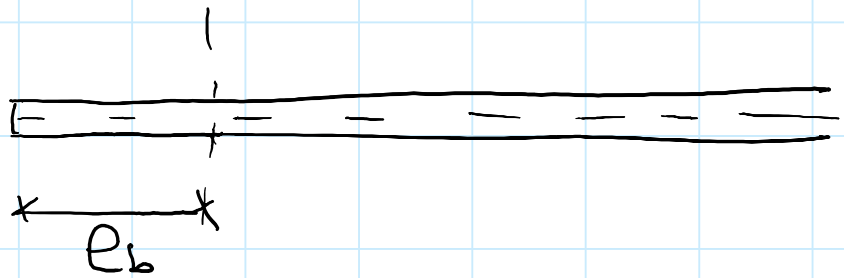
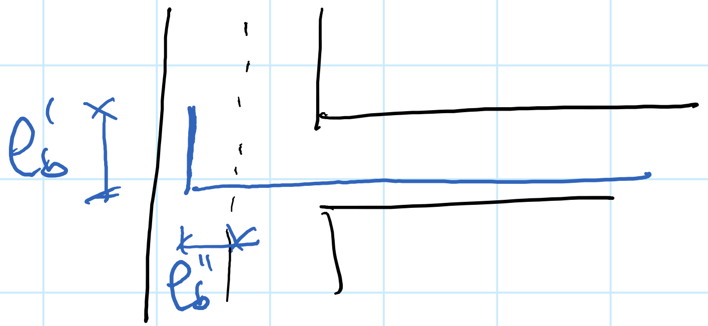
SOLUZIONI DI ANCORAGGIO



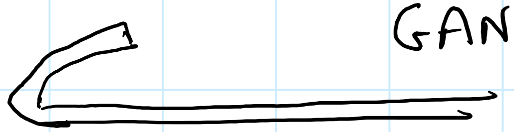
DRITTO



$$\ell_b = \ell_b' + \ell_b''$$

$\ell_b' \geq 10\,cm$
$\geq 5\phi$

GANCIO (VECCHIE ARMATURE LISCE)



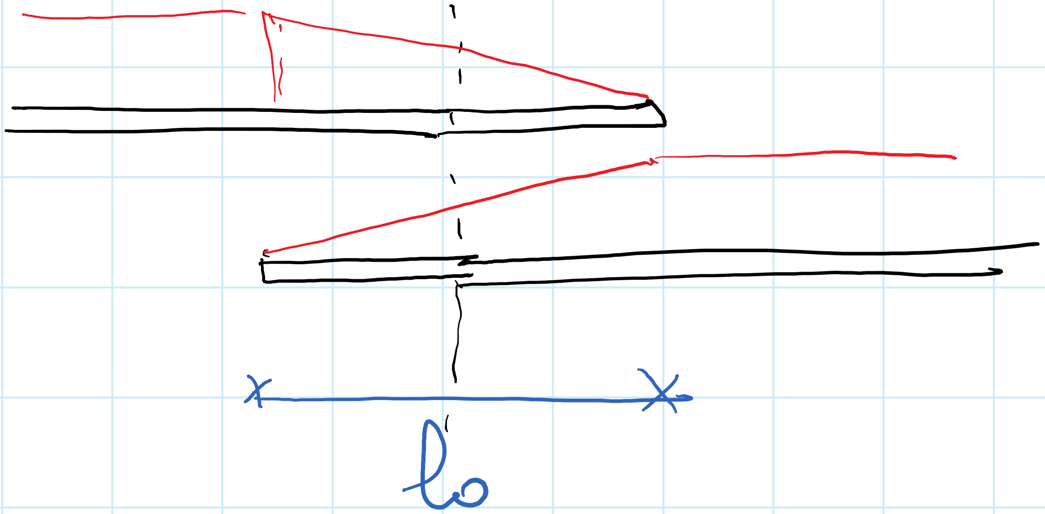
$$\ell_{bd} = \alpha_1 \alpha_2 \alpha_3 \alpha_4 \alpha_5 \ell_b$$

