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NONLINEAR VIBRATION OF A BOLT JOINTED BEAM UNDER MICROSLIP

Abstract

In the spacecraft ground vibration tests, the fundamental natural frequency of the spacecraft may decrease as the excitation level increases,which is a typical nonlinear behavior and may results from many reasons. In this paper, the effects of microslip on the friction interface of structural joints' are taken into consideration. We examine a beam with one end fixed and the other end constrained to the base by a bolt joint, which is considered not tightened enough and allows microslip along the joint interface. An Iwan model is used to formulate the mechanical behavior of the joint, leading to a hysteresis nonlinear boundary condition in transverse freedom of the joint end. The method of multiple scales is applied to determine the steady-state response of the beam when under base harmonic excitation. The nonlinear frequency response function (FRF) is derived from the solvability condition, and the stability of the steady-state response is analyzed by the Lyapunov-linearized stability theory. The results of the examples show that all the resonance peaks of FRF curves are left-bended as expected, showing a softening effect, which are consisted with the frequency shift phenomenon in the spacecraft vibration tests. When the parameters of the equation are varied within a certain range, an unstable region will arise in each of the FRF curves as well as the relationship curves of response amplitude and the excitation amplitude. The effects of the related parameters on the stability of the vibration amplitude are also studied, the results suggest that the unstable region can be reduced or even disappeared by the way of reducing the excitation amplitude, increasing the damping or strengthening the constraint of the joint.