University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2016
Program: B.Sc. Engineering (Civil)

Course Title: Project Planning and Construction Management — Course Code: CE 401

Time: 3 hour — Full marks: 150

There are 7 (seven) questions. Answer any 6 (six) of them (25*6)

1. a. (16)

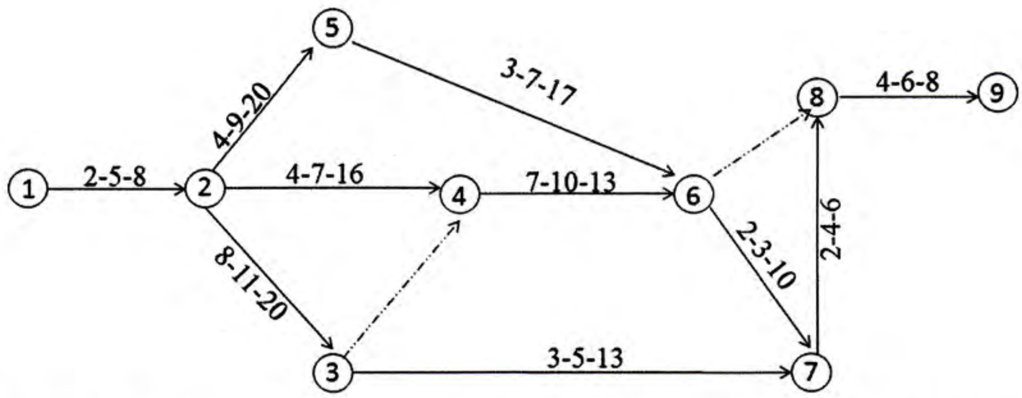


Fig. shows the PERT network for a construction project along with the three time estimates of each activity marked. Determine:

i. Critical path and its standard deviation

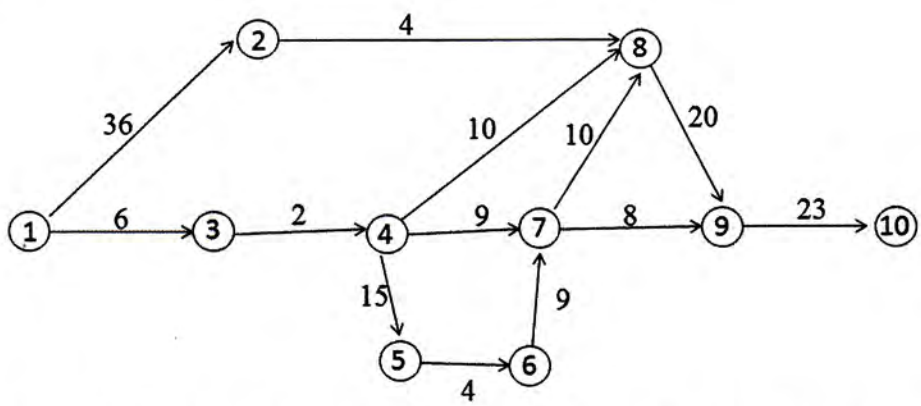
ii. Probability of completion of project in 37 and 45 days

iii. Time duration that will provide 95% probability of its completion in time.

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

c. Write down the advantages and disadvantages of least-square method. (4)

2. a. (15)



The network for a certain project is shown in fig., along with the estimated time of completion of each activity marked.

i. Compute event times, activity times, total float, and free float

ii. Determine the critical path

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

c. Explain super critical activity, critical activity, and sub-critical activity. (5)

3. a. Briefly discuss different demand forecasting methods. (6)

b. Following is a demand data for a product as shown in Table. (12)

Year	Demand	Year	Demand
2001	18	2006	23
2002	18	2007	22
2003	19	2008	24
2004	20	2009	24
2005	22	2010	25

i. Find the least square regression line for the data given

ii. Determine the demand of the product for the year 2022.

c. Describe how methods of forecasting and environmental changes occur error and uncertainty in demand forecasting. What do you suggest to cope with these uncertainties? (7)

4. a. What do you understand by 'Time value of money'? (3)

b. ABC Company is considering two different projects, project P and project Q. The expected cash flows of these projects are as follows: (12)

Year	Project P	Project Q
0	1,000	1,600
1	1,200	200
2	600	400
3	250	600
4	2,000	800
5	4,000	100

i. Compute the NPV for project P and Q

ii. Compute the BCR for project P and Q

iii. What is the IRR of each project?

iv. Which project would you choose if r is 10 percent? 20 percent?

c. Name the different types of hazard, and describe any two of them. (5)

d. Describe the types of accident measurement. (5)

5. a. Provide a description on Open Tendering Method (OTM). Why OTM is considered to be the best procurement method? Explain your opinion. (9+3)

What are the criteria to find out the potential sources/bidders in procurement? (3)

b. Discuss how plant capacity can be defined in two ways. Name the factors that affect capacity decision. Discuss any three of them. (7)

c. The known investment cost for 6,000 units of capacity for the manufacturer of a certain item is Tk. 1,000,000. What will be the investment cost for 10,000 units of capacity if the capacity-cost factor is 0.4 (3)

6. a. What do you understand by SIC? Name the different SIC system, and provide a brief of their basis and uses. (8)

b. What are the objectives of material management? Name the six types of inventory, and discuss any two of them. (7)

c. A project plan consisting of ten events have predecessor relationships as under: (7)

Event	Immediate Predecessor	Event	Immediate Predecessor
1	---	6	3,5
2	1	7	3,4
3	2	8	3,7
4	2	9	7
5	2	10	3,6,8,9

Draw the network diagram for the project plan.

d. According to OSHA, what are the most common types of construction injury? (3)

7. Write short notes on any 5 (five) of the following: (5*5)

   a. PPE
   b. Gantt chart
   c. Unit price contract
   d. RFQ
   e. Quality control and assurance
   f. Slack

Standard Normal Probabilities

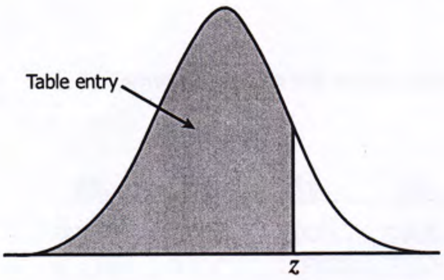


Table entry for z is the area under the standard normal curve to the left of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

Standard Normal Probabilities

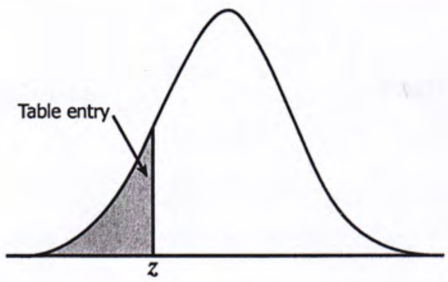


Table entry for z is the area under the standard normal curve to the left of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
−1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
−1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
−0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
−0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
−0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
−0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2016
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 FIVE 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? Select one irrigation method that, in your opinion, is most appropriate for irrigation during non-monsoon period in Bangladesh. Justify your answer. 1+6
   c) Explain the differences between duty and delta of a crop. 5
   d) Explain the necessities of river training works. 3
2. a) Write five precautions that you should take for using saline water during irrigation. 4
   b) 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 (°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

c) Design a lined canal having the following data: 6
Full supply discharge = 150 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.

3. a) Derive the relationship between depth of irrigation water, consumptive use of water and leaching requirement. 3

b) Estimate depth of ground water evaporation that may turn a 32 cm depth of soil saline over a period of 3 months. The electrical conductivity of groundwater is 4.9 mmhos/cm. The electric conductivity (EC) value of saturated extract of soil is 2.15 mmhos/cm. The soil has a mean bulk density of 1.45 g/cm^3 and saturation point of 40 percent. The density of water is assumed as 1 g/cm^3. 5

c) A stream of 130 liters per second was diverted from a canal and 100 liters per second were 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 50% of the available moisture. Determine the following: 10

(i) water conveyance efficiency,
(ii) water application efficiency,
(iii) water storage efficiency
(iv) water distribution efficiency

4. a) Explain the procedures for determining the required discharge capacity and number of spillways. 5

b) A centrifugal pump is required to lift water at the rate of 150 liters/sec. Calculate the brake horse power of the engine from the following data when the water is directly supplies to the field channel: 5

- Suction head = 6 m
- Coefficient of friction = 0.01
- Efficiency of pump = 70%
- Diameter of pipe = 17 cm

c) After how many days will you supply water to soil in order to ensure sufficient irrigation of the given crop, if, 8

Field capacity of the soil = 28%
Permanent wilting point = 13%
Dry density of soil = 1.3 gm/cc
Effective depth of root zone = 68 cm
Daily consumptive use of water for the given crop = 10 mm.
Readily available moisture is 80% of the available moisture.

5. a) Explain the following: i) Groyne; ii) Super passage; iii) Spoil bank; iv) Borrow pit. 6

b) 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. 4

b) The cultivable commanded area of a watercourse is 1200 hectares. Intensities of sugarcane, wheat and rice crops are 20%, 35% and 40% respectively. The duties for the crops at the head of the watercourse are 780 hectares/cumec, 1750 hectares/cumec and 1500 hectares/cumec respectively. Calculate the following: 8

(i) The discharge required at the head of the watercourse

(ii) Determine the design discharge at the outlet, assuming a time factor equal to 0.8.

SECTION B

MARKS: 25

There are FOUR questions. Answer <u>question no. 06 (COMPULSORY)</u> and any TWO from the rest (13 + 2*6 = 25).

6. a) What are the structural and non-structural measures of flood management in Bangladesh? 4

   b) Select two structural measures and two non-structural measures that you think most appropriate for flood management in Dhaka city. Justify your selection. 5

   c) Select one principle of transboundary water resources management that you think most important for irrigation and flood management in Bangladesh? Justify your answer. 4

7. Explain the following (any four): 6
   i. Integrated Water Resources Management
   ii. Barrage
   iii. Weir
   iv. Polder
   v. Dam

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

9. Explain different components of flood risk management. 6

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2016
Program: B.Sc Engineering (Civil)

Course Title: Transportation Engineering II | Course Code: CE 451
Time: 3 hrs | Full Marks: 100

1. Answer any 10 (10X4 =40)

a. Why California Bearing Ratio test and Plate Bearing Test of soil are important 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 on these 3 soil samples with respect to their suitability as subbase or base course material.

b. Explain present serviceability rating (PSR) and present serviceability index (PCI).

c. What are the differences between Conventional flexible pavements, Full-depth asphalt pavements?

d. How will you measure the fatigue cracking and understand its severity level?

e. Write the significance of crushing test, impact test and abrasion test of aggregate in pavement design/construction?
Please comment with respect to pavement design/construction i) Crushing test value of a sample of aggregates 9, ii) impact test value of a sample 40 percent.

f. You have to construct
 i) An airport runway- generally which penetration grade bitumen will you choose and why?
 ii) A rural road- generally which penetration grade bitumen will you choose and why?

g. Find out the required gradation (see Table 1) for maximum density of bituminous mix design (use fuller law, $p = (\frac{d}{D})^n$:

Table 1:

Particle Size (mm)
19.0
12.5
9.5
2.0
0.30
0.075

h. You have to design and construct railway in a mountainous area, what considerations will you adopt in terms of alignment, gradient, gauge, and curvature?

i. Define break of gauge. State two problems of multi gauge system. Calculate maximum axle load for i) For rails of 52 kg /m, and ii) For rail of 60 kg/m

j. Write suitability of sand ballast, Moorum Ballast, and Broken stone ballast.

k. A 25000 lb load is placed on two tires of a locked-wheel trailer. At a speed of 30 mi/hr, a force of 10000 lb is required to move the device. Determine the Skid Resistance (SK) and the surface type assuming that treaded tires were used. Comment referring to Table 2.

