UNIVERSITI SAINS MALAYSIA

First Semester Examination
2011/2012 Academic Session

January 2012

EAH 422/4 – Advanced Water Resources Engineering

[*Kejuruteraan Sumber Air Lanjutan*]

Duration : 3 hours
[*Masa : 3 jam*]

Please check that this examination paper consists of **FOURTEEN (14)** pages of printed material including appendices before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi **EMPAT BELAS (14)** muka surat yang bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.*]

Instructions : This paper contains **FIVE (5)** questions. Answer **FOUR** questions.
[***Arahan** : Kertas ini mengandungi **LIMA (5)** soalan. Jawab **EMPAT** soalan.*

You may answer the question either in Bahasa Malaysia or English.
[*Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris*].

All questions **MUST BE** answered on a new page.
[*Semua soalan **MESTILAH** dijawab pada muka surat baru*].

In the event of any discrepancies, the English version shall be used.
[*Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai*].

1. (a) An area of 50 ha is proposed for mixed development. Outline the proposed stormwater device in the development area using best management practice based on control at source and treatment train for stormwater quantity and quality controls.

[5 marks]

(b) An area with 7000 m^2 will be developed with 35 units of medium cost terrace house. The data for pre-development (C_p) and post development (C_a) rational coefficient, design rainfall (5 year ARI) and critical storm (Q_d,10 year ARI) for the whole development area of 7000 m^2 are given in Table 1. To meet the requirement for water quantity control, determine the following:

(i) peak discharge for predevelopment condition

[5 marks]

(ii) peak discharge for post development condition

[5 marks]

(iii) permissible site discharge (PSD)

[5 marks]

(vi) the volume of OSD perunit terrace house.

[5 marks]

Table 1

C_a	C_p	$^5I_{40}$	t_c	t_{cs}	Q_d	t_d
0.85	0.60	71.50 mm/hr	40 min	10 min	201.5 l/s	20 min

2. (a) (i) Briefly describe **FOUR (4)** methods of measuring soil water content and **TWO (2)** methods of measuring soil water suction.

[4 marks]

(ii) Briefly describe **THREE (3)** methods of measuring infiltration in irrigation practice.

[3 marks]

(b) Moisture content at field capacity of a clay loam soil is 28% by weight, while the permanent wilting point is 14% by weight. Root zone depth is 1 m and the bulk density is 1.2 g/cm^3.

(i) Calculate the net and gross depths of irrigation required if the irrigation efficiency is 0.7.

(ii) For the peak of ET 7.5 mm/day, determine the shortest interval for irrigation.

[6 marks]

(c) (i) A weir is installed to measure flow in the range of 0.5 to 1.0 m^3/s. If the maximum depth that can be accommodated at the weir is 1 m and the width of the channel is 4 m, determine the height of a suppressed weir that should be used to measure the flow rate.

[5 marks]

(ii) An irrigation channel with a design discharge of 2.265 m^3/s is to be laid along a terrain having an average slope of 0.005 m/m. To maintain subcritical flow in the channel section, the bottom of the channel must be limited to 0.001 m/m. The extra fall is to be absorbed by drop structures such as the one shown in Figure 1 having a width of 3.048 m. Compute the number of structures required in a 16.09 km length of channel if the drop height (d_Z) is equal to 1.829 m.

[7 marks]

