Abstract

Rail corrugation is a wavy defect that appears on the running surfaces of rails. It is one of the main reasons for abnormal increase in rolling noise and vibrations. Despite it being an old railway problem and there being an extensive literature on the subject, the causes of its occurrence are not yet fully understood in many cases. In this context, mathematical models simulating the initiation and development of the corrugation can help understand the causes behind it.

In this Thesis, a nonlinear mathematical model is presented for predicting the growth of rail corrugation. The tool developed is based on a feedback process that involves, firstly, the vehicle-track interaction dynamics, and secondly, a methodology for estimating wear of rails. The train-track interaction model considers the hypothesis of cyclic track together with the flexibility and the inertial effects associated with the rotation of the wheelset.

The same wheel-rail contact model, which relies on non-hertzian and non-steady-state hypotheses, is used both for calculating the train-track dynamics and for estimating wear. In the contact model developed here, which is based on the Variational Theory by Kalker, the potential contact area is discretized into triangular elements on which the distributions of contact stresses vary linearly. By doing so, a better representation of the contact stresses distributions is expected to be obtained in comparison to the original method.

The influence of both the non-steady-state and the non-hertzian effects at wheel-rail contact on calculating the wear depth on the railhead is analyzed through simulations. Additionally, the influence of the flexibility and the inertial effects of the flexible rotating wheelset on estimating wear and rail corrugation growth is studied in order to identify possible wavelength-fixing mechanisms related to the dynamics of the wheelset.

Keywords: rail corrugation, wear, wheel-rail contact, rotating flexible wheelset.