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MEMORANDUM FOR PRS (In-House/Contractor Publication)

FROM: PROI (STINFO)

08 Mar 2001

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-VG-2001-049**
Liu, C.T., "Predicting the Initial Crack Length in a Solid Propellant" (VuGraphs)

JANNAF 34th Structures & Mechanical Behavior Subcommittee Meeting
(Cocoa Beach, FL, 26-30 Mar 2001) (Deadline: 22 Mar 2001)

(Statement A)

Predicting the Initial Crack Length in a Solid Propellant



Dr. C. T. Liu

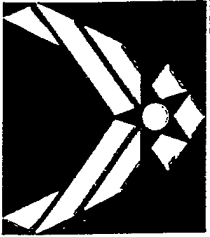
Air Force Research Laboratory

Dr. Y. G. Kwon

Naval Postgraduate School

T. L. Hendrickson

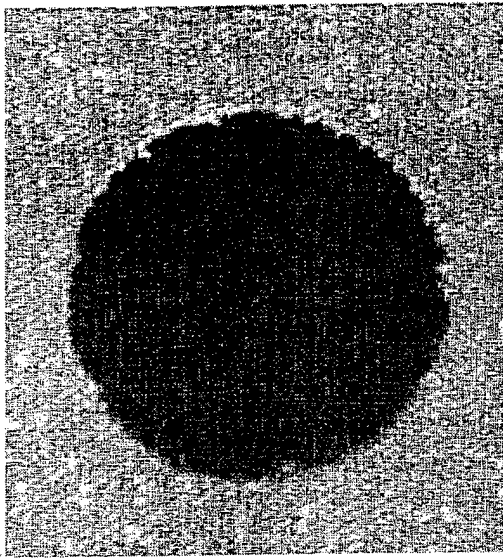
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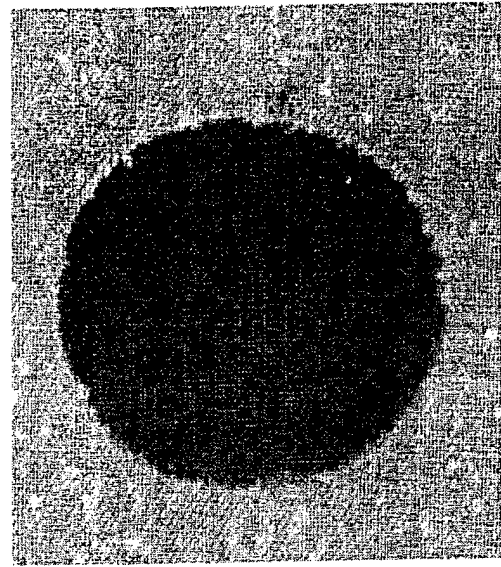
Objective



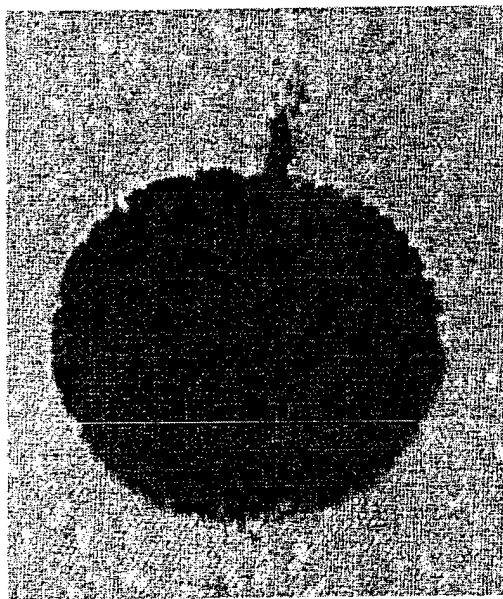
- Predict the Initial Crack lengths in High Stress Regions in a Solid Propellant



(a)



(b)



(c)

