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The Behaviour of the Process Region at Large Scale Yielding

Talk given at Int. Conf. on Computational Mechanics, Tokyo, May 25-29, 1986. Orationem Meam.

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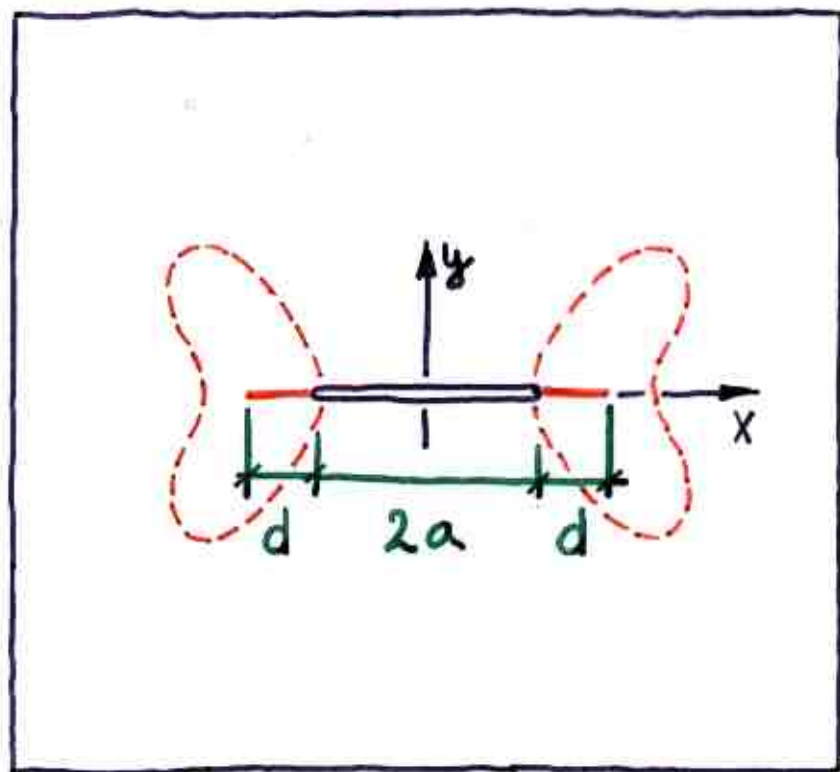
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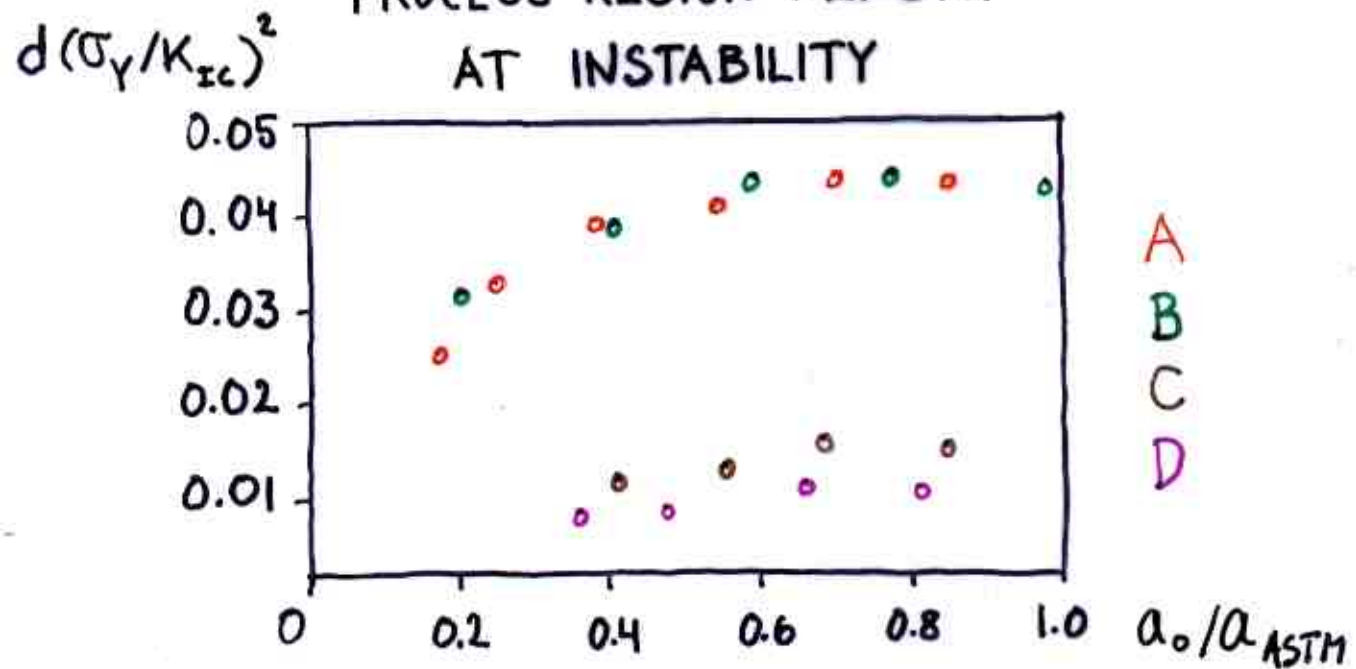
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σ_{∞}  σ_{∞}

