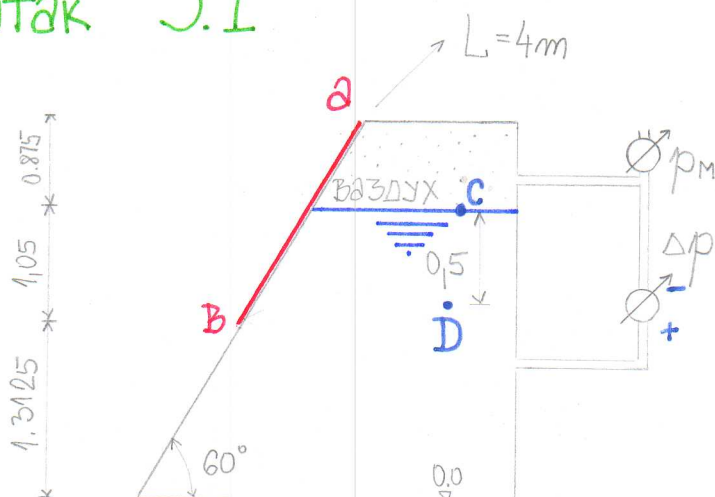


Задатак НЗ - петак

Задатак 3.1



$$a = \frac{5+30}{40}$$

$$a = 0,875$$

$$\Delta p = (9,8 - 30/12) \text{ kPa} = 7,3 \text{ kPa} = 7300 \text{ Pa}$$

$$p_m = 15 \cdot 0,875 \text{ kPa} = 13,125 \text{ kPa} = 13125 \text{ Pa}$$

(1) Одређивање густине флуида

$$\Delta p = p^+ - p^-$$

Притисак у тачки С износи 13.125 kPa (ваздух занемарљиве густине)

Разлика између притисака у тачки D и C износи 7.3 kPa.

$$p^+ = p_D = \rho g (\pi - z_D) \quad z_D = (1,3125 + 1,05 - 0,5) \text{ m} = 1,8625 \text{ m}$$

$$p^- = p_C = \rho g (\pi - z_C) \quad z_C = (1,3125 + 1,05) \text{ m} = 2,3625 \text{ m}$$

$$\rho g (\pi - z_D) - \rho g (\pi - z_C) = \Delta p$$

$$\rho g (\pi - z_D - \pi + z_C) = \Delta p$$

$$\Rightarrow \rho = \frac{\Delta p}{g(z_C - z_D)} = \frac{7300 \text{ Pa}}{9,81 \text{ m/s}^2 (2,3625 - 1,8625) \text{ m}}$$

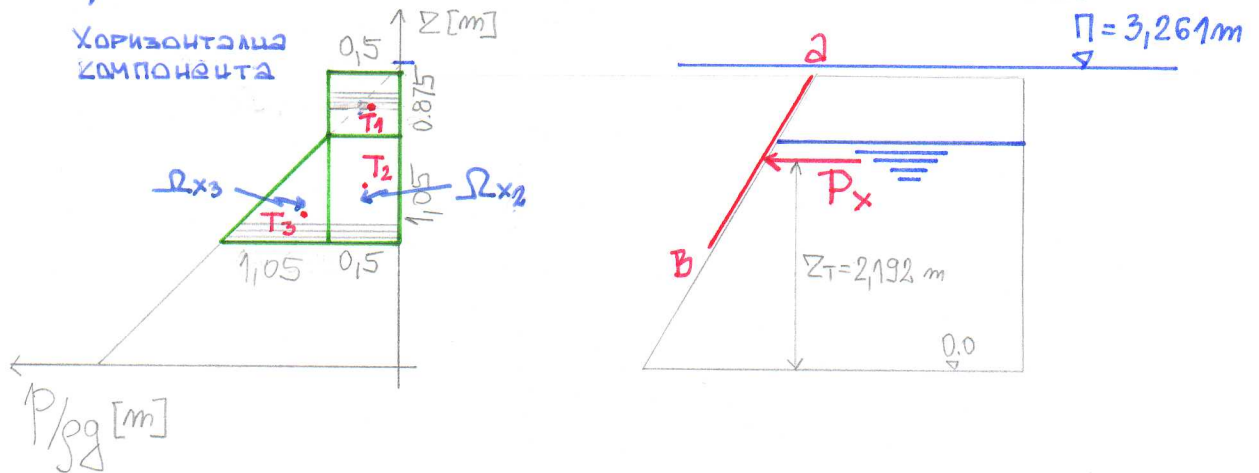
$$\rho = 1488,277 \text{ kg/m}^3$$

ОДРЕЂИВАЊЕ П-КОТЕ ФЛУИДА

$$p_c = p_m \Rightarrow \Pi = \frac{p_c}{\rho g} + z_c = \frac{13125 \text{ Pa}}{1488,277 \text{ kg/m}^3 \cdot 9,81 \text{ m/s}^2} + 2,3625 \text{ m}$$

