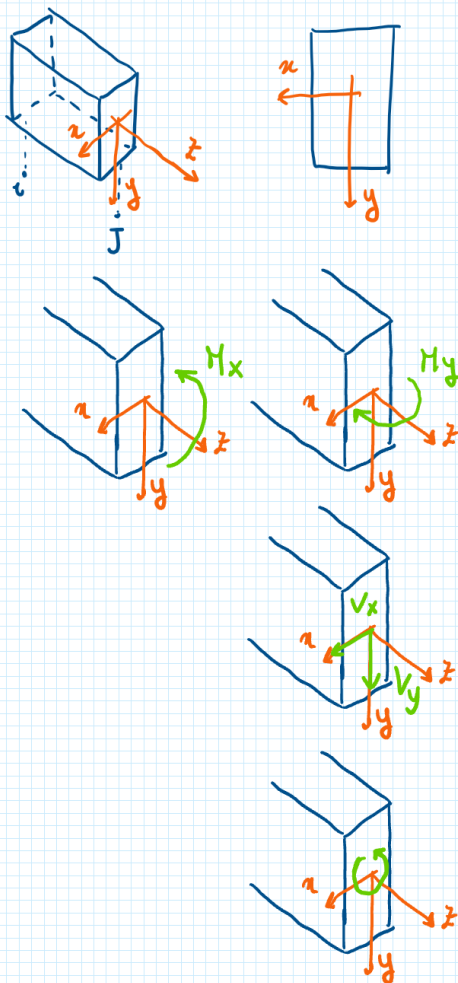


CARATTERISTICHE
DELLA SOLLECITAZIONE

$$\left. \begin{array}{l} N \left\{ \begin{array}{l} N^+ \\ N^- \end{array} \right. \\ M \\ N+M \end{array} \right\} \sigma \quad \left. \begin{array}{l} V \\ T \end{array} \right\} \tau$$

CONVENZIONE DEI SEGNI



$\sigma^+; \epsilon^+ \rightarrow$ TRAZIONE

$\sigma^-; \epsilon^- \rightarrow$ COMPRESSIONE

$u(x); v(y); w(z) > 0 \rightarrow$ concordi con gli assi

$N^+ \rightarrow$ TRAZIONE

$N^- \rightarrow$ COMPRESSIONE

$M_x^+ \rightarrow$ y su z

$M_y^+ \rightarrow$ z su x

$V_x^+ \rightarrow$ concordi con \vec{x} e \vec{y}

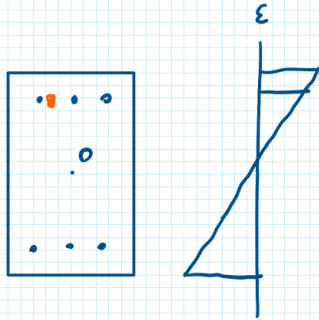
$V_y^+ \rightarrow$

$T^+ \rightarrow$ x su y

IPOTESI DI BASE DELLA TEORIA DEL C.A.

1) MANTENIMENTO DELLA SEZIONE PIANA \rightarrow DIAGRAMMA ϵ LINEARE

2) PERFETTA ADERENZA ACCIAIO - C.C. $\rightarrow \epsilon_c = \epsilon_s$



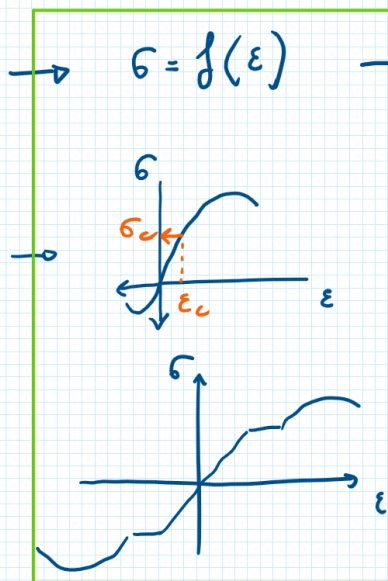
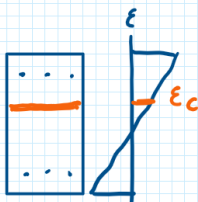
$$\epsilon_x = \epsilon_p + \chi_x x + \chi_y y$$

