STRESS MEASUREMENT COMPANY OY

In situ rock stress measurements from existing tunnels with the LVDT-cell

Advantages

- Robust, fast and reliable (*Fig 1*)
- Flexible, drilling is done with a compact drill rig
- Short boreholes – cost effective
- Verified quality in drill and blast tunnels
- Applicable for high stress conditions
- No gluing or hardening times
- Full service with one order

Description

- Five measurements around existing excavation profile yields full 3D *in situ* stress tensor (*Fig 2*)
- Basic layout in tunnel is to do two holes on opposite walls and three in the roof (*Fig 2*). In shaft or TBM-tunnel holes should cover half of the profile
- Measurement depth is 0.5 - 0.75 m from the tunnel wall in order to avoid the excavation damaged zone (*Fig 3*)
- Preferably the length of the measurement section is less than one tunnel diameter
- Method is applicable in good quality rock where at the minimum a 400 mm long pilot hole can be drilled in unfractured rock
- In the case of a drill and blast tunnel an uncovered surface and careful blasting is highly recommended
- Normally the overcoring technique is used but in high stress conditions core damage can be avoided by sidecoring
- Elastic parameters of rock are defined on-site by biaxial testing of pilot cores
- For the inverse solution a 3D surface model of the tunnel and measurement holes is built based on 3D photogrammetry (*Fig 4*)
- The full stress tensor, six unknowns, is solved based on 20 independent measurements hence increasing the confidence (*Fig 5*)
- The solution is based on tunnel scale numerical inversion representing a large rock volume (>1000 m^3)
- Regular field work time for one five measurement hole section is one week
- Quality control is performed for field work
- Professional quality reporting
- Over twenty measurements in Finland and Sweden performed between 2009 – June 2013

Technical data

- The minimum diameter for a measurement profile is 1.5 m
- The pilot hole diameter is 126 mm and 200 mm for overcoring or sidecoring
- Continuous logging of pilot hole convergences with eight LVDT-sensors (*Fig 1*)
- Normal logging interval is one second
- Measurement resolution and cell stability is better than one micrometer enabling high quality data
- Continuous logging of temperatures for rock, the probe and flushing water
- Continuous logging of drilling advance
- Requires AC 400 V / 16 A, water line (hose), four survey points (*x,y,z*) and scaffold to get access to the tunnel roof

Figure 1. LVDT-cell version II for a 126 mm pilot hole.

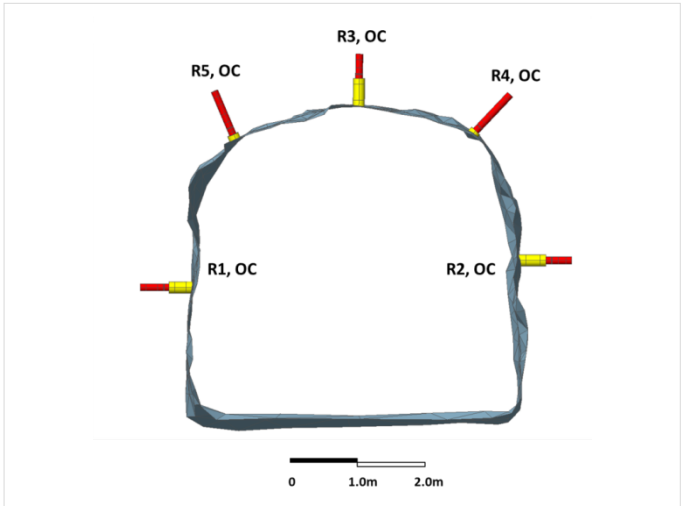

Figure 2. The basic layout for five overcoring measurement holes around a tunnel profile.

Figure 3. The LVDT-probe installed in a pilot hole and ready for overcoring.

Figure 4. A 3D-photogrammetric model of the measurement section.

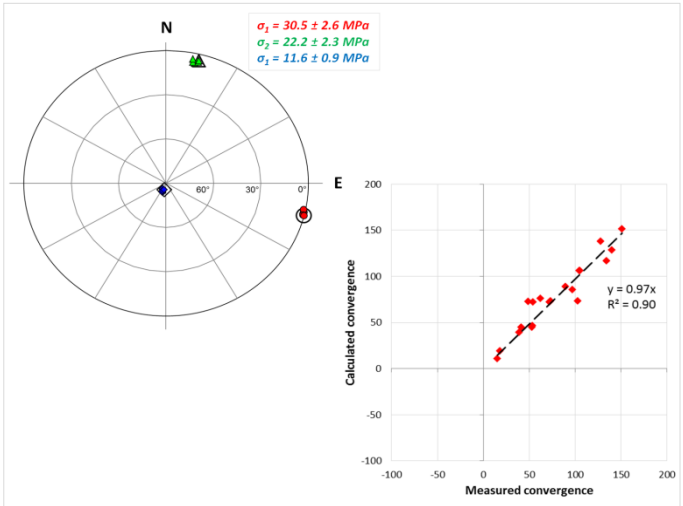

Figure 5. The interpreted *in situ* stress based on six different solutions (left) and the correlation between measured and best fit solution convergences (right).