



Australian Government
Department of Industry



AMAZING ARCHITECTURE

EXPLORE THE POSSIBILITIES
OF PRECAST CONCRETE

FOREWORD



Australia's continued economic prosperity relies on our ability to boost innovation and maximise productivity. It is dependent on industries and organisations making conscious decisions to improve and evolve. The precast concrete sector has achieved significant growth over the past decade, breaking down numerous barriers and adapting to new opportunities. It has invested in technical innovations that have increased the viability and applicability of precast concrete.



Precast concrete offers unsurpassed design flexibility that delivers a low maintenance and durable solution, with exceptional thermal mass benefits when insulated. Its offsite manufacture delivers a plethora of benefits which are recognised by many and its proven versatility, durability and strength is showcased in many iconic buildings that will endure for generations to come. From patterned lightweight panels in recital centres to highly polished curved forms in educational structures, the array of patterns, shapes, textures and colours are endless.

This publication includes case studies showcasing the successful use of precast concrete in Australian architecture. We hope it inspires you to consider what the precast sector can do for your business and the benefits it can bring to your next project.

A handwritten signature in black ink that reads "Mark Newson".

Dr Marc Newson
Clean Technologies Supplier Advocate

A handwritten signature in black ink that reads "Sarah Bachmann".

Sarah Bachmann
CEO, National Precast Concrete Association Australia

Important Notice and Disclaimer

This handbook on **Amazing Architecture** is one in a series of information handbooks produced by the Department of Industry with the assistance of the National Precast Concrete Association Australia. The purpose of this handbook is to provide construction industry participants with general information on the benefits of using precast concrete. It is not intended to provide exhaustive coverage of the precast concrete industry in Australia.

Users must exercise their own skill and care with respect to their use of this handbook and carefully evaluate the accuracy, currency, completeness and relevance of the material for their purposes. Users should obtain appropriate professional advice relevant to their particular circumstances before commencing a construction project. The Australian Government and the National Precast Concrete Association Australia expressly disclaim all liability arising from or connected to the use of, or reliance on, the information in this Handbook other than in accordance with this Important Notice and Disclaimer.

AMAZING ARCHITECTURE USING PRECAST CONCRETE

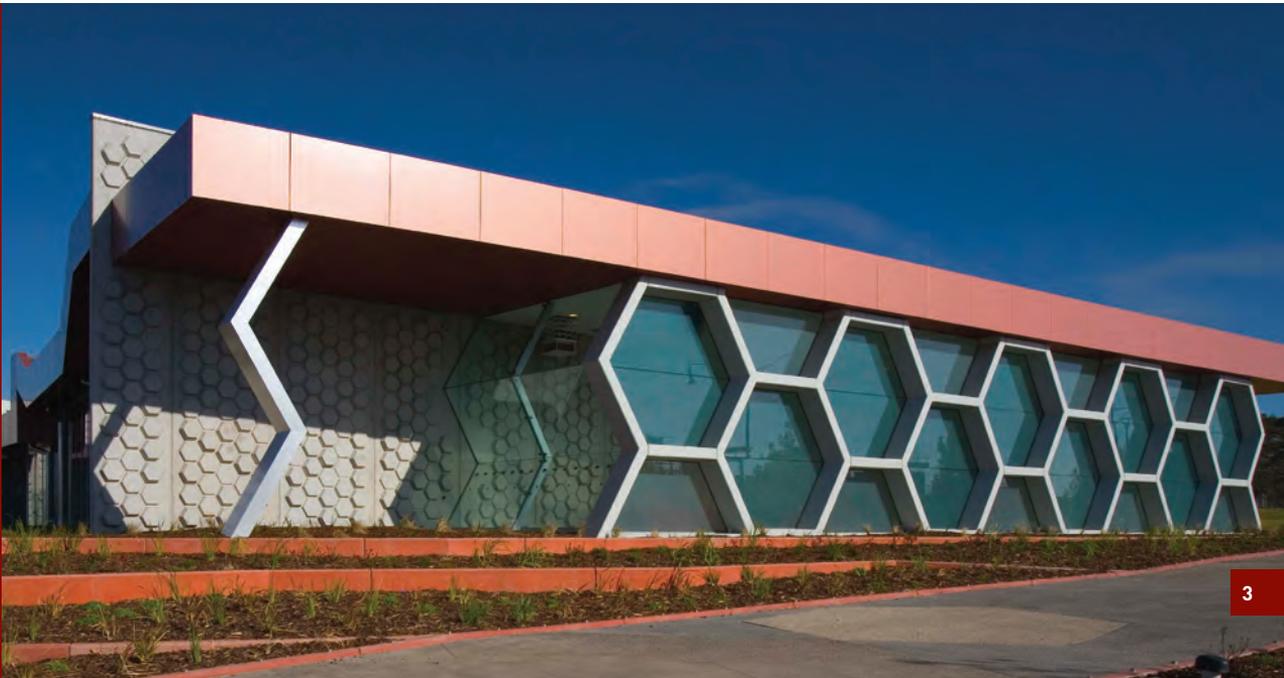
Precast concrete is a style of concrete construction that has been used since ancient times. Available in a vast array of shapes, colours and textures, precast concrete is often specified for monumental and institutional buildings, prestige buildings and hotels. It is used extensively for office, retail and public applications of all sizes as well as industrial buildings and civil structures. Its use in residential buildings continues to grow and its application even extends to street furniture.

