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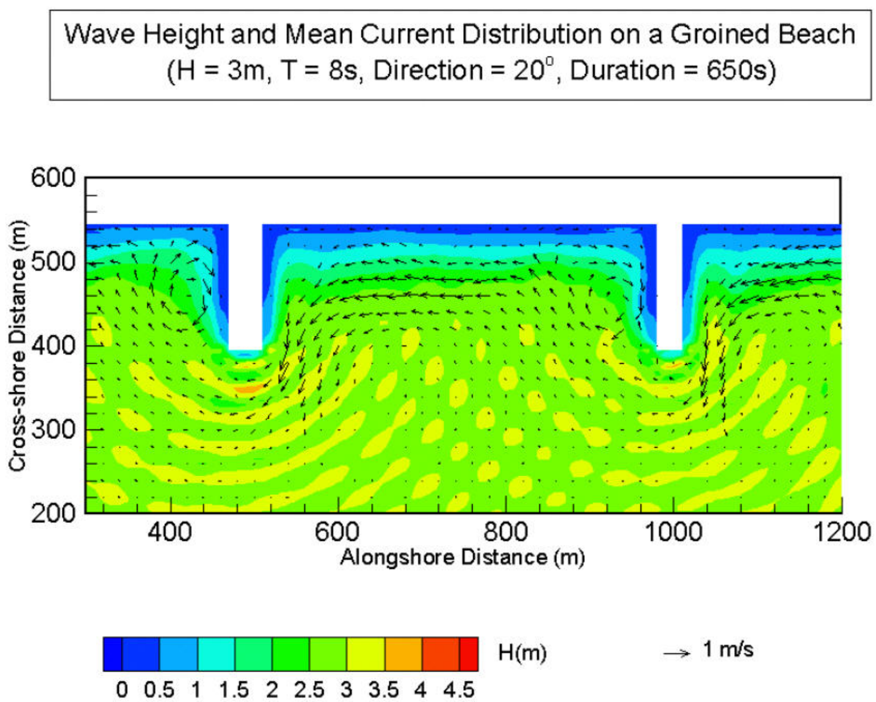
Boussinesq Wave Modeling for Structures, Harbors and Inlets

Purpose: To provide information about ***BOUSS-2D,*** a comprehensive numerical wave model of Boussinesq-type for simulating the propagation and transformation of ocean waves in coastal regions and harbors. BOUSS-2D is appropriate for the most significant physical processes at and around inlets and in harbors.



Background: BOUSS-2D is based on a time domain solution of weakly and fully nonlinear set of Boussinesq-type equations, which represent the depth-integrated equations for the conservation of mass and momentum for waves propagating in water of variable depth. The governing equations are uniformly valid from deep to shallow water and can simulate most of the phenomena of interest in the nearshore zone and harbor basins including: shoaling/refraction over variable topography reflection/diffraction near structures energy dissipation due to wave breaking and bottom friction cross-spectral energy transfer due to nonlinear wave-wave interactions breaking-induced longshore and rip currents wave-current interaction wave interaction with porous structures. Many processes at inlets and harbors can be examined using BOUSS-2D.

Facts: The numerical model solves the governing equations expressed in terms of the water surface elevation and two components of the horizontal velocity at a specified depth below the still water level using a time-domain, finite difference method. The area of interest is discretized as a rectangular grid with the equation variables defined at the grid points in a staggered manner. Along offshore or internal generation boundaries, time histories of velocity fluxes corresponding to an incident storm condition are input. The incident wave conditions may be periodic or non-periodic, unidirectional or multidirectional. Damping layers are placed around the perimeter of the computational domain to absorb outgoing waves. Porosity layers are used to model the reflection, dissipation and transmission characteristics of breakwaters and harbor structures. Outputs of the model are the significant wave height and mean current distribution over the entire computational domain, and time histories of the water surface elevation, velocities and pressure at points of interest in the computational domain. Three-dimensional animation of the model results, showing the evolution of waves in space and time, can also be produced with the model. This allows the modeler to quickly detect numerical instabilities as well as observe complex interactions in an intuitive manner.

BOUSS-2D can be applied to a wide variety of coastal and ocean engineering problems including complex wave transformation over small coastal regions (1-5 km), wave agitation and harbor resonance studies, wave breaking over submerged obstacles, breaking-induced nearshore circulation patterns, wave-current interaction near tidal inlets, infragravity wave generation by groups of short waves, wave transformation around artificial islands. Recent applications of the model include nearshore wave climate studies Ponce de Leon Inlet, Florida, wave agitation studies for Barbers Point Harbor, Hawaii, wave-induced circulation and shoreline erosion studies at the Saco Bay, Maine.

Points of Contact: For additional information, please contact
Dr. Zeki Demirbilek at 601-634-2834 (Zeki.Demirbilek@erdc.usace.army.mil) or
Mr. Dennis Markle at 601-634-3460 (dennis.g.markle@erdc.usace.army.mil).