

Interactive comment on “Modeling snow slab avalanches caused by weak layer failure – Part I: Slabs on compliant and collapsible weak layers” by Philipp L. Rosendahl and Philipp Weißgraeber

Anonymous Referee #1

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Modeling snow avalanches caused by weak layer failure Part I: slabs on compliant and collapsible weak layers

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General comments

This manuscript deals with the failure modeling within a snow mantle including a weak layer. This topic is of importance in snow engineering, as just a little is known today about how failure occurs and which parameters control the failure propagation within a snowpack. The authors have developed an original, analytical approach, based on elasticity equations and crack propagation. The basic idea is that the weak layer is

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prone to collapse, triggering a cracking mechanism within the subsequent layers. Even though this approach is appealing as it is quite easy-to-use, some remarks should be raised. In particular, the assumption that the computation can be run starting from an elastic state is questionable. What does elasticity mean in snow? Snow is first and foremost a (cohesive) granular material, in which the elasticity domain is very limited. Plastic dissipation develops early. Additional remarks are reported below.

In conclusion, I consider that this manuscript should be revised before being considered for publication in The Cryosphere.

Specific comments

Introduction section Line18 “If the conditions allow for crack propagation, . . .” Could the authors be more specific?

Mechanical modeling Failure initiation and propagation is a truly 3D problem. How can this approach be extended in 3D conditions?

Boundary conditions are supposed to play a very important role in failure propagation. How can this aspect be accounted for?

FEM computations make it possible to estimate both strain and stress within the snow pack, even though inhomogeneous conditions are considered. Thus, what is the interest of applying a simplified approach? In addition, more complex mechanical constitutive relations can be used in FEM (visco-plastic models, etc.). Could the authors develop a little bit more along this line?

Weak layer collapse under the snowpack can be regarded as the triggering event preceding snowpack failure. How this collapse can reasonably be considered in the present approach?

Equation 29 The Young modulus is expressed as a function of the relative density of snow. Does the temperature play no role and can it be ignored? Is it the expression of the Young modulus, referring to a truly elastic behavior, or does this term refer to

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the compressibility of a given snow specimen, irrespective of the behavior (elastic or anelastic)?

Finally, more recent numerical tools exist to deal with the mechanical behavior of snow-pack, including the detection of failure. DEM (discrete element method) approaches stand probably as a convenient and promising way. Also, micro-mechanically based constitutive approaches should be mentioned. It is regrettable that the authors have completely ignored this part of the state-of-the art. This should be considered in the revised version.

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