L-4/T-1/CE **Date : 03/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

Sub : **CE 411** (Structural Analysis and Design II)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols and Notations have their usual meanings.

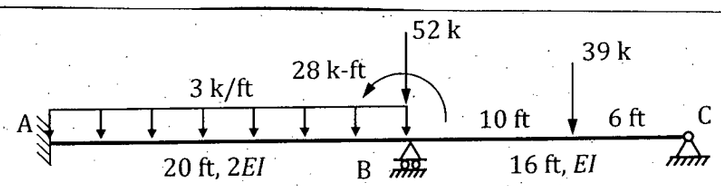
USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

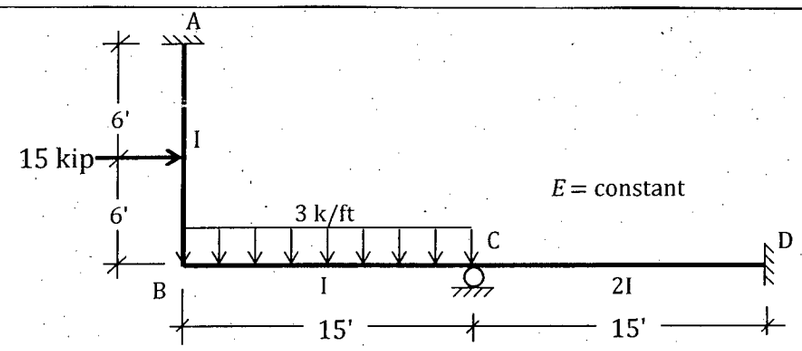
1. (a) Analyze the beam of Fig. 1 using stiffness method and draw shear force and bending moment diagrams. **(18)**

Fig.1



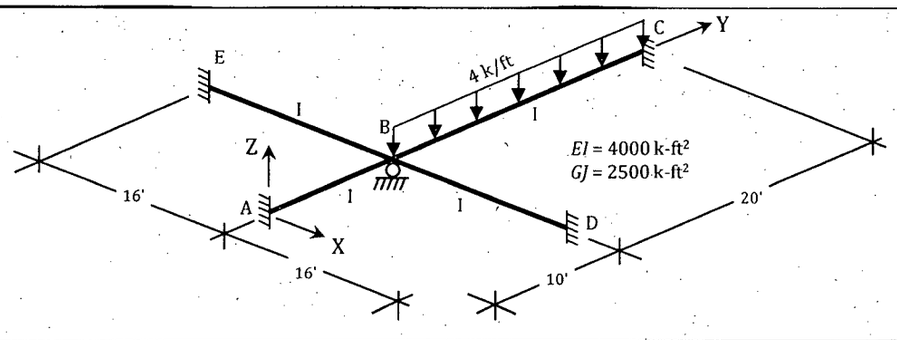
(b) Analyze the frame shown in Fig. 2 using stiffness method and determine the forces and moments developed at support A. **(17)**

Fig.2



2. (a) Analyze the plane grid of Fig. 3 following stiffness method and determine the vertical reaction and bending moment at support C. The frame lies in horizontal X-Y plane while the *udl* on beam acts vertically downward (in –ve Z direction). **(18)**

Fig.3



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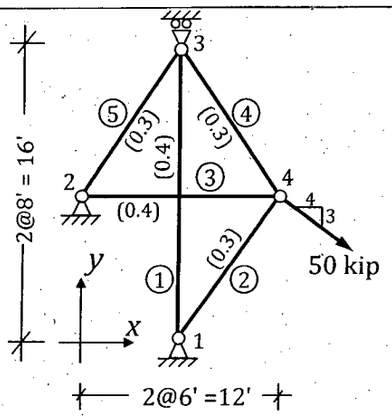
Contd ... Q. No. 2

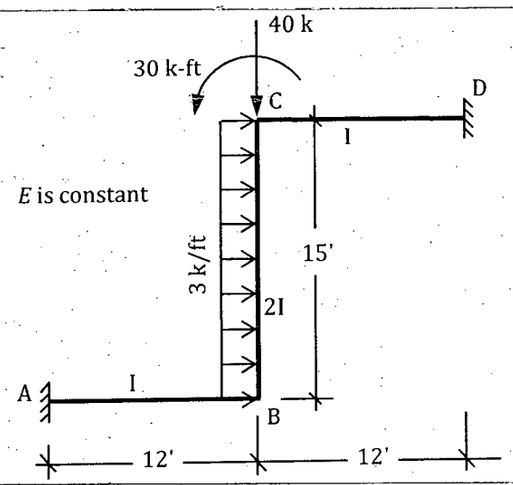
(b) For the pin connected plane truss shown in Fig. 4, (i) write down the joint coordinate matrix, member connectivity matrix, member destination vectors, global nodal load vector and global displacement vector, (ii) write down the stiffness matrices for members 1 and 2 considering them as pin-connected truss element and (iii) assemble the elements of stiffness matrices of the same members in the global stiffness matrix. Figures in bracket indicate member cross-sectional areas. Assume E=5000 k/ft^2. **(17)**

Fig.4



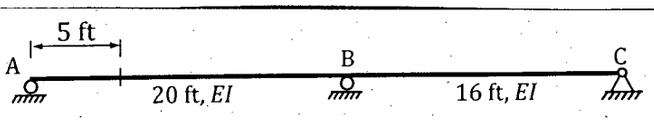
3. (a) Analyze the plane frame of Fig. 5 using stiffness method and determine vertical displacement at joint B. **(18)**

Fig.5



(b) For the continuous beam of Fig. 6, determine the ordinate of influence line for support reaction R_B at a location 5-ft to the right of support A. **(17)**

Fig.6



4. (a) For the continuous beam shown in Fig. 7(a) the deflected shape is given in Fig. 7(b). Element stiffness matrices are also given below. Based on stiffness method, determine moment and shear at the ends of each member and draw the shear force and bending moment diagrams of the beam. **(18)**

Contd P/3

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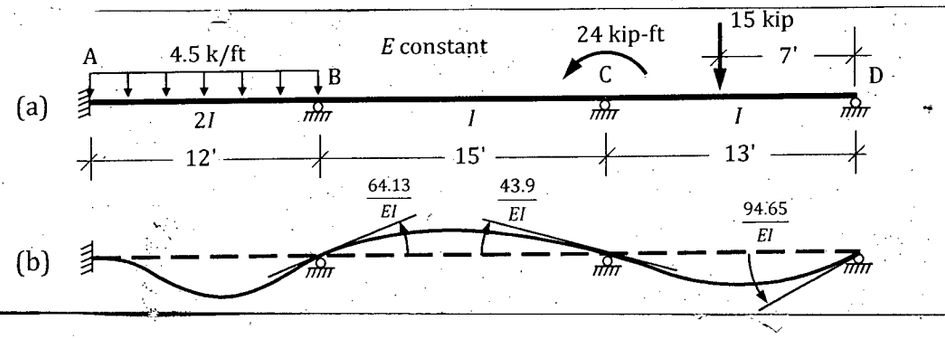
Contd ... Q. No. 4(a)

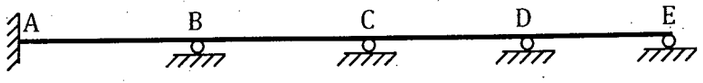
$$K_{AB} = \begin{bmatrix} \frac{24EI}{12^3} & \frac{12EI}{12^2} & -\frac{24EI}{12^3} & \frac{12EI}{12^2} \\ \frac{12EI}{12^2} & \frac{8EI}{12} & -\frac{12EI}{12^2} & \frac{4EI}{12} \\ -\frac{24EI}{12^3} & -\frac{12EI}{12^2} & \frac{24EI}{12^3} & -\frac{12EI}{12^2} \\ \frac{12EI}{12^2} & \frac{4EI}{12} & -\frac{12EI}{12^2} & \frac{8EI}{12} \end{bmatrix} \quad K_{BC} = \begin{bmatrix} \frac{12EI}{15^3} & \frac{6EI}{15^2} & -\frac{12EI}{15^3} & \frac{6EI}{15^2} \\ \frac{6EI}{15^2} & \frac{4EI}{15} & -\frac{6EI}{15^2} & \frac{2EI}{15} \\ -\frac{12EI}{15^3} & -\frac{6EI}{15^2} & \frac{12EI}{15^3} & -\frac{6EI}{15^2} \\ \frac{6EI}{15^2} & \frac{2EI}{15} & -\frac{6EI}{15^2} & \frac{4EI}{15} \end{bmatrix} \quad K_{CD} = \begin{bmatrix} \frac{12EI}{13^3} & \frac{6EI}{13^2} & -\frac{12EI}{13^3} & \frac{6EI}{13^2} \\ \frac{6EI}{13^2} & \frac{4EI}{13} & -\frac{6EI}{13^2} & \frac{2EI}{13} \\ -\frac{12EI}{13^3} & -\frac{6EI}{13^2} & \frac{12EI}{13^3} & -\frac{6EI}{13^2} \\ \frac{6EI}{13^2} & \frac{2EI}{13} & -\frac{6EI}{13^2} & \frac{4EI}{13} \end{bmatrix}$$

