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XXXX - LIGHT STEEL FRAMING

STRUCTURAL AND BUILDING PHYSICS PERFORMANCE

1. Introduction

XXXX- Light Steel Framing uses a range of light steel C sections to create low-rise building frames, floors and secondary components. The machinery is installed in a factory, but it can be placed on-site to provide 'just in time' manufacture and assembly in so-called 'field-factories'.

XXXX-LSF uses cold rolled galvanized C sections as its basic components. They are of 75 & 100 mm depth in 1.2 to 1.6 mm thick steel, depending on the application. The XXXX-LSF machinery cuts the sections to precise length and punches a single hole at their ends for a riveted connection. This hole also provides for 'self-jigging' of the frame for dimensional accuracy. Additional screws can be added if required.

The system of construction is based on the 'warm frame' principle, where insulation is placed outside the structural frame. In this way, the risk of condensation and thus corrosion is avoided. The technology reflects existing practice in the UK. Similarly, acoustic insulation is achieved by multiple layers of board and quilt. Performance data for board materials may be obtained from British Gypsum and Lafarge Plasterboard.

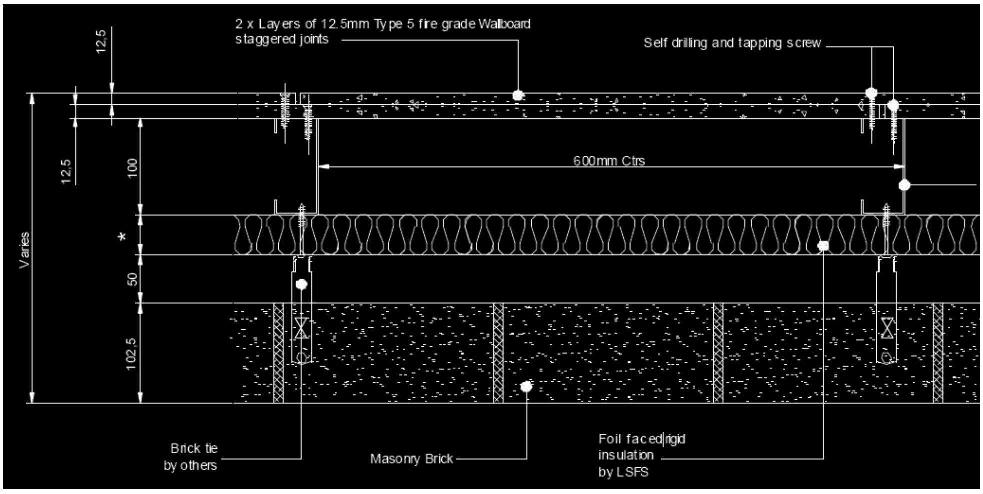


Fig.10 - Generic detail showing external wall with masonry cladding

This technical documentation reviews the existing structural performance data on the XXXX-LSF system and demonstrates its range of application by simple design tables. Details for acoustic and thermal insulation are presented, based on generic light steel framing technology given in various Steel Construction Institute publications. These details are relevant to the general use of the XXXX-LSF system in residential buildings, but precise details used for particular applications should be specified by XXXX-LSF.

1.1 Range of Application

The XXXX-LSF system is aimed at low-rise buildings and secondary components in medium to high-rise buildings. The current range of applications are:

- Complete frames using wall panels and floor joists for 1, 2 or 3 storey houses.
- Multi Storey Apartments (4-6 storey)

- Long span floor joists of lattice cross-section.
- Infill or separating walls used in primary steel or concrete frames.
- 'Open' habitable roof systems.
- Small halls or other single storey buildings.
- Modular units in 'box' or open-sided form.
- Over-cladding or re-cladding sub-frames for existing buildings.
- Roof or purlins, in 'C' or latticed form.

These applications can be designed as 'bespoke' for particular projects, or as standard components using design tables. Frames are installed as separate storey-high panels in so-called 'platform' construction, as illustrated in Figure 1.1.

