Задатак 8.2

$a = 39.3\,cm = 0.393\,m$

$h = 1.2\,m$

$U = 7.86\,\frac{m}{s}$

$\rho = 1.2\,\frac{kg}{m^3}$

Тачка	1	2	3	4
C_p	1.0	0.1	-0.6	0.1

а) $p = c_p \frac{1}{2} \rho U^2 = c_p \frac{1}{2} 1.2 \cdot 7.86^2 = 37.06776\,c_p$

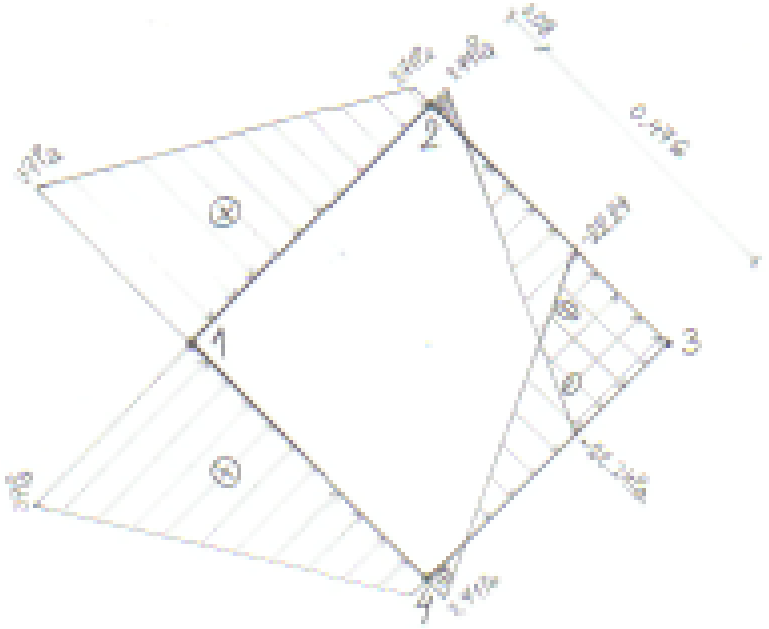
$p_1 = 1.0 \cdot 37.06776 = 37.07\,Pa$

$p_2 = 0.1 \cdot 37.06776 = 3.71\,Pa$

$p_3 = -0.6 \cdot 37.06776 = -22.24\,Pa$

$p_4 = 3.71\,Pa$

б)



$l = a\sqrt{2} = 0.556\,m$

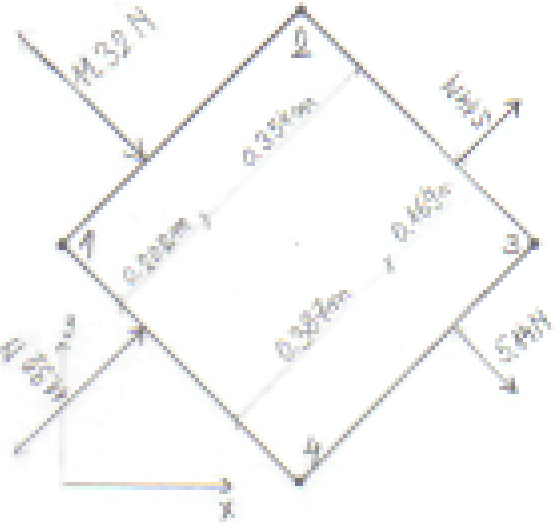
$F_{1-2} = \frac{37 + 3.71}{2} \cdot 0.556 = 11.32\,N$

$F_{1-4} = F_{1-2} = 11.32\,N$

$F_{2-3} = \frac{3.71 \cdot 0.05}{2} - \frac{22.24 \cdot 0.556}{2} = 0.4634 - 5.2334 = -5.14\,N$

$F_{3-4} = F_{2-3} = -5.14\,N$

cu ule otnopa



$$\sum F_x = -2 \cdot F_{1-2} \cdot \sin 45^\circ - 2 \cdot F_{3-4} \sin 45 = -16 - 7.27 = -23.27\,N$$

$$\sum F_y = F_{4-2} \cdot \sin 45 - F_{1-4} \sin 45 + F_{3-4} \sin 45 - F_{2-3} \sin 45 = 0$$

$$A_{pp} = d \cdot h = 2a \cdot h = 2 \cdot 0.393 \cdot 1.2 = 0.9432\,m^2$$

$$C_{F_x} = \frac{F_x}{\frac{1}{2} \rho U^2 A_{pp}} = \frac{-23.27}{\frac{1}{2} \cdot 1.2 \cdot 7.86^2 \cdot 0.9432} = -0.666$$

$$C_{F_y} = \frac{F_y}{\frac{1}{2} \rho U^2 A_{pp}} = 0$$

c) $a_1 = 1.965\,m$

$h_s = 6\,mm$

$U_\infty = 2\,\frac{m}{s}$

$\rho = 1000\,\frac{kg}{m^3}$

$$A_{PB} = 2 a_1 h_s = 2 \cdot 1.9656 = 23.58\,m^2$$

$$F = C_F \cdot \frac{1}{2} \rho U_\infty^2 A_{PB} = 0.666 \cdot \frac{1}{2} \cdot 1000 \cdot 2^2 \cdot 23.58$$

$$= 31408.56\,N$$

$$F = 31.41\,kN$$

Задатак 8.3

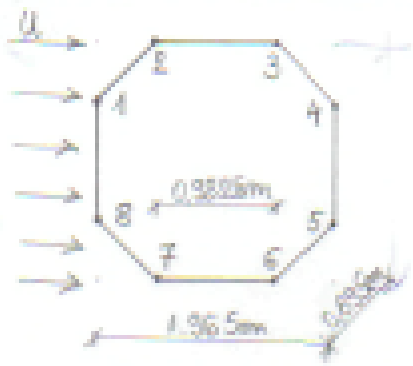
$\rho_{vazd} = 1.2 \frac{kg}{m^3}$

$U = 20 \frac{m}{s}$

$a = 1.965m$

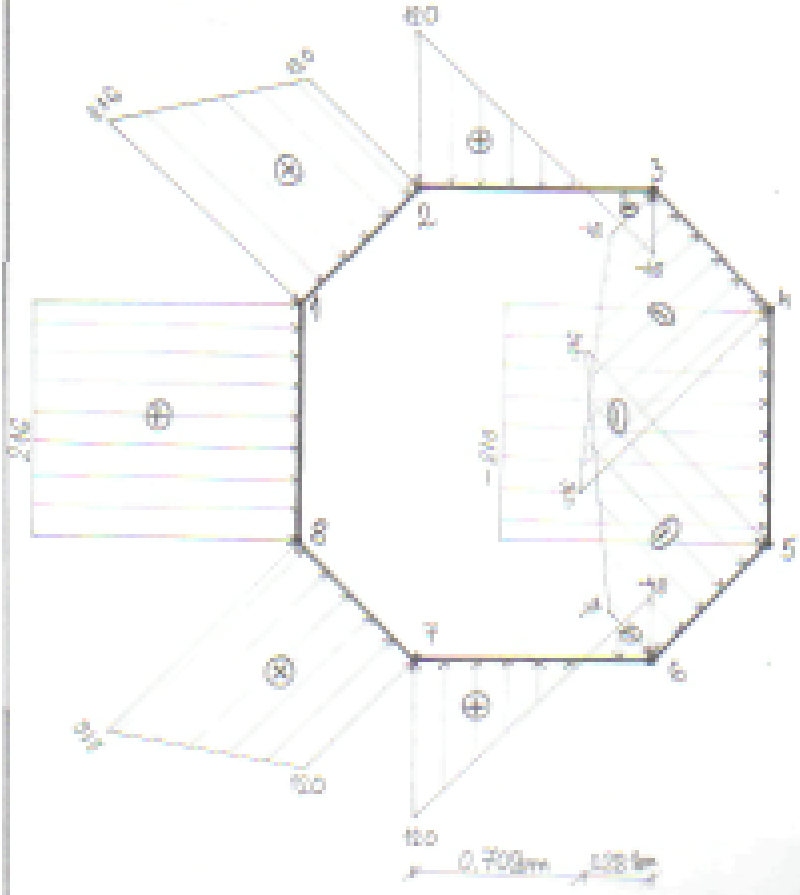
$a = 0.0196 \cdot 50m$

$P = C_p \cdot \frac{1}{2} \rho U^2 = C_p \cdot \frac{1}{2} \cdot 1.2 \cdot 20^2 = 240 C_p$



