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NATIONAL PRECAST CONCRETE ASSOCIATION AUSTRALIA

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PRECAST Shows the Way

PROJECT BACKGROUND

The Pacific Highway between Logan and Nerang forms the major part of the only substantial road link between Brisbane and the Gold Coast. It is one of the most heavily trafficked sections of the Highway, carrying up to 85 000 vehicles per day.

In 1986 the Queensland Government announced that this 43 km section of the Pacific Highway would be upgraded to a multi-lane, world-class motorway. The $750m project includes:

- A 35 km eight lane section from Logan Motorway to Smith Street Motorway
- An 8 km six lane section from Smith Street to Pappas Way, Nerang
- A service road network for residents making local trips
- 16 interchanges
- 90 bridges and major culverts
- Parkway landscaping of over one million trees and shrubs to enhance the experience of driving the motorway.

Elevation of multi-hued panels after erection (above) and an aerial view of Nerang-Broadbeach Road featuring some 362 precast noise barrier panels (right)

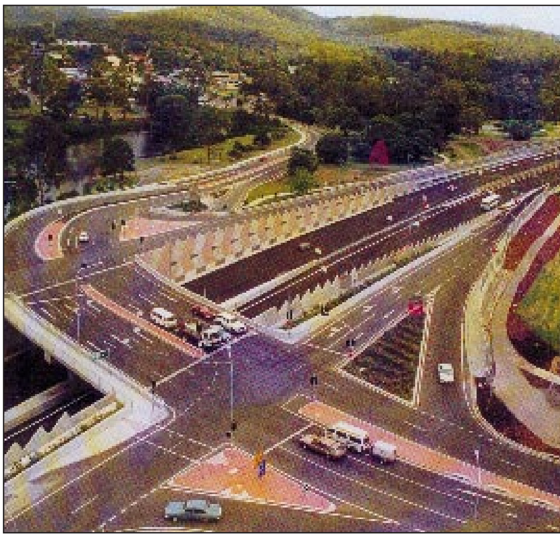
The overall project was divided into six separate contracts . Section 6, the 2.5 km section from Nerang River to Pappas Way was designed by Hyder Consulting and built by John Holland Construction & Engineering. This section featured a major interchange at the Nerang-Broadbeach Road, which featured precast noise barriers supplied by NPCAA Member, Precast Concrete Pty Ltd of Carole Park.

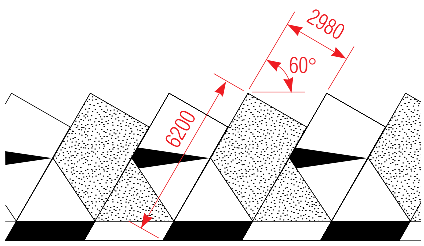
PRECAST CONSTRUCTION

Precast concrete plays a major part in the overall project in both a structural sense and an architectural sense – structurally, in its ability to readily accommodate the substantial heights of earth; architecturally, in providing the freedom of expression to create a structural landmark rather than an intrusion in the landscape.

Precast concrete was preferred for the interchange because of the versatility it offered in opening up a range of design options. Achieving the mosaic pattern, a stand-out feature to the walling, could only have been achieved economically and to superior quality levels through horizontal stage casting under factory conditions. Moreover, the unique varying surface textures and colouring using oxide pigments, was readily accomplished through producing the units in a controlled under-cover facility.

The supply of the precast noise barriers was a challenging project in its own right with the manufacturer required to supply some 362 complicated patterned panels which varied in weight from 6 tonne to 19 tonne over a nine month period. Initially a series of prototypes had to be made to ensure the multi–hued mosaic pattern could be replicated satisfactorily. Most of the panels incorporated different hues and different surface textures within a single





