2.2.2 WALLS

2.2.2.1 LOW-RISE WALL PANELS

GENERAL DESCRIPTION

Precast wall panels are commonly used as external walls for single-storey industrial and commercial buildings. They can be either cladding panels or loadbearing panels. Their external surface is usually off-form, often grey or painted but can have other decorative finishes as set out in Chapter 10 of this Handbook.

Typically, where two- to four-hour fire resistance levels are required, 150- and 175-mm-thick panels respectively will meet these requirements. The cover externally will generally be 40 mm, but covers both internally and externally will need to be determined to meet the minimum durability requirements for the location. The vertical joints between panels will need to be fire-rated to match the required fire resistance levels. This can be with a fire-rated sealant or fire-rated in accordance with Section 7 of the Concrete Institute of Australia's, Current Practice Note 24 (CPN 24).

For initial sizing, the thickness of the panels should be of the order of span/40 to span/50. Panel thickness exceeding span/50 will need to be designed as a column, taking into account the P-Δ effect. A minimum thickness of the precast wall panels is 125 mm when reinforced and 150 mm where a vertical projecting bar from the footing or floor engages with a dowel duct in the bottom of the precast panel. For panels up to 175 mm thick, one layer of central mesh is generally used; above that, two layers are used. Trimmer bars are normally provided around the perimeter of the panel.

The width of the panel will depend on the layout adopted and on transport. Generally, they should not exceed 3–3.5 m wide (which can be transported on drop-down trailers) but larger sizes are possible from some precasters. The weight of panels should generally be in the range of 5–15 t to suit site mobile cranage and transport. Designers should consult with their local precasters on allowable size and weight in their area.

Vertical wall panels will usually be supported on a strip footing, piers, slab edge, edge beam or similar and must be positively restrained at the bottom at the time of erection. Restraint fixing at the top of the panel can be by simple steel clips to the structure and connections to the roof structure. Restraint fixings at the base can be by grouted dowels, connection angles, a rebate or bars casts into the slab at the base of panels if the slab is cast later.

DESIGN OPTIONS

For precast wall panels there are two basic options. The first option is to use the walls as cladding only, attached to the steel portal frames and eaves tie beam. The second option is for the walls to be loadbearing, carrying vertical imposed actions from the roof or floors in addition to the lateral actions. This results in both axial actions vertically and bending due to lateral actions in the panels as well as shear actions in the plane of the panels. Generally, the base of the panel in either option is "pinned" for lateral actions.

For both options, the controlling lateral action generally will be the wind actions but other actions such as earthquake and earth pressure due to fill must be considered. An intermediate strut or eaves tie beam is usually provided to laterally support the panels at intermediate joint locations between the columns.

The BCA in Part C, Clause 1.11, requires that in the event of a fire the panel either continues to stand or, if it fails, it must fall inwards. This is particularly important for steel-framed buildings, with which in an intense fire the steel frame generally buckles, twists and collapses inwards.

CLADDING PANELS

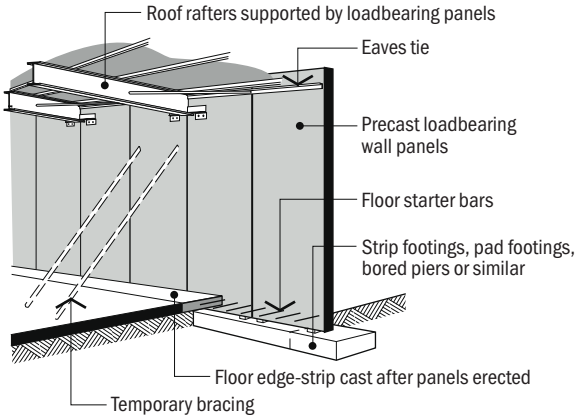
For cladding wall panels, the cladding can be in either of two configurations, vertical or horizontal. In the horizontal configuration, the panels span between columns, usually the portal columns, while the weight of the panels is supported on the panel below and in turn on the edge beam or footing. In the vertical configuration, the panels span from the footing or floor to an eaves/tie beam. Wall panels used as cladding, while not being the most cost-effective solution in material costs, allow simple and quick erection, usually with no temporary bracing. This also means the floor can be cast after the panels are erected. This option also allows easy future expansion and alteration compared to loadbearing panels and may be the more economical overall solution. Precast cladding panels are frequently not on the critical path for construction.

