L-3/T-2/WRE **Date : 07/08/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

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

Full Marks : 280 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) Show the forces acting on a vehicle traveling on a horizontal curve section of a road. Also, derive the expression for minimum radius of a circular curve (R). **(4+6)**

   (b) Draw the land use-transportation cycle. Compare between 'collision diagram' and 'condition diagram'. **(3+6)**

   (c) What are the drawbacks of at grade intersections? Write short note on 'Trumpet Interchange' considering left-hand driving convention. **(4+4 2/3)**

   (d) Briefly describe the two types of visual acuity. **(7)**

   (e) A sag vertical curve is to be designed to join a –5% grade to a +2% grade. If the design speed is 40 mi/h, determine the minimum length of the curve that will satisfy all criteria. Assume a = 11.2 ft/sec^2 and perception-reaction time = 2.5 sec. **(12)**

2. (a) Write down the 'design control and criteria' for geometric design of highways? Draw the cross-section of a typical four lane-two way rural highway of Bangladesh. **(5+6 2/3)**

   (b) Define: (i) Peak Hour Factor; (ii) Pace; and (iii) PIEV. **(6)**

   (c) What are the functions and limits of shoulder and super elevation on a highway? Why roads are widened at horizontal curves? **(6+2)**

   (d) State the methods of collecting and presenting data for the following surveys: **(9)**

   (i) Spot Speed; (ii) Volume; and (iii) Parking.

   (e) An engineer wishing to determine whether there is a statistically significant difference between the average speed of passenger cars and that of large trucks on a section of highway, collected the data shown below. Determine whether the engineer can conclude that the average speed of large trucks is the same as for passenger cars. Assume a confidence level of 95%. **(12)**

	Trucks	Passenger Cars
Average Speed (mph)	62	59
Standard deviation of speed (mph)	5.5	6.3
Sample size	275	175

Contd P/2

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3. (a) Explain diagrammatically the method of attaining super elevation considering a crowned pavement revolved about the profile of the inside edge. **(11)**

(b) Differentiate between: **(9)**

(i) 'Spacing' and 'Headway'.

(ii) 'Decision Sight Distance' and 'Passing Sight Distance'.

(iii) 'Semi-actuated Signal' and 'Fully-actuated Signal'.

(c) Show diagrammatically the distance d_1, d_2, d_3 and d_4 in the calculation of minimum passing sight distance for a two-lane two-way straight highway considering left-hand driving convention. **(6)**

(d) A section of highway has the following flow-density relationship: **(9)**

$$q = 80\,k - 0.4\,k^2$$

(i) Determine the capacity of the highway section.

(ii) What is the speed at capacity?

(iii) Find the density when the highway is at one-quarter of its capacity?

(e) The intersection angle of a 4°curve is 55°25′, and the PC is located at station 238 + 44.75. Determine the length of the curve, the station of PT, the deflection angles and the chord lengths for setting out the curve at whole stations from the PC. **(11 2/3)**

4. (a) Write down the general requirements of traffic control devices. What type of traffic signs are needed for priority typed intersection? List the warrants for traffic signal. **(5+2+5)**

(b) State three criteria for selection of a 'Traffic Analysis Zone'. Write down the final form of the gravity model of trip distribution. **(5+5)**

(c) What are the three most common mathematical formulations (model) of trip generation? State the three factors that affect the mode choice of the travelers. **(3+3)**

(d) What is the main difference between 'all-or-nothing' and 'capacity restraint' traffic assignment techniques? Which assignment technique would you use to assign trips into road network of Dhaka city? Why? **(2+2+3)**

(e) A traffic zone has the following characteristics. Using Logit model determine the probability that a person with an income of 20,000 Tk. will travel by transit? The calibrated utility functions for auto and transit travel are: **(11 2/3)**

Auto : $V_a = -0.5 - 0.06X - 0.1Y - 0.06C$

Transit: $V_t = -0.04X - 0.1Y - 0.04C$

Where, V_i = utility function of mode i

X = in-vehicle travel time (min)

Y = out-of vehicle travel time (min)

C = ratio of cost of travel/income

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Contd ... Q. No. 4(e)

	Auto Travel	Transit Travel
In-vehicle time (min)	25	60
Out-of-vehicle time (min)	5	10
Travel cost (Taka)	50	25

SECTION – B

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

5. (a) Make a detailed comparison between 'Flexible Pavement' and "Rigid Pavement'. Based on this comparison, which type of pavement will you prefer for Bangladesh? **(10)**

(b) Briefly explain 'design life' and 'climate conditions' as two important factors governing pavement design. Also, identify the 'failure criteria' of flexible and rigid pavements considered in the design process. **(6+4)**

(c) What are the common modes of distresses of flexible pavements? Identify the main causes of 'Pothole formation' and 'Rutting and Wear' of such pavements. Write short notes on 'Pumping' and 'Faulting' of rigid pavements. **(2+4+4)**

(d) A flexible pavement for 4-lane rural highway is to be designed using the AASHTO method to carry a design ESAL of 3×10^6. The HMA will be laid on an untreated base course and a sand-gravel subbase course. The quality of drainage is considered fair as water can be removed from the subbase within a week. However, due to large amount of precipitation, 30% of the time the pavement will be exposed to moisture levels approaching saturation. The material properties and other useful information are summarized below: **(16⅔)**

CBR of subgrade soil = 4

Resilient modulus of sand-gravel subbase = 15,000 psi

Resilient modulus of untreated base = 35,000 psi

Resilient modulus of HMA = 430,000 psi

Reliability level (R) = 99%

Standard deviation (S_0) = 0.35

Initial serviceability, $P_i = 4.5$

Terminal serviceability, $P_t = 2.0$

Drainage modifying factors (according to the aforementioned drainage conditions) for base and subbase courses = 0.8

Determine the thicknesses of the different layers and show them in a neat cross-sectional sketch of the pavement. See appendices A and B for necessary charts and nomographs.

Contd P/4

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6. (a) Why are joints required in concrete pavements? Briefly explain with the help of neat diagrams the four basic categories of joints commonly found in such pavements. Differentiate between 'Dowel bars' and 'Tie bars'. **(2+8+2)**

(b) Bitumen is a solid material at normal temperatures and therefore cannot be readily mixed with aggregates to form asphaltic concrete. Name and explain three methods that you can use to overcome this difficulty. **(10)**

(c) State the specific purposes of using 'Prime Coats' and 'Tack Coats' in pavement maintenance. **(6)**

(d) Identify two major differences in the modes of operation of 'Batch Plant' and 'Drum Mixer Plant'. **(5)**

(e) 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 50% – 65%, 25% – 45% and 5 – 10% respectively. **(13 2/3)**

Passing sieve	Retained sieve	% by weight			Specific limit
		CA	FA	MF	
1 1/2"	1"	5	---	---	0 – 5
1"	3/4"	40	---	---	5 – 45
3/4"	1/2"	23	---	---	10 – 30
1/2"	3/8"	12	---	---	6 – 16
3/8"	# 4	10	10	---	8 – 23
# 4	# 16	6	35	---	5 – 30
# 16	# 50	4	25	5	8 – 25
# 50	# 100	---	20	15	7 – 20
# 100	# 200	---	8	38	5 – 8
# 200	---	---	2	42	2 – 6
Total	---	100	100	100	---

7. (a) Compare roadways with railways. State the widths of different railways gauges that are available in Bangladesh. What are the difficulties associated with such non-uniformity of gauges throughout the country? **(4+2+3)**

(b) Suppose you have to select the alignment for a new railway track from Faridpur to Barisal. What are the factors that you should consider for this task? **(6)**

(c) Name the different basic types of runway configurations. Explain in detail, the parallel runway and Open-V runway configurations. **(8)**

(d) Write down the requirements of ideal fastening and good ballast for a railway track. **(10)**

Contd P/5

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Contd ... Q. No. 7

(e) Calculate the maximum permissible train load that can be pulled by a locomotive with four pairs of driving wheels with an axle load of 25t each on a B.G. track with a ruling gradient of 1 in 200 and a maximum curvature of 4 degrees, travelling at a speed of 40 km/h. Take the coefficient of friction to be 0.2. **(13 2/3)**

8. (a) List the factors that are usually considered while selecting the site for a new airport. **(8)**

(b) What is the function of points and crossings? Draw a labeled diagram of a left hand turnout showing its different components. **(3+5)**

(c) Classify railway yards. Differentiate between a 'Junction' and a 'Terminal'. **(6)**

(d) Explain with the help of schematic diagrams how coning of wheels and tilting of rails are used to negotiate curves. **(8)**

(e) For a particular B.G. line, superelevation, $e = 1.315\ v^2/R$, allowable cant deficiency, $C_d = 70$ mm, allowable safe speed, $v = 4.4$ sqrt (R-70). If actual cant provided for a 2.5° curve on the line is 3 cm, determine train speed for equilibrium cant and maximum permissible speed of train on this track. **(16 2/3)**

If a 6° curve branches out in the opposite direction from the main line (with 2.5° curve) and the speed restriction on the main line is 5 kmph less than the maximum permissible speed (as determined) on that track, calculate the maximum permissible speed on the branch line.

