UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2007/2008

April 2008

EAH 225/3 - Hydraulics
[*Hidraulik*]

Duration: 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **THIRTEEN (13)** printed pages including appendices before you begin the examination.
*[Sila pastikan kertas peperiksaan ini mengandungi **TIGABELAS** (13) muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

Instructions: This paper contains **SEVEN (7)** questions. Answer **FIVE (5)** questions only. All questions carry the same marks.
*[**Arahan**:Kertas ini mengandungi **TUJUH** (7) soalan. Jawab **LIMA** (5) soalan sahaja. Semua soalan membawa jumlah markah yang sama.]*

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.]*

Write the answered question numbers on the cover sheet of the answer script.
[Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.]

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1. (a) Classify the open-channel flow by depth variation.

Berikan definisi jenis-jenis aliran saluran terbuka berdasarkan kedalaman aliran.

(5 marks / *5 markah)*

(b) Water flows at a velocity of 1 m/s in a rectangular channel 1.0m wide. The bed slope is 0.002 and n = 0.015. Find the depth of flow under uniform flow condition.

Air mengalir pada halaju 1 m/s dalam sebuah saluran segiempat yang lebarnya 1.0m. Cerun membujur adalah 0.002 dan n = 0.015. Kira kedalaman aliran seragam.

(5 marks / *5 markah)*

(c) Find the discharge in a trapezoidal channel with a bed width of 10m, side slopes 1:1 and depth of flow of 2.0m under uniform flow condition. The bed slope is 0.0001 and n = 0.02.

Kira luahan dalam sebuah saluran trapezoid dengan lebar dasar 10m, cerun sisi 1:1 dan kedalaman aliran seragam 2.0m. Cerun membujur adalah 0.001 dan n = 0.02.

(5 marks */5 markah)*

(d) A trapezoidal channel has side slopes of 1:1. It is required to carry a discharge of $25m^3/s$ with the bed slope of 1 in 1500. Design the section if n = 0.0135, R = $y_o/2$ and B = $0.828y_o$.

Sebuah saluran trapezoid mempunyai cerun sisi 1:1. Ia perlu membawa luahan $25m^3/s$ pada kecerunan membujur 1 dalam 1500. Rekabentuk saluran tersebut jika n = 0.0135, R = $y_o/2$ dan B = 0.828 y_o.

(5 marks / *5 markah)*

2. A rectangular channel 3m wide carries a discharge of $15m^3/s$. The channel slope is 0.004 and n = 0.01.

Sebuah saluran segiempat yang lebarnya 3m membawa luahan $15m^3/s$.Cerun membujur adalah 0.004 dan n = 0.01.

(a) Determine the state of the flow. Is it supercritical or subcritical?

Tentukan jenis aliran. Adakah aliran subkritikal atau aliran superkritikal?

(5 marks / *5 markah)*

(b) If a hydraulic jump takes place at this depth, what is the sequent depth at the jump?

Jika lompatan hidraulik terjadi, tentukan kedalaman aliran selepas lompatan tersebut.

(5 marks / *5 markah)*

(c) Verify that sub critical flow occur at the downstream of the jump.

Sahkan aliran subkritikal terjadi selepas lompatan tersebut.

(5 marks / *5 markah)*

(d) Estimate the energy head loss through the jump.

Kira kehilangan tenaga akibat lompatan tersebut.

(5 marks / *5 markah)*

3. a) Water flows from storage A through a 120mm diameter pipe and with a length of 120m to a junction D. A pipe with a 75mm diameter and with a length of 60m is connected from the junction D to storage B which is 16 meter lower in elevation than storage A. Another pipe with 60 mm diameter and with a length of 40m is also connected at junction D and connected to Storage C which is 24 m lower than Storage A. If the friction coefficient of all these pipes is 0.01, determine the flows in each pipes.