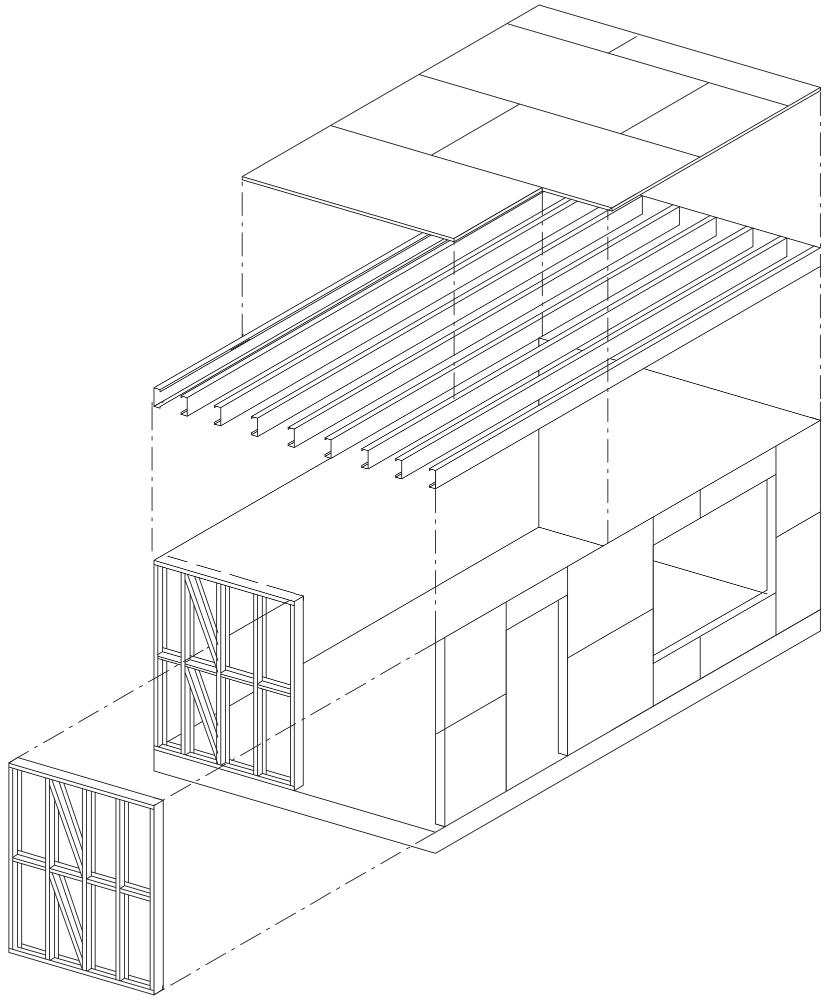


Figure 1.1 *Platform construction of wall panels and floors*

1.2 Structural Components

The system uses a range of C sections which are produced by the machine in XXXX-LSF's factory.

The XXXX-LSF C sections are produced in the following size ranges (see Table 1.1).

Table 1.1 *Size range of XXXX-LSF sections and steel thicknesses*

Depth (mm)	Width (mm)	Thickness (mm)
75	42	1.2, 1.6
100	42	1.2, 1.6

1.2.1 Strip Steel

All the strip steel is produced to BS EN 10326 in S350 grade (yield strength = 350 N/mm^2). It is galvanised to G275 grade (275 grams of zinc per m^2). The strip steel is obtained in the correct widths for rolling from Corus Strip UK or similar approved suppliers.

1.2.2 Accuracy and Tolerances

The accuracy of the section shape is within +/- 0.5 mm. The ends of the members are pre-formed with holes and swaged ends to permit easy inter-connection. The accuracy of position of the end fixing is within 1 mm, which results in frames +/- 2mm on panels up to 5000mm long, +/- 4mm 5000mm to 10,000mm long. These tolerances are applicable to height, length and diagonal for squareness

It is important that the foundation level is accurately measured before commencing installation of the wall frames, as even a 5 mm out of vertical level and +/- 10mm horizontal or diagonal will lead to an equivalent out of verticality of the wall frame.

If the gap between the bottom rail of the wall and the substructure is less than 10mm, then packing to carried out using steel shims. For gaps of 10 – 20mm shims are required under each stud, and grout is required under the whole of the base rail. For gaps of more than 20mm, remedial works to the base / sub structure are required.

1.2.3 Section Properties

The section properties of the XXXX-LSF C sections are obtained by calculation to BS 5950-1, 1998, incorporating Amendment No. 1, taking account of the effective width of the elements in compression and bending. All flanges are stiffened by an edge lip which is considered to be sufficient to restrain local buckling of the edge when fastened to plasterboard or floorboard.

