University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2015
Program: B.Sc. Engineering (Civil)

7-I

Course Title: Project Planning and Management — Course Code: CE401
Time: 3 hour — Full Marks: 50

(Answer No 1 and any 4 Questions)

1. A firm has estimated the following time for its project. The company has quoted 17 days for the project to be completed. What would be the probability of success that the project will be completed on time? — 10

Activity	Predecessor	Optimistic Time (days)	Most likely Time (days)	Pessimistic Time (days)
a	-	3	4	5
b	-	3	5	7
c	-	5	6	7
d	a	2	3	4
e	b	6	8	10
f	b	5	3	7
g	c	5	6	7
h	d, e	5	3	7
i	f, g	1	2	3

Determine the total duration of the project, Free float, Total Float of each activity and critical path of the project.

2.(a) What is the basic difference between traditional quality control and modern view of quality control? — 3

(b) Briefly describe quality improvement methodology (PDCA). — 3

(c) Describe 7 principles to prevent accident in construction site. — 4

3. Write short notes of the following: (2x5) — 10

(a) Ergonomic hazard

(b) PPE

(c) Safety and Hazard

(d) Opportunity Cost

(e) Quality Control and Assurance

4.(a) Sketch procurement process with milestones. — 2.5

(b) Briefly describe the points to remember while purchasing/procurement. — 2.5

(c) Describe Open Tendering Method (OTM) — 5

5.(a) What do you understand by 'Time Value of Money'? — 1

(b) When and why should you consider for replacement of an asset? — 2

(c) An asset purchased 2 years ago for $40,000 is harder to maintain than expected. It can be sold now for $12,000 or kept for a maximum of 2 more years, in which case its operating cost will be $20,000 each year, with a salvage value of $10,000 after 1 year or $9000 after two years. A suitable challenger will have an annual worth of $-24,000 per year. At an interest rate of 10% per year, should the defender be replaced now, one year from now, or two years from now? — 7

... Continued

6.(a) What are the objectives of material management? 2

(b) Write down the names of 6 types of inventory and describe any one of it. 3

(c) A factory has a current market value of $60,000 and can be kept in service for 4 more years. Annual operation and maintenance cost is $15,000/year. With an MARR of 12%/year, when should it be abandoned? The following data are projected for future years: 5

	Year 1	Year 2	Year 3	Year 4
Net revenue	$50,000	$40,000	$15,000	$10,000
Market value	$35,000	$20,000	$15,000	$5,000

Z Score Table- chart value corresponds to area below z score.

z	**0.09**	**0.08**	**0.07**	**0.06**	**0.05**	**0.04**	**0.03**	**0.02**	**0.01**	**0.00**
–3.4	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
–3.3	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005	0.0005
–3.2	0.0005	0.0005	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007
–3.1	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0010
–3.0	0.0010	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013
–2.9	0.0014	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018	0.0018	0.0019
–2.8	0.0019	0.0020	0.0021	0.0021	0.0022	0.0023	0.0023	0.0024	0.0025	0.0026
–2.7	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032	0.0033	0.0034	0.0035
–2.6	0.0036	0.0037	0.0038	0.0039	0.0040	0.0041	0.0043	0.0044	0.0045	0.0047
–2.5	0.0048	0.0049	0.0051	0.0052	0.0054	0.0055	0.0057	0.0059	0.0060	0.0062
–2.4	0.0064	0.0066	0.0068	0.0069	0.0071	0.0073	0.0075	0.0078	0.0080	0.0082
–2.3	0.0084	0.0087	0.0089	0.0091	0.0094	0.0096	0.0099	0.0102	0.0104	0.0107
–2.2	0.0110	0.0113	0.0116	0.0119	0.0122	0.0125	0.0129	0.0132	0.0136	0.0139
–2.1	0.0143	0.0146	0.0150	0.0154	0.0158	0.0162	0.0166	0.0170	0.0174	0.0179
–2.0	0.0183	0.0188	0.0192	0.0197	0.0202	0.0207	0.0212	0.0217	0.0222	0.0228
–1.9	0.0233	0.0239	0.0244	0.0250	0.0256	0.0262	0.0268	0.0274	0.0281	0.0287
–1.8	0.0294	0.0301	0.0307	0.0314	0.0322	0.0329	0.0336	0.0344	0.0351	0.0359
–1.7	0.0367	0.0375	0.0384	0.0392	0.0401	0.0409	0.0418	0.0427	0.0436	0.0446
–1.6	0.0455	0.0465	0.0475	0.0485	0.0495	0.0505	0.0516	0.0526	0.0537	0.0548
–1.5	0.0559	0.0571	0.0582	0.0594	0.0606	0.0618	0.0630	0.0643	0.0655	0.0668
–1.4	0.0681	0.0694	0.0708	0.0721	0.0735	0.0749	0.0764	0.0778	0.0793	0.0808
–1.3	0.0823	0.0838	0.0853	0.0869	0.0885	0.0901	0.0918	0.0934	0.0951	0.0968
–1.2	0.0985	0.1003	0.1020	0.1038	0.1056	0.1075	0.1093	0.1112	0.1131	0.1151
–1.1	0.1170	0.1190	0.1210	0.1230	0.1251	0.1271	0.1292	0.1314	0.1335	0.1357
–1.0	0.1379	0.1401	0.1423	0.1446	0.1469	0.1492	0.1515	0.1539	0.1562	0.1587
–0.9	0.1611	0.1635	0.1660	0.1685	0.1711	0.1736	0.1762	0.1788	0.1814	0.1841
–0.8	0.1867	0.1894	0.1922	0.1949	0.1977	0.2005	0.2033	0.2061	0.2090	0.2119
–0.7	0.2148	0.2177	0.2206	0.2236	0.2266	0.2296	0.2327	0.2358	0.2389	0.2420
–0.6	0.2451	0.2483	0.2514	0.2546	0.2578	0.2611	0.2643	0.2676	0.2709	0.2743
–0.5	0.2776	0.2810	0.2843	0.2877	0.2912	0.2946	0.2981	0.3015	0.3050	0.3085
–0.4	0.3121	0.3156	0.3192	0.3228	0.3264	0.3300	0.3336	0.3372	0.3409	0.3446
–0.3	0.3483	0.3520	0.3557	0.3594	0.3632	0.3669	0.3707	0.3745	0.3783	0.3821
–0.2	0.3859	0.3897	0.3936	0.3974	0.4013	0.4052	0.4090	0.4129	0.4168	0.4207
–0.1	0.4247	0.4286	0.4325	0.4364	0.4404	0.4443	0.4483	0.4522	0.4562	0.4602
–0.0	0.4641	0.4681	0.4721	0.4761	0.4801	0.4840	0.4880	0.4920	0.4960	0.5000

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
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

Interest Rate	10.00%								10.00%
n	**F/P**	**P/F**	**A/F**	**A/P**	**F/A**	**P/A**	**A/G**	**P/G**	**n**
1	1.100	0.9091	1.0000	1.1000	1.000	0.909	0.000	0.000	**1**
2	1.210	0.8264	0.4762	0.5762	2.100	1.736	0.476	0.826	**2**
3	1.331	0.7513	0.3021	0.4021	3.310	2.487	0.937	2.329	**3**
4	1.464	0.6830	0.2155	0.3155	4.641	3.170	1.381	4.378	**4**
5	1.611	0.6209	0.1638	0.2638	6.105	3.791	1.810	6.862	**5**
6	1.772	0.5645	0.1296	0.2296	7.716	4.355	2.224	9.684	**6**
7	1.949	0.5132	0.1054	0.2054	9.487	4.868	2.622	12.763	**7**
8	2.144	0.4665	0.0874	0.1874	11.436	5.335	3.004	16.029	**8**
9	2.358	0.4241	0.0736	0.1736	13.579	5.759	3.372	19.421	**9**
10	2.594	0.3855	0.0627	0.1627	15.937	6.145	3.725	22.891	**10**

Interest Rate	12.00%								12.00%
n	**F/P**	**P/F**	**A/F**	**A/P**	**F/A**	**P/A**	**A/G**	**P/G**	**n**
1	1.120	0.8929	1.0000	1.1200	1.000	0.893	0.000	0.000	**1**
2	1.254	0.7972	0.4717	0.5917	2.120	1.690	0.472	0.797	**2**
3	1.405	0.7118	0.2963	0.4163	3.374	2.402	0.925	2.221	**3**
4	1.574	0.6355	0.2092	0.3292	4.779	3.037	1.359	4.127	**4**
5	1.762	0.5674	0.1574	0.2774	6.353	3.605	1.775	6.397	**5**
6	1.974	0.5066	0.1232	0.2432	8.115	4.111	2.172	8.930	**6**
7	2.211	0.4523	0.0991	0.2191	10.089	4.564	2.551	11.644	**7**
8	2.476	0.4039	0.0813	0.2013	12.300	4.968	2.913	14.471	**8**
9	2.773	0.3606	0.0677	0.1877	14.776	5.328	3.257	17.356	**9**
10	3.106	0.3220	0.0570	0.1770	17.549	5.650	3.585	20.254	**10**

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2015 (Set 1)
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 **any 10 (ten)** of the following 14 questions]

1. Fig. 1 shows a plane truss *abcdef* whose joint *d* deflects 10-mm to the right and 10-mm upwards due to the applied forces. Use the Stiffness Method to calculate the applied forces (P_x, P_y) and deflections at joint *c* [Given: $S_x = EA/L$ = constant = 5 kN/mm].

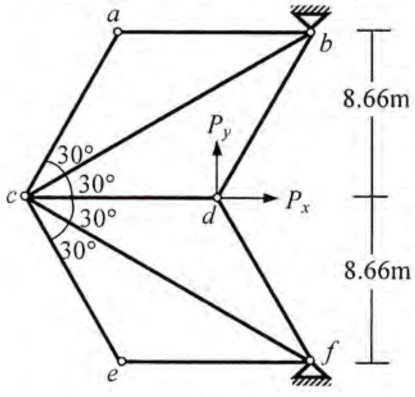


Fig. 1

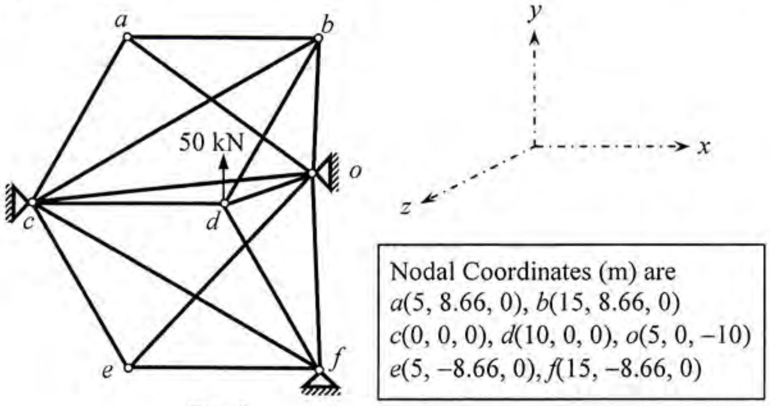


Fig. 2

2. Use the Stiffness Method to calculate the nodal deflections of the space truss *oabcdef* loaded as shown in Fig. 2 [Given: $S_x = EA/L$ = constant = 5 kN/mm].

3. Consider axial and flexural deformations to assemble the stiffness matrix, load vector and specify boundary conditions for the beam *abcd* loaded as shown in Fig. 3

[Given: $E = 400 \times 10^3$ k/ft^2].

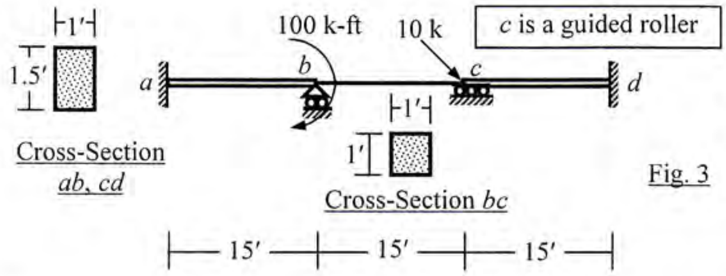


Fig. 3

4. Fig. 4 shows a frame *abcdef* whose joint *b* rotates 1° (anticlockwise) due to the applied loads.
Use the Stiffness Method considering flexural deformations only to calculate the distributed load (w_0) applied as well as the rotation at joint *d* of the frame [Given: $EI = 40 \times 10^3$ k-ft^2].

