L-3/T-2/WRE **Date : 09/06/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **CE 391** (Transportation Engineering)

Full Marks: 280 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Assume missing value/data (if any).

1. (a) A two lane road of 54 km long is to be widened to four lanes at a cost of Tk. 220 lac/km including all improvements. The VOC (vehicle operating cost) on the existing two lanes is Tk. 20/veh-km, while it is Tk. 13.5/veh-km on the improved facility. The AADT may be assumed 5050 vehicle over a design period of 20 years. The interest rate is 9.5% per year. The maintenance cost is Tk. 27,500/km on existing road and Tk. 40000/km on improved road. Is the investment in the improvement scheme worthwhile? **(12⅔)**

   (b) Describe with a simplified flow chart of recovery and refining of petroleum asphalt. List the tests for bitumen. State the desirable properties of aggregates to be used in highway construction. **(18)**

   (c) Compare bitumen with tar. Explain system approach of transportation planning. Define costs of highway transportation with examples. **(16)**

2. (a) Compare road ways with railways. Why is uniformity in railway gauge in a country desirable? **(12)**

   (b) State the importance of aggregate blending. Combine the three types of aggregates to meet the required specification from the following sieve analysis data. The given specified limits for CA, FA and MF are 48% – 65%, 35% – 50% and 5% – 8% respectively. **(16)**

Passing sieve	Retained sieve	% by weight			Specific limit
		CA	FA	MF	
3/4″	1/2″	5	—	—	0 – 5
1/2″	3/8″	35	—	—	8 – 40
3/8″	# 4	40	—	—	8 – 45
# 4	# 10	15	8	—	6 – 27
# 10	# 40	5	30	—	5 – 20
# 40	# 80	—	35	5	9 – 30
# 80	# 200	—	26	34	5 – 8
# 200	—	—	1	61	2 – 6
Total	—	100	100	100	—

   (c) What are the requirements of a passenger platform for Railway? Write down the functions of the followings: **(18⅔)**

   (i) Ballast (ii) Railway signals (iii) Sleepers.

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3. (a) A 7° curve branches off from a 4° main in opposite direction of a B.G yard. If the speed restrictions on main line is 58 km/hr, what would be the speed restriction on branch line? Assume permissible cant deficiency 75 mm. **(11⅔)**

(b) Describe the construction steps of earth road. State the importance of maintenance of low cost roads. **(12)**

(c) What are the functions of pavement? Explain the desirable characteristics of pavement. **(10)**

(d) What are the causes of pavement failure? Briefly discuss the different types of joints in rigid pavements. **(13)**

4. (a) Discuss the different types of asphalt concrete commonly used in flexible pavement construction. What are the purposes of using Prime Coat and Task Coat? **(13⅔)**

(b) For the following data carry out Fatigue analysis using PCA method. Design period = 20 years, sub-base/subgrade k = 130 lb/in^3, concrete modules of rapture = 650 psi, the pavement is with doweled joints and without concrete shoulders. Assume load safety factor = 1.2 and pavement thickness = 11.5″. **(18)**

Single Axle (kip)	Expected repetitions	Tandem Axle (kip)	Expected repetitions
40	11,000	50	9,000
36	13,750	46	13,000
32	29,000	40	33,000
30	56,000	36	54,000
28	71,000		
26	96,000		
24	1,30,000		

(c) A 6 lane divided Highway is to be constructed on a new alignment. Traffic volume forecasts indicate that the annual average daily traffic (AADT) in both directions during the first year of operation will be 16,000 with the following vehicle composition and axle loads. **(15)**

Passenger Cars (1000 lb/axle) = 38%

2-axle single unit truck (3000 lb/axle) = 30%

3-axle single unit truck (15000 lb/axle) = 20%

3-axle single unit truck (22000 lb/axle) = 12%

The vehicle composition is expected to remain the same throughout the design life of the pavement. If the expected annual traffic growth rate is 5% for 2 axle unit truck, 4% for 3 axle unit truck and 8% for the passenger cars, determine the design ESAL, given a design period of 20 years. Assume 46% truck volume on design lane.

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SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Point out the significant characteristics of transportation system that makes it diverse and complex. Briefly describe each point in two or three sentences. **(10)**

(b) State the names of major and minor disciplines of transportation engineering. **(4)**

(c) What are the drawbacks of at grade intersections? Write short note on 'Single-Point Urban Interchange (SPUI)' considering left-hand driving. **(2+4⅔=6⅔)**

(d) What are the 'design control and criteria' for geometric design of highways? What are the problems associated with intersections having acute angle, intersections on sharp horizontal curve and intersections having steep vertical grades? **(5+9=14)**

(e) A vertical crest curve on a single carriageway road with a design speed of 80 kmph is to be built in order to join a +4.0% grade to a –3.5% grade. Desired stopping sight distance for 80 kmph road is 160 m. If driver's eye height is 1.05 m and object height is 0.20 m – **(6+6=12)**

(i) calculate the minimum curve length which satisfies the requirements of SSD.

(ii) calculate the minimum curve length when object height is assumed to be zero. Comment on the answer.

Given:

$$S < L : L = \frac{AS^2}{100\left(\sqrt{2h_1} + \sqrt{2h_2}\right)^2};$$

$$S > L : L = 2S - \frac{100\left(\sqrt{2h_1} + \sqrt{2h_2}\right)}{A};$$

Note that the symbols carry their usual meaning.

6. (a) Draw the cross-section of a typical 'four lane-two way rural highway of Bangladesh. Point out the cross-sectional elements of a highway in your figure. **(9⅔)**

(b) Define Transportation Planning. Make a list of the important factors that are believed to justify a transportation project. **(3+4=7)**

(c) What are the basic requirements for a comprehensive transportation plan? Draw a flow-chart showing the basic elements of transportation planning. **(3+6=9)**

(d) Classify road-traffic accidents based on the severity of accident. What are the key data that should be included in the accident report form for every reported accident? **(4+5=9)**

(e) Four vehicles are found to be travelling at constant speeds between section X and Y (320 m apart) at a particular instant in time. An observer at point X found the four vehicles passing point X during a period of 15 seconds. The speeds of the vehicles are measured as 48, 40, 60 and 52 km/hr respectively. Calculate the flow, density, time mean speed and space mean speed of the vehicles. **(12)**

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7. (a) Briefly describe the four main investigative approaches to develop accident reduction programs. What are the four major planning steps that all of these four approaches involve? **(12+2=14)**

(b) In reference to the traffic stream characteristics, draw qualitative speed vs flow, flow vs density and speed vs density curves. **(7⅔)**

(c) What are the four steps in conventional Transportation Modeling? Name two most common mathematical formulations for each step. **(2+8=10)**

(d) Make a comparison between 'Diamond interchange' and 'Cloverleaf interchange'. **(6)**

(e) Draw a circular curve and show different components of the curve in the figure. **(9)**

8. (a) What are the criteria to ensure an efficient water transport system? State the features of successful water transit. **(2+6=8)**

(b) Name the main components of an airport and mention their functions. **(2+6=8)**

(c) Make a comparison between 'Airfield Pavement' and 'Highway Pavement'. **(5)**

(d) Write a brief but comprehensive note on 'superelevation' in horizontal curves. Mention the factors, selection criteria and recommendations for maximum superelevation. **(8)**

(e) Following speed data have been obtained in a speed study on a rural highway. Determine 'modal speed', 'mean speed', 'pace', 'percentage of vehicle in pace' and 'standard deviation of speeds'. In an attempt to improve accident situation, some speed controlling devices have been installed in this road which reduced the speed of all vehicles by 4.5 mph. Is this reduction in speeds statistically significant at 95% confidence level? Given, **(10+7⅔=17⅔)**

for 95% confidence level, Z = 1.96 and $S_d = \sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}$;

the symbols carry their usual meaning.

Speed Class (mph)	Number of observation in class
20 – 24.9	05
25 – 29.9	13
30 – 34.9	22
35 – 39.9	30
40 – 44.9	34
45 – 49.9	18
50 – 54.9	08

Table 1. Growth Factors — 2.4(c)

Design Period, Years (n)	Annual Growth Rate, Percent (r)							
	No Growth	2	4	5	6	7	8	10
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	2.0	2.02	2.04	2.05	2.06	2.07	2.08	2.10
3	3.0	3.06	3.12	3.15	3.18	3.21	3.25	3.31
4	4.0	4.12	4.25	4.31	4.37	4.44	4.51	4.64
5	5.0	5.20	5.42	5.53	5.64	5.75	5.87	6.11
6	6.0	6.31	6.63	6.80	6.98	7.15	7.34	7.72
7	7.0	7.43	7.90	8.14	8.39	8.65	8.92	9.49
8	8.0	8.58	9.21	9.55	9.90	10.26	10.64	11.44
9	9.0	9.75	10.58	11.03	11.49	11.98	12.49	13.58
10	10.0	10.95	12.01	12.58	13.18	13.82	14.49	15.94
11	11.0	12.17	13.49	14.21	14.97	15.78	16.65	18.53
12	12.0	13.41	15.03	15.92	16.87	17.89	18.98	21.38
13	13.0	14.68	16.63	17.71	18.88	20.14	21.50	24.52
14	14.0	15.97	18.29	19.16	21.01	22.55	24.21	27.97
15	15.0	17.29	20.02	21.58	23.28	25.13	27.15	31.77
16	16.0	18.64	21.82	23.66	25.67	27.89	30.32	35.95
17	17.0	20.01	23.70	25.84	28.21	30.84	33.75	40.55
18	18.0	21.41	25.65	28.13	30.91	34.00	37.45	45.60
19	19.0	22.84	27.67	30.54	33.76	37.38	41.45	51.16
20	20.0	24.30	29.78	33.06	36.79	41.00	45.76	57.28
25	25.0	32.03	41.65	47.73	54.86	63.25	73.11	98.35
30	30.0	40.57	56.08	66.44	79.06	94.46	113.28	164.49
35	35.0	49.99	73.65	90.32	111.43	138.24	172.32	271.02

Note: Factor = $[(1 + r)^n - 1]/r$, where $r = \frac{\text{rate}}{100}$ and is not zero. If annual growth is zero, growth factor = design period.

Source: Reproduced from *Thickness Design—Asphalt Pavements for Highways and Streets*, Manual Series No. 1, The Asphalt Institute, College Park, Md., September 1981.

