L-4/T-1/CE **Date: 17/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2016-2017

Sub: **CE 411** (Structural Analysis and Design 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**.

Symbols carry their usual meaning.

1. (a) What do you understand by a linear structural system? When does a structure show non-linearity? **(10)**

   (b) Draw the bending moment diagram and the qualitative deflected shape of the beam shown in Fig. 1. Use Flexibility method. Given: EI = 3000 k-ft^2. **(25)**

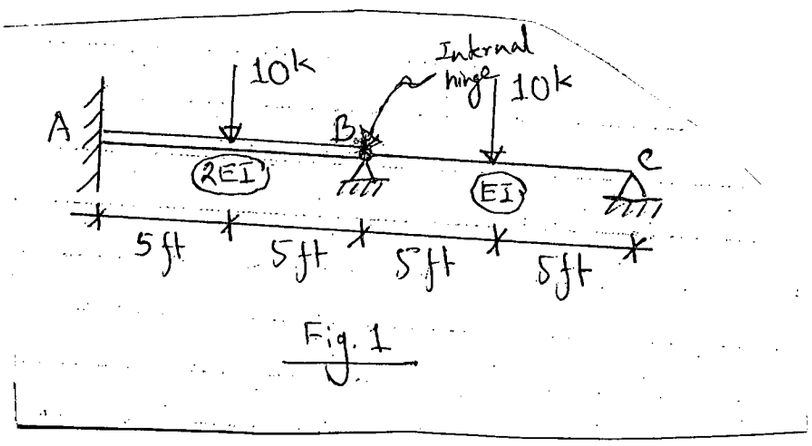

Fig. 1

2. (a) What is P-Δ effect? When is it important? **(8)**

   (b) Support C of the frame shown in Fig. 2 settles $\frac{1}{2}''$ downward due to the imposed loads. Draw the bending moment diagram and the qualitative deflected shape of the frame. Given: EI = 4000 k-ft^2. Ignore axial deformation. **(27)**

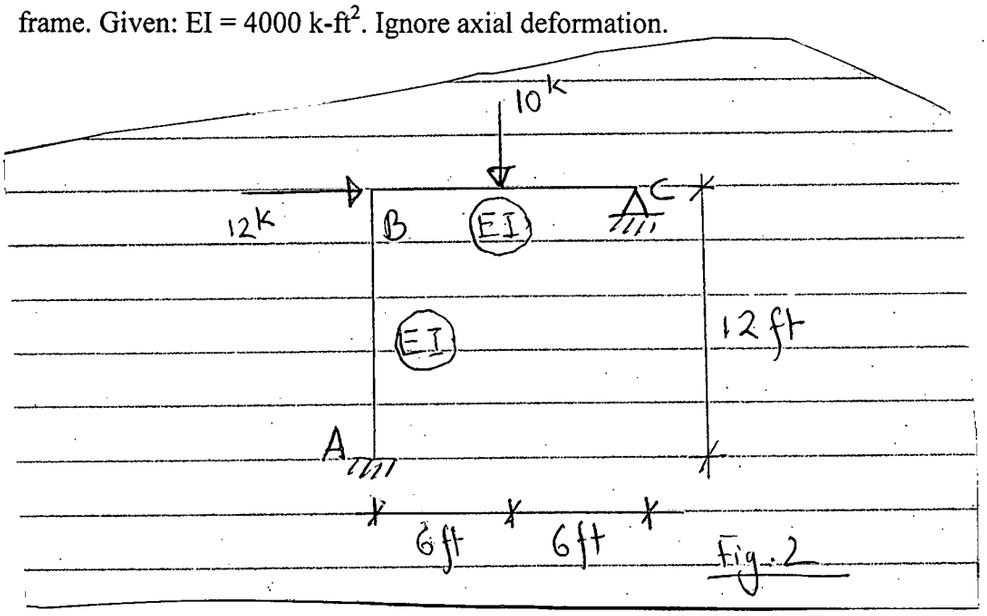

Fig. 2

Contd P/2

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3. (a) Is truss a 1-D structure? Why? Only the top chords of the truss shown in Fig. 3 are subjected to an increase in temperature by 50°C. Determine reactions. Given: EA = 300^k and $\alpha = 13\times10^{-6}$/°C. **(18)**

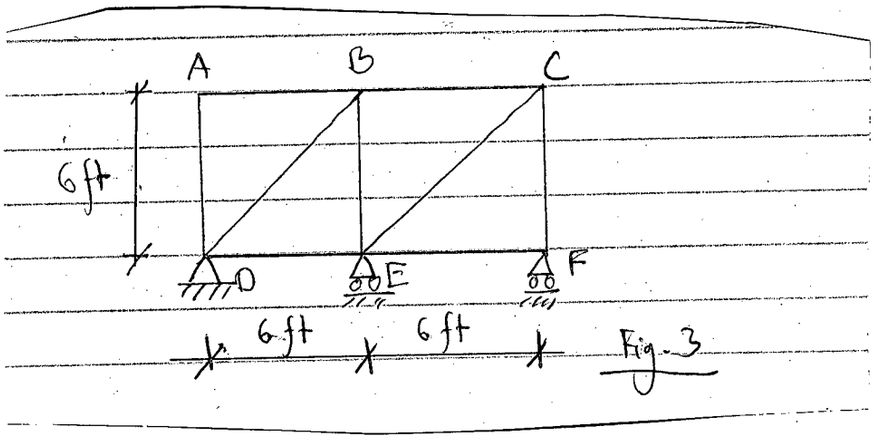

Fig. 3

(b) Determine influence line of moment at A of the beam shown in Fig. 4. Given: EI is constant. **(17)**

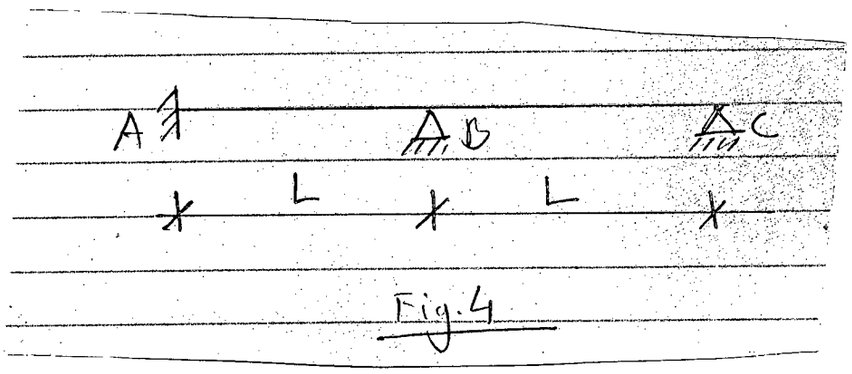

Fig. 4

4. Draw the axial force, shear force and bending moment diagrams of the following frame (Fig. 5) using general stiffness method. Given: EI = 3000 k-ft^2 and AE = 300^k. **(35)**

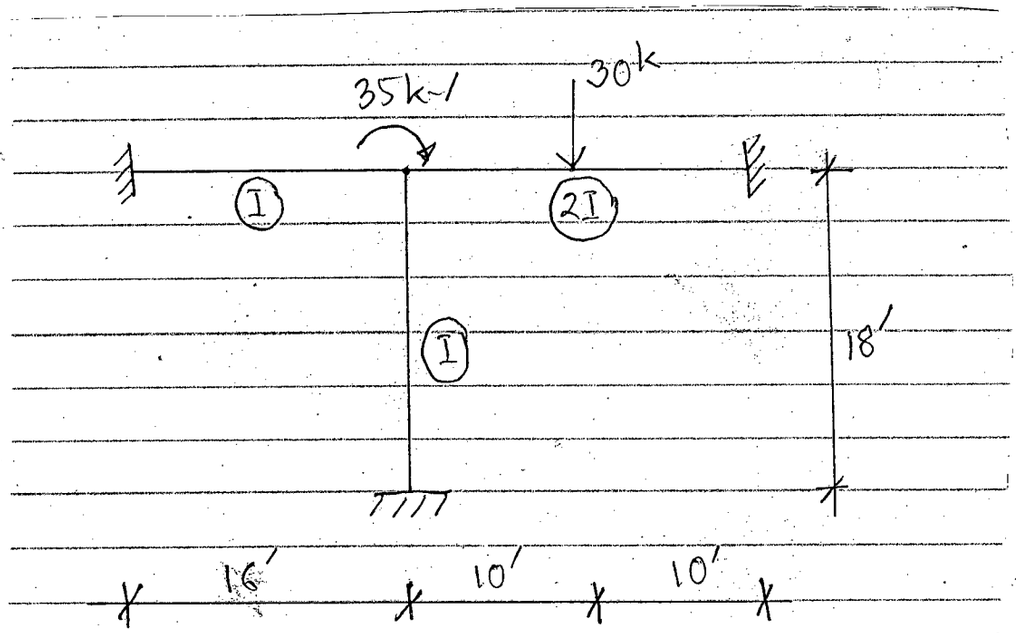

Fig. 5

Contd P/3

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SECTION – B

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

Assume any reasonable value of missing data.

