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US Army Corps of Engineers®
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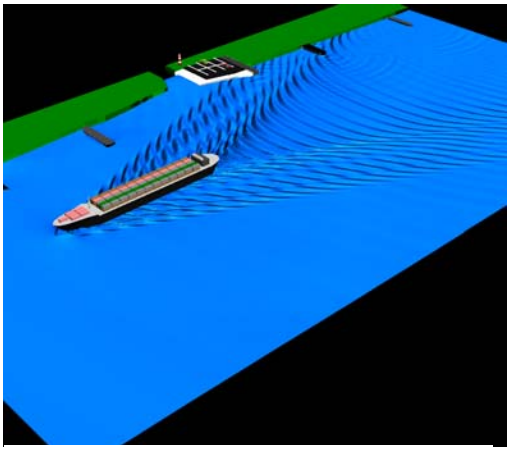
Coastal Inlets Research Program

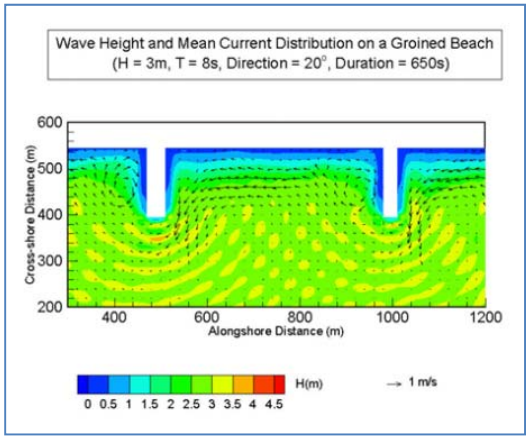
Boussinesq Modeling for Inlets, Harbors & Structures (Bouss-2D)

Description



Modeling of vessel-generated wakes

The Boussinesq Modeling Technology (BMT) comprises of one- and two- dimensional (BOUSS-2D) numerical wave models for simulating nearshore waves and wave-induced circulation. This technology is applicable to a variety of high-fidelity coastal and ocean engineering and naval architecture problems, including transformation of waves over small to medium spatial scale regions (1-15 km); planning and design of ports/harbors/ marinas; investigation of wave agitation and harbor resonance; risk analysis for ship transit; ship mooring & motion studies; wave breaking over submerged obstacles; wave-structure interaction; wave runup and overtopping of coastal structures, levees, groins, beaches, dunes and barrier islands; breaking-induced nearshore circulation in surf and swash zone; wave-current interaction in channels and inlets; generation and impacts of infra-gravity waves on ports and harbors; wave transformation over reefs, shoals/berms and around artificial islands; and impacts of vessel-generated waves on erosion of coastal shorelines and river banks. BMT is a Federal Emergency Management Agency (FEMA) approved model for flooding and inundation works for use in military and civil work applications. It may be used from deep to shallow water to simulate the nonlinear wave processes of interest in the open coast, nearshore zone, and inside complicated port/harbor basins. Wave processes represented by BOUSS-2D include wave reflection and 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 and wave interaction with porous media, wave propagation over vegetated areas, wetlands and marshes, and vessel wakes and ship-channel-shore-bank interactions.



Input waves may be periodic (regular) or non-periodic (irregular); either unidirectional or multi-directional sea states may be simulated. The model can be driven with data with a laboratory data time series or wave spectra, or wave parameters obtained from WaveNet for measured field buoys or gauges, or with data from CMS-Wave spectral wave model. A user-friendly interface of BMT is available in the Surface-water Modeling System (SMS) that allows users to generate model grids, as well as input files and post-process model results. Either wave parameters or wave spectra files from SMS-based spectral wave models can be

used directly in the interface as inputs to BMT. Graphical user interface (GUI) display and analyses capabilities in SMS interface allow users to produce 1D/2D/3D contour plots, animations, and time- and frequency-domain statistical analyses of model inputs/outputs.

Issue Addressed

The Corps O&M budget spent for dredging navigation channels will increase with calls for deepening and widening channels to accommodate future fleets having larger vessels and drafts. New structures will be proposed to reduce navigation channel shoaling and decrease vessel influence (e.g., waves, erosion). Ship-to-ship and ship-to-bank interactions and the risk of accidents will also increase with these demands. Aging and natural deterioration of navigation structures increases ship transit and maneuvering risks along high-traffic shipping routes, channels, and ports. BMT is one the most advanced wave modeling capability available that supports these USACE needs for military and civil works by helping engineers to make reliable and rational decisions in planning, design, and operation of coastal navigation and flooding projects. It provides key engineering estimates for coastal and hydraulic engineering practice and guidance for storms and non-storm waves, wave setup and wave-induced currents in a risk-based design approach in evaluation of navigation and flooding projects. This decision support technology is used in design and modification of ports/harbors and coastal infrastructures, levees to reduce flooding, as well as studies designed to reduce flooding and inundation of vulnerable coastal areas. It is used for operational risk problems in ports and harbors, and for quantifying the impacts of vessel-generated waves on erosion of shores and banks. BMT may be used to understand how well projects are achieving their design goals to develop resilient and cost-effective engineering solutions for coastal and hydraulic problems. It helps the Corps improve O&M design criteria and methods, construction, maintenance and operations practices, and identifies where present technologies are inadequate or where further research is required.

Products

The primary product is BOUSS-2D, a multi-purpose advanced numerical wave model developed for PC and super-computers. It has a comprehensive and user-friendly interface in the SMS for grid generation, viewing and processing model inputs and outputs, and GIS data used in modeling.

Application of Products

BMT has been applied to more than 100 project sites in the USA and abroad. Example applications in USA include ports of San Diego, Los Angeles/Long Beach and Morro Bay harbors, CA; Brookings harbor, OR; Sitka Harbor, AK; Kahului, Pearl, Kawaihae, Barbers Point, Kikiaola, Hilo harbors, HI; Grays Harbor and Mouth of the Columbia River, WA/OR; Field Research Facility, NC; and miscellaneous harbor projects in Guam, Samoa, Korea, Japan, Canada, EU countries, South Africa, Brazil, Peru, India, Indonesia, and Persian Gulf states.

Projected Benefits

BMT helps the Corps evaluate the effects of waves on navigation and flooding projects to reduce O&M costs by developing more resilient and cost-effective engineering solutions. BMT based optimization of integrated navigation system improves the safety, reliability and maintenance of coastal systems by developing innovative infrastructures design and performance metrics for design and utilization of ports/harbors/marinas. Model is designed for studies of channel realignment, deepening and dredging of channels to improve safety of navigation operations, including advanced dredging practices and modifications of ports, harbors and marinas. BMT is provides improved, reliable probabilistic engineering design and rehabilitation estimates for jetties and breakwaters, and evaluation of impacts of engineering activities on coastal navigation (e.g., channel deepening, and jetty modifications). It is widely used in port access and utilization studies to quantify ship transit effects and ship-generated wakes causing shoreline and river banks erosion.

Documentation

Model documentation includes a technical report and a series of technical notes describing model's theory, numerics, V&V examples, and a step-by-step user's guidance on model's SMS interface and project reports illustrating practical applications. More than a dozen peer-reviewed journal and conference papers and book chapters provide information about BMT capabilities. Publications can be found on the CIRP website and in open literature.

Points of Contact

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CIRP Website

- Please see the CIRP website to download documentation: http://www.erdc.usace.army.mil/Missions/WaterResources/CIRP/Publications.aspx
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