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Effects of obliquely opposing and following currents on wave propagation in a new 3D wave-current basin

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INTRODUCTION & MOTIVATION

The design of structures in coastal and offshore areas and their maintenance are key components of coastal protection. Usually, assessments of processes and loads on coastal structures are derived from experiments with flow and wave parameters in separate physical models. However, Peregrin (1976) already points out that processes in natural shallow coastal waters flow and sea state processes do not occur separately, but influence each other non-linearly. Kemp & Simons (1982) perform 2D laboratory tests and study the interactions between a turbulent flow and following waves. They highlight the significance of wave-induced changes in the current properties, especially in the mean flow profiles, and draw attention to turbulent fluctuations and bottom shear stresses. Kemp & Simons (1983) also study these processes and features with opposing waves. Studies on the wave-current interaction in three-dimensional space for a certain wave height, wave period and water depth were conducted by MacIver et al. (2006).

The research focus is set on the investigation of long-crested waves on obliquely opposing and following currents in the new 3D wave-current basin.

METHODOLOGY

In a first step the *flow analysis without waves* is carried out and includes measurements of flow profiles in the sweet spot of the basin at predefined measurement positions. Five measuring points in the water column have been delineated in different water depths in order to obtain vertical flow profiles. For the characterization of the undisturbed flow properties in the basin, an uniformly distributed flow was generated in the wave basin. In the second step *wave analysis without current*, the unidirectional wave propagation and wave height were investigated for long-crested waves in intermediate wave conditions. In the sweet spot of the wave basin waves with three different wave directions, three wave periods and uniform wave steepness were examined. For evaluation, we applied a common 3D wave analysis method, the Bayesian Directional Spectrum method (BDM). BDM was presented by Hashimoto et al. (1988). Lastly, *identification of the wave-current interaction*, the results from experiment with simultaneous waves and currents are compared with results for only-currents and only-waves in order to identify and exemplify the significance of nonlinear interaction processes.

RESULTS

The first results of the wave-current interaction show, as expected, a reduction in the wave height in the direction of flow and an increase in wave heights against the flow with unidirectional monochromatic waves. The superposition of current and orbital velocities cannot be conducted linearly. Furthermore, the results show a current domination for low wave periods and wave domination for larger wave periods. The criterion of a current or wave domination will be presented in the presentation.

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