Characterizing the mechanical properties of snow and its evolution is a major challenge for many applications such as avalanche forecasting. There is not a unique snow material but numerous snow types distinguished by the shape, the size and the spatial arrangement of their ice particles, which is called “microstructure”. The mechanical properties of snow are tied to this microstructure. However, because of the wide range of microstructural patterns and the difficulty in conducting mechanical tests on this fragile and heterogeneous material, the relationship between microstructure and mechanical properties is still poorly understood. To decipher this link, we built mechanical models based on the three-dimensional microstructure of snow obtained by X-ray micro-tomography. The main idea is to numerically reproduce mechanical experiments by considering snow simply as a porous structure of ice. The difficulty of this approach is the processing of the large amount of data obtained by tomography at high resolution (e.g. 10 μm). For loadings involving small local deformations such as the elastic behaviour, the strategy is to use a fine description of the structure but a simple constitutive law for ice and finite element models. For loadings involving complex structural re-arrangements such as the penetration of an object (e.g. SMP), compression or structural collapse, the degrees of freedom of the structure are constrained to inter-granular deformations and discrete element models are considered. This approach overcomes the difficulty of conducting real experiments on fragile snow types and enables to apply different and controlled loadings on the same sample. This presentation will give an overview of the different numerical methods developed and will focus on two specific applications: the computation of the snow failure envelope and of the post-peak softening observed during the collapse of weak layers.