AVALANCHE FRACTURE MECHANICS RESULTS FOR PRACTITIONERS

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ABSTRACT: It is indisputable that dry slab avalanches are initiated by weak layer shear fractures. I formulated the first fracture mechanical model of dry slab avalanche release about 30 years ago. Since then, there have been numerous papers on the subject which include theoretical models and field tests. In this paper, I will provide a review of results from these studies which can be of practical use to avalanche forecasters both in the backcountry and for other applications e.g. along transportation routes. The results I will discuss include: avalanche fracture mechanical size effects and their role in determining destructive potential, instability evaluation in relation to fracture toughness and fracture stress intensity factor, and the meaning of propagation saw tests (PST) in terms of measured critical lengths, L. Data used within the paper will be from hundreds of snow slabs and their dimensions, hundreds of precision lab experiments and hundreds of field tests on critical lengths for shear fracture propagation underneath snow slabs.

The principal results for practitioners include 3 applications:
1. Use of depth to the weak layer, D, to estimate avalanche size (destructive potential). Field data suggest that avalanche size on the Canadian scale increases by one size as D doubles.
2. Use of shear quality (or fracture character) tests to estimate instability. Skier triggering data suggest that for shear quality: Q1,Q2, Q3 the likelihood of triggering decreases in the ratio: 15,3,1 respectively or triggering is about 15 times more likely if Q1 is observed than Q3.
3. Use of the dimension-less ratio: L/D from propagation saw tests to estimate instability. Field data summarized from 500 tests show the ratio L/D is log-normally distributed with values between 0.1 to more than 2. Field data from surface hoar layers show that the median values of L double as slope angles increase from zero to 35 degrees which suggests tests should be done on slopes of 30 degrees or more.

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