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Quantification of Rockfall Mitigation by Forests using Simulations

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The challenge when regarding the forest stand as a protection barrier against rockfall is to assess and predict its protection effect. A new trajectory software RAMMS::rockfall (as part of the software package RAMMS = RApid Mass MovementS used for debris flows, avalanches and rockfall) now allows the simulation of the energy absorption of the forest as 1) a collection of single trees and 2) using a blurred forest model.

The blurred model assumes an averaged braking coefficient that absorbs a certain amount of kinetic energy from the falling rock per field distance. It is given as a field property same as the coefficient of restitution, the penetration rate within the GIS-based trajectory model. The relevant forest parameter must be adjusted, for example, using the results from field test. However, there are too many unknowns influencing parameters such as the forest density, the energy absorption of a single tree depending on impact height, tree geometry, tree species etc. For this purpose the implementation of a single tree modus within the simulation software can be used to calibrate large forest areas using preliminary detailed simulations considering the rock-tree-interaction. This approach also offers reasonable simulation times because the forest model is calibrated within a small simulation area. It then can be extrapolated to the full size of the forest allowing the wished quantification of its overall protection effect.

The single trees are distributed in the forested area by chance restricted to a minimum neighbour distance. Latest research now offers the necessary single tree properties to achieve a most lifelike model of the single tree depending on impact height, impact angle, eccentricity, tree diameter at breast height (DBH) etc. (Jonsson 2007). These interaction parameter studies were determined using fully detailed, dynamic and non-linear Finite-Element simulations and could be validated by the results of full-scale field tests. The combination of many single trees within the trajectory simulation software clearly shows typical details like the contact free flight distances of the rock within the forest and its maximally reachable velocities.

Jonsson, M. (2007) Energy absorption of trees in a rockfall protection forest, Diss ETH Zurich