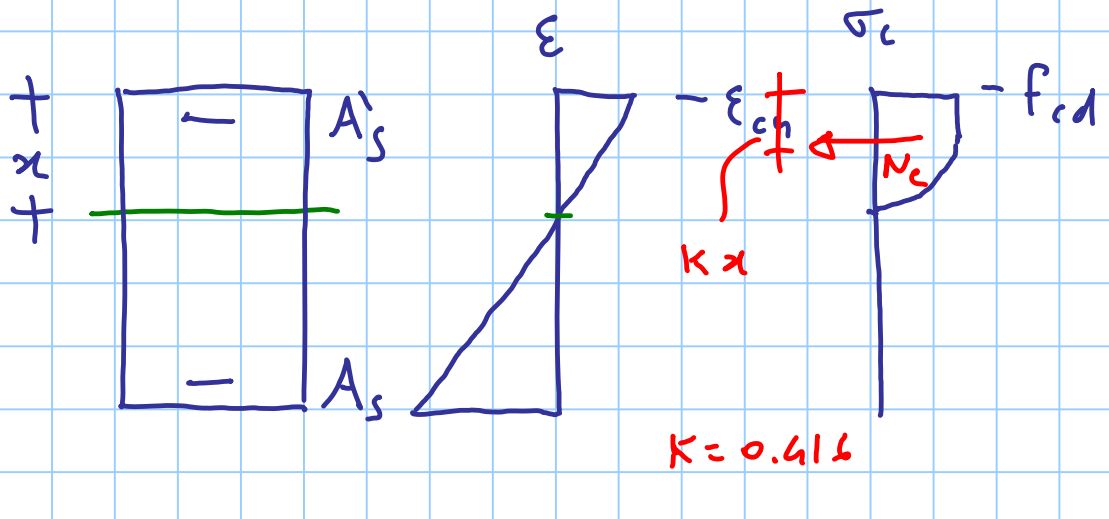
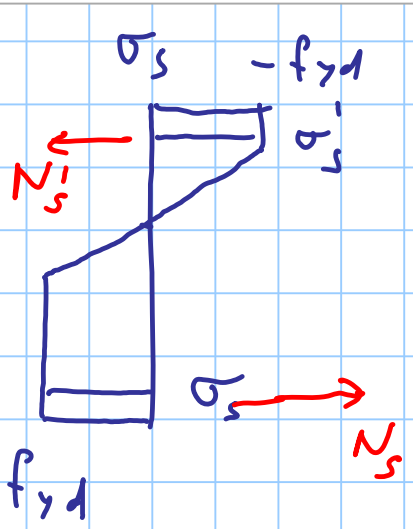
FLESSIONE SEMPLICE - VERIFICA

