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Process-induced residual stress of variable-stiffness composite laminates during cure

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Abstract: One of the most important issues for designing variable-stiffness composite structures reflects on determination of the steered fiber paths. In this paper a linear variation of steered fiber curves and the change rule of the fiber angles were presented to create the mathematical model of variable-stiffness composite laminates. Compared to the straight-fiber laminate, the reference path with linearly changed angles leads to higher mechanical strength and more design freedoms. A novel methodology was developed to predict the distributions of process-induced residual stresses during cure. A three-dimensional (3D) thermochemical model of the curing process was established and the mechanical responses during cure were evaluated coupled with the results of thermochemical analyses. The distributions of the temperature and the degree of cure were obtained. The process-induced residual stresses were calculated using ABAQUS. The resin modulus was determined using the cure hardening instantaneous linear elastic (CHILE) model. The cure kinetic process was simulated using Kamal model for AS4/3501-6 prepregs. The results show that the process-induced residual stresses of variable-stiffness composite panels are reduced with increasing the end angle of the present fiber path during cure.

Keywords: Composite materials; Process-induced residual stress; Variable stiffness; Cure; Finite element method

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