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

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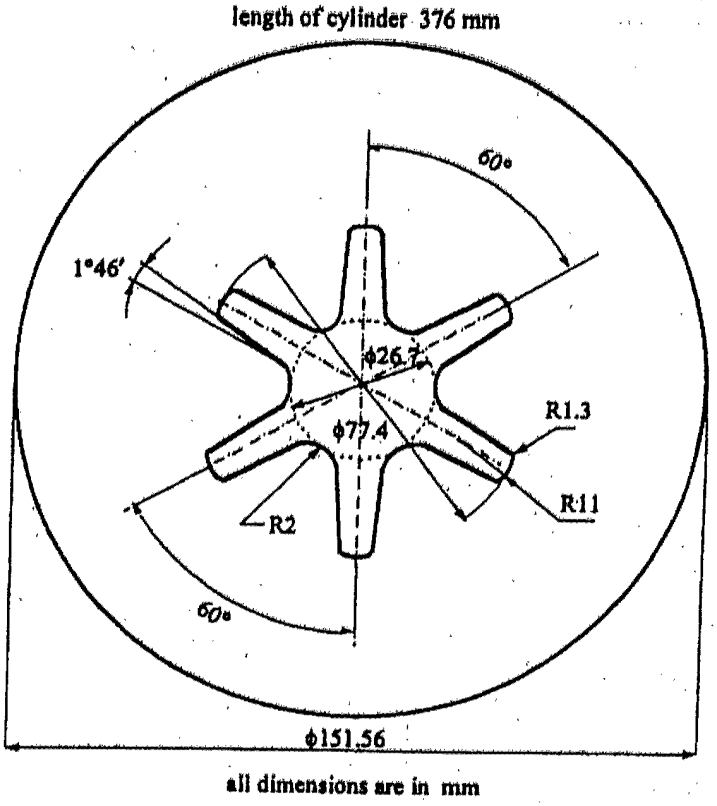
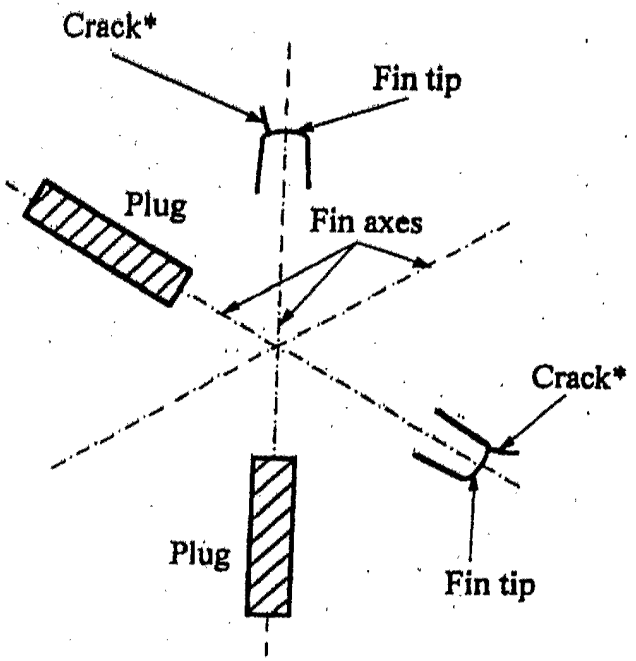
Objective:

- Investigate the effect of crack location on the crack growth behavior in centrally perforated cylinders under internal pressure.

