NUMBER 19 • OCTOBER 1998

NATIONAL PRECASTER

NATIONAL PRECAST CONCRETE ASSOCIATION AUSTRALIA

NPCAA

CORPORATE MEMBERS

Asurco Pty Ltd
Auscore Concrete Pty Ltd
BCP Precast Pty Ltd
Cambar Precast
Constress Pty Ltd
CSR Humes
Delta Corporation Ltd
Duggans Concrete Pty Ltd
Girotto Precast Pty Ltd
Glenn Industries Pty Ltd
Hollow Core Concrete Pty Ltd
ICM 2000 Pty Ltd
Precast Concrete Pty Ltd
Rescrete Industries Pty Ltd
SA Precast Pty Ltd
Structural Concrete Industries (Aust) Pty Ltd
Ultrafloor Pty Ltd
Unicrete Industries Pty ltd
Westkon Precast Concrete Pty Ltd

ASSOCIATE MEMBERS

Ancon CCL Pty Ltd
BHP Reinforcing Products
Blue Circle Southern Cement Ltd
Camsons Quarry Products
CEM-FIL International Ltd (UK)
CMC Australia Pty Ltd
Howard Quarries Ltd
L W Contracting Pty Ltd
MBT (Australia) Pty Ltd
Mironi Manufacturing Pty Ltd
Prospect Panel Erectors Ltd
Queensland Cement Ltd
Reid Construction Systems Pty Ltd
Sika Australia Pty Ltd
Smorgon ARC
Sunstate Cement Ltd
Xypex Australia

MEMBER PROFILE

RECENT PRECAST PRODUCTS SUPPLIED BY UNICRETE INCLUDE T-ROFF BRIDGE BEAMS FOR THE SOUTH-EASTERN ARTERIAL IN VICTORIA *(ABOVE)* AND BEAMS FOR THE WESTERN LINK OF THE TULLAMARINE FREEWAY ALSO IN VICTORIA. *(RIGHT)* THESE 37.5 m MODIFIED SUPER-T BEAMS WEIGH 82 TONNES AND HAVE A DEPTH OF 1625 mm.

UNICRETE INDUSTRIES is a newly formed company located in Braybrook, a suburb 12 km west of Melbourne.

Unicrete operates from a long-established precasting yard which has a successful record in manufacturing prestressed bridge beams, planks, piles, culverts and other civil engineering products.

Unicrete is currently supplying over 100 T-Roff bridge beams for the widening of the South-Eastern Arterial as part of the City Link Project.

Although Unicrete will continue to produce the traditional products it is also developing new ones. As part of its new product range, Unicrete is making sound absorption panels using its own 'Unibloc 5060' acoustic material system.

Unicrete has the capacity to make the largest to the smallest transportable elements in Victoria. It has a vast amount of accumulated knowledge and a ready availability of technical support.

UNICRETE
PRECAST AND PRESTRESSED CONCRETE

UNICRETE PTY LTD
- Telephone: [03] 9311 0761
- Facsimile: [03] 9312 5782
- 47 Burke Street
  Braybrook VIC 3019

ACN 051 987 181

ISSN 1037-9908

SEGMENTS READY FOR DEMOULDING

LONG LIFE TUNNEL SEGMENTS

The Land Transport Authority of Singapore (LTA) is building a 23 km, twin tube extension to its Mass Rapid Transit system. This extension will run from the World Trade Centre in the south of the island to Punggol in the north.

All contracts are design and build, including stations, cut and cover tunnels and bored tunnels. A total length of approximately 22.5 km of bored tunnels using Earth Pressure Balance Machines will be constructed; the first drive commenced in late September 1998.

One of the LTA's criteria for the precast tunnel lining segments is that they should have a 100-year design life. The general specification calls for the segments to be coated with a solvented Coal Tar Epoxy (CTE) material on the extrados and four sides, with the intrados remaining uncoated. the 28-day compressive strength of the concrete should be a minimum of 60 MPa.

In late 1997 Sika (Singapore) approached contractors and precasters on the bored tunnel contracts with a total durability strategy. This included the use of a high performance concrete containing 5–7% silica fume by weight of cement, a W/C ratio of <0.40 and a very low chloride penetrability (<1000 Coulombs in accordance with ASTM C1202). In addition to the concrete mixture, an environmentally safer epoxy emulsion coating material, Sikagard 65W, was proposed as an alternative to the specified CTE.

