Technical Note No. 15

CLADDING TYPES

Introduction

Cladding is an all-encompassing term for the external skin of a building which keeps out the weather and provides the building's aesthetic effect. In low-rise construction it may support its own weight but self-weight and wind loading are normally transferred to the structural building frame. It may form the full thickness of the vertical envelope of the building but can simply be the outer layer with additional layers providing insulation and the internal lining.

Principles of operation

Apart from providing the external appearance of the building, the main function of cladding is to protect the structure from the weather particularly rain. This may be achieved in one of three ways as follows:

- Porous materials. Porous materials such as brickwork absorb water during rain and subsequently dry out. If the wall is of sufficient thickness and the permeability is reasonably low water will not penetrate during a rainstorm. In modern construction a cavity is normally introduced into the wall to provide an additional barrier to the passage of water.

- Sealed construction. Impermeable cladding materials will only permit the passage of water at joints. Sealing the joints with gaskets or wet applied sealants provides a continuous impermeable layer.

- Rainscreen. As its name suggests, the purpose of the outer rainscreen panels is to shield the wall from direct rain. The joints between the panels may allow some water to penetrate but an air gap and airtight backing wall behind the panels combine to limit this penetration. This may be achieved by the drained and ventilated method in which the air gap is continuous and well ventilated to encourage drying out. Alternatively the pressure equalised system may be used in which the gap behind the panels is compartmentalised allowing the air to be pressurised by the wind. The reduced pressure difference across the panel joints limits water penetration.

Methods of achieving weathertightness are described in greater detail in Technical Note 17 *Weathertightness and drainage*.

Description of principal cladding types

There are many types of cladding available, which are described below, grouped according to type of construction. Some of the categories are clearly defined but others cover a range of options and some variations could be considered to fall in more than one category. The distinction between curtain walling and some other cladding types is particularly blurred.

In some cases weathertightness will always be achieved using the same method but in other cases apparently small changes to the design of the cladding will change the cladding from a sealed façade to a rainscreen. It is necessary to appreciate the effect of such decisions on the design of both the cladding and the supporting structure.

Masonry

Masonry is the predominant form of wall construction for low rise housing and is widely used in all types of building although on large structures it is often used for small areas with less labour intensive cladding materials being used for large areas of façade. The wide range of materials available means that it can be suitable for both low-cost industrial buildings and prestige structures.

Masonry is a composite construction of individual brick or block units built up in horizontal, overlapping layers (courses) and bonded and sealed with mortar (sand, cement,

and lime or plasticizer). Bricks may be manufactured from clay, calcium silicate or concrete and blocks are normally concrete or stone.

Cavity wall construction is used almost without exception for external walls because it provides an increased degree of thermal insulation and protection against water penetration compared with a solid wall of the same overall thickness. In modern construction the external leaf is normally a non load bearing cladding 100mm thick and the units are chosen primarily for their appearance, durability and cost. The load bearing structure may be a steel, concrete or timber frame or an inner leaf of load bearing masonry.

The inner leaf of a cavity wall may consist of concrete blocks, concrete or an insulated panel typically consisting of a timber frame with plywood or plasterboard sheathing. Where masonry is used for the inner leaf the requirements for the unit are normally low density (for insulation), adequate strength and low cost. An inner leaf is typically 100mm thick but this may be increased to improve insulation or strength. Thermal insulation (typically mineral fibre quilt) is often required within the cavity to comply with Part L of the Building Regulations.

In load bearing masonry and non-loadbearing low rise construction the masonry will support its own weight but the external leaf needs to be tied to the inner leaf and structural frame to give it lateral stability. In non-structural, multi-storey applications the weight of the masonry should be transferred to the frame at each storey level. In the past this was often achieved by supporting the wall directly on the floor with brick slips on the edge of the floor. Current practice is generally to support the wall on metal angles. These should be adjustable, particularly in the lateral direction to ensure alignment and adequate bearing of each panel of masonry.

Profiled metal systems

Profiled metal sheeting has traditionally been considered as a relatively cheap form of cladding for agricultural and industrial buildings. More recently with a wider range of colours and profiles becoming available its use has been extended to include retail, office, leisure and education buildings. Guidance on the use of profiled metal is given in BS 5427.

Profiled sheets of aluminium or galvanised steel may be used in various ways as follows:

- The simplest form is a single uninsulated skin supported on cladding rails spanning between the main structural columns.

- For most structures it will be necessary to incorporate insulation and this can be accommodated by using two skins of metal sheeting separated by a spacer bar and with insulation in the resulting cavity, as shown in Figure 1.

- The need for sheeting rails and spacer bars can be eliminated by using liner trays which span between columns providing both the internal lining and support for the outer sheets. The liner trays can also be filled with insulation.

