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Computer Program Simplifies Design of Rotating Components of Turbomachinery

The problem:

In designing rotating axisymmetric turbomachinery components that are subject to varying conditions of temperature, pressure, and load, it is necessary to perform a stress analysis of each design. The stress for each component must be known for normal operating conditions and the speed at which the component will completely fail must also be known. These stress and "burst speed" calculations are difficult if not impractical to perform manually.

The solution:

A digital computer program to perform stress analysis and burst speed calculations on axisymmetric solids. The program produces an easily followed print record containing the displacement of each nodal point of each finite element, the stresses at the center of each finite element, the approximate fundamental frequency of the component, the approximate weight of the component, the average tangential stress within the component and the burst speed.

How it's done:

To use the program the axisymmetrical component is first divided into many finite cylindrical elements. Each nodal point of the element is identified by its distance from the axis of rotation and a reference plane perpendicular to the axis of rotation. Each element is identified by its nodal point identification number. A data deck containing this information together with temperature, load and displacement condition at each nodal point, the angular speed, the pressure at the component boundaries, and the material properties are entered into the computer.

The computer analysis of solids uses a method of successive approximations to solve problems with nonlinear material properties. The procedure is based on the repeated solution of a series of linear problems in which the loads and material stiffness are successfully redefined using the results of the previous solution. The burst speed calculation is achieved by two calculations. The first is perhaps the most basic form of limit analysis for rotating axisymmetric bodies and is concerned only with the effects of rotation. The second calculation is simply the weighted average tangential stress due to any or all of the effects of pressure, temperature, rotation, and acceleration. This second calculation cross-checks the basic program and the calculation of burst speed and provides a comparison of the average tangential stress due to rotation and the average tangential stress due to other effects.

Notes:

1. The program is written in Fortran IV language for use on the IBM 7094 computer.
2. The computer printout consists of all the input, the displacement of each nodal point, the stress at the center of each element, the approximate fundamental frequency of the component, the average tangential stress due to rotation only, the average tangential stress due to rotation, temperature, and pressure, and the burst speed.
3. This program will be particularly useful to a designer of rotating machinery.
4. Inquiries concerning this program may be directed to:

   COSMIC
   Computer Center
   University of Georgia
   Athens, Georgia 30601
   Reference: B67-10235

(continued overleaf)

Patent status:

No patent action is contemplated by AEC or NASA.

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