L-4/T-1/CE **Date : 15/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2015-2016

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.

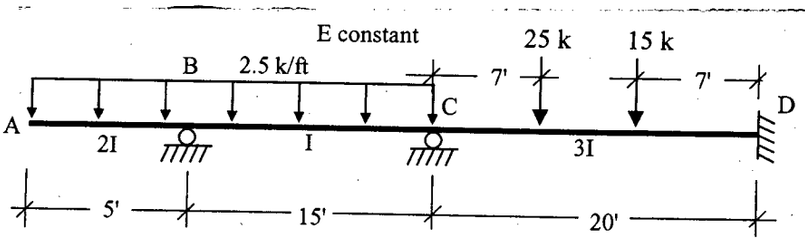
SECTION – A

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

Symbols and notations have their usual meanings. Unless otherwise stated, neglect axial deformation of the frame members.

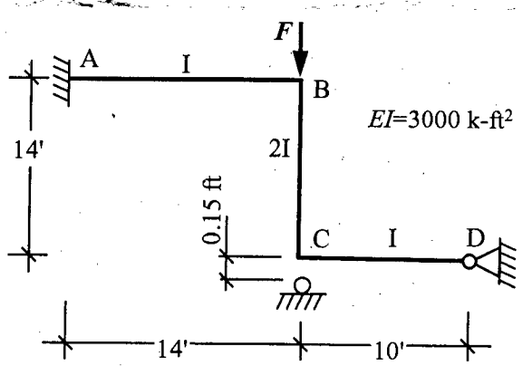
1. (a) Analyze the beam shown in Fig.1 using moment distribution method and draw the shear force and bending moment diagrams. Also draw the qualitative deflected shape. **(18)**

Fig.1



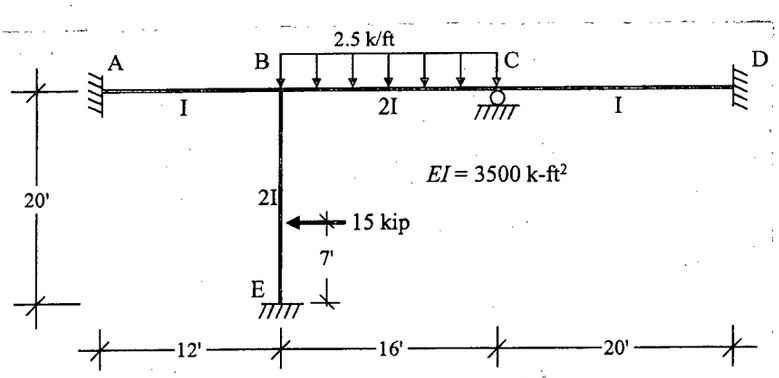
(b) In order to prevent vertical deflection at C, a roller support is placed beneath point C of the plane frame of Fig. 2. However, due to construction defect, a vertical gap of 0.15 ft has been introduced at C. Determine the magnitude of force *F* that will cause point C to just touch the roller support. Follow moment distribution method of analysis. **(17)**

Fig.2



2. (a) In addition to the loads acting on the plane frame as shown in Fig.3, support at E settles down by 0.15 ft. Analyze the frame using stiffness method and determine all the reaction forces and moments occurring at support E. **(18)**

Fig.3



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CE 411

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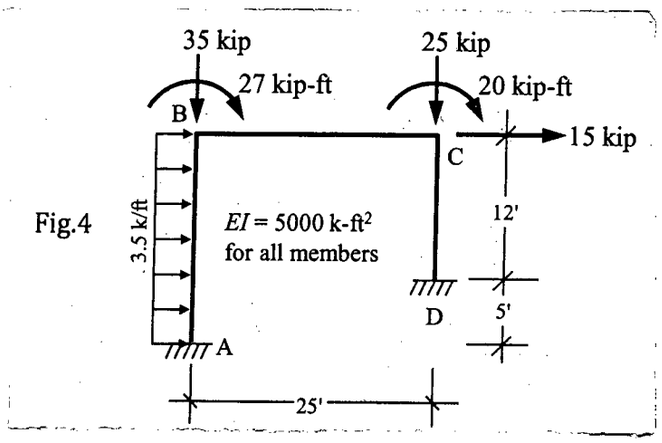
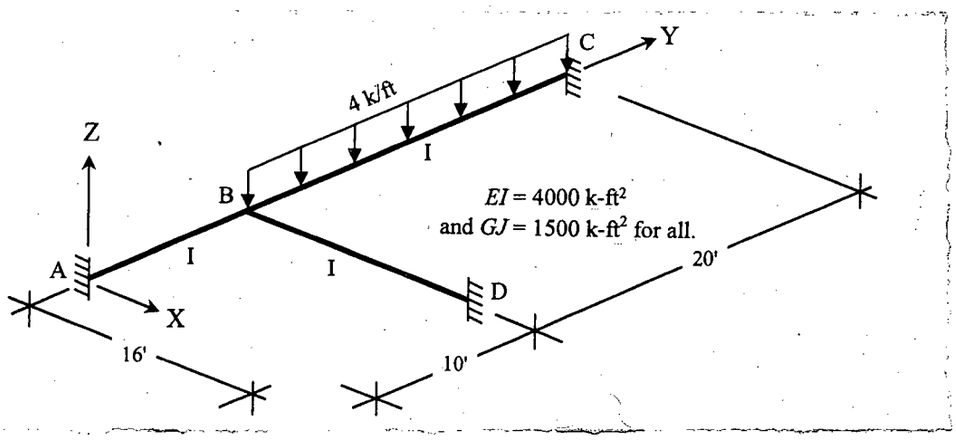
(b) Analyze the plane frame of Fig.4 using stiffness method and determine all the reaction forces and moments at support A. **(17)**

Fig.4



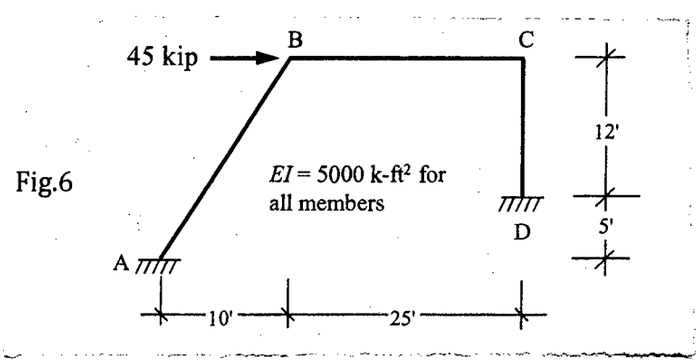
3. (a) The plane grid frame shown in Fig.5 lies in X-Y plane (horizontal plane) while the uniformly distributed load on member BC acts vertically downward (in the negative Z direction). Determine the vertical deflection at point B using stiffness method. **(18)**

Fig.5



(b) Analyze the plane frame of Fig.6 using moment distribution method and determine the horizontal sway at point C. **(17)**

Fig.6



Contd P/3

CE 411

4. (a) Analyze the plane frame of Fig.7 using moment distribution method and determine the vertical reactions at supports A and C. **(18)**

