PIV AND PTV EXPERIMENTAL OBSERVATIONS OF SEDIMENT MOTION INITIATION.

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Abstract

Most of the analysis of incipient particle motion is made using the concepts of drag and lift forces exerted by the fluid. However when a particle is not exposed to fluid forces because surrounding particles block any movement a third factor is fundamental in the initiation of motion. This factor is the turbulent forces that produce a vibration in the closely packed bed and helps expose the particles to the fluid forces. There is a lack of experimental results in the literature trying to explain the effect of turbulent forces in the initiation of motion. The difficulty comes from intrusive experimental probes that are not able to inspect the solid-fluid interface without disturbing the flow and the bed. In this research in order to describe the mechanisms of motion initiation, Particle Image Velocimetry (PIV) with fluorescent tracer particles and Particle Tracking velocimetry (PTV) has been used to measure the fluid and solid velocity fields above plane beds of uniform and non uniform sediments. Fluid velocities were used to find distributions of vorticity and turbulence intensity. Vortices that develop in the solid-fluid interface and are advected by the flow play a major role in the conditions of incipient motion. Particle velocities defined using the PTV technique were used to define the state of motion. It helped us to differentiate between contact load motion, saltation and suspension.

Most classical theories and experimental results for incipient motion of sediments consider uniform beds and neglect the effect of turbulence on sediment motion. This paper focuses in the effect of turbulence intensity and related vorticity in the mechanisms of sediment motion initiation. A comparison of classic experimental results for motion initiation velocities and the PIV and PTV results is made. Preliminary results show that those data are similar of the results of this research for low turbulent flows but differ slightly when turbulent intensity increases. In the case of nonuniform sediments, grain size distribution plays a major role in sediment motion. Experiments are in progress to show the relationship between grain size distribution, turbulent intensity and motion initiation.

Keywords: Motion initiation; Sediment; PIV; PTV; Turbulence; Vorticity