ACSE AWARDS 2022

Loreto Kirribilli

Medium Project Category

Photo 1: Innovation Centre Completed

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INTRODUCTION

'Spiritus' is Loreto Kirribilli's new Innovation Centre designed to support the growing STEM needs for the school's year 7-12 cohort.

Loreto's Kirribilli campus has grown on the site over the past 200 years, and now consists of many buildings of varying construction materials and scales supporting the junior and high school requirements.

The new 7 storey Innovation Centre was excavated into the steeply sloping site and interfaces with three adjacent buildings, providing better connectivity through the campus. The development also took the opportunity to improve the functionality of the existing gymnasium and junior school buildings, discussed in more detail below.

Photo 2: Innovation Centre Completed

Project Brief

The structural system for the new building is relatively conventional, comprising post-tensioned slabs and reinforced concrete vertical elements.

The challenges for us came through the additional structural components that connect the new building with the adjacent existing buildings, as well as the complex excavation and ground conditions.

The key components of the development are summarised below:

- Demolition of existing two storey ‘Block B’ building, excavation and construction of a new 7 storey Innovation Centre;
- Improvements to the existing Gymnasium including new steel transfer truss and three storey addition to the north of the Gymnasium for staff facilities;
- Improvements to the existing Junior School building including new concrete-framed walkways that wrap around the existing building at two levels, and new stairs connecting the Junior School with the main school access point
- New egress stairs linking the Gymnasium and Innovation Centre with Elemang Avenue

Design and Construction

Working with complex site conditions and existing buildings, we took a practical approach to risk management, working closely with the geotechnical and construction teams to adjust our design as required on site. We ended up using a significant amount of the existing structure to support new loads, undertaking testing and analysis to minimise structural strengthening required. The result is a clever integration of existing and new, with minimal structural redundancy.

Excavation

One of the most challenging aspects of this project from both a design and construction perspective was the significantly sloping site, especially considering the proximity to existing buildings.

The figure below shows the relationship between the new Innovation Centre and adjacent buildings, with the existing ground shown dashed. Class III sandstone generally followed the slope of the site, which falls approximately 22m, varying from depths of 1-4m. To avoid excess shoring, we worked closely with the geotechnical engineer to develop solutions for retaining the soil overlying the sandstone and adopting rock bolts and shotcrete where required to stabilise the excavation.

BIM, site surveys and regular inspection of works during construction were required to mitigate the risks of excavating in such close proximity to existing buildings. Refer photos below for the scale of rock cut and adjacent structures.

Existing Building Foundations

During the design phase, we undertook analysis of the existing Junior School building to assess the likelihood of it being able to withstand some additional loads due to the new walkways. We calculated that the existing columns had significant additional capacity – however on site found that the existing footings were bearing on rock with significant joints, limiting their capacity to support current loads, let alone any load increases.

We worked closely with the geotechnical engineer to understand the risks, and remediation measures required to be comfortable with the bearing capacity and stability of the rock, which was adjacent a vertical cut face. Limited by access and equipment weights, our solution was to adopt micropiles around the existing foundations to secure the jointed rock profile.