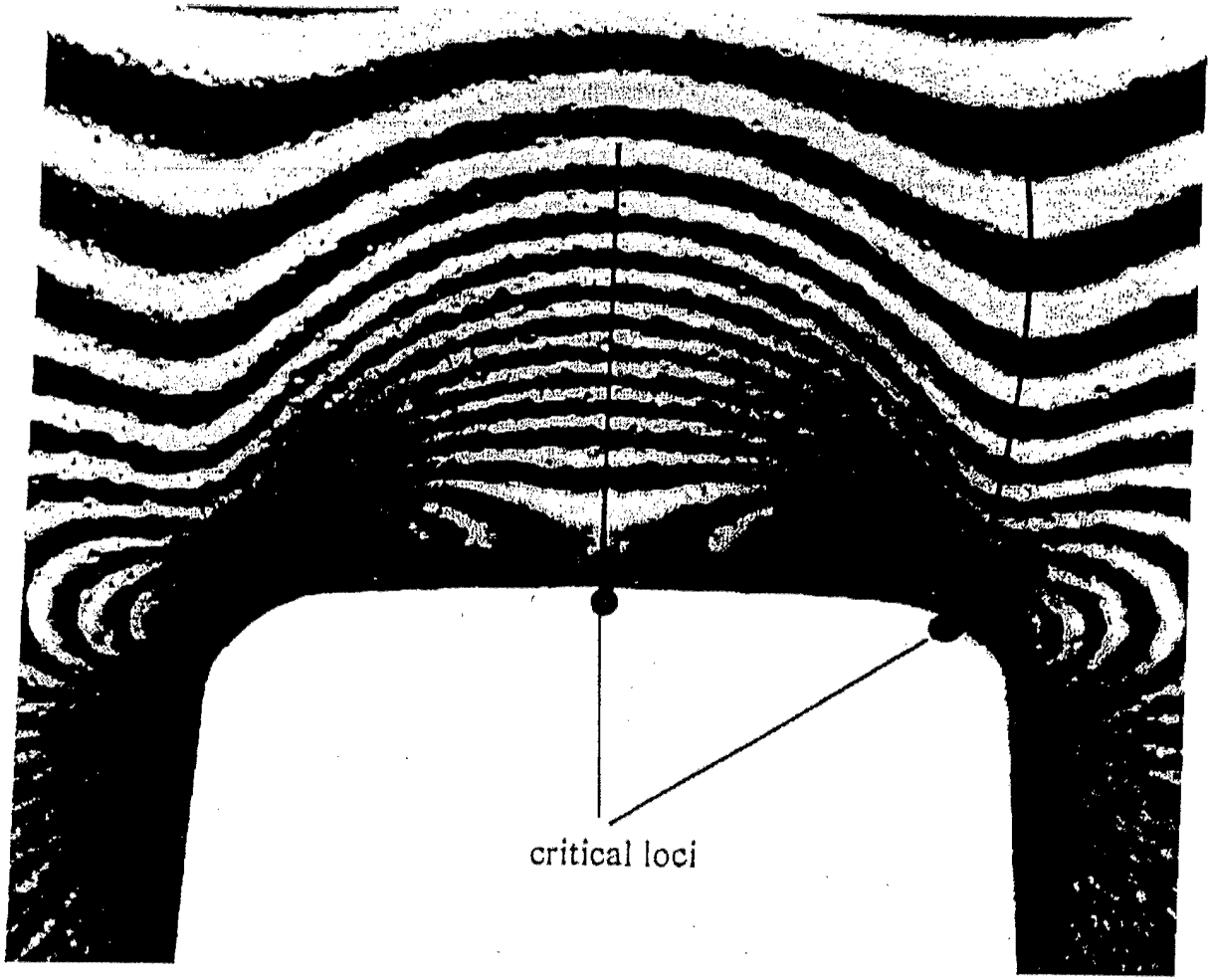
Specimen Dimensions and Crack Locations



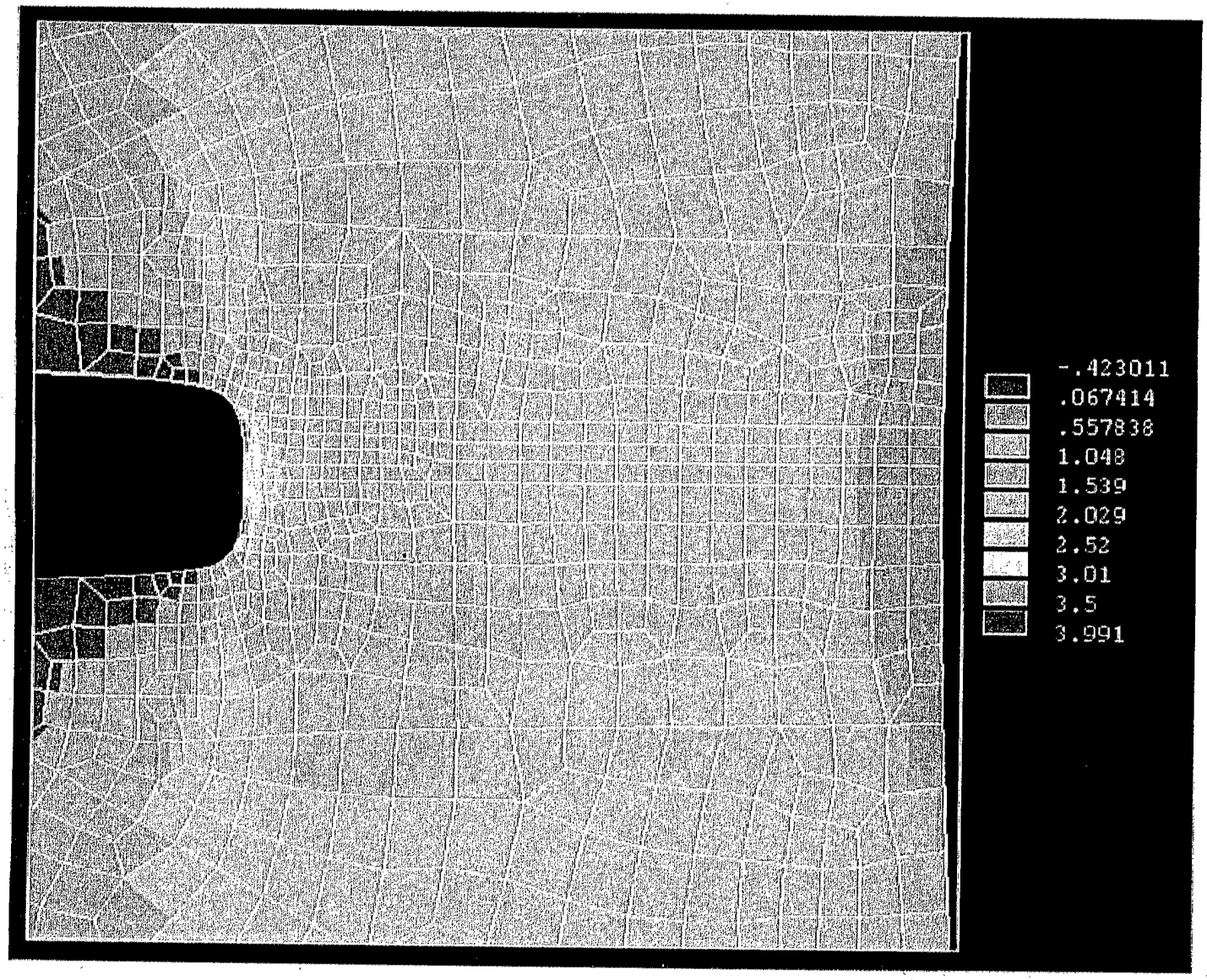


