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• NATIONAL •

PRECASTER

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Change of Address

Readers should please note that the National Precast Concrete Association Australia has re-located. Details are –

Postal address for all correspondence:

PO Box 774 Warners Bay NSW 2282

Telephone/Fax: 049 42 7210

THE CURING OF CONCRETE

The importance of curing freshly placed concrete should be recognised by all those involved: designers, contractors and suppliers.

For those harbouring any doubt, the following comments should dispel any thought that curing is tedious, expensive and of doubtful value.

The reaction between cement and water, known as 'hydration', requires two essential conditions for it to occur. They are:

- The continuing presence of water during the hydration period.
- A temperature such that hydration is not inhibited. The lower the temperature, the lesser is the rate of hydration until, at around 5°C and below, the hydration rate is negligible. Conversely, higher temperatures will accelerate the rate of hydration.

The valued properties of concrete include:

- strength
- watertightness
- durability.

All are enhanced by the development of the hydration process. Curing thus reflects upon the early and long-term strength of the concrete and its eventual watertightness and durability.

One of the recognised problems with fresh concrete is its potential to lose water as a result of uncontrolled drying out. It is logical to accept that, if the concrete loses volume (water, through evaporation), the concrete will react to that volume loss by shrinking. Such shrinkage will be likely to result in cracking.

To recap then, the following requirements are paramount:

- maintaining a suitable temperature for the continuation of hydration;
- maintaining the presence of water, either by maintaining the mix water in the concrete or by recognising possible water loss and compensating for that loss by the addition of external water.

There are numerous techniques available for curing. Broadly described they are:

- curing in ambient conditions;
- curing in non-ambient conditions.

Curing in ambient conditions embraces methods such as:

- ponding with or immersion in water;
- periodic spraying (to be effective the concrete surface should never be allowed to dry out between spraying applications);
- covering with sand which must be kept wet;
- similarly, covering with hessian which also must be kept wet.

All these methods, whilst providing a good curing regime, are recognised as being wasteful of water and labour intensive. Some may stain the concrete and all depend upon the need to perform the process with a good measure of integrity.

The more practical alternatives are:

- Retaining the concrete in the mould or form and covering any exposed surface.
- Covering with an impermeable covering

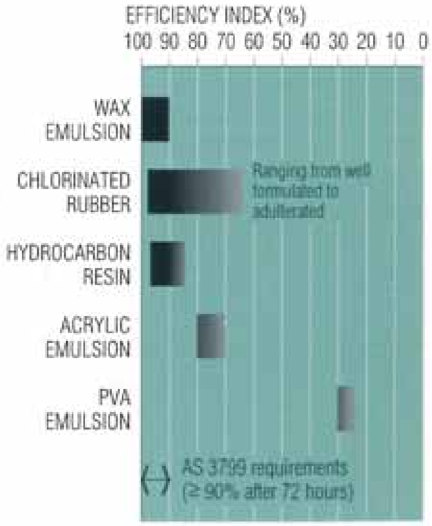

FIGURE 1 COMPARATIVE EFFICIENCY OF CURING COMPOUNDS

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such as quality polythene with all joints taped.

- Using applied curing compounds. There are a number of generic varieties and a substantial gulf between the effectiveness of each. Some, such as wax emulsions and chlorinated rubbers, can retain around 80 and 70% respectively of the moisture in the concrete given reliable applications. At the other end of the scale, PVA-based materials can be described as of doubtful value unless re-applied at regular intervals. Curing compounds should comply with AS 3799-1990.

Curing in non-ambient conditions includes:

- low-pressure (atmospheric) steam curing
- high-pressure steam curing (autoclaving)
- radiant heat curing
- infra-red curing.

The Australian precast concrete industry favours low-pressure steam curing, but note that the significant climate variations throughout the continent require a level of flexibility by manufacturers.

Steam curing provides two important components:

- added moisture
- added temperature.

If we go back to paragraph 3 of this article, we will immediately recognise that the presence of moisture and temperature are the critical ingredients required to provide for hydration of the cement.

Steam curing thus provides the perfect environment for curing allowing hydration which in turn gives:

- early strength gain;
- reduced capillaries, thereby improving watertightness and durability;
- reduced shrinkage.

The steam curing process (low-pressure or ambient) is a part of the precast production process.

