

Scheme development: Selection of the external wall envelope system for single storey buildings

This document describes the main design considerations in the selection of walls for single storey buildings and the wall systems which can be used.

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1. Design criteria

Single storey buildings are bespoke, and can be of any size. Many designs are based on a matrix grid giving many combinations of width and length. The steel grids can be selected to accommodate racking systems and dock door loading bays. Modular construction is increasingly used and in the right circumstances can substantially reduce costs. The same concepts can be carried through to offices, hospitals, schools, hotels etc, which can also be designed completely or partially modular, using the benefits of this fast and economic form of construction.

Steel wall cladding is a highly visible element of a building which can be supplied with a range of finishes and formed into a number of shapes, which are both aesthetically pleasing and have an advanced appearance in design.

There are a number of considerations to be taken into account in the selection of a wall finish or system. The choice of material is as important as the design criteria of the wall itself. It is crucial to assess whether the material can provide the durability for the location and environmental climate. Cost is a key factor, but should be viewed in terms of the whole life of the building. Other issues such as detailing, maintenance and disposal should also be considered.

The main factors in the selection of walling products or systems can be summarised as follows:

- perform basic function of keeping out the weather and have structural integrity
- look aesthetically pleasing because the wall cladding is the most visible element of any building
- be available in a range of colours/finishes
- have sufficient strength and stiffness to resistant impact damage and also prevent damage from wind loadings
- permit flexible detailing to allow freedom in design
- provide for insulation meeting the requirements of Energy Performance of Buildings Directive through national building regulations
- provide for any acoustic requirements
- provide for any fire regulations which tend to be individual to each country
- be a sustainable product, which is manufactured in such a way to minimise the impact on the environment by reducing CO₂ emissions, conserves resources, increases the use of renewable material, improves productivity and increases recyclability. Also minimises the impact on-site by reducing the time required, the level of noise, the level of waste and the requirement for the use of water.

There are a number of systems that are available which fulfil these functions; the guide considers a number of options which are specified for a range of building types commonly found in Europe.

2. Built-up system with vertical or horizontal cladding profiles

A built up or double skin system consists of a metal profiled liner that is fastened to the structure, followed by a bracket and rail spacer system, insulation and the outer sheet, see Figure 2.1. These systems are very versatile offering the designer a number of combinations of colour, profile and texture together with fast track economic solutions, then meet the thermal, acoustic and fire requirements of the building fabric. Highly visible surface mounted flashings and the option to include curved details can also be used to produce significant features when using built-up systems.

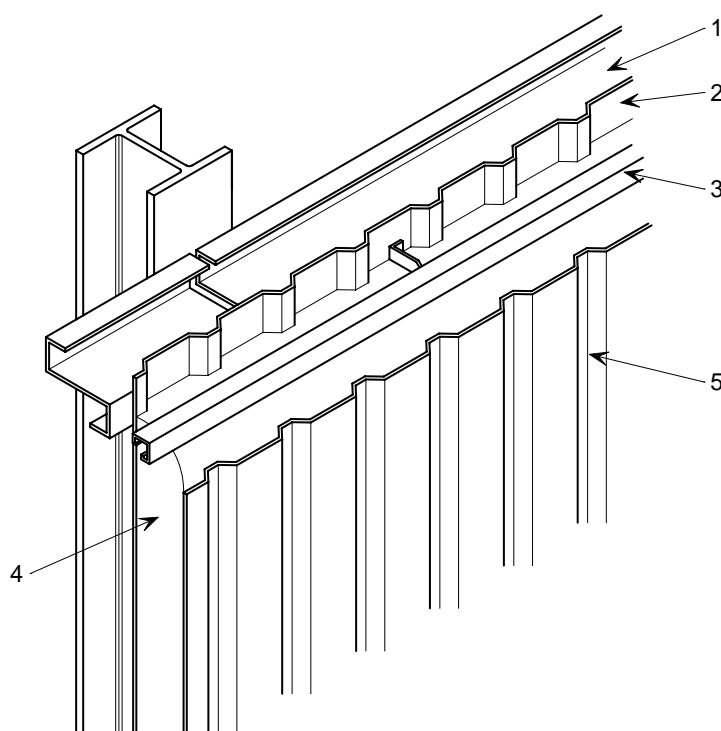


Figure 2.1 Built up cladding system with vertical cladding

Key:

1. Structural support, here a cold formed side rail
2. Liner
3. Bracket and rail system
4. Insulation
5. Outer sheet

2.1 Colour

The range of colours offered in pre-coated steel is very wide, from neutral greys through to attractive pastel colours and on to strong primaries. Metal or pearly aspects are possible for some colours and coatings.