Presek 1

tačka	1	2	3	4	5	6	7	8
C_p	0.9	0.5	-0.2	-0.9	-0.9	-0.2	0.5	0.9
P[N]	216	120	-48	-216	-216	-48	120	216



$F_{8-1} = 246 \cdot 0.008825 = 2.1222\,N$

$F_{1-5} = -F_{8-1} = -2.1222\,N$

$F_{1-2} = \frac{246+180}{2} \cdot 0.00695 = 1.1676\,N$

$F_{7-8} = F_{1-2} = 1.1676\,N$

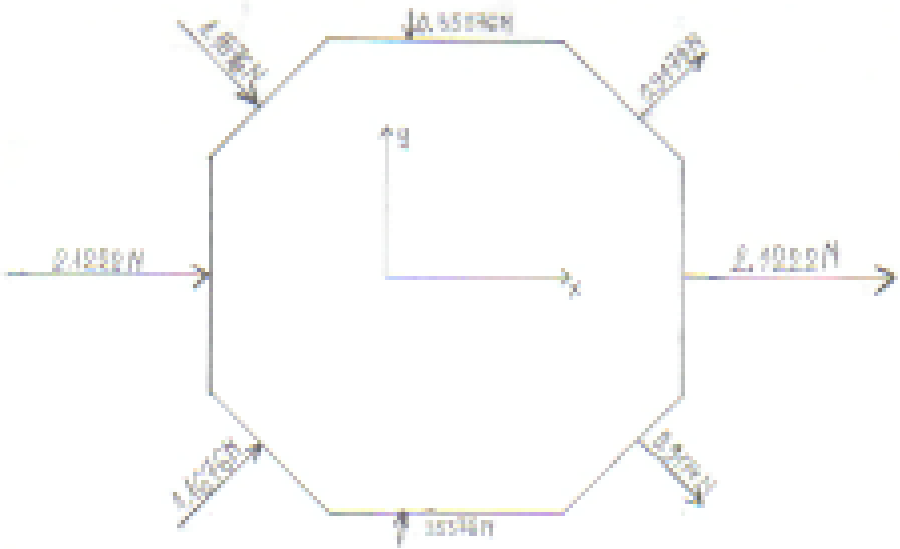
$F_{8-2} = \frac{120 \cdot 0.00782}{2} - \frac{48 \cdot 0.00281}{2} = 0.4212 - 0.06744 = 0.35376\,N$

$F_{6-7} = F_{2-3} = 0.35376\,N$

$F_{3-4} = \frac{216+48}{2} \cdot 0.00695 = 0.9174\,N$

$F_{5-6} = F_{3-4} = 0.9174\,N$

Сили опора



$\sum F_x = 2 \cdot 2.1222 + 2 \cdot 1.1676 \cdot \cos 45 + 2 \cdot 0.9174 \cdot \cos 45 =$

$= 4.2444 + 1.6512 + 1.2974 = 7.193\,N = F_x$ C_{F_y} ..

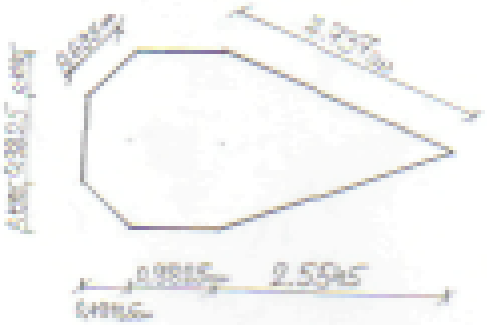
$\sum F_y = 1.1676 \cdot \cos 45 - 1.1676 \cdot \cos 45 + 0.35376 - 0.35376 - 0.9174 \cos 45$

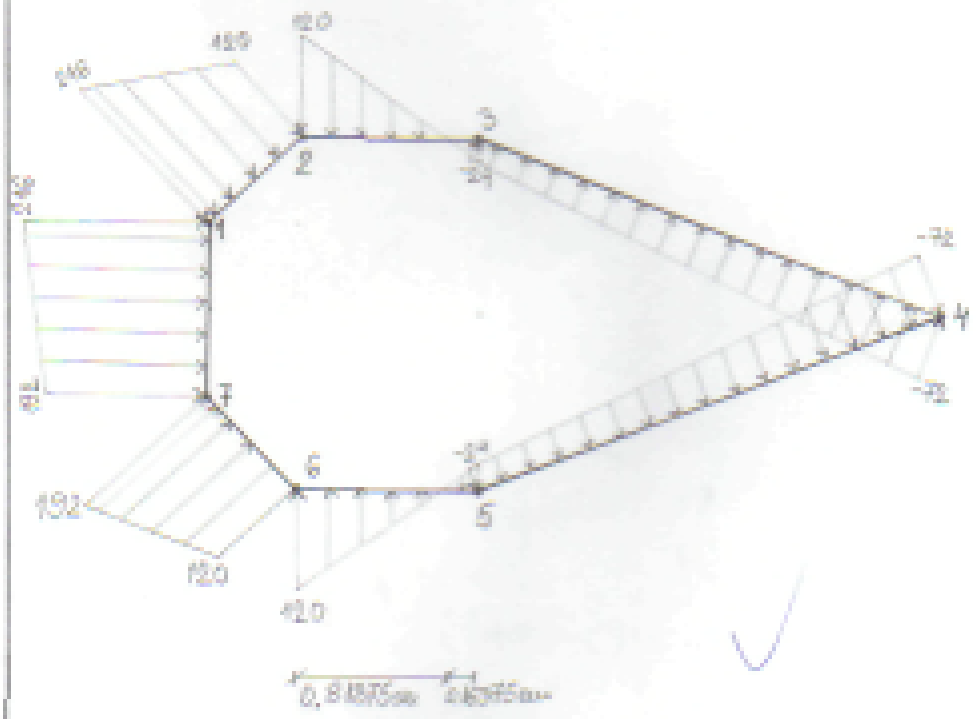
$+ 0.9174 \cdot \cos 45 = 0$

$C_{F_x} = \frac{F_x}{\frac{1}{2} \rho v^2 A_{ref}} = \frac{7.193}{\frac{1}{2} \cdot 1.2 \cdot 107^2 \cdot 0.0065} = 1.525$

Пресек 2

точка	1	2	3	4	5	6	7
C_p	0.9	0.5	-0.1	-0.3	-0.1	0.5	0.8
$P[daN]$	216	120	-24	-72	-24	120	192





$F_{7-1} = \frac{92+112}{2} \cdot 0.009825 = 2.0043\ N$

$F_{1-2} = \frac{246+180}{2} \cdot 0.00695 = 1.1676\ N$

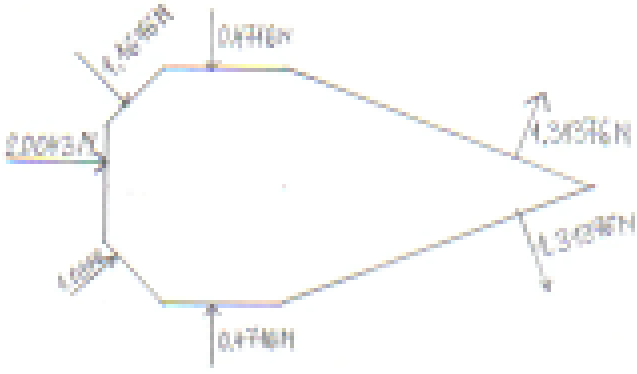
$F_{2-3} = \frac{0.008875 \cdot 180}{2} - \frac{0.004375 \cdot 24}{2} = 0.48125 - 0.01965 = 0.4716\ N$

