Digishape meeting session: Soil retaining structures

The goal of this session is the presentation of the collaboration agreement between TU Delft and Port of Rotterdam (PoR). The 2-years collaboration agreement starts from the following observations:

- PoR has a lot of field test data gathered in the past and will gather a lot of data in the future;
- This data is currently underutilized and combined with academic knowledge a lot of added value can be created.

The session has three intervention: (1) collaboration agreement activities, (2) first research ideas, (3) reliability updating for ground anchors and (4) proposal of a standard format for anchor test data.

1   Collaboration agreement activities

The program activity can be subdivided into the following activities:

1) Definition of an infrastructure for successfully exchanging data and speeding up the development of added value;
2) Definition of a formal agreement for data exchange;
3) Identification of pilot projects where added value can be created;
4) Research & quantification of added value;
5) Dissemination of results.

The expected results of the collaboration are:

1) Prove that the data delivery infrastructure works;
2) Quantify of the added value provided by using the data for research;
3) Define the direction of the future research;
4) Set up a community.

2   First research ideas

The first research ideas are based on (1) grout anchor test data and (2) wall thickness measurements.

The interpretation of grout anchor test data will allow to understand the mechanical response of anchors and will allow to verify both the current empirical design approaches and the test procedures. In particular, the design approach seems excessively over-conservative, leading to an overestimation of the anchor numbers and to an underestimation of the perturbations that can be applied on the system (stored goods, vessel loads…). Test procedures can be improved by avoiding cyclic loads (that may induce cyclic soil properties degradation) and by measuring strains along the anchor.

The validation of corrosion curves or, if necessary, the introduction of new ones and the introduction of simple models to estimate the evolution of quay wall safety with time will allow to improve the management of existing quay walls: a more reliable estimation of the residual life will on one hand increase safety and on the other one reduce the consumptions of raw materials (substitute quay walls only when really necessary).

3   Reliability updating for ground anchors

The reliability updating is based on a statistical procedure named Bayesian updating. This allows to include newly acquired information into initial statistical distributions. This process allows to reduce the uncertainty while new data are acquired, thus the design resistance of the anchor can be increased. The result (in term of

added value) is a reduction in construction of new quay walls or the possibility of increasing the loads applied to existing ones. The results of a preliminary research carried out by Royal Haskoning DHA and Deltares highlight that an increase between 5 and 15% or 0 and 40% (depending on the followed approach) in the design resistance of grout anchors can be obtained by using reliability update.

4   Definition of a standard for ground anchor tests

In the current practice, results of ground anchor tests are presented in different formats and sometimes are not complete. For this reason, the practical use of these results is very time consuming. The introduction of a standard for presenting the results will allow to significantly reduce the time necessary to start using these data and, consequently, the costs.

The standard test report has to include:

- Test results (time, force, displacements) and information on the measurement data;
- Technical anchor data (geometry, type);
- Location;
- Type of test;
- Data during the installation (grout mix design, flow rate, pressure, drilling torque…);
- Requirement for measurement frequency;
- Data structure for measurement device (load cells, fibre-optic sensors, strain gauges).

Concluding remarks

The main conclusion of the session, shared by the whole community, are:

- The definition of a standard format for test results, also including useful metadata, is necessary;
- The introduction of a set of subroutines for reading, using and representing the data will reduce the time necessary to use the data;
- Sharing these subroutines in the community will be very beneficial for both the users and the developers;
- A large room for the improvement in the ground anchor design exists but it passes through the interpretation of test data and the understanding on the mechanical response.