4-1

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2021
Program: B.Sc. Engineering (Civil)

Course Title: Project Planning and Management — Course Code: CE 401
Time: 3 Hours — Credit Hours: 3.00 — Full Marks: 150

Answer all the questions.

1. (i) What are the provisions to extend Tender Validity Period? Briefly describe in accordance with Public Procurement Rules (PPR), 2006. **[7.5]**

(ii) "The ultimate goal of e-Government Procurement is *Public Spending Optimization.*". Discuss the goals of e-Government Procurement system in context to the above quoted statement. **[7.5]**

2. The network of a construction project is shown in **Fig. 1**, along with the duration of each activity.

(i) Compute the followings:

(a) Earliest and Latest Event Time of each activity. **[15]**

(b) Activity Time (EST, EFT, LST, LFT) of each activity. **[15]**

(c) Total Float of each activity. **[5]**

(ii) Locate the critical path on the network. **[5]**

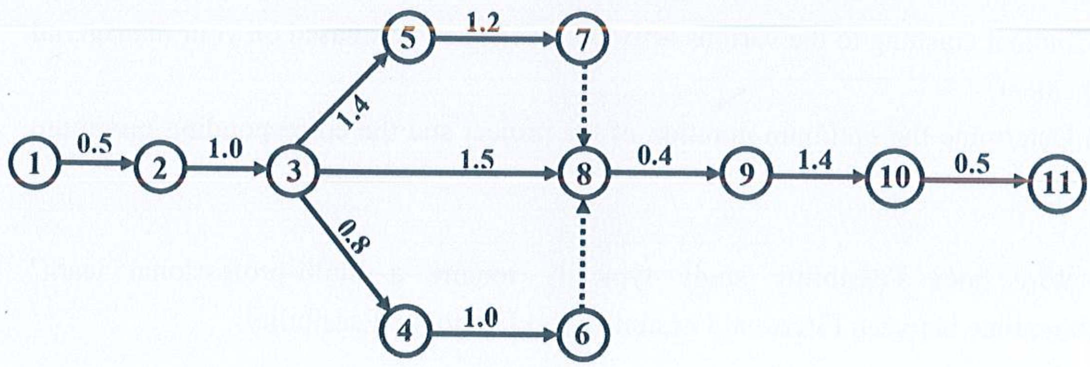

Fig. 1

3. Suppose you are the Project Manager of a reputed construction company in Bangladesh. For one of your upcoming projects, the Assistant Project Manager has prepared the network diagram including the estimated durations for various activities. You have seen the network and found that these activities can be completed in lesser time than estimated by Assistant Project Manager. You have edited the network as shown in **Fig. 2**, with the normal duration of each activity entered below its activity arrow, while the crash duration entered in the bracket. The data for the duration and costs of each activity are given in **Table 1**. The indirect cost of the project is Tk. 3000 per week.

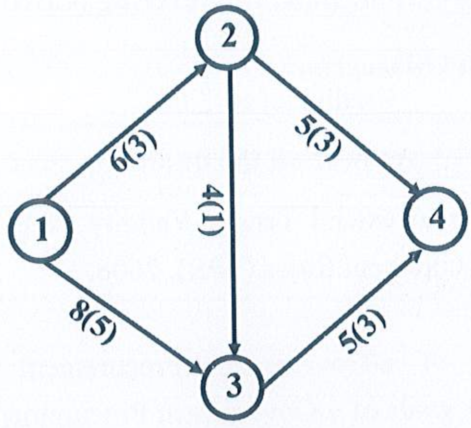

Fig. 2

Table 1

Activity	Normal Duration (weeks)	Normal Cost (Tk.)	Crash Duration (weeks)	Crash Cost (Tk.)
1 - 2	6	7,000	3	14,500
1 - 3	8	4,000	5	8,500
2 - 3	4	6,000	1	9,000
2 - 4	5	8,000	3	15,000
3 - 4	5	5,000	3	11,000

(i) Conduct crashing to the various activities of the network based on your managerial judgement. **[20]**

(ii) Determine the optimum duration of the project and the corresponding minimum cost. **[10]**

4. (i) Why does Feasibility study typically require a multi-professional team? Differentiate between Financial Feasibility and Economic Feasibility. **[5+10]**

(ii) Mr. 'X' is the Purchasing Officer of "ABC Construction Company Ltd.". This year he is going to purchase a new construction equipment for his company. As the manufacturer of the equipment sells their products in installments also, Mr. 'X' can pay one time or in installments. For one-time payment, he has to pay $7,500 now to get the equipment. If he pays in installments, he has to pay $3,000 in this year and $2,000 per year in the next 3 consecutive years. Which payment option (one-time or installment) is more profitable for "ABC Construction Company Ltd."? Using a discount rate of 5%, analyze based on Present Value. **[15]**

5. (i) Using graphical representation show the relation of Holding, Ordering and Total Cost with Order Quantity. **[15]**

(ii) The "XYZ Equipment Company" estimates its annual holding cost at 15% of its acquisition cost and ordering cost at $9 per order. The estimated half yearly requirement is 24,000 units at a price of $4 per unit. Calculate the followings:

(a) What is the most Economical Order Quantity (EOQ)? **[10]**

(b) How many orders should be placed in a year? **[05]**

(c) How often should an order be placed? **[05]**

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University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2021
Program: B.Sc. Engineering (Civil)

Course Title: Structural Engineering III   Credit Hours: 3.0   Course Code: CE 411
Time: 3 hours   Full Marks: 100 (10× 10)

ANSWER ALL THE QUESTIONS. Any missing data can be assumed reasonably.

1. Use the Energy Method to calculate the load (i) ***P*** needed to form beam mechanism, (ii) ***w*** needed to form the sidesway mechanism in the frame ***abcde*** loaded as shown in ***Fig.1***
[Given: $M_{P(beam)} = 100$ *k-ft*, $M_{P(column)} = 200$ *k-ft]*.

2. Frame structure ***abcde*** shown in ***Fig.2*** is subjected to a dynamic load, $w = 10t^2$ (*k/ft*).
Use *Constant Average Acceleration* (CAA) Method to calculate the rotation of joint ***c*** at time $t = 0.10$ sec
[Given: $EI = 43\times10^4$ *k-ft*², $\mu = 0.0043$ *k-sec²/ft²*, *Damping ratio of the system* = *4.3%*].

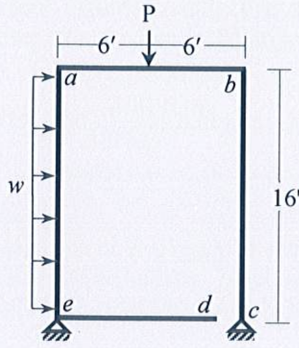


Fig.1

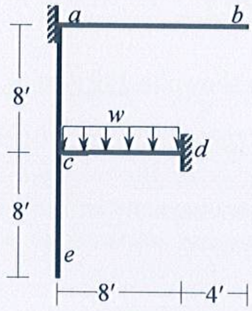


Fig.2

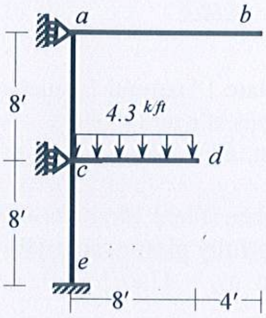


Fig.3

3. Use Stiffness Method considering geometric nonlinearity and flexural deformations only to calculate the unknown rotation at ***a*** and ***c*** of the frame ***abcde*** loaded as shown in ***Fig.3*** [Given: $EI = 43 \times 10^3$ *k-ft*²].

4. Identify zero-force members of the 2D truss loaded as shown in ***Fig.4***. Determine the displacements of joints ***a*** and ***b***. Also, calculate member forces [Given: *EA/L =4300 k/ft*].

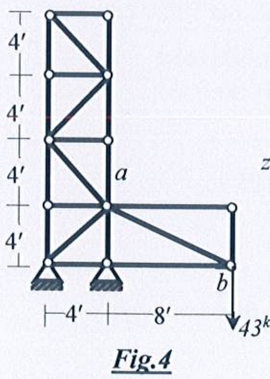


Fig.4

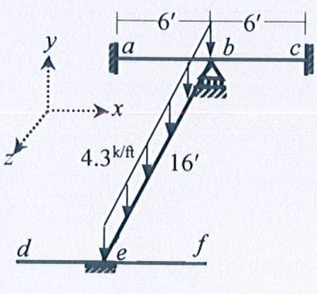


Fig.5

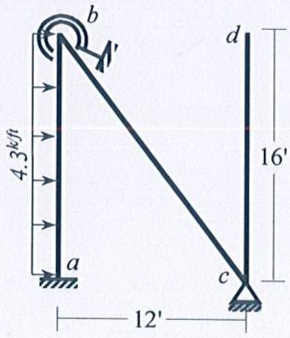


Fig.6

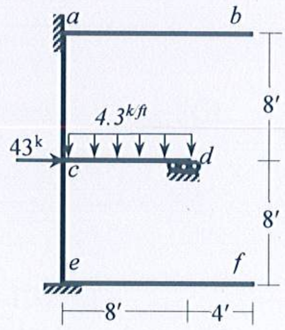


Fig.7

5. Use stiffness method to calculate rotations θ_x and θ_z of joint ***b*** of the grid system ***abcdef*** loaded as shown in ***Fig.5*** [Given: EI = 43×10^3 k-ft² and GJ = 43×10^3 k-ft²].

