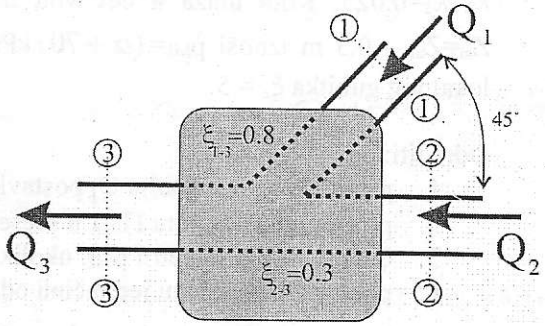
ZADACI ZA OVERU PRISUSTVA NA VEŽBAMA

(*Napomena: slike kotirati u metrima, a ne u opštim brojevima*)

ZADATAK 5.1

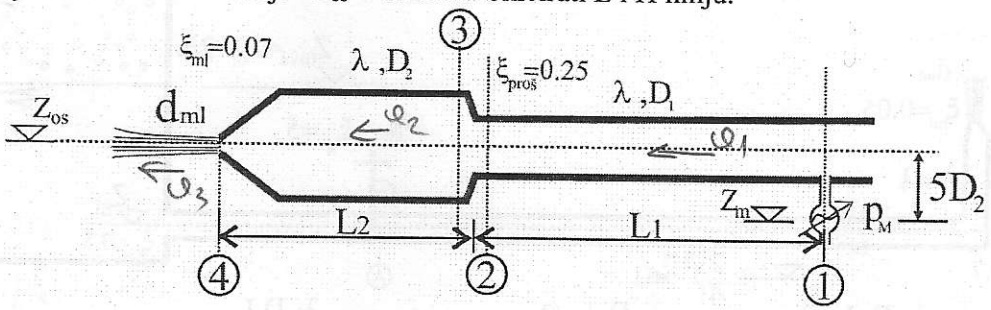
Za potrebe dimenzionisanja ankernog bloka (sprečava oštećenja na cevovodu pri promeni pravca), potrebno je odrediti komponente sile $-\vec{K}$ (sila fluida na konturu) u X i Y pravcu. Prečnici cevovoda su $D_1 = (40+2\alpha)$ mm, $D_2=1.1D_1$ i $D_3=1.25D_1$. Poznat je protok $Q_3=(7+\alpha/5)$ L/s kao i odnos $Q_2/Q_3= 0.65$. U preseku 3-3 je registrovan pritisak od $p_3=1.5\beta$ KPa. Gustina vode iznosi $\rho_v=1$ kg/dm^3.

Napomena: *Cevovod je u horizontalnoj ravni na koti z=5.0 m.*



ZADATAK 5.2

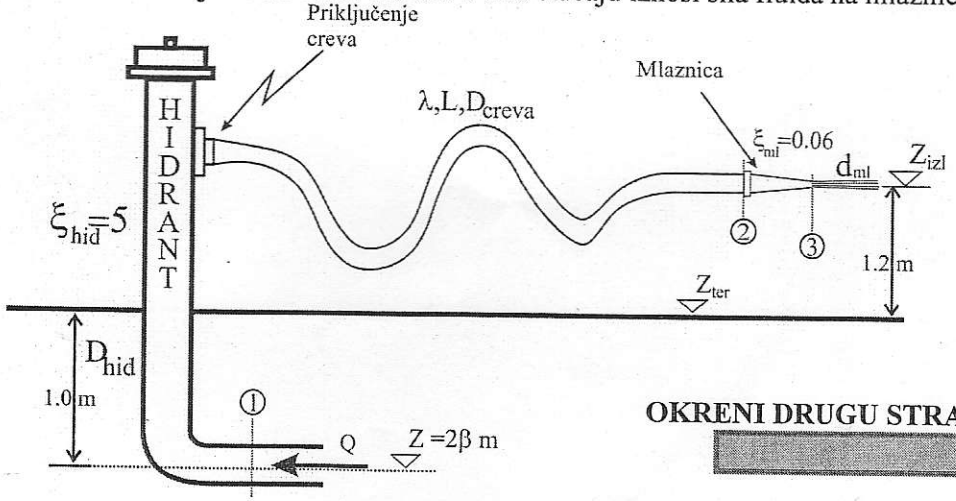
Na slici je prikazan cevovod sa naglim proširenjem sa prečnika $D_1=(55+2\alpha)$ mm na prečnik $D_2=1.2D_1$ koji se završava mlaznicom prečnika $d_{ml}=(15+\alpha)$ mm. Ukoliko je čitanje na manometru $p_M = 2\beta$ KPa odrediti protok kroz instalaciju postavljanjem en.jednačine između preseka 1 i 4. Dužine deonica su: $L_1=2\alpha$ m i $L_2=\alpha$ m a koeficijent λ =0.02. Postavljanjem energetske jednačine između preseka 1 i 2 odrediti pritisak u preseku 2. Zatim postavljanjem energetske jednačine između preseka 2 i 3 odredtiti i pritisak u preseku 3. Konačno, postaviti dinamičku jednačinu između preseka 2 (neposredno pre proširenja) i 3 (neposredno iza proširenja) odrediti silu fluida u pravcu toka (sila $-\vec{K}$) na proširenje. Kota osovine cevi je $Z_{os} = 1.5\alpha$ m. Skicirati E i Π liniju.



