UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	HYDRAULICS
COURSE CODE	:	BFC 2073 / BFC 21103
PROGRAMME	:	BFF
EXAMINATION DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **TWELVE (12)** PAGES

Q1 (a) Define the conveyor factor, *K*.

(2 marks)

(b) A very wide channel with its slope, S_o = 4 x 10^{-4} and Manning's coefficient, n = 0.02. If the discharge per meter width, q of 2.8 m^3/s.m is to be flowed in this channel, estimate the normal depth, y_o.

(6 marks)

(c) A trapezoidal channel 1.5(V) : 3(H) is designed to carry a water of 15 m^3/s. This channel is rest on 1:1500 channel slope with its surface roughness, n = 0.025. Determine the best effective section of this channel.

(12 marks)

Q2 (a) Discuss briefly the characteristics of the specific energy curve.

(5 marks)

(b) A 2.6 m width of rectangular channel carries a flow as shown in **Figure Q2 (Appendix V)**. A broad crested weir was constructed downstream of the channel causing water depth to rise 2.3 m. Identify the :-

(i) Flow rate, Q
(ii) Depth of water above the weir, y_2
(iii) Height of the weir, H
(iv) Depth of water at downstream just after the weir, y_3.

(12 marks)

(c) Show the sketch of the specific energy curve with values calculated from **Q2 (b)**.

(3 marks)

Q3 (a) State on how bottom slope of the channel can be classified.

(4 marks)

(b) A very wide channel has bottom slope, S_o = 1/3000 and Manning's coefficient, n = 0.010. If the discharge per meter width, q = 2.42 m^3/s.m is to be flowed in this channel, determine the normal and critical depths.

(4 marks)

(c) When the flow in Q3 (b) meet with weir structure at the downstream, depth of water behind the weir increases 90% from the normal depth. Estimate the length of water surface profile for backwater from the depth of water behind the weir to 1.5 m depth of flow using the direct integration method. Given that M = 3 and N = 10/3.

(12 marks)

Q4 (a) Define the :-

(i) Pump
(ii) Turbine
(iii) Cavitation
(iv) Geometry similarity.

(4 marks)

(b) Differentiate between the model and prototype.

(6 marks)

(c) A centrifugal pump with an impeller diameter of 20 cm discharges 120 L/s at a speed of 200 rpm, power of 6750 W and 10 m head. Calculate the :-

(i) Specific speed, N_s
(ii) If the prototype for similar pump produces 240 L/s at 20 m head, determine its size, D and rotation speed, N.

(Note : rpm = rotation per minute)

(10 marks)

Q5 (a) Distinguish between the controlled and uncontrolled spillway.

(4 marks)

(b) A 115 m^3/s of water flows from a reservoir through a 6.0 m width of a high flow spillway. The measured head over the spillway crest is 4.0 m while the depth of water behind the reservoir is 70.5 m. The movement of flow creates a very high kinetic energy at the downstream end of the spillway and to reduce this energy an energy dissipater structure should be proposed. Design a stilling basin at the downstream of the spillway based on the Stilling Basin Type III structure.

(12 marks)

(c) Sketch the Stilling Basin Type III structure component blocks calculated from **Q5 (b)** with its dimensions.

(4 marks)

S1 (a) Takrifkan faktor hantaran, *K*.

(2 markah)

(b) Sebuah saluran sangat lebar dengan cerun saluran, S_o = 4 x 10^{-4} dan pekali Manning, n = 0.02. Jika kadar alir per unit lebar, q ialah 2.8 m^3/s.m dikehendaki untuk mengalir di dalam saluran ini, anggarkan kedalaman normal, y_o.

(6 markah)

(c) Sebuah saluran trapezoid 1.5(Tegak) : 3(Ufuk) direkabentuk untuk membawa air sebanyak 15 m^3/s. Saluran ini terletak pada 1:1500 cerun saluran dengan kekasaran permukaan, n = 0.025. Tentukan keratan paling berkesan untuk saluran ini.

