

$$C_0 = \frac{f_3}{f_d} - 1$$

1.1.

$$M = 2371 \text{ g}$$

$$M_d = 1948 \text{ g}$$

$$G_s = 2,72$$

$$g = 9,807 \frac{\text{m}}{\text{s}^2}$$

$$f_w = 9,807 \frac{\text{kN}}{\text{m}^3}$$

$$w, f, f_d, f_z, f_s, e, n, S_r = ?$$

$$\checkmark \checkmark \checkmark \checkmark \checkmark \checkmark \checkmark \checkmark$$

$$d = 8,0 \text{ cm}$$

$$h = 25,0 \text{ cm}$$

ВЛАЖНОСТ УЗОРКА:

$$w = \frac{M - M_d}{M_d} = \frac{2371 - 1948}{1948} = 0,2171 \Rightarrow w = 21,71 \%$$

ЗАПРЕМИНА:

$$V = \frac{d^2 \cdot \pi}{4} \cdot h = \frac{8^2 \cdot 3,14}{4} \cdot 25 = 50,26 \cdot 25 = 1256,64 \text{ cm}^3$$

ГУСТИНА У ПРИРОДНОМ СТАЊУ:

$$\rho = \frac{M}{V} = \frac{2371 \text{ g}}{1256,64 \text{ cm}^3} = 1,887 \frac{\text{g}}{\text{cm}^3}$$

ЗАПРЕМИНСКА ТЕЖИНА У ПРИРОДНОМ СТАЊУ:

$$f = \rho \cdot g = 1,887 \frac{\text{g}}{\text{cm}^3} \cdot 9,807 \frac{\text{m}}{\text{s}^2} = 18,50 \frac{\text{kN}}{\text{m}^3}$$

ЗАПРЕМИНСКА ТЕЖИНА У СУВОМ СТАЊУ:

$$f_d = \rho_d \cdot g = \frac{M_d}{V} \cdot g = \frac{1948}{1256,64} \cdot 9,807 = 15,20 \frac{\text{kN}}{\text{m}^3}$$

ЗАПРЕМИНСКА ТЕЖИНА У ЗАСИЋЕНОМ СТАЊУ:

$$f_z = \left(1 + \frac{w_z}{100}\right) \cdot f_d \quad w_z = ? \quad f_z = \left(1 + \frac{27,76}{100}\right) \cdot 15,20 = 19,42 \frac{\text{kN}}{\text{m}^3}$$

ВЛАЖНОСТ ТЛА ПРИ ЗАСИЋЕЊУ:

$$w_z = \left(\frac{f_w}{f_z} - \frac{f_d}{f_s}\right) \cdot 100 \quad f_s = ? \Rightarrow \left(\frac{9,807}{19,42} - \frac{9,807}{26,68}\right) \cdot 100 = 27,76 \%$$

## ЗАПРЕМИНСКА ТЕЖИНА ЧВРСТИХ ЧЕСТИЦА

$$\gamma_s^* = G_s \cdot \gamma_w = 2,72 \cdot 9,807 \frac{\text{KN}}{\text{m}^3} = 26,68 \frac{\text{KN}}{\text{m}^3} \quad \text{ТО САД ВРАТИМО У ПРЕТХОДНЕ ФОРМУЛЕ}$$

## ЗАПРЕМИНСКА ТЕЖИНА У ПОТОПЉЕНОМ СТАЊУ

$$\gamma' = \gamma_s^* - \gamma_w = 26,68 - 9,807 = 16,87 \frac{\text{KN}}{\text{m}^3}$$

## КОЕФИЦИЈЕНТ ПОРОЗНОСТИ

$$e = \frac{\gamma_s^*}{\gamma_d^*} - 1 = \frac{26,68}{15,20} - 1 = 0,755$$

## ПОРОЗНОСТ

$$n = \frac{e}{1+e} \cdot 100 = \frac{0,755}{1,755} \cdot 100 = 0,4302 \cdot 100 = 43,02 \%$$

$$n = \left( 1 - \frac{\gamma_d^*}{\gamma_s^*} \right) \cdot 100$$

## СТЕПЕН ЗАСИЋЕЊА

$$S_r = \frac{W}{W_z} \cdot 100 = \frac{21,71}{27,76} \cdot 100 = 78,21 \%$$

1.2.

$$a = 20 \text{ cm}$$

$$M = 14,5 \text{ kg}$$

$$W = 17,8 \%$$

$$G_s = 2,75$$

$$e, n, S_r = ?$$

$$\checkmark \checkmark \checkmark$$

$$V = a^3 = (20 \text{ cm})^3 = 8000 \text{ cm}^3 = 0,008 \text{ m}^3$$

$$\rho = \frac{M}{V} = \frac{14,5 \text{ kg}}{0,008 \text{ m}^3} = 1812,5 \frac{\text{kg}}{\text{m}^3}$$

$$\gamma = \rho \cdot g = 1812,5 \cdot 9,807 = 17775 \frac{\text{N}}{\text{m}^3} = 17,78 \frac{\text{KN}}{\text{m}^3}$$

$$\gamma_s^* = G_s \cdot \gamma_w = 2,75 \cdot 9,807 = 26,97 \frac{\text{KN}}{\text{m}^3}$$

$$\gamma_d^* = \frac{\gamma}{1+W} = \frac{17,78}{1+0,178} = \frac{17,78}{1,178} = 15,09 \frac{\text{KN}}{\text{m}^3}$$

$$w_z = \left( \frac{\rho_w}{\rho_d} - \frac{\rho_w}{\rho_s} \right) \cdot 100 = \left( \frac{9,807}{15,09} - \frac{9,807}{26,97} \right) \cdot 100 = 28,63 \%$$

$$e = \frac{\rho_s}{\rho_d} - 1 = \frac{26,97}{15,09} - 1 = 0,787$$

$$n = \frac{e}{1+e} \cdot 100 = \frac{0,787}{1,787} \cdot 100 = 44,04 \%$$

$$S_r = \frac{w}{w_z} \cdot 100 = \frac{17,8}{28,63} \cdot 100 = 62,17 \%$$

1.3.

$$\rho = 19,8 \frac{\text{KN}}{\text{m}^3}$$

$$w = 15,2 \% = 0,152$$

$$e = 0,56$$

$$n, G_s, S_r, \rho_z, w_z$$

$$\checkmark \quad \checkmark \quad \checkmark \quad \checkmark \quad \checkmark$$

$$n = \frac{e}{1+e} \cdot 100 = \frac{0,56}{1,56} \cdot 100 = 35,9 \%$$

$$\rho = \frac{G_s \cdot (1+w)}{1+e} \cdot \rho_w \Rightarrow G_s = \frac{\rho \cdot (1+e)}{\rho_w \cdot (1+w)} = \frac{19,8 \cdot (1+0,56)}{9,807 \cdot (1+0,152)} = \frac{19,8 \cdot 1,56}{9,807 \cdot 1,152} = \frac{30,888}{11,298} = 2,73$$

$$\rho_s = G_s \cdot \rho_w = 2,73 \cdot 9,807 = 26,77 \frac{\text{KN}}{\text{m}^3}$$

$$\rho_d = \frac{\rho}{1+w} = \frac{19,8}{1+0,152} = 17,19 \frac{\text{KN}}{\text{m}^3}$$

$$w_z = \left( \frac{\rho_w}{\rho_d} - \frac{\rho_w}{\rho_s} \right) \cdot 100 = \left( \frac{9,807}{17,19} - \frac{9,807}{26,77} \right) \cdot 100 = 20,42 \%$$

$$\rho_z = \left( 1 + \frac{w_z}{100} \right) \cdot \rho_d = \left( 1 + 0,2042 \right) \cdot 17,19 = 20,70 \frac{\text{KN}}{\text{m}^3}$$

$$S_r = \frac{w}{w_z} \cdot 100 = \frac{0,152}{0,2042} \cdot 100 = 74,44 \%$$

1.4

$$\gamma = 19,3 \frac{\text{KN}}{\text{m}^3}$$

$$W, W_z, \gamma_s, n = ?$$

$$\gamma_d = 16,2 \frac{\text{KN}}{\text{m}^3}$$

$$\gamma' = 10,0 \frac{\text{KN}}{\text{m}^3}$$

✓ ✓ ✓ ✓

$$\gamma' = \gamma_z - \gamma_w \Rightarrow \gamma_z = \gamma' + \gamma_w = 10,0 + 9,807 = 19,807 \frac{\text{KN}}{\text{m}^3}$$

$$\gamma_z = \left(1 + \frac{W_z}{100}\right) \cdot \gamma_d \Rightarrow W_z = \frac{\gamma_z - \gamma_d}{\gamma_d} \cdot 100 = \frac{19,807 - 16,2}{16,2} \cdot 100 = 22,26 \%$$

$$W_z = \left(\frac{\gamma_w}{\gamma_d} - \frac{\gamma_w}{\gamma_s}\right) \cdot 100 \Rightarrow \gamma_s = \frac{\gamma_w}{\frac{\gamma_w}{\gamma_d} - \frac{W_z}{100}} = \frac{9,807}{\frac{9,807}{16,2} - \frac{22,26}{100}} = 25,62 \frac{\text{KN}}{\text{m}^3}$$

$$\gamma_d = \frac{\gamma}{1+W} \Rightarrow W = \frac{\gamma}{\gamma_d} - 1 = \frac{19,3}{16,2} - 1 = 0,1914 = 19,14 \%$$

$$n = \left(1 - \frac{\gamma_d}{\gamma_s}\right) \cdot 100 = \left(1 - \frac{16,2}{25,62}\right) \cdot 100 = 36,77 \%$$

1.5

$$M_d = 0,31 \text{ kg} = 310 \text{ g}$$

$$V_{\max} = 207,0 \text{ cm}^3$$

$$V_{\min} = 171 \text{ cm}^3$$

$$V_c = 450 \text{ cm}^3$$

$$M_{dc} = 0,78 \text{ kg} = 780 \text{ g}$$

$$\gamma_s = 27,1 \frac{\text{KN}}{\text{m}^3}$$

$$Dr, W_z = ?$$

✓ ✓

МАКСИМАЛНА И МИНИМАЛНА ЗАПРЕМ. ТЕЖИНА ПЕСКА:

$$\gamma_{d, \max} = \frac{M_d}{V_{\min}} \cdot g = \frac{310 \text{ g}}{171 \text{ cm}^3} \cdot 9,807 = 17,78 \frac{\text{KN}}{\text{m}^3}$$

$$\gamma_{d, \min} = \frac{M_d}{V_{\max}} \cdot g = \frac{310 \text{ g}}{207 \text{ cm}^3} \cdot 9,807 = 14,69 \frac{\text{KN}}{\text{m}^3}$$

$$N = \frac{\text{kg} \cdot \text{m}}{\text{m}^3 \cdot \text{s}^2}$$

СУВА ЗАПРЕМИНСКА ТЕЖИНА ПЕСКА У НАСИПУ:

$$\gamma_d = \frac{M_{d,c}}{V_c} \cdot g = \frac{780}{450} \cdot 9,807 = 17,00 \frac{\text{кН}}{\text{м}^3}$$

ПРИРОДНИ, МИНИМАЛНИ И МАКСИМАЛНИ КОЕФИЦИЈЕНТИ ПОРОЗНОСТИ У НАСИПУ:

$$e = \frac{\gamma_s}{\gamma_d} - 1 = \frac{27,1}{17,0} - 1 = 0,594$$

$$e_{\min} = \frac{\gamma_s}{\gamma_{d,\max}} - 1 = \frac{27,1}{17,78} - 1 = 0,524$$

$$e_{\max} = \frac{\gamma_s}{\gamma_{d,\min}} - 1 = \frac{27,1}{14,69} - 1 = 0,845$$

РЕЛАТИВНА ЗБИЈЕНОСТ ПЕСКА У НАСИПУ:

$$D_r = \frac{e_{\max} - e}{e_{\max} - e_{\min}} \cdot 100 = \frac{0,845 - 0,594}{0,845 - 0,524} \cdot 100 = 78,15 \%$$

$$= \frac{(\gamma_d - \gamma_{d,\min}) \gamma_{d,\max}}{(\gamma_{d,\max} - \gamma_{d,\min}) \gamma_d} \cdot 100$$

ВЛАЖНОСТ ПРИ ЗАСИЋЕЊУ:

$$w_z = \left( \frac{\gamma_w}{\gamma_d} - \frac{\gamma_w}{\gamma_s} \right) \cdot 100 = \left( \frac{9,807}{17,0} - \frac{9,807}{27,1} \right) \cdot 100 = 21,5 \%$$

1.6

$$M = 948,0 \text{ kg}$$

$$RC = 95\% - ?$$

$$V = 503,0 \text{ cm}^3$$

$$f_d = ?$$

$$W = 10,3\% = 0,103$$

$$e_{\max} = 0,652$$

$$e_{\min} = 0,461$$

$$G_s = 2,68$$

$$RC = \frac{f_d}{f_{d\max}} \quad \text{57,9\% (20-53\% POSTI)}$$

$$f_s = G_s \cdot f = 2,68 \cdot 9,807 = 26,28 \frac{\text{KN}}{\text{m}^3}$$

$$f = \frac{M}{V} \cdot g = \frac{948}{503} \cdot 9,807 = 18,48 \frac{\text{KN}}{\text{m}^3}$$

$$f_d = \frac{f}{1+W} = \frac{18,48}{1,103} = 16,75 \frac{\text{KN}}{\text{m}^3}$$

$$e = \frac{f_s}{f_d} - 1 = \frac{26,28}{16,75} - 1 = 0,569$$

$$Dr = \frac{e_{\max} - e}{e_{\max} - e_{\min}} \cdot 100 = \frac{0,652 - 0,569}{0,652 - 0,461} \cdot 100 = 43,46\%$$

$$e_{\min} = \frac{f_s}{f_{d\max}} - 1 \Rightarrow f_{d\max} = \frac{f_s}{e_{\min} + 1} = \frac{26,28}{1,461} = 17,99 \frac{\text{KN}}{\text{m}^3}$$

$$RC = \frac{f_d}{f_{d\max}} = \frac{16,75}{17,99} = 0,9311 = 93,11\% \quad \text{НИЈЕ ПОСТИГНУТ}$$

СТЕПЕН ЗАБИЈЕНОСТИ

$$0,95 = \frac{f_{d\text{potrebno}}}{f_{d\max}} \Rightarrow f_{d\text{pot}} = f_{d\max} \cdot 0,95 = 17,99 \cdot 0,95 = 17,09 \frac{\text{KN}}{\text{m}^3}$$

$$e_{\text{pot}} = \frac{f_s}{f_{d\text{pot}}} - 1 = \frac{26,28}{17,09} - 1 = 0,538$$

$$Dr_{\text{pot}} = \frac{e_{\max} - e_{\text{pot}}}{e_{\max} - e_{\min}} \cdot 100 = \frac{0,652 - 0,538}{0,652 - 0,461} \cdot 100 = 59,68\%$$

5.9.

