

ELASTIC AND INELASTIC ANALYSIS OF FORGED TEE JOINTS BY THE FINITE ELEMENT METHOD

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SUMMARY

A series of computer programs for the stress and thermal stress analysis of forged tee joints to American standard B16.9 is described, and typical results are presented.

The tee joints may vary substantially in thickness and shape, and have complex forms which are not defined mathematically. An eight node three-dimensional isoparametric finite element was found to have suitable characteristics for joints with a wide range of thicknesses, and was incorporated into the program. To reduce the data preparation effort, a means of describing the joint as shallow cones joined by a variable radius transition was devised, and an automatic mesh generation procedure developed.

The following programs have been developed (1) elastic stress analysis; (2) transient heat flow analysis; (3) thermal stress analysis; and (4) inelastic stress analysis assuming linear kinematic strain hardening. A program for inelastic stress analysis assuming a non-linear isotropic strain hardening is near completion.

The features of the programs for elastic and inelastic stress analysis are described, with emphasis on the inelastic analysis. The automatic mesh generation procedure is reviewed, and the problem of accounting for different conditions of loading symmetry or antisymmetry in both elastic and inelastic analysis are considered. The iterative technique used to solve the inelastic analysis problem is described. The inelastic analysis program includes provision for arbitrary combinations of specified loads and displacements to be applied to the connected pipes, in addition to internal pressure. Cyclic loads may also be applied. The procedures for specifying loads and displacements are explained, and the computational advantages of specifying displacements rather than loads are emphasized. The results of typical elastic and inelastic analysis are presented.

