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DESIGN-ORIENTED STRUCTURAL ANALYSIS OF FILAMENT WOUND SHELLS USING EQUIVALENT PLATE METHODOLOGY

Abstract

During the conceptual design of filament wound shells (FWS's) e.g. thin-walled laminated composite beams and pressurized structures for advanced space system applications, many candidate configurations must be evaluated in multidisciplinary design trades to determine the characteristics of a candidate configuration that will best meet specified measures of overall performance. The FWS should be lightweight and have sufficient strength and stiffness necessary to satisfy all of the specified requirements. General-purpose finite element structural analysis codes are available to model and analyze the static and dynamic response of FWS's in great detail. However, such analyses often require substantive time to generate the finite element model, and repetitive analyses can be computationally expensive. With the objective of reducing design-cycle time, a design-oriented structural analysis capability for FWS's that utilize Equivalent Plate Methodology (EPA) is described. This new capability is very propitious to design optimization of FWS's. The paper focuses on the model definition of FWS's, the associated analytical formulation, and the approach used to couple the different shell analyses. The modeling approach used to minimize the amount of preparation of input data by the user and to facilitate the making of design changes is described. The FWS analysis is based on shell equations, but the procedure is formulated to be analogous to that used for plates. Connector springs are used to couple the different shell models constituting FWS's. Typical analysis results for FWS's is presented and compared with those from convention finite element analyses and tests to assess the accuracy of this analysis capability.