ARTICLE FROM NUMBER 11 • JANUARY 1995

• NATIONAL •
PRECASTER

NATIONAL PRECAST CONCRETE ASSOCIATION AUSTRALIA
WEB ADDRESS: www.npcaa.com.au • EMAIL: info@npcaa.com.au

Fully precast, terrace style housing, North Adelaide

PRECAST, Residential Construction

We are witnessing a significant change in construction materials and construction techniques in domestic work. These changes are occurring over the entire range of housing stock, with an emphasis on medium density. They have been driven by developers and builders seeking reduced construction times, minimal risk and design flexibility yet not sacrificing customer appeal.

Factory manufactured precast concrete has satisfied all these requirements, its application varying from complete structures to componentry in the form of flooring units, balconies, stair flights, lift service cores, stair wells and wall panels, both internal and external. This article looks briefly at such application.

APPLICATIONS

The use of precast concrete in housing may extend to:

- Walling, both loadbearing and cladding
- Floors, a wide choice of options
- Stair flights
- Core units for lifts and stairs
- Balcony units
- Structural Frames.

WALLING

Panel Size – the general rule that panels should be as large as can be suitably handled holds good, providing for quick closure of the structure, thus permitting early finishing. Cast-in grooves, known as dummy joints, permit the designer to establish the domestic scale of the facade. Large panels have the further advantage of reducing joint length and joint sealing and hence, long-term maintenance.

Panel Shape – virtually any configuration of panel shape is possible, noting the issues of handling and joint length.

Figure 1 shows a range of panel shapes which are quite common. The imagination of the designer, tempered by commercial considerations is the ultimate criterion. Bear in mind that moulds can be expensive and that the expense is amortised more readily by the greater number of castings from the mould. In the picture above, the single-window panels were cast using the two-window panel mould with an adjustment for length and with the window position re-sited. The precast industry is always ready to provide advice relating to technology and commercial considerations.

Surface Finish comprises surface moulding, surface texture and colour.

Surface Moulding generally in the form of indented dummy joints, designed to give scale to the panel and to enhance weathering by breaking up surface rainwater and hence minimising staining of the facade.

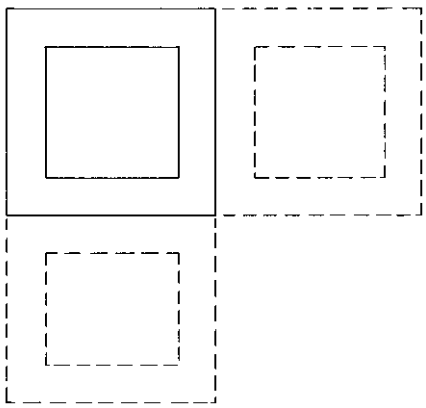
Additionally, there is a range of commercially available form-liners against which the concrete can be cast to provide a variety of moulded patterns at the face.

Decorative treatments in the form of string courses, mouldings and the like can be cast-in during manufacture or applied following erection. GRC (glass fibre reinforced cement) is an ideal material for such work.

Surface Texture; in this context, finishes achieved by further work following demoulding, include:

- polished and honed
- bush-hammered
- high pressure water or sand blasting
- etched finishes.

Polished/honed and bush-hammered finishes are relatively expensive and are likely to be reserved for prestige or feature areas of the facade. By contrast, high pressure water/sandblasting or etched finishes are significantly less expensive offering textures varying from a fine matt texture to distinctly coarse. Using colour combined with these finishes, materials such as sandstone can be readily simulated, as shown left.



'CLOSED' PANEL
May be used as single, double or triple panel units
Designer to select a joint layout to define scale and control weathering
Units may be preglazed prior to delivery

Figure 1 *Possible panel configurations. Also 'T'-, 'L'- and 'U'-shaped panels together with spandrel panels alternating with glazing*

Colour can be achieved either by:
- oxide pigments added to the mix
- certain coarse and fine aggregates (using washing/blasting/etching techniques to expose the materials)
- paints and coatings.

Whilst it may be argued that the latter introduces the issue of ongoing maintenance, it must also be recognised that the longevity of such finishes has increased immensely and is influenced largely by the quality of surface preparation and application.

Again, with smooth finishes which are the most likely surfaces to be painted, application by spray or roller significantly reduces the cost of initial application and subsequent maintenance.

JOINTS*

Joints must be designed to accommodate changes in the wall panel dimensions and movements of the building structure itself, while at the same time the joint sealant system has to prevent air and water penetration through the facade.

The face-sealed joint (**Figure 2**) uses a backing rod and a gun-applied sealant close to the external face of the panel. The joint is easy and economical to form, and provides good access for any long-term maintenance. Important considerations are:
- careful choice of sealant to accommodate movement and resistance to ultraviolet light
- importance of good workmanship, ie panel edges, clean and dry.