Table 2 Load Equivalency Factors — 2.4(c)

Gross Axle Load		Load Equivalency Factors		Gross Axle Load		Load Equivalency Factors	
kN	lb	Single Axles	Tandem Axles	kN	lb	Single Axles	Tandem Axles
4.45	1,000	0.00002		182.5	41,000	23.27	2.29
8.9	2,000	0.00018		187.0	42,000	25.64	2.51
13.35	3,000	0.00072		191.3	43,000	28.22	2.75
17.8	4,000	0.00209		195.7	44,000	31.00	3.00
22.25	5,000	0.00500		200.0	45,000	34.00	3.27
26.7	6,000	0.01043		204.5	46,000	37.24	3.55
31.15	7,000	0.0196		209.0	47,000	40.74	3.85
35.6	8,000	0.0343		213.5	48,000	44.50	4.17
40.0	9,000	0.0562		218.0	49,000	48.54	4.51
44.5	10,000	0.0877	0.00688	222.4	50,000	52.88	4.88
48.9	11,000	0.1311	0.01008	226.8	51,000		5.23
53.4	12,000	0.189	0.0144	231.3	52,000		5.63
57.8	13,000	0.264	0.0199	235.7	53,000		6.04
62.3	14,000	0.360	0.0270	240.2	54,000		6.47
66.7	15,000	0.478	0.0360	244.6	55,000		6.93
71.2	16,000	0.623	0.0472	249.0	56,000		7.41
75.6	17,000	0.796	0.0608	253.5	57,000		7.92
80.0	18,000	1.000	0.0773	258.0	58,000		8.45
84.5	19,000	1.24	0.0971	262.5	59,000		9.01
89.0	20,000	1.51	0.1206	267.0	60,000		9.59
93.4	21,000	1.83	0.148	271.3	61,000		10.20
97.8	22,000	2.18	0.180	275.8	62,000		10.84
102.3	23,000	2.58	0.217	280.2	63,000		11.52
106.8	24,000	3.03	0.260	284.5	64,000		12.22
111.2	25,000	3.53	0.308	289.0	65,000		12.96
115.6	26,000	4.09	0.364	293.5	66,000		13.73
120.0	27,000	4.71	0.426	298.0	67,000		14.54
124.5	28,000	5.39	0.495	302.5	68,000		15.38
129.0	29,000	6.14	0.572	307.0	69,000		16.26
133.5	30,000	6.97	0.658	311.5	70,000		17.19
138.0	31,000	7.88	0.753	316.0	71,000		18.15
142.3	32,000	8.88	0.857	320.0	72,000		19.16
146.8	33,000	9.98	0.971	325.0	73,000		20.22
151.2	34,000	11.18	1.095	329.0	74,000		21.32
155.7	35,000	12.50	1.23	333.5	75,000		22.47
160.0	36,000	13.93	1.38	338.0	76,000		23.66
164.5	37,000	15.50	1.53	342.5	77,000		24.91
169.0	38,000	17.20	1.70	347.0	78,000		26.22
173.5	39,000	19.06	1.89	351.5	79,000		27.58
178.0	40,000	21.08	2.08	356.0	80,000		28.99

Note: kN converted to lb are within 0.1 percent of lb shown.

Source: Reproduced from *Thickness Design—Asphalt Pavements for Highways and Streets*, Manual Series No. 1, The Asphalt Institute, College Park, Md., September 1981.

3.

Table 3: Equivalent Stress values for single Axles (without concrete shoulders) Q. 4 (b)

Slab thickness (in)	k of subgrade - sub-base (lb/in³)			
	50	100	150	200
7	375	331	307	292
7.5	340	300	279	265
8	311	274	255	242
8.5	285	252	234	222
9	264	232	216	205
9.5	245	215	200	190
10	228	200	186	177
10.5	213	187	174	165
11	200	175	163	154
11.5	188	165	153	145

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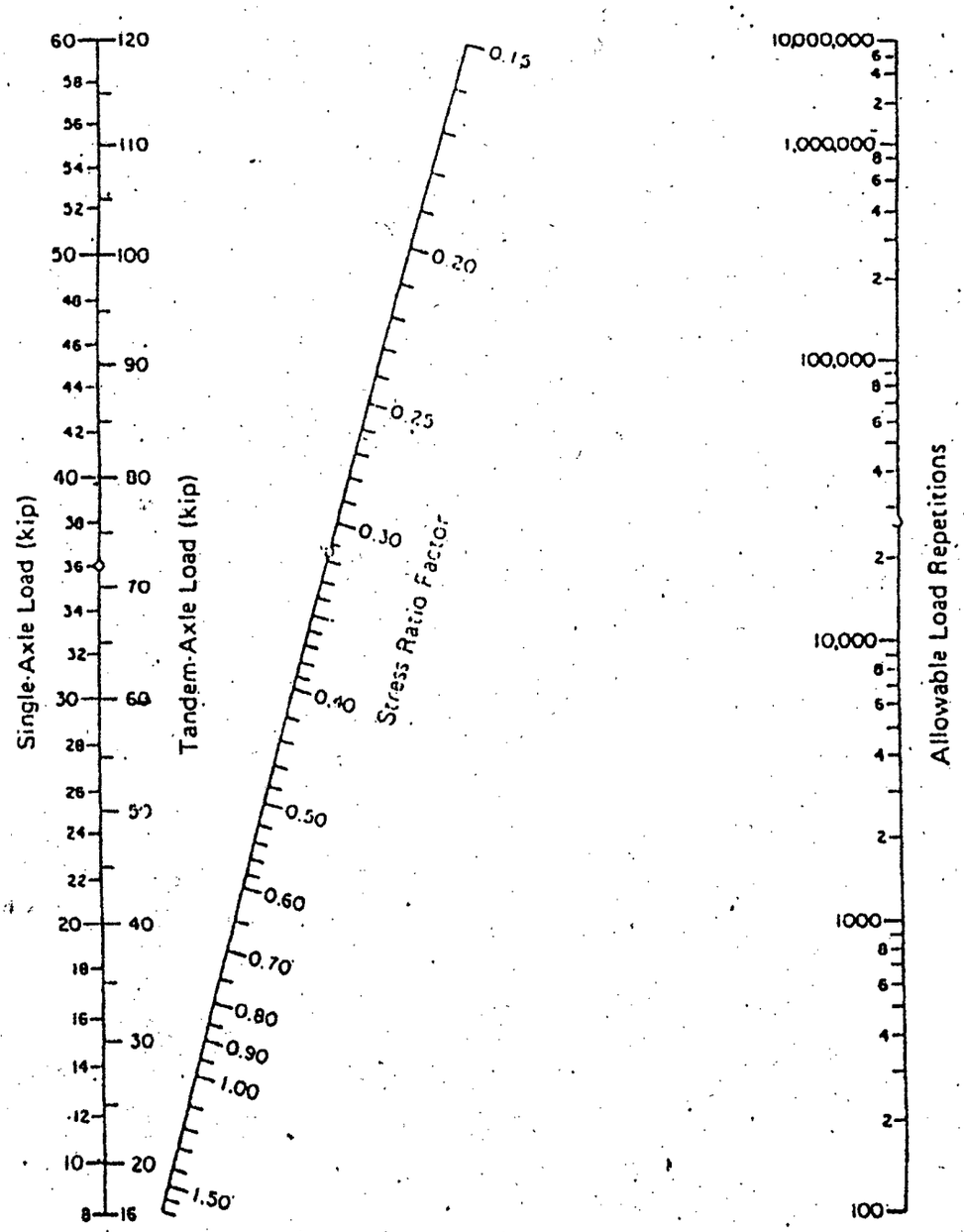
Figure 1 (3.42) Allowable Load Repetitions for Fatigue Analysis Based on Stress Ratio



Q. 4 (b)

L-3/T-2/WRE **Date : 12/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **CE 481** (Foundation Engineering)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Explain different available borehole stabilization techniques. **(10)**

   (b) Explain Cone Penetration Test (CPT). For a bore log where a 5 m thick clay layer is overlying a 10 m thick dense sand; Show cone resistance with depth for such a bore log. **(10)**

   (c) SPT was performed on a near surface deposit of clean sand, where the number of blows is shown below. Assume E_m = 60%, the borehole diameter is 100 mm, and the drill rod length is 5 m; γ_s = 17 kN/m^3. Calculate the measured SPT - N value (blows per foot), N_{60} and $(N_1)_{60}$. Also indicate the density condition of the sand. **(15)**

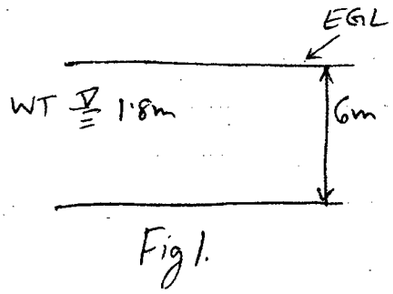


Fig 1.

Depth (m)	SPT-N
1.5	3
3.0	6
4.5	7
6.0	9

2. (a) Explain with neat sketches Wash Boring and Rotary Drilling techniques. **(15)**

   (b) Explain the factors that affect the sample qualities. **(10)**

   (c) A sampling tube has an outside diameter D_t = 3 inch, a tip diameter De = 2.84 inch, and a wall thickness of 0.065 inch. If $D_w = D_t$; calculate the clearance ratios, area ratio, and indicate if the sampling tube meets the criteria for undisturbed soil sampling. **(10)**

3. (a) Explain bearing capacity failures of shallow foundations with neat sketches. **(12)**

   (b) Explain bearing capacity equation developed by Terzaghi and explain its different parameters. **(8)**

   (c) A strip footing will be constructed in a clay deposit (S_u = 15 kPa) and the site is underlain by heavily consolidated clay that has an undrained shear strength of S_u = 200 kPa and a drained shear strength of $\phi_2 = 28°$ and C_2 = 5 kPa. The proposed strip footing will be 1.8 m wide and embedded 0.6 m below the ground surface. The ground water table is located at a depth of 0.6 m, performing both a total stress analysis and an effective stress analysis; determine the allowable load, Q_{all}. **(15)**

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4. (a) Explain the selection criteria of foundation type. **(10)**

   (b) Explain various types of piles, in terms of their support capacity. **(10)**

   (c) A proposed strip footing that is 1.2 m wide will be located 0.6 m below ground surface. The soil type is uniform dense sand that has a friction angle ϕ of 32°. The total unit weight of the soil is equal to 18 kN/m^3. The ground water table is well below the bottom of the footing and will not be a factor in the bearing capacity analysis. Estimate the allowable bearing pressure. **(15)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

Attached Figures (1). Correction between relative density Dr and subgarde modulus K_v for cohesionless soil (2) Allowable soil bearing pressure for footing on sand barrel on standard penetration test.

