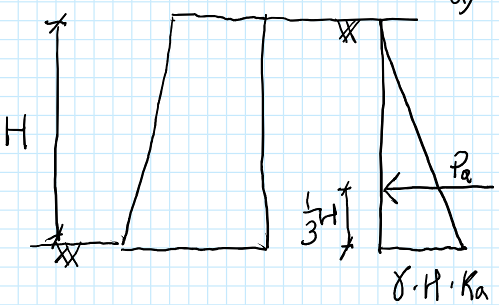
18/11/2025 Prof. Ing. Zanetti

UNIVERSITÀ DEGLI STUDI DI TRIESTE

I) Valutare le spinte attive sec. La teoria di Rankine.

a) $\gamma = 18 \frac{kN}{m^3} \quad c' \neq 0 \quad \varphi' = 30°$

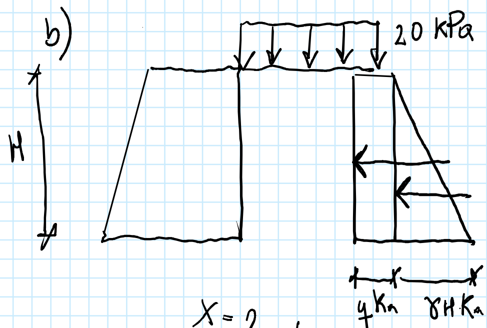


$K_a = tg^2\left(\frac{\pi}{4} - \frac{\varphi'}{2}\right) = tg^2(45 - 15) = \frac{1}{3} \cong 0,33$

$\sigma_{ha} = 18 \cdot 6 \cdot \frac{1}{3} = 36 \text{ kPa}$

$P_a = \frac{1}{2} \cdot \sigma_{ha} \cdot H = 36 \cdot 3 = 108 \frac{kN}{m}$

b)

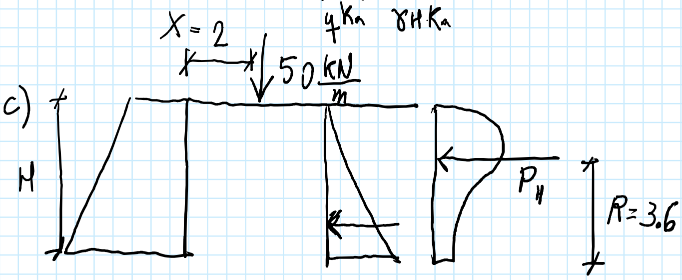


$q = 20 \frac{kN}{m^2}$

$\sigma_{ha} = q \cdot K_a + \gamma \cdot H \cdot K_a = \frac{20}{3} + 36 = 42,7 \text{ kPa}$

$P_a = K_a \cdot q \cdot H + \frac{1}{2} K_a \gamma H^2 = 148 \frac{kN}{m}$

c)



$X = m \cdot H \rightarrow m = \frac{2}{H} = 0.33$

$R = 0,6 \cdot H = 3,6 \text{ m}$

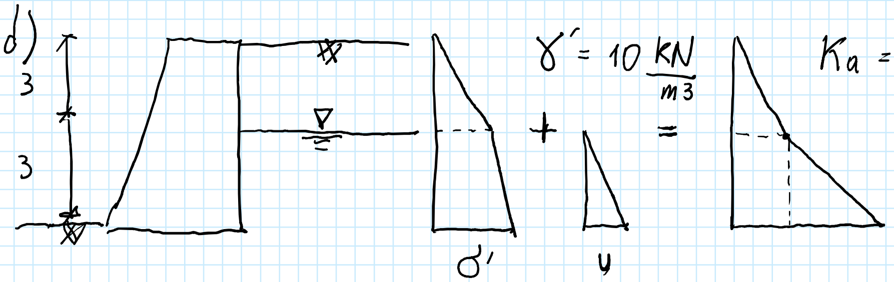
Essendo m<0.4

$\sigma_{h,q} = \frac{Q_L}{H} \cdot \frac{0,2\, n}{(0.16 + n^2)^2}$

$P_a = 0.55 \cdot Q_L = 27.5 \frac{kN}{m}$

$P_{a,tot} = P_a^{\Delta} + P_{a,Q} = 108 + 27,5 = 135,5 \frac{kN}{m}$

d)



