09 - RELACIÓN ENTRE CONSTANTES ELÁSTICAS:

viernes, 9 de julio de 2021 10:26

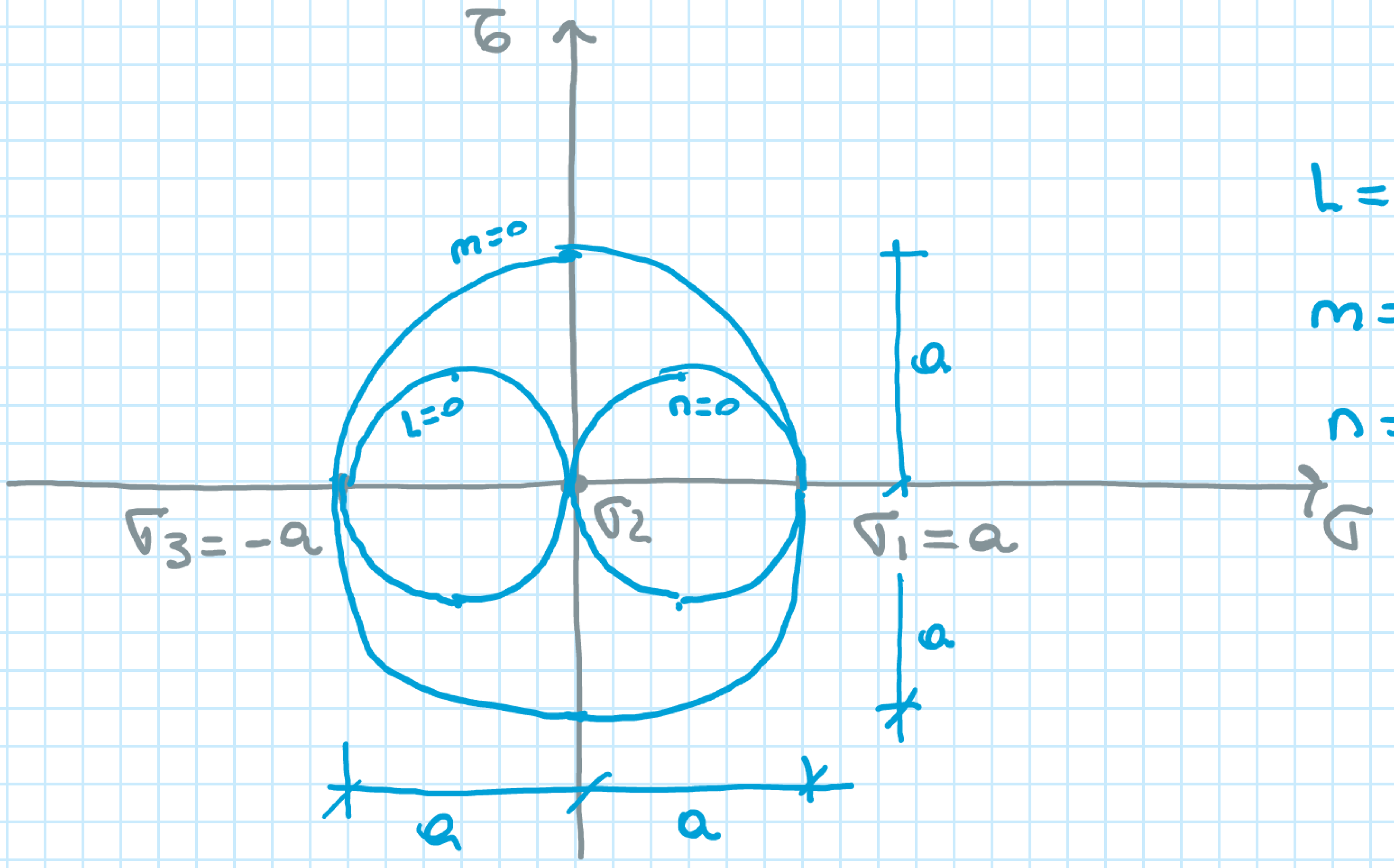
- MATERIAL ELÁSTICO E ISÓTROPO → 3 CTES PROPIAS DEL MATERIAL.

$$E \; ; \; G \; ; \; \mu .$$

- ESTUDIO → TERNA PPAL. → ESTADO PARTICULAR DE TENSIONES.

$$\begin{cases} \sigma_1 = a \\ \sigma_2 = 0 \\ \sigma_3 = -a \end{cases}$$

- ESTE ESTADO DE TENSIÓN → CIRCUNF. DE MOHR.



$l=0 \rightarrow \tau_{máx,1}$

$m=0 \rightarrow \tau_{máx,2}$

$n=0 \rightarrow \tau_{máx,3}$

$\rightarrow \boxed{\tau_{máx} = \tau_{máx,2}} \rightarrow a$

$$\varepsilon_1 = \frac{1}{E}\left[\sigma_1 - \mu(\sigma_2 + \sigma_3)\right] = \frac{1}{E}\left[a - \mu(0 - a)\right] = \boxed{\frac{1+\mu}{E} \cdot a} \checkmark$$

$$\varepsilon_2 = \frac{1}{E}\left[\sigma_2 - \mu(\sigma_1 + \sigma_3)\right] = \frac{1}{E}\left[0 - \mu(a - a)\right] = \boxed{0} \checkmark$$

$$\varepsilon_3 = \frac{1}{E}\left[\sigma_3 - \mu(\sigma_1 + \sigma_2)\right] = \frac{1}{E}\left[-a - \mu(a + 0)\right] = \boxed{-\frac{(1+\mu)\,a}{E}} \checkmark$$

$$\tau_{máx} = a \longrightarrow \boxed{\varepsilon_{t,máx}} = \frac{\tau_{máx}}{2G} = \boxed{\frac{a}{2G} = b}$$

09 - RELACIÓN ENTRE CONSTANTES ELÁSTICAS:

