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Mechanics and failure of snow under accelerational loading

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The response performance of snow under seismic load falls within the general area of snow mechanics. In the present study, a series of cold-laboratory experiments was performed to simulate earthquake-induced failures, examining the stability of snowpack and subjecting the snow to accelerational loadings with the aim of improving our understanding of the poorly studied mechanisms that act to trigger avalanches during earthquakes. The experiments investigated artificial snow samples (containing a weak layer) using specially constructed shaking table with different numbers of degree-of-freedom oscillations and different inclinations. Acceleration in the snow samples was measured using high-frequency sensors, enabling calculation of vibration-induced stresses within the snow at the moment of fracture. A high-speed camera was used to film the different types of fracturing. In all cases, the vibrations caused failure of the snow via fracturing along the weak layer or at the base of the snow sample. A unique condition of failure was observed and quantitatively described, it was caused by unique type of stress within the snow, consisting of a tensile stress oriented perpendicular to the shear plane as a result of a component of acceleration normal to the shear plane (it corresponds to a left-ward shift of the principal stress on the Mohr diagram into tensional stress regime); this stress was responsible for the smaller values of shear strength in the snow and is produced only in association with earthquakes, not with any other natural process related to avalanche triggering.

Keywords: shaking table, experiments, snow failure, cold laboratory, normal stress, shear stress