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## Fracture Mechanics Fundamentals

Talk given at ABB Atom Västerås, Sweden, Orationem Meam

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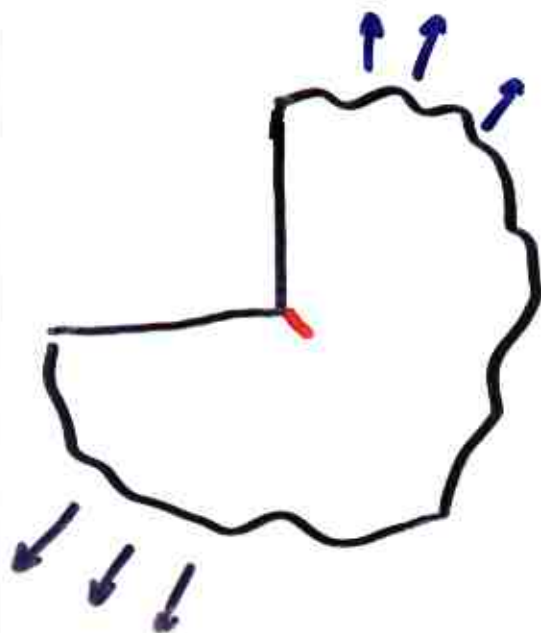
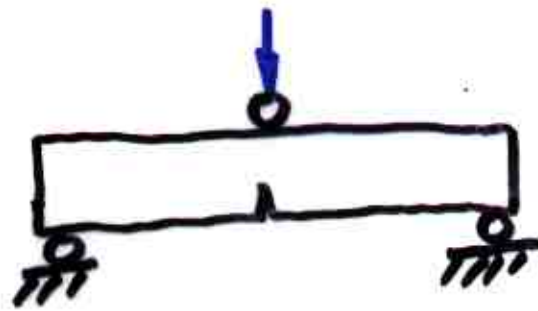
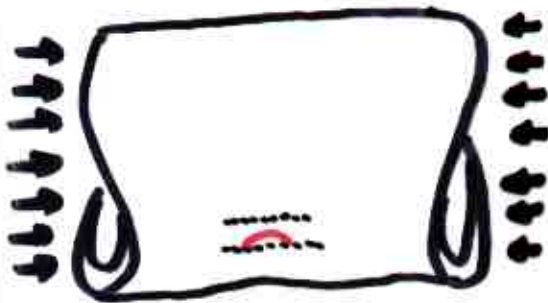
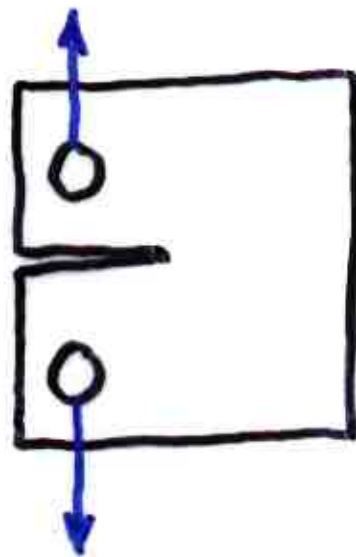
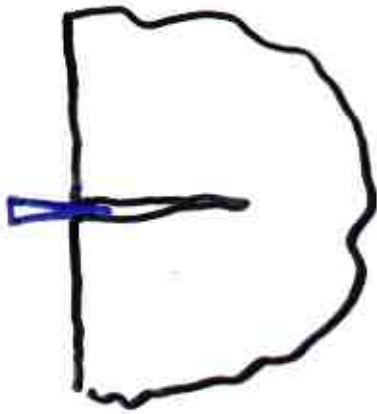
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# Olika belastningsklasser



# Klassa mha Teller Q.

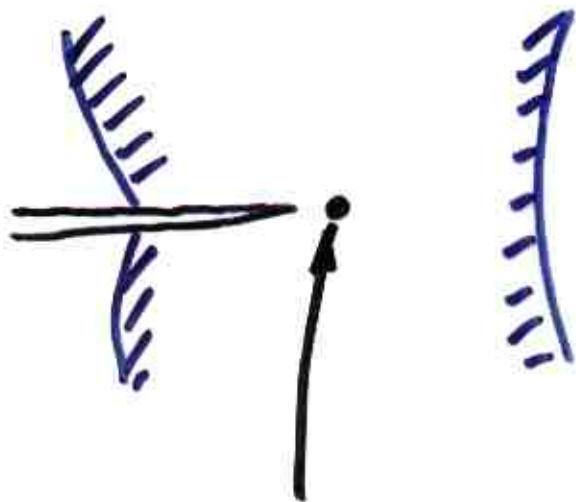
T-stress

Rice 1976

Larsson & Carlsson 1978



$$\sigma_{ij} = \frac{K_I}{\sqrt{2\pi r}} f_{ij}(\theta) + T \cdot g_{ij}(\theta)$$



$$Q = \frac{(\sigma_{\theta}(\theta=0))_{\text{Actual}} - (\sigma_{\theta}(\theta=0))_{\text{Prandtl}}}{\sigma_s}$$

