

→ Automatic surveying systems

Modern geodetic sensors, such as robotic total stations, have significantly enhanced the topographic monitoring of dams. Robotic total stations particularly incorporate high-precision rangefinders and allow direct measurement of the 3D coordinates of reflectors. They ensure precise measurements and automate data collection for increased efficiency. Remote operation enhances safety, while CAD integration streamlines design processes. Faster data processing reduces project timelines and labour costs, making them essential for modern rehabilitation projects. SISGEO's data management platform (AIDA IoT) can fully integrate robotic total stations into any existing instrumentation infrastructure.

→ Design, supply and installation

Designing and implementing instrumentation and monitoring systems in engineering projects is vital for managing physical, engineering, and geological phenomena. Careful consideration of measurement needs, parameters, and instrumentation architecture is necessary. Critical parameters such as measurement range, frequency, accuracy, and data usage must be assessed. Design involves technical documents, plans, and maintenance schedules. Protecting instrumentation during civil works is crucial. SISGEO, a leading inclinometer technology provider, emphasizes detailed specifications and user manuals for efficient storage and installation. The installation phase requires strict adherence to specifications. SISGEO trains its staff for efficient installation, recognizing its impact on system performance. Meticulous design, detailed specifications, and expert installation are essential for high-quality monitoring solutions in engineering applications.

→ System maintenance operations

System maintenance operations include two main types:

- A) Routine maintenance involves all system control and overhaul activities, including functional checks of all instruments and data loggers, inspection of remote connections and data transmission networks, and repair or replacement of sensors or components exhibiting abnormal behaviour.
- B) Extraordinary maintenance is typically initiated at the customer's request to address repairs, faults, and malfunctions.

The frequency of maintenance plans primarily depends on the type of plant, environmental conditions, and other specific factors. Generally, routine maintenance programs are conducted more frequently (monthly) during the initial months, transitioning to quarterly or semiannual schedules based on the customer's resources and the availability of on-site specialists.

→ Data Management Software

AIDA-IoT, the SISGEO data management platform is designed to facilitate data visualization, analysis, and information processing, crucial for generating alerts and reports. For effective monitoring, a reliable cloud-based platform like AIDA IoT - powered by Field - is utilized. This platform efficiently stores and manages large volumes of raw data, generating alarms and reports as needed. AIDA IoT offers high customization, allowing for tailored charts and handling data from various monitoring systems, whether manual, semi-automated, or fully automated. Data acquisition units (DAUs) collect electrical signals from instruments, which are then transmitted to a central server for validation, processing, and integration into a SQL database. Clients benefit from real-time access to diverse analysis types, including dynamic, static, hydraulic, geodetic, and metrological information, through a personalized dashboard.

→ After-sales assistance, periodic calibration, repair and maintenance

Following installing the instruments and data loggers, our commitment extends to comprehensive technical support. Our dedicated support team is available to address any questions or technical issues that may arise. Whether you require assistance with product setup, configuration, troubleshooting, or periodic calibration services, our experts offer prompt and effective solutions to help you optimize your instruments' functionality. Additionally, our maintenance services encompass thorough inspections, testing, firmware updates, and any necessary adjustments to ensure your tools operate efficiently.

Our unwavering dedication to excellence and customer satisfaction sets us apart as a trusted partner in precision measurement technology.



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REFERENCE PROJECTS

Europe

Sveťa Petka Dam, Macedonia
Vianden dam, Luxemburg
Louet Dam, France
Mont Cenis Dam, France
Déversoir du Maresquier, France
Chambon Dam, France
Choranche Dam, France
Vouglans Dam, France
Tech Dam, France
Tignes Dam, France
Maccheronis Dam, Italy
Castel Giubileo Dam, Italy
Castagnara sul fiume Metramo Dam, Italy
Molato Dam, Italy
Capanna Silcheri - Flumendosa Dam, Italy
Ravedis Dam, Italy
Mercatale Dam, Italy
Casanuova dam, Italy
Mauvoisin Dam, Switzerland
Grande Dixence Dam, Switzerland
Globocica dam, Macedonia
Mavrovo dam, Macedonia
Kozjak dam, Macedonia
Spilje dam, Macedonia
Asopos dam, Greece
Karatzas dam, Greece
Dabar HPP, Serbia
Racibórz hydroproject, Poland
Isola Dam, Switzerland
Bavigne dam, Luxembourg
Schiffenen, Switzerland
Les Toules, Switzerland
Z'Mutt and Ferpècle -Dixence, Switzerland
Eupen, Belgium
Naret I - II, Switzerland
Hongrin, Switzerland
Montsalvens, Switzerland
Mapragg, Switzerland
Gigerwald, Switzerland
Verzasca, Switzerland
Zeuzier, Switzerland
Carmena, Switzerland
El Atazar, Spain
Vrutci, Serbia
Erhöhung-Limbersperre, Austria
Sperré Paal, Austria

