L-3/T-1/WRE **Date : 28/06/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

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

Symbols carry their usual meanings.

Assume any reasonable values for missing data (if any).

1. (a) Using method of joints, find the bar force "a" of the truss as shown in Figure 1. The 10 kN load at the joint is 30° inclined to the vertical. **(12)**

   (b) A 10-storied RC residential building has a plan dimension of 90 ft × 60 ft and typical floor-to-floor height of the building is 10 ft except the ground floor. The height of the ground floor is 11 ft. The building is an intermediate moment resisting frame having slab thickness of 6 inch. Floor finish, partition wall load and service live load are 25 psf, 70 psf, and 40 psf, respectively. Determine the shear force distribution along the height of the building for Earthquake resistant design. **($34\frac{2}{3}$)**

   Given: R = 8, I = 1.0, S = 1.5 and Z = 0.15

2. (a) A three-hinged parabolic arch has span 16 m and central rise 4 m. It carries a concentrated load of 120 kN at 3 m from left support. Determine bending moment, radial shear force and moment thrust at a section 10 m from the left support. Draw also bending moment diagram. **(36)**

   Given: Equation of the arch, $y = \frac{4hx}{L^2}(L - x)$ [Figure 2]

   (b) Determine the degree of indeterminacy and the bar force "P" of the truss shown in Figure 3 using approximate method. Assume that diagonals can carry only tension force. **($10\frac{2}{3}$)**

3. (a) Draw the shear force and bending moment diagrams of the building frame shown in Figure 4. **(28)**

   (b) Draw the shear force and bending moment diagrams for column DEF of the millbent shown in Figure 5. **($18\frac{2}{3}$)**

4. Draw the shear force and bending moment diagrams of the beams and columns for the building frame as shown in Figure 6. **($28\frac{2}{3}$+28)**

   (i) Use Portal method.

   (ii) Use Cantilever method.

   Relative column cross-sectional area is given in Figure 6.

Contd P/2

CE 321 (WRE)

SECTION – B

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

5. (a) Compute the change in slope of the cross bar at point 'F' of the frame due to the loads as shown in Fig. 6(a). All the members have properties as follows: $E = 29 \times 10^3$ ksi, $I = 54$ in^4, $A = 18$ in^2. **(28)**

   (b) Determine the absolute maximum bending moment for the simply supported beam due to the moving wheel loads as shown in Fig. 6(b). **(18⅔)**

6. (a) Determine vertical deflection of point 'c' in the truss shown in Fig. 7(a) due to **(28)**

   (i) the loads shown in Fig. 7(a)

   (ii) a drop in temperature by 50° F in the top chord only, $a_t = 1/150000$ per ° F

   (iii) a horizontal displacement of support 'j' by 4 inch to the right and a vertical displacement of support 'a' by 3 inch upwards. For all members, $A = 10$ in^2; $E = 29 \times 10^3$ ksi.

   (b) For the frame in Fig. 7(b), draw the influence lines for all the reactions at 'a' if the load can only move between point 'b' to point 'd'. Also draw influence line for shear of the member 'ac'. **(18⅔)**

7. (a) Determine maximum positive bending moment at section a-a of the beam due to the series of wheel loads shown in Fig. 8(a). **(23)**

   (b) Draw influence lines for axial force in members 'U_3U_4', 'U_3L_4' and 'L_3L_4' of the truss shown in Fig. 8(b). Unit load moves along the bottom chord of the truss. **(23⅔)**

8. (a) Draw influence lines for all the floor beam reactions of the plate girder shown in Fig. 9(a). Also draw influence lines for V_{2-3} and M_3. **(26)**

   (b) A suspension bridge with stiffening truss is shown in Fig. 9(b). Determine the forces in the bars that are marked due to the loads imposed on the bridge. **(20⅔)**