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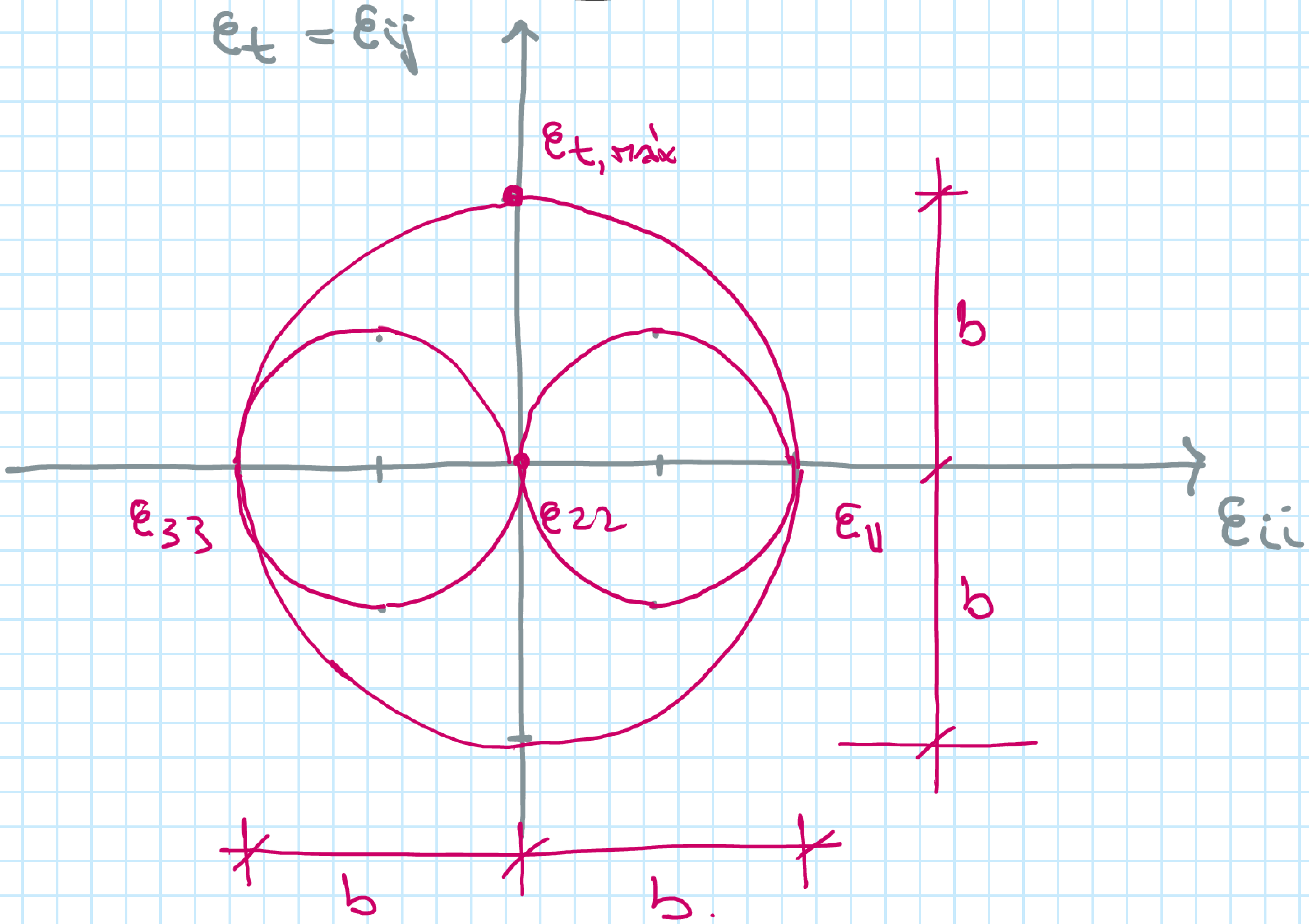
- REPRESENTO EL $\boxed{ED}$ CORRESPONDIENTE AL $\boxed{ET}$ PARTICULAR ANTERIOR.



$$\varepsilon_{11} = \frac{1+\mu}{E}\cdot a = b \quad ; \quad \varepsilon_{t,máx} = \frac{a}{2G} = b.$$

$$\frac{(1+\mu)\,\cancel{a}}{E} = \frac{\cancel{a}}{2G}$$

$$\boxed{\begin{aligned} E &= (1+\mu)\,2G = 2(1+\mu)\,G \\ G &= \frac{E}{2(1+\mu)} \\ \mu &= \frac{E}{2G} - 1. \end{aligned}}$$

$$\varepsilon_{ij} = \frac{\tau_{ij}}{2G} = \frac{\tau_{ij}}{\cancel{2}\cdot\frac{E}{\cancel{2}(1+\mu)}}$$

$$\boxed{\varepsilon_{ij} = \frac{1+\mu}{E}\cdot\tau_{ij}}$$

10 - LEY GENERALIZADA DE HOOKE:

viernes, 9 de julio de 2021 10:59

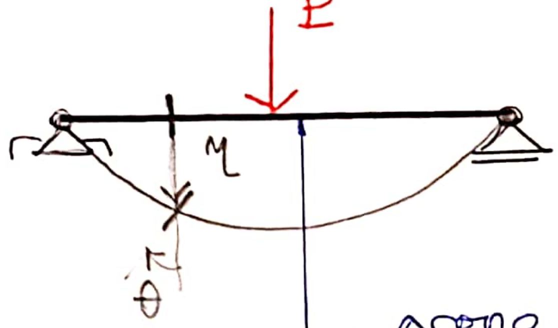
$$
\begin{Bmatrix} \varepsilon_{xx} \\ \varepsilon_{yy} \\ \varepsilon_{zz} \\ \hdashline \varepsilon_{xy} \\ \varepsilon_{yz} \\ \varepsilon_{zx} \end{Bmatrix} = \frac{1}{E} \left[\begin{array}{ccc:ccc} 1 & -\mu & -\mu & & & \\ -\mu & 1 & -\mu & & \underline{0} & \\ -\mu & -\mu & 1 & & & \\ \hdashline & & & (1+\mu) & 0 & 0 \\ & \underline{0} & & 0 & (1+\mu) & 0 \\ & & & 0 & 0 & (1+\mu) \end{array} \right] \begin{Bmatrix} \sigma_x \\ \sigma_y \\ \sigma_z \\ \hdashline \tau_{xy} \\ \tau_{yz} \\ \tau_{zx} \end{Bmatrix}
$$

RELACIONES ENTRE TENSIONES Y DEFORMACIONES:

ET ⇄ ED

MAGNITUDES ESTÁTICAS

MAGNITUDES CINEMÁTICAS



- ACERO η_{AC} θ_{AC}
- MADERA η_{M} θ_{M}
- PLÁSTICO η_{P} θ_{P}

- EL CAMINO DE ESTUDIO P/ ET Y ED → LÓGICO – ANALÍTICO – DEDUCTIVO → ACÁ NO VA A SER APLICABLE

- EL CAMINO A SEGUIR P/ RTyD →
  - EXPERIMENTAL
  - LÓGICO ANALÍTICO DEDUCTIVO

[TT] → 3×3 → 6 SIMÉTRICO.

