3-1

University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2023
Program: B.Sc. in Civil Engineering

Course Title: Principles of Accounting | Course Code: ACN 301
Time: 2 hours | Credit Hour: 2 | Full Marks: 50

Submit your question inside your answer script

(5*3=15)

1. Answer **any three** of the following questions:

i. Why do we need to do ratio analysis? Explain with examples.
ii. "All steps of accounting cycle are linked with each other"- do you agree with the statement? Justify your answer.
iii. Define variable, fixed and mixed cost with relevant examples.
iv. What is adjusting entries? Briefly differentiate product cost and period cost.

(8+4+8=20)

2. a. Knight Cements produces cements whose selling price is Tk 100 per packet and whose variable expense is Tk 60 each. The company's monthly fixed expense is Tk 10,000.

i. Calculate the company's break-even point in unit sales.
ii. Calculate contribution margin ratio.
iii. Calculate the company's break-even point in Tk sales.
iv. If the company's fixed expenses increase by Tk 1500, what would become the new break-even point in unit sales? In Taka sales?

b. Mini Corporation has a single product whose selling price is Tk 60 per unit and whose variable expense is Tk 40 per unit. The company's monthly fixed expense is Tk 25,000.

i. Calculate the unit sales needed to attain a target profit of Tk 30,000.
ii. Calculate the Taka sales needed to attain a target profit of Tk 25,000.

c. Data for Han Corporation are shown below:

	Per unit
Sales	Tk 100
Variable expense	60
Contribution margin	Tk 40

Fixed expenses are Tk 30,000 per month and the company is selling 2,000 units per month.

i. How much will net operating income increase (decrease) per month if the monthly rent expense increases by Tk 5,000 and the monthly sales volume increases by 100 units?
ii. Refer to the original data. How much will net operating income increase (decrease) per month if the company uses higher-quality components that increase the variable expense by Tk 2 per unit, increase unit sales by 10% and decrease fixed expense by Tk 2000.

(15)

3. Answer **any one** of the followings:

a. The comparative statements of Moon Company are presented below:

Moon Company
Balance sheet
On December 31, 2020

	2020(Taka)	2019(Taka)	2018 (Taka)
Assets:			
Current assets			
Cash	21,000	18,000	20,000
Short- term investments	18,000	15,000	14,000
Accounts receivables (net)	86,000	74,000	70,000
Inventory	90,000	70,000	100,000
Total Current Assets	215,000	177,000	204,000
Fixed Assets	423,000	383,000	346,000
Total Assets	**Tk 638,000**	**Tk. 560,000**	**Tk 550,000**
Liabilities and Stockholder's Equity:			
Current liabilities			
Accounts payable	122,000	110,000	100,000
Income tax payable	23,000	22,000	20,000
Total Current Liabilities	145,000	130,000	120,000
Long term liabilities			
Bond payable	120,000	80,000	100,000
Total Liabilities	265,000	210,000	220,000
Stockholders' equity			
Common stock (Tk 5 par)	150,000	150,000	150,000
Retained earnings	223,000	200,000	180000
Total stockholders' equity	373,000	350,000	330,000
Total Liabilities & Stockholders' Equity	**Tk 638,000**	**Tk 560,000**	**Tk 550,000**

Other Information:

	2020 (Taka)	2019 (Taka)	2018 (Taka)
Net Sales	600,000	520,000	550,000
Cost of Goods Sold	415,000	354,000	300,000
Net Income	38,400	31,400	35,000

Required:

Compute the following ratios of 2020 and 2019 and compare the results of two years:

i. Current ratio
ii. Receivable turnover
iii. Profit margin
iv. Return on asset
v. Debt to asset ratio

Or,

b. XYZ has the following information in trial balance:

	Debit (tk)	Credit (tk)
Prepaid insurance	3,600	
Supplies	2,800	
Equipment	25,000	
Accumulated depreciation- equipment		8,400
Notes payable		20,000
Unearned rent revenue		10,200
Rent revenue		60,000

	Interest expense	1000
	Salaries and wages expense	14,000

i. The equipment depreciates Taka 400 per month.
ii. One-third of the unearned rent revenue was earned during the quarter.
iii. Interest of Taka 500 is accrued on the notes payable.
iv. Supplies on hand total Taka 900.
v. Insurance expires at the rate of Taka 200 per month.
vi. Accrued expense Taka 1,000.
vii. Accrued revenue Taka 1260.

Required:

Prepare the adjusting entries and ledgers (start with the beginning balance of trial balance).

University of Asia Pacific
Department of Civil Engineering
Final Examination, Fall 2023
Program: B.Sc. in Civil Engineering

Course Title: **Open Channel Flow** Course Code: **CE 361**

Time: **3 hours** Credit Hour: **3.00** Full Marks: **100**

[Answer all the questions. Assume any reasonable data if necessary.

Use separate answer scripts for Part-A and Part-B]

Part-A

1. (a) Explain unsteady rapidly varied flow with an appropriate example. (5)

   (b) Summarize the characteristics of specific energy curve with appropriate figures. (8)

   (c) State the assumptions in designing a stable alluvial channel using Lacey's method. (5)

2. A triangular channel has side slopes of 1.5 : 1. Determine the followings: (7+3)

   (a) The state of flow if the depth of flow is 3 m and the mean velocity of flow is 1.8 m/s.
   (b) If elementary waves are created in this channel, determine the speed of the wave fronts upstream and downstream.

3. A broad-crested weir is built in a rectangular channel of width 4.4 m. The height of the weir crest above the channel bed is 2.5 m and the head above the weir is 1 m. (10)

   Determine the discharge.

4. Determine the depth of flow 150 m upstream of the dam of a rectangular channel with b=5 m which is laid on a slope of 0.002 using the fourth-order Runge-Kutta methods. (12)

   The depth produced by the dam immediately upstream of it is 3 m. Also, the channel carries a 20 m^3/s discharge. Take $\alpha=1$ and $n=0.025$.

Part-B

5. A horizontal triangular channel with b = 5m and s = 1.5 carries a discharge of 80 m^3/s. If the upstream depth of flow is 2m and a hydraulic jump is formed then determine, (7+4+4)

   i) Downstream depth which will create a hydraulic jump (Give 1 trial only).
   ii) Categorize the jump according to USBR jump types.
   iii) Determine the length of the jump (using the Silvester equation).

