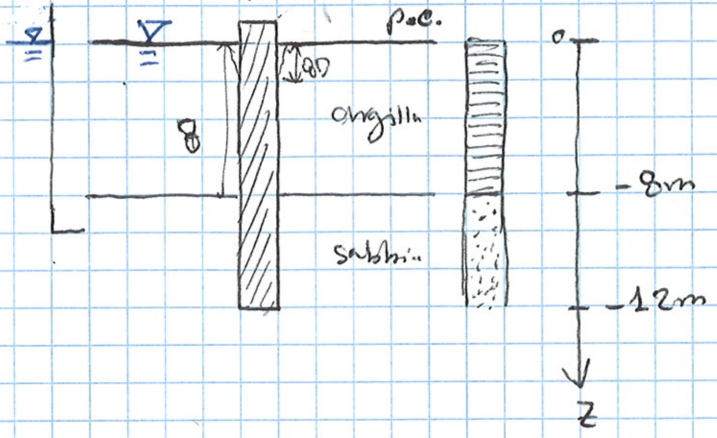
INFISSI

"ESERCIZI SU PALI"

ES1 PALO INFISSO IN SABBIA E ARGILLA

D = 40 cm (palo di diametro intermedio)?



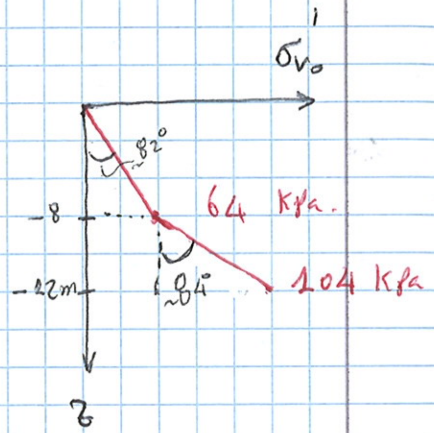
Dati:

→ $c_u = 30$ k. ; $\gamma = 18\ kN/m^3$

→ $D_r = 60\%$; $\phi' = 33°$; $\gamma' = 10\ \frac{kN}{m^3}$

e $\phi'_{cv} = 30°$

Soluzione: (L.T.) Lungo termine (in sabbia sempre!)



① Resistenza di base (in sabbia)

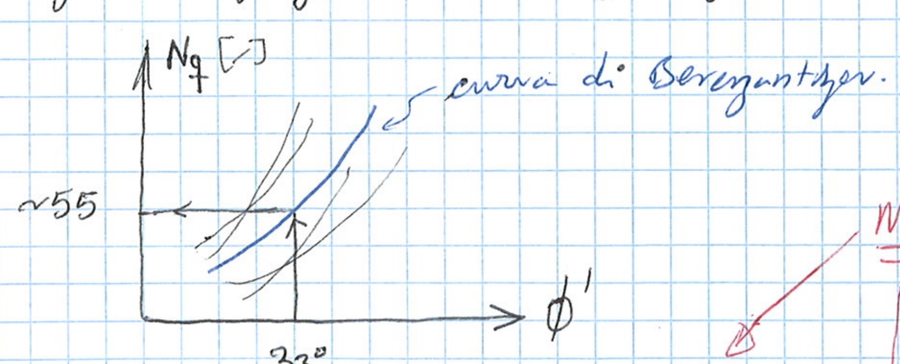
$$R_B = A_B \cdot (\underbrace{N_q \cdot \sigma'_{v_0}}_{q_B})$$

$$\sigma'_{v_0}\Big|_{z=8} = \sigma_{v_0} - U$$

$$= (18)\cdot(8) - 10 \cdot 8 = 64\ \text{kPa}$$

$$\sigma'_{v_0}\Big|_{12} = 104\ \text{kPa} \quad ✓$$

- il prob. e' che non conosco N_q ⇒ uso la soluzione grafica di Berezantzev:



NB!

kPa = kN/m²

- infine:

$$R_B = \frac{\pi \cdot D^2}{4}(55 \times 104) = 718\ kN$$

$$D = 40\ cm = 0{,}4\ m$$

attenzione!

INFISSI

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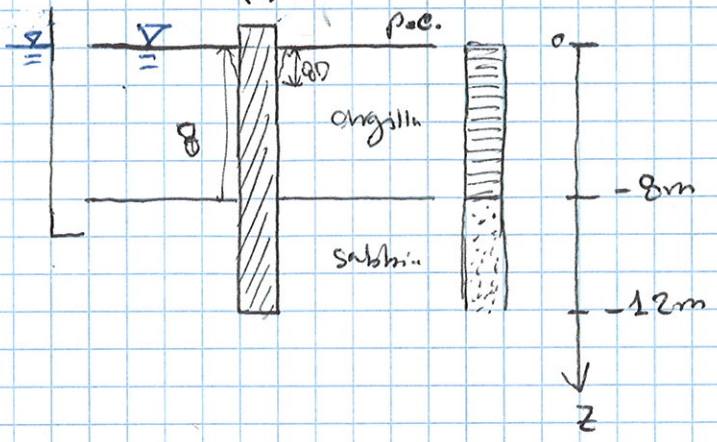

Dati:

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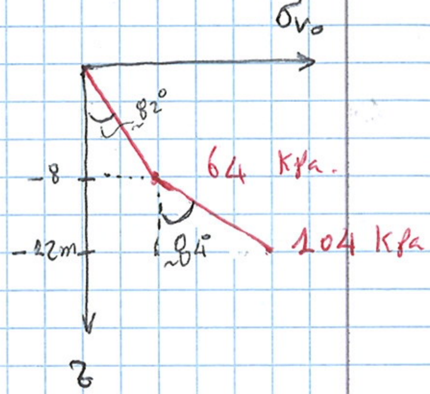
① Resistenza di base (in sabbia)



$$R_B = A_B \cdot \underbrace{(N_q \cdot \sigma'_{v0})}_{q_B}$$

$$\sigma'_{v0}\Big|_{z=8} = \sigma_{v0} - U$$

$$= (18)\cdot(8) - 10 \cdot 8 = 64 \text{ kPa}$$

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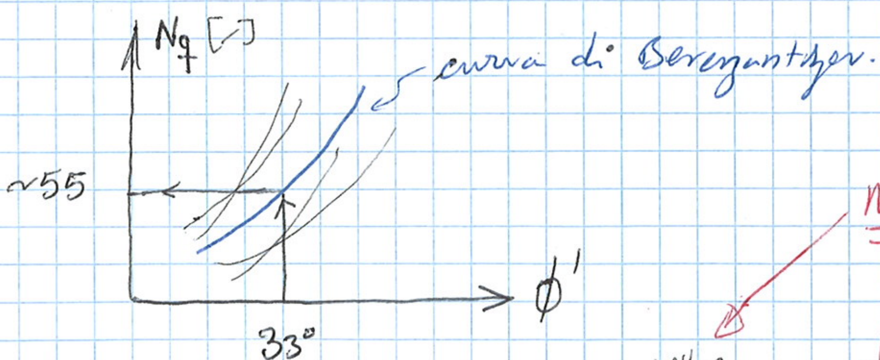


NB!

kPa = kN/m²

- infine:
$$R_B = \frac{\pi \cdot D^2}{4}(55 \times 104) = 718 \text{ kN}$$

$$D = 40 \text{ cm} = 0{,}4 \text{ m}$$ attenzione!

② – Resistenza laterale in sabbia (4 m).

$$R_L = 2 \cdot \pi \cdot r \cdot \int_0^z \tau_{lim} \, dz$$

$$= \pi D \cdot \int_0^z \bar{\sigma}_h' \cdot tg\delta \, dz \qquad ; \bar{\sigma}_{v0}' = \sigma_v' \big|_{z=10m} = 84 \text{ kPa}.$$

$$= \pi D \int_0^{z=4} K \cdot \bar{\sigma}_{v0}' \cdot tg(\delta) \, dz$$

$$= \pi \cdot D \cdot K \cdot \bar{\sigma}_{v0}' \cdot tg(\delta) \cdot 4$$

K → ? = (1 ÷ 2) per pali costruiti fuori opera (scelta K = 1)

δ → ? = $\frac{3}{4}\phi'$ (per pali costruiti fuori opera).

$$= \pi \cdot (0{,}4) \cdot (1) \cdot (84) \cdot tg\left(\frac{3}{4} \cdot 33°\right) \cdot 4$$

$$= 194{,}65 \text{ KN}.$$

8m – 8D ?

③ – Resistenza laterale in argilla → si sviluppa in 7m ?

~~Considero sempre 1 m meno!!!~~

$$R_L = \pi \cdot D \int_0^7 \tau_{lim} \, dz$$

$$= \pi \cdot D \cdot 7 \cdot \tau_{lim} \ ?$$

Uso il metodo α per il calcolo di τ_{lim} con raccomandazioni AGI:

$$\tau_{lim} = \alpha \cdot cu$$

$\alpha = 1$ se $cu \leq 25$ kPa

$\alpha = 0{,}5$ se $cu \geq 70$ kPa.

interpolazione lineare per cu = 30

$\alpha = 0{,}9\bar{4}$

$$= \pi \cdot D \cdot 7 \cdot 0{,}94 \cdot 30$$

$$= \pi \cdot 0{,}4 \cdot 7 \cdot 0{,}94 \cdot 30 = 248 \text{ KN}.$$

Infine $R_{Lim} = Q_B + Q_L$

$$= (718 + 194{,}65 + 248)\ \text{kN}$$

$$= 1160{,}65\ \text{kN}$$

- **verifica: secondo il DM'88:**

$$R_{amm} = \frac{R_{Lim}}{F_s} = \frac{1160}{2{,}5} \simeq 464\ \text{kN}.$$

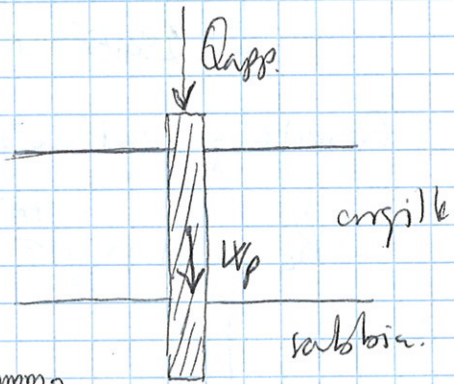
? hp. palo rigido e terreno rigido-perfettamente plastico ⇒

⇒ $F_s = 2{,}5$

AGI: $2{,}5 \le F_s \le 3{,}5$

La verifica consiste in:

$$Q_{app} + W_{palo} \le R_{amm}$$



- Ipotizzo che

Ramm (per sbaglio ho scritto 400 in realtà è 464 kN)

$$W_p + G_K \simeq \frac{2}{3} \cdot 400 \simeq 270\ \text{kN} \Rightarrow$$

$$\Rightarrow Q_K \simeq 130$$

- **VERifica R.I. 2008:** avendo

$$\begin{cases} W_p + G_K = 270\ \text{kN} \\ Q_K \simeq 130 \end{cases}$$

(1) applico DA1 e Combinazione 1

DA1 : A_1 M_1 R_1

$$E_d = 1{,}3\,(W_p + G_K) + 1{,}5\,Q_K = 546\ \text{kN}$$

$$R_d = \frac{R_K}{\gamma_R} = \frac{1}{1} \cdot R_K \Rightarrow \text{ove}$$

$$R_K = \min\left\{\frac{R_{c\,medio}}{\xi_1} ; \frac{R_{c\,min}}{\xi_2}\right\}$$

Se abbiamo una prova verticale $\Rightarrow R_{c\,medio} = R_{min}$.

e $\xi_1 = \xi_2 = 1{,}7$ come qui:

$$R_d = \frac{1}{\gamma_{R_1}} \cdot R_K = \frac{1}{1}\left(\frac{628 + 146 + 248}{1{,}7}\right) = 601\ \text{kN}$$

$R_d \geq E_d \Rightarrow$ verificato!