Photo 3: Excavation progress

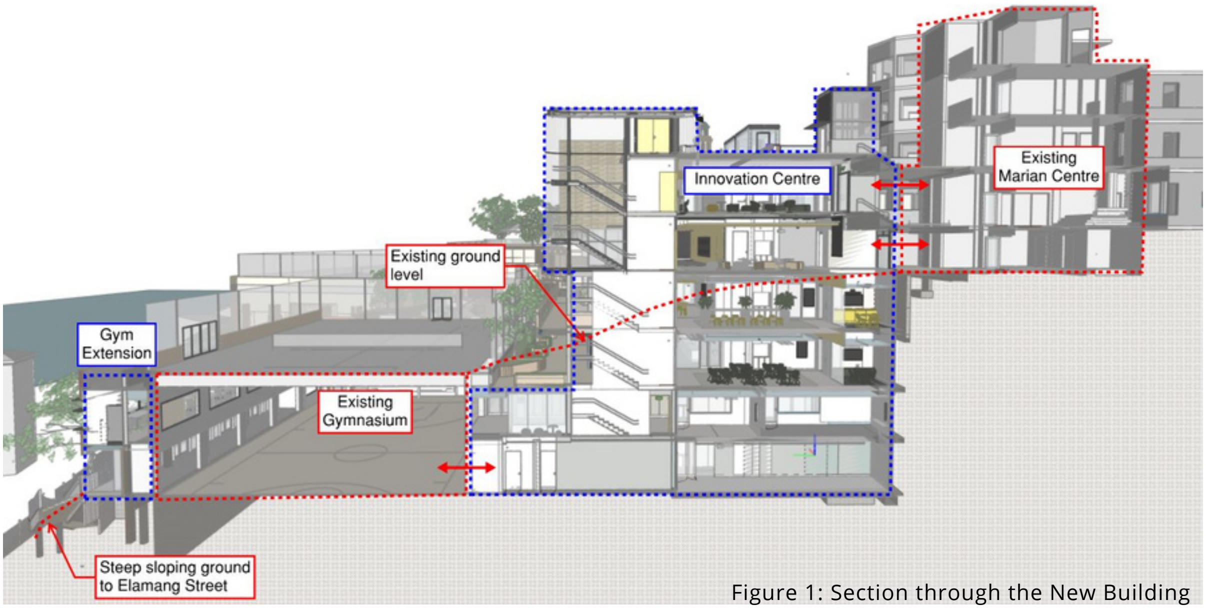

Figure 1: Section through the New Building

Design and Construction

New Junior School Walkways

Accessibility across campus was an important outcome for the school and a key component of this was providing a new walkway to link the new building with existing. Concrete was chosen to achieve the fluid-form, winding shape which hugs the existing Junior School building.

Photo 4: Walkways wrapping around Junior School

The form of the structure had to be heavily massaged during construction when the extent of adjacent excavations were investigated and better understood. The proposed walkway extent was found to project out over an adjacent underground services plenum, rather than be over natural ground.

This required increasing the extent of the walkway so that we could land our new columns over existing columns through the plenum. Strengthening of existing columns with steel PFCs was required to support the additional load. The slab depth was increased to accommodate the larger span and a skylight void was introduced to minimize loads.

Live Site

The school was fully operational during construction which posed several additional challenges. To provide additional classroom capacity, temporary demountable classrooms were installed on top of one of the existing tennis courts, a suspended PT slab. Northrop designed the grillage structure and propping to safely transfer the load to this structure. Safe access for students was also required through several areas of the site, requiring bespoke temporary structures.

Northrop reviewed temporary works and excavation strategies with the additional risk of a live site in consideration. There were several periods during construction where we made judgement calls to implement exclusion zones in classrooms or egress paths adjacent construction works to mitigate any risk to students.

Photo 5: New walkway column locations adjusted to sit over existing structure

Creativity and Innovation

Integrating the innovation centre with the active campus and ensuring connectivity between new and existing was a key driver for innovative structural solutions on the project.
One of the most challenging aspects of this was the steel transfer truss in the existing gymnasium

The existing gymnasium houses an internal multi-purpose court at ground level and a tennis court above on the suspended slab. Built in the early 90s, the structure consists of post-tensioned slabs and beams spanning ~19m, with columns at approx. 4.8m centres along each side.

To accommodate additional bleacher seating and provide improved viewing, two existing columns were proposed to be removed as part of the new development.

Buildability had to be considered early, and played a big part in the final solution. Propping the existing structure would be difficult in the double-height space, especially with the gym being used for Richard Crookes' site sheds.

Concrete transfer options were quickly ruled out due to accessibility constraints, so we started developing a steel solution. Minimising member lengths and weights, in conjunction with a desire to remove requirements for propping led to us adopting a 'sandwich' solution for the truss.