[TD] → 3×3 → 6 "

$$\boxed{\underset{\substack{\uparrow \\ [TD] \\ 6\times1}}{\{\bar{\varepsilon}_d\}} = \underset{\substack{\uparrow \\ 6\times6}}{[B]}\ \underset{\substack{\uparrow \\ [TT] \\ 6\times1}}{\{\bar{\sigma}\}}}$$

VAMOS A TRABAJAR

- MATERIAL → ISÓTROPO
  → HOMOGÉNEO
- PERÍODO → ELÁSTICO

$$\underset{6\times1}{\begin{Bmatrix} \varepsilon_{xx} \\ \varepsilon_{yy} \\ \varepsilon_{zz} \\ \hline \varepsilon_{xy} \\ \varepsilon_{yz} \\ \varepsilon_{zx} \end{Bmatrix}} = \underset{6\times6}{\begin{bmatrix} a_{11} & \cdots & a_{16} \\ \vdots & & \vdots \\ a_{61} & \cdots & a_{66} \end{bmatrix}} \underset{6\times1}{\begin{Bmatrix} \sigma_x \\ \sigma_y \\ \sigma_z \\ \hline \tau_{xy} \\ \tau_{yz} \\ \tau_{zx} \end{Bmatrix}}$$

- DE LA REALIZACIÓN DE LOS ENSAYOS Y EXPERIMENTOS OBSERVAMOS:

I) → POR ESTAR DENTRO DEL PERIODO ELÁSTICO → SE CUMPLE "LEY DE BETTY" → LEY DE RECIPROCIDAD:

$$\boxed{a_{ij} = a_{ji}} \rightarrow [B] \rightarrow \text{SIMÉTRICA.}$$

II) → EXISTE INDEPENDENCIA. ENTRE:

$\underbrace{\varepsilon_{ii} \text{ y } \sigma_{ij}}_{\text{DISOCIADAS}}$ ← └→ LAS DEFORM. ESPECÍFICAS LONGITUDINALES Y LAS TENSIONES 'τ'

$\underbrace{\varepsilon_{ij} \text{ y } \sigma_{ii}}_{\text{DISOCIADAS.}}$ ← └→ LAS DEFORM. ESPECÍFICAS TRANSV. Y LAS TENSIONES 'σ'.

- LA EXPRESIÓN MATEMÁTICA QUEDARÁ SIMPLIFICADA:

$$\begin{Bmatrix} \varepsilon_{xx} \\ \varepsilon_{yy} \\ \varepsilon_{zz} \\ \hdashline \varepsilon_{xy} \\ \varepsilon_{yz} \\ \varepsilon_{zx} \end{Bmatrix} = \left[\begin{array}{ccc|ccc} a_{11} & a_{12} & a_{13} & & & \\ a_{21} & a_{22} & a_{23} & & 0 & \\ a_{31} & a_{32} & a_{33} & & & \\ \hline & & & a_{44} & a_{45} & a_{46} \\ & 0 & & a_{54} & a_{55} & a_{56} \\ & & & a_{64} & a_{65} & a_{66} \end{array}\right] \begin{Bmatrix} \sigma_x \\ \sigma_y \\ \sigma_z \\ \hdashline \tau_{xy} \\ \tau_{yz} \\ \tau_{zx} \end{Bmatrix}$$

$$\{\bar{\varepsilon}_d\} = [B]\{\bar{\sigma}\}$$

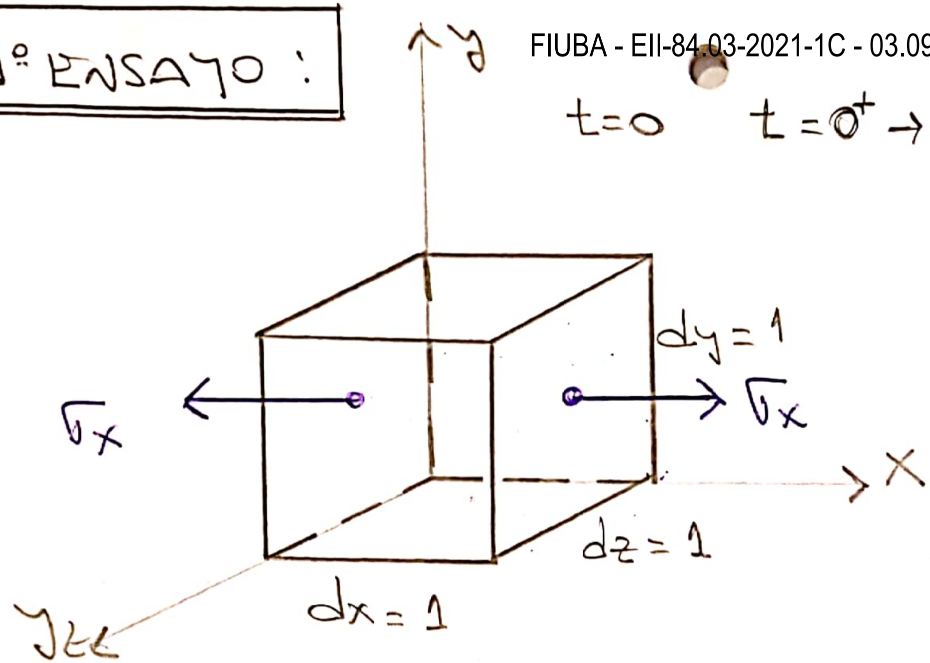
MATRICES CONSTITUTIVAS

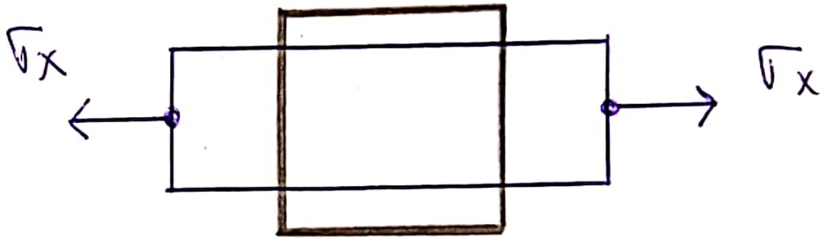
$$\{\bar{\sigma}\} = [E]\{\bar{\varepsilon}_d\}$$

→ $[B]$ y $[E]$ → MATRICES DE ELASTICIDAD.

1º ENSAYO:

$t=0 \qquad t=0^{+} \rightarrow$ APLICO FZAS





$$\varepsilon_{ii} = \frac{\Delta L_{ii}}{L_{0,i} = 1} \rightarrow \varepsilon_{ii} = \Delta L_{ii}$$

1º CASO: $\sigma_x \neq 0 \quad \sigma_y = \sigma_z = 0$

$$\varepsilon_{xx} = \frac{\sigma_x}{E}$$

$$\varepsilon_{yy} = -\mu_{yx}\,\varepsilon_{xx} = -\mu_{yx}\frac{\sigma_x}{E}$$

$$\varepsilon_{zz} = -\mu_{zx}\cdot\varepsilon_{xx} = -\mu_{zx}\frac{\sigma_x}{E}$$

2º CASO: $\sigma_y \neq 0 \quad \sigma_x = \sigma_z = 0$

$$\varepsilon_{yy} = \frac{\sigma_y}{E}$$

$$\varepsilon_{xx} = -\mu_{xy}\cdot\varepsilon_{yy} = -\mu_{xy}\frac{\sigma_y}{E}$$

$$\varepsilon_{zz} = -\mu_{zy}\cdot\varepsilon_{yy} = -\mu_{zy}\cdot\frac{\sigma_y}{E}$$

3º CASO: $\sigma_z \neq 0 \quad \sigma_x = \sigma_y = 0$

$$\varepsilon_{zz} = \frac{\sigma_z}{E}$$

$$\varepsilon_{xx} = -\mu_{xz}\cdot\varepsilon_{zz} = -\mu_{xz}\cdot\frac{\sigma_z}{E}$$

$$\varepsilon_{yy} = -\mu_{yz}\cdot\varepsilon_{zz} = -\mu_{yz}\frac{\sigma_z}{E}$$

EFECTO

μ_{ij}

CAUSA

$$\underbrace{\mu_{yx} = \mu_{xy} = \mu_{zx} = \mu_{xz} = \mu_{yz} = \mu_{zy} = \mu}_{\text{MATERIALES ISÓTROPOS}}$$

COEFICIENTE DE POISSON.

$$\mu = -\frac{\varepsilon_{\perp}}{\varepsilon_{\parallel}}$$

LA DEFORMACIÓN EN LA DIRECCIÓN $\perp$ A LA APLICACIÓN DE LA CARGA.

