L-3/T-1/WRE **Date: 19/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2018-2019

Sub: **WRE 301** (Open Channel Hydraulics)

Full Marks: 280 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**.

Assume any reasonable value, if missing.

1. (a) By using the trapezoidal rule of numerical integration, compute the discharge per unit width, the mean velocity for the following velocity measurements (u is the velocity at a distance d from the channel bottom) along a vertical in a wide channel, when the total depth is 8.0m. **(10)**

d (m)	0.0	0.45	1.00	2.05	3.90	4.75	6.10	7.15	8.00
u (m/s)	0.0	0.68	1.38	2.27	3.14	3.79	1.96	1.66	1.02

(b) Compute and compare the geometric properties of the (i) trapezoidal and (ii) triangular channel. Given (i) b = 2.75m, y= 1. 42m and z = 2, (ii) y = 3.45 m and z = 3. **(8)**

(c) Compute the values of the distribution coefficients α and β for the velocity distribution $u = 3.0 + 4.0\frac{z}{y}(m/s)$ along a vertical in a wide channel when the depth of flow in the channel is 2.0m. **(12)**

(d) Define: (i) Non prismatic channel, (ii) Stage, and (ii) Mobile boundary channel. **(9)**

(e) Show that the total pressure head can be expressed as

$$\text{Total pressure head} = y\left(1 \pm \frac{1}{g}\frac{V^2}{r}\right)$$ **($7\frac{2}{3}$)**

2. (a) Prove that at minimum specific energy the critical flow occurs. **(8)**

(b) Find the critical depth for rectangular channel. **($8\frac{2}{3}$)**

(c) Water is flowing at a velocity of 1.20m/s and a depth of 1.50m in a long rectangular channel 2.50m wide. Compute (a) the height of a smooth upward step in the channel bed to produce critical flow, and (ii) the depth and change in water level produced by (i) a smooth upward step of 0.15m, and (ii) a smooth upward step of 0.75m. In all cases, neglect energy losses and take α =1.05. **(18)**

(d) A trapezoidal channel is given with b = 5.0m, z = 2 and Q = 14.0 m^3/s. Calculate the critical depth and velocity by Newton-Raphson method. Given α =1.00. **(12)**

Contd........... P/2

WRE 301

3. (a) The values of initial depth and sequent depth in connection with a hydraulic jump in a horizontal rectangular channel are 0.22m and 2.96m respectively. Compute the values of V_1 (m/s), V_2 (m/s), q (m^2/s), Fr_1, Fr_2 and h_L. **(12)**

(b) Derive the relationship for efficiency of a hydraulic jump. **($10\frac{2}{3}$)**

$$\frac{E_2}{E_1} = \frac{\left(1+8F_{r1}^2\right)^{3/2} - 4F_{r1}^2 + 1}{8F_{r1}^2\left(2+F_{r1}^2\right)}$$

(c) Define: (i) Dentated sill, and (ii) Stilling basing. **(6)**

(d) A horizontal trapezoidal channel is 6.0m wide and z = 2 carries a discharge of 80m^3/s. If the upstream depth of flow is 0.8m compute the downstream depth that will create a hydraulic jump in the channel. **(12)**

(e) A bridge has four piers with semicircular noses and tails, each 12m long and 3m wide. During a flood peak of 1200 m^3/s, the total width of the stream was 120m and the average depth in a downstream section was 5.9m. Estimate the afflux. **(6)**

4. (a) Show that the best hydraulic rectangular channel section is one half of a square. **(8)**

(b) What are the advantages of putting lining in an open channel? **(6)**

(c) A lined channel with n = 0.025 is to be laid on a slope of 1 in 1200. The side slope of the channel is to be maintained at 2.0H: 1.0V. Determine the section dimensions of a practical triangular section with rounded corners to carry a discharge of 35.0m^3/s. The maximum permissible velocity is 2.0m/s. **(12)**

(d) Using the Lacey method, design a stable alluvial channel when d_{50} = 0.6mm and Q = 10.0m^3/s. **(12)**

(e) The shear stress ratio K in the design by 'Tractive Force Method' can be expressed by side angle of the channel (ϕ) and angle of repose (Ψ) of the soil-prove. **($8\frac{2}{3}$)**

SECTION – B

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

The symbols and notations have their usual meanings
Assume reasonable value of any data, if required

5. (a) Define uniform flow. "Uniform flow can be steady only"–explain. Briefly describe spatially varied flow with relevant examples and figures. **(12)**

(b) Derive the Chezy formula with necessary assumption(s). **(8)**

(c) Briefly explain the factors affecting Manning roughness coefficient. **(10)**

(d) A channel consists of a main section and two side sections with respective roughness, energy and momentum coefficients as shown in Figure 1. Compute the total discharge and the mean velocity of flow for the entire section if the bed slope is 0.0002. Also compute the numerical values of n, α and β for the entire section. **($16\frac{2}{3}$)**

WRE 301

6. (a) Under what circumstances the slope-area method can be used to compute flood discharge. Mention the salient features to be considered during selection of a suitable channel reach to apply this method. **(10)**

(b) Compute the flood discharge through a river reach 1000 m long having a fall in water surface of 0.85m. Neglect the eddy loss. Use the following data: **($20\frac{2}{3}$)**

Section	A(m^2)	P(m)	n	α
Upstream	12000	2150	0.03	1.15
Downstream	10500	2050	0.03	1.18

(c) A rectangular channel is 6 m wide and laid on a slope of 0.25%. The channel is made of concrete (k_s = 1 mm) and carries water at a depth of 0.50 m. Determine the mean velocity, discharge and the state of flow. Also computer the velocity along a vertical at a depth of 0.20m from the water surface. Given that the von Karman constant is 0.40. **(16)**

7. (a) Derive the equation: **(12)**

$$\frac{dh}{dx} = S_o \frac{1-\left(\frac{h_n}{h}\right)^N}{1-\left(\frac{h_c}{h}\right)^M}$$

where the notations have their usual meanings.

(b) Deduce the expression for the length of the flow profile between two sections in a wide channel by Bresse method. Consider that the conveyance is expressed in terms of the Chezy formula. **(10)**

(c) What data or information are generally required in computing a flow profile? **(4)**

(d) A trapezoidal channel with bottom width of 5m, side slope = 1V: 2H, Manning roughness coefficient = 0.020 and bottom slope = 0.002 carries a discharge of 48.67m^3/s. A dam constructed across the channel raises the water level to a depth of 5 m just upstream of it. Show the resulting flow profile if h_c = 1.69 m and h_n = 2.02m. How far upstream or downstream from the dam will the depth be 4.90 m. Apply the direct step method. Assume uniform velocity distribution and neglect eddy loss. **($20\frac{2}{3}$)**

Contd............ P/4

WRE 301

8. (a) Draw the possible flow profile (s) in the following serial arrangements of channels: **(16)**

   (i) Steep-Mild-Critical

   (ii) Critical-Horizontal-Steep

   (iii) Steep-Critical-Mild

   (iv) Mild-Steep

   (b) Explain the theoretical behavior of flow profile when the depth approaches: **(10)**
   (i) normal depth and (ii) critical depth.

   (c) Derive the expression to compute normal depth for a triangular channel. **(10)**

   (d) For a trapezoidal channel with bottom width of 6m, side slope of 1V:2H and longitudinal slope of 0.001 carries a discharge of 14 m^3/s. Compute the normal depth by the method of Bisection for n=0.025. **($10\frac{2}{3}$)**

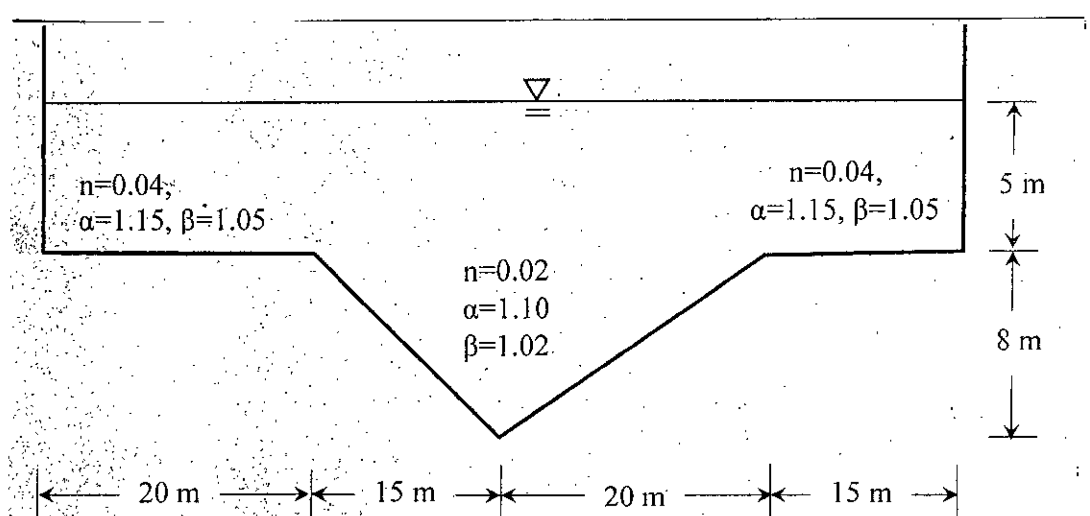


Figure 1 for Question 5(d)

L-3/T-1/WRE Date : 24/10/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **CE 321** (Structural Analysis and Design-I)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. For the plate girder bridge as shown in Figure 1, draw influence lines for all floor beam reactions (FBR_B, FBR_C, FBR_E, FBR_F and FBR_H), main girder reactions (R_B and R_H), shear in panel 'CE' (V_{CE}) and moment at 'D' (M_D) for the plate girder. Unit load moves over the stringer from 'A' to 'H'. **(28)**

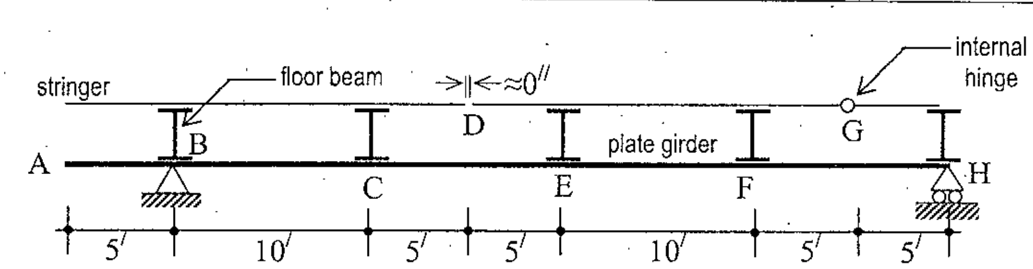


Figure 1

2. For the suspension bridge (having a stiffening girder of self-weight = 2 kip/ft), as shown in Figure 2; Determine the followings– **(28)**

(i) horizontal component of cable tension (H), (ii) maximum cable tension ($T_{maximum}$), (iii) support reactions at 'L' and 'R', (iv) uniform load on the cable (w_0), (v) hanger tensile force (F), and (vi) draw shear force and bending moment diagram for the left portion 'LI' of stiffening girder.