5. (a) Explain pile group efficiency in cohesive soil with a neat sketch. **(10)**

   (b) Explain downdrag loads on a single pile and on pile group. **(10)**

   (c) Estimate the bearing capacity of a cast-in-situ 450 mm diameter pile for the following data: **(15)**

Depth (m)	SPT-N	Soil type
1.5	2	Silty clay c = 30 kPa γ = 14 kN/m^3
3.0	1	
4.5	2	
6.0	3	
7.5	4	
9	10	Medium Dense Find Sand ϕ = 34° γ = 17 kN/m^3
10.5	11	
12	13	
13.5	14	
15	15	
16.5	25	
18	26	
19.5	29	
21	32	

6. (a) Explain adhesion between the cohesive soil and pile or pier perimeter. **(10)**

   (b) Explain "Standard Test Method for Piles Under lateral load". **(10)**

   (c) A 4 by 4 pile group will support a pile cap that is subjected to a vertical load of 3500 kN, that is offset from the center line of the pile cap by a distance of 1 m. The piles have a diameter of 350 mm, are spaced at four pile diameters in both directions, and the pile cap is 6 m by 6 m. Determine the load that each pile supports. **(15)**

7. (a) Define maximum differential settlement, modulus of subgarde reaction and maximum angular distortion. **(9)**

Contd P/3

(b) Explain under consolidated, normally consolidated and over consolidated soil. **(9)**

(c) A site consists of a sand deposit where the field standard penetration test "N" value is equal to 18. The groundwater table is well below the bottom of the footing and the total unit weight γ_t of the sand is 19 kN/m^3. For a square spread footing that is 3 m wide and a depth of 1.5 m below the ground surface, determine the settlement if the footing exerts a vertical pressure of 350 kPa on to the sand. Do the same problem with groundwater table located at 0.5 m below the ground surface. **(17)**

8. (a) Explain Schmertmann's method to estimate settlement. **(8)**

(b) Explain surficial and gross slope stabilities with equation and neat sketches. **(14)**

(c) A site has a level ground surface and a level groundwater table located 7 m below the ground surface. The site is underlain with sand, except for a uniform and continuous clay layer that is located at a depth of 10 m to 15 m below the ground surface. Below the ground water table, the pore water pressures are hydrostatic in the sand layers. The average void ratio e_0 of the clay layer is 0.90 and the buoyant unit weight γ_b of the clay layer = 7.9 kN/m^3. The total unit weight γ_t of the sand alone the ground water table = 18.7 kN/m^3 and the total unit weight γ_t of the sand below the groundwater table = 19.7 kN/m^3. A laboratory consolidation test performed on an undisturbed specimen obtained from the centre of the clay layer indicates the maximum past pressure σ_{vm} = 100 kPa and the compression index C_c = 0.15. Determine the primary consolidation settlement S_e of the 5 m thick clay layer if a uniform surcharge fill of 40 kPa is applied over a very large area at ground surface. **(13)**

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TABLE ~~2.6~~ 1 Correlation between $(N_1)_{60}$ and Density of Sand

$(N_1)_{60}$ (blows per foot)	Sand density	Relative density D_r, percent
0–2	Very loose condition	0–15
2–5	Loose condition	15–35
5–20	Medium condition	35–65
20–35	Dense condition	65–85
Over 35	Very dense condition	85–100

Source: Tokimatsu and Seed (1987).

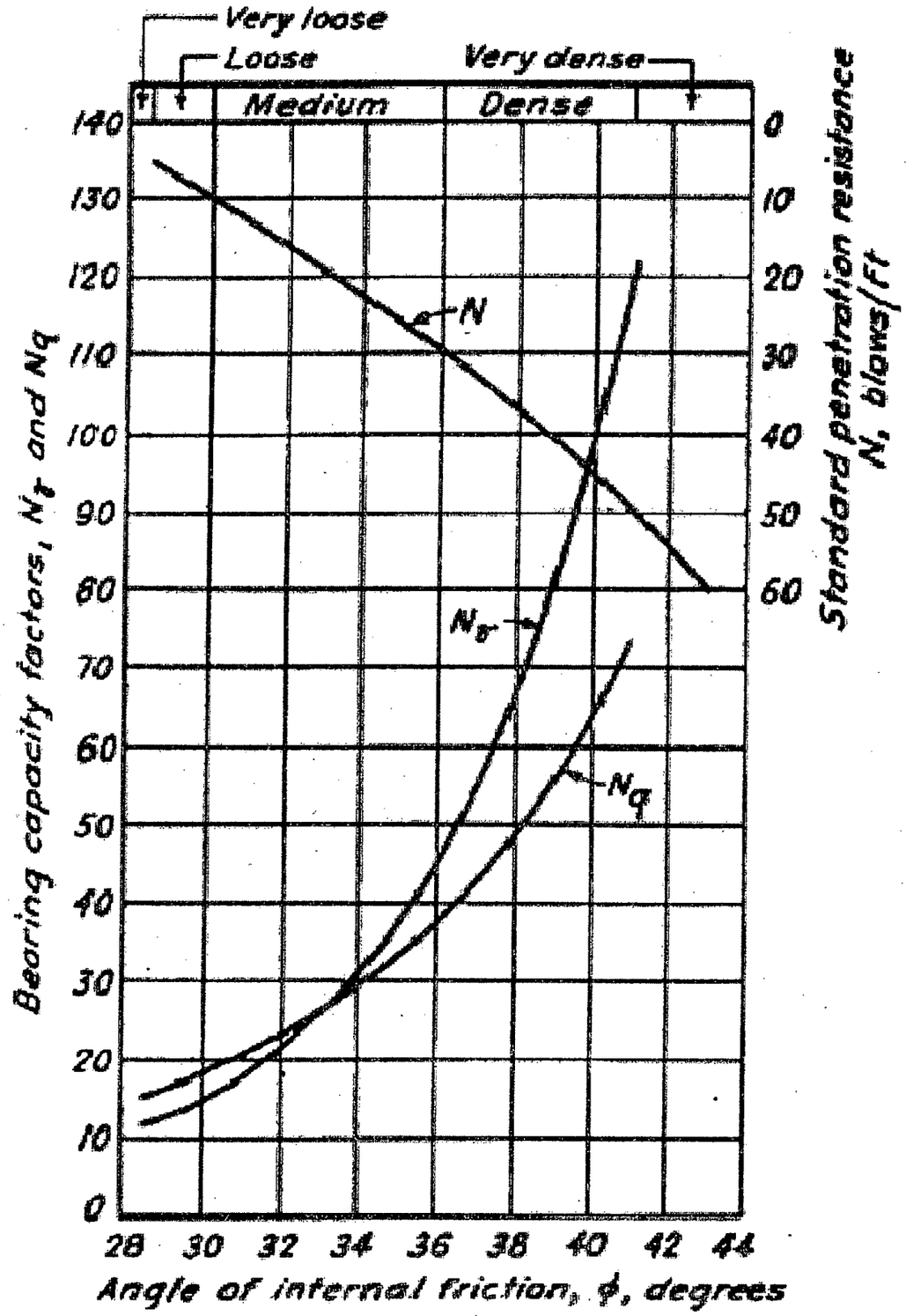


FIGURE ~~6.5~~ 1 Bearing capacity factors N_γ and N_q that automatically incorporate allowance for punching and local shear failure. *Note:* For analysis using the standard penetration test, assume N refers to the N_{60} value from Eq. 2.4. *(From Peck, Hanson, and Thornburn, 1974, reproduced with permission of John Wiley & Sons.)*