Typical elevation of panels facing roadway

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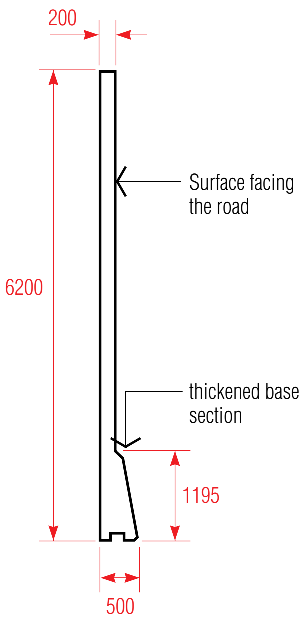
Panels in storage at precaster's yard awaiting delivery (above) and a 6.2 m x 3 m precast panel being transported from factory (left)



Typical sectional view of panel

panel – ranging from off-form black through to off-white and sandblasted simulated sandstone. Colouring oxides were used together with offwhite cement to achieve these effects. Some of the more complex panels were wet cast in five separate stages to ensure that the pattern was consistently achieved.

The handling and erection phases presented further challenges to the manufacturer; special storage racks and transport frames needed to be designed to get the large panels safely to site without damage. Many panels could only be transported one at a time to the site because of their size. Special erection equipment was also utilised to position panels into the 60° orientation required.

In summary, precast 'showed the way' in providing a key section of of the Pacific Motorway with noise barriers having excellent noise attenuation properties, superior structural performance, aesthetically appealing surfaces and a long, maintenance-free life. ■

CORRIGENDUM

In the feature on the award-winning **St James Estate, Northbridge** in Issue 24 – September 2000, we wrongly accredited the design aspects to Sinclair Knight Merz Pty Ltd. We apologise sincerely for this error and wish to give due recognition to Barwood Parker Australia Pty Ltd as the design consultants responsible. Barwood Parker were engaged by the Fini Group to carry out the structural engineering design of this major building in the complex.

There were many details used that were developed by the company including the 'jetted-in' hollowcore basement walls and the precast floor to wall connections.

Barwood Parker Australia Pty Ltd of Canning Bridge, Western Australia commenced practice in 1978 as Barwood Parker Pty Ltd, specialising in Civil and Structural Engineering. The principals each have 20 to 30 year's experience encom-passing a wide range of civil and structural engineering. Much of this experience originates from early years in construction including mining, contracting, the Snowy Mountain Scheme and the precast concrete industry. ■

SPECIFICATION of Surface Finishes Under AS 3610

1 INTRODUCTION

Precast concrete offers designers opportunities to achieve a high standard of surface finish. It however encompasses a wide range of products – from below ground pits to polished reconstructed granite facades. This data sheet deals with those precast concrete components which are exposed to view and which are required to have a finish meeting certain architectural criteria and which are not adequately dealt with by AS 3610. This will include facade units other than those with an applied finish, some structural components such as bridge units, building columns and beams and street furniture.

There are two broad categories of architectural precast concrete – off form and exposed aggregate finishes. The latter category includes sandblasted, polished, honed, water washed, acid etched and like finishes where the off form surface layer of fines is removed.

The Australian standard which covers surface finish is AS 3610—1995, *Formwork for Concrete*, and its Supplement 1—1990. These documents cover only off form surfaces and do not apply to unformed or subsequently treated surfaces.

2 DIFFICULTIES WITH AS 3610—1995

Specifiers often call for inappropriate classes of finish based on AS 3610. The most common of these are calling for a class of finish concerned with off form concrete when exposed aggregate is specified, calling for a class of finish where the surface in question is unformed, and calling for a Class 1 finish which is impossible to achieve in all but a minority of cases.

A further difficulty is the administration of the AS 3610 specification for colour control. The colours in the code are grey and difficult to translate to typical precast concrete colours and therefore especially difficult to use for the evaluation of individual precast units.

This data sheet seeks to provide a basis for rational specification of surface finishes.

3 APPLICABILITY OF SURFACE CLASSES

Class 1 Class 1 should not be specified except as allowed by AS 3610. The restrictions covered by the code include:

- Class 1 is the highest standard with the most rigorous specification and is only recommended for use in very special features of buildings of a monumental nature.

- Selected small elements
- Areas of special importance in limited quantities
- Elements contained in a single pour. This of course implies that finishes from different pours will differ from one another.