Asia

Nurek Dam, Tajikistan
Akhangaran Dam, Uzbekistan
Saradar Sarovan Dam, India
Charvak Dam, Uzbekistan
Andjan Dam, Uzbekistan
Kotri Barrage Dam, Pakistan
Nai Gaj Dam, Pakistan
Nam Louk dam, Thailand
Vedi dam, Armenia
Wala dam, Jordan
Ahsuba dam, Kingdom of Saudi Arabia
Namrood dam, Iran
Dayqah dam project, Oman
Azad dam, Iran
Kotri dam, Pakistan
Ulu Jelay hydroelectric project, Malaysia
NG dam, Laos
Jinvali, Georgia
Lam Phra Phloeng Dam, Thailand
Lam Nang Rong Dam, Thailand

Africa

Bab Louta dam, Maroc
Cahora Bassa hydropower project, Mozambique
Al Himer dam, Maroc
Sidi Mohammed Ben Abdallah Dam, Maroc
Kariba Dam, Zambia
Mkukurumdzi dam, Kenya
Matala Dam, Angola
Inga hydroelectric project, Congo
Ouldjet Mellegue dam, Algeria
Beni Slimane dam, Algeria
Metolong dam, Lesotho
Songloulou dam, Cameroun
Zhinvali dam, Georgia

America

Ralco Dam, Chile
Betania Dam, Colombia
Mazar Dam, Ecuador
El Quimbo Dam, Colombia
El Cajón hydroelectric project, Honduras
Miel Dam, Colombia
Zimapan Dam, Mexico
Tablachaca dam, Perú
Ituango Dam, Colombia
Cerro del Águila Dam, Perú
Sogamoso Dam, Colombia
Salto Grande Dam, Uruguay/Argentina
Brazo de Aña Cuá Dam, Paraguay/Argentina
Pedreira-Duas Pontes Dam, Brasil

REHABILITATION AND MODERNIZATION OF MONITORING SYSTEMS IN DAMS



SISGEO
SISGEO LATINOAMÉRICA SAS
FIELD SRL
HUGGENBERGER AG

REHABILITATION AND MODERNIZATION OF MONITORING SYSTEMS IN DAMS

Dams are critical infrastructures designed to manage water resources and produce electricity, many of which have reached the end of their useful life or may require extensive rehabilitation. In 2021, UNU-INWEH (United Nations University - Institute for Water, Environment and Health) published a report titled "Ageing water infrastructure: An emerging global risk." The authors urged that by 2050, most of the earth's population will live downstream of tens of thousands of large dams built during the 20th century, many of which have remained in operation beyond their useful life.

GROUP EXPERTISE

Dam rehabilitation aims to ensure safety and operational performance, and the geotechnical and structural monitoring systems are essential for controlling, maintaining, and safeguarding structural integrity.

Furthermore, the design, verification, installation, implementation, and maintenance of monitoring systems typically require extensive collaboration among professional engineers from various disciplines. Realizing maximum benefits and the return on investment in monitoring instrumentation systems strongly depends on the efficiency of the data management platform. This platform transforms data into valuable analytics based on which authorities can make timely and informed decisions.

SISGEO group is honored to collaborate with hundreds of professionals in various disciplines. Over the past three decades, it has delivered state-of-the-art instrumentation solutions to over a Thousand dams worldwide. SISGEO instrumentation solutions ensure high quality and provide dependable precision, usability, and, most importantly, unparalleled technical support.