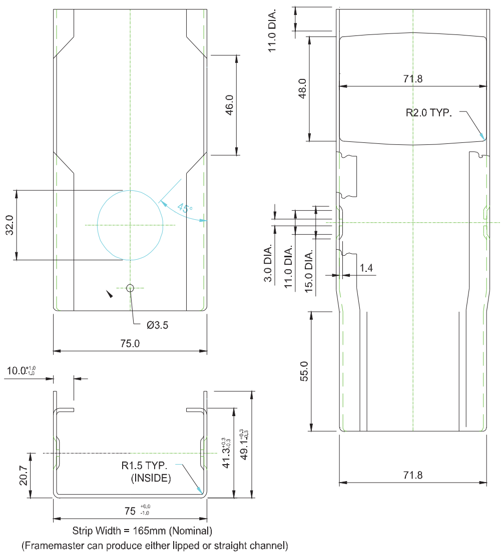
The principal section properties used for design are presented in Table 1.2 below, together with their definitions. All properties are calculated at a stress of p_y = 350 N/mm^2.

Table 1.2 **Gross** ***section properties of XXXX-LSF C sections taking into account 0.04mm of galvanised coating***

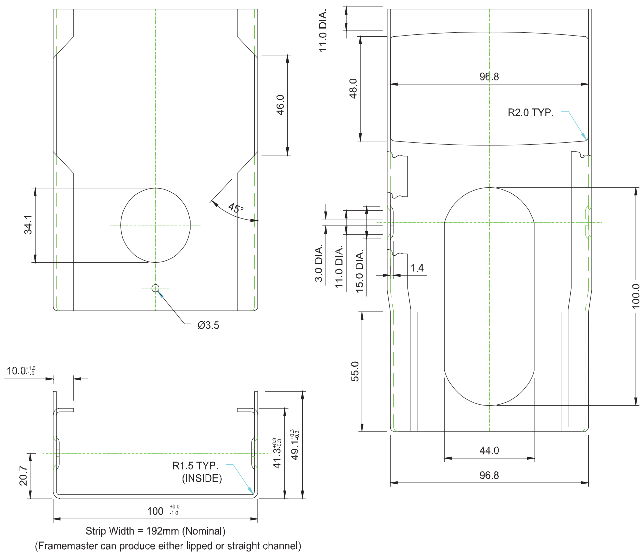
Depth (mm)	Thickness (mm)	Mass kg/m	Gross Area mm^2	Q	Z_{xx} mm^3	Z_{yy} mm^3	I_{xx} mm^4	I_{yy} mm^4	r_{xx} mm	r_{yy} mm
75	1.2	1.54	198	0.864	4835	1626	183053	48840	30.40	15.49
75	1.6	2.05	263	0.958	6399	2162	240114	66319	30.20	15.31
100	1.2	1.77	227	0.761	6713	1637	355334	52559	39.56	15.21
100	1.6	2.36	302	0.862	9302	2194	467856	68270	39.34	15.03

Definitions:

Q is the effective cross-sectional area/gross area in compression
Z_{xx} is the major axis bending section modulus
Z_{yy} is the minor axis bending section modulus
I_{xx} is the major axis second moment of area
I_{yy} is the minor axis second moment of area
r_{xx} is the major axis radius of gyration
r_{yy} is the minor axis radius of gyration



75mm Section



100mm Section

1.2.4 Durability and Design Life

The design life of galvanised steel in dry environments is 200 years, which applies to 'warm frame' construction. SCI publication P262 presents guidance on durability (see References).

1.3 Typical Applications in Buildings

1.3.1 Application – Wall Frames

Wall frames are manufactured as 2-dimensional panels consisting of:

- Studs (compression members) at 400 or 600 mm centres, or as modified at openings.
- Bottom and top tracks which fit around the studs.
- Noggins (small infill pieces) at half height of the wall to provide lateral restraint.
- Bracing either as integral C sections between the studs or as cross-flats fixed externally to the studs (see Figure 1.2).