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

Poiché la sez non è omogenea e lineare

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

Fissato diag
di deformaz. ϵ



$$N = \int \sigma dA$$

$$M_x = \int \sigma y dA$$

$$M_y = - \int \sigma x dA$$

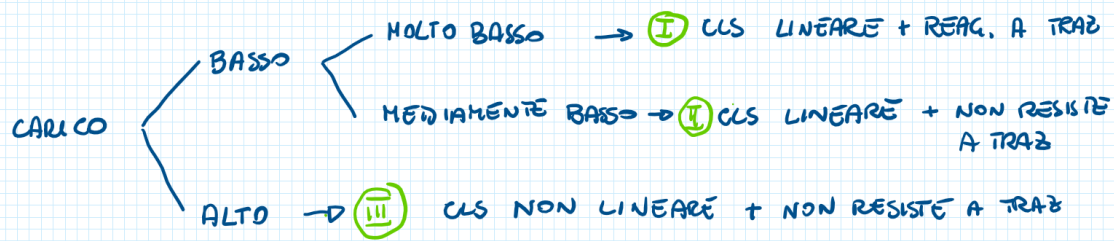
legoni sperimentali



Espressioni analitiche



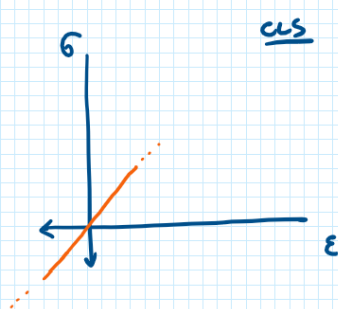
3 STADI DI COMPORTAMENTO



I } SLE I → VER. A FESSURAZIONE
II } SLE II → VER. SUE TENSIONI IN ESERCIZIO
III SLU

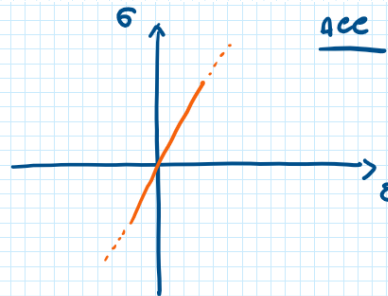
I STADIO

carichi molto bassi → σ molto basse → cls resistente a trazione



$$\sigma_c = \bar{\epsilon}_c \bar{E}_c$$

- CLS → LINEARE
- RESISTENTE A TRAZIONE

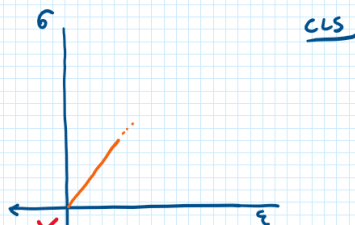


$$\sigma_s = \bar{\epsilon}_s \bar{E}_s$$

- ACC → LINEARE

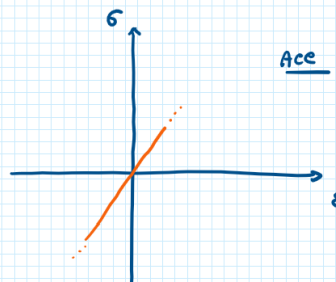
II STADIO

carichi bassi → tensioni basse → cls non resiste a trazione



$$\sigma_c = \bar{\epsilon}_c \bar{E}_c$$

- CLS → LINEARE
- NON RESISTE A TRAZIONE

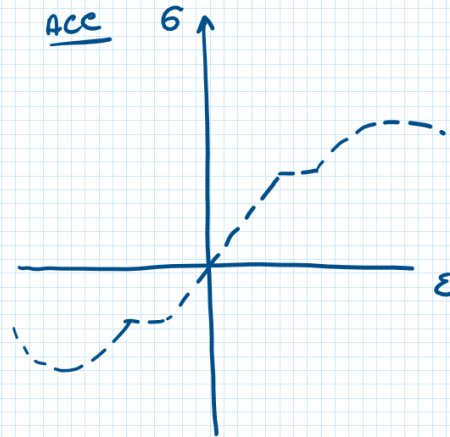
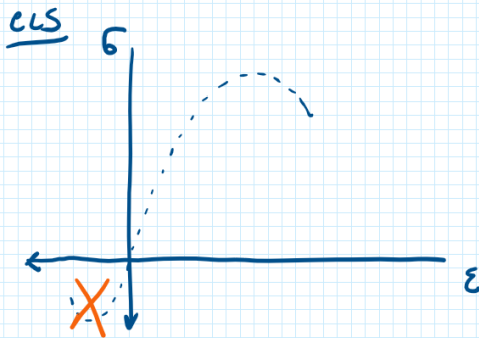