Every year, both in Australia and overseas, peak architectural bodies recognise the timeless form and function of precast buildings in their awards. The architect's journey in creating a unique building façade, monument or a single piece of street art can be inspiring for all those involved.

It is never too early in a project's concept stage to engage with the precast industry to assess what may be achievable.

When determining what can be achieved in construction, the capabilities of the precast industry and its ability to fulfil design intent need to be understood. When early sketches are being drawn and preliminary materials discussed, a conversation with an experienced precast manufacturer can be extremely beneficial. The range of available finishes can be reviewed and samples provided.

A full gamut of variables should be assessed including the shape, form and size of the elements, the selection of desired finishes and the capabilities of the individual precast manufacturer.



FROM CONCEPT TO CREATION: MANY POSSIBILITIES

COST CONSIDERATIONS

The need to keep costs under control is always present and it is reasonable to ask the precast industry for pricing estimates. In order to do this, preliminary sizing of the precast elements, quantity, structural performance requirements (loadbearing or cladding) and details of finishes will need to be provided. At no stage should a project cost plan be prepared solely based on the square meterage required without assessing the full picture, including the number of elements involved and finishes required. It is not unusual for the precaster to make suggestions to improve the cost efficiency of the precast design at this early stage.

SHAPE AND FORM

The shape of precast, whether straight or curved, is determined from moulds that are often custom-made, generally from steel, concrete or timber. Rubber mould liners are becoming increasingly popular as architects and designers utilise them to create a range of patterns and textures.

Mould shapes can be profiled with computer-controlled equipment, enabling the most complex and irregular shapes to be transferred straight from the designer's CAD system to the master mould.

ELEMENT SIZE

Element size is generally governed by the weight that can be handled by building site cranes and what can easily be transported. Element weights generally fall between eight to twelve tonnes. 20 tonnes is usually the maximum weight for a single element.

With precast, the golden rule to maximise cost effectiveness is to make the elements as large as possible within the limitations of handling and transportation capacities.

LIGHTWEIGHT PRECAST ELEMENTS

The use of steel or glass fibre reinforcement in the precast concrete mix can produce slender and lightweight precast elements. Alternatively, lightweight concrete mixes are available that can reduce element weight by up to 20%.





CASE STUDY **ORACLE** QLD

CHALLENGE

The Oracle luxury apartment and retail development at Broadbeach comprises twin 52-story and 42-story apartment towers set at 180 degrees from each other, the taller facing the beach, the other overlooking the hinterland. This building faced a number of architectural challenges. A hammerhead shaped panel with a variable shaft height was requested and over 1,540 exterior precast panels were designed in an 'S' shape with both concave and convex curves. Most panels had subtly different shapes on every level, resulting in 518 different panel shapes and further increasing the level of difficulty. As well, the apartment towers had to integrate with a lightweight concrete retail podium.

