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考虑应变路径的多轴低周疲劳寿命预测模型

陈家权, 陈国军, 温洁明

广西大学机械工程学院,南宁 530004

MULTI-AXIAL LOW CYCLE FATIGUE LIFE PREDICTION MODEL BASED ON STRAIN PATH

CHEN Jia-quan, CHEN Guo-jun, WEN Jie-ming

College of Mechanical Engineering, Guangxi University, Nanning 530004, China

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摘要 通过分析材料在多轴非比例加载下产生附加强化的机理,该文以拉扭薄壁管试件为研究对象,分析了临界平面上的应变状态,并在此基础上以塑性应变能为控制参数定义表征多轴低周疲劳寿命对应变路径依赖性的非比例度。基于多轴疲劳临界损伤面原理,应用von-Mises 准则和本文定义的应变路径非比例度参数建立起能反映应变路径对非比例附加强化影响的多轴低周疲劳寿命预测模型。利用该模型预测08X18H10T 不锈钢、Ti-6Al-4V合金、S460N 钢和2.25Cr-1Mo 钢这4 种材料的多轴疲劳寿命,并与试验值进行比较。结果表明:该模型的预测结果与试验结果吻合良好,能同时适用于比例与非比例加载,预测精度较高,便于工程应用。

关键词: 多轴疲劳 应变路径非比例度 塑性应变能 附加强化 临界平面

Abstract: The paper investigates the mechanism of additional hardening of materials under multi-axial non-proportional loading, and then studies the state of the strain on the critical plane of thin-walled tubular specimens. The plastic strain energy for control parameter is used to define the non-proportionality to characterize the influence of strain path on the multi-axial low cyclic fatigue life. The model for predicting multi-axial low cycle fatigue life is proposed by means of von-Mises criterion and the non-proportionality state of strain path based on the critical damage plane of multi-axial fatigue, which can determine the effect of strain path on the non-proportional additional hardening. Multi-axial fatigue life of 08X18H10T stainless steel, Ti-6Al-4V alloy, S460N steel and 2.25Cr-1Mo steel are predicted by this model, and calculated results are compared with experimental data. The results indicate that predicted results are in good agreement with experimental results, and the model can be applied to both proportional and non-proportional loading conditions. It is convenient for engineering application with high precision.

Key words: multi-axial fatigue non-proportionality of strain path plastic strain energy additional hardening critical plane

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地址：北京清华大学新水利馆114室 邮政编码：100084

电话：(010)62788648 传真：(010)62788648 电子信箱：gclxbjb@tsinghua.edu.cn