Australian Government
Department of Industry

NATIONAL PRECAST
CONCRETE ASSOCIATION AUSTRALIA

MITIGATING CONSTRUCTION RISK

HOW PRECAST CONCRETE REDUCES COST AND IMPROVES SAFETY

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. This innovation has borne fruit because precast concrete is now being used in many ways from flooring and insulated walling in high density residential construction, to dam walls, to seating in sports stadiums.

The precast concrete sector already delivers a number of environmental and social benefits. Precast concrete elements and components are locally manufactured and created from products sourced from Australian suppliers, creating Australian jobs. It uses recycled materials including waste products from iron ore smelters and fly ash from coal fired power plants. Its use results in more efficient construction processes with shortened construction times, significant cost savings, safer sites and a high quality and reliably delivered product.

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

Dr Marc Newson
Clean Technologies Supplier Advocate

Sarah Bachmann
CEO, National Precast Concrete Association Australia

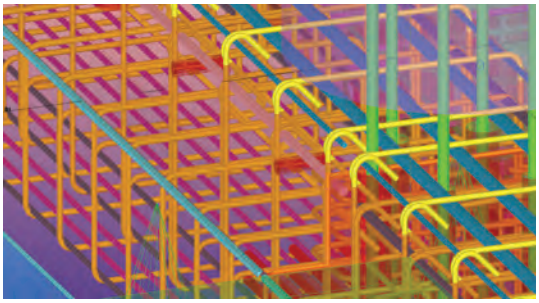
MITIGATING CONSTRUCTION RISK USING PRECAST CONCRETE

Manufactured off-site in dedicated factories, precast concrete is arguably the most significant prefabricated building element used in construction today.

Off-site manufacture in Australia: Current State and Future Directions, the 2007 Cooperative Research Centre for Construction Innovation report, outlined the numerous benefits of off-site manufacture and identified the barriers to its uptake. Over the last 10 years, as the financial investment in the precast manufacturing industry has dramatically increased, many of these barriers have been removed.

The installation of sophisticated concrete batching equipment, hydraulic powered fabricated steel moulds and semi-automatic production facilities, as well as adoption of the latest in 3D drafting and BIM practices are just some of the advances that have been made by the precast industry in recent times.

Despite this, the benefits of precast manufacturing are not fully understood, particularly with regards to how it can reduce construction risk.



ABOUT CONSTRUCTION RISK

Construction risk begins at a project's early conceptual stage and ends as the last finishing trade leaves the site.

Risks include time extensions from inadequate programming, delays in material delivery, labour disruptions, safety issues and inclement weather. Risk is heightened where project documentation is incomplete, material quality poor or workmanship tardy. If not properly managed, construction risk can significantly increase a project's costs. Precast addresses many of these risks and minimises potential cost increases.

IMPORTANCE OF GOOD WORKING DRAWINGS

Producing fully detailed working drawings before commencing precast manufacture is essential. Whilst going to tender with partially completed documentation can be beneficial for assessing current building cost and construction techniques, unfortunately the necessary detail design development is often overlooked. Poor working drawings can lead to increased construction risk and cost.

Thorough project working drawings are crucial in order to mitigate construction risk. It is evident when best practice buildings are constructed, sufficient time has been spent on producing highly detailed working drawings.

With good working drawings, the subsequent shop drawing process which preceeds precast manufacture can eliminate many of the frustrations from the early stages of the project.

TIME BENEFITS OF USING PRECAST

It is easy to see the value that time savings bring to a construction site.

Time savings using precast come about from good programming, the benefits of a factory-made environment, a reliable supply of elements and speedy construction.

PROGRAMMING

To maximise precast concrete's time saving benefits, meticulous planning is critical and should cover all activities from factory to site. Before any manufacture is commenced, a manufacturing and delivery programme must be agreed to by all. The programme is nearly always a compromise between factory demands and the required order of deliveries to site. It is imperative that once the programme is agreed, any last minute changes are minimised, as these can increase costs.

SKILLED WORKFORCES

The skill levels in precast factories are a definite advantage and help to reduce construction risk. Precast factories assess and train their workforces, with many employees completing competency assessments for the licenced tasks undertaken in their factory.

RELIABLE SUPPLY

Unforseen weather conditions such as rain, high winds or extremes in heat or cold ordinarily have an enormous impact on construction, particularly when the majority of work occurs on site. Taking work offsite into a factory environment removes such disruption and reduces the need to plan for inclement weather.

FAST CONSTRUCTION

Manufacturing of precast components can begin as soon as shop drawings are approved. Once precast erection commences, on-site construction and off-site manufacture can be overlapped, reducing overall construction times. The increase in the size and availability of mobile cranes has encouraged larger and heavier elements to be produced that are now easily lifted directly into position on the site, further speeding construction times. Construction times of 75% less than other construction methods are not uncommon.

