NUMBER 24 • SEPTEMBER 2000

NATIONAL PRECASTER

NATIONAL PRECAST CONCRETE ASSOCIATION AUSTRALIA

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Total precast structure of St James Estate, Northbridge, Perth, WA

ANOTHER First for Precast

AWARD WINNER – ST JAMES ESTATE

The Fini Group's St James Estate residential development project in Perth has won the prestigious international Millenium FIABCI Prix D'Excellence Award – Residential Category, at a glittering ceremony held at the Royal Festival Hall in London, from over 303 entries around the world.

FIABCI (the International Real Estate Federation), represents some 150 property associations from over 55 countries and is responsible for real estate advice to the United Nations. FIABCI's International Awards are considered to be the Academy Awards for the property industry. Previous award winners have been the Trump International Hotel, New York and Euro Disney in Paris.

The massive St James project, located in the heart of bustling Northbridge, features some 20 residential buildings including the Hotel of Serviced Apartments, which was a total precast structure. Each of the buildings has its own unique architectural identity and finishes brought together to form a cosmopolitan village.

Initial planning for the project, comprising of a diversity of terraces, town-houses and apartments, specified brick walling and in-situ concrete flooring as the major building materials. However, a reassessment of the project looked towards precast concrete to overcome many of the problems associated with developing inner city sites. Subsequently, precast walls and floors were incorporated in many of the buildings at the design stage after consultation with the precaster, Delta Corporation. Overall, precast components extended to basement retaining wall panels, party walls, lift shaft walls, staircase flights and hollowcore floor panels.

Moreover, the use of precast has contributed to the diversity of colours, features and detail on each of the different buildings, adding to the character of the development.

According to Project Manager, Jim Ashenden, this was the first time the Fini Group used precast concrete as a system for a major project and they have been impressed by the benefits it offers. Jim says "Using precast materials has vastly increased the speed of construction and has minimised the requirements for exterior scaffolding. Aside from its bottom-line cost effectiveness, it has also allowed a greater ease of architectural detailing."

The Fini Group's design and construction team for the St James Estate included architects, Jones Coulter Young Pty Ltd and engineers, Sinclair Knight Merz Pty Ltd. ■

ACN 051 987 181

ISSN 1037-9908

PRECAST Connections and Fixings – Part 2

This is the second part of a three-part technical advice series covering recommended practice for design of precast connections and fixings. In this issue, the focus is on bearing and restraint connections for both solid cladding and hollowcore cladding.

CLADDING PANEL CONNECTIONS

There are a number of important principles that should be followed in the design of connections for precast cladding units:

- Panel connections must resist the self-weight of the panel in combination with the external forces imposed on it. The primary external forces arise from wind and earthquake. Induced forces may also arise from movement of the building frame and panel creep or shrinkage. Temperature variation will also cause panels to bow and move axially, giving rise to restraint forces. All these forces can be calculated with reasonable accuracy and resisted or dispersed by simple detailing. Generally bowing and axial movement nearly compensate for each other and the small dimensional change is absorbed by the fixing.
- The panel should be attached to the building frame so as to reduce the effects of any induced forces. This means that the panel should be supported in a statically determinate manner. Thus there should be no more than two supports and two restraints. Supports and restraints should be as far apart vertically as the panel dimensions and structure permit; small lever arms allow out-of-plane rotation.