$$\ell_{bd} \geq \begin{cases} 20\phi \\ 15\,cm \end{cases}$$

α_1 → TIPO ANCORAGGIO

α_2 → COPRIFERRO

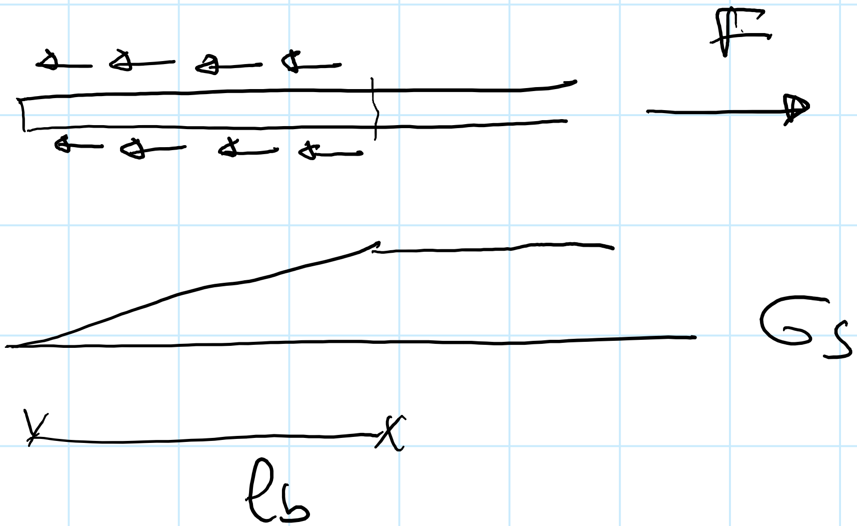
LUNGHEZZE DI SOVRAPPOSIZIONE



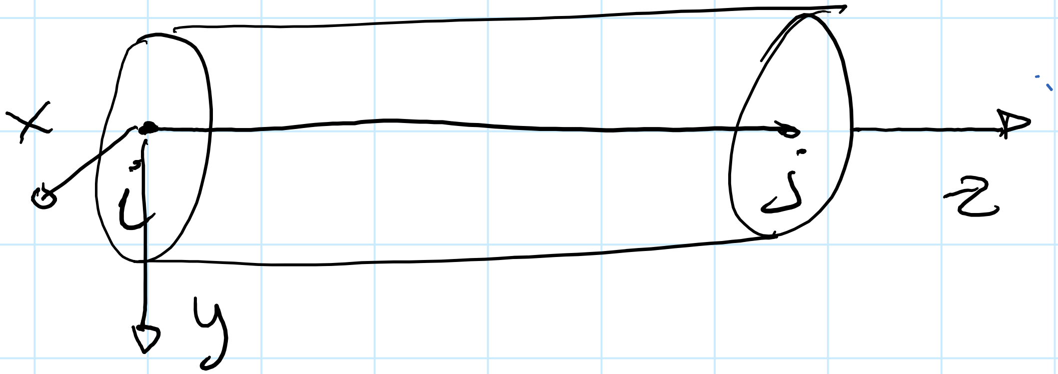
$$l_0 = \alpha_6 \, l_b$$

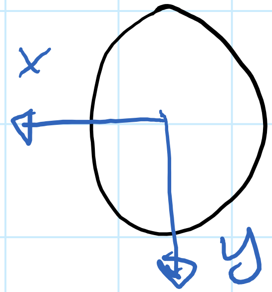
$$\alpha_6 = 1 \quad \text{SE } N_b \text{ INTERROTTE} \le \frac{1}{4} N_b \text{ TOTALE}$$

$$\alpha_6 = 1{,}5$$



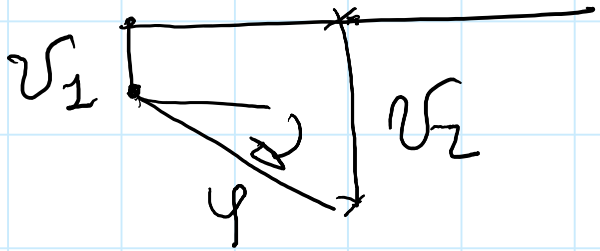
CONVENZIONE DEI SEGNI





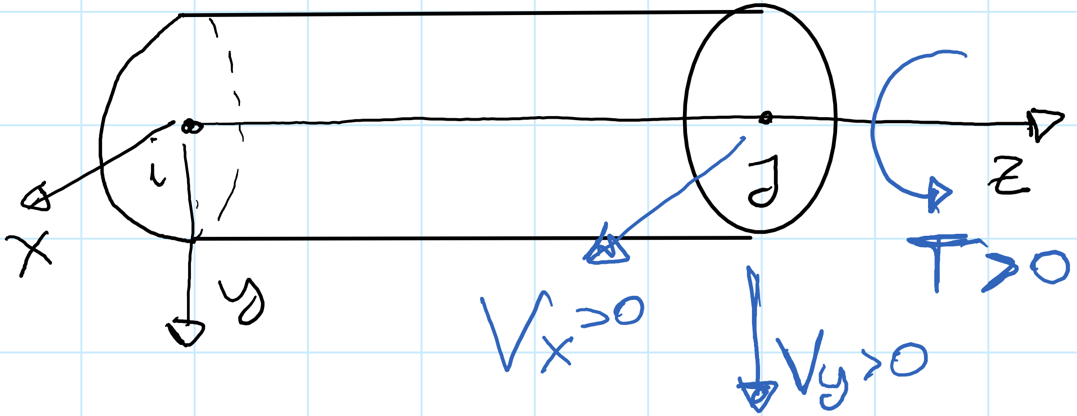
$u_x > 0$
$v_y > 0$ SE CONCORDI CON ASSI } SPOSTAMENTI
$w_z > 0$

