Numerical analysis of a nonlinear double disc rotor-seal system

非线性双圆盘转子-密封系统的数值分析

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Main goal

A nonlinear double disc rotor-seal system model is established and solved to research the nonlinear vibration characteristics and motion response of double disc rotor-seal system.

Main methods

Based on the finite element method (FEM) and Lagrange equation, the nonlinear double disc rotor-seal system model is established. The fourth order Runge-Kutta method is applied to solve the motion equations of the system and numerically determine the vibration response of the center of the discs.

Double disc rotor-seal system model

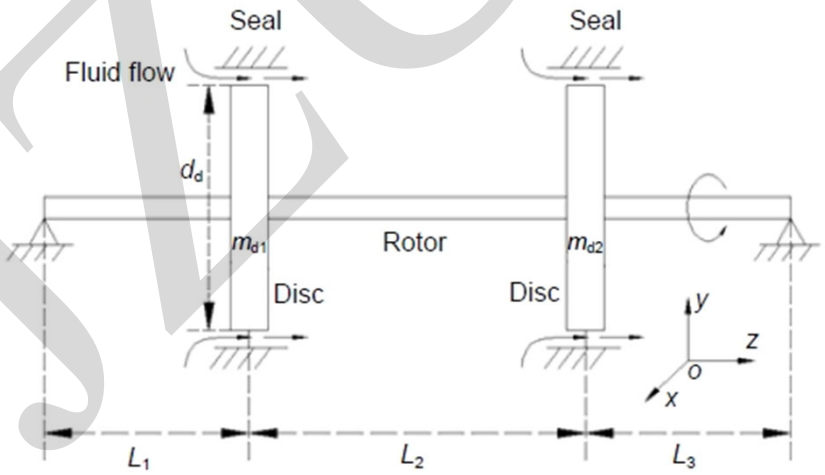

Fig. 1 Double disc rotor-seal system

Numerical results and discussion

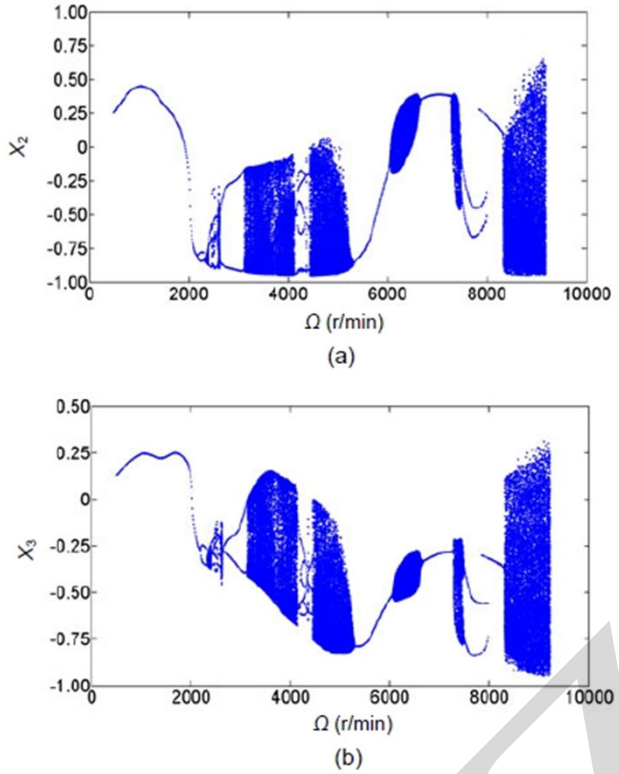

Fig. 5 Bifurcation diagrams of left (a) and right (b) discs

Rotor speed is an important parameter of rotating machinery which significantly influences the vibration characteristics and dynamic response of rotor-seal systems.

With the rotor speed increasing, the system presents rich forms including periodic, multi-periodic, quasi-periodic, and chaotic motion, which can be analyzed by using bifurcation diagrams, time-history diagrams, axis orbit diagrams, Poincaré maps, and amplitude spectrums.

