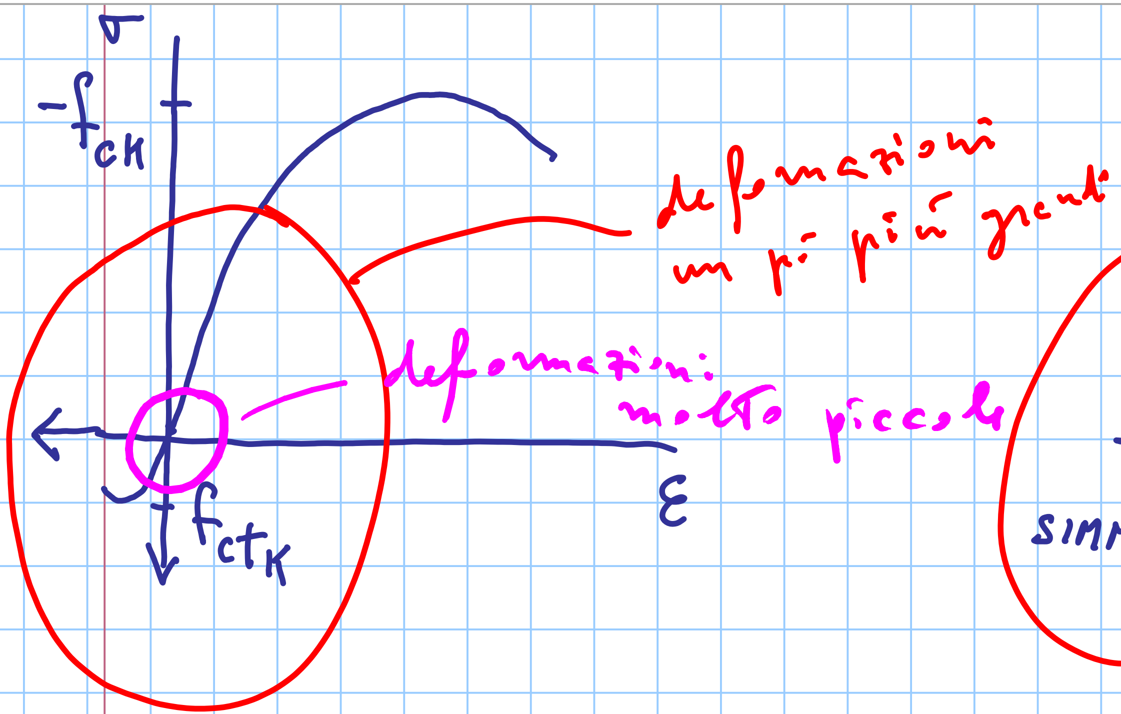
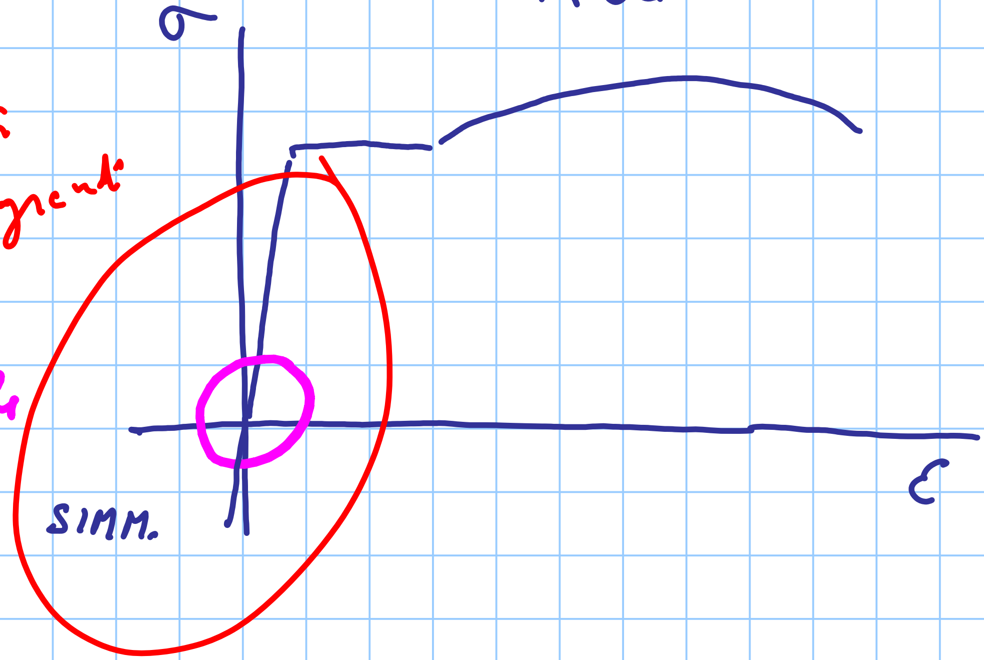
CLS



