Nonlinear Analysis of a Vibration around the Stability Limit of a Rotor Model Supported by a Journal Bearing

Tsuyoshi Inoue, Department of Engineering, Nagoya University, Nagoya, Japan
Tatsuya Miura, Department of Engineering, Nagoya University, Nagoya, Japan

Long Abstract

Introduction

The journal bearing is generally modeled by linear stiffness and linear damping around the equilibrium point, and utilised for the stability analysis and the vibration analysis. However, the force characteristic is essentially nonlinear, and the rotor may into the large amplitude asynchronous whirling motion when the external impulsive is given to the rotor system due to earthquake or etc even if the rotational speed is smaller than the stability limit for oil whirl or oil whip obtained from the linearized system. Therefore, it is important to clarify the dynamical characteristic of such nonlinear vibration to improve the stability of the rotor system. This study investigates the nonlinear bifurcation of the rotor system supported by the journal bearing, and crafify its characteritic for the parameters of journal bearing.

1. Methods

The rotor system shown in Fig.1 is considered. It is modeled by the lumped parameter rotor model with 4 degree of freedom. The equation of motion is arranged and the reduced order dynamical equation which is fundamental for the bifurcation at the stability limit for oil whirl or oil whip. Then, the reduced order dynamical equation is arranged further to remove the nonlinear terms which does not affect on this bifurcation phenomenon.
Figure 2 shows the result of the theoretical analysis obtained from the finally derived reduced order dynamical equation. It shows the influence of the rotor mass to the type of bifurcation. As the rotor mass increases, the bifurcation characteristic changes from the sub-critical type to the super critical type. So, in this case, the rotor may not enter the large amplitude asynchronous whirling motion even if the external impulsive is given to the rotor system when the rotor mass is larger than this threshold value.

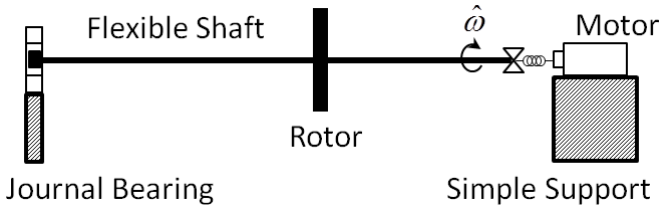

Figure 1. Rotor model

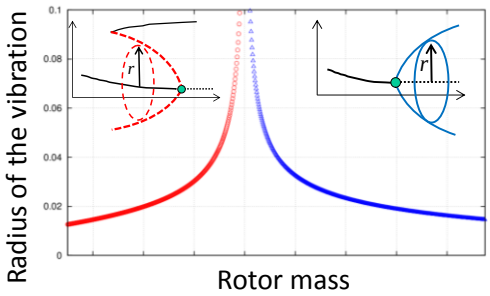

Figure 2. Influence of the rotor mass to the bifurcation type of oil whirl or oil whip

References

[1] Y.Hori and T.Kato, Seismic Effect on the Stability of a Rotor Supported by Oil Film Bearings, Transaction of JSME, Ser.C, Vol.55, No.511, pp.611-617, 1989.

[2] T.Kato, K.Koguchi and Y.Hori, Seismic Response of a Multirotor System Supported by Oil Film Bearings, Transaction of JSME, Ser.C, Vol.57, No.544, pp.3761-3768, 1991..