A Comparative Analysis of Step Loading and Staircase Testing for Fatigue Strength Estimation of an Engine Component

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Abstract

Staircase testing is a standard method for evaluating the fatigue strength of components. However, staircase testing assumes a normal distribution, while components can display bimodal behavior due to flaws in material, or issues during the manufacturing process. Three unique step loading data sets on different production crankshafts provide evidence that step loading reliably identifies material or manufacturing issues, that lower a component's fatigue strength. Staircase testing has an 87% or greater chance of overestimating the component's fatigue strength, which in turn overestimates the component's expected reliability. For example, a component with a 99.9% reliability, based on staircase testing would only have a 74% reliability based on step loading. If a component contains an undetectable manufacturing defect, staircase testing has a 99% chance of overestimating the component's fatigue strength. Step loading reliably improves the estimation of a component's fatigue strength distribution while providing insights into a component's defect tolerance.

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