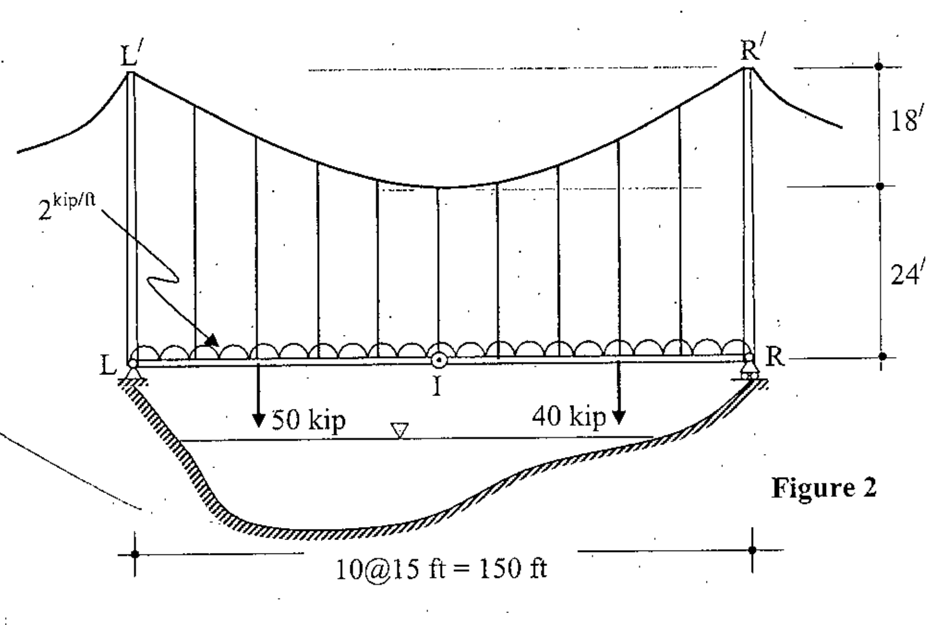


Figure 2

3. For the mill-bent, laterally loaded as shown in Figure 3, determine all reaction components at supports 'A' and 'C'. Also, draw axial force, shear force and bending moment diagram for the left column 'AB'. What will be the axial force in truss member 'JK'? **(28)**

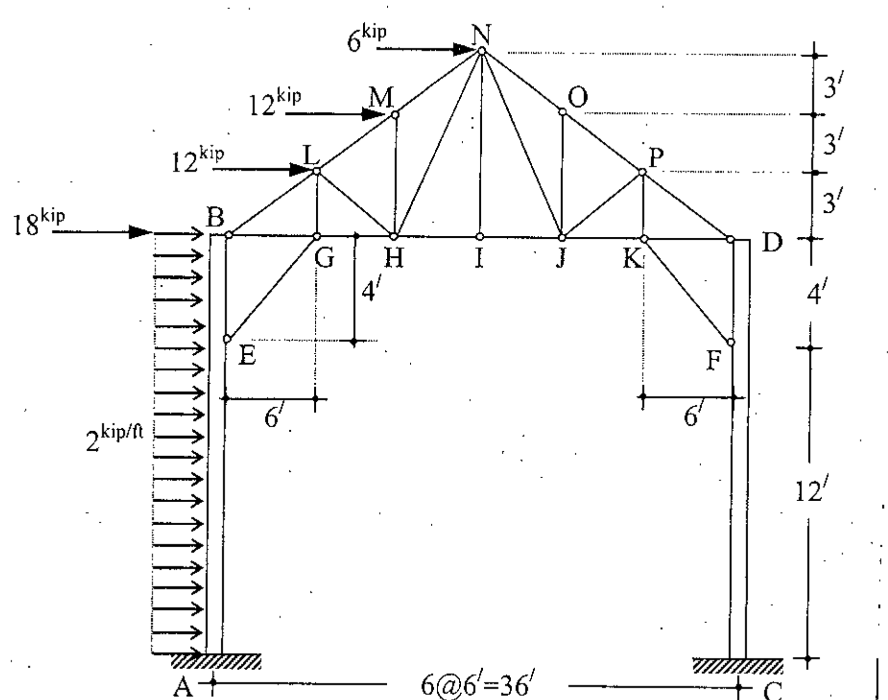


Figure 3

4. For the braced truss loaded as shown in Figure 4, determine– **(28)**

   (i) Member forces in diagonals CF and DE (mid-panel) assuming that diagonals can carry tensile force only.

   (ii) Member forces in diagonals EH & GF (top-panel) assuming that both diagonals can carry tension as well as compression.

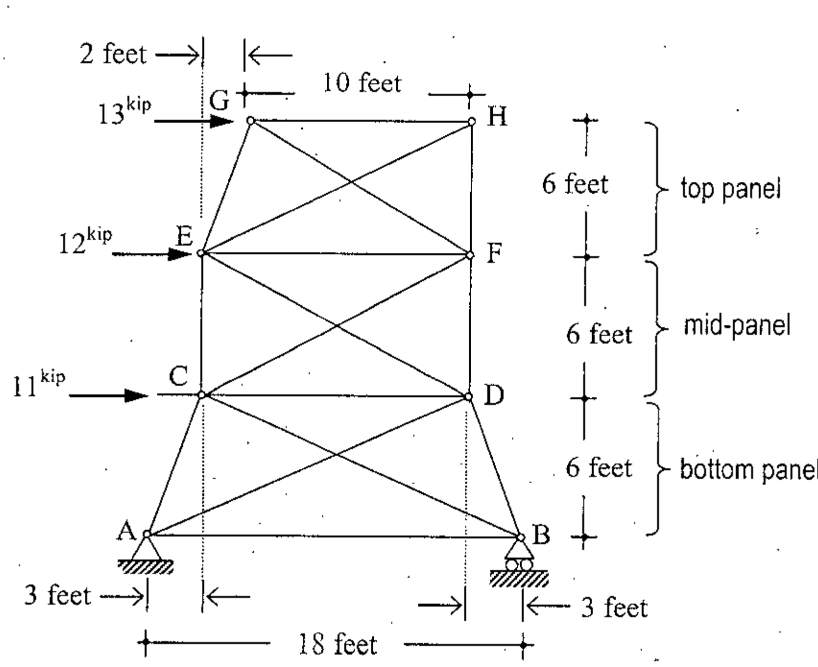


Figure 4

Contd P/3

<u>CE 321</u>

5. for the bridge truss as shown in Figure 5, check whether counter diagonal is needed or not for panel '4'. If needed, determine the force in counter diagonal 'L_3U_4'. What will be the force is main diagonal 'L_4U_3'? Given, truss self-weight = 0.75 kip/ft., vehicle load = 1.25 kip/ft. and roving concentrated load = 18 kip. Unit load moves over the top chord (from L_0 to L_8). **(28)**

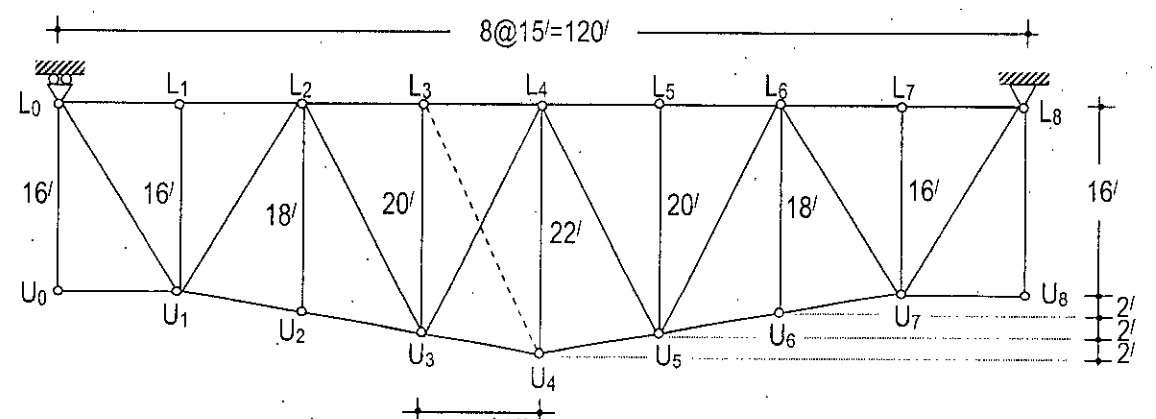


Figure 5

6. For the plane frame as shown in Figure 6, draw influence lines for
   - vertical reactions at 'F' and 'G'
   - axial force in member 'BF'
   - shear and moment at 'C'
   - shear just right of 'D'
   - moment just left of 'B'

   Unit load moves over the horizontal member 'ABCDE' (i.e, from 'A' to 'E')

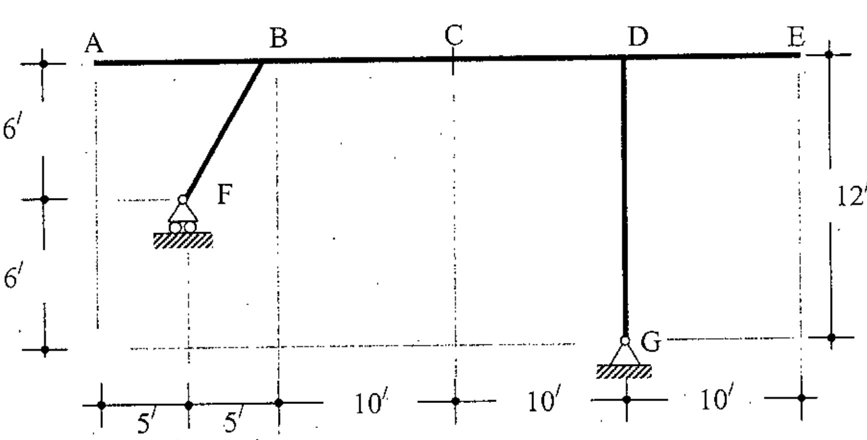


Figure 6

7. A three-hinged parabolic arch having supports at different elevation carries a uniformly distributed load of 2 kip/horizontal foot on it's right segment 'CB' as shown in Figure 7. Determine the following: **(28)**

CE 321

Contd..... Q. No. 7

(i) horizontal thrust (H) at supports, (ii) vertical support reactions at 'A' and 'B', (iii) Draw bending moment diagram of the arch and (iv) maximum bending moment and it's location.

