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# Hydraulic analysis of propagation direction of antidunes

Francisco Núñez-González (1) and Juan Pedro Martín-Vide (2)

(1) Hydraulics Department, Technical University of Catalonia, Jordi Girona 1-3, D1, 08034, Barcelona, Spain (fngon@yahoo.com), (2) Hydraulics Department, Technical University of Catalonia, Jordi Girona 1-3, D1, 08034, Barcelona, Spain (juan.pedro.martin@upc.edu)

Among bed features developed by unidirectional water flows in alluvial channels, those features classed as antidunes occur in the so-called upper-regime flow; in contrast to bedforms in lower-regime, which can only move in the downstream direction, antidunes can migrate upstream, downstream or remain stationary. In this work the hydraulic conditions that determine each of these antidune movement possibilities are analyzed. A new theory is developed, based on fundamental hydraulics, which allows discriminating the antidune movement direction as a function of the wave-length and the bulk flow parameters, namely, Froude number and mean water depth. The theory is developed from an energy balance over a symmetrical antidune; for this, the Bernoulli equation is applied between the antidune crest and antidune trough, and the pressure head is corrected to account for the centrifugal forces generated by curvilinear flow over in-phase bedforms. Manipulation of the fundamental equations produces an antidune movement dimensionless number (Fa=Fdk, where F is the Froude number, d is the mean water depth and k is the wave number), whose critical value (Fa=1) corresponds to the stationary condition of the antidune, while values higher and lower than the critical correspond to downstream- and upstream- propagation, respectively. Likewise, by introducing a restriction for the maximum standing-wave height above antidunes, theory predicts ranges of hydraulic variables and bed form steepness for which antidunes are likely to occur. According to this restriction, downstream-migrating antidunes could attain steeper height-wavelength ratios than upstream-migrating antidunes. Comparison with published experimental data showed agreement between theory and experimental observations.