FOS-Based Monitoring of Underwater Port Structures

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SUMMARY

An operable port infrastructure is an essential module in the global logistics chain. Parts of the critical infrastructure will be damaged if the ports are in operation for a longer period. Manual or automatic inspections are necessary to verify the degree of damage and the stability (e.g., of quay walls). While classical geotechnical and geodetic methods can well monitor the above-water parts, the permanent monitoring of the underwater components is still a challenge. Only a few sensor types, such as inclinometers and fibre-optic sensors (FOS), are adequate to be mounted underwater on an existing underwater structure. This investigation considers on their potential for underwater monitoring applications, since the cost of individual FOS is significantly lower than that of an underwater inclinometer. These sensors, as well as extensometers, are mounted on a quay wall. They form a spatially distributed multi sensor network, or more specifically a geo sensor network. In addition, sensors acquire environmental parameters, such as water level and temperature. The processing program records automatically measurements of all sensors and transmits them to a server. There, the data is visualized on a web interface and analyzed by a self-developed monitor program for deformations of the quay wall. Based on these time series from the measurements, the suitability of the installed FOS sensors for use in an underwater monitoring system and the consistency of the data are evaluated. In this context, also the relation between the chosen mounting type and the consistency of the data is considered. In comparison, the reliability of the cost-effective FOS is lower than that of other sensors. Numerous failures still occur with the chosen mounting method. However, after pre-processing, the cross-correlation to neighboring underwater inclinometers can be more than 0.6.

Reliable time series are used to describe and model subsequently the deformation behavior of the wall. For that purpose, the interactions between potential influencing forces and deformations are investigated by time series analysis (e.g., trend determination, correlation, spectral analysis).

Finally, a developed deformation model describes the dependency of local geometric changes and the acquired environmental parameters.