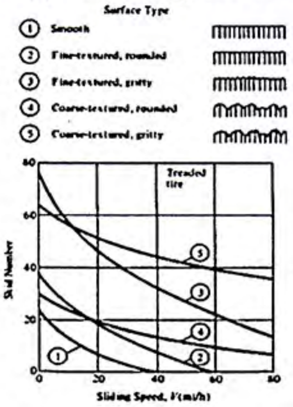


Table 2:

Skid Number	Comments
<30	Take measures to correct
≥30	Acceptable for low volume roads
31 – 34	Monitor pavement frequently
≥35	Acceptable for heavily travelled roads

2. Answer any Four (15X4= 60)

a. A six-lane divided highway is to be designed to replace an existing highway. Traffic survey conducted on year 2015 showed that AADT (both directions) in year 2015 is 6000 vehicles. It is expected that new highway will start its operation on year 2020. Traffic growth rate is 5% per annum. The percent of traffic on the design lane is 45%. ***Determine the design ESAL*** if the design life is 20 years and the vehicle mix is: Passenger cars (1000 lb/axle) = 50%, 2-axle single-unit trucks (5000 lb/axle) = 40%, 3-axle single-unit trucks (7000 lb/axle) = 10%. For this six-lane divided highway ***Design the suitable flexible pavement*** using ***AASHTO*** method 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 and roadbed soil resilient modulus 15000 lb/in^2. Assume all m_i values =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 initial serviceability index 4.5 and terminal serviceability index 2.5.Explain step by step design process.

b. An existing rural four-lane highway is to be replaced by a six-lane divided expressway (three lanes in each direction). Traffic volume data on the highway indicate that the AADT (both directions) during the first year of operation is 24,000 with the following vehicle mix and axle loads. Passenger cars = 50% , 2-axle single-unit trucks (12,000 lb/axle) =40%, and 3-axle single-unit trucks (16,000 lb/axle) =10%. ***Determine the design ESAL*** if the vehicle mix is expected to remain the same throughout the design life of 20 years, although traffic is expected to grow at a rate of 3.5% annually. Using the ***AASHTO design procedure, design a concrete pavement*** required for the design period of 20 years. Initial serviceability index 4.5, Terminal serviceability index 2.5, S_c = 650 lb/in^2, E_c= 5X10^6 lb/in^2, k=130 lb/in^3, J= 3.2, C_d=1.0, S_o = 0.3, R=95%. Explain step by step design process.

c. ***Determining proportions of different aggregates*** to obtain a Required Gradation Table 3 gives the specifications for the aggregates and mix composition for highway pavement asphaltic concrete and results of a sieve analysis of samples from the materials available. ***Design a bitumen concrete mixture*** for a highway pavement to support medium traffic, for aggregate proportion determined and Table 4 showing data obtained using the Marshall method were used. Bulk specific gravity for coarse, fine and filler are 2.65, 2.75 and 2.70 respectively. Determine the optimum asphalt content for this mix for the specified limits given in **Table 5**.

Table 3:

Passing Sieve Designation (mm)	Required Gradation	Percent by Weight		
		Coarse	Fine	Filler
19	0–5	5	-	-
12.5	8–42	35	-	-
9.5	8–48	38	-	-
4.75	6–28	17	8	-
Total Coarse Aggregate	48-65			
2	5–20	5	30	-
0.425	9–30	-	35	5
0.180	3–20	-	26	35
0.075	2–6	-	1	60
Total Fine Aggregate	35–50			

Table 4:

Bitumen %	Weight of Specimen (g) In Air	In Water	Stability (lb)	Flow (0.1 in.)	Max. Specific Gravity of Paving Mixture
5	1325.6	780.1	1460	7	2.54
5.5	1331.3	789.6	1600	10	2.56
6.0	1338.2	799.8	1560	11	2.58
6.5	1343.8	799.8	1400	13	2.56
7.0	1349.0	798.4	1200	16	2.54

Table 5:

Maximum and Minimum Value	
Marshal Method Mix Criteria	**Medium Traffic**
Stability N (lb)	5338 (1200)
Flow, 0.25 mm (0.1 in.)	8 to 16
Air Voids %	3-5
Voids filled with bitumen %	75-85

d. A flexible pavement is to be designed to carry a 1.5 X 10^6 ESAL during its design period. **Design a flexible pavement** consisting of an asphalt concrete surface and un-treated granular base with R value as 70 using the **California (Hveem) method**. The results of a stabilometer test on the subgrade soil given in Table 6. Explain the step by step design process.

Table 6:

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

e. **Classify a soil sample using USCS method**. The following data were obtained for a soil sample.

Table 7:

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

Using the USCS method for classifying soils, determine the classification of the soil and state whether this material is suitable in its natural state for use as a subbase material.

Required Charts and Tables

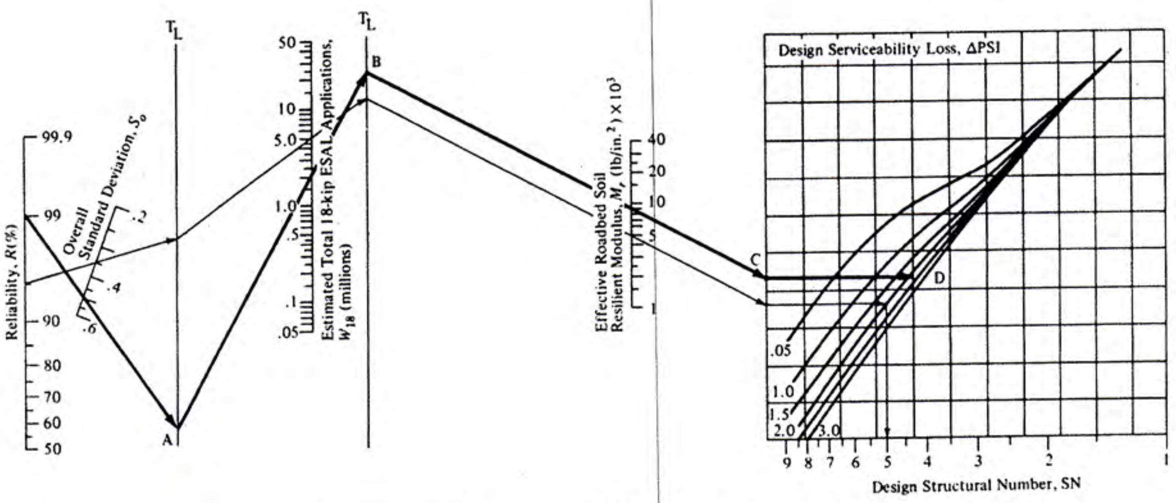


Figure 1: Design Chart for Flexible Pavements Based on Using Mean Values for each Input

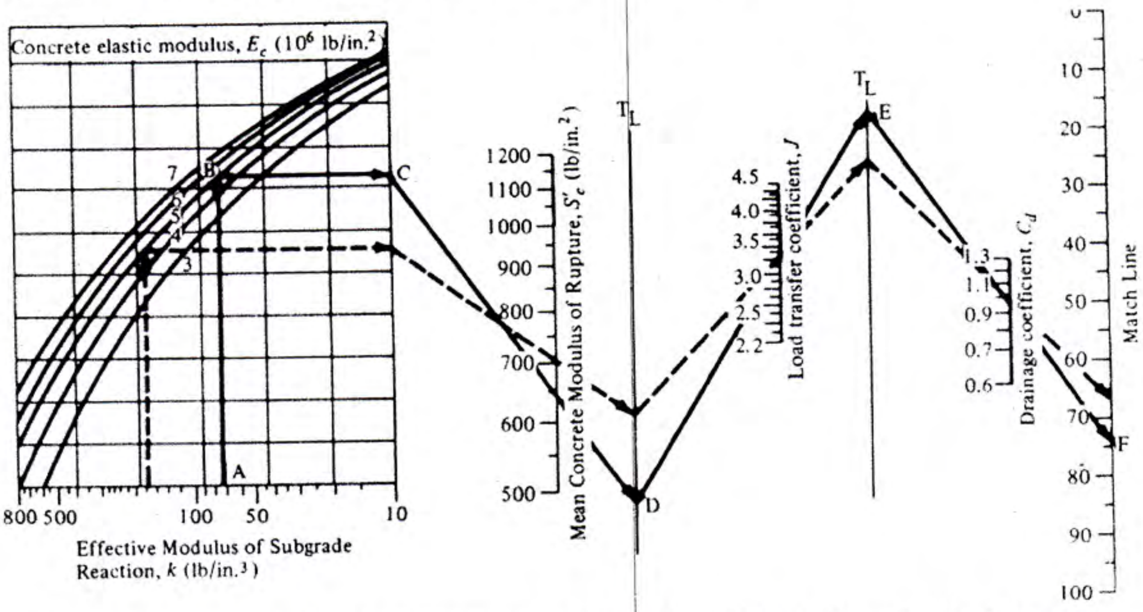


Figure 2: Design Chart for Rigid Pavement Based on Using Values for Each Input Variable (Segment 1)

Table 1: 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

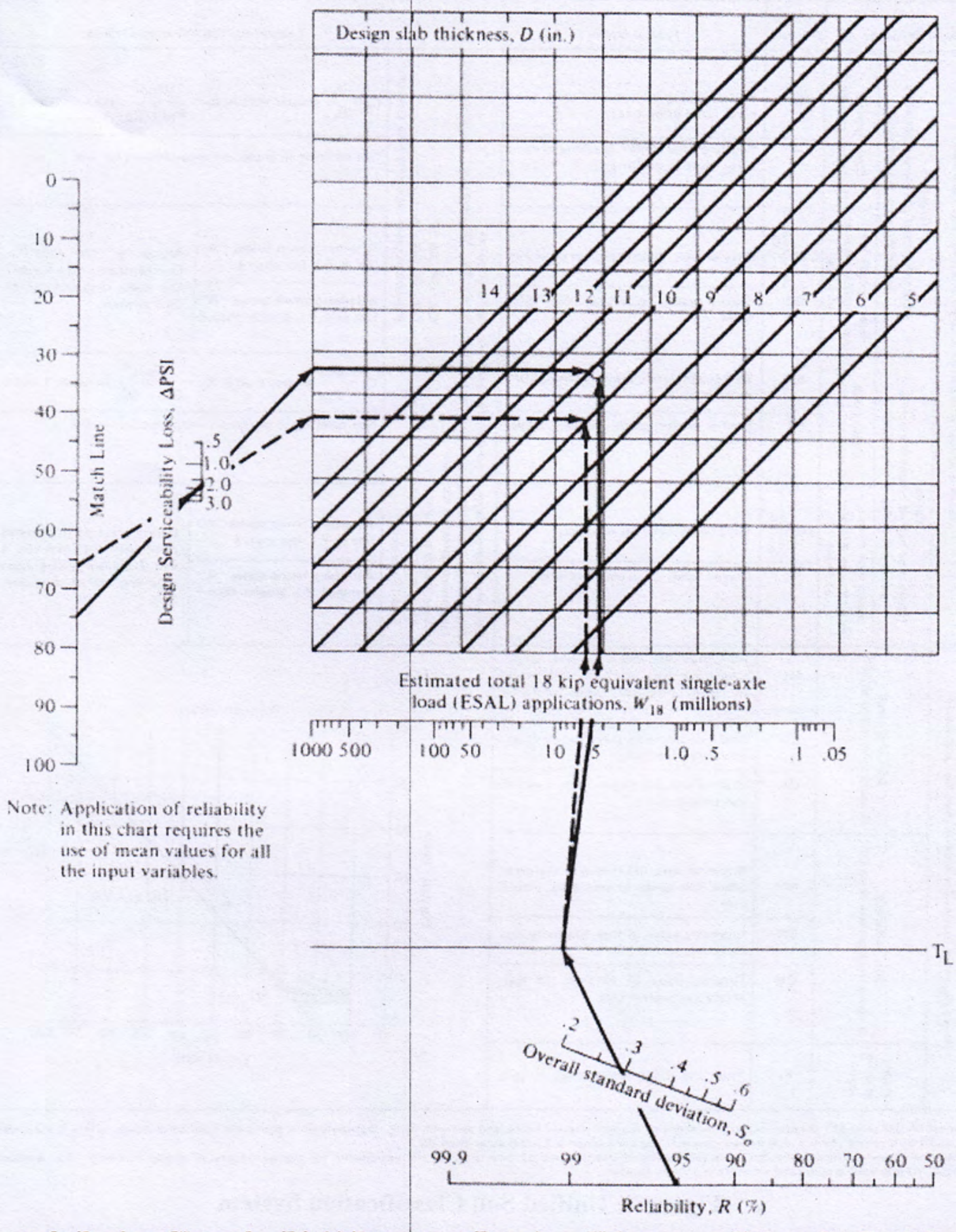
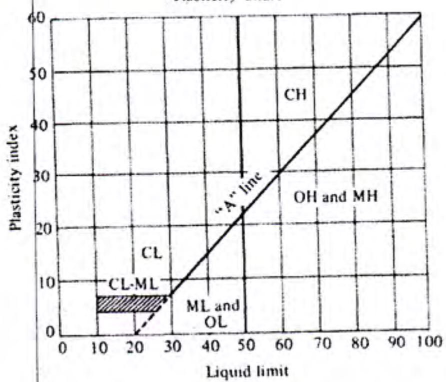


Figure 3: Design Chart for Rigid Pavement Based on Using mean Values for Each Input Variables.