(2) – applico DA2 (A_2 M_1 R_2):

$$E_d = 1 \cdot (270) + 1{,}3\,(130) = 439\ \text{kN}$$

$$R_d = \frac{1}{\gamma_{R_2}} \cdot R_K = \frac{1}{1{,}45}\left(\frac{628 + 146 + 248}{1{,}7}\right) = 415\ \text{kN}$$

$R_d \geq E_d \rightarrow$ non verificato anche se di poco!

(3) – applico DA3: ($A_1 + M_1 + R_3$):

$$E_d = 546\ \text{kN}$$

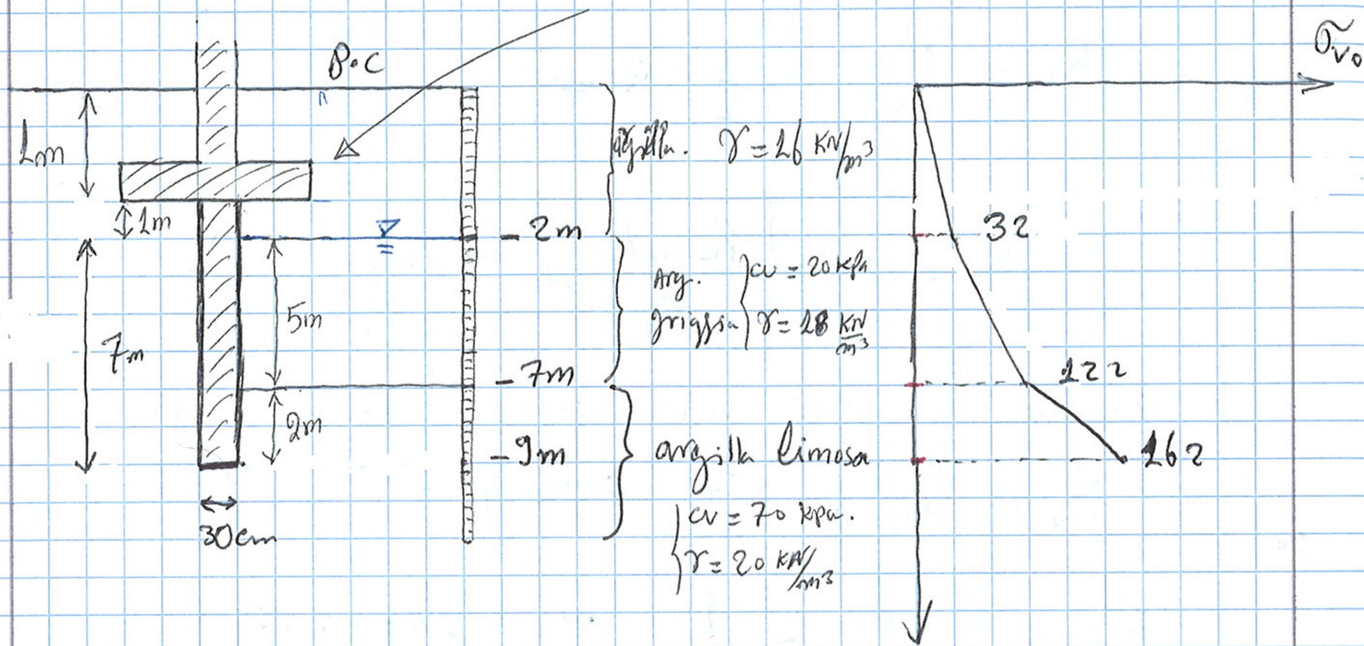
$$R_d = \frac{1}{\gamma_R} \cdot R_K = \frac{1}{1{,}15}\left(\frac{628 + 146 + 248}{1{,}7}\right) = 523 \rightarrow \text{non verificato di poco!}$$

— o —

ES 2 PALO INFISSO IN AGILLA

↑cilindrico

Disegno non e' ∝ (proporzionale)!



SOLUZIONE:

1 - Resistenza di base: (in argilla sempre a breve termine!)

condizioni non drenate!!!

⇓

σ_{v0}

$$R_B = A_B (c_u \cdot N_c + \sigma_{v0})$$

↑ e' l'unico prob.?

$$\sigma_{v0} = 16 \times 2 + 18 \times 5 + 20 \times 2$$

$$= 162 \text{ KPa}$$

$$A_B = \frac{\pi}{4} \cdot (0{,}3)^2 = 0{,}07069 \text{ m}^2$$

$N_c = 9$ per quanto $L_{imm} \geq (3 \div 4) D$

$2 m \geq 0{,}9 m$

infine

$$R_B = 55{,}98 \text{ KN}$$

NB! (L.T.)
→ E' Lecito usare la condizione drenante per fare il calcolo di R_L!!!

② - Resistenza laterale del palo: considero il palo da "2" a "9" metri. i) usando il metodo α!

$$R_L\Big|_{argilla\ (2\div 9)m} = \pi \cdot D \int_0^z \tau_{lim}\, dz$$

$$= \pi \cdot D \cdot \int_0^z \alpha \cdot c_u\, dz$$ ← metodo α!

