L-3/T-1/CE **Date: 29/09/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 301** (Professional Practices & Communication)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

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

1. As per ASCE Code of Ethics lecture notes given to you answer the following: **(12+12+11=35)**
   (i) What steps should the Engineer take to increase the effectiveness of the engineering profession?
   (ii) Whom shall the Engineer not associate with and by whom shall he not allow the use of his name?
   (iii) What aspects of another engineer shall the Engineer not falsely attempt to injure and if he believes another engineer is guilty then in that case what should he do?

2. (a) Describe "Courtesy" which is one of the seven components of effective communication. **(17)**
   (b) What is abstraction and why is it necessary? Explain what is slanted abstract and what is its purpose. **(18)**

3. (a) List the items to be checked for preliminary and detailed evaluation to determine the responsiveness of a tender? **(17)**
   (b) What are the three broad categories of communication in an organization? Describe the various types of internal operational communication. **(18)**

4. (a) For the selection of a consultant for intellectual services under QCBS, following information about technical and financial evaluation are available for the proposals submitted. The weightage for technical and financial score is 80:20. **(17)**

NAME OF THE FIRM	TECHNICAL SCORE (100)	FINANCIAL OFFER VALUE (million BDT)
Abacus Ltd.	85	100
System Engineers	95	130
Delta Inc.	70	---
Wye System Inc.	80	95

The qualifying technical score is 80%. Determine the combined score and ranking of the firms.

Contd P/2

CE 301
Contd... Q. No. 4

(b) What is arithmetic correction? Describe the rules for conducting arithmetic correction in the evaluation of a tender. Demonstrate the arithmetic correction through example. **(18)**

SECTION – B

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

5. (a) Define "Civil Engineers" as per ASCE Body of Knowledge. **(5)**

(b) Define "Project" in details. **(5)**

(c) What are project characteristics? **(10)**

(d) Shown in a diagram the participants in project development. **(8)**

(e) What are the six elements required for contract to be binding? **(7)**

6. (a) What are some commonly used contract formats? **(5)**

(b) What are "think twice" Contract clauses? **(15)**

(c) What are the specific concerns for professional liability insurance? **(10)**

(d) Briefly discuss "Fiduciary Risk". **(5)**

7. (a) What are the attributes of an effective brief ? **(10)**

(b) What are the defaults for a tenderer for which the tender security is to be forfeited? **(8)**

(c) List, in order of priority, the documents that form the contract. **(10)**

(d) What are the most important aspects that surety companies inquire before issuing bonds? **(7)**

8. (a) Describe the selection criteria (using a flow-chart) for various FIDIC conditions of contract. **(20)**

(b) Prepare a sample BoQ for concrete works in foundation for a quantity of 100 cubic meter. **(15)**

L-3/T-1/CE **Date: 24/09/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 311** (Structural Analysis)

Full Marks: 280 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

Assume reasonable values for any missing data.

1. (a) Using the method of virtual work, find rotation of point **a** of the frame shown in Fig. 1. Consider the deflection of each member of the frame is primarily caused by the bending strain energy. Given that $E = 29000$ ksi, $I = 6000\ in^4$, $A = 50\ in^2$, $\vartheta = 0.3$ and $K = 1.2$, and these material properties are same for all members of the frame. **($23\frac{2}{3}$)**

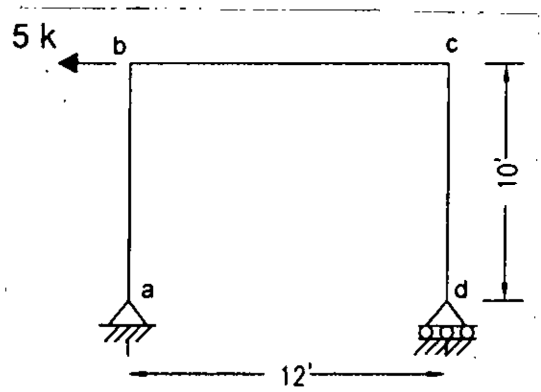

Fig. 1 for Ques 1a

(b) Calculate horizontal deflection at joint 'C' of the truss due to load shown in Fig. 2. Given, modulus of elasticity $E = 29000$ ksi and each member's cross-sectional area is shown in the figure in brackets (unit of the numerical value of Area is in^2). Use virtual work method for computation. **(23)**

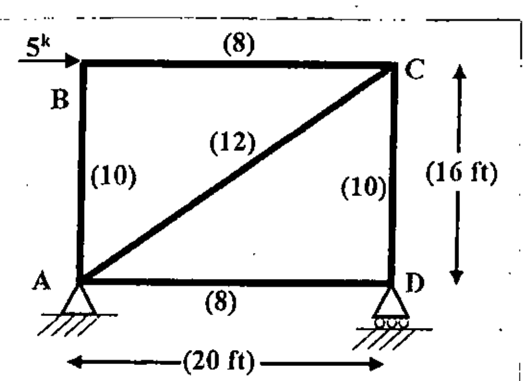

Fig. 2 for Ques 1b

Contd P/2

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2. (a) Using the method of virtual work, determine the vertical deflection of point **D** of the beam shown in Fig. 3. Consider that deflection of the beam is primarily caused by the bending and shear strain energy. Given that $E = 29000$ ksi, $I_1 = 200$ in^4, $I_2 = 1.2\, I_1$, $A_1 = 20$ in^2, $A_2 = 1.2\, A_1$, $\vartheta = 0.3$ and $K = 1.2$. E ϑ and K are same for every section of the beam. **(23)**

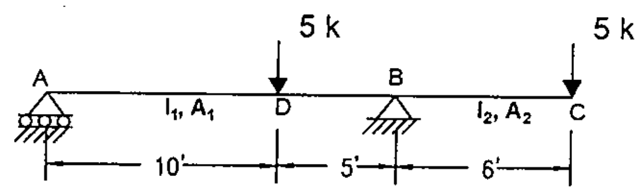

Fig. 3 for Ques 2a

(b) The girder shown in Fig. 4 is suspended from the parabolic cable. Draw shear force and bending moment diagram of the girder when the structure is subjected to the loading shown in the figure. **($23\frac{2}{3}$)**

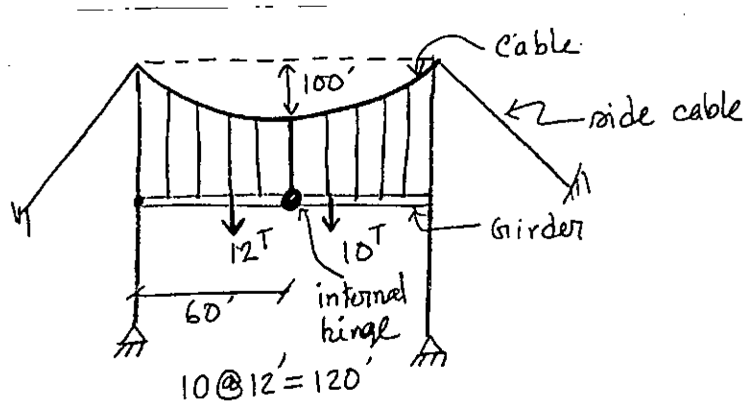

Fig. 4 for Ques 2b

3. (a) For the beam shown in Fig. 5, draw influence lines for (i) reaction at B, (ii) shear just left of D, (iii) moment at C. **($12\frac{2}{3}$)**

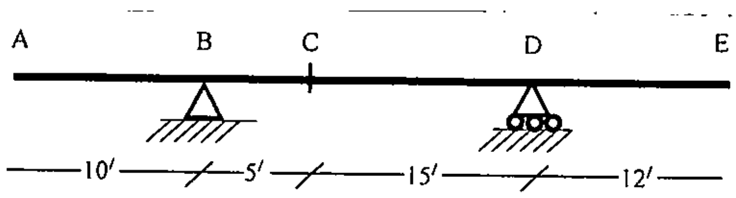

Fig. 5 for Ques 3a

(b) Calculate the earthquake story force at level 4 of a 6 storied RC office building at Sylhet. Given, occupancy category is II, site class is SC, seismic zone is 4, each story height is 3 m, structural system is concrete moment resisting frame. Plan dimension is 25 m × 25 m. Seismic zone coefficient (Z) = 0.36 and damping correction factor (η) = 1.2. Dead load including self-weight is 8 kN/m^2 and live load is 2.4 kN/m^2 for all floors. Also given that self-weight of all pedestals is 100 kN. Follow BNBC 2020 for

Contd P/3

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Contd.... for Q. No. 3(b)

Earthquake Load Calculation. Use Table 1-2 to determine seismic design category and response reduction factor which are the required parameters for solving this problem. Use Table 3 and following equations for calculating. Normalized Acceleration Response Spectrum. **(34)**

$$C_s = S\left(1+\frac{T}{T_B}(2.5\eta-1)\right) \text{ for } 0 \le T \le T_B$$

$$C_s = 2.5S\eta \quad \text{for } T_B \le T \le T_C$$

$$C_s = 2.5S\eta\left(\frac{T_C}{T}\right) \quad \text{for } T_C \le T \le T_D$$

$$C_s = 2.5S\eta\left(\frac{T_C T_D}{T^2}\right) \quad \text{for } T_D \le T \le 4\,\text{sec}$$

4. (a) An RC office building is located in a flat open country of Narayanganj. The building plan dimension is 50 ft by 50 ft. The overall height of the building is 30 ft. Given that the roof is flat, the building classification is enclosed, importance factor (I) = 1.15, adjustment factor for building height and exposure (λ) = 1.4 and 3-sec gust speed of wind is 61.1 m/s. Determine the horizontal design wind pressure of MWFR of the building following simplified procedure of BNBC 2020. Use Table 4. **(12⅔)**

(b) A typical 20-storied RC residential building is situated at a flat terrain of Cox's Bazar. Building plan dimension is 50 m × 50 m, each story height is 3 m and overall height of the building is 60 m. Occupancy category is II and exposure category is C. Basic wind speed of Cox's Bazar is 80 m/s. Assume that the building is classified as OPEN. Use following formula for determining velocity pressure exposure coefficient (K_z) when you need that for wind load calculation as per BNBC 2020. **(34)**

$$K_z = 2.01\left(z/z_g\right)^{2/\alpha} \text{ for } 4.57\,m \le z \le z_g$$

$$K_z = 2.01\left(4.57/z_g\right)^{2/\alpha} \text{ for } z < 4.57\,m$$

Determine (i) the gust effect factor (G), and (ii) the design wind pressure for wind towards X direction (for both windward and leeward direction).

See Table 5-6 and Appendix A for solving this problem.

Contd P/4

SECTION – B

There are **SEVEN** questions in this section. Answer any **FIVE** questions.