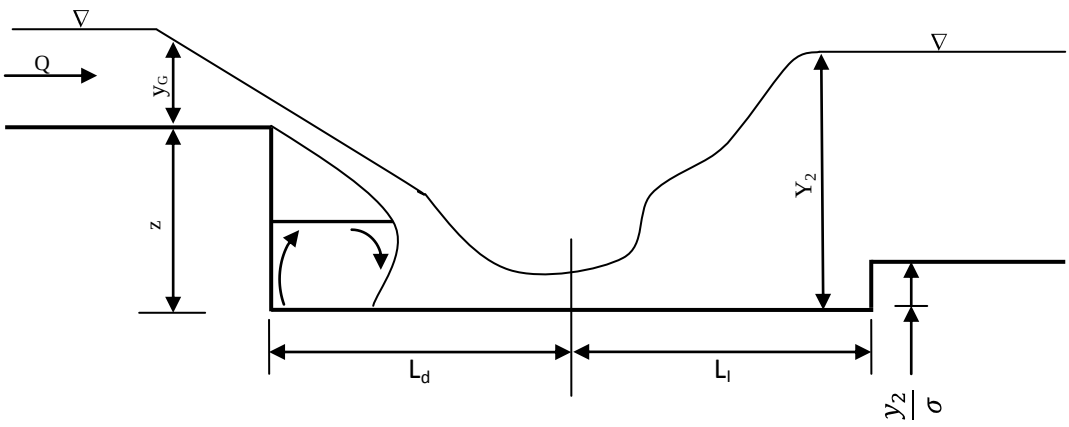


Figure 1 Schematic of the drop structure

3. (a) Given a design discharge of 2.40 m^3/s. By assuming a full pipe flow, calculate the size of a box culvert required with the following characteristics:

L = 60.0 m

n = 0.015

H_{max} = 1.50 m

K_e = 0.6

S_0 = 0.05

Check if submerged flow occur at the entrance of the culvert.

[12 marks]

(b) A bridge is proposed to be built across a river as shown in Figure 2. The following flow characteristics are:

Q = 250.00 m^3/s

B = 60.0 m

y_3 = 3.0 m

K = 0.9

No. of pier = 3

Pier thickness, a = 2.0 m

(i) Examine if water choking happens at the bridge

(ii) Calculate the difference in water level Δy upstream and downstream of the bridge.

[13 marks]

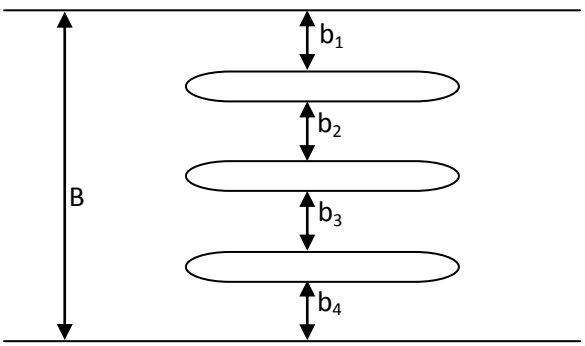


Figure 2

4. (a) Sg Kerian Agriculture Development Agency (SKADA) is currrently planning a new comprehensive sustainable water resources plan of the water resources for its area. A multi-purpose development of the water resources is proposed, i.e.

(i) Flood control

(ii) Public Water Supply

(iii) Irrigation

(iv) Water Quality

(v) Groundwater

Discuss the listed options with respect to sustainable water resources.

[10 marks]

(b) Distinguish the **FIVE (5)** major issues that affects sustainable development in Malaysia.

[15 marks]

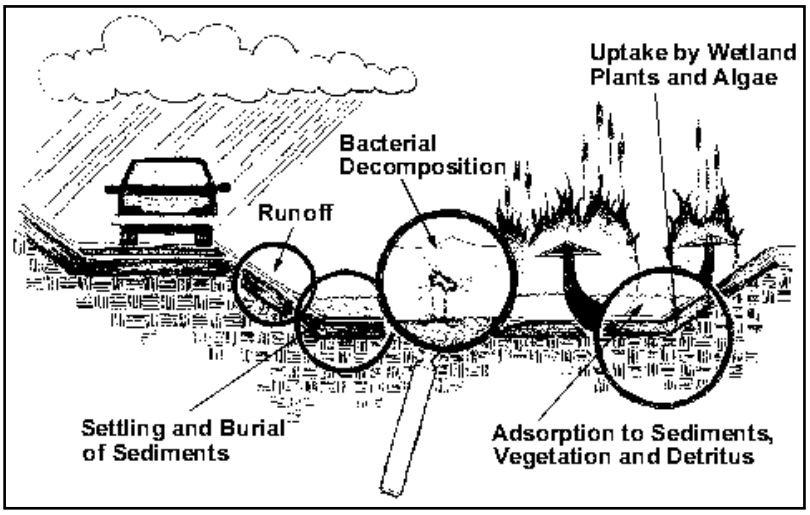


Figure 3

5. (a) As referred to Figure 3, describe the treatment mechanism in a retention pond. Explain the reason sedimentation process is the most effective removal mechanism.

[5 marks]

(b) Estimate the preliminary size of an infiltration trench proposed for the USM School of Civil Engineering building in Nibong Tebal, Pulau Pinang. The impervious area is 65% of the catchment area as in Figure 4. From the site investigation, it is found that the local soil type is sandy loam with final infiltration rate of 0.035m/hr and the ground water level is 3 meters depth.