Fig.7



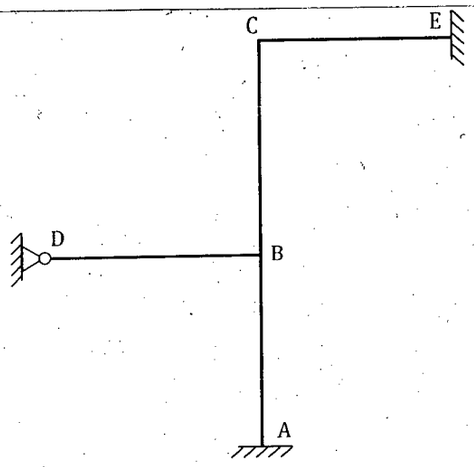
(b) (i) For the continuous beam of Fig. 8, draw qualitative shape of influence lines for M_A, R_A R_C, M_B, V_{CL} and V_{CR}. **(12)**

Fig.8



(ii) For the plane frame of Fig. 9, draw qualitative shape of influence lines for beam end moment M_{BA} and support horizontal reaction C_x. **(5)**

Fig.9



SECTION – B

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

5. Determine the reactions and draw the shear force and bending moment diagrams for the beam shown in Figure 10 due to the applied loads and due to the support settlements of 5/8 inch at B. Consider EI = 3000 k-ft^2 for the beam and use the moment-distribution method. **(35)**

Contd P/4

CE 411

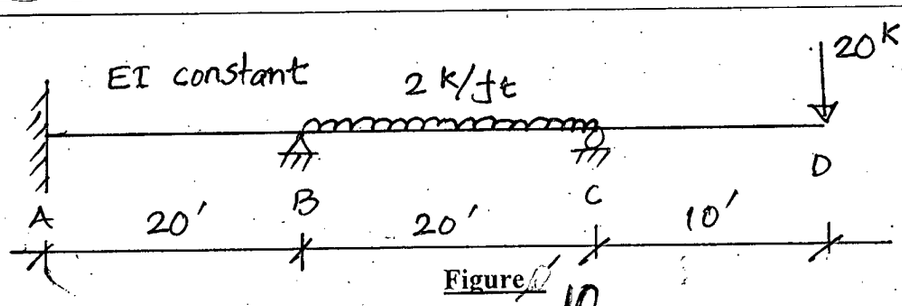


Figure 10

6. (a) Determine the reaction and moment at A of the fixed support for the nonprismatic beam shown in Figure 11(a) by using the moment-distribution method. Portion AB has inertia 2I and portion BD has inertia I. Given EI = 3000 k-ft^2. **(12)**

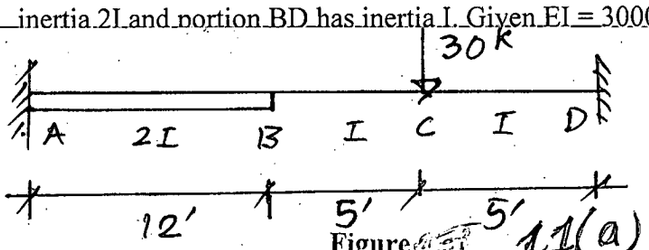


Figure 11(a)

(b) Draw the shear force and bending moment diagrams for the beam AB of the frame shown in Figure 11(b) due to applied loads. Consider EI is constant and use the moment distribution method. **(23)**

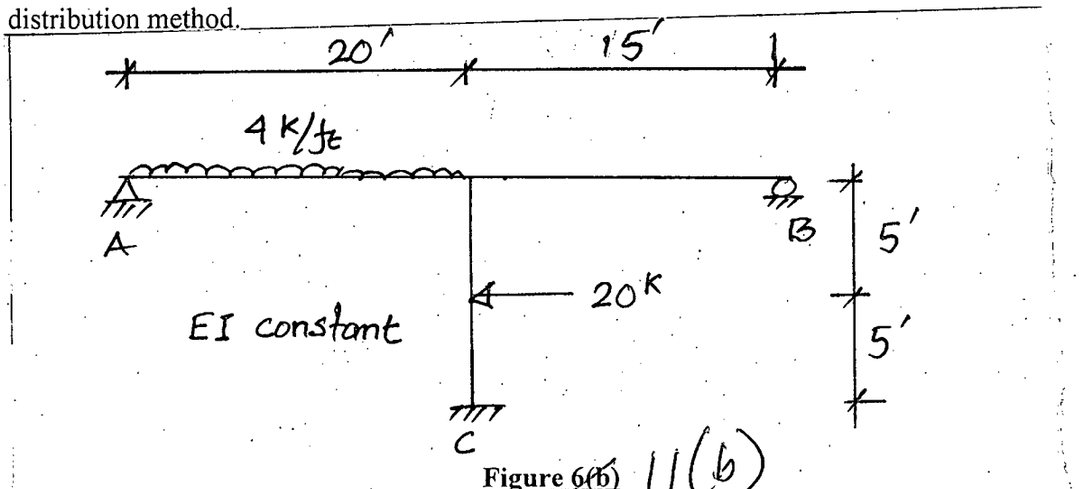


Figure 6(b) 11(b)

7. (a) Determine the support reactions at B for the frame shown in Figure 12(a) using the moment-distribution method. EI is constant. **(25)**

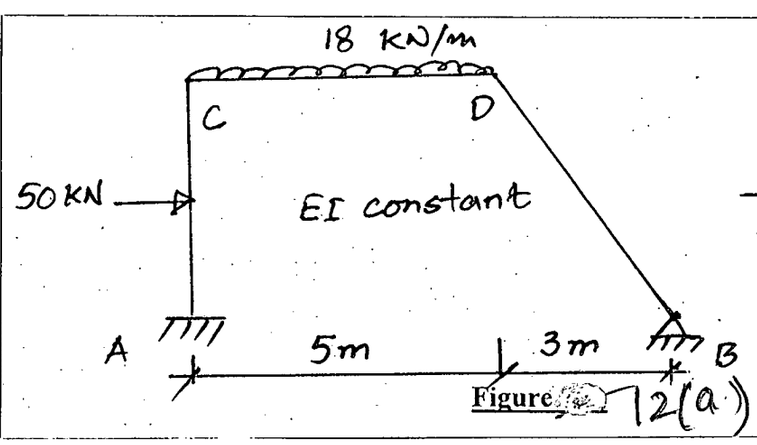


Figure 12(a)

L-4/T-1/CE **Date : 12/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

Sub : **CE 401** (Project Planning and Construction Management)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

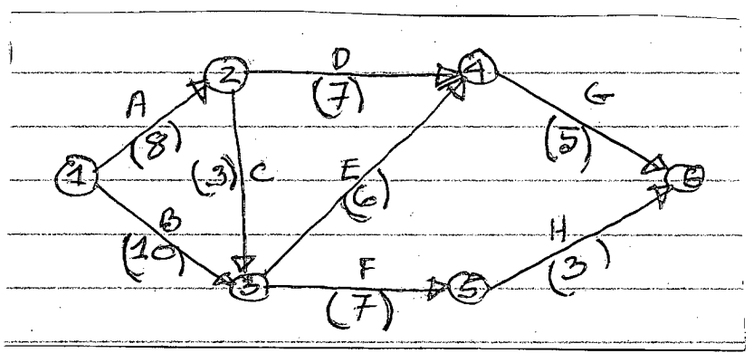
There are **FOUR** questions in this Section. Answer any **THREE**.

Normal Graph paper required for Solving Question 2. (a).

