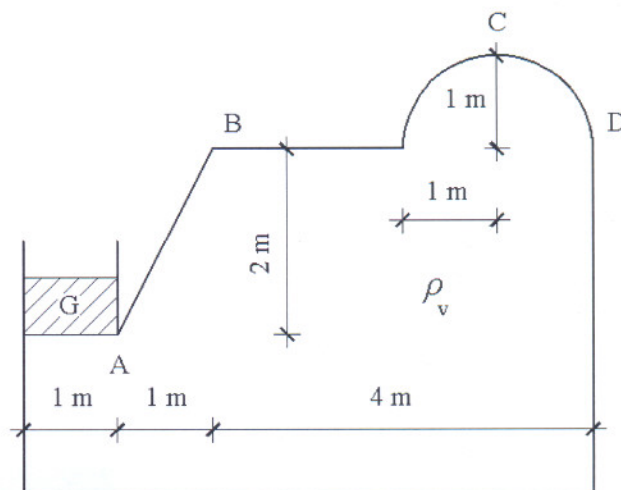


1) Rezervoar je potpuno napunjen vodom kao što je prikazano na slici. Potrebno je izračunati tlakove u točkama A, B, C i D. Nacrtati horizontalni i vertikalni dijagram hidrostatskog tlaka na dio konture rezervoara A-B-C-D te izračunati vrijednost ukupne hidrostatske sile kojom voda djeluje na dio konture A-B-C-D. Zadatak je ravninski (računati na 1m širine rezervoara).

(20 bodova)

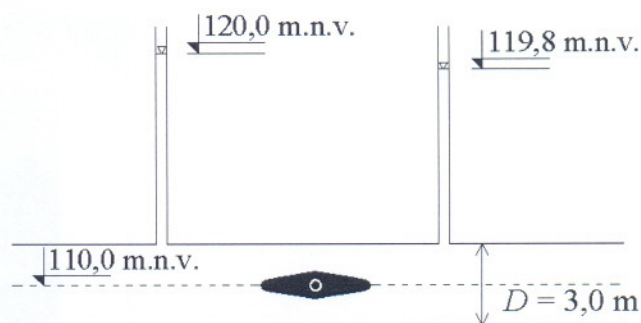
Zadano je: $G=19.62 \text{ kN}$



2) U horizontalnom tunelu kružnog poprečnog presjeka postavljen je leptirasti zatvarač. Površina poprečnog presjeka zatvarača kroz njegovu os je 15% površine poprečnog presjeka tunela. Za tlakove prema slici i protok $Q=20 \text{ m}^3/\text{s}$ izračunajte:

- Koeficijent lokalnog gubitka zatvarača
- Silu kojom voda djeluje na zatvarač
- Koeficijent otpora oblika zatvarača

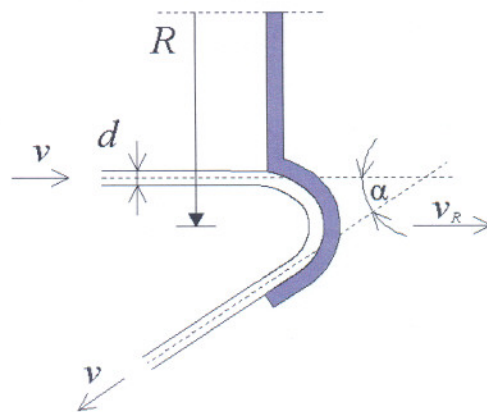
Nacrtati energetsku i piezometarsku liniju. Linijske gubitke zanemariti. (25 bodova)



3) Odredite veličinu sile kojom mlaz vode udara na lopaticu turbine i teoretsku snagu turbine. Duljina lopatice, odnosno radijus turbine je $R = 1.5 \text{ m}$. Tangencijalna brzina lopatice turbine je označena s v_R .

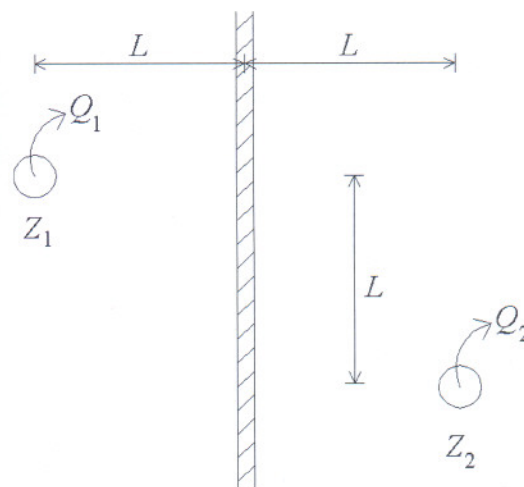
(20 bodova)