The choice of colour can determine whether the building blends with the surrounding or stands out in contrast. The use of colour combinations can help to enliven the appearance of large buildings or simple shape buildings, by emphasising the vertical or horizontal aspects.

2.2 Profile

The overall visual appearance is achieved as the result of the basic design, colour and the profile chosen. Shadow can have a marked effect on the overall colour. This shadow effect varies with profile. With sinusoidal profiles there is a soft effect due to gradual transition from shadow to highlight. With trapezoidal sections the shadows are sharply defined giving character to the cladding and a wide crest and narrow trough can be used to hide the fixings in the shadow and the side lap detail is less intrusive. Large bold cladding profiles have a strong character and are probably more suitable for large buildings, and light sections may be more appropriate for small buildings as illustrated on Figure 2.2. Profiles can also be formed with a wide flat outermost and narrow recess into which the fixings are partially hidden, these profiles are termed as 'plank', and give an appearance between a profiled sheet and flat panel.

A built up system offers flexibility to the designer, profilers will supply ready formed smooth or crimped curves. The combination of trapezoidal profiles and curved sheets can be used to a strong effect. Incorporating a curved eave allows a transfer from roof to cladding profile and can be used to form a hidden gutter. Curves can also be used effectively at a junction between the main cladding and corner detail; profilers will supply curved mitred corners to allow the curve effect to be continued on the corners of the structure. These mitred corners may be manufactured at any angle to suit the structure.

Fixing the cladding profile horizontally allows the opportunity of including horizontally mitred corners or curved profile corner as shown on Figure 2.3. The profile shape is more emphasised which can add to the interest of a large building with simple overall geometric shape.

Profiles identified for the vertical plane are often precluded from installation on the roof because of their configuration and side lap detailing.



Figure 2.2 *The warehouse and office complex has a striking appearance when cladding with different profiles, textures and colours, are combined
(Photograph by kind permission of Michael Sparks Associates)*



Figure 2.3 *Industrial building clad with a combination of horizontal and curved details to produce smooth lines.*

(Photograph by kind permission of Corus P & P)

2.3 Texture

Texture can be used to highlight and create shadow. Smooth and textured coatings of the same colour, when compared from a distance will look different.

Plastisols are thick film coatings typically between 100 and 200 μm . The thermoplastic coating means that they can be embossed with a textured pattern to improve appearance and the relative thickness makes them less susceptible to damage.

Polyesters and polyurethane have similar properties and are based on low cost thin film coatings. These offer limited flexibility and moderate durability and tend to be used for basic external wall applications in drier environments such as those found in Southern Europe. Polyesters provide an ideal reverse side and interior coating as the requirements are generally not as severe as the exterior side.

PVDF (often referred to as PVF₂) is a high grade polymer coating with an inherent UV resistance offering good colour retention and stability. The coating has a good resistance to chalking and gloss reduction. The thin coat finish has limited flexibility and is less robust than other topcoats.

The reverse side of the pre-coated steel is coated with an organic coating with thickness of 5 μm and is compatible with most adhesives and paints.

3. Structural liner tray

A variation of a built-up system is to use longer spanning structural liner trays fixed horizontally between the main columns or vertically between ground rails and eaves beams, see Figure 3.1. Mineral wool is normally placed between within the troughs of the liner tray and restrained by the tray flanges. A thin layer of insulation or timber battens are placed over the ribs of the tray to reduce the thermal bridge between the flange and the external weathering sheet. Vertically or horizontally running metal profiled outer sheets are then fixed through the thin insulation or battens to the ribs of the tray which provide the structural support for the outer sheet. Structural liner trays can also be supplied either partially or fully perforated and are used as part of specialist acoustic walling systems.

Structural liner trays can be designed to span up to eight metres and therefore can be fixed between columns, eliminating the majority of cladding rails normally required in steel construction with secondary members required at openings such as windows and doors. The result is a clean finish interrupted only by the main portal frame columns.