$$\Pi = 3,261 \text{ m}$$

12) ПРОРАЧУН ХИДРОСТАТИЧКЕ СИЛЕ НА ПОКЛОПАЦ



$$A_v = 0,875 \text{ m} \cdot 4 \text{ m} = 3,5 \text{ m}^2$$

$$\Omega x_2 = 0,5 \text{ m} \cdot 1,05 \text{ m} = 0,525 \text{ m}^2$$

$$\Omega x_3 = \frac{1,05^2}{2} = 0,551 \text{ m}^2$$

$$P_{x1} = p_m \cdot A_v = 13,125 \text{ kPa} \cdot 3,5 \text{ m}^2 = 45,9375 \text{ kN}$$

$$P_{x2} = \rho g \Omega x_2 \cdot L = 1488,277 \text{ kg/m}^3 \cdot 9,81 \text{ m/s}^2 \cdot 0,525 \text{ m}^2 \cdot 4 \text{ m}$$

$$P_{x2} = 30,66 \text{ kN}$$

$$P_{x3} = \rho g \Omega x_3 \cdot L = 1488,277 \text{ kg/m}^3 \cdot 9,81 \text{ m/s}^2 \cdot 0,551 \text{ m}^2 \cdot 4 \text{ m}$$

$$P_{x3} = 32,193 \text{ kN}$$

$$\Sigma P_x = (45,9375 + 30,66 + 32,193) \text{ kN}$$

$$\Sigma P_x = 108,79 \text{ kN}$$

ОДРЕЂИВАЊЕ ТЕЖИШТА

$$\Sigma T_1 = \left(1,3125 + 1,05 + \frac{0,875}{2} \right) m = 2,8 m$$

$$\Sigma T_2 = \left(1,3125 + \frac{1,05}{2} \right) m = 1,8375 m$$

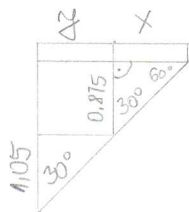
$$\Sigma T_3 = \left(1,3125 + \frac{1}{3} \cdot 1,05 \right) m = 1,6625 m$$

$$\Sigma T = \frac{\Sigma T_1 \cdot P_{x1} + \Sigma T_2 \cdot P_{x2} + \Sigma T_3 \cdot P_{x3}}{\Sigma P_x} = \frac{2,8 \cdot 45,94 + 1,84 \cdot 30,66 + 1,66 \cdot 32,19}{108,79 \text{ kN}}$$

$$\Sigma T = \frac{238,48 \text{ kN} \cdot m}{108,79 \text{ kN}}$$

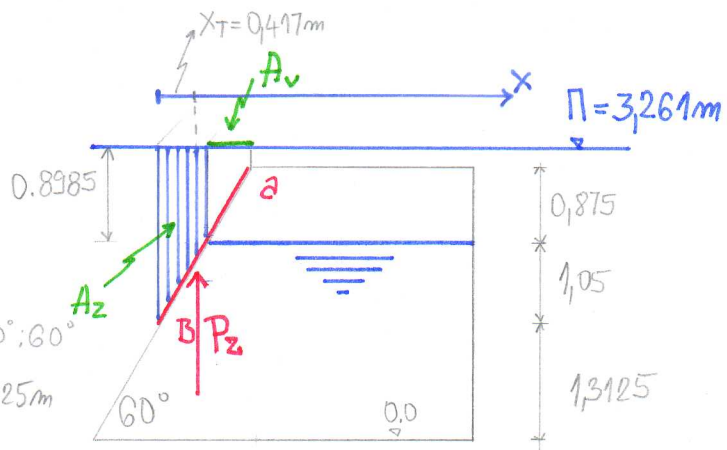
$$\Sigma T = 2,192 m$$

ВЕРТИКАЛНА КОМПОНЕНТА



$$x: 0,875 = 30^\circ : 60^\circ \quad y: 1,05 = 30^\circ : 60^\circ$$

$$x = \frac{0,875 \cdot 30}{60} = 0,4375 m \quad y = 0,525 m$$



СИЛА ОД ВАЗДУХА

$$A_v = ? \quad A_v = x \cdot L \quad A_v = 0,4375 m \cdot 4 m = 1,75 m^2$$

$$P_{z,v} = p_{vaz} \cdot A_v = 13,125 \text{ kPa} \cdot 1,75 m^2 = 22,969 \text{ kN}$$

