Instruments for Dam Safety Monitoring
The importance of monitoring for dam safety is widely accepted. Monitoring provides the information that is needed to develop a better understanding of the on-going performance of the dam during the construction, impounding and operation phases. Therefore, good dam safety monitoring should be a key part of every dam owner’s risk management.

Instrumentation can be used to implement a monitoring system that provides more comprehensive and real time information regarding the on-going performance of the dam.

Geosense instruments have been installed on many dams worldwide as part of dam safety monitoring programmes.

**PORE WATER PRESSURE & WATER LEVEL**
- VW Piezometers
- Standpipe Piezometer
- Water Level Meter

**SOIL PRESSURE**
- VW Total Pressure Cells

**INCLINATION & TILT**
- Portable Inclinometer
- In-Place Inclinometer
- AXMi 3D Inclinometer
- QJ Inclinometer Casing
- XC Inclinometer Casing
- Pendulums
- Tilt Meters
- Tilt Beams

**CRACK & JOINT MONITORING**
- 3D Mechanical Crack Meter
- VW Crack Meter 3D
- VW Crack Meter
- VW Joint Meter
- VW Soil Extensometer
Instruments For Dam Safety Monitoring

**STRAIN MONITORING**
- VW Strain Gauges
- Rosettes
- Zero Strain Container

**SETTLEMENT**
- VW Liquid Level Settlement System
- GEO-XM Magnetic Settlement System
- AXM In-Place Magnetic Extensometer
- Reed Switch Probe

**SEEPAGE**
- V-notch Weirs
- VW Weir Monitor
- Staff Gauges
- Ultrasonic Flow Meter

**DATA ACQUISITION**
- GeoLogger G8 Plus
- Remote Smart Mux
- Smart Mux Interface
- VW Readout VWR01
- Telependulum TP-2000

**STRONG MOTION MONITORING**
- Accelerometers & Recorders

**SOFTWARE**
- GeoAxiom Vista

**METEOROLOGY**
- Weather Station
**Baish Dam, Saudi Arabia**

### Project Summary

<table>
<thead>
<tr>
<th>NAME: Baish Dam</th>
<th>YEAR: 2016</th>
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<tbody>
<tr>
<td>CLIENT: Ministry of Water and Electricity</td>
<td>MAIN CONTRACTOR: N/A</td>
</tr>
<tr>
<td>INSTRUMENTATION: Triad Technical Services</td>
<td>CONSULTANT: Geosense</td>
</tr>
</tbody>
</table>

### Overview

The Baish Dam is a gravity dam on Wadi Baish about 35km northeast of Baish in the Jizan Region of southwestern Saudi Arabia.

The dam has many purposes including flood control, irrigation and groundwater recharge. The total reservoir capacity of the dam is 192 million m³.

The dam was constructed between 2003 and 2009 and at 106m high on completion, it was the tallest dam in Saudi Arabia. It is owned and operated by the Ministry of Water and Electricity.

Baish dam is one of six dams currently undergoing the change from a manual to a fully-automated monitoring system.

The original instrumentation equipment was installed during construction and was entirely manually-read. The Ministry made the decision to upgrade the instrumentation to a modern automatic system including full data logging of all instruments together with alarm trigger levels and data access via the Internet.

### Monitoring

After consultation with Ministry Engineers, Geosense designed a system installing new instruments side by side with the existing instrumentation and upgrading several areas to provide a fully-integrated and automatic dam safety monitoring system.

All the new instruments were connected into a data logging system and provide real-time visualisation within the dam control room.

The dam integrity is carried out by monitoring key areas as follows:

- **Main dam body**
  - Inclination
- **Galleries**
  - Expansion joints
  - Seepage
- **Dam main drain**
  - Seepage
- **Dam reservoir**
  - Water level
- **Dam abutments**
  - Settlement
  - Seismic monitoring

### Products used

- **VW piezometers**
  - Measurement of pore water pressure.
- **AXMi 3D Inclinometers**
  - Combined Magnetic Extensometer & In-Place Inclinometer for both settlement and inclination profiles.
- **Pendulums & Telependulums**
- **VW triaxial crack gauges**
  - Measures expansion or contraction in the dam joints.
- **V-notch weir & monitor**
  - Measurement of seepage flows.
- **Remote Multiplexers**
  - Allows multiple sensor cables to be connected into one central location for connection to a data logger via one multi-core cable.
- **GeoLogger GL1000**
  - Multi-channel data logger for remote reading and logging all instruments.
- **Accelerometers & Recorders**
  - Measures seismic activity for early damage detection.
- **GeoAxiom Vista**
  - Data visualisation software. All data is fully accessible via the internet.
Construction of a new multi-purpose 40 Megawatt dam in Taraba State, Nigeria will generate much needed electricity for the country and provide job opportunities, social and economic benefits to people in the area.

