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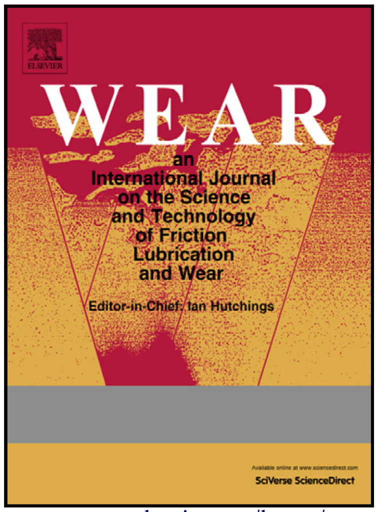

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N. Burgelman, Z. Li, R. Dollevoet

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A new rolling contact method applied to conformal contact and the train-turnout interaction

N. Burgelman[a], Z. Li[a,*], R. Dollevoet[a]

[a]*Delft University of Technology, Faculty of Civil Engineering and Geosciences, Section of Road and Railway Engineering Stevinweg 1, 2628 CN Delft, the Netherlands*

Abstract

This article introduces a new computer program called WEAR. It contains a new and more accurate method for calculating wheel-rail contact stresses to predict degradation due to wear, deformation and fatigue. WEAR accounts for conformal contact by using influence numbers that are based on quasi-quarter spaces instead of the traditional half-spaces and considers the varying geometrical spin due to the varying contact angle through a contact patch.

This new contact method is applied to two cases: wheel-rail contact in a turnout and conformal contact in a curve with a heavily worn wheel profile. In both cases, many of the assumptions commonly made in excising solution methods for wheel-rail contact problems, such as a small contact patch and a constant spin creepage, may be violated. The case of conformal contact demonstrates the effect of the influence numbers and the varying spin creepage on the resulting stresses and creep forces and provides a comparison of this new method with the well-established contact method CONTACT. For the turnout case, the first task is to obtain realistic input for all timesteps of a vehicle coasting through a turnout (i.e., diverging route) in a simulation. This step is necessary because the contact forces, which cause wear, deformation and fatigue of the wheels and rails, and the dynamics of the vehicle-turnout interaction strongly influence each other. WEAR converged for all timesteps, including many cases with multiple-point contacts at the switch blade and with extremely high creepages. This robustness demonstrates suitability of the new method for online contact force evaluation in vehicle dynamics simulations.

1. Introduction

1.1. Wheel-rail contact in the train-turnout interaction

Turnouts are a major concern for railways due to their high maintenance and repair costs, risk of derailment, and discomfort for passengers. These problems are largely due to the high wheel-rail contact forces, especially in the lateral direction, which are caused by the sharp turn in a turnout, which cannot be compensated for with rail cant. These high forces may lead to severe rolling contact fatigue and excessive wear of the rails and wheels, especially at the switch blade, as well as tilting of the rail, deformation of the switch control mechanism and displacement of the entire track. These effects may cause turnouts to malfunction, in turn causing wheel climb and subsequent derailment.

These problems demonstrate the need to accurately calculate of the contact forces and resulting stresses and strains. Because the contact forces and vehicle dynamics strongly influence each other, any accurate modeling of the contact forces and their consequent effects on wear, deformation and fatigue should consider the dynamics of the vehicle-track interaction. Such a model should provide insight into the mechanisms of these adverse phenomena so that counter measures may be developed, which may include improved design of turnouts and rolling stock and more intelligently scheduled maintenance. In the contact patch, the product

*Corresponding author
Email address: z.li@tudelft.nl (Z. Li)