CHAPTER 9

A NOTE ON FATIGUE SCATTER AND LIFE PREDICTIONS

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One of the major problems in predicting fatigue life for service components from laboratory data is that the scatter of laboratory data often differs from that of actual service components. In this note a method to estimate fatigue lives from crack propagation models is presented. It will be shown that the result is a scatter and life prediction which well represents those desired for typical manufactured parts.

Fatigue crack growth can be reasonably well characterized by

\[
\frac{da}{dN} = c(\Delta K)^m
\]  

(1)

where \(a\) is the crack length, \(N\) the number of cycles, \(c\) a constant, \(\Delta K\) the stress intensity factor, and \(m\) an exponent, usually about 4. From notch analysis of fracture [1] a similar relation is obtained, namely

\[
\frac{da}{dN} = a\left(\frac{\sigma}{\sigma_o}\right)^{m'} \quad m' \approx 4
\]  

(2)

where \(\sigma\) is the maximum cycle stress and \(\sigma_o\) a material constant. Mean stress and threshold effects are also readily incorporated in these formulae [2]. For the present estimate the second equation is used. After integration one obtains

\[
\ln \frac{a}{a_o} = \left(\frac{\sigma}{\sigma_o}\right)^4 N
\]  

(3)
Figure 1. Assumed crack distribution and stress probability for hypothetical manufactured parts.

Figure 2. Assumed S-N curve for material with scatter bars resulting from the assumed initial crack distribution.