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Research Brief: Mixing and Deformation of Alluvial Bed Surfaces in Rivers

Issue

Existing methodologies for calculating sediment transport do not allow for changes in the bed-material gradation with discharge. Sediment transport calculations are frequently based on bed-material samples collected at low flow, and the bed gradation is assumed to remain the same at higher flows. However, during the course of flood events, the bed gradation changes as finer sediment sizes are selectively removed from bed surface or the coarse surface layer is destroyed. When the bed surface gradation changes so does the sediment transport and the surface bed form. Bed gradation data collected at low flow can lead to significant errors in the estimation of sediment transport, sediment yield, and channel forming discharge.

Objective

The following objectives apply to this research:

- " Produce a numerical algorithm to simulate the long-term mixing process that occurs at the bed surface of alluvial rivers. This includes both the armoring process that occurs with a sediment deficit and the mixing process that occurs with equilibrium transport and with a sediment surplus.
- " Formulate an algorithm to predict bed form type, length, height, and speed, thus providing the composition and characteristics of an alluvial bed for a variety of flow conditions.

Research/Design

It is hypothesized that bed response can be determined from the characteristics of the alluvial bed material collected under a specific set of field conditions and the variation of flow parameters with discharge. Algorithms will be developed for

- " Sand bed streams, where bed forms and hydraulic mixing are expected to be the most significant alluvial processes.
- " Sand and gravel bed streams, where surface layer formation and destruction are expected to be the most significant processes.
- " Gravel-boulder bed streams, where hydraulic roughness and critical shear stress are expected to be the most significant characteristics. Guidelines for collection of bed-material samples will be developed in conjunction with other federal agencies through the Federal Interagency Sedimentation Project.

Available river and flume data on armoring, hydraulic sorting, and bed forms will be collected. Additional field data will be collected from gaged stream sites where bed material gradation varies with discharge. Methods for prediction of bed form occurrence and geometry will be evaluated based on prototype data collected. Relationships between hydraulic and sediment parameters will be evaluated to find regression relationships for variable bed-material gradation. In conjunction with the empirical approach, an analytical methodology will be formulated to simulate

the armoring, hydraulic sorting, and bed form formation processes. Test cases will be evaluated.

Application

This analytical method will be suitable for incorporation into existing and future numerical sedimentation models. The particle-sorting algorithm to be formulated in this work unit will be useful to planning level studies where elaborate numerical models are not feasible and simple tools such as the SAM hydraulic design package are used to evaluate sedimentation issues. A reliable hydraulic sorting and armoring algorithm is also essential for proper simulation of sedimentation processes in numerical models. Knowledge of the occurrence and geometry of bed forms in alluvial rivers is necessary when formulating hydraulic sorting algorithms in numerical sedimentation models and when calculating hydraulic roughness.

Products

Links and information will be posted here. View online at http://rsm.usace.army.mil.

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