L-3/T-2/WRE **Date : 17/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2013-2014

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) Why do you need to know the characteristics of wastewater? Characterise domestic wastewater according to their sources. **(9)**

   (b) State the role of Temperature in wastewater treatment process. **(3+9)**

   How can you measure the organic pollution load in wastewater? Describe.

   (c) Differentiate between (i) Sullage and Sewage (ii) Sewer and Sewerage (iii) Pour flush latrine and VIP latrine (vi) Facultative pond and Maturation pond. **(10)**

   (d) Determine the 1-day BOD and ultimate BOD of a wastewater whose 5-day BOD at 20°C is 200 mg/L. What would have been the 5-day BOD if it had been conducted at 25°C? Assume k = 0.23/day and $k_T = k_{20}(1.047)^{T-20}$. **(15⅔)**

2. (a) With a flow-chart show the processes involved in Wastewater Treatment System. **(10)**

   Why is Biological process preferable to chemical process in treating domestic wastewater? Explain. **(10)**

   (b) Name the secondary processes in Wastewater Treatment system. **(3+9)**

   Differentiate among the biological treatment processes according to their basic principles.

   (c) Define 'Sludge Bulking'. How can it be controlled? **(8)**

   (d) Design a Primary sedimentation clarifier to treat a wastewater of an average flow of 10 MLD and peak flow rate of 22.5 MLD. Surface over-flow Rate should not exceed 40 m^3/m^2day. Assume any reasonable value of missing data, if necessary. **(16⅔)**

3. (a) Describe the mechanisms involved in treating wastewater in a Facultative Pond. What are the reasons for varying depth of different Waste Stabilization Pond? **(6+4)**

   (b) Why is Sludge Treatment necessary? List the different sludge treatment and disposal options. What methods are adopted for disposing of the fecal sludge in Bangladesh? **(3+3+3)**

   (c) What are the guidelines of preventing contamination of groundwater from On-Site Sanitation Systems? **(3+4+4)**

   What factors influence the growth of microbes? State the salient features of a Compost latrine.

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(d) Determine the volume of an Oxidation Pond which is to be designed to serve a population of 3000, where sewage flow is 75 gpcd, BOD_5 is 200 mg/L and design temperature is 24°C. **(16⅔)**

4. (a) Describe the advantages of SBS system over Conventional Sewerage System. **(12)**

(b) State the importance of formulating Environmental Policy for Bangladesh. **(6+4+4)**

What factors should be considered in setting Environmental Quality Standards (EQS)?

What is the difference between two approaches of setting EQS?

(c) What is the role of Baseline study in conducting EIA? **(10⅔)**

State three negative impacts of 'Padma Bridge" project. Suggest some mitigation measures to minimize those impacts.

(d) Why is Public consultation necessary in EIA? Explain. **(10)**

SECTION – B

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

Assume any reasonable value/data, if needed.

5. (a) A new water storage reservoir needs to be provided to meet the fluctuation in consumption for a community with a population of 45000. Average daily water demand of the population is 9900 m^3 which is supplied from the treatment plant by 12-hrs continuous pumping from 6.00 AM to 6.00 PM. Average daily consumption is phased as follows: **(18)**

Time	Consumption (m^3)
12.00 AM to 6.00 AM	990
6.00 AM to 10.00 AM	2480
10.00 AM to 2.00 PM	3270
2.00 PM to 8.00 PM	2370
8.00 PM to 12.00 AM	790

Calculate the capacity of the tank required to meet the fluctuation in water demand. Assume no loss from trunk main.

(b) With suitable illustrations describe briefly different modes of solid wastes collection options. **(13⅔)**

(c) Define point sources and non-point sources of water pollution. Write down the adverse effects of the following water pollutants: (i) oil and (ii) suspended solids. **(4+11)**

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6. (a) Write down the advantages of roughing filter over rapid sand filter for treatment of water. **(5+7)**

Water from a groundwater source need to be treated before supplying for domestic use. Show the appropriate sequence of water treatment unit processes to treat water having following concentration of respective water quality parameters–

pH = 7.1;
Hardness = 70 mg/L as $CaCO_3$;
Alkalinity = 150 mg/L as $CaCO_3$;
Iron = 0.5 mg/L
Arsenic = 0.11 mg/L
Turbidity = 35 NTU
Color = 5 Pt-Co unit ;
CO_2 = 25 mg/L ;

(b) Discuss briefly the major difficulties related with withdrawing groundwater in Bangladesh. **(8+10⅔)**

A 200 mm diameter tubewell is sunk to withdraw water from a 40 ft thick confined aquifer having coefficient of permeability 0.07 l/s/ft^2. The depth of water below the piezometric level is 95 ft and it falls 7 ft in the tubewell while pumping. If the yield of water from the tubewell is 1.10 ft^3/sec, calculate the diameter of the cone of depression for that tubewell.

(c) Differentiate between different types of landfill gas collection system. Describe the process of municipal waste composting. **(8+8)**

7. (a) Write down and discuss briefly about different types of surface water collection methods. Write short notes on total coliform and fecal coliforms. **(16)**

(b) In November 30, 2015, the following air quality data have been recorded at the Continuous Air Monitoring Station (CAMS) near Sangsad Bhaban, Dhaka. **(15)**

PM-2.5 = 240 μg/m^3 (24-hr);
O_3 = 0.135 ppm (1-hr)
O_3 = 0.78 ppm (8-hr)
NO_2 = 0.50 ppm (annual)
SO_2 = 0.28 ppm (24-hr)
Calculate AQI and report the air quality for that location on the specified day.

(c) Write down the significant impact of short lived climate pollutants (SLCPs). How presence of carbon monoxide in blood affects the oxygen carrying capacity of blood? **(6+6+3⅔)**

Name at least two air quality management strategies successfully implemented in Bangladesh.

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8. (a) Illustrate the possible impacts of noise pollution on human health. **(10)**

(b) Write down some advantages and disadvantages of different water supply distribution pipe network layout options. **(12)**

(c) Write down the name of commonly used population estimation methods. The urban population of Dhaka city for last three decades is given below. Estimate the population of the city for year 2030 using appropriate prediction method. **(3+12⅔)**

Year	1985	1995	2000	2005	2015
Population (Millions)	4.8	7.7	10.1	12.6	17.5

(d) Write down and also illustrate with diagram the basic principle of reverse osmosis process. **(9)**

Table for question no. 7 (b)- Air Pollutants Breakpoint concentrations

Breakpoints								
O_3 (ppm) 8-hr	O_3 (ppm) 1-hr(i)	$PM_{2.5}$ ($\mu g/m^3$) 24-hr	PM_{10} ($\mu g/m^3$) 24-hr	CO (ppm) 8-hr	SO_2 (ppm) 24-hr	NO_2 (ppm) Annual	AQI	Category
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	0.5-12.4	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

L-3/T-2/WRE **Date : 23/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2013-2014

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**.

1. (a) Distinguish between (i) mean temperature and normal temperature (ii) tropical cyclone and extra-tropical cyclone. **(6)**

(b) Show in neat diagrams (i) the hydrologic cycle (ii) the general atmospheric circulation. **(8)**

(c) Estimate the constant rate of withdrawal from a 1200 ha reservoir in a month of 30 days during which the reservoir level dropped by 0.5 m inspite of an average inflow of 6.0 m^3/s. During the month the rainfall was 185 mm and evaporation and seepage losses = 12 cm. **(11)**

(d) At a climatic station, air pressure is 101.3 kPa, air temperature = 24°C and dew-point temperature = 18°C. Calculate the corresponding vapour pressure, relative humidity and air density. **(10)**

2. (a) Briefly describe with neat figures the various methods of base flowseparation. **(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 for the catchment. **(14)**

Time(h)	0	6	12	18	24	30	36	42	48	54	60	66	72
Discharge (m^3/s)	40	65	215	360	400	350	270	205	145	100	70	50	40

(c) The ordinates of a 6-h unit hydrograph are given below. A storm had two successive 6-h intervals of rainfall magnitude of 3.2 and 4.8 cm respectively. Assuming a ϕ index of 0.2 cm/h and a base flow of 10 m^3/s, calculate the ordinates of the resulting flood hydrograph. **(14)**

Time(h)	0	3	6	9	12	18	24	30	36	42	48	54	60	66
HU ord. (m^3/s)	0	15	25	45	60	80	70	60	45	30	20	10	5	0

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3. (a) State the assumptions and limitations of the theory of unit hydrograph. **(6)**

(b) The ordinates of a 4-h unit hydrograph are given below. Derive the ordinates of a 2-h unit hydrograph for the same catchment. **(14)**

Time(h)	0	2	4	6	8	10	12	14	16	18	20	22	24
UH ordinate (m^3/s)	0	25	100	160	190	170	110	70	30	20	10	5	0

