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NATIONAL PRECASTER

NATIONAL PRECAST CONCRETE ASSOCIATION AUSTRALIA WEB ADDRESS: www.npcaa.com.au EMAIL: info@npcaa.com.au

PRESIDENT'S Message

As part of our modernisation and enhancement of the Association's image I am proud to present to you, our latest edition of the National Precaster, which has undergone a complete facelift.

Perhaps more importantly is the content detail, which highlights the sophisticated, innovative, and quality based industry that we are. Our focus is now on the cutting edge issues that are community and socially related to modern Australia. Precast is responding to the demands of modern construction in addressing issues, such as energy efficiency, sound transmission, quality of construction and affordability.

The use of precast in residential construction is being rapidly embraced throughout Australia, for all the above reasons.This issue includes the first of a series of articles prepared by Dr. Edward Harkness which deals with the social and economic benefits precast provides in construction. Dr. Harkness provides an in-depth review of the benefits precast affords in energy efficiency in multi-storey structures.

Another initiative approved by the NPCAA Board is a formal procedure for Member Certification. This sets a minimum criteria that must be met before a precast concrete manufacturer can be admitted to the Association as a Corporate Member. This initiative has been introduced to raise the standing of the Association and its Members and to provide the construction industry with assurance that, by choosing to deal with our members they can be assured that they are dealing with a competent manufacturer, capable of providing quality products and service.

Contractors will be able to confirm a manufacturer's credentials by a Certificate of Membership, signed by the President and issued to Corporate Members on an annual basis.

Another highlight since our previous edition of National Precaster is the Concrete Institute of Australia "2003 Award for Excellence in Concrete – Technology" for our *Precast Concrete Handbook*. We were delighted to be presented with this prestigious Award at the Institute's Biennial Conference Awards Night held on the 19th July 2003 in Brisbane. The comments made by the presenter confirmed the quality of the publication and the extensive material it contains for all aspects of the Australian precast concrete industry.

The Handbook content accurately reflects the state-of-the-art practices in the precast concrete industry. It is a fantastic publication and is a must-have document in every engineer's, architect's and designer's technical library.

Matt Perrella,
President

MOOREBANK Ave Interchange –

A Tribute to the Versatility of Precast Concrete in Fast Track Infrastructure Construction

Precast headstocks being erected on Y-shape pier columns

The recently completed Moorebank Interchange has removed the last remaining set of traffic lights on the main highway link between Sydney and Albury. Motorists can now travel from the north side of Sydney Harbour via the Sydney Harbour Tunnel, the Eastern Distributor, the M5 East and M5 motorways and the Hume Highway unimpeded to Canberra and the Victorian border.

The grade separation interchange with onloading and offloading ramps in all directions was constructed over an intersection with an operating motorway that carries 90,000 vehicles each day. The site was small and constricted and the design solution demanded that safety of motorists and construction personnel and continuous traffic movement be uncompromised.

The interchange bridge consists of two 18m long simply supported spans, two abutments and a central pier located in the motorway median. The bridge is variable in width ranging from 50m over the central pier to 64m at the abutments.

Initial design considerations favoured steel because of its apparent ease of construction. Maintenance requirements, however, over-ruled this material. Concrete was the material of choice.

A further consideration for the designers was speed of construction. A short construction period would reduce the exposure of traffic to construction conditions while similarly reducing risk to construction personnel. Nor did the obvious cost savings achievable through a shorter construction period pass un-noticed by the Construction and Design Management team of Kellogg Brown and Root (KBR).

Precast concrete construction appeared a natural outcome to the designers combining both the ease and speed of construction with the durability and low maintenance requirements inherent in high-class, high-strength precast concrete.