$$\sigma_s = \bar{\epsilon}_s \bar{E}_s$$

- ACC → LINEARE

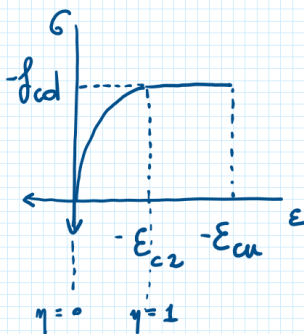
III STADIO

cariche molto alti \rightarrow comportamento NON lineare del cls e dell'acc



CALCESTRUZZO

1) PARABOLA-RETTANGOLO



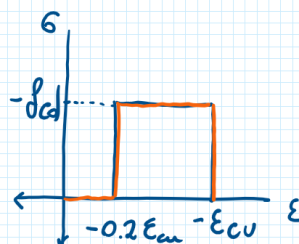
Per $c < c_{50/60}$: $\epsilon_{c2} = -0.002 = -2\%$
 $\epsilon_{cu} = -0.0035 = -3.5\%$
 $f_{cd} = \alpha_{cc} \frac{f_{ck}}{\gamma_c}$

$$\eta = -\frac{\epsilon_c}{\epsilon_{c2}}$$

$$0 \leq \eta \leq 1 ; \sigma_c = -\eta(2-\eta)f_{cd}$$

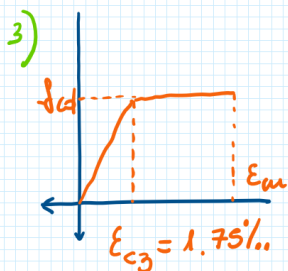
$$\eta \geq 1 ; \sigma_c = -f_{cd}$$

2) STRESS-BLOCK



$$\epsilon < 0.2 \epsilon_{cu} \Rightarrow \sigma_c = 0$$

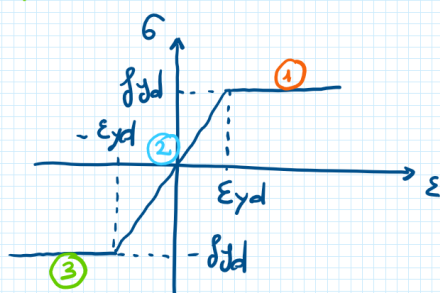
$$\epsilon \geq 0.2 \epsilon_{cu} \Rightarrow \sigma_c = -f_{cd}$$



⇒ NON LO UTILIZZEREMO

ACCIAIO

1) ELASTO-PLASTICO PERFETTO SENZA LIMITI DI DEFORMAZIONE



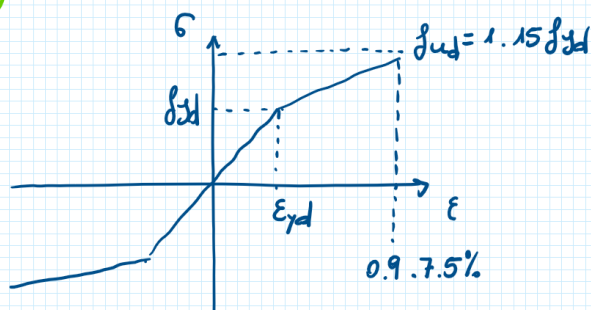
① $\epsilon_s > \epsilon_{yd} ; \sigma_s = f_{yd}$

② $-\epsilon_{yd} \leq \epsilon_s \leq \epsilon_{yd} ; \sigma_s = \frac{\epsilon_s}{\epsilon_{yd}} f_{yd}$

③ $\epsilon_s \leq -\epsilon_{yd} ; \sigma_s = -f_{yd}$

$$\sigma_s = E_s \epsilon_s \Rightarrow \epsilon_{yd} = \frac{f_{yd}}{E_s} = \frac{391.3}{200000} = 0.00196$$

2) ELASTO-PLASTICO INCRUDENTE



NON LO UTILIZZEREMO

VERIFICHE DI SEZIONI IN C.A.