(c) Characteristics of two catchments A and B are given below. 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 the rainfall excess. Assuming the catchments A and B are meteorologically similar, determine the elements of the 6-h unit hydrograph for catchment B by using Snyder's method **(15)**

Catchment A	**Catchment B**
L = 150 Km	L_{ca} = 50 Km
L_{ca} = 75 Km	L = 105 Km
A = 2700 Km^2	A = 1400 Km^2

4. (a) With the help of typical annual hydrographs, give a comparison between an intermittent stream and an ephemeral stream. **(5)**

(b) What is meant by (i) confidence limits (ii) risk (iii) return period (iv) time of concentration? **(8)**

(c) Analysis of annual flood series data of a river covering a period of 35 years yielded a mean and standard deviation of 2960 and 1450 m^3/s respectively. For a proposed bridge over this river, it is decided to have an acceptable risk of 10% in its expected life of 40 years. Estimate the design flood discharge for this bridge by Gumbel's method. Also calculate 80% confidence limits for this estimate. Given: reduced mean = 0.538, reduced standard deviation = 1.119 and f(c) = 1.282. **(12)**

(d) Compute the runoff volume due to a rainfall of 15 cm in a day on a 500 ha watershed. The hydrologic soil groups are 50% of group B and 50% of group C randomly distributed in the watershed. The land use is 60% cultivated with good-quality bunding and 40% wasteland. Assume antecedent moisture condition of Type II. CN_{II} values are given below: **(10)**

Land use	Hydrologic soil group	
	B	C
Cultivated with good-quality bunding	69	76
Wasteland	80	85

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SECTION – B

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

Assume reasonable values if necessary.

5. (a) Describe briefly unsteady flow effect on a rating curve. **(4)**

(b) During velocity measurement using moving boat method, the magnitude (V_R) and direction (θ) of the resultant velocity relative to the moving boat are measured. The depth of the stream was also simultaneously recorded. Estimate the discharge in the river from the following data. Assume mean velocity in a vertical to be 0.95 times the surface velocity measured by the instrument. The sections are 75 m apart. **(16)**

Section	0	1	2	3	4	5	6	7	8	9	10
V_R (m/s)	-	1.75	1.84	2.0	2.28	2.30	2.20	2.0	1.84	1.7	-
θ (deg)	-	55	57	60	64	65	63	60	57	54	-
Depth (m)	-	1.8	2.5	3.5	3.8	4.0	3.8	3.0	2.5	2.0	-
Remark	Right Bank										Left Bank

(c) The stage-discharge data of a river are given below. Establish a stage-discharge relationship to predict the stage for a known discharge. Assume the stage value for zero discharge as 20.50 m. Determine the stage of the river corresponding to a discharge of 2600 m^3/s. **(15)**

Stage (m)	Discharge (m^3/s)	Stage (m)	Discharge (m^3/s)
22.45	220	24.55	1010
22.80	295	24.85	1220
23.40	490	25.40	1300
23.75	500	25.55	1550
24.05	780	25.90	1760

6. (a) A small reservoir has the following storage-elevation relationship. **(20)**

Elevation (m)	55.00	58.00	60.00	61.00	62.00	63.00
Storage ($10^3 m^3$)	250	650	1000	1250	1500	1800

A spillway provided with its crest at elevation 60.00 m has the discharge relationship $Q = 15\ H^{3/2}$, where H = head of water over spillway crest. When the reservoir elevation is at 58.00 m a flood as given below enters the reservoir. Route the flood using the

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Goodrich method and determine the maximum reservoir elevation, peak outflow and attenuation of the flood peak.

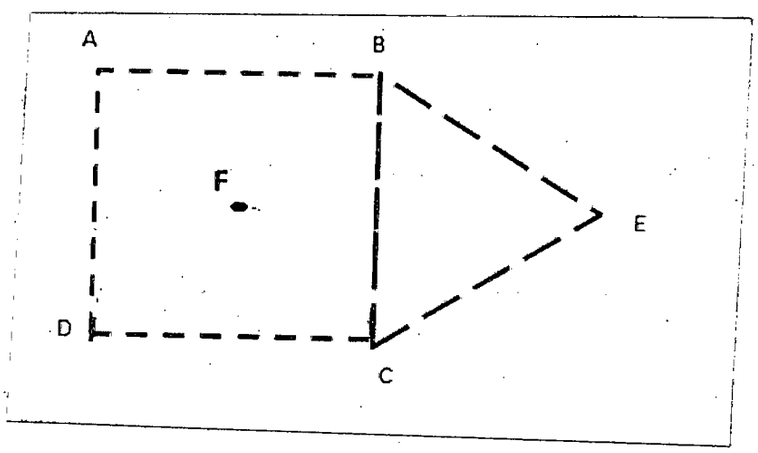
Time (h)	0	6	12	15	18	24	30	36	42
Inflow (m^3/s)	5	20	40	60	50	32	22	15	10

(b) The storage in the reach of a stream has been studied. The value of Muskingum weighting factor is 0.28 and storage time constant is 1.6 days. If the inflow hydrograph to the reach is as given below, compute the outflow hydrograph. Assume the outflow from the reach at t = 0 as 3.5 m^3/s. **(15)**

Time (h)	0	6	12	18	24	30
Inflow (m^3/s)	35	55	92	130	160	140

7. (a) Write short note on (i) Depth-Area-Duration curve (ii) Probable Maximum Precipitation (iii) IDF curve (iv) Drawback of evaporation pan. **(8)**

(b) Find the mean precipitation for the area shown in following Figure by Thiessen Polygon Method. The area is composed of square and an equilateral triangular area. The sides of triangle and square are 10 km. Rainfall readings at stations A, B, C, D, E and F are 46, 65, 76, 80, 60 and 70 cm, respectively. Station F is located at the centre of the square. **(15)**



(c) A catchment area has five rain gauges. In a year, the normal annual precipitation of those five raingauge stations P, Q, R, S and T are respectively 125, 102, 76, 113 and 137 cm. **(12)**

(i) For a 5% error in the estimation of the mean rainfall, calculate the minimum number of additional stations required to be established in catchment.

(ii) During a particular storm the precipitation recorded by the stations P, Q, R, S are 13.2, 9.2, 6.8 and 10.2 cm respectively. The instrument at station T was inoperative. During that storm, estimate the rainfall at station T during that storm.

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8. (a) (i) Briefly describe the factors that control infiltration capacity of a soil. **(8)**

(ii) Explain the methods to reduce evaporation losses.

(b) Calculate the ratio of actual and potential evapotranspiration for a reservoir from the following data in the month of July from the following data. **(15)**

Latitude = 28°N, Elevation = 230 m (above sea level), Mean monthly temperature = 32.0°C, Mean relative humidity = 70%, Mean observed sunshine = 11 hr, Wind velocity at 2 m height = 85 km/day, Mean monthly solar radiation at the top of the atmosphere = 16 mm, Mean monthly value of possible sunshine hour = 13.4 hr, Average surface area = 20 km^2, Mean rate of inflow = 30 m^3/s, Outflow = 15 m^3/s, Monthly rainfall = 10 cm and Decrease in storage = 12 million m^3. Assume seepage loss to be 1.8 cm. Given

$$H_n = H_a(1-r)\left(a+b\frac{n}{N}\right)-\sigma T_a^4\left(0.56-0.092\sqrt{e_a}\right)\left(0.10+0.90\frac{n}{N}\right)$$

(c) A 24 hour storm occurred over a catchment of 1.8 km^2 area and the total rainfall was 10 cm. An infiltration capacity curve prepared had the initial infiltration capacity of 1 cm/hr and attained a constant value of 0.3 cm/hr after 15 hours of rainfall with total infiltration of 4.65 cm in that 15 hour. A Colorado Sunken Pan installed in the catchment indicated a decrease of 0.6 cm in the water level during that 24 hr period. Determine the runoff from the catchment during that 24 hour. Assume other losses are negligible. **(12)**

L-3/T-2/WRE **Date : 27/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2013-2014

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.

Assume missing value/data (if any). Symbols have their usual meaning.

