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NATIONAL PRECASTER

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PLACING PRECAST CONCRETE MODULAR WALL PANELS; NOTE WORKFORCE CONTENT.

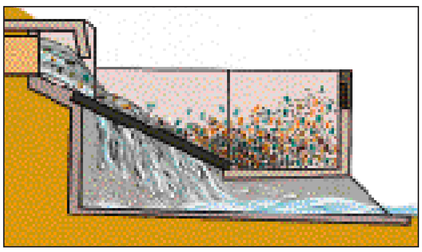
CATCHING THE NASTIES

The hallmark of a good invention is its practicality, its simplicity and a cost which makes it affordable to the community.

The Baramy Gross Pollutant Trap (GPT)* is such a development, using the flow energy of the stormwater to separate the gross pollutants.

The essential difference between Baramy and its conventional GPT forerunners is that the former is designed to use a combination of flow energy and gravity to keep the sloped trash rack clear of debris in contrast to the latter which generally trap pollutants on a vertical trash rack.

The stormwaters drop, unhindered, through the rack to flow away (*see diagram below*).



Ongoing flow velocity directs pollutants onto the collection rack. Litter as small as 15 mm is effectively trapped. Cleaning may be performed using manual or mechanical means.

A further advantage of the system is that pollutants are stored in a generally dry state thus limiting putrification and reducing the mass of the material at collection.

The Baramy unit, by virtue of its modular design, can be sized to meet a range of design flows. Precast concrete modular units were the obvious choice of material and construction mode.

For units up to 450 mm diameter pipe entry, the units are manufactured as a single element, with a modular panelised system being used for larger capacity units. This allows for limited site access and easy erection; given the prepared site, installation should be completed in one working day.

The Baramy GPT is a registered design of Baramy Engineering Pty Ltd. Licensed precast concrete suppliers exist throughout Australia.

** The Baramy GPT was placed First in the Engineering section of the 1997 Australian Design Awards.*

Future Function

NPCAA in assocation with Cement and Concrete Association and supported by Curtin University of Technology, The University of Melbourne, University of New South Wales and Queensland University of Technology announce a series of full day seminar/workshops on the topic of '**DESIGN OF STRUCTURAL PRECAST CONCRETE**'.

The seminar/workshops will be conducted by Dr Kim Elliott, University of Nottingham, UK and will be held at the following times and venues:

7 April Curtin University of Technology, WA
9 April The University of Melbourne
14 April University of New South Wales
17 April Queensland University of Technology.

If you wish to receive advance information, contact NPCAA on:
Phone/fax: [02] **4942 7210**
or email: **precast@hunterlink.net.au**

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SURFACE FINISHES

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

This issue deals with:

i) exposed aggregate by chemical retardation

ii) exposed aggregate – face-down casting using the sand embedment method.

EXPOSED AGGREGATE BY CHEMICAL RETARDATION

The application of this technique is almost solely limited to face-down casting or vertical casting often involving surface detail. For face-up casting, normal water washing to expose the aggregate as discussed in Issue No. 16 of *National Precaster* is the preferred option.

The process requires the application of a chemical retarder to the mould face. The selection of a suitable retarder will be dependent upon the depth of exposure of the aggregate required by the designer.

The purpose of a chemical retarder is to delay but not inhibit the set of the cement paste at the surface of the element. Following overnight curing to allow adequate strength gain to provide for stripping the unit from the mould, the surface can then be water-washed and brushed to remove the retarded matrix and fine aggregate thus exposing the coarse aggregate to the degree required.

Chemical retarding agents are available having a range of retarding effects to provide light, medium or heavy surface exposure levels. The compatibility of the retarding agent with accelerated curing techniques should be established. The selection of an appropriate retarder must be made by, initially, reference to suppliers literature and recommendations followed by sample panel trials. Sample panels should include that part of the work having the greatest surface detail.

Benefit is invariably provided by the use of a gap-graded coarse aggregate, rounded or cubical in shape, eliminating flakey shaped particle.

Good work practices are essential. These should include;

- Uniform application of the retarding agent; application may be by roller, brush or spray or alternatively, cloth and paper impregnated with retarder are available.
  Note that any re-distribution of the retarder whereby it is allowed to collect in returns, rebates, grooves etc will give heavier retardation and hence greater aggregate exposure will occur in those areas.
- A uniform time period between application of the retarder and concrete placement.
- Avoidance of retarder on reinforcement and fittings.
- Care when placing concrete to prevent abrasion and hence redistribution of the retarder.
- Uniform curing procedures.
- Minimum delay period between stripping and water washing.
- Standard washing procedures.