ZADACI ZA DOMAĆI RAD

ZADATAK 5.3

Na slici je prikazan protivpožarni hidrant sa prikačenim protivpožarnim crevom koje se završava mlaznicom. Na mestu priključka hidranta na glavnu mrežu (presek 1-1) zahteva se pritisak od 2.5 bara. Odredtiti protok kroz hidrant pri ovom pritisku postavljanjem energetske jednačine između preseka 1 i 3. Od preseka 1 do priključka creva, svi gubici su obuhvaćenim koeficijentom gubitka na hidrantu $\xi_{hid} = 5$ (množi se sa brzinskom visinom kroz hidrant). Zatim odrediti silu fluida na mlaznicu postavljanjem dinamičke jednačine između preseka 2 i 3. Hidrant je prečnika D_{hid}=80 mm. Crevo je prečnika $D_{creva}=\left(70+\beta/5\right)$ mm, dužine L=20 m i koeficijenta linijskog gubitka $\lambda = 0.025$. Mlaznica ima koeficijent lokalnog gubitka 0.06 i prečnik $d_{ml}=(13+\alpha/5)$ mm. Za koliko se procentualno smanji protok ako se pritisak u preseku 1-1 smanji za 0.5 bara? Koliko u tom slučaju iznosi sila fluida na mlaznicu?



