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轮轨摩擦接触下钢轨多裂纹相互作用研究

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A STUDY OF MULTIPLE CRACK INTERACTION IN RAIL UNDER WHEEL-RAIL FRICTION CONTACT

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摘要

利用热机耦合有限元法,建立了轮轨摩擦接触时钢轨表面多裂纹的热弹性平面应变有限元模型。数值模型中,考虑轮轨摩擦温升对轮轨材料参数的影响,通过移动载荷和热源来模拟运动车轮对钢轨的作用。分析了轮轨滑动接触时多裂纹相互作用和表面裂纹数量对钢轨疲劳裂纹扩展特性的影响。计算结果表明:与单个裂纹相比,多裂纹有降低钢轨疲劳裂纹扩展的作用;钢轨裂纹尖端应力强度因子 K_1 和应力强度因子范围 ΔK_2 均随裂纹数的增多而减小;钢轨表面裂纹数为5条时可以反映更多裂纹时的裂纹扩展特性。

关键词: 轮轨摩擦接触 表面多裂纹 应力强度因子 热机耦合 有限元法

Abstract:

A thermo-elastic plane strain finite element model incorporating multiple surface cracks in rail is established by using a thermo-mechanical coupling finite element method. In the numerical model, the temperature-dependent material properties are considered. The movement of wheel-rail contact forces and fictional heat resource is used to simulate the wheel sliding on the rail. The effect of multiple crack interaction and number of cracks on the crack growth behavior in rail is investigated during wheel-rail full slip contact. The results indicate that comparing to the single crack, the multiple crack interaction can reduce the possibility of crack growth. The stress intensity factor K_1 and stress intensity factor range ΔK_2 of cracks in rail decrease with increasing the number of cracks. Only five cracks in rail can reveal the interaction among many cracks.

Key words: wheel-rail friction contact multiple surface cracks stress intensity factor thermo-mechanical coupling finite element method

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