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Validations of Coupled Eulerian-Lagrangian approach on the dynamic behavior of granular flows

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In Taiwan, granular flow hazards, such as flow-like landslide, debris/mudflow, has caused an increasing catastrophic destruction and casualties widespread due to rapidly development of mountain areas. To deal with the granular flow hazards, effective measures should consider both impact force and capacity, obeying the technical regulation of Taiwan. In this study, a Coupled Eulerian-Lagrangian (CEL) approach was used to analyze the dynamic behavior of granular flow. Compared to conventional finite element analysis, the CEL approach combines the Eulerian and Lagrangian algorithms overcoming mesh distortions attributing to large deformations. Validations of the CEL performance on the granular flows were conducted through a series of small-scale laboratory tests considering various slopes. The flow mobility was described using the equations of state (EOS) and Bingham plastics models characterized by the hydrodynamic and non-Newtonian fluid behavior, respectively. The results show that the kinematic process of the granular flow, from impact force evolution to deposition pattern, were satisfactory compared with the experimental results. Parametric studies show that significant fluctuations of the impact force as the sound speed of material increased at the post stage of the movement were observed. In addition, the viscosity played a crucial role on the maximum impact force and the volume of residual mass behind the barrier. The validated CEL approach could be further applied to analyze the dynamic behavior of granular flow and facilitate in future designs of protective measures.