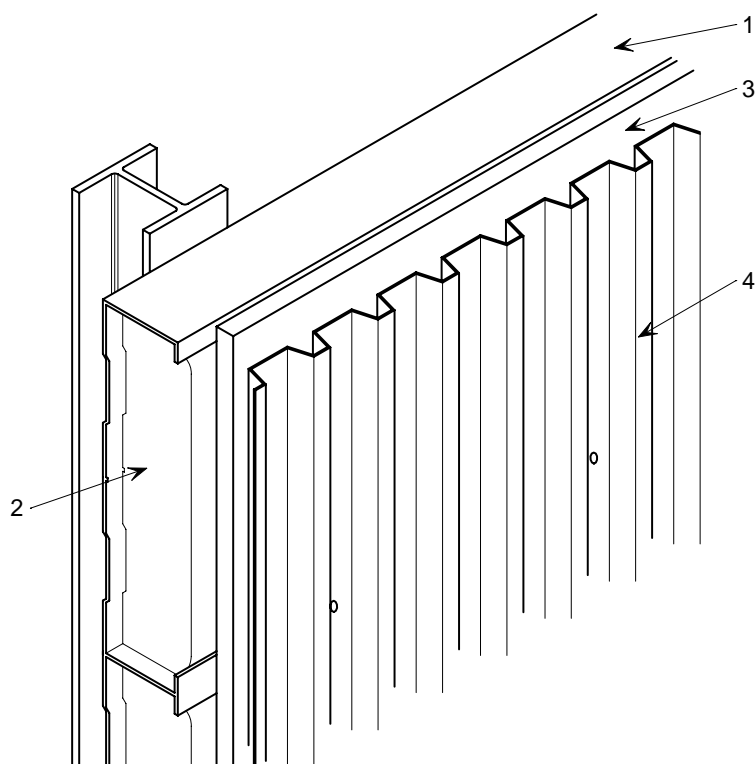


Figure 3.1 Built-up system with structural liner tray

Key:

1. Structural liner tray
2. Mineral wool insulation
3. Board insulation
4. Outer profiled sheet

4. Composite panels

Composite panels consist of an outer sheet and liner sheet which are bonded to a rigid polyurethane or polyisocyanurate foam or rockfibre core, see Figure 4.1. The foam cored panels, with a typical density of 45 kg/m^3 , are very light, yet at the same time highly rigid, allowing greater distances between supports and easy on-site handling. Rockfibre cored wall panels offer improved acoustic performance, a higher degree of fire resistance and are suitable for boundary wall conditions and are often the preferred option of some insurance companies. A rockfibre cored panel will have a typical density of 120 kg/m^3 and consideration should be given to handling on site.

The standard finishes for composite wall panels are either flat or with a micro-rib shape which is a shallow profile usually no more than 1 or 2 mm deep (see Figure 4.1). Micro-rib panels are a popular choice because the panels are less susceptible to any appearance to be out-of-true, or to damage and weathering. Composite panels can also be supplied with a beaded, trapezoidal or corrugated profile with a similar aesthetic appearance to built-up systems. Composite panels tend to be supplied as standard with plastisol, polyester or PVDF (often referred to as PVF₂) coating in a wide choice of colours.

Wall panels are supplied in standard widths, with the length manufactured to suit, allowing rapid mounting on site. The shear resistant bond between the facings and core reduces the need for sheeting rails with secondary members required only at openings such as windows and doors; this can further be reduced by the selection of structural profiles for the facings.



Figure 4.1 *An office complex clad with horizontally mounted panels with a micro-rib finish (Photograph by kind permission of Corus P & P)*

Composite wall panels can be supplied to fit vertically or horizontally, with manufacturers offering a range of male and female jointing system depending on the application and required finish. Most systems are designed so that the end joints are assembled on site. These joints are often masked by a section cap which can be manufactured from either the same material as the face or a contrasting colour. A typical jointing detail is shown in Figure 4.2.

