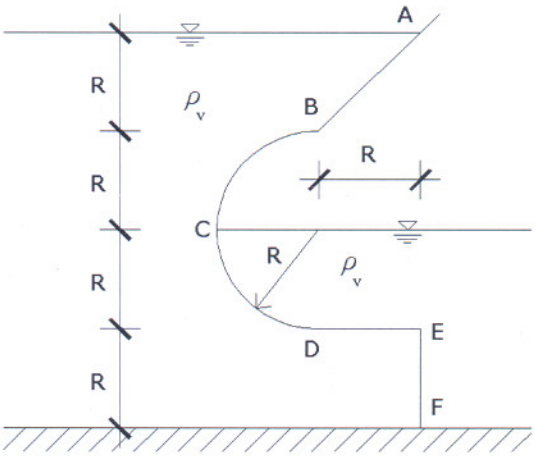
1) Za sistem na slici nacrtati horizontalni i vertikalni dijagram hidrostatskog tlaka vode. Odrediti veličinu i smjer rezultantne hidrostatske sile vode na profiliranu plohu A-F po jedinici širine.

(20 bodova)

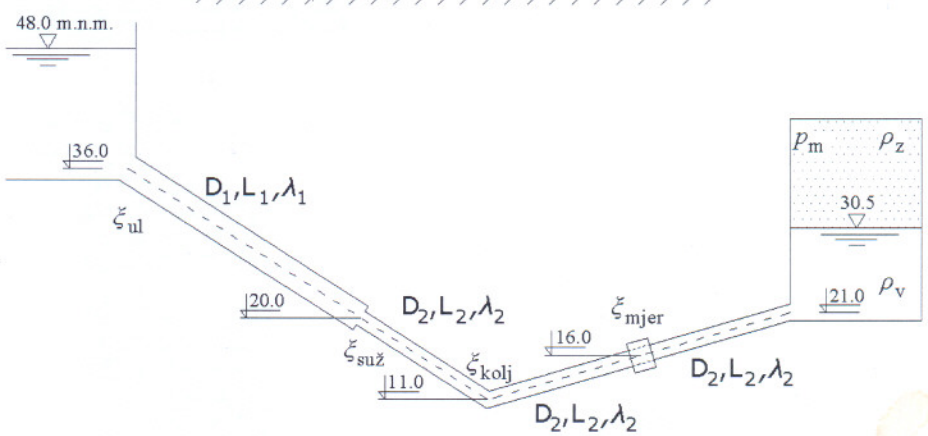
Zadano je: R=3m



2) Na mjernom uređaju koji je montiran na cijev na položaju kao na slici i visinskoj koti 16.0m.n.m., izmjeren je protok od Q=150l/s. Za sistem na slici treba proračunati tlak zraka p_m u desnom rezervoaru pri kojem se ostvaruje izmjereni protok vode iz lijevog rezervoara u desni. Nacrtati energetsku i piezometarsku liniju.

(25 bodova)

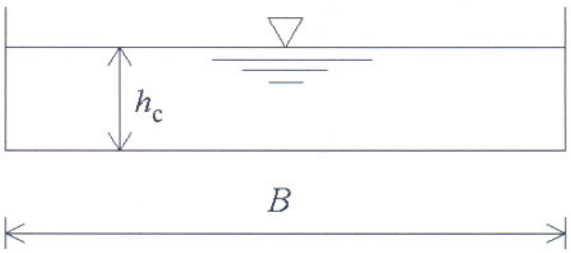
Zadano je: D_1=0.25m; D_2=0.18m; L_1=30m; L_2=15m; λ_1=0.02; λ_2=0.025m; ξ_{ul}=0.5; $\xi_{suž}=f(v_2)$=0.7; ξ_{kolj}=0.3; ξ_{mjer}=0.8;



3) Za kanal pravokutnog presjeka i zadani protok Q=150m^3/s treba odrediti kritičnu dubinu h_c i minimalnu specifičnu energiju H_{min}. Izračunati pad dna kanala I_{kr} za taj slučaj, ako je n=0.0125m$^{-1/3}$s (Manningov koef. hrapavosti).

