UNIVERSITY OF ASIA PACIFIC
Department of Civil Engineering
Term Final Examination Fall 2017
Program: B. Sc. in Engineering (Civil)

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

[Assume Reasonable Values for Any Missing Data]

SECTION – A

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

1. **(a)** 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)**

   (b) What challenges are being faced by the construction industry nowadays? What are the negative sides of Project Management? **(10)**

   (c) List the 'think twice' contract clauses. **(5)**

2. **(a)** Differentiate between Quality Control and Quality Assurance and write down the modern view of Quality Control. **(10)**

   (b) Write down the seven principles to prevent accidents. **(10)**

   (c) Differentiate between Open Tendering & Limited Tendering Methods. **(5)**

3. **(a)** The construction of a bridge requires 1,000 bags of cement per month (assume 30 days per month and 12 months per year). Cost associated with each order is Tk. 3,000 and the annual holding cost per cement bag is Tk. 500. The lead time for the order to arrive is 7 days. Calculate the Economic Order Quantity (EOQ). **(10)**

   (b) As the procurement manager for a large housing development company, you order cement in bulk for every quarter. The price for each cement bag is Tk. 400 and a profit charged for each cement bag is Tk. 100 from the project. For maintaining high quality, the company sells all leftover cement bags after each quarter for Tk. 360 per bag. You have calculated that the average A/F Ratio is 0.98 with standard deviation of 0.2 for the last 10 quarters. Based on information supplied by project managers, the estimated demand for next quarter is 30,000 cement bags. What will be your profit maximizing ordering quantity using the Newsvendor Model? See the attached table for Z-score. **(15)**

4. **(a)** What are the disadvantages of low inventory turns? What are the reasons for holding inventory? **(10)**

(b) Which of the following generators would you recommend buying if the discount factor is 10 percent? Would you select the same generator if discount factor were 20 percent? Note that there is no salvage value at the end of operating life for either model. Also find the crossover discount rate. **(15)**

Information Available	DIESEL MODEL	GASOLINE MODEL
OPERATING LIFE *(YEARS)*	10	5
PRICE *(BDT)*	100,000	50,000
ANNUAL OPERATING & MAINTENANCE COST *(BDT)*	10,000	15,000

SECTION – B

There are **FOUR** questions in this section. Answer question **FIVE** and any **TWO** from the rest.

5. **(a)** The Company X is planning to install a new computerized system. The management has determined the activities required to complete the project. **(4+4+4+4+4=20)**

The precedence relationships of the activities are as follows:

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 EST, EFT, LST, LFT time for each activity

iii. Find the critical path

iv. Find the project completion time

v. If you reduce the time required for activity 8 and 10 by 1 week each, find the project completion time and critical path as well.

(b) Compare between Greenfield and Brownfield project with example. **(5)**

6. **(a)** A firm can produce three types of cloth, A, B, and C. Three kinds of wool, red wool, green wool, and blue wool are required for it. **(15)**

One unit length of Type A cloth needs 2 yards of red wool and 3 yards of blue wool; one unit length of Type B cloth needs 3 yards of red wool, 2 yards of green wool, and 2 yards of blue wool; and one unit length of Type C cloth needs 5 yards of green wool and 4 yards of blue wool. It is assumed that the income obtained from one unit length of Type A cloth is Tk. 3, of Type B is Tk. 5 and that of Type C cloth is Tk. 4.

The firm has a stock of 8 yards of red wool, 10 yards of green wool and 15 yards of blue wool. Formulate the problem as a linear programming problem.

(b) Discuss Regression analysis of Forecasting in detail. What are the advantages of regression analysis? In which case is it applicable? Justify your answer. **(5+3+2 = 10)**

7. **(a)** A dairy feed company may purchase and mix one or more of the three types of grains containing different amounts of nutritional elements. The data are given in the table below.

The production manager specifies that any feed mix for his livestock must meet at least minimal nutritional requirements and seeks the least costly one among all such mixes. Formulate the linear programming model. **(15)**

Nutritional Ingredient		One unit weight of			Minimal Requirement
		Grain – 1	Grain – 2	Grain – 3	
	A	2	3	7	1250
	B	1	1	0	250
	C	5	3	0	900
	D	6	25	1	1232.5
Cost/ unit weight (Tk.)		**41**	**35**	**96**	

(b) Discuss the uncertainties in demand forecasting. **(10)**

8. **(a)** The XYZ company is considering three investment projects, Project A, Project B and Project C. The expected cash flows are as follows: **(4+4+4+3 = 15)**

Year	Project A	Project B	Project C
0	5000	5000	5000
1	3500	1000	15000
2	2500	3000	10000
3	1500	4000	---------

i. Construct NPV profiles for the three projects
ii. Construct BCR for the three projects
iii. What is the IRR of each project
iv. Which project would you choose if r is 12 % (percent)?

(b) Define feasible normal capacity (FNC) and nominal maximum capacity (NMC). What are the factors that affect capacity decision? Explain in brief how the investment costs per unit of capacity decreases as the plant capacity increases. **(2+3+5 = 10)**

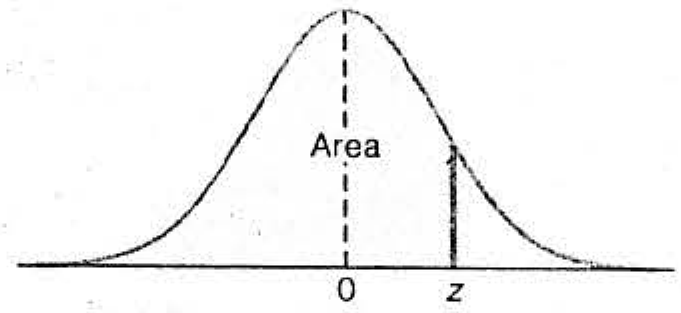


Table A.3 Areas under the Normal Curve

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
−3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
−3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
−3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
−3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
−2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
−2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
−2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
−2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
−2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
−2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
−2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
−2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
−2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
−2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
−1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
−1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
−1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
−1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
−1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
−1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
−1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
−1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
−1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
−1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
−0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
−0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
−0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
−0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
−0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
−0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
−0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
−0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
−0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
−0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

Table A.3 (continued) Areas under the Normal Curve

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2017
Program: B.Sc. in Civil Engineering

Course Title: Structural Engineering III — Course Code: CE 411
Time: 3 hours — Full Marks: 100

[Answer ***ALL*** the following questions]

QUESTION 1 (MARKS 20)

a. Determine the degree of kinematic indeterminacy (doki) and show the corresponding deflections and rotations of the 3D frame ***Fig.1(a)*** and 2D frame ***Fig.1(b)*** shown below for the following cases:
(i) Not considering boundary conditions
(ii) Considering boundary conditions
(iii) Neglecting axial deformations. **[10 marks]**

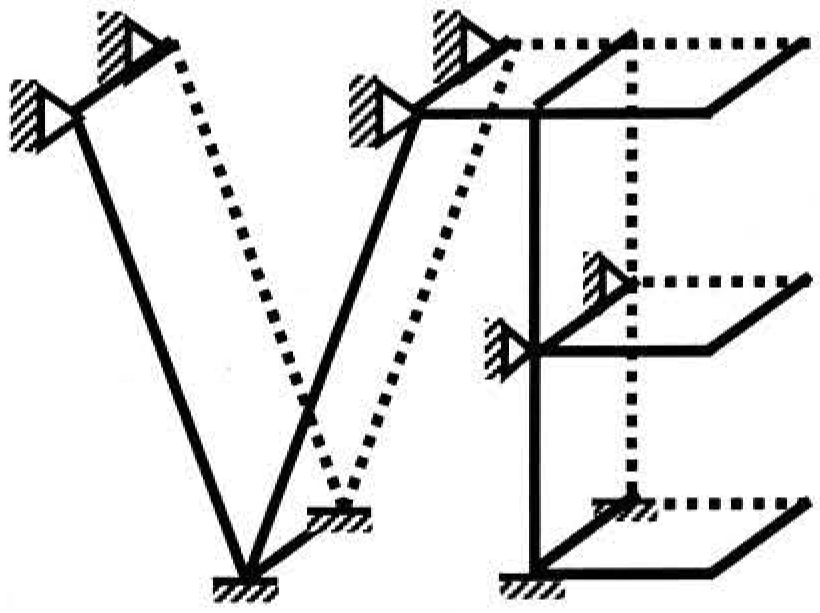


Fig.1(a)

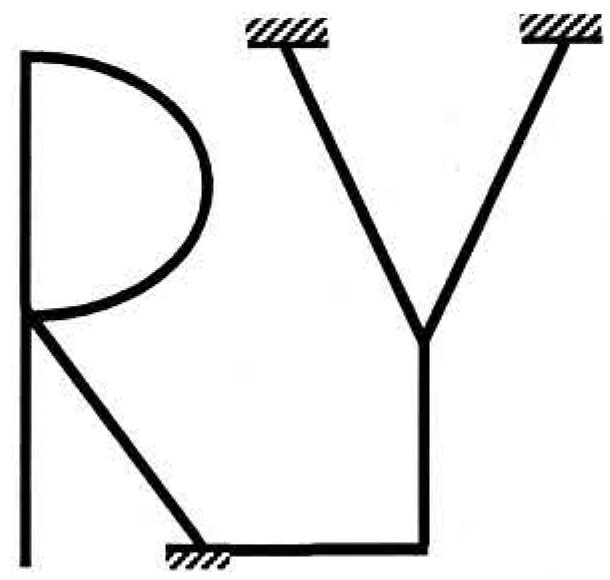


Fig.1(b)

b. Frame structure ***abcdefg*** shown in ***Fig.2*** is subjected to a dynamic load, $w = e^t$ *(k/ft)*. Use *Constant Average Acceleration* (*CAA*) Method to calculate the rotation of joint ***c*** at time $t = 0.10$ sec.
[Given: $EI = 40\times 10^3$ k-ft^2, $\mu = 0.0045$ k-sec^2/ft^2, Damping ratio of the system =0%]. **[10 marks]**

QUESTION 2 (MARKS 20)

a. Ignore zero-force members and apply boundary conditions to form the stiffness matrix of the space truss ***abcdefgh*** as shown in ***Fig.3*** [Given: S_x = constant = 10^4 N/mm; Nodal Coordinates (m) are *a*(0,0,0), *b*(0,0,-2), *c*(4,0,-2), *d*(4,0,0), *e*(0,10,0), *f*(0,10,-2), *g*(4,10,-2), *h*(4,10,0)] **[10 marks]**