(12 markah)

S2 (a) Bincangkan dengan ringkas ciri-ciri yang terkandung di dalam lengkung tenaga tentu.

(5 markah)

(b) Sebuah saluran segiempat 2.6 m lebar membawa aliran seperti ditunjukkan dalam **Rajah S2 (Lampiran V)**. Empang berpuncak lebar telah dibina di hilir saluran menyebabkan aras air naik 2.3 m. Kenalpasti :-

(i) Kadar alir, Q
(ii) Ukur dalam air di atas empang, y_2
(iii) Tinggi empang, H
(iv) Ukur dalam air dihilir sebaik sahaja empang, y_3

(12 markah)

(c) Tunjukkan lakaran lengkung tenaga tentu dengan nilai-nilai yang telah dikira daripada **S2 (b)**.

(3 markah)

S3 (a) Nyatakan bagaimana cerun dasar saluran boleh dikelaskan.

(4 markah)

(b) Sebuah saluran sangat lebar mempunyai kecerunan dasar, S_o = 1/3000 dan pekali Manning, n = 0.010. Jika kadar alir per unit lebar, q = 2.42 m^3/s.m di alirkan di dalam saluran ini, tentukan ukurdalam normal dan ukurdalam genting.

(4 markah)

(c) Apabila aliran S3 (b) bertemu dengan struktur empang di hilir, kedalaman air dibelakang empang telah meningkat sebanyak 90% daripada kedalaman normal. Anggarkan panjang profil (susuk) permukaan aliran air balik daripada kedalaman air di belakang empang sehingga mencapai kedalaman 1.5 m menggunakan kaedah pengamiran terus. Diberi nilai M = 3 dan N = 10/3.

(12 markah)

S4 (a) Takrifkan :-

(i) Pam
(ii) Turbin
(iii) Peronggaaan
(iv) Keserupaan geometri.

(4 markah)

(b) Bezakan antara model and prototaip.

(6 markah)

(c) Sebuah pam empar dengan diameter pendesak 20 cm mengalirkan 120 L/s pada kelajuan 200 pps, kuasa 6750 W dan turus 10 m. Kirakan :-

(i) Kelajuan tentu, N_s
(ii) Jika prototaip bagi pam yang serupa menghasilkan 240 L/s pada turus 20 m, tentukan saiz, D and kelajuan putaran, N.

(Nota : pps = putaran per saat)

(10 markah)

S5 (a) Bezakan di antara alur limpah terkawal dan tidak terkawal.

(4 markah)

(b) Air mengalir sebanyak 115 m^3/s daripada sebuah takungan melalui sebuah alur limpah aliran tinggi 6.0 m lebar. Turus yang diukur di atas puncak alur limpah ialah 4.0 m sementara ukur dalam air di belakang empangan ialah 70.5 m. Pergerakan aliran menghasilkan tenaga kinetik yang sangat tinggi di hujung hulu alur limpah dan untuk mengurangkan tenaga ini sebuah struktur pelesap tenaga perlu dicadangkan. Rekabentukkan sebuah lembangan penenang berpandukan struktur *Stilling Basin Type III.*

(12 markah)

(c) Lakarkan blok komponen struktur *Stilling Basin Type III* daripada **S5 (b)** beserta dimensinya.

