Dam break over mobile bed: experimental and numerical study

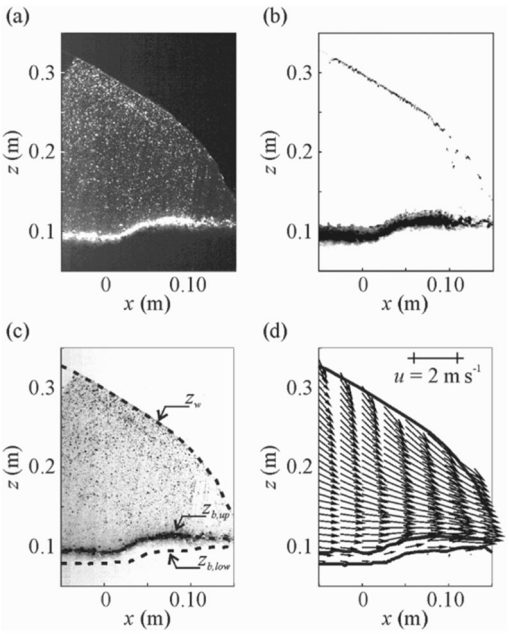
Summary

The dam break flow is a very catastrophic event that involves large volumes of water and sediments with complex interactions. Studying such very transient flows is required for accurate hazard and risk assessment and for the definition of flooded areas and consequent topography evolution. An accurate understanding of the physics of the phenomenon is necessary to allow for reliable modelling. This is achieved by small scale laboratory models, where all variables are analyzed. The new technologies and the non-intrusive tools allow a more precise determination of the hydraulic and morphodynamic variables, which are responsible for the evolution of the dam break wave. The present PhD program focused on a dam break flow over mobile bed made by coarse sand. Using fast high definition cameras to record the event an accurate determination of the free surface was accomplished. The limit between the clear water layer and the mobile sediment bed, and the limit between the mobile and non-mobile sediments was defined.

Particle Image Velocimetry was applied to obtain a detailed two-dimensional velocity field, in particular at the limit between the moving grains and the water layer. The detailed velocity field also allowed for an accurate measurement of the pressure distribution and the shear stress. These detailed data were consequently used to validate numerical models based on different depth-averaged representations of the flow. The models were based on the main hypothesis of hydrostatic pressure distribution during the flow evolution, the limits of this assumption being investigated by means of detailed pressure measurements. In particular, a depth-averaged two phase model was introduced and explored in detailed in order to assess its applicability to a dam break flow involving bed load sediment transport. The results obtained by the two-phase model were compared with the simulations performed by an existing clear water layer model, a mixture layer model and a two layer model. No significant differences were observed between the different models whose results mainly depend on the choice of the parameters involved in the closure equations. All reproduced well the dam break wave evolution but they showed a deficit in the computation of bed evolution, for which the parameters are difficult to calibrate.

Keyword

Finite volume, two-phase model, shallow water model, shear stress, dam break flow, mobile bed, pressure distribution, velocity field, sediment bed, unsteady flow, particle image velocimetry.



Automatic detection of the flow interfaces of a dam-break flow.

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