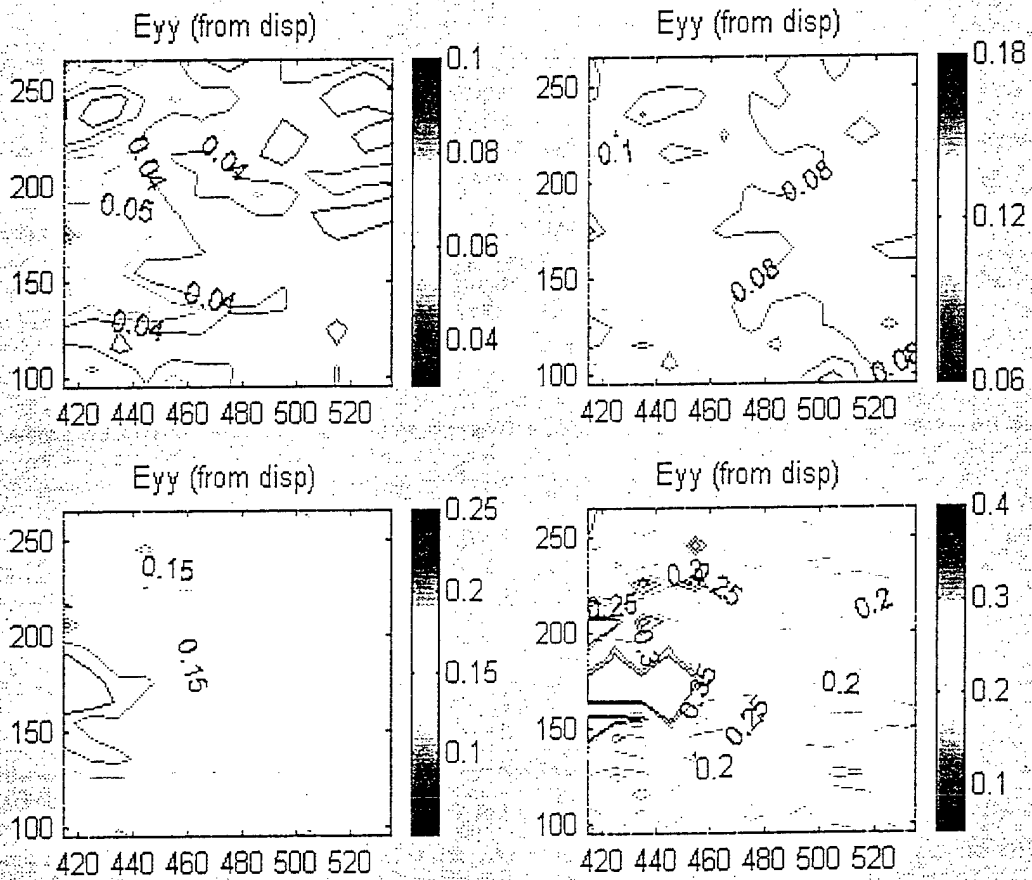


(d)

Figure Formation of Initial Cracks at the Notch Tip: Increase in Applied Load from (a) to (d)

Contour Plots of Normal Strain in the Vertical Direction (ϵ_{yy})
(Obtained from displacement fields)