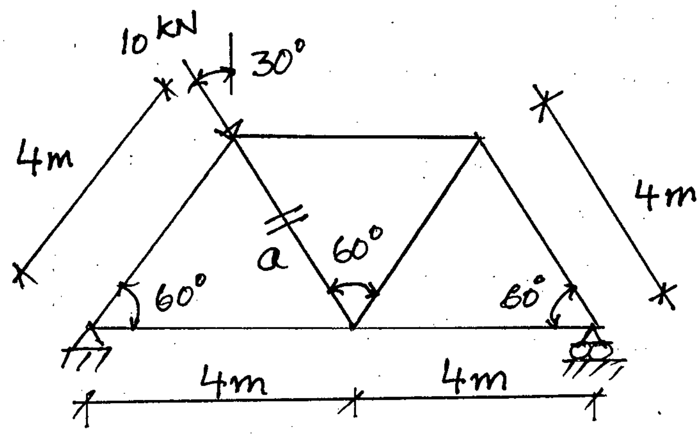

Figure 1

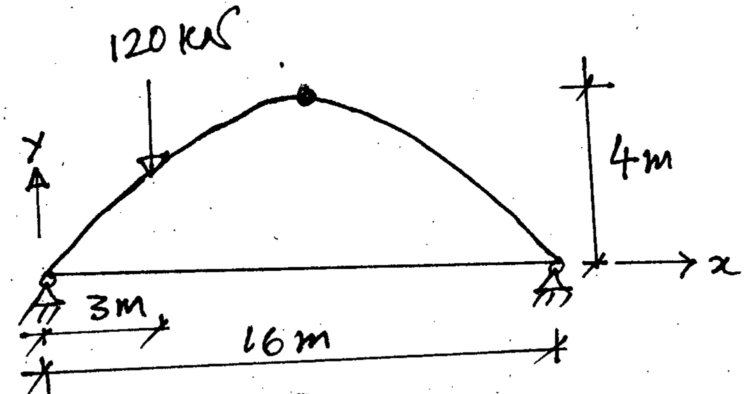

figure 2

