University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2018
Program: B. Sc. in Civil Engineering

Course Title: Project Planning & Management | Course Code: CE 401
Time: 3 Hours | Full Marks: 150

PART – A
Answer all of the following questions.

1. **(a)** What challenges are being faced by the construction industry nowadays? **(10)**
   (b) What are the elements of a legal contract? What are the best measures for an engineer to take when entering into a contract with a client? **(10)**
   (c) Differentiate between 'Open Tendering Method' and 'Limited Tendering Method'. **(5)**

2. **(a)** Mention the principles of preventing accidents. **(10)**
   (b) Write down the modern views on quality control and the general goals of 'Six Sigma'. **(10)**
   (c) Differentiate between 'Quality Control' and 'Quality Assurance'. **(5)**

3. **(a)** What are the disadvantages of low inventory turns? What are the reasons for holding inventory? **(10)**
   (b) A cement bag distributor sells 1000 bags of cement in one month. Cost of placing an order for him is \$60 and the cost of holding one bag in inventory is \$10. The lead time is six days. Find the optimum order quantity and the total annual cost. **(10)**
   (c) Differentiate between 'Kanban' and 'Mark-to-Order' methods. **(5)**

PART – B

There are 4 (FOUR) questions. Answer question 4 (FOUR) and any 2 (TWO) from the rest (25x3)

4. Company XYZ is planning to install a new computerized accounts system. Bank management has determined the activities required to complete the project. The precedence relationships of the activities are as follows: **(25)**

Activity	Activity Predecessor	Time (weeks)
1	---	3
2	1	2
3	1	5
4	1	4
5	2	3
6	3	2
7	4	8
8	5,6	4
9	8	4
10	7	4
11	9,10	7

i. Draw the network diagram
ii. Find ES, EF and LS, LF time for each activity
iii. Find the total float and free float of each activity
iv. Find the critical path, and project completion time
v. If the time required for activity 8 and 10 are reduced by 1 week each, find the project completion time and critical path as well.

5. **(a)** The sales of a certain product during each month of a year have been given below: **(20)**

Year	**Sales**	**Year**	**Sales**
1995	2000	2002	4000
1996	2200	2003	3900
1997	2100	2004	4000
1998	2300	2005	4200
1999	2500	2006	4300
2000	3200	2007	4900
2001	3600	2008	5300

Develop a regression analysis to forecast the demand and find the forecast for the years of 2015 and 2018.

(b) What do you understand by 'Cash Flow'? **(5)**

6. **(a)** Write down the advantages and disadvantages of least square method. **(5)**
(b) Consider the cash flow of two projects: **(20)**

Year	**Cash Flow of P**	**Cash Flow of Q**
0	1,000	1,600
1	1200	200
2	600	400
3	250	600
4	2,000	800
5	4,000	100
6	---	100

i. Construct the NPV profile for Projects P and Q
ii. Construct the BCR for Projects P and Q
iii. What is the IRR of each project?
iv. Which project would you choose if r is 10 percent? 20 percent?

7. **(a)** Write short notes on the following three: **(3x5)**
a. Dummy activity
b. Gantt Chart
c. Delphi method

(b) As a PM (Project Manager) what would be your decision regarding completion of the project if the project schedule time is lower than the Expected time? **(5)**

(c) What do you understand by critical path? Why is it necessary to find the critical path? **(5)**

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2018
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

1. Use Stiffness Method to calculate the unknown deflections at joint ***d*** and ***e*** of the grid ***abcdefgh*** loaded as shown in ***Fig. 1*** [Given: $EI = 30 \times 10^3$ k-ft^2].

2. Use Stiffness Method to calculate (i) the unknown deflections at joint ***b*** and ***d*** and (ii) member forces of the plane truss ***abcde*** loaded as shown in ***Fig. 2*** [Given: EA/L = 1000 k/ft].

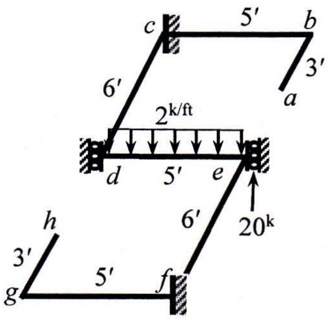


Fig. 1

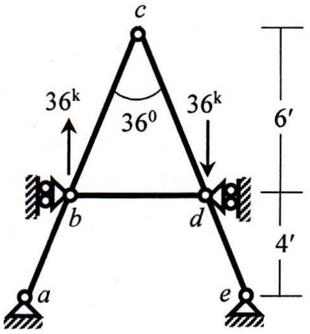


Fig. 2

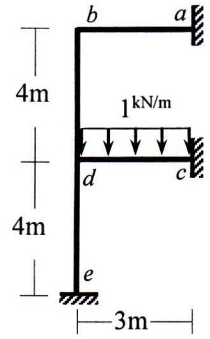


Fig. 3

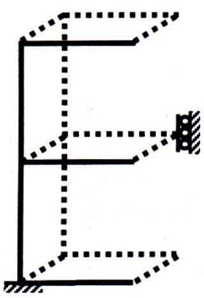


Fig. 4

3. Use Stiffness Method considering flexural deformations only to calculate the unknown rotations at joint ***b*** and ***d*** of the frame ***abcde*** loaded as shown in ***Fig. 3*** [Given: $EI = 16 \times 10^3$ kN-m^2].

4. Determine the degree of kinematic indeterminacy (doki) and show the corresponding deflections and rotations of the 2D frame (***Fig. 3***) and 3D frame (***Fig. 4***), for the following cases (i) Not considering boundary conditions, (ii) Considering boundary conditions, (iii) Neglecting axial deformations.

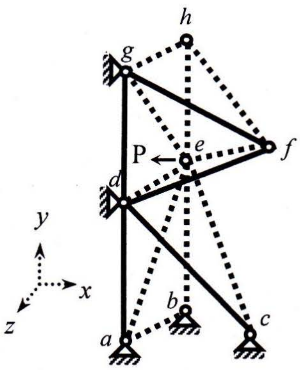


Fig. 5

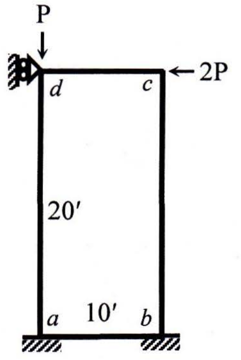


Fig. 6

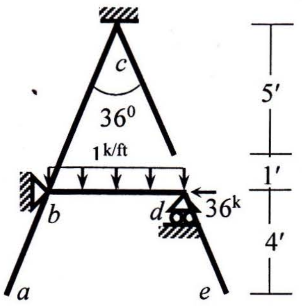


Fig. 7

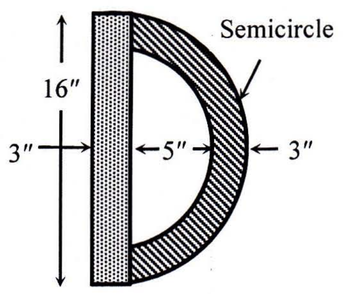


Fig. 8

5. Ignore zero-force members and apply boundary conditions to form the stiffness matrix of the space truss ***abcdefgh*** shown in ***Fig. 5*** [Given: S_x = constant = 10^4 N/mm, Nodal Coordinates (m) are *a*(0,0,0), *b*(0,0,-10), *c*(20,0,-5), *d*(0,20,0), *e*(0,20,-10), *f*(20,30,-5), *g*(0,40,0), *h*(0,40,-10)].

6. Use Stiffness Method (neglecting axial deformations) to calculate the value of applied load P required to cause buckling of the frame ***abcd*** loaded as shown in ***Fig. 6*** [Given: $EI = 40 \times 10^3$ k-ft^2; consider axial force at *ab*, *bc*, *cd* and *da* is 0, 0, 2P and P (in kip) respectively].

7. Use Stiffness Method to calculate unknown rotations at ***b*** and ***d*** (considering flexural deformations and geometric nonlinearity) of the frame ***abcde*** loaded as shown in ***Fig. 7*** [Given: $EI = 40 \times 10^3$ k-ft^2].

8. Calculate the Yield Moment (M_y) and Plastic Moment (M_p) capacity of the section shown in ***Fig. 8*** if it is made of elastic-fully plastic material [Given: $\sigma_y = \sigma_{yp} = 60$ ksi].

9. In the frame ***abcd*** loaded as shown in ***Fig. 9***, use Energy Method to
   (a) Calculate the Plastic moment (M_p) required to prevent formation of beam mechanism of *bc* and sidesway mechanism of the frame.
   (b) Also calculate the required yield strength (f_y) of the elasto-plastic material.

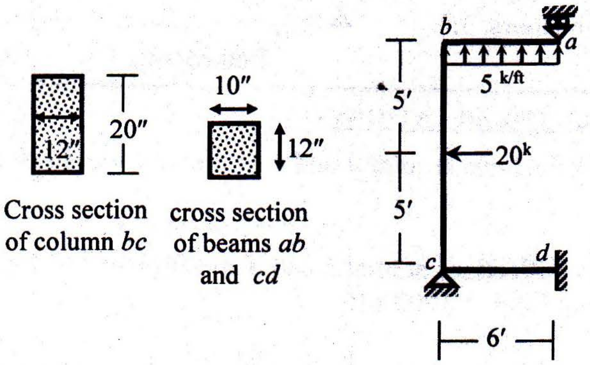


Fig. 9

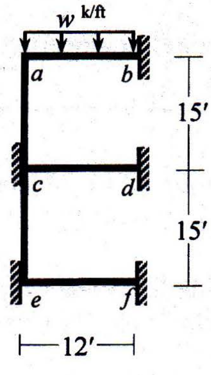


Fig. 10

10. Frame structure ***abcdef*** shown in ***Fig. 10*** is subjected to a dynamic load, w = 10 *cos (πt/6) (k/ft)*. Use *Constant Average Acceleration* (*CAA*) Method to calculate the rotation of joint ***a*** at time t = 0.10 sec [Given: EI = 10^4 k-ft^2, μ = 0.005 k-sec^2/ft^2, Damping ratio of the system = 8%].

