Study on Mechanism of Radial Long Cracks Propagation on Sliding Surface of Wheel Brake Discs

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Abstract

Radial long cracks at bolt holes have been observed on steel brake discs used in high-speed rail systems. The crack propagation process is obviously different from traditional thermal fatigue propagation. Because the causes of the cracks and corresponding propagation mode are not well known, further study is warranted. In the present study, the microstructure evolution near the sliding surface of a cast steel brake disc was characterized. The variation in the mechanical properties of the disc material under the influence of microstructure evolution and temperature was analysed. Combining the establishment of the extended finite element model (XFEM) with changes in mechanical properties, the propagation mechanism of the radial long crack at the bolt hole on the brake disc sliding surface was analysed. The microanalysis and tensile test results showed that the grain size and the strength of material gradient increased from the sliding surface to the core of the disc. The simulation results showed that the interaction of strength decline and high-level stress concentration in the vicinity of the bolt hole led to rapid crack propagation along the radial direction of the disc. In addition, the formation of the radial long cracks was equivalent to the introduction of the fatigue crack source on the sliding surface, and the crack was very likely to continue to propagate to the core of the disc through fatigue propagation, which ultimately led to the failure of the brake disc. Based on the results of this study, recommendations regarding the presence of radial long cracks on the sliding surface and maintenance procedures for the cast steel brake disc are proposed.

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