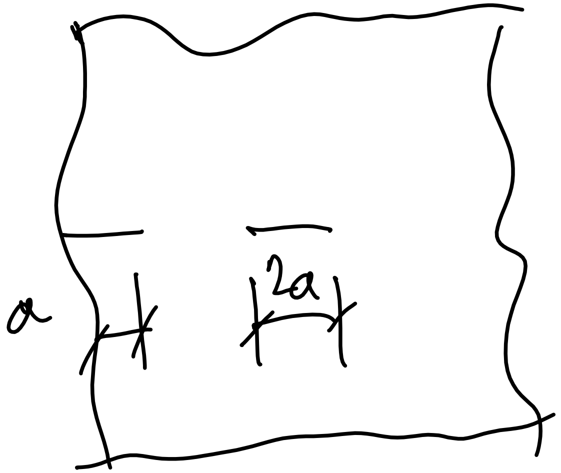
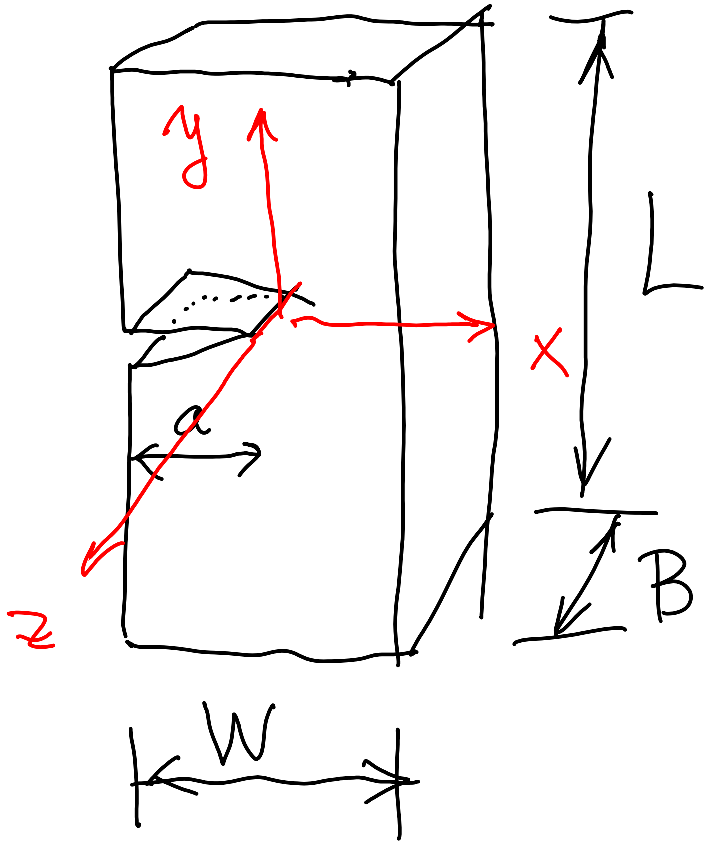
- LM
  - LLM
    - G-faktor ✓
    - K-faktor
  - NLM
    - CTOD
    - J-integrál



