

Proračun bočnog preljeva

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UNIVERSITY OF SPLIT





SVEUČILIŠTE U SPLITU



FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I
GEODEZIJE

ZAVRŠNI RAD

SPLIT, 16.09.2020.

IVAN BARAĆ



SVEUČILIŠTE U SPLITU



FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I
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ZAVRŠNI RAD

SPLIT, 16.09.2020

1. SAŽETAK

Tema završnog rada je projektiranje bočnog preljeva na kanalizacijskom kolektoru. Kanalizacijski sustav je mješovitog tipa. Zadani su dotoci za sušni period kao i maksimalni dotok koji se preljeva posebnim odvodnim kanalom u more. Proračun se radi tako da se osigura preljev u mirnome režimu.

Ključne riječi: bočni preljev, prigušnica, mirni režim, siloviti režim

2. ZADATAK

PREDMET: OSNOVE VODOGRADNJE

STUDENT: IVAN BARAĆ

ZADATAK ZA ZAVRŠNI RAD

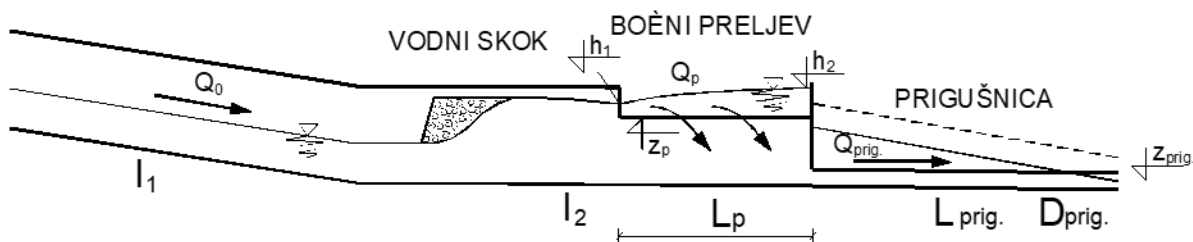
Potrebno je projektirati bočni preljev na kanalizacijskom kolektoru. Kanalizacijski sustav je mješovitog tipa.

Sušni dotok iznosi $Q_s=50$ (l/s). Preljev treba projektirati tako da se prelijevanje preko bočnog preljeva aktivira kod trostrukog protoka od Q_s , odnosno kod protoka od 150 (l/s). U tu svrhu treba projektirati prigušnicu odgovarajućeg promjera. Kroz prigušnicu se propušta protok prema uređaju za pročišćavanje, a višak vode (maksimalni dotok iznosi 3000 (l/s)), se prelijeva posebnim odvodnim kanalom u more.

Preljevanje treba biti u mirnom režimu. Kako bi se osiguralo prelijevanje u mirnom režimu, a dolazni dotok teče u silovitom režimu, potrebno je tako projektirati dio kolektora uz preljev da se vodni skok ostvaruje uzvodno od preljeva.

Izračun prelijevanja vode preko preljeva izvesti sljedeći način:

1. Preljevanje preko preljeva računati uz pretpostavku da je dubina ispred preljeva, duž cijelog preljeva, konstantna, te da se bočni preljev može računati kao čeonu oštrobridni preljev.



Slika 1. Shematski hidraulički uzdužni presjek

Zadano je:

$$I_1=0.04,$$

$$I_2=0.001,$$

$$D_1=1.4 \text{ (m)},$$

$$\varepsilon = 0.0015 \text{ (m)},$$

$$\nu = 0.00000131 \text{ (m}^2/\text{s)},$$

$m=0.4$ (za prelijevanje u varijanti 1)

$$L_p=?,$$

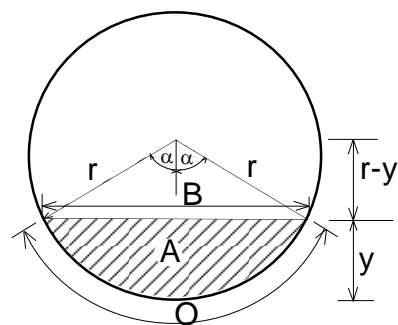
$$z_p=?,$$

$$z_{prig.} = 100 \text{ (m.n.m)}$$

$$D_{prig.}=?$$

$$L_{prig.}=?$$

Na slici 2. dat je poprečni presjek cijevi s osnovnim geometrijskim karakteristikama.



Slika 2. Poprečni presjek cijevi

$$\cos(\alpha) = \left(\frac{r-y}{r}\right) \rightarrow \alpha = \arccos\left(\frac{r-y}{r}\right) \quad (1)$$

$$B = 2 \cdot r \cdot \sin(\alpha) \quad (2)$$

$$A = r^2 \cdot \pi \cdot \frac{2\alpha}{2\pi} - B \cdot \frac{r-y}{2} = r^2 \cdot \left[\alpha - \sin(\alpha) \cdot \left(\frac{r-y}{r}\right)\right] = r^2 \cdot \alpha - r \cdot (r-y) \cdot \sin(\alpha) \quad (3)$$

Istjecanje kroz prigušnicu računati prema:

$$Q_{prig.} = \frac{1}{\sqrt{\xi_u + \lambda \cdot \frac{L_{prig.}}{D_{prig.}} + \alpha}} \sqrt{2g \cdot (h_2 - z_{prig.})} \cdot D_{prig.}^2 \cdot \frac{\pi}{4} \quad (4)$$

U varijanti 1 vodostaj duž preljeva je konstantan i iznosi h_2 , a preljevni protok treba računati prema:

$$\text{ako je } h_2 > z_p, \quad Q_p = m \cdot L_p \cdot \sqrt{2g} \cdot (h_2 - z_p)^{3/2} \quad (5)$$

$$\text{ako je } h_2 = z_p, \quad Q_p = 0.00 \quad (6)$$

$$\text{ako je } h_2 < z_p, \quad Q_{p2} = 0.00 \quad (7)$$

$$Q_0 = Q_{prig.} + Q_p. \quad (8)$$

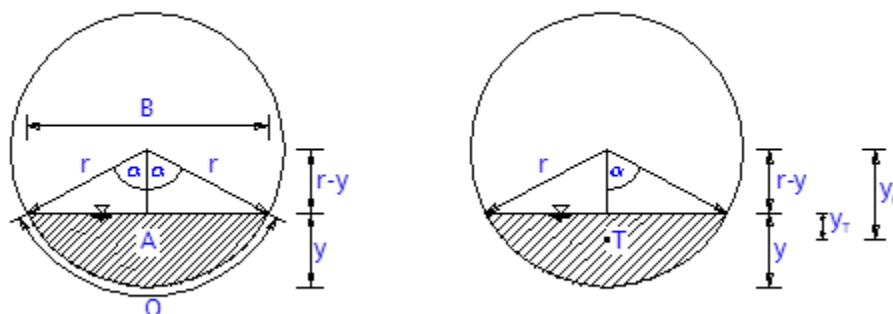
Split, 24.05.2020.

Doc. dr. sc. Davor Bojanić

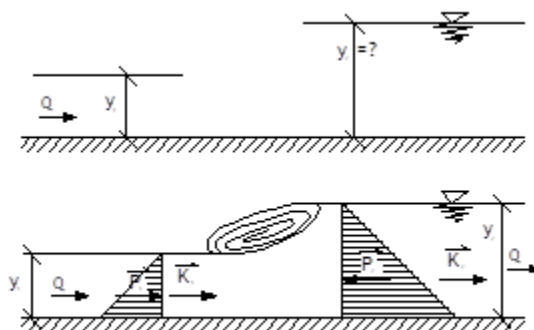
3. SADRŽAJ

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4. KORIŠTENE FORMULE I PRISTUP PUTEM IZRADE PRORAČUNA



Slika 1. Poprečni presjek kanala



Slika 2. Količine gibanja i tlačne sile u kanalu pri vodnom skoku

Rješenje:

Zadano je:

Q, y_1, R, ρ, g

Izračuna se:

$\rightarrow a_1, A_1, y_{01}, y_{T1}, P_1, K_1, P_1+K_1$

POSTUPAK:

$$\cos(\alpha) = \left(\frac{r-y}{r} \right) \Rightarrow \alpha = \arccos\left(\frac{r-y}{r} \right);$$

$$B = 2r \sin(\alpha)$$

$$A = r^2 \pi \frac{2\alpha}{2\pi} - B \frac{r-y}{2} = r^2 \left[\alpha - \sin(\alpha) \left(1 - \frac{y}{r} \right) \right] = r^2 \alpha - r \cdot (r-y) \cdot \sin(\alpha);$$

$$O = 2r\alpha$$

$$y_0 = \frac{2}{3} r \frac{\sin^3 \alpha}{\alpha - \sin \alpha \cdot \cos \alpha}$$

$$y_T = y_0 - (r-y) = y_0 + y - r$$

$$K = \rho \cdot Q \cdot v$$

$$P = \rho \cdot g \cdot y_T \cdot A$$

$$K_1 = \rho \cdot Q \cdot v_1$$

$$P_1 = \rho \cdot g \cdot y_{T1} \cdot A_1$$

Q (m ³ /s)	y ₁ (m)	r (m)	ρ (kg/m ³)	g (m/s ²)	α (rad)	A ₁ (m ²)	v ₁ (m/s)	y ₀₁ (m)	y _{T1} (m)	K ₁ (N)	P ₁ (N)	K ₁ +P ₁ (N)
30,000	1,000	4,000	1000	9,81	0,7227	3,626	8,272	3,405	0,405	248173,6	14394,8	262568,4

