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Substantial Fatigue Similarity of a New Small-Scale Test Rig to Actual Wheel-Rail System

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Abstract : The substantial similarity of fatigue mechanism in a new test rig for rolling contact fatigue (RCF) has been investigated. A new reduced-scale test rig is designed to perform controlled RCF tests in wheel-rail materials. The fatigue mechanism of the rig is evaluated in this study using a combined finite element-fatigue prediction approach. The influences of loading conditions on fatigue crack initiation have been studied. Furthermore, the effects of some artificial defects (squat-shape) on fatigue lives are examined. To simulate the vehicle-track interaction by means of the test rig, a three-dimensional finite element (FE) model is built up. The nonlinear material behaviour of the rail steel is modelled in the contact interface. The results of FE simulations are combined with the critical plane concept to determine the material points with the greatest possibility of fatigue failure. Based on the stress-strain responses, by employing of previously postulated criteria for fatigue crack initiation (plastic shakedown and ratchetting), fatigue life analysis is carried out. The results are reported for various loading conditions and different defect sizes. Afterward, the cyclic mechanism of the test rig is evaluated from the operational viewpoint. The results of fatigue life predictions are compared with the expected number of cycles of the test rig by its cyclic nature. Finally, the estimative duration of the experiments until fatigue crack initiation is roughly determined.

Keywords : fatigue, test rig, crack initiation, life, rail, squats
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