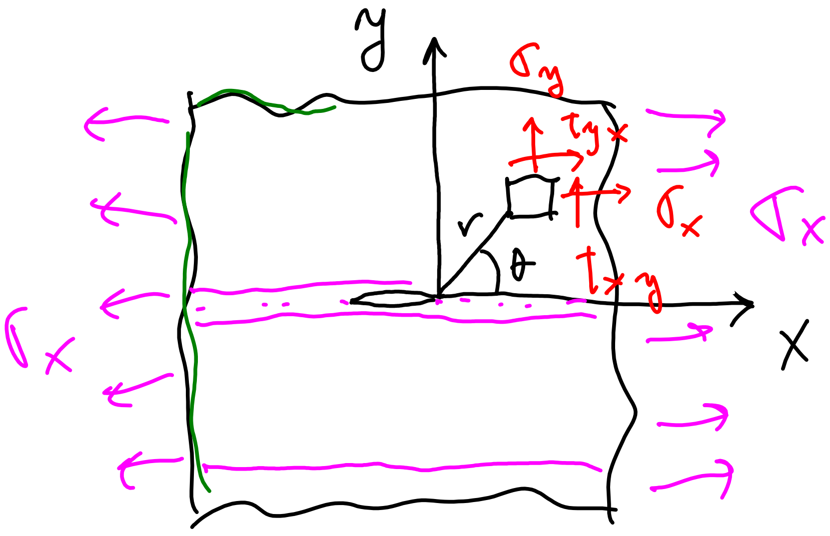


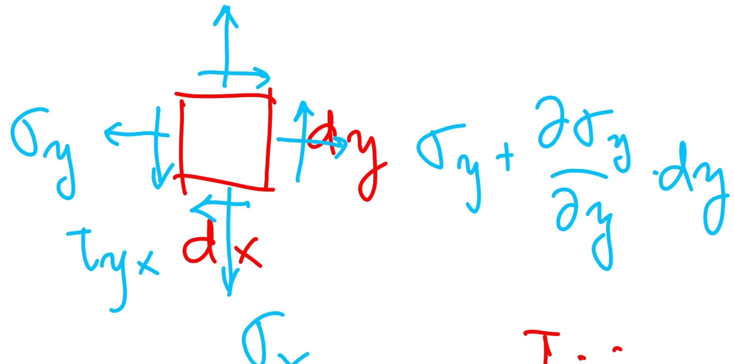
šířka W

tloušťka B

délka L

čelo trhliny





τ_{ij} ... i - normála

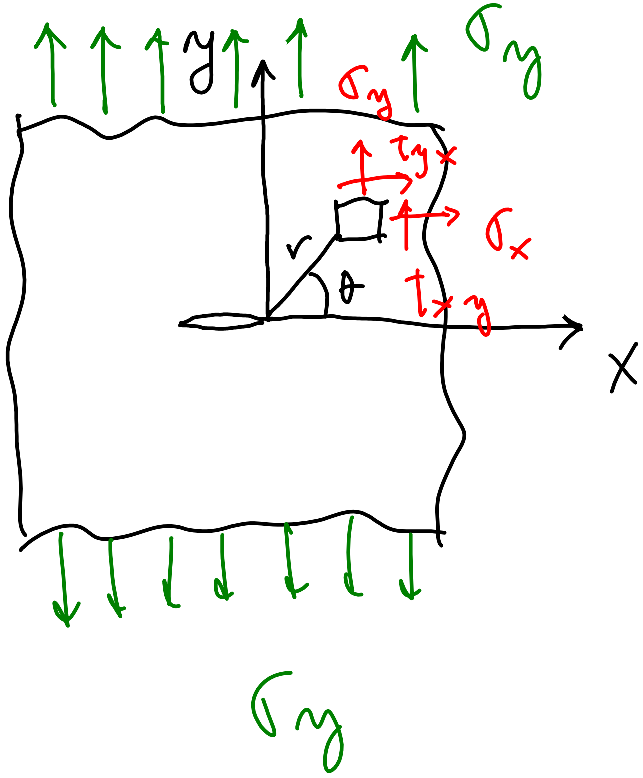
j - ∥ osa

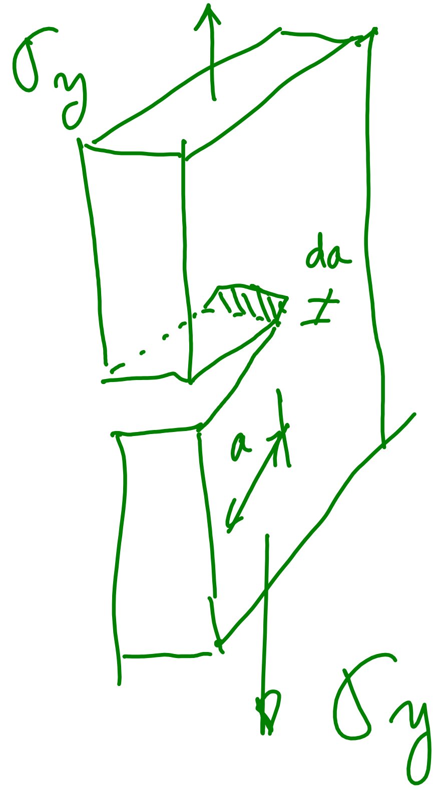
$\tau_{xy} = \tau_{yx}$

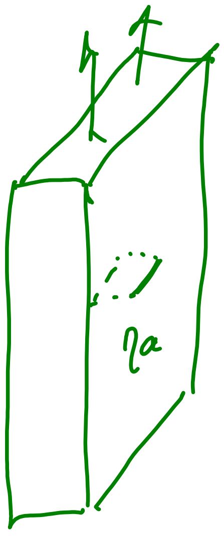
σ_x - nerozevírá trhlinu

- nemá vliv
- neuvažuji

$$\sigma_{ij} = \begin{bmatrix} \cancel{\sigma_x} & \tau_{xy} & \tau_{xz} \\ & \sigma_y & \tau_{yz} \\ & & \sigma_z \end{bmatrix}$$



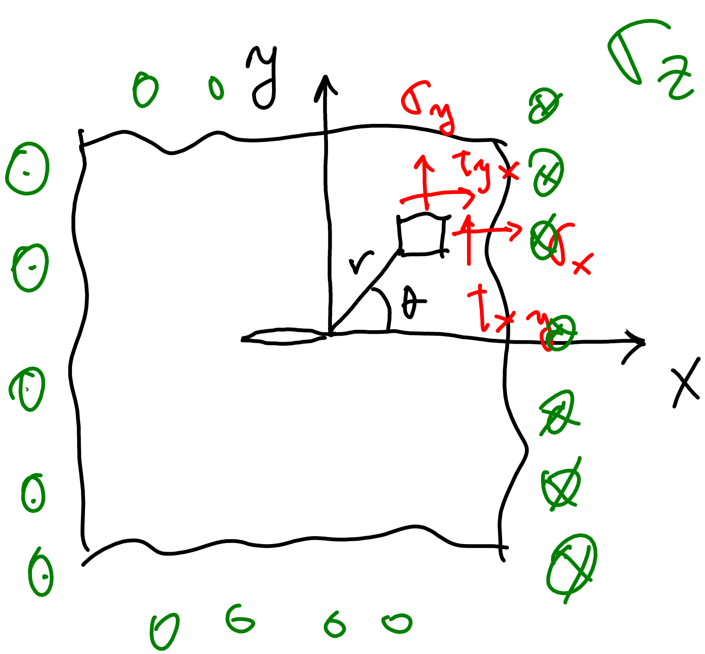




Mód I

Tahový mód

- řízen σ_y (tahovou složkou)