SECTION – A

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

1. (a) List the basic Engineering properties of soils that are important in connection of pavement design. Describe desirable properties of Aggregate used for highway construction. **(13⅔)**

   (b) Discuss classification of Sand according to source and size. What are the differences between "Fractional distillation" and "Destructive distillation process". State the uses of Asphalt Cement, Asphalt Emulsion and Blown Asphalts. **(16)**

   (c) List various Low Cost Surfaces. Explain construction steps of Gravel roads. Why maintenance of Water bound Macadam road is so important? **(17)**

2. (a) Compare Rigid pavement with Flexible Pavement. Describe the functions of different structural components of a Flexible Pavement. **(13)**

   (b) Explain the design procedure of a Flexible Pavement using staged construction. A full depth asphalt concrete pavement is to be constructed in two stages. The design period is 20 years, and the 2nd stage will be constructed 10 years after the first stage. If the ESAL on the design lane during the first year is 65,000 and the growth rate for all vehicles is 6%, determine the asphalt thickness for the first and 2nd stages of construction, if the sub grade resilient modulus is 15,000 lb/in^2. **(17)**

   (c) Discuss the various resistances which a locomotive has to overcome before hauling a train. A curve of 6^o is situated on a B.G. line and a train with a total weight of 1200 tonnes is passing over it. Find the curve resistance. **(16⅔)**

3. (a) What are the factors affecting the choice of a particular gauge? What are the advantages of flat footed rails? What are the points to be kept in mind while selecting location for a railway station? **(14)**

   (b) What are the factors affecting design of Rigid Pavement? What are the factors considered in the AASHTO method of Rigid Pavement design? Explain the requirements of joints in Rigid Pavement **(14)**

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(c) Design a Rigid Pavement using the AASHTO method for the following design criteria. **(12)**

Effective modulus of sub grade reaction k = 72 lb/in^3, concrete elastic modulus, E_C = 5 × 10^6, Mean concrete modulus of rupture S_C^1 = 650 psi, Load transfer coefficient J = 3.2, Drainage co-efficient, C_d = 1.0, Present serviceability index, P_i = 4.2, Final serviceability index, P_t = 2.5. Reliability, R = 95%, overall standard deviation, S_0 = 0.29, ESAL = 6 × 10^6.

(d) Why Highway maintenance is important? Classify highway maintenance works. **(6⅔)**

4. (a) State importance of an Airport in a city/country. Explain the advantages of Air-transport. What are the factors influencing Air Travel Demand? **(15)**

(b) List the Factors considered in Airport site selection. Name the different types of Runway Configurations? Explain in detail, the parallel runway and Open-V runway configurations. **(15)**

(c) What are the differences between Prime Coat and Tack Coat? What are the requirements of an ideal permanent way? Define Passenger Load factor (PLF). Calculate PLF from the following data: **(16⅔)**

5 flight per day
Seat capacity = 100 passengers
Average distance traveled = 200 km
Average Passengers per flight = 65

SECTION – B

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

5. (a) State the purposes and implications of road classification systems. Explain schematically the relationship between access and movement function of road. **(4+6)**

(b) 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*). **(3+6)**

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

(d) Write down the important steps in transportation system analysis. **(9)**

(e) The gap between two consecutive automobiles (distance between the back of a vehicle and the front of the following vehicle) is 65 ft. At a certain time, the front vehicle is traveling at 45 mph, and the following vehicle at 35 mph. If both vehicles start

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accelerating at the same time, determine the gap between the two vehicles after 15 sec if the acceleration of the vehicles can be assumed to take the following forms: **(12)**

$$\frac{du}{dt} = 3.4 - 0.07u_t \text{ (leading vehicle)}$$

$$\frac{du}{dt} = 3.3 - 0.065u_t \text{ (following vehicle)}$$

Where, u_t is the vehicle speed in fps.

6. (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+6⅔)**

(b) Define: (i) Design Vehicle; (ii) 30th -highest Hourly Volume; (iii) PIEV. **(6)**

(c) What are the functions and limits of shoulder and median 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) Volume; (ii) Delay; (iii) Parking.

(e) The owner of a parking garage located in a CBD has observed that 20% of those wishing to park are turned back every day during the open hours of 8 a.m. to 6 p.m. because of lack of parking spaces. An analysis of data collected at the garage indicates that 60% of those who park are commuters, with an average parking duration of 9 hr, and the remaining are shoppers, whose average parking duration is 2 hr. If 20% of those who cannot park are commuters and the rest are shoppers, and a total of 200 vehicles currently park daily in the garage, determine the number of additional spaces required to meet the excess demand. Assume parking efficiency is 0.90. **(12)**

7. (a) 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)**

(b) Differentiate between: (i) 'Time Headway' and 'Distance Headway'; (ii) 'Stopping Sight Distance' and 'Passing Sight Distance'; (iii) 'Semi-actuated Signal' and 'Fully-actuated Signal'. **(9)**

(c) Explain diagrammatically the method of attaining superelevation considering pavement revolved about the centerline. **(12)**

(d) Speed-density relationship for a given site is found as follows: **(8)**

$$v_s = 65\left(1 - \frac{k}{110}\right)$$

(i) Determine the flow-density and flow-speed relationship, and (ii) Show the value of free-flow speed, jam density, and capacity.

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(e) The intersection angle of a 4° curve is $55^{0}25'$, 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. **(11⅔)**

8. (a) State 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) What are the sequential travel demand forecasting models and why are they called 'sequential'? Explain the difference between 'Origin-Destination' and 'Production-Attraction'. **(5+5)**

(c) Name the factors that affect the mode choice of travelers. How can the mode choice models be classified into different categories? **(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) Assign the vehicle trips shown in the O-D trip table to the network shown in Figure 1 using the 'all-or-nothing' assignment technique. Make a list of the links in the network and indicate the volume assigned to each. Calculate the total vehicle minutes of travel. Show the minimum path and assign traffic for each of the five nodes. **(11⅔)**

Trips Between Zones

From/To	1	2	3	4	5
1	0	100	100	200	150
2	400	0	200	100	500
3	200	100	0	100	150
4	250	150	300	0	400
5	200	100	5	350	0

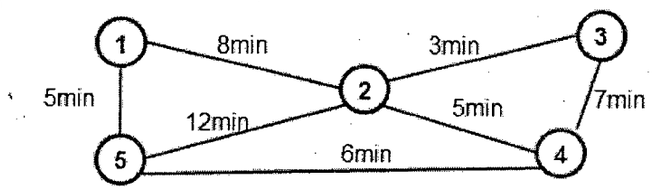


Figure 1

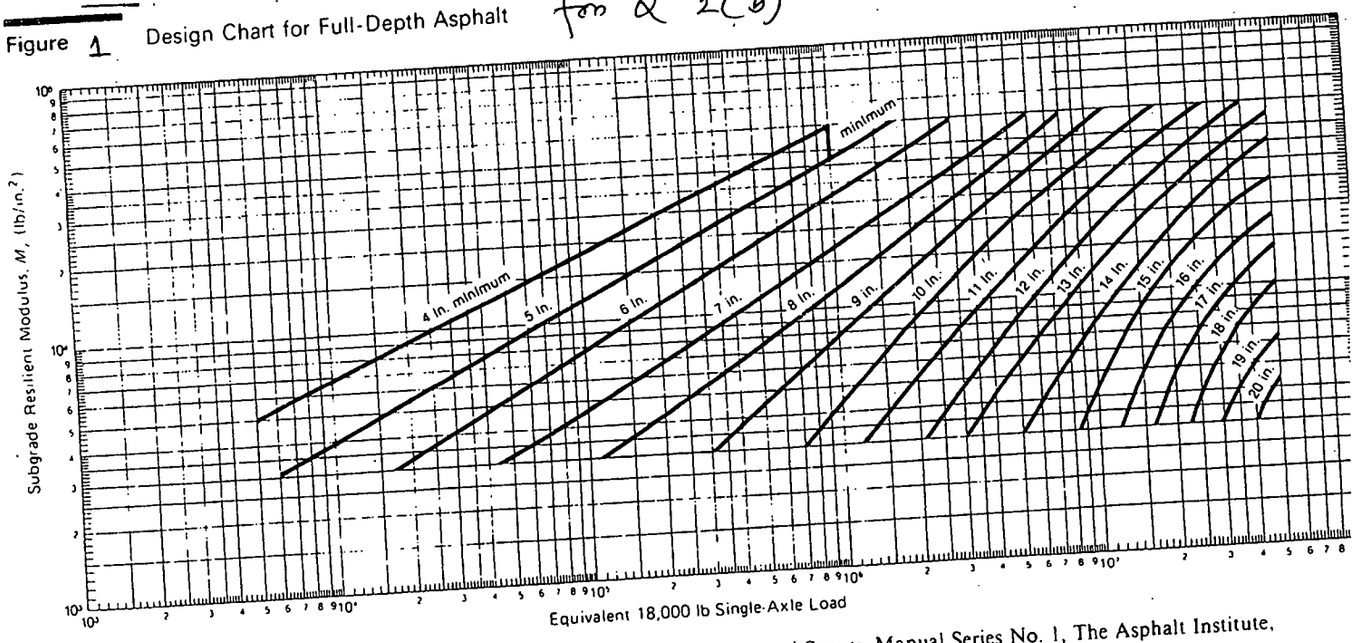
Table 1 Growth Factors for Q 2(b)

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.