Following the exposure of the coarse aggregate to the required degree, the unit should be washed with a dilute muriatic acid to remove residual paste/slurry resulting from the washing operation. Diluted acid strength is generally in the order of 5%. This is followed by washing with water, at mains pressure to remove any residual acid solution from the surface. The placement of the element in an inclined position during acid washing is a useful consideration.

The designer may wish to consider the blending of the matrix to approximate to that of the coarse aggregate being exposed; such blending will marginalise any minor variations of coarse aggregate distribution.

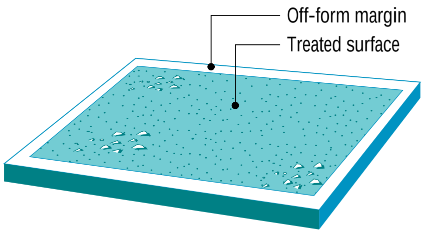
Exposed aggregate finishes capitalise upon the extensive, pleasing range of coarse aggregates available in Australia, including a wide range of crushed granites, crushed and natural river gravels. Such finishes also offer good weathering characteristics.

The requirements for consistent quality work practices in a controlled environment limit this type of finish to a factory based precasting operation.

EXPOSED AGGREGATE BY SAND EMBEDMENT (Aggregate Facing)

This technique allows for the use of large-sized coarse aggregate of generally 50 mm+. As with all exposed aggregate finishes, the depth of exposure is around one third of the aggregate size. With such larger sized material, note the need to ensure adequate cover to reinforcement following exposure. As with all water washed exposed aggregate finishes, rounded or cubical shaped aggregates are preferred. This method is suited to the face-down casting technique.

A layer of sand, similar to that used in the backing mortar and concrete is spread evenly over the mould surface. Thickness of the sand layer is a function of the aggregate size and degree of exposure required. The selected aggregate is hand placed on the sand bed, a rather labour intensive operation.



SMOOTH, OFF-FORM MARGIN – WIDTH DETERMINED BY PANEL DIMENSIONS, TYPICALLY 50–75 mm.
NOTE: TREATMENTS SUCH AS SHOWN ABOVE BECOME INCREASINGLY IMPORTANT AS AGGREGATE SIZE INCREASES.

The stones are covered with a cement/sand mortar, followed by the structural concrete for the panel.

After adequate strength gain to allow stripping from the mould, the surface is washed/brushed to remove adhering sand. Again, a dilute acid wash is likely to be required to remove any cement paste which may remain on the aggregate surface. This acid wash is followed by washing with clear water to remove any residual dilute acid.

Sample panels are essential for this technique, if only to ensure a compaction method which provides for full compaction without dislodgement of the stones. It is desirable that panels having this embedment technique and using large size aggregates be provided with a margin, generally smooth, off-form around all edges of the panel face. If that is not provided and the aggregates are taken right up to the arris of the panel, then subsequent washing and brushing may give a non-uniform, torn appearance to the arris.

With exposed aggregate finishes, the designer should be aware of the variation of appearance likely to occur where flat and vertical faces are cast together as in a vertical surface with a return (eg. a spandrel face with return soffit).

Again, such possible minor variation can be minimised by providing an off-form margin to both interfacing surfaces, thus preventing direct comparison. ■

PRECAST FLOORS

This is the second in a series of articles covering available precast concrete solutions for floor construction. The first article which appeared in issue no.16 of National Precaster *dealt with the generic systems available in Australia.*

HOLLOW CORE FLOOR PLANKS are precast, prestressed units produced on long-line beds using slide forming or extrusion methods. Plank widths are usually 1200 mm wide, though some manufacturers can produce 2400 mm wide units. These wider units may require increased crane capacity but offer greater speed of placement, less joints, grouting and sealing. Thicknesses vary from 150–300 in 50 mm increments, the thickness being determined by span, loading, fire rating and cover to reinforcement to satisfy exposure conditions. Planks may be used as plain sections or topped to give a composite unit, the topping being used to increase plank capacity or fire rating and provide a flat, uniform surface or, alternately, provide required falls.