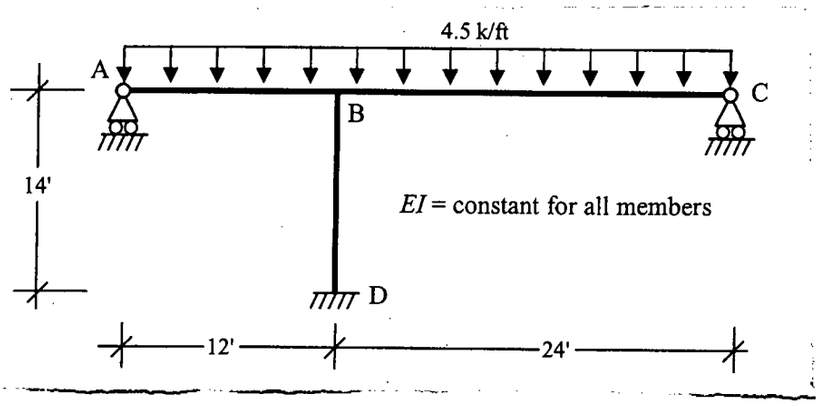


Fig.7

(b) Analyze the pin-connected plane truss shown in Fig.8 considering axial stiffness of the members only and determine the member forces and support reactions following stiffness method. Figures in bracket indicate member cross sectional areas in ft^2. **(17)**

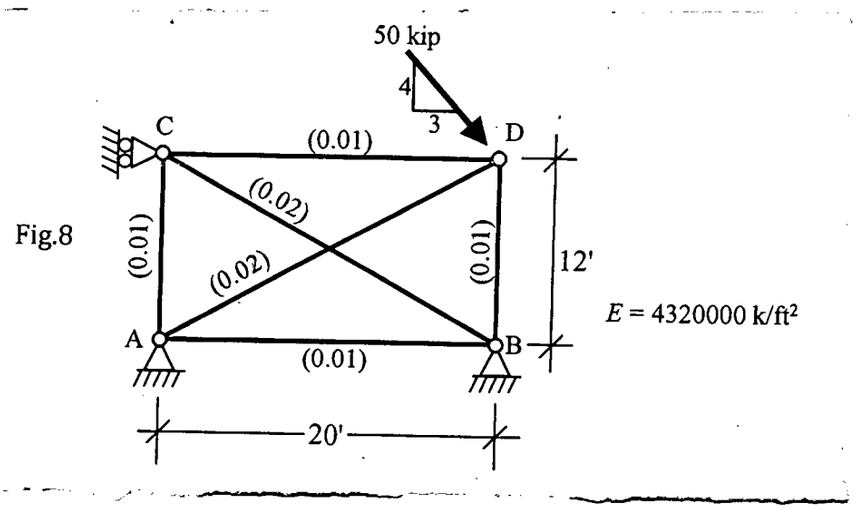


Fig.8

SECTION-B

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

5. (a) Analyze the truss in Fig. 9 by the consistent deformation method (EA = constant for all the bars). **(27)**

(b) Show the two possible primary (released) structures and redundants for the structures in Fig. 10. **(8)**

Contd P/4

CE 411

6. (a) Draw qualitative influence lines for bending moment at A, B, shear force at C and reaction at A of the continuous beam in Fig. 11. **(8)**

(b) Analyze the frame in Fig. 12 by the consistent deformation method and draw the bending moment diagram (EI is constant). **(27)**

7. (a) For the frame in Fig. 13, draw qualitative influence lines for

(i) Maximum negative bending moment at C of the beam BC, **(8)**

(ii) Maximum positive bending moment at P and

(iii) Maximum axial force in column CD.

Show the corresponding uniformly distributed live load loading pattern for each of them.

(b) Analyze the frame in Fig. 14 using stiffness method and determine all support reactions and the amount of sway. **(27)**

8. (a) Find the reactions due to the loads and vertical downward settlements (in ton-m unit) of 200/EI and 100/EI at the supports A and B respectively of the beam in Fig. 15. (EI = constant). **(27)**

(b) Compute the translational stiffness of joint B in the horizontal direction (K_{33}) for the frame in Fig. 16. (E = constant). **(8)**