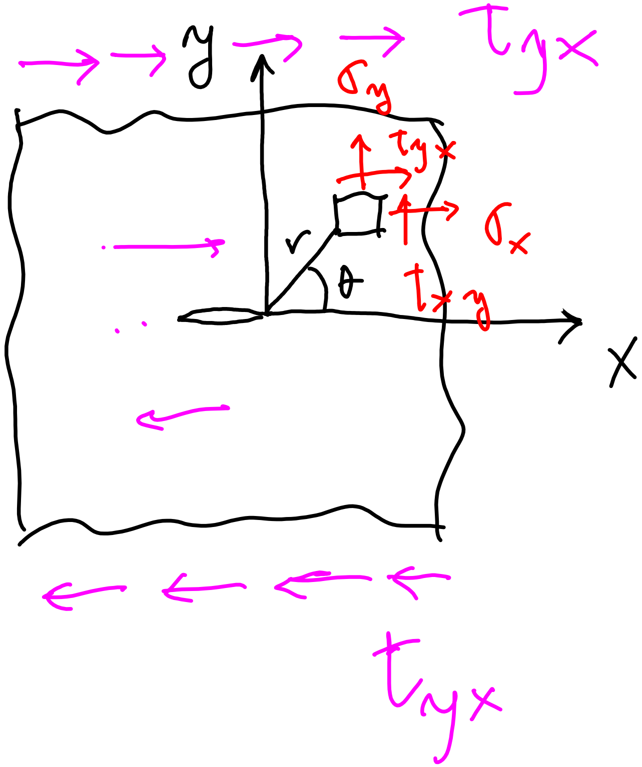


působící σ_z

→ nerozšiřuje trhlin

- nemá vliv

- nemusí uvažovat

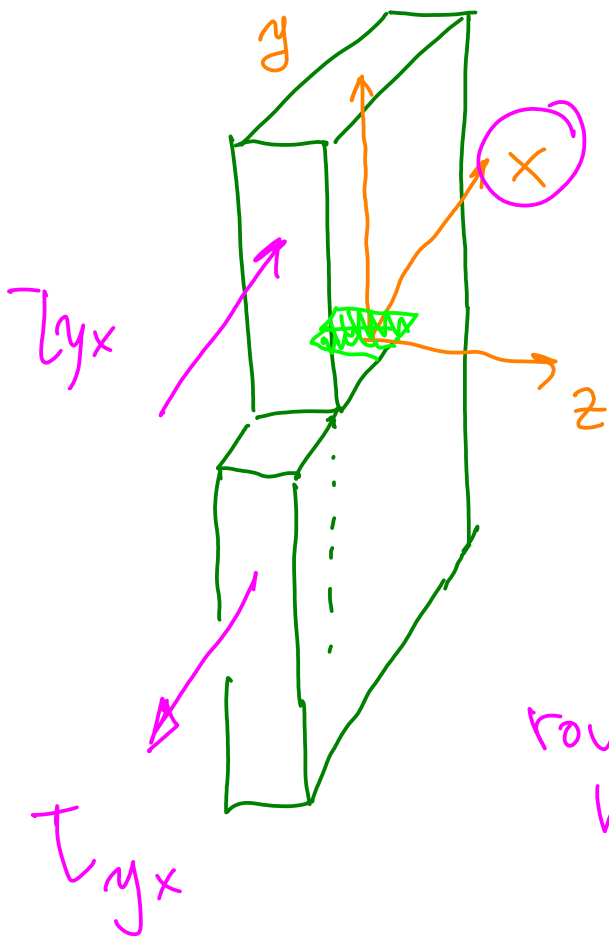


řízen složkou $\underline{\tau_{yx}}$.

