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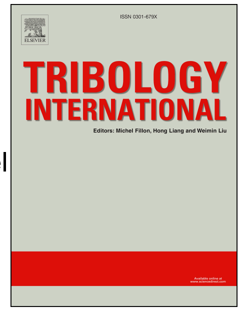

Modelling and experimental validation of dynamic impact in 1:9 railway crossing panel

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Modelling and experimental validation of dynamic impact in 1:9 railway crossing panel

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Abstract

To improve the understanding of dynamic impact in 1:9 crossing panel, which is suffering from rapid surface degradation, detailed modelling and experimental studies are performed. A three-dimensional explicit finite element (FE) model of a wheel rolling over a crossing rail, that has an adaptive mesh refinement procedure coupled with two-dimensional geometrical contact analyses, is developed. It is demonstrated that this modelling strategy performs much better than the 'conventional' FE modelling approach. Also, the experimental validations show that the FE results agree reasonably well with the field measurements. Using the validated FE model, the tribological behaviour of contact surfaces is studied. The results indicate that the proposed modelling strategy is a promising tool for addressing the problems of wheel-crossing dynamic impact.

Keywords: Dynamic impact; Finite element model; Experimental validation; Switches and crossings.

1. Introduction

Switches & crossings (S&C, also called 'turnouts', See Figure 1) are key operating devices on the railway network to manage the traffic flow effectively. As one of the three major components (namely, switch, closure and crossing panels, See Figure 1a), the crossing panel is specially designed to enable the wheel successfully travelling from the wing rail to the nose rail or the other way around. By this means, the vehicles are capable of safely switching from through/diverging routes in either facing or trailing directions (See Figure 1a). However, due to the natural geometrical discontinuity of the rail and the resulting gaps at the transition region (See Figure 1a and Figure 1c), highly concentrated impact loads on the crossing rail are induced and amplified from the passing vehicles. These repeated high impact loads would lead to the rapid degradation of contact interfaces (e.g., accumulated plastic deformations) and/or the initiation of micro-cracks on the rail surface/subsurface. The small cracks might further deteriorate into the spalling damage (See Figure 1d) or even lead to the sudden fracture of the crossing rail. Nowadays, the Dutch railway network is severely suffering from these problems according to [1], where it has been reported that a typical crossing (e.g., the one shown in Figure 1b-d) needs to be repaired urgently every half year. Thus, the crossing panel is being one of the most maintenance demanding components in the Dutch railway infrastructure.

During the last decades, extensive research resources [1–16] have been devoted to the subject of dynamic impact at S&C for the purpose of finding effective strategies to address the aforementioned impact-induced problems. Usually, these dynamic impact problems are studied experimentally [2, 4, 5, 7] and/or numerically [1, 3, 8–16]. Both approaches