Air mengalir dari takungan A melalui paip bergaris pusat 120mm dan panjangnya 120m ke simpang D. Paip yang bergaris pusat 75mm dan panjangnya 60m bersambung dari D ke takungan B yang aras airnya ialah 16 meter di bawah aras takungan A. Paip ketiga bergaris pusat 60mm dan panjangnya 40m, bersambung dari D ke takungan C, dengan aras air ialah 24m di bawah aras takungan A. Dengan mengambil faktor geseran adalah 0.01 untuk kesemua paip, tentukan aliran dalam setiap paip.

(10 marks / *10 markah)*

(b) Determine the elevation of the water surface in the upstream reservoir if the discharge in the system is 0.15 m^3/s as shown in Figure 1. The value for coefficient of contraction (K_c) is 0.37 (contraction between pipe D_{30} and D_{15})

Tentukan nilai turus permukaan air di takungan hulu sekiranya aliran dalam sistem tersebut adalah 0.15 m^3/s seperti di Rajah 1. Nilai K_c (coefficient of contraction) adalah 0.37 (pengecilan antara paip D_{30} dan D_{15}).

(10 marks / *10 markah)*

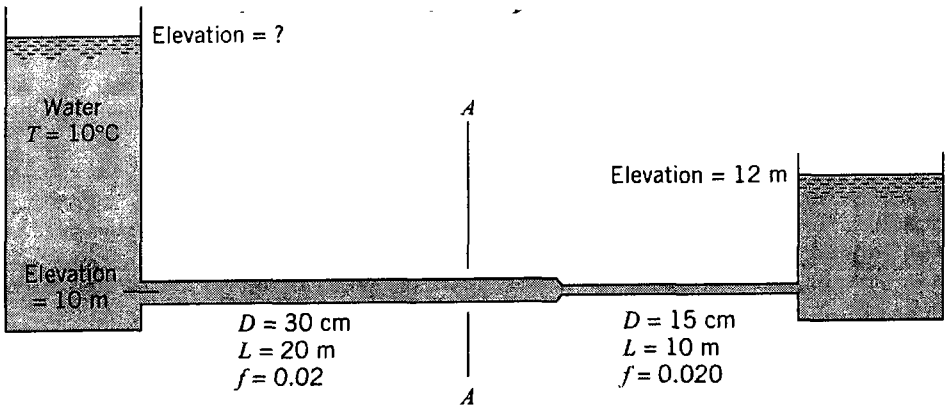

Figure 1 / Rajah 1

4. (a) Describe 2 types of minor losses and explain the factors that affect them.

Terangkan 2 jenis kehilangan kecil dan terangkan faktor yang mempengaruhi kehilangan tersebut.

(5 marks / *5 markah)*

(b) Two pipes with the same length and their diameters are 50mm and 100mm respectively, are connected in parallel between two storage tanks that has a elevation head of 10m, If the friction coefficient is 0.008 (f = 0.008), determine the followings:

i. The discharges for each pipe
ii. The size of a single pipe that could replace both pipes.

Dua batang paip yang sama panjang dan bergarispusat 50mm dan 100mm, disambungkan selari di antara dua buah tangki yang mempunyai perbezaan aras 10m. Jika pekali geseran adalah 0.008 (f = 0.008) tentukan:

i. Kadar alir setiap paip
ii. Garis pusat, D, bagi paip tunggal yang memberi aliran yang sama apabila mengantikan kedua-dua paip tersebut.

(15 marks / *15 markah)*

5. A river reach is to be straightened as shown in Figure 2. Dimensions of the proposed channel are as follows:

Channel shape = rectangular
Bed width, B = 15m
Manning Roughness, n = 0.025
Bed Slope, So = 1/500
Mean bed material diameter, d_{50} = 2.0mm

Sebatang sungai akan diluruskan seperti Rajah 2. Dimensi saluran yang dicadangkan seperti berikut :

Bentuk saluran = segi empat
Lebar dasar sungai, B = 15m
Kekasaran Manning, n = 0.025
Cerun dasar, So = 1/500
Garispusat min endapan, d_{50} =2.0mm