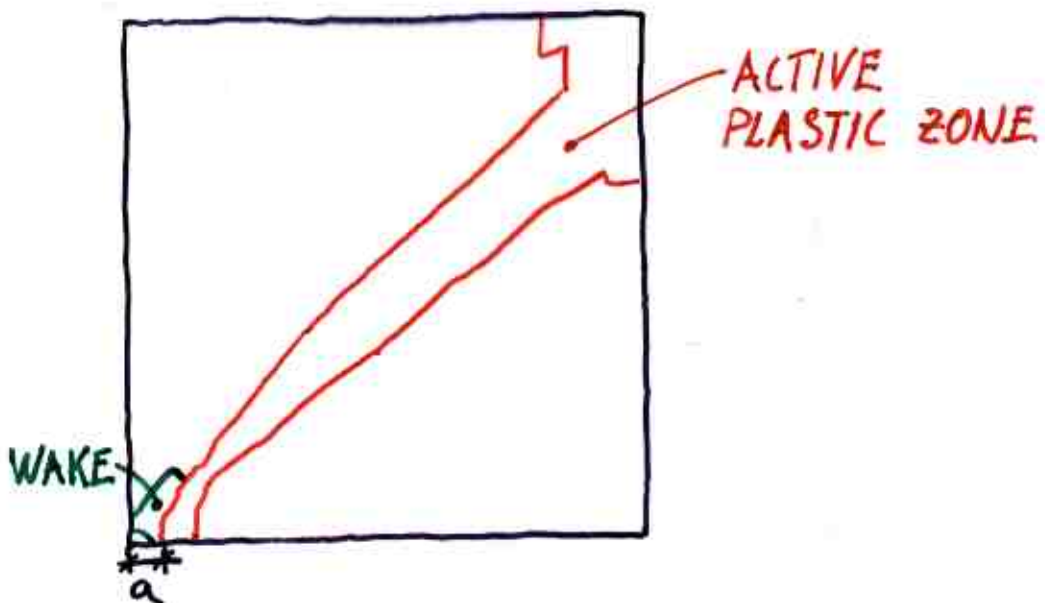
- INFINITE PLATE
- PLANE STRAIN
- SYMMETRY

PROCESS REGION LENGTH AT INSTABILITY



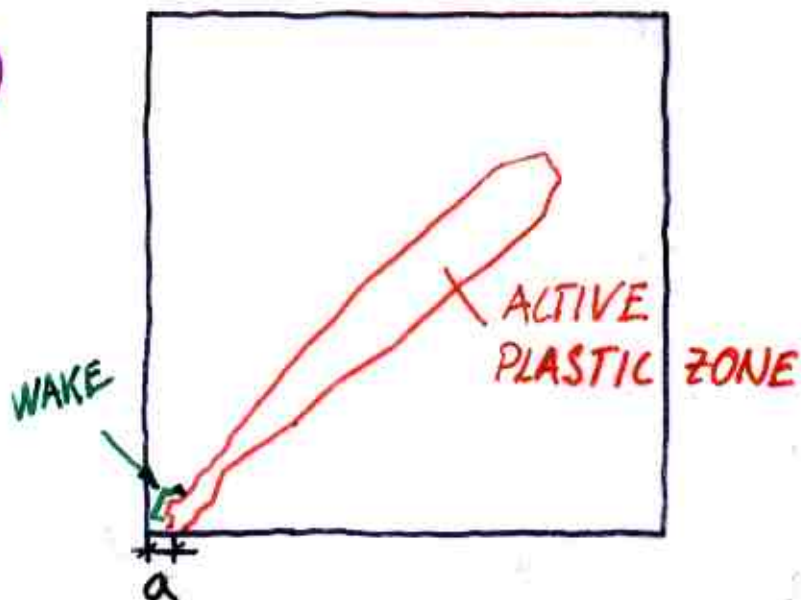
$$\sigma_\infty/\sigma_Y = 1.12, \sigma_D = 2.5\sigma_Y, H = 0.01E$$

(A)