The preliminary design was for a dam with a storage capacity of 200 million m$^3$ but this was subsequently increased to 500 million m$^3$.

The main challenges were related to the lack of data in the hydrological and geological studies as well as the project location in the extreme south-eastern part on Nigeria, which required long travel times on very poor roads.

The hydropower station was initially designed with an installed capacity of 18 MW, however, following detailed hydrological modelling and yield analysis carried out by Aurecon, a 40 MW installed capacity was implemented. Aurecon's input on this project led to a more economical design of the dam and an increased installed capacity for the hydropower station.

The dam is expected to be ready for commissioning in December 2014.
Shahdag Tourism Complex, Azerbaijan

**Overview**

Shahdag Tourism Complex is located in the north eastern of the Caucasus near to city of Gusar which is 180km away from Baku in Azerbaijan. When it is completed, the complex will provide a number of activities for the visitors both in summer and winter period.

The Tourism Complex will be located within the Shahdag National Park, which is known for having an intact ecological system and an untouched flora and fauna.

**Monitoring**

The most critical section of the tourism complex is the 24m high earth dam which is an artificial reservoir with a 15900m³ capacity which will be used for water storage during the lifetime of the project to provide a continuous water supply for snow production. Therefore a monitoring system is required for both construction control and the long-term performance and overall stability of the reservoir.

The vertical settlement and lateral displacement in the reservoir body will be monitored by a number of borehole locations which include vertical or horizontal inclinometer systems and a number of vertical inclinometer systems combined with a magnetic extensometer system allowing the acquisition of data for both horizontal and vertical displacement from a single borehole.

**Project Summary**

- **NAME:** Shahdag Winter Summer Tourism Complex
- **YEAR:** August 2013 – Ongoing
- **CLIENT:** Ministry of Culture and Tourism of Azerbaijan Republic
- **MAIN CONTRACTOR:** DiA Holding FZCO
- **CONSULTANT:** Enargeo

**Products used**

- **QJ Inclinometer casing**
  For use with portable inclinometers.

- **Portable MEMS inclinometer**
  Includes both vertical and horizontal probe for measuring lateral and vertical displacements.

- **Inclinalysis Software**
  For analysing the data from vertical and horizontal boreholes.

- **Data loggers**
  Multi-channel remote reading & logging.

- **GXM300i**
  Magnetic settlement & inclinometer casing system for measuring ground settlement and lateral displacement.

- **Reed switch probe**
  For use with GXM300i system.
Zeizoun Dam, Syria

The Zeizoun dam is situated on the Orontes river north of Hama in Syria and was originally constructed in 1996 with a capacity of 71 million³ and used for widespread irrigation in the Al-Ghab province. On 4th June 2002 a failure occurred in the original dam which was completely destroyed and resulted in widespread flooding and damage.

As part of the re-building program a new design with an extensive monitoring system is currently being implemented. The new dam design includes a much deeper foundation which is intended to remove the weak strata identified as part of the reason for the failure. A grouting and monitoring gallery is included in the new design, which is located beneath the core foundation.

**Overview**

The Zeizoun dam is situated on the Orontes river north of Hama in Syria and was originally constructed in 1996 with a capacity of 71 million³ and used for widespread irrigation in the Al-Ghab province. On 4th June 2002 a failure occurred in the original dam which was completely destroyed and resulted in widespread flooding and damage.

As part of the re-building program a new design with an extensive monitoring system is currently being implemented. The new dam design includes a much deeper foundation which is intended to remove the weak strata identified as part of the reason for the failure. A grouting and monitoring gallery is included in the new design, which is located beneath the core foundation.

**Monitoring**

The dam integrity is carried out by monitoring key areas as follows:

- **Main Dam Body**
  - Pore water and total soil pressures, settlement and lateral movement within the core. Seismic response of the crest.
- **New Dam Foundation**
  - Water levels under the downstream shoulder
  - Groundwater levels beyond the dam toe
- **Existing Dam Body**
  - Pore water pressures within the core
- **Reservoir Level**
  - Water level, pressure and loading
- **Dam Abutments**
  - Groundwater levels
- **New/Existing Dam Connection**
  - Joint movements
- **Gallery**
  - Seepage
  - Joint movements
  - New/Existing Dam Body
  - Surface movements
  - Downstream Open Channels
  - Water level and flow

**Project Summary**

- **NAME:** Zeizoun Dam
- **YEAR:** 2010-0n-going
- **CLIENT:** Directorate of Water Resources Hama Governorate
- **MAIN CONTRACTOR:** General Company for Hydro Projects
- **INSTRUMENTATION:** Al Mutawasset
- **CONSULTANT:** Agrocomplect SA, Bulgaria