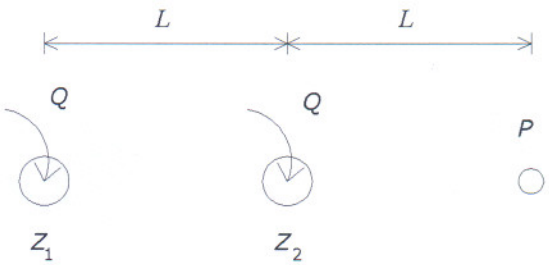
(20 bodova)

Zadano je: B=20m, α=1.1(Coriolisov koef.)



4) U svaki od dva zdenca ulijeva se količina vode od Q=20l/s. Na piezometru P izmjereno je povišenje razine vode s_P=1.5m. Vodonosnik je pod tlakom. Odredi koeficijent propusnosti vodonosnika k, ako je zadana debljina vodonosnog sloja M=15m i radijus utjecaja zdenca R=120m. L=15m.

(20 bodova)

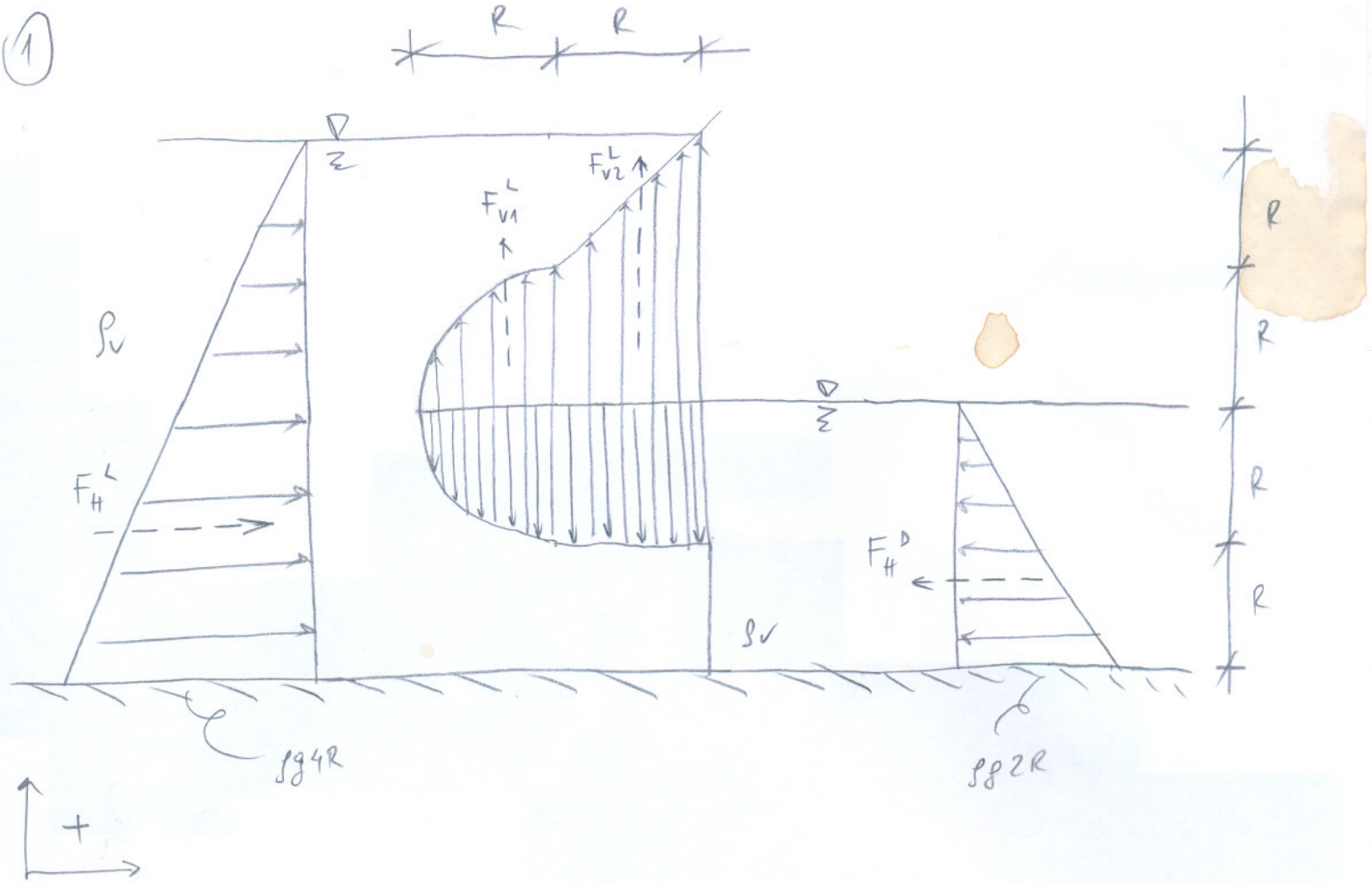


Teorija: (15 bodova)

1. Napiši izraz za snagu pumpe i turbine te objasni članove.
2. Napiši jednadžbu za zakon održanja količine gibanja te objasni članove.
3. Napiši izraz za odnos vremena na modelu i u prirodi ako je zadovoljena Reynoldsova sličnost.
