The analysis of fatigue as presented in this paper has been developed from discussions on specific points with Prof. J. O. Smith of the University of Illinois, Dr. A. Herzog, and W. J. Trapp, of the Materials Laboratory at Wright Air Development Center. Acknowledgment is also made of the time spent by Prof. T. J. Dolan and H. T. Corten of the University of Illinois, in reviewing the paper. The author wishes to thank them for the time they have contributed and the interest they have shown in this analysis.

**BIBLIOGRAPHY**


**Discussion**

R. E. Peterson. The procedure proposed by Captain Dirkes is in remarkably good agreement with test data for the cases covered. However, it does depend on running fatigue tests for any variation in geometry. In many design problems, one must make an estimate without the benefit of special tests, and it is of interest to see what one would obtain in this instance. The yield, tensile, and unnotched fatigue strengths of ordinary engineering materials are available to designers, as are also a variety of theoretical stress-concentration factors. A design rule is usually a simplification in which the error is on the safe side. Referring to Fig. 8, based on Captain Dirkes' Fig. 5, the simplest design rule for a notched member under alternating stress is

\[ S_m = S_e / K \]

where

- \( S_m \) = design stress for notched member
- \( S_e \) = unnotched fatigue strength
- \( K \) = stress-concentration factor (theoretical)

To account for mean stress, the simplest rule is to connect \( S_0 \) of Fig. 8 with the yield strength, \( S_y \), or tensile strength, \( S_t \), by means of a straight line. As seen from Fig. 8, this procedure results in values well on the safe side of the test points. Incidentally,
Captain Dirkes mentioned the widely used straight-line assumption as being in error on the unsafe side, referring to the straight dashed line of Fig. 5 drawn to the notched tensile strength value (see also top straight line of Fig. 8); however, this does not correspond with usual design procedure. With regard to estimating the notched fatigue strength under alternating stress conditions one can use more elaborate methods\(^6\) as indicated on Fig. 8, wherein average notch-sensitivity factors\(^6\) and the Mises criterion\(^5\) are used and these come closer to the test results. However, in a large percentage of cases, these design refinements are probably not justifiable. At best, design rules are not as satisfactory as actual tests and the writer is in agreement with Captain Dirkes in that wherever possible supporting test data be obtained and utilized.

**Author's Closure**

Mr. Peterson's comments are appreciated, particularly the information regarding common design practices. Inspection of Fig. 5, considering Mr. Peterson's comments, shows that the area of greatest error with conventional-design procedures is that where high mean stresses are applied.

The original interest in developing a more accurate design procedure was caused by the need for weight saving in aircraft and missile structures. If the proper contour for an alternating-mean stress curve can be established with reasonable accuracy, then a safety factor can be applied such that the original shape of the curve is maintained. This concept still requires additional experimental investigation, particularly since recent tests have indicated that modification is necessary if the test material creeps under the stress and temperature applied.

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