It is clear therefore that, as much as all concerned would have a preference for specifying what seems to be the best, Class 1 must never be specified for areas such as a facade, for structural units in a project or for other instances which fall outside of the restrictions quoted above.

Class 2 Class 2 is that which will be specified for most good quality architectural precast concrete.

Class 3 Class 3 has application for buildings and structures where visual quality is important but which is of less importance architecturally. It provides a perfectly acceptable standard for many industrial and civil structures and will result in cost savings for the owner.

Classes 4 and 5 These classes are for situations where the visual quality is not important and apply to surfaces which are concealed from general view or are never seen. They are outside the scope of this data sheet.

4 CONTROLLING SURFACE FINISHES IN PRACTICE

The specification of Class 1 finish can only be for a very important element in a very important structure. It will rarely occur. It is essential that the specifier be completely confident of what can be achieved or that trials are carried out before an order is let.

The overwhelming majority of finishes will be Class 2 and 3. These are simple to specify and achieve for flat or uncomplicated precast units but far more difficult for complex units. AS 3610 is very difficult to apply to off form finishes for blowhole and colour control. It will often lead to a greater range of colour variation or blowhole size and number than is desirable. By far the best result in these areas comes from the provision of samples from the manufacturer and by reference to existing buildings with similar characteristics.

Sophisticated polished, sandblasted and other such architectural finishes must be controlled by samples and by reference to good practice as found on existing buildings. Samples made from moulds incorporating any complex shapes or other details may be required if the outcome cannot be confidently predicted. The designer must then inspect the first panels from the production moulds to ensure that variables such as the depth of sandblast are satisfactory.

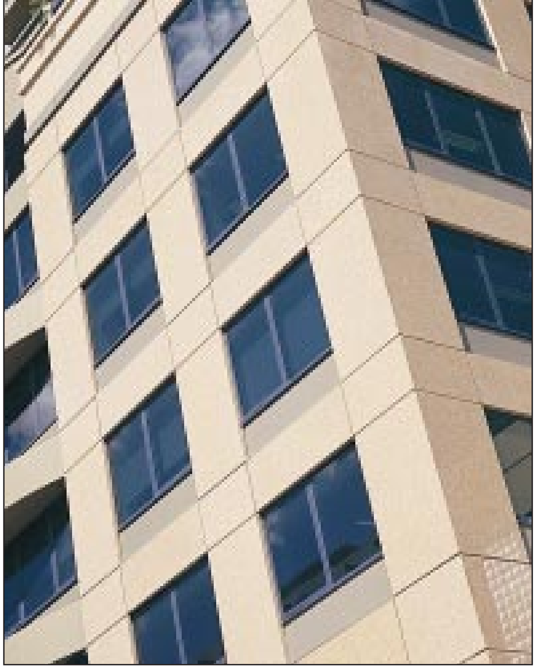
Top quality Class 2 off-form finish in industrial building representative of best industry practice

Above all it must be remembered that perfect colour, segregation and blowhole control cannot be achieved. Precast concrete is made from natural materials and subject to variation for a host of reasons. For absolute uniformity in these areas precast units should be painted.

5 HOLLOWCORE

Prestressed hollowcore wall and floor units are widely used in Australia with over 500 000 square metres being produced per annum. They are an exceptionally efficient product which use a minimum of steel and concrete.

All precast concrete facades can be painted as these hollowcore wall panels have been



High-rise office building clad with high-quality polished facade panels providing Class 2 finish – the best the precast industry can produce

Hollowcore units are manufactured with slipform or screw feed technology with a standard of finish determined by the characteristics of the machine. Hollowcore units will generally be in the range of Classes 2 and 3 but each manufacturing method will give different results and it is therefore imperative that specifications which are available from the manufacturers be used instead of specifications for conventional concrete.

6 PAINT FINISHES

Precast concrete which complies with good practice and AS 3610 may nevertheless require further treatment of airholes or other minor but normal imperfections prior to application of some paint finishes. This work, unless otherwise agreed, is normally the responsibility of the customer.