5. (a) Determine the reactions and draw the shear force and bending moment diagrams for the beam shown in Figure 6(a) by using the moment-distribution method. **(23)**

(b) Determine the deflection at B for the nonprismatic beam shown in Figure 6(b) by using the moment-distribution method. Portion AB of the beam has inertia I and portion BC has inertia 2I. Given EI = 3000 k-ft^2. **(12)**

6. (a) Determine the support reactions at A for the frame of Figure 7(a) for the loading shown in the figure and the support settlements of 1 inch at A and 1.5 inch at D. Use the moment-distribution method. **(25)**

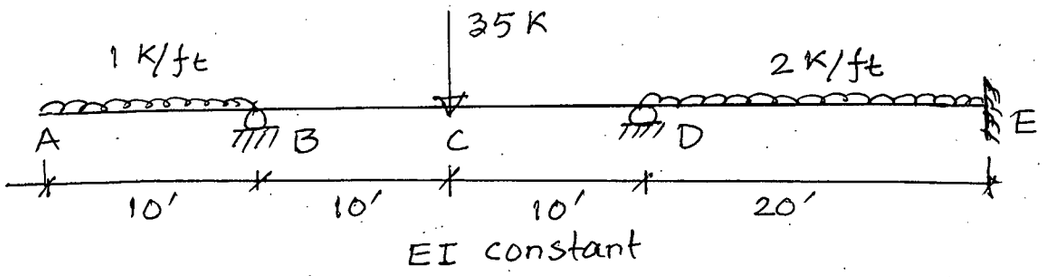
(b) Draw the shear force and bending moment diagram for the beam shown in Figure 7(b) due to a settlement of 20 mm at support B. Use the moment-distribution method. **(10)**

7. (a) Determine the member end moments and reactions for the frame shown in Figure 8(a) by using the moment-distribution method. **(18)**

(b) Develop member local stiffness matrix and member global stiffness matrix for a truss member. Given, the member cross-sectional area is A, modulus of elasticity is E and length is L. **(17)**

8. (a) Determine the internal shear and moment in member 1 of the beam shown in Figure 9(a). EI is constant. Use stiffness method (stiffness matrix). **(25)**

(b) Draw the shear force and bending moment diagram for the beam shown in Figure 9(b) by using stiffness method (stiffness matrix). EI is constant for all members of the beam. **(10)**



EI constant

Figure 6(a)

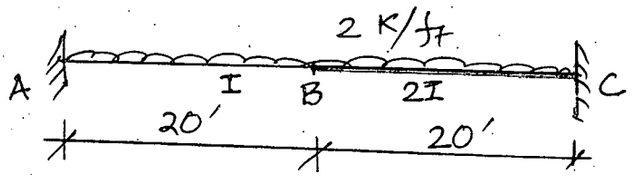
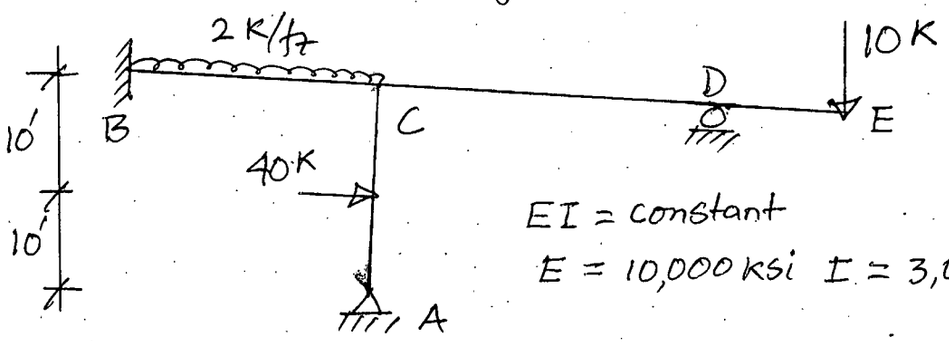


Figure 6(b)



EI = constant

E = 10,000 ksi I = 3,000 in^4

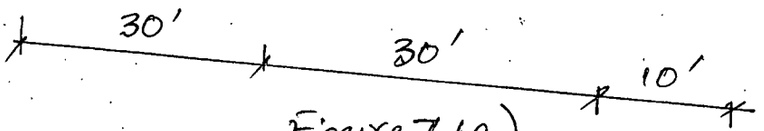
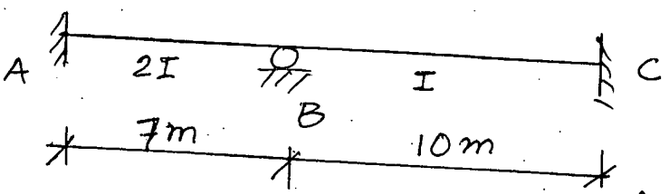


Figure 7(a)



E = 70 GPa I = 800x10^6 mm^4

Figure 7(b)

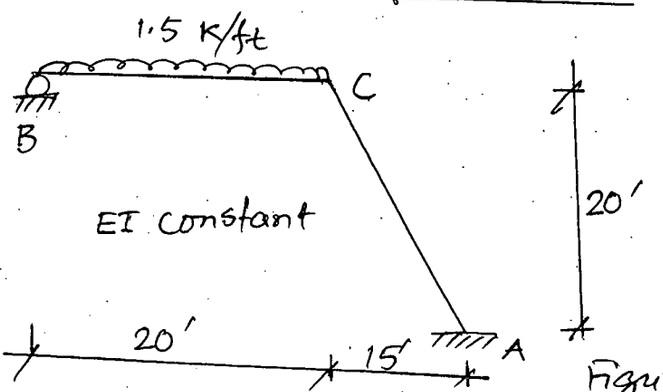


Figure 8(a)

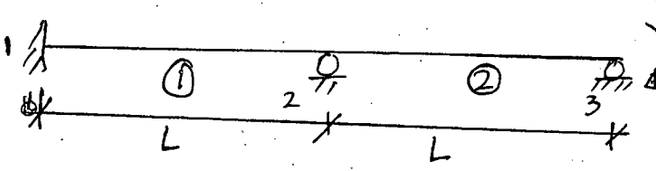


Figure 9(a)

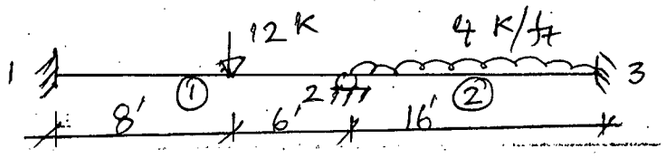


Figure 9(b)

L-4/T-1/CE **Date: 22/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2016-2017

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

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. The following project represents construction of a new drive-in weighing station for a company.

Activity Name	Description	Duration	Preceding Tasks
A	Lay Foundation	10	—
B	Dig Hole for Scales	06	—
C	Insert Scale Bases	15	B
D	Erect Frames	12	A, C
E	Complete Building	20	D
F	Insert Scales	05	E
G	Insert Display Cases	03	E
H	Install Office Equipment	06	G
I	Finish	03	H, F

(a) Draw network diagram for the activities of the project identifying each activity and its duration. **(20)**

(b) Make an appropriate table and determine the critical activities of the project and its expected earliest completion time. **(26⅔)**

2. The walkway of a bridge needs to be made of wooden planks. Either chambal wood planks (which weighs 3 pounds each) or kerosene wood planks (which weighs 4 pounds each) or a combination of both may be used. The total weight of planks must be within 600 pounds to 900 pounds as per building code. Chambal planks cost Tk. 300/each and kerosene planks Tk. 400/each.