The freshly placed, compacted, and often finished concrete still in the mould, is placed within an enclosure. In the case of some standard products this enclosure may be a permanent structure or, with very large elements such as wall panels, bridge beams and the like, the enclosure may be formed by covering with a heavy duty tarpaulin.

HEAVY DUTY TARPAULIN PROVIDING CURING ENCLOSURE TO PRECAST, PRESTRESSED BRIDGE BEAMS

Steam is then allowed to circulate around the mould providing both an elevated temperature and moisture.

TIME AND TEMPERATURE

The steam curing cycle consists of a number of specific time periods. They are:

Preset Period The preset period allows the concrete to gain some strength before the applied heating causes differential movements within the concrete and from external influences such as the mould. It also allows the concrete to build up some internal heat from the hydration process. The effectiveness of heat curing diminishes after about 4 hours preset. Heat should be applied as soon as possible after initial set for maximum strength gain.

The normal preset period is 1.5 to 3 hours which is increased appropriately for set retarded concrete. The longer time should be used for large (15 tonne+) units. As a rule, heating should not commence earlier than the initial set of the cement.

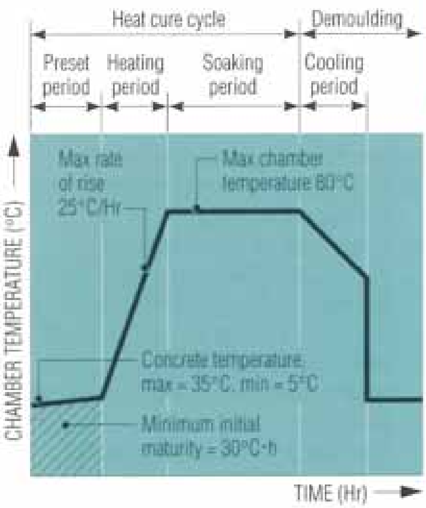


FIGURE 2 CHAMBER, TIME/TEMPERATURE PROFILE

Rate of Temperature Rise Rate of temperature rise will depend on the setting characteristics of the cement, the shape and size of the member being cured and, to a lesser extent, the mix proportions. Bulky and intricately shaped members require heating more slowly to avoid cracking due to mould restraint.

The recommended rate of temperature rise is 15 to 25°C/hr. The measured temperature is that of the chamber or enclosure.

Soaking Period The maximum recommended chamber temperature is 80°C. This allows for an increase in product temperature over that of the chamber due to heat of hydration effects. Short time variations of chamber temperature are not reflected in the product and thus some variation about the intended profile is acceptable.

The time at maximum temperature is adjusted to achieve the required strength in the ambient conditions. A typical range is 2 to 8 hours.

Cooling Period The heat supply is terminated completely at the end of the soaking period. The product is usually demoulded within 3 to 5 hours, but can be demoulded immediately. Long line pre-tensioned members are released as soon as possible to minimise transverse cracking. Re-covering is not necessary while the product cools down unless surface cracking occurs in particularly massive units.

Accelerated curing is a sound, widely accepted production process. The primary objective is to provide a system which will guarantee a quality end product yet maintain an economic production process. Low pressure steam curing does just this.

GLASS REINFORCED CONCRETE

A BACKGROUND

As the name implies, Glass Reinforced Concrete (GRC) is a mixture of two materials, glass fibre (around 5%) and cement. Frequently, other materials such as fine aggregate (sand) and admixtures are also incorporated into the mix. The sand acts as an economical filler material and as a material resistant to volume change. Hence, it minimises shrinkage of the final GRC product.

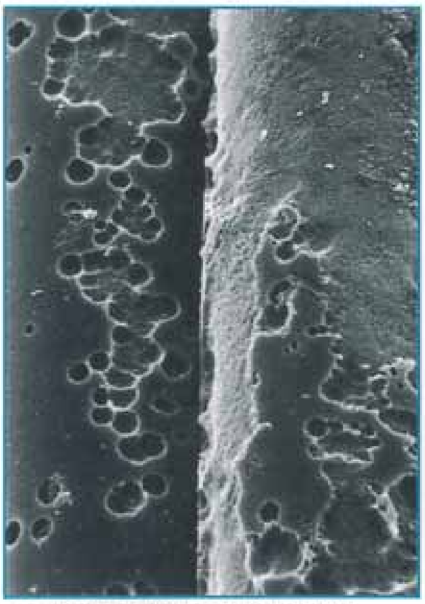
Admixtures are used for a variety of purposes including, in the plastic state:

- improving workability without increasing the water content of the mix;
- reducing segregation and bleeding;
- retarding or accelerating the setting time (stiffening) of the mix.