5. Compute maximum shear at quarter point of a simply supported beam of 80 ft due to the wheel load shown in Fig. 6. **(28)**

6. Find maximum moment at One-third point of a simply supported beam of 90 ft for the load shown in Fig. 6. **(28)**

7. Determine maximum force for the member "**a**" of the truss shown in Fig. 7. Assume the loads given in Fig. 6. **(28)**

8. Using Portal Method, analyze the frame as shown in Fig. 8 and draw, (a) axial force diagram, (b) shear force diagram, (c) bending moment diagram of all the columns and beams. **(28)**

9. Using Cantilever Method, analyze the frame as shown in Fig. 9 and draw, (a) axial force diagram of column, (b) bending moment diagram of columns, (c) bending moment diagram of beams, (d) shear force diagram of beams. Note-numbers beside the columns indicate their cross sectional area in $inch^2$. **(28)**

10. Determine the member forces of AB, BC, CD, DE, CE, BE, EF, and AG of the indeterminate truss as shown in Fig. 10. Assume the diagonals can support both tensile and compressive forces. **(28)**

11. Analyze the truss as shown in Fig. 11 and determine the member forces GM, MN, and FP. Apply necessary assumptions as required. Also, (a) draw shear force and (b) bending moment diagram of the Column AJI. **(28)**

Chart 1 for Ques 1 and 2: Integration Chart

Table for Evaluating $\int_0^L m\, m'\, dx$

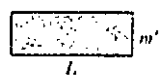
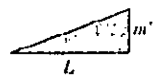
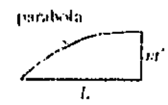
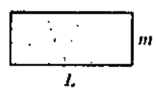
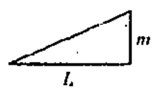
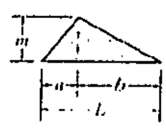
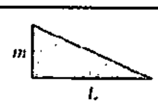
$\int_0^L m\, m'\, dx$				
	$mm'L$	$\frac{1}{2}mm'L$	$\frac{1}{2}m(m'_1 + m'_2)L$	$\frac{2}{3}mm'L$
	$\frac{1}{2}mm'L$	$\frac{1}{3}mm'L$	$\frac{1}{6}m(m'_1 + 2m'_2)L$	$\frac{5}{12}mm'L$
	$\frac{1}{2}m'(m_1 + m_2)L$	$\frac{1}{6}m'(m_1 + 2m_2)L$	$\frac{1}{6}[m'_1(2m_1 + m_2) + m'_2(m_1 + 2m_2)]L$	$\frac{1}{12}[m'(3m_1 + 5m_2)]L$
	$\frac{1}{2}mm'L$	$\frac{1}{6}mm'(L + a)$	$\frac{1}{6}m[m'_1(L + b) + m'_2(L + a)]$	$\frac{1}{12}mm'\left(3 + \frac{3a}{L} - \frac{a^2}{L^2}\right)L$
	$\frac{1}{2}mm'L$	$\frac{1}{6}mm'L$	$\frac{1}{6}m(2m'_1 + m'_2)L$	$\frac{1}{4}mm'L$

Table 1 for Ques 3b

Response Reduction Factor, Deflection Amplification Factor and Height Limitations for Different Structural Systems

Seismic Force–Resisting System	Response Reduction Factor, R	System Overstrength Factor, Ω_o	Deflection Amplification Factor, C_d	Seismic Design Category B	Seismic Design Category C	Seismic Design Category D
				Height limit (m)		
C. MOMENT RESISTING FRAME SYSTEMS (no shear wall)						
1. Special steel moment frames	8	3	5.5	NL	NL	NL
2. Intermediate steel moment frames	4.5	3	4	NL	NL	35
3. Ordinary steel moment frames	3.5	3	3	NL	NL	NP
4. Special reinforced concrete moment frames	8	3	5.5	NL	NL	NL
5. Intermediate reinforced concrete moment frames	5	3	4.5	NL	NL	NP
6. Ordinary reinforced concrete moment frames	3	3	2.5	NL	NP	NP

Table 2 for Ques 3b

Seismic Design Category of Buildings

Site Class	Occupancy Category I, II and III			
	Zone 1	Zone 2	Zone 3	Zone 4
SA	B	C	C	D
SB	B	C	D	D
SC	B	C	D	D
SD	C	D	D	D
SE, S_1, S_2	D	D	D	D

Table 3 for Ques 3b

Site Dependent Soil Factor and Other Parameters Defining Elastic Response Spectrum

Soil type	S	T_B(s)	T_C (s)	T_D (s)
SA	1.0	0.15	0.40	2.0
SB	1.2	0.15	0.50	2.0
SC	1.15	0.20	0.60	2.0
SD	1.35	0.20	0.80	2.0
SE	1.4	0.15	0.50	2.0

Table 4 for Ques 4a [ps30 in *psf*]

Basic Wind Speed (mph)	Roof Angle (degrees)	Load Case	Zones									
			Horizontal Pressures				Vertical Pressures				Overhangs	
			A	B	C	D	E	F	G	H	EOH	GOH
130	0 to 5°	1	26.8	-13.9	17.8	-8.2	-32.2	-18.3	-22.4	-14.2	-45.1	-35.3
	10°	1	30.2	-12.5	20.1	-7.3	-32.2	-19.7	-22.4	-15.1	-45.1	-35.3
	15°	1	33.7	-11.2	22.4	-6.4	-32.2	-21.0	-22.4	-16.1	-45.1	-35.3
	20°	1	37.1	-9.8	24.7	-5.4	-32.2	-22.4	-22.4	-17.0	-45.1	-35.3
	25°	1	33.6	5.4	24.3	5.5	-14.9	-20.4	-10.8	-16.4	-27.8	-23.7
		2	------	------	------	------	-5.7	-11.1	-1.5	-7.1	------	------
	30 to 45	1	30.1	20.6	24.0	16.5	2.3	-18.3	0.8	-15.7	-10.6	-12.1
		2	30.1	20.6	24.0	16.5	11.6	-9.0	10.0	-6.4	-10.6	-12.1
140	0 to 5°	1	31.1	-16.1	20.6	-9.6	-37.3	-21.2	-26.0	-16.4	-52.3	-40.9
	10°	1	35.1	-14.5	23.3	-8.5	-37.3	-22.8	-26.0	-17.5	-52.3	-40.9
	15°	1	39.0	-12.9	26.0	-7.4	-37.3	-24.4	-26.0	-18.6	-52.3	-40.9
	20°	1	43.0	-11.4	28.7	-6.3	-37.3	-26.0	-26.0	-19.7	-52.3	-40.9
	25°	1	39.0	6.3	28.2	6.4	-17.3	-23.6	-12.5	-19.0	-32.3	-27.5
		2[4]	------	------	------	------	-6.6	-12.8	-1.8	-8.2	------	------

Table 5 for Ques 4b: External Pressure Coefficient

Wall Pressure Coefficients, C_p			
Surface	L/B	C_p	Use With
Windward Wall	All values	0.8	q_z
Leeward Wall	0-1	-0.5	q_h
	2	-0.3	
	≥ 4	-0.2	
Side Wall	All values	-0.7	q_h

Table 6 for Ques 4b: Terrain Exposure Constants

Exposure	α	z_g (m)	$\hat{a}$	$\hat{b}$	$\bar{\alpha}$	$\bar{b}$	c	l (m)	$\bar{\epsilon}$	z_{min} (m)*
A	7.0	365.76	1/7	0.84	1/4.0	0.45	0.30	97.54	1/3.0	9.14
B	9.5	274.32	1/9.5	1.00	1/6.5	0.65	0.20	152.4	1/5.0	4.57
C	11.5	213.36	1/11.5	1.07	1/9.0	0.80	0.15	198.12	1/8.0	2.13

*z_{min} = Minimum height used to ensure that the equivalent height z is greater of $0.6h$ or z_{min}. For buildings with $h \leq z_{min}$, $\bar{z}$ shall be taken as z_{min}.

Appendix A for Ques 4b: BNBC 2020 Provisions for Gust Effect Factor Calculations

2.4.8.1 Rigid structures

For rigid structures as defined in Sec 2.1.3, the gust-effect factor shall be taken as 0.85 or calculated by the formula:

$$G = 0.925 \frac{1+1.7 g_Q I_{\bar{z}} Q}{1+1.7 g_v I_{\bar{z}}} \qquad (6.2.6)$$

$$I_{\bar{z}} = c\left(\frac{10}{\bar{z}}\right)^{1/6} \qquad (6.2.7)$$

Where, $I_{\bar{z}}$= the intensity of turbulence at height $\bar{z}$ where $\bar{z}$ = the equivalent height of the structure defined as $0.6h$, but not less than z_{min} for all building heights h. z_{min} and c are listed for each exposure in Table 6.2.10: g_Q and the value of g_v shall be taken as 3.4. The background response Q is given by

$$Q = \sqrt{\frac{1}{1+0.63\left(\frac{B+h}{L_{\bar{z}}}\right)^{0.63}}} \qquad (6.2.8)$$

Where, B, h are defined in Sec 2.1.4; and $L_{\bar{z}}$ = the integral length scale of turbulence at the equivalent height given by

$$L_{\bar{z}} = l\left(\frac{\bar{z}}{10}\right)^{\bar{\epsilon}} \qquad (6.2.9)$$

In which l and $\bar{\epsilon}$ are constants listed in Table 6.2.10.

2.4.8.2 Flexible or dynamically sensitive structures

For flexible or dynamically sensitive structures as defined in Sec 2.1.3 (natural period greater than 1.0 second), the gust-effect factor shall be calculated by

$$G_f = 0.925\left(\frac{1+1.7 I_{\bar{z}}\sqrt{g_Q^2 Q^2 + g_R^2 R^2}}{1+1.7 g_v I_{\bar{z}}}\right) \qquad (6.2.10)$$

The value of both g_Q and g_V shall be taken as 3.4 and g_R is given by

$$g_R = \sqrt{2\ln(3600 n_1)} + \frac{0.577}{\sqrt{2\ln(3600 n_1)}} \qquad (6.2.11)$$

R, the resonant response factor, is given by

$$R = \sqrt{\frac{1}{\beta} R_n R_h R_B (0.53 + 0.47 R_L)} \qquad (6.2.12)$$

$$R_n = \frac{7.47 N_1}{(1+10.3 N_1)^{5/3}} \qquad (6.2.13)$$

$$N_1 = \frac{n_1 L_{\bar{z}}}{\bar{V}_{\bar{z}}} \qquad (6.2.14)$$

$$R_l = \frac{1}{\eta} - \frac{1}{2\eta^2}(1 - e^{-2\eta}) \text{ for } \eta > 0 \qquad (6.2.15a)$$

$$R_l = 1 \text{ for } \eta = 0 \qquad (6.2.15b)$$

Where, the subscript l in Eq. 6.2.15 shall be taken as h, B, and L, respectively, where h, B, and L are defined in Sec 2.1.4.

n_1 = building natural frequency

$R_l = R_h$ setting $\eta = 4.6 n_1 h/\bar{V}_{\bar{z}}$

$R_l = R_B$ setting $\eta = 4.6 n_1 B/\bar{V}_{\bar{z}}$

$R_l = R_L$ setting $\eta = 15.4 n_1 L/\bar{V}_{\bar{z}}$

β = damping ratio, percent of critical

$\bar{V}_{\bar{z}}$ = mean hourly wind speed at height $\bar{z}$ determined from Eq. 6.2.16.

$$\bar{V}_{\bar{z}} = \bar{b}\left(\frac{\bar{z}}{10}\right)^{\bar{\alpha}} V \qquad (6.2.16)$$

Where, $\bar{b}$ and $\bar{\alpha}$ are constants listed in Table 6.2.10.

