Optimization of Geometric Discontinuities in Stress Fields

Paper by A.J. Durelli, K. Brown and P. Yee was published in EXPERIMENTAL MECHANICS, August 1978, Pages 303-308

Discussion

by Henry O. Fuchs

It was a pleasure to read this paper on the optimization of geometric discontinuities in stress fields. There are not nearly enough papers which show a marriage of design and analysis. Professor Durelli and his associates have done an admirable job of presenting an example of a successful marriage of this type.

Some questions should be raised about the use of the coefficient of efficiency. The improved ring carried 21 percent more load and weighed 10 percent less. An increase in efficiency of 33 percent seems indicated. Yet the ratio of coefficients is

$$0.952/0.587 = 1.62$$

It seems that the coefficient measures not the efficiency but the uniformity of stress distribution. To consider efficiency, or optimization, we must know what failure criteria and what performance criteria are considered. If the mode of failure is yielding and the material is ductile, we can obtain better efficiency by exceeding the allowable load stress in small areas (limit design). Stress peaks in small areas are not damaging, but they would either reduce the coefficient or increase it above 100 percent.

The method shown in the paper is beautiful in its ability to eliminate or to decrease stress concentrations. Whether stress concentrations are actually harmful, and how their effects should be quantified when they are harmful are questions which require more complex answers.

Quantitative measures of 'goodness' permit arithmetic to be used in place of judgment. This is valuable only when the quantitative measures really express the effects which should be achieved. When the effects are complex, as are the effects of stress concentrations, it would be better to call for judgment, not for calculation.

It seems to me that the coefficient of efficiency shown in the paper is one of many instances where an imperfect equation is proposed to replace qualitative judgment.

The authors deserve congratulations for demonstrating a visual experimental way to improve design.

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Authors' Closure

The interest shown by Professor Fuchs in our work is greatly appreciated. Professor Fuchs is correct in calling attention to the fact that the proposed concept of 'coefficient of efficiency' cannot be applied in the same way to structures in which the material behaves in a ductile manner and to brittle failures (the example chosen was Homalite 100) or to the long-life fatigue failure of ductile materials. These last two cases, for which the concept is most useful, include a very large part of mechanical and aeronautical engineering structures.

The quantification of the stress distribution at the edge of a discontinuity is a concept useful in the development of a judgment for the design of a structure, just as the value of the stress concentration is a useful concept in the design of that structure. A lower stress-concentration factor means, in many cases, a longer life of a structure or its ability to support higher loads. A higher coefficient of efficiency, in a similar manner, not only indicates a better distribution of the stress, but also indicates the limit of improvement above which the designer cannot expect to go, if he keeps the constraints of the design. Of course, under different sets of constraints, which may include different failure criteria or, for instance, different allowable stresses in compression and tension, different measures of efficiency may have to be used.

ERRATA:

Classification of Stress-intensity Factors from Isochromatic-fringe Patterns

by J.W. Dally and R.J. Sanford

On pages 441-448 of the December 1978 issue of EXPERIMENTAL MECHANICS, *there appeared the paper "Classification of Stress-intensity Factors from Isochromatic-fringe Patterns" by J.W. Dally and R.J. Sanford.*

Regretfully, most of the figures used in this paper did not reproduce satisfactorily upon printing, prompting the Editors to prepare a number of reprints for which new engravings have been made. These reprints are now being offered, free of charge, to all interested parties. Anyone desiring a copy should address his or her request to Editorial Office, SESA, 21 Bridge Square, P.O. Box 277, Saugatuck Station, Westport, CT 06880.

The Editors