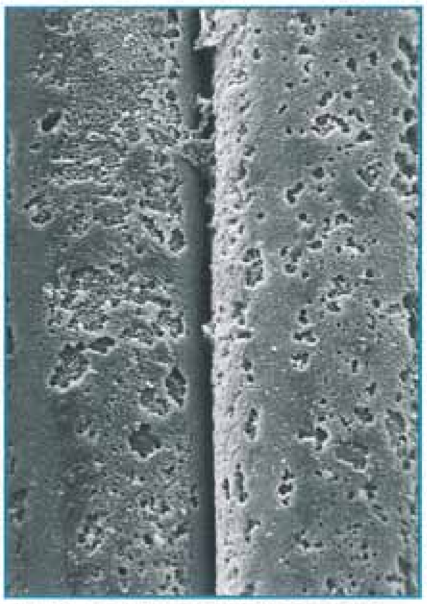
Whilst in the hardened state, admixtures may be used to:

- increase the rate of early strength development following setting;
- increase the strength;
- decrease permeability;
- improve fire resistance.

Whilst glass fibre had been successfully used in the reinforcement of plastics (GRP) from the 1950s, its incorporation in a cement matrix pointed clearly to the fact that the type of glass fibre used, a borosilicate 'E' glass, deteriorated when used in a highly alkaline environment. A cement-based matrix with a pH of around 12 was such an environment.



'E' GLASS IN ORDINARY PORTLAND CEMENT (TYPE A OR GENERAL PURPOSE PORTLAND CEMENT IN AUSTRALIA). 8 DAYS IMMERSION AT 50°C.



'E' GLASS + ACRYLIC POLYMER IN OPC. 8 DAYS AT 50°C.

'AR' 'CEM-FIL' IN OPC. 3 MONTHS AT 50°C (CONSIDERED EQUIVALENT TO 25 YEARS NATURAL WEATHERING).

This led developers of the product to adopt two distinct approaches to resolve the problems, namely:

- to develop a low alkali matrix;
- to develop a glass fibre which would be resistant to such alkali attack using conventional portland cements.

A major research project by the Building Research Establishment UK (commenced around the mid 1960s) soon established that the former of these two approaches would have only limited application and that the development of an alkaline resistant glass fibre was a more realistic approach.

In 1971, following cooperation between BRE, Pilkington Bros (a household name when talking glass), and the National Research Development Corporation, the product 'CEM-FIL' was launched, a genuine AR (alkaline resistant) type glass fibre.

The photographs above indicate the levels of deterioration of 'E' glass whilst clearly indicating the resistance of 'AR' type glass fibre.

Manufacturers and suppliers recommend that only 'AR' type glass fibre be specified in GRC work.

The GRC Group of NPCAA will shortly (probably September/October 96) release its publication entitled *A Code of Practice for the Manufacture, Design and Installation of Glass Reinforced Cement (GRC) Products.*

Members of the NPCAA involved in the manufacture of GRC include:

Asurco Pty Ltd
Glenn Industries Pty Ltd
Precast Concrete Pty Ltd
Rescrete Industries Pty Ltd
'CEM-FIL' International Ltd (a leading GRC authority and supplier of 'AR' glass). ■

COMPUTER PROGRAM AVAILABLE

AT LAST! A COMPUTER PROGRAM TO DESIGN PRESTRESSED, HOLLOW-CORE CONCRETE FLOORS.

You can select 80% of the precast concrete planks you need from load tables, but it's the other 20% that cause all the problems.

Or did, until now!