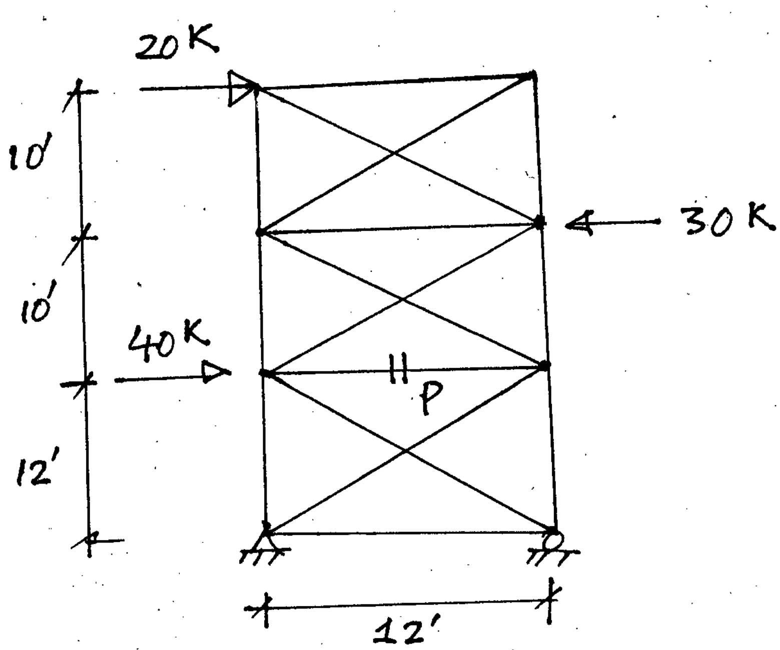

figure 3

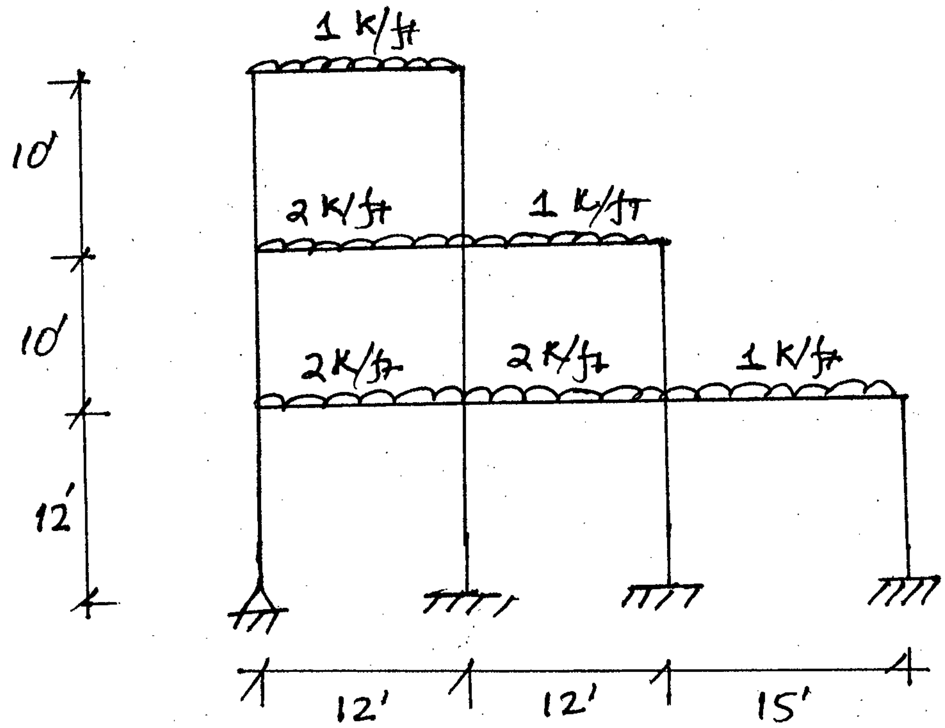

Figure 4

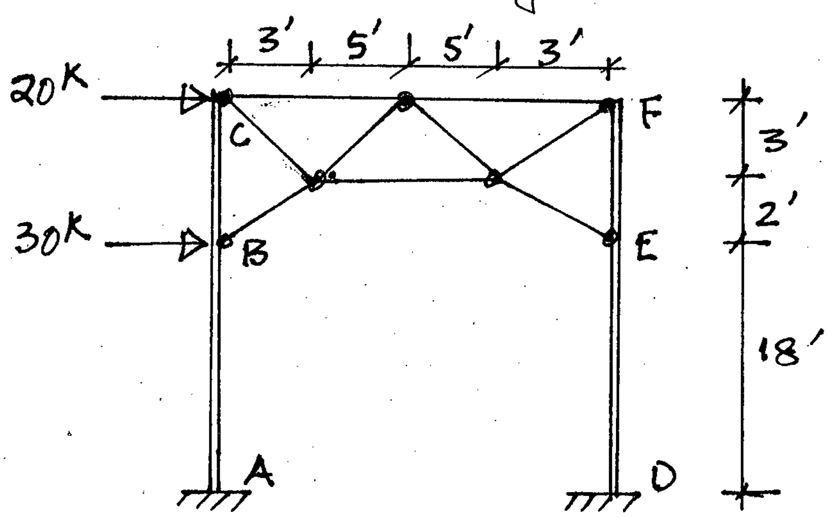