ТЕЖИШТЕ

$$x_{T,v} = y + \frac{1}{2} x = 0,525 m + \frac{0,4375}{2} m \quad x_{T,v} = 0,744 m$$

СИЛА ОД ТЕЧНОСТИ

$$V=? \quad V=A_v \cdot L \quad A_v=?$$

$$A_v = 0,8985\text{m} \cdot 0,525\text{m} + \left(\frac{1}{2} \cdot 1,05 \cdot 0,525\right)\text{m}^2 = 0,472\text{m}^2 + 0,276\text{m}^2$$

$$A_v = 0,748\text{m}^2$$

$$V = (0,748 \cdot 4)\text{m}^3 = 3\text{m}^3$$

$$P_{z,T} = \rho g V = 1,488 \text{ kg/dm}^3 \cdot 9,81 \text{ m/s}^2 \cdot 3\text{m}^3$$

$$\underline{P_{z,T} = 43,8 \text{ kN}}$$

ТЕЖИШТЕ

$$x_{T,T} = \frac{\left(\frac{1}{2} \cdot 0,525 \cdot 0,525 \cdot 0,8985 + \frac{1}{3} \cdot \frac{1}{2} \cdot 0,525 \cdot 0,525 \cdot 1,05\right)\text{m}^3}{0,748 \text{ m}^2}$$

$$\underline{x_{T,T} = 0,23 \text{ m}}$$

ТЕЖИШТЕ ВЕРТИКАЛНЕ КОМПОНЕНТЕ ХИДРОСТАТИЧКЕ СИЛЕ

$$x_T = \frac{0,744 \text{ m} \cdot 22,969 \text{ kN} + 0,23 \text{ m} \cdot 43,8 \text{ kN}}{22,969 \text{ kN} + 43,8 \text{ kN}}$$

$$\boxed{x_T = 0,417 \text{ m}}$$

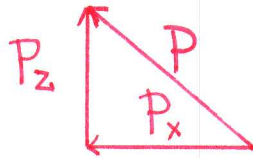
$$\sum P_z = 22,969 \text{ kN} + 43,8 \text{ kN}$$

$$\boxed{\sum P_z = 66,769 \text{ kN}}$$

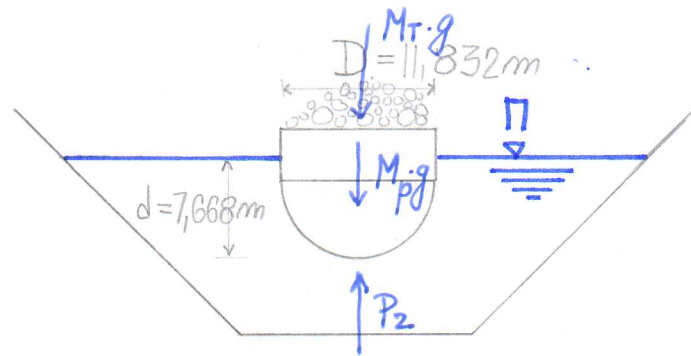
Резултативна хидростатичка сила на поклопац А-В

$$P = \sqrt{P_x^2 + P_z^2} = \sqrt{108,79^2 + 66,769^2}$$

$$P = 127,645 \text{ kN}$$



Задатак 3.2



$$L = 2(5+30)\text{m} = 70\text{m}$$

$$D = 2\sqrt{5+30}\text{m} = 11,832\text{m}$$

$$d = 1,4\sqrt{30}\text{m} = 7,668\text{m}$$

$$M_p' = 0,5D \frac{\text{toma}}{\text{m}'} = 5,916 \frac{\text{toma}}{\text{m}'}$$

$$\rho = 1 \frac{\text{kg}}{\text{dm}^3}$$

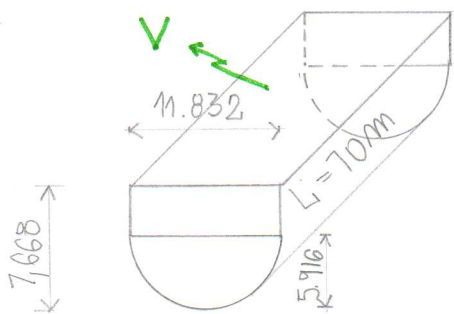
$$M_T = ?$$

$$M_p = M_p' \cdot L = 5,916 \frac{\text{toma}}{\text{m}} \cdot 70\text{m} = 414,126 \text{toma}$$