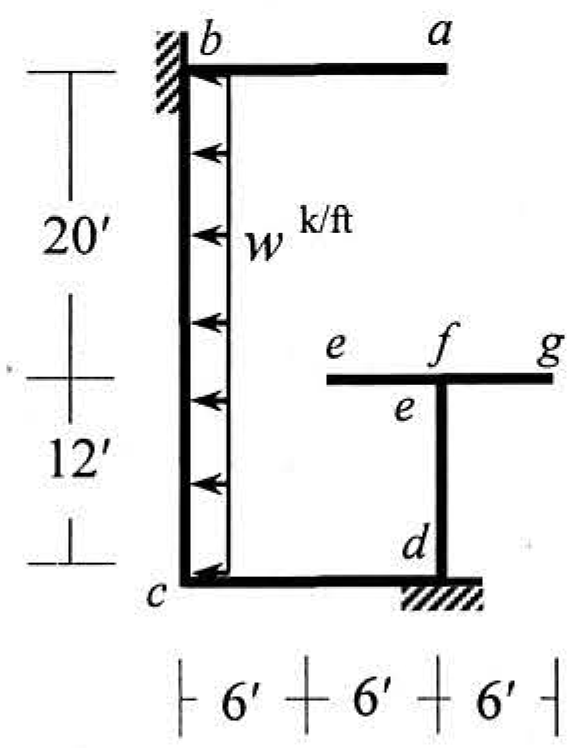


Fig.2

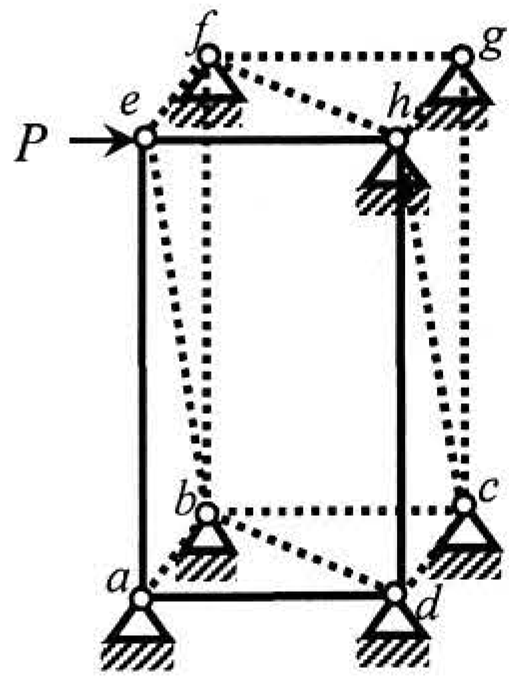


Fig.3

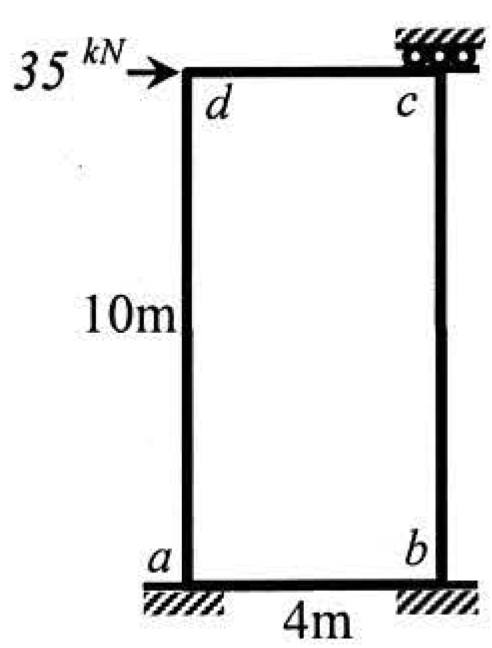


Fig.4

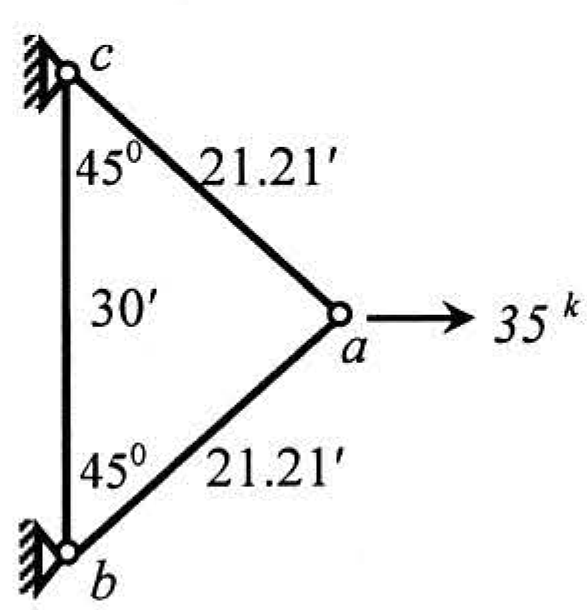


Fig.5

b. Use Stiffness Method (neglecting axial deformation) to calculate the unknown deflection and rotation of the frame ***abcd*** loaded as shown in ***Fig.4*** [Given: $EI = 16\times 10^3$ kN-m^2]. **[10 marks]**

QUESTION 3 (MARKS 20)

a. For the plane truss ***abc*** loaded as shown in ***Fig.5***, calculate (i) horizontal and vertical deflection at joint ***a*** and (ii) Axial force in all members. [Given: S_x = constant = 1000 k/ft] **[7 marks]**

b. For the plane truss ***abc*** shown in ***Fig.5***, calculate its natural frequencies (neglecting zero-force members) using consistent mass matrices [Given: S_x = constant = 1000 k/ft, mass per length μ = 0.0045 k-sec^2/ft^2]. **[7 marks]**

c. Use the Stiffness Method (neglect axial deformations) to calculate the rotation at joint ***c*** of the frame loaded as shown in ***Fig.6***, if the support at ***c*** is a circular foundation of radius 3m on the surface of sub-soil (half-space) with shear-wave velocity (v_s) equal to 50m/sec [Given: $EI = 20 \times 10^3$ kN-m^2, Unit weight of soil = 18 kN/m^3, Poisson's ratio = 0.25]. **[6 marks]**

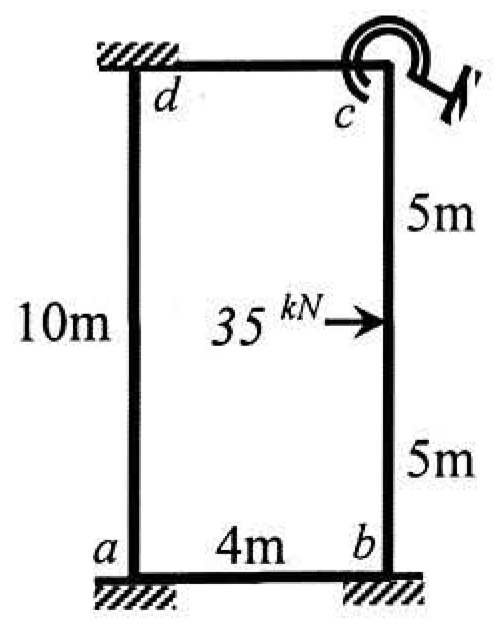


Fig.6

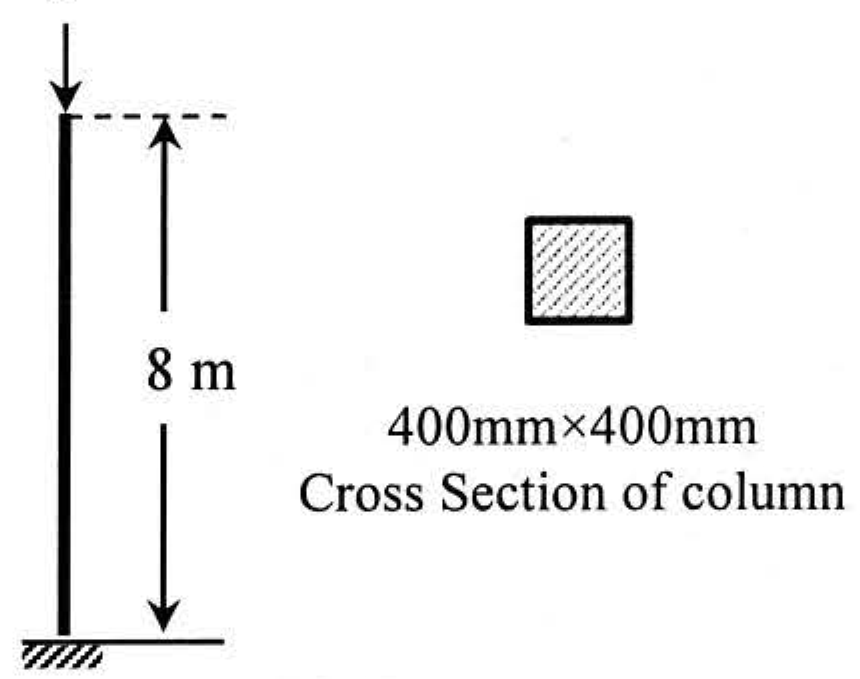


Fig.7

QUESTION 4 (MARKS 20)

A reinforced concrete cantilever column of convention centre is shown in ***Fig.7***. The column is required to carry the floor load of **P**. Modulus of elasticity of reinforced concrete is 30,000 N/mm^2. **Apply the concept** of geometric nonlinearity of structure to

a. Calculate the allowable load of **P** based on buckling of column. **[10 marks]**
b. Obtain the combined matrix (**K**+**G**) if the column consists of two equal elements. **[10 marks]**

QUESTION 5 (MARKS 20)

A prototype of reinforced concrete bridge girder (ABD) is shown in ***Fig.8*** with appropriate support conditions. There is an internal hinge at point C of girder BD, which however is optional and could be removed if required. The girder ABD has to carry the ultimate load of 18 kN/m. Ignore the effects of compression reinforcements [Given: f'_c = 30 MPa and f_y = 550 MPa].

a. **Evaluate** whether the girder can sustain the load. **[15 marks]**
b. If not, **propose** a suitable structural system that can sustain the load and justify your selection. **[5 marks]**

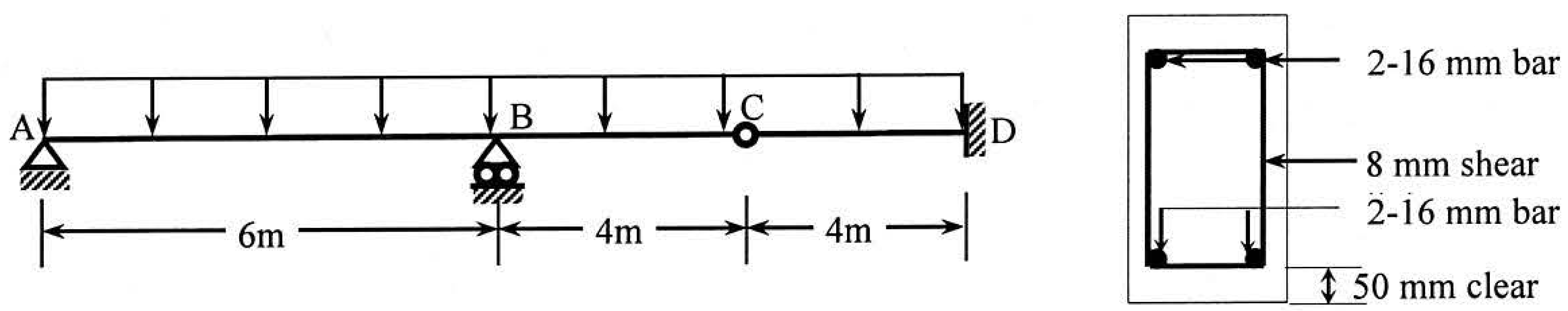


Fig.8

300 mm×500 mm

List of Useful Formulae for CE 411

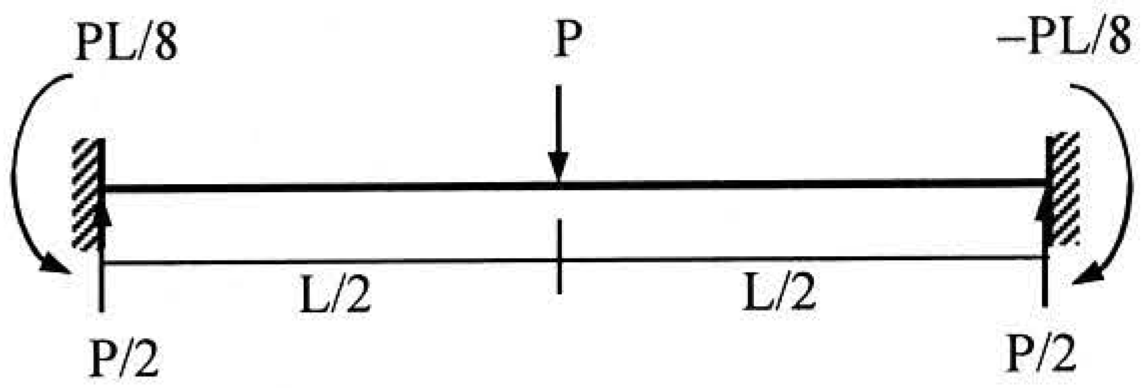
* The stiffness matrix $\mathbf{K_m}^G$ of a 2D truss member in the global axis system is given by