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria	
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM[a]	d	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
				u			
			GC		Clayey gravels, gravel-sand-clay mixtures	Atterberg limits below "A" line with P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a]	d	Silty sands, sand-silt mixtures	Atterberg limits above "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
				u			
			SC		Clayey sands, sand-clay mixtures	Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity		
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			OL		Organic silts and organic silty clays of low plasticity		
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			CH		Inorganic clays of high plasticity, fat clays		
			OH		Organic clays of medium to high plasticity, organic silts		
	Highly organic soils		Pt		Peat and other highly organic soils		

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:
Less than 5 per cent — GW, GP, SW, SP
More than 12 per cent — GM, GC, SM, SC
5 to 12 per cent — *Borderline* cases requiring dual symbols[b]

Plasticity Chart



[a]Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.
[b]Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

Figure 4: Unified Soil Classification System

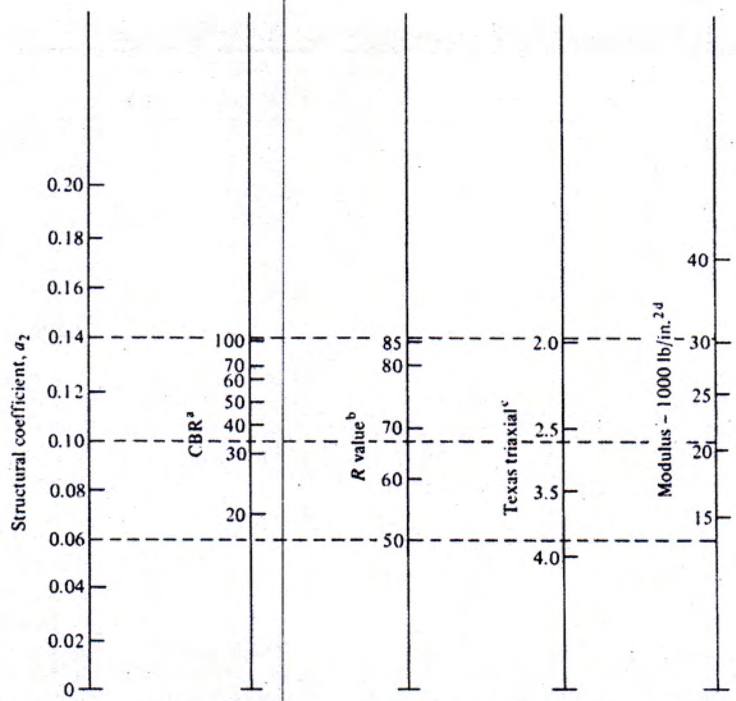


Figure 6: Variation in Granular Base Layer Coefficient, a2, with Various Subbase Strength Parameters

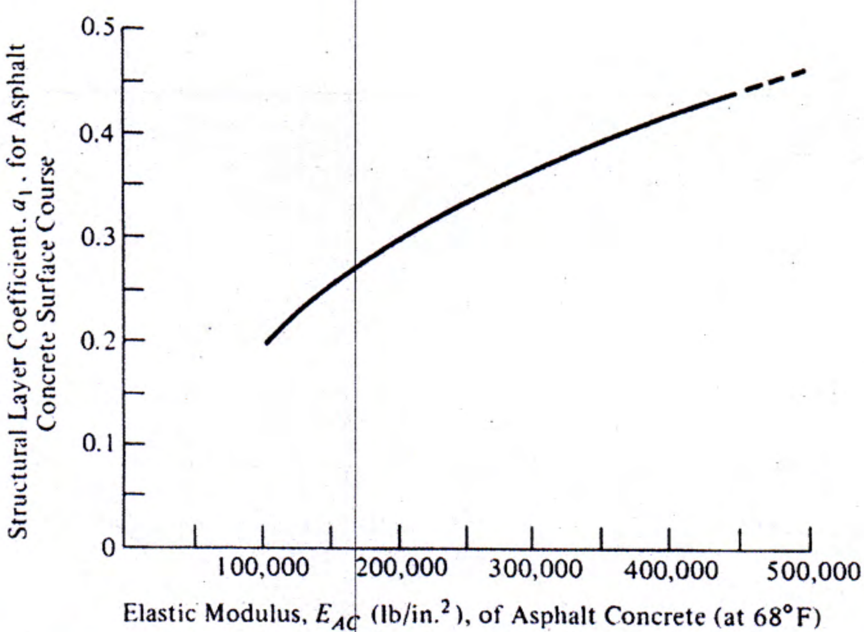


Figure 7: Chart for Estimating Structural Layer Coefficient of Dense-Graded/Asphalt Concrete Based on the Elastic (Resilient) Modulus

Table 2: Comparable Soil Groups in the AASHTO and USCS Systems

Soil Group in Unified System	*Comparable Soil Groups in AASHTO System*		
	Most Probable	*Possible*	*Possible but Improbable*
GW	A-1-a	—	A-2-4, A-2-5, A-2-6, A-2-7
GP	A-1-a	A-1-b	A-3, A-2-4 A-2-5, A-2-6, A-2-7
GM	A-1-b, A-2-4, A-2-5, A-2-7	A-2-6	A-4, A-5, A-6, A-7-5, A-7-6, A-1-a
GC	A-2-6, A-2-7	A-2-4, A-6	A-4, A-7-6, A-7-5
SW	A-1-b	A-1-a	A-3, A-2-4, A-2-5, A-2-6, A-2-7
SP	A-3, A-1-b	A-1-a	A-2-4, A-2-5, A-2-6, A-2-7
SM	A-1-b, A-2-4, A-2-5, A-2-7	A-2-6, A-4, A-5	A-6, A-7-5, A-7-6, A-1-a
SC	A-2-6, A-2-7	A-2-4, A-6 A-4, A-7-6	A-7-5
ML	A-4, A-5	A-6, A-7-5	—
CL	A-6, A-7-6	A-4	—
OL	A-4, A-5	A-6, A-7-5, A-7-6	—
MH	A-7-5, A-5	—	A-7-6
CH	A-7-6	A-7-5	—
OH	A-7-5, A-5	—	A-7-6
Pt	—	—	—

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2016
Program: B. Sc. Engineering (Civil)

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

PART–1

ANSWER **ANY 3 (THREE)** OF THE FOLLOWING QUESTIONS.

1. (a) What do you understand by the degree of disturbance of a soil sample? How is the undisturbed soil sample collected from the field? $(2 + 1 = 3)$

   (b) A ten-story 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 50 m × 30 m footprint area and is expected to be supported on individual shallow foundations located 2 m below the ground surface. Determine the required number and depth of the boring. (3)

   (c) For the individual square shallow footing as shown in Fig. 1, determine:

   i) Gross ultimate bearing capacity, q_u

   ii) Net ultimate bearing capacity, $q_{u(net)}$

   iii) Net allowable bearing capacity, $q_{allow(net)}$

   Use general bearing capacity equation and Meyerhof's bearing capacity factors. Use a factor of safety, $FS = 3$. $(10\frac{2}{3})$

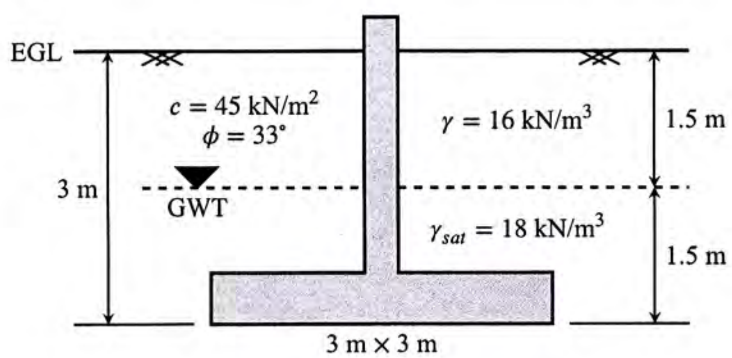


Figure 1: Question 1 (c)

2. (a) Give a brief description of Standard Penetration Test (SPT). (3)

   (b) What do you understand by General Shear Failure, Local Shear Failure, and Punching Shear Failure of shallow foundations? (6)

   (c) A mat foundation on a saturated clay soil has dimension of 50 m × 25 m with $c = 50$ kN/m^2, and $\gamma_{sat} = 18$ kN/m^3. The total dead and live load on the mat is 100 MN. Determine the depth, D_f, of the mat assuming a fully compensated foundation. What will be the factor of safety (FS) of the mat if the depth of the mat (D_f) is 3 m? Use Meyerhof's bearing capacity factors. $(7\frac{2}{3})$

3. (a) What do you understand by the load-carrying capacity of a single pile? Write the expression of the ultimate load-carrying capacity of a single pile. $(1 + 2 = 3)$

   (b) Discuss the effects of ground water table on the bearing capacity of shallow foundations. (4)

   (c) An individual cast in situ concrete pile in sand having a diameter (D) of 450 mm is shown in Fig. 2. Determine the ultimate load-carrying capacity (Q_u) of the pile. Assume $\delta = 0.8\phi$, $\psi = 75°$, and $K = 1 - \sin\phi$. $(9\frac{2}{3})$

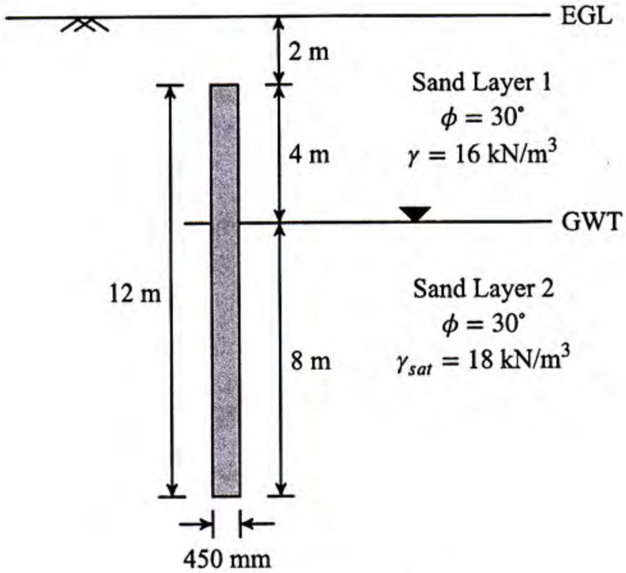


Figure 2: Question 3 (c)

4. (a) What is the importance of minimum spacing of individual piles in a pile group? (2)

(b) How is the vane shear test conducted in field? A vane shear test was conducted in a saturated clay. The height and diameter of the vane were 120 mm and 60 mm, respectively. During the test, the maximum torque applied was 0.08 N-m. Determine the undrained shear strength, $c_{u(f)}$, of the clay in field. The clay soil has a liquid limit of 51 and a plastic limit of 26. What would be the corrected undrained shear strength, $c_{u(c)}$, of the clay for design purposes? $(2 + 5 = 7)$

(c) An individual cast in situ concrete pile in soft saturated clay having a diameter (D) of 450 mm is shown in the following figure (Fig. 3). Calculate the ultimate frictional resistance (Q_s) of the pile by the λ method. $(7\frac{2}{3})$

