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IMPLEMENTATION OF TRANSFER MATRIX ANALYSIS OF MULTI-SECTION ROTORS USING ANSYS PARAMETRIC DESIGN LANGUAGE

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ABSTRACT

Critical speed analysis of rotor systems is a difficult process due to the fact that there exists no direct formula to determine the natural frequency of a multi-section rotor. Finite Element packages provide a suitable platform for such an analysis but demand considerable experience on part of the user to perform modeling, meshing, solving and post-processing. The primary objective of this paper is to identify a suitable method for determining rigid bearing critical speeds of multi-section rotors in order to validate the results obtained through traditional FEA package and also to simplify the latter. The only drawback of transfer matrix analysis is the existence of mathematical equations and multiple roots which makes it a cumbersome process by solving manually. This problem has been tackled in this present work through the use of Ansys Parametric Design Language (APDL). The strength of APDL as a macro language have been taken advantage of in this present work to develop an interactive macro which mimics the Finite Element Method and thus relaxes the rigorous routine involved in a traditional tool-based finite element analysis. The results thus obtained through Transfer Matrix Analysis and FEM macro are compared with traditional ANSYS results.

KEYWORDS: *Critical speed, Multisection rotor, Transfer matrix analysis, Finite element method, APDL.*

I. INTRODUCTION

Vibrations are fluctuations of a mechanical or structural system about an equilibrium position. Vibrations are initiated when an inertia element is displaced from its equilibrium position due to an energy imparted to the system through an external source. A restoring force or moment pulls the element back towards equilibrium. The physical movement or motion of a rotating machine is normally referred to as vibration.

1.1 Critical Speeds

The critical speed of a rotor is an operating range where turning speed equals one of its natural frequencies due to bending or torsional resonances. If a rotor is operated at or near a critical speed, it will exhibit high vibration levels, and is likely to be damaged. Much rotating equipment is operated above its lowest critical speed, and this means it should be accelerated relatively rapidly so as not to spend any appreciable time at a critical speed. In the field of rotor dynamics, the critical speed is the theoretical angular velocity which excites the natural frequency of a rotating object, such as a shaft. As the speed of rotation approaches the object’s natural frequency, the object begins to resonate which dramatically increases systemic vibration. The resulting resonance occurs regardless of orientation. When the rotational speed is equal to the numerical value of the natural vibration then that speed is called critical speed.