Technische Universiteit Delft

Offshore & Dredging Engineering

The experimental study of stable and unstable breaches

When dredging close to underwater sand slopes, steep slopes might form. In dense sand with low permeability this might lead to the so-called breaching process. The creation of a steep underwater slope marks the beginning of a breaching process.
Pore volumes of densely packed sand tend to increase during shear deformations. This effect is called dilation. As the grain slides over each other, the pore volume increases resulting in increased underpressures. Water, eventually, has to flow in to compensate for this underpressure. The flow rate depends on sand properties. The underpressure keeps the sand body, temporarily, stable. When enough water has flowed in and the sand has dilated enough, sand particles release at the front. This is at the start of the breaching process. This leads to a density current consisting of sand mixed with the surrounding water, which runs down the slope and might cause erosion. The steep front of the slope moves with a certain velocity, which is called the headwall velocity.

A breach can be stable or unstable. A breach is stable if the breaching height decreases in time and unstable if the breaching height increases in time. This work aims to improve the prediction of the stability of a breach. For this purpose I carried out a series of large scale breaching experiments. During these experiments the initial breaching height, slope angles, and sand types and varied.

Literature suggest that the stability of a breach can be predicted using the headwall velocity and the angle at the toe of the breach. The experiments show that this is indeed the case, but that breaches are more stable than literature suggests.

Therefore, to predict the stability of a breach we must know the angle at the toe, and the headwall velocity. The experiments show that the angle at the toe converges towards the angle that is predicted using equations found in literature.

A formula to predict the wall velocity can be found in literature. Comparison with the experiments show that this formula can predict the wall velocity when no slides are present, but at large breach heights these slides often occur.

The experiments show a clear correlation between the breach height, and the frequency of sliding wedges. Empirical equations following from the test data predict the percentage of the sliding wedges at different breaching heights are proposed.

A steady state numerical model, to calculate the pore pressure during a breaching process, was programmed in MATLAB. Using these pore pressures, a stability analysis was carried out. This analysis confirms that breaching height is an important factor for the prediction of sliding wedges.

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April 25th 2018

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