1. (a) Draw a CPM network diagram for the following activities. **(23⅔)**

Activity	Immediate Predecessor
A	-
B	-
C	A
D	A, B
E	A, B
F	C
G	D, F
H	E, G

(b)



The above diagrams represents the CPM network activity diagram for a project. Make a table with columns showing each activity name, activity duration (days), EST, LST, EFT, LFT and slack time. Using the table identify the current critical activities and critical path for the project. How many days can activity B be delayed without delaying the project? **(23)**

2. (a) Solve the following linear programming problem graphically and find the values of x_1 and x_2 for maximum z and the corresponding maximum value of z. **(23⅔)**

Maximize $z(x_1, x_2) = 7x_1 + 6x_2$

Subject to: $3x_1 + x_2 \leq 120$

$x_1 + 2x_2 \leq 160$

$x_1 \leq 35$

$x_1 \geq 0$

$x_2 \geq 0$

Contd P/2

CE 401

Contd ... Q. No. 2

(b) A chemical manufacturer produces three chemicals: A, B and C using two different processes: 1 and 2. Process 1 produces 3 units of A, 1 unit of B and 1 unit of C in 1 hour and costs $ 4 per hour to run. Process 2 produces 1 unit of A, 1 unit of B and none of C and costs $1 per hour to run. To meet customer demand, at least 10 units of A, 5 units of B and 3 units of C must be produced daily. The chemical manufacturer wants to run process 1, say for x_1 hours per day and process 2, say for x_2 hours per day such that cost of production is minimized. Formulate (NOT solve) the objective function and constraint equations for the chemical manufacturer as a linear programming problem. **(23)**

3. (a) Draw a typical construction project life cycle. Compare the various stages of construction project life cycle. **(15)**

   (b) Construction industry often encounters various problems. What are the factors affecting (i) cost overruns and (ii) lack of harmony (mention at least five factors for each) **(15)**

   (c) Being a project manager of a bridge construction company which three factors will you consider before procurement of equipments? Compare and contrast use of excavator and crane. **(4+12⅔)**

4. (a) Describe reasons for delays in construction with respect to (i) lack of commitment (ii) inefficient site management and (iii) lack of clarify in project scope. **(15)**

   (b) As a project manager, which project cost management process will you apply in order to have revised cost estimate? Describe inputs and outputs of that process. **(16⅔)**

   (c) What are the work breakdown structures for major components of a lake development project in Dhaka city? (Mention work breakdown structure for at least 3 components) **(15)**

SECTION – B

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

5. (a) What steps you should take in your construction firm for effectively manage your human resources? List any 8 steps. **(15⅓)**

   (b) What are five dysfunctions of a team? Explain. **(15⅓)**

   (c) Define five components of emotional intelligence. What are the hallmarks of these components? **(16)**

6. (a) What are the disadvantages of low inventory turns? Derive the economic order quantity (EOQ) equation. **(15⅓)**

CE 401

Contd ... Q. No. 6

(b) As a project manager, you store cement bags for a number of construction sites. You found that the overage cost (due to quality deterioration) and underage cost (due to over pricing) are equal. The expected actual demand for next quarter is 10,000 cement bags with standard deviation of actual demand of 100 cement bags. How many cement bags will you order? Use news vendor model and assume normal probability distribution. **(15⅓)**

(c) What is PPP procurement? How it differs from EPC procurement? **(16)**

7. (a) To evaluate potential investment projects, what are the three characteristics of project cash flow that should be considered? Define – **(15⅓)**

   (i) NPV (ii) IRR (iii) BCR

   (b) What do you understand by payback period? What are the strengths and weakness of payback period? **(15⅓)**

   (c) Find the BCR for following net cash flow from a project (discount rate 10%) **(16)**

Year	0	1	2	3	4
Net cash flow (USD)	- 200,000	40,000	40,000	40,000	100,000

8. (a) What are the purposes of financial and economic feasibility assessment of a development project. **(15⅓)**

   (b) A toll road project that reduces the travel time and vehicle operating cost has an economic IRR of 20% whereas the financial NPV is negative. One way of making this project financially viable is to provide viability gap funding of 30% of project cost. Should government provide this VGF? Write three reasons supporting your answer. **(15⅓)**

   (c) Assume that your firm with a cost of capital of 10% p.a. must choose between two mutually exclusive projects having net cash flow as shown below: **(16)**

Year	0	1	2	3
Project X	– 10,000	7,000	4,000	2,000
Project Y	– 10,000	2,000	4,000	8,200

   (i) using NPV method, which project is preferred?

   (ii) using IRR method, which project is preferred?

L-4/T-1/CE **Date : 18/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

Sub : **WRE 451** (Hydrology, Irrigation and Flood Management)

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) The ordinate of 4-h unit hydrograph (UH) are given below. Compute the ordinates of a 3-h UH. **(18)**

Time (hr)	0	4	8	12	16	20	24	28	32
Ordinates of 4-h UH (m^3/s)	0	8	21	16	11	7	4	2	0

(b) The amount of perceptible 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. Assume 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. **(12)**

(c) Discuss in brief the logic behind forming polygons in Thiessen Polygon method. **(5)**

2. (a) The time distribution of a storm event is given below:

Time from start (hr)	1	2	3	4	5	6	7	8
Cumulative rainfall (cm)	0.5	1.9	4.9	7.3	9.2	9.9	11.1	12

(i) Draw with free hand the qualitative rainfall hyetograph.

(ii) The φ-index is computed to be 1.3 cm/hr. Find out the volume of direct runoff if the catchment area is 0.9 km^2.

(iii) Compute the total volume of infiltration.

(iv) Find out the runoff coefficient for the catchment. **(18)**

(b) The design precipitation intensity for a storm with a T-year return period is 2.5 in/hr. The slope is 0.007 and the maximum length of travel of water is 1500 m for the catchment. Estimate the design return period (T). In addition, estimate the design precipitation volume (m^3) and design peak discharge (m^3/s) using Rational method for the catchment. The area of the catchment is 3 km^2 and runoff coefficient is 0.7. Use IDF curves (Figure 1) and Kirpich formula for your estimation. **(12)**

(c) Define: (i) Residence time, and (ii) Biological water. **(5)**

3. (a) Following are the ordinates of a storm hydrograph of a river draining a catchment area of 500 km^2 due to 6-h isolated storm. Derive the ordinates of a 6-h unit hydrograph for the catchment.

Time from short of storm (hr)	0	6	12	18	24	30	36	42	48	54	60	66	72
Discharge (m^3/s)	50	150	300	250	200	150	120	100	85	75	65	55	50

Consider, end of direct runoff to be 72 hours from the start of storm event. **(18)**

Contd P/2

WRE 451
Contd ... Q. No. 3

(b) The ordinates of 6-h unit hydrograph (UH) for a catchment is given below: **(12)**

Time from start (hr)	0	6	12	18	24	30	36	42	48	54
UH ordinates (m^3/s)	0	50	125	170	150	100	60	40	15	0

The average storm rainfall values over that catchment in three successive 6-hr intervals are known to be 7.8, 5.3 and 2.8 cm. The φ-index for the catchment is estimated to be 0.3 cm/hr. The base flow is 10 m^3/s at the beginning of storm and increases by 2 m^3/s every 12 hrs. Estimate the resulting flood hydrograph.

(c) Compare the base flow contribution between Intermittent and Ephemeral streams. **(5)**

4. (a) The shape of a drainage basin can be approximated by a polygon whose vertices are located at the following coordinates: (6, 6), (– 6, 6), (– 6, – 6), (0, – 12) and (6, – 6). The rainfall amounts of a storm were recorded by a number of rain gages as follows:

Gage number	Coordinates	Recorded rainfall (mm)
1	(3, 4)	60
2	(– 2, 5)	40
3	(– 3, – 3)	100
4	(2, – 3)	50
5	(7, 0)	90

All the coordinates are expressed in kilometers. Determine the average rainfall on the basis of Thiessen Polygon method. Use plain graph paper. **(18)**

(b) Flood frequency computations for a river by using Gumbel's method yielded the following results: **(12)**

Return period (years)	Peak flow (m^3/s)
50	60,000
100	75,000

`Estimate the flood magnitude for a return period of 500 years.

(c) Discuss infiltration capacity regarding (i) forest soil, and (ii) water with heavy suspended particles. **(5)**

SECTION – B

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

For missing data, assume reasonable value.