For example, over 60 hollowcore floor planks or 30 wall panels can be placed in a day with one erection crew. Precast concrete's ability to enclose a structure more rapidly results in earlier access for subsequent trades. Its ability to open up multiple workfaces can have a dramatic, positive influence on the construction programme.

INSTANT WORK PLATFORM

Precast's long clear spans provide an instant work platform for following trades, while minimal propping further enhances access and improves construction times.

CASE STUDY

DOLPHIN DIVE QLD

CHALLENGE

Construction of a 360 metre jetty and marine offloading facility was a crucial part of developing the new Gladstone Liquid Natural Gas plant and the success of one of Queensland's major mining projects. Located on Curtis Island on the Central Queensland Coast, the extensive facility comprises a new barge berth, a sea water intake pump support structure, passenger ferry berths, an access catwalk, a bulk aggregate berth and a load-on-load-off and roll-on-roll-off facility. A highly complex and large scale project, head contractor Bechtel engaged John Holland to oversee its engineering, procurement, design and construction. ARUP was selected as the engineer, while Stresscrete was chosen to supply and deliver the specialised precast elements.

The project had inherent safety risks from working over water and had to meet a very tight construction program.

SOLUTION

Precast concrete was selected to construct the dolphins - self-contained marine structures used for mooring and berthing roll-on-roll-off berthing vessels. The precast for the project included manufacture of 137 dead man anchors weighing 14 tonnes each, 25 fender panels which also weighed 14 tonnes a piece and 11 dolphin shells weighing between 35 and 42 tonnes. Stresscrete also oversaw the procurement of all structural steel cast-in items for the dolphins to save time.

Transporting the seven metre wide dolphins was also a challenge. The vehicle stretched over two lanes of traffic on the Bruce Highway between Rockhampton and Gladstone and two police escorts were called in to assist.

BENEFITS

The hazards of working over water were minimised with precast, as construction personnel worked in a contained area with built-in edge restraints. Using precast also meant there was no need to assemble and strip complex framework systems over water, saving considerable time in construction, making this a far more economical option.

Despite some of the logistical challenges, the clear advantages of using precast over casting insitu were unmistakeable to all concerned, delivering time and cost benefits and a safe working environment that facilitated the smooth delivery of the project despite tight timelines.

HIGH QUALITY AND GOOD FOR CONSTRUCTION

There has been much discussion around how to achieve quality and its associated benefits.

When quality is expressed as 'achieving the same result every time' and that 'quality is built, not specified', it is easy to understand the benefits of using precast to reduce construction risk.

FACTORY-PRODUCED QUALITY

The benefits of a controlled factory environment are clear when comparing a factory-based activity with a similar on-site activity. As the precast process is repetitive, identical or similar elements are easily produced, making it a very cost-effective building method to produce products of exceptional quality.

Factory shop drawings for precast elements show all dimensions to the last millimetre, details of the reinforcing steel and all concrete finishes. Site working drawings rarely contain this degree of detail. At every important stage of the manufacturing process, the product is checked against these shop drawings for accuracy.