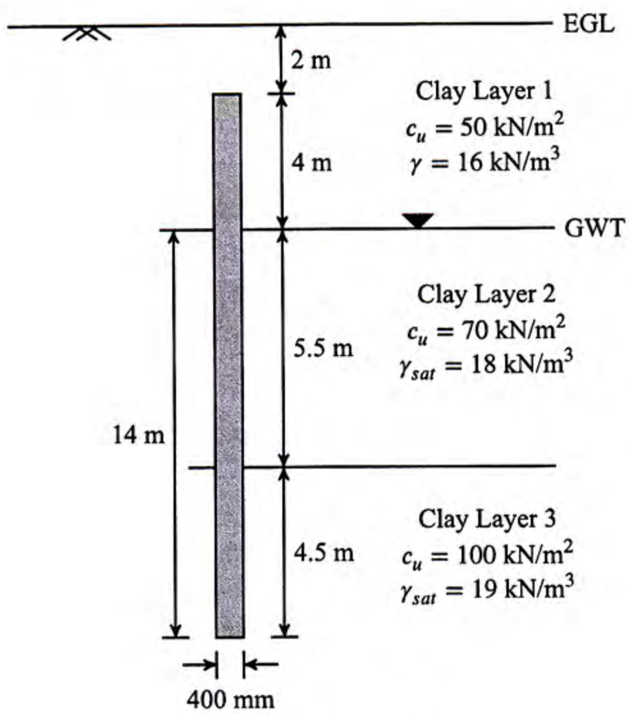


Figure 3: Question 4 (c)

Necessary Equations and Tables

Table 1: Rough guidelines for the spacing of exploratory boring for proposed medium to heavy weight structures

Subsurface conditions	**Structure footprint area for each borehole**	
	(m^2)	(ft^2)
Poor quality and/or erratic	$100 - 300$	$1,000 - 3,000$
Average	$200 - 400$	$2,000 - 4,000$
High quality and uniform	$300 - 1,000$	$3,000 - 10,000$

Table 2: Rough guidelines for the depth of exploratory boring for structures on shallow foundations

Subsurface conditions	**Minimum depth of 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 3: Bearing Capacity Factors for General Bearing Capacity Equation

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				

Table 4: Shape, Depth & Load Inclination Factors for General Bearing Capacity Equation

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

Table 5: Values of bearing capacity factors (Janbu, 1976)

	$\psi = 60^\circ$		$\psi = 75^\circ$	
ϕ	N_c^*	N_q^*	N_c^*	N_q^*
0°	5.74	1	5.74	1
5°	4.92	1.43	5.69	1.5
10°	5.98	2.05	7.11	2.25
20°	9.26	4.37	11.78	5.29
30°	15.68	10.05	21.82	13.6
35°	21.41	15.99	31.53	23.08

Table 6: Variation of λ with pile embedment length, L

L (m)	λ	L (m)	λ
0	0.500	35	0.132
5	0.336	40	0.127
10	0.245	50	0.118
15	0.200	60	0.113
20	0.173	70	0.110
25	0.150	80	0.110
30	0.136	90	0.110

Vane Shear Test

$$c_{u(f)}\,(\text{kN/m}^2) = \frac{T\,(\text{N-m})}{K} \qquad K = \left(\frac{\pi}{10^6}\right)\left(\frac{D^2 H}{2}\right)\left(1 + \frac{D}{3H}\right) \qquad D, H \text{ are in cm}$$

$$\lambda = \text{correction factor} = 1.7 - 0.54 \log\left[PI\,(\%)\right]$$

PART - 2

Answer the following questions.

5. Determine the ultimate capacity and allowable bearing capacity of a group of 4 piles in the given soil profile using both Terzaghi-Peck method and Converse-Labarre method. 8+8=16

   Pile type: concrete bored pile
   Pile diameter = 700 mm
   Critical depth = 15D, pile spacing = 0.8 m
   Pile-soil friction angle = $0.6\phi'$

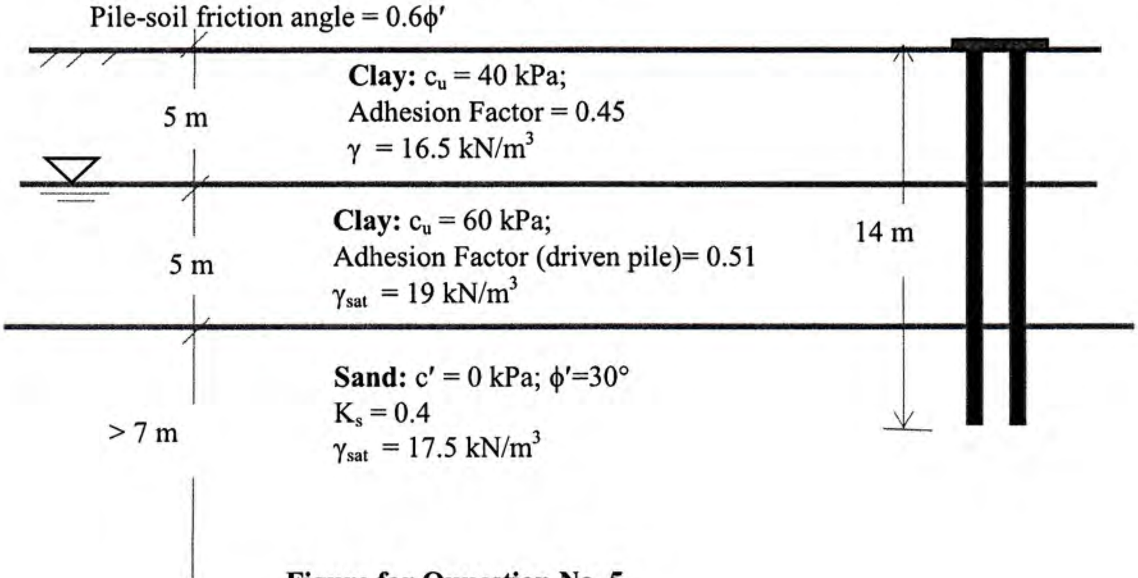


Figure for Quuestion No. 5

6. **Answer either 6(a) or 6(b):**
   (a) Estimate the settlement of 3 m of the soil just below the pile tip due to vertical load (1800 kN) carried by the group of 9 piles in the soil profile. 16
   Pile type: Pile diameter = 700 mm, pile length = 12 m
   pile spacing = 1.3 m c/c

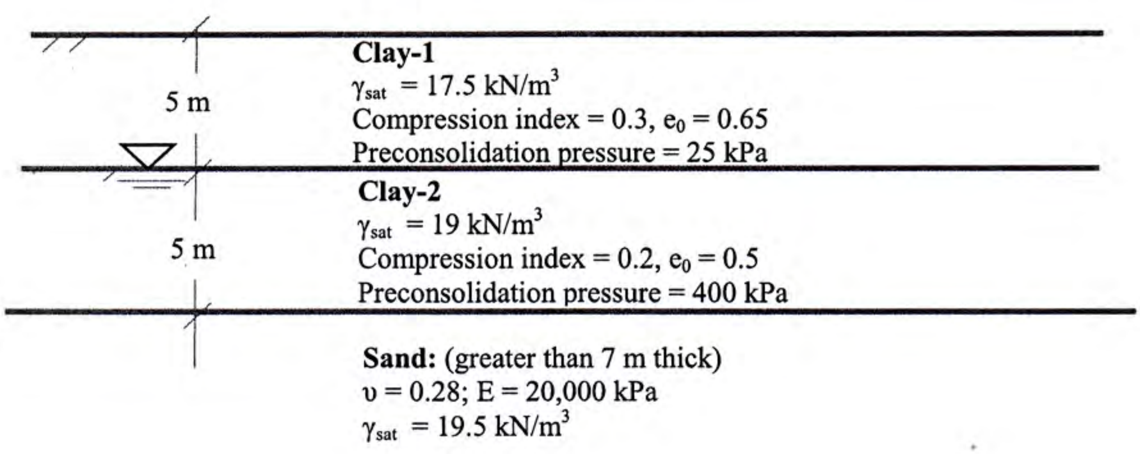


Figure for both the Questions 6 (a) & 6 (b)

(b) Estimate the settlement of a square footing (2m x 2m) at a depth of 1.7 m. The footing carries a vertical load of 160 kN in the soil profile. 16

7. Answer either 7(a) or 7(b):

(a) For the slope shown in Figure 4, determine the factor of safety for the trial slip surface AC using Ordinary Method of Slices. The width of the equal slices is 2 m and the width of the rightmost inequal slice is 1.4 m. The average height and pore water pressure of each slice are given in the Table 4.1. 18

The formula is derived using the ordinary method of slices as follows:

$$F = \frac{\Sigma(c'l + (W_n cos\alpha_n - ul)tan\varphi')}{W_n sin\alpha_n}$$

(b) For the slope shown in Figure 4, determine the factor of safety for the trial slip surface AC using Bishop's simplified method of slices. The width of the equal slices is 2 m and the width of the rightmost inequal slice is 1.4 m. The weight of the slices and α angles are measured as given Table 4.2. 18

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

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

Table for Question No. 7(a)

h (m)	1.6	3.75	5.2	5.6	5.4	5.2	4.7	1
u (kPa)	5	10	14	12	12	10	7	0

Table for Question No. 7(b)