By consulting early in the design process with industry specialist, Structural Concrete Industries (Aust) Pty Ltd

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(SCI), an elegant solution evolved which allowed all of the bridge structure above pile cap level to be entirely precast (with the single exception of the insitu deck pavement), thus providing the option for staged construction of the overpass without impeding traffic flow. This solution for the two-span bridge comprised the following principal precast concrete elements:

- 550 mm square Abutment Columns
- Abutment Headstocks with integrated backwall
- Y-shaped Pier Columns
- W-shaped Pier Headstocks and
- Type 2 Open-Top Super-T's

Precast substructure - ready for girders

The completed interchange.

In using precast, the two span portal structure was designed with fixity at the base of the abutment and pier columns so as to be totally freestanding and without reliance on the adjacent civil works. This independence of structure allowed significant construction planning freedom, particularly in respect of efficient use of resources.

This independent fully precast structure solution also overcame many of the safety and resourcing aspects so often inherent in construction adjacent to, within and over a very busy operating motorway.

Through the efficiency of off-site precasting, the bridge substructure was erected in just days using night-time possession periods when traffic flows were low. This allowed other concurrent work activities involving reinforced earth walls and earth embankment construction to proceed with minimal interface or interference to the bridgeworks construction.

To achieve fixity at the bottom of the abutment columns, four 80mm dia vertical ducts were cast into their bases. These ducts mated with accurately located reinforcing bars projecting from the pile caps and on erection were grouted with high strength grout. The precast abutments were similarly fixed to these columns through ducts in the abutment elements mating with bars projecting from the column heads.

Due to the restriction of space within the column base and the congestion of reinforcement, fixity of the Y-columns with the pile caps was achieved using proprietary cast steel grout sleeves. The beneficial feature of these devices is their relative shortness in length compared with a grouted duct requiring full bar bond length to provide the same anchorage force.

Immediately after erection, the abutment and pier headstock segments were structurally joined to provide continuously reinforced headstocks over the full width of the bridge. These connections were achieved through large complex bar joining recesses in the internal ends of each precast segment and the use of specialised mechanical reinforcing bar couplers. Once the coupler connections were in place, the recesses were filled with concrete with the same strength characteristics as the precast elements.

The abutment headstocks are of reinforced concrete and sit on the closely spaces abutment columns. The pier headstocks are of prestressed concrete and span as cantilevers some 5 m between tops of each Y arm.

Because the abutment columns sit behind an architectural feature precast, reinforced earth wall they are not visible in the completed bridge structure. On the other hand, the Y-columns and pier headstocks are highly visible to approaching and passing traffic. For this reason, great attention to detail has been employed to ensure that the resultant pier structure presents as form expressing function in a most aesthetic way.

Minimum section size, tapered edges and fluted faces have been incorporated with a very high class finish into the Y-columns with striking effect. Together with their tapered W-shaped headstocks, the Y-columns present a superb structural image, particularly at night where judicious floodlighting has been used to great effect.

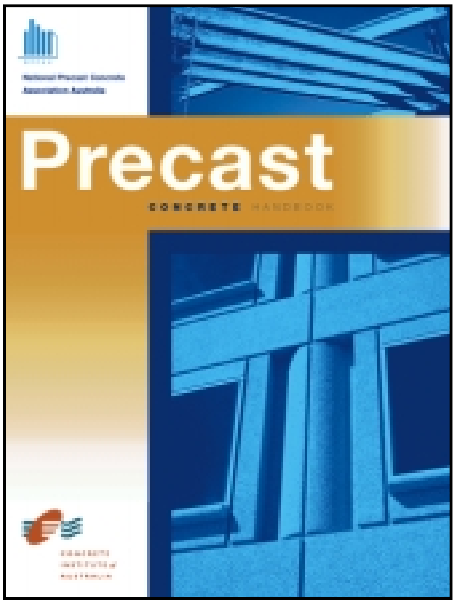
Erection of abutment headstocks.

The overall visual effect is further enhanced by the vaulted soffit provided by the Super T superstructure establishing this interchange overall as a fine piece of highway architecture.