LA DEFORMACIÓN EN LA DIRECCIÓN DE APLICACIÓN DE LA CARGA.

SE DEFINE (+).

QUÉ PASARÍA SI APLICAMOS $\sigma_x \neq 0$ $\sigma_y \neq 0$ $\sigma_z \neq 0$ EN FORMA SIMULTÁNEA.

→ APLICAMOS PSE POR LA RELACIÓN LINEAL ENTRE LAS VARIABLES:

$$\varepsilon_{xx} = \frac{\sigma_x}{E} - \mu\frac{\sigma_y}{E} - \frac{\mu}{E}\sigma_z = \frac{1}{E}\left[\sigma_x - \mu(\sigma_y + \sigma_z)\right].$$

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

$$\varepsilon_{zz} = \frac{\sigma_z}{E} - \frac{\mu}{E}\sigma_x - \frac{\mu}{E}\sigma_y = \frac{1}{E}\left[\sigma_z - \mu(\sigma_x + \sigma_y)\right].$$

LEY DE HOOKE GENERALIZADA

I) μ: ES UNA CARACTERÍSTICA O PROPIEDAD DEL MATERIAL.

II) EN ANISÓTROPOS Y ORTÓTROPOS → LOS μ_{ij} SON $\neq$ 0.

$$\mu_{yx} = -\frac{\varepsilon_{yy}}{\varepsilon_{xx}} \qquad \mu_{zy} = -\frac{\varepsilon_{zz}}{\varepsilon_{yy}}.$$

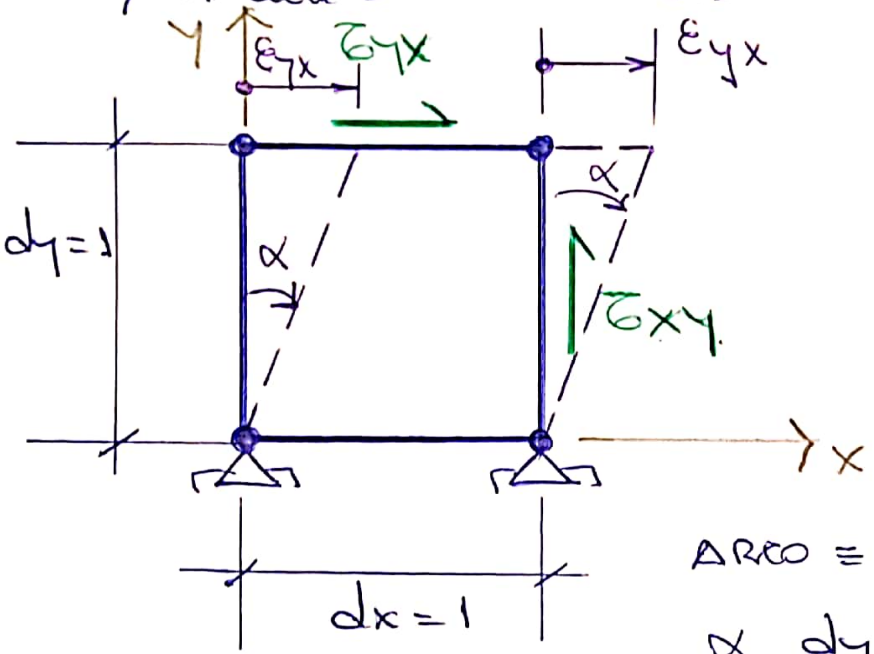
EFECTO

$$\mu_{ij} = -\frac{\varepsilon_{ii}}{\varepsilon_{jj}}$$

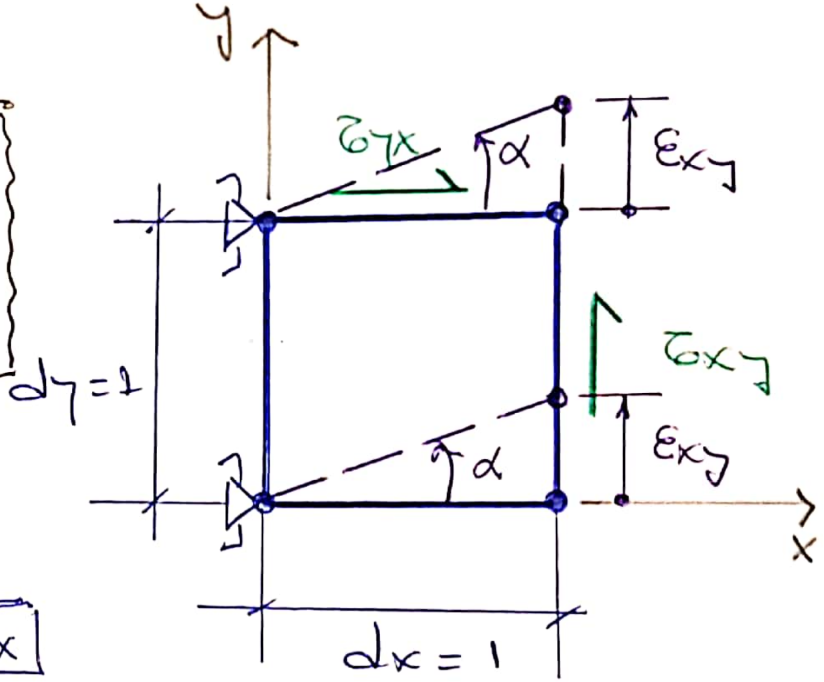
CAUSA.

2º ENSAYO:

↳ VINCULAR A LAS TENS. TANGENCIALES CON LAS DEFORM. ESPEC. TRANSVERSALES.