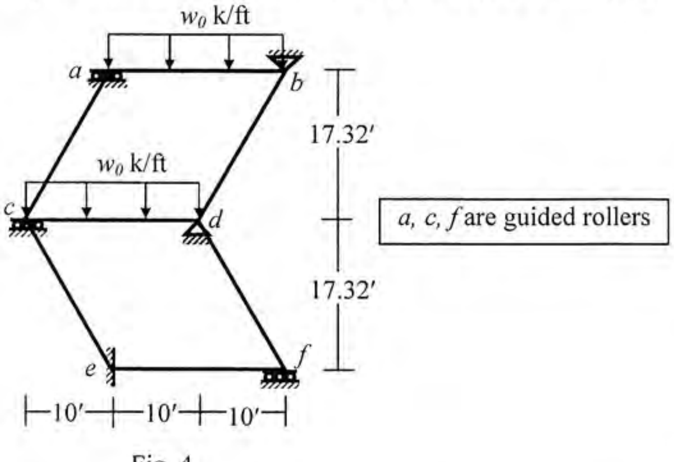


Fig. 4

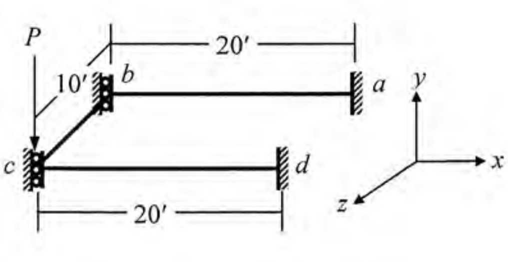


Fig. 5

5. Fig. 5 shows a grid *abcd* whose joint *c* deflects 0.10′ downward due to the applied force *P*.
Use Stiffness Method to calculate the force applied and the deflection at joint *b*
[Given: $EI = 40 \times 10^3$ k-ft^2, $GJ = 30 \times 10^3$ k-ft^2].

6. Use Stiffness Method to calculate the unknown joint deflections and rotations of the beam ABC loaded as shown in Fig. 6, considering flexural deformations only if $P = 0$ $[E = 400 \times 10^3 \text{ k/ft}^2]$.

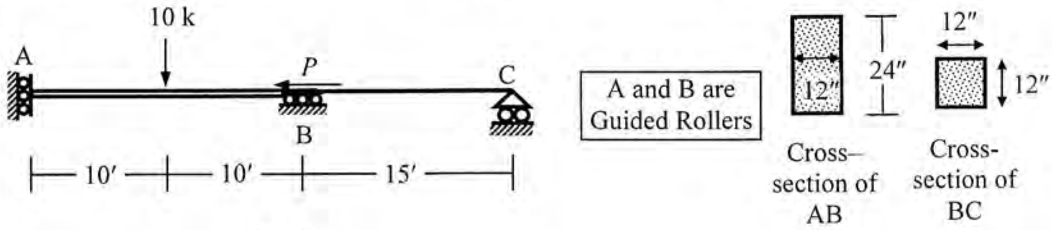


Fig. 6

7. Use Stiffness Method to calculate the unknown joint deflections and rotations of the beam ABC loaded as shown in Fig. 6, considering flexural deformations only with geometric nonlinearity, if $P = 200$ k $[E = 400 \times 10^3 \text{ k/ft}^2]$.

8. Consider flexural deformations and geometric nonlinearity to calculate the distributed load w required to cause buckling of the frame ABC loaded as shown in Fig. 7
[Given: $EI_{BC} = 2EI_{AB} = 40 \times 10^3$ k-ft^2].

9. Consider flexural deformations only (with consistent mass matrix) to calculate the natural frequencies of the frame ABC shown in Fig. 7
[Given: Mass per unit length $\mu_{ABC} = 0.010$ k-sec^2/ft^2,
$EI_{BC} = 2EI_{AB} = 40 \times 10^3$ k-ft^2].

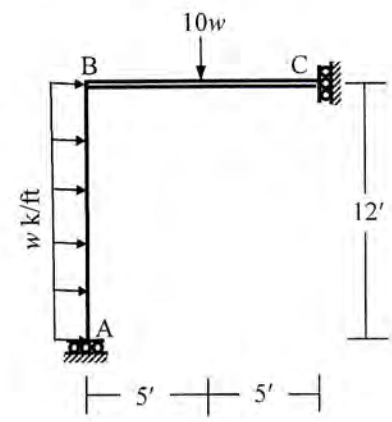


Fig. 7

10. Fig. 8 shows a 10-ft high single-storied RC building having 4 columns subjected to earthquake ground acceleration, $a_g = 20\ Cos(20t)$.

Use *Constant Average Acceleration* (*CAA*) Method to calculate the horizontal deflection at top of the building at time $t = 0.05$ sec

[Given: $E = 400 \times 10^3$ k/ft^2, Stiffness of each column $= 12EI/L^3$, Damping ratio of the system = 5%, Total weight of slab = 64.4 k].

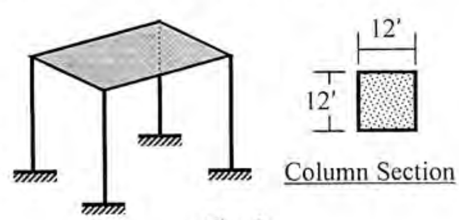


Fig. 8

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

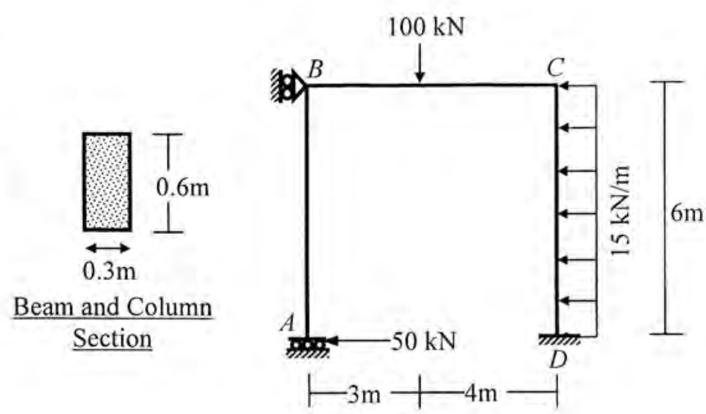


Fig. 9

12. Use bending moment diagram to calculate the distributed load w (k/ft) needed to develop plastic hinge mechanism in the RC beam *ABCDE* loaded as shown in Fig. 10 [Given: $f_c' = 4$ ksi, $f_y = 60$ ksi].

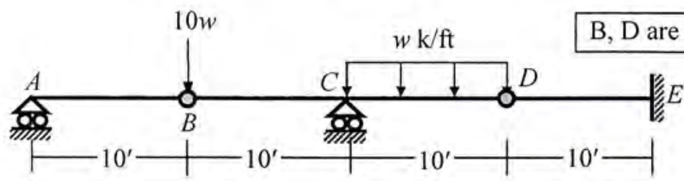
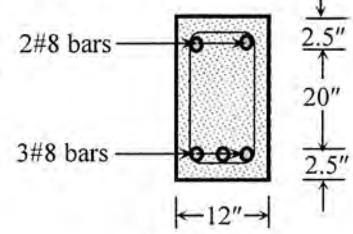


Fig. 10



Beam Section

13. Use Stiffness Method using flexural deformations only to calculate the vertical deflection at node A of the beam AB [with $EI = 20 \times 10^3$ k-ft^2] loaded as shown below, if the node B is
   (i) Hinged, as shown in Fig. 11(i)
   (ii) Supported by circular foundation of radius 4-ft on the surface of sub-soil (half-space) with shear modulus $G_s = 400$ k/ft^2 and Poisson's ratio $\nu = 0.3$, as represented in Fig. 11(ii).

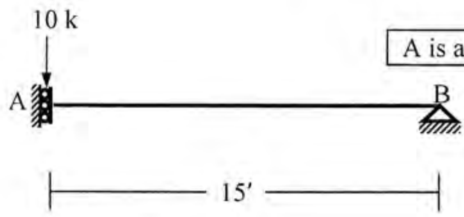


Fig. 11(i)

A is a Guided Roller

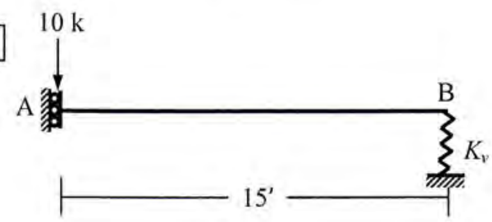


Fig. 11(ii)

14. Briefly explain the
   (a) Basic assumption of Constant Average Acceleration method of numerical time-step integration
   (b) Effect of foundation flexibility on the structural response to seismic ground motion.
   (c) Terms material nonlinearity, plastic moment and collapse mechanism.

   Briefly explain why
   (d) A structure becomes unstable at buckling load (explain with reference to stiffness matrix).

List of Useful Formulae for CE 411

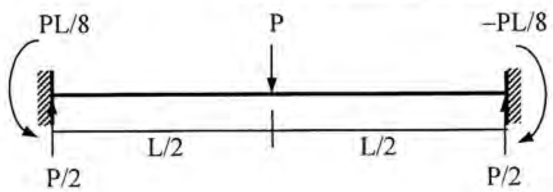
* The stiffness matrix $\mathbf{K_m}^G$ of a 2D truss member in the global axis system is given by

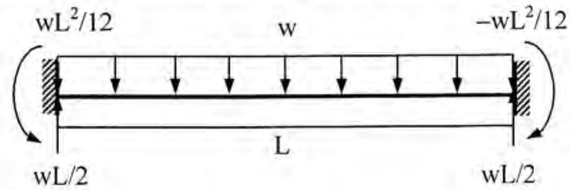
$$\mathbf{K_m}^G = S_x \begin{pmatrix} C^2 & CS & -C^2 & -CS \\ CS & S^2 & -CS & -S^2 \\ -C^2 & -CS & C^2 & CS \\ -CS & -S^2 & CS & S^2 \end{pmatrix}$$

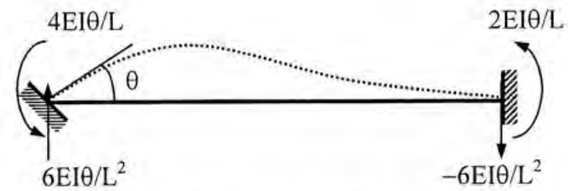
and Truss member force, $P_{AB} = S_x\,[(u_B-u_A)\,C + (v_B-v_A)\,S]$

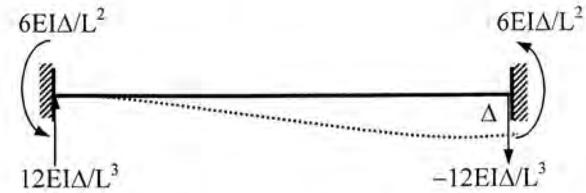
[where $C = \cos\theta$, $S = \sin\theta$]

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 $P_{AB} = S_x\,[(u_B - u_A)\,C_x + (v_B - v_A)\,C_y + (w_B - w_A)\,C_z]$
* Torsional stiffness $T_1 = GJ/L$
* 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- and Consistent-Mass matrix for axial rod

$$\mathbf{M_m} = (\mu L/2)\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \qquad \mathbf{M_m} = (\mu L/3)\begin{pmatrix} 1 & 0.5 \\ 0.5 & 1 \end{pmatrix}$$

Consistent-Mass matrix for beam [μ = Mass per unit length]

$$\mathbf{M_m} = (\mu L/420)\begin{pmatrix} 156 & 22L & 54 & -13L \\ 22L & 4L^2 & 13L & -3L^2 \\ 54 & 13L & 156 & -22L \\ -13L & -3L^2 & -22L & 4L^2 \end{pmatrix}$$

* 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 2015 (Set 2)
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 **any 10 (ten)** of the following 14 questions]

1. Fig. 1 shows a plane truss *abcdef* whose support *e* deflects 10 mm to the left due to the applied force *P*. Calculate (i) Axial force in all members, (ii) Applied force *P* [Given: S_x = constant = 500 k/ft].

