Implementation and test of a modeling strategy for depth-induced breaking in fully nonlinear potential flow models

Christos E. Papoutsellis ([a]) ([b]), Bruno Simon ([a]), Michel Benoit ([a]) ([b]) and Marissa L. Yates ([c])([d])

(a) *Institut de Recherche sur les Phénomènes Hors Equilibre (IRPHE), Marseille, France*
(b) *École Centrale Marseille, Marseille, France*
(c) *Saint-Venant Hydraulics Laboratory, Université Paris-Est, Chatou, France*
(d) *Cerema, Water, Sea and Rivers, Margny-les-Compiègne, France*

A modeling approach is tested for the treatment of breaking waves in the coastal zone, within the limits of numerical wave models based on fully nonlinear potential flow theory. Assuming irrotational flow and a non-overturning free surface, fully nonlinear models such as the Hamiltonian Coupled-Mode System (HCMS) [1] and models using a spectral approach in the vertical direction [2], are not able to predict the overturning and breaking of waves and their post-breaking evolution.

In order to overcome this limitation, a strategy is adopted involving a breaking wave identification algorithm, based on certain local criteria such as the slope or vertical velocity of the free surface elevation. The identified breaking waves are forced to dissipate energy through the action of an appropriate external surface pressure applied locally, which is computed by assuming an analogy between a breaking wave and an hydraulic jump [3]. In order to assess the performance of the present approach, the calculations are compared with experimental measurements of plunging or spilling breakers over barred and sloping bathymetries (e.g. [4], [5]). Numerical aspects and the sensitivity of the method to free parameters (e.g. thresholds for breaking initiation and termination, duration and spatial extent of the pressure term) will be discussed.

References:

[1] Ch. Papoutsellis, G. Athanassoulis, A new efficient Hamiltonian approach to the nonlinear water-wave problem over arbitrary bathymetry, (Submited)). (2017). http://arxiv.org/abs/1704.03276.

[2] C. Raoult, M. Benoit, M.L. Yates, Validation of a fully nonlinear and dispersive wave model with laboratory non-breaking experiments, Coast. Eng. 114 (2016) 194–207. doi:10.1016/j.coastaleng.2016.04.003.

[3] S. Guignard, S. Grilli, Modeling of wave shoaling in a 2D-NWT using a spilling breaker model, in: ISOPE 2001, Stavanger, Norway, 2001.

[4] S. Beji, A. Battjes, Experimental investigation of wave propagation over a bar, Coast. Eng. 19 (1993) 151–162. doi:10.1016/0378-3839(93)90022-Z.

[5] F.C.K. Ting, J.T. Kirby, Observation of undertow and turbulence in a laboratory surf zone, Coast. Eng. 24 (1994) 51–80. doi:10.1016/0378-3839(94)90026-4.