PhD thesis abstract

Humans have been fascinated by snow from centuries and, in recent years, the interest in this natural material has progressively increased for many different reasons. Winter sports and leisure activities during the cold seasons have considerably spread worldwide, resulting in a growing interest in other snow-related topics and issues, such as: snow avalanche formations and dynamics, evolution of the snowpack, snow management, etc. All these topics, and many others (e.g., road safety, avalanche countermeasures, effects of climate changes, etc.), have to be faced by means of scientific, physical, chemical, and engineering expertises in the general framework of snow mechanics.

Snow mechanics is based on the execution of tests and experiments on snow specimens with the aim at measuring the deformation processes of the material, its mechanical characteristics like strength, stiffness, etc. Moreover, mechanical models allow performing computer simulations of more complex situations to deal with practical problems that involve, in most cases, the safety of human lives. Mechanical and constitutive models are essential to relate the actions on snow with the consequent behaviour of the material and to associate the stress states to the strain ones. The scientific literature provides many constitutive models for snow but they are specifically tailored for some particular and well-defined types of snow and often fail to reproduce other types.

In this doctoral thesis, a novel constitutive model for snow is introduced which tries to overcome the limitations of the existing snow models and aims to be more general than the available ones. The model accounts for the effects of sintering, mechanical degradation, and strain rate, and some introductory specifications on the snow types have been put forward to build a basis on which future developments of the model could be laid. The law is a nonlinear relationship, written in terms of infinitesimal deformation, and uses the theory of the visco-plasticity to describe the time dependence of the mechanical response of snow.

The model has been numerically implemented into the commercial finite element code Abaqus/Standard by means of a user material subroutine (UMAT), written in Fortran. The constitutive relationship has been tested with reference to some available literature data coming from laboratory experiments. Finally, the results show that the proposed constitutive law is able to catch and reproduce several phenomena described in the literature.