5. (a) Explain how irrigation works as an engineering component in a multipurpose project. Use example from any successful irrigation project in Bangladesh. **(12)**

(b) Briefly discuss how irrigation can contribute in a hydrologic cycle. **(8)**

(c) 800 m^3 of water is applied to a farmer's rice field of 0.6 hectors. When the moisture content in the soil falls to 40% of the available water between the field capacity (36%) of soil and permanent wilting point (15%) of the soil crop combination, determine the field application efficiency. The root zone depth of rice is 60 cm. Assume porosity = 0.4. **(10)**

Contd P/3

WRE 451
Contd ... Q. No. 5

(d) Estimate the water requirement of a wheat crop of 130 days duration when the duty of water for the crop is 2496 ha per cumec. **(5)**

6. (a) Derive the expression for the depth of soil water storage in a plant's root zone. From that, explain, how frequency of irrigation is calculated. **(13)**

(b) A stream of 125 lit/sec was diverted from a canal and 100 lit/sec were delivered to the field. An area of 1.6 hectors was irrigated in 8 hours. Effective depth of root zone was 1.7 m. The runoff loss in the field was 420 cum. The depth of water penetration varied linearly from 1.7 m at the head end of the field to 1.3 m at the tail end. Available moisture holding capacity of the soil is 20 cm per meter depth of soil. Determine water conveyance, water application, water storage and water distribution efficiencies. The irrigation was started at a moisture extraction level of 50% of available moisture. **(11)**

(c) The gross area of an irrigation project is 50000 ha. Out of this, about 5000 ha have been utilized for construction of dwellings, roads, etc. The area to be cultivated during rabi is 25000 ha and during kharif is 24,000 ha. The duty of canal water for rabi crops is 5000 ha per cumec and for kharif crops is 3000 ha per cumec. Find the design discharge for the canal after giving 10% allowance for peak discharge and loss of water in transit. What would be the annual intensity of irrigation? **(11)**

7. (a) What is 'border flooding' method of irrigation? Discuss the advantages and disadvantages of this method. **(10)**

(b) For border flooding derive: $t = 2.3\frac{y}{f}log\left(\frac{Q}{Q - fA}\right)$

where,

Q = discharge through the supply ditch,
y = depth of flow over the border soil,
f = rate of infiltration of soil,
A = area of land strip to be irrigated,
t = time required to cover the given area,

Also, show that for border flooding, $A_{max} = \frac{Q}{f}$ **(10)**

(c) An area of 25 ha of crops will be irrigated by a pump working 10 hours a day. Irrigation is desired at 50% soil water depletion. The available water holding capacity of soil is 20 cm per meter depth of soil. Root zone depth is 75 m. The conveyance and water application efficiencies are 75% and 80% respectively. The daily consumptive use rate of crops is 5 mm per day. Work out (i) Net irrigation requirement (ii) gross irrigation requirement (iii) Irrigation period (iv) required capacity of irrigation system. **(9)**

Contd P/4

WRE 451
Contd ... Q. No. 7

(d) Estimate the leaching requirement when electrical conductivity (EC) value of a saturated extract of a soil is 10 mmhos/cm at 25% reduction in the yield of a crop. The EC of irrigation water is 1.2 mmhos/cm. What will be the required depth of water to be applied to the field if the consumptive use requirement of the crop is 80 mm. **(6)**

8. (a) Discuss how salinity can be introduced by water-logging in an irrigation land. **(5)**

(b) Explain leaching as a land reclamation process. **(5)**

(c) Describe different floods based on their sources, duration and extents of flooding. **(10)**

(d) Briefly discuss flood forecasting and floodplain zoning. **(10)**

(e) 'Sometimes flood is beneficial for Bangladesh'. – Explain. **(5)**

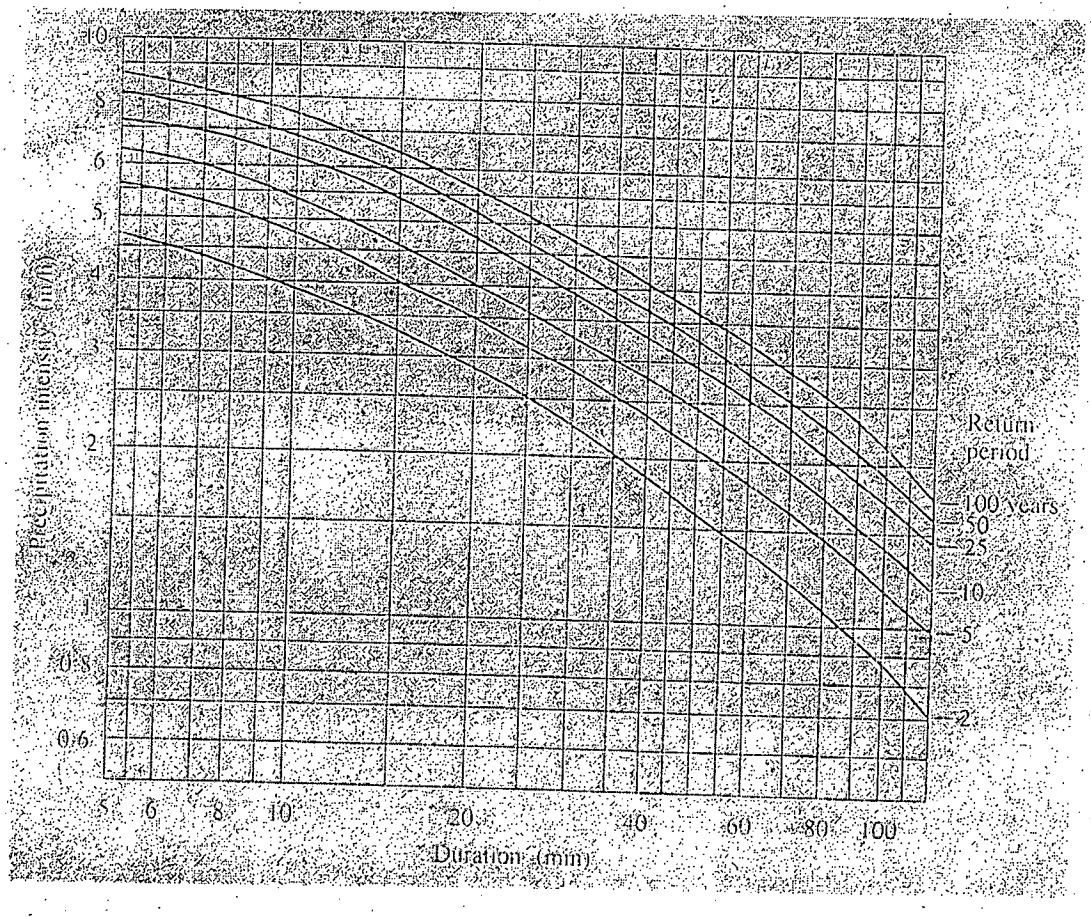


Figure 1: Intensity - Duration - frequency (IDF) curves for Q. No. 2(b)

L-4/T-1/CE **Date : 24/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

Sub : **CE 441** (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**.

Use enclosed tables and charts as and when necessary

Assume any reasonable value of missing data, if any

1. (a) Calculate the capacity of the driven pile in sand and draw necessary sketches. Soil condition and pile details are given below: **(15)**

15 inch × 15 inch pile, Length of the pile = 50 ft.

Top of the pile = 5 ft. below ground level, Water Table: 10 ft. below EGL, Unit wt. of soil: 120 pcf, SPT Values, ϕ of the soil, δ are given below:

Depth	5 ft.	10 ft.	15 ft.	20 ft.	25 ft.	30 ft.	40 ft.	50 ft.	60 ft.	65 ft.	70 ft.
N	20	20	20	20	20	20	30	30	30	30	30
ϕ	35°	35°	35°	35°	35°	35°	35°	40°	40°	40°	40°
δ	25°	25°	25°	25°	25°	25°	25°	28°	28°	28°	28°

Assume $N_q = 70$ for $\phi = 35°$, $N_q = 90$ for $\phi = 40°$, critical depth = 20 ft

(b) Calculate the maximum and minimum gross pressure on an eccentrically loaded footing. Use Conventional Method and Myerhoff's Method

Details of the footing are given below: **(20)**

footing size 18ft by 24 ft

Footing depth = 5 ft. below ground level

Thickness of the footing = 3 ft.