$\gamma' = 10 \frac{kN}{m^3}$

$K_a = tg^2\left(\frac{\pi}{4} - \frac{\varphi'}{2}\right) = \frac{1}{3}$

$\sigma_v = \sigma_v' + u$

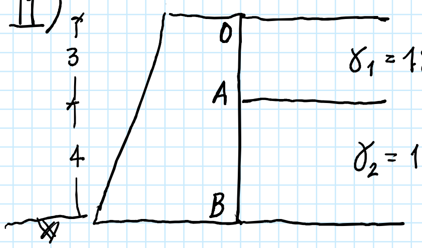
$\sigma_h = \sigma_h' + u$

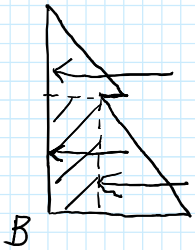
Tensioni totali attive alla base del muro:

$$\sigma_{ha} = \underbrace{(H-3)\gamma K_a + (H-3)\gamma' K_a}_{\sigma'} + \underbrace{(H-3) \cdot \gamma_w}_{u}$$

$$P_a = \frac{1}{2}(H-3)^2 \gamma \cdot K_a + (H-3)^2 \gamma \cdot K_a + \frac{1}{2}(H-3)^2 \gamma' K_a + \frac{1}{2}(H-3)^2 \cdot \gamma_w = 141 \frac{kN}{m}$$

II)





$K_{a1} = \frac{1}{3}$

$K_{a2} = 0{,}283$

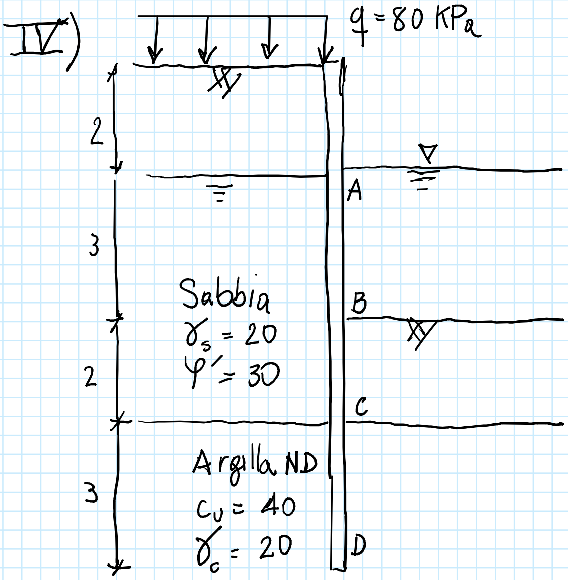
$$\left.\begin{aligned}\sigma_{haA,1} &= 3 \cdot \gamma_1 \cdot K_{a1} = 18\ kPa \\ \sigma_{haA,2} &= 3 \cdot \gamma_1 \cdot K_{a2} = 15.28\ kPa\end{aligned}\right\} \Delta$$