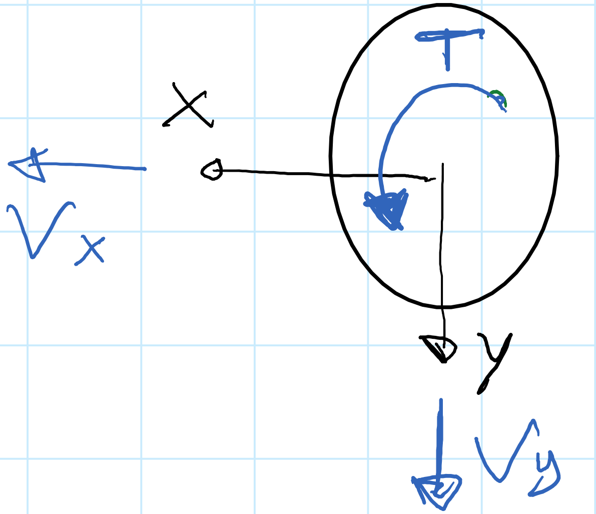
$\varphi > 0$ SE ANTI-ORARIE

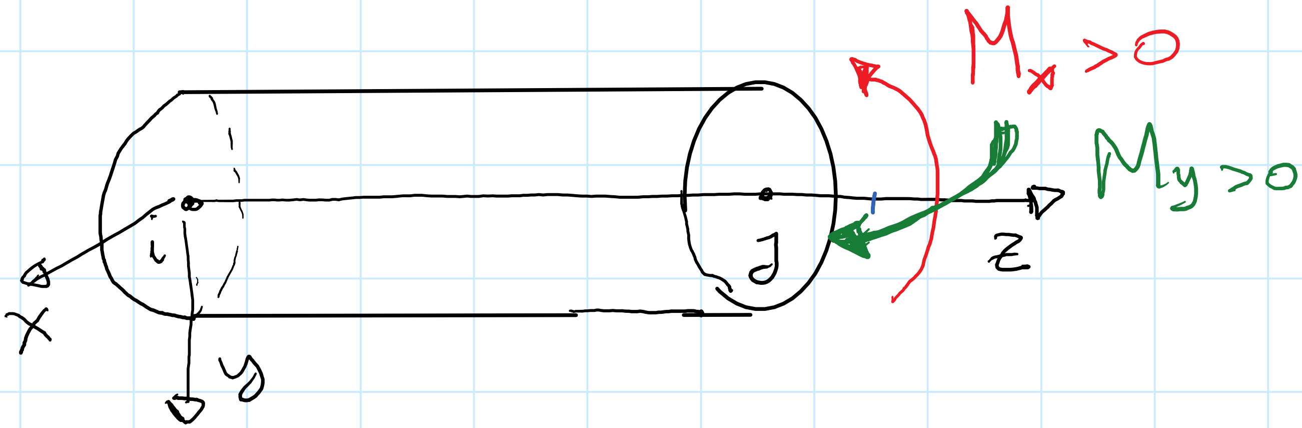


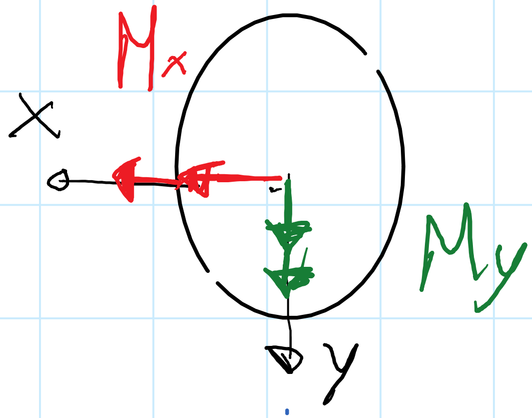
$$\frac{dv}{dz} = -\varphi$$

SEGNI DELLE CARATTERISTICHE DELLA SOLLECITAZIONE

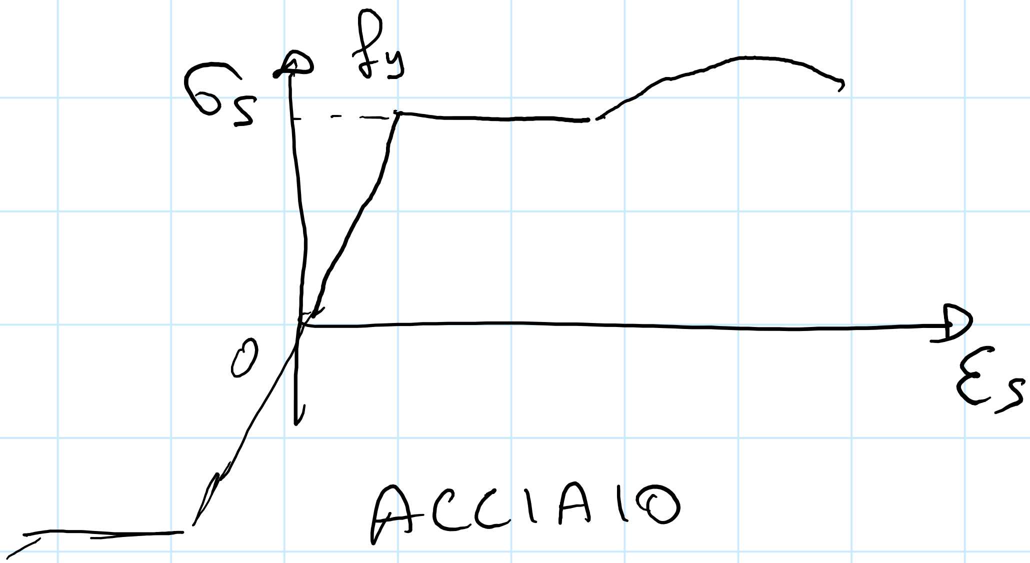




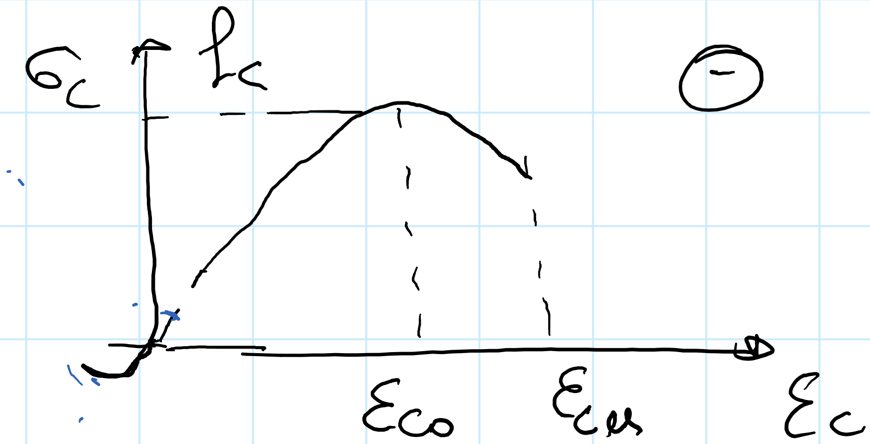




LEGAMI COSTITUTIVI SPERIMENTALI



ACCIAIO



CLS

PER FORMULARE ANALITICAMENTE I LEGAMI DISTINGUO 3 STADI DI COMPORTAMENTO