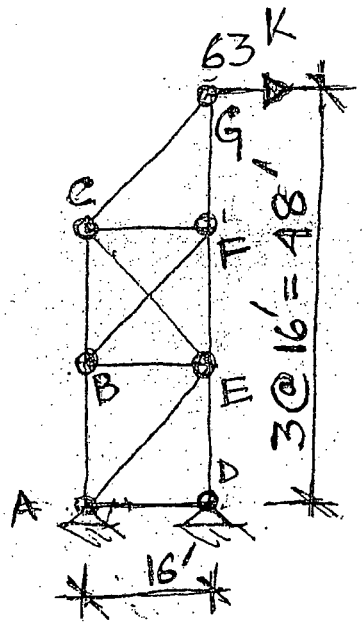


Fig. 9

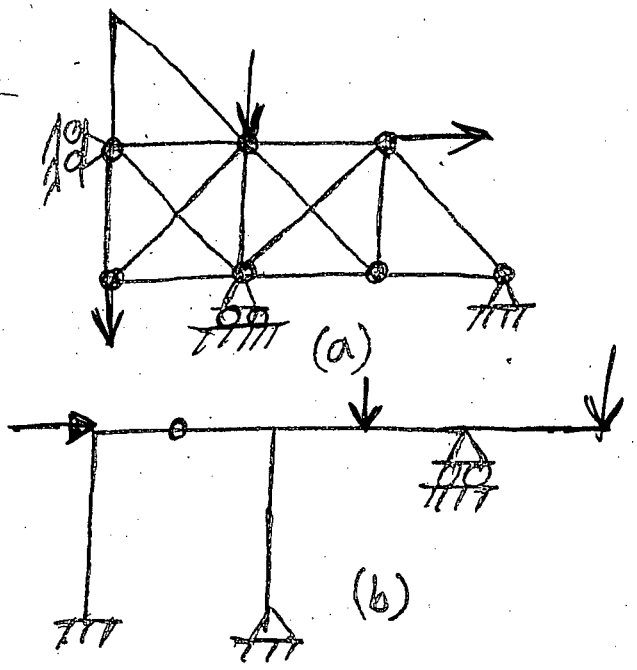


Fig. 10

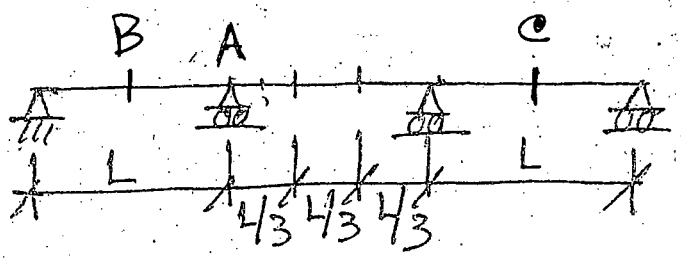


Fig. 11

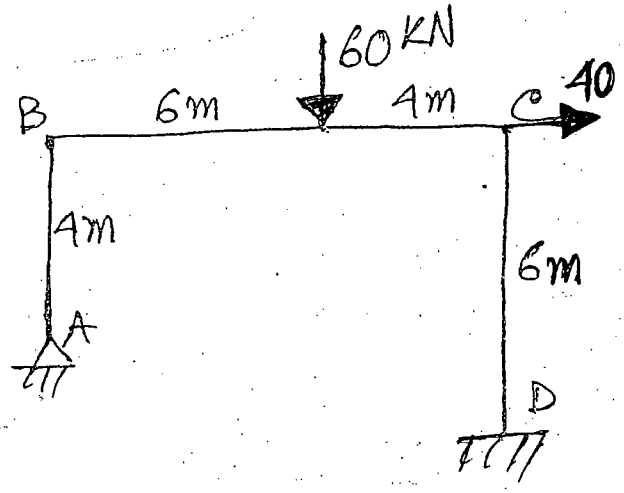


Fig 12

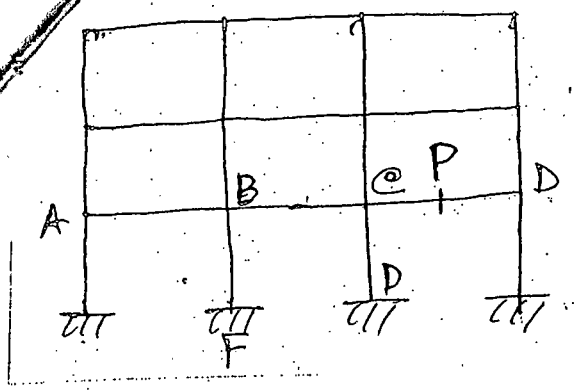


Fig. #13

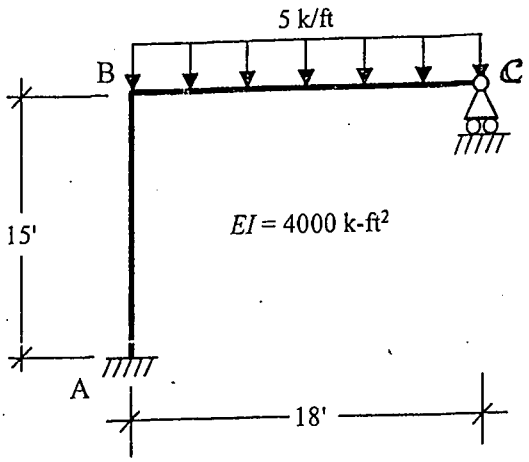


Fig. #14

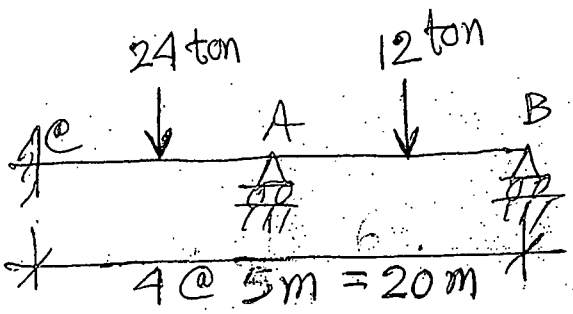


Fig. #15

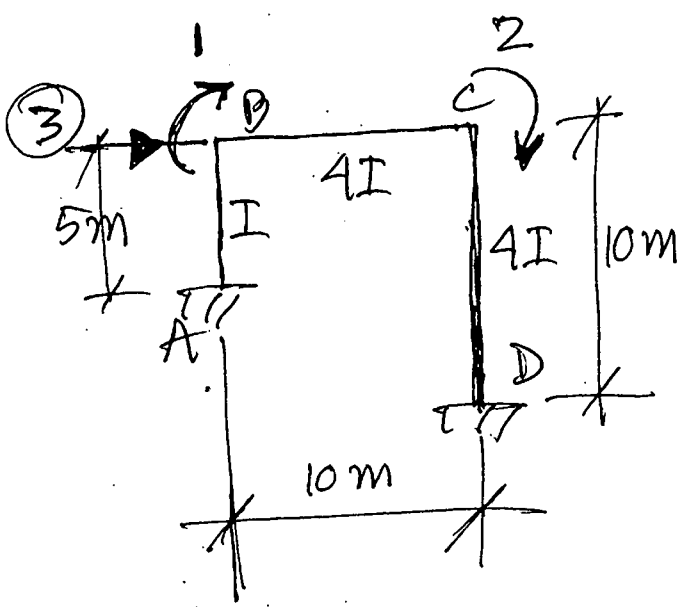


Fig #16

L-4/T-1/ME **Date : 21/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2015-2016

Sub : **ME 467** (Automobile Engineering)

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**.

Abbreviations have their standard meaning.

1. (a) Why do we use an alternator for charging a DC battery in an automobile? An alternator charging light remains ON in the dash board after the engine has started - state two reasons why this may happen. **(10)**

   (b) An automotive battery is designated as: 12 V, 72 Plate, 90 A-h - what do you understand from the specification? **(6)**

   (c) What is an ECU? List the functions that are typically controlled by 'ECU of a modern vehicle. **(9)**

   (d) What is a MAP sensor? Briefly explain its functionality. **(10)**

2. (a) How is power consumption due to aerodynamic drag on a vehicle calculated? Briefly discuss the effect of vehicle velocity and body-shape on aerodynamic drag of a vehicle. **(11)**

   (b) Why do we need to limit a vehicle speed when following a curved track? Deduce expressions for "Overturning" and "Skidding" speeds for taking a turn on a flat curved road. **(14)**

   (c) Briefly explain the following — "Rear Spoiler" and "Rear Defogger". **(10)**

3. (a) Define "Dedicated" and "Retrofitted" CNG vehicles. Which type is common in Bangladesh? List the changes expected in a dedicated NGV. **(12)**

   (b) What do you understand by type-1 and type-2 CNG cylinders? Why do we need to retest automotive CNG cylinders after every 5 years? **(12)**

   (c) List the safety devices typically attached to an automotive CNG storage system. **(5)**

   (d) What do you understand by "Single Wire" configuration used in automobile electrical systems? Why is it used? **(6)**

4. (a) Briefly explain how a compressor is engaged when we put on the "A/C" switch in an automobile. **(10)**

   (b) Compare the construction and function of the "Condenser" of a refrigeration system and the "Radiator" of a water cooling system in an automobile. Comment on their relative placement in a car. **(10)**

   (c) An automotive tyre is designated as — 165/80 R 15 H what do you understand from this tyre specification? **(5)**

   (d) What do you understand by "Radial" tyre? Briefly explain its advantages. **(10)**

Contd P/2

ME 467

SECTION – B

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

5. (a) What are the functions of a clutch in automobiles with manual transmission? Draw a neat diagram and briefly explain the construction and operation of a clutch assembly. **(15)**

(b) How many gears will there be in a 5-speed manual transmission gear box with overdrive? Describe briefly, how gears are engaged in a synchromesh gearbox. **(10)**

(c) Describe the working principle of a band and servo mechanism used in planetary gear set controls of automatic transmission system. **(10)**

6. (a) Describe, with a neat sketch, the construction and operation of a limited/non-ship differential. **(15)**

(b) Explain the term transaxle. Describe a transaxle along with its components. **(10)**

(c) Discuss, with neat sketches, camber, caster, and steering-axis inclination. **(10)**

7. (a) Draw a neat sketch of a liquid-filled shock absorber and describe its construction and working principle. **(15)**

(b) List and compare the various types of front-suspension systems used in automobiles. **(10)**

(c) Name the various types of steering gears. Explain the operation of a rack-and-pinion steering along with its advantages and limitations. **(10)**

8. (a) Why are disc brakes used on front wheels and drum brakes on rear wheels of a small- to medium-sized automobiles? Explain the construction and operation of a floating-caliper disc brake. **(15)**

(b) Discuss the construction of a master cylinder of a dual-braking system with a neat sketch. Why is the size of the master cylinder smaller than that of the slave cylinders? **(10)**

(c) Write short notes on: **(10)**

(i) ABS

(ii) Power-assisted braking

(iii) Overdrive.

L-4/T-1/CE **Date : 21/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2015-2016

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

Full Marks: 280 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **SEVEN** questions in this section. Answer **Q. No 1** & any **FOUR** from the rest.

Assume reasonable values for missing data, if any.

1. Answer any five of the followings.

(a) A manufacturer produces two products X and Y with two machines A and B. The cost of the producing each unit of X is for machine A: 65 minutes and for machine B is 40 minutes. The cost of producing each unit of Y is for machine A: 30 minutes and for machine B: 40 minutes. Working plans for a particular week are: 45 hours of work on machine A and 38 hours of work on machine B. The week starts with a stock of 30 units of X and 95 units of Y, and a demand of 75 units of X and 105 of Y. How to plan the production in order to end the week with the maximum stock. (Use LP model to formulate the problem only.) **(5×8=40)**

(b) State the safety measures that should be taken for hot bituminous works.

