Nonlinear forced vibration of metal foam rectangular plates reinforced with graphene platelets

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Abstract. Primary, superharmonic, and subharmonic resonances of graphene platelet (GPL) reinforced metal foam (GPLRMF) rectangular plates are investigated. Various GPL distributions and porosity distributions are considered. Governing equations and general boundary conditions are obtained via Hamilton's principle. Introducing the stress function, ordinary differential equations of the nonlinear system are received by using the Galerkin method. Finally, frequency-response relationships are solved by applying the multiple scale method. The effects of the porosity coefficient, the weight fraction of GPL, the amplitude of the excitation, and the damping ratio on frequency-response curves are studied. Results show that GPLRMF plate shows the hardening nonlinearity in primary and superharmonic resonances.

Introduction

In recent decades, GPLs have attracted widespread interest since they were discovered. As a kind of reinforcing filler, GPLs are often added to various matrices to improve the mechanical characteristic of the structure. GPLRC structures can be used in very strict environmental and mechanical conditions, providing a broader application prospect. With the development of GPLs, the dynamic problems that may appear in the practical application of GPL reinforced composite structures are also attracting a lot of attention, including bending, buckling, vibration, etc. In practical application, most of vibration systems are nonlinear systems. They are often affected by external forces. The nonlinear forced vibration is the closest description of the actual structure vibration. Therefore, it is necessary to carry out researches on the forced vibration of beams, plates, and shells.

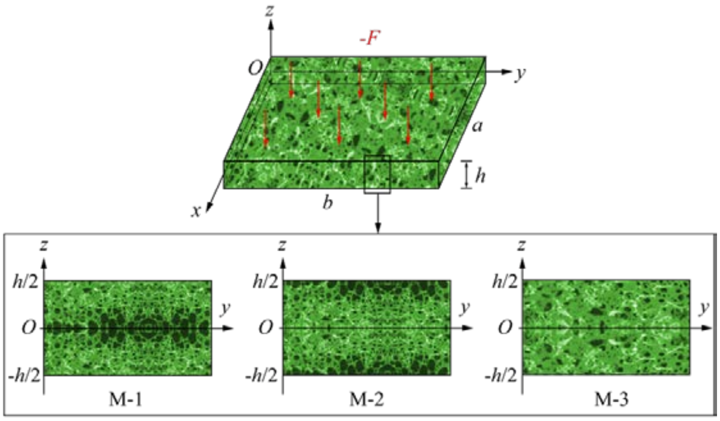

Figure 1: A GPLRMF rectangular plate and different porosity distributions of metal form.

Results and discussion

The effects of the porosity coefficient, the weight fraction of GPL, the amplitude of the excitation, and the damping ratio on frequency-response curves are studied for various porosity distributions and GPL patterns. Results show that GPLRMF plates show the hardening nonlinearity in primary and superharmonic resonances. In addition, the effect of GPL pattern is less than that of porosity distribution on the nonlinear behavior of GPLRMF plates.

References

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