4. Zašto se i gdje kod zdenca uz nepropusnu granicu za rješenje sniženja postavlja fiktivni zdenac?

Za pristupanje usmenom dijelu ispita potrebno je ostvariti minimalno 50 bodova i točno riješiti 1. i 2. zadatak!

(1)



$$F_H^{UK} = F_H^L - F_H^D = \rho g 4R \cdot \frac{4R}{2} \cdot \frac{1}{2} - \rho g 2R \cdot 2R \cdot \frac{1}{2}$$

$$= \rho g (8R^2 - 2R^2) = \rho g \cdot 6R^2 = 1 \cdot 9{,}81 \cdot 6 \cdot 3^2$$

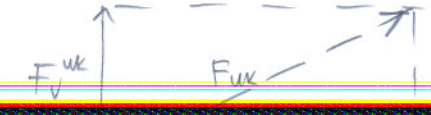
$$= 529{,}74 \text{ kN}$$

$$F_V^{UK} = F_{V1}^L + F_{V2}^L = \rho g \frac{R^2 \pi}{4} + \rho g \frac{R + 2R}{2} \cdot R$$

$$= \rho g \left(\frac{R^2 \pi}{4} + \frac{3R^2}{2} \right) = 1 \cdot 9{,}81 \cdot \left(\frac{3^2 \pi}{4} + \frac{3 \cdot 3^2}{2} \right)$$