6. Use Stiffness Method (neglect axial deformations) to calculate rotation of joint ***b*** of the frame loaded as shown in ***Fig.6***, if the joint ***b*** is a circular foundation of radius 4 ft on the surface of subsoil (half-space) with shear wave velocity (v_s) equals to 860 ft/sec
[Given: $EI = 43 \times 10^3$ *k-ft*², $\gamma_{soil} = 120$ *pcf, Poisson's ratio of soil,* $\nu = 0.25$]

7. Use Stiffness Method considering geometric nonlinearity and flexural deformations only to calculate the unknown rotation at ***c*** and displacement at ***d*** of the frame ***abcdef*** loaded as shown in ***Fig.7***
[Given: $EI = 43 \times 10^3$ *k-ft*²].

8. Determine the degree of kinematic indeterminacy (**doki**) and show the corresponding deflections and rotations of the 2D frame (***Fig.2***) and 3D frame (***Fig.8***) for the following cases
   (i) Not considering boundary conditions
   (ii) Considering boundary conditions
   (iii) Neglecting axial deformations.

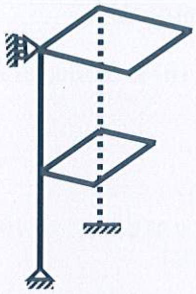


Fig.8

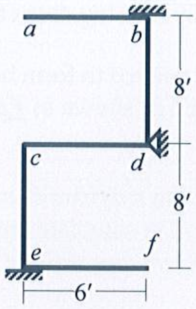


Fig.9

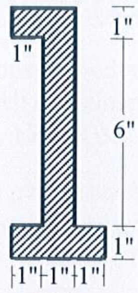


Fig.10

9. Calculate 1[st] natural frequency of the frame shown in ***Fig.9*** using consistent mass matrices (Considering rotations at ***c*** and ***d*** only)
   [Given: $EI = 43 \times 10^3$ *k/ft*, $\mu = 0.0043$ *k-sec²/ft²*].

10. Calculate Yield Moment and Plastic Moment capacity of the section shown in ***Fig.10*** if it is made of elastic-fully plastic material
    [Given: $\sigma_{yp} = 43$ *ksi*].

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2021
Program: B. Sc. Engineering (Civil)

Course Title: Geotechnical Engineering II | Course Code: CE 441
Time: 3 Hours | Credit Hours: 3.0 | Full Marks: 120

Answer all the questions

1. (a) What is subsurface exploration in terms of geotechnical engineering? Mention four purposes of geotechnical subsurface exploration. 6

(b) What preliminary information should be available to a good geotechnical engineer to execute a subsurface exploration program for a multi-span bridge project. 2

(c) Write down any three general guidelines used for the selection of depth of boreholes for different civil engineering projects. 3

(d) For a site actual depth of geotechnical exploration is maintained as $2.5D + D_f$. Utilizing 10% stress criterion and the following information, check, whether this depth of exploration is adequate. Justify your answer. 9

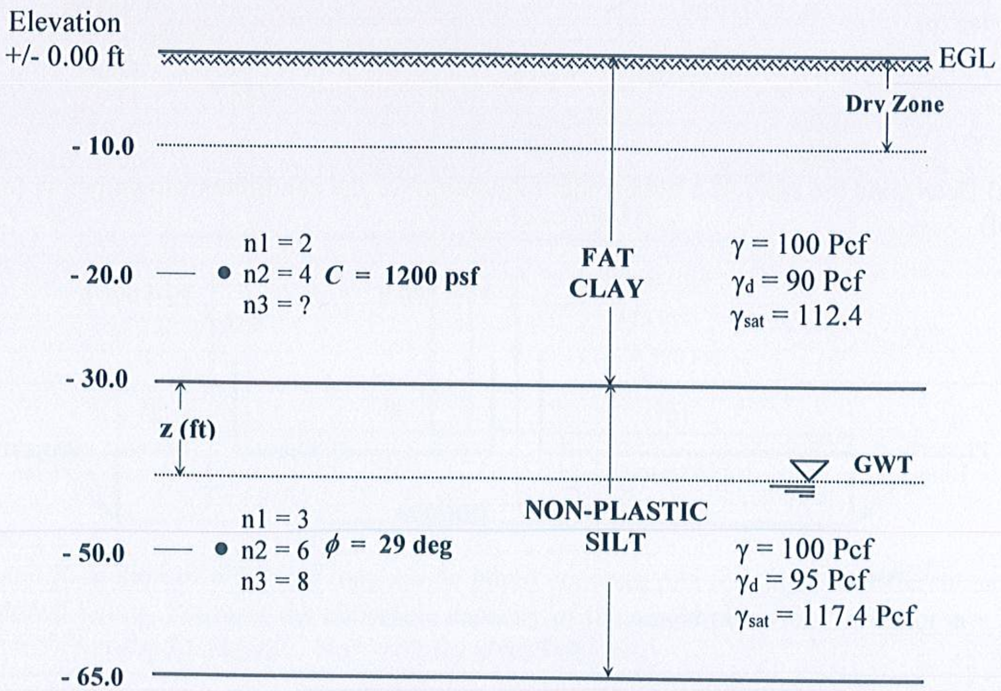
Circular foundation system.
P_{max} = 400 Kips
q_a = 4.0 ksf
Foundation bearing level is to be 10 feet below EGL.

2. (a) Write down the names of any five (5) in-situ testing performed in the field under the field investigation phase of a sub-surface exploration program. Write a very short note on the one frequently used in Bangladesh? 3

(b) A geotechnical site investigation was conducted at a site in Bangladesh. Estimate n3 at corresponding depth of 20 ft below EGL. Also estimate z as shown in the figure below. Use *APPENDIX A* in conjunction with the following information: 12

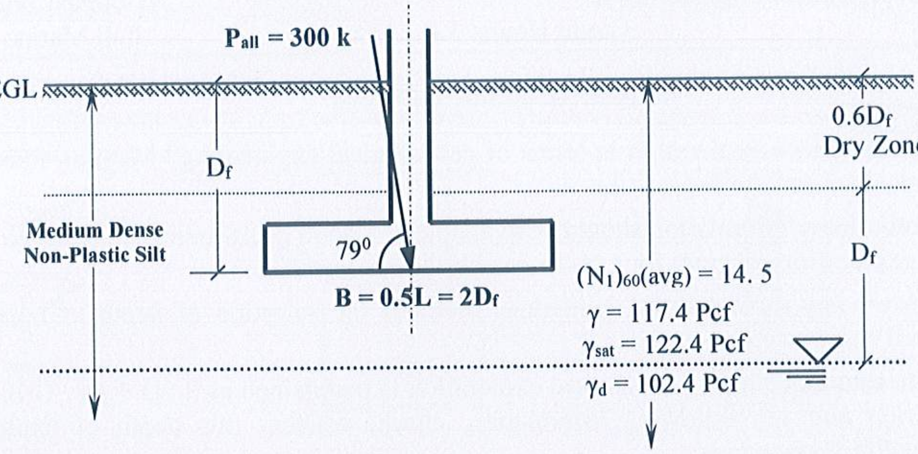
- Borehole dia = 4 inches
- No liner was used during drilling
- Hammer efficiency as 52.6%

n1 = SPT blow counts for first 6-inch penetration
n2 = SPT blow counts for second 6-inch penetration
n3 = SPT blow counts for third 6-inch penetration

