TSP 203*PLUS* System
The solution for Tunnel Seismic Prediction

The TSP 203PLUS is the latest high-end technology based on many years of experience. This system solution is specifically developed for underground construction.

It evaluates seismic echo signals reflected from changes in the elastic rock characteristics normally associated with discontinuities in rock masses.

TSP 203PLUS provides accurate spatial information concerning the geology and rock mechanical properties in front of and in the vicinity of the face.

Success is in the details
- Practical system components
- Comprehensive measurement
- Expert software

Practical features of TSP 203PLUS
- Ready to measure within 30 minutes
- Prediction range from up to several hundred metres
- Can be used in both TBM and conventional headings
- Easy non-obstructing integration in the construction operation thanks to flexible application (face access not necessary)
- Spatial positioning of fault zones and potentially water-bearing features thanks to 3-component seismic sensors (P- and S-waves)
- Fully independent battery operation
- Built for the roughest site conditions

Further information about TSP 203PLUS from Amberg Technologies are available from your local distributor or by e-mail: geophysics@amberg.ch

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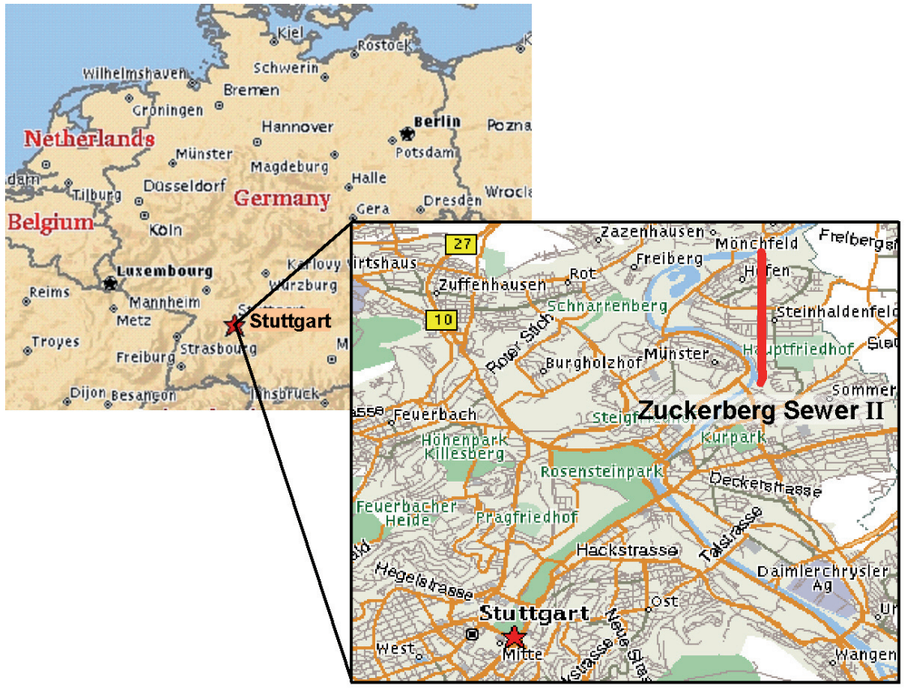
Project report TSP 203*PLUS*

Tunnel Seismic Prediction for karstic zones

Zuckerberg Tunnel – Project Sewer II, Germany



Location of the Zuckerberg Sewer II in the city of Stuttgart in southern Germany.

Project

In the framework of modernisation measures to the existing sewage plants the city of Stuttgart invested in the building of a second sewer under the Zuckerberg Mountain in order to convey mixed water through this 2747 meter long tunnel, with the old sewer being used for dirty water. The Zuckerberg sewer II has an average diameter of 3.4m and was being advanced from the north portal by open faced TBM.

The sewer crosses a ridge of Triassic hard rock (Lower Keuper and Upper Muschelkalk) superimposed by thin young soft soil. The limestone of the Upper Muschelkalk of 80m thickness is crossed by two almost vertically dipping faults. Besides minor phenomena of corrosion along single fracture planes no indication of karst phenomena inside the limestone sequence had been given from previous investigations. The sewer entirely runs through this limestone