		$G_{3F} \left( \frac{KN}{m^2} \right)$	$G_{1F} \left( \frac{KN}{m^2} \right)$	$U_F \left( \frac{KN}{m^2} \right)$
УЗОРАК	1	200	350	140
УЗОРАК	2	400	700	280

$$G_1 - G_3 = 2C \cos \phi + (G_1 + G_3) \sin \phi$$

$$G'_1 - G'_3 = 2C \cos \phi' + (G'_1 + G'_3) \sin \phi'$$

$$G'_i - G_i = U$$

		$G_{3F}$	$G_{1F}$	$U_F$	$G'_{3F}$	$G'_{1F}$
УЗОРАК	1	200	350	140	60	210
УЗОРАК	2	400	700	280	120	420

а) ОДРЕДИТИ ПАРАМЕТРЕ ЧВРСТОЌЕ ЗА ЕФЕКТИВНЕ  $(\phi', c')$  И ТОТАЛНЕ НАПОНЕ  $(\phi_{cu}, c_{cu})$

$$G_1 - G_3 = 2C \cos \phi + (G_1 + G_3) \sin \phi$$

$$1. \quad 350 - 200 = 2C \cos \phi + (350 + 200) \sin \phi$$

$$2. \quad 700 - 400 = 2C \cos \phi + (700 + 400) \sin \phi$$

$$\begin{array}{l} 150 = 2C \cos \phi + 550 \sin \phi \quad \text{3A } \sin \phi \\ 300 = 2C \cos \phi + 1100 \sin \phi \quad \text{3A } C \cdot 1 \end{array}$$

$$150 = 550 \sin \phi \Rightarrow \sin \phi = \frac{150}{550}$$

$$\sin \phi = 0,272727 \Rightarrow \phi = 15,826620^\circ$$

$$0 = -2C \cos \phi \Rightarrow C = 0$$

$$\sigma_1' - \sigma_3' = 2C' \cos \phi' + (\sigma_1' + \sigma_3') \sin \phi'$$

$$1. \quad 210 - 60 = 2C' \cos \phi' + (210 + 60) \sin \phi'$$

$$2. \quad 420 - 120 = 2C' \cos \phi' + (420 + 120) \sin \phi'$$

$$150 = 2C' \cos \phi' + 270 \cdot \sin \phi'$$

$$300 = 2C' \cos \phi' + 540 \cdot \sin \phi'$$

$$3A \sin \phi'$$

$$3A C'$$

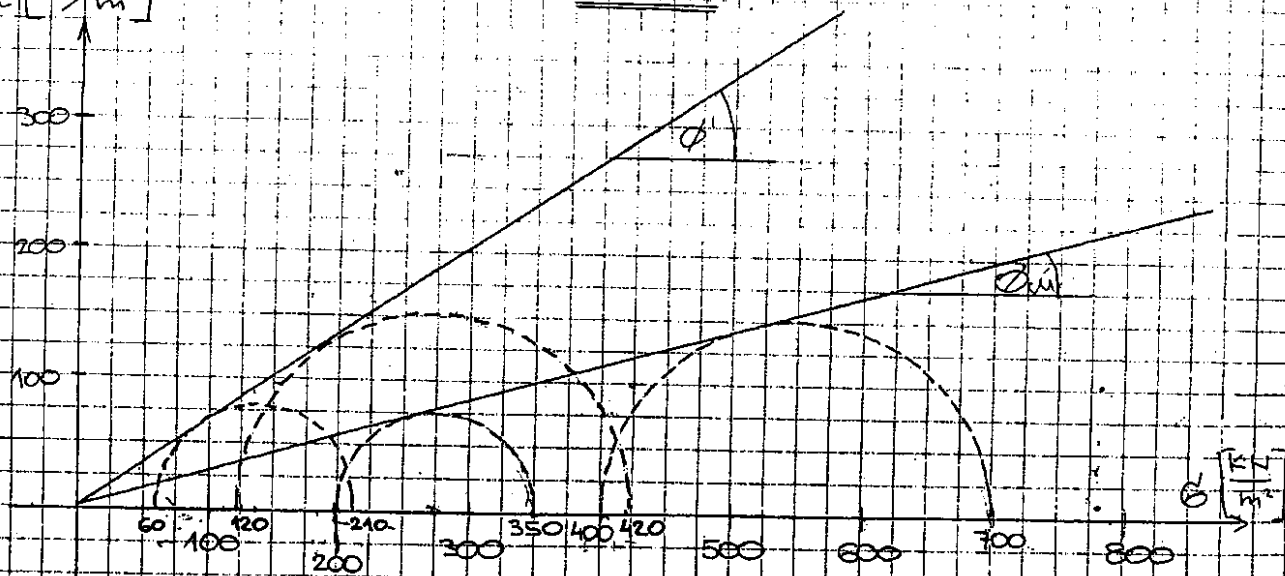
$$(-1)$$

$$(-2)$$

$$150 = 270 \sin \phi' \Rightarrow \sin \phi' = \frac{150}{270} = 0.5555...$$

$$\phi' = 33.7489886^\circ$$

$$\tau [KN/m^2] \quad 0 = -2C' \cos \phi' \Rightarrow \underline{C' = 0}$$



6) ОДРЕДИТИ ЕФЕКТИВНИ НОРМАЛНИ НАПОН  $\sigma_a$  И СМИЧУЋИ НАПОН  $\tau_f$  КОЈИ ДЕЛУЈУ НА РАВАН ЛОМА КОД УЗОРКА БРОЈ 2.



$$\sigma_n' = \frac{\sigma_{1F}' + \sigma_{3F}'}{2} + \frac{\sigma_{1F}' - \sigma_{3F}'}{2} \cdot \cos(2\theta)$$

$$\tau_F' = \frac{\sigma_{1F}' - \sigma_{3F}'}{2} \cdot \sin(2\theta)$$

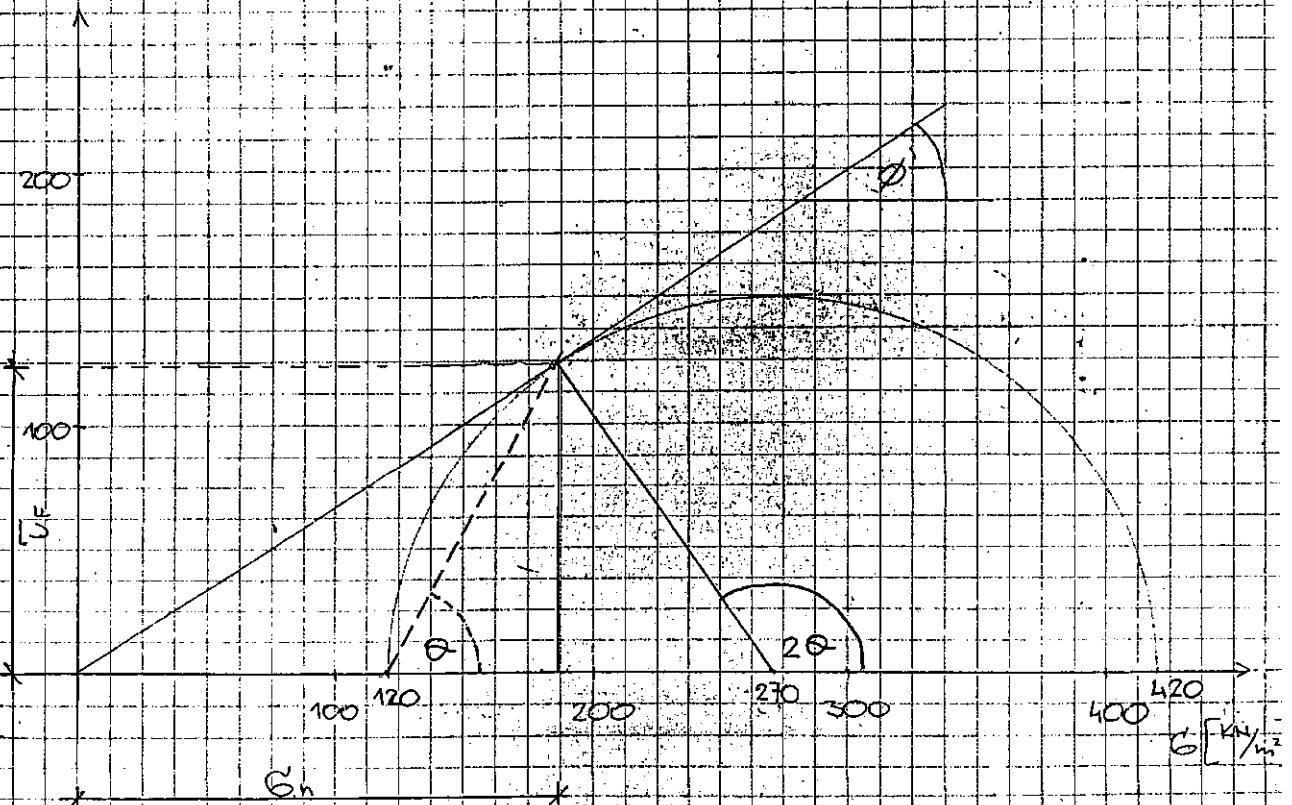
$$\theta = 45^\circ + \frac{\phi'}{2}$$

$$\theta = 45^\circ + \frac{\phi'}{2} = 45^\circ + \frac{33.75^\circ}{2} = 61.8744943^\circ$$

$$\sigma_n = \frac{420 + 120}{2} + \frac{420 - 120}{2} \cos(123.75^\circ) = 186.67 \frac{\text{KN}}{\text{m}^2}$$

$$\tau_F = \frac{420 - 120}{2} \sin(123.75^\circ) = 124.72 \frac{\text{KN}}{\text{m}^2}$$

$\tau$  [KN/m<sup>2</sup>]



5.10.

		$G_{3F} \left[ \frac{KN}{m^2} \right]$	$G_{1F} \left[ \frac{KN}{m^2} \right]$	$U_F \left[ \frac{KN}{m^2} \right]$
Y30PAK	1	50	150	12
Y30PAK	2	100	240	40

	$G_{3F}$	$G_{1F}$	$U_F$	$G'_{3F}$	$G'_{1F}$
Y30PAK 1	50	150	12	38	138
Y30PAK 2	100	240	40	60	200

$$G'_{1F} - G'_3 = 2C' \cos \phi' + (G'_1 + G'_3) \sin \phi'$$

$$1. \quad 138 - 38 = 2C' \cos \phi' + (138 + 38) \cdot \sin \phi'$$

$$2. \quad 200 - 60 = 2C' \cos \phi' + (200 + 60) \cdot \sin \phi'$$

$$100 = 2C' \cos \phi' + 176 \sin \phi'$$

$$140 = 2C' \cos \phi' + 260 \sin \phi' \quad \leftarrow (-1)$$

$$40 = 84 \sin \phi'$$

$$\sin \phi' = \frac{40}{84} \Rightarrow \sin \phi' = 0,476130476$$

$$\phi' = 28,43689015^\circ$$

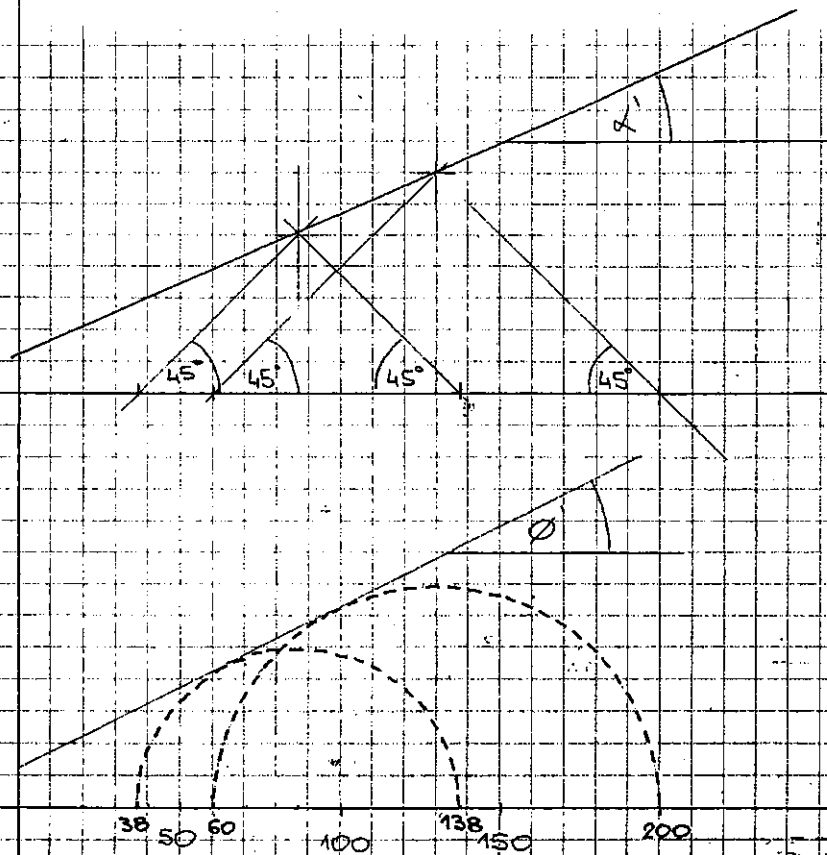
$$100 = 2C' \cos 28,436 + 176 \cdot \sin 28,436$$

$$100 = 2C' \cdot 0,8733 + 83,81$$

$$C' \cdot 1,75868 = 16,19$$

$$C' = \frac{16,19}{1,75868}$$

$$C' = 9,206086$$



$$a' = c' \cdot \cos \phi'$$

$$\operatorname{tg} \alpha' = \sin \phi'$$

$$a' = 9,206086 \cdot \cos 28,44^\circ \Rightarrow a' = 8,095299528 \frac{\text{KN}}{\text{m}^2}$$

$$\operatorname{tg} \alpha' = \sin 28,44^\circ \Rightarrow \operatorname{tg} \alpha' = 0,47619 \Rightarrow \alpha' = 25,46334506^\circ$$