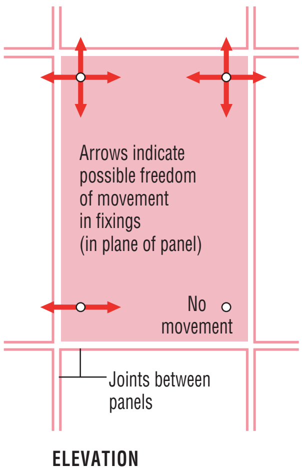


***Figure 1** Typical panel fixings*

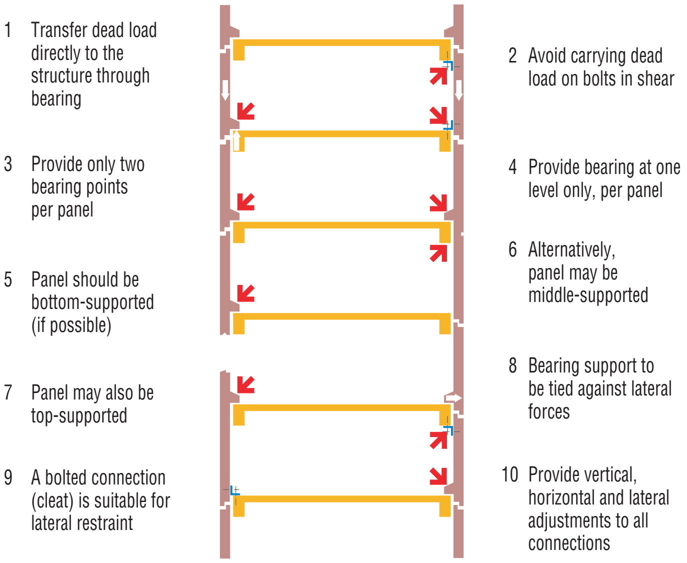


***Figure 2** Design principles for cladding-panel connections*

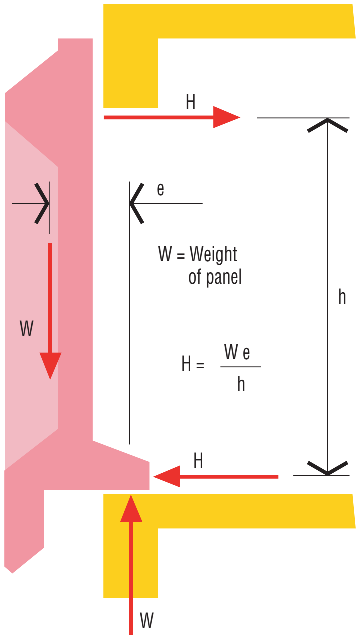


***Figure 3** Eccentricity of gravity forces*

- The entire weight of the unit is carried at the one level. The restraint fixings should preferably be accessible from this level for ease of erection. The panel fixings should be carried in direct bearing if possible. The preferred fixing system to a building frame consists of two concrete haunches and two steel restraint angles. This gives a robust but flexible attachment of the panel to the structure. Dowels in the haunches resist lateral loads. Clearance holes and packing at the restraint fixings absorb building tolerances and isolate the panel from differential movement of the structure. Other support methods substitute steel fabrications for the haunch and clips for the restraint angle.
- Units should be provided with fixings as shown in **Figure 1**. The arrows show the freedom to movement that can be provided at each of the fixings in the plane of the panel. Each of the fixings must provide resistance to wind and earthquake forces perpendicular to the plane of the panel. These may augment gravity forces.
- Connections should be chosen so that the loads are transferred through the connections as simply as possible with minimal eccentricities. The design of the component fixing must allow for the forces and moments in the detailed design **Figure 3**.
- Connections should allow economical fabrication of the precast elements. The hardware should not interfere with concrete placement, cause finishing problems nor make it difficult to provide the specified cover to reinforcement.
- Connection details should be standard-ised as much as possible. This results in economy, speed and simplicity during production and erection, and also reduces the chance of error.
- Connections should be detailed so that hoisting equipment can be quickly released. It may be necessary to provide temporary connections that are released after final adjustments are made.

Cladding Panel Connection Categories There are many possible combinations of anchors, plates, bolts and angles, etc to form various connection assemblies. However, there are two basic categories of panel connections – bearing and restraint.