СИЛЕ У ВЕРТИКАЛНОМ ПРАВЦУ

$$M_T \cdot g + M_p \cdot g = P_Z$$

СИЛА ПОТИСКА ОД ВОДЕ P_Z



$$V = L \left(\frac{\frac{D^2 \pi}{4}}{2} + D \cdot \left(d - \frac{D}{2} \right) \right)$$

$$V = 70\text{m} \left(\frac{11,832^2 \pi}{8} + 11,832 \cdot 1,752 \right) \text{m}^3$$

$$V = 5\,299,358 \text{m}^3$$

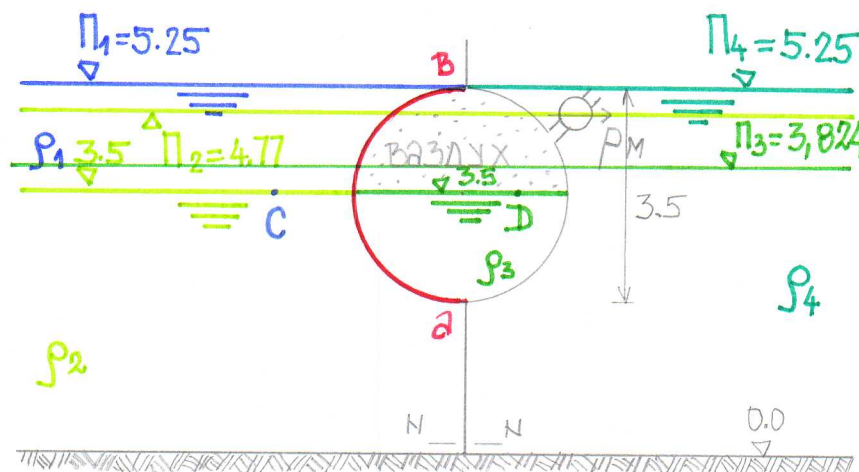
$$P_Z = \rho g V = 1000 \frac{\text{kg}}{\text{m}^3} \cdot 9,81 \frac{\text{m}}{\text{s}^2} \cdot 5\,299,358 \text{m}^3$$

$$P_Z = 51\,986,698 \text{kN}$$

$$M_T + M_p = \frac{P_Z}{g} \Rightarrow M_T = \frac{P_Z}{g} - M_p = (5\,299,358 - 414,186) \text{t}$$

$$M_T = 4\,885,232 \text{toma}$$

Задатак 3.3



$$a = \frac{5+30}{40}$$

$$a = 0.875$$

$$\rho_1 = \left(1.1 - \frac{0.875}{5}\right) \text{ kg/dm}^3 = 0.925 \text{ kg/dm}^3$$

$$\rho_2 = \left(1.1 + \frac{0.875}{5}\right) \text{ kg/dm}^3 = 1.275 \text{ kg/dm}^3$$

$$\rho_3 = 1.1 \text{ kg/dm}^3$$

$$\rho_4 = \left(1.1 + \frac{0.875}{8}\right) \text{ kg/dm}^3 = 1.209 \text{ kg/dm}^3$$

$$p_M = 4 \cdot 0.875 \text{ kPa} = 3.5 \text{ kPa}$$

(1) ПИЈЕЗОМЕТАРСКЕ КОТЕ ФЛУИДА 1-4

$$\Pi_1 = 5.25 \text{ m} \quad \Pi_4 = 5.25 \text{ m}$$

$$\Pi_2 = ? \quad \Pi_3 = ?$$

$$(*) \quad p_c = \rho_1 g (\Pi_1 - Z_c) \quad Z_c = 3.5 \text{ m}$$

$$(**) \quad p_c = \rho_2 g (\Pi_2 - Z_c)$$

$$(*) \quad p_c = 0.925 \text{ kg/dm}^3 \cdot 9.81 \text{ m/s}^2 (5.25 \text{ m} - 3.5 \text{ m})$$

$$p_c = 15.88 \text{ kPa}$$

$$(**) \Rightarrow \Pi_2 = \frac{p_c}{\rho_2 g} + Z_c = \frac{15.88 \text{ kPa}}{1.275 \text{ kg/dm}^3 \cdot 9.81 \text{ m/s}^2} + 3.5 \text{ m}$$

