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Height vs water depth for small sand ripples – An aid to palaeohydraulics

Water flowing over a plane non-cohesive sediment surface throws it into a series of rhythmic bedforms which are designated as ripples (height < 0.075 m) and dunes (≥ 0.075 m) in lower flow regime. The nature and magnitude of these bedforms of lower flow regime are dependent on parameters like flow velocity, water depth and sediment grain size. The relationship between dune height and water depth has been worked out by Allen[1], $H = 0.086 \cdot d^{1.19}$ (H being the dune height and d, the corresponding water depth). Using some well-known hydraulic relationships in proper sequence, attempts are made to determine the flow velocities and mean annual discharge for ancient streams from dune heights preserved in rock sequences[2–4] (see ref. 5, pp. 279–280 for details).

The dimensions of the dunes used by Allen for establishing the above-mentioned relationship are large (H varying between 0.10 m and 10 m), but the ripples encountered in ancient sediments (rock record) are often of much smaller dimension. A series of experiments were conducted in a 'close circuit' hydraulic channel using sand grains of two different size ranges (Table 1) to determine the relationship between small ripple height and water depth. The heights and wavelengths of the ripples generated over these sand beds at a fixed flow velocity (~ 0.30 m/s) but varying water depths (0.088–0.185 m above the sand bed) ranged between 0.009–0.0165 m and 0.17–0.32 m respectively. The relationship between water depth and ripple height obtained from these experiments is $H = 0.065 \cdot d^{0.82}$, d being the effective water depth above the ripple crest (Figure 1). This relationship, somewhat different from that obtained by Allen, is expected to provide a realistic clue to palaeohydraulic parameters when small ripples are involved. Obviously, this relationship is valid for small water depths only. Although Allen used water depths as large as 10 m, in great water depths (as in oceans) ripple height may be independent of water depth.

Table 1. Grain-size of the sands used in the experiments

Sand no.	Mean grain-size (mm)	Standard deviation (mm)
IIT-1.1 (*)	0.42	0.287
IIT-4.1 (+)	0.175	0.052

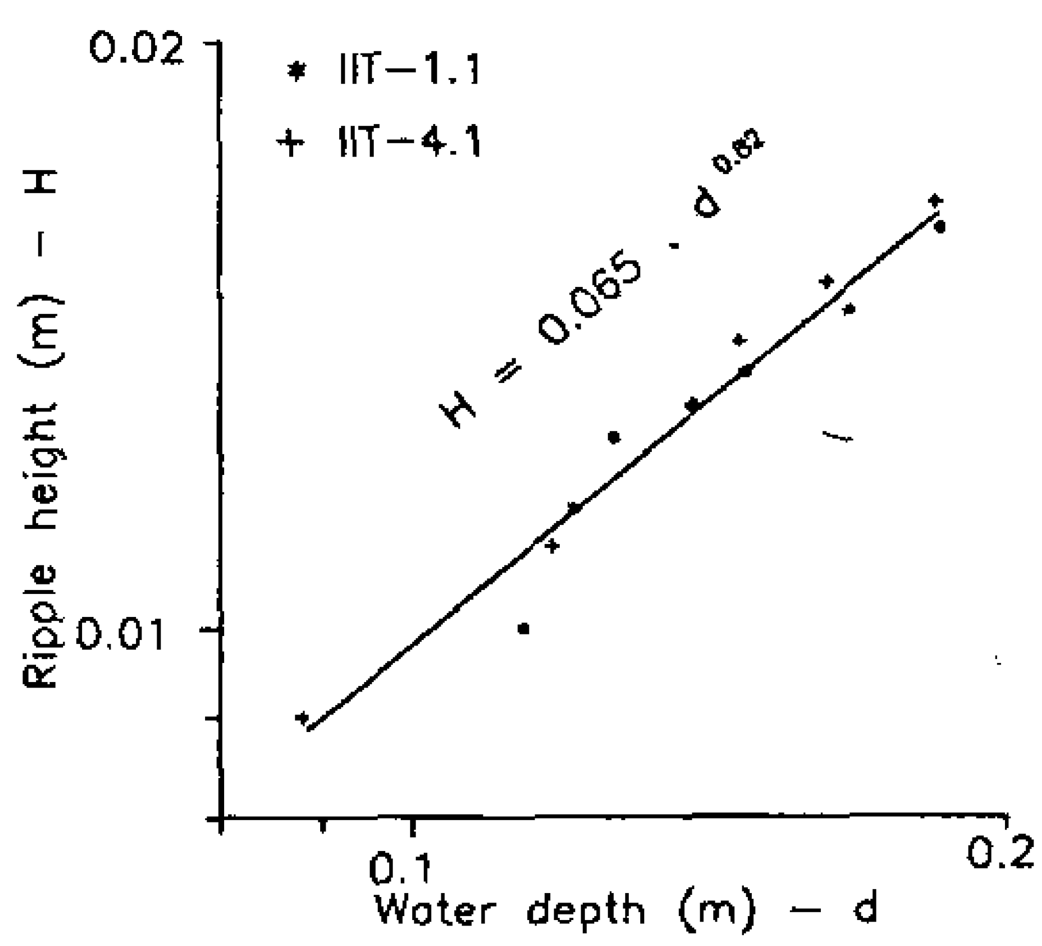

Figure 1. Water depth vs ripple height for small ripples.

The dimensions of subaqueous bedforms are known to be dependent not only on water depth, but also on flow velocity and grain size. The ranges of grain size and flow velocity for the data compiled by Allen are not explicitly stated in his publication. In the present case the grain sizes of both the sand samples used for the experiments as also the flow velocity lie within the lower flow regime ('ripple field' of Southard and Boguchwal[6]), thereby eliminating the possibility of distortions arising out of grain size or velocity variation.

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