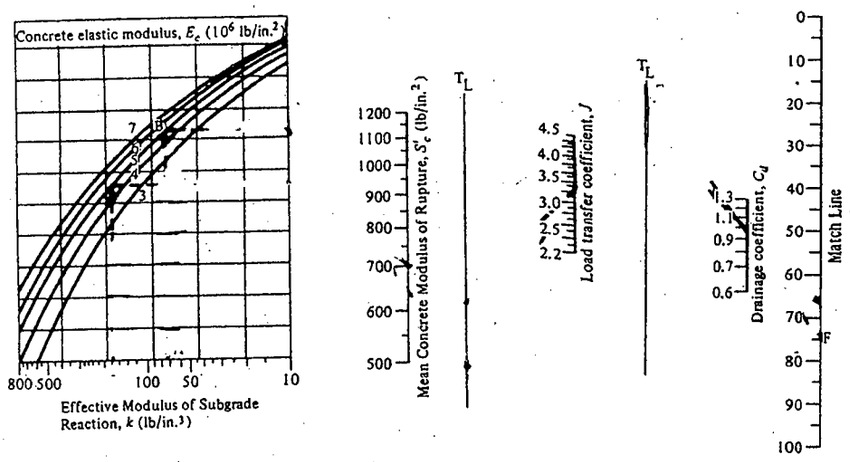
Source: Reproduced from *Thickness Design—Asphalt Pavements for Highways and Streets*, Manual Series No. 1, The Asphalt Institute, College Park, Md., September 1981.

Figure 1 Design Chart for Full-Depth Asphalt for Q 2(b)



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

Figure 2 Design Chart for Rigid Pavements Based on Using Mean Values for Each Input Variable (Segment 1)

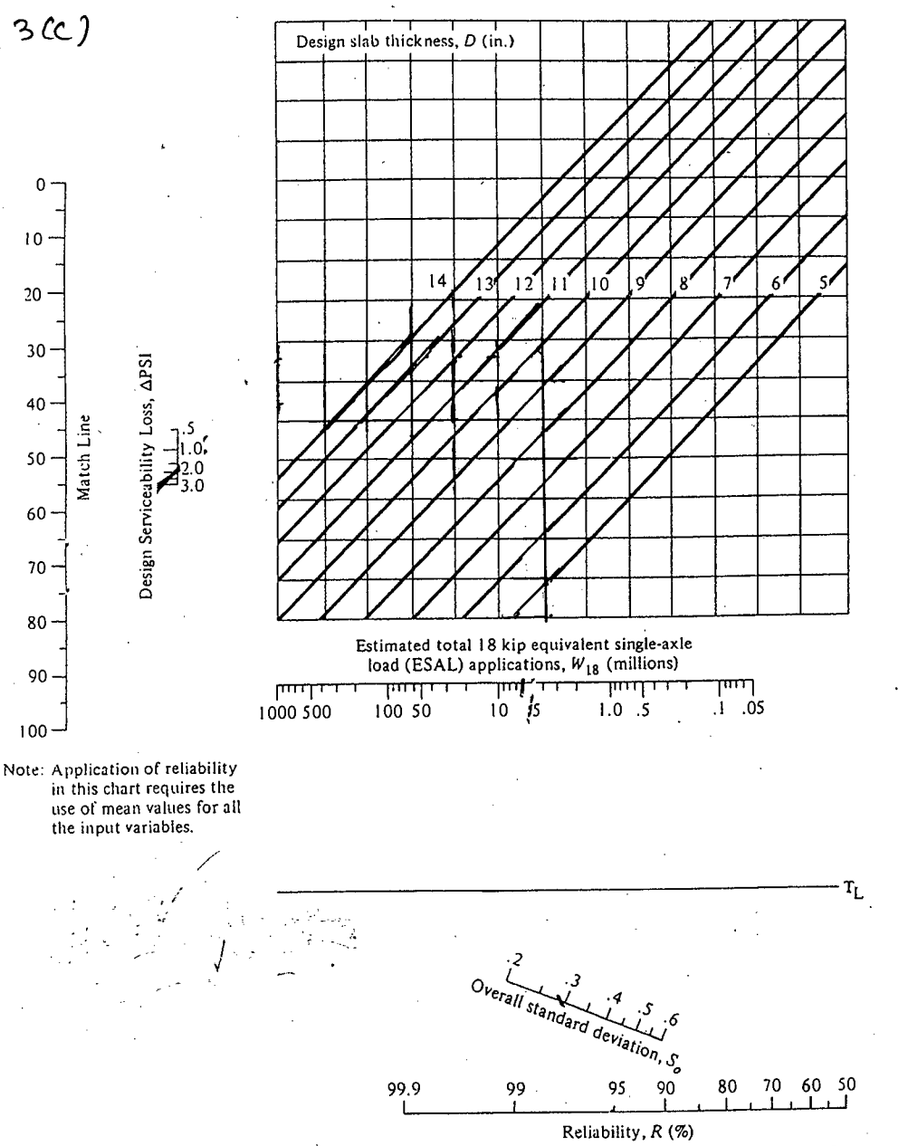


Example:

k = 72 lb/in.^{3}	S_o = 0.29
E_c = 5 X 10^6 lb/in.^{2}	R = 95% (Z_R = −1.645)
S'_c = 650 lb/in.^{2}	ΔPSI = 4.2 − 2.5 = 1.7
J = 3.2	W_{18} = 5.1 X 10^6 (18 kip ESAL)
C_d = 1.0	Solution: D = 10.0 in. (nearest half-in., from segment 2)

Source: Redrawn from *AASHTO Guide for Design of Pavement Structures*, Washington, D.C.: The American Association of State Highway and Transportation Officials, copyright 1986. Used by permission.

Figure 3 Design Chart for Rigid Pavements Based on Using Mean Values for Each Input Variable (Segment 2)



Note: Application of reliability in this chart requires the use of mean values for all the input variables.

Source: Redrawn from *AASHTO Guide for Design of Pavement Structures*, Washington, D.C.: The American Association of State Highway and Transportation Officials, copyright 1986. Used by permission.

L-3/T-2/WRE **Date : 31/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2013-2014

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.

SECTION – A

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

1. (a) For column supported slab, 100 percent of the applied load must be carried in each direction — Explain. **(3)**

   (b) State the restrictions of Direct Design Method for analysis of two way slab. **(5)**

   (c) A two-way reinforced concrete building floor system is composed of slab panels measuring 20'×20' in plan, supported by shallow column line beams cast monolithically with the slab as shown in Fig. 1. Using concrete strength of $f_c' = 4000$ psi and steel with $f_y = 60{,}000$ psi, design a typical interior panel to carry a service live load of 144 psf in addition to the self weight of the floor. Show reinforcement in neat sketches. **(27)**

2. (a) What is the basic difference between behaviour of short column and long (slender column)? What are ACI criterions for slender column? **(10)**

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

3. (a) A ground floor column of a multistoried building is to be designed for the following load combinations (axial force and uniaxial bending)— **(20)**

   Gravity load condition , $P_u = 700$ kip, $M_u = 80$ kip ft. Lateral load combination, $P_u = 600$ kip, $M_u = 500$ kip ft. Architectural combinations require that a rectangular column with b = 16" and h = 25 in. is to be used. Material strengths are $f_c' = = 4$ ksi and $f_y = 60$ ksi.

   Find the required column reinforcement and show in a sketch. Use supplied design chart and assume that the reinforcement are distributed along the perimeter.

   (b) Design tie for the above column considering seismic provisions of an IMRF system. **(9)**

   (c) Why are ϕ values lower for compression than those of flexure or shear? **(6)**

Contd P/2

CE 325

4. (a) A four-story reinforced concrete wall is subjected to factored lateral loads as shown in Fig. 3. 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. Given f'_c = 4 ksi, f_y = 60 ksi. **(25)**

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

$$\frac{A_w}{S_1} \geq 0.0025\, h$$

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

$$\frac{Z}{l_w} = \frac{1}{2 + 0.85\, \mathrm{B}_1 l_w \dfrac{h f'_c}{A_{st}\, f_y}} \qquad \beta_1 = 0.85$$

where, h = thickness of wall, h_w = height of wall.

(b) Why is seismic detailing essential for earthquake resistant design of structures? Draw and explain seismic detailing provisions for beam of an intermediate moment resisting frame as per ACI/BNBC code. **(10)**

SECTION – B

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

5. (a) Design a square footing for an interior column that carries total working DL = 600 kip and LL = 400 kip. The column is 25" × 25" in cross-section. Allowable bearing capacity of soil is 4200 psf. The bottom of the footing is 6 ft below the grade. Show the reinforcement in plan and sections with neat sketches. **(18)**

Given: f'_c = 3000 psi and f_y = 60,000 psi.

