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钢轨横向不均匀支撑刚度对钢轨波磨的影响

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摘要　建立了钢轨波浪形磨损计算模型，模型中考虑车辆轨道垂向横向耦合动力学行为、轮轨三维滚动接触力学行为和轮轨材料摩擦磨损的循环相互作用关系. 发展了相应的计算程序，并用1：1试验装置验证了理论模型. 详细分析了实际线路上由轨枕离散支撑导致的钢轨横向不均匀刚度和不同行车速度对曲线钢轨接触表面不均匀磨损的影响. 通过数值分析可知：(1)列车通过曲线钢轨时，轨枕离散支撑导致的钢轨横向不均匀刚度易引发曲线钢轨波磨的形成和发展；(2)这类钢轨波磨具有与轨枕间距几乎相等的波长和28~35㎜的短波长，这个短波长不均匀磨损主要是由轮轨高频接触振动引起；(3)同一个转向架4个车轮作用下形成的钢轨波磨最大深度波谷的分布是不同的；(4) 改变过车速度不能有效地抑制轨枕离散支撑导致的钢轨波磨形成和发展速度.

关键词　钢轨波磨,轨枕间距,滚动接触力学,接触振动,材料磨损,动力学

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Effect of lateral undulatory support stiffness of rail on initiation and evolution of rail corrugation

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Abstract

A model of rail corrugation calculation is put forward. The model considers a combination of a theory of wheel/rail in rolling contact, an undulatory wear model of rail material and a dynamical performance of railway vehicle coupled with a curved track. A computer code for rail corrugation is developed, and the model is verified with a full scale test facility. The effects of the uneven lateral support stiffness of rail, due to discrete sleeper support, and the different curving speed of the vehicle on the initiation and development of rail corrugation are numerically investigated in detail. In the calculation the damage on the running surface of rail, concerning rail corrugation formation, is restricted to wear mechanism of rail material. Through the numerical analysis it is found that: (1) The uneven lateral support stiffness of rail, due to discrete sleeper support, easily causes the initiation and development of rail corrugation; (2) The corrugation mainly contains the same wave-length as a sleeper bay and 28~35 mm wave-lengths. The undulatory wear with 28~35 mm wave-lengths and very small depth trough is caused by a contact vibration of the wheel and rail at high frequencies; (3) The distribution of the maximum depth of undulatory wears on the rails under the 4 wheels of the same bogie is different; (4) The change of the curving speeds doesn't decrease the growth of the rail corrugation caused by the discrete sleeper support.

Key words　钢轨波磨　轨枕间距　滚动接触力学　接触振动　材料磨损　动力学

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