Comprising horizontal 380 PFC sections bolted to the existing columns with diagonal SHS sections slotted in between, this configuration could be fully installed before demolishing any existing structure, significantly reducing the risk of the proposed works, as well as temporary works required.

The truss was pre-loaded using hydraulic jacks and experienced 6mm deflection before being bolted into place.

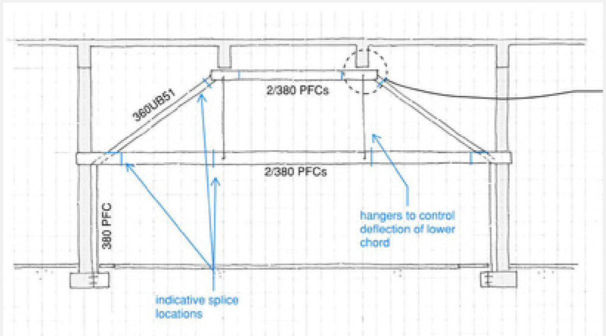

Figure 2: Preliminary Sketch showing Member Configuration

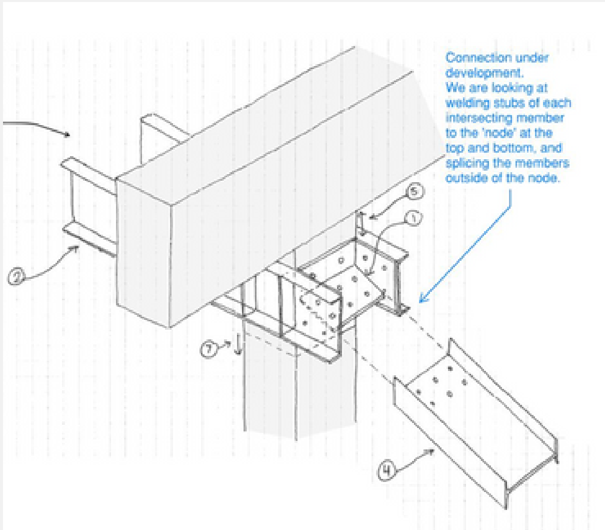

Figure 3: Preliminary Sketch showing Connection Detail


Photo 6: Year 12 Loreto students under completed transfer truss

Photo 7: Structural Engineering Workshop

Photo 8: Women in STEM Careers Panel

Sustainability

Northrop also provided sustainability consulting services on the project, which was front of mind for the structural design. The key project initiatives included adopting a high-performance façade with a metal mesh interlayer, giving the building its distinctive bronze colour whilst also limiting light and heat transmission.

The walkway design and interfaces between the new and existing buildings also encourage windows and doors to be left open, naturally ventilating the space for most of the year. This was achieved through collaboration with sustainability, mechanical and architectural design teams.

From a structural perspective, our team has helped to increase the functionality of adjacent existing buildings, reducing the school's requirements to build brand new spaces. For example, building new outdoor spaces around the existing junior school buildings has significantly increased their usability and benefit to student wellbeing. Modernising the existing Gymnasium by extending the building for staff spaces, and increasing space for spectators, has also ensured that these buildings will continue to be used and delayed their replacement.

Community and Contribution

Our structural engineering team were also eager to engage with the Loreto students through the process, especially as there were several senior women across the engineering, architecture and construction teams. We joined a career panel for students interested in STEM, and also ran a structural workshop for senior maths students, taking them through the design of the steel truss in the gym. This included putting together a homework assignment on the Method of Joints for the students to work through and get a practical introduction to engineering.

Despite being a relatively small project, Loreto's new Innovation Centre was one of the more challenging and structurally complex developments our team has worked on this year. We are proud to present what we feel is a clever and innovative response to complex site conditions and significant interface challenges with existing buildings. We can't wait to see the building fully utilised in December this year.

Project Team

Project Manager: Bloompark Pact
Architect: fjmt studio
Contractor: Richard Crookes Constructions
Geotechnical Engineer: JK Geotechnics
Early Works Contractor: DECC

Budget: Approximately $30m