(4 markah)

APPENDIX I

FINAL EXAMINATION

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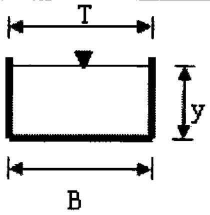
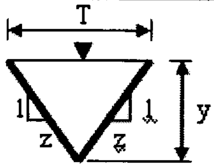
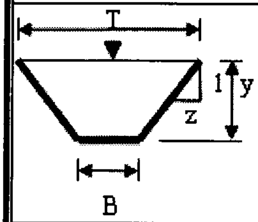
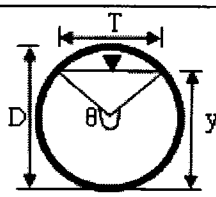
TABLE / JADUAL

Table 1 : Geometric elements of a channel

Shape	A	T	P
	By	B	$B + 2y$
	zy^2	$2zy$	$2y\sqrt{1+z^2}$
	$By + zy^2$	$B + 2zy$	$B + 2y\sqrt{1+z^2}$
	$\frac{D^2}{8}(\theta - \sin\theta)$ θ in radian	$D\left(\sin\frac{\theta}{2}\right)$ or $2\sqrt{y(D-y)}$	$\frac{\theta D}{2}$ θ in radian

APPENDIX II

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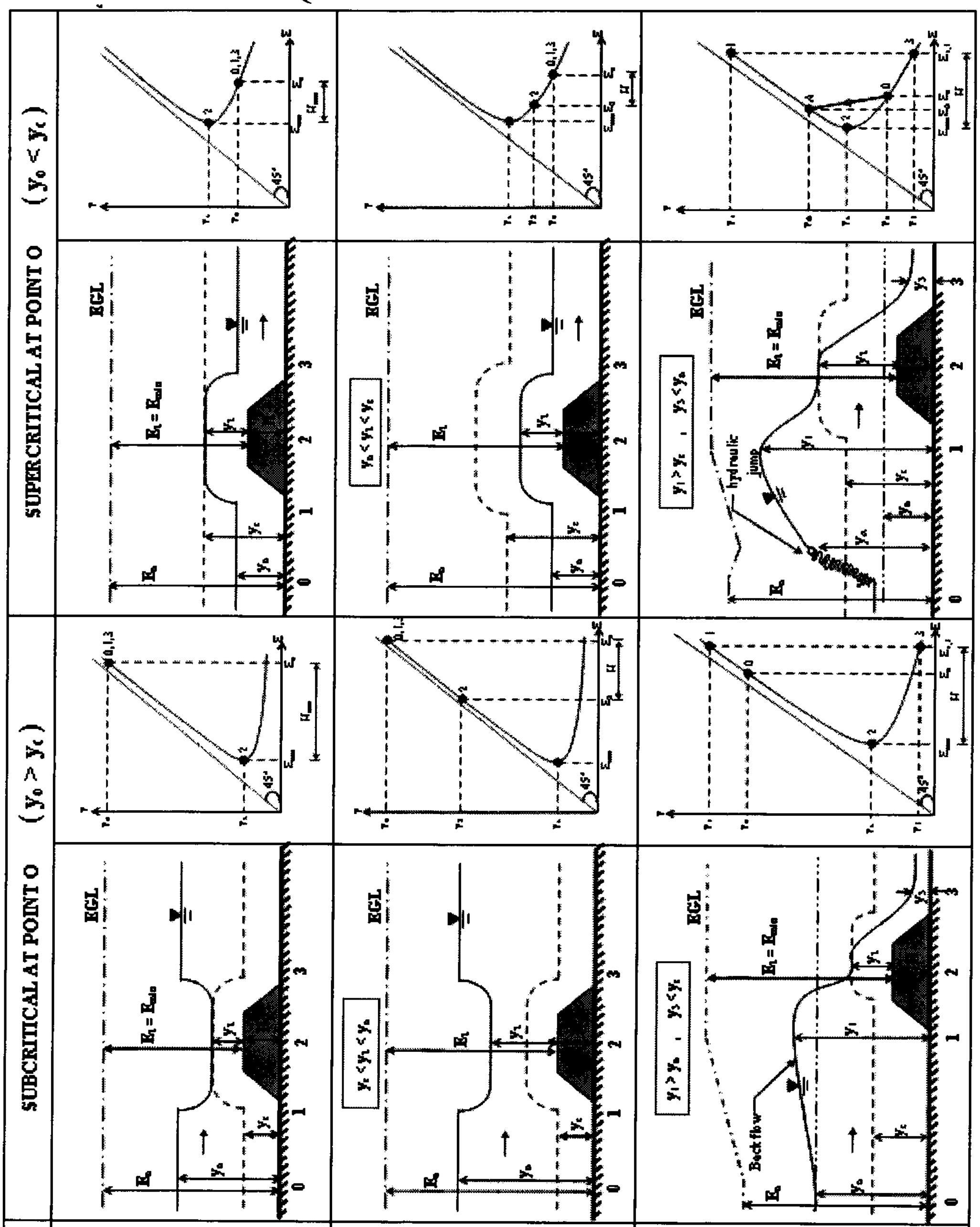
TABLE / JADUAL