Titolo nota 15/11/2016





SLU

$$N'_s = A'_s \, \sigma'_s$$

$$N_s = A_s \, \sigma_s$$

$$N = \int \sigma \, dA = 0 \quad \Rightarrow \quad x$$

$$M_{Rd} = \int \sigma \, y \, dA$$

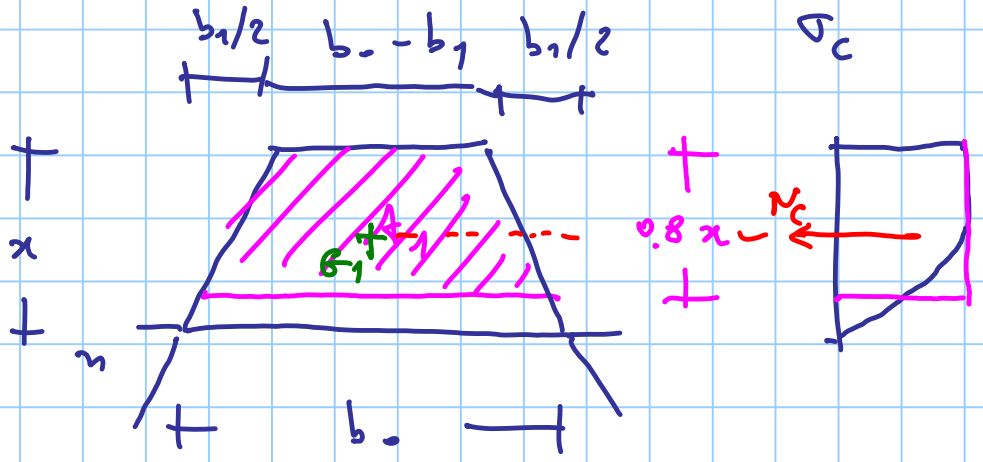
$$N_c + N_s + N'_s = 0$$

per sezione rettangolare

$$N_c = \int \sigma_c \, dA_c = -0.810 \, b \, x \, f_{cd}$$