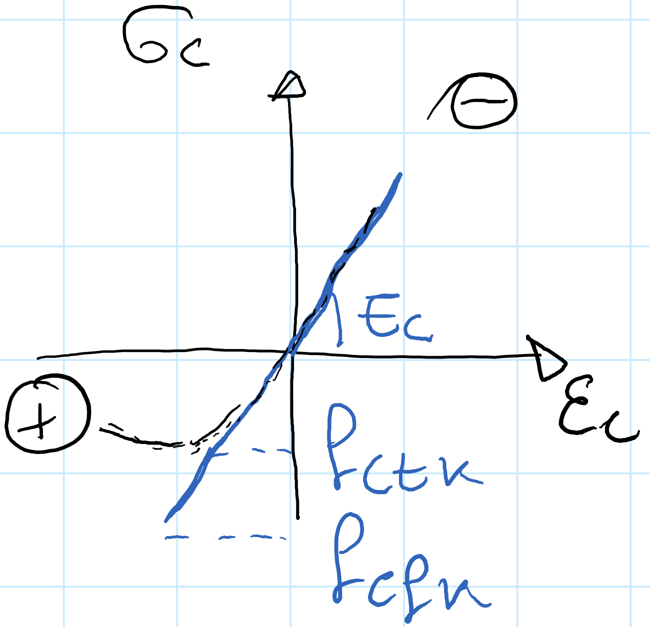
I STADIO
II STADIO } → SLE

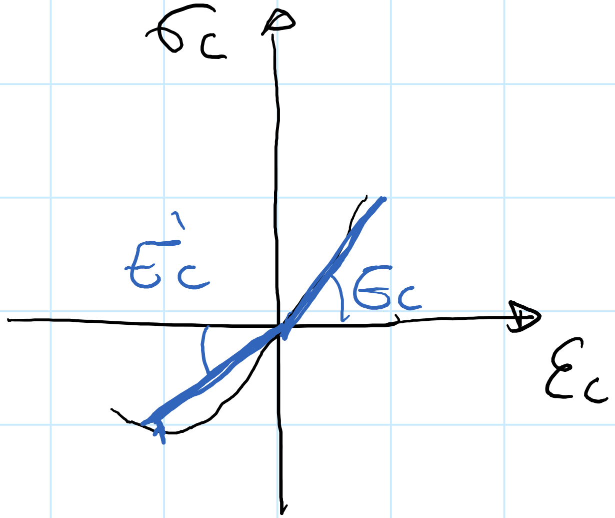
III STADIO → SLU

I STADIO

- σ, ε MOLTO BASSI
- SI USA PER VERIFICHE DI FESSURAZIONE

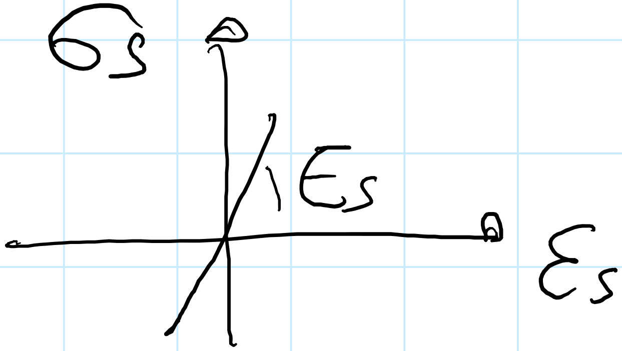
CALCESTRUZZO





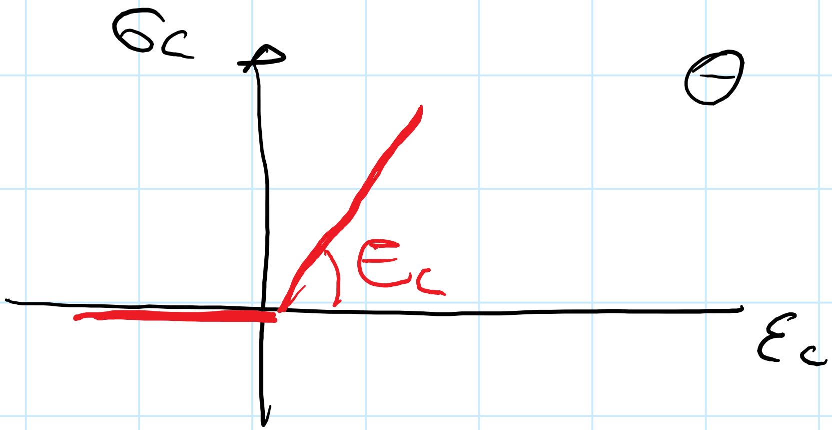
USATO IN PASSATO

ACCIAIO



II STADIO

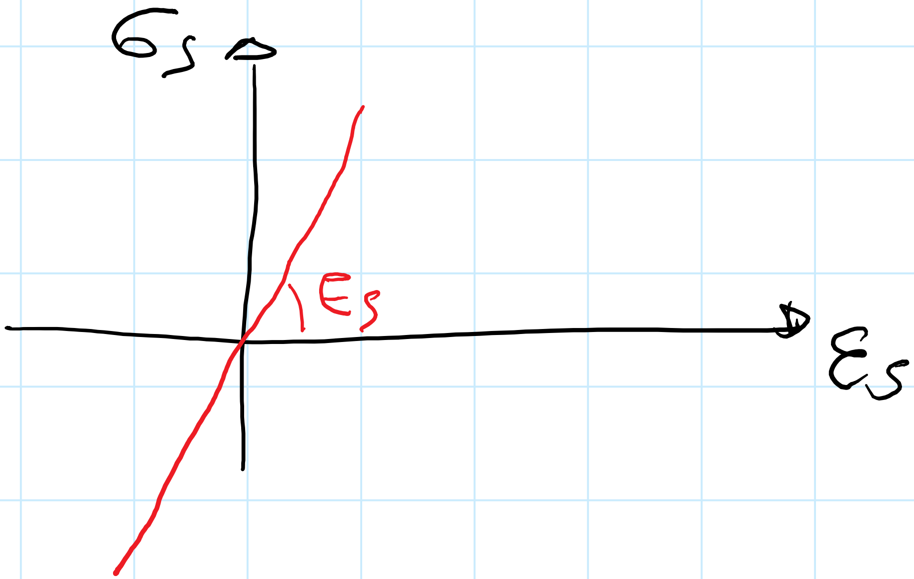
VERIFICHE ALLE TENSIONI DI ESERCIZIO



COMPORTAMENTO LINEARE VEROSIMILE SE

