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Focusing of long waves with finite crest over sloping beach

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Analytical solutions of nonlinear and linear shallow water-wave equations are important in several counts. These solutions not only provide insight to establish relationship among the parameters of the problem, but also could provide benchmark results for numerical studies. Here, first, we introduce a new analytical solution to study three-dimensional evolution and runup of long waves over linearly sloping beach. Then, we extend our solution to study the canonical problem, i.e. long wave propagation over a sloping beach connected with a constant-depth region. Koshimura et al. (1999, Coastal Eng Japan, v. 41(2), pp. 151-164) solved this problem in the presence of a vertical wall at the shoreline. The same form of solution has also appeared in the propagation of edge waves, as presented by Fujima et al. (2000, Coastal Eng Japan, v. 42(2), pp. 211-236) and recently by Geist (2013, Pure Appl Geophys, doi: 10.1007/s00024-012-0491-7). On the other hand, Carrier (1995, in: Tsunami: Progress in Prediction, Disaster Prevention and Warning, Tsuchiya and Shuto (eds.), pp. 1-20) started with the nonlinear shallow-water-wave equations, reduced the problem into the linear one and solved as an initial-value problem. In the present study, we differ from the existing analytical studies providing initial conditions as recently described by Kanoglu et al. (2013, Proc R Soc A, v. 469, 20130015, doi: 10.1098/rspa.2013.0015). They introduced a new exact analytical solution to study the propagation of a finite strip source over constant-depth using the linear shallow-water wave theory showing the existence of focusing points for realistic N-wave-type initial displacements (Tadepalli and Synolakis, 1994, Proc R Soc Lond A, v. 445, pp. 99-112, doi: 10.1098/rspa.1994.0050). Here, we discuss the existence of focusing point –a point where unexpectedly large wave heights may be observed due to the configuration of the initial waveform– for the canonical problem, a phenomenon already shown for constant-depth basin by Kanoglu et al. (2013). We also discuss effect of focusing over the runup.

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