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Stress distribution calculations through a snow slab of varying elastic modulus; comparison with stability evaluation in the field

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Field observations are the main tools for assessing the snow stability concerning dry snow slab avalanche release. Often, theoretical studies cannot directly be translated into useful information for avalanche recreationists and forecasters in the field, and vice versa; field observations are not always objective and quantifiable for theoretical studies. Moreover, numerical models often simplify the snowpack and generally use an isotropic single layer slab which is not representative of the real-life situation.
The aim of this study is to investigate the stress distribution in a snowpack with an elastic modulus that continuously varies with depth. The focus lies on the difference between a slab with a gradient in hardness and a slab with isotropic hardness and the effect on the calculated maximum stress and the stability evaluation in the field.
Approximately 20 different snow pits were evaluated in the mountains around Tromsø, Norway and Longyearbyen, Svalbard. In addition to the standard snowpack observations, the hardness was measured using a thin-blade gauge. Extended column tests were executed for stability evaluation. Measurements from the field were used as input for stress calculations for each snow pit using a line load solution for a sloping half space with a non-homogeneous elastic modulus. The hardness measurements were used to calculate the elastic modulus and a power law relation was fit through the modulus in the slab. The calculated shear stress was compared to the estimated stability and character of the specific snowpack
The results show that the approach used for this study improves the calculation of stress at a given depth, although many assumptions and simplifications were still needed. Comparison with the snow profiles indicate that calculated stresses correlate well with the observed snowpack properties and stability. The calculated shear stresses can be introduced in the standard stability index and give a better indication for the snowpack stability. Further research is required to delimit the stresses needed for propagation of a weak layer fracture.