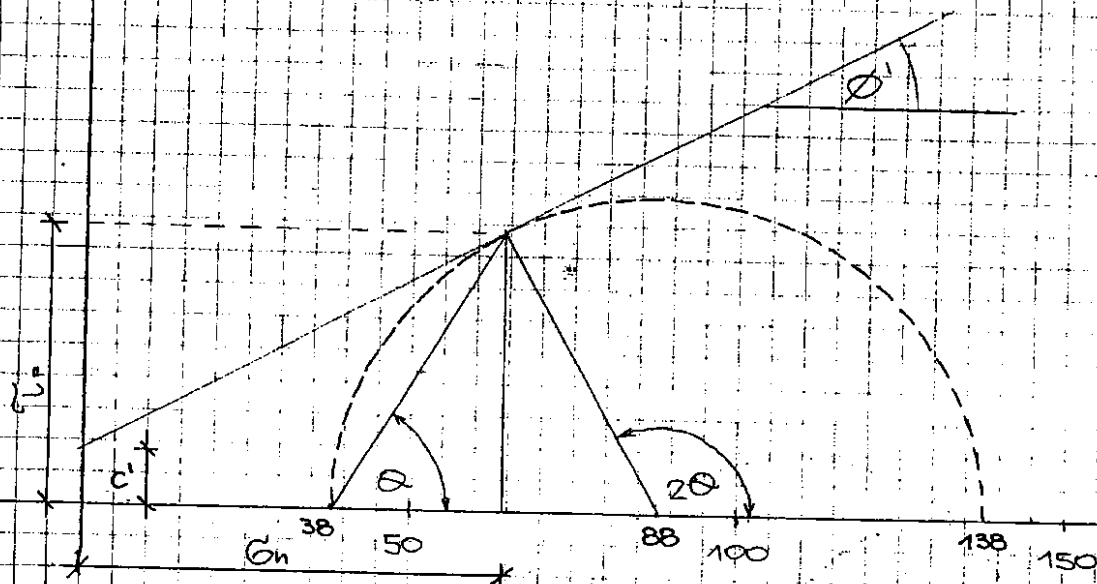
$$\Theta = 45 + \frac{\phi'}{2} \Rightarrow \Theta = 59,21844507^\circ$$

$$G_n' = \frac{138+38}{2} + \frac{138-38}{2} \cdot \cos 2 \cdot 59,21844507$$

$$G_n' = 88 + 50 \cdot (-0,47619) \Rightarrow G_n' = 64,19047619 \frac{\text{KN}}{\text{m}^2}$$

$$\tilde{L}_F = \frac{138-38}{2} \cdot \sin 2\Theta$$

$$\tilde{L}_F = 50 \cdot 0,879342157 \Rightarrow \tilde{L}_F = 43,96710789 \frac{\text{KN}}{\text{m}^2}$$



(\*)

	$G_{3F}$	$G_{1F}$
$Y_{30PAK 1}$	100	320
$Y_{30PAK 2}$	200	590

KAD HEMA  $U_F$  OHAA:

$$G_{1F} = G'_{1F}$$

$$G_{3F} = G'_{3F}$$

$$1. \quad 320 - 100 = 2C \cos \phi' + (320 + 100) \sin \phi'$$

$$2. \quad 590 - 200 = 2C \cos \phi' + (590 + 200) \sin \phi'$$

$$220 = 2C \cos \phi' + 420 \sin \phi'$$

$$390 = 2C \cos \phi' + 790 \sin \phi' \quad \leftarrow (-1)$$

$$170 = 370 \sin \phi' \Rightarrow \sin \phi' = \frac{170}{370} \Rightarrow \sin \phi' = 0,459459459$$

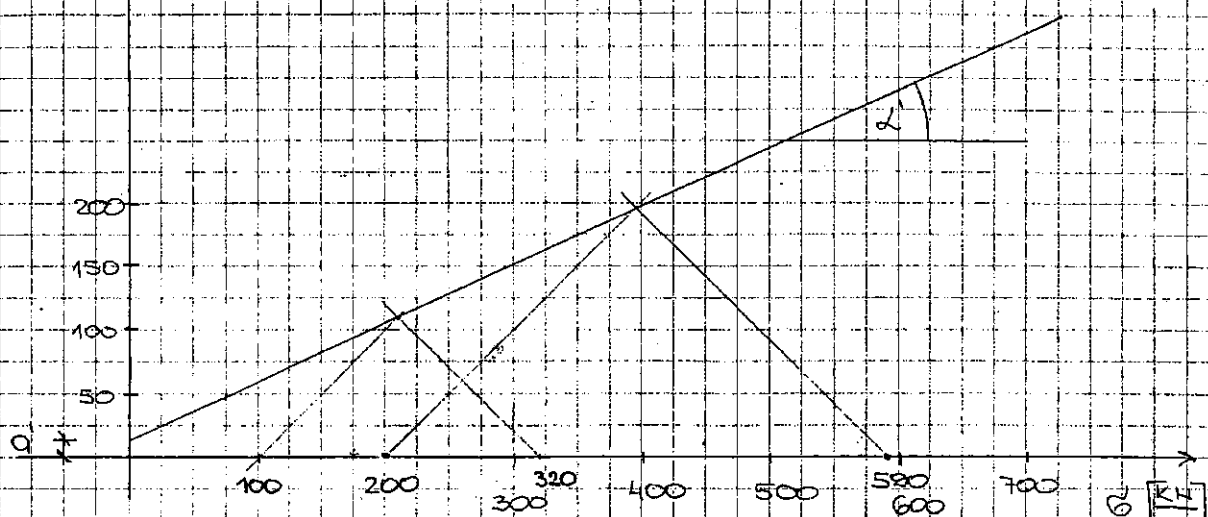
$$\phi' = 27,35223291^\circ$$

$$220 = 2C \cos 27,35^\circ + 420 \sin 27,35^\circ$$

$$220 = 1,77639 \cdot C + 192,9729$$

$$1,77639 \cdot C = 27,02702703 \Rightarrow C = 15,21451549 \frac{KN}{m^2}$$

$$c' = \frac{c}{3}$$



$$a' = c' \cdot \cos \phi' = a' = 15,2145 \cdot 0,88819 \Rightarrow a' = 13,5135 \frac{\text{kN}}{\text{m}^2}$$

$$\tan \alpha' = \sin \phi' \Rightarrow \tan \alpha' = 0,453459 \Rightarrow \alpha' = 24,67686317^\circ$$

(\*)

$$\phi' = 30^\circ$$

$$c' = 50 \frac{\text{kN}}{\text{m}^2}$$

$$G_1 = 400 \frac{\text{kN}}{\text{m}^2} = G_1'$$

$$G_3 = 50 \frac{\text{kN}}{\text{m}^2} =$$

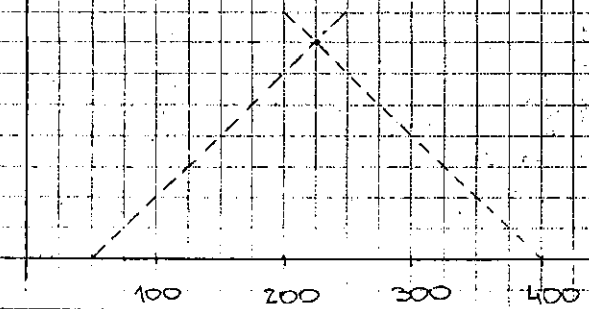
$$400 - G_3' = 2 c' \cos \phi' + (400 - G_3') \sin \phi'$$

$$400 - G_3' = 100 \cdot 0,866 + (400 - G_3') \cdot 0,5$$

$$400 - G_3' = 86,6025 + 200 - 0,5 G_3'$$

$$1,5 G_3' = 113,3974596 \Rightarrow \underline{G_3' = 75,59830641}$$

↑



$$a' = c' \cdot \cos \phi' = 50 \cdot 0,866 = 43,30$$

$$\alpha' = \arctan \sin \phi' = \underline{26,56505118^\circ}$$

\* 5.23.

$\Delta\phi', P_F', \phi_B = ?$

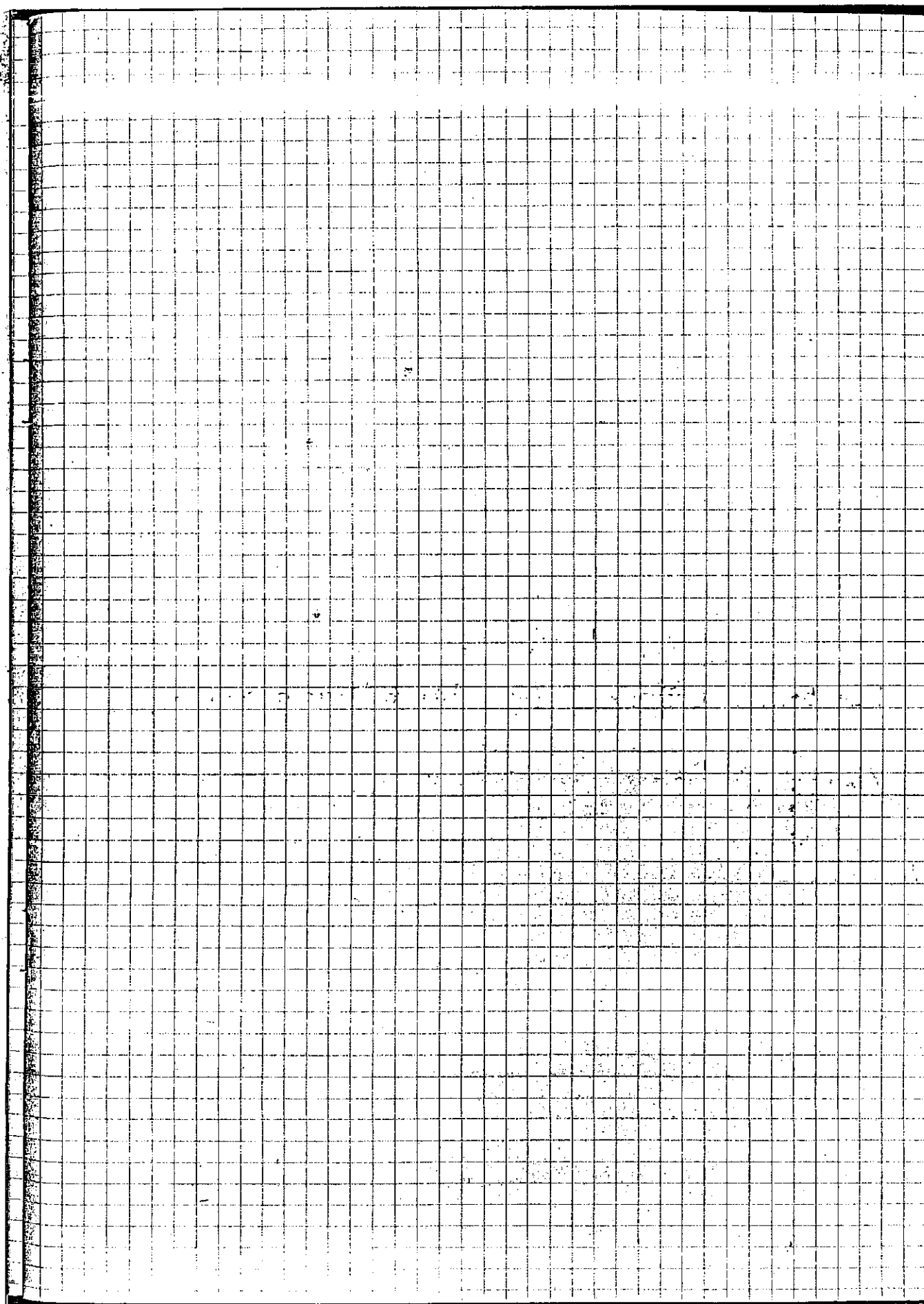
		$G'_{3F}$	$G'_{1F}$
$Y_{30PAK}$	1	250	1594,6
$Y_{30PAK}$	2	1000	5397,1
$Y_{30PAK}$	3	4500	18719,7

$$\sin \phi'_s = \frac{G'_{1F} - G'_{3F}}{G'_{1F} + G'_{3F}}$$

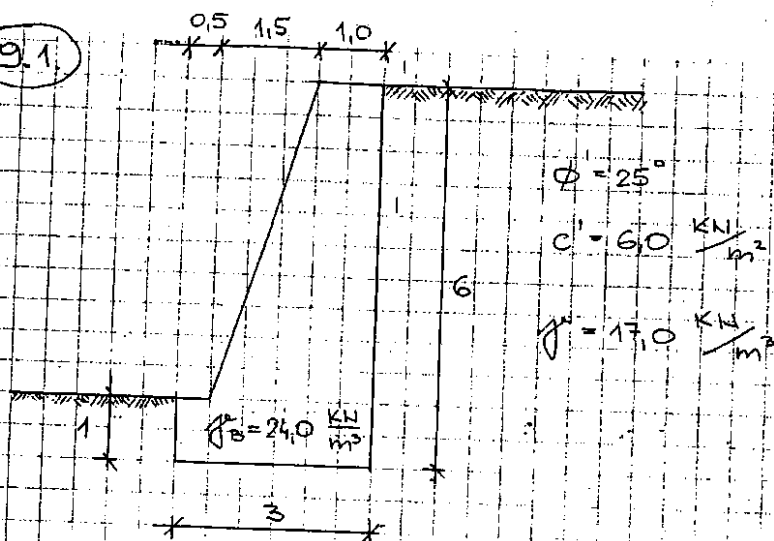
$$G'_{FF} = G'_{3F} \cdot (1 + \sin \phi'_s) \Rightarrow G'_{FF} = \frac{2G'_{1F} \cdot G'_{3F}}{G'_{1F} + G'_{3F}}$$

$$\phi'_s = \phi'_B + \frac{\Delta\phi' \cdot P_F'}{P_F' + G'_{FF}}$$

		$G'_{1F}$	$G'_{3F}$	$G'_{1F} - G'_{3F}$	$G'_{1F} + G'_{3F}$	$G'_{FF}$	$\phi'_s$
$Y_{30PAK}$	1	1594,6	250	1344,6	1844,6	432,235	
$Y_{30PAK}$	2	5397,1	1000	4397,1	6397,1	1687,358	
$Y_{30PAK}$	3	18719,7	4500	14219,7	23219,7	7255,791	



9.1



а) СИЛА АКТИВНОГ ПРИТИСКА ТЛА  $Z = 6.0\text{ m}$

ЕФЕКТ. ВЕРТ НАПОН:  $\sigma_z = \gamma \cdot Z = 17 \frac{\text{kN}}{\text{m}^3} \cdot 6.0\text{ m} = 102 \frac{\text{kN}}{\text{m}^2}$

КОЕФ. АКТИВНОГ ПРИТИСКА:

$$K_a = \tan^2\left(45 - \frac{\phi'}{2}\right) = \tan^2\left(45 - \frac{25}{2}\right) = \tan^2 32.5 \Rightarrow K_a = 0.4058$$

