SmartMeasures

Tough projects call for smart measures.

AmbergSeismics

Instituto Costarricense de Electricidad, Costa Rica
Extension Project of the Cachí Hydropower Plant

Project

- Cachí Hydropower Project
- Tunnel of 6 km length – in parallel and 50 meters next to existing tunnel that was being excavated 60 years ago
- Excavation with drill & blast method
- Contractor: Instituto Costarricense de Electricidad (ICE), www.grupoice.com

Duration

- 2012-2015

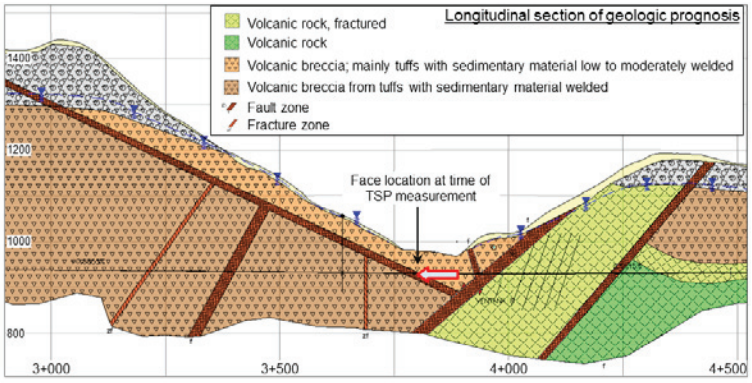
Task

- Seismic data acquisition
- Data control
- Seismic data processing
- Evaluation and interpretation
- Result verification and comparison with geologic observation

Enormous savings for 60% higher capacity

The hydropower plant Cachí had been constructed by the Costa Rican Electricity Institute (ICE) between 1962 and 1967. It was one of the first hydroelectric projects in Costa Rica with an installed capacity of 102 MW.

ICE currently expands the plant by additional access to Reventazon river with rising water inflow during the rainy season. The installed capacity of the plant will increase by 60 MW, while the works include a conduction tunnel of approximately 6 km length being excavated with the drill & blast method.



The extension involves excavating a tunnel parallel to the existing tunnel built in 1967. According to geological documentation of the prior tunnel, the overall quality of the massif could be seen as favourably though the excavated rock mass was composed of volcanic rocks with mainly weak characteristics revealing 15 fault zones. Temporary steel arches support of approximate 30% of tunnel length was being supposed.

AMBERG TECHNOLOGIES

«The use of Amberg technology, especially the tunnel seismic prediction, permitted us to see possible adverse conditions of excavations and take actions to minimize the risks. TSP helped us to obtain the results about the geological conditions in less time. This way we could take decisions on time and save money in comparison with our conventional process.»

Jorge Bonilla Morales
Senior Geologist
Instituto Costarricense de Electricidad (ICE), Costa Rica