$$= \pi \cdot D \cdot \alpha \cdot c_u \cdot \int_0^z dz$$

AGI

$$\alpha \begin{cases} 1 & se \quad c_u \le 25 \\ 0{,}5 & se \quad c_u \ge 70 \end{cases}$$

$$= \pi \cdot D \cdot c_u \cdot \alpha \int_0^z dz$$

$$= \pi \cdot (0{,}3) \cdot \left[(20) \cdot 1 \cdot 5 + 70 \cdot 0{,}5 \cdot 2\right]$$

$$= 160\ KN.$$

ii) usando metodo β per R_L: hp.
$$\begin{cases} \phi' = 28° & sopra \\ \phi' = 33° & sotto \\ argilla\ NC \rightarrow OCR = 1 \end{cases}$$

$$R_L = \pi \cdot D \cdot \int_0^z \tau_{lim}\, dz$$ ($\tau_{lim} \to \beta \cdot \sigma'_{v_0}$)

$$= \pi \cdot D \cdot \int_0^z \underbrace{(1 - \sin\phi') \cdot (OCR)^{0{,}5} \cdot \tan\phi'}_{\beta} \cdot \sigma'_{v_0}\, dz$$

1 perche' argille NC!

$$= \pi \cdot D \cdot (1 - \sin\phi')\, tg\phi' \cdot \overline{\sigma}'_{v_0} \int_0^z dz$$

$$= \pi \cdot (0{,}3) \left[(1 - \sin 28)\, tg(28) \cdot \overline{\sigma}'_{v_0} \cdot 5 + (1 - \sin(33°))\, tg(33°) \cdot \overline{\sigma}'_{v_0} \cdot 2\right]$$

$$\sigma'_{v_0} = 16 \cdot 2 = 32\ kPa$$
$$\sigma'_{v_0} = 32 + (18 - 10)5 = 72\ kPa$$
$$\sigma'_{v_0} = 72 + (20 - 10) \cdot 2 = 92\ kPa$$

$$\overline{\sigma}'_{v_0} = \frac{32 + 72}{2} = 52\ kPa$$

$$\overline{\sigma}'_{v_0} = \frac{92 + 72}{2} = 82\ kPa$$

Infine ho:

$$R_L\Big|_{2\div 9m} = 114 \text{ KN}$$ che e' molto basso rispetto il metodo α!

considerando migliore il metodo α ⇒ Scelgo $R_L\Big|_{metodo\ \alpha}$

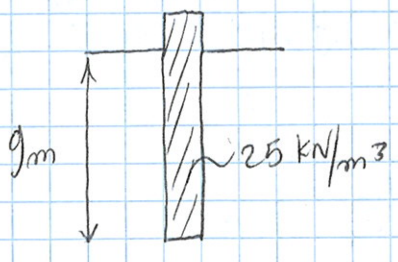
$$R_{Lim} = R_B + R_L = 55,98 + 160 \cong 216 \text{ KN}.$$

(I) - **VERIFICA : DM'88 :**

$$R_{amm} = \frac{R_{Lim}}{F_S} = \frac{216}{2,5} = 86,4 \text{ KN}$$

$$R_{amm} \geq Q_{app.} + W_{palo}$$

- con la nuova normativa dobbiamo dare dei carichi al palo



$$W_{palo} = 25\,(9) \cdot \frac{\pi D^2}{4} = 25\,(9) \cdot \pi \cdot (0,3)^2 \cdot \frac{1}{4} = 15,65 \text{ KN}.$$

Ip: $G_K = 40$ KN ; $Q_K = 20$ KN

- verifico questi valori con la vecchia normativa:

$$R_{amm} \geq (15,65 + 40 + 20) = 75,65$$

Verifica soddisfatta!

- Verifica nuova normativa: R.I. 2008

i) - DA1 (A_1 M_2 R_1):

$$E_d = 1,3\,(W_p + G_K) + 1,5\,Q_K = 102,4\ KN$$

$$R_d = \frac{R_K}{\gamma_{R_1}} = \frac{1}{1} \cdot R_K = \frac{R_{Lim}}{\xi_1 = \xi_2} = \frac{216}{1,7} = 127\ KN$$

hp. prova verticale ⇝ $R_{c\,medio} = R_{c\,min} \Rightarrow \xi_1 = \xi_2 = 1,7$.

$R_d \geq E_d$ ⇝ OK verificata!

ii) - DA2 (A_2 M_1 R_2):

$$E_d = 1\,(W_p + G_K) + 1,3\,(Q_K) \cong 81\ KN$$

$$R_d = \frac{R_K}{\gamma_{R_2}} = \frac{1}{1,45}\left(\frac{216}{1,7}\right) \cong 87,6\ KN$$

$R_d \geq E_d$ OK verificato.

iii) - DA3 (A_1 M_1 R_3)

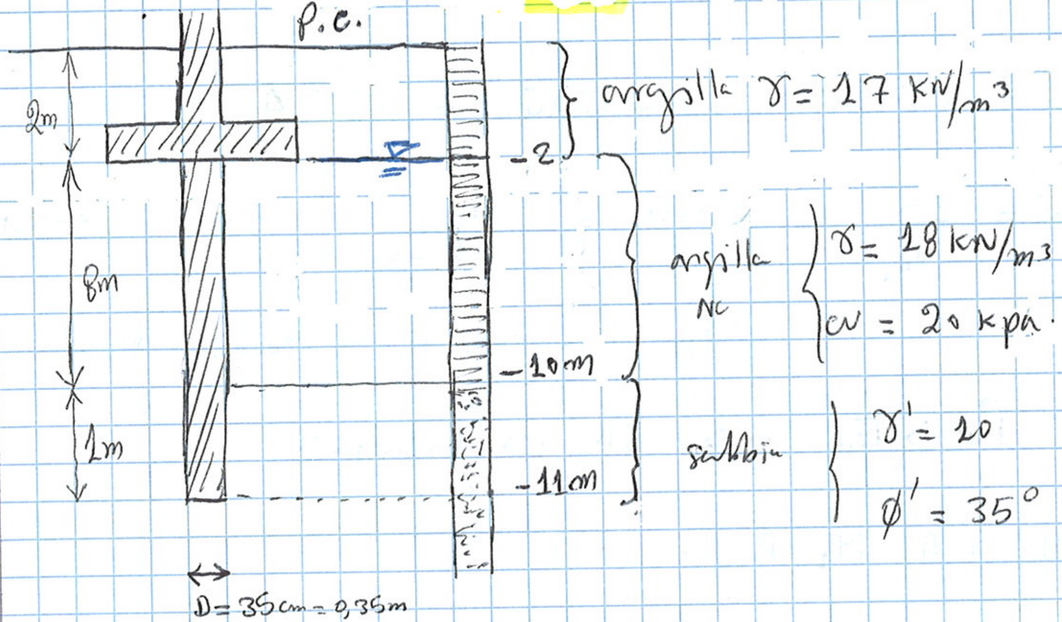
$$E_d = 1,3\,(G_K + W_p) + 1,5\,Q_K = 102,4\ KN$$

$$R_d = \frac{R_K}{\gamma_{R_3}} = \frac{1}{1,15}\left(\frac{216}{1,7}\right) = 110,48\ KN$$

$R_d \geq E_d$ verificato ok!

