TRANSIENT RESPONSE OF SANDWICH VISCOELASTIC BEAMS, PLATES, AND SHELLS UNDER IMPULSE LOADING*

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Sandwiches are widely used in structural applications requiring high stiffness-to-weight and strength-to-weight ratios and high damping. Among these applications, a considerable part make up aeronautical, ship and automobile structures and its parts made from sandwich beams, plates and shells with viscoelastic layers. Damping in this case plays one of the more important roles, since passive damping is an essential dynamic parameter of vibration and sound control, fatigue endurance and impact resistance.

Due to increasing application of highly damped and lightweight structures, significant progress has been recently achieved in the analysis of such structures. However, majority analyses are performed in the frequency domain, and only small quantity of investigations is devoted to the solution in the time domain. This can be explained by considerable difficulties arising in the analysis. To overcome these difficulties, a method using the fast Fourier transform and based on the trigonometrical polynomial representation of the input signals and matrix of the transfer functions has been developed. In this case, the rheological behaviour of viscoelastic materials is described by the complex modulus model, since this model is solvable, permits the use of existing computing facilities, and the results of such a theoretical analysis show sufficiently good agreement with experiments. The present implementation gives a possibility to preserve the frequency dependence for the storage and loss moduli of viscoelastic materials exactly. Moreover, the storage and loss moduli in this case are defined directly in the frequency domain by experimental technique for each material and can be used without any transformation in the numerical analysis.

In the present investigation, the finite element method was used. Finite element modeling is based on the first-order shear deformation theory including rotation around the normal and applied separately for each layer of sandwich. This case corresponds to the broken line model requiring fulfillment of the displacement continuity conditions between the layers of a sandwich construction.

Test problems and numerical examples showing the transient response of sandwich beams, plates, and shells under single and multiple impulse loading are given to demonstrate the validity and application of the method presented.

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