in generale

$$N_c = -\beta \, A_c \, f_{cd}$$



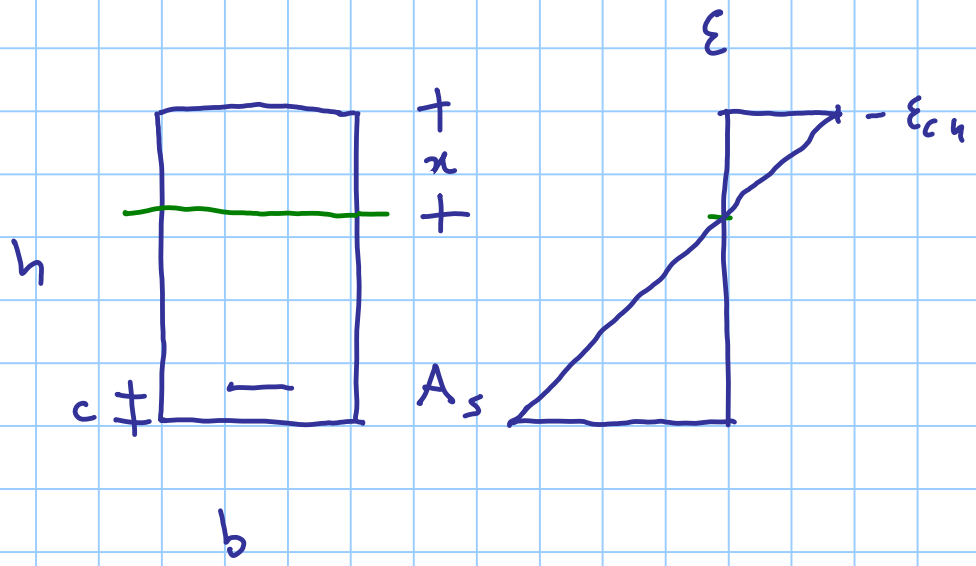
$$N_c = \int \sigma_c \, dA_c$$

$$N_c = \int_{A_1} \sigma_c \, dA_c = -A_1 f_{cd}$$

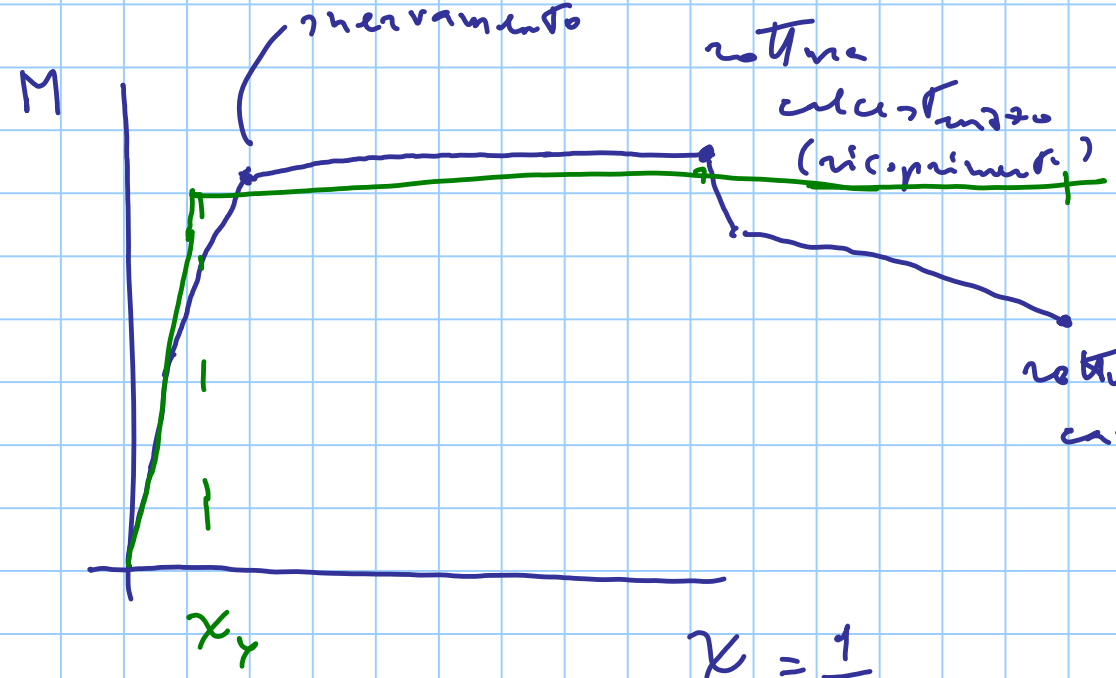
G_1 baricentro di A_1

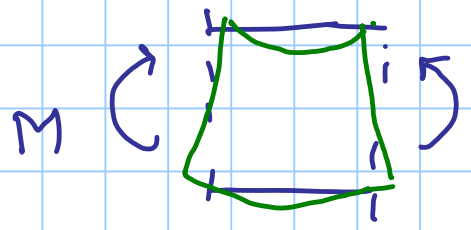
FLESSIONE SEMPLICE – PROGETTO