— o —

ES3 "PALO INFISSO CON PUNTA IN SABBIA"



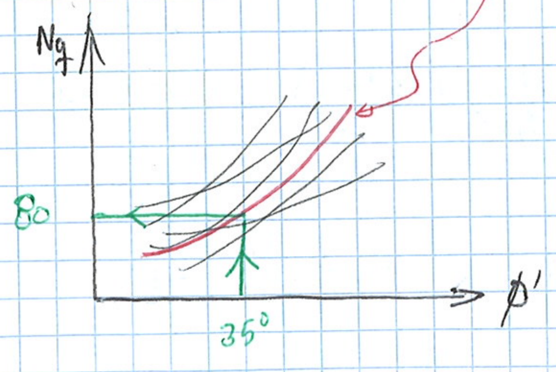
Solu**z**ione: (punta in sabbia ⇒ sempre L.T.)!

① $R_B = A_B \cdot q_B$

$= \frac{\pi \cdot D^2}{4} \cdot N_q \cdot \sigma'_{v0}$

$\sigma'_{v0} = 17 \cdot 2 + (18-10)\,8 + (10) \cdot 1 = 108\ kPa$

N_q calcolo con Berezantzev:



NB! La resistenza di punta molto alto in sabbia!

infine

$R_B = \frac{\pi \cdot (0{,}35)^2}{4} \cdot (80)(108) \simeq 831\ kN$

② → Resistenza laterale in argilla (R_L): "Metodo α"

$$R_L = \pi \cdot D \int_0^z \tau_{Lim}\, dz$$

$$= \pi \cdot D \cdot \int_0^z \alpha \cdot c_u\, dz$$

$$= \pi \cdot D \cdot \alpha \cdot c_u \int_0^8$$

? qua non diminuisco il palo di 1m ! → perché sono già sotto!

$$= \pi \cdot D \cdot \alpha \cdot c_u \cdot 8 \quad (\alpha = 1)$$

con $\alpha \begin{cases} 1 & \text{se } c_u \leq 25 \\ 0,5 & \text{se } c_u \geq 70 \end{cases}$

$$\simeq 176\ kN$$

Siccome $c_u = 20 \rightarrow \alpha = 1$

→ R_L con "metodo β": (Sempre in condizioni drenate L.T) !!!

$$R_L = \pi \cdot D \int_0^z \tau_{Lim}\, dz$$

$$= \pi \cdot D \int_0^z \beta \cdot \bar{\sigma}'_{v0}\, dz$$

$$= \pi \cdot D \cdot \beta \cdot \bar{\sigma}'_{v0} \int_0^z$$

$$= \pi \cdot D \cdot (1 - \sin\varphi')\, OCR^{0,5} \cdot tg\,\varphi' \cdot \bar{\sigma}'_{v0} \cdot 8$$

1 perché argilla N.C.

$$= 173,1\ kN$$

$$\left.\begin{aligned} \sigma'_{v0} &= 2 \cdot 17 = 34\ kPa \\ \sigma'_{v0} &= 34 + (18-10)8 = 98 \end{aligned}\right\} \quad \bar{\sigma}'_{v0} = \frac{34+98}{2} = 66\ kPa$$

NB! $R_L|_{metodo\,\alpha} \approx R_L|_{metodo\,\beta}$!

③ Resistenza laterale Q_L in sabbia:

$$Q_L = \pi \cdot D \cdot \int_0^z \tau_{Lim} \cdot dz$$

$$= \pi \cdot D \cdot \int_0^z \sigma'_h \cdot tg\,\delta\, dz$$

$\tau_{Lim} = \sigma'_h \cdot tg\,\delta$

palo infisso in sabbia!!!

$$Q_L = \pi \cdot D \cdot \overline{\sigma_h}' \cdot tg\delta \cdot \int_0^z dz$$

$$= \pi \cdot D \cdot K \cdot \overline{\sigma_{v_0}}' \cdot tg\delta \cdot 1m$$

$\frac{3}{4}\phi'$: per pali costruiti fuori opera!

K=1 ; perché AGI : $K = 1 \div 2$ per pali costruiti fuori opera.

$$= 55,85 \text{ KN}.$$

$$\overline{\sigma_{v_0}}' = 17 \cdot 2 + (18-10)8 + (10) \cdot \frac{1}{2} = 103 \text{ KPa}.$$

_ Infine:

$$R_{Lim} = R_B|_{sabbia} + R_L|_{sabbia} + R_L|_{argilla}$$

$$= 831 + 56 + 173$$

$$= 1060 \text{ KN}$$

scelgo quello del metodo β (che e' piu' piccolo) perché piu' cautelativo!