The advantage of using Sikagard 65W is that it can be applied to freshly demoulded concrete with a minimum of surface preparation and it acts as a curing membrane in the very early life of the concrete. In this sequence of application the coating will work in synergy with the concrete to produce a dense, impermeable paste matrix.

Extensive testing of the performance of the coating was conducted in the UK during the first six months of 1998. Tunnel lining segments using the moulds and concrete mix design from the Copenhagen Metro project, were cast in the London factory of Taywood Precast Ltd. Cores were taken from coated and uncoated segments and the testing of various performance properties were conducted at the laboratories of Taywood Engineering Ltd.

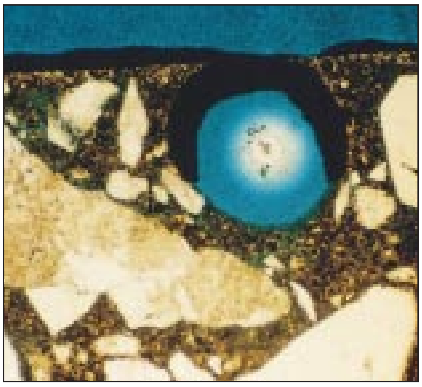
Results of the testing showed that, despite being water vapour permeable, the coating was impermeable to water and reduced chloride permeability by 57%. Microscopic analysis of thin sections revealed that early application of the coating eliminated the surface microcracking that is normally associated with the production of steam-cured concrete. It also confirmed that the application of the coating to warm concrete resulted in capillary penetration of the resin to a depth of 50 to 80 microns from the surface giving excellent bond and impact properties.

COATED SEGMENTS READY FOR DELIVERY TO SITE

In May 1998 the singapore LTA gave its approval for use of the Sikagard 65 W total durability system on contract C703 which is being constructed by the Korean contractor Samsung. The production of precast tunnel segments has been sub-contracted to Jume Industries at its Pasir Gudang factory in Johor, Malaysia

Use of the system eliminates the requirements for water curing of the segments. As the segments are demoulded, minor repairs to the arisses of gasket recesses are made with a cement/epoxy mixture and the segments are coated on five faces. Within a few hours from demoulding and after the intrados has had a wax-based curing membrane applied to it, the coating is sufficiently hardened for the segments to be transported to final outside storage.

MICROPHOTOGRAPH SHOWING EFFECTIVE COATING PENETRATION INTO SURFACE BUGHOLE



The North East Line project in Singapore is the second time that the Sikagard 65W durability system has been used to provide precast tunnel segments with a 100-year durability. The first project was the Adlertunnel in Switzerland where, during 1996/97, segments were coated on all six faces to provide a long term resistance to aggressive soils and groundwaters.

Further details of this project can be obtained from Sika (Australia) Pty Ltd. Telephone (02) 9725 1700 or facsimile (02) 9756 5001.

SEMI-PRECAST FLOORS

This is the fourth in a series of articles covering available precast concrete solutions for floors. This article outlines the basic design principles for 'semi-precast element floors' with special consideration to correct detailing for earthquake design.

THE SYSTEM The semi-precast element floor has been widely used in Europe and elsewhere for over 40 years. Overseas trends indicate that this precast flooring system is a favoured method for construction of suspended concrete slabs and in some parts of Europe it accounts for 60% of all suspended work reaching production rates of 80 million square metres per year. In Australia this type of flooring (known as Transfloor or HumeSlab) has been in use since 1982 and offers many advantages over cast insitu floors while maintaining the full structural integrity and monolithic requirements of the slab.

The system uses a combination of precast reinforced concrete panels and poured insitu topping as a means of constructing suspended concrete slabs. Wire trusses and all of the bottom reinforcement is embedded in the precast panels while the top reinforcement is included on site. The use of site-placed reinforced concrete effectively ties all the precast elements together providing safety, rigidity and structural redundancy.

DESIGN The structural design of precast concrete floors should not only deal with the calculation of bending moment and shear force capacity of the separate units, but also with the total coherence of the floor. In the final stage, the individual components should be connected in a manner that ensures adequate overall capacity with interaction between the units and the supporting structure.