Appendix - A

Q. 5(d)

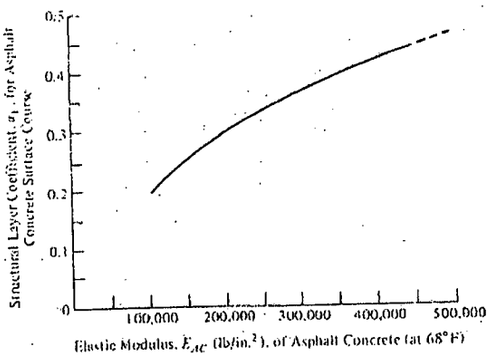
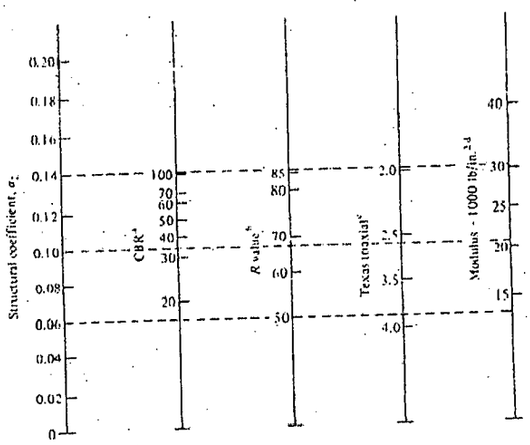
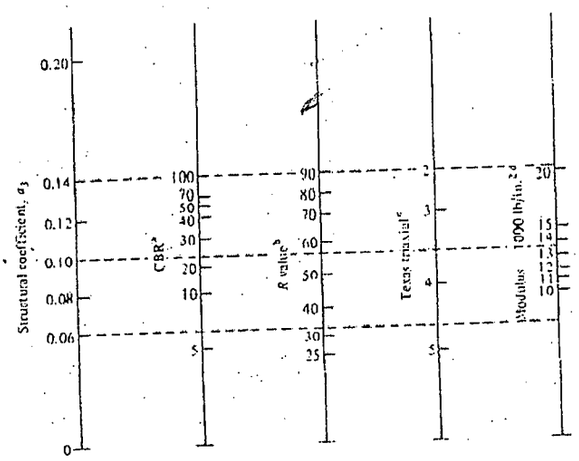


Figure 1 Chart for Estimating Structural Layer Coefficient of Dense-Graded/Asphalt Concrete Based on the Elastic (Resilient) Modulus



[a] Scale derived by averaging correlations obtained from Illinois.
[b] Scale derived by averaging correlations obtained from California, New Mexico, and Wyoming.
[c] Scale derived by averaging correlations obtained from Texas.
[d] Scale derived on NCHRP project 128, 1972.

Figure 2 Variation in Granular Base Layer Coefficient, a_2, with Various Subbase Strength Parameters



[a] Scale derived from correlations from Illinois.
[b] Scale derived from correlations obtained from The Asphalt Institute, California, New Mexico, and Wyoming.
[c] Scale derived from correlations obtained from Texas.
[d] Scale derived on NCHRP project 128, 1972.

Figure 3 Variation in Granular Subbase Layer Coefficient, a_3, with Various Subbase Strength Parameters

SOURCE: Redrawn from *AASHTO Guide for Design of Pavement Structures*, American Association of State Highway and Transportation Officials, Washington, D.C., 1993. Used with permission.

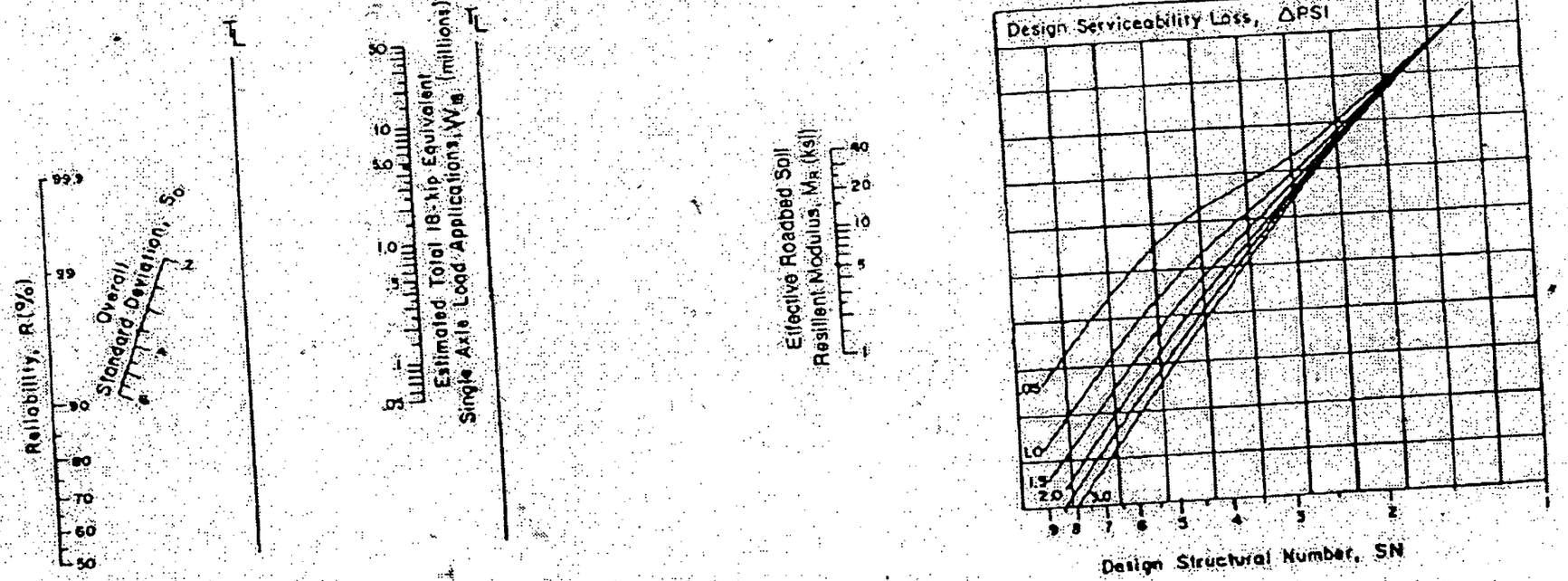
Table: AASHTO-Recommended Minimum Thicknesses of Highway Layers

Traffic, ESALs	Minimum Thickness (in.)	
	Asphalt Concrete	Aggregate Base
Less than 50,000	1.0 (or surface treatment)	4
50,001–150,000	2.0	4
150,001–500,000	2.5	4
500,001–2,000,000	3.0	6
2,000,001–7,000,000	3.5	6
Greater than 7,000,000	4.0	6

AASHTO Design Nomograph for Flexible Pavement

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$



L-3/T-2/WRE **Date : 17/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

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

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Assume reasonable values for missing data.

SECTION – A

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

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

   (b) For the column section shown in Fig. 1, 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)**

2. (a) In a three-story structure, an exterior column is to be designed for a service dead load of 222 kips, maximum live load of 350 kips, dead load moment of 170 ft-kips and live load moment of 240 ft-kips. The minimum live load compatible with the full live load moment is 166 kips that may act on this column. Given, b = 20 in and h = 25 in. Find the required column reinforcement for the condition that full live load acts. Also, check against adequacy of your design for the condition of minimum live load. f'_c =4000 psi, f_y = 60000 psi (use design graph provided). **(20)**

   (b) Why are ties provided in column? State the requirements of ties according to ACI code. **(8)**

   (c) What is ACI spiral? Explain the failure behavior of ACI spirally reinforced column. **(7)**

3. (a) Write down the ACI/BNBC code detailing requirements for beams and columns in regions of moderate seismic risk. **(12)**

   (b) A 15 in. concrete wall supported a dead load, DL = 16^k/ft and a live load, LL = 12^k/ft. The allowable bearing capacity of soil is q_a = 4 ksf at the bottom level of footing which is 5′ below grade. Design the footing of the concrete wall with f'_c =3000 psi and f_y = 40000 psi. Check development length. **(23)**

4. (a) Select the length and width of the combined footing supporting two columns as shown in Fig. 2. The bottom of the footing is 6 ft below grade where the allowable bearing capacity of soil is 5 ksf. The outer end of the combined footing cannot protrude beyond the outer face of the exterior column which coincide with property line. If d = 26 inch, check adequacy against punching. Also, design the transverse beam. Given: f'_c =3.5 ksi; f_y = 60 ksi. **(18)**

   (b) The plan of a pile cap with 12 nos 20 in. diameter cast-in-situ piles with the column (24″ × 24″) is shown in Fig. 3. The column carries a DL = 800 kip and a LL = 600 kip (working). The individual pile capacity is adequate. Design the pile cap. Given, f'_c =3.0 ksi and f_y = 60 ksi. **(17)**

Contd P/2

CE 325/WRE

SECTION – B

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

5. (a) What are the limitations of Direct Design method for the analysis of two way slab? **(10)**

(b) A residential building is to be designed using a flat plate floor system. The interior columns are 24″ × 24″ and they are spaced 22 ft c/c in one direction and 24 ft c/c in other direction. Design the interior panel (22′ × 24′) and show reinforcement in long direction only with neat sketch. Assume slab thickness of 8″. Specified live load = 40 psf, Floor finish and partition wall load = 60 psf in addition to the self weight of floor slab. $f'_c = 3500$ psi and $f_y = 60{,}000$ psi. **(25)**

6. (a) What are the common types of shear reinforcement used for flat plates? Show with neat sketches. **(4)**

(b) A flat plate floor has thickness h = 7.5″ and is supported by 18 inch square columns spaced 20 ft on center each way. The floor will carry a DL = 160 psf including its self weight and a live load of 90 psf. Check the adequacy of the slab in resisting punching shear and provide shear reinforcement, if needed using 'bent bars'. Consider d = 6″, $f'_c = 4$ ksi and $f_y = 60$ ksi. **(16)**

(c) Make final design for the preliminary section shown in Fig. 4, allowing $f_b = -1.80$ ksi and $f_o = 150$ ksi, other values are, **(15)**

$M_T = 320$ kip-ft, $M_G = 40$ kip-ft, ft = –1.60 ksi, $f_{se} = 125$ ksi; F = 187 kip

Preliminary section has following properties.