List of Useful Formulae for CE 411

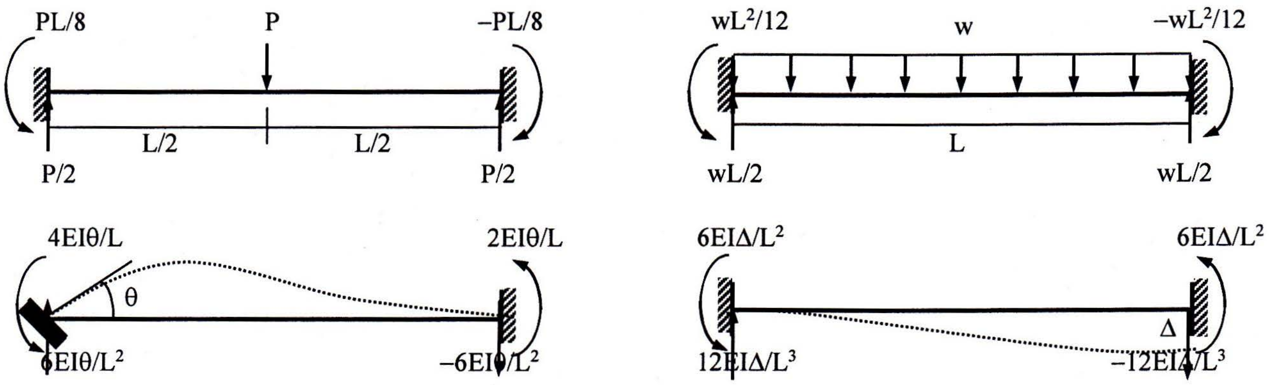
* The stiffness matrix K_m^G of a 2D truss member in the global axis system is given by

$$K_m^G = S_x \begin{pmatrix} C^2 & CS & -C^2 & -CS \\ CS & S^2 & -CS & -S^2 \\ -C^2 & -CS & C^2 & CS \\ -CS & -S^2 & CS & S^2 \end{pmatrix}$$

and Truss member force, $P_{AB} = S_x\,[(u_B - u_A)\,C + (v_B - v_A)\,S]$

[where $C = \cos\theta$, $S = \sin\theta$]

<u>Fixed End Reactions for One-dimensional Prismatic Members under Typical Loadings</u>



* The stiffness matrix of a 3D truss member in the global axes system [using $C_x = \cos\alpha$, $C_y = \cos\beta$, $C_z = \cos\gamma$] is

$$K_m^G = S_x \begin{pmatrix} C_x^2 & C_xC_y & C_xC_z & -C_x^2 & -C_xC_y & -C_xC_z \\ C_yC_x & C_y^2 & C_yC_z & -C_yC_x & -C_y^2 & -C_yC_z \\ C_zC_x & C_zC_y & C_z^2 & -C_zC_x & -C_zC_y & -C_z^2 \\ -C_x^2 & -C_xC_y & -C_xC_z & C_x^2 & C_xC_y & C_xC_z \\ -C_yC_x & -C_y^2 & -C_yC_z & C_yC_x & C_y^2 & C_yC_z \\ -C_zC_x & -C_zC_y & -C_z^2 & C_zC_x & C_zC_y & C_z^2 \end{pmatrix}$$

$$\boxed{\begin{array}{l} C_x = L_x/L,\ C_y = L_y/L,\ C_z = L_z/L \\ \text{where } L = \sqrt{[L_x^2 + L_y^2 + L_z^2]} \end{array}}$$

* Member force $P_{AB} = S_x\,[(u_B - u_A)\,C_x + (v_B - v_A)\,C_y + (w_B - w_A)\,C_z]$

* Ignoring axial deformations, the matrices K_m^L and G_m^L of a frame member in the local axis system are

$$K_m^L = \begin{pmatrix} S_1 & S_2 & -S_1 & S_2 \\ S_2 & S_3 & -S_2 & S_4 \\ -S_1 & -S_2 & S_1 & -S_2 \\ S_2 & S_4 & -S_2 & S_3 \end{pmatrix} \qquad G_m^L = (P/30L)\begin{pmatrix} 36 & 3L & -36 & 3L \\ 3L & 4L^2 & -3L & -L^2 \\ -36 & -3L & 36 & -3L \\ 3L & -L^2 & -3L & 4L^2 \end{pmatrix}$$

where $S_1 = 12EI/L^3$, $S_2 = 6EI/L^2$, $S_3 = 4EI/L$, $S_4 = 2EI/L$

* $K_{total} = K + G$, buckling occurs (i.e., $P = P_{cr}$) when $|K_{total}| \doteq 0$

* For sections of Elastic-Fully-Plastic material, $A_t = A_c = A/2$, and $M_p = A_c\,\bar{y}_c + A_t\,\bar{y}_t$
* For RC sections, $M_p = A_s f_y (d - a/2)$, where $a = A_s f_y/(0.85 f_c'\,b)$
* Virtual work done by external forces (δW_E) = Virtual work done by internal forces (δW_I)
* For simply supported beams under (i) concentrated midspan load $P_u = 4\,M_p/L$, and (ii) UDL $w_u = 8\,M_p/L^2$
* For fixed-ended beams under (i) concentrated midspan load $P_u = 8\,M_p/L$, and (ii) UDL $w_u = 16\,M_p/L^2$
* For hinged-fixed ended beams under UDL $w_u = 11.66\,M_p/L^2$

* Using CAA Method, $(m + c\Delta t/2 + k\Delta t^2/4)a_{i+1} = f_{i+1} - ku_i - (c + k\Delta t)v_i - (c\Delta t/2 + k\Delta t^2/4)a_i$
[m = Total mass, c = Damping = $2\xi\sqrt{(km)}$, where ξ = Damping Ratio]
Also $v_{i+1} = v_i + (a_i + a_{i+1})\Delta t/2$, and $u_{i+1} = u_i + v_i\,\Delta t + (a_i + a_{i+1})\Delta t^2/4$, starting with $a_0 = (f_0 - cv_0 - ku_0)/m$

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2018
Program: B.Sc. Engineering (Civil)

Course Title: Geotechnical Engineering II — Course Code: CE 441
Time: 3 hours — Full Marks: 100

Answer the following questions.

1. (a) Identify the types of laboratory tests in which disturbed but representative specimens can be used. 4

   (b) During soil exploration, standard penetration tests were carried out at a test site. Given that $\gamma_{sat} = 17.5$ kN/m^3. Water table is at the ground level. 6

   (i) Calculate N_{60}, if the numbers of blows (for each 150 mm of penetration) are recorded 7, 7 and 8. Hammer efficiency is 0.53. Given that borehole diameter = 120 mm, rod length = 7 m, sampler correction factor = 1.

   (ii) Determine $(N_1)_{60}$ at depths of 2.5 m and 8 m, if $N_{60} = 10$ for the both.

2. Calculate the settlement (due to primary consolidation of the normally consolidated clay layer) of the square footing of size 3 m x 3 m, shown in Figure 1. Use 2:1 pressure distribution. The depth of foundation is 2.5 m. 15

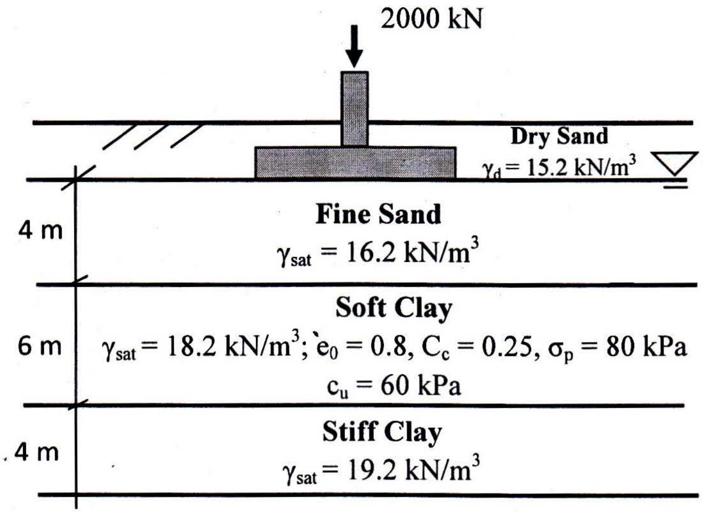


Figure 1

3. The arrangement of eight piles (in a group) and the soil profile is shown in Figure 2.

(a) Calculate the capacity of the pile group, if c/c pile spacing is 2 m. 10
(b) Recalculate the capacity of the pile group, if c/c pile spacing is 1.2 m. 5
(c) Compare the group efficiency. 2
Given that $\alpha = 0.5$, $K_s = 0.8\, K_0$, $\delta/\varphi = 0.8$.

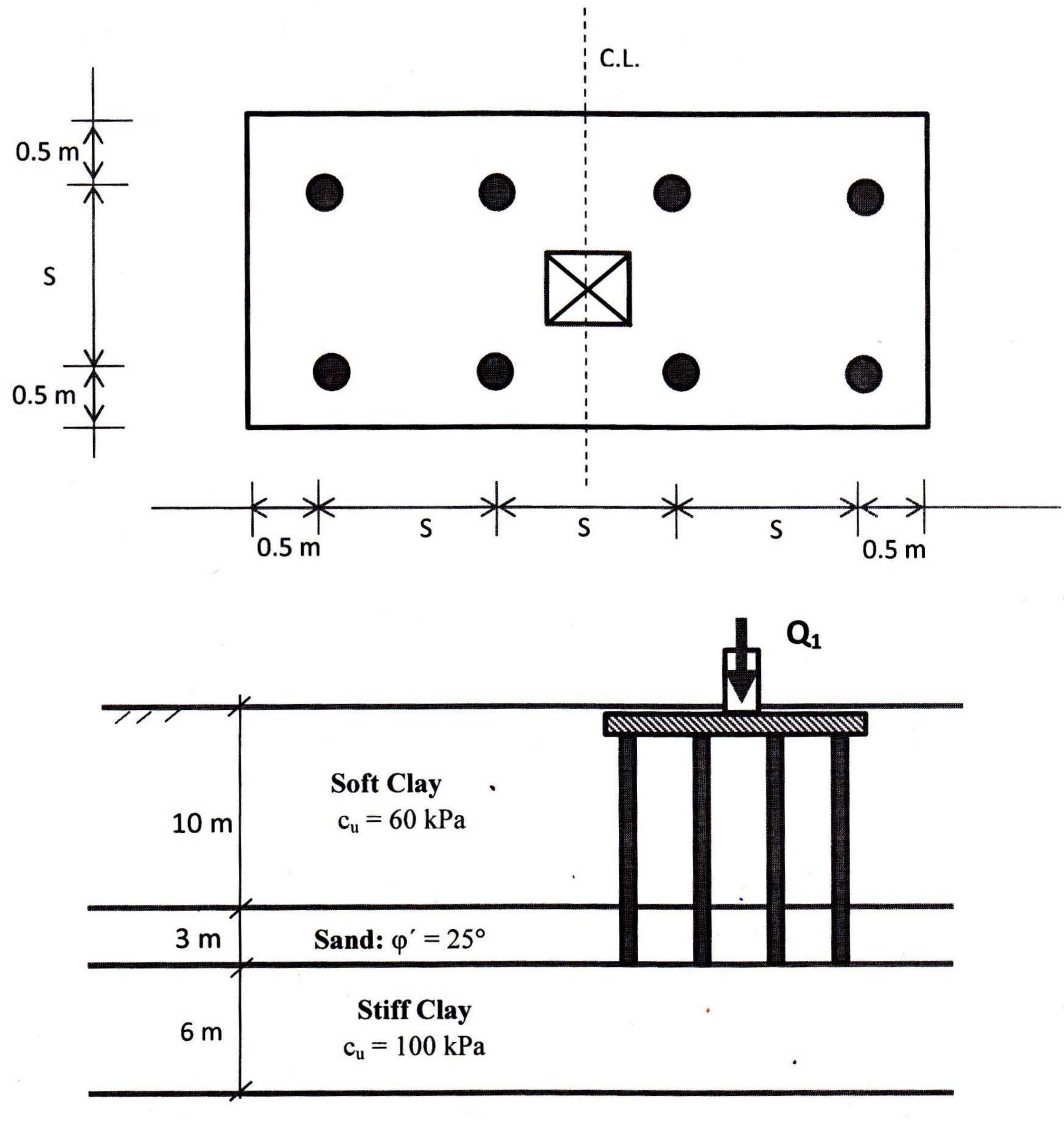


Figure 2

4. According to the soil exploration report, the upper loose sand layer is found homogeneous and overlying medium dense sand (Figure 3). The ground water table is located at 1.5 m below GL. Upper layer extends up to 4.5 m below the ground level.