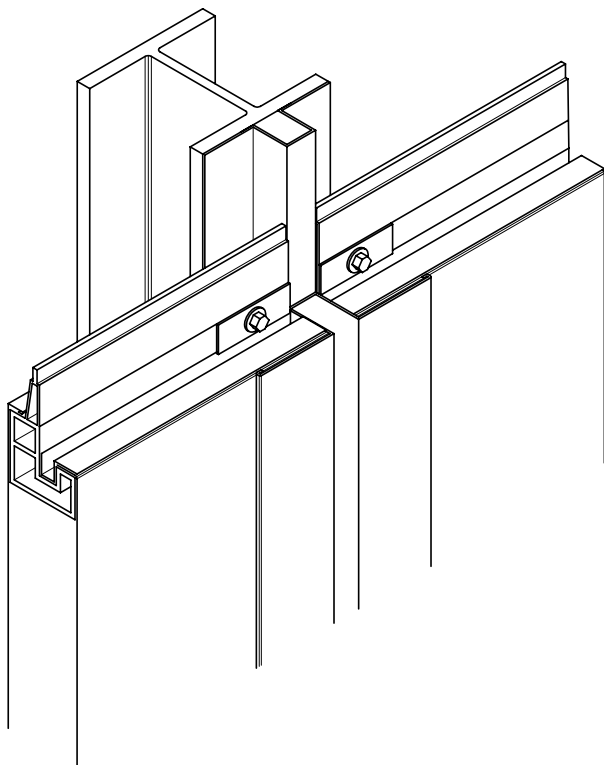


Figure 4.2 A typical composite panel joining detail with top hat

In addition to water-tightness, jointing systems must be designed to minimise thermal bridging and maximise the air tightness. Most jointing details will therefore incorporate factory fitted, soft joint-sealing strips.

When selecting a panel system, consideration should be given to the tolerance of the frame specified by the manufacturer which will have a marked effect on the finish and performance of the jointing details. If panels are being fitted in an area susceptible to damage, consideration should also be given to the type of joint system, because this will affect the ease with which a panel can be replaced.

5. Site assembled composite cladding system

A site assembled composite cladding system is a mixture of a built-up and composite system, it is made up of a metal profiled liner that is first fixed to the sheeting rails. The space between the liner and outer sheets is then filled with either mineral wool or foam board, which has been pre cut to match the liner and outer sheets as part of the manufacturing process. The profile outer sheet is then held in position using stand off type fixings, which have a separate thread under the head which engages the outer sheet. These fixings hold the insulation in place whilst providing support to the outer sheet. The complete system should be installed progressively, the insulation and top sheet being fixed directly after the liner sheet, to ensure a good fit, see Figure 5.1.

Site assembled composite cladding systems offer several features. The system reduces cold bridging: there are no spacers, as in a standard built up system, and no cross panel joints, as in a standard composite panel. The metal liner can be readily sealed, achieving high levels of air

tightness. Rockfibre or phenolic cores are often tested for high levels of fire resistance with systems achieving good levels of fire insulation and integrity. Polyurethane or polystyrene cores are suitable for constructions where there is a lower fire risk.

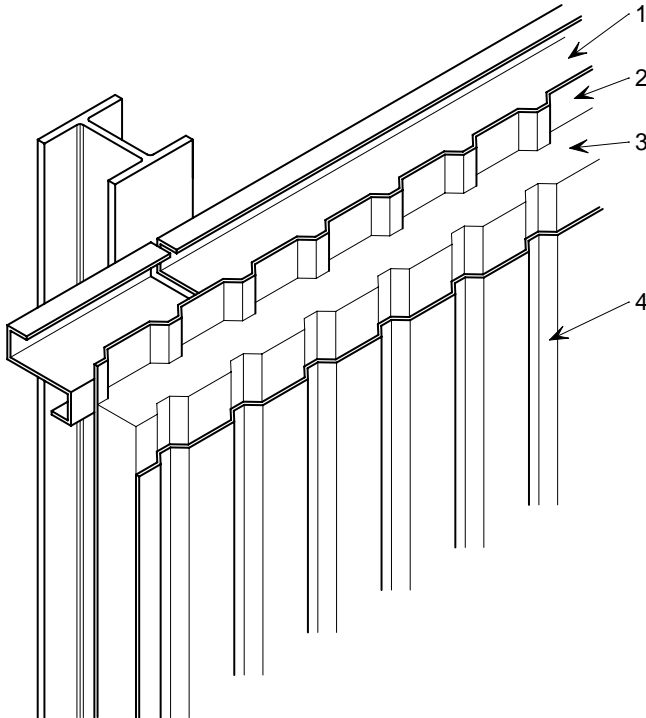


Figure 5.1 Site assembled composite system

Key:

1. Structural support
2. Liner
3. Preformed insulation
4. Outer sheet

6. Rainscreen or sealed façade cassettes

Rainscreen or sealed façade cassettes consist of modular panels with factory formed joints on all four edges which are fixed to totally integrated, pre-engineered frameworks. Modular wall panels systems are often perfectly smooth and are designed to achieve flat, clean lines. Modular panels are high quality factory manufactured products which produce an exceptional level of façade finish and tend to be used on buildings or parts of buildings where the visual impact is a key function of the building fabric.