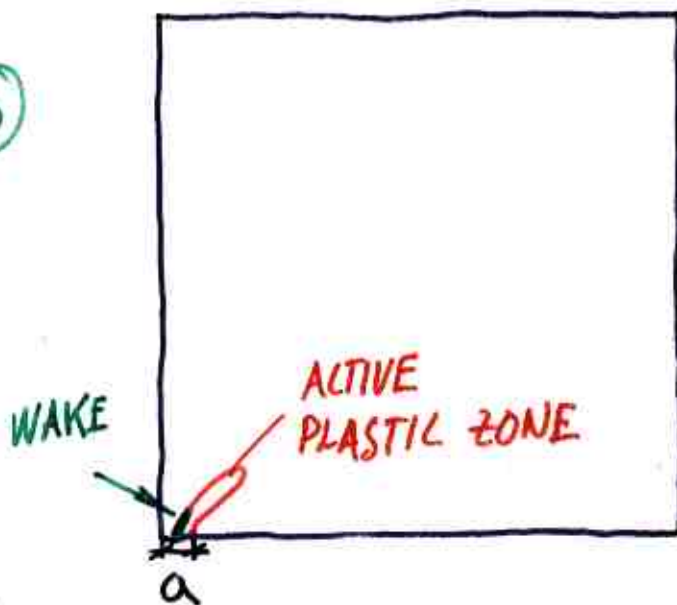
$$\sigma_{\infty}/\sigma_Y = 0.98, \sigma_D = 3.1\sigma_Y \text{ AND } H = 0.001E$$

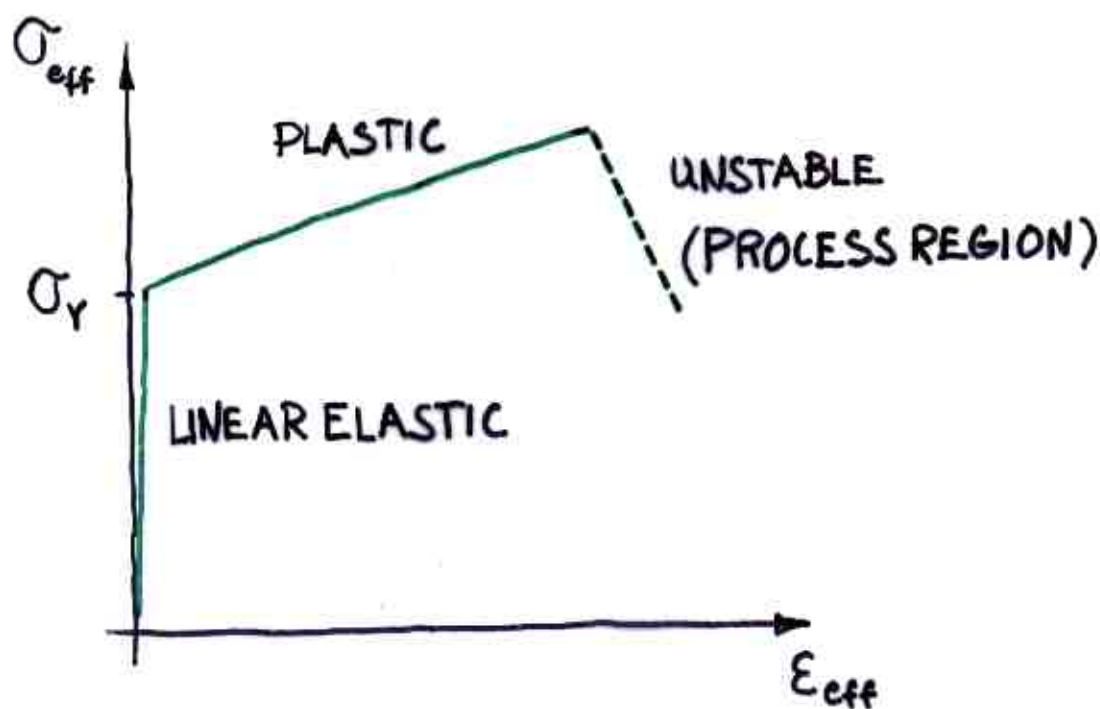
(D)