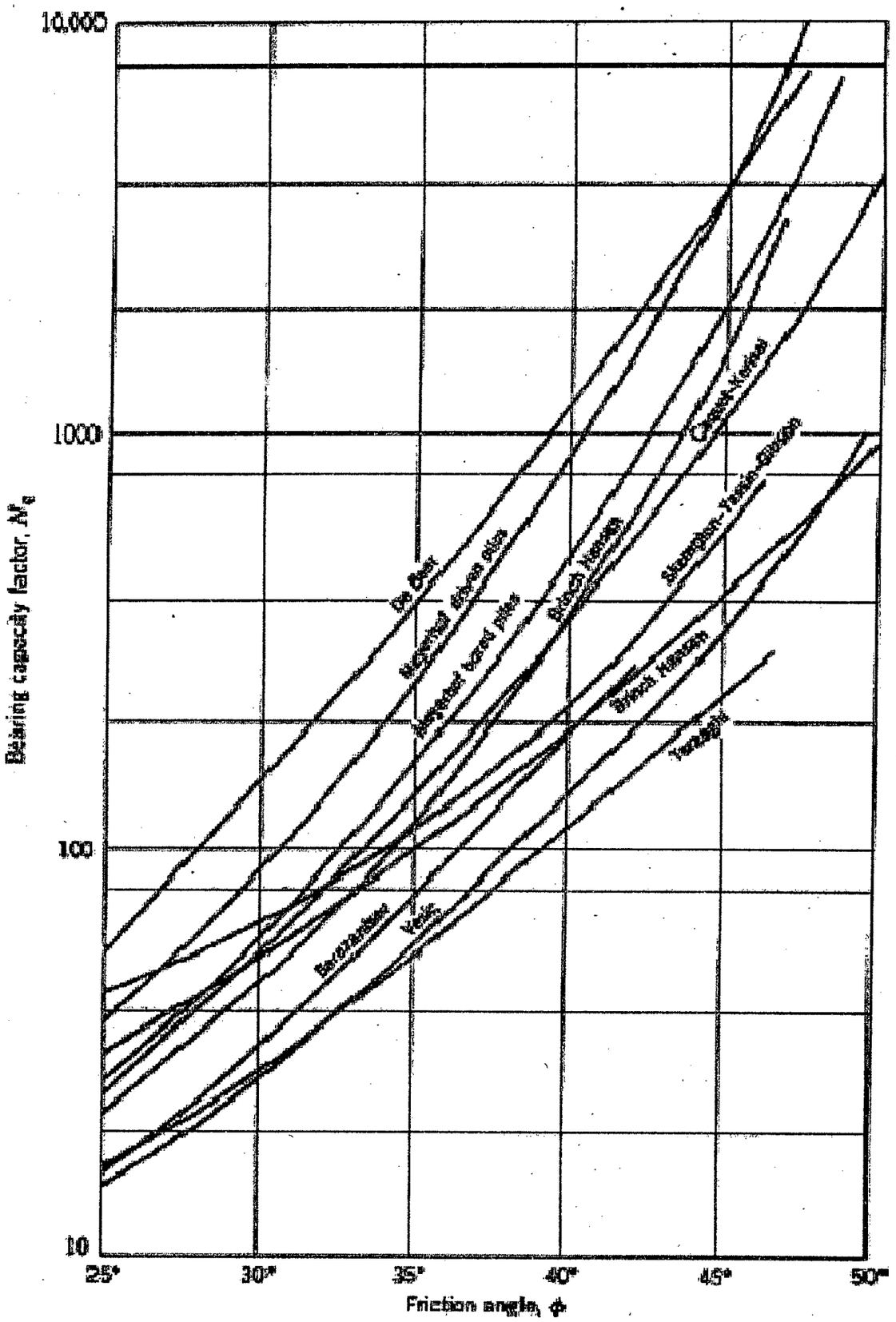


FIGURE 2 Bearing capacity factor N_q as recommended by various researchers for deep foundations. (*From Vesić, 1967; reproduced from Lambe and Whitman, 1969.*)

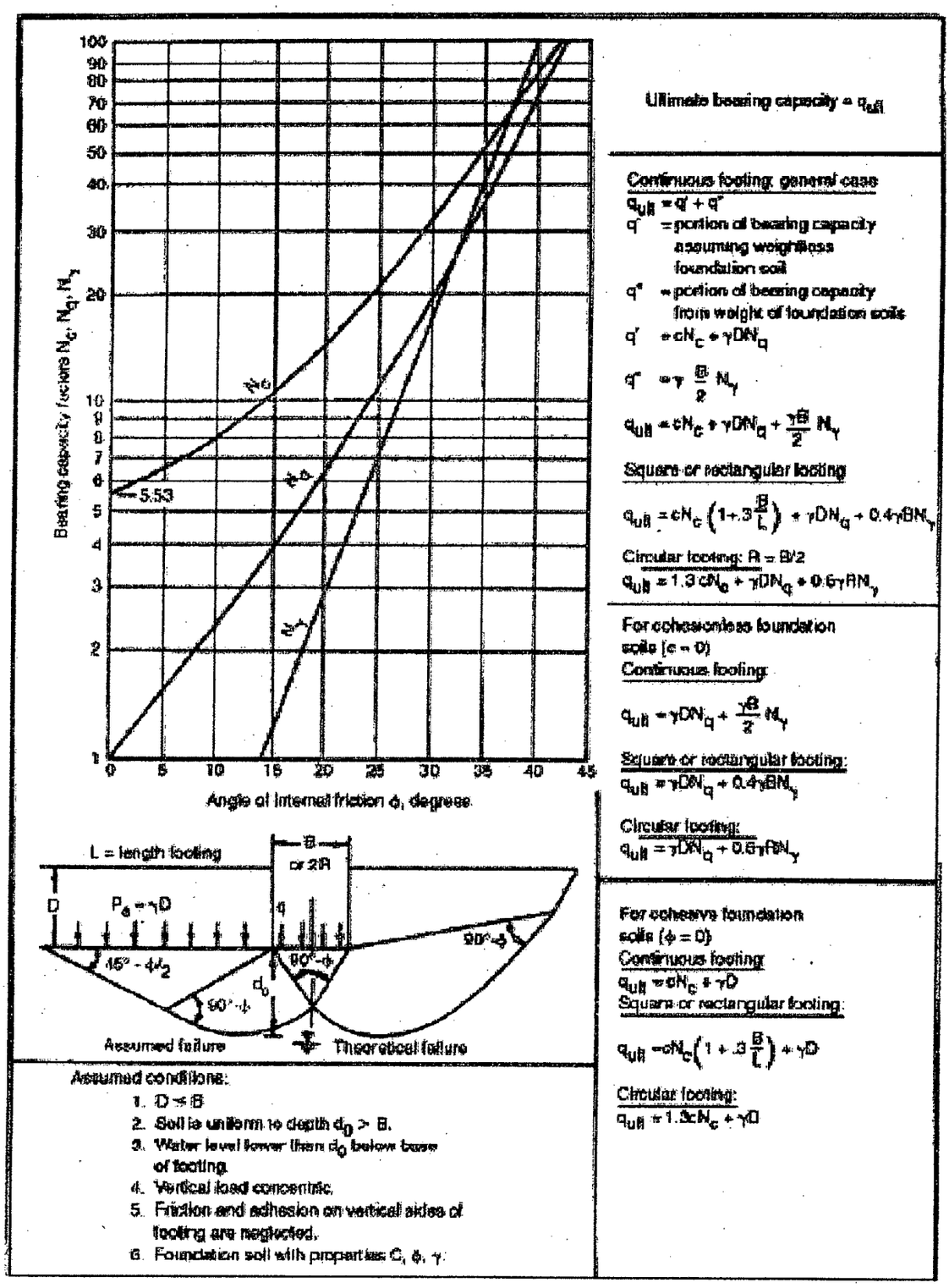


FIGURE 6-3 Bearing capacity factors N_γ, N_q, and N_c that do not include allowance for punching shear failure. [*Note:* For punching shear of loose sands or soft clays, the value of ϕ to be used in this figure = $\tan^{-1}$ (0.67 tan ϕ) and the cohesion used in the bearing capacity equation = 0.67 c]. (*Reproduced from NAVFAC DM-7.2, 1982.*)

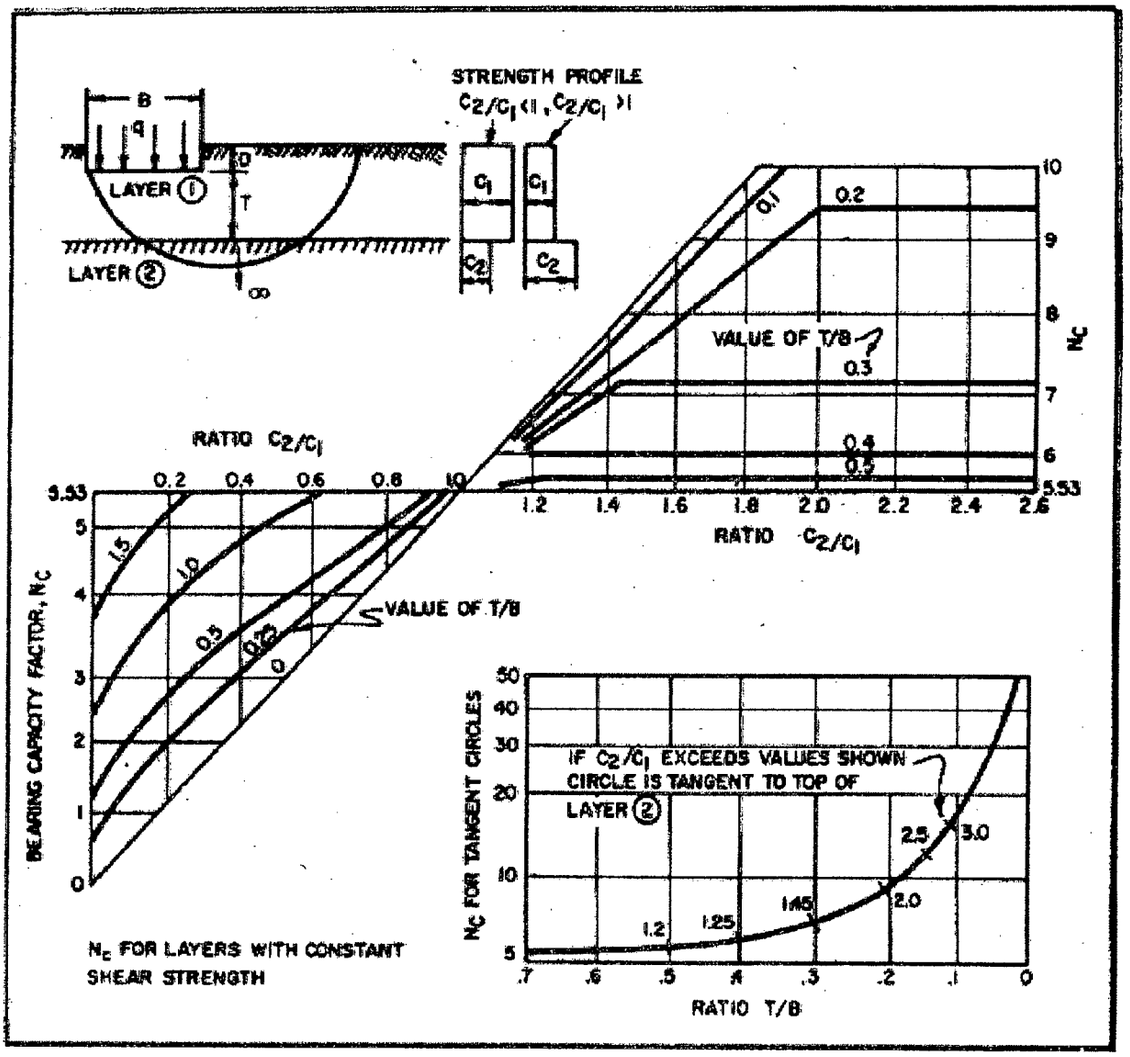


FIGURE 4 Ultimate bearing capacity of a shallow foundation constructed on two layers of cohesive soil. (*From NAVFAC DM-7.2, 1982.*)