[20 marks]

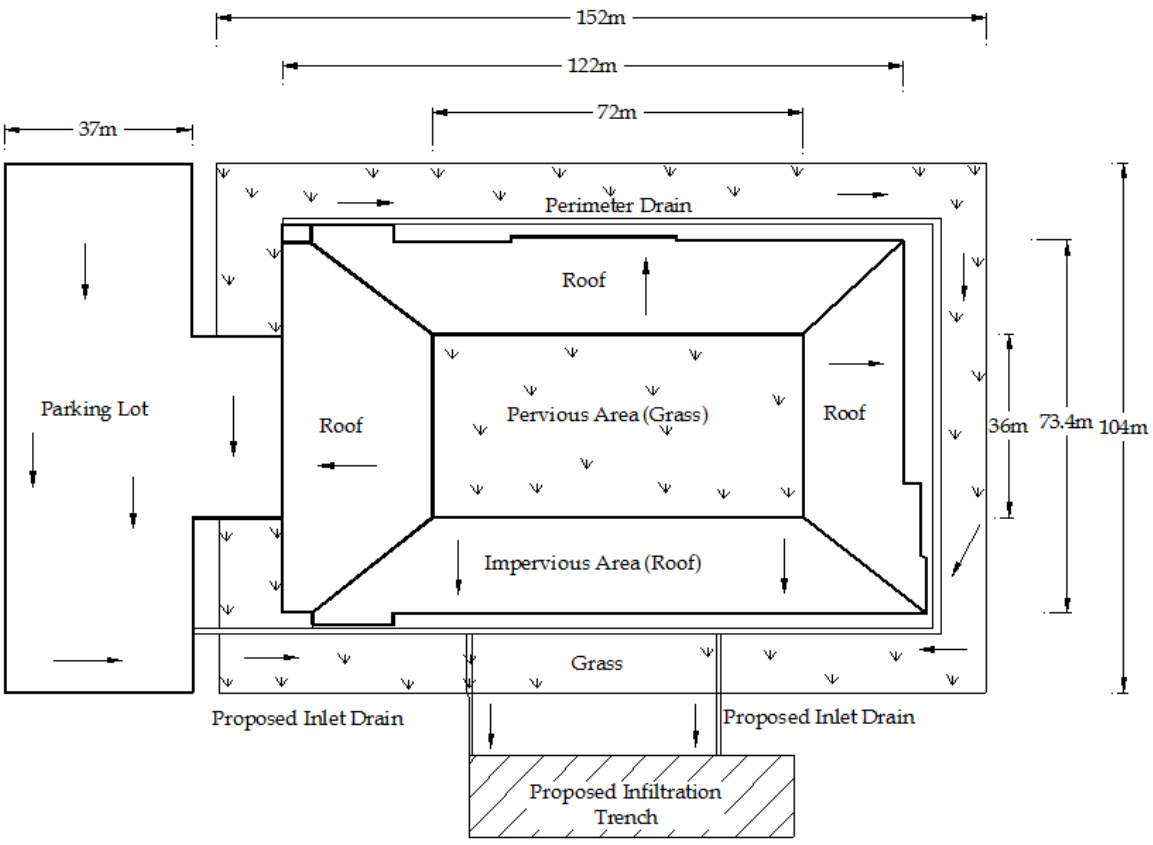


Figure 4 Building and Drainage Layout

1. (a) *Kawasan seluas 50 ha dicadangkan untuk pembangunan bercampur. Gariskan cadangan kemudahan air ribut di dalam kawasan pembangunan tersebut mengikut pengurusan amalan terbaik berasaskan kawalan di punca dan rawatan bersiri untuk kawalan kuantiti dan kualiti air ribut.*

[5 markah]

(b) *Suatu kawasan seluas 7000 m^2 akan di bina dengan 35 unit rumah teres kos sederhana. Pekali Rational sebelum (C_p) dan selepas pembangunan (C_a), hujan rekabentuk (5 tahun ARI) dan air ribut kritikal (Q_d, 10 tahun ARI) untuk keseluruhan kawasan pembangunan seluas 7000 m^2 diberikan pada Jadual 1. Untuk memenuhi kawalan kuantiti air ribut tentukan perkara berikut:*

