Accepted Manuscript

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PII: S0997-7538(17)30534-X

DOI: 10.1016/j.euromechsol.2017.09.011

Reference: EJMSOL 3496

To appear in: *European Journal of Mechanics / A Solids*

Received Date: 8 July 2017

Revised Date: 25 September 2017

Accepted Date: 26 September 2017

Please cite this article as: Zeng, X.-t., Lu, A.-z., Zhang, N., Analytical stress solution for an infinite plate containing two oval holes, *European Journal of Mechanics / A Solids* (2017), doi: 10.1016/ j.euromechsol.2017.09.011.

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Analytical stress solution for an infinite plate containing two oval holes

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ABSTRACT: The problem refers to an elastic infinite plate bounded by two oval holes, which is subjected to uniform surface tractions on the boundary of the holes and uniform tension and shear stress at infinity. By looking for a new mapping function, the considered region is conformally mapped onto an annulus, and a complex variable method is used to obtain the stress solution. The problem that an elastic infinite plate contains two circular holes or a circular hole and an oval hole is the special case of this article. The present solution has been validated by both published solutions for special cases and ANSYS software. Some computational examples are given to investigate the effects of the separation distance of the two holes, relative ratio of applied stresses, surface tractions on the boundaries, the size of a hole and shear stress at infinity on the stress distribution of the hole boundaries. Practical significance of the solution is placed in the fact that it could be used as a quick-solver with high accuracy.

Keywords: elastic infinite plate; two oval holes; complex variables; analytical stress solution

1. Introduction

For plate structural components that contain holes under the action of external loads, there is often a greater stress concentration around the holes. Therefore, accurately calculating the stresses at the edge of the holes plays an important role in evaluating the stability of the structure and reinforcing the structure. A comprehensive treatise on the problem of stress concentration around holes was compiled by Savin (1961).

While the size of a plate is large, it can be assumed to be an infinite plate and we can simplify it as a two-dimensional infinite domain problem. If a thin plate is loaded by forces applied at the boundary, parallel to the plane of the plate and distributed uniformly over the thickness, it is a plane stress problem. It is a plane strain problem while the dimension in the axial direction of the hole is larger and the strain is zero. It is a simply connected region problem when the plate contains only one hole and a multiply connected region problem when the plate contains two or more holes.

It is much more difficult to solve a multiply-connected region problem than a simply connected region problem. Still, many scholars have used various methods, such as the bipolar coordinate method, the stress function method, the complex variable method, and the Schwarz alternating method to solve multiply connected region problems.

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