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Book of Abstracts

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The effect of the slope angle on the failure of the grass revetment due to wave impact

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Introduction

Parts of the Netherlands are protected against floods from the sea by a variety of dikes. At the Dollard in the Netherlands, a green dike was constructed. A green dike is a dike with a grass cover on the entire slope and such a dike does not contain a hard revetment to deal with the incoming waves (Figure). The assessment of the strength of the grass revetment against wave impact is captured in the "Wettelijk Beoordelingsinstrumentarium" (WBI). However, it is uncertain under which storm circumstances the seaside grass revetment fails, because the slope angle is not included in the safety assessment (WBI). The objective of this research is to determine the effect of the slope angle on the duration until failure of the revetment due to wave impact, also termed resistance-duration.

Methods

Results of historic experiments were gathered from literature and they were used to establish the relation between the slope angle and the resistance-duration of the seaward grass cover. The results of the experiments with different slope angles are compared with the WBI and the Wave Impact Pressure Erosion (WIPE) model. Additionally, the effect of the slope angle on failure probability in the case of the green dike at the Dollard was quantified.

Results

From the data analysis of the executed experiments, a linear negative correlation between slope angle and resistance-duration was found. This means that a grass revetment on a slope of 1:6 has twice the resistance-duration compared to a revetment on a slope of 1:3 with similar wave conditions. When this relation is applied for the Dollard case, we found a return period of a storm that results in failure of once in 90 years for a slope of 1:7. According to the detailed assessment of the WBI, that does not take the slope angle into account, a return period of less than 10 years is predicted. Thus, the slope angle substantially reduces the failure probability for the grass revetment in case of a gentle seaside slope. Including the slope angle in the safety assessment gives a more accurate strength estimation of a wide green dike. This is a first step towards a realisation of a dike that meets the safety requirements while it contributes to the ecological value of the environment.

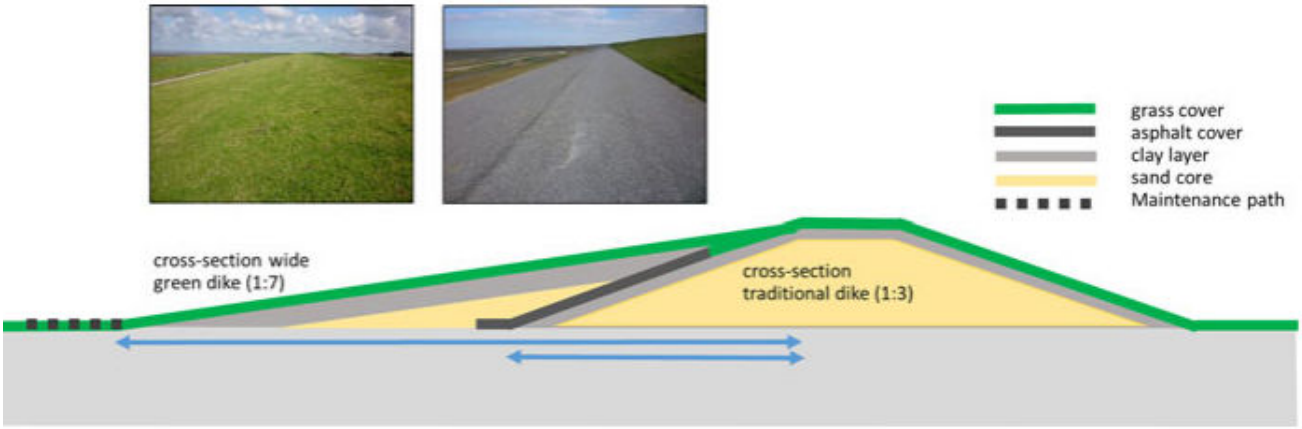

Figure 1 Cross section of a traditional dike and a wide green dike. Source: Van Loon-Steensma and Vellinga (2019)

Reference

Van Loon-Steensma, J. and Vellinga, P. (2019). How "wide green dikes" were reintroduced in the Netherlands: a case study of the uptake of an innovative measure in long-term strategic delta planning. Journal of Environmental Planning and Management.