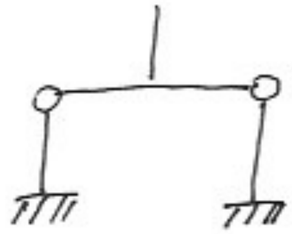
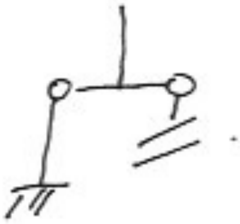
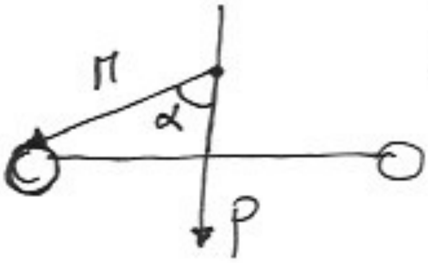


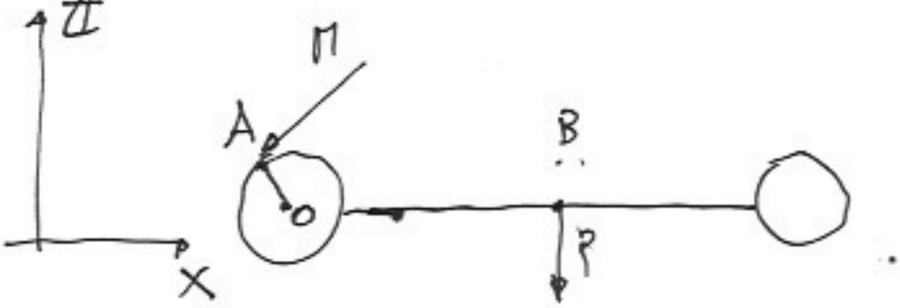
bipodalica



monopodalica

$\alpha = 45^\circ$ bipodalica
$\alpha = 16^\circ$ monopodalica





$$\bar{M} \cdot \overline{OA} = \bar{P} \cdot \overline{OB}$$

$$\bar{M} = \bar{P} \cdot \frac{\overline{OB}}{\overline{OA}} \qquad \frac{\overline{OB}}{\overline{OA}} = K \simeq 10$$

$$\bar{M} = K \bar{P}$$

$$R_z = -P - M\cos\alpha = -P - KP\cos\alpha$$

$$R_x = -M\sin\alpha = -KP\sin\alpha$$

$$R = \sqrt{R_z^2 + R_x^2} = \sqrt{P^2(1+K^2\cos^2\alpha + 2K\cos\alpha) + K^2P^2\sin\alpha}$$

$$R = P\sqrt{1+K^2\cos^2\alpha + K^2\sin^2\alpha + 2K\cos\alpha} = P\sqrt{1+K^2+2K\cos\alpha}$$

$P = P_{ind} + \underline{\alpha} P_{ind}$ 10% < α < 13%.

$\overset{\shortparallel}{P_{agg}} \simeq 10\,kg \cdot g \simeq 100\,N$

$\underline{P = 800\,N}$

· bipodalico

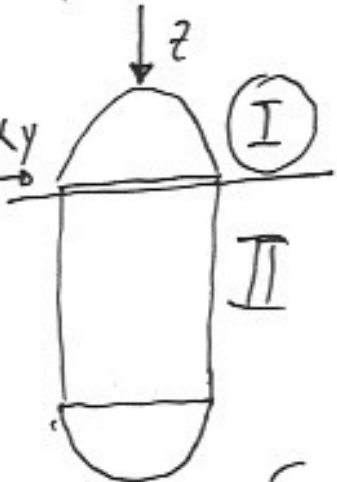
$|R_z| = P(1+K\cos\alpha) = 800\,(1+10\cos 45°) = 6456\,N$