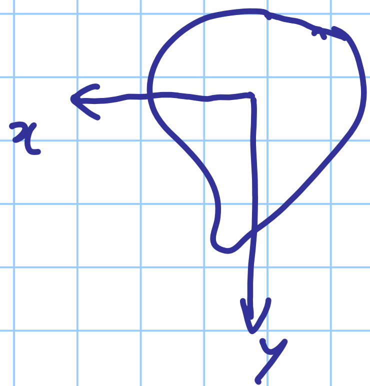
ACC

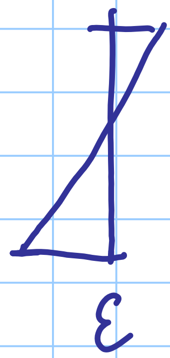


C.A. calcestruzzo + acciaio

Ipotesi base

1) mantenimento della sezione piana





diagr. ε lineare

$\varepsilon \longrightarrow \varepsilon_s = \varepsilon_c$

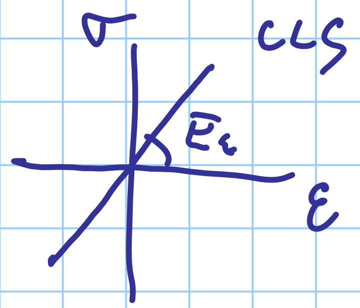
2) perfetta aderenza acciaio - calcestruzzo

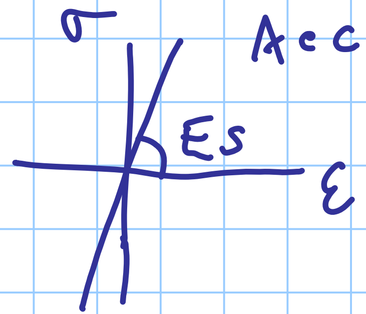
$$\varepsilon_s = \varepsilon_c$$

PRIMO MODELLO DI COMPORTAMENTO

deformazioni molto piccole

- legame costitutivo lineare
- calcestruzzo resistente anche a trazione

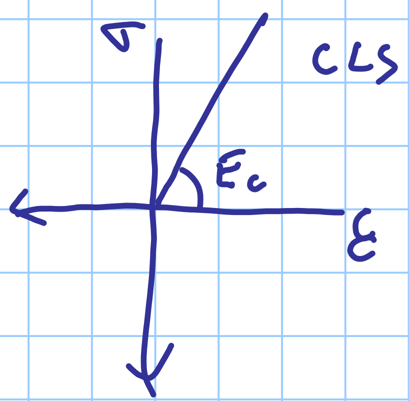


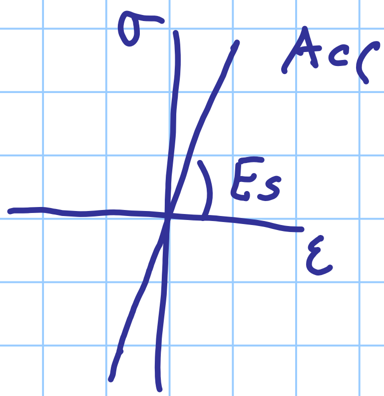


SECONDO MODELLO DI COMPORTAMENTO

deformazioni un po' più grandi

- comportamento lineare
  - per acciaio sia a trazione che compressione
  - per il calcestruzzo a compressione
- trascuro (considero nulla) la resistenza a trazione del cls





TERZO MODELLO DI COMPORTAMENTO

per deformazioni elevate

- modello non lineare per acciaio teso/compresso
- modello non lineare per il calcestruzzo compresso
- nessuna resistenza per il calcestruzzo teso

CHE FARE se nel I mod. comp. ?