6. (a) An earthen canal is to be laid on a slope of 1 in 2500. The side slope of the channel is to be maintained at 1:1 and the lining is expected to give, n = 0.025. Design the channel section from the practical point of view if Q = 120 m^3/s, velocity is kept 2 m/s. Draw a schematic diagram of the channel. (8)

   (b) From an engineering point of view, it is necessary to reduce the seepage and percolation loss of the earthen canal. What necessary steps you will take to make the channel more cost efficient and allow more discharge? (7)

7. Prove that, best hydraulic trapezoidal section is one half of a regular hexagon (10)

8. A channel (S_0 = 0.0002) consists of a main section and two side sections as shown in figure 1. Compute the total discharge and mean velocity of flow. Manning's coefficient for side channels are 0.045 and main channel is 0.025. (10)

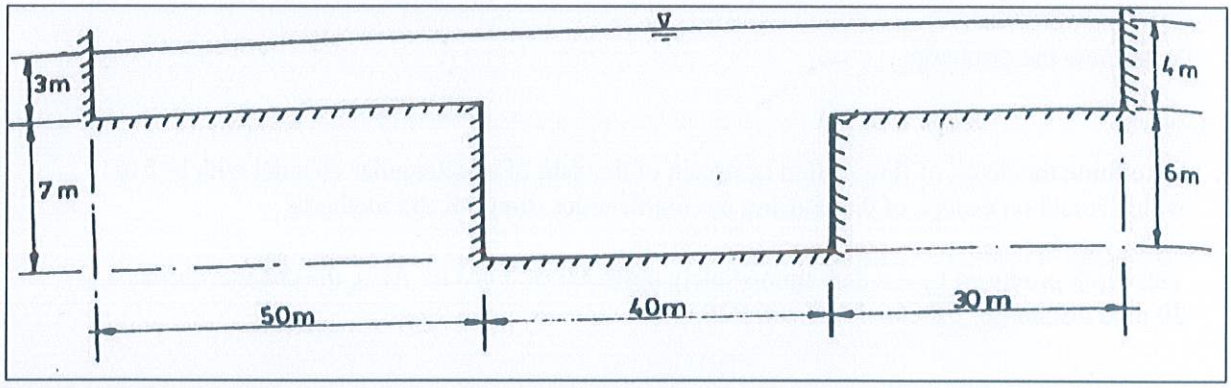


Figure: 1

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2023
Program: B. Sc. Engineering (Civil)

Course Title: Environmental Engineering I — Course Code: CE 331
Time: 3.00 Hours — Credit Hour: 3.00 — Full Mark: 120

Answer all the questions in both of the sections. (36+24+36+24= 120)
(Necessary formulae and table are attached; Assume reasonable data if necessary)

Section A

1.(a) In a rapidly growing urban area of Bangladesh, the water supply infrastructure is facing a complex challenge due to corrosion, water hammer action, and widespread failures in the conveyance system. Years of exposure to corrosive elements in the groundwater have led to extensive deterioration in the aging water supply pipes. Furthermore, the deteriorating condition of the conveyance system exacerbates water quality issues, exacerbating public health concerns and environmental risks. To address the problem, local govt. took an initiative to test a sample of water from the pipe. The results are as following:
pH=4.5
Total Alkalinity=120mg/L
The concentration of sulphate =10000 mg/L, and the water is nutrient-rich.

i) Considering this scenario, identify the type of corrosion that develops in the supply pipe carrying this water and explain how the characteristics of this sample water influence this particular type of corrosion. (7)

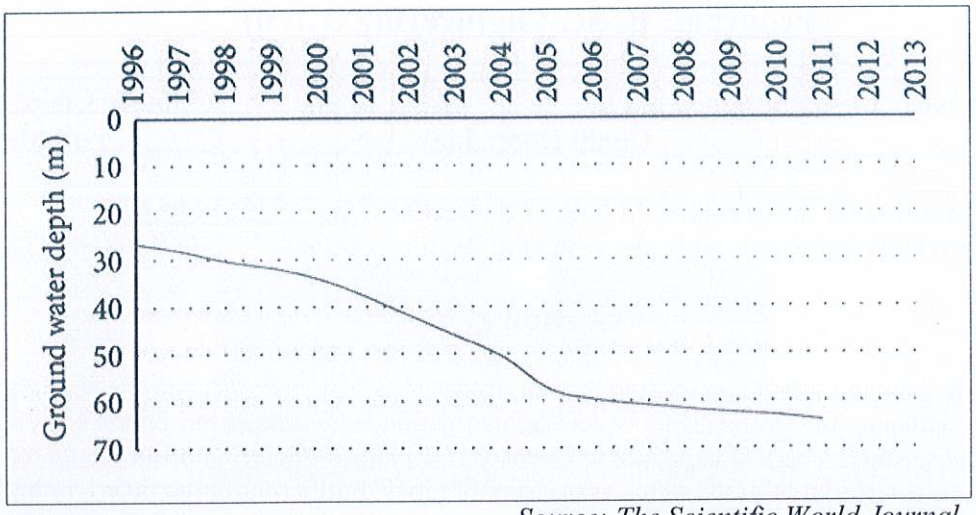
ii) Given the deteriorating condition and failure of this urban water supply network due to corrosion and conveyance system failures, propose an integrated engineering approach to address these challenges. (8)

iii)Explain how you will prevent the water hammer action on this pipe as a civil engineer. (5)

(b) With a well of 12 inch in diameter having a depth of 100 ft below the level of the water table, the depth of water when the well is being pumped is 80 ft. As indicated by the test on the sample, the effective size of the soil in the water-bearing a stratum is 0.30 mm and the porosity is 30%. The corresponding coefficient of permeability is 1260 gpd/sft. The radius of drawdown is assumed to be 1000 ft. Determine the probable rate of discharge of the well in gpm. (6)

(c) Calculate the probable maximum load on a concrete pipe that is laid in a trench of 3.5 ft wide if the depth of the fill above the top of the pipe is 9 ft and the filling material is saturated clay (γ = 130 lb./cu ft). (4)

(d) Below is the ground water depletion data of Dhaka city from the year 1996 to 2013. (6)

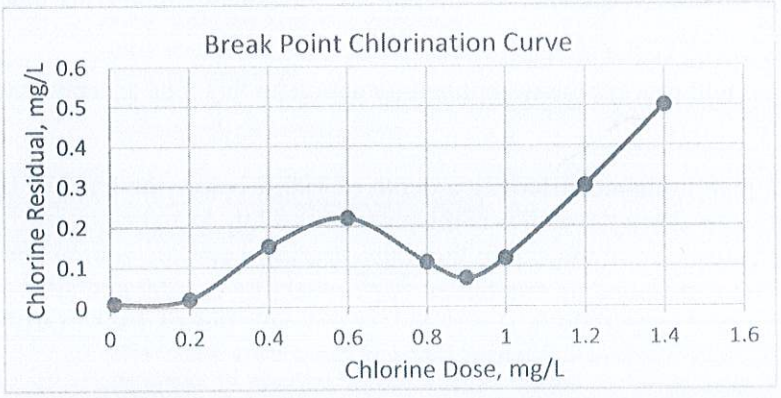


Source: The Scientific World Journal

Discuss the reasons behind this continual decline in groundwater levels in Dhaka city.

2.(a) Illustrate a **cost-effective** treatment scheme (in flowchart) for a source of water with turbidity = 50 NTU and Fecal Coliform count = 100,000. Mention which filtration technology you can employ with justification. Choose and design a settling basin for a plant with a flow rate of 45 m^3/hr using an overflow rate of 0.5m^3/m^2-hr. The detention time is 3 hours. (8 +6)

(b) The disinfection chlorine demand curve for the river water used in the plant is presented below.



i) Which amount of dosing will provide you with no free residual, but with only combined residual? (2)

ii) What is the chlorine dose for maintaining a Free Residual of 0.3 mg/L? (2)

iii) What type of residuals is formed during the chlorine doses ranging from 0.2 to 0.6 mg/L? What compound reacts with chlorine in this region? (3)

iv)Why does the chlorine residual decrease during the chlorine doses ranging from 0.6 to 0.9 mg/L? What would be your recommended dose for the source of problem 2(a). (3)

Section B

3.(a) Design the components of a well utilizing the data provided below following appropriate steps: (4+3+3+2)

i) Find out the water-bearing/most productive part of the aquifer (depth range) from the given grain size distribution summary at different depths showing suitable reasoning.