HIPOTESIS DE PEQUEÑOS DESPLAZAMIENTOS



ARCO ≡ CUERDA ≡ TANGENTE

$$\alpha \cdot \underbrace{dy}_{=1} = \varepsilon_{yx} \rightarrow \boxed{\alpha = \varepsilon_{yx}} \quad (1)$$

ARCO ≡ CUERDA ≡ TANGENTE

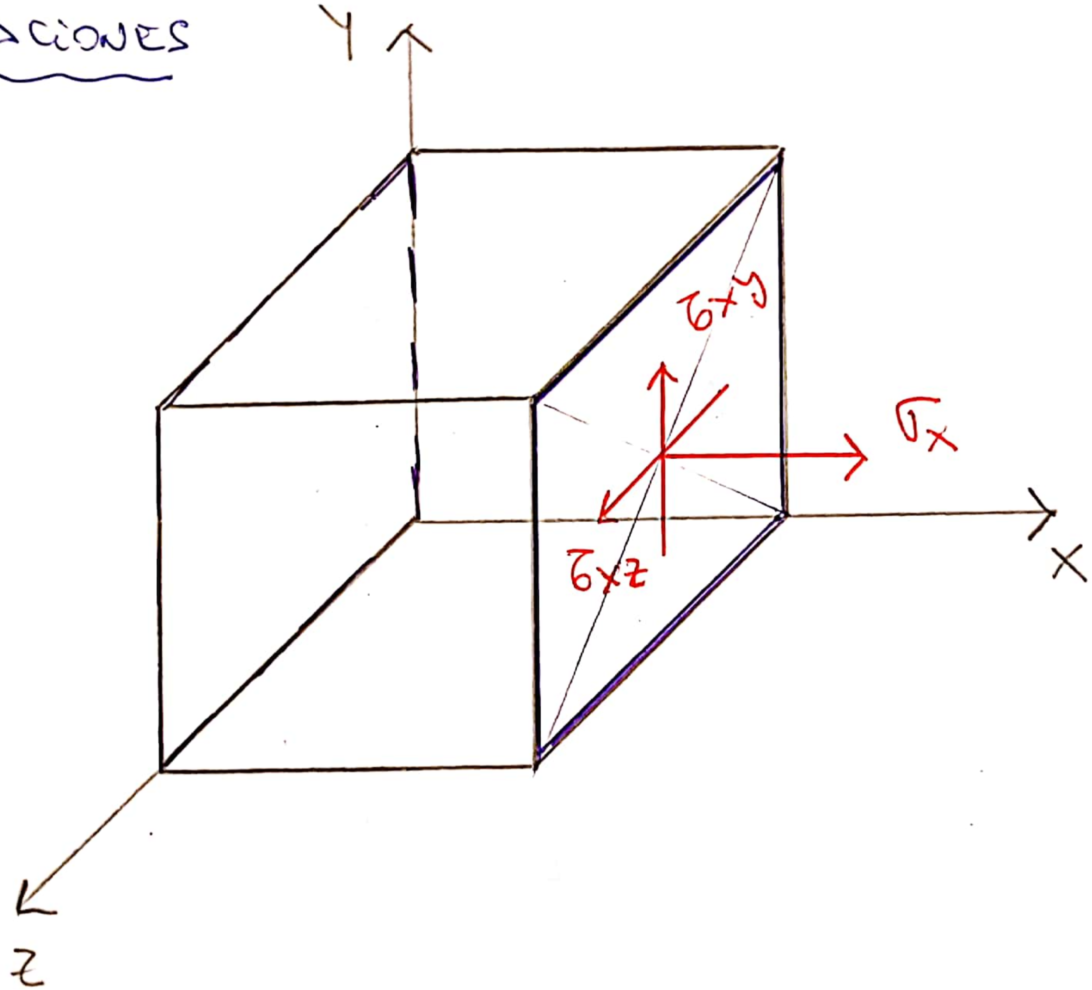
$$\alpha \cdot \underbrace{dx}_{=1} = \varepsilon_{xy} \rightarrow \boxed{\alpha = \varepsilon_{xy}} \quad (2)$$

$$\tau_{ij}$$

EL PLANO EN EL QUE ACTÚA

LA DIRECCIÓN DE LA TENSIÓN τ.

ACLARACIONES



$\sigma_{ij} \rightarrow i = j \rightarrow$ NORMAL

$i \neq j \rightarrow$ TANGENCIAL

τ_{ij}

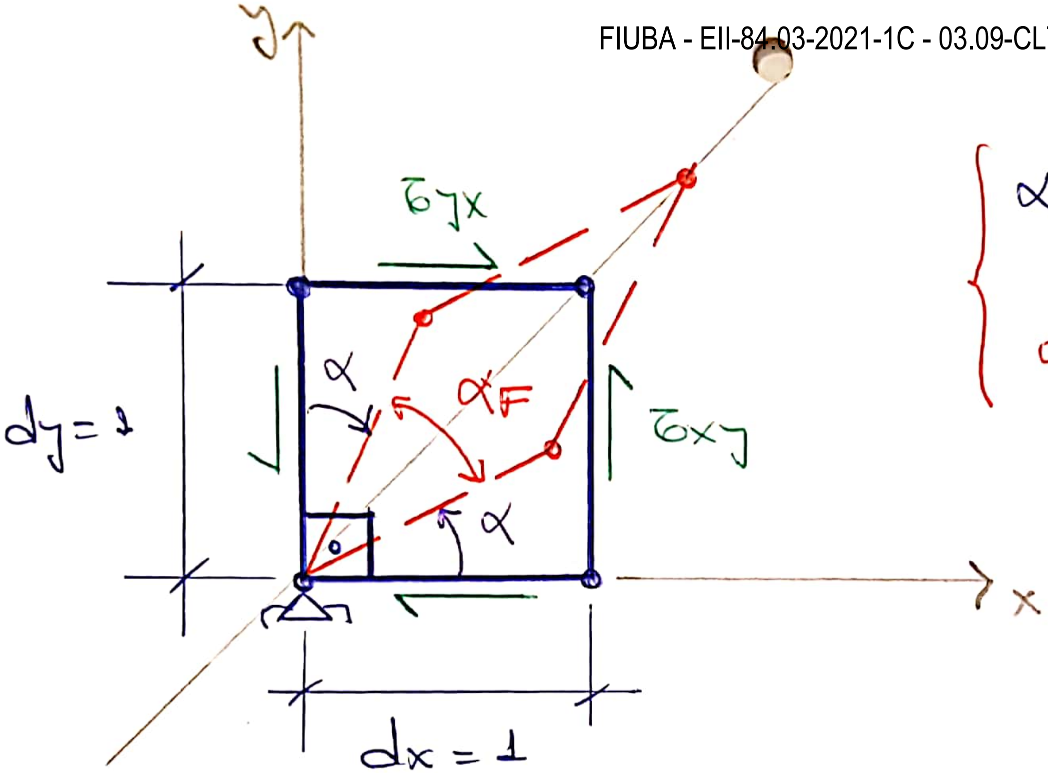
- DE 1 y 2.

$$\left.\begin{array}{ll} \alpha = \varepsilon_{yx} & (1) \\ \alpha = \varepsilon_{xy} & (2) \end{array}\right\} \rightarrow \boxed{\varepsilon_{xy} = \varepsilon_{yx}}$$