SISGEO Group offers full spectrum of specialized instrumentation solutions worldwide including:

→ Diagnosis and functional tests on existing instrumentation

The inspection of instrumentation functionality and monitoring processes such as data collection, data storage, and telecommunication systems is essential for dam rehabilitation projects, implying the following actions:

- Retrieving the existing technical documentation;
- Identification of out-of-use instruments;
- Organizing historical readings and highlighting anomalies;
- Gathering new readings utilizing modern data loggers with data analysis capabilities;
- Evaluating the integrity of signal cables, electrical connections, and mechanical fixtures;
- Evaluating conversion formulas and regression models;
- Providing status reports and summarizing the findings;

→ Data acquisition, digitization, and online accessibility

Given the site specificity and the client's needs, the existing infrastructure can often be upgraded to a fully automated platform. The automation of monitoring systems is necessary for a variety of reasons:

- To avoid or mitigate human error in the data collection process;
- To set and reset the sampling frequency and enhance statistical inference as necessary
- To digitize and compress the data, which significantly enhances data transmission and the storage capacity for historical records and, more importantly, facilitates access to the records;
- To minimize the sunk costs due to the reduced cabling and complexity of the central data acquisition system;
- To allow real-time dynamic and static asset monitoring without human intervention.

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GROUP PORTFOLIO

RALCO - Chile



The Ralco power plant, managed by Enel Generación Chile S.A., is a key energy source in the Biobío Region, utilizing the Biobío River's power through an artificial dam with a capacity of 689 MW. Teaming up with Geosinergia LTD, (our local partner), we've implemented several upgrades:

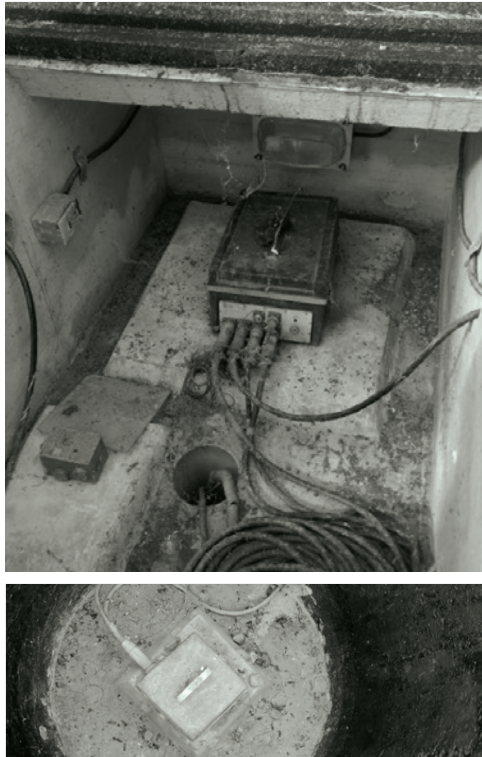
- Replacing mechanical RST joint gauges with VW Sisgeo joint meters and installing stainless-steel supports for managing filtration water jets.
- Installing filtration level gauges with adjustable stainless-steel supports.
- Incorporating a large-capacity reservoir level gauge.
- Implementing a weather station for comprehensive environmental monitoring.
- Designing and implementing a Warehouse Management System (WMS).
- Automating operations with wireless loggers connected to joint meters, piezometers, water level meters, and reservoir gauges.
- Conducting general civil works and constructing a new facility.

AFTER



These endeavors are geared toward enhancing the dam's efficiency, safety, and overall performance, showcasing our dedication to innovative engineering solutions.

BETANIA - Colombia



AFTER



BEFORE

Betania HPP, situated in Huila, Colombia, boasts an installed capacity of 540.9 MW. Sisgeo Latinoamérica spearheaded the service and installation of the seismic monitoring system. Moreover, we undertook the following initiatives:

- Rehabilitation of 8 inclinometers.
- Execution of general civil works and construction of a new facility.
- Replacement and installation of 3 new wireless accelerometers, along with setting up associated servers and dynamic system management software. These endeavors signify our commitment to enhancing infrastructure efficiency and safety in Colombia's energy landscape.

