EJERCICIO 1

4m

$\gamma' = 18 kN/m^3$

$\phi' = 20°$

$c' = 8 kN/m^2$

- calculamos σ'_v

$\sigma'_v = \sigma_v = \gamma' \cdot h = 18 kN/m^3 \cdot 4m$

$\boxed{\sigma'_v = 72{,}00 kN/m^2}$

- calculamos K_a

$$K_a = \frac{1 - sen\phi'}{1 + sen\phi'} = \frac{1 - sen 20°}{1 + sen 20°} = \frac{1 - 0{,}342}{1 + 0{,}342} = 0{,}49$$

- empuje sin considerar cohesión

$e_{ah_1} = \sigma'_v \cdot K_{ah} = 0{,}49 \cdot 72{,}00 = 35{,}28 kN/m^2$

$\boxed{e_{ah_1} = 35{,}28 kN/m^2}$

- empuje considerando cohesión

$e_{ah} = \sigma'_v \cdot K_{ah} \cdot 2 \cdot c \cdot \sqrt{K_a} = 35{,}28 kN/m^2 - 2 \cdot 8 kN/m^2 \cdot \sqrt{0{,}49} =$

$= 35{,}28 kN/m^2 - 16 \cdot 0{,}7 = 35{,}28 - 11{,}20 = 24{,}08 kN/m^2$

- profundidad crítica

$$h_0 = \frac{2 \cdot c}{\gamma} \cdot tg\left(45 + \frac{\phi'}{2}\right) = \frac{2 \cdot 8 kN/m^2}{18 kN/m^3} \cdot tg(45° + 10°) =$$

$$= \frac{16 m}{18} \cdot 1{,}428 = 1{,}27 m$$

$h_0 = 1{,}27 m$

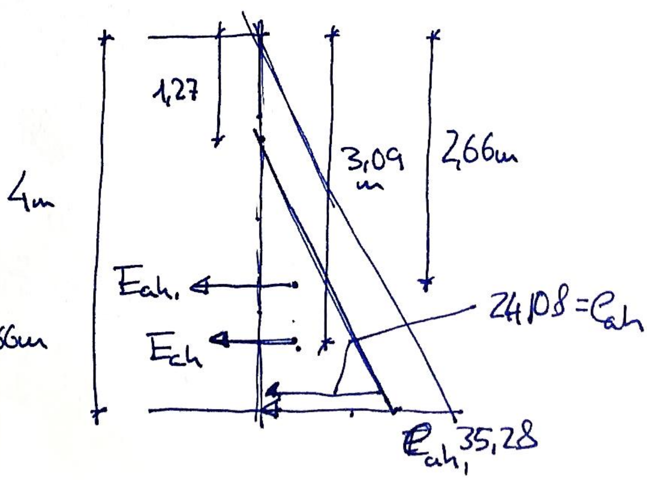
- empujes (resultantes)

$E_{ah_1} = e_{ah_1} \cdot \frac{4}{2} = 70{,}56 kN$

punto aplicación $= h \cdot \frac{2}{3} = 4 \cdot \frac{2}{3} = 2{,}66 m$

~~$E_{ah} = 24{,}08 kN/m^2 \cdot (h - h_0) =$~~

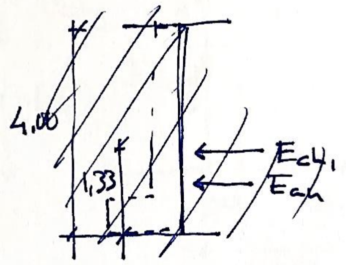
~~$= 24{,}08 \cdot (4 - 1{,}27) = 65{,}73 kN$~~

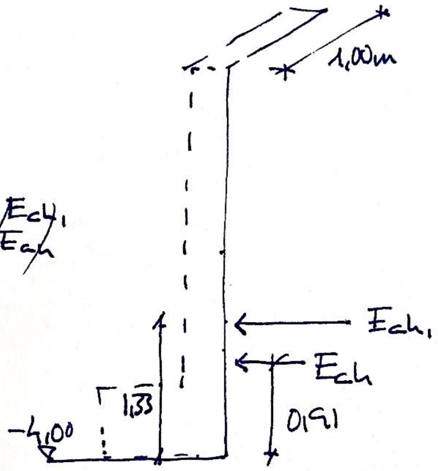


cont. E1

$$E_{ah} = 24{,}08\ kN/m^2 \cdot \frac{h - h_0}{2} = 24{,}08 \cdot \frac{4 - 1{,}27}{2} =$$