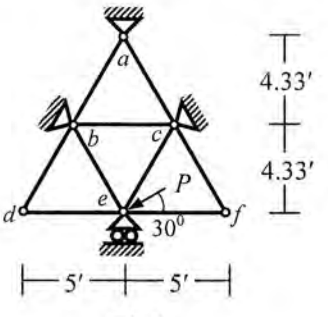


Fig 1

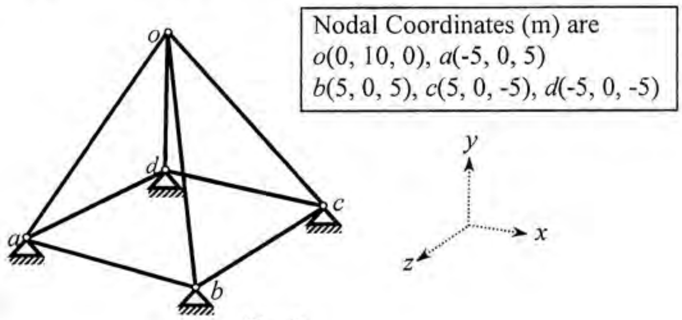


Fig. 2

2. Ignore zero-force members and apply boundary conditions to form the stiffness matrix of the space truss *oabcd* shown in Fig. 2 [Given: S_x = constant = 5 kN/mm].

3. For the frame shown in Fig. 3, calculate the unknown deflection and rotations neglecting axial deformation [Given: $EI = 40 \times 10^3$ k-ft²].

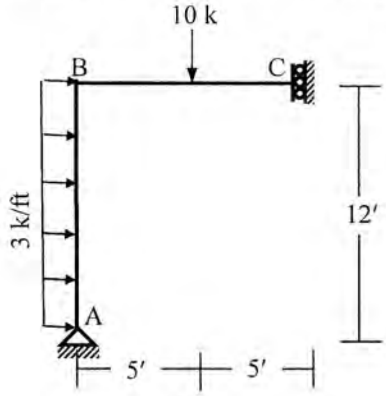


Fig. 3

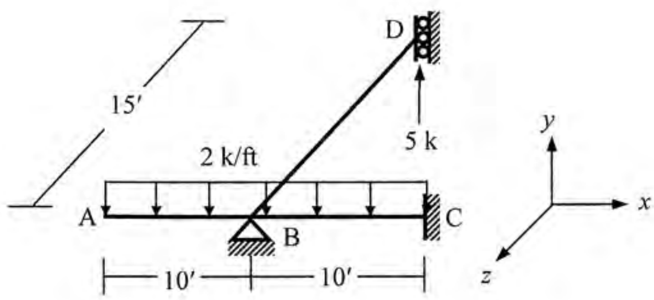


Fig. 4

4. For the grid loaded as shown in Fig. 4, use the stiffness method to calculate the vertical deflection and rotations [Given: $EI = 40 \times 10^3$ k-ft², $GJ = 30 \times 10^3$ k-ft²].

5. Determine the degree of kinematic indeterminacy (doki) and show the corresponding deflections and rotations of the 2D frame and 3D frame shown in Fig. 5, for the following cases

(i) Not considering boundary conditions

(ii) Considering boundary conditions

(iii) Neglecting axial deformations.

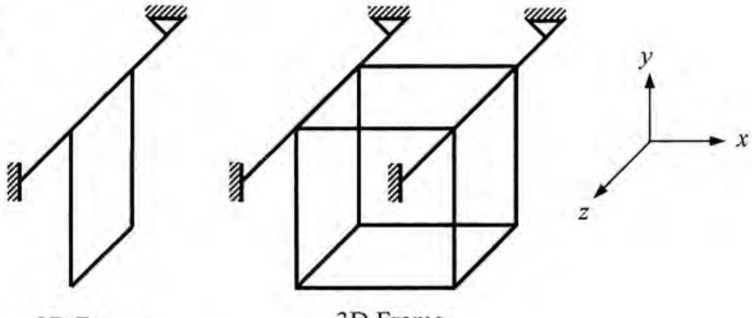


Fig. 5

6. Consider flexural deformations and geometric nonlinearity to calculate the force P required to cause buckling of the beam *abcd* loaded as shown in Fig. 6.

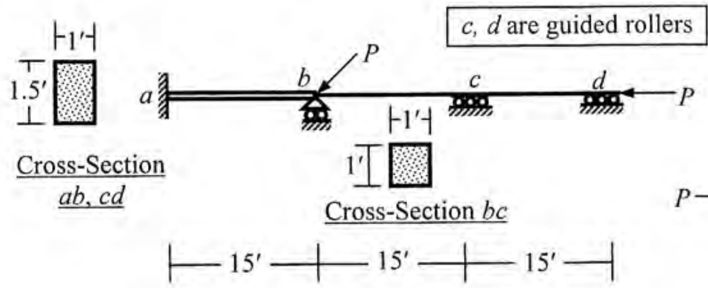


Fig. 6

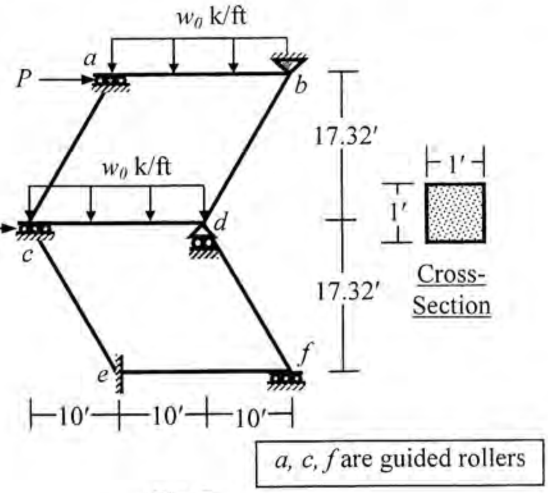


Fig. 7

7. Consider flexural deformations and geometric nonlinearity to calculate the rotation at joint b and d of the frame *abcdef* loaded as shown in Fig. 7 [Given: $E = 500 \times 10^3$ k/ft²]..

8. Consider flexural deformations only with consistent mass matrix to calculate the natural frequencies of the frame *abcdef* shown in Fig. 7 [Given: $E = 500 \times 10^3$ k/ft², Unit weight = 0.15 k/ft³].

9. Consider axial deformations only with lumped mass matrix to calculate the natural frequencies of the frame *abcdef* shown in Fig. 7 [Given: $E = 500 \times 10^3$ k/ft², Unit weight = 0.15 k/ft³].

10. Use *Constant Average Acceleration* (*CAA*) *Method* to calculate the horizontal deflection at node b of the weightless beam *ab* (supporting a mass $m_0 = 100$ kN-s²/m at b) shown in Fig. 8 at time $t = 0.01$ sec after starting from rest, if it is subjected to ground acceleration $a_g = 3\, Cos(50t)$ (m/sec²)

[Use stiffness $k = EA/L$ for the beam, with $E = 20$ GPa, $\xi = 0.05$, $c = 2\xi\sqrt{(km)}$].

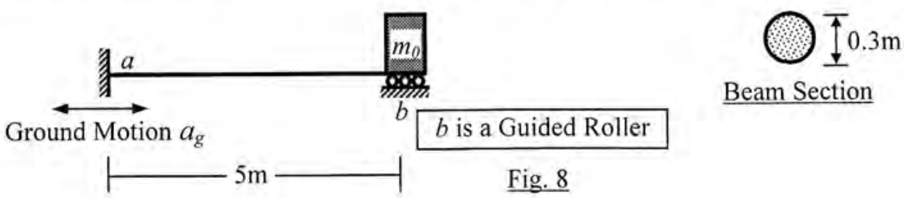


Fig. 8

11. In the frame *abcd* loaded as shown in Fig. 9, use Energy Method to calculate the

(i) Plastic moment (M_p) required to prevent formation of beam mechanism of *bc*, *cd* and sidesway mechanism of the frame.

(ii) Required yield strength (f_y) of the elasto-plastic material.

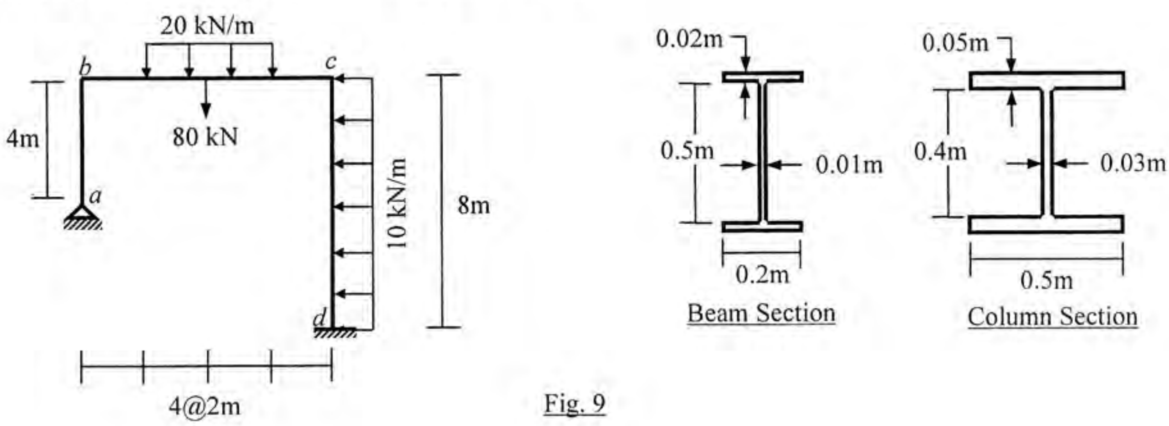


Fig. 9

12. Use the Bending Moment Diagram (BMD) to calculate the concentrated force P needed to develop plastic hinge mechanism in the RC beam *abcde* loaded as shown in Fig. 10
[Given: $f_c' = 4$ ksi, $f_y = 70$ ksi].

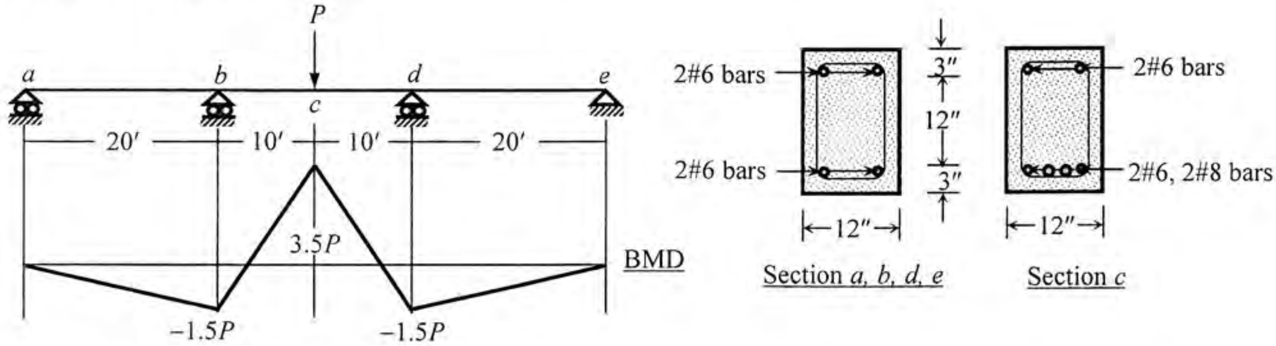


Fig. 10

13. Use Stiffness Method to calculate the vertical deflection at node b and c of the grid *abcd* loaded as shown in Fig. 11
[Given: $EI = 80 \times 10^3$ kN-m^2, $GJ = 60 \times 10^3$ kN-m^2, and both nodes are supported on circular foundation of radius 1-m on the surface of sub-soil (half-space) with shear modulus $G_s = 16 \times 10^3$ kN/m^2 and Poisson's ratio $\nu = 0.30$].

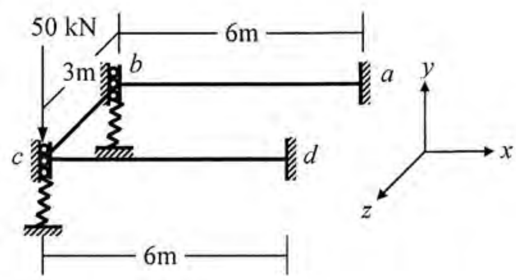


Fig. 11

14. Briefly explain
(i) How buckling load can be calculated by using shape functions for deflected shape of beam
(ii) Why flexural deformations may increase or decrease due to geometric nonlinearity
(iii) The difference between plastic moment (M_p) of steel and RC section
(iv) The difference between dynamic equations of motion due to wind load and seismic ground motion
(v) Effect of foundation flexibility on natural frequency of a structure and its response to static loads.

