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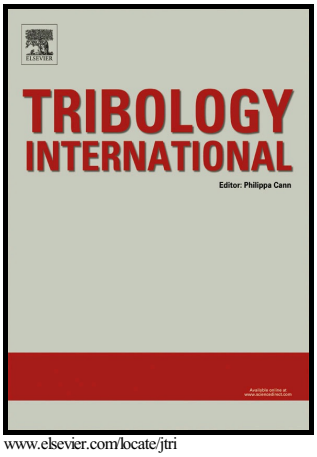


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# Effects of non-metallic inclusions on the crack propagation in bearing steel

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**Abstract**

The crack propagation in bearing steel with a non-metallic inclusion is analyzed by Voronoi finite element method. The load applied on the Voronoi finite element model is obtained by combination of quasi-dynamic method and Hertzian contact theory. Von Mises stress distribution in the micro-domain is calculated to determine the crack initiation. The result shows that the non-metallic inclusion acts as stress raiser and the maximum von Mises stress appears near the inclusion. Thus, we can conclude that the crack is initiated near the inclusion. Stress intensity factors (SIFs) were calculated to study the crack propagation as a function of inclusion elastic modulus, size, and depth. The crack is more likely to grow when the inclusion is soft, small and shallow.

**Abbreviation**

RCF, rolling contact fatigue; SIF, stress intensity factor; VFEM, Voronoi finite element method

**Keywords：** Inclusion; Stress concentration; Subsurface crack; Stress intensity factors

**Nomenclature**

| | |
|---|---|
| $\boldsymbol{A}$ | area of the element |
| $\boldsymbol{B}$ | strain matrix of the element |
| $b$ | contact half-width (mm) |
| $\boldsymbol{D}$ | material property matrix of the element |
| $E$ | elastic modulus of the element (GPa) |
| $K_{\mathrm{I}}$, $K_{\mathrm{II}}$ | stress intensity factors (MPa・mm$^{0.5}$) |
| $\boldsymbol{k}^{\mathrm{e}}$ | stiffness matrix of the element |
| $l$ | contact length of the roller |
| $P$ | normal pressure (MPa) |
| $P_{\max}$ | maximum Hertzian contact pressure (MPa) |
| $Q$ | contact load between the roller and the raceway (N) |
| $r$ | distance of the nodes from the crack tip (mm) |
| $T$ | friction force (MPa) |
| $t$ | unit thickness |