Fracture Mechanics Fundamentals

Talk given at ABB Atom Västerås, Sweden, Orationem Meam

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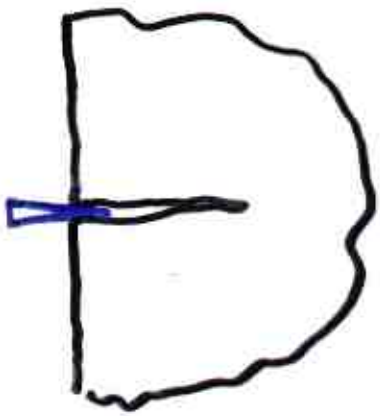
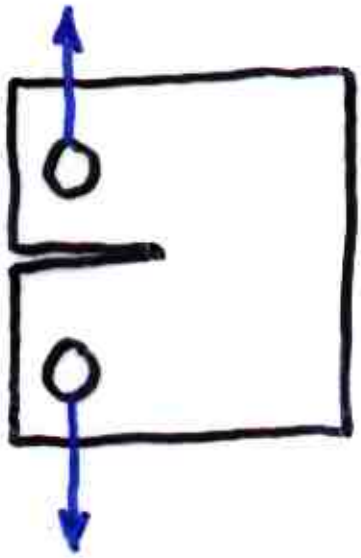
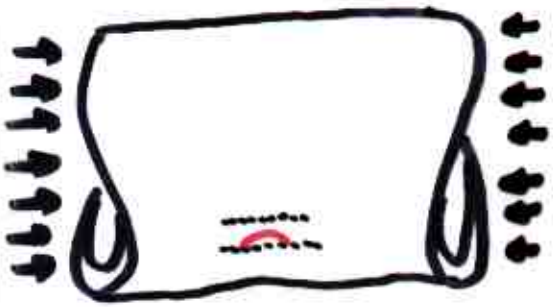
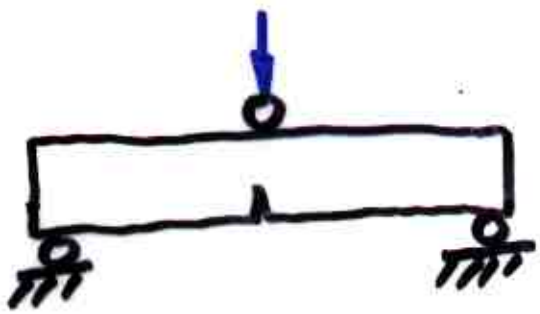
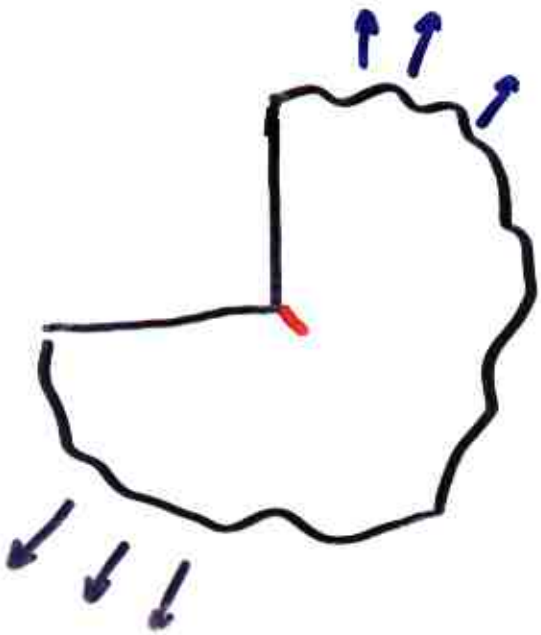
Olika belastningsklasser





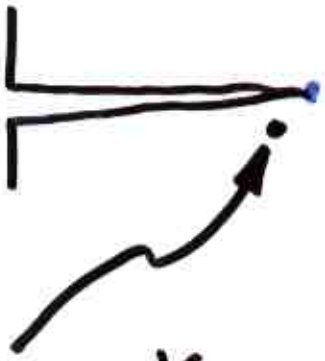






Klassa mha Teller Q.