OKRENI DRUGU STRANU

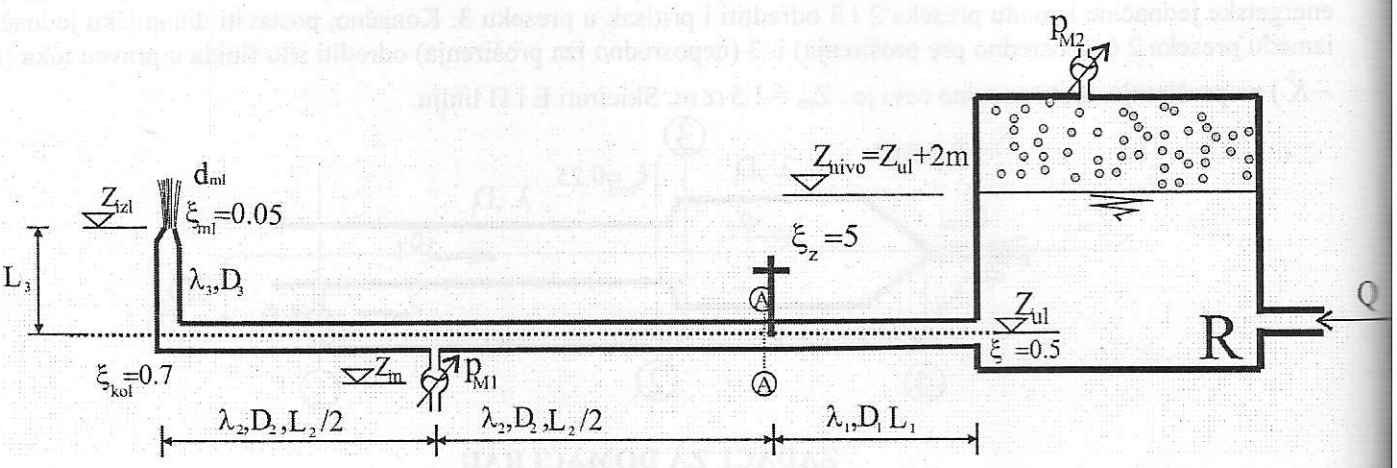
ZADATAK 5.4

Iz rezervoara pod pritiskom voda ističe u atmosferu. Prečnici cevovoda su $D_1=(90+\beta)$ mm, $D_2=D_1-20$ mm, $D_3=0.8D_2$ i $d_{ml}=0.65D_3$. Dužine cevovoda su $L_1=\alpha$ m, $L_2=2L_1$ i $L_3=1$ m. Koeficijenti linijskih gubitka su $\lambda_1=0.02$ i $\lambda_2=\lambda_3=0.025$. Kota ulaza u cevovod iz rezervoara je $Z_{ul}=\beta$ m, a pritisak koji pokazuje manometar na koti $Z_m=Z_{ul}-0.3$ m iznosi $p_{M1}=(\alpha+70)$ kPa. Na cevovodu se nalazi i delimično otvoren zatvarač sa koeficijentom lokalnog gubitka $\xi_z=5$.

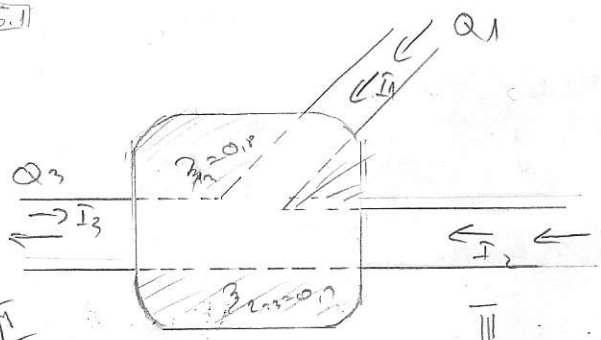
Odrediti:

1. protok kroz instalaciju Q, postavljanjem en.jednačine između preseka p_{M1} i Z_{izl},
2. pijezometarsku kotu $\Pi_{A\text{-}A}$ u preseku A-A i pijezometarsku kotu u rezervoaru R,
3. čitanje na manometru p_{M2}, ukoliko je poznat nivo vode u rezervoaru Z_{nivo},
4. postaviti dinamičku jednačinu od preseka A-A (neposredno iza zatvarača) do izlaza i izračunati silu vode na konturu ($-\vec{K}$) u horizontalnom ($-\vec{K}_x$) i vertikalnom ($-\vec{K}_z$) pravcu,
5. presečne sile u preseku A-A (M, N i T) koje nastaju od sile na konturu i težine cevi koja je jednaka G=900 N/m' (obratiti pažnju da je sopstvena težina vode već uračunata u silu $-\vec{K}$).

Nacrtati Π i E liniju u pogodnoj razmeri.



5.1



$D_1 = 0,052\ m$
$D_2 = 0,0572\ m$
$D_3 = 0,0655\ m$
$Q_3 = 8,12 \cdot 10^{-3}\ \frac{m^3}{s}$
$Q_2 = 5,33 \cdot 10^{-3}\ \frac{m^3}{s}$
$Q_1 + Q_2 = Q_3 \Rightarrow Q_1 = 2,87 \cdot 10^{-3}\ \frac{m^3}{s}$

$Q_2/Q_3 = 0,65$
$p_3 = 49050$
$\rho_v = 1000\ kg/m^3$
$z = 5\ m$

$A_i = \frac{D_i^2 \pi}{4}$

I

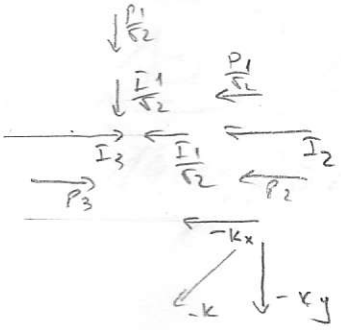
II
$v_1 = \frac{Q_1}{A_1} \Rightarrow v_1 = 1,351\ m/s$
$v_2 = \frac{Q_2}{A_2} \Rightarrow v_2 = 2,074\ m/s$
$v_3 = \frac{Q_3}{A_3} \Rightarrow v_3 = 2,471\ m/s$