   (a) Estimate the allowable bearing capacity of a 2 m wide strip footing, placed at a depth 2 m below the ground level. Provide a factor of safety equal 2. Use Meyerhof's theory of bearing capacity and Hanna's design charts for modified bearing capacity factors. 10

   (b) Calculate the net ultimate bearing capacity of a 2 m wide strip footing if upper sand layer is 10 m thick. 5

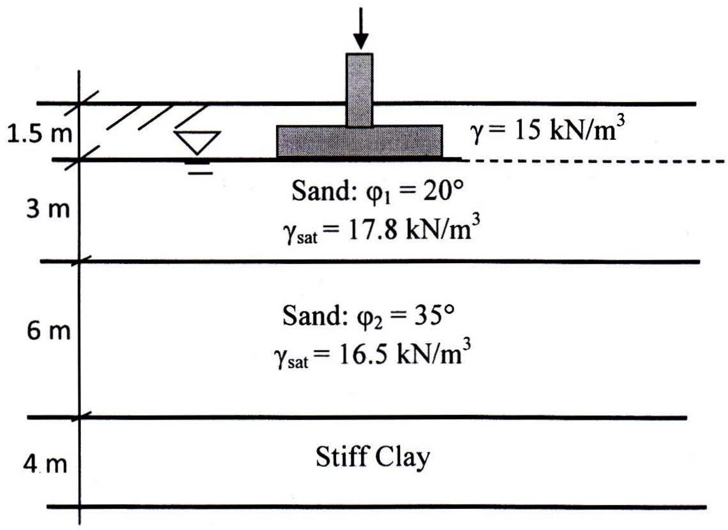


Figure 3

5. (a) Design a square shallow foundation (placed at a depth 1.5 m below the ground level) to support 400 kN load for the given soil information. Provide a factor of safety equal 3. According to the soil exploration report, the upper layer is found homogeneous and extends up to 10 m below the ground level. The ground water table is located at GL. Use Meyerhof's theory of bearing capacity. 10

   The properties of the homogeneous soil layer is as follows:

   Given data: $\gamma_{sat} = 18.2$ kN/m^3; c= 10 kPa; $\varphi = 35°$

   (b) Determine the gross ultimate bearing capacity of a mat foundation with a dimension of 15 m x 20 m. The depth of foundation is 4 m. The mat will be constructed on a deep bed of saturated clay with $c_u = 95$ kPa and $\gamma_{sat} = 17.5$ kN/m^3. 5

   (c) Calculate the depth of fully compensated mat foundation. 3

   Total load = 28,000 kN
   Dimension of the mat: 15 m x 20 m
   $c_u = 95$ kPa and $\gamma_{sat} = 17.5$ kN/m^3

6. (a) Determine the factor of safety for the trial slip surface (Figure 4) using Bishop's simplified method of slices for the given data. 20
The α angles, width of the slices, pore-water pressure and weight of the slices are given in Table 1.
(b) Recalculate (only 1 trial) the factor of safety for the trial slip surface, if the slip surface passes through Layer I only. Use Bishop's simplified method of slices. 5

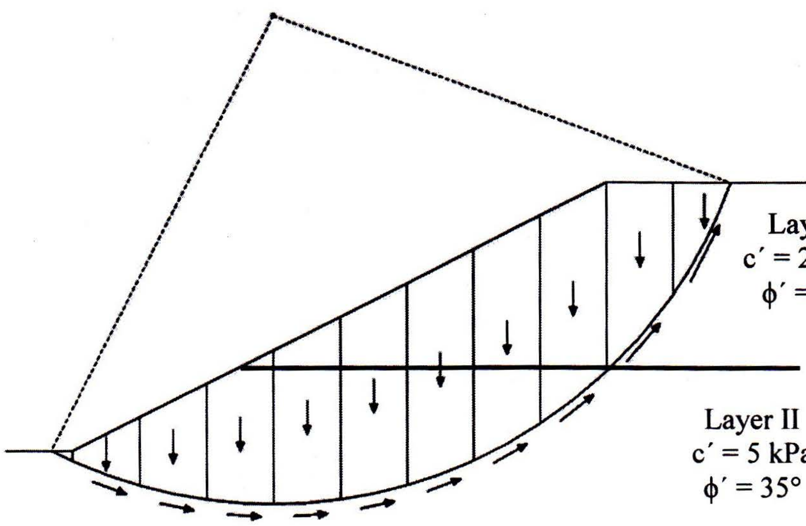


Figure 5

Table 1

Slice No.	α (°)	b (m)	u (kPa)	W (kN/m)
1	-18	2.5	5	68
2	-10	2.5	10	160
3	0	2.5	14	204
4	15	2.5	12	221
5	21	2.5	12	238
6	27	2.5	10	229
7	33	2.5	7	221
8	48	2.5	6	221
9	53	2.5	5	204
10	65	1.6	0	108

The formular of factor of safety derived using Bishop's simplified method of slices is given below:

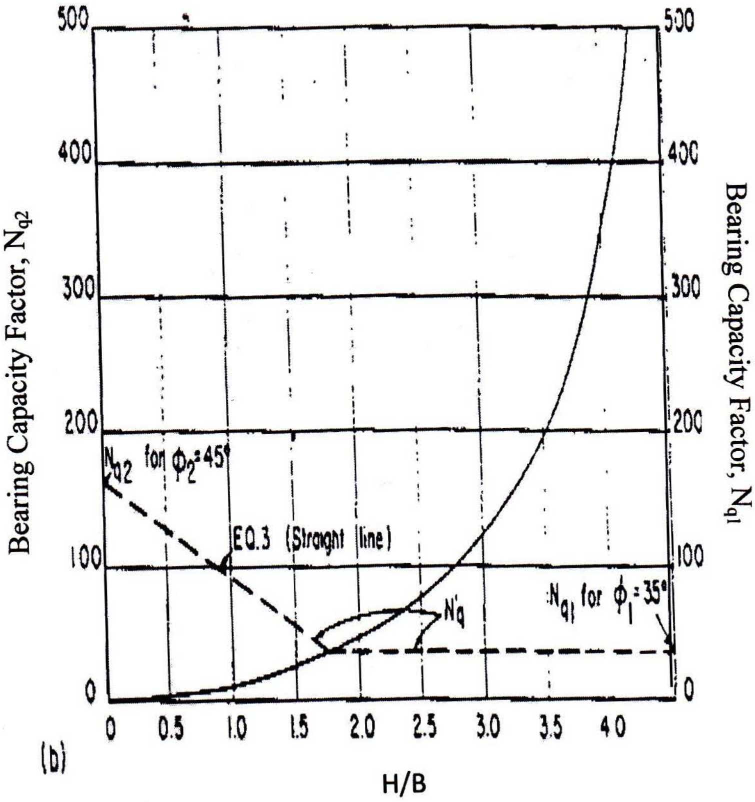
$$F = \frac{\sum(c'b_n + W_n tan\varphi').\frac{1}{m_{\alpha(n)}}}{W_n sin\alpha_n}$$

$$m_{\alpha(n)} = cos\alpha_n + \frac{tan\varphi'.sin\alpha_n}{F_s}$$

Table: Shape, Depth and Inclination Factors

Factor	Condition	Equation
Shape	φ = 0°	$F_{cs} = 1 + 0.2\,(\frac{B}{L})$ $F_{qs} = F_{\gamma s} = 1$
	φ ≥ 10°	$F_{cs} = 1 + 0.2\,(\frac{B}{L}) tan^2(45^\circ + \frac{\varphi}{2})$ $F_{qs} = F_{\gamma s} = 1 + 0.1\,(\frac{B}{L}) tan^2(45^\circ + \frac{\varphi}{2})$
Depth	φ = 0°	$F_{cd} = 1 + 0.2\,(\frac{D_f}{B})$ $F_{qd} = F_{\gamma d} = 1$
	φ ≥ 10°	$F_{cd} = 1 + 0.2\left(\frac{D_f}{B}\right).tan(45^\circ + \frac{\varphi}{2})$ $F_{qd} = F_{\gamma d} = 1 + 0.1\left(\frac{D_f}{B}\right).tan(45^\circ + \frac{\varphi}{2})$
Inclination	Any φ	$F_{ci} = F_{qi} = (1 - \frac{\alpha^\circ}{90^\circ})^2$
	$\varphi > 0^\circ$	$F_{\gamma i} = (1 - \frac{\alpha^\circ}{\varphi^\circ})^2$
	$\varphi = 0^\circ$	$F_{\gamma i} = 0$

Design Charts for N_q' and N_γ' (applicable to weak sand over strong sand)



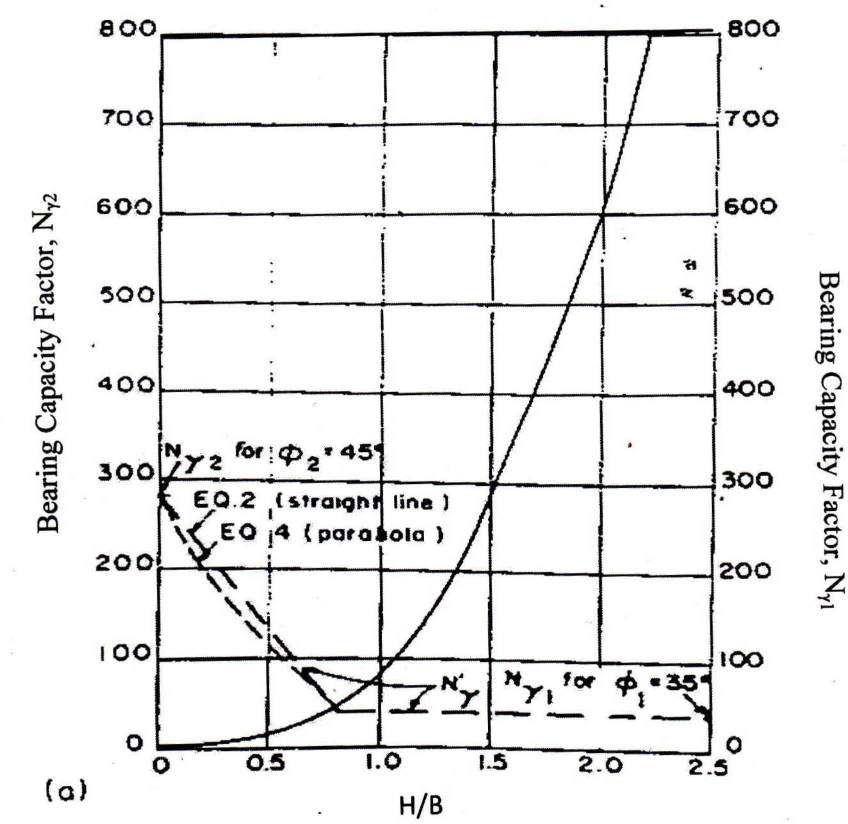
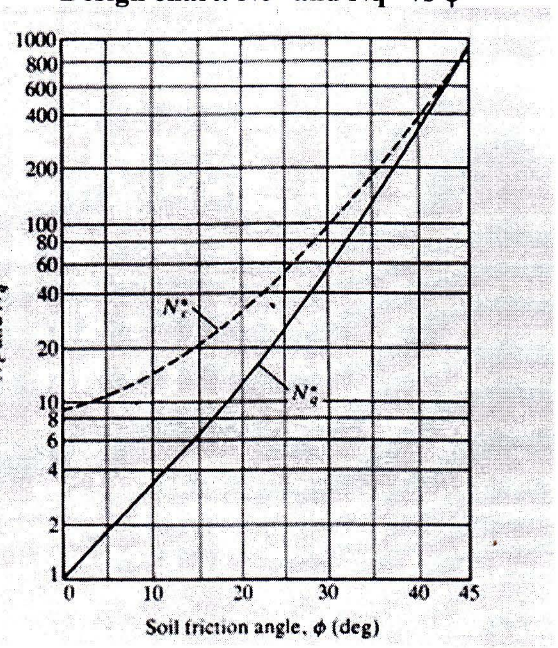