$\tau_{yx} = \tau_{xy}$

x - normála

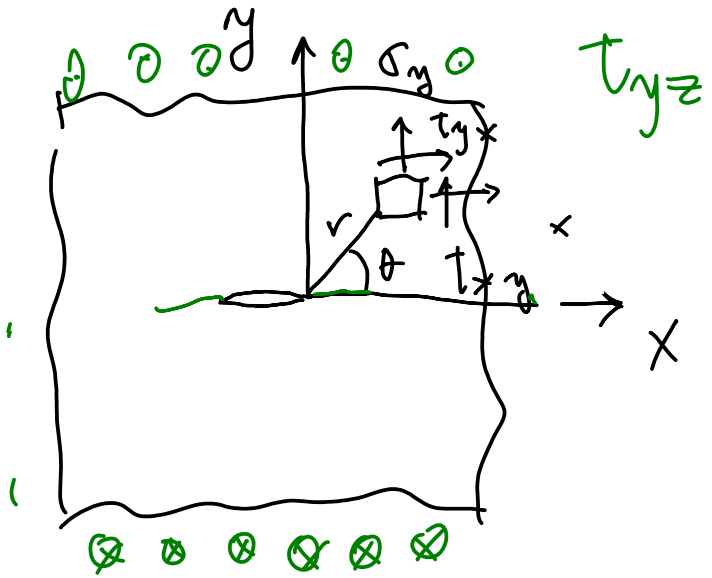
y - směr ∥

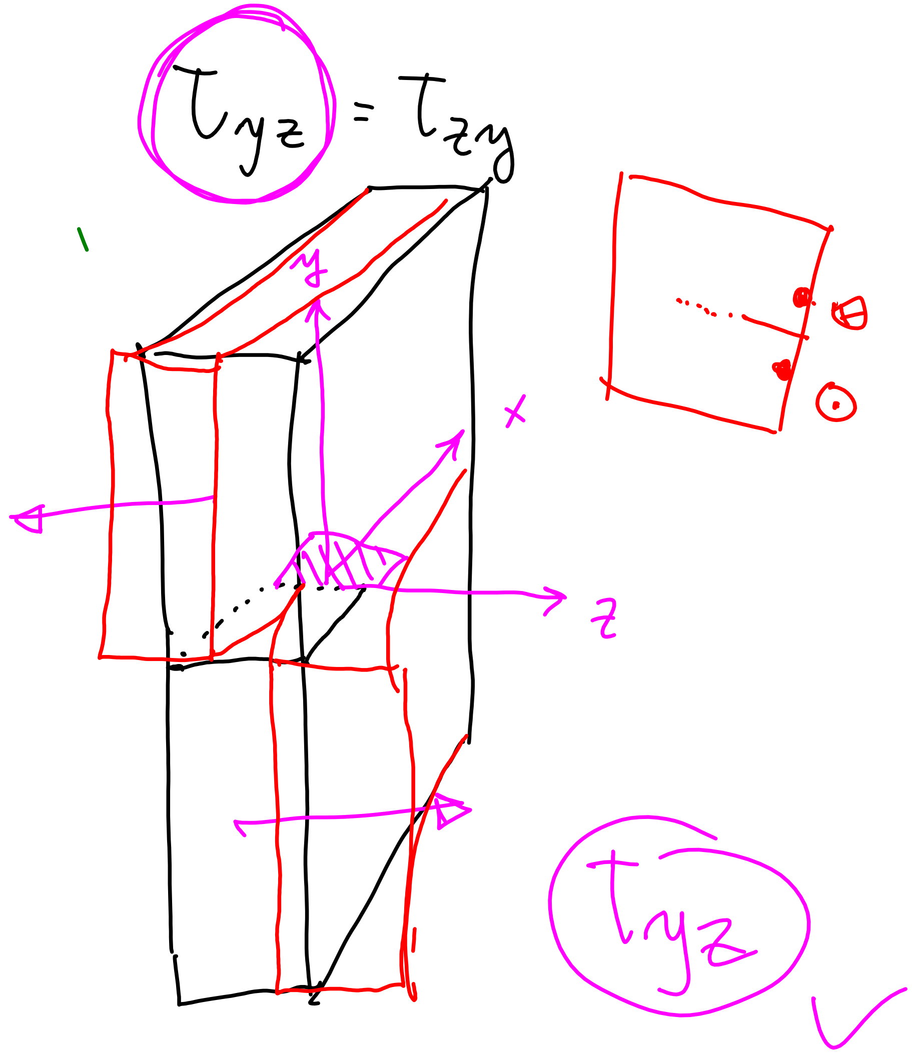


Mód II

rovinný smyk

mód

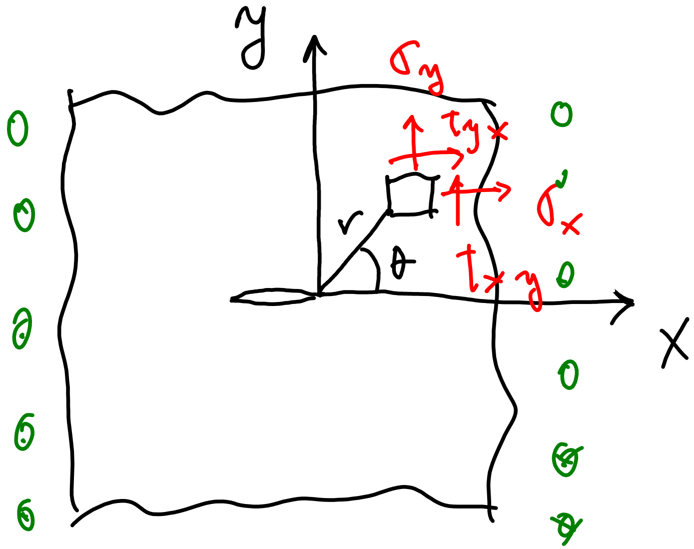




Mód III

– antirovinný smyk.
mód

$$\tau_{xz} = \tau_{zx}$$

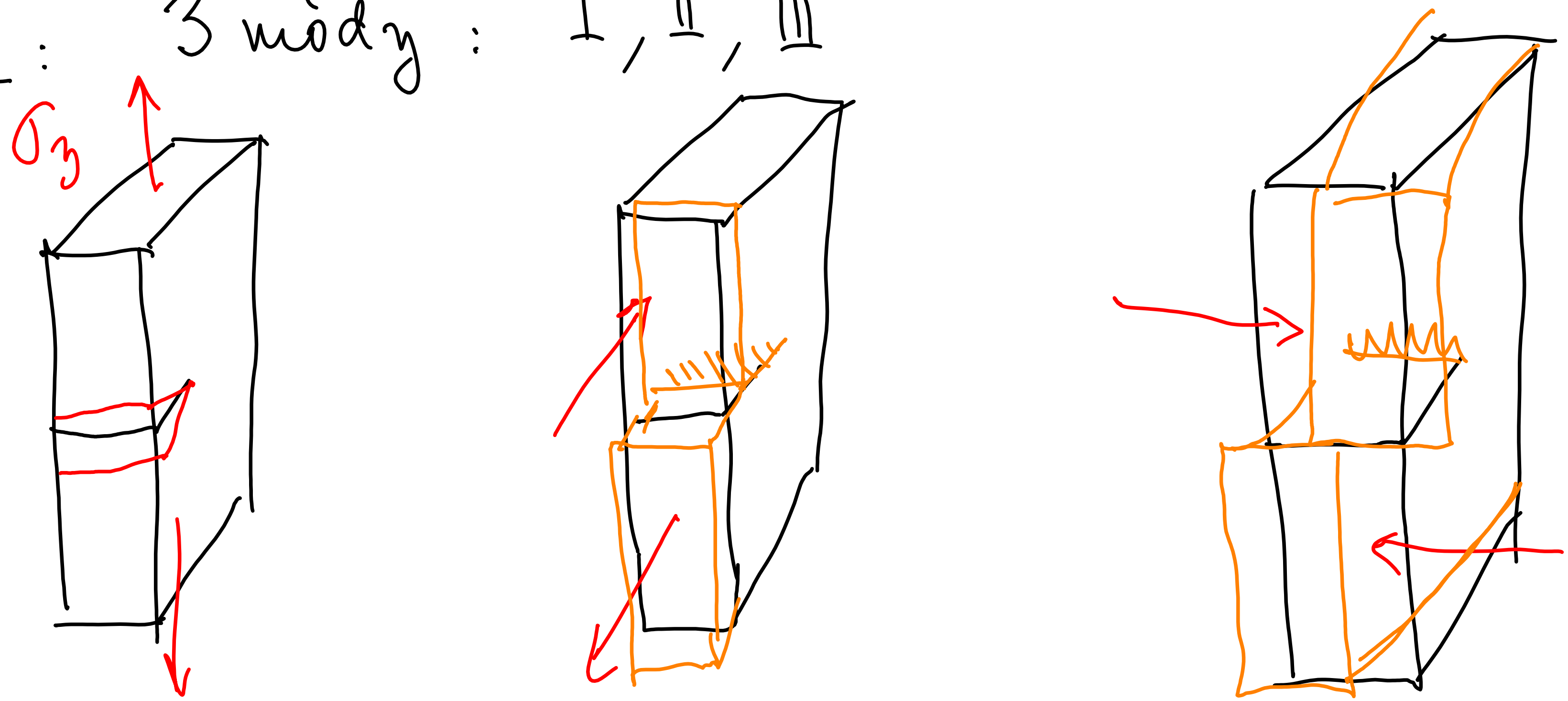


– nemá vliv na šíření trhliny

ZÁVER:

$$\sigma_{ij} = \begin{bmatrix} \sigma_x & \tau_{xy} & \tau_{xz} \\ & \sigma_y & \tau_{yz} \\ & & \sigma_z \end{bmatrix}$$

Σ: 3 módy: I, II, III



σ_y normál mód (I)

τ_{yx} rovinný smyk m. (II)

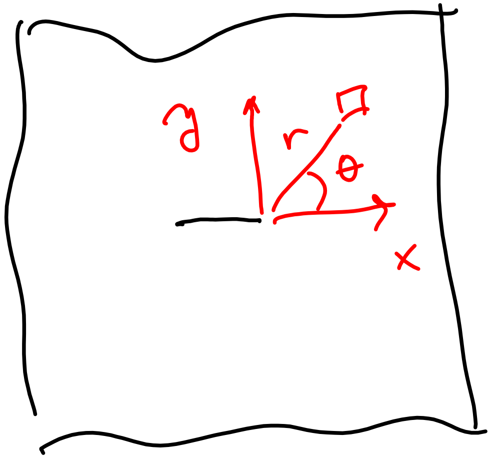
τ_{yz} antirovinný smyk. (III)

Westergaard, 1936?

Airy: $F(x, y)$; $\sigma_x = \frac{\partial^2 F}{\partial x^2}$ $\sigma_y = \frac{\partial^2 F}{\partial y^2}$ $\tau_{xy} = -\frac{\partial^2 F}{\partial x \partial y}$