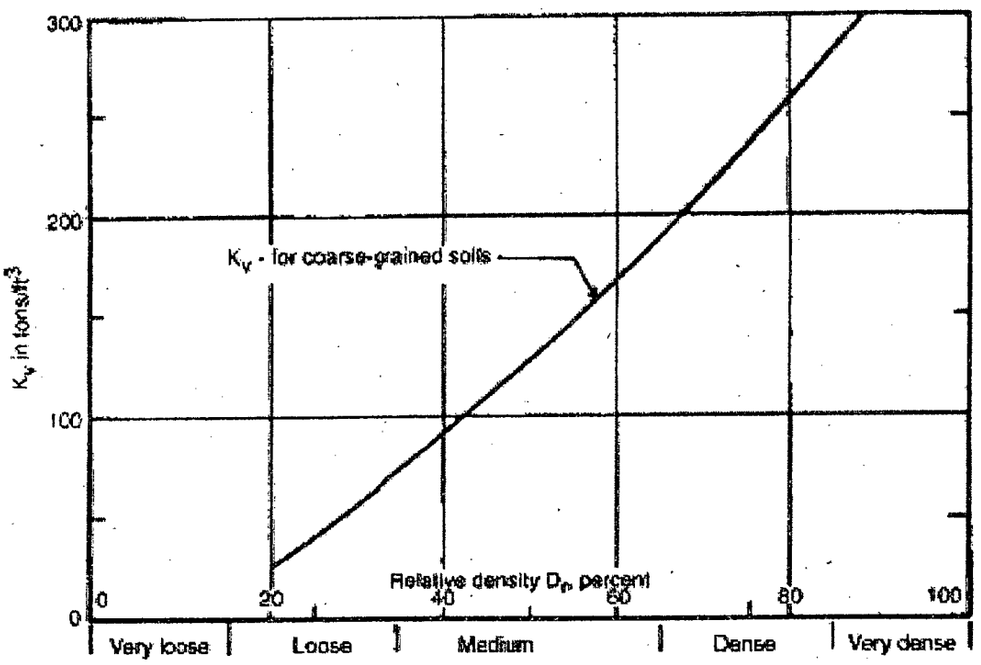


FIGURE 5 Correlation between relative density D_r and subgrade modulus K_v for cohesionless soil. *(Adapted from NAVFAC DM-7.1, 1982.)*

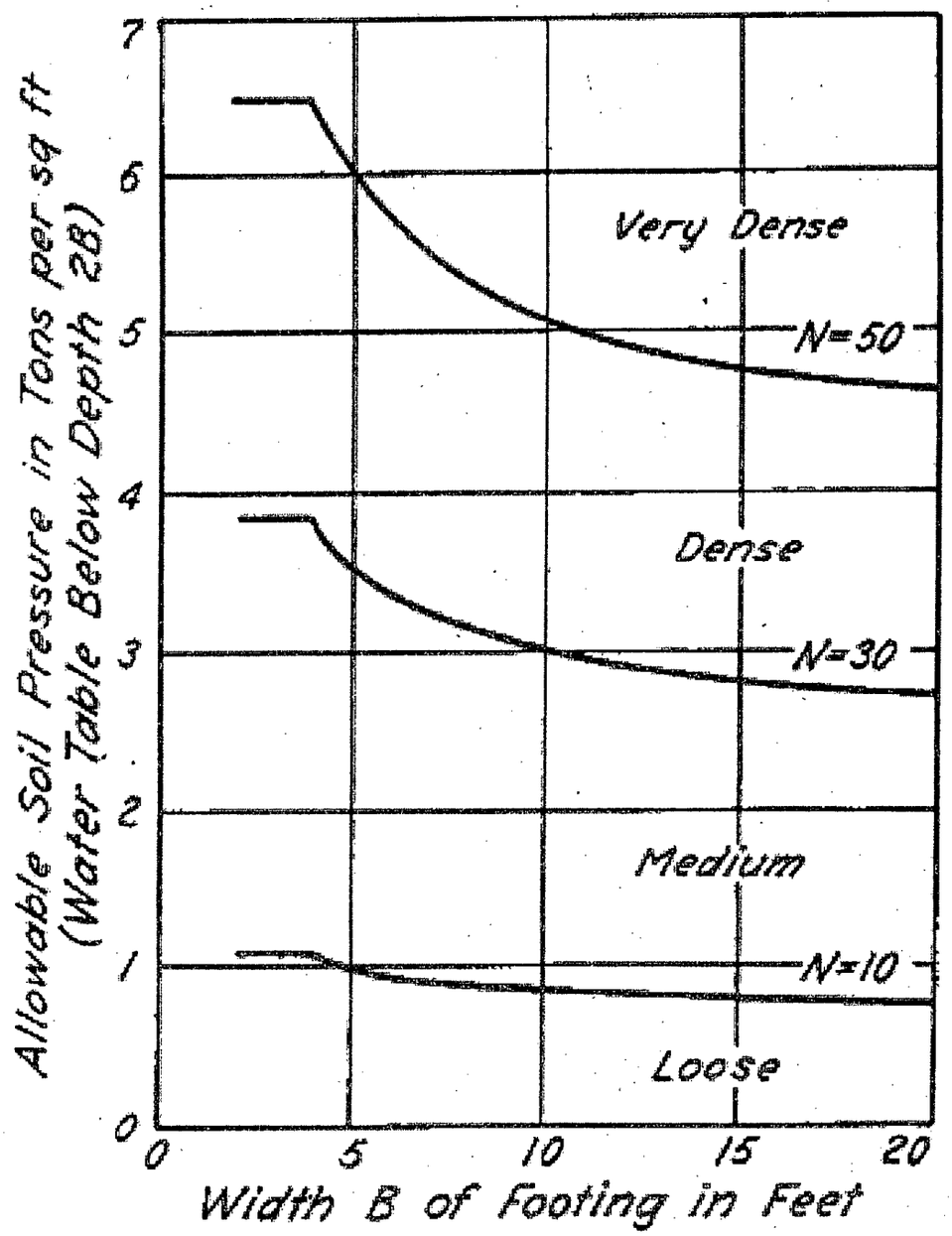


FIGURE 2.6 Allowable soil bearing pressures for footings on sand based on the standard penetration test. *Note:* assume N refers to the N_{60} value from Eq. 2.4. (*From Terzaghi and Peck, 1967; reprinted with permission of John Wiley & Sons.*)

26.05.14

L-3/T-2/WRE **Date : 26/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **CE 325** (Design of Concrete Structures II)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE** questions.

1. (a) Why are ties provided in column? State the requirements of ties according to ACI/BNBC code. **(10)**

   (b) Design a square tied column with reasonable reinforcement to support. **(12)**

   P_{DL} = 600 kips and P_{LL} = 450 kips

   Given : f'_c = 4 ksi, f_y = 60 ksi

   (c) A designer choose 24" × 24" column section with 12 # 9 bars as shown in Fig. 1. For the following loading conditions,

   P_{DL} = 120^k and P_{LL} = 150^k

   M_{DL} = 60 k-ft and M_{LL} = 95 k-ft.

   Check whether his/her design is adequate or not. Use the attached interaction diagram. **(13)**

2. (a) Differentiate between the behaviour of a short column and a long (slender) column. **(10)**

   (b) For the column section shown in Fig. 2, draw the strength interaction diagram (for bending about X-X axis) with five points corresponding to balanced failure, pure axial load, pure bending, tension failure and compression failure. **(25)**

   Given. f'_c = 4ksi , f_y = 60 ksi

3. (a) Write down the ACI/BNBC code detailing requirements for beams and columns in regions of moderate seismic risk. **(10)**

   (b) Design a footing to support a 20" square tied interior column reinforced with 8 # 9 bars. The column carries an unfactored axial dead load of 240 kip and an axial live load of 200 kip. The base of the footing is 5 ft below the final grade and allowable soil pressure is 5 ksf. Use, f'_c = 4 ksi, f_y = 60 ksi.

   Limit one side of the footing to 7.5 ft. Check against development length and transfer of forces at the base of the column. **(25)**

4. (a) A combined footing supports two columns 'A' and 'B' with their respective working loads as shown in Fig. 3. Effective depth of the footing is 40". Check the adequacy of the depth against punching shear. **(15)**

Contd P/2

CE 325

Contd ... Q. No. 4

(b) A pile cap is to be designed to distribute a concentric force from a single column to a nine-pile group, with geometry as shown in Fig. 4. The column transfers 300^k of dead load and 600^k of live load to the pile cap. The 24" square column is reinforced with 16 # 9 bars. The permissible load per pile is 100 kips. Find the required effective depth and total depth of the pile cap and the reinforcement. **(20)**

Given, $f'_c = 4$ ksi, $f_y = 60$ ksi.

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) State five different floor systems with neat sketches for reinforced concrete buildings. **(10)**

(b) A flat plate floor system without edge beam is supported by 20" × 20" square column ~~speed~~ 25' × 25' grid. The floor will carry 30 psf floor finish, 80 psf partition wall load and 40 psf live load in addition to its own weight. **(25)**

(i) Design a typical interior panal. Use direct design method and show reinforcement in detail. Use relevant charts provided.

(ii) Determine if shear reinforcement is required for the slab and if so, design shear reinforcement using bent bars to carry the excess shear.

Given, $f'_c = 4$ ksi, $f_y = 60$ ksi.

6. (a) What kind of shear are critical in the design of flat plates, flat slabs or footings. What are the common types of shear reinforcement used for flat plates? Show with neat sketches. **(10)**

(b) A four-story reinforced concrete wall is subjected to factored lateral loads as shown in Fig. 5. The wall is 15 ft long and 10" thick. Design reinforcement for the wall at the first level between the base and first floor. **(25)**

Given: $f'_c = 4$ ksi, $f_y = 60$ ksi.

$$\frac{A_{vv}}{S_1} \geq \left[0.0025 + 0.5\left(2.5 - \frac{h_w}{l_w}\right)\left(\frac{A_{vh}}{S_2 h} - 0.0025\right)\right]h$$

$$\frac{A_{vv}}{S_1} \geq 0.0025h$$

$$M_u = \phi\left[0.5A_{st}f_y l_w\left(1 - \frac{z}{l_w}\right)\right]$$

$$\frac{z}{l_w} = \frac{1}{2 + 0.85\beta_1 . l_w . \frac{hf'_c}{A_{st}f_y}}$$

where, h_w = thickness of the wall.