Table: Bearing Capacity Factors (Meyerhof's Chart)

ϕ	N_c	N_q	N_γ (Meyerhof)	ϕ	N_c	N_q	N_γ (Meyerhof)	ϕ	N_c	N_q	N_γ (Meyerhof)
0°	5.10	1.00	0.00	17°	12.34	4.77	1.66	34°	42.16	29.44	31.15
1°	5.38	1.09	0.00	18°	13.10	5.26	2.00	35°	46.12	33.30	37.15
2°	5.63	1.20	0.01	19°	13.93	5.80	2.40	36°	50.59	37.75	44.43
3°	5.90	1.31	0.02	20°	14.83	6.40	2.87	37°	55.63	42.92	53.27
4°	6.19	1.43	0.04	21°	15.81	7.07	3.42	38°	61.35	48.93	64.07
5°	6.49	1.57	0.07	22°	16.88	7.82	4.07	39°	67.87	55.96	77.33
6°	6.81	1.72	0.11	23°	18.05	8.66	4.82	40°	75.31	64.20	93.69
7°	7.16	1.88	0.15	24°	19.32	9.60	5.72	41°	83.86	73.90	113.99
8°	7.53	2.06	0.21	25°	20.72	10.66	6.77	42°	93.71	85.37	139.32
9°	7.92	2.25	0.28	26°	22.25	11.85	8.00	43°	105.11	99.01	171.14
10°	8.34	2.47	0.37	27°	23.94	13.20	9.46	44°	118.37	115.31	211.41
11°	8.80	2.71	0.47	28°	25.80	14.72	11.19	45°	133.87	134.87	262.74
12°	9.28	2.97	0.60	29°	27.86	16.44	13.24	46°	152.10	158.50	328.73
13°	9.81	3.26	0.74	30°	30.14	18.40	15.67	47°	173.64	187.21	414.33
14°	10.37	3.59	0.92	31°	32.67	20.63	18.56	48°	199.26	222.30	526.46
15°	10.98	3.94	1.13	32°	35.49	23.18	22.02	49°	229.93	265.50	674.92
16°	11.63	4.34	1.37	33°	38.64	26.09	26.17				

Design chart: Nc* and Nq* vs ϕ



University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2018
Program: B. Sc. Engineering (Civil)

Course Title: Transportation Engineering (II) — Course Code: CE 451
Time: 3 (Three) hours — Full Marks: 120

[Assume Reasonable Values for Any Missing Data]

Answer 1 or 2

1.	(a)	Distinguish between i) hot mix hot laid and ii) Cold mix cold laid bitumen mixture.	5+5=10
	(b)	Compare and justify the use of VG-10, VG-20, VG-30, and VG-40 Bitumen for constructing an airport pavement.	10

OR

2.	(a)	Clarify the importance of i) penetration test, ii) ductility test, iii) Softening point test, iv) flash and fire point test, v) loss on heating test of bitumen for pavement design and construction.	10
	(b)	Explain the significance of structural number for design of flexible pavement in AASHTHO method.	10

Answer 3 or 4

3.	(a)	Write short note on i) Conventional layered flexible pavement, II) Full-depth asphalt pavement	10
	(b)	Draw a typical cross section of flexible pavement and explain the different layers of flexible pavement.	6+4=10

OR

4.	(a)	As a pavement inspector you are assigned to assess the pavement condition. By manual survey the distresses you found are potholes, and fatigue cracking. Explain how will you understand the severity level of these distresses?	10
	(b)	Explain the importance of Westergaards Modulus of Subgrade Reaction (k) in rigid pavement design and the state factors upon which k value depends.	6
	(c)	Summarize the application of Equivalent Single Axle Load.	4

Answer 5 or 6

5.	(a)	State the significance of i) Plate Bearing Test, and ii) California Bearing Ratio Test of soil.	5+5=10
	(b)	The following results were obtained by a mechanical sieve analysis. Classify the soil according to the AASHTO classification system and give the group index. **Discuss whether this material is suitable in its natural state for use as a subbase material.**	10

Sieve No.	Percent Finer	Plasticity Test
4	97	LL= 48%
10	93	PL=26%
40	88	
100	78	
200	70	

OR

6.	(a)	In designing an asphalt concrete mixture for a highway pavement to support medium traffic, data in Table 1 showing the aggregate characteristics and Table 2 showing data obtained using the Marshall method were used. **Determine the optimum asphalt content for this mix.**	20

Table 1: Aggregate Characteristics

Aggregate Type	Percent by Weight of Total Paving Mixture	Bulk Specific Gravity
Coarse	52.3	2.65
Fine	39.6	2.75
Filler	8.1	2.70

Table2: Marshall Test Result

Asphalt % by Weight of Total Mix	Weight of Specimen (g) (In Air)	Weight of Specimen (g) (In Water)	Stability (lb)	Flow (0.01 in.)	Maximum Specific Gravity of Paving Mixture
5.0	1325.6	780.1	1450	7	2.54
5.5	1331.3	789.6	1550	10	2.56
6.0	1338.2	798.6	1600	11	2.58
6.5	1343.8	799.8	1400	13	2.58
7.0	1349.0	798.4	1200	16	2.60

7. A six-lane divided highway is to be constructed to replace an existing highway. The AADT (both directions) on year 2016 was *6000* vehicles and it is expected to grow at *5%* per annum. It is also expected that the construction of pavement will be completed five year after the traffic count taken on 2016. The percentage of traffic on the design lane is *45%*. **Predict the design ESAL** if the design life is 20 years and the vehicle mix is: Passenger cars (*1000 lb/axle*) = *60%*, 2-axle single-unit trucks (*5000 lb/axle*) = *30%*, 3-axle single-unit trucks (*7000 lb/axle*) =*10%*. 8

ANSWER i) *or* ii) from BELLOW WITH the CALCULATED ESAL

i) **Design a suitable pavement of an asphalt mixture surface** with an elastic modulus of *250,000 lb/in²*, a granular base layer with a structural coefficient of *0.14* on a subgrade having resilient modulus of elasticity *9000 lb/in²*. Assume all m_i values as *1*, and the percentage of traffic on the design lane is *45%*. Use a reliability level of *85%*, a standard deviation of *0.45*, and a design serviceability loss of *2.0*. Explain design procedure. 12

OR

ii) **Determine the pavement layer thicknesses of a HMA** over an untreated granular base, resting on an untreated granular subbase, on the in-situ soil. The HMA M_R = *450,000 psi*. The CBR of the base and subbase are *100* and *40*, respectively. The quality of the drainage for the base and subbase are good and fair. Assume m_i values of base layer *1.15* and subbase layer *0.80*. The resilient modulus of the in-situ soil is *5000 psi*. Adopt AASHTO method and explain process to determine the pavement layer thickness. 12

Answer 8 or 9

8. a. A concrete pavement is to be constructed for a four-lane urban expressway on a subgrade with an effective modulus of subgrade reaction k of *100 lb/in³*. The accumulated equivalent axle load for the design period is $3.25X10^6$. The initial and terminal serviceability indices are *4.5* and *2.5*, respectively. Using **the AASHTO design method, determine a suitable thickness of the concrete** *pavement* if the working stress of the concrete is *600 lb/in²* and the modulus of elasticity is $6X10^6$ *lb/in²*. Take the overall standard deviation S_o as *0.30*, the load-transfer coefficient J as *3.2*, the 20

drainage coefficient as *0.7*, and Reliability *90%*.

OR

9. a. **Measure Effective Modulus of Subgrade Reaction for a Rigid Pavement** using AASHTO Method. A *6* in. 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 3. If the rock depth is located *5* ft below the subgrade surface and the projected slab thickness is *9* in., estimate the effective modulus of subgrade reaction, using the AASHTO method. 20

Table 3:

Month	Roadbed Modulus, M_r (lb/in^2)	Subbase Modulus, E_{sb} (lb/in^2)
January	20,000	50,000
February	20,000	50,000
March	2,500	15,000
April	4,000	15,000
May	4,000	15,000
June	7,000	20,000
July	7,000	20,000
August	7,000	20,000
September	7,000	20,000
October	7,000	20,000
November	4,000	15,000
December	20,000	50,000

<u>**Answer 10 or 11**</u>

10. a. Explain basic requirements of an ideal alignment of railway. 20

OR

11. a. Summarize the importance of rail. 10

b. Draw different types of rail sections. Justify which rail section should be preferred. (5+5)=10

Required Formula:

$$G_{mb} = \frac{W_a}{W_a - W_w} \qquad P_a = 100\frac{G_{mm} - G_{mb}}{G_{mm}}$$

$$G_{sb} = \frac{P_{ca} + P_{fa} + P_{mf}}{\frac{P_{ca}}{G_{bca}} + \frac{P_{fa}}{G_{bfa}} + \frac{P_{mf}}{G_{bmf}}} \qquad G_{se} = \frac{100 - P_b}{(100/G_{mm}) - (P_b/G_b)}$$