Tablica 1. Izračun hidrauličkih parametara u profilu prve konjugirane dubine

Pretpostavi se y₂ i izračuna:

→ a₂, A₂, y₀₂, y_{T2}, P₂, K₂, P₂+K₂

$$K_2 = \rho \cdot Q \cdot v_2$$

$$P_2 = \rho \cdot g \cdot y_{T2} \cdot A_2$$

y _{2p} (m)	α ₂ (rad)	A ₂ (m ²)	v ₂ (m/s)	y ₀₂ (m)	y _{T2} (m)	K ₂ (N)	P ₂ (N)	K ₂ +P ₂ (N)	$\frac{\partial \alpha_2}{\partial y_2}$	$\frac{\partial A_2}{\partial y_2}$	$\frac{\partial K_2}{\partial y_2}$	N	$\frac{\partial y_0}{\partial y_2}$	$\frac{\partial y_{T2}}{\partial y_2}$	$\frac{\partial P_2}{\partial y_2}$	$\frac{\partial F}{\partial y_2}$	F	y _{2novo} (m)
2,9948	1,3168	17,177	1,747	2,252	1,247	52395,8	210172,6	262568,4	0,2583	7,7433	-23619,8	1,0736	-0,6398	0,3602	155447,11	131827,312	0,0000	2,9948

Tablica 2. Izračun druge konjugirane dubine na temelju pretpostavljene vrijednosti y₂

$$K_1 + P_1 = K_2 + P_2$$

Newton-ova metoda

$$F(y) = K_2 + P_2 - (K_1 + P_1) \equiv 0 \text{ (kod točnog rješenja).}$$

U iteraciji Newton-ovim postupkom, nova vrijednost dubine y₂ računa se na sljedeći način:

$$y_2^N = y_2^{\text{pretp}} - \frac{F(y_2^{\text{pretp}})}{\left. \frac{\partial F}{\partial y} \right|_{y=y_2}}$$

gdje je:

- y_2^{pretp} "pretpostavljena" vrijednost za y_2 ,

- y_2^{n} "nova" vrijednost za y_2 .

$$\frac{\partial F}{\partial y} = \frac{\partial K_2}{\partial y} + \frac{\partial P_2}{\partial y}$$

$$\frac{\partial K_2}{\partial y} = ?$$

$$K_2 = \rho \cdot Q \cdot v_2 = \rho \cdot \frac{Q^2}{A_2} = \rho \cdot Q^2 \cdot A_2^{-1}$$

$$\frac{\partial K_2}{\partial y} = -\rho \cdot \frac{Q^2}{A_2^2} \cdot \frac{\partial A_2}{\partial y}$$

$$\frac{\partial A}{\partial y} = r^2 \left[\frac{\partial \alpha}{\partial y} - \cos(\alpha) \frac{\partial \alpha}{\partial y} \left(1 - \frac{y}{r}\right) - \left(-\frac{1}{r}\right) \sin(\alpha) \right]$$

$$\frac{\partial \alpha}{\partial y} = \frac{d}{dy} \left[\arccos \left(\frac{r-y}{r} \right) \right] = -\frac{1}{\sqrt{1 - \left(\frac{r-y}{r}\right)^2}} \left(-\frac{1}{r} \right) = \frac{1}{r \sqrt{1 - \left(\frac{r-y}{r}\right)^2}}$$

$$\frac{\partial P_2}{\partial y} = ?$$

$$P_2 = \rho \cdot g \cdot y_{T2} \cdot A_2$$

$$\frac{\partial P_2}{\partial y} = \rho \cdot g \cdot \frac{\partial y_{T2}}{\partial y} \cdot A_2 + \rho \cdot g \cdot y_{T2} \cdot \frac{\partial A_2}{\partial y}$$

$$y_T = y_0 + y - r$$

$$\frac{\partial y_T}{\partial y} = \frac{\partial y_0}{\partial y} + 1$$

$$\frac{\partial y_0}{\partial y} = \frac{2}{3} \cdot r \cdot \frac{3 \sin^2 \alpha \cdot \cos \alpha \cdot \frac{\partial \alpha}{\partial y} \cdot (\alpha - \sin \alpha \cdot \cos \alpha) - \sin^3 \alpha \cdot \left(\frac{\partial \alpha}{\partial y} - (\cos^2 \alpha - \sin^2 \alpha) \cdot \frac{\partial \alpha}{\partial y} \right)}{(\alpha - \sin \alpha \cdot \cos \alpha)^2}$$

$$N = \alpha - \sin \alpha \cdot \cos \alpha$$

$$\frac{\partial y_0}{\partial y} = \frac{2}{3} \cdot r \cdot \sin^2 \alpha \cdot \frac{\partial \alpha}{\partial y} \cdot (3 \cos \alpha \cdot N - 2 \sin^3 \alpha) / N^2$$

$$F = K_2 + P_2 - (K_1 + P_1)$$

$$\frac{\partial F}{\partial y} = \frac{\partial K_2}{\partial y} + \frac{\partial P_2}{\partial y}$$

$$y_2^{\text{n}} = y_2^{\text{pretp}} - \frac{F(y_2^{\text{pretp}})}{\left. \frac{\partial F}{\partial y} \right|_{y=y_2}}$$

Koristeći iteraciju u Excel-u:

y_{2p} (m)	α_2 (rad)	A_2 (m ²)	v_2 (m/s)	y_{02} (m)	y_{12} (m)	K_2 (N)	P_2 (N)	K_2+P_2 (N)	$\frac{\partial \alpha_2}{\partial y_2}$	$\frac{\partial A_2}{\partial y_2}$	$\frac{\partial K_2}{\partial y_2}$	N	$\frac{\partial y_0}{\partial y_2}$	$\frac{\partial y_{T2}}{\partial y_2}$	$\frac{\partial P_2}{\partial y_2}$	$\frac{\partial F}{\partial y_2}$	F	y_{2novo} (m)
2,9948	1,3168	17,177	1,747	2,252	1,247	52395,8	210172,6	262568,4	0,2583	7,7433	-23619,8	1,0736	-0,6398	0,3602	155447,11	131827,312	0,00	2,9948

Tablica 3. Izračun druge konjugirane dubine iteracijom na temelju pretpostavljene vrijednosti y_2

5. PRORAČUN

VARIJANTA 1 (NAJPOVOLJNIJI SLUČAJ): $Z_P = 101$ (m.n.m), $L_P = 3$ (m)

Q_0 (m ³ /s)	h_2 izračunato	Q_p (m ³ /s)	$Q_{prig.}$ (m ³ /s)
0.100	100.44212	0	0.1
0.102	100.4599674	0	0.102
0.104	100.4781679	0	0.104
0.106	100.4967216	0	0.106
0.108	100.5156284	0	0.108
0.110	100.5348883	0	0.11
0.112	100.5545014	0	0.112
0.114	100.5744676	0	0.114
0.116	100.5947869	0	0.116
0.118	100.6154593	0	0.118
0.120	100.6364849	0	0.12
0.122	100.6578636	0	0.122
0.124	100.6795955	0	0.124
0.126	100.7016805	0	0.126
0.128	100.7241186	0	0.128
0.130	100.7469098	0	0.13
0.132	100.7700542	0	0.132
0.134	100.7935517	0	0.134
0.136	100.8174024	0	0.136
0.138	100.8416061	0	0.138
0.140	100.866163	0	0.14
0.142	100.8910731	0	0.142
0.144	100.9163362	0	0.144
0.146	100.9419525	0	0.146
0.148	100.9679219	0	0.148
0.150	100.9942445	0	0.15