(c) State the function of the following construction equipments-Excavator-Asphalt paver-Road Roller.

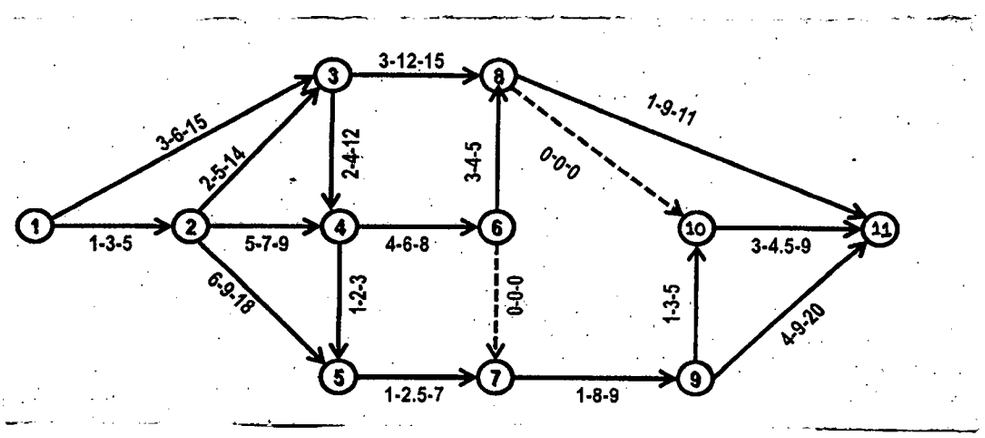
(d) Differentiate between "Forward planning", "Backward planning", and "Combined planning".

(e) What are the steps to follow to make a construction site safe?

(f) Give some examples of personal protective equipment in construction site. Also mention which part of body these equipment will protect?

(g) What are the advantages and limitations of EOI?

2. A construction company has an opportunity to submit a bid for the construction of a new office building. From the specification provided by the client, the PERT network along with the time estimate (in weeks) for each activity are shown in the following Figure. **(25)**



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CE 401

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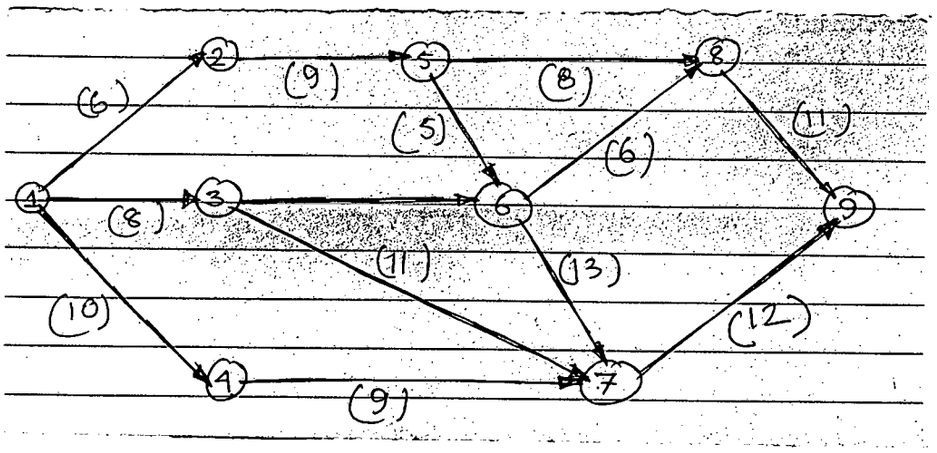
Determine:

(i) Critical path and its standard deviation.

(ii) Duration of completion time for which the company should bid to provide 90% probability of completing the project in time.

3. The network of The Bridge project is shown in the following Figure along with the duration of each activity. Compute activity time and total float of each activity. Locate the critical path in the network. **(25)**



4. (a) Explain the tendering process with a flow diagram. What are the differences between single and two stage tendering? **(13)**

(b) A project consists of 8 activities A to H with their times of completion as follows:

Activity	A	B	C	D	E	F	G	H
Duration (week)	2	4	2	4	6	4	5	4

The precedence relationships are as follows: ⇒ A and B can be performed parallel ⇒C and D cannot start until A is completed ⇒ E cannot start until half the work of activity C is completed. ⇒ F can start only after activity D is complete. ⇒ G succeeds C. ⇒ H is the last activity which should succeed E. **(12)**

(i) Draw the bar chart

(ii) What is the total time of completion of the project?

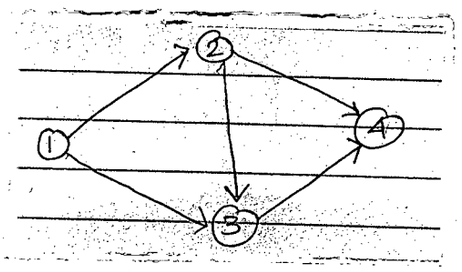
5. (a) Following figure shows the network for a project, the data for the duration and costs of each activity are given in the table. The direct cost is TK 3000 per day. Determine the optimum duration and the corresponding minimum cost of the project. **(25)**

Activity	Normal duration(days)	Normal cost (TK)	Crash duration(days)	Crash cost (TK)
1-2	6	7000	3	14500
1-3	8	4000	5	8500
2-3	4	6000	1	9000
2-4	5	8000	3	15000
3-4	5	5000	3	11000

Contd P/3

CE 401

Contd ... Q. No. 5(a)



6. (a) Civil Engineering Department is preparing a study trip for 400 students. The company who is providing the transportation has 10 Buses of 50 seats each and 8 buses of 40 seats; but only has 9 drivers available. The rent cost for a large bus is USD 800 and USD 600 for the small bus. Calculate how many buses of each type should be used for the trip for the least possible cost using LP model (Using graphical method). **(15)**

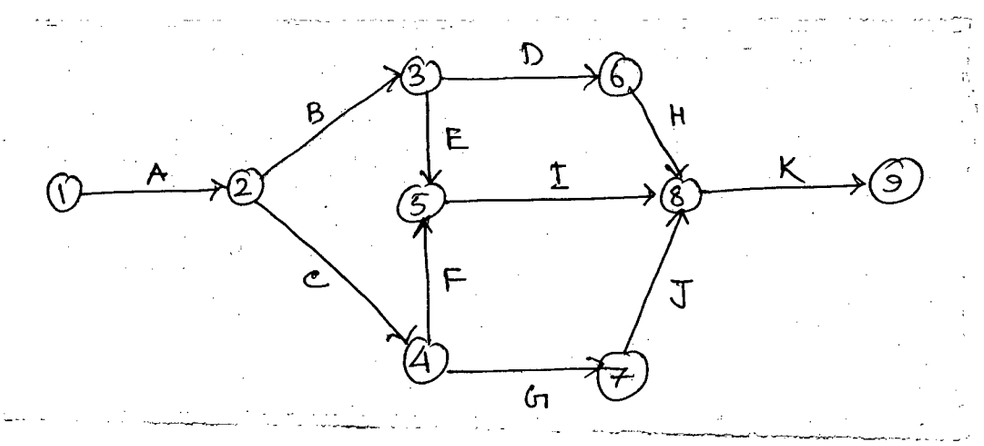
(b) A project plan consisting of ten events have predecessor relationship as follows: **(10)**

Event	Immediate predecessor	Event	Immediate predecessor
1	–	6	3,5
2	1	7	3,4
3	2	8	3,7
4	2	9	7
5	2	10	3,6,8,9

Draw the network diagram based on above information.

