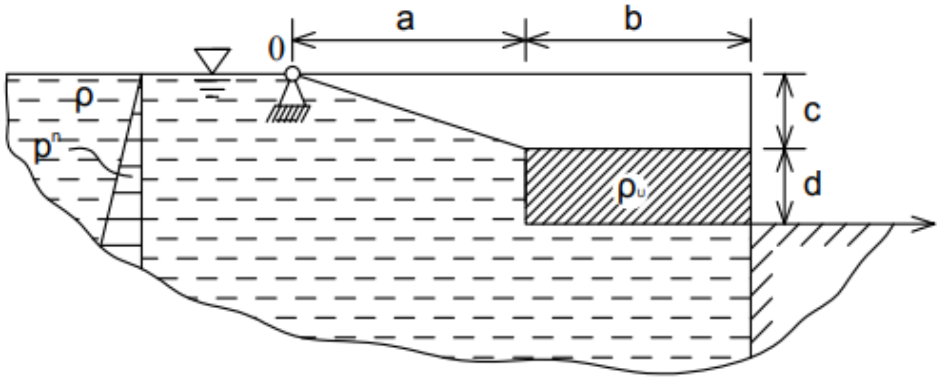
Naloga 5. Zapornica je vrtljivo vpeta v točki 0. Stik med zapornico in robom je zatesnjen. Določite gostoto uteži, da bo zapornica obstala v narisani legi, in prijemališče sile vode na zapornico.

ρ_u = ? [kg/m³]

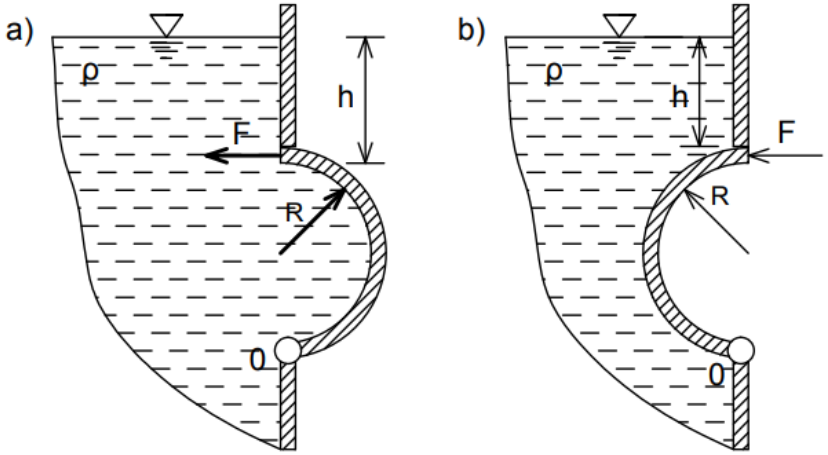


Podatki: $\rho_0 = 1000 \frac{kg}{m^3}$, $a = 3{,}8\,m$, $b = 2{,}7\,m$, $c = 2{,}6\,m$, $d = 2{,}5\,m$

Iščemo: $\rho_p = ?$ $\vec{r}_F = ?$

Naloga 6. Zapornica v obliki lupine polvalja je vrtljivo vpeta v točki 0. Stik med zapornico in jezom je zatesnjen. Določite velikost sile F, da bo zapornica obstala v narisani legi.

$F_{(a)}$ = ? [KN]
$F_{(b)}$ = ? [KN]

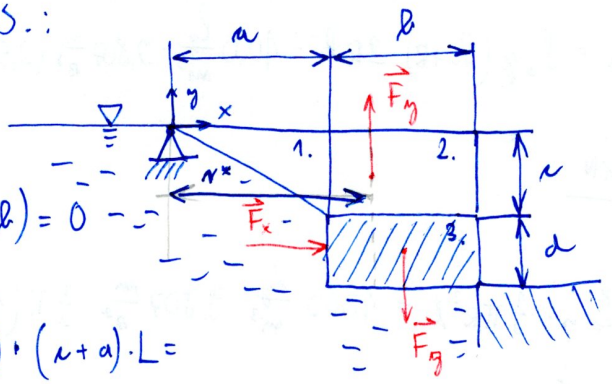


Podatki: $\rho_0 = 1000 \frac{kg}{m^3}$, $R = 1{,}3\,m$, $h = 2{,}5\,m$, $l = 3{,}2\,m$

Iščemo: $\vec{F}_a = ?$ $\vec{F}_R = ?$

Vrota momentov okoli izhodišča K.S.:

$$\sum_i M_{i,0} = 0$$



$$F_x \cdot \frac{2}{3}(c+d) + F_y \cdot r^* - F_g\left(a + \frac{1}{2}b\right) = 0$$

$$\hookrightarrow F_x = \rho_0 g y_T A = \rho_0 g \cdot \frac{1}{2}(c+d) \cdot (c+d) \cdot L =$$

$$= \frac{1}{2}\rho_0 g (c+d)^2 L$$

$$F_y = \rho_0 g V_v = \rho_0 g \left(\frac{1}{2}(a \cdot c) + b(c+d)\right) L \quad , \quad F_g = \rho_p g V_s = \rho_p g \cdot b d L$$

$$\hookrightarrow x_{T_1} = \frac{2}{3}a \qquad x_{T_2} = a + \frac{b}{2} \qquad x_{T_3} = a + \frac{b}{2} \qquad x_T = \frac{\sum_{i=1}^{3} x_{T,i} A_i}{\sum_{i=1}^{3} A_i} = \frac{2}{3}3{,}8\,m$$