7 SUMMARY

Precast concrete can deliver exceptional architectural results but in order to achieve that designers and specifiers must understand the product rather than relying solely on prescriptive specifications.

AS 3610—1995 is a useful document but is not suitable for specifying classes of surface finish for most architectural precast concrete and does not deal at all with the specific characteristics of hollowcore. In particular the term 'Class 1' implies that other classes are inferior to it. This is not the case.

The Precast Handbook currently being produced by the CIA and NPCAA will deal with the subject of this data sheet in more detail. ■

Should you require this information in the form of a Data Sheet, please contact the NPCAA [02] 9890 8853 or access the NPCAA website www.npcaa.com.au where it can be downloaded.

PRECAST Connections and Fixings – Part 3

This is the final part of a three-part technical advice series covering recommended practice for design of precast connections and fixings. In this issue, we cover loadbearing connections for both column and wall elements as well as bearing pad requirements.

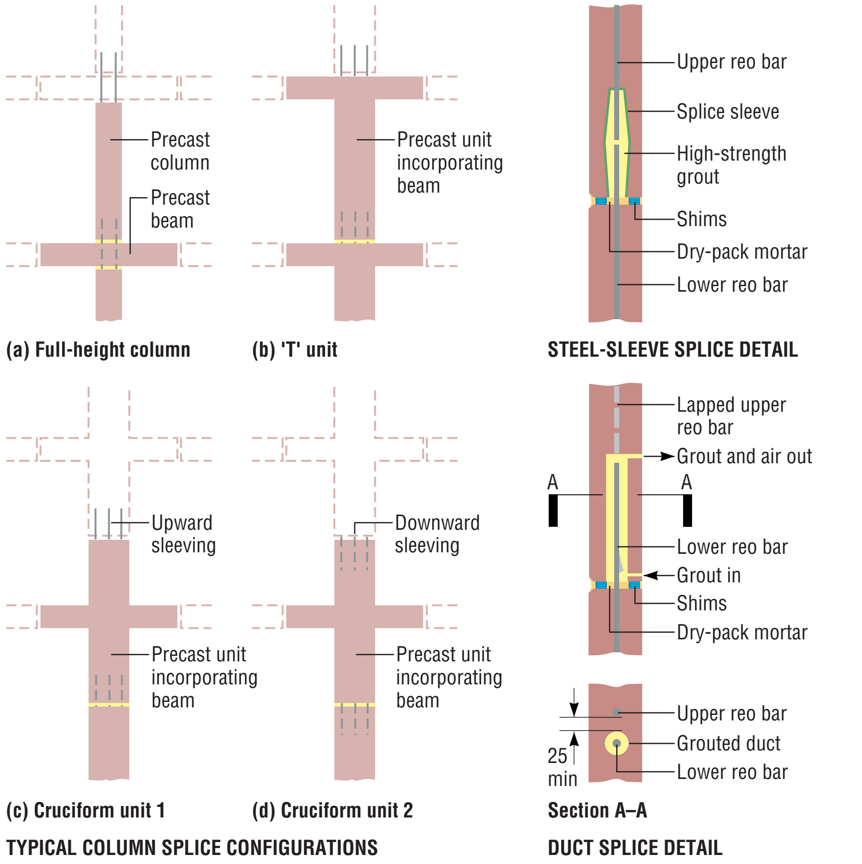


***Figure 1** Typical loadbearing column connections*

LOADBEARING CONNECTIONS

COLUMN ELEMENTS The connections of a column element must be detailed to carry the required design loads in service and allow quick and easy erection. There are a number of means of splicing or connecting columns into a structure; the two most common are by grouted dowels and by steel base plates. Precast concrete units are accurately made factory products. Advantage can be taken of this by connecting precast to precast.