Design for Bending Accepted principles of Ultimate Strength Theory apply to the design of precast element floors since the finished slab can be considered as monolithic.

The system is usually designed to span uniaxially (one-way action), however, two-way action can be achieved by omitting void formers and placing additional bars on top of panels in the transverse direction.

SEMI-PRECAST PANELS BEING PLACED ON SITE

In a uniaxial design the precast panel contains all of the bottom reinforcement required in the final design. This will consist of a light fabric, truss bottom chords and additional bar reinforcement (Figure 1).

Precast/insitu Interface The required capacity at the interface can be calculated in accordance with relevant design codes. The level of surface roughness is somewhat open to interpretation but can be considered as rough with small ridges and undulations. The surface roughness achieved during the casting process is satisfactory when, at the same time, truss web members are used as shear plane reinforcement.

If an intentionally roughened surface is specified, care should be taken not to disturb the grain structure of the concrete or dislodge aggregates near the surface. A light broom finish is all that is required.

Vertical Shear If a voided slab is used the shear forces can only be carried by the concrete in the rib sections. Voids must be terminated in regions of high shear (at supports and point loads) and will generally not be included within one slab depth from the section at which the ribs are just sufficient to resist the applied shear.

The overall slab thickness is not normally controlled by shear strength

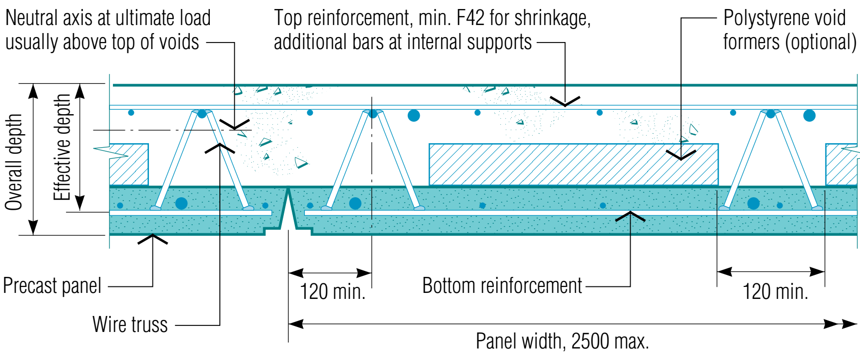


FIGURE 1 TYPICAL SLAB CROSS SECTION

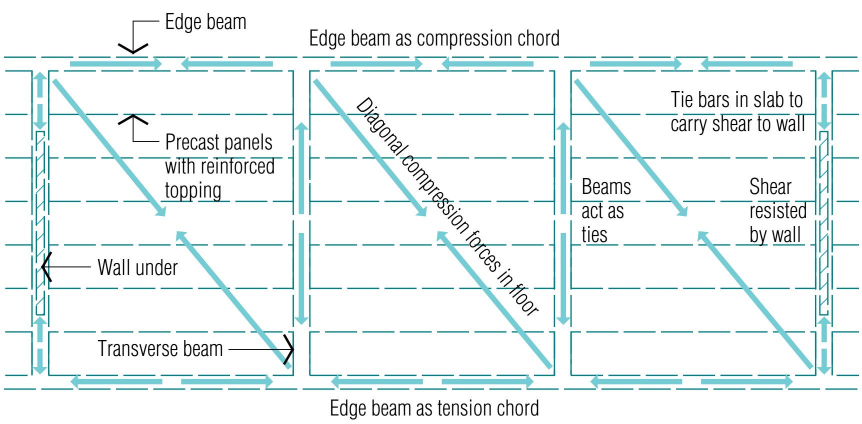


FIGURE 2 ACTIONS IN A DIAPHRAGM (STRUT AND TIE MODEL)

