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This Week's Citation Classic

Elber W. The significance of fatigue crack closure. *Damage tolerance in aircraft structures.* Philadelphia: American Society for Testing and Materials, 1971. p. 230-42. ASTM STP 486.
[NASA Langley Research Center, Hampton, VA]

Evidence is presented that a fatigue crack growing under cyclic tension can close on itself at about half the maximum load. The significance of this effect on crack growth calculations under random loading is described. Tests on aluminum alloys confirm the predictions. [The *SCI*® indicates that this paper has been cited in over 240 publications since 1971.]

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"The original discovery of the crack closure phenomenon was made when I was a graduate student at the University of New South Wales in Sydney, Australia. Rather than being the result of years of directed effort, it was a split-second observation made while cutting up a fatigue-cracked plate. Because of the geographic isolation, I was not aware during the ensuing months, during which I wrote up that discovery into my thesis, that I was going to contradict many of the existing teachings in fracture mechanics, or how much that phenomenon contributed to the resolution of the complexity of crack growth under variable-amplitude loading.

"After having my thesis initially rejected by the first American reviewer, I went to the Federal Republic of Germany to continue my research in the government aerospace research company (DFVLR). Because of continued disbelief in the phenomenon, I published essentially a defensive paper outlining the basic critical experiment required to prove the existence of the phenomenon.[1] After two years in the Federal Republic of Germany, I went to work with H.F. Hardrath at NASA Langley Research Center. He advised me to write a more comprehensive paper on the phenomenon and its significance to the phenomena of crack retardation, delayed retardation, and accelerated growth. That paper began to convince a number of skeptics, many of whom later based their own work on this new phenomenon. Today, most research in fatigue crack growth includes consideration of crack closure, contributing to the frequent citation of the subject publication.

"The time from the initial discovery of any phenomenon to a profitable application is often long. In this case, the inclusion of crack closure in numerical crack growth calculations adds significant cost and complexity for gains in accuracy only required in the space and aeronautics industries. Many industries will continue to use simpler and less accurate theories, leaving the continued work in crack closure as an area of basic research. The most recent and advanced work in that area is probably that of my colleague, J.C. Newman."[2]

1. **Elber W.** Fatigue crack closure under cyclic tension. *Eng. Fracture Mech.* 2:37-45, 1970. (Cited 90 times.)
2. **Newman J C, Jr.** Prediction of fatigue crack growth under variable-amplitude and spectrum loading using a closure model. (Abelkis P R & Hudson C M, eds.) *Design of fatigue and fracture resistant structures.* Philadelphia: American Society for Testing and Materials, 1982. p. 255-77. ASTM STP 761.