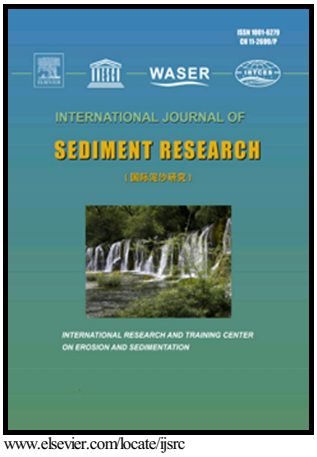
Turbulent structure in uniform inclined open channel flow over different rough porous beds

Evangelos Keramaris



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Turbulent structure in uniform inclined open channel flow over different rough porous beds

Evangelos Keramaris

University of Thessaly, Department of Civil Engineering, Division of Hydraulic and Environmental Engineering, Pedion Areos, 38334, Volos, Greece

e-mail: ekeramaris@civ.uth.gr

Abstract

In this study the effects of the different rough porous beds in an open inclined channel are studied experimentally for impermeable and permeable porous bed. For the simulation of porous bed two different types of permeable bed with the same thickness (s´=3cm) and the same porosity ε=0.70 are used: a) porous filters and b) gravel bed. Laboratory experiments were used for the calculation of turbulent velocity profiles. Measurements of velocity were taken for inclined channel for three different slopes (S= - 0.002, S= - 0.004 and S= - 0.006) and for five different flow depths (h= 5cm, 7cm, 9cm, 11cm and 13cm). The total discharge Q varies from 0.78 to 1.31l/s. The measurements were obtained using a two-dimensional (2D) Particle Image Velocimetry (PIV). The total discharge was estimated using a calibrated venture apparatus. Results showed that the presence of rough porous bed in inclined open channels influence significantly the turbulent characteristics of the flow in comparison with impermeable open channels with the same slopes.

Keywords: Particle image velocimetry, Porous filters, Gravel bed, Channel slope, Turbulent characteristics

1. Introduction

The flow of a fluid in an open inclined channel with a free surface under gravity has a wide application in the designs of drainage, irrigation canals, flood discharge channels and coating to paper rolls. This phenomenon has long been studied experimentally and several empirical results have been reported by many investigators for laminar flow (Beavers & Joseph, 1967; Poulikakos & Kazmierczak, 1987; Rudraiah, 1985; Vafai &Thiyagaraja, 1987; Sahraoui & Kaviany, 1992; Alberto Ochoa-Tapia & Whitaker, 1995; Choi & Waller, 1997).

Tani (1986) aimed to extend the analysis to the boundary layers in non zero pressure gradients and also to those on rough walls, with a view to searching for the conditions under which the equilibrium state could exist. Amati et al. (1999) discussed some preliminary results along this line with specific attention to channel flow turbulence, possibly the simplest instance of real-life flow of engineering interest.