Sample Depth (ft)	D_{10}	D_{30}	D_{60}	$U = D_{60} / D_{10}$	FM	% Coarse Sand	% Medium Sand	% Fine Sand
210-220	0.12	0.195	0.3	2.50	1.26	3	68	30
220-270	0.15	0.21	0.33	2.20	1.41	4	71	26
270-310	0.17	0.28	0.3	1.76	1.63	6	78	17
310-370	0.17	0.28	0.31	1.82	1.69	11	73	17
370-410	0.17	0.24	0.38	2.24	1.5	5	75	20
410-450	0.17	0.29	0.395	2.32	1.63	5	82	15
450-480	0.15	0.22	0.37	2.47	1.47	5	70	24

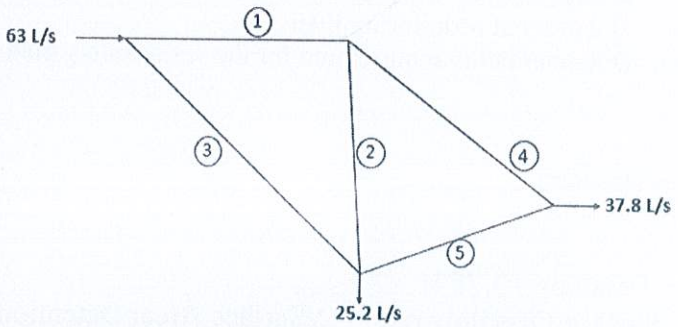
ii) Find out the length of the casing pipe with static water level at 280 ft, drawdown of 15 ft with a water level declination of 2.5 ft per year, design life of 25 years, and a safe distance of 10 ft. Assume 80% of the aquifer screening can be made and find out the length of the strainer.

iii) Find out the yield from the well if 40 slot strainer is used with a diameter of 4.5 inches. (Assume the minimum permissible velocity of 0.1 fps and factor of safety of 2.0). What is the yield per day from the well if it pumps water for 10 hours per day?

iv) Considering the well has to serve a community with 90,000 people with water demand of 40 liter per capita per day, how many wells will be required to be installed?

(b) Calculate the corrected flow in various pipes of the distribution network as shown in following. Use Hardy Cross method. One trial is required. (9)

Pipe	Length (m)	Dia(mm)
1	305	150
2	305	150
3	610	200
4	457	150
5	153	200



(c) Select an alternative water supply technology for a coastal area where salt water intrusion is a major concern for that community in the area and justify your answer. (4)

(d) Differentiate between submersible pump and deep well turbine. (5)

(e) Design a suitable set of pumping unit to deliver 4,50,000 gph from an intake well of a river bank to the treatment plant. Total length of rising main from the intake well to the treatment plant is 800 ft. The suction head is 25 ft and the discharge head is 35 ft. Design also the cast iron main. (6)

velocity of water =12 fps
friction factor=0.0075
efficiency =70%
[Assume: pipe entrance is well rounded i.e., r/D>0.2, Kentrance = 0.03, K_{bend} = 0.35, K_{exit} = 1]

4.(a) Considering the features of i) design life, ii) ease of operation, iii) health safety protection, iv) efficiency in service, and v) sustainable management with cost and maintenance, please evaluate and rank the following water supply technologies from most preferable to least preferable based on your judgement with very brief justification. [Hint: Consider total score 5 (1 for each of the 5 qualities) and grade each option to find out which gets the most or least] (12)

A. Tara handpump Tubewell
B. Infiltration Gallery
C. Rain water Harvesting
D. Pond Sand Filter
E. Piped Water Supply

(b) Consider the System you studied as a source or to evaluate water quality in the project of CE 332 course (also consider flooding is common and outbreaks are regular). Prepare the following for the water supply system from the source in consideration with pertinent knowledge on the water quality, according to the Water Safety Plan: (4+3+3+2)

A. System Description
B. Risk Identification and Analysis following the quantitative approach (attached table) (Hint: consider possible risks from disasters, source quality etc.)
C. Operational Monitoring Plan
D. Documentation requirement for the water safety plan

Given Formulae:

I. 1 Gallon = 3.78 L

II. Surface Overflow rate = Q/Surface Area; Detention time = Q/V

$G = \sqrt{(P/\mu V)}$; $Q = \pi D L(0.01p) v_c$

III. $w = c\gamma B^2$

$w = c\gamma BD$

IV. $P_W = \frac{h_p Q}{3960}$

$$P_W = \frac{\gamma h_p Q}{75}$$

V. $$Q = \frac{\pi K\left(D^2 - d^2\right)}{\log_e(R/r)} \qquad Q = \frac{2\pi K m(D-d)}{\log_e(R/r)}$$

VI. $$h_L = H/L = 1.39\times10^6 Q^{1.85} D^{-4.87}$$

VII. $$\Delta = -\frac{\sum kQ_a^{\,x}}{x\sum k\Delta Q_a^{\,x-1}} \qquad \Delta = -\frac{\sum H}{x\sum H/Q_a}$$ *(x = 1.85 according to Hazen Williams formula)*

Table of the Values for coefficient of c

Fill Material	Sand and gravel	Saturated top soil	Clay	Saturated Clay
Specific weight lb/cu ft.	100	100	120	130
Cover depth / Trench width = H/B	Values of c			
1.0	0.84	0.86	0.88	0.90
2.0	1.45	1.50	1.55	1.62
3.0	1.90	2.00	2.10	2.20
4.0	2.22	2.33	2.49	2.65
5.0	2.45	2.60	2.78	3.04
6.0	2.60	2.70	3.04	3.33
7.0	2.75	2.95	3.23	3.57
8.0	2.80	3.03	3.37	3.76
9.0	2.88	3.11	3.48	3.92
10.0	2.92	3.17	3.56	4.04
12.0	2.97	3.24	3.68	4.22
14.0	3.00	3.28	3.75	4.34

Risk = Likelihood × Impact

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2023
Program: B.Sc. Engineering (Civil)

Course Title: Structural Engineering I — Course Code: CE 311
Time: 3 hours — Credit Hour: 3.0 — Full Marks: 100

ANSWER ALL QUESTIONS. Assume any missing data reasonably.

PART-A

1. Draw Influence Line for the frame shown in ***Fig A1***: **[12]**
   a) Bending moment at section 1-1 and section 2-2
   b) Shear force at section 1-1 and section 2-2. Load moves over the beam KD.

