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Effect of Integral Viscoelastic Core on the Nonlinear Dynamic Behaviour of Composite Sandwich Beams with Rectangular Cross Sections

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Abstract

This paper deals with geometrically nonlinear transient analysis of sandwich beams with viscoelastic cores and laminated composite skins. The formulation is based on the Full Layerwise theory (FLWT) and the Boltzmann's superposition principle and using weakly singular Koltunov-Rzhanitsyn kernel for modelling the viscoelastic core. The nonlinear governing integro-partial differential equations (IPDEs) of the sandwich beams are derived using Hamilton's principle. The Galerkin method in combination with the Newmark-Beta procedure, which is coupled to the Newton-Raphson algorithm, are employed to solve the obtained nonlinear IPDEs. The effects of using integral model and considering the history of strain for viscoelastic core on the dynamic response of sandwich beams are investigated. The results indicate that, employing the integral model with Koltunov-Rzhanitsyn kernel in the constitutive equation affects the amplitude and the frequency of the dynamic response of sandwich beam. For comparison purpose, the finite element analysis is carried out within ANSYS software environment and the user-material subroutine is developed to model the Koltunov-Rzhanitsyn kernel. The results of the used semi-analytical model agree well with those obtained from finite element method (FEM) of analysis. It should be noted that, because of employing a large number of degrees of freedom in the FEM analysis for accurate modelling of the viscoelastic sandwich beams, the FEM analysis is rather computationally inefficient in comparison to the presented method. Moreover, the Koltunov-Rzhanitsyn kernel is capable of modelling the viscoelastic behaviour accurately with lower number of rheological parameters in comparison to the Prony series.