assegnato M_{Ed} determinare b, h, A_s, A'_s



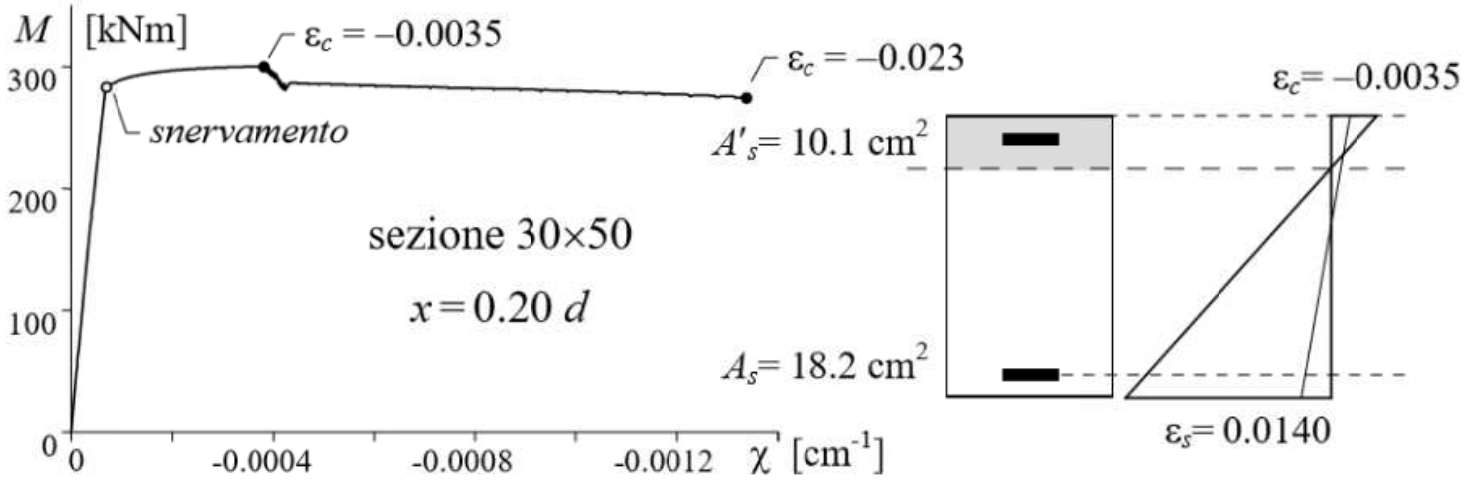
comportamento della sezione

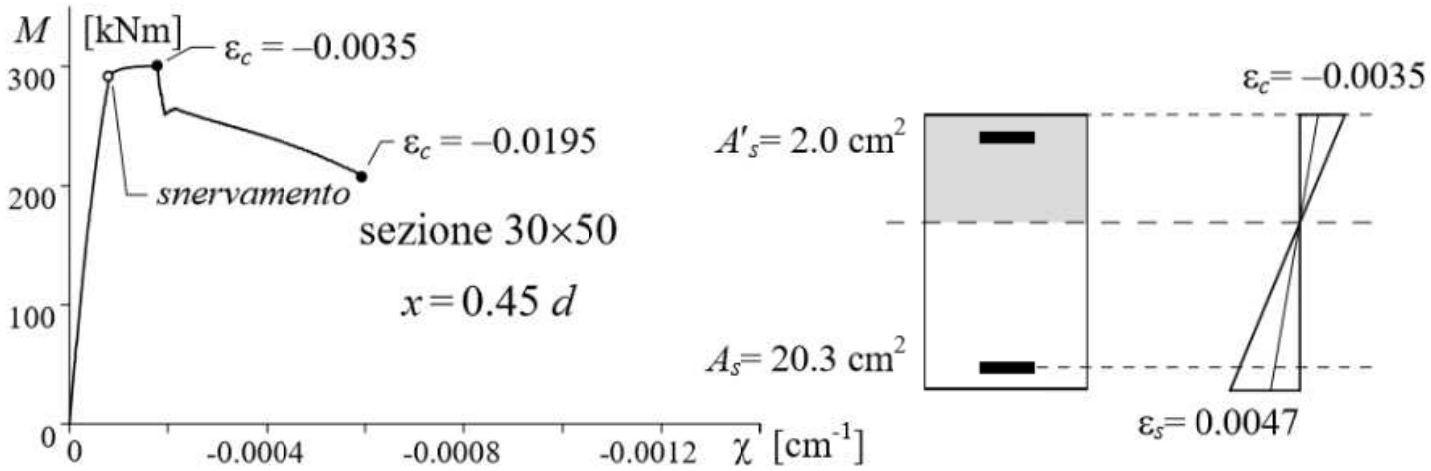




curvature $\chi = \frac{1}{r}$

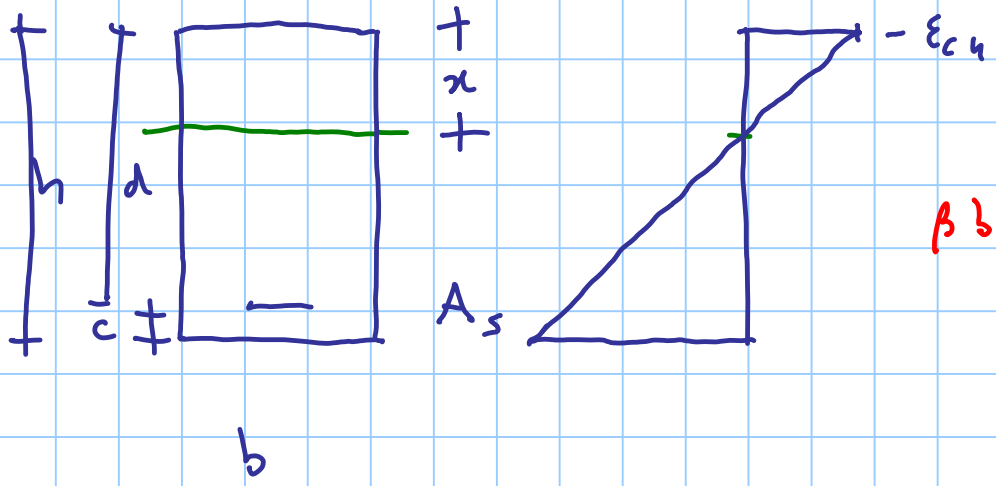
duttilità $\frac{\chi_u}{\chi_y}$

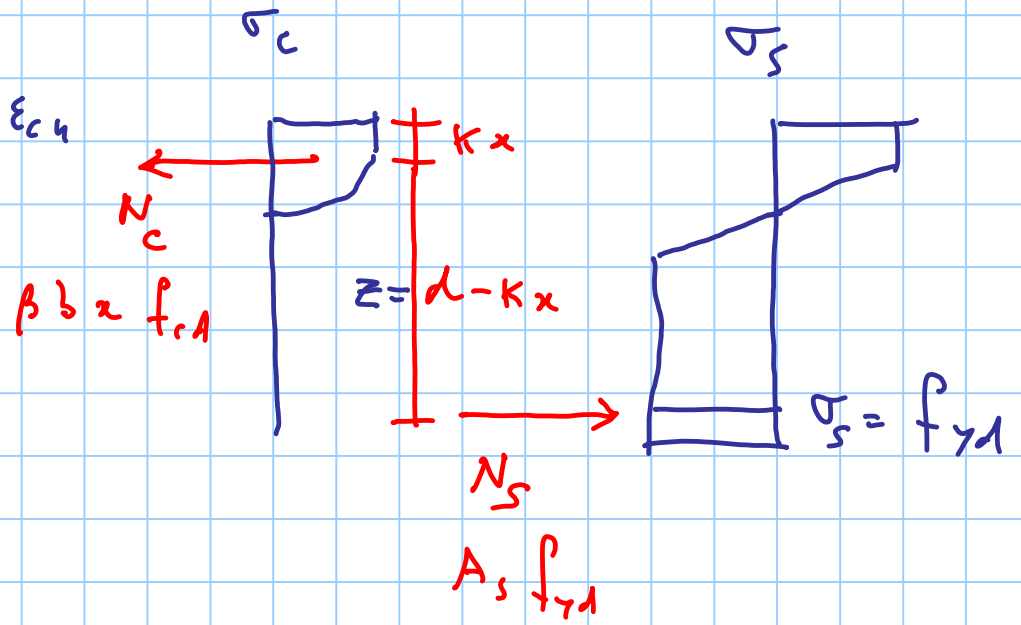

M [kNm]
300
200
100
0
0
-0.0004
-0.0008
-0.0012
χ [cm-1]
εc = –0.0035
εc = –0.023
snervamento
sezione 30×50
x = 0.20 d
A's = 10.1 cm2
As = 18.2 cm2
εc = –0.0035
εs = 0.0140


M [kNm]
300
200
100
0
0
-0.0004
-0.0008
-0.0012
χ [cm-1]
εc = –0.0035
εc = –0.0195
snervamento
sezione 30×50
x = 0.45 d
A's = 2.0 cm2
As = 20.3 cm2
εc = –0.0035
εs = 0.0047

