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考虑应力状态的疲劳裂纹闭合分析

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THEORETICAL ANALYSIS OF FATIGUE CRACK CLOSURE CONSIDERING STRESS STATES

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摘要

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摘要 利用改进的条带屈服模型 (Modified Strip Yield Model),通过对裂端约束的研究,提出组合约束因子的概念,发展了 Budiansky和 Hutchinson的解析模型,建立了可考虑不同应力状态的疲劳裂纹闭合模型,可方便地推广到穿透厚度裂纹的闭合分析中。与航空结构合金的实验数据及有限元结果的比较显示该模型能准确预测疲劳裂纹闭合中载荷比、应力状态和厚度等重要因素的影响。给出的显式结果可以方便地用于航空工程实际。

关键词: 应力状态 疲劳裂纹闭合 约束 张开应力比 厚度效应 穿透厚度裂纹

Abstract: A theoretical analysis is performed for fatigue crack closure based on a modified strip yield model and the complex function method developed by Budiansky and Hutchinson (1978) in plane stress. By introducing a reasonable constraint factor, Budiansky and Hutchinson's model is extended to the general stress state with the upper and lower limits of plane strain and plane stress. The present theory can be easily extended to analyze the closure in the through thickness crack growing. Effects of the stress ratio and stress constraint factor can be calculated quantitatively, and the comparison of the present model with available data from two and three dimensional finite element simulations and experimental investigations shows quite good agreement. The explicit equations for the opening stress can be applied in engineering.

Keywords: stress state fatigue crack closure constraint opening stress ratio thickness effect through thickness cracks

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