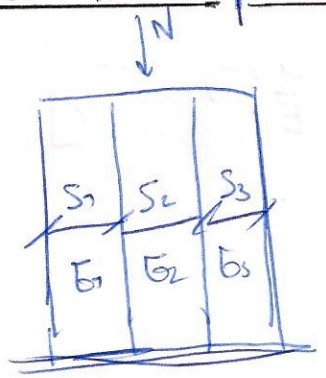
## Carico sulle parti della muratura




$S_1 = S_3 \qquad E_1 = E_3$

$$\sigma = \frac{N}{S_1+S_2+S_3} \qquad \nu_i = \frac{N_i}{\ell\omega} \qquad \varepsilon_i = \frac{\nu_i}{E} = \frac{N_i}{\ell\omega}$$

$$\begin{cases} N = N_1 + N_2 + N_3 \\ \dfrac{N_1+N_3}{E_1(S_1+S_3)} = \dfrac{N_2}{E_2 S_2} \\ [\varepsilon_{1,3} = \varepsilon_2] \end{cases} \Rightarrow \begin{cases} N_1+N_3 = N - N_2 \\ \dfrac{N-N_2}{E_1(S_1+S_3)} = \dfrac{N_2}{E_2 S_2} \quad (1) \end{cases}$$

(1) $\Rightarrow (N-N_2) E_2 S_2 = N_2 E_1 (S_1+S_3)$

$$\Rightarrow N_2 = \frac{N E_2 S_2}{E_1(S_1+S_3) + E_2 S_2}$$

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## Cerchiatura colonne

a) $r$ = raggio colonna  $r_0$ = raggio colonna iniziale  $E, \nu$ = coeff colonna

E' bravo colonna: $\varepsilon_r = -\nu \dfrac{\sigma_r}{E}$

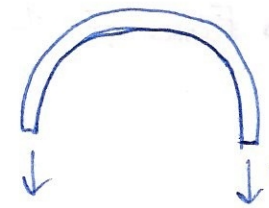
$$r = r_0 + r_0 \varepsilon_r = r_0(1+\varepsilon_r) \Rightarrow r_0 = \frac{r}{1+\varepsilon_r} = \frac{r}{1-\nu\frac{\sigma_r}{E}}$$

b) a $t_0$ ambientale la cerchiatura ha raggio $r' < r$;
a $t_1$ ha raggio $r$

$$2\pi r = 2\pi r' \left[1+\alpha_a(t_1-t_0)\right]$$

$$\Rightarrow r' = \frac{r}{1+\alpha_a(t_1-t_0)}$$

c) raffreddamento: il raggio della colonna diviene $r_1$, $r' < r_1 < r$




$$-S\sigma_a + \int_0^{\pi/2} r_1 (-\sigma_r) \operatorname{sen}\alpha \, d\alpha = -S\sigma_a - r_1 \sigma_r = 0 \Rightarrow S\sigma_a = -r_1\sigma_r$$

equilibrio

$$\frac{2\pi(r_1-r')}{2\pi r'} = \frac{r_1-r'}{r'} = \varepsilon_a = \frac{\sigma_a}{E_a} \Rightarrow r_1 = r'\left(1+\frac{\sigma_a}{\sigma_r}\right) = \frac{r\left(1+\frac{\sigma_a}{E_a}\right)}{1+\alpha_a(t_1-t_0)}$$

allungamento involucro  ↓ raggio finale colonna

## Dilatazione finale colonna

$$\varepsilon_r' = \frac{r_1 - r_0}{r_0}$$

$$\frac{r_1 - r_0}{r_0} = \frac{1}{E}\left(\sigma_r - \nu\sigma_z\right) \Rightarrow r_1 = r_0\left[1 + \frac{1}{E}\left(\sigma_r - \nu\sigma_z\right)\right]$$

$$\Rightarrow r_1 = \frac{r\left[1 + \frac{1}{E}\left(\sigma_r - \nu\sigma_z\right)\right]}{1 - \nu\frac{\sigma_a}{E}}$$

1) $r = r_0 + r_0 \cdot \varepsilon_r \Rightarrow r_0 = \dfrac{r}{1 - \nu\frac{\sigma_a}{E}}$ colonna

2) $2\pi r = 2\pi r'\left[1 + \alpha(t_1 - t_0)\right] \Rightarrow r' = \dfrac{r}{1 + \alpha(t_1 - t_0)}$ cerchiatura

3) $-S\sigma_a - \int_0^{\pi/2} r_1(-\sigma_r)\sin\alpha\, d\alpha = 0$

$$\Rightarrow -S\sigma_a = r_1\sigma_r$$

4) $\dfrac{2\pi(r_1 - r')}{2\pi r'} = \dfrac{r_1 - r'}{r'} = \dfrac{\sigma_a}{E_a} \Rightarrow r_1 = \left(1 + \dfrac{\sigma_a}{E_a}\right)r' = \dfrac{r\left(1 + \frac{\sigma_a}{E_a}\right)}{1 + \alpha(t_1 - t_0)}$

5) $\varepsilon_r' = \dfrac{r_1 - r_0}{r_0} = \dfrac{1}{E}\left(\sigma_r - \nu\sigma_z\right) \Rightarrow r_1 = \dfrac{r\left[1 + \frac{1}{E}\left(\sigma_r - \nu\sigma_z\right)\right]}{1 - \nu\frac{\sigma_a}{E}}$

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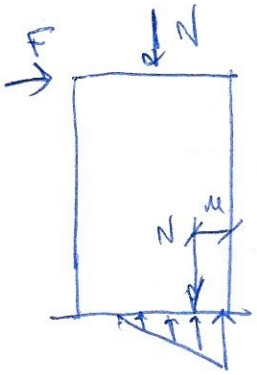
## Ribaltamento muro




$$\sigma_{max} = \frac{2N}{3ut} \qquad F_{rim} \cdot h = N \cdot e_{rim} = N \cdot \frac{b}{2}$$

$$\Rightarrow F_{rim} = \frac{N}{2l}, \quad l = \frac{b}{3} \Rightarrow F_{rim} = 3F_{ec} = 3\frac{N}{6l}$$

valore di compressione massima:

$$\sigma_{max} = \sigma_{Rc} = \frac{2N}{3ub} \Rightarrow \frac{\sigma_{max}\, 3ut}{2} = N$$

$$\Rightarrow u = \frac{b}{2} - e = \frac{2N}{3\sigma_{Rc}t} \cdot \frac{b}{b} = \frac{2}{3}\frac{\sigma_0}{\sigma_{Rc}}b$$

Essendo $F_{rim} \cdot h = N\left(\frac{b}{2} - u\right) = N\frac{b}{2}\left(1 - \frac{2u}{b}\right)$:

$$F_{rim} = \frac{N}{2l}\left(1 - \frac{2u}{b}\right), \quad \frac{u}{b} = \frac{2}{3}\frac{\sigma_0}{\sigma_{Rc}} \Rightarrow F_{rim} = \frac{N}{2l}\left(1 - \frac{4}{3}\frac{\sigma_0}{\sigma_{Rc}}\right)$$