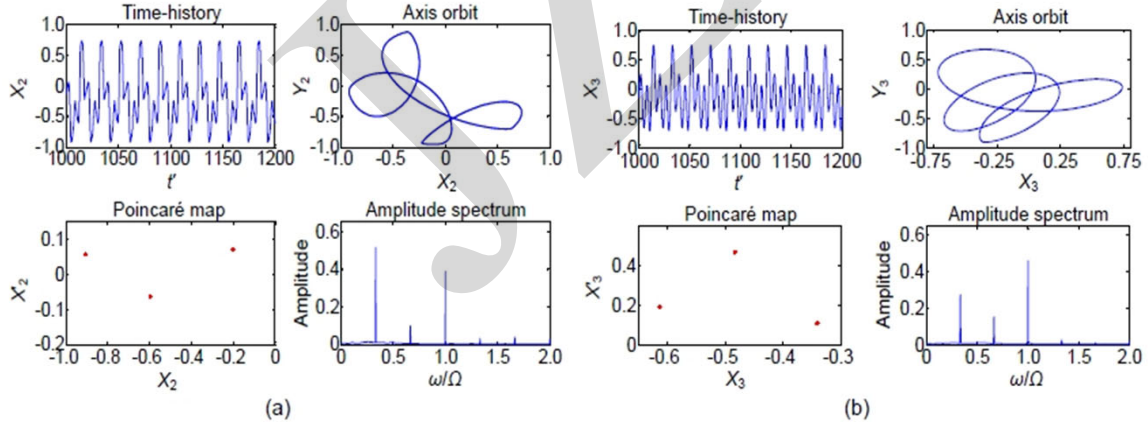

Fig. 7 Numerical analysis of left (a) and right (b) discs at Ω=4420 r/min

Numerical results and discussion

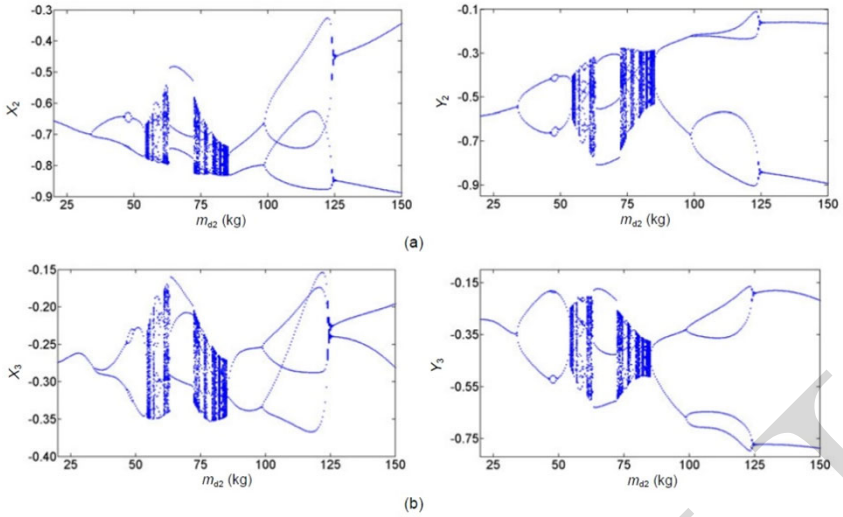

Fig. 11 Bifurcation diagrams of left (a) and right (b) discs with increasing m_{d2}

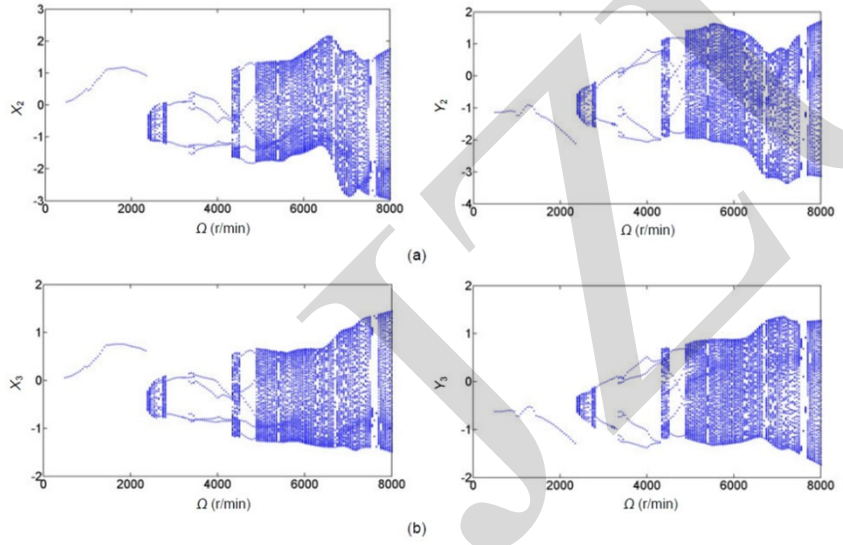

Fig. 15 Bifurcation diagrams of left (a) and right (b) discs with a linear model

The effects of the distance between the two discs, the mass of the discs, seal clearance, seal length, and seal drop pressure on the dynamic behavior of the system. The numerical results demonstrate that a symmetrical disc structure, small disc mass, proper seal clearance, long seal length and high seal drop pressure can enhance the stability of a double disc rotor-seal system.

Compared with a linear seal model, the nonlinear seal model is more suitable for solving nonlinear vibration problems and analyzing actual situations.