III
$h_3 = \frac{p_3}{\rho g} + z = h_3 = 10\ m$
$E_1 = E_3 + \Delta E_{1-3}$
$h_1 + \frac{v_1^2}{2g} = h_3 + \frac{v_3^2}{2g} + \xi_{1-3}\frac{v_3^2}{2g} \Rightarrow h_1 = 10,467\ m$
$E_2 = E_3 + \Delta E_{2-3}$
$h_2 + \frac{v_2^2}{2g} = h_3 + \frac{v_3^2}{2g} + \xi_{2-3}\frac{v_3^2}{2g} \Rightarrow h_2 = 10,185\ m$

IV
$p_1 = \rho g(h_1 - z) = 53631,2\ Pa$
$p_2 = \rho g(h_2 - z) = 50869,85\ Pa$

V
$P_1 = p_1 A_1 = 113,898\ N$
$P_2 = p_2 A_2 = 130,71\ N$
$P_3 = p_3 A_3 = 162,763\ N$

VI
$I_1 = \rho Q_1 v_1 = 3,874\ N$
$I_2 = \rho Q_2 v_2 = 11,054\ N$
$I_3 = \rho Q_3 v_3 = 20,26\ N$



$\Sigma F_x = 0: \quad I_3 - I_2 - \frac{I_1}{\sqrt{2}} + P_3 - P_2 - \frac{P_1}{\sqrt{2}} - K_x = 0$
$-K_x = 42,02\ N$

$\Sigma F_y = 0: \quad -\frac{P_1}{\sqrt{2}} - \frac{I_1}{\sqrt{2}} - K_y = 0$
$-K_y = 83,145\ N$

13.21

$D_1 = 0,064\,m$

$D_2 = 0,08094\,m$

$d_{m1} = 0,021\,m$

$p_M = 65400\,Pa$

$L_1 = 12\,m$

$L_2 = 6\,m$

$\lambda = 0,02$

$z_{OS} = 9\,m$

$E_1 = E_4 + \Delta E_{1-4}$

$$\frac{p_1}{\rho g} + z_1 + \frac{v_1^2}{2g} = \frac{p_4}{\rho g} + z_4 + \frac{v_3^2}{2g} + \lambda \cdot \frac{L_1}{D_1}\frac{v_1^2}{2g} + \xi_{prot}\frac{v_2^2}{2g} + \lambda \cdot \frac{L_2}{D_2}\frac{v_2^2}{2g} + \xi_{mL}\cdot\frac{v_3^2}{2g}$$

$$H_1 = H_4 + \frac{v_1^2}{2g}\left(\frac{\lambda \cdot L_1}{D_1} - 1\right) + \frac{v_2^2}{2g}\left(\lambda \cdot \frac{L_2}{D_2} + \xi_{prot}\right) + \frac{v_3^2}{2g}\left(1 + \xi_{mL}\right)$$

$v_1 A_1 = v_2 \cdot A_2 = v_3 \cdot A_3$

$3,526 \cdot 10^{-3} v_1 = 5,074 v_2 = 3,464 v_3$

$v_2 = 0,695 v_1$

$v_3 = 1,018 v_1$

$$H_4 - H_1 = \frac{v_1^2}{2g}\left(1 - \frac{\lambda L_1}{D_1}\right) - \frac{v_2^2}{2g}\left(\lambda \cdot \frac{L_2}{D_2} + \xi_{prot}\right) - \frac{v_3^2}{2g}\left(1 + \xi_{mL}\right)$$

$$H_4 - H_1 = \frac{v_1^2}{2g}\left(\left(1 - \frac{\lambda L_1}{D_1}\right) - 0,4751\left(\frac{0,2 \cdot L_2}{D_2} + \xi_{prot}\right) - 1,036\left(1 + \xi_{mL}\right)\right)$$

$9 - 15,26 = \frac{v_1^2}{2g} \cdot (-114,52)$ $\quad v_1 = 1,0172\,m/s$

$v_3 = 1,0913\,m/s$ $\quad v_2 = 0,714\,m/s$ $\quad Q = 3,574\,l/s$

$E_1 = E_2 + \Delta E_{1-2}$

$H_1 + \frac{v_1^2}{2g} = H_2 + \frac{v_1^2}{2g} + \lambda \frac{L_u}{D_u} \cdot \frac{v_1^2}{2g} \Rightarrow H_2 = 14,553\,m$

$p_2 = \rho g (H_2 - z_{OS})$

$p_2 = 69,189\,kPa$

$E_2 = E_3 + \Delta E_{2-3}$

$H_2 + \frac{v_1^2}{2g} = \frac{v_1^2}{2g} = H_3 + \frac{v_3^2}{2g} + \xi_{prot} \cdot \frac{v_3^2}{2g} \Rightarrow H_3 = 14,576\,m$

