions for U-value calculations BRE Report BR 443: BRE 2006. Click here to download.

link - www.bre.co.uk/filelibrary/pdf/rpts/BR_443_(2006_Edition).pdf

BS EN ISO 6946:2007

Building components and building elements. Calculation method for thermal resistance and thermal transmittance.

BS ISO 10456:2007

Building materials and products, hygrothermal properties, tabulated design values and procedures for determining declared and design thermal values.

CIBSE Guide A 2006, Section 3.3.11

Doran SM, and Kosmina L, 'Examples of U-value calculations using BS EN ISO 6946:1997' December 1999. Click here to download

link - www.communities.gov.uk/documents/planningandbuilding/pdf/133394.pdf

Structural Timber Association
The e-Centre
Cooperage Way
Alloa
FK10 3LP

t: 01259 272140
f: 01259 272141
e: office@structuraltimber.co.uk
w: www.structuraltimber.co.uk

STRUCTURAL TIMBER ASSOCIATION
Building solutions in timber