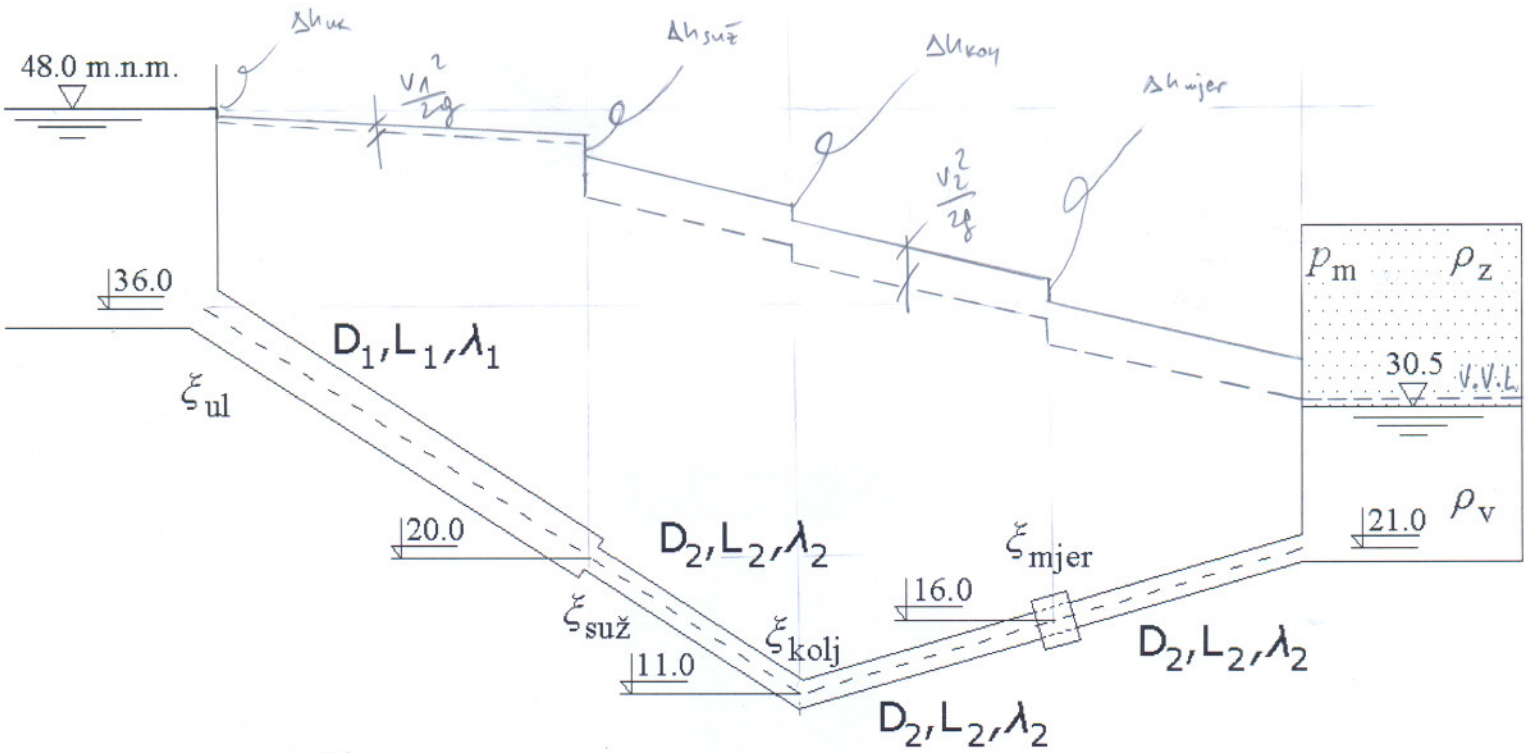
$$= 201{,}78 \text{ kN}$$

$$F_{UK} = \sqrt{(F_V^{UK})^2 + (F_H^{UK})^2} = 566{,}87 \text{ kN}$$



$\Rightarrow \alpha = 20{,}8°$

(2)



$Q = 0{,}15\ m^3/s$

$D_1 = 0{,}25\ m \rightarrow A_1 = \frac{D_1^2 \pi}{4}$

$D_2 = 0{,}18\ m \rightarrow A_2 = \frac{D_2^2 \pi}{4}$

$v_1 = \frac{Q}{A_1} = \frac{0{,}15 \cdot 4}{0{,}25^2 \pi} = 3{,}06\ m/s \rightarrow \frac{v_1^2}{2g} = 0{,}477\ m$

$v_2 = \frac{Q}{A_2} = \frac{0{,}15 \cdot 4}{0{,}18^2 \pi} = 5{,}89\ m/s \rightarrow \frac{v_2^2}{2g} = 1{,}768\ m$

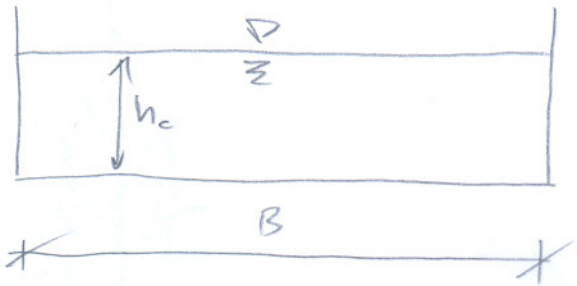
$$z_1 = z_2 + \frac{p_m}{\rho g} + \frac{v_1^2}{2g}\left(\zeta_{ul} + \frac{\lambda_1 L_1}{D_1}\right) + \frac{v_2^2}{2g}\left(\zeta_{suž} + 3\,\frac{\lambda_2 L_2}{D_2} + \zeta_{kolj} + \zeta_{mjer} + 1\right)$$

