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转子非包容失效安全性的计算机辅助分析方法

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Computer Aided Analysis for Uncontained Rotor Failure Safety

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摘要

转子非包容失效是威胁飞机飞行安全的典型特殊风险之一,为了分析其对飞机安全性的影响,开发了转子非包容失效安全性分析系统(URFSAS)。将飞机功能危险分析(FHA)中的灾难性功能危险与故障树分析(FTA)中的底事件及飞机数字样机中的设备模型形成映射关系,建立了需求信息关系模型。在CATIA环境下基于Monte Carlo法以随机飞散角和平动角对转子碎片及其扫掠路径作空间几何变换,基于区域划分和层次包围盒法检测失效的飞机设备,通过故障树最小割集与仿真结果数据的对比分析,实现了对转子非包容失效所触发最小割集的识别和安全性的定量分析。最后,以某型飞机的应用实例分析,表明了该系统的有效性和实用性。

关键词: 发动机 转子非包容失效 碎片 安全性分析 飞机数字样机

Abstract:

Uncontained rotor failure is one of the typical risks that impose a particular threat on the safety of an aircraft. In this work, an uncontained rotor failure safety analysis system (URFSAS) is developed to facilitate its safety analysis. The relationship model of information required is provided by the relationship mapping between the catastrophic hazard of aircraft functional hazard analysis (FHA), the failure mode of the basic events of fault tree analysis (FTA) and the parts of aircraft digital mock-up. A simulation method based on Monte Carlo is proposed. All the parameters are set in the CATIA environment. Rotor fragment and its sweep path model are geometrically transformed. Space decomposition and hierarchical bounding are used to detect collision. Fault tree minimal cut sets generated are analyzed in comparison with simulation results. The hazard that is triggered by an uncontained fragment is recognized with the quantitative analysis of the uncontained rotor failure safety provided. Finally, an application instance is presented, which indicates that the URFSAS is valid and practical.

Keywords: engine uncontained rotor failure fragment safety analysis aircraft digital mock-up

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