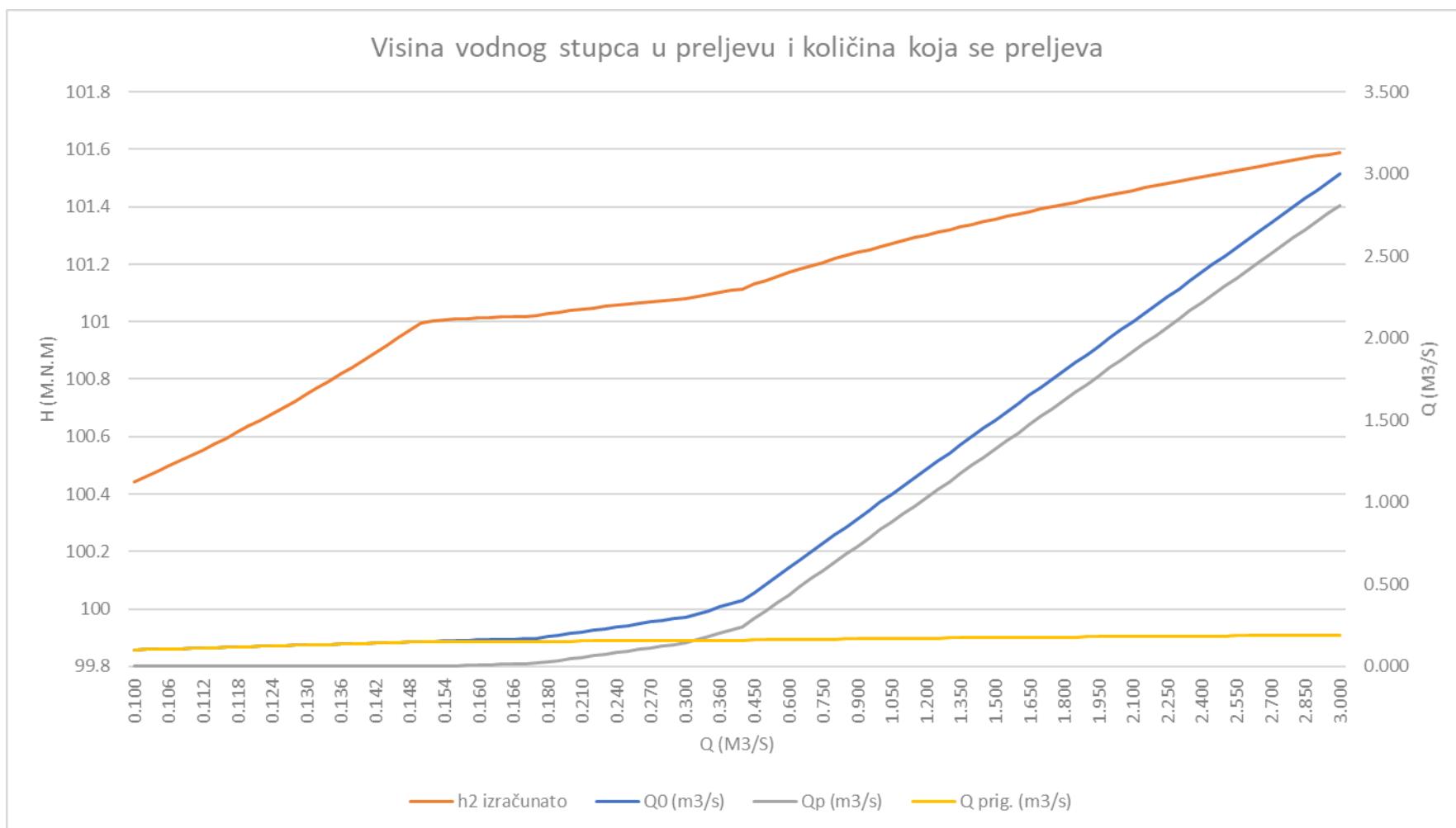
Tablica 1. Proračun visine vodnog stupca u preljevu i količine koja se preljeva

0.152	101.0035304	0.001300786	0.150699214
0.154	101.0062901	0.003093604	0.150906396
0.156	101.008573	0.004922433	0.151077567
0.158	101.0106029	0.0067704	0.1512296
0.160	101.0124659	0.008631	0.151369
0.162	101.0142069	0.010500845	0.151499155
0.164	101.015853	0.012377879	0.151622121
0.166	101.0174225	0.014260739	0.151739261
0.168	101.0189279	0.016148461	0.151851539
0.170	101.0203788	0.01804033	0.15195967
0.180	101.0270223	0.02754618	0.15245382
0.190	101.0329592	0.037105939	0.152894061
0.200	101.0384213	0.046702026	0.153297974
0.210	101.0435327	0.056325005	0.153674995
0.220	101.0483699	0.065969061	0.154030939
0.230	101.0529841	0.07563029	0.15436971
0.240	101.0574118	0.085305908	0.154694092
0.250	101.0616801	0.094993843	0.155006157
0.260	101.06581	0.104692497	0.155307503
0.270	101.069818	0.114400607	0.155599393
0.280	101.0737173	0.12411715	0.15588285
0.290	101.077519	0.133841285	0.156158715
0.300	101.0812323	0.143572308	0.156427692
0.320	101.0884234	0.163052721	0.156947279
0.340	101.0953404	0.182554554	0.157445446
0.360	101.1020211	0.202074894	0.157925106
0.380	101.108495	0.221611465	0.158388535
0.400	101.1147858	0.241162444	0.158837556
0.450	101.1298297	0.290093755	0.159906245
0.500	101.1440647	0.339089057	0.160910943
0.550	101.1576418	0.388136601	0.161863399

Tablica 2. Proračun visine vodnog stupca u preljevu i količine koja se preljeva

0.600	101.1706686	0.437227987	0.162772013
0.650	101.1832251	0.486356946	0.163643054
0.700	101.1953731	0.535518638	0.164481362
0.750	101.2071611	0.584709227	0.165290773
0.800	101.2186287	0.633925605	0.166074395
0.850	101.2298082	0.683165211	0.166834789
0.900	101.2407266	0.732425901	0.167574099
0.950	101.2514069	0.781705857	0.168294143
1.000	101.2618687	0.831003519	0.168996481
1.050	101.2721288	0.880317538	0.169682462
1.100	101.2822021	0.929646736	0.170353264
1.150	101.2921015	0.978990076	0.171009924
1.200	101.3018385	1.028346639	0.171653361
1.250	101.3114233	1.077715607	0.172284393
1.300	101.320865	1.127096245	0.172903755
1.350	101.3301718	1.176487895	0.173512105
1.400	101.3393511	1.225889956	0.174110044
1.450	101.3484098	1.275301887	0.174698113
1.500	101.3573538	1.324723192	0.175276808
1.550	101.3661889	1.374153417	0.175846583
1.600	101.3749201	1.423592146	0.176407854
1.650	101.3835522	1.473038994	0.176961006
1.700	101.3920896	1.522493608	0.177506392
1.750	101.4005363	1.571955659	0.178044341
1.800	101.408896	1.621424842	0.178575158
1.850	101.4171723	1.670900875	0.179099125
1.900	101.4253683	1.720383491	0.179616509
1.950	101.4334872	1.769872443	0.180127557
2.000	101.4415317	1.819367501	0.180632499
2.050	101.4495046	1.868868447	0.181131553
2.100	101.4574082	1.918375077	0.181624923
2.150	101.4652451	1.967887197	0.182112803
2.200	101.4730173	2.017404629	0.182595371
2.250	101.4807269	2.066927199	0.183072801
2.300	101.488376	2.116454747	0.183545253
2.350	101.4959664	2.16598712	0.18401288
2.400	101.5034998	2.215524171	0.184475829
2.450	101.510978	2.265065765	0.184934235
2.500	101.5184025	2.314611769	0.185388231
2.550	101.5257748	2.364162059	0.185837941
2.600	101.5330965	2.413716517	0.186283483
2.650	101.5403688	2.46327503	0.18672497
2.700	101.547593	2.51283749	0.18716251
2.750	101.5547705	2.562403793	0.187596207
2.800	101.5619024	2.611973842	0.188026158
2.850	101.5689898	2.661547543	0.188452457
2.900	101.5760338	2.711124805	0.188875195
2.950	101.5830355	2.760705542	0.189294458
3.000	101.589996	2.810289671	0.189710329

Tablica 3. Proračun visine vodnog stupca u preljevu i količine koja se preljeva



Grafikon 1. Visina vodnog stupca u preljevu i količina koja se preljeva

VARIJANTA 2 : $Z_P = 101.2$ (m.n.m), $L_P = 3$ (m)

Q_0 (m ³ /s)	h_2 izračunato	Q_p (m ³ /s)	$Q_{prig.}$ (m ³ /s)
0.100	100.44212	0	0.1
0.102	100.4599674	0	0.102
0.104	100.4781679	0	0.104
0.106	100.4967216	0	0.106
0.108	100.5156284	0	0.108
0.110	100.5348883	0	0.11
0.112	100.5545014	0	0.112
0.114	100.5744676	0	0.114
0.116	100.5947869	0	0.116
0.118	100.6154593	0	0.118
0.120	100.6364849	0	0.12
0.122	100.6578636	0	0.122
0.124	100.6795955	0	0.124
0.126	100.7016805	0	0.126
0.128	100.7241186	0	0.128
0.130	100.7469098	0	0.13
0.132	100.7700542	0	0.132
0.134	100.7935517	0	0.134
0.136	100.8174024	0	0.136
0.138	100.8416061	0	0.138
0.140	100.866163	0	0.14
0.142	100.8910731	0	0.142
0.144	100.9163362	0	0.144
0.146	100.9419525	0	0.146
0.148	100.9679219	0	0.148
0.150	100.9942445	0	0.15
0.152	101.0209202	0	0.152
0.154	101.047949	0	0.154
0.156	101.0753309	0	0.156
0.158	101.103066	0	0.158
0.160	101.1311542	0	0.16
0.162	101.1595956	0	0.162
0.164	101.1883901	0	0.164

