Title of the project:
Effects of berms and revetment roughness on wave overtopping at dikes 06.19

Assignment no.:

Internal/external:
optional

Head graduation committee:
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Daily advisor:
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Dr. Marcel van Gent (Deltares)

Name(s) of participating companies or institutes:
Deltares

Start of the project:
a.s.a.p.

Required courses:
Short Waves and Coastal Dynamics, Data Analysis in Water Eng. & Man., Hydraulic Engineering

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Short description and objective of the project:
There will be an increasing risk of coastal flood disasters all over the world due to enhanced loads resulting from climate change, sea level-rise and land subsidence (Temmerman et al., 2013). Dikes are important structures to protect infrastructure and people in coastal areas from storm attack (Fig. 1). When designing a dike, wave overtopping is often used to determine the crest level and cross-section geometry by ensuring that the average overtopping discharge is below acceptable limits. Hence, a reliable estimation of overtopping discharge is important for dike design and safety assessment.

In practical engineering, berms and roughness elements are often applied to reduce the average overtopping discharge. Effects of berms and roughness on wave overtopping are parameterized as influence factors in the empirical overtopping formulae given by TAW (2002) and EurOtop (2007, 2018). These manuals provide methods to estimate berm influence and roughness influence. However, the existing methods have limited accuracy of predicting the berm influence and roughness influence. It is necessary to improve the estimation methods of influence factors, thereby improving the accuracy of predicted overtopping discharge.

Physical model tests have been conducted at Deltares (Fig. 2) and new formulas are derived based on the results of the tests to estimate the berm influence and roughness influence (Chen et al., in prep.). These new equations for the roughness factor are developed only for protruding block and open block revetments. The experimental data for rocks covered slopes has not been analyzed yet, which will be done in this MSc assignment. Additionally, the validity range of the new formulae is still limited and therefore a validation is necessary to extend the applicability range. It is expected to extend these equations to a wide variety of roughness elements by calibrating the empirical coefficient based on existing data from the CLASH database and additional physical model tests.

The goal of this MSc thesis research is to perform a validation of the new developed formulae and develop new formulae for roughness and berm influence of rock revetments. To achieve this goal, available overtopping data will be collected and analyzed. The CLASH database (2016) (http://overtopping.ing.unibo.it/overtopping/) consists of more than 18000 tests. Moreover, new raw data of tests on model sections covered by rocks are available to analyze the roughness factor of rocks and berm influence factor of the rock berm. In addition to these existing data, it is envisioned that more physical model tests are conducted in the Pacific Basin at Deltares in 2019 to

further investigate the roughness influence and berm influence on wave overtopping. The possibilities for these tests will be explored during the preparation.

This MSc project will involve the following steps:

1. Analyse the available data of model tests on overtopping over sections covered by rocks.
2. Develop new formulae for the berm and the roughness influence for the rock revetment, to improve existing formulae for wave overtopping.
3. Collect suitable data of overtopping discharges at dikes with berms and a variety of roughness elements from the CLASH database.
4. Possibly perform physical model tests on overtopping over different dike configurations at Deltares.
5. Validate the new formulas for a wider applicability range.

Figure 1 Overtopping at dikes (EurOtop, 2018)

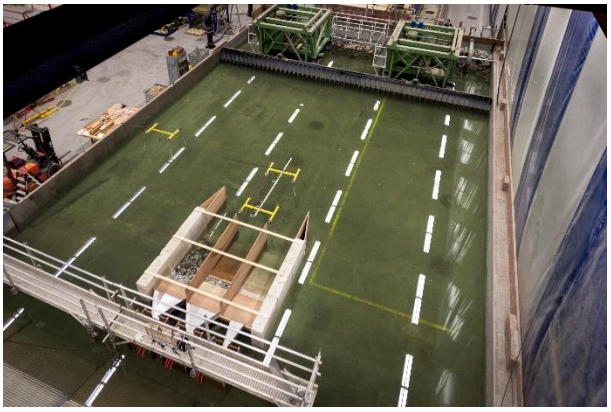

Figure 2 Overview of the Pacific Basin at Deltares

References

EurOtop, 2018. Manual on wave overtopping of sea defences and related structures, An overtopping manual largely based on European research, but for worldwide application.Van der Meer, J.W., Allsop, N.W.H, Bruce, T., De Rouck, J., Kortenhaus, A., Pullen, T., Schüttrumpf, H., Troch, P., Zanuttigh, B.,www.overtopping-manual.com.

EurOtop, 2007. Wave Overtopping of Sea Defences and Related Structures–Assessment Manual. UK NWH Allsop, T. Pullen, T. Bruce. NL JW van der Meer. H. Schüttrumpf, A. Kortenhaus. www. overtopping-manual. com.

TAW, 2002. Technical report wave run-up and wave overtopping at dikes, Technical Advisory Committee on Flood Defence, Delft, The Netherlands.

Temmerman, S., Meire, P., Bouma, T.J., Herman, P.M.J., Ysebaert, T., De Vriend, H.J., 2013. Ecosystem-based coastal defence in the face of global change. Nature 504, 79.