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A new approach to assess the skier additional stress within a multi-layered snowpack

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The physical and mechanical processes of dry-snow slab avalanche formation can be distinguished into two subsequent phases: failure initiation and crack propagation. Several approaches tried to quantify slab avalanche release probability in terms of failure initiation, based on a simple strength-of-material approach (strength vs. stress). Even if it is known that both weak layer and slab properties play a major role in avalanche release, apart from weak layer characteristics, often only the slab thickness and its average density were considered. For calculating the amount of additional stress (e.g. due to a skier) at the depth of the weak layer, the snow cover was often assumed to be a semi-infinite elastic half space in order to apply Boussinesq's theory. However, finite element (FE) calculations have shown that slab layering strongly influences the stress at depth. To avoid FE calculations, we suggest a new approach based on a simplification of multi-layered elasticity theory. It allows computing the additional stress due to a skier at the depth of the weak layer, taking into account the layering of the snow slab and the substratum. The proposed approach was first tested on simplified snow profiles and compared reasonably well with FE calculations. We then implemented the method to refine the classical skier stability index. Using manually observed snow profiles, classified in different stability classes using stability tests, we obtained a satisfactory discrimination power. Lastly, the refined skier stability index was implemented into the 1-D snow cover model SNOWPACK and presented on two case studies. In the future, it will be interesting to implement the proposed method for describing skier-induced stress within a multi-layered snowpack into more complex models which take into account not only failure initiation but also crack propagation.