

Technical Information Sheet ED020

Sustainability of Light Steel Construction

Sustainability, in the context of designing and planning buildings, is quantified in terms of various measures of environmental, social and economic performance. In the UK, offices and public buildings are assessed using BREEAM, and housing and residential buildings are assessed to the Government's Code for Sustainable Homes (CfSH, 2010). Similar sustainability assessment procedures exist in other countries, such as Leadership in Energy and Environmental Design (LEED) in the USA.

This Information Sheet reviews the key sustainability indicators and how they are satisfied using light steel framing and modular construction.

Key sustainability benefits

The sustainability benefits of light steel framing and modular construction are based on the off-site nature of the construction process; these are:

- High levels of thermal insulation and air-tightness are achieved in light steel framing, and modular construction.
- The light weight of these construction systems means that foundation loads and sizes are reduced by over 70% relative to concrete and block-work construction.
- Productivity and speed of construction is increased by over 30% which reduces site impacts.
- Transport is greatly reduced. A single delivery of light steel frames is typically sufficient for 3 houses.
- Site safety is improved by a factor of 5 according to HSE statistics due to the off-site construction process.
- Site waste is virtually eliminated by the use of pre-fabricated light steel and modular components compared to the industry average wastage of 10% in construction materials.
- Use of components rolled to length results in no production waste.
- Embodied carbon in the building fabric is reduced by up to 20% when using light steel framing and modular construction.
- Renewable energy technologies can be attached to and built-in the light steel and modular components.
- Light steel structures can be modified and extended easily. Modular units can be dis-assembled and re-used.
- Light steel and modular construction are widely used in building extensions and in renovation, due to their light weight and speed of installation.

Applications

Light steel framing and modular construction are used for housing, residential buildings, educational and health sector buildings where achieving high levels of sustainability according to the Code for Sustainable Homes and BREEAM is important. They may also be used in renovation, such as roof-top extensions.

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Code Level 5 modular houses in west London

(Image courtesy of Futureform and Ayrshire Framing Systems)



Houses development in London

(Image courtesy of Metek UK)



Zero waste from sections produced to length in factory

(Image courtesy of BW Industries)

Sustainability Indicators

Code for Sustainable Homes and BREEAM

The Code for Sustainable Homes and BREEAM are systems of rating the sustainability of buildings according to various criteria, for which credits are awarded. These credits are then weighted to obtain a score out 100. The available credits to the Code for Sustainable Homes are given in Table 1. The BREEAM ratings that are often sought for large office and retail developments are 'Very Good' and 'Excellent'. The Code for Sustainable Homes rating of Level 4 is compatible with the Building Regulations (2013).

CATEGORY	CREDITS	% OF TOTAL
1. Energy and CO2	29	36.4%
2. Water	6	9%
3. Materials	24	7.2%
4. Surface water run off	4	2.2%
5. Waste	7	6.4%
6. Pollution	4	2.8%
7. Health and well being	12	14%
8. Management	9	10%
9. Ecology	6	12%

Table 1 Available credits to the Code for Sustainable Homes

Approximately 15% of the credits are directly related to the form of construction and its performance credentials. The Code and BREEAM cross-refer to the BRE Green Guide in which lightweight construction systems score well in relation to heavy weight systems.

The carbon compliance hierarchy developed by the Zero Carbon Hub (ZCH) is presented in Figure 1. Energy saving measures are the main scope of revisions to the Building Regulations. Low or Zero Carbon (LZC) technologies include renewable energy systems that are integrated into the building fabric or are installed on site. Allowable Solutions include district heating and combined heat and power that may also be supplied at a local level.

Sustainability assessments

The BRE SmartLife project (Cartwright, 2008) compared the site productivity and materials waste of brick and block-work construction, light steel framing, timber framing and insulated concrete formwork for three similar housing developments in Cambridge. The developments comprised 106 houses in total.

It was shown that the light steel system was the fastest to construct overall, had the highest productivity per person and generated the least waste whilst being comparable in cost to traditional construction.

The benefits recorded for light steel framing were:

- 50% reduction in time to complete envelope
- 25% increase in productivity per person
- 25% reduction in waste.

In 2010, three modular residential buildings in Wolverhampton of 8, 9 and 25 stories were monitored to ascertain the rate of construction, site productivity, number of deliveries of building components and waste created. The overall construction period of the 25,000 m² floor area project was only 15 months (from foundation level).