Column connection detail principles

- The column length between splices should be as long as possible to minimise the number of joints and the number of pieces to be erected. A typical length would be 2 stories in multi-storey construction. Three stories is a normal maximum. The frame must be braced and not rely on the splice for frame stability.
- The connection should be easily accessible during construction. Locate in a zone between floor level and say, 1.5 metres above the floor. The latter will place it where bending is a minimum. Where there is a change in column section, locate it at floor level.
- The type of connection is selected on convenience and cost. The most convenient is the bolted baseplate; the most economical is the grouted pocket. The grouted pocket is usually only used at foundation level. A baseplate connection is the quickest to erect. Plumbing is by adjusting the holding down bolts, the column is immediately stable and the crane can be released. The baseplate is flush with the outside of the column for intermediate splices. In this case the bolts are housed in recesses at the corners of the section.
- Dowelled connections are economical but require the column to be separately stabilised until grouted. Two or three props are required for stability. These are secured to the main structure and are adjustable for plumbing of the column.
- There are a number of techniques for forming the dowelled splice. Usually the column bars project from the unit below into core holes formed in the unit above. This can allow an in-situ floor slab to be carried directly on the column with the bars projecting through. Proprietary grout sleeves are available to form the core hole, these minimise the bond length required. The column bars may also project from each unit and connected by welding to splice angles or by fusion. However this requires very accurate construction.
- The number of bars to be spliced at the joint should be a minimum to avoid congestion and simplify erection. Eight bars is a practical maximum. Load can be transferred through the connection by bearing, with most of the column bars being discontinuous. Extra ties may be required to carry local stresses.
- The mixing of the grout must be properly controlled and tested to ensure that the design strength is achieved. Premixed and proprietary grouts are the best means of doing this. The designer should examine the products available and specify a particular product type rather than employ generic names such as *non-shrink* grout.
- Core holes may be grouted by pouring directly into access holes in the side of the column or by pumping into holes drilled into the duct near the base. This ensures that all air is displaced, see **Figure 1**.
- The duct size must be large enough to provide sufficient erection tolerance and clearance and to permit free flow of grout around the bars. Generally, a duct size two and a half to three times the bar diameter is satisfactory. The horizontal joint between units must be wide enough to provide adequate tolerance and to permit free flow of grout throughout the bearing area. A width of 20 to 25 mm is generally adequate.
- The pressure of the grout at the joint can be considerable. A one-and–a-half metre head will lead to a pressure of 36 kPa. Thus the joint needs to be very securely sealed.

WALL ELEMENTS The design of connections for load bearing wall elements follows principles similar to those given above for column units. Loads are transmitted either by direct bearing or by dowelled connections. Close attention to detail, planning, manufacture and site activities is required.

Wall unit connection detail principles

- Generally the principles given for column units above apply. Reference should be made to these.
- Load transfer is through grout or dry-packed mortar. **Figure 2** shows typical examples: (a) with the horizontal joint at slab level; (b) similar but with the joint clear of the floor where it is more accessible and visible; (c) a thickened wall panel where a double row of long dowels provides moment resistance as well as bearing support.
- Lateral joints are left open or are connected by insitu grout or concrete infill sections.