$p_3 = \rho g (H_3 - z_{OS})$

$p_3 = 69,416\,kPa$

10

14.11.2014

$I_2 = \rho Q v_1 = 3,852\,kN$

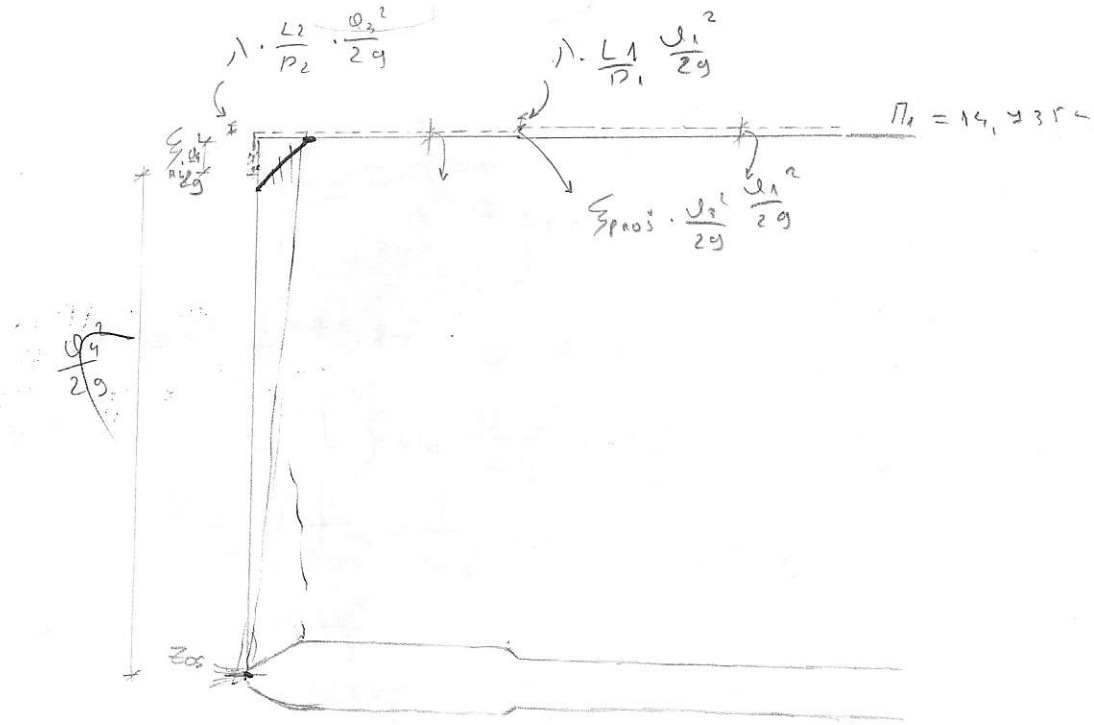
$I_3 = \rho Q v_3 = 2,1476\,kN$

$P_2 = p_2 \cdot A_2 = 229,59\,N$

$P_3 = p_3 \cdot A_3 = 331,695\,N$

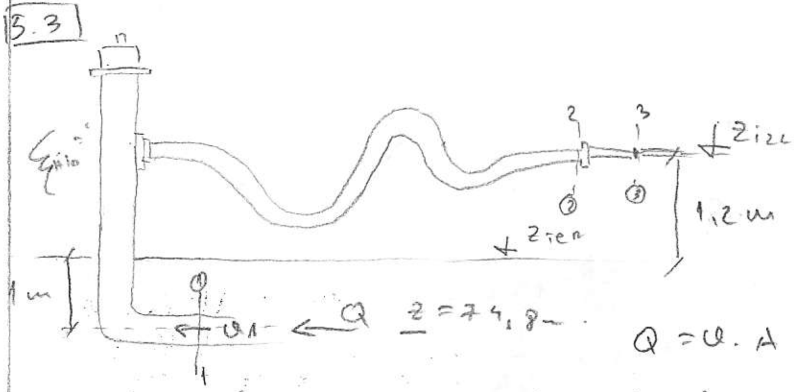
$I_3 + P_3 + K_x - P_2 - I_2 = 0 \Rightarrow -K_x = 100,429\,N$

✓



УОЧИТИ ГРЕШКЕ!