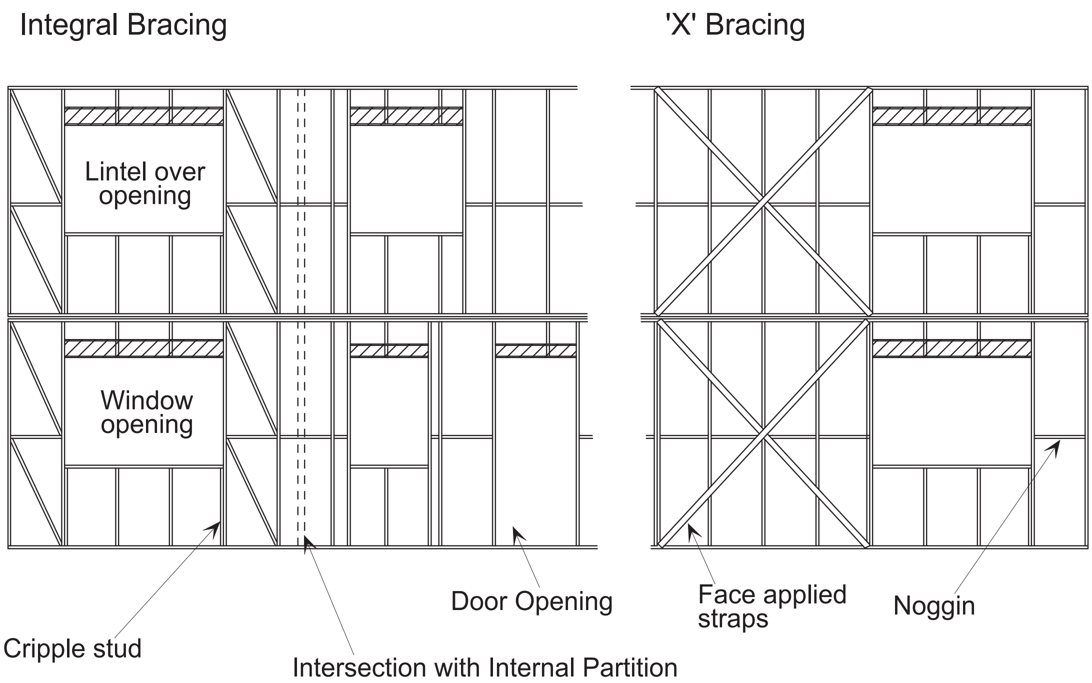


Figure 1.2 *Typical braced frames*

Wall frames are usually designed as load-bearing, and also to resist wind loads when used on the periphery of the building.

1.3.2 Application – Infill Walls

Infill walls are fitted between floors in multi-storey buildings either as:

- Separating walls for acoustic insulation and fire compartmentation.
- External walls as a 'rapid dry envelope'.

They are not subject to significant vertical load, but may be exposed to high wind loads, dependent on the building location and height.

Generally, 75 mm deep C sections are used for floor-ceiling heights of up to 3 m in low or medium rise buildings. Figure 1.3 shows a typical infill wall located between floors. The spacing of the wall ties to attach to brickwork depends on the wind load (i.e. building elevation and exposure. The minimum requirement is 3.70 ties/m². Brickwork should generally be independently supported. Guidance on infill walls is given in Section 7.

