Non-ideal vibrations of super-critical rotors with coupled bending-torsion behavior

Emna Sghaier*†[1,2], Jean Luc Dion[3], Didier Remond[4], Nicolas Peyret[5], and Adeline Bourdon[6]

[1]SUPMECA - Institut supérieur de mécanique de Paris – Laboratoire QUARTZ EA 7393 - SUPMECA Paris, 3 rue Fernand Hainaut, 93400 Saint Ouen, France – France

[2]LaMCoS – Univ Lyon, INSA-Lyon, CNRS UMR5259, LaMCoS, F-69621, France. – France

[3]Laboratoire d'Ingénierie des Systèmes Mécaniques et des MAtériaux (LISMMA) – SUPMECA Paris – Supméca - 3, rue Fernand Hainaut - 93407 St Ouen Cedex, France

[4]Laboratoire de Mécanique des Contacts et des Structures (LaMCoS) – CNRS : UMR5259, Institut National des Sciences Appliquées (INSA) - Lyon, Institut National des Sciences Appliquées [INSA] - Lyon – Bâtiment Jean d'Alembert 18-20, rue des Sciences F69621 VILLEURBANNE CEDEX, France

[5]Laboratoire QUARTZ-SUPMECA EA 7393 – Laboratoire QUARTZ EA 7393 - SUPMECA Paris, 3 rue Fernand Hainaut, 93400 Saint Ouen, France – France

[6]Laboratoire de Mécanique des Contacts et des Structures (LaMCoS) – Institut National des Sciences Appliquées [INSA] - Lyon, Institut National des Sciences Appliquées (INSA) - Lyon – France

Résumé

Most of the studies on rotor dynamics focus on the exploration of the bending and torsion behavior in a separate way. However, in some cases, this kind of separate analysis leading to a decoupled behavior in the lateral and torsional direction doesn't always ensure good accuracy. This is mainly the case for very high-speed rotors. On one hand, in this case, when the angular velocity becomes very high, the gyroscopic effect becomes very important leading as a consequence to an important coupling between flexion and torsion. On the other hand, when the studied speed range gets very large, the torsional deformation may intercept the lateral frequencies and the coupling between bending and flexion may take place. In this paper, we propose a fully coupled bending-torsion dynamic model for unbalanced rotors accelerating through critical speeds. The finite element method is used herein and six degrees of freedom are considered on each node. The degree of freedom in rotation is represented in away such it combines at the same time the intrinsic nominal rotation as well as the torsional deformation. The assumption of non-ideal energy source is made for modeling, which offers more freedom on coupling the rotor to other machineries. The accuracy of the new proposed model is tested on an example of rotors and compared with other existing models. The results show that the new model better estimates the rotors vibrations and exhibit unpredicted vibrations on the torsional deformation when crossing through the lateral critical speeds.

Mots-Clés: rotordynamics, critical speeds, coupled bending, torsion vibrations, non, ideal rotors, gyroscopic effect

*Intervenant

†Auteur correspondant: emna.sghaier@supmeca.fr