3.3



$D_{cr} = 76,54$

$D_{нiп} = 0,08m$

$d_{ml} = 14,2 = 0,0142\ m$

$P_1 = 2,5\ bar = 250\ kPa$

$\lambda = 0,025$

$L = 20m$

$\Delta p = 0,5\ b = 50kPa$

$z_{izl} = 77m = П_3$

$Q = v \cdot A$

$$П_1 + \frac{v_1^2}{2g} = П_3 + \frac{v_{ml}^2}{2g} + \xi_{нiп} \cdot \frac{v_{нiп}^2}{2g} + \frac{\lambda \cdot L}{D_{cr}} \cdot \frac{v_{cr}^2}{2g} + \xi_{ml} \cdot \frac{v_{ml}^2}{2g}$$

$$П_1 - П_3 = \frac{Q^2 \cdot 16}{2\pi^2 g}\left(\frac{1}{d_{ml}^4} - \frac{1}{D_{нiп}^4} + \frac{\xi_{нiп}}{D_{нiп}^4} + \frac{\lambda \cdot L}{D_{cr} \cdot D_{cr}^4} + \frac{\xi_{ml}}{d_{ml}^4}\right)$$

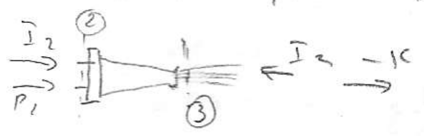
$$\Rightarrow Q = 3,1796 \cdot 10^{-3} \frac{m^3}{s}$$

$3,1796 : 250 = x : 200 \Rightarrow x = 2,54368\ l/s$

$Q_2 = 3,1796 \cdot 10^{-3} \frac{m^3}{s}$ $\quad \frac{\Delta Q}{Q} \cdot 100 = 20\%$

$\Delta Q = 0,63592\ l/s$

ако се притисак смали за 50 kPa протокот се смалува за 20%



$I_2 = \rho \cdot Q \cdot v_{cr} = 2,144N$

$I_3 = \rho \cdot Q \cdot v_{ml} = 648,185\ N$

$P_2 = p_2 \cdot A_2 = \rho g(П_2 - 1,2)A_2 = 4570,98N$

$p_3 = 0$

$I_2 + P_2 - I_3 + K = 0 \Rightarrow -K = 4507,45N$

$$П_2 + \frac{v_{cr}^2}{2g} = П_3 + \frac{Q^2 \cdot 16}{2g\pi^2}\left(\frac{1}{d_{ml}^4} + \frac{\xi_{ml}}{d_{ml}^4} - \frac{1}{D_{cr}^4}\right)$$

$$\Rightarrow П_2 = 100,026m$$

5.4 $D_1 = 122{,}4$ mm $L_1 = 6$ m $z_{OL} = 32{,}4$ m $p_{M1} = 761$ kPc

$D_2 = 102{,}4$ mm $L_2 = 10$ m $z_{nivo} = 34{,}4$ m

$D_3 = 82{,}16$ mm $L_3 = 1$ m $z_M = 32{,}4$

$d_{M1} = 53{,}404$ mm $z_{izl} = 38{,}4$ m

$$n_{M1} = z_M + \frac{p_{M1}}{\rho g}$$

$n_{M1} = 44{,}745$ m

① $E_1 = E_2 + \Delta E_{1-2}$ $\quad Q = v \cdot A$

$$n_{M1} + \frac{v_2^2}{2g} = z_{izl} + \frac{v_{izl}^2}{2g} + \lambda_2 \cdot \frac{6m}{D_2} \cdot \frac{v_2^2}{2g} + \xi_{kol} \cdot \frac{v_2^2}{2g} + \lambda_3 \cdot \frac{1m}{D_3} \cdot \frac{v_3^2}{2g} + \xi_{izl} \cdot \frac{v_{izl}^2}{2g}$$

$$n_{M1} - z_{izl} = \frac{Q^2}{2g}\left(\frac{1}{A_{izl}^2} - \frac{1}{A_2^2} + \lambda_2 \frac{6}{D_2} \cdot \frac{1}{A_2^2} + \xi_{kol} \cdot \frac{1}{A_2^2} + \lambda_3 \cdot \frac{1m}{D_3} \cdot \frac{1}{A_3^2} + \xi_{izl} \cdot \frac{1}{A_{izl}^2}\right)$$