(i) *puncak kadaralir keadaan pra-pembangunan*

[5 markah]

(ii) *puncak kadaralir keadaan pasca –pembangunan*

[5 markah]

(iii) *aliran keluar dari tapak yang dibenarkan (PSD)*

[5 markah]

(vi) *isipadu OSD perunit rumah teres.*

[5 markah]

Jadual 1

C_a	C_p	$^5I_{40}$	t_c	t_{cs}	Q_d	t_d
0.85	*0.60*	*71.50 mm/hr*	*40 min*	*10 min*	*201.5 l/s*	*20 min*

2. (a). (i) *Jelaskan **EMPAT (4)** kaedah/cara pengukuran kandungan air tanah dan **DUA (2)** kaedah/cara pengukuran sedutan air tanah.*

[4 markah]

(ii) *Jelaskan **TIGA (3)** kaedah pengukuran penyusupan dalam praktis pengairan.*

[3 markah]

(b). Kandungan lembapan pada muatan ladang tanah liat gambut adalah 28 % berat dan titik layu kekal adalah 14 % berat. Kedalaman zon akar adalah 1 m dan ketumpatan pukal adalah 1.2 g/cm^3.

(i) Tentukan kedalaman bersih dan kasar keperluan pengairan jika kecekapan pengairan adalah 0.7.

(ii) Untuk ET puncak 7.5 mm/hari, tentukan jeda pengairan terpendek

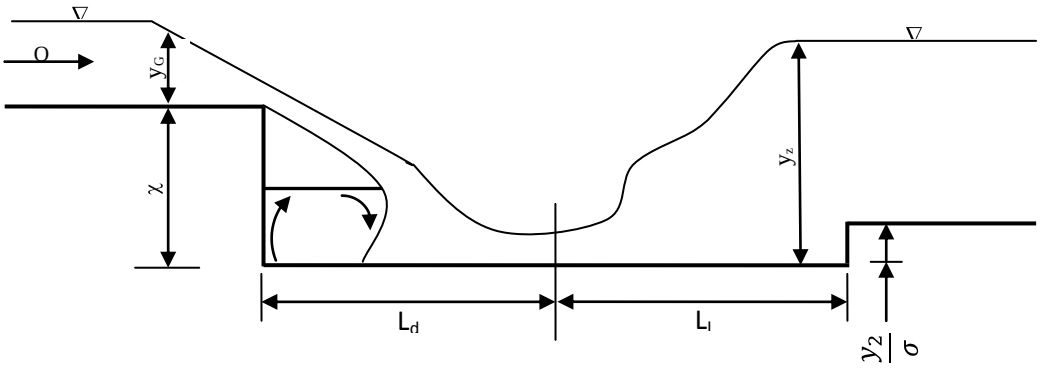
[6 markah]

(c). (i) Satu empang dasar dipasang untuk mengukur aliran dalam julat 0.5 hingga 1.0 m^3/s. Jika kedalaman maksimum air di empang dasar adalah 1 m dan lebar saluran 4 m, tentukan ketinggian empang dasar yang digunakan untuk mengukur kadaraliran.

[5 markah]

(ii) Saluran pengairan dengan reka bentuk kadaralir 2.265 m^3/s akan dibina disepanjang kawasan yang mempunyai kecerunan purata 0.005 m/m. Untuk mengekalkan aliran subkritikal dalam saluran, kecerunan bahagian bawah saluran adalah terhad pada 0.001 m/m. Penurunan tambahan adalah untuk menyerap tenaga oleh struktur penurun seperti yang ditunjukan dalam Rajah 1 yang mempunyai lebar 3.048 m. Hitung jumlah struktur yang diperlukan untuk panjang 16.09 km saluran, jika penurunan (d_Z) adalah 1.829 m.

[7 markah]



Rajah 1 Skema struktur penurunan

3. (a) *Diberi kadaralir rekabentuk 2.40m^3/s. Dengan anggapan bahawa aliran adalah jenis aliran penuh paip, kirakan saiz kotak pembentung yang diperlukan untuk ciri-ciri hidraulik berikut:*

L = 60.0m

n = 0.015

H_{max} = 1.50m

K_e = 0.6

S_o = 0.05

Semak jika aliran tenggelam berlaku di alur masuk kotak pembentung.

