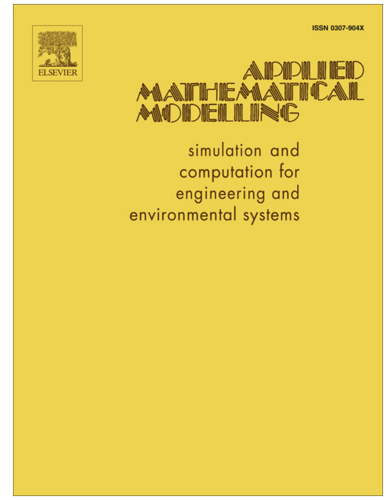

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Nonlinear time delay saturation-based controller for suppression of nonlinear beam vibrations

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Abstract

In the present paper, time delay is considered in active suppression of nonlinear vibrations applying saturation-based controller. Its effect on the system behavior is studied. Time delay inherently exists in many active control systems as a result of transport delay, on-line computation, measurements of the system states, executing the control algorithms and processing of the errors and control signals. The 1:2 internal resonance cases between the main system and the nonlinear saturation-based controller is studied when the main system is excited at a frequency near its natural frequency. The method of multiple scales is applied to obtain approximate solution for the system response. With the time delay varying for fixed controller parameters, it is seen that the vibration can be suppressed at some values of time delay. These values form a so called "vibration suppression region" which we found as a periodic function of time delay. However, the vibration suppression is invalid at some values of time delay. The effects of the gains γ, λ and the excitation amplitude f on the vibration suppression are investigated. The analyses showed that, all predictions from analytical solutions are in good agreement with the numerical simulation. A comparison with the available published work is included.

1-introduction

Nonlinearities are responsible for unusual phenomena in the presence of internal and/or external resonances. The theory and techniques of vibration suppression are extensively studied for many years. Various types of controllers are developed so as to channel the exceed energy from excitation to the slave system in order that the vibration in the primary system can be suppressed. One of the novel methods of vibration control is taking the advantages of the saturation phenomenon, in the case of quadratic non-linearities; the energy transfer is complete if the natural frequencies of the main system and the secondary system are in the ratio two to one. When the main system is excited at a frequency near its natural frequency, the main system responds at the frequency of excitation and the amplitude of the response increases linearly with the excitation amplitude. However, when the response amplitude reaches a critical value, the response of the main system saturates and all additional energy added to the main system by increasing the excitation amplitude is channeled to the secondary system. This

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