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Felled trees as a rockfall protection system: Impact on simply supported fresh wood stems, experimental and numerical study

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Forest is a well known and efficient natural protection solution against rockfall. In forested areas, the maintenance of forests is required to ensure their protective function and health. During this process that consists in removing some trees, the protective capacity of the forest decreases. To compensate the temporary loss of protection, some of the felled trees can be left in an oblique position to the slope. It is a financially feasible solution to ensure the protection against rockfall during the regeneration of forests. Thus, felled trees can become a useful protection system if they are correctly placed. No studies have been done concerning the efficiency of these devices and particularly their resistance to rock impacts and their energy dissipation capacity. In order to estimate the capacity of these devices to dissipate energy, it is necessary to study the dynamic response of tree stems under impact as well as rock's trajectory changes due the interaction with such structures. Experimental and numerical studies are carried out to determine the efficacy of this devices.

Laboratory experiments enabled studying the response of fresh wood stems under dynamic and quasi-static loadings. A Mouton-Charpy pendulum was used on the dynamic loading tests performed onto simply supported stems. The experimental device was instrumented in order to obtain the impact force data and the stem's displacements fields. The mechanical properties of fresh wood are analyzed from the experimental results which also allow carrying out a detailed study of the stems dynamic response.

A numerical model based on the Discrete Element Method (DEM) enables to simulate the interaction of a rock and a felled tree device. To simulate the rock - tree interactions, rocks are represented by spherical solid bodies while cylindrical bodies represent the trees. The fresh wood constitutive law and the contact law are integrated on the model allowing realistic simulations. The numerical model is calibrated and validated by the experimental data. The estimation of the protective capacity of these devices is assessed by the integration of the DEM model on a rockfall trajectographic one.