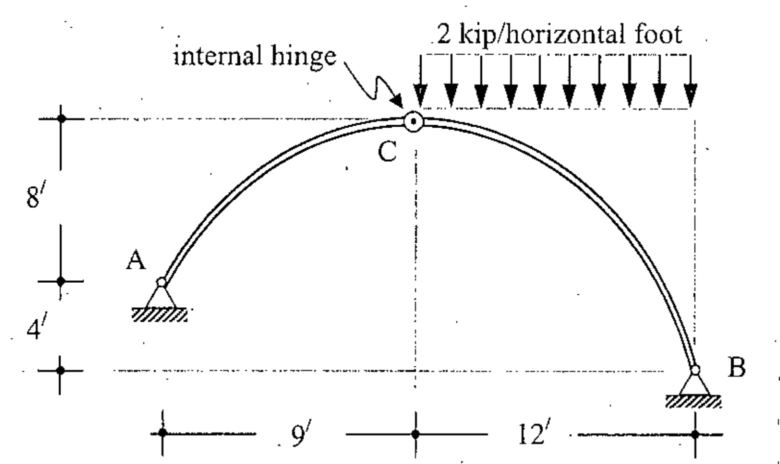


Figure 7

SECTION – B

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

8. Calculate the vertical distribution of earthquake forces at each level of a 30 m high 10 storied hospital building located in Dhaka. Given, structural system is IMRF, each storey height is 3 m, soil type is S2. Plan dimension is 30 m × 30 m. **(28)**
   Given,
   Dead load = 4 kN/m^2, partition wall load = 6 kN/m^2 for each floor.
   Z = 0.15 for Dhaka, I = 1.25, R = 8, C_t = 0.073 and S = 1.2.

9. Using the method of virtual work, find vertical deflection at C of the frame shown in Fig. 8. Consider that deflection of each member of the frame is primarily caused by the axial and bending strain energy. Given that E = 29000 ksi, A = 30 in^2 and I = 700 in^4. **(28)**

10. Using portal method, draw the bending moment diagrams of the beams of the frame shown in Fig. 9. **(28)**

11. Draw the shear force and bending moment diagrams for the building frame loaded as shown in Fig. 10. **(28)**

12. Due to the wheel loads shown in Fig. 11, compute the absolute maximum bending moment for a simply supported beam having a span of 80 ft. **(28)**

13. Due to the wheel loads shown in Fig. 11, calculate the maximum live load shear at the quarter point of a simply supported beam of 100-ft deck span. **(28)**

14. Due to a moving uniform load of 5 k/ft combined with a moving concentrated load of 60 kips, calculate the maximum shear force just right of support D and maximum bending moment at C of the beam shown in Fig. 12. **(28)**

Contd P/5

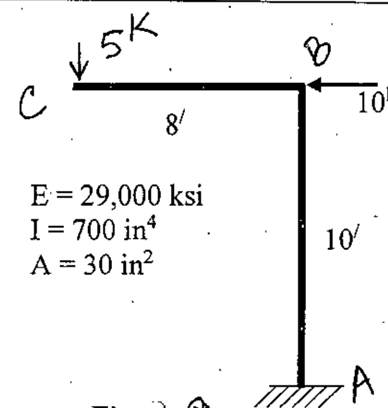


Fig. 8

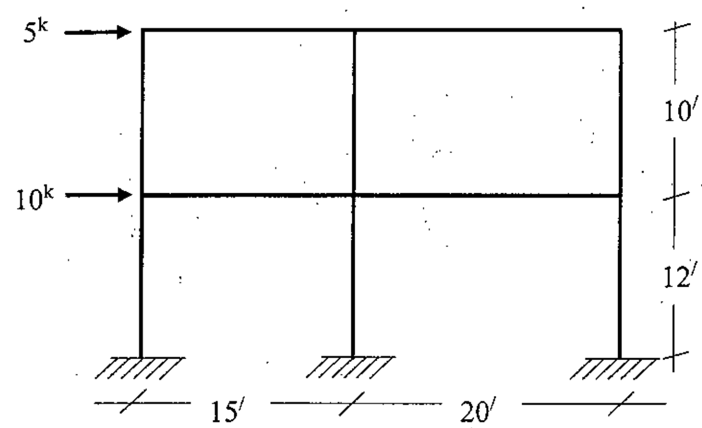


Fig. 9

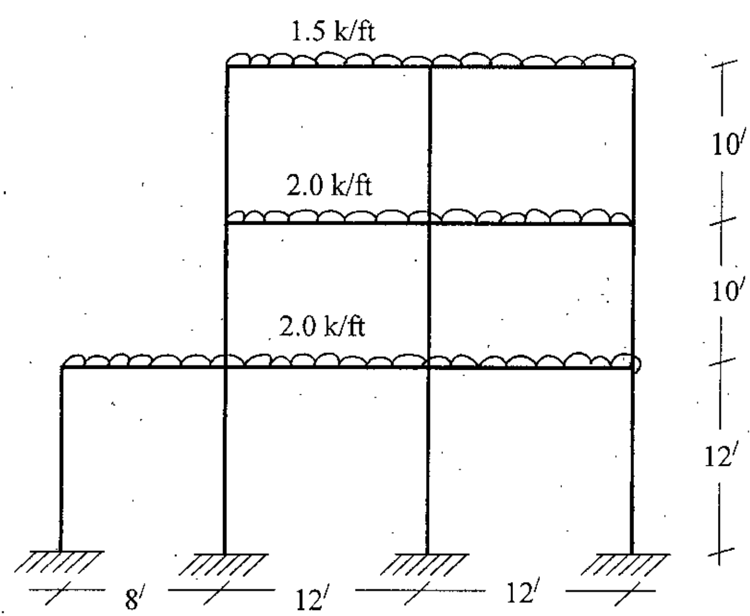


Fig. 10

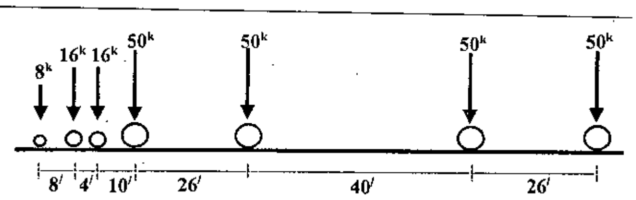


Fig. 11

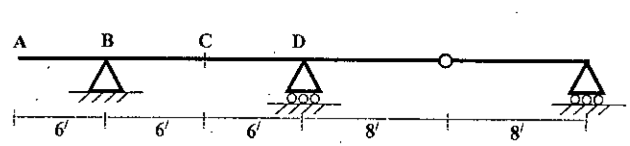
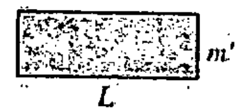
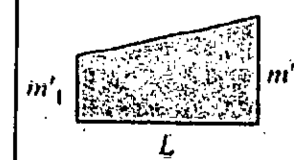
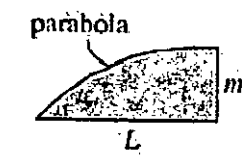
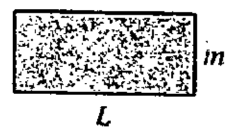
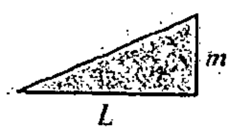
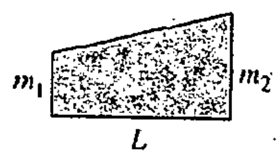
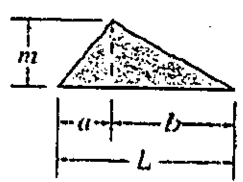
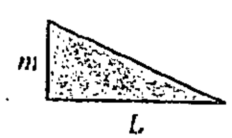


Fig. 12

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

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

CE 321

=6=

L-3/T-1/WRE **Date : 29/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **CE 323** (Design of Concrete Structures 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**.

1. (a) A cantilever one-way slab (span = 10.0 ft) has to carry a service live load is 40 psf, superimposed dead load of 30 psf in addition to its self-weight. Design the slab and show the reinforcement with neat sketches. **(13)**

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

   (b) Design the one-way slab panel "S1" as shown in Fig. 1. The slab carries a uniform live load of 40 psf and superimposed dead load of 40 psf in addition to its self-weight. Draw the reinforcement details also. Use Fig. 2 for calculation. **(22)**

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

2. (a) Design the two-way slab panel "S1" as shown in Fig. 3. The slab carries a uniform live load of 40 psf and a super-imposed dead load (floor finish and partition wall) of 80 psf in addition to it's self-weight. Draw the reinforcement details also. Use Table 1, 2, and 3 for calculation. Given f_c' = 3ksi, f_y = 60 ksi. **(27)**

   (b) Why hooks are provided in the reinforcing bars? Draw the standard hook dimensions according to ACI code. **(8)**

3. (a) Explain, with examples, the difference between primary and secondary torsion. **(5)**

   (b) The 24ft span beam shown in Fig. 4 carries a monolithic slab cantilevering 7 ft past the beam centerline. The resulting L beam supports a live load of 1.5 k/ft along the beam centerline and uniformly distributed 30 psf of live load and 20 psf of superimposed dead load over the slab. The effective depth to the flexural steel centroid is 21.5 in, and the distance from the beam surfaces to the centroid of stirrup steel is 1.75 inch. Material strengths are f_c' = 3.5ksi, f_y = 60 ksi. **(30)**

   (i) Check whether torsional reinforcement is required or not.