$$E_{ah} = 32{,}87\ kN$$





$M_{d_1} = 93{,}84\ kN \cdot m$

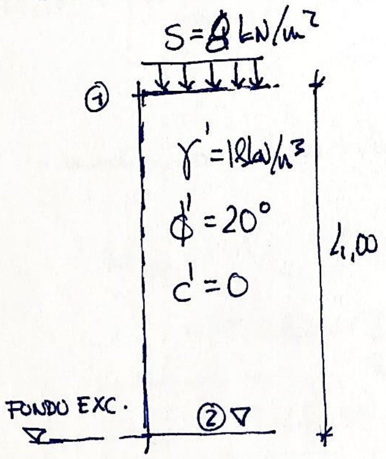
$M_{d_1} = E_{ah_1} \cdot 1{,}33m = 70{,}56 \cdot 1{,}33$

$= 93{,}84\ kN \cdot m$

$M_d = E_{ah} \cdot 0{,}91m$

$$\boxed{M_d = 29{,}91\ kN/m}$$

EJERCICIO 2



- calculamos tensiones verticales efectivas

$\sigma'_{v_1} = \sigma_{v_1} = S = 8\ kN/m^2$

$\sigma'_{v_2} = \sigma_{v_2} = S + \gamma' \cdot h = 8\ kN/m^2 + 18\ kN/m^3 \cdot 4\ m$

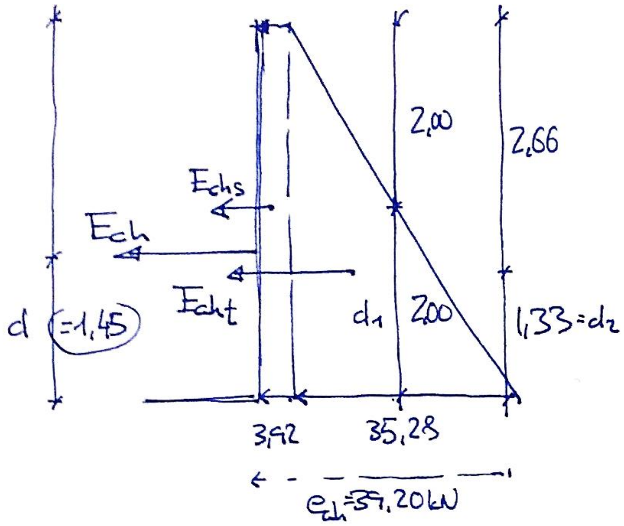
$$\boxed{\sigma'_{v_2} = 80\ kN/m^2}$$

- $K_{ah} = 0{,}49$ (ej. 1)

$e_{ah_1} = \sigma'_{v_1} \cdot K_{ah} = 8\ kN/m^2 \cdot 0{,}49 = 3{,}92\ kN/m^2$

$e_{ah_2} = \sigma'_{v2} \cdot K_{ah} = 80\ kN/m^2 \cdot 0{,}49 = 39{,}20\ kN/m^2$

cont. E_2



$E_{ch_s} = 3{,}92\ kN/m^2 \cdot 4m = 15{,}68$

$\boxed{E_{ch_s} = 15{,}88\ kN}$

→ ejercicio 1

$E_{ch_t} = 35{,}28\ kN/m^2 \cdot 4m \cdot \frac{1}{2}$

$\boxed{E_{ch_t} = 70{,}56\ kN}$

$E_{ch} = E_{ch_s} + E_{ch_t} = 15{,}88\ kN + 70{,}56\ kN$

$\boxed{E_{ch} = 86{,}44\ kN}$

- aumento empuje resp. a terreno sin sobrecarga

$$\%\Delta E = \left[\frac{86{,}44\ kN - 70{,}56}{70{,}56\ kN}\right] \times 100 = \frac{15{,}88}{70{,}56} \times 100 = \boxed{22{,}51\%}$$

- momento desestabilizador

$$M_d = M_{d_s} + M_{d_t} = E_s \cdot d_1 + E_t \cdot d_2 =$$

$$= 15{,}88\ kN \cdot 2m + 70{,}56\ kN \cdot 1{,}33m = 31{,}76\ kN \cdot m + 93{,}84\ kN \cdot m$$

$\boxed{M_d = 125{,}60\ kN \cdot m}$

$$\%\Delta M_d = \frac{125{,}60 - 93{,}84}{93{,}84} \times 100 = \boxed{+33{,}84\%}$$

