TECHNOLOGY

Avoiding the faults

Using roadheaders on the New Irvington Tunnel avoided possible boring-machine mishaps associated with seismic ground conditions

Antraquip roadheader

The New Irvington Tunnel

Location:	Sunol Valley/ Fremont, California, US
Construction schedule:	July 2010 to November 2015
Cost:	US$339 million
Tunnel length:	18,660ft or 3.5 miles
Depth:	From 30ft to 700ft
Cement grout:	7.8 million pounds
Finished int. diameter:	8.5ft

A water tunnel designed with earthquake-resistance in mind was completed at the end of last year and is now in service.

The New Irvington Tunnel now conveys drinking water to 2.6 million people in the Bay Area around San Francisco, California. Construction on the project reached substantial completion in September and was completed in November, San Francisco Public Utilities Commission (SFPUC) says.

The New Irvington Tunnel Project completes the last three tunnels in the agency's US$4.8 billion Water System Improvement Program (WSIP), creating a critical water lifeline able to withstand earthquakes on the Hayward, Calaveras and San Andreas faults.

Located between the Sunol Valley and Fremont, the new tunnel provides an 'earthquake-proof' connection between water supplies from the Sierra Nevada Mountains and the Alameda Watershed to Bay Area water distribution systems.

It serves as a rigid alternative to the existing tunnel and allows the SFPUC to take the existing tunnel out of service for overdue maintenance and repair.

The tunnel will carry approximately 90 million gallons (341 million litres) of water a day on average during normal operating conditions when both tunnels are in service. There is an additional 90 million gallons of water per day flowing through the existing tunnel.

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The tunnel was constructed by the joint venture of Southland Tutor Perini, which began tunnelling in March 2011.

The New Irvington Tunnel near San Francisco is an example of excavating a longer 3.5-mile (5.6km) tunnel with roadheaders instead of a TBM. Because of the number of fault zones, a TBM would have run the risk of getting stuck in the squeezing ground normally associated with these fault zones.

The tunnel was successfully excavated by two Antraquip AQM 150-HR roadheaders, equipped with a special 360° rotating drilling attachment, allowing the machine to work either as a roadheader or drill, as well as a Mitsui Miike 200 roadheader. The material encountered had a UCS of up to 17,000psi (1,172bar).

Below, Karl Mitterndorfer, president of Antraquip, explains more about why roadheaders can be the best choice for tunnel construction.

Success on the short trip

Roadheaders are the preferred and most economical way to excavate shorter tunnels as long as the geology is favourable for mechanised excavation.

Roadheaders are relatively easy to mobilise and manoeuvre in the tunnel, making them the economical solution, not just for short tunnels, but also for tunnels requiring change of direction/turns. Roadheaders are available from 13t operating weight to over 135tons, with cutting power of 30kW all the way up to 400kW.

Naturally, the higher the cutting power, the harder the rock can be cut and the greater the excavation rate. The heaviest machines can cut rock with a UCS of up to 30,000psi.

Longer tunnels (over 2 miles in length) are normally most efficiently excavated with tunnel boring machines (TBMs),

unless the geological condition is unstable and frequently changing and shifting which can cause serious problems for the TBM.

Making the best choice

This is a matter of efficiency and safety. Efficiency refers to the combination of speed and precise excavation relative to price of machine and operating costs. Safety is a function of the operating conditions being safe for the crew, as well as minimising the risk of damaging structures or harming people within the surrounding area above or near the tunnel excavation.

Utilisation of roadheaders minimises such safety concerns within and around the area of the tunnel, especially in comparison with drill and blast. This is especially important in cities or when excavating underneath existing buildings or structures.

Additionally, given the proper rock conditions, the use of roadheaders is up to three times as efficient as drill and blast.

Learning curve

Naturally, everything starts with the best training available. No personnel without special training conducted by the machine manufacturer or contractor should ever be allowed close to a roadheader.

All operating and service recommendations by the machine manufacturer must be strictly followed to ensure safe operation and to minimise down time on the machine. During operation safety is the most important thing for every operator to keep in mind at all times.

There is of course a learning curve involved with the operation of a roadheader, so naturally productivity and efficiency will increase as the operator becomes more experienced.

It is important to know, as exact as possible, the rock you will encounter. Basic roadheaders, dependent on their size, can only cut rock up to a certain hardness. Plan ahead and add either a drill attachment or a hydraulic breaker option, if there is the danger that the material is getting much harder. Do not drive standard roadheaders against a rockface that is too hard.

Improving technology

Roadheader innovation in recent years has focused on increasing reliability and versatility in ever changing geological conditions.

The reliability changes are often not seen from the outside but improved design achieves the goal of reducing down time in the challenging application of tunnel excavation.

Versatility has been increased by adding technology and features that allow the contractor to adapt to rock conditions. Some examples include:

- An additional drill boom mounted on top of machine, so that the roadheader can either be used for cutting rock or for drilling and blasting or for forepoling;
- A hydraulic breaker option;
- Interchangeable cutting systems (transverse to inline/axial and vice versa);
- Radio remote control;
- Automatic guidance systems;
- Hydraulic steel support installation systems mounted the roadheader;
- Improved dust control systems installed on machines; and
- Integral roof bolters.

Antraquip is in the process of upgrading its AQM 200 and AQM 260 models.

This page: images of Antraquip roadheaders, including one (left) fitted with the optional drill-boom attachment on top