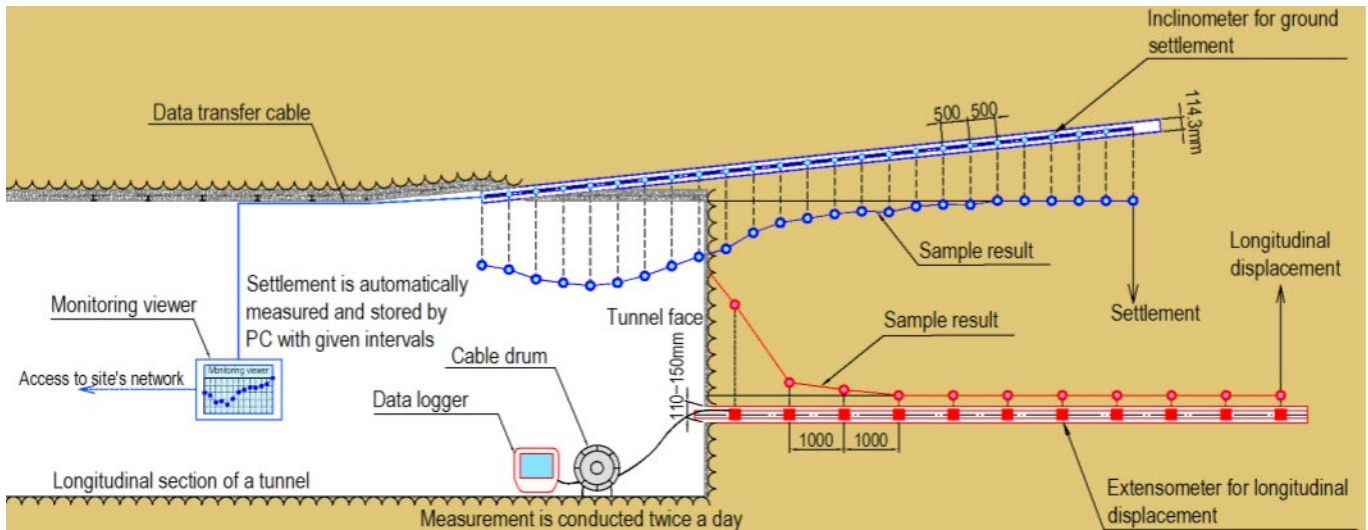


Urban Tunnelling: Hakata station of the Fukuoka city subway - Japan

Displacement monitoring ahead of tunnel face



For the tunnel excavation of the Hakata station of the Fukuoka city subway in Japan partial excavation was carried out. A road with heavy traffic and different structures , as subground car park, gas pipelines, important sewers, are situated above the tunnel construction.

Taking into account constraints as shallow overburden and unconsolidated ground above the future tunnel, based on systematic performed safety considerations, acceptable, in general, very small values for displacements and deformations have been identified for every structure. In order to control these design values it is essential to analyse ground behaviour during start of excavation work when the effects are still small. Therefore monitoring ground movements ahead of the tunnel was carried out systematically.

Settlement Monitoring ahead of the tunnel face: therefore, a MEMS-type in-place inclinometer with short segments were used. We propose to have inclinometer casing installed, that can be measured with a portable probe but can also be equipped with an automatic measuring system. Before excavation starts, readings with the portable system, the horizontal-Inclinometer type Sisgeo OS241DH3000 are taken.

When excavation starts, automatic monitoring is carried out. The inclinometer casing is therefore equipped with BH-profile in-place inclinometer. This in-place inclinometer is moved to the next monitoring station and the past ones are measured manually again for long-term control.



BH-profile probes



Horizontal inclinometer OS241DH3000

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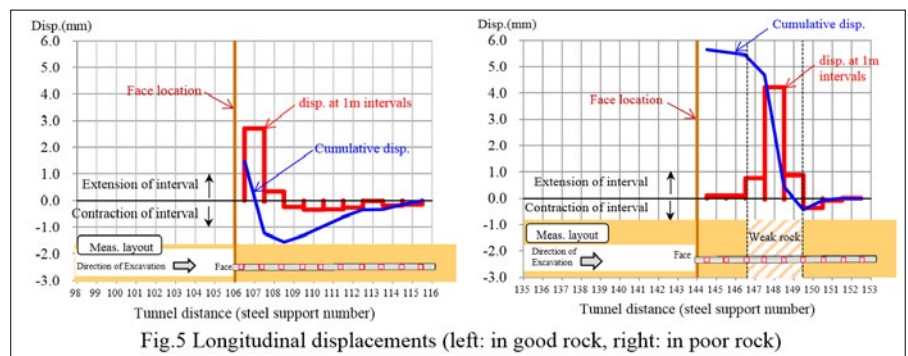
The portable T-Rex probe that slides within the measurement casing detects very accurately the distance between two adjacent magnet rings. The T-Rex system consist of the probe, a cable and the readout unit with data storage and eventually of a calibration device. The readout, the cable and the rods to operate the system are the same also to operate the horizontal-Inclinometer. Due to this dual use, cost and transport on the site are largely optimized.



Example of project in Sochi - Russia

Extrusion measurement ahead of the tunnel face:

the portable probe extensometer, Sisgeo's T-Rex-system, was applied to measure horizontal movements in the ground ahead of the tunnel face. The same measurement casing, as used for the horizontal inclinometer, is equipped every meter with a magnet ring and installed in the borehole ahead of the tunnel face.



Generally, the T-Rex-system provided displacement profiles as the left figure in sections with good rock quality. Significant ground movements were detected near the excavation face. When weak rock existed ahead of the face large extension was observed, as shown in the right side.



T-Rex measuring system

Reference:

Case study of the displacement monitoring ahead of the face in an urban tunnel construction project Authors: Kazuo Sakai, Takuya Tani, Ken-ichi Fumimura (Taisei Corporation) Yasuhiro Hara, Shinnosuke Goto, Toshiyuki Hara (Fukuoka City Transportation Bureau)

LINKS:

HORIZONTAL INCLINOMETER
HORIZONTAL BH-PROFILE IN-PLACE INCLINOMETERS
T-Rex-SYSTEM