FLESSIONE SEMPLICE – PROGETTO

assegnati M_{Ed}, f_{cd}, f_{yd} — determinare b, h, A_s, A'_s





$x = 0.25\ d$

$$M_{Ed} = N_c z = N_s z$$

$$M_{Ed} = N_c \, z = \beta \, b \, x \, f_{cd} \left(d - K_x \right)$$

$$x = \xi \, d \qquad \xi = 0.25$$

$$M_{Ed} = \beta \, b \, \xi \, d \, f_{cd} \left(d - K \, \xi \, d \right) =$$

$$= \beta \, \xi \, f_{cd} \left(1 - K \, \xi \right) b \, d^2$$

$$\frac{b \, d^2}{z^2}$$

$$= \Sigma$$

$$r = \frac{1}{\sqrt{0.810 \times 0.25 \times (1 - 0.416 \times 0.25) \times 14.17 \times 10^3}} = 0.0197$$

$$M = \frac{b\,d^2}{r^2}$$

massimo momento che può portare la sezione

$$d = r\sqrt{\frac{M}{b}}$$

formula per il progetto dell'altezza utile
(TRAVI EMERGENTI)

$$b = \frac{M\,r^2}{d^2}$$

formula per il progetto della larghezza
(TRAVE A SPESSORE)

$M_{Ed} = 180 \ kNm$ emergente $b = 30$

$$d = r\sqrt{\frac{M}{b}} = 0.0197\sqrt{\frac{180}{0.30}} = 0.48 \ m = 48 \ cm$$

$h = 48 + 4 = 52 \ cm \rightarrow 30 \times 60$ e poi A_s

trave a spessore $h = 28 \ cm$ $d = 24 \ cm$

$$b = \frac{M r^2}{d^2} = \frac{180 \times 0.0197^2}{0.24^2} = 1,21 \ m \rightarrow 130 \times 28$$

$$M = N_s \, z = A_s \, f_{yd} \, z$$

$$A_s = \frac{M_{Ed}}{z \, f_{yd}}$$

$$z = d(1 - k\xi) \simeq 0.9 \, d$$

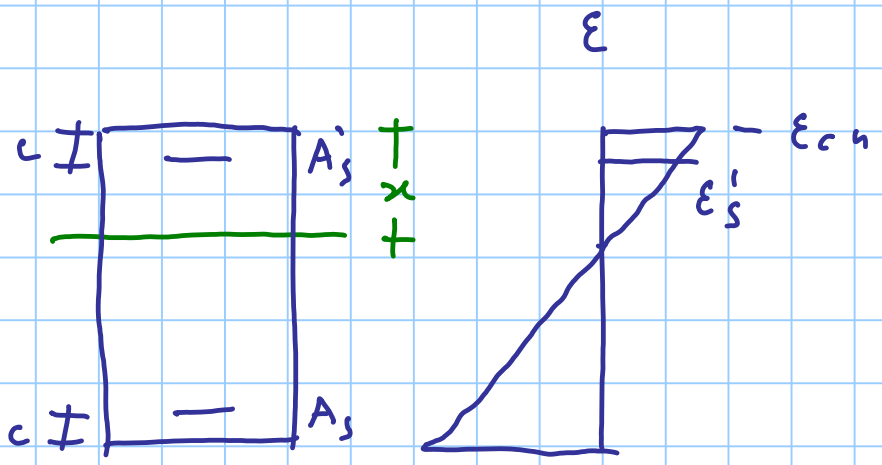
$$A_s = \frac{M_{Ed}}{0.9 \, d \, f_{yd}}$$