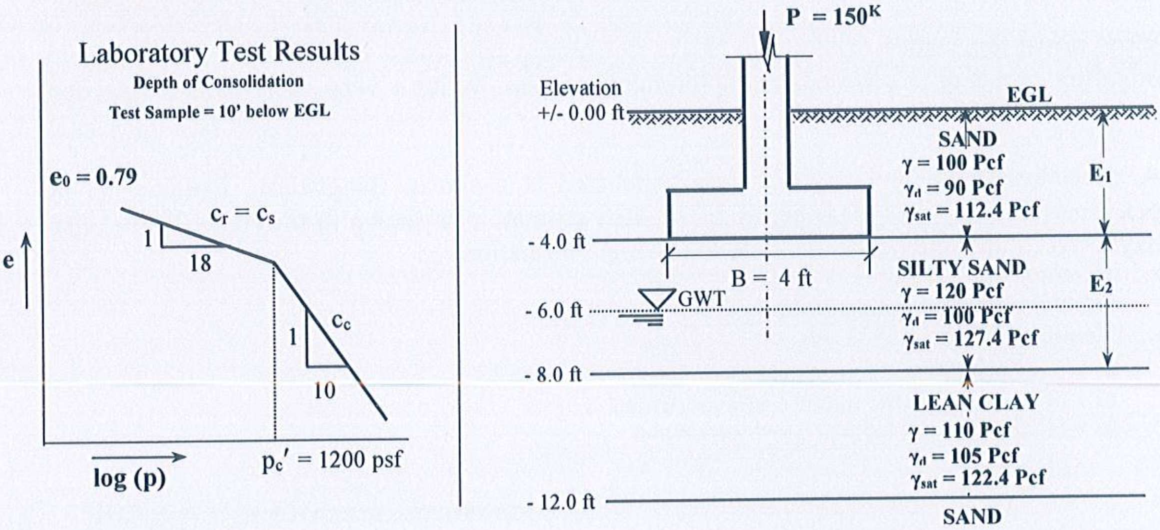


Subsurface Soil Stratigraphy

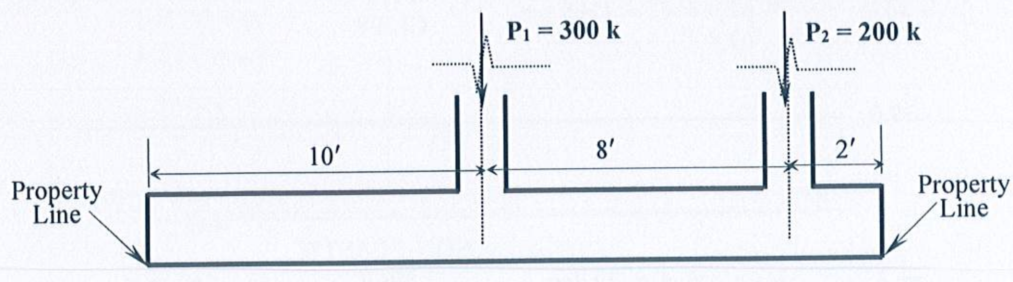
3. (a) Using general bearing capacity equation, determine the size of the individual column rectangular spread footing for the following condition. Use F. S. = 2.5. 12



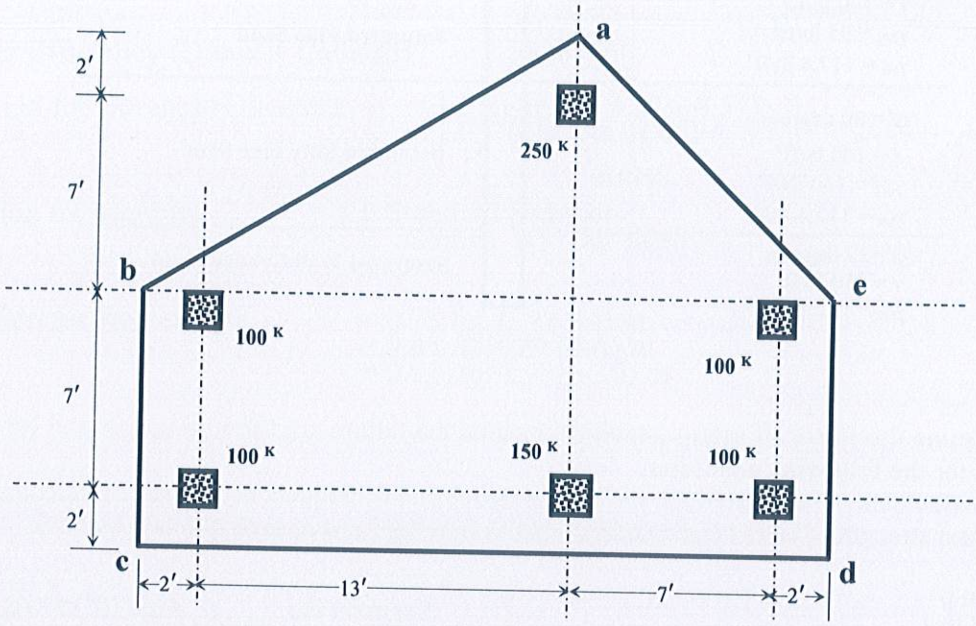
(b) A rectangular footing (4 ft x 6 ft) designed as per allowable bearing capacity based on shearing failure is shown in the following figure. Estimate consolidation settlement for the clay layer. 13



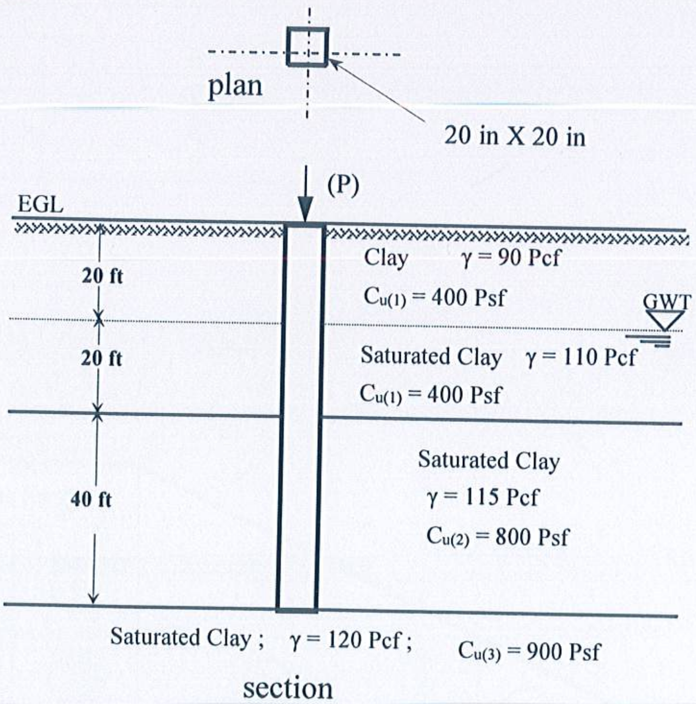
4. (a) Determine the sizes of a trapezoidal foundation for the conditions shown below (q_a = 1.25 tsf) 9



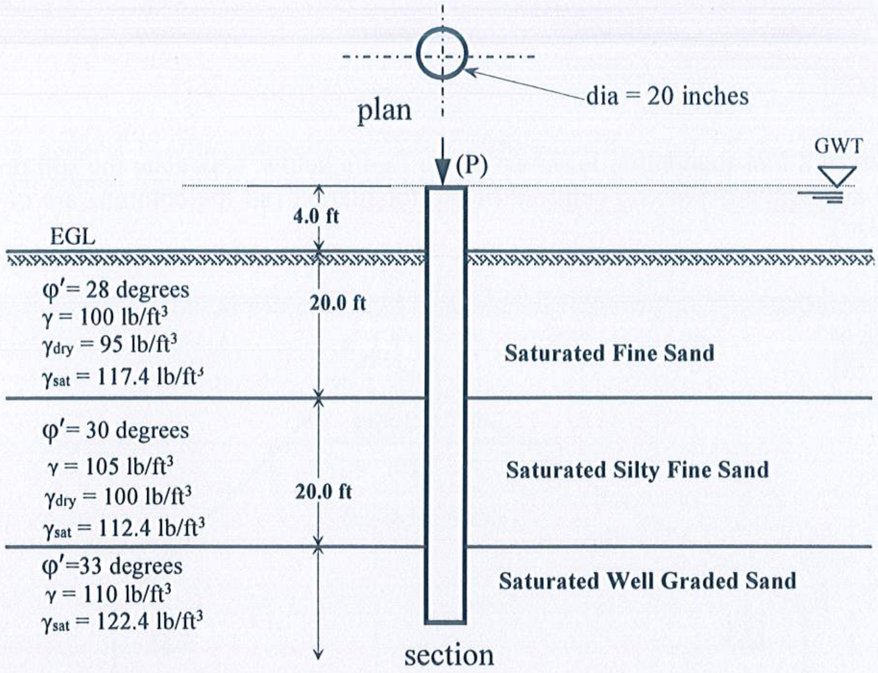
(b) The plan of a mat foundation is shown in the figure below. Calculate the soil pressures at points a, c and at the geometric centroid of the foundation (all the columns are of 15 by 15 inches in size). 16



5. (a) For the soil stratigraphy as shown below, a group of 12 pre-cast concrete driven piles (20 by 20 inches each) were installed as per minimum center-to-center distance required. Calculate the capacity of the group pile. 11



(b) The plan and X-section of a 54-foot long single bored concrete pile (circular) in different sand deposits are shown below. Estimate the allowable capacity of the single pile. (N_q^* = 25 for φ'= 28 degrees; N_q^* = 32 for φ'= 30 degrees; N_q^* = 52 for φ'= 33 degrees) 9



6. Determine the factor of safety (stability) against the failure arc through the natural (original) slope for the following condition: 15
As an aftermath of removal of the surface vegetation and consequent occurrence of torrential rain, the shear strength of layer I (sandy clay) is reduced by 75% and of layer II (clay) by 60%.