7. (a) List the good practices, the owner should follow during tender evaluation. **(10)**

(b) From the following network diagram find the inter-relationships among the activities. **(7)**



(c) What is mile stone chart? How we can convert mile stone chart into network diagram-explain. **(8)**

CE 401

SECTION-B

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

Assume values for missing data if necessary

8. (a) Explain the meaning and significance of opportunity cost of capital and the Sinking Fund Factor. What is a "Sensitivity Analysis? **(23⅔)**

In a metropolitan area, new traffic signals were installed at 40 intersections. Accident data were analyzed for two years before and after the installation at each site. There were significant changes in accidents at those sites with a reduction of accidents, from 7.5 accidents per site per year to 2.0 accidents. evaluate the program of signal installation using Net Present Value and Benefit Cost Ratio methods, given the following data:

Capital Costs of Signal Installation: $ 100,000 per intersection

Operating and maintenance costs: $ 10,000 per intersection per year.

Appraisal period: 6 years.

Discount Rate: 8 percent

Average cost of an accident: $ 45,000

Expected Residual value: $ 15,000

Assume all the data if necessary.

(b) Explain the elements of the process of management and state the principles connected with "management organization" and "motivation". List the key factors in (i) Departmentation , (ii) Span of control and (iii) Influencing. **(23)**

9. (a) State your understanding about the meaning and activities of a project. Discuss different aspects of project preparation and list the essential components that should be considered in preparing a feasibility report of a superhighway type project. State the importance of civil engineering leadership in managing the infrastructure projects in the government sector. **(24⅔)**

(b) Briefly discuss the most commonly used methods/measures for evaluating capital investments in development projects. **(22)**

What is the yield for a project where $ 300,000 is invested to produce an average cash flows of $ 60,000 p.a. over its economic life of 7 years with an expected salvage value of $ 10,000?

10. (a) What is the difference between a working group and an effective team. How should you respond if one of your direct report complains about workplace bulling? **(24⅔)**

(b) Show the algorithm for using conflict for improving team outcomes. What are the components of emotional intelligence? Explain in detail with a definition of the term emotional intelligence. **(22)**

Contd P/5

CE 401

11. (a) Define the terms "Inventory" and "Throughput" and discuss the advantages and disadvantages of having inventory. What is an environmental management plan (EMP) for a project and what are its components? **(20)**

(b) The task duration for three of your teams to perform a work are 623 seconds, 665 seconds and 602 seconds. What is the average labour utilization? **(8⅔)**

(c) Define and discuss the following: **(18)**

(i) Concept and importance of morale

(ii) Matching jobs and individuals and

(iii) Delegation of authority and responsibility.

Standard Normal Distribution Function

Z (+)	Probability (P_r)(%)	Z (−)	Probability (P_r) (%)
0	50·0	0	50·0
+0·1	53·98	−0·1	46·02
+0·2	57·93	−0·2	42·07
+0·3	61·79	−0·3	38·21
+0·4	65·54	−0·4	34·46
+0·5	69·15	−0·5	30·85
+0·6	72·57	−0·6	27·43
+0·7	75·80	−0·7	24·20
+0·8	78·81	−0·8	21·19
+0·9	81·59	−0·9	18·41
+1·0	84·13	−1·0	~~15·87~~ 15·7
+1·1	86·43	−1·1	13·57
+1·2	88·49	−1·2	11·51
+1·3	90·32	−1·3	9·68
+1·4	91·92	−1·4	8·08
+1·5	93·32	−1·5	6·68
+1·6	94·52	−1·6	5·48
+1·7	95·54	−1·7	4·46
+1·8	96·41	−1·8	3·59
+1·9	97·13	−1·9	2·87
+2·0	97·72	−2·0	2·28
+2·1	98·21	−2·1	1·79
+2·2	98·61	−2·2	1·39
+2·3	98·93	−2·3	1·07
+2·4	99·18	−2·4	0·82
+2·5	99·38	−2·5	0·62
+2·6	99·53	−2·6	0·47
+2·7	99·65	−2·7	0·35
+2·8	99·74	−2·8	0·26
+2·9	99·81	−2·9	0·19
+3·0	99·87	−3·0	0·13

L-4/T-1/CE **Date : 30/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2015-2016

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 design **Table-1** and **Chart-1**, as and when necessary.

Assume any reasonable value of missing data, if any.

1. (a) Calculate the axial compressive capacity of the drilled pier using AASHTO Method and draw necessary sketches. **(25)**

Given: Diameter of the driller pier = 30 inch., Length of the drilled pier = 60 ft.
Top of the drilled pier = 5 ft. below ground level, Water Table: 10 ft. below EGL,
Unit wt. of soil: 120 pcf;
SPT Values are:

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

(b) Write down the properties of underwater concrete. Discuss briefly underwater concreting methodology for a drilled pier. **(10)**

2. (a) A Pile group consisting of 20 piles is subjected to eccentric load. Calculate the loads on 4 corner piles. Draw necessary sketches. **(20)**

Given:

Vertical load = 1000 ton
Center to center spacing of piles = 4 ft.
Eccentricity in short direction = 2 ft.
Eccentricity in long direction = 3 ft.
Thickness of the pile cap = 5 ft.
Soil above the pile = 4 ft.
Unit weight of the pile = 120 pcf
Pile cap is extended 2 ft. from center of corner piles.
Water table is below 10 ft. from ground level.

(b) Calculate the vertical compressive capacity of the driven pile and draw necessary sketches. **(15)**

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:

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 $N_q = 60$ for $\phi = 35°$, $N_q = 80$ for $\phi = 40°$, $D_c = 20$ ft.

Contd P/2

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3. (a) For a raft foundation resting on over consolidated clay following data are given: **(25)**

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 over burden pressure = 7000 psf,
Below 30 ft.	dense sand,
Water table	at 20 ft.

Foundation:

Raft foundation, size = 80 ft × 100 ft, depth = 14 ft. below ground level,
Gross contact pressure = 4000 psf.
Draw a net sketch showing the stated condition.
Calculate the settlement of the raft at corner and at center due to clay layer.
Divide the thick clay layer into two layers for settlement calculation.

(b) For a raft foundation resting on clay following data are given: **(10)**

Raft foundation width = 100 ft.
Raft foundation length = 150 ft.
Depth of raft foundation = 20 ft. below ground level
Gross contact pressure = 4 ksf and 5 ksf

Deep deposit of clay, unconfined compression strength 4 ksf
Water table = 25 ft. below GL
Unit wt. of soil: 120 pcf

Draw plan and section of the raft foundation.
Calculate the factor of safety of the raft foundation.

D_f / B	0.0	0.5	1.0	1.5	2.0	3.0	4.0
N_c (Strip)	5.2	5.9	6.4	6.8	7.2	7.5	7.5

4. (a)For a footing resting on sand following data are given: **(15)**

Footing size: 10 ft. × 10 ft.
Column load: 200 kip
Depth of the footing: 5 ft.
Thickness of footing: 2 ft. 6 inch
Water Table: 10 ft. below EGL
Unit wt. of soil: 120 pcf
SPT Values:

Depth	2.5 ft.	5 ft.	7.5 ft.	10 ft.	12.5 ft.	15 ft.	17.5 ft.	20 ft.	25 ft.
N (corrected)	20	20	20	20	20	20	20	20	20

Calculate the factor of safety against bearing capacity and settlement of the foundation.

(b) Write short notes: **(20)**

(i) Well point dewatering system
(ii) Engineering News formula
(iii) Pile load test
(iv) Negative skin friction.