$$\sigma_{rr} = \frac{1}{r}\frac{\partial F}{\partial r} + \frac{1}{r^2}\frac{\partial^2 F}{\partial \theta^2} \; ; \; \sigma_{\theta\theta} = \frac{\partial^2 F}{\partial r^2}$$

$$\tau_{r\theta} = -\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial F}{\partial \theta}\right)$$



$\sigma_x(r, \theta)$

$\sigma_y(r, \theta)$

$t_{xy}(r, \theta)$

$r \to 0$ σ_x?

Mód I

$\sigma = \sigma_y$

RD

$$\sigma_x(r,\theta) = \frac{\sigma\sqrt{a}}{\sqrt{2r}}\left(1-\sin\frac{\theta}{2}\sin\frac{3\theta}{2}\right)\cos\frac{\theta}{2}$$

$$\sigma_y(r,\theta) = \frac{\sigma\sqrt{a}}{\sqrt{2r}}\left(1+\sin\frac{\theta}{2}\sin\frac{3\theta}{2}\right)\cos\frac{\theta}{2}$$

$$\tau_{xy}(r,\theta) = \frac{\sigma\sqrt{a}}{\sqrt{2r}}\sin\frac{\theta}{2}\cos\frac{3\theta}{2}\cos\frac{\theta}{2}$$

$$\sigma_z(r,\theta) = 2\mu\frac{\sigma\sqrt{a}}{\sqrt{2r}}\cos\frac{\theta}{2}$$