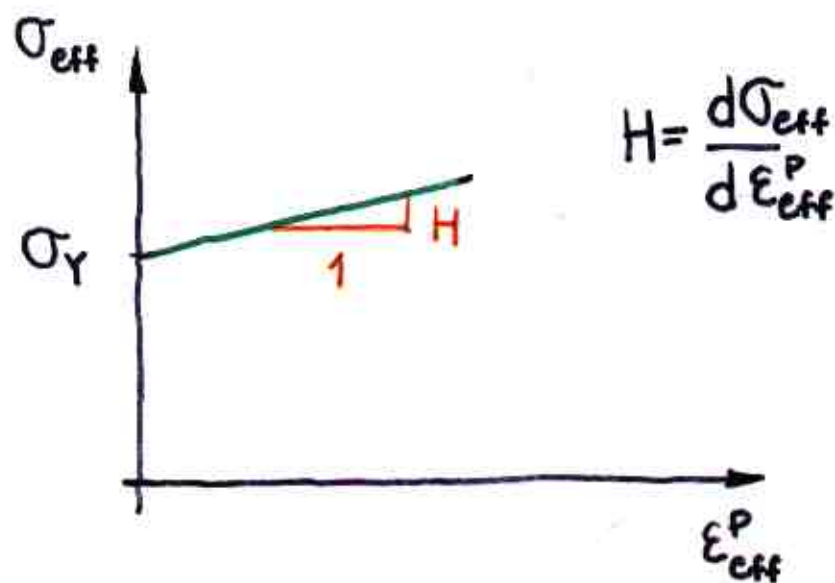
$$\sigma_{\infty}/\sigma_Y = 0.8, \sigma_D = 2.5\sigma_Y \text{ AND } H = 0.001E$$

(B)





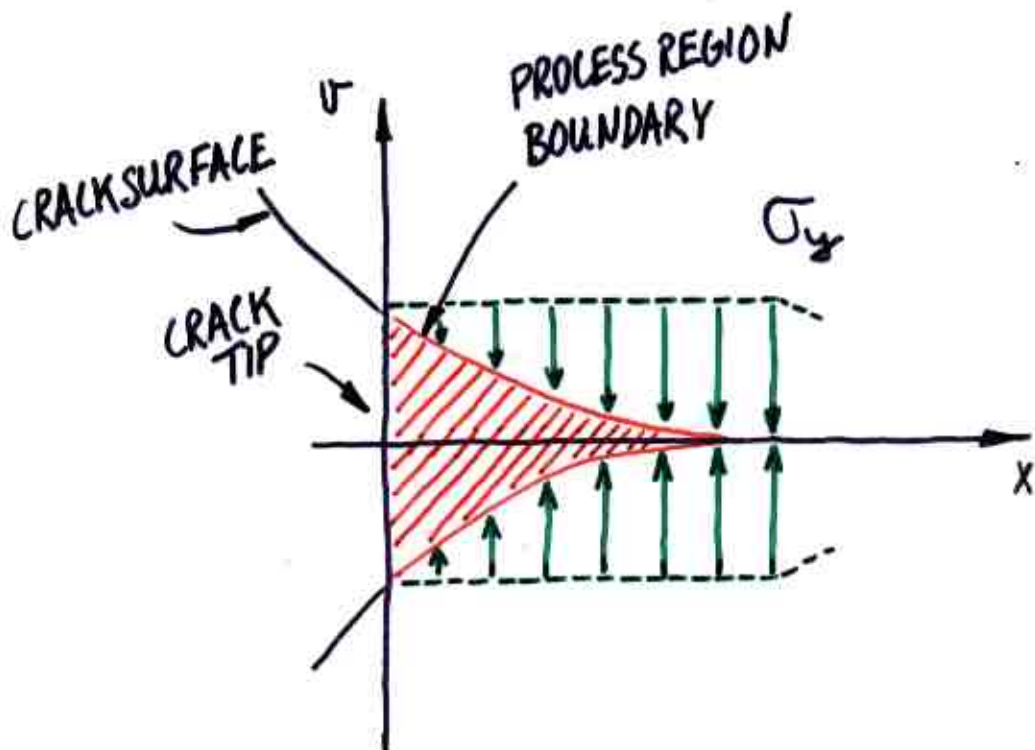
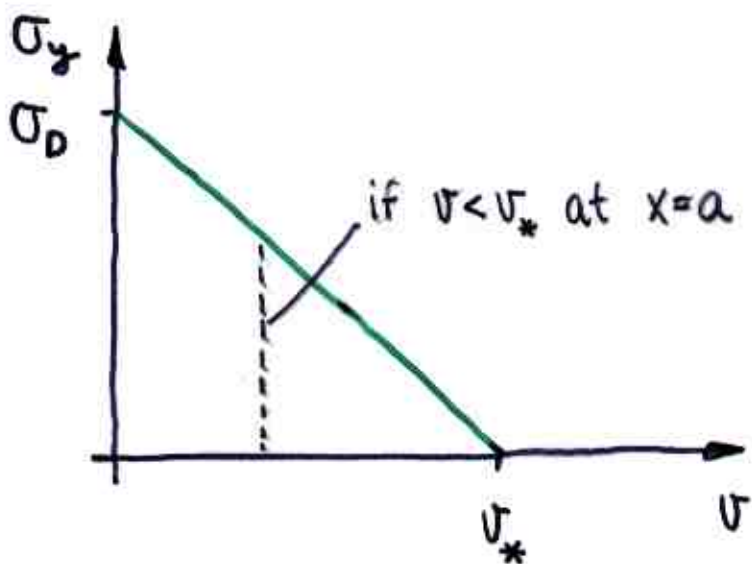
- LINEAR ELASTIC: $E, \nu = 0.3$
- PLASTIC: VONMISES YIELD CRIT. AND FLOW RULE