Zadano je: $Q=0.08 \text{ m}^3/\text{s}$; $d=0.1 \text{ m}$; $\alpha=30^\circ$; kutna brzina lopatice turbine $\omega=2\pi/\text{sek}$



4) S lijeve strane nepropusne granice, u vodonosniku sa slobodnim vodnim licem ($H_0 = 20 \text{ m}$; $k_1 = 0.002 \text{ m/s}$), nalazi se zdenac Z_1 ($R_1 = 300 \text{ m}$). S desne strane nepropusne granice, u vodonosniku pod tlakom ($M = 16 \text{ m}$; $k_2 = k_1 = 0.002 \text{ m/s}$), nalazi se zdenac Z_2 ($R_2 = R_1 = 300 \text{ m}$). Oba zdenca su radijusa $r_{01} = r_{02} = 0.3 \text{ m}$. Potrebno je izračunati sniženje vodnog lica u zdencima Z_1 i Z_2 ako se iz njih crpi $Q_1 = Q_2 = 0.1 \text{ m}^3/\text{s}$. $L = 100 \text{ m}$.

(20 bodova)

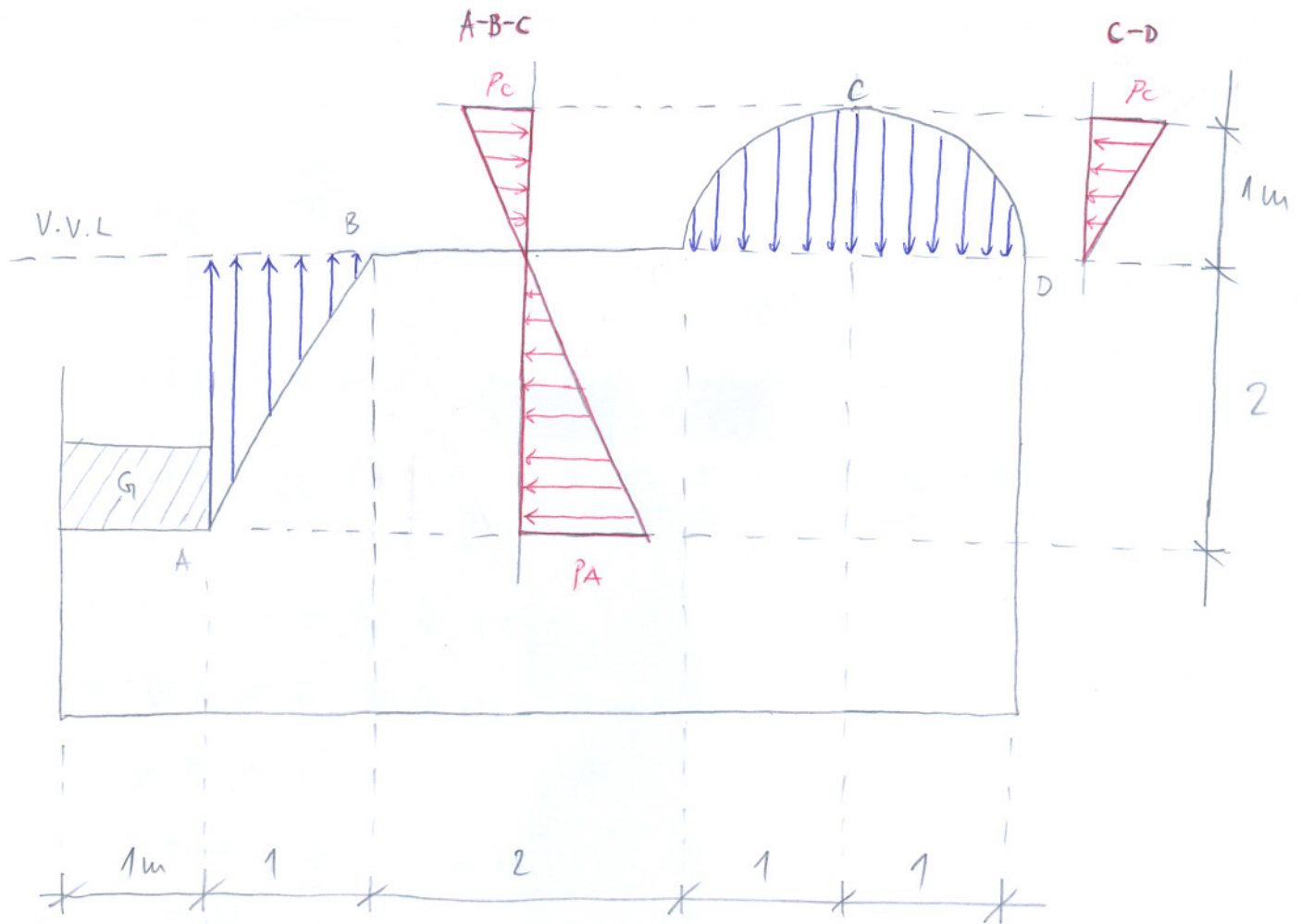


Teorija: (15 bodova)

1. Objasnite što je to homogeno, a što nehomogeno polje.
2. Koje sve vrste energije sadrži Bernoullijeva jednažba?
3. Što je to Pitot cijev, a što Prandtl-Pitot cijev?
4. Napišite Darcyjev zakon i objasnite članove.

Uvjeti za usmeni dio ispita: minimalno 50 bodova i točno riješeni 1. i 2. zadatak!

1



$$p_A = \frac{G}{A} = \frac{19,62}{1 \cdot 1} = 19,62 \text{ kPa}$$

$$p_B = p_A - \rho_v \cdot g \cdot 2 = 0 \text{ kPa}$$

$$p_C = p_B - \rho_v \cdot g \cdot 1 = -9,81 \text{ kPa}$$

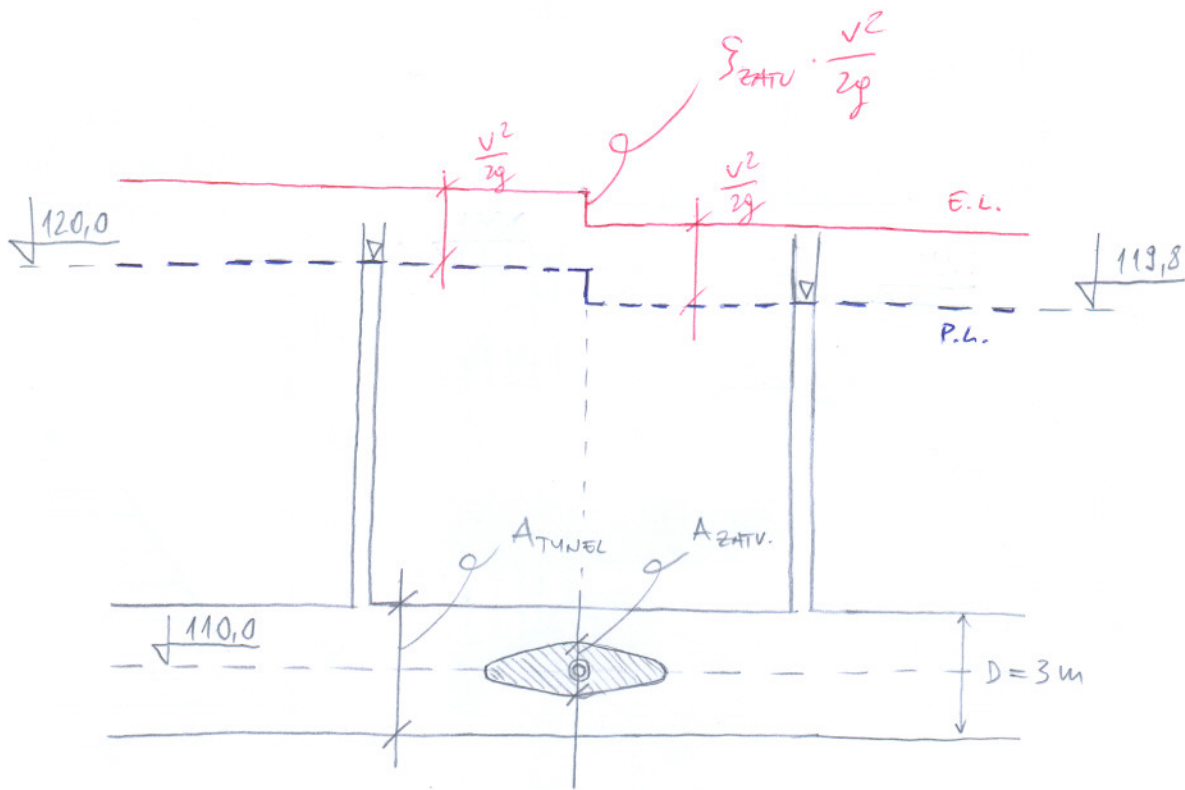
$$p_D = p_B = 0 \text{ kPa}$$

$$\leftarrow F_x^{A \rightarrow D} = - p_A \cdot 2 \cdot \frac{1}{2} = -19,62 \text{ kN}$$

