INSTYTUT MECHANIKI
I PODSTAW KONSTRUKCJI MASZYN
WYDZIAŁU MECHANICZNEGO

WYTĘŻENIE MATERIAŁU.

ks

Dla jednoosiowego rozciągania

$$W=\frac{\sigma}{K_r} \qquad K_r \left\langle \begin{matrix} R_e \\ R_m \end{matrix} \right.$$

$$0 \leq W \leq 1$$

dla stanu złożonego

$$F=F((s_{ik}),c_j)=F(\sigma_x,\sigma_y,\sigma_z,\tau_{xy},\tau_{yz},\tau_{zx},E,\nu,\dots)$$

$$F_0=F_0(\sigma_0,c_j)$$

$$F=F_0 \quad \Rightarrow \quad \sigma_0=\dots$$

$$\sigma_0=f(\sigma_x,\sigma_y,\sigma_z,\tau_{xy},\tau_{yz},\tau_{zx},c_j)$$

$$\sigma_0=\varphi(\sigma_1,\sigma_2,\sigma_3,c_j)$$

$$W=\frac{\sigma_0}{K_r}$$

$$\boxed{\sigma_0 \leq k_r} \qquad k_r=\frac{K_r}{n}$$

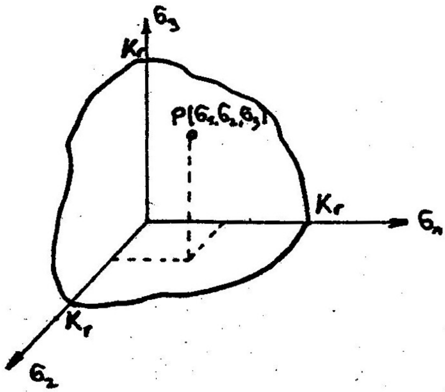
$$W \leq \frac{1}{n}$$

$\sigma_0 = K_r$

$W = 1$

$f(\sigma_x, \sigma_y, \sigma_z, \tau_{xy}, \tau_{yz}, \tau_{zx}) = K_r$

$\varphi(\sigma_1, \sigma_2, \sigma_3, c_j) = K_r$



Hipotezy wytężeniowe:

I Naprężeniowe:

1. $[\sigma_{max}]$ Galileusz
2. $[\sigma_{extr}]$ Clebsch - Rankine
3. $[\tau_{max}]$ Coulomb-Tresca-Guest

II Odkształceniowe

1. $[\varepsilon_{max}]$ de Saint Venant
2. $[\varepsilon_{extr}]$ Grashof

III Energetyczne

1. $[\Phi]$ Beltrami
2. $[\Phi_f]$ Huber-Mises-Hencky
3. $[\omega_1, \omega_2]$ Burzyński

IV Mieszane

1. $[\varepsilon_{max}/\tau_{max}]$ Dawidenkow-Fridman
2. $[\varepsilon_{extr}/\Phi_f]$ Pełczyński

V Probabilistyczne

h. [σ_{max}]

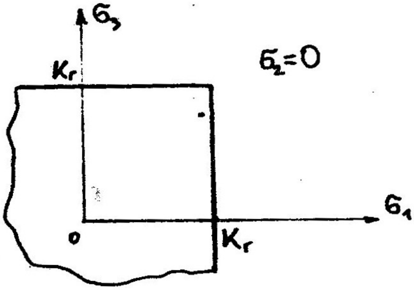
$$\left.\begin{aligned} F((s_{ik}), c_j) &= \sigma_I \\ F_0(\sigma_0, c_j) &= \sigma_0 \end{aligned}\right\} F = F_0$$

$$\boxed{\sigma_0 = \sigma_I}$$

$\sigma_I = \sigma_1 \qquad \sigma_1 = K_r$

$\sigma_I = \sigma_2 \qquad \sigma_2 = K_r$

$\sigma_I = \sigma_3 \qquad \sigma_3 = K_r$



h. [σ_{extr}]