List of Useful Formulae for CE 411

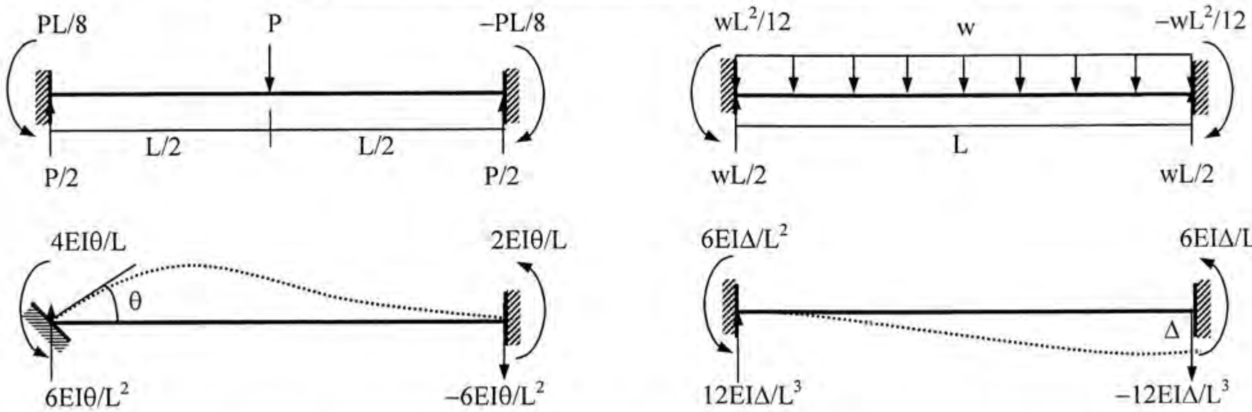
* The stiffness matrix $\mathbf{K}_m{}^G$ of a 2D truss member in the global axis system is given by

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

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

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

<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

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

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

* Member force $P_{AB} = S_x\,[(u_B - u_A)\,C_x + (v_B - v_A)\,C_y + (w_B - w_A)\,C_z]$
* Torsional stiffness $T_1 = GJ/L$
* 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- and Consistent-Mass matrix for axial rod

$$\mathbf{M}_m = (\mu L/2)\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \qquad \mathbf{M}_m = (\mu L/3)\begin{pmatrix} 1 & 0.5 \\ 0.5 & 1 \end{pmatrix}$$

Consistent-Mass matrix for beam [μ = Mass per unit length]

$$\mathbf{M}_m = (\mu L/420)\begin{pmatrix} 156 & 22L & 54 & -13L \\ 22L & 4L^2 & 13L & -3L^2 \\ 54 & 13L & 156 & -22L \\ -13L & -3L^2 & -22L & 4L^2 \end{pmatrix}$$

* 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 2015
Program: B.Sc. Engineering (Civil)

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

PART-1

There are 6 questions. Answer any 5 questions. **(5x10=50 marks)**

1. (a) Differentiate between 'disturbed' and 'undisturbed' soil samples. In which tests can these samples be used? 2
   (b) How can a carefully collected undisturbed sample be disturbed after sampling? 1
   (c) Suggest the spacings of borings for the projects- multi-storied building, one storey industrial plant, highway and dams. 2

   (d) During soil exploration, standard penetration tests were carried out at a test site. Given that $\gamma = 16.5$ kN/m^3. 5
   (i) Calculate the field SPT N and N_{60}, if the number of blows (in each 150 mm of penetration) are recorded 10, 15 and 18. Hammer efficiency is 0.73. Assume that other correction factors equal 1.
   (ii) Calculate the field SPT N value, if the number of blows (in each 75 mm of penetration) are recorded 6, 7, 11, 14, 12 and 18.
   (iii) Determine N_{70}, if $N_{60} = 24$.
   (iv) Determine $(N_1)_{60}$ if $N_{60} = 24$ at a depth of 4 m.

2 Calculate the total settlement (primary consolidation settlement and immediate settlement) of the square footing of size 5 ft x 5ft, shown in Figure 1. Use 2:1 pressure distribution.
$I\rho = 1.12$, $\upsilon = 0.28$, $E = 600\ c_u$, Depth correction factor = 0.88

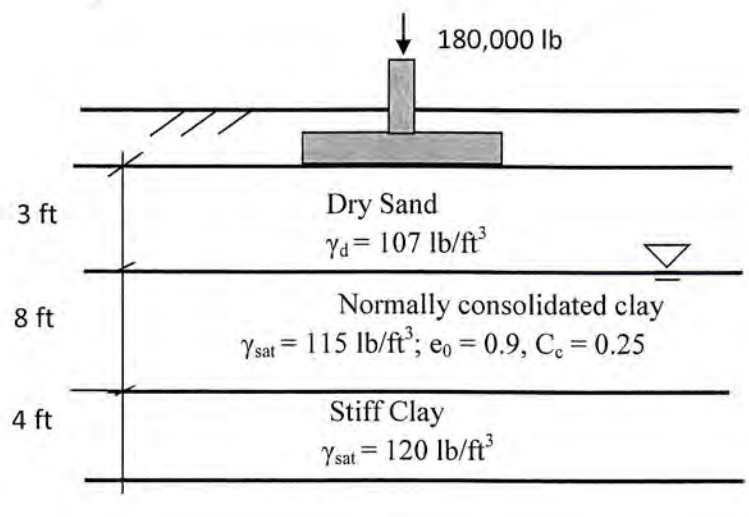


Figure 1

3 Eight piles (in a group, shown in Figure 2) are arranged in 1.5 m centre to centre spacing. The pile group was consisting of 10 m long end bearing piles.

(a) Calculate maximum and minimum vertical Pile load in the pile group, when Q_1 = 1500 kN, Q_2 = 2000 kN and M_2 = 1750 kN-m.

(b) Determine the consolidation settlement of the pile group in the soil profile, shown in Figure 4(b). Given that $Q_1 + Q_2$ = 4000 kN and M_2 = 0. The total of $Q_1 + Q_2$ includes the weight of the pile cap. Use 2:1 pressure distribution and divide the layer into two equal layers.

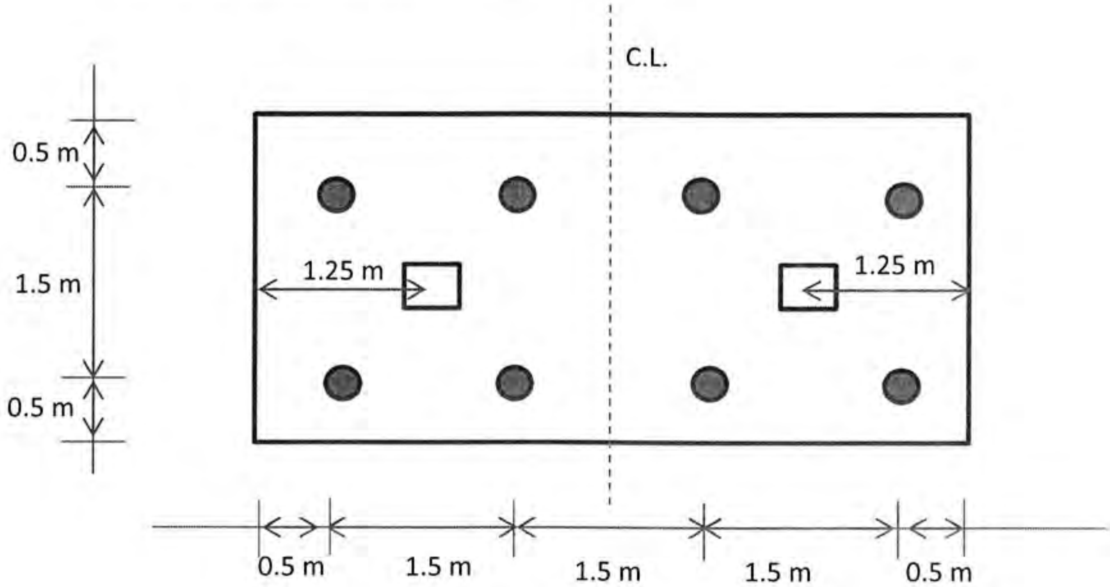


Figure 2 (a)

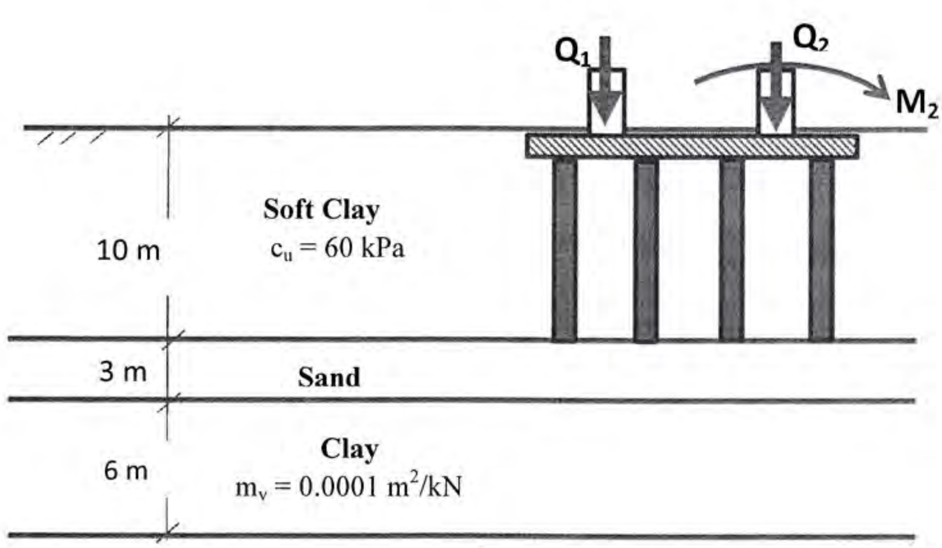


Figure 2 (b)

4. Estimate the allowable bearing capacity of a 2 m wide strip footing, placed at a depth 1.5 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. 5

According to the soil exploration report, the upper loose sand layer is found homogeneous and overlying medium dense sand. The ground water table is located at 1.5 m below GL. Upper layer extends upto 3 m below the ground level. The data of the soil layers is as follows:

Given data: γ_{sat} = 18.2 kN/m^3;

Layer-1: $\varphi_1 = 22°$

Layer-2: $\varphi_2 = 35°$

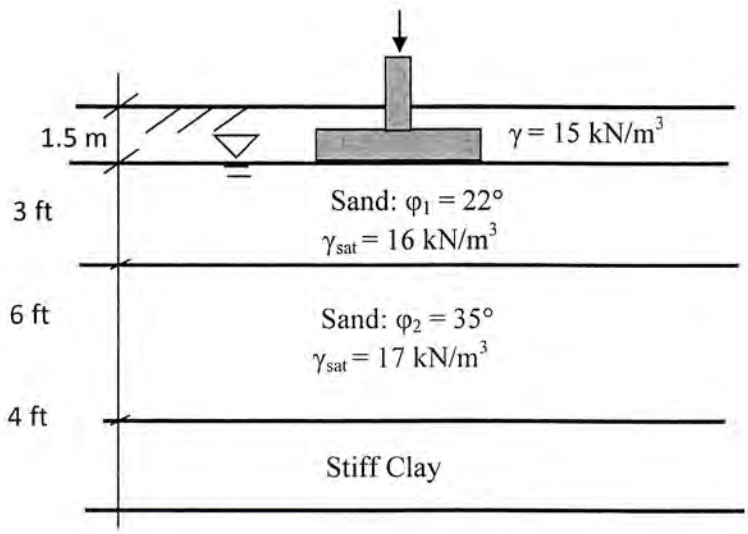


Figure 3

5. Design a square shallow foundation (placed at a depth 1.5 m below the ground level) to support 300 kN load for the following soil data. 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.