$$\downarrow F_y^{A \rightarrow D} = \rho_v \cdot g \left(2 \cdot 1 \cdot \frac{1}{2} - 1^2 \cdot \frac{\pi}{2} \right) = -5,6 \text{ kN}$$

$$\swarrow F_{ux}^{A \rightarrow D} = \sqrt{(F_x^{A \rightarrow D})^2 + (F_y^{A \rightarrow D})^2} = 20,4 \text{ kN}$$

(2)



$$Q = 20 \text{ m}^3/\text{s}$$

$$A_{\text{TUNEL}} = \frac{D^2 \pi}{4} = \frac{3^2 \pi}{4} = 7,07 \text{ m}^2$$

$$A_{\text{ZATV}} = 0,15 \cdot A_{\text{TUNEL}} = 1,06 \text{ m}^2$$

$$v = \frac{Q}{A_{\text{TUNEL}}} = \frac{20}{7,07} = 2,83 \text{ m/s} \quad \rightarrow \quad \frac{v^2}{2g} = 0,41 \text{ m}$$

$$\Delta h_{\text{LOK}} = \Delta h_{\text{ZATV}} = \frac{v^2}{2g} \cdot \zeta_{\text{ZATV}} = 0,2 \text{ m}$$

$$\zeta_{\text{ZATV}} = \frac{0,2 \cdot 2 \cdot g}{2,83^2} = \underline{\underline{0,49}}$$

$$F_{\text{ZATV}} = F_{\text{u2v}} - F_{\text{v12v}} =$$

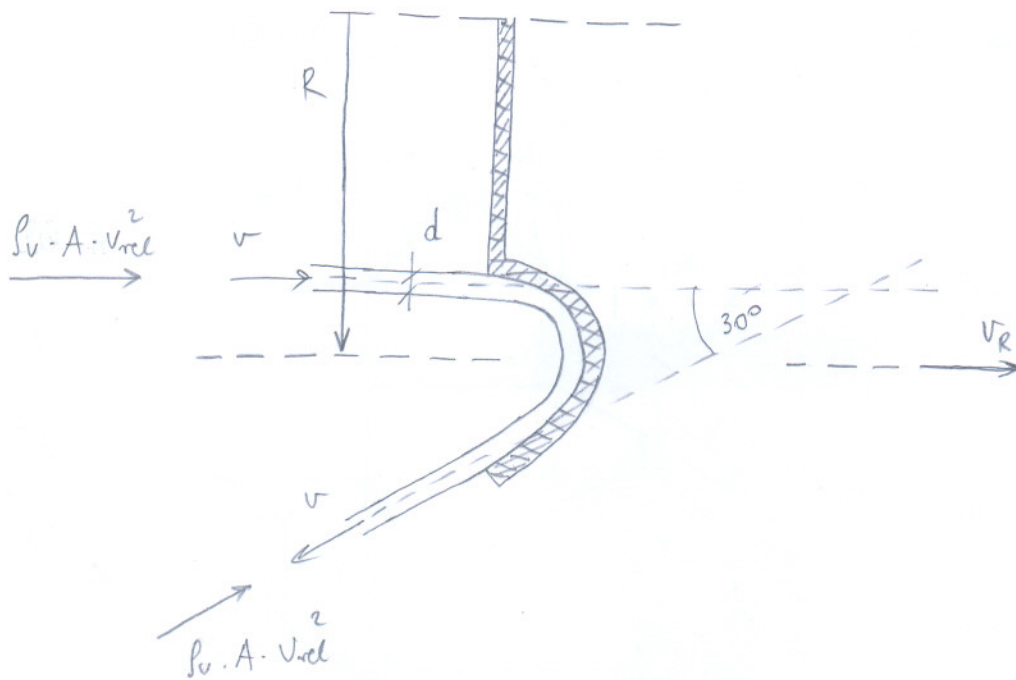
$$= \left[\rho_v \cdot g \cdot (120 - 110) \cdot A_{\text{TUNEL}} \right] - \left[\rho_v \cdot g \cdot (119,8 - 110) \cdot A_{\text{TUNEL}} \right]$$

$$= \rho_v \cdot g \cdot A_{\text{TUNEL}} \cdot 0,2 = \underline{\underline{13,87 \text{ kN}}}$$