- Composite panels can be formed from two metal skins separated by a layer of rigid insulation. Mineral wool can be bonded to the skins with adhesive while polyurethane (PUR) or polyisocyanurate (PIR) foams can either be bonded with adhesive or extruded between the skins, and autohesively bonded to them under expansion. The panels are supported on sheeting rails and fixed together at the edges only, relying on composite action between the skins and the core to prevent flexing of the panel between the fixing points. The edge joints may be formed by lap joints where the metal sheet overhangs the insulation along one edge or by tongue and groove joints as shown in Figure 2.

Systems typically use profiled sheets having a cover width of between 600 and 1000mm, and a length of at least 2m. The depth of the corrugations ranges from 7mm to 120mm, and the wavelength/pitch from 30 to 350mm. The spacing of fixings depends upon the wind load

and flexibility of the sheet (e.g. depth of profile) and pitch (of roof cladding), but fixings are typically made every 250-300mm along the spacers. A maximum fixing spacing is suggested as being 450mm. Aluminium has a much higher coefficient of thermal expansion than steel and the thermal movement of aluminium sheets must either be allowed for in the end lap joint design or controlled by limiting the length of sheets.

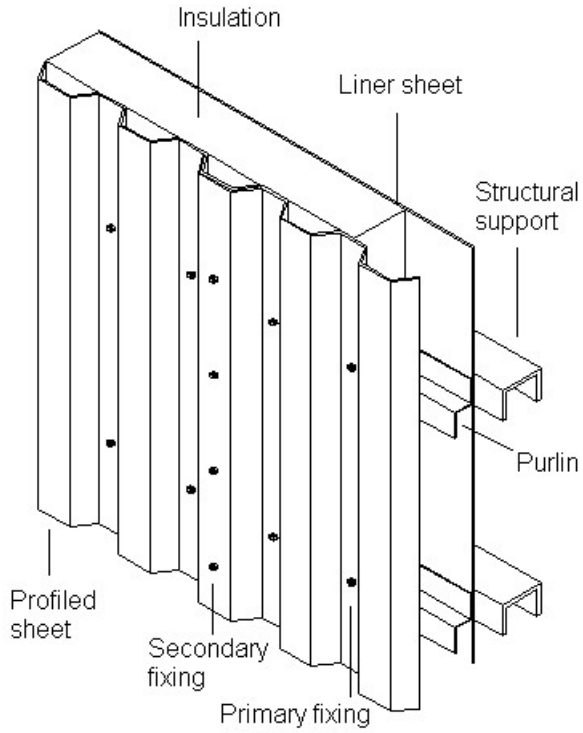

Figure 1 Site-assembled profiled sheet metal system

The simplest fixing technique is to use self-drilling, self-tapping screws with integral sealing washers through the valley of the profile and into the spacer (Figure 1). However, the fixings can also be made through the crown of the profile, in which case an additional spacer may be used to prevent the profile from being distorted and the need for an excessively long fixing. To join and seal the sheets together, stitching fixings are used along the side and end overlaps, and these may again be at the peak or trough of the profile.

A more sophisticated technique is to use a form of hidden fixing. This is common with standing seam systems, which also tend to have much shallower corrugations between the seams. Standing seam sheets lock into fixing brackets which are fitted along the spacers, and overlap the neighbouring sheet. Because these systems are designed to hide the fixings, the sheets will be narrower, and there will not be any intermediate fixings.

Secret fix cladding systems offer greater weathertightness reliability and final appearance due to the absence of fixings that penetrate through the outer sheet.

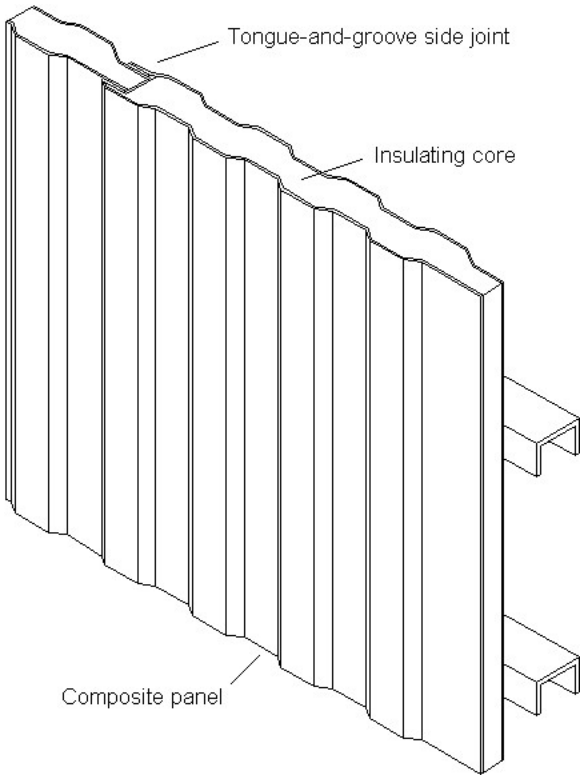

Figure 2 Composite panel with tongue and groove joint

Small cladding panels

Cladding panels vary widely in size and materials used. This section describes cladding panels that are too small to span between the main structural framing members and are either supported by a backing wall or secondary framing members (Figures 3 and 4). Small overlapping units such as tile hanging and weatherboarding have not been included in this category. Most of the cladding panels described

in this section may be fixed with sealed joints but may also be used as rainscreen panels. The

