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Studies in Oscillatory Flow Bedload Sediment Transport

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Oceanography

by

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ABSTRACT OF THE DISSERTATION

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A series of laboratory experiments have been conducted that reveal significant insights into the nature of oscillatory flow bedload sediment transport. The 730 data runs represent 170 combinations of flow field, sediment size, and bed slope.

An analysis of two grain sizes (440 and 1100 μm) shows that at high velocities, the bedload transport rate is independent of grain size. However, below a threshold which is a function of grain size, velocity and period, the transport rate is found to be inversely proportional to the grain size though the exact relationship is not

well constrained. Observationally, this change occurs when the top layer of sediment becomes fully mobilized to an approximate depth of one to two grain diameters. These two types of transport occur in what has been traditionally termed the bedload regime, and this analysis indicates that it is more appropriate to consider bedload as two regimes which should be modeled with different equations.

While most bedload transport models include the velocity as the only flow parameter, the data show a clear dependence on at least one additional flow parameter in all regimes investigated. While the instantaneous acceleration is a logical candidate for this second parameter, experiments show that it should not be modelled with a standard power law relationship, as is done with the velocity. Another possibility is that the transport rate is Markovian; it is not only a function of instantaneous flow parameters, but also of the time history of those parameters.

Sloping bed transport experiments are discussed and compared with the models of Bagnold (1963, 1966) and Kobayashi (1982). Agreement with Bagnold's theoretical development is quite good for a value of $\phi \approx 30^{\circ}$; and using his formulation, a model is developed to modify a

flat bed transport model to account for the effects of bed slope.