Adhesion modelling in wheel-rail frictional contact

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The paper is concerned with the analysis and numerical evaluation of adhesion and fatigue [1,2] in wheel-rail contact problems. Adhesion has a noticeable impact on both contact pressure distribution and contact length variation during each cycle [3,4].

The two-dimensional wheel-rail contact problem between a rigid wheel and an elasto-plastic rail lying on a rigid foundation is investigated. The contact phenomenon includes Coulomb friction, frictional heat generation as well as the wear of the contacting surfaces. The displacement and stress of the rail in contact are governed by the coupled elasto-plastic and heat conductive equations. The elastic and plastic responses are approximated, respectively, by Hooke's law and by von Mises yield criterion with isotropic power law hardening. The wear depth function appears as an internal variable in the non-penetration condition updating the gap between the worn surfaces of the bodies. Moreover the dissipated energy due to friction is calculated to evaluate the loss of the rail material and to determine the shape of the contacting surfaces during the wear evolution process. Therefore the wear phenomenon is modeled by the combined Archard and power dissipation models. The adhesion contact model is built based on RCC model [5]. The tangential resistance is based on the definition of the shear strength and the surface free energy [1,5].

The contact problem is solved numerically. The finite element method is used to discretize it. The original coupled problem is solved numerically using the splitting method [6]. In this approach first for a given temperature the displacements, stresses and wear depth are calculated using the generalized Newton method. The plastic flow and friction inequality conditions are reformulated as equality conditions using the nonlinear complementarity functions [7]. In the next step, for a given displacement and stress, the temperature is updated using Cholesky method. The numerical results, including the distribution of von-Mises stress, plastic strains, and the tangential traction, are discussed. .

References

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