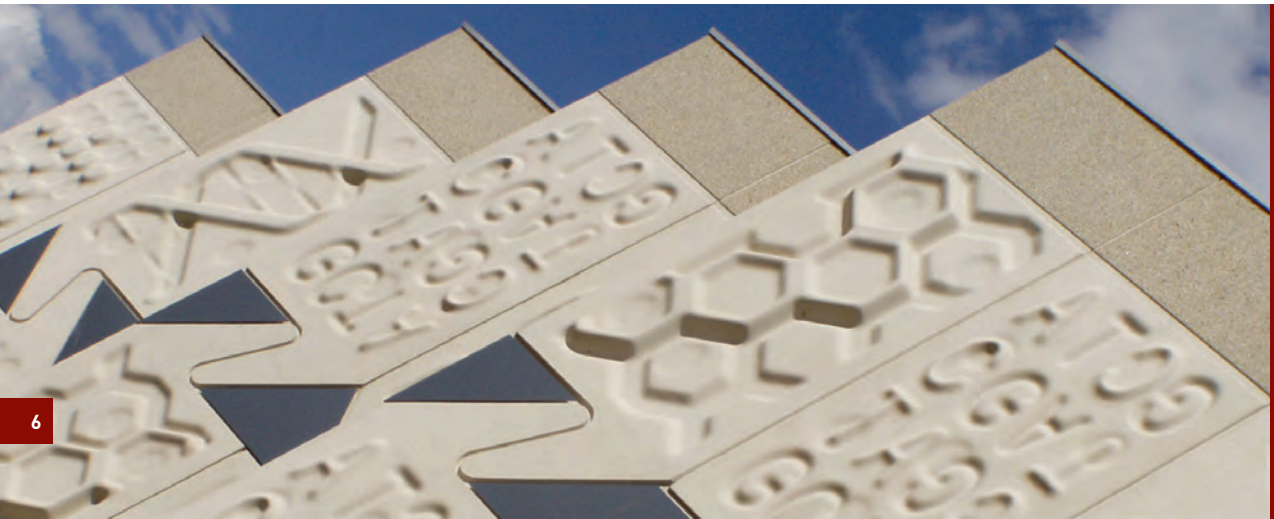
QUALITY ACCREDITATION

Many precast operations have third-party accredited quality assurance programs in place, which deliver the quality benefits that are required by industry. The risks associated with using site cast tilt-up elements or insitu concrete construction methods are dramatically minimised by using precast.

MOULDS

Experienced precast manufacturers design their own moulds based on the customer's shape and performance requirements. Moulds and mould liners can be made from steel, timber, concrete or rubber. They can often be kept and reused, either on the same project at a later stage or for alternative projects.

As the need for good off-form concrete is usually paramount, important considerations in design and manufacture include mould surfaces, stiffness and sealing against slurry or grout loss. Good precast element design permits moulds to be made with a minimum of loose pieces and a minimal number of mould changes during the course of a project.



CASE STUDY

SOUTHERN SEAWATER DESALINATION PLANT WA

CHALLENGE

Perth's water shortage problems have been alleviated by the construction of a second salt water desalination plant by the WA Government at Binningup. The plant is 100% powered by renewable energy, uses reverse osmosis technology and can deliver 100 billion litres of drinking water per year to drought-prone Perth and nearby Bunbury. The $955 million project, awarded to Southern Seawater Alliance, is the largest integration project ever undertaken by the WA Water Corporation and includes 13 large plant process buildings, an administration and control centre, an ocean inlet, outlet pipelines and major works to connect the new supply into the existing system.

AJ Lucas, as part of the Southern Seawater Alliance, was awarded the contract to design, construct and operate the desalination plant, which included the ongoing maintenance of the facility for the next 25 years. The correct selection of building materials was vital to the project's long term success.

SOLUTION

PERMAcast was awarded the main contract to manufacture, supply, install, grout and seal 1,035 precast façade panels for the process buildings. All panels have a design life of 100 years and were made with an S50 low heat concrete mix to meet durability requirements. Underground electrical tunnels were also constructed, which involved the design and manufacture of 60 large inverted box culverts and 100 precast covers from steel moulds designed specifically for this purpose.

31,000m^2 of precast panels and 2,600 tonnes of box culverts were manufactured, making this one of the largest precast contracts ever awarded to a local WA precaster.

BENEFITS

Precast was a natural choice for the building façades because of its consistently high quality, durability in coastal environments, acoustic properties, cost effectiveness and speed of erection. The planning and arrangement of buildings, use of precast walls and an eight metre high vegetated berm, help reduce the noise generated by the pumps.

The high quality of the precast concrete supplied will ensure the stringent long term performance requirements for the facility will be met in the years ahead.

PRECAST IMPROVES CONSTRUCTION SAFETY

One of the key benefits of precast is that it reduces construction risk by removing activity from the building site.

It is important to understand the manufacture of precast concrete elements in a factory is not considered to be high risk by authorities. This is testimony to the safe history of precast manufacture in Australia. Installing precast however, requires the preparation of Safe Work Method Statements for all the tasks undertaken when erecting precast with cranes. It is worth noting authorities consider both the casting on-site of tilt-up elements and their installation as high risk.

SAFER SITES BY TAKING WORK OFF SITE

By using precast concrete elements in construction, a number of activities that were traditionally carried out on site, can instead be undertaken by workers standing safely on a concrete floor in a factory. This significantly reduces the risks resulting from falls from height, extreme weather, dirty sites and adverse working conditions.

SAFETY IN DESIGN

Safety in Design imposes a responsibility on the principal contractor to have at least one risk-assessed method of construction at the project concept stage. Too often in the past, consideration of how a building was to be constructed was ignored at the design stage.

The revised National Code of Practice for Precast and Tilt-up Concrete Elements and the latest revision of AS3850 Prefabricated Concrete Elements are two excellent documents that provide the necessary guidance for the safe erection of precast elements.

RECENT TRENDS IN MANAGING CONSTRUCTION SAFETY RISK

Construction risk is often under-estimated, or sometimes ignored. There has been a trend by some principal contractors to manage their construction risk by transferring it to subcontractors. This fragmented approach to mitigating risk is potentially dangerous as individual subcontractors may not have the contractual controls, knowledge or expertise to assess and manage the construction risk on site.

An ideal building environment is one where risk assessment is dynamic and seen as an everyday part of the building process. Associated documentation should be a living, breathing resource.