$|R_x| = PK\sin\alpha = 800 \cdot 10 \cdot \sin 45° = 5656\,N$

· monopodalico

$|R_z| = P(1+K\cos\alpha) = 800\,(1+10\cos 16°) = 8490\,N$

$|R_x| = PK\sin\alpha = 800 \cdot 10 \cdot \sin 16° = 2205\,N$



$\sigma = \varepsilon E$

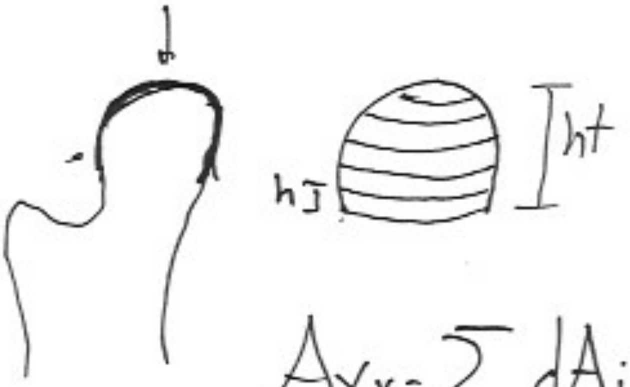
$\varepsilon = \dfrac{\sigma}{E} = \dfrac{F}{AE}$

bipodalico $E_{os} = 0.5\,GPa$

$\varepsilon_z = \dfrac{F_z}{A_z E_{os}} = \dfrac{6456}{2\pi R^2 \cdot 0.5\,10^9} = \dfrac{6456}{6.28 \cdot 4 \cdot 10^{-4} \cdot 0.5 \cdot 10^9} =$

$R = 2\,cm$ $\varepsilon_z =$ $\varepsilon_z = 514 \cdot 10^{-5} = 0.5$ mstraim

$\varepsilon_{xy} = \dfrac{F_{xy}}{A_{xy} E_{os}} = \dfrac{5656}{0.5 \cdot 10^9 A_{xy}}$



$$A_{xy} = \sum dA_i$$

$$A_{xy} = \int 2\pi r \, dz = \int_{h_{ost}}^{h_t} 2\pi r \, dz$$

$$r = \sqrt{x^2+y^2+z^2} \qquad = \int_{h_{ost}}^{h_t} 2\pi \sqrt{x^2+y^2+z^2} \, dz =$$

$$= \frac{2}{3}\pi \left[\frac{(x^2+y^2+h_t^2)^{\frac{3}{2}}}{h_t} - \underbrace{\frac{(x^2+y^2+h_{ost}^2)^{\frac{3}{2}}}{h_{ost}}}_{\approx \varnothing} \right]$$

$h_{ost} = 100\,nm$

$$A_{xy} = \frac{2}{3}\pi \left[\frac{(x^2+y^2+h_t^2)^{\frac{3}{2}}}{h_t} \right] = \boxed{\left(\frac{2}{3}\pi \frac{r^3}{h_t} \right)}$$

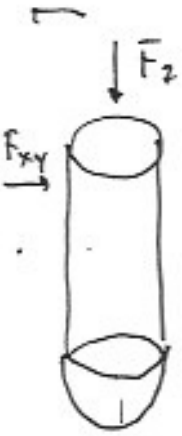
$$A_{xy} = \frac{2}{3}\pi \frac{r^3}{r} = \frac{2}{3}\pi r^2 = \qquad r = 2\,cm$$

$$= \frac{2 \cdot 3.14}{3} \cdot 4 \cdot 10^{-4} = 8.37 \cdot 10^{-4}\, m^2$$

$$\varepsilon_{xy} = \frac{F_{xy}}{A_{xy}\cdot E_{os}} = \frac{5656}{8.37\cdot 10^{-4}\cdot 0.5\cdot 10^{9}} = 1351\cdot 10^{-5} =$$

$$= 13.51 \text{ m strain}$$

$\varepsilon_z = 0.5$ m strain



$$\varepsilon_z = \frac{F_z}{A_z\cdot E_{oc}^{z}} = \frac{6456}{\pi R^2\cdot 17\cdot 10^{9}} = \frac{6456}{3.14\cdot 4\cdot 10^{-4}\cdot 17\cdot 10^{9}}$$

$$\boxed{\varepsilon_z = \frac{F_z}{A_z E_{oc}^{z}} + \frac{F_z}{A_z E_{os}} =}$$

$$\varepsilon_z = 30\cdot 10^{-5} = $$

$$= 300\,\mu\text{strain.}$$

$$\varepsilon_{xy} = \frac{F_{xy}}{A_{xy}\cdot E_{oc}^{xy}} = \frac{5656}{12\cdot 10^{9}\cdot 62.8\cdot 10^{-3}} = 75\cdot 10^{-6}$$

$$= 75\,\mu\text{strain}$$

$$A_{xy} = 2\pi r\cdot h = 6.28\cdot 2\cdot 10^{-2}\cdot 5\cdot 10^{-1} = 62.8\cdot 10^{-3}$$

$$h = 50\text{ cm} = 5\cdot 10^{-1}\text{ m}$$

$$\varepsilon_z^{II} = 300\,\mu\text{strain} + 0.5\text{ m strain} = 800\,\mu\text{ strain}$$