**Products used**

- **VW Piezometers**
  - For accurate measurement of pore water pressure and water level.
- **V-notch weirs**
  - Accurate measurement of seepage.
- **VW Weir Monitor**
  - Used with V-notch weirs.
- **Staff gauges**
  - Measuring water level in dam reservoir.
- **Ultrasonic Flow Meter**
  - Measurement of flow in open channels.
- **GEO-XM magnetic system**
  - For measuring ground settlement.
- **Reed switch probe**
  - For use with the GEO-XM system.
- **Inclinometer casing**
  - For use with portable inclinometers.
- **Portable MEMS Inclinometer**
  - For measuring lateral displacement.
- **VW Total Pressure Cells**
  - For measuring total earth pressures.
- **VW Soil Extensometers**
  - For measuring lateral & longitudinal deformation.
- **Data loggers**
  - Multi-channel remote reading and logging of all instruments.
- **GeoViewer**
  - Data visualisation software.
Tishreen Dam, Syria

Project Summary

NAME: Tishreen Dam Automatic Instrumentation  
YEAR: 2006  
CLIENT: General Organisation Of The Euphrates Dam  
MAIN CONTRACTOR: N/A  
INSTRUMENTATION: Geosense  
CONSULTANT: Geosense

Overview

Completed in 1991 and situated within the Tigris-Euphrates basin, the 630MW hydro-electric Tishreen Dam has a storage capacity of 1.9 km³ and generates 1.6 billion kWh of electricity every year.

The dam is constructed with a chalk impervious core and seepage beneath it controlled by a Bentonite/cement cut-off wall. The complex comprises the main dam, a powerhouse constructed as a gravity dam and a small fuse plug.

The original instrumentation equipment was installed during construction and was entirely manually read.

Due to a serious dam failure in Syria the General Organisation for Euphrates Dam (GOED) decided to upgrade the instrumentation to a modern automatic system including full data logging of all instruments together with alarm trigger levels.

After consultation with the GOED Engineers, Geosense designed a new system installing new instruments side by side with the existing instrumentation and upgrading several areas to provide a fully integrated and automatic dam safety monitoring system.

Monitoring

The dam integrity is carried out by monitoring key areas as follows:

- **Main dam body**
  - Pore water pressures
- **Dam main drain**
  - Seepage
- **Dam abutments**
  - Groundwater levels
- **Power house**
  - Expansion joints
  - Relief well seepage
  - Upstream pore water pressures
  - Downstream pore water pressures
  - Temperature
- **Bridge deck**
  - Expansion joints
  - Temperature
- **Galleries**
  - Seepage
  - Upstream pore water pressures
  - Downstream pore water pressures

Products used

- **VW piezometers**
  - Measurement of pore water pressure.
- **Borehole packers**
  - Produce a response zone in a borehole in combination with a piezometer.
- **VW triaxial crack gauges**
  - Measures expansion or contraction in the dam joints.
- **V-notch weirs**
  - Measurement of seepage flows.
- **Terminal switch boxes**
  - For the connection and reading of up to 34 Instruments.
- **Data loggers**
  - Multi-channel remote reading and logging with solar panel and back-up battery.
- **Telemetry system**
  - Radio based system to connect the main processing computer with the remote data loggers.
- **GeoViewer**
  - Data visualisation software which retrieves data from the data logger in near real time and processes the information in either map, profile or graph formats. Trigger levels & alarms can also be set.
Chemususu Dam, Kenya

**Overview**

Chemususu Dam, completed in 2014, is now the third largest dam in Kenya. It is located on the Chemususu River, a tributary of the Tigiri River, some 80kms North-West of Nakuru Town and approximately 15kms West of Eldama-Ravine Town. This a high altitude site where the crest elevation is 2340m above sea level.

The dam will improve water storage by storing approximately 10.94million m³ and provides an uninterrupted water supply of about 35,000 M³/day to Nakuru Town, parts of Baringo and Koibatek Districts, including Eldama-Ravine Town.

The project included a Rockfill dam approximately 40m high with a crest length of approximately 350m. It has a narrow inclined clay core only, measuring only 20m at its base.

In addition there is a large concrete spillway and an intake/culvert for both water supply and river flow maintenance.

**Monitoring**

Monitoring of the dam construction integrity and long term safety was carried out by recording measurements in the following key areas:

- **Main dam foundation**
  - Pore water pressures upstream of the grout curtain.
  - Pore water pressures downstream of the grout curtain.

