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Towards a general constitutive model for snow

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Reproducing the mechanical behaviour of snow is a challenging task for many disciplines (e.g., Civil and Environmental Engineering, Physics, etc.) and can be addressed in various topics, such as: the stability of mountain snowpacks, the safety of structures in cold environments, the social and physical risk for people and goods in snow-covered areas.

The available constitutive models for snow generally use the elasto-plasticity to reproduce different and complex items of this peculiar material with reference to laboratory and on-site conditions. Nevertheless, these models are often related to some specific snow types (i.e., rounded grains, faceted crystals, etc.) and cannot be used for general cases. Moreover, many models do not consider viscosity, rate-sensitivity, bonding, etc.

In this work, we introduce the theoretical bases of our proposal for a new constitutive model for snow. The model is based on the theory of visco-plasticity and is implemented in applications with an implicit integration scheme, and can reproduce both the elastic and plastic behaviour quantitatively the findings of some literature experimental data. For instance, the results are obtained for the following tests: triaxial compression and relaxation, volume change, and creep. Finally, we suggest possible improvements of the model to include features not considered so far, such as: the collapse in compression of the weak planes, the change in shape of snow grains, the ductile-to-brittle transition of the material, etc.