An Efficient Finite Element Model for High-speed Spindle-bearing System

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High-speed spindle employs angular contact ball bearings not only because they provide high precision and high-speed capacity, but because they can support axial and radial loads. However, it is well known that angular contact ball bearing has complicated properties as a function of applied loads, rotational speed, location and arrangement. In addition, the numerical model of bearing is represented by a 5x5 matrix so as to complicate the spindle-bearing model. This paper presents an efficient finite element model for spindle-bearing system that can simplify the modeling procedure yet provide the same numerical result as the conventional model. The essence of the proposed model is to introduce the effective location of bearing at which stiffness coefficients other than the axial and radial stiffness coefficients can be numerically removed. Numerical examples are provided to validate the proposed method, as well as to show its superiority to the conventional model.

Keywords: Spindle-bearing system, Stiffness coefficients of bearing, Finite element method, Effective location, Natural frequency