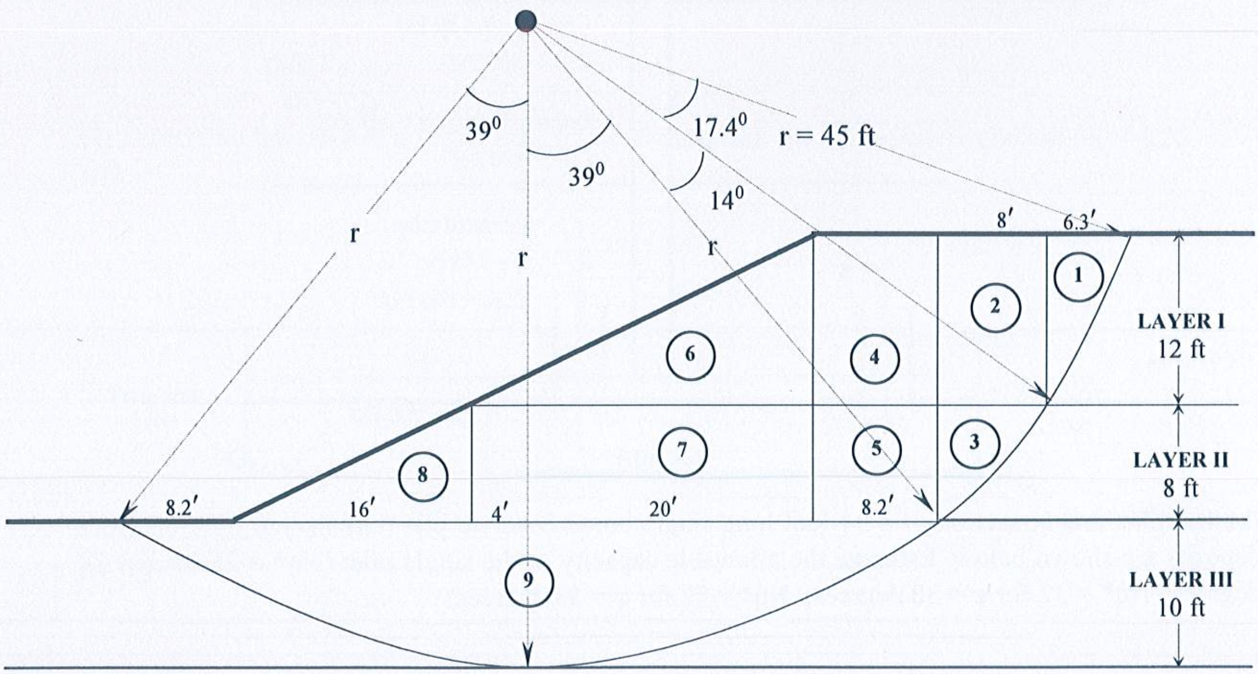
LAYER I:
Sandy Clay
Average SPT Blow Count, N = 5
Unit Weight = 110 pcf

LAYER II:
Clay
Average SPT Blow Count, N = 10
Unit Weight = 115 pcf

LAYER III:
Clay
Average SPT Blow Count, N = 14
Unit Weight = 120 pcf

Segment No.	Area (ft^2)	Arm (ft)
1	---	38.3
2	96	---
3	32	---
4	98.4	24.1
5	---	---
6	---	---
7	192	---
8	---	---
9	385	0

-- to be calculated



APPENDIX

Parameter for 60% Energy & Other Corrections for Field SPT

E_m = Hammer Efficiency (Donut + Cathead) = 0.55 to 0.60

C_B = Correction for Borehole Diameter
= 1.0 (For Dia 2.5" – 4.5")
= 1.05 (For Dia of 6")
= 1.15 (For Dia 8")

C_S = Correction for Sampler
= 1.0 Standard Sampler
= 1.2 Sampler Without Liner

C_R = Correction for Rod Length
= 0.75 for L = (3-4) m
= 0.85 for L = (4-6) m
= 0.95 for L = (6-10) m

= 1.0 for L > 10 m

Relevant Empirical Correlations

$$CF_1 = \sqrt{\frac{100}{\sigma_{v0}'}} \quad (\sigma_{v0}' \text{ in kPa})$$

$$CF_1 = \sqrt{\frac{2000}{\sigma_{v0}'}} \quad (\sigma_{v0}' \text{ in psf})$$

$q_{unc} = 300\ N_{60}$ (q_{unc} in psf)

$q_{unc} = 15\ N_{60}$ (q_{unc} in kPa)

$$\phi = 15 + \sqrt{20(N_1)_{60}}$$

THE GENERAL BEARING CAPACITY EQUATION

$$q_u = c'N_c F_{cs} F_{cd} F_{ci} + q_f N_q F_{qs} F_{qd} F_{qi} + 0.5\, \gamma_{bf} B N_\gamma F_{\gamma s} F_{\gamma d} F_{\gamma i}$$

F_{cs}, F_{qs}, $F_{\gamma s}$ = Shape Factors
F_{cd}, F_{qd}, $F_{\gamma d}$ = Depth Factors
F_{ci}, F_{qi}, $F_{\gamma i}$ = Inclination Factors

Table: General Bearing Capacity Factors

ϕ'	N_c	N_q	N_γ
0	5.14	1.00	0.00
10	8.35	2.47	1.22
20	14.83	6.40	5.39
26	22.25	11.85	12.54
28	25.80	14.72	16.72
30	30.14	18.40	22.40
32	35.49	23.18	30.22
34	42.16	29.44	41.06

Shape Factors

$F_{cs} = 1 + (B/L)\,(N_q/N_c)$
$F_{qs} = 1 + (B/L)\tan\phi'$
$F_{\gamma s} = 1 - 0.4\,(B/L)$
Where L = Length of the foundation (L>B)

Depth Factors

For D_f/B < or = 1

$F_{cd} = 1 + 0.4\,(D_f/B)$
$F_{qd} = 1 + 2\tan\phi'\,(1 - \sin\phi')^2\,(D_f/B)$
$F_{\gamma d} = 1$

For $D_f/B > 1$

$F_{cd} = 1 + 0.4\tan^{-1}(D_f/B)$
$F_{qd} = 1 + 2\tan\phi'\,(1 - \sin\phi')^2\tan^{-1}(D_f/B)$
$F_{\gamma d} = 1$
The factor $\tan^{-1}(D_f/B)$ is in radians.

Inclination Factors

$F_{ci} = F_{qi} = (1 - \beta^0/90^0)^2$
$F_{\gamma i} = (1 - \beta/\phi')^2$
β = Inclination of the applied load on the foundation with respect to the vertical

Table: Values of K_s & δ (Broms, 1966)

Installation Method	K_s	Pile-soil Interface	δ
Driven Pile, Large Displacement	1.5-2.0	Steel / Sand	0.5 φ- 0.7 φ
Driven Pile, Small Displacement	1.0-2.0	Precast concrete / Sand	0.8 φ -1.0 φ
Bored & Cast-in-situ Pile	0.7-1.0	Cast-in-situ / Sand	1.0 φ

University of Asia Pacific
Department of Civil Engineering
Final Examination – Fall 2021
Program: B.Sc. Engineering (Civil)

Course Title: Transportation Engineering II	Course Code: CE 451
Time: 3 hours Credit Hour: 3:00	Full Marks: 120

1. a) Discuss the significance of - i) Check rail, ii) Coning of rail and iii) Tilting of rail. (15)

   b) Compute the length of a transition curve required for a M.G. curve of four degrees. The maximum permissible speed on the curve is 120 km.p.h. This transition curve is to be used to join the ends of a 4° circular curve with the straight. Set the transition curve with the straight taking offsets at every 73 m interval. (15)

   c) Explain which type of sleeper is more suitable for modern rail and why. (5)

   d) A ***2-6-2*** Locomative is required to haul a train at 150 kmph. The axle load of the driving wheels of the engine is 55 tonnes. The train is to run on a 3.5 degree meter gauge curved track. Calculate the maximum permissible train load that the engine can pull. If the train climbs a gradient of 1 in 250 and six degree curvature, then how much of the speed should be reduced? (10)

2. a) The pavement that needs to be constructed is shown in figure 1. The average two-way traffic per day on the existing highway counted in 2008 was 8,000 commercial vehicles and it is expected to grow at 5% per annum. It is also expected that the construction of pavement will be completed 6 years after the traffic count taken on 2008. The AADT (both directions) on year 2008 was 10,000 vehicles. The percentage of traffic on the design lane is 65%. The pavement has a terminal serviceability index (pt) of 2.5 and SN of 3. Predict the cumulative traffic for the design period and also calculate the design ESAL if the design life is 30 years and the vehicle mix is as follows: (20)
   Passenger cars (1000 lb/axle) = 5%,
   2-axle single-unit trucks (5000 lb/axle) = 30%,
   3-axle single-unit trucks (7000 lb/axle) =10%.
   3-axle tandem-unit trucks (10000 lb/axle) =45%.
   4-axle tandem-unit trucks (18000 lb/axle) =10%.

