Infiltration Detection - Application Note

FIBER OPTIC INFILTRATION DETECTION SYSTEM FOR DAMS, DIKES AND RESERVOIRS

THE BEST WAY TO MONITOR SEAPAGE, SOIL MOVEMENT OR TO DETECT THE PRECISE LOCATION OF LEAKAGE IS WITHOUT ANY DOUBT A DISTRIBUTED FIBER OPTIC SOLUTION.

Smartec has developed fiber optic based solutions to detect leakage and soil movements using proven fiber optic (FO) technology by applying advanced technologies such as Raman and Brillouin interrogation techniques.

These solutions allow the precise measurement of temperature and/or strain every meter along a fiber optic cable that could be deployed over long distances.

Internal Erosion

Seepage through an embankment (earth and tailing dam, dike etc) can induce the movement of soil particles. This phenomenon, as known as internal erosion and has been identified as one of the most important causes of failure. Detecting internal erosion is difficult at an early stage, so Distributed Sensing is increasingly recommended by designers as an essential monitoring solution for the safety management of the dam.

References

- Koudiat Acerdoune Dam (RCC type) - Algeria
- Artificial Water Reservoir (Dike type) - Spain
- Nam Ngum II Dam (CFRD type) - Laos
- Kalivac Dam (CFRD type) - Albania
- Laguna Dam (Rock-filled type) - Chile
- Siah Bishe Dam (CFRD type) - Iran
- Landfill waste (Dike type) - Chile
- Biolixiviation Valley (Dike type) - Chile
- Ksko (Dike type) - Slovenia
- Sava River Dike - Slovenia (under installation)
- GERD, Grand Ethiopian Rennaissance Dam, Main Dam (RCC) and Saddle Dam (Rock-Filled) - Ethiopia (under installation)

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During the construction of a dam, independent if it is a roller-compacted concrete dam (RCC), concrete face rock-filled dam (CRFD) earth dam or other, the FO solution from Smartec provides real-time monitoring of the behaviour of the concrete or structure. This phase gives important information to designers about the future performance of the structure.

ACTIVE OR PASSIVE APPROACH

The monitoring system can be based on an active or passive approach.

The active method (also known as Heat-Pulse Method) is preferred when the expected temperature variation between the water and the soil is small. By applying heat to the FO cable, it allows amplification of the temperature shift in case of a seepage.

On the other hand, the passive method is more economical to deploy when larger temperature changes are expected in the case of even a small leakage.

These solutions allow the precise measurement of temperature and/or strain every meter along a fiber optic cable that could be deployed over long distances.

BENEFITS

This monitoring technique has many benefits:

- Detection and localization of linfiltrations
- Precise identification of leakage path
- Localization of leaks with better than 1m accuracy over distances of 30km and more
- Accurate temperature mapping with 0.01°C resolution
- Autonomous and continuous monitoring 24/7
- Rugged and durable cable constructions for direct embedding in soil or concrete
- Easy and quick to install, use and maintain
- Can be combined with distributed strain sensors for soil stability monitoring
- Immune to electromagnetic fields & corrosion
- Remote monitoring and alerting..

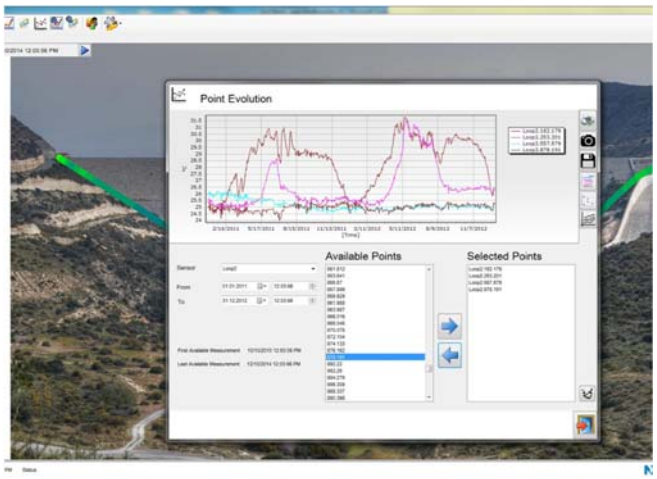
GERD, Grand Ethiopian Rennaissance Dam

INSTALLATION

The installation is quick, easy and robust, as the optical fibers are protected by a stainless steel armoured reinforced cable. Customized monitoring software is offered when the customer is interested in seeing the position of the sensor in the structure, as well as the exact location of an event when alarm or warnings occur.

REAL TIME DATA GATHERING

The real-time data gathered by the monitoring solution can also be uploaded to a private and protected website for further analysis and/or archiving.



DiView, Fiber Optic Distributed Data - Strain and Temperature - Management and Analysis Software

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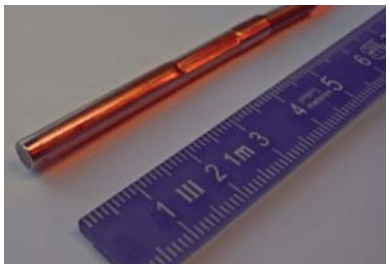
FIBER OPTIC INSTRUMENTATION AND MONITORING SYSTEMS FOR DAMS AND DIKES

1) Albigna - Switzerland
2) Luzzone - Switzerland
3) iLevee Monitoring, New Orleans - USA
4) Nam Ngum II - Laos
5) Laguna Seca Tailing Dam - Chile
6) Artificial water reservoir - Spain

Fiber Optic Piezometer



Fiber Optic Micro Piezometer

Fiber Optic Total Pressure Cell

SOFO Long Base Sensor ≤ 10 m

MuST FBG Long Base Sensor 1 m

SMARTProfile Flat Sensing Cable

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DiTest Dual
Brillouin Reading Unit
Strain & Temperature

DiTemp
Raman Reading Unit
Temperature

DiTemp Light
Raman Reading Unit
Temperature

DiTemp Harsh+
Raman Reading Unit
Temperature

DiTemp
Ordinary Cable
Temperature

DiTemp
Self-Heating Cable
Temperature

DiTest / DiTemp
Hydro & Geo Cable
Strain & Temperature

DiView Visualization and
Analysis Software

FIBER OPTIC
INFILTRATION DETECTION SYSTEM
FOR DAMS, DIKES AND RESERVOIRS

Smartec

Smartec 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.

Smartec offers a wide range of pressuremeters, rock dilatometers, laboratory and in-situ testing equipment for soil and rock.

Services

- System Design
- Installation, Operation and Maintenance
- Data Management
- Data Analysis

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

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