SOLUTION

Meeting the program schedule required meticulous planning, modelling and moulding. Precast Concrete Products cast 10 panels a day, a mammoth logistics exercise, necessitating tight teamwork between the builder and architect. In addition to creating the shapely façade of the building, precast panels formed the edge of the structural formwork. They contained cast-in starter bars which were used to attach the panels and form the perimeter of the building and structural balcony elements.

Asurco Contracting supplied glass reinforced concrete (GRC) walling panels for the retail podium, which were supported on the edge of the first level slab without the need for large structural supports. The 12mm GRC skin was overlayed over a hot dipped galvanized RHS steel frame that provided the structural support. Additionally, 26 distinctive hood-shaped 'fins' made from GRC for the podium south commercial building, nine metres high and one metre deep, were painted in a vivid green to create a feature entrance to the commercial area.

BENEFITS

The use of precast materials led to a stunning result, creating an iridescent landmark on the Broadbeach skyline. The precast panels with their flowing kidney-shaped curves and lightweight screen panels are lit at night with coloured lights, clearly distinguishing Oracle from its neighbours.

Involving the precast manufacturers early in the design phase and close collaboration between the two design firms that worked on this project – DBI Design and IGNITE Architects – paid off. The result is a well-integrated, strong and unique mixed-use development which is being justly recognised in awards for its contribution to the urban environment.

COLOURS



Photo: Michael Nicholson

An infinite array of colours are available using precast concrete.

Achieving a unique colour solution requires a good understanding of the natural ingredients and the manufacturing process. When samples are being made, colours can be finessed by changing sands, cements, aggregates and pigments. Painting and staining are also finishing options.

CEMENTS

The colour of the concrete used in precast elements is determined by its components such as cements, sands, aggregates, pigments and moisture content. Some colour difference between nominally identical units is inevitable, but colour variation, both between and within elements, should be kept within an agreed sample.

The decision to use grey, off-white or white cement will be determined by the architectural requirements that may expose the aggregate. Generally, grey cement will be used with dark aggregates, off-white cement with mid-range aggregate colours and white cement with white quartz.

SANDS AND AGGREGATES

Mechanically or chemically treating the element surface exposes the colour of sand and stone aggregates and imparts an overall colour to the concrete. The coarse aggregates have the most influence on the final colour. Using coloured

sands and off-white cement, the cement matrix can be created in lighter shades of brown, red or yellow. Darker grey tones can be achieved using dark sands and grey cement.

PIGMENTS

Where the desired colour cannot be achieved by the cement and aggregates alone, pigments can be incorporated. In concrete for exterior use, pigments must be colourfast and not reduce the durability of the concrete. Pigments are available in a wide range of colours, from deep to pale pastel colours and hues. The major non-blend standard pigments are green, black, red, brown, yellow, blue and white. These can be obtained in commercially blended forms to produce many intermediate colours. The dosage rates for precast concrete are typically 1 to 3% by weight of concrete.

STAINING

An alternative to using pigments in the concrete mix or painting is the use of a stain that is absorbed into the concrete surface. The colour palette is almost infinite and is generally guaranteed for over 25 years on vertical surfaces. Colour matching is also available with staining. These stains can be translucent or opaque and are often combined with the use of form liners to achieve a broad combination of aesthetic results. Staining can be applied in the factory before delivery to site.

SURFACE FINISHES

Precast concrete offers many different textures, from a smooth off-form through to a sophisticated polished finish.

Careful selection of finishes can turn a building's design into an award-winning visual masterpiece.

The range of available finishes may depend on the manufacturer selected and to an extent, the type of precast element. It is not uncommon to have elements with more than one finish.

The unique ability of precast to blend in with existing structures or to replicate patterns, shapes and other materials gives the architect a wide palette of choice. Some of the most popular precast finishes are listed below.

