Deformation Measurement with Trimble's S8 Total Station and Other Sensors

Jonas VAN DOSSELAER, Jonas VAN HOOREWEGHE and Bram VAN LONDERSELE, Belgium

Key words: Total station, monitoring, geodetic and geotechnical sensors, deformation measurements

SUMMARY

Demand is increasing for deformation measurements and monitoring to ensure the stability of ageing infrastructure and structures impacted by nearby construction projects. Not only the stability of existing infrastructure needs to be guaranteed, also human lives at a yard are at stake. Real time monitoring provides data collection, analysis by an experienced surveyor and an automated warning alarm to immediately alert project responsibles and onsite personnel of a structural movement. This is possible using a three-part work-flow: (1) data acquisition, (2) data analysis, storage and if necessary generating an alarm signal and (3) visualization and reporting of the data. Data acquisition occurs through different sensors, amongst others the Trimble S8 total station, currently Trimble's most advanced optical platform. Prisms can be measured with millimeter accuracy. The software allows the client to log in on a website at any time and check the obtained and stored data. The surveyor thus can offer a custom-made monitoring process. The system can be adapted to every project: the type of sensors that are used, the periodicity of the measurements, the visualization, the modus of alarm (text message or email for instance) and different thresholds and rules for generating alarms. Deformation measurements are the newest generation of high-precision surveying.

Deformation Measurement with Trimble's S8 Total Station and Other Sensors

Jonas VAN DOSSELAER, Jonas VAN HOOREWEGHE and Bram VAN LONDERSELE, Belgium

1. INTRODUCTION

Monitoring has a made a great leap forward because of technical progress made during the past decade. Before, construction sites, bridges, landslides, and tunnels were monitored by manual deformation measurements, either with total stations, levels, or geotechnical sensors. Manual readings and measurements were most of the times the only option, due to a lack of useable communication networks and sensor integration. Nowadays, motorized total stations can be used to perform automated measurements. Software can process this data, amongst data from other sensors. Depending on the project, automated monitoring can reduce labour costs and can be done 24/7 with the same accuracy, thus increasing dramatically the reliability of the monitoring service and, in doing so, the overall security of any project.
This flash presentation will present the use of Trimble's S8 total station to perform monitoring in combination with other sensors.

2. DATA ACQUISITION: THE SENSORS

There are two main groups of sensors which are used within monitoring, geodetic and geotechnical sensors. The main difference between them is the fact that geodetic sensors measure georeferenced displacements, mostly in three dimensions, and geotechnical sensors measure relative physical quantities.
The first group consists of the basic known survey equipment like total stations, levels and GNSS systems. The Trimble S8 total station is the key to high precision measurements in most of the monitoring projects. With a 0.5" angle precision and 0.8mm+1ppm distance accuracy, reliable measurements can be assured. Most geodetic sensors and Camble dataloggers can be integrated in the Trimble 4D control software. Nowadays we can also take laser scanners into consideration as geodetic sensor, for instance in tunnels [Nuttens,2010]. Geotechnical sensors are inclinometers, extensometers, and piezometers. For the combination of these sensors with geodetic sensors, specialized software is needed, for example the Swissmon system from Terra monitoring. This system controls the sensors trough cables or wireless communication devices. It stores the data on a remote server, performs powerful controls and data analysis, generates the required alarms and puts the data and graphs on the web, so that project responsibles can check the system at any time and from any place using only a web browser.

3. ANALYSIS AND VISUALISATION

After data is collected with the sensors, the data is processed in the software and basic alarms can be generated on a specific threshold. These alarms can be audiosignals on site, text messages or e-mails (figure 1).The client can log in on a webUI to get a view of the results from the monitoring (figure 2).

