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Efficiency of an expansion transition in open channel subcritical flow

B. C. Basak[1] and Mohammed Alauddin[2]

1 *Department of Civil Engineering, Dhaka University of Engineering and Technology, Gagipur-1700, Bangladesh, E-mail: bcbasak@duet.ac.bd.*

2 *Department of Civil Engineering, Dhaka University of Engineering and Technology, Gagipur-1700, Bangladesh, E-mail: mauddin_roj@yahoo.com (corresponding author).*

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Abstract

Open channel transitions involving an expansion of width are a common feature of canals and flumes. Subcritical flow through an expansion transition can result in significant head loss due to separation of flow and subsequent eddy formation. The body of the hydraulic structure is subjected to lateral vibrations due to intermittent shedding of eddies, which are dangerous and hence, undesirable. Moreover, uneven distribution of velocity may cause asymmetry of flow and thus develop scour at places of highly concentrated velocities. This paper presents the results of experimental investigations on subcritical flow through gradual expansion in rectangular rigid-bed channels. The velocity distributions of flow through the transition models are made, thus, the efficiencies of the transitions evolved by different investigators are evaluated.

Key words: *Expansion transition, Subcritical flow, Velocity distribution, Efficiency of transition*

1. Introduction

Open channel expansions for subcritical flow are encountered in the design of hydraulic structures such as aqueducts, siphons, barrages, and so on. In these structures the flow tends to separate while subjected to the positive pressure gradient associated with flow deceleration, thus resulting in a considerable loss of energy. In an expanding flow, the distribution of velocity in the cross section can be extremely uneven, and uneven distribution of velocity may cause asymmetry of flow and thus develop scour at places of highly concentrated velocities. This study involves the performance-evaluation of transitions evolved by different investigators in an open channel subcritical flow. To evaluate the transition profiles, efficiencies of the transition models are determined in a laboratory setup flow, defining this as the ratio of gain of potential energy to loss of kinetic energy (Ibrahim *et al.*, 2006; Li and Zhou, 2008).

2. Available methods

Because of the importance of knowledge concerning expansions in rigid-bed channels, several investigators studied with different aspects of flow in expansion. The methods available for the design of expansion transitions were contributed by Hinds (1928), Hartley *et al.* (1940), Chaturvedi (1963), Nashta and Garde (1988) and Swamee and Basak (1993). A brief outline of each method is given

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