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## Basis characteristic of hydraulic jump on pebbled rough bed

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### Abstract

In open channel flows, such as in streams and rivers, the hydraulic jump is a sudden transition from a high-velocity, supercritical flow into a slow-moving, subcritical flow. It is characterized by a sharp rise of the free-surface elevation associated with strong energy dissipation, large-scale turbulence, air entrainment, and spray. Its properties have been extensively studied over the last century. However, only a few studies have focused on the characteristics of a hydraulic jump flow over pebbled rough beds.

This paper reports the results of an experimental study of a hydraulic jump flow over a pebbled rough bed, which is typical of natural bed condition, as well as on smooth bed as a reference. Basic flow properties in both the shear region and recirculation zones were investigated. Inflow Froude number  $Fr_1$  was in the range from 1.54 to 4.95 and from 1.31 to 2.87 for the smooth bed and the pebbled rough bed, respectively. Visual observations demonstrated some differences between formation of a hydraulic jump on rough and smooth bed. The conjugate depths relationship, the jump roller and air-flow lengths were measured and compared with those from past literature studies on other types of rough bed as well as on smooth bed. The results showed that pebbled rough bed has a greater effect on controlling the flow so that shorter length of jump roller leads to higher rate of energy dissipation. Furthermore, there was no significant difference between rough and smooth bed for the conjugate depth ratio and the length of air-flow.

Since the impingement point is a source of air bubbles as well as vorticity, the oscillations of the jump toe position along with vortex advection velocity were analyzed using high speed camera recording. Though dimensionless advection velocity of large vortices was the same for both bed type, it was demonstrated that the dimensionless characteristic frequency of the longitudinal jump toe was slightly higher for the rough bed.

**Keywords:** *hydraulic jump, physical modeling, basic parameters, bed roughness, pebble*