NASA TECH BRIEF

Lewis Research Center

RETSCP - A Computer Program for Analysis of Rocket Engine Thermal Strains with Cyclic Plasticity

The Problem:

High performance liquid rocket engines cause high chamber pressures which result in high heat flux levels. With the requirement of thermal and pressure cycling, the stress analyst must be able to define the life potential of a given design, considering cyclic fatigue where chamber wall stresses are sufficiently high to cause plastic strains.

The Solution:

A computer program has been developed for the analysis of rocket engine thermal strains with cyclic plasticity.

How It's Done:

RETSCP is a finite element program which employs a three-dimensional isoparametric element. The isoparametric element is a very complex element which leads to accurate results with a course structural model. The finite element method is a procedure for approximating a continuum by an assembly of distinct elements having a finite number of unknowns. For structural analysis, this amounts to solving the force displacement equations for the element assembly subject to prescribed boundary values.

One of the equations to be solved represents the relationship between forces and displacements at nodal points in the structure and the master stiffness matrix for the assembly. The force and displacement boundary conditions are used to solve for the stiffness matrix. Boundary conditions include stress boundary conditions, prescribed boundary conditions, and symmetry conditions. The mathematical treatment is such that the stress boundary condition is automatically satisfied since forces at nodes on a free surface are zero in the normal direction. Prescribed boundary force values are treated by making substitutions in the force vector of the equations. The symmetry plane is often skew with respect to the physical coordinate axis so a transformation is derived to treat skew boundary conditions.

The method of solution in RETSCP is to solve the set of governing equations by Gaussian elimination. The master stiffness matrix is partitioned in the interest of computational efficiency. The governing equations are treated as matrix equations in terms of submatrices.

Notes:

1. The program is written in FORTRAN IV for the IBM 7094 computer.
2. Inquiries concerning this program should be directed to:

   COSMIC
   Information Services
   112 Barrow Hall
   University of Georgia
   Athens, Georgia 30602
   Reference: LEW-12388

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