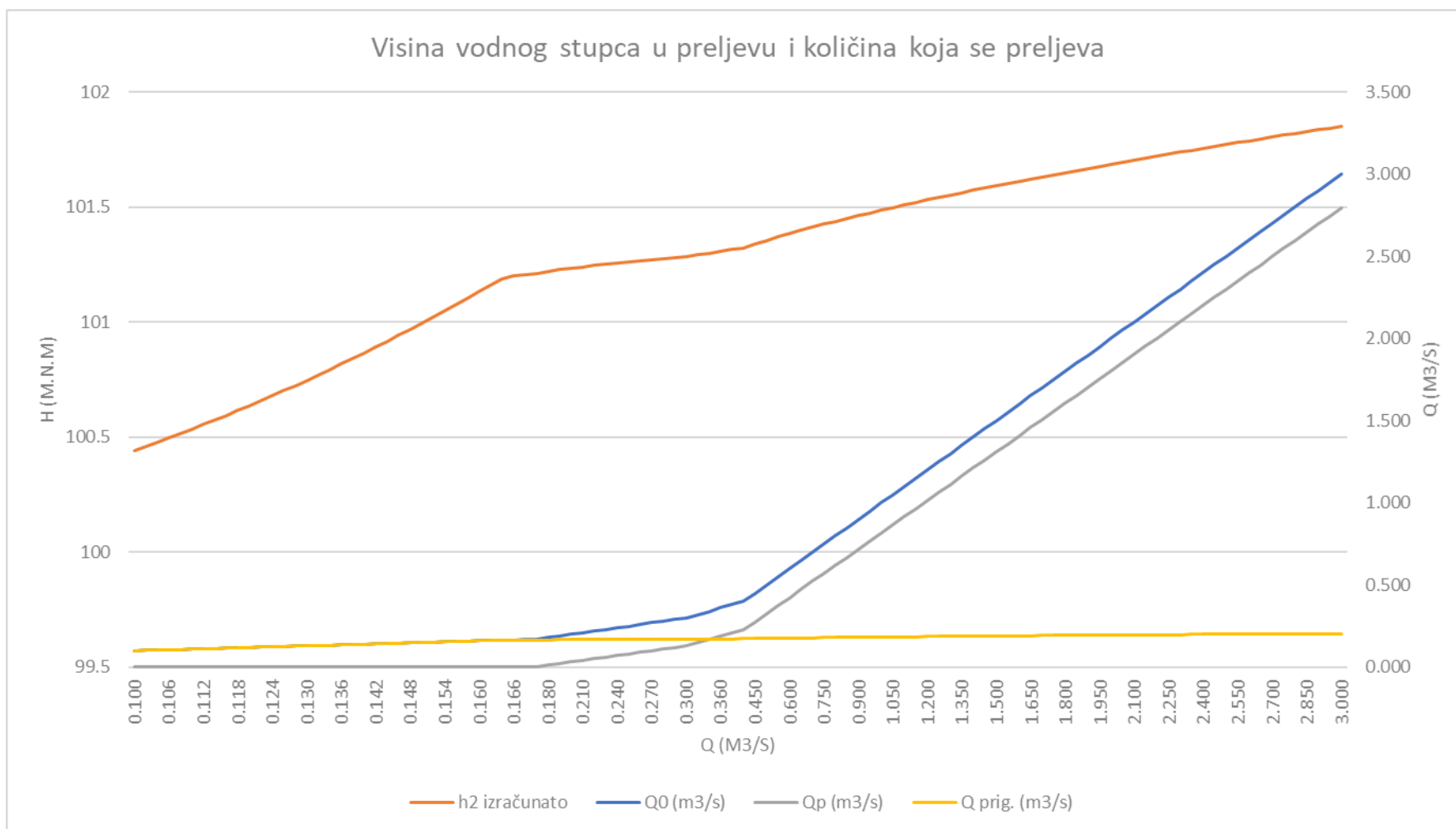
Tablica 4. Proračun visine vodnog stupca u preljevu i količine koja se preljeva

0.166	101.2032357	0.000978321	0.165021679
0.168	101.2064564	0.002757505	0.165242495
0.170	101.2090545	0.004579591	0.165420409
0.180	101.2189825	0.013901487	0.166098513
0.190	101.2268358	0.023367041	0.166632959
0.200	101.2337118	0.032900517	0.167099483
0.210	101.2399713	0.04247694	0.16752306
0.220	101.2457913	0.052084067	0.167915933
0.230	101.251275	0.061714734	0.168285266
0.240	101.2564894	0.071364287	0.168635713
0.250	101.2614811	0.081029487	0.168970513
0.260	101.2662842	0.090707964	0.169292036
0.270	101.2709244	0.100397917	0.169602083
0.280	101.2754222	0.110097937	0.169902063
0.290	101.2797935	0.119806893	0.170193107
0.300	101.2840516	0.129523861	0.170476139
0.320	101.2922705	0.148978892	0.171021108
0.340	101.3001477	0.168458199	0.171541801
0.360	101.3077342	0.187958209	0.172041791
0.380	101.315069	0.20747619	0.17252381
0.400	101.3221826	0.227009985	0.172990015
0.450	101.3391502	0.275903024	0.174096976
0.500	101.3551606	0.324864921	0.175135079
0.550	101.3704	0.373882488	0.176117512
0.600	101.3849992	0.422946441	0.177053559
0.650	101.3990543	0.472049927	0.177950073
0.700	101.4126387	0.521187704	0.178812296
0.750	101.4258101	0.570355647	0.179644353
0.800	101.4386147	0.619550433	0.180449567
0.850	101.4510906	0.668769338	0.181230662
0.900	101.4632691	0.718010088	0.181989912
0.950	101.4751769	0.767270766	0.182729234
1.000	101.4868366	0.81654973	0.18345027
1.050	101.4982679	0.865845564	0.184154436
1.100	101.5094876	0.915157034	0.184842966
1.150	101.5205107	0.964483056	0.185516944

Tablica 5. Proračun visine vodnog stupca u preljevu i količine koja se preljeva

1.200	101.5313504	1.013822674	0.186177326
1.250	101.5420183	1.063175035	0.186824965
1.300	101.5525249	1.112539377	0.187460623
1.350	101.5628795	1.161915013	0.188084987
1.400	101.5730906	1.211301323	0.188698677
1.450	101.5831659	1.260697747	0.189302253
1.500	101.5931123	1.310103771	0.189896229
1.550	101.6029362	1.359518926	0.190481074
1.600	101.6126436	1.408942782	0.191057218
1.650	101.6222396	1.458374945	0.191625055
1.700	101.6317293	1.507815048	0.192184952
1.750	101.6411173	1.557262753	0.192737247
1.800	101.6504078	1.606717747	0.193282253
1.850	101.6596047	1.656179739	0.193820261
1.900	101.6687118	1.705648455	0.194351545
1.950	101.6777323	1.755123643	0.194876357
2.000	101.6866697	1.804605064	0.195394936
2.050	101.6955267	1.854092495	0.195907505
2.100	101.7043064	1.903585728	0.196414272
2.150	101.7130112	1.953084564	0.196915436
2.200	101.7216438	2.002588819	0.197411181
2.250	101.7302064	2.052098317	0.197901683
2.300	101.7387013	2.101612892	0.198387108
2.350	101.7471305	2.151132388	0.198867612
2.400	101.7554961	2.200656656	0.199343344
2.450	101.7638	2.250185556	0.199814444
2.500	101.7720439	2.299718953	0.200281047
2.550	101.7802295	2.34925672	0.20074328
2.600	101.7883585	2.398798737	0.201201263
2.650	101.7964324	2.448344887	0.201655113
2.700	101.8044527	2.497895061	0.202104939
2.750	101.8124207	2.547449153	0.202550847
2.800	101.8203378	2.597007063	0.202992937
2.850	101.8282053	2.646568695	0.203431305
2.900	101.8360245	2.696133956	0.203866044
2.950	101.8437964	2.74570276	0.20429724
3.000	101.8515222	2.79527502	0.20472498

Tablica 6. Proračun visine vodnog stupca u preljevu i količine koja se preljeva



Grafikon 2. Visina vodnog stupca u preljevu i količina koja se preljeva

VARIJANTA 3 : $Z_P = 101.2$ (m.n.m), $L_P = 6$ (m)

Q_0 (m ³ /s)	h_2 izračunato	Q_p (m ³ /s)	$Q_{prig.}$ (m ³ /s)
0.100	100.44212	0	0.1
0.102	100.4599674	0	0.102
0.104	100.4781679	0	0.104
0.106	100.4967216	0	0.106
0.108	100.5156284	0	0.108
0.110	100.5348883	0	0.11
0.112	100.5545014	0	0.112
0.114	100.5744676	0	0.114
0.116	100.5947869	0	0.116
0.118	100.6154593	0	0.118
0.120	100.6364849	0	0.12
0.122	100.6578636	0	0.122
0.124	100.6795955	0	0.124
0.126	100.7016805	0	0.126
0.128	100.7241186	0	0.128
0.130	100.7469098	0	0.13
0.132	100.7700542	0	0.132
0.134	100.7935517	0	0.134
0.136	100.8174024	0	0.136
0.138	100.8416061	0	0.138
0.140	100.866163	0	0.14
0.142	100.8910731	0	0.142
0.144	100.9163362	0	0.144
0.146	100.9419525	0	0.146
0.148	100.9679219	0	0.148
0.150	100.9942445	0	0.15
0.152	101.0209202	0	0.152
0.154	101.047949	0	0.154
0.156	101.0753309	0	0.156
0.158	101.103066	0	0.158
0.160	101.1311542	0	0.16
0.162	101.1595956	0	0.162
0.164	101.1883901	0	0.164
0.166	101.2021414	0.001053416	0.164946584

