



MANAGING BLAST VIBRATION AND INCREASING TUNNEL ADVANCE RATES

CASE STUDY

THE SITUATION

To address the issue of flooding in Toyota City in Japan, Kajima Corporation were contracted to excavate the Anei River Tunnel – an 85 square metre, 1.86 kilometre long tunnel – to increase drainage capacity from 10 cubic metres per second to 90 cubic metres per second.

The initial plan was to excavate the Anei River Tunnel by mechanical means but the granite rock proved too hard for this method. Blasting was the obvious solution for such hard rock however the tunnel ran directly beneath a residential area. The project's Licence to Operate (LTO) depended heavily on the acceptance of construction activities by the City of Toyota and its residents. Blasting in the Anei River Tunnel commenced with a local supplier's pre-programmed delay detonators. Kajima received numerous complaints from neighbours about the blasting activities. Attempts to lessen the impact of blasting by reducing the Maximum Instantaneous Charge (MIC) were costly for excavation productivity and did not eliminate complaints.

SITE PROFILE

Toyota City is located in north-central Aichi Prefecture, Japan. It is home of the car manufacturing giant, Toyota, hosting the global head office, technical centre and several key manufacturing plants. Some low lying areas of Toyota City are prone to flooding. The Anei River, which was built in the 1700s, is the existing water course which drains flood water from these areas, however at times of heavy rainfall flooding still occurs.





TECHNICAL SOLUTION – MANAGING VIBRATION

Kajima approached Orica for a solution that would reduce vibration enabling them to maintain their LTO. Orica proposed the eDev™ II Electronic Tunnel Blasting System. The accuracy of the system combined with Orica's SHOTPlus™ T software for design, modelling and vibration analysis allowed Kajima to customise their initiation sequence to suit the environmental requirements.

By programming blasts to produce shorter duration, higher frequency waveforms, the public perception of the blasting vibrations improved significantly. In direct consultation with neighbours, the engineering team also developed a technique dubbed "knock the door". This refers to firing three distinct charges, representative of knocking on the door, to give prior notice before firing the entire blast in less than one second.

ADVANCED TECHNICAL SOLUTIONS – INCREASING ADVANCE RATES

With the eDev™ II Electronic Blasting System in place, it became evident that the project could be accelerated to further reduce the impact on neighbours. The user-friendly delay-by-numbers system, coupled with the wide range of available delays gave scope for the team to employ a rarely used "multi-deck" technique, firing two blasts as one. By extending the drill holes to twice their normal length, multiple charges were loaded within a single blasthole. Each charge was assigned a unique, individual firing time specifically designed to create frequencies and peak vibration consistent with a conventional blast, while firing two blasts in one. This method substantially increased the advance per round and reduced the total number of blasts required to complete the project.

THE RESULTS

The initial introduction of eDev™ II reduced the impact on neighbours and allowed a productive level of blasting to continue. The system's simple delay-by numbers user interface and safe at-face testability meant the system was quickly adopted by the existing blast crew.

Following the introduction, Kajima's technical team realised much greater value in the eDev™ II system as an enabler for advanced blasting techniques. With support from Orica's Global Technical Team, Kajima fired Japan's first ever Multi Deck Tunnel Blast in September 2013, achieving an astounding four metre round with an MIC of only 0.8 kilograms compared to the standard of two metres when using the conventional blasting technique.

Refer to <http://www.orica.com/eDevII> for further detail on this project.

KEY OUTCOMES

- REDUCED IMPACT ON LOCAL COMMUNITIES
- ADVANCE PER ROUND WAS DOUBLE THE CONVENTIONAL METHOD

"If we only consider the cost of explosives the use of eDev™ II would be difficult to justify. However we must also consider the impact we have on the communities in which we operate along with our overall efficiency and time to completion. At the Anei River Tunnel, eDev™ II allowed us to minimise disturbance to our neighbours while blasting operations continued. Further, by employing the Multi Deck Tunnel Blasting technique we fired fewer blasts, which resulted in fewer opportunities to disturb our neighbours and we also realised increased productivity in other aspects of the tunnel cycle."

Mr. Koshikawa
Project Manager
Kajima Corporation