Contd P/3

CE 325

7. (a) Write down the sources of prestress loss. **(8)**

(b) A simply supported rectangular beam as shown in Fig. 6, is to carry a uniformly distributed live load of 0.8 kips/ft in addition to its own weight. The beam will be pretensioned with multiple seven wire strands with the centroid at a constant eccentricity of 8". The prestress force P_i immediately after transfer will be 160 kips; after time dependent losses, the force will reduce to P_e = 135 kips. Calculate the concrete flexural stress at the midspan section of the beam at the time of transfer, and after all losses with full service (dead and live load) in place. **(27)**

8. (a) Write down the advantages and disadvantages of prestressed concrete as compared to reinforced concrete. **(10)**

(b) Differentiate between, **(12)**

(i) strand and cable.

(ii) Pre-tensioning and post-tensioning.

(iii) Bonded and unbonded tendons.

(c) A post-tensioned concrete beam with a cable of 12 parallel wires (total steel area = 1.2 in^2) is tensioned with 2 wires at a time. Immediately after anchoring, an initial prestress of 150,000 psi is obtained. Compute the loss of prestress due to elastic shortening of concrete. **(13)**

CE 325

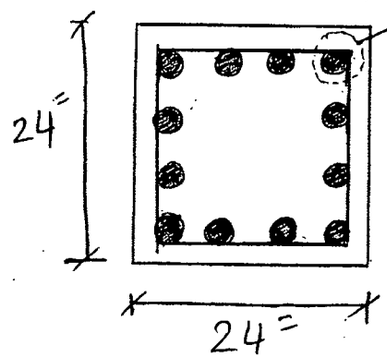


Fig. 1

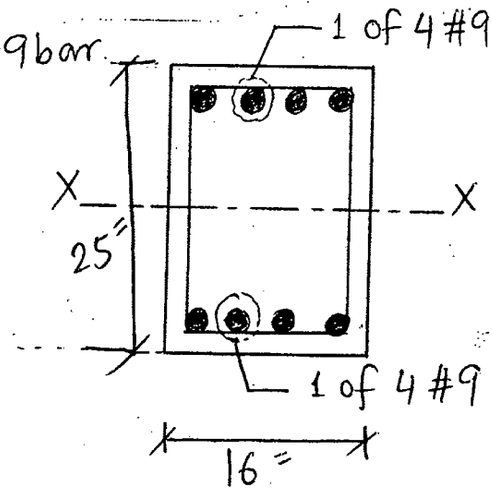


Fig. 2

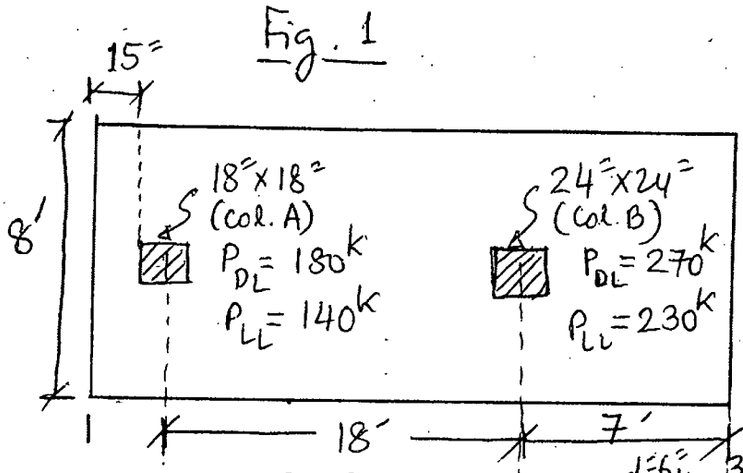


Fig. 3

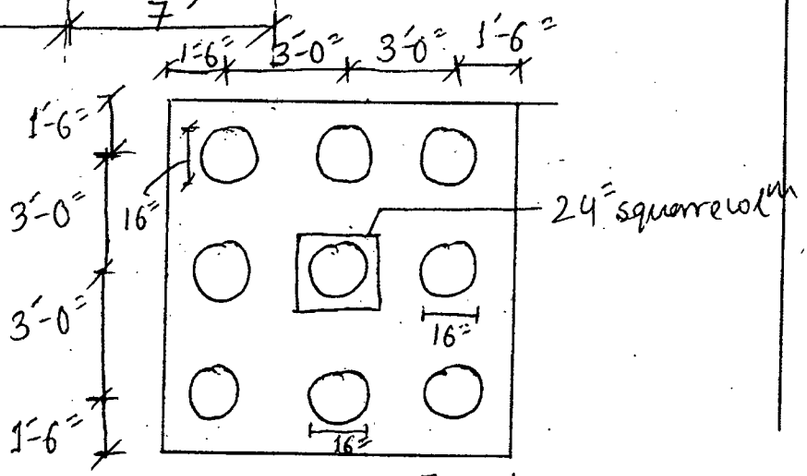


Fig. 4

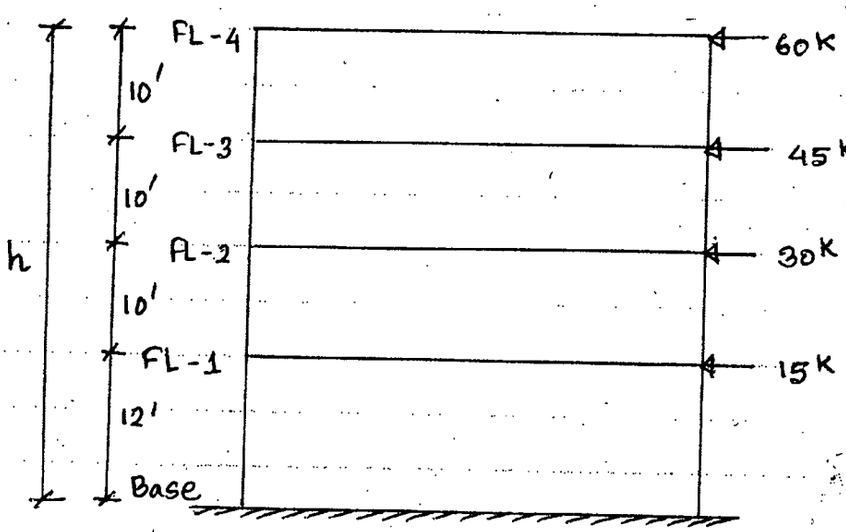


Fig. 5 Elevation

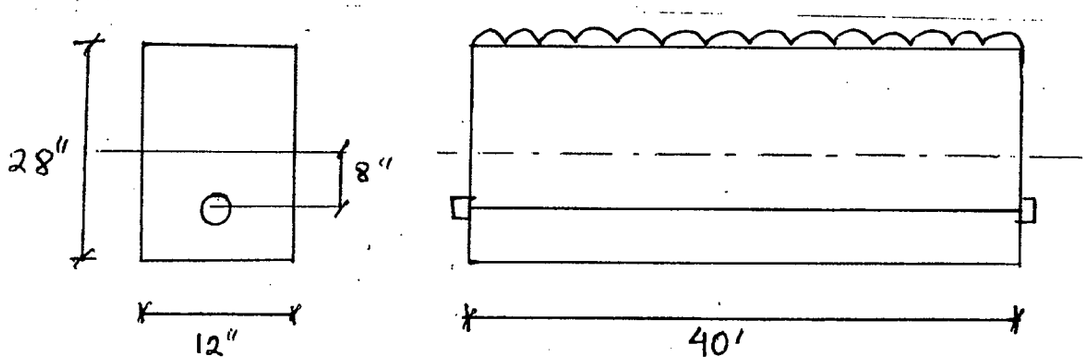
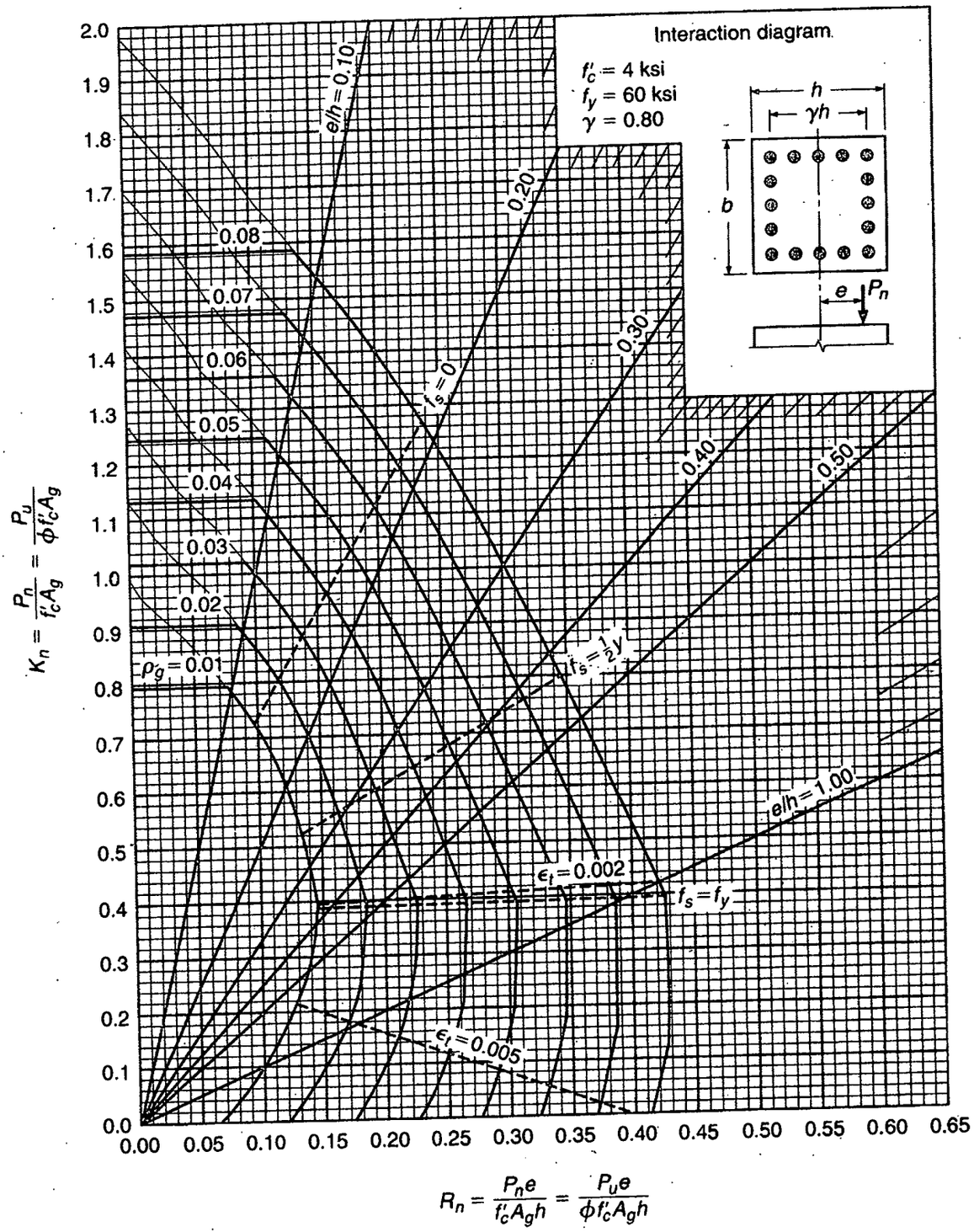
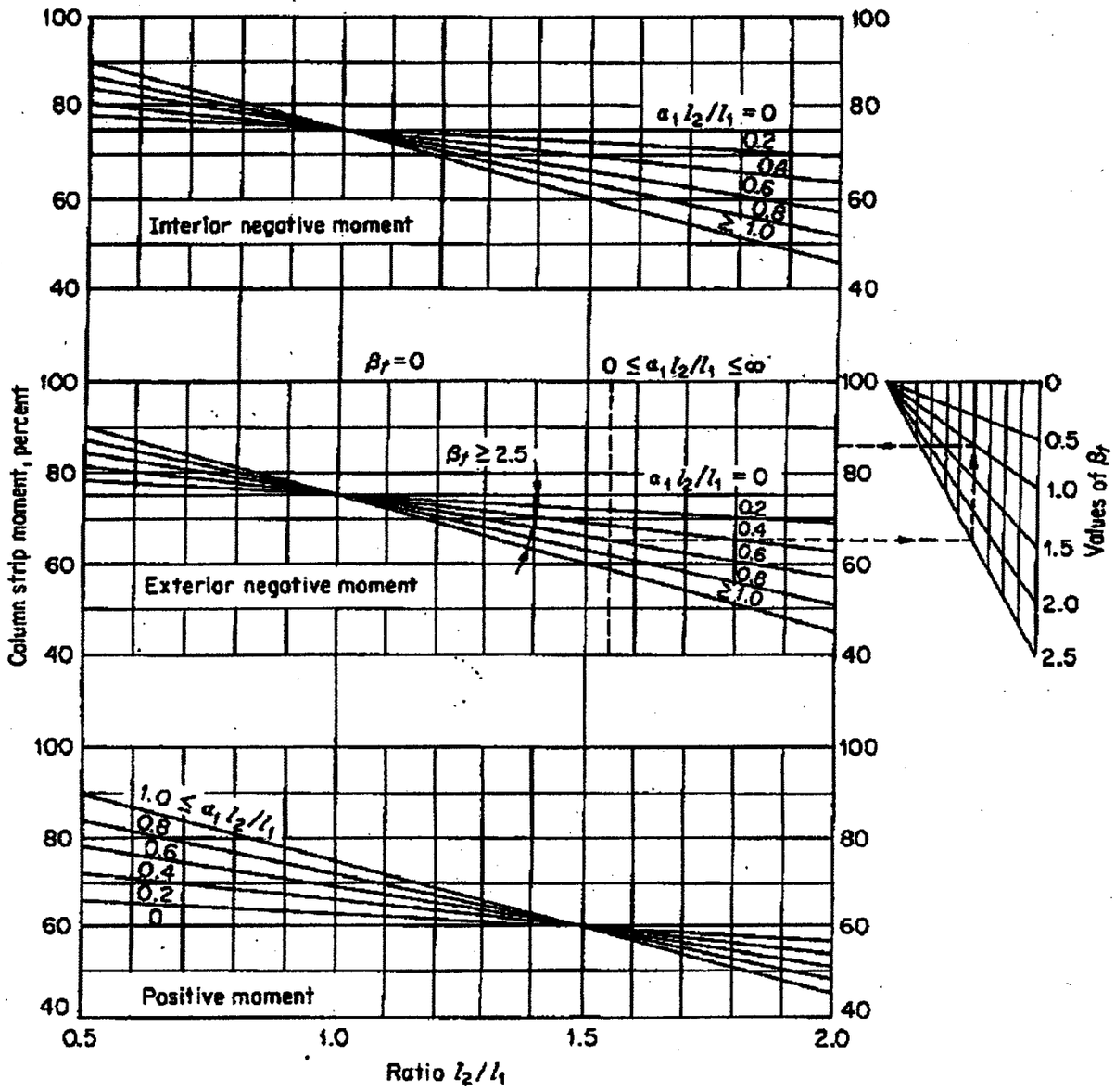


Fig. 6

CE 325



GRAPH A.7
Column strength interaction diagram for rectangular section with bars on four faces and $\gamma = 0.80$ (for instructional use only).



GRAPH A.4
Interpolation charts for lateral distribution of slab moments.

TABLE 9.5(c)—MINIMUM THICKNESS OF SLABS WITHOUT INTERIOR BEAMS

Yield strength, f_y, psi*	Without drop panels†			With drop panels†		
	Exterior panels		Interior panels	Exterior panels		Interior panels
	Without edge beams	With edge beams‡		Without edge beams	With edge beams‡	
40,000	$\frac{\ell_n}{33}$	$\frac{\ell_n}{36}$	$\frac{\ell_n}{36}$	$\frac{\ell_n}{36}$	$\frac{\ell_n}{40}$	$\frac{\ell_n}{40}$
60,000	$\frac{\ell_n}{30}$	$\frac{\ell_n}{33}$	$\frac{\ell_n}{33}$	$\frac{\ell_n}{33}$	$\frac{\ell_n}{36}$	$\frac{\ell_n}{36}$
75,000	$\frac{\ell_n}{28}$	$\frac{\ell_n}{31}$	$\frac{\ell_n}{31}$	$\frac{\ell_n}{31}$	$\frac{\ell_n}{34}$	$\frac{\ell_n}{34}$

* For values of reinforcement yield strength between the values given in the table, minimum thickness shall be determined by linear interpolation.

† Drop panel is defined in 13.3.7.1 and 13.3.7.2.

‡ Slabs with beams between columns along exterior edges. The value of α for the edge beam shall not be less than 0.8.

L-3/T-2/WRE **Date : 02/06/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 -B. Sc. Engineering Examinations 2011-2012

Sub : **CE 371** (Environmental Engineering)