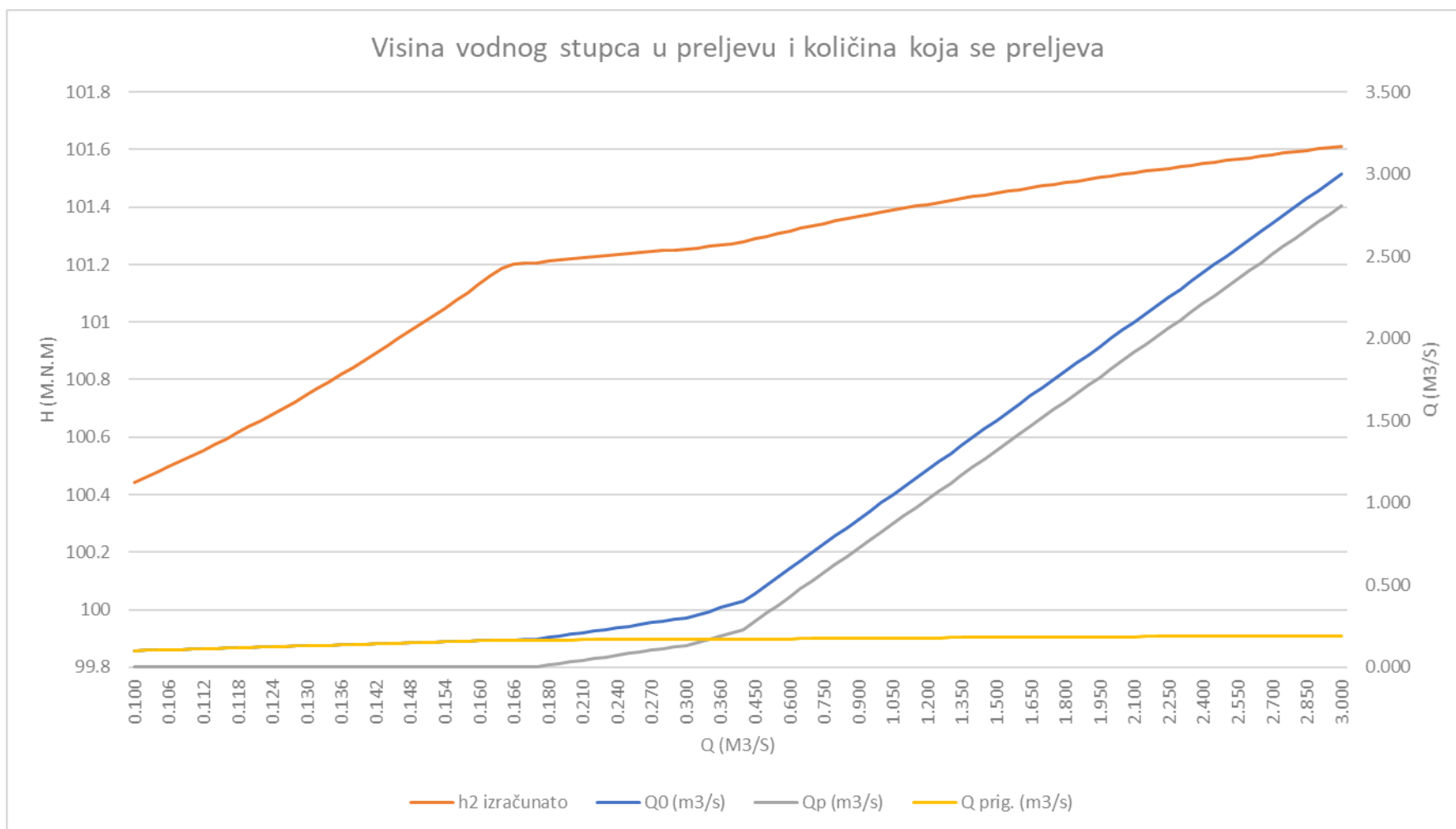
Tablica 7. Proračun visine vodnog stupca u preljevu i količine koja se preljeva

0.168	101.2042169	0.002911019	0.165088981
0.170	101.2058829	0.004796801	0.165203199
0.180	101.2122214	0.01436298	0.16563702
0.190	101.2172198	0.02402168	0.16597832
0.200	101.2215899	0.033723854	0.166276146
0.210	101.2255648	0.043453425	0.166546575
0.220	101.2292582	0.053202537	0.166797463
0.230	101.2327366	0.062966603	0.167033397
0.240	101.2360428	0.07274265	0.16725735
0.250	101.2392069	0.082528609	0.167471391
0.260	101.2422506	0.092322969	0.167677031
0.270	101.2451904	0.102124585	0.167875415
0.280	101.2480394	0.111932558	0.168067442
0.290	101.2508077	0.121746172	0.168253828
0.300	101.253504	0.131564838	0.168435162
0.320	101.2587071	0.151215462	0.168784538
0.340	101.2636926	0.170881367	0.169118633
0.360	101.2684933	0.19056029	0.16943971
0.380	101.2731337	0.210250502	0.169749498
0.400	101.2776335	0.229950641	0.170049359
0.450	101.288364	0.279237699	0.170762301
0.500	101.2984864	0.32856788	0.17143212
0.550	101.3081191	0.37793288	0.17206712
0.600	101.3173455	0.427326861	0.172673139
0.650	101.3262265	0.476745521	0.173254479
0.700	101.334809	0.526185573	0.173814427
0.750	101.3431295	0.575644433	0.174355567
0.800	101.3512174	0.625120022	0.174879978
0.850	101.3590969	0.674610635	0.175389365
0.900	101.3667879	0.724114853	0.175885147
0.950	101.3743073	0.773631478	0.176368522
1.000	101.3816696	0.823159487	0.176840513
1.050	101.388887	0.872697996	0.177302004
1.100	101.3959705	0.922246237	0.177753763
1.150	101.4029295	0.971803535	0.178196465

Tablica 8. Proračun visine vodnog stupca u preljevu i količine koja se preljeva

1.200	101.4097722	1.021369294	0.178630706
1.250	101.4165062	1.070942984	0.179057016
1.300	101.4231381	1.120524131	0.179475869
1.350	101.4296737	1.170112308	0.179887692
1.400	101.4361184	1.219707131	0.180292869
1.450	101.4424772	1.269308249	0.180691751
1.500	101.4487544	1.318915345	0.181084655
1.550	101.4549541	1.368528129	0.181471871
1.600	101.46108	1.418146332	0.181853668
1.650	101.4671354	1.46776971	0.18223029
1.700	101.4731236	1.517398036	0.182601964
1.750	101.4790474	1.567031101	0.182968899
1.800	101.4849095	1.61666871	0.18333129
1.850	101.4907124	1.666310681	0.183689319
1.900	101.4964584	1.715956848	0.184043152
1.950	101.5021497	1.765607051	0.184392949
2.000	101.5077884	1.815261145	0.184738855
2.050	101.5133763	1.86491899	0.18508101
2.100	101.5189152	1.914580457	0.185419543
2.150	101.5244068	1.964245424	0.185754576
2.200	101.5298527	2.013913777	0.186086223
2.250	101.5352544	2.063585406	0.186414594
2.300	101.5406132	2.113260209	0.186739791
2.350	101.5459305	2.162938089	0.187061911
2.400	101.5512076	2.212618954	0.187381046
2.450	101.5564456	2.262302717	0.187697283
2.500	101.5616458	2.311989295	0.188010705
2.550	101.566809	2.361678609	0.188321391
2.600	101.5719365	2.411370584	0.188629416
2.650	101.5770291	2.461065149	0.188934851
2.700	101.5820879	2.510762236	0.189237764
2.750	101.5871135	2.560461779	0.189538221
2.800	101.5921071	2.610163716	0.189836284
2.850	101.5970692	2.659867988	0.190132012
2.900	101.6020008	2.709574539	0.190425461
2.950	101.6069025	2.759283312	0.190716688
3.000	101.6117751	2.808994256	0.191005744

Tablica 9. Proračun visine vodnog stupca u preljevu i količine koja se preljeva



Grafikon 3. Visina vodnog stupca u preljevu i količina koja se preljeva

VARIJANTA 4 : $Z_P = 101$ (m.n.m), $L_P = 2$ (m)

Q_0 (m ³ /s)	h_2 izračunato	Q_p (m ³ /s)	$Q_{prig.}$ (m ³ /s)
0.100	100.44212	0	0.1
0.102	100.4599674	0	0.102
0.104	100.4781679	0	0.104
0.106	100.4967216	0	0.106
0.108	100.5156284	0	0.108
0.110	100.5348883	0	0.11
0.112	100.5545014	0	0.112
0.114	100.5744676	0	0.114
0.116	100.5947869	0	0.116
0.118	100.6154593	0	0.118
0.120	100.6364849	0	0.12
0.122	100.6578636	0	0.122
0.124	100.6795955	0	0.124
0.126	100.7016805	0	0.126
0.128	100.7241186	0	0.128
0.130	100.7469098	0	0.13
0.132	100.7700542	0	0.132
0.134	100.7935517	0	0.134
0.136	100.8174024	0	0.136
0.138	100.8416061	0	0.138
0.140	100.866163	0	0.14
0.142	100.8910731	0	0.142
0.144	100.9163362	0	0.144
0.146	100.9419525	0	0.146
0.148	100.9679219	0	0.148
0.150	100.9942445	0	0.15
0.152	101.0048608	0.001200873	0.150799127
0.154	101.0087654	0.002908019	0.151091981
0.156	101.0120117	0.004664969	0.151335031
0.158	101.0149057	0.006448631	0.151551369
0.160	101.0175662	0.008250018	0.151749982
0.162	101.0200555	0.010064419	0.151935581
0.164	101.0224114	0.011888969	0.152111031
0.166	101.0246593	0.013721761	0.152278239

