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Experimental and numerical investigation of the hydrodynamics generated by regular breaking waves

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Great improvements have been brought to the knowledge of the hydrodynamics and the general processes occurring in the surf zone, widely affected by the breaking of the waves. Nevertheless, the turbulent flow structure is still very complicated to investigate. The description of the hydrodynamics in the surf zone is then a field of research requiring efforts and improvements. The rapid advances of the experimental techniques and the recent progresses in applied mathematics and computers architectures offer the possibility to overtake some limitations. On the basis of the published experimental [1-2] and numerical [3] works, the hydrodynamics of regular waves shoaling and breaking over a sloping beach is presented. The breaking processes including shoaling, overturning, splash-up, roller propagation with air entrainment, will be presented and discussed. The turbulent flow structures generation will be carefully described.

The experiments were conducted in the EGIM wave tank, which is 17 m long and 0.65 m wide. The beach is 13 m long and the slope is 1/15. The initial wave height is 11.38 cm and the mean water depth is fixed to 70.5 cm. The wave period is 1.275 s. The numerical tool [4] is well suited to deal with strong interface deformations, occurring during wave breaking, and with turbulence modeling in the presence of a free surface in a more general way. It has already been shown to give accurate results for coastal applications [3-5].

The results showed that the wave starts breaking showing a short spilling phase at the top of the crest. Then a jet of liquid is rapidly ejected from the wave crest and the overturning wave front curls forward. A first splash-up is generated when the jet of liquid hits the front face of the wave. A large amount of air entrained with foam and bubbles is observed. Some other splash-ups are then generated. A roller propagates towards the shoreline, with a great air-water mixing area. The bubbles are generated in the upper part of the water column and advected towards the bottom with a slight slanting axis. The volume of entrained bubbles decreases gradually till the wave crosses the shoreline, runs up before coming back. This is in agreement with the general description of the flow, which can be found in the literature. Very promising results have already been obtained and led to a better understanding of energy dissipation and turbulent flow structures generation processes. Our main goal is to improve the description of the flow and to show the role of air entrainment on the generation of turbulence and the energy dissipation.

References

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