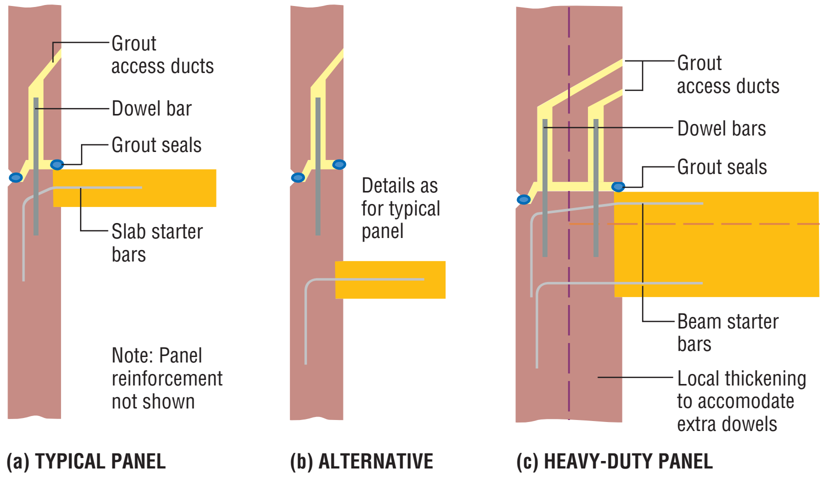


Figure 2 *Typical loadbearing wall connections*

- Hard packers used for levelling during erection must be removed. These create a stress concentration that lead to vertical splitting and spalling of the unit. Plastic packers or similar, which can deform under long-term load, should be used when they must be left in place. The packers should be located at points where a stress concentration would be least critical.
- Progressive collapse must be considered in load bearing wall panel construction. Providing alternate load paths in the structure by continuity of reinforcement across joints does this.
- Realistic erection tolerance should be provided for.
- Loading from floor and roof structure usually applies eccentric loads on wall units. Connections and the members must be designed for realistic eccentricities.
- Details for shear connection between panels to form shear walls are shown in **Figure 3**.

BEARING PADS

Bearing pads are used to distribute vertical loads over the bearing area. Some pads also reduce force build-up at the connection by permitting small displacements and rotations.

There are several materials commonly available as bearing pads. In some cases, various grades are available in the same material and they exhibit different properties and behaviour. In case of doubt, consult the pad supplier or precast manufacturer for proper selection of the pad. Most pad manufacturers have technical brochures available to aid the designer.

Bearing pads typically belong to one of the following categories:

- Commercial grade elastomeric pads are readily available. However, these pads exhibit wide variations in shear-deformation characteristics and bearing strength. These pads are not recommended unless performance data is available.
- Structural grade chloroprene pads used in places where uniform bearing is necessary or when it is desired to reduce volume change restraints. For high compression stresses and/or large horizontal displacements, laminated pads consisting of layers of elastomer bonded between steel or fibreglass plates can be used. Each layer behaves in compression like an individual pad, but the shear deformation is a function of the thickness of the total assembly.
- Laminated fabric bearing pads composed of multiple layers of 190 g/m^2 cotton fabric with a high quality binder are generally used where a higher compressive strength is desired. These pads do not deform as readily as elastomeric pads, and thus provide less tolerance of horizontal movement and rotation than do chloroprene pads.
- Pads reinforced with randomly oriented fibres have been used successfully in recent years. Vertical load capacity is higher than plain chloroprene pads, but tolerance of rotation and horizontal movement is somewhat lower than chloroprene pads. No national standard specifications are available for this material.
- A multi-polymer plastic bearing strip is manufactured expressly for bearing purposes. It is a commonly used material for the bearing support of hollow-core slabs, and is highly suitable for this application. The material has a compressive strength higher than the typical design range of concrete used in precast construction. Research has shown that most of the stress-relieving characteristics of elastomeric bearing pads are due to slippage instead of pad deformation.

Tempered hardboard strips are also used with hollow-core slabs to prevent concrete to concrete bearing. However, they should be used with caution in situations where moist conditions exist. ■