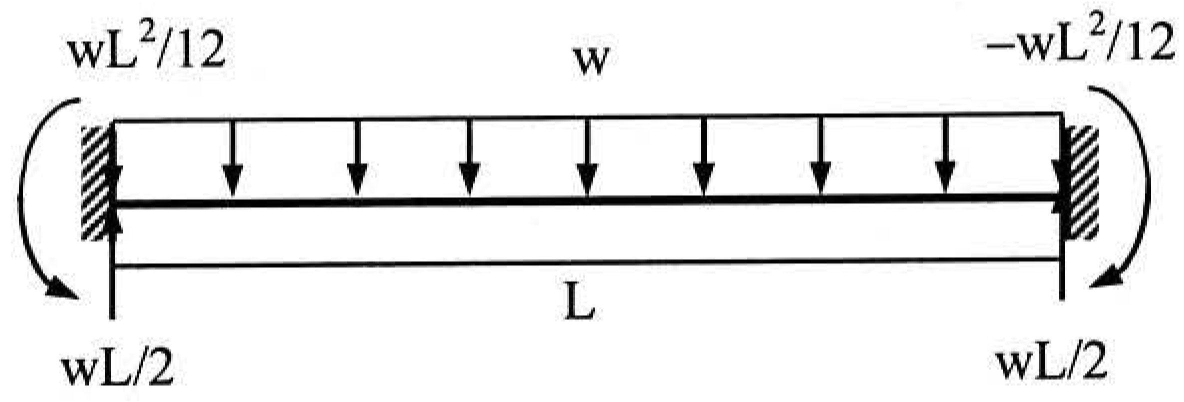
$$\mathbf{K_m}^G = S_x \begin{pmatrix} C^2 & CS & -C^2 & -CS \\ CS & S^2 & -CS & -S^2 \\ -C^2 & -CS & C^2 & CS \\ -CS & -S^2 & CS & S^2 \end{pmatrix}$$

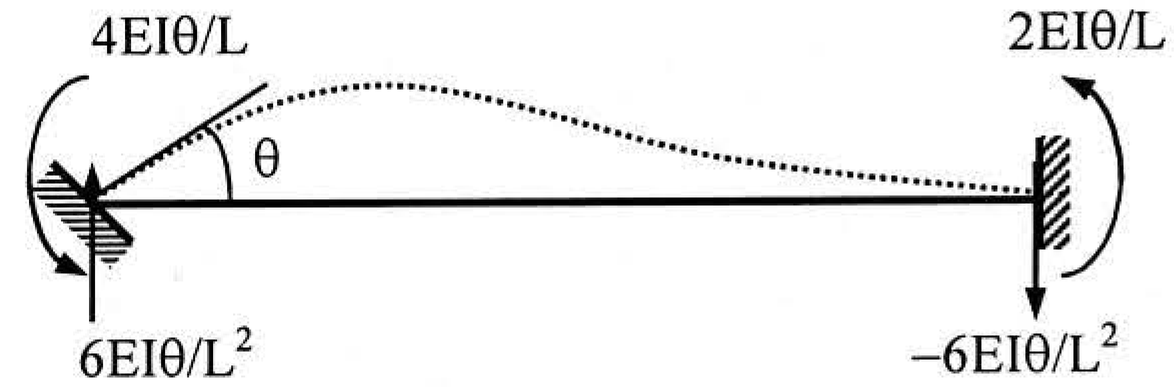
and Truss member force, $P_{AB} = S_x [(u_B - u_A) C + (v_B - v_A) S]$

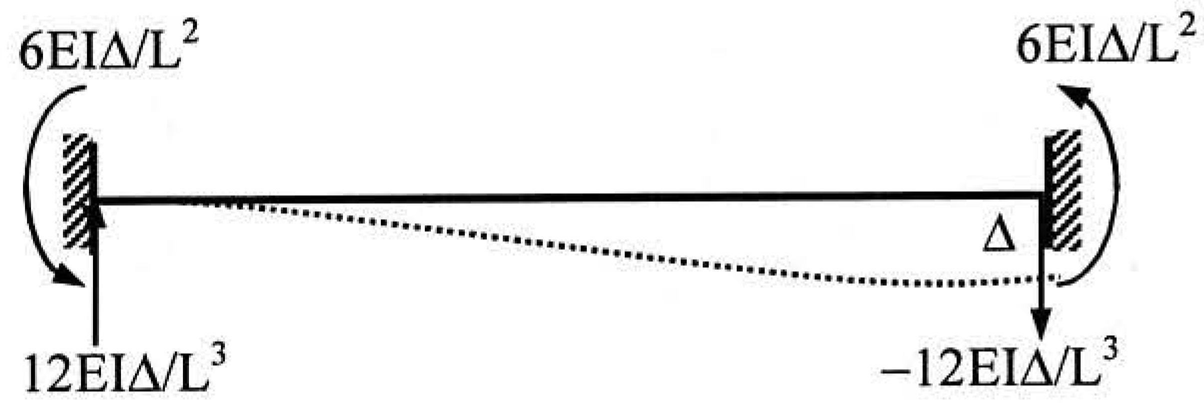
[where $C = \cos\theta$, $S = \sin\theta$]

Fixed End Reactions for One-dimensional Prismatic Members under Typical Loadings









* 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

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

$C_x = L_x/L$, $C_y = L_y/L$, $C_z = L_z/L$
where $L = \sqrt{[L_x^2 + L_y^2 + L_z^2]}$

* 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 $\mathbf{K_m}^L$ and $\mathbf{G_m}^L$ of a frame member in the local axis system are

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

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

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

* 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 $a_0 = (f_0 - cv_0 - ku_0)/m$

* Lumped-Mass matrix for axial rod; Consistent-Mass matrix for truss and beam [μ = Mass per unit length]

$$\mathbf{M_m} = (\mu L/2) \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \quad \mathbf{M_m}^G = (mL/3) \begin{pmatrix} C^2 & CS & C^2/2 & CS/2 \\ CS & S^2 & CS/2 & S^2/2 \\ C^2/2 & CS/2 & C^2 & CS \\ CS/2 & S^2/2 & CS & S^2 \end{pmatrix} \quad \mathbf{M_m} = (\mu L/420) \begin{pmatrix} 156 & 22L & 54 & -13L \\ 22L & 4L^2 & 13L & -3L^2 \\ 54 & 13L & 156 & -22L \\ -13L & -3L^2 & -22L & 4L^2 \end{pmatrix}$$

* At natural frequency (i.e., $\omega = \omega_n$), $|\mathbf{K} - \omega_n^2 \mathbf{M}| = 0$
* Stiffness of Circular Surface Foundations on Half-Space

Motion	Horizontal	Vertical	Rotational	Torsional
$K_{Halfspace}$	$8G_sR/(2-\nu)$	$4G_sR/(1-\nu)$	$8G_sR^3/(3-3\nu)$	$16G_sR^3/3$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2017
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) Standard penetration test was performed within a cohesion-less deposit. At a depth of 7 m, the recorded blow counts are 3/6/6 for three consecutive 150 mm penetrations. 4

Calculate N_{60} and $(N_1)_{60}$ at the depth of 7 m.

Given that

Borehole diameter = 110 mm; γ_{moist} = 16.1 kN/m^3; γ_{sat} = 17.1 kN/m^3; rod length = 10 m.

The hammer efficiency is 45%, and utilized method of sampling was standard. Water table is at 5 m below the ground level.

(b) A six-storied RCC office building is to be built on a site, where the soils are expected to be of average quality and average uniformity. The building will have a 150 ft × 100 ft footprint and is expected to be supported on individual shallow foundations located 6 ft below the ground surface. 4
Determine the required number and depth of the borings.

(c) Specify an internal diameter of thin walled sampler so that undisturbed samples can be collected. Consider area ratio as the sample disturbance parameter. 2

Outside diameter of the tube sampler = 45 mm

2. Answer any **3 (three)** questions from the following: 3*8=24

(a) Calculate the net allowable load on the rectangular footing (3 m x 4 m), if factor of safety is 2.25. The footing and the soil profile is given in Fig.1. Use Meyerhof's chart.

(b) Evaluate the safety of the rectangular footing (3 m x 4 m), if eccentricity along the footing length is 0.3 m. The footing and the soil profile is given in Fig.1.
Given that the column load = 1250 kN.

(c) Evaluate the safety of a square footing (3m x 3m) in loose sand overlying dense sand. The depth of foundation is 1.8 m. Use the design charts (applicable to weak sand over strong sand) to obtain N_q' and N_γ'.

Given that the applied dead and live loads are 356 kN and 700 kN, respectively.
Unit weight of upper sand layer = 16.2 kN/m^3
Unit weight of lower sand layer = 17.4 kN/m^3
The upper sand layer (having $\varphi'$of 25°) is found from GL up to the depth of 3.5 m, and the underlying sand layer ($\varphi'$of 45°) is 8.5 m thick. Water table is at the ground surface.

(d) Calculate the depth of the mat (D_f) for a factor of safety of 3 against bearing capacity failure.
Dimension of mat: 25 m × 18.4 m.
c = 65 kN/m^2, φ' = 0° and γ_{sat} = 17.5 kN/m^3.
The total (dead and live) load on the mat is 20x10^3 kN.
Use Meyerhof's bearing capacity factors.

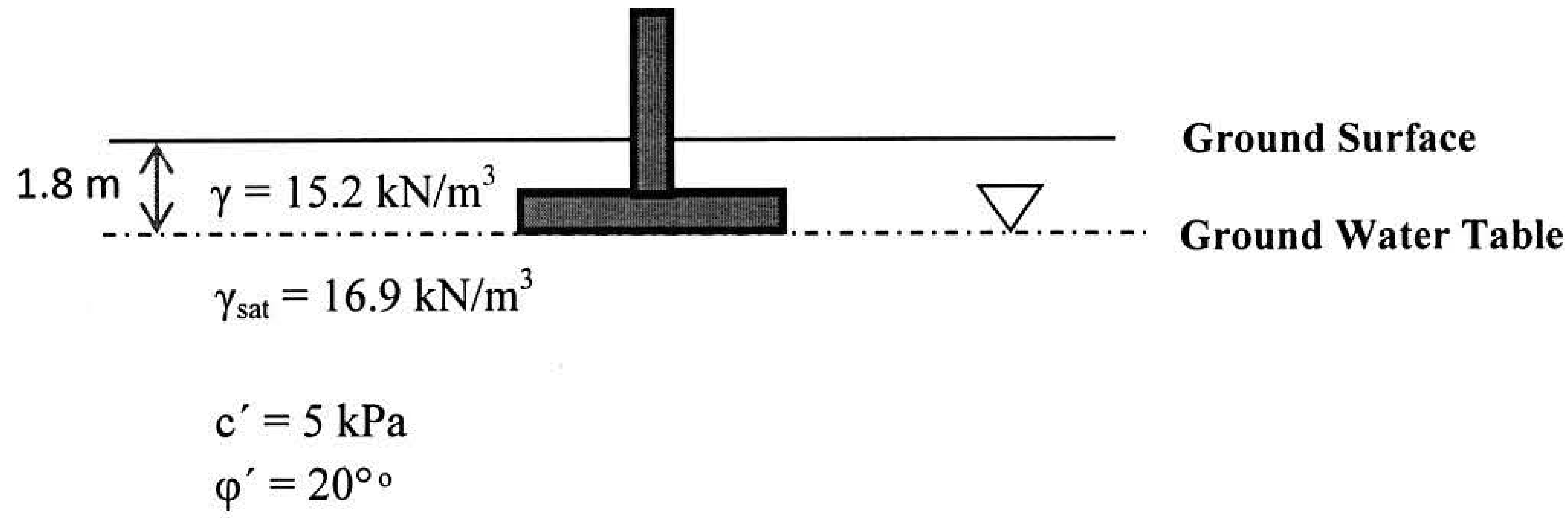


Fig. 1

3.(a) Determine the ultimate bearing capacity of the 750 mm diameter and 18 m long concrete, bored pile given in Fig.2. 15
Given that
Pile-soil friction angle =0.75 * ϕ'
K_s = 0.5
α = 0.38

