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This Week's Citation Classic

Barenblatt G I. The mathematical theory of equilibrium cracks in brittle fracture. *Advan. Appl. Mech.* 7:55-129, 1962.
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On the basis of a detailed crack-edge analysis, the elastic equilibrium problem for bodies with brittle and quasi-brittle cracks is stated as a nonlinear problem in elasticity theory. Stability of crack propagation is discussed. A review of previous results is presented in light of a proposed general problem statement. [The *SCI*® indicates that this paper has been cited in over 150 publications since 1962, making it the most-cited paper published in this journal.]

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"I believe that some of the success of this paper could be attributed to the fact that it presents a general approach to the fracture problem. This approach was proposed at the right time in the development of fracture mechanics and has proved to be rather fruitful for further investigations. Both before and after this work, I studied problems in various fields of mechanics: turbulence, fluid and gas filtration, combustion, mechanics of solids, similarities of various types, etc. I have published about 150 papers and several books. This work, however, has a special place in my heart.

"Modern elasticity theory allows one to determine stress and strain in the structures of arbitrary form. However, these quantities are not of primary interest for a customer-engineer: he wants mainly to learn at which loads (or after which time) a certain structure will fail. The linear elasticity theory is unable to answer this question.

"It is necessary, therefore, to introduce a nonlinearity into elasticity theory to obtain the fracture phenomenon. Practically, the elasticity theory was supplemented by local fracture conditions—stresses (or their certain combinations) were prohibited to exceed a definite value. A.A. Griffith[1] understood in 1920, however, that crack-like defects play a governing role in brittle fracture; his ideas influenced all subsequent studies. For cracked bodies, however, the approach mentioned here is impossible. According to elasticity theory, the stresses on the crack edges are infinite at arbitrary loads.

"In my earlier work, summarized by this paper, an analysis of the situation near the crack edges was performed and on its basis a new approach to the crack problem was proposed. 'Cohesion forces' acting at crack edges were introduced into consideration explicitly. The main hypotheses were formulated, the most basic being the hypothesis of 'authonomity,' which states that in the mobile-equilibrium state, the heads of all cracks in a given material are the same, like the heads in zippers. The performed analysis led to a statement of the equilibrium problem for elastic bodies with cracks as well as of the crack development problem under growing loads as nonlinear problems in elasticity theory—not only are elastic fields to be determined but also crack sizes. The fracture from a mathematical viewpoint appears to be the existence loss of the solution to this problem. One of the important results is that limiting loads do not depend on the initial crack size if the cracks grow stably even in a short stage of the loading process.

"Later, I continued these studies both alone and with my students and colleagues, dealing mainly with the problems of kinetics and dynamics of cracks. Now other problems seem to be urgent: ductile fracture, ductile-brittle transition, and fatigue fracture. They are important from a practical viewpoint and very difficult. New ideas are necessary because the principal shortcomings of existing approaches are evident now. The situation seems to be the same as in fracture mechanics a quarter of a century ago. I consider this situation optimistically—I believe progress will be achieved as before, not through difficult theories with heavy mathematics but through some simple ideas as yet unknown. There has been much recent work in this field."[2-5]

1. **Griffith A A.** The phenomenon of rupture and flow in solids. *Phil. Trans. Roy. Soc. A* **221**:163-98, 1920. (Cited 725 times.)
2. **Liebowitz H,** ed. Fracture: an advanced treatise. New York: Academic Press, 1968. Vols. I & II.
3. **Sneddon I N & Lowengrub M.** *Crack problems in the classical theory of elasticity.* New York: Wiley, 1969. 221 p.
4. **Hahn H G.** *Bruchmechanik: Einführung in die theoretischen Grundlagen.* Stuttgart: Teubner, 1976. 221 p.
5. **Bui H D.** *Mécanique de la rupture fragile.* Paris: Masson, 1978. 215 p.