RN $\sigma_z = 0$

RD $\varepsilon_z = 0$

RN

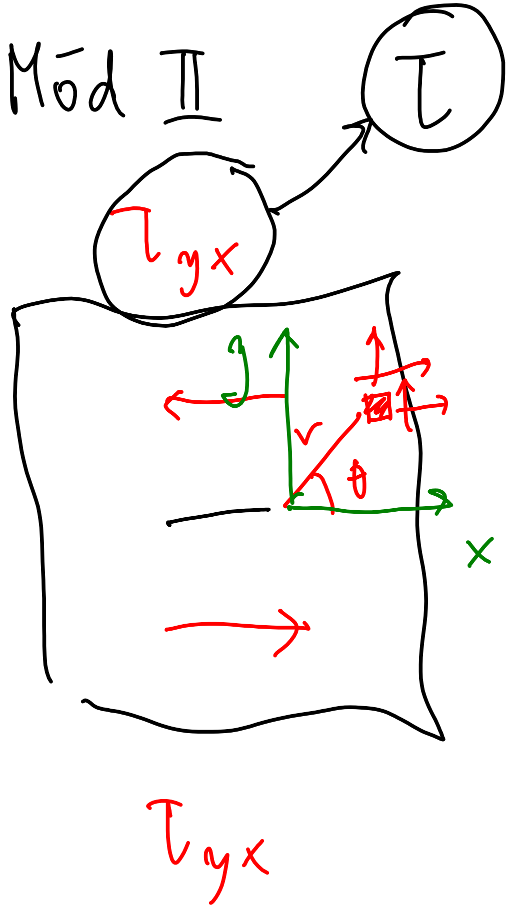
$$\sigma_z = \tau_{xz} = \tau_{yz} = 0$$

$$\varepsilon_x = \frac{1}{E}\left[\sigma_x - \mu(\sigma_y + \sigma_z)\right] \quad \theta$$

$\varepsilon = C\sigma$ — m.m.p. RN

$\sigma = D\varepsilon$ — m.m.t. RN

Mód II



RD:

$$\sigma_x(r,\theta) = -\frac{t\sqrt{a}}{\sqrt{2r}}\left(2+\cos\frac{\theta}{2}\cos\frac{3\theta}{2}\right)\sin\frac{\theta}{2}$$

$$\sigma_y(r,\theta) = +\frac{t\sqrt{a}}{\sqrt{2r}}\left(\sin\frac{\theta}{2}\cos\frac{\theta}{2}\cos\frac{3\theta}{2}\right)$$

⋮

RN:

Mód III

$$\sigma_x = \sigma_y = 0$$

$$\tau_{xz}(r,\theta) = -\frac{\tau\sqrt{a}}{\sqrt{2r}}\sin\frac{\theta}{2}$$

$$\tau_{yz}(r,\theta) = \frac{\tau\sqrt{a}}{\sqrt{2r}}\cos\frac{\theta}{2}$$

I - σ (σ_y)

II - τ (τ_{yx})

III - τ (τ_{yz})

Σ:

$$\sigma_{ij,k}(r,\theta) = \frac{\sigma_k \sqrt{a}}{\sqrt{2r}} \cdot f_{ij,k}(\theta)$$

k ... I, II, III

i,j ... x,y

$$K_I = \sigma\sqrt{\pi a}$$

$$K_{II} = \tau\sqrt{\pi a}$$

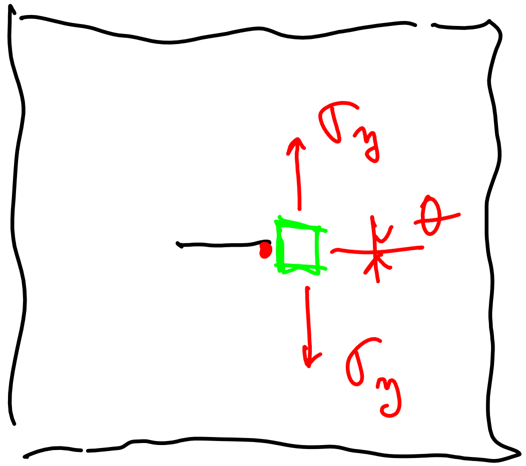
$$K_{III} = \tau\sqrt{\pi a}$$

Faktor intenzity napětí $K_{I,II,III}$ $[MPa\sqrt{mm}]$

$\sigma\sqrt{\pi a}$ $[Pa\sqrt{m}]$

$$\sigma_x(r,\theta) = \frac{K_I}{\sqrt{2\pi r}} \cdot \cos\frac{\theta}{2}\left(1 - \sin\frac{\theta}{2}\sin\frac{3\theta}{2}\right)$$

$$K_I = \lim_{r\to 0}\sqrt{2\pi r}\,\sigma_y(r,0)$$



$$K_I = \sigma\sqrt{\pi a} \quad ✓$$

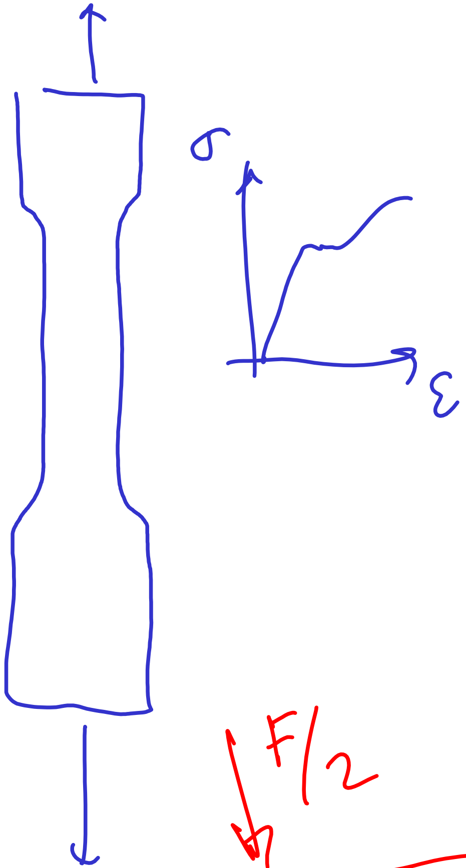
$$K_{II} = \lim_{r\to 0}\sqrt{2\pi r}\,\tau_{yx}(r,\theta)$$

