

## ***Interactive comment on “Measurement of fracture toughness of an ice core from Antarctica” by J. Christmann et al.***

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"general comments" This paper presents the data from 108 four-point-bend fracture tests on machined sections of Antarctic ice cores. Careful measurements of the associated densities are reported. The fracture tests were conducted at one rate and one temperature.

"specific comments" Being very familiar with the fracture testing of ice, my impression is that the paper would benefit if it were quite focused. With regard to previous fracture testing of ice, just reference those who have tested antarctic ice. Referencing Schulson and Duval (book) rather than Rist (1999) is not proper. You have failure times of 1 second, and you are doing an elastic analysis, so straying into time dependent

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discussions seems unwarranted. In sections, the paper reads with an overview style, whereas I think that you should make it a more focused experimental report.

How did you cut the cracks? How did you measure the notch radius? You could mention that Wei et al (1991) studied the influence of notch acuity. With a depth  $W$  of 14.30 mm, what lead you to choose a crack length "a" equal to 2.5 mm? Given that the minimum grain size was 0.05 mm, and the maximum grain size was 4.48 mm, the crack face passed through a maximum of 5 grains, and a minimum of half a grain! On average, the fabricated crack passed through slightly more than two grains. What lead you choose  $B$  much larger than  $W$ ? Could you have made  $W$  larger?

Your equation for the four-point-bend stress-intensity-factor is unknown to me. Please cite a very specific reference. Often these expressions are accurate for specific outer span to depth ratios, very commonly 4 or 8. Your outer span to depth ration is 7.2.

You completed 108 fracture tests, with 17 breaking away from the notch. Of course this a classic case of "notch insensitivity". Cases of notch insensitivity were discussed in 1991:

Dempsey, J.P., (1991) The fracture toughness of ice. Ice-Structure Interaction. IUTAM Proc.(ed. S. J. Jones, R. F. McKenna, J. Tillotson, and I. J. Jordaan) Springer-Verlag, Berlin Heidelberg, 109-145.

In this paper, the circumferentially-notched-round-bar (CNRB) fracture tests reported by Nixon (1988) and Nixon and Schulson (1988) were discussed (you cite these papers). Their tests were also notch insensitive.

It would be wise to complete a notch sensitivity study for your specific geometry to guide you as to the optimum crack length. Needless to say, one tries very hard to avoid notch insensitive tests.

In Figure 6, is the Force the central load  $F$ , and is the displacement the load-point-displacement (LPD) "u"? It would be very much more revealing to plot the force versus

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the displacement, and the displacement versus the time, along with the specified displacement versus time.

Did you examine the crack paths, making thin sections to see whether the crack went through the air bubbles, through the grains or along the grain boundaries?

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