   (ii) Check whether the beam section is adequate to satify the limiting criteria for combined shear and torsional stresses as per ACI Code?

   (iii) Calculate the required spacing of the #4 stirrups for the torsion and shear values at a distance d from the column face.

   (iv) Also calculate the longitudinal reinforcement for torsion at distance **d** from the column face.

Contd 2

CE 323

4. (a) The beam shown in Fig. 5 cantilevers from a supporting column at the left. Flexural reinforcement consists of two #11 bars at a 21 in effective depth. Transverse #3 stirrups with 1.5 in cover are provided at 4 inch spacing from the face of the column. Material strengths are $f_c' = 3$ksi, $f_y = 60$ ksi. The beam uses normal weight concrete. **(20)**

(i) Check to see if proper development length can be provided for the #11 bars. Use the simplified development length equations.

(ii) Check to see if adequate embedment can be provided within the column for the hooked # 11 bars.

(b) Fig. 6 shows the column reinforcement for a 16 in. diameter concrete column. Analysis of the building frame indicates a required $A_s = 7.30$ in^2 in the lower column and 5.80 in^2 in the upper column. Spiral reinforcement consists of #3 bars with a 2 in pitch. Column bars are to be spliced just above the construction joint at the floor level, as shown in the sketch. Calculate the minimum permitted length of splice. Given, $f_c' = 5$ksi, $f_y = 60$ ksi. **(15)**

SECTION – B

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

Symbols carry their usual meaning. Assume any reasonable value for missing data (if any)

5. (a) Why is concrete cover over rebar important? What are the recommended values of 'cover' for RC beam and slab as per ACI code? **(5)**

(b) What are the sources of uncertainties in analysis, design and construction of RC structures? **(5)**

(c) Figure 7 shows the simple floor plan, beams 12 in wide and 20 in. deep are spanning 30 ft. The beams are located 9 ft center to center. A 5-in thick spans from beam to beam. The floor structure will be used in a general office building, thus the minimum uniformly distributed live load is 50lb/ft^2. Assume 20 psf for the superimposed dead load for the partitions, mechanical and electrical systems, and so on. **(10+15)**

(i) Calculate the dead and live loads that one interior beam has to carry.

(ii) If the end of the rectangular beams [b = 12″ and h = 20″] is simply supported and is reinforced with 3 # 8 bars with a cover of 3 in. at the bottom, determine the stresses caused by the design load as determined from (i). Given, $f_c' = 4$ksi, $f_y = 60$ ksi, and $f_r = 475$ psi.

CE 323

Contd..... Q. No. 5(c)

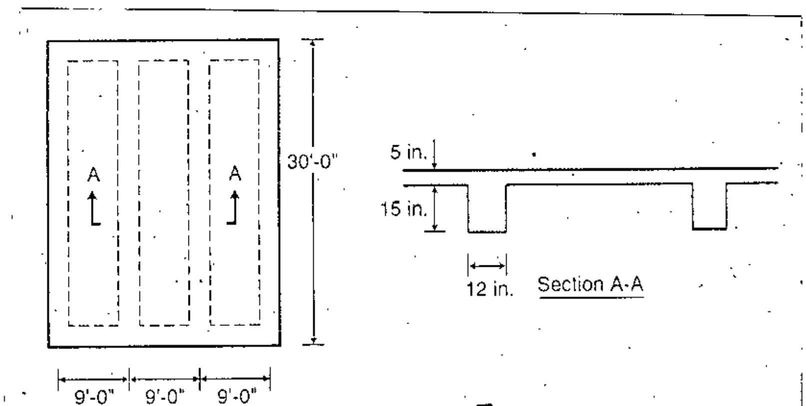


Figure : 7

6. (a) Determine effective flange width, b_e and design moment capacity, ΦM_n for the T-section [A-A] as shown in Figure 8. Given, $f_c' = 4$ksi, $f_y = 60$ ksi, **(3+12=15)**

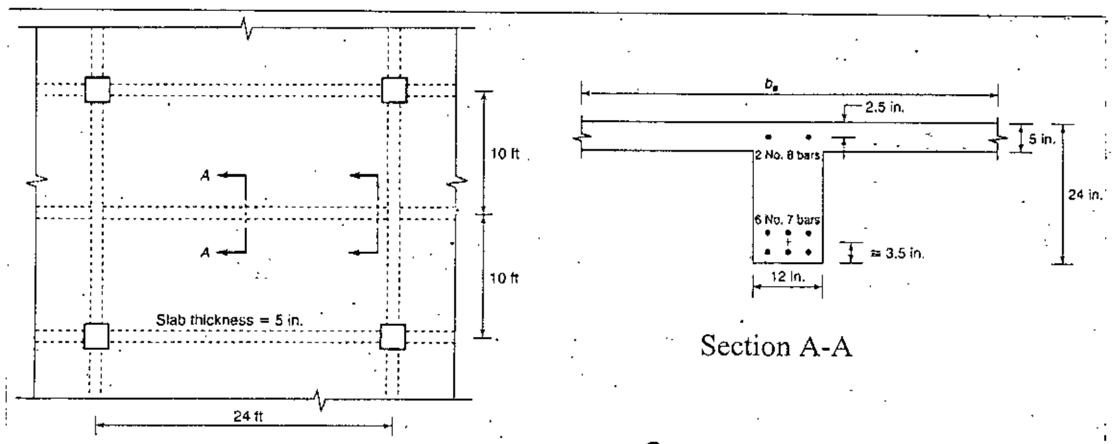


Figure : 8

(b) Compute the positive moment strength, ΦM_n for the beam section shown in Figure 9. Given, $f_c' = 3$ksi, $f_y = 60$ ksi. **(20)**

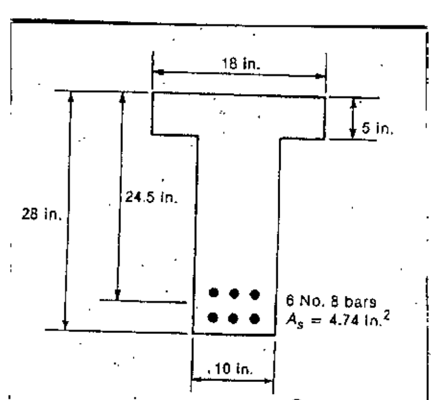


Figure : 9

7. (a) Describe with neat sketches diagonal tension cracking in a reinforced concrete beam. **(6)**

(b) Design the shear reinforcement and show the spacing in a neat sketch for the simple supported beam with a span of 30 ft loaded as shown in Figure 10. The beam carries unfactored dead load, D = 1.3 kips/ft and unfactored live load, L = 1.6 kips/ft. Given, $f_c' = 3$ksi, $f_y = 60$ ksi. **(22)**

Contd 4

CE 323

Contd..... Q. No. 7(b)

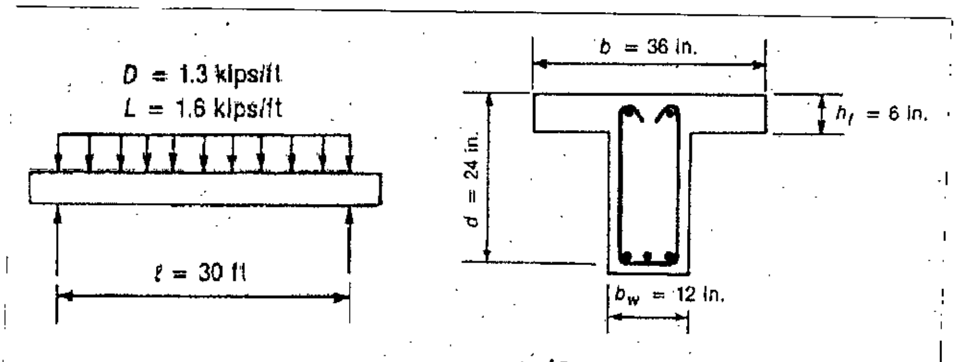


Figure 10

(c) What is the purpose of providing minimum amount of flexural steel in a RC beam? Write ACI/BNBC code provisions for minimum reinforcement ratios. **(7)**

8. (a) A rectangular beam of width b = 12″ is limited by architectural consideration to a maximum depth h = 20″. It must carry a total factored load moment. M_u = 380 kip-ft. Design the flexural reinforcement for this member, using compression steel, if necessary. Allow 3 inch to the center of the bars from the compression or tension face of the beam. Show a sketch of your final design. Given, f_c' = 3ksi, and f_y = 60 ksi. **(20)**

(b) Determine the design moment capacity of the beam shown in Figure 11. Given, f_c' = 3ksi and f_y = 60 ksi. **(15)**