$F_{3-6} = F_{2-3} = 0.4716\ N$

$F_{3-4} = \frac{72+24}{2} \cdot 0.02737 = 1.31376\ N$

$F_{4-5} = F_{3-4} = 1.31376\ N$

$F_{7-6} = \frac{180+192}{2} \cdot 0.00695 = 1.0842\ N$



$\sin\alpha = 0.35816967$

$\cos\alpha = 0.93332154$

$\sum F_x = 2.0043 + 1.1676\cos 45 + 1.31376\sin\alpha + 1.31376\sin\alpha - 1.0842\cos 45 = 4.5397\ N$

$C_{F_{x_2}} = \frac{F_{x_2}}{\frac{1}{2}\rho U^2 A_{pr}} = \frac{4.5397}{\frac{1}{2} \cdot 1.2 \cdot 20^2 \cdot 0.01965} = 0.9626$

$\sum F_y = 1.1676\cos 45 + 0.4716 - 1.31376\cos\alpha + 1.31376\cos\alpha - 0.4716 + 1.0842\cos 45 = -0.0589\ N$

$C_{F_{y_2}} = \frac{F_y}{\frac{1}{2}\rho U^2 A_{pr}} = \frac{0.0589}{\frac{1}{2} \cdot 1.2 \cdot 20^2 \cdot 0.01965} = 0.01249$

$C_{F_{x_2}} < C_{F_{x_1}} \Rightarrow$ пресек 2 је повољнији

$A_{PPS} = d_S \cdot l = 50 \cdot 0.01965 = 0.9825\,mm^2$

$C_{Fx,y} = \frac{2 F_{x,y}}{\rho_v u_v^2 A_{PPS}} \Rightarrow F_{y,x} = \frac{C_{Fx,y} \cdot \rho_v u_v^2 \cdot A_{PPS}}{2}$

$F_x = \frac{C_{Fx} \cdot \rho_v \cdot u_v^2 \cdot A_{PPS}}{2} = \frac{0.9626 \cdot 1000 \cdot 1.2^2 \cdot 0.9825}{2} = 680.96\,N$

$F_y = \frac{C_{Fy} \cdot \rho_v \cdot u_v^2 \cdot A_{PPS}}{2} = \frac{0.01243 \cdot 1000 \cdot 1.2 \cdot 0.9825}{2} = 8.84\,N$

$F = \sqrt{F_x^2 + F_y^2} = \sqrt{463706.52 + 78.1456} = 681.02\,N/m$

ZADACI ZA OVERU PRISUSTVA NA VEŽBAMA

(Napomena: slike kostruisati u matrixu, a ne u opštim brojevima)

ZADATAK 9.1

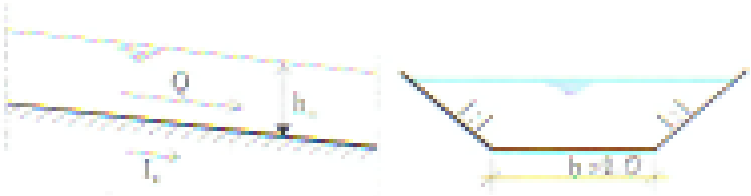
Za betonski kanal prikazan na slici, čiji je podužni nagib $I_0=5^0/_{00}$ i koef. hrapavosti obloge $n=0.018\ m^{-1/3}s$, potrebno je odrediti:

a) protok u kanalu, ako je normalna dubina $h_n=0.75+\frac{n}{50}$ m;

b) protok i Fruđov broj za dubine u kanalu h = 0.25 h_n, 0.75 h_n, h_n i 2 h_n. Nacrtati dijagram zavisnosti dubine vode u kanalu i protoka (krivu protoka). Vrednosti dubina se nanose na ordinatu, a vrednosti protoka na apscisu.

c) Koji je režim tečenja u kanalu pri normalnoj dubini?

d) Sračunati kritičnu dubinu koja odgovara protoku sračunatom pod a). Pri kom nagibu dna kanala bi kritična dubina ujedno bila i normalna?



ZADACI KOJI SE OCENJUJU NA NAREDNOM ČASU

ZADATAK 9.2

U horizontalnom kanala pravougaonog poprečnog preseka nalazi se široki prag visine $p=\frac{\delta-2\alpha}{50}$ m.

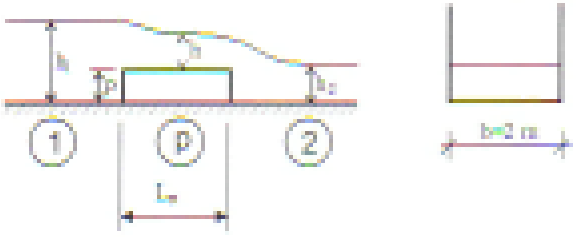
Ako je u preseku na pragu izmerena dubina $h=h_{kr}=0.45+\alpha/10$ m, sračunati:

a) protok kroz kanal;

b) dubine ispred i iza širokog praga, tako da je tečenje ispred praga u mirnom a iza praga u burnom režimu.

- gubitak energije između preseka 1 i p iznosi 15% brzinske visine u preseku p;
- gubitak energije između preseka p i 2 je 10% ulazne brzinske visine.

c) Skicirati liniju nivoa i energetsku liniju. Rastojanje između preseka sa jednake dvostrukoj dužini praga $L_p=3p$.



ZADATAK 9.3

U kanalu pravougaonog poprečnog preseka, širine dna b=2 m, postavljena je ustava. Protok kroz kanal je $Q=1.5+\frac{\beta-2\alpha}{25}$ m³/s. Sračunati:

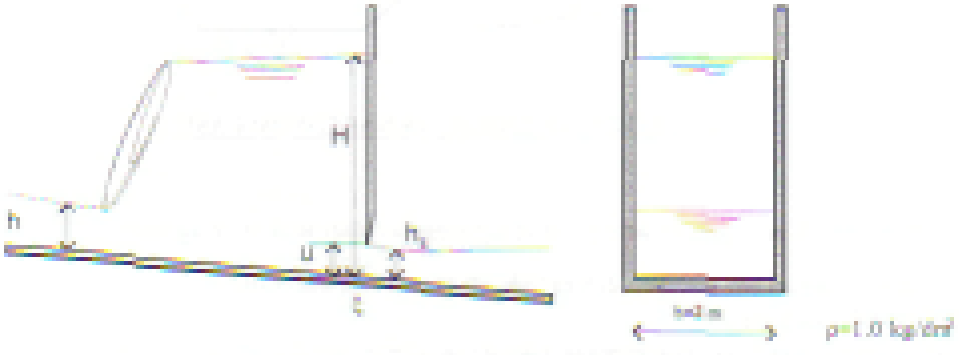
a) dubinu vode iza ustave h_u, ako je otvorenost ustave u=0.5m, a koef. kontrakcije mlaza 0.75;

b) dubinu vode neposredno ispred ustave H, ako je koeficijent gubitka energije između preseka ispred i iza ustave ξ=0.2;

c) kritičnu dubinu za dati protok;

d) specifične energije u presecima neposredno ispred (H) i iza ustave (h_u), kao i specifičnu energiju za kritičnu dubinu (h_{cr}) i nacrtati dijagram specifične energije. Dijagram specifične energije ima dve asimptote: vertikalnu (ordinatna osa) i kosu asimptotu (e = h);

e) dubinu vode u kanalu h, pod pretpostavkom da se ispred ustave formira hidraulički skok i da su dubine H i h konjugovane. Dubinu ispred skoka h odrediti očitavanjem sa dijagrama funkcije skoka. Dijagram funkcije skoka nacrtati na osnovu sračunatih vrednosti funkcije pri protoku $Q=1.5+\frac{\beta-2\alpha}{25}$ m³/s za vrednosti dubina od: $h=0.25h_{cr}$, $0.75h_{cr}$, h_{cr} i $2h_{cr}$ (gde je h_{cr} kritična dubina određena pod c)).