Flat panels are manufactured to a high standard to achieve greater flatness than ordinary composite panels. The complete system is designed for precise installation. Each panel is pre-engineered and is delivered with integrated seals, trims and accessories that are suitable for most building applications. Modular panels are supplied as either composites, using a rockfibre or PIR core providing a high level of insulation, or heavy gauge single skins. They are equally suited to both single and multi-storey developments, as illustrated in Figure 6.1.

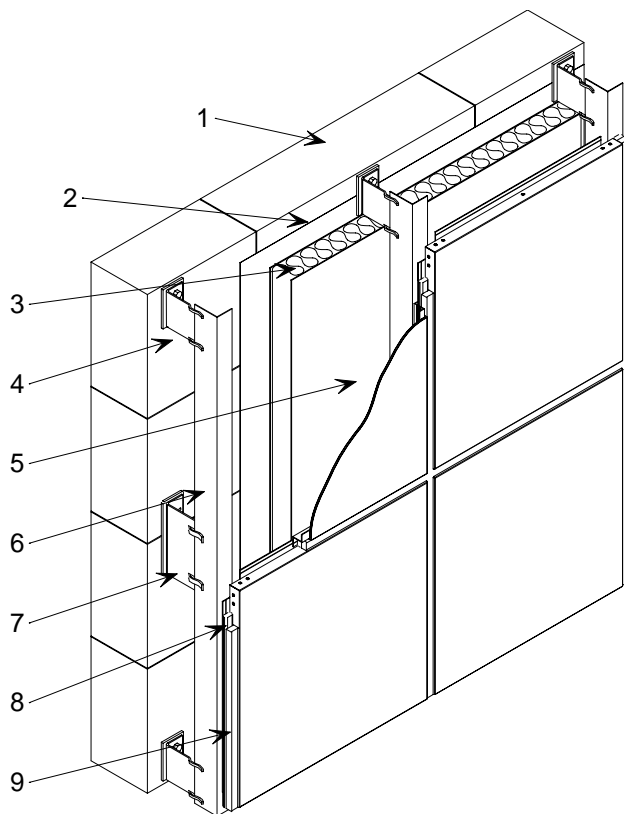


Figure 6.1 *Hotel and Inn clad with modular flat panels with fully integrated windows and pre-formed corner panels*
(Photograph by kind permission of Corus P & P)

Manufacturers have placed emphasis on the joint detail and panel integrity and most are supplied with a bi-modular self draining, horizontal and vertical interlocking joint system. Secret fixing methods are used to provide optimum water tightness and aesthetic appeal.

Modular panel systems are also supplied as rain-screens in which the horizontal and vertical joints between the modular panels are left open. A spacer system is used to hold the rain-screen modular panels away from the inner wall, with a ventilated cavity immediately behind the façade. Insulation, usually mineral wool, is fixed between and over a metal frame which is protected from moisture ingress by a breather membrane. Alternatively dense mineral wool boards are fixed back to block work or similar substrate; these systems are commonly used for refurbishment projects.

Most modular panel systems include windows, doors louvers and other openings. To ensure continuity of the system, components are also supplied for the corners and other junctions.



Key

- | | | |
|----------------------|-------------------|---|
| 1. Existing Wall | 4. Thermal Break | 7. Adjustable cleat to suit cladding zone |
| 2. Breather membrane | 5. Air gap | 8. Backup material |
| 3. Insulation | 6. Vertical Track | 9. Sealing material |

Figure 6.2 A typical rain screen cladding and spacer system

7. References

- 1 MCRMA Technical Paper No.5, Revised edition, October 2004
Metal Wall Systems Design Guide
- 2 Euro-Build in Steel, October 2005
Steel Construction in Industrial Buildings in the UK

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