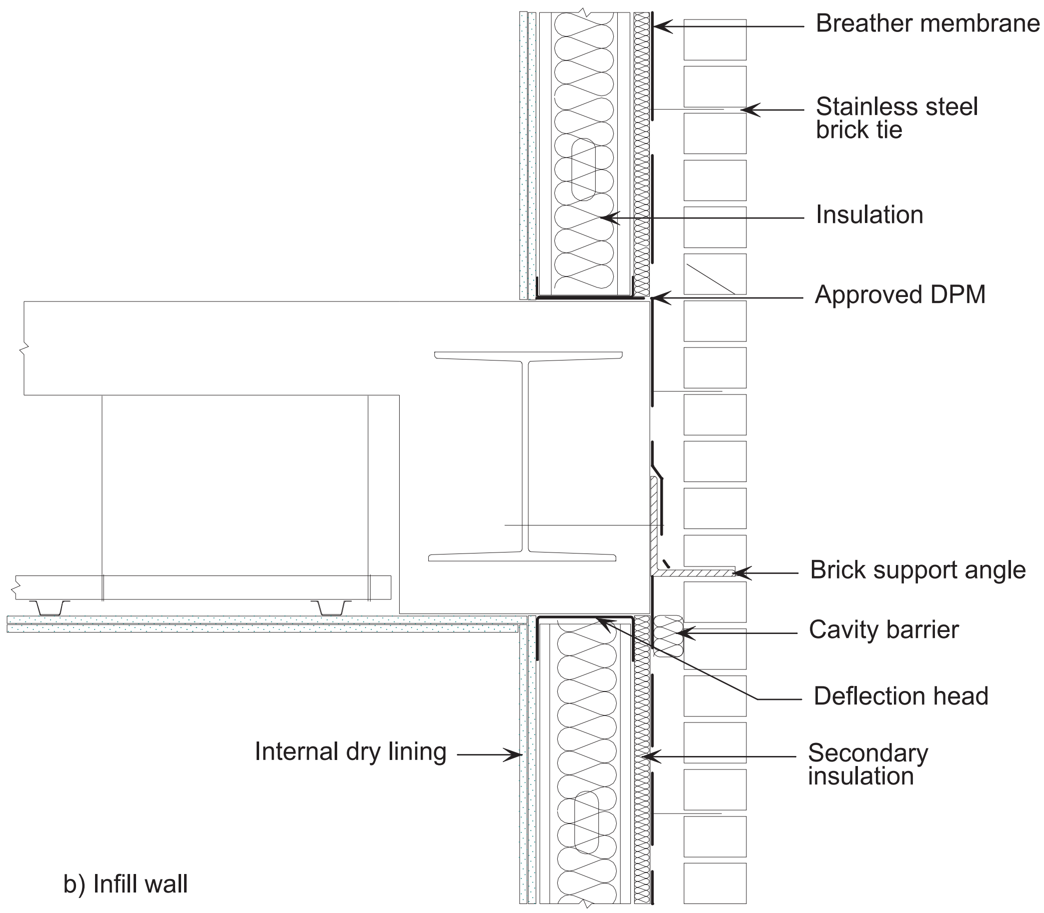


Figure 1.3 *Infill wall in a hot rolled steel or concrete framed building*

1.3.3 Application – Floor Joists

- Lattice joists of 225 to 500 mm depth for spans of up to 8.7 m.

Lattice joists use 75 or 100 mm deep C sections as the chord and bracing members, and the thickness is selected to minimise the weight of the members, whilst retaining sufficient shear strength of the flanges. Joists are normally placed at 400 mm centres, but the spacing can be increased to 600 mm, depending on the type and thickness of floor boarding. Additional screws at the joints may be required for longer span joists.

Details of lattice joists in a floor cassette that are supported at their edge by a deep cold formed Z section, are shown in Figure 1.4. This Z section stabilises the edge of the joists. The direct stud to stud connection continues the load path as in SCI Publication P 301, p53.

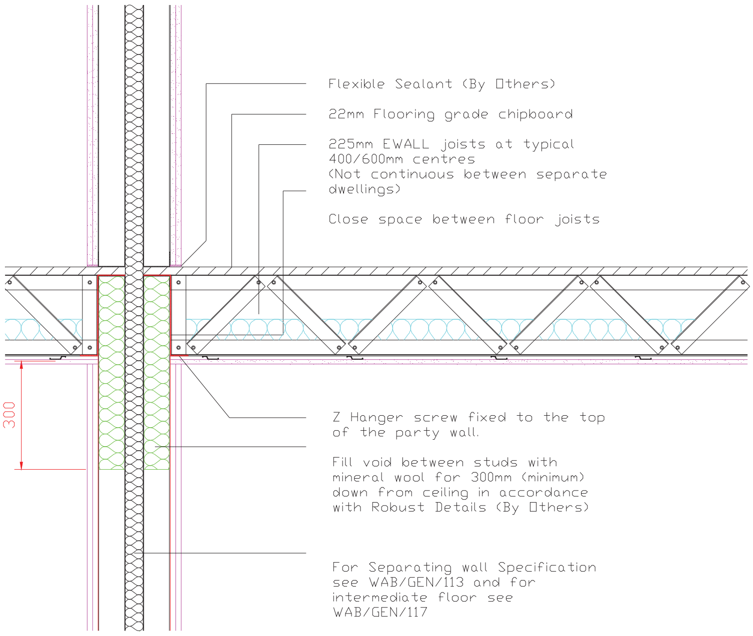


Figure 1.4 *Lattice joist and perimeter C section*

1.3.4 Application – Roof Trusses

A variety of forms of roof trusses may be created using C sections:

- ‘Fink’ truss, as in timber roof truss.
- Longitudinal lattice truss between cross walls.
- Hipped roofs.

A traditional ‘Fink’ truss may be manufactured using 75 or 100 mm C sections to replace the equivalent timber members but this does not provide for habitable space.