Several factors combined to make this project an outstanding success. The first factor is the early recognition of the benefit of consulting with the specialist precaster at concept stage to establish achievable limits. The second was that the client selected carefully those contractors which they considered should be on their tender list. The successful contractor then brought on board their specialist precast concrete supplier so that together, with the designers, the fine detail and buildability issues of the project design could be properly resolved. This attention to detail plus the achievement of the fine tolerances necessarily achieved in the manufacture of the components ensured that the whole bridge was assembled faultlessly in just days.

The interchange has received wide acclaim for its aesthetics, the minimal disruption to motorway activities and the fact that construction took only 9 months. The Moorebank Interchange represents a genuine success story which champions the benefits of precast concrete in infrastructure.

To find our more about the design of the precast elements featured in the Moorebank Project, refer to Section 2 of the award-winning *"Precast Concrete Handbook"*.



Precast
CONCRETE HANDBOOK

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DESENSITISATION of the building facade

By Dr Edward L Harkness FRAIA FIEAust CPEng

Dr Harkness has joined National PRECASTER as an occasional author of technical articles. An architect and engineer, he has 20 years experience as an energy consultant and presently lectures at UNSW and the University of Sydney. His books were published in the UK and Russia. Experience includes practice in Australia, South East Asia and the Middle East.

In 2002 he completed a three-month study in the Far East, Europe, UK and USA meeting with key players in the international trading of carbon credits. He has formulated a proposal for the abatement of greenhouse gas emissions by shading buildings.

Introduction

This article is a conceptual assertion that shading existing buildings would be an effective approach to achieving significant greenhouse gas abatement. Space limitations have led to a decision to mention only buildings in Sydney and the development of shading in the work of only one architect: Harry Seidler. More detailed quantification of greenhouse gas abatement achievable from shading will be presented in a subsequent article in National PRECASTER.

1. Imminent action

The time has come to desensitise the facades of existing buildings that have thermally sensitive facades and to ensure that future buildings are built with facades of low sensitivity. See Fig.1.

Currently, international legislation is being directed towards minimising greenhouse gas emissions that are said to cause climate change.

This in turn is said to raise the level of the seas. [1], [2] Holland, that lowest of low-lying countries, much of which is below sea level, is at the forefront of encouraging co-inhabitants of this planet to take action to minimise the rate at which waters in the world's oceans may rise. [3]

The Commonwealth Government of Australia has initiated Round 3 of its Greenhouse Gas Abatement Program with proposals submitted on the 21st August 2003.

Although not a signatory to the Kyoto Protocol, Australia appears to be intent on meeting the expectations of that Protocol. [4]

The NSW Government has initiated a system of saleable credits for reducing greenhouse gas emissions. This is the NSW Greenhouse Gas Abatement Scheme, which issues NSW Greenhouse Abatement Certificates (NGACs). Electricity Retailers are involved in purchasing and surrendering NSW Greenhouse Abatement Certificates (NGACs) to the Scheme Administrator. This process encourages retailers to reduce their average emissions to the approved Greenhouse Benchmark Level. Users can reduce the impact by undertaking energy efficiency projects that produce NGACs (for the user) and then sell them back to the Retailer. [5]

On international, national and state government levels there are currently actions aimed at reducing greenhouse gas emissions.

2. Emission factors

The Australian Greenhouse Office (AGO) provides emission factors for electricity usage in all States (conversion equivalent of tonnes CO_2 per MWh). [6] See Table 1.

TABLE 1

Greenhouse Gas Emission Equivalents in the States and Territories of Australia

VIC:	1.444kg CO_2 per kWh
SA:	1.197kg CO_2 per kWh
WA:	1.114kg CO_2 per kWh
QLD:	1.079kg CO_2 per kWh
ACT:	1.012kg CO_2 per kWh
NSW:	1.012kg CO_2 per kWh
NT:	0.654kg CO_2 per kWh
TAS:	0.002kg CO_2 per kWh

Reduction in electricity consumption would achieve more greenhouse gas abatement in Victoria than in NSW. Very little abatement would accrue from reducing electricity consumption in Tasmania. Abatement in the Northern Territory would be only about 65% of that in NSW.