Additional defence can be provided by grooving the panel edges and inserting a baffle strip. This may be advisable in exposed locations.

The most commonly used field-moulded sealants are in the following three groups:

Polysulphides – Polysulphide sealants have been available for over 20 years. They remain flexible over a wide temperature range and are highly resistant to ultraviolet light, ozone. Polysulphide-based sealants bond well to concrete when a suitable primer is used and can accommodate joint movement of ±25%.

Polyurethanes – Polyurethane sealants have high resistance to ultraviolet light and will remain flexible for periods of at least 8–15 years because of their stable chemical structure. They have a safe strain capacity of ±25% and as well as their excellent elastic properties are resistant to abrasion, tearing and indentation.

Silicones – Silicone sealants have the highest strain capacity of all modern sealant materials, being able to accommodate joint movements of ±100% in many cases. They have good resistance to ultraviolet radiation and a wide range of chemicals and possess good colour stability. Neutral-cured compounds are recommended.

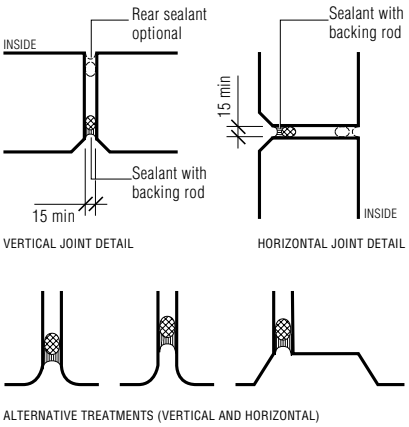


Figure 2 *Face-sealed joint.*

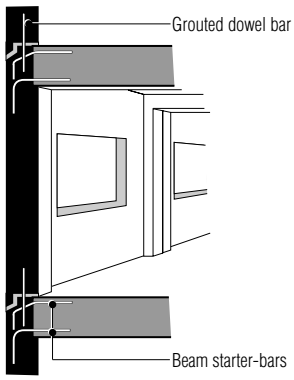


Figure 3 *Note panel detail and reinforcement omitted for clarity*

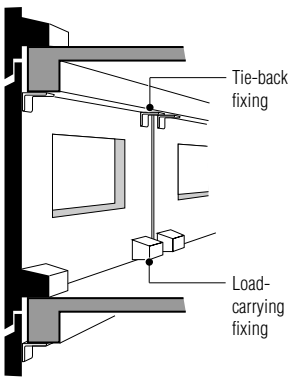


Figure 4 *Note panel detail and reinforcement omitted for clarity*

Fire Rating – most sealant manufacturers can provide for up to four-hour fire resistance.

CONNECTIONS

Loadbearing panels, both external and internal, will normally be connected using grouted dowel connections (**Figure 3**).

Structural framed residential buildings are less common, particularly in the low/medium-rise application. If used, panels are most likely to be supported on cast-in corbels, dowelled and grouted (**Figure 4**).

FLOORS

Precast flooring arrangements epitomise the advantages of precast construction offering some, or all, of the following:
- Off-site manufacture.
- The near elimination of formwork, propping and on-site steel-fixing.
- Delivery to site to the contractor's requirements. No site storage required.
- Rapid placement; rates of 1000 m^2/day are common.
- Rapid closure of the structure.
- Safe working and storage platform.
- The precast panels are cast on smooth, level beds or moulds thus the soffit or ceiling is itself smooth and capable of receiving decoration direct. Alternatively, if a suspended ceiling is required then simple clips are available or the soffit may be battened.
- Inclement weather problems measurably reduced.
- Flexibility in the siting of non-loadbearing partition walls.
- Site environmental issues massively reduced, particularly noise and clean-up requirements.
- Ongoing marketing advantages including:
  - significant noise reduction between floors and occupancies so essential in medium density construction. Whilst authorities generally call for an STC (Sound Transmission Class) of 45, precast flooring elements can easily achieve STC ratings of 45–59. (The larger the STC value the greater is the sound insulation.)
  - excellent resistance to fire.

PRECAST FLOOR TYPES

Hollow Core Planks Plank width is 1.2 m but some suppliers can provide 2.4-m-wide planks. Lengths are to suit required spans with thicknesses varying between 150 and 300 mm, the choice of thickness being determined by loading, fire resistance levels and cover to prestressing strand to meet durability requirements.

The planks provide one-way slab action and can accommodate long spans giving flexible open space with fewer beams, walls and supporting columns. Clear spans of up to 12 m can be obtained economically.

7.5-m HC planks spanning two occupancies, utilising plank properties. Note use of HC plank as balcony parapet wall

Thin coating of a proprietary self-levelling compound at panel joints where thin, flexible floor coverings are used

In planning a structural arrangement, significant benefits accrue from establishing a planning module which takes heed of the plank span capability and width module.

