EDITORIAL

There was a time when it was thought that Tunnel Boring Machines were not useful in difficult geological conditions particularly if there were sudden variations at short intervals. So, in the context of our country particularly for tunnels in the Himalayan region with its complex geological set up changing frequently and the number of shear planes, fault zones and flowing ground conditions present every now and then, Tunnel Boring Machines (TBMs) were never seriously considered.

The scene has changed now, partly because of the constant improvements and innovations in the design and construction of TBMs and partly because their performance around the world. Slowly but surely it seems that TBMs are entering into areas which were considered out of bounds for them, not so long ago. One such area was the large diameter tunnels.

According to the News items appearing in the press and technical presentations made on different forums, it seems that bigger and bigger diameter tunnels are now being constructed with the help of TBMs. Some of these tunnels recently constructed - or are under construction - are briefly mentioned below.

GERMAN SHIELD FOR MADRID MEGA TUNNEL

When built a few years ago, the German Earth Pressure Balancing Shield S-300 was one of the world's largest TBM with some unique features in terms of engineering. It was built to master one of the world's largest excavation diameter in challenging ground conditions, Herrenknecht engineers developed a unique cutting wheel concept for this project. It consisted of a 7m-diameter central cutting wheel and an outer cutting wheel, located on the same level, with a maximum excavation diameter of 15.20 m.

Both cutting wheels could be rotated independently in clockwise and anti-clockwise direction. For a controlled excavation of the ground and safe support of the tunnel face, three screw conveyors were integrated in the shield. Two large screw conveyors removed the ground of the outer cutting wheel to a conveyor belt in the rear. A smaller screw conveyor, installed in the bottom section, cleared the area of the central cutting wheel and removed the excavated material to the rear.

The Mega TBM and its superlative dimensions broke several records. The tunneling giant weighed 4,364 tonnes. It had a thrust force of 316,000 KN at 400 bar. The S-300 was a real power machine with an installed torque of 125,268 KNm. This was enough to lift a fully loaded Boeing 747, weighing 410 tonnes, with a 30 m long lever arm. The Mega TBM had one of the highest torques installed in a TBM.

The M-30 Madrid project was a worldwide unique pioneering project in mechanized tunneling. The inner diameter of the Spanish Mega tunnel was 13.45 m, providing three lanes for the heavy-weight traffic in one direction as well as sidewalks on both sides of the tunnel tube. Overburdens of up to 75 m above the tunnel alignment as well as pressures up to 6 bar put man and the machine to the test. The tunnel was scheduled for opening some time back.

SOME OF THE LARGEST SLURRY BORERS DIGGING NEW CHINESE LINK

Two of the world's largest tunnel slurry borers have been driving 9-kilometer-long tunnels under China's Yangtze River, in Shanghai. They are a key element of the 25.5 km Shanghai-Chongming Expressway. The link between Shanghai, Changxing Island and Chongming Island is to be completed in time for the 2010 Shanghai Universal Exposition.

At the Yangtze's estuary in Shanghai, one 15.43-meter-dia tunnel-boring machine set off from a shaft. The second, close on its heels, was also expected to drive 400 m a month through clay, silt and sand.

Shanghai Tunnel Engineering and Rail Transit Design and Research Institute designed the tunnel, supported by three other organizations – two of them from outside China.

Germany's Herrenknecht AG won the TBM supply contract and began delivering the main components, including cutting wheels. There, Shanghai Tunnel Engineering Company (STEC) fabricated heavy steelwork elements and assembled the TBMs, completing the first. It was later dismantled and rebuilt at its shaft 6 km away, to start work on the 7.5-km stretch.

Another Yangtze crossing was taking shape some 260 km upstream, at Nanjing. The first 14.93-m-dia slurry TBM for the 3.7-km crossing had arrived and was now at work. Herrenknecht was fabricating the second.

At Wuhan, some 900 km upstream from Shanghai, work had begun on the Yangtze's first tunnel. France's NFM Technologies SA delivered the two 11.38-m-dia slurry TBM for the 2.7-km bored section. Boring had begun and a mile of cut-and-cover work was progressing well.

NUMBER OF TBMs IN CHINA

It would appear from the above description that there were a number of TBMs working in China at present. Whereas the total number of TBMs working at present in China is not known exactly, but one can make a guess from the fact that Herrenknecht from Germany alone had supplied nearly 40 full-face TBMs to China. With other suppliers, the total would probably be more than 50, estimated an official with the manufacturer.

ONE OF THE LARGEST HARD ROCK TBM AT NIAGRA TUNNEL PROJECT

At the Rapid Excavation and Tunneling Conference in Toronto, Canada, held some time back, Doug Harding of Robbins Co. gave an update of the Niagara Tunnel Project. The project is a 10.4 km long, 14.4 m bored tunnel that will run under the City of Niagara Falls from the Upper Niagara River to the Sir Adam Beck power station. The completed project will enhance the capacity of the Sir Adam Beck power station by adding 500 cubic meters of water per second through the tunnel. The project has employed the world's one of the largest hard rock tunnel boring machine (TBM). The Robbins TBM called "Big Becky" is 14.4 m in diameter.

ROCK MASS CLASSIFICATION AND TBMs

Since a comparatively larger capital expenditure is involved in the use of TBMs, it is imperative that the geotechnical investigations are carried out as thoroughly as possible. Any hold up due to surprises such as the presence of dykes in between or squeezing grounds could lead to abnormal delays. The conventional Rock Mass Classification and the support system required needs to be modified to suit the use of mechanical excavation. Such attempts have already been made. Barton has already modified his system for TBMs.

THE SCENE IN INDIA

In addition to the tunnels required for the hydroelectric projects, TBMs have been used for the construction of Delhi Metro. TBMs are also being used at present in the ongoing work of Delhi Metro. As the experience accumulates, chances are that TBMs will be used more and more, particularly for the upcoming Metros of Bangalore, Chennai and Mumbai. There is a need to document this experience, rationalize it and draw the right conclusions to move forward.

I am sure the Journal of Rock Mechanics and Tunneling Technology would be more than happy to publish these findings and help document this experience in every possible way.

Best wishes

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