Airport Link, Northern Busway and Airport Roundabout Upgrade Project - Australia

LOCATION:
Brisbane, Australia

SUBMITTING FIRM:
Parsons Brinckerhoff and Arup

FIDIC MEMBER:
Consult Australia
**FIDIC Awards 2014**

*Airport Link, Northern Busway (Windsor to Kedron) and Airport Roundabout Upgrade*

The revolutionary AUD$5.6 billion Airport Link has delivered a landmark infrastructure project for Brisbane, tackling traffic congestion, enhancing the busway network and removing an infamous traffic bottleneck through an innovative and inspired design.

Airport Link includes three separate projects — AirportLinkM7 (a 6.7km toll road including 5.2km of tunnel), the Northern Busway (a 3km two-way dedicated busway from Windsor to Kedron with two new architecturally designed stations) and the Airport Roundabout Upgrade (a new four-lane flyover and a fast-diamond interchange). Together they represent the largest single investment in transport infrastructure ever undertaken in Australia.

Although they are three distinct projects delivered under separate design-and-construction or public–private partnership (PPP) models, it was essential to develop and construct them concurrently due to the tightly integrated nature of the alignments and surface connectivity.

Aside from 10km of tunnel, the scheme boasts 25 bridges, 16 out-and-cover structures, 7km of new surface roadways and bicycle paths, 3.5ha of new parklands, one million new trees and shrubs, three ventilation stations, and an operations control building.

Parsons Brinckerhoff and Arup joined forces as PBA to deliver the design, providing technical input to the tender and delivering the detailed design and construction phase services. It was a highly effective team formation that combined extensive local and international skills and resources.

PBA employed more than 1,000 staff, worked more than one million hours from start-up in November 2006 to demobilisation from site in late 2012. In this time, what the team produced was significant: over 18,000 for-construction drawings in 700 packages and a total of 3,800 submission cycles were delivered.

Due to its sheer size and scale, the design for Airport Link was broken into six major design packages:

- Southern connection at Bowen Hills — a multi-level surface interchange with complex connections to existing interchange infrastructure
- Kedron interchange — a unique multi-level interchange including bridges, surface roads and underground ramps
- Eastern connection at Toombul — a grade-separated fast-diamond interchange with Sandgate Road
- East West Arterial Gateway at the Gateway Motorway intersection for Brisbane Airport — a signalised intersection and elevated structures, including an 800m segmental bridge
- Mined tunnel — constructed using road header mining equipment; 17 road headers operated concurrently
- TBM tunnel — bored with two of the largest TBM's ever used in Australia, each with a diameter of 12.4m and 10.5m long, both costing AUD$5m.

Key features of the project includes:

- 25 bridges — the tallest is 25m high and the longest is 684m
- Largest road cavern in the world — 28m wide (equivalent to a nine-storey building on its side)
- Excavation and lining of 15km of tunnels and ramps
- Over 7km of new roads
- State-of-the-art tunnel fire management system using the ventilation system in smoke ducts, and a complex deluge system — arguably creating the world’s safest tunnel
- 13km of new cycle and pathways
- 3.5ha of new parkland
Innovation, quality, and professional excellence

Airport Link was a vast, complex undertaking designed and built in record time while meeting high quality and performance standards. It deployed a wide range of construction methodologies and structures, innovation and international expertise to deliver an exceptional, record-breaking piece of infrastructure. Delivering a project of this significance required technological innovation on an unprecedented scale. Some of the design challenges overcome by the PBA team included:

- Underground roadway interchanges: Road tunnels conventionally do not merge traffic streams within the tunnel environment. Usually, if three lanes enter the tunnel, three lanes emerge. What sets the Airport Link tunnels apart is the location of the interchanges in caverns, the largest of which was 28m wide. This complexity brought huge challenges across a number of major areas such as geometry, road safety, tunnel fire and life safety and constructability.

- Large jacked box structure: The team was presented with the additional challenge of tunneling underneath a main passenger and freight line consisting of four heavy rail lines with heavy utilisation levels that could not be interrupted. Other constraints included maintaining the rail geometry throughout construction to within 10mm horizontal and/or vertical tolerance. This led to an innovative solution: constructing a 9m high by 12m wide concrete box to act as the tunnel structure, which was hydraulically jacked by a specialist design and construct team underneath the rail embankment.