The data of this soil layer is as follows:

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

6. Calculate the allowable pile capacity of a single pile in a group of 9 piles in homogeneous clay soil, using both the methods:
(a) Converse-Labarre method,
(b) Terzaghi-Peck method.

Given Data:

Pile geometry/arrangement	Soil data
Pile length = 15 m Pile diameter = 0.5 m Factor of safety = 2.5 Pile spacing: 1 m (centre to centre)	c_u = 50 kPa γ = 17 kN/m^3

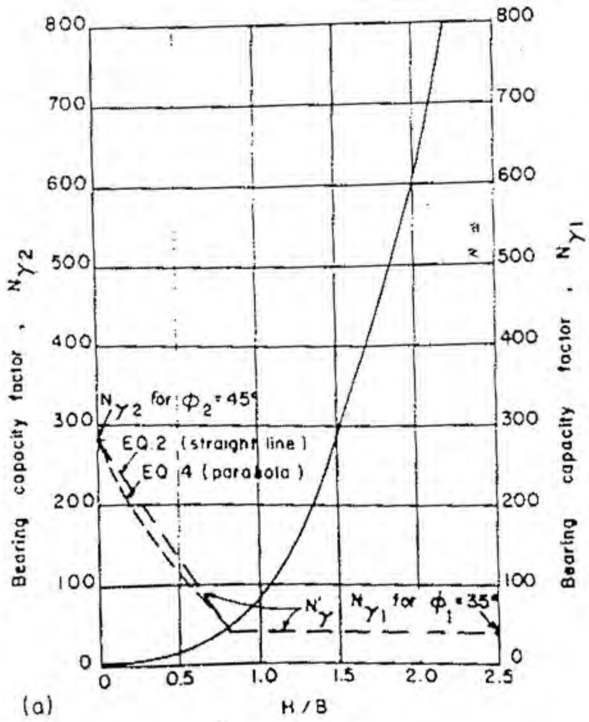
The group action reduction function is as follows:

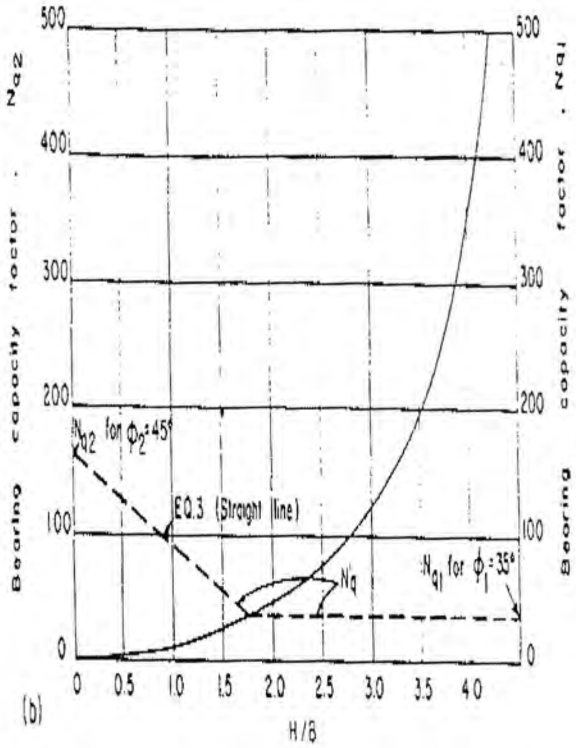
$$E = 1 - \theta[\frac{(n-1)m + (m-1)n}{90\ mn}$$

Table: Bearing Capacity Factors from Meyerhof's Chart

φ	N_c	N_q	N_γ
22°	16.8	7.82	3.05
35°	46.1	33.3	37.1

Design Charts for N_γ' and N_q' (Hanna, 1982)





PART–II

Answer **any 3 (THREE)** of the following questions

6. (a) What are the advantages and disadvantages of cast in situ piles. (3)

   (b) Describe the differences between a point bearing pile and a friction pile. What do you understand by a compaction pile? (4)

   (c) An individual cast in situ concrete pile in sand having a diameter (D) of 0.45 m is shown in the following figure (Fig. 4). Calculate the Ultimate Bearing Capacity (Q_u) of the pile. Assume $\delta = 0.8\phi$ and $K = 1 - \sin\phi$. ($9\frac{2}{3}$)

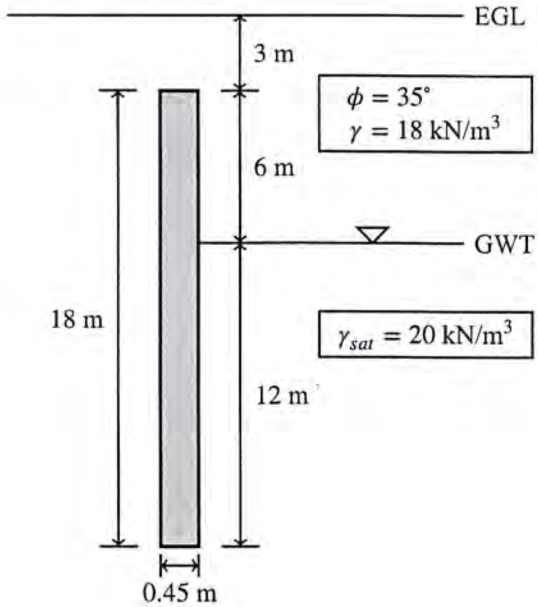


Figure 4: for QUES 6(c)

7. (a) What do you understand by a fully compensated foundation? How it is useful in the construction of a building? (2)

   (b) Following are the results of a standard penetration test in the field (sandy soil). Estimate the net allowable bearing capacity of a mat foundation 60 ft × 40 ft in plan. (7)

Depth (ft)	N_{60}
5	8
10	14
15	19
20	24
25	27
30	34

Given:

$D_f = 10$ ft
$S_e = 1.5$ in

   (c) Suppose you want to construct two basements (each having height of 10 ft) under a highrise residential building to accomodate car parking facilities. The dimension of the proposed mat foundation is 60 ft × 40 ft and the unit weight (γ) of soil is 100 lb/ft^3. If the total load from the superstructure is 5,400 kips, determine whether it is possible to construct two basements beneath the superstructure. Assume you want to utilize the fully compensated foundation. ($7\frac{2}{3}$)

8. (a) Derive an expression for the factor of safety (F_s) of an infinite slope without seepage. (10)

   (b) For the infinite slope shown in the following figure (Fig. 5), determine: ($6\frac{2}{3}$)

i. The factor of safety (F_s)

ii. The height when $F_s = 1$

Assume that, there is ground water seepage and the ground water table coincides with the ground surface.

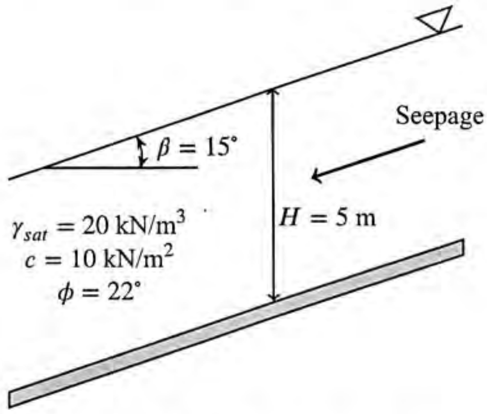


Figure 5: for QUES 8(b)

9. (a) Describe the different modes of failure of finite slope. (3)

(b) For the slope shown in the following figure (Fig. 6), find the factor of safety (F_s) against sliding for the trial slip surface ABC using the Bishop's modified method of slices. ($13\frac{2}{3}$)

Given:

$c' = 10$ kN/m^2

$\phi' = 30°$

$\gamma = 20$ kN/m^3

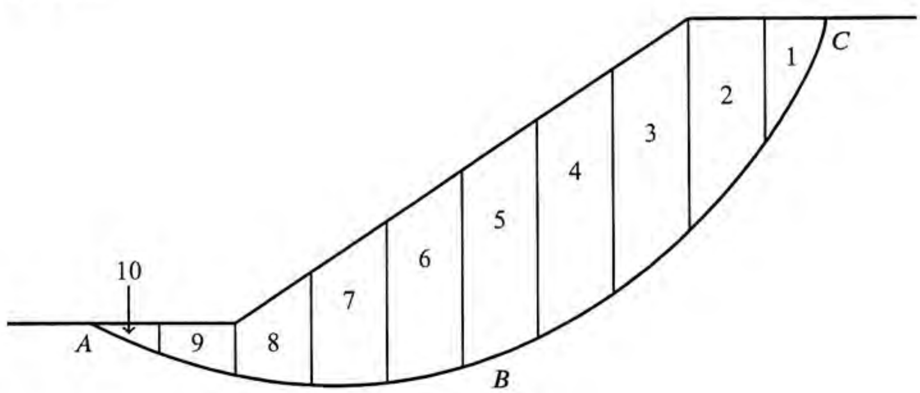


Figure 6: for QUES 9(b)

Slice No.	Width, b_n (m)	Average depth, z_n (m)	α_n (degrees)
1	3.5	9.5	78°
2	5	17.3	61°
3	5	20.5	44°
4	5	19.8	32°
5	5	17.9	21°
6	5	15	12°
7	5	11.2	6°
8	5	6.6	−3°
9	5	3.1	−9°
10	3.5	1.1	−14°

Table: Interpolated values of N_q^* for estimating Q_p of pile

ϕ	N_q^*	ϕ	N_q^*	ϕ	N_q^*	ϕ	N_q^*	ϕ	N_q^*
0°	1	22°	15.5	28°	39.7	34°	115	40°	346
5°	1.76	23°	17.9	29°	46.5	35°	143	41°	420
10°	3.5	24°	21.4	30°	56.7	36°	168	42°	525
15°	6.1	25°	26	31°	68.2	37°	194	43°	650
20°	12.4	26°	29.5	32°	81	38°	231	44°	780
21°	13.8	27°	34	33°	96	39°	276	45°	930

Net allowable bearing capacity of mat foundation based on SPT values and allowable settlement

$$q_{net} = 0.25N_{60}\left[1 + 0.33\left(\frac{D_f}{B}\right)\right][S_e] \leq 0.33N_{60}[S_e]$$

where,

q_{net} is in kip/ft^2
S_e is in inch

Bishop's modified method of slices

$$F_s = \frac{\sum\left[(c'b_n + W_n\tan\phi')\frac{1}{m_{\alpha(n)}}\right]}{\sum W_n \sin\alpha_n} \qquad m_{\alpha(n)} = \cos\alpha_n + \frac{\tan\phi'\sin\alpha_n}{F_s}$$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2015
Program: B. Sc. Engineering (Civil)

Course Code: CE 441 (B) Course Title: Geotechnical Engineering II (Foundation Engineering)
Time: 3 hours Full Marks: 100

PART–I

Answer **any 4 (FOUR)** of the following questions

1. (a) Discuss the purposes of subsurface exploration or soil investigation? (6)
   (b) What factors contribute to the variation of standard penetration number (SPT) at a given depth for similar soil profiles? Discuss the correction for SPT in granular soil. (6.5)

2. For the rectangular shallow foundation shown in the following figure (Fig. 1), determine: (12.5)
   i) Gross ultimate bearing capacity
   ii) Net ultimate bearing capacity
   iii) Net allowable bearing capacity

   Use Meyerhof's bearing capacity factors. Assume a Factor of Safety (FS) of 3.0.