[12 markah]

(b) *Rajah 2 menunjukkan pelan jambatan yang dicadangkan untuk melintasi sebatang sungai. Antara ciri-ciri aliran adalah seperti berikut:*

Q = 250.0 m^3/s

B = 60.0 m

y_3 = 3.0 m

K = 0.9

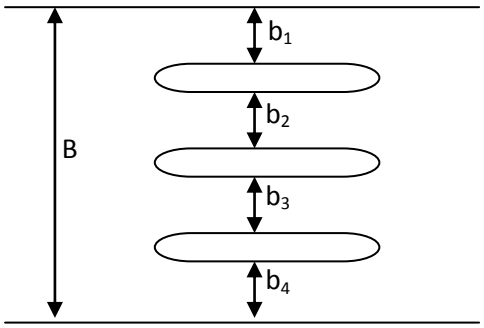
Bilangan Tembok Sambut = 3

Ketebalan Tembok Sambut, a = 2.0m

(i) *Semak jika aliran tercekik akan berlaku di kawasan jambatan dicadangkan.*

(ii) *Kirakan perbezaan aras air Δy di antara hulu dan hilir kawasan jambatan.*

[13 markah]



Rajah 2

4. (i) *Agensi Pembangunan Pertanian Sg Kerian (SKADA) sedang membangunkan pelan sumber air lestari yang menyeluruh untuk sumber air di kawasannya. Satu pelan pembangunan pelbagai dicadangkan untuk sumber air iaitu*

(i) Kawalan banjir

(ii) Bekalan air awam

(iii) Pengairan

(iv) Kualiti air

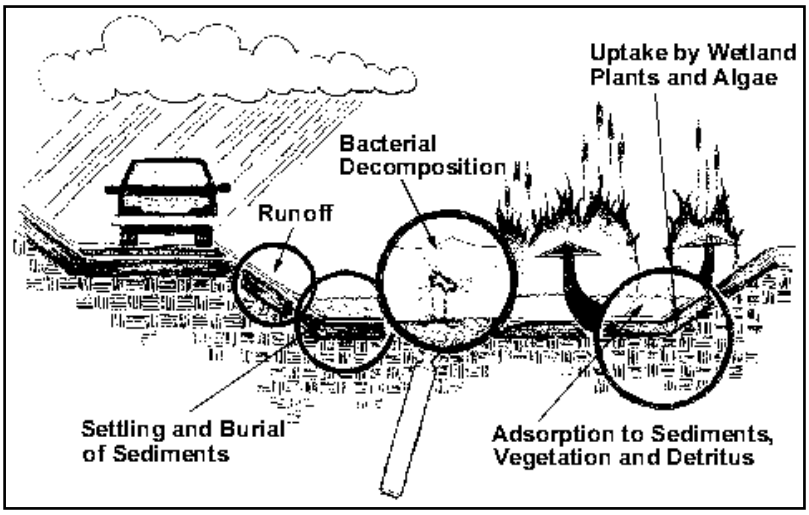
(v) Air bumi

Bincang opsyen-opsyen tersebut berdasarkan kepada sumber air yang lestari.

[10 markah]

(ii) *Kenal beza **LIMA (5)** isu penting yang memberi kesan kepada pembangunan lestari di Malaysia.*

[15 marks]