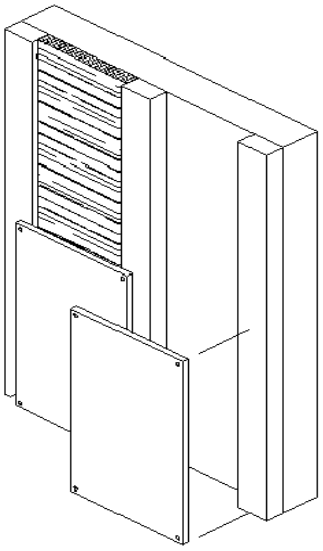

Figure 3 Flat sheet cladding supported on timber battens

method of achieving weathertightness will affect the design of both the cladding and the supporting structure.

These materials are most likely to be used for commercial buildings although they may also be used for over-cladding existing structures including blocks of flats.

Various forms of cladding panel which can be supported on timber battens or metal rails are available. This method requires a backing wall to support the fixing rails and it will usually be necessary to incorporate insulation in the wall, generally in the cavity between the cladding panel and supporting wall. This form of cladding may be used for new construction but is particularly suitable for upgrading existing buildings.

For new construction the supporting rails can be made of heavier section so that they can span between floors, as shown in Figure 4, which allows the use of a lightweight internal lining.

Panels may be fixed to the supporting rails using screws, rivets, structural adhesive, a screw-fixed pressure plate, or the edges of the panels may be folded, punched and hung onto pins through the supporting rail.

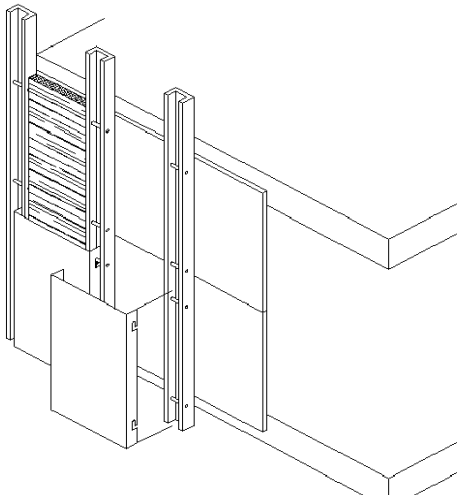

Figure 4 Metal cladding panels used as a rainscreen supported on rails spanning between floors

A range of materials may be used for the cladding panels as follows

- Fibre cement sheets are manufactured in thicknesses between 5 and 10mm and in sizes up to 1220mmx3050mm. Both cellulose and glass fibres may be used and a wide range of finishes is available including untreated, various types of paint and resin bonded aggregate. Sheets are normally supplied to site ready cut to size and with predrilled fixing holes. Similar panels may be manufactured using fibre reinforced calcium silicate, resin laminate and glass reinforced polyester.
- Panels may be made from both aluminium and steel sheet and may be given increased stiffness by folding the edges as shown in Figure 4 or adding stiffeners either within or at the back of the panel.
- Thin composite metal panels may be formed from two layers of aluminium separated by a layer of polyethylene giving an overall panel

thickness of 3 to 8 mm. The composite action of the layers gives a stronger panel than the aluminium alone. Panels can be used as flat sheets but can be bent to form curved panels or folded to form sharp corners if the inner layer of aluminium is first cut along the line of the fold.

- Thick composite panels may be formed from aluminium or steel strip separated by a core of insulation. These panels differ from those produced from profiled metal in that they are manufactured as rectangular panels and may have flat faces. The edges of the panels may incorporate grooves to facilitate fixings, which can then be hidden by gaskets. Alternatively a pressure plate fixing system can be used.

Stone has traditionally been used as masonry to form an external facing material for buildings but is now being increasingly used as a non loadbearing cladding as a result of developments in stone processing which allow stone to be cut into thin panels.

Stone types used for cladding are granites, marbles, hard limestones, slates, quartzites, limestones and sandstones that offer a range of colours and surface textures with good durability.

