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Multiaxial Fatigue Reliability Analysis of Dipped Rail Joint

A Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of Master of Science in Rolling Stock Engineering

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Abstract:

Nowadays rail damages regime changes from wear to fatigue, because of increasing axle load and velocity in railway transportation system. In recent year although, the rail mechanical fracture is controlled and dedicated a small fraction, but due to the suddenly failure, the extremely high human and financial cast has been forced to railroads in the world. Therefore the fatigue of rails is one of big challenges in railroads. One of the most important and most sensitive parts of track, is rail joint region. However, today the bolt rail joint is less used, but with new functions in train traffic signaling system, they have significant role in railway. This research presents a comprehensive probability fatigue life prediction model for rail head and bolt hole in rail joint region by using finite element, response surface, probability and reliability methods. The parameters of axle load, velocity, number of car body and train and mechanical properties of rail are considered randomly. In this study, wheel and rail contact models are analyzed quasi statistically. The results of finite element are validated by Hertz theory. For reliability analysis, number of random samples should be big enough, to make sure convergence of results. Three dimensional simulation of wheel and rail contact is too time consuming. The response surface method is used for this problem. A second order model between random inputs and output variables was fitted. We used these approximate relations instead of finite element analysis. The Monte Carlo simulation was used for reliability analysis. The generated random variables were put in Jiang-Sehitoglu model, then fatigue crack initiation life was calculated for per wheel passing. In the next step, damage index was evaluated with Miner's cumulative damage low in each train passing. The limit state function is a function of critical cumulative damage value, damage parameter in each train passing and the number of train in specific operation time. At the end, reliability index was calculated. As expected, reliability index in rail head region reduced rapidly because of low cycle fatigue regime. But in bolt hole, reliability reduced slightly due to low stress level.

Keywords: Rolling Contact Fatigue, Response Surface Method, Monte Carlo Simulation, Reliability Analysis.