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ORIGINAL

A novel method to estimate derailment probability due to track geometric irregularities using reliability techniques and advanced simulation methods

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Abstract

Track irregularities have a dramatic impact on the response and vibration of a railway vehicle and on the interaction between wheel and rail. The random nature of the track structure and constituent materials and the effects of other factors such as maintenance conditions and transit traffic give rise to the random nature of track irregularities. This research provides a method to estimate the derailment probability of a railway vehicle where track irregularities are assumed to be random, and the interaction of the track and the moving train is considered using advanced dynamic analysis. For this purpose, the limit state function of derailment was estimated using the response surface method and advanced simulation. The probability of derailment was then estimated using a Level 3 reliability method.

Keywords Estimation of derailment - Response surface method - Derailment - Saturated design method - Track-rail interaction - SIMPACK - Importance sampling method

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List of symbols

$f_x(x)$	Joint probability distribution function for n-dimensional vector of base variables
$G_x(x)$	Limit state function
Y	Wheel flange force
Q	Instantaneous load of wheel
β	Wheel flange angle
μ	Coefficient of friction between flange rim and rail
N	Total number of tests for Monte Carlo analysis
k	Number of observations for $G(x) \leq 0$
$G(x)$	Real limit state function of derailment
$G^*(x)$	Approximate limit state function of derailment (response surface function)
a, b, c, d	Coefficients of response surface function
x_i	Random variables representing track geometric parameters
n	Total number of random variables
$h_y(v_i)$	Joint probability density function of importance sampling
$f_x(v_i)$	Main joint density function of random variables
$I(v_i)$	Indicator function with a value of one if x is located in failure region and zero if x is located in safe region

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