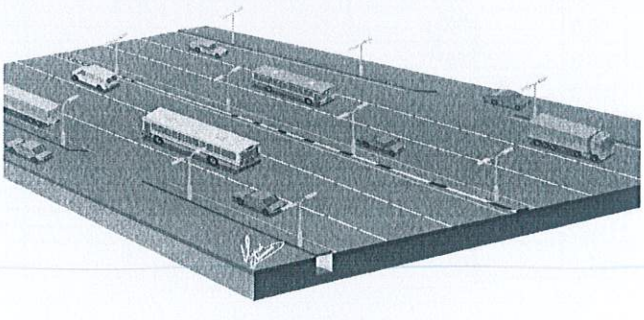


Figure 1

b) Design a suitable pavement structure for the highway shown in figure 1 [considering design ESAL calculated in Q 2(a)] consisting of an asphalt mixture surface with an elastic modulus of 250,000 lb/in^2. The structural layer coefficient for base course and sub base course materials are 0.14 and 0.10 respectively. Resilient modulus of elasticity for subgrade is 4000 lb/in^2, for base course is 35000 lb/in^2 and for sub base course is 9000 lb/in^2. Assume all mi values as 1. Use a reliability level of 92%, a standard deviation of 0.35, and a design serviceability loss of 3.0. Explain design procedure. (20)

Answer 3 (a) or 3 (b)

3. a) A 9-inch layer of cement-treated granular material is to be used as subbase for a rigid pavement. The monthly values for the roadbed soil resilient modulus and the subbase elastic (resilient) modulus are given in Table 4. If the rock depth is located 10 ft below the subgrade surface and the projected slab thickness is 9.5 in, estimate the effective modulus of subgrade reaction, using the AASHTO method. (20)

Table 4:

Month	Roadbed Modulus (lb/in^2)	Sub-base Modulus (lb/in^2)
January	16,000	100,000
February	12,000	75,000
March	20,000	50,000
April	6,000	20,000
May	3,000	30,000
June	2,000	15,000

b) Design a rigid pavement for a two-lane residential street using PCA method in such a way that the assumed pavement thickness is adequate for fatigue analysis. Here, the configurations of sub-base layer of the pavement are same as Q 3(a). Assume subgrade K value 100 lb/in^3 and concrete modulus of rupture 735 lb/in^2. The pavement has asphalt shoulder on both side of road with doweled joint. The traffic data are as follows: (20)

Single axle	Expected Repetitions
25	21,320
42.5	42,870
45	124,900
Tandem axle	**Expected Repetitions**
55	930,700
102	156,000
110	51,000

4. a) You have to construct a flexible pavement for highway from Dhaka to Sylhet. The construction of the pavement will start in the month of May (length 290 km). You need to find out the suitability of soil using AASTHO soil classification system. The results in table 2 were obtained by a mechanical analysis. Classify the soil according to the AASHTO classification system and give the group index. Also comment whether you can use the soil as subgrade material in its natural state. (10)

Sieve Analysis, % Finer				
No. 10	No. 40	No. 200	Liquid Limit	Plastic Limit
84	58	8	-	N.P.

b) What laboratory tests of soil will you conduct for the construction of pavement in question 4 (a)? Explain the significance of the test. (5)

Table 1 Axle Load Equivalency Factors for Flexible Pavements
Single Axles (Pt = 2.5)

Axle Load	Pavement Structural Number (SN)					
(kips)	1	2	3	4	5	6
2	0.0004	0.0004	0.0003	0.0002	0.0002	0.0002
4	0.003	0.004	0.004	0.003	0.002	0.002
6	0.011	0.017	0.017	0.013	0.01	0.009
8	0.032	0.047	0.051	0.041	0.034	0.031
10	0.078	0.102	0.118	0.102	0.088	0.08
12	0.168	0.198	0.229	0.213	0.189	0.175
14	0.328	0.358	0.399	0.388	0.36	0.342
16	0.591	0.613	0.656	0.645	0.623	0.606
18	1	1	1	1	1	1
20	1.61	1.57	1.49	1.47	1.51	1.55

Table 2 Axle Load Equivalency Factors for Flexible Pavements
Tandem Axles (Pt = 2.5)

Axle Load	Pavement Structural Number (SN)					
(kips)	1	2	3	4	5	6
2	0.0001	0.0001	0.0001	0	0	0
4	0.0005	0.0005	0.0004	0.0003	0.0003	0.002
6	0.002	0.002	0.002	0.001	0.001	0.001
8	0.004	0.006	0.005	0.004	0.003	0.003
10	0.008	0.013	0.011	0.009	0.007	0.006
12	0.015	0.024	0.023	0.018	0.014	0.013
14	0.026	0.041	0.042	0.033	0.027	0.024
16	0.044	0.065	0.08	0.057	0.017	0.043
18	0.07	0.097	0.109	0.092	0.077	0.07
20	0.107	0.141	0.162	0.141	0.121	0.11

Table 3 Growth Factors

Design Period, Years (n)	No Growth	Annual Growth Rate, Percent (r) 2	4	5	6	7	8	10
15	15.0	17.29	20.02	21.58	23.28	25.13	27.15	31.77
16	16.0	18.64	21.82	23.66	25.67	27.89	30.32	35.95
17	17.0	20.01	23.70	25.84	28.21	30.84	33.75	40.55
18	18.0	21.41	25.65	28.13	30.91	34.00	37.45	45.60
19	19.0	22.84	27.67	30.54	33.76	37.38	41.45	51.16
20	20.0	24.30	29.78	33.06	36.79	41.00	45.76	57.28
25	25.0	32.03	41.65	47.73	54.86	63.25	73.11	98.35
30	30.0	40.57	56.08	66.44	79.06	94.46	113.28	164.49
35	35.0	49.99	73.65	90.32	111.43	138.24	172.32	271.02

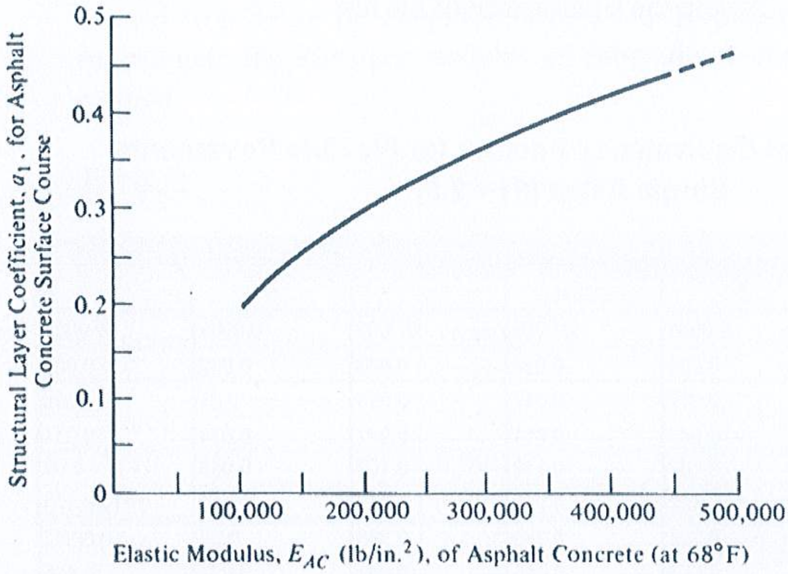


Figure 2 Chart for Estimating Structural Layer Coefficient of Dense-Graded/Asphalt Concrete Based on the Elastic (Resilient) Modulus