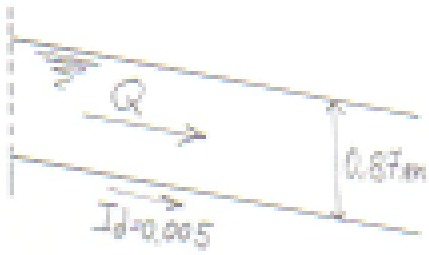


Zadatak 9.1

$I_d = 5\% = 0.005$

$n = 0.018\ m^{-1/3}s$

$h_{nk} = 0.87\ m$



a) $Q = \frac{1}{n} A R^{\frac{2}{3}} \sqrt{I_E}$

$A = \frac{2+2+2h}{2} \cdot h = \frac{4+2h}{2} \cdot h = (2+h) \cdot h = h^2 + 2h$

$O = 2 + 2 \cdot h \cdot \sqrt{2} = 2 + 2\sqrt{2}h$

$R = \frac{A}{O} = \frac{h^2+2h}{2(1+h\sqrt{2})}$

$Q = \frac{1}{n} \cdot (h^2+2h) \cdot \left(\frac{h^2+2h}{2(1+h\sqrt{2})}\right)^{\frac{2}{3}} \cdot \sqrt{I_E} =$

$= \frac{1}{0.018} \frac{(h^2+2h)^{\frac{5}{3}}}{(2+2h\sqrt{2})^{\frac{2}{3}}} \cdot \sqrt{0.005} = 3.92837 \frac{(h^2+2h)^{\frac{5}{3}}}{(2+2h\sqrt{2})^{\frac{2}{3}}}$

$Q(0.87) = 3.92837 \cdot \frac{(0.87^2+2\cdot 0.87)^{\frac{5}{3}}}{(2+2\cdot 0.87\sqrt{2})^{\frac{2}{3}}} = 6.662\ \frac{m^3}{s}$

b) $h_k = 0.25 \cdot 0.87 = 0.2175\ m$

$Q_k(0.2175) = 3.92837 \frac{(0.2175^2+2\cdot 0.2175)^{\frac{5}{3}}}{(2+2\cdot 0.2175\sqrt{2})^{\frac{2}{3}}} = 0.614\ \frac{m^3}{s}$

$F_{Rk} = \frac{Q^2 \cdot (2+2\cdot 0.2175)}{g\ A^3} = \frac{0.614^2 (2+2\cdot 0.2175)}{9.81 \cdot (0.2175^2+2\cdot 0.2175)^3} = 0.833$

$h_2 = 0.75 \cdot 0.87 = 0.6525\,m$

$$Q_2(0.6525) = 3.92837 \frac{(0.6525^2 + 2 \cdot 0.6525)^{\frac{5}{3}}}{(2 + 2 \cdot 0.6525\sqrt{2})^{\frac{3}{3}}} = 3.933 \frac{m^3}{s}$$

$$Fr_2 = \frac{Q_2^2 (2 + 2 \cdot 0.6525)}{g \cdot A^3} = \frac{3.933^2 \cdot (2 + 2 \cdot 0.6525)}{9.81 \cdot (0.6525^2 + 2 \cdot 0.6525)^3} = 1.0356$$

$h_3 = h_{kr} = 0.87\,m$

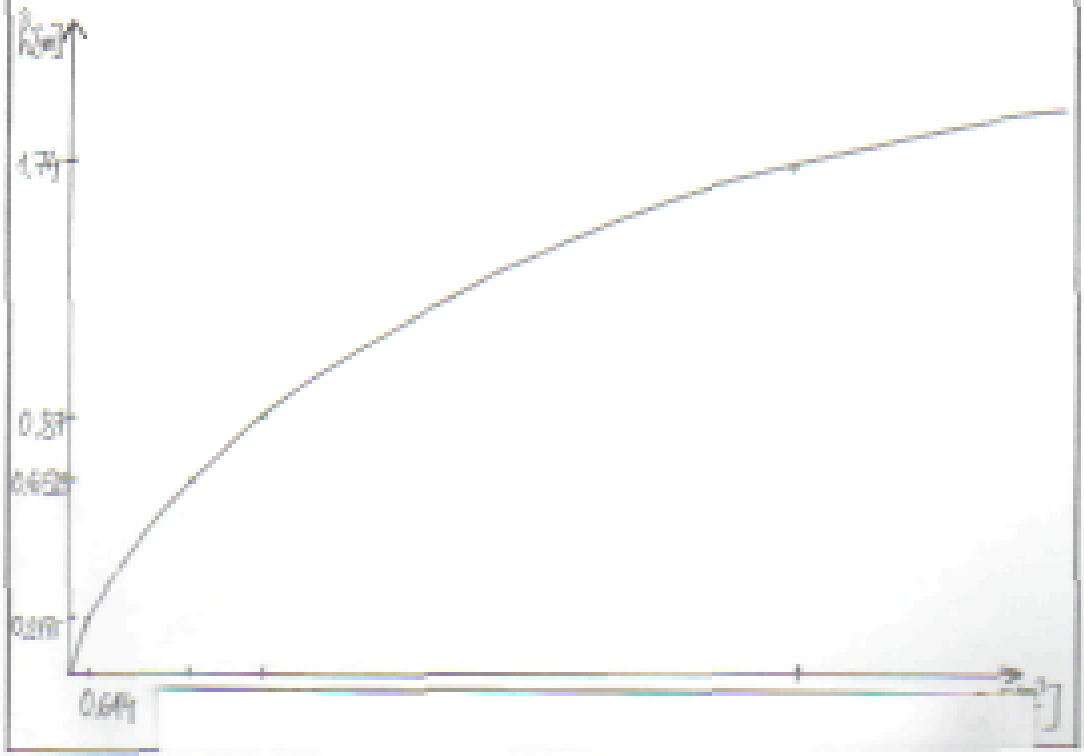
$$Q_3(0.87) = 6.662 \frac{m^3}{s}$$

$$Fr_3 = \frac{6.662^2 (2 + 2 \cdot 0.87)}{9.81 \cdot (0.87^2 + 2 \cdot 0.87)^3} = 1.087$$

$h_4 = 2 \cdot 0.87 = 1.74\,m$

$$Q_4(1.74) = 3.92837 \cdot \frac{(1.74^2 + 2 \cdot 1.74)^{\frac{5}{3}}}{(2 + 2 \cdot 1.74 \cdot \sqrt{2})^{\frac{3}{3}}} = 24.535 \frac{m^3}{s}$$

$$Fr_4 = \frac{24.535^2 (2 + 2 \cdot 1.74)}{9.81 \cdot (1.74^2 + 2 \cdot 1.74)^3} = 1.2201$$



c) $Fr_3 = 1.087 > 1$ буран режим

d) $Fr > 1 \Rightarrow h < h_{cr} \Rightarrow h_{cr} > 0.87m$

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

$F_r = \frac{\text{инерц.}}{\text{сила}} \rightarrow$

$\leftarrow$

$B = 2 + 2 \cdot h_{cr}$

$A = h_{cr}^2 + 2 \cdot h_{cr}$

$$1 = \frac{6.662^2 \cdot (2 + 2h_{cr})}{9.81 (h_{cr}^2 + 2 \cdot h_{cr})^5} = 4.5242 \cdot \frac{2 + 2h_{cr}}{(h_{cr}^2 + 2 \cdot h_{cr})^3}$$

$$0.22103 = \frac{2 + 2h_{cr}}{(h_{cr}^2 + 2h_{cr})^3}$$

$h_{cr} = 0.9m$

$0.22103 \neq 0.21373$

$h_{cr} = 0.89m$

$0.22103 \neq 0.22214$

$h_{cr} = 0.88$

$0.22103 \neq 0.2309$

$h_{cr} = 0.885$

$0.22103 \neq 0.2265$

$h_{cr} = 0.8875$

$0.22102 \neq 0.22431$

$h_{cr} = 0.888$

$0.22103 \neq 0.22312$

$h_{cr} = 0.891$

$0.22103 = 0.22123$

$$h_{cr} = 0.891m$$

$$6.662 = \frac{1}{0.018} \frac{(0.891^2 + 2 \cdot 0.891)^{\frac{5}{2}}}{(2 + 2 \cdot 0.891 \cdot \sqrt{2})^3} \cdot \sqrt{I_d}$$