$$2g(n_{M1} - z_{izl}) = Q^2 \left| \frac{1}{A_3^2}\left(\xi_{kol} + \frac{\lambda_3}{D_3}\right) + \frac{1}{A_2^2}\left(\lambda_2 \frac{6}{D_2} - 1\right) + \left|1 + \xi_{izl}\right) \frac{1}{A_{izl}^2}\right)$$

$$2g(n_{M1} - z_{izl}) = \frac{4^2 Q^2}{\pi^2}\left(\frac{1}{D_3^4}\left(\xi_{kol} + \frac{\lambda_3}{D_3}\right) + \frac{1}{D_2^4}\left(\lambda_2 \frac{6}{D_2} - 1\right) + \left(1 + \xi_{izl}\right) \frac{1}{d_{M1}^4}\right)$$

$Q = 0{,}02468 \frac{m^3}{s}$ $\quad v_2 = \frac{Q}{A_2} = 2{,}715 \frac{m}{s}$ $\quad v_3 = 4{,}243 \frac{m}{s}$

$v_{izl} = 10{,}092 \frac{m}{s}$

$v_1 = 1{,}926 \frac{m}{s}$

② $E_A = E_1 + \Delta E_{A-1}$

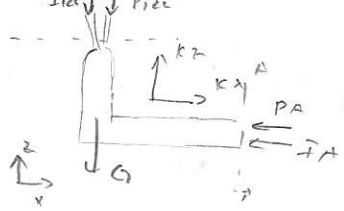
$$n_A + \frac{v_2^2}{2g} = n_{M1} + \frac{v_2^2}{2g} + \lambda_2 \cdot \frac{6}{D_2} \cdot \frac{v_2^2}{2g} \Rightarrow n_A = 45{,}182 \text{ m}$$

$E_3 = E_A + \Delta E_{3-A}$

$$n + \frac{v^2}{2g} = n_A + \frac{v_2^2}{2g} + \xi \frac{v_1^2}{2g} + \lambda_1 \cdot \frac{6}{D_1} \cdot \frac{v_1^2}{2g} + \xi_z \cdot \frac{v_2^2}{2g} \qquad n = 46{,}746 \text{ m}$$

③ $p_{M2} = p_A = \rho g(n - z_{nivo}) = 72{,}06426$ kPc

④



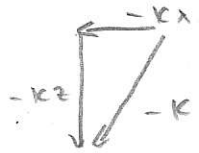
$G = mg = \rho \cdot v \cdot g = \rho \cdot g(L_2 \cdot A_2 + (L_3 - D_2)A_3) = 939{,}49$ N

$P_A = p_A \cdot A_2 = \rho g(n_A - z_M) \cdot \frac{D_2^2 \pi}{4} = 691{,}606$ N

$P_{izl} = \cancel{p_{izl}}^{0} \cdot A_{izl} = 0$

$I_A = \rho Q v_2 = 66{,}789$ N

$I_{izl} = \rho Q v_{izl} = 247{,}0322$ N



$\Sigma F_x = 0 : \quad K_x - P_A - I_A = 0 \Rightarrow -K_x = -757{,}395$ N

$\Sigma F_z = 0 : \quad -I_{izl} - G + K_z = 0 \Rightarrow -K_z = -1186{,}5282$ N

