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Non-Linear Load-Deflection Response of Shape Memory Alloys-Reinforced Composite Cylindrical Shells under Uniform Radial Load

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Abstract : Shape memory alloys (SMA) are often implemented in smart structures as the active components. Their ability to recover large displacements has been used in many applications, including structural stability/response enhancement and active structural acoustic control. SMA wires or fibers can be embedded with composite cylinders to increase their critical buckling load, improve their load-deflection behavior, and reduce the radial deflections under various thermo-mechanical loadings. This paper presents a semi-analytical investigation on the non-linear load-deflection response of SMA-reinforced composite circular cylindrical shells. The cylinder shells are under uniform external pressure load. Based on first-order shear deformation shell theory (FSDT), the equilibrium equations of the structure are derived. One-dimensional simplified Brinson’s model is used for determining the SMA recovery force due to its simplicity and accuracy. Airy stress function and Galerkin technique are used to obtain non-linear load-deflection curves. The results are verified by comparing them with those in the literature. Several parametric studies are conducted in order to investigate the effect of SMA volume fraction, SMA pre-strain value, and SMA activation temperature on the response of the structure. It is shown that suitable usage of SMA wires results in a considerable enhancement in the load-deflection response of the shell due to the generation of the SMA tensile recovery force.

Keywords : airy stress function, cylindrical shell, Galerkin technique, load-deflection curve, recovery stress, shape memory alloy
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