Table Q2 : Characteristics of broad crested weir



CONDITION	CASE 1	CASE 2	CASE 3
	$E_{min} + H = E_o$ OR $H = H_{min}$ $y_1 = y_3 = y_o$ & $y_2 = y_c$	$E_{min} + H < E_o$ OR $H < H_{min}$ $y_1 = y_3 = y_o$ & $y_2 \neq y_c \rightarrow E_2 = E_o - H$	$E_{min} + H > E_o$ OR $H > H_{min}$ $y_2 = y_c$; y_1 & y_3 $\rightarrow E_{1,3} = E_{min} + H$

APPENDIX III

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Table Q3 : Values of F(u,N) and F(v,J) for gradually varied flow calculation

u \ N	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
1.26	0.855	0.692	0.574	0.482	0.410	0.351	0.304	0.265	0.233	0.205
1.28	0.827	0.666	0.551	0.461	0.391	0.334	0.288	0.250	0.219	0.198
1.30	0.800	0.644	0.530	0.442	0.373	0.318	0.274	0.237	0.207	0.181
1.32	0.775	0.625	0.510	0.424	0.357	0.304	0.260	0.225	0.196	0.171
1.34	0.752	0.605	0.492	0.406	0.342	0.290	0.248	0.214	0.185	0.162
1.36	0.731	0.588	0.475	0.393	0.329	0.278	0.237	0.204	0.176	0.153
1.38	0.711	0.567	0.459	0.378	0.316	0.266	0.226	0.194	0.167	0.145
1.40	0.692	0.548	0.444	0.365	0.304	0.256	0.217	0.185	0.159	0.138
1.42	0.674	0.533	0.431	0.353	0.293	0.246	0.208	0.177	0.152	0.131
1.44	0.658	0.517	0.417	0.341	0.282	0.236	0.199	0.169	0.145	0.125
1.46	0.642	0.505	0.405	0.330	0.273	0.227	0.191	0.162	0.139	0.119
1.48	0.627	0.493	0.394	0.320	0.263	0.219	0.184	0.156	0.133	0.113
1.50	0.613	0.480	0.383	0.310	0.255	0.211	0.177	0.149	0.127	0.108
1.55	0.580	0.451	0.358	0.288	0.235	0.194	0.161	0.135	0.114	0.097
1.60	0.551	0.425	0.335	0.269	0.218	0.179	0.148	0.123	0.103	0.087
1.65	0.525	0.402	0.316	0.251	0.203	0.165	0.136	0.113	0.094	0.079
1.70	0.501	0.381	0.298	0.236	0.189	0.153	0.125	0.103	0.086	0.072