_ VERIFICHE : DM'88 :

$$R_{amm} = \frac{R_{Lim}}{F_S} = \frac{1060}{2,5} = 424 \text{ KN}$$

$$R_{amm} \geq (W_p + Q_{app})$$

ove $$W_p = 25 \cdot \frac{\pi \cdot D^2}{4} \cdot 11 = 26.5 \text{ KN}$$

hp.

$$G_K = \frac{2}{3}(424) = 282,\bar{6} \text{ KN}$$

$$Q_K = \frac{1}{3}(424) = 141,\bar{3} \text{ KN}.$$

- verifica con R.I.-2008 : $\begin{cases} w_p = 26,5 \text{ kN} \\ G_k = 283 \text{ kN} \\ Q_k = 141 \text{ kN} \end{cases}$

i) – DA1 (A_1, M_1, R_1)
(1,3) (1,5) (1)

$$E_d = 1,3\,(283 + 26,5) + 1,5\,(141) = 613,85 \text{ kN}$$

$$R_d = \frac{R_k}{\gamma_{R_1}} = \frac{1}{1} \cdot R_k = \left(\frac{R_3 + R_L + R_L}{\xi_1 = \xi_2 = 1,7}\right) = \frac{R_{Lim}}{1,7} = 623,53 \text{ kN}$$

$R_d \geq E_d$ OK. verificata!

ii) – DA2 (A_2 M_1 R_2)
(1) (1,3) (1,45)

$$E_d = 1\,(26,5 + 283) + 1,3 \cdot (141) = 509,8 \text{ kN}$$

$$R_d = \frac{1}{\gamma_{R_2}} R_k = \frac{1}{1,45} \frac{R_{Lim}}{\xi_1 = 1,7} = 430 \text{ kN}$$

$R_d \geq E_d$ ok verificata?

iii) – DA3: (A_1 M_1 R_3)
(1,3) (1,5) (1,15)

$$E_d = 1,3\,(26,5 + 283) + 1,5\,(141) = 613,85 \text{ kN}$$

$$R_d = \frac{1}{\gamma_{R_3}} \cdot R_k = \frac{1060}{1,7} \cdot \frac{1}{1,15} = 542 \text{ kN}$$

$R_d \geq E_d$ Non è verificata!

— o —

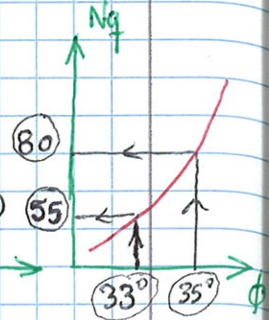
FORMULARIO

"RIASSUNTO DEGLI ES. DEI PALI INFISSI"

- PALO INFISSO IN SABBIA: (sempre L.T.)

(i) → $$R_B = A_B \cdot q_B = \frac{\pi \cdot D^2}{4} \cdot N_q \cdot \sigma'_{v0}$$

N_q ← Berezantzev; σ'_{v0} ← ok! (consolidazione)



(ii) → $$R_L = \pi \cdot D \cdot \int_0^z \tau_{Lim}\, dz$$

$$= \pi \cdot D \int_0^z \overline{\sigma}'_h \cdot \tan \delta \cdot dz$$

NB! è medio! ($\overline{\sigma}'_h$)

$$= \pi \cdot D \int_0^z K \cdot \overline{\sigma}'_{v0} \cdot \tan\left(\frac{3}{4}\phi'\right) dz$$

$$= \pi \cdot D \cdot K \cdot \overline{\sigma}'_{v0} \cdot \tan\left(\frac{3}{4}\phi'\right) \cdot Z.$$

K ← 1 (AGI)

- PALO INFISSO IN ARGILLA:

→ R_B (sempre a B.T.) ⇒ σ_{v0}

(iii) $$R_B = A_B \cdot (N_c \cdot c_u + \sigma_{v0})$$

N_c ← 9 se $L_{imm} \geq (3 \div 4) D$

→ R_L (sempre a L.T). ⇒ σ'_{v0} ⇝ { metodo α (i); metodo β (ii) }

(iv) (i) $$R_L = \pi \cdot D \cdot \int_0^z \tau_{Lim} \cdot dz$$

$$= \pi \cdot D \cdot \int_0^z \alpha\, c_u\, dz$$

$$= \pi \cdot D\, \alpha \cdot c_u \cdot z$$

AGI: α { 1 se $c_u \leq 25$; 0,5 se $c_u \geq 70$ }

(ii) $R_L = \pi \cdot D \int_0^z \tau_{Lim} \cdot dz$ NB! e' σ medio!!!

$$\stackrel{!}{=} \pi \cdot D \cdot \int_0^z \beta \cdot \overline{\sigma_{v_0}'} \, dz$$

$$\stackrel{!}{=} \pi \cdot D \cdot \beta \cdot \overline{\sigma_{v_0}'} \cdot z$$

$$\stackrel{!}{=} \pi \cdot D \cdot (1 - \sin\phi') \cdot (OCR)^{0,5} \cdot tg\,\phi' \cdot \overline{\sigma_{v_0}'} \cdot z$$

- NORMATIVA : $R_{Lim} = R_L + R_B$

- DM'88 $\rightsquigarrow$ $R_{amm} = \frac{R_{Lim}}{F_s} = \frac{R_{Lim}}{2,5}$

verifica $R_{amm} \geq (W_p + Q_{agg})$.

- hp: $\begin{cases} G_K = \frac{2}{3} R_{amm} \\ Q_K = \frac{1}{3} R_{amm} \\ W_p = 25 \cdot \frac{\pi \cdot D^2}{4} \cdot (L_{palo}) \end{cases}$