АКТИВНИ ПРИТИСАК ТЛА:

$$P_a = \sigma_z \cdot K_a - 2c' \sqrt{K_a}$$

$$P_a = 102 \cdot 0.4058 - 2 \cdot 6 \cdot \sqrt{0.4058} = 41.3916 - 7.6443 = 33.747 \frac{\text{kN}}{\text{m}^2}$$

ДУБИНА ЗОНЕ ЗАТЕЗАЊА У ТЛУ:

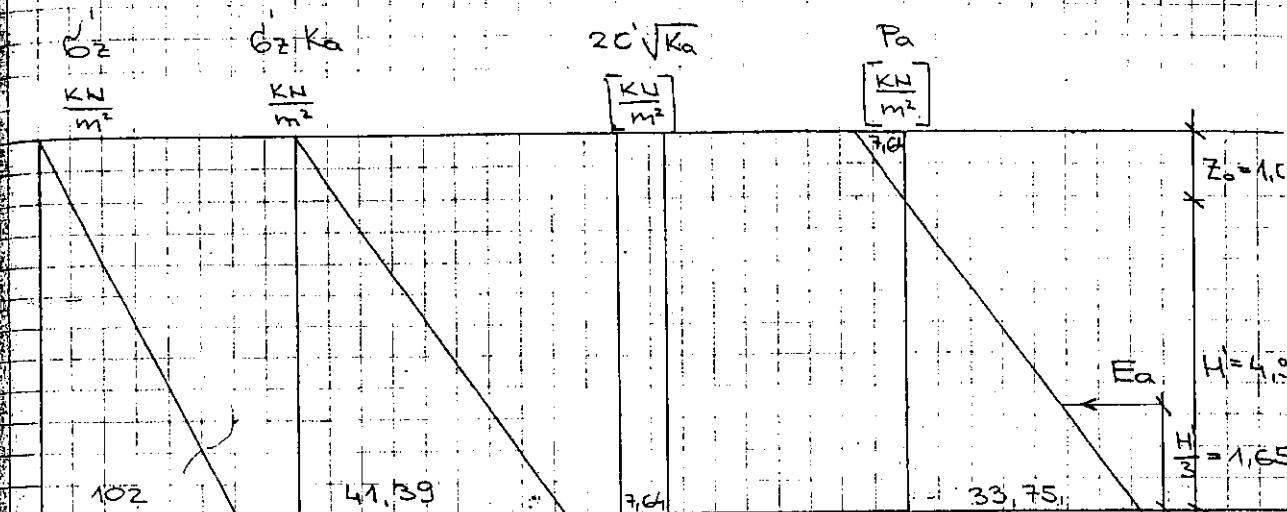
$$P_a(z_0) = \gamma \cdot z_0 \cdot K_a - 2c' \sqrt{K_a} = 0$$

$$z_0 = \frac{2c'}{\gamma \sqrt{K_a}} = \frac{2 \cdot 6}{17 \sqrt{0.4058}} = 1.04\text{ m}$$

ВИСИНА ПРИТИСНУТОГ ДЕЛА ЗИДА:

$$H' = H - z_0 = 6 - 1.04 = 4.96\text{ m}$$





СИЛА АКТИВНОГО ПРИТІСКА ТЛА  $\vec{E}_a$  НА ПОТПОРНИ ЗІД

ІНТЕНЗИТЕТ СИЛЕ:

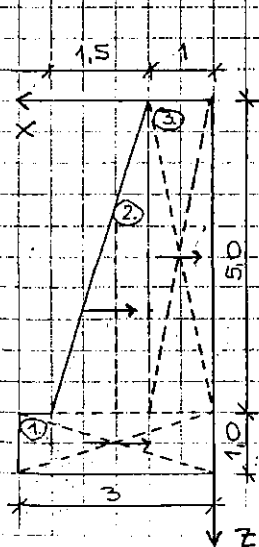
$$E_a = \int P_a \cdot dz = P_a \cdot \frac{H}{2} = 33,75 \cdot \frac{4,96}{2} = \underline{83,7 \frac{\text{кН}}{\text{м}^2}}$$

НАПАДНА ТАЧКА:

$$Z_E = Z_0 + \frac{2}{3} H = 1,5 + \frac{2}{3} 4,96 = \underline{4,35 \text{ м}}$$

5) АНАЛІЗ СТАБІЛЬНОСТІ ПОТПОРНОГО ЗІДА:

■ ПРОРАХУН ТЕЖИНЕ G І КООРДИНАТА ТЕЖИШТА ПОТПОРНОГО ЗІДА ( $X_G, Z_G$ )



i	$F_i$ $\text{м}^2$	$X_i$ $\text{м}$	$Z_i$ $\text{м}$	$F_i \cdot X_i$ $\text{м}^3$	$F_i \cdot Z_i$ $\text{м}^3$
1	3,0	1,5	5,5	4,5	16,5
2	3,75	1,5	3,33	5,625	12,49
3	5,0	0,5	2,5	2,5	12,50
$\Sigma$	11,75			12,625	41,49

$$G = \gamma \cdot \sum F_i = 24 \frac{\text{KN}}{\text{m}^3} \cdot 11,75 \text{ m}^3 = 282,0 \frac{\text{KN}}{\text{m}}$$

$$X_G = \frac{\sum F_i \cdot x_i}{\sum F_i} = \frac{12,63}{11,75} = 1,07 \text{ m}$$

$$Z_G = \frac{\sum F_i \cdot z_i}{\sum F_i} = \frac{41,49}{11,75} = 3,53 \text{ m}$$

■ ФАКТОР СИГУРНОСТИ ПРОТИВ КЛИЗАЊА У ТЕМЕЉНОЈ СПОЈНИЦИ ( $\mu \approx \tan \phi'$ ,  $c_a \approx c'$ )

$$F_k = \frac{S + E_F}{T} = \frac{N \cdot \mu + c_a + E_F}{E_a} \rightarrow F_k = \frac{G \cdot \tan \phi' + c' \cdot B}{E_a} \quad \begin{array}{l} \text{ШИРИНА} \\ \text{ТЕМЕЉНЕ} \\ \text{СТОПЕ} \end{array}$$

$$F_k = \frac{282 \cdot \tan 25^\circ + 6,0 \cdot 3,0}{83,7} = \frac{149,5}{83,7} = 1,786 \approx 1,8$$

б) ЕКСЦЕНТРИЦИТЕТ РЕЗУЛТАНТЕ ОПТЕРЕЖЕЊА У ОДНОСУ НА ТЕЖИШТЕ ТЕМЕЉНЕ СПОЈНИЦЕ

$$e_b = \frac{M_o}{N} = \frac{E_a(H - z_e) + G(x_g - \frac{B}{2})}{G} = \frac{83,7(6 - 4,35) + 282 \cdot (1,07 - \frac{3}{2})}{282}$$

$$e_b = \frac{83,7 - 1,65 + 282 \cdot (-0,43)}{282} = 0,0597 \text{ m}$$

ЕФЕКТИВНА ШИРИНА ТЕМЕЉА:

$$B' = B - 2e_b = 3 - 2 \cdot 0,0597 = 2,88 \text{ m}$$

МОБИЛИСАНИ ПАРАМЕТРИ ЧВРСТОЋЕ:

$$\phi'_m = 17,27^\circ$$

$$c'_m = 2,4 \text{ KN/m}^2$$

$$N_2 = \tan^2\left(45^\circ + \frac{\phi'}{2}\right) \cdot c' \cdot \underbrace{\pi \cdot \tan \phi'}_{\text{ПРОДОР ПАУХНАТА}} = 1,8444 \cdot 2,6556 = 4,8982$$

## ФАКТОРИ НОСИВОСТИ

$$N_c = (N_g - 1) \cdot \operatorname{ctg} \phi'_m = 3,8982 \cdot 3,2166 = \underline{12,54}$$

$$N_q = 1,8 \cdot (N_g - 1) \cdot \operatorname{tg} \phi'_m = 7,0168 \cdot 0,3109 = \underline{2,18 \approx 2,2}$$

## ФАКТОР ДУБИНЕ:

$$d_c = 1 + 0,35 \frac{D_f}{B} = 1 + 0,35 \frac{1}{3} = \underline{1,12 \text{ m}}$$

## ФАКТОРИ ЗАКОШЕНОСТИ:

$$\chi = \frac{E_a}{A \cdot c'_m + G \cdot \tan \phi'_m} = \frac{83,7}{2,88 \cdot 1 \cdot 2,4 + 282 \cdot \tan 17,27^\circ} = \frac{83,7}{94,58} = \underline{0,88}$$

$$i_q = \frac{1 + \sin \phi \sin(2\alpha - \phi)}{1 + \sin \phi} e^{-(\frac{\pi}{2} + \phi - 2\alpha) \cdot \operatorname{tg} \phi} \quad i_q = i_q^2$$

## ДОЗВОЉЕНО ОПТЕРЕЋЕЊЕ (НОСИВОСТ) ТЛА:

$$q_a = 0,5 \cdot 17 \cdot 2,9 \cdot 2,2 \cdot 0,23 + \left( (2,4 + 17 \cdot 0,311) \cdot 12,5 + 1,12 \cdot 0,41 + 17 \cdot 1 \right)$$

$$q_a = \underline{73,59 \frac{\text{KN}}{\text{m}^2}}$$

## ИВИЧНИ КОНТАКТНИ НАПОНИ У ТЕМЕЉНОЈ СЛОЈНИЦИ:

УЗ УСЛОВ  $q_{\min} > 0$

$$q_{\max/\min} = \frac{N}{B} \left( 1 \pm \frac{6 \cdot e_B}{B} \right) = \frac{282}{3} \cdot \left( 1 \pm \frac{6 \cdot 0,05}{3} \right) = 94 \pm 9,4 = \begin{matrix} 103,4 \frac{\text{KN}}{\text{m}^2} \\ 84,6 \frac{\text{KN}}{\text{m}^2} \end{matrix}$$

ЗА  $q_{\min} < 0$  ОДНОСНО  $e_B > \frac{B}{6}$

$$q_{\min} = 0 \quad q_{\max} = \frac{2 \cdot N}{3 \cdot \left( \frac{B}{2} - e_B \right)} = \frac{2 \cdot 282}{3 \cdot \left( \frac{3}{2} - 0,05 \right)} = \underline{129,65 \frac{\text{KN}}{\text{m}^2}}$$

## УПОРЕДНИ КОНТАКТНИ НАПОН:

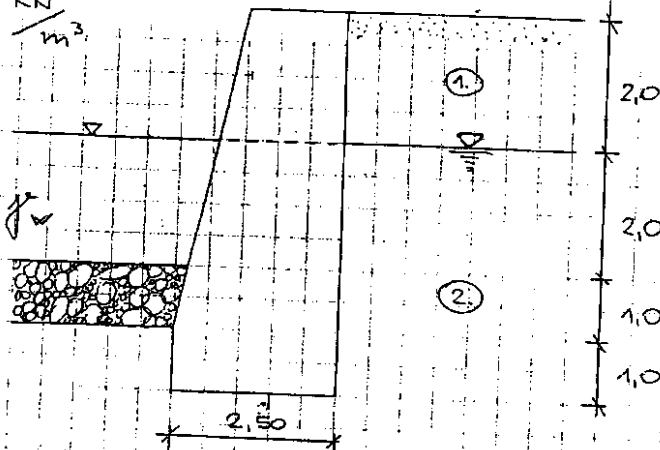
$$q_{\text{уп}} = \frac{V}{A} = \frac{282}{2,5} = 97,24 \frac{\text{KN}}{\text{m}^2} > q_a$$

НИЈЕ ЗАДОВОЉЕНА  
НОСИВОСТ ТЕМЕЉА  
ПОТПОРНОГ ЗИДА

9.2

$$\gamma_b = 24 \frac{\text{KN}}{\text{m}^3}$$

$$\gamma_b = \gamma_b - \gamma_w$$

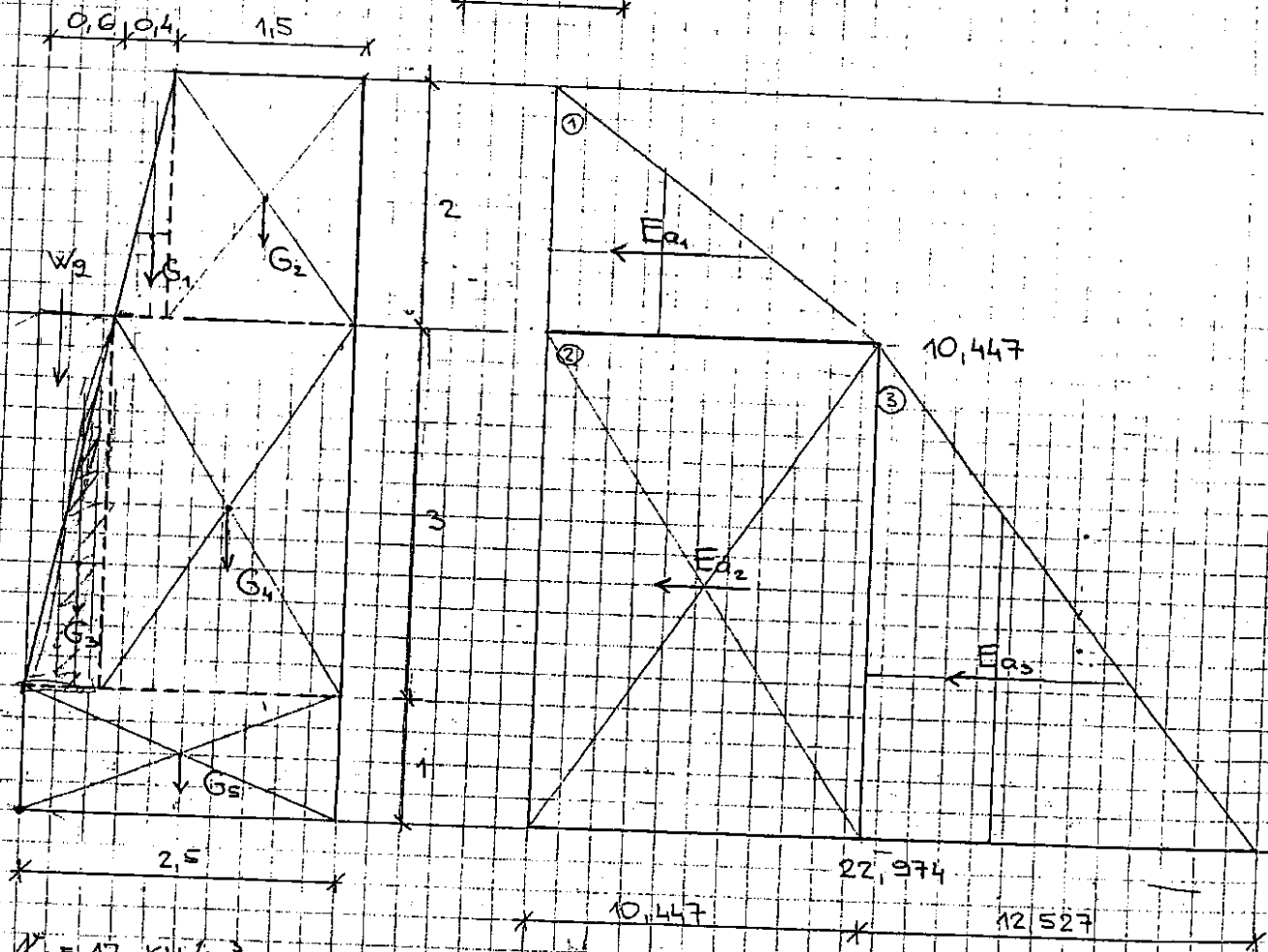


$$\phi' = 32^\circ$$

$$\gamma = 17.0 \frac{\text{KN}}{\text{m}^3}$$

$$\phi' = 32^\circ$$

$$\gamma_z = 20.0 \frac{\text{KN}}{\text{m}^3}$$



$$\gamma_z = 17 \frac{\text{KN}}{\text{m}^3}$$

$$\gamma_z = 20 \frac{\text{KN}}{\text{m}^3}$$

$$\gamma_z' = \gamma_z - \gamma_w = 20 - 9.807 = 10.193 \frac{\text{KN}}{\text{m}^3}$$