Contd P/3

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SECTION-B

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

5. (a) Mention the purpose and significance of sub-soil exploration. **(10)**

(b) Discuss the relative advantages and limitations of different methods of exploratory boring. Also outline the boring method which is mostly used in Bangladesh. **(8+5)**

(c) A raft foundation, 30 ft wide and 50 ft long, is to be placed 10 ft below the surface of the surrounding ground. Exploratory borings indicated that the sub-soil consists of uniform find sand up to a depth of 40 ft below which a rock layer exists. The minimum average standard penetration resistance between depths of 10 and 40 ft, corrected for overburden pressure, is 19 blows/ft. The water table is located at 10 ft below the ground surface. If the structure is to have a basement and if the sand layer has a saturated unit weight of 100 pcf, determine the maximum soil pressure that should be allowed at the base of the raft? **(12)**

6. (a) Mention the use of disturbed and undisturbed soil samples for various laboratory tests. **(8)**

(b) During a sub-soil exploration, the SPT-N value of a clay layer at a depth of 20 ft was recorded as 10. Later, an inspection of the drilling equipments revealed that the hammer used by the driller is 20 lb less than the standard weight. Is there any way to correct the measured SPT-N value? If so, give justification of the correction procedure and determine the corrected SPT-N value. **(5)**

(c) What is a borelog? Schematically show a borelog and discuss different information that are usually placed in a borelog. **(3+9)**

(d) What is the significance of recording water table in a sub-soil exploration? Observation of water table was intended in a borehole made in silty sub-soil (i.e. soils with moderate permeability) by Hvorslev's method. Accordingly, water was bailed out of the borehole and depths of the water levels in the borehole were recorded at 24 hour intervals (data given in the table below). **(4+6)**

Time elapsed, hr	Depth of water level from the ground surface, m
0	9.5
24	8.5
48	7.7
72	7.2

Determine, the depth of water table. Relevant formulae for the method are:

$$h_o = \frac{\Delta h_1^2}{\Delta h_1 - \Delta h_2}, h_2 = \frac{\Delta h_2^2}{\Delta h_1 - \Delta h_2}, h_3 = \frac{\Delta h_3^2}{\Delta h_2 - \Delta h_3}$$

The notations represent their usual meanings.

Contd P/4

CE 441

7. (a) Write short notes on (i) Electrical resistivity survey (ii) Cone penetration test **(12)**

(b) An oil tank, 80 ft in diameter, is planned to be constructed that will exert 500 psf pressure on the ground surface. The subsoil at the site consists of an upper sand layer underlain by a soft clay layer as shown in Fig. 1. A hard clay deposit is found to exist below the soft clay layer. Available soil parameters are shown in the Figure. Estimate the settlement of the center of the tank. **(13)**

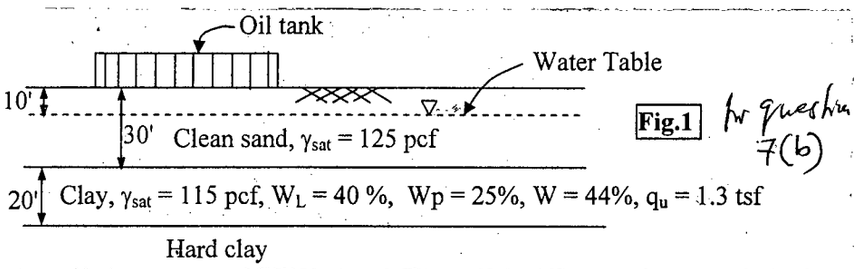


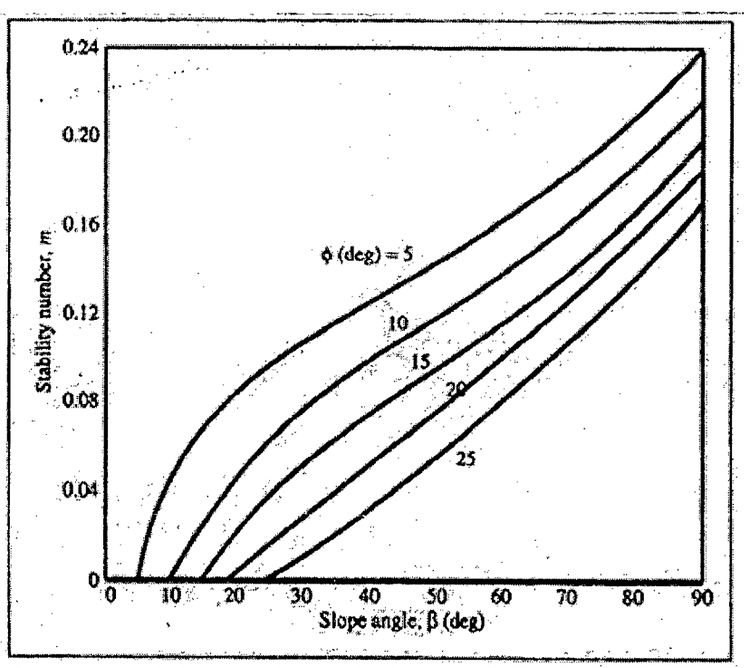
Fig.1 for question 7(b)

(c) Analytically show that for an infinite slope made of soils having both cohesion and friction, there is a critical depth beyond which stability cannot be attained, whereas for soils having only friction there is no such critical depth. **(10)**

8. (a) A road embankment is to be constructed with a side slope of $\beta = 45°$. The embankment soil is homogeneous and has effective stress parameters of $\phi = 20°$, $c = 25$ kN/m^2. The unit weight of the compacted soil will be 18 kN/m^3. Using Taylor's method determine: (i) critical height of the slope and (ii) factor of safety with respect to strength if the height of the slope is 10 m, (Chart for Taylor's method is provided in Fig. 2) **(12)**

(b) State the assumptions and limitations of the 'Ordinary method of slices' and 'Bishop's simplified method of slices' for slope stability analyses. **(7)**

(c) Distinguish between 'net ultimate bearing capacity' and 'gross ultimate bearing capacity' showing equations for clay soil. State the assumptions behind these bearing capacity equations. Also discuss the effect of B/L on the bearing capacity factor for foundations on clay. **(6+5+5)**



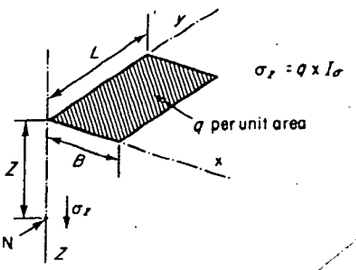
for Ques. 8(a)

Fig.2 Plot of stability number with slope angle, $\phi > 0$ (after Taylor, 1937)

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



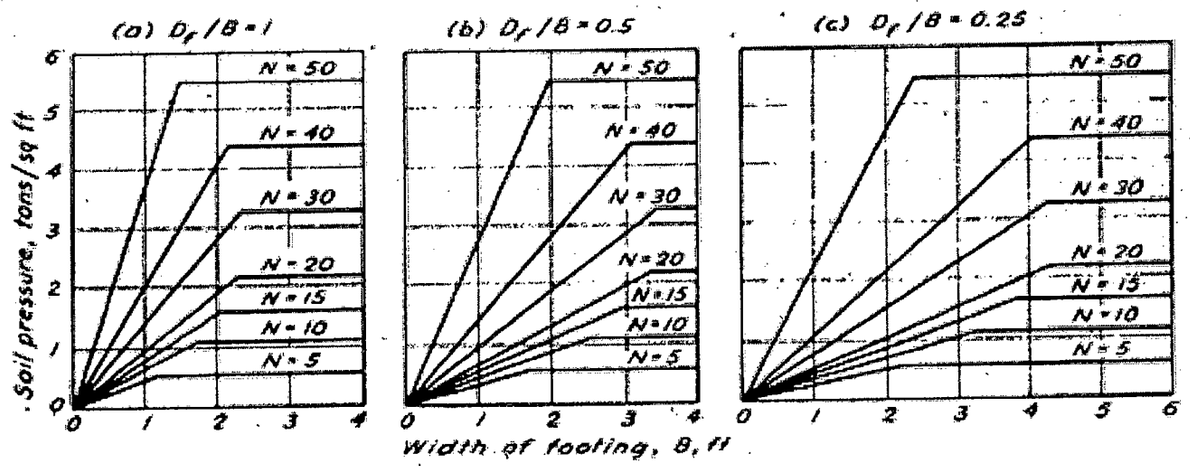


Chart 1 FIGURE Design chart for proportioning shallow footings on sand.

