AEC-NASA TECH BRIEF

Finite Element Analysis of Compressible Solids with Nonlinear Material Properties

The potential widespread use of this program should be of interest to many engineers since the procedure used may be applied to structures of many different materials of practically any geometry.

The problem:

To solve for the state of stress and strain in a revolving solid which may have arbitrary geometry, loading, or boundary conditions. The analysis should extend into the plastic region.

The solution:

Using the direct stiffness approach, a finite-element computer program is written which solves for nodal point displacements in an axisymmetric solid.

How it's done:

The finite-element method is applied to the determination of displacements and stresses within plane or axisymmetric solids with linear or nonlinear material properties.

The continuous body is replaced by a finite number of discrete triangular or quadrilateral elements interconnected at joints or nodal points. Approximations are developed relative to the behavior of any one element and applied to the solution of the continuous structure. Equilibrium equations, in terms of unknown nodal point displacements, are developed at each nodal point and the solution of this set of equations constitutes a solution to the system.

The stress in the solid is found from the displacements at the nodes. The options in the program include axisymmetric solids analysis, plane stress analysis, nonlinear (plastic) analysis, and equivalent stress and strain (according to the Von Mises yield condition).

Advantages of the finite-element method compared to other numerical approaches include the following:

1) The method is completely general with respect to geometry and material properties.

2) Complex bodies composed of many different materials are easily represented.

3) Since anisotropic materials are automatically included in the formulation, filament structures are readily handled.

4) Displacement or stress boundary conditions may be specified at any nodal point within the finite-element system.

5) Arbitrary thermal, mechanical, and accelerational loads are possible.

6) In addition, the finite-element approach provides equilibrium equations which produce a symmetric, positive-definite matrix which may be placed in a band form and solved with a minimum of computer storage and time.

Notes:

1. This program is written in FORTRAN H for use on the IBM 360/65 system.
2. Inquiries should be made to:

   COSMIC
   Computer Center
   University of Georgia
   Athens, Georgia 30601
   Reference: B69-10238

Patent status:

No patent action is contemplated by NASA.

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