



Tunnels

TRIMBLE MONITORING SOLUTIONS

SOLUTIONS FOR SAFE TUNNELING OPERATIONS

The Role of Monitoring

Monitoring forms an essential component of the construction of NATM (sequential excavation) tunnels, one of the most popular forms of tunneling construction.

Potential deformations of the excavation and movement of the infrastructure above the tunneling operation must be carefully monitored through the installation of geodetic, GNSS, geotechnical and seismic sensors.

Managing the risk of infrastructure movement caused by the tunneling operations in dense city environments is a major challenge for tunneling contractors, one that is directly addressed by the installation of a structural monitoring system.

The Focus of Monitoring

It is necessary to establish baseline measurements of the positions of buildings, streets, surface and subsurface infrastructure prior to the commencement of tunneling operations, particularly if dewatering or compensation grouting is to form part of the tunneling operations.

This information is to be recorded accurately and repeatedly at the start of the contract, during the course of the tunneling operations and for a maintenance period after contract completion whilst settlement and compaction occurs.

Local structural behavior is monitored by externally mounted total stations which observe prisms and direct surface measurements combined with GNSS receivers which relates the monitoring network to external stable reference points.

Vertical movement of structures and, through multiple point extensometers, subsurface services may be monitored using levelling techniques.

Geotechnical sensors such as in-place inclinometer arrays, tilt meters, crack gauges, extensometers, piezometers and strain

gauges complete the array of sensors used to monitor the behavior of the infrastructure above the tunneling operation. Tunnel convergence monitoring is accomplished using tape extensometers, permanently installed extensometers and geodetic surveying. Joints in the tunnel lining can be monitored using crack gauges and strain gauges.

Trimble 4D Control

Trimble® 4D Control™ software is the key element of the Trimble Monitoring system. The modular design facilitates an industry specific solution, capturing data from GNSS, optical, geotechnical and seismic sensors.

The solution provides a variety of web based visualization and analysis tools to identify potential failure scenarios. Information from different sensor types may be combined with displacement indicators like slope distance change, settlement, displacements or tilt to detect common failure indicators.

Significant events such as TBM location, downtime, dewatering activities grouting activities, maintenance and construction related events, images and documentation may be logged and referenced on the charts.

Comprehensive alarm conditions may be set with notifications issued by email and SMS to selected recipients Audible and visual alarms may also be triggered.

Designed for Demanding Environments

The Trimble Monitoring Solution is ideally suited for the monitoring of infrastructure above, below and within the tunnel operation by the geotechnical, seismic and survey monitoring analyst.

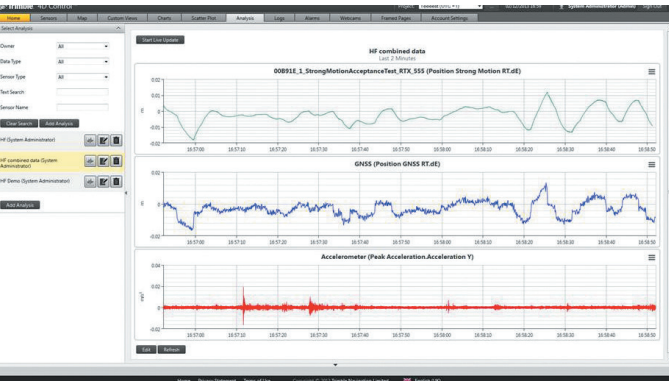
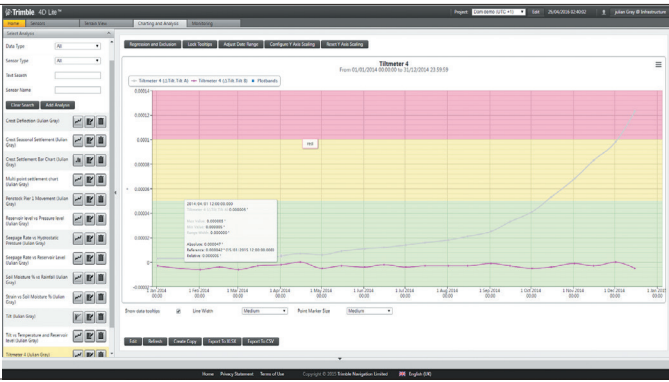
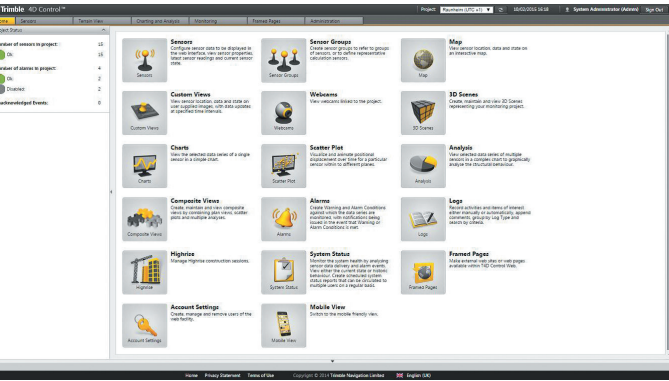
Intricate data from multiple sensor types is converted into meaningful information from which informed decisions can be made with confidence.

The solution can integrate manual surveying and data acquisition operations into a complex automated monitoring system using the Trimble 4D Control software.

Key Features

- ▶ Automated, real-time monitoring system
- ▶ Structural deformation monitoring
- ▶ Periodic deformation surveys
- ▶ Stability assessment above tunneling activity
- ▶ Long and short term analysis of structural behavior





TRIMBLE S7, S9 TOTAL STATIONS

Advanced total stations that combine Trimble FineLock™ technology with long-range, distance measurement to provide fast and precise monitoring measurements.

TRIMBLE NETR9® TI-M GNSS RECEIVER

A full-feature, top-of-the-line receiver with an industry-leading 440 channels for unrivaled GNSS multiple constellations tracking performance intended for monitoring applications.

TRIMBLE DINI® DIGITAL LEVEL

A digital height measurement sensor for any job site where fast and accurate height determination is required.

TRIMBLE REF TEK 130-SMHR

A strong motion 24-Bit Strong Motion Accelerograph that combines the third generation broadband seismic recorder and an advanced low-noise, force-feedback accelerometer.

TRIMBLE REF TEK 147A

A triaxial force balance accelerometer that converts acceleration signals into voltage signals to measure various low frequency and ultra-low frequency motion.

TRIMBLE 4D CONTROL MONITORING SOFTWARE

A powerful monitoring software that integrates GNSS, optical and geotechnical sensors to collect and manage data, provide computation and analysis, visualization and mapping and alerts and alarms.

Contact your Trimble Dealer today

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