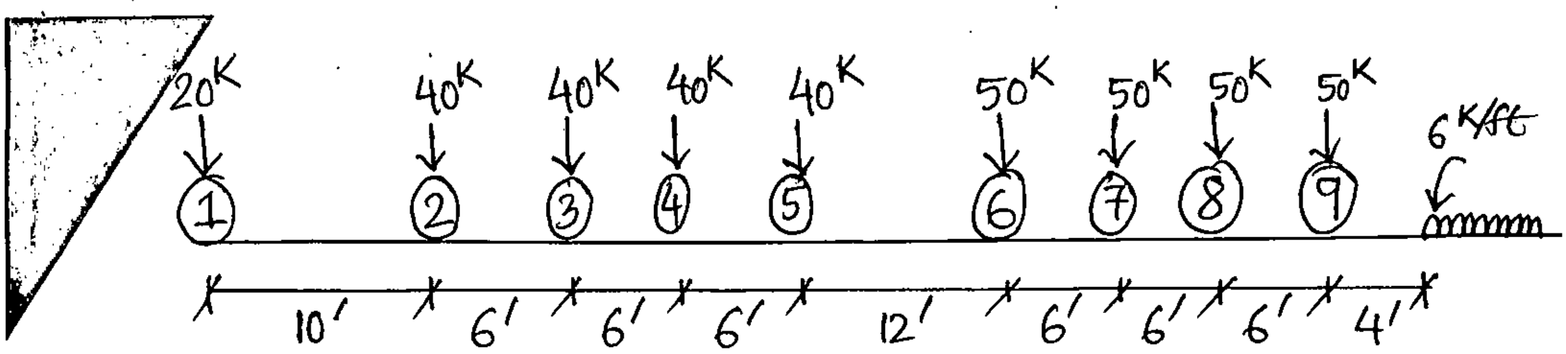


Fig. 6

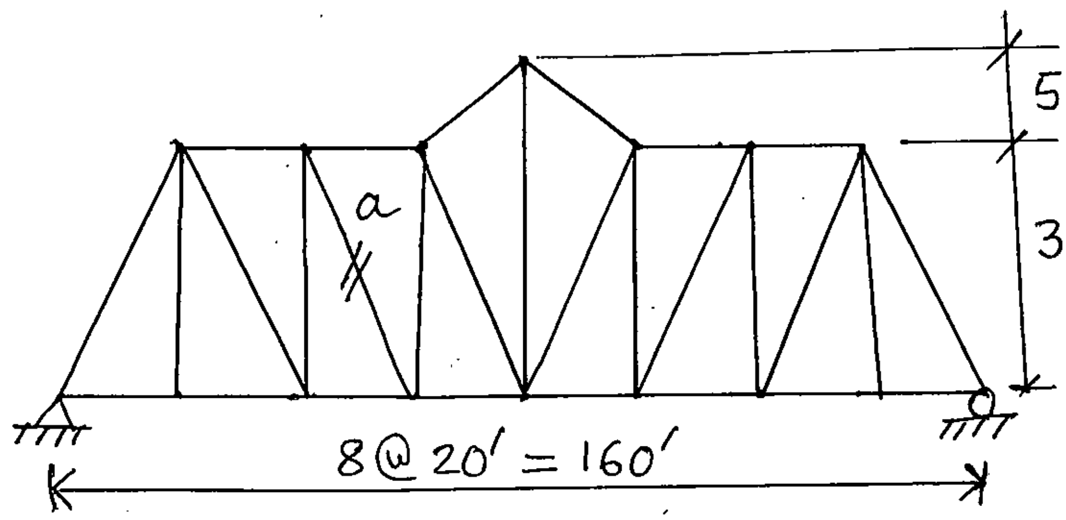


Fig. 7

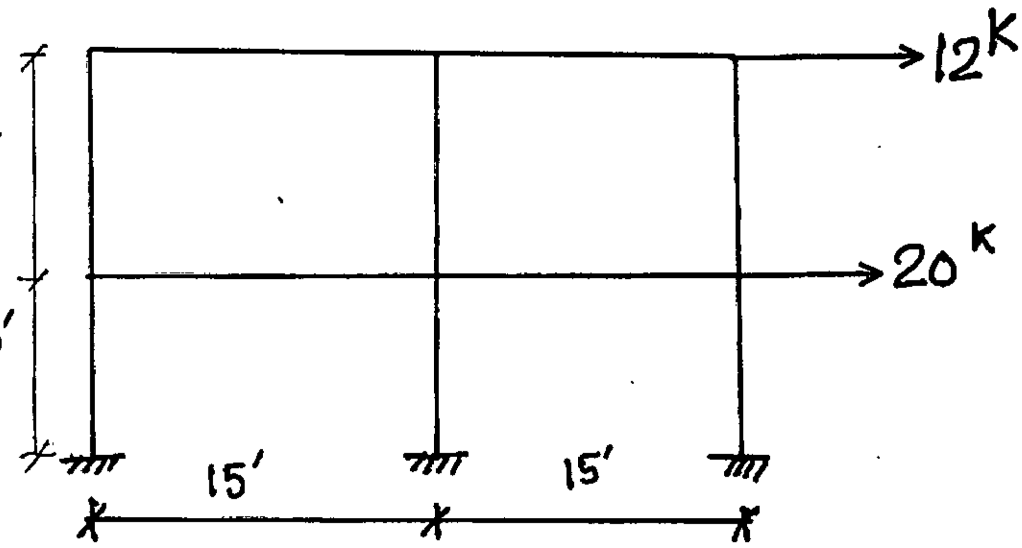


Fig. 8

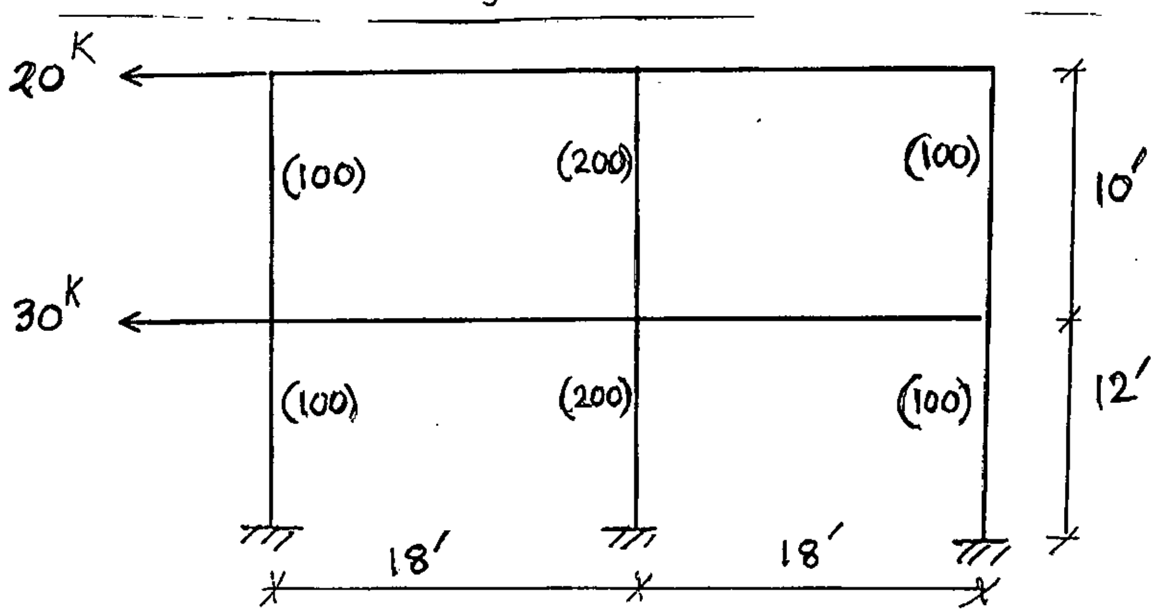


Fig. 9

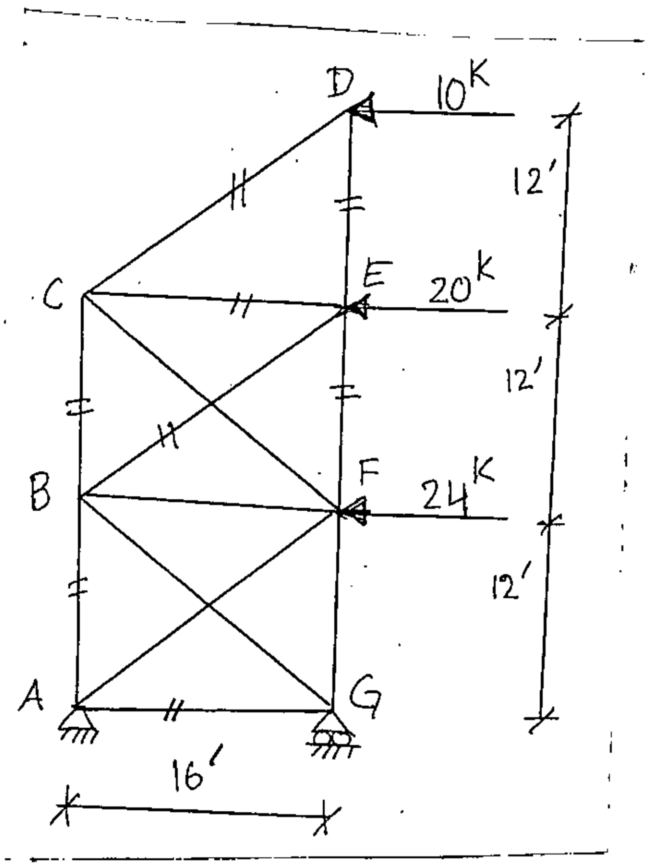

D
10^K
12'
C
E
20^K
12'
B
F
24^K
12'
A
G
16'