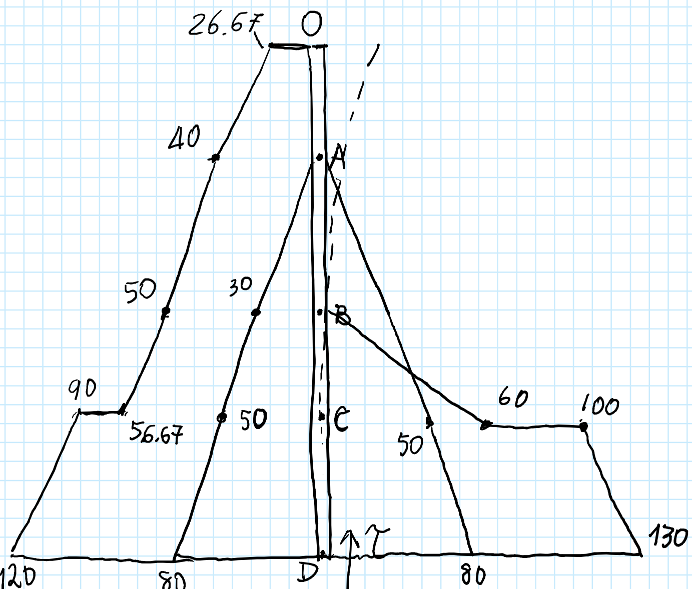
$$\sigma_{haB} = \sigma_{haA,2} + 4 \cdot \gamma_2 \cdot K_{a2} = 15.28 + 4 \cdot 19.5 \cdot 0.283 = 37.35\ kPa$$

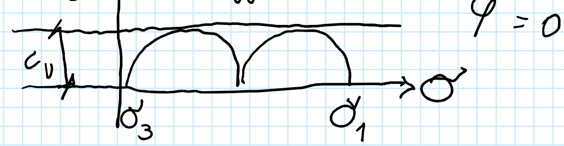
$$P_{a1} = \frac{1}{2} 3^2 \cdot \gamma_1 \cdot K_{a1} = 27\ kN/m$$

$$P_{a2} = \overbrace{\gamma_1 4 \cdot 3 \cdot K_{a2}}^{\square} + \overbrace{\frac{1}{2} 4^2 \cdot \gamma_2 K_a}^{\blacktriangle} = 105\ \frac{kN}{m}$$

IV)







$K_{as} = \frac{1}{3} \qquad K_{ps} = tg^2\left(\frac{\pi}{4} + \frac{\varphi'}{2}\right) = 3$

$K_{ac} = K_{pc} = 1$

$$\sigma_{ha,q} = K_{as} \cdot q = 26{,}67\ kPa$$

$$\sigma_{haA} = \gamma_s \cdot z_A \cdot K_{as} + \sigma_{ha,q} = 13{,}3\ kPa + 26.67 = 40\ kPa$$

$$\sigma_{haB} = \sigma_{haA} + (\gamma_s - \gamma_w) \cdot (z_B - z_A) \cdot K_{as} + \gamma_w \cdot (z_B - z_A) = 50\ kPa + 30 = 80\ kPa$$

$$\sigma_{haA} = (\gamma_s \cdot z_A \cdot K_{as}) + q K_{as}$$

$$\sigma_{haC,S} = \sigma_{haB} + (\gamma_s - \gamma_w)(z_C - z_B) \cdot K_{as} + \gamma_w (z_C - z_B) = 80\ kPa + 26{,}67 = 106{,}67\ kPa$$

$$\sigma_{haC,c} = [z \cdot \gamma + (z - z)\gamma'] K + \gamma_w (z - z) + q K - 2c \qquad \text{|| Tresca}$$

$$\sigma_{haC,s} = \sigma_{haB} + (\gamma_s - \gamma_w)(z_C - z_B)\cdot K_{as} + \gamma_w (z_C - z_B) = 80\ \text{kPa} + 26{,}67 = 106{,}67\ \text{kPa}$$

$$\sigma_{haC,a} = \left[z_A \cdot \gamma_s + (z_C - z_A)\gamma_s'\right] K_{aC} + \underbrace{\gamma_w (z_C - z_A)}_{U_{C-A}} + q \underset{1}{K_{aC}} - 2c_u = 140\ \text{kPa}$$

