CORRESPONDENCE

The Editor,
Journal of Glaciology

SIR, *The role of stress concentration in slab avalanche release: comments on Dr R. A. Sommerfeld's paper*

Sommerfeld (1969, p. 451) dismisses Haefeli's contributions with the statement "Haefeli (1942, 1963) speaks of the shear fracture of a weak layer". Actually, Haefeli (1963) emphasized the importance of tensile failure in his theory of "stress metamorphosis". Also, recall his discussion in Roch (1966):

> "We must take into account that the formation of snow slab avalanches is in its first approach not a problem of shear strength in the sliding surface but of the tensile strength within the fracture surface. The latter stays vertical (perpendicular) to the slope. The opening of the crack and the failure process is progressive. The breaking down of the sliding layer and the overcoming of the shear strengths along the sliding surface is no longer a static but a dynamic process, due to the heavy shock produced by the opening of the crack."

Although Haefeli and Sommerfeld are in agreement on the importance of tensile failure, Sommerfeld advocates a Griffith criterion and Haefeli a Coulomb-Mohr criterion. A Griffith criterion, based on sound first principles, may be preferable; however, the Coulomb-Mohr criterion is still considered a good approximation for the macroscopic failure of granular materials (Paul, 1968).

It is noteworthy that the Coulomb-Mohr criterion has been modified to account for "tensile cut-offs" (Paul, 1968), which makes it quite applicable to the "stress metamorphosis" model.

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REFERENCES

Haefeli, R. 1963. Stress transformations, tensile strengths and rupture processes of the snow cover. (*In* Kingery, W. D., *ed. Ice and snow; properties, processes, and applications: proceedings of a conference held at the Massachusetts Institute of Technology, February 12–16, 1962.* Cambridge, Mass., The M.I.T. Press, p. 560–75.)

Paul, B. 1968. Macroscopic criteria for flow and fracture. (*In* Liebowitz, H., *ed. Fracture, an advanced treatise. Vol. 2. Mathematical fundamentals.* New York and London, Academic Press, p. 313–496.)

Roch, A. 1966. Les déclenchements d'avalanches. *Union de Géodésie et Géophysique Internationale. Association Internationale d'Hydrologie Scientifique. Commission pour la Neige et la Glace. Division Neige Saisonnière et Avalanches. Symposium international sur les aspects scientifiques des avalanches de neige, 5–10 avril 1965, Davos, Suisse*, p. 182–95.

Sommerfeld, R. A. 1969. The role of stress concentration in slab avalanche release. *Journal of Glaciology*, Vol. 8, No. 54, p. 451–62.

SIR, *The role of stress concentration in slab avalanche release: reply to Dr R. Perla's letter*

I am sorry if I have been unfair to Dr Haefeli's pioneering work. However, I don't think it is unfair to imply that Haefeli has been instrumental in inspiring much of the work in the shear failure of snow and particularly of internal layers. The Coulomb-Mohr criterion as proposed by Haefeli presupposes shear failure.

As Perla points out, the Coulomb-Mohr criterion is a good approximation for granular materials. Part of the point of my paper is that it may be more realistic to view snow not as a granular material but as a solid ceramic with the unique property of extremely variable density. This implies that a Griffith criterion would be more applicable.

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