$$H = \frac{d\sigma_{eff}}{d\epsilon_{eff}^P}$$

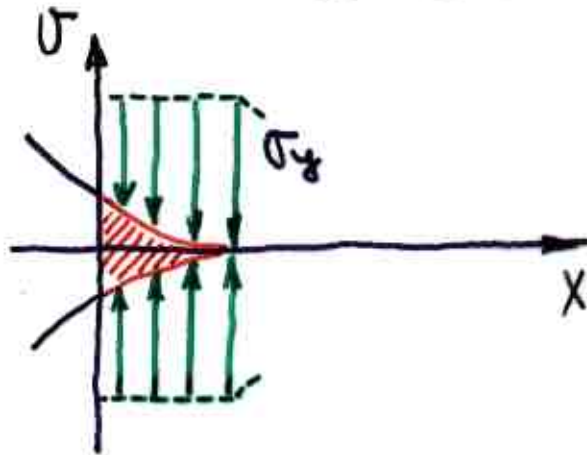
$$H = 0.01E, 0.001E$$

• UNSTABLE MATERIAL

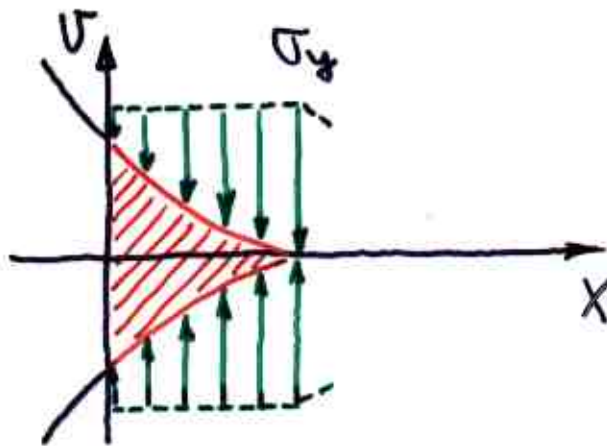


$$\sigma_D = 2.5 \sigma_Y, 3.1 \sigma_Y$$

DEVELOPING PROCESS REGION

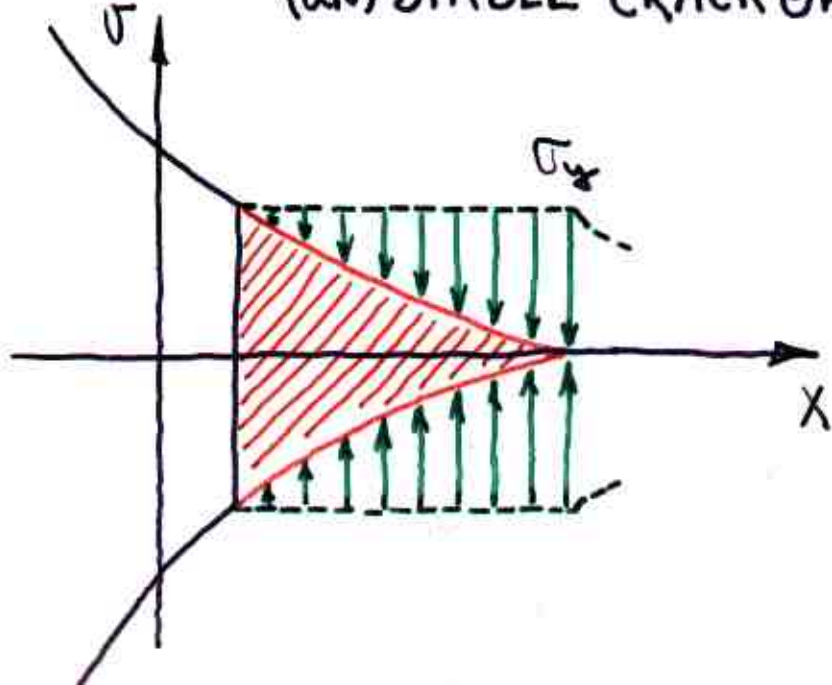


$a = a_0$
 $v < v_*$
 at $x = a$



PROCESS REGION FULLY DEVELOPED (UN) STABLE CRACK GROWTH

$a > a_0$
 $v = v_*$
 at $x = a$



MATERIALS

$$A \left\{ \begin{array}{l} \sigma_D = 2.5 \sigma_Y \\ H = 0.01 E \end{array} \right.$$