Ac = 248 inch^2, I = 42,200 inch^4, $K_t = K_b = 9.4$ inch.

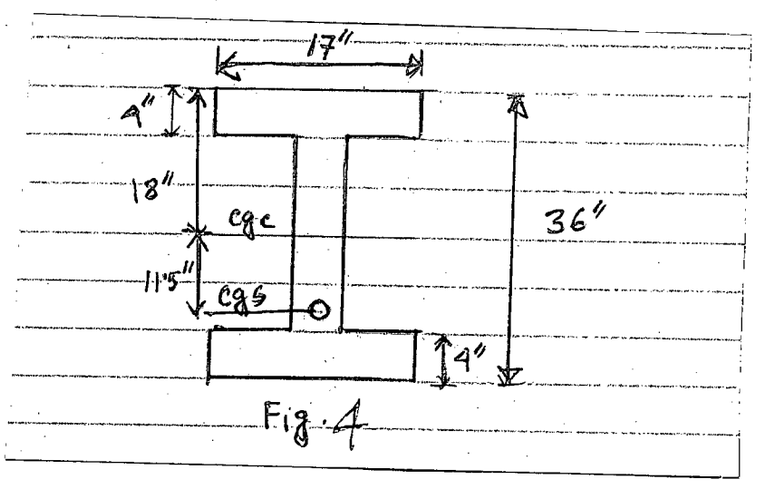


Fig. 4

CE 325/WRE

7. (a) Compare in brief, prestressed concrete with reinforced concrete with respect to serviceability, safety and economy. **(8)**

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

(c) A post tensioned bonded concrete beam has a prestress of 400 kip in the steel immediately after transfer, which eventually reduces to 335 kip due to losses. The beam carries two live load of 12 kip each at the third points in addition to its own weight. Compute the extreme fiber stresses at midspan: **(20)**

(i) under initial condition of full prestress without live load.

(ii) under final working condition.

The beam has a rectangular cross section of (12 inch × 32 inch) and total prestressing steel of 2.4 inch^2 laid parabolically with e = 10″ at midspan and e = 0 at the end. Span = 40′ (simply supported).

8. (a) Discuss different modes of failure of a high-rise shear wall. **(10)**

(b) A three storied 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 the first floor. f_y = 60 ksi, f'_c = 4 ksi. **(25)**

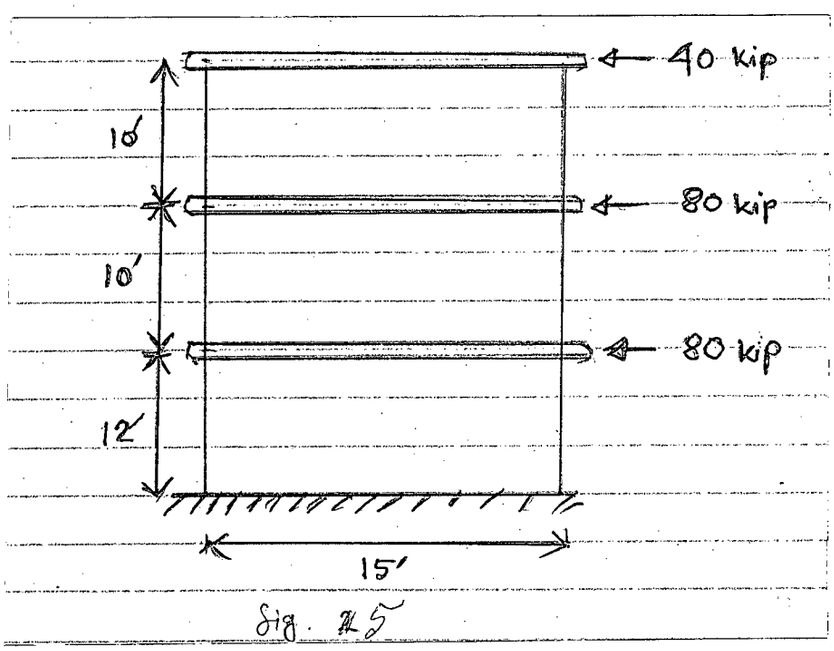


Fig. # 5

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

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

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

$\frac{Z}{lw} = \frac{1}{2 + \frac{0.85\beta_1 l_w h f'_c}{A_{st} f_y}}$ $\qquad \beta_1 = 0.85$

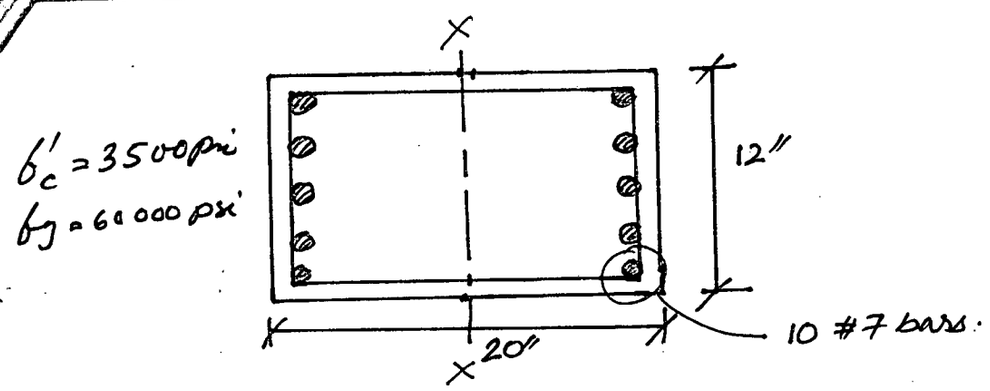


Figure 1.

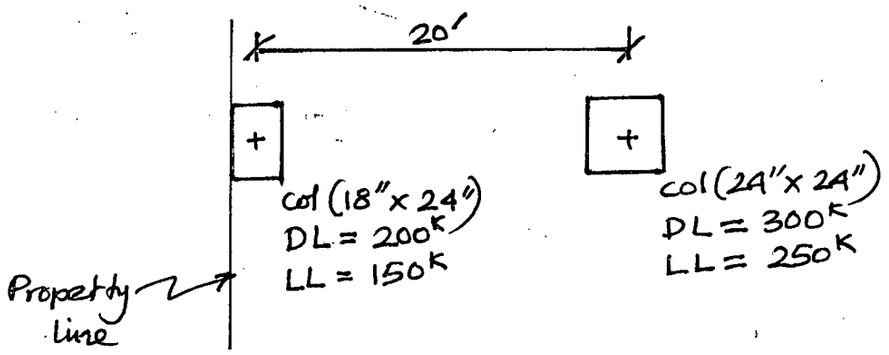


Figure 2

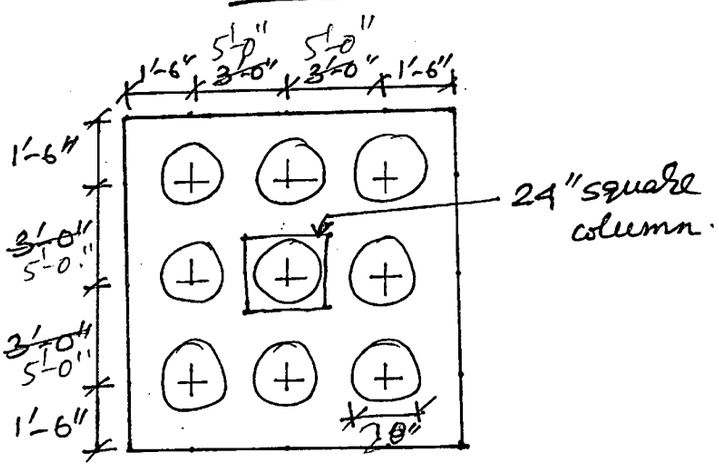
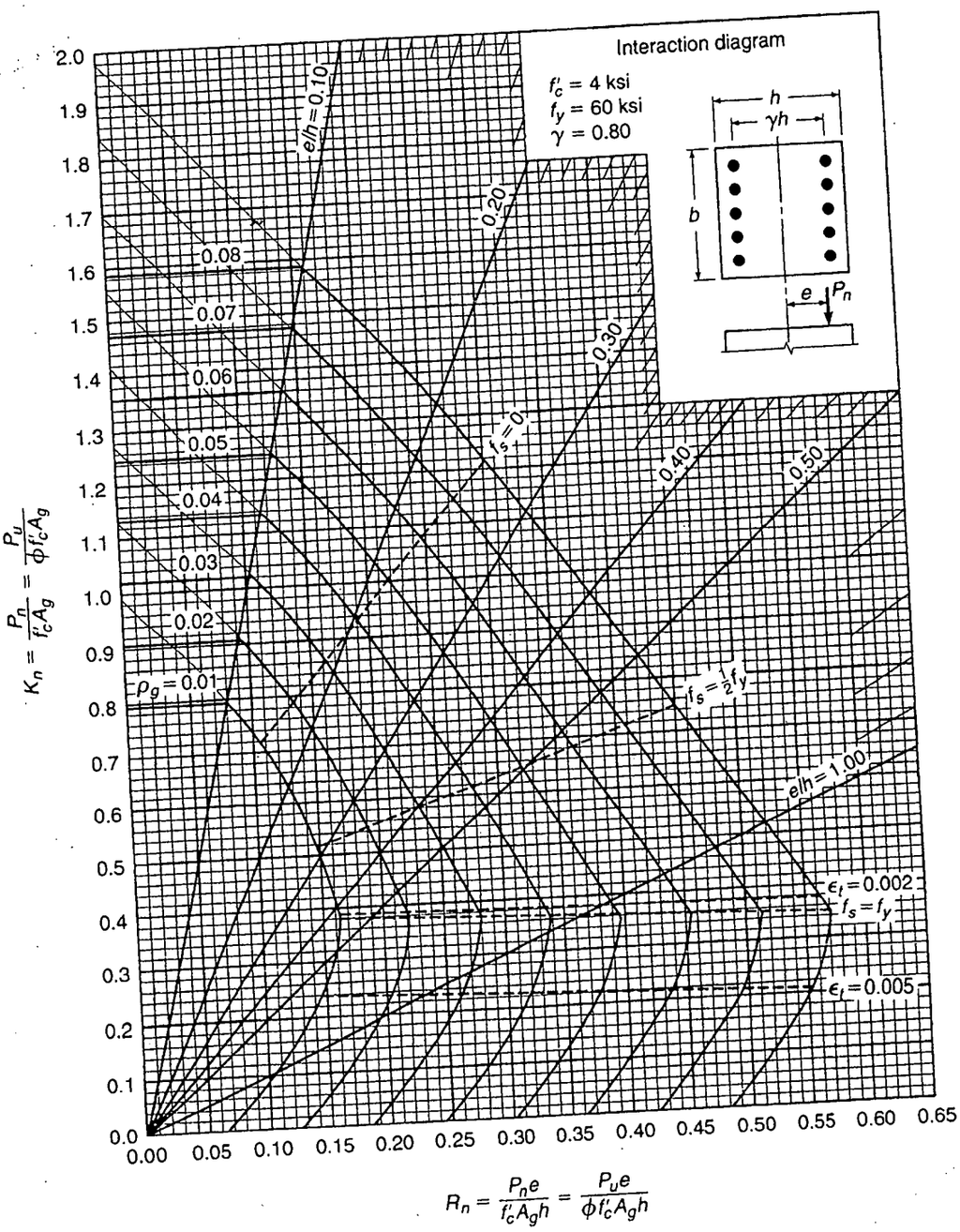


