NASA TECH BRIEF

Marshall Space Flight Center

Program for Analysis of Nonlinear Equilibrium and Stability (PANES)

The problem:

Better methods were needed to assist in the analysis of structures with material and geometric non-linearities.

The solution:

A computer program, PANES (Program for Analysis of Nonlinear Equilibrium and Stability), was developed to utilize improved techniques for the analysis of structures with material and geometric nonlinearities, including the limit point and bifurcation behavior which occurs in buckling and collapse problems.

How it's done:

The methods used in this program are: (a) incremental loading; (b) Newton-Raphson iteration and its modifications, involving periodic updating of the Jacobian matrix; and (c) higher order methods, including various orders of predictor and corrector algorithms. In order to make current methods applicable to cases of large strain and arbitrary nonlinear materials, the equation generation process is accomplished in the present work by a finite-difference expansion procedure. It is found that the generation of the nonlinear equations by this means, within a perturbation context, provides a unifying basis for the definition of the nonlinear solution terms, including as special cases the first-order Newton-Raphson and incremental-loading methods, as well as an almost unlimited variety of higher-order solution techniques. The perturbation procedures have the advantage of a sound theoretical basis in classical developments and lend themselves readily to both limit-point and postbuckling problems, as well as to simple nonlinear behavior without critical points.

Notes:

1. This program was written in FORTRAN IV for the IBM 370 computer.
2. Inquiries concerning this program should be directed to:
   COSMIC
   112 Barrow Hall
   University of Georgia
   Athens, Georgia 30601
   Reference: MFS-23172

Source: R. G. Vos of
The Boeing Aerospace Co.
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