A combined low and high cycle fatigue life prediction model considering the crack closure effect of micro-defects based on the continuous damage mechanics

Xin Ding[1], Xiaojun Yan[1], Dawei Huang[1], Zixu Guo[1], and Kaimin Guo[2]

[1]Beihang University
[2]Research Institute of Aero-Engine Beihang University Beijing 100191 China

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Abstract

In this study, a combined low and high cycle fatigue (CCF) life prediction model, which considers the crack closure effect (CCE) of micro-defects, is proposed based on the continuous damage mechanics. The CCF life prediction model is decomposed into three sub-models: the low cycle fatigue (LCF), high cycle fatigue (HCF) under the maximum stress of LCF (HCFLM), and their coupled damage models. The CCE is considered by taking one CCE parameter into the HCFLM sub-model. The experimental CCF data of K403 full-scale turbine blades under different vibration stresses is used to verify the accuracy of the proposed model to compare with other life prediction models. The prediction life from the proposed model falls within the 2 times of scatter band compared with the experimental results. Further, there are the different damage evolution forms at different vibration stresses. When the vibration stress is below 64.48MPa, the CCF damage mainly is caused by the LCF damage. However, while the vibration stress is higher than 64.48MPa, the HCFLM damage plays a major role in the CCF damage accumulation, and it is predicted that the CCF damage of the first stage serration on the K403 turbine blades is mainly from LCF.

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