LOADBEARING PANELS

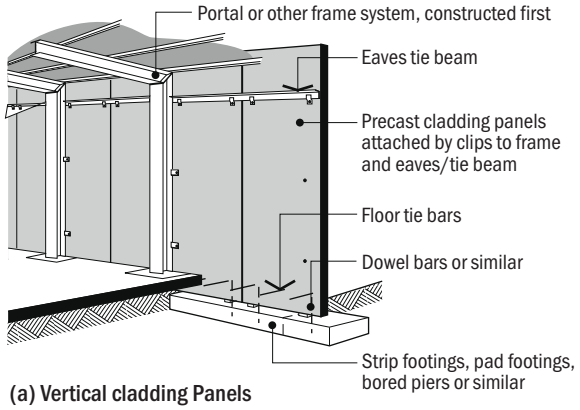
A loadbearing panel building is typically a box-like structure and utilises a stiffened roof structure to transmit lateral actions to transverse walls and then to the footings. While this can be a cost-effective structure in terms of material cost, it needs the wall panels to be erected and temporally braced, then the roof steelwork erected and completed before the temporary bracing is removed. One advantage is that no columns intrude into the interior space. For this option, each element depends on the other for support. In addition, as the floor is typically used for the fixing of the bottom of the braces, it must be cast first. Moreover, no other work can proceed in the area of bracing until the erection of all the concrete panels and steel has been completed. This means the time to complete the building can be longer than for the cladding option. It also has a greater construction risk because of the temporary bracing required.

Usually, all the wall panels on the perimeter of the building will contribute in carrying the applied actions, including acting as shear walls for lateral actions. Rafters are bolted to the wall panels while eaves ties connect individual panels at the roof level. These provide connection points for bracing trusses in the roof plane that distribute the lateral actions. The base connections have to be able to transmit the induced actions to the footings, eg by dowels into the footings and reinforcement tying into the floor slabs. Both the Cement Concrete and Aggregates Australia's, *Guide to Tilt-up Design and Construction* and *Concrete Panel Buildings* cover the design process in more detail for these types of building.

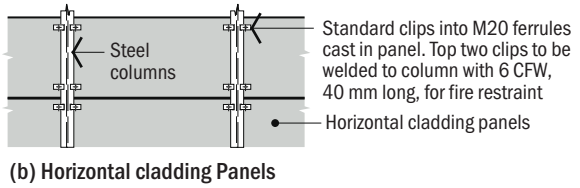
LOADBEARING PANELS – GENERAL ARRANGEMENT



CLADDING PANELS – GENERAL ARRANGEMENTS



(a) Vertical cladding Panels



(b) Horizontal cladding Panels

2.2.2 WALLS

2.2.2.2 ARCHITECTURAL WALL PANELS

GENERAL DESCRIPTION

Precast concrete wall panels create a building's character, provide fire resistance, control the thermal environment in the building and attenuate sound influx and emissions.

The surface finishes available are described in detail in Chapter 10 *Architectural Elements*. They range from heavily-textured to smooth and polished. The methods used to achieve these textures include:

- Water washing
- Grit blasting
- Bush hammering
- Acid etching
- Honing and polishing.