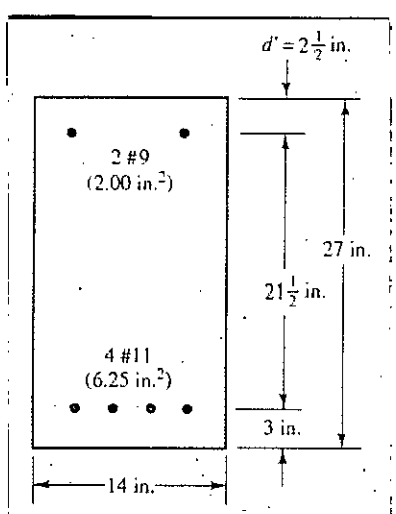


Figure 11

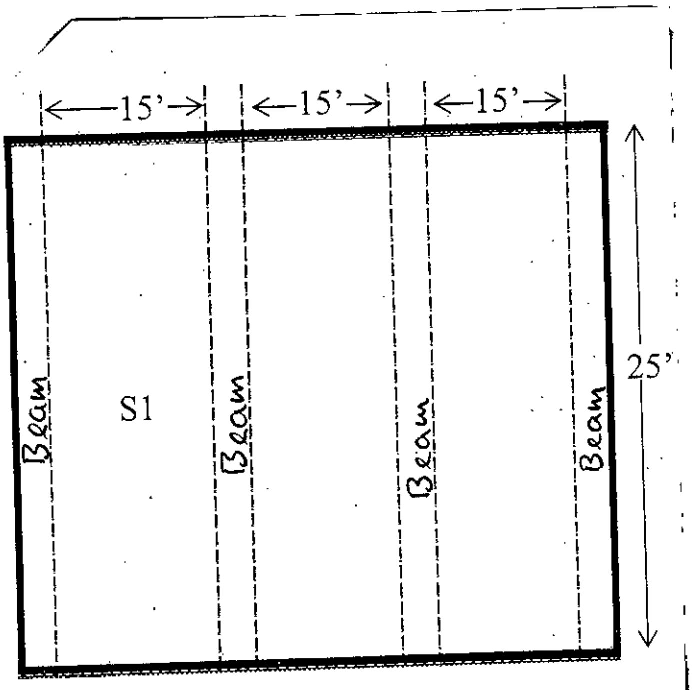


Fig. 1

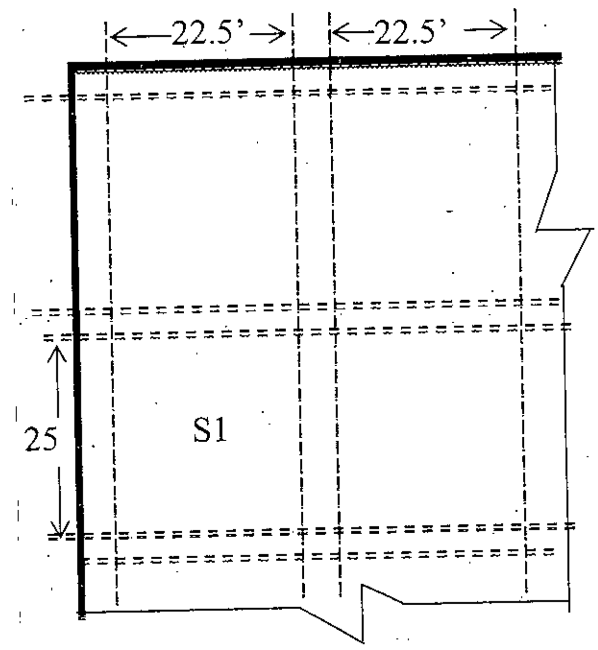
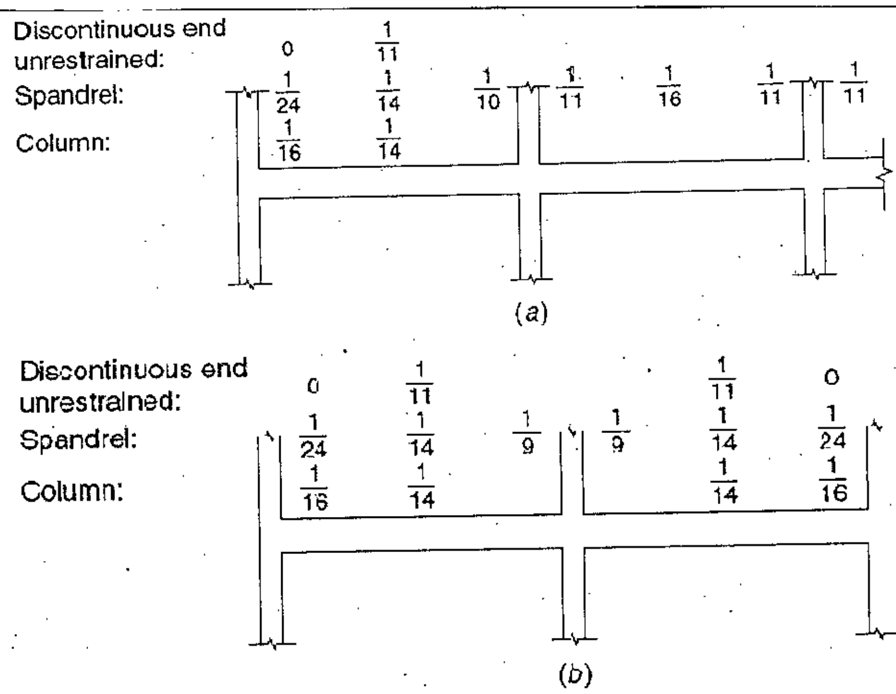


Fig. 3



Moment coefficients: (*a*) beams with more than two spans; (*b*) beams with two spans only;

Fig. 2

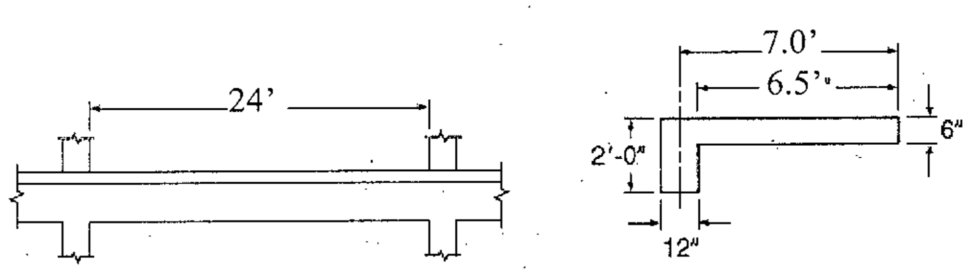


Fig. 4

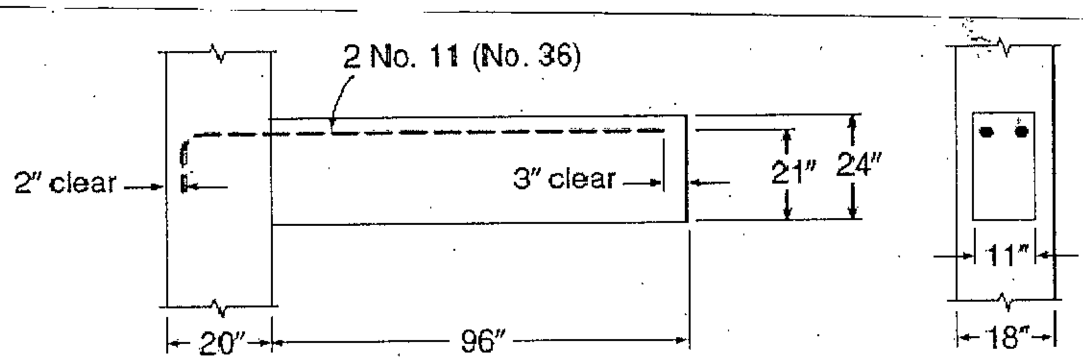


Fig. 5

Contd. — P/6

CE 323 = 6 =

Table 1: Co-efficients for Negative Moments in Slabs

$M_{a(negative)} = C_{a(negative)} w L_a^2$; $M_{b(negative)} = C_{b(negative)} w L_b^2$; where, w = total uniform dead plus live load, L_a = shorter clear span & L_b = longer clear span of a slab panel

Ratio $\frac{L_a}{L_b}$	Co-efficient	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a, (negative)}$	---	0.045	---	0.05	0.075	0.071	---	0.033	0.061
	$C_{b, (negative)}$	---	0.045	0.076	0.05	---	---	0.071	0.061	0.033
0.95	$C_{a, (negative)}$	---	0.05	---	0.055	0.079	0.075	---	0.038	0.065
	$C_{b, (negative)}$	---	0.041	0.072	0.045	---	---	0.067	0.056	0.029
0.90	$C_{a, (negative)}$	---	0.055	---	0.06	0.08	0.079	---	0.043	0.068
	$C_{b, (negative)}$	---	0.037	0.07	0.04	---	---	0.062	0.053	0.025
0.85	$C_{a, (negative)}$	---	0.06	---	0.066	0.082	0.083	---	0.049	0.072
	$C_{b, (negative)}$	---	0.031	0.065	0.034	---	---	0.057	0.046	0.021
0.80	$C_{a, (negative)}$	---	0.065	---	0.071	0.083	0.086	---	0.055	0.075
	$C_{b, (negative)}$	---	0.027	0.061	0.029	---	---	0.051	0.041	0.017
0.75	$C_{a, (negative)}$	---	0.069	---	0.076	0.085	0.088	---	0.061	0.078
	$C_{b, (negative)}$	---	0.022	0.056	0.024	---	---	0.044	0.036	0.014
0.70	$C_{a, (negative)}$	---	0.074	---	0.081	0.086	0.091	---	0.068	0.081
	$C_{b, (negative)}$	---	0.017	0.05	0.019			0.038	0.029	0.011
0.65	$C_{a, (negative)}$	---	0.077	---	0.085	0.087	0.093	---	0.074	0.083
	$C_{b, (negative)}$	---	0.014	0.043	0.015	---	---	0.031	0.024	0.008
0.60	$C_{a, (negative)}$	---	0.081	---	0.089	0.088	0.095	---	0.08	0.085
	$C_{b, (negative)}$	---	0.01	0.035	0.011	---	---	0.024	0.018	0.006
0.55	$C_{a, (negative)}$	---	0.084	---	0.092	0.089	0.096	---	0.085	0.086
	$C_{b, (negative)}$	---	0.007	0.028	0.008	---	---	0.019	0.014	0.005
0.50	$C_{a, (negative)}$	---	0.086	---	0.094	0.09	0.097	---	0.089	0.088
	$C_{b, (negative)}$	---	0.006	0.022	0.006	---	---	0.014	0.01	0.003

*A crosshatched 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.

