INFORMATION TECHNOLOGY

Mater Hospitals, Brisbane.

Mater Private Clinic.

A milestone was reached in the $220M Stage 2 redevelopment of the Mater Hospital at South Brisbane with the erection of four giant support trusses. The steel trusses each weigh 40 tonnes and bridge 31m across the air space above Water Street, supporting a three storey sky-bridge structure which forms the Link Building component of the now completed Mater Private Clinic which joins the Mater Private Hospital.

Project Team

CLIENT:
Mater Private Hospital

BUILDER:
Multiplex Constructions (Qld) Pty Ltd

CONSULTING ARCHITECT:
Peddle Thorp Architects

CONSULTING STRUCTURAL ENGINEER:
Alexander Browne Cambridge & Partners

PROJECT MANAGER:
APP Projects Pty Ltd

SPECIALIST FIRE ENGINEERING:
BHP Steel (now OneSteel)

STEEL FABRICATOR & ERECTOR:
Schmider Engineering Group

FIRE SAFE

The daring sky-bridge design concept was created by Brisbane designers and hospital planners Peddle Thorp Architects. The steel truss solution evolved through the contributions of consulting engineers Alexander Browne Cambridge & Partners, project managers APP Projects and steel manufacturers OneSteel. Transfield Construction (Qld) provided crucial design stage input into transport logistics and erection techniques for the massive steel trusses.

The sky-bridge construction links the existing Mater Hospital's, Mater Private Hospital to the north with a new eight storey Private Clinic to the south. The Link Building accommodates operating theatres, patient rooms, a day unit, rehabilitation centre, and major air conditioning plant within the three storey construction. Brett Hudson of Peddle Thorp Architects said that "using public road airspace as a serviceable building rather than just a walkway is a pioneering development in architectural design. The structure had to be inherently functional, and the use of structural steel made this possible in a cost effective way".

The Multiplex built complex projects a new image for South Brisbane and contributes significantly to the rejuvenation of the area. The hospital's integration with the new Mater Hill Bus Station increases public access to the complex and forms an integral part of the revitalisation of the Stanley Street precinct. The Mater Hospital's Mater Private Clinic attests to the expertise of Peddle Thorp Architects in creating a design that embraces technological and design innovation, whilst maintaining human scale and making a positive contribution to the urban landscape.

In the style of international hospitals such as the Mayo Clinic and John Hopkins Hospital, the Mater started life as a number of discrete buildings, grew into a campus, and now has become a precinct and part of the community of South Brisbane.

PROJECT MANAGEMENT

According to Rob Jackson, Project Manager with APP Projects Pty Ltd, the biggest challenge faced was the simultaneous construction of the Mater Link Building and the South East Transit Busway beneath. An extremely short window of opportunity of one week existed in which the four 36m long trusses could be lifted off the Busway concrete floor and located in position 16m above the floor. In a well planned construction operation, the four trusses and the steel floor framing were erected in just five days.

Rob believes that **the ability of the structural steel trusses to be fabricated and transported to site in complete 36m lengths, and to be quickly erected, was a tremendous success** and greatly minimised the impact of the Mater construction on the Transit Busway construction program.

STRUCTURE

The design of the sky-bridge structure presented consulting engineers Alexander Browne Cambridge & Partners (ABC) with one of the most significant design challenges in its 65 year history. ABC's challenge was to design the support structure for the three storey Link Building to meet the following criteria:-

- structure main span 31m
- support four Operating Theatres, which are both vibration and deflection sensitive
- the construction had to be completed within one week (during which time the construction of the Busway below was to be suspended)
- the structural elements had to be able to be lifted by a single mobile crane because of access restrictions in the Busway construction area.

In situ concrete solutions were not feasible because they could not be completed within the available time. Precast concrete options were eliminated because the weight of individual elements exceeded the capacity of available cranage.

Clearances required between the Busway in Water Street and the underside of the Link Building placed restrictions on the depth available for the support structure. Following discussions with the architects it was decided to locate the large Plant Room at the lowest floor (Level 6) of the Link Building so that the trusses could occupy the full floor-to-floor height of Level 6. The truss bottom and top chords support the Level 6 and Level 7 floor structures respectively. This also assists with the vibration damping of the trusses.

To avoid the need for scaffolding, the Level 6 Plant Room slab was supported on profiled metal decking and steel secondary beams. The Plant Room slab was designed to support the weight of the construction loads from the Level 7 floor slab.