- SE HACE LO MISMO PARA LOS PLANOS 'XZ' e 'YZ'

$$\varepsilon_{xz} = \varepsilon_{zx} \qquad \varepsilon_{yz} = \varepsilon_{zy}.$$

$$\underline{\varepsilon_{ij} = \varepsilon_{ji}}$$



$$\left\{ \begin{array}{l} \alpha_{ORIGINAL,\,xy} = \alpha_{INICIAL,\,xy} = \dfrac{\pi}{2} = 90^{\circ}. \\ \\ \alpha_{F,\,xy} \end{array} \right.$$

$$\alpha_{inic.} - \alpha_F = \frac{\pi}{2} - \alpha_F = \gamma_{xy}.$$

$$\gamma_{xy} = \alpha + \alpha = 2\alpha = 2\,\varepsilon_{xy}$$

$$\gamma_{xy} = 2\,\varepsilon_{xy} \rightarrow \varepsilon_{xy} = \frac{\gamma_{xy}}{2}$$

$$\boxed{\gamma_{ij} = 2\,\varepsilon_{ij}} \leftrightarrow \boxed{\varepsilon_{ij} = \frac{\gamma_{ij}}{2}}$$

$$\gamma_{xy} = \frac{\tau_{xy}}{G} = 2\,\varepsilon_{xy} \quad \leftrightarrow \quad \varepsilon_{xy} = \frac{\tau_{xy}}{2G} = \frac{\gamma_{xy}}{2}$$

$$\gamma_{yz} = \frac{\tau_{yz}}{G} = 2\,\varepsilon_{yz} \quad \leftrightarrow \quad \varepsilon_{yz} = \frac{\tau_{yz}}{2G} = \frac{\gamma_{yz}}{2}$$

$$\gamma_{zx} = \frac{\tau_{zx}}{G} = 2\,\varepsilon_{zx} \quad \leftrightarrow \quad \varepsilon_{zx} = \frac{\tau_{zx}}{2G} = \frac{\gamma_{zx}}{2}.$$

LEY DE HOOKE GENERALIZADA:

$$\begin{Bmatrix} \varepsilon_{xx} \\ \varepsilon_{yy} \\ \varepsilon_{zz} \\ \hline \varepsilon_{xy} \\ \varepsilon_{yz} \\ \varepsilon_{zx} \end{Bmatrix} = \left[\begin{array}{ccc|ccc} 1/E & -\mu/E & -\mu/E & & & \\ -\mu/E & 1/E & -\mu/E & & \underline{0} & \\ -\mu/E & -\mu/E & 1/E & & & \\ \hline & & & 1/2G & 0 & 0 \\ & \underline{0} & & 0 & 1/2G & 0 \\ & & & 0 & 0 & 1/2G \end{array} \right] \begin{Bmatrix} \sigma_x \\ \sigma_y \\ \sigma_z \\ \hline \tau_{xy} \\ \tau_{yz} \\ \tau_{zx} \end{Bmatrix}$$

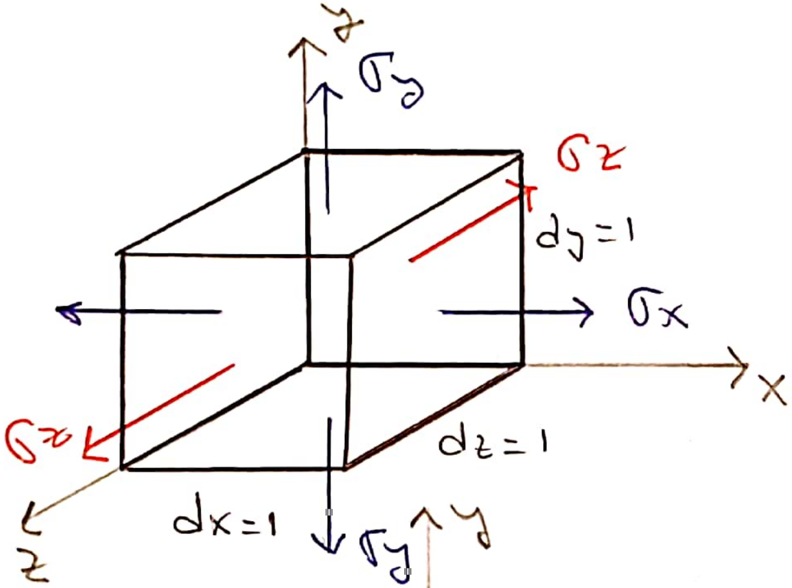
E : MÓDULO DE ELASTICIDAD LONGITUDINAL

G : " " " TRANSVERSAL.

μ : COEF. DE POISSON

CONSTANTES ELÁSTICAS DEL MATERIAL.

VARIACIÓN ESPECÍFICA DE VOLUMEN:



$$V_0 = dx\, dy\, dz = 1.1.1 = 1$$

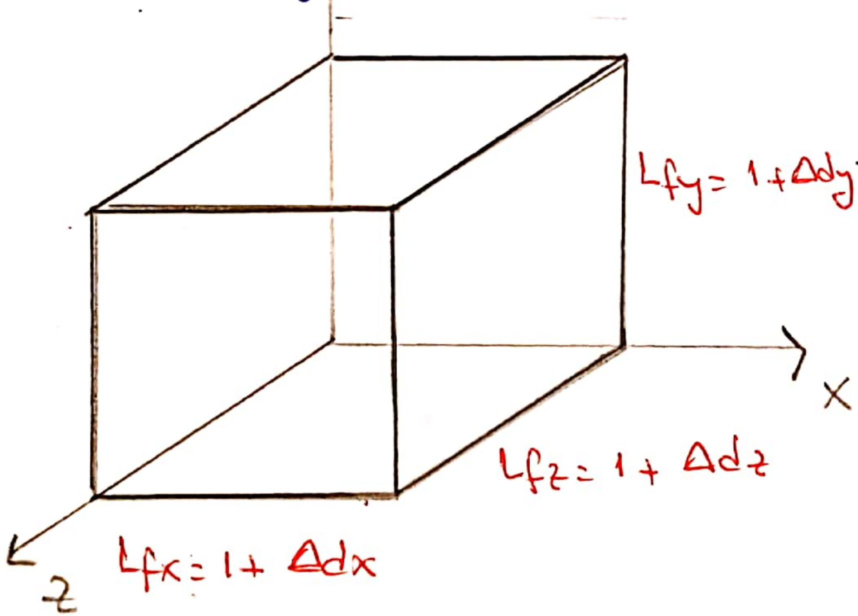
$\boxed{x}$ $Lf_x = Lo_x + \Delta dx = dx + \Delta dx = 1 + \Delta dx$

$$\Delta L_x = Lf_x - Lo_x = Lf_x - dx = 1 + \Delta dx - 1$$

$$\underline{\Delta L_x = \Delta dx}$$

$$\varepsilon_{xx} = \frac{\Delta L_x}{Lo_x} = \frac{\Delta dx}{1} = \Delta dx$$

$$\underline{\varepsilon_{xx} = \Delta dx}$$



$\boxed{y}$ $\varepsilon_{yy} = \Delta dy$

$\boxed{z}$ $\varepsilon_{zz} = \Delta dz$

$$V_f = L_{fx} \cdot L_{fy} \cdot L_{fz} = (1+\Delta d_x)(1+\Delta d_y)(1+\Delta d_z) = (1+\varepsilon_{xx})(1+\varepsilon_{yy})(1+\varepsilon_{zz}) =$$

$$V_f = 1 + \varepsilon_{xx} + \varepsilon_{yy} + \varepsilon_{zz} + \cancel{\varepsilon_{xx}\cdot\varepsilon_{yy}} + \cancel{\varepsilon_{xx}\cdot\varepsilon_{zz}} + \cancel{\varepsilon_{yy}\cdot\varepsilon_{zz}} + \cancel{\varepsilon_{xx}\cdot\varepsilon_{yy}\cdot\varepsilon_{zz}}$$