Full Marks: 280 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Discuss with sketches the essential elements of water supply system. **(20)**

   (b) What are the factors to be considered in designing and locating Intake Structure? **(6⅔)**

   (c) Population of the BUET residential area (Staff Campus) is 16400 in 2014. the population of the area was 12300 in 2000. What will be the population of the area in 2020? Determine the water demand for fire of the area in 2020. **(20)**

2. (a) Describe briefly the different sources of water. State the hydraulics of ground water flow for a well in an unconfined aquifer and deduce the mathematical expression for the yield of such a well. **(25)**

   (b) Discuss briefly the sinking methods of Deep Tubewell. **(13)**

   (c) Discuss with sketches the salt water intrusion in ground water of coastal zones of Bangladesh. **(8⅔)**

3. (a) Discuss the role of bacteria in sewage treatment. **(15)**

   (b) Define the following terms **(15)**

   (i) BOD (ii) COD (iii) Aquifer (iv) Environment (v) EIA and (vi) Sustainable Development

   (c) 5 day BOD of a wastewater at 20°C is 200 mg/L. Determine ultimate BOD assuming BOD removal constant as 0.23/d (base e). **(16⅔)**

4. (a) State and prove Marai's theorem. **(10⅔)**

   (b) Design a waste stabilization pond system for the following condition: **(26)**

   L_i = 600 mg/L, N_i = 4 x 10^7/100 ml, N_e = 1000/100 ml, T = 20°C, Q = 10000 m^3/d

   (Assume any reasonable data if required)

   (c) State the standards for sound in Bangladesh. **(10)**

Contd P/2

CE 371/WRE

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

Assume any reasonable value, if needed.

5. (a) What are the current problems associated with air quality monitoring system in Bangladesh? Name at least two successful air quality management schemes/strategies so far taken in Bangladesh. **(14)**

How exposure to CO in air affects the oxygen carrying capacity of blood?

(b) For a water supply of a small rural town with daily requirement of 2,25,000 liter, it is proposed to construct a distribution reservoir. The pattern of water draw off is as under: **(20⅔)**

7.00 AM – 8.00 AM : 30% of day's supply

8.00 AM – 5.00 PM : 35% of day's supply

5.00 PM – 6.30 PM : 30% of day's supply

6.30 PM – 7.00 AM : 5% of day's supply

The pumping is to be done at a constant rate of 8 hours per day (8.00 AM to 4.00 PM). Determine the storage capacity of the reservoir using mass curve method.

(c) Derive the relationship between ultimate nitrogenous BOD and TKN. Write down the adverse effects of different types of synthetic organic insecticides. **(12)**

6. (a) The following results are obtained in the laboratory analysis of a groundwater source. Fe = 2.1 mg/L; Manganese = 0.08 mg/L; Hardness = 330 mg/L as $CaCO_3$; Fecal coliform = 32 CFU/10 mL; Color = 12Pt-Co unit; Alkalinity = 100 mg/L as $CaCO_3$. **(15)**

Draw a flow diagram showing the typical treatment unit processes to treat the groundwater to supply for domestic use for a community. Note that water also contains considerable amount of CO_2 and organic substances.

