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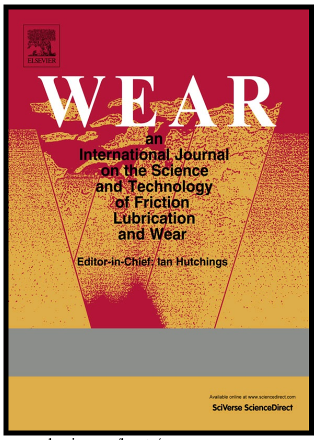

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Matin Sh. Sichani, Yann Bezin

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Differential wear modelling - effect of weld-induced material inhomogeneity on rail surface quality

Matin Sh. Sichani*, Yann Bezin

Institute of Railway Research, University of Huddersfield, Huddersfield, UK

*Corresponding author:matin.s.sichani@gmail.com

Abstract

A methodology is introduced to enable prediction of differential wear along the rail due to the presence of geometrical imperfections and microstructural inhomogeneities. The method incorporates vehicle-track dynamic interaction, wheel-rail contact and wear modelling in order to predict long-term longitudinal rail profile evolution. The effect of different contact and wear modelling features on the results is investigated. As a case study, the differential rail wear due to material inhomogeneity caused by rail head weld repairs is considered. It is concluded that, regardless of the magnitude of hardness variation within the heat affected zone, the long-term surface degradation can be minimized by limiting the length over which the variation occurs.

Keywords

Differential wear, Non-uniform wear, Rail weld, Rail head repair, Aluminothermic welding, Cupping, Railway

1. Introduction

Over the past two decades there has been many publications on uniform wear modelling with emphasis on wheel wear. A thorough overview of the relevant studies is given in . There are also a number of studies on uniform rail wear modelling (see , for instance). In these studies, the assumption of uniformity implies that the rail wears out uniformly along a section of the track and the aim is to predict how the transverse profile is changed after a given amount of traffic. Any variations between the transverse profiles along that section is therefore neglected. This makes it possible to sum up the wear due to the contact cases occurring in that section to obtain the wear depth at each transverse coordinate. In contrast, non-uniform wear modelling, also known as differential wear, concerns the evolution of the rail profile in the longitudinal direction. In this case the variations in loading and contact conditions along the rail are considered. The most common example of this is rail corrugation which is a periodic rail surface irregularity. Over the past 60 years, many studies were published on corrugation. A good summary of rail corrugation modelling may be found in .

However, few studies are published on differential wear due to discrete imperfections on the rail. The insulated rail joints, welded rail ends or weld repaired lengths are an example of such imperfections affecting the running surface quality. Presence of rail joints causes impact forces known as P1 and P2 forces that result in contact condition variation and consequently differential surface evolution.