$$6.662 = 98.421571 \sqrt{I_d}$$

$$\sqrt{I_d} = 0.06768$$

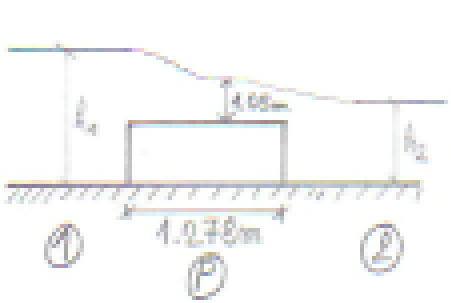
$$I_d = 0.2601 \approx 2.6\%$$

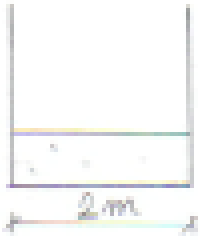
Задатак 9.2

$P = \frac{33 - 2 \cdot 6}{50} = 0.426 m$

$L_P = 1.278 m$

$h = h_{cr} = 1.05 m$





a) $F_R = 1$

$F_R = \frac{Q^2 B}{g A^3}$

$B = 2m$

$A = B h_{cr} = 2 \cdot 1.05 = 2.1 m^2$

$\frac{Q^2 \cdot 2}{9.81 \cdot 2.1^3} = 1$

$Q^2 = 45.425 \quad Q = 6.74 \frac{m^3}{s}$

$Q = V_P A_P$

$V_P = \frac{Q}{A_P} = \frac{6.74}{2.1} = 3.21 \frac{m}{s}$

b) $F_{R_1} < 1$

$F_{R_2} > 1$

$E_1 = E_P + \Delta E_{1-P}$

$\Delta E_{1-P} = 0.15 \frac{V_P^2}{2g} = 0.15 \cdot \frac{3.21^2}{2 \cdot 9.81} = 0.079 m$

$\Pi_1 + \frac{V_1^2}{2g} = \Pi_P + \frac{V_P^2}{2g} + \Delta E_{1-P}$

$\Pi_1 = h_1 \quad A_1 = 2 \cdot h_1$

$V_1 = \frac{Q}{A_1} = \frac{6.74}{2h_1} = \frac{3.37}{h_1}$

$$\Pi_P + \frac{v_P^2}{2g} = \Pi_2 + \frac{v_2^2}{2g} + \Delta E_{P-2}$$

$\Pi_P = 1.476\,m$

$$1.476 + \frac{3.21^2}{2 \cdot 9.81} = h_2 + \frac{3.37^2}{2 \cdot 9.81 \cdot h_2^2} + \frac{0.05782}{h_2^2}$$

$$1.476 + 0.5252 = h_2 + \frac{0.5788}{h_2^2} + \frac{0.05782}{h_2^2}$$

$$2.0012 = h_2 + \frac{0.63668}{h_2^2} \quad / \cdot h_2^2$$

$$2.0012 h_2^2 = h_2^3 + 0.63668$$

$$h_2^3 - 2.0012 h_2^2 + 0.63668 = 0$$

$h_{2_1} = 1.806\,m$ jer je $h_2 < \Pi_P$

$h_{2_2} = -0.504\,m$

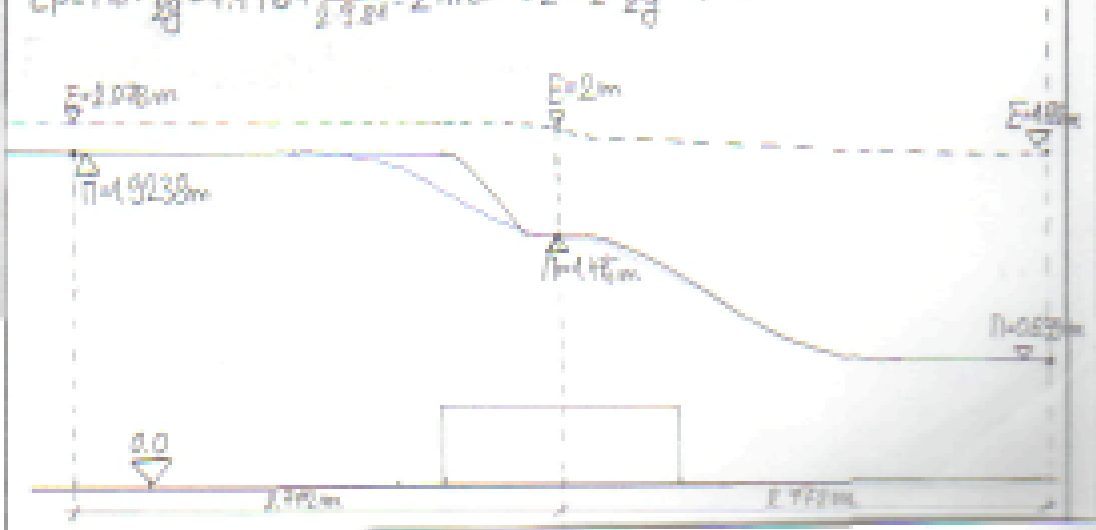
$h_{2_3} = 0.699\,m$ $\Rightarrow h_2 = 0.699\,m$

$h_{kritc} = 1.05\,m$

$$V_1 = \frac{3.37}{1.9238} = 1.75\,\frac{m}{s} \qquad V_2 = \frac{3.37}{0.699} = 4.82\,\frac{m}{s}$$

$$E_1 = \Pi_1 + \frac{v_1^2}{2g} = 1.9238 + \frac{1.75^2}{2 \cdot 9.81} = 2.079\,m$$

$$E_P = \Pi_0 + \frac{v_P^2}{2g} = 1.476 + \frac{3.21^2}{2 \cdot 9.81} = 2\,m \qquad E_2 = \Pi_2 + \frac{v_2^2}{2g} = 1.88\,m$$



$\Pi_p = p + h = 0.426 + 1.05 = 1.476\,m$

$h_1 + \frac{3.37^2}{2 \cdot 9.81 \cdot h_1^2} = 1.476m + \frac{3.21^2}{2 \cdot 9.81} + 0.079$

$h_1 + \frac{0.5788}{h_1^2} = 1.476 + 0.5252 + 0.079$

$h_1 + \frac{0.5788}{h_1^2} = 2.0802 \,/ h_1^2$

$h_1^3 + 0.5788 = 2.0802 h_1^2$

$h_1^3 - 2.0802 h_1^2 + 0.5788 = 0$

$h_{1_1} = 1.9238m$

$h_{1_2} = -0.4759m$

$h_{1_3} = 0.6322m$ jer $h_1 > \Pi_p$

$1 = \frac{Q^2 B}{g A_1^3} = \frac{6.74^2 \cdot 2}{9.81 \cdot 8 \cdot h_{cr}^3} = 1.1577 \cdot \frac{1}{h_{cr}^3}$

$h_{cr}^3 = 1.1577$

$h_{cr} = 1.05m$

$Fr < 1 \Rightarrow h_1 > h_{cr} \Rightarrow h_{1_1} > h_{cr} \Rightarrow h_1 = 1.9238m$

$E_p = E_2 + \Delta E_{p-2}$

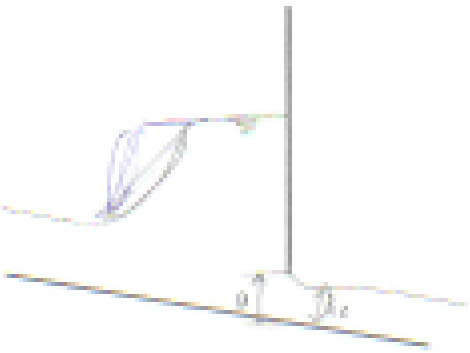
$\Delta E_{p-2} = 0.1 \frac{V_2^2}{2g} \quad A_2 = 2h_2$

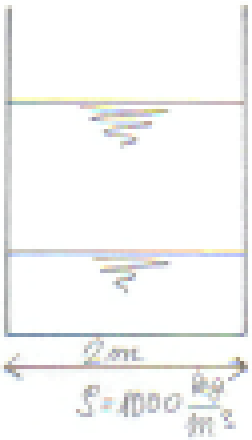
$V_2 = \frac{Q}{A_2} = \frac{6.74}{2h_2} = \frac{3.37}{h_2}$