$$48 = 30{,}5 + \frac{p_m}{\rho g} + 0{,}477\left(0{,}5 + \frac{0{,}02 \cdot 30}{0{,}25}\right) + 1{,}768\left(0{,}7 + 3\,\frac{0{,}025 \cdot 15}{0{,}18} + 0{,}3 + 0{,}8 + 1\right)$$

$$48 = 30{,}5 + \frac{p_m}{\rho g} + 0{,}238 + 1{,}145 + 1{,}238 + 3 \cdot 3{,}683 + 0{,}530 + 1{,}414 + 1{,}768$$

$$\frac{p_m}{\rho g} = 0{,}118 \rightarrow p_m = 1{,}16\ kPa$$

7)



$Q = 150\ m^3/s$

$B = 20\ m$

$\alpha = 1,1$

$n = 0,0125\ m^{-1/3}\,s$

$F_r = 1$

$$\frac{\alpha Q^2}{g A^3} \cdot B = 1 \rightarrow \frac{\alpha Q^2}{g h_c^3 \cdot B^2} = 1 \rightarrow \alpha Q^2 = g h_c^3 B^2$$

$$h_c = \sqrt[3]{\frac{\alpha Q^2}{g B^2}} = \sqrt[3]{\frac{1,1 \cdot 150^2}{9,81 \cdot 20^2}} = 1,84\ m$$

$$E_{min} = h_c + \frac{\alpha v_c^2}{2g} = h_c + \frac{\alpha Q^2}{2g B^2 \cdot h_c^2} = 1,84 + \frac{1,1 \cdot 150^2}{2 \cdot g \cdot 20^2 \cdot 1,84^2}$$

$$= 1,84 + 0,92 = 2,76\ m$$

$$v_c = \frac{Q}{B \cdot h_c} = \frac{150}{20 \cdot 1,84} = 4,07\ m/s$$

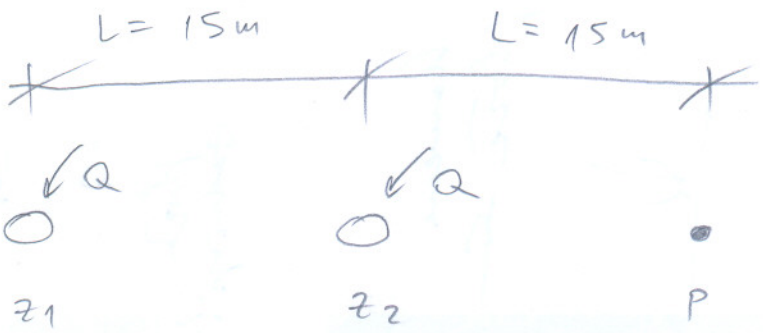
$$v_c = \frac{1}{n} R_c^{2/3} J_c^{\frac{1}{2}} \quad / ^2$$

$$v_c^2 = \frac{1}{n^2} \cdot R^{4/3} \cdot J_c \rightarrow J_c = \frac{v_c^2 \cdot n^2}{R_c^{4/3}}$$

$$R_c = \frac{A_c}{O_c} = \frac{B \cdot h_c}{B + 2h_c} = \frac{20 \cdot 1,84}{20 + 2 \cdot 1,84} = 1,55\ m$$

$$J_c = \frac{4,07^2 \cdot 0,0125^2}{1,55^{4/3}} = 0,0014$$

(4)



$Q = 0{,}02\ m^3/s$

$sp = 1{,}5\ m$

$M = 15\ m$

$R = 120\ m$

$$sp = \sum_i \frac{Q}{2\pi kM}\left(\ln \frac{R}{r_i}\right)$$

$$sp = \frac{Q}{2\pi kM}\ln\frac{R}{L} + \frac{Q}{2\pi kM}\ln\frac{R}{2L}$$

$$1{,}5 = \frac{0{,}02}{2\pi k \cdot 15}\left(\ln\frac{120}{15} + \ln\frac{120}{30}\right)$$

$$k = \frac{1}{1{,}5}\cdot\frac{0{,}02}{2\pi\cdot 15}\left(\ln\frac{120}{15} + \ln\frac{120}{30}\right)$$

$$k = 0{,}0005\ m/s$$