$$\gamma_b = 24 \frac{\text{KN}}{\text{m}^3}$$

$$\gamma_b' = \gamma_b - \gamma_w = 24 - 9.807 = 14.193 \frac{\text{KN}}{\text{m}^3}$$

$$a) K_{a1} = K_{a2} = \operatorname{tg}^2 \left( 45 - \frac{\phi}{2} \right) = \operatorname{tg}^2 29 = \underline{0,307258}$$

$$G_{z1} = \gamma_1 \cdot h_1 = 17 \cdot 2 = \underline{34 \frac{\text{KN}}{\text{m}^2}}$$

$$G_{z2} = G_{z1} + \gamma'_{z2} \cdot h_2 = 34 + 10,193 \cdot 4 = \underline{74,772 \frac{\text{KN}}{\text{m}^2}}$$

ПАСИВНИ ПРИТИСАК

$$P_a = K_a G_z - 2c \sqrt{K_a}$$

$$P_{a1} = 0,307258 \cdot 34 = \underline{10,447 \text{ KN/m}^2}$$

$$P_{a2} = 0,307258 \cdot 74,772 = \underline{22,974 \text{ KN/m}^2}$$

$$\left. \begin{aligned} E_{a1} &= A_{\text{ТРОУГЛА}} = \frac{1}{2} \cdot 2 \cdot 10,447 = \underline{10,447 \text{ KN/m}} \\ E_{a2} &= A_{\text{ПРАВОУГОЛНИКА}} = 4 \cdot 10,447 = \underline{41,788 \text{ KN/m}} \\ E_{a3} &= A_{\text{ТРОУГЛА}} = \frac{1}{2} \cdot 4 \cdot 12,527 = \underline{25,054 \text{ KN/m}} \end{aligned} \right\} E_a = 77,289 \text{ KN/m}$$

$$W_z = A \cdot \gamma_w = \frac{1}{2} \cdot 3 \cdot 0,6 \cdot 9,807 = \underline{8,826 \text{ KN/m}}$$

$$b) G_i = A_i \cdot \gamma'$$

$$G_1 = \frac{1}{2} \cdot 0,4 \cdot 2 \cdot \gamma'_B = 0,4 \text{ m} \cdot 24 \text{ KN/m}^3 = \underline{9,6 \text{ KN/m}}$$

$$G_2 = 1,5 \cdot 2 \cdot \gamma'_B = 3 \text{ m} \cdot 24 \text{ KN/m}^3 = \underline{72 \text{ KN/m}}$$

$$G_3 = \frac{1}{2} \cdot 0,6 \cdot 3 \cdot \gamma'_B = 0,90 \text{ m} \cdot 14,193 \text{ KN/m}^3 = \underline{12,77 \text{ KN/m}}$$

$$G_4 = 3 \cdot (1,5 + 0,4) \cdot \gamma'_B = 5,7 \text{ m} \cdot 14,193 \text{ KN/m}^3 = \underline{80,90 \text{ KN/m}}$$

$$G_5 = 2,5 \cdot 1 \cdot \gamma'_B = 2,5 \text{ m} \cdot 14,193 \text{ KN/m}^3 = \underline{35,48 \text{ KN/m}}$$

$$N = V = G_1 + G_2 + G_3 + G_4 + G_5 + W_z$$

$$N = 9,6 + 72 + 12,774 + 80,30 + 35,483 + 8,826 = \underline{219,583 \text{ KN/m}}$$

$$T = H = E_{a1} + E_{a2} + E_{a3}$$

$$T = 10,447 + 41,788 + 25,054 = \underline{77,289 \text{ KN/m}}$$

КОЕФ. СИГУРНОСТИ НА КЛИЗАЊЕ

$$F_K = \frac{N \cdot \tan \phi'}{T}$$

$$F_K = \frac{219,583 \cdot \tan 32^\circ}{77,289} = \frac{219,583 \cdot 0,624869^\circ}{77,289} = \underline{1,7753}$$

КОЕФ. СИГУРНОСТИ НА ПРЕТУРАЊЕ

$$F_P = \frac{\sum M^{\curvearrowright}}{\sum M^{\curvearrowleft}} = \frac{310,94}{165,734} = 1,8761$$

$$\sum M^{\curvearrowleft} = E_{a1} \cdot \left(4 + \frac{1}{3} \cdot 2\right) + E_{a2} \cdot 2 + E_{a3} \cdot \frac{1}{3} \cdot 4$$

$$= 10,447 \cdot 4,6667 + 41,788 \cdot 2 + 25,054 \cdot 1,333$$

$$= 48,753 + 83,576 + 33,405 \Rightarrow \underline{\sum M^{\curvearrowleft} = 165,734 \text{ KN/m}}$$

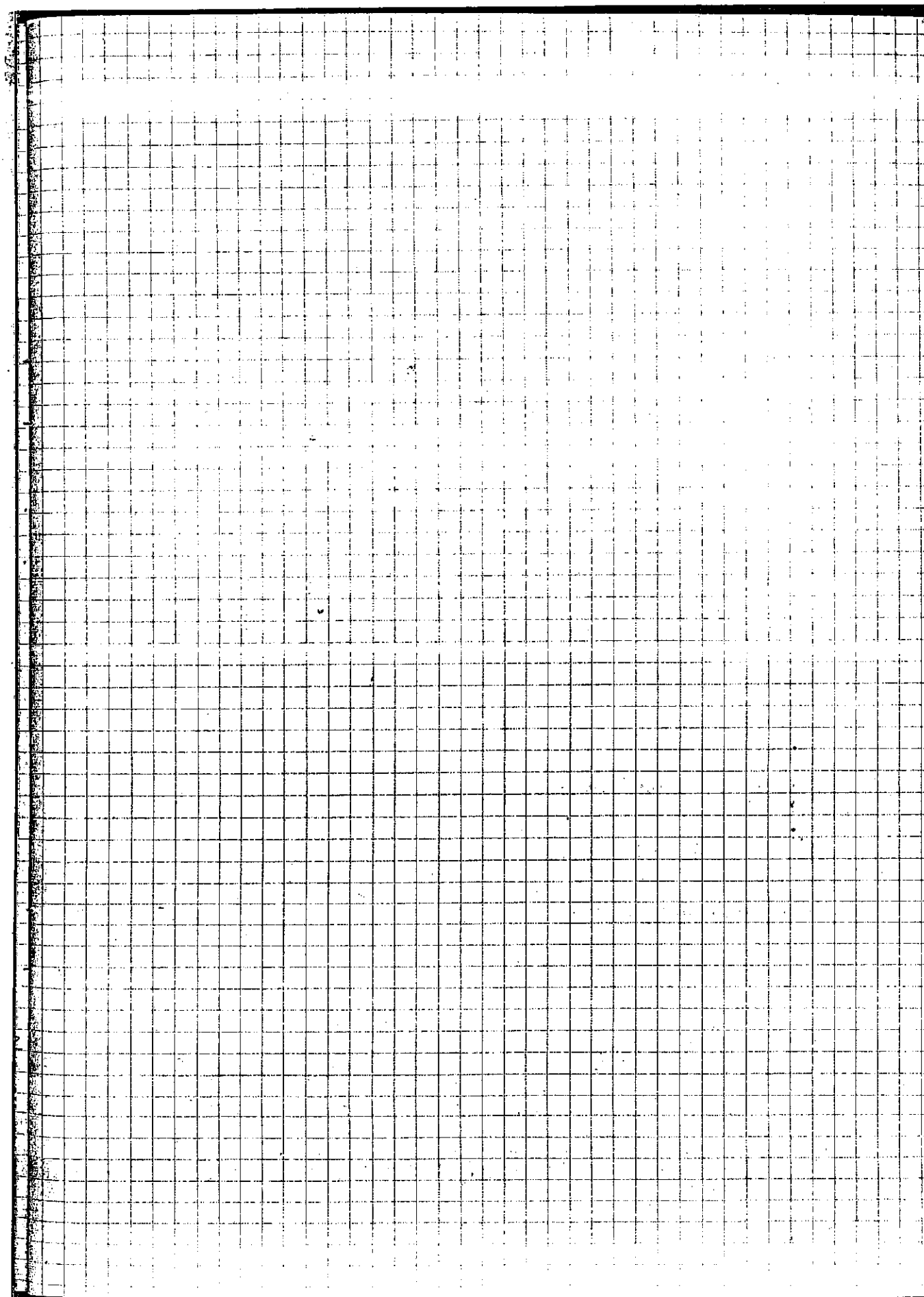
$$\sum M^{\curvearrowright} = G_1 \cdot \left(\frac{2}{3} \cdot 0,4 + 0,6\right) + G_2 \cdot (1 + 0,75) + G_3 \cdot 0,8 \cdot \frac{2}{3} + G_4 \cdot (0,6 + 0,95) +$$

$$+ G_5 \cdot 1,25 + W_z \cdot \frac{1}{3} \cdot 0,6$$

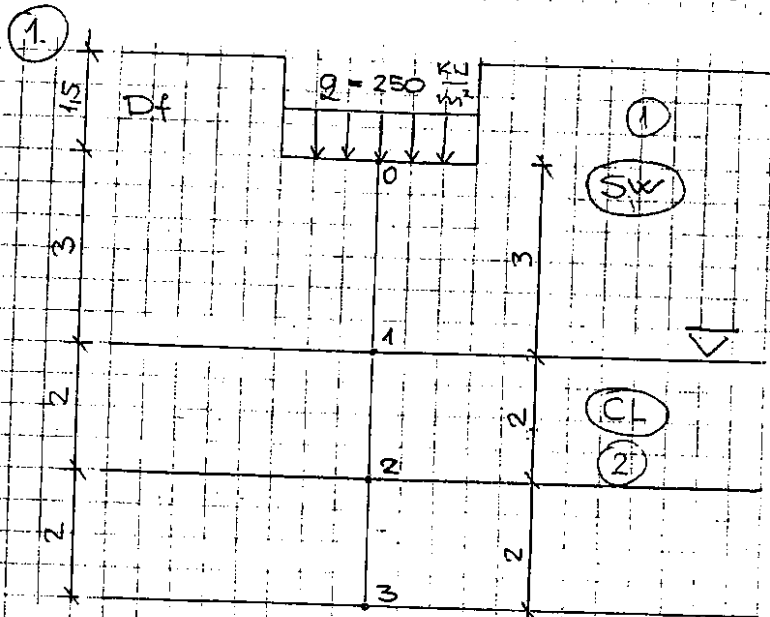
$$= 9,6 \cdot 0,8667 + 72 \cdot 1,75 + 12,77 \cdot 0,4 + 80,30 \cdot 1,55 + 35,48 \cdot 1,25 + 8,826 \cdot 0,2$$

$$= 8,32 + 126 + 5,108 + 125,395 + 44,35 + 1,7652$$

$$\Rightarrow \underline{\sum M^{\curvearrowright} = 310,94 \text{ KN/m}}$$



# СЛЕГАЊЕ ТЕМЕЉА



$$\gamma_1 = 18 \text{ kN/m}^3$$

$$M_v = 20000 \text{ kN/m}^2$$

$$\gamma_{2,2} = 19 \text{ kN/m}^3$$

$$G_s = 2.8$$

$$C_c = 0.3$$

$$C_R = 0.06$$

$$OCR = 1.72$$

$$\gamma'_2 = \gamma_{2,2} - \gamma_w = 19 - 9.807 = 9.193 \text{ kN/m}^3$$

ИЗРАЧУНАТИ СЛЕГАЊЕ ЦЕНТРАЛНЕ ТАЧКЕ ТЕМЕЉА  
 $B \times L = 4 \times 6$  ПО ŠTAJNBRENERU РАЧУНАЈУЋИ НАПОНЕ И  
 СПЕЦИФИЧНЕ ДЕФОРМАЦИЈЕ У ТАЧКАМА 0, 1, 2, 3

НЕТО КОНТАКТНИ НАПОН

$$q_n = q - D_f \cdot \gamma_1 = 250 - 1.5 \cdot 18 = 250 - 27 = 223 \text{ kN/m}^2$$

ПОЧЕТНИ НАПОНИ У ТЛУ

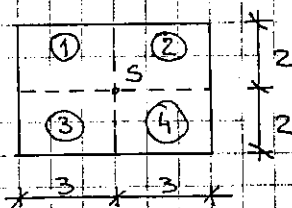
$$p_{0,0} = \gamma_1 \cdot h = 18 \cdot 1.5 = 27 \text{ kN/m}^2$$

$$p_{0,1} = p_{0,0} + \gamma_1 \cdot h = 27 + 18 \cdot 3 = 27 + 54 = 81 \text{ kN/m}^2$$

$$p_{0,2} = p_{0,1} + \gamma'_2 \cdot h = 81 + 9.193 \cdot 2 = 81 + 18.386 = 99.386 \text{ kN/m}^2$$

$$p_{0,3} = p_{0,2} + \gamma'_2 \cdot h = 99.386 + 9.193 \cdot 2 = 99.386 + 18.386 = 117.772 \text{ kN/m}^2$$





$$a = 3$$

$$b = 2$$

$$\frac{a}{b} = \frac{3}{2} = 1,5$$

$$\Delta G_z' = 4 I z_0 = 4 \cdot I \cdot 223 \Rightarrow \Delta G_z' = 892 I$$

$$z = 0 \Rightarrow \frac{z}{b} = \frac{0}{2} = 0 \Rightarrow I = 0,25 \Rightarrow \Delta G_z' = 892 \cdot 0,25$$

$$\Delta G_z' = 223 \text{ KN/m}^2$$

$$z = 3 \Rightarrow \frac{z}{b} = \frac{3}{2} = 1,5 \Rightarrow I = 0,145 \Rightarrow \Delta G_z' = 892 \cdot 0,145$$

