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Accuracy of fatigue limits estimated by the staircase method using different evaluation techniques

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Abstract

The staircase method is often used to determine the fatigue limit of components. Several evaluation techniques are available for these fatigue tests. Here, artificial fatigue tests are generated and evaluated using the Monte Carlo simulation statistical tool to compare the accuracy of these methods. Monte Carlo simulations are also used to compare the performances of these methods for estimating the fatigue limit for 50% probability of failure and the standard deviation for the log-normal distribution. This work demonstrates the use of statistical testing for evaluating experimental results in comparison with quality standards.

Keywords fatigue limit, fatigue testing, staircase test, numerical simulation, statistical testing

List of Symbols

α	significance level or probability of occurrence
a_I, b_I	auxiliary variables for estimating the standard deviation for the advanced IABG evaluation method
C	confidence level C = 1 - α
$c_{ML,corr}$	factor for the bias correction of the standard deviation of the log-normal distribution estimated by the maximum likelihood method
d	staircase factor
$F_{D/M}$, $A_{D/M}$, $B_{D/M}$	auxiliary variables of the Dixon and Mood evaluation
f_i	number of test results on stress level i
F_I, A_I, B_I	auxiliary variables of the advanced IABG evaluation method
H_0	null hypothesis
H_1	alternative hypothesis
i	order number of stress levels for which there are test results
k_I	auxiliary variance of the advanced IABG evaluation method
L	likelihood function
m	logarithmic mean
$m(\sigma_e)_{sample,\alpha}$	estimate for the median or mean of the fatigue limit (sample mean) with probability of occurrence α
$m(s_{log}(\sigma_e)_{pop})$	mean of $s_{log}(\sigma_e)_{pop}$
$m(\sigma_e)_{pop}$	defined mean fatigue limit of the population (P_f = 50%)