SLOPE INFLUENCE ON BEDLOAD TRANSPORT

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Considering a granular bed submitted to a surface fluid flow, bedload transport is classically defined by opposition to suspension as the part of the load in contact with the granular bed, i.e. in rolling, sliding or small jumping motions. The slope influence on bedload transport is classically considered as resulting from the modification of the gravity contribution on both the granular media and the surface fluid flow. This effect is studied simulating idealized turbulent bedload transport configurations with a validated coupled fluid-Discrete Element Model [1]. Varying the channel inclination angle and the specific density, it is evidenced that these two parameters effect are coupled and not well taken into account by the classical picture. Analyzing analytically the continuous two-phase flow equations, it is shown that the impact of the slope variation on the fluid flow inside the granular bed cannot be neglected and should be taken into account. The latter is responsible for the transition from bedload to debris flow-like behavior, for which the whole granular layer is mobilized. The critical angle of debris flow predicted by Takahashi [2] is recovered from the equations and observed in the simulations. In addition, a rescaling of the Shields number is proposed from the equations and is shown to make all the data collapse onto a master curve when considering the dimensionless sediment transport rate as a function of the modified Shields number. Therefore, the latter characterizes well the slope influence on bedload transport and opens perspectives for a better understanding of the field observations. Further work is required to determine if it should be taken into account in the Shields number formulation or if it can be included in the critical Shields number.

References

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