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Force – displacement characteristics of simply supported beam laminated with shape memory alloys

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Abstract As a preliminary step in the nonlinear design of shape memory alloy (SMA) composite structures, the force-displacement characteristics of the SMA layer are studied. The bilinear hysteretic model is adopted to describe the constitutive relationship of SMA material. Under the assumption that there is no point of SMA layer finishing martensitic phase transformation during the loading and unloading process, the generalized restoring force generated by SMA layer is deduced for the case that the simply supported beam vibrates in its first mode. The generalized force is expressed as piecewise-nonlinear hysteretic function of the beam transverse displacement. Furthermore the energy dissipated by SMA layer during one period is obtained by integration, then its dependencies are discussed on the vibration amplitude and the SMA ' s strain (Ms-Strain) value at the beginning of martensitic phase transformation. It is shown that SMA ' s energy dissipating capacity is proportional to the stiffness difference of bilinear model and nonlinearly dependent on Ms-Strain. The increasing rate of the dissipating capacity gradually reduces with the amplitude increasing. The condition corresponding to the maximum dissipating capacity is deduced for given value of the vibration amplitude. The ob-tained results are helpful for designing beams laminated with shape memory alloys.

Keywords: Shape memory alloy Laminated beam Bilinear hysteretic model Force – displacement characteristics Energy dissipation

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