

THE INFLUENCE OF LINEAR AND NONLINEAR MODES ON THE DRY FRICTION BACKWARD WHIRL IN ROTOR/STATOR SYSTEMS

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ABSTRACT

Dry friction backward whirl is a self-excited vibration state in rotor-to-stator contact systems, by which the rotor is in continuous contact with the stator, rolling or slipping continuously on the contact surface and whirling backward at a super-synchronous frequency, and has destructive effects on the rotating machinery. The current knowledge on dry friction backward whirl is still limited. It was found in tests that there are two ways that the dry friction backward whirl may be triggered: by an outside disturbance or directly by the imbalance excitation. However, it is still little known on the features of the onset conditions.

In this paper, through the study on a *general* rotor/stator model that accounts for both the dynamics of the rotor and the stator as well as the friction and the deformation at the contact surfaces, the influence of the linear and nonlinear modes on the onset condition of dry friction backward whirl under imbalance excitation is exploited. For this model, there are two modes of the linear coupled rotor/stator system and three modes of the nonlinear coupled rotor/stator system with three negative “natural” frequencies. Two of the three negative frequencies equal, respectively, the whirl frequencies of dry friction backward whirl at the two starting points of the two regions where it exists. The two linear natural frequencies provide the upper limit of the magnitudes of the whirl frequencies of dry friction backward whirl in the two regions. In general, dry friction backward whirl will be triggered by imbalance near the two negative “natural” frequencies mentioned above. The interplay among the linear and nonlinear modes will induce the shifts of the onset condition under imbalance.

Keyword: rotor/stator rubbing, dry friction backward whirl, self-excited vibration