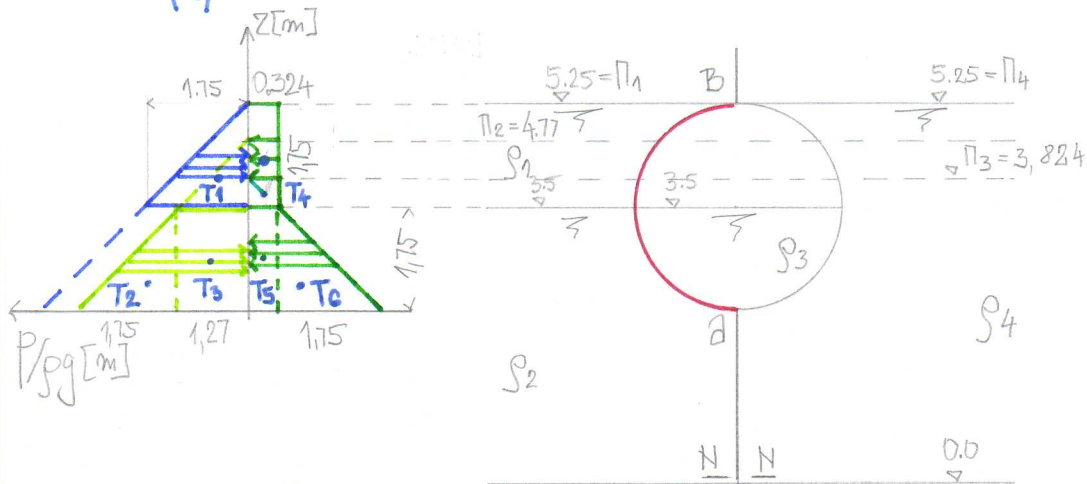
$$\Pi_2 = 4.77 \text{ m}$$

$$p_D = p_M = 3,5 \text{ kPa} \quad Z_D = 3,5 \text{ m}$$

$$p_D = \rho_3 g (\Pi_3 - Z_D) \Rightarrow \Pi_3 = \frac{p_D}{\rho_3 g} + Z_D = \frac{3,5 \text{ kPa}}{1,1 \text{ kg/dm}^3 \cdot 9,81 \text{ m/s}^2} + 3,5 \text{ m}$$

$$\Pi_3 = 3,824 \text{ m}$$

(2) УКУПНА ХИДРОСТАТИЧКА СИЛА НА ЗИД А-В



$$\Omega_{X1} = \frac{1,75^2}{2} = 1,531 \text{ m}^2$$

$$\Omega_{X2} = \frac{1,75^2}{2} = 1,531 \text{ m}^2$$

$$\Omega_{X3} = 1,27 \cdot 1,75 = 2,2225 \text{ m}^2$$

$$Z_{T1} = 1,75 + \frac{1}{3} \cdot 1,75 = 2,333 \text{ m}$$

$$Z_{T2} = \frac{1,75}{3} = 0,583 \text{ m}$$

$$Z_{T3} = \frac{1,75}{2} = 0,875 \text{ m}$$

$$\Omega_{X5} = 0,324 \cdot 1,75 = 0,567 \text{ m}^2$$

$$\Omega_{X6} = \frac{1,75^2}{2} = 1,531 \text{ m}^2$$

$$A_v = 1,75 \cdot 1 \text{ m} = 1,75 \text{ m}^2$$

$$Z_{T4} = \frac{1,75}{2} = 0,875 \text{ m}$$

$$Z_{T5} = \frac{1,75}{2} = 0,875 \text{ m}$$

$$Z_{T6} = \frac{1,75}{3} = 0,583 \text{ m}$$

$$\underline{\underline{P_{X1} = \rho_1 g \cdot \Omega_{X1} = 0,925 \text{ kg/dm}^3 \cdot 9,81 \text{ m/s}^2 \cdot 1,531 \text{ m}^2 = 13,893 \text{ kN/m}}}$$

$$\underline{\underline{P_{X2} = \rho_2 g \cdot \Omega_{X2} = 1,275 \text{ kg/dm}^3 \cdot 9,81 \text{ m/s}^2 \cdot 1,531 \text{ m}^2 = 19,149 \text{ kN/m}}}$$

$$\underline{\underline{P_{X3} = \rho_2 g \cdot \Omega_{X3} = 1,275 \text{ kg/dm}^3 \cdot 9,81 \text{ m/s}^2 \cdot 2,2225 \text{ m}^2 = 27,798 \text{ kN/m}}}$$

$$\underline{\underline{P_{X4} = p_M \cdot A_v = 3,5 \text{ kPa} \cdot 1,75 \text{ m}^2 = 6,125 \text{ kN/m}}}$$

$$\underline{\underline{P_{X5} = \rho_3 g \cdot \Omega_{X5} = 1,1 \text{ kg/dm}^3 \cdot 9,81 \text{ m/s}^2 \cdot 0,567 \text{ m}^2 = 6,118 \text{ kN/m}}}$$

$$\underline{\underline{P_{X6} = \rho_3 g \cdot \Omega_{X6} = 1,1 \text{ kg/dm}^3 \cdot 9,81 \text{ m/s}^2 \cdot 1,531 \text{ m}^2 = 16,529 \text{ kN/m}}}$$