$$A_1 = \frac{1}{2}ac \qquad A_2 = bc \qquad A_3 = bd$$

$$= \frac{\frac{2}{3} \cdot 3{,}8\,m \cdot 4{,}94\,m^2 + 5{,}15\,m \cdot 7{,}02\,m^2 + 5{,}15\,m \cdot 6{,}75\,m^2}{4{,}94\,m^2 + 7{,}02\,m^2 + 6{,}75\,m^2} =$$

$$\hookrightarrow \frac{\pi}{3} \cdot \frac{1}{2}\rho_0 g (c+d)^3 L + r^* \cdot \rho_0 g \left(\frac{1}{2}ac + b(c+d)\right) L =$$

$$= \rho_p g b d L \left(a + \frac{1}{2}b\right) \qquad = 4{,}4591\,m$$

$$\rho_p = \frac{\frac{1}{3}\rho_0 (c+d)^3 + \left(\frac{1}{2}ac + b(c+d)\right) r^*}{bd\left(a + \frac{1}{2}b\right)} =$$

$$= \frac{\frac{1}{3}(2{,}6\,m + 2{,}5\,m)^3 + \left(\frac{1}{2} \cdot 3{,}8\,m \cdot 2{,}6\,m + 2{,}7\,m \cdot (2{,}6\,m + 2{,}5\,m)\right) \cdot 4{,}4591\,m}{2{,}7\,m \cdot 2{,}5\,m \cdot \left(3{,}8\,m + \frac{1}{2} \cdot 2{,}7\,m\right)} \cdot 1000\,\frac{kg}{m^3} =$$

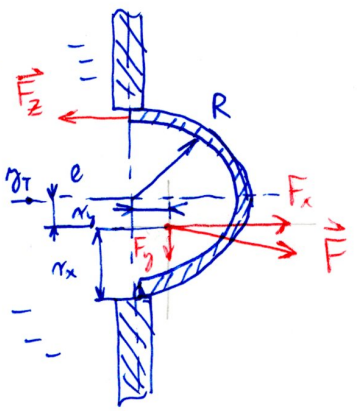
$$= \frac{127{,}6468\,m^3}{34{,}7625\,m^3} \cdot 1000\,\frac{kg}{m^3} \left(= 3671{,}97\,kg/m^3\right) \approx \boxed{3672\,\frac{kg}{m^3}}$$

a.) $F_x = \rho_0 g\, y_T A = \rho_0 g (h+R)\cdot 2Rl = 1000\frac{kg}{m^3}\cdot 9{,}807\frac{m}{s^2}\cdot(2{,}5m+1{,}3m)\cdot 2\cdot 1{,}3\,m =$

$= \underline{310{,}153\,kN}$

$F_y = \rho_0 g V_v = \rho_0 g \cdot \frac{1}{2}\pi R^2 l = 1000\frac{kg}{m^3}\cdot 9{,}807\frac{m}{s^2}\cdot\frac{1}{2}\cdot\pi(1{,}3m)^2\cdot 3{,}2\,m = \underline{83{,}335\,kN}$

↳ Ravnotežje momentov: $F_z \cdot 2R - F_x \cdot r_x - F_y \cdot r_y = 0$; F_z ... zaporna sila



$$F_z = \frac{F_x r_x + F_y r_y}{2R}$$

$$r_y = \frac{4R}{3\pi}\,,$$

$$r_x = R - e = R - \frac{I_{y_T}}{y_T A} = R - \frac{\frac{1}{12}l(2R)^3}{(h+R)\cdot 2Rl} =$$

$$= R - \frac{8R^3}{24R(R+h)} = R\left(1 - \frac{R}{3(R+h)}\right) =$$

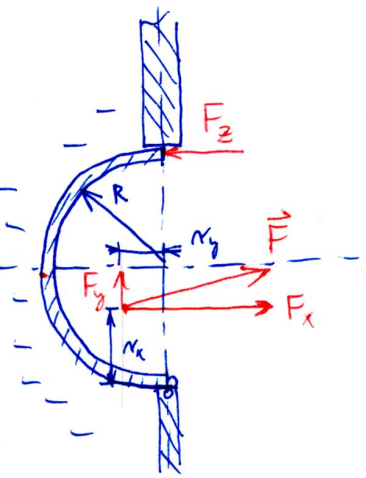
$$= 1{,}3\,m\cdot\left(1 - \frac{1{,}3m}{3\cdot 3{,}8\,m}\right) = 1{,}1518\,m$$

$$F_z = \frac{310{,}153kN\cdot 1{,}1518\,m + 83{,}335\,kN\cdot 0{,}5517\,m}{2\cdot 1{,}3\,m} = \boxed{155{,}081\,kN}$$

b.) $F_x = \rho_0 g (h+R)\cdot 2Rl = 310{,}153kN$; $F_y = \frac{1}{2}\rho_0 g \pi R^2 l = 83{,}335kN$

↳ Ravnotežje momentov: $F_z \cdot 2R - F_x \cdot r_x - F_y \cdot r_y = 0$

$$F_z = \frac{F_x r_x + F_y r_y}{2R}$$



↳ Ker so F_x, F_y, r_x in r_y v ~~prvem~~ primeru b.) enaki kot v primeru a.), je zato tudi zaporna sila F_z enaka.

$\underline{F_z = 155{,}081\,kN}$