Computational stress and damage modelling for rolling contact fatigue

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Rolling contact fatigue in radial roller bearings is studied by means of a 2D plane strain finite element program. The Dang Van multiaxial fatigue criterion is firstly used, in a macroscopic study modeling the bearing raceway, to investigate the region where fatigue cracks are more likely to nucleate. A Hertzian and an elastohydrodynamic lubricated pressure distribution are applied on the bearing raceway to model the contact between the roller and the ring, and the results are compared in light of the Dang Van criterion. The beneficial effects of a hardening treatment of the ring surface and of compressive residual stresses are also analyzed. The stress history of a material point at the depth where the maximum Dang Van damage factor is reached is then recorded and used in a subsequent micro-mechanical analysis. The stress history is applied as periodic boundary conditions in a representative volume element where a single inclusion is embedded in a bearing steel matrix. The effects of different inclusion volume fractions, material particles and inclusion orientations are examined. The fatigue crack growth of a preexisting crack nucleated in the matrix is finally investigated for an alumina inclusion by means of cohesive elements and damage mechanics. Results for different load conditions and different crack orientations are compared.

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