$$\sum P_x = P_{x1} + P_{x2} + P_{x3} - P_{x4} - P_{x5} - P_{x6}$$

$$\sum P_x = 32,076 \text{ kN/m}^1$$

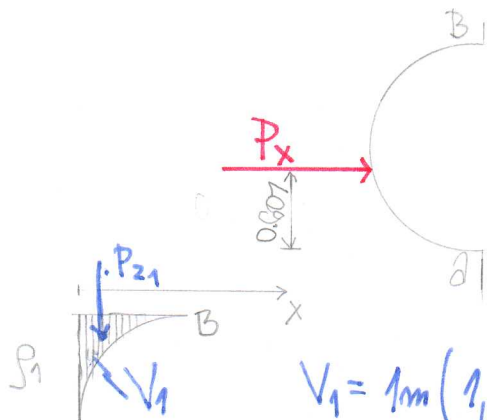
ХОРИЗОНТАЛНА КОМПОНЕНТА

МЕСТО ДЕЛОВАЊА

$$Z_d = \frac{P_{x1} \cdot Z_{T1} + P_{x2} \cdot Z_{T2} + P_{x3} \cdot Z_{T3} + P_{x4} \cdot Z_{T4} + P_{x5} \cdot Z_{T5} + P_{x6} \cdot Z_{T6}}{P_{x1} + P_{x2} + P_{x3} + P_{x4} + P_{x5} + P_{x6}}$$

$$Z_d = \frac{47,569 \text{ kNm}}{89,604 \text{ kN}} = 0,607 \text{ m} \quad Z_T = (1,75 + 0,607) \text{ m}$$

$$Z_T = 2,357 \text{ m}$$

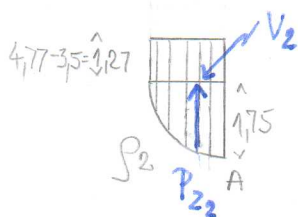


$$V_1 = 1 \text{ m} \left(1,75^2 - \frac{1}{4} 1,75^2 \pi \right) \text{ m}^2 = 0,657 \text{ m}^2$$

$$P_{z1} = \rho_1 g V = 0,925 \text{ kg/dm}^3 \cdot 9,81 \text{ m/s}^2 \cdot 0,657 \text{ m}^2 = 5,964 \text{ kN/m}^1$$

ТЕЖИШТЕ ЗАПРЕМИНЕ

$$X_{T1} = \frac{\frac{1}{2} \cdot 1,75 \cdot 1,75^2 - \left(1,75 - \frac{4}{3} \frac{1,75}{\pi} \right) \cdot \frac{1}{4} 1,75^2 \pi}{0,657 \text{ m}^2} \quad X_{T1} = 0,391 \text{ m}$$

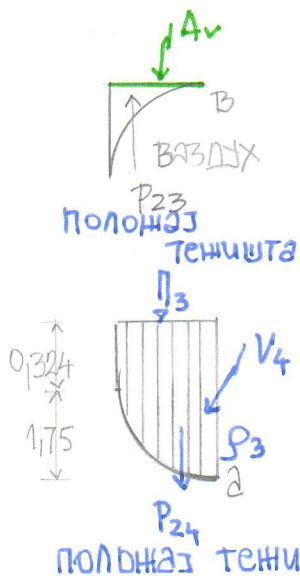


$$V_2 = 1 \text{ m} \left(\frac{1}{4} 1,75^2 \pi + 1,75 \cdot 1,27 \right) \text{ m}^2 = 4,628 \text{ m}^3$$

$$P_{z2} = \rho_2 g \cdot V_2 = 1,275 \text{ kg/dm}^3 \cdot 9,81 \text{ m/s}^2 \cdot 4,628 \text{ m}^3 = 57,883 \text{ kN/m}^1$$

ТЕЖИШТЕ ЗАПРЕМИНЕ

$$X_{T2} = \frac{\frac{1}{2} \cdot 1,75 \cdot 1,75 \cdot 1,27 + \left(1,75 - \frac{4}{3} \frac{1,75}{\pi} \right) \cdot \frac{1}{4} 1,75^2 \pi}{1,27 \cdot 1,75 + \frac{1}{4} 1,75^2 \pi} \quad X_{T2} = 0,944 \text{ m}$$



$$A_v = 1,75 \text{ m} \cdot 1 \text{ m} = 1,75 \text{ m}^2$$

$$P_{z3} = p_n \cdot A_v = 3,5 \text{ kPa} \cdot 1,75 \text{ m}^2 = 6,125 \text{ kN/m}$$

