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IMPLEMENTATION AND EXPERIMENTAL VALIDATION OF THE SENDOVA-WALTON THEORY FOR MODE-I FRACTURE

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The Sendova-Walton fracture theory [1] incorporates atomistic effects into a continuum framework by ascribing a surface tension excess property to the fracture surfaces. We are interested in implementing a numerical model of this theory using the finite element method for mode-I brittle fracture. This is a challenge since the curvature-dependent surface tension yields a weak formulation with higher-order derivatives. We propose an alternative formulation using a Green's function which we implement using nonlocal calculations on standard finite elements. We present the results of our simulation, which show good agreement with the predictions of the theory (in particular, exhibiting finite stresses at the crack tips) for the correct choice of surface tension parameters.

Due to the difficulties of accurately measuring crack profiles in fracture experiments, we have chosen to validate the model using a contact problem. The equilibrium governing equation is the same as in the fracture problem, but the excess property is now ascribed to the free surface outside the contact region. We conducted corresponding nanoindentation experiments on a cured epoxy resin. By comparing the graphs of applied force versus penetration depth, we show close correlation between the experimental and simulation results. We also use the empirical data to recover the first surface tension parameter for this material.

REFERENCES

[1] Sendova, T. and Walton, J.R. A new approach to the modeling and analysis of fracture through extension of continuum mechanics to the nanoscale. *Math. Mech. Solids* (2010) **15**(3):368–413.