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Modelling boulder impacts on deformable layers: role of rolling and toppling

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Rockfalls are apparently simple processes where few or no blocks interactions occur. Nevertheless, the extreme variability in the type of interactions between falling block and ground surface or material make the modelling of this phenomenon extremely complicated. To model the trajectories followed by a block falling along a slope it is crucial the adoption of laws capable of simulating the changes in block energy content due to impacts. The numerical simulation of impacts is thus fundamental for modelling block trajectories, assessing the risk associated with rockfall events and for designing sheltering structures.

In this work, an extension of the hybrid model BIMPAM (di Prisco and Vecchiotti, 2006) in which block rotation is taken into account by adding another degree of freedom, is illustrated. The rheological model is developed assuming a lumped mass method. The additional kinematics variable enables the model not only to follow a more realistic trajectory but also to take into account additional dissipative mechanisms, which, in absence of the rotation, are absolutely neglected. These mechanisms are the block toppling and rolling. In this contribution, these mechanisms are modelled by the macro-element concept, and the delayed plasticity theory introducing two plastic sliders whose behaviors are described via two elasto-plastic constitutive laws.

In order to illustrate the potentiality of this new version of the model a numerical parametric analysis, concerning in-clined trajectories on horizontal strata, is illustrated. The numerical results demonstrate that, in this new model version, the dissipated energy is increased and that during the impact a boulder spin originates, even in case the initial motion of the block is purely translational. This is opening a new set of possibilities and applications for rock fall modelling.