Video 1



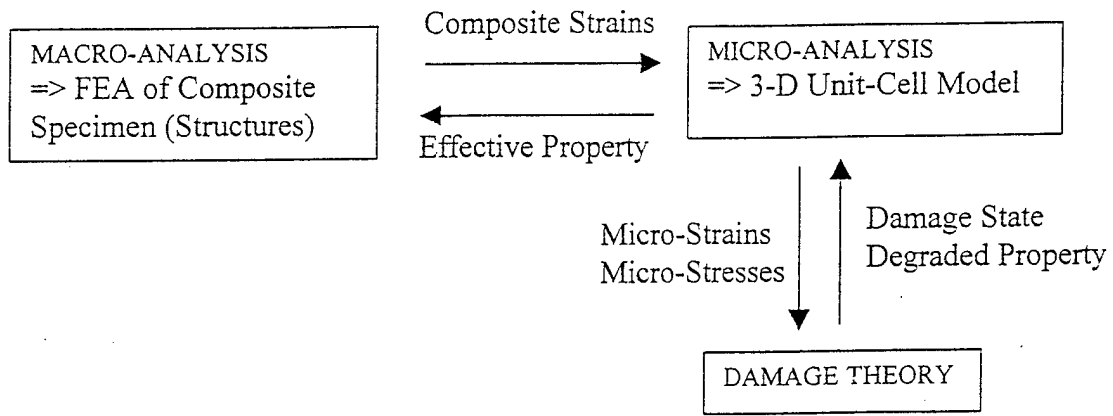


Figure . Interaction between Micro-analysis and Macro-analysis

