

Technical Information Sheet ED019

Thermal Performance of Light Steel Construction

The thermal performance of buildings is important in order to satisfy the Building Regulations, and the Code for Sustainable Homes in the residential sector. It is also important in order to achieve high BREEAM ratings in the commercial, educational and other sectors. Light steel and modular construction can easily satisfy the high levels of thermal performance that are required in buildings.

Key benefits

The benefits of light steel framing and modular construction in housing in terms of thermal performance are:

- U-values of less than $0.15 \text{ W/m}^2\text{K}$ can be achieved cost effectively by lightweight construction without leading to excessively thick walls.
- High levels of airtightness (less than $3 \text{ m}^3/\text{m}^2/\text{h}$) can be achieved by use of sheathing boards and membranes that are provided in the light steel framing and modular systems.
- Extensive thermal analysis of construction details has led to predictive γ values of less than $0.08 \text{ W/m}^2\text{K}$ in whole building energy models.
- High levels of insulation and low thermal mass do not lead to excessive over-heating (as heat is not stored over successive hot days).
- Thermal isolating details have been developed for balcony attachments to reduce thermal bridging.
- Lightweight systems do not suffer from over-heating in the summer and they are more responsive than heavyweight systems.
- The off-site nature of modular construction means that higher levels of air-tightness and greater reliability of the building fabric are achieved.
- Renewable energy technologies may be built-in or attached to improve the energy balance of the building and zero energy design can be achieved.

Applications

In housing and residential buildings, light steel framing comprises pre-fabricated wall panels, floor joists and roof trusses. Modular construction uses assemblies of volumetric units that are finished in factory conditions.

Energy use targets for housing and residential buildings are presented by the Zero Carbon Hub (ZCH). The main requirement is to improve the energy efficiency of the building fabric before considering use of renewable energy technologies. The performance targets required by the Building Regulations (2013) based on former guidance by the ZCH is:

- Apartments/Mid Terrace 36 kWh/yr/m^2
- Semi & Detached Houses 45 kWh/yr/m^2

Similar requirements exist for schools and public sector buildings and so the guidance on thermal performance in this Technical Information Sheet is relevant to all sectors.

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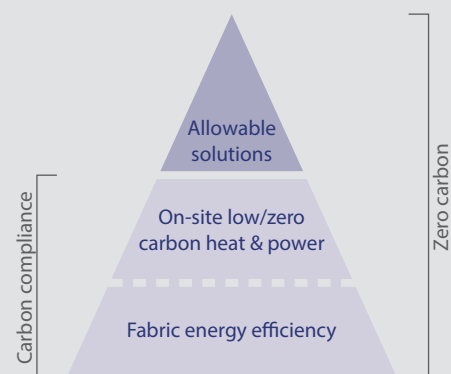
Light steel key worker accommodation in London

(Image courtesy of Fusion Building Systems)



Code Level 5 modular house in London

(Image courtesy of Futureform and Ayrshire Framing Systems)



Energy efficiency compliance methods

(Image courtesy of Zero Carbon Hub)

Thermal Performance

Technical details

Light steel framing is typically manufactured from a series of panels, including the floor cassettes as shown in Figure 1. The walls transfer vertical loads and provide stability to the building. The light steel walls typically use 70 to 100 mm deep C sections in various steel thicknesses. Figure 2 shows typical light steel residential construction.

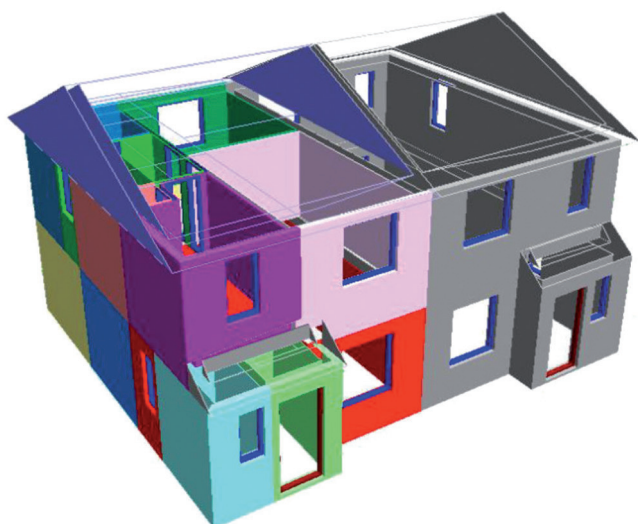


Figure 1 Light steel panel system for housing

Thermal insulation is characterised by the heat loss per unit area of façade (i.e. U value). The target thermal insulation requirements to satisfy the Building Regulations (2013) are given in Table 1.