$\sigma_I = K_r\,; \qquad \sigma_{III} = -K_c$

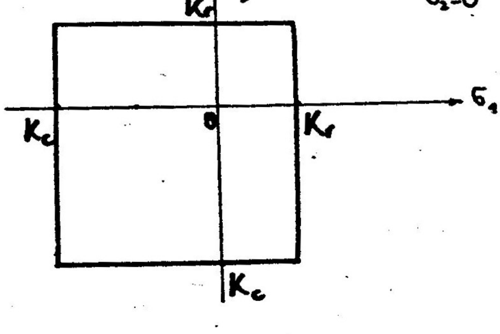
$$z = \frac{K_c}{K_r}$$

$$\sigma_{III} = -z K_r$$

$$F((s_{ik}), c_j) = \max\left(\sigma_I, -\frac{\sigma_{III}}{z}\right)$$

$$F_0(\sigma_0, c_j) = \sigma_0$$

$$\boxed{\sigma_0 = \max\left(\sigma_I, -\frac{\sigma_{III}}{z}\right)}$$

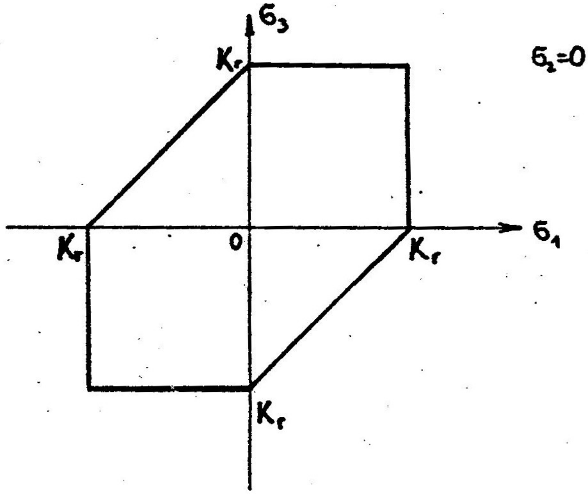


h. [τ_{max}]

$$F\left((s_{ik}), c_j\right) = \frac{\sigma_I - \sigma_{III}}{2}$$

$$F_0\left(\sigma_0, c_j\right) = \frac{\sigma_0}{2}$$

$$\boxed{\sigma_0 = \sigma_I - \sigma_{III}}$$

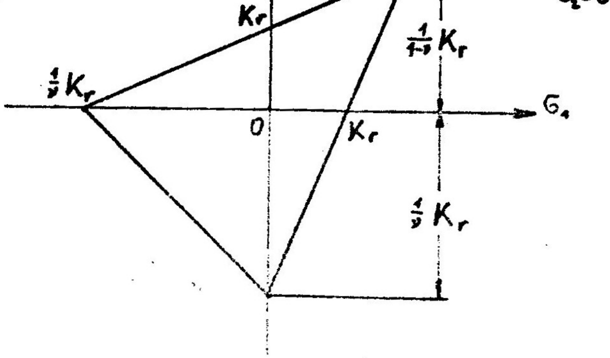


h. [ε_{max}]

$$F\left((\sigma_{ik}), c_j\right) = \frac{1}{E}\left[\sigma_I - \nu(\sigma_{II} + \sigma_{III})\right]$$

$$F_0\left(\sigma_0, c_j\right) = \frac{\sigma_0}{E}$$

$$\boxed{\sigma_0 = \sigma_I - \nu(\sigma_{II} + \sigma_{III})}$$

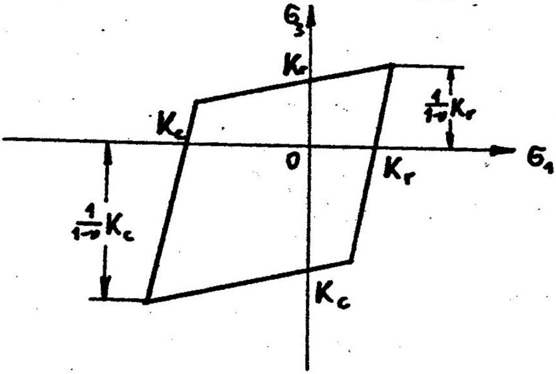


h. [ε_{extr}]

$$F((s_{ik}),c_j) = \max\begin{cases} \frac{1}{E}\left[\sigma_I - \nu(\sigma_{II}+\sigma_{III})\right] \\ -\frac{1}{zE}\left[\sigma_{III} - \nu(\sigma_I+\sigma_{II})\right]. \end{cases} \qquad z = \frac{K_c}{K_r}$$

$$F_0(\sigma_0,c_j) = \frac{\sigma_0}{E}$$

$$\sigma_0 = \max\begin{cases} \sigma_I - \nu(\sigma_{II}+\sigma_{III}) \\ -\frac{1}{z}\left[\sigma_{III} - \nu(\sigma_I+\sigma_{II})\right] \end{cases}$$



h. [ϕ]

$$F((s_{ik}),c_j) = \frac{1}{2E}\left[\sigma_x^2+\sigma_y^2+\sigma_z^2 - 2\nu(\sigma_x\sigma_y+\sigma_y\sigma_z+\sigma_z\sigma_x) + 2(1+\nu)(\tau_{xy}^2+\tau_{yz}^2+\tau_{zx}^2)\right]$$

