

Technical Information Sheet ED016

Fire Safety of Light Steel Construction

This Information Sheet describes the benefits of light steel construction in relation to fire safety, both during the construction phase and when the building is complete. Fire safety, particularly during construction, has become a significant issue with some forms of construction. This Information Sheet explains the excellent performance of light steel and modular construction in fire.

Key benefits

The benefits of light steel construction in relation to fire safety are:

- Steel is non-combustible; it does not add to the fire load of the building.
- Fire protection for light steel framing is typically provided by the boards used for internal lining, e.g. gypsum-based boards.
- Fire resistance periods of up to 120 minutes are readily achievable.
- The amount of combustible material in a light steel framed building is much lower than in some other forms of construction.
- Modules and pre-boarded light steel panels are fire protected before delivery to site.
- Light steel floors, walls and modules are easily repairable after small fires.
- The fire risk during construction is much lower for light steel framing than for some forms of construction.

Forms of construction

Light steel construction uses cold-formed steel sections for load-bearing walls and floors. Light steel framed buildings are typically constructed using pre-fabricated storey-high wall panels and pre-fabricated floor cassettes that are supported by the load-bearing walls. Volumetric or modular units are also manufactured using light steel walls, floors and ceilings, which form a self-supporting and rigid 3-D unit. Light steel construction is used for many types of building from low-rise residential buildings to multi-storey mixed use developments.

The cold-formed sections used in load-bearing walls are typically C sections. Floor joists can also be C sections but other solutions for floors, such as sigma sections, light steel lattice trusses and composite slabs supported by light steel framing are also common. Light steel sections are generally 70 to 250 mm in depth and thicknesses are typically 1.0 to 2.4 mm. Some manufacturers provide thicker sections for specialist applications.

Light steel sections and pre-fabricated light steel panels are also used as non-load bearing infill walls in concrete or steel framed buildings. The wide range of infill wall applications includes multi-storey offices, educational, health and residential buildings.

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Light steel in residential building

(Image courtesy of Metek UK)



Light steel modular building

(Image Courtesy of Lightspeed Construction Ltd)



Light steel floor after a loaded fire test

Fire Protection and Safety Attributes

Fire protection to light steel elements is typically provided by one or two layers of plasterboard or similar material; three layers are provided for fire resistance periods of more than 90 minutes. Many different types of board material are used in light steel construction, including gypsum-based boards (such as plasterboard and gypsum fibre reinforced board), cement particle board and magnesium silicate boards. All these boards contribute to the fire protection of the system, although different types of boards will provide different levels of protection.



Figure 1 Multi-storey X-braced light steel framing
(Image courtesy of Metek UK)

Fire safety attributes

Light steel framing possesses the following attributes in terms of fire safety:

- Steel is non-combustible.
- Plasterboard is non-combustible and provides fire resistance by virtue of its insulating properties and inherent chemically-bonded water content. Typical floor and wall build-ups are shown in Figures 2 to 5.
- Mineral wool or glass wool may be used as both acoustic and thermal insulation. They are non-combustible.
- Modular units are lined with plasterboard or similar material and fitted with external sheathing board off site. If a fire were to start within a module, it would be totally contained.
- Resilient bars, which are used to improve acoustic performance, can be used without detriment to the fire performance.
- Tests have shown that the temperature of light steel can remain below 100°C after a real fire with a duration up to 80% of its specified fire resistance period, and thus the light steel can be re-used.
- Steel connections are very robust in fire and do not fail before the connected members.

Fire-resistant plasterboards, conforming to the requirements of Type F to BS EN 520, are designed to provide specific levels of fire protection. Fire resistances of 60 to 120 minutes can be readily achieved.

Light steel construction is designed to be resistant to a potential fire inside the building; in some situations it is also necessary to consider protection from fire external to the building. The fire resistance period of a given wall construction will be different for internal and external exposure.