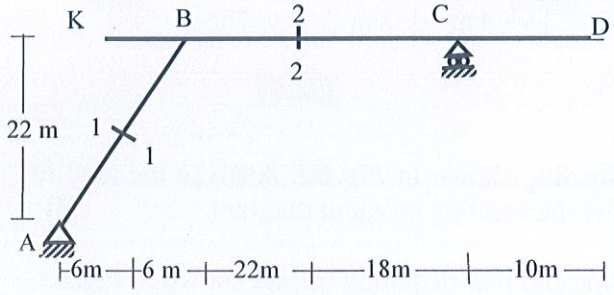


Fig.A1

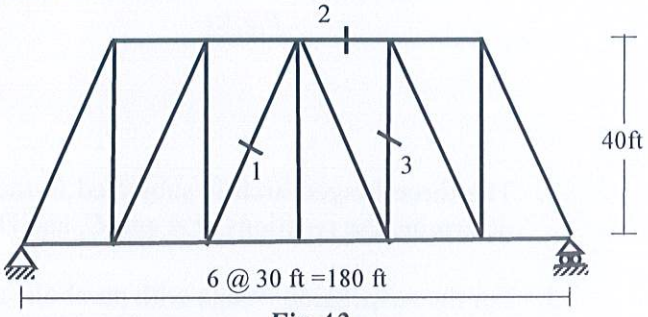


Fig.A2

2. For the truss shown in ***Fig A2***, draw the influence lines of member 1, 2 and 3. Note that, each bottom chord joint consists of a cross girder and load moves over the floor beams placed over the girders. **[12]**

3. A continuous beam is shown in ***Fig A3.*** Draw the influence line for the following cases:
   (i) shear force at just right of the support B,
   (ii) bending moment at B and R.
   Also calculate the maximum positive and negative bending moment at B and R for the combination of dead load of 10 kip/ft, moving live load of 18 kip/ft and a moving point live load of 120 kip. **[14]**

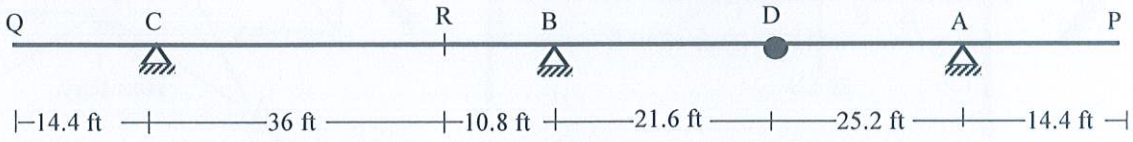


Fig.A3

4. For the girders with floor beam shown in ***Fig A4,*** draw influence line for floor beam reaction at 2, bending moment at 3 and shear force in panel 2-3. **[12]**

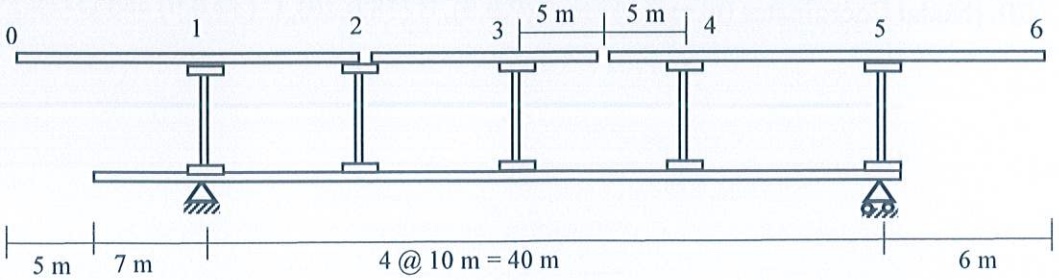


Fig.A4

PART-B

1. Analyze the frame shown in ***Fig.B1*** and draw the shear force and bending moment diagram. **[15]**

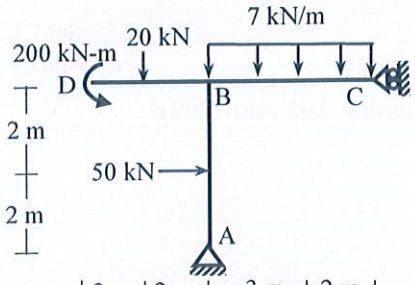


Fig.B1

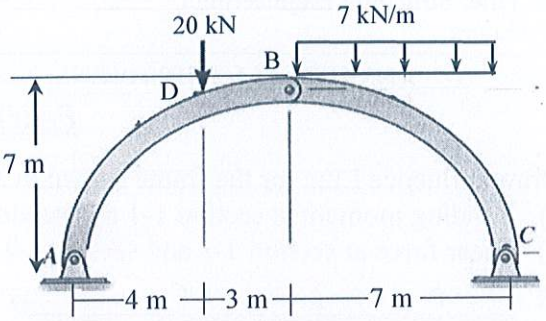


Fig.B2

2. The three-hinged arch is subjected to the loading shown in ***Fig.B2***. Analyze the arch to determine the reactions at *A* and *C*, and Draw the bending moment diagram. **[5]**

3. For the suspension bridge with parabolic cable and two stiffening trusses shown in ***Fig.B3***, determine the maximum and minimum tension of the cable. The trusses are pin connected at C, supported by a pin at A and roller at B. Determine the forces of the members **DE** and **DF**. **[18]**

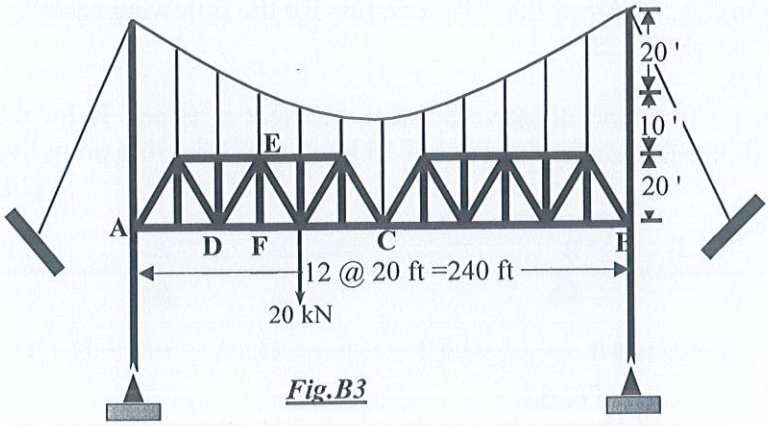


Fig.B3

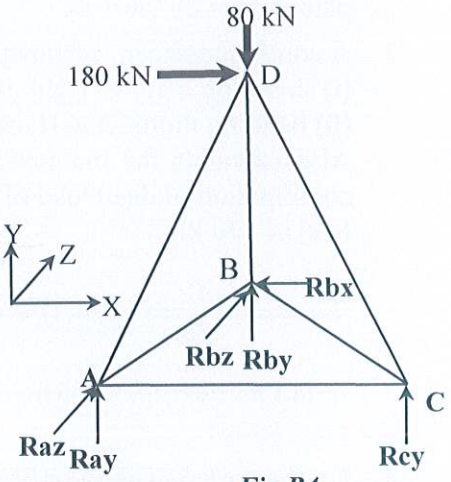


Fig.B4

4. Analyze the space truss shown in ***Fig.B4*** to determine the reactions and force of member ***CD***. [Nodal Coordinates (in meter) are A (0,0,0), B (18,0,20), C (30,0,0) and D (18,25,10)]. **[12]**

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2023
Program: B.Sc. in Civil Engineering

Course Title: Design of Concrete Structures I Course Code: CE 315 Credit: 3.0
Time: 3 hour Full Marks: 100

Answer all questions

Question 01: **[5x4=20]**

a. Explain with diagram the two types of bond failure for concrete and tensile reinforcement.
b. Explain the requirement of temperature and shrinkage reinforcemt as used in slabs?
c. Illustrate with diagram, how diagonal tension is developed in beam without shear reinforcement.
d. Illustrate the crieteria for effect flange width in T-beams as per the ACI code.