Figure 1. Sydney building facades have various thermal sensitivities. The least sensitive have concrete or GRC facades with shaded windows. Some of the more sensitive unshaded fully glazed facades have low energy star ratings and could become unleasable if a minimum energy rating of 3 stars were required by prospective tenants. Photographs by E. L. Harkness

Fig. 2. 50 Bridge Street, Sydney: a highly sensitive facade.

3. Some benefits of shading

Described in Rewards for Shading [7] are ways in which the cooling loads on chillers may be reduced. These include, in descending order of effectiveness: (a) reducing the area of glass (b) shading that reduced area of glass and (c) double-glazing.

Whereas so-called "high performance glass" was used on new buildings in the closing decades of the 20th Century, it is now known that shading which glass would achieve further greenhouse gas abatement. A significant glass tower of that period is 50 Bridge Street, Sydney, which is the black glass tower second from the left in Fig.1 and in Fig.2.

This building is the poorest performing building in energy terms in the AMP Henderson Global Investors' portfolio. It has a voluntary self-rated SEDA rating of 1.5 stars.

Shading the glass on the northern and western facades of 50 Bridge Street would reduce cooling loads on chillers in one hour commencing at 3 pm Eastern Summer Time in February by approximately 1 megawatt.

Applying a coefficient of performance of 4 for chillers, this equates to reducing greenhouse gas abatement by about 0.25 tonnes equivalent of CO_2 in one hour.

In the facade of the Renaissance Hotel, Sydney, windows occupy less than 50% of the length of the facade, admitting less that 50% of instantaneous radiation compared to a facade in which windows occupy the full length of the facade. See Fig. 3.

Grosvenor Place has shaded windows in a GRC facade making it less sensitive than 50 Bridge St and the Renaissance Hotel. See Fig. 4.

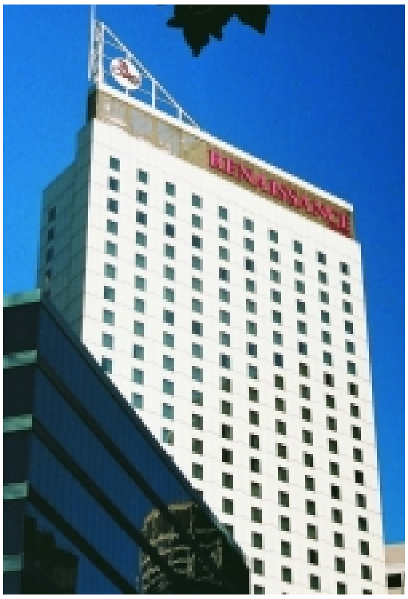

Fig 3. Rennaissance Hotel, Sydney: a sensitive facade.

5. Commonwealth Greenhouse Gas Abatement Program

A proposal for which the author of this paper is a consultant, is a bid for a grant under the Commonwealth Greenhouse Gas Abatement Program Round 3 to shade sufficient windows in buildings throughout Australia to achieve an abatement of 250,000 tonnes equivalent of CO_2.

There will be other proposals. The receivers of grants will be those who can demonstrate cost effective achievement of abatement and a high level of expectation of achieving greenhouse gas abatement.

There is absolute certainty in any air-conditioned building that greenhouse gas abatement would be achieved by shading any type of glass whether it be clear or the best of so-called "high performance glass."

Fig. 5. Precast wall with shaded windows: low sensitivity.

Fig 4. Grosvenor Place, Sydney: a facade of low sensitivity.

