REVIEW

NUMERICAL MODELING OF WATER WAVES SECOND EDITION

by

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ISBN - 0-8493-2311-8

CRC Press, Boca Raton, Florida

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The second edition of the book entitled **Numerical Modeling of Water Waves** is a well-written, comprehensive treatise of the evolving science of computer modeling of waves. Its author, Dr. Charles Mader - a pioneering researcher and a world authority on numerical modeling - presents an all-encompassing treatment based on his life-long research on the subject, conducted mainly at the Los Alamos National Laboratory. In this second edition however - and in a very skillful and methodical manner - the author provides new insights on the subject and updates the reader with what is being done with state-of-the-art, high-performance computers which allow for the adaptation of new codes that can result in even more accurate simulations of waves generated from a variety of source mechanisms - whether earthquakes, landslides, explosions, or the impact of asteroids.

The discussions in the second edition include thorough reviews of theoretical principles and of the development of codes for specific applications to computer modeling of real and theoretical data sets, as well of examples from the literature specific to the methodology used. The new codes allow the rapid solution of highly complex equations that describe wave generation, wave energy propagation, and allow the prediction of near and far field wave characteristics. In addition to validating the results with historical and hydraulic modeling data, the new edition of the book provides several conclusions concerning the effects of various source characteristics on wave generation, propagation and termination. These characteristics relate to the unique mechanisms of wave generation from different sources and the effects on the distribution of wave energy and its attenuation across a body of water. The modeling described is based on finite discretization in space and time using structured rectangular meshes with codes using finite difference schemes. However, the codes that are used for the calculations have been modified or extended to allow for mesh refinements.

By far, the greater part of the second edition of the book is devoted to selected applications of codes for wave computer modeling used in simulating various historical tsunamis and in developing animations from a variety of other actual or postulated wave generative mechanisms. Specifically in the Second Edition, Dr. Mader does a remarkable job in summarizing succinctly the principles of water wave theory and the governing mathematical equations of Eulerian conservation of mass, momentum and energy which are used to describe different forms of water waves. Subsequently, he explains the classical theory of the shallow water model and the mathematical equations that describe wave motions - thus leading to the development of the finite-difference equations that he used with different

codes to model waves including those of historical tsunamis. Through such skillful and methodical presentation and examples - ensuring that every aspect of modeling receives appropriate consideration - the author not only explains how the basic theory is applied, but also introduces several new important ideas, procedures and concepts in tsunami science that can be used as the fundamental basis for the simulations of such waves,

More specifically in the second edition, Dr. Mader describes in detail: a) the WAVE code which solves the equations for Airy, third-order Stokes and the Laitone solitary gravity waves; b) the shallow-water SWAN code which solves the long wave, shallow water, nonlinear equations of fluid flow; c) the two-dimensional ZUNI code which solves the incompressible, viscous fluid flows with a free surface using the Navier-Stokes equations; d) the three-dimensional ZUNI code (SOLA) that solves the incompressible viscous fluid flows with a free surface, also using the full Navier-Stokes equations; e) the Carrier linear gravity wave LGW code which uses analytical methods to solve the linear gravity model; and f) TIDE, a classic computer program used for calculating tides. Additionally he furnishes on the book's CD-ROM the FORTRAN source and the executable codes which he uses to generate realistic graphic animations showing the result of finite differences at every time step. With all of these code descriptions, the author provides examples of wave propagation from analytical, postulated and historical wave source mechanisms - such as those of the 1994 Skagway tsunami as well as for other north Pacific historical tsunamis.

The most remarkable part of the book is the use, for the first time, of compressible numerical modeling methodologies to model, in two and three dimensions, the generation of water waves by explosions, projectile and asteroid impacts and their propagation from the source. These include modeling of the KT Chicxulub asteroid impact and the modeling of the impact landslide that generated the largest historical tsunami which flooded to 520 meter altitude in Lituya Bay, Alaska in 1958.

In summary, the Second Edition of **Numerical Modeling of Water Waves** by Dr. Charles Mader represents an outstanding work of of scholarship and a valuable reference for any researcher involved in numerical modeling of waves.