Investigating the Three-Dimensional Effect on Crack Growth Behavior in an Incompressible Material

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Objective:

- Investigate the effect of crack location on the crack growth behavior in centrally perforated cylinders under internal pressure.
Specimen Dimensions and Crack Locations

length of cylinder 376 mm

* Path of crack to maximum depth
Fringe Patterns Near Critical Loci at Fin Tip
Contour Plot of Stress $\sigma_{yy}$
(No Crack)
Two-Dimensional Crack Growth Tests

A

B
Two-Dimensional Crack Growth Tests

A
Crack initiated at the center of the fin

B
Crack initiated at the corner of the fin
Typical Off-Axis Inclined Crack Which is Perpendicular to the Fin Surface

D – camera view of the photograph

FS – fin surface
C – crack front

S

Eliminating shear mode
Starter crack
Eliminating shear mode

Section S - S

magnification factor 3.68
Stress Distribution at Crack Tip

growth modes at crack tip

I = Normal Stress (Mode I)
II = In-Plane Shear (Mode II)
III = Out-of-Plane Shear (Mode III)
Typical Off-Axis Straight Crack Which is Parallel to the Fin Axis

Section S-S

Fin surface
C - crack front
D - camera view of the photograph

Magnification factor: 1.73
Typical Symmetric Crack Which is Near the Fin Axis

\[ a_0 \text{ - initial crack} \]
\[ a \text{ - final crack} \]
Conclusions:

- When the crack is perpendicular to the fin surface, a significant three-dimensional effect occurs during crack turning.
- During crack turning, normal mode (Mode I) and shear modes (Mode II and Mode III) are developed at the crack tip.
- After the crack turning process is completed, the crack grows under normal mode (Mode I loading).
- When the crack is parallel to the fin axis, there is no crack turning observed and the crack grows under normal mode only.
- Crack turning induces a significant reduction in crack growth rate.