Fluvial Sediment Transport from a Grain Scale Perspective

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Abstract

The prediction of sediment transport in rivers is notoriously poor; many accepted prediction methods have levels of accuracy that would not be acceptable in other branches of engineering. Many decades of research have been conducted but with limited success. Traditional approaches rely on the measurement of large scale integrated (or averaged) parameters such as bed load transport rate and boundary shear stress. In this seminar the use of detailed experimental observations, discrete particle simulations and predictions based at a grain scale will be described.

A probabilistic approach to describe the risk of entrainment of sediments can be used by determining the overlap of the probability distributions of the applied turbulent fluid forces and the forces grains can generate to resist the movement of particles. The main limitation of such an approach is that there is little data that link the entrainment of grains from water worked deposits with simultaneous measurements of the local flow velocities. Significant difficulties arise, even in the laboratory, when trying to observe the beginning of sediment motion. Techniques of image analysis have been used to observe particle movement from sediment deposits, however these studies used highly simplified physical models, with idealized surface grain arrangements or spherical particles. The work presented here will involve observations of grain entrainment from a “natural” gravel bed in a laboratory flume in which the local flow velocity and grain behaviour have been measured using a modified PIV system. These observations offer an insight into the physical mechanisms that cause sediment entrainment and transport in rivers.

These measurements are combined with theoretically based deterministic approaches based on grain scale mechanics so that so that “averaged” sediment entrainment and transport rate relationships can be obtained. This work was carried out in order to discover whether an approach based on grain scale mechanics offer a better opportunity to develop sediment transport formulae that are better able to simulate the transport of mixed grain size sediments in rivers.