IMPACT OF A FREE ROTOR AGAINST THE RETAINER BEARING

Agnes Muszynska, Ph.D.
A.M. Consulting
P.O. Box 792, Minden, NV 89423
Tel. (775) 782 7229
agnes@gbis.com

ABSTRACT

Practical observations of the dynamic behavior of horizontal rotors dropped at full speed onto retainer bearings reveal that after the drop, a transition to either devastating dry whip self-excited vibrations or pendulum regime starts with an impacting phase, during which, at each moment of contact with the bearing surface the rotor gains tangential backward velocity. Throughout this "adhesive" contact mechanism, with little slippage, the rotor rotational energy is being transferred into its lateral vibrational energy ending up in the orbiting backward mode of dry whip. If this energy transfer mechanism is "efficient," the dry whip occurs. Otherwise the rotor will pass to the pendulum oscillatory phase, ending up at the bearing bottom, when the entire energy gets used up. The latter regime is desirable, while the rotor dry whip represents the highly unwelcome regime.

This paper presents a model and a computational algorithm of a rotor-after-drop free motion and its transient process of impacting against the retainer-bearing wall. The MATLAB program, based on this algorithm has been designed and several cases were numerically investigated. The considered dynamic situation corresponds to a failure of the magnetic bearing, which normally supports the rotor. It is assumed that at an instant of the magnetic bearing failure the rotor rotates at a constant speed, and laterally vibrates, so its lateral motion may represent a complex orbit. In the simulation it is assumed that at the instant of machine failure rotor may be situated at any position within the retainer bearing clearance, and it may have a specific initial velocity, which depends on the rotor orbital motion.

The impact of the rotor against the retainer bearing inner surface is modeled using two restitution coefficients: the classical radial restitution coefficient and a novel "tangential restitution coefficient," which models the rotor/bearing "adhesive" contacts.

The presented results of the numerical simulations demonstrate the rotor after-failure transient process. It is shown that depending on specific conditions this process leads to either a stable pendulum motion at the bottom of the retainer bearing, or to the unwelcome self-excited dry whip regime.