Figure 3


Interaction diagram
f'_c = 4 ksi
f_y = 60 ksi
γ = 0.80
h
γh
b
e
P_n
e/h = 0.10
0.20
0.30
0.40
0.50
$f_s = 0$
$f_s = \frac{1}{2}f_y$
e/h = 1.00
$\epsilon_t = 0.002$
$f_s = f_y$
$\epsilon_t = 0.005$
0.08
0.07
0.06
0.05
0.04
0.03
0.02
$\rho_g = 0.01$
$K_n = \frac{P_n}{f'_c A_g} = \frac{P_u}{\phi f'_c A_g}$
$R_n = \frac{P_n e}{f'_c A_g h} = \frac{P_u e}{\phi f'_c A_g h}$
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65

L-3/T-2/WRE **Date : 23/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

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) Define BOD and COD. Why COD of a sample is usually greater than BOD. Draw BOD curves for different temperatures. **(20)**

   (b) Derive 1st stage BOD equation. **(11⅔)**

   (c) Show that the ratio of the $2\frac{1}{2}$ day, 35°C BOD to the 5-day BOD at 20°C is approximately unity. Assume $\theta = 1.05$. **(15)**

2. (a) Describe the role of bacteria in sewage treatment process. **(16⅔)**

   (b) Describe briefly the growth pattern of micro organisms in a batch culture. **(15)**

   (c) A 15 inch sewer conveys 3.1 cfs sewage when flowing full. Determine velocity of flow and slope of the sewer. Value of Manning's n is 0.013. **(15)**

3. (a) What are the general design considerations for pit latrines? State the advantages and disadvantages of pit latrines. **(16⅔)**

   (b) Design a septic tank for a family of 10 persons with a desludging interval of 10 years. The sewage flow rate is 100 lpcd. Assume reasonable values of the missing data. **(15)**

   (c) Draw flow diagrams for the following treatment processes. **(15)**

   (i) Aerated lagoon.
   (ii) Two stage trickling filter.
   (iii) Activated sludge process.
   (iv) Waste stabilization ponds system
   (v) Oxidation ditch.

4. (a) Define the functional elements of solid waste management. What are the effects of solid waste mismanagement? **(16⅔)**

   (b) Briefly discuss the suitability of solid waste recovery as resource in Bangladesh. **(10)**

   (c) Design a waste stabilization ponds system to treat 10000 m^3/d of domestic sewage which has a BOD_5 of 330 mg/L. The design temperature is 20°C and the required effluent standards are: BOD_5<25 mg/L, and FC<5000/100 ml. Assume reasonable values of the missing data.

Contd P/2

SECTION – B

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

5. (a) Describe the factors affecting 'per capita demand of water'. The population of a city was 20 million in 1970, 25 million in 1980, 33 million in 1990, 50 million in 2000 and 70 million in 2010. Estimate the probable population of the city in 2020 and 2030 by the least square parabola method? **(23)**

   (b) Show the essential elements of a surface water based water supply system in a neat sketch. State the hydraulics of groundwater flow towards a well. Deduce the mathematical expression for the yield of wells in an unconfined aquifer. **(23⅔)**

6. (a) What are the sanitary significance of arsenic and iron in water? What are the different factors to be considered in the selection of water treatment process? Derive stokes equation for discrete particle settling. Briefly explain the theory of filtration in a sand bed. **(25)**

   (b) List the differences in characteristics between slow Sand and Rapid Sand Filters. List the factors governing the location of an intake in surface water collection system. What are the main requirements of a good water distribution system? **(21⅔)**

7. (a) Define environmental policy? What are the main objectives of Bangladesh Environmental Policy 1992? What legal framework was proposed and institutional arrangements were considered to implement Bangladesh Environmental Policy? **(22⅔)**

   (b) What are the purposes of setting standards? What is the difference between guidelines and standards? Give examples. **(23)**

8. (a) What are the 10 steps that are recommended as standard EIA procedure in the FPCO EIA guidelines? What are the main elements of an Environmental Management Plan (EMP)? **(23⅔)**

   (b) Write short notes on (i) The Water Act 2013 and (ii) Public Interest Litigation (PIL). What are the main limitations of the Environmental Conservation Rules (ECR) 1997? **(23)**

L-3/T-2/WRE **Date : 27/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

Sub : **WRE 303** (Hydrology)

Full Marks: 210 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**.

One normal graph paper needs to be supplied.

1. (a) Briefly explain (i) unsteady flow effect on a rating curve, (ii) extrapolation of a rating curve. **(5+5)**

(b) During a high flow, water surface elevations of a small stream were noted at two sections A and B, 10 km apart. The water surface elevation, cross-sectional area of flow and hydraulic radius at section A are 86.995 m, 68.25 m^2 and 2.85 m respectively and those parameters at section B are 86.625, 90.55 m^2 and 3.25 m respectively. The Manning roughness coefficient of that stream is 0.022. Given that, the section A is upstream of section B and the eddy loss coefficients of 0.3 for graduation expansion and 0.1 for gradual contraction. Estimate the discharge in that stream. **(10)**

(c) The stream discharges for various stages at a particular section were observed to be as follows. Obtain the rating curve equation and determine the discharge for a stage of 16.5 m. Assume the stage for zero discharge is 8.0 m. **(15)**

Stage (m)	10	11	12	13	14	15	16	17	18	19	20
Discharge (cumec)	50	120	210	340	450	590	720	880	1100	1350	1600

2. (a) Briefly describe (i) float gauge recorder for measuring stage, (ii) calibration of current meter. **(5+5)**

(b) Describe different types of streams based on annual hydrograph. **(10)**

(c) In moving boat method of flow measurement the magnitude (V_R) and direction (θ) of the velocity of the stream relative to the moving boat are measured starting from left bank to right bank. The flow depths are also simultaneously recorded. The measured data are given below. The sections are spaced at a constant distance of 60 m. Assume that the mean velocity of a vertical is 0.93 times the surface velocity of that vertical. Estimate the discharge of that stream. **(15)**

Section	0	1	2	3	4	5	6	7	8	9
V_R(m/s)	-	2.1	2.35	2.56	2.84	2.62	2.45	2.2	2.0	-
θ (deg)	-	50	55	62	68	64	58	54	52	-
Depth (m)	-	2.0	2.6	3.2	4.6	3.8	3.0	2.6	2.2	-

Contd P/2

WRE 303

3. (a) Explain the procedure of deriving a D-hr unit hydrograph from a number of isolated storm hydrographs of the same catchment. **(10)**

(b) The φ-index of a catchment is 0.5 cm/hr and the base flow can be assumed as 20 cumec till the end of direct runoff hydrograph for a 12-hr duration rain in that catchment. The ordinate of a 4-h unit hydrograph (UH) of that catchment is given below. **(10)**

Time (hr)	0	4	8	12	16	20	24	28	32	36	40
Ordinates of 4-h UH (m^3/s)	0	12	48	66	46	26	16	10	5	2	0

Derive the flood hydrograph of that catchment due to storm given below.