Now there is a computer program called PCP4 to design exactly what you need. In less than ten minutes it will create a report that summarises:

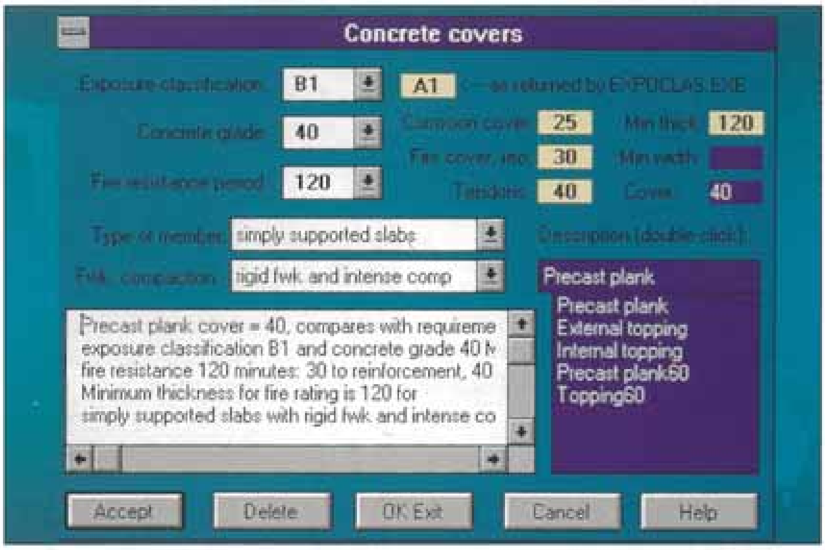
- exposure classification, creep and shrinkage values;
- concrete covers for durability and fire rating;
- bending moments and shear forces;
- 124 values relevant to precast, hollow-core design.

PCP4* performs hundreds of calculations and lets you select the right plank from all the planks produced Australia-wide by members of the NPCAA, and it costs just $395.

To order your copy of PCP4 or for more information, phone Engineers' Compendium on 048 62 1295.

PCP4 is sponsored by the National Precast Concrete Association Australia and may also be ordered from any of its members.

** Requires IBM or compatible 486 or better PC with 8 MB RAM, VGA colour, Windows 3.1 or later.*



MEMBER PROFILE

BEBO ARCH USED AS A PEDESTRIAN FOOTBRIDGE PROVIDING PLEASING AESTHETIC LINES.

CSR HUMES PTY LTD

The name Humes has been synonymous with concrete products since early this century when Australian inventor, Walter Hume, devised a revolutionary method of making pipes. His use of centrifugal spinning resulted in pipes with greater strength and durability, and his process is now used throughout Australia and several countries around the world.

In 1988, Humes became part of the Readymix Group, itself a subsidiary of the Australian giant, CSR Limited. CSR was founded in Sydney in 1855 as a sugar refining company and became involved in the manufacture of building materials in 1940. CSR is now one of the world's largest building and construction materials companies and has substantial operations in Australia, North America, New Zealand and South-East Asia.

CLASSIC ARCH UNITS BEING ERECTED – PENRITH LAKES BRIDGE, OLYMPICS 2000 ROWING COURSE.

CSR Humes operations are spread over 26 manufacturing locations throughout Australia, strategically located to respond quickly to local demand, in both city and country areas. This geographical distribution of manufacturing facilities and product range is illustrated in the list of recent projects by CSR Humes.

CSR Humes prides itself on its strengths in design and engineering services, and to providing total solutions which are economical and technically correct. The combination of CSR Humes' technical skills with its experience from decades of concrete product manufacture continues to keep it at the forefront in innovation and design in the market place.

Recent extensions have been made to the CSR Humes business with the Blacktown and Grafton operations expanding with new dedicated prestress areas primarily concentrating on the manufacture of large bridge beams, structural frames and flooring. At Newman, WA a new plant has been established specifically for rail sleeper production.

The company produces an extensive range of products with general lines including pipes, pumpwells, sewer manholes, stormwater pits, headwalls, kerb lintels, box culverts, retaining walls, rural products, bebo arches and bridge beams.