Density of soil = 120 pef

Total load on the footing = 200 kip

Eccentricity in long directions = 2ft

Eccentricity in short directional = 1 ft

Draw neat sketches showing the stated conditions.

2. Calculate the factor of safety against bearing capacity and settlement of the footing. Soil condition and footing details are given below: **(35)**

Soil Condition:

0 - 40 ft overconsolidated clay, density = 125 pcf, $C_r = 0.03$, $C_c = 0.16$, $e_0 = 0.9$,

Past maximum overburden pressure = 7500 psf., unconfined, compressive strength = 3.5 ksf

Contd P/2

CE 441

Contd ... Q. No. 2

Below 40 ft., thick deposit of dense sand

Water table at 25 ft below ground level

Footing details:

Footing size for the column = 12 ft × 15 ft.

Thickness of the footing = 30 inch

Depth of the footing = 10 ft, below surrounding ground level

Dead load on column = 250 kip

Live load on column = 120 kip

Divide the thick clay layer into two layers (15 ft each) for settlement calculation Draw neat sketches showing the stated conditions.

3. (a) Calculate the factor of safety and settlement (at center and at corner) of the raft foundation. Details are given below: **(35)**

Soil Condition:

0 - 20 ft, overconsolidated clay, density = 125 pcf, $C_r = 0.03$, $C_c = 0.18$, $e_0 = 1.0$,

Past maximum overburden pressure = 6000 psf., unconfined, compressive strength = 2 ksf

Below 30 ft., thick deposit of dense sand

Water table at 20 ft. below ground level

Raft Foundation:

Raft foundation = 60 ft. × 100 ft.

Depth of the raft foundation = 16 ft. below ground level

Gross contact pressure under the raft = 3.5 ksf

Draw neat sketches showing the stated conditions.

4. (a) (i) Discuss the methodology for calculating settlement of a pile group embedded in clay.

(ii) Discuss the construction methodology of a drilled pier.

(iii)Discuss the properties of concrete used in drilled pier. **(20)**

(b) Calculate the maximum and minimum load on a pile in an eccentrically loaded pile group foundation. Details of the pile group are given below: **(15)**

Pile foundation, 20 numbers of piles

Size of the pile = 16 inch × 16 inch

Spacing of the pile, c/c = 4 ft.

Top of the pile = 5 ft. below ground level

Thickness of the pile cap = 3 ft

Contd P/3

CE 441

Contd ... Q. No. 2(b)

Pile cap is extended 2 ft from the centre of corner piles

Density of soil = 120 pcf

Total load on pile group from column = 200 kip

eccentricity in long direction = 3 ft

Eccentricity in short direction = 2 ft

Draw neat sketches showing the stated conditions.

SECTION – B

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

5. (a) Discuss the significance of sub-soil exploration for design of Civil engineering structures. **(10)**

(b) Discuss the spacing and layout of borings that may be suggested as guideline for sub-soil investigation of various geotechnical design areas? **(10)**

(c) A footing 10 ft by 14 ft in plan and 2 ft in thickness is placed in a sand layer with an average N value of 30 (corrected for overburden pressure). The base of the footing is 5 ft below the ground surface and water table is at 5 ft below the base. Determine the maximum load that footing can support if the settlement is not to exceed 0.5 inch, (design chart provided). **(15)**

6. (a) Describe the procedure used in 'seismic refraction survey' for determining various sub-soil layers. Also discuss its limitations. **(12)**

(b) State the use of different types of auger with areas of their application and advantages for making boreholes. **(11)**

(c) A 20 m high embankment is to be made. The shear strength parameters of the embankment soil is c = 36 kPa and ϕ = 20°. Determine, using Bishop and Morgenstern's solution with seepage, the factor of safety if the embankment is made with a slope of 2 (horizontal): 1 (vertical) and comment on the type of the critical circle. Assume that average value of non-dimensional pore pressure quantity is 0.5. Unit weight of soil is 18 kN/m^3. Relevant stability coefficients for $\frac{c}{\gamma H} = 0.1$ are given below. **(12)**

	m′	n′		m′	n′
Toe circle	1.804	2.101	D = 1.25	1.874	1.301
D = 1.00	1.841	1.143	D = 1.50	2.079	1.528

Contd P/4

CE 441

7. (a) Discuss the contents of a good sub-soil investigation report? **(12)**

(b) What is the difference between Spencer's solution for the stability of simple slopes over Bishop's method of slices. **(4)**

(c) A reinforce concrete pile 15 m long and 450 mm is diameter is driven to medium dense sand; $\phi = 36°$, $\gamma = 17.5$ kN/m^3. Calculate the ultimate capacity of the pile in compression. Also determine the allowable pullout load with $F_s = 3.0$. Use $\delta = \frac{3}{4}\phi$ and $K_s = 1.5$. Consider that water table is at the ground surface. **(12)**

(d) Explain the basic principle of determining the factor of safety of a slope in homogeneous clay under undrained condition using mass procedure. **(7)**

8. (a) For a river bank soil saturated unit weight is 18 kN/m^3, cohesion is 20 kPa and angle of internal friction is 40 degree. The height of the slope is 22 m and draw down is 5 m. What bank slope may be provided to have a factor of safety of 2.5? Determine using Morgenstern's method of slices for rapid drawdown condition. (Morgenstern's stability chart is provided) **(10)**

(b) Show that an infinite slope of dry sand is stable as long as the slope angle does not exceed the angle of internal friction of the sand. Also discuss, after deducing a theoretical expression, the changes in factor of safety if there is steady state seepage parallel to the slope. **(12)**

(c) A footing 3.5 m square, is placed at a depth of 1.5 m below the ground surface. The soil, up to a depth of 20 m, is silty sand of density 17.5 kN/m^3. The average N-value after correction of overburden pressure is 35 from which the angle of internal friction of the sand has been estimated as 38 degree. Determine the net ultimate bearing capacity and the column load that can be supported by the footing with an FS = 2.5 against bearing capacity failure. Water level is at the base of the footing. Given, $N_q = 48$ and $N_\gamma = 66$. **(13)**

Stress influence values I_σ 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

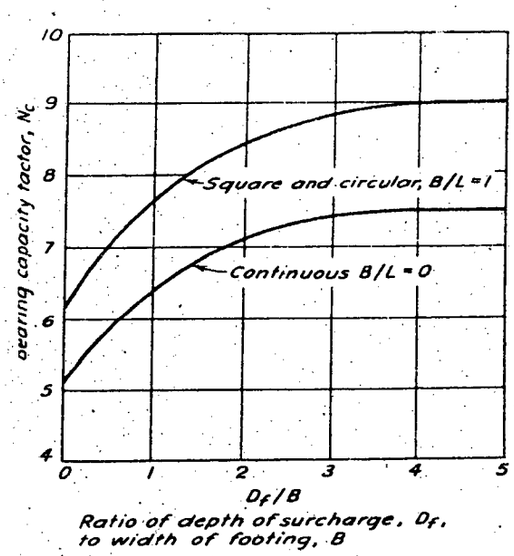


FIGURE . . Bearing capacity factors for foundations on clay under $\phi = 0$ conditions (after Skempton, 1951).

