Lock monitoring and measuring the reference grid on the working site using Leica Viva TS15

ENSURING SMOOTH FLOW THROUGH A BUSY CANAL

RENOVATION OF THE KIEL CANAL REQUIRES THE BUILDING OF AN EXTRA SLUICE CHAMBER TO HANDLE THE CANAL'S TRAFFIC. KATHERINE LEHMULLER LOOKS AT HOW AUTOMATIC POSITION MONITORING IS BEING USED TO ENSURE THAT CONSTRUCTION IS AS SAFE AS POSSIBLE

Germany's busy Kiel Canal has been used as an international shipping lane for more than 100 years. Linking the North Sea to the Baltic, it enables ships not only to save a distance of roughly 280 nautical miles but also to avoid the potentially dangerous storm-ridden conditions of Denmark's northern Jutland Peninsula. One of the most travelled artificial waterways in the world, it is the lifeline and gate that connects German ports to the Baltic, and many countries rely heavily on it for the economy of their industries and businesses.

After a century of heavy traffic on the canal, German's Ministry of Transport, Building and Urban Development decided to modernise and improve safety on the locks of the Waterways and Shipping Authority (WSA Brunsbüttel). Closing the canal during this seven-year construction project would be unthinkable, so a fifth sluice chamber will need to be added to the existing infrastructure. With an expected completion in 2020, this will handle the traffic while renovation of the older locks is being carried out.

The Kiel Canal not only functions as a shipping lane but also neutralises the effects of the North Sea's tidal fluctuations. The water level of the locks continuously fluctuates, rising and sinking roughly 3m over the course of six hours as the tides change. The Brunsbüttel lock system also provides important coastal protection from the Baltic Sea's notorious water level differences that occur due to gales and storm flooding from the sea.

The WSA Brunsbüttel has numerous water sensors that continuously collect water level data to foresee any possible difficulties for the locks' infrastructure and the canal's surrounding area, supplying vast amounts of back-analysis. A geodetic monitoring system is also onsite and continuously collects massive amounts of data. Further review of the data dictated the need for a program that could read and combine sensor information into the data processing software.

Before beginning construction, the stability of this enormous project had to be assessed. The new infrastructure presented demanding technical and logistical challenges that needed to be taken into consideration. The fifth sluice chamber, when completed, will be roughly 350m long, 45m wide, with an underwater extending cill on the lock gate at 14m below sea level. The chamber will be built into the sluice island between the large and small locks, and requires the removal of roughly 1.6m cubic metres of mostly clay soil. Three months of monitoring the existing lock system at Brunsbüttel was necessary to analyse the stability of the structure before starting construction and the construction site will be monitored until its completion.

Monitoring movements during construction

Kirchner Engineering Consultants GmbH was contracted to monitor the movements of the structure during construction. A key requirement for

Heavy traffic at WSA Brunsbüttel made extension, renovations and safety improvements a necessity

One of the locks being monitored for deformations during renovation

One of the special monitoring prisms used by total stations to track deformations

WSA was to incorporate data collected from existing water sensors scattered throughout the lock structure at Brunsbüttel and to easily integrate this information into the automatic, real-time geodetic monitoring analysis.

Kirchner contracted ALLSAT GmbH, a company specialising in geomonitoring using high-precision total stations that had been collecting geodetic data from the Brunsbüttel for some time. The project requires the best possible deviation measurements and GeoMoS Monitor software used by ALLSAT delivers an accuracy of ±2mm.

After collecting and analysing new and previous data for three months, the building of the chamber could start. During construction, the chamber walls next to the building site will be continuously monitored three times per hour for any deviations of 2mm or more and for any deformation activity of more than 15mm from the position and height of each point being monitored.

The data collected for existing chambers gates and walls used four Leica Geosystems Nova TM50 total stations set up on pillars throughout the lock infrastructure and also used Leica Geosystems special monitoring prisms.

Installations were completed by ALLSAT, which used the Leica GeoMoS software for data processing and visualisations. Communication boxes with GPRS data modems were also installed on top of the measuring pillars using mobile service providers to transfer data. Total stations were also secured by weather element protectors.

Necessity is the mother of all invention

Due to WSA's special requirements, Leica Geosystems added a new format editor to its GeoMoS software. This new editor could automatically process data from one or more sources, such as sensors, data loggers, files and databases.

With this addition, Intelligent Open Interface was enabled, allowing the integration of any comma separated value (CSV) file. After a one-time content configuration, the GeoMoS CSV-module could automatically process any new raw data content from the water sensors on the tidal range water levels surrounding the locks. Each data field, separated by a semicolon within the CSV file, received certain configuration parameters, such as time format, identifier, observation, unit and location. With this information, any CSV file could be processed in pre-defined time intervals.

In this case, the raw data of the water levels was combined with the coordinates of the geodetic monitoring system. With the virtual sensor editor, the system could process the deformations corrected by the tide influence to become a complete monitoring analysis.

With the new editor, the monitoring software became highly flexible and able to read any software interface. Sensor data available via the Internet could be quickly integrated into real-time analyses. All changes to the canal's water levels could be taken into account when analysing the geodetic measurements for deformation tolerance levels.

The software also processed this data into easily understood visualisations that could be customised to the level and need of those responsible receiving the information.

Should any of the data measurements exceed the set maximum deformation limits, a second measurement is made immediately after the completion of that measuring cycle. If this second data measurement still exceeds the maximal allowed limits, the people responsible at Kirchner are immediately informed by an automatic email message so they can take the necessary actions.

"The ability to use the open interfaces in Leica GeoMoS monitoring software simplifies access to any sensor data. The combination of geodetic, geotechnical and environmental sensors is important to effectively analyse and understand the impact of environmental change on man-made structures," says Michael Rutschmann, senior project manager of structural monitoring at Leica Geosystems.

DUE TO WSA'S SPECIAL REQUIREMENTS, LEICA GEOSYSTEMS ADDED A NEW FORMAT EDITOR TO ITS GEOMOS SOFTWARE

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