* Path of crack to maximum depth

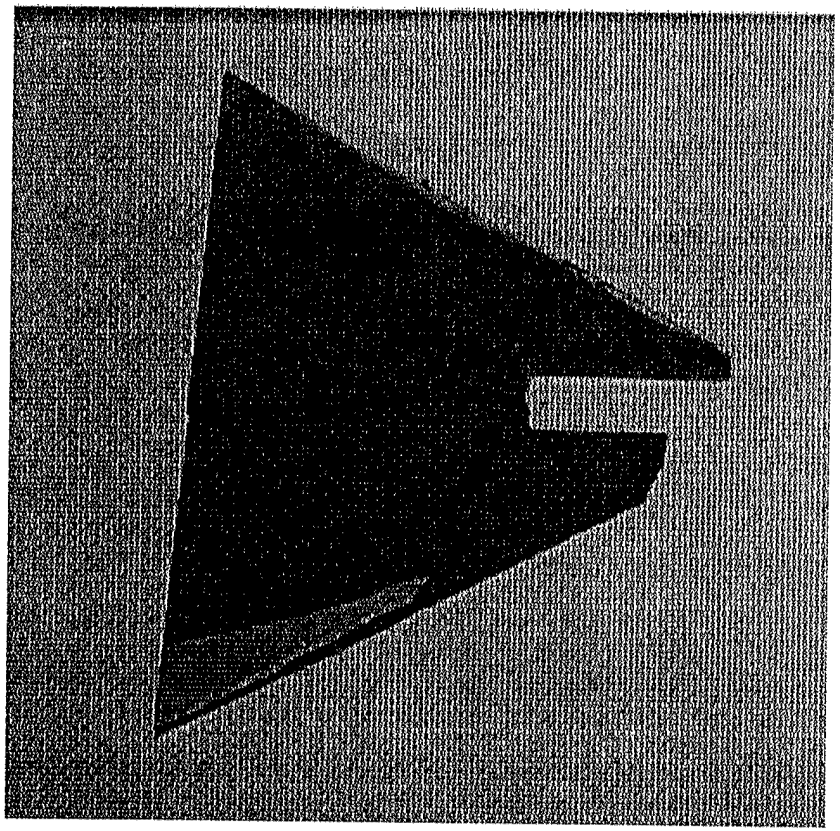
Fringe Patterns Near Critical Loci at Fin Tip