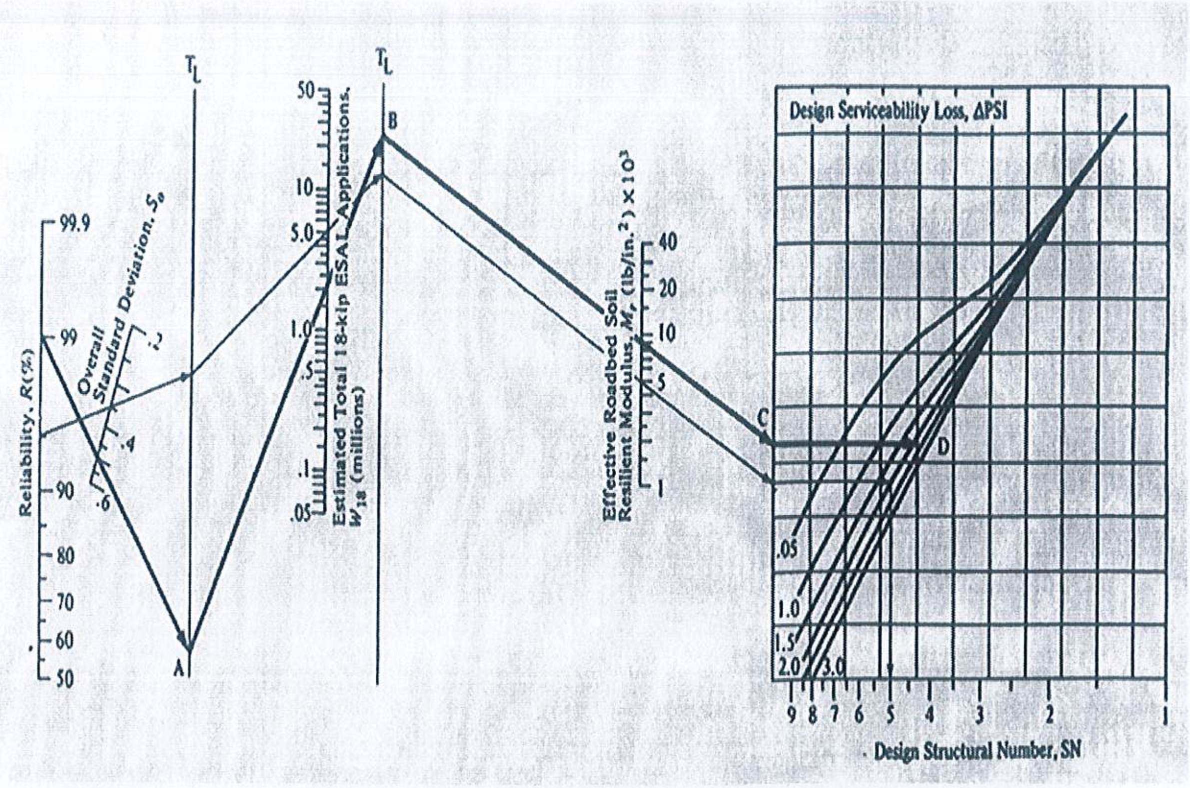


Figure 3 : Design Chart for Flexible Pavements Based on Using Mean Values for each Input

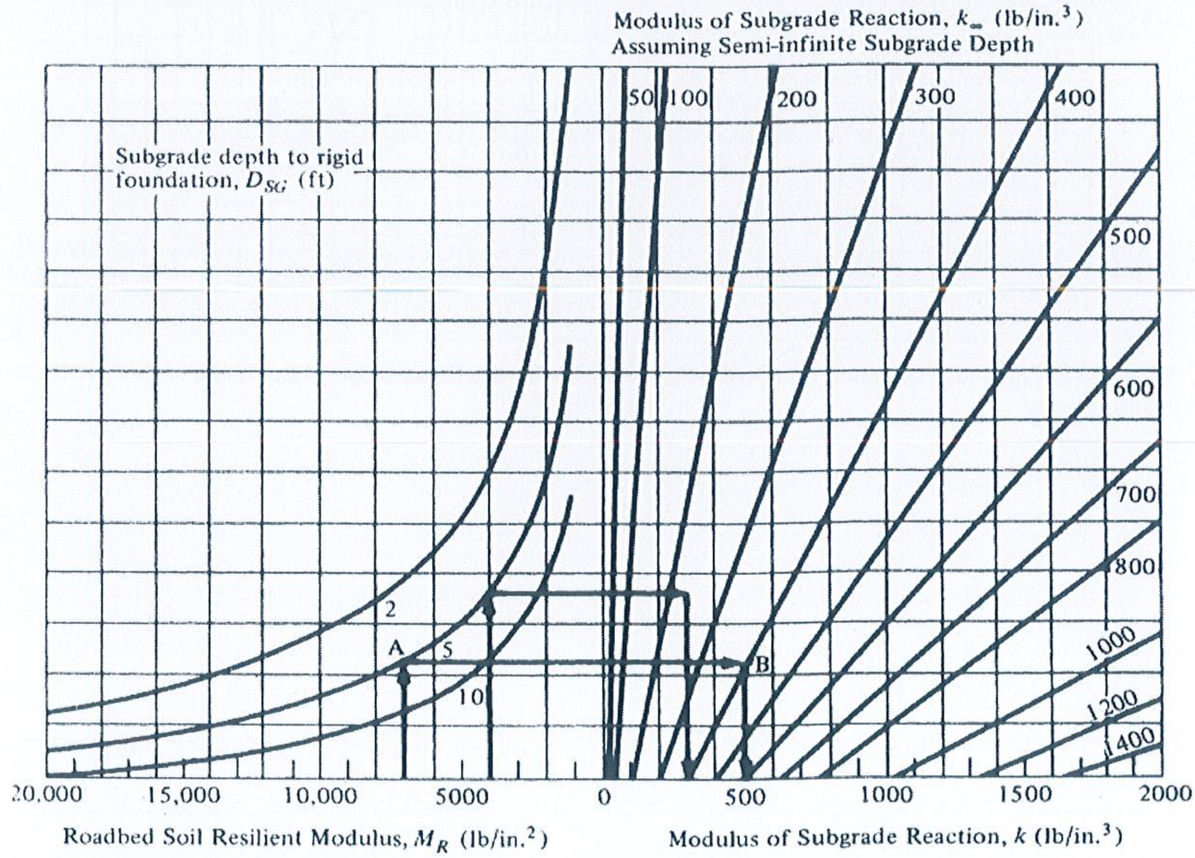


Figure 4 Chart to Modify Modulus of Subgrade Reaction to Consider Effects of Rigid Foundation Near Surface (within 10 ft)

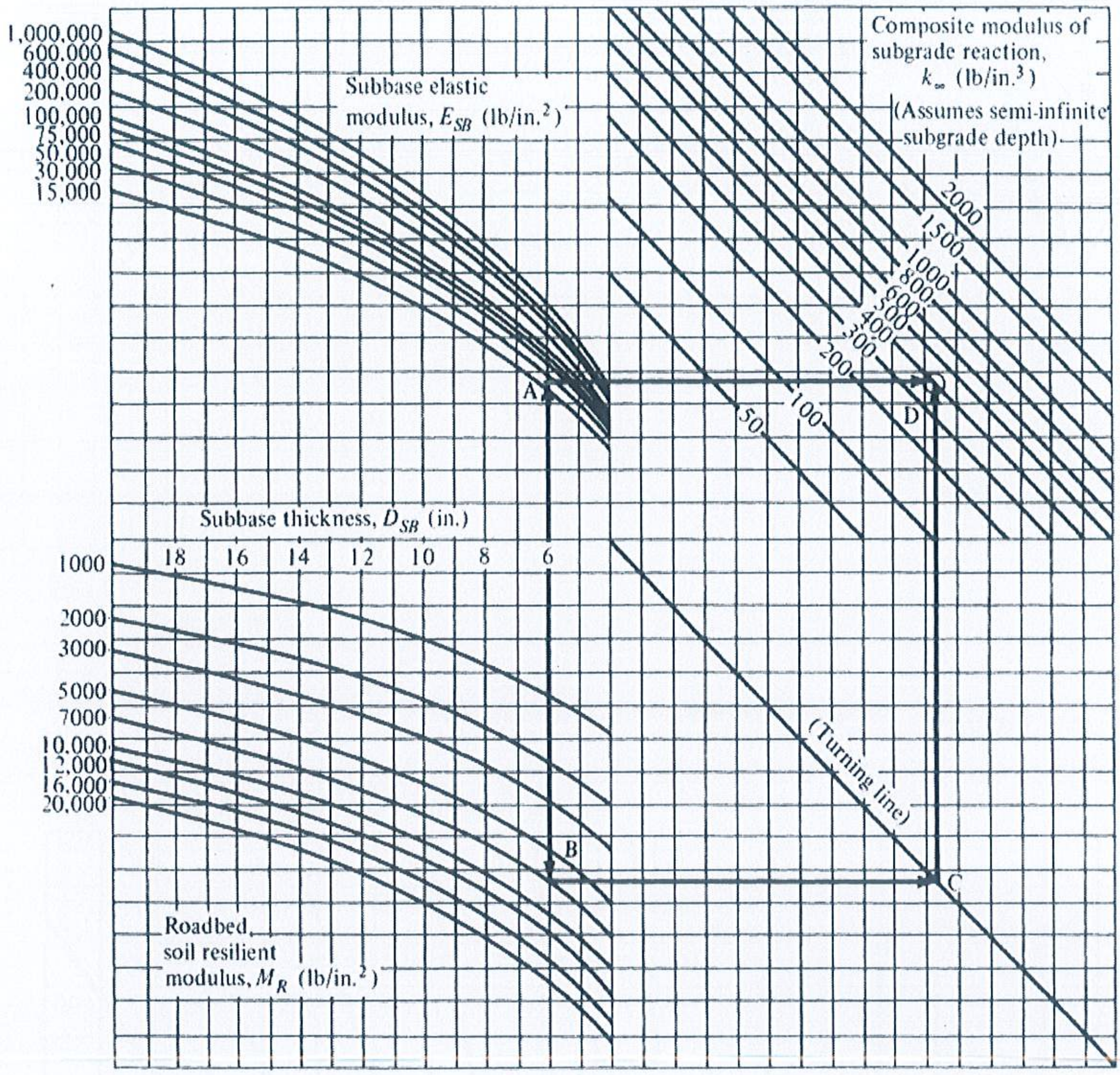


Figure 5 Chart for Estimating Composite Modulus of Subgrade Reaction, K_∞, Assuming a Semi-Infinite Subgrade Depth*