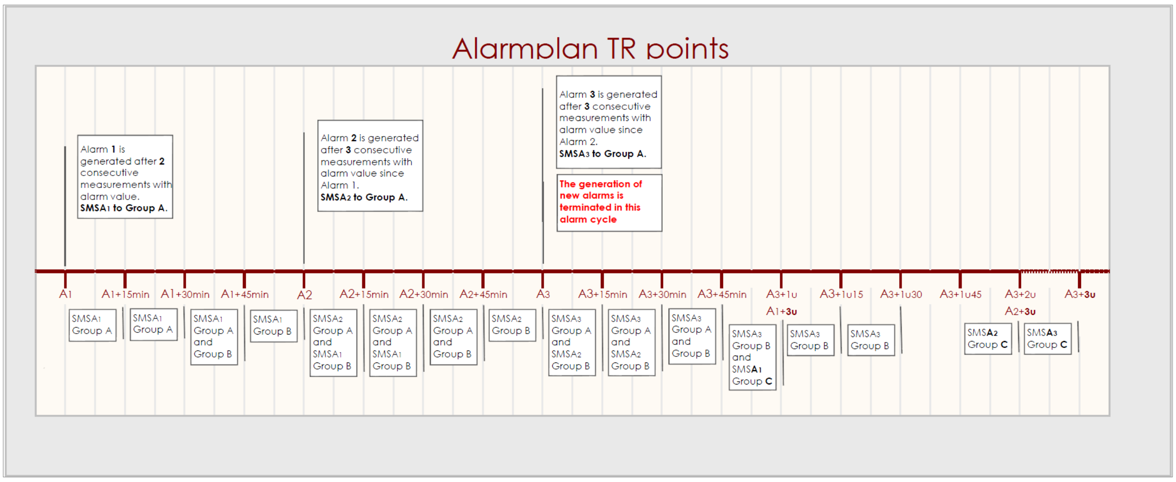

Figure 1: Alarmplan of the monitoring system

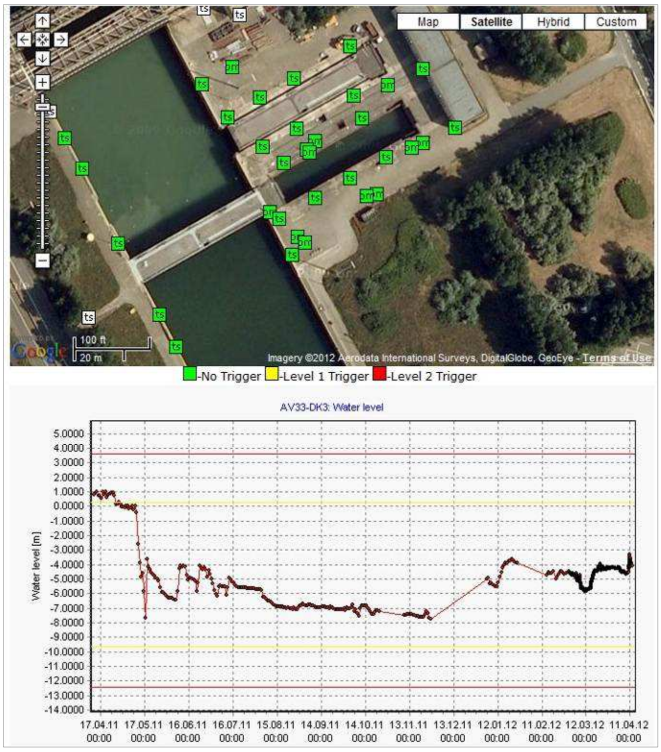

Figure 2: webUI of the software package

4. CASE STUDY

4.1 Monitoring one of the lock doors of the Vandamme lock in Zeebrugge during refitment

Figure 3: Picture of the lock door

Contractor HYE is performing maintenance works on lock door 3 (figure 3) in the port of Zeebrugge, commissioned by maritime access of Belgium. Therefore the lock door chamber had to be completely drained, which imposes huge risks for the whole structure and people working on site. Permanent monitoring was the solution to generate an alarm when the risk becomes too high. GeoService, a subsidiary of Couderé, the Belgian authorized distributor of Trimble, installed the following sensors on site:

- 2 Trimble total stations S8 (figure 4)
- 7 Piëzo meters
- 1 webcam
- 7 reference prisms targets and 21 monitoring prisms
- 3x3 inclinometers were already installed and integrated in the system

Figure 4: Installation of a Trimble S8 total station on site

Figure 5: protected prisms

All these sensors are integrated in the Swissmon monitoring system. Time intervals are relatively short, especially for the piezometers which monitor water height around the door chamber.

4.2 Monitoring settlement blocks

The first monitoring project of ‘MEET HET’ is way smaller in scale than the previously mentioned project. The scope of the project is to monitor settlement blocks (figure 6). These blocks are placed between a buried pipeline and a site where sand is going to be stacked 3 meters high.
Every two weeks, the settlement of the blocks will be measured by an S8 total station. The measurements can then be put in Trimble 4D control to give an overview of the deformation over time.

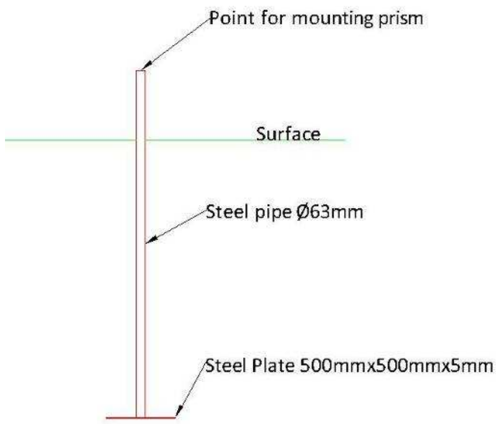

Figure 6:Principle of a settlement block

REFERENCES

Couderé, Bruges (SwissMon system,Terra monitoring)
Trimble technical notes (S8, Monitoring systems and 4d software)
Nuttens, T. , 2010, High Resolution Terrestrial Laser Scanning for Tunnel Deformation Measurements, FIG Congress 2010

BIOGRAPHICAL NOTES

Bram Van Londersele (°1986)
MSc in Geomatics and Surveying – Ghent University (Belgium) (2010)
Self-employed since: 2010
Working experience: Ghent University dept Geography (2010-2011)
Specialties: private sector
Member of: Royal Confederation of Surveyors (Belgium), Flanders Maritime Cluster

Jonas Van Dosselaer (°1986)
MSc in Geomatics and Surveying – Ghent University (Belgium) (2009)
Self-employed since: 2010
Working experience: B.I.T.S. nv – survey company (2009-2010)
Specialties: industrial sector
Member of: Royal Confederation of Surveyors (Belgium), Flanders Maritime Cluster

Jonas Van Hooreweghe (°1985)
BSc in Geomatics and Surveying – Ghent University (Belgium) (MSc expected in 2012)
Self-employed since: 2010
Specialties: architecture and archeology
Member of: Royal Confederation of Surveyors (Belgium), Flanders Maritime Cluster

CONTACTS

Jonas Van Dosselaer
Partner of MEET HET
Elfjulistraat 90
9000 Gent
BELGIUM
+32478/095635
jonasvd@meet-het.be
www.meet-het.be