Plank Width Most manufacturers provide 1200 mm wide planks. Some manufacturers can offer a 2400 mm wide unit. Obviously, economic advantage occurs if designers incorporate these modular values in their design. If this is not possible, planks can be sawn longitudinally by the manufacturer, or partially widths cast. Alternatively, an insitu pour can be made to make-up the non-standard dimension but such treatment tends to nullify the many advantages of using a precast floor system. This concern may be mitigated if an insitu topping is to be used, when the infill pour and topping placement can be paralleled.

Plank Depth As an initial guide, the load-span graphs (Figures 1, 2, 3 and 4) may be used to determine a likely plank depth. Deflection limits are usually considered as:

- floor slabs; the ratio of span to overall depth is usually in the range of 35–40
- roof slabs; in the range of 40–45 and
- for handling purposes the span to depth ratio should not exceed 45.

Where deflection is likely to be more critical ie. machinery, sustained live loads, plank thickness may need to be increased.

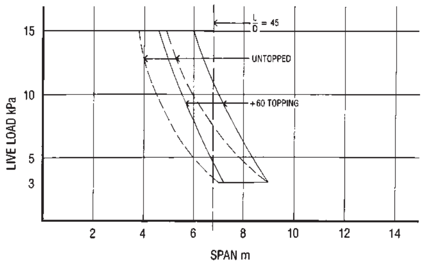


FIGURE 1 150 PLANK

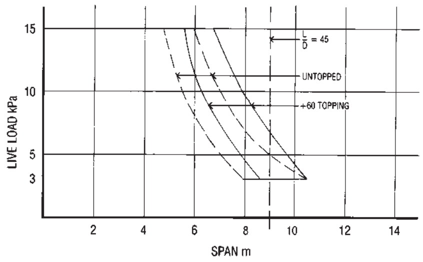


FIGURE 2 200 PLANK

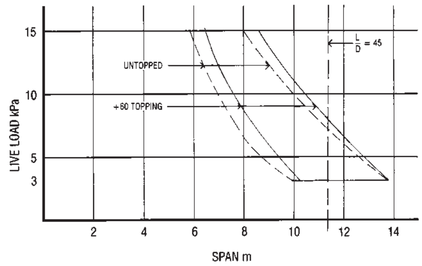


FIGURE 3 250 PLANK

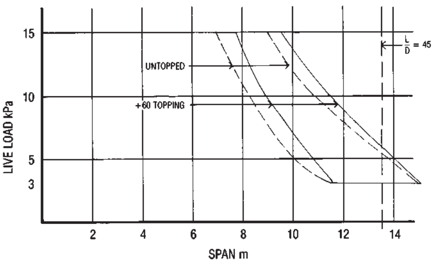


FIGURE 4 300 PLANK

High fire rating requirements increase cover, reducing the effective depth of the plank and hence may require increased plank depth.

Design Requirements The design of hollow core floors is generally undertaken in two stages; firstly a Preliminary Design when the general layout, the overall dimensions of the plank and the typical details are selected to suit the building requirements, and secondly a Final Design when the details of the planks – strand patterns, connections, embedded items are decided and the shop drawings produced.

The preliminary design is carried out by the Structural Engineer responsible for the project and is incorporated in the contract documents. Where the detailed final design is left open for the Manufacturer by way of a performance specification, the Structural Engineer must provide on the general arrangement drawings full details of the design criteria so that a plank designed to these criteria meets the requirements of the structure. These criteria include vertical loads and lateral forces to be resisted, interface with other construction materials and building elements and the forces to be transmitted through connections.

The manufacturer usually advises the most economical connection type and details the items to be embedded in the planks. The remainder of the connection to the supporting member should be detailed in the contract documents. In this way the scope of work and extent of items to be provided by the Manufacturer and by the Builder is clearly defined.

The Structural Engineer is responsible for the checking of any Manufacturer's calculations and for the review and approval of the shop and erection drawings. The Structural Engineer should ensure that these drawings comply with the intent of the design and that the proper design loads, connection details, fire rating and openings have been provided for.

The Architect reviews the shop drawings to ensure that the geometry and details are compatible with the final architectural drawings.

Load Distribution Hollow core planks are usually designed as simple one way spanning slabs. When the planks are installed and the keys grouted the individual planks act together and transfer forces from one plank to another. Frequently hollow core slabs are subject to non-uniform loading in the form of concentrated loads, live loads or load concentrations at openings. The interaction between the planks allows these load concentrations to be shared by several planks.