(a) Formulate the above as a standard LP problem. Show and identify the feasible region, constraints and objectives function in x-y coordinate space. **(20)**

(b) use the simplex algorithm to determine how many of each planks should be used to minimize costs. **(26⅔)**

Contd P/2

CE 401

3. (a) Determine the Economic Order Quantity (EOQ) equations as an optimum policy and use it to find the EOQ for a Cement Reseller who sells 1000 bag of cement per month. The lead time for him to receive a bulk order is 10 days. Placing per order costs him Tk. 600/ and cost of holding one bag in inventory is Tk. 100/. **(20)**

(b) How a team behaves and what is the role of a team leader during team forming and team norming stage? **(26⅔)**

4. (a) What are the principles of value for money? Show in a diagram how the Environmental Management Plan (EMP) can be better integrated within a project life cycle. **(20)**

(b) How different types of conflict impacts individuals and a team? **(26⅔)**

SECTION – B

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

Notations carry their usual meaning.

5. (a) Explain NPV, IRR, Benefit Cost Ratio and Payback Period as project investment decision criteria. **(26⅔)**

(b) The following information were given relating to a proposed capital investment: **(20)**

Year	0	1	2	3	4
Net cash flow (after tax) in lac	(7,000)	2,500	3,200	3,000	2,500

Calculate the project's:

(i) NPV

(ii) IRR

(iii) Payback period

Under each method, explain whether or not the firm should accept the project. For investments of this type, the firm's risk-adjusted discount rate is 15% p.a. The cutoff for payback period is 2 years.

6. (a) What do you understand by financial and economic feasibility of a project? What are the steps you need to follow for a financial feasibility assessment? **(26⅔)**

(b) For a government project the sources and cost of capitals are given below. If the inflation rate is 5%, what will be weighted average real cost of capital for the project? **(20)**

	Weight	Nominal Cost	After Tax (Tax 40%)
ADB loan	40%	6.70%	4.02%
Commercial loan	20%	12.00%	7.20%
Grant	5%	0.00%	0.00%
Equity Participation	35%	10.00%	10.00%

Contd P/3

CE 401

7. (a) Define Project Management. What are the characteristics of project phases and project life cycle? **(6⅔)**

(b) Draw a typical construction project life cycle mentioning different stages. Briefly explain all those stages. **(8)**

(c) Compare different 'project characteristics' among **(8)**

(i) Functional Organization,

(ii) Balanced Matrix Organization,

(iii) Projectized Organization.

(d) Explain elaborately the typical problems encountered in Construction Industry. **(8)**

(e) State the function of the following construction equipments. **(16)**

(i) Excavator

(ii) Cranes

(iii) Concrete Mixer Truck

(iv) Road Roller

8. (a) State the safety measures that should be taken at a building construction site. **(6⅔)**

(b) Explain the various inputs and outputs from risk identification process. **(8)**

(c) Explain the significance of "Quality Planning" and "Quality Control" processes in project quality management. **(8)**

(d) What are the major processes in Project Cost Management? Explain each of the processes. **(8)**

(e) RAJUK is undertaking a lake development project in Dhaka City. What would be the inputs, tools and techniques and outputs from Cost Estimating process for that particular lake development project? **(16)**

L-4/T-1/CE **Date: 27/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2016-2017

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 ordinates of a 8-h unit hydrograph is given below. Compute the ordinates of a 4-h unit hydrograph. **(15)**

Time (hr)	0	4	8	12	16	20	24	28	32	36	40
Ordinates of 8-h UH (m^3/s)	0	22	60	100	75	65	50	30	18	10	0

(b) At a climatic station, air pressure 101.3 kPa, air temperature = 20°C and relative humidity = 60%. Calculate the corresponding vapor pressure, specific humidity, air density and dew-point temperature. **(15)**

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

2. (a) Consider a catchment with longitudinal slope = 0.005, area = 2 km^2 and runoff coefficient = 0.1. The peak discharge is computed to be 4.2 m^3/s. Compute the corresponding intensity of rainfall, time of concentration and maximum length of travel of water for a return period of 100 years. Use Rational Method, IDF curves (Fig. 1) and Kirpich formula for your estimation. **(15)**

(b) For Horton's infiltration capacity equation suppose $f_{co} = 5$ cm/hr, $f_{cf} = 1$ cm/hr and $K_h = 2$ hr^{-1}. Determine the infiltration rates (fct) and cumulative infiltrations (F_{ct}) after 0, 0.5, 1.0, 1.5 and 2 hr. The infiltration rate is the time derivative of the cumulative infiltration, i.e. $f_{ct} = \frac{dF_{ct}}{dt}$. The notations have their usual meaning. **(15)**

(c) Define the components of 'Initial Loss' in hydrologic cycle. **(5)**

3. (a) The ordinates of a storm hydrograph of a river draining a catchment area of 165 km^2 due to a 6-h rainfall are given below. Derive the ordinates of a 6-h unit hydrograph. **(15)**

Time (hr)	0	6	12	18	24	30	36	42	48	54
Discharge (m^3/s)	20	100	400	600	300	200	90	50	40	40

(b) The average storm rainfall values over a catchment in three successive 6-h intervals are known to be 4.2, 8.2 and 6.2 cm. The 6-h unit hydrograph is given below. The Q-index is 0.2 cm/h. The base flow is 10 m^3/s at the beginning of storm and increases by 2 m^3/s every 12 hr. Estimate the resulting flood hydrograph. **(15)**

(c) Compare the base flow contributions between Perennial and Intermitten Streams. **(5)**

Contd P/2

WRE 451/CE

4. (a) The annual maximum recorded floods in a river for the period of 1995 to 2008 are given below. Estimate the flood discharge with return periods of (i) 100 years and (ii) 300 years. Given, $\bar{y}_n = 0.51$ and $S_n = 1.0095$ for N = 14. The notations have their usual meaning. **(15)**

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Maximum flood (m^3/s)	3800	2900	4800	3900	3350	6650	5400	4250	3760	4160	8890	3980	4200	5700

(b) Four rain gages are located within a rectangular area with four corners at (0,0), (0,13), (14,13) and (14,0) having the following coordinates and recorded rainfalls: **(15)**

Rain gage location	Rainfall (mm)
(2,9)	18
(7,11)	25
(12,10)	35
(6,2)	42

All coordinates are expressed in kilometers. Compute the average rainfall in the area by Thiessen Polygon Method. Use plain graph paper.

(c) Explain the importance of infiltration index in hydrologic calculations. **(5)**

SECTION – B

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

5. (a) What do you understand by irrigation? Write down the advantages and disadvantages of irrigation. **(10)**

(b) Write down the social and environmental aspects of irrigation in the context of Bangladesh. **(5)**

(c) Rabi season is the main irrigation season of Bangladesh and favorable for high yield, explain. **(5)**

(d) Classify irrigation development and write down the considerations for development of any water resources project. **(10)**

(e) What do you understand by soil moisture tension or suction? **(5)**

6. (a) Write down the names of different methods for the measurement of soil moisture and prove that moisture content by volume is a product of moisture content by weight and apparent specific gravity. **(7)**

(b) Show the sources of irrigation water in a chart and briefly explain the problems of irrigated lands in our country. **(12)**

Contd P/3

WRE 451/CE

Contd... Q. No. 6

(c) Determine the consumptive use and net irrigation requirement for paddy from the given data: **(8)**

Dates and periods of growth	Pan evaporation, Ep	Consumptive use coefficient	Effective precipitation in cm
Oct. 16-31	8.49	0.44	3.42
Nov. 1-30	15.57	0.54	2.19
Dec. 1-31	16.59	0.94	0.54
Jan. 1-31	19.10	0.99	0.15
Feb. 1-2	1.54	0.73	0.02

(d) What are the various impurities which make the water unfit for irrigation? Write down the guidelines (special consideration) for using poor quality irrigation water. **(8)**

7. (a) Differentiate between surface and subsurface irrigations. Discuss briefly the various techniques used for distributing water in the firm. **(15)**

(b) Define infiltration rate and write down the factors influencing infiltration. **(5)**

(c) What do you understand by duty and delta? Derive the relationship between duty and delta. **(5)**