W (kN/m)	48	107	137	140	148	135	98	38
α (°)	0	8	14	22	32	40	57	70

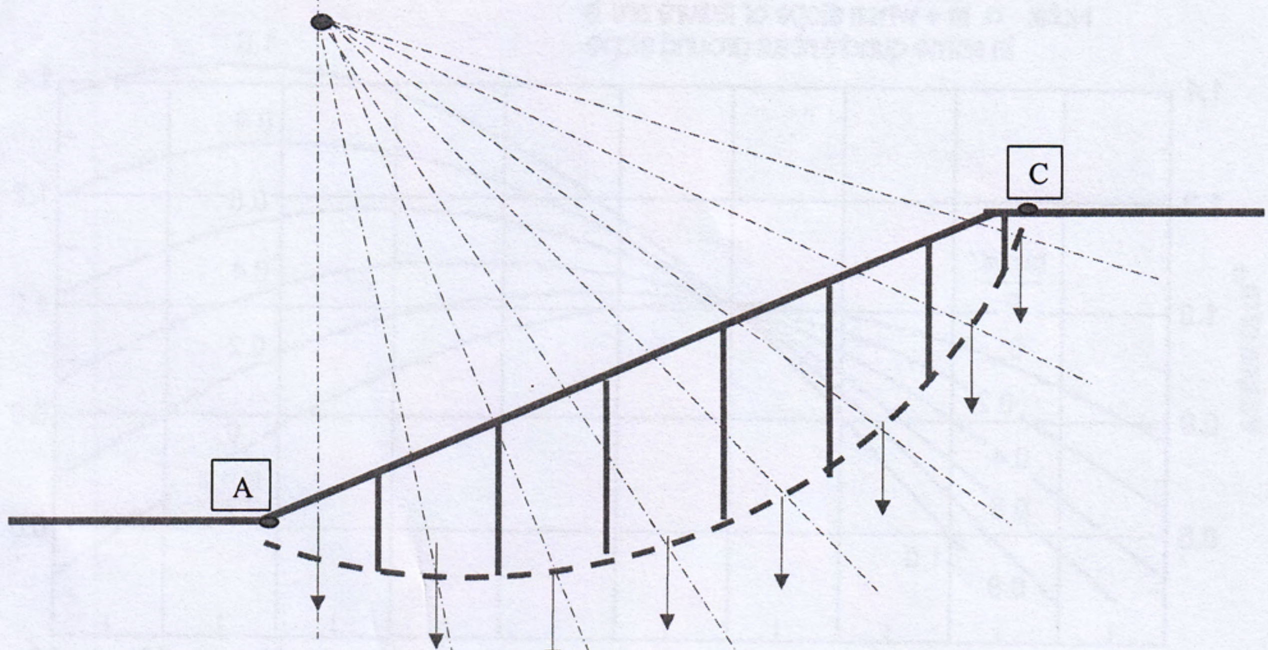
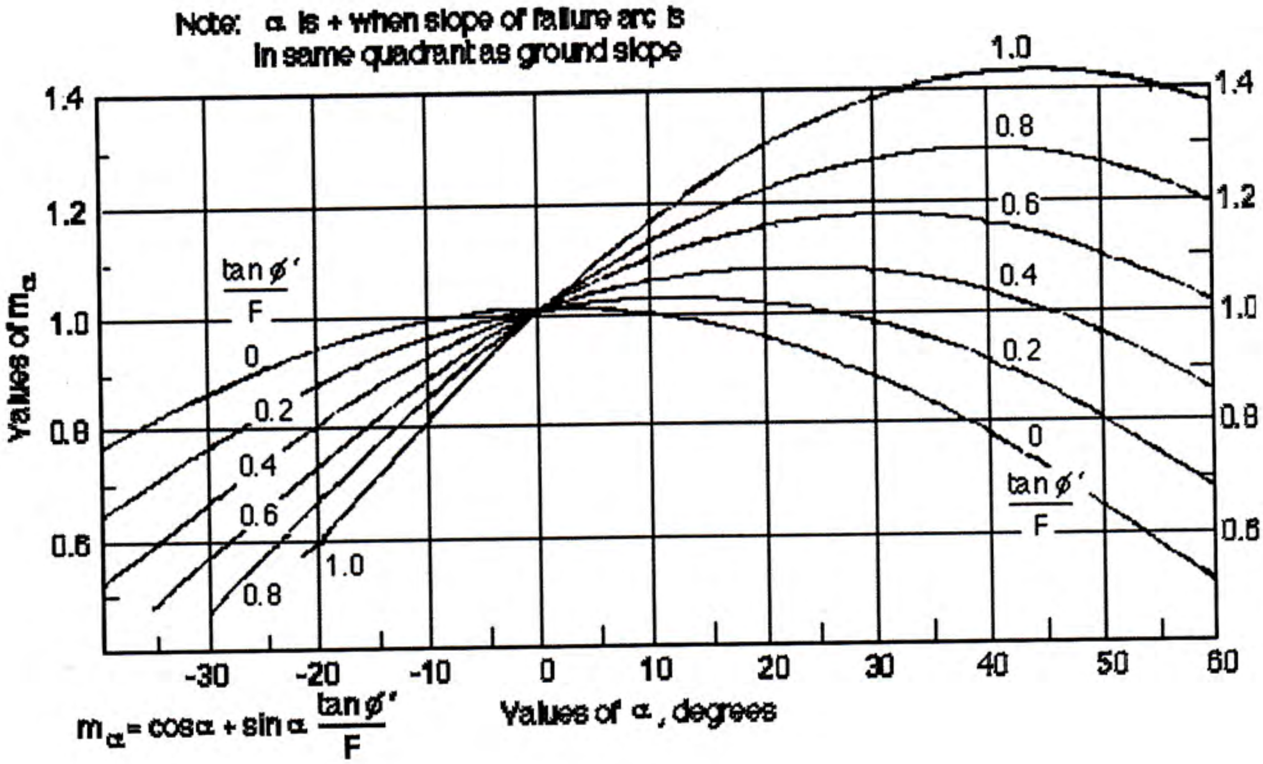


Figure for Question No. 7

Attach this sheet with your answer script.


Note: α is + when slope of failure arc is in same quadrant as ground slope
Values of m_α
Values of α, degrees
tan ø′ / F
0
0.2
0.4
0.6
0.8
1.0
1.4
1.2
1.0
0.8
0.6
-30
-20
-10
0
10
20
30
40
50
60
$m_\alpha = \cos\alpha + \sin\alpha \frac{\tan\phi'}{F}$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2016
Program: B. Sc. Engineering (Civil)

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

PART–1

ANSWER **ALL** OF THE FOLLOWING QUESTIONS.

1. (a) In a standard penetration test, borehole diameter = 120 mm; sampling method (Standard); γ_{sat} = 17.1 kN/m^3; rod length = 5 m. Water table is at 5 m below the ground level.
   i) Determine the hammer efficiency, if the recorded blow counts are 3/5/5 for three consecutive 150 mm penetrations and $(N)_{60} = 10$. (3)
   ii) At a depth of 7 m, the recorded blow counts are 3/6/6 for three consecutive 150 mm penetrations. Calculate $(N_1)_{60}$. Apply the hammer efficiency determined in (a). (3)

   (b) Estimate the net bearing capacity of a raft foundation (30 m × 40 m) on deep bed of clay soil having cohesion of 20 kPa. ($10\frac{2}{3}$)

2. **Answer one of the following questions (2a or 2b):**

   (a) According to the soil exploration report, the upper layer is found homogeneous and extends up to 3 m below the ground level. The ground water table is located at 1.5 m below GL. The data of the soil layers are as follows:

   $\gamma_{sat} = 18.2$ kN/m^3
   Layer 1: $\phi_1 = 20°$
   Layer 2: $\phi_2 = 30°$

   i) Estimate the ultimate bearing capacity of a 2 m wide strip footing, placed at a depth 1.5 m below the ground level. Apply Hanna's design charts for the modified bearing capacity factors. ($6\frac{2}{3}$)
   ii) Recalculate the ultimate bearing capacity of the same footing if the foundation is placed at a depth of 2 m. Use the same design charts. (6)
   iii) Compute the increase in the ultimate bearing capacity (in %) if the depth of foundation is 2.2 m. (4)

   (b) Design a square (isolated) footing that is placed at a depth of 2 m below the ground level. The footing has to support 250 kN load for the following soil data. Provide a factor of safety equal to 2.5. The water table is at the foundation level. ($16\frac{2}{3}$)

   Given data: $\gamma_{sat} = 16.3$ kN/m^3; $c = 18$ kPa; $\phi = 18°$

3. **Answer one of the following questions (3a or 3b):**

   (a) Determine the immediate settlement of the sand layer below a rectangular footing (2 m × 3 m) carrying a load of 160 kN. The soil profile is given in Fig. 1. Depth of foundation = 2 m. ($16\frac{2}{3}$)

   (b) Determine the primary consolidation settlement of the clay layer below a rectangular footing (3 m × 4 m) carrying a load of 160 kN. The depth of foundation is 1.5 m. ($16\frac{2}{3}$)

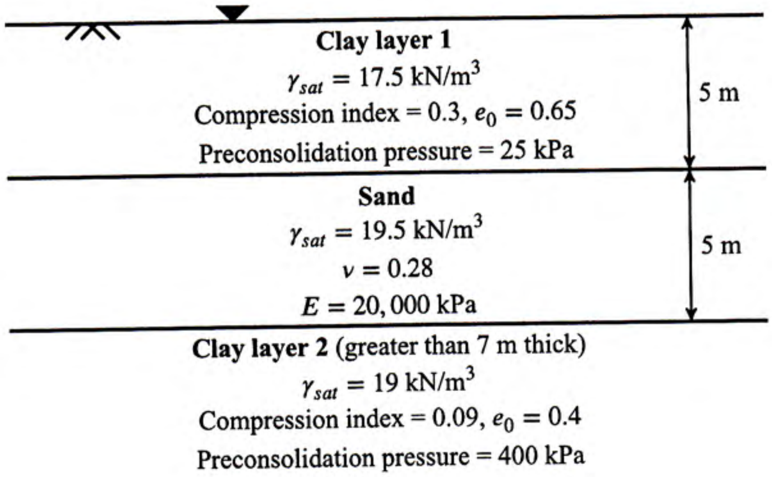


Figure 1: Question 3 (a) and 3 (b)

Additional Information

ϕ	N_c	N_q	N_γ
17°	12.34	4.77	1.66
18°	13.10	5.26	2.00
19°	13.93	5.80	2.40
20°	14.83	6.40	2.87
21°	15.81	7.07	3.42
22°	16.88	7.82	4.07
23°	18.05	8.66	4.82
24°	19.32	9.60	5.72
25°	20.72	10.66	6.77
26°	22.25	11.85	8.00
27°	23.94	13.20	9.46
28°	25.80	14.72	11.19
29°	27.86	16.44	13.24
30°	30.14	18.40	15.67
31°	32.67	20.63	18.56
32°	35.49	23.18	22.02
33°	38.64	26.09	26.17

$$S_c = 1 + 0.2\left(\frac{B}{L}\right)$$

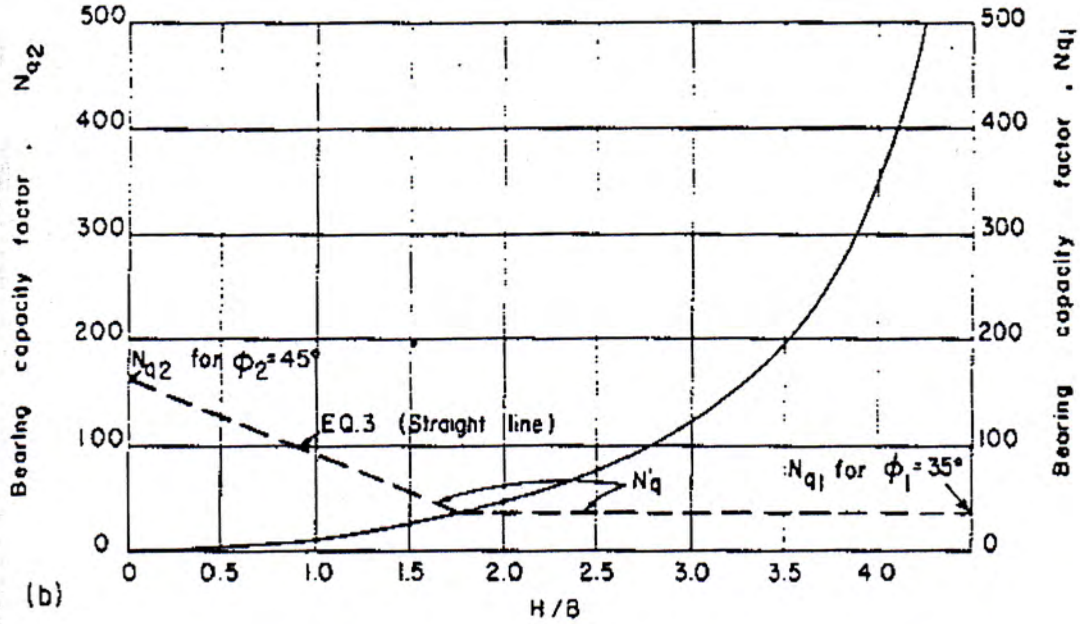
$$S_q = 1 + 0.2\left(\frac{B}{L}\right)$$

$$S_\gamma = 1 + 0.4\left(\frac{B}{L}\right)$$

$$d_c = 1 + 0.2\left(\frac{D_f}{B}\right)$$

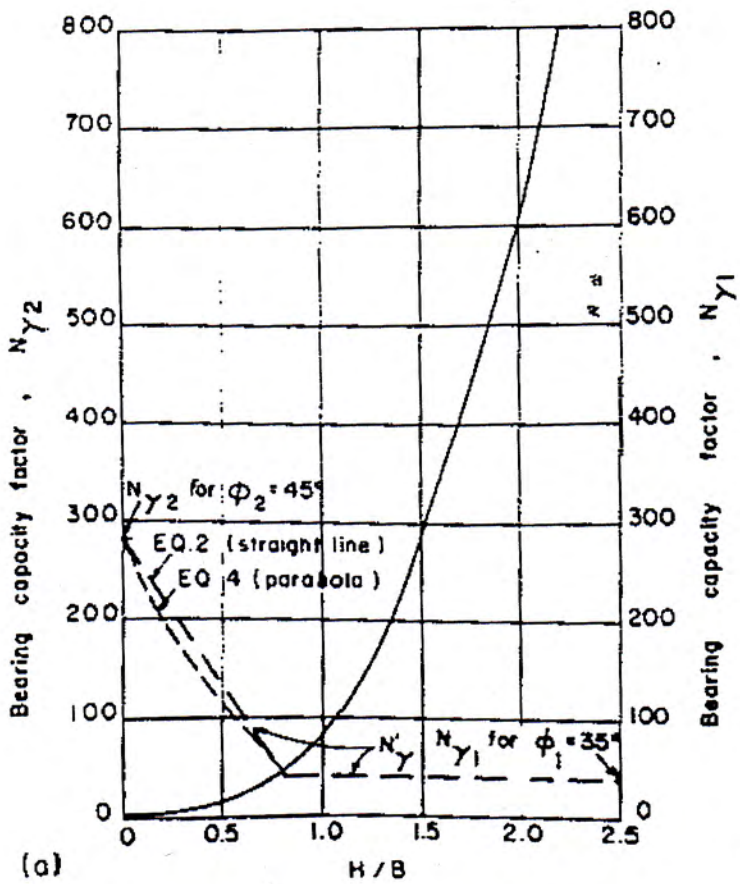
$$d_q = d_\gamma = 1 + 0.1 D_f \tan\left(45 + \frac{\phi}{2}\right)$$