Tresca // $\sigma_{ha} = \sigma_v - 2c_u$

$$\sigma_{haD} = \sigma_v - 2c_u = \left[z_A \cdot \gamma_s + (z_C - z_A)\gamma_s' + (z_D - z_C)\gamma_c'\right] K_{aC} + \underbrace{\gamma_w (z_D - z_A)}_{80} - 2c_u + K_{aC}\cdot q = 200\ \text{kPa}$$

$$\sigma_{hpB} = U_{B-A} = \gamma_w \cdot (z_B - z_A) = 30\ \text{kPa}$$

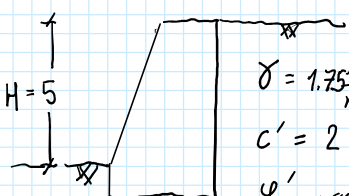
$$\sigma_{hp,C,s} = \gamma_s' (z_C - z_B)\cdot K_{p,s} + \gamma_w (z_C - z_A) = 60 + 50 = 110\ \text{kPa}$$

$$\sigma_{hpC,c} = \gamma_s' (z_C - z_B) K_{pC} + 2c_u + \gamma_w (z_C - z_A) = 20 + 80 + 50 = 150\ \text{kPa}$$

$$\sigma_{hpD} = \sigma'_{hpC,c} + \gamma_c'(z_D - z_C)\cdot K_{pc} + 2c_u + \gamma_w (z_D - z_A) = 20 + 10\cdot(3)\cdot 1 + 80 + 80 = 210\ \text{kPa}$$

VI)

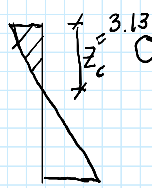
Calcolare le spinte attive sec. Teoria di Rankine a tergo del muro in Argilla limosa



$\gamma = 1{,}75\ \frac{t}{m^3}$

$c' = 2\ \frac{t}{m^2}$

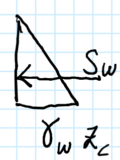
$\varphi' = 18^0$



$$\sigma_{ha} = z\gamma\cdot K_a - 2c'\sqrt{K_a} = 0$$

$$z_c = \frac{2c'}{\gamma\cdot\sqrt{K_a}} = \frac{4}{1.75\sqrt{0{,}528}} = 3{,}13\ m$$

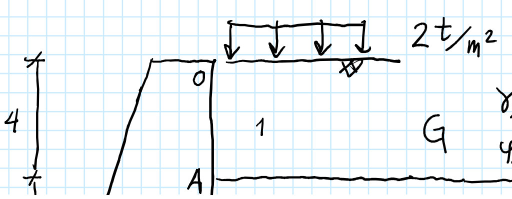
$$K_a = tg^2\left(\frac{\pi}{4} - \frac{\varphi}{2}\right) = 0{,}528$$



$$\sigma_{ha} = \gamma H \cdot K_a - 2c'\sqrt{K_a} = 1{,}75\cdot 5\cdot 0{,}528 - 4\cdot\sqrt{0{,}528} = 1{,}713\ \frac{t}{m^2}$$

$$u = \gamma_w \cdot z_c = 3{,}13\ \frac{t}{m^2}$$

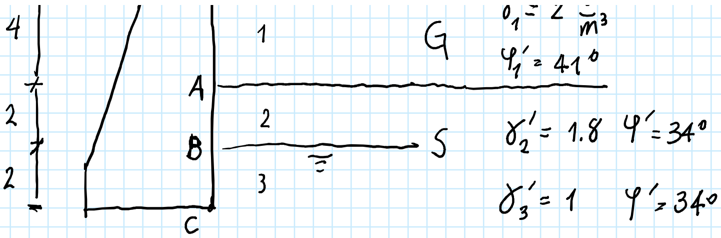
$$P_a = \frac{1}{2}\cdot 1{,}713\cdot (H - z_c) + \frac{1}{2} u\cdot z_c = \frac{1{,}713}{2}\cdot(5 - 3{,}13) + \frac{1}{3}\cdot 3{,}13\cdot 3{,}13 = 1{,}6 + 4{,}9 = 6{,}5\ \frac{t}{m}$$

