SmartMeasures
Tough projects call for smart measures.

AmbergSeismics

China Railway First Survey & Design Institute Group Ltd., PR China
Baoji-Lanzhou Highspeed Rail Project

Project

- Baoji-Lanzhou highspeed rail project
- 401 km total project length including 272 km tunnels
- The second longest 14 km long Maijishan Mountain tunnel is classified as high-risk tunnel
- Excavation by drill & blast method

Contractor

- China Railway MajorBridge Engineering Group Co. Ltd.
- Company in charge for geological prediction: China Railway First Survey & Design Institute Group Ltd.

Duration

2013 - 2015

Task

- Seismic data acquisition, processing and evaluation and interpretation
- Detection of geological and hydrological conditions ahead tunnel face including fault zones, weak rock zones, waterbearing bodies, heavily jointed zones with hazards to tunnel construction due to rockfall, collapse and water rush-in etc.

China's ambitious railway network plan soon achieved

Reaching 12,000 kilometres of high speed railway lines soon, China will be becoming the world leader of high speed rail network allowing speeds up to 350 km/h. A very important passenger link is the Baolan Line currently under construction between the Cities of Baoji and Lanzhou. It will soon close one of the last gaps of the National Railway Network Plan "Four North-South and Four East-West Network".

The Baolan Line consists of 401 km of which epic 272 km comprise 74 tunnels to be built. With its 14 km, the Maijishan mountain tunnel near the city of Tianshui is marked out as a double-track tunnel in adverse geological ground conditions with up to 675 m overburden.

Geological situation at site location

The geological baseline study indicates a major fault zone (F6) at IDK739+400 ~IDK739+460±20 with strike and dip of N66°E and 65°S, respectively. The rock is dominated by crushed variable sandstones and partly crumbled mylonite surrounded by metasandstones from the upside of the Ordovician System. The fault is supposed to intersect the tunnel at large angle with great impact to the tunnelling work.

The TSP measurement had been conducted at face station IDK739+394, where the geology consists of crushed metasandstones classified as rock class IV. Breccias rock had been encountered in the surrounding of the tunnel face.

AMBERG TECHNOLOGIES

«The use of TSP 303 system from Amberg allows us to make prediction of adverse conditions like fault zones, lithological contact zones, karst development zones as well as water-bearing formations in front of the tunnel face more effectively and precisely thanks to the 3D analysis of the evaluation. Based on such analysis, we could enhance the prediction accuracy with regard to the strike and dip of the fault zone which helps us prevent accidents and guide construction method.»

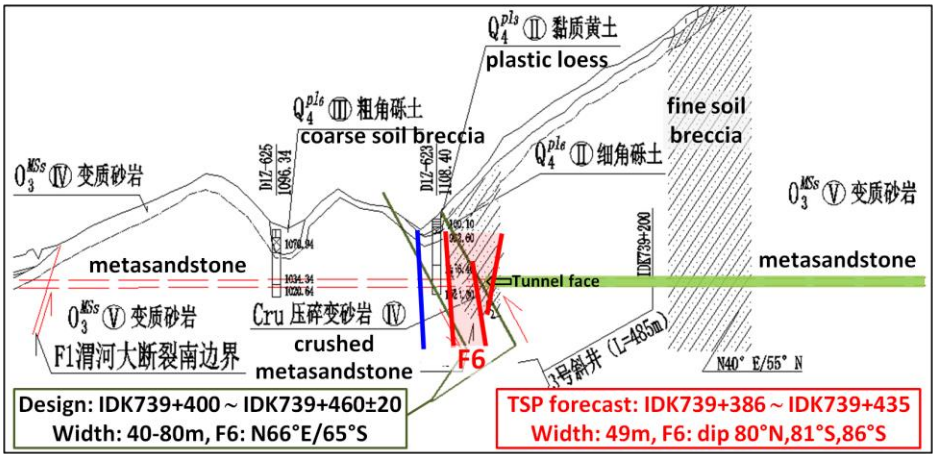
Li Youneng
Engineer
New Technology Division of China Railway First Survey&Design Institute Co., Ltd.

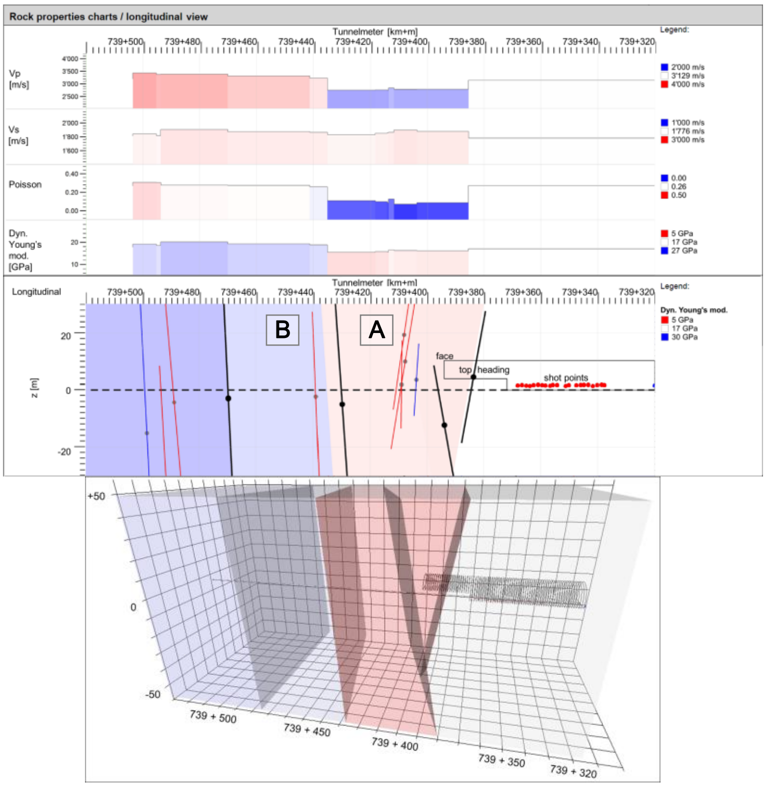
Challenges

- Adverse ground conditions
- Unstable rock behavior at tunnel face
- Fault zones ahead of tunnel face are expected

Products used

- One Amberg TSP 303 Plus System





Results of the TSP seismic prediction

Section A: IDK739+386~IDK739+435 (49 m), high reflector density is detected with a decrease in the P-wave velocity of about 400 m/s to Vp=2,770 m/s. The calculated Dyn. Young's Modulus is 15.6 GPa. This section is interpreted as a highly fractured fault zone, most probably crushed rock and crumbled mylonite tending to rockfall and collapse. Water-bearing is not being expected.
The location and properties of the fault, which dips between 80° (front) and 86° (back), is indicated in the longitudinal profile of the baseline study.
Section B: IDK739+435~IDK739+470 (35 m), compared to Section A, seismic velocities and other parameters increase up to Vp=3300 m/s and to a Dyn. Young's Modulus of 19 GPa. This section is interpreted as a fault-impacted zone with improved rock strength, most probably crushed metasandstones and medium developed joints tending to rockfall and collapse. It is assumed that this section is influenced by the previous fault zone. Crushed metasandstone prevails and the rock stiffness improves.

Conclusion

The finding after the excavation of the predicted section encountered a fault zone at IDK739+384, which was predicted over a length of approx. 50 m. The ongoing excavated rock conditions verified the ground image forecasted by the TSP measurement. The 3D analysis of TSP 303 not only predicted the adverse geological ground conditions ahead of tunnel face, but also the right spatial position.

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