Fig. 10

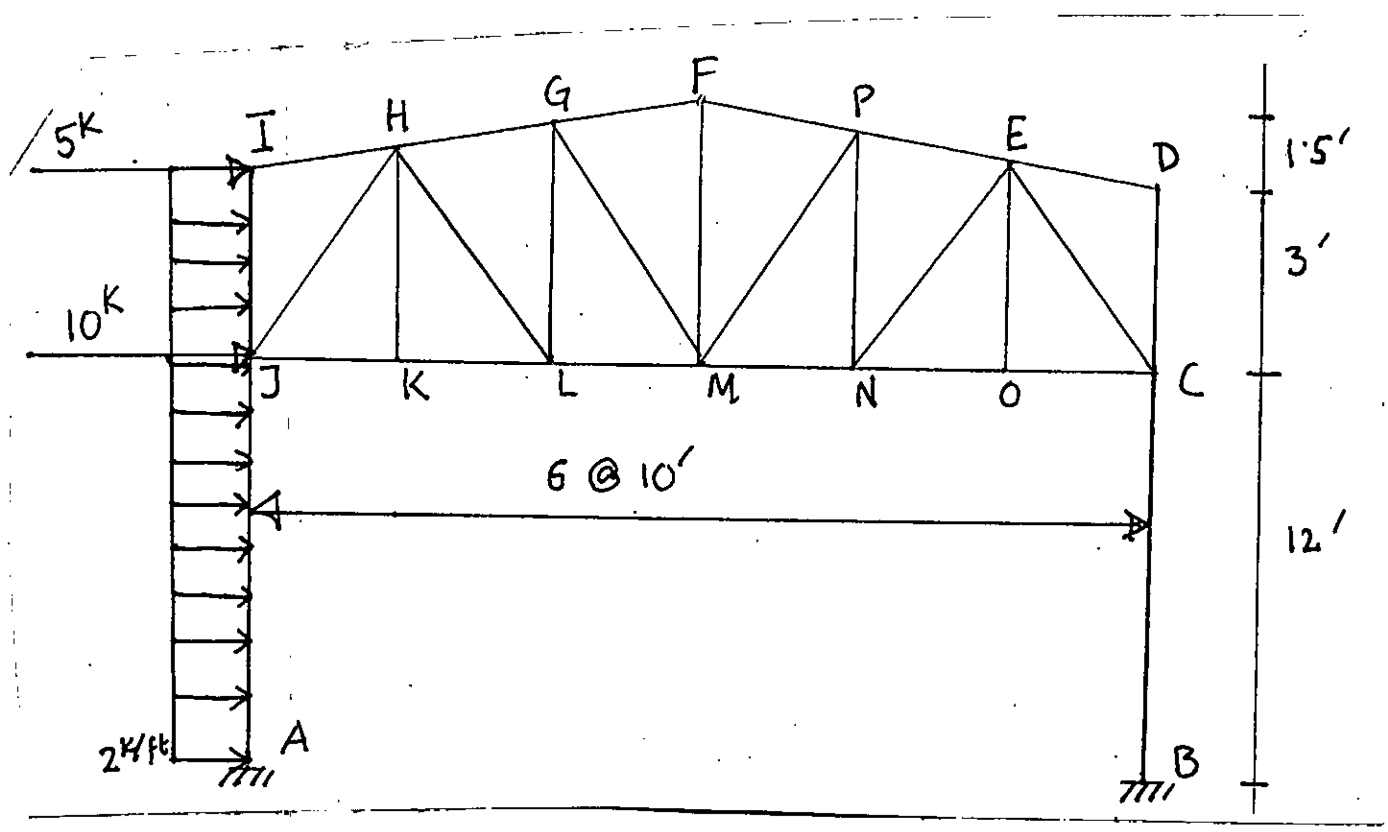

5^K
I
H
G
F
P
E
D
1.5'
3'
10^K
J
K
L
M
N
O
C
6 @ 10'
12'
$2^{K}/ft$
A
B

Fig. 11

L-3/T-1/CE **Date: 25/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 315** (Design of Concrete Structures-I)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

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

Use USD Method of Design if not mentioned otherwise.

Assume reasonable value for any missing data.

1. (a) What are the sources of uncertainties in the analysis, design, and construction of RC structures? How does the Strength Design method take care of these uncertainties and ensure safety in design? **(7)**

(b) Discuss the behavior of RC rectangular beam in flexure under increasing load by drawing neat sketches for strain and stress distribution of uncracked, cracked and ultimate conditions. **(8)**

(c) A simply supported rectangular beam with a span of 20 ft has a width b = 14 in., an effective depth of d = 17.5 in., and a total depth of h = 20 in. It is made using concrete of f_c' = 5.0 ksi and steel of f_y = 60 ksi. The concrete modulus of rupture f_r = 530 psi. The elastic moduli of the concrete and steel are respectively, E_c = 4030 ksi and E_s = 29000 ksi. The tensile steel consists of four No. 8 bars. Assume n = 7.

(i) Determine the cracking moment M_{cr} **(10)**

(ii) Find the maximum service load moment that can be resisted without stressing the concrete above 0.45 f_c' or the steel above 0.4 f_y. **(10)**

2. (a) Why must a certain minimum thickness of concrete cover be maintained outside the reinforcing steel? What are the ACI/BNBC requirements for concrete covers for beams and slabs? **(7)**

(b) If f_c' = 4 ksi, f_y = 60 ksi, find the following **(8)**

(i) Balanced reinforcement ratio, ρ_b

(ii) Maximum reinforcement ratio, $\rho_{max} = \rho_{0.004}$

(iii) Reinforcement ratio, $\rho_{0.005}$

(iv) Minimum reinforcement ratio, ρ_{min}

(c) A beam section is limited to width b = 14 in. and total depth h = 29 in. Calculate the required reinforcement if the beam has to resist a factored moment M_u = 750 kip-ft. **(20)**

Contd P/2

CE 315

Contd... Q. No. 2(c)

Assume two layers of tensile reinforcement with d = 25 in. and d_t = 26.5 in. Also, assume d' = 2.5 in. if compression steel is required.

Given: f_c' = 4 ksi, f_y = 60 ksi.

3. (a) A floor system consists of a 6 in. slab supported by continuous T-beams with 25 ft span and centre-to-centre spacing of 12 ft. 6 in. as shown in Fig. 1. Web dimensions as determined by negative moment requirements at support are b_w = 12. and d = 21 in. What tensile reinforcement is required at midspan to resist a factored moment M_u = 500 kip-ft? Also, check minimum reinforcement and ε_t. **(15)**

   Given: f_c' = 3 ksi, f_y = 60 ksi.

   (b) A rectangular RC beam as shown in Fig. 2 measures 14 in. wide and has an effective depth of 26 in. Tension steel consists of Eight No. 10 bars in two layers (d = 26 in., d_t = 27.5 in.) and compression steel consists of Three No. 9 bars is located 2.5 in. from the compression face. Find the nominal and design moment capacities of the beam according to ACI/BNBC code? Check for yielding of compression steel and ε_t. **(20)**

   Given: f_c' = 4 ksi, f_y = 60 ksi.

4. (a) A rectangular beam carries a service live load (unfactored) of 2.0 kip/ft and an unfactored superimposed dead load of 1.0 kip/ft (in addition to self-weight of the beam) on a 22ft simple span. The beam will have a cross-section of 12" × 24" for architectural reason. Design the beam for flexure using USD method. **(15)**

   Given: f_c' = 3.0 ksi, f_y = 60 ksi.

   (b) A rectangular beam has a width 14 in. and an effective depth 24.0 in. as shown in Fig. 3. It is reinforced with eight No. 9 bars in two rows (d = 24.0", d_t = 25.5"). What is the nominal flexural strength M_n and what is the maximum moment φM_n that can be utilized in the design? **(14)**

   Given: f_c' = 5.0 ksi, f_y = 60 ksi.

   (c) What are primary and secondary torsion? What is the difference? Explain. **(6)**

Contd P/3

CE 315

SECTION – B

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

Assume reasonable values for any missing data.

5. (a) Design one-way slab as shown in Fig. 4 for service live load 100 psf. Consider floor finish load 30 psf and partition wall load 50 psf excluding self weight of the slab. Material strengths are f_c' = 3500 psi and f_y = 60,000 psi. Moment co-efficients are shown in Fig. 4. Show the slab reinforcements with neat sketch. **(23)**

   (b) Explain temperature and shrinkage reinforcements and discuss their necessity in RC designs with reference to slabs. **(12)**

6. (a) Design a singly reinforced beam for the loads shown in Fig. 5. All loads are factored. Assume f_c' = 3000 psi ; f_y = 60,000 psi ; b = 12" and $\rho = 0.6\ \rho_{max}$. **(15)**

   (b) Design the shear reinforcements (stirrups) for the beam in Q. 6(a). Calculate stirrups with 3 sets of spacing. Show the stirrups with neat sketch. **(20)**

7. (a) Design a slab of panel 20 ft by 24 ft to support a uniform live load of 100 psf. The panel is a corner panel of a group. Consider partition wall load 50 psf ; floor finish load 35 psf in addition to self weight of slab. Material strengths : f_c' = 3.0 ksi ; f_y = 60.0 ksi. Use ACI moment co-efficients from Supplied tables. Show the slab reinforcements with neat sketch. **(25)**

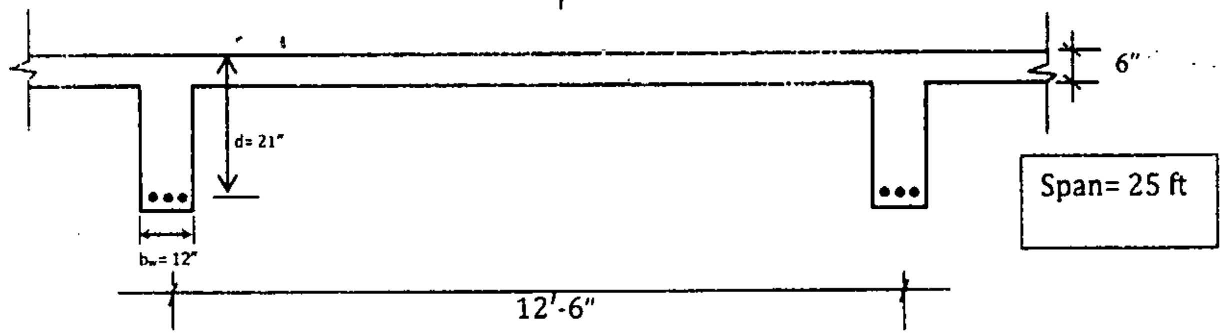
   (b) Discuss in short about the special reinforcements provided at exterior corners of a two-way slab system. **(10)**

8. (a) Discuss briefly the factors that influence development length of a reinforcing bar. **(10)**

   (b) Calculate the development length for 16 mm and 25 mm uncoated bars, when f_c' = 3.5 ksi and f_y = 6.0 ksi. **(10)**

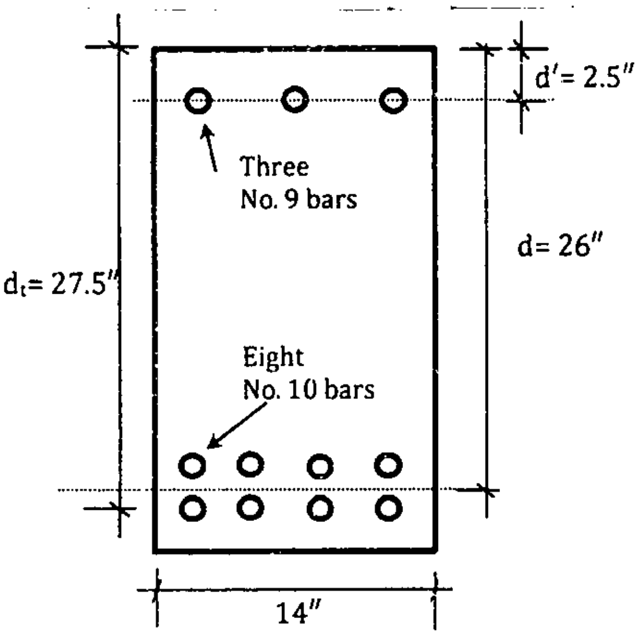
   (c) What are the minimum length of lap for column splices as per ACI/BNBC code? **(7)**

