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Resolved simulations of a granular-fluid flow through a check dam with a SPH-DCDEM model

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Debris flows represent some of the most relevant phenomena in geomorphological events. Due to the potential destructiveness of such flows, they are the target of a vast amount of research. Experimental research in laboratory facilities or in the field is fundamental to characterize the fundamental rheological properties of these flows and to provide insights on its structure. However, characterizing interparticle contacts and the structure of the motion of the granular phase is difficult, even in controlled laboratory conditions, and possible only for simple geometries. This work addresses the need for a numerical simulation tool applicable to granular-fluid mixtures featuring high spatial and temporal resolution, thus capable of resolving the motion of individual particles, including all interparticle contacts and susceptible to complement laboratory research. The DualSPHysics meshless numerical implementation based on Smoothed Particle Hydrodynamics (SPH) is expanded with a Distributed Contact Discrete Element Method (DCDEM) in order to explicitly solve the fluid and the solid phase. The specific objective is to test the SPH-DCDEM approach by comparing its results with experimental data. An experimental set-up for stony debris flows in a slit check dam is reproduced numerically, where solid material is introduced through a hopper assuring a constant solid discharge for the considered time interval. With each sediment particle possibly undergoing several simultaneous contacts, thousands of time-evolving interactions are efficiently treated due to the model's algorithmic structure and the HPC implementation of DualSPHysics.
The results, comprising mainly of retention curves, are in good agreement with the measurements, correctly reproducing the changes in efficiency with slit spacing and density. The encouraging results, coupled with the prospect of so far unique insights into the internal dynamics of a debris flow show the potential of high-performance resolved approaches to the description of the flow and the study of its mitigation strategies.

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