Case Study
Tunnel Drill and Blast Feasibility
Brisbane City Legacy Way Project

Site Profile

The city of Brisbane is undergoing a transformation with a number of significant infrastructure projects. One of these is Legacy Way (formerly the Northern Link) that will be formed using a combination of excavation methods including tunnel boring, cut and cover and some blasting of cross passages and substations. The geology is predominantly a phylitic rock mass with foliation and jointing that decays with depth. The cost effective, timely and safe development of key infrastructure is critical to meeting the future growth requirements of the City of Brisbane.

The Situation

Orica Mining Services input was sought on the possibility of using drilling and blasting to excavate the majority of the tunnel. Tunnels in many countries routinely use this method of excavation. For example, in central Stockholm blasted tunnels are being constructed presently for both road and rail use. These are being constructed adjacent to historic buildings and vibration-sensitive equipment. A successful demonstration that drilling and blasting could be conducted within the required vibration limits would enable the contractor to compete against alternative excavation methods in a safe, cost-effective manner.

Technical Solutions

Orica Mining Services proposed a blast evaluation study that focused on the likely vibration levels that may be expected in drilling and blasting the tunnel.

The field work conducted at three sites along the proposed tunnel line involved the firing of 46 individual charges below the ground and had masses between approximately 400 grams to 1600 grams. The ground vibrations produced by the charges resulted in 468 triaxial recordings at distances between the charge and the monitor locations of approximately 15 to 288 metres. A vibration recorder (orange box) and the associated accelerometer mounted in soil are shown below for one of the sites.

The data collected is aggregated for blasting at each site so that any site specific properties such as base vibration levels and their attenuation may be determined.

A data set for one of the sites is shown below. The data is a log-log plot and is used to produce a charge weight scaling law for the specific site. The red line is the 95% confidence line below which it is expected statistically that most of the vibrations will lie.
The charges were representative of the planned tunnel blasting parameters and were initiated using Orica’s i-kon™ electronic delay detonators to provide precise controlled timing.

The Result

The field results from the three field sites were combined to produce a global charge weight scaling law. The charge weight scaling law predicted that a charge of 4.3 kg is required to produce a 25 mm/s vibration at 40 m. This limit is identified in Australian Standard AS 2187.2-2006 as appropriate for occupied non-sensitive sites, such as factories and commercial premises. This charge weight is suitable for advancing the tunnel at up to 5.3 metres per blasted round. Such round lengths for the drilling and blasting would deliver excellent tunnelling rates that would minimise the construction time of the tunnel. Table 1 shows the predicted advance per blasted round for two possible blasthole diameters and two explosive densities that maintain a 25 mm/s vibration limit.

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Density (g/cc)</th>
<th>Charged Length (m)</th>
<th>Advance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>0.8</td>
<td>4.7</td>
<td>5.3</td>
</tr>
<tr>
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</tr>
<tr>
<td>45</td>
<td>1.0</td>
<td>2.7</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Table 1. Predicted advance per round assuming 40 m cover and 25 mm/s limit

The blast evaluation study by Orica Mining Services gave practical values and guidelines to the consortium on what levels of vibration to expect from tunnel blasting in the Brisbane city region. This enabled drilling and blasting techniques to be fully evaluated against excavation by alternative means such as tunnel boring.

Acknowledgements

Orica Mining Services acknowledges the support given by the consortium during the study.