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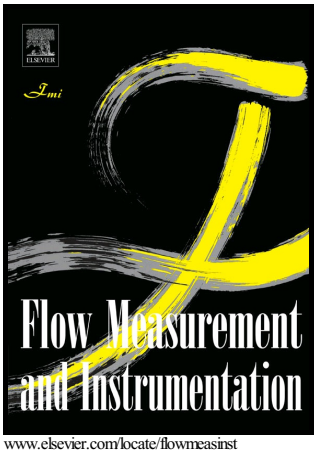

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An Improved Method for Predicting Discharge of Homogeneous Compound Channels Based on Energy Concept

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ABSTRACT

Accurate estimation of flow discharge in a compound river channel is increasingly important in river management and hydro-environment design. In this paper, a new model is developed to improve the prediction of flow based on Energy Concept Method (ECM) and Weighted Divided Channel Method (WDCM) along with the apparent shear stress at the interface between main channel and floodplain. The new model is compared with a wide range of our experimental data and the data available in the literature. The 27 datasets used include homogenous symmetric channels (22 datasets) and asymmetric channels (5 datasets) with various aspect ratios [channel total width (B) at bankfull / main channel bottom (b) =1.5 ~ 15.8], and bed slopes (S_o = 4.3x10^{-4} ~1.3x10^{-2}). It was found that the new model has significantly improved the accuracy of flow prediction compared with the traditional Divided Channel Method (DCM), and has also considerably better results than the ECM and WDCM methods against all the datasets, particularly for relatively low flow depths of floodplain where the flow discharges are most difficult to predict correctly. The new model predicts the total discharge well for both symmetric and asymmetric channels, within an averaged relative error of about 5%.

Keywords: Overbank Flow, Compound Channel Flow, Energy Transition, Zonal Discharge, Symmetric and Asymmetric Channel

1 INTRODUCTION

Many natural rivers and man-made channels have a compound cross-section, which consists of one deep main channel connected with one or two shallow floodplains. Such a compound channel will increase conveyance capacity of channel in times of floods when the flow is above the bankfull stage, and also provide environmental friendly space in the floodplain where no flow exists in dry seasons. Conventional one-dimensional (1-D) channel divisional methods, namely the Single Channel Method (SCM) and the Divided Channel Method (DCM), are still widely used to predict discharge in practice because of their simplicity. However it is well-known that these methods either under-estimate or over-estimate channel discharge (Wormleaton et al. 1982; Knight et al. 1984; Tang & Knight, 2007; Yang et al. 2007). Most recently, Hamidifar et al. (2016) compared SCM and various DCMs with their experimental data, and concluded that these methods are less accurate compared with the Coherence Method (COHM) by Ackers (1993) and Shiono & Knight Method (SKM) by Shiono and Knight (1991). When a floodplain is inundated, the velocity differences between the main channel and floodplain result in a mixing shear layer due to lateral momentum exchange. Sellin (1964) carried out experimental study on the mechanism of momentum transfer in a compound channel; afterward many other researches indicated the importance of taking into account the main channel / floodplain interaction