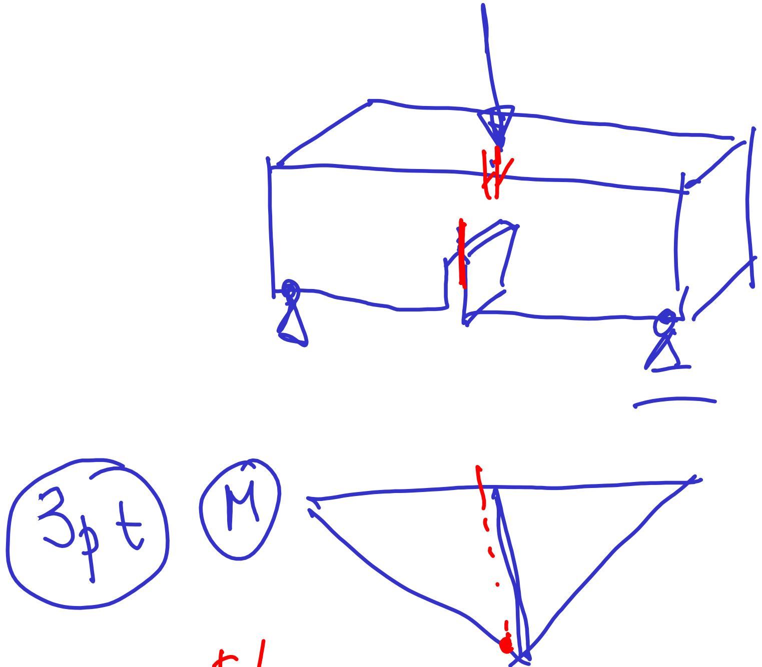
$$K_{II} = \tau\sqrt{\pi a} \quad ✓$$

K – velmi běžně používané veličina

– posouzení stability trhliny

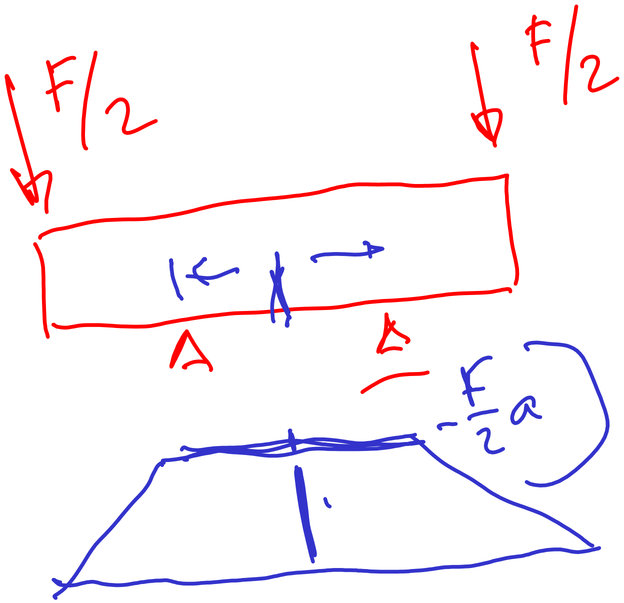
$K_I < K_{I.c}$ $K_{II} < K_{II.c}$ $K_{III} < K_{III.c}$

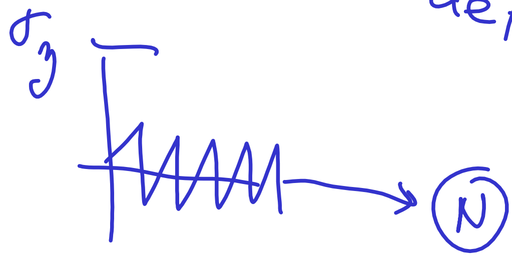


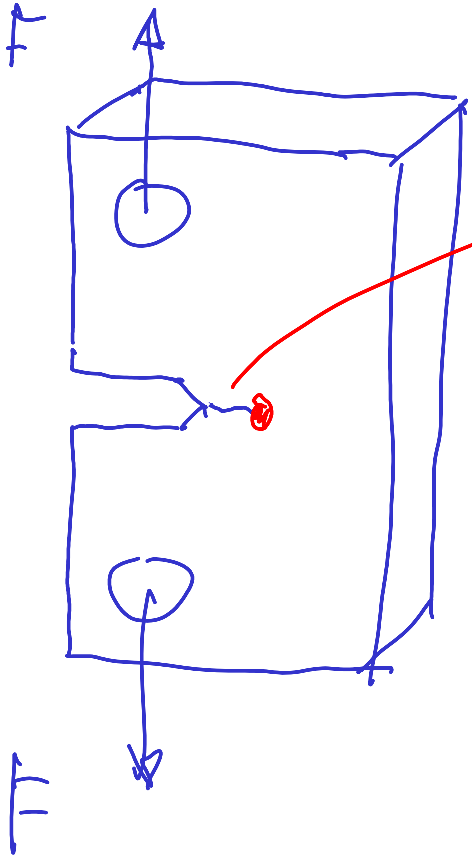


L.

předcyklová
N vysoké
∅ plast. def.