CASE STUDY

PULLMAN HOTEL NSW

CHALLENGE

St Hilliers was awarded the contract to build the five-star Pullman Hotel at Sydney Olympic Park. The hotel has 212 rooms on levels three to 16, located above a four level podium. The selection of building materials was particularly important as the hotel needed to be visually striking, in keeping with the vibrant surrounds of Olympic Boulevard. Safety during construction was an absolute must.

SOLUTION

A significant design review process was undertaken to ensure the selected materials satisfied demanding quality and buildability requirements. With significant input from the precast industry, a total precast solution which included precast floors from Ultrafloor and precast walls from Austral Precast was implemented. Prefabricated stair elements were also used, removing the need for any conventional formwork.

The need for perimeter scaffolding at the edge of the floors was avoided as fall protection was provided by a temporary handrail system fixed to the wall panels prior to them being lifted into place. Handrails were bolted on to the inside face of a 300mm wall upstand above floor level.

The precast flooring system provided a safe and ready working platform. The flooring was temporarily propped off-centre to allow immediate access for following trades.

BENEFITS

Removing work from site by using precast walls and floors immediately boosted safety on site.

The elimination of external scaffolding by providing an integral handrail with the wall panels created a safer working environment on site and significant cost savings for the project. The Ultrafloor precast flooring reduced the need for insitu concrete construction, thus eliminating the risk of formworkers falling from heights. Fast construction delivered a remarkable six day floor-to-floor cycle in a safe working environment.

The hotel exudes a striking visual impact with an imposing tower of painted precast concrete, sunshades on the north and west faces and a southern four-storey wing constructed from a glass and panelled façade.

PRECAST'S COST BENEFITS

Savings in time, better quality products and safer sites all contribute to the profitability of a project and realisation of cost benefits. The challenge is to understand the relationship between them.

A good understanding of the precast process, as well as meticulous planning and reduced time on site can deliver considerable cost savings when precast is used.

UNDERSTANDING THE PROCESS REALISES SAVINGS

The incessant demand from many in the industry to reduce prices without understanding the commercial realities of precast manufacturing is sometimes difficult to comprehend. The answer is not to use strong-arm negotiation tactics to reduce margins, but to work with the precast manufacturer to utilise the precast process to realise significant savings.

GOOD PLANNING REAPS REWARDS

Good planning combined with good design results in the impressive time and cost benefits precast can offer. By using this consistently high quality product, manufactured under factory controlled conditions and erected safely on site by small experienced erection crews, a project's anticipated cost and delivery schedule can generally be achieved.

BUILDING ON PAPER REDUCES COST

The precast factory environment delivers an inherent construction advantage as shop drawings are often used in a BIM environment to build a project in detail before construction begins. This can eliminate any problems before they actually occur. The manufacture and reliable delivery of consistently high quality products can save builders and developers significant time and money when compared to insitu construction. The need for quick and often costly commercial decisions to keep the insitu build on track is removed when precast is used.

There are simply fewer surprises with precast which results in reduced construction risk and cost savings.

CASE STUDY

MELBOURNE WATER VIC

CHALLENGE

The Melbourne Water headquarters - located in Melbourne's rapidly developing 'Digital Harbour' precinct - needed to blend seamlessly into the Docklands area. Part of the Digital Harbour design philosophy is to not only provide green buildings but adaptable structures as well.

The builder Equiset, approached Hollow Core Concrete to prepare a design that would meet both budgetary and programme targets, for what was an extremely short construction timeline. With a gross floor area of over 20,000m^2 the nine level structure needed to be erected in just eight months and achieve a six Green Star rating. The car park levels provided additional challenges, requiring limited column locations and tight head clearances around ramps.

SOLUTION

The structure was divided into two separate buildings connected by a central insitu core. The northern precast skeletal-framed structure was constructed as an independent building allowing early access for following trades and taking the south build off the critical path. It has a lower multi-level car park and six levels of office space above.

An ingenious solution to utilise the side barrier walls on the ramps and stepped precast beams as structural support, was adopted. This was achieved using sophisticated 3D software to model the entire structure.

The southern building adopted a different design solution to span over an operating public road leading to Etihad Stadium. Supporting the building structure over the road was a two level steel truss, 54 metres in length. This truss supported hollowcore planks spanning 16 metres on levels one and three. On level three, the hollowcore planks cantilevered a further three metres, which in turn supported the perimeter precast edge beams that supported the extensive external glazing.

This design was able to provide a marginally lighter floor structure in order to reduce the loads on the steel truss.

BENEFITS

The end result is a stunning example of the flexibility of precast concrete as a building material, evidence that precast buildings do not need to be repetitive or modular. The building, for one of Melbourne's most environmentally conscious occupants, has been a success. It was completed on time, on budget and achieved its essential green credentials.

SUPPLIER
ADVOCATE

CLEAN TECHNOLOGIES