Wadi Muddiq to Gillay Tunnel

Client: Ruler of Sharjah
Contractor: Six Construct - Overseas AST JV
Location: Sharjah, UAE
Products: Special Formwork

The Wadi Muddiq to Gillay mountain tunnel is part of a new highway scheme that will ultimately link the city of Sharjah in the UAE with the coastal town of Kalba. Cut through the heavy rock of the Al Hajar mountain range, it is the longest road tunnel in the region. Here, David Barrington, RMD Kwikform Middle East’s Sharjah-based engineer responsible for the project, describes his company’s formwork solutions.

The Al Hajar mountain range forms a formidable spine running from the northernmost tip of the Arabian Peninsula, and on down into Oman. It runs parallel with, and a few kilometres inshore from, the eastern coast of the Emirate of Sharjah and is a natural barrier between the Gulf of Oman coastal towns, cities in the east and the capital city, some 100 kilometres due west on the Persian Gulf.

Kalba is one of the more prominent of these cities and is just ten kilometres north of the border with Oman. As part of a major scheme to end the remoteness of the region, increase the prosperity of the nearby valleys and shorten driving time to the capital, a highway is being cut through the mountains and across the plain beyond - it will shorten the Kalba to Sharjah journey by approximately 30 kilometres.

The tunnel connects the Al Badeeq and Al Qula’ei valleys, linking the Al Hilw valley with Kalba city, where the mountain range peaks at some 750 metres above sea level. The tunnel entrance is 484 metres above sea level. Both the excavation and formwork engineers had to contend with ground and rock conditions that had been adversely affected by years of hydrothermal alteration.

The elliptical cross section tunnel, which is known as the Wadi Muddiq to Gillay tunnel, is 1,270 metres long, with the tunnel opening having a 110 square metre profile. 1,150 metres are cut through the mountain; 40 metres to the west, and 80 metres to the east are cut-and-cover construction.

Around-the-clock digging operations started in May 2001 - ultimately resulting in the removal of 150,000 tonnes of rock and sand - and continued at a rate that, on occasions, exceeded nine linear metres a day. On completion, the tunnel used 20,000 tonnes of reinforced concrete. RMD Kwikform’s formwork erection started in November 2001, following design work that was undertaken during the late summer months.

The project was undertaken by a joint venture between Six Construct and civil and marine engineering firm, Overseas Ast Company. Halcrow was responsible for the design and construction supervision of the project. The tunnel’s construction called for solutions that would provide support both inside the tunnel and externally for the cut and fill east and west portals. A major consideration was to devise an internal formwork solution that would enable concreting within the tunnel to achieve a cycle of 50 metres every seven days.

Although utilising a substantial number of standard components, the Wadi Muddiq to Gillay tunnel also demanded a number of bespoke solutions for its successful completion. These included special radiused steel channels that were used in conjunction with standard Alform aluminium beams and plywood form facing for the portals. Most significantly, the project also called for a purpose-designed, hydraulically operated tunnel lining traveller, which was developed from RMD Kwikform’s experience gained on similar tunnel projects elsewhere in the world, such as the E18 highway tunnel in Vestfold, Norway and the 200-metre long Buranda tunnel in Brisbane, Australia.

The RMD Kwikform solution for the Wadi Muddiq to Gillay tunnel comprised of three major elements:

- Standard Alform aluminium beams and accessories for the external formwork for the tunnel.
- Purpose made steel-faced ‘kicker’ formwork.
- Purpose made steel-faced travelling formwork for the tunnel lining. At its maximum, the Wadi Muddiq to Gillay tunnel measures 12.3 metres wide and 8.8 metres high, and there was a requirement...
to provide a five-metre by five-metre central void at road level to enable site and excavation traffic to pass through freely and safely.

The way in which this was achieved was that, prior to pouring the horseshoe shaped tunnel lining, one-metre high concrete starter walls or ‘kickers’ were first poured at either side of the tunnel. To accomplish this, RMD Kwikform constructed five-meter long travelling forms.

These ‘kickers’ performed two functions. Their flat, horizontal base provided temporary support for the rail track on which the main tunnel formwork was moved; they also formed the permanent bottom kerb of the tunnel lining. The special internal curved steel facing of the formwork followed the shape of the tunnel.

The tunnel’s main travelling formwork - which was ten metres long and weighed in excess of 100 tonnes - moved through the tunnel on the rail tracks, driven by hydraulic motors as the digging proceeded. Indeed, all of the operations on the tunnel formwork, striking, moving and re-erection, were all fully hydraulically operated.

The travelling formwork itself was fabricated from structural steel, and was used in conjunction with RMD Kwikform’s high load capacity Megashor jacks at either end of the traveller, along with seven 165kN intermediate jacks along each rail track. These aligned vertically with hydraulic rams and turnbuckle spindles used to manipulate the formwork when the traveller was moved to the next position, after the concrete had cured. The main internal upright legs at either side, and either end of the travelling formwork, the cross beams and braces were of all of composite construction, built using rolled steel channels, angles and mild steel flats.

The outer panels against which the tunnel’s concrete lining was poured and the arch rib panels of the traveller were made in a number of sections, each with different geometry. The two base panels were then welded to the 1.2-metre long fixed base sections that aligned with the concrete edge “kickers”. The remaining sections were joined using special hinged plates that provided the formwork with the flexibility to allow it to be hydraulically moved into position and, subsequently, withdrawn from the concrete face after curing.

Access to the hydraulic rams and the working face was provided at either end of the traveller, and at the cross beam level - immediately above the five-metre clearance point - along with two other levels between the ground and the cross beam. Again this was a structural steel solution, but one that also utilised standard couplers and tubes for the guard rails.

Much of the travelling formwork for the Wadi Muddiq to Gillay tunnel was structural steel construction, such was the unique shape and complexity of the tunnel. However, the solution relied heavily on RMD Kwikform’s experience in heavy shoring and tunnel applications, and the company’s ability not to limit its thinking to standard products and systems when they did not represent the most cost effective or efficient solution.

A major milestone of the project, and for the RMD Kwikform traveller was reached in July 2002 - the 100th successful pour was undertaken, marking the completion of 1km of the tunnel length.

The remoteness of the project demonstrated the important role of project management, planning and formwork design. Tunnels can be among the most complex of formwork challenges, even when in accessible locations. They undoubtedly benefit from the ability to tap into the specialist global expertise RMD Kwikform has gained in the international construction industry.