Major recent projects supplied by CSR Humes include:

- 'Sea Wall' wave deflection units for the third runway at Kingsford Smith Airport, Sydney.
- Approximately 3100 tonnes of box culverts and 1200 tonnes of pipes for Chinderah Bypass.
- Super-Tee beams for Silverwater Road extensions.
- Tee-Roff beams, Bebo and Classic arches for numerous crossings for the new M2 motorway.
- Tee-Roff bridge beams for the Raleigh Bridge project in Northern NSW.
- Doublewall retaining wall for the ACTEW Corporation at Lower Molongolo Water Quality Treatment Plant.
- 182 Classic arch units (22.5 tonnes each), Yandina Bypass Project, Nambour, Queensland.
- Major large box culvert project – Logan Motorway and Gateway Motorway extension, Queensland.
- 850 000 precast concrete rail sleepers, BHP/Hammersley Iron, Western Australia.
- Tunnel segments/liners, BHP, Port Headland.
- 1500 precast step units – ocean outfall treatment works, South Australia. ■

PRECAST WAVE DEFLECTION WALL – KINGSFORD SMITH AIRPORT, SYDNEY.

'DOUBLEWALL', EARTH-FILLED RETAINING WALL SYSTEM.

FLEXIBILITY, SPEED AND DESIGN

SIMPLE PAINTED FINISH TO THE SOFFIT OF HUMESLAB, POSSIBLE DUE TO THE CLASS 2 OR 3 FINISH PROVIDED

FLEXIBILITY, SPEED AND DESIGN CERTIFICATION FOR SUSPENDED SLABS

Flexibility, speed and design certification – these are just three of the benefits found by Action Project Management and Construction when they utilised Humeslab (in Queensland – elsewhere in Australia known as 'Transfloor') in an eight-level apartment project in Brisbane recently.

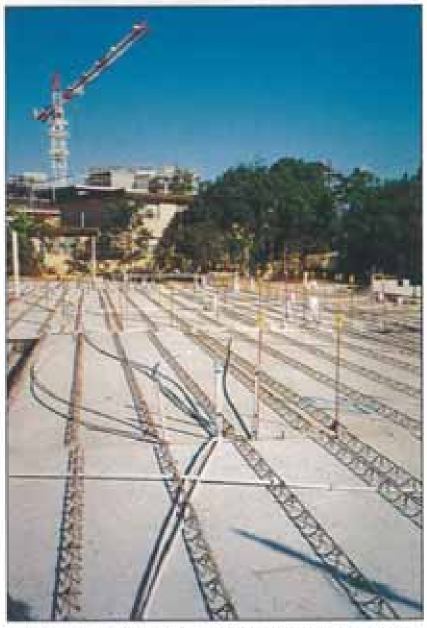
Humeslab is typically a 55-mm-thick precast concrete soffit element incorporating bottom reinforcement and lattice girder trusses to form permanent participative formwork.

'Ellenmac', a 14-apartment development at 150 Swann Road, Taringa is situated on a steeply sloping site with commanding views of the city and surrounds.

Mr John Ponturo, Managing Director of APM&C, the main contractor, said, 'This is one of the reasons we chose Humeslab for this project. The site was steep and tight, a logistical nightmare in terms of material handling and storage. Humeslab, being a permanent formwork system, minimised the amount of formwork materials required.'

Humeslab was incorporated into 2300 m^2 of flooring on five levels and proved to be very flexible. Curves, setdowns, cantilevers, beams, penetrations and services were all easily catéred for, as were near-circular balcony panels.

John continued, 'Penetrations, junction boxes, fire collars and bottom steel can be included in the panels off-site. When the panels are placed, a substantial portion of the work is already complete. Edge forming, minor electrical and plumbing works and placement of top steel followed by an insitu topping is all that's required. This actually maximises your crane and labour efficiency. The panels also form an immediate safe working platform which is of real benefit.'



PRECAST PERMANENT, PARTICIPATING FORMWORK IN PLACE. SHOWS CAST-IN TRUSSES, SERVICES IN PLACE, AWAITING TOP, CRACK-CONTROL STEEL AND TOPPING

PRECAST HUMESLAB (TRANSFLOOR) BALCONY PANEL BEING LIFTED – NOTE NEAR-CIRCULAR END TO PANEL

Floor to floor construction cycle times of 12 working days were achieved on what could be described as 'less than simple' decks of around 500 m^2 in size. Panels were quickly placed even during wet weather. Panels for each complete floor were placed in one day.

The developer also included precast edge beams in the design to minimise site formwork and speed erection. He plans to use Humeslab on future projects at Nambour and Clayfield.

The Humeslab supplier was able to offer design assistance and certification for the suspended slabs in the project. Other benefits of the Humeslab system include quality of soffit finish, early detection and solution of constructional discrepancies and cleaner, more open work spaces.