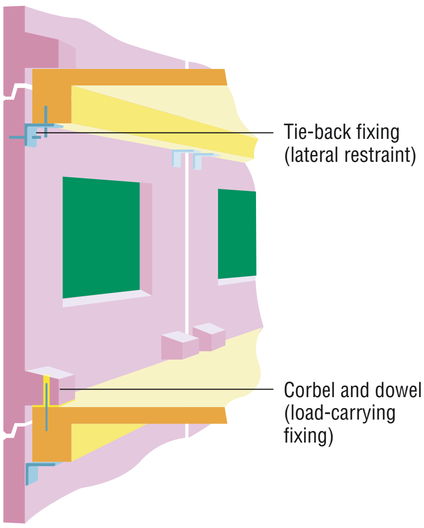
Bearing Connections Bearing connections transmit load by direct bearing of one unit on another or the structure. Particular care should be taken in the detailing to prevent cracking in the supported as well as the supporting member.The interface material must cater for the vertical, horizontal, and rotational forces.

Some form of variable-thickness packing material is necessary to absorb tolerances (eg mortar or shims).

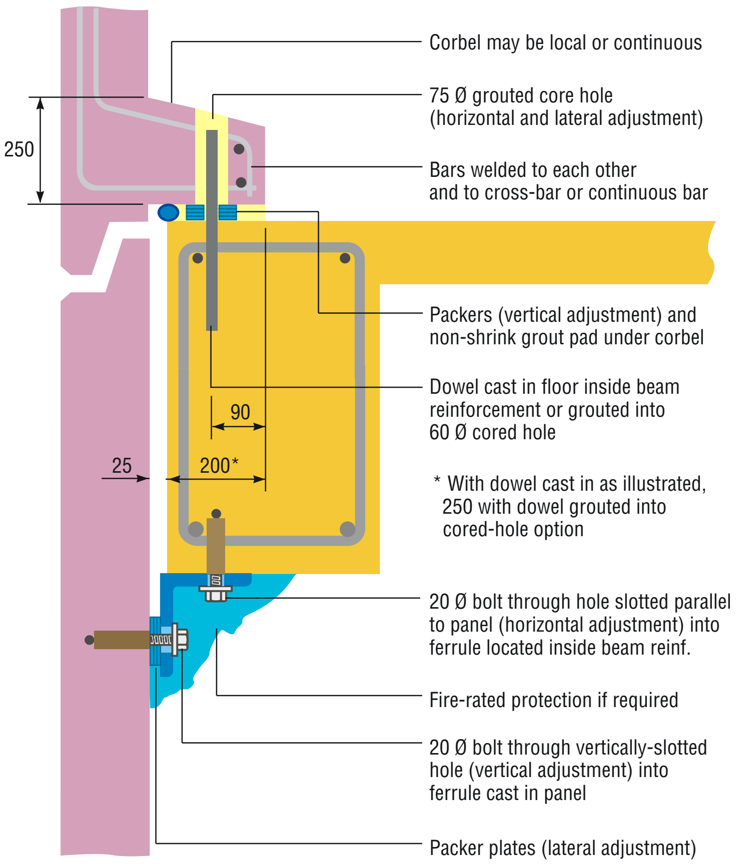
High bearing-intensities may be developed at edges of a bearing surface due to deflection and twisting of the supported member, as well as mismatching of the bearing surfaces. This can cause cracking and spalling unless they are taken into account or avoided in the design of the connection. Chamfered or protected edges will alleviate this problem.

- **Haunches** These can be either concrete or steel. A typical concrete corbel or haunch cast on a cladding unit is shown in **Figure 4**. It can also be fabricated from a rolled steel section such as an angle or channel, a plate on edge, or for light-weight units (up to 3t) a plate on flat.
- **Angle seat bearing connections** Other items used to support cladding units are steel angles. Depending on the load to be supported, the angle may need to be stiffened. Note that confinement reinforcement is needed around the embedded ferrules to add ductility to the connection.

Restraint connections These stabilise the panel against out-of-balance gravity loads and resist horizontal windloads. For ease of erection they should preferably be accessible from the same lever as the support fixings. The simplest is an angle as in **Figures 5**. Panel-to-panel restraint connections can also be used in the horizontal direction to hold adjacent panels together.