• HIP. PEQ. DESPLAZ. + HIP. PEQ. DEFORMACIONES. → TÉRMINOS → INFINITÉSIMOS DE O.S.

$$\boxed{V_f = 1 + \varepsilon_{xx} + \varepsilon_{yy} + \varepsilon_{zz}}$$

$$\Delta V = V_f - V_0 = 1 + \varepsilon_{xx} + \varepsilon_{yy} + \varepsilon_{zz} - 1 \rightarrow \Delta V = \varepsilon_{xx} + \varepsilon_{yy} + \varepsilon_{zz}.$$

$$\varepsilon_V = \frac{\Delta V}{V_0} = \frac{\varepsilon_{xx} + \varepsilon_{yy} + \varepsilon_{zz}}{1} \rightarrow \boxed{\varepsilon_V = \varepsilon_{xx} + \varepsilon_{yy} + \varepsilon_{zz}}$$

TRAZA DEL [TD].

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

$$\varepsilon_V = \frac{1}{E}\left[(\sigma_x - 2\mu\sigma_x) + (\sigma_y - 2\mu\sigma_y) + (\sigma_z - 2\mu\sigma_z)\right]$$

$$\varepsilon_V = \frac{1}{E}\left[(1-2\mu)\sigma_x + (1-2\mu)\sigma_y + (1-2\mu)\sigma_z\right]$$

$$\varepsilon_V = \frac{(1-2\mu)}{E}(\sigma_x + \sigma_y + \sigma_z) = \frac{1-2\mu}{E} \cdot I_{1,[T\sigma]}$$

$$\boxed{\varepsilon_V = I_{1,[TD]} = \frac{1-2\mu}{E} I_{1,[T\sigma]}}$$

PARTICULARIDADES:

- SUPONDREMOS QUE $\sigma_x = \sigma_y = \sigma_z = p > 0$

(I)

$$\varepsilon_V = \frac{(1-2\mu)}{E} \cdot 3p > 0$$

$$1 - 2\mu > 0 \rightarrow$$

$$\rightarrow \mu < \frac{1}{2} \rightarrow \boxed{\mu < 0{,}5}$$

(II) $\varepsilon_V = \dfrac{1-2\mu}{E} \cdot 3p$

$$\varepsilon_V = \frac{p}{\underbrace{\dfrac{E}{3(1-2\mu)}}_{K}}$$

$$\varepsilon_V = \frac{p}{K} \rightarrow p = K \cdot \varepsilon_V$$

$$\boxed{K = \frac{E}{3(1-2\mu)}}$$

$\rightarrow$ Si $\mu \rightarrow 0{,}5 \rightarrow K \rightarrow \infty \rightarrow \boxed{\varepsilon_V \rightarrow 0}$

Si $\mu \rightarrow 0{,}5 \rightarrow$ EL MATERIAL ES CADA VEZ, MÁS RÍGIDO. EN EL LÍMITE CUANDO ~~CUAN~~ $\mu = 0{,}5 \rightarrow$ EL MATERIAL ES INFINITAMENTE RÍGIDO.

→ SI $\mu \to 0 \to K \to \frac{E}{3} \to$

$$\boxed{\varepsilon_V = \frac{3p}{E}}$$

→ SI $\mu \to -\infty \to K \to 0 \to$

→ $\boxed{\varepsilon_V \to \infty}$ → RIGIDEZ NULA.

$$\boxed{0 \leq \mu < 0{,}5}$$

→ AUMENTA LA RIGIDEZ

DISMINUYE LA RIGIDEZ ←

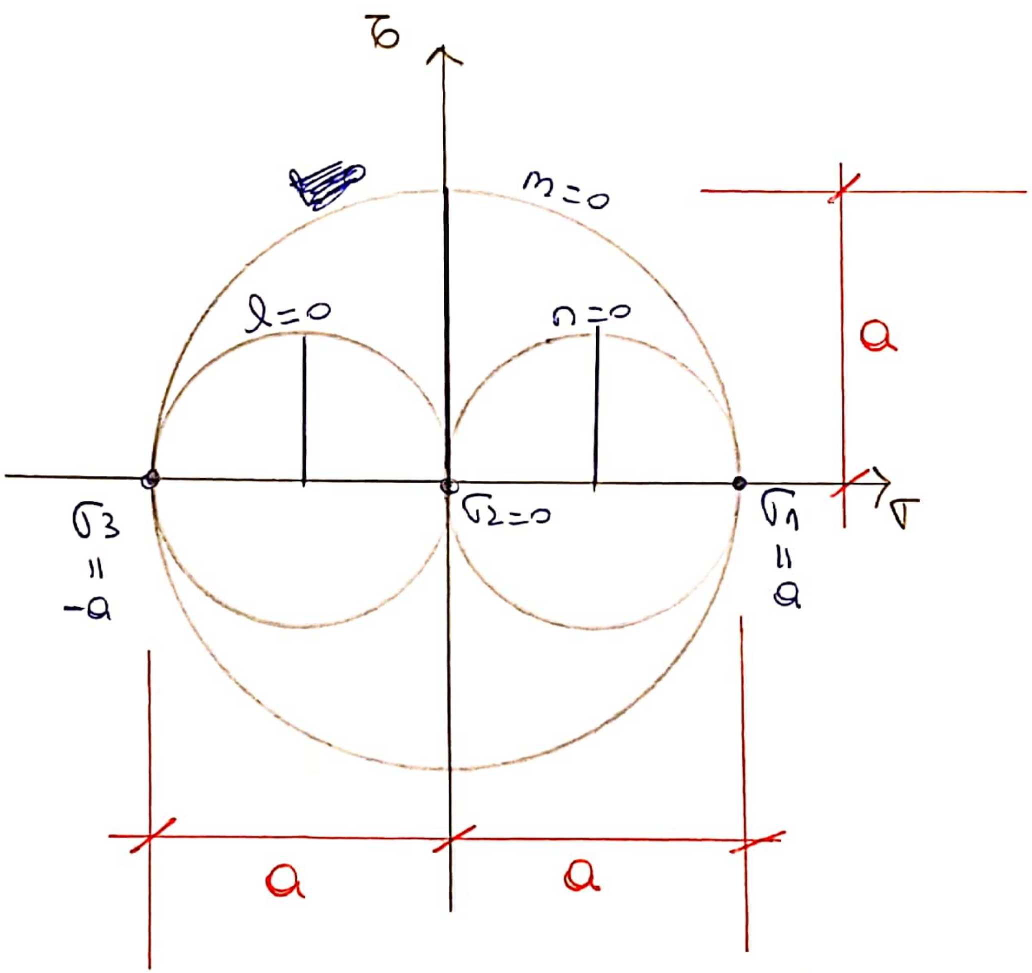
→ SI $\mu > 0{,}5 \to K < 0 \to$ UN MATERIAL TRACCIONADO DISMINUIRÍA SU VOLUMEN.

