Numerical initiation of motion of non-spherical sediment particles on inclined bedforms

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ABSTRACT

The computation of the incipient motion of a set of sediment ellipsoidal particles that compose an inclined bedform is analysed using a numerical approach based on the Discrete Element Method (DEM) and an analytical. The interaction of the flow with the surrounding particles under laminar and turbulent flows cause the breakage of equilibrium of the arrangement and the subsequent motion of the outermost particles. The flow-particles interactions are modelled by drag and lift forces that take into account the ellipsoidal nature of the particles. Additionally, to model the effect of the flow in voids of the bed the seepage force is also inserted. The particles-contact interactions play an important role in the subsequent motion. The Discrete Element Method (DEM) computes the motion of each individual particle and the interaction with the surrounding particles. It is a numerical tool suitable to simulate the motion of the superficial particles at a small scale of the bedform and its formulation includes the coupling with flow.

The initiation motion is traditionally stablished in the geophysical community as a experimental-analytical relationship between the dimensionless flow Reynolds number $Re^\star$ and the critical shear stress $\tau^\star$ that produces the initiation of motion of a particle, see [1]. The experiments and previous works assume that the particles are spherical, see [2], hypothesis that do not represent the realistic configuration of sediment bed layers. This work extends the previous results that experiments cannot provide by a numerical relationship for a wide variety of shapes and inclinations. The analytical approach helps to verify the most simple configurations, the numerical approach covers a range of incipient movements that can not be covered by the analytical approach.

REFERENCES

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