Geophysical Research Abstracts
Vol. 18, EGU2016-12642, 2016
EGU General Assembly 2016

Laboratory measurements of grain-bedrock interactions using inertial sensors.

Georgios Maniatis (1), Trevor Hoey (1), Rebecca Hodge (2), Manousos Valyrakis (3), and Tim Drysdale (4)

(1) School of Geographical and Earth Sciences, University of Glasgow, Glasgow, United Kingdom (g.maniatis.1@research.gla.ac.uk), (2) Department of Geography, Durham University, Durham,United Kingdom, (3) School of Engineering, University of Glasgow, Glasgow, United Kingdom, (4) Department of Engineering and Innovation, The Open University, London,UK

Sediment transport in steep mountain streams is characterized by the movement of coarse particles (diameter c.100 mm) over beds that are not fully sediment-covered. Under such conditions, individual grain dynamics become important for the prediction of sediment movement and subsequently for understanding grain-bedrock interaction. Technological advances in micro-mechanical-electrical systems now provide opportunities to measure individual grain dynamics and impact forces from inside the sediments (grain inertial frame of reference) instead of trying to infer them indirectly from water flow dynamics.

We previously presented a new prototype sensor specifically developed for monitoring sediment transport [Maniatis et al. EGU 2014], and have shown how the definition of the physics of the grain using the inertial frame and subsequent derived measurements which have the potential to enhance the prediction of sediment entrainment [Maniatis et al. 2015]. Here we present the latest version of this sensor and we focus on beginning of the cessation of grain motion: the initial interaction with the bed after the translation phase.

The sensor is housed in a spherical case, diameter 80mm, and is constructed using solid aluminum (density = 2.7 kg.m-3) after detailed 3D-CAD modelling. A complete Inertial Measurement Unit (a combination of micro- accelerometer, gyroscope and compass) was placed at the center of the mass of the assembly, with measurement ranges of 400g for acceleration, and 1200 rads/sec for angular velocity.

In a 0.9m wide laboratory flume, bed slope = 0.02, the entrainment threshold of the sensor was measured, and the water flow was then set to this value. The sensor was then rolled freely from a static cylindrical bar positioned exactly on the surface of the flowing water. As the sensor enters the flow we record a very short period of transport (1-1.5 sec) followed by the impact on the channel bed. The measured Total Kinetic Energy (Joules) includes the translational energy component of transport (defined as a function of 3-dimensional translational velocity) as well as the rotational component (a function of the 3-axis angular velocity measurements from the gyroscope) which is neglected in the majority of contemporary saltation models. The results suggest that, for this grain scale, the magnitude of the impact of mobile grains on the bed is primarily controlled by their inertia.

References

Maniatis et al. 2014 EGU General assembly
http://meetingorganizer.copernicus.org/EGU2014/EGU2014-12829.pdf

Maniatis et. al 2015: "CALCULATION OF EXPLICIT PROBABILITY OF ENTRAINMENT BASED ON INERTIAL ACCELERATION MEASUREMENTS" J. Hydraulic Engineering, Under review.