Figure 5

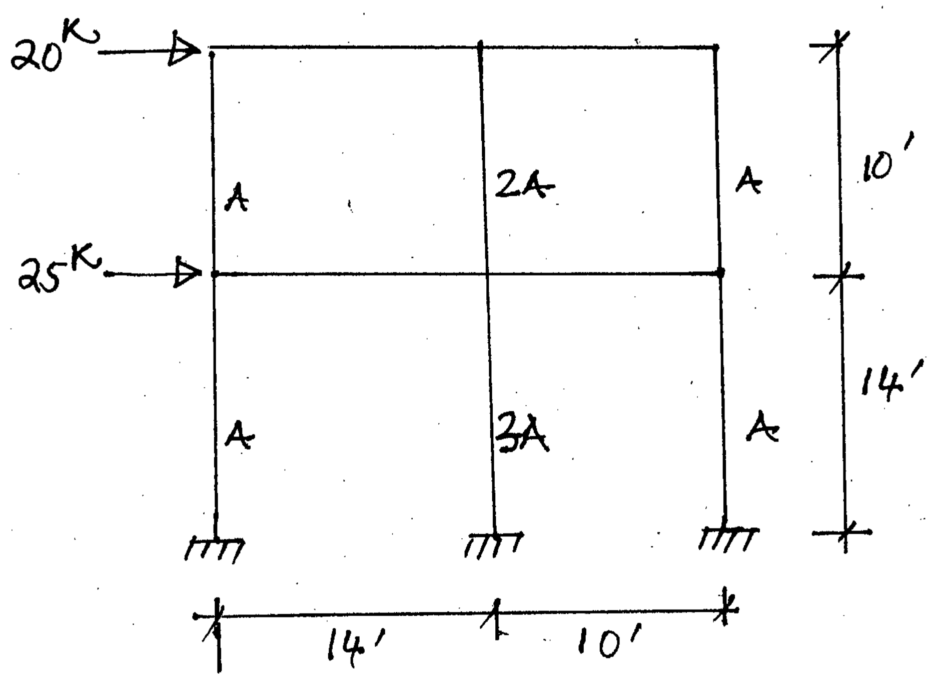

Figure 6

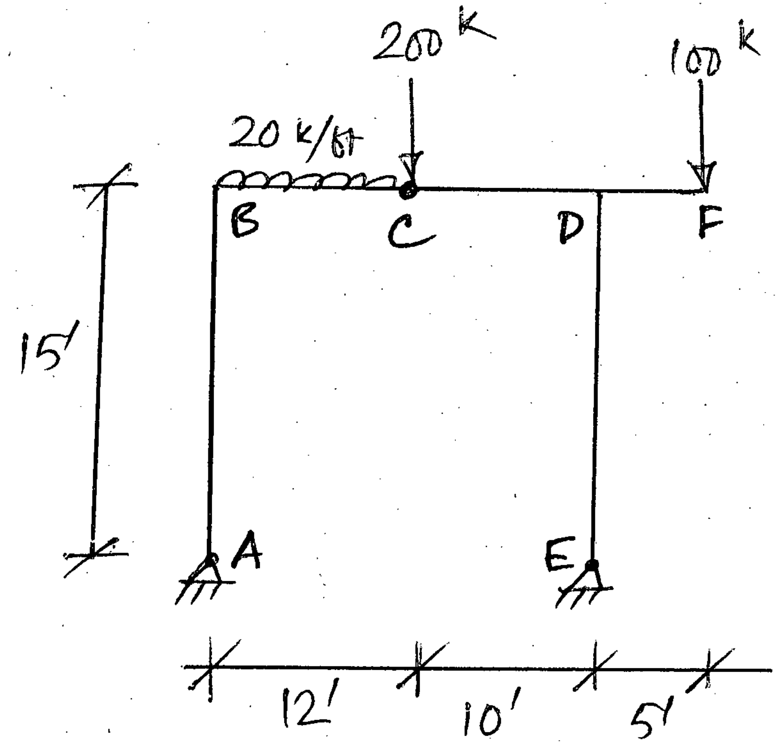

Fig. 6 (a)

