Inovatívne metódy geotechnického monitoringu na stavbách v SR a v zahraničí

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Minimizing Risks with Testing and Monitoring

• Prior to construction, design stage
• During construction, realisation
• After completion of construction, permanent monitoring
Testing and Monitoring at different project stages

Exploration

Deep excavation Alptransit Lötschberg

Gabcikovo
Demand for Monitoring and Testing is growing

- Higher demand of security and safety
- Economic design requires better control of the behaviour of the structure
- Development of new instruments and improvement of measuring procedures
- Automated measurements and data visualisation
From manual to automated reading

Manual Inclinometer reading

Data acquisition GEOMONITOR 2
Tasks of the Instrumentation and Testing

• Prior construction: Geotechnical and hydrogeological data for the design
• During construction: Monitoring to compare predicted interaction between structure and sub ground, survey of adjacent buildings
• After construction: Long term behaviour for safety reasons
Automated control of Dams

Concrete arch dam Valle di Lei, Switzerland
Bases for Planing and Design of testing procedures and measurements

- Assessment of the possible amount of damage
- Assessment of the probability of occurrence
- Assessment of the combined effect of possibility and probability

(K.Kovari, M.Bosshard)
Field Tests in Tunnelling prior to Construction

- Hydrogeological in situ tests
- Hydrogeological Instrumentation with Multiple Packer Systems
- Geomechanical testing
Hydro Test Equipment

- Test tubing
- Shut-in valve
- Triple pressure probe
- Top packer
- Screen
- Bottom packer
- Annulus pressure (P3)
- Interval pressure (P2)
- Bottom hole pressure (P1)

Data acquisition system:
- A/D unit
- PC

Packer pressure

Flowboard:
- Flow measurement
- Pressure regulation
- Pump
Pump Storage Plant Linth Limmern

The sites are not always easy accessible
Pump Storage Plant Linth Limmern
Pump Storage Linth Limmern

Hydrogeological tests in the abutment of the Lake Mutt
Pump Storage Scheme Linth Limmern

Hydro tests underground to explore ground water conditions for the turbine cavern
Hydro Tests for Alptransit Lötschberg, Switzerland

Transmissivity, permeability and formation water pressure in a 1400 m deep borehole Head varying between 20 to 100 m above ground level
Multiple Packer System

Pore Water Pressure distribution

Riedberg Tunnel, Switzerland, monitoring unstable slope
Geomechanical Testing, Deformation

Modulus

Dilatometer, probe diameters, 92, 96, 118, 142, 152, 216mm

V-Modulus 1200 MPa, E-Modulus 2100 MPa
Large Scale Test in Foundation Engineering

Determination of the soil structure interaction prior to construction

- Pile load test, interaction between pile and soil
- Embankment loading test on compressible soils
Pile Load Test

Stadium Hardturm, Zürich, pile diameter 1.20m length 15.0 m measurement of strain distribution with Sliding Micrometer
Measurement of Strain within the Pile, Sliding Micrometer

Differential and integrated displacements
At load of 1200 to 0.33mm/m over the length of 15.0 m
Sliding Micrometer, differential displacement along Pile

Strain distribution to the depth of 15 m (pile) showing small scatter (homogenous) concrete but low mobilisation of friction
Embankment Loading test on soft soil

Loading test Bocca di Lido, Venezia, Italy
Distribution of settlement under embankment load

Displacement distribution along a measuring line of 62 m showing soft soil between 14 and 15 m
Advance Tunnelling Exploration

- Hydrogeological investigation in advance of the tunnel face with Pump Down Packer System (PDPS).

- Geomechanical investigation in advance of the tunnel face with Reverse Head Extensometer (MRHX)
Advance Hydrogeological Tests

La Réunion, France, volcanic rock with dykes, large inflow of water
Advance Hydrogeological Test with PDPS

1. PDPS is pumped down casing, System latches into the outer core barrel
2. Inflate the packers, Open access to the test interval
3. Performance of the hydraulic test
4. Deflate the packers, Retrieval of PDPS using overshot tool and wireline system

Pump Down Packer System
Advance Geotechnical Investigation

Reverse head Extensometer MRHX

Permanent displacement measurement ahead of the excavation (Extrusion)
Installed from the tunnel face

Measuring results displacement vs. time
Excavation advances, anchor cut
Geotechnical Measurements and Monitoring of Structures and Soil Settlement

Basel, Luzernerring, Northern Bypass, Switzerland
Geomonitor 2, automatic data acquisition

Automatic reading of sensors with various signals (potentiometric, VW, digital etc.)
Web Davis, Data Visualisation, Section West

Basel, Luzernerring, view of the monitored area, with location of instruments
Optical Instruments read by GEOMONITOR

Theodolite

Digital Level, motorised
Web Davis, Plot

TCA-Messung

Basel, Luzernerring, Settlement vs. time of the St. Jakob Station
Basel, Luzernerring Settlements

Presented with Web Davis

Isoline of settlements

Settlement profile along axes A and B, Differential settlement 1/333 lead to cracks in the railway station
Installation and Instruction to the Client is important for the proper Function

Rokkasho, Japan, low and medium nuclear waste repository, installation of Multiple Packer System
We can’t avoid any risk but we can minimize it
Thank you for your attention

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