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腐蚀/疲劳交替作用下飞机金属材料疲劳寿命计算方法

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Fatigue Life Prediction Method for Aircraft Metal Material Under Alternative Corrosion/Fatigue Process

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摘要

使用环境下飞机金属结构剩余寿命评定是确定飞机结构疲劳寿命与日历寿命关系的关键。为此,本文模拟飞机结构经历的"地面腐蚀+空中疲劳"过程,提出了腐蚀/疲劳交替作用下飞机金属材料的疲劳寿命计算方法。首先,通过分析2A12-T4铝合金试样预腐蚀/疲劳试验结果,发现其在模拟腐蚀/疲劳交替作用时计算得到的疲劳寿命偏于保守。随后,根据2A12-T4铝合金试样真实的交替试验结果,采用回归算法,建立了基于均匀分布耦合损伤形式的腐蚀/疲劳交替寿命计算模型;并分别采用BP、Elman神经网络对上述模型的计算结果进行验证。结果表明,本文提出的均匀分布耦合损伤模型计算结果与真实试验结果吻合较好;通过进一步的计算与试验对比发现,该模型也可以用于加载循环与腐蚀周期组合发生变化时的疲劳寿命预测,具有较好的适用性。

关键词： 腐蚀 疲劳 2A12-T4铝合金 均匀分布 神经网络

Abstract:

Residual life evaluation for aircraft metal components is critical in the consideration of the relationship of fatigue life and calendar life under in-service environments. Therefore, the process of "corrosion on the ground+fatigue in the air" is simulated to establish a fatigue life prediction model under an alternative corrosion-fatigue process. Firstly, 2A12-T4 aluminum alloy specimens are implemented with a pre-corrosion fatigue test. Compared with the actual data, the theoretical life obtained by simulating the alternative corrosion-fatigue process based on the pre-corrosion test results is rather conservative. Afterwards, an alternative corrosion-fatigue prediction model based on actual alternative test results is established by regression arithmetic with coupling damage uniform distribution. Furthermore, the BP and Elman artificial neural networks are used to verify the model. The result shows that the predicted life by the coupling damage uniform distribution model is in good agreement with the actual life. Further calculation and test results show that the model can be used to predict the fatigue life with different combinations of loading cycles and corrosion times, and it exhibits good perspective for application.

Keywords: corrosion fatigue 2A12-T4 aluminum alloy uniform distribution neural network

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