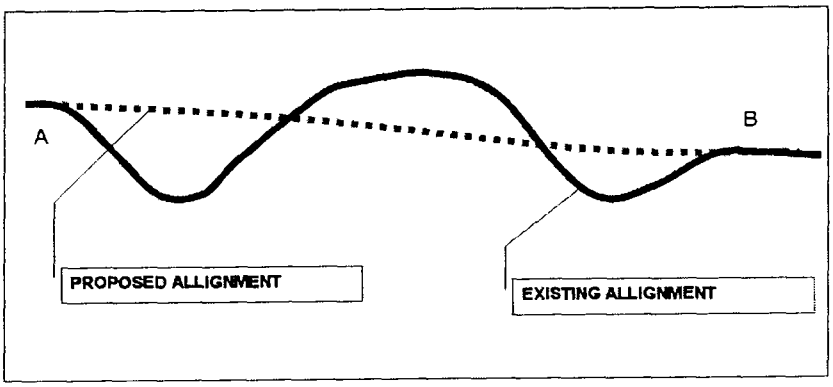

Figure 2 / Rajah 2

(a) Discuss the effect of channel straightening.

Bincang kesan pelurusan sungai

(4 marks / *4 markah)*

(b) Using Shield Diagram, determine the minimum riprap size to protect the bed from being eroded if the flow depth, y = 2m. Assume the flow is in rough region.

Menggunakan Rajah Shield, tentukan saiz minimum riprap untuk pelindungi dadar saluran dari hakisan sekiranya kedlaman aliran, y = 2m. Andaikan aliran dalam keadaan bergelora.

(8 marks / *8 markah)*

(c) Using Shield Diagram, determine whether the bed material will move if the depth of flow, y = 0.5m.

Menggunakan Rajah Shield, semak sekiranya bahan dasar bergerak sekiranya kedalaman aliran, y = 0.5m

(8 marks / *8 markah)*

6. The following data were collected from a river station

Water discharge,	Q =	1.59 m^3/s
Mean velocity	V =	0.62 m/s
Flow Area	A =	2.55 m^2
Wetted perimeter	P =	6.13 m
Bed Slope	So =	0.00096
Measured Bed Load	Q_b =	0.00032 m^3/s
Measured Suspended Load	Q_s =	0.000016 m^3/s
Sediment mean diameter		d_{50} = 0.9 mm

Data berikut telah dicerap dari sebuah stesyen sungai

Kadaralir,	$Q = 1.59\ m^3/s$
Purata Halaju	$V = 0.62\ m/s$
Luas Airan	$A = 2.55\ m^2$
Perimeter basah	$P = 6.13\ m$
Cerun Dasar	$So = 0.00096$
Beban dasar cerapan	$Q_b = 0.00032\ m^3/s$
Beban Terampai cerapan	$Q_s = 0.000016 m^3/s$
Garispusat min endapan	$d_{50} = 0.9mm$

(a) Compute total load using Graf Equation

Kira jumlah beban menggunakan Persamaan Graf

(7 marks / *7 markah)*

(b) Compute bed load using
Kira beban dasar menggunakan

i. Meyer - Peter - Muller Equation
Persamaan Meyer-Peter-Muller

(5 marks / *5 markah)*

ii. Einstein-Brown Equation
Persamaan Einstein-Brown

(5 marks / *5 markah)*

(b) Determine which equation/equations is/are suitable to predict the sediment discharge for this particular cross-section

Tentukan persamaan/persamaan-persamaan yang sesuai digunakan untuk meramal luahan endapan bagi keratan rentas ini.

(3 marks / *3 markah)*

7.(a) When freewheeling, the angular velocity Ω of a wind mill is found to be a function of the windmill diameter D, the wind velocity V, the air density ρ, the wind mill height H as compared to the atmospheric boundary layer height L, and the number of blades N :

Apabila "freewheeling", halaju sudut Ω "wind mill" adalah fungsi diameter D, halaju angin V, ketumpatan angin P, ketinggian "wind mill" H berbanding dengan ketinggian lapisan sempadan atmosfera L dan bilangan bilah kipas N :

$$\Omega = function(D, V, \rho, \frac{H}{L}, N)$$

Viscosity effects are negligible. Find appropriate pi (π) groups for this problem and rewrite the function in dimensionless form.