- **Dam core**
  - Contact zone pore water pressures close to the culvert and the core foundation.
  - Contact zone soil pressures between core and the culvert.
  - Pore water pressures within the dam core.
  - Horizontal & vertical loading within the core.
  - Vertical settlement of the core.
  - Horizontal movement of the core.

- **Dam abutments**
  - Groundwater levels

- **Spillway Wing Walls**
  - Earth and pore water pressures in the core / wing wall contact zone

- **Surface Movements**
  - Settlement and displacement of the crest and rockfill

- **Reservoir Level**
  - Water level and loading

**Project Summary**

- **NAME:** Chemususu Dam
- **YEAR:** 2011-2014
- **CLIENT:** National Water Conservation & Pipeline Corp
- **MAIN CONTRACTOR:** FRABO Construction Ltd, NBO
- **INSTRUMENTATION:** Vas Motor Mart
- **CONSULTANT:** Otieno Odongo & Partners

**Products used**

- **VW piezometers**
  - Measurement of pore water pressure.

- **V-notch weirs**
  - Measurement of seepage flows.

- **VW weir monitor**
  - Used with V-notch weirs.

- **GXM300i**
  - Magnetic settlement & inclinometer casing system for measuring ground settlement and lateral displacement.

- **Reed switch probe**
  - For use with GXM system.

- **Inclinometer casing**
  - For use with portable inclinometers.

- **Portable MEMS inclinometer**
  - For measuring lateral displacement.

- **VW rigid-back total pressure cells**
  - For measuring total earth pressures.

- **Data loggers**
  - Multi-channel remote reading & logging.

- **GeoViewer**
  - Data visualisation software which retrieves data from the data logger in near real time.

- **Reflective targets**
  - Survey targets for use with total station survey equipment to detect surface movements.
The Al Abyad dam is currently being constructed on a tributary of the Orontes river near to Jisr Al Shurghur, between Aleppo and Latakia in Syria. The dam will provide water storage, primarily for irrigation, in this agricultural area. The project includes a conventional clay core dam supported by rockfill shoulders. Also included is a large spillway structure with plunge pool and water intake tower with associated discharge culvert.

The dam has a grouting, drainage and monitoring gallery running the full length of the core foundation with access at both abutments and the downstream toe.

Built on a severely faulted rock foundation, this structure has been highlighted for geotechnical monitoring.

Monitoring of the dam construction integrity and long term safety is carried out by recording measurements in the following key areas:

**Main dam body**
- Pore water pressures in the core
- Settlement in the core

**Dam gallery**
- Seepage
- Pressure relief
- Foundation pore pressures

**Dam abutments**
- Groundwater levels

**Intake tower**
- Reservoir water level

### Products used

- **VW piezometers**
  - Measurement of pore water pressure.
- **Standpipe piezometers**
  - Simple measurement of groundwater levels.
- **V-notch weirs**
  - Measurement of seepage flows.
- **V-notch weir monitor**
  - Used in combination with V-notch weirs.
- **Staff gauges**
  - For measuring water level in dam reservoir.
- **GEO-XM**
  - Magnetic system for measuring ground settlement.
- **Reed switch probe**
  - For use with GEO-XM system.
- **Data loggers**
  - Multi-channel remote reading and logging with solar panel and back-up battery.
- **GeoViewer**
  - Data visualisation software which retrieves data from the data logger in near real time and processes the information in either map, profile or graph formats. Trigger levels & alarms can also be set.
**Balarud Dam, Iran**

**Project Summary**

<table>
<thead>
<tr>
<th>NAME</th>
<th>Balarud Dam, Iran</th>
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<tbody>
<tr>
<td>YEAR</td>
<td>2015 - on going</td>
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<tr>
<td>CLIENT</td>
<td>Khuzestan Water &amp; Power Authority</td>
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<tr>
<td>MAIN CONTRACTOR</td>
<td>OMRAN MARON</td>
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<tr>
<td>INSTRUMENTATION</td>
<td>LARZEH SAKHT SAVALAN</td>
</tr>
<tr>
<td>CONSULTANT</td>
<td>DEZAB</td>
</tr>
</tbody>
</table>

**Overview**

Balarud dam is located in Khuzestan Province, 27km north of Andimeshk. It is an earthfill dam with a central clay core, 1070m in length and 77.5m high. It provides water for irrigation, potable water, industry and hydro power. It impounds a 131,000,000 m³ reservoir and its plant capacity is 4Mw.

**Monitoring**

Monitoring of the dam construction integrity and long-term safety is carried out by recording measurements in the following key areas:

- **Main dam body**
  - Pore water pressures in the core
  - Effective stress in the core
  - Inclination in the core & shell
  - Settlement in the core & shell
  - Groundwater levels

- **Foundation**
  - Pore water pressures in the rock
  - Groundwater levels

- **Dam main drain**
  - Seepage

**Products used**

- **VW piezometers**
  - Measurement of pore water pressure.