L-4/T-1/CE **Date : 05/02/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2015-2016

Sub : **CE 451** (Transportation Engineering II: Pavement Design and Railway 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) What is Engineered Earth road? Discuss its suitability under Bangladesh rural setting. Illustrate the features of Natural Gravel Surface, Lime stabilized Natural surface and Stone Chippings Surface as low cost road option. Discuss features of four commonly used low cost road surface in Bangladesh. **(23)**

   (b) Compare among different bituminous seal options: Chip Seal, Sand Seal, Slurry Seal and graded Aggregate Seal. Also, make a comparative table putting road surface options of Water Bound Macadam, Penetration Macadam, and Dense Bituminous Surface Treatment (DBST) in column 1 and putting materials used, Construction steps and equipment used in 2nd, 3rd and 4th column respectively. Explain general crack repair scheme for various sizes of cracks in flexible pavement. **(23⅔)**

2. (a) Explain construction site mobilization task and responsibility of owning agency's and contractor's Engineers in mobilization process. Explain techniques of temporary erosion control measures in road/bridge construction site. Also, explain quality control and assurance tests, methods, and allowable variations for earth road embankment construction in cases of– i) Compaction control ii) Dimension/Geometry control. **(23)**

   (b) Discuss Batch Mixing and continuous Mixing plant methods of bituminous concrete mix preparation. What are the surface evaluation check after construction of bituminous pavement? Write down eight important construction measures for rigid pavement construction and mention the critical factors for cement concrete paving. **(23⅔)**

3. (a) Define Gauge of Railway. Briefly explain the factors affecting choice of gauge. State the principle of Maglev train. Write short notes on check Rail and Track Circuiting. Briefly discuss the advantage and disadvantage of concrete sleepers. **(23)**

   (b) Write short notes on interlocking mentioning the fundamental principles of interlocking. **(23⅔)**

Contd P/2

CE 451

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

Calculate the maximum permissible payload (excluding of locomotive's weight) that a B. G. locomotive with 3 pairs of driving wheels with axle load of 20 tons each on a straight level track at a speed of 70 kmph. Calculate the reduction in speed if the train has to run on a rising gradient of 1 in 120. Also calculate the compensated grade if a 5° curve is to be laid on the rising gradient. Assume, coefficient of friction as 0.2

4. (a) State the major functions of Sleeper and Ballast. What are the typical causes and symptoms of embankment failure? What are the requirements of Ideal Fastening? Classify Yards and Stations. **(23)**

(b) Draw a schematic diagram of a simple Right Hand Turnout showing the principal parts. What are the advantages and limitations of Long Rail? **(23⅔)**

Bangladesh, India and Sri Lanka have adopted a standard rail length for B. G. track. If 45 kg rail is used in a particular B. G. track in Rajshahi; what is the total weight of each individual rail girder? What maximum axle load can be safely imposed on that track? If length of a rail is 14 yard and the track is meter gauge, what is the minimum sleeper density per rail?

SECTION-B

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

5. (a) Broadly classify pavements. Draw typical cross sections for flexible, rigid, semi-rigid pavements. Differentiate between flexible and rigid pavements with respect to distribution mechanism, Aggregate type & Module of Elasticity. Write short notes on 'Perpetual pavement' and 'Polymer Modified Binder (PMB)'. Briefly state the significance of PMB use in Bangladesh. **(4+6+6+4+2=22)**

(b) Mention four important places where rigid pavement is recommended. Joint-wise classify rigid pavement. Write down two important benefits of continuously reinforced rigid pavement (CRCP)? What special considerations are needed for odd-shaped panel? Schematically show the reinforcement details of rigid pavement also show construction & contraction joints. **(2+3+2+3+5=15)**

(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.

Contd P/3

CE 451

Contd... Q. No. 5 (c)

Determine the pavement layer thickness by using RHD flexible pavement design guide method. Consider annual traffic growth rate 10% and design period 20 years. Use Base type II. Necessary Tables are given at the end of the question paper. **(9⅔)**

Vehicle Categories	Base year Two-way Flow/day
Heavy truck	60
Medium truck	400
Light truck	200
Large bus	300

6. (a) Write down four common modes of distresses of flexible and rigid pavements. What are the problems associated with pavement 'Fatigue Cracking' and main causes of this distress? State the ways of removing 'Bleeding of bituminous pavement'? Write down the sequences of pavement failure under submerged condition in Bangladesh. Why joints are used in rigid pavement? **(4+4+2+6+2=18)**

(b) What were the purposes and outcomes of AASHO road test? What is standard axle load? A truck in an intercity road applies 24 Kip and 16 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+4=10)**

(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. **(18⅔)**

Truck Axle Load Distributions			
Axle Load Groups (kip)	Number of Axles, N	Axle Load Groups (kip	Number of Axles, N
Single Axles		**Tandem Axle**	
22	6,500	32	1,25,000
24	15,000	36	2,00,000

Modulus of Sub grade Reaction, k:	100 pci
Modulus of Rupture, MR:	550 psi
Load Safety Factor:	1.2
Doweled joints:	Yes
Concrete Shoulder:	No
Untreated Subbase:	6 in

Contd P/4

CE 451

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

Effect of Untreated Subbase on k Values,

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

7. (a) What are the most important properties of aggregates used for highway construction? Briefly state the importance of aggregate grading and the methods to obtain a specified grading. **(16⅔)**

(b) What are the laboratory tests for bituminous materials in road constructions? What were the requirements of Asphalt Cement for overlay mixes? **(15)**

(c) What are the major classifications of asphalt binder? Briefly state performance grade binder, list test parameters and equipment needed for superpave binder test. **(15)**

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

(b) How to find CKE and surface capacity in the Hveem method of mix design? An asphaltic concrete sample cut from a completed pavement weighs 3540 gm in air and 1962 gm in water. The laboratory compacted specimen of the same mix has a bulk specific gravity G_{mb} of 2.384 and voids percent of 5.5 percent. Find the % air voids in the field sample. Is the mix satisfactory? **(18⅔)**

(c) What are the general steps for determining optimum/design binder content in any mix design method? Compare Marshall and Hveem method with regard to test schedule and design criteria for heavy traffic. **(16)**

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						
30 - 40		125		250	300	250		
25 - 30		110						
17 - 25		105				200		
15 - 17		95						
11 - 15		90						
9 - 11		80		200	250			
7 - 9		70						
6 - 7		65						
5 - 6		60						
4 - 5		55						
3 - 4		45		175	200	175		
< 3		35		150	175	150		

