Head-collision of nonlinear waves in a shallow basin: wave field and bottom pressure

Artem Rodin¹, Natalia Rodina², Andrey Kurkin¹, Julien Touboul³, and Efim Pelinovsky⁴,⁵,⁶

¹Nizhny Novgorod State Technical University n.a. R.E. Alekseev, Nizhny Novgorod, Russia, e-mail: xmrarro@gmail.com, aakurkin@gmail.com
²Lobachevsky State University of Nizhni Novgorod, Nizhny Novgorod, Russia, e-mail: na4aikovskaya@mail.ru
³Universite de Toulon, M.I.O, SeaTech, La Garde, France, email: julien.touboul@mio.osupytheas.fr
⁴Institute of Applied Physics, Nizhny Novgorod, Russia, e-mail: pelinovsky@gmail.com
⁵Special Research Bureau for Automation of Marine Researches, Yuzhno-Sakhalinsk, Russia
⁶National Research University – Higher School of Economics, Nizhny Novgorod, Russia

The collision of solitary waves has been studied analytically and numerically in numerated papers for last 50 years. In the weakly nonlinear theory, the soliton interaction is inelastic. Here we study more general class of the head-collision of nonlinear waves of various shape (Riemann waves of both polarities, shock waves and solitons) in the shallow water within nonlinear shallow-water theory, Serre-Green-Naghdi and Euler equations. The structure of wave field and induced bottom pressure at the moment of wave interaction is analysed analytically and numerically. It is shown that such an interaction leads to a phase shift and shape deformation in the moment of interaction. Estimates of the height of the Riemann waves as well solitons of moderate amplitudes at the moment of interaction are in agreement with theoretical predictions. The phase shift in the interaction of non-breaking waves is small enough, but becomes noticeable in the case of the shock waves motion. The approximated analytical solution for the wave field and bottom pressure distribution is obtained analytically within Serre-Green-Naghdi system. Computed bottom pressure in dispersive theories has two-bell shape for large amplitude solitary waves in quality agreement with theoretical analysis.