NATIONAL PRECAST
CONCRETE ASSOCIATION AUSTRALIA

Guidance Note

Better application of AS 3600 and designing for precast construction: how to maximise efficiency

Often described as the “80/20” rule, the Pareto Principle is commonly observed and applied in many professions. Underlying the principle is that 80 percent of effects come from 20 percent of causes.

When it comes to structural engineering design and documentation, very often timeline pressures dictate that 80 percent of the design documentation (and billing for that matter) may be generated in 20 percent of the time … all while under great pressure of cost overruns for the designer. It is also this vital last 20 percent of design that typically includes critical or high risk aspects, such as the design of connection details.

While the Preface of AS 3600 *Concrete structures* clearly outlines its secondary objective – which is to provide guidance to ensure conformance of construction to design requirements – its scope is similarly clear regarding the minimum requirements for design and construction. That objective equally applies to the prefabrication of precast concrete elements.

That last 20 percent of the design and detailing can steer designers toward quicker and overly-conservative designs, which in many cases can not only make the precast difficult to manufacture, but inefficient and more expensive construction. This can have a significant time and cost impact on the precast, derailing some of the programming and cost advantages of using precast in the first instance.

For example, poor reinforcement detailing can result in congestion issues. Precast is frequently cast flat with minimal concrete depth and formwork height and specified reinforcement must be able to fit within the confines of the element, with allowances for cover requirements. As well as creating manufacturing difficulties, congested reinforcement can also create challenges in ensuring sufficient access by vibrating equipment, both of which can very easily compromise the economic benefits of precast.

Ensuring the economy of precast is realised requires careful and thorough detailing, preferably sooner rather than later in the design stage. To deliver efficient precast design, manufacture and construction, good design must be practical to fabricate.

AS 3600-sanctioned considerations for efficient precast design and documentation:

1. That the design has been informed through consultation with the constructors and precasters involved, whereby design reviews by precasters in the early stages will result in more efficient outcomes.
2. That reinforcement bars are drawn at their rib-to-rib size, not at their nominal size (for example, N12 is closer to 15mm from rib to rib, so should be drawn as 15mm).
3. That the required reinforcement (with compliant bends, laps and terminations) and other cast-in items - including precast lifting anchors, grout tubes and fixing inserts - are actually able to fit within the dimensions of the concrete element.
4. That there are no congestion issues for reinforcement and other cast-in items at element junctions (for example, column to beam to slab) and at corners and returns (where bar stacking can cause cover issues).
5. That reinforcement processor bending tolerances are considered in drawings.
6. That sequencing of the placement of reinforcement layers is considered when factoring in placement of other cast-in items such as grout tubes, to ensure that required cover can be achieved.
7. That connections between elements or other framing have been designed to accommodate acceptable dimensional tolerances.
8. That compaction and curing requirements are adequately considered and addressed in design documentation.

Most, if not all, of the focus in design documentation seems to be on concrete mix design and material content, yet - despite numerous references in AS 3600 - compaction and curing are often left unspecified, despite being critical to achieving the desired design properties for a specified concrete.

Note that because precast is frequently cast flat with minimal concrete depth and formwork height, compaction tends to be easier to achieve. Additionally, the very nature of precast - which is typically cast and stored in enclosed factory conditions - affords superior curing conditions, compared to on-site in-situ or tilt-up (on-site prefabrication) concrete construction.

Increasing concrete strength to offset congestion problems

Where congestion in precast elements may be an issue, one potential solution that is easy to apply is to increase the grade of concrete that is specified.

While it is no surprise that the price of concrete rises with an increase in strength, the relatively small cost increase of a higher grade concrete well offsets the increased reinforcement costs that are now common place, especially with increased seismic requirements. For the common exposure classifications of B1 and B2, the cover reduction allowed by specifying f'c = 50MPa, rather than 40MPa, certainly provides a benefit in easing common congestion difficulties.

Note however that concrete strengths greater than 50MPa may require additional vertical bar restraint as part of detailing for seismic conditions.

The challenge remains for concrete structure designers to deliver the smartest, most considered and risk managed engineering designs for the lowest overall design and construction cost - and all within the working limits of AS 3600. This can be better achieved with sufficient time and the right information. Designing in precast from the outset affords advantages, especially regarding practical reinforcement detailing, concrete compaction and curing.