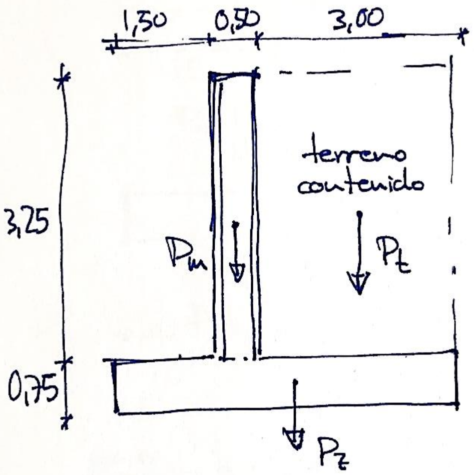
- punto de aplicación

$$M_d = E_s \cdot d_1 + E_t \cdot d_2 = E \cdot d \qquad d = \frac{M_d}{E} = \frac{125{,}60\ kN \cdot m}{86{,}44\ kN} = 1{,}45m$$

$\boxed{d = 1{,}45m}$

~~comprobación~~

EJERCICIO 3: comprobación deslizamiento



$P_m = 0{,}50m * 3{,}25 \cdot (1m) \cdot 25\ kN/m^3 = 40{,}63\ kN$

$P_z = 5{,}00 \times 0{,}75 \times (1m) \cdot 25\ kN/m^3 = 93{,}75\ kN$

$P_t = 3{,}00 \times 3{,}25 \cdot (1m) \cdot 18\ kN/m^3 = 175{,}50\ kN$

$\Sigma F_v = P_m + P_z + P_t = 309{,}88\ kN$

caso 1: $E_{ah} = 70{,}56\ kN$ (sin sobrecarga)

$$F_d = \frac{\Sigma F_v \cdot tg\,\delta'}{E_{ah}} = \frac{309{,}88 \cdot tg\ 13{,}33^\circ}{70{,}56} = \frac{309{,}88 \cdot 0{,}237}{70{,}56} = 1{,}04$$

$$\delta' = \frac{2}{3}\phi' = \frac{2}{3} \cdot 20^\circ = 13{,}33^\circ \rightarrow tg\ 13{,}33^\circ = 0{,}237$$

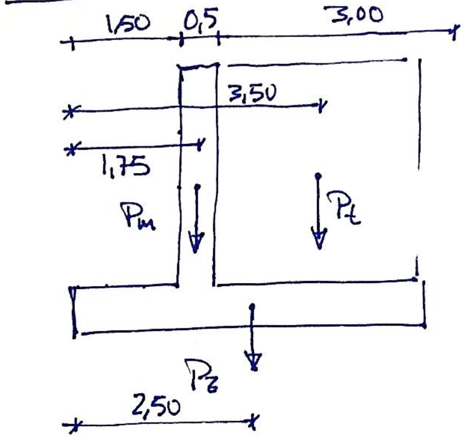
$F_d = 1{,}04 \leq 1{,}50 \rightarrow$ no desliza, pero tiene un coeficiente de seguridad muy escaso y un riesgo muy alto.

caso 2: $E_{ah} = 86{,}44\ kN$

$$F_d = \frac{\Sigma F_v \cdot tg\,\delta}{E_{ah}} = \frac{309{,}88 \cdot 0{,}237}{86{,}44} = 0{,}85$$

$\boxed{F_d = 0{,}85 \leq 1} \rightarrow$ ~~el~~ muro deslizaría

Ej. 3: comp. vuelco



$$M_{estab.} = P_m \cdot 1{,}75m + P_z \cdot 2{,}50m + P_t \cdot 3{,}50m$$

$$M_{est.} = 40{,}63 \cdot 1{,}75 + 93{,}75 \cdot 2{,}50 + 175{,}50 \cdot 3{,}50$$

$$= 71{,}10 + 234{,}38 + 614{,}25$$

$$\boxed{M_{est} = 919{,}73 \text{ kN} \cdot m}$$

caso 1

$$M_{des.} = E_{ah} \cdot d = 70{,}56 \cdot 1{,}33 = 93{,}84 \text{ kN}$$

$$F_{v_1} = \frac{919{,}73}{93{,}84} = 9{,}80 \qquad \boxed{F_{v_1} > 1{,}5}$$ (mucho mayor)

caso 2 (de ejercicio 2)

$$M_{des.} = 125{,}60 \text{ kN} \qquad F_{v_2} = \frac{919{,}73}{125{,}60} = 7{,}32 \qquad \boxed{F_{v_2} > 1{,}5}$$

conclusión: el problema, en este caso, es el deslizamiento del muro en su base. Habría que pensar en otras estrategias para maximizar su resistencia al deslizamiento y hacer una zapata de menor dimensión