

Effect of Interference Fits on Threshold Speeds of Rotordynamic Instability

John M. Vance

Texas A&M University

Daniel Ying

Bently Nevada Corp. •

ABSTRACT

Most turbomachine rotors are an assembly of parts that utilize interference fits for integrity. The microslip at the fits can produce internal damping that is known to be destabilizing at supercritical speeds. This paper documents some experimental investigations of the effect of interference fits on threshold speeds of rotordynamic instability. In a little noted paper published in 1975, Henry Black analytically predicted that rotors with hysteretic (not viscous) internal damping, if unstable, would have a finite speed range of instability so that higher operational speeds could be safe. Detailed studies of the internal friction characteristics of mechanical assemblies by Lazan have indicated that the viscous friction model is not realistic, so that Black's prediction should be realized. In the laboratory experiments reported here, a rotor test rig was assembled with a press-fitted aluminum sleeve to investigate the above hypothesis experimentally. Transient tests were performed to measure the imbalance response and asynchronous whirling of the rotor with and without the sleeve. The frequency spectrum waterfall map of the rotor with the aluminum sleeve showed several finite speed ranges of instability. Steady-state tests were conducted to observe the effect of changing the fit tightness on the instability while running at supercritical speeds. The subsynchronous whirl component appeared immediately when heating loosened the fit, suggesting that friction slip of the sleeve occurred. Rap tests were also done to obtain the natural frequencies and characteristics of the damping provided by the fitted sleeve. The experimental results strongly suggest that, in agreement with Black's theory, the rotor with a press-fitted sleeve exhibits Coulomb damping at low supercritical speeds and hysteretic damping at high supercritical speeds. An analytical model to accurately predict the threshold speeds of instability due to internal friction in machine rotors is yet to be developed. It will require accurate quantitative information about the internal friction developed in the rotor assembly when the fundamental mode on bearings is excited.