(b) A pile group consists of 12 piles. Find the allowable bearing capacity of the single pile in the group. 5
Given that
The skin frictional resistance of a single pile = 750 kN.
The end bearing resistance of a single pile = 80 kN.
No of piles in each row = 3
Centre-to-centre pile spacing = 1 m
Pile diameter = 450 mm.
Use the following efficiency factor:

$$E = 1 - \theta\left[\frac{m(n-1) + n(m-1)}{90mn}\right]$$

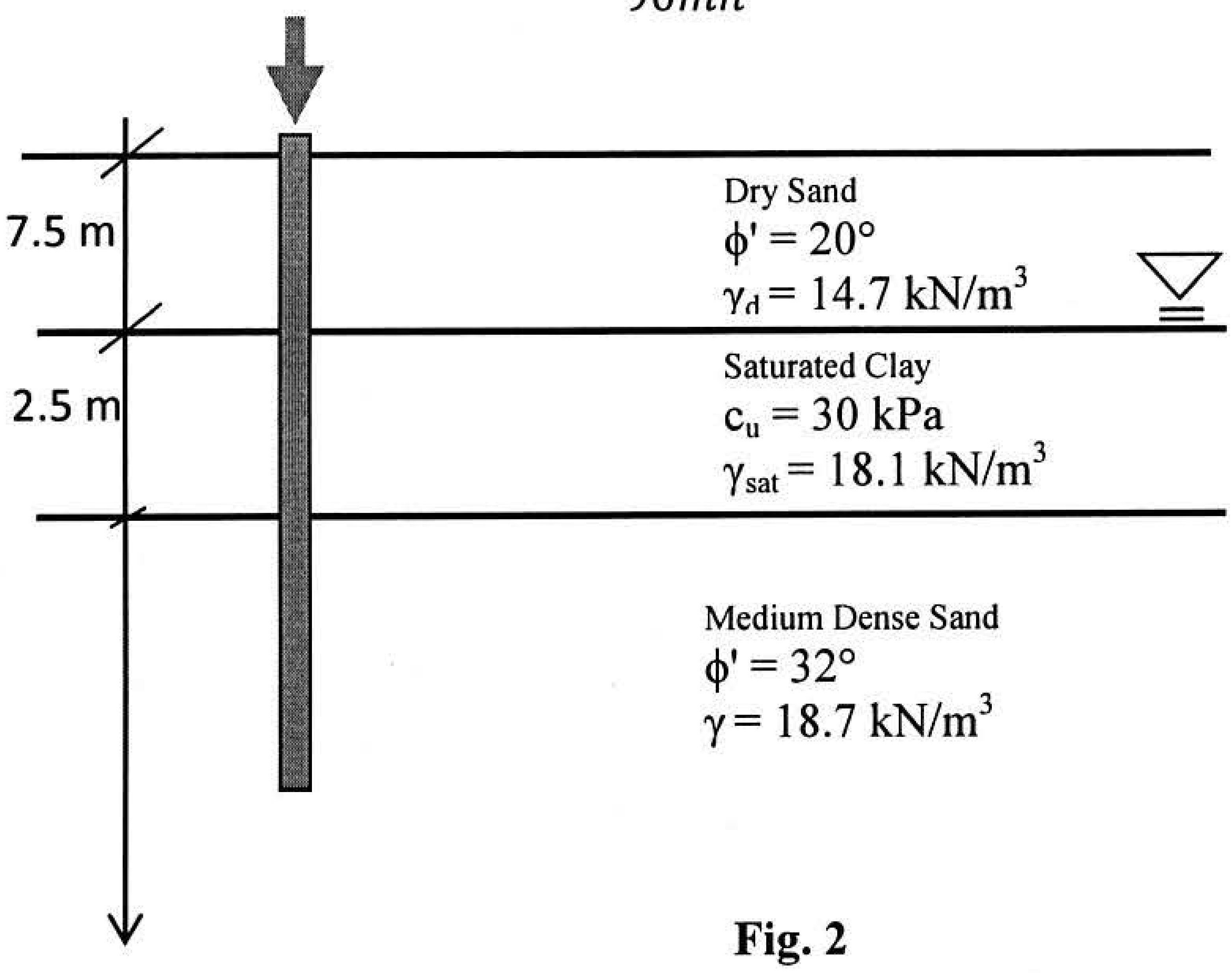


Fig. 2

4. Estimate the consolidation settlement of the mat foundation (Fig. 3). 16
Dimension of mat: 30 m x 40 m
Total load: 200 x 10^3 KN
Depth of foundation = 3.5 m
Calculation should be performed for strips (or sub-layers).

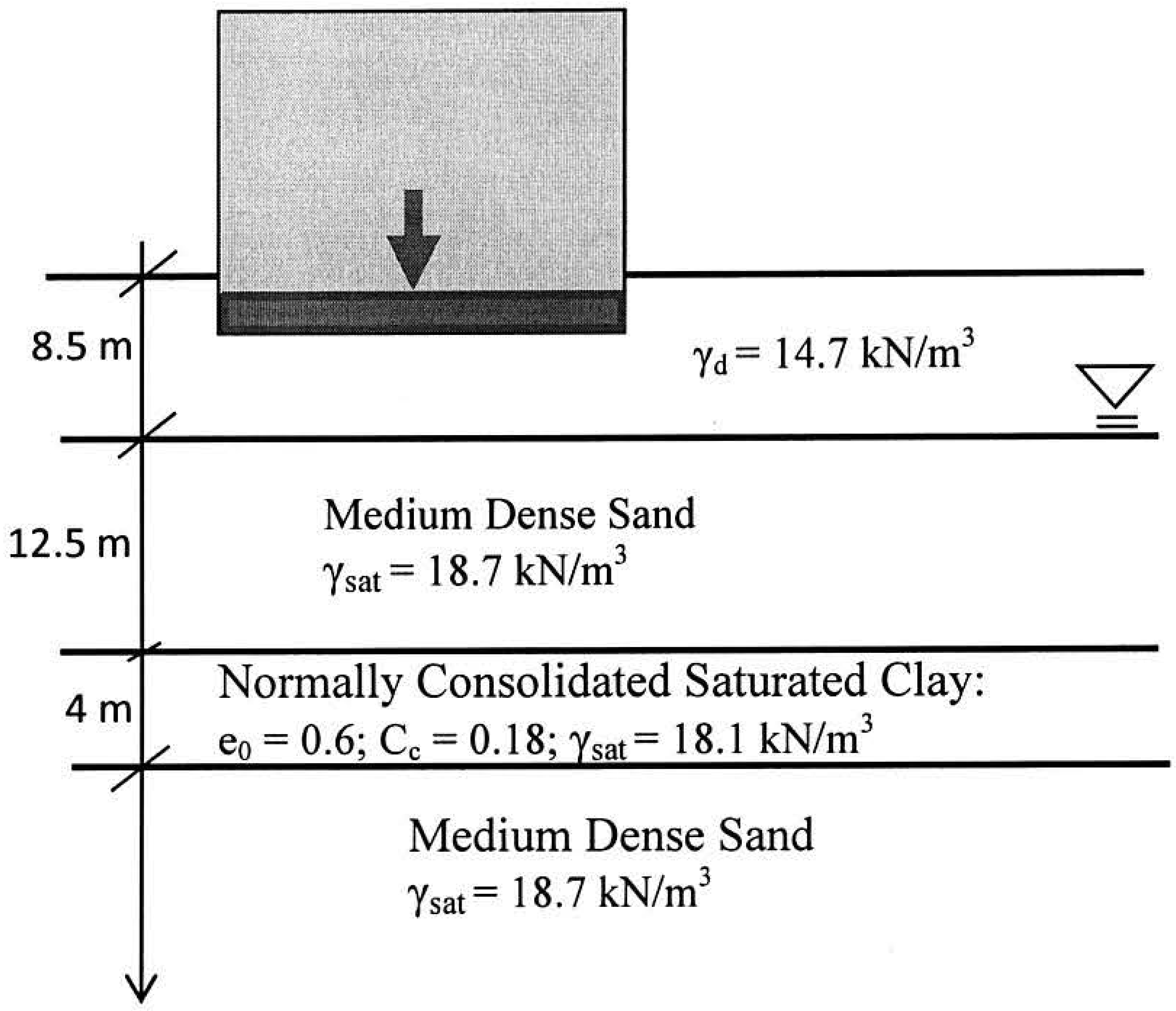


Fig. 3

5. The slope and the soil properties are given in Fig. 6. The weight, width and α of different slices are given in Table 6. The slices were numbered from left to right. Note that slice no. 6 is the only slice that is completely in Layer 1.

(a) Graphically identify different slices (Slice No. and width of slices). 5

(b) Compute the long term FS for the failure surface using Bishop's modified method of slices. 25

Provide two trials of computing Factor of Safety.

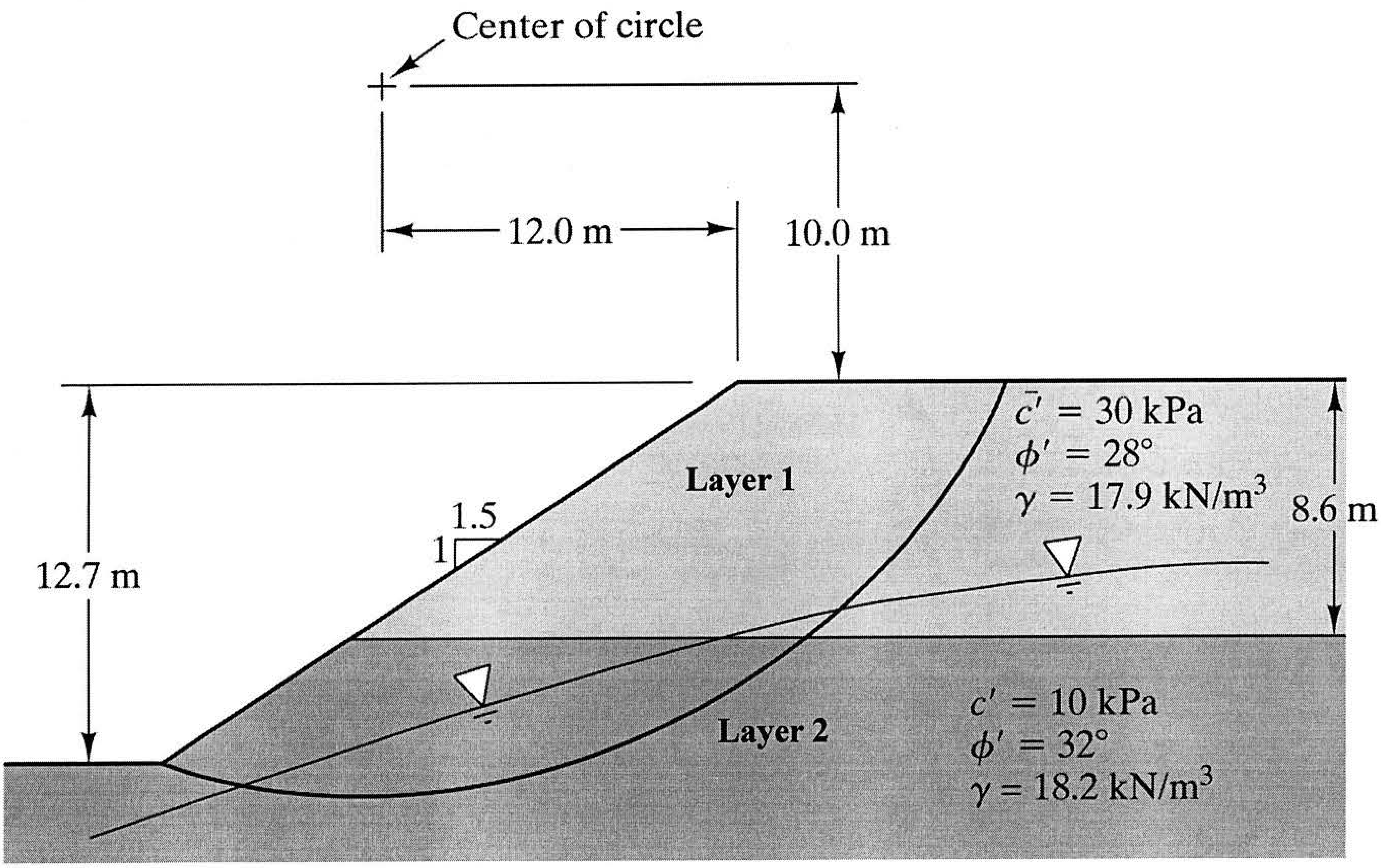


Fig. 4

Table 1: Weight, width, pore-water pressure and α of slices

Slice No.	W_n (kN/m)	b_n (m)	α (°)	u_n (kPa)
1	293	6.2	-12	5
2	133	1.3	-1	18
3	814	6.0	8	22
4	1031	6.0	22	22
5	337	2.0	35	12
6	546	7.1	54	0