$\varepsilon_{xy}^{II} =$
- 13.51 mstrain $+ 75\,\mu$strain $= 1426\,\mu$strain
- 13.51 mstrain
- $75\,\mu$strain

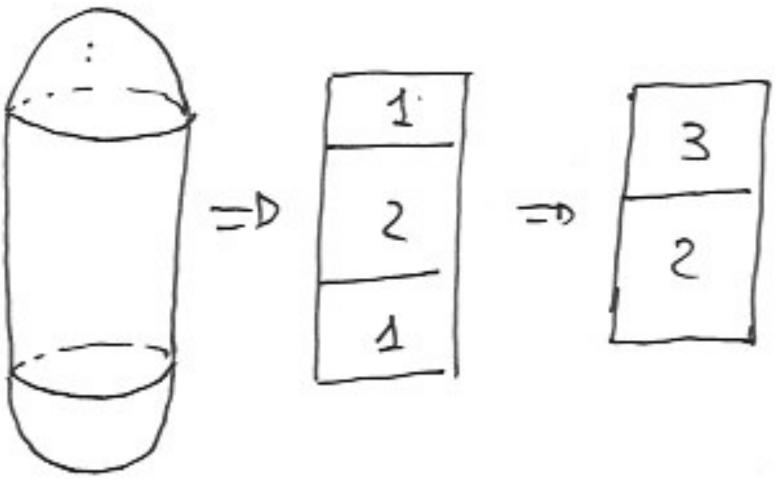
$$\varepsilon_{osso\ sano} = \varepsilon_{osso\ residuo + protesi}$$

Elasticità

$$\sigma = \varepsilon E$$

$$\frac{\cancel{\sigma}}{E_{sano}} = \frac{\cancel{\sigma}}{E_{osso\ residuo + protesi}}$$

