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NATIONAL PRECAST CONCRETE ASSOCIATION AUSTRALIA

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Completed building cantilevering full height over the site.

LIFE SCIENCES Building University of Newcastle

National Precaster is proud to feature the new Life Sciences Building at the University of Newcastle as an example of innovative architecture, unusual engineering design and excellence in construction combining to achieve an environmentally responsible building comprised entirely of precast concrete.

Without doubt, it thoroughly deserves to be recognised for the two distinguished awards it has recently received – the 2001 'Sulman Architectural Award' for public buildings, and the 2001 Concrete Institute of Australia 'Excellence in Concrete Award – Projects'.

The steeply sloping site and the building's twenty-one metre cantilever at its northern end provide for a singularly imposing structure. It was this cantilever that provided challenges for the design team and resulted ultimately in specifying a totally precast concrete structure. Given the site constraints, it is a credit to the flexibility and environmental soundness of concrete, as a building material, that such an elegant building solution has been achieved.

The south end, four-storey core was constructed of in-situ concrete to provide a monolithic structure to which the building could be tied back to anchor the huge cantilever. Other than a 60 mm topping and some small construction joints, the remainder of the entire structure north of the core is comprised of precast concrete. Precast columns have been located on two lines of the structure only to provide clear, uninterrupted floor space. Precast, prestressed concrete beams span transversely across the columns, transferring the load from the hollowcore floors. The longitudinal spandrel beam tension ties are also constructed of precast concrete. The spandrels transfer the tension loads created by the cantilever back to the anchor core. **Figure 1** depicts the primary structural elements and their structural function.

The structural design and buildability for transfer of the tension force from the cantilever and inclined strut to the anchor block was the unusual design feature of the project. A number of options were considered. These included:

- Longitudinal post-tensioning of the tension ties
- Welded structural steel plate connections between the tension ties
- In-situ pour strips with conventional lapped splices in the tension ties

After extensive consultation with the specialist precast concrete designer/supplier, the CADWELD system was adopted for mechanical coupling of the main tensile reinforcement. While this system has been used extensively in overseas projects, this was the first use of this coupling system in an Australian building. The unique advantage for its choice was the compactness of each joint, resulting in a hidden in-situ pour strip only 600 mm long at each joint. Because the precast concrete surfaces are exposed in all of the structure to provide an important visual statement, the pour strip was incorporated behind a 80 mm thick section of the spandrel. This provided for continuity and uniformity of the high class surface finish required.

Transverse beams cantilever in pairs in a westerly direction up to 6 m past their line of support. Precast prestressed hollowcore floor units span longitudinally between these pairs of transverse beams and when interconnected with a 60 mm topping slab, each floor forms a horizontal diaphragm. This diaphragm action provides the necessary transverse rigidity for the building. For architectural considerations and interior space restrictions, all of the precast concrete elements were confined to a maximum thickness of only 300 mm. It was only possible to construct these slender beam elements and still maintain the required 25 mm cover to reinforcement because of the extremely

Totally precast frame and floor featuring twin 18m cantilever beams.

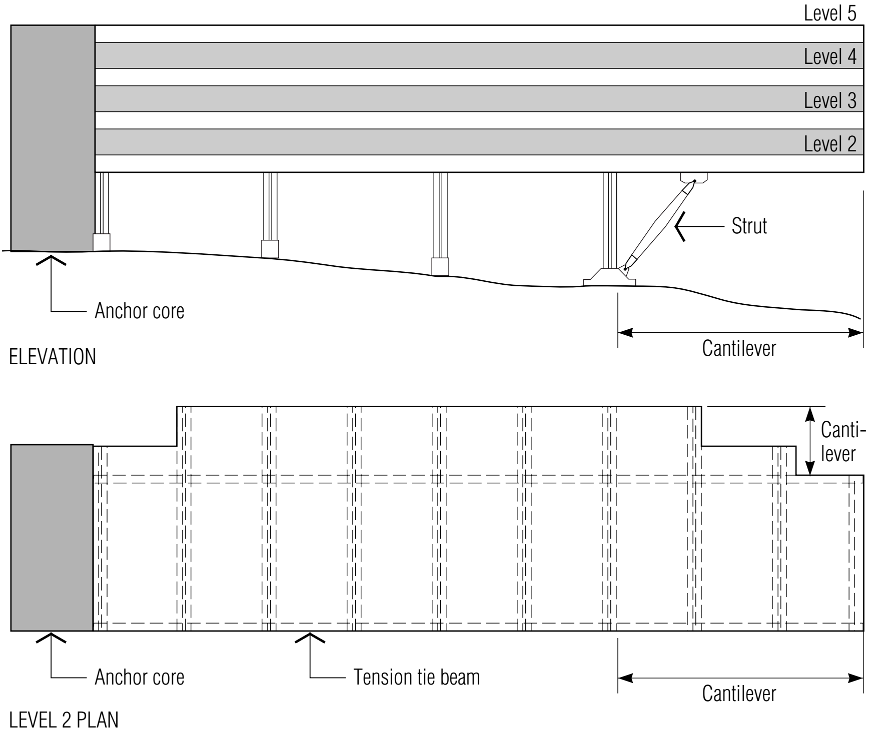

Figure 1 *Elevation and plan of Life Sciences Building*

Erection of precast spandrel tension tie (note temporary stability support for wall)

low tolerances (± 2 mm) and precise jigging of the welded cage reinforcement developed by the precaster.

The 300 mm thickness of all sections created extreme congestion of reinforcement and continuity ducts particularly at the cantilever support points where elements interacted in three directions.

Because of the high congestion of reinforcement in the precast components, high performance concrete of 240 mm slump was developed to ensure proper concrete placement and intense form vibration necessary to achieve uniformity of surface finish. The concrete mix was designed using the precaster's extensive experience in the use of super-plasticised concrete for complex bridge girder manufacture.

Application of this technology combined with a rigorous manufacturing procedure allowed a superior, high class F1 off-form finish to be achieved on all elements.

To ensure buildability of this challenging structure, it was necessary to prepare full size (1:1 scale) drawings which show the interaction of each reinforcing bar with interfacing elements in three dimensions at all cross sections through the entire building. The attached 13 drawings, (selected from the nearly 700 that were produced to fully describe this project and the manufacturing process), demonstrate the high complexity of tolerance and fit of all areas of the construction. This meticulous approach to detailing ensured resolution of the many complex interface and interaction difficulties inherent within the design. All of this phase of the work was required to be complete before manufacture and erection could commence.

By utilising the most complex of pieces, it demonstrates convincingly that anything is possible of construction through the free-form qualities of precast concrete.

The project team responsible for this remarkably innovative and outstanding building was:

- Architect **Suters Architects** and **Stutchbury and Pape**
- Structural Engineer **Northrop Engineers Pty Ltd**
- Builder **Lahey Constructions Pty Ltd**
- Precast Manufacturer and Specialist Consultant **Structural Concrete Industries Pty Ltd.** ■