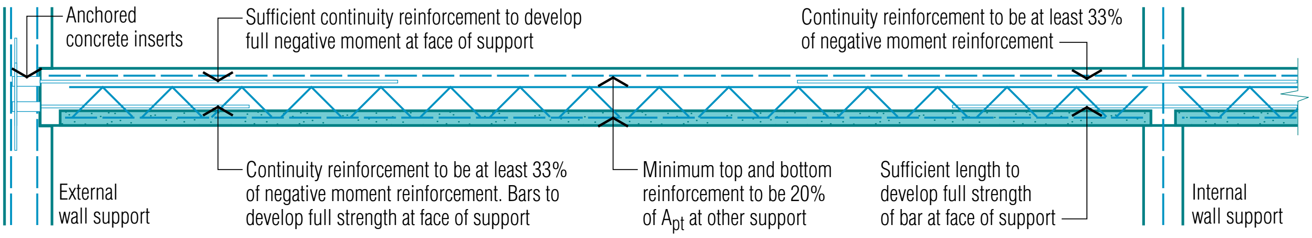


FIGURE 3 TYPICAL SLAB REINFORCEMENT DETAILS FOR EARTHQUAKE LOADING (AS 3600)

requirements but, when required, the diagonal wires of the trusses may be treated as inclined stirrups provided the pitch of the wires does not exceed the depth of the slab, trusses extend through the full slab depth and truss spacing does not exceed the recommended stirrup spacing given in AS 3600.

Support Conditions The correct detailing of precast concrete involves consideration of the design, manufacture and construction requirements at the start of the project. It is important to consider detailing during the early design stages so as to obtain the full benefits of any precast system.

As with insitu floors, when designing composite precast element floors attention must be given to anchoring of reinforcement at the supports. Reinforcement end details are specified in the relevant design codes and the amount of reinforcement to be carried into the support will depend on the end restraint condition.

Connections between composite precast element floors and supporting members present few problems since continuity can be provided by lapping the panel reinforcement with bars projecting from the supporting beams or walls (Figure 3).

SEISMIC CONSIDERATIONS for precast element floors will follow the same design rules as for insitu floors but will require adequate detailing to achieve seismic integrity at the connections. The main criteria to consider is:

- Maintain structural integrity without collapse of all or a significant part of the structure.
- Achieve ductility of both precast elements and their connections.
- Provide structural continuity.

Structural Integrity It has generally been found that insitu floor slabs acting monolithically with supporting beams are very capable of transmitting lateral forces unless the number of large openings is excessive. Precast element floors, acting monolithically, will adequately transmit lateral loads through diaphragm action. The strength and ductility of the overall structural system will depend on the integrity of the jointing details and in particular, the connections between the floor (horizontal diaphragm) and the supporting structure.

The majority of reported damage caused to precast construction during earthquakes is confined to the joints and connections and can be summarised as follows:

- Failure of connection between wall panel and roof system resulting in roof failure, tilting of wall panels and increased stresses in the lower level floor connections.
- Failure of connections between wall panels and the floor system.
- Flexibility of thin cast in place topping slab that forms the horizontal diaphragm causing overstressing and cracking resulting in separation from the precast elements.

The 1988 earthquake in Armenia highlighted some of the problems caused by inadequately detailed precast construction. A common form of construction for the medium rise residential buildings was to use precast concrete panels or frames for the vertical elements and precast concrete floor planks without the addition of a topping slab. These precast systems performed poorly due mainly to the inadequate provision of viable load paths and inadequate tying of the horizontal floor planks to the vertical elements and to each other for effective diaphragm action.

Diaphragm Action Horizontal loads from earthquakes are usually transmitted to the vertical cores or shear walls by the roof and floor acting as horizontal diaphragms. The floor can be analysed by the strut and tie method or by considering the floor to act as a deep horizontal beam. The central core, shear walls or other stabilising components act as supports with the lateral loads being transmitted to them as shown in Figure 2.

TRANSFLOOR PANELS CONNECTING INTO A LOAD BEARING WALL

As stated by Clough (*Considerations in the Design of Precast Concrete for Earthquake Loads*, PCI Journal, vol 27), 'In zones of high seismic intensity, or with configurations which impose large in-plane compatibility forces under lateral load, diaphragms joined by cast in place reinforced concrete, usually are satisfactory'. It is essential to ensure that the topping is adequately bonded to the precast elements such as in precast element floors where the topping is bonded by mechanical connectors (wire trusses as in plane reinforcement). Without adequate bonding separation can occur and the topping may buckle when subject to diagonal compression from diaphragm action.

Detailing for Seismic Loads Designers should ensure that not only is there an adequate load path for the forces that need to be transferred between the diaphragm and any lateral force resisting elements, such as walls or frames, but that connections are detailed such that they adequately transfer the anticipated loads.