$\Delta E_{p-2} = 0.1 \cdot \frac{3.37^2}{2 \cdot 9.81 \cdot h_2^2} = 0.05788 \frac{1}{h_2^2} = \frac{0.05788}{h_2^2}$

Задатак 9.3

$Q = 2.352 \frac{m^3}{s}$





a) $u = 0.5 m$

$c = 0.75$

$h_s = c \cdot u = 0.375 m$

$F_r = \frac{Q^2 B}{g A^3} = \frac{2.352^2 \cdot 2}{9.81 \cdot (2 \cdot 0.375)^3} = 2.67 > 1$ superkritično

б) $E_{uzv} = E_{niz} + \Delta E_{u-n}$

$V_{niz} = \frac{Q}{A_{niz}} = \frac{2.352}{2 \cdot 0.375} = 3.136 \frac{m}{s}$

$V_{uzv} = \frac{Q}{A_{uz}} = \frac{2.352}{2 \cdot H} = \frac{1.176}{H}$

$\Delta E_{u-n} = \xi \frac{V_{niz}^2}{2g} = 0.2 \cdot \frac{3.136^2}{2 \cdot 9.81} = 0.1 m$

$\Pi_{uzv} = H$

$H + \frac{V_{uz}^2}{2g} = h_s + \frac{V_{niz}^2}{2g} + \Delta E_{u-n}$

$H + \frac{1.176^2}{2 \cdot 9.81 \cdot H^2} = 0.375 + \frac{3.136^2}{2 \cdot 9.81} + 0.1$

$H + \frac{0.0705}{H^2} = 0.9762 / \cdot H^2$

$H^3 + 0.0705 = 0.9762 H^2$

$H^3 - 0.9762 H^2 + 0.0705 = 0$

$H_1 = 0.886 m$

$H_2 = 0.244 m \Rightarrow H = 0.886 m$

$H_3 = 0.330 m$ $\quad V_{uz} = \frac{1.176}{0.886} = 1.327 \frac{m}{s}$

c) $Fr=1$

$$Fr=\frac{Q^2 B}{g A^3}$$

$$1=\frac{2.352^2 \cdot 2}{9.81 \cdot 2^3 \cdot h_{cr}^3}$$

$$1=0.14097\,\frac{1}{h_{cr}^3}$$

$$h_{cr}^3=0.14097$$

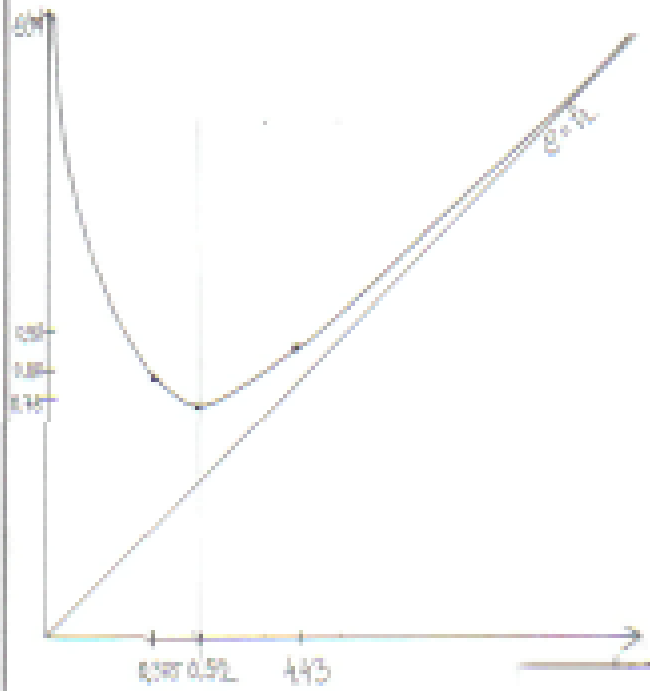
$$h_{cr}=0.52\,m$$

d) $E(H)=H+\frac{V_{02}^2}{2g}=0.826+\frac{1.327^2}{2\cdot 9.81}=0.9758\,m$

$$E(h_s)=h_s+\frac{V_{m2}^2}{2g}=0.375+\frac{3.136^2}{2\cdot 9.81}=0.8762\,m$$

$$V_{cr}=\frac{Q}{A_{cr}}=\frac{2.352}{2\cdot 0.52}=2.262\,\frac{m}{s}$$

$$E(h_{cr})=h_{cr}+\frac{V_{cr}^2}{2g}=0.52+\frac{2.262^2}{2\cdot 9.81}=0.7808\,m$$



е) $G \approx 0$

$h_н$ H кипящее $\Rightarrow \Phi(h_1) = \Phi(H)$

$$\Phi(h) = h_т A + \frac{Q^2}{gA}$$

$A = 2 \cdot h$

$h_т = \frac{h}{2}$

$$\Phi(h) = \frac{h}{2} \cdot 2h + \frac{Q^2}{g2h} = h^2 + \frac{Q^2}{2gh}$$

$$\Phi(h) = h^2 + \frac{2.352^2}{2 \cdot 9.81h} = h^2 + \frac{0.2819}{h}$$

$h_{кр} = 0.25 \cdot h_{cr} = 0.25 \cdot 0.52 = 0.13m$

$$\Phi_1(0.13) = 0.13^2 + \frac{0.2819}{0.13} = 0.0169 + 2.16846 = 2.19m^3$$

$h_2 = 0.75 h_{cr} = 0.75 \cdot 0.52 = 0.39m$

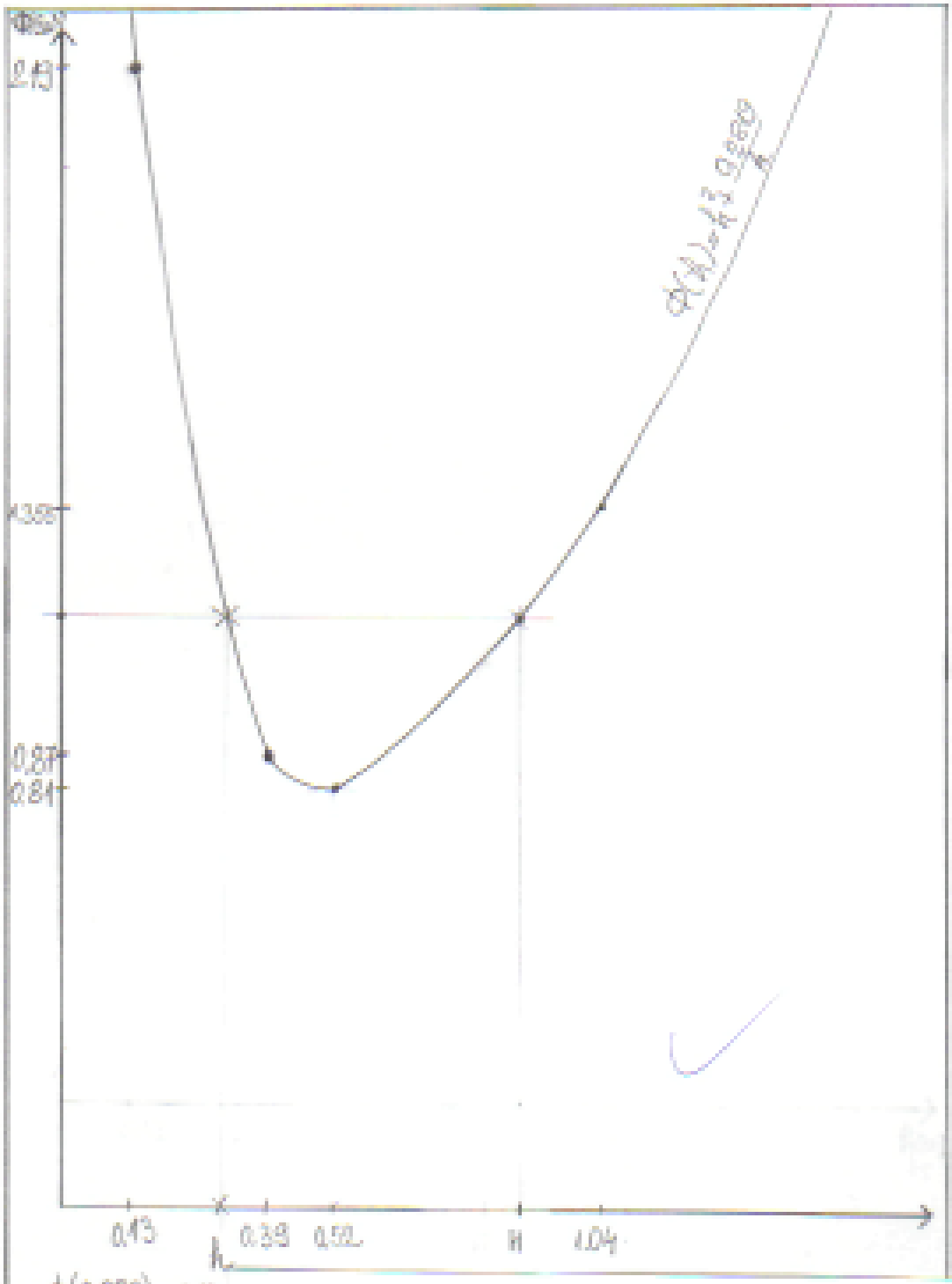
$$\Phi_2(0.39) = 0.39^2 + \frac{0.2819}{0.39} = 0.1521 + 0.723 = 0.87m^3$$

