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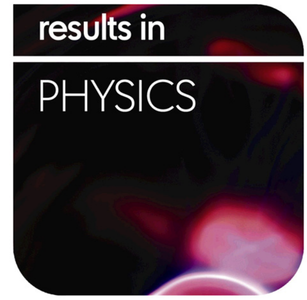

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Nonlinear oscillations of rectangular plate with 1:3 internal resonance between different modes

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Abstract: The energy transfer between different modes of rectangular plate with 1:3 internal resonance is investigated. The ordinary differential equations of motion for the plate are worked out by applying the Galerkin's method. The nonlinear frequency responses and the waveforms under specific excitation frequencies are obtained by using Runge-Kutta Method. The energy transfer process between different modes is analyzed through the waveforms. The results indicate that the energy transfer mode is different when the internal resonance occurs between different modes. In addition, as a result of the presence of in-plane excitation, the internal resonance between two modes can occur when the excitation frequency is not close to any linear natural frequencies.

Key word: internal resonance; nonlinear; rectangular plate; frequency response； energy transfer

Introduction

Internal resonance is a typical nonlinear vibration phenomenon. The energy transfer can be generated between several modes of a system when the natural frequencies of those modes are commensurable or nearly commensurable [1], this phenomenon is called as internal resonance. Whether from the angle of vibration control or the angle of vibration utilization, internal resonance is a phenomenon worthy of attention. When a structure is subjected to a single frequency excitation, with the excitation amplitude increases, the vibration state of the structure is changed from single frequency response to internal resonance response and then to chaotic response. The study on the characteristic of internal resonance can deepen the understanding of chaotic vibration.

Internal resonance of structures has been paid extensively attention over the years. Hao et. al [2] studied the nonlinear responses of functionally graded rectangular plate with 1:1, 1:2 and 1:3 internal resonances under combined excitations. Chen et. al [3, 4] investigated the nonlinear vibrations of symmetric cross-ply composite laminated plate and composite truss core sandwich plate respectively under consideration of internal resonance. Rossikhin and Shitikova [5] studied the nonlinear responses of viscoelastic plate under the conditions of different internal resonances. Emam and Nayfeh [6] analyzed the nonlinear behaviors of buckle beam with 1:1 and 1:3 internal resonances. Chen et. al [7] analyzed the nonlinear frequency responses of axially accelerating strings with internal resonance. Xiong et. al [8] investigated the nonlinear forced vibration of a viscoelastic buckled beam with internal resonance. Shaw et. al [9] experimentally studied the periodic vibration of a cantilever beam with a nonlinear spring at the tip with 1:3 internal resonance. Mahmoudkhani [10] performed the analysis of comprehensive response and