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Probabilistic size effect law for mode II fracture of critical lengths in snow slab weak layers

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Snow slab avalanches initiate by mode II fracture within relatively thin weak layers under stronger, cohesive slabs. For risk based avalanche prediction, it is important to understand the fracture properties of alpine snow. Alpine snow is a quasi-brittle material with a size effect on nominal shear strength meaning that strength decreases with increasing sample size. A related size effect is the critical length required for rapid propagation of a shear fracture. In that case, the probability of fracture increases with increasing crack length. In this paper, 45 sets of field measured critical lengths are presented based on 591 individual tests. From analysis, a probabilistic size effect law is derived analogous to the deterministic size effect law for nominal shear strength related to fracture mechanics. It is shown that in the limit of small crack length, the plastic limit is approached with a very low probability of failure implying very high shear strength. At the other limit, for long enough cracks, the limit of Linear Elastic Fracture Mechanics (LEFM) is approached implying high probability of failure and low nominal shear strength compatible with large sample size. It is shown that the strength size effect law and the critical length size effect law form a duality for analysis of snow avalanche weak layers. It is expected the critical length size effect law will be important in applications.