(d) The gross command area for a distributary is 25,000 ha, 60% of which is culturable irrigable. The intensity of irrigation (I.I) for Rabi (Wheat) is 40% and for Kharif (Rice) is 15%. If the total water requirement of the two crops are 37.5 cm and 120 cm and their periods of growth are 160 days and 140 days respectively; (i) determine the outlet discharge from average demand considerations. (ii) Also determine the peak demand discharge assuming that the kor water depth for two crops are 13.5 cm and 19 cm and their kor periods are 4 weeks and 2 weeks respectively. **(10)**

8. (a) What is flood? Classify floods of Bangladesh and briefly discuss the causes and impacts of flood. **(8)**

(b) Mention the main reasons for the failure of any flood management policy and enlist the possible impacts on water resources system of Bangladesh. **(10)**

(c) Write down the flood management measures to mitigate flood damages in Bangladesh. **(7)**

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

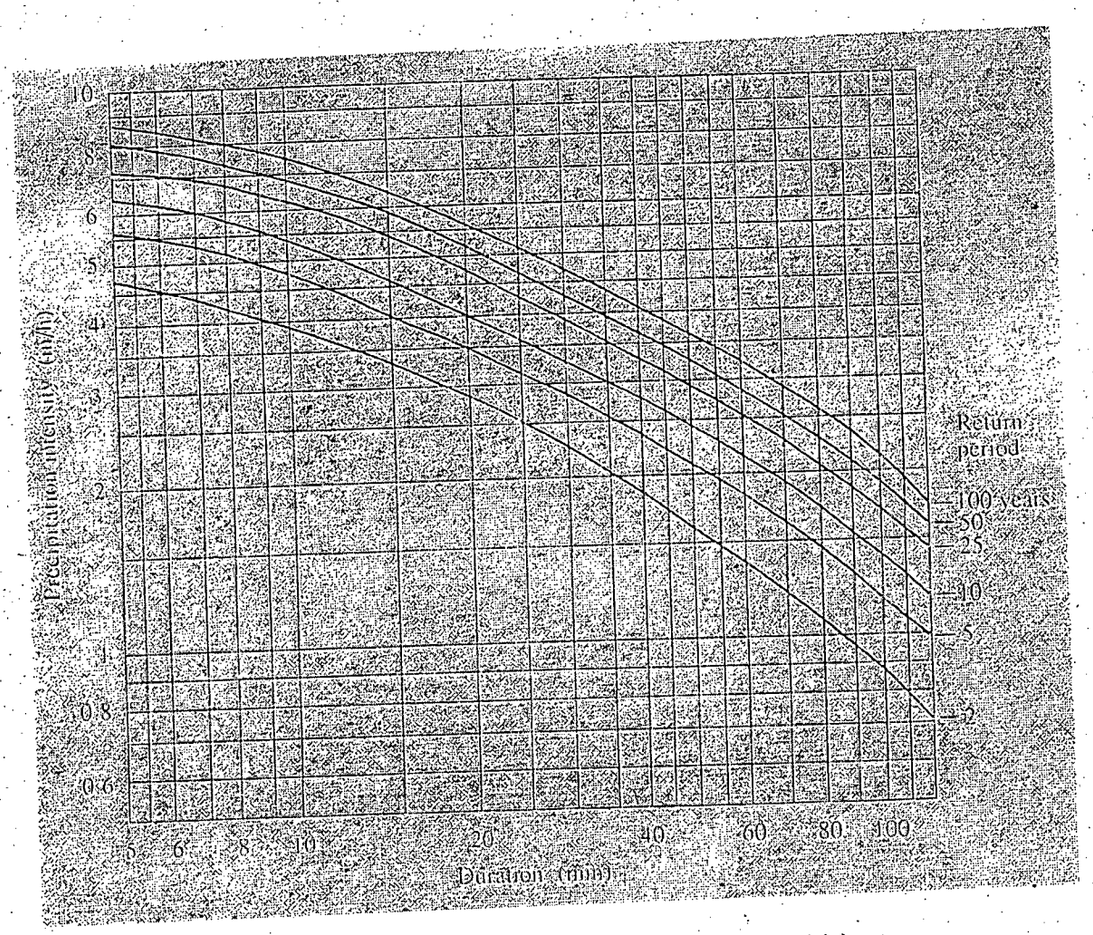


Fig. 1: Intensity-Duration-Frequency (IDF) curves for Q. No. 2(a)

L-4/T-1/CE **Date : 05/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2016-2017

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**.

1. (a) Calculate the factor of safety and settlement of the footing. **(35)**

Given:

Soil Condition:

0-30 ft. over consolidated clay, density = 120 pcf, $C_r = 0.03$, $C_c = 0.12$, $e_0 = 0.8$,

Past maximum overburden pressure = 7000 psf., unconfined compression strength = 3 ksf

Below 30 ft., thick deposit of dense sand

Water table at 20 ft. below ground level

Foundation data:

Footing size for a column = 10 ft × 12 ft

Depth of the footing = 8 ft. below ground level

Footing thickness = 24 inch

Dead load on column = 200 kip

Live load on column = 100 kip

Draw a neat sketch showing the stated condition

Divide the thick clay layer into two layers for settlement calculation.

2. Calculate the factor of safety and settlement (at center and at corner) of the raft foundation. **(35)**

Given:

Soil Condition:

0-20 ft. over consolidated clay, density = 120 pcf, Cr = 0.04, Ce = 0.15, $e_0 = 0.9$,

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

Below 20 ft., thick deposit of dense sand

Water table at 20 ft. below ground level

Contd P/2

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Contd ... Q. No. 2

Foundation data:

Raft foundation = 80 ft × 100 ft.

Depth of the raft foundation = 12 ft. below ground level

Dead load on raft = 12000 kip

Live load on raft = 5000 kip

Draw a neat sketch showing the stated condition

3. Calculate the factor of safety and settlement of the pile group **(35)**

Given:

Soil Condition:

0-20 ft normally consolidated clay, density = 110 pcf, $C_c = 0.25$ $e_0 = 1.2$
unconfined compression strength = 0.8 ksf, reduction factor = 0.9
20-50 ft normally consolidated clay, density = 120 pcf, $C_c = 0.20$ $e_0 = 1.0$
unconfined compression strength = 1.2 ksf, reduction factor = 0.8
50-60 ft normally consolidated clay, density = 125 pcf, $C_c = 0.18$ $e_0 = 0.9$
unconfined compression strength = 1.5 ksf, reduction factor = 0.75

Below 60 ft, thick deposit of dense sand

Water table at 20 ft. below ground level

Foundation data:

Pile foundation, 20 numbers of piles
Size of the pile = 16 inch × 16 inch
Spacing of the pile = 4 ft. (centre to centre)
Length of the pile = 45 ft.
Top of the pile = 3 ft. below ground level
Dead load on pile group = 200 kip
Live load on pile group = 100 kip

Draw a neat sketch showing the stated condition.

4. (a) Calculate the capacity of the driven pile in sand and draw necessary sketches. **(20)**

Given:

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:

Contd P/3

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Contd ... Q. No. 4

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	35^0	35^0	35^0	35^0	35^0	35^0	35^0	40^0	40^0	40^0	40^0
δ	25^0	25^0	25^0	25^0	25^0	25^0	25^0	28^0	28^0	28^0	28^0

Assume $N_q = 110$ for $\phi = 35°$, $N_q = 140$ for $\phi = 40°$, $D_c = 20$ ft

(b) Write down the properties of underwater concrete. Discuss briefly underwater concreting methodology for a drilled pier. **(15)**

SECTION – B

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

5. (a) List technical information that you would expect on a boring log. **(6)**

(b) How would you decide on the spacing and depth of boreholes while planning a sub-soil exploration program? **(10)**

(c) A square footing fails by general shear in a cohesionless soil under an ultimate load of Q_{ult} = 1688 kip. The footing is placed at a depth of 6.5 ft below ground level. Given $\phi = 35°$, $N_q = 41$, $N_\gamma = 42$ and $\gamma = 110$ pcf, determine the size of the footing if the water table is at a great depth. **(15)**

(d) Explain the differences between 'Ordinary Method of Slices' and 'Bishop's Method of Slices' for slope stability analysis. **(4)**