SARDAR SAROVAR - India



AFTER



BEFORE

Sardar Sarovar, an imposing gravity concrete dam standing 136 meters high with a crest length of 1300 meters, underwent significant instrumentation upgrades. Originally equipped with over 300 Huggenberger sensors with Carlson technology installed around 1994, in 2021, we conducted a functional test of these existing instruments. Subsequently, we upgraded the system from manual to semi-automatic by installing Hek-Mux Boxes. Following rehabilitating existing shafts in 2022, we installed new 76-meter-long plumb lines featuring direct pendulums. Additionally, we supplied automatic

Telelot VDD2v4 systems tailored for measuring the dam's horizontal deformations. These enhancements mark a substantial improvement in monitoring capabilities, ensuring the safety and efficiency of the Sardar Sarovar dam in India.

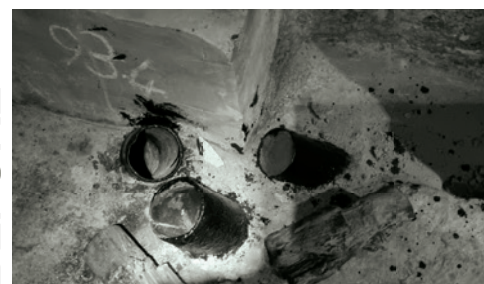
MERCATALE - Italy



Field has successfully implemented data management and maintenance for the automatic topographic monitoring system at Mercatale Dam, overseen by the Public Authority Consorzio di Bonifica Marche.

This sophisticated system comprises a total robotic station and a topographic network of macroprisms and clinometers connected to a data logger, facilitating real-time monitoring. Operating in fully automatic mode, it detects displacements and plano-altimetric variations with precision while safeguarding against environmental factors. Data is processed and analyzed using the integrated AIDA IoT system, offering a customizable web interface for real-time data visualization and graph analysis. This comprehensive solution ensures efficient monitoring and protection of the Mercatale Dam.

KARIBA - Zambia



AFTER



BEFORE

Located on the Zambezi River, bordering Zambia and Zimbabwe, the Kariba Dam is a monumental structure constructed between 1956 and 1959, creating one of the largest artificial lakes globally. Currently, renovations include enlarging and reshaping the plunging pool, necessitating the implementation of an additional monitoring system for better dam behavior control during excavations and dewatering activities. Our responsibilities encompass supplying, installing, testing, and commissioning numerous Telelot units, alongside an automatic data logging system for existing piezometers.

Additionally, we're automating uplift pressure measurements in the dam galleries. The project incorporates 12 Huggenberger telependulums model VDD2V4 Teletots, Sisgeo Up-lift Pressure Sensors (Piezometers and Manometers), 5000 meters of cables for piezometers, and 1200 meters of digital cables for the automatic system. These efforts demonstrate our commitment to ensuring the safety and efficiency of the Kariba Dam infrastructure amidst ongoing renovations and improvements.

SIX DAMS - Macedonia



Sisgeo has played a key-role in the rehabilitation and automation of monitoring instrumentation across six hydropower plants in the Republic of Macedonia, managed by ELEM-JSC Macedonian Power Plants. These assets include the clay-core dams of Mavrovo, Spilje, Globocica, Tikves, and Kozjak, as well as the Sveta Petka arch dam. Installed Systems:

- Device for measuring pump operation time
- Measurement of pore and total pressure cells
- High voltage protection system
- Data transmission and processing

These installations mark a significant step forward in enhancing the operational efficiency and safety of the hydropower plants, underscoring our commitment to delivering advanced engineering solutions.

EL QUIMBO - Colombia



AFTER



The El Quimbo Dam, located in Huila Department, Colombia, is a concrete-faced rock-fill hydroelectric facility positioned 1300 meters upstream from the confluence of the Páez River with the Magdalena River. The accompanying powerhouse in Huila District has a 400-megawatt capacity, generating an estimated 2216 gigawatt-hours annually. Installed Systems:

- 8 triaxial joint gauges between the face and the retaining wall, recalibratable for movements up to 750 millimeters.
- A protection system, including galvanized steel boxes, designed, manufactured, and installed to handle movements up to 750 millimeters.

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