Challenges

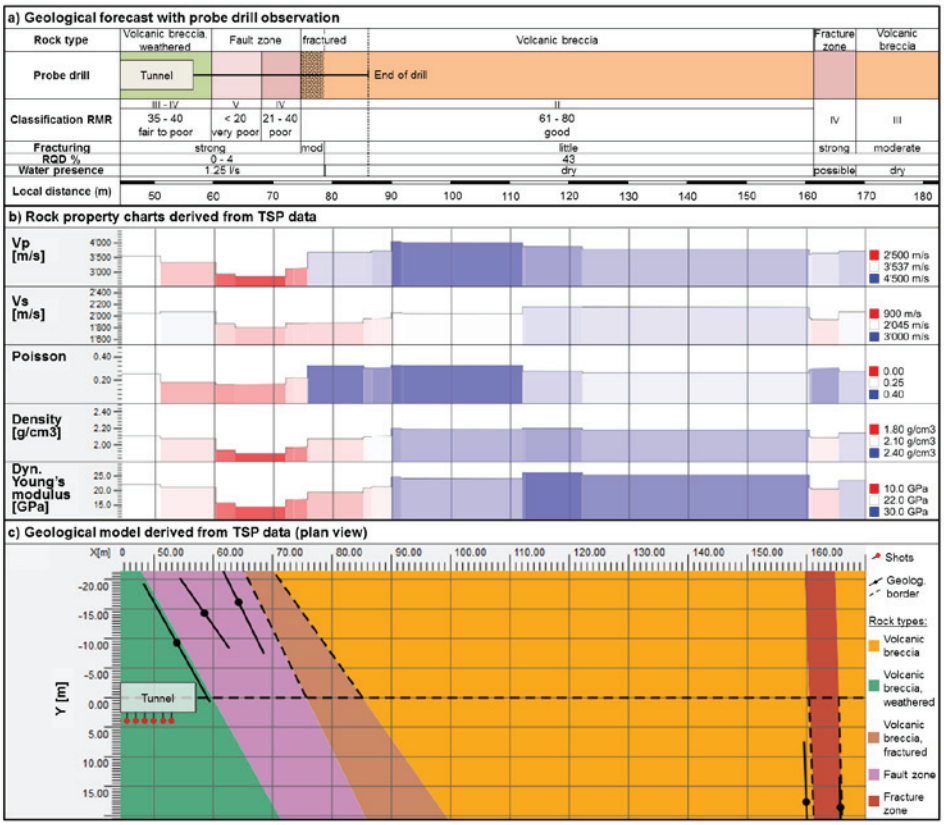
- Adverse ground conditions
- Unstable rock behaviour at tunnel face
- Rather poor seismic energy transfer

Products Used

- One system of TSP 303 Plus

Geological situation at site location

The geology in the seismic layout area from receiver location at Tm 3,852 to face at Tm 3,795 was dominated by weathered volcanic breccia with RMR class III-IV. Unstable rock behaviour at the tunnel face was being considered.



Result verification and comparison

Figure a) summarizes the geological forecast based on the 30 m probe drill ahead of the tunnel face. The ongoing forecast represents the extrapolation of the encountered geology of the parallel tunnel until meter 182. The already excavated tunnel and the first 3 m of the probe drill is placed in weathered Volcanic breccia where geomechanical rock conditions show fair to poor rock mass quality (RMR III-IV). From meter 60 to 75, an embedded Fault zone of poor rock mass quality (RMR IV-V) shows up followed by a 4 meter fractured contact zone. Behind, rock mass improves to good quality of Volcanic Breccia (RMR II) revealed by the probe drill to meter 87.

As illustrated in Figure b) the measured direct P-wave velocity of 3,540 m/s corresponds to a fair to poor rock mass of the weathered volcanic rock. Ahead the tunnel face at meter 60, P-wave velocity declines to 2,840 m/s – more than S-wave velocity (1,800 m/s) – and both considerably show the fault zone extended until meter 75. A contact zone between meter 75 and 90 indicates a strong fractured not weathered volcanic breccia. Within this transition zone, the ground (Dyn. Young's Modulus) changes to fair and good condition until meter 90. Good rock mass condition persists for about 70 m. About 100 m ahead of the tunnel face, at meter 161, the P-wave velocity drops slightly (from 3,760 m/s to 3,630 m/s), while the S-wave velocity drops stronger (from 2,150 m/s to 1,940 m/s) indicating a fracture zone of possible water bearing forecasted for this area. The geological model in Figure c) shows the plan view of the rock mass changes along the tunnel axis interpreted from TSP's rock borders and properties.

Conclusion

The seismic prognosis is in very good agreement with the geological findings of the probe drill and the further geological forecast. The result points out a fault and fracture zone as adverse ground conditions and confirms stable rock mass conditions between the fault and fracture zone, where heading can speed up again.

Contact

Amberg Technologies AG
Trockenloostrasse 21
8105 Regensdorf-Watt
Switzerland
Phone +41 44 870 92 22
geophysics@amberg.ch
www.amberg.ch/at

Made in Switzerland

AMBERG TECHNOLOGIES