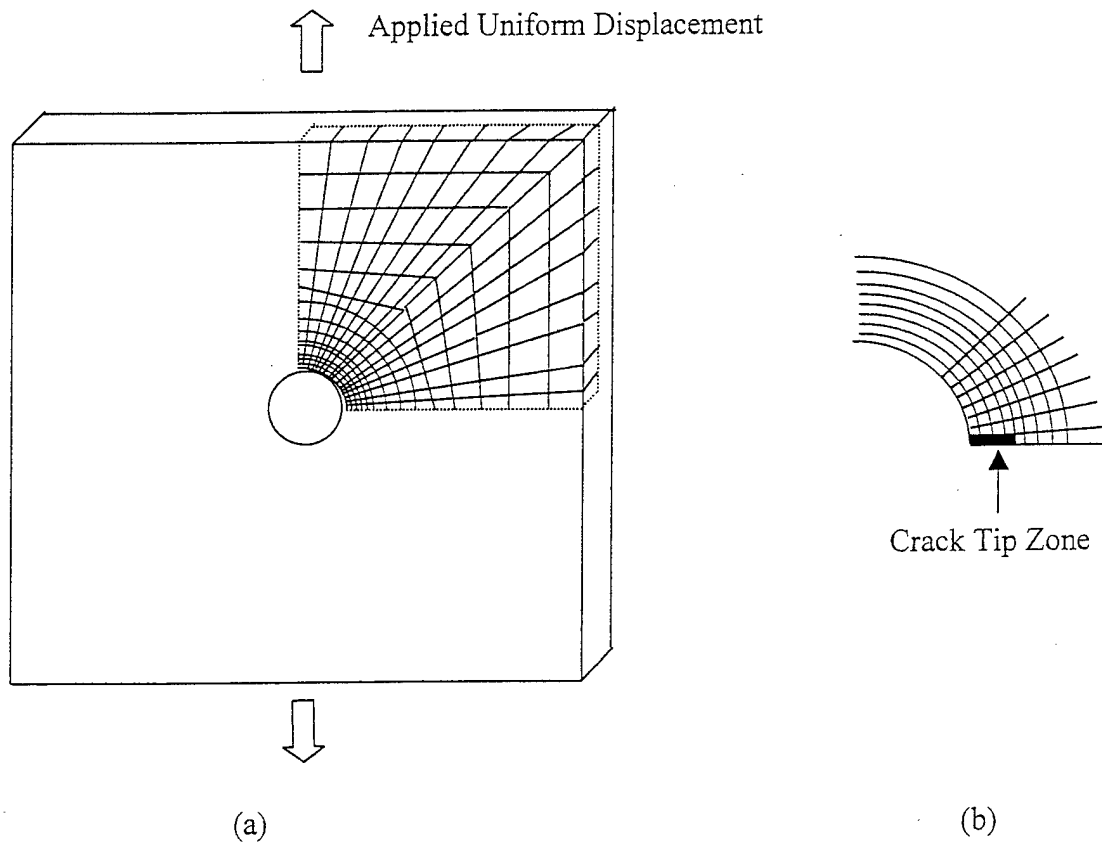
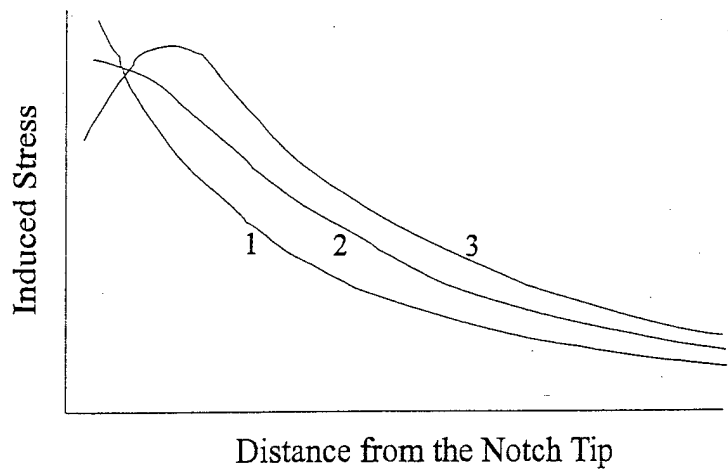
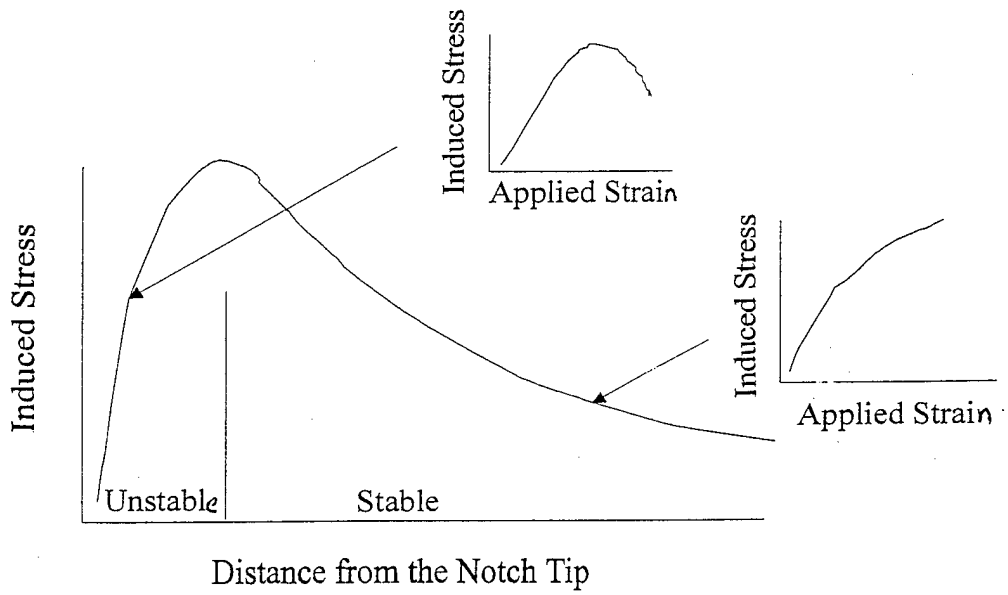