Tiada kesan kelikatan. Dapatkan kumpulan pi (π) yang sesuai untuk masalah ini dan tulis semula fungsi dalam bentuk tidak berdimensi.

(10 marks / *10 markah)*

(c) A pump delivers gasoline at 20^0C and 12 m^3/h. At the inlet P_1 = 100 kPa, Z_1 = 1 m, and V_1 = 2 m/s. At the exit P_2 = 500 kPa, Z_2 = 4 m and V_2 = 3 m/s. How much power is required if the motor efficiency is 75 percent?

Sebuah pam menghantar gas petrol pada 20^0C dan 12 m^3/j. Di inlet P_1 = 100 kPa, Z_1 = 1 m, dan V_1 = 2 m/s. Di outlet P_2 = 500 kPa, Z_2 = 4 m dan V_2 = 3 m/s. Berapakah kuasa yang dipamkan sekiranya kecekapan motor adalah 75 peratus?.

(10 marks / *10 markah)*

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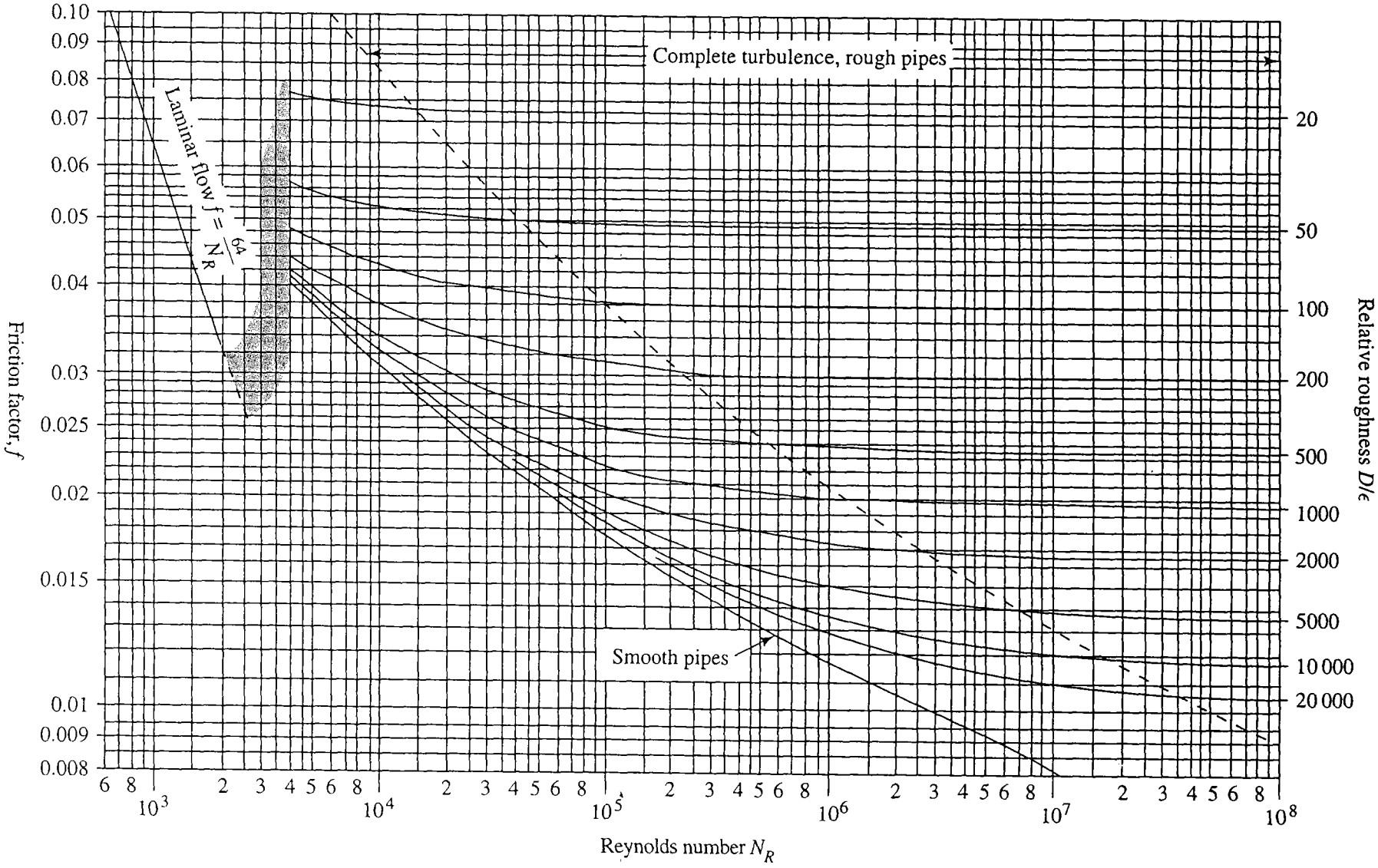
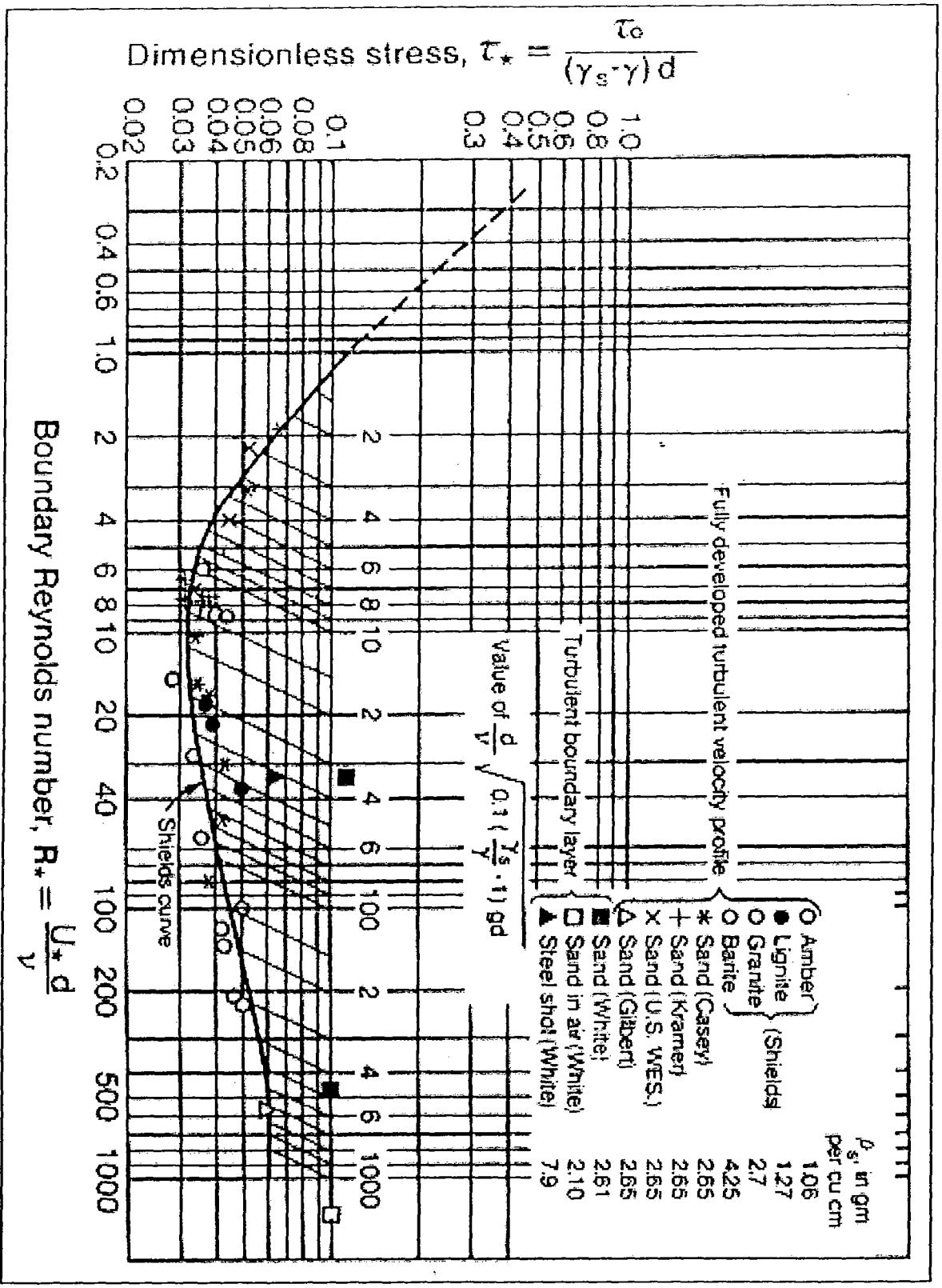