Question 02: **[20]**

A floor system shown in Fig.1, consists of a 3 in concrete slab supported by continuous T-beams with a 24 ft. span, 47 in. on centers. Web dimensions, as required by the negative moment requirements at the supports are: b_w = 11 in., and d = 20 in. Calculate tensile steel area is required at mid span to resist a factored moment of 6400 kip-in., if f_y = 60,000 psi and f_c' = 3000 psi.

Question 03: **[10+10]**

(a) A simply supported rectangular beam having an effective depth of 22 in. and width of 16 in. carries a total factored load of 9.4 kips/ft. on a 20 ft. clear span. It is reinforced with 8.00 in^2 of tensie steel, which continues uninterrupted into the supports. If f_c' = 4000 psi, Determine the portion of length of the beam where shear reinforcement required?
(b) Desing the web reinforcement of the above beam, using a vertical stirrup with f_{yt} = 60,000 psi.

Question 04: **[20]**

A reinforced concrete slab is built integrally with its supports and consists of two equal spans, each with a clear span of 15 ft. The service live load is 100 psf, fc' = 4000 psi and fy = 60,000 psi. Design the slab, following the provisions of ACI code, considering safety and environmental issues.

Question 05: **[8+4+8 = 20]**

Fig. 2 shows a beam-column joint in a continuous building frame. The negative steel required at the end of the beam is 2.90 in^2; however, two no. 11 bars are used, (As = 3.12 in^2.) Beam dimensions are: b = 10 in.; d = 18 in and h = 21 in. The design shear reinforcement will include no. 3 stirrups, first four of which are spaced at 3 in. and the remaining stirrups spaced at a constant 5 in. spacing in the region of the support, with 1.5 in. clear cover. Normal weight concrete with f' = 4000 psi and steel with f_y = 60,000 psi is used. Find the development length, l_d at which the negative bars can be cut off.

(a) Using the simplified equation of table 6.1 **[8]**
(b) Using Table A.10 **[4]**
(c) Using the basic equation Eq. 6.4 **[8]**

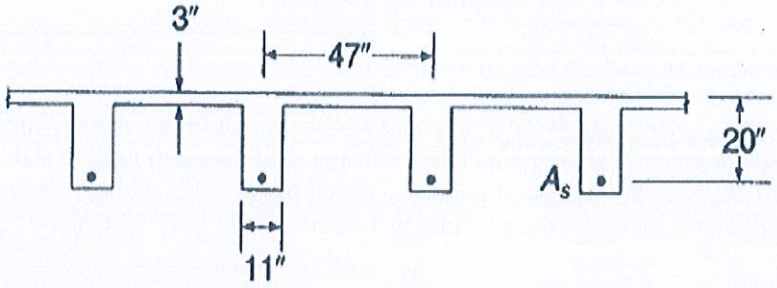


Figure 1: T-Beam floor system

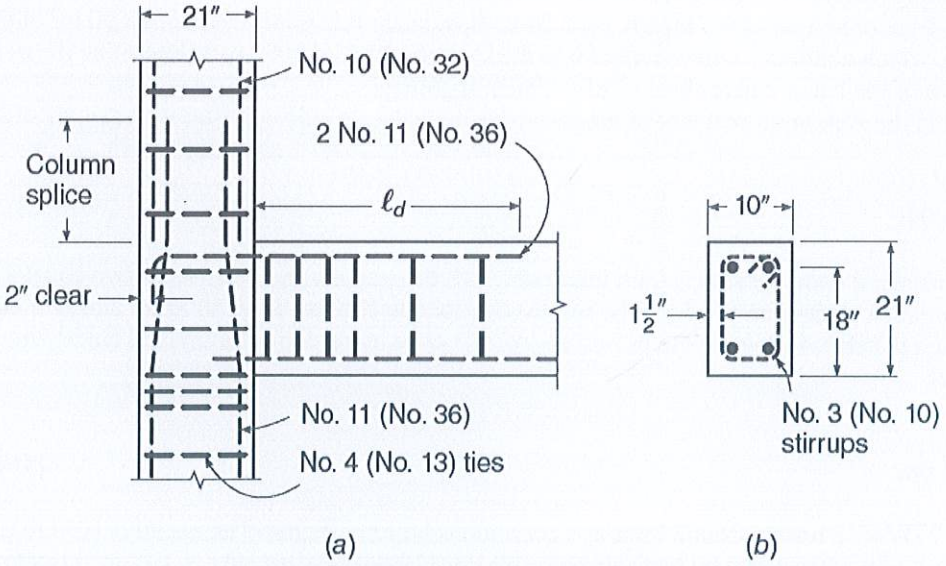


Figure 2: Bar details at beam-column joint

Formulae

$$\rho_{max} = 0.85\beta_1 \frac{f_c'}{f_y} \frac{\epsilon_u}{\epsilon_u + 0.004}$$

$$\rho_b = \alpha \frac{f_c'}{f_y} \frac{\epsilon_u}{\epsilon_u + \epsilon_y}$$

$$\varphi = 0.483 + 83.3\epsilon_t$$

$$c = \frac{\rho f_y d}{\alpha f_c'}$$

$$a = \frac{A_s f_y}{0.85 f_c' b}$$

$$M_n = \rho f_y b d^2 \left(1 - 0.59 \frac{\rho f_y}{f_c'}\right)$$

$$M_n = A_s f_y \left(d - \frac{a}{2}\right)$$

$$A_{sf} = \frac{0.85 f_c'(b - b_w) h_f}{f_y}$$

$$A_s - A_{sf} = \frac{\phi M_{n2}}{\phi f_y (d - a/2)}$$

$$V_c = 2\lambda \sqrt{f_c'} b_w d$$

$$s = \frac{\phi A_v f_{yt} d}{V_u - \phi V_c}$$

$$A_{s,min} = \frac{3\sqrt{f_c'}}{f_y} bd \geq \frac{200bd}{f_y}$$

$$\rho_{0.005} = 0.85\beta_1 \frac{f_c'}{f_y} \frac{\epsilon_u}{\epsilon_u + \epsilon_t}$$

$$f_s' = \epsilon_u E_s \frac{c - d'}{c}$$

$$k = \frac{n}{n + r}$$

$$j = 1 - \frac{k}{3}$$

$$M = \left[\frac{f_c (kj)}{2}\right] bd^2$$

$$\rho_{min} = \frac{3\sqrt{f_c'}}{f_y} \geq \frac{200}{f_y}$$

TABLE 13.1
Minimum thickness *h* of nonprestressed one-way slabs

Simply supported	$l/20$
One end continuous	$l/24$
Both ends continuous	$l/28$
Cantilever	$l/10$