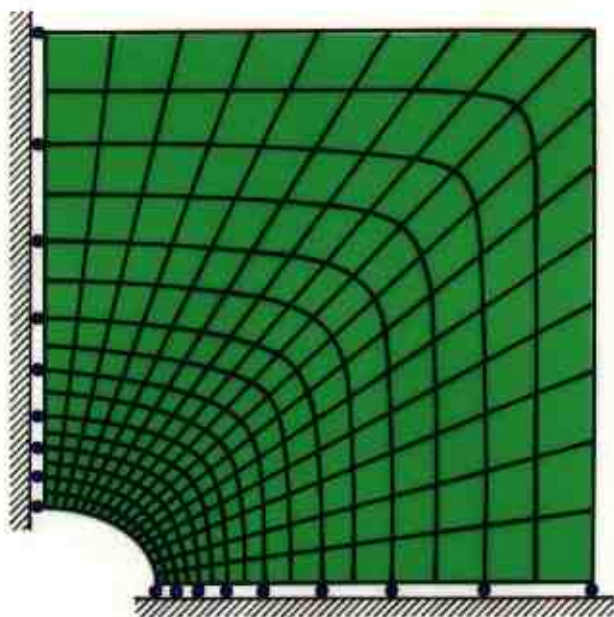
$$B \left\{ \begin{array}{l} \sigma_D = 2.5 \sigma_Y \\ H = 0.001 E \end{array} \right.$$

$$C \left\{ \begin{array}{l} \sigma_D = 3.1 \sigma_Y \\ H = 0.01 E \end{array} \right.$$

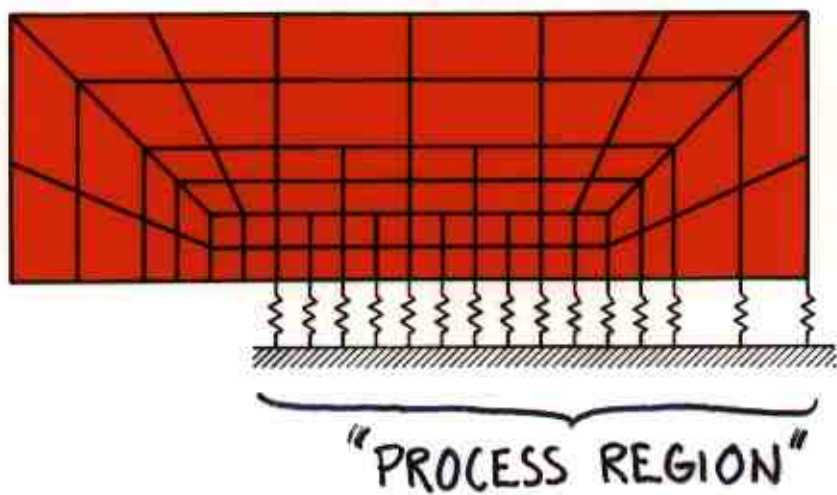
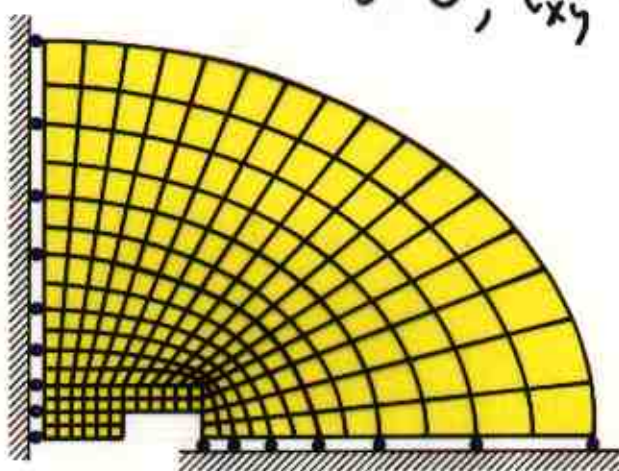
$$D \left\{ \begin{array}{l} \sigma_D = 3.1 \sigma_Y \\ H = 0.001 E \end{array} \right.$$