$h_3 = h_{cr} = 0.52m$

$$\Phi_3(0.52m) = 0.52^2 + \frac{0.2819}{0.52} = 0.2704 + 0.5421 = 0.81m^3$$

$h_4 = 2 h_{cr} = 1.04m$

$$\Phi_4(1.04) = 1.04^2 + \frac{0.2819}{1.04} = 1.0816 + 0.271 = 1.353m^3$$

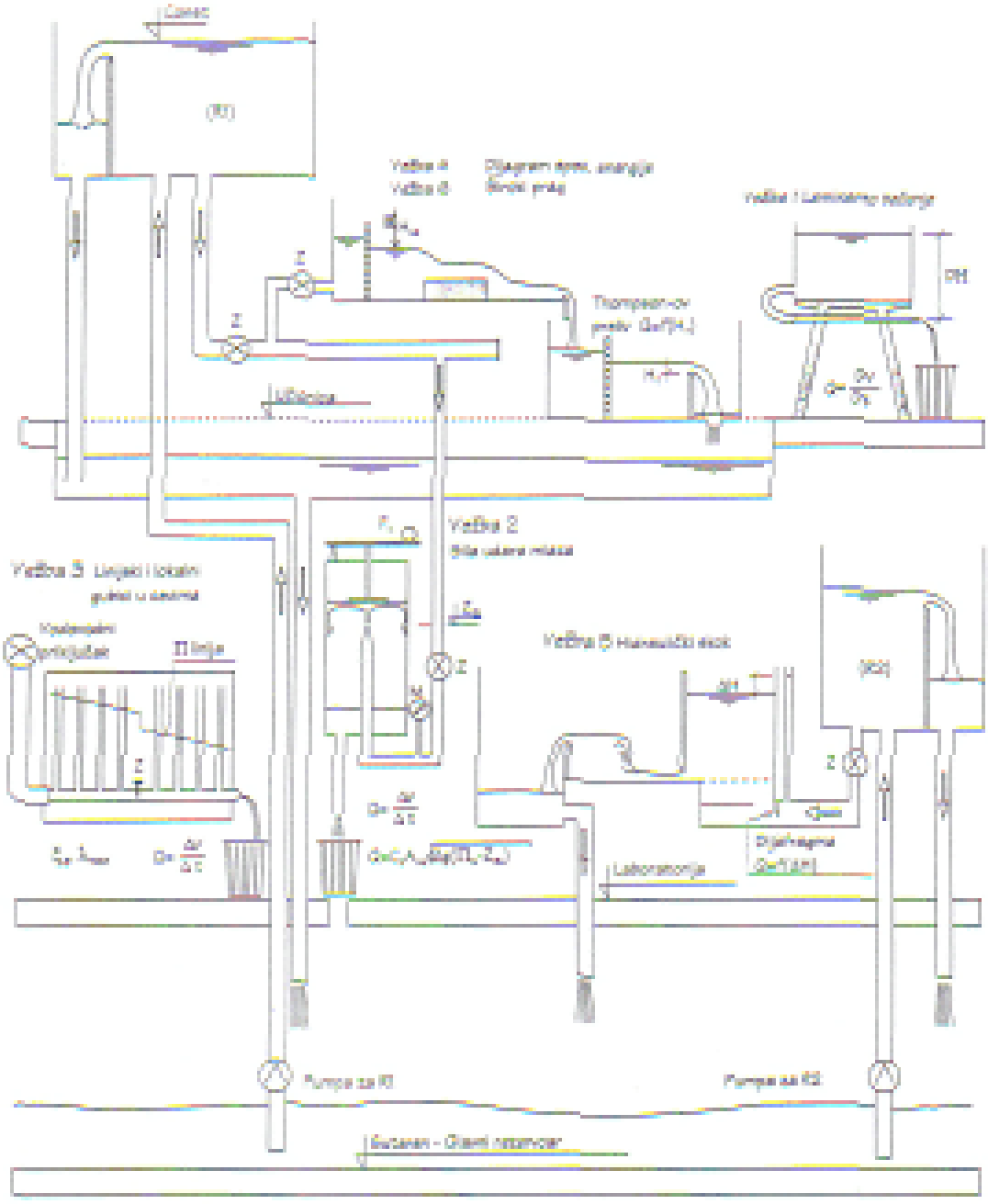


$h(0.886) = 1.14$

$h = 0.34\,m$

Uvod u laboratorijske vježbe

(Mehanika fluida)



Na laboratorijskoj instalaciji, prikazanoj na slici, mere se:

- protok, odnosno brzina tečenja (ΔV) i vreme merenja (Δt), i
- denivelacija (ΔH) između nivoa vode u tanku i izlaznog preseka.

Uz zanemarenje svih lokalnih i linijskih gubitaka koje nastaju u cevi i pretpostavku da je koeficijent gubitka energije na ulazu u tanku cev približno konstantan u celoj oblasti tečenja i da je jednak 0,6, denivelacija (ΔH) je jednaka:

$$\Delta H = \frac{v^2}{2g}\left(0{,}6 + \lambda\,\frac{L}{d} + 1{,}0\right)$$

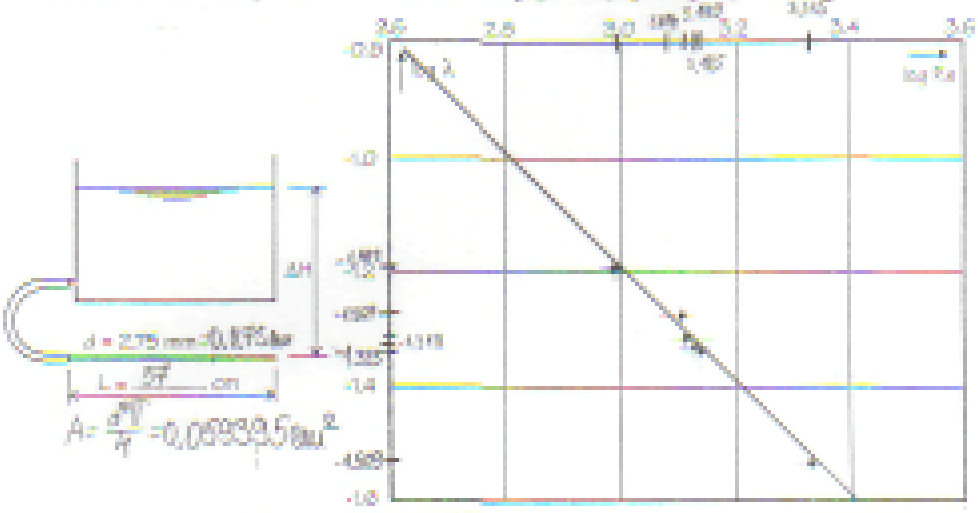
za laminarno tečenje koje se pretpostavlja u cevi, koeficijent trenja je dat sledećim izrazom:

$$\lambda = \frac{64}{Re} \qquad \text{gde je} \qquad Re = \frac{dV}{\nu}$$

Odrediti:

- kinematski koeficijent viskoznosti (ν) iz izraza $\nu = \frac{d^2 V}{64L}\left(\frac{2g\,\Delta H}{v^2} - 1{,}6\right)$

- Rejnoldsov broj (Re) i koeficijent trenja (λ), koristeći dobijenu vrednost koeficijenta viskoznosti. Dobijene vrednosti predstaviti kao tačke na dijagramu (log λ, log Re).



