Rockfall fragmentation simulations of real scale tests

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Consideration of fragmentation during rockfalls is relevant for the assessment of hazard since it affects the number of generated blocks, their trajectories and impact energies, which also depends on the topography. Recently many scholars have paid attention to these phenomena since there are still many uncertainties around fragmentation regarding how mass and energy are distributed after fragmentation and how trajectory dispersion affects risk analysis. We developed a specific fragmentation model (Rockfall Fractal Fragmentation Model), as well as a 3D trajectory simulator called RockGIS with the fragmentation module implemented. In this contribution, we present the calibration of our rockfall trajectory simulator, based on real scale fragmentation tests performed on a quarry.

The RockGIS model considers a lumped mass approach and accounts block fragmentation upon impact with the terrain. Some improvements have been made on the simulator code regarding the consideration of rotation inside the kinematics of the model and restitution factors. The block size distributions obtained from natural rockfall events inventoried, as well as from the real scale fragmentation tests in a quarry, shows a fractal behaviour. On this way, the fractal fragmentation model implemented in the RockGIS simulator is able to reproduce the observed block size distributions.

To calibrate the model we used data gathered from a real scale rockfall test performed in a quarry. We calibrate the relations between the impact energy conditions and the fragmentation model parameters to generate the measured fragments size distribution. The initial volume of the tested blocks were measured manually using a tape and the release positions of the blocks were obtained with terrestrial photogrammetry. Both, the volume and spatial distribution of the fragments after each release were measured on the orthophotos obtained from UAV flights. Three calibration criteria were considered: runout distribution, volume distribution and cumulative volume as a function of the runout. Finally, the degree of fragmentation can be adjusted in the simulations allowing the comparison between different possible hazard scenarios (null, moderate, or severe fragmentation).

Finally, the results of the calibration shows that the RockGIS is able to reproduce the fragmentation behaviour in terms of block size distribution after breakage, as well as the spatial propagation, being a new tool with capabilities to assess the hazard related with fragmental rockfalls and the consequently risk associated.

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