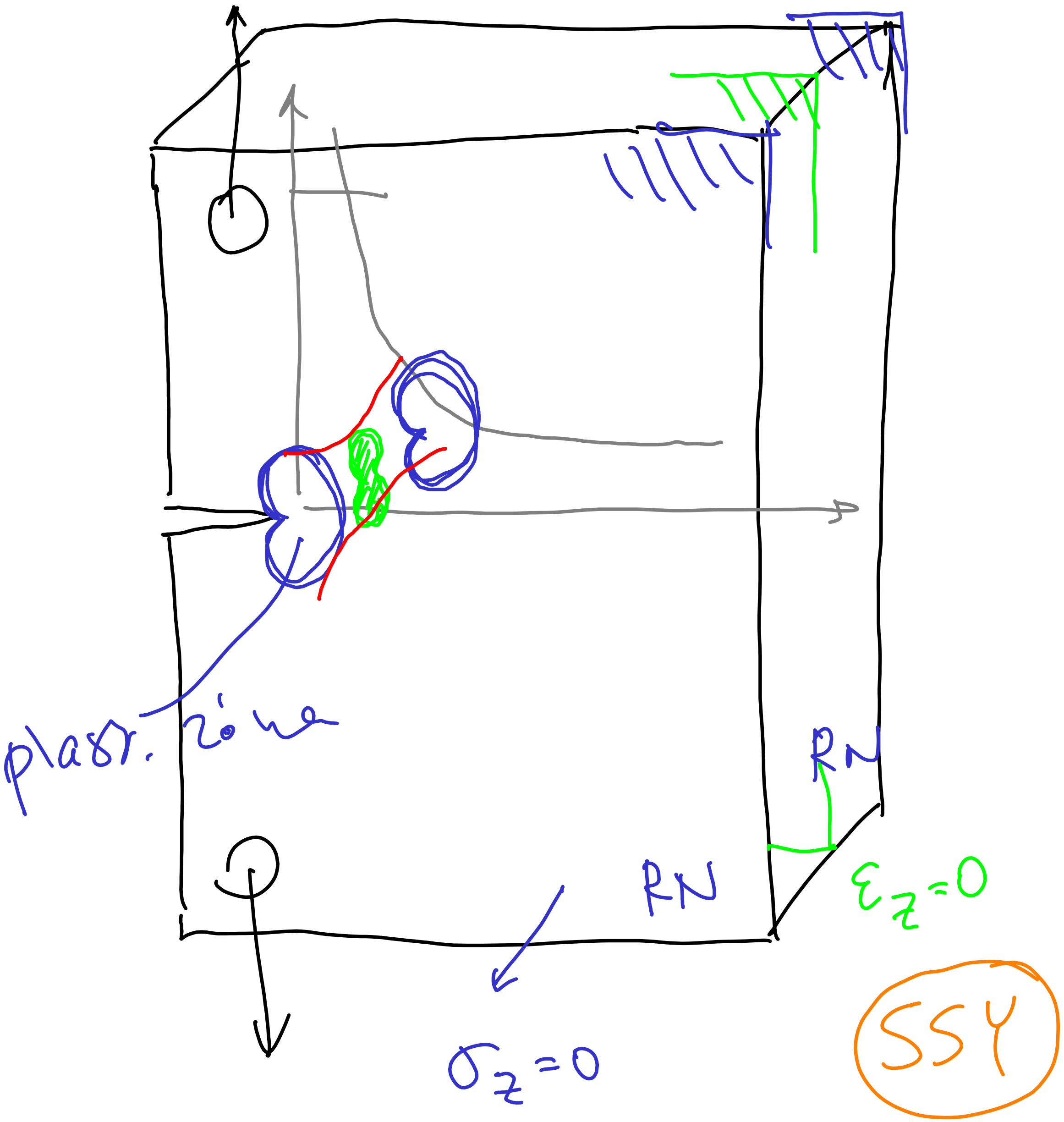


předcykl. trhlina (~~nízko~~ vysoko cykl. únava)

$\sigma < R_y$

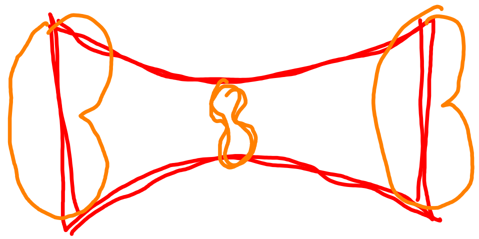
(LLM) $\sigma < R_y$

✓ SSY ... small scale yielding



$$\left.\begin{aligned} &\sigma_x(r,\theta)\\ &\sigma_y(r,\theta)\\ &\tau_{xy}(r,\theta)\end{aligned}\right\}\ \text{HMH}$$

$$\sigma_{red} > R_y$$



malá plast. zóna

KRITICKÁ DÉLKA TRHLINY

$K_I = \sigma\sqrt{\pi a}$

provozní napětí σ_p

pro toto σ_p určit délku a_c

$K^2 = \sigma_p^2 \pi a$

$$a_c = \frac{1}{\pi} \cdot \left(\frac{K_c}{\sigma_p}\right)^2$$

K_c - mat

σ_p - působí provoz. napětí

TRANZITNÍ VELIKOST TRHLINY a_t

- dojde k plastické def. nebo lomu?

$$K_I = \sigma\sqrt{\pi a}$$

Dáno: $\sigma = R_y$

K_c

$$K_c = R_y\sqrt{\pi a}$$

$$K_c^2 = R_y^2 \pi a$$

$$a_t = \frac{1}{\pi} \cdot \left(\frac{K_c}{R_y}\right)^2$$

lom. houž. (K_c)

mez. kluzu