Summary of performance achieved:

- 7.5 modules installed per day, equivalent to 190 m² floor area.
- Reduction of 11 months in construction period. This equated to approximately a 40% overall reduction in construction period.
- Site personnel reduced by 50% (on average, 52 workers were employed on the project, including 5 site management staff).
- Site waste sent to disposal reduced by 95%, saving up to £15,000 for this project.
- Number of deliveries to site reduced by 60%.

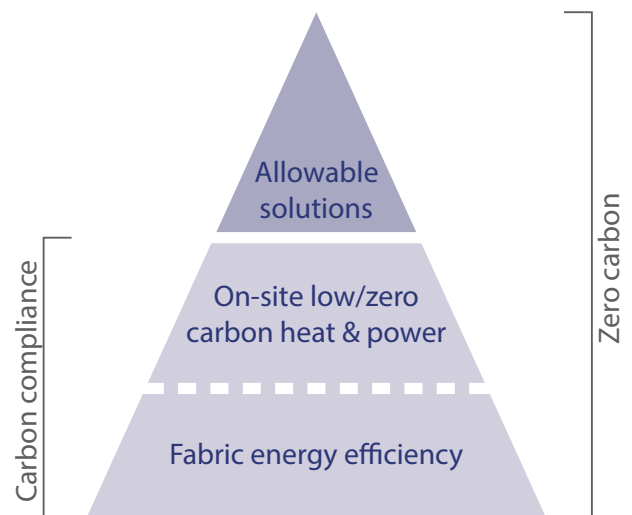


Figure 1 Carbon compliance hierarchy
(Image courtesy of Zero Carbon Hub)

Embodied Carbon Assessments

Embodied carbon assessment

The embodied carbon (in kg CO₂ per unit area of the functional unit) is a measure of the energy required to manufacture the materials and to transport and construct the building elements. The embodied carbon includes the wastage of materials. The results of an embodied carbon assessment of infill walling systems are presented in Table 2. This assessment has been carried out for infill walling systems all designed to achieve the same level of performance. It is apparent that lightweight cladding systems lead to about a 60% reduction in embodied carbon relative to brickwork and terracotta cladding systems.

The lightweight construction system also saves on the weight of the supporting elements, which is important when building on podiums, such as over retail space.

FORM OF CONSTRUCTION	SELF-WEIGHT kg/m ²	EMBODIED CARBON kgCO ₂ /m ²
1. Light steel framing and brickwork	240	86
2. Light steel framing and insulated render	43	34
3. Light steel framing and terracotta tiles	82	122
4. Timber framing and brickwork	250	88
5. Brick-and block-work	291	91
6. Block-work with external render	200	69

Table 2 Embodied carbon assessment of infill walling



Figure 2 Multi-storey light steel frame housing
(Image courtesy of Kingspan Steel Building Solutions)

BRE Green Guide ratings for different forms of framing and cladding systems are presented in Table 3. The Green Guide ratings range from A+ to E and it can be seen that light steel systems consistently score A+ or A whereas heavyweight systems score D or E.

An A+ rating gains two additional points under the materials ratings in the Code for Sustainable Homes.



Figure 3 Integration of PV panels and green roof in modular construction
(Image courtesy of Fusion Building Systems)

Cladding

Various forms of cladding may be used, such as brickwork, rain-screen cladding, insulated render and board materials. Green Guide ratings for different types are given in Table 3.

FORM OF CONSTRUCTION	RATING
<i>Framework:</i>	
Separating wall using light steel framing, glass wool insulation and plasterboards	A
Chipboard decking on light steel floor joists and plasterboard ceiling	A
OSB decking on light steel floor joists and plasterboard ceiling	A+
Composite floor slab on steel decking with resilient surface and OSB board with plasterboard ceiling	A or B
<i>Cladding:</i>	
Brickwork on light steel insulated wall	A+
Terracotta rain screen on light steel insulated wall	A

Table 3 BRE Green Guide ratings for light steel residential specifications

Sources of Information



Figure 4 Light steel development in Abingdon
(Image courtesy of Metek UK)

Bibliography

The following publications may be referred to for more information.

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

Cartwright, P.
SmartLIFE – Lessons Learned (R500)
BRE, 2008

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

Building Research Establishment Environmental Assessment Method (BREEAM)
www.breeam.org

Green Guide to Specification
Building Research Establishment, 2009

Code for Sustainable Homes (2010) - Technical Guidance
www.gov.uk/government/publications

Using modern methods of construction to build more homes quickly and efficiently
National Audit Office, 2005

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
- ED019: Thermal Performance 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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