$$X_{T3} = 1,75 \cdot \frac{1}{2} = 0,875 \text{ m}$$

$$V_4 = 1 \text{ m} \left(\frac{1}{4} 1,75^2 \pi + 1,75 \cdot 0,324 \right) \text{ m}^2 = 2,972 \text{ m}^3$$

$$P_{z4} = \rho_{\text{ж}} g V_4 = 1,1 \frac{\text{kg}}{\text{dm}^3} \cdot 9,81 \frac{\text{m}}{\text{s}^2} \cdot 2,972 \text{ m}^3 = 32,076 \frac{\text{kN}}{\text{m}}$$

$$X_{T4} = \frac{\frac{1}{2} \cdot 1,75 \cdot 1,75 \cdot 0,324 + \left(1,75 - \frac{4}{3} \frac{1,75}{\pi} \right) \cdot \frac{1}{4} 1,75^2 \pi}{0,324 \cdot 1,75 + \frac{1}{4} 1,75^2 \pi} = 1,311 \text{ m}$$

ТЕЖИШТЕ ВЕРТИКАЛНЕ КОМПОНЕНТЕ

$$X_T = \frac{P_{z1} \cdot X_{T1} + P_{z2} \cdot X_{T2} + P_{z3} \cdot X_{T3} + P_{z4} \cdot X_{T4}}{P_{z1} + P_{z2} + P_{z4} + P_{z3}}$$

$$X_T = \frac{104,378 \text{ kNm}}{102,043 \text{ kN}}$$

$$X_T = 1,023 \text{ m}$$

$$\sum P_z = -P_{z1} + P_{z2} + P_{z3} - P_{z4} = -5,964 + 57,883 + 6,125 - 32,076$$

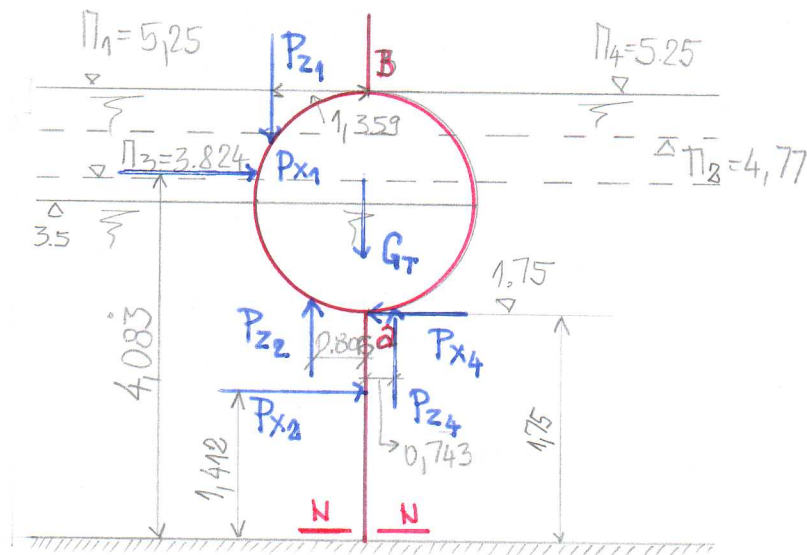
$$P_z = 25,973 \text{ kN/m}$$

УКУПНА ХИДРОСТАТИЧКА СИЛА

$$P = \sqrt{P_x^2 + P_z^2} = \sqrt{32,076^2 + 25,973^2}$$

$$P = 41,273 \text{ kN/m}$$

(3) Момент од хидростатичких сила флуида
1-4 у пресеку N-N



$$\underline{P_{x1} = 13,893 \text{ kN/m}} \quad \underline{\Sigma T_1 = 1,75 \text{ m} + 2,3 \text{ m} = 4,083 \text{ m}}$$

$$P_{x2} = P_{x2}^I + P_{x2}^{II} \quad P_{x2}^I = \rho_2 \cdot g \cdot R_{x2}^I \cdot V^I$$

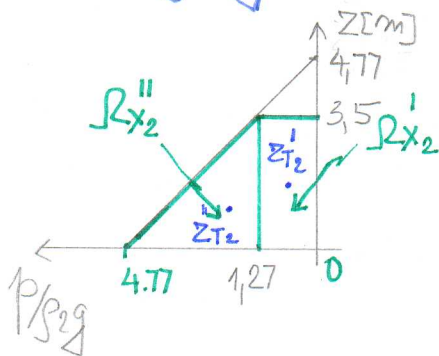
$$P_{x2}^{II} = \rho_2 \cdot g \cdot R_{x2}^{II} \cdot V^{II}$$

$$R_{x2}^I = 1,27 \text{ m} \cdot 3,5 \text{ m} = 4,445 \text{ m}^2$$

$$R_{x2}^{II} = \frac{3,5^2}{2} = 6,125 \text{ m}^2$$

$$Z_{T2}^I = 1,75 \text{ m}$$

$$Z_{T2}^{II} = \frac{1}{3} \cdot 3,5 \text{ m} = 1,167 \text{ m}$$



$$P_{x2}^I = 1,275 \text{ kg/dm}^3 \cdot 9,81 \text{ m/s}^2 \cdot 4,445 \text{ m}^2 = 55,597 \text{ kN/m}$$

$$P_{x2}^{II} = 1,275 \text{ kg/dm}^3 \cdot 9,81 \text{ m/s}^2 \cdot 6,125 \text{ m}^2 = 76,61 \text{ kN/m}$$