- R.I. 2008

i) DA1 : $(A_1 \quad M_1 \quad R_1)$ comb. 1, $R_1 = 1$

: $(A_2 \quad M_1 \quad R_2)$ comb 2, $R_2 = 1,45$

ii) DA2 : $(A_1 \quad M_1 \quad R_3)$, $R_3 = 1,15$

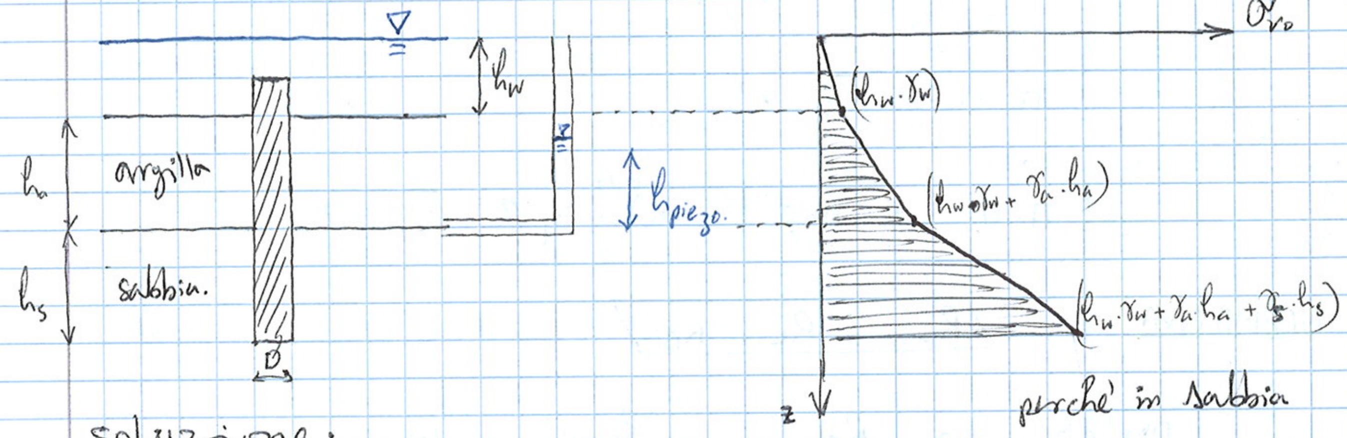
e.g.

i) $E_d = 1,3(W_p + G_K) + 1,5\,Q_K$

$R_d = \frac{R_K}{\gamma_{R_1}} = \frac{1}{1} \frac{R_{Lim}}{1,7} = \frac{R_{Lim}}{1,7}$.

infine: $\boxed{R_d \geq E_d}$

ES. 4 09-2010 "PALO INFISSO CON PUNTA IN SABBIA"



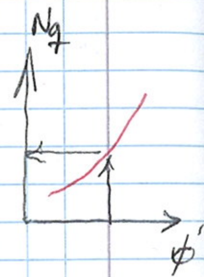
perché in sabbia

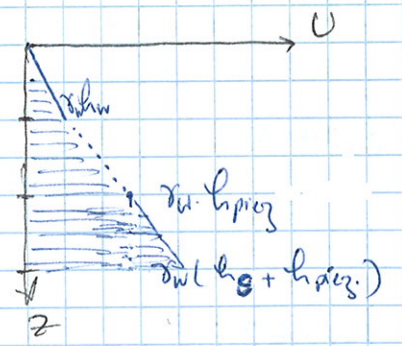
soluzione:

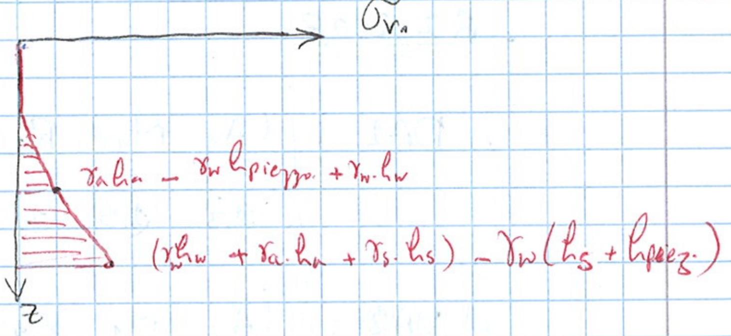
- Resistenza di Base: R_B (sempre a L.T).

$$\begin{cases} R_B = A_B \cdot q_B \\ \quad = \dfrac{\pi \cdot D^2}{4} \cdot (N_q \cdot \sigma_{v0}') \\ \sigma_{v0}' = (\gamma_w h_w + \gamma_a \cdot h_a + \gamma_s \cdot h_s) - \gamma_w (h_w + h_{piez.}) \end{cases}$$

N_q da Berezantzev







- Resistenza laterale in sabbia:

$$R_L \Big|_{sabbia} = \pi \cdot D \int_0^z \tau_{Lim} \, dz$$

$$= \pi \cdot D \int_0^z \bar{\sigma}_h' \cdot tg \delta \, dz$$

$$= \pi \cdot D \cdot K \cdot \bar{\sigma}_{v0}' \cdot tg\left(\frac{3}{4}\phi'\right) \cdot z \Big|^{h_s}$$

($K \rightarrow 1$; $\bar{\sigma}_{v0}'$?)

$$\bar{\sigma}'_{v0}\Big|_{sabbia} = \left(\gamma_w \cdot h_w + \gamma_a \cdot h_a + \gamma_s \cdot \frac{h_s}{2}\right) - \gamma_w \left(\frac{h_s}{2} + h_{piez}\right)$$

– Resistenza laterale in argilla :: Sapore a L.T. $\begin{cases} \text{metodo } \alpha \\ \text{metodo } \beta \end{cases}$

$$R_L\Big|_{argilla}^{metodo\ \alpha} = \pi \cdot D \cdot \int_0^z \tau_{lim}\, dz$$

$$= \pi \cdot D \cdot \int_0^z \alpha\, cu\, dz$$

$$= \pi \cdot D\, \alpha \cdot cu \cdot h_a$$

AGI: $\begin{cases} \alpha = 1 \text{ se } cu \leq 25\ kPa \\ \alpha = 0{,}5 \text{ se } cu \geq 70\ kPa \end{cases}$

$$R_L\Big|_{argilla}^{metodo\ \beta} = \pi \cdot D \int_0^z \tau_{lim} \cdot dz$$

$$= \pi \cdot D \cdot \int_0^z \beta \cdot \bar{\sigma}'_{v0}\, dz$$

$$= \pi \cdot D \cdot \beta \cdot \bar{\sigma}'_{v0} \cdot h_a$$

$$= \pi \cdot D \cdot (1 - \sin\phi') \cdot (OCR)^{0,5} \cdot tg(\phi') \cdot \bar{\sigma}'_{v0} \cdot h_a.$$

$$\bar{\sigma}'_{v0} = \left(\gamma_w \cdot h_w + \gamma_a \cdot \frac{h_a}{2}\right) - \left(\frac{\gamma_w \cdot h_w + h_{piez}}{2}\right)$$ ✓