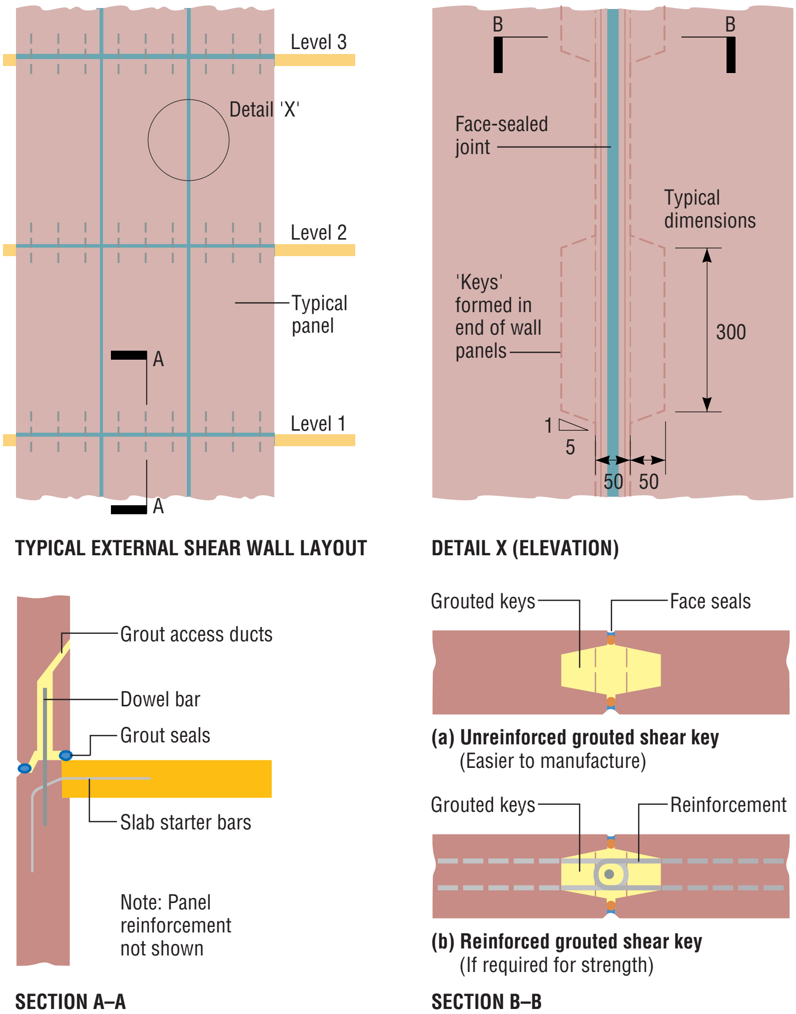


Figure 3 *Shear wall details*

Subiaco Oval Redevelopment, Perth which includes 3000 precast elements.

MEMBER Profile

JOHN HOLLAND PRECAST John Holland Precast has been providing economic and innovative precast solutions to their clients since 1985.

John Holland Precast evolved after the successful completion of a contract to manufacture one million railway sleepers at Meckering, 140 km east of Perth. Using some of the plant from this project, a precast manufacturing facility was set up in Kwinana, south of Perth, to manufacture prestressed wall panels on the Mandurah Canals Project. This innovative prestressing system was further developed to produce prestressed walls and floors which are marketed under the names, 'Holland Wall' and 'Holland Core'.

From these humble beginnings John Holland Precast has now established itself as a leading precast manufacturer of quality precast concrete in both the building and engineering markets.

Supported by a 36 000 sq m manufacturing facility incorporating undercover production areas and 400 m of prestressing beds, the company can manufacture a full range of precast products under a quality system that complies with ISO 9001 Standards. These facilities were fully utilised during the recent $35m Subiaco Oval redevelopment; the grandstand structure of 26 structural bays was predominantly a precast structure. The John Holland Precast team played an integral part in altering the construction methodology with tangible benefits to the builder and the client. In all over 3000 precast elements from prestressed floor panels, beams, columns, wall panels, seating units to 45 tonne post-tensioned beams were manufactured over a 12 month period.

John Holland Precast is also a major supplier of precast flooring systems, covering the full range of spans for most applications. It manufactures Hollandcore, HollandRib, Holland Floor, Double-Tee units and is the WA licensee for Transfloors. The company has had notable success in offering full structural packages, including walls, floors, balconies and stairs for multi-storey apartment buildings.

John Holland Precast also manufactures high quality architectural precast with current projects including the Science and Health Building at Edith Cowan University.

Other areas of work include shopping centres. Multi-level carparks, marine structures, rail sleepers and sewer tunnel segments. ■

Edith Cowan University Science and Health Building, Joondalup, WA currently under construction

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NEW MEMBERS

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

CORPORATE MEMBER

Tilt-Tec Precast and Construction

Queensland precaster specialising in the design and manufacture of precast and prestressed concrete including standard products 'Smartfloor™' (flooring), 'Smartwall™'(noise barriers) and 'Maxitee™' (prestressed flooring).

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