(b) Write down briefly about the importance of 3R processes in solid wastes management system. How these techniques can be applied in solid wastes management of Dhaka city? Differentiate between landfill gas collection methods. **(20)**

(c) Discuss the advantages and disadvantages of different types of distribution network layouts. **(11⅔)**

7. (a) What is the present scenario of noise pollution in Dhaka city? Write down some possible options for controlling noise pollution in Dhaka city. **(12)**

(b) Illustrate the mechanism of reverse osmosis process. Make comparison of different types of filtration techniques used for water treatment. **(16⅔)**

Contd P/3

CE 371/WRE

Contd... Q. No. 7

(c) A septic tank needs to be provided for a family of 7 members. The house has the facility of piped water supply system and the nominal water supply is 180 lpcd. Design the septic tank for the family assuming retention time and desludging interval are 24 hours and 2 years respectively. Note that only the sanitary sewage from the house will be discharged into the septic tank. The ambient temperature of the area is above 10°C throughout the year. (Table-1 attached). **(18)**

8. (a) Write down short note on bacteriological quality of water. **(5)**

(b) Write down merits of different types of conventional sewage collection systems. What are the advantages of Reed Odorless Earth Closet system? **(12⅔)**

(c) Describe chemical characteristics analysis methods for solid wastes. What are the drawbacks of community collection system of solid wastes? **(14)**

(d) In December 5, 2013, the following air quality data have been recorded at a Continuous Air Monitoring Station (CAMS) in Dhaka. **(15)**

PM-2.5 = 158.5 $\mu g/m^3$ (24-hr);

NO_2 = 0.45 ppm (annual)

SO_2 = 0.289 ppm (24-hr)

CO = 9.35 ppm (8-hr)

O_3 = 0.069 ppm (1-hr)

Calculate AQI for that day. Assume any reasonable value, if needed. (Table-2 attached).

Number of years between desludging	Value of "F" (sludge digestion factor)		
	Temperature >20°C	Temperature >10°C	Temperature <10°C
1	1.3	1.5	2.5
2	1	1.15	1.5
3	1	1	1.27
4	1	1	1.15
5	1	1	1
6 or more	1	1	1

Table -1 for Question No. – 7 (c)

Breakpoints							AQI	Category
O_3 (ppm) 8-hr	O_3(ppm) l-hr	$PM_{2.5}$ (µg/m^3) 24-hr	PM_{10} (µg/m^3) 24-hr	CO (ppm) 8-hr	SO_2 (ppm) 24-hr	NO_2 (ppm) Annual		
0.000-0.064	—	0.0-15.4	0-54	0.0-4.4	0.000-0.034	--	0-50	Good
0.065-0.084	—	15.5-40.4	55-154	4.5-9.4	0.035-0. 144	--	51-100	Moderate
0.085-0.104	0.125-0.164	40.5-65.4	155-254	9.5-12.4	0.145-0.224	--	101-150	Unhealthy for Sensitive Groups
0.105-0.124	0.165-0.204	65.5-150.4	255-354	12.5-15.4	0.225-0.304	--	151 -200	Unhealthy
0.125-0.374	0.205-0.404	150.5-250.4	355-424	15.5-0.4	0.305-0.604	0.65-1.24	201-300	Very Unhealthy
--	0.405-0.504	250.5-350.4	425-504	30.5-40.4	0.605-0.804	1.25-1.64	301-400	Hazardous
--	0.505-0.604	350.5-500.4	505-604	40.5-50.4	0.805-1.004	1.65-2.04	401-500	Hazardous

Table -2 for Question No. – 8 (d)

L-3/T-2/WRE **Date : 19/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **WRE 303** (Hydrology)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE.**

1. (a) Explain briefly how stage discharge relationship is developed and used for a gauging section under the influence of variable backwater effects. **(7)**

(b) In a moving boat method of discharge measurement the following values of resultant velocity (V_R), direction of flow velocity relative to moving boat (θ) and depth were recorded. Assuming mean velocity in a vertical to be 0.9 times the surface velocity, calculate the discharge. The sections are 70 m apart. **(14)**

Section	0	1	2	3	4	5	6	7	8	9	0
V_R (m/s)	-	1.7	1.8	2.0	2.3	2.4	2.2	2.0	1.8	1.7	-
θ (degree)	-	55	57	60	65	67	64	60	56	53	-
Depth (m)	-	1.8	2.4	3.2	3.7	4.0	3.8	3.0	2.5	2.0	-

(c) Following are the data of stage and discharge collected at a particular section of a river. Develop a stage discharge relationship for this river at this section. Assume that the value of stage corespoinding to zero discharge is 7.5 m. **(14)**

Stage (m)	7.7	7.9	8.1	8.5	9.0	9.3	9.5	11.1
Discharge (m^3/s)	30	60	150	180	280	550	970	1600

2. (a) What are the factors affecting a flood hydrograph? Explain the different methods of base flow separation. **(7)**

(b) The following are the ordinates of the hydrograph of flow from a catchment area of 770 km^2 due to a 6-h rainfall. Derive the ordinates of a 6-h unit hydrograph. **(14)**

Time (h)	0	6	12	18	24	30	36	42	48	54	60	66	66
Discharge (m^3/s)	40	65	215	360	400	350	270	200	140	100	70	50	40

(c) The ordinates of a 6-h unit hydrograph are given below. Derive the ordinates of a 3-h unit hydrograph for the same catchment. **(14)**

Time (h)	0	3	6	9	12	15	18	21	24	27	30
UH Ordinates (m^3/s)	0	30	120	170	210	160	85	45	25	15	0

3. (a) With the help of typical hydrograph state the salient features of (i) perennial, (ii) intermittent and (iii) ephemeral streams. **(6)**

(b) The ordinate of a 6-h unit hydrograph of a catchment is given bwlow.

Time (h)	0	3	6	9	12	15	18	24	30	36	42	48	54	60	66
UH ordinates (m^3/s)	0	25	50	85	125	160	185	160	110	60	35	25	15	7	0

Derive the flood hydrograph in the catchment due to the storm given below.

Contd P/2

WRE 303

Contd ... Q. No. 3(b)

Time from start of storm (h)	0	6	12
Accumulated rainfall (cm)	0	3.5	11.0

The storm loss rate (ϕ-index) for the catchment is estimated as 0.25 cm/h. Assume base flow to be uniform at 15 m^3/s. **(15)**

(c) Characteristics of two catchments A and B are given below:

Catchment A	Catchment B
L = 150 km	L = 150 km
L_{ca} = 75 km	L_{ca} = 50 km
A = 2700 Km^2	A = 1400 Km^2

For the 6-h unit hydrograph in catchment A, the peak discharge is 200 m^3/s and occurs at 37 h from the start of rainfall excess. Assuming the catchments A and B to be meteorologically similar, determine the elements of the 6-h synthetic unit hydrograph for catchment B by using Snyder's method. **(14)**

4. (a) Distinguish between reservoir routing and channel routing. Briefly describe the Goodrich method of reservoir routing. **(10)**

(b) A 100-ha watershed has the following characteristics:

Maximum length of travel of water = 3500 m, slope = 0.02; runoff coefficient = 0.3. The maximum intensity - duration - frequency relationship for the catchment is given by :

$$i = \frac{3.97T^{0.17}}{(D+0.15)^{0.73}}$$

Where the variable have their usual meanings and unities. Estimate the 25-year peak runoff from the watershed at its outlet. **(11)**

(c) Route the following flood hydrograph through a river reach for which K = 10 h and x = 0.25. At the start of the inflow flood the out flow discharge is 10 m^3/s. **(14)**

Time (h)	0	6	12	18	24	30	36	42	48	54
Inflow (m^3/s)	10	20	50	60	55	45	35	27	20	15

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

Notations have their usual meaning.

5. (a) Explain why the actual vapor pressure is taken equal to saturation vapor pressure at dew-point temperature. **(5)**

(b) Give a qualitative comparision between atmospheric moisture and groundwater in terms of residence time. **(5)**

(c) Differentiate between relative humidity and special humidity. **(5)**

(d) Define : (i) Frontal lifting, and (ii) Biological water. **(5)**

WRE 303

Contd ... Q. No. 5

(e) In a 140-min storm, the following intensities of rainfall were observed in successive 20-min intervals: 3.3, 3.6, 9.0, 6.6, 0.6, 0.9 and 6.0 cm/hours. Assume the φ-index value as 3.0 cm/hours, compute (i) total volume of runoff, (ii) total volume of infiltration, and (iii) time of rainfall excess. The catchment area is 2 km^2. **(15)**

6. (a) Explain why the temperature increases with altitude in the thermosphere. **(5)**

(b) Explain why the perpendicular bisectors are drawn in forming polygons in the Thiessen polygon method. **(5)**

(c) Explain why the earth's major deserts occur in the horse latitudes. **(5)**

(d) 'Transpriation is a side effect' - explain. **(5)**

(e) The ralative humidity and saturation vapor pressure are computed to be 70% and 2400 Pa respectively. Assuming standared air pressure, find out the following: **(15)**

(i) air temperature, (ii) actual vapor pressure at air temperature, (iii) dew-point temperature, (iv) Specific humidity, (v) gas constant for moist air, and (vi) dessity of moist air.

7. (a) Explain : A forest soil will have a higher value of infiltration capacity than the soil in an urban area under identical condition. **(5)**

(b) Define the two compontents of 'initial loss' in the hydrologic cycle. **(5)**

(c) With a neat sketch, show Hadley cell, Polar cell, Trade wind, Westerlies and belts of high pressure in the Nothern hemisphere. **(5)**

(d) Derive the equations regarding variations of pressure and temperature in Troposphere. **(5)**

(e) The amount of precipitable water in a saturated air column in the first 2 km from the ground is 500 kg corresponding to a ground area of 10 m^2. Assmume linear variation of air density and specific humidity in the column. The average air density in the column is 1 kg/m^3 and specific humidity at ground surface is 50% higher than the same at an elevation of 2 km. Find out the specific humidity at ground surface and at 2 km elevation. **(15)**

8. (a) Define exceedence probability and return period. **(5)**

(b) Explain the use of plotting position formula in frequency analysis. **(5)**

(c) 'Isohyetal method is more flexible than Thiessen polygon method' - explain. **(5)**

(d) The annual maximum recorded floods in a river for the period of 1991 to 2008 are given below. Verify whether the Gumbel distribution fit the recorded value. Estimate the flood discharge with recurrence interval of 50 years by graphical extrapolation. Use semi-log papers. **(20)**

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999
Max. Discharge (cumec)	225	260	350	280	190	240	160	285	260

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008
Max. Discharge (cumec)	380	310	340	245	281	307	341	302	279
