A railway tunnel near Sochi in the Russian Krasnodar region is being monitored as part of the construction preparations for the 2014 Winter Olympic Games. The tunnel is part of the only rail line for all passenger traffic to the Sochi resort area from central parts of Russia and for cargo traffic supplying construction sites in Sochi. Due to the planned construction of two road tunnels above the railways, the decision was made in 2011 to set up an automatic monitoring system for the existing tunnel.

The company Tunneldorstroy is building two road tunnels, with a total length of 770m, above the current rail tunnel.

Out of concern for the safety of passenger and freight trains passing through the current tunnel, it was decided to monitor a part of the existing tunnel to detect possible deformations resulting from the construction of the road tunnels and to detect possible problems before they become critical.

Frequent trains and the necessity of acquiring data every two hours made it nearly impossible to perform classic methods of monitoring. Therefore, total stations and the automatic deformation monitoring system Leica GeoMoS were installed and have been working around the clock. Project planning recommended installing two Leica TM30 (1’’) robotic total stations in the middle of the existing rail tunnel to have line of sight to all prisms and to measure reliable data. These instruments can achieve an angle accuracy of 1’’ and a distance accuracy of 0.6mm + 1ppm. Automatic target recognition (ATR) allows the Leica TM30 to reliably aim to the center of each reflector and thus to determine the smallest deformations.

Leica Geosystems TruStory
Rail Tunnel Monitoring in Sochi/Russia

Objective
Rail tunnel monitoring during construction

Customer/Institution
Tunneldorstroy

Date
2011 – ongoing

Location
Sochi/Russia

Project Summary

Instruments
Leica TM30 Monitoring Sensors
Leica Geosystems Monitoring prisms

Software
Leica GeoMoS Monitor / Analyzer

Communication
- Ethernet via LAN cables and mobile Internet
- Uninterrupted Power Supply (UPS)

Challenge
Real-time deformation monitoring among frequent rail traffic
Because of an unreliable power supply inside the tunnel construction area, an uninterrupted power supply (UPS) and power conditioner had to be set up for continuous operation of the total stations and the communication devices.

Four stable control prisms were mounted on each side of the tunnel. These points are frequently checked by an independent survey campaign. Before the monitoring points are measured, each total station positions to the stable control prisms located in the deformation-free area. These measurements are used to compute the actual total station position and corrections (e.g. orientation or Vz correction) using resection calculations. For the actual monitoring, five monitoring prisms were installed in each tunnel profile. The distances between the profiles are between 1 to 5m. A total of 196 monitoring prisms are located along the entire rail tunnel structure. All points are measured every two hours.

Communication
The total stations are connected to a GPRS/GSM modem installed near one tunnel end by LAN cable and the Ethernet converters inside the rail tunnel. The communication between the total stations and the software is via TCP/IP and Mobile Internet.

Data Processing Center
The measurements of the Leica TM30 total stations are managed by the Leica GeoMoS. With an integrated TCP/IP connection GeoMoS is able to establish a bi-directional communication with the total stations over the GPRS/GSM modem and the tunnel LAN. The GeoMoS Monitor software is installed at the Tunneldorstroy office on the other side of the city.

Benefits
Once the automatic monitoring system was installed, the system works beside all difficulties caused by lack of electricity and heavy train traffic absolutely reliable and delivers high accurate monitoring data.

It is responsible for control of the total station, data acquisition, data storage and automatic processing of the instrument’s resection (free station computation).

In case of a deformation event an SMS or email is sent to the responsible staff for further investigation and inspection of the deformation. The monitoring data analysis including graphs and reports is completed using Leica GeoMoS Analyzer.