1.75	0.480	0.362	0.282	0.222	0.177	0.143	0.116	0.095	0.079	0.065
1.80	0.460	0.349	0.267	0.209	0.166	0.133	0.108	0.088	0.072	0.060
1.85	0.442	0.332	0.254	0.198	0.156	0.125	0.100	0.082	0.067	0.055
1.90	0.425	0.315	0.242	0.188	0.147	0.117	0.094	0.076	0.062	0.050
1.95	0.409	0.304	0.231	0.178	0.139	0.110	0.088	0.070	0.057	0.046
2.00	0.395	0.292	0.221	0.169	0.132	0.104	0.082	0.066	0.053	0.043
2.10	0.369	0.273	0.202	0.154	0.119	0.092	0.073	0.058	0.046	0.037
2.20	0.346	0.253	0.186	0.141	0.107	0.083	0.065	0.051	0.040	0.032
2.3	0.326	0.235	0.173	0.129	0.098	0.075	0.058	0.045	0.035	0.028
2.4	0.308	0.220	0.160	0.119	0.089	0.068	0.052	0.040	0.031	0.024
2.5	0.292	0.207	0.150	0.110	0.082	0.062	0.047	0.036	0.028	0.022
2.6	0.277	0.197	0.140	0.102	0.076	0.057	0.043	0.033	0.025	0.019
2.7	0.264	0.188	0.131	0.095	0.070	0.052	0.039	0.029	0.022	0.017
2.8	0.252	0.176	0.124	0.089	0.065	0.048	0.036	0.027	0.020	0.015
2.9	0.241	0.166	0.117	0.083	0.060	0.044	0.033	0.024	0.018	0.014
3.0	0.230	0.159	0.110	0.078	0.056	0.041	0.030	0.022	0.017	0.012
3.5	0.190	0.126	0.085	0.059	0.041	0.029	0.021	0.015	0.011	0.008
4.0	0.161	0.104	0.069	0.046	0.031	0.022	0.015	0.010	0.007	0.005
4.5	0.139	0.087	0.057	0.037	0.025	0.017	0.011	0.008	0.005	0.004
5.0	0.122	0.076	0.048	0.031	0.020	0.013	0.009	0.006	0.004	0.003
6.0	0.098	0.060	0.036	0.022	0.014	0.009	0.006	0.004	0.002	0.002
7.0	0.081	0.048	0.028	0.017	0.010	0.006	0.004	0.002	0.002	0.001
8.0	0.069	0.040	0.022	0.013	0.008	0.005	0.003	0.002	0.001	0.001
9.0	0.060	0.034	0.019	0.011	0.006	0.004	0.002	0.001	0.001	0.000
10.0	0.053	0.028	0.016	0.009	0.005	0.003	0.002	0.001	0.001	0.000
20.0	0.023	0.018	0.011	0.006	0.002	0.001	0.001	0.000	0.000	0.000