Truss details are listed below:-

- Span : 30.6 metres
- Length : 35.6 metres
- Depth : 3.65 metres
- Spacing : 7.20 metres
- Member Sizes
  - Top Chords : 400 WC sections
  - Bottom Chords : 400 WC sections
  - Vertical Web Members : 400 WC sections
  - Diagonal Web Members : 400 WC sections & 310 UC sections
- Steel Grade
  - Top & Bottom Chords : Grade 400
  - Web Membranes : 300PLUS®

Preference in the choice of truss member sizes was given to members with low surface area to mass ratios, which assisted in eliminating the need for passive fire protection of the trusses. This was beneficial in reducing the cost of the trusses and in achieving tight program requirements for construction.

"...a design that embraces technological and design innovation."

FABRICATION AND ERECTION

Schmider Engineering Group fabricated the four steel trusses (total weight 140 tonnes) as well as the floor beams and bracing (total weight 20 tonnes). The trusses were transported to site in one piece and were erected by a Brambles 330 tonne SWL mobile crane. The trusses were erected without incident and only minimal adjustments on site were required.

The accuracy of the truss fabrication and the speedy erection, was a credit to steel fabricators Schmider and building contractors Multiplex.

FIRE ENGINEERING ASSESSMENT

The link construction over Water St consists of three levels with the lowest level containing services, the next containing operating theatres and the highest providing an inpatient facility. Two of the steel trusses are located along the outside of the service level such that they become an architectural feature with the external wall of this level being comprised of glass or glass/louvered grille combination. The building has a smoke detection system, an EWIS and incorporates a Fire Indicator Panel. The closest fire stations are located 3km and 4km away.

A fire engineering study assessed the impact of potential fires on the performance of the steel trusses, and considered whether the BCA performance requirements would be achieved should the trusses have no applied fire protection.

What fires should be considered in relation to the trusses? Two possible exposure conditions were identified:

(a) Vehicles Below

Data on the frequency of heavy vehicle fires within vehicle tunnels gives an average probability of a non-car vehicle fire (buses/trucks) of 5×10^{-8} $vh^{-1}yr^{-1}$ for a given tunnel in Germany. Considering the length of Mater St occupied by trusses in comparison with the length of the above tunnel suggests that the appropriate fire incident rate to use in relation to the Mater St construction is 1×10^{-9}. The above rate cover *all* fires including minor ones. In the case of the situation being considered, it was analysed that the fire brigade would be able to tackle the majority of the fires. It was conservatively assumed that about one in one hundred bus fires become serious and reach flashover within the bus.

The average number of trucks within the service roadway was recognised as being relatively low (60 delivery vans per day with one fuel tanker per year[1]) compared with the number of buses and these were ignored in estimating the total volume of traffic travelling below the trusses. Information provided by Queensland Transport indicated a daily average total flow of buses below the trusses of 3310 vehicles per day. This gives a fire incident rate of 1.2×10^{-3} yr^{-1}. Thus a vehicle fire will occur, on the average, once in a thousand years. However, this will not be a major fire: such a fire could be expected, on the average, once in every one hundred thousand years - a rare event indeed, and it is questioned whether this fire scenario should even be considered given the relatively more likely fire scenarios within the hospital building itself.

Nevertheless, the impact of a major bus fire was considered using published test data which enabled the temperature of the trusses to be estimated in the event of bus fire below the trusses. It was found that temperatures would not exceed 100 deg C and **it was concluded that the truss members did not require passive fire protection** to withstand the effects of a vehicle fire below.

(b) Effect on Trusses of Fire within the Service Level and Operating Theatres

The service area contains equipment for air conditioning, power distribution and other services. Although fire ignition is quite likely, the fire load within the service level is low and it was considered that a severe fire cannot develop within this level. This fact, combined with the low exposed surface-area-to-mass ratios of truss members, means that the truss members do not require passive fire protection. The fire load density within the operating theatres is also low and considered to be incapable of generating a fire with sufficient severity to affect the steel members.

Footnotes

[1] Fuel tanker fires are very rare, and when they occur are usually associated with a major accident involving impact and excessive speed: even so, they are very rare despite the fact that many kms are travelled by tankers throughout the year. The likelihood of such an occurrence within the service lane is considered to be so low as to able to be discounted from further consideration.

FIRE SAFE