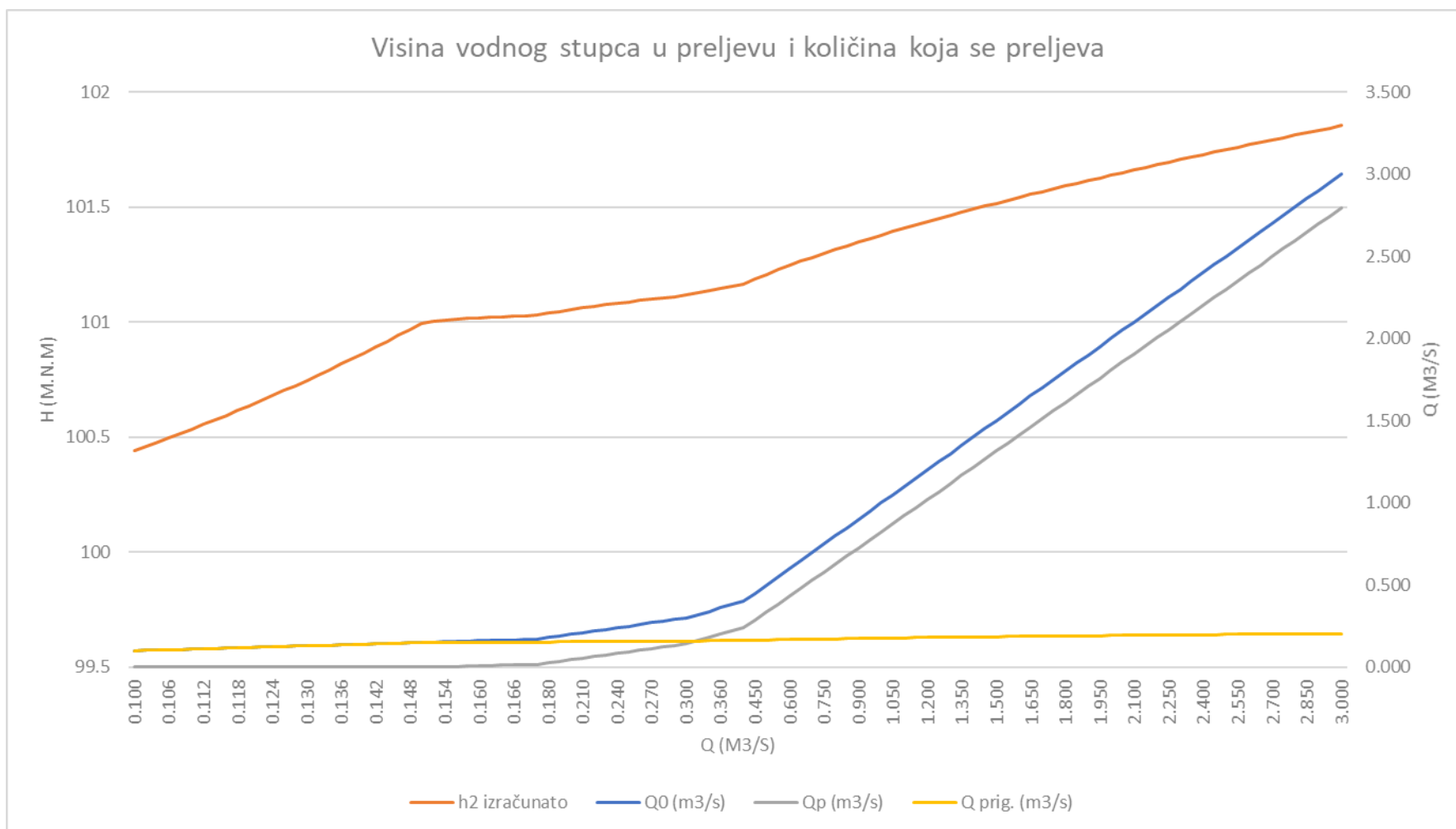
Tablica 10. Proračun visine vodnog stupca u preljevu i količine koja se preljeva

0.168	101.0268168	0.015561443	0.152438557
0.170	101.0288972	0.017407011	0.152592989
0.180	101.0384349	0.026701023	0.153298977
0.190	101.04697	0.036071989	0.153928011
0.200	101.0548297	0.045494992	0.154505008
0.210	101.06219	0.05495661	0.15504339
0.220	101.0691591	0.064448556	0.155551444
0.230	101.0758098	0.073965251	0.156034749
0.240	101.0821941	0.083502713	0.156497287
0.250	101.0883506	0.093057971	0.156942029
0.260	101.094309	0.102628735	0.157371265
0.270	101.1000928	0.112213188	0.157786812
0.280	101.1057212	0.121809861	0.158190139
0.290	101.1112097	0.131417543	0.158582457
0.300	101.1165714	0.14103522	0.15896478
0.320	101.1269573	0.160297249	0.159702751
0.340	101.1369501	0.179590411	0.160409589
0.360	101.1466039	0.1989105	0.1610895
0.380	101.1559608	0.218254222	0.161745778
0.400	101.1650546	0.237618936	0.162381064
0.450	101.1868078	0.286109268	0.163890732
0.500	101.2073981	0.334692997	0.165307003
0.550	101.227042	0.383353033	0.166646967
0.600	101.245894	0.432077143	0.167922857
0.650	101.2640688	0.480856185	0.169143815
0.700	101.2816552	0.52968309	0.17031691
0.750	101.298723	0.578552252	0.171447748
0.800	101.315329	0.627459125	0.172540875
0.850	101.3315197	0.67639996	0.17360004
0.900	101.3473341	0.725371616	0.174628384
0.950	101.362805	0.774371427	0.175628573
1.000	101.3779606	0.823397107	0.176602893
1.050	101.3928254	0.872446678	0.177553322
1.100	101.4074206	0.921518409	0.178481591
1.150	101.4217649	0.970610778	0.179389222

Tablica 11. Proračun visine vodnog stupca u preljevu i količine koja se preljeva

1.200	101.4358747	1.019722437	0.180277563
1.250	101.4497648	1.068852184	0.181147816
1.300	101.4634483	1.117998941	0.182001059
1.350	101.476937	1.167161737	0.182838263
1.400	101.4902417	1.216339693	0.183660307
1.450	101.5033721	1.265532012	0.184467988
1.500	101.5163369	1.314737966	0.185262034
1.550	101.5291443	1.363956887	0.186043113
1.600	101.5418017	1.413188165	0.186811835
1.650	101.5543159	1.462431234	0.187568766
1.700	101.5666932	1.511685575	0.188314425
1.750	101.5789394	1.560950704	0.189049296
1.800	101.59106	1.610226175	0.189773825
1.850	101.60306	1.659511569	0.190488431
1.900	101.614944	1.708806499	0.191193501
1.950	101.6267165	1.758110602	0.191889398
2.000	101.6383815	1.807423537	0.192576463
2.050	101.6499429	1.856744985	0.193255015
2.100	101.6614042	1.906074646	0.193925354
2.150	101.6727689	1.95541224	0.19458776
2.200	101.6840401	2.004757498	0.195242502
2.250	101.6952209	2.054110172	0.195889828
2.300	101.7063141	2.103470023	0.196529977
2.350	101.7173224	2.152836826	0.197163174
2.400	101.7282484	2.20221037	0.19778963
2.450	101.7390944	2.251590452	0.198409548
2.500	101.7498629	2.30097688	0.19902312
2.550	101.7605558	2.350369473	0.199630527
2.600	101.7711754	2.399768055	0.200231945
2.650	101.7817237	2.449172463	0.200827537
2.700	101.7922024	2.498582538	0.201417462
2.750	101.8026134	2.547998129	0.202001871
2.800	101.8129585	2.597419092	0.202580908
2.850	101.8232392	2.646845291	0.203154709
2.900	101.8334572	2.696276592	0.203723408
2.950	101.843614	2.745712869	0.204287131
3.000	101.8537109	2.795154002	0.204845998

Tablica 12. Proračun visine vodnog stupca u preljevu i količine koja se preljeva



Grafikon 4. Visina vodnog stupca u preljevu i količina koja se preljeva

VARIJANTA 5 : $Z_P = 101$ (m.n.m), $L_P = 2.5$ (m)

Q_0 (m ³ /s)	h_2 izračunato	Q_p (m ³ /s)	$Q_{prig.}$ (m ³ /s)
0.100	100.44212	0	0.1
0.102	100.4599674	0	0.102
0.104	100.4781679	0	0.104
0.106	100.4967216	0	0.106
0.108	100.5156284	0	0.108
0.110	100.5348883	0	0.11
0.112	100.5545014	0	0.112
0.114	100.5744676	0	0.114
0.116	100.5947869	0	0.116
0.118	100.6154593	0	0.118
0.120	100.6364849	0	0.12
0.122	100.6578636	0	0.122
0.124	100.6795955	0	0.124
0.126	100.7016805	0	0.126
0.128	100.7241186	0	0.128
0.130	100.7469098	0	0.13
0.132	100.7700542	0	0.132
0.134	100.7935517	0	0.134
0.136	100.8174024	0	0.136
0.138	100.8416061	0	0.138
0.140	100.866163	0	0.14
0.142	100.8910731	0	0.142
0.144	100.9163362	0	0.144
0.146	100.9419525	0	0.146
0.148	100.9679219	0	0.148
0.150	100.9942445	0	0.15
0.152	101.0042883	0.001243859	0.150756141
0.154	101.0076924	0.002988437	0.151011563
0.156	101.0105163	0.004776882	0.151223118
0.158	101.0130307	0.006588758	0.151411242
0.160	101.0153406	0.008416145	0.151583855
0.162	101.0175007	0.010254904	0.151745096
0.164	101.0195442	0.012102521	0.151897479
0.166	101.0214932	0.013957324	0.152042676