1) VERIFICHE A FESSURAZIONE - SLE

$$\sigma_{ct} \leq f_{ctk} \quad (\sigma_{ct} \leq f_{ctk})$$

• I STADIO DI COMPORT.

• Val. "k" di carichi e resistenze

2) VERIFICHE SUE TENSIONI IN ESERCIZIO - SLE

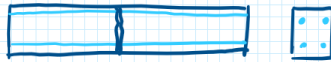
- Val. "k" di calcoli e resistenze

- II STADIO DI COMPORT.

- $\sigma_c \leq 0.6 f_{ck}$ CARICHI IN COMB. RARA

- $\sigma_c \leq 0.45 f_{ck}$ CARICHI IN COMB. QUASI PERMANENTE \Rightarrow LIMITARE ϵ E VISCOSITÀ

- $\sigma_s \leq 0.8 f_{yk}$ CARICHI IN COMB. RARA



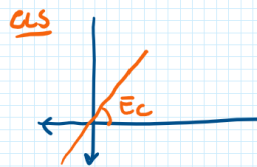
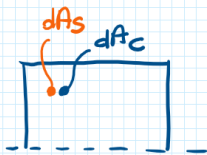
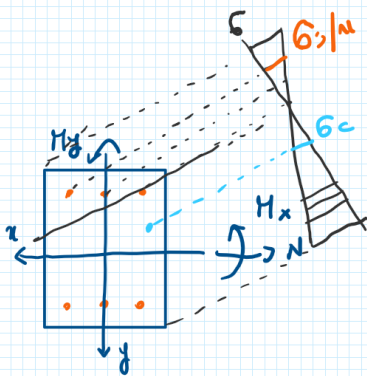
3) VERIFICHE SU

- III STADIO DI COMPORT.

- Valori di prog. "d" di calcoli e resistenze

- $R_d \geq E_d$

I STADIO



Teoria dell'elasticità? NO!

SEZ CS + ACE = NON OMOGENEA

$$\epsilon_s = \epsilon_c = \epsilon$$

$$\begin{cases} \sigma_s = E_s \epsilon \\ \sigma_c = E_c \epsilon \end{cases}$$

$$\frac{\sigma_s}{E_s} = \frac{\sigma_c}{E_c} \Rightarrow \sigma_s = \left(\frac{E_s}{E_c} \right) \sigma_c$$

$n = \text{coeff. di omogeneizzazione}$

$$c 25/30 \quad n = \frac{200000}{31475} = 6.35$$

$$G_c dA_c$$

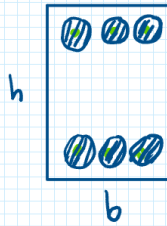
$$G_s dA_s = m G_c dA_s = G_c m dA_s$$

$$dA_s \xrightarrow{G_s dA_s} \xrightarrow{G_c dA_c} \widetilde{G}_c m dA_s = G_s dA_s$$

$$dA_c = m dA_s$$

SEZIONE IN CLS

SEZ. OMOGENIZZATA



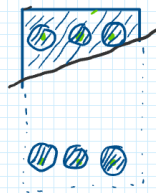
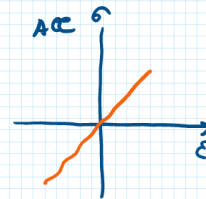
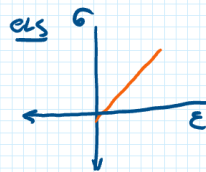
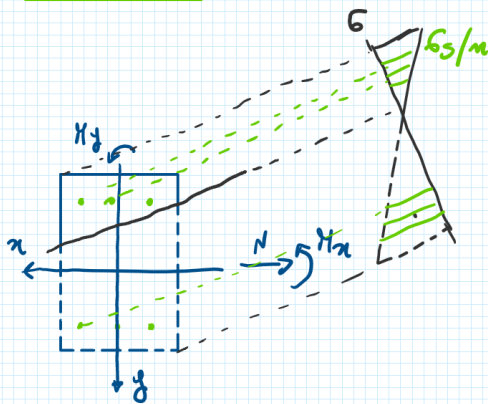
$$A_{ci} = A_c + m A_{s, TOT}$$