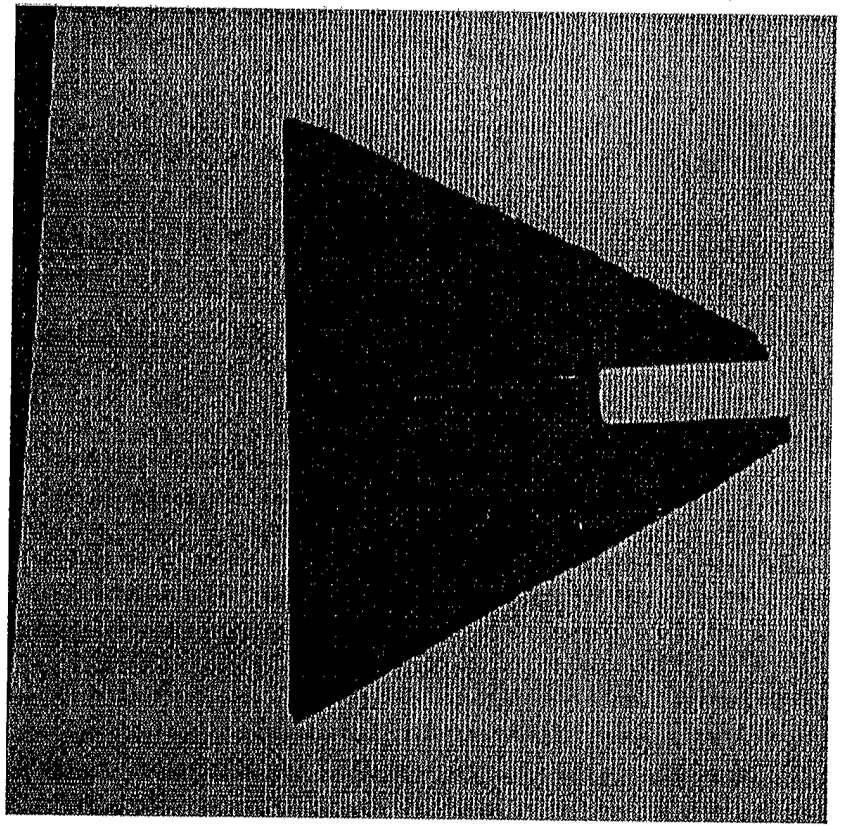
Contour Plot of Stress σ_{yy}
(No Crack)