The ability of planks to distribute loads has been demonstrated by full scale testing and explained by a combination of shear stresses induced in the grouted keyways and by transverse bending in the planks. For design purpose an effective load resisting width can be used to calculate design bending moments and shears. This effective width depends upon the span and is illustrated in Figure 5.

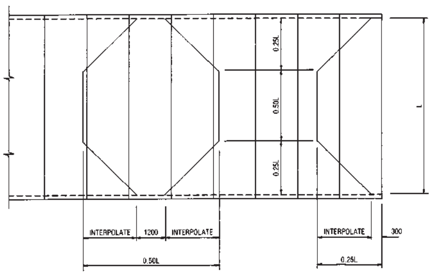


FIGURE 5 EFFECTIVE WIDTH FOR LOAD DISTRIBUTION

	Fire Resistant Period (minutes)					
	30	60	90	120	180	200
Effective thickness (mm)	60	80	100	120	150	170
Concrete thickness between cores and between cores and exposed surface (mm)	25	25	25	25	30	34
Required cover (mm)						
Simply supported span	20	25	35	40	55	65
Continuous span	15	20	25	25	35	45

This concept of an effective width can be used to account for the effect of items such as masonry partitions, local equipment loads and openings in slabs.

Continuous Spans Hollow core planks usually have a reinforced topping. Continuous spans can be obtained by designing reinforcement in the topping or the grouted cores or keyways to resist the calculated negative moments at the supports.

The choice between a simple span and continuous design depends upon the relative economics of the two systems. Usually the prestressing strand is more cost effective than normal reinforcement in resisting bending stresses so a simple span arrangement would be adopted. Where reinforcement for structural integrity ties or shrinkage control is placed in the topping its negative moment capacity is low so the plank should usually be designed for the full simply supported positive moment.

Preliminary Design Check List

1. Determine a feasible arrangement for columns, walls and beams. Note preferred options for structural efficiency.
2. Establish the basic design data:
   a) Occupancy of the structure
   b) Fire rating (building regulations)
   c) Sound transmission class (building regulations)
   d) Exposure classifications and durability requirements (AS 3600).
3. Determine the minimum slab thickness from step 2(b) and (c) and the minimum concrete strength and cover from step 2(b) and (d).
4. Select a suitable overall depth of plank and topping to satisfy deflection control from the guideline values. Typical Span/Depth Ratios are:
   Floors 35–40
   Roofs 40–45
5. Determine the dead and live loads (AS 1170). Note: Special loads such as masonry partitions, wheel loads, machinery vibrations and construction loads should be considered separately.
6. Check the strength capacity of the plank from the preliminary selection graphs Load v Span in Figures 1 to 4.

Fire Rating The fire rating or fire resistance period of a floor is specified in the building code as the period in minutes during which the floor must retain its structural adequacy, integrity and insulation when subjected to the standard fire test.

The Concrete Structures Code AS 3600 specifies the design for fire resistance to be met either by testing or calculation or by proportioning members to comply with certain rules.

In practice the deemed to comply rules are adopted usually as a convenient method of compliance. Two criteria must be satisfied.

- Insulation requires a minimum effective thickness of concrete and a minimum thickness of concrete between adjacent core and between a core and the exposed surface.
- Structural Adequacy requires a minimum concrete cover to the strand.

The deemed to comply requirements of AS 3600 are summarised in the table above.

Proximity to cores and difficulty in ensuring full bond make strand covers in excess of 45 mm undesirable. Continuity should be seriously considered when fire resistance periods of 3 hours or more are required. It is good practice to locate the strands in the flange section, not in the web or near the web-flange junction. For the purpose of fire rating, a slab is considered as continuous if under imposed load it is flexurally continuous at least at one end.

For a hollow core plank the effective concrete thickness is taken as the nett cross sectional area divided by the width of the cross section. If the effective thickness of a plank is not sufficient to achieve the required fire rating, this can be increased by either providing a concrete topping or an insulating layer to the soffit.

The equivalent thickness of a hollow core plank depends upon the size and spacing of the cores. As these vary with the particular machine there are some small differences in the deemed to comply fire resistance levels of the planks provided by different manufacturers. In practice these differences tend to be significant only for the higher fire ratings and for planks that are not topped. As a concrete topping is frequently provided for fire rated planks, the higher ratings can be met by all hollow core products without difficulty.

For untopped planks the grouted joints have been shown by fire tests to provide a fire resistance level at least equal to that of the plank section.

