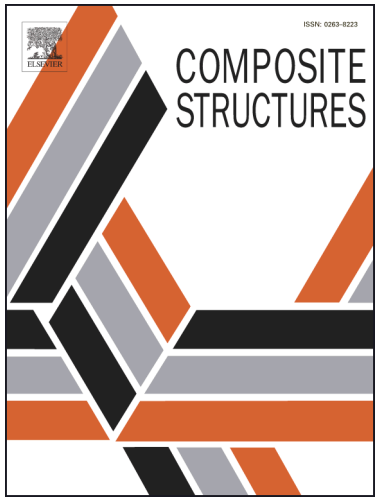

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PII: S0263-8223(18)32201-3
DOI: https://doi.org/10.1016/j.compstruct.2018.08.071
Reference: COST 10121

To appear in: *Composite Structures*

Received Date: 19 June 2018
Revised Date: 7 August 2018
Accepted Date: 27 August 2018

Please cite this article as: Guo, X., Jiang, P., Zhang, W., Yang, J., Kitipornchai, S., Sun, L., Nonlinear Dynamic Analysis of Composite Piezoelectric Plates with Graphene Skin, *Composite Structures* (2018), doi: https://doi.org/10.1016/j.compstruct.2018.08.071

Nonlinear Dynamic Analysis of Composite Piezoelectric Plates with Graphene Skin

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Abstract: This paper studies the nonlinear dynamical characteristic of a composite plate made of new three-phase materials which include the graphene (GP) combined with macro fiber composite (MFC) in the polymer. The GP is supposed to be uniformly dispersed in the upper and lower surfaces of the composite laminated plate with 1-3 mode of macro fiber. The cross-ply MFC composite laminated plate is subjected to transversal excitations. The constitutive laws for the MFC-GP composite material are obtained based on the rule of mixture for multi-components of composite material. The nonlinear governing equations of motion of the MFC-GP plate are derived by Hamilton's principle and the von Kármán geometrical kinematics. Galerkin's approach is employed to discretize the partial differential governing equations into a two-degree-of-freedom nonlinear system. Then, stability analysis is conducted to investigate the influences of various parameters on natural frequencies of the MFC-GP plate, with a particular focus on the effects of GP volume fraction, initial conditions and damping coefficients on nonlinear vibration behaviours of the composite plate.

Keyword: MFC-GP Plates; Mixture Rules; Stability Analysis; Nonlinear Vibration

1. Introduction

Graphene (GP) has gained wide attention in the world as soon as it came out, since it opened a new area of research in many fields of science and technology, such as materials science, engineering, medicine, biomaterials and energy production [1]. Meanwhile, GP can be used as a skin material to supply some special performance for composite material, for example, the Rice University reported that "thin coating of graphene nanoribbons in epoxy developed has proven effective at melting ice on a helicopter blade" and so on. Such kind of composite material also features excellent