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• N A T I O N A L • PRECASTER

NATIONAL PRECAST CONCRETE ASSOCIATION AUSTRALIA

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.

CONCRETE AND COLOUR

The aesthetics of concrete as an architectural material can be enhanced by:

- utilising the initially plastic nature of the concrete, moulding it to a wide range of shapes, profiles and textures;
- treating the exposed surface of the hardened concrete to produce a texture generally highlighting the colour, size, shape and distribution of the coarse aggregate. Examples of such treatment include water-washed finishes, grit/water blasting, bush-hammering, honing and polishing;
- introducing colour to the concrete by the use of:
  - coloured aggregates (the photograph above shows a hotel facade at an Adelaide beachside suburb where the creamy colour of the precast concrete cladding is achieved using an off-white cement and a cream/yellow sand).
  - a colouring pigment mixed into the concrete. Pigments are available in a wide range of colours in either a powder or granule form. A selection of an extensive range of colours and shades is shown here.

PLACING A GREEN-TINTED CONCRETE VENEER FOR A LARGE WALL PANEL; NOTE VENEER TURNED-UP AROUND WINDOW REVEALS PRIOR TO THE PLACEMENT AND COMPACTION OF THE STRUCTURAL, GREY CONCRETE BACKING.

The Application of Oxides in Precast Concrete

Oxides are commonly used in precast concrete architectural wall cladding, columns, spandrel elements, permanent formwork and GRC.

In these units, colour may be throughout the full thickness of the element or restricted to the face of the element as a veneer to grey structural backing concrete. The veneer approach may be appropriate if the face mix contains an expensive aggregate, ie coloured granite and/or if a white or off-white cement is used.

Precast concrete and GRC manufacture offers the most satisfactory conditions for the use of oxides for the following reasons:

- Mixes are generally cement rich, well-graded, low-slump concrete mixes. Such mixes are made possible by the use of quality watertight forms and good compaction techniques, generally employing both external and internal vibration; further, such mixes are not prone to bleeding.
- As a generalisation, most cladding panels are cast flat. This further limits any inclination to bleed. In instances where vertical placement is used, the concrete characteristics mentioned previously will control bleeding.

Oxides may be used in architectural precast concrete in the following ways:

1 To provide a specific colour to the mix when the unit is cast with a smooth, off-form finish or moulded with relief or moulded and textured, as with the use of an elastomeric form liner.

In such applications the dosage rate of pigment is high, possibly in the order of 5–8% by weight of cement. The required colour may determine the need for white, off-white or a grey cement. It should be noted that grey cements vary in colour from one manufacturer to another.

It should be emphasised that for any project where colour control is required, and obviously this is so when oxides are used, all the materials – cement, fine/coarse aggregate and pigment – must each come from a single source. This may dictate the need to stockpile and blend materials such as the fine aggregate (sand).

2 To tint the matrix to provide colour compatibility with the coarse aggregate. This is particularly the case with polished, reconstructed granite. The aim is to achieve the maximum concentration of aggregate at the surface since it is the aggregate and not the matrix which receives the polish. Nevertheless, there will be small isolated pockets of matrix at the surface which, if left untinted, would detract from the overall colour and appearance of the element. Using an oxide to tint the matrix allows the precaster to blend the matrix to a level of colour to match that of the granite aggregate.

FACADE – OFF-FORM USING TREATED FORMLINER AND RED OXIDE.

For such purposes, low levels of oxide dosage are normal, values of 0.5 to 1% of oxide by weight of cement being common.

The rate of oxide addition is determined by a number of concerns, principally the colour and its required intensity.

It is necessary to understand just how oxide pigments colour the matrix. The ultra-fine particles (approximately one-tenth the size of cement particles) do not dissolve and stain the concrete materials. Instead, they are dispersed as fine solids throughout the concrete matrix and bound in the same manner as the other aggregates.

It is this distribution throughout the mix and the intensity of colour of the oxide particles which provides the colour characteristic of the hardened concrete.

It can be seen that the efficient measuring of all the materials is critical, as is the complete mixing of the concrete to ensure uniform distribution of the pigment.

In a normal off-form concrete mix the principal colouring agent is the cement. If the surface is subsequently tooled, (eg sandblasted, bush-hammered or polished) the aggregates, particularly the coarse aggregates, will predominate – especially so if the aggregates themselves have colour. Thus, for a pigment to be used successfully in a concrete mix it has to overcome or blend with the cement to produce the desired colour. Hence, the normal way to specify pigment addition to the mix is to relate the quantity of pigment to the quantity of cement as a percentage *by weight* of the cement content.