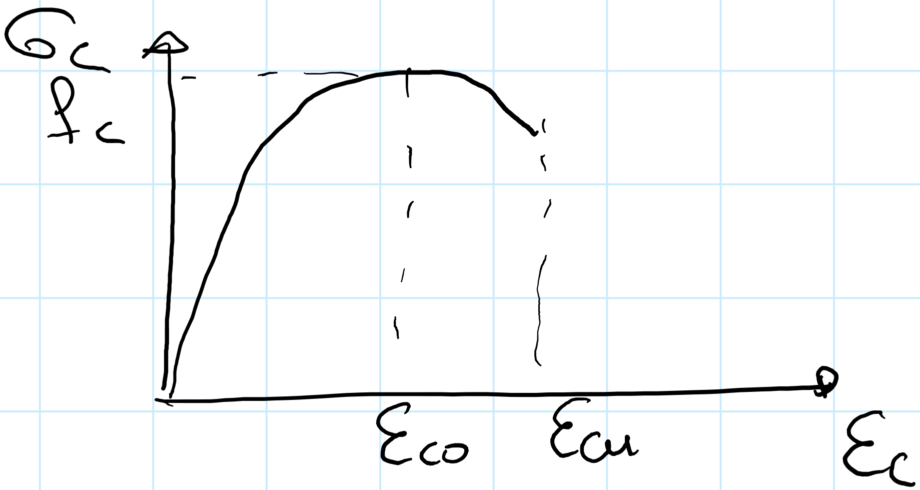
$$\sigma_c \leq 0.6 f_{ck}$$

+

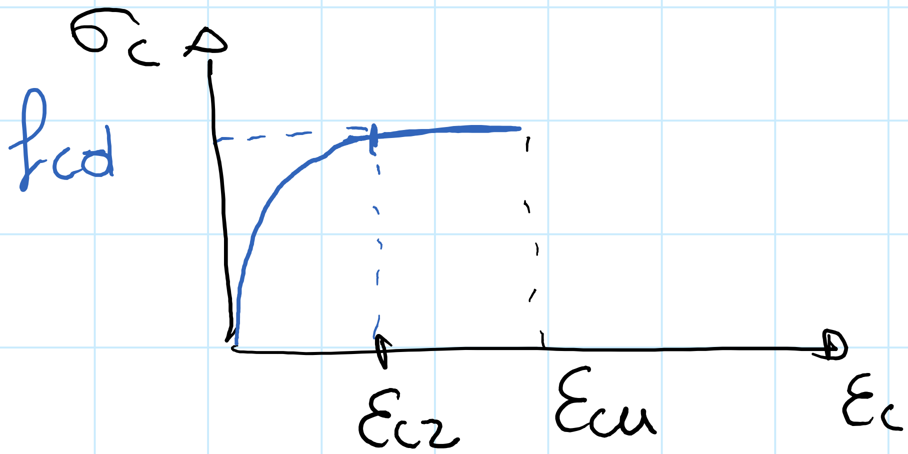


III STADIO, CALCESTRUZZO

VERIFICA ALLO SLU



PARABOLA - RETTANGOLO



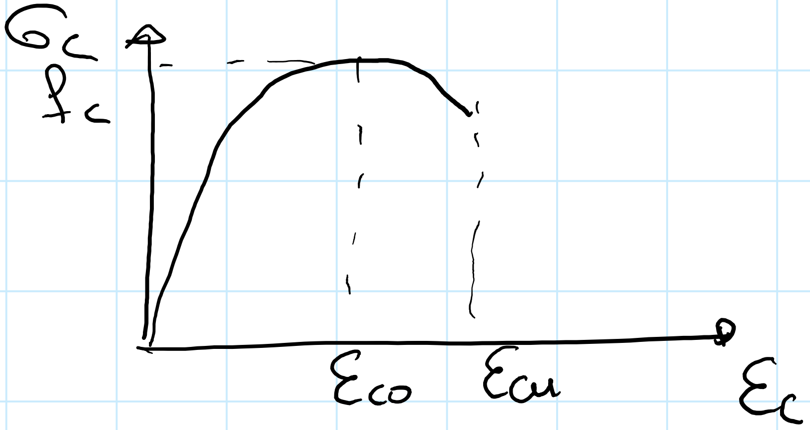
CLASSE NON SUPERIORE A C50/60 → $\varepsilon_{c2} = 2‰$

$\varepsilon_{cu} = 3,5‰$

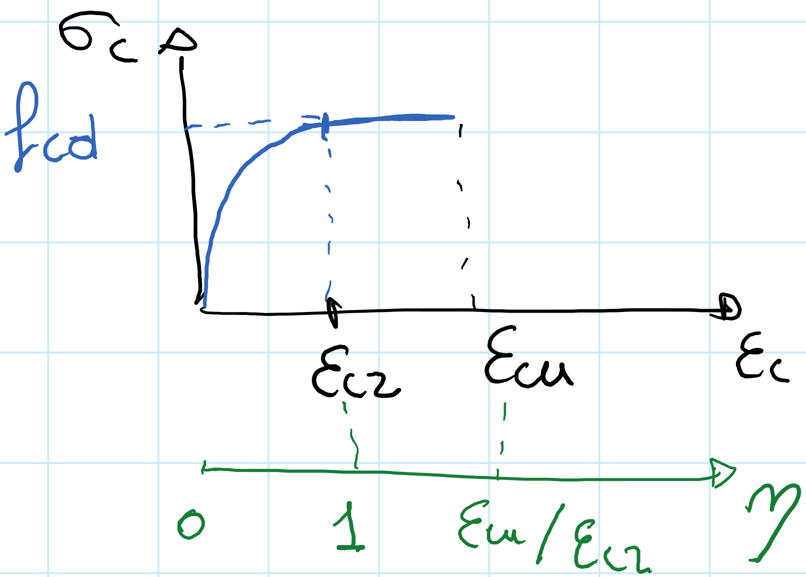
AL CRESCERE DI f_{ck} $\begin{cases} \varepsilon_{c2} \text{ CRESCE} \\ \varepsilon_{cu} \text{ SI RIDUCE} \end{cases}$

