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Interactive comment on "Micromechanical modeling of snow failure" *by* Grégoire Bobillier et al.

Anonymous Referee #1

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The manuscript titled "Micromechanical modeling of snow failure" by Bobillier et al. reports the setup and the results of numerical DEM models aiming at studying the failure of weak snow layers. The paper is based on the fact that complex and detailed numerical models are extremely time-consuming. On the contrary, it is possible to build simplified models that are able to catch the main characteristics of the investigated material. In the proposed approach, such models are constituted by different layers of spherical particles. The approach is original and interesting results can be obtained from such numerical setup. The authors "tuned" particle properties by simulating real experiments. This approach is commonly used in other engineering disciplines.

In addition, they predicted the behaviour of such complex material under particular stress conditions, say, pure traction, for which no experimental pieces of evidence are

present. Referring to this last point, the possibility of "extrapolating" the behaviour to something that is hard to replicate in a laboratory has to be further discussed in detail and the limitation of the approach must be clearly stated.

In addition, there are some points that are not clear and must be detailed.

- P.2, L.6: to which properties do the authors refer with "and possibly other ones"?
- Referring to the contact model (P.3), it is not clear when the contacts are activated and when not. In other words, it is possible that new contacts form during the test, or not?
- P.3 L.15: scaling the size of the layer through homothetic transformation does allow to state that the mechanical properties are conserved? A short but detailed study on scaling laws would be appreciated.
- P.3 L.25: a lot of attention is given to the density. Why? It seems that the results are not density-dependent.
- P.4 L.5: the authors assumed that bond strength and particle elastic modulus are independent. Is this consideration supported by data, observations, previous researches, or is it a hypothesis?
- P.4 L.20: it is not clear the test setup. It seems that the density of the actuator layer is rapidly increased to simulate a normal vertical pressure. Why we should expect shear strains into the weak layer?
- Referring to the characterization of macroscopic properties, the authors performed a Latin hypercube sampling on the values of the elastic modulus of the particle and the strength of the bond and obtained the macro-properties of the slab. Many issues arise: why in Figure 2a only 9 simulation points appear, while

the authors have performed 100 simulations? Are those points related to a particular value of σ_{bond}^{th}? Are the values of coefficients $\beta_0, \ldots$ feasible/realistic? Please add the units of measure to β_0 and γ_0.

- Referring to the mechanical behaviour of layers, it is necessary to define what a failure is. Failure in tension is different from failure in compression or in shear. Referring, for example, to tension tests, how such tests were performed? Have the results of tension tests been compared with tests on real snow? In general, synthetic models are able to "interpolate" rather than "extrapolate".

- P.8 L.11: Which is the meaning of "shear acceleration"?

- Referring to the failure envelope reported in Eqn. (9), what σ^{th} does represent? Can the failure envelope be used in a real snowpack on a real slope? In addressing this issue, the authors must consider the fact that their tests were performed in unconstrained lateral conditions, different from boundary conditions that can be observed in a continuous layered snowpack.

- As stated in the introduction, the failure of snow slabs depends on many parameters, such as the fracture energy. Have the authors considered this important parameter in their simulations?

- In granular materials, failure mechanisms presupposes the formation and the subsequent destruction of force chains. Evidence of such behaviour has been observed on real snow tests (De Biagi *et al.*, European J. of Mech. - A/Solids, 74, 26-33, 2019). The observation of such mechanisms in simplified numerical models supports the conclusions. Have the authors noted such behaviours in their tests?

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