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Effective fully-reflective boundary conditions at the shore for modeling of wave processes in long bays

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Nonlinear wave transformation in the coastal zone is usually studied in the framework of 2D shallow-water or Bousinesq equations. However, as a result of refraction, waves propagate almost normally to the shore in the nearshore region and can be described by 1D equations. If the wave is long enough, its amplification at the coast is moderate. This is why fully-reflective boundary conditions, corresponding to the vertical sea wall at some small depth, have become so popular. The accuracy of this assumption is studied here with application to the inclined bay of parabolic cross-section. Moreover, the possibility of forecast of run-up heights at the coast using calculated wave heights at the wall is discussed.

Two different problems corresponding to different bottom topographies are considered: (i) wave run-up in the linearly inclined bay with boundary condition of boundedness of water displacement at the shore applied, and (ii) wave impact on the vertical wall placed at some depth of the same linearly inclined bay with fully-reflective boundary conditions applied. The connection between wave run-up and water oscillations at the wall for the same incoming wave field is established. This connection can be used in many practical applications, for example, in coastal planning and defense and in real-time forecast of tsunami run-up height. Based on obtained formulas, a method for express-estimates of wave run-up heights and flow velocity at the coast using simulated wave oscillations at the sea wall is developed.