

ETUDE DE LA REACTION D'UN GUIDE DE LIGNE D'ARBRE SOUMIS A UNE SURCHARGE SOUDAINE

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Abstract: During the last decades, technological development has been directed towards improving the performance of mechanical systems to preserve the environment, lighten the installations and reduce their production costs. The aeronautical field has particularly experienced a significant development concerning the air conditioning systems in aircraft. The key component of these systems is the turbomachinery operating in rotation by aerodynamic bearings. Actually, in flight of the aircraft, these bearings may submit to sudden overloads due to take-off, landing, turbulence or air holes, which can lead to dysfunction or damage to these systems. The present work concerns the theoretical study of the dynamic behavior of air foil bearings subjected to sudden external overloads. It is thus a question of treating the case of an air bearing constituted of a flexible corrugated foils bearing housing (bumps) supporting a rigid rotor. In order to avoid any possible dry contact between the rotor and the housing, due to sudden or severe external excitations, these foils tend to be deformed by widening the reduced air film thickness. As for numerical modeling, starting from the hypothesis of the mechanics of thin viscous films and the mechanics of continuous media, the dynamic behavior of the air is given by the compressible Reynolds equation. The study of the dynamic behavior of air foil bearing is carried out by modeling three different parts: the air, the rotor and the structure. The fluid behavior is expressed by the unsteady Reynolds equation, the movement of the rotor is obtained by the fundamental law of dynamics and the deformations of the structure are determined by a simplified mechanical approach. The temporal dynamic problem can be solved using the Verlet algorithm which reduces computational errors. This algorithm obviously includes the nonlinear air-structure interaction by applying finite difference discretization in implicit scheme and Newton Raphson's method. The stability of the rotor without external excitations and the convergence of calculations to validate the program, are presented. In theory, different cases of external excitation are introduced to the algorithm to see their effect on the trajectory and on the temporal behavior of the rotor. Finally, a parametric study combining the influence of external excitations, operating conditions and stiffness of the flexible structure all on the operation stability and dynamic behavior of air foil bearing is presented.

Keywords : Air foil bearing, elasto-aerodynamic, dynamic behavior, external excitations, compliance, rotor stability