Time from start of rain (hr)	0	4	8	12
Accumulated rain (cm)	0	5	10	13

(c) The ordinates of a 6 hour unit hydrograph for a particular basin are given below. Determine the ordinates of S-curve hydrograph and therefrom the ordinates of 9 hour unit hydrograph (with necessary corrections). **(15)**

Time (hr)	0	3	6	9	12	15	18	21	24	27	30	33	36
Discharge (cumec)	0	25	100	160	190	170	110	60	30	20	8	4	0

4. (a) The inflow hydrograph for a stream reach are given below for which the Muskingum coefficients of K = 30 hr and x = 0.18. At the beginning of the flood, the value of outflow is same as inflow. Route the flood through the reach and determine the outflow hydrograph. Also determine the value of attenuation and lag. **(15)**

Time (hr)	0	12	24	36	48	60	72	84	96	108	120	132	144
Inflow (cumec)	40	70	160	270	370	280	230	190	160	130	80	60	50

(b) The observed values of inflow and outflow hydrographs at two sections of a river reach are given below. Determine the best values of K and x for use in the Muskingum method of flood routing. **(20)**

Time (hr)	0	6	12	18	24	30	36	42	48	54
Inflow (cumec)	20	80	210	240	200	170	120	70	30	15
Outflow (cumec)	20	25	80	140	160	180	150	90	50	30

Contd P/3

WRE 303

SECTION – B

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

Assume reasonable values if any data is missing.

5. (a) Explain Hadley's Circulation and General atmospheric circulation with neat diagrams. **(8)**

(b) Flood frequency analysis for the River 'X', by Gumbel's method, yielded the following results: **(12)**

Return Period T (years)	Discharge Q (m^3/s)
50	45000
100	51000

Estimate the flood magnitude in this river with a return period of 500 years.

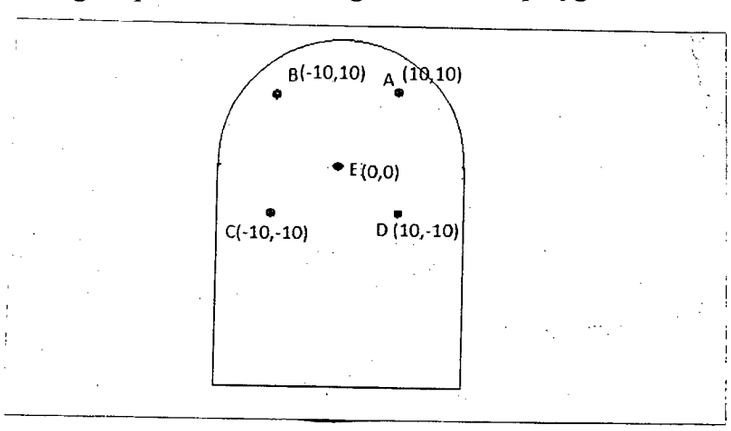
(c) At a climatic station, air pressure is measured at 101 kPa, saturation vapor pressure 2400 Pa and relative humidity 70%. Calculate the corresponding (i) air temperature, (ii) actual vapor pressure, (iii) dew point temperature, (iv) specific humidity and (v) air density. **(15)**

6. (a) What are the common causes of inconsistency of records from a raingauge station? **(3)**

(b) The mass curve of rainfall in a storm of total duration 90 minutes is given below. Determine the maximum intensity for duration of 20, 30 and 60 min of this storm. **(12)**

Time (min)	0	10	20	30	40	50	60	70	80	90
Cumulative rainfall (mm)	0	2.1	6.3	14.5	21.7	27.9	33.0	35.1	36.2	37

(c) A semi-circle of diameter 40 km with a square of side 40 km below its diameter is a close approximation to a river basin. The 5 raingauge stations A, B, C, D and E are located within the basin with respect to a coordinate axes system whose x axis is coincident with diameter. The position coordinates of the stations A, B, C, D and E are (10,10), (-10,10), (-10,-10), (10,-10) and (0,0) km, respectively. If the rainfalls recorded at these raingauges are 85, 100, 130, 80 and 120 mm respectively, determine the average depth of rainfall using the Thiessen polygon method. **(20)**



Contd P/4

WRE 303

7. (a) Write down the factors that affect depression storage. **(3)**

(b) The mass curve of an isolated storm in a 500 ha watershed is as follows **(12)**

Time from start (h)	0	2	4	6	8	10	12	14	16
Cumulative rainfall (cm)	0	0.8	2.6	4.1	7.3	10.8	11.8	12.4	12.6

If the direct runoff produced by the storm is measured at the outlet of the watershed as 0.340 Mm^3, estimate the φ index of the storm and duration of rainfall excess.

(c) Determine the best values of parameters of Horton's infiltration capacity equation for the following data pertaining to infiltration tests on a soil using double ring infiltrometer. **(20)**

Time since start (minutes)	5	15	25	45	60	75	90	110	130
Cumulative infiltration (mm)	21	47.6	56.9	63.8	69.8	74.8	79.3	86	92

8. (a) What is remote sensing? How remote sensing can be used in quantifying precipitation? **(3)**

(b) A urban catchment has an area of 500 ha and runoff coefficient 0.3 **(12)**

The maximum length of travel of water is 4000 m and the elevation difference between the highest and outlet points of the watershed is 25 m. The maximum depth of rainfall with a 25 year return period is as below. If a culvert for drainage at the outlet of this area is to be designed for a return period of 25 years, estimate the required peak-flow rate.

Duration (min)	20	40	60	80	100
Depth of rainfall (mm)	17	26	40	50	57

(c) The following table gives the observed annual flood values in the River 'X'. Estimate the flood peaks with return periods of 100 year using Log-Pearson type III distribution **(20)**

Year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Discharge (m^3/s)	3200	4000	1350	1400	3300	2480	1860	3405	2480	3110	4130	1820

=5=

Table 7.6 $K_z = F(C_s, T)$ *for Use in Log-Pearson Type III Distribution*

Coefficient of skew, C_s	Recurrence interval T in years						
	2	10	25	50	100	200	1000
3.0	−0.396	1.180	2.278	3.152	4.051	4.970	7.250
2.5	−0.360	1.250	2.262	3.048	3.845	4.652	6.600
2.2	−0.330	1.284	2.240	2.970	3.705	4.444	6.200
2.0	−0.307	1.302	2.219	2.912	3.605	4.298	5.910
1.8	−0.282	1.318	2.193	2.848	3.499	4.147	5.660
1.6	−0.254	1.329	2.163	2.780	3.388	3.990	5.390
1.4	−0.225	1.337	2.128	2.706	3.271	3.828	5.110
1.2	−0.195	1.340	2.087	2.626	3.149	3.661	4.820
1.0	−0.164	1.340	2.043	2.542	3.022	3.489	4.540
0.9	−0.148	1.339	2.018	2.498	2.957	3.401	4.395
0.8	−0.132	1.336	1.998	2.453	2.891	3.312	4.250
0.7	−0.116	1.333	1.967	2.407	2.824	3.223	4.105
0.6	−0.099	1.328	1.939	2.359	2.755	3.132	3.960
0.5	−0.083	1.323	1.910	2.311	2.686	3.041	3.815
0.4	−0.066	1.317	1.880	2.261	2.615	2.949	3.670
0.3	−0.050	1.309	1.849	2.211	2.544	2.856	3.525
0.2	−0.033	1.301	1.818	2.159	2.472	2.763	3.380
0.1	−0.017	1.292	1.785	2.107	2.400	2.670	3.235
0.0	0.000	1.282	1.751	2.054	2.326	2.576	3.090
−0.1	0.017	1.270	1.716	2.000	2.252	2.482	2.950
−0.2	0.033	1.258	1.680	1.945	2.178	2.388	2.810
−0.3	0.050	1.245	1.643	1.890	2.104	2.294	2.675
−0.4	0.066	1.231	1.606	1.834	2.029	2.201	2.540
−0.5	0.083	1.216	1.567	1.777	1.955	2.108	2.400
−0.6	0.099	1.200	1.528	1.720	1.880	2.016	2.275
−0.7	0.116	1.183	1.488	1.663	1.806	1.926	2.150
−0.8	0.132	1.166	1.448	1.606	1.733	1.837	2.035
−0.9	0.148	1.147	1.407	1.549	1.660	1.749	1.910
−1.0	0.164	1.128	1.366	1.492	1.588	1.664	1.880
−1.4	0.225	1.041	1.198	1.270	1.318	1.351	1.465
−1.8	0.282	0.945	1.035	1.069	1.087	1.097	1.130
−2.2	0.330	0.844	0.888	0.900	0.905	0.907	0.910
−3.0	0.396	0.660	0.666	0.666	0.667	0.667	0.668

L-3/T-2/WRE **Date : 01/08/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

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

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Assume reasonable value(s) for missing data only.

SECTION – A

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

1. (a) Define: **(9)**
   (i) shallow foundation
   (ii) ultimate bearing capacity
   (iii) allowable bearing pressure.