RELACIÓN ENTRE E, G Y μ:

MAT. ISÓTROPO → 3 CTES PROPIAS ELÁSTICAS

$$\left\{ \begin{matrix} E \\ G \\ \mu \end{matrix} \right\}$$

- VAMOS A REALIZAR EL SIGUIENTE ESTUDIO:
  - → TERNA PPAL.
  - → $\begin{cases} \sigma_1 = a \\ \sigma_2 = 0 \\ \sigma_3 = -a \end{cases}$
- MOSTRAMOS ESTA SITUACIÓN A TRAVÉS DE LAS CIRCUNF. MOHR.



$$\varepsilon_3 = \frac{1}{E}\left[\sigma_3 - \mu(\sigma_1+\sigma_2)\right] = \frac{1}{E}\left[-a - \mu(a+0)\right]$$

$$\varepsilon_3 = -\frac{(1+\mu)\,a}{E}.$$

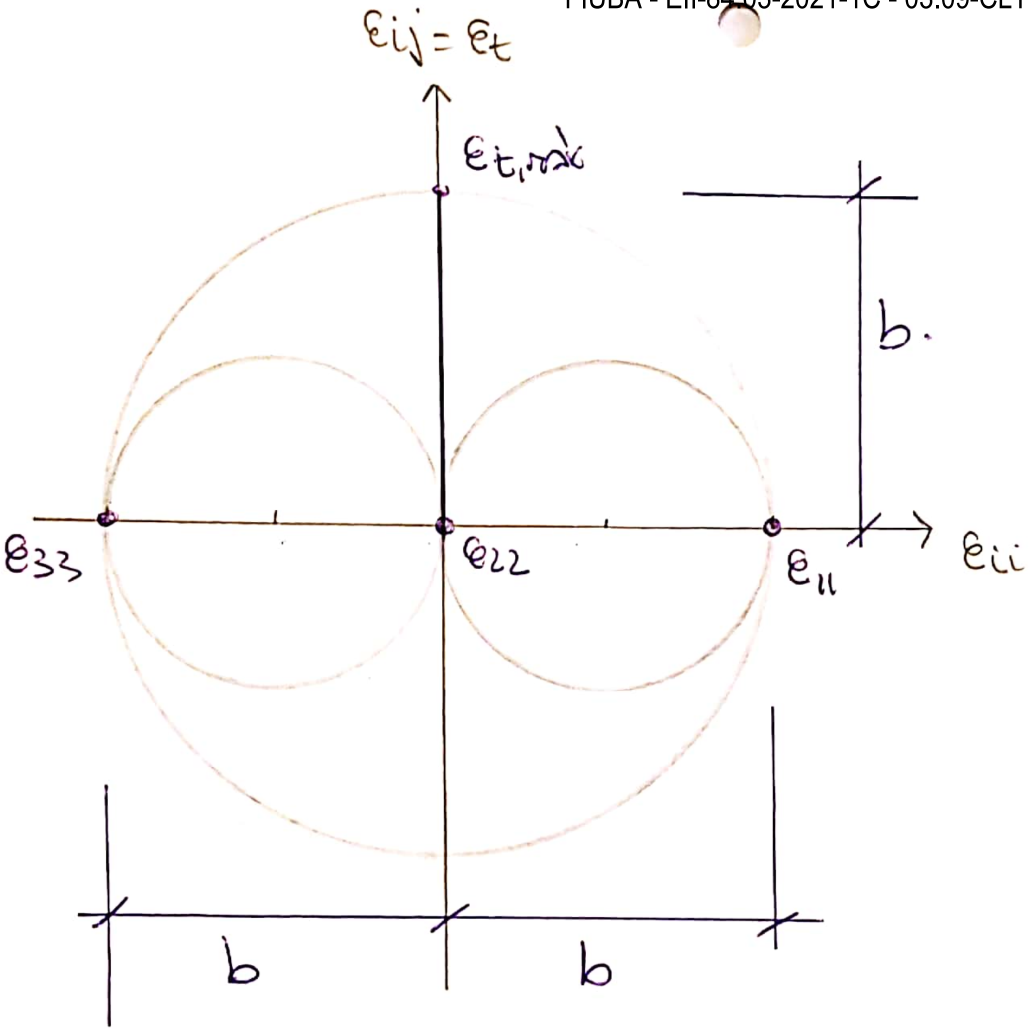
$$\tau_{máx} = a \rightarrow \varepsilon_{t,máx} = \frac{\tau_{máx}}{2G}$$

$$\boxed{\varepsilon_{t,máx} = \frac{a}{2G} = b}$$

$$\varepsilon_1 = \frac{1}{E}\left[\sigma_1 - \mu(\sigma_2+\sigma_3)\right] = \frac{1}{E}\left[a - \mu(0-a)\right]$$

$$\varepsilon_1 = \frac{1+\mu}{E}\,a$$

$$\varepsilon_2 = \frac{1}{E}\left[\sigma_2 - \mu(\sigma_1+\sigma_3)\right] = \frac{1}{E}\cdot\left[0 - \mu(a-a)\right] = 0$$



$$\frac{(1+\mu)\cancel{a}}{E} = \frac{\cancel{a}}{2G}$$

$$\boxed{\begin{array}{l} E = 2.(1+\mu)G \\[2ex] G = \dfrac{E}{2(1+\mu)}. \\[2ex] \mu = \dfrac{E}{2G} - 1 \end{array}}$$

$$\varepsilon_{ij} = \frac{\tau_{ij}}{2G} = \frac{\tau_{ij}}{\cancel{2}.\frac{E}{\cancel{2}(1+\mu)}} = \frac{1+\mu}{E}\tau_{ij}.$$

$$\left.\begin{array}{l} \varepsilon_{11} = \dfrac{(1+\mu)a}{E} = b. \\[3ex] \varepsilon_{t,máx} = \dfrac{a}{2G} = b \end{array}\right]$$ LAS IGUALO.

19/19

$$\begin{Bmatrix} \varepsilon_{xx} \\ \varepsilon_{yy} \\ \varepsilon_{zz} \\ \hline \varepsilon_{xy} \\ \varepsilon_{yz} \\ \varepsilon_{zx} \end{Bmatrix} = \frac{1}{E} \left[\begin{array}{ccc|ccc} 1 & -\mu & -\mu & & & \\ -\mu & 1 & -\mu & & \underline{0} & \\ -\mu & -\mu & 1 & & & \\ \hline & & & (1+\mu) & 0 & 0 \\ & \underline{0} & & 0 & (1+\mu) & 0 \\ & & & 0 & 0 & (1+\mu) \end{array}\right] \begin{Bmatrix} \sigma_x \\ \sigma_y \\ \sigma_z \\ \tau_{xy} \\ \tau_{yz} \\ \tau_{zx} \end{Bmatrix}$$