FINITE ELEMENT MESH

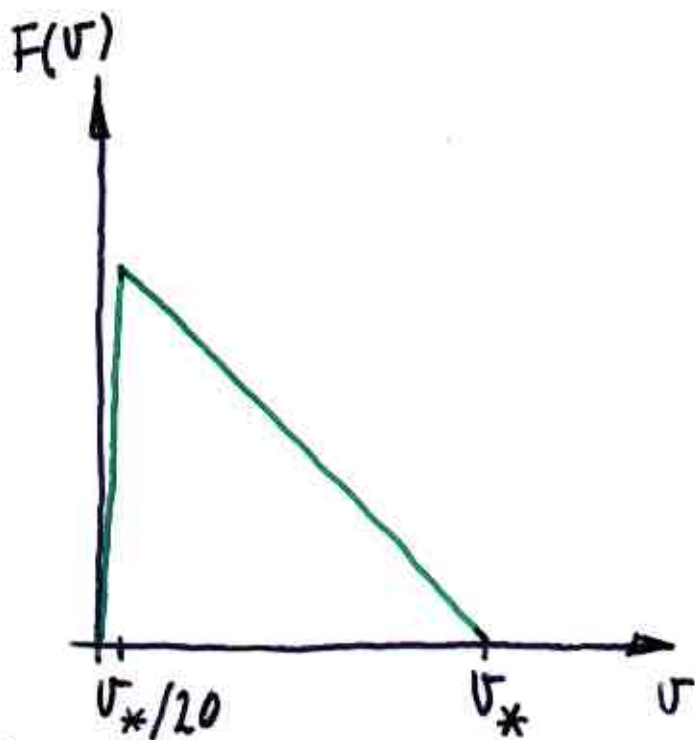
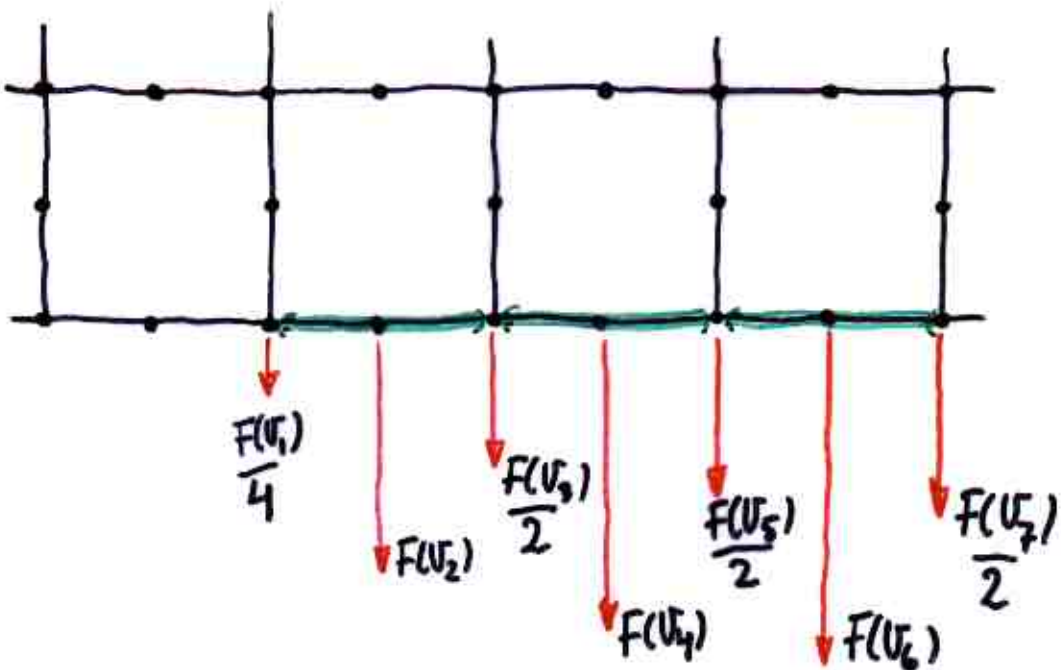
$$u=0, \\ \tau_{xy}=0$$