The slab soffit is typically Class 2 to 3 off form finish (AS 3610). This is suitable for direct application of a texture or stippled paint with minimal surface preparation.

The process of using a precast formwork system requires the user to plan ahead to allow preparation and approval of workshop drawings. Potential dimensional or structural discrepancies can be dealt with at an early date before they become problems.

Humeslab requires minimal propping, providing a cleaner, less cluttered and safer work site.

Overseas trends indicate that this precast permanent formwork system is a favoured method for construction of suspended slabs. In Europe this system has been established for 40 years where it accounts for 60% of all suspended slabs or 80 M/m^2 per year. ■

Quality Assurance Policy Statement

The Association supports, encourages and advises members in their efforts to achieve and satisfy clients' quality and quality assurance requirements. This Association and its members are committed to providing real quality and quality assurance to users of precast components in accordance with the specification requirements for each project.

ADMIXTURES IN PRECAST CONCRETE

Admixtures (materials other than cements, aggregates and water) are regularly used in the precast concrete industry to improve either the plastic or hardened state properties of the concrete. The benefits of such materials are numerous including:

- providing a more workable mix, less susceptible to damage during transporting, placing and finishing;
- offering either reduced or extended times before stiffening occurs, thus being able to adjust the mix to offset weather variations and reduce difficulties of placement and finishing.

These advantageous properties provide for an improved production efficiency and enhance concrete quality and surface finish.

THE RELATIVELY THIN-WALL SECTION OF A PRECAST 'U' BEAM. PLACEMENT OF CONCRETE AND COMPACTION IS AIDED BY THE USE OF A HRWR.

RHEOPLASTIC CONCRETE MIX TREATED WITH A HIGH-RANGE WATER-REDUCING SUPERPLASTICISER (HRWR). NOTE THAT EVEN WITH THE EXTREME SLUMP AND HIGH FLUIDITY OF THE MIX, COARSE AGGREGATE PARTICLES ARE STILL HELD IN SUSPENSION AND REMAIN UNIFORMLY DISTRIBUTED. FURTHER, THERE IS NO FLOW OF WATER OR CEMENT PASTE AROUND THE PERIPHERY OF THE MIX.

PLASTIC STATE PROPERTIES

Of major impact is the ability to obtain high workability, with low water content. Using a 'superplasticiser' admixture, slumps of up to 230 mm have been obtained with mixes having a w/c ratio of 0.4 or less. The derived benefits for precaster and client in using an admixture such as Rheo plastic high-slump concrete include:

- improved ease of concrete placement in the mould;
- reduced vibration effort yet providing complete filling of the mould and enclosure of reinforcement together with absorbing mould detail;
- controlled setting time;
- superior finish and detail.

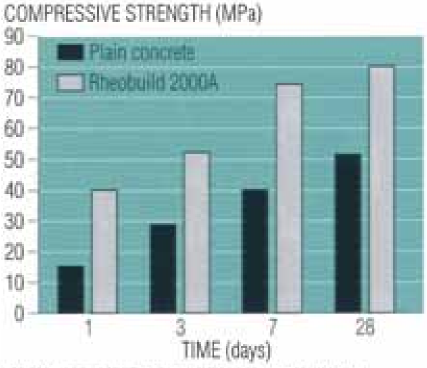


FIGURE 1 TYPICAL PERFORMANCE WITH AGE

CRISP DETAIL OF ARCHITECTURAL PRECAST CLADDING PANEL USING HRWR

For the precaster, these add up to a more efficient production cycle, whilst maintaining a high quality product.

HARDENED STATE PROPERTIES

Through the use of chemical admixtures (such as superplasticisers) to reduce the water content of concrete mixes without loss of workability, the hardened properties of precast concrete elements are also improved. Properties such as compressive strength (both early and ultimate), water permeability, chloride penetration, chemical resistance and drying shrinkage can all be improved with the use of chemical admixtures.

In summary, chemical admixtures assist the precast concrete producer to manufacture the highest quality products in the minimum amount of time. It is the resultant cost effectiveness and end product quality of this process that makes the use of chemical admixtures in precast concrete so attractive.

MBT (Australia) Pty Ltd is a valued Associate Member of the National Precast Concrete Association Australia.

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