   (d) Show with neat sketches cut off or bend points for bars in approximately equal spans with uniformly distributed loads. **(8)**



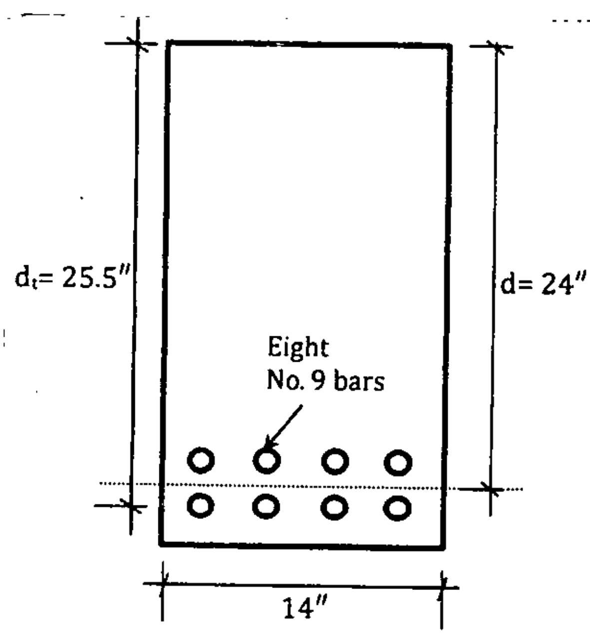
Given:
f_c' = 3 ksi
f_y = 60 ksi

Fig. 1



Given:
f_c' = 4.0 ksi
f_y = 60 ksi

Fig. 2



Given:
f_c' = 5.0 ksi
f_y = 60 ksi

Fig. 3

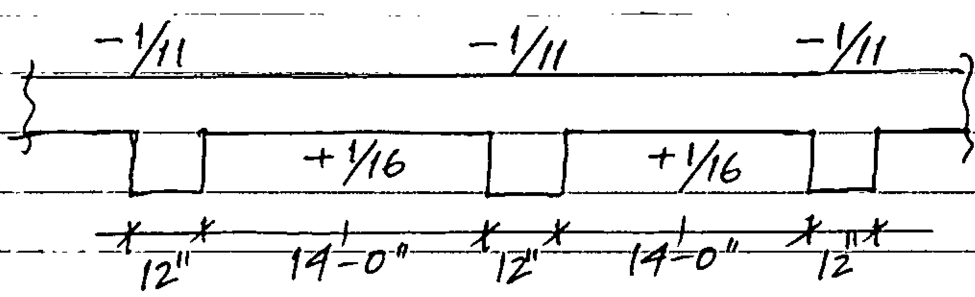
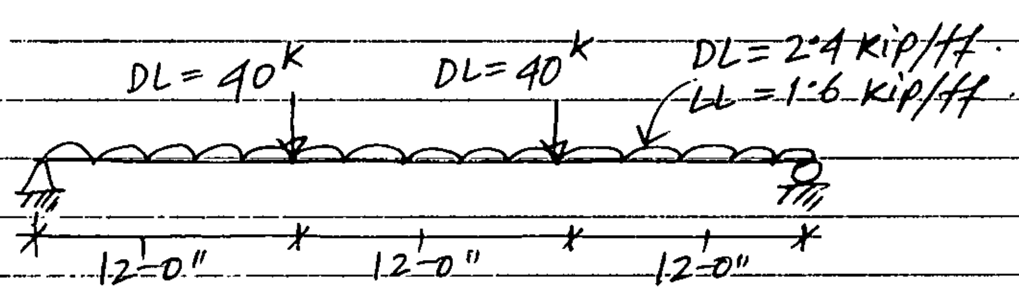


Fig. 4: Cross-section of One-way Slab.



All loads are factored.
Dead load including self wt. of beam

Fig. 5

Table 4.2 Coefficients for negative moments in slabs*

$M_{A\,neg} = C_{A\,neg} \times w \times A^2$
$M_{B\,neg} = C_{B\,neg} \times w \times B^2$ } where w = total uniform dead plus live load

Ratio $m = \frac{A}{B}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{A\,neg}$		0.045		0.050	0.075	0.071		0.033	0.061
	$C_{B\,neg}$		0.045	0.076	0.050			0.071	0.061	0.033
0.95	$C_{A\,neg}$		0.050		0.055	0.079	0.075		0.038	0.065
	$C_{B\,neg}$		0.041	0.072	0.045			0.067	0.056	0.029
0.90	$C_{A\,neg}$		0.055		0.060	0.080	0.079		0.043	0.068
	$C_{B\,neg}$		0.037	0.070	0.040			0.062	0.052	0.025
0.85	$C_{A\,neg}$		0.060		0.066	0.082	0.083		0.049	0.072
	$C_{B\,neg}$		0.031	0.065	0.034			0.057	0.046	0.021
0.80	$C_{A\,neg}$		0.065		0.071	0.083	0.086		0.055	0.075
	$C_{B\,neg}$		0.027	0.061	0.029			0.051	0.041	0.017
0.75	$C_{A\,neg}$		0.069		0.076	0.085	0.088		0.061	0.078
	$C_{B\,neg}$		0.022	0.056	0.024			0.044	0.036	0.014
0.70	$C_{A\,neg}$		0.074		0.081	0.086	0.091		0.068	0.081
	$C_{B\,neg}$		0.017	0.050	0.019			0.038	0.029	0.011
0.65	$C_{A\,neg}$		0.077		0.085	0.087	0.093		0.074	0.083
	$C_{B\,neg}$		0.014	0.043	0.015			0.031	0.024	0.008
0.60	$C_{A\,neg}$		0.081		0.089	0.088	0.095		0.080	0.085
	$C_{B\,neg}$		0.010	0.035	0.011			0.024	0.018	0.006
0.55	$C_{A\,neg}$		0.084		0.092	0.089	0.096		0.085	0.086
	$C_{B\,neg}$		0.007	0.028	0.008			0.019	0.014	0.005
0.50	$C_{A\,neg}$		0.086		0.094	0.090	0.097		0.089	0.088
	$C_{B\,neg}$		0.006	0.022	0.006			0.014	0.010	0.003

*A cross-hatched edge indicates that the slab continues across or is fixed at the support; an unmarked edge indicates a support at which torsional resistance is negligible.

Table 4.3 Coefficients for dead-load positive moments in slabs*

$M_{A\,pos\,DL} = C_{A\,DL} \times w \times A^2$
$M_{B\,pos\,DL} = C_{B\,DL} \times w \times B^2$ } where w = total uniform dead load

Ratio $m = \frac{A}{B}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{A\,DL}$	0.036	0.018	0.018	0.027	0.027	0.033	0.027	0.020	0.023
	$C_{B\,DL}$	0.036	0.018	0.027	0.027	0.018	0.027	0.033	0.023	0.020
0.95	$C_{A\,DL}$	0.040	0.020	0.021	0.030	0.028	0.036	0.031	0.022	0.024
	$C_{B\,DL}$	0.033	0.016	0.025	0.024	0.015	0.024	0.031	0.021	0.017
0.90	$C_{A\,DL}$	0.045	0.022	0.025	0.033	0.029	0.039	0.035	0.025	0.026
	$C_{B\,DL}$	0.029	0.014	0.024	0.022	0.013	0.021	0.028	0.019	0.015
0.85	$C_{A\,DL}$	0.050	0.024	0.029	0.036	0.031	0.042	0.040	0.029	0.028
	$C_{B\,DL}$	0.026	0.012	0.022	0.019	0.011	0.017	0.025	0.017	0.013
0.80	$C_{A\,DL}$	0.056	0.026	0.034	0.039	0.032	0.045	0.045	0.032	0.029
	$C_{B\,DL}$	0.023	0.011	0.020	0.016	0.009	0.015	0.022	0.015	0.010
0.75	$C_{A\,DL}$	0.061	0.028	0.040	0.043	0.033	0.048	0.051	0.036	0.031
	$C_{B\,DL}$	0.019	0.009	0.018	0.013	0.007	0.012	0.020	0.013	0.007
0.70	$C_{A\,DL}$	0.068	0.030	0.046	0.046	0.035	0.051	0.058	0.040	0.033
	$C_{B\,DL}$	0.016	0.007	0.016	0.011	0.005	0.009	0.017	0.011	0.006
0.65	$C_{A\,DL}$	0.074	0.032	0.054	0.050	0.036	0.054	0.065	0.044	0.034
	$C_{B\,DL}$	0.013	0.006	0.014	0.009	0.004	0.007	0.014	0.009	0.005
0.60	$C_{A\,DL}$	0.081	0.034	0.062	0.053	0.037	0.056	0.073	0.048	0.036
	$C_{B\,DL}$	0.010	0.004	0.011	0.007	0.003	0.006	0.012	0.007	0.004
0.55	$C_{A\,DL}$	0.088	0.035	0.071	0.056	0.038	0.058	0.081	0.052	0.037
	$C_{B\,DL}$	0.008	0.003	0.009	0.005	0.002	0.004	0.009	0.005	0.003
0.50	$C_{A\,DL}$	0.095	0.037	0.080	0.059	0.039	0.061	0.089	0.056	0.038
	$C_{B\,DL}$	0.006	0.002	0.007	0.004	0.001	0.003	0.007	0.004	0.002

*A cross-hatched edge indicates that the slab continues across or is fixed at the support; an unmarked edge indicates a support at which torsional resistance is negligible.

Table 4.4 Coefficients for live-load positive moments in slabs*

$$\left.\begin{aligned} M_{A,pos,LL} &= C_{A,LL} \times w \times A^2 \\ M_{B,pos,LL} &= C_{B,LL} \times w \times B^2 \end{aligned}\right\} \text{where } w = \text{total uniform live load}$$

Ratio $m = \frac{A}{B}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{A,LL}$	0.036	0.027	0.027	0.032	0.032	0.035	0.032	0.028	0.030
	$C_{B,LL}$	0.036	0.027	0.032	0.032	0.027	0.032	0.035	0.030	0.028
0.95	$C_{A,LL}$	0.040	0.030	0.031	0.035	0.034	0.038	0.036	0.031	0.032
	$C_{B,LL}$	0.033	0.025	0.029	0.029	0.024	0.029	0.032	0.027	0.025
0.90	$C_{A,LL}$	0.045	0.034	0.035	0.039	0.037	0.042	0.040	0.035	0.036
	$C_{B,LL}$	0.029	0.022	0.027	0.026	0.021	0.025	0.029	0.024	0.022
0.85	$C_{A,LL}$	0.050	0.037	0.040	0.043	0.041	0.046	0.045	0.040	0.039
	$C_{B,LL}$	0.026	0.019	0.024	0.023	0.019	0.022	0.026	0.022	0.020
0.80	$C_{A,LL}$	0.056	0.041	0.045	0.048	0.044	0.051	0.051	0.044	0.042
	$C_{B,LL}$	0.023	0.017	0.022	0.020	0.016	0.019	0.023	0.019	0.017
0.75	$C_{A,LL}$	0.061	0.045	0.051	0.052	0.047	0.055	0.056	0.049	0.046
	$C_{B,LL}$	0.019	0.014	0.019	0.016	0.013	0.016	0.020	0.016	0.013
0.70	$C_{A,LL}$	0.068	0.049	0.057	0.057	0.051	0.060	0.063	0.054	0.050
	$C_{B,LL}$	0.016	0.012	0.016	0.014	0.011	0.013	0.017	0.014	0.011
0.65	$C_{A,LL}$	0.074	0.053	0.064	0.062	0.055	0.064	0.070	0.059	0.054
	$C_{B,LL}$	0.013	0.010	0.014	0.011	0.009	0.010	0.014	0.011	0.009
0.60	$C_{A,LL}$	0.081	0.058	0.071	0.067	0.059	0.068	0.077	0.065	0.059
	$C_{B,LL}$	0.010	0.007	0.011	0.009	0.007	0.008	0.011	0.009	0.007
0.55	$C_{A,LL}$	0.088	0.062	0.080	0.072	0.063	0.073	0.085	0.070	0.063
	$C_{B,LL}$	0.008	0.006	0.009	0.007	0.005	0.006	0.009	0.007	0.006
0.50	$C_{A,LL}$	0.095	0.066	0.088	0.077	0.067	0.078	0.092	0.076	0.067
	$C_{B,LL}$	0.006	0.004	0.007	0.005	0.004	0.005	0.007	0.005	0.004

*A cross-hatched edge indicates that the slab continues across or is fixed at the support; an unmarked edge indicates a support at which torsional resistance is negligible.