Pigments must be:

- chemically inert to avoid affecting the chemical reaction between the cement and water;
- alkaline resistant since cement and hence concrete is highly alkaline;
- insoluble to prevent leaching-out by weather; and
- light-fast, to eliminate fading.

Iron oxide pigments are the most widely used materials, fulfilling all the above requirements and providing the colours yellow, brown, red and black. Further, by blending these colours the manufacturers can offer an immense range of colour shades.

Pigments may be either natural or synthetic. The latter offer a superior product due to their controlled chemical composition and extremely fine particle size. They produce strong colours and colour saturation. By contrast natural oxides have low tinting strength.

Other colours available include:

- **white** using titanium oxide – with the availability of white and off-white cements the main value of this oxide is for tinting other colours to give lighter shades;
- **green**, using chromic oxide;
- **blue**, using cobalt oxide.

It should be noted that both the green and blue oxides are very expensive, as much as 20 times the cost of brown oxides, and will certainly require the use of white or off-white cements and light coloured aggregates to enhance the brightness of these colours.

The decisive property of a pigment is its tinting or colour strength. This in turn depends upon its purity, its content of colouring substance and its fineness.

The graph below indicates that with increasing pigment addition, colour intensity moves towards a saturation point at which increasing pigment content has little or no colouring impact and is both economically and technically undesirable.

For the widely used synthetic iron oxides this saturation point frequently lies between 5 and 8% by weight of cement. Note that the saturation point differs depending on cement type and brand.

It is worth noting that oxides having a lower tinting strength, although being cheaper, will require greater oxide addition to achieve the defined colour which may offset their cost advantage, and may impair the workability of the concrete mix.

Only quality oxides should be considered, such as those supplied by Bayer or equal.

Effects of Cement Colour

The immediate effect of mixing an oxide with a grey cement is to subdue the brightness of colour of the oxide. This is not necessarily undesirable since a whole range of natural, pleasing colours can be obtained using a grey cement, certainly in the red, yellow/brown/black range, albeit that they have a reduced brightness. Essentially the lighter the pigment colour the greater is the need to use a white or off-white cement. Since the latter is produced in Australia whilst the former is totally imported there is considerable economic sense in using an off-white cement.

Finishes

It is recommended that the use of *smooth, as-cast, off-form surfaces* using an oxide should be treated with caution. Most oxides will darken the surface. Designers should consider the need to provide architectural detailing to the panel face in the form of grooves, preferably vertical to assist in weathering, recessed areas and panelisation of the surface. Remember, the lighter the surface colour the less is the risk of contamination by agents such as efflorescence.

Some form of finishing treatment should be considered which will reduce or eliminate the threat of laitance or efflorescence. Surface treatments such as sand/grit/water blasting, bush hammering, acid etching (note that such treatments are inclined to marginally lighten the colour), honing and polishing of the surface are widely used and time proven.

POLISHED FINISH – USING A MIX OF CALCA AND TARANA GRANITE WITH BROWN OXIDE TO TINT THE MATRIX.

Acid washing of the panels after these treatments is normal practice to remove loose calcium hydroxide particles from the surface. A 2% acid/water solution is common, followed by washing with clean water.

Sample Panels and Prototypes

It is common for Architects and Principals to select a colour and finish on the evidence of a small (typically 300 x 300 mm) sample panel. This approach should be treated with caution since such samples are essentially of laboratory quality and at best indicate the colour likely to be obtained using a certain level of oxide addition to a certain cement type. The problem is essentially one of scale since, even if the ultimate panels are a perfect reflection of the sample colour, the satisfaction of the Architect may be muted when he views the ultimate (say 6- x 3.5-m) panel. This is not an unusual reaction; on a simple domestic painting project, frequently the paint colour and shade chosen from a colour card can look quite different when applied to the lounge-room walls – the effect of scale, lighting and surface texture.

One solution to this, and the problem of concrete appearance in general, is for the designer to limit the size of architectural cladding panels. This can be achieved without restricting the apparent size of individual panels (with the consequent increase of lifting time and joint sealing) by the greater use of false joints cast into the panel face. Such jointing patterns, apart from controlling scale, can be useful in breaking-up water flow and hence controlling weathering of a facade.

