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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 different application fields (e.g., Civil and Environmental Engineering, Physics, etc.) and can be useful to study many topics, such as: the stability of mountain snowpacks, the safety of structures and infrastructures 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-plastic (EP) theory to reproduce different and complex items of this peculiar material with reference to both laboratory and on-site conditions. Nevertheless, these models are often related to some specific types of snow (i.e., rounded grains, faceted crystals, etc.) and cannot be used for general purposes. Moreover, many models do not consider viscosity, rate-sensitivity, bonding effects, etc.

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