

三维疲劳多裂纹扩展数值模拟的计算方法及程序设计

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Title: Methodology and programming of numerical simulation for the multiple 3D fatigue crack growth

作者: [束一秀](#); [李亚智](#); [樊振兴](#)
西北工业大学航空学院 710072 西安

Author(s): [Shu Yixiu](#); [Li Yazhi](#); [Fan Zhenxing](#)
School of Aeronautics, Northwestern Polytechnical University, 710072, Xi'an, China

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摘要: 研究了含多条初始裂纹的紧固孔件的裂纹扩展模拟及裂纹扩展寿命。紧固孔形式为直通孔和沉头(有镦窝)孔,裂纹形式为孔边角裂纹,将裂纹前缘形状简化为二次曲线形式。采用更新网格法追踪裂纹扩展,并人为干预裂纹前缘形状,解决了裂纹前缘端点跨越模型角点时的网格畸变问题;在裂纹扩展法则中使用了AFGROW裂纹闭合模型,并引入多裂纹协调扩展算法,避免了逐一应力循环计算,缩短了计算时间;试件失效判据使用净截面屈服和裂纹前缘塑性区连通准则,试件满足任一判据即判定为失效;最后在ANSYS软件的基础上进行二次开发,设计了适应多种模型的全寿命自动分析程序,并使用VB语言编写了用户界面,分别对单孔和一排五孔两种平板试件从镦窝孔边起裂的角裂纹扩展进行了数值模拟,并与试验结果进行了对比。结果表明:使用AFGROW裂纹闭合模型对寿命的预测精度明显高于Paris模型,其寿命预测误差在5%以内;对位于模型表面的裂纹尺寸的模拟与试验结果吻合较好,并很好地模拟了五孔模型在发生裂纹连通之后加速扩展的情况。

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