TABLE 11.1
Moment and shear values using ACI coefficient†

Positive moment	
End spans	
If discontinuous end is integral with the support	$\frac{1}{14} w_u \ell_n^2$
If discontinuous end is unrestrained	$\frac{1}{11} w_u \ell_n^2$
Interior spans	$\frac{1}{16} w_u \ell_n^2$
Negative moment at interior faces of exterior supports for members built integrally with their supports	
Where the support is a spandrel beam or girder	$\frac{1}{24} w_u \ell_n^2$
Where the support is a column	$\frac{1}{16} w_u \ell_n^2$
Negative moment at exterior face of first interior support	
Two spans	$\frac{1}{9} w_u \ell_n^2$
More than two spans	$\frac{1}{10} w_u \ell_n^2$
Negative moment at other faces of interior supports	$\frac{1}{11} w_u \ell_n^2$
Negative moment at face of all supports for (1) slabs with spans not exceeding 10 ft and (2) beams and girders where ratio of sum of column stiffness to beam stiffness exceeds 8 at each end of the span	$\frac{1}{12} w_u \ell_n^2$
Shear in end members at first interior support	$1.15 \frac{w_u \ell_n}{2}$
Shear at all other supports	$\frac{w_u \ell_n}{2}$

†w_u = total factored load per unit length of beam or per unit area of slab.
ℓ_n = clear span for positive moment and shear and the average of the two adjacent clear spans for negative moment.

a. Equation for Development Length for Bars and Wires in Tension

According to ACI Code 25.4.2.3, for deformed bars or deformed wires,

$$\ell_d = \left(\frac{3}{40} \frac{f_y}{\lambda \sqrt{f'_c}} \frac{\psi_t \psi_e \psi_s}{\left(\frac{c_b + K_{tr}}{d_b} \right)} \right) d_b \qquad (6.4)$$

in which the term $(c_b + K_{tr})/d_b$ may not be taken greater than 2.5. In Eq. (6.4), the terms are defined and values established as follows.

ψ_t = casting position factor
- More than 12 in. of fresh concrete is placed below horizontal reinforcement: 1.3
- Other situations: 1.0

ψ_e = epoxy coating factor
- Epoxy-coated or zinc and epoxy dual-coated bars or wires with cover less than $3d_b$ or clear spacing less than $6d_b$: 1.5
- All other epoxy-coated or zinc and epoxy dual-coated bars or wires: 1.2
- Uncoated and zinc-coated (galvanized) reinforcement: 1.0
- However, the product of $\psi_t \psi_e$ need not be taken greater than 1.7.

ψ_s = reinforcement size factor
- No. 6 (No. 19) and smaller bars and deformed wires: 0.8†
- No. 7 (No. 22) and larger bars: 1.0

λ = lightweight aggregate concrete factor
- When lightweight aggregate concrete is used: 0.75
- However, when f_{ct} is specified, $\lambda = f_{ct}/(6.7\sqrt{f_{cm}}) \leq 1.0$, where f_{cm} is the measured compressive strength.
- When normalweight concrete is used: 1.0

c_b = spacing or cover dimension, in.
- Use the smaller of either the distance from the center of the bar to the nearest concrete surface or one-half the center-to-center spacing of the bars being developed.

K_{tr} = transverse reinforcement index: $40A_{tr}/sn$
- where A_{tr} = total cross-sectional area of all transverse reinforcement that is within the spacing s and that crosses the potential plane of splitting through the reinforcement being developed, in²
- s = maximum spacing of transverse reinforcement within ℓ_d center to center, in.
- n = number of bars or wires being developed along the plane of splitting

TABLE A.10
Simplified tension development length in bar diameters ℓ_d/d_b for uncoated bars and normalweight concrete

		No. 6 (No. 19) and Smaller[a]			No. 7 (No. 22) and Larger		
		f'_c, psi			f'_c, psi		
	f_y, ksi	4000	5000	6000	4000	5000	6000
(1) Bottom Bars							
Spacing, cover and ties as per Case *a* or *b*	40	26	23	21	32	29	26
	60	38	34	31	48	43	39
	75	48	43	39	60	54	49
	80	51	46	42	64	57	52
Other cases	40	38	34	31	48	43	39
	60	57	51	47	72	64	59
	75	72	64	59	89	80	73
	80	76	68	62	95	85	78
(2) Top Bars							
Spacing, cover and ties as per Case *a* or *b*	40	33	30	27	42	37	34
	60	50	45	41	62	56	51
	75	62	56	51	78	69	63
	80	66	59	54	83	74	68
Other cases	40	50	45	41	62	56	51
	60	74	67	61	93	83	76
	75	93	83	76	116	104	95
	80	99	89	81	124	111	101

Case *a*: Clear spacing of bars being developed or spliced ≥ d_b, clear cover ≥ d_b, and stirrups or ties throughout ℓ_d not less than the Code minimum.
Case *b*: Clear spacing of bars being developed or spliced ≥ $2d_b$, and clear cover not less than d_b.
[a]ACI Committee 408 recommends that the values indicated for bar sizes No. 7 (No. 22) and larger be used for all bar sizes.

TABLE 6.1
Simplified tension development length in bar diameters according to the ACI Code

	No. 6 (No. 19) and Smaller Bars and Deformed Wires†	No. 7 (No. 22) and Larger Bars
Clear spacing of bars or wires being developed or spliced ≥ d_b, clear cover ≥ d_b, and stirrups or ties throughout ℓ_d not less than the Code minimum	$\ell_d = \left(\frac{f_y \psi_t \psi_s}{25\lambda\sqrt{f'_c}} \right) d_b$	$\ell_d = \left(\frac{f_y \psi_t \psi_s}{20\lambda\sqrt{f'_c}} \right) d_b$
Clear spacing of bars or wires being developed or spliced ≥ $2d_b$, and clear cover ≥ d_b	Same as above	Same as above
Other cases	$\ell_d = \left(\frac{3f_y \psi_t \psi_e}{50\lambda\sqrt{f'_c}} \right) d_b$	$\ell_d = \left(\frac{3f_y \psi_t \psi_e}{40\lambda\sqrt{f'_c}} \right) d_b$

† For reasons discussed in Section 6.3a, ACI Committee 408 recommends that ℓ_d for No. 7 (No. 22) and larger bars be used for all bar sizes.

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2023
Program: B.Sc. Engineering (Civil)

Course Title: Geotechnical Engineering I | Course Code: CE 341
Time: 3 hours | Credit Hour: 3.0 | Full Marks: 150

*[There are **Six** questions here. **Answer all** the questions. Related formulae, charts are given in the Appendix. Assume reasonable values of any data, if missing. Digits in the right margin inside the first parenthesis indicate marks]*

PART-A

1. (a) Draw neatly the Plasticity Chart according to Unified Soil Classification System (USCS) showing the classifications of important soil deposits. **(6)**

(b) Classify the following two inorganic soils according to Unified Soil Classification System (USCS): **(8)**

Soil A : Percent finer No. 200 sieve (0.075 mm) = 95

Liquid Limit = 52%

Plastic limit = 21%

Soil B : Percent finer No. 4 sieve (4.75 mm) = 90

Percent finer No. 200 sieve (0.075 mm) = 8

D_{60} = 1.8 mm; D_{30} = 0.5 mm; D_{10} = 0.08 mm

Consistency limit of fraction passing No. 200 sieve

Liquid Limit = 39%

Plastic limit = 28%

(c) Liquid limit of a soil in air-dry state and oven-dry state have been found to be 84% and 58%, respectively. Plastic limit of the soil in air-dry state is 45%. What is the group symbol and group name of the soil according to Unified Soil Classification System (USCS)? **(5)**

