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ENSURING SMOOTH FLOW

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, the canal 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 - the coastal gale winds and increasingly difficult tidal changes of the Skagervak between Denmark and Norway.

After a century of heavy traffic, German's Ministry of Transport, Building and Urban Development decided to modernise and carry out safety improvements on the locks of the Waterways and Shipping Authority (WSA Brunsbüttel). The Kiel Canal is one of the most travelled artificial waterways in the world and many countries rely heavily on the canal for the economy of their industries and businesses. Closing the Kiel Canal during this seven-year construction project would be unthinkable since the canal is the lifeline and gate that connects German ports to the Baltic Sea. Therefore, a fifth sluice chamber needed to be added to the existing infrastructure. With an expected completion in 2020, this fifth chamber will handle the shipping traffic while the older locks' renovation is being carried out.

ANALYSING THE RISE AND FALL OF THE TIDE

The Kiel Canal not only functions as a shipping lane but also neutralises the effects of the North Sea's tide fluctuations and the water level of the locks that continuously fluctuates, rising and sinking roughly 3 metres 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 gale winds and storm flooding from the sea.

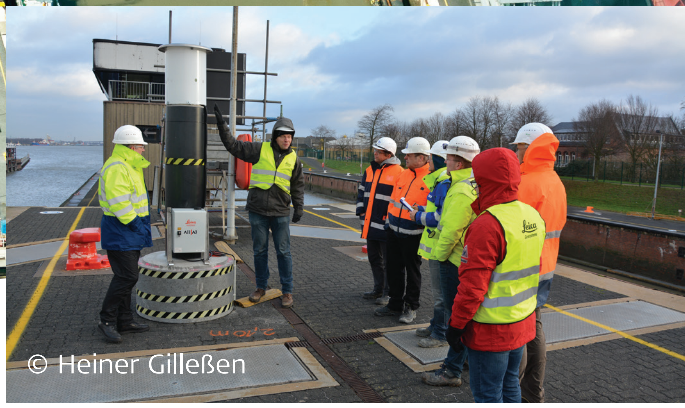
The WSA Brunsbüttel has numerous water sensors that continuously collect water level data to foresee any possible water-related difficulties for the locks' infrastructure and the canal's surrounding area, supplying vast amounts of historic analysis. A geodetic monitoring system is also onsite and continuously collects massive amounts of data. Further review of the data dictated the need for a programme 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, which needed to be taken into consideration. The fifth sluice chamber, when completed will measure roughly 350 m in length, 45 m in width, with an underwater extending cill on the lock gate at 14 m below sea level. The chamber will be built into the sluice island between the large and small locks and requires the removal of roughly 1.6 million m³ of mostly clay soil. Three months of monitoring the existing lock system at Brunsbüttel was necessary in order to analyse the stability of the structure before starting with construction. Once the project began, the seven-year 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 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.

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



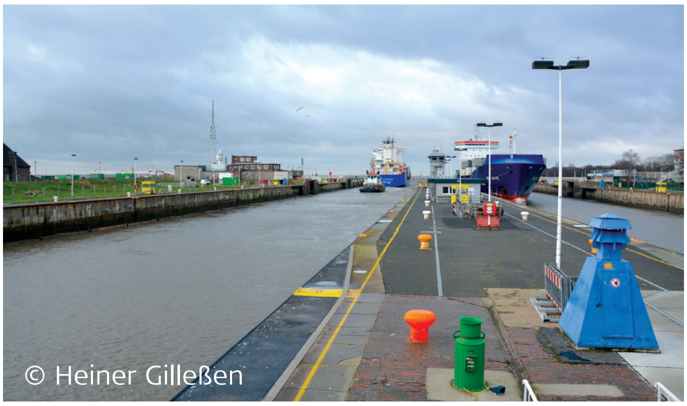
After collecting and analysing new and previous data for three months, the building of the chamber could start. During construction, the chamber walls next to the building site will be continuously monitored three times per hour for any standard deviations (2 mm) and for any deformation activity of more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

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

Installations were completed by ALLSAT, who used 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 the special demands required by WSA, Leica Geosystems added a new format editor to its GeoMoS software. This new editor can automatically process data from one or multiple sources, such as sensors, data loggers, files or databases. With this editor 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 can 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 were 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 this new file formatting editor, the monitoring software became highly flexible and able to read any software interface. Sensor data available via the Internet could be quickly integrated for real-time analyses. All changes to the canal's water levels can be taken into account when analysing the geodetic measurements for deformation tolerance levels. The software also processed this data into easily understood visualisations that can be customised to the level and needs of those responsible receiving the information.

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

GeoConnexion

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