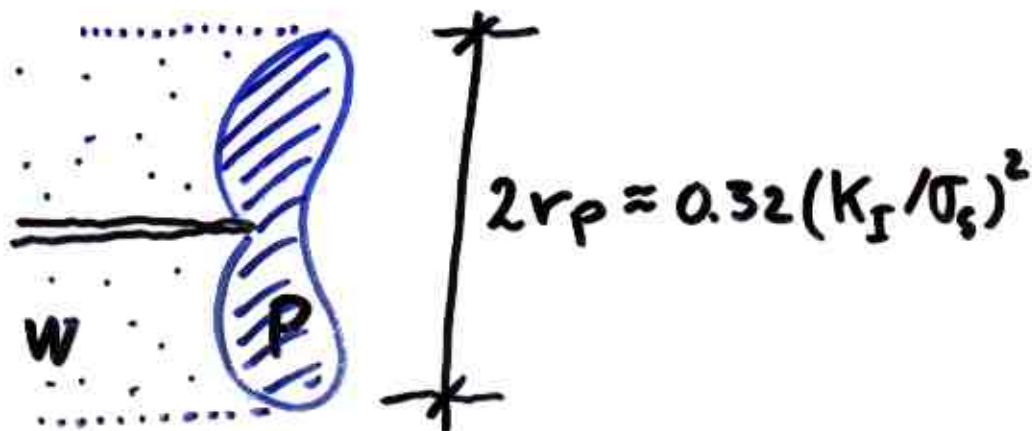
Fong & O'Dowd 1991

$$\frac{\sigma_{ij}}{\sigma_s} = \frac{f_{ij}(\theta)}{\sqrt{2\pi(r\sigma_s^2/K_I^2)}} = \frac{f_{ij}(\theta)}{\sqrt{2\pi r}}$$

- Alla längder jämförs med längden

$$(K_{Ic}/\sigma_s)^2$$

Ex. Plastiska zonenens storlek  $r_p$ ,



$$a_{ASTM} = 2.5 (K_{IC} / \sigma_s)^2 E$$

$$\approx \frac{2.5}{0.16} r_p \approx 16 r_p$$

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Väl; följande kriterier  
för linjär brottmekanik:

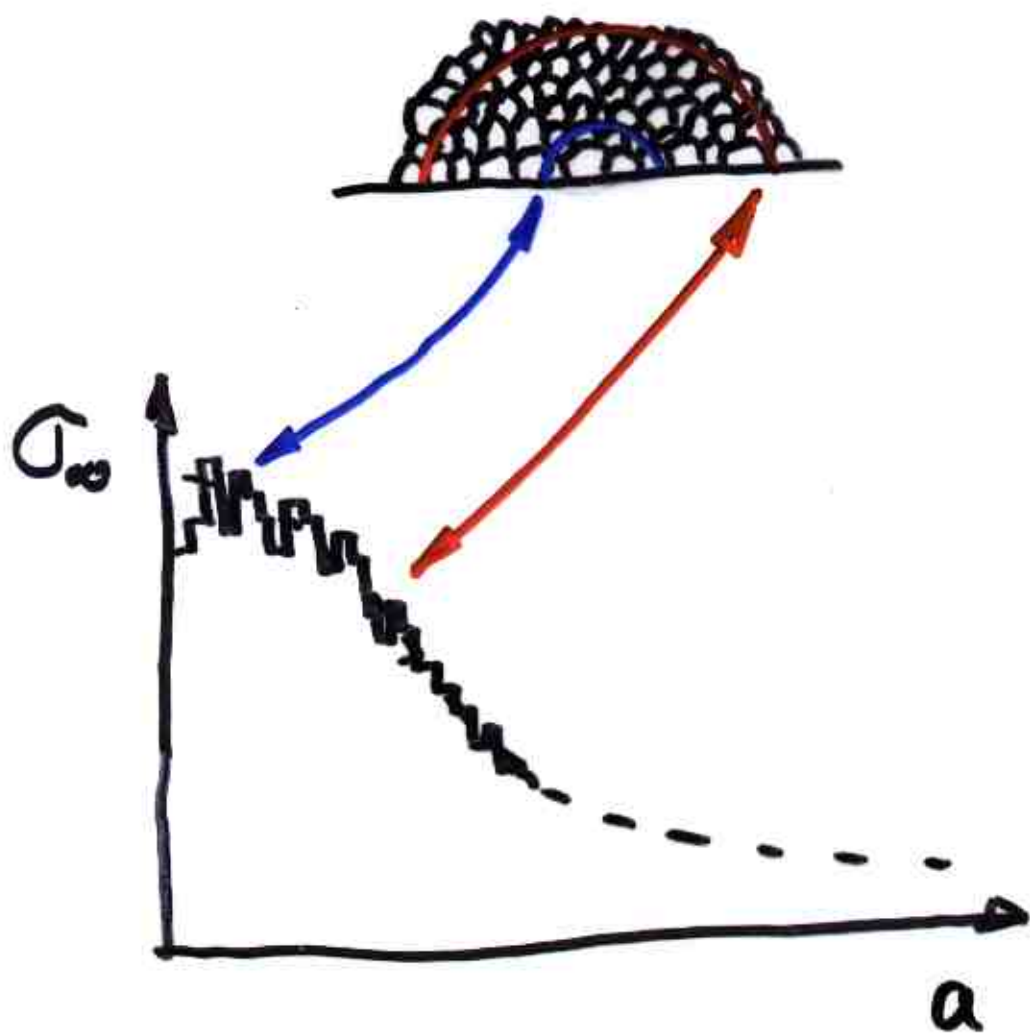
$$a > a_{ASTM}$$

och

$$a > 16 l_{gr}$$

$l_{gr}$  = kornstorlek

# Spridning pga växelverkan mellan korn och spricklängd



- multiple cracking

Ex plastiskt

$$COD_{tip} = \frac{K_I^2}{\sigma_s E} = \frac{\pi a \sigma_0^2}{\sigma_s E}$$

$$\sigma_0 = 0.3 \sigma_s, E = 1000 \sigma_s$$

$$l_{cr} = 50 \mu m, a = 16 l_{cr}$$

$$COD_{tip} = 0.23 \mu m$$



# Ex. Elastiskt

$$\left. \begin{aligned} \text{COD} &= 4\sqrt{\frac{2}{\pi}} \frac{K_I}{E} \sqrt{r} \\ K_I &= \sigma_{\infty} \sqrt{\pi a} \end{aligned} \right\} \Rightarrow \text{COD} = 4\sqrt{2} \frac{\sigma_{\infty}}{E} \sqrt{r \cdot a}$$

$$\text{COD}_a = 4\sqrt{2} \frac{\sigma_{\infty}}{E} a$$

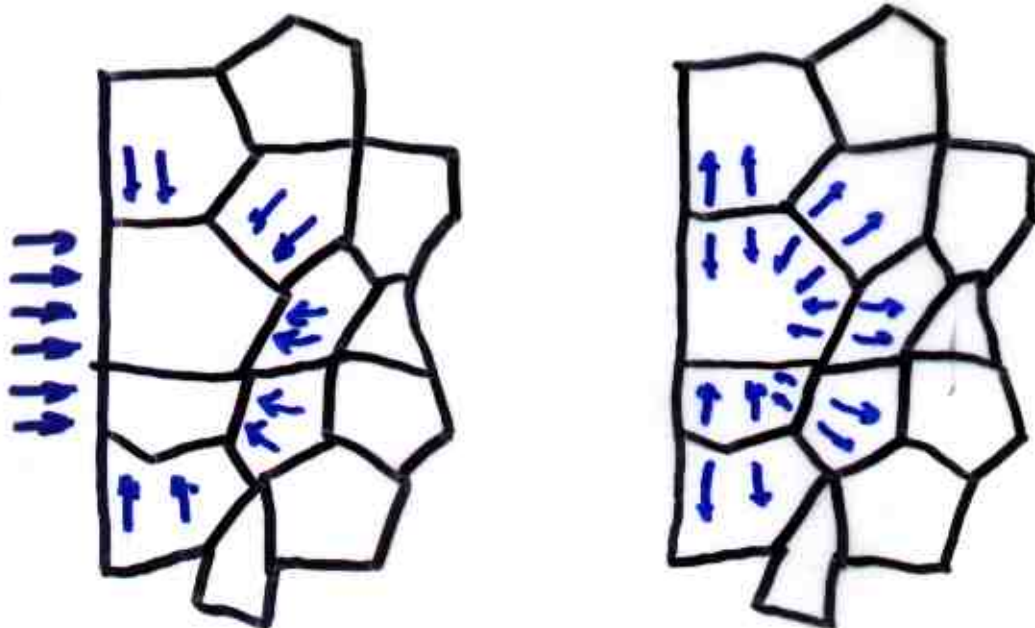
$$\sigma_{\infty} = 0.3\sigma_s, \quad E = 10000\sigma_s$$

$$l_{gr} = 50 \mu\text{m}, \quad a = 16 l_{gr} = 0.8 \mu\text{m}$$

$$\text{COD}_a = 1.4 \mu\text{m}$$

$$\text{COD}_{l_{gr}} = 0.4 \mu\text{m}$$





Plastisk deformation av ett korn.

Energi:

$$W_{gr} = 3\sigma_s \epsilon l_p^3 = 7.5 \cdot 10^{-7} \text{ Nm}$$

Jfr.

$$m = 0.1, S = 1 \text{ cm}$$

$$W = gms = 0.01 \text{ Nm} = 13000 W_{gr}$$

$$\text{dvs. } 24 \times 24 \times 24 l_p^3 = [1.2 \text{ mm}]^3$$