(d) A specimen of saturated normally consolidated clay sample was fully consolidated in the triaxial cell under a cell pressure of 400 kN/m^2. Pore pressure within the specimen at the end of consolidation was zero. Deviator stress was then applied under undrained condition and increased until failure took place. The value of deviator stress at failure was found to be 500kN/m^2. Consolidated drained triaxial compression test on an identical specimen of the sample provided $\phi' = 30°$. Determine the values of pore pressure at failure (u_f) and the pore pressure parameter A at failure (A_f) for the consolidated undrained test. **(6)**

2. (a) With neat sketches define various types of primary structure of cohesive soil. Also explain thixotropy and critical void ratio of sands. **(6)**

(b) For a soil, the following results were obtained from grain size distribution and Atterberg limit tests:

Percent finer No. 200 sieve (0.075 mm) = 90

Liquid Limit = 52%

Plastic limit = 25%

Classify the soil based on AASHTO Soil Classification System. **(5)**

(c) The following results were obtained in a consolidated drained (CD) direct shear test carried out on a clay sample: **(8)**

Specimen No.	Normal Load (kg)	Peak Shear Force (N)
1	24	159
2	48	253
3	96	444

Diameter and height of each specimen were 63.5 mm and 25 mm, respectively. Determine the values of effective shear strength parameters (c′and ϕ') and write down the Mohr-Coulomb equation of the failure envelope. Also comment on the stress history of the sample.

(d) A clay sample (liquid limit = 58%, plastic limit = 27% and natural moisture content = 45) was collected from a depth of 8 m below the existing ground level. Water table is at the existing ground level and saturated unit weight of the sample is 20 kN/m^3. From a laboratory one-dimensional consolidation test, the preconsolidation pressure of the sample was found to be 326 kN/m^2. Estimate the value of undrained shear strength of the sample at that depth. **(6)**

3. (a) Draw neatly the following qualitative curves: **(5)**

(i) Pore pressure change versus axial strain for saturated samples of normally consolidated and overconsolidated clays in consolidated undrained (CU) triaxial compression tests.

(ii) Volume change versus shear displacement for saturated samples of loose sand and dense sand in consolidated drained (CD) direct shear tests.

(iii) Skempton's pore pressure coefficient B versus degree of saturation

(iv) Variation of the magnitude of lateral earth pressures (at-rest, active and passive) with tilt or deformation of wall.

(b) Define active earth pressure and passive earth pressure.

A vane, 100 mm height and 50 mm diameter was pressed into a clay deposit at the bottom of a borehole and the bottom of the vane is flush with the surface of the clay. Torque was applied and its value at failure was found to be 17 N-m. Assuming uniform mobilization of end shear, calculate the in-situ undrained shear strength of the clay. If the values of liquid limit and plastic limit of the clay are 56 and 20, respectively, what will be the design value of undrained shear strength of the clay? **(6)**

(c) A smooth vertical wall of height 9 m retains a soft clay backfill of unit weight 17.5 kN/m^3. Undrained shear strength of the clay backfill is 35 kN/m^2. For undrained condition ($\phi = 0$) of the backfill, calculate the following: **(6)**

(i) Depth of tension crack and unsupported height of the wall

(ii) Active earth force before tension crack forms

(iii) Active earth force after tension crack forms

(d) For the retaining wall shown in **Fig. 1**, draw Rankine's passive pressure diagram and determine the total passive force per meter length of the wall. **(8)**

PART-B

4. a) Differentiate normally consolidated clay and overconsolidated clay. **(5)**
   b) A footing is placed on a sandy layer underlying a normally consolidated silty clay stratum, with properties shown in **Fig. 2**. Calculate the followings. **(10+5+5)**

   i. Primary consolidation settlement of the clay layer.
   ii. Settlement after 100 years.
   iii. Find required footing dimension (square or rectangular) to control the settlement within a value of 15mm after 100 years.

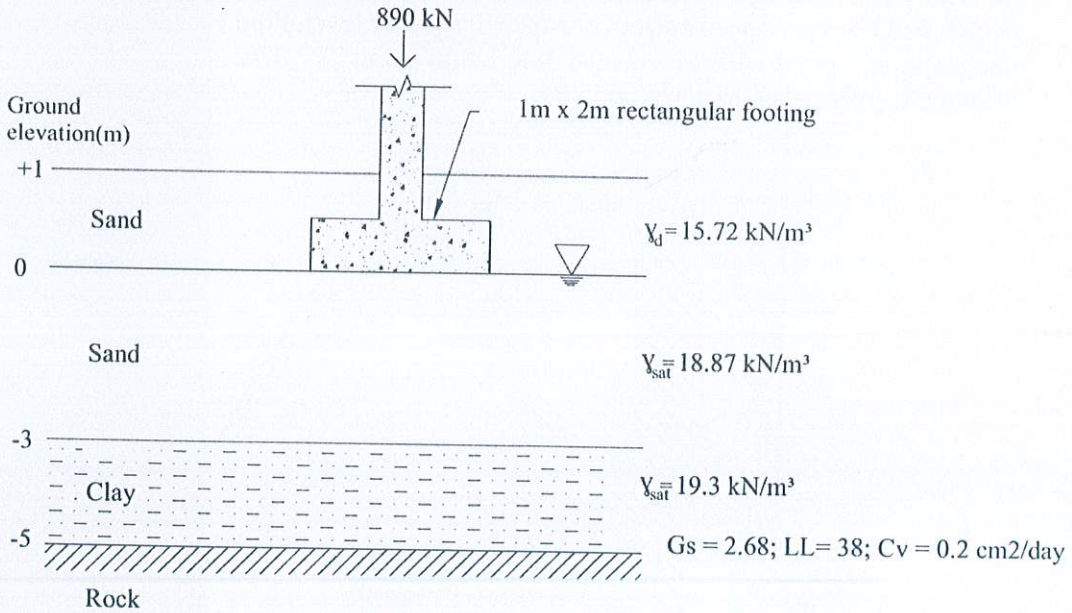
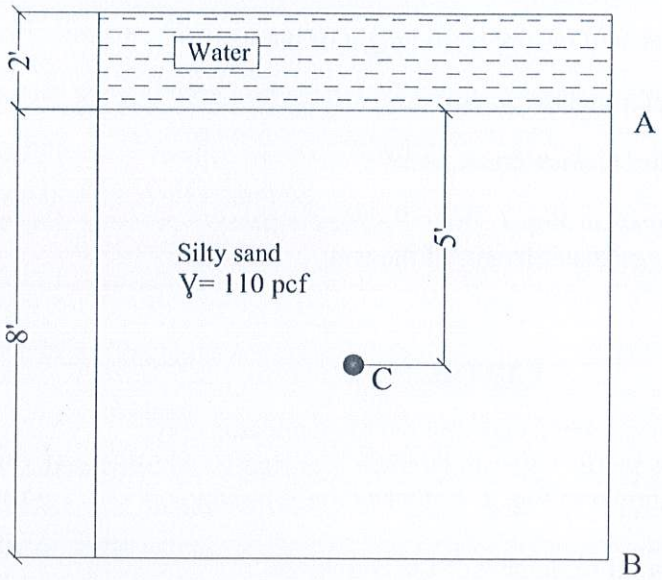


Fig. 2

5. a) Differentiate between compaction and consolidation. **(5)**

b) For the following soil profile shown in **Fig-3**, find the total stress, effective stress and pore water pressure for the following conditions. **(10+5+5)**

i. No seepage condition.
ii. Upward seepage condition.
iii. Downward seepage condition.