Infine:

$$R_{Lim} = R_B\big|_{sabbia} + R_L\big|_{sabbia} + R_L\big|_{argilla}.$$

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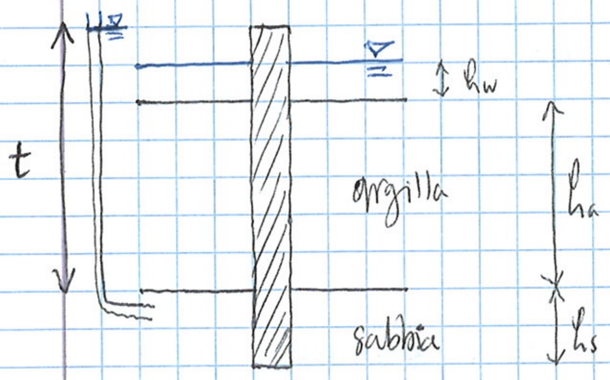
ES 5 01-2010

PALO INFISSO CON PUNTA IN SABBIA

con calcolo DEI CEDIMENTI → con le curve di trasferimento!

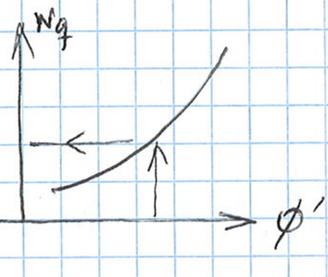


– Resistenza di base: (sempre a lungo termine L.T.)

$$R_B = q_B \cdot A_B = \frac{\pi \cdot D^2}{4} \cdot N_q \cdot \sigma'_{v0}$$

$$\sigma'_{v0} = (\gamma_w h_w + \gamma_a \cdot h_a + \gamma_s \cdot h_s) - \gamma_w (h_s + t)$$ NB!

N_q → Berezantzev



– Resistenza laterale in sabbia:

$$R_L\big|_{sabbia} = \pi \cdot D \cdot \int_0^z \tau_{lim} \, dz = \pi \cdot D \cdot \bar{\sigma}'_h \cdot tg(\delta) \cdot h_s = \pi \cdot D \cdot K \cdot \bar{\sigma}'_{v0} \cdot tg\left(\frac{3}{4}\phi'\right) \cdot h_s$$

(K ↑ 1)

$$\bar{\sigma}'_{v0} = \left(\gamma_w \cdot h_w + \gamma_a \cdot h_a + \gamma_s \cdot \frac{h_s}{2}\right) - \gamma_w \left(t + \frac{h_s}{2}\right)$$

- $R_L\big|_{argilla} = \pi \cdot D \cdot \int_0^z \cdot \tau_{lim} \, dz$ $\begin{cases} \text{metodo } \alpha \text{ (i)} \\ \text{metodo } \beta \text{ (ii)} \end{cases}$

(i) $= \pi \cdot D \alpha \cdot cu \cdot ha$

α AGI: $\alpha \begin{cases} 1 & \text{se } cu \leq 25 \text{ kPa} \\ 0,5 & \text{se } cu \geq 70 \text{ kPa} \end{cases}$

- (ii) $R_L\big|_{argilla} = \pi \cdot D \int_0^z \beta \cdot \bar{\sigma}_{v0}' \, dz$

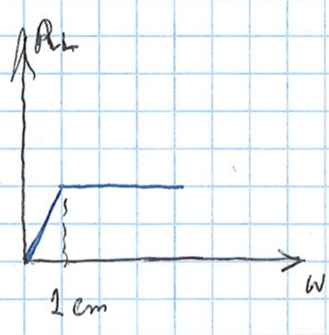
$= \pi \cdot D \beta \cdot \bar{\sigma}_{v0}'$

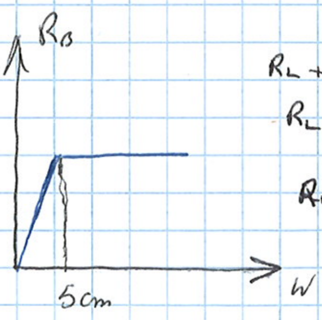
$= \pi \cdot D \cdot (1 - \sin\phi')(OCR)^{0,5} \cdot tg\phi' \cdot \bar{\sigma}_{v0}' \cdot ha$

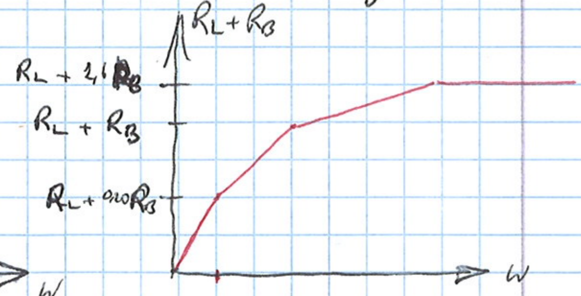
$$\bar{\sigma}_{v0}' = \left(\gamma_w \cdot h_w + \gamma_a \cdot \frac{ha}{2}\right) - \left(\frac{h_w \gamma_w + t \cdot \gamma_w}{2}\right)$$

Infine: $R_{Lim} = R_B\big|_{sabbia} + R_L\big|_{argilla} + R_L\big|_{sabbia}$

- calcolare dei cedimenti con le curve di trasferimento:







hp: palo infinitamente rigido! e terreno rigido-perfettamente plastico!