If the required cover to the strand results in an inefficient design for the specified load capacity, this can be overcome by applying an appropriate thickness of insulating material to the soffit.

Sound Insulation Hollow core floor planks can provide high levels of acoustical resistance to both sound transmission and impact noise. One important parameter which is used to measure the resistance of a material or system to sound transmission is the Sound Transmission Class rating. The larger the value of STC the greater the sound insulation.

Building codes specify minimum value of sound insulation for floors and walls separating different occupancies in residential buildings. A floor separating flats must have an STC not less than 45. A 100 thick concrete slab without joints is deemed to comply with this rating. A 150 hollow core plank untopped with grouted joints also meets this requirement. ■

THE TWO FACES OF GRC

CASE STUDIES OF GLASS REINFORCED CONCRETE

Ambulatory Care Centre – Randwick Hospital The redevelopment of the Prince of Wales Hospital, Randwick NSW has witnessed a number of new building structures. Possibly the most visually pleasing is the Ambulatory Care Centre, the last of a close grouping of three interrelated structures.

The development master plan for the precinct called for a ‘flat’ facade surface with horizontal linear emphasis. Such a finish occurs as one of the parameters of GRC appearance, the material being capable of being intricately moulded or finished ‘super’ flat.

The Ambulatory Care Centre was a design and construct project (designed by SJPH Design Partnership and constructed by Thiess Contractors) constrained by a very tight construction programme and significant cost penalties for late handover. Consequently, the contractor sought a facade construction method which offered speed of erection without the need for external scaffolding.

Additional criteria included a quality waterproofing system, a ten year guarantee of the facade and attention to the minimisation of facade maintenance. Cladding systems used on adjacent buildings were evaluated and rejected in favour of a GRC facade.

Some 3000 m^2 of GRC panels, 430 in total were manufactured in Adelaide and road freighted to Sydney in 22 loads without incurring a single delay to the Contractor’s erection schedule. The largest panel was some 8.6 x 3.7 m. The lightweight GRC skin was mounted on a steel stud frame in the factory. Prior to delivery, panel surfaces were treated with a Dulux Acrashield finish, roller applied.

THE FLAT, CLEAN, CLINICAL APPEARANCE OF THE GRC CLADDING.

EQUATORIAL HOTEL FACADE WITH GRC FASCIAS, CORNICES AND COLUMN CLADDING.

Equatorial Hotel, Ho Chi Minh, Vietnam The structure comprised a reinforced concrete frame, with brick infill panels subsequently rendered.

GRC was used to provide the ornate detail to the facade using horizontal fascias and cornices above and below window openings at all levels and at all roof extremities. Additionally, one piece column cladding elements were moulded to enclose in-situ column units.

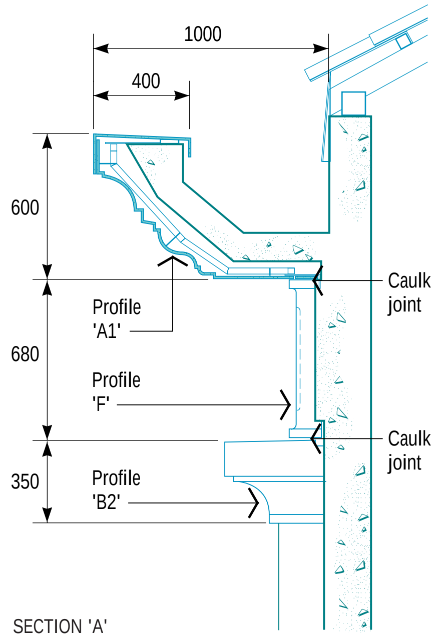
The ability to provide such ornate details is one of the many advantageous properties of glass reinforced concrete.

Section ‘A’ (right) indicates the profile of (from top to bottom);

- Profile ‘A1’ – Fascia cornice profile. Conceals large concrete box gutter. Also includes capping piece.
- Profile ‘F’ – one-piece column cladding.
- Profile ‘B2’ – cornice profile.

The project required some 2300 linear metres of cornices.