Two-Dimensional Crack Growth Tests

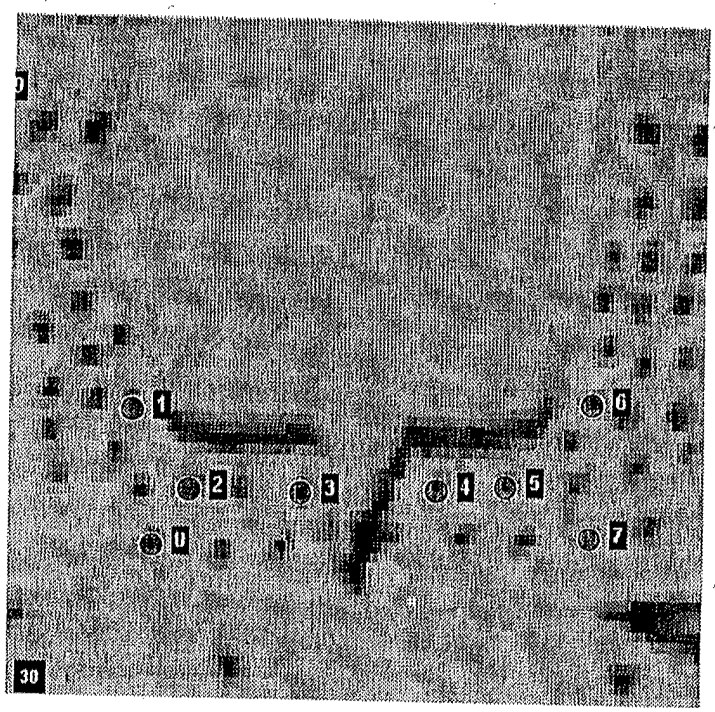


A



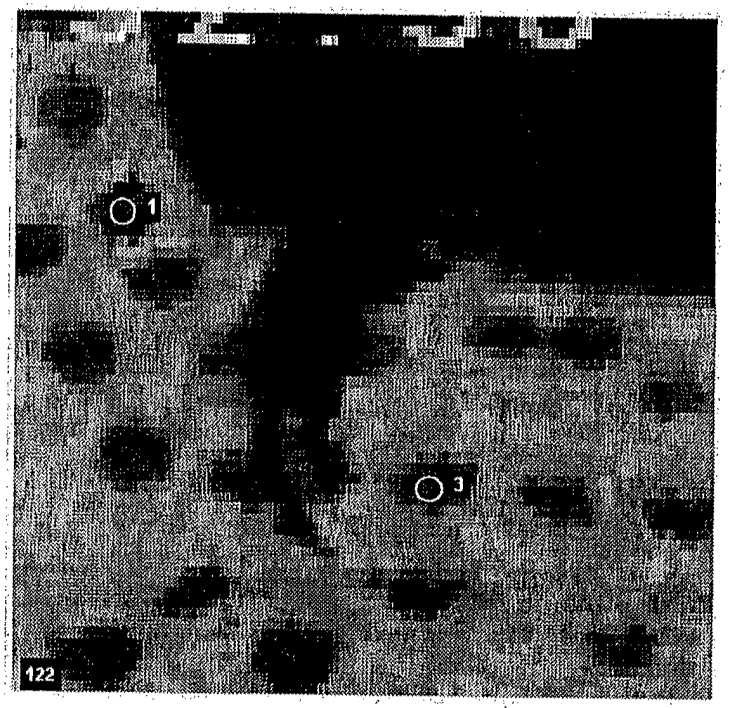
B

Two-Dimensional Crack Growth Tests



A

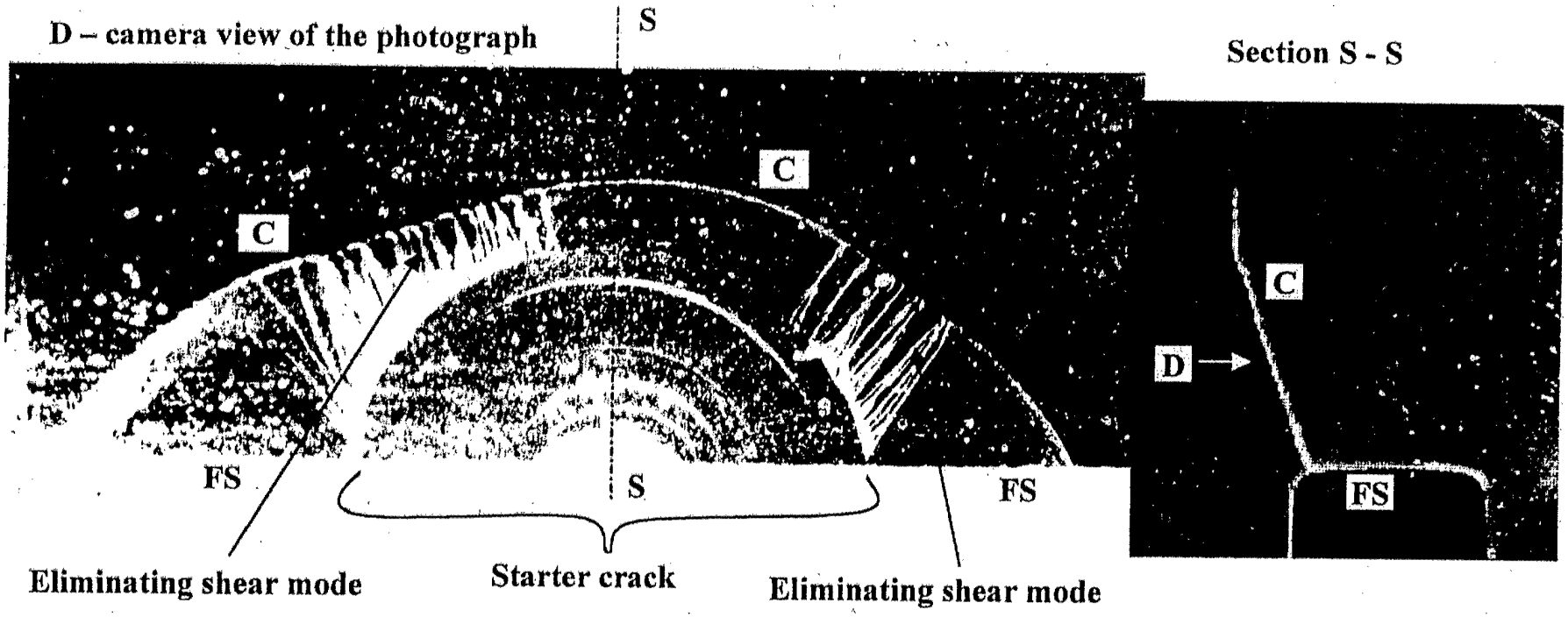
Crack initiated at the center of the fin



