Sediment transport and bedform development in the lee of bars: Evidence from fixed- and partially-fixed bed experiments

Reesink, A.J.H., Parsons, D.R. and Thomas, R.E.

The co-existence, interaction, and repeated (re-)establishment of bars, dunes and ripples in natural channels is responsible for many important flow-form-flow dynamics. Small bedforms are constantly generated, superimposed on larger ones, particularly in zones affected by large-scale secondary circulation patterns produced by the larger bedforms. These superimposed bedforms migrate onto the downstream stoss slope of larger-scale forms where they i) generate additional form-roughness, ii) change sediment transport dynamics, iii) control bedform splitting and merging, iv) alter the geometry of the host lee slope, and v) change the resultant sedimentary structures. Our understanding of superimposed bedform development is de-rived from investigations of bedform development on flat beds in uniform flow and does not adequately de-scribe bedform development in distinctly non-uniform flows and areas with large-scale secondary circulations.

In order to expand our understanding of bedform initiation, this paper presents fixed-bed and partially-fixed-bed experiments that investigate the effect of a host-bedform's separated flow on the development of smaller, secondary bedforms in its trough. The results show that: 1) scour in the trough of bars increases in depth and decreases in downstream length with increasing flow velocity over the crest; 2) the point of bedform initiation moves downstream and the amplitude of the incipient ripples decreases with increasing flow velocity; 3) crest-trough velocity gradients and coherence of the separated flows in the lee of ripples in bar troughs depend on their position relative to the separated flow of the larger-scale host bedform and tend to increase downstream.

These observations indicate that the development of secondary bedforms is hindered by reattachment of the host bedform's separated flow and is also dependent on the length of the downstream stoss slope. The reduction of bedform amplification is attributed to the reduced strength and coherence of the separated flows in the lee of the secondary bedforms as a result of the stronger separated flow of the host bedform. Thus, this study presents a step towards a fuller understanding of bedform initiation and development in areas with complex topography and local variability in the flow field.

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bedforms in unsteady flows