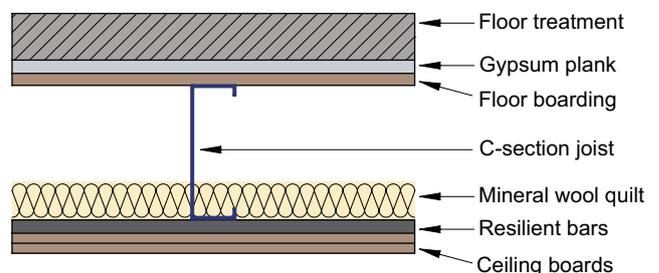


Figure 2 Typical light steel floor detail

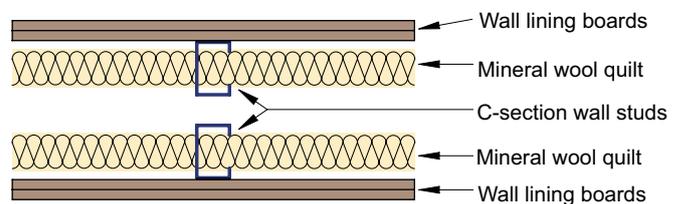


Figure 3 Typical light steel separating wall detail

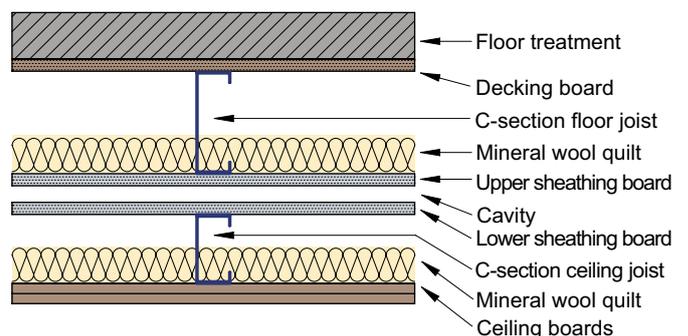


Figure 4 Typical light steel modular floor and ceiling detail

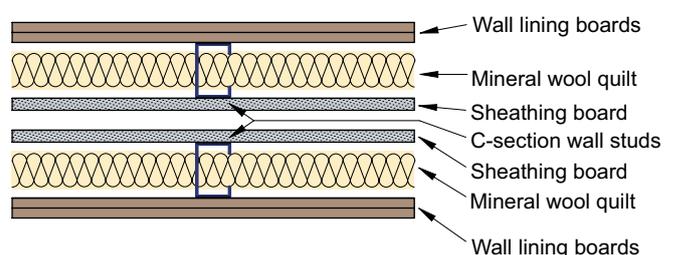


Figure 5 Typical modular wall detail

Fire Safety of Light Steel Construction

In common with other construction technologies, the combustible elements of a light steel framed building are the timber-based floor boarding and external PUR (polyurethane) or EPS (expanded polystyrene) insulation, which tend to char or melt rather than burn. Floor boarding is typically water-resistant particle board, which does not burn readily. External insulation is protected by internal fire resistant board. It follows that the quantity of combustible material in a light steel or modular building is much lower than that of a timber framed building.

The limiting temperature for cold formed steel sections is 550°C for a load ratio of 0.4 in fire conditions. This is shown by the strength retention values given in Table 1.

Table 1 Strength and stiffness retention factors for cold formed sections (from BS EN 1993-1-2)

TEMPERATURE °C	200	300	400	500	600	700
Strength retention factor	0.89	0.78	0.65	0.53	0.30	0.13
Elastic modulus retention factor	0.90	0.80	0.70	0.60	0.31	0.13

Light steel construction is fully fire resistant to the required period when boarded. Modular construction is boarded off-site and is fully fire resistant on-site. Table 2 gives some examples of fire protection specifications for floors and walls. However, it should be noted that products are continually developing (and manufacturers' literature should be consulted). Board products with even better performance may be available. (Note: Load ratio is termed utilization factor in EN 1993-1-2).

Fire test data

The performance of a light steel floor during a fire test is shown in Figure 6. The structural elements of the floor were 200 mm deep light steel joists at 400 mm centres. The load ratio for the test was 0.3 and the target fire resistance of 90 minutes was exceeded. The temperature of the light steel joists remained at less than 100°C for over 80 minutes and so they would be essentially undamaged and re-usable after a fire of that duration.