modello lineare SdC $\sigma = E\,\varepsilon$

modello lineare TdC

$\sigma_c = E_c\,\varepsilon_c$

$\sigma_s = E_s\,\varepsilon_s$

$$\left.\begin{aligned} N &= \int \sigma \, dA \\ M_x &= \int \sigma\, y \, dA \\ M_y &= -\int \sigma\, x \, dA \end{aligned}\right\}$$

relazioni generali

non dipendono dal legame σ-ε

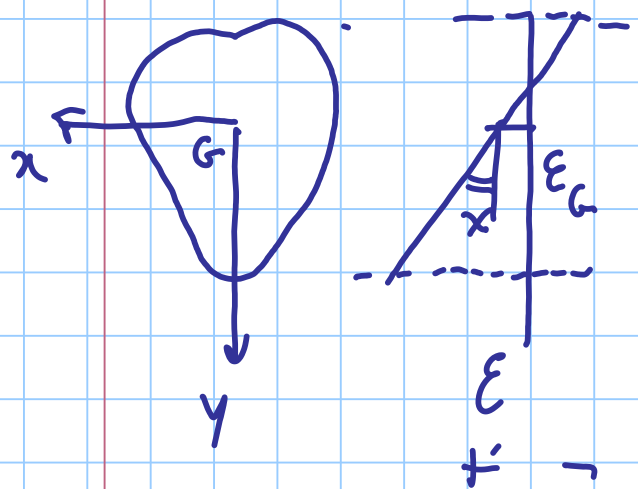
lineare / non lineare

formule di Navier

$$\sigma = \frac{N}{A} + \frac{M_x}{I_x} y$$

relazione lineare

$$\varepsilon = \varepsilon_G + \chi y$$



$$\frac{d\varepsilon}{dy} = \chi = \frac{1}{r} \quad \text{curvatura}$$

$b = b(y)$

$$\sigma = E \varepsilon$$

$$N = \int_{A} \sigma \, dA = \int_{A} E \, \varepsilon \, dA = \int_{y_{min}\,(sup)}^{y_{max}\,(inf)} E \left(\varepsilon_c + \chi y \right) b_{(y)} \, dy =$$

$$= E \, \varepsilon_c \underbrace{\int_{y_{sup}}^{y_{inf}} b_{(y)} \, dy}_{A} + E \, \chi \underbrace{\int y \, b_{(y)} \, dy}_{S_{(c)} = 0}$$

$$N = E \, \varepsilon_c \, A \qquad \varepsilon_c = \frac{N}{EA}$$

$$M_x = \int_{xz} \sigma_y \, dA = \int_{xz} E \varepsilon y \, dA = \int_{y_{min}\,(sup)}^{y_{max}\,(inf)} E\left(\varepsilon_G + \chi y\right) y \, b_{(y)} \, dy =$$

$$= E \varepsilon_G \underbrace{\int_{y_{sup}}^{y_{inf}} b_{(y)} y \, dy}_{S = 0} + E \chi \underbrace{\int y^2 b_{(y)} \, dy}_{I_x}$$

$$M = E \chi I_x \qquad \chi = \frac{M}{E I_x}$$

$$\varepsilon = \varepsilon_c + \chi\, y$$

$$\underbrace{E\,\varepsilon}_{\sigma} = \cancel{E}\,\varepsilon_c + \chi\,\cancel{E}\,y$$

$$E\varepsilon \downarrow \sigma \qquad \varepsilon_c \downarrow \frac{N}{\cancel{E}A} \qquad \chi \downarrow \frac{M_x}{\cancel{E}I_x}$$

$$\sigma = \frac{N}{A} + \frac{M_x}{I_x}\, y$$

Navier

C.A. I STADIO

$$\sigma_c = E_c \, \varepsilon_c$$
$$\sigma_s = E_s \, \varepsilon_s$$
$$\varepsilon_c = \varepsilon_s$$

$$\sigma_c = E_c \, \varepsilon$$
$$\sigma_s = E_s \, \varepsilon$$

$\sigma \, dA$ forze infinitesime risult. di σ su dA infinit.