- **VW Total Pressure Cells**
  - For measuring total earth pressures.

- **Standpipe piezometers**

- **3D Mechanical Crack Meter**

- **Remote Smart Mux**

- **Smart Mux Interface**

- **Portable MEMS Inclinometer**

- **V-notch weirs**
  - Measurement of seepage flows.

- **Staff gauges**
  - Water level in dam reservoir.

- **GEO-XM**
  - Magnetic system for measuring ground settlement.

- **VW Readout VWR01**
  - Measures all types of vw instruments.

- **G8 PLUS Data Logger**

- **Geoaxiom software**

- **Weather Station**
Karam Abad Dam, Iran

**Overview**

Karam Abad dam is located in West Azerbaijan Province, 20km from Poldasht. It is an earthfill dam with clay core, 1991m in length and 43m high. The dam provides Potable & Industry. It impounds a 53,700,000 m³ reservoir.

Karam Abad Dam was built to create a reservoir dam to store the excess water from the reservoir of Aras Dam at a rate of 5.30 cubic meters per second. Using the Ganbar Kundi pumping station in the vicinity of the reservoir of the Aras Dam, the result is the development of agricultural land.

**Project Summary**

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<tr>
<td>CLIENT: West Azerbaijan Regional Water Authority</td>
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<tr>
<td>MAIN CONTRACTOR: SAZ AB KIYAN PAD</td>
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<td>INSTRUMENTATION: LARZEH SAKHT SAVALAN</td>
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<td>CONSULTANT: ZISTAB</td>
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</tbody>
</table>

**Monitoring**

Monitoring of the dam construction integrity and long-term safety is carried out by recording measurements in the following key areas:

- **Main dam body**
  - Pore water pressures in the core
  - Effective stress in the core
  - Inclination in the core & shell
  - Settlement in the core & shell
  - Groundwater levels

- **Foundation**
  - Pore water pressures in the rock
  - Groundwater levels

- **Dam main drain**
  - Seepage

**Products used**

- **HD VW piezometers**
  - Measurement of pore water pressure.
- **VW Total Pressure Cells**
  - For measuring total earth pressures.
- **Standpipe piezometers**
- **Remote Smart Mux**
- **Smart Mux Interface**
- **Portable MEMS Inclinometer**
- **V-notch weirs**
  - Measurement of seepage flows.
- **Staff gauges**
  - For measuring water level in dam reservoir.
- **GEO-XM**
  - Magnetic system for measuring ground settlement.
- **VW Readout VWR01**
  - Measures all types of vw instruments.
- **G8 PLUS Data Logger**
- **Geoaxiom software**
- **3D Mechanical Crack Meter**
- **Weather Station**
Belobin Dam, Iran

PROJECT SUMMARY
Name: Belobin Dam, Iran
Year: 2017 - on going
Client: Zanjan Regional Water Authority
Main Contractor: Zangan Persia
Instrumentation: Larzeh Sakht Savalan
Consultant: Arkan Rahab

OVERVIEW
Belobin Dam is located south of Zanjan Province, 11 km from Halab city. It is an earthfill dam with clay core, 325m in length and 59m high. The dam provides potable and industry. It impounds a 53,780,000 m³ reservoir.

MONITORING
Monitoring of the dam construction integrity and long-term safety is carried out by recording measurements in the following key areas:

Main dam body
- Pore water pressures in the core
- Effective stress in the core
- Inclination in the core & shell
- Settlement in the core & shell
- Groundwater levels

Foundation
- Pore water pressures in the rock
- Groundwater levels

Dam main drain
- Seepage

PRODUCTS USED
- VW piezometers
  Measurement of pore water pressure
- VW Total Pressure Cells
  For measuring total earth pressures
- Standpipe piezometers
- 3D Mechanical Crack Meter
- Portable MEMS Inclinometer System
  For measuring lateral displacement
- Remote Smart Mux
- Smart Mux Interface
- V-notch Weirs
  Measurement of seepage flows
- Staff gauges
- GEO-XM
  Magnetic system for measuring ground settlement.
- VW Readout VWR1
  Measures all types of vw instruments.
- G8 PLUS DataLogger
- GeoAxiom software
Kalgan Dam is located south west of Bostan Abad on the Kalgan River (East Azerbaijan Province) in Iran. Commissioned in 2006, the dam provides water to the Potable & Industry. Kalgan Dam is an earthfill dam, with a clay core. It is 456m in length and 65m high. The dam was constructed using 1.0 Mm³ of Materials. It impounds a 22,000,000 m³ reservoir.

