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Contributions of longitudinal track unevenness and track stiffness variation to railway induced vibration

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Abstract

Dynamic train-track interaction originates from excitation mechanisms such as longitudinal track unevenness, parametric excitation due to track stiffness variation and impact excitation due to wheel flats, wheel out-of-roundness and rail joints. Track stiffness variation can be regarded as longitudinal track unevenness in loaded condition, but for the mitigation of track geometry degradation it is important to distinguish between track unevenness in unloaded condition and track stiffness variation. This paper studies how longitudinal track unevenness and track stiffness variation contribute to railway induced vibration. A case study is performed for a railway line in Furet, Sweden. Based on measured track unevenness and stiffness data from the IMV 100 track recording car, the train-track interaction forces and free field vibrations are computed for each of these two excitation mechanisms separately, as well as for a combination of both. The computed free field vibrations are in good agreement with measured vibrations at the same site. The contribution of the track stiffness variation to the interaction forces and free field vibrations is much lower than the contribution of the longitudinal track unevenness. Track stiffness variation can also be modeled as equivalent track unevenness, leading to results slightly different from those obtained when track unevenness and track stiffness variation are modeled separately, and a poorer agreement with the measured vibrations.

Keywords: Track modeling, track unevenness, parametric excitation, train-track interaction, railway induced vibration

1. Introduction

Ground-borne noise and vibration due to railway traffic are generated by a combination of quasi-static and dynamic excitation. The quasi-static component results from the moving train loads while the dynamic component is due to train-track interaction caused by longitudinal track unevenness, parametric excitation due to track stiffness variation (transition zones, hanging sleepers, variation in track and subgrade stiffness) and impact excitation due to wheel flats, wheel out-of-roundness, switches, crossings and rail joints [1–4].

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