L-3/T-1/CE **Date: 19/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2020-2021

Sub: **CE 331** (Environmental Engineering I)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Describe with sketch the essential elements of a water supply system. **(15)**

(b) Discuss briefly how do the following factors affect in determining per captia water consumption: **(10)**

(i) Rates and Metering
(ii) Nature of supply
(iii) Water quality
(iv) Climatic condition

(c) Determine the quantity of water for fire-fighting using knichling formula in an area of a city with a population of 10,000. How many fire streams may be called into use at the same time in that area? **(10)**

2. (a) How can an Environmental Engineer contribute in conserving and maintaining the environmental quality? Explain. **(7+8=15)**

Describe the importance of 'Climate Change' in Bangladesh perspective.

(b) State SDG 6 and Target 6.1. **(3+7=10)**

Describe the 'equity issue' in water supply sector of Bangladesh.

What is your opinions in overcoming the challenges to achieve SDG target? Describe.

(c) An elevated cylindrical water tank of 1 lac gallon capacity has to be designed. Determine the economic dimension considering the concrete work per sft in the floor and wall of the tank (shell) costs Tk. 1200/- and Tk. 1800/- respectively. **(10)**

3. (a) Describe the importance of Rain Water Harvesting (RWH) in the context of rapid urbanization and climate change in Bangladesh. State the rules of BNBC 2020 in implementing RWH system. **(9+6=15)**

(b) A two level six storied residential concrete building as shown in Figure 1 should have RWH system according to BNBC 2020 rule. The number of residents is 36 and potable and non-potable water demand are 20 lpcd and 100 lpcd respectively. The rainfall distribution throughout the year is shown in Table 1. Determine the size of underground rainwater storage tank considering the demand and supply approach. In your opinion which approach is economical to adopt and why? **(20)**

(Assume any reasonable value of missing data if necessary.)

Contd P/2

4. (a) Write short notes on: **(12)**
   (i) Intake
   (ii) Role of water vapor in Global Warming
   (iii) Bio-diversity conservation
   (iv) Pond Sand Filter.

(b) A submersible pump has to be installed to withdraw and supply water to an elevated water tank. Determine the pump capacity for the following data: **(13)**

Daily water demand: 7,50,000 litres
Daily pumping hours: 8
Water Table below Ground level: 20 m
Maximum depression on pumping level: 5 m
Ht. of Water Tank above GL: 30 m
Maximum depth of water in the tank: 4 m
Distance between pump station and tank: 50 m
Diameter of discharge and suction pipe: 200 mm
Pump efficiency: 70%

(Use Darcy's equation for frictional loss and assume any reasonable value of missing data, if necessary.)

(c) What factors should be considered in the selection of the type of pump? Why should $NPSH_{available}$ be greater than $NPSH_{required}$? Explain. **(5+5=10)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.
Assume reasonable values for parameter not given. One Figure is attached.

5. (a) A settling column analysis of a flocculent suspension has been carrier out. The resulting removal percentages of suspended solids (SS) at different depths of the column have been plotted as iso-removal lines as shown in the attached Figure. Estimate the overall removal efficiency of SS in a settling basin having a depth of 3 m and a detention time of 20 minutes. **(12)**

[**Note**: Attached the worked out version of the attached Figure with your Answer Script]

(b) How do the filter materials used in SSF and RSF differ? What are the purposes of a Rouging filter? **(7)**

(c) What are the purposes of "dual media filters" and "mixed or multi-media filters"? How do such filters achieve the desired gradation after backwashing? Explain. **(8)**

(d) Discuss briefly with sketches the salt water intrusion in the coastal areas of Bangladesh. **(8)**

Contd P/3

6. (a) With appropriate sketches/figures, describe the destabilization of colloidal particles by "double layer compression" and "adsorption and charge neutralization". What do you understand by "sweep coagulation"? **(16)**

(b) Deduce a mathematical expression for the yield of a well in an unconfined aquifer. **(11)**

(c) What is water hammer? Explain the phenomenon of water hammer using suitable sketches. **(8)**

7. (a) State the advantages and disadvantages of ion exchange process for softening compared to the lime-soda softening process. What is the difference between Reverse Osmosis (RO) and Electro-dialysis? **(7)**

(b) Determine the lime and soda-ash dose in mg/l as $CaCO_3$ to soften the following water to a final hardness of 60 mg/l as $CaCO_3$. The ion concentrations (all in mg/l as $CaCO_3$) in the water are given below: **(15)**

Ca = 225
Mg = 70
HCO_3^- = 264
CO_2 = 19

(c) Critically examine the merits and demerits of groundwater and surface water as sources of municipal water supply. **(8)**

(d) Discuss briefly the causes of corrosion in metallic water pipes. **(5)**

8. (a) Draw appropriate process flow diagram(s) for the simultaneous removal of iron and arsenic from groundwater having high Alkalinity (>130 mg/l as $CaCO_3$) and no organic matter. What process modifications would you suggest if the water also contains high concentration of manganese? State the purpose of each step in your process flow diagrams. **(17)**

(b) A water contains 105 mg/l bicarbonate at a pH of 10.3. If he water has a total hardness of 310 mg/l as $CaCO_3$, calculate the total alkalinity, carbonate hardness and non-carbonate hardness of the water. Relevant equations are as follows: **(6)**

$$K_w = \{H^+\}\{OH^-\} = 10^{-14}$$
$$H_2CO_3 = HCO_3^- + H^+; \quad K_1 = 10^{-6.3}$$
$$HCO_3^- = CO_3^{2-} + H^+; \quad K_2 = 10^{-10.3}$$

(c) From jar test experiment, the optimum dose of the coagulant $FeCl_3$ has been estimated at 28 mg/l. Estimate the amount of Alkalinity that would be consumed at this optimal dose. Consider the following equation: **(6)**

$$FeCl_3 + 3HCO_3^- + 3H_2O = Fe(OH)_3.3H_2O(s) + 3CO_2 + 3Cl^-$$

[Given: atomic wts: Fe = 55.85; Cl = 35.45]

(d) With regard to water pollutants/contaminants, what do you understand by POPs and CECs? Give examples. **(6)**

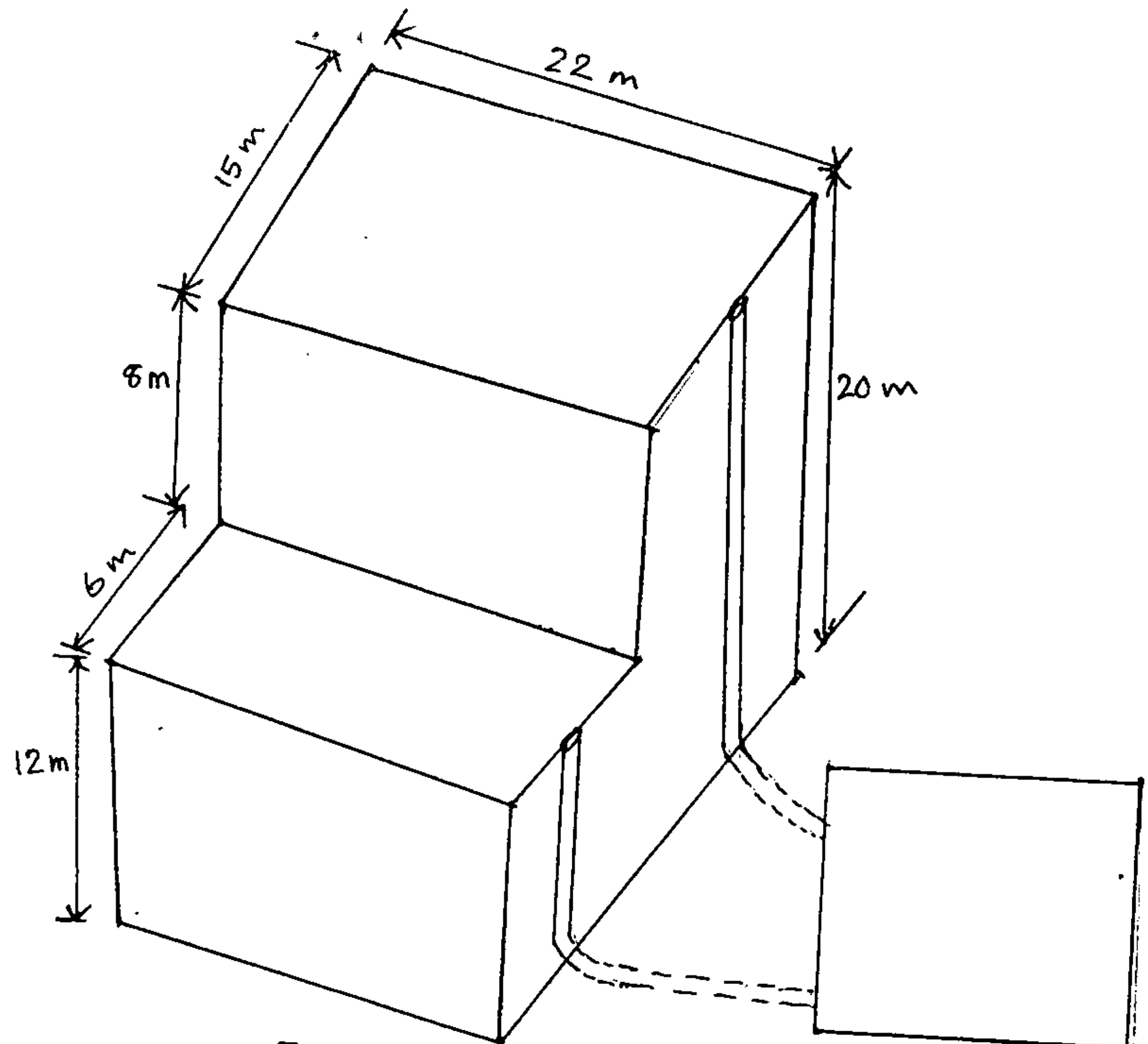


Figure 1

Month	Jan	Feb	March	April	May	June	July	August	Sept	Octo	Nov	Decem
Rainfall (mm)	5	24	53	200	250	400	590	490	210	140	61	12