Monitoring of the dam construction integrity and long-term safety is carried out by recording measurements in the following key areas:

**Main dam body**
- Pore water pressures in the core
- Effective stress in the core
- Inclination in the core & shell
- Settlement in the core & shell
- Groundwater levels

**Foundation**
- Pore water pressures in the rock
- Groundwater levels

**Dam main drain**
- Seepage

**Overview**
Kalgan Dam is located south west of Bostan Abad on the Kalgan River (East Azerbaijan Province) in Iran.

Commissioned in 2006, the dam provides water to the Potable & Industry. Kalgan Dam is an earthfill dam, with a clay core. It is 456m in length and 65m high. The dam was constructed using 1.0 Mm³ of Materials. It impounds a 22,000,000 m³ reservoir.

**Products used**
- HD VW piezometers
  Measurement of pore water pressure.
- VW Total Pressure Cells
  For measuring total earth pressures.
- Standpipe piezometers
- Remote Smart Mux
- Portable MEMS Inclinometer
- V-notch weirs
  Measurement of seepage flows.
- Staff gauges
  For measuring water level in dam reservoir.
- GEO-XM
  Magnetic system for measuring ground settlement.
- Reed switch probe
  For use with GEO-XM system.
- VW Readout VW2106
  Measures all types of vw instruments.
- G8 PLUS Data Logger
- Geoaxiom software
Bidvaz Dam, Iran

**Project Summary**

NAME: Bidvaz Esfarayen Dam, Iran  
YEAR: 2016 - on going  
CLIENT: North Khorasan Regional Water Authority  
MAIN CONTRACTOR: GALA  
INSTRUMENTATION: LARZEH SAKHT SAVALAN  
CONSULTANT: TOOSAB

---

**Overview**

Bidvaz Esfarayen Dam is located in the North East of Khorasan Shomali Province, 20km from Esfarayen city. It is an earthfill dam with clay core, 104m in length and 80m high. The dam provides potable & industry. It impounds a 52,900,000 m³ reservoir.

A new cut-off wall is under construction upstream of the dam.

---

**Monitoring**

Monitoring of the dam construction integrity and long-term safety is carried out by recording measurements in the following key areas:

- **Main dam body**
  - Pore water pressures in the core
  - Effective stress in the core
  - Inclination in the core & shell
  - Settlement in the core & shell
  - Groundwater levels

- **Foundation**
  - Pore water pressures in the rock
  - Groundwater levels

- **Dam main drain**
  - Seepage

---

**Products used**

- **VW piezometers**
  - Measurement of pore water pressure.

- **VW Total Pressure Cells**
  - For measuring total earth pressures.

- **Standpipe piezometers**
  - Simple measurement of groundwater levels.

- **Remote Smart Mux**

- **Smart Mux Interface**

- **V-notch weirs**
  - Measurement of seepage flows.

- **Staff gauges**
  - For measuring water level in dam reservoir.

- **GEO-XM**
  - Magentic system for measuring ground settlement.

- **Reed switch probe**
  - For use with GEO-XM system.

- **VW Readout VWR01**
  - Measures all types of vibrating wire instruments.

- **G8 PLUS Data Logger**

- **Geoaxiom software**
Golgohar Dam, Iran

**Overview**

Golgohar Dam is located 53Km South West of Sirjan in the Kerman Province in Iran.

Commissioned in 2011, Golgohar Dam is an earthfill dam, with a clay core. It is 795m in length and 25m high. The dam has seven sections needing instrumentation.

The dam was constructed for environmental protection in order to reserve tailing materials resulting from the iron mine concentration process.

**Project Summary**

| NAME: Golgohar Tailing Dam, Iran |
| YEAR: 2013-2015 |
| CLIENT: Golgohar Mining & Industrial Co |
| MAIN CONTRACTOR: AB & KHAK |
| INSTRUMENTATION: LARZEH SAKHT SAVALAN |
| CONSULTANT: MEHR AB POYESH |

**Monitoring**

Monitoring of the dam construction integrity and long-term safety is carried out by recording measurements in the following key areas:

**Main dam body**
- Pore water pressures in the core
- Effective Stress in the core
- Inclination in the core & shell
- Settlement in the core & shell
- Groundwater levels

**Foundation**
- Pore water pressures in the rock
- Groundwater levels

**Dam main drain**
- Seepage

**Products used**

- **VW HD Piezometers**
  Measurement of pore water pressure.
- **Standpipe Piezometers**
  Simple measurement of groundwater levels.
- **Portable MEMS Inclinometer System**
  For measuring lateral displacement.
- **Terminal Box**
- **Smart Mux Interface**
- **V-notch Weir**
  Measurement of seepage flows.
- **Staff gauges**
  For measuring water level in dam reservoir.
- **GEO-XM**
  Magnetic system for measuring ground settlement.
- **Reed switch probe**
  For use with GEO-XM system.
- **VW Readout VWR01**
  Measures all VW instruments.
- **CR1000 Data Logger**
- **Soil Extensometer**
Sarcheshmeh Tailing Dam, Iran

Overview

Sarcheshmeh Tailing dam is located in the Sarcheshmeh. The dam was constructed to reserve 1,000,000,000 tons of tailing materials resulted copper mine concentration process. It is an earth fill dam with a clay core, 1500 m length and 75 m high, and reservoir volume is 123,000,000 m³.