BS 8298 gives guidance on the use of stone panels which are normally between 30mm and 100mm thick and supported using a combination of brackets, dowels and hooks in holes or slots in the edges or back of the panels. Fixings are normally limited to four per panel and should be located on a circle to allow the panel to bow freely under thermal and moisture movements. Fixings may be attached to a supporting wall of concrete or masonry or a secondary metal frame. Guideance on the selection and testing of stone is given in CWCT's 'Guide to the selection and testing of stone panels for external use'

To reduce weight, a recent development is to use stone as a thin veneer (less than 10mm thick) bonded to a supporting background. Aluminium honeycomb faced with fibre reinforced epoxy resin on both faces has been used as a background for a number of years. Alternative treatments include fibre reinforced resin polymer and a metal mesh set in resin in grooves cut in the back of the panel. The main concern with these systems is the long-term durability of the adhesive bond, which can only be proved by experience in service. This form of cladding is described in greater detail in BRE Information Paper 17/98.

Large cladding panels

Cladding panels with sufficient strength to span between discrete fixing points on the main building frame, often as storey height panels, may be manufactured from reinforced concrete. Glass fibre reinforced polyester and glass fibre reinforced cement were introduced in the 1960s and 1970s respectively but have now largely fallen out of use. Some composite metal panel systems may be used to span horizontally between columns and strictly fall into the group but in other respects are as described above.

Precast concrete can be used to produce loadbearing cladding panels but they are normally non-load bearing. Guidance on their use is given in BS 8297.

Precast concrete cladding systems come in three forms:

- Small units supported on brackets and used to fill gaps between conventional glazing systems,
- Larger mullion and spandrel units which 'cloak' the structural frame members, often to form a window opening within each bay. Units are normally supported on bearing pads on the concrete floor slab, with packing shims providing vertical adjustment. Horizontal restraint and adjustment is provided by angle brackets and adjustable bolts,
- Full bay-width, storey-height panels with cast ('punched') window openings. Panels are of a sufficient size and stiffness to be able to span horizontally or vertically between structural frame members without requiring any intermediate support.

Panel-to-panel joints are either weather sealed with single or double wet-applied seals or left open (but baffled to prevent direct water ingress).

Concrete panels/units can be produced with a variety of smooth and coarse finishes or faced with factory-set natural stone, clay brick or tiling systems. They can also be made from carefully selected materials to give the appearance of stone.

Curtain walling

The term 'curtain walling' is sometimes restricted to metal framed curtain walls however it can also include other forms of cladding panel which are supported outside the structural frame and span between floors such as precast concrete panels. Curtain walling is a prestigious form of cladding, which is most likely to be used for high quality commercial buildings.

Technical Note 14 describes the following types of curtain walling:

- Stick systems,
- Unitised systems,
- Panellised systems,
- Spandrel panel ribbon glazing,
- Structural sealant glazing,
- Structural glazing.

Fully supported metal sheeting

Copper and lead sheeting may be used for cladding but are expensive and hence only used to a limited extent where required for appearance on prestige buildings. Due to its weight and low strength lead must be fully supported, usually by plywood boards. Due to its cost, copper is used in thin sheets that also need continuous support. Guidance on the use of lead and copper are given in BS 6915 and CP 143 Part 12 respectively.

Others

Weatherboarding and tile hanging are traditional forms of cladding which are generally confined to housing. PVC and fibre cement panels are now available as alternatives to timber for weatherboarding. Tile hanging may use traditional clay or concrete tiles, or slates of natural stone or fibre cement.

Rendering may be used as a decorative or weatherproofing finish on masonry walls but may also be used on a lightweight background. Traditionally this would be wooden lath but this has now been replaced by metal mesh that may either be expanded metal or a lightweight welded mesh. This form of cladding is not widely used and is generally restricted to housing.

The cladding types described above are established methods. New systems or developments of existing systems using new materials are continually being produced, a recent example being the use of titanium and terracotta.

Summary

There is a range of cladding systems available to suit different types of building and budgets. Claddings may use new or traditional materials, which may be used in novel ways. The principal cladding types are as follows:

- Masonry,
- Profiled metal,
- Small panels requiring support from a backing wall or secondary frame. Panels may be of various materials including metal, fibre reinforced cement or plastic, and stone,
- Precast concrete,
- Curtain walling,
- Fully supported copper or lead sheet.

References

BS 5427, *Code of practice for the use of profiled sheet for roof and wall cladding on buildings,* Part 1: 1996, *Design,* British Standards Institution.

BS 6915, 1988, *Specification for design and construction of fully supported lead sheet roof and wall coverings*, British Standards Institution.

BS 8297, 1995, *Code of practice for design and installation of non-loadbearing precast concrete cladding*, British Standards Institution.

BS 8298, 1994, *Code of practice for design and installation of natural stone cladding and lining,* British Standards Institution.

CP 143: *Code of practice for sheet roof and wall coverings,* Part 12: 1988, *Copper*, British Standards Institution.

BRE, 1998, *Lightweight veneer stone cladding panels*, Building Research Establishment, Information Paper 17/98.

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