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A discrete element modelling approach for block impacts on trees

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These past few year rockfall models explicitly accounting for block shape, especially those using the Discrete Element Method (DEM), have shown a good ability to predict rockfall trajectories. Integrating forest effects into those models still remain challenging.
This study aims at using a DEM approach to model impacts of blocks on trees and identify the key parameters controlling the block kinematics after the impact on a tree. A DEM impact model of a block on a tree was developed and validated using laboratory experiments. Then, key parameters were assessed using a global sensitivity analyse.
Modelling the impact of a block on a tree using DEM allows taking into account large displacements, material non-linearities and contacts between the block and the tree. Tree stems are represented by flexible cylinders model as plastic beams sustaining normal, shearing, bending, and twisting loading. Root soil interactions are modelled using a rotation stiffness acting on the bending moment at the bottom of the tree and a limit bending moment to account for tree overturning. The crown is taken into account using an additional mass distribute uniformly on the upper part of the tree. The block is represented by a sphere. The contact model between the block and the stem consists of an elastic frictional model.
The DEM model was validated using laboratory impact tests carried out on 41 fresh beech (*Fagus Sylvatica*) stems. Each stem was 1,3 m long with a diameter between 3 to 7 cm. Wood stems were clamped on a rigid structure and impacted by a 149 kg charpy pendulum.
Finally an intensive simulation campaign of blocks impacting trees was done to identify the input parameters controlling the block kinematics after the impact on a tree. 20 input parameters were considered in the DEM simulation model : 12 parameters were related to the tree and 8 parameters to the block.
The results highlight that the impact velocity, the stem diameter, and the block volume are the three input parameters that control the block kinematics after impact.