$$\underline{E_{sano}} = E_{osso\ residuo + protesi}$$



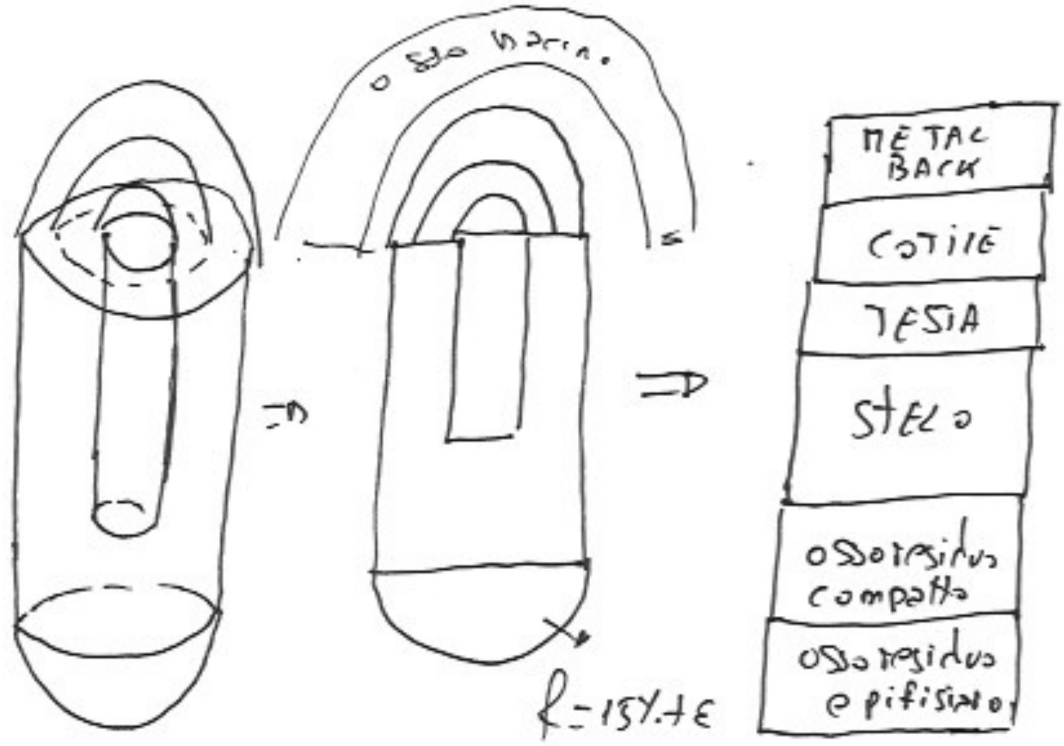
$f_1 = 15\%$

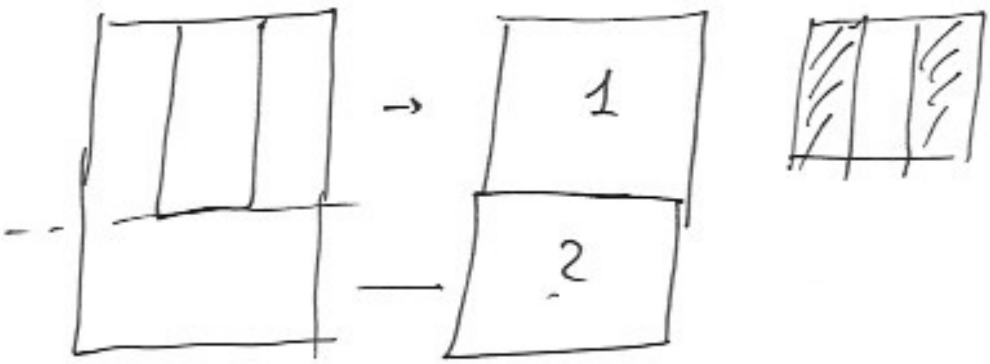
$f_3 = 30\%$

$f_2 = 70\%$

$$E_z = \frac{E_3 \cdot E_2}{f_2 \cdot E_3 + f_3 \cdot E_2} \qquad E_{xy} = f_3 E_3 + f_2 E_2$$

$$\boxed{E_{osso\ sano}}$$



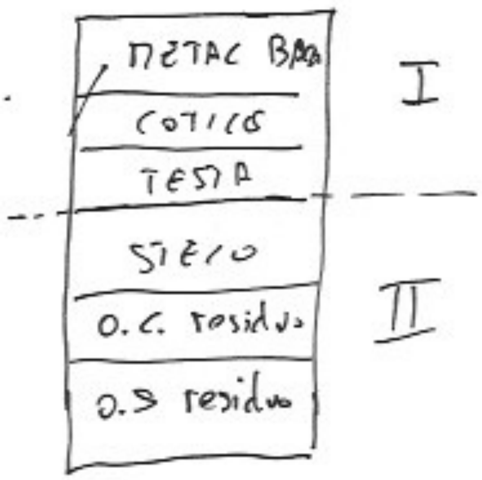


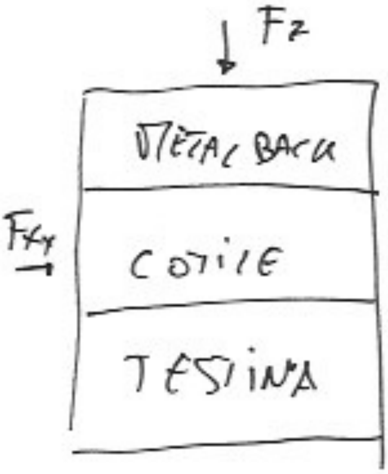
Omogenizzazione $E_{osso\,sano} = E_{osso\,resi+protesi}$

↓ Completa

↓ parziale

Puntuale $\mathcal{E}_{osso\,sano} = \mathcal{E}_{osso\,residuo+protesi}$





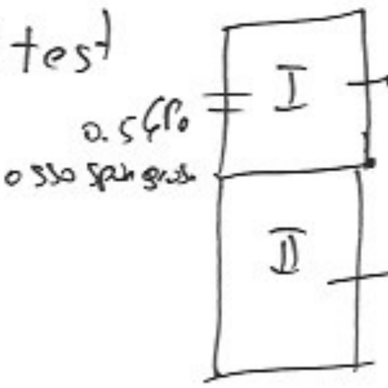
$$\begin{cases} \dfrac{1}{E_z} = \dfrac{f_{MB}}{E_{MB}} + \dfrac{f_{COT}}{E_{COT}} + \dfrac{f_{TEST}}{E_{TEST}} \\[2ex] E_{xy} = f_{MB}E_{MB} + f_{COT}E_{COT} + f_{TEST}E_{TEST} \\[2ex] f_{MB} + f_{COT} + f_{TEST} = 1 \end{cases}$$

$$\boxed{V_{TOT} = V_{MB} + V_{COT} + V_{TEST}}$$

ℓ_{est} METAL BACK

ℓ_{int} METAL BACK

ℓ_{test}



I $\rightarrow$ $\dfrac{E_{osso\,sano}}{}$ =

II $\rightarrow$ $E_{osso\,sano}$

E_z sano

$\rightarrow E_{xy}$ san.

