# Discrete element modelling of failure initiation and crack propagation in weak snowpack layers

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## ABSTRACT

Dry-snow slab avalanches are generally caused by a sequence of failure processes including (1) failure initiation in a weak snow layer underlying a cohesive slab resulting in the formation of a crack, (2) crack propagation within the weak layer and (3) tensile fracture through the slab which eventually leads to its detachment [1, 2]. Our knowledge of these processes is limited by the complex microstructure of snow and its highly porous character. In particular, it is not clear yet how to characterize the mechanical behavior of weak snowpack layers under mixed-mode loading as well as the effect of the volumetric collapse of the weak layer which induces slab bending with two opposite effects on crack propagation: stress redistributions in the weak layer which promotes the propagation, but also tensile stresses in the slab which might lead to slab fracture and thus the arrest of propagation.

The past decades have witnessed the development of new experimental methods such as the "Propagation Saw Test" (PST) [3] which allows characterizing not only the onset of crack propagation but also its dynamic phase including the possible slab fracture [4]. Yet, without any clear mechanical framework to interpret these field observations, it remains unclear how and which snowpack properties affect crack propagation.

To shed more light on these issues, we performed two types of cohesive discrete element simulations to characterize failure initiation and crack propagation propensity. Different simplified weak layers were modeled allowing to mimic the high porosity of snow, from very simple triangular shapes, to cohesive ballistic deposition. First, mixed-mode shear-compression loading simulations allowed us to assess the failure envelope of the weak layer. Second, simulations of the PST allowed us to evaluate the critical length required for crack propagation as well as the crack propagation speed and distance. Finally, the numerical results were compared to laboratory and field experiments based on particle tracking showing the promise of our approach.

## REFERENCES

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