Место деловања

$$\Sigma T_2 = \frac{P_{x2}^I \cdot Z_{T2}^I + P_{x2}^{II} \cdot Z_{T2}^{II}}{P_{x2}^I + P_{x2}^{II}} = \frac{55,597 \cdot 1,75 + 76,61 \cdot 1,167}{55,597 + 76,61} = \underline{1,412 \text{ m}}$$

$$\underline{P_{x2} = P_{x2}^I + P_{x2}^{II} = 132,207 \text{ kN/m}}$$

$$P_{x4} = \rho_{zT4} \cdot A_4 = \rho_4 \cdot g \cdot (\Pi_4 - Z_{T4}) \cdot A_4$$

$$A_4 = 5,25 \text{ m} \cdot 1 \text{ m}' = 5,25 \text{ m}^2 \quad \underline{Z_{T4} = \frac{4}{3} \cdot 5,25 \text{ m} = 1,75 \text{ m}}$$

$$P_{x4} = 1,209 \frac{\text{kg}}{\text{dm}^3} \cdot 9,81 \frac{\text{m}}{\text{s}^2} \cdot (5,25 \text{ m} - 1,75 \text{ m}) \cdot 5,25 \text{ m}^2$$

$$\underline{P_{x4} = 217,933 \text{ kN/m}'}$$

$$G_T = \rho_{z9} \cdot V = 1,1 \frac{\text{kg}}{\text{dm}^3} \cdot 9,81 \frac{\text{m}}{\text{s}^2} \cdot \frac{1}{2} \cdot 1,75^2 \cdot \pi \cdot 1 \text{ m}'$$

$$\underline{G_T = 51,911 \text{ kN/m}'}, \quad \underline{X_T = 0 \text{ m}}$$

↓
тещина флуида ρ_4

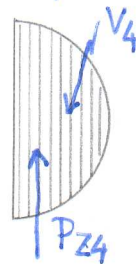
$$P_{z1} = 5,964 \frac{\text{kN}}{\text{m}'}, \quad X_{T1} = 1,75 \text{ m} - 0,391 \text{ m} = 1,359 \text{ m}$$

$$P_{z2} = 57,883 \frac{\text{kN}}{\text{m}'}, \quad X_{T2} = 1,75 - 0,944 \text{ m} = 0,806 \text{ m}$$

$$P_{z4} = \rho_4 \cdot g \cdot V_4 = 1,209 \frac{\text{kg}}{\text{dm}^3} \cdot 9,81 \frac{\text{m}}{\text{s}^2} \cdot 4,811 \text{ m}^3$$



=



$$\underline{P_{z4} = 57,055 \frac{\text{kN}}{\text{m}'}}$$

$$V_4 = \frac{1}{2} \cdot 1,75^2 \cdot \pi \cdot 1 \text{ m}' = 4,811 \text{ m}^3$$

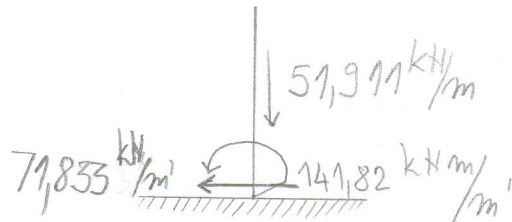
$$\underline{Z_{T4} = 0,743 \text{ m}}$$

$$Z_{T4} = \frac{4}{3} \frac{R}{\pi} = \frac{4}{3} \cdot \frac{1,75 \text{ m}}{\pi}$$

Момент у пресеку N-N

$$\sum M_{N-N}^{\oplus} = P_{x1} \cdot z_{T1} + P_{x2} \cdot z_{T2} - P_{z1} \cdot x_{T1} + P_{z2} \cdot x_{T2} \\ - P_{x4} \cdot z_{T4} - P_{z4} \cdot x_{T4} + G_{\text{ст}} \cdot 0$$

$$\sum M_{N-N}^{\oplus} = -141,82 \text{ kNm/m}'$$



Силе у пресеку
N-N