Figure Specimen Geometry and Finite Element Mesh: (a) Plate of 76.2 mm x 76.2 mm x 6.35 mm with a hole of radius 6.35 mm, (b) Enlarged View near the Notch Tip



(a)



(b)

Figure Stress Distribution along the Minimum Section from the Notch Tip as a function of damage: (a) Damage Increases from Curve 1 to Curve 3, (b) Stable and Unstable Zones when Damage Saturates at the Notch Tip

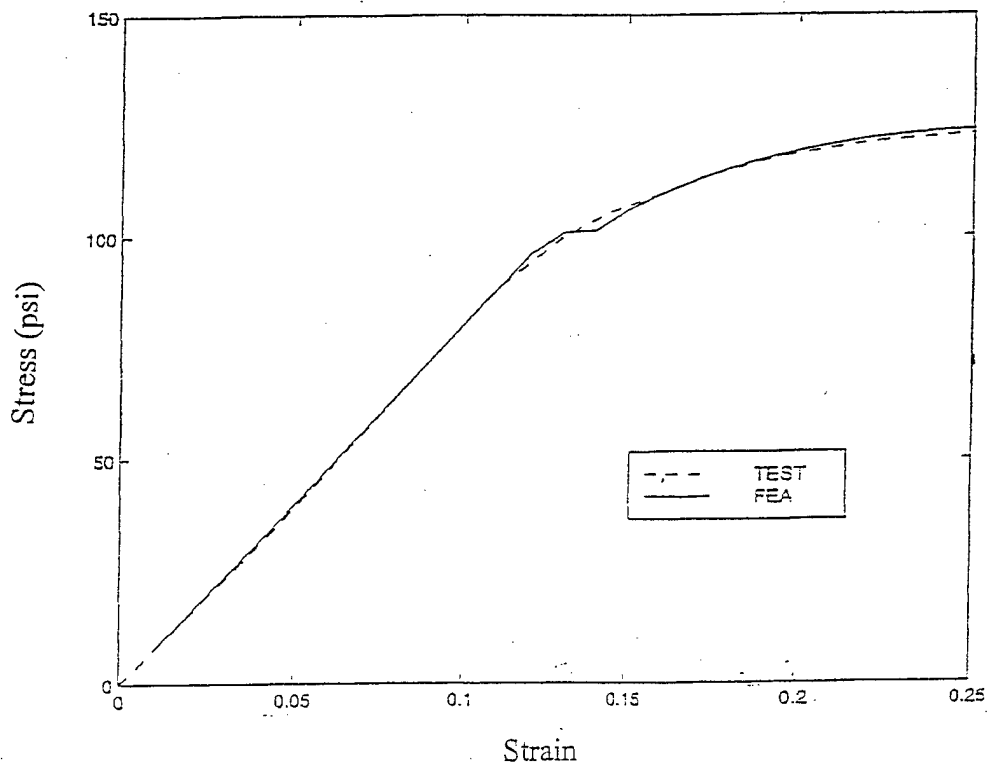


Figure Stress-Strain Curves.