Core layout and amount of prestress can be varied to suit loading requirements.

All manufacturers supply design charts and data on properties for their range of plank thicknesses and profiles.

Installation Manufacturers deliver (and will erect, if required) the planks to the builder's construction schedule, allowing planks to be lifted from the transport and placed directly into position. A prerequisite for placement is a level bearing surface of adequate width.

Planks are supplied with a key along each longitudinal edge which requires grouting to allow the individual planks to work together in the transfer of load and shear forces.

Grouting and topping of the planks may be completed in one operation or, if the planks are to be left untopped, then the shear keys between planks should be grouted using a 1:3 cement:sand mortar.

Openings and penetrations can be readily provided – larger openings, such as for stairs, by using a header plank supported on a fabricated steel flat, while smaller penetrations can be cored through the plank on site, taking care to avoid the prestressing strands.

Planks are sometimes topped to develop composite action and eliminate the camber effect inherent in prestressed members. A 60- to 80-mm-thick, 25-MPa concrete topping using a light reinforcing mesh to control shrinkage cracking is normal as is the use of contraction joints.

There is now widespread use of untopped planks, the difference in prestressing camber between adjacent planks being adjusted by the erector and only the shear keys grouted.

Those floor coverings requiring a flat/smooth floor finish (eg vinyl), are frequently laid using a proprietary self-levelling compound applied to the plank surface.

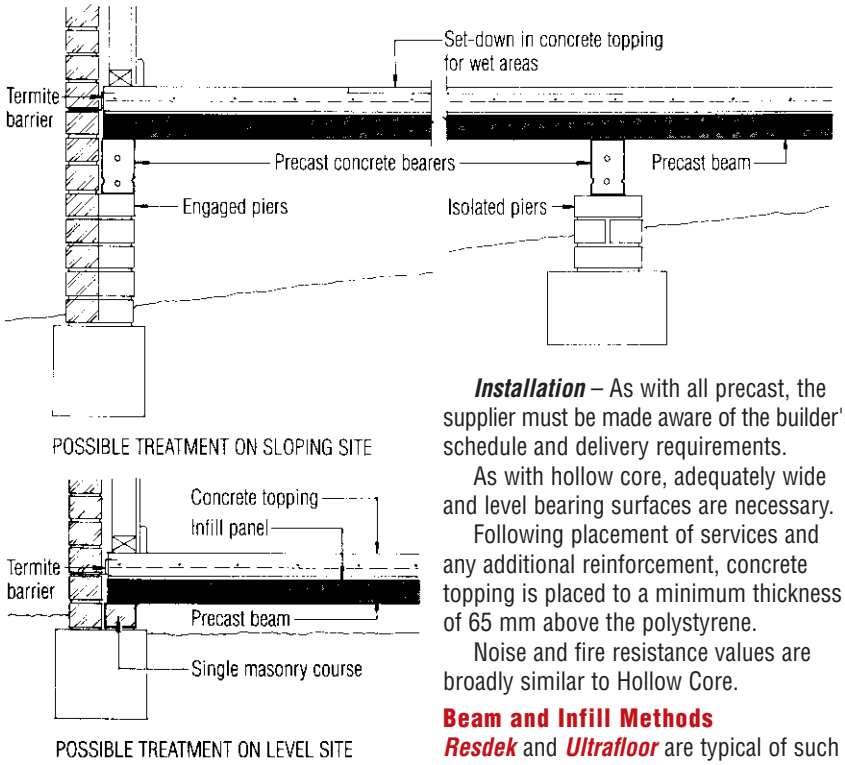


Figure 5 *Typical support treatment for Ultrafloor system*

Transfloor **or** ***Humeslab*** Involves a combination of a precast concrete soffit and an insitu concrete topping.

The soffit comprises a 55-mm-thick precast concrete panel which provides the soffit of the eventual floor. Since the units are cast in steel moulds, this soffit provides a very smooth ceiling.

The bottom reinforcement and bottom chords of the trusses are embedded in the soffit concrete as is any additional reinforcement required by the designer. Polystyrene void formers are placed between the trusses to reduce the self-weight of the unit.

Typical panels are illustrated below.

Generally, panel dimensions are a nominal 55-mm-thick soffit, panel width up to 2.5 m and length up to 12 m.

Additionally, plan shapes can be varied and blockouts for openings and services readily provided.

Installation – As with all precast, the supplier must be made aware of the builder's schedule and delivery requirements.

As with hollow core, adequately wide and level bearing surfaces are necessary.

Following placement of services and any additional reinforcement, concrete topping is placed to a minimum thickness of 65 mm above the polystyrene.

Noise and fire resistance values are broadly similar to Hollow Core.

Beam and Infill Methods

Resdek and ***Ultrafloor*** are typical of such systems. Each system comprises prestressed beams at specified centres with an infill panel. Any required penetrations for services are provided in this infill panel. Top crack-control reinforcement is placed and the floor completed with an insitu concrete topping.