$\times 10^3 / 10^2$

Es. 30×60 $\quad M = 180 \ KN_m$

$d = 56 \ cm$

$$A_s = \frac{180 \times 10}{0.9 \times 0.56 \times 391.3} = 9.13 \ cm^2$$



$$\varepsilon_s' \rightarrow \sigma_s' = \varepsilon_s' E_s \quad -f_{yd}$$

$$\sigma_s' = -s' f_{yd}$$

$s' = 1$ armadura

$s' < 1$ elastica

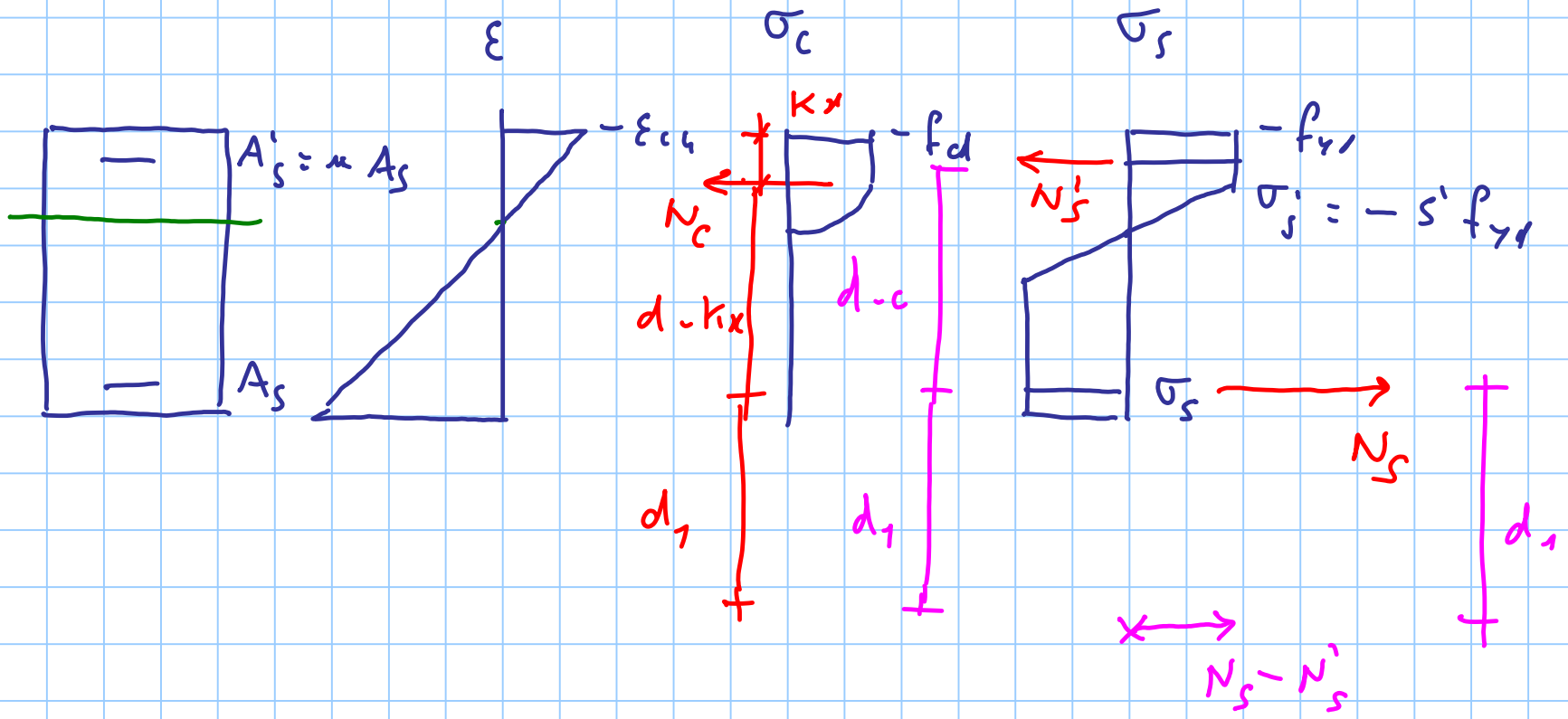
$$\frac{A_s'}{A_s} = n$$

$$\frac{\varepsilon_s'}{x-c} = \frac{-\varepsilon_{cu}}{x}$$

$$\varepsilon_s' = -\frac{x-c}{x}\varepsilon_{cu}$$

$$\varepsilon_s' = -\varepsilon_{yd} \qquad \frac{x-c}{x}\varepsilon_{cu} = \varepsilon_{yd} \qquad (x-c)\varepsilon_{cu} = x\,\varepsilon_{yd} \qquad x(\varepsilon_{cu}-\varepsilon_{yd}) = c\,\varepsilon_{cu}$$