   (b) Derive an expression for calculating ultimate bearing capacity of a shallow foundation as shown in Fig. 1 using slip circle method. The foundation with dimension B×L rests on clay. Assume cohesion of soil is C. **(13)**

   (c) A footing 10 ft square with 2′-6″ thickness rests at a depth of 3 ft on clay that has an unconfined compressive strength of 1.5 ton/sq.ft. If the factor of safety is not to be less than 2.5, what is maximum column load that can be supported by the footing. Use chart 1. **(13)**

2. (a) Discuss the relationships those exist among soil pressure, width of footing and settlement of footing for narrow, intermediate and wide footing resting on sand. Also out line a procedure, how design chart for proportionating shallow foundation can be constructed from the above relationships. **(11)**

   (b) Estimate the settlement of the footing shown in Fig. 2. Compute the factor of safety against a bearing capacity failure. The unit weight of the sand is 115 lb/cu.ft. Given N value is corrected for overburden pressure. Use Fig. 3 and Fig. 4 to solve this problem. **(17)**

   (c) How the settlement of a footing resting on sand can be estimated based on standard penetration value and also comments on the reliability of this estimation. **(7)**

3. (a) Calculate axial load carrying capacity 'p' of a drilled shaft pile shown in Fig. 5 using Reese and O'neill (1988) procedure. Use factor of safety = 3.0. **(15)**

   (b) Calculate axial load carrying capacity of a driven pile shown in Fig. 6 with a minimum factor of safety of 2.5. use Fig. 7 to solve this problem. **(15)**

   (c) Compute pile group efficiency for the problem shown in Fig. 8 using Converse Laborre equation. **(5)**

4. (a) A factor of safety of 3 is required for the pile group resting on clay (Fig. 8). Find the allowable value of P. **(17)**

   (b) Describe, how can you estimate elastic settlement of a pile embeded in sandy soil? Using this information, how can you estimate the pile group settlement? **(6)**

   (c) What is negative skin friction? How can you mitigate its effect? **(6)**

   (d) What is the purpose of conducting pile load test? How allowable pile capacity can be estimated from the load test, performed on service pile. **(6)**

Contd P/2

CE 481

SECTION – B

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

5. (a) State the purposes of sub-soil exploration. **(8)**

(b) Discuss the considerations for the layout and depth of boring for sub-soil exploration. **(10)**

(c) Name different methods of boring used for soil exploration. Briefly describe the boring method that is mostly used in our country. **(8)**

(d) Discuss the factors affecting the bearing capacity of a shallow foundation. **(9)**

6. (a) What is a borelog? List information that should be placed in a borelog. **(8)**

(b) Discuss the use of disturbed and undisturbed samples that are collected in soil exploration. **(8)**

(c) Briefly describe the SPT procedure. **(4)**

(d) A cut slope is to be made in a saturated clay. Given: c_u = 500 psf (ϕ = 0 condition) and γ = 110 pcf. The slope makes an angle of 56° with the horizontal. Determine the maximum depth up to which the cut could be made. Assume that the critical surface of sliding is circular. What is the nature of the critical circle. (i.e. toe, slope or midpoint)? If we need a factor of safety of 2, how deep should the cut be made? (relevant charts are provided in Fig. 9) **(15)**

7. (a) Write short notes on (i) Shelby tube (ii) piston sampler. **(6)**

(b) Discuss the correlations between the SPT-N values and the density of sand. **(6)**

(c) Explain the correction of field SPT-N values in sand for overburden pressure. **(8)**

(d) A group of pile in clay is shown in Fig. 10. Determine the consolidation settlement of the pile group. All the clay layers are normally consolidated. **(15)**

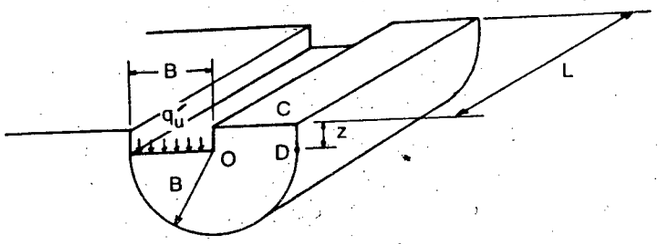
8. (a) What soil parameters can be obtained from SPT-N value using correlations? Discuss the major concerns with the SPT correlations. **(10)**

(b) Write the advantages and limitations of field vane shear test. **(7)**

(c) Fig. 11 shows the cross-section of a homogeneous earth slope for which an arbitrary circular failure surface is considered. The center of the failure surface is also shown. Calculate the factor of safety, using ordinary method of slices, for the given failure surface, considering 4 Nos. of slices (Given, γ = 16.8 kN/m^3, c = 18 kPa, $\phi = 15^o$). **(18)**

According to ordinary method of slices, the factor of safety is given by the following expression (the notations carry their usual meanings).

$$F_s = \frac{\sum_{n=1}^{n=p} \left(c\Delta L_n + W_n \cos\alpha_n \tan\varphi \right)}{\sum_{n=1}^{n=p} W_n \sin\alpha_n}$$



Foundation failure rotation about one edge.

Fig. 1

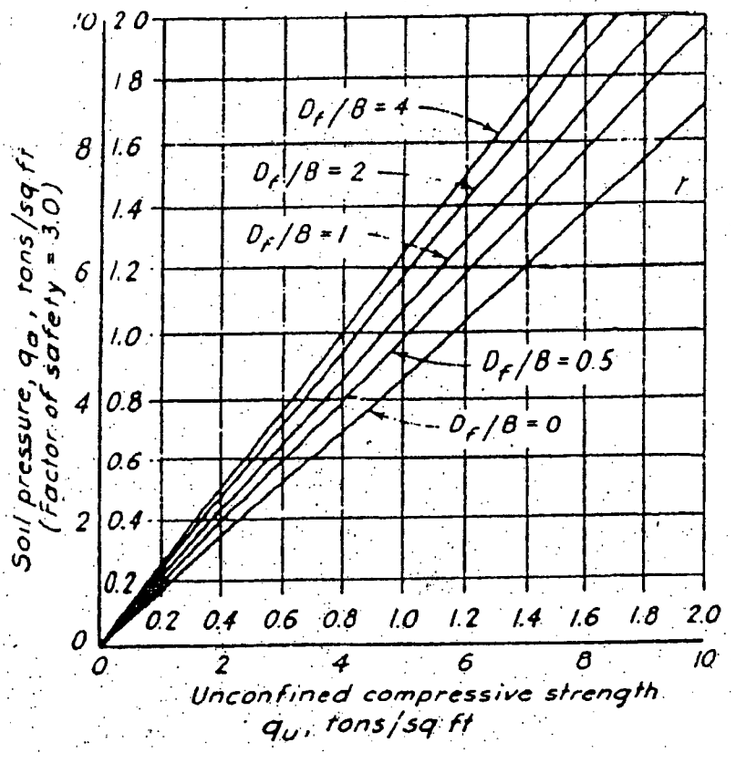
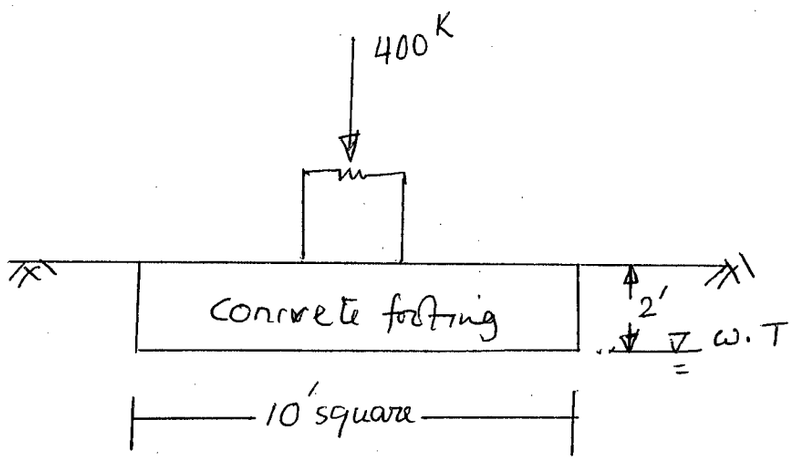


Chart- 1 Net allowable soil pressure for footings on clay and plastic silt, determined for a factor of safety of 3 against bearing capacity failure ($\phi = 0$ conditions). Chart values are for continuous footings ($B/L = 0$); for rectangular footings, multiply values by $1 + 0.2\ B/L$; for square and circular footings, multiply values by 1.2.



Nav = 25

Fig. 2

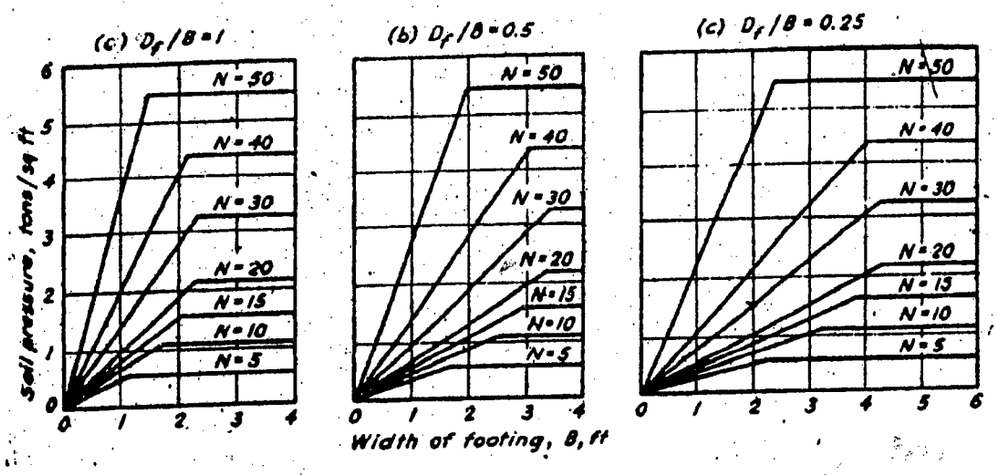


Fig. 3

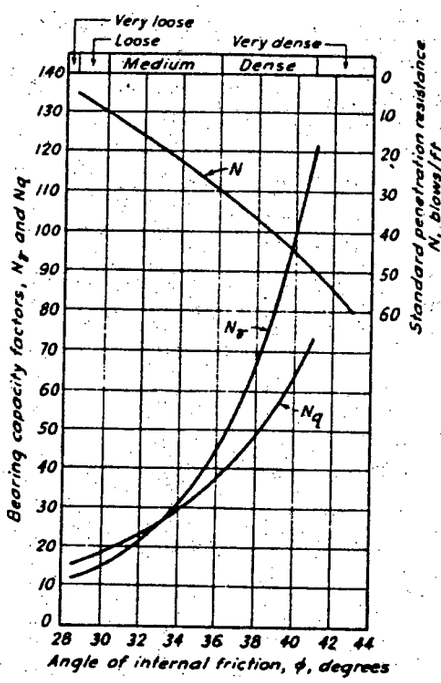


FIGURE 4. Curves showing the relationship between bearing-capacity factors and ϕ, as determined by theory, and rough empirical relationship between bearing capacity factors or ϕ and values of standard penetration resistance N.