Table 1 : Rainfall Distribution

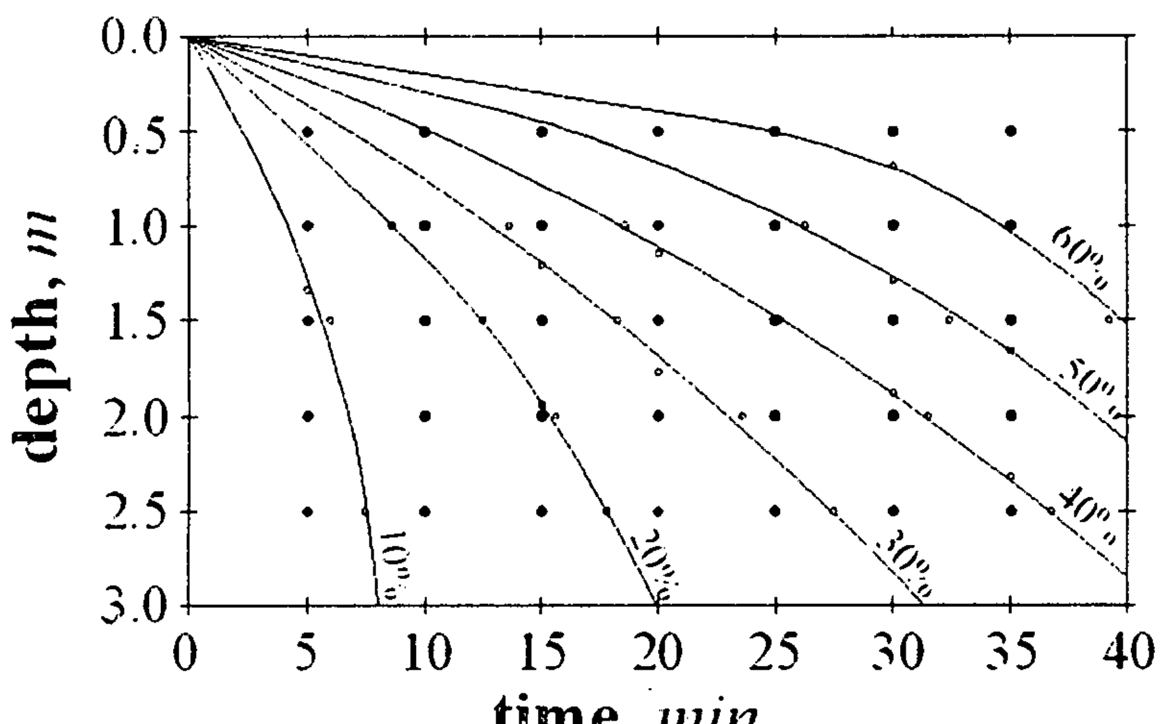


Figure for Question Number 5(a)
[Attach worked out version of this figure with your Answer Script]

L-3/T-1/CE **Date : 15/10/2022**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2020-2021

Sub : **CE 341** (Principles of Soil Mechanics)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Using phase diagram, show that for a saturated soil, $\gamma_b = \gamma_w (G_s + e)/(1 + e)$. The symbols carry their usual meanings. **(12)**

(b) From field density test on a compacted clay layer, the bulk unit weight was found as 121 lb/ft^3 and the moisture content was 12.5%. The specified relative compaction is 90% or more. Standard Proctor Compaction was performed on the same soil and it produced a maximum dry unit weight of 118 lb/ft^3 and optimum moisture content of 14%. Is the field compaction acceptable as per the specifications? **(10)**

(c) A sheet pile wall penetrates 4 m into a permeable soil stratum with coefficient of permeability of 5×10^{-6} m/s (Fig. 1). The permeable stratum extends upto 8 m from the ground level and is underlain by an impermeable stratum. The water level on the upstream and downstream side are 6 m and 1 m above the ground level. Draw a flow net and find the seepage flow per meter length of sheet pile wall per day. Also, determine the exit gradient and check stability against failure by piping. **(18)**

(d) Draw qualitative diagrams showing the variation of laboratory compaction curves for different soil types. **($6\frac{2}{3}$)**

2. (a) A cylindrical pipe, 30 cm long and 6 cm in internal diameter, is fitted with a screen at the bottom and is open at the top. The pipe is filled with three distinct layers of sand each of thickness 5 cm. The coefficient of permeability of the top, intermediate and bottom layers are 3×10^{-4} cm/s, 4×10^{-4} cm/s and 6×10^{-4} cm/s, respectively. The cylinder is filled with water up to its top and the water level is maintained at that position by external supply of water. Determine the equivalent coefficient of permeability of the sand assembly and the volume of water that will flow through the sand layers in 5 minutes. **(15)**

(b) A soil in a location consists of clay upto a depth of 3 m from the ground level underlain by a sand layer. The water table is at 2 m below the ground level. The unit weight of the clay layer above and below water table are respectively, 15 kN/m^3 and 18 kN/m^3. The unit weight of the sand layer is 20 kN/m^3. Draw a schematic diagram of the soil profile. Also, draw the total and effective vertical stress diagram, showing the controlling ordinates, upto a depth of 10 m below the ground surface. **(15)**

Contd P/2

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Contd ... Q. No. 2

(c) Explain the effect of sample disturbance on the compression index obtained from laboratory one-dimensional consolidation test. Also, state the process of establishing field $e \sim \log(p)$ curve from the laboratory results for NC clay of low to medium plasticity. **($6\frac{2}{3}$+10)**

3. (a) A soil profile is shown in Fig. 1(a). If 4 m fill of density 18 kN/m^3 is placed on the ground surface, determine the total consolidation settlement of the clay layer. **(18)**

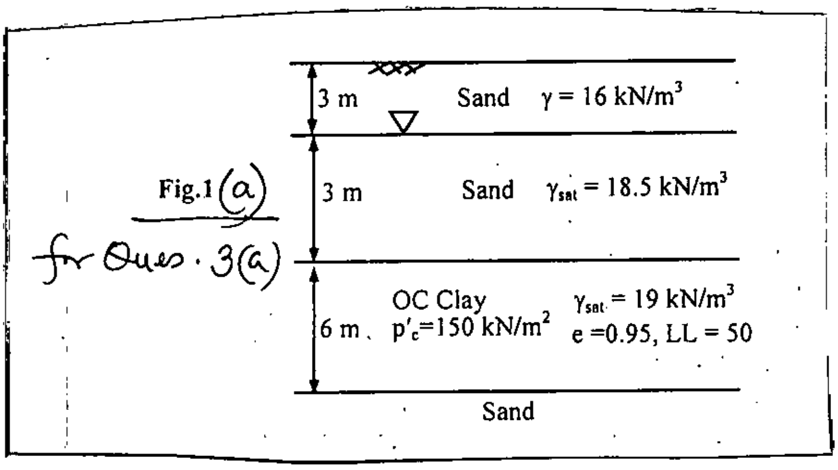

Fig.1(a) for Ques. 3(a)

(b) Two clay layers A and B are, respectively, 4 m and 5 m thick. Both layers have permeable boundaries at top and bottom. The time taken for the clay layer A to reach 90% consolidation is 130 days. Calculate the time that will be required for clay layer B to reach the same degree of consolidation, if the coefficient of consolidation of layer B is 1.5 times that of layer A. **($12\frac{2}{3}$)**

(c) State the basic properties of flow net. **(10)**

(d) Discuss the distribution of contact pressure and settlement below flexible foundations on sand and clay. **($6\frac{2}{3}$)**

4. (a) How laboratory compaction results are utilized for specifying and controlling field compaction? Mention various type of rollers along with their suitability for compacting different soil types. **($6\frac{2}{3}$+8)**

(b) Write short notes on (i) Average degree of consolidation (ii) Secondary consolidation. **(10)**

(c) Compare the vertical stress increase with depth below circular, square and strip footing. **(8)**

(d) A rectangular area 2 m by 3 m (Fig. 2) is subjected to a uniformly distributed load of 150 kPa. Determine the increase in stress at a depth of 2 m below point P as shown in the figure. Use Fadum's chart for Newmark's influence coefficient (Fig. 3). **(14)**

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Contd ... Q. No. 4(d)

Fig.2

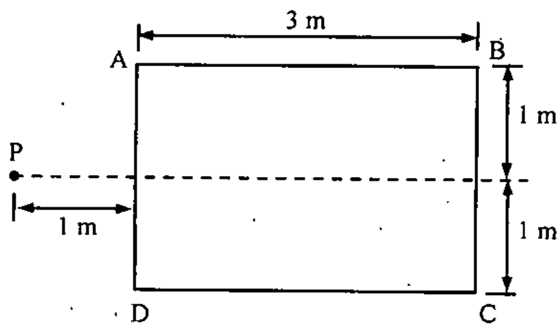
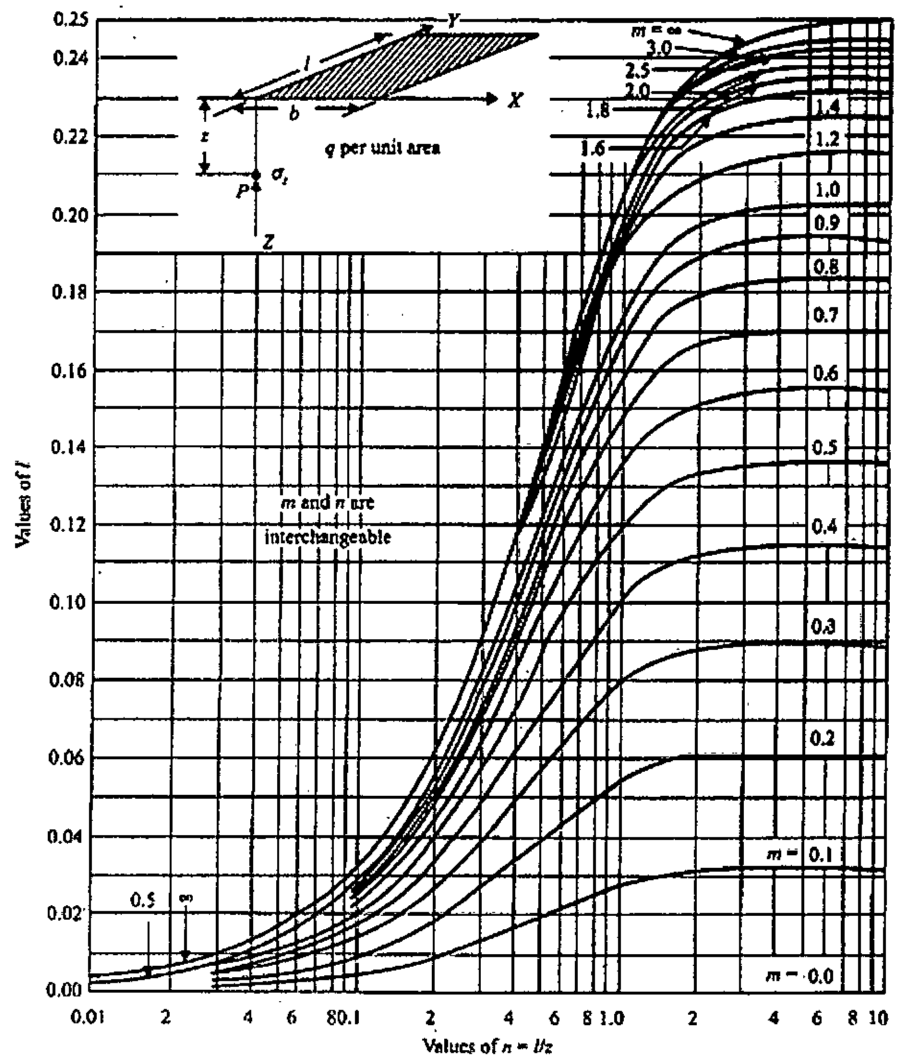


Fig.3



Fadum's chart for obtaining Newmark's influence coefficient, I

Fig. 2 and 3 for Ques. 4(d)

SECTION – B

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

Assume reasonable value of missing data, if any. Use attached Chart where necessary.