$$F_0(\sigma_0,c_j) = \frac{\sigma_0^2}{2E}$$

$$\sigma_0 = \sqrt{\sigma_x^2+\sigma_y^2+\sigma_z^2 - 2\nu(\sigma_x\sigma_y+\sigma_y\sigma_z+\sigma_z\sigma_x) + 2(1+\nu)(\tau_{xy}^2+\tau_{yz}^2+\tau_{zx}^2)} =$$

$$= \sqrt{\sigma_1^2+\sigma_2^2+\sigma_3^2 - 2\nu(\sigma_1\sigma_2+\sigma_2\sigma_3+\sigma_3\sigma_1)}$$

h. [Φ_f]

$$F\left((s_{ik}), c_j\right) = \frac{3}{4G}\,\omega_2^2$$

$$\omega_2 = \frac{1}{3}\sqrt{(\sigma_x-\sigma_y)^2+(\sigma_y-\sigma_z)^2+(\sigma_z-\sigma_x)^2+6\left(\tau_{xy}^2+\tau_{yz}^2+\tau_{zx}^2\right)} =$$

$$= \frac{1}{3}\sqrt{(\sigma_1-\sigma_2)^2+(\sigma_2-\sigma_3)^2+(\sigma_3-\sigma_1)^2}$$

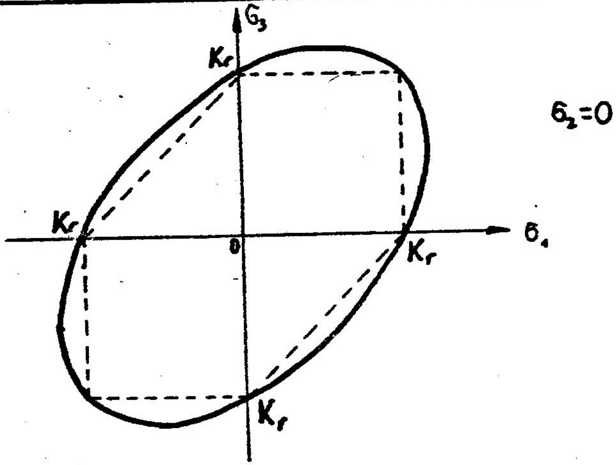
$$F_0(\sigma_0, c_j) = \frac{3}{4G}\,(\omega_2)_0^2$$

$$(\omega_2)_0 = \frac{\sqrt{2}}{3}\,\sigma_0$$

$$\frac{\cancel{3}}{\cancel{4G}}\cdot\frac{2}{9}\,\sigma_0^2 = \frac{\cancel{3}}{\cancel{4G}}\,\omega_2^2$$

$$\boxed{\sigma_0 = \frac{3}{\sqrt{2}}\,\omega_2}$$

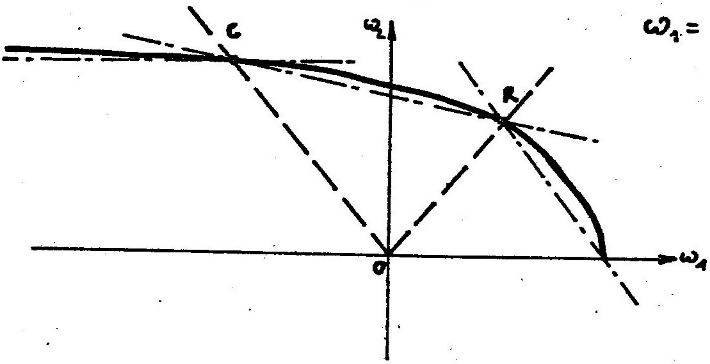
$$\boxed{\sigma_0 = \frac{1}{\sqrt{2}}\sqrt{(\sigma_x-\sigma_y)^2+(\sigma_y-\sigma_z)^2+(\sigma_z-\sigma_x)^2+6\left(\tau_{xy}^2+\tau_{yz}^2+\tau_{zx}^2\right)}}$$



h. $[\omega_1, \omega_2]$

$$F((s_{ik}), c_j) = \Phi_f + \eta\, \Phi_v \qquad 0 \leq \eta \leq 1$$

$$\frac{3}{4G}\,\omega_2^2 + \eta\,\frac{3}{4H}\,\omega_1^2 = \mathrm{Const}$$



$$\omega_1 = \frac{1}{3}(\sigma_x + \sigma_y + \sigma_z)$$

$$R \begin{cases} \omega_1 = \frac{1}{3} K_r \\ \omega_2 = \frac{\sqrt{2}}{3} K_r \end{cases}$$