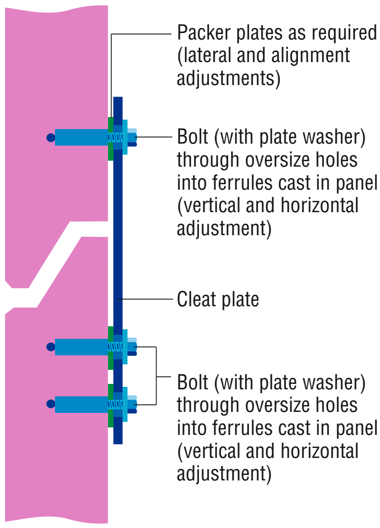


GENERAL ARRANGEMENT



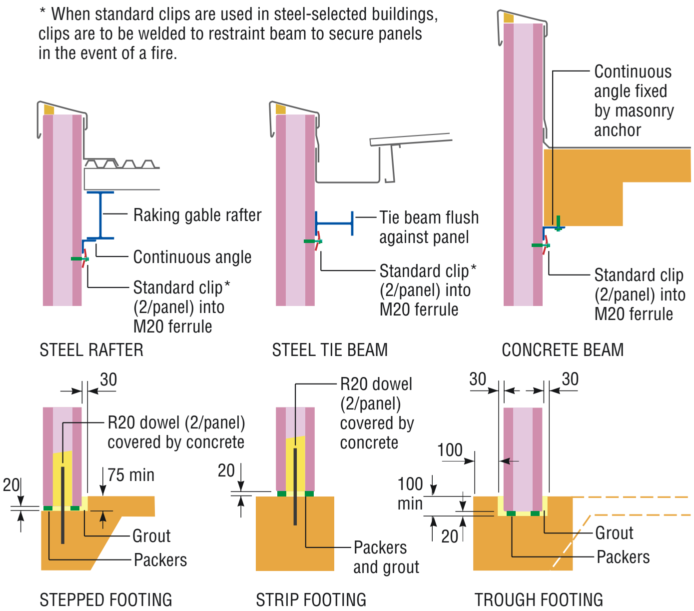
CONNECTION DETAILS

Figure 4 Concrete or steel corbel bearing connections

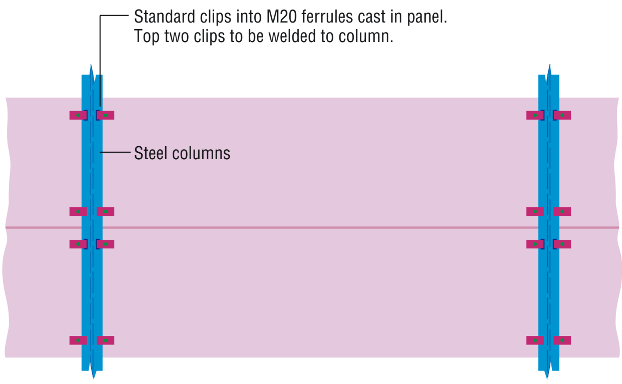


NOTE: Lower panel must have lateral restraint (eg, a corbel)

Figure 5 Restraint connections



HOLLOW CORE WALL PANELS USED IN VERTICAL CONFIGURATION



HOLLOW CORE WALL PANELS USED IN HORIZONTAL CONFIGURATION

Figure 6 Hollowcore panel connections

Hollowcore panel connections

Hollowcore panels are usually non-loadbearing cladding panels. They may be single-storey panels spanning vertically or horizontally and are fixed to the building frame. The frame can be of steel or concrete. Details of typical fixings at the top and bottom of the panels are shown in **Figure 6**.

More detailed information on the subject of Precast Connections and Fixings is covered in the **PRECAST CONCRETE HANDBOOK** *to be published by the NPCAA and CIA early next year.*

Western elevation of Westin Hotel facing Swanston St, Melbourne

WESTIN HOTEL Project, City Square

Melbourne's famous Swanston St has taken on a new look with the redevelopment of the City Square site to accommodate the 5-star Westin Hotel supported by attractive landscaping with gardens and paving.

Fifty percent of the redevelopment consists of 13 levels of hotel and apartment space (262 rooms and 32 units, respectively), above 3 levels of underground car park designed to accommodate some 550 vehicles. The other 50% of the site adjoining Swanston St has been landscaped with water features and planted areas.