Moody's diagram. (Source: Pao, R. H. F. 1961. *Fluid Mechanics*. New York: John Wiley & Sons, p. 284.)

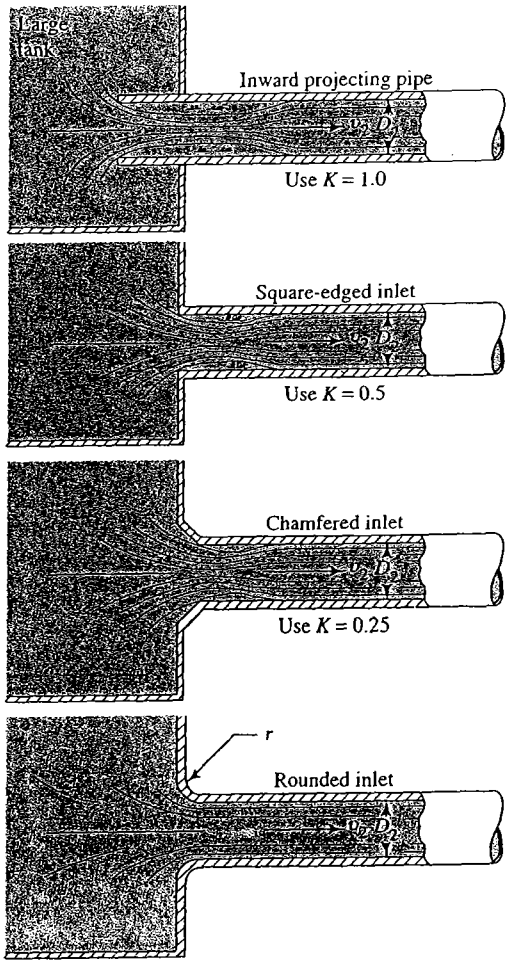


SHIELD DIAGRAM

Resistance coefficient – Sudden **contraction**

D_1/D_2	Velocity, V_2								
	0.6 m/s 2 ft/s	1.2 m/s 4 ft/s	1.8 m/s 6 ft/s	2.4 m/s 8 ft/s	3 m/s 10 ft/s	4.5 m/s 15 ft/s	6m/s 20 ft/s	9 m/s 30 ft/s	12 m/s 40 ft/s
1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.1	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.06
1.2	0.07	0.07	0.07	0.07	0.08	0.08	0.09	0.10	0.11
1.4	0.17	0.17	0.17	0.17	0.18	0.18	0.18	0.19	0.20
1.6	0.26	0.26	0.26	0.26	0.26	0.25	0.25	0.25	0.24
1.8	0.34	0.34	0.34	0.33	0.33	0.32	0.31	0.29	0.27
2.0	0.38	0.37	0.37	0.36	0.36	0.34	0.33	0.31	0.29
2.2	0.40	0.40	0.39	0.39	0.38	0.37	0.35	0.33	0.30
2.5	0.42	0.42	0.41	0.40	0.40	0.38	0.37	0.34	0.31
3.0	0.44	0.44	0.43	0.42	0.42	0.40	0.39	0.36	0.33
4.0	0.47	0.46	0.45	0.45	0.44	0.42	0.41	0.37	0.34
10.0	0.49	0.48	0.48	0.47	0.46	0.45	0.43	0.40	0.36
∞	0.49	0.48	0.48	0.47	0.47	0.45	0.44	0.41	0.38

Entrance resistance coefficients.