* 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

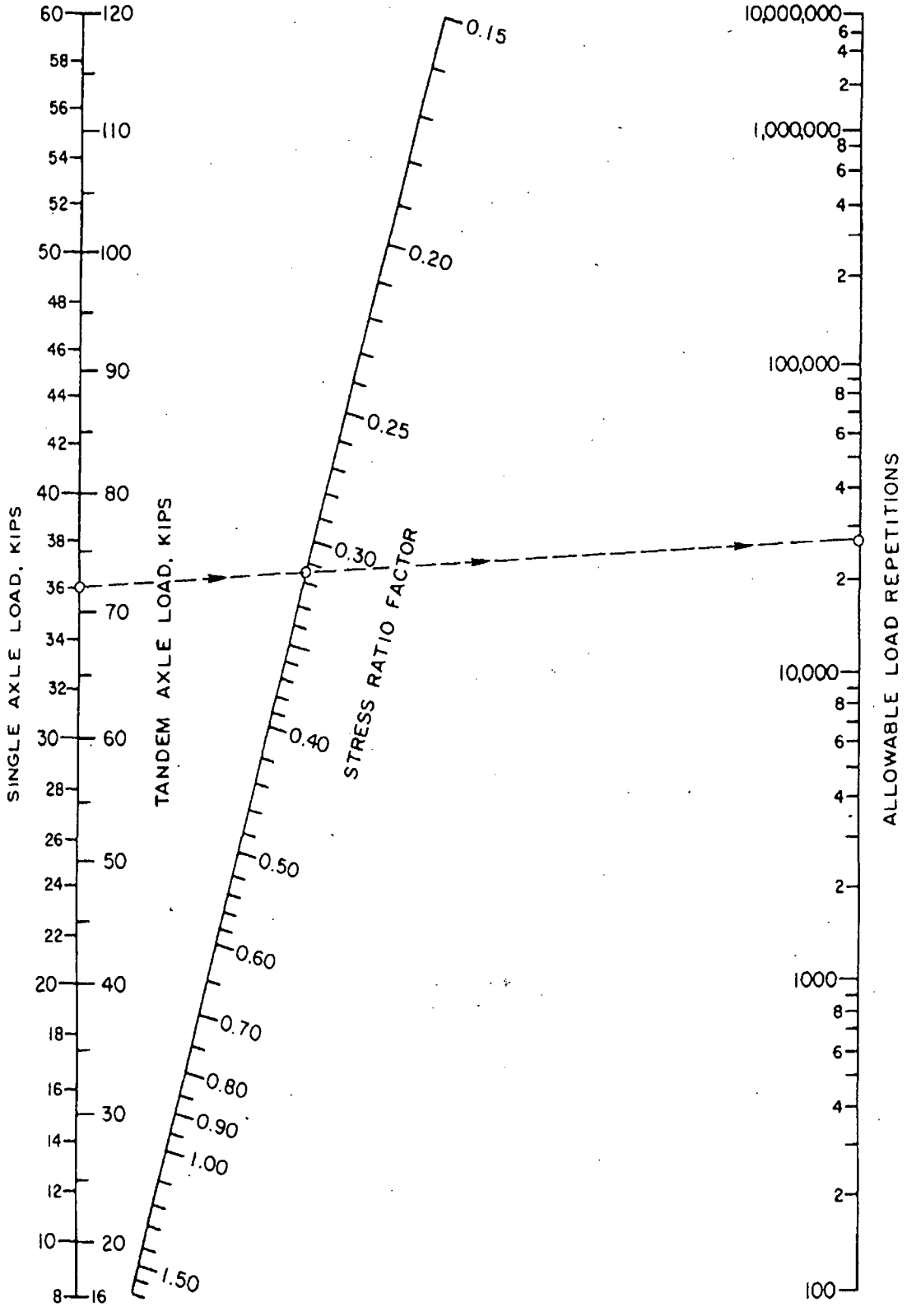
For Q 6(c)

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

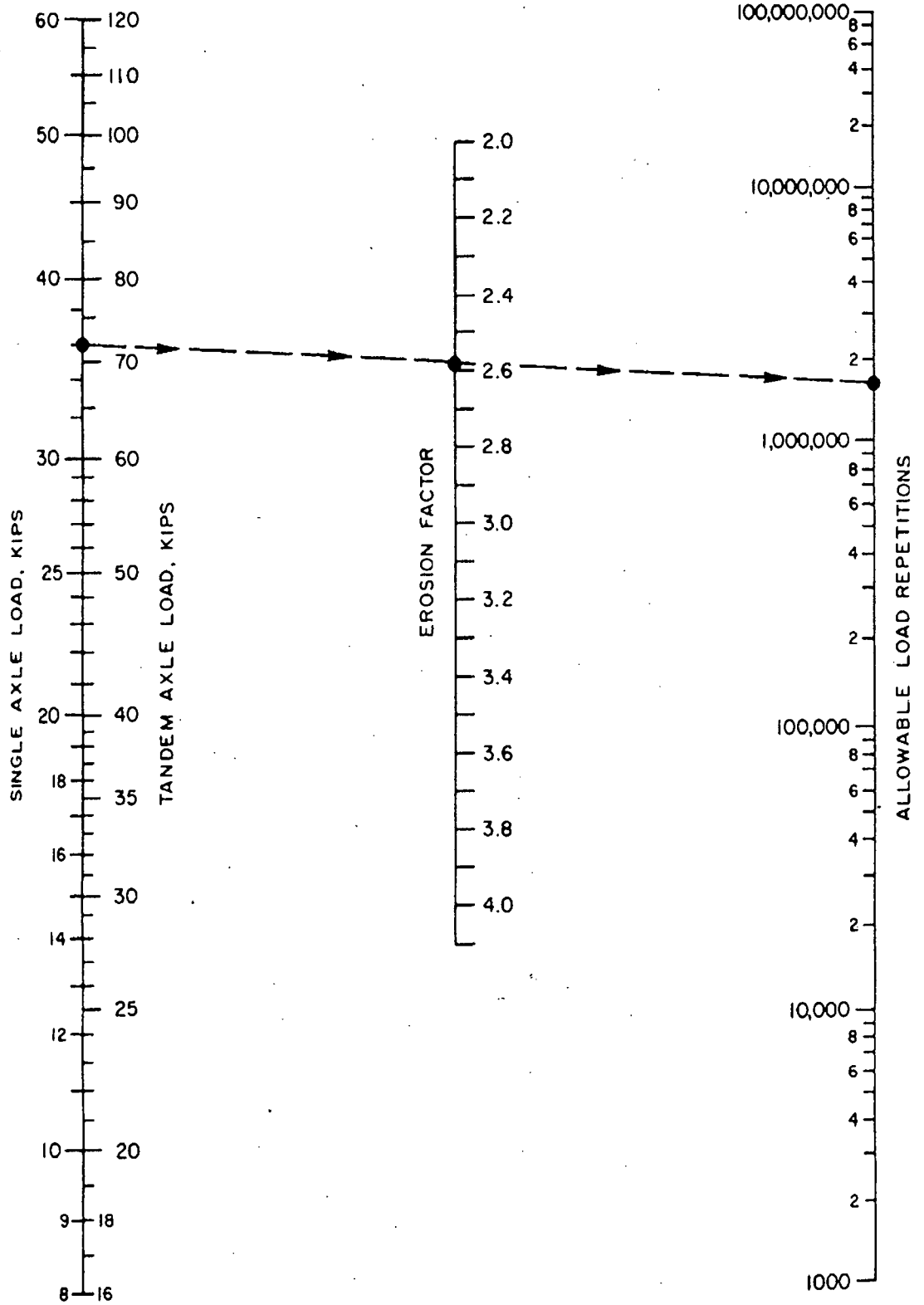
Slab thickness, in.	*k* of subgrade-subbase, pci						
	50	100	150	200	300	500	700
4	825/679	726/585	671/542	634/516	584/486	523/457	484/443
4.5	699/586	616/500	571/460	540/435	498/406	448/378	417/363
5	602/516	531/436	493/399	467/376	432/349	390/321	363/307
5.5	526/461	464/387	431/353	409/331	379/305	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	