(b) A 16 in. concrete wall supports a dead load, DL = 14 kips/ft and a live load, LL = 10 kips/ft. The allowable bearing pressure is q_a = 5 kips/ft^2 at the level of the bottom of the footing, which is 4 ft below grade. Design a footing for this wall using 4000 psi concrete and Grade 60 steel. Also, check the adequacy of development length. **(17)**

6. (a) An exterior and interior columns are to be supported by a combined rectangular footing whose outer end cannot protrude beyond the outer face of the exterior column. Column sizes and their respective loads are shown in Fig. 4. The bottom of the footing is 6 ft below grade where the net allowable bearing pressure deducting soil load, self weight of footing and other surcharges is 4000 psf. Determine size of the footing. If d = 18 inch, check adequacy against punching. Also design the transverse beam. **(18)**

Contd P/3

CE 325

Contd... Q. No. 6

(b) 18" dia cast-in-situ piles shall be provided for a RC column 24" × 24" in section carrying DL = 500^k and LL = 400^k. The allowable load carrying capacity of each pile is 100^k. Pile spacing shall be 3 times the pile diameter. Design the pile cap showing all the reinforcements with necessary details. Given, f'_c = 4 ksi and f_y = 60 ksi. **(17)**

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

(b) A simply supported rectangular beam as shown in Fig. 5 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 Pe = 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) A flat plate floor has thickness h = 8" and is supported by 18" × 18" columns spaced 20 ft on centres each way. The floor will carry a DL = 180 psf including its self weight and a live load of 100 psf. Check the adequacy of the slab in resisting punching shear and provide shear reinforcement, if needed. Consider d = 6.5", f'_c = 3500 psi and f_y = 60,000 psi. **(17)**

(b) Make final design for the preliminary section shown in Fig. 6, allowing $f_b = -1.80$ ksi and $f_o = 150$ ksi. Other values are: **(18)**

$$M_T = 320\,\text{k-ft}$$
$$h = 36\,\text{in}$$
$$f_{se} = 125\,\text{ksi}$$
$$f_t = -1.60\,\text{ksi}$$

For preliminary section, A_c = 200 in^2, C_t = 13.5 in, C_b = 22.5 in, I = 26000 in^4, k_t = 5.8 in, K_b = 9.6 in and F = 164 k.

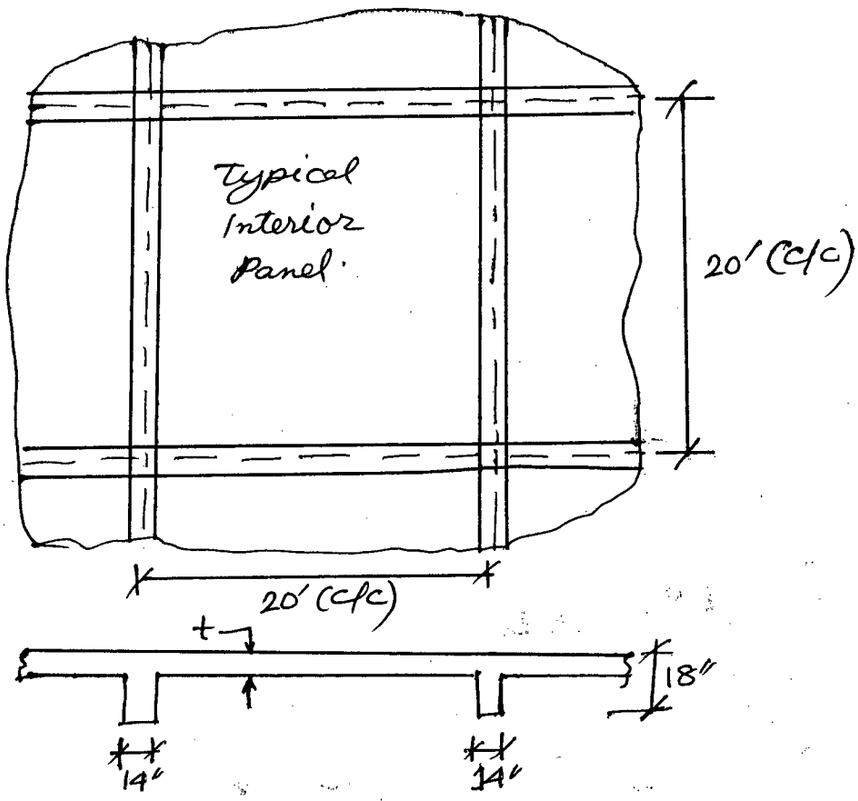


Fig 1.

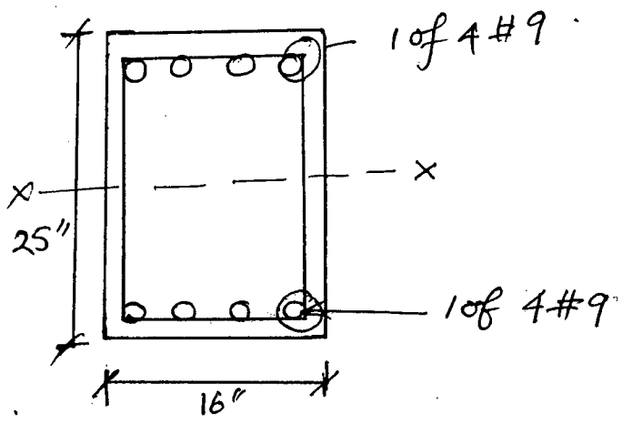


Fig. 2.

