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Laboratory modeling of extreme waves

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Sudden waves of considerable height are frequently observed at sea. These waves, with abnormally high amplitude, do not occur only in deep Ocean, but also in the coastal zone. A lot of studies have considered these waves in the open ocean; however, they have received little attention in the coastal zone. The physical processes involved in the transformation of these waves from the open sea to the coastal zone are poorly understood, despite the significant impact these waves may have on the coasts, such as overtopping, material damages, and erosion. The aim of the present work is to bring a contribution to the study of these processes from physical modeling.
Present tests are carried out in a 22 m long, 0.8 m wide, and 0.8 m high wave flume. Solitary waves are generated. Preliminary tests have been performed to compare the characteristics of the experimental waves with the theoretical prediction of Boussinesq [1]. A good agreement is obtained as well for the wave form, than for the wave speed and duration. The transformation of solitary waves during their propagation towards the shore has been studied using an artificial 4% slope in the flume, placed 9.5m downwards from the wave paddle. A particular attention has been focused on the evolution of the wave energy. Above the 9.5m long horizontal bed upwards from the slope, an energy dissipation ranging from 20 % to 30 % has been obtained. However, the wave energy was found to increase during the propagation of the solitary waves above the sloping bottom, from 15 % to 30 % according to the considered tests, in agreement with the results depicted in [2]. Sapce-time diagrams have been plotted, allowing to describe the propagation of solitary waves above the horizontal and sloping bed. On these diagrams we can clearly see that the solitary wave has a symmetric profile about its crest and an approximately constant celerity before it reaches the slope. The wave height then increases when the solitary wave climbs up the slope. As water depth decreases, the solitary wave progresses with increasing of asymmetry and the front became more and more steep. Finally, the maximum runup is considered, and a new formula is proposed for its estimation (depending on the tangent of the 4% slope)
Formation of freak waves resulting from the focusing wave group propagating in finite water depth was also investigated experimentally. Runup, breaking and energy dependence have been investigated.

References

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