$$\sigma_c \, dA_c$$
$$\sigma_s \, dA_s$$

$$N = \int_{CLS} \sigma_c \, dA_c + \int_{ACC} \sigma_s \, dA_s$$

$$\sigma_s \, dA_s = E_s \, \varepsilon \, dA_s = \frac{E_s}{E_c} E_c \, \varepsilon \, dA_s =$$

$$= \underbrace{E_c \, \varepsilon}_{\sigma_c} \underbrace{\frac{E_s}{E_c}}_{n} dA_s \qquad n = \frac{E_s}{E_c}$$

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

coefficiente di omogeneizzazione

SEZIONE OMOGENEIZZATA

tutto il calcestruzzo

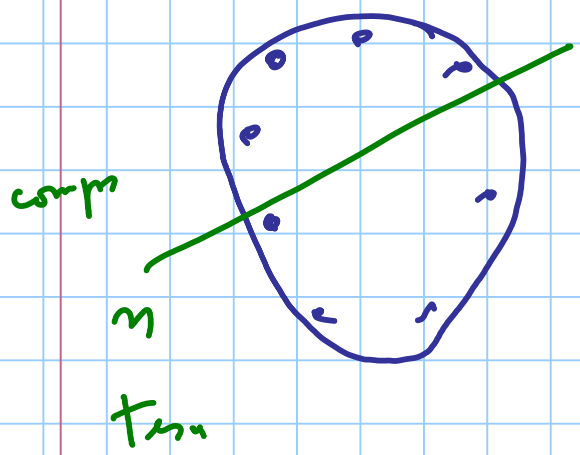
tutto l'acciaio con aree amplificate di n

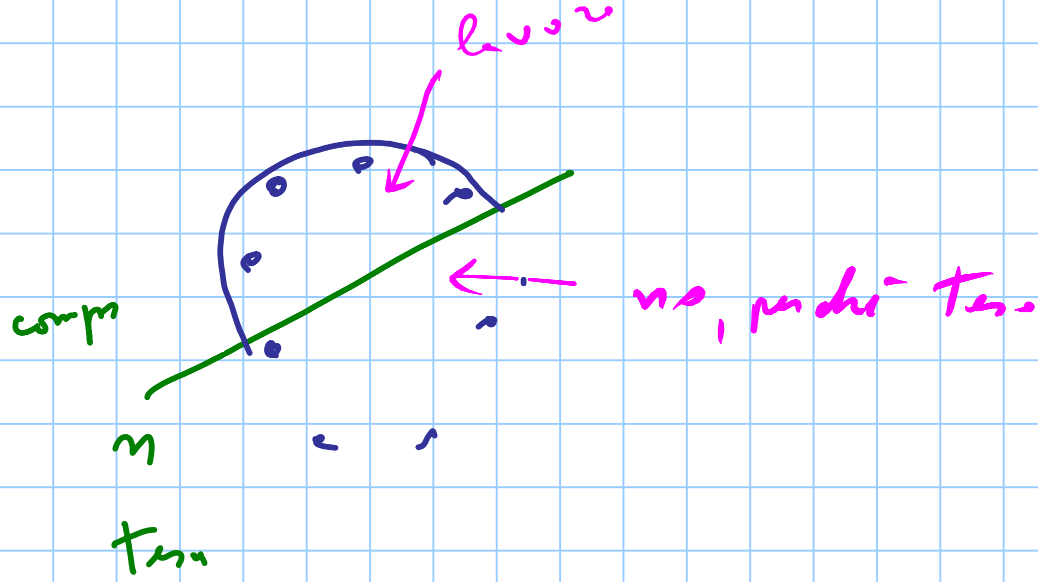
I m.d. comp.