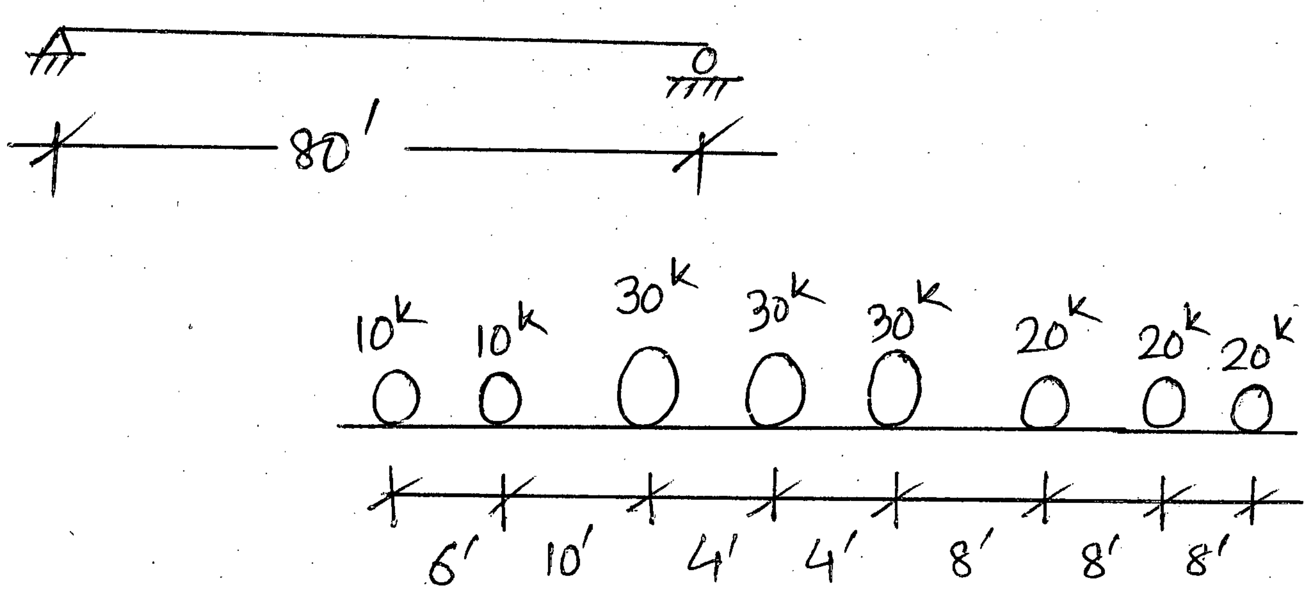

Fig. ~~6 (b)~~ 6(b)

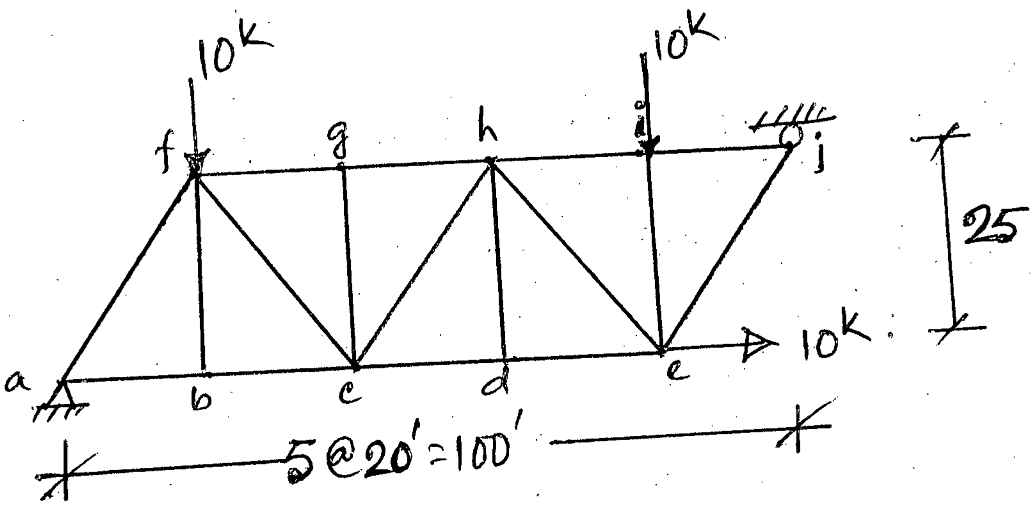

Fig. ~~2(a)~~ 7(a)

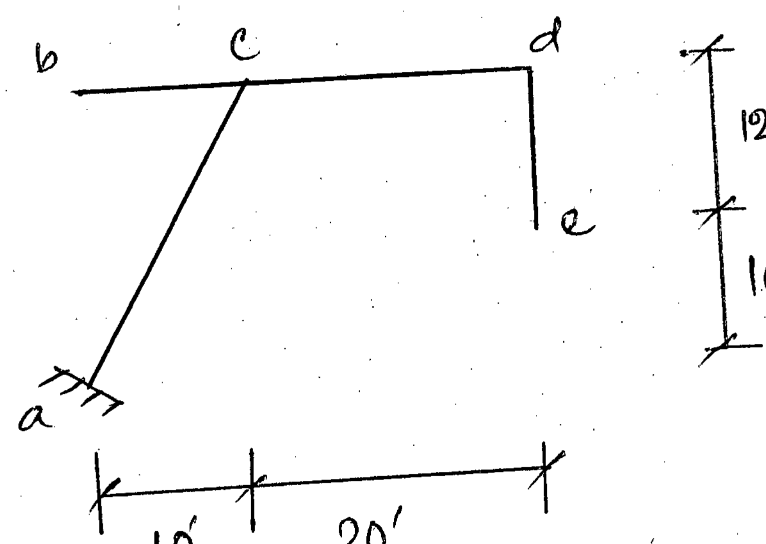

Fig ~~2(b)~~. 7(b)

