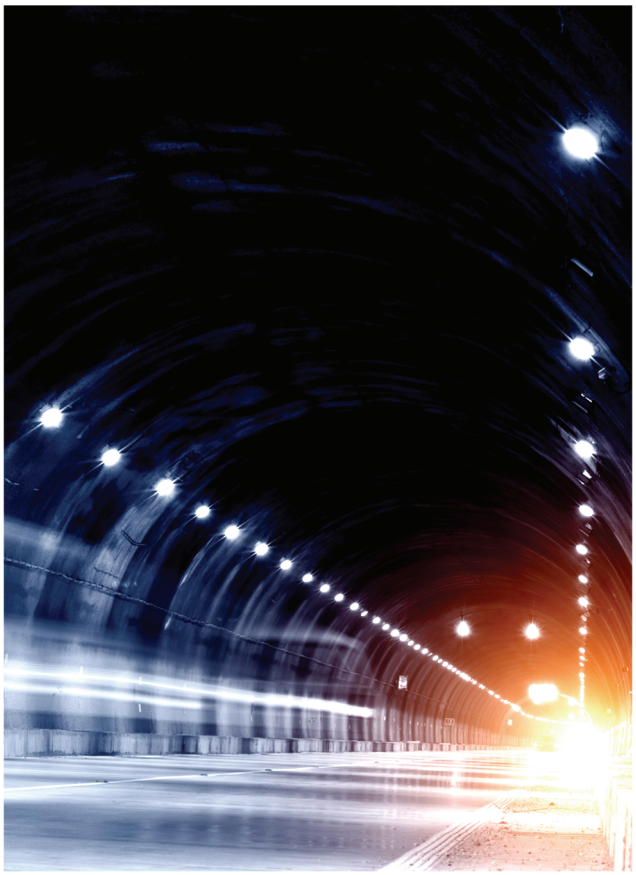
Tunnels - Application Note



TUNNEL INSTRUMENTATION & STRUCTURAL HEALTH MONITORING

PROJECT MANAGERS, DESIGNERS, CONTRACTORS AND OPERATORS ALL AGREE UPON THE NEED FOR WELL PLANNED MONITORING, ADAPTED TO EACH INDIVIDUAL TUNNEL.

Instrumentation is used to accurately quantify certain parameters of structural behavior and to monitor their rate of change. It is possible to observe movement stabilization, or, in the case of acceleration, to deduce the possibility of failure. The comparison of measured values with design values enables the monitoring of tunnel stability and the possibility of implementing corrective measures at the appropriate moment.

References

- Grondines – Canada
- Montreal subway system – Canada
- Toronto subway system – Canada
- Éole – RER – France
- La Chamoise – France
- La Galaure – France
- La Nerthe – France
- Meyssiez – France
- Pech Brunet – France
- Puymorens – France
- Riqueval – France
- Saint Marcel – France
- Ten – France
- Villejust – France
- Monaco – France – Monaco
- Central Station, Mass Railway Transit – Hong Kong
- Cheung Ching – Hong Kong
- Eurotunnel – UK-FR
- Beacon Hill – USA
- Central Artery – USA
- Dallas Area Rapid Transit – USA
- Los Angeles metro system – USA
- Super Collider – USA
- WIPP Site – USA
- WMATA Green Belt – USA
- Yucca Mountain Project – USA
- Yacambu – Venezuela

TUNNEL INSTRUMENTATION & STRUCTURAL HEALTH MONITORING

Monitoring plays an important role in every stage of the construction of a tunnel:

- At the design stage involving an exploration tunnel for site evaluation or the doubling of an existing tunnel.
- During construction, to accurately evaluate the impact of geological conditions, the effect of the tunnel on nearby structures and construction methods to be used. Design hypotheses can be confirmed, the needs of the support structures defined and the optimum moment for instrument installation in accordance with convergence-confinement (NATM) methods can be determined.
- Once the tunnel is in service, to enable long-term monitoring thus ensuring the safety of the tunnel over its life span.

TYPES OF MEASUREMENT

The types of measurement and instrument location must be adapted to the existing geological and environmental conditions as well as construction methods.

Nonetheless, there are certain general guidelines to follow for instrumentation selection, based on tunnel construction.

Certain projects, such as tunnels in soft grounds, carried out in urban areas, would be practically impossible to achieve without instrumentation and automated data acquisition systems.

Roctest instruments used in major projects in more than 75 countries continue to provide reliable data for critical parameters such as pressure, deformation, displacement, inclination and load.

