

In-situ test and analysis of subgrade vibration with ballasted track in deep seasonally frozen regions

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Abstract: The effect of seasons on the vibration characteristics of subgrade has been a worldwide problem with the rapid development of high-speed railways, especially in Northeast China. To this end, field investigations were carried out on the Harbin-Jiamusi rapid railway during unfrozen and frozen periods. The vertical acceleration responses in time and frequency domains were studied in detail. To explain the influence of track structure on the vibration responses of subgrade, the authors also conducted a comparison between ballasted and ballastless tracks. The results showed that the amplitude of vertical acceleration increased with the increasing train speed and attenuated with increasing distance from the track centreline. The attenuation rate in the unfrozen period was greater due to the soil's damping properties. It was also found that the peak frequencies in the ballast layer were generated by resonance at its natural frequency, which increased from about 80 Hz to around 100 Hz as the subgrade was frozen. The comparisons between ballasted and ballastless tracks revealed that the acceleration amplitude of the subgrade with ballasted track was higher than that of the subgrade with ballastless track. Furthermore, the wide high-frequency range in the ballasted track is mainly generated by the short-wave track irregularities (i.e., 0.01-0.5 m). The frequencies induced by the short-wave track irregularities were not significant in the subgrade with ballastless track due to the different properties of ballast and concrete track slab. Overall, the study provides a helpful reference for the construction and operation of high-speed railways, particularly in seasonally frozen regions.

Keywords: Field investigations; Vibration characteristic; Seasonally frozen region; High-speed railway; Ballasted track