A NUMERICAL AND SUBSTRUCTURING ANALYSIS FOR DISCONTINUOUS THIN SHELLS OF REVOLUTION

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SUMMARY

A discrete structural analysis method is developed for efficiently and accurately predicting the linear (small deflection and elastic) static response of asymmetrically loaded, arbitrarily shaped, stacked and branched (discontinuous) thin shells of revolution. First, a numerical analysis is developed to provide a method of evaluating the deformations and stresses at interior locations of a continuous, layered-orthotropic, thin shell of revolution subjected to an arbitrary mechanical load vector. Second, a substructuring (stiffness) analysis is developed which enables a complex (discontinuous) shell structure to be completely analyzed by examining each of its continuous shell of revolution segments separately.

The numerical analysis is based on an energy formulation that utilizes Fourier series expansion and finite difference discretization techniques to ultimately define a system of linear difference equations which govern the linear static response of asymmetrically loaded, continuous, thin shells of revolution. An energy approach is also used to derive the expressions for the influence and fixed-edge coefficients (for each boundary of each shell segment that is a discontinuity in the complex shell structure), which are required to formulate the overall stiffness matrix and boundary constitutive relations arising in the substructuring analysis. Solution of the overall stiffness matrix leads to evaluation of each Fourier harmonic of a discontinuous shell structure on an individual (continuous) shell segment basis.

Since in the current method each continuous thin shell segment is examined separately and results in the repeated solution of relatively small matrix problems (in comparison to "single-pass" methods), the present analysis is much less sensitive to the discretization and round-off error and computer time and storage problems associated with "single-pass" methods (when analyzing discontinuous shell structures).