Fig. 4

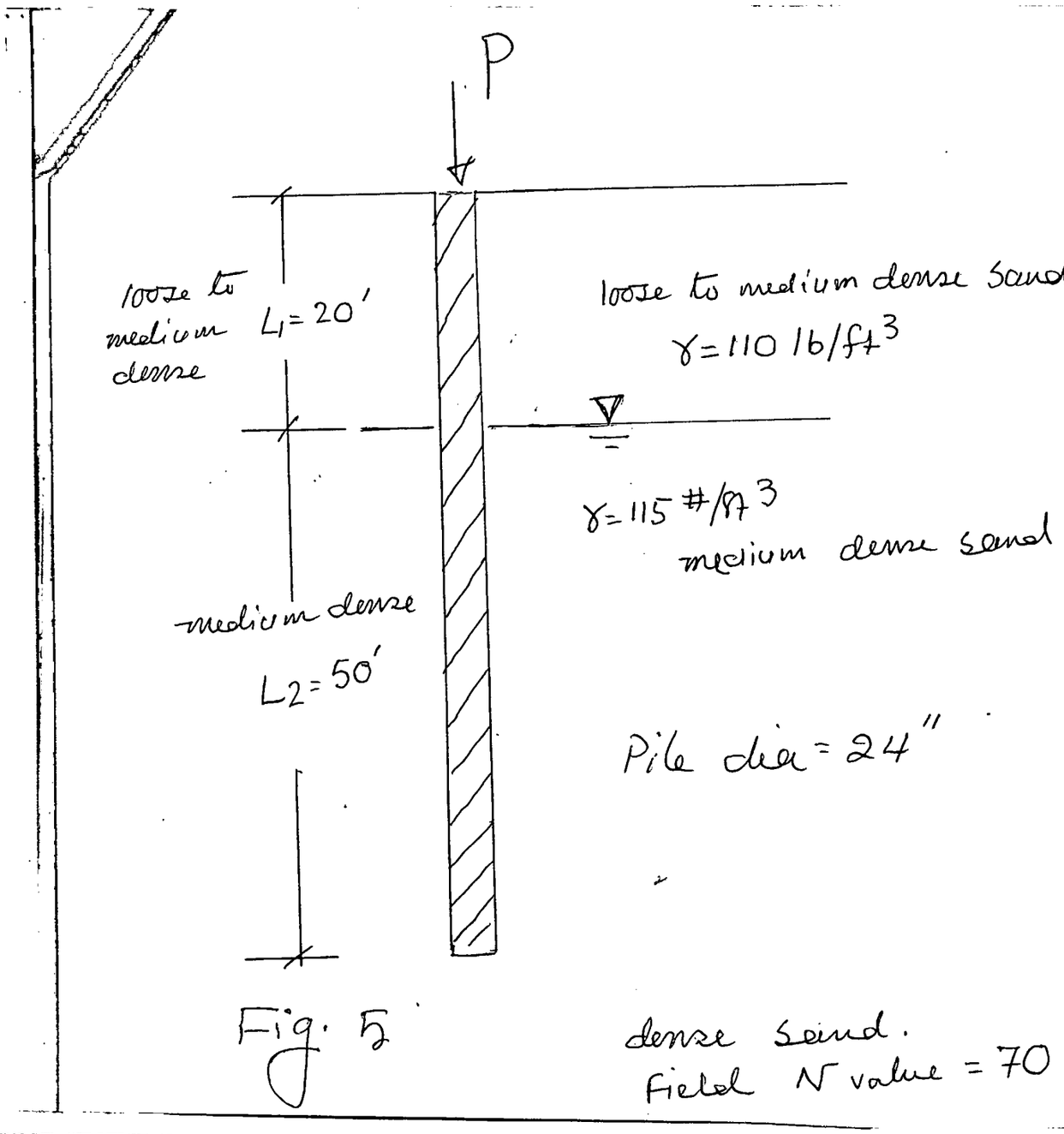


Fig. 5

dense sand.
Field N value = 70

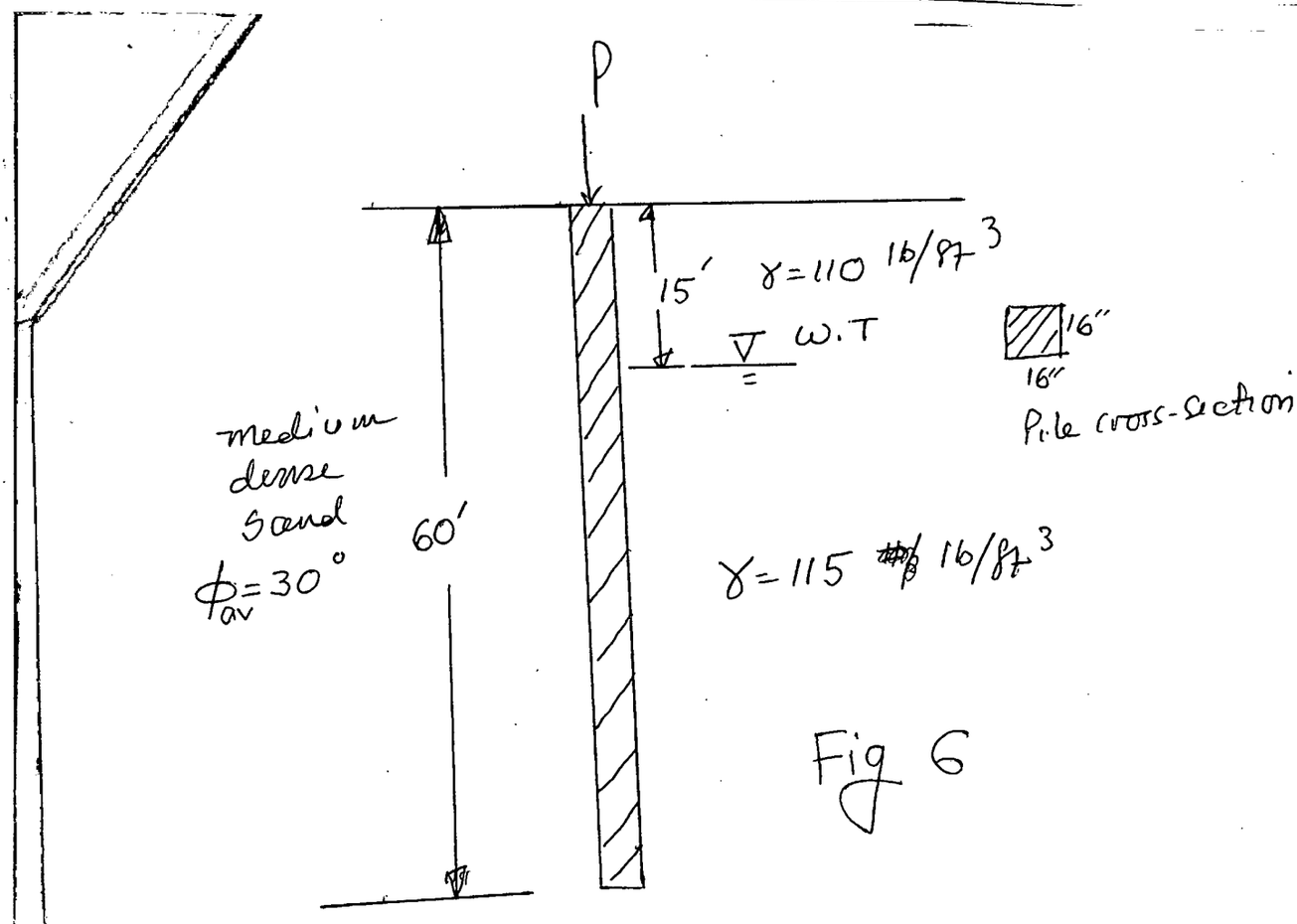


Fig 6

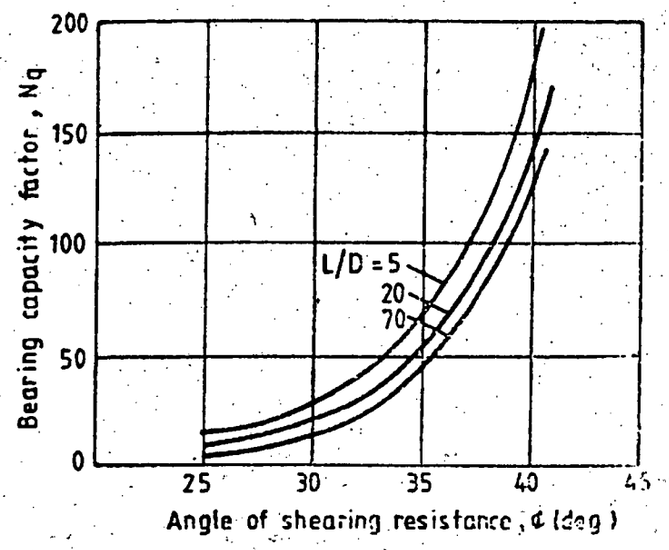
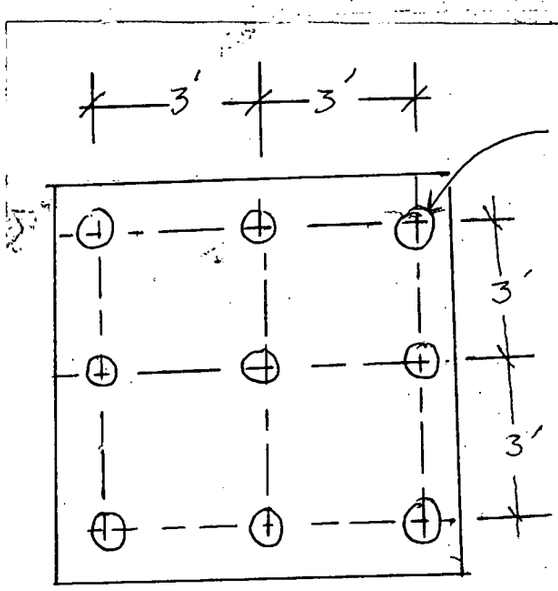
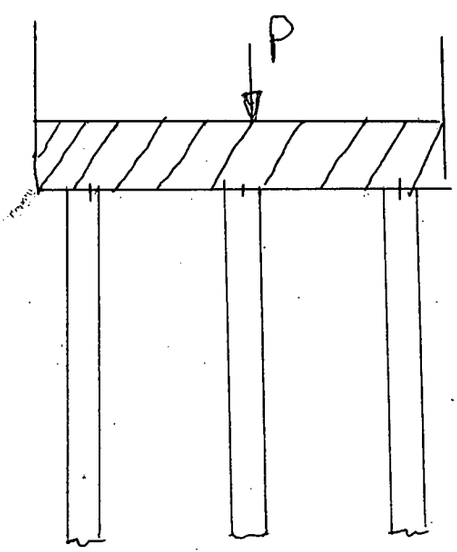


Fig. 7. Berezantzev's bearing capacity factor, N_q (After Berezantzev *et al.*, 1961)



dia.
15" RCC piles
(Bored piles)



20' $q_{u_1} = 0.5$ tsf
