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NONLINEAR DYNAMIC RESPONSE OF A SIMPLY-SUPPORTED LAMINATED COMPOSITE PLATE SUBJECTED TO EXPLOSIVE PRESSURE PULSES

Zafer Kazancı[1], Zahit Mecitoğlu[2]

[1]Turkish Air Force Academy
Aeronautical Engineering Department, Yeşilyurt, 34149, İstanbul, Turkey
z.kazanci@hho.edu.tr

[2]İstanbul Technical University
Faculty of Aeronautics and Astronautics, Maslak, 34469, İstanbul, Turkey
mecit@itu.edu.tr

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ABSTRACT

Advanced laminated composites are used in several engineering fields. With the advent of the new composite material structures and their increased use in the industry, there is a need to reconsider the problem of the nonlinear dynamic behavior of laminated composite plates exposed to time-dependent pulses, such as sonic boom and blast loadings.

Several studies related to the effects of air blast loading on the panel structures are investigated in the literature. Hause and Librescu [1] have addressed the problem of the dynamic response in bending of flat sandwich panels exposed to time-dependent external blast pulses. Librescu and Nosier [2] have investigated the response of laminated composite flat panels to sonic boom and explosive blast loadings. Kazancı and Mecitoğlu [3] have studied on the nonlinear damped vibrations of a fully-clamped laminated composite plate subjected to blast load. Kazancı et al. [4,5] have considered in-plane stiffness and inertias in the analytical solution of the laminated composite plates under the blast load.

However, only a few studies in the nonlinear response of simply supported laminated composite plates subjected to blast load are investigated. Birman and Bert [6] considered the response of simply supported anti-symmetrically laminated angle-ply plates to explosive blast loading. Chen et al. [7] developed a semi-analytical finite strip method for the analysis of the nonlinear response to dynamic loading of simply supported rectangular laminated composite plates.

Present work includes in-plane stiffness and inertia effects on the motion of a laminated composite plate subjected to explosive pressure pulses. The geometric nonlinearity effects are taken into account with the von Kármán large deflection theory of thin plates. All edges simply supported boundary conditions are considered in the analyses. The equations of motion for the plate are derived by the use of the virtual work principle. Approximate solutions are assumed for the space domain and substituted into the equations of motion. Then the Galerkin Method is used to obtain the nonlinear differential equations in the time domain. The finite difference method is applied to solve the system of coupled nonlinear equations. The influence of loading

effects on the nonlinear dynamic response has been predicted for all edges simply-supported plates. The results of approximate-numerical analyses are compared with the finite element results obtained by the use of ANSYS software.

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