~~$$F_{\text{u2v}} = C_{\text{env}} \cdot \rho_v \cdot A_{\text{env}} \cdot \frac{v^2}{2} \quad \rightarrow \quad C_{\text{ZATV}} = \frac{2 F_{\text{ZATV}}}{\rho_v \cdot A_{\text{ZATV}} \cdot v^2}$$~~

$$C_{\text{ZATV}} = \underline{\underline{3,27}}$$

3



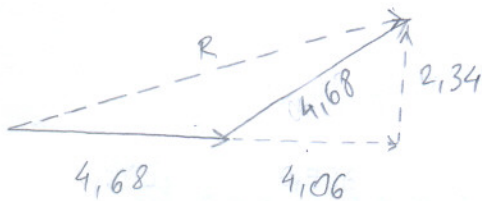
$$v = \frac{Q}{A} = \frac{4Q}{d^2\pi} = \frac{4 \cdot 0,08}{0,1^2\pi} = 10,19 \text{ m/s}$$

$$v_r = \omega \cdot R = \frac{2\pi}{3} \cdot 1,15 \text{ m} = 9,42 \text{ m/s}$$

$$v_{rel} = v - v_r = 0,77 \text{ m/s}$$

$$A = \frac{d^2\pi}{4} = 0,0079 \text{ m}^2$$

$$\rho_v \cdot A \cdot v_{rel}^2 = 4,68 \text{ N}$$



$$F_x = 4,68 + 4,06 = 8,74 \text{ N}$$

$$F_y = 2,34 \text{ N}$$

$$N_1 = \vec{F} \cdot \vec{v}_r = F_x \cdot v_r = 8,74 \cdot 9,42 = 82,33 \text{ W}$$

4

$$L = 100 \text{ m}$$

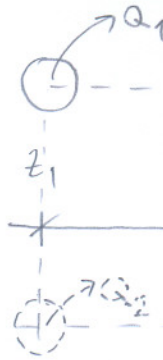
$$Q_1 = Q_2 = 0,1 \text{ m}^3/\text{s}$$

$$H_0 = 20 \text{ m}$$

$$k_1 = 0,002 \text{ m/s}$$

$$R_1 = 300 \text{ m}$$

$$r_{01} = 0,3 \text{ m}$$



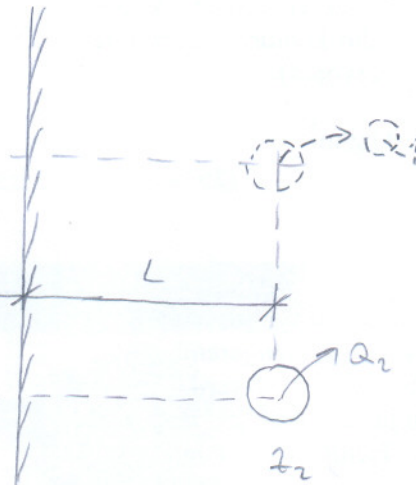
Vodovodnik sa
slobodnim v.L.

$$M = 16 \text{ m}$$

$$k_2 = 0,001 \text{ m/s}$$

$$R_2 = 250 \text{ m}$$

$$r_{02} = 0,3 \text{ m}$$



Vodovodnik pod tlakom

$$\Delta\phi_1 = \frac{Q_1}{2\pi} \left(\ln \frac{R_1}{r_{01}} + \ln \frac{R_1}{2L} \right) = \frac{0,1}{2\pi} \left(\ln \frac{300}{0,3} + \ln \frac{300}{200} \right)$$

$$= 0,0153 (6,91 + 0,41) = 0,116$$

$$\Delta\phi_1 = \frac{k_1 (H_0^2 - h_1^2)}{2} \Rightarrow H_0^2 - h_1^2 = \frac{2 \cdot 0,116}{0,002} = 116,0$$

$$h_1 = \sqrt{H_0^2 - 116,0} = \sqrt{400 - 116,0} = 16,85 \text{ m}$$

$$s_1 = H_0 - h_1 = 20 - 16,85 = 3,15 \text{ m}$$

$$s_2 = \frac{Q_2}{2\pi k_2 M} \left(\ln \frac{R_2}{r_{02}} + \ln \frac{R_2}{2L} \right)$$

$$s_2 = \frac{0,1}{2 \cdot \pi \cdot 0,002 \cdot 16} \left(\ln \frac{300}{0,3} + \ln \frac{300}{200} \right)$$

$$s_2 = 0,497 (6,91 + 0,41)$$

$$s_2 = 3,64 \text{ m}$$