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The Cryosphere Discussions

Interactive comment on "Evaluation of the criticality of cracks in ice shelves using finite element simulations" *by* C. Plate et al.

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I am struck by how useful this paper is. The computation of stress intensity factors is very difficult, and involves a lot of magic and approximation... and this paper presents a fully functional alternative to one of two prior approaches I have seen in my brief period of study (I am no expert, but am trying to learn): one method has been in glaciology for a while–the use of what are essentially tables of evaluations to account for geometry of a body with an idealized notch-shaped crack in it... the other method is the J-integral method, which is relatively new to glaciology (at least in my awareness) in the sense that it was used by Tsai and Rice (unpublished) to evaluate the hydrofracture of a crack at the base of an ice sheet for the purposes of studying supraglacial lake drainage in Greenland.

This paper presents an alternative to the above two methods, i.e., it computes a field called G within the body of the object, and uses this field to evaluate stress intensity. It is an alternative to evaluating the J-integral, and (I am guessing) is probably more consistent with the numerics of a finite-element model (where it is difficult to evaluate derived quantities associated with model variables on a point by point basis). The way I see it, the method uses the Eshelby stress tensor (page 474) as part of the field called G... This stress tensor (which otherwise means nothing to me as a glaciologist, having never seen or heard of it before) forms the integrand of the J-integral; so I suspect that the methodology here is related to efforts to evaluate stress intensity factors using the J-integral.

Overall, it seems to me that a numerical solution of a problem that has as its objective to find stress intensity factors should do well to use the method described here; and I wouldn't be surprised if the method here is superior to determining the same result by evaluating J-integrals using numerical data (that is possibly inconsistent with the finite-element nodal fields)...

One thing that I have worried about, but without progress (and this is *not* a criticism of the discussion paper) is to what extent is the realization of ice as an elastic body (e.g., with a Poisson ratio that is not 0.5, and where the pressure will not be lithostatic as a result) is different from its realization as a viscous (or "Glennian") body? The elastic stresses will be very different from the viscous stresses (but there can be only one stress field, right?) depending on the assumptions made... Also, elastic stresses are not temperature dependent, whereas viscous stresses depend on the temperature profile of the ice body (as analyzed in, e.g., one of the papers cited by the referee). This is something I would like to know at a deeper level (and regret that my expertise and education are not to the level that would allow me to know or understand the answer).

I looked at the review, and think that it offers nice constructive criticism, however I doubt that it will be possible to fully answer part 1... there are numerous methodologies in use and each has its strengths and weaknesses...

TCD
6, C221–C223, 2012

On page 479, is there a "Mega" missing from the units for stress intensity in this sentence? The diagram shows, that the critical stress intensity factor KIc, which ranges between (1–4) [check these units] (Rist et al., 2002),

D.R.M.

Interactive comment on The Cryosphere Discuss., 6, 469, 2012.

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6, C221–C223, 2012

Interactive Comment