ELEMENT	VALUE
U-values for Walls	0.18 W/m ² K
U-values for Roof	0.13 W/m ² K
U-values for Floors	0.13 W/m ² K
U-values for Glazing	1.40 W/m ² K
Building Air-tightness	5 m ³ /hr.m ²
Thermal bridging (γ-values)	Use ECDs

Table 1 Typical performance requirements for the building fabric

These performance targets can be achieved by light steel framing. Table 2 presents the required insulation thicknesses to achieve the specified U-value for brick-clad light steel framing.



Figure 2 External insulation to brick clad light steel residential development

(Image courtesy of Metek UK)

INSULATION THICKNESS (mm)	U-VALUE OF CLOSED CELL INSULATION IN CAVITY (W/m ² K)	OVERALL WALL THICKNESS (mm)
60	0.20	337
80	0.18	357
100	0.15	377

Table 2 Insulation thickness for light steel framing (100mm C-section) with brick façade

Note: Values are for walls constructions as shown in Figure 3, comprising mineral wool insulation placed between the studs and in the cavity.

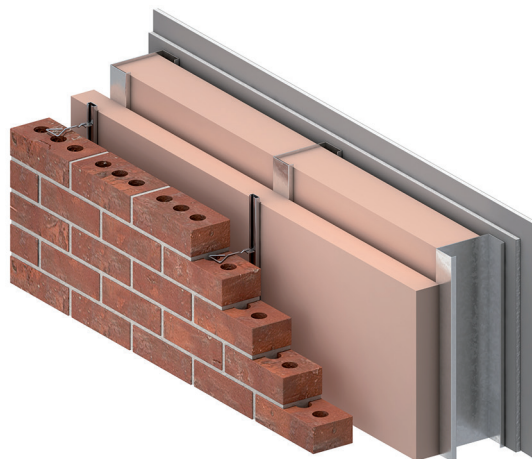


Figure 3 Brick cladding attached to light steel wall

(Image courtesy of BW Industries)

Technical Solutions

Lightweight cladding

Various forms of lightweight cladding may be used, such as, rain-screen cladding, insulated render, terracotta and board materials. Lightweight cladding often requires the use of a sheathing board, which adds to the shear resistance of the walls. Composite panels may also be combined with tiles as shown in Figure 4.

Table 3 presents the required insulation thicknesses to achieve the specified U-value for light steel framing with insulated render.

INSULATION THICKNESS (mm)	EXPANDED POLYSTYRENE EPS ($\lambda = 0.035\text{W/mK}$)	CLOSED CELL INSULATION PIR/PUR ($\lambda = 0.025\text{W/mK}$)
80	0.23	0.19
100	0.20	0.16
120	0.18	0.14

Table 3 Target Insulation thickness for light steel framing (100mm C-section) with insulated render cladding

Note: Mineral wool is placed between the C sections in all cases.



Figure 4 Composite panels with terracotta cladding
(Image courtesy of Kingspan Panels and Profiles)

Control of over-heating

Thermal capacity is not important in housing and residential buildings mainly because of the occupancy pattern. This is illustrated by the graphs in Figure 5 which compare heavyweight and lightweight buildings. The number of hours over 24°C is similar for all systems. The first graph also shows that heating load is reasonably constant.

Air-tightness

Air-tightness is important as un-wanted air leakage can add up to 30% to the heat loss from a building. Typical air-permeabilities of light steel and modular construction are presented in Table 4. They are much lower than envisaged by the Building Regulations.

BUILDING TYPE	AIR LEAKAGE RATE AT 50Pa ($\text{m}^3/\text{m}^2/\text{hr}$)
Typical on-site construction satisfying the Building Regulations	4 to 8
Prefabricated light steel framed houses (terraced house)	2 to 5
Residential building using modular construction	1 to 3