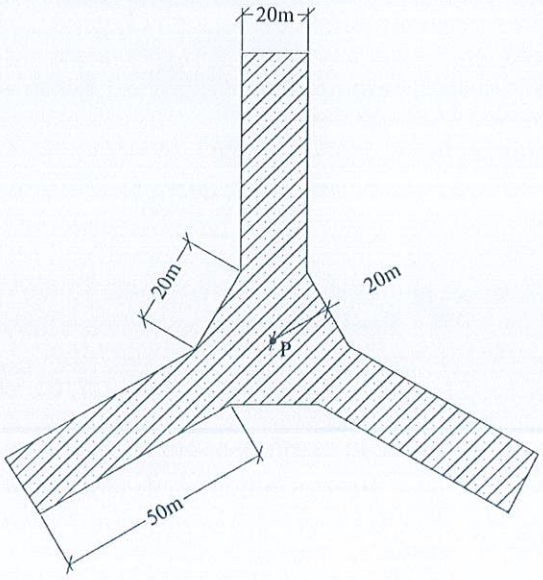


During seepage head difference between point A and B becomes 1'

Fig. 3

6. a) Derive relationship between moisture content, degrees of saturation, void ratio and specific gravity of soil solids. **(5+20)**

b) The Following figure shows the base of "Jeddah Tower" which will be experienced a stress of 2.65 MPa at base level. Find the stress at a point which is located 30m below point "**P**". Use Newmark Influence Chart Method.



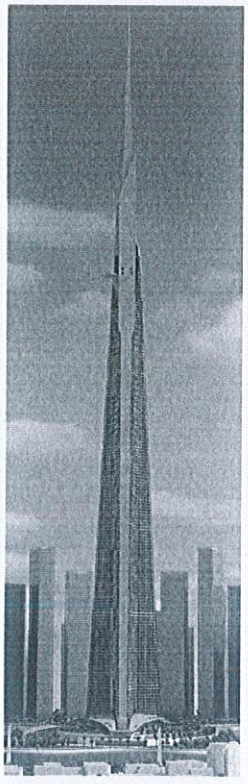


Fig. 4

Chart 1 AASHTO Soil Classification System

General Classification	Granular Material (35% or less passing No. 200 sieve)							Silt Clay Materials (More than 35% passing No. 200 Sieve)			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve Analysis; Percent Passing											
No. 10	50 max	...	...	...	...	...	...	...	...	...	...
No. 40	30 max	50 max	51 min	...	...	...	...	...	...	...	...
No. 200	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing No. 40											
Liquid Limit	...		...	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min*
Plasticity Index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min *
Usual types of significant constituent materials	Stone Fragments; gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General Rating as Subgrade	Excellent to good							Fair to poor			

- Plasticity index of A-7-5 subgroup is equal to or less than L.L. minus 30.
- Plasticity index of A-7-6 subgroup is greater than L.L. minus 30.

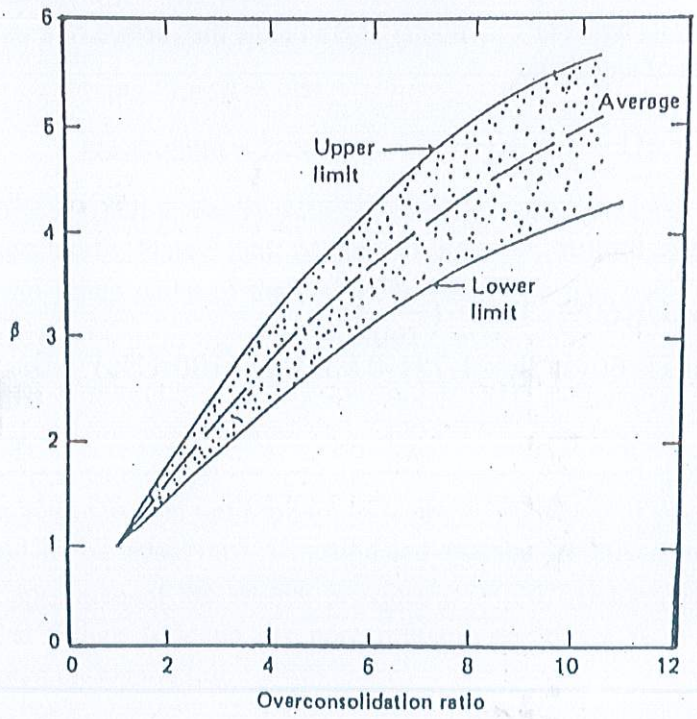


Chart 2 Plot of β versus Overconsolidation Ratio

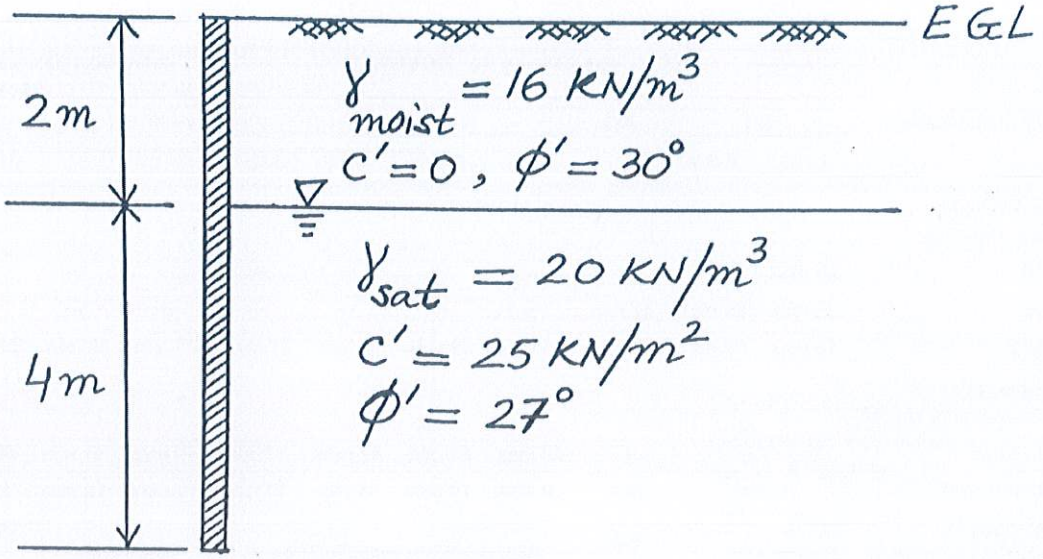


Fig. 1

- vertical stress at a particular depth below the surface of a uniformly loaded area of any shape_

$$\sigma_z = q[1 - \frac{1}{\{1+\left(\frac{a}{z}\right)^2\}^{3/2}}]$$

- Time Factor_

For U≤60%; $T_v = \frac{\pi}{4}\left(\frac{U\%}{100}\right)^2$

For U>60%; $T_v = 1.781 - 0.933\log_{10}(100 - U\%)$