SELECTION CRITERIA FOR INSTRUMENTATION

Three major criteria should guide instrument selection:

- Reliability of the measurements obtained (accuracy, resolution, precision and drift)
- Longevity of the instruments supported by numerous references.
- Ease of automation, essential for efficient data collection and interpretation

Roctest tunnel monitoring instruments respond precisely to these three criteria.

AUTOMATED DATA ACQUISITION AND PROCESSING

The collection and analysis of large quantities of data, especially over long distances, requires centralized and automated measuring techniques. Results are more accurate and data can be processed more rapidly thus enabling efficient alarm systems to be implemented when predetermined thresholds are exceeded.

It is practically impossible to consider the instrumentation of a major tunnel without automated data acquisition systems.

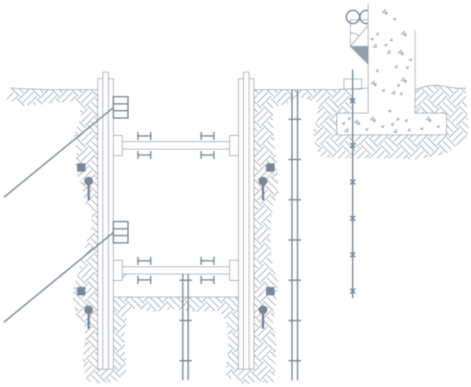
Roctest has supplied and installed over thousands automated data acquisition systems. These remote monitoring systems enable efficient data management from networks of several hundred instruments. Cabling can be reduced to a minimum via system linked to telephone, modem, radio or satellite transmission devices.

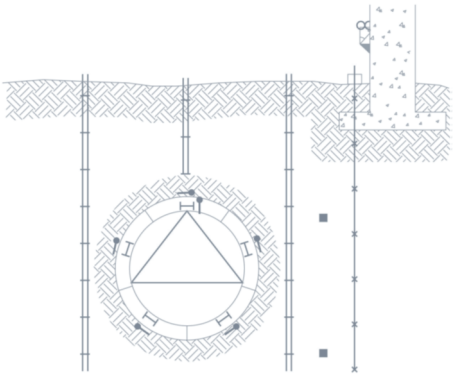
Tunnels - Application Note

CUT AND FILL TUNNEL

Objectives
- Ensure stability in the retaining walls
- Monitor the integrity of adjacent structures

Measured Parameters
- Stress in struts
- Load in anchors
- Deformation of adjacent ground and buildings





SHALLOW TUNNEL IN UNCONSOLIDATED GROUND

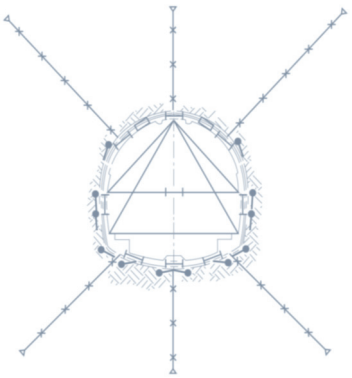
Objectives
- Monitor the integrity of adjacent structures
- Ensure stability in lining segments

Measured Parameters
- Stress in lining segments
- Load on tunnel linings
- Convergence
- Ground settlement
- Deformation of adjacent buildings

DEEP TUNNEL IN ROCK

Objectives
- Ensure the stability of the excavations
- Monitor the integrity of the tunnel lining

Measured Parameters
- Convergence
- Deformation of the rock mass around the excavation
- Stress in the lining

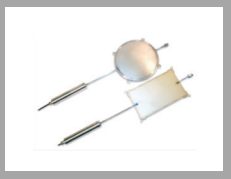


Strain gauge
Tiltmeter
Total pressure cell
Convergence meter
Piezometer
Borehole extensometer
Load cell
Inclinometer and Probe extensometer

Tunnels - Application Note

Vibrating Wire Piezometer
PW Series

Vibrating Wire Strain Gauge
EM-5



Total Pressure Cell
TPC

Borehole Extensometer
BOR-EX

Load Cells
VH, ANCLO, HYDLO

Digital Tape Extensometer
CONVEX-D

Inclinometer Probe
PROFIL

Magnetic Probe
Settlement System
R-4

TUNNEL INSTRUMENTATION & STRUCTURAL HEALTH MONITORING

About Roctest

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.

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

Application Notes Available

- Dam Safety and Monitoring Instrumentation
- Bridge Instrumentation and Rehabilitation Monitoring
- Dam Safety and Monitoring Instrumentation
- FO Leak Detection for Dams and Dikes
- FO Leak Detection for Gas &Toxic / Flammable Liquids
- Geotechnical and Structural Monitoring
- Historical Monuments Instrumentation
- Nuclear Power Plants Instrumentation
- Storage Facilities Instrumentation
- Mine Instrumentation
- Tunnel Instrumentation
- Cliff Instrumentation

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