OFF-FORM

Off-form (or off-mould) concrete elements are the most commonly produced, using grey or off-white cement. The quality of the moulds and the quality-assured manufacturing techniques used result in an extremely high quality finish that generally requires no additional treatments, other than perhaps a stain or paint. To further

enhance a grey off-form finish, colours, shapes and patterns can be incorporated by most precast manufacturers.

CUSTOM SHAPES AND 3D SURFACES

Elements can be custom designed and manufactured with 3D surface finishes to create unique textures and profiles. This can be done using custom-made moulds, form-liners, tiles, bricks, stone, void-formers or other techniques such as bush-hammered or hammered-nib applications. An advantage of using a 3D surface pattern is that it can self-shade a vertical element, reducing thermal conductivity from the sun. With the use of CAD, CAM or CAE technologies, the possibilities are endless.

ETCHING

Etching is a process that removes the fines from a concrete surface after the element has been manufactured. The result is a light, flat, sand-textured surface that resembles limestone or sandstone, which is usually complimented by adding a subtle pigment to the concrete mix. A very good off-form surface finish with a minimum of voids is required.

Photo: Nic Bailey



GRIT (OR SAND) BLASTING

Grit (or sand) blasting is a technique of abrasive surface preparation that uses compressed air or water to propel various particles such as granulated furnace slag, aluminium oxide or glass beads onto a concrete surface. The surface layer of concrete is removed to expose the aggregates, creating a deeper, textured finish. The depth of the grit blasting can be varied from a smooth to a coarse texture and this, along with the aggregate selection and the matrix colour, can have a significant effect on the concrete's final appearance.

EXPOSED AGGREGATE

An exposed aggregate finish removes the top layer of the concrete matrix, revealing the top surface of the aggregates in the concrete mix. Chemical retarders are often applied to the surface to etch away the concrete matrix without sacrificing the aggregate. Alternatively, a water washing technique may be used. This is often applied in conjunction with other finishes.

HONING AND POLISHING

Honing and polishing are two individual surface treatments that can be combined as a two-step process to create a superior surface similar to natural polished stone or granite. Honing refers to the removal of the outer surface of concrete by using a grinder that has a coarse abrasive effect, exposing the aggregate in the concrete and giving it a matt level surface.

Polishing is a similar process, taking the finish to the next level and it uses finer abrasive materials to take a finer cut from the concrete. The result is a very smooth, shiny finish. Both processes use lubrication to ensure the surface is not gouged or scratched.

Aggregates for honed and polished surfaces are chosen for colour, durability and their ability to hold a polish. Polished surfaces shed water and dirt easily and have little surface absorption, therefore requiring little ongoing maintenance. Polishing and honing curves and small recesses are possible, but the shape of the element must be considered for this surface, along with the capability of the individual precast manufacturer.



CASE STUDY

HAWKE BUILDING SA

Photo: Sam Noonan

CHALLENGE

The five-storey Hawke Building is a public portal to the University of South Australia and a focus for its engagement with the community. Its design serves to support UniSA's commitment to be the people's university now and into the future. Designed by architects John Wardle in association with Hassell, the Hawke building, named after former Prime Minister Bob Hawke, brings a striking modern presence to the historic North Terrace precinct.

All the precast façade panels for this building are different, each one unique. This introduced challenges for SA Precast, who needed to ensure the geometry of the features remained accurate and in accordance with the architectural intent. The 68 façade panels had to be consistent in colour. This was particularly important as the building would inevitably be compared with the other fine buildings on North Terrace. An in-situ solution could not have delivered the quality of finish required.

SOLUTION

The complex custom precast concrete façade was modelled in 3D by a specialist façade engineer and panels were manufactured correct to the last millimetre. Panels were cast

in the factory face down on complex moulds of concrete, steel and timber and an off-form white finish was achieved using 45 MPa concrete comprised of Salisbury aggregate, white sand and Brighton Lite Cement with white titanium oxide to produce a lustrous finish. Face areas were coated with an anti-graffiti and anti-pollution treatment to ensure the façade looks as good in the future as it does now.

