Morávka Dam Monitoring System

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Morávka Dam Details

The Morávka Dam was built as a potable water supply for the Ostrava region, in North East Moravia, Czech Republic between 1961 and 1967. The dam was constructed in the Beskydy Mountains on the Morávka River in the Odra river watershed. The dam owner is Povodí Odry State Enterprise.

The dam is 39 meters high and 395 meters long at the crest. Morávka dam is a rock fill dam with bituminous concrete sealing on its upstream face. The bedrock is sealed with a cement grout curtain, installed from the grout gallery. The total volume of the dam is 12,186,000 cubic meters.

Dam Reconstruction

After floods in 1996, part of the bituminous concrete sealing was damaged and, a 4 x 6 meter large hole appeared on the upstream face. This hole was repaired with reinforced concrete and supported by grout. The dam survived another flood in 1997 but after that, the dam owner decided upon a major reconstruction of the dam body and surroundings.

Reconstruction occurred from November 1997 to June 2000 and included the following:

- Drainage of the left slope (new drainage tunnel)
- Reconstruction of the upstream face sealing (new geomembrane instead of old bituminous concrete sealing)
- Construction of two new water output tunnels
- Reconstruction of the old grouting curtain along the whole grouting gallery
- Upgrade of the old manual monitoring system to an automated, data acquisition based system

Reconstruction of the upstream face sealing (new geomembrane)

Monitoring system upgrade

Experience

After a good experience at the Slezská Harta Dam (finished 1997) in the same watershed, the dam owner and project designer decided to use the same monitoring instruments as that which had been used at Slezska Harta.

At Slezská Harta, Geokon vibrating wire piezometers were selected on account of their reliability, rapid response, long-term stability and ruggedness. The fact that they could be read over long cables, without loss, or degradation of the signal, and be easily datalogged were also important factors in the selection process. The data acquisition system at Slezská Harta comprised of the Geokon Micro-10 Datalogger and Multiplexers. The Micro-10 Datalogger is a very powerful and versatile instrument capable of reading practically all types of electrical sensors including vibrating wire transducers and thermistors. Data is retrieved by telephone modems, short haul modems, radios, or satellite transmission.

Head assembly of Geokon's model A-6 borehole extensometer with VW readout

Piezometers

A system of 64 monitoring boreholes was drilled in the grouting gallery. Boreholes were drilled on both the upstream side and downstream side of the grout curtain. All boreholes were of

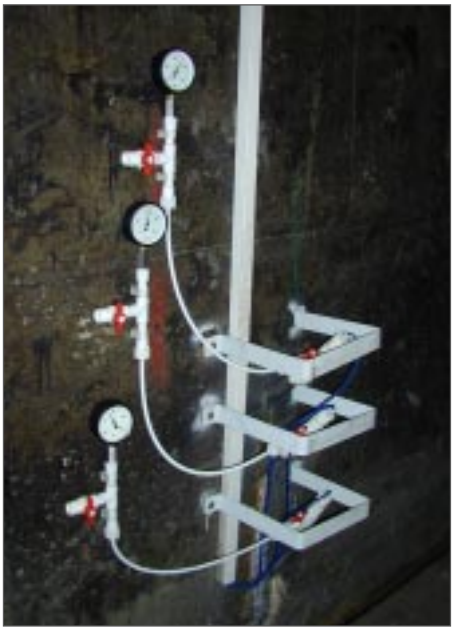
different inclination and length. They were equipped with 1" PVC pipes with a 3 meter long slotted screen at the bottom. Measuring the water level with the piezometers ensured that the grout curtain was functioning properly. An additional 22 standpipe piezometers were placed on the downstream face and around the dam body. Water levels in all boreholes are measured with submerged Geokon, Model 4500S vibrating wire piezometers which are supplied complete with thermistors to allow for measurement of temperature changes in the groundwater. Normally the temperature of the groundwater is different from the temperature of the water in the reservoir. If there is any significant leakage through the up-stream face sealing, it can be detected early as a change in the water temperature.

Inclinometers and extensometers

Three inclinometers were installed to check the left slope and dam body stability. The inclinometers consisted of conventional grooved casings and Geokon's Model 6000 servo-accelerometer based inclinometer probe with GK-603 electronic readout. Dam body stability was also monitored with two rod-type extensometers grouted into 30-meter deep boreholes, at an angle of 30°, at the downstream toe. Geokon Model 4450 Vibrating Wire Displacement Transducers were used for the extensometer measurements. The Model 4450 Vibrating Wire Displacement Transducers provides for remote readout and are particularly useful where other types of Vibrating Wire sensors are used and for installations where long cable runs are required.

Data Acquisition system

All 64 piezometers from the grouting gallery, one compensation barometer, 17 piezometers from the downstream face and surrounding dam body, and 2 extensometers are connected to an automatic data acquisition system which comprises of 6 strategically placed Multiplexers (automatic switch boxes) and one Micro-10 Datalogger. Data from the datalogger is automatically transferred via Short Haul modem to the office in the Control Room where it is interpreted with a computer to provide current data, historical data, graphs, and charts. It is also able to activate alarms if data exceeds pre-set thresholds.