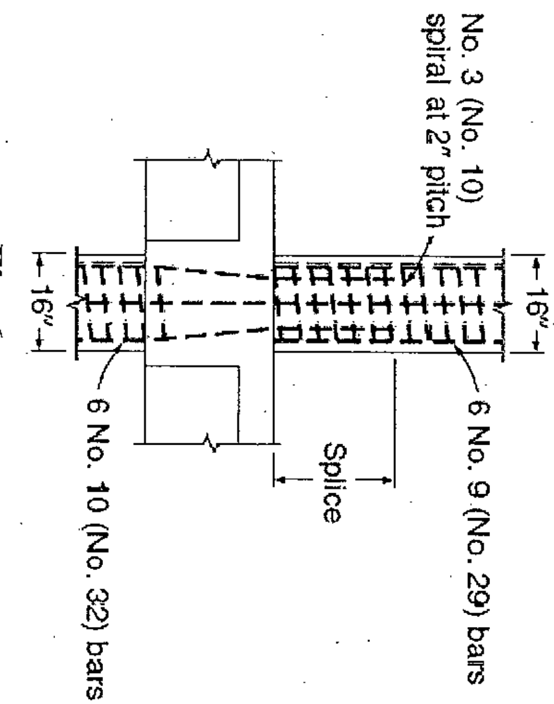


Fig. 6

Contd.— P/7

Table 2: Co-efficients for **Dead Load Positive Moments** in Slabs

$M_{a,(positive),DL} = C_{a,(positive)} w_{DL} L_a^2$; $M_{b,(positive),DL} = C_{b,(positive)} w_{DL} L_b^2$; where w_{DL} = total uniform dead load

Ratio $\frac{L_a}{L_b}$	Co-efficient	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a,(positive)}$	0.036	0.018	0.018	0.027	0.027	0.033	0.027	0.02	0.023
	$C_{b,(positive)}$	0.036	0.018	0.027	0.027	0.018	0.027	0.033	0.023	0.02
0.95	$C_{a,(positive)}$	0.040	0.02	0.021	0.03	0.028	0.036	0.031	0.022	0.024
	$C_{b,(positive)}$	0.033	0.016	0.025	0.024	0.015	0.024	0.031	0.021	0.017
0.90	$C_{a,(positive)}$	0.045	0.022	0.025	0.033	0.029	0.039	0.035	0.025	0.026
	$C_{b,(positive)}$	0.029	0.014	0.024	0.022	0.013	0.021	0.028	0.019	0.015
0.85	$C_{a,(positive)}$	0.050	0.024	0.029	0.036	0.031	0.042	0.04	0.029	0.028
	$C_{b,(positive)}$	0.026	0.012	0.022	0.019	0.011	0.017	0.025	0.017	0.013
0.80	$C_{a,(positive)}$	0.056	0.026	0.034	0.039	0.032	0.045	0.045	0.032	0.029
	$C_{b,(positive)}$	0.023	0.011	0.02	0.016	0.009	0.015	0.022	0.015	0.01
0.75	$C_{a,(positive)}$	0.061	0.028	0.04	0.043	0.033	0.048	0.051	0.036	0.031
	$C_{b,(positive)}$	0.019	0.009	0.018	0.013	0.007	0.012	0.02	0.013	0.007
0.70	$C_{a,(positive)}$	0.068	0.03	0.046	0.046	0.035	0.051	0.058	0.04	0.033
	$C_{b,(positive)}$	0.016	0.007	0.016	0.011	0.005	0.009	0.017	0.011	0.006
0.65	$C_{a,(positive)}$	0.074	0.032	0.054	0.05	0.036	0.054	0.065	0.044	0.034
	$C_{b,(positive)}$	0.013	0.006	0.014	0.009	0.004	0.007	0.014	0.009	0.005
0.60	$C_{a,(positive)}$	0.081	0.034	0.062	0.053	0.037	0.056	0.073	0.048	0.036
	$C_{b,(positive)}$	0.010	0.004	0.011	0.007	0.003	0.006	0.012	0.007	0.004
0.55	$C_{a,(positive)}$	0.088	0.035	0.071	0.056	0.038	0.058	0.081	0.052	0.037
	$C_{b,(positive)}$	0.008	0.003	0.009	0.005	0.002	0.004	0.009	0.005	0.003
0.50	$C_{a,(positive)}$	0.095	0.037	0.08	0.059	0.039	0.061	0.089	0.056	0.038
	$C_{b,(positive)}$	0.006	0.002	0.007	0.004	0.001	0.003	0.007	0.004	0.002

*A crosshatched 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 3: Co-efficients for **Live Load Positive Moments** in Slabs

$M_{a,(positive),LL} = C_{a,(positive)} w_{LL} L_a^2$; $M_{b,(positive),LL} = C_{b,(positive)} w_{LL} L_b^2$; where w_{LL} = total uniform live load

Ratio $\frac{L_a}{L_b}$	Co-efficient	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	$C_{a,(positive)}$	0.036	0.027	0.027	0.032	0.032	0.035	0.032	0.028	0.03
	$C_{b,(positive)}$	0.036	0.027	0.032	0.032	0.027	0.032	0.035	0.03	0.028
0.95	$C_{a,(positive)}$	0.040	0.03	0.031	0.035	0.034	0.038	0.036	0.031	0.032
	$C_{b,(positive)}$	0.033	0.025	0.029	0.029	0.024	0.029	0.032	0.027	0.025
0.90	$C_{a,(positive)}$	0.045	0.034	0.035	0.039	0.037	0.042	0.04	0.035	0.036
	$C_{b,(positive)}$	0.029	0.022	0.027	0.026	0.021	0.025	0.029	0.024	0.022
0.85	$C_{a,(positive)}$	0.050	0.037	0.04	0.043	0.041	0.046	0.045	0.04	0.039
	$C_{b,(positive)}$	0.026	0.019	0.024	0.023	0.019	0.022	0.026	0.022	0.02
0.80	$C_{a,(positive)}$	0.056	0.041	0.045	0.048	0.044	0.051	0.051	0.044	0.042
	$C_{b,(positive)}$	0.023	0.017	0.022	0.02	0.016	0.019	0.023	0.019	0.017
0.75	$C_{a,(positive)}$	0.061	0.045	0.051	0.052	0.047	0.055	0.056	0.049	0.046
	$C_{b,(positive)}$	0.019	0.014	0.019	0.016	0.013	0.016	0.02	0.016	0.013
0.70	$C_{a,(positive)}$	0.068	0.049	0.057	0.057	0.051	0.06	0.063	0.054	0.05
	$C_{b,(positive)}$	0.016	0.012	0.016	0.014	0.011	0.013	0.017	0.014	0.011
0.65	$C_{a,(positive)}$	0.074	0.053	0.064	0.062	0.055	0.064	0.07	0.059	0.054
	$C_{b,(positive)}$	0.013	0.01	0.014	0.011	0.009	0.01	0.014	0.011	0.009
0.60	$C_{a,(positive)}$	0.081	0.058	0.071	0.067	0.059	0.068	0.077	0.065	0.059
	$C_{b,(positive)}$	0.010	0.007	0.011	0.009	0.007	0.008	0.011	0.009	0.007
0.55	$C_{a,(positive)}$	0.088	0.062	0.08	0.072	0.063	0.073	0.085	0.07	0.063
	$C_{b,(positive)}$	0.008	0.006	0.009	0.007	0.005	0.006	0.009	0.007	0.006
0.50	$C_{a,(positive)}$	0.095	0.066	0.088	0.077	0.067	0.078	0.092	0.076	0.067
	$C_{b,(positive)}$	0.006	0.004	0.007	0.005	0.004	0.005	0.007	0.005	0.004

*A crosshatched 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/WRE Date : 06/11/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2018-2019

Sub: **CE 381** (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**.

Assume reasonable Value of missing data, if any. Use attached Charts where necessary.

1. (a) Explain he following with neat sketches/expressions: **(21)**

(i) Degree of roundness of coarse grained soil

(ii) Field identification of fine grained soil

(iii) Basic structural units of clay minerals.

(b) (i) Write and explain the following expressions for hydrometer analysis. **(6+6)**

- Diameter of soil particles (D)

- % Finer than size (D)

(ii) Explain the corrections needed for hydrometer analysis.

(c) The natural inorganic soil along a proposed highway alignment have the following grain size distributions: **($13\frac{2}{3}$)**

Passing # 4 size = 93%

Passing # 10 size = 74%

Passing # 40 size = 32%

Passing # 100 size = 17%

Passing # 200 size = 10%

The soil has Liquid Limit of 51 and a plastic Limit of 25. Classify the soil according to AASHTO soil classification system and rate its suitability for pavement support.

2. (a) Explain the following with necessary figures/expressions: **(18)**

(i) Plasticity Chart

(ii) Flow curve

(iii) Linear Shrinkage

(b) For the soil mentioned in Q 1(c), find the shrinkage limit. **(12)**

(c) Classify the inorganic soil from Q 1(c), using the Unified Soil Classification System. **($16\frac{2}{3}$)**

3. (a) Explain the following with necessary figures or expressions: **(18)**

(i) Newmarlis Chart for stress estimation for uniformly loaded area of any shape

(ii) Surface Tension

(iii) Critical Hydraulic Gradient

Contd P/2

CE 381

Contd….. Q. No. 3

(b) A foundation trench is to be excavated in a stratum of clay, 6m thick underlain by a bed of sand. In a trial borehole, the ground water table is found to be at a depth of 1m from the ground surface. Find the depth to which excavation can be safely carried out without the danger of the bottom becoming unstable under the uplift pressure of ground water. The saturated unit weight of the clay is 19.62 kN/m^3. If excavation is to be carried out safely to a depth of 5m, how much should the water table be lowered in the vicinity of the trench? **(14)**

(c) A rectangular foundation 6.5m × 3.5m carries a uniform pressure of 175 kPa near the surface of soil mass. Determine the vertical stress at a depth of 2.75m below a point on the center line and 1.75m outside a long edge of the foundation. **($14\frac{2}{3}$)**

4. (a) For Loose and Dense sand, draw neat sketches of stress versus strain curves. Also explain the relation between normal stress and shear stress. **(14)**

(b) Derive ϕ'_{cs} and θ for Mohr-Coulomb Model. **(15)**

(c) An embankment is shown in Figure 1. Determine the stress increase under the embankment at points X and Y. **($17\frac{2}{3}$)**

CE 381

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.
Symbols indicate their usual meaning.

5. (a) Using phase diagram, derive S.e = w G_s. In the diagram, total volume of void (V_v) is the sum of volumes of air (V_a) and water (V_w), Dry unit weight of the soil sample is determined at 6 points, by changing V_w from $V_w = 0$ state to $V_w = V_v$ state. In doing so, no compaction is applied on the soil sample. Show graphically, the variation of dry unit weight with the moisture content (w). **(10+5)**

(b) Briefly describe the methods of laboratory determination of dry maximum and minimum densities of a granular soil. State the factors controlling the magnitude of $\gamma_{d(max)}$. **(10+5)**

(c) What are the three most common clay minerals? Which one usually causes the most problems for geotechnical engineers? Why? Also, state which one is the stable clay mineral? Why it is so?