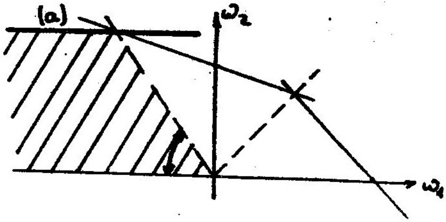
$$C \begin{cases} \omega_1 = -\frac{1}{3} K_c \\ \omega_2 = \frac{\sqrt{2}}{3} K_c \end{cases}$$

zakres I

$$-\sqrt{2} \leqslant \frac{\omega_2}{\omega_1} \leqslant 0$$

(a) $$\omega_2 = \frac{\sqrt{2}}{3} K_c = \frac{\sqrt{2}}{3} z K_r$$

$$\sigma_0 = \frac{1}{z}\,\frac{3}{\sqrt{2}}\,\omega_2$$

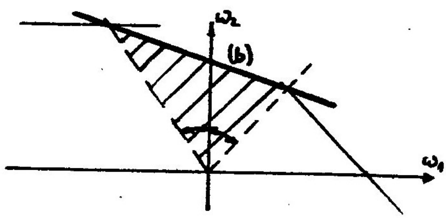


zakres II

$$\begin{cases} -\infty \leqslant \frac{\omega_2}{\omega_1} \leqslant -\sqrt{2} \\ \sqrt{2} \leqslant \frac{\omega_2}{\omega_1} \leqslant \infty \end{cases}$$

(b) $$\omega_2 = -\sqrt{2}\,\frac{z-1}{z+1}\,\omega_1 + \frac{2\sqrt{2}}{3}\,\frac{z}{z+1}\,K_r$$

$$\sigma_0 = \frac{3}{2\sqrt{2}}\,\frac{z+1}{z}\,\omega_2 + \frac{3}{2}\,\frac{z-1}{z}\,\omega_1$$

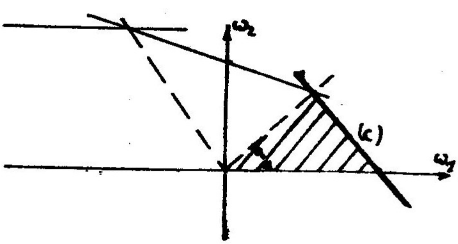


zakres III

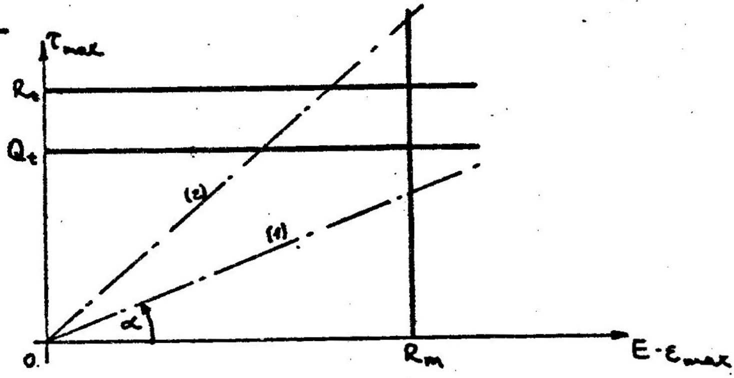
$$0 \leqslant \frac{\omega_2}{\omega_1} \leqslant \sqrt{2}$$

(c) $$\omega_2 = -\sqrt{2}\,(z-1)\,\omega_1 + \frac{\sqrt{2}}{3}\,z\,K_r$$

$$\sigma_0 = \frac{3}{\sqrt{2}} \cdot \frac{1}{z}\,\omega_2 + 3\,\frac{z-1}{z}\,\omega_1$$



h. [ε_{max} / τ_{max}]



$$\tau_{max} = \frac{\sigma_I - \sigma_{III}}{2}$$

$$E \cdot \varepsilon_{max} = \sigma_I - \nu(\sigma_{II} + \sigma_{III})$$

$$\tau_{max} = m \, E \varepsilon_{max}$$

$$m = tg\alpha = \frac{\sigma_I - \sigma_{III}}{2[\sigma_I - \nu(\sigma_{II} + \sigma_{III})]}$$

n.p. dla (1) $\longrightarrow$ h. [ε_{max}]

dla (2) $\longrightarrow$ h. [τ_{max}]

PK Zam. 218/78 - 1000 egz.