- Maintain an operational interchange: The Airport Roundabout Upgrade component replaced an existing grade-separated roundabout interchange at the junction of two major urban arterial roadways. Through the tender phase the design team developed an innovative multi-level flyover for the major cross-movements, with a fast-diamond intersection for turning movements all of which was constructed ahead of schedule under live traffic conditions.

From a fire and life safety perspective, PBA led a fully integrated Fire and Life Safety (FLS) design that incorporated emergency lighting and signage, radio/PA announcement, smoke ventilation systems, fire detection systems, fire suppression systems, structural fire protection, occupant egress routes and fire brigade access routes.

No road tunnel can be completely free of risk from a fire incident, but due to the extensive fire safety system technology included within the design, the AirportlinkM7 tunnels have been described as the safest in the world. Australia is one of only a few countries in the world – the others being Japan and New Zealand – that regularly uses a deluge suppression system in their road tunnels, to quickly control the size of the fire incident and limit the risk of fire spread to other vehicles.

Through innovation and utilisation of international expertise, the project team integrated concepts, techniques and theories to deliver an exceptional piece of infrastructure, above and underground. Overcoming many challenges within this tight
timetable required the most thoughtful and intelligent design, while maintaining extensive coordination with the construction crew. In delivering this project, the design team provided technical solutions to problems that had never been previously encountered, embracing the fundamental principle that engineering in its purest sense is about problem solving.

The project has already received recognition on a global scale for its cutting-edge design and construction techniques.

- Northern Busway (Windsor to Kedron) – Planning Institute of Australia Awards 2013, Award for Urban Design, Winner.
- Airport Link, Northern Busway, Waterford to Spearwood Upgrade – Queensland Engineering Excellence Awards 2013, Award for Excellence Project Infrastructure over $50m, Winner.
- Airport Link, Northern Busway, Airport Roundabout Upgrade – Queensland Engineering Excellence Awards 2013, R.W. Hawken Award, Winner.
- Airport Link, Northern Busway, Airport Roundabout Upgrade – Global Road Achievement Awards 2013, Award for Design, Winner.
- Airport Link, Northern Busway, Airport Roundabout Upgrade – Engineers Australia Australian Engineering Excellence Awards 2013, The Sir William Hudson Award, Winner.
- Airport Link, Northern Busway, Airport Roundabout Upgrade – Consult Australia Awards for Excellence 2013 Award for Safety in Design, Winner.
- Airport Link (Thiess John Holland) – Ground Engineering 2013, International Project of the Year, Winner.
- Airport Link – The Special Recognition Award for Sustaining Our Society, Bentley Be Inspired 2012, Winner.
- Airport Link – Project of the year (Over $1 billion) NCE International Tunneling Awards 2012, Finalist.
- Toombul Jacked Box – Fleming Award for Excellence 2011, British Geotechnical Association, Winner.

After eight months of operation, feedback from users has been extremely positive with significant reduction of surface traffic congestion by 45% and improved journey times to the airport, delivering a time savings of approximately 20 minutes through road-users avoiding 18 sets of traffic lights.

This phenomenal accomplishment of a truly one-of-its-kind project deserves worldwide recognition.

Principles of transparency and integrity

Communicating openly with the community and communicating within the project teams was critical to the successful delivery of this complex project.

Working with the community: From the early planning stage of the project, a robust and transparent community engagement program was very high on the Government’s agenda. The project team worked hard to plan a solution that met community requirement while managing the vast engineering elements. A community centre was opened in a local
shopping centre, providing a drop-in centre for local residents. Here, the public could access key information about the project, construction programs, information on construction techniques, view replica models of the site, watch the interactive flythrough videos that were created. The centre was staffed by members of the project team who had direct project knowledge and insights, enhancing the quality of the information made available to the community...

The area which the project ran though was a high density, suburban area which had a number of traffic “black spots”. Through a carefully considered engagement program which involved the community, these issues were largely overcome. The magnitude of the achievement and benefit to the community was echoed by the then Queensland Premier’s endorsement: “Once the worst congestion black spot in Queensland’s South East, construction work since April 2009 has seen the problem solved a year early.” (Anna Bligh).