$$E_z = \frac{E^z_{oc} \cdot E_{os}}{f_{os} \cdot E^z_{oc} + f_c \cdot E_{os}}$$

$$E_{xy} = f_{oc} E^{xy}_{oc} + f_{os} E_{os}$$

$$f_{TEST} = \frac{V_{TEST}}{V_{TOTALE}} = \frac{\frac{2}{3}\pi r^3_{TEST}}{\frac{2}{3}\pi r^3_{ac}}$$

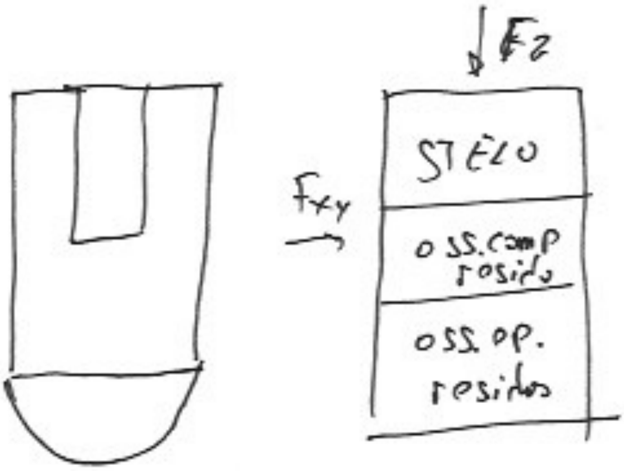
$$f_{TEST} = \left(\frac{r_{TEST}}{r_{ac}}\right)^3$$

$$f_{COT} = \frac{V_{COT}}{V_{TOTALE}} = \frac{\frac{2}{3}\pi r^3_{COT} - \frac{2}{3}\pi r^3_{TEST}}{\frac{2}{3}\pi r^3_{ac}} =$$

$$f_{COT} = \frac{r^3_{COT} - r^3_{TEST}}{r^3_{ac}}$$

$$f_{MB} = \frac{V_{MB}}{V_{TOT}} = \frac{\frac{2}{3}\pi r^3_{ac} - \frac{2}{3}\pi r^3_{COT}}{\frac{2}{3}\pi r^3_{ac}} =$$

$$f_{MB} = 1 - \left(\frac{r_{COT}}{r_{ac}}\right)^3$$

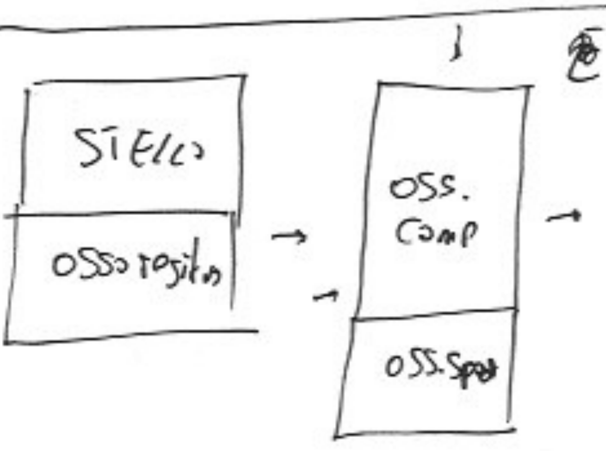


$$\begin{cases} \dfrac{1}{E_z} = \dfrac{f_{ST}}{E_{ST}} + \dfrac{f_{oss\,comp}}{E^{z}_{oss\,comp}} + \dfrac{f_{oss\,sp}}{E_{oss\,sp}} \\ E_{xy} = f_{ST} E_{ST} + f_{oss\,comp} E^{xy}_{oc} + f_{oss\,res} E_{oss} \\ f_{ST} + f_{oss\,comp} + f_{oss\,spongiosa\,residuo} = 1 \end{cases}$$

$$E^{z}_{os.comp\,residuo} = \underset{\substack{\shortparallel \\ 17\,GPa}}{E_0} (1-p)^{\alpha} A^{\beta} \dot{\varepsilon} \delta^{\gamma}$$

$$E^{xy}_{os.comp\,residuo} = \underset{\substack{\shortparallel \\ 12\,GPa}}{E_0} (1-p)^{\alpha} A^{\beta} \dot{\varepsilon} \delta^{\gamma}$$

$$E_{os.sp.residuo} = \underset{\substack{\shortparallel \\ 0.5\,GPa}}{E_0} (1-p)^{\alpha} A^{\beta} \dot{\varepsilon} \delta^{\gamma}$$