After erection the GRC was finished with an acrylic coating system. GRC manufacture was by an Adelaide based member of NPCAA. ■

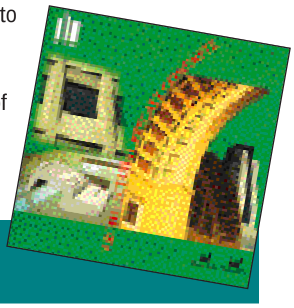


SECTION 'A'

ARCHITECTURAL PRECAST CONCRETE

NPCAA has recently produced a CD ROM entitled *Architectural Precast Concrete.* Intended initially for multiple circulation to all libraries associated with Schools of Architecture and Building in the Australian Universities systems, the CD ROM will be of great interest to all designers and contractors wishing to know more about precast concrete facades with specific reference to surface finishes.

Available from NPCAA at a cost of $15.00, which includes postage and packaging.



FINAL INSPECTION OF REINFORCEMENT AND FITTINGS PRIOR TO CLOSING MOULD. FOR EXTREME ACCURACY OF POSITION AND TO ENSURE CORRECT COVER, REINFORCEMENT WAS ASSEMBLED IN A JIG AND LIFTED AS A 6 TONNE CAGE INTO THE MOULD.

BRIDGE OF SIZE

GEORGES RIVER BRIDGE
M5 Motorway, Sydney

The M5 motorway is a dual carriageway road, which stretches some 24 kilometres to the southwest of Sydney connecting with the Hume Highway to Melbourne. Where it crosses the Georges River and the main southern railway line near Liverpool a duplicate bridge is being constructed. The existing bridge was built as a four-lane carriageway handling both eastbound and westbound traffic in two lanes each way, using steel box girders with a composite concrete deck.

The new construction is a duplication of the original bridge profile to create a separate eastbound river, rail and road crossing. It is comprised of seven spans varying in length from 36 to 44 metres, with 56 metres for the river crossing span. The superstructure is entirely comprised of precast prestressed concrete utilising Super Tee girders and variable height double cantilever I girders.

The bridge is located on one of the most difficult sites imaginable. Foundations were constructed through an old disused rubbish tip. Two sets of high voltage electrical mains interfered with crane manoeuvrability in girder erection. The main southern railway line was kept continuously operational and together with proximity of work to the existing bridge all necessitated the development of carefully thought out construction methods.

The cost-effective solution adopted for this site by the designers, Maunsell Pty Limited in collaboration with the RTA of NSW was precast prestressed concrete for the superstructure.

To comply with existing vertical alignment and clearance for road, rail and water crossings necessitated the use of a slender deck. Two 36 metre Super Tee spans were supported on temporary tower structures and post tensioned to the ends of cantilever girders to create the 44 metre span. The 56 metre span over water was achieved using 10 m cantilevers from the piers and connecting simply supported Super Tees with halving joints at each support.

In total the precast supplier manufactured and supplied from its precast plant at Teralba, near Newcastle, 63 Super Tee girders, 36 metres long and weighing 60 tonnes each together with 14 double cantilever I girders 2400 mm high, precast formwork slabs, fascia panels and 102 precast kerb elements. After girder erection, a 270 mm thick reinforced concrete deck was constructed to act compositely with the precast girders.

All girders were manufactured on a daily casting cycle and cured using steam at atmospheric pressure to ensure high concrete durability during service life. This curing regime also ensured that the minimum compressive strength required for the transfer of prestress was achieved. Compressive strength at 28 days was specified as 50 MPa.

Girders were delivered on special heavyhaul vehicles that had the ability to steer the axle of the rear jinker to allow manoeuvring on the congested site. All girders were stored on site adjacent to final location and positioned by the head contractor, John Holland Construction & Engineering Pty Ltd. Mobile cranes were used for the four eastern spans. The two western spans over rail lines and existing road together with the water span were erected using a steel launching truss.

The manufacture and construction techniques have proven to be highly successful and pave the way for a similar approach in future.

The major perceived advantages for this Super Tee design and construction technique includes lowest initial first cost and a long life maintenance free super-structure. In particular the use of Super Tees allowed for the quick construction over busy railway lines, roads and waterways whilst simultaneously providing an immediate and complete working platform. This allows deck reinforcement to be placed as soon as girders are erected. Deck concrete quickly follows. Safety is assured at minimum risk to workers on site and development of precast kerbs makes site formed kerbs obsolete. ■

LOCATING ONE OF THE 10-METRE CANTILEVER UNITS. THESE UNITS PROVIDED SUPPORT FOR THE SUPER TEE UNITS WHICH SPANNED THE ROAD, RIVER AND RAIL CROSSINGS.

Better Built with Concrete

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