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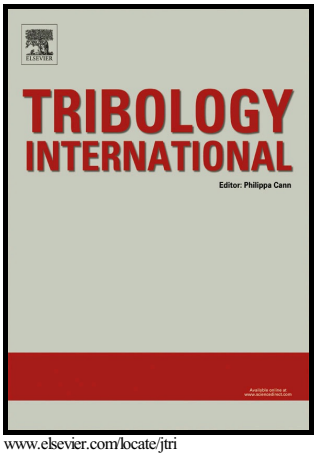

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Linkai Niu[a,*], Hongrui Cao[b], Xiaoyan Xiong[a]

[a.] Key Laboratory of Advanced Transducers and Intelligent Control System, Ministry of Education, Taiyuan University of Technology, Taiyuan 030024, China

[b.] Stake Key Laboratory for Manufacturing Systems Engineering, Xi'an Jiaotong University, Xi'an 710049, China

*Corresponding author. Tel/Fax: +86 0351 6014551. (niulinkai@tyut.edu.cn)

ABSTRACT

A dynamic model to investigate the dynamics and vibration responses of angular contact ball bearings with ball defects is proposed. In the proposed model, each ball has 6 degrees of freedom (DOFs), meaning that the three-dimensional motion of balls is considered. The results show that whether a ball hit a race and the frequency property of the envelope spectrum largely depend on the geometrical characteristics and operating conditions. This increases the difficulty in diagnosing the ball defect when using vibration-based monitoring techniques. The current investigation suggests that the vibration response simulations should be carried out to investigate the vibration mechanism and to diagnose the ball defect more effectively.

Keywords: Angular contact ball bearings; ball defect; bearing dynamics; fault diagnosis

Nomenclature

a, b : Lengths of the semi-major axis and the semi-minor axis of the contact ellipse.
A, B, C, D : Four orbital positons of a ball.
A_1, A_2 : The left and the right ends of the contact ellipse.
c_y, c_z :The damping coefficients of the bearing housing along the y_i and z_i directions.
d_m : Pitch diameter of the bearing.
D : Ball diameter.
f_{bdf} : Ball defect frequency.
f_i : Groove curvature factor of inner race.
f_o : Groove curvature factor of outer race.
f_s : Rotation frequency of the bearing.
F_{hy}, F_{hz} : The forces acting on the bearing housing along the y_i and z_i directions.
$\mathbf{F}$: Force vector.
J : Principal moment of inertial.
k_y, k_z : The stiffness coefficients of the bearing housing along the y_i and z_i directions.
K : Hertzian contact stiffness coefficient.
m : Mass of a bearing component.
m_h : Mass of the bearing housing.
$\mathbf{M}$: Moment vector.
$P_{\max}$: The maximum Hertzian contact stress at the contact ellipse.