Stress Characterization in Thick Walled Cylinders with Elliptical Cross-Bores

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A thesis submitted in partial fulfillment for the Degree of Master of Science in Mechanical Engineering in the Jomo Kenyatta University of Agriculture and Technology

2009

ABSTRACT

An investigation was conducted to determine the elastic stress profiles in a thick walled closed ended cylinder with a radial elliptical cross-bore. The orientation of the elliptical cross-bore with respect to the cylinder axis was varied. Various crossbore to cylinder bore radius ratios were investigated. Investigations were also done for various geometries of the elliptical cross-bore.

The aim of this research was to determine the stress profiles and stress concentration factors in the vicinity of an elliptical cross-bore with regard to changing orientation of the cross-bore. The research was also aimed at determining stress trends when the cross-bore geometry was changed.

Investigations were done by computer simulation. An elastic three-dimensional finite element method computer programme in FORTRAN code was developed.

The displacement formulation was used. Cylinder geometries of thickness ratios *k=2.0*, *k=2.25* and *k=2.5* were considered. Cylinder length was taken to be 9 times the wall thickness. The cross-bore was positioned at the centre of the cylinder to avoid any end effects. The Bauschinger effect was ignored.

The results obtained showed that the maximum stress concentration factor was experienced when the major axis of the elliptical cross-bore lay in the meridional plane, whereas, the minimum stress concentration factor was experienced when the major axis of the elliptical cross-bore lay in the transverse plane.

For an elliptical cross-bore of cross-sectional area equivalent to that of a circular cross-bore of cross-bore to cylinder bore radius ratio of 0.15, the stress concentration factor (SCF) was a constant at 2.1 for angle of rotation (AOR) of 74.5° for semiminor axis to semi-major axis ratio (*b/a*) between 0.3 and 0.7. For an elliptical crossbore of cross-sectional area equivalent to that of

a circular cross-bore of cross-bore to cylinder bore radius ratio of 0.20, the SCF was a constant at 2.1 for AOR = 73° for *b/a* between 0.3 and 0.7. For an elliptical cross-bore of cross-sectional area equivalent to that of a circular cross-bore of cross-bore to cylinder bore radius ratio of 0.25, the SCF is a constant at 2.1 for AOR = 72.5° for *b/a* between 0.3 and 0.7.

The results obtained from this research give details on the stress profiles and SCF that arise for a radial elliptical cross-bore at any orientation with respect to the cylinder axis. These results form a good basis for re-evaluating existing data for design of cylinders with elliptical cross-bores. The program developed can be commercialized and used to collect further data for design.