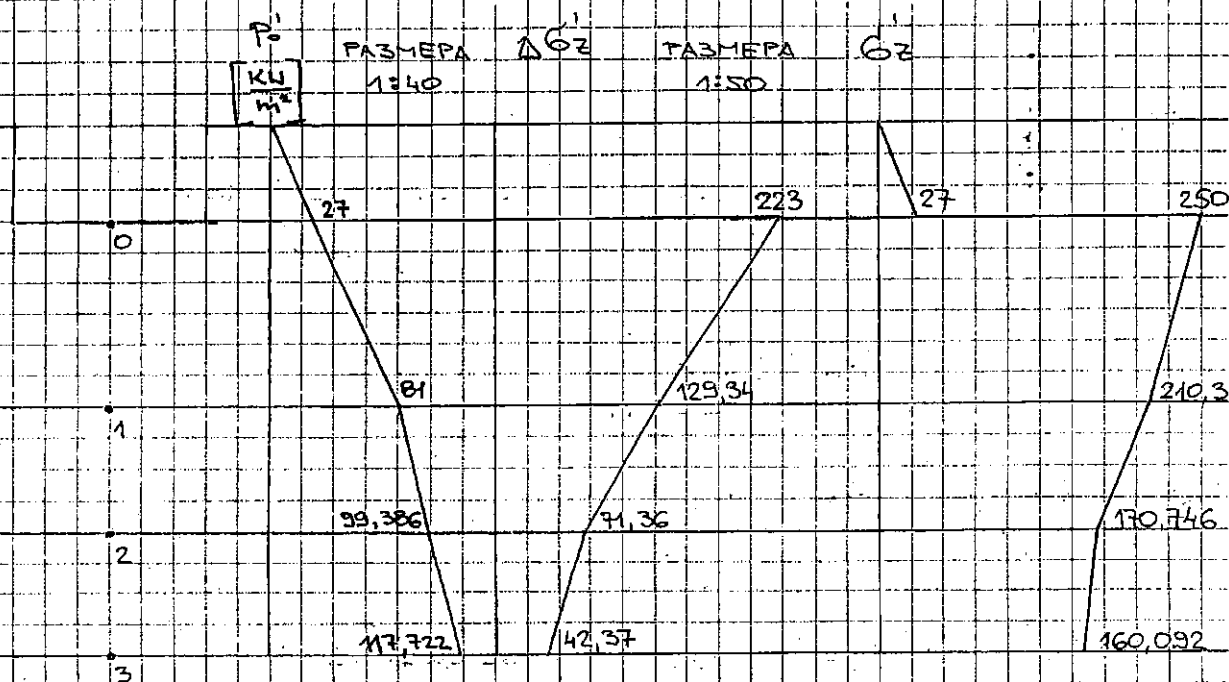
$$\Delta G_z' = 129,34 \text{ KN/m}^2$$

$$z = 5 \Rightarrow \frac{z}{b} = \frac{5}{2} = 2,5 \Rightarrow I = 0,08 \Rightarrow \Delta G_z' = 892 \cdot 0,08$$

$$\Delta G_z' = 71,36 \text{ KN/m}^2$$

$$z = 7 \Rightarrow \frac{z}{b} = \frac{7}{2} = 3,5 \Rightarrow I = 0,0475 \Rightarrow \Delta G_z' = 892 \cdot 0,0475$$

$$\Delta G_z' = 42,37 \text{ KN/m}^2$$



# СПЕЦИФИЧНЕ ДЕФОРМАЦИЈЕ (ВЕРТИКАЛНЕ)

(SW)  $M_v = 20000 \text{ kN/m}^2$

$$z = 0 \text{ m} \quad \epsilon_{z,0} = \frac{\Delta \sigma'_{z,0}}{M_v} = \frac{223}{20000} = 1,115 \cdot 10^{-3}$$

$$z = 3 \text{ m} \quad \epsilon_{z,1} = \frac{\Delta \sigma'_{z,1}}{M_v} = \frac{129,34}{20000} = 6,467 \cdot 10^{-3}$$

(CL)  $G_s = 2,8$

$C_c = 0,3$

$C_m = 0,06$

$OCR = 1,72$

$$p_0 = \frac{G_s \cdot p_w - p_e}{p_e - p_w}$$

$$p_0 = \frac{2,8 \cdot 9,807 - 19}{19 - 9,807} = \frac{8,4536}{9,193} = 0,92022$$

$$z_1 = 3 \text{ m} \Rightarrow p_{c,1} = OCR \cdot p_{0,1} = 1,72 \cdot 81 = 139,32 \text{ kN/m}^2$$

$$p_{0,1} < p_{c,1} < \sigma'_{z,1}$$

$$81 < 139,32 < 210,34 \quad (\checkmark)$$

$$\epsilon_{z,1} = \frac{C_m}{1+e_0} \log(OCR) + \frac{C_c}{1+e_0} \log\left(\frac{\sigma'_{z,1}}{p_{c,1}}\right)$$

$$\epsilon_{z,1} = \frac{0,06}{1+0,92} \log(1,72) + \frac{0,3}{1+0,92} \log\left(\frac{210,34}{139,32}\right) \Rightarrow \epsilon_{z,1} = 35,315 \cdot 10^{-3}$$

$$z_2 = 5 \text{ m} \quad p_{c,2} = OCR \cdot p_{0,2} = 1,72 \cdot 99,386 = 170,944 \text{ kN/m}^2$$

$$p_{0,2} < p_{c,2} < \sigma'_{z,2}$$

$$99,386 < 170,944 < 170,746 \quad (\times)$$

$$\epsilon_{z,2} = \frac{C_m}{1+e_0} \log \frac{\sigma'_{z,2}}{p_{0,2}}$$

$$\epsilon_{z,2} = \frac{0,06}{1,92} \log \frac{170,746}{99,386} \Rightarrow \epsilon_{z,2} = 1,345 \cdot 10^{-3}$$

$$z_3 = 7m$$

$$P'_{q,3} = OCR \cdot P'_{q,3} = 1,72 \cdot 117,772 = \underline{202,568 \text{ KN/m}^2}$$

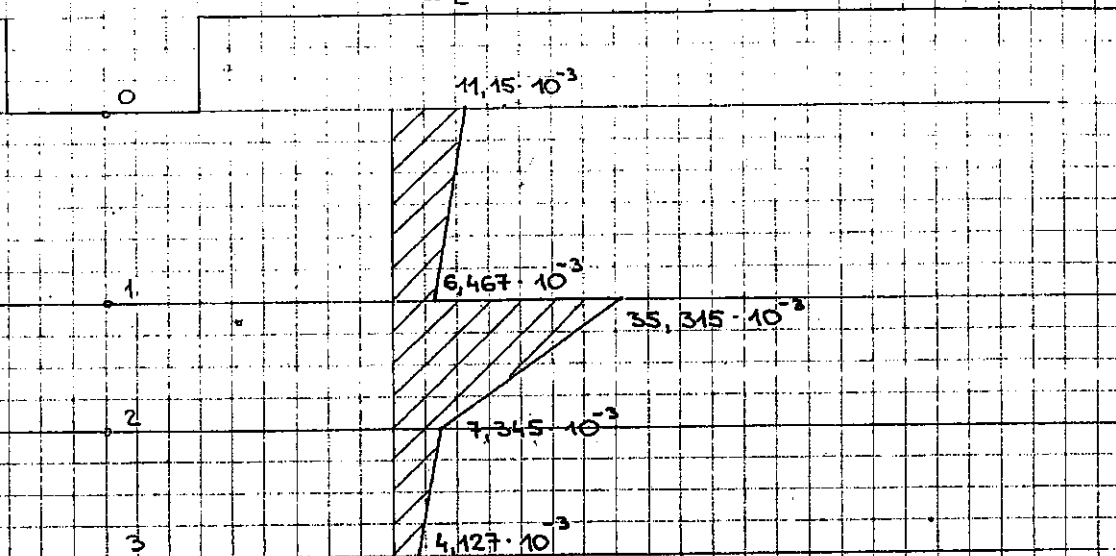
$$P'_{q,3} < P'_{q,3} < G'_{z,3}$$

$$117,722 < 202,568 < 160,092 \quad (\text{X})$$

$$E_{z,3} = \frac{C_m}{1+b_0} \cdot \log \frac{G'_{z,3}}{P'_{q,3}}$$

$$E_{z,3} = \frac{0,06}{1,92} \cdot \log \frac{160,092}{117,722} \Rightarrow E_{z,3} = \underline{4,127 \cdot 10^{-3}}$$

$E_z$

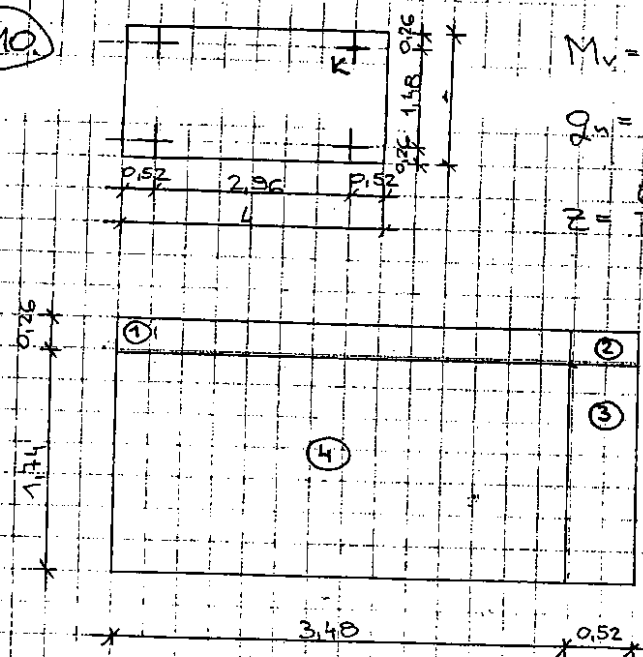


$$S = \int_0^3 E_z \, dz = \left[ \frac{11,15 + 6,467}{2} \cdot 1 + \frac{35,315 + 7,345}{2} \cdot 1 + \frac{7,345 + 4,127}{2} \cdot 1 \right] \cdot 10^{-3}$$

$$= (26,4255 + 42,66 + 11,472) \cdot 10^{-3}$$

$$= \underline{80,5575 \cdot 10^{-3}}$$

6.10



$$M_v = 5000 \text{ KN/m}^2$$

$$q_n = 200 \text{ KN/m}^2$$

$$z = \frac{L}{B} = 2$$

$$\frac{L}{B} = 2$$

$$I_1 = I\left(\frac{a}{b}, \frac{z}{b}\right) = I\left(\frac{3.48}{0.26}, \frac{2}{0.26}\right) = (13.38, 7.69) = 0.04$$

$$I_2 = I\left(\frac{a}{b}, \frac{z}{b}\right) = I\left(\frac{0.52}{0.26}, \frac{2}{0.26}\right) = (2, 7.69) = 0.015$$

$$I_3 = I\left(\frac{a}{b}, \frac{z}{b}\right) = I\left(\frac{1.74}{0.52}, \frac{2}{0.52}\right) = (3.35, 3.85) = 0.07$$

$$I_4 = I\left(\frac{a}{b}, \frac{z}{b}\right) = I\left(\frac{3.48}{1.74}, \frac{2}{1.74}\right) = (2, 1.149) = 0.187$$

СУПЕРПОЗИЦИЈА ВЕРТИКАЛНИХ НАПОНА

$$\Delta G_z' = q_n \cdot \sum I = 200 \cdot (0.04 + 0.015 + 0.07 + 0.187) = 62.4 \text{ KN/m}^2$$

СЛЕГАЊЕ

$$S \approx \epsilon_z \cdot \Delta z = \left(\frac{\Delta G_z'}{M_v}\right) \cdot \Delta z = \left(\frac{62.4}{5000}\right) \cdot 400 = 4.992 \approx 5 \text{ cm}$$

8) МЕТОДА КАКУ - А

$$\frac{L}{B} = \frac{4}{2} = 2$$

$$\frac{z}{B} = \frac{2}{2} = 1$$

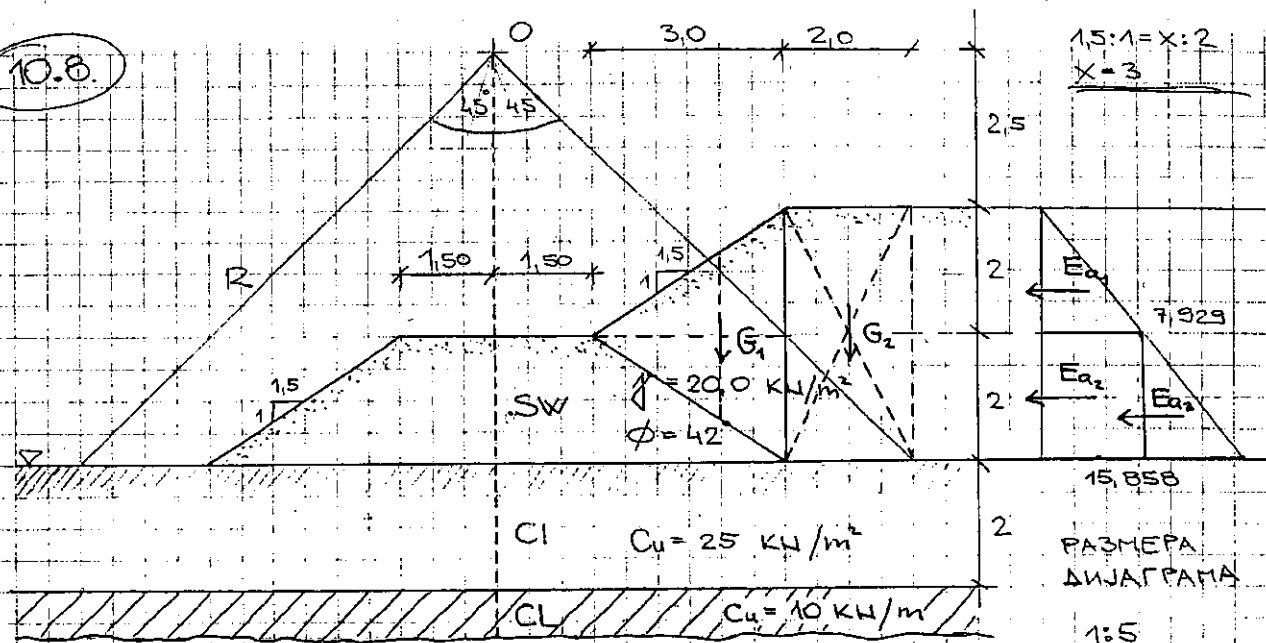
$$I = 0.30125$$

$$\Delta G_z' = q_n \cdot I = 200 \cdot 0.30125 = 60.25 \text{ KN/m}^2$$

$$S \approx \frac{60.25}{5000} \cdot 400 = 4.82 \text{ cm}$$

## СТАБИЛЬНОСТЬ КОСИНА

10.8.