6. (a) State the basic principles of 'seismic refraction survey' and 'electrical resistivity survey' methods used for sub-soil exploration. Also state the applicability of these methods. **(8+3)**

(b) Discuss the problems of Shelby tube in collecting good quality undisturbed clay soil samples of various consistency? Also explain, with sketches, the advantages of piston sampler to overcome such problems. **(5+7)**

(c) An excavation was made in homogeneous saturated clay. The side slope of the cut made and angle of 36° with the horizontal. Slope failure occurred when the cut reached a depth of 8 m. Available geotechnical information show that a clay layer exists to large depths. Considering circular failure surface, determine the undrained cohesion of the clay and comment on the nature of the critical circle. Use the plot of Fellenius (**Fig. 1**) **(12)**

Contd P/4

CE 441

7. (a) Why the position of ground water table is of importance to a geotechnical engineer? **(3)**

(b) Compare the applicability, advantage and limitations of CPT and SPT. **(12)**

(c) A reinforced concrete pile 13 m long and 500 mm in diameter is driven to medium dense sand; $\phi = 36°$, $\gamma = 17.5$ kN/m^3 and water table is at great depth. Calculate the pullout capacity and allowable pullout load with $F_s = 3.0$ Use $\delta = ¾\ \phi$ and the values of K_s are 1.0 for loose sand and 2.0 for dense sand. Also, calculate the allowable load if the pile tip is enlarged to 800 mm diameter for a length of 500 mm, while other data remain the same. **(10+10)**

8. (a) What is meant by rapid draw down condition? Draw a typical qualitative plot of stability chart developed by Morgenstern for relevant slope stability analysis. **(5)**

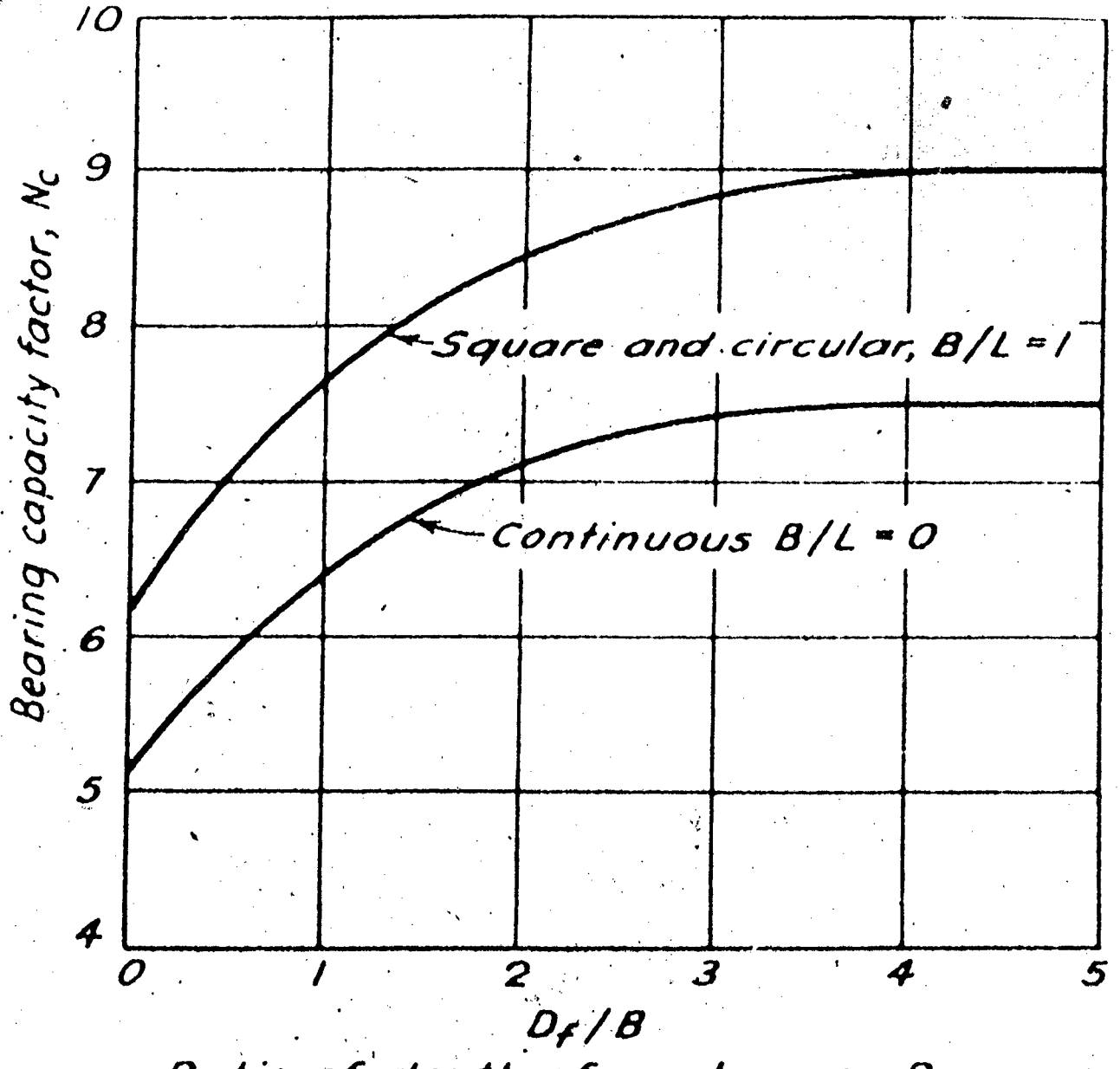
(b) **Fig. 2** shows the cross-section of an earth slope in homogeneous clay soil. The figure also shows an arbitrary failure surface, its center and five slices. Calculate the factor of safety, using **Ordinary Method of Slices**, Given $\gamma = 16.8$ kN/m^3, $q_u = 50$ kPa. For homogenous soil and Ordinary method of slices, Factor of Safety is given by: **(15)**

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

(Symbols have their usual meanings)

(c) A water tank foundation has a footing size 6 m × 6 m, placed at a depth of 3 m below ground level in a medium dense sand stratum of great depth. From site investigation, corrected average SPT value is found as 20 and average density of soil as, $\gamma = 18.5$ kN/m^3. The foundation is subjected to a vertical load at an eccentricity of B/10 along one of the axes. Estimate the ultimate load Q_{ult} by Meyerhof's method. Symbols have their usual meanings. Given: **(15)**

ϕ (deg)	28	30	32	34	36	38	40
N_q	14.7	18.4	23.2	29.4	37.7	48.9	64.1
N_γ	11.2	15.7	22.0	31.1	44.4	64.0	93.6



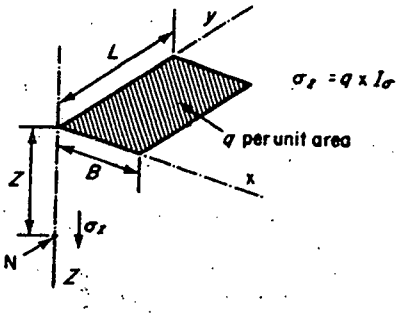
. Bearing capacity factors for foundations on clay under $\phi = 0$ conditions (after Skempton, 1951).