$$x = \frac{\varepsilon_{cu}}{\varepsilon_{cu}-\varepsilon_{yd}} c = \frac{0.0035}{0.0035-0.00196} c = 2.27\,c$$



$$N_s = A_s f_{yd}$$

$$N'_s = - n s' A_s f_{yd}$$

$$N'_s (d - c + d_1) = N_s d_1$$

$$n s' \cancel{A_s f_{yd}} (d - c + d_1) = \cancel{A_s f_{yd}} d_1$$

$$n s' (d - c + d_1) = d_1$$

$$n s' (d - c) = d_1 (1 - n s')$$

$$\gamma = \frac{c}{d}$$

$$d_1 = \frac{n s' (d - c)}{1 - n s'} = \frac{s' n (1 - c/d)}{1 - s' n} d$$

$$M = N_c (d - K x + d_1) =$$

$$= \beta b x f_{cd} \left[d - K x + \frac{s' n (1 - \gamma)}{1 - s' n} d \right]$$

$$= \beta b \xi d f_{cd} \left[1 - K \xi + \frac{s' n (1 - \gamma)}{1 - s' n} \right] d$$

$$M = \beta \xi f_{cd} \left[1 - K\xi + \frac{s' m (1-\gamma')}{1 - s' m} \right] b d^2$$

$$M = \underbrace{\beta \xi f_{cd} (1 - K\xi)}_{\frac{1}{z^2}} \left[1 + \frac{s' m (1-\gamma')}{(1 - s' m)(1 - K\xi)} \right] b d^2$$

$$\frac{1}{z'^2}$$

$$M = \frac{b d^2}{z'^2}$$

$$\tau' = \frac{1}{\sqrt{\beta \xi f_{cd} (1-K\xi)\left[1 + \frac{s'_m (1-\gamma')}{(1-s'_m)(1-K\xi)}\right]}}$$

$$1 + \frac{s'_m (1-\gamma')}{(1-s'_m)(1-K\xi)} \simeq 1 + \frac{s'_m}{1-s'_m} = \frac{1}{1-s'_m}$$

$$\tau' \simeq \tau \frac{1}{\sqrt{\frac{1}{1-s'_m}}} \simeq \tau \sqrt{1-s'_m}$$

CLS C25/30 $\tau = 0.0197$

$\gamma = \frac{c}{d}$ 0.1 Trave alta $\mu = 0.25$ $\tau' = 0.0171$ $\mu = 0.5$ $\tau' = 0.0139$

0.2 Trave a spessore $\tau' = 0.0189$ $\tau' = 0.0181$

$$A_s = \frac{M}{0.9\, d\, f_{yd}} \leq \rho\, b\, d$$

$\rho = 0.01 \div 0.015$

$\tau_s = 0.0165$ $\tau_s = 0.0138$

$$M \leq 0.9\, f_{yd}\, \rho\, b\, d^2 = \frac{b\, d^2}{\tau_s^2}$$

$$\tau_s = \frac{1}{\sqrt{0.9\, f_{yd}\, \rho}}$$

Trave emergente b = 30 M = 180 kNm

$$d = z' \sqrt{\frac{M}{b}} = 0.017 \sqrt{\frac{180}{0.30}} = 0.42\ m = 42\ cm$$

30 × 50

h = 42 + 4 = 46 cm

0.018
17
16

Trave a spessore h = 28 cm d = 24 cm M = 180 kNm

$$b = \frac{M z'^2}{d^2} = \frac{180 \times 0.019^2}{0.24^2} = 1.13\ m$$

120 × 28

opt. con 0.018 → 1.01 m 110 × 28