Equations

$$q_{pl} = 50 * N_q^*.\ tan\varphi$$

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

$$F_s = \frac{\Sigma(c'b_n + (W_n - u_n b_n)tan\varphi'.\frac{1}{m_{\alpha(n)}}}{\Sigma W_n sin\alpha_n}$$

Design Charts / Guidelines

Factor	Equipment Variables	Value
Borehole Diameter factor, C_B	65 – 115 mm	1.00
	150 mm	1.05
	200 mm	1.15
Sampling Method	Standard Sampler	1.00
	Sampler without liner (not recommended)	1.20
Rod length factor, C_R	3 – 4 m (10 – 13 ft)	0.75
	4 -6 m (20 – 30 ft)	0.85
	6 – 10 m (20 – 30 ft)	0.95
	> 10 m (> 30 ft)	1.00

Table: Guidelines for spacing of exploratory borings

Subsurface Conditions	Structure Footprint Area for each boring	
	m^2	ft^2
Poor Quality and/or erractic	100 - 300	1000 – 3000
Average	200 – 400	2000 – 4000
High quality and Uniform	300 - 1000	3000 – 10,000

Table: Guidelines for the depth of exploratory borings for structures on shallow foundation

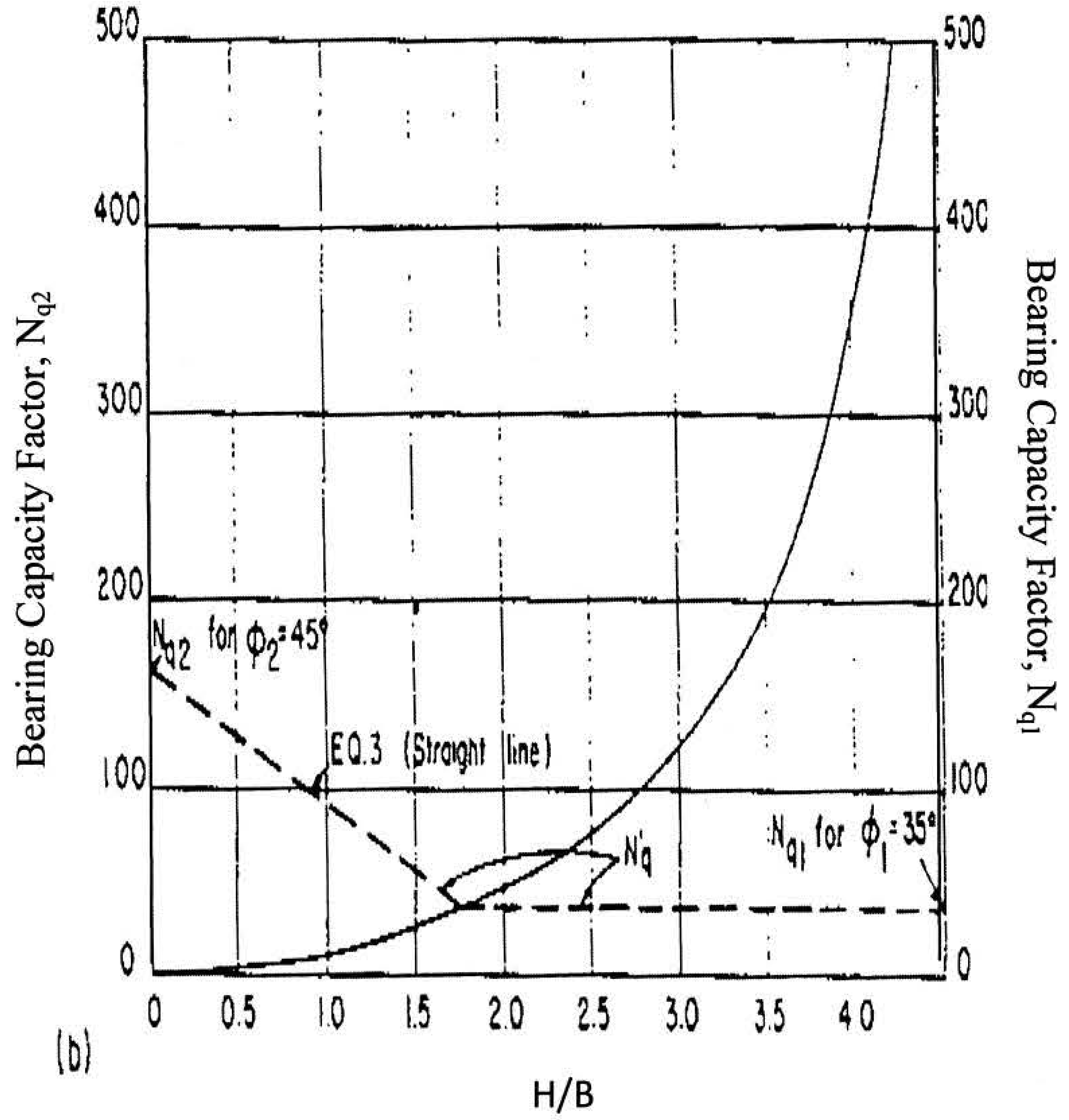
Subsurface Conditions	Structure Footprint Area for each boring	
	m	ft
Poor	$6S^{0.7} + D$	$20S^{0.7} + D$
Average	$5S^{0.7} + D$	$15S^{0.7} + D$
Good	$3S^{0.7} + D$	$10S^{0.7} + D$

S = number of stories
D = anticipated depth of foundation

Table: Shape, Depth and Inclination Factors

Factor	Condition	Equation
Shape	φ = 0°	$F_{cs} = 1 + 0.2\left(\frac{B}{L}\right)$ $F_{qs} = F_{\gamma s} = 1$
	φ ≥ 10°	$F_{cs} = 1 + 0.2\left(\frac{B}{L}\right)tan^2(45^\circ + \frac{\varphi}{2})$ $F_{qs} = F_{\gamma s} = 1 + 0.1\left(\frac{B}{L}\right)tan^2(45^\circ + \frac{\varphi}{2})$
Depth	φ = 0°	$F_{cd} = 1 + 0.2\left(\frac{D_f}{B}\right)$ $F_{qd} = F_{\gamma d} = 1$
	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)



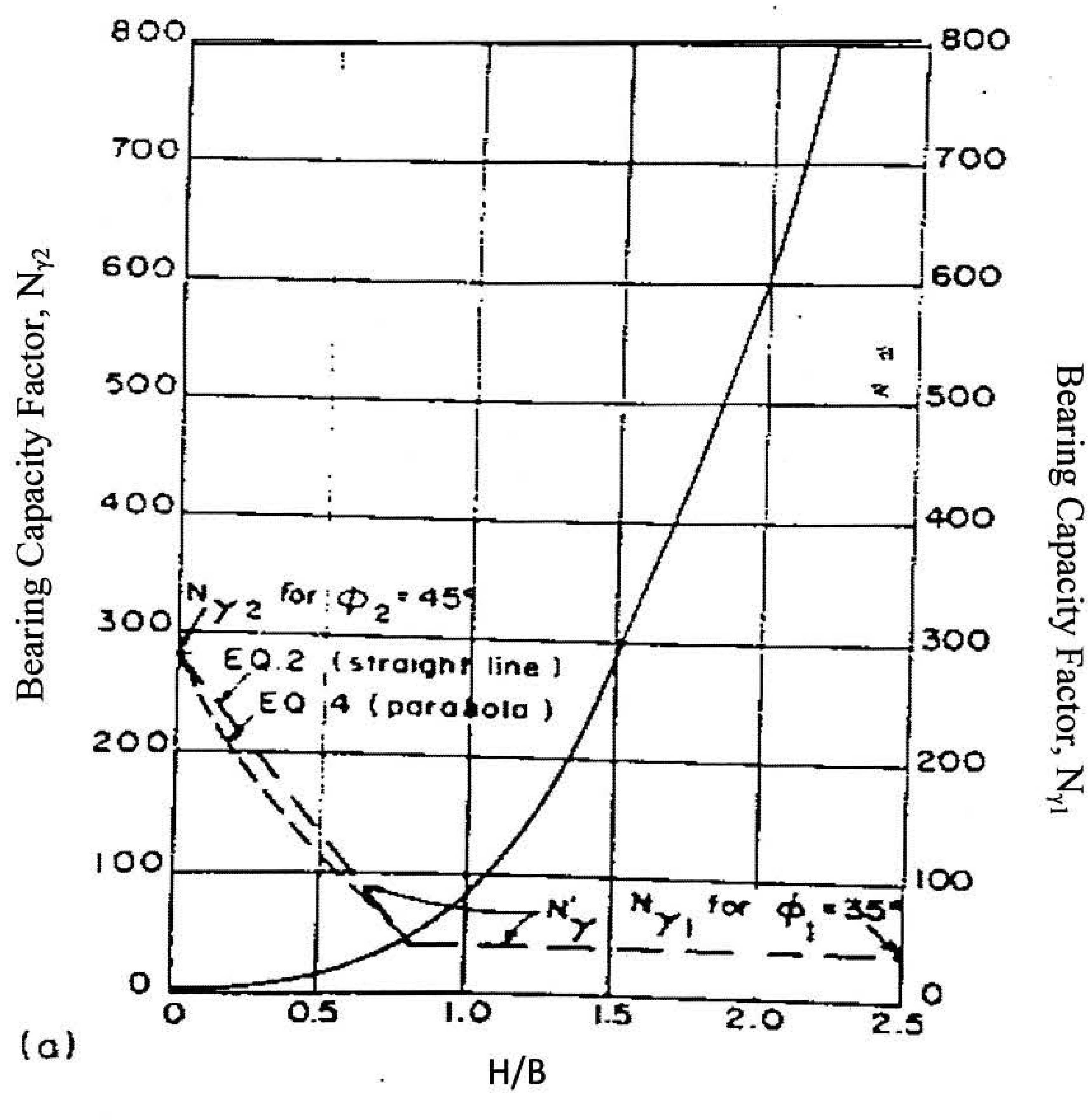
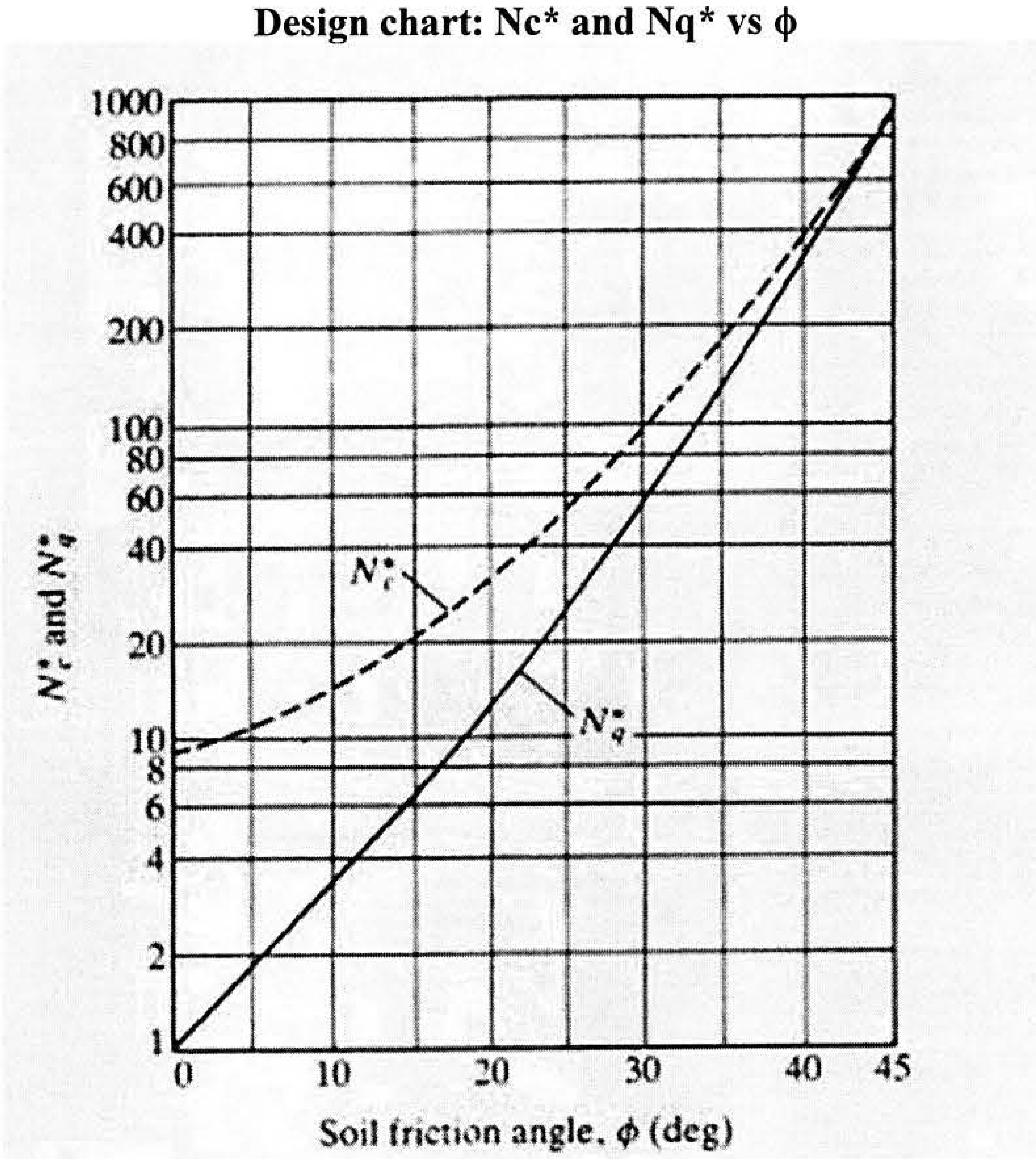