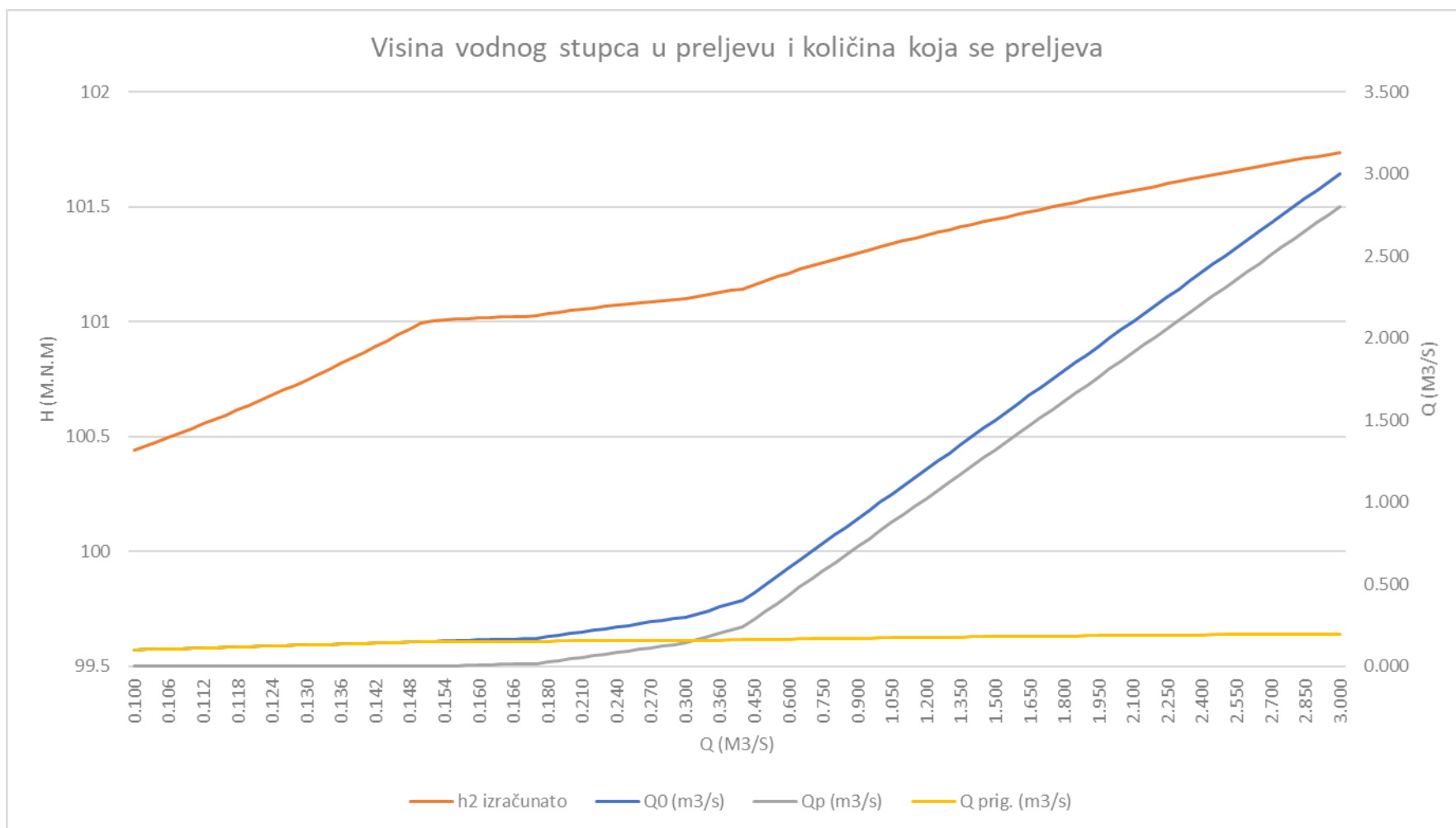
Tablica 13. Proračun visine vodnog stupca u preljevu i količine koja se preljeva

0.168	101.0233635	0.01581813	0.15218187
0.170	101.0251664	0.01768406	0.15231594
0.180	101.0334277	0.027071258	0.152928742
0.190	101.0408159	0.036525284	0.153474716
0.200	101.0476167	0.046024431	0.153975569
0.210	101.0539833	0.055557024	0.154442976
0.220	101.0600102	0.065115861	0.154884139
0.230	101.0657606	0.074696101	0.155303899
0.240	101.0712797	0.084294289	0.155705711
0.250	101.0766011	0.09390785	0.15609215
0.260	101.0817507	0.103534797	0.156465203
0.270	101.0867488	0.11317356	0.15682644
0.280	101.0916122	0.122822865	0.157177135
0.290	101.0963542	0.132481665	0.157518335
0.300	101.1009864	0.142149083	0.157850917
0.320	101.1099582	0.161506911	0.158493089
0.340	101.1185894	0.180891564	0.159108436
0.360	101.1269268	0.200299409	0.159700591
0.380	101.1350071	0.219727603	0.160272397
0.400	101.1428596	0.239173866	0.160826134
0.450	101.161641	0.287857114	0.162142886
0.500	101.1794159	0.336620702	0.163379298
0.550	101.1963717	0.385449912	0.164550088
0.600	101.2126423	0.434334215	0.165665785
0.650	101.2283272	0.483265743	0.166734257
0.700	101.2435031	0.53223842	0.16776158
0.750	101.2582306	0.581247426	0.168752574
0.800	101.2725587	0.630288856	0.169711144
0.850	101.2865278	0.679359489	0.170640511
0.900	101.3001715	0.728456627	0.171543373
0.950	101.3135184	0.777577981	0.172422019
1.000	101.3265927	0.826721591	0.173278409
1.050	101.3394157	0.875885755	0.174114245
1.100	101.3520057	0.925068991	0.174931009
1.150	101.3643789	0.974269991	0.175730009

Tablica 14. Proračun visine vodnog stupca u preljevu i količine koja se preljeva

1.200	101.3765495	1.023487599	0.176512401
1.250	101.3885302	1.072720784	0.177279216
1.300	101.4003325	1.121968619	0.178031381
1.350	101.4119665	1.171230273	0.178769727
1.400	101.4234415	1.220504992	0.179495008
1.450	101.4347658	1.269792091	0.180207909
1.500	101.4459473	1.319090946	0.180909054
1.550	101.4569927	1.368400984	0.181599016
1.600	101.4679086	1.41772168	0.18227832
1.650	101.4787008	1.46705255	0.18294745
1.700	101.4893747	1.516393148	0.183606852
1.750	101.4999355	1.56574306	0.18425694
1.800	101.5103878	1.615101901	0.184898099
1.850	101.5207359	1.664469314	0.185530686
1.900	101.5309839	1.713844964	0.186155036
1.950	101.5411356	1.763228541	0.186771459
2.000	101.5511944	1.812619752	0.187380248
2.050	101.5611638	1.862018323	0.187981677
2.100	101.5710468	1.911423997	0.188576003
2.150	101.5808463	1.960836532	0.189163468
2.200	101.5905652	2.010255699	0.189744301
2.250	101.600206	2.059681283	0.190318717
2.300	101.6097712	2.10911308	0.19088692
2.350	101.6192631	2.158550897	0.191449103
2.400	101.6286839	2.207994552	0.192005448
2.450	101.6380357	2.25744387	0.19255613
2.500	101.6473205	2.306898687	0.193101313
2.550	101.6565401	2.356358847	0.193641153
2.600	101.6656965	2.405824199	0.194175801
2.650	101.6747912	2.455294602	0.194705398
2.700	101.6838259	2.50476992	0.19523008
2.750	101.6928022	2.554250024	0.195749976
2.800	101.7017216	2.603734789	0.196265211
2.850	101.7105854	2.653224097	0.196775903
2.900	101.7193951	2.702717835	0.197282165
2.950	101.7281519	2.752215894	0.197784106
3.000	101.7368571	2.801718169	0.198281831

Tablica 15. Proračun visine vodnog stupca u preljevu i količine koja se preljeva



Grafikon 5. Visina vodnog stupca u preljevu i količina koja se preljeva

PRORAČUN KONJUGIRANIH DUBINA ZA $r = 1\text{m}$

Q_0 (m ³ /s) ▼	y_1 (m.v.s) ▼	y_2 (m.v.s) ▼
0.100	0.075842811	0.249712961
0.105	0.077615975	0.25621371
0.110	0.079346022	0.262570057
0.115	0.081035917	0.268791623
0.120	0.082688302	0.274887
0.125	0.084305542	0.280863903
0.130	0.085889767	0.286729289
0.135	0.087442899	0.292489454
0.140	0.088966685	0.298150124
0.145	0.090462712	0.303716521
0.150	0.091932432	0.309193425
0.155	0.093377175	0.314585223
0.160	0.094798163	0.319895953
0.165	0.096196522	0.325129344
0.170	0.097573294	0.330288846
0.175	0.098929441	0.335377658
0.180	0.100265859	0.340398757
0.185	0.101583379	0.345354913
0.190	0.102882778	0.350248712
0.195	0.104164779	0.355082575
0.200	0.105430061	0.359858767
0.210	0.107912968	0.369246515
0.220	0.11033613	0.378427495
0.230	0.112703655	0.387415512
0.240	0.115019202	0.396222895
0.250	0.117286047	0.404860714
0.260	0.11950714	0.413338946
0.270	0.121685147	0.421666628
0.280	0.123822484	0.429851972
0.290	0.125921353	0.437902469
0.300	0.127983765	0.445824973
0.320	0.132006439	0.461310672
0.340	0.135903555	0.476353726
0.360	0.139686245	0.490992355
0.380	0.1433641	0.505259575
0.400	0.146945451	0.519184137
0.420	0.150437586	0.532791265
0.440	0.153846928	0.546103231
0.460	0.157179167	0.559139824