For economy, the facade should be divided into the largest units that can be transported and on-site cranage can handle. The usual dimensions are storey-height by bay-width. Robustness dictates that the overall slenderness of a panel should be 1:40 or less. The fire resistance requirements of the building will often determine the thickness. This effectively sets it between 120–150 mm (2 hr FRP) and 175–250 mm (4 hr FRP). The minimum is 100 mm for sufficient cover to reinforcement. Panels 125 mm thick and less have only one layer of reinforcement. The nominal joint width between precast members is 20 mm, with 35 mm between insitu construction and precast.

Frequently, panels are shaped to shade the interior of the building from direct solar radiation. Even shallow profiling can give significant reductions in the energy requirements of a building. The thickness and density of panels results in a lag in energy transmission between interior and exterior, reducing peak cooling and heating loads. These characteristics also reduce the transmission of sound, giving a quieter building interior. These subjects are further discussed in Chapter 9 *Thermal and Acoustic Properties*.

Non-loadbearing panels are usually supported by concrete haunches, or similar, in direct bearing on the supporting structure. Metal angles provide restraint. See *Design Principles for Cladding Panel Connections*.

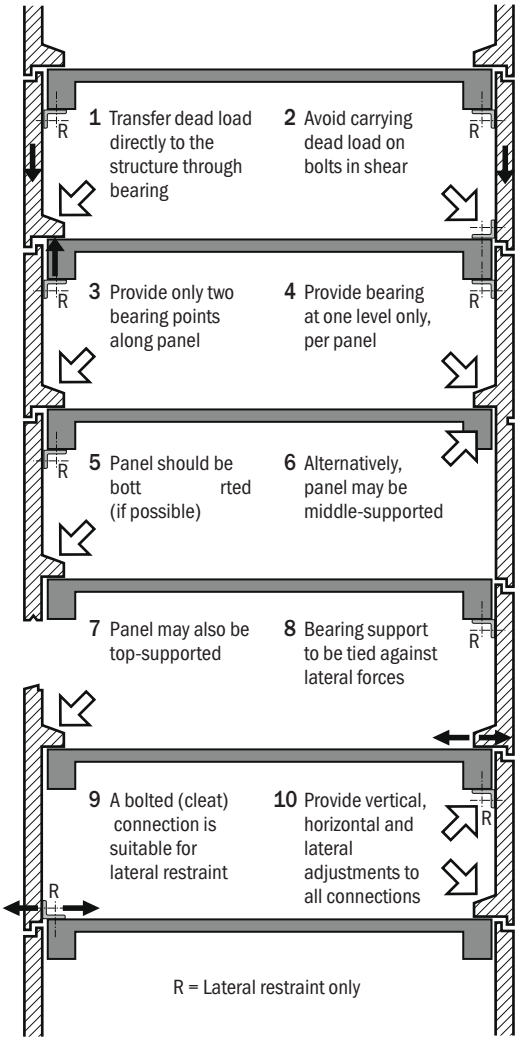
Precast panels have an inherent structural capacity. On the exterior of the building, window panels can be utilised to carry floor and column loads. Spandrel panels can span between supports to carry floor loads. The design of connections for loadbearing wall elements follows principles similar to those for columns. Loads are transmitted either by direct bearing or by dowelled connections. Progressive collapse must be considered in loadbearing wall panel construction. Alternative load paths in the structure are provided by continuity of reinforcement across joints and supports (see *Design Principles for Loadbearing Panels*).

Flat reinforced panels are used for loadbearing members internally in multi-storey construction, particularly for apartment and hotel structures Flat panel construction is an economical and simple way to build low-rise commercial and industrial buildings. The panels may be fire-rated cladding or may be loadbearing walls which also provide the lateral stability to the structure.

The thickness is usually the minimum required for fire resistance or to act as slender columns in loadbearing applications in accordance with AS 3600, Sections 10 and 11, or in accordance with an accepted higher-tier method.

Exposed steel connections will need to have the same fire rating as the wall panels.

DESIGN PRINCIPLES FOR CLADDING PANEL CONNECTIONS



DESIGN PRINCIPLES FOR LOADBEARING PANELS