Required Charts and Tables

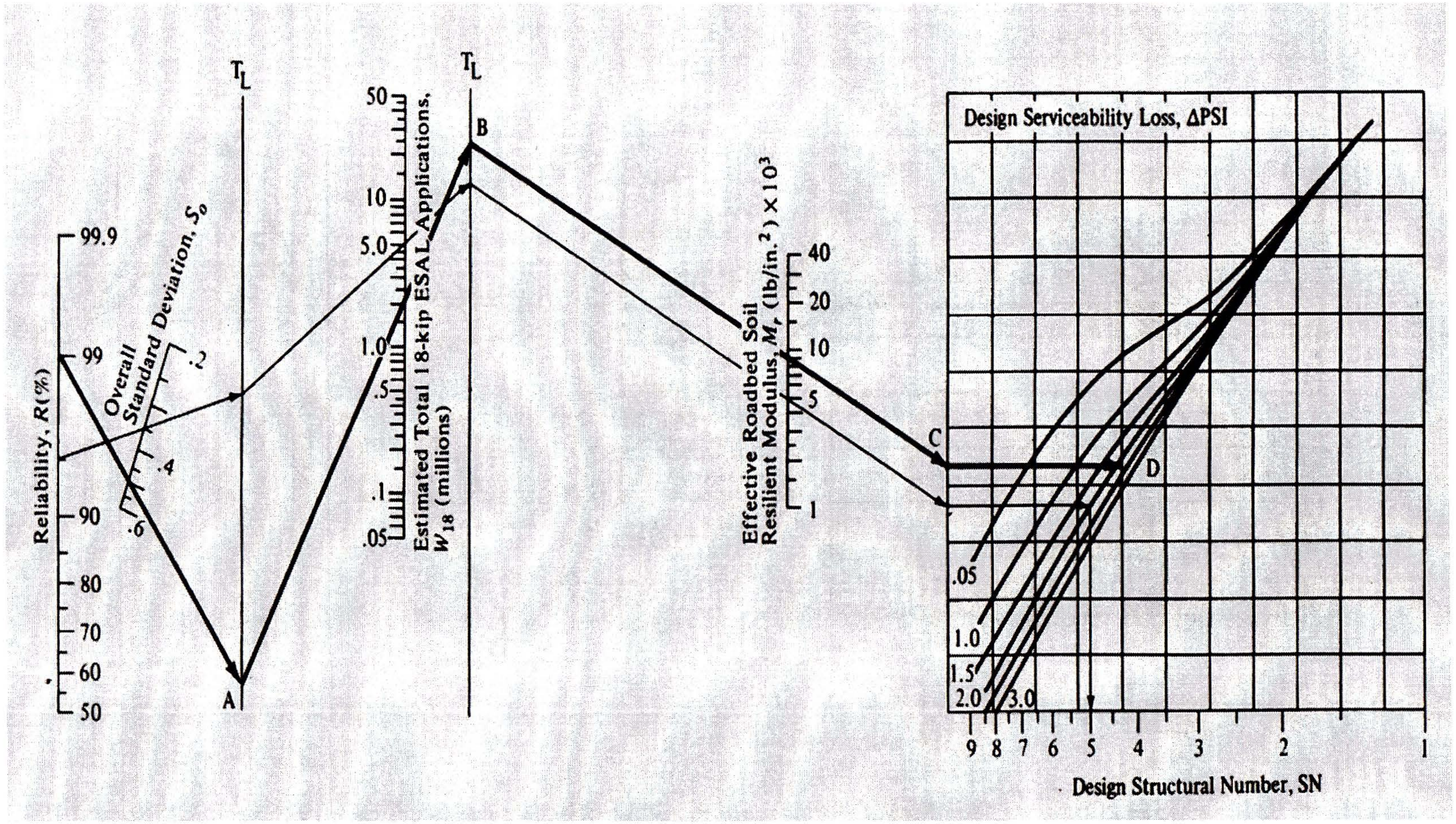


Figure 1: Design Chart for Flexible Pavements Based on Using Mean Values for each Input

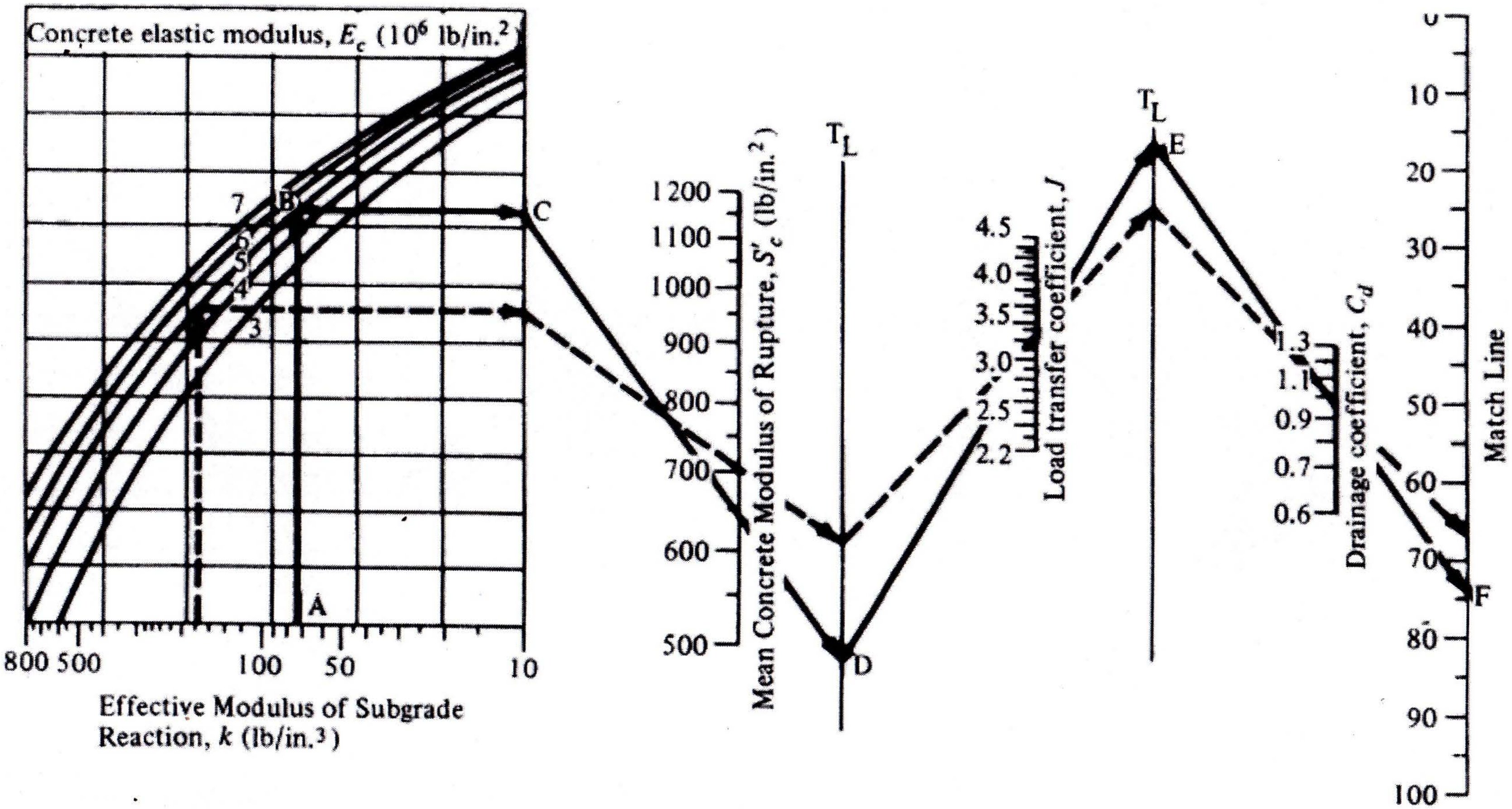


Figure 2: Design Chart for Rigid Pavement Based on Using Values for Each Input Variable (Segment 1)

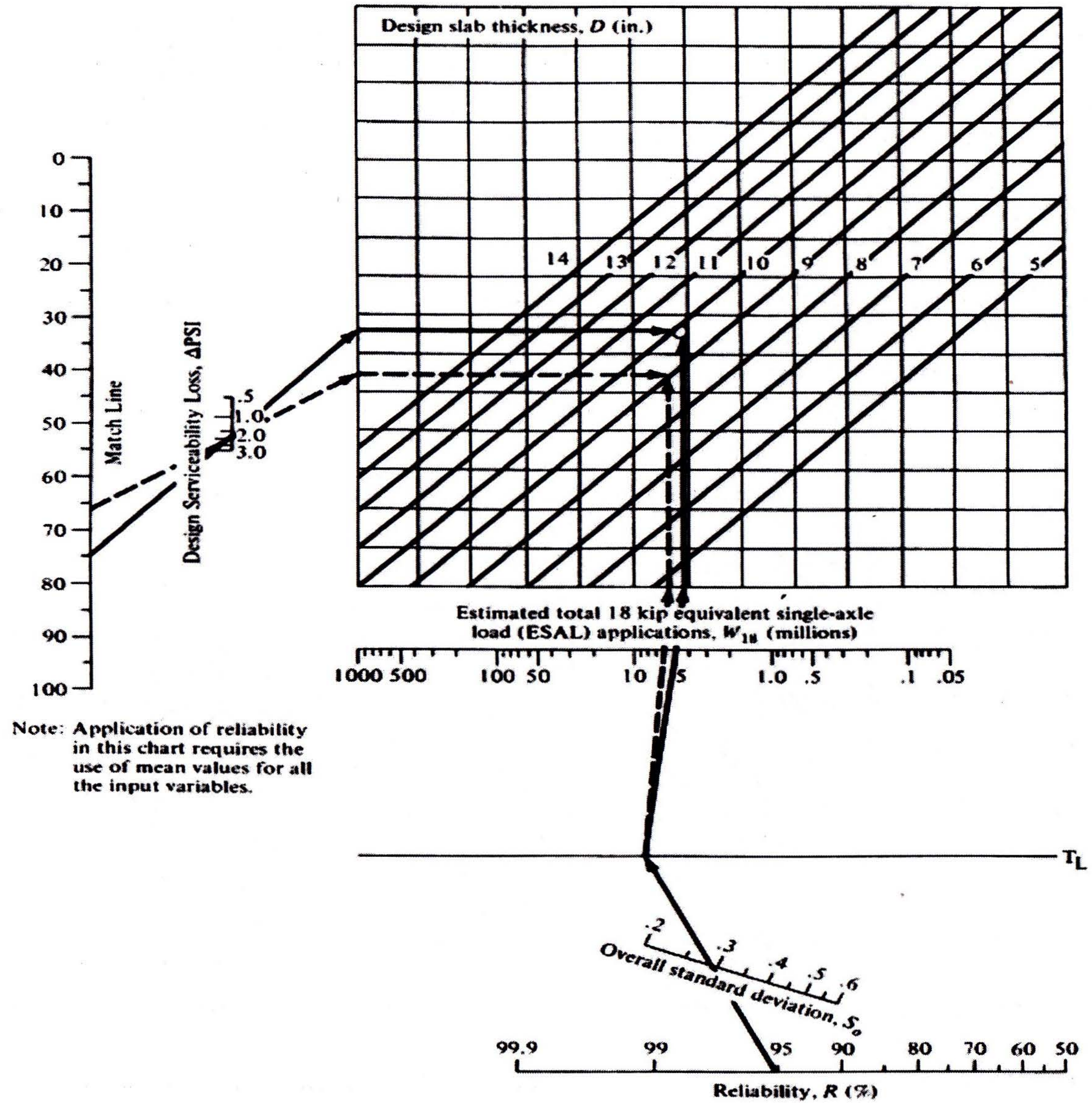


Figure 3: Design Chart for Rigid Pavement Based on Using mean Values for Each Input Variables.