SEZ. OMOGENIZZATA
CLS e ACC \rightarrow LINEARE

TEO. DELL'ELASTICITA'

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

II STADIO

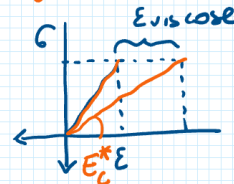


SEZ. REAGENTE OMOGENIZZATA

$$A_{c, COMPRESSA} + m A_{s, TOT}$$

carichi di lunga durata $m = 15$

DETERMINAZIONE DELL'ASSE NEUTRO
E' FONDAMENTALE

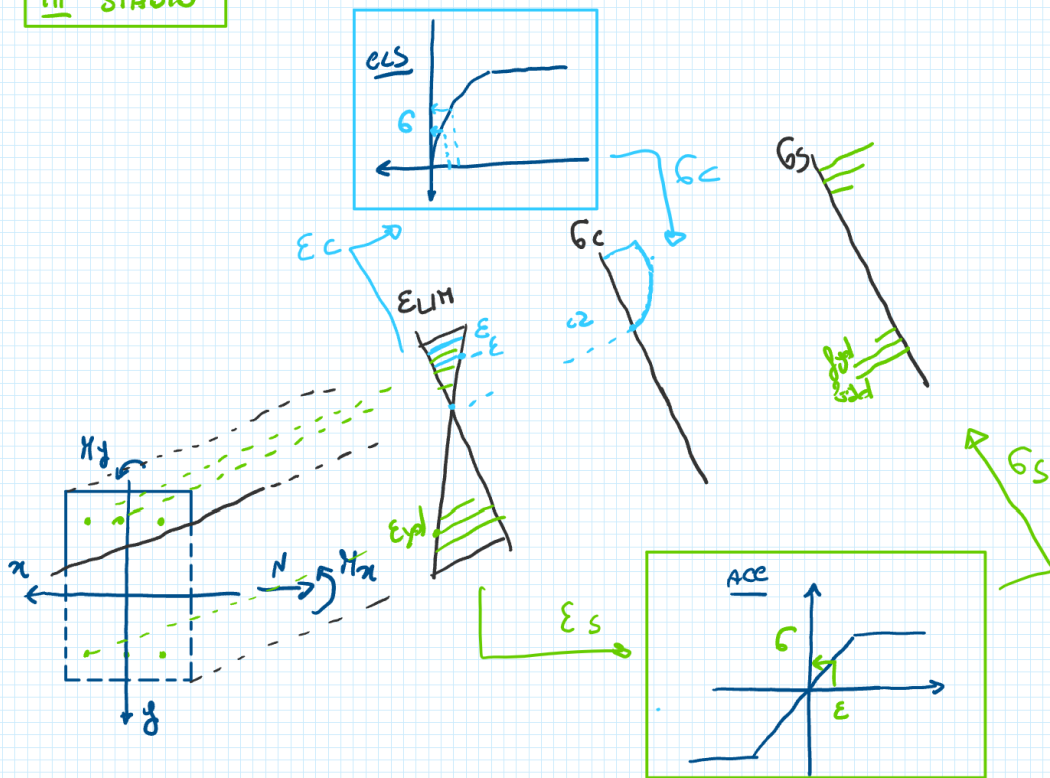


SEZ. REAG. OMOG.

CLS e ACC \rightarrow LINEARI

TEO. DELL'ELASTICITA'

III STADIO



$$\epsilon_{lim} \rightarrow \begin{matrix} \sigma_s \\ \sigma_c \end{matrix} \text{legami } (\sigma - \epsilon) \rightarrow \begin{aligned} N &= \int \sigma dA \\ M_x &= \int \sigma y dA \\ M_y &= - \int \sigma x dA \end{aligned}$$

$R_d \geq E_d$