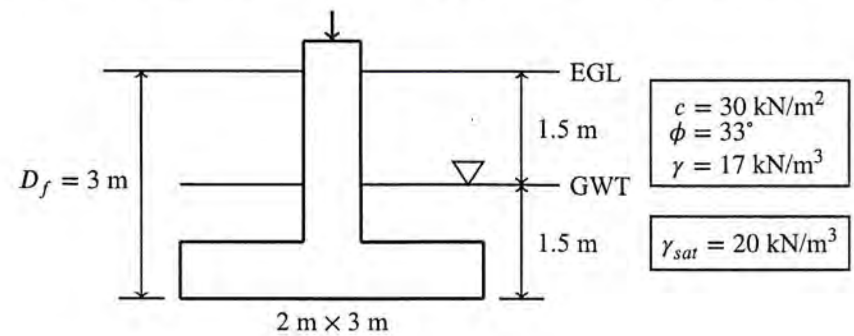


Figure 1: for QUES 2

3. (a) Write the assumptions of Terzaghi's bearing capacity theory. (5)
   (b) Following are the results of a standard penetration test in the field (sandy soil). Estimate the net allowable bearing capacity of a mat foundation 40 ft × 30 ft in plan. (7.5)

Depth (ft)	N_{60}
5	10
10	15
15	21
20	24
25	28
30	31

Given:

$D_f = 10$ ft
$S_e = 1.25$ in

4. (a) What do you understand by a fully compensated foundation? How it is useful in the construction of a building? (4)
   (b) Suppose you want to construct two basements (each having height of 10 ft) under a highrise residential building to accomodate car parking facilities. The dimension of the proposed mat

foundation is 60 ft × 40 ft and the unit weight (γ) of soil is 100 lb/ft^3. If the total load from the superstructure is 5,400 kips, determine whether it is possible to construct two basements beneath the superstructure. Assume you want to utilize the fully compensated foundation. (8.5)

5. (a) Discuss the effect of water table on the bearing capacity of shallow foundation. (6)

(b) A square shallow foundation as shown in the following figure (Fig. 2), has to carry a gross allowable load of 4000 kN. Use Terzaghi's bearing capacity equation to determine the size of the foundation (B). Assume a factor of safety (FS) of 3. (6.5)

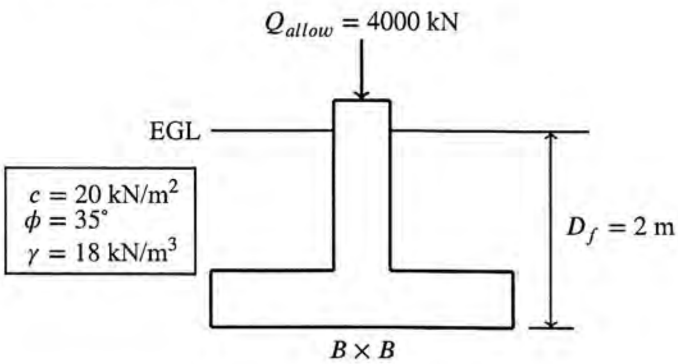


Figure 2: for QUES 5(b)

Terzaghi's bearing capacity equations

$$q_u = 1.3\,cN_c + qN_q + 0.4\gamma BN_\gamma \qquad Square$$

$$q_u = 1.3\,cN_c + qN_q + 0.3\gamma BN_\gamma \qquad Circular$$

General bearing capacity equation

$$q_u = cN_cF_{cs}F_{cd}F_{ci} + qN_qF_{qs}F_{qd}F_{qi} + \frac{1}{2}\gamma BN_\gamma F_{\gamma s}F_{\gamma d}F_{\gamma i}$$

Table: Terzaghi's Bearing Capacity Factors for General Shear Failure

ϕ	N_c	N_q	N_γ	ϕ	N_c	N_q	N_γ	ϕ	N_c	N_q	N_γ
0°	5.70	1.00	0.00	17°	14.56	5.45	3.63	34°	52.64	36.50	35.23
1°	6.00	1.10	0.08	18°	15.52	6.04	4.13	35°	57.75	41.44	41.08
2°	6.30	1.22	0.18	19°	16.56	6.70	4.70	36°	63.53	47.16	48.11
3°	6.62	1.35	0.28	20°	17.69	7.44	5.34	37°	70.07	53.80	56.62
4°	6.97	1.49	0.39	21°	18.92	8.26	6.07	38°	77.50	61.55	67.00
5°	7.34	1.64	0.51	22°	20.27	9.19	6.89	39°	85.97	70.61	79.77
6°	7.73	1.81	0.65	23°	21.75	10.23	7.83	40°	95.66	81.27	95.61
7°	8.15	2.00	0.80	24°	23.36	11.40	8.90	41°	106.81	93.85	115.47
8°	8.60	2.21	0.96	25°	25.13	12.72	10.12	42°	119.67	108.75	140.65
9°	9.09	2.44	1.15	26°	27.09	14.21	11.53	43°	134.58	126.50	172.99
10°	9.60	2.69	1.35	27°	29.24	15.90	13.15	44°	151.95	147.74	215.16
11°	10.16	2.98	1.58	28°	31.61	17.81	15.03	45°	172.29	173.29	271.07
12°	10.76	3.29	1.84	29°	34.24	19.98	17.21	46°	196.22	204.19	346.67
13°	11.41	3.63	2.12	30°	37.16	22.46	19.75	47°	224.55	241.80	451.29
14°	12.11	4.02	2.43	31°	40.41	25.28	22.72	48°	258.29	287.86	600.15
15°	12.86	4.45	2.79	32°	44.04	28.52	26.21	49°	298.72	344.64	819.32
16°	13.68	4.92	3.19	33°	48.09	32.23	30.33				

Table: Bearing Capacity Factors for General Bearing Capacity Equation

ϕ	N_c	N_q	$N_\gamma(M)$	ϕ	N_c	N_q	$N_\gamma(M)$	ϕ	N_c	N_q	$N_\gamma(M)$
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				

Table: Shape and depth factors for general bearing capacity equation

Factor	Condition	Relationship
Shape	for $\phi = 0°$	$F_{cs} = 1 + 0.2\left(\frac{B}{L}\right)$
		$F_{qs} = F_{\gamma s} = 1.0$
	for $\phi \geq 10°$	$F_{cs} = 1 + 0.2\left(\frac{B}{L}\right)\tan^2\left(45 + \frac{\phi}{2}\right)$
		$F_{qs} = F_{\gamma s} = 1 + 0.1\left(\frac{B}{L}\right)\tan^2\left(45 + \frac{\phi}{2}\right)$
Depth	for $\phi = 0°$	$F_{cd} = 1 + 0.2\left(\frac{D_f}{B}\right)$
		$F_{qd} = F_{\gamma d} = 1.0$
	for $\phi \geq 10°$	$F_{cd} = 1 + 0.2\left(\frac{D_f}{B}\right)\tan\left(45 + \frac{\phi}{2}\right)$
		$F_{qd} = F_{\gamma d} = 1 + 0.1\left(\frac{D_f}{B}\right)\tan\left(45 + \frac{\phi}{2}\right)$

Net allowable bearing capacity of mat foundation based on SPT values and allowable settlement

$$q_{net} = 0.25N_{60}\left[1 + 0.33\left(\frac{D_f}{B}\right)\right][S_e] \leq 0.33N_{60}[S_e]$$

where,

q_{net} is in kip/ft^2
S_e is in inch

Part - II

There are 6 questions. Answer any 5 questions. **(5x10=50 marks)**

1. Determine the ultimate capacity of a 600 mm diameter concrete bored pile, shown in the soil profile (Figure 1). Assume critical depth = 20D. the pile-soil friction angle = $0.75\phi'$.

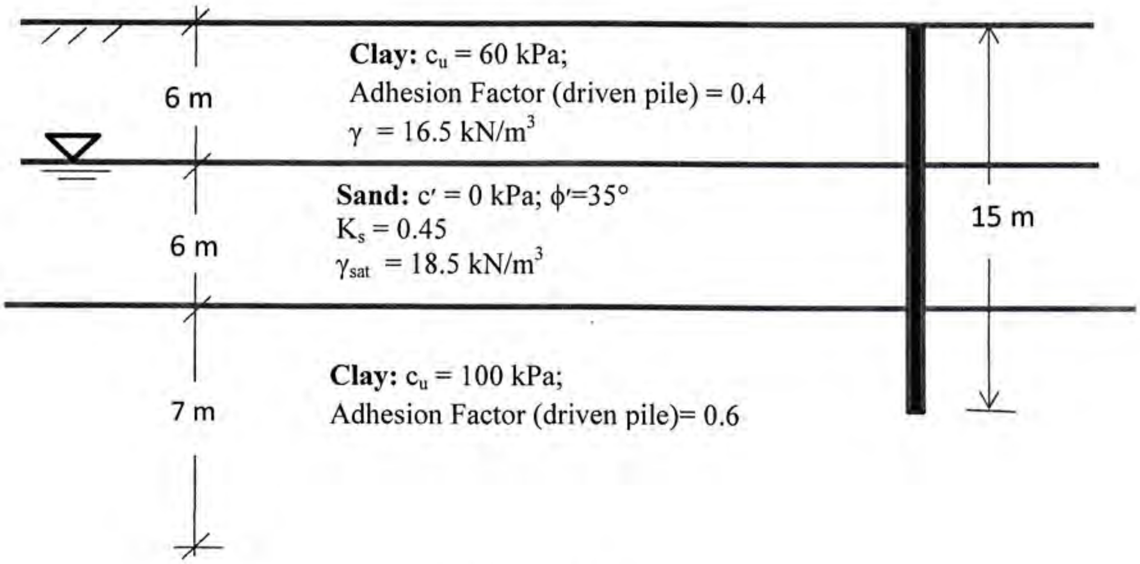


Figure 1

2. An excavation will be made for a 10-storey 15 m x 25 m building. At the site, 10 m thick medium dense sand layer is overlying medium stiff clay. Temporary support of earth pressure and water pressure will be made by cantilever pile wall (Figure 2). Gross pressure due to dead and live loads from the structure and thhe weight of the raft is 130 kPa. This pressure may be assumed uniform.
   (i) What is the net foundation pressure at the end of the construction but bebfore the void space between the wall and the building has been filled. GWT is located at 6 m below the ground level (position 1).
   (ii) What is the net foundation pressure long after the completion of the building. GWT is located at 2 m below the ground level (position 2).
   (iii) Calculate the factor of safety against uplift, when GWT is at position 2.

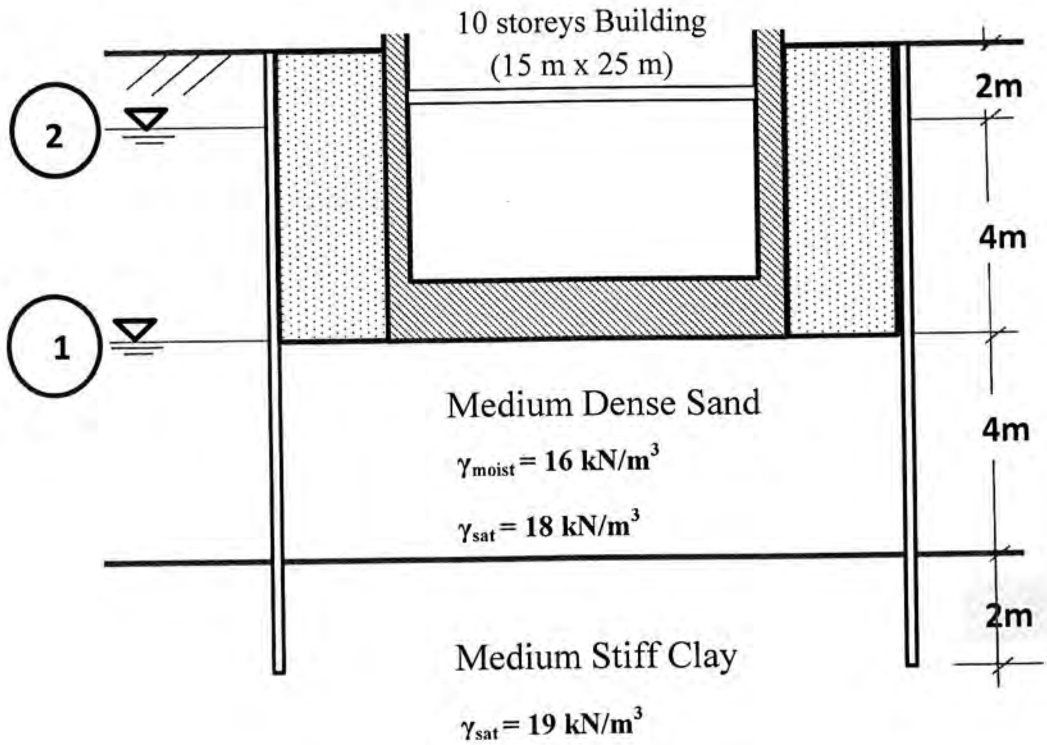


Figure 2

3. A finite slope (shown in Figure 3) makes an angle 30° with the horizontal. Using Taylor's stability number, calculate the following:

   (i) Factor of safety with respect to cohesion, if height of the slope is 8 m
   (ii) Critical height of the slope, using the FS obtained above
   (iii) Safe height of the slope for a factor of safety of 1.5 with respect to shear strength (apply FS to both c and φ).