	MERENJE			RAČUNANJE							
	ΔV	Δt	ΔH*	Q	v	v**	v_{sr}	Re	λ	log Re	log λ
	cm³	s	cm	cm³/s	cm/s	cm²/s	cm²/s	-	-	-	-
1	965	0,46	44,4	2.097	340,5	0,0033	0,0031	2.833	0,023	3,453	-1,638
2	965	0,56	39,8	1.723	279,8	0,0033		2.328	0,027	3,367	-1,569
3	965	0,66	35,3	1.462	237,4	0,0033		1.975	0,032	3,296	-1,495
4	965	0,76	31,2	1.270	206,2	0,0033		1.716	0,037	3,234	-1,432
5	965	0,86	27,6	1.122	182,2	0,0033		1.516	0,042	3,181	-1,377
6	965	0,96	24,6	1.005	163,2	0,0033		1.358	0,047	3,133	-1,328

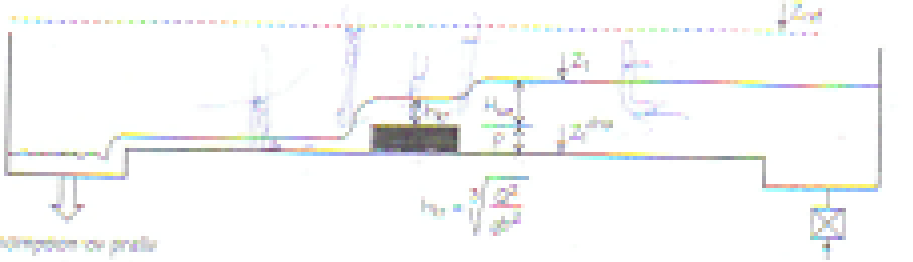
*) Napomena: ΔH meriti sa tačnošću od 0,2 mm

**) Napomena: ν = 0,0031 cm²/s

ν = 0,0031

✓

Laboratorijski kanal 1:
Širina kanala b = 10 cm



Meri se:

- protok, Thompson-ovim prelivom:

$$Q = \frac{8}{15}\sqrt{2g}\,H_T^{2,5} \qquad ; \qquad H_T = h_T - h_0$$

- uzvodna dubina:

$$H_{uz} = z_1^{dno} - z_1 - p$$

Odredi:

- koeficijent protoka:

$$C_Q = \frac{Q}{b\sqrt{2g}\,H_{uz}^{2,5}} \qquad Y_{uz} = \frac{Q}{b\,(H_{uz}+p)}$$

- koeficijent lokalnog gubitka energije između presека (uz) i preseka na pragu, u kome se javlja kritična dubina.

$z_1^{dno} = 27.32$ cm $z_2^{dno} = 28.93$ cm $p = 5.6$ cm

$z_1^{dno} - p = 33.13$ cm

		MERENO		RAČUNATO								
		h_T	z_1	Q	H_{uz}	$\sqrt{2g}H_{uz}^{2,5}$	C_Q	h_{cr}	$\frac{v^2}{2g}$	$\frac{v^2}{2g}$	Y_{uz}	k_{uz}
		cm	cm	L/s	cm	L/s	-	cm	cm	cm	-	Cas
PREDEK	1	43.04	-23.6	1.083	3.53	3.53	0.307	2.02	1.047	0.05	0.53	1.33
	2	43.34	-23.86	1.231	3.87	4.047	0.304	2.2	1.118	0.06	0.56	3.67
	3	44.3	-22.34	1.782	4.79	5.572	0.32	2.82	1.413	0.1	0.46	10.59
	4	45.1	-21.51	2.337	5.62	7.082	0.33	3.34	1.733	0.15	0.4	11.42
	5	43.73	-23.11	1.474	4.92	4.284	0.344	2.48	1.25	0.08	0.296	3.82

*) Napomena: uplelisati direktno čitanja sa manometra

Ламинарно течење у цеви

$d = 0.275 cm$

$L = 57 cm$

$V = \frac{d^2 V}{64L}\left(\frac{2.98\Delta H}{V^2} - 1.6\right) = \frac{0.275^2 \cdot V}{64 \cdot 57}\left(\frac{2.981\Delta H}{V^2} - 1.6\right) =$

$= 0.00002073V(1962\frac{\Delta H}{V^2} - 1.6)$

$Re = \frac{dV}{\nu} = \frac{0.275V}{0.01007} = 27.308838V$

Преливање преко широког прага

$H_{t_1} = 0.0542m$ $H_{t_4} = 0.0778m$

$H_{t_2} = 0.0602m$ $H_{t_5} = 0.0647m$

$H_{t_3} = 0.0638m$

$F_R = \frac{Q^2 B}{gA^3} = 1$ $F_R = \frac{Q^2 \cdot B}{g \cdot B^3 \cdot h_{cr}} = \frac{Q^2}{g B^2 h_{cr}} = 1$

$B = 0.1Q$

$A = B h_{cr}$

$h_{cr}^3 = \frac{Q^2}{gB^2}$ $h_{cr} = \sqrt[3]{\frac{Q^2}{gB^2}}$

$V_{kr} = \frac{Q}{b \cdot h_{cr}}$

$\frac{V_{cr}^2}{2g} = \frac{Q^2}{2gb^2 h_{cr}^2}$

$V_{uz} = \frac{Q}{b \cdot h_{uz}} = \frac{Q}{b(z_u^{kon} - z_4)}$ $\frac{V_{uz}^2}{2g} = \frac{Q^2}{2gb^2(z_u^{kon} - z_4)^2}$

$h_{uz} = z_u^{kon} - z_4$

$E_{uz} = E_0 + \Delta E_{uz-p}$

$\Pi_{uz} + \frac{V_{uz}^2}{2g} = \Pi_n + \frac{V_{kp}^2}{2g} + \xi_{+P} \cdot \frac{V_k^2}{2g}$

$\Pi_{uz} = h_{uz}$

$\Pi_n = h_{cr} + P$

$$h_{wz} + \frac{V_{wz}^2}{2g} = h_{cr} + P + \frac{V_k^2}{2g}(1+\xi_{1-P})$$

$$h_{wz} + \frac{V_{wz}^2}{2g} - h_{cr} - P = \frac{V_k^2}{2g}(1+\xi_{1-P})$$

$$\frac{h_{wz} + \frac{V_{wz}^2}{2g} - h_{cr} - P}{\frac{V_k^2}{2g}} = 1 + \xi_{1-P}$$

$$\xi_{1-P} = \frac{h_{wz} + \frac{V_{wz}^2}{2g} - h_{cr} - P}{\frac{V_k^2}{2g}} - 1$$

$$\xi_{1-P,1} = \frac{9.33 + 0.05 - 2.02 - 5.8}{1.047} - 1 = 0.53$$

$$\xi_{1-P,2} = \frac{9.67 + 0.06 - 2.2 - 5.8}{1.108} - 1 = 0.56$$

$$\xi_{1-P,3} = \frac{10.53 + 0.1 - 2.82 - 5.8}{1.413} - 1 = 0.16$$

$$\xi_{1-P,4} = \frac{11.42 + 0.15 - 3.34 - 5.8}{1.753} - 1 = 0.40$$

$$\xi_{1-P,5} = \frac{9.82 + 0.08 - 2.48 - 5.8}{1.25} - 1 = 0.196$$