B

Crack initiated at the corner of the fin

Typical Off-Axis Inclined Crack Which is Perpendicular to the Fin Surface

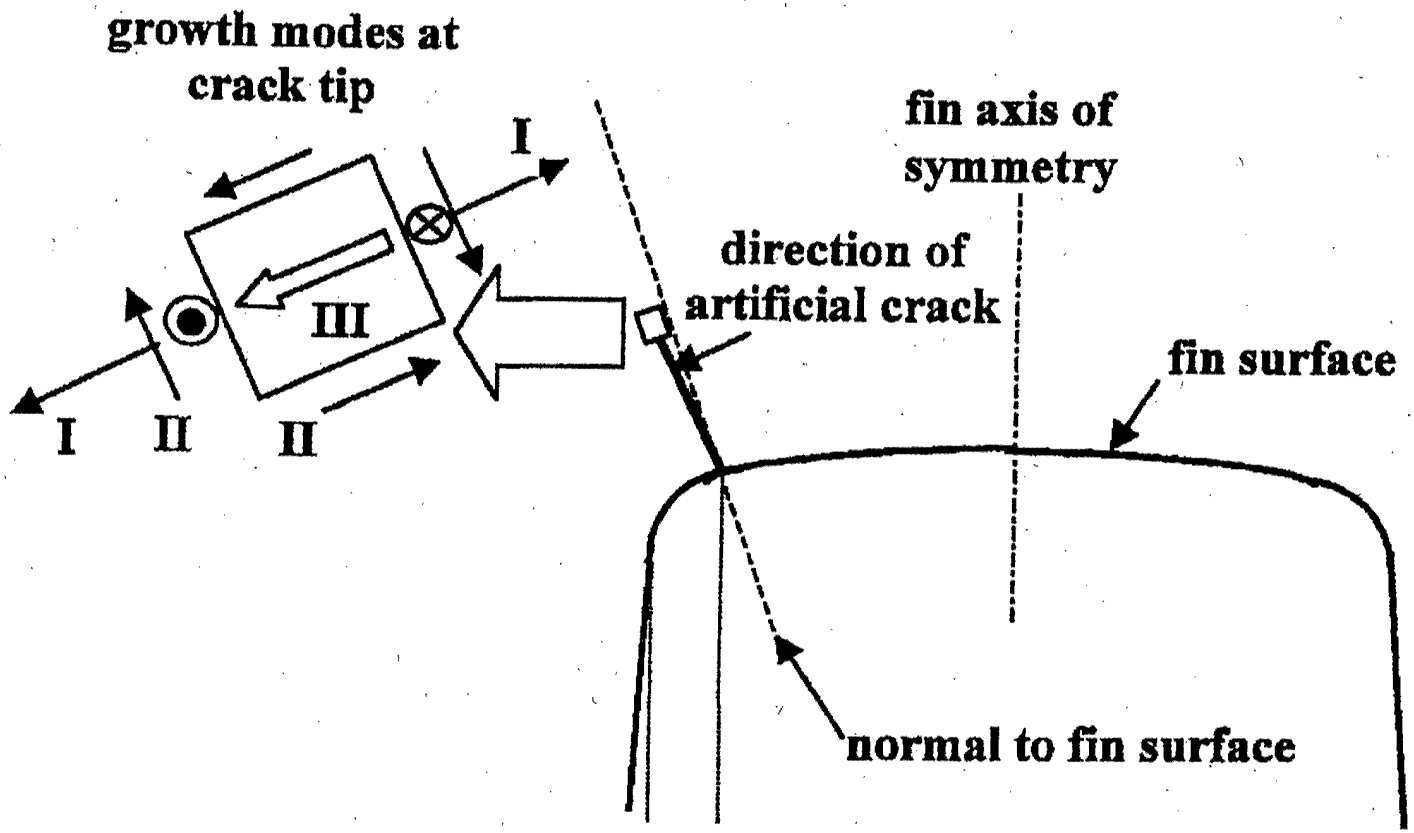


FS – fin surface

C – crack front

