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NASA TECH BRIEF

Langley Research Center

Geometrically Nonlinear Static and Dynamic Analysis of Arbitrarily Loaded Shells of Revolution

The problem:

The design of many shell structures is influenced by the geometrically nonlinear response of the shell when subjected to static and/or dynamic loads. As a consequence, a number of investigations have been devoted to the study of the buckling phenomenon exhibited by shells. Most early works examine the behavior of the shallow spherical cap, the truncated cone, and the cylinder under axisymmetric loads.

The solution:

A computer program was developed for the geometrically nonlinear static and dynamic response of arbitrarily loaded shells of revolution. It was developed due to the lack of information on the axisymmetric response of shells with other meridional geometries and on the response of shells subjected to asymmetric loads.

How it's done:

The program can be used to analyze any shell of revolution for which the following conditions hold:

1. The geometric and material properties of the shell are axisymmetric, but may vary along the shell meridian.
2. The applied pressure and temperature distributions and initial conditions are symmetric about a datum meridional plane.
3. The shell material is isotropic, but the modulus of elasticity may vary through the thickness. Poisson's ratio is constant.
4. The boundaries of the shell may be closed, free, fixed, or elastically restrained.

The governing partial differential equations are based upon Sanders' nonlinear thin shell theory for the condition of small strains and moderately small rotations.

At each load or time step, an estimate of the solution is obtained by extrapolation from the solutions at the previous load or time steps. The sets of algebraic equations are repeatedly solved using Potter's form of Gaussian elimination, and the pseudo loads are recomputed, until the solution converges.

An automatic variable load incrementing routine is included in the program for the static analysis. Post-buckling behavior cannot be determined in the static analysis because of the method of solution employed.

The documentation contains a description of the theory, the method of solution, instructions for preparing the input data, and two sample problems to illustrate the data preparation and output format.

Notes:

1. This program is written in FORTRAN IV Level H to be used on the IBM-360/67 computer with 150K bytes of core. The program has also been successfully compiled on the CDC-6400 computer.
2. The dynamic analysis capability of this program is a recent extension of a program developed for the non-linear static analysis of arbitrarily loaded shells of revolution.
   (Reference computer program LAR-10736)
3. Inquiries concerning this program should be directed to:

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   112 Barrow Hall
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   Athens, Georgia 30601
   Reference: LAR-11109

Source: Robert E. Ball of
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