CE-441 TABLE 1 (6)

Table 1. Influence values (I_σ) for vertical normal stress σ_z at point N beneath corner of a uniformly loaded rectangular area

B/z \ L/z	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8
0.1	0.004 70	0.009 17	0.013 23	0.016 78	0.019 78	0.022 23	0.024 20	0.025 76	0.026 98	0.027 94	0.029 26	0.030 07	0.030 58	0.030 90
0.2	0.009 17	0.017 90	0.025 85	0.032 80	0.038 66	0.043 48	0.047 35	0.050 42	0.052 83	0.054 71	0.057 33	0.058 94	0.059 94	0.060 58
0.3	0.013 23	0.025 85	0.037 35	0.047 42	0.055 93	0.062 94	0.068 58	0.073 08	0.076 61	0.079 38	0.083 23	0.085 61	0.087 09	0.088 04
0.4	0.016 78	0.032 80	0.047 42	0.060 24	0.071 11	0.080 09	0.087 34	0.093 14	0.097 70	0.101 29	0.106 31	0.109 41	0.111 35	0.112 60
0.5	0.019 78	0.038 66	0.055 93	0.071 11	0.084 03	0.094 73	0.103 40	0.110 35	0.115 84	0.120 18	0.126 26	0.130 03	0.132 41	0.133 95
0.6	0.022 23	0.043 48	0.062 94	0.080 09	0.094 73	0.106 88	0.116 79	0.124 74	0.131 05	0.136 05	0.143 09	0.147 49	0.150 28	0.152 07
0.7	0.024 20	0.047 35	0.068 58	0.087 34	0.103 40	0.116 79	0.127 72	0.136 53	0.143 56	0.149 14	0.157 03	0.161 99	0.165 15	0.167 20
0.8	0.025 76	0.050 42	0.073 08	0.093 14	0.110 35	0.124 74	0.136 53	0.146 07	0.153 71	0.159 78	0.168 43	0.173 89	0.177 39	0.179 67
0.9	0.026 98	0.052 83	0.076 61	0.097 70	0.115 84	0.131 05	0.143 56	0.153 71	0.161 85	0.168 35	0.177 66	0.183 57	0.187 37	0.189 86
1.0	0.027 94	0.054 71	0.079 38	0.101 29	0.120 18	0.136 05	0.149 14	0.159 78	0.168 35	0.175 22	0.185 08	0.191 39	0.195 46	0.198 14
1.2	0.029 26	0.057 33	0.083 23	0.106 31	0.126 26	0.143 09	0.157 03	0.168 43	0.177 66	0.185 08	0.195 84	0.202 78	0.207 31	0.210 32
1.4	0.030 07	0.058 94	0.085 61	0.109 41	0.130 03	0.147 49	0.161 99	0.173 89	0.183 57	0.191 39	0.202 78	0.210 20	0.215 10	0.218 36
1.6	0.030 58	0.059 94	0.087 09	0.111 35	0.132 41	0.150 28	0.165 15	0.177 39	0.187 37	0.195 46	0.207 31	0.215 10	0.220 25	0.223 72
1.8	0.030 90	0.060 58	0.088 04	0.112 60	0.133 95	0.152 07	0.167 20	0.179 67	0.189 86	0.198 14	0.210 32	0.218 36	0.223 72	0.227 36
2.0	0.031 11	0.061 00	0.088 67	0.113 42	0.134 96	0.153 26	0.168 56	0.181 19	0.191 52	0.199 94	0.212 35	0.220 58	0.226 10	0.229 86
2.5	0.031 38	0.061 55	0.089 48	0.114 50	0.136 28	0.154 83	0.170 36	0.183 21	0.193 75	0.202 36	0.215 12	0.223 64	0.229 40	0.233 34
3.0	0.031 50	0.061 78	0.089 82	0.114 95	0.136 84	0.155 50	0.171 13	0.184 07	0.194 70	0.203 41	0.216 33	0.224 99	0.230 88	0.234 95
4.0	0.031 58	0.061 94	0.090 07	0.115 27	0.137 24	0.155 98	0.171 68	0.184 69	0.195 40	0.204 17	0.217 22	0.226 00	0.232 00	0.236 88
5.0	0.031 60	0.061 99	0.090 14	0.115 37	0.137 37	0.156 12	0.171 85	0.184 88	0.195 61	0.204 40	0.217 49	0.226 32	0.232 36	0.237 35
6.0	0.031 61	0.062 01	0.090 17	0.115 41	0.137 41	0.156 17	0.171 91	0.184 96	0.195 69	0.204 49	0.217 60	0.226 44	0.232 49	0.236 71
8.0	0.031 62	0.062 02	0.090 18	0.115 43	0.137 44	0.156 21	0.171 95	0.185 00	0.195 74	0.204 55	0.217 67	0.226 52	0.232 58	0.236 81
10.0	0.031 62	0.062 02	0.090 19	0.115 44	0.137 45	0.156 22	0.171 96	0.185 02	0.195 76	0.204 57	0.217 69	0.226 54	0.232 61	0.236 84
∞	0.031 62	0.062 02	0.090 19	0.115 44	0.137 45	0.156 23	0.171 97	0.185 02	0.195 77	0.204 58	0.217 70	0.226 56	0.232 63	0.236 86

B/z \ L/z	2.0	2.5	3.0	4.0	5.0	6.0	8.0	10.0	∞
0.1	0.031 11	0.031 38	0.031 50	0.031 58	0.031 60	0.031 61	0.031 62	0.031 62	0.031 62
0.2	0.061 00	0.061 55	0.061 78	0.061 94	0.061 99	0.062 01	0.062 02	0.062 02	0.062 02
0.3	0.088 67	0.089 48	0.089 82	0.090 07	0.090 14	0.090 17	0.090 18	0.090 19	0.090 19
0.4	0.113 42	0.114 50	0.114 95	0.115 27	0.115 37	0.115 41	0.115 43	0.115 44	0.115 44
0.5	0.134 96	0.136 28	0.136 84	0.137 24	0.137 37	0.137 41	0.137 44	0.137 45	0.137 45
0.6	0.153 26	0.154 83	0.155 50	0.155 98	0.156 12	0.156 17	0.156 21	0.156 22	0.156 23
0.7	0.168 56	0.170 36	0.171 13	0.171 68	0.171 85	0.171 91	0.171 95	0.171 96	0.171 97
0.8	0.181 19	0.183 21	0.184 07	0.184 69	0.184 88	0.184 96	0.185 00	0.185 02	0.185 02
0.9	0.191 52	0.193 75	0.194 70	0.195 40	0.195 61	0.195 69	0.195 74	0.195 76	0.195 76
1.0	0.199 94	0.202 36	0.203 41	0.204 17	0.204 40	0.204 49	0.204 55	0.204 57	0.204 58
1.2	0.212 35	0.215 12	0.216 33	0.217 22	0.217 49	0.217 60	0.217 67	0.217 69	0.217 70
1.4	0.220 58	0.223 64	0.224 99	0.226 00	0.226 32	0.226 44	0.226 52	0.226 54	0.226 56
1.6	0.226 10	0.229 40	0.230 88	0.232 00	0.232 36	0.232 49	0.232 58	0.232 61	0.232 63
1.8	0.229 86	0.233 34	0.234 95	0.236 98	0.239 35	0.236 71	0.236 81	0.236 84	0.236 86
2.0	0.232 47	0.236 14	0.237 82	0.239 12	0.239 54	0.239 70	0.239 81	0.239 85	0.239 87
2.5	0.236 14	0.240 10	0.241 96	0.243 44	0.243 92	0.244 12	0.244 25	0.244 29	0.244 32
3.0	0.237 82	0.241 96	0.243 94	0.245 54	0.246 08	0.246 30	0.246 46	0.246 50	0.246 54
4.0	0.239 12	0.243 44	0.245 54	0.247 29	0.247 91	0.248 17	0.248 36	0.248 42	0.248 46
5.0	0.239 54	0.243 92	0.246 08	0.247 91	0.248 57	0.248 85	0.249 07	0.249 14	0.249 19
6.0	0.239 70	0.244 12	0.246 30	0.248 17	0.248 85	0.249 16	0.249 39	0.249 46	0.249 52
8.0	0.239 81	0.244 25	0.246 46	0.248 36	0.249 07	0.249 39	0.249 64	0.249 73	0.249 80
10.0	0.239 85	0.244 29	0.246 50	0.248 42	0.249 14	0.249 46	0.249 73	0.249 81	0.249 89
∞	0.239 87	0.244 32	0.246 54	0.248 46	0.249 19	0.249 52	0.249 80	0.249 89	0.250 00



