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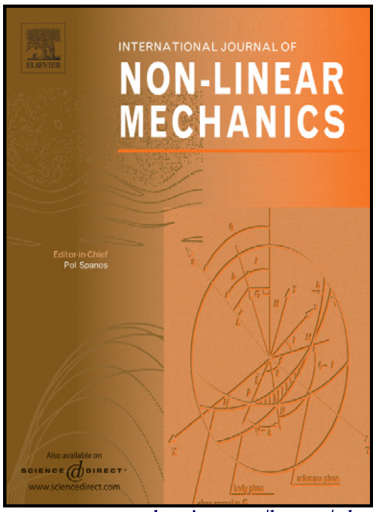

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Lateral vibration attenuation of a rotor under mass eccentricity force using nonlinear energy sink

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Abstract

This paper studies the efficiency of a number of smooth nonlinear energy sinks (NESs) on the vibration attenuation of a rotor system under mass eccentricity force. The nonlinear energy sinks have a linear damping, linear stiffness and a cubic stiffness. To reduce the number of equations of motion, the modal coordinates and complex transformations are used. For analytical solution, Multiple Scales-Harmonic Balance Method (MSHBM) is used. The most important parameters to examine NES efficiency is the range of happening of the SMR in the detuning parameter range. For different parameters of the system, the SMR, the WMR, the low amplitude periodic motion, and the high amplitude periodic motion happen in the system. It is shown that, the linear stiffness of the NES is cancelled out by the stiffness which is created by the centrifugal force and therefore, by changing the linear stiffness of the NESs, the collection of the NESs to the desired rotational speed of the rotor can be tuned. It should be noted that after this cancellation, the remained stiffness is essentially nonlinear (nonlinearizable) stiffness. In addition, when the external force reaches its medium magnitude, the area of the occurrence of the SMR in the domain of the system parameters would be larger and the collection of the NESs demonstrates an impressive effect.

Keywords:

rotor, smooth nonlinear energy sink, strongly modulated response (SMR), weakly modulated responses (WMR), Multiple Scales-Harmonic Balance Method (MSHBM), Hopf bifurcations

1. Introduction

The rotor vibrations are an important problem in practical applications. On the other hand, scientifically and practically, in recent years there is much attentions to nonlinear energy sinks as nonlinear-absorbers. Therefore, study of the NES effect on the vibration mitigation of the rotor is attractive. Duffy et al. [1,2] studied the effect of a self-tuning impact damper on the vibration mitigation of the rotating components of a turbo-machinery. The numerical and experimental results indicated that self-tuning impact damper decreases vibration amplitude and hence increases the fatigue life of these components. Also, they demonstrated that the self-tuning damping is more effective than the simple tuned mass dampers.

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