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# The Effect of Rail Defects on Track Impact Factors

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**Abstract**

This paper investigates the effect of rail surface flaws on track impact factors for different track and vehicle conditions. For this purpose, a three dimensional vehicle and track as an integrated system modelled. The vehicle, consists car body, bogie frames and wheelsets, is able to model displacements in vertical and lateral directions. Hertz nonlinear springs utilized to connect vehicle to track structure and simulate the interaction between vehicle and track subsystems. Track comprises rail, rail pads, sleepers and ballast materials. For each subsystem, matrices of mass, stiffness and damping were formed and then matrices of total vehicle-track system considering their interaction were solved. Using FRA spectral density functions for rail irregularities, response of track with different qualities to train dynamic forces obtained. Rail random irregularities, rail corrugation and rail joint defects as three common rail defects have been considered in this paper. For each defects the influence of different track and train parameters on impact factor has been studied. The results of study indicate substantial effect of the depth and frequency of the rail flaws on impact factors. This paper has also considered the impact of vehicle speed on dynamic forces and found the critical speed for each case.

*Keywords:* High-Speed Rail; Vibration; Rail Defect; Impact Factor.

## 1. Introduction

Rail surface defects not only damage the wheels and vehicle but also cause a considerable increase in dynamics loads and expedite the deterioration rate of railroad track. It is also shown that rail defects including broken rail are the main reason of rail accidents. Based on the results of an analysis of causes of major train derailment conducted by Liu et al. [1], rail defects accounted for almost 20% of all derailments and more than 30% of all derailed cars on class I main lines. Therefore, Rail defects have always been a matter of concern and investigated by many researchers [2-4]. Since the conventional theoretical model cannot properly predict track behavior [5], more realistic three dimensional models developed for track analysis. Sun and Dhanasekar [6] using a 3D vehicle-track model and considering periodic and impulsive defects concluded that periodic defect is more serious than the impulse excitation and the impulse excitation produces much higher impact forces. Kabo et al. [7], carried out numerical analyses of high-frequency dynamic train–track interaction which is combined with the analysis of material deterioration in terms of rolling contact fatigue and plastic deformations to analyze the influence of insulated rail joints. The result of the study showed that introduction of an insulated joint alters the dynamic characteristics of the track. This effect and the introduced surface irregularity of the rail cause high contact load a magnitude that increases with increasing train speed. Sun et al. [8] using a rail vehicle-track interaction dynamics model, determined the track vertical dynamic forces due to short wavelength dip defects such as squat, dip joints and welds. The dependence of the track vertical dynamic forces on the rail dip defect size and vehicle speed also investigated. Wu and Thompson [9] theoretically investigated the impact noise generation due to a wheel passing over dipped rail joints. They showed that train speed has a great influence on wheel/rail impact force as well as the level of noise. Jin et al. [10] modeled a three-dimensional train–track interaction system and studied rail corrugation for different conditions. They concluded that the corrugation with high passing frequencies has a great influence on the dynamic performance of the wheelsets and track, but little on the car-body and the bogie frame. It is also shown that under the condition of the same speed and the same wavelength, the deeper the corrugation depth from peak to trough is, the greater the influence on the dynamic performance and the rail material wear are.

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