6. Thermally sensitive building facades unlikely to be shaded

The heritage-listed first of the AMP buildings at Circular Quay is the concave curved facade building second from the left on the waterfront in Fig. 1. In a post occupancy evaluation of that building carried out by the author of this paper in 1963 some of its occupants considered it to be thermally uncomfortable. They were instructed by the building managers to keep internal venetian blinds set at a standard angle in the expectation that would eliminate thermal discomfort from solar radiation. It didn't. Internal blinds cannot be as effective as external shades.

Also heritage-listed, Seidler's cylindrical Australia Square Tower is unlikely to have its shading increased. The radial projecting columns provide only partial shading.

Fig. 6. Cast-in fixings for on-site attachment of light -weight shades.

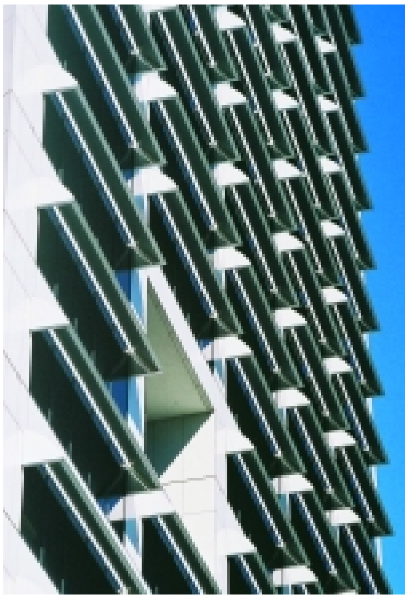

Fig 7. Shades on IBM Building

7. Thermally less sensitive facades

The MLC octagonal planned building, also by Seidler, which is in front of Centre Point Tower in Fig. 1, has windows set deeply back from the facade. Seidler used shades on his Grosvenor Place, which is the tallest convex curved building third from the right in Fig.1. See also Fig. 4.

8. Lightweight shades on precast walls

Fig. 5 shows lightweight shades fitted to precast concrete wall panels. Fixings can be cast into the precast wall panels in preparation for on site placement of lightweight shades. Fig.6 shows how fixings can be accurately located prior to casting in the factory. Concrete can also be self-shading with cast-in shading forms.

9. Glass box buildings will be shaded

So-called "high performance glass" does admit, instantaneously, radiation from the sun.

It is now known in the 21st Century, that greenhouse gas abatement has a higher priority than building owners' preparedness to pay for energy use. That higher priority is a responsibility to the international community to reduce the rate of climate change.

Glass box buildings will be retrofitted with shading.

10. Forms of shade

Shades on the IBM Building, Darling Harbour, Sydney appear as large-scale forms with changing shadow patterns throughout the day. See Fig. 7.

Horizon Apartments, by Seidler, show the use of concrete to self-shade the building. The facade has interesting forms. See Fig. 8.

The geometry of shade has evoked a new awareness among architects and engineers because of its benefits in reducing the size of air-conditioning plant and its creative potential.

11. Existing buildings

Given that at 3pm Eastern Summer time, the direct component of solar radiation is 600 watts/sqm and the diffuse radiation is 144 watts/sqm, a window of area 2000mm high x 4000mm wide of heat absorbent glass of 50% transmittance would admit instantaneously, about 3000 watts.

This quantity of heat gain could be reduced by approximately half by fitting insulated panels to half of the window area. These panels could be fitted vertically to occupy half of the horizontal length of the window. Alternatively, half of the height of the full width of the window could be covered with insulated panels so as to leave unobstructed views horizontally.

Both configurations would reduce the instantaneous heat gain to 1500 watts. Leaving the entire glazed area and simply shading it would reduce the heat gain to 345 watts. That is, an 88% reduction.

12. New Buildings

Opportunities are available in the design of new buildings to minimise the consumption of electrical energy by shading glass; and optimising the design of air-conditioning equipment to peak cooling loads that would be significantly less than if the glass were not shaded. Shading the glass would extend the hours during which up to 100% outside air may be sufficient for cooling and therefore reduce the hours of operation of chillers and extend the life of those chillers.

