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飞机柔性对前起落架摆振的影响分析

冯飞[1], 常正[2], 聂宏[1], 张明[1], 彭一明[1]

1. 南京航空航天大学 飞行器先进设计技术国防重点学科实验室, 江苏 南京 210016;
2. 上海飞机设计研究院 强度设计部, 上海 200232

Analysis of Influence of Aircraft Flexibility on Nose Landing Gear Shimmy

FENG Fei[1], CHANG Zheng[2], NIE Hong[1], ZHANG Ming[1], PENG Yiming[1]

1. Key Laboratory of Fundamental Science for National Defense-Advanced Design Technology of Flight Vehicles, Nanjing University of Aeronautics and Astronautics,Nanjing 210016,China;
2. Department of Strength Design,Shanghai Aircraft Design and Research Institute,Shanghai 200232,China

摘要 以某型客机为对象,研究了飞机滑跑时前起落架的摆振动力学问题。基于多体动力学理论,采用子结构模态综合法将关键部件柔性化,建立了计及前起落架和机身弹性的全机地面滑跑刚柔耦合动力学模型,并进行了摆振稳定性仿真分析。采用起落架静力试验和模态试验的结果对模型进行校验,仿真结果与试验结果吻合较好。给出了以飞机速度和防摆阻尼系数组成的飞机摆振稳定区域图,研究了机身刚体运动与弹性对摆振的影响。结果表明:采用线性防摆阻尼时,定义摆振临界稳定所需的初始摆角对临界防摆阻尼的影响可忽略不计;采用简化方法将起落架弹性等效为起落架和机身连接刚度的方法会带来较大的误差,仅适用于定性分析;机身刚体运动对防摆阻尼影响很小,机身柔性的影响相对较大,使得中高速情况下所需防摆阻尼平均增加了12.1%。

关键词: 起落架 摆振 机身刚体运动 机身柔性 动力学

Abstract: The dynamics of nose landing gear shimmy is studied in this paper with a certain type of aircraft. Based on the multi-body dynamics theory,a dynamics model of shimmy is developed which takes into consideration the flexibility of nose landing gear and airframe by means of the component mode synthesis method,to investigate the stability of shimmy. The model is verified with the data of static tests and mode tests. Diagrams of the stable region are presented accordingly,formed by the taxiing speed and critical anti-shimmy damping coefficients,to explore the influence of the movement and flexibility of the airframe. The result shows that,the initial angle of nose wheel contributes little to shimmy analysis. A simplified method,which replaces the flexibility of the nose landing gear by the connection stiffness between the nose landing gear and airframe,is not accurate enough and can only be applied to qualitative analysis. The movement of the rigid airframe exerts little influences on the critical damping coefficient. However,the flexibility of the airframe has considerable influence and it may increase the critical damping coefficient by 12.1% on the average at mid and high speeds.

Keywords: landing gear shimmy movement of rigid airframe flexibility of airframe dynamics

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Corresponding Authors: 聂宏 Email: hnie@nuaa.edu.cn

About author: 冯飞(1985-) 男,博士研究生。主要研究方向:飞机起落装置设计。 Tel: 025-84891024 E-mail: fefe1985@qq.com
常正(1969-) 男,高工。主要研究方向:起落架强度。 Tel: 021-54108606-705 E-mail: changzheng@comac.cc
聂宏(1960-) 男,博士,教授,博士生导师。主要研究方向:飞行器起落装置设计、结构疲劳与断裂、飞机起落架自适应控制技术等。 Tel: 028-84892411 E-mail: hnie@nuaa.edu.cn

张明(1981-) 男,博士,副教授。主要研究方向:飞机起落装置设计、飞行器系统动力学。 Tel: 025-84892384 E-mail: zhm6196@126.com
彭一明(1987-) 男,硕士研究生。主要研究方向:飞机起落装置设计。 Tel: 025-84891024 E-mail: pym415263@163.com

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