Effect of plastic accumulation on the nucleation of cracks in railroad rails due to bidirectional loaded traffic

Thairon Reis, Eduardo de Abreu Lima, Felipe Bertelli, Auteliano Antunes dos Santos Junior

PII: S0142-1123(18)30386-4
DOI: https://doi.org/10.1016/j.ijfatigue.2018.08.015
Reference: JIJF 4811

To appear in: *International Journal of Fatigue*

Received Date: 2 June 2018
Revised Date: 8 August 2018
Accepted Date: 11 August 2018

Please cite this article as: Reis, T., de Abreu Lima, E., Bertelli, F., Antunes dos Santos Junior, A., Effect of plastic accumulation on the nucleation of cracks in railroad rails due to bidirectional loaded traffic, *International Journal of Fatigue* (2018), doi: https://doi.org/10.1016/j.ijfatigue.2018.08.015

Effect of plastic accumulation on the nucleation of cracks in railroad rails due to bidirectional loaded traffic

Thairon Reis[1], Eduardo de Abreu Lima[1], Felipe Bertelli[2], Auteliano Antunes dos Santos Junior[1]

[1]School of Mechanical Engineering, University of Campinas, Campinas, São Paulo, Brazil

[2]Postgraduate Program in Mechanical Engineering, Santa Cecilia University, Santos, São Paulo, Brazil

*Corresponding author: felipe.berteli@gmail.com

Abstract

Bidirectional loaded traffic effect was investigated for heavy haul railway lines, using a coupled analytical and numerical method. A tridimensional elastoplastic finite element model of a rail was developed to obtain the stress and strain distributions. Hertz and Kalker theories were used to estimate the contact pressure and tangential forces on the wheel/rail surface. The resulting critical stress tensor was used to investigate the crack nucleation with Dang Van and Findley's criteria. The results reveal that the plastic strains stabilize early, the resulting stress range is similar, and that the bidirectional loading affects the life to crack nucleation.

Keywords

Railway rail; Wheel-rail interaction; Plastic accumulation; Finite element method; Kalker theory.

1 - Introduction

The passes of the wheel over the rail develop cyclic stresses inside the material, close to the contact region. The continuous load increase per axle directly affects the magnitude of the stresses and increases the propensity to failure of the wheels and rails. Several types of failures in rails have been studied by researchers over the years, and special attention has been given to failures caused by the fatigue phenomenon [1]. Due to the complexity of the stresses developed inside the material under rolling contact, models have been proposed to evaluate the fatigue life of bodies in rolling contact.

Two important models applied to high cycle fatigue investigation should be highlighted: the Dang Van model, which proposed a multiaxial fatigue criterion based on mesoscopic steady state stresses [2], and