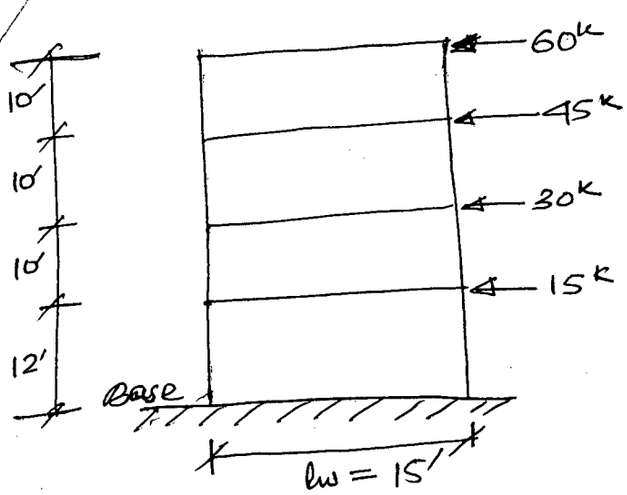
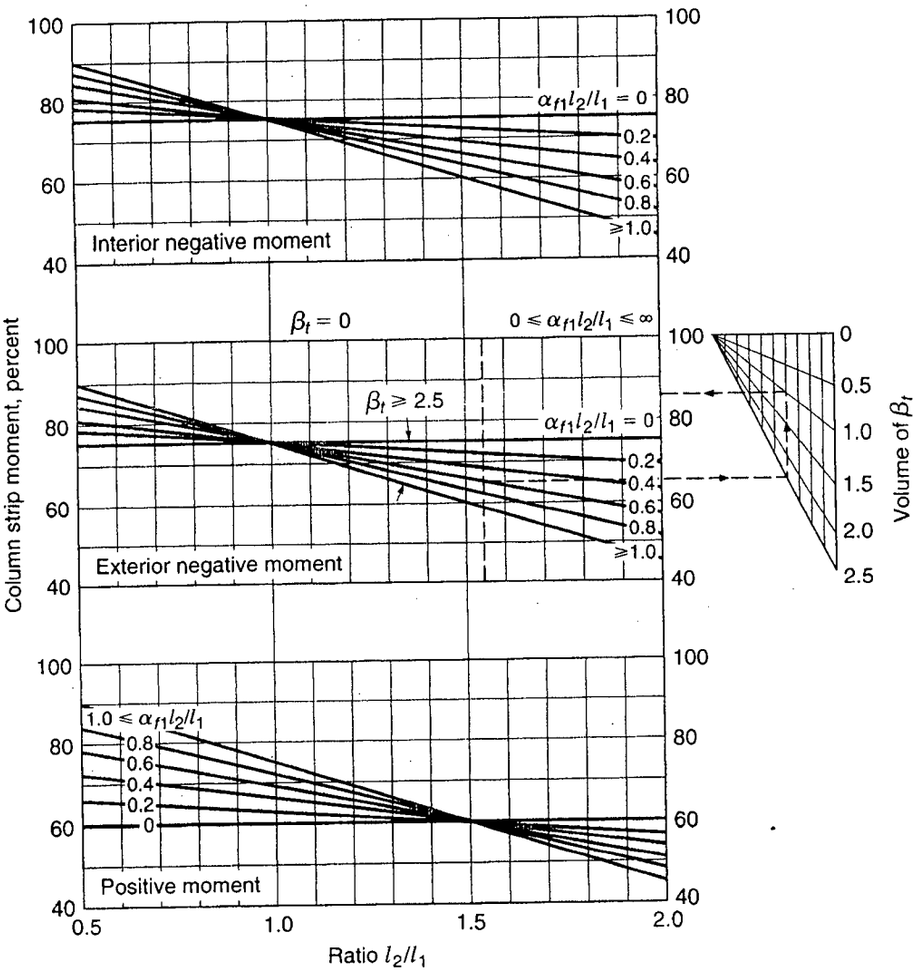
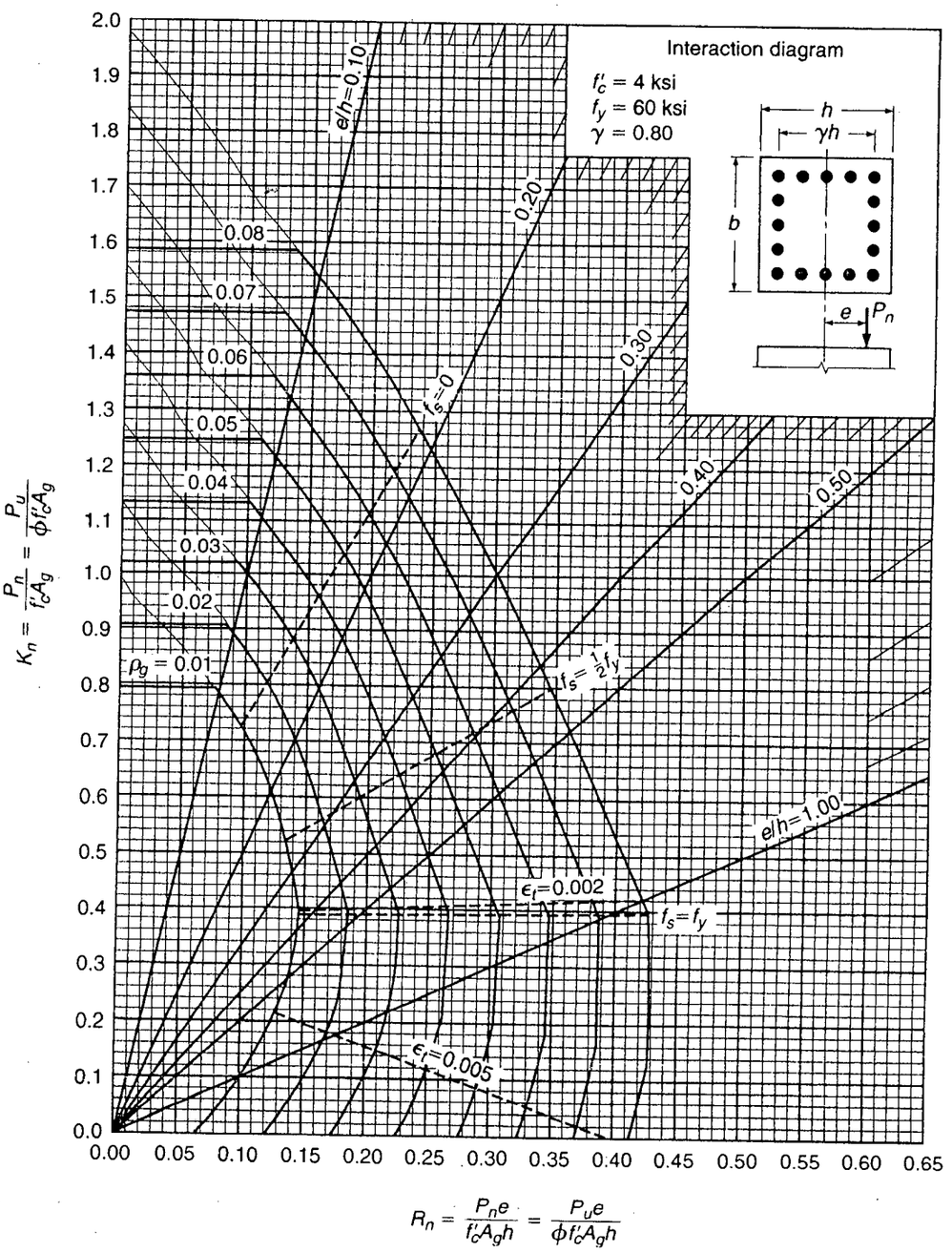


Fig. 3.

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





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

Design of Concrete Structures, 14th Edn.
by Nelson, Darwin, Dolan.
Page 774.

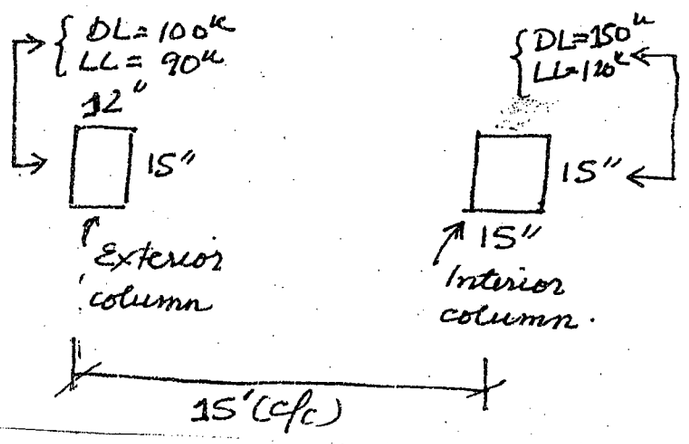


Fig. 4

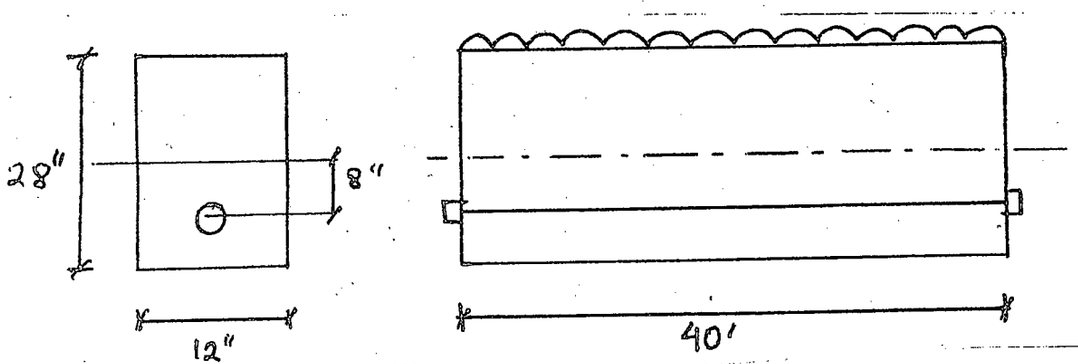


Fig. 5

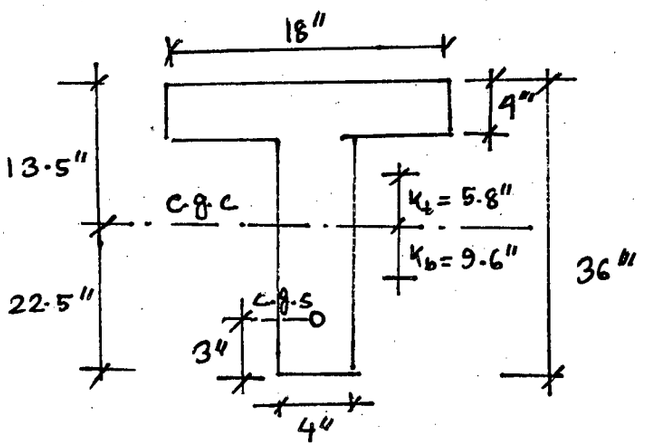


Fig. 6

L-3/T-2/WRE **Date : 06/02/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2013-2014

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**.

Assume reasonable missing values.

1. (a) Discuss different types of corrections recommended for field SPT values. **(10)**

   (b) Discuss the construction procedure of a bored pile 80 ft long and 30 inch diameter in Dhaka city. **(15)**

   (c) Write the specifications of concrete for construction of bored piles. **(10)**

2. (a) Using AASHTO method calculate the axial capacity of a drilled shaft and draw necessary sketches. **(20)**

   Given,

   Diameter of drilled shaft = 36 inch

   Length of drilled shaft = 80 ft

   Top of the drilled shaft = 8 ft below ground level

   Water table = 10 ft below ground level.