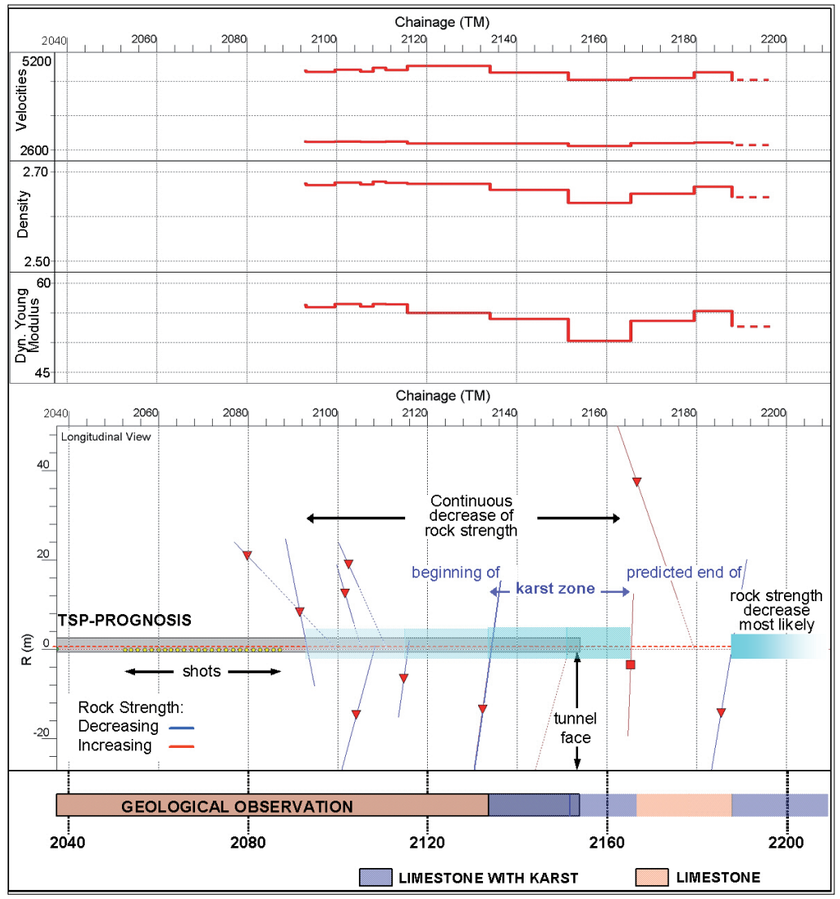
Problem

The TBM heading encountered unforeseen problems due to some karst zones and zones of tectonic disruption, which abruptly came in without any previous notice. The length of the fracture zones passed ranged between 10m and 30m, where boulders were torn from the rock mass by the turning cutter wheel due to poor formation strength. These enormous overbreaks resulted at the tunnel face forced the site personnel to cut loose boulders manually in various cases. At tunnel face station TM 2134 because of considerable overbreak a core drilling had been ordered, which required large-scale conversion work of the TBM. In conclusion, the 38m long horizontal borehole and two further vertical boreholes from the surface could not give any evidence of possible fracture zones.

Solution

The contractor decided to apply a TSP survey in order to predict a possible end of the current karst zone. The figure over page shows the longitudinal section image of the TSP survey conducted at face TM 2154.

Because of the unplanned TSP operation and lack of working space in the TBM backup area the receivers were located at TM 2037, 60m behind the ideal position. With 117m between receiver and tunnel face the interpretation range still extends some 70m ahead of the face. The TSP results firstly confirmed the front of the karst zone at TM 2134 and revealed the corresponding end at TM 2165, 11m ahead of the face. Moreover, it predicted a further decrease of rock strength from TM 2188. Due to the caved zones, poor geology conditions and the related high signal absorption no further seismic signal energy was possible to evaluate.



Graphical result output of the TSP survey and geological observation after excavation representing karst zones. The karst zones are indicated by the TSP result parameters of p- and s-velocities, density and dyn. Young's Modulus as well.

After start-up from the shutdown, the TBM left the karst zone at TM 2166 and encountered poor rock quality again at 2190 formation strength.

These enormous over-breaks resulted at the tunnel face forced the site personnel to cut loose boulders manually in various cases. At tunnel face station TM 2134 because of considerable overbreak a core drilling had been ordered, which required large-scale conversion work of the TBM. In conclusion, the 38m long horizontal borehole and two further vertical boreholes from the surface could not give any evidence of possible fracture zones.

Benefit

Because the TSP survey predicted a shorter range of karstic fracture zone the contractor decided to slowly continue the heading instead of planning and excavating an expensive bypass through the karst zone. Moreover, he was prewarned for a further decreased rock strength that enabled him to take appropriate logistic measures for the necessary reinforced rock support. Consequently, the contractor saved several days of TBM downtime and related extra costs.

Longitudinal section of geology forecast