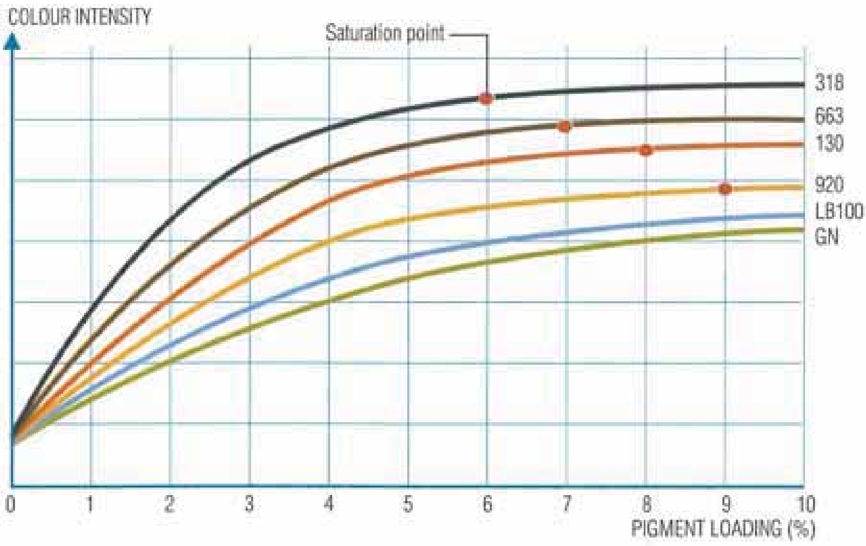
Where a total-facade effect is required, it is not the individual quality of a panel which is critical but more the requirement to minimise variation between panels.

It is strongly recommended that for coloured work the contract makes provision for a full-size sample panel and that where there is significant geometry change in the panels (ie flat panels and curved panels) that a sample of each should be required.

Where colour control is specified, AS 3610 requires the parties to establish a suitable tonal scale for the project.

The belief, often expressed as a requirement, that coloured, precast facades should retain their original colour and brightness over time is unrealistic. Atmospheric pollution will ensure this not to be the case. Further, the modern design approach of avoiding the use of weathering aids, such as sills, copings, throatings, grooves and the like will contribute not just to the general dirtying of a facade but to areas of concentrated staining.

Any long-term change in colour is not attributable to the oxide.



Summary

Methods of achieving colour to precast concrete elements include:

- utilising the available colours of cement (grey, off-white, white);
- selection of coloured aggregates which are then subsequently exposed by a range of techniques;
- the addition of oxide pigments to the mix.

The use of oxide pigments to colour or tint the concrete matrix is a well-established

PRECAST HOUSING

Throughout Australia there is a growing momentum to include quality factory-cast precast concrete into housing either as the total concept or in part, recognising that such precast massively reduces the risk element of construction. There is now another facet of factory precast which is earning recognition, namely, that after some years of 'hard slog' developing Quality Assurance programmes, precast concrete from the factory can offer clients certain considerations which cannot be found using on-site techniques. The core of this service includes:

- Quality Assurance provided by third-party certification; importantly, this is offered by companies of stature from whom guarantees are meaningful. QA extends not just to the quality of the product but to its on-time delivery and, if required, erection.
- The certainty of time and cost. In an industry where risk is significant, it should be a point of comfort to the contractor to have certainty of availability and delivery on time. That this is possible is largely a function of being able to parallel factory precasting with preliminary site works ensuring that by the time footings are prepared, precast wall and/or floor elements are available.
- Any contract for the supply of precast concrete will be on the basis of *supply-at-site* or *supply-and-erect* for which firm costs will be available.

The following case studies are representative of the many housing projects currently under way which utilise factory precast in entirety or in part.

INSTANT SAFETY – PRECAST BALCONY PANEL WITH KERB AND RAILING.

Brisbane, Queensland

This entire project was factory precast simultaneously with site operations of earthworks and footings. Wall panels of dimensions up to 12.8 x 2.4 m weighing around 12 tonnes used the Reid *Swiftlift* system, handling and placing time was generally under 30 minutes per panel.

External wall panels were cast with dummy joints on the panel face to provide architectural expression and assist in breaking up surface flow of rainwater which may otherwise cause staining of the face. Panels were 150 mm thick with F82 fabric placed centrally and Y12 trimmer bars.

The project further utilised *Humeslab* floor panels – a permanent participating formwork system including bottom reinforcement and polystyrene voiding blocks to give weight redOuction. This system is described more fully in issue No.7 of *National Precaster*. Placing rates for these floor units was in the order of 80 m^2/h. Units were typically 4.2 x 2.5 m with all penetrations for plumbing and electrical services cast-in.

PRECAST PARTY WALLS IN PLACE WITH PRECAST *HUMESLAB* FLOOR PANELS OVER.

The structure was completed using a custom-made balcony floor and balustrade wall unit again with electrical services cast-in. The balustrade wall unit had cast-in corbels which located and supported the unit on the balcony floor, the unit being finally secured by bolting.

