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Optimal design of snow avalanche passive defence structure using reliability approach to quantify buildings vulnerability

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To protect elements at risk (humans, roads, houses, etc.) against snow avalanches, civil engineering structures, such as dams or mounds, are used. The design of such defence structures is done following a deterministic approach which considers European regulation. The minimization of expected total losses is an interesting alternative that generalizes cost-benefit approach to a continuous decision variable. For this purpose, not only the hazard magnitude but also the buildings vulnerability must be evaluated carefully.

The aim of this work is therefore to combine state of the art sub-models for the probabilistic description of avalanche flows and the numerical evaluation of damages to buildings. We defined the risk as the expectation of the cost consequences of avalanches activity. Disposal consequences are quantified thanks to reliability methods. In this formulation, the accuracy of both the hazard estimation and the vulnerability calculation has to be consistent according to precision and computational costs. To do so, a numerical approach has been developed to evaluate the physical vulnerability of concrete buildings submitted to avalanche loadings.

The ensuing application illustrates our approach. A reinforced concrete slab is considered to model the building with a finite element method. Reliability approach enables to produce a response spectrum of the structure against avalanche impact. Finally, vulnerability curves are built. Outcomes of the risk calculation are examined to find sensitivity on the optimal design of snow defence structures.