III STADIO, CALCESTRUZZO

VERIFICA ALLO SLU



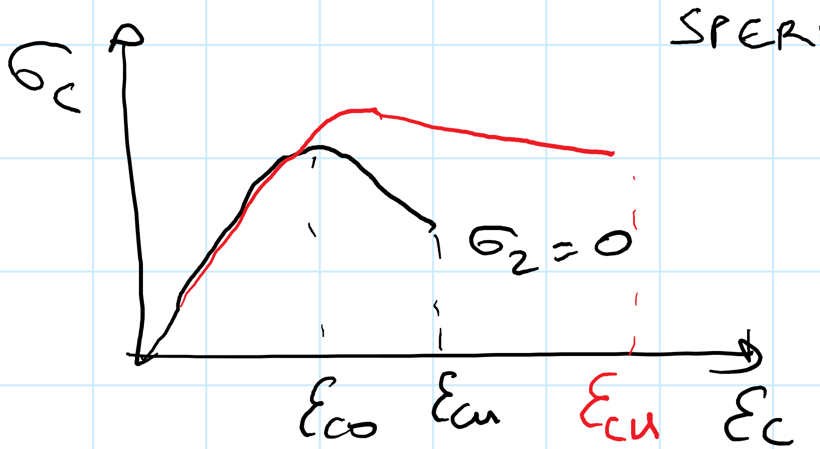
PARABOLA - RETTANGOLO

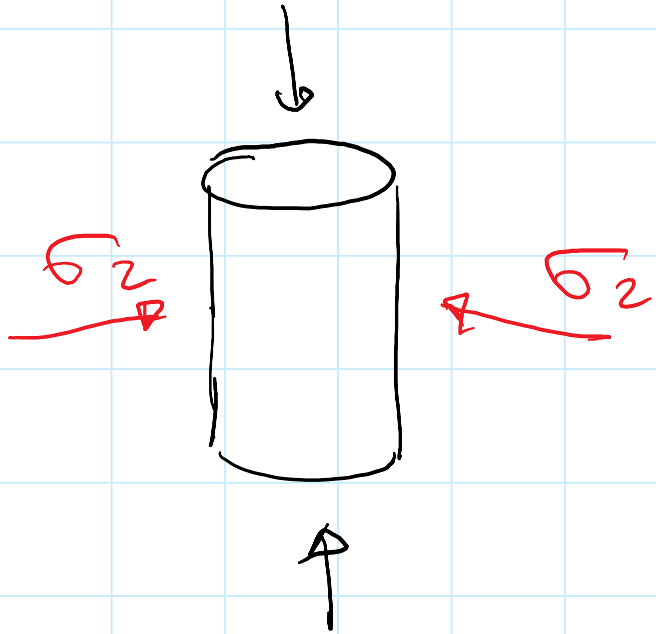


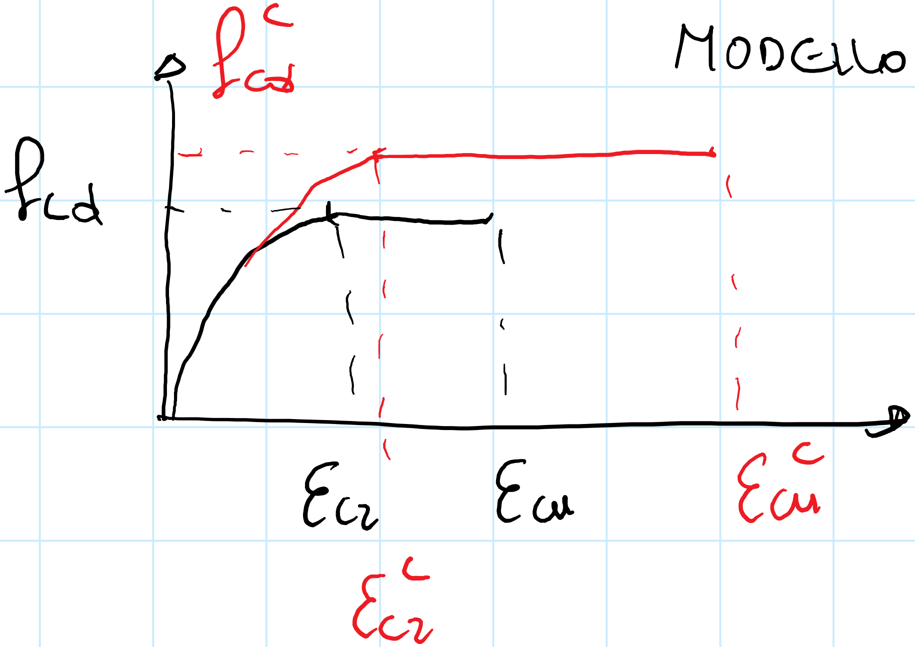
$$\eta = -\frac{\varepsilon_c}{\varepsilon_{c2}} \quad \text{se} \quad \varepsilon_c = -\varepsilon_{c2} \rightarrow \eta = 1$$

$$\sigma_c = \begin{cases} -f_{cd} \cdot \eta\,(2-\eta) & \text{se } \eta \leq 1 \\ -f_{cd} & \eta > 1 \end{cases}$$

EFFETTO DEL CONFINAMENTO







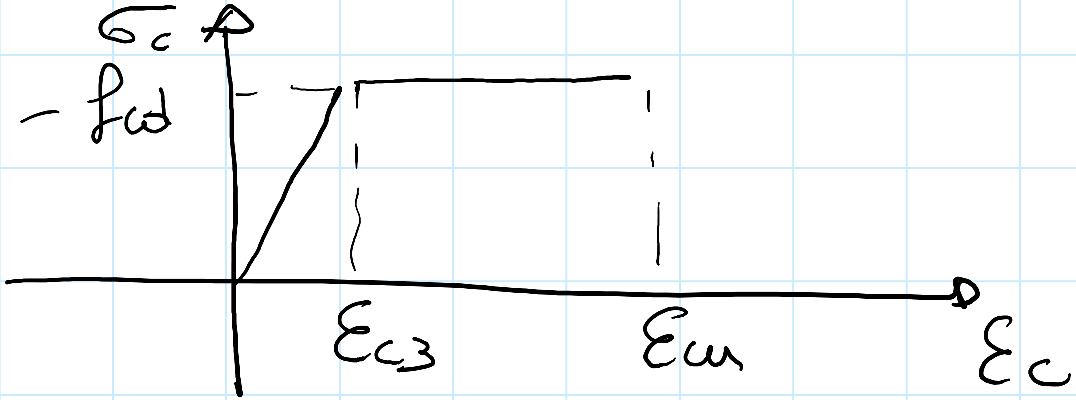
$$f_c^c = f_c K$$

$$K = \begin{cases} 1 + 5\,\sigma_2/f_{ck} & \sigma_2/f_{ck} \le 0{,}05 \\ 1.125 + 2.5\,\sigma_2/f_{ck} & \dfrac{\sigma_2}{f_{ck}} > 0.05 \end{cases}$$

$$\varepsilon_{c2}^c = \varepsilon_{c2} K^2$$

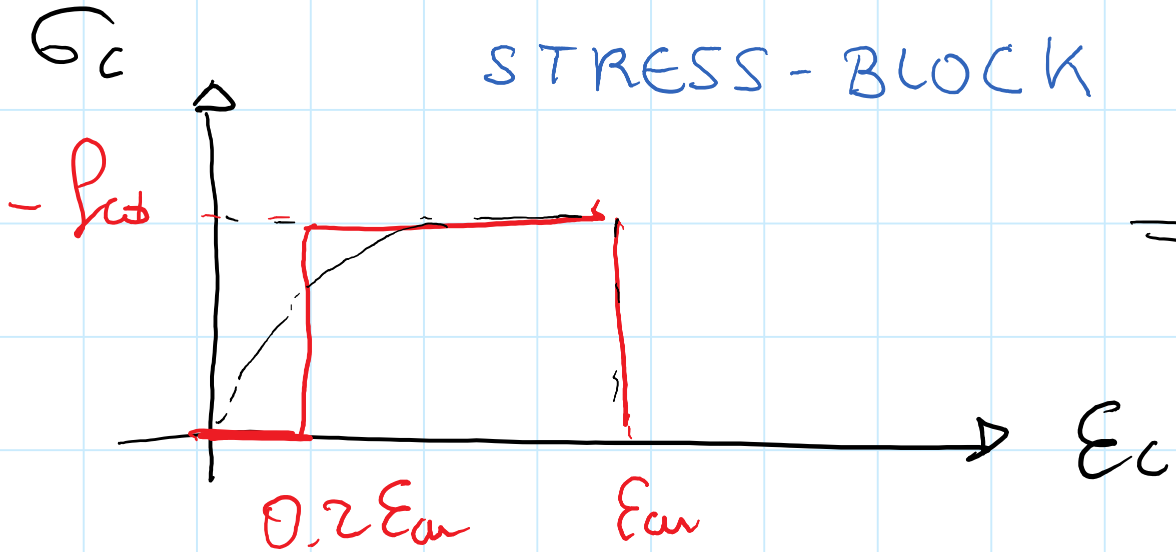
$$\varepsilon_{cu}^c = \varepsilon_{cu} + 0.2\,\frac{\sigma_2}{f_{ck}}$$