Monitoring

Automatic monitoring of seepage was identified as being a requirement to ensure the long term integrity of the dam and allow water quality measurements to be made.

Changes in seepage volumes and water quality could be quickly identified and checked with changes in reservoir level and filling activities.

Products used

- **V-notch weir**
  Provides a method of measuring volumetric. Since the geometry of the top of the weir is known and all water flows over the weir, the depth of water behind the weir can be converted to a rate of flow.

- **VW Weir Monitor**
  Automatically measures the height of water behind the V-notch weir.
OVERVIEW

Shamil Reservoir Dam project is designed to prevent seasonal flooding and for the collection of water for agricultural purposes.

It is a clay core earth-fill dam with the height of 32.3m and crest length of 1200m. It has a surface water intake and deep discharge system, underground pumped storage type is situated upstream of the dam.

It is located 70km from Bandar Abbas. Latest work includes the installation of Geosense sensors to automate existing sensors which were placed installed during dam construction.

MONITORING

Monitoring of the dam construction integrity and long-term safety is being carried out by recording measurements in the following key areas:

Main dam body
- Water pressures in the core shell
- Inclination in the core & shell
- Settlement in the core & Shell
- Groundwater levels

All existing VW sensors were double checked using the VWR1 readout unit.

PRODUCTS USED

Stand Pipe Piezometer
Measurement of pore water pressure

Inclinometer Casing
For use with portable inclinometers

Dip Meter

Portable MEMS Inclinometer system
For measuring lateral displacement

Reed switch probe
For use with the GEO-XM system

VW Readout VWR1
Measures all types of vibrating wire instruments

G8 PLUS Data logger

Remote Smart Mux 12 CH & 6CH
A modular multiplexer that allows the management of multiple sensors as part of a remote or automatic data acquisition system.

Smart Mux Interface

PROJECT SUMMARY

PROJECT NAME: Shamil Dam
PROJECT DATE: 2017-2018
CLIENT: Hormozgan Regional Water Company
CONTRACTOR: Didas construction Company
CONSULTANT: Moshanir Consulting Engineers Co.
INSTRUMENTATION SPECIALIST: Larzeh Sakht Savalan

Dam Safety Monitoring

Shamil Dam, Iran
Nian Dam, Iran

PROJECT SUMMARY

PROJECT NAME: Nian Dam
PROJECT DATE: 2017-2018
CLIENT: Hormozgan Regional Water Company
CONTRACTOR: Didas construction Company
CONSULTANT: Moshanir Consulting Engineers Co.
INSTRUMENTATION SPECIALIST: Larzeh Sakht Savalan

OVERVIEW

Nian Reservoir dam project is designed to prevent seasonal flooding and for the collection of water for agricultural purposes.

It is a clay core earth-fill dam with the height of 27.3m and crest length of 510m with four radial spillway gates and an inflow of 4630m³/s surface water, artificial feeding intake and semi-deep discharge system.

It is located 70km from Bandar Abbas.

Latest work includes the installation of Geosense sensors to automate existing sensors which were installed during dam construction.

MONITORING

Monitoring of the dam construction integrity and long-term safety is being carried out by recording measurements in the following key areas:

- Main dam body
- Water pressures in the core shell
- Inclination in the core & shell
- Settlement in the core & Shell
- Groundwater levels

All existing VW sensors were double checked using the VWR1 readout unit.

PRODUCTS USED

Stand Pipe Piezometer
Measurement of pore water pressure

Inclinometer Casing
For use with portable inclinometers

Dip Meter

Portable MEMS Inclinometer system
For measuring lateral displacement

Reed switch probe
For use with the GEO-XM system

VW Readout VWR1
Measures all types of vibrating wire instruments

G8 PLUS Data logger

Remote Smart Mux 12 CH & 6CH
A modular multiplexer that allows the management of multiple sensors as part of a remote or automatic data acquisition system.