Table 4 Air-tightness measurements for typical forms of construction

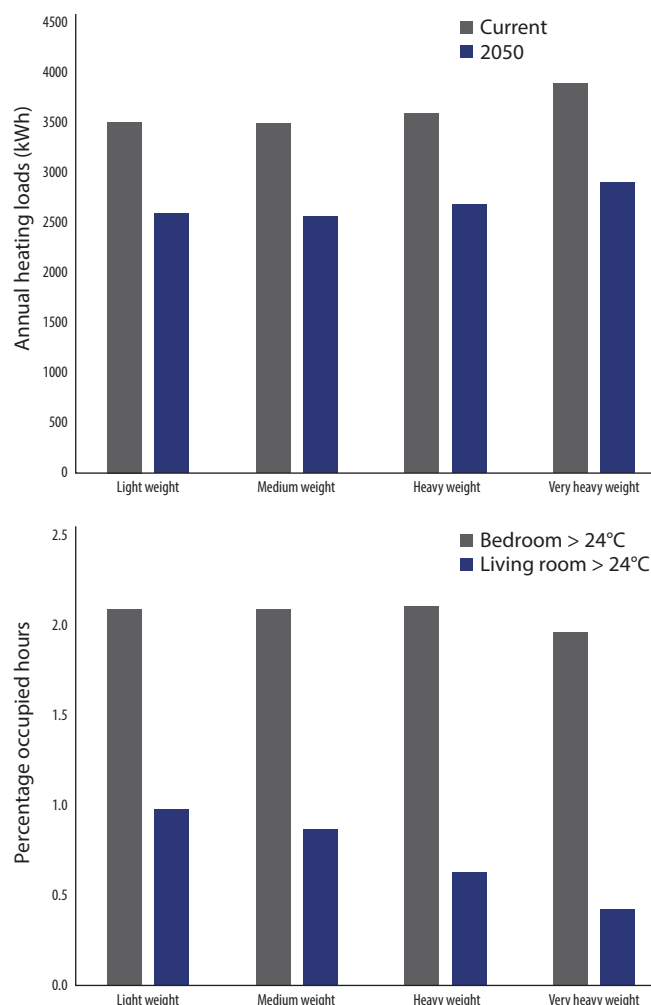


Figure 5 Comparison of over-heating and energy use of lights weight and heavyweight house constructions

Sources of Information

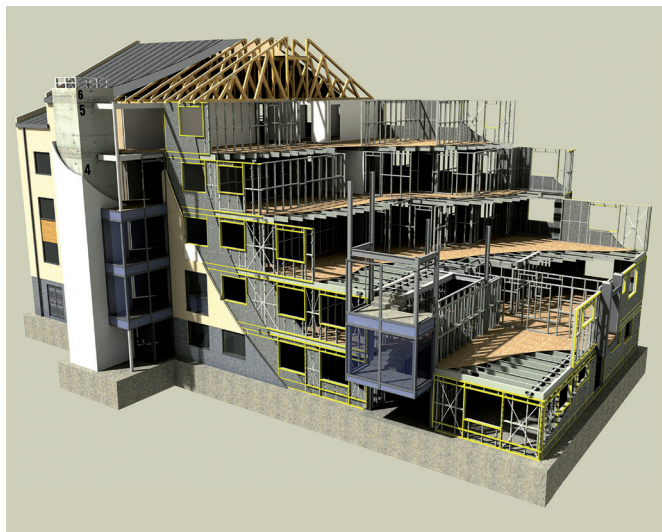


Figure 6 Insulated light steel wall panel construction
(Image courtesy of Fusion Building Systems)

Bibliography

The following publications may be referred to for more information on light steel framing and modular construction.

Lawson, R. M., Way, A. G. J. and Yandzio, E.
Building design using cold formed steel sections: Residential buildings (P402)
The Steel Construction Institute, 2014

Wright, C. et al
Insulated render systems used with light steel framing (P343)
The Steel Construction Institute, 2006

Lawson, R. M. and Francis, K.
Energy efficient housing using light steel framing (P367)
The Steel Construction Institute, 2007

Lawson, R. M.
Sustainability of steel in housing and residential buildings (P370)
The Steel Construction Institute, 2007

Approved Documents L1A. The Building Regulations 2010. Conservation of fuel and power (New dwellings)
The Stationery Office, 2013

Zero Carbon Hub Website - www.zerocarbonhub.org

Other technical information sheets

The following technical information sheets give further details.

- ED010: Light Steel Solutions for All Applications
- ED011: Light Steel Residential Buildings
- ED012: Light Steel Framed Housing
- ED013: Light Steel Infill Walls
- ED014: Light Steel Modular Construction
- ED015: Acoustic Performance of Light Steel Construction
- ED016: Fire Safety of Light Steel Construction
- ED020: Sustainability of Light Steel Construction
- ED021: Robustness of Light Steel Construction
- ED022: Durability of Light Steel Construction

Manufacturers

The following manufacturers are active in the light steel and modular construction sector and may be contacted for further information.

Ayrshire Metal Products Ltd. - www.ayrshire.co.uk

BW Industries Ltd. - www.bw-industries.co.uk

Fusion Building Systems - www.fusionbuild.com

Kingspan Steel Building Solutions -
www.kingspanpanels.com

Metek UK Ltd. - www.metek.co.uk



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