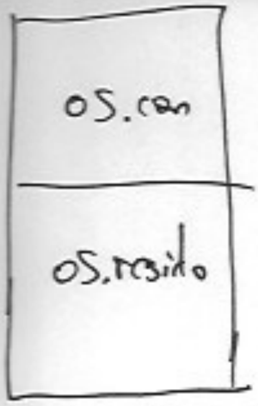


$$\cancel{E^{*}_{z} = E^{z}_{oss\,comp}\ E_{os}}$$

$$E^{*}_{z} = \frac{E^{z}_{oss\,comp} \cdot E_{oss\,sp}}{f_{os} E^{z}_{oss\,comp} + f_{oc} E_{oss\,sp}}$$

$$E^{*}_{xy} = E^{xy}_{oss.comp} f_{oc} + f_{os\,spon} \cdot E_{oss\,sp}$$

$$f_{oc} + f_{os} = 1$$



$$\rightarrow \quad E^*_z = E^*_0$$

$$E^*_{xy} = E^*_0$$

70%

15%

$$E^{reale} = E^*(1-p)^\alpha A^\beta \dot{\varepsilon} \gamma^\delta$$

$$E_z^{sano} = \frac{E_z^{oss.residuo} \cdot E_{stelo}}{f_{st} \cdot E_z^{ossoresiduo} + f_{osres} \cdot E_{st}}$$

$$E_{xy}^{sano} = f_{ST} E_{ST} + f_{os.res} E_{xy}^{ossoresiduo}$$

r stelo

h stelo

$$f_{ST} + f_{ossresiduo} = 1$$

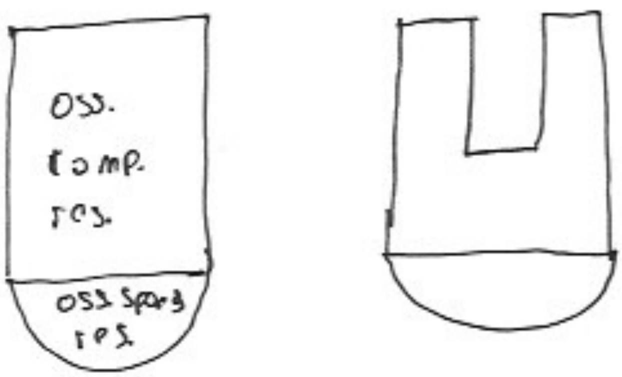
$$f_{ST} = \frac{V_{ST}}{V_{TOTALE}} = \frac{\pi r^2_{st} \cdot h_{st}}{\pi r^2_f \cdot h_{femore} + \frac{2}{3}\pi r^3_f + \varepsilon} \quad \varepsilon \simeq 0$$

$$f_{ossresiduo} = \frac{V_{ossresiduo}}{V_{TOT}} = \frac{\pi r^2_f \cdot h_{femore} - \pi r^2_{st} h_{st} + \frac{2}{3}\pi r^3_f}{\pi r^2_f \, h_{femore} + \frac{2}{3}\pi r^3_f + \varepsilon}$$

$$f_{ossresiduo} = 1 - f_{ST}$$

$$E = E_o^* (1-\rho)^{\alpha}$$ < Ramberg-Osgood

$$E = E_o^* A^{\beta}$$ < "



$$E = E_o^* (1-\rho)^{\alpha} = E_o (1 - f_{ST})^{\alpha}$$ < Ramberg-Osgood

$$E > 1 \text{ GPa}$$

$$E > 1 \qquad E_o (1 - f_{ST})^{\alpha} > 1$$

$$0.5 < E \leq 1 \text{ GPa}$$

$$0.1 < E \leq 0.5 \text{ GPa}$$

$$E \leq 0.1 \text{ GPa}$$