Factor	Equipment Variables	Value
Borehole diameter factor, C_B	65 - 115 mm (2.5 - 4.5 in)	1.00
	150 mm (6 in)	1.05
	200 mm (8 in)	1.15
Sampling method factor, C_S	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 (13 - 20 ft)	0.85
	6 - 10 m (20 - 30 ft)	0.95
	> 10 m (> 30 ft)	1.00



500
400
300
200
100
0
Bearing capacity factor , Nq2
Nq2 for φ2 = 45°
EQ.3 (Straight line)
N'q
Nq1 for φ1 = 35°
Bearing capacity factor , Nq1
0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
H / B

(b)



800
700
600
500
400
300
200
100
0
Bearing capacity factor , Nγ2
Nγ2 for φ2 = 45°
EQ.2 (straight line)
EQ 4 (parabola)
N'γ
Nγ1 for φ1 = 35°
Bearing capacity factor , Nγ1
0 0.5 1.0 1.5 2.0 2.5
H / B

(a)

PART–2

ANSWER **ANY 3 (THREE)** OF THE FOLLOWING QUESTIONS.

1. (a) What do you understand by the load-carrying capacity of a single pile? Write the expression of the ultimate load-carrying capacity of a single pile. $(1 + 2 = 3)$

   (b) A new highway embankment is to be constructed for a proposed 4-lane highway. The height of the embankment is required to be 12 m above the existing ground surface. From the slope stability analysis, it has been found that the critical height of the slope for a slope angle of 45° is 10.3 m. If the embankment (12 m height) is constructed with that slope angle (assuming that other shear strength parameters of soil are constant), will the embankment be safe? If not, how can the embankment be made safe if the height can not be reduced? (3)

   (c) An individual cast in situ concrete pile in sand having a diameter (D) of 450 mm is shown in the following figure (Fig. 2). Determine the ultimate load-carrying capacity (Q_u) of the pile. Assume $\delta = 0.8\phi$, $\psi = 75°$, and $K = 1 - \sin\phi$. $(10\frac{2}{3})$

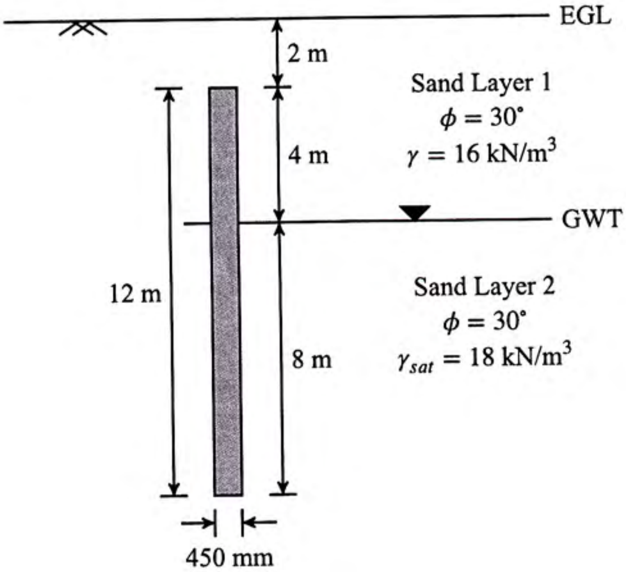


Figure 2: Question 1 (c)

2. (a) Derive an expression for the factor of safety (F_s) of an infinite slope without seepage. (6)

   (b) For the infinite slope shown in the following figure (Fig. 3), determine: $(2 + 2 = 4)$

      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.

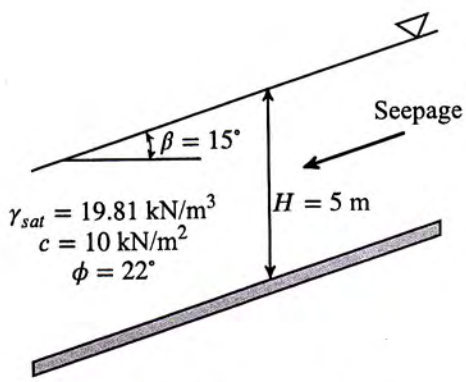


Figure 3: Question 2 (b)

(c) An individual cast in situ concrete pile in soft saturated clay having a diameter (D) of 400 mm is shown in the following figure (Fig. 4). Calculate the ultimate frictional resistance (Q_s) of the pile by the α method. ($6\frac{2}{3}$)

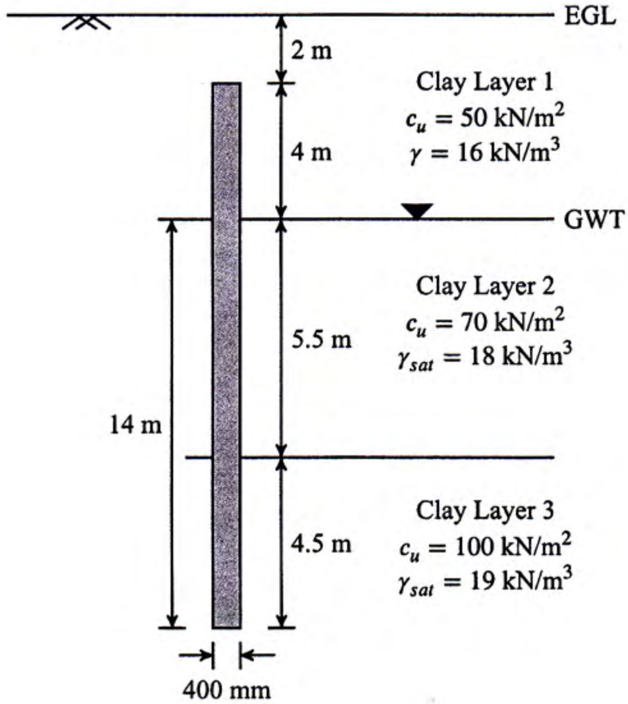


Figure 4: Question 2 (c)

3. (a) What are the causes of settlement of a foundation? Discuss the basic types of foundation settlement. $(1 + 2 = 3)$

(b) Define the factor of safety of a slope with respect to strength. (3)

(c) For the shallow foundation shown in the following figure (Fig. 5), determine the immediate settlement. ($10\frac{2}{3}$)

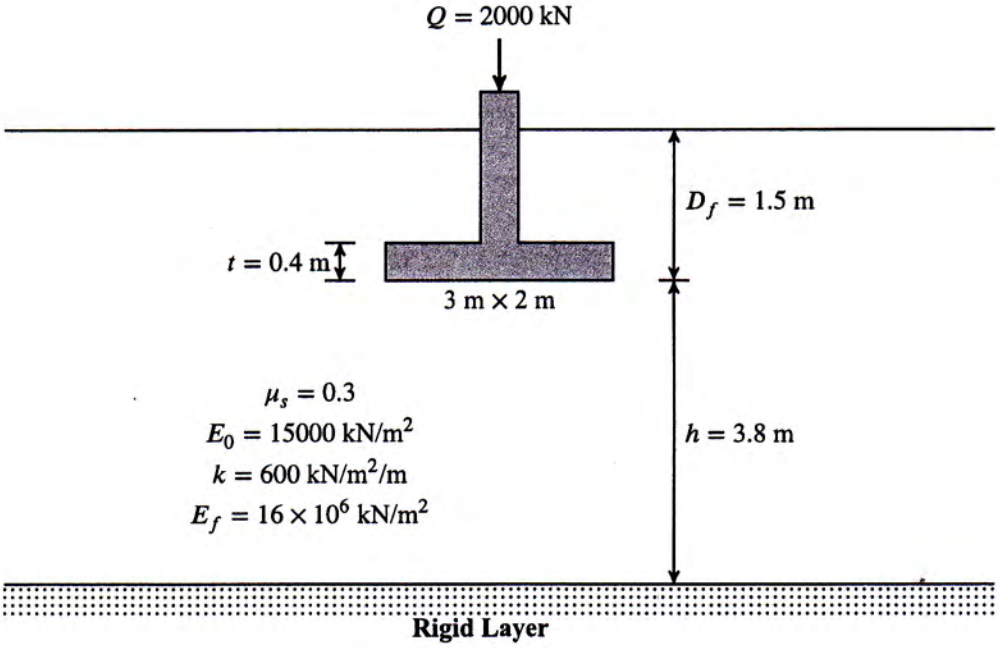


Figure 5: Question 3 (c)

4. (a) What is the importance of minimum spacing of individual piles in a pile group? (2)

(b) Discuss the different modes of failure of finite slopes with circular failure surface. Also discuss the types of failure circles associated with each mode of failure. (4)

(c) For the slope shown in Fig. 6, find the factor of safety (F_s) against sliding for the trial slip surface ABC using the Ordinary method of slices. ($10\frac{2}{3}$)

Given:

$c' = 10\ \text{kN/m}^2$, $\phi' = 30°$, $\gamma = 18\ \text{kN/m}^3$

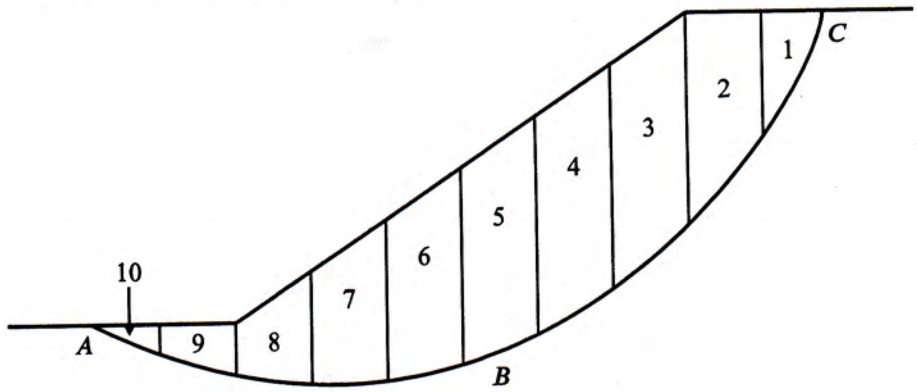


Figure 6: Question 4 (c)

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°

Necessary Equations and Tables

Table 1: Values of bearing capacity factors (after Janbu, 1976)

	$\psi = 60°$		$\psi = 75°$	
ϕ	N_c^*	N_q^*	N_c^*	N_q^*
0°	5.74	1	5.74	1
5°	4.92	1.43	5.69	1.5
10°	5.98	2.05	7.11	2.25
20°	9.26	4.37	11.78	5.29
30°	15.68	10.05	21.82	13.6
35°	21.41	15.99	31.53	23.08

