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Explicit Modeling of Composite Plates and Beams in the Dynamics of Multibody Systems

F. M. L. Amirouche*, S. K. Ider†, and M. Moumene†
Department of Mechanical Engineering
University of Illinois at Chicago

Abstract

The state of the art dynamic response analysis of flexible multibody systems is currently restricted to elastic bodies with homogeneous materials. The requirements for high speed operation has made it necessary to use lightweight multi layered composite bodies in robotic systems and space structure applications. Dynamic modeling and analysis of such systems are particularly important since the effects of body flexibility to the performance are likely to be more pronounced.

In this paper first the eight-noded isoperimetric quadrilateral element with independent rotational and displacement degrees of freedom is extended to laminated composite elements. The element includes an arbitrary number of bonded layers, each of which may have a different thickness. The transverse shear deformation which is a predominant factor in the analysis of laminated composite structures is taken into account in developing the stiffness and mass matrices. The corresponding 3-D mode shapes are then incorporated to the multibody system dynamical equations. Floating body reference frames allow the selection of different boundary conditions, and the dynamical equations contain all the nonlinear interactions between the rigid and elastic motion. Example simulations are presented to illustrate the methods proposed.

*Assistant Professor, Member ASME, AIAA
†PhD, Member ASME