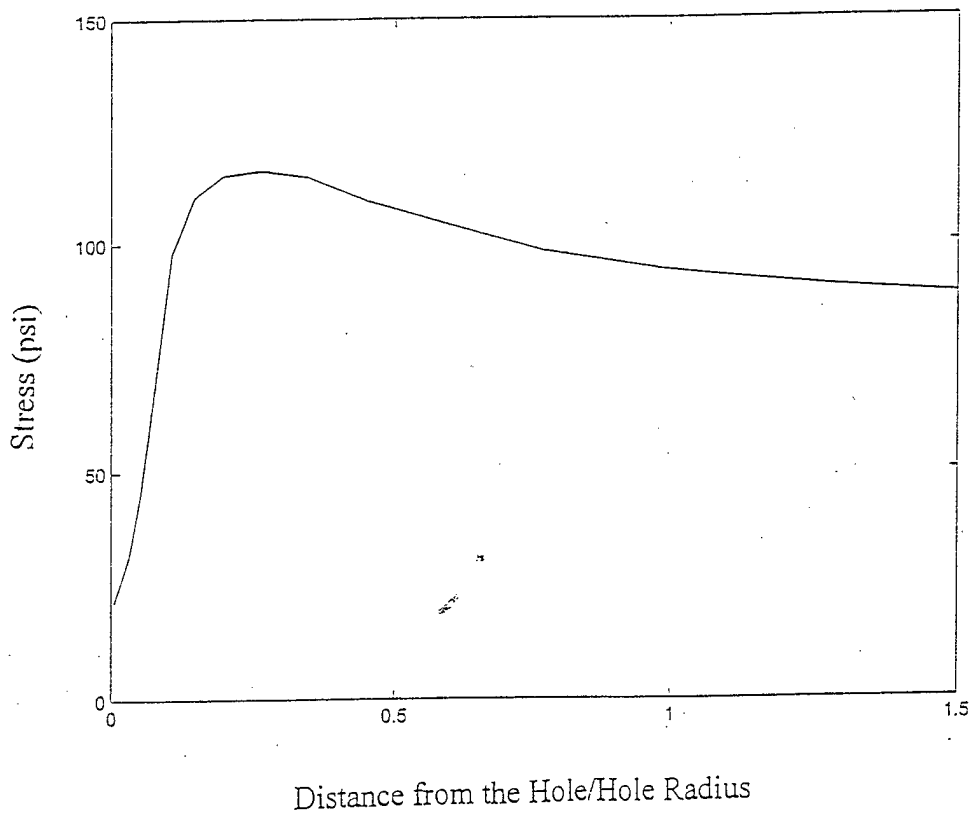


Figure Normal Stress Distribution as a Function of the Normalized Distance from the Edge of the Hole (0.5 in Hole Diameter).

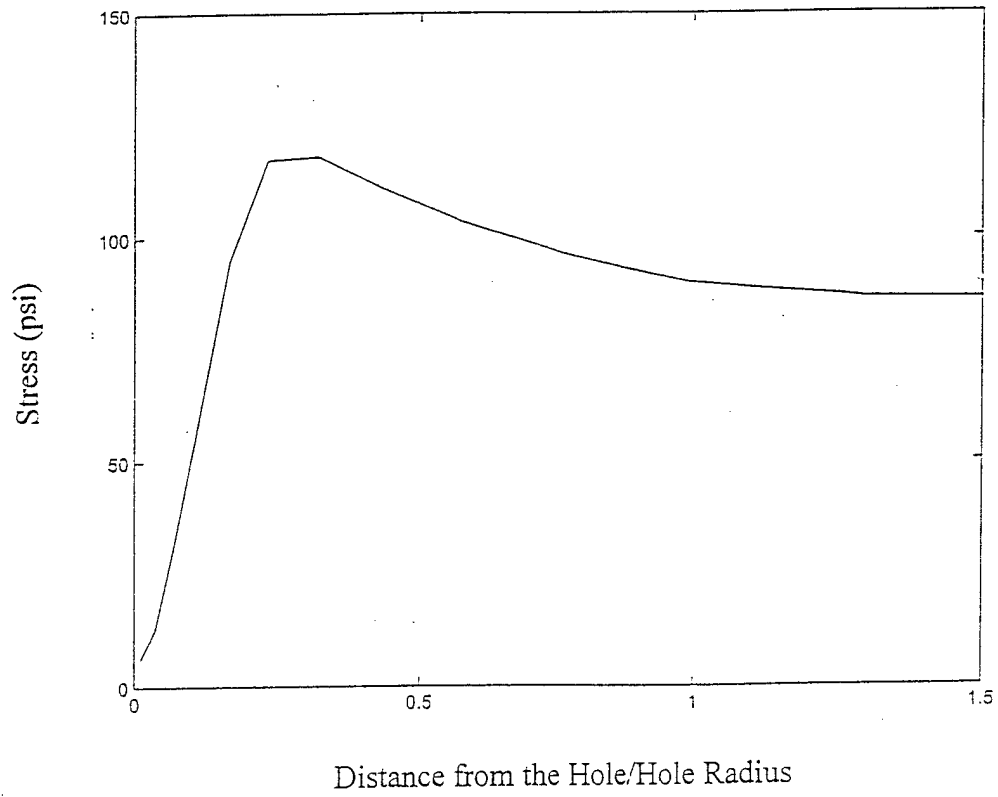
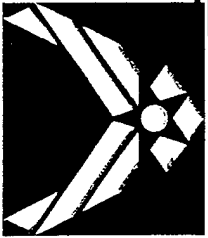


Figure Normal Stress Distribution as a Function of the Normalized Distance from the Edge of the Hole (0.25 in Hole Diameter).



Conclusions

- A technique ^{was} developed, based on a micro-macro approach and a stress instability criterion, to predict the initial crack length in a high stress region.
- The predicted and the measured average initial crack lengths are 0.0242 in. and 0.0307 in for $D = 0.25$ in. hole and 0.0489 in. and 0.0526 in for $D = 0.5$ in. hole.