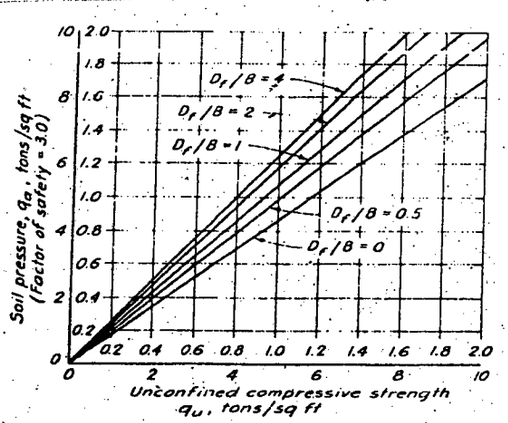


FIGURE Net allowable soil pressure for footings on clay and plastic silt, determined for a factor of safety of 3 against bearing capacity failure ($\phi = 0$ conditions). Chart values are for continuous footings ($B/L = 0$); for rectangular footings, multiply values by $1 + 0.2\ B/L$; for square and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

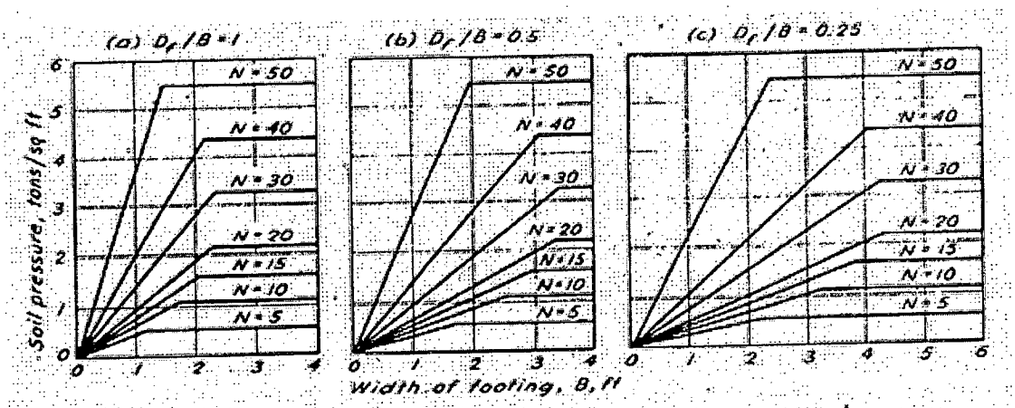


FIGURE Design chart for proportioning shallow footings on sand.

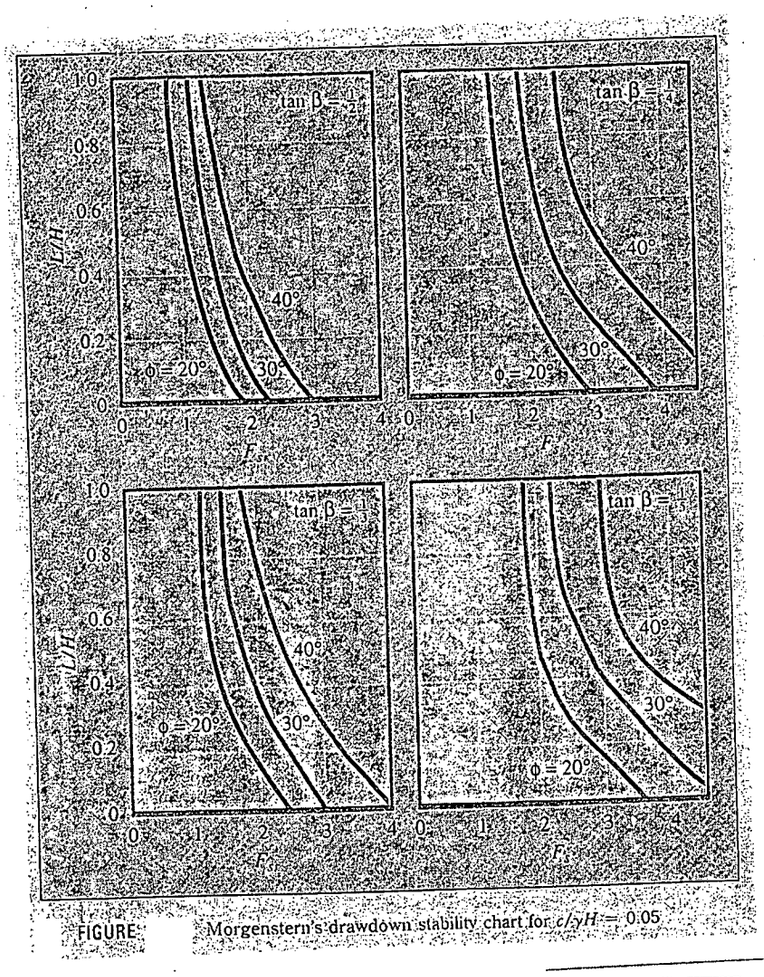


FIGURE Morgenstern's drawdown stability chart for $c/\gamma H = 0.05$.

L-4/T-1/CE **Date : 30/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

Sub : **CE 451** (Transportation Engineering II: Pavement Design and Railway 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) Explain nature and values of various train resistance for a moving locomotive. **(10⅔)**

   (b) Explain factors affecting the choice of a railway gauge and mention examples of countries for different gauges. **(12+4=16)**

   (c) Write short notes on the following: **(20)**

   (i) Deficiency in super-elevation
   (ii) Working principles of compressed air and vacuum brakes
   (iii) Types of wear on rails
   (iv) Coning of wheels
   (v) Minimum depth of ballast cushion

2. (a) Explain with neat sketches the construction and function of a semaphore signal. **(6⅔)**

   (b) Explain with neat sketches the classification of railway signals according to location. **(20)**

   (c) What is a "turnout"? Draw a complete labelled diagram for a left hand turnout. **(20)**

3. (a) Explain the following construction field measures with particular reference to highway and bridge construction on existing operating road: **(4×6=24)**

   (i) Mobilization process
   (ii) Alternative traffic control plan and traffic control tools and devices
   (iii) Prevention, control and abatement of erosion and water pollution
   (iv) Clearing and grubbing process

   (b) Describe detailed features of Portland cement stabilized road, Dense bituminous carpet road and Wheel Track Paving Strip Roads construction including materials detail. **(22⅔)**

4. (a) Explain asphalt pavement lifecycle diagram showing role of effective maintenance practice. Also, using a flowchart explain highway network maintenance management system. **(23⅔)**

   (b) Write down possible causes, maintenance/rehabilitation/reconstruction options and construction machinery need for the following defects of asphalt concrete pavement: **(15)**

   (i) Reflection cracks (ii) Depression and upheaval (iii) Potholes

   (c) Explain rigid concrete pavement construction steps with mentioning of relevant equipment. **(8)**

Contd P/2

CE 451

SECTION – B

Assume reasonable values for missing data (if any).

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

5. (a) Define flexible, semi-rigid and rigid pavements and draw typical sections for these. In your opinion which type of pavement would be suitable for Bangladesh and why, give TWO important reasons. Write down TWO major functions and TWO major desirable characteristics of flexible pavement. Draw stress distribution patterns over time for flexible pavement. **(10+3+2+4=19)**

(b) Write down the sequences of pavement failure under submerged condition in Bangladesh. What are the technological advancements that made perpetual pavement possible? List FOUR important common modes of distresses for flexible and rigid pavements. Draw typical sections of Contraction and Construction Joints. Write down two important benefits of continuously reinforced rigid pavement (CRCP). **(4+4+4+2+2=16)**

(c) An existing 4-lane regional highway constructed on embankment requires full reconstruction. A number of trial pits were undertaken and the CBR of the sub-grade beneath the existing road was found to be 3%. A 24 hour classified traffic count was carried out on a typical weekday and shown only heavy vehicles as follows. Determine the pavement layer thicknesses by using RHD flexible pavement design guide method. Consider annual traffic growth rate 10% and design period 20 years. Use Base type-1. Necessary Tables are given at the end of the question paper (Table 1 and Table 2). **(11⅔)**

Vehicle Categories	Base Year Two-way Flow/day
Heavy truck	80
Medium truck	450
Light truck	300
Large bus	400

6. (a) Write short notes on 'Fog Seal' and 'Micro Seal'. Mention TWO major purposes and TWO major outcomes of AASHO road test? Why Joints are used in rigid Pavement? Schematically show the layout arrangement of different type of reinforcements that are used in the concrete pavement. **(4+2+4+6=16)**

(b) Why structural design of pavement is a complex one? List different methods of pavement design. Why ditto copy of AASHTO is not appropriate for roadway design of Bangladesh, give THREE important reasons? Draw a typical concrete pavement joint detail showing sealant reservoir and backer rod. **(4+4+3+2=13)**

(c) Design a concrete pavement by using PCA method for the conditions given below. Give one trial and put your comments on the trial thickness. Solution should be given in the worksheet provided at the end of question paper. **(17⅔)**

Contd P/3

CE 451

Contd ... Q. No. 6(c)

Truck Axle Load Distributions

Axle Load Groups (kip)	Number of Axles, N	Axle Load Groups (kip)	Number of Axles, N
Single Axles		**Tandem Axle**	
20	18,500	34	35,000
22	14,000	36	10,000

