Titiwangsa mountains, Malaysia
Pahang Selangor Raw Water Transfer Project

Project

- Pahang Selangor Raw Water Transfer Project
- Tunnel of 44.6 km length x 5.4 m diameter through the granitic Main Range Mountains of the Malaysian Peninsular
- Most of the tunnel is being excavated using three hard rock TBMs
- Contractor: SNUI JV (Shimizu Corporation, Nishimatsu Construction, UEM Builders Bhd. and IJM Construction), www.snuijv.com

Duration

- TBM tunnelling started in November 2010 and will last till end of 2013 (estimated)

Task

- Seismic measurements besides probe drilling in all three TBM headings

Water for 7.2 Million Malaysians

It's the biggest infrastructure project of Malaysia. Once completed, this tunnel will transfer 27.6 cubic meters of raw water per second to a new treatment plant. The drinking water will supply about 7.2 million people.

Malaysia has experienced substantial economic development since the 1980s, resulting in increasing water demands in the commercial and industrial development centres. The Selangor / Kuala Lumpur region, which is the political, commercial and industrial centre of the nation, is the most important focus for these high demands which are expected to continue their rapid growth into the 21st century.

However, the water resources available within the Selangor / Kuala Lumpur region will not be able to meet the demands in the near future.

A scheme to transfer water from Pahang to Selangor has been proposed to cope with this water demand shortfalls. Pahang State, which lies to the east of Selangor State, possess ample water resources compared with their local demand and has sufficient reserve for interstate transfer.

Most of the new tunnel is being excavated using three hard rock TBMs. The extent of site investigation carried out along the tunnel alignment from the surface was quite limited given the topography with high overburden, up to 1,200 m. Once into the tunnel drives, serious problems including large breakouts, collapses, flooding and in-rush could arise as a consequence due to little or no warning of adverse

«We are driving long tunnels (3 TBM drives each exceeding 11 km in length) under high ground cover of up to 1,200 m in uncertain ground conditions with only a limited amount of site investigations carried out from the surface. All three TBM drives are critical to our construction programme. We have made very good experience with the use of TSP to get the geological uncertainties better under control. The TSP forecast is in good agreement with actual geological conditions.»

Pittard, Frank
Chief Geologist
SNUI JV, Malaysia

Challenges

- Bedrock along the tunnel consists of metamorphosed rocks of the Karak Formation for 3.5 km from the inlet. The remaining portion is in hard, abrasive granitic rock. Unforeseen fault zones partially with water ingress may result in hazard incidents.

Products Used

- Two systems of TSP 203*Plus*

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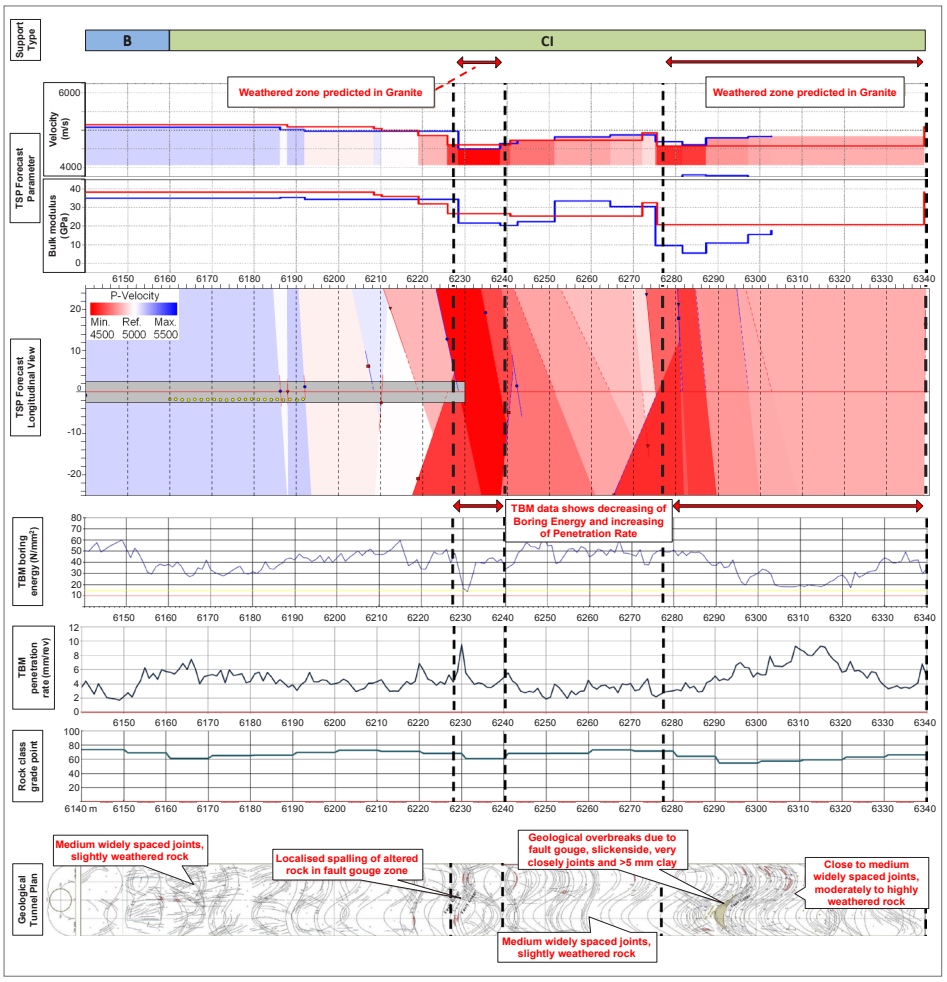
geological features. To overcome these drawbacks, the SNUI JV added seismic measurements besides probe drilling in all three TBM headings.
The actual TSP testing on site takes about an hour, and data processing a further two to three hours. The SNUI JV is logging continuously machine performance data via different sensors on the TBMs. It is desirable that the seismic predictions are directly related to TBM advance parameters, including penetration rate or TBM thrust forces. Exploring such correlations however, is ambiguous. The success of the SNUI JV's approach to using all available parameters to support the TBM drives and mitigate geological risks, can be assessed by comparing the forecast result of a TSP measurement taken in the TBM-3 drive in February 2012 and the later experience of geological conditions actually encountered. These are presented in the figure below.



TSP forecast, TBM data and compared geological findings

The graphs outline the developing of the TBM power consumption and its penetration rate. There is satisfactory correlation between the two parameters and the parameters derived from the seismic exploration data. However, a direct comparison of seismic exploration data with TBM data is limited by the circumstance that velocity changes are represented as step functions, whereas TBM data show also gradual changes. Gradual changes are almost impossible to image by seismic methods since a defined acoustic impedance contrast is necessary to record seismic reflection data.
"The prognosis of TSP correlates well with actual geological conditions," said Naufal Bakhudin, geologist with SNUI JV and one of the TSP operators. The first fault gouge zone, found at tunnel heading 6,226 - 6,240 m is indicated by changes in the TBM data as well. It was successfully detected by TSP as a drop in seismic velocity.

For further details feel free to download the complete report from our website: www.amberg.ch/at > Downloads > Tunnel Seismics > Brochures > Publications

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