5. (a) Draw neatly the Plasticity Chart according to Unified Soil Classification System (USCS) showing the classifications of important soil deposits. **($9\frac{2}{3}$)**

(b) Liquid limit test was carried out on a silty clay sample using Casagrande's apparatus and the following results were obtained: **(18)**

No. of blows (N)	15	19	24	30	35
Water Content (%)	66.9	64.6	62.4	60.2	58.7

Plot the flow curve and determine the liquid limit of the sample. Also, compute the flow index of the sample.

Contd P/4

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Contd ... Q. No. 5

(c) For a soil, the following results were obtained from grain size distribution and Atterberg limit tests: **(9)**

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

Liquid Limit = 53%

Plastic limit = 24%

Classify the soil based on AASHTO soil classification system.

(d) Explain the following: **(10)**

(i) Thixotrophy (ii) Critical void ratio

6. (a) Classify the following two inorganic soils according to Unified Soil Classification System: **(13)**

Soil A : Percent finer No. 200 sieve (0.075 mm) = 93

Liquid Limit = 53%

Plastic limit = 23%

Soil B : Percent finer No. 4 sieve (4.75 mm) = 92

Percent finer No. 200 sieve (0.075 mm) = 10

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

<u>Consistency limit of fraction passing No. 200 sieve</u>

Liquid Limit = 38%

Plastic limit = 27%

(b) The following results were obtained in a consolidated drained (CD) direct shear test carried out on a clay sample. **($17\frac{2}{3}$)**

Specimen No.	Normal Load (kg)	Peak Shear force (N)
1	8	106
2	16	149
3	32	235

Diameter and height of each specimen were 63.5 mm and 25 mm, respectively. Draw the failure envelope and determine the values of effective shear strength parameters from it. Also, comment on the stress history of the sample.

(c) Draw the following qualitative curves: **(10)**

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

(ii) Volumetric strain versus axial strain for saturated samples of loose sand and dense sand in consolidated drained (CD) direct shear tests.

(iii) Skempton's pore pressure parameter A at failure (A_f) versus overconsolidation ratio (OCR).

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

Contd P/5

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Contd ... Q. No. 6(c)

(d) Liquid limit of a soil in air-dry state and oven-dry state were found to be 84% and 58%, respectively. Plastic limit of the soil in air-dry state was 45%. What is the group symbol and group name of the soil according to Unified Soil Classification System (USCS)? **(6)**

7. (a) Explain the concepts of Rankine's active earth pressure and passive earth pressure. **(10)**

(b) A smooth vertical wall of height 10 m retains a soft clay backfill of unit weight 16.5 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: **(14)**

(i) Unsupported height of the wall.

(ii) Active earth force after tension crack forms

Also, draw the active earth pressure diagram.

(c) State the assumptions in Coulomb's theory of earth pressure. Also, deduce an expression for passive earth pressure due to a cohesive frictional (c-ϕ) backfill. **($10\frac{2}{3}$)**

(d) A specimen of normally consolidated clay sample was fully consolidated in the triaxial cell under a cell pressure of 300 kN/m^2. Pore pressure within the specimen at the end of consolidation was zero. Then, under undrained conditions the cell pressure was increased to 400 kN/m^2 and deviator stress was applied and increased until failure took place. Pore pressure parameters B and A_f of the specimen were found to be 0.95 and 0.4, respectively. If effective angle of internal friction (ϕ') of the specimen is 30°, what would be the value of deviator stress at failure for this specimen? **(12)**

8. (a) Describe briefly the behavior of saturated clay samples in unconsolidated undrained (UU) triaxial compression test. Also, show with neat sketches two examples of consolidated undrained (CU) analyses in clays. **($10\frac{2}{3}$)**

(b) The following results were obtained at failure in a series of consolidated undrained (CU) triaxial compression tests performed on three specimens of a saturated clay sample: **(18)**

Specimen No.	Cell pressure (kN/m^2)	Deviator Stress (kN/m^2)	Pore Pressure (kN/m^2)
1	75	200	25
2	150	272	50
3	300	418	100

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Contd ... Q. No. 8(b)

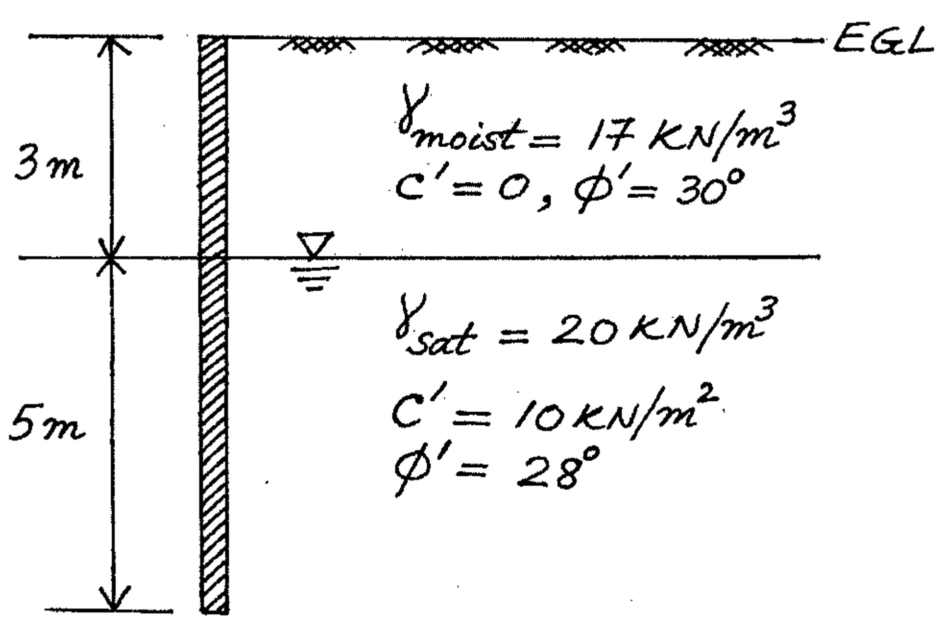
Draw the Modified Failure Envelope and hence estimate the values of effective shear strength parameters c′ and ϕ' from it. Also, write down the Mohr-Coulomb equation for the effective stress failure envelope.

(c) For the retaining wall of height 8 m shown in Fig. 4, draw Rankine's active pressure diagram and determine the total active earth force per metre length of the wall. If the backfill supports a uniformly distributed load of 30 kN/m^2, what will be the increase in active force per metre length of the wall? **(18)**

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 1 AASHTO Soil Classification System



~~Fig. 1~~ Fig. 4 For Ques. 8 (c)

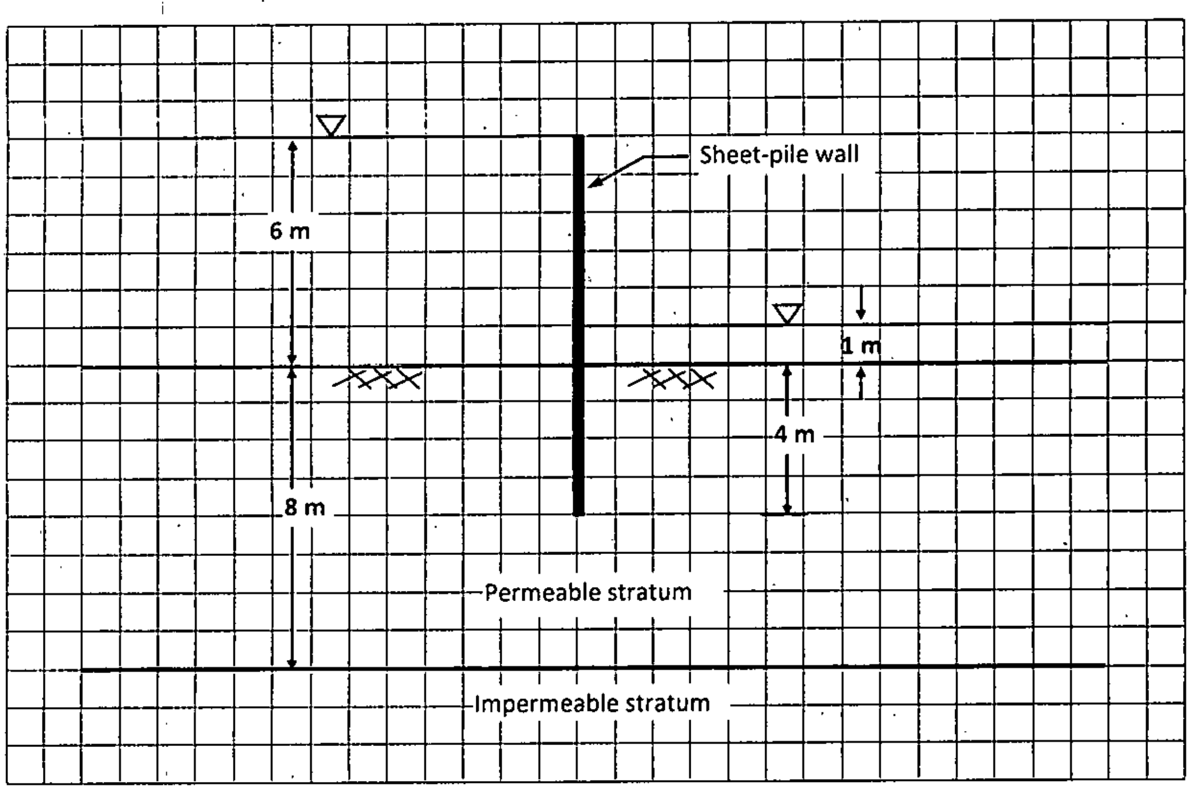


Fig. 1 (for Ques. 1(c))