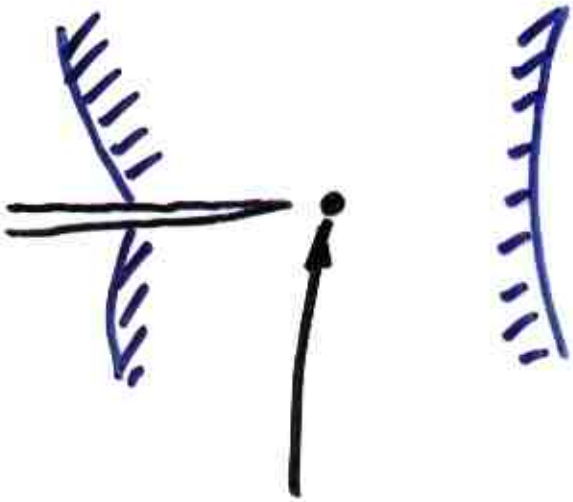
T-stress



Rice 1976

Larsson & Carlsson 1971

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



$$Q = \frac{(\sigma_\theta(\theta=0))_{actual} - (\sigma_\theta(\theta=0))_{prandtl}}{\sigma_s}$$

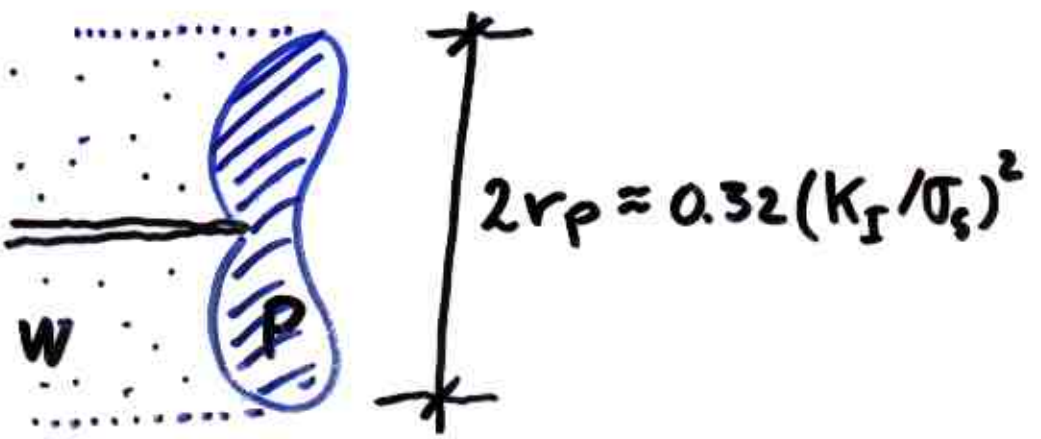
Fong & O'Dowd 1991

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

- Alla längder jämförs med längden

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

Ex. Plastiska zonens storlek r_p,



$$a_{ASTM} = 2.5 (K_{Ic}/\sigma_s)^2 \approx$$

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

Välj följande kriterier för linjär brottmekanik:

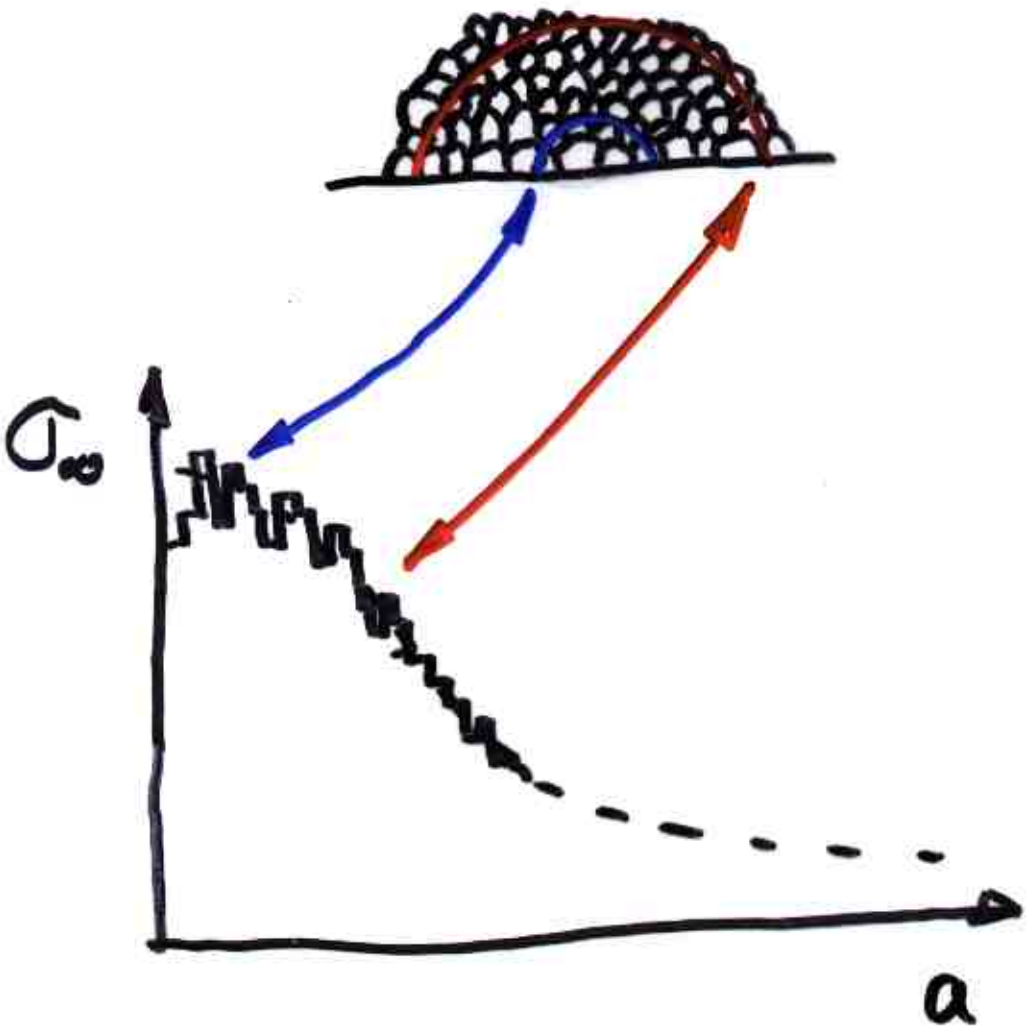
$$a > a_{ASTM}$$

och

$$a > 16 l_{gr}$$

l_{gr} = kornstorlek

Spridning pga växelverkan mellan korn och sprickläng



- multiple cracking

Ex Plastiskt

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

$\sigma_\infty = 0.3\sigma_s$, $E = 1000\sigma_s$

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

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

Ex. Elastiskt

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

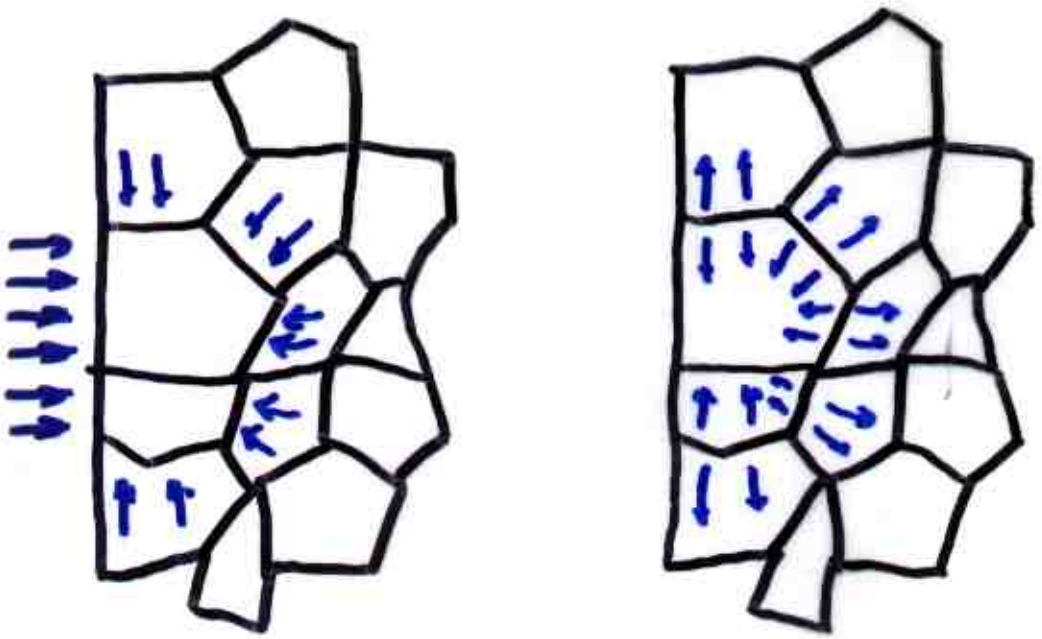
$$COD_a = 4\sqrt{2}\,\frac{\sigma_\infty}{E}\,a$$

$\sigma_\infty = 0.3\sigma_s$, $E = 1000\,\sigma_s$

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

$COD_a = 1.4\,\mu m$

$COD_{l_{gr}} = 0.4\,\mu m$



Plastisk deformation av ett korn.

Energi:

$$W_{qr} = 3\sigma_s \varepsilon l_{qr}^3 = 7.5 \cdot 10^{-7}\ Nm$$

Jfr.

$m = 0.1$, $S = 1cm$

$$W = gmS = 0.01 Nm = 13000\ W_{qr}$$

dvs. $24 \times 24 \times 24\ l_{qr}^3 = [1.2mm]^3$