QUANTIFICATION OF GRASS EROSION DUE TO WAVE OVERTOPPING AT THE AFSLUITDIJK

Grass erosion on the crest and inner slope due to wave overtopping is one of the mechanisms that can cause a flood defense to fail according to the Dutch WBI 2017 safety standards. The corresponding probability of failure is determined based on the combination of significant wave height and average overtopping discharge. However, this relationship is only available for wave heights up to 3 meter. The goal of this study is to find the relationship between the significant wave height and the critical average overtopping discharge for higher waves. This is done for the new design of dike section 17a of the Afsluitdijk using the cumulative overload method (COM) and a combination of the coupled crest-inner slope velocity equations (VE) and the transition model (TM).

Both the COM and the VE-TM predict an increasing critical average overtopping discharge for a decreasing significant wave height for all cross-sectional locations. Figure 1 shows the relationship between the significant wave height and the critical average overtopping discharge that is found with the VE-TM. In all simulations the inner toe is predicted as the weakest cross sectional location, with a minimum critical average overtopping discharge of 3.4 L/s/m (COM) and 1.4 L/s/m (VE-TM) for a wave height of circa 4 meter. Furthermore, both modelling approaches predict similar relationships at the crest, while these are different for the other locations as a result of a varying inner slope length. Lastly, the COM predicts that a grass-to-asphalt transition can withstand a larger average overtopping discharge than an asphalt-to-grass transition, while the VE-TM predicts the opposite. This is likely a result of inaccurate incorporation of the local turbulence in the VE-TM.

It is recommended to carry out (scaled) wave overtopping experiments that include the inner slope and inner berm for wave heights larger than 3 meter. The data that results from these experiments can be used to validate the results that are found in this study. Furthermore, it is recommended to apply a more detailed turbulence model in the VE-TM to obtain more realistic results at cover material transitions. Finally, in order for the simulation results to be included in the WBI 2017, the modelling approach in this study should be modified so that a distribution for the probability of failure can be found for waves larger than 3 meter.

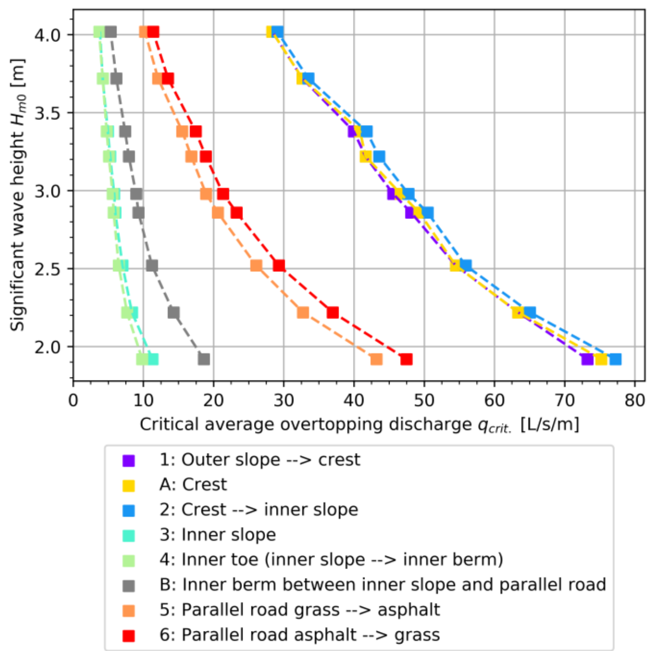

Figure 1: Critical average overtopping discharges for different cross-sectional locations of the Afsluitdijk, as simulated with the coupled crest-inner slope velocity equations combined with the transition model.

Martijn Kriebel

Graduation Date:
12 July 2019

Graduation committee:
University of Twente
Prof.dr. S.J.M.H. Hulscher
Dr. J.J. Warmink
V.M. van Bergeijk MSc.

Witteveen+Bos
Ing. C. Kuiper
Ir. H. Trul