applichiamo le formule teoria elastica

alla sezione omogeneizzata

C.A. II STADIO





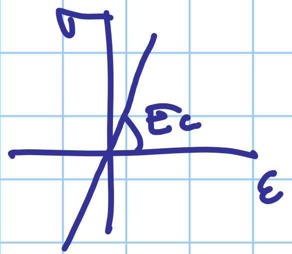
tutto il cls teso

→ solo cls compresso

OMOGENEIZZO

SEZIONE FORMATA DA

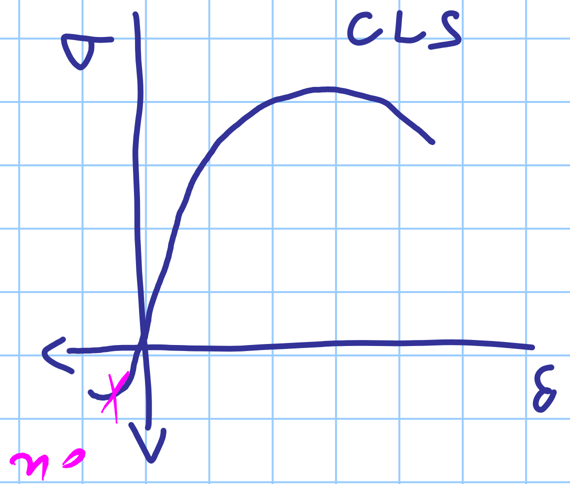
- CLS COMPRESSO
- ACCIAIO Teso + compresso omogeneizzato