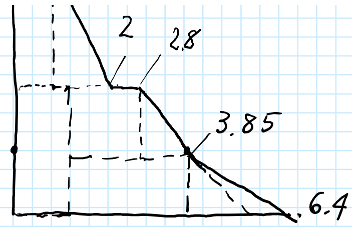


$\gamma_1 = 2\ \frac{t}{m^3}$

$\varphi_1' = 41^0$

Tensioni Totali





$K_{a1} = 0.208 \qquad K_{a2} = K_{a3} = 0.283$

$\sigma_{haA,1} = q K_{a1} + \gamma_1 z_A \cdot K_{a1} = 0.416 + 1.664 = 2.08\ t/m^2$

$\sigma_{haA,2} = \underbrace{q K_{a2} + \gamma_1 z_A \cdot K_{a2}}_{=} = 0.567 + 2.264 = 2.83$

$\sigma_{haB,2} = (=) + \gamma_2 (z_B - z_A) K_{a2} = 0.567 + 2.264 + 1.02 = 3.85\ \frac{t}{m}$

$\sigma_{haB,3} = q K_{a3} + [\gamma_1 z_A + \gamma_2 (z_B - z_A)] K_{a3} = \sigma_{haB,2}$

$\sigma_{haC} = q \cdot K_{a3} + \gamma_1 \cdot z_A \cdot K_{a3} + \gamma_2 (z_B - z_A) \cdot K_{a3} + \gamma'_3 (z_C - z_B) K_{a3} + \gamma_w \cdot (z_C - z_B)$

$= 6.42\ \frac{t}{m^2}$

$P_1 = 0.416 \cdot z_A + \frac{1.664\, z_A}{2} = 1.66 + 3.32 = 4.99 \simeq 5\ \frac{t}{m}$

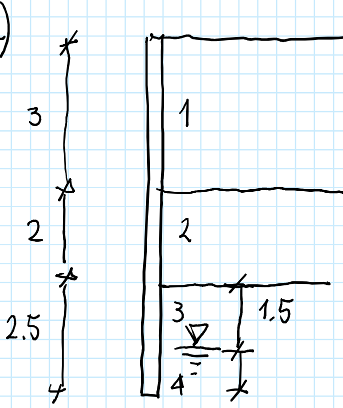
$P_2 \simeq 0.567 (z_B - z_A) + 2.264 \cdot (z_B - z_A) + \frac{1.02 \cdot (z_B - z_A)}{2} = 6.68\ \frac{t}{m}$

$P_3 = 0.57 \cdot (z_C - z_B) + 2.264 (z_C - z_B) + 1.02 (z_C - z_B) + \frac{0.567 \cdot (z_C - z_B)}{2} + \frac{1}{2} (z_C - z_B) \cdot \gamma_w$

$= 1.13 + 4.53 + 2 + 0.567 + 2 = 10.27\ \frac{t}{m}$

$P_{atot} = \sum_{i=0}^{n} P_a = 21.95\ \frac{t}{m}$

X)



$\gamma_1 = 18.8$

$\varphi'_1 = 26^\circ$

$c' = 8\ kPa$

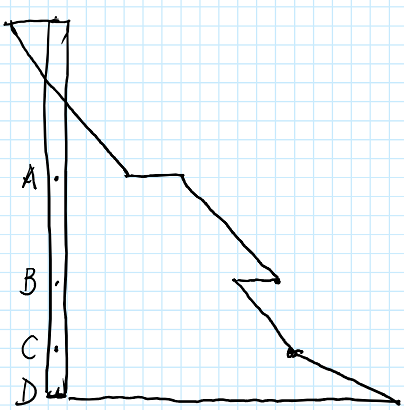
$\gamma_2 = 18$

$\varphi'_2 = 32^\circ$

$\gamma'_{d3} = 17.2$

$\gamma_{sat\,3} = 19.4$

$\varphi'_3 = 38^\circ$



$K_a = tg^2\left(\frac{\pi}{4} - \frac{\varphi'}{2}\right)$