Table: Bearing Capacity Factors (Meyerhof's Chart)

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 Fall 2017
Program: B.Sc. Engineering (Civil)

Course Title: Transportation Engineering II — Course Code: CE 451
Time: 3 hour — Full Marks: 100

Part A

There are **Nine** questions. Answer any **Eight. Each contain equal marks (8x5 =40)**

1. Draw a neat diagram of flexible pavement and explain the function and importance of each component of flexible pavement.
2. Distinguish between Hot Mix Hot Laid, and Cold Mix Cold Laid Bitumen.
3. Summarize the importance of California Bearing Ratio Test and Plate Bearing Test of soil for pavement design. After analyzing soil sample by AASHTO method you found first sample as A-1 b, second sample as A-7-6 and third sample as A-2-5. Comment with justification on these 3 soil samples with respect to their suitability as subbase or base course material.
4. As 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?
5. Explain the Westergaard's modulus of subgrade reaction (k).
6. Summarize the effect of environment on flexible pavement.
7. i) **Assess** the **maximum axle load** for rails of 90 lbs per yard.
   ii) Sleeper density is $M + 7$ on a broad-gauge route and the length of the rail is 13 m. **Evaluate the number of sleepers per rail length** of the track on that route.
8. If you want to construct a railway in a mountainous area compile the factors that should be considered for the good alignment?
9. A given pavement rating method uses six distress types to establish the Distress Rating (DR). These are corrugation, alligator cracking, ravelling, longitudinal cracking, rutting, and patching. For a stretch of highway, the numbers of points assigned to each category were *6, 4, 2, 4, 3,* and *3*. If the weighing factors are *2, 1, 0.75, 1, 1,* and *1.5*, **Evaluate the DR** for the section.

Part B

Question 10 is compulsory. From question **11, 12, 13** answer any **Two.**

10. 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 percent of traffic on the design lane is 45%. (10)
    Measure growth factor and 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%*

11. Using the **design ESAL calculated** in **question 10 design** a suitable pavement for the six-lane divided highway consisting of an **asphalt mixture surface** with an elastic modulus of *250,000 lb/in*^{2}, a granular base layer with a structural coefficient of *0.14* on a subgrade having a *CBR* of *10*. Assume all m_i values as *1*, and the percent 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*. (25)

12. Using the **calculated design ESAL in question 10 evaluate the thickness of a concrete pavement for the six-lane divided highway.** This roadway will be constructed on a subgrade with an effective modulus of subgrade reaction *k* of *170 lb/in*^{3}. The working stress of the concrete to be used is *650 lb/in*^{2} and the modulus of elasticity is $5X10^6$ *lb/in*^{2}. Assume the initial serviceability is *4.75* and the terminal serviceability is *2.5*. Assume the overall standard deviation as *0.35*, the load transfer coefficient as *3.2*, the drainage coefficient as *1.15*, and Reliability as *95%*. (25)

13. An existing two-lane rural highway is to be replaced by a four-lane divided highway on a new alignment. Construction of the new highway will commence two years from now and is expected to take three years to complete. The design life of the pavement is 20 years. The present ESAL is $0.133175 X 10^6$. **Design a flexible pavement** consisting of an asphalt concrete surface and lime-treated base. The results of a stabilometer test on the subgrade soil are as follows: (25)

Moisture Content (%)	**R Value**	**Exudation Pressure (lb/in^2)**	**Expansion Pressure Thickness (ft)**
19.8	55	575	1.00
22.1	45	435	0.15
24.9	16	165	0.10

Required Charts and Tables

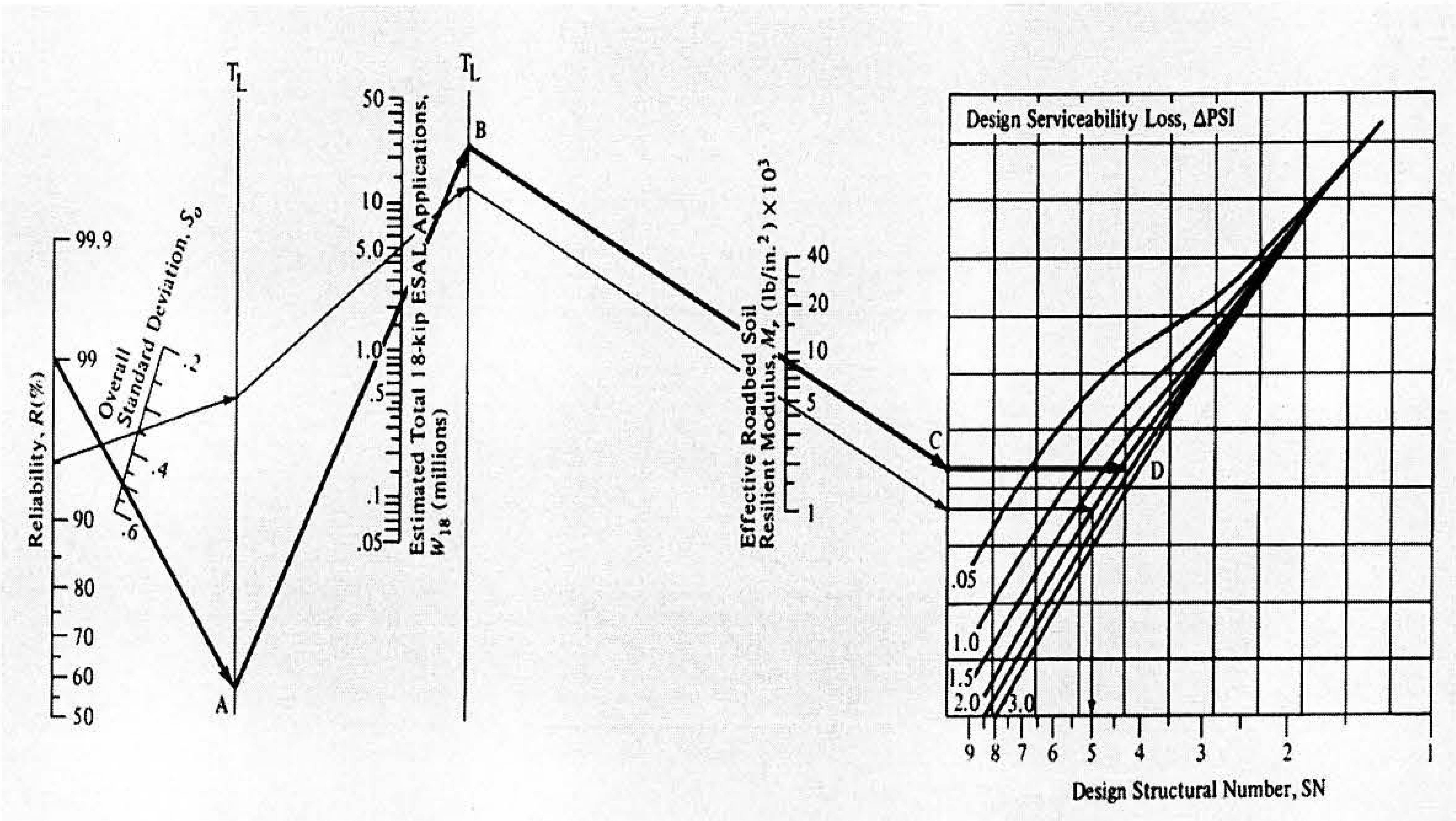


Figure 1: Design Chart for Flexible Pavements Based on Using Mean Values for each Input