In a particular locality, it is commonly observed that small structures such as, boundary wall and one-or two-storied masonry structures have been suffering intensively from noticeable cricks. The subsoil is observed to be clay. What could be probable reason of cracks in the shallows structures? **($10+6\frac{2}{3}$)**

6. (a) What are the types of rollers used for compacting different types of soils in the field? How do you decide the compactive effort required for compacting the soil to a desired density in the field? How does the concept of (i) lift thickness and (ii) number of roller-pass in a compaction scheme using vibratory roller in sand subsoil conditions play its role? **(8+7)**

(b) Describe compaction curve of a clay. State the geotechnical importance of 'zero-air-void' line in compaction curve. **(15)**

(c) A sample of soil compacted according to the standard Proctor test has a density of 20.2 kN/m^3 at 100% compaction and at optimum moisture content of 14%. (i) What is the dry unit weight? (ii) What is the dry unit weight at zero-air-voids? Also, the saturated unit weight at zero air-voids? (iii) If the voids become filled with water what would be the saturated unit weight? Assume $G_s = 2.67$. **($16\frac{2}{3}$)**

7. (a) What are assumptions of Terzaght's first theory to derive time rate of consolidation for saturated clays? Derive the following differential equation of one-dimensional time rate of consolidation for saturated clays:

$$\frac{\partial u}{\partial t} = C_v \frac{\partial^2 u}{\partial z^2}$$ (the symbols have their usual meanings).

Write down the solution for this equation stating the boundary conditions.

Also, show graphically (i) variation of U_z and T_v and z/H_{dr} and (ii) average degree of consolidation, U(%) with T_v. **(5+15+5+4×2=33)**

CE 381

Contd..... Q. No. 7

(b) State the basic concept of consolidation and its associated settlement.

The thickness of a saturated specimen of clay under a consolidation pressure of 2 kg/cm^2 is 20.70 mm and its water content is 16%. On increase of the consolidation pressure to 4 kg/cm^2, the specimen thickness decreases by 1.04 mm. Determine the compression index for the soil. The specific gravity of soil is 2.72. **($13\frac{2}{3}$)**

8. (a) State the lateral earth pressure conditions for the following cases with brief reasoning:

(i) Design of a riverside retaining wall to facilitate jetty service.

(ii) Design of a free-standing cantilever wall

A 4 m tall cantilever wall is to be backfilled with a dense silty sand. How far must this wall move to attain the active condition in the soil behind it? Is it appropriate to use the active pressure to design? Explain using the Table 1 below. **(10+10)**

Table 1: Wall movement required to reach the active condition:

Soil Type	Horizontal Movement Required to Reach the Active Condition	
Dense cohesionless	0.001 H	
Loose cohesionless	0.004 H	(H: height of wall)
Stiff cohesive	0.010 H	
Soft cohesive	0.020 H	

(b) A wall with a smooth vertical back 3 m high retains a mass of dry cohesionless sand that has a horizontal surface. The sand weighs 18 kN/m^3 and has an angle of internal friction of 36°. The water level behind the wall rises to an elevation 1 m below the crest. The submerged unit weight of the sand is $10 kN/m^3$. If the deformation condition for the active Rankine state is satisfied, what is the resultant pressure that the earth and water exert against the wall? At what height above the base does the resultant of the earth and water pressure act? **(10)**

(c) Show graphically, using Mohr circle failure envelop, the changes in stress conditions in a soil as it transits/moves from the at rest condition to the active condition. Also, show the development of shear failure panes in the soil behind a wall as it transits from the at-rest condition to the active condition. **($16\frac{2}{3}$)**

Contd. → P/5

CE 381

= 5 =

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 (after Atkins, 1997)

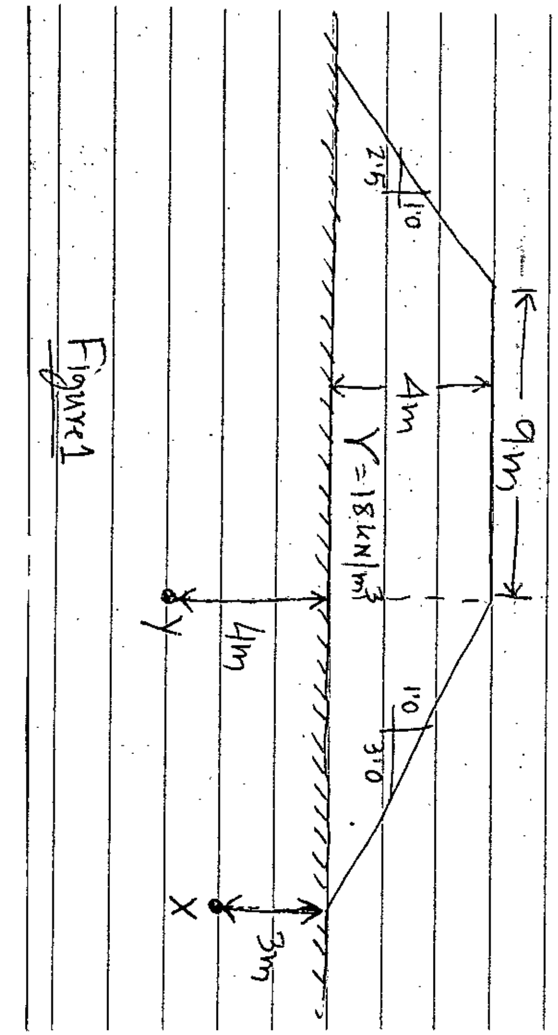


Figure 1

Contd. — P/6

prepared by Osterberg (1957) for finding the influence coefficient for this case is presented in Figure 8.13. The chart gives the influence coefficient, I_z, in terms of a/z and b/z.

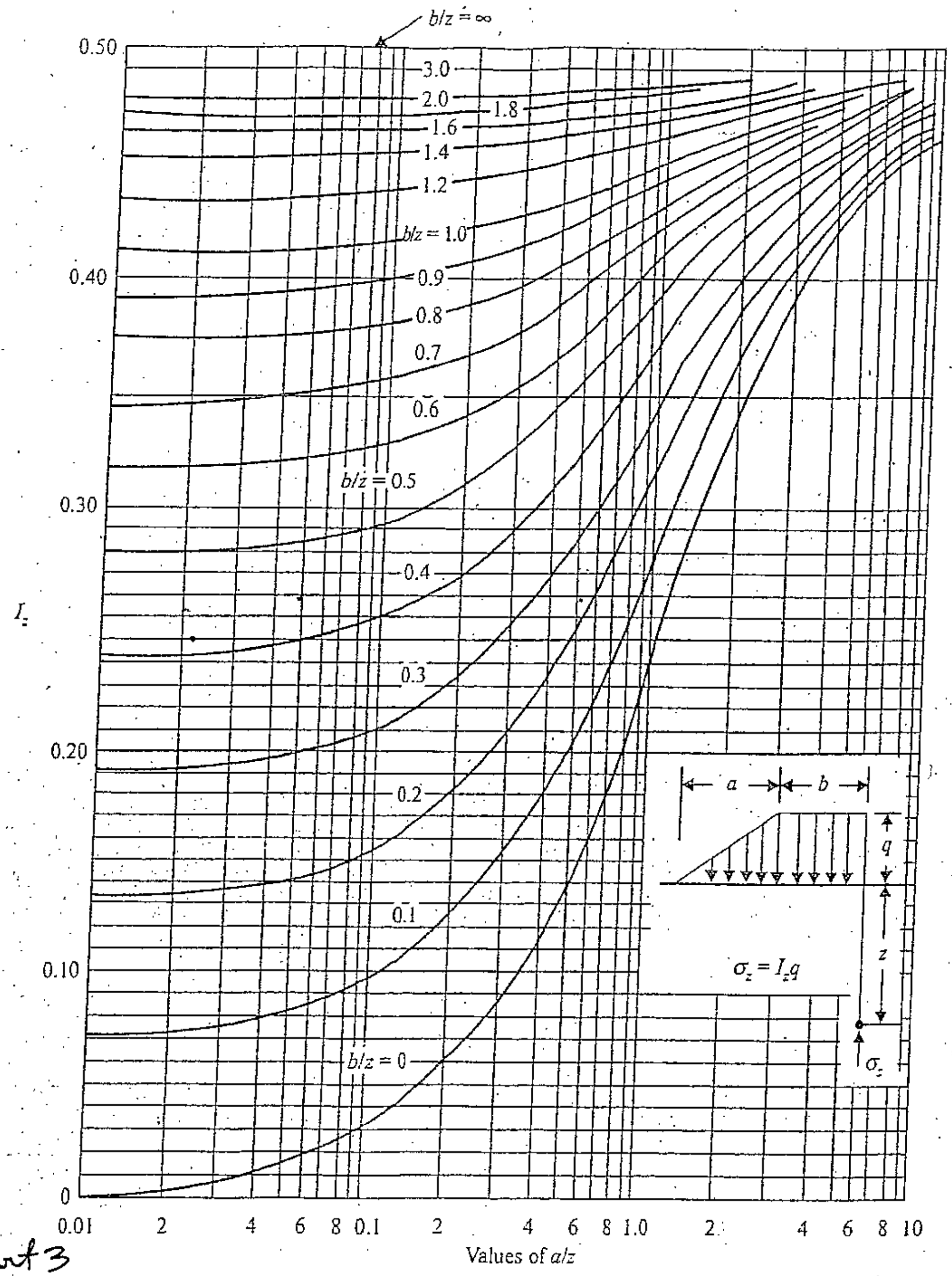


Chart 3

...3 Influence coefficient for vertical stress under a long embankment (after Osterberg, 1957).

... 8.11 gives the chart given by Fadum (1948) for obtaining Newmark's Influence Coefficient in terms of m and n.

