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PERTURBED FLOW AND TURBULENCE STATISTICS OVER BEDFORM STRUCTURES SIMULATED THROUGH LABORATORY EXPERIMENTS

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The surface protrusion developed at the bed surface comprises the grain roughness and the form roughness that resists the flow, sediment movements and aquatic habitats. The resistance in the alluvial channel flow can be considered to be the grain resistance and the form resistance due to undulations at the bed. One can expect the large variations in resistance to the river flow due to the variation of size and shape of the undulation at the sediment bed. The flow over a plane sandy bed may cause the bed to deform due to immovable objects at the bed, which in turn perturbs the main flow. The bed forms are developed from defects in the sand bed which are propagated downstream by flow separation, and that the origin of the defects is linked to coherent flow structures. Wave-like bedforms, such as ripples, dunes or anti-dunes, generated from a flat sand bed interacting with the flow show significant changes in the mean flow, turbulence characteristics and suspension concentration. The resistance to flow in rivers and estuaries depends primarily on: (a) size, shape and orientation of the sediment grains forming the bed, (b) bed roughness induced by saltation of particles, (c) thickness of the bed load layer, (d) bedforms such as dunes and ripples, (e) forward facing dune-like waveform structures, (f) suspension concentration, and (g) roughness due to waving aquatic plants (Nikora, 2007, 2010; Nikora et al. 2008; Kothyari at el. 2009). The resistance to the river flow may also depend on the large obstacles such as plates, fences, or hills. Because of difficulties involved in predicting the bed roughness under various flow conditions in rivers and estuaries, the estimation of resistance to flow is very difficult. The above consideration motivates the need to investigate experimentally the physical mechanism of flow perturbation due to the different kind of bedforms/roughness in rivers and estuaries.

Several experiments were conducted under controlled conditions in an especially constructed hydraulic flume at the Fluvial Mechanics Laboratory, Indian Statistical Institute, Calcutta in collaboration with a group of graduate students. Laboratory investigations and theoretical analysis have been the main approaches for examining the problem of bedform-flow interactions. The following examples will be focused in the presentation:- (1) roughness produced by saltation of granular particles due to near-wall turbulence investigated using motion-picture photography (Mazumder, et al. 2008); (2) to ascertain the influence of grain roughness in the main flow as well as in suspension concentration above the heterogeneous sediment beds (Mazumder et al. 2005, Ghoshal et al. 2010); and (3) to study of turbulent flow over wave-like bedform structures with or without surface waves, and understanding its impact on sediment movement (Ojha and Mazumder, 2008, 2010), (4) to focus the tidal flow over the forward-facing dunes immersed in turbulent boundary layer (Mazumder and Sarkar 2011).

The velocity data were collected using 3-D Micro-acoustic Doppler velocimeter (ADV) at the centerline of uniform, turbulent open channel flow in a laboratory flume. The present studies address the some glimpses of physical mechanisms of resistance to mean flow, turbulence characteristics and its coherent flow structures, sediment movement, stability of bedforms and

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dune/ripple migration. These papers attempt to visualize the stream-wise perturbed velocities and recirculation in different trough regions constructing the velocity vector and contour plots.

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