The project, which embraced a mix of 30 two- and three-storey apartments, will be complete in 20 weeks a time frame according to A and P Constructions Managing Director which dictated the precast option.

A good level of repetition of units, together with guaranteed quality dictated by the precaster's QA plan confirmed the choice. The high-quality, smooth finish of the panels provides for various paint finishes to be applied direct.

Narrabundah, ACT

This development of 84 apartments was sold off-the-plan within 60 minutes, indicating a clear acceptance of quality-built medium density housing.

The project uses clay-brick external walls with concrete masonry party walls.

THE PRECAST FAMILY – STAIRS, HOLLOWCORE FLOOR PANELS AND CUSTOM-MADE BALCONY ELEMENTS.

Precast hollowcore floor panels span 7.5 m and are carried on the party walls. These 200-mm-thick hollowcore panels are placed, adjusted to eliminate differential camber and joints grouted. The resultant finish and levels has eliminated any need for topping.

Custom-made balcony units and precast stair elements complete the precast content of this project. Balcony units are complete with upstand or kerb which provides the safety requirements of a kickboard. With the metal balustrade unit quickly set into cast-in sockets, the assembled units provide near instant safety requirements for ongoing construction. Madison Constructions, the contractor for the project, was confident that the use of precast elements had reduced the contract duration by around one third. Again, the builder emphasised the advantage of the precaster's quality assurance programme.

An interesting comment was that, with the precaster's QA programme having rigorous manufacturing and pre-delivery checks, there was no requirement for local regulatory authorities to inspect the work as would be necessary with insitu construction.

FLOOR PENETRATIONS FOR WASTE PIPES WERE CORED ON SITE AND SEALED AGAINST FIRE PENETRATION. CORING ON-SITE IN THIS INSTANCE GAVE GREATER FLEXIBILITY OF FLOOR PANEL USE. IN OTHER INSTANCES IT MAY BE MORE EXPEDIENT TO CAST ALL SERVICES INTO THE UNIT AT THE PRECAST YARD.

method of extending the visual range of architectural precast concrete. The mainstream precast concrete manufacturers and the suppliers of quality oxide pigments can offer very significant expertise. Designers are strongly advised to make use of this knowledge at the earliest opportunity, ideally at the conceptual stage of the project.

Bibliography

There is no Australian Standard on oxide pigments. Use may be made of BS 1014: (a) 5 *Pigments for Portland Cements and Portland Cement Products.*

Further information is contained in Data Sheet No. 2 *The Use of Colouring Oxides in Precast Concrete* available from the National Precast Concrete Association Australia. ■

MORLEY SHOPPING CENTRE

MEMBER PROFILE

The story of Delta Corporation is a story of the great Australian dream.

Giovanni Perrella arrived in Australia in 1950 aged 25 and leaving behind him in Italy a wife and three sons. Working 12-hour shifts at the quarry face at a WA stone quarry, he saved to bring out his family and to provide a deposit for a vineyard at Middle Swan. Then followed a change of employment, still putting in the 12-hour day, until in 1961 he started making precast concrete paving slabs on his property assisted by his sons.

As product demand grew, he left his employment to concentrate on his precast business. From these humble beginnings was created Delta Corporation, a company widely acknowledged and respected for its precast product. Giovanni died in 1993 following a prolonged illness and stroke.

DELTA CORPORATION'S HERNE HILL PLANT

The company, now public, is managed by Matteo Perrella, Giovanni's eldest son, whilst youngest son, Gino, is Design and Product Development Manager.

Delta Corporation based at Herne Hill some 25 km north-west of Perth, like most mainstream precast manufacturers, operates a diverse business producing Architectural, Structural and Hollowcore units together with a very attractive, wide range of street and civic furniture. The 'Urbanstone' division within Delta takes enormous pride in its diverse and superior range of these products with interstate cities as far away as Sydney – nearly 3000 km distant – bearing testimony to the product.

Some four years ago Delta carried out a significant expansion programme, tripling its capacity plus establishing a hollowcore manufacturing facility.

The Forest Place project Perth, completed around 1990 highlighted the architectural and structural capacity of the company.

More recently the Family Law Courts, Perth Busport, Observation Rise Apartments, Innaloo and Morley Shopping Centres, the Perth Northern Transit Railway utilising structural precast columns, beams and double T panels have evidenced Delta's expertise.

The satellite city of Joondalup is a superb testimony to the 'Urbanstone' division's products including paving, tree surrounds, kerbing and coping units.

