INTER-COUPLED TSUNAMI MODELLING THROUGH AN ABSORBING-GENERATING BOUNDARY

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INTRODUCTION

For many practical and theoretical purposes, various types of tsunami wave models have been developed and utilized so far. Some distinction among them can be drawn based on governing equations used by the model. Shallow water equations and Boussinesq equations are probably most typical ones among others since those are computationally efficient and relatively accurate compared to 3D Navier-Stokes models. From this idea, some coupling effort between Boussinesq model and shallow water equation model have been made (e.g., Son et al. (2011)). In the present study, we couple two different types of tsunami models, i.e., nondispersive shallow water model of characteristic form(MOST ver.4) and dispersive Boussinesq model of non-characteristic form(Son and Lynett (2014)) in an attempt to improve modelling accuracy and efficiency. In particular, we focus on the treatment of connected boundary where two different types of variable exist together. Therefore, additional care on matching boundary condition is required because each model deals with different type of primary variables. Using an absorbing-generating boundary condition developed by Van Dongeren and Svendsen(1997), model coupling and integration is achieved. Characteristic variables(i.e., Riemann invariants) in MOST are converted to non-characteristic variables for Boussinesq solver without any loss of physical consistency. Figure 1 shows characteristic variables of one-dimensional wave propagation for example. Established modelling system has been validated through typical test problems to realistic tsunami events. Simulated results reveal good performance of developed modelling system. Since coupled modelling system provides advantageous flexibility feature during implementation, great efficiencies and accuracies are expected to be gained through spot-focusing application of Boussinesq model inside the entire domain of tsunami propagation.

TSUNAMI MODELS

Two types of tsunami models have been adopted and intercoupled to produce a combined modeling system of tsunami forecast; Method Of Splitting Tsunami(MOST in abbreviation, Tolkova (2016)) and Boussinesq-type model (Son and Lynett (2014)). The MOST had originally been developed by Titov and Synolakis (1995) for one-dimensional shallow water equations, and later extended to two-dimensional (Titov and Synolakis(1998)). Up to recent times, MOST has been upgraded to version (Tolkova (2016)) which is advanced for parallelized computation. MOST showed good accuracy and wide applicability to the various, historical tsunami events. Another tsunami model for inter-coupling is a depth-integrated Boussinesq model, which includes weakly-dispersive, turbulent and rotational effects of wave-current flows (Son and Lynett (2014)). This model can capture approximated bottom-induced turbulence and the associated vertical and horizontal rotational features. In the recognition that dispersive, turbulent and rotational properties of tsunamis cannot be ignored in the nearshore, we have adopted Boussinesq-type model to simulate the nearshore evolution of tsunamis. Therefore, it is expected that turbulence-induced physics such as large eddies and gyres formed in the nearshore can be effectively captured through the model.

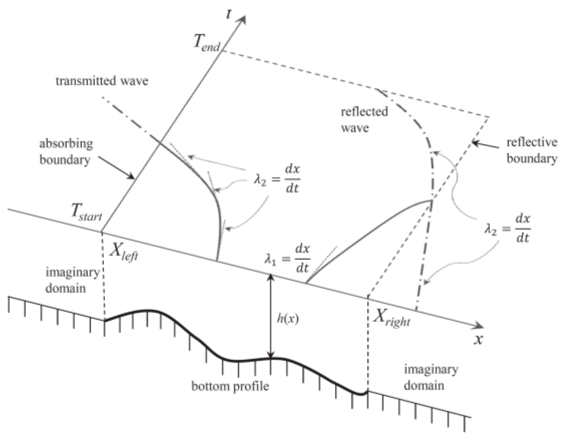

Figure 1 - An illustration of characteristics of the one-dimensional wave propagation in x − t domain.

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