   Unit wt. of soil = 120 pcf

   SPT values are given below for a sand deposit

Depth	10 ft	20 ft	30 ft	40 ft	50 ft-140 ft
N	12	15	20	25	30

   (b) A pile group consisting of 20 piles is subjected to an eccentric load. Calculate the Forces on four corner piles. Draw necessary sketch,

   Given: **(15)**

   Centre to centre spacing of piles = 4 ft

   Eccentricity in long direction, e_L = 3 ft

   Eccentricity in short direction, e_s = 2 ft

   Depth Thickness of pile cap t = 4 ft

   Soil above the pile = 3 ft

   Unit weight of soil = 125 pcf

   Pile cap extends 2 ft from the centre of pile,

   Total vertical load = 1000^k

   Water table at 10 ft below ground level

3. Calculate the factory of safety against bearing capacity failure and Settlements at corner and at centre for a raft 100′ × 120′ placed 10 ft below ground level. Draw necessary sketches **(35)**

Contd P/2

CE 481

Contd ... Q. No. 3

Given: 0 ft – 50 ft over consolidated clay, unit weight 120 pcf, past maximum over burden pressure 9000 psf, $e_0 = 0.65$, $C_c = .11$, $C_r = .03$, unconfined compression strength 3000 psf. Below 50 ft dense sand, water table at 30 ft. Gross contact pressure 3000 psf. Divide the thick clay layer into two layers for settlement calculation.

4. (a) Calculate the pressure distribution underneath a footing 20 ft × 25 ft using conventional method and Meyuhofs Effective width concept. **(25)**

Eccentricity in long direction = 2 ft

Eccentricity in short direction = 1.5 ft

Vertical load = 800^k

Footing depth = 42 inch

Depth of footing = 8′ – 0″

Unit weight of soil = 125 pcf

Ground water level at 20 ft.

Draw necessary sketches.

(b) How do you find the centre of critical circle for slope failure analysis for a given slope.

SECTION – B

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

5. (a) Explain bearing capacity failure of a shallow foundation on clay with neat sketches. **(8)**

(b) Explain the effect of water table on the bearing capacity of shallow foundation on sand. **(7)**

(c) A concrete footing 6′ × 8′ with thickness 18″ rests on a clay soil by 7 ft below ground level. Soil conditions from a bore-log is described below. **(20)**

0-30 ft clay, Unit wt. 125 pcf

$c = 2000$ psf, $e_0 = 0.9$

$C_c = 0.15$, $C_r = 0.03$

$\sigma'_{v_{max}} = 8$ ksf

30 ft-100 ft Dense sand, $\gamma = 128$ pcf

Water table is at 20 ft below ground level.

(i) Calculate the load that can be supported by the footing with F.S = 2.5.

(ii) Calculate the settlement of the footing due to consolidation of clay layer if the load on column is 150 kip.

Contd P/3

CE 481

6. (a) A factor of safety of 3 is required for the group of friction piles shown in Figure-1. Find the maximum load P as determined by, **(20)**

   (i) The piles acting as individuals.

   (ii) The piles acting as a group.

   (b) What is negative skin friction? How can you roughly compute the magnitude of negative skin friction in a group of piles? **(7)**

   (c) What are the advantages of a raft foundation? What is a fully compensated foundation? **(8)**

7. (a) Show in a graph, how soil pressure varies with width of footing for a given settlement S_1 in sandy soils. With the help of this figure explain how design charts for shallow footings on sand are prepared. **(10)**

   (b) Explain why the design charts for footings on sand are based on N-values and not on angle of internal friction ϕ of the soil. How these N-values are obtained and what relations do they have with field N-values? **(10)**

   (c) If the footing shown in Figure-2 is not to settle more than 1 inch, what is the maximum load it can carry? The N-values have been corrected for over burden pressure. What would be the maximum load this footing can carry if the allowable settlement is 2 inches? **(10)**

   (d) What is the purpose of conducting load test for pilling works? **(5)**

8. Using design charts, determine - **(35)**

   (i) Allowable load on a wall footing 2 ft wide resting at 5 ft width.

   (ii) Allowable load on a 10 ft by 10 ft square footing resting at 7.5 ft depth. Calculate factor of safety against bearing capacity failure.

   Given:

   Corrected SPT values for the given site,

Depth	2.5′	5.0′	7.5′	10.0′	12.5′	15.0′	20.0′	25.0′
N_{corr}	20	22	21	22	23	25	25	27

   Unit weight of soil is 120 pcf. Ground water table is at 10 ft below ground level

   Thickness of 2 ft wide footing = 12″

   Thickness of square footing = 30″

Table 1

Stress influence values I_σ [illegible] to compute stresses at depth ratios $M = B/z$; $N = L/z$ beneath the *corner* of a base $B \times L$.

M and *N* are interchangeable.

N \ M	.100	.200	.300	.400	.500	.600	.700	.800	.900	1.000
.1	.005	.009	.013	.017	.020	.022	.024	.026	.027	.028
.2	.009	.018	.026	.033	.039	.043	.047	.050	.053	.055
.3	.013	.026	.037	.047	.056	.063	.069	.073	.077	.079
.4	.017	.033	.047	.060	.071	.080	.087	.093	.098	.101
.5	.020	.039	.056	.071	.084	.095	.103	.110	.116	.120
.6	.022	.043	.063	.080	.095	.107	.117	.125	.131	.136
.7	.024	.047	.069	.087	.103	.117	.128	.137	.144	.149
.8	.026	.050	.073	.093	.110	.125	.137	.146	.154	.160
.9	.027	.053	.077	.098	.116	.131	.144	.154	.162	.168
1.0	.028	.055	.079	.101	.120	.136	.149	.160	.168	.175
1.1	.029	.056	.082	.104	.124	.140	.154	.165	.174	.181
1.2	.029	.057	.083	.106	.126	.143	.157	.168	.178	.185
1.3	.030	.058	.085	.108	.128	.146	.160	.171	.181	.189
1.4	.030	.059	.086	.109	.130	.147	.162	.174	.184	.191
1.5	.030	.059	.086	.110	.131	.149	.164	.176	.186	.194
2.0	.031	.061	.089	.113	.135	.153	.169	.181	.192	.200
2.5	.031	.062	.089	.114	.136	.155	.170	.183	.194	.202
3.0	.031	.062	.090	.115	.137	.155	.171	.184	.195	.203
5.0	.032	.062	.090	.115	.137	.156	.172	.185	.196	.204
10.0	.032	.062	.090	.115	.137	.156	.172	.185	.196	.205

N \ M	1.100	1.200	1.300	1.400	1.500	2.000	2.500	3.000	5.000	10.000
.1	.029	.029	.030	.030	.030	.031	.031	.031	.032	.032
.2	.056	.057	.058	.059	.059	.061	.062	.062	.062	.062
.3	.082	.083	.085	.086	.086	.089	.089	.090	.090	.090
.4	.104	.106	.108	.109	.110	.113	.114	.115	.115	.115
.5	.124	.126	.128	.130	.131	.135	.136	.137	.137	.137
.6	.140	.143	.146	.147	.149	.153	.155	.155	.156	.156
.7	.154	.157	.160	.162	.164	.169	.170	.171	.172	.172
.8	.165	.168	.171	.174	.176	.181	.183	.184	.185	.185
.9	.174	.178	.181	.184	.186	.192	.194	.195	.196	.196
1.0	.181	.185	.189	.191	.194	.200	.202	.203	.204	.205
1.1	.186	.191	.195	.198	.200	.207	.209	.211	.212	.212
1.2	.191	.196	.200	.203	.205	.212	.215	.216	.217	.218
1.3	.195	.200	.204	.207	.209	.217	.220	.221	.222	.223
1.4	.198	.203	.207	.210	.213	.221	.224	.225	.226	.227
1.5	.200	.205	.209	.213	.216	.224	.227	.228	.230	.230
2.0	.207	.212	.217	.221	.224	.232	.236	.238	.240	.240
2.5	.209	.215	.220	.224	.227	.236	.240	.242	.244	.244
3.0	.211	.216	.221	.225	.228	.238	.242	.244	.246	.247
5.0	.212	.217	.222	.226	.230	.240	.244	.246	.249	.249
10.0	.212	.218	.223	.227	.230	.240	.244	.247	.249	.250