For the facade cladding from level 2 to 7, acid washed precast load-bearing panels were chosen. These were supplied by South Australian manufacturer, Constress

Key features of the precast component of the project:

CONCRETE PROPERTIES

Surface Finish The architect required a sandstone appearance to complement adjacent heritage buildings. Fortunately, South Australian aggregate suppliers were able to source a wide range of coloured sands which give a more natural appearance than oxides with this type of finish. From an extensive range submitted, the architect chose a sample containing a blend of off-white cement together with 75% yellow and 25% red sand.

Mix Design The mix provided a concrete strength of 50 Mpa sufficient to satisfy both the load-bearing design and to ensure colour consistency throughout the project. While some plasticisers tend to noticeably darken the concrete, the chosen type was a milky colour, which was ideal for blending with the off-white cement in terms of strength and colour consistency. In terms of the mixing process, all concrete was batched in a computerised pan mixer with electronic slump control, which automatically compensated for moisture content in the aggregates.

MOULD DESIGN AND MANUFACTURE

The simulated sandstone appearance demanded a type of finish that exhibited minimum surface irregularities which therefore required precision mould manufacture. Apart from design for sufficient rigidity, extreme care was taken to conceal lining joints under rebates and false groove formwork on the base of the mould. A small chamfer was designed to incorporate a rubber seal to avoid slurry leakage.

Considerable cost saving was effected by casting the hundreds of sills into the main panels even though the sills protruded past the casting surface. This was achieved by casting the panel over the edge of the mould.

As the job detailing required an inordinately large number of small panels, production efficiency was maintained by setting up 3 or 4 pieces in the one mould table, thus allowing all to be cast at the same time.

Precast panels propped, aligned and pre-grouted prior to erection of formwork for next level

T-shaped precast panel incorporating overhanging sill being hoisted into place

After casting and demoulding, the panels were acid washed face up with a slight fall to allow smooth brooming of the face without ponding.

PROGRAMME

With the large number of panels involved 1216, (approximately 100 per floor), careful planning was required to ensure that the builders met their tight construction schedule.

The precaster's computerised manufacturing programme chose the most efficient casting sequence and gave the casting date of every panel on the project. The computer then matched this with the builder's floor cycles and identified any panel which might be late. A decision could then be made either to interchange late panels with those ahead of programme or to introduce additional moulds to speed up the casting sequence.

As the project progressed, the builder's actual delivery dates were inserted in the programme and the priority of the panels reassessed. Although the builder accelerated construction from its original programme, all panels were delivered 'just in time' as a result of the close cooperation with the precaster.

The design and construction team responsible for the project was:

Builder Grocon Pty Ltd
Project Management Staged Developments Pty Ltd
Architect City Square Hotel Architects
Engineer Bonacci Winward
Precaster Constress Pty Ltd

PRECAST Clarifies the Solution

For years there has been increasing demand for structural precast elements. A long time ago precasters found that the skills acquired in non-structural/architectural units could be practically and profitably put to use in their heavy-duty counterparts.

Periods of economic growth, especially the much-maligned mid-1980's, coincided with the increased relevance of structural precast. The advantages of speed and quality of construction, made possible due to off-site factory fabrication, along with a ready made skill base in this very familiar material made structural precast more and more attractive to contractors.

Whilst hardly the most glamorous of projects, the four new sewerage clarifier tanks for Melbourne Water at the Werribee Treatment Plant in Melbourne's outer West, currently being built by John Holland, are an excellent example of structural precasting used to its best advantage. Part of what is officially known as the Environmental Improvement Project in Lagoon 55 East, it is an example of Melbourne Water's commitment to the continued research into ecologically sound methods of treating the ever-increasing supply of sewerage.

The key to making any large scale precast job a success is repetition. The designers of the clarifier tanks, Sinclair Knight Mertz, have rationalised the elements to eight. With nearly 300 units to produce across all types within a tight schedule it is the near elimination of non-productive moulds at the end of a day's work that is the constant aim of the precaster and can mean the difference between an economical project and a blowout.