$\alpha_1 = 0.85$

40' $q_{u_1} = 1.5$ tsf
$\alpha_2 = 0.65$

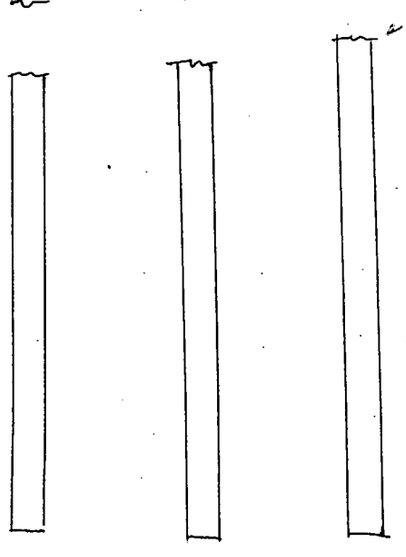


Fig. 8

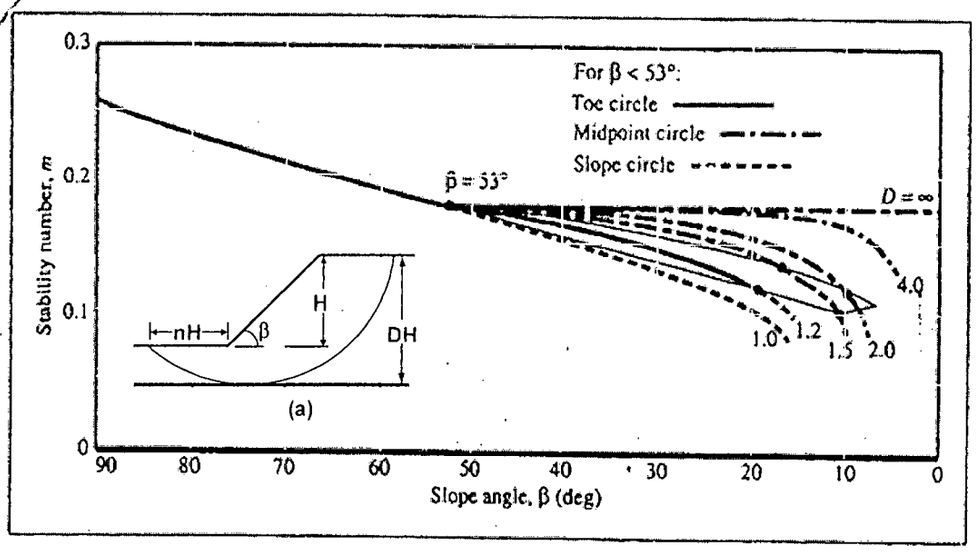


Fig.9 Chart for stability number against slope angles for different values of depth factor D for slope stability analysis using Fellenious method.

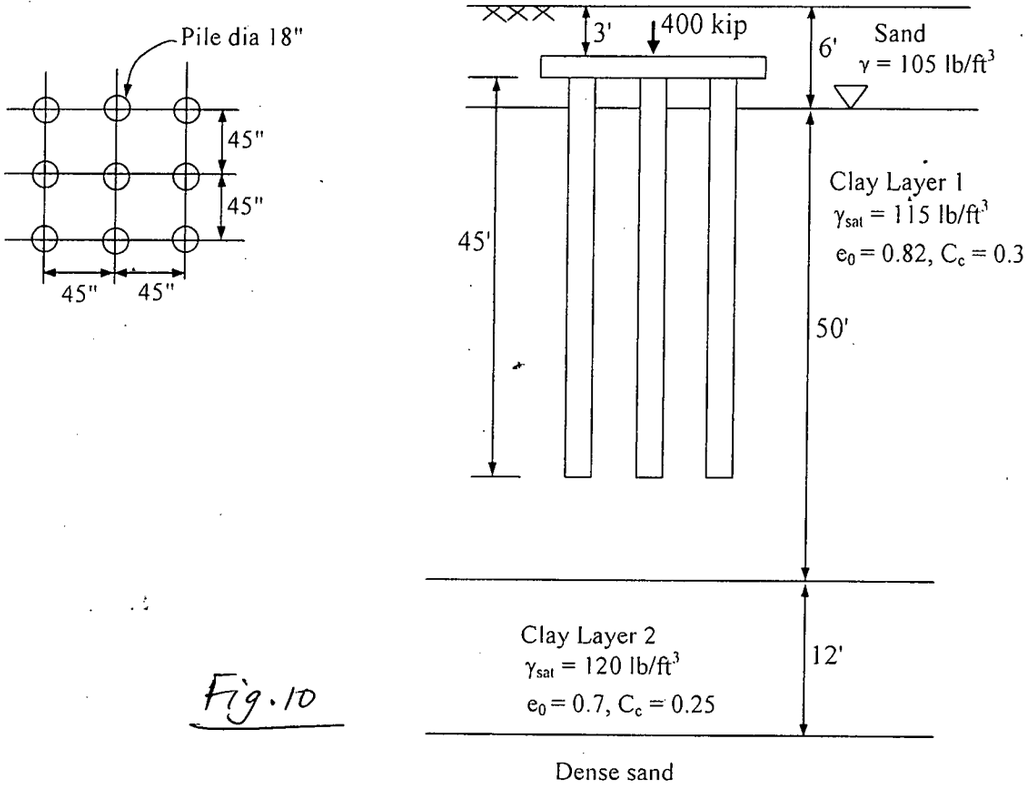


Fig.10

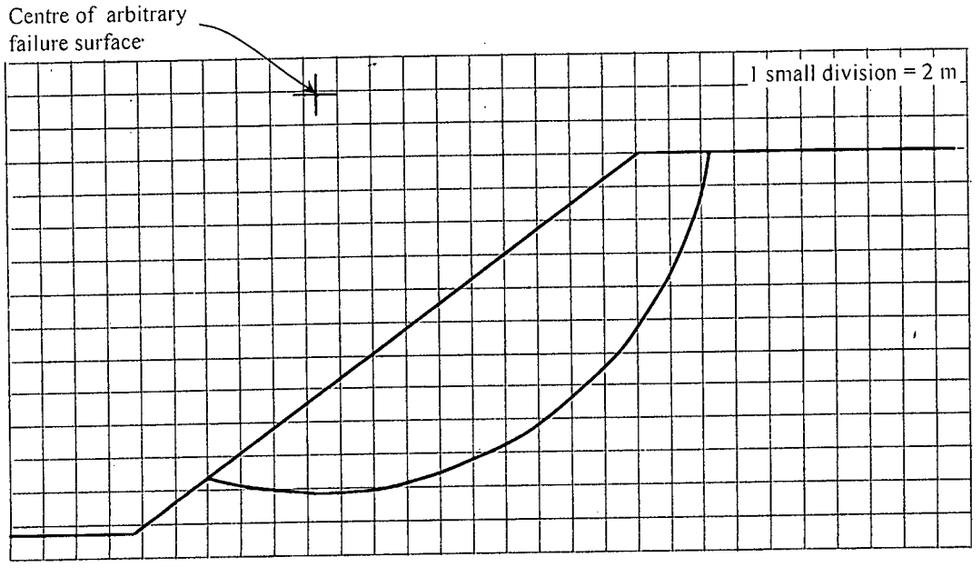


Fig.11