A WELL-PLANNED AND IMPLEMENTED MONITORING SYSTEM IS ESSENTIAL FOR A SUCCESSFUL TAILINGS DAMS OPERATION. TAILINGS DAMS MUST ADHERE TO NUMEROUS REGULATIONS AND STRICT ADMINISTRATIVE STANDARDS IN MANY COUNTRIES.

Monitoring primarily ensures the longevity and safety of a tailings dam. Monitoring must enable a timely detection of any behavior that could deteriorate the dam, potentially resulting in a shutdown or failure.

Similar to an earthen dam but more fragile and dangerous, a tailings dam must be monitored continuously and remotely to detect any weakness. Fiber optic instrumentation along with various other technologies such as vibrating wire answers this critical need.

References

- El Torito - Chile
- Muro Principal of Las Tortolas, copper mine - Chile
- Muro Oeste of Las Tortolas, copper mine - Chile
- Perez Caldera II, copper mine - Chile
- Sierra Gorda, copper / molybdenum - Chile
- Bioxidation valley - Chile
- Laguna Seca, copper mine - Chile
- Cerro Verde, copper mine - Peru
- Mareesburg, platinum mine – South Africa
- Minas Rio, iron mine - Brazil
WHAT ARE TAILINGS AND TAILINGS DAMS?

Mechanical and chemical processes are used to extract the desired product from the run of the mine ore and produce a waste stream known as tailings. The unrecoverable metals, minerals, chemicals, organics and process water are discharged, normally as slurry, to a final storage area commonly known as a Tailings Storage Facility (TSF). The tailing dams (embankment, large surface impoundment) is the most common construction technique used in tailings storage facilities.

TYPE OF TAILING DAM

The three principal designs are downstream, upstream and centreline structures, which designate the direction in which the embankment crest moves in relation to the starter dike at the base of the embankment wall (Vick 1990). The material used and the construction method will influence the permeability and the general stability of the dam. The control of pore water pressure (within and beneath the embankment), the seepage (that is essentially unavoidable and often necessary) and soil compaction are fundamental if we want to guarantee a safety condition during the operation and the abandoned state.

MAIN FAILURES

The main causes of failures of tailings dams are meteorological events like unusual rainfall and snow melting (the climate change will make the situation worse), poor management (improper maintenance of the dam drainage structures, quick rate of raising, and use of heavy machinery) and structural issues (foundations, seepage/piping, overtopping and mine subsidence). Seismic activity is another major aspect to consider at the design stage of a monitoring system.

INSTRUMENTATION:

Instrumentation is used to accurately quantify specific parameters of structural behavior over time and to monitor their rates of change. The reading frequency depends on former observations and on the critical nature of the parameters as well as their potential risks and the site characteristics.

SELECTION CRITERIA FOR INSTRUMENTATION

Three major criteria drive the selection of the instruments:

- Reliability of the measurements obtained (accurate as well as precise and without drifting)
- Longevity and robustness, supported by numerous references
- Ease of readout automation, essential for efficient data collection and interpretation

TYPES OF MEASUREMENTS

The types of measurement to be carried out as well as instrument location must be selected according to the particular type and conditions of the tailing dam itself. Our solutions involves contact sensors based on fiber optic and vibrating wire technologies. When combined with contactless sensors, the monitoring and the knowledge of the structure’s health is even more completed.

MONITORING INSTRUMENTS

Tailings dams are built near the equilibrium limit and require close monitoring. The main parameters that required measurements for a dam stability analysis and slide prevention are pore water pressure, settlement, leakage and horizontal deformation.

In addition to offering a complete line of monitoring instruments for new embankments, Smartec designs and builds monitoring systems for existing tailings dams and adapts their instruments to each specific project.

The instruments used include the following:

- Piezometers
- Settlement gauges
- In-place inclinometers
- Fiber optic deformation sensors (1D and 3D)
- Fiber optic distributed temperature sensing cable
- Fiber optic distributed strain sensing cable
- Accelerometers
- Survey methods (GPS, GNSS, laser, terrestrial/satellite SAR...)

Piezometers are used to measure pore water pressure. Borehole inclinometers, 3D deformation sensors as well as distributed strain sensing cable are installed for settlement and stability measurements. Seismic activities are monitored by permanent strong-motion equipment that guarantees accurate observation of the dynamic behaviour of the structure. Distributed temperature sensing cable detects seepage. A full application note is dedicated to this monitoring method (FO Leak Detection for Dams and Dikes). Finally, distributed strain sensing cables are typically installed in the body of the dam with the scope of detect landslides and unsuspected movements over the whole area. Early warning messages are strongly recommended to prevent disasters, for both human lives and environment.
APPLICATION EXAMPLES

SOFO sensor inside a special case - 3D deformation sensor in Laguna Seca project.

Fiber optic piezometers in boreholes in Cerro Verde project.

Distributed strain sensing cable for movements and landslides detection in Perez Caldera II project.

AUTOMATED DATA ACQUISITION AND PROCESSING

The gathering and analysis of large quantities of data, especially over long distances, requires centralized and automated measuring equipment. Results are more accurate and data can be processed faster, enabling a more efficient alarm systems using predetermined thresholds. A well-designed tailings dam monitoring program will include automated data acquisition systems using alarm levels and their associated action plans. Smartec’s dataloggers allows economical data logging and can be easily connected to multi-node networks for real-time monitoring.
Roctest is the leading developer, manufacturer and supplier of innovative sensing technologies based on vibrating wire and fiber optic sensors for geotechnical and structural instrumentation. We are featuring a complete line of conventional sensor-based solutions ranging from the ultra-robust traditional vibrating wire technology to state-of-the-art fiber-optic technology used for the measurement and monitoring of geotechnical projects and structural health monitoring (SHM) of critical assets such as: dams, tunnels, mines, buildings, bridges, nuclear power plants and many other structures too numerous to list.

Services, Maintenance & Support

Roctest offers a full range of pre and after-sales services such as System Design, Installation, Operation & Maintenance, Data Management and Data Analysis to ensure total peace of mind including on-site service, hotline support, service plans and maintenance.

Our maintenance and support plans provide annual check, performance check, software updates and system maintenance. Please contact us for more information on the multiples services offered by our skilled multilingual Project Engineers and Support team.

Available Application Notes

- FO Leak Detection for Dams and Dikes
- Dam & Dike Instrumentation and Safety Monitoring
- Tunnel Instrumentation & Structural Health Monitoring
- Bridge Instrumentation & Structural Health Monitoring
- Building Instrumentation & Structural Health Monitoring
- Historical Monument Instrumentation
- Geotechnical and Structural Monitoring
- Nuclear Power Plant Instrumentation
- FO Movement Detection in Tunnels
- FO Leak Detection for Chemical Plants
- FO Leak Detection for Pipelines
- Storage Facility Instrumentation
- Cliff Instrumentation
- Penstock

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