Installation of 3 m high panels to form walling of 45 m dia Clarifier Tank, for Melbourne Water at Werribee Sewerage Treatment Plant

Designed to be post tensioned due to the nature of the job they are to do, the units are also heavily reinforced. The precaster, Westkon Precast Concrete noting the volume and complexity of steel fixing required in the job, enlisted the help of it's steel supplier Smorgon ARC, to supply prefabricated, tack-welded cages direct to the factory on a near daily basis.

The heaviest and most complex of the units are the post-tensioned anchorage panels. Requiring their own specially fabricated mould and weighing in at a considerable 15 tonne, these items fortunately make up only 4 of the 73 panels per tank. Reinforced at a rate of approximately 350kg/m^3, the cages take up to 3 days to fabricate at the Smorgon factory. With a casting turnaround of 1 panel per 2 working days (other panels being cast at up to 6 per day) ongoing production requires constant co-ordination of all contributing parties. The anchorage panels are very much the exception to repetition that proves the rule.

The structural precast elements are generally in the order of 3 m by 4 m, 200 mm thick curved panels. They are designed to form circular tanks of 45 m internal diameters. The forms for all panels were designed and custom made by the precaster. The most challenging aspect of the standard form was achieving (and maintaining) the constant radius across the arc length. The moulds were professionally surveyed and approved prior to the commencement of casting. The radius was critical due to the tight tolerances of the rotating arms to stir the brew that extend to the edge of the tank.

Construction of the Olympic Rail Loop with TechSpan® Arch Tunnels in Sydney

MEMBER Profile

REINFORCED EARTH PTY LTD is a specialist engineering design and supply company with more than 25 years experience in the civil engineering industry in Australia.

Since introduction to Australia in 1974, Reinforced Earth technology has been utilised in more then 600 projects, providing specialised engineering systems to a wide variety of clients in Australia, New Zealand and other areas of South East Asia and the Pacific. They aim to achieve successful outcomes for their clients and business partners through skillful implementation of specialised services which will assist clients by providing innovative yet practical and cost effective solutions for projects.

Specifically, Reinforced Earth Pty Ltd is the market leader in the design and supply of mechanically stabilised soil retaining walls, particularly with precast concrete facing panels. They also offer sophisticated concrete arch structures where experienced and professional design services tailor systems to meet the needs of the project. Detailed design drawings are produced and submitted to the client together with manufacturing and construction specifications. They then manufacture the specialised materials and supply to the client's project site. Extensive onsite technical back-up is provided to assist the client in installing the Reinforced Earth structure correctly and cost effectively to achieve the best result.

Reinforced Earth's product range includes the following:

TechSpan® – A three pinned reinforced concrete arch system that is designed and supplied to meet the specific needs of the project. TechSpan arches have been supplied to a wide range of projects including rail tunnels, road tunnels, water crossings, and reclaim tunnels for mines, amongst others.

TechCulvert® – a single piece, two pinned arch in smaller spans to the TechSpan, most practically used in culvert applications.

TerraClass® – The familiar cruciform shaped concrete facing panels used by the Reinforced Earth Company for many years. These popular panels can be supplied with many attractive finishes.

Terraset® – The larger rectangular panels offered by Reinforced Earth for four years now. Also available in a range of finishes.

The 'Terra' range of products represent the traditional Reinforced Earth technology. These products are used to construct retaining walls that may act as bridge abutments, seawalls, dump structures, containment structures, headwalls and other applications. ■

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NEW MEMBERS

The President, Directors and Members welcome the following new members to the Association:

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Major manufacturer of building and civil engineering precast products in WA.

ASSOCIATE MEMBER Grace Construction Products
Suppliers of concrete admixtures, curing compounds and waterproofing systems.

OVERSEAS MEMBER Golden Trend Construction Ltd
Suppliers of precast concrete facades, stairways and beams to the Hong Kong building industry.

Published by **National Precast Concrete Association Australia** 8–10 Palmer Street North Parramatta NSW 2151 Australia • **Tel [02] 9890 8853**