同济大学学报自然科学版

铁道车辆几何滤波现象及弹性车体共振分析

Analysis on the Geometry Filter Phenomenon and the flexible car body resonant vibration of railway vehicles

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中文摘要

运用简化铁道车辆模型，对几何滤波现象进行了分析。然后建立了刚柔耦合弹性车体模型，分析了几何滤波现象对车体响应功率谱的影响，以及几何滤波与弹性车体共振频率的关系。研究表明，几何滤波分为轴距滤波和定距滤波。在某些特定轨道不平顺波长下，车体的点头和浮沉响应均为0，该现象称为轴距滤波；定距滤波是指在某些波长下，车体的浮沉或者点头响应为0。在车体‘空’点头响应频率附近，轨道对车体浮沉振动的加速度传递率达到局部最大，当车体的垂向一阶弯曲频率与这些峰值频率吻合时，将产生车体弹性共振现象。分析还表明，较高频率处的车体弹性共振，由于轨道不平顺输入较小，而被车体结构阻尼迅速衰减，不会对运行平稳性构成影响。

英文摘要

The geometry filter phenomenon is analyzed with a simplified vertical railway vehicle. Then the relations between geometry filter phenomenon and the resonant vibration of flexible carbody is studied with a full vehicle model. It is found that geometry filter phenomenon consist of ‘wheelbase filter’ effects and ‘bogie center filter’ effects. It is called wheelbase filter effect when there is neither car body bounce nor pitch responses at some wavelengths. And it is called bogie center filter effects when there is no car body bounce or pitch response at some track wavelengths. Near the null pitch response frequencies, the acceleration transmissibility from track unevenness to carbody bounce will reach local maximum. So if the carbody first bending frequency coincides with the frequencies which have the peak values of acceleration transmissibility, resonant vibration of flexible carbody will happens, which then will impose great impact on vehicle ride quality.

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