Alternatively, longitudinal lattice trusses can be positioned so as to create habitable roof space economically, as in Figure 1.5. The rafters can be manufactured and installed as inclined wall panels. End gables are manufactured as triangulated wall panels. Double studs are required where they support the lattice joists. Gable trusses located on plan provide local resistance to wind pressure at eaves level.

The same roof systems may be used in roof-top extensions to existing buildings, although some adaptation will be required to create habitable space. XXXX-LSF will design purpose-made roof trusses for these applications.

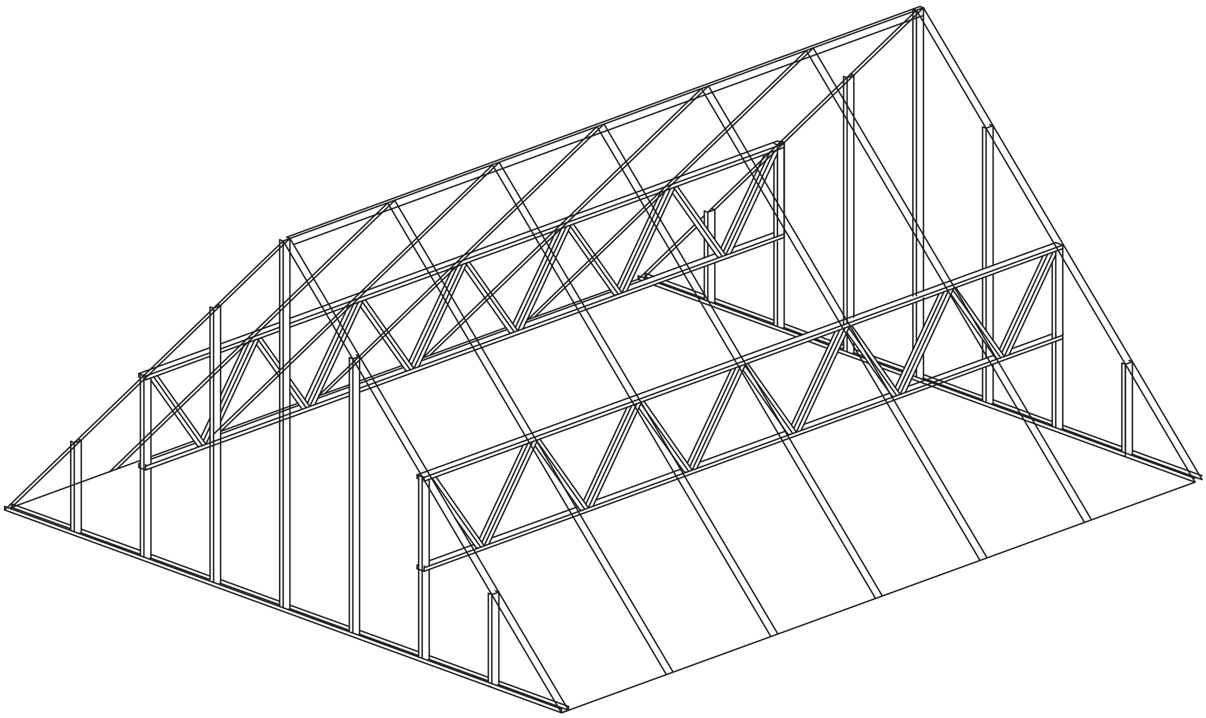


Figure 1.5 *Open roof system using longitudinal lattice joists*

1.3.5 Application – Over cladding of existing buildings

In renovation, new cladding can be attached to existing buildings using sub-frames manufactured as wall panels and attached to the existing floor slab or façade (where it is sufficiently strong). The sub-frame is designed to resist wind loading and to support the weight of the new façade.

Over-cladding is a specialist activity and the quality of the fixings to the existing building is very important to the adequacy of the system. Light steel sub-frames may be used with most types of over-cladding materials, such as:

- profiled sheeting
- steel or aluminium cassettes
- composite panels
- impregnated boards

Sub-frames should generally be designed as storey-height in order to avoid fixing into the existing often poor quality façade materials. More robust fixings can be made to the concrete floor slab or columns.

The environmental conditions behind the new over-cladding may be considered as to be 'mild', provided pressure equalisation can occur in the cavity. Previous studies have shown that a design life of 30 years can be achieved (refer to SCI publication 262).