APPENDIX IV

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TABLE / JADUAL

Table Q5 : Dimensions for Stilling Basin Type III

Block A	**Block B**	**Block C**
$h_1 = s_1 = w_1 = y_1$	$h_3 = y_1\left(0.168Fr_1 + 0.63\right)$ $t_3 = \frac{h_3}{5}$ $s_3 = w_3 = \frac{3h_3}{4}$ $L_1 = \frac{4y_2}{5}$ $z_1 = 1.0$	$h_4 = y_1\left(\frac{Fr_1}{18} + 1\right)$ $z_2 = 2.0$

APPENDIX V

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FIGURE / RAJAH

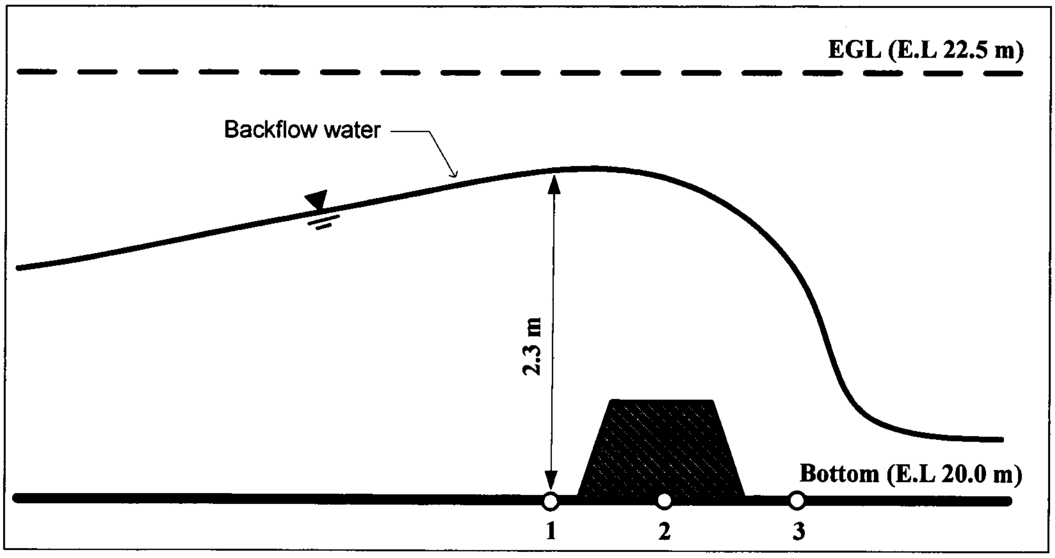

Figure Q2 / Rajah S2

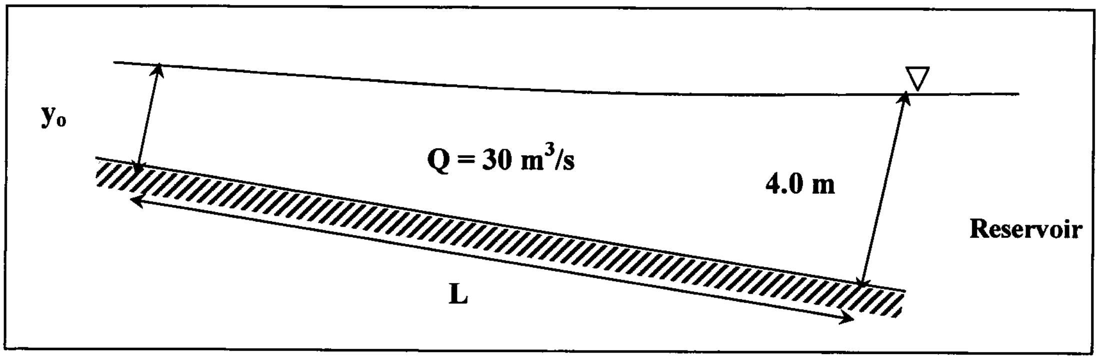

Figure Q3 / Rajah S3

APPENDIX VI

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FIGURE / RAJAH

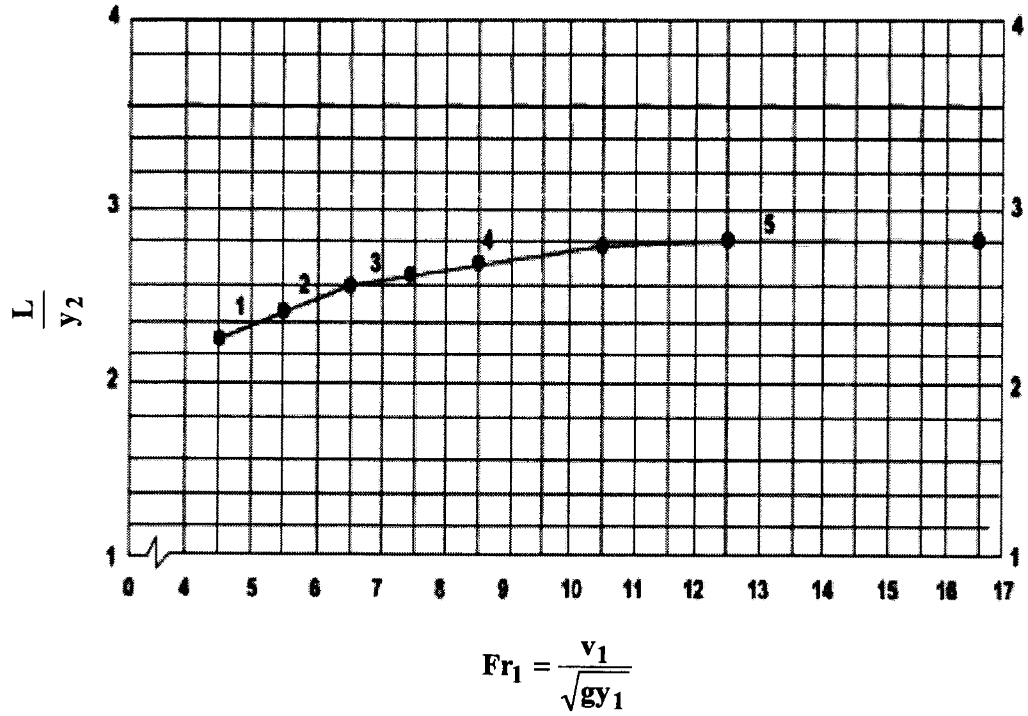

Figure Q5 : Dimension for Stilling Basin Type III

APPENDIX VII

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EQUATIONS

$$Fr_1 = \frac{v_1}{\sqrt{gy_1}} \qquad y = \frac{q}{v} \qquad v_1 = \sqrt{2g\left[H_1 - \frac{H_o}{2}\right]} \qquad Q = \frac{AR^{2/3}S_o^{1/2}}{n}$$

$$y_c = \sqrt[3]{\frac{q^2}{g}} \qquad i = \frac{n^2v^2}{R^{4/3}} \qquad E = y + \frac{v^2}{2g} \qquad AR^{2/3} = \frac{nQ}{\sqrt{S_o}} \qquad H_{min} = E_o - E_{min}$$