⑤ $G_{cevi1} = 12 \cdot 0{,}1g = 10{,}8$ kN

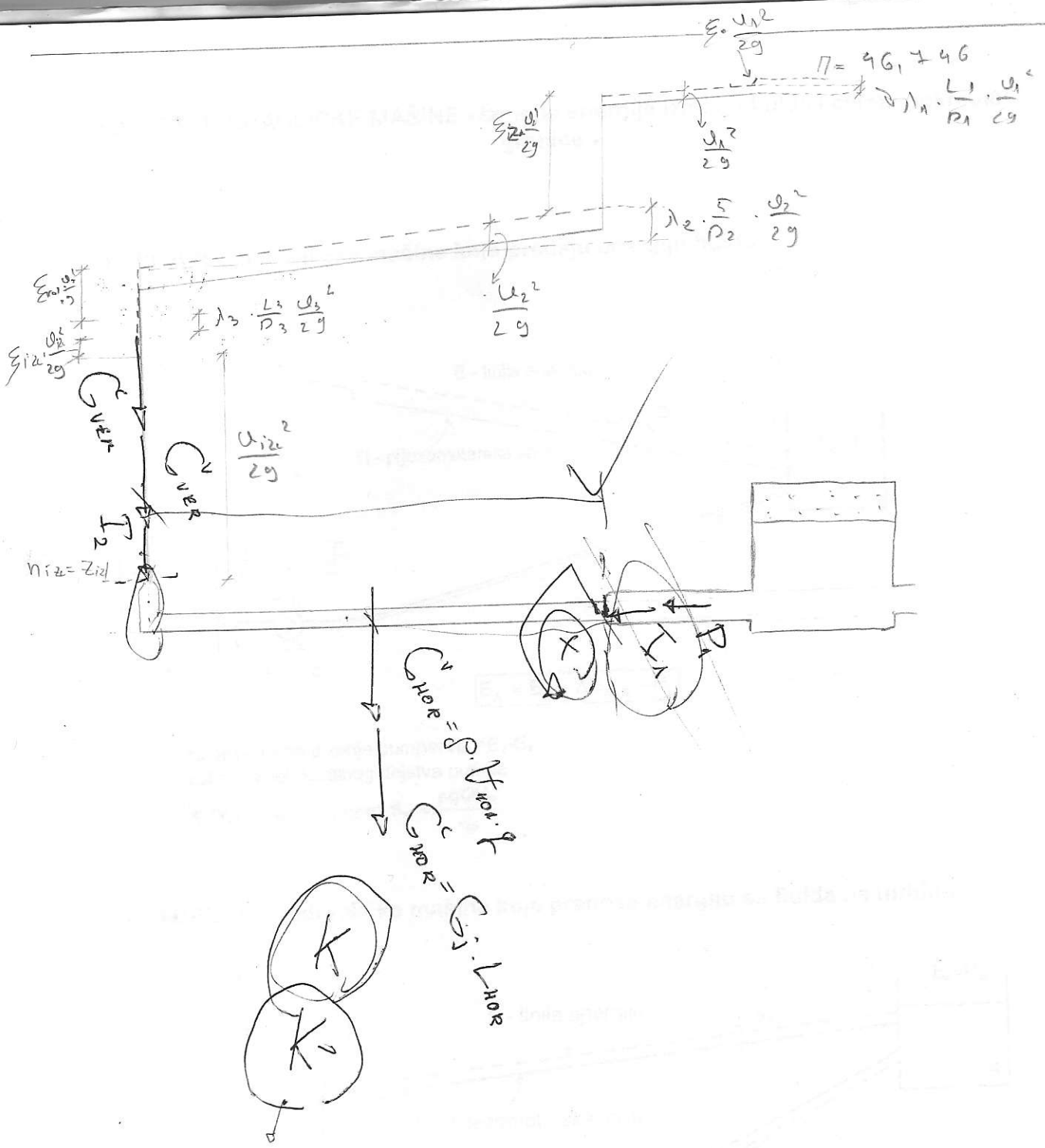
$G_{cevi2} = 1 \cdot 0{,}1g = 0{,}98$ kN

$N = G_{cevi1} + G_{cevi2} - K_z = 8{,}96$ kN

$T = I_A - K_x = -652{,}949$ N

$M = ?$

НЕДОСТАЈЕ ПРОРАЧУН МОМЕНТА У ОДНОСУ НА ПРЕСЕК А–А


$\xi_0 \frac{v_1^2}{2g}$
$\Pi = 96,746$
$\lambda_1 \cdot \frac{L_1}{D_1} \cdot \frac{v_1^2}{2g}$
$\xi_{12} \frac{v_1^2}{2g}$
$\frac{v_1^2}{2g}$
$\lambda_2 \cdot \frac{5}{D_2} \cdot \frac{v_2^2}{2g}$
$\xi_{23} \frac{v_2^2}{2g}$
$\lambda_3 \cdot \frac{L_3}{D_3} \frac{v_3^2}{2g}$
$\frac{v_2^2}{2g}$
$\xi_{i2} \frac{v_{i2}^2}{2g}$
C_{VER}
$\frac{v_{i2}^2}{2g}$
C_{VER}
T_2
$n_{i2} = z_{i2}$
$C_{HOR}^V = \rho \cdot A_{HOR} \cdot g$
$C_{HOR}^C = C_j \cdot L_{HOR}$
K
K'
X
Y_1