MODELLI ALTERNATIVI AL III STADIO (CLS)



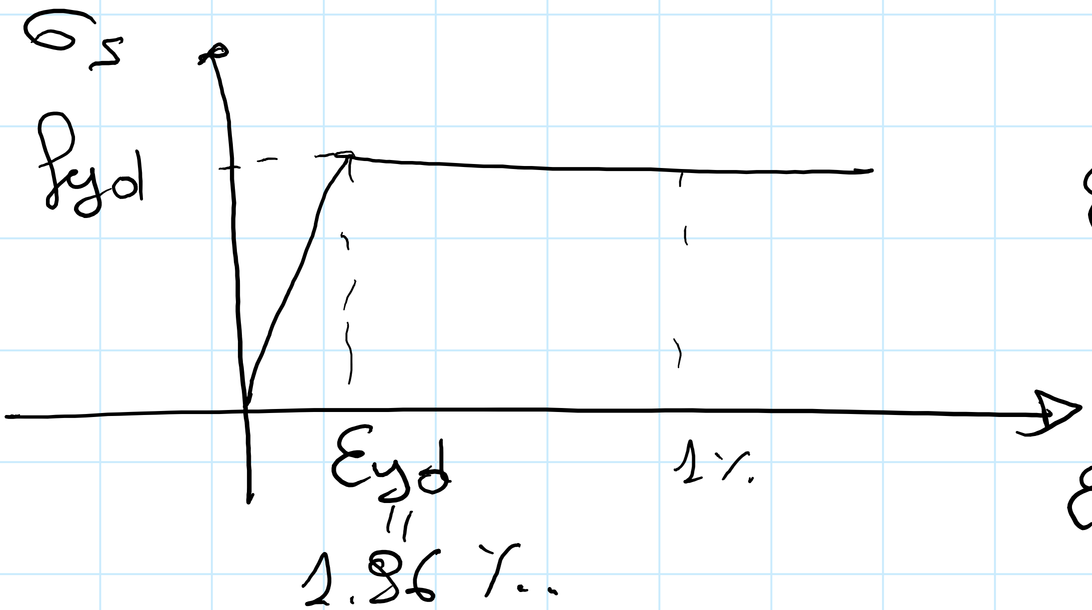
$\varepsilon_{c3} = 1,75‰$

STRESS-BLOCK



$\Rightarrow$ UTILE PER SEZIONI NON RETTANGOLARI

III STADIO - ACCIAIO (2 OPZIONI)



$$\varepsilon_{yd} = \frac{f_{yd}}{E_s} = \frac{391.3 \ N/mm^2}{200'000 \ N/mm^2}$$

$\varepsilon_{su} \rightarrow \infty$ (IN PASSATO $\varepsilon_{su} = 1\%$)

$f_t = K f_{yd}$ $\quad K = 1.15$

ε_s

$$\varepsilon_{ud} = 0.9\, \varepsilon_{uk} = 0.9 \times \frac{7.5}{100}$$

IPOTESI DI BASE

1. PERFETTA ADERENZA ACCIAIO - CLS

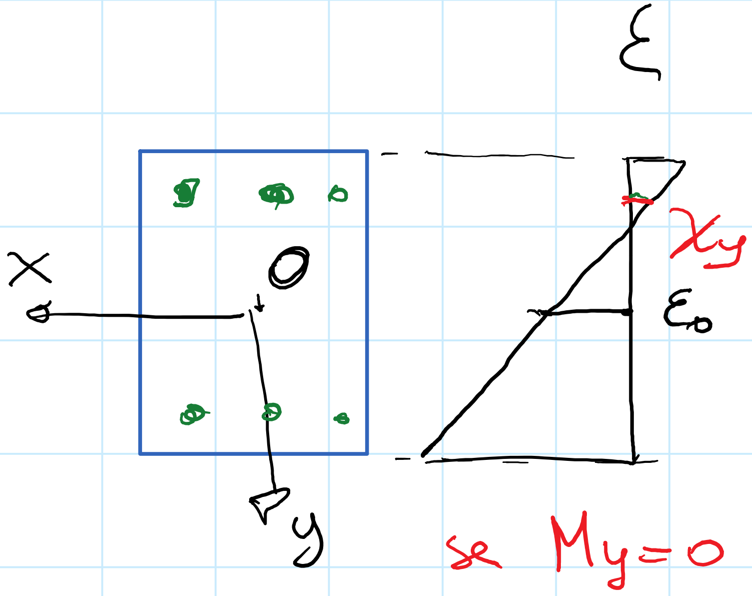
$$\varepsilon_s = \varepsilon_c$$

2. CONSERVAZIONE SEZIONI PIANE

$$\varepsilon_z = \varepsilon_0 + \chi_x X + \chi_y y$$

DOVE

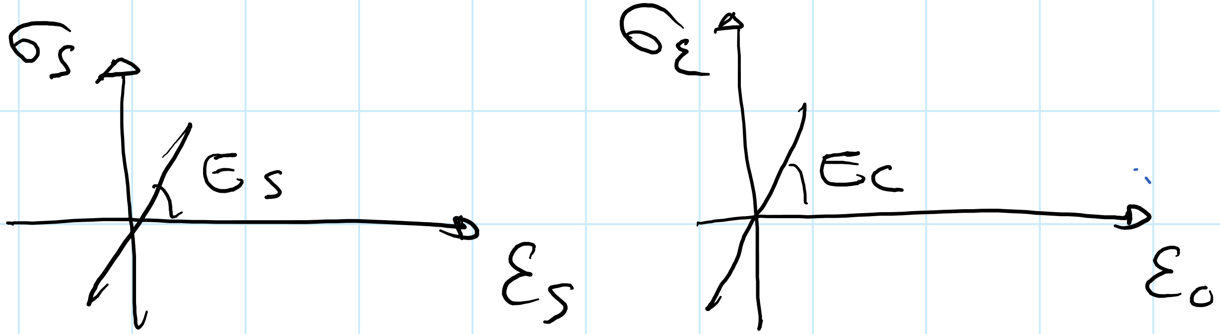
$$\chi_x = \frac{\partial \varepsilon}{\partial x} \quad ; \quad \chi_y = \frac{\partial \varepsilon}{\partial y}$$

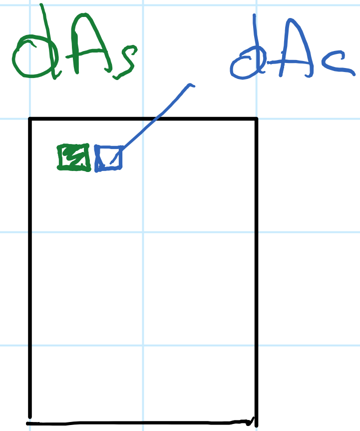


NOTO $\sigma = f(\varepsilon) \longrightarrow$

$$N = \int \sigma \, dA \quad ; \quad M_x = \int \sigma y \, dA \; ; \quad M_y = -\int \sigma x \, dA$$

I STADIO





$\varepsilon_c = \varepsilon_s$ (PERFETTA ADER.)

