APPLICATIONS OF PARTICLE VELOCITY TO

BEDLOAD MOTION

Abstract

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The advances made in scientific visualization techniques have enhanced our capabilities of tracking sediment and measuring sediment transport rates. The focus of this study is to incorporate a new experimental approach to determine the displacement speed and the virtual velocity of particles rolling atop a well packed bed and provide a formula that describes the average speed of particles as a function of the flow, bed condition, and the particles' geometry, weight, and settling velocity. The displacement speed is the velocity of a particle moving from one point of rest to another, while the virtual velocity is the velocity of a particle including its resting period. Such formulas are lacking because the emphasis in research has been placed on developing expressions that provide the displacement speed of particles during saltation only.

The present study is experimental. As such, tests were performed in a laboratory flume so that flow and sediment conditions could be precisely controlled. The motion of spherical particles with diameters ranging from 8 mm to 25.4 mm was monitored under different flow conditions and bed roughness. The flow varied between the incipient flow conditions and conditions representing general sediment motion in natural gravel bed rivers. Incipient flow conditions were determined based on a trial and error method and

were defined as the moment a particle is first displaced. Bed conditions were well packed with spheres of 8 mm, spheres of 19 mm, and gravel with a mean size of 6.5 mm. Overall, 42 experimental runs were conducted.

Once sediment motion was established, it was monitored using a digital camera mounted above the flume to obtain plan view images of the test section and the particles' pathways. Individual particles were monitored to obtain their average displacement, resting time, and velocities. The particle velocity information can be applied to new bedload measuring techniques and bedload formulas. It is shown that particle interaction decreases the expected bedload, and a clustering correction is required. The image analysis technique was used to investigate this correction. The applications of particle velocity are promising, and future work is warranted.