The comments in this section relate to 'Intermediate Moment Resisting Frames', defined in AS 3600 as moment resisting frames of ductile construction, complying with the additional requirements of Appendix A in AS 3600. The intent of these special detailing requirements is to improve the ductility and reduce the vulnerability of concrete structures in a manner consistent with the relatively low seismic hazard in Australia (Figure 3). ■

The **Transfloor System** is licensed by **Smorgon ARC** to the following manufacturers:

VIC **Fabcon Pty Ltd**, **Cambar Precast**
QLD **CSR Humes**
SA **CSR Humes**
WA **John Holland**
NSW **Rescrete Industries**
NT **Alice Precasters**

SURFACE FINISHES

This is the fifth article in a series dealing with treatments and finishes which can be provided to architectural and, in some instances, structural precast elements where those elements may have visual exposure.

ACID CLEANING

Background Historically, precast concrete manufacturers have used a weak, acid in water solution to clean the surface of elements prior to delivery.

Following manufacture, it is common for the surface of an element to exhibit a thin, whitish film of water-insoluble calcium carbonate. This film results from calcium hydroxide, present at the surface reacting with carbon dioxide present in the atmosphere to produce calcium carbonate.

Other salts of potassium and sodium may be present.

This whitish film may not be noticeable on elements manufactured using a light grey, off-white or white cement.

Additionally, accepted finishing techniques such as water-washing, abrasive blasting and polishing will exhibit this whitish discolouration due to the cementitious slurry generated by the finishing technique. Naturally, this whitish film reduces the colour and lustre of the exposed aggregate.

The precast concrete industry, with more than 50 years of experience of the acid cleaning technique, recognise it as a technically sound and cost-effective cleaning treatment.

PANEL CLEANING

The purpose of theis article is to discuss the technique of acid cleaning of precast concrete panels.

It is important that the clear distinction between *acid cleaning* and *acid etching* is understood. In **acid cleaning**, a weak acid in water solution is used to clean the element surface of any residue. Often this residue is cementitious bound. It is not the intention to change the texture of the element.

By contrast, **acid etching** using a somewhat stronger acid solution and possibly several applications aims to etch the smooth, off-form surface to produce a matt to coarse texture as required, often a texture akin to fine to coarse sandpaper.

DRAFT SPECIFICATION

For the guidance of specifiers and others, a draft specification is provided.

0.1 General

Cleaning of precast concrete units. Prior to delivery to site, the manufacturer shall clean the units to remove calcium deposits, other salts and accumulated dirt.

The use of a dilute (acid in water) solution shall be acceptable. *Note: It is normal to only require the cleaning of surfaces of elements which are to be exposed to view.*

0.2 Acid Solution

A solution of acid (hydrochloric/ muriatic) in water shall be used. The concentrations shall be in the order of 2–5% acid in water.

0.3 Method

The units shall be inclined, checked for the presence of cracks and pre-wetted to minimise the absorption of the acid solution.

The acid solution shall be uniformly applied over the element surface using a suitable means such as a soft broom.

Small areas of the panel should be carried out at the one time, washing the acid away with copious quantities of water. The panel should finally be cleaned with a high-pressure water spray.

LIGHT ACID CLEANING OF POLISHED PANEL PRIOR TO DELIVERY

0.4 Safety

The manufacturer shall ensure that all personal safety precautions are undertaken by the operator and work is undertaken only by those experienced in this type of work.

0.5 Testing

As indicated in C&CAA publication S62, *Chloride Movement through Precast Concrete Panels* by Associate Professor M G Symons and F J P O'Sullivan, University of South Australia, chlorine concentration through acid washing is not perceived as a problem. However the client may require testing to ensure that the levels of chlorides present do not exceed acceptable levels as shown in AS 3600—1994 *Concrete Structures* – Table 4.9.1. Those values are total chlorides available from all sources including aggregates, water and acid cleaning.

The Client should note the cost of testings and subsequent patching and consider the viability and/or the extent of testing. Having the work performed by a main-stream precast concrete manufacturer may itself provide adequate insurance of quality.

