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Determination of apparent and composite friction factors for flooded equatorial natural rivers

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ABSTRACT
This paper presents results, calculated from field measurements taken in several frequently flooded natural rivers, which include D and R relationships, variation of flow resistance with depth of flow, the apparent friction factor, and the composite friction factor for flooded natural rivers. The results obtained have shown the complexity of flow resistance in natural rivers due to the interaction between the main channel and floodplain flow. The interaction has given rise to a pair of apparent shear stresses at the interface region, which can significantly reduce the discharge capacity of the rivers. The apparent shear was quantified in terms of an apparent friction factor, f_a, and it was found that the apparent shear stress is many times greater than the averaged boundary shear stress of the rivers. Based on the averaged boundary shear stress and apparent shear stress, the composite (actual) friction factor for the rivers can be estimated accurately ($R^2 = 0.99$) using a statistical method that had been derived.

Keywords: Flow resistance; friction factor; momentum transfer; natural river; overbank flow.

1 Introduction

The estimation of resistant coefficient and hence discharge capacity in a channel or river is one of the fundamental problems facing the river engineers. Without an accurate estimate of conveyance, very little confidence can be placed in the subsequent design calculations or predictions.

At the present moment, the accuracy of the friction factor for predicting flow characteristics in a particular reach, with a dynamic vegetation and flow regime remains questionable. Many studies of flow resistance have been carried out to provide an accurate estimate of resistance coefficient in any given circumstance especially under overbank conditions. However, none as yet has lead to a general applicable method. In addition, as most of this work is based on laboratory experiments, these results may not reflect the real situations in natural rivers with highly irregular shape and variations in surface roughness. In the work presented, an attempt was made to focus on the estimation of flow resistance in natural rivers under flood conditions.

2 Reviews

An important component in open channel flow is the estimation of flow resistance resulting from the viscous and pressure drag over the wetted perimeter. Such resistance is commonly represented by parameters such as Manning's roughness coefficient (n), or the Darcy-Weisbach friction factor (f), as given below.

The Manning equation gives

$$n = (R^{2/3} S_o^{1/2})/V \tag{1}$$

The Darcy-Weisbach equation for channel flow gives

$$f = (2gDS_o)/V^2 \tag{2}$$

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