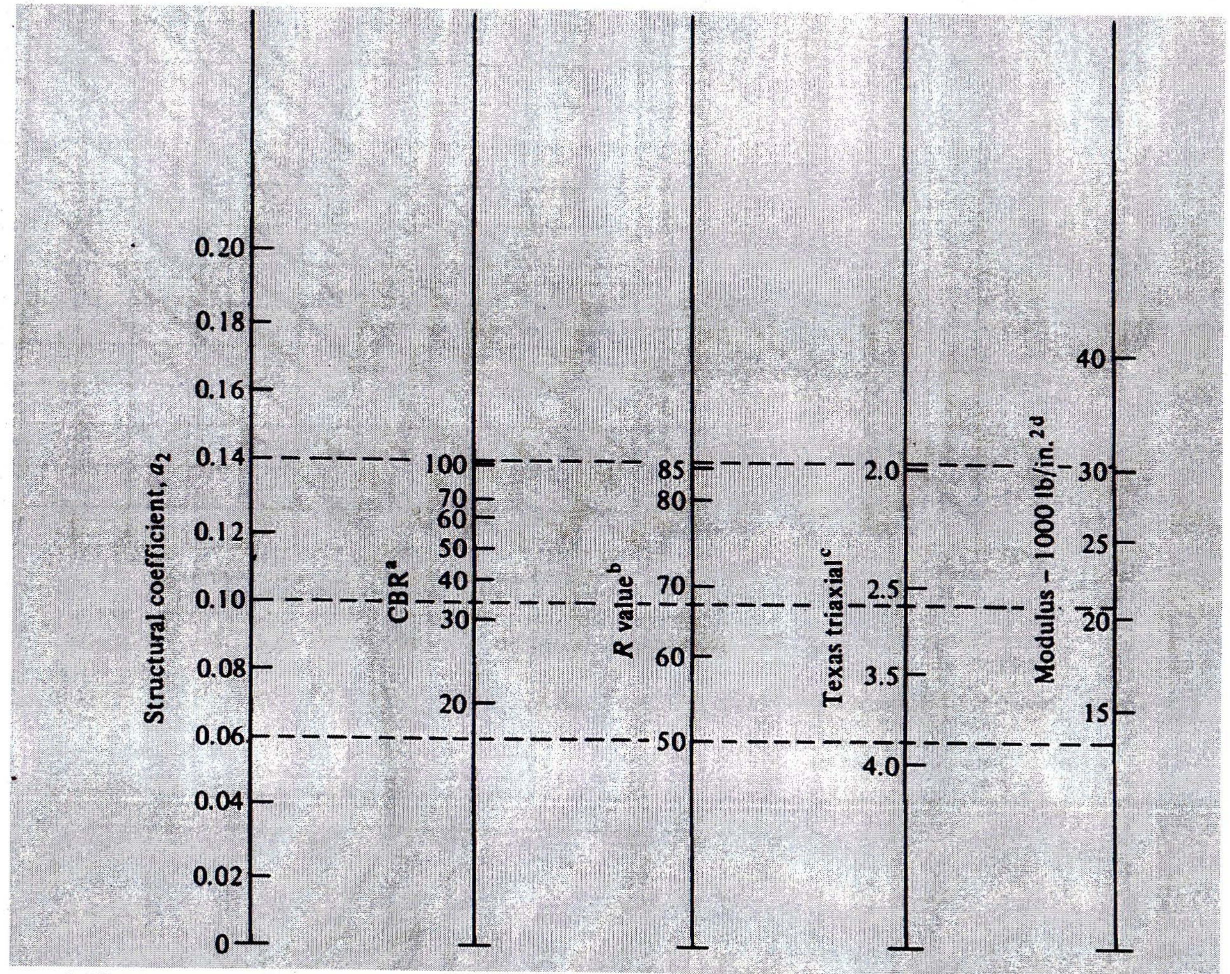


Figure 4: Variation in Granular Base Layer Coefficient, a_2, with Various Subbase Strength Parameters

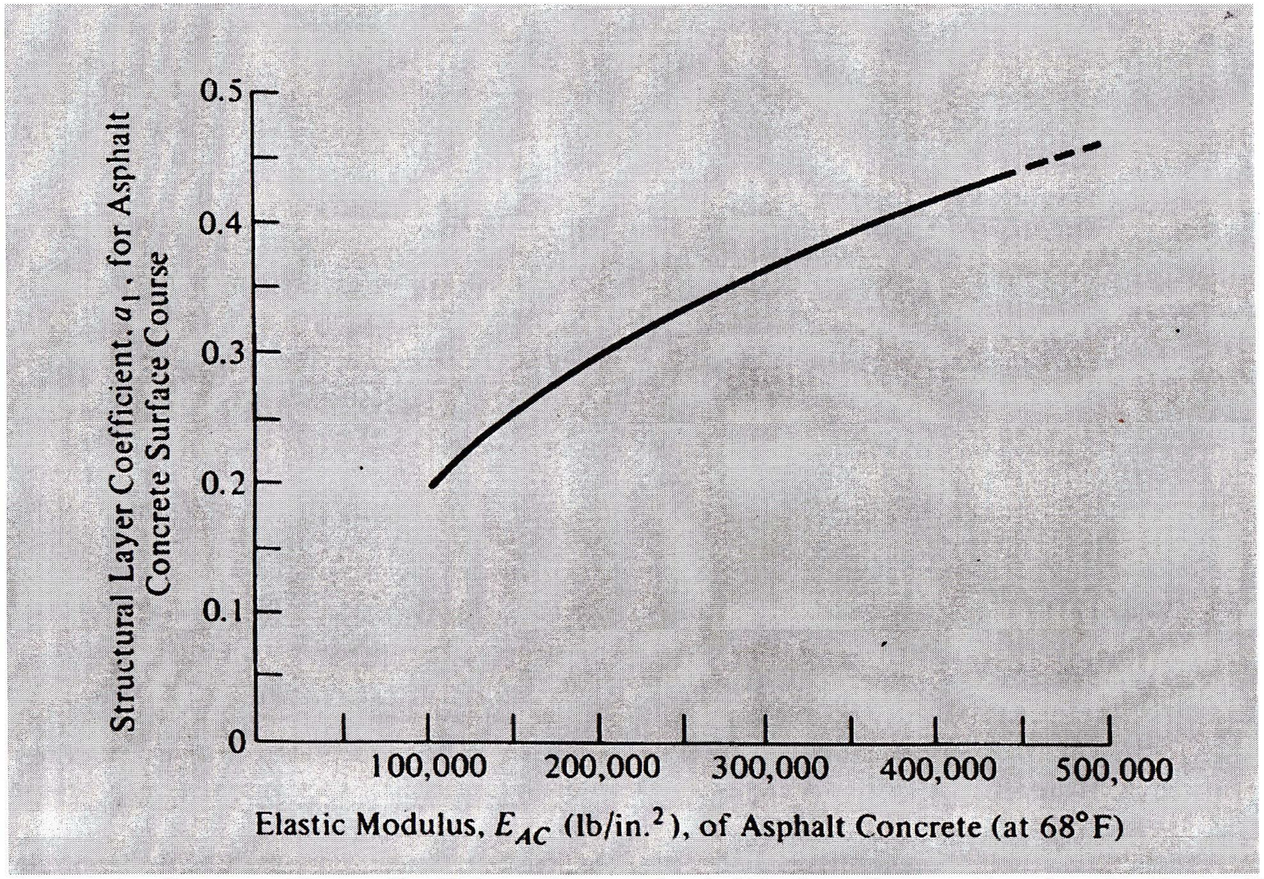
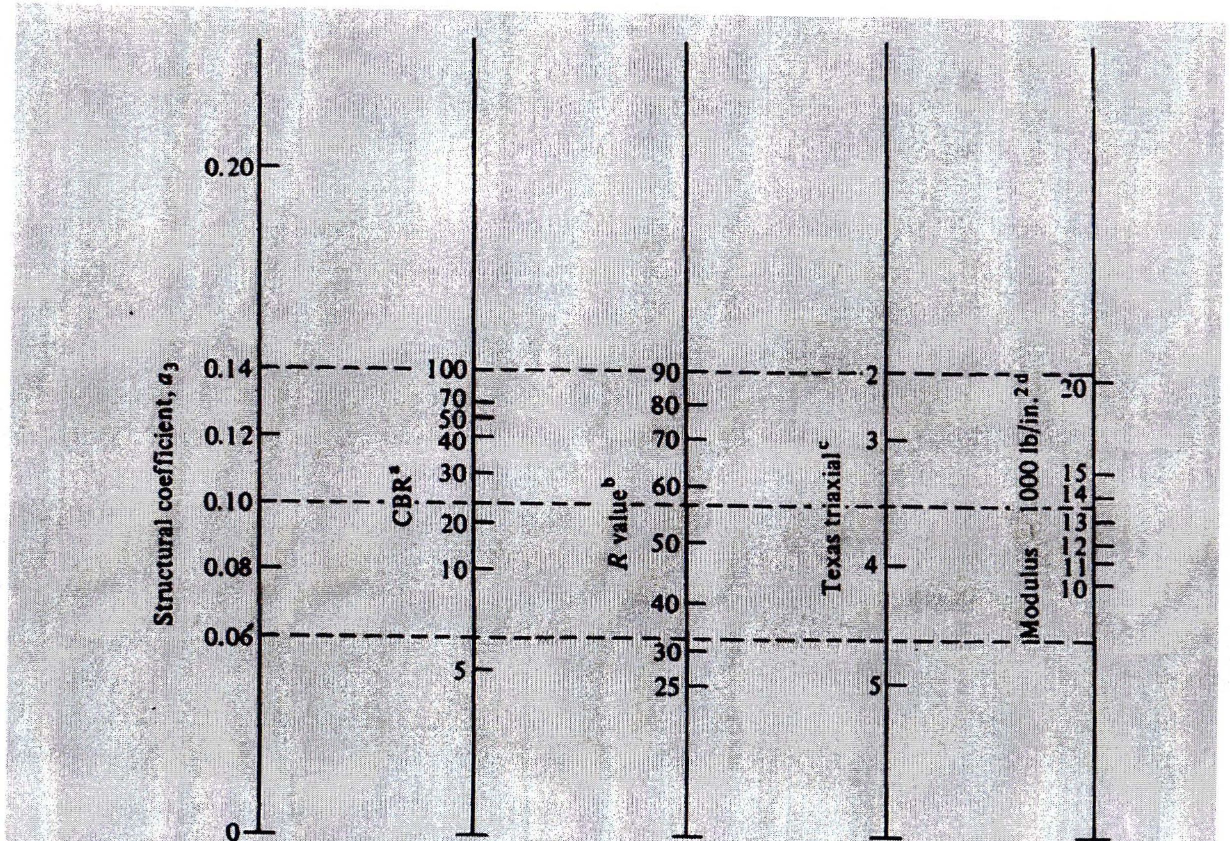


Figure 5: Chart for Estimating Structural Layer Coefficient of Dense-Graded/Asphalt Concrete Based on the Elastic (Resilient) Modulus



[a] Scale derived from correlations from Illinois.
[b] Scale derived from correlations obtained from The Asphalt Institute, California, New Mexico, and Wyoming.
[c] Scale derived from correlations obtained from Texas.
[d] Scale derived on NCHRP project 1 28, 1972.

