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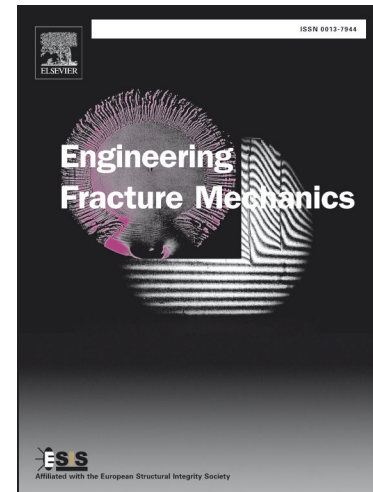
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Effect of fracture toughness on vertical split rim failure in railway wheels

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ABSTRACT

Vertical split rim (VSR) cracks are the most common cause for the removal of broken or cracked heavy haul car wheels in North America. This failure mode is characterized by rapid, unstable crack propagation in the hoop or in the tangential direction. To investigate the methods to prevent VSRs, an understanding of how the service loads correlate to their occurrence is necessary. In this study, a finite element analysis is conducted to evaluate the rim stresses below the tread surface during rolling contact between the wheel tread and the rail. Then, the stress intensity factor is calculated using the stress distribution in the wheel rim obtained using the finite element analysis. The results of the analysis show that axial residual tensile stress, which contributes to unstable vertical crack propagation, increases at deeper positions below the tread surface owing to cyclic rolling contact. These results indicate that a vertical crack can propagate rapidly below the tread surface. The fracture toughness of the wheel steel is measured using Charpy impact tests. The results of the test show that Weibull distribution enables the approximation of the relationship between fracture probability and fracture toughness. To evaluate the effect of the fracture toughness of wheel steel on the differences in VSR crack probability, a comparison between high fracture toughness wheels and conventional Class-C wheels is made. The VSR rate can be predicted from the stress intensity factor and Weibull equation for fracture toughness. The prediction results show that the VSR rate of high fracture toughness wheels is only 5% of that of conventional Class-C wheels. Therefore, high fracture toughness steel wheels are considered to have a higher resistance to VSR cracks compared with conventional Class-C wheels.

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