Joints between panels were stepped and sealed front and back to ensure permanent weather tightness. Important in this age of energy conservation, the fully-sealed precast façade eliminates air leakages that cause heating and cooling losses.

BENEFITS

The use of precast concrete in this stunning public building demonstrates the clarity, consistency and completeness of the design resolution and is a lasting contribution to the urban design.

The fastidiously detailed faceting of the white precast concrete façade plays with light and shadow so the appearance of the façade alters as sunlight changes over the course of the day.

MANUFACTURING CONSIDERATIONS



After the precast design has been established, it is wise to evaluate the capability of the precast manufacturer, paying attention to shop drawing experience, use of materials and moulds, manufacturing, storage and quality processes.

The following areas will impact the manufacturer's ability to provide a quality product in a timely manner:

SHOP DRAWINGS

These are best prepared by an experienced manufacturer from the project working drawings and are submitted for review before any manufacture commences. They should show all element dimensions, reinforcing, finishes and cast-in items. They are an integral part of the quality assurance process.

MATERIALS

If the decision is made to use an architectural concrete mix with special aggregates and sands, then a sufficient stockpile of each to satisfy the project's requirements needs to be established before manufacture. It is commonplace for the manufacturer to undertake concrete batching within the factory to provide the flexibility and control needed in the manufacturing process.

MOULDS

The accuracy and robustness of any manufactured moulds is important and

should only be produced by experienced mould-makers. The skill of the mould-maker to produce spectacular architectural forms is integral to the creation of beautiful architectural elements. This should always form part of the precast supply contract.

MANUFACTURING

All manufacturing should take place under cover and with enough capacity to meet the agreed manufacturing program. Planning is usually based on a daily production cycle with an extended working day. Any post-treatment such as grit (sand) blasting, etching, honing, polishing or staining will have dedicated areas for these activities.

STORAGE

This is an important area in any precast factory and it is the manufacturer's responsibility to design all elements for handling and storage. The area has to be of sufficient size to store elements, ideally in their erected positions, to meet the project's requirements. Unnecessary handling of elements should be avoided as the elements are susceptible to minor damage at this time which will then require repair.

QUALITY

All reputable precast operations will have a quality assurance program, usually third party accredited, as an integral part of their manufacturing control process.





CASE STUDY TOP RYDE CITY NSW

CHALLENGE

Upon arrival at Top Ryde City, the two most distinguishing features greeting the visitor are the immediate proximity of the network of arterial roadways and the striking 25 metre site cross-fall.

The sheer scale of Top Ryde City is impressive. Occupying a 3.5 hectare site with 80,000m² of retail space, it boasts around 300 retailers and over 3,000 undercover car spaces, including an outdoor fashion promenade, an entertainment and dining precinct, water features and public artworks.

SOLUTION

Maria Ann Smith has long been respected as a local legend for cultivating the Granny Smith apple. Coincidentally, across the lower end of Tucker Street is a playground full of Top Ryde school children facing this façade. What better way to celebrate and promote this local heritage celebrity than to create a full graphic façade, depicting an apple orchard sitting over a patchwork quilt of earthen colours? The beautiful, rich colours were applied by Nawkaw to the precast panels, which were

manufactured by Hanson Precast. The panels are randomly stacked in as many shapes as there are colours in the palette. It is fun, eye catching and unique to this local community.

The façade borders one of the busiest roadways in the state. A soft honed precast panel was employed both to combat this aggressive environment and also create a sense of quality and reliability.

An open air, internal pedestrian Strada is lined with high-end retail fashion, cutting edge merchandising and coffee bars. Semi-polished creamy precast panels have been used to construct this alfresco arcade, creating a functional, yet elegant retail retreat.

BENEFITS

Precast concrete panelling offered expediency in construction, an unlimited choice of shapes and finishes and helped to create a sophisticated, inviting retail environment.

The combination of soft honed panels, semi-polished panels and off-form multi-coloured stained panels showcase the wonderful capabilities of the precast industry.



SUPPLIER
ADVOCATE

CLEAN TECHNOLOGIES