

## EFFECTIVE ELASTIC CONSTANTS FOR PERFORATED PLATES WITH SQUARE PENETRATION PATTERNS

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### SUMMARY

In the determination of effective elastic constants for perforated plates, most of the analytical procedures are restricted to thin or thick plates where a state of plane stress or generalized plane strain can be assumed. Perforated plates of moderate thickness often constitute a very difficult problem in three-dimensional elasticity. Most of the analytical methods become impractical and little information is yet available in the literature. The Welding Research Council is currently attempting to define "thin" and "thick" perforated plates and the effective elastic constants which should be used for perforated plates in the transition region.

The purpose of this presentation is to introduce a unified procedure which can be used for the determination of effective elastic constants for perforated plates of arbitrary thickness. Perforated plates with a square penetration pattern of circular holes are considered for in-plane and bending conditions. The effective elastic constants are determined by a three-dimensional finite-element analysis made on a typical cell unit of the square penetration pattern. Perforated plates with square penetration patterns are known to be anisotropic and the effective elastic constants are generally expressed in terms of Young's modulus and Poisson's ratio in the pitch and diagonal directions.

Numerical results were generated for plates whose ligament efficiencies varied from 0.1 to 0.4 and the plate thickness to pitch ratios ranged from 0.15 to 4.0. The results of the analyses show that the effective elastic constants for bending and in-plane loading are generally different except for thick plates where a state of generalized plane strain, as suggested by Slot and O'Donnell, can be assumed. As the plate thickness decreases, the bending and in-plane elastic constants deviate and asymptotically approach the plane stress values for thin plates obtained by Meijers.

For a given perforated plate having a square penetration pattern of holes, four simple computer runs are needed for the determination of the effective elastic constants. In these runs uniform extension and uniform rotation is applied in both the pitch and diagonal directions. The stress results obtained from the analysis will also serve as a basis for the future stress evaluation.

The three-dimensional finite element procedure provides a simple and convenient method for the determination of the effective elastic constants for perforated plates of arbitrary thickness. The computational procedures are general and can be extended to perforated plates of any perforation patterns and hole shapes.