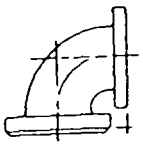


r/D_2	K
0	0.50
0.02	0.28
0.04	0.24
0.06	0.15
0.10	0.09
>0.15	0.04 (Well-rounded)

A Properties of Water

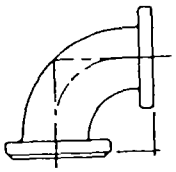
TABLE : SI Units [101 kPa (abs)]

Temperature (°C)	Specific Weight γ (kN/m^3)	Density ρ (kg/m^3)	Dynamic Viscosity μ (Pa·s) or (N·s/m^2)	Kinematic Viscosity ν (m^2/s)
0	9.81	1000	1.75×10^{-3}	1.75×10^{-6}
5	9.81	1000	1.52×10^{-3}	1.52×10^{-6}
10	9.81	1000	1.30×10^{-3}	1.30×10^{-6}
15	9.81	1000	1.15×10^{-3}	1.15×10^{-6}
20	9.79	998	1.02×10^{-3}	1.02×10^{-6}
25	9.78	997	8.91×10^{-4}	8.94×10^{-7}
30	9.77	996	8.00×10^{-4}	8.03×10^{7}
35	9.75	994	7.18×10^{-4}	7.22×10^{-7}
40	9.73	992	6.51×10^{-4}	6.56×10^{-7}
45	9.71	990	5.94×10^{-4}	6.00×10^{-7}
50	9.69	988	5.41×10^{-4}	5.48×10^{-7}
55	9.67	986	4.98×10^{4}	5.05×10^{7}
60	9.65	984	4.60×10^{-4}	4.67×10^{-7}
65	9.62	981	4.31×10^{-4}	4.39×10^{-7}
70	9.59	978	4.02×10^{-4}	4.11×10^{-7}
75	9.56	975	3.73×10^{-4}	3.83×10^{-7}
80	9.53	971	3.50×10^{-4}	3.60×10^{-7}
85	9.50	968	3.30×10^{-4}	3.41×10^{-7}
90	9.47	965	3.11×10^{-4}	3.22×10^{-7}
95	9.44	962	2.92×10^{-4}	3.04×10^{-7}
100	9.40	958	2.82×10^{-4}	2.94×10^{-7}



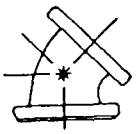
K = $30f_T$

(a) 90° elbow



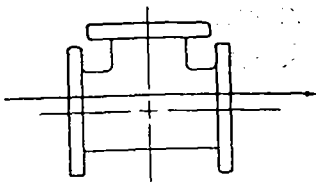
K = $20f_T$

(b) 90° long radius elbow



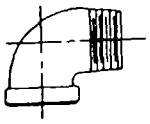
K = $16f_T$

(c) 45° elbow



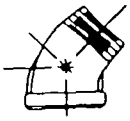
K = $20f_T$

(a) Flow through run



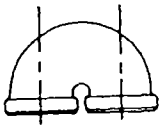
K = $50f_T$

(d) 90° street elbow



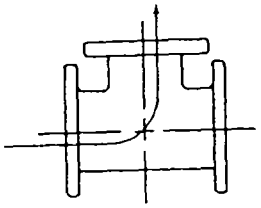
K = $26f_T$

(e) 45° street elbow



K = $50f_T$

(f) Return bend



K = $60f_T$

(b) Flow through branch

TABLE : resistance in valves and fittings expressed as **equvialent** length in pipe diameters, L_e/D

Type	Equivalent Length in Pipe Diameters, L_c / D
Globe valve – fully open	340
Angle valve - fully open	150
Gate valve – fully open	8
- 3/4 open	35
- 1/2 open	160
- 1/4 open	900
Check valve – swing type	100
Check valve – ball type	150
Butterfly valve – fully open	45
Foot valve - poppet disc type	420
Foot valve - hinged disc type	75
90° standard elbow	30
90° long radius elbow	20
90° street elbow	50
45° standard below	16
45° street elbow	26
Close return bend	50
Standard tee – with flow through run	20
- with flow through branch	60