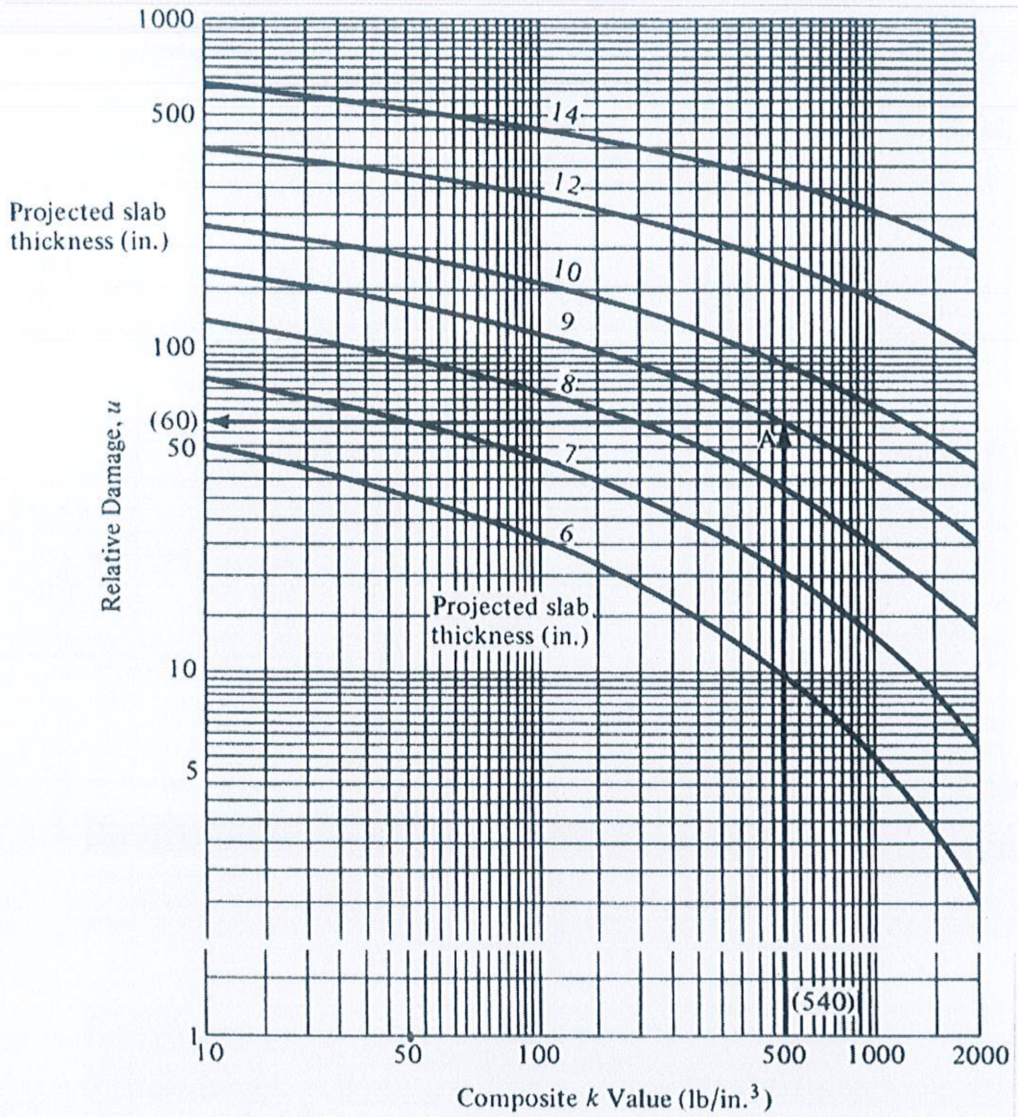


Figure 6 Chart for Estimating Relative Damage to Rigid Pavements Based on Slab Thickness and Underlying Support

Table 4 Design *k* Values for Untreated and Cement-Treated Subbases

(a) Untreated Granular Subbases

Subgrade k Value (lb/in³)	Subbase k Value (lb/in³)			
	4 in.	6 in.	9 in.	12 in.
50	65	75	85	110
100	130	140	160	190
200	220	230	270	320
300	320	330	370	430

(b) Cement-Treated Subbases

Subgrade k Value (lb/in³)	Subbase k Value (lb/in³)			
	4 in.	6 in.	9 in.	12 in.
50	170	230	310	390
100	280	400	520	640
200	470	640	830	—

Table 5 **Load Safety Factor (Multiplication factor for axle loads)**

Traffic Volume	LSF
High (interstates, multilane highways)	1.2
Moderate (highways and arterials)	1.1
Low (collectors, residential streets)	1.0

Table 6 Equivalent Stress Values for Single Axles and Tandem Axles (without concrete shoulder)

Slab Thickness (in.)	k of Subgrade-Subbase (lb/in³) (Single Axle/Tandem Axle)						
	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
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 4 Design *k* Values for Untreated and Cement-Treated Subbases

(a) Untreated Granular Subbases

Subgrade k Value (lb/in³)	*Subbase k Value (lb/in³)*			
	4 in.	*6 in.*	*9 in.*	*12 in.*
50	65	75	85	110
100	130	140	160	190
200	220	230	270	320
300	320	330	370	430

(b) Cement-Treated Subbases

Subgrade k Value (lb/in³)	*Subbase k Value (lb/in³)*			
	4 in.	*6 in.*	*9 in.*	*12 in.*
50	170	230	310	390
100	280	400	520	640
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	50	*100*	*150*	*200*	*300*	*500*	*700*
4	825/679	726/585	671/542	634/516	584/486	523/457	484/443
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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
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