magnification factor 3.68

Stress Distribution at Crack Tip



I = Normal Stress (Mode I)

II = In-Plane Shear (Mode II)

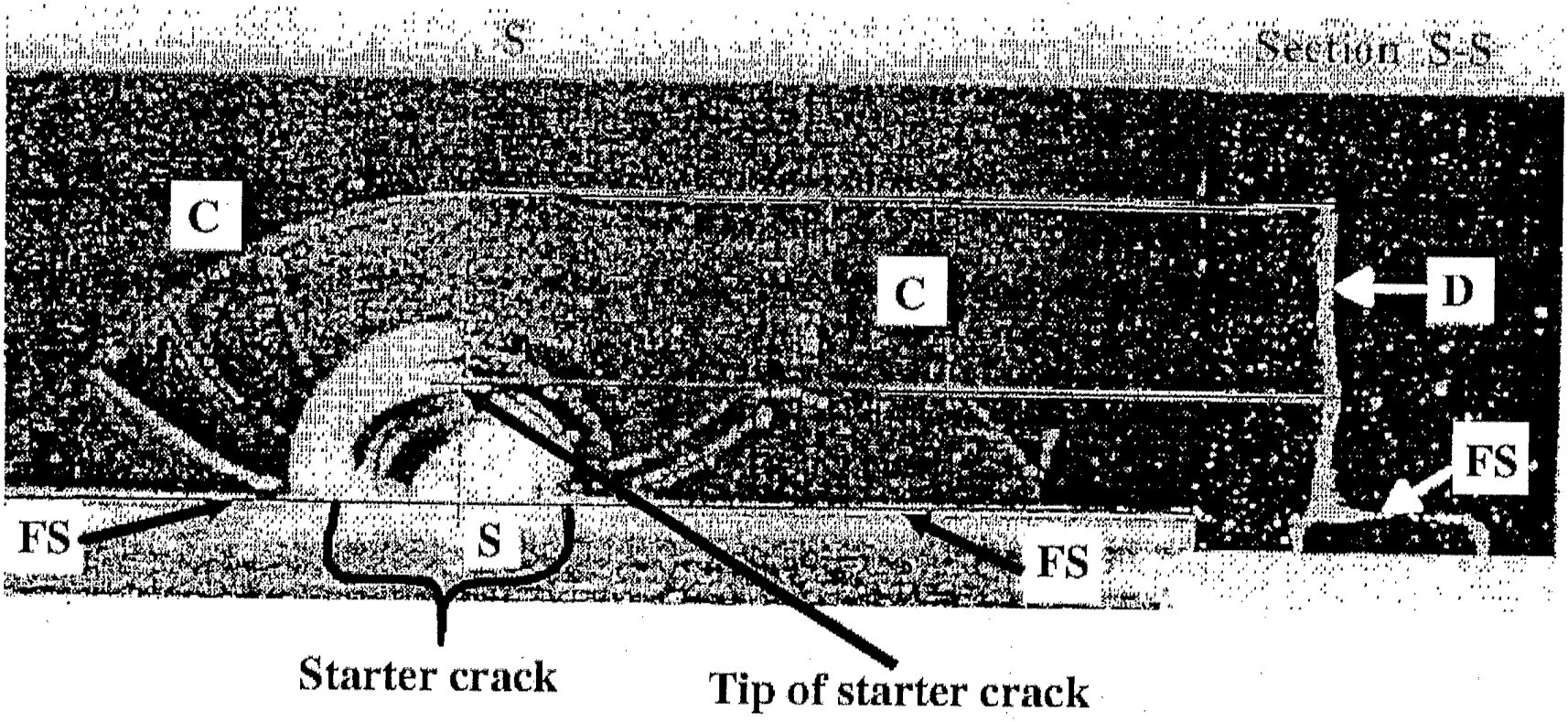
III = Out-of-Plane Shear (Mode III)

