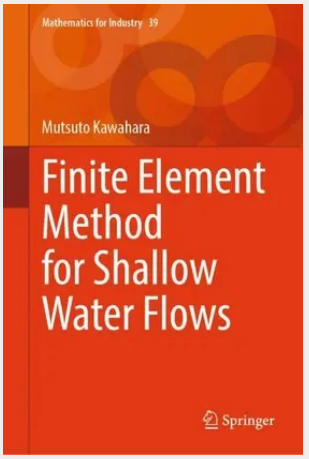
Kawahara

Finite Element Method for Shallow Water Flows



This book presents a detailed account of flow simulation in shallow water regions using the finite element method. Shallow water equations are widely employed to model water behavior in oceans, coastal waters, estuaries, rivers, and lakes, and also provide a basis for the analysis of fluid flows in an adiabatic state. The computational approaches discussed in this volume are therefore applicable beyond shallow water problems and extend to a broader class of continuum flow analyses.

The book focuses on finite element formulations for linear waves and shallow water flows. The early chapters introduce the theoretical background through the mild slope equation and the Helmholtz equation, with particular attention to numerical treatments of unbounded domains. These are followed by derivations of the shallow water and Boussinesq equations and an introductory presentation of finite element methods for their analysis. More advanced topics are addressed in later chapters, which survey recent developments such as bubble function interpolations, mixed and discontinuous interpolation methods, as well as formulations in curvilinear and spherical coordinate systems. The final part of the book extends the discussion to analyses involving uncertainty, introducing the Kalman filter finite element method to reconcile numerical simulations with observational data.

With illustrative numerical examples throughout, this book offers a coherent treatment of theoretical foundations and numerical methods. It serves as a useful reference for researchers and graduate students engaged in computational fluid dynamics, coastal and hydraulic engineering, and related fields concerned with the numerical simulation of shallow water flows.

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