$$R = h\sqrt{2} = (2,5 + 2 + 2)\sqrt{2} = 6,5\sqrt{2} \Rightarrow \underline{R = 9,1924 \text{ m}}$$

ДУЖИНА КРУЖНОГ ЛУКА

$$L = \frac{R \sin \alpha}{\sin \beta} = \frac{9,124 \cdot \sin 30^\circ}{\sin 38^\circ} = \underline{\underline{14,3319 \text{ m}}}$$

$$G_1 = \frac{4 \cdot 3}{2} \cdot \gamma = 6 \cdot 20 = \underline{\underline{120 \text{ kN/m}}}$$

$$G_2 = 4.2 \cdot f = 8 \cdot 20 = \underline{\underline{160 \text{ KN/m}}}$$

$$G_1 = h \cdot \gamma = 2 \cdot 20 = \underline{40 \text{ kN/m}^2}$$

$$G_2 = G_1 + h_2 \cdot \gamma = 40 + 2 \cdot 20 = 80 \text{ kN/m}^2$$

$$K_0 = \tan^2 \left( 45 - \frac{\phi}{2} \right) = \tan^2 \left( 45 - \frac{42}{2} \right) = \tan^2 24^\circ = 0,198228$$

$$P_{a,1} - K_a \cdot C_1 = 0.198228 \cdot 40 = 7.929 \text{ kN/m}^2$$

$$P_{a_2} = K_a \cdot G_2 = 0,198228 \cdot 80 = 15,858 \text{ kN/m}^2$$

РАЗМЕРА  
ДИЈАГРАМА  
1:5

Hand 2442 125105

$$E_{a1} = A \cdot P_{a1} = \frac{1}{2} \cdot 2 \cdot 7,929 = \underline{7,929 \text{ KN/m}^2}$$

$$E_{a2} = A \cdot P_{a2} = 2 \cdot 7,929 = \underline{15,858 \text{ KN/m}^2}$$

$$E_{a3} = A \cdot P_{a3} = \frac{1}{2} \cdot 2 \cdot 7,929 = \underline{7,929 \text{ KN/m}^2}$$

$$F_s = \frac{R \cdot C_u \cdot L}{\sum M}$$

$$\downarrow (15,858 - 7,929)$$

$$\sum M = G_1 \cdot \left( \frac{2}{3} \cdot 3 + 1,5 \right) + G_2 \cdot (1 + 3 + 1,5) + E_{a1} \cdot \left( \frac{2}{3} \cdot 2 + 2,5 \right) + E_{a2} \cdot (1 + 1,5) + E_{a3} \cdot \left( \frac{2}{3} \cdot 2 + 1,5 \right)$$

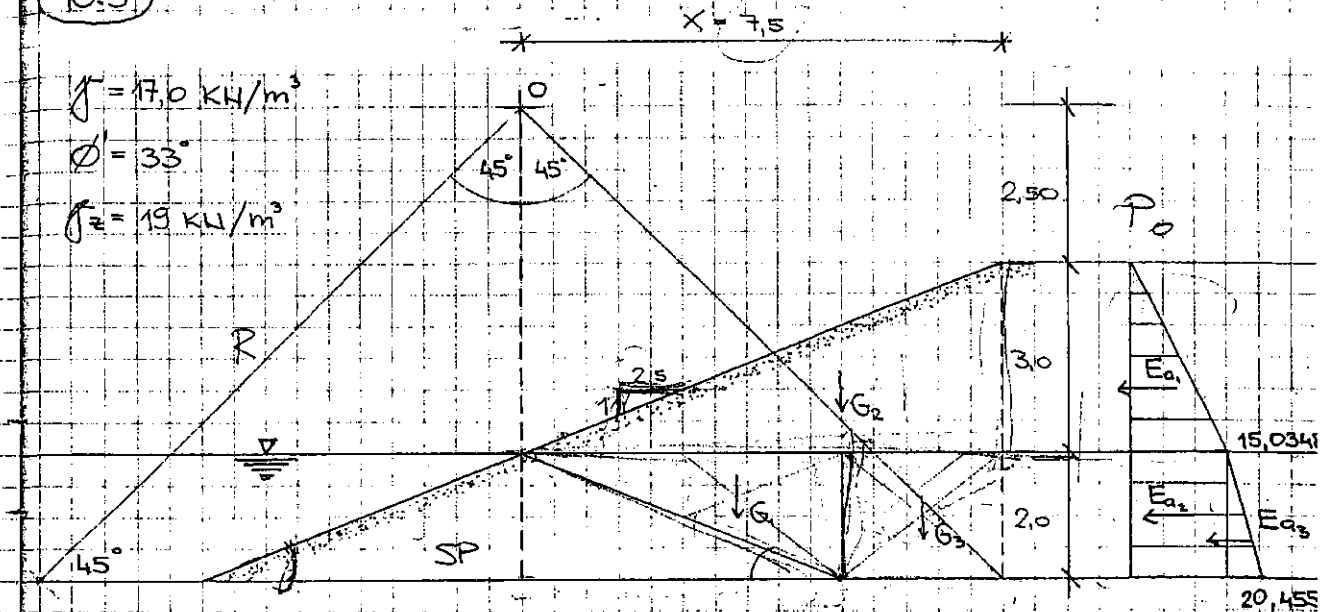
$$= 120 \cdot 3,5 + 160 \cdot 5,5 + 7,929 \cdot 3,8333 + 15,858 \cdot 2,5 + 7,929 \cdot 2,8333$$

$$= 420 + 880 + 30,39 + 39,645 + 22,47 =$$

$$\underline{\underline{\sum M = 1463,859}}$$

$$F_s = \frac{9,1924 + 25 \cdot 14,3318}{1463,859} = \frac{3293,61}{1463,859} = \underline{\underline{2,2499}}$$

$$f_z = 19 \text{ kW/m}^3$$

 $\text{CH}$ 

$1:2,5 = 3:X$

$$1:2,5 = 2:4$$

$$f_0 = f_3 - f_w = 19 - 9,807 = \underline{9,193}$$

$$\bar{x} = 7,5$$

50

$$R = 7,5\sqrt{2} = \underline{\underline{10,607}}$$

$$L = \frac{R \sin \alpha}{180^\circ} = \frac{10,607 \cdot \sin 90^\circ}{180^\circ} = \underline{\underline{16,6608}}$$

$$G_1 = \frac{5.2}{2} \cdot f_2' = 5.9193 = \underline{\underline{45.965 \text{ kN/m}}}$$

$$G_2 = \frac{7,5 \cdot 3}{2} \cdot 17 = 191,25 \text{ kW/m}$$

$$G_3 = 2,5 \cdot 2 \cdot \gamma_2 = 5 \cdot 9,193 = \underline{45,965 \text{ kN/m}}$$

$$G_1 = h_1 \cdot \gamma = 3 \cdot 17 = \underline{\underline{51 \text{ kN/m}^2}}$$

$$G_2 = G_1 + h_2 \cdot \gamma_z = 51 + 2 \cdot 9,193 = \underline{\underline{69,386 \text{ kN/m}^2}}$$

$$K_a = \tan^2 \left( 45 - \frac{\phi}{2} \right) = \tan^2 \left( 45 - \frac{33}{2} \right) = \tan^2 28.5 = \underline{0.294801}$$

$$P_{a,1} = K_a \cdot G_1 = 0,294801 \cdot 51 = \underline{15,0348 \text{ KN/m}^2}$$

$$P_{a,2} = K_a \cdot G_2 = 0,294801 \cdot 69,386 = \underline{20,4551 \text{ KN/m}^2}$$

$$E_{a,1} = \frac{1}{2} \cdot 3 \cdot 15,0348 = \underline{22,5522}$$

$$E_{a,2} = 2 \cdot 15,0348 = \underline{30,0696}$$

$$E_{a,3} = \frac{1}{2} \cdot 2 \cdot (20,4551 - 15,0348) = \underline{5,4203}$$

$$\begin{aligned} \sum M &= G_1 \left( \frac{2}{3} \cdot 5 \right) + G_2 \cdot (5) + G_3 \left( \frac{1}{2} \cdot 2,5 + 5 \right) + E_{a,1} \left( \frac{2}{3} \cdot 3 + 2,5 \right) + \\ &+ E_{a,2} \left( \frac{1}{2} \cdot 2 + 3 + 2,5 \right) + E_{a,3} \left( \frac{2}{3} \cdot 2 + 3 + 2,5 \right) \\ &= 45,965 \cdot 3,333 + 191,25 \cdot 5 + 45,965 \cdot 6,25 + 22,5522 \cdot 4,5 + \\ &+ 30,0696 \cdot 5,5 + 5,4203 \cdot 6,8333 \\ &= 153,2 + 956,25 + 287,28 + 101,48 + 165,38 + 37,04 = \end{aligned}$$

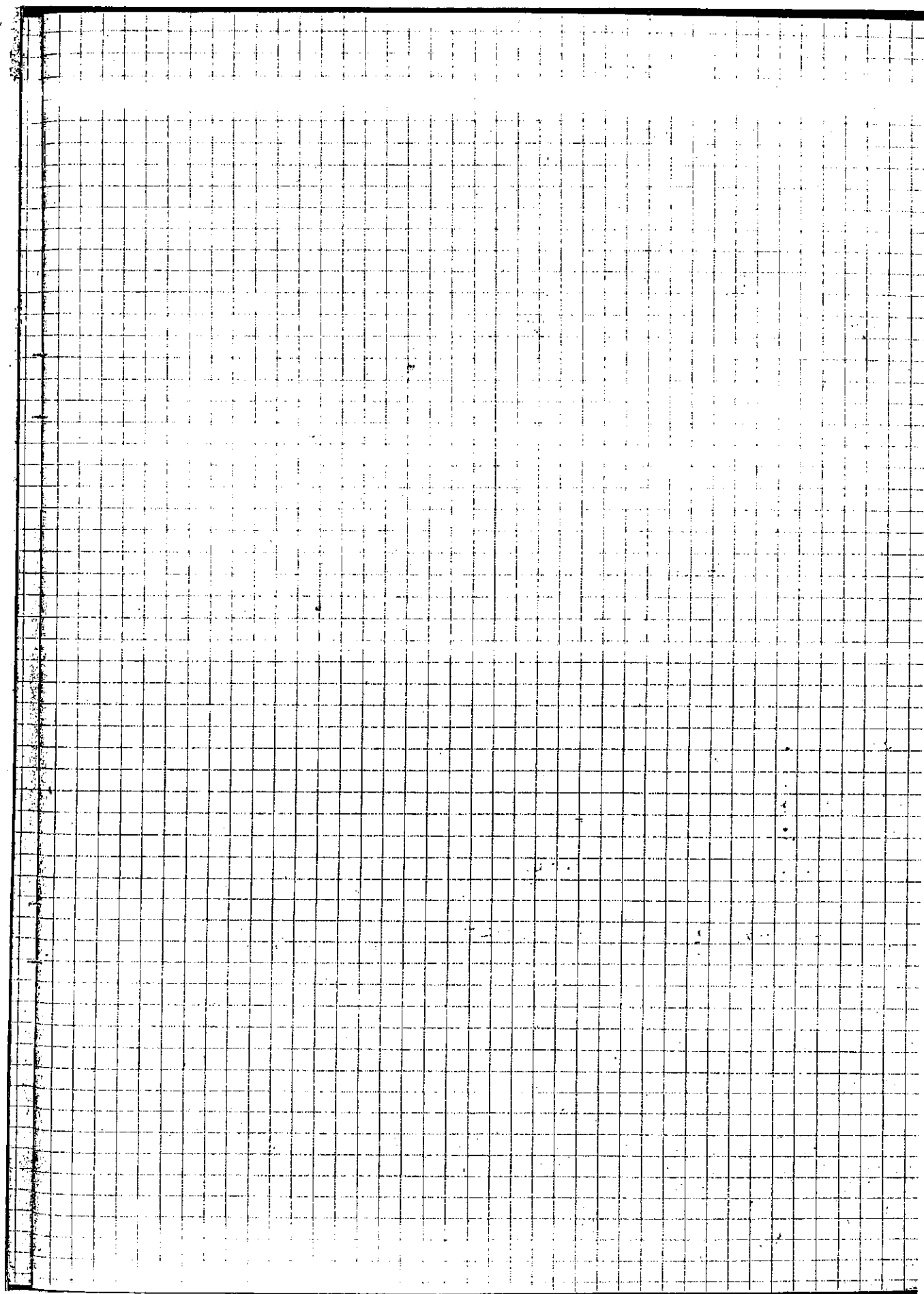
$$\underline{\sum M = 1700,63}$$

$$F_s = \frac{R \cdot c_u \cdot L}{\sum M} \Rightarrow c_u = \frac{F_s \cdot M}{R \cdot L}$$