A transparent team: From a project perspective PBA was located onsite with the Thies John Holland Design and Construction team and supported by local, international and subconsultant offices. The challenge of ensuring appropriate data control, communication and interface management required a supreme effort — a challenge we were able to meet through a rigorous approach and our close working partnership with our technology providers where technology solutions were customised to ensure the best possible outcome in terms of being able to deliver cutting-edge design solutions, improving work flow, maintaining the quality and accessibility of data and minimising any issues or errors...

On average 30 packages of work were delivered for review or approval each week. The team at its peak consisted of 500 people, of whom around half were based in the site office, while the remainder operated remotely from 20 national and international offices.

Packages identified for remote design were generally developed by the remote office package lead in the site office to a level where interface issues were resolved, and then package leads returned to their home offices to complete the detailed design. Technical leads from within the site-based project team regularly visited each of the remote offices to provide training, quality reviews and guidance.

The project made extensive use of Bentley’s range of products available through Parsons Brinckerhoff’s global arrangements. The effectiveness of the technical and management processes implemented by the project were recognised when it received the Bentley ‘Be Inspired’ global project of the year award in late 2012.
**Sustainability and respect for the environment**

Ground-breaking both above and below ground, Airport Link delivered on its sustainability commitments and provided an economic and social legacy for Brisbane.

The PBA design solution essentially ‘buries’ all the large, heavy traffic movements, leaving a surface solution for local movements to cater for buses, pedestrians and cyclists. Design innovations will alleviate potential noise and visual impacts, delivering positive overall benefits to the broader community.

The key sustainability and design features of the project included:

- Avoiding 18 sets of traffic lights which achieves a carbon reduction
- Busway efficiency improves patronage and reduces carbon emissions
- Baseline monitoring was undertaken for operational traffic noise in early 2008, six months prior to the start of construction – within 12 months of operation commencing, a comparative study was undertaken to confirm that traffic noise remains compliant with noise goals from the Queensland Department of Transport and Main Roads
- Ventilation station outlets have been designed to achieve acoustic goals when in full operation so as to not adversely affect community members in nearby properties.
- Airport Link is designed to provide a safe driving environment for motorists – as the tunnel will carry thousands of vehicles per day, maintaining the quality of air both in and outside the tunnel is an important part of day-to-day operation
- Sustainability outcomes achieved on the Airport Roundabout Upgrade include incorporation of temporary works into permanent design particularly prehead nailing, drainage and pavements, and reuse of existing materials particularly pavement rehabilitation.

PBA’s approach to this project was to build excellence and innovation into every element so there was a full integration and compatibility of engineering and environmental solutions and urban design outcomes.

Some of the key environmental aspects of the project included:

- The toll-road tunnel utilises the most up to date traffic technology to provide Brisbane’s road users with ‘real time’ information.
- Motorists can expect to travel the length of the tunnel in four to five minutes, cutting out up to 18 sets of traffic lights from Bowen Hills to the Airport, significantly reducing travel times.
- 3.6ha of land as new parklands and improved bicycle paths, and reduction in suburban through traffic with major air quality and road safety benefits.
- The tunnel itself is arguably the safest tunnel in the world with state ventilation and emergency equipment – the ventilated tunnel provides for the efficient disbursement of vehicle fumes providing improved air quality to local residents.
- The ventilation station at the Eastern Connection is a huge building over 100m long, 40m wide and 7.5m high. It houses the jet fans that ventilate the AirportlinkM7 tunnels during operation and in the event of a fire. To minimise the impact on the local community, the ventilation station was built entirely 10m underground except for the outlet building that underground greatly improved the urban environment of the area and provided a parkland connection between Sandgate Road and Kalinga Park. Its concrete walls 1m thick have also mitigated the noise generated by the jet fans inside the building.
- One of the unique urban design features of the Eastern Connection is the living green wall – a vertical garden – covering the portal walls connecting the East-West Arterial to the AirportlinkM7 tunnels. The living green wall is the largest of its type in Australia and will become an important signpost for local and international visitors as they head towards the sub-tropical city of Brisbane. The wall spans 155m along both sides of the portal and is up to 4.5m high. The design uses 65 different species of plants in 44 different arrangements.