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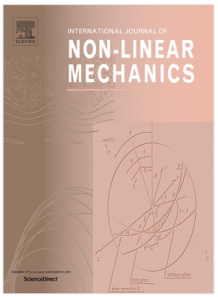

Dynamics of an axially moving unidirectional plate partially immersed in fluid under two frequency parametric excitation

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Dynamics of an axially moving unidirectional plate partially immersed in fluid under two frequency parametric excitation

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Abstract: This paper analyzes characteristics of combination resonances and its stability for an axially moving plate partially immersed in fluid subjected to two frequency excitation. With a consideration to fluid–structure interaction, the equations of motion are established based on the classical thin plate theory. The Galerkin method is applied to discretize the vibration equations. Adopting multiple scales method to solve combination resonances, system's frequency-response equations under steady state motion are obtained. Based on Lyapunov's stability theory, judging conditions for the stability of equations are acquired. Through numerical example, this paper analyzes characteristics of combination resonances while the ratio of two excitation frequencies meet with 2:1, and further provides time history curves, frequency-response curves and phase trajectories in moving phase plane. Influences played on dynamic characteristics by parameters such as excitation amplitudes, axially moving speed, damping and detuning parameters are also discussed. Results reveal that, under two frequency excitation, system presents rich and interesting non-linear phenomena.

Keywords: Axially moving unidirectional plate; Fluid-structure interaction; Combination resonances; Stability.

1. Introduction

Plates immersed in fluid have wide applications in areas like aerospace and aeronautical industries, aircraft construction, shipbuilding, and nuclear and naval engineering, etc. It is of great significance to understand the dynamic characteristics of plates immersed in fluid when subjected to different loading conditions, so that they may be safely used in these industrial applications. It is well known that plates in contact with fluid behave differently from those in the air. Namely, due to the effect of the fluid, the vibration analysis of plates becomes rather complex. This challenging problem has been investigated for many years and the earliest works were done by Lamb [1], who investigated vibrations of elastic plate in contact with still water, and calculated the resonance

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