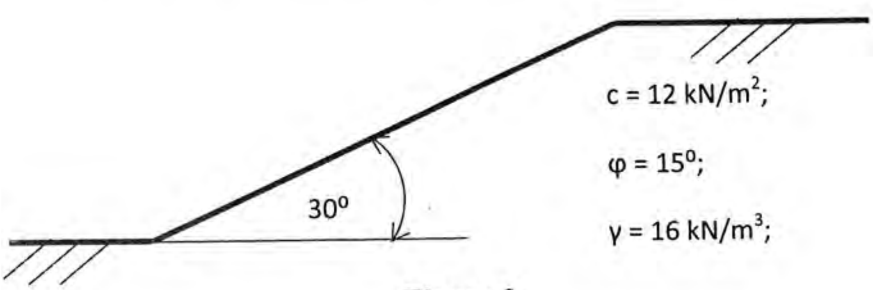


Figure 3

Table: Taylor's Stability Number

φ (°)	i= 90°	i= 75°	i= 60°	i= 45°	i= 30°	i= 15°
10	0.218	0.173	0.138	0.108	0.075	0.023
15	0.199	0.152	0.116	0.083	0.046	-

4. Calculate the allowable pile capacity of a single pile in a group of 9 piles in homogeneous clay soil, using both the methods:
(a) Converse-Labarre method,
(b) Terzaghi-Peck method.

Given Data:

Pile geometry/arrangement	Soil data
Pile length = 15 m Pile diameter = 0.5 m Factor of safety = 2.5 Pile spacing: 1 m centre to centre	$c_u = 50$ kPa $\gamma = 17$ kN/m^3

The group action reduction function is as follows:

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

5. Eight piles (in a group, shown in Figure 4) are arranged in 1.5 m centre to centre spacing. The pile group was consisting of 10 m long end bearing piles.

(a) Calculate maximum and minimum vertical Pile load in the pile group, when $Q_1 = 1500$ kN, $Q_2 = 2000$ kN and $M_2 = 1750$ kN.

(b) Determine the consolidation settlement of the pile group in the soil profile, shown in Figure 4(b). Given that $Q_1 + Q_2 = 4000$ kN and $M_2 = 0$. The total of $Q_1 + Q_2$ includes the weight of the pile cap. Use 2:1 pressure distribution and divide the layer into two equal layers.

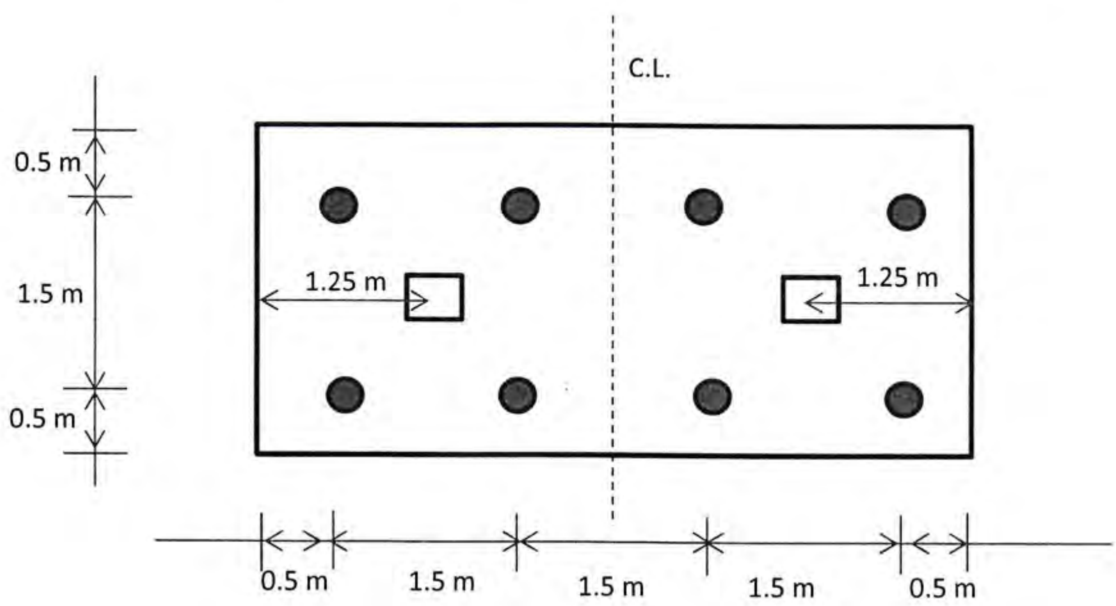


Figure 4 (a)

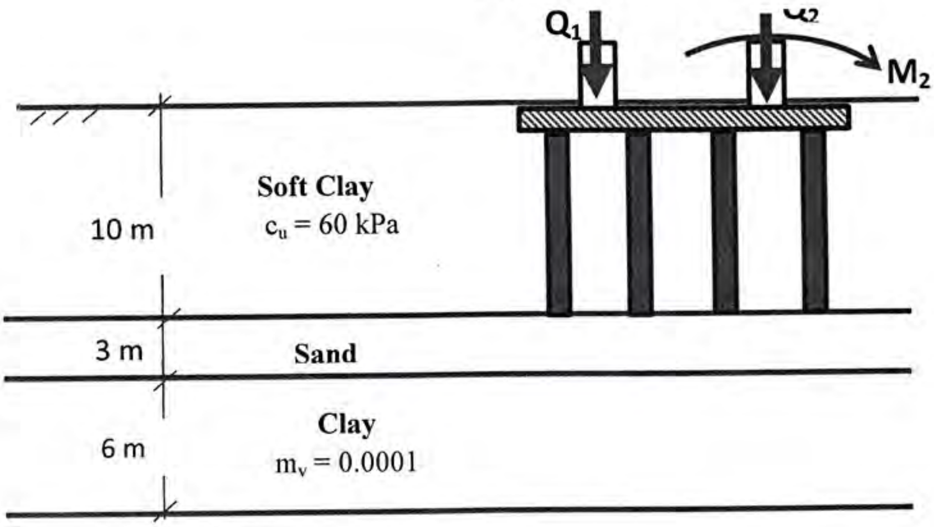


Figure 4(b)

6.(a) The load settlement data (shown in Figure 2) were obtained from a full scale load test on a 600 mm diameter and 18 m long concrete pile (28-day compressive strength of concrete, f'c = 40 MPa). Use Davisson's method to compute the ultimate downward load capacity. According to this method, the ultimate capacity occurs at a settlement of $0.012\ B_r + 0.1\ B/B_r + PL/(AE)$. Modulus of elasticity of concrete can be obtained using the following relation: 4

$E = 15{,}200\ \sigma_r\ (f'c / \sigma_r)^{0.5}$; reference stress, $\sigma_r = 0.1$ MPa

(b) Draw a slip circle (toe failure) for a 7.5 m high slope, cutting a purely cohesive soil. 6

Soil data:

$\varphi = 0$

$c_u = 38$ kN/m^2

$\gamma = 18$ kN/m^3

Area of sliding soil mass = 42 m^2

Calculate the factor of safety for the slip circle against sliding.

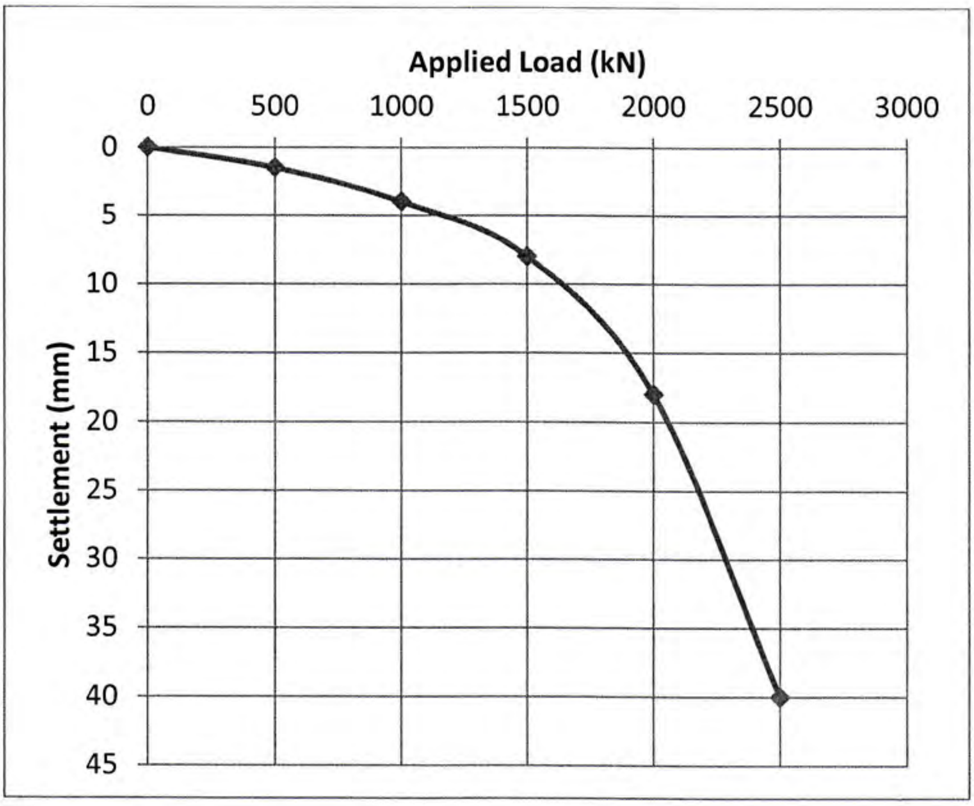


Figure 2: Pile Load Settlement Curve

(Attach it to your answer script)

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2015
Program: B.Sc. Engineering (Civil)

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

Section- A: Answer any 3 (three) out of 4 (Four) questions

1. (a) Mention some advantages that we get from proper track maintenance. (05)
   (b) What are the characteristics a well maintained railway track should have? (05)

2. (a) What is a Railway Station? (02)
   (b) What are the purposes that a railway station can serve? (05)
   (c) Classify stations as per operational considerations. (03)

3. (a) A train of 15 wagons (each wagon weighing 20 tonnes) with a locomotive (weighing 150 tonnes) will be travelling at a speed of 60 km per hour. Tractive effort and rolling resistance of locomotive are 12 tonnes and 3 kg/tonne respectively. Compute the steepest gradient that the train can travel if rolling resistance of wagon is 2.5 kg/tonne. (10)

4. (a) Calculate the maximum permissible train load that can be pulled by a locomotive having four pairs of driving wheels having an axle load of 28.42 tonnes each on a B.G. track with a gradient of 1 in 200 and maximum curvature of 3° at a speed of 48.3 km per hour. Consider co-efficient of friction = 0.2. (04)
   (b) Why Compressed Air brakes are not adopted now? (03)
   (c) What are the advantages of Vacuum Air brakes? (03)

Formulae:

$R_1 = 0.0016W$

$R_2 = 0.00008WV$

$R_3 = 0.0000006WV^2$

$$R_5 = \left.\begin{matrix} 0.0002WD \\ 0.0003WD \\ 0.0004WD \end{matrix}\right\} \textit{depending upon gauge}$$

Section- B: Question 1 is compulsory. Answer any 4 (Four) from questions 2 to 6.