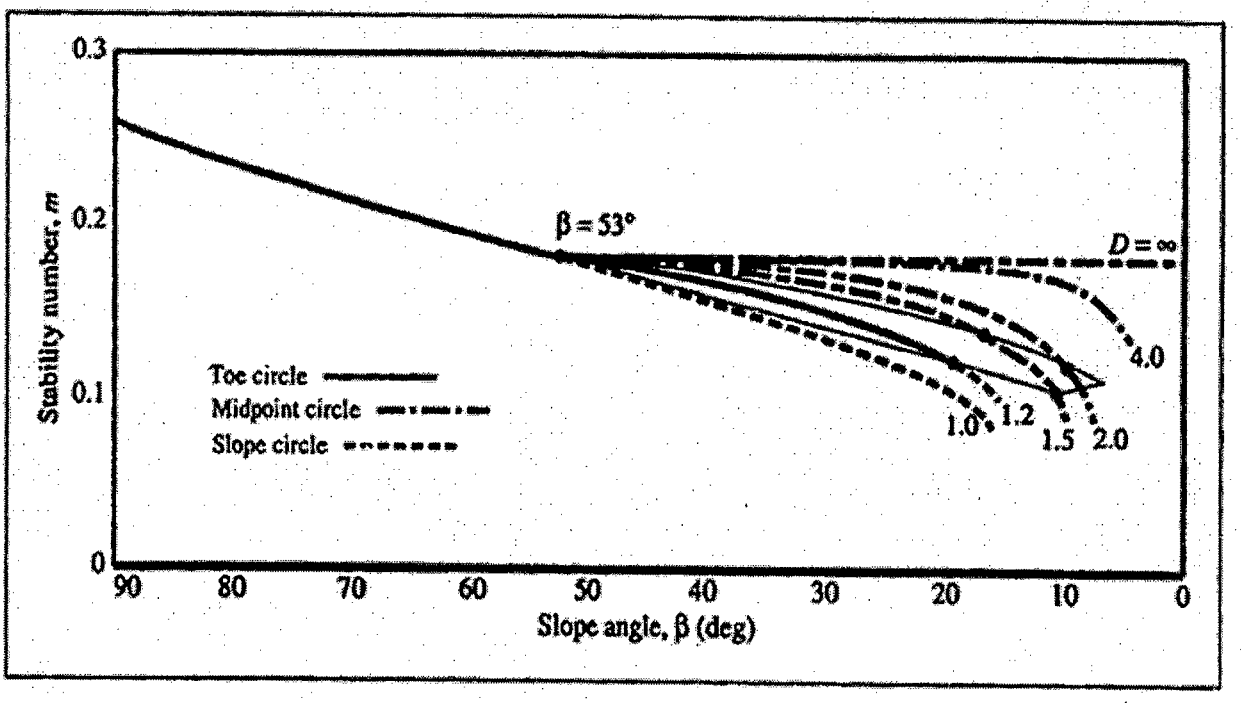


Fig. 1 Plot of Stability number against Slope angle Fellenius (1927).

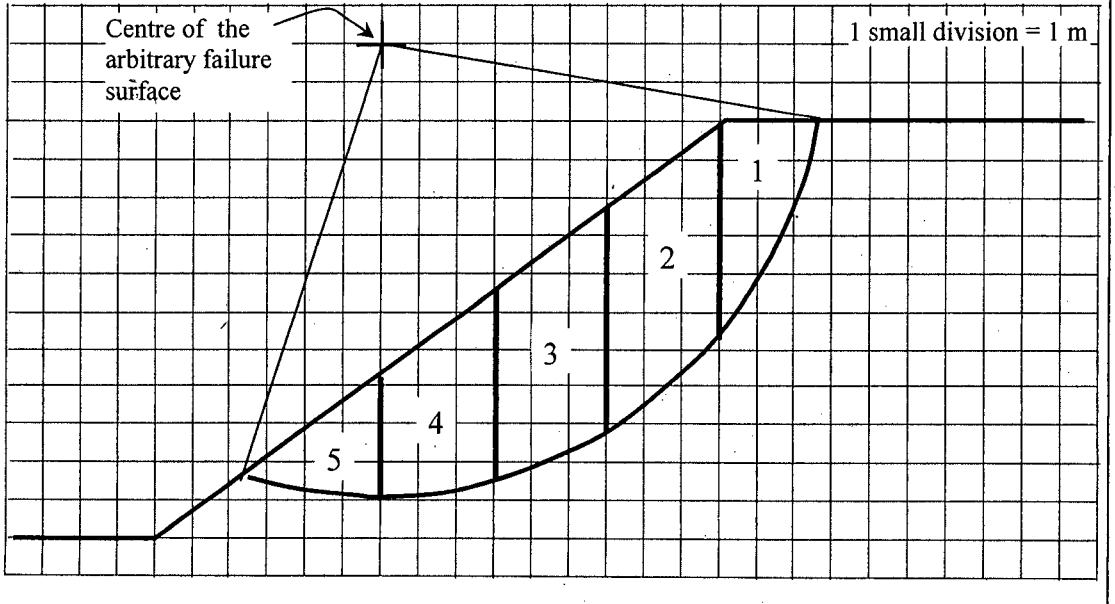


Fig. 2 Cross-section of an earth slope and arbitrary failure surface.

X

L-4/T-1/CE **Date: 11/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2016-2017

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) Broadly classify pavements. Draw typical cross sections for flexible, rigid, semi-rigid pavements. Differentiate between flexible and rigid pavements w.r.t Load distribution mechanism, Aggregate Type and Modulus of Elasticity. Write short note on 'Perpetual pavement' and 'Polymer Modified Binder (PMB)'. Briefly state the significance of PMB use in Bangladesh. **(4+6+6+4+2)**

   (b) Write short notes on: Fog-seal, Slurry seat, and Micro-seal. List FIVE important common modes of distresses for flexible and rigid pavements. **(6+5)**

   (c) Design reinforcement for the following: **(13⅔)**

Thickness of rigid pavement, t	= 11 inch
No. of lanes	= 2
Width of pavement, w	= 22 ft
Spacing of transverse joint	= 44 ft (Contraction Joint @ 22 ft)
Allowable strength of:	
Shrinkage steel (bar-mat)	= 35000 psi
Tie bars	= 30000 psi
Bond	= 355 psi

2. (a) Write down the sequences of pavement failure under submerged condition in Bangladesh. Why joints are use in rigid pavement? What are the main functions of Tie bars and Dowel bars in rigid pavement? Write down the odd-shaped panel considerations to reduce the risk of cracking in curved areas in concrete pavement. **(5+4+4+4)**

   (b) What are the major outcomes of AASHO road test? Define standard axle load? A truck in an intercity road applied 20 kip and 12 kip loads by the rear and front axles. Using the 4th power approximation, determine the total equivalent damage caused by one pass movement of this truck in terms of ESALs. **(4+2+6)**

   (c) Design a flexible pavement by AASHTO method for the data given below. Give one trial and put you comments for the next trial thickness (if any). Solution could be given in the worksheet provided at the end of question paper. (Design Nomograph is attached). **(17⅔)**

Contd P/2

CE 451

Contd... Q. No.

Given:

Assumed Structural Number, SN = 6.0

Estimated Design ESAL, W_{18} =20 million ESAL

Consider:

Design period = 20 years

Initial serviceability, Po = 4.6

Terminal Serviceability, Pt = 2.5

Reliability, R = 0.95

Overall std. dev., So = 0.35

Z_R = –1.645

Pavement Layer	Material Used	Resilient Modulus M_R (psi)		Layer Coefficients	Drainage Coefficients	
Surface Course (AC)	Asphalt Concrete	E_{AC} =	375,000	$a_1 = 0.169*LN(E_{AC})–1.764$	m_1=	1.0
Base Course (BS)	Granular	E_{BS} =	32,000	$a_2 = 0.249*LOG_{10}(E_{BS})–0.977$	m_2=	1.1
Subbase Course (SB)	Granular	E_{SB} =	12,000	$a_3 = 0.227*LOG_{10}(E_{SB})–0.839$	m_3=	1.2
Roadbed Course (RB)	Compacted soil	E_{RB} =	5,600			

3. (a) Compare roadways with railways. Discuss the difficulties associated with non-uniformity of gauges throughout a Country. **(7+6)**

(b) Define "Permanent way". Schematically show the different components of a typical permanent way. What are the requirements of an ideal permanent way? **(2+4+7)**

(d) Discuss different types of rail resistance. **(8+12⅔)**

A 2-8-2 Locomotive is required to haul a train at 80 km/hr. The axle load of the driving wheels of the engine is 22.5 tones. The train is to run on a straight level track. Find the maximum permissible train load that the engine can pull. If the train climbs a gradient of 1 in 200, how much of the speed should be reduced?