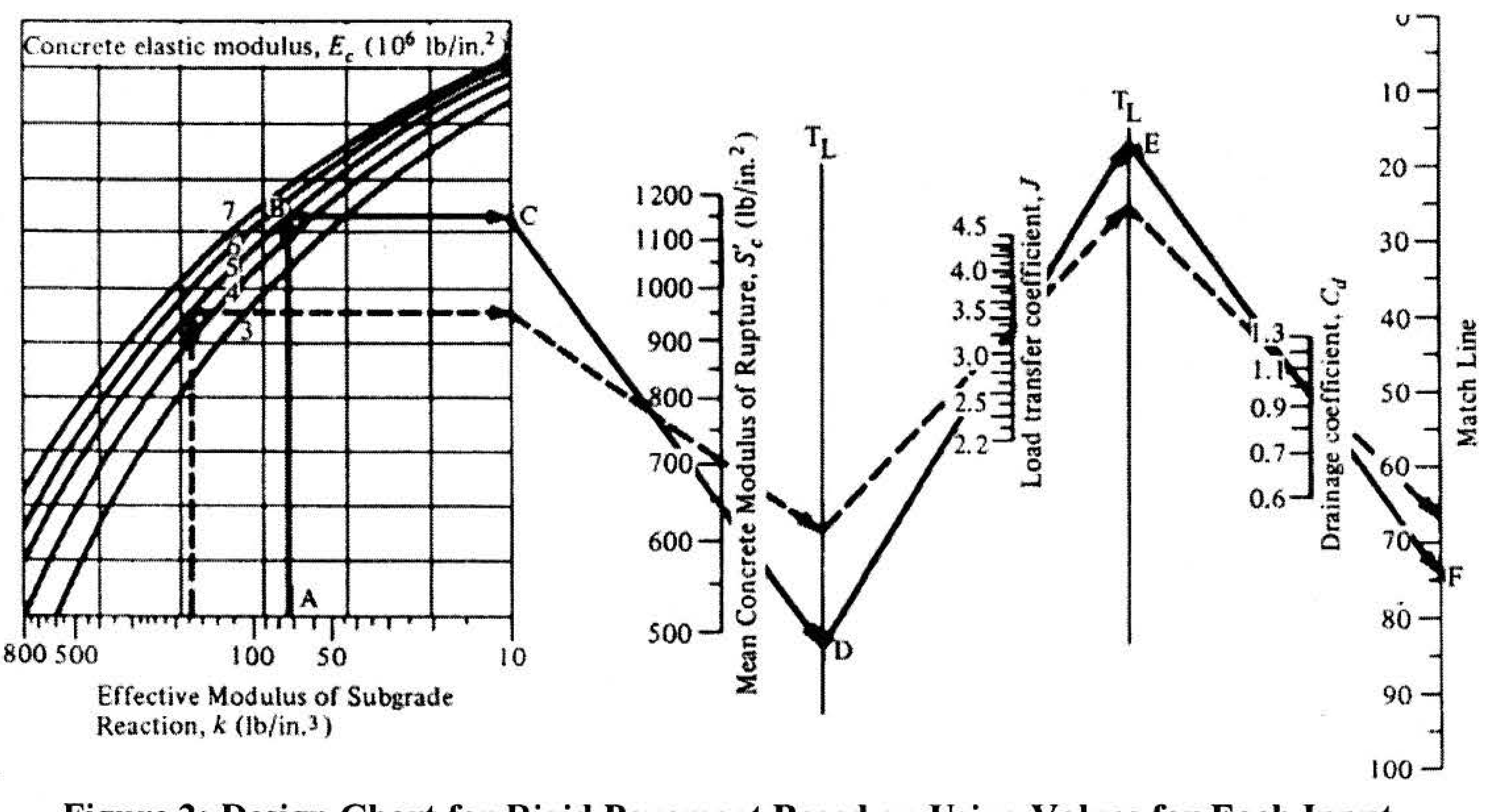


Figure 2: Design Chart for Rigid Pavement Based on Using Values for Each Input Variable (Segment 1)

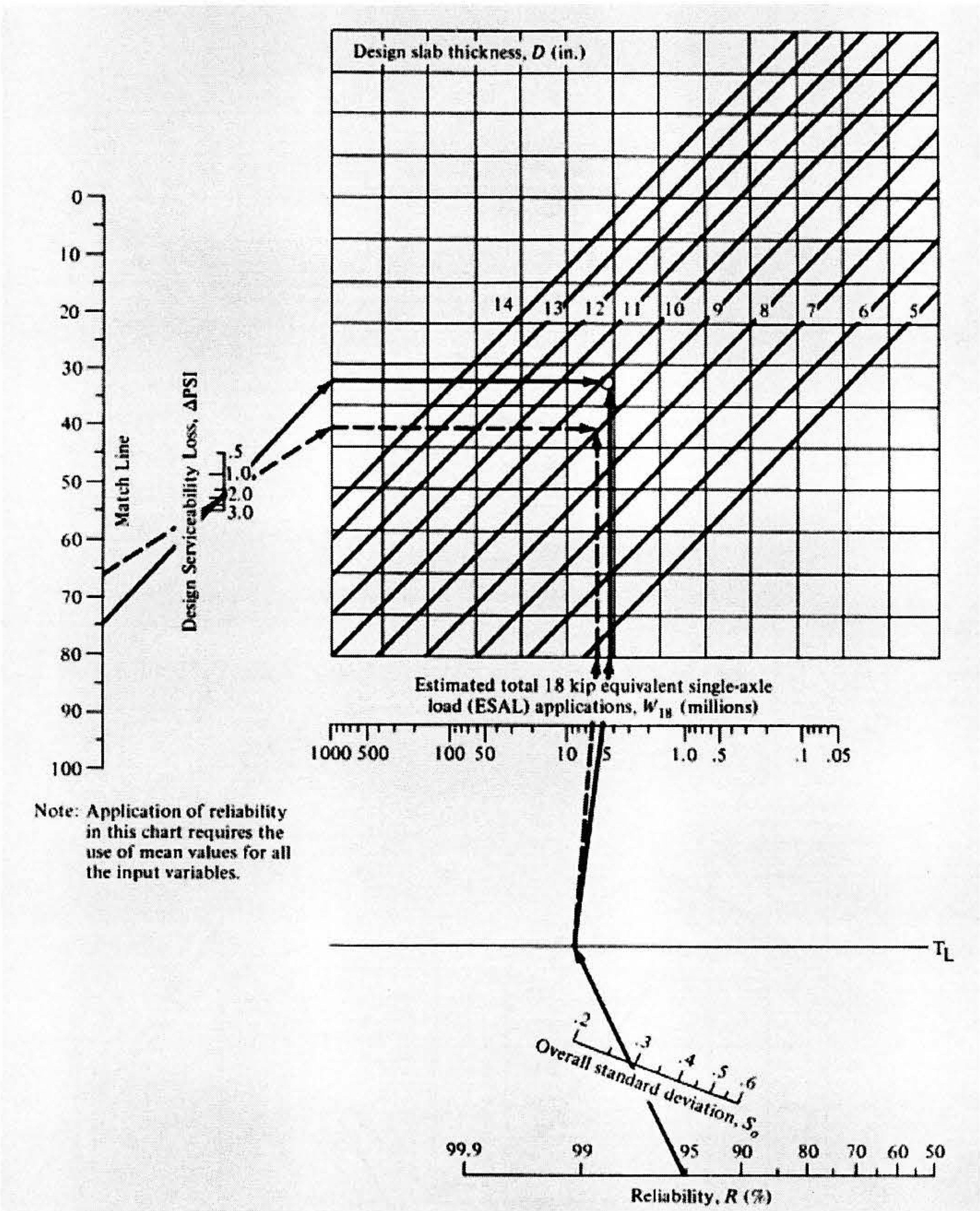


Figure 3: Design Chart for Rigid Pavement Based on Using mean Values for Each Input Variables

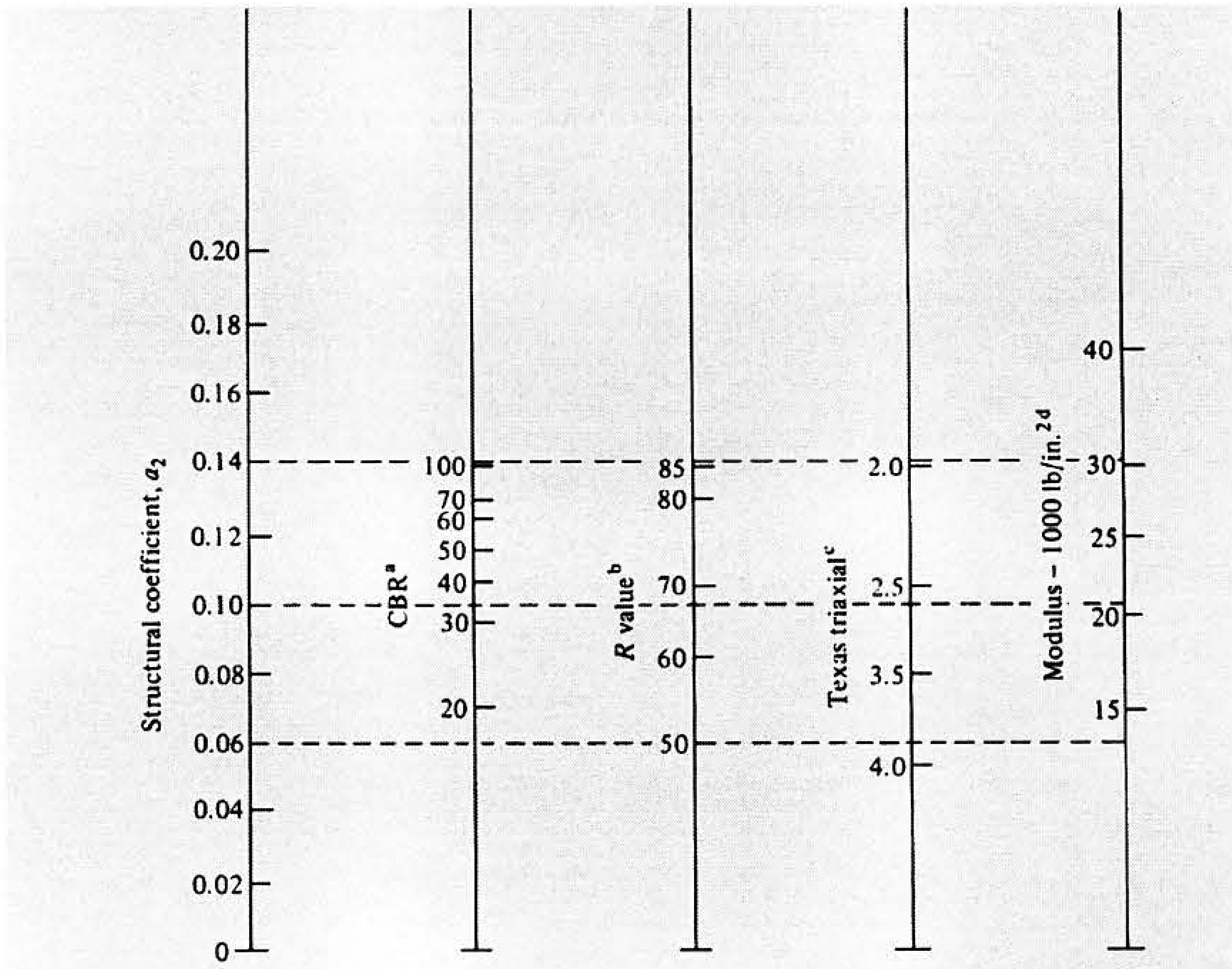


Figure 4: Variation in Granular Base Layer Coefficient, a_2, with Various Subbase Strength Parameters