$\sigma_c = E_c \, \varepsilon$ $\rightarrow$ $\varepsilon = \frac{\sigma_c}{E_c}$

$\sigma_s = E_s \, \varepsilon$

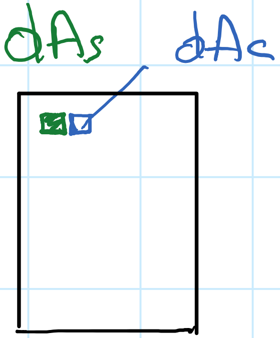
$\downarrow$

$\sigma_s = \frac{E_s \cdot \sigma_c}{E_c}$

$n = \frac{E_s}{E_c}$ = COEFF. DI OMOGENEIZZAZIONE

C30/37 $\rightarrow$ $E_c = 32800$ MPa $\rightarrow$ $n = \frac{200000}{32800} = 6.1$

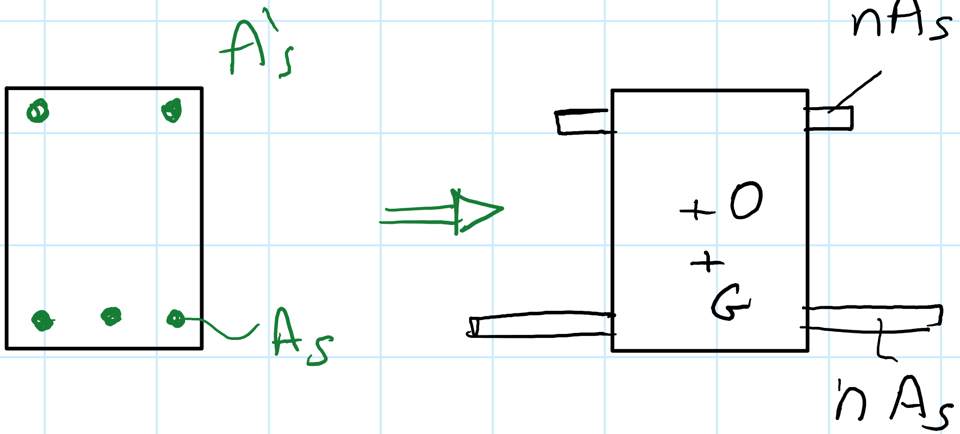
I STADIO



$N_c = \sigma_c \, dA_c$

$N_s = \sigma_s \, dA_s = \sigma_c \cdot n \, dA_s$

($n \, dA_s$): AREA DI CLS EQUIVALENTE

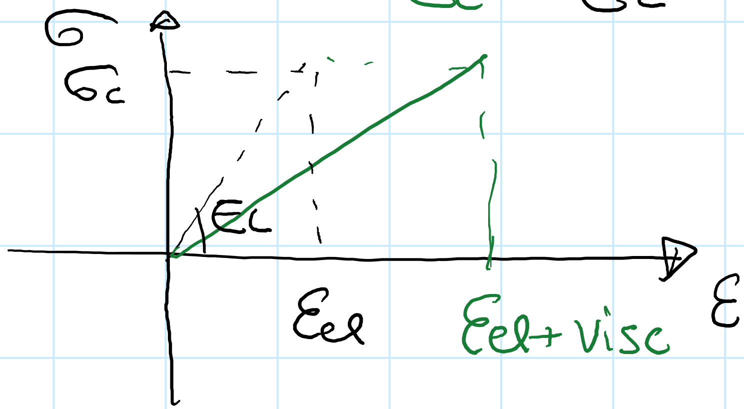


SEZIONE OMOGENEIZZATA

$G \neq O$

LUNGA DUR.

$E_L < E_c$



$n = \frac{E_s}{E_c}$ PER CARICHI DI BREVE DURATA

$n = 15$ CARICHI DI LUNGA DURATA

NEL CASO DI I STADIO

FISSO ORIGINE IN G (BARICENTRO SEZ. OMOGEN.)

$$\varepsilon = \varepsilon_G + \chi_x X + \chi_y Y \qquad \sigma = E_c \varepsilon \Rightarrow$$

$$\sigma = E_c (\varepsilon_G + \chi_x X + \chi_y Y)$$

$$N = \int \sigma \, dA \rightarrow$$

$$N = E_c \varepsilon_G \int dA + E_c \chi_x \underbrace{\int x \, dA}_{0} + E_c \chi_y \underbrace{\int y \, dA}_{0} \Rightarrow$$

$$N = E_c \varepsilon_G A \Rightarrow$$

$$\boxed{\varepsilon_G = \frac{N}{E_c A}}$$

NEL CASO DI I STADIO

FISSO ORIGINE IN G (BARICENTRO SEZ. OMOGEN.)

$$\varepsilon = \varepsilon_G + \chi_x X + \chi_y Y \qquad \sigma = E_c \varepsilon \Rightarrow$$

$$\sigma = E_c (\varepsilon_G + \chi_x X + \chi_y Y)$$

$$M_x = \int \sigma y \, dA = E_c \varepsilon_G \underbrace{\int y \, dA}_{0} + E_c \chi_x \underbrace{\int xy \, dA}_{0} + E_c \chi_y \underbrace{\int y^2 dA}_{I_x}$$

$$\rightarrow M_x = E_c \chi_y I_x \rightarrow \chi_y = \frac{M_x}{E_c I_x}$$

$$M_y = -\int \sigma x \, dA \rightarrow \chi_x = -\frac{M_y}{E_c I_y}$$

SOSTITUENDO IN $\sigma = E_c(\varepsilon_G + \chi_x X + \chi_y Y) \rightarrow$

$$\sigma_c = \frac{N}{A} + \frac{M_x}{I_x} y - \frac{M_y}{I_y} x$$

TENSIONI NEL CALCESTRUZZO

Es $M_y = 0 \Rightarrow$