4. (a) What are the advantages of flat footed rails? What are the functions of Ballast and sleepers in a railway track? Define Cant Deficiency, Equilibrium speed and Cant excess. **(5+8+6)**

(b) What are the purposes of railway stations? What criteria are generally followed for the site selection of a railway station? "The function of a Marshalling yard in a railway system is like the function of the heart in a human body" – Explain. **(4+6+6)**

(c) Why points and crossings are provided in a railway track? What are the advantages of Cast Manganese Steel (CMS) crossing? State the objective of railway signaling. **(4+3⅔+4)**

Contd P/3

CE 451

SECTION – B

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

Assume reasonable values for missing data, if any.

5. (a) What are the superpave binder test equipment and purposes? How is the moisture sensitivity evaluated in the superpave mix design process? **(12)**

(b) Briefly state the differences between Marshall and Hveem method of mix design with regard to (i) compaction of specimens (ii) design criteria, and (iii) tests of specimens. **(18)**

(c) What are the characteristics of a high type bituminous pavements? A design is being prepared for an asphalt concrete paving mixture. The following ingredients are to be used in the preparation of a trial mixture: **(16⅔)**

	Percent of total mix by weight	Specific Gravity
Coarse aggregate	55.0	2.611
Fine aggregate	31.0	2.690
Mineral filler	7.0	3.100
Asphalt cement	7.0	1.030

The maximum specific gravity of the paving mixture G_{mm} = 2.478 and the bulk specific gravity of the compacted specimen G_{mb} = 2.384. Compute percent air voids in the compacted mixture, Pa and VMA and VFA.

6. (a) What are the especial qualities of bitumen required for road construction in Bangladesh? How can these qualities be achieved? **(12)**

(b) Briefly state the steps to get straight run asphalt. How is the asphalt cement graded? Show with typical examples. **(16)**

(c) Briefly state the important properties of aggregates used for highway construction. The dry mass of a sample of aggregate is 1982.0 g. The net volume of aggregate is 734.4 cm^3. The mass of aggregate is SSD condition is 2006.7 g. Find the apparent specific gravity, the bulk specific gravity and the percentage absorption. **(18⅔)**

7. (a) Describe the commonly used low cost road surfaces in Bangladesh. Explain how HBB facilitates staged road construction. **(22⅔)**

(b) Describe detail features of bituminous surface treatment (SBST or DBST), Penetration Macadam and Geo Cell paving type of road surface construction including materials details. **(8×3=24)**

Contd P/4

CE 451

8. (a) Write down names of ten highway construction equipment along with their uses. Describe hot-rolled bituminous surface compaction process mentioning temperature range in each stage. **(23⅔)**

(b) Write down possible causes, maintenance options and rehabilitation/reconstruction options for the following defects of asphalt concrete pavement: **(5×3=15)**

(i) Alligator Cracking

(ii) Rutting

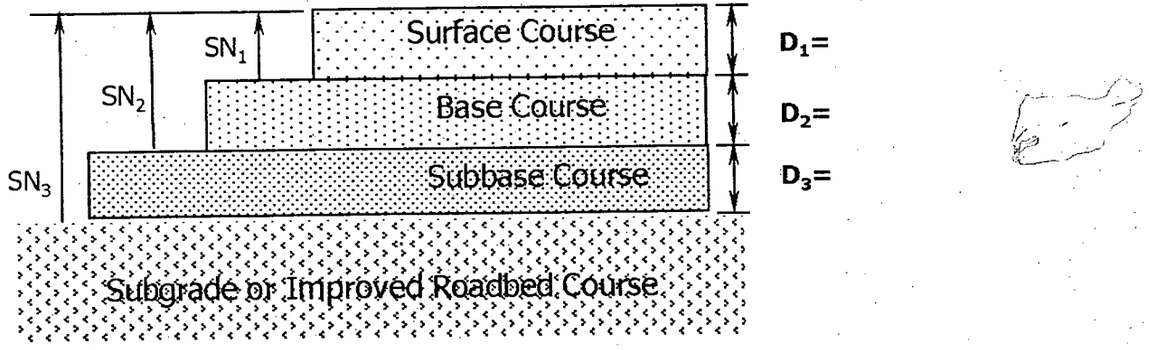
(iii) Corrugation.

(c) Illustrate the dowel bar installation defects in rigid pavement with relevant drawings. Also describe the temperature reinforcement installation process for rigid pavement. **(4+4=8)**

AASHTO Worksheet For Flexible Pavement Design

Pavement Layer	Material Used	Resilient Modulus M_R (psi)	Layer Coefficients		Drainage Coefficient		Required SN above the layer	Calculations For Layer Thicknessed	Thickness D (inch)
Surface Course	Asphalt Concrete	E_{AC} = 375,000	$a_1 = 0.169*LN(E_{AC}) - 1.764$ =		m_1 =	1.0			
Base Course	Granular	E_{BS} = 32,000	$a_2 = 0.249*LOG_{10}(E_{BS}) - 0.977$ =		m_2 =	1.1			
Subbase Course	Granular	E_{SB} = 12,000	$a_3 = 0.227*LOG_{10}(E_{SB}) - 0.839$ =		m_3 =	1.2			
Roadbed Course	Compacted soil	E_{RB} = 5600							
Check for SN3 = a1m1D1 + a2m2D2 + a3m3D3 =									

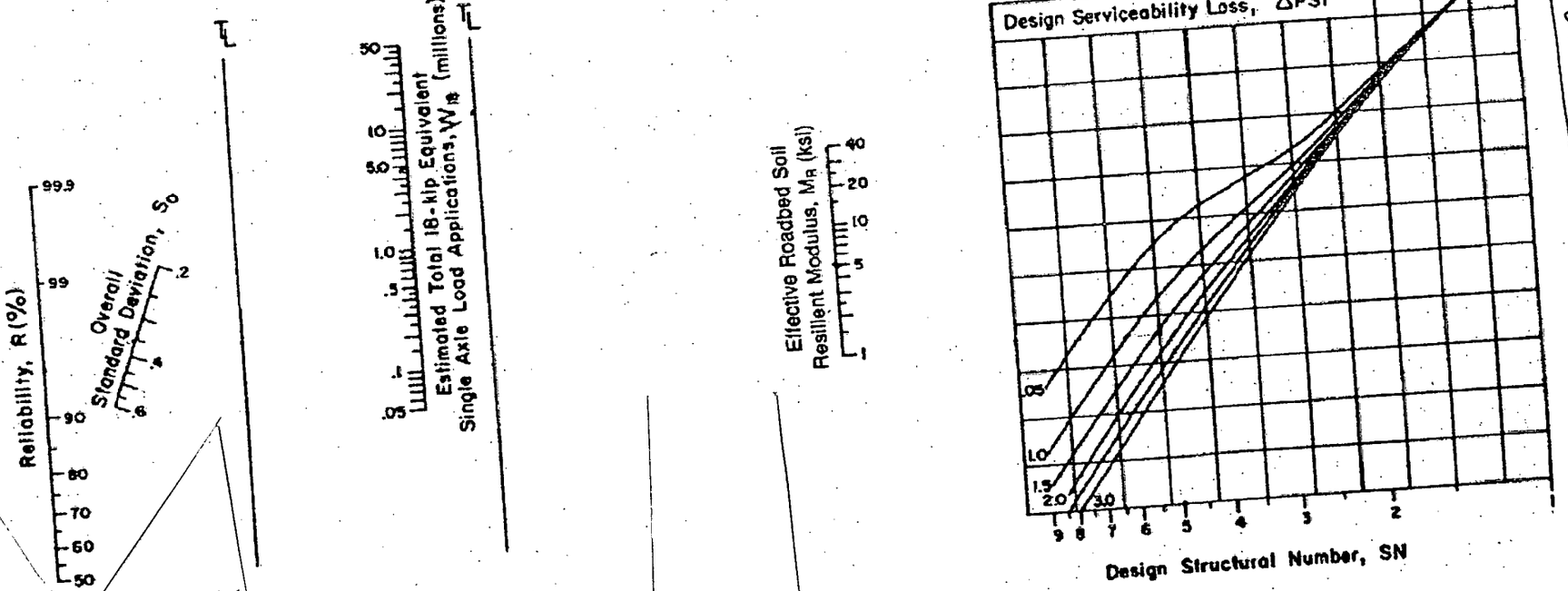
For Q 2(c)



AASHTO Design Nomograph for Flexible Pavement

NOMOGRAPH SOLVES:

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



For Q.2(c)