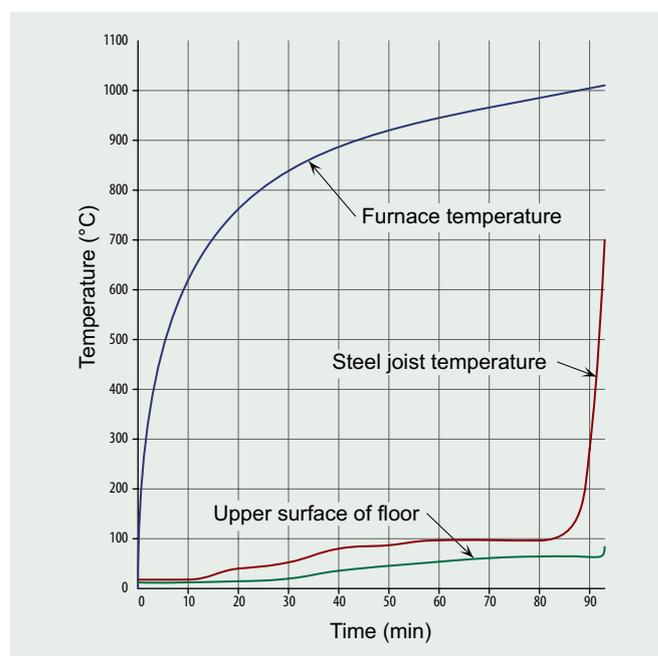


Figure 6 Temperature-time curves for a floor fire test

Table 2 Examples of fire protection for light steel construction for fire resistance periods of 30 to 120 minutes

FIRE RESISTANCE	NUMBER OF LAYERS AND THICKNESS OF BOARD ⁽¹⁾			NOTES
	LOAD BEARING WALLS	INFILL WALLS IN STEEL FRAMES	SUSPENDED FLOORS	
30 mins	1 × 12.5 mm	1 × 12.5 mm	1 × 12.5 mm	Standard wall board may be used for some applications
60 mins	1 × 15 mm ⁽²⁾	1 × 12.5 mm ⁽³⁾	2 × 12.5 mm	2 × 15 mm boards are generally required for separating walls
90 mins	2 × 15 mm ⁽⁴⁾	2 × 12.5 mm ⁽³⁾	3 × 12.5 mm	Provides sufficient acoustic insulation for separating walls and floors
120 mins	3 × 15 mm	2 × 15 mm ⁽³⁾	3 × 15 mm	Superior acoustic performance

Notes:

- (1) Specifications are for fire resistant plasterboards (Type F to BS EN 520) and for a load ratio of less than 0.4 in fire conditions. Other fire resistant boards are available and can be used effectively.
- (2) The use of a single 15 mm thick board for load-bearing walls is affected by the horizontal joints in the boards, which require a steel backing strip. Alternatively, a full height board may be used or 2 layers of 12.5 mm boards.
- (3) For infill walls, it may be necessary to use a thicker board if it also provides protection to the steel edge beams or columns.
- (4) For load-bearing walls, the load ratio should be less than 0.4. For higher load ratios, 3 layers of 12.5 mm boards may be required.

Fire Safety During Construction

Light steel frames and floor cassettes may be delivered as large pre-fabricated elements and are lifted into position from the lorry by crane. They are non-combustible, except for the timber floor boarding, which possesses only a low fire load. The wastage rates for light steel construction are extremely low; so there is almost no combustible waste material stored on-site. Generally, the bundles or pallets of insulation are stored externally, as they will be installed on the outside of the light steel walls and roof.



Figure 7 Light steel floor cassette
(Image courtesy of Kingspan Profiles and Sections)

Carpentry is generally carried out after the ceiling and wall boards have been fixed, at which point the light steel framework is fully fire protected to its design resistance period. Therefore, light steel structures possess little risk of fire during construction, thanks to the non-combustibility of the materials used, and the 'just in time' nature of the construction process.

It is not necessary to phase the construction programme of a light steel structure in order to reduce the risk of fire, because of the low fire load, nor is there any fire risk to adjacent buildings.

The use of modular construction almost totally eliminates the risk of fire associated with temporary storage of materials. Modules do not require temporary storage because they are craned directly into position, thus eliminating the risk of fire during the construction phase. Also, the insulation and internal fire protection is installed off-site, so there is no temporary storage of insulation materials or unprotected steel during construction.

Sources of Information

Other technical information sheets

The following technical information sheets provide further guidance about light steel construction.

- 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

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 Profiles & Sections - www.kingspanprofiles.com

Metek UK Ltd - www.metek.co.uk



Figure 8 Health care building Scotland using light steel
(Image courtesy of BW Industries Ltd)



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