NASA TECH BRIEF

Marshall Space Flight Center

Computer Program for Numerical Analysis of Stiffened Shells of Revolution

The problem:

The use of shell theory to analyze structural problems usually involves complex mathematical and numerical techniques. These are nearly impossible to treat without the aid of automated systems.

The solution:

These programs use the Love-Reissner first-order shell theory method to assist in the numerical analysis of the shells of revolution. These programs can analyze orthotropic thin shells of revolution subjected to unsymmetric distributed loading or concentrated line loads and thermal strains, or they can perform stability or vibration analysis of thin shells of revolution subjected to axisymmetric distributed loading or concentrated line loads and thermal strains.

How it's done:

The shell wall cross section used can be a sheet, a sandwich, a reinforced sheet, or a reinforced sandwich. The reinforcement can consist of rings and/or stringers, a waffle construction rotated at any angle to the principal coordinates, or an isogrid construction. The reinforcement material properties can differ from those of the main shell, and a temperature variation can cause different properties in the two face sheets of the sandwich shell.

The basic approach to the problem is to cut the structure into several shell regions. These regions need to be singly connected shell sections and can only have line loads applied at their end points. There are no restrictions on geometry or uniform or thermal loads. The regions are subdivided into several shell segments, each being free to have its own geometric shape, provided the shape falls into one of the categories mentioned below. Stiffness matrices obtained for each segment are coupled by standard matrix methods to obtain region stiffness, which, after being reduced in size, are in turn coupled to form the total shell structure under analysis.

The shells that can be analyzed with these programs can consist of any combination of the following nine geometric shapes:

1. Ellipsoidal/spherical
2. Ogival/toroidal
3. Modified ellipse shape
4. Conical/circular plate
5. Cylindrical
6. General point input geometry
7. Dummy geometry slot to be filled by the user
8. Discrete ring
9. Elastic support

Notes:

1. This program was written in FORTRAN V for the UNIVAC 1100-series computer.
2. Inquiries concerning this program should be directed to:

   COSMIC
   112 Barrow Hall
   University of Georgia
   Athens, Georgia 30601
   Reference: MFS-23027

Source: J. Key
Marshall Space Flight Center and
V. Svalbonas of
Grumman Aerospace Corp.
under contract to
Marshall Space Flight Center
(MFS-23027)

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