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Influence of mechanical and morphological parameters on the dynamic state of a rockfall

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In this research we analyse the influence of the most important parameters affecting rockfall dynamics. We simulated a series of rockfalls along synthetic slopes with different slope angle, roughness, spatial resolution and energy restitution parameters (restitution and friction coefficients). Simulations have been performed through an original code in which both a kinematic and a dynamic (hybrid) approach have been implemented and different contact functions are available to describe energy dissipation at impact or by rolling. These last characteristics allow us to take into account also of the shape and mass of the falling block along a 3D geometry. Micro-topographic features have been introduced in the simulations by a local roughness expressed as deviation from the mean topographic gradient for the entire slope. We observe that "dynamic regimes", already recognised by some authors through experimental work, can be identified. Dynamic regimes depend on slope inclination and roughness, and are different when kinematic or dynamic models are adopted. Despite anomalous behaviours have been observed in some cases in presence of very rough surfaces, three main dynamic regimes have been clearly recognized: a decelerated regime (regime A), with progressive decrease of the block velocity since its release at the top of the slope; a steady motion regime (regime B) characterised by a progressive acceleration of the block up to a constant velocity; an accelerating regime (regime C) where the falling block motion is characterised by sharp jumps that cannot hamper a progressive acceleration. We studied the threshold conditions separating different regimes and their sensitivity to changes in the controlling parameters (roughness, slope). Type of motion and characteristics of the trajectory, impact angles and velocity have been analysed. This analysis is relevant both in the choice of the modelling and design parameters, since the sensitivity of the controlling parameters result in sharp changes of the gen-

eral behaviour of the rockfall during its descent along the slope. In fact, block velocity, flying height, the spatial frequency of impacts and rebounds, lateral dispersion and the fall direction can experience strong changes as a result of small changes of the controlling parameters which cause a switch of the rockfall dynamic regime. Finally, the evaluation of "phase diagrams" portraying the threshold conditions between different regimes is useful in a preliminary evaluation of the potential behaviour of rockfalls on specific slopes.