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Experimental study of the runup of long nonlinear regular and irregular waves

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We study experimentally the role of the asymmetry and nonlinearity of long regular and irregular waves approaching the coast and its influence on the dynamics and statistics of the shoreline motion (wave runup). In addition to the verification of purely inviscid models, we study dependence of the runup on the bed roughness and record velocity statistics in the near-bed boundary layer with the view to use in shore erosion applications.
We have tested a range of incident wave fields: regular, narrow band, and wide band and studied the wave runup on the smooth slope, as well as on the slope with affixed roughness elements, 50x50mm logs. The experiment was conducted in the Large Wave Flume (GWK), Hannover, Germany. The water depth of 3.5m was used in all tests. The incident wave field was measured by an array of resistance gauges spread along the flume. The shoreline position was measured with a capacitance gauge consisting of two isolated wires suspended at 10mm above the slope. Two components of water velocity were measured in the near-bottom boundary layer using Ultrasound Velocity Profiler. The force exerted by the waves on selected roughness elements was measured with load cells. Water profile in the swash zone was measured by video-recording a lasersheet reflected from the water surface. For calibration purposes, the shoreline position was also video-recorded.
The strong influence of the steepness of the wave front on the long wave runup characteristics which has previously been predicted theoretically has now been confirmed experimentally. Among waves of a fixed amplitude and frequency (length), the steepest wave penetrates inland to the largest distance. Consequently, the least dangerous are symmetric sinusoidal waves. It has been shown that the narrow band incident wave fields result in a greater significant runup height than the wider band ones of a similar mean square amplitude. Higher loss of the wave energy (weaker reflected wave) has also been found to occur when incident waves have the narrow band spectrum.