Modulus of Subgrade Reaction, k:		110	pci
Modulus of Rupture, MR	:	650	psi
Load Safety Factor	:	1.2	
Doweled joints	:	Yes	
Concrete Shoulder	:	No	
Untreated Subbase	:	6 in	

Effect of Untreated Subbase on k Values

Subgrade value, pci	Subbase k value, pci			
	4 in.	6 in.	9 in.	12in.
50	65	75	85	110
100	130	140	160	190
200	220	230	270	320
300	320	330	370	430

7. (a) Describe the functions of various materials in highway pavement construction. Explain the properties and uses of following stone aggregates: Limestones, Sandstones, Granite and Quartzite. **(16⅔)**

(b) Explain the importance of particle shape and surface texture of coarse aggregates used in flexible and rigid pavement constructions. What is the importance of aggregate blending process? Combine the following aggregate samples to meet the specification. **(20)**

Passing Sieve	Retained Sieve	% by Weight			Specific Limit
3/4"	½"	5	--	--	0-5
½"	3/8"	35	--	--	8-40
3/8"	# 4	40	--	--	10-50
# 4	# 10	15	8	--	6-25
# 10	# 40	5	30	--	5-20
# 40	# 80	--	35	5	10-30
# 80	# 200	--	26	35	5-8
# 200		--	1	60	2-6

Contd P/4

CE 451

Contd ... Q. No. 7

(c) Classify sand according to source and size. Explain the "bulking of sand", what are the effects of this phenomenon on Highway construction? What is Performance Grade (PG) bitumen? **(10)**

8. (a) Differentiate between Bitumen and Tar. Describe the sources of asphaltic materials. With a simplified flowchart explain the recovery and refining processes of petroleum asphalts. **(14⅔)**

(b) Describe the uses of Slow-curing asphalts, Asphalt cement and Asphalt emulsion. What are the basic engineering properties of soil that highway engineers are interested? Prove that $n = e/(1+e)$ where e = void ratio and n = porosity of soil. **(18)**

(c) State the basic steps of Marshall Method of mix design. Show the qualitative shape of Marshall Property curves. Explain with a figure the narrow range of acceptable asphalt contents to determine optimum asphalt content. **(14)**

For Q 5(c)

Table 1: Improved Sub-grade Requirements

CBR Required	Compacted thickness of additional layer to provide required CBR				
	CBR of underlying layer				
	<2%	2%	3%	4%	5%
5%	Sub-grade material should be removed	450mm	300mm	250mm	200mm

Table 2: Thickness Design Table for Flexible Pavements (RHD design guide method)

mm	Surfacing (mm)		Roadbases (mm)* (Select one type)			Sub-bases (mm)** *Subgrade CBR %*		
Traffic ESA (mill)	Asphalt Wearing Course	Asphalt Base-Course	Cement-bound Granular	Granular Base Type I	Granular Base Type II	5	8 - 25	> 25
60 - 80	40	155	Refer to BRRL for design advice	N/A	N/A	300	150	0
40 - 60		140		250	300	250		
30 - 40		125				200		
25 - 30		110		200	250			
17 - 25		105						
15 - 17		95						
11 - 15		90						
9 - 11		80						
7 - 9		70						
6 - 7		65						
5 - 6		60						
4 - 5		55		175	200	175		
3 - 4		45		150	175	150		
< 3		35						

* CBR of granular base type I is min. 80%
* CBR of granular base type II is min. 50%
** CBR of sub-base material is 25%

N/A. = not applicable

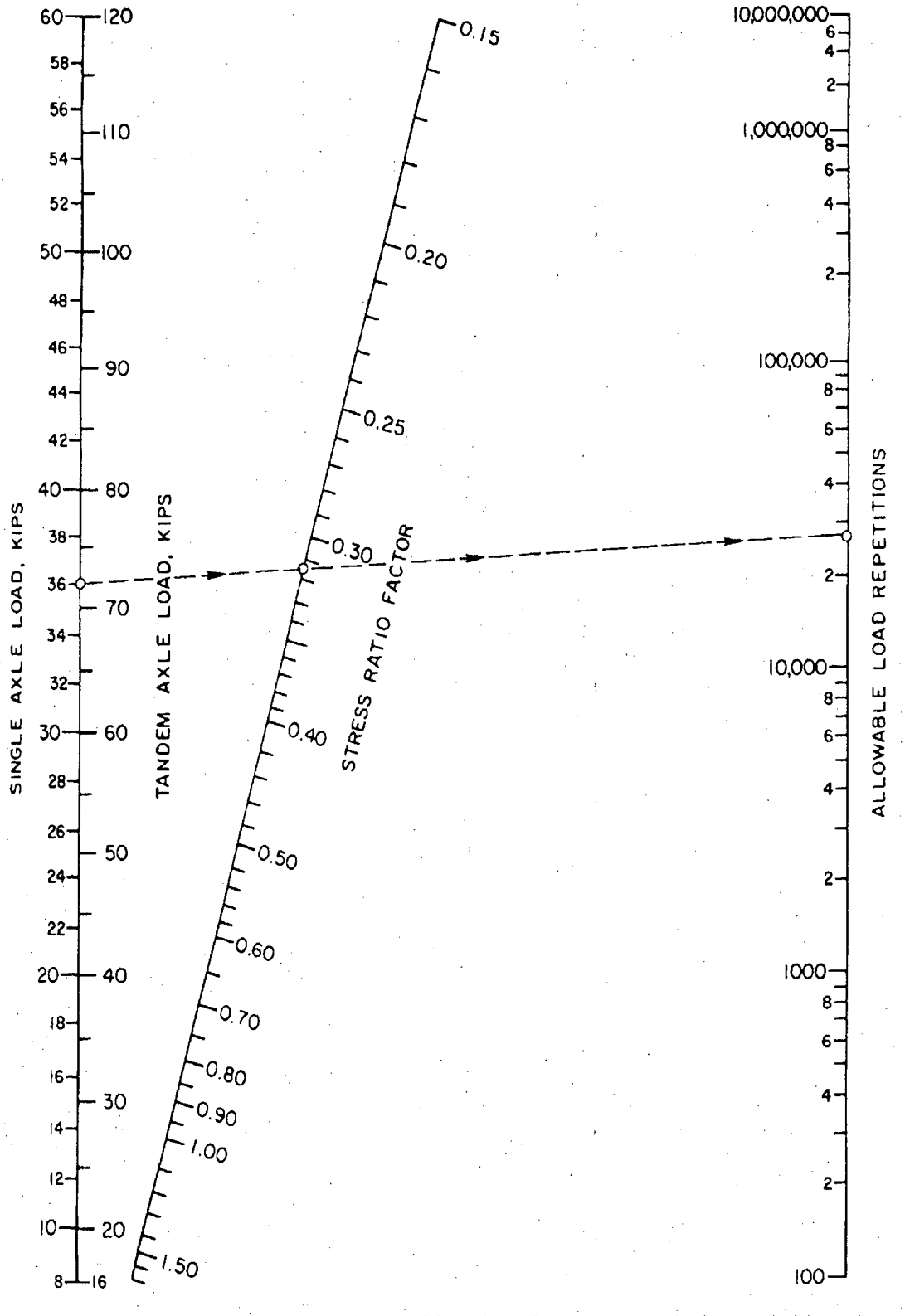
For Q 6(c)

Equivalent Stress — No Concrete Shoulder (Single Axle/Tandem Axle)