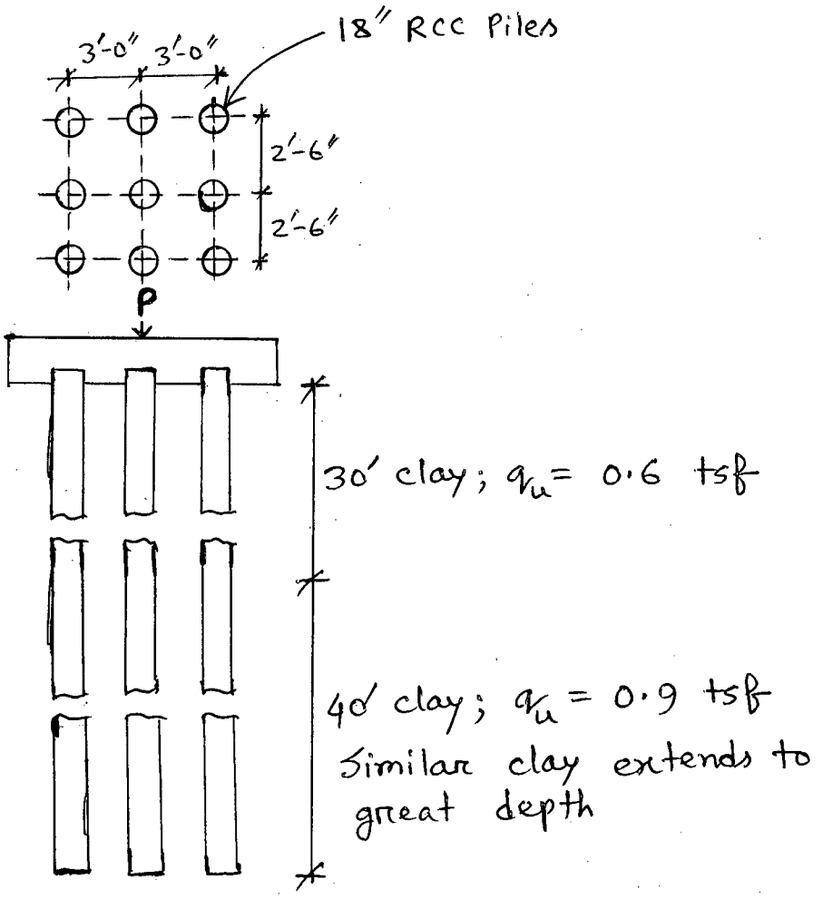


Figure - 1

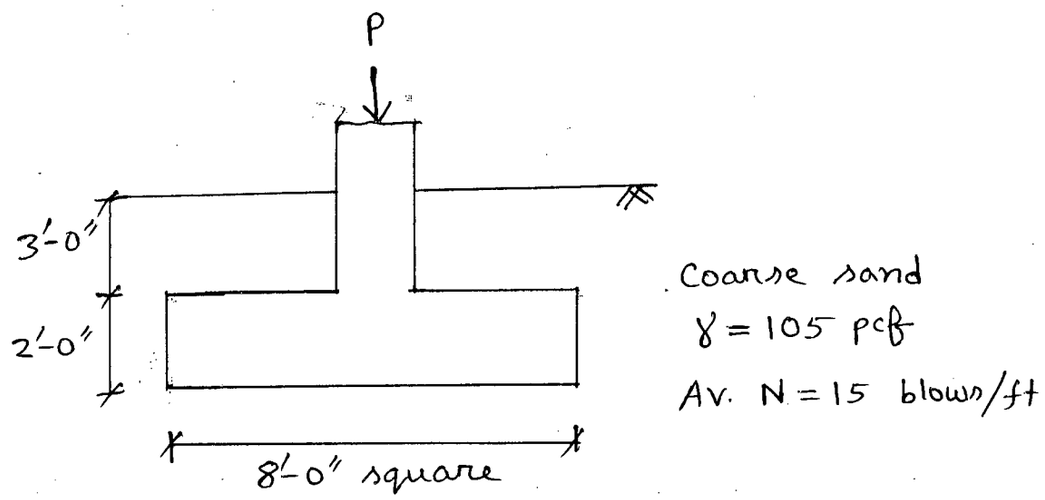


Figure - 2

19/12/15

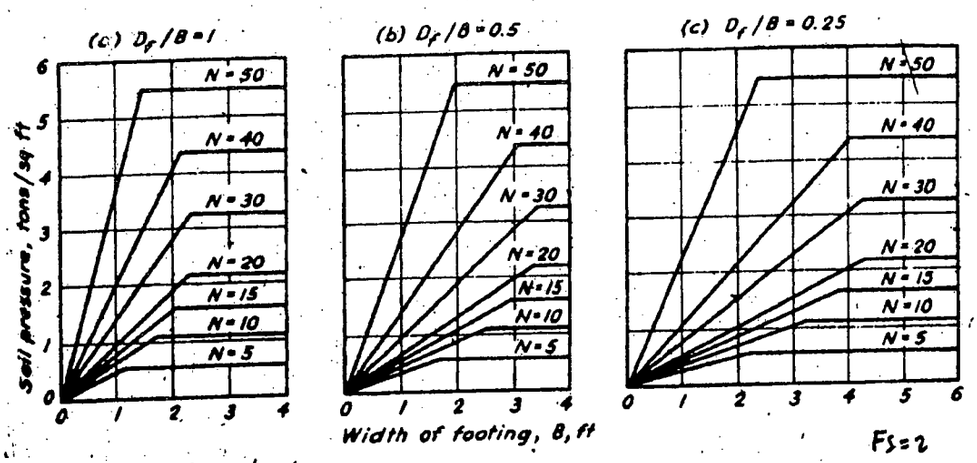


Chart 1

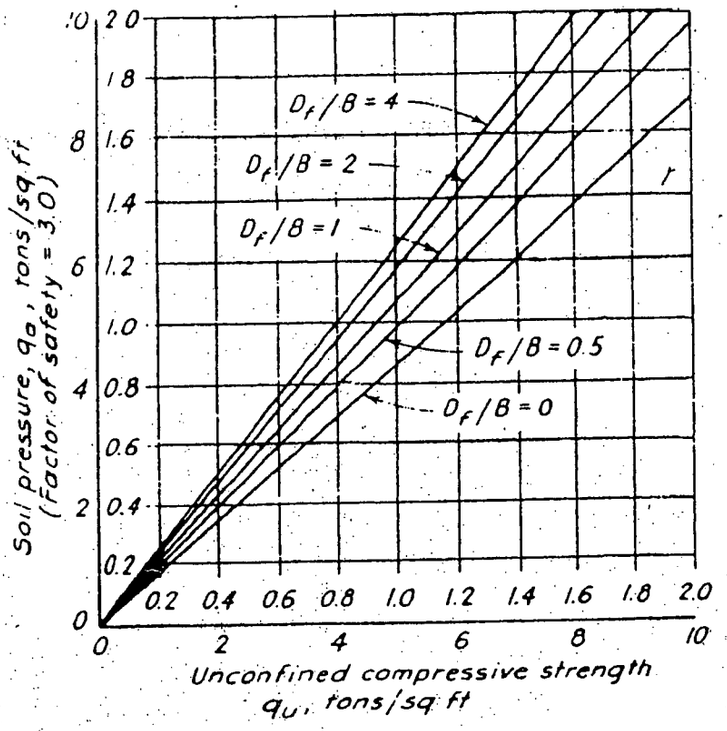


Chart-2 Net allowable soil pressure for footings on clay and plastic silt, determined for a factor of safety of 3 against bearing capacity failure ($\phi = 0$ conditions). Chart values are for continuous footings ($B/L = 0$); for rectangular footings, multiply values by $1 + 0.2\ B/L$; for square and circular footings, multiply values by 1.2.

19/12/15

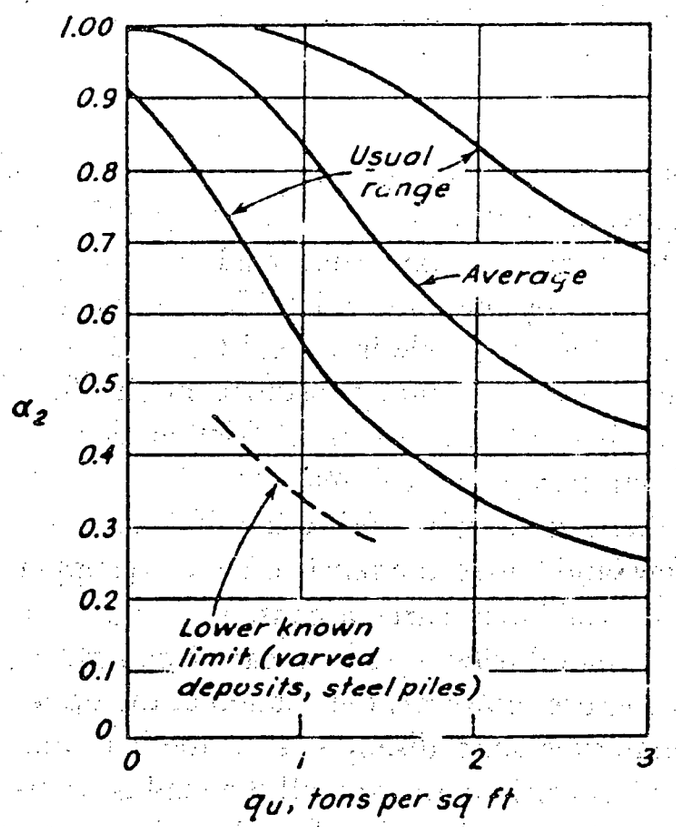


Chart 3 Values of reduction factor α_2 for calculation of static capacity of friction piles in clays of different unconfined compressive strengths q_u.

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