Should the Client desire testing, then the following clause may be applicable:

'The Manufacturer shall test for the presence of chlorides by taking one core sample per … panels. Core samples shall be taken in accordance with AS 1012 Part 14, *Method of Securing Cores from Hardened Concrete etc.* Testing for the presence of chlorides shall be in accordance with AS 1012, Method 20 *Determination of chlorides and sulphate in hardened concrete and concrete aggregates.*'

SUMMARY

Acid cleaning, using the procedures outlined in this Data Sheet, make the process both technically sound and cost effective.

Several decades of use of the method supported by testing and importantly a practical exhibition of its adequacy gives the precast industry extreme confidence in the use of a dilute, acid in water cleaning method.

For the guidance of specifiers and others, the above draft specification is provided. ■

For further information, contact NPCAA
Tel: [02] 9890 8853 Fax: [02] 9890 8854

WELCOME TO:

NPCAA are pleased to welcome the following members:

ASSOCIATE MEMBERS

- **Ancon CCL**
- **CMC Australia**
- **Howard Quarries**
- **Prospect Panel Erectors**
- **Xypex Australia**

CORPORATE MEMBER

- **Cambar Precast**

The President, Directors and Members of NPCAA welcome the forthcoming support of these new members in further consolidating the status of the precast concrete industry.

GET WITH THE FLOW

The management of drainage and stormwater projects is invariably a high risk operation. Issues such as rainfall, producing localised flooding of excavations, the requirement for often extensive shoring if excavations are to be open for an extended period, the labour component for formwork, steel-fixing and concrete placement, often in a congested area are all well recognised. The degree to which one addresses these issues will ultimately determine the degree of risk for the project.

Reducing on-site construction time is one obvious issue. The ability to perform work off-site in a factory environment is a major advantage offered by the use of precast construction. Other important factors include:

- quality of manufacture, excellent dimensional control and control of cover to reinforcement
- guarantee of delivery to site at the time nominated by the contractor
- no requirement for site storage and, given good site management, no requirement for double handling.

Australian precast concrete manufacturers produce a wide range of drainage, stormwater and utilities products, both of *standard* dimensions and geometry and *customised* elements to suit the clients particular requirements. Types of products available include:

- box culverts
- drainage and stormwater pits
- manholes
- stormwater detention pits
- headwalls – standard/multicell and dissipator types
- gross pollutant traps
- oil/grease arrestors
- septic tanks
- electrical pits
- inlet gullys.

Possibly the most effective way to illustrate the use and advantages of these products is to present a number of case studies with the briefest of narrative:

CASE 1 Multi-cell Headwall *(below)* The limited workforce and obvious speed of placement clearly indicates the precast advantage.

CASE 2 Box Culverts Frequently, box culverts are used to carry stormwater under road and rail structures, although many other varied applications exist eg animal and wildlife thoroughfares. Invariably the need to minimise closure time for road or rail prompts the need to consider the use of precast concrete construction.

Use of box culvert units plus precast headwall and apron is shown below. Note openings in recently-placed and about-to-be-placed units to permit side entry from road drains. Minimal closure time of half of road prevents the need for detours and limits lost public time due to waiting.

Box culverts placed side by side can be used to span areas such as floodplains *(above)*. Note box culverts stored on site ready to replace a timber trestle rail bridge for RSA (Northern Division). Approximately 36 hours elapsed between commencing demolition and restoring traffic.

Another precast solution to a somewhat similar problem is shown above. The solution makes use of the CSR Humes Classic Arch structure.

CASE 3 Headwalls Precast headwalls remove from site the delays associated with formwork, steel fixing and concrete placements. The photo below shows a headwall and apron, incorporating dissipator blocks to reduce flow velocity and subsequent scouring.

CASE 3 Gross Pollutant Traps Ever increasing concerns with environmental degradation and water quality have accelerated the demand for such units. Be they sited in areas of difficult access or in urban locations, precast construction using a single cast element or modular construction will significantly reduce construction time and site labour. The photograph above illustrates the simplicity of modular precast construction.

Summary Precast construction offers the client and contractor the best possible control over completion within time and budget. The range of standard products is widely complemented by the industry's experience and desire to offer precisely what the client wants in the way of *customised* products. Make use of the **precast advantage**.

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

DESIGNED AND PRODUCED BY HELEN CHRISTINA RIX