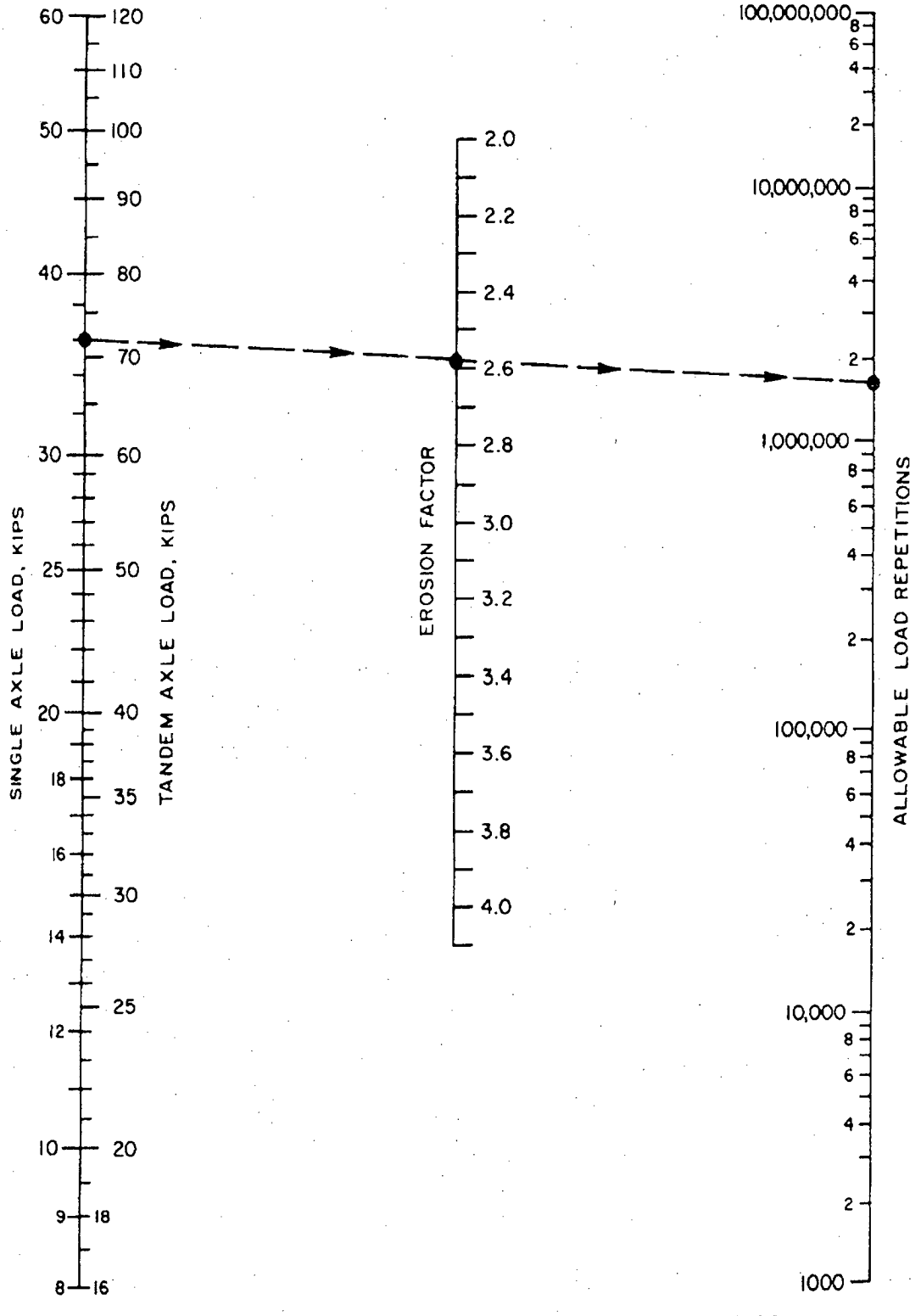
Slab thickness, in.	*k* of subgrade-subbase, pci						
	50	100	150	200	300	500	700
4	825/679	726/585	671/542	634/516	584/486	523/457	484/443
4.5	699/586	616/500	571/460	540/435	498/406	448/378	417/363
5	602/516	531/436	493/399	467/376	432/349	390/321	363/307
5.5	526/461	464/387	431/353	409/331	379/305	343/278	320/264
6	465/416	411/348	382/316	362/296	336/271	304/246	285/232
6.5	417/380	367/317	341/286	324/267	300/244	273/220	256/207
7	375/349	331/290	307/262	292/244	271/222	246/199	231/186
7.5	340/323	300/268	279/241	265/224	246/203	224/181	210/169
8	311/300	274/249	255/223	242/208	225/188	205/167	192/155
8.5	285/281	252/232	234/208	222/193	206/174	188/154	177/143
9	264/264	232/218	216/195	205/181	190/163	174/144	163/133
9.5	245/248	215/205	200/183	190/170	176/153	161/134	151/124
10	228/235	200/193	186/173	177/160	164/144	150/126	141/117
10.5	213/222	187/183	174/164	165/151	153/136	140/119	132/110
11	200/211	175/174	163/155	154/143	144/129	131/113	123/104
11.5	188/201	165/165	153/148	145/136	135/122	123/107	116/98
12	177/192	155/158	144/141	137/130	127/116	116/102	109/93
12.5	168/183	147/151	136/135	129/124	120/111	109/97	103/89
13	159/176	139/144	129/129	122/119	113/106	103/93	97/85
13.5	152/168	132/138	122/123	116/114	107/102	98/89	92/81
14	144/162	125/133	116/118	110/109	102/98	93/85	88/78

Erosion Factors — Doweled Joints, No Concrete Shoulder (Single /Tandem Axle)

Slab thickness, in	*k* of subgrade-subbase, pci					
	50	100	200	300	500	700
4	3.74/3.83	3.73/3.79	3.72/3.75	3.71/3.73	3.70/3.70	3.68/3.67
4.5	3.59/3.70	3.57/3.65	3.56/3.61	3.55/3.58	3.54/3.55	3.52/3.53
5	3.45/3.58	3.43/3.52	3.42/3.48	3.41/3.45	3.40/3.42	3.38/3.40
5.5	3.33/3.47	3.31/3.41	3.29/3.36	3.28/3.33	3.27/3.30	3.26/3.28
6	3.22/3.38	3.19/3.31	3.18/3.26	3.17/3.23	3.15/320	3.14/3.17
6.5	3.11/3.29	3.09/3.22	3.07/3.16	3.06/3.13	3.05/3.10	3.03/3.07
7	3.02/3.21	2.99/3.14	2.97/3.08	2.96/3.05	2.95/3.01	2.94/2.98
7.5	2.93/3.14	2.91/3.06	2.88/3.00	2.87/2.97	2.86/2.93	2.84/2.90
8	2.85/3.07	282/299	2.80/2.93	2.79/2.89	2.77/2.85	2.76/2.82
8.5	2.77/3.01	2.74/2.93	2.72/2.86	2.71/2.82	2.69/2.78	2.68/275
9	2.70/2.96	2.67/287	2.65/2.80	2.63/2.76	2.62/2 71	2.61/2.68
9.5	2.63/2.90	2.60/2.81	2.58/2.74	2.56/2.70	2.55/2.65	2.54/2.62
10	2.56/2.85	2.54/2.76	2.51/2.68	2.50/2.64	2.48/2.59	2.47/256
10.5	2.50/2.81	2.47/2.71	2.45/2.63	2.44/2.59	2.42/2.54	2.41/2.51
11	2.44/2.76	2.42/2.67	2.39/2.58	2.38/2.54	2.36/2.49	2.35/2.45
11.5	2.38/2 72	2.36/2.62	2.33/2.54	2.32/2.49	2.30/2.44	2.29/2.40
12	233/2.68	2.30/2 58	2.28/2.49	2.26/2.44	2.25/2.39	2.23/2.36
12.5	2.28/2.64	2.25/2.54	2.23/2.45	2.21/2.40	2.19/2.35	2.18/2.31
13	2.23/2.61	2.20/2.50	2.18/2.41	2.16/2.36	2.14/230	2.13/2 27
13.5	2.18/2.57	2.15/2.47	2.13/2.37	2.11/2.32	2.09/2.26	2.08/2 23
14	2.13/2.54	2.11/2.43	2.08/2.34	2.07/2.29	2.05/2.23	2.03/2.19



Fatigue analysis—allowable load repetitions based on stress ratio factor (with and without concrete shoulder).



Erosion analysis—allowable load repetitions based on erosion factor (without concrete shoulder).

Worksheet for Q 6(c)

Calculation of Pavement Thickness

Project _____

Trial thickness _____ in
Subbase-subgrade, k _____ pci
Modulus of Rupture, MR _____ psi
Load safety factor, LSF _____

Doweled joints yes ____ no ____
Concrete shoulder yes ____ no ____
Design Period _____ years

Axle Load, kips	Multiplied by LSF	Expected repetitions	Fatigue analysis		Erosion Analysis	
			Allowable repetitions	Fatigue Percent	Allowable repetitions	Damage Percent
1	2	3	4	5	6	7

8. Equivalent stress _____
9. Stress ratio factor _____
10. Erosion factor _____

Single Axles

11. Equivalent stress _____
12. Stress ratio factor _____
13. Erosion factor _____

Tandem Axles

			Total		Total	