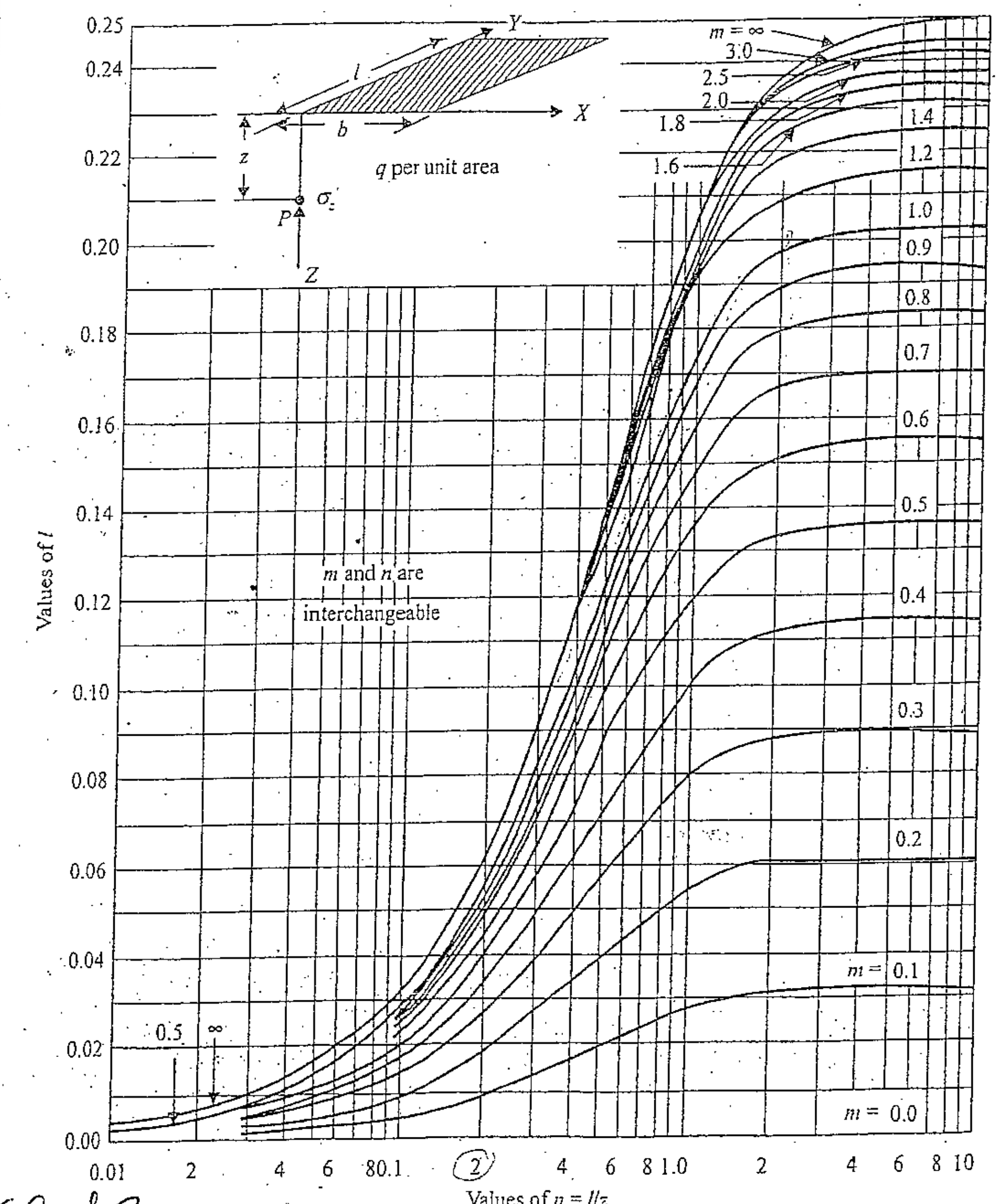


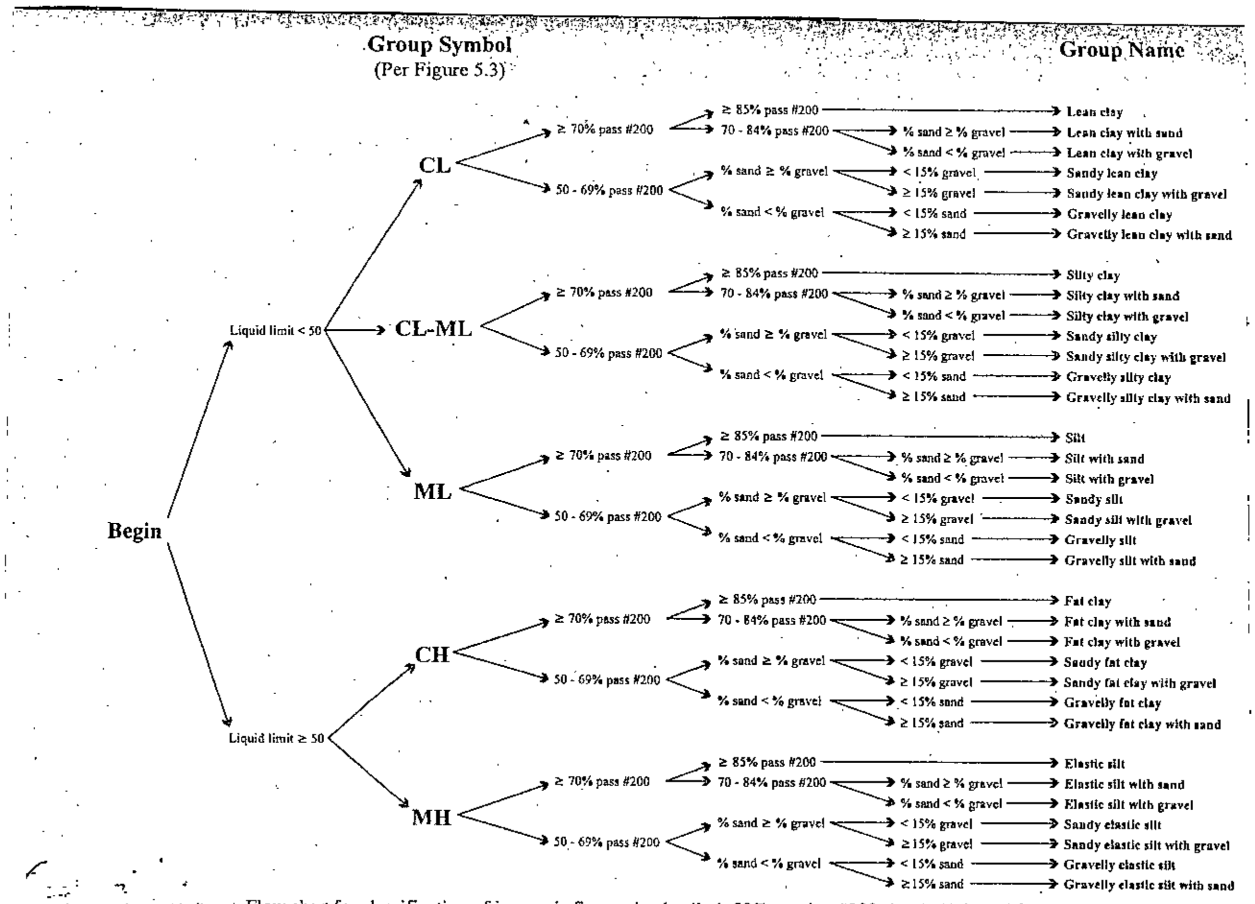
Chart 2

Fadum's chart for obtaining Newmark's influence coefficient, I in terms of m and n.

CE 381

= 6 =

Contd. — P/7



Flow chart for classification of inorganic fine-grained soils (≥50% passing #200 sieve) (Adapted from ASTM D2487).

Chart 4

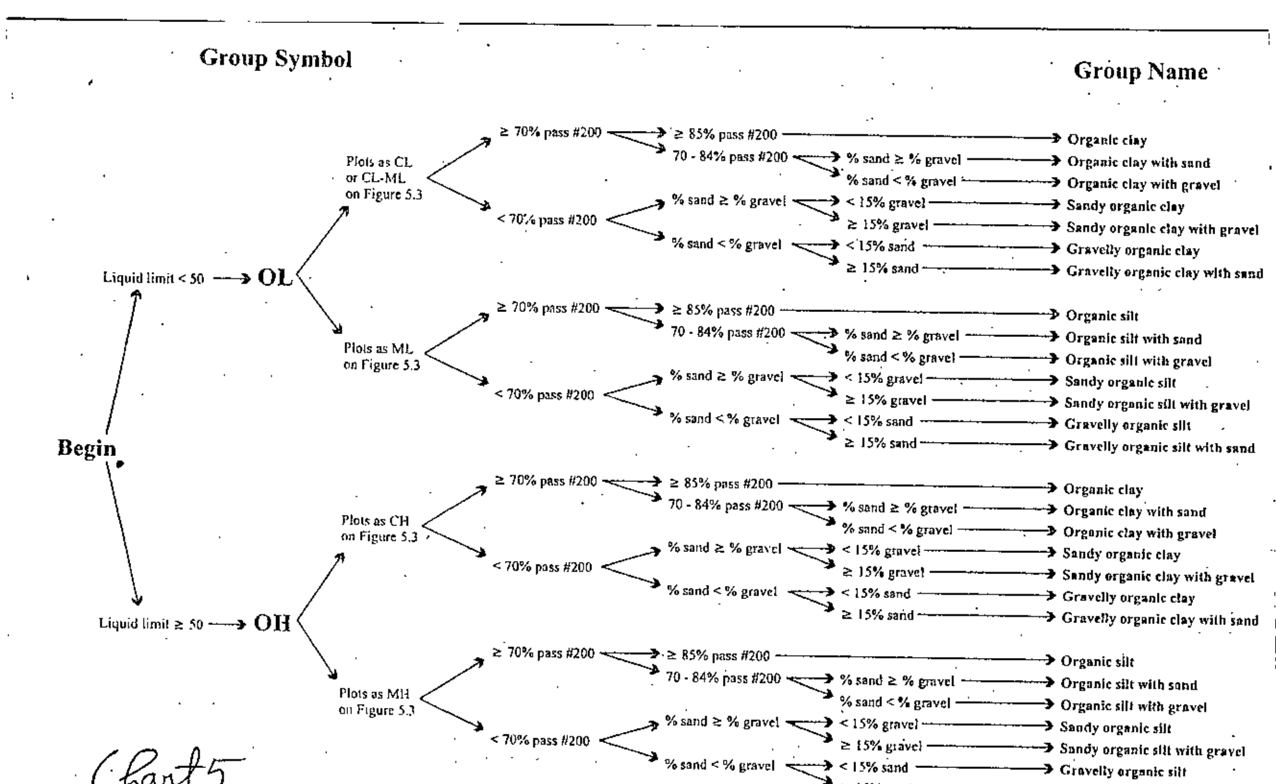


Chart 5

Flow chart for classification of organic fine-grained soils (≥50% passing #200 sieve) (Adapted from ASTM D2487).