Figure 6: Variation in Granular Subbase Layer Coefficient, a_3, with Various Subbase Strength Parameters

Table 1: Recommended m_i Value

Quality of Drainage	*Percent of Time Pavement Structure Is Exposed to Moisture Levels Approaching Saturation*			
	Less Than 1%	*1 to 5%*	*5 to 25%*	*Greater Than 25%*
Excellent	1.40–1.35	1.35–1.30	1.30–1.20	1.20
Good	1.35–1.25	1.25–1.15	1.15–1.00	1.00
Fair	1.25–1.15	1.15–1.05	1.00–0.80	0.80
Poor	1.15–1.05	1.05–0.80	0.80–0.60	0.60
Very poor	1.05–0.95	0.95–0.75	0.75–0.40	0.40

Table 2: AASHTO Soil Classification System

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			

*Plasticity index of A-7-5 subgroup ≤ LL − 30. Plasticity index of A-7-6 subgroup > LL − 30.

SOURCE: Adapted from *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*, 27th ed., Washington, D.C., The American Association of State Highway and Transportation Officials, copyright 2007. Used with permission.

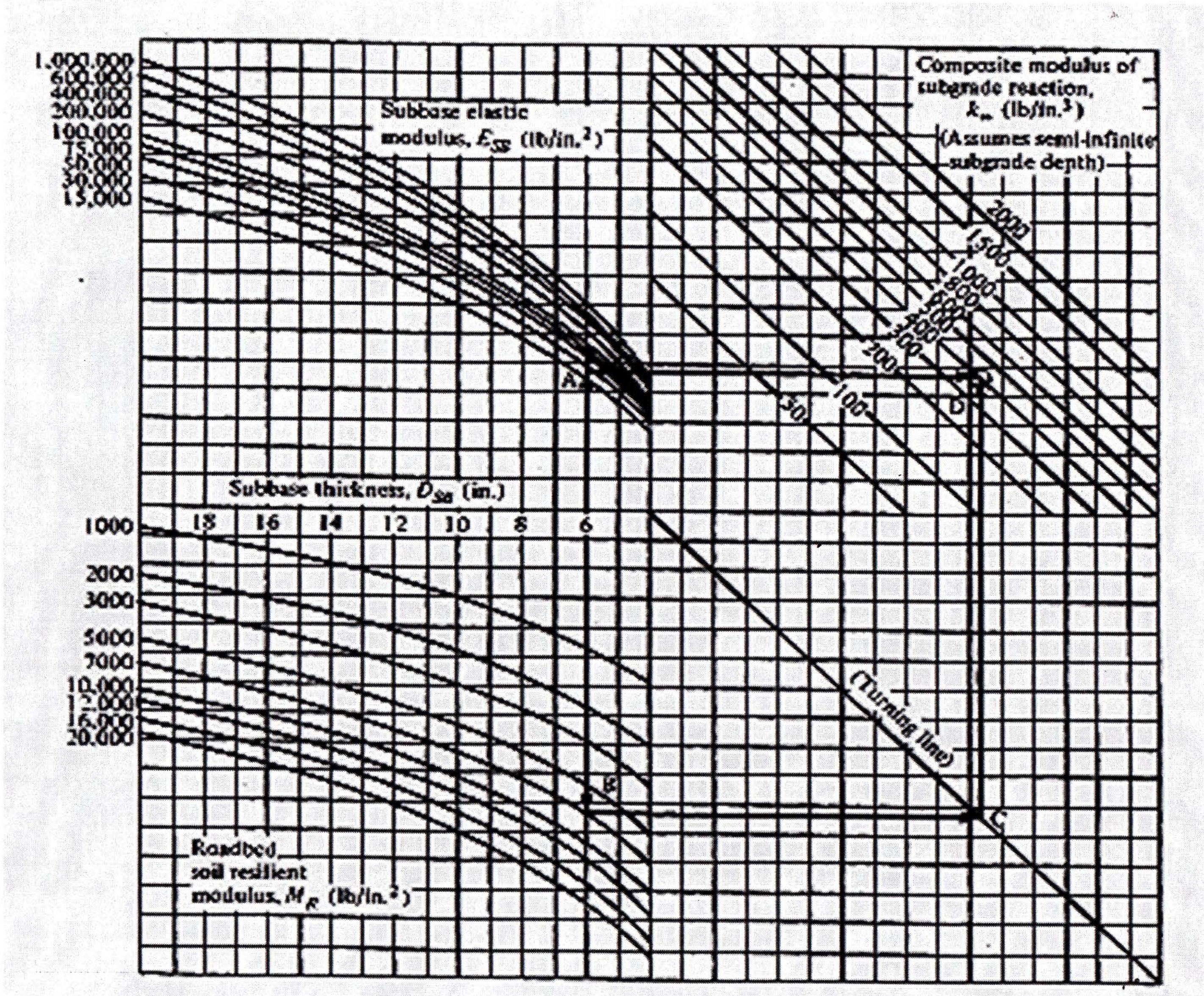


Figure 7 Chart for Estimating Composite Modulus of Subgrade Reaction, K∞, Assuming a Semi-Infinite Subgrade Depth

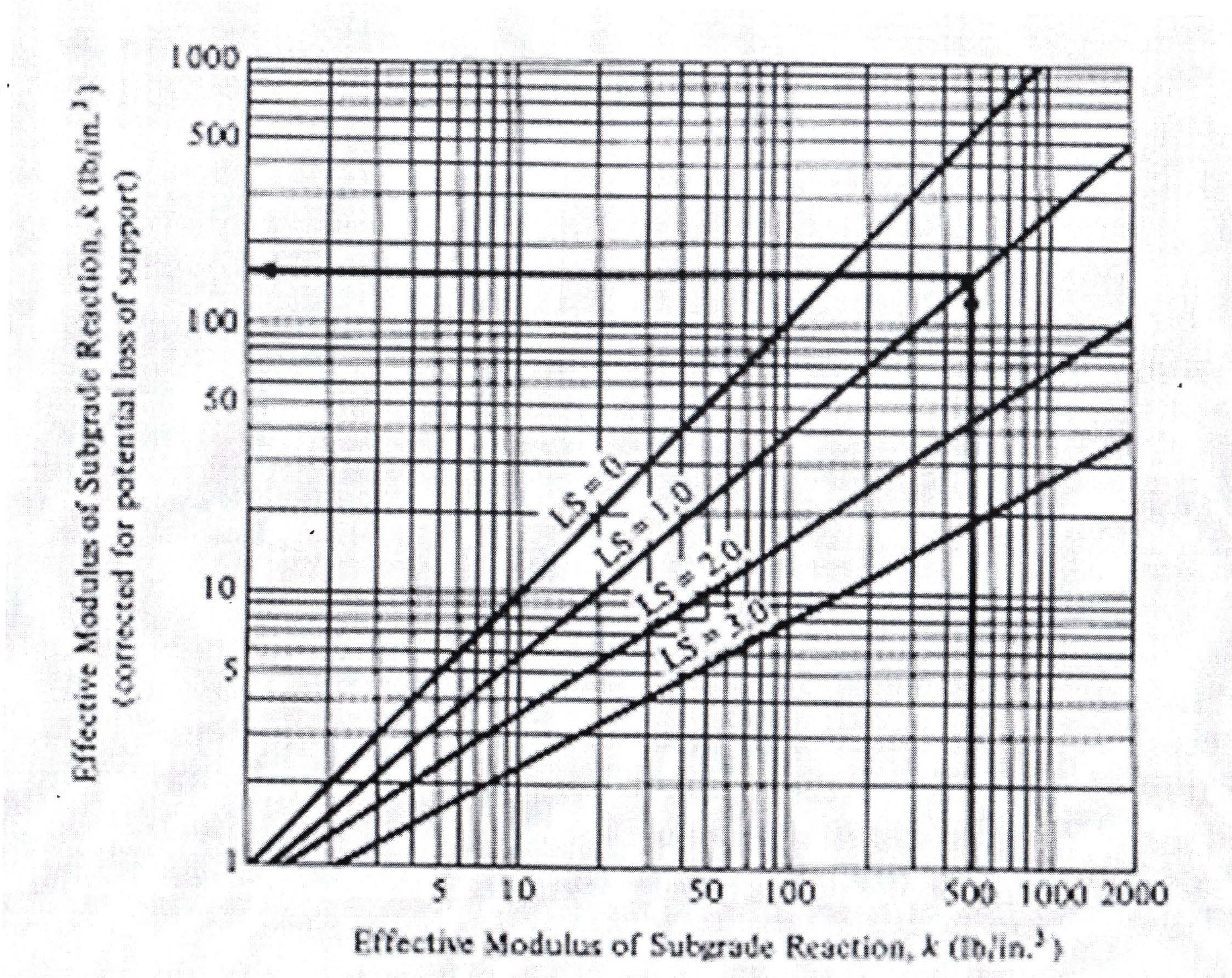


Figure 8 Correction of Effective Modulus of Subgrade Reaction for Potential Loss of Subbase Support