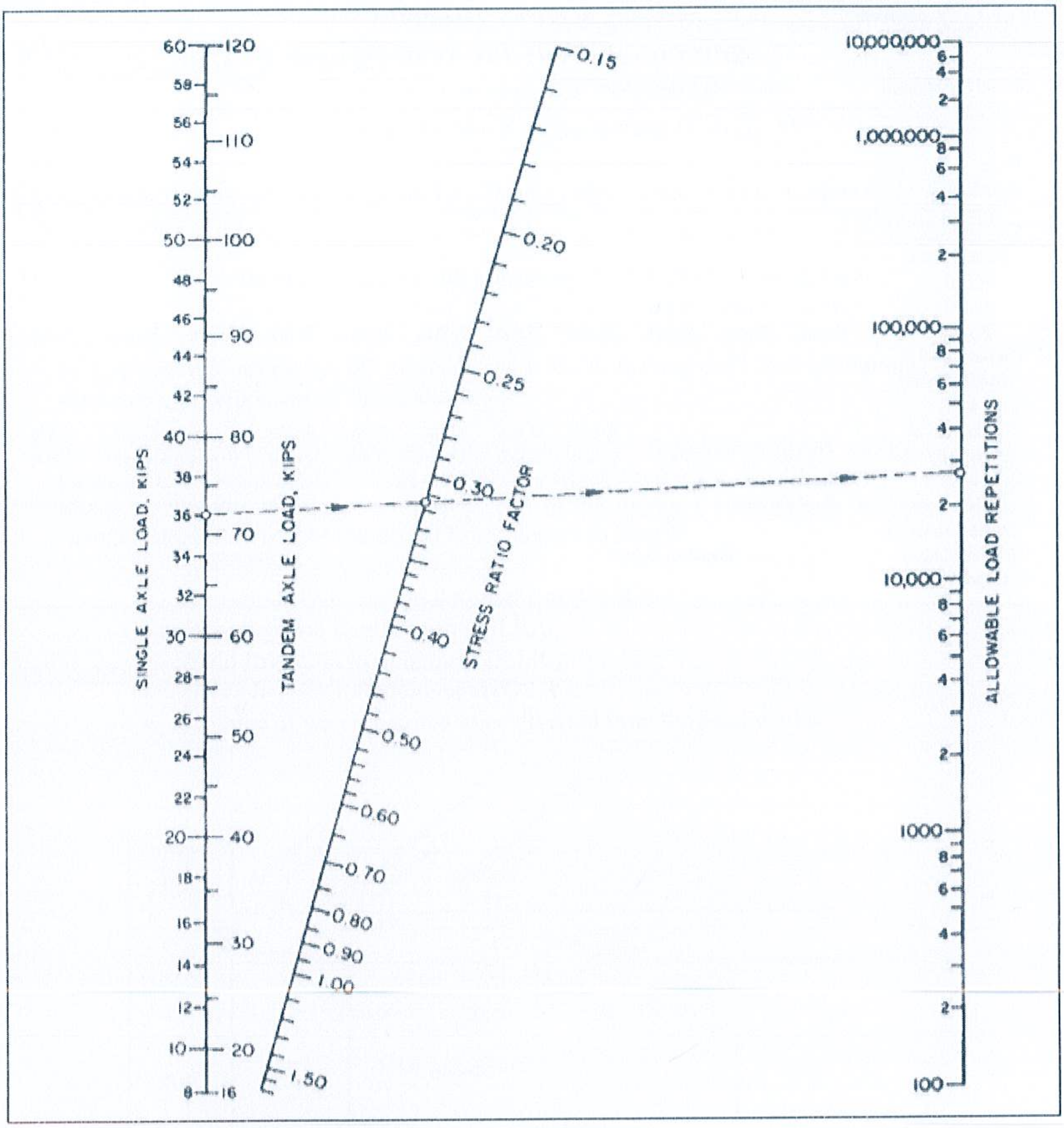

Figure 7 Allowable Load Repetitions for Fatigue Analysis Based on Stress Ratio

Table 7 AASHTO Classification of Soils and Soil Aggregate Mixtures

General Classification	*Granular Materials (35% or Less Passing No. 200)*							*Silt-Clay Materials (More than 35% Passing No. 200)*			
	A-1			*A-2*							*A-7*
Group Classification	*A-1-a*	*A-1-b*	*A-3*	*A-2-4*	*A-2-5*	*A-2-6*	*A-2-7*	*A-4*	*A-5*	*A-6*	*A-7-5, A-7-6*
Sieve analysis											
Percent passing											
No. 10	−50 max.	–	–	–	–	–	–	–	–	–	
No. 40	30 max.	50 max.	51 min.	–	–	–	–	–	–	–	–
No. 200	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing No. 40:											
Liquid limit	–		–	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.		N.P.	10 max.	10 max.	11 min.	11 min.	10 max.	10 max.	11 min.	11 min.*
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General rating as subgrade	Excellent to good							Fair to poor			

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2021
Program: B.Sc. Engineering (Civil)

Course title: Irrigation and Flood Control — Course code: CE 461
Time: 3 Hours — Full marks: 100

There are FIVE (5) questions. Answer all questions. Assume any missing data.

1. a) Explain the necessity of irrigation and flood management for promoting sustainable development of Bangladesh. 8

b) An irrigation project located in Kurigram district of Bangladesh divert surface water from Dharala river through a canal for irrigating an area of 4100 hectares, Based on the data and information provided in the **figure 1** and **table 1** below, calculate the following for the period from January to March: 14

- Consumptive Water Use (C_U);
- Consumptive Irrigation Requirement (C.I.R.);
- Net Irrigation Requirement (NI.R.);
- Field Irrigation Requirement (F.I.R.);
- Gross Irrigation Requirement (G.I.R.);
- Volume of water required to be diverted from the head works.

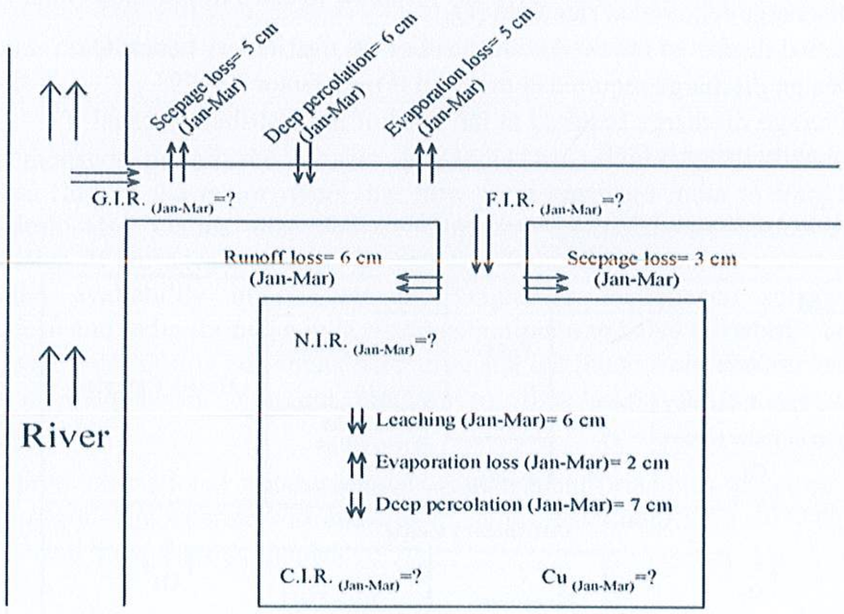

Figure 1

Table 1

Month	Monthly temperature (°C) averaged over the last 5 years	Monthly percent of day time hour of the year computed from the Sun-shine	Useful rainfall in cm averaged over the last 5 years	Crop factor
January	23.0	7.00	1.70	0.69
February	19.7	7.40	1.55	0.72
March	24.5	8.10	3	0.59

c) Find out the following by analyzing the data and information provided in **figure 2** below: 14

- Discharge required at the potato field (Q_1);
- Discharge required at the wheat field (Q_2);
- Discharge required at rice field (Q_3);
- Actual discharge required at the head of the distributary canal (Q);
- Design discharge required at the head if time factor is 0.79;
- Average discharge required at the head of the distributary canal if capacity factor is 0.69.

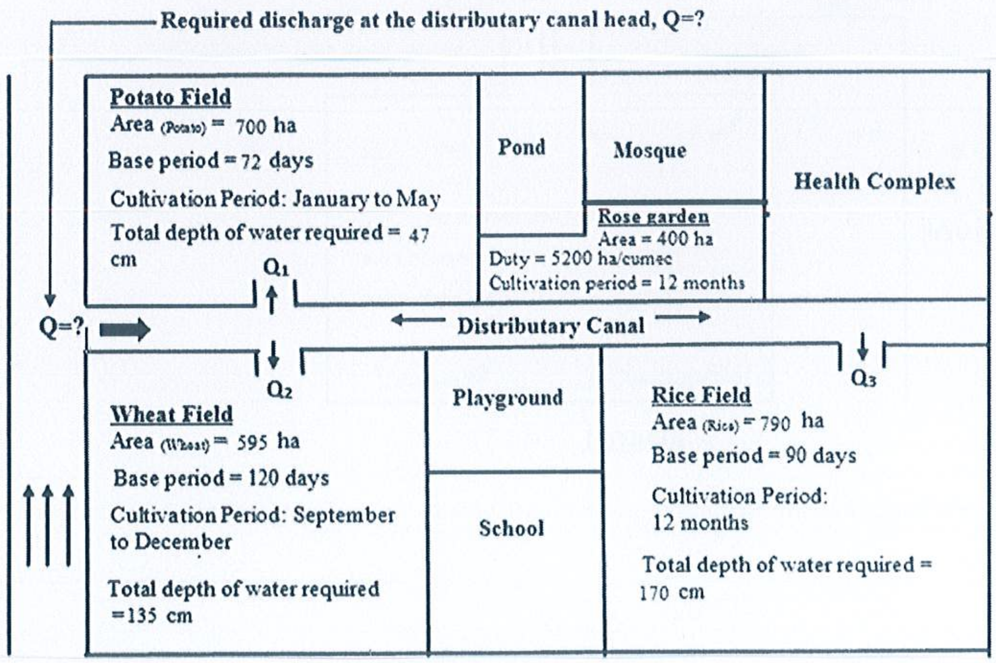

Figure 2

2. a) Explain the following: i) Critical velocity ratio; ii) Silt factor; iii) Balancing depth. 6

b) An irrigation project is located in an area formed by alluvial soil. The responsible engineering department is planning to construct a new irrigation canal to provide sufficient water in the agricultural plots located in the project area. To decrease the cost and keep the options open for possible future changes in the cropping pattern and water distribution requirement in the project area, the engineering department decided to construct an unlined canal. 12

As a newly recruited engineer in the local engineering department, design that canal having the following data (**TWO TRIALS ARE COMPULSORY**):
Full supply discharge = 6 m^3/s
Rugosity coefficient (n) = 0.0224
C.V.R (m) = 1
Side slope = 1:1
Bed slope = 1 in 5150
Assume other reasonable data for the design

3. a) Explain different types of spurs with neat sketch. 6

b) Find out after how many days you should supply water to soil in order to ensure sufficient irrigation of the given crop, if, 12

- Field capacity of the soil = 31%
- Permanent wilting point = 14%
- Dry density of soil = 1.3 gm/cc
- Effective depth of root zone = 67 cm
- Daily consumptive use of water for the given crop = 10 mm.

If the crop period is 50 days, find out the base period of this particular crop.

4. During monsoon period, the farmers of Bangladesh are facing flood due to the excessive flow in the major rivers that flow from upstream India to Bangladesh. Bangladesh also claims that due to excessive extraction of water through construction of barrages and dams in upstream India during non-monsoon period, the water availability in downstream Bangladesh is reduced substantially. Bangladesh and India formed a joint rivers commission to solve this conflict related to too little water during non-monsoon period and too much water during monsoon period in Bangladesh. You are representing Bangladesh in the joint rivers commission. 10

Select three international water resources management principles based on which you can negotiate/cooperate with India to solve this water conflict. Justify why you have selected those three principles.

5. a) Explain different components of flood risk management. 10

b) Select two structural and two non-structural measures of flood management that you think are most important for flood management in Bangladesh. Justify your answer. 8