Photoelastic Fringe Patterns

Crack Turning
Completed

Crack Turning
Incomplete

Typical Off-Axis Straight Crack Which is Parallel to the Fin Axis



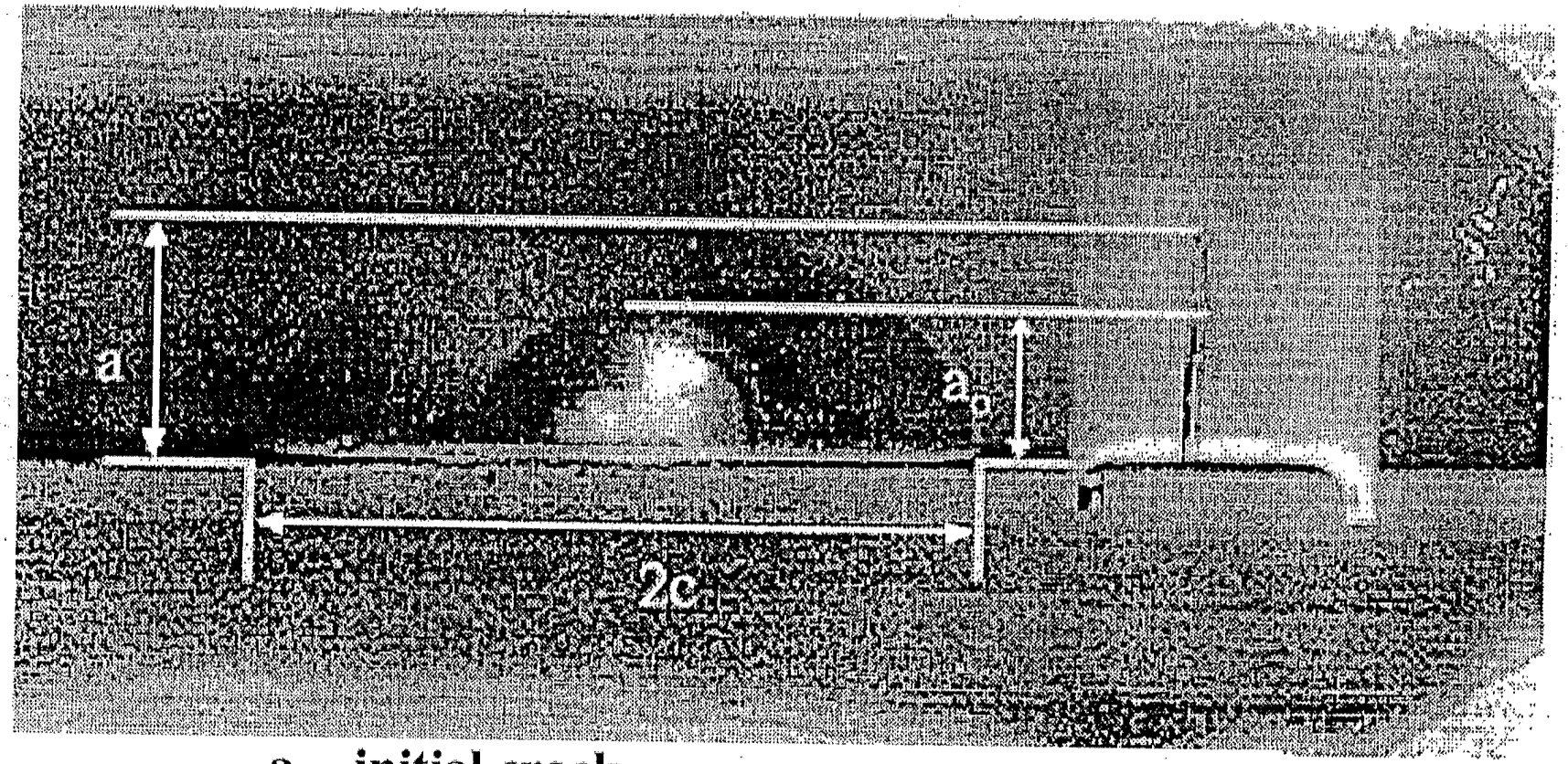
Fin surface

C - crack front

D - camera view of the photograph

Magnification factor: 1.73

Typical Symmetric Crack Which is Near the Fin Axis



a_0 - initial crack

a - final crack

M.F 2.52

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.