This beam-and-infill-panel arrangement is attracting significant usage in both suspended floors for multi-floor residences and as a suspended floor arrangement for ground floors, particularly on sloping sites where there is an increasing reluctance to cut and fill.

Further, due to the durable nature of concrete, the clearance between natural ground and the beam can be reduced, giving savings in brick courses and ground clearance.

The precast beams may be carried on:

- masonry dwarf walls, or
- on engaged piers
- on larger beams acting as bearers, in turn supported on engaged piers using single-leaf masonry.

Manufacturers can modify beam design to cover a wide range of loadings and spans.

Resdek *beams on engaged piers with intermediate piers as required by span and spacing*

Custom-Made Solutions

Given a development of adequate size and sufficient repetition, precast manufacturers can provide floor elements of a non-standard design. Presently, custom-made balcony units are typical of this application. Panels can be provided with cast-in kerbs, with fittings or recesses to accommodate guardrails, together with openings or spigots for rainwater run-off.

LIFTSHAFTS, STAIR WELLS AND STAIR FLIGHTS

The value of using precast concrete liftshafts and stair wells for low- and medium-rise buildings is being recognised by an increasing number of clients/designers and contractors.

Very significant improvements in project construction time are available, with considerable improvements in site control.

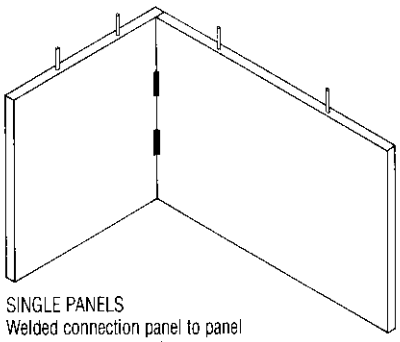
Additionally, precast concrete stair flights provide an early, safe passage between floors. A significant asset of precast stair flights is that, resulting from the extreme dimensional accuracy of casting, subsequent topping of the stair treads is eliminated.

The geometry of liftshafts and stair wells will vary, determined by such issues as access and crane size, panels may be:

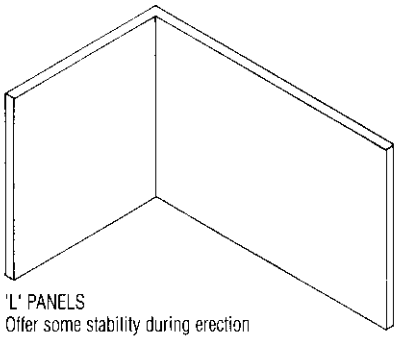
- flat but having return wall
- 'U'-shaped on plan
- open box on plan
- full storey height
- part storey height.

As a general statement, open box (on plan) shaped units, eliminating vertical joints are to be preferred with unit mass to suit crane capacity controlled by the unit height, ie half storey height. Such configurations allow for the more simple and reliable dowel connections.

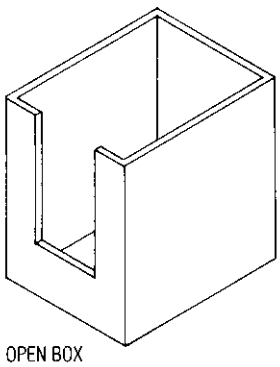
Locating precast stair flight and landing; use also of precast core walls



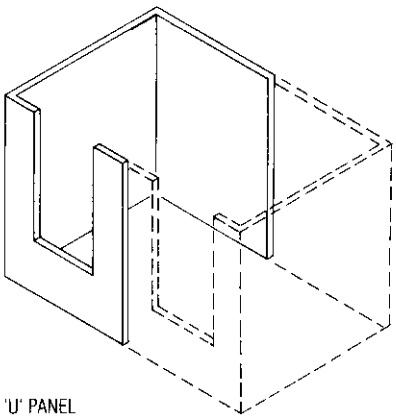
SINGLE PANELS
Welded connection panel to panel
Dowelled level to level



'L' PANELS
Offer some stability during erection



OPEN BOX
Dowelled connection level to level



'U' PANEL
Application as dual service core may require dividing wall if one lift is fire rated.
Dowelled vertical connections
Dowelled or welded horizontal connections

Figure 6 *Possible layout treatments for lift service cores and stair well cores. Note also that units may be cast floor to floor height or multiples of such allowing greater flexibility of lifting equipment*

CONCLUSION

Given sympathetic architectural input, together with practical engineering content and enthusiasm for the product by the builder, there can be only one end result: satisfaction for all parties. The client and builder use a minimal-risk construction system, controlling costs and time and, for the eventual owner, a structure of strength, good thermal and acoustic performance, excellent fire resistance, and given the architectural input mentioned above, an appearance of significant architectural merit. ■