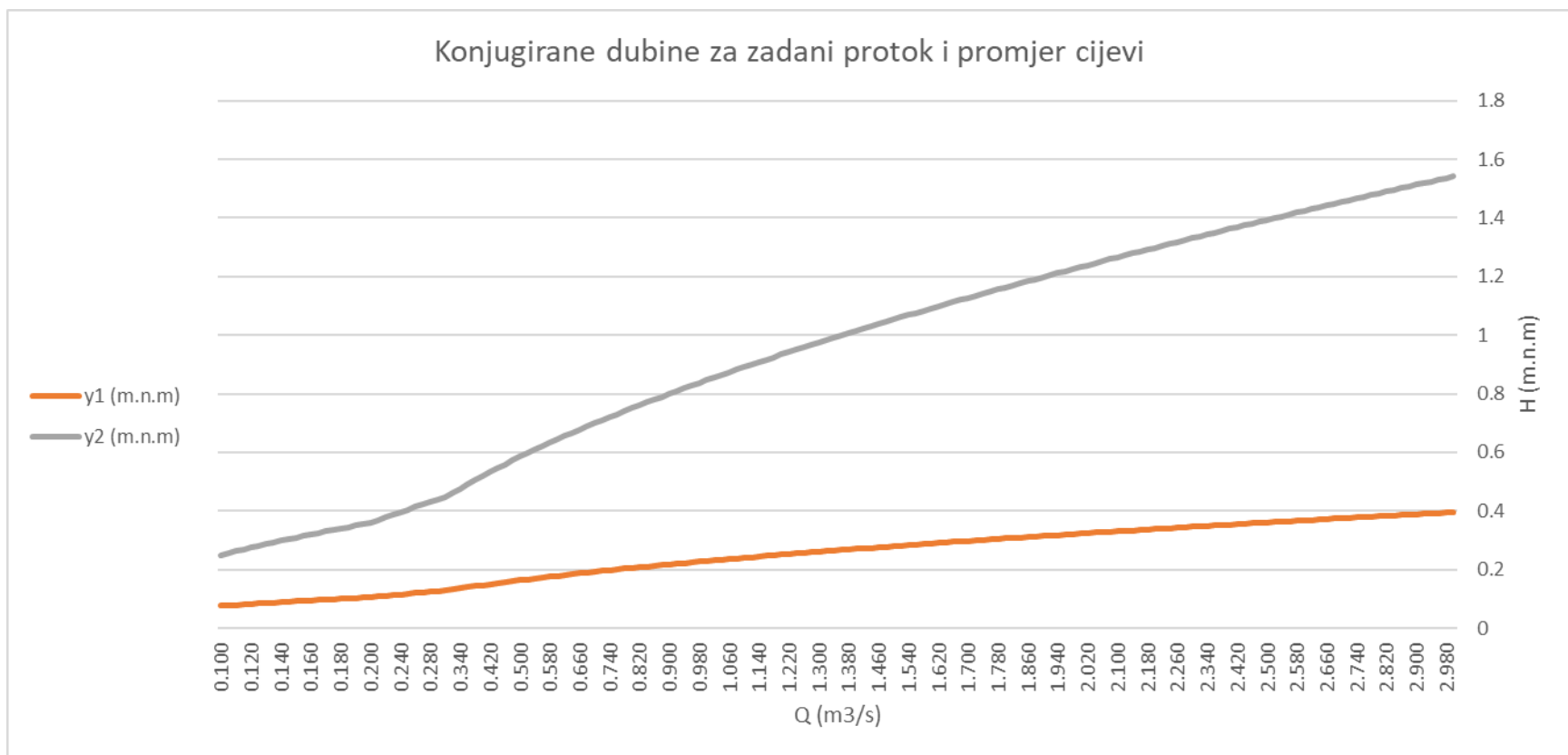
Tablica 16. Proračun konjugiranih dubina za odabrane protoke

0.480	0.160439377	0.571918713
0.500	0.1636321	0.584455761
0.520	0.166761426	0.596765268
0.540	0.16983105	0.608860182
0.560	0.172844323	0.620752268
0.580	0.175804297	0.63245226
0.600	0.17871376	0.643969977
0.620	0.181575268	0.655314434
0.640	0.184391169	0.666493929
0.660	0.187163626	0.677516119
0.680	0.189894641	0.688388092
0.700	0.192586065	0.69911642
0.720	0.195239618	0.709707211
0.740	0.197856898	0.720166157
0.760	0.200439398	0.730498569
0.780	0.202988508	0.740709414
0.800	0.205505533	0.750803342
0.820	0.207991692	0.76078472
0.840	0.210448133	0.770657649
0.860	0.212875932	0.78042599
0.880	0.215276105	0.790093383
0.900	0.217649607	0.799663262
0.920	0.219997342	0.809138875
0.940	0.222320164	0.818523292
0.960	0.224618881	0.827819425
0.980	0.226894259	0.837030035
1.000	0.229147024	0.846157743
1.020	0.231377867	0.855205042
1.040	0.233587443	0.864174302
1.060	0.235776376	0.873067782
1.080	0.237945261	0.881887635
1.100	0.240094666	0.890635917
1.120	0.24222513	0.899314589
1.140	0.244337171	0.907925527
1.160	0.246431283	0.916470526
1.180	0.248507937	0.924951303
1.200	0.250567587	0.933369504
1.220	0.252610665	0.941726707
1.240	0.254637588	0.950024427
1.260	0.256648753	0.958264117

Tablica 17. Proračun konjugiranih dubina za odabrane protoke

2.160	0.335207541	1.28501113
2.180	0.336754626	1.291540069
2.200	0.338295108	1.298044737
2.220	0.339829079	1.30452548
2.240	0.341356631	1.310982638
2.260	0.342877851	1.317416541
2.280	0.344392827	1.323827513
2.300	0.345901643	1.33021587
2.320	0.347404382	1.336581923
2.340	0.348901125	1.342925974
2.360	0.350391951	1.34924832
2.380	0.351876939	1.355549252
2.400	0.353356163	1.361829052
2.420	0.354829698	1.368088
2.440	0.356297618	1.374326368
2.460	0.357759993	1.380544422
2.480	0.359216894	1.386742424
2.500	0.360668388	1.392920629
2.520	0.362114543	1.399079288
2.540	0.363555424	1.405218647
2.560	0.364991096	1.411338947
2.580	0.366421623	1.417440422
2.600	0.367847065	1.423523305
2.620	0.369267484	1.429587823
2.640	0.37068294	1.435634196
2.660	0.37209349	1.441662644
2.680	0.373499192	1.447673379
2.700	0.374900102	1.453666612
2.720	0.376296275	1.459642548
2.740	0.377687766	1.465601388
2.760	0.379074627	1.47154333
2.780	0.380456912	1.477468569
2.800	0.38183467	1.483377293
2.820	0.383207953	1.48926969
2.840	0.384576809	1.495145944
2.860	0.385941288	1.501006233
2.880	0.387301437	1.506850734
2.900	0.388657302	1.512679621
2.920	0.39000893	1.518493062
2.940	0.391356367	1.524291225
2.960	0.392699656	1.530074274
2.980	0.394038841	1.535842367
3.000	0.395373966	1.541595664

Tablica 18. Proračun konjugiranih dubina za odabrane protoke



Grafikon 6. Visina konjugiranih dubina u dovodnoj cijevi

6. ZAKLJUČAK

Proračunima za visinu preljeva kao i količinu vode koja se preljeva kod određenih dotoka dokazali smo da je najpovoljnija varijanta izvedbe ovoga preljeva ta da dužina preljeva bude $L_p = 3 \text{ m}$ te da se gornja kota prije nego li dođe do preljeva nalazi na $Z_p = 101 \text{ m.n.m.}$

Kod prigušnice smo dokazali da je najpovoljnija situacija kojom se zadovolji uvjet, gdje joj je protok 150 l/s , ta u kojoj je promjer prigušnice $D_{\text{prig.}} = 25 \text{ cm}$, te joj je dužina $L_{\text{prig.}} = 5.5 \text{ m}$.

Prilikom proračuna konjugiranih dubina u dovodu da bi dobili siloviti režim prije preljeva odredili smo da promjer dovodne cijevi mora biti $D = 2 \text{ m}$ da bih se osigurala dovoljna visina sustava da dođe do silovitog režima tečenja prije preljeva.

7. LITERATURA

„Osnove vodogradnje“ skripta – autor Doc. Dr. Sc. Davor Bojanić