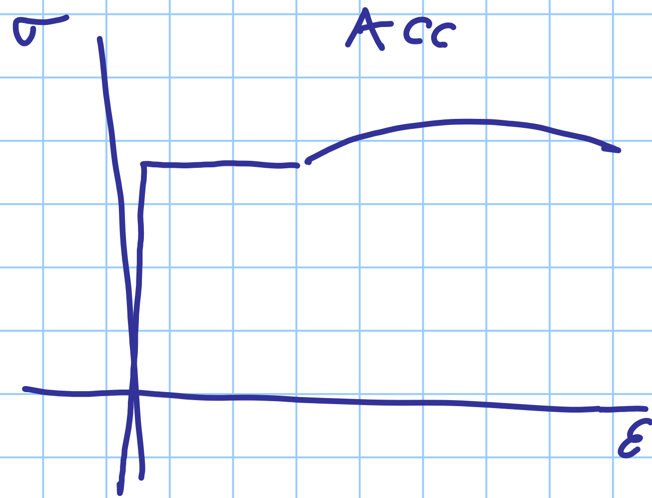


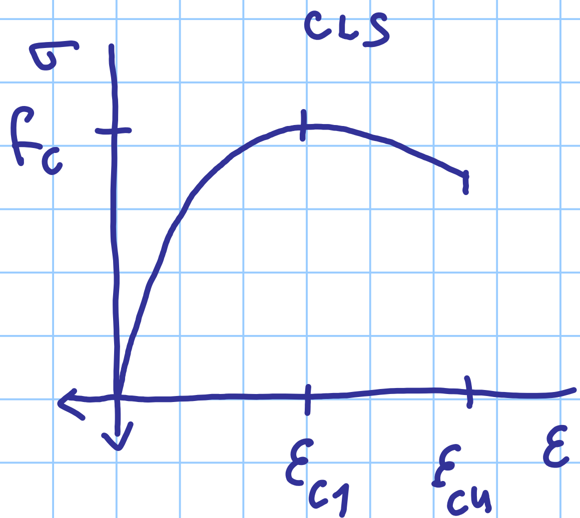
SEZIONE
REAGENTE
OMOGENEIZZATA

posso applicare tutte le formule
dell'elasticità lineare

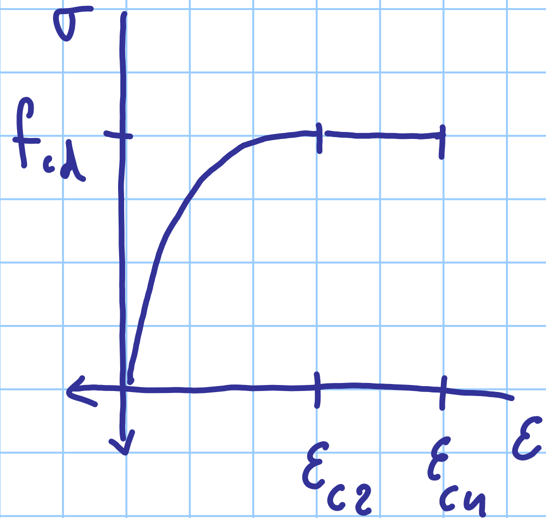
III STADIO







per valutare duttilità



$$\varepsilon_{c2} = -0,002$$

2‰

$$\varepsilon_{cu} = -0,0035$$

3.5‰

per valutare resistenza SLU

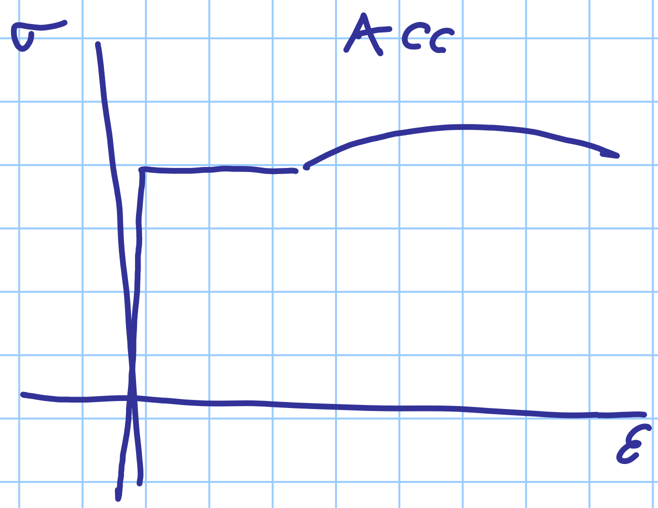
$\varepsilon < 0$ accorciamento

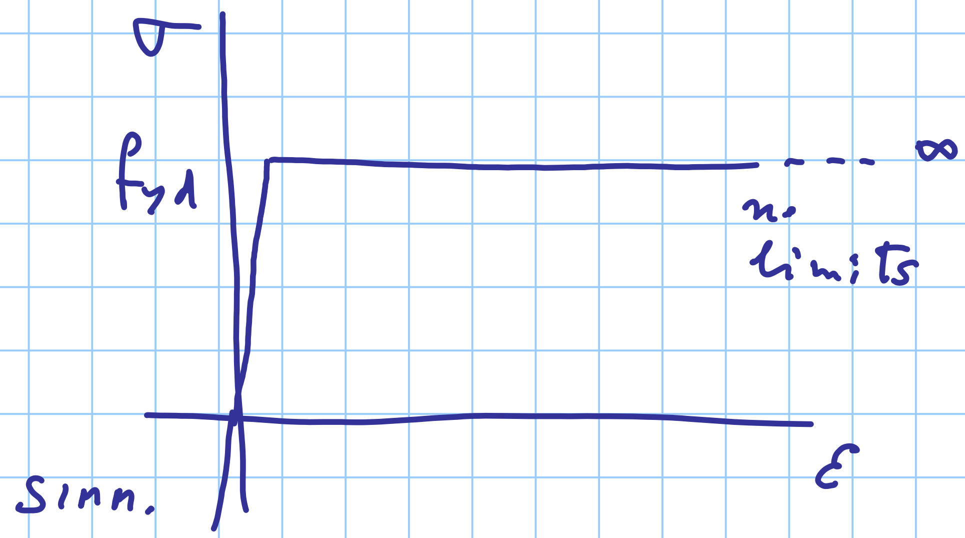
per $|\varepsilon| \leq |\varepsilon_{c2}|$ $\qquad \eta = \dfrac{\varepsilon}{\varepsilon_{c2}} \qquad 0 \leq \eta \leq 1$

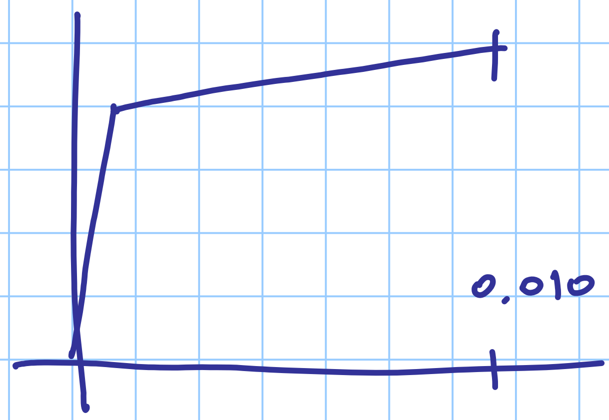
PARABOLA $\qquad \sigma_c = -\eta(2-\eta)\, f_{cd}$

per $|\varepsilon_{c2}| \leq |\varepsilon| \leq |\varepsilon_{cu}|$ $\qquad 1 \leq \eta \leq \dfrac{3.5}{2} = 1.75$

$$\sigma_c = -f_{cd}$$


σ
Acc
ε


σ
f_{yd}
∞
no limits
ε
Sinn.


0,010