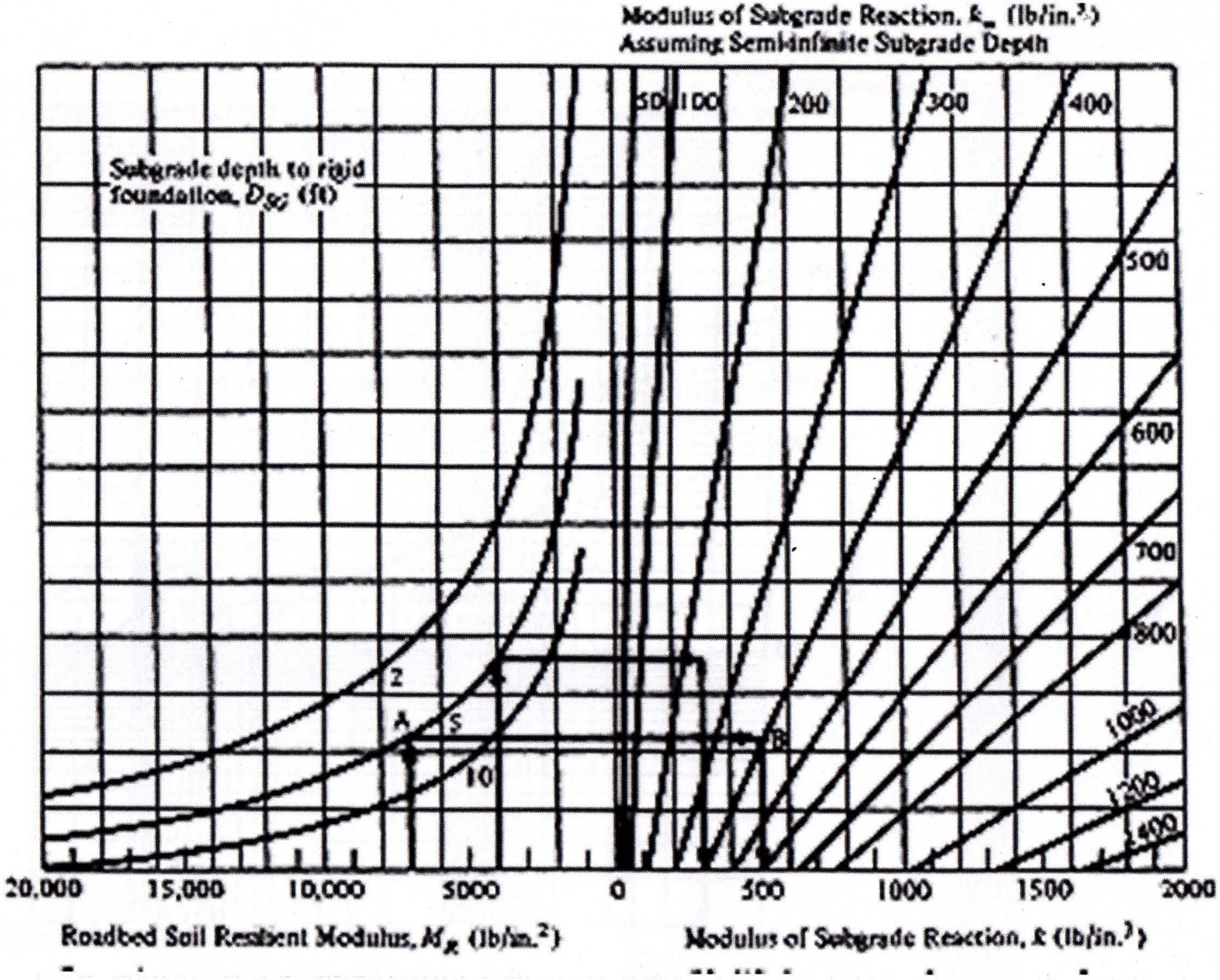


Figure 9 Chart to Modify Modulus of Subgrade Reaction to Consider Effects of Rigid Foundation Near Surface (within 10 ft)

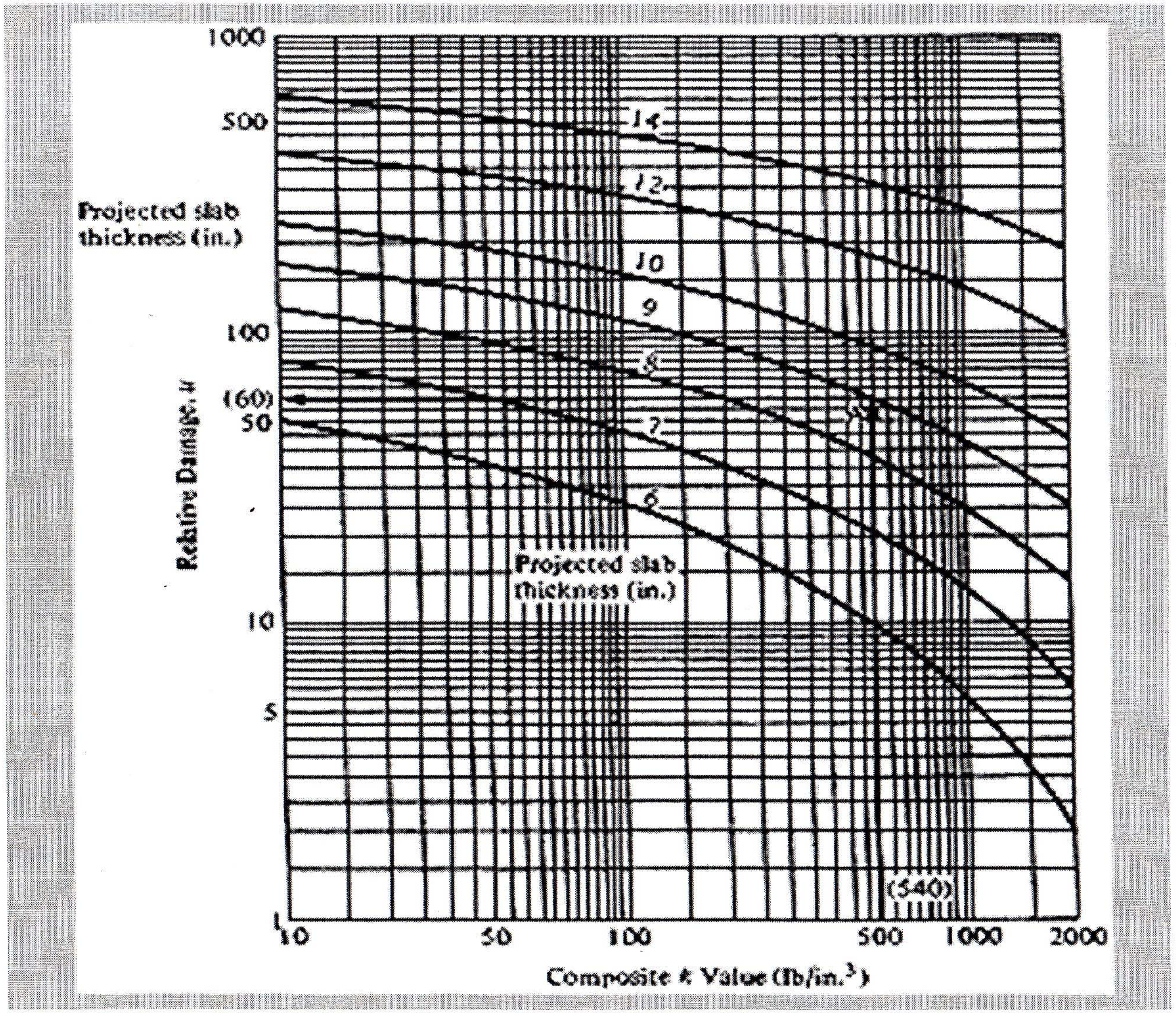


Figure 10 Chart for Estimating Relative Damage to Rigid Pavements Based on Slab Thickness and Underlying Support

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 18
Program: B.Sc. Engineering (Civil)

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

There are TWO sections in the question paper namely "SECTION A" and "SECTION B". You have to answer from both sections according to the instruction mentioned on each section.

SECTION A
MARKS: 72

There are FIVE (5) questions. Answer any FOUR (4*18=72). (Assume any missing data.)

1. a) Explain the following: i) Irrigation; ii) Conjunctive use of water; iii) Aquifer. 6
   b) Do you think that the socio-economic and environmental development of Bangladesh depends on the development of agriculture? Justify your answer. 6
   c) Do you agree that in Bangladesh *basin flooding method* is more appropriate than *furrow irrigation method*? Justify your answer. 6

2. a) Classify the irrigation water based on the electrical conductivity and sodium hazards. Summarize the suitability of these classes with respect to soils and crops. 5+5
   b) Estimate the possible change in soil salinity owing to evaporation of 11 cm ground water having an electrical conductivity of 12 mmhos/cm over a period of 4 months. The 31 cm depth of soil has a mean bulk density of 1.45 g/cm^3 and saturation point of 32 percent. The density of water is assumed as 1 g/cm^3. It is considered that the 31 cm depth of soil will be effected by the rise of salt concentration. 6
   c) Explain leaching requirement. 2

3. a) Explain soil moisture tension and soil moisture stress. 5
   b) Explain the following: i) Berms ii) Spoil Banks 3
   c) A stream of 120 liters per second was diverted from a canal and 105 liters per second was delivered to the field. An area of 2 hectares was irrigated in 9 hours. The effective depth of root zone was 1.8 m. The runoff loss in the field was 605 m^3 and seepage loss is 6 m^3. The depth of water penetration varied linearly from 2.1 m at the head end of the field to 1.4 m at the tail end. Available moisture holding capacity of the soil is 18 cm per meter depth of soil. Irrigation was started at a moisture extraction level of 65% of the available moisture. 10
   Calculate the following:
   - water conveyance efficiency
   - water application efficiency
   - water storage efficiency
   - water distribution efficiency

4. a) Graphically demonstrate the following (in one figure): 5
   - Capillary water
   - Hygroscopic water
   - Optimum moisture content
   - Readily available moisture
   - Permanent wilting point
   - Field capacity

   b) After how many days will you supply water to soil in order to ensure sufficient irrigation of the given crop, if, 6
   - Available moisture = 19%
   - Unavailable moisture = 16%
   - Optimum moisture content = 16%
   - Dry density of soil = 1.3 gm/cc
   - Effective depth of root zone = 62 cm
   - Daily consumptive use of water for the given crop = 13 mm

   c) The gross command area for a distributary is 2400 hectares, 75% of which is cultivable. Intensities of rice and wheat crops are 50% and 30% respectively. The duties for the crops at the head of the watercourse are 550 hectares/cumec and 600 hectares/cumec respectively. Calculate the following: 7
   - discharge required at the head of the watercourse
   - design discharge at the outlet, assuming a time factor equal to 0.8.
   - average discharge at the outlet, assuming a capacity factor equal to 0.73

5. a) Explain the following: i) Coefficient of rugosity; ii) Critical velocity ratio; iii) Berm. 6

   b) Explain the following with neat sketch: i) Barrage; ii) Groyne; iii) Weir. 6

   c) An irrigation project is located in an area formed by non-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 take the advantage of stable and impervious nature of the soil in the project area, the engineering department decided to construct an unlined canal. 6

   As a newly recruited engineer in the local engineering department, design that canal having the following data:
   Discharge of the canal = 24 cumec
   Permissible mean velocity = 0.80 m/sec.
   Bed slope = 1 in 5000
   Side slope = 1:1
   Chezy's constant, C = 44
   Assume other reasonable data for the design.

SECTION B
MARKS: 28

There are THREE (3) questions. Answer <u>question no. 06 (COMPULSORY)</u> and any ONE (1) from the rest (16+12=28). (Assume any missing data.)

6. a) Explain delta formation process and how delta formation process relates to flood. 6

   b) During non-monsoon period, the farmers of Bangladesh are facing water shortages due to the reduction of flow in the major rivers that flow from upstream India to Bangladesh. Bangladesh claims that due to excessive extraction of water through construction of barrages and dams in upstream India, the water availability in downstream Bangladesh is reduced substantially. A joint commission of Bangladesh and India is formed to solve this conflict. You are representing Bangladesh in the joint commission. 6

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

   c) Draw the typical layout of diversion head works. 4

7. a) Select three structural and three non-structural measures of flood management that you think are most important for flood management in Dhaka city. Justify your answer. 7

   b) Graphically explain how flood hazards vary with different geological conditions in Bangladesh. 5

8. a) What is flood risk management? Draw a flood risk map for your own village/ward/neighborhood. 2+4

   b) Explain the following (any two): 3+3
      i. Integrated water resources management
      ii. River training works
      iii. Haor