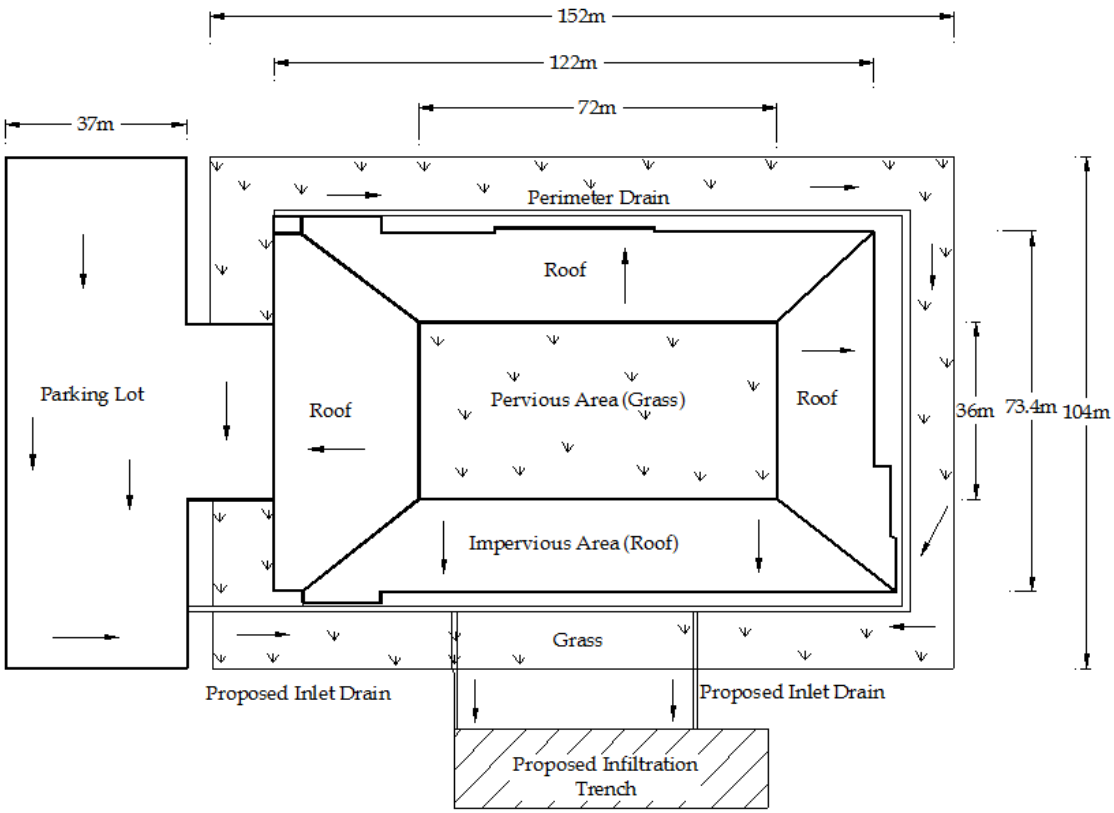
Rajah 3

5. (a) *Merujuk kepada Rajah 3 di atas, terangkan mekanisma rawatan di kolam takungan. Terangkan proses pemendapan sedimen merupakan kaedah penyingkiran yang paling berkesan.*

[5 markah]

(b) *Tentukan saiz awal untuk sebuah cadangan longkang penyusupan (trench) di Pusat Pengajian Kejuruteraan Awam, USM di Nibong Tebal, Pulau Pinang. Kawasan berturap adalah 65% dari kawasan tadahan seperti di Rajah 4. Dari penyiasatan tapak didapati tanah adalah jenis gambut berpasir dengan keupayaan kadar penyusupan adalah 0.035m/jam dan aras air bumi adalah 3m dalam.*

[20 markah]



Rajah 4 Pelan bangunan dan saliran

Appendix 1

Lampiran 1

Given:

$$PSD = \frac{a - \sqrt{a^2 - 4b}}{2}$$

$$a = 4\left(\frac{Q_a}{t_c}\right)\left(0.333t_c\frac{Q_p}{Q_a} + 0.75t_c + 0.25t_{cs}\right)$$

$$b = 4Q_aQ_p$$

$$SSR = 0.06t_d(Q_d - c - d)$$

$$c = 0.875PSD\left(1 - 0.459\frac{PSD}{Q_d}\right)$$

$$d = 0.214\frac{PSD^2}{Q_d}$$

Appendix 2

Lampiran 2

Values of K as a function of pier shape

Pier shape	K	Remarks
Semicircular nose and tail	0.9	All Values applicable for piers with length to breadth ratio equal to 4; Conservative estimates of Δy have been found for larger ratios;
Lens-shaped nose and tail	0.9	
Twin-cylinder piers with connecting diaphragm	0.95	
Twin cylinder piers without diaphragm	1.05	Lens-shaped nose is formed From two circular curves, each radius to twice the pier width and each tangential to a pier face
90° triangle nose and tail	1.05	
Square nose and tail	1.25	

Yarnell's (1934) experimental data on the flow through bridge piers resulted in the following empirical equation

$$\frac{\Delta y}{y_3} = KFr_3^2\left(K + 5Fr_3^2 - 0.6\right)\left(\alpha + 15\alpha^4\right)$$

$$\sigma = \frac{\left(2 + \frac{1}{\sigma}\right)^3 Fr_3^4}{\left(1 + 2Fr_3^2\right)^3}$$

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