$$E = y + \frac{q^2}{2gy^2} \qquad E_{min} = \frac{3}{2}y_c \qquad q = \frac{Q}{B} \qquad \frac{A_c^3}{T_c} = \frac{Q^2}{g} \qquad R = \frac{A}{P} \qquad \frac{A^{5/3}}{P^{2/3}} = \frac{nQ}{\sqrt{S_o}}$$

$$u_2 = \frac{y_2}{y_o} \qquad u_1 = \frac{y_1}{y_o} \qquad J = \frac{N}{N - M + 1} \qquad v_1 = u_1^{N/J} \qquad v_2 = u_2^{N/J}$$

$$N_{sm} = \frac{N_m\sqrt{Q_m}}{H_m^{3/4}} \qquad N_{sm} = \frac{N_m\sqrt{P_m}}{H_m^{5/4}} \qquad \frac{y_2}{y_1} = \frac{1}{2}\left[-1 + \sqrt{1 + 8Fr_1^2}\right]$$

$$\frac{H_m}{D^2{}_m N^2{}_m} = \frac{H_p}{D^2{}_p N^2{}_p} \qquad \frac{P_m}{\gamma_m D^5{}_m N^5{}_m} = \frac{P_p}{\gamma_p D^5{}_p N^5{}_m} \qquad \frac{Q_m}{N_m D^3{}_m} = \frac{Q_p}{N_p D^3{}_p}$$

$$\frac{N_m D_m}{\sqrt{H_m}} = \frac{N_p D_p}{\sqrt{H_p}} \qquad \frac{P_m}{D^5{}_m N^3{}_m} = \frac{P_p}{D^5{}_p N^3{}_p} \qquad \frac{y_1}{y_2} = \frac{1}{2}\left[-1 + \sqrt{1 + 8Fr_2^2}\right]$$

$$L = \frac{y_o}{S_o}\left\{\left[(u_2 - u_1) - \{F(u_2, N) - F(u_1, N)\} + \left(\frac{y_c}{y_o}\right)^M\left(\frac{J}{N}\right)\{F(v_2, J) - F(v_1, J)\}\right]\right\}$$