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考虑小载荷强化的模糊疲劳寿命预测理论

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Prediction of Fuzzy Fatigue Life Under Low Amplitude Loading Strengthening

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摘要 在实际工程应用中，多选用Miner法则进行疲劳寿命预测。由于小载荷特别是在疲劳极限附近的载荷对结构或材料的损伤不容忽略，考虑到小载荷的每一次循环对材料产生损伤的同时还产生了强化作用，建立了基于小载荷强化损伤的寿命预测模型以及相应的模糊疲劳寿命计算公式。该模型不但考虑了低于疲劳极限的载荷的强化作用，还引入隶属函数来描述小载荷的累积损伤的模糊性，完善了Miner法则的适用范围，提高了预测精度。两个不同载荷谱的疲劳寿命预测实例验证了该模型的有效性。

关键词： 疲劳寿命 强化作用 模糊累积损伤Miner法则 隶属函数 寿命预测

Abstract： For the usual failure mode of structural components under variable loading, fatigue life prediction is very important for the selection, design, and safety assessments of these components. The linear damage model (Miner's rule) is used most widely for life prediction in practical engineering application. However, the fatigue damage caused by small loads cannot be ignored, especially when the load is near the constant amplitude of fatigue limit of a component. This article discusses in detail an acumulative fatigue damage model and the corresponding formula of fuzzy fatigue life based on the damage and coaxing effect caused by each loading cycle on a metallic material. The fatigue life of structures depends on both the damage and coaxing effect of the small load and a new approach is proposed. This model has improved the application of Miner's rule not only by considering the coaxing effect caused by a stress lower than the fatigue limit, but also by introducing membership functions in the fuzzy accumulative damage caused by small loads. In order to apply the proposed model conveniently, different membership functions that affect the result of estimating fatigue life are investigated.Two examples are given in which the structural fatigue life is estimated by two different load spectrums. By comparing the results, the law of selecting membership functions for different load spectrums is found, and the errors of predicted fatigue life are reduced. The examples show that the prediction of fatigue life by the proposed method is more accurate than by the traditional method.

Keywords： fatigue life coaxing effect fuzzy accumulative damage Miner's rule membership functions life prediction

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