1. (a) Describe the steps involved in preparation of an embankment for a highway. (10)

2. (a) Write short notes on: (09)
   i. Water Bound Macadam
   ii. Surface Dressing
   iii. Tack Coat and Seal Coat

   (b) List some tests of aggregate and their recommended limits to be used in highway. (06)

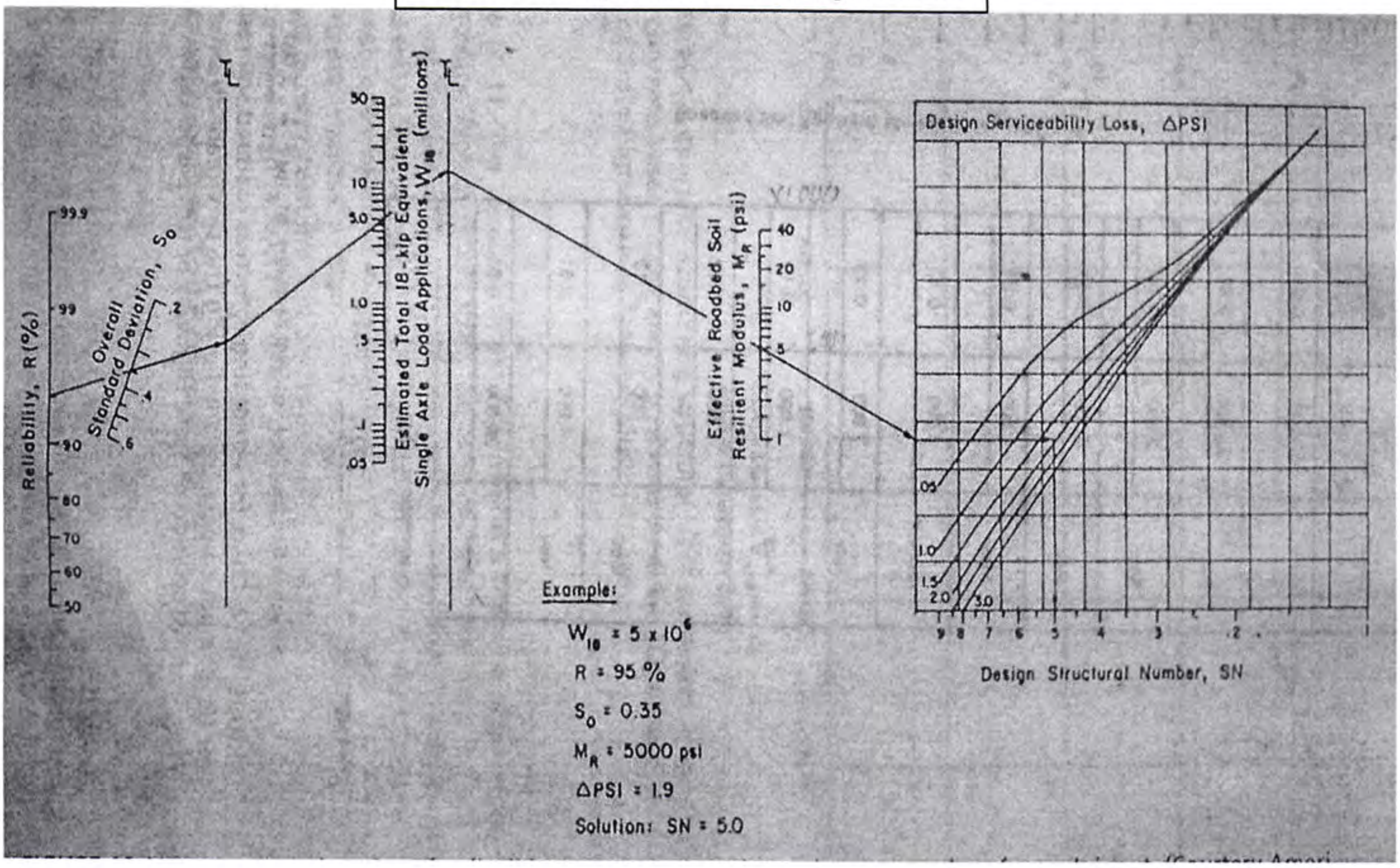
3. (a) Mention some differences between Tar and Asphalt as road construction materials. (05)
   (b) Why Optimum Bitumen Content is necessary to find out? (04)
   (c) Discuss "Emulsified Asphalt". (06)

4. (a) What are the advantages of Flexible Pavements? (03)
   (b) A flexible pavement has been designed with the parameters below: (12)
   4″ hot mix asphalt concrete (a_1 =0.44)
   7″ dense graded crushed limestone (a_2 =0.18)
   10″ crushed stone (a_3 =0.11)
   R = 90%; S_o = 0.4; PSI_i =4.2; PSI_f =2.5; $PSI_{env\ loss}$ =0.2
   Effective roadbed modulus = 10000 psi
   How many 20k single axle trucks (factor 1.5) can be carried by the pavement?
   If 500 trucks (growth rate 3%) and 300 buses (growth rate 5%) use this pavement daily, how many years will this pavement serve?
   Use AASHTO design chart for flexible pavements attached with question.

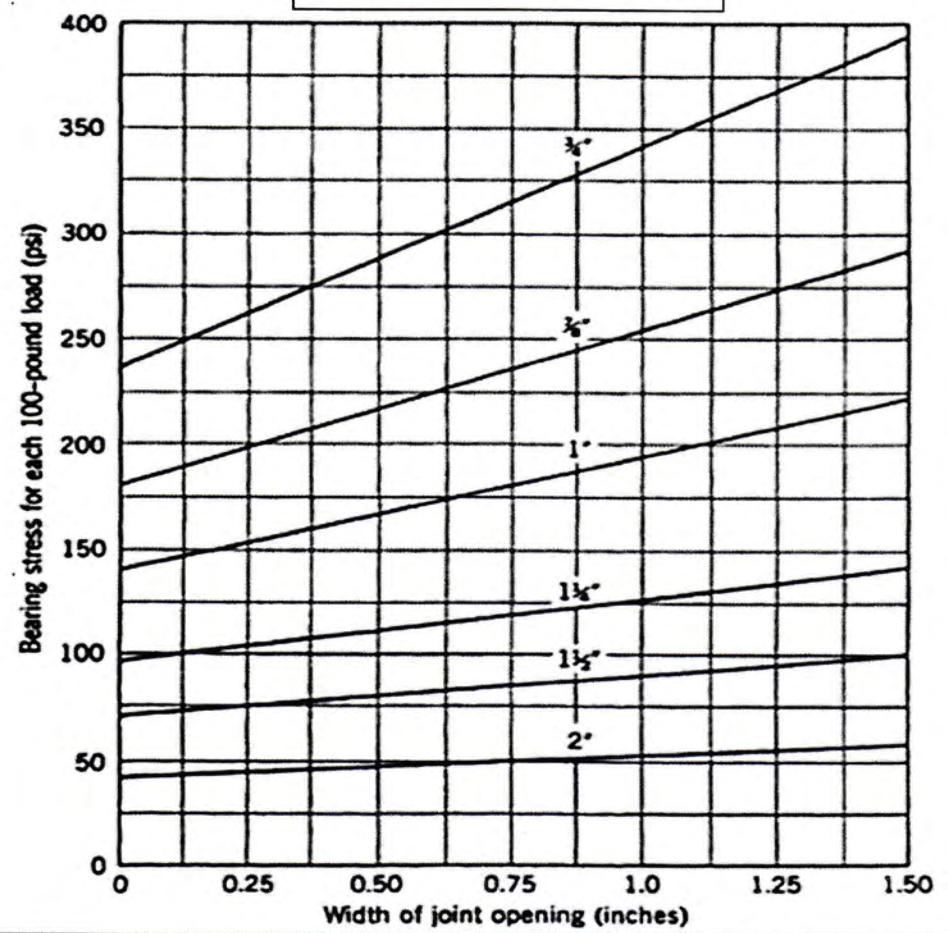
5. (a) Design axle for an h inch thick slab was K kip with wheel spacing X ft. Find size of dowel bar if width of joint opening is 0.75 inch. f'_c = 4 ksi; E = 3.5*10^6 psi; μ = 0.3. (12)
   Given: H = 10″ (for odd); 8″ (for even)
   $K = 32^k$ (for odd); 36^k (for even)
   X = 6′ (for odd); 5′ (for even)
   k = 50 pci (for odd); 100 pci (for even)
   $$l = \sqrt[4]{\frac{Eh^3}{12(1-\mu^2)k}} \quad ; \qquad f_b = \frac{(4-b)f'c}{3}$$
   (b) Write a short note on Contraction Joint in rigid pavement. (03)

6. (a) What is High Type Bituminous Pavement? Mention the objectives of asphalt paving mix design. (06)
   (b) Define: Marshall Stability (04)
   Marshall Flow
   (c) Draw qualitative diagrams of test property curves for hot-mix design data by Marshall method. (05)

AASHTO Design chart for flexible pavements



Bearing Stress on single dowels



University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2015
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 the both sections according to the instruction mentioned on each section.

SECTION A
MARKS: 75

There are SIX questions. Answer <u>question no. 01 (COMPULSORY)</u> and any THREE from the rest (21 + 3*18=75). (Assume any missing data.)

1. a) Define irrigation. Write the benefits of irrigation and the harmful effects of excess irrigation. 2+4
   b) What are the different methods of irrigation water distribution? Describe basin flooding method along with its advantages and disadvantages. 2+4
   c) Explain the necessity of cross-drainage works. 3
   d) Define spillway. Explain the procedures for determining the required discharge capacity and number of spillways. 1+5

2. a) Explain river training works. 2
   b) The gross command area for a distributary is 6000 hectares, 80% of which is cultivable. The intensity of irrigation for Rabi season is 50% and that for 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
   c) Wheat has to be grown at a certain place, the useful climatological conditions of which are tabulated below. Determine the evapo-transpiration and consumptive irrigation requirement of wheat crop. Also determine the field irrigation requirement if the water application efficiency is 80%. Use Blaney-Criddle equation and a crop factor is 0.8. 8

Month	Monthly temperature (^{o}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
November	18.0	7.20	1.7

December	15.0	7.15	1.42
January	13.5	7.30	3.01
February	14.5	7.10	2.75

3. a) Derive the relationship between Duty and Delta for a given base period. 3
   b) Explain the following with neat sketch: i) Aqueduct ii) Super passage iii) Level crossing. 6
   c) A stream of 130 liters per second was diverted from a canal and 100 liters per second was delivered to the field. An area of 1.6 hectares was irrigated in 8 hours. The effective depth of root zone was 1.7 m. The runoff loss in the field was 420 m^3. The depth of water penetration varied linearly from 1.7 m at the head end of the field to 1.1 m at the tail end. Available moisture holding capacity of the soil is 20 cm per meter depth of soil. Irrigation was started at a moisture extraction level of 60% of the available moisture. 9
   Find out the following:
   - water conveyance efficiency
   - water application efficiency
   - water storage efficiency

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

   b) A centrifugal pump is required to lift water at the rate of 100 liters/sec. Calculate the brake horse power of the engine from the following data: 7
   - Suction head = 5 m
   - Delivery head = 1 m
   - Coefficient of friction = 0.01
   - Efficiency of pump = 75%
   - Diameter of pipe = 15 cm

   c) After how many days will you supply water to soil in order to ensure sufficient irrigation of the given crop, if, 7
   - Field capacity of the soil = 30%
   - Permanent wilting point = 15%
   - Dry density of soil = 1.3 gm/cc
   - Effective depth of root zone = 77 cm
   - Daily consumptive use of water for the given crop = 12 mm
   - Readily available moisture is 75% of the available moisture.

5. a) What is groyne? Explain different types of groynes with neat sketch. 4
   b) Describe how reciprocating pump works with neat sketch. 6
   c) Calculate the balancing depth for a channel section having a bed width equal to 18 m and side slopes of 1:1 in cutting and 2:1 in filling. The bank embankments are kept 3.0 m higher than the ground level (berm level) and crest width of banks is kept as 2.0 m. 8

6. a) Draw the typical layout of diversion head works. 4
   b) Explain the following: i) Coefficient of rugosity ii) Critical velocity ratio iii) Hydraulic mean depth 4
   c) Find out the wetted perimeter and bed slope of an unlined irrigation channel on non-alluvial soil with the following data: 10

   - Discharge of the canal = 40 cumec
   - Permissible mean velocity = 0.95 m/sec.
   - Side slope = 1 H: 1 V
   - Coefficient of rugosity (n) = 0.0225
   - B/D ratio = 6.5

SECTION B
MARKS: 25

There are FOUR questions. Answer <u>question no. 07 (COMPULSORY)</u> and any TWO from the rest (13 + 2*6 = 25).

7. a) What are the structural and non-structural measures of flood management in Bangladesh? 7
   b) What is flood risk management? Explain different components of flood risk management. 6

8. Explain the following (any three) 6
   i. Integrated Water Resources Management
   ii. Embankment
   iii. Flood
   iv. Polder

9. Explain delta formation process and how delta formation process relates to flood. 6

10. Graphically explain how flood hazards vary with different geological conditions in Bangladesh. 6