Measuring the water level with the piezometers Geokon model 4500S

Geokon model 4500S and 4500AL vibrating wire piezometers

Stand-alone piezometers

The five piezometers surrounding the dam body are measured as stand-alone boreholes with Geokon's LC-1 single channel dataloggers.

First filling

The very precise measurement of the new monitoring system helped to verify the performance of the dam during the first filling, which took place over a very short time, only 57 days.

Description of the instruments

4500S Vibrating Wire Piezometer (86 pcs.)

4580-1 Vibrating Wire Barometer (1 pc.)

4450 Vibrating Wire Displacement Transducer (2 pcs.)

8032 16-Channel Multiplexers (6 pcs.)

8020 Micro-10 Multichannel Datalogger (1 pc.)

Short-Haul Modem (2 pcs.)

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Geokon Micro-10 datalogger and model 8032 16-channel multiplexer

G4C's geotechnical instrumentation reference list

Slezska Harta Dam
installation: 1996-1997
measuremets, maintanance, data interpretation: from 1996
- 3 Micro-10 multichannel dataloggers
- 13 16-channel multiplexers
- 150 vibrating wire (VW) piezometers and pressure transducers
- 1 reference VW barometer
- 25 single channel dataloggers LC-1
- approximately 12 kms of cables

Moravka Dam
installation: 2000
measuremets, maintanance, data interpretation: from 2000
- 1 Micro-10 multichannel datalogger
- 6 16-channel multiplexers
- 86 VW piezometers
- 1 reference VW barometer
- 2 VW displacement transducers
- 2 borehole rod-type extensometrs
- 5 single channel dataloggers LC-1
- 3 inclinometer boreholes
- approximately 8 kms of cables

Šance Dam
installation: 2000
measuremets, maintanance, data interpretation: from 2000
- 1 Micro-10 multichannel datalogger
- 3 16-channel multiplexers
- 44 VW piezometers and pressure transducers
- 1 reference VW barometer
- approximately 3 kms of cables

Mosty u Jablunkova – backtied anchored pilewall
installation: 1995-2000
measuremets, maintanance, data interpretation: from 1995
- 44 VW piezometers
- 1 reference VW barometer
- 22 VW load cells
- 18 single channel dataloggers LC-1
- 17 inclinometer boreholes

Trinec Landslide – tilt measurement of the high voltage leading tower
installation: 1998
measuremets, maintanance, data interpretation: 1998-99
- 2 VW tiltmeters
- 2 single channel dataloggers LC-1

Sance – Recica Landslide
installation: 1998-1999
measuremets, maintanance, data interpretation: from 1998
- 2 CR510 dataloggers
- 1 tipping bucket precipitation gage with snow adaptor
- 4 VW piezometers
- 3 VW long range displacement meters
- 5 single channel dataloggers LC-1
- 2 GSM modems
- 2 solar panels

Jablunkov – landslide
Axial strain changes measurement in the high pressure natural gas pipeline
installation: 1995
measuremets, maintanance, data interpretation: from 1995
- 27 VW spot welded strain gages (9 profiles)

Trinec – landslide
Axial strain changes measurement in the high pressure natural gas pipeline
installation: 1995
measuremets, maintanance, data interpretation: from 1995
- 6 VW spot welded strain gages (2 profiles)

Hostalkovice – undermined area
Axial strain changes measurement in the high pressure natural gas pipeline
installation: 1996
measuremets, maintanance, data interpretation: from 1996
- 21 VW spot welded strain gages (7 profiles)

Perú
Axial strain changes measurement in the crude oil pipeline for Petroperu
installation: 1997
measuremets, maintanance, data interpretation: 1997
- 18 VW spot welded strain gages (6 profiles)

Karvina – undermined area
Axial strain changes measurement in the high pressure natural gas pipeline
installation: 1997
measuremets, maintanance, data interpretation: from 1997
- 69 VW spot welded strain gages (23 profiles)

Vsetin – Strelna – landslides
Axial strain changes measurement in the high pressure natural gas pipeline
installation: 2000
measuremets, maintanance, data interpretation: from 2000
- 213 VW spot welded strain gages (71 profiles)
- 8 Micro-10 multichannel dataloggers
- 19 16-channel multiplexers
- 8 GSM modems
- 8 solar panels
- approximately 8 kms of cables

Inclinometer boreholes (1995-2002)
installation: 1995-2002
measuremets, data interpretation: from 1995
- 57 installed and a measured boreholes
- 39 boreholes' recenty measured
- over 40 kms totally mesured

Vsetin – Strelna – landslides
Axial strain changes measurement in the high pressure natural gas pipeline
installation: 2001 - 2002
measuremets, maintanance, data interpretation: from 2000
- 21 VW spot welded strain gages (7 profiles)
- 1 Micro-10 multichannel datalogger
- 1 16-channel multiplexer
- 1 GSM modems
- 1 solar panels
- approximately 1 kms of cables

Zermanice Dam
installation: 2001 - 2002
measuremets, maintanance, data interpretation: from 2001
- 1 Micro-10 multichannel datalogger
- 2 16-channel multiplexer
- 17 VW piezometers
- 1 reference VW barometer
- 3 VW tiltmeters
- 2 VW high sensitivity settlement system
- approximately 1 kms of cables

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