Incipient motion criteria of uniform gravel bed under falling spheres in open channel flow

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Abstract

Prediction on initial motion of sediment is crucial to evaluate sediment transport and channel stability. The condition of incipient movement of sediment is characterized by bed shear stress, which is generated from force of moving water against the bed of the channel, and by critical shear stress, which depends on force resisting motion of sediment due to the submerged weight of the grains. When the bed shear stress exceeds the critical shear stress, sediment particles begin rolling and sliding at isolated and random locations. In Mountain River, debris flow frequently occurs due to heavy rainfall and can lead some natural stones from mountain slope into the bed river. This phenomenon could add additional forces to sediment transport system in the bed of river and also affect or change direction and magnitude of sediment movement. In this paper, evaluations on incipient motion of uniform coarse gravel under falling spheres impacts using small scale flume channel were conducted. The drag force of falling spheres due to water flow and length movement of falling spheres were investigated. The experiments were carried out in flume channel made by glass wall and steel floor with 12 m long, 0.6 m wide, and 0.6 m deep. The bed slopes were selected with the range from 0.7% to 1.5%. The thickness of granular layer was at least 3 times of diameter of granular particle to meet grain placement condition. The sphere diameters were chosen to be 4cm, 6 cm, 8 cm, 10 cm. The spheres were fallen in to the bed channel for critical condition and under critical condition of motion particle. Based on the experimental results, the Shields curve of particles Reynold number and dimensionless critical shear stress were plotted. The relationship between with drag force and the length movement of spheres were plotted. The pathways of the bed material Under the impact of spheres falling were analyzed.

Key words: Inception motion, sediment transport, critical shear stress, drag force, bed shear stress.

Acknowledgment

This research was supported funding from the National Research Foundation of Korea (NRF-2015R1A2A2A01007100).

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