13. Summary recommendations

Existing buildings with highly sensitive facades should have the first priority for being fitted with shades to abate greenhouse gas emissions.

GRC is ideal for retrofitting shading.

Existing buildings with less sensitive facades should have the second priority for being fitted with shades to abate greenhouse gas emissions.

Existing buildings that are exemplars of design at the time they were designed, should be exempted from this proposed program.

In new buildings precast concrete wall systems can incorporate forms for shading.

Research and development should be undertaken to produce shading systems at low cost and with low embodied energy.

Fig 8. Horizon Apartments.

Building owners and users should be educated regarding the environmental and financial benefits that could result from well-designed shading.

Architects and consultants may be engaged to design shading to enhance the appearance of buildings.

Acknowledgements

Appreciation is expressed to Frank Lowe, Editor of TAS & Archizine and President of the Francis Greenway Society; Bruce Forwood of the University of Sydney and Steve King of UNSW for reading this paper and making suggestions.

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[6] AGO Factors and Methods Workbook: http://www.greenhouse.gov.au/challenge/tools/workbook/index.html (Greenhouse emissions factors for fuels)

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Photographs by Dr E L Harkness

The next issue of National Precaster will featured the second article in Dr Harkness's series entitled "Effect on Chiller Size of Various Proportions of Precast, Glazing and Shading".

TOWARDS MORE efficiency & sustainability in construction

Hollowcore planks deliver strength and fire rating with up to 45% less material plus savings in structure dead load and transport costs.

It has not been too fashionable within the construction industry to look for building techniques that minimise the use of raw materials and energy. Concepts such as sustainable development, intergenerational equity and the precautionary principal have had scant exposure. Instead, the construction industry has been focussed pretty exclusively on making money. Adversarial contracts too often dictate that the only important criteria is finishing on schedule and to hell with the collateral damage to the quality of the building or to the future environment.

In far too many cases the initial cost of a building is the governing factor. When the developer intends to sell a building immediately after construction profit is maximised by maximising floor area and minimising the cost of construction. The result is too often a building which is expensive to maintain and to heat and cool and which will be difficult to demolish.

Making money will continue to be the prime driver for business but the legal and regulatory environment will change to reflect changing community concerns and sustainability imperatives.

Change can come about in several ways. Increases in the cost of fuel of all types will automatically lead the cost minimisers to design so as to reduce usage. More discriminating purchasers and tenants of buildings will demand better standards of sun shading and energy use and laws enacted by government will force change upon the industry. When it becomes necessary to change in order to maximise profits, then change will occur.

In recent years we have been given no choice about installing better QA and OH&S systems and there is on doubt that compliance with the AS/NZS ISO 14000 International environmental standards will follow.

The Australian precast concrete industry is in a unique position to assist the construction industry in the reduction in waste, the best use of resources, the reduction of the release of pollutants into the environment and in the provision of products which minimise their environmental impact in production, use and disposal. One of the world's largest precasters, Addtek whose headquarters are in Finland points out that in Europe, with the use of precast concrete in comparison with in-situ construction, one can obtain:

- Reduced use of materials of up to 45%
- Reduced use of energy of up to 30%
- Reduced waste at demolition of up to 40%"

There is no reason to doubt that similar figures could be achieved in Australia.

Precast concrete has many natural environmental advantages, some of them are:

- Production in factories with controlled emissions and recycling of waste water and solids
- Optimum use of resources possible with planned factory manufacture
- Shorter on site construction time, no dust or noise on site, no on site waste
- Excellent acoustic, fire resistance and thermal properties
- Durability derived from production under factory conditions
- Ease of design for simple demolition at the end of a structure's life

The *National Precaster* will bring more news on this subject as it becomes available.

The information provided in this publication is of a general nature and should not be regarded as specific advice. Readers are cautioned to seek appropriate professional advice pertinent to the specific nature of their interest.

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