Smart Mux Interface
Gordiyan Dam, Iran

PROJECT SUMMARY

PROJECT NAME: Gordiyan Dam
PROJECT DATE: 2015
CLIENT: East Azerbaijan Regional Water Authority
CONTRACTOR: Azar Ettefag
CONSULTANT: Faraz AB
INSTRUMENTATION SPECIALIST: Larzeh Sakht Savalan

OVERVIEW

Gordiyan Dam is located 20 Km South East of Jolfa (East Azerbaijan Province) in Iran.
The dam provides water to the Potable & Industry. Gordiyan Dam is an earthfill dam, with a clay core. It is 1420 m in length and 40 m high and impounds a 23,000,000 m³ reservoir.

MONITORING

Monitoring of the dam construction integrity and long-term safety is carried out by recording measurements in the following key areas:

Main dam body
Pore water pressures in the core
Effective stress in the core
Inclination in the core & shell
Settlement in the core & Shell
Groundwater levels
Foundation
Pore water pressures in the rock
Groundwater levels
Dam main drain
Seepage

PRODUCTS USED

VW Total Pressure Cells
For measuring total earth pressures
OverView

Takht e Gonbad Dam is located 65km North East of Sirjan (Kerman Province) in Iran. The Dam provides water for use by a Copper Mine Factory.

Takht e Gonbad Dam is an earthfill dam with a clay core. It is 800m in length and 20m high. It impounds a 15,000,000m³ reservoir.

Monitoring

Monitoring of the dam construction integrity and long-term safety is carried out by recording measurements in the following key areas:

- Foundations
- Pore water pressures in the rock
- Groundwater levels

Products Used

VW Piezometer HD
For measuring por pressure at foundation

Linx Datalogger with GPRS communication
For Remote monitoring

Project Summary

Name: Takht e Gonbad Dam, Iran
Year: 2018
Client: Shining Copper Company
Contractor: Shining Copper Company
Instrumentation: Larzeh Sakht Savalan
OVERVIEW
This Earth-Rock-fill Dam was built 160km South-East of Kerman on the Baft River. Aims of dam construction are storage of flood and river run-off for irrigation and drinking water to serve Baft and its industries.
Height: 65m
Crest Length: 1160 m
Reservoir Volume: 40 Mm³

PROJECT SUMMARY
Name: Baft Dam, Iran
Year: 2018
Client: Kerman Regional Water Authority
Main Contractor: Zangan Pershia
Instrumentation: Larzeh Sakht Savalan
Consultant: AB-NIRU Consulting Eng.

MONITORING
Monitoring of the dam construction integrity and long-term safety is carried out by recording measurements.

PRODUCTS USED
Portable MEMS Inclinometer system
For measuring lateral displacement
Reed Switch Probe
For use with the GEO-XM system
OVERVIEW
This Earth-Rock fill Dam was built 160 km south of Kerma. Aims of dam construction are storage of flood and river run-off for irrigation and drinking water for Sirjan and its Industries.
Height: 71m
Crest Length: 1100 m
Reservoir Volume: 38.2 Mm³

PROJECT SUMMARY
Name: Sirjan Tanguen Dam, Iran
Year: 2018
Client: Kerman Regional Water Authority
Instrumentation: Larzeh Sakht Savalan
Consultant: Mahab Ghodss Consulting Eng.

MONITORING
Monitoring of the dam construction integrity and long-term safety is carried out by recording measurements.

PRODUCTS USED
Portable MEMS Inclinometer system
For measuring lateral displacement
Reed Switch Probe
For use with the GEO-XM system
**Overview**

Joghan Dam is located in 16Km South West of Bostan Abad on the Asb Abad Chai River (East Azerbaijan Province) in Iran.

Commissioned in 2006, the dam provides water to potable & industry. Joghan Dam is an earthfill dam, with a clay core. It is 179.5m in length and 37.75m high. The Dam was constructed using 0.55Mm³ of materials. It impounds a 3,000,000 m³ reservoir.

**Project Summary**

- **NAME:** Joghan Dam, Iran
- **YEAR:** 2009
- **CLIENT:** East Azerbaijan Regional Water Authority
- **CONTRACTOR:** ALAND AB
- **INSTRUMENTATION:** LARZEH SAKHT SAVALAN
- **CONSULTANT:** OMRAN PAZHOHESH RAHVAR

**Monitoring**

As part of a rehabilitation programme, existing instruments were upgraded to allow for automatic readings to be taken.

In addition, seepage monitoring was added to detect any change in water flow through the dam.

**Products used**

- **Terminal Box (Auto & Manual)**
  Provide a central location where multiple instruments can be read.

- **V-notch weir**
  Provides a method of measuring volumetric. Since the geometry of the top of the weir is known and all water flows over the weir, the depth of water behind the weir can be converted to a rate of flow.

- **VW Weir Monitor**
  Automatically measures the height of water behind the V-notch weir.