Case Study

Increasing Construction Productivity through Risk Management and Technology

Brisbane Airport Link Project, Australia

Site Profile

At a total of $4.8 Billion Brisbane's Airport Link Project is Australia's biggest road infrastructure project.

Scheduled for completion in mid 2012 the 6.7kilometre underground toll road will connect Brisbane's central business district, and the Clem Jones Tunnel (CLEM7) to the East-West Arterial Road leading directly to the Brisbane Airport.

It will be the first major motorway to link Brisbane city to the northern suburbs and airport precinct, allowing motorists to avoid up to 18 sets of traffic lights.

The Situation

Orica Mining Service's expertise in controlled blasting technology was called upon by the project leaders, Thiess John Holland (TJH), to clear large areas of rock which was too hard for mechanical rock breakers to work efficiently.

TJH sought Orica's advice to come up with a solution to excavate 30,000 cubic metres of hard massive volcanic tuff from the site of a critical tunnel portal, right next to a major arterial road, heritage listed buildings, a church and a three story office building.

Heritage listed buildings & Church only 70 metres from the site

The task was all the more complex because it was located in the middle of a busy construction site and tunnel portal that had to remain open 24hrs a day. There were strict vibration limits applying to the large concrete soil mix and secant pile walls adjacent to the site, and the adjacent privately owned and heritage listed structures.

These issues were managed while complying with the site's strict environmental limits and reducing the effects of blasting operations on nearby residents.

Blasting close to critical works, the tunnel never stops

Risk Management

The local rock mass was hard massive volcanic tuff which exceeded 200 MPa in some areas.

Areas of the pit had been hammered with rock breakers to refusal, and a design had to be developed that would break the rock and at the same time address the risks associated with blasting in this tight environment.

The first step was to prepare a detailed risk assessment and work method statement to fully understand and address the unique blasting requirements of the site. This risk assessment was then mapped to TJH's Safety Management System and used to develop a blasting management plan for the site.

Case Study

Increasing Construction Productivity through Risk Management and Technology

Brisbane Airport Link Project, Australia

Orica's technical services personnel worked closely with TJH during the design phase to research the maximum tolerable vibration levels at the nearby receivers, the vibration transmission characteristics of the ground, and the potential travel distance of flyrock.

Prior knowledge of sustainable vibration levels when blasting next to sensitive structures were incorporated in the blast design. Flyrock projection and scaled depth of burial calculations were completed to assist in managing the risk of flyrock.

The Orica Blast Controller worked with TJH on multiple levels to develop a detailed clearance procedure for the area so that each blast could be fired safely and efficiently with the safety of the community and impact on associated works being the major priorities.

So exacting were the customer's requirements that each blast could only be fired during a 45 minute window, and the adjoining major arterial roadway could be closed for no more than three minutes.

Aerial photo of the community surrounding the blast site

Technical Solutions

Several conceptual blast designs were modeled using Orica's propriety software. The SHOTPlus™-i Pro program allowed blast designers to run multiple iterations and consider the fragmentation and blast induced vibration of each design.

Once the designs and safety management plans were verified by an independent consultant and approved by TJH, Orica supplied a Rock on Ground service which included blast design, drilling, explosives supply, Shotfiring and the Blast Management expertise to supervise and conduct the blast clearance for a total of twelve blasts.

Centra™ Gold being delivered into a tight blast area

The design called for the use of the Centra™ Gold Bulk System. Centra™ Gold is a chemically sensitized, variable density product with a bulk strength of 165% relative to ANFO.

This high energy, water resistant pumped emulsion blend gave the blast designer the flexibility and energy required to break the hard massive volcanic tuff, while being significantly less costly that packaged emulsion explosives typically used in this application.

Centra™ Gold is specifically designed for small diameter quarry and construction blasting applications in both wet and dry conditions, and is intended for use where charge weight and total energy needs to be managed.

Centra™ Gold is delivered by Orica in purpose built Mobile Manufacturing Units (MMU®). Centra™ Gold is manufactured on the MMU® and pumped into blastholes on demand. To manage vibration Orica

developed a method to deliver charge weights to a precision of 1 kg.

The delivery flexibility and energy of this product allowed Orica to work within TJH's strict production schedules and significantly improve their productivity.

Orica shotfirer shows TJH foreman the i-kon™ system

Advanced Vibration Management

Conventional blasting methods would have required firing one small blast every afternoon. With each blast requiring road closures, shutting down the worksite, and evacuating the adjacent three story office building adjacent, the daily disruption to workers and neighbors would have been considerable and costly.

Orica and TJH worked together to develop a unique method to fire large blasts every four days instead of a small blast every day, and thereby reduce the overall number of blasts required to complete the project. The innovative method involved loading blastholes with up to five individual explosive decks with each charge firing separately to control vibration levels. A maximum instantaneous charge weight of 4kg was derived from measurements taken from blasting in Brisbane Tuff nearby to the Kedron site. With this low charge weight, decked loading was required to achieve the energy distribution necessary to effectively break the rock.

The initiation of large, decked blasts was only made possible by using the i-kon™ Electronic Blasting System. This electronic detonator provides accurate, flexible and reliable sequencing and also ensures the user has 2 way communications with the detonators up until the moment of firing.

The i-kon™ X-414 armored detonator and PPX 200 booster were used as the primary initiation system for this section of the Airport Link project. The X-414 detonator which has an armored shell was selected for this project due to its high resistance to dynamic shock desensitization which can be experienced in decked loading applications.

Orica's i-kon™ System enabled engineers to design the blasts with precise control over the maximum instantaneous charge, and the designed firing sequence. i-kon™ offers fully programmable detonator delays between 0 and 15,000 milliseconds.

Blasting in this environment required novel timing techniques to reduce adverse affects on the public and surrounding worksite. The engineer designed a firing sequence intended to generate vibration frequencies in excess of 35Hz with many of the blasts recording a frequency of over 100Hz. At these frequencies the displacement of the sensitive receivers was less than 0.05mm thus eliminating the possibility of damage to the surrounding structures.

The Result

All twelve blasts were fired on time with no delays, under the management of an Orica Blast Controller**,** 12 blast sentries, four traffic controllers and four police officers.

The project was an outstanding example of Orica's capabilities in:

- Managing the risks of using explosives in a large, busy urban construction project;
- firing large blasts to reduce disruption to other activities on the site and surrounding roads;

- 3D computer blast design using SHOTPlus™-i Pro, to meet precise excavation tolerances
- Precise loading of bulk explosives down to 1 kg, to manage vibration cost-effectively.
- Vibration management, frequency channeling to reduce displacement.

All shots were successfully fired and excavated, with vibration and overpressure readings well under the compliance limits.

Testimonial

“Controlled blasting was the solution on this project, allowing TJH to improve the productivity of its rockbreakers and excavate this critical site while protecting the sensitive nature of the site surrounds,” said Earl Alcon, TJH Senior Project Engineer.

Acknowledgments

Orica would like to thank TJH Site Management and staff especially Adam Haber, Steve Bowering, Earl Alcon, Cobus Rossouw, Gary Todd and Travis Simpson for the opportunity to assist with site efficiency improvements and vibration control.