$$v=0, \tau_{xy}=0$$

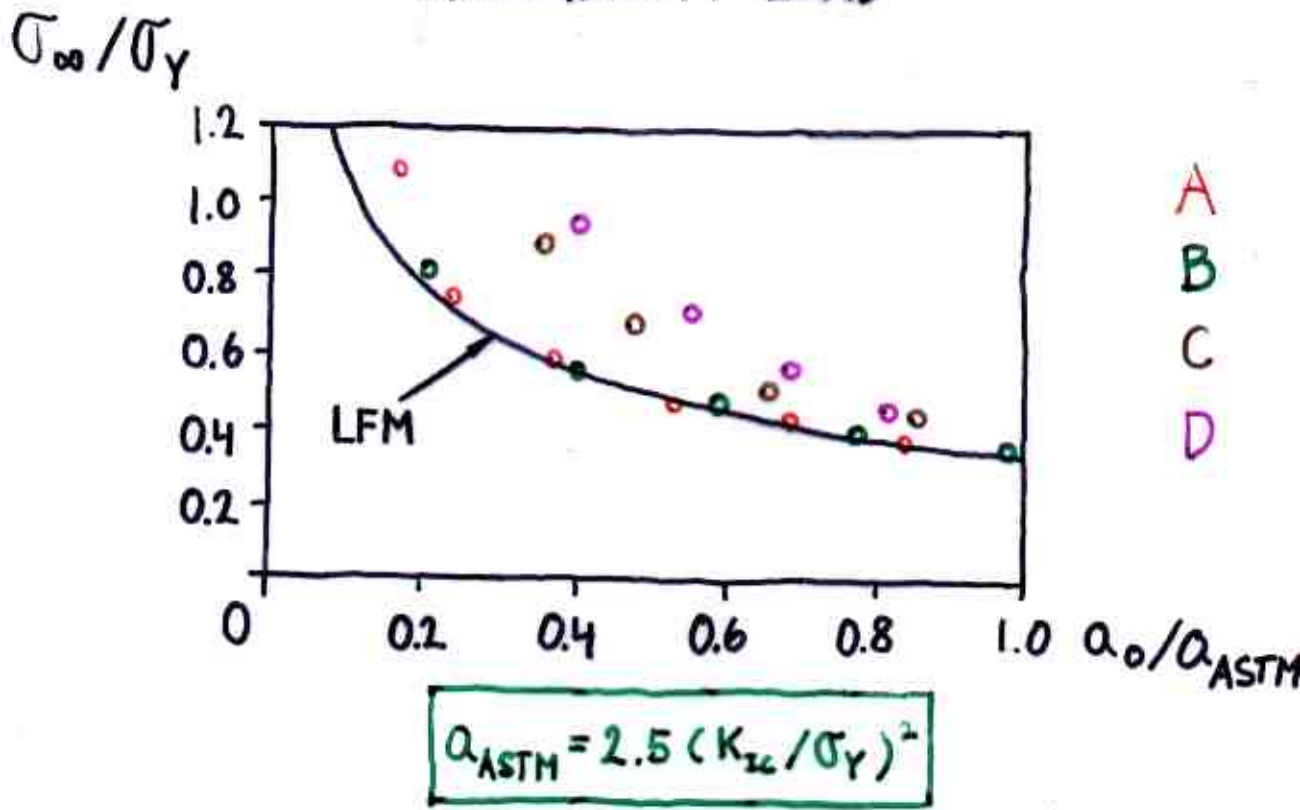


CRACK PROCESS REGION

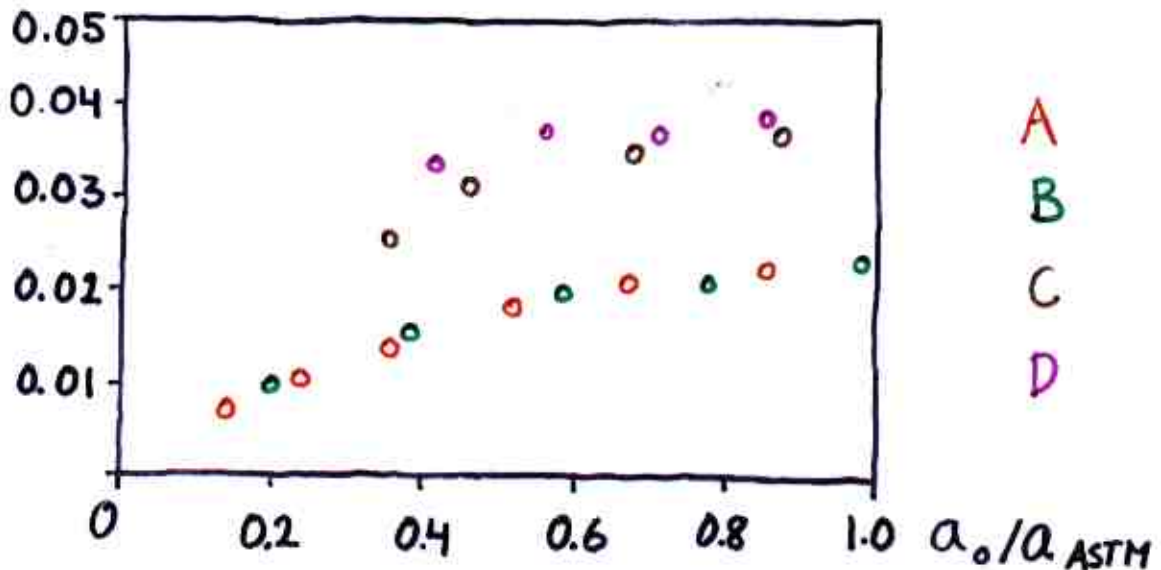


SMALL CRACKS

INSTABILITY LOAD



$(a-a_0)(\sigma_Y/K_{Ic})^2$ STABLE CRACK GROWTH



AT LARGE CRACKS

DISSIPATED ENERGY PER
UNIT CRACK EXTENSION :

$$\frac{(1-\nu^2) K_{Ic}^2}{E}$$

ENERGY DISSIPATED IN THE PROCESS REGION:

$$U_* \sigma_D$$

$U_* \sigma_D / \left[\frac{(1-\nu^2) K_{Ic}^2}{E} \right]$	MATERIAL
74 %	A
67 %	B
22 %	C
12 %	D