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DISCUSSION

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This investigation is very valuable because it verifies by experiment a number of notions about crack growth in a stress field which is far from uniform.

The experiments on crack arrest are of special interest. Preoccupation with rates of crack growth too often obscures the fact that *zero* rate of crack growth is of the greatest practical interest. The author arrested cracks in a field of tensile self-stress by holding the applied load cycle entirely in the compression range. The opposite procedure is to prevent cracks from growing under tensile load cycles by providing a field of compressive self-stress; overloading in tension before applying tensile load cycles can achieve this.

The writer believes that this latter set of conditions—applied tensile load and a field of compressive self-stress—is of the greatest interest in preventing the growth of fatigue cracks, and is worthy of more detailed investigation.

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M. A. Tucchio[3]

The author is to be commended in his work on the problems of crack propagation and residual stresses. This problem is usually avoided because of the sensitive nature of compression testing thin, plate type specimens with through cracks.

It appears that two regions might be necessary to explain the crack growth rate. These regions can be described when the residual stress is solely dependent upon the original discontinuity which caused the first plastic zone, or is solely dependent upon the plastic zone at the crack tip. It seems to me that these effects would each be dominant at a time depending upon the current crack length and the size of the original plastic zone. The crack growth rate would be larger in the first region than in the second and therefore account for a decreasing crack propagation rate as shown by the data in the paper.

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Author's Closure

The author thanks the discussers for their comments. As H. O. Fuchs states, a compressive residual stress field in the region material discontinuity will delay or reduce the rate of crack growth in that region. It is of interest to note that cracks growing under the influence of a tensile residual stress field caused by plastic flow in the region of a material discontinuity loaded in compression, as is the case in the present paper, may be arrested or retarded by loading the samples in tension-causing compressive residual stress field at the tip of the crack. Similarly, the cracks which occur in the field of tensile stress of a material discontinuity loaded in compression may be retarded by the application of a compressive load sufficient to cause plastic flow and residual compressive stress upon load release. For most discontinuity geometries such a compressive load sufficient to cause plastic flow in the tensile stress region would also cause plastic flow in the compressive stress region of a much greater extent, thus aggravating the problem of crack growth under residual tension.

As M. A. Tucchio states, two factors may be significant when considering crack growth in a field of residual tension, the character of the residual stress field and the interaction of the growing crack and this field. Note that the residual tension is associated with compressive loading and discontinuity geometry and that the crack extends under the influence of the residual tension. In the cases studied in the present paper, the plastic deformation associated with the propagating crack apparently did not significantly modify the residual tension field associated with the original material discontinuity.

Finally, it is subjectively noted that the use of crack-growth rate as an indication of the stress intensity may be the most significant idea of the paper and could aid stress analysis of complex cases.