FOREST PLACE, PERTH

STRUCTURAL FRAME – RAIL/BUS TRANSFER STATION

ADDRESS
Lot 3 Campersic Road Herne Hill WA 6056
MANAGEMENT
Matt Perrella, General Manager
PRODUCTS
Architectural – cladding, facades
Structural – beams, columns, frames, o/h lighting and service poles
Drainage – box culverts
Street and civic furniture and decorative paving. ■

NO SWEAT

Stages 1 and 2 of the Cullerain deviation on the Hume Highway between Yass and Goulburn used in excess of 600 precast box culverts, some 2500 tonnes.

Precast was chosen since:

- once the ground was opened up an immediate drainage structure was provided;
- culverts provided working platform and bridging for construction traffic;
- installation was simple and quick with conventional craneage;
- manufacture at the precaster's plant was at a rate to guarantee adequate stock to meet contractor's needs;
- units were manufactured in steel moulds to ensure dimensioned quality and good surface finish;
- each batch of 20 units was proof-load tested for conformance prior to delivery.

The project, for the Roads and Traffic Authority NSW, was managed by Barclay Mowlem and was completed three weeks ahead of schedule.

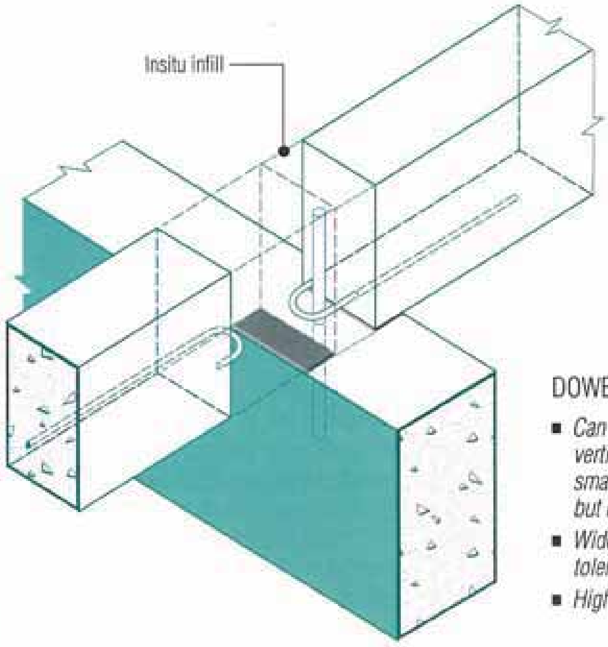
UNITS STORED, AWAITING CONTRACTOR'S INSTRUCTION TO DELIVER.

UNITS IN PLACE.

TYPICAL DETAIL

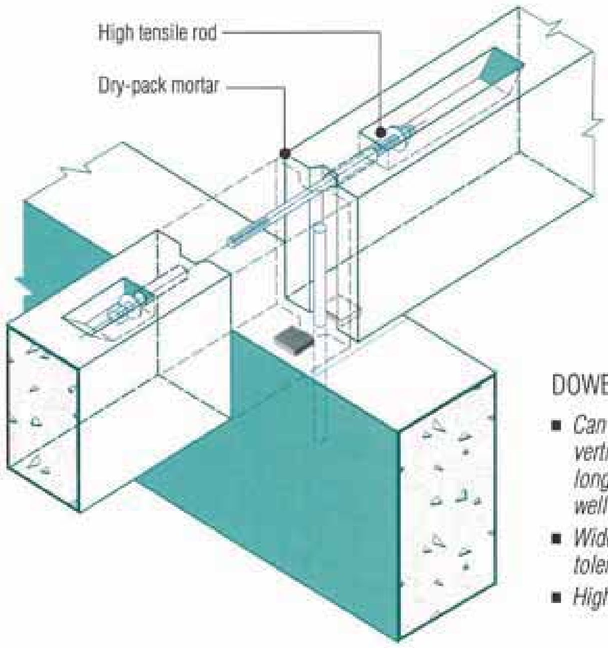
THIS ISSUE **SECONDARY BEAM TO MAIN BEAM/2**

- *This arrangement allows the full section of the main beam or girder to be effective but increases the height of the building*
- *The greater part of the shrinkage and/or creep shortening of the secondary beams should preferably have taken place prior to their erection*



DOWELLED

- *Can transmit large vertical shear forces and small longitudinal forces but not moments*
- *Wide construction tolerances*
- *High fire-resistance level*



DOWELLED AND TIED

- *Can transmit large vertical shear and longitudinal forces as well as some moment*
- *Wide construction tolerances*
- *High fire-resistance level*

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