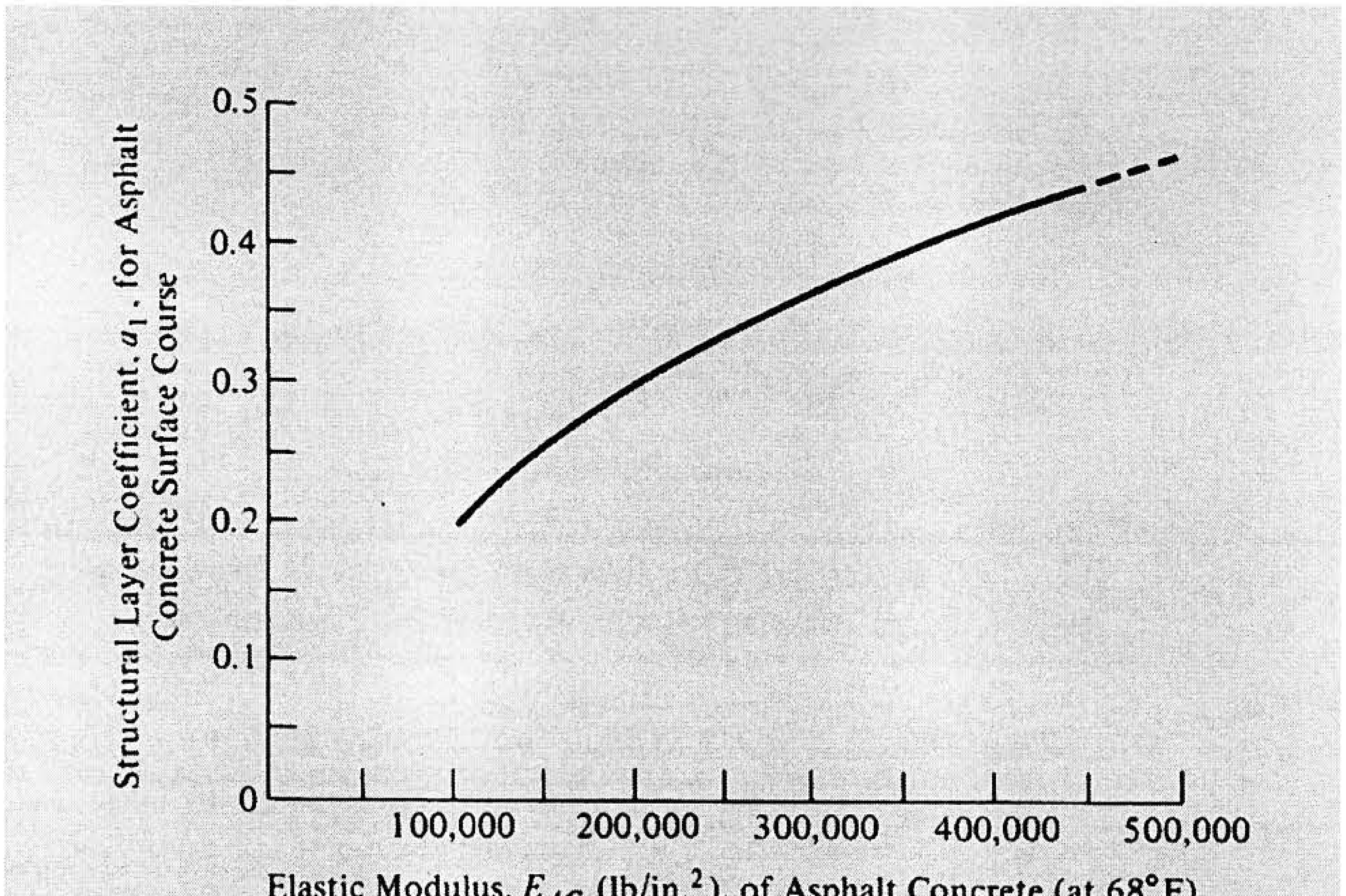
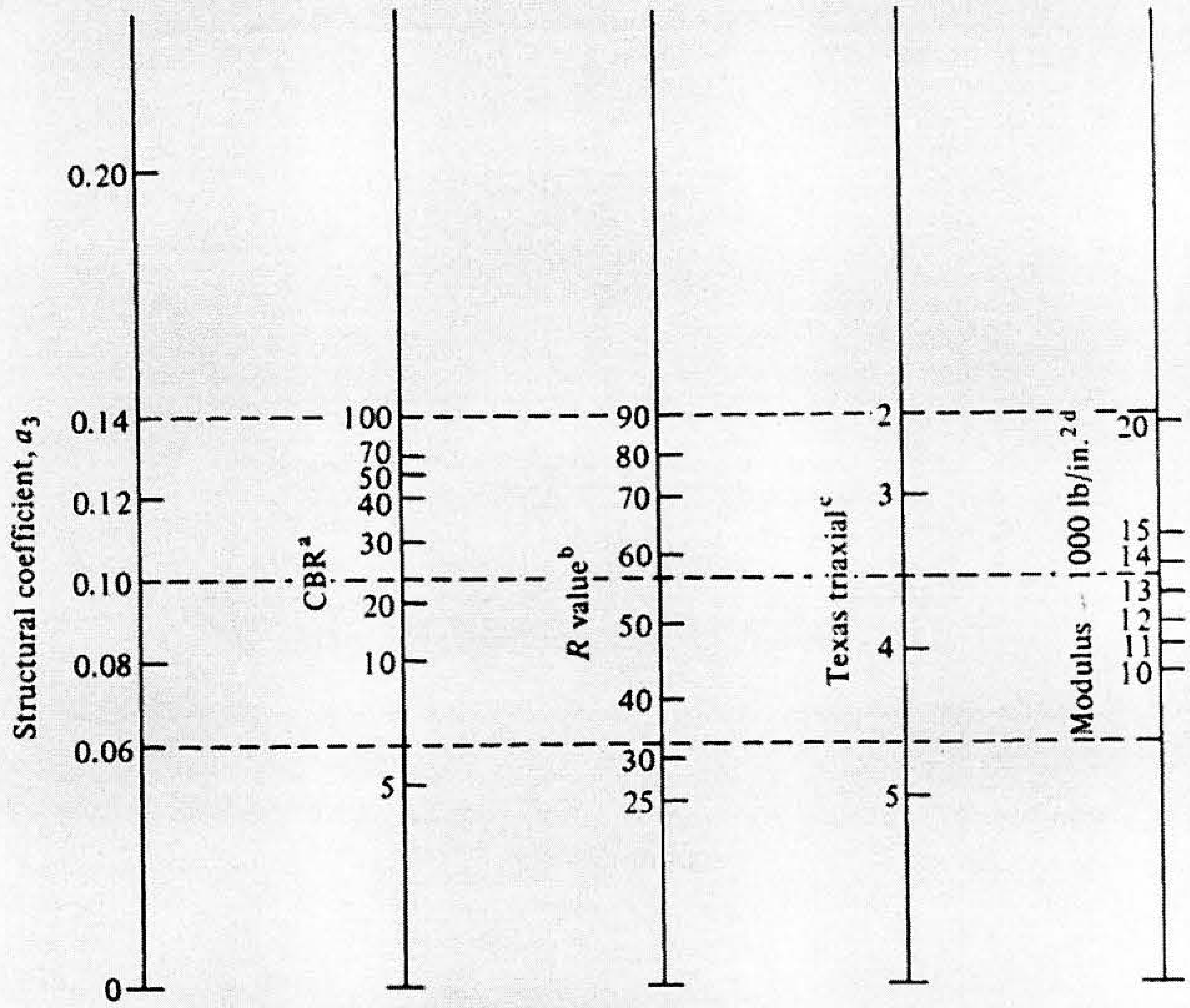


Figure 5: Chart for Estimating Structural Layer Coefficient of Dense-Graded/Asphalt Concrete Based on the Elastic (Resilient) Modulus



[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

	Percent of Time Pavement Structure Is Exposed to Moisture Levels Approaching Saturation			
Quality of Drainage	*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: Gravel Equivalent Factors for Different Types of Materials

Material	G_f
Cement-treated base	
Class A	1.7
Class B	1.2
Lime-treated base	1.2
Untreated aggregate base	1.1
Aggregate subbase	1.0
Asphalt concrete for TI of	
≤5.0	2.54
5.5–6.0	2.32
6.5–7.0	2.14
7.5–8.0	2.01
8.5–9.0	1.89
9.5–10.0	1.79
10.5–11.0	1.71
13.5–14.0	1.52

Required Formula:

$$\mathrm{TI} = 9.0\left(\frac{\mathrm{ESAL}}{10^6}\right)^{0.119}$$

$$\mathrm{GE} = 0.0032(\mathrm{TI})(100 - R)$$

University of Asia Pacific
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Final Examination Fall 2017
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 <u>question no. 01 (COMPULSORY)</u> and any THREE (3) from the rest (18+ 3*18=72). (Assume any missing data.)

1. a) Explain irrigation and its necessity in Bangladesh. 2 + 4
b) What is meant by "Furrow Irrigation" and "Sprinkler Irrigation"? Which one is preferred in Bangladesh and why? 8
c) In a rural village of Bangladesh, the farmers together decided to install a centrifugal pump to supply irrigation water to the agricultural fields at a rate of 150 liters/second through an existing earthen canal network. Calculate the brake horse power of the pump from the following data: 4
    - Suction head = 5 m
    - Delivery head = 2 m
    - Coefficient of friction = 0.01
    - Efficiency of pump = 70%
    - Diameter of pipe = 18 cm

2. a) Derive the relationship between Duty and Delta for a given base period. 4
b) Estimate the leaching requirement when electric conductivity (EC) value of a saturated extract of soil is 10 milli mho/cm at 25% reduction in the yield of a crop. The EC of irrigation water is 1.2 milli mho/cm. What will be the required depth of water to be applied to the field if the consumptive use requirement of the crop is 80 mm? EC value of the leaching water may be suitably assumed. 10
c) What is meant by C2-S2 water? Discuss its usefulness for irrigating fine textured soils. 2+2

3. a) Summarizes four social factors that you should consider during planning an irrigation project that mostly rely on groundwater. 3
b) Explain the following: i) Berms ii) Spoil Banks 3
c) An irrigation project located in Kurigram district of Bangladesh divert surface water from Teesta river through a canal for irrigating an area of 5000 hectares. Water conveyance efficiency of the canal is 75% and water application efficiency in the field is 50%. Determine the volume of water required to be diverted from the head works using the data given in the table below. Use Blaney-Criddle equation and a crop factor is 0.75. 12

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	Leaching requirement (cm)
November	20.0	7.50	1.50	4
December	19.0	7.45	1.45	6
January	15.6	7.10	2.05	5
February	15.5	7.20	2.30	4

4. a) Draw the schematic diagram of soil-water-plant relationship. 3

b) After how many days will you supply water to soil in order to ensure sufficient irrigation of the given crop, if, 7

- Available moisture = 18%
- Unavailable moisture = 15%
- Optimum moisture content = 16%
- Dry density of soil = 1.3 gm/cc
- Effective depth of root zone = 59 cm
- Daily consumptive use of water for the given crop = 13 mm

c) The cultivable command area for a distributary is 4800 hectares. The intensity of irrigation for Rabi season is 50% and that of Kharif season is 25%. If the average duty at the head of the distributary is 2000 hectares/cumec for Rabi season and 900 hectares/cumec for Kharif season, find out the discharge required at the head of the distributary from average demand considerations. 8

5. a) Distinguish between spur and groyne with neat sketch. 4

b) Explain the following with neat sketch: i) Aqueduct ii) Super passage iii) Level crossing. 6

c) An irrigation project is located in an area where irrigation water efficiency is very low due to excessive seepage loss. 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 seepage loss and increase irrigation water efficiency, the engineering department decided to construct a lined canal instead of an earthen canal. 8

As a newly recruited engineer, you need to design that canal having the following data:
Full supply discharge = 120 m^3/sec
Side slope = 1.25:1
Bed slope = 1 in 5000
Rugosity coefficient = 0.018
Permissible velocity = 1.75 m/sec
Assume other reasonable data for the design.

SECTION B
MARKS: 28

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

6. a) Select three structural and three non-structural measures of flood management in Bangladesh that are most important in your opinion. Justify your answer. 6
b) Explain integrated flood management and the problems associated with non-integrated flood management. 6
c) Explain the procedures for determining the required discharge capacity and number of spillways. 4

7. a) Explain delta formation process and how delta formation process relates to flood. 6
b) During non-monsoon period, the farmers of Dinajpur district of Bangladesh heavily rely on groundwater based irrigation due to unavailability of surface water. Several international rivers (e.g. Korotoya and Atrai) flow through Dinajpur that are the main sources of surface water for irrigation. It is reported that excessive extraction of surface water from the major international rivers in upstream country creates shortage of surface water in downstream Dinajpur. As a result, excessive groundwater extraction in the district led to lowering of groundwater table at an alarming rate. 1+5

Select three international water resources management principles based on which Bangladesh can negotiate/cooperate with upstream country to solve the water scarcity problem and claim more water in non-monsoon season. Justify why you have selected those three principles

8. a) Explain different components of flood risk management. 6
b) Explain the following (any two): 3+3
i. Integrated water resources management
ii. Changing paradigms of flood management
iii. River training works