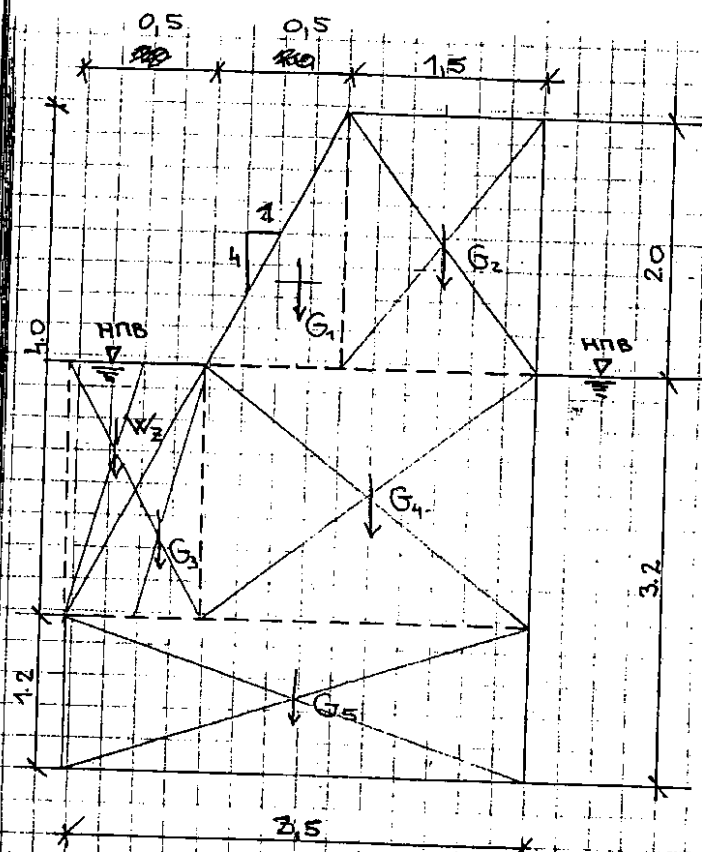
$$c_u = \frac{1,5 \cdot 1700,63}{10,607 \cdot 16,6608} = \frac{2550,945}{176,72} = \underline{14,43 \text{ KN/m}^2}$$

$$\underline{c_u > 14,43 \text{ KN/m}^2}$$





18. ЯНУАР 2008. А-группа



$$\gamma_B = 24 \text{ kN/m}^3$$

$$\gamma'_B = 24 - 9,807 = 14,193 \text{ kN/m}^3$$

$$\gamma = 18 \text{ kN/m}^3$$

$$\gamma'_z = 20 \text{ kN/m}^3$$

$$\gamma'_z = 20 - 9,807 = 10,193 \text{ kN/m}^3$$

$$\phi' = 35^\circ$$

$$1:4 = x:4$$

$$\underline{x = 1}$$

$$K_a = \tan^2 \left( 45 - \frac{\phi'}{2} \right) = \tan^2 27,5 \rightarrow \underline{K_a = 0,27099}$$

$$G_{z1} = \gamma \cdot h_1 = 18 \cdot 2 = \underline{36 \text{ kN/m}^2}$$

$$G_{z2} = G_{z1} + \gamma'_z \cdot h_2 = 36 + 10,193 \cdot 3,2 = \underline{68,618 \text{ kN/m}^2}$$

$$P_{a1} = K_a \cdot G_{z1} - 2C\sqrt{K_a} = 0,27099 \cdot 36 - 9,756 \text{ kN/m}^2$$

$$P_{a2} = K_a \cdot G_{z2} - 2C\sqrt{K_a} = 0,27099 \cdot 68,618 = \underline{18,595 \text{ kN/m}^2}$$

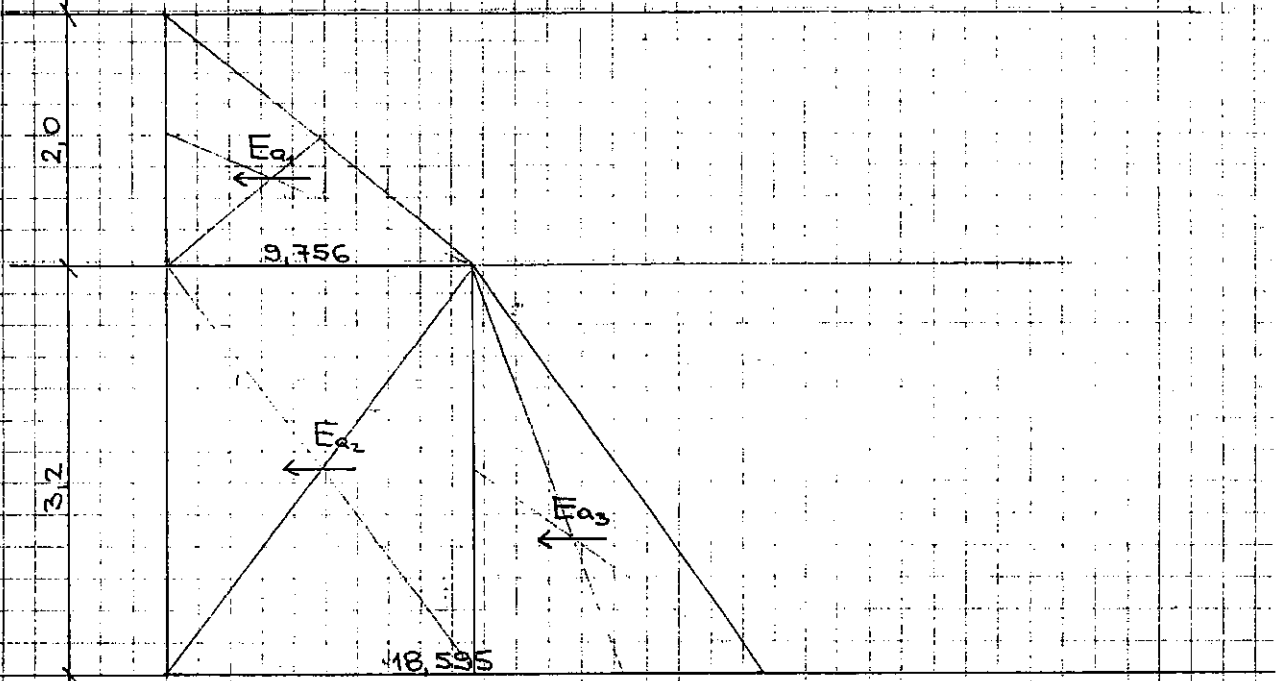
$$E_{a1} = \frac{1}{2} \cdot 2 \cdot 9,756 = \underline{9,756 \text{ kN/m}}$$

$$E_{a2} = 3,2 \cdot 9,756 = \underline{31,22 \text{ kN/m}}$$

$$E_{a3} = \frac{1}{2} \cdot 3,2 \cdot (18,595 - 9,756) = \underline{14,142 \text{ kN/m}}$$

ПАЗМЕРА

1:2



$$G_1 = \frac{1}{2} \cdot 2 \cdot \frac{1}{2} \cdot \gamma_B = \frac{1}{2} \cdot 24 = 12 \text{ KN/m}$$

$$G_2 = 2 \cdot 1.5 \cdot \gamma_B = 3 \cdot 24 = 72 \text{ KN/m}$$

$$G_3 = \frac{1}{2} \cdot 0.5 \cdot 2 \cdot \gamma_B = 0.5 \cdot 14.193 = 7.0965 \text{ KN/m}$$

$$G_4 = 2 \cdot 2.0 \cdot \gamma_B = 4.0 \cdot 14.193 = 56.77 \text{ KN/m}$$

$$G_5 = 2.5 \cdot 1.2 \cdot \gamma_B = 3.0 \cdot 14.193 = 42.58 \text{ KN/m}$$

$$W_z = \frac{1}{2} \cdot 0.5 \cdot 2 \cdot \gamma_w = 0.5 \cdot 9.807 = 4.9035 \text{ KN/m} \text{ } \text{шта је ово ???}$$

$$N = G_1 + G_2 + G_3 + G_4 + G_5 + W_z$$

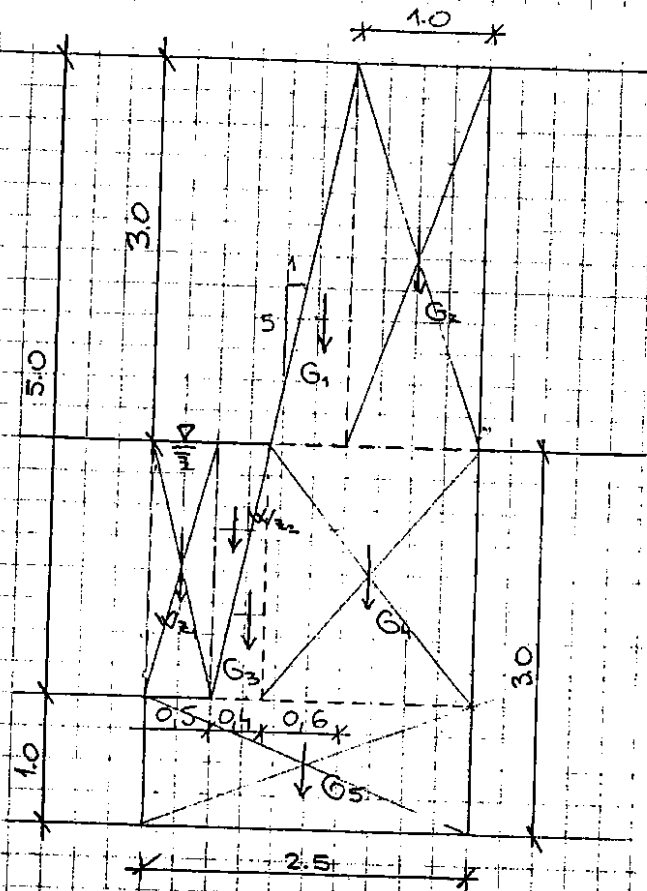
$$= 12 + 72 + 7.0965 + 56.77 + 42.58 + 4.9035 \Rightarrow N = \underline{195.35 \text{ KN/m}}$$

$$T = E_{01} + E_{02} + E_{03}$$

$$= 3.756 + 31.22 + 14.142 \Rightarrow T = \underline{55.118 \text{ KN/m}}$$

$$F_K = \frac{N \cdot \tan \phi}{T} = \frac{195.35 \cdot 0.7}{55.118} \Rightarrow F_K = \underline{2.48}$$

15. JYH, 2007.



$$f_B = 24 \text{ KN/m}^3$$

$$\sigma'_B = 14.193 \text{ kN/m}^3$$

$$\gamma = 18 \text{ kN/m}^3$$

$$\gamma_z = 19,5 \text{ KN/m}^3$$

$$f_2 = 9.693 \text{ kN/m}^2$$

$$\phi = 34^\circ$$

$$1:5 = x:3$$

$$X = 0,6$$

$$K_a = \operatorname{tg}^2\left(45 - \frac{\phi}{2}\right) = \operatorname{tg}^2 28^\circ = 0,282715$$

$$G_{z1} = \gamma \cdot h_1 = 18 \cdot 3 = \underline{\underline{54 \text{ kN/m}^2}}$$

$$G_{z_2} = G_{z_1} + \rho \cdot h_2 = 54 + 3,693 \cdot 3 = 54 + 29,079 = \underline{\underline{83,079 \text{ KN/m}^2}}$$

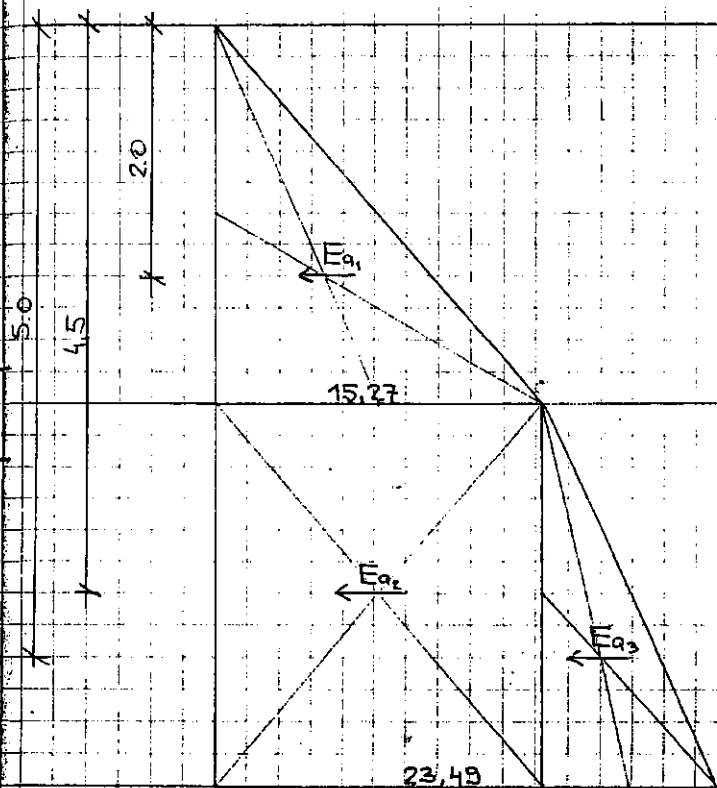
$$P_{a1} = K_a \cdot G_{a1} \cdot \cancel{20} \sqrt{K_a} = 0,282715 \cdot 54 = \underline{15,27 \text{ kN/m}^2}$$

$$P_{a2} = K_a \cdot G_{z2} - 2c \sqrt{K_a} = 0,282715 \cdot 83,079 = \underline{23,49 \text{ kN/m}}$$

$$E_a = \frac{1}{2} \cdot 3 \cdot 15.27 = 22.905 \text{ kN/m}$$

$$E_{a_2} = 3 \cdot 23,49 = 70,47 \text{ KN/m}$$

$$E_{a3} = \frac{1}{2} \cdot 3 \cdot (23,49 - 15,27) = 1,5 \cdot 8,22 = \underline{12,33 \text{ kN/m}}$$



$$G_1 = \frac{1}{2} \cdot 0,6 \cdot 3 \cdot \gamma_B = 0,9 \cdot 24 = 21,6 \text{ KN/m}$$

$$G_2 = 1 \cdot 3 \cdot \gamma_B = 3 \cdot 24 = 72 \text{ KN/m}$$

$$G_3 = \frac{1}{2} \cdot 0,4 \cdot 2 \cdot \gamma_B' = 0,4 \cdot 14,193 = 5,68 \text{ KN/m}$$

$$G_4 = 1,6 \cdot 2 \cdot \gamma_B' = 3,2 \cdot 14,193 = 45,42 \text{ KN/m}$$

$$G_5 = 2,5 \cdot 1 \cdot \gamma_B' = 2,5 \cdot 14,193 = 35,48 \text{ KN/m}$$

$$W_{E1} = 0,5 \cdot 2 \cdot \gamma_w = 9,807 \text{ KN/m}$$

$$W_{E2} = \frac{1}{2} \cdot 0,4 \cdot 2 \cdot \gamma_w = 0,4 \cdot 9,807 = 3,92 \text{ KN/m}$$

$$N = 21,6 + 72 + 5,68 + 45,42 + 35,48 + 9,807 + 3,92$$

$$N = 193,907 \text{ KN/m}$$

$$T = 22,905 + 70,47 + 12,33 \Rightarrow T = 105,705 \text{ KN/m}$$

$$F_k = \frac{N \cdot \tan \phi'}{T} = \frac{193,907 \cdot \tan 34^\circ}{105,705} = \frac{130,79}{105,705} = 1,24$$