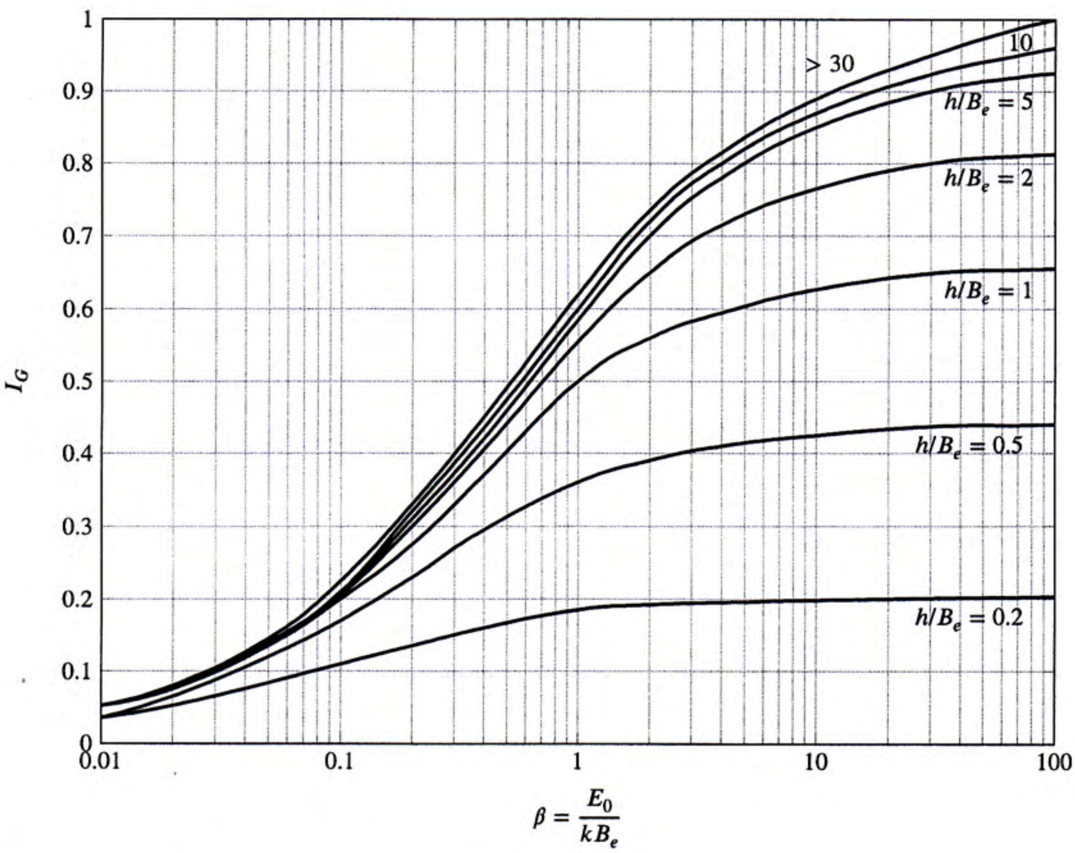
Table 2: Variation of α (interpolated values based on Terzaghi, Peck and Mesri, 1996)

c_u/p_a	α	c_u/p_a	α
≤ 0.1	1.00	1.2	0.42
0.2	0.92	1.4	0.40
0.3	0.82	1.6	0.38
0.4	0.74	1.8	0.36
0.6	0.62	2.0	0.35
0.8	0.54	2.4	0.34
1.0	0.48	2.8	0.34

Improved Relationship By Mayne and Poulos (1999)

$$S_e = \frac{\Delta\sigma B_e I_G I_F I_E}{E_0}\left(1 - \mu_s^2\right) \qquad B_e = \sqrt{\frac{4BL}{\pi}}$$

$$I_F = \frac{\pi}{4} + \frac{1}{4.6 + 10\left(\dfrac{E_f}{E_0 + \dfrac{kB_e}{2}}\right)\left(\dfrac{2t}{B_e}\right)^3} \qquad I_E = 1 - \frac{1}{3.5\exp\left(1.22\mu_s - 0.4\right)\left(\dfrac{B_e}{D_f} + 1.6\right)}$$



Ordinary Method of Slices

$$F_s = \frac{\sum_{n=1}^{n=p}\left(c'\Delta L_n + W_n \cos\alpha_n \tan\phi'\right)}{\sum_{n=1}^{n=p} W_n \sin\alpha_n} \qquad \Delta L_n = \frac{b_n}{\cos\alpha_n}$$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2016 (Set-1)
Program: B.Sc. Engineering (Civil)

Course Title: Structural Engineering III		Course Code: CE 411
Time: 3 hours	Credit Hour : 3.0	Full Marks: 10 x 10

[Answer **any 10 (ten)** of the following 14 questions]

1. Ignore the zero-force members of the truss shown in Fig. 1. Use Stiffness Method to determine the displacements of joint *b*. Given, $\frac{EA}{L} = 1000\ \frac{k}{ft}$.

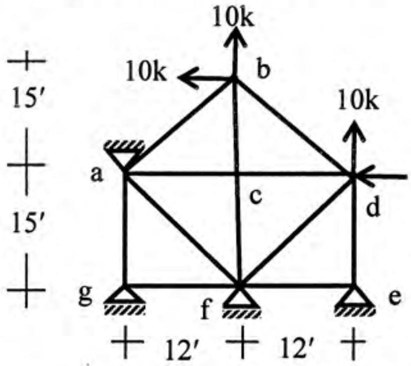


Fig. 1

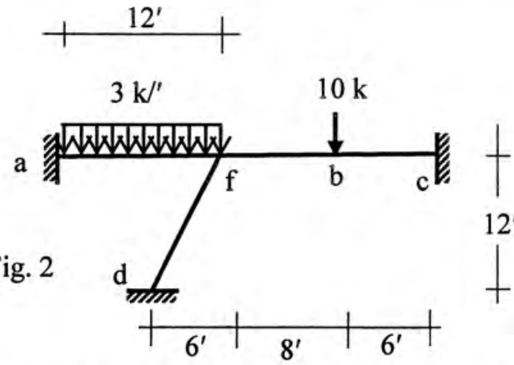
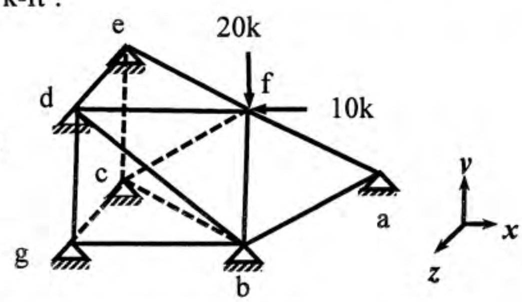


Fig. 2

2. Use Stiffness Method to calculate the rotation of joint *f* of the frame shown in Fig. 2. $EI = 40 \times 10^3$ k-ft^2.

Fig. 3



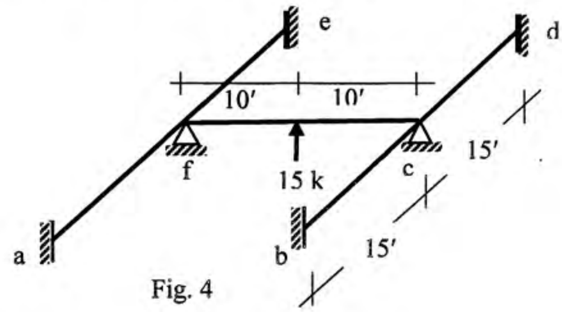


Fig. 4

Nodal Coordinates (ft) are
a(-12,6,0), *b*(12,0,0), *c*(6,0,-12), *d*(0,12,0),
e(6,12,-10), *f*(12,12,0), *g*(0,0,0)

3. Ignore the zero-force members of the space truss shown in Fig. 3. Use Stiffness Method to formulate its stiffness matrix, force vector and load vector. Given, $\frac{EA}{L} = 1200\ \frac{k}{ft}$.

4. Use Stiffness Method to calculate the rotations at *f* and *c* about z-axis of the grid shown in Fig. 4. Given, $EI = 40 \times 10^3$ k-ft^2, $GJ = 30 \times 10^3$ k-ft^2.

5. Determine the degree of kinematic indeterminacy (DOKI) of the 2D frame in Fig. 5(a) and 3D frame shown in Fig. 5(b), for the following cases

(a) Not considering boundary conditions
(b) Considering boundary conditions
(c) Neglecting axial deformations.

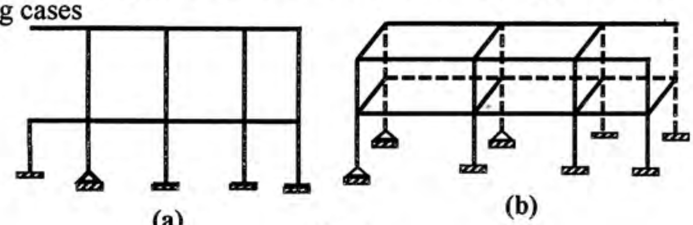


Fig. 5

6. Use Stiffness Method to calculate the rotations at joint b and c of the frame abc loaded as shown in Fig.6, considering flexural deformations only with geometric nonlinearity [Given: $EI = 400 \times 10^3$ k/ft^2].

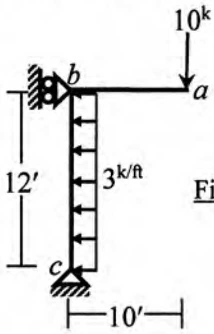


Fig.6

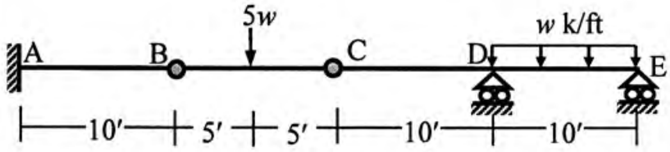


Fig.7

7. Consider flexural deformations only (with lumped mass matrix) to calculate the natural frequencies of the frame abc loaded as shown in Fig.6 [Given: mass per length $\mu = 1.5 \times 10^{-6}$ k-sec^2/in^2].

8. Use bending moment diagram to calculate the distributed load w (k/ft) needed to develop plastic hinge mechanism in the beam $ABCDE$ loaded as shown in Fig.7 [Given: $M_p = 200$ k-ft].

9. For the plane truss $abcdef$ as shown in Fig.8, modulus of elasticity $E = 30000$ ksi, cross-sectional area $A = 2$ in^2, mass per length $\mu = 1.5 \times 10^{-6}$ k-sec^2/in^2. Calculate its natural frequencies (neglecting zero-force members) using consistent mass matrices.

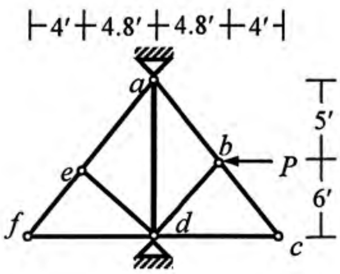


Fig.8

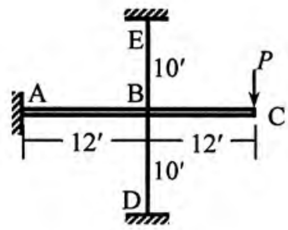


Fig.9

10. Frame structure $ABCD$ shown in Fig.9 is subjected to a dynamic load, $P = 10\ e^{5t}$ (kips). Use *Constant Average Acceleration* (*CAA*) Method to calculate the rotation of joint B at time $t = 0.10$ sec [Given: $EI_{ABC} = 2EI_{BD} = 50\times 10^3$ k-ft^2, $\mu = 0.0045$ k-sec^2/ft^2, Damping ratio of the system = 4%].

11. In the frame $abcd$ loaded as shown in Fig.10, use Energy Method to
   (a) Calculate the Plastic moment (M_p) required to prevent formation of beam mechanism of ab and sidesway mechanism of the frame.
   (b) Also calculate the required yield strength (f_y) of the elasto-plastic material.

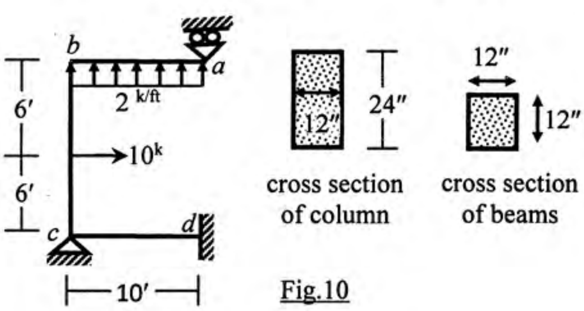


Fig.10

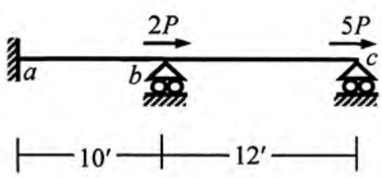


Fig.11

12. Consider flexural deformations and geometric nonlinearity to calculate the value of P required to cause buckling of the beam *abc* loaded as shown in Fig.11 [Given: $EI = 40 \times 10^3$ k-ft^2].

13. Use Stiffness Method using flexural deformations only to calculate the vertical deflection/rotation at node *b* of the beam *abc* loaded as shown in Fig.12 [Given: $2EI_{ab} = EI_{bc} = 20 \times 10^3$ k-ft^2], if the node *b* is

(i) Hinged, as shown in Fig.12(a)

(ii) Supported by circular foundation of radius 4 ft on the surface of sub-soil (half-space) with shear modulus $G_s = 450$ k/ft^2 and Poisson's ratio $\nu = 0.40$, as represented in Fig.12(b).

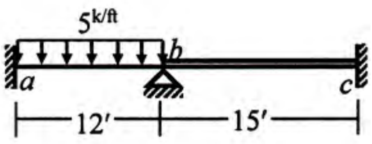


Fig.12(a)

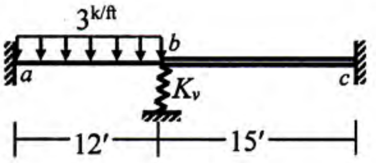


Fig.12(b)

14. Briefly explain

(a) Possible ways to improve the buckling load calculated by Stiffness Method
(b) Difference between the yield moment (M_y) and plastic moment (M_p) of a cross-section
(c) Difference between the 'Beam Mechanism' and 'Side-sway Mechanism' for frames
(d) Basic assumption of Constant Average Acceleration method of numerical time-step integration
(e) Effect of foundation flexibility on the structural response to seismic ground motion.

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2016 (Set-2)
Program: B.Sc. Engineering (Civil)

Course Title: Structural Engineering III		Course Code: CE 411
Time: 3 hours	Credit Hour : 3.0	Full Marks: 10 x 10

[Answer **any 10 (ten)** of the following 14 questions]

1. Fig.1 shows a plane truss *abcdef* whose joint *b* moves leftward 1 inch and 0.5 inch downward due to the applied force *P*. Calculate (i) Axial force in all members, (ii) Applied force *P* [Given: S_x = constant = 10^3 k/ft].

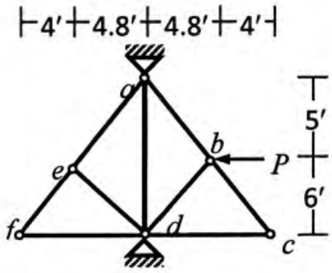


Fig.1

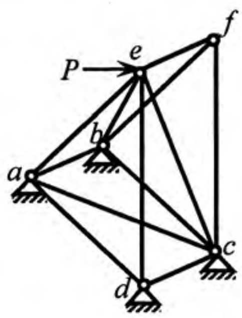


Fig.2

Nodal Coordinates (m) are
a(0,0,0), *b*(0,0,-6), *c*(12,-8,-6), *d*(12,-8,0), *e*(12,8,0), *f*(12,8,-6)

2. Ignore zero-force members and apply boundary conditions to form the stiffness matrix of the space truss *abcdef* as shown in Fig.2 [Given: S_x = constant = 10^5 N/mm].

3. For the frame shown in Fig.3, calculate the unknown rotations at joint *b* and *c* neglecting axial deformation [Given: $EI = 20 \times 10^3$ k-ft^2].

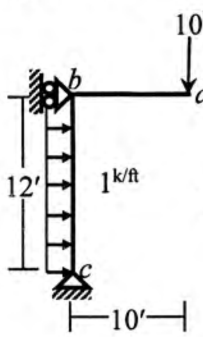


Fig.3

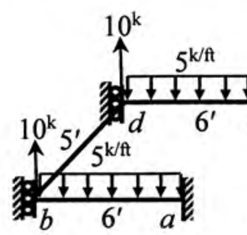


Fig.4

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-ft^2, $GJ = 30 \times 10^3$ k-ft^2].

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.

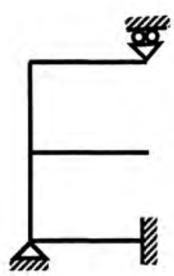


Fig.5(a)

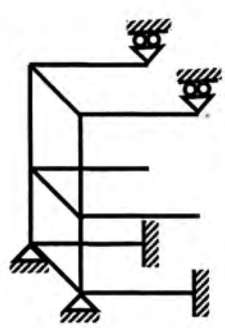


Fig.5(b)

6. Use Stiffness Method to calculate the unknown joint deflections and rotations of the beam shown in Fig.6, considering flexural deformations only with geometric nonlinearity. Given, P = 200 k, E = 3600 ksi, A and C are Guided Rollers.

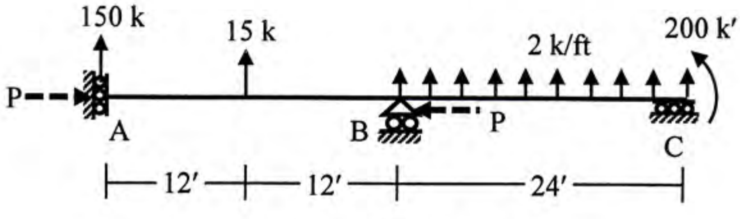
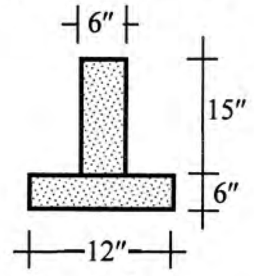


Fig. 6



Beam X-Section

7. Briefly explain

a) Analysis for Geometric and Material Nonlinearity.
b) The matrices **K** and **G** used for the nonlinear analysis of frames are only approximate.
c) Summarize what you have learnt from this course?
d) What is Collapse Mechanics? Plastic Hinge and Ultimate Load.

8. Determine the distributed load w of the beam shown in Fig. 7.

(a) Using BMD to determine w that needed to develop the plastic hinge mechanism.

(b) Using the Energy Method of Collapse Mechanism.

Given, σ_{yp} = 50 ksi.

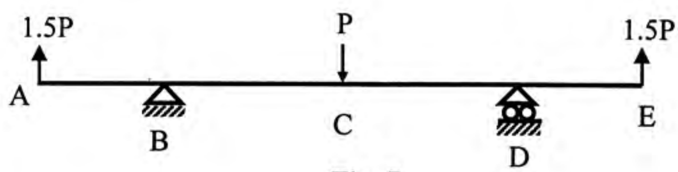
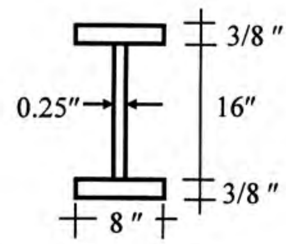


Fig. 7



Beam X-section

9. Consider flexural deformations and geometric nonlinearity to calculate the load P required to cause buckling of the beam shown in Fig. 6. Given, $E = 40 \times 10^3 \frac{\text{k}}{\text{ft}^2}$.

10. Calculate the natural frequencies of a cantilever beam in transverse direction by considering one consistent-mass element. Given, E = 3600 ksi, beam size = 12″ × 20″, $\mu = 2.0 \times 10^{-7} \frac{\text{k-s}^2}{\text{in}^2}$ and polynomial shape functions are $\psi_1(x) = \frac{1}{4} \times (1-x)^2 \times (2+x)$; $\psi_2(x) = \frac{1}{8} \times (1-x)^2 \times (1-x)$; $\psi_3(x) = \frac{1}{4} \times (1+x)^2 \times (2-x)$; $\psi_4(x) = -\frac{1}{8} \times (1+x)^2 \times (1-x)$. Use the shape functions to determine the stiffness matrix and the mass matrix is given in the formula sheet.

11. Use Constant Average Acceleration Method to calculate acceleration, velocity and displacement of a single degree of freedom system at time t = 0.125 sec. Given, mass $10 \frac{\text{k-s}^2}{\text{ft}}$, stiffness = $900 \frac{\text{k}}{\text{ft}}$, dynamic load $P(t) = 10 + 2e^t$, damping ratio of the system 5%, t = 0, $x(0) = 0.02\text{ft}$, $\dot{x}(0) = 0.2 \frac{\text{ft}}{\text{sec}}$.

12. Use consistent mass matrices to determine natural frequencies of the 2D truss shown in Fig. 8. Given, E = 29000 ksi, cross-sectional area A= 2 in^2, μ = 0.0018 $\frac{\text{k-s}^2}{\text{ft}^2}$.

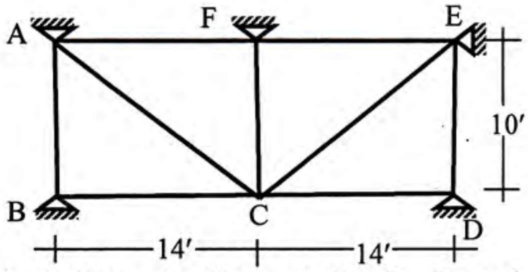


Fig. 8

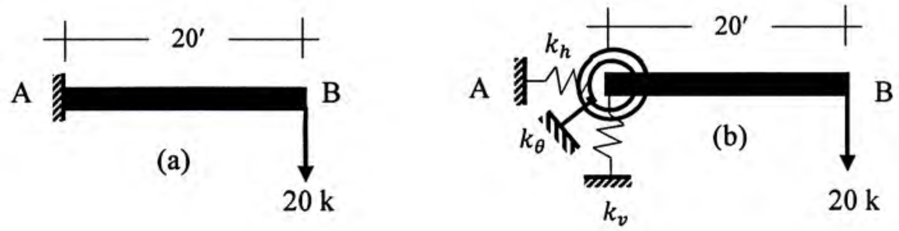
13. A cantilever beam AB is subjected to loads as shown in Fig. 9. Determine the vertical deflection and rotation at B, considering the

(a) Support A is fixed shown in Fig. 9(a).

(b) Support A has been replaced by horizontal, vertical and rotational springs. Ignore the horizontal deformation shown in Fig. 9(b).

Given, $\Delta_{\theta(A)}$= 0.011 rad, R = 4 ft on sub-soil (half-space), $v_s = 1000\frac{\text{ft}}{\text{sec}}$, $\gamma_{soil} = 120\frac{\text{lb}}{\text{ft}^3}$, $\vartheta = 0.3$, EI = 1000 k-ft^2.

Fig. 9



14. Use the Energy Method to calculate the load of the frames shown in Fig. 10 (a) and (b).

(a) The point load Q needs to form beam mechanism

(b) The point load P needs to form the side sway mechanism

Given, σ_{yp} = 50 ksi, beam and columns have the same cross-section as shown below.

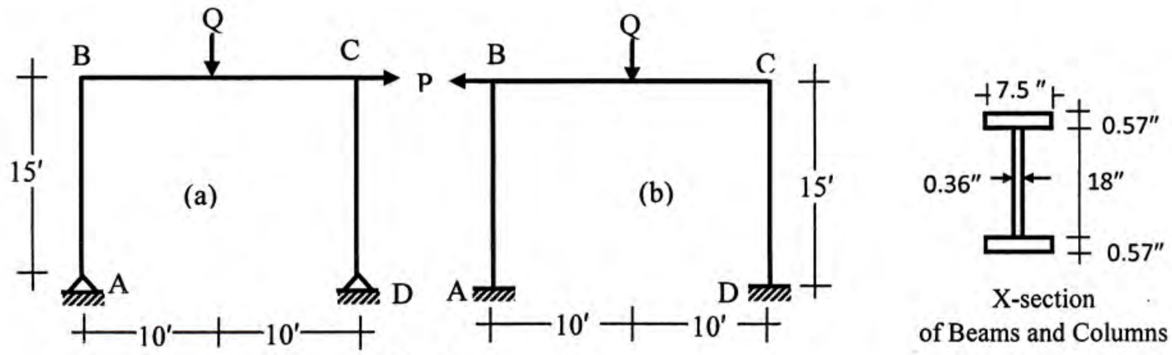


Fig. 10