轮轨动力学与安全特性阶段研究报告

王悦明[1] 董孝卿[1] 任尊松[2] 曾晓辉[3] 刘玉标[3]
(1.中国铁道科学研究院；2.北京交通大学；3.中国科学院力学研究所)

摘 要：该研究将任务分解4个部分进行研究，分别由4个研究小组完成。研究小组1开展高速列车轮轨关系和运行安全性试验研究，通过对比国内外高速列车轮轨动力学试验方法和研究成果，验证了中国高速列车试验方法可以满足高速列车运行安全的评估要求。并通过高速列车试验，获得时速最高达420 km/h的16辆编组高速列车轮轨作用力数据，获得时速最高达420 km/h的16辆编组高速列车振动频谱特。研究小组2开展高速列车-轨道系统高频振动动力学仿真研究。采用有限元法，在建立道岔区辙叉模型和车轮模型基础上，研究了车轮通过道岔辙叉区时的轮轨接触状态、车轮重心变化以及轮轨动力等动态特征，分析了轮对横移量对轮/岔接触影响因素。在建立车辆-板式轨道耦合系统动力学模型基础上，研究了京津线路随机不平顺和42号高速道岔激扰下轮轨振动特性和轨道板的疲劳寿命。研究小组3开展气流扰动下的列车稳定性分析方法研究，主要研究考虑气动载荷作用下，高速列车蛇行运动稳定性的分析方法，分别建立了针对直线和曲线轨道的分析方法和计算程序。进而，针对气动载荷对高速列车蛇行运动稳定性的影响进行了详细分析。研究小组4开展高速列车多体系统动力学仿真研究。通过数值模拟研究不同行驶速度下，高速列车在明线运行和明线横风两种场景下的行驶安全性。为今后研制侧风预警系统合理设定侧风环境下运行速度限值提供科学依据。研究成果部分已应用于中国高速列车的联调联试试验，对我国高速铁路线路和车辆的优化设计、高速铁路的安全运营和维护有重要的理论指导意义。

关键词：轮轨动力学试验 车-轨耦合系统 气流扰动 多体动力学 高速列车

The Stage Report for the High-speed EMU Wheel-rail Dynamics and Safety Characterics Research

Wang Yueming[1] Dong Xiaoqing[1] Ren Zunsong[2] Zeng Xiaohui[3] Liu Yubiao[3]
(1.China Academy of Railway Sciences; 2.BeiJing Jiaotong University; 3.Institute of Mechanics, Chinese Academy of Sciences)

Abstract: The project research tasks include 4 parts, which were completed by four research groups. The first group carried out a high-speed train wheel -rail dynamics and safety research. By comparing the domestic and foreign high-speed train wheel-rail dynamics test methods and research results, it is confirmed that Chinese high-speed trains running test methods can meet the high-speed train safety assessment requirements. Through the high-speed train test, they have got wheel-rails force data for different speeds of up to 420 km/h of 16 high-speed trains, and the vibration spectrum. The second group two carried out high frequency vibration dynamics simulation research of train - track system. Using the finite element method, establishing turnout area frog model and wheel model,the research of the wheel through the turnout frog zone and of wheel-rail contact state , wheels and wheel-rail power center of gravity changes and other dynamic characteristics have been carried out, and the wheel traverse position on wheel/turnout exposure factors have been analyzed. In the establishment of the vehicle - coupled slab track system dynamics model, studies of the Beijing-Tianjin line 42 random irregularity and the next round of high-speed rail turnouts Excitation orbital plate vibration characteristics and fatigue life have completed. The third research group developed the airflow disturbance stability analysis method. Mainly considering aerodynamic loads, high speed train Hunting Stability analysis methods were established for straight and curved track analytical ways and calculation procedures. Furthermore, a detailed analysis of the Hunting Stability for the high-speed train were carried out considering the aerodynamic loads.

Key Words: Wheel-rail dynamics test; Vehicle-rail systems; Air disturbance; Multi-body dynamics; High-speed train

阅读全文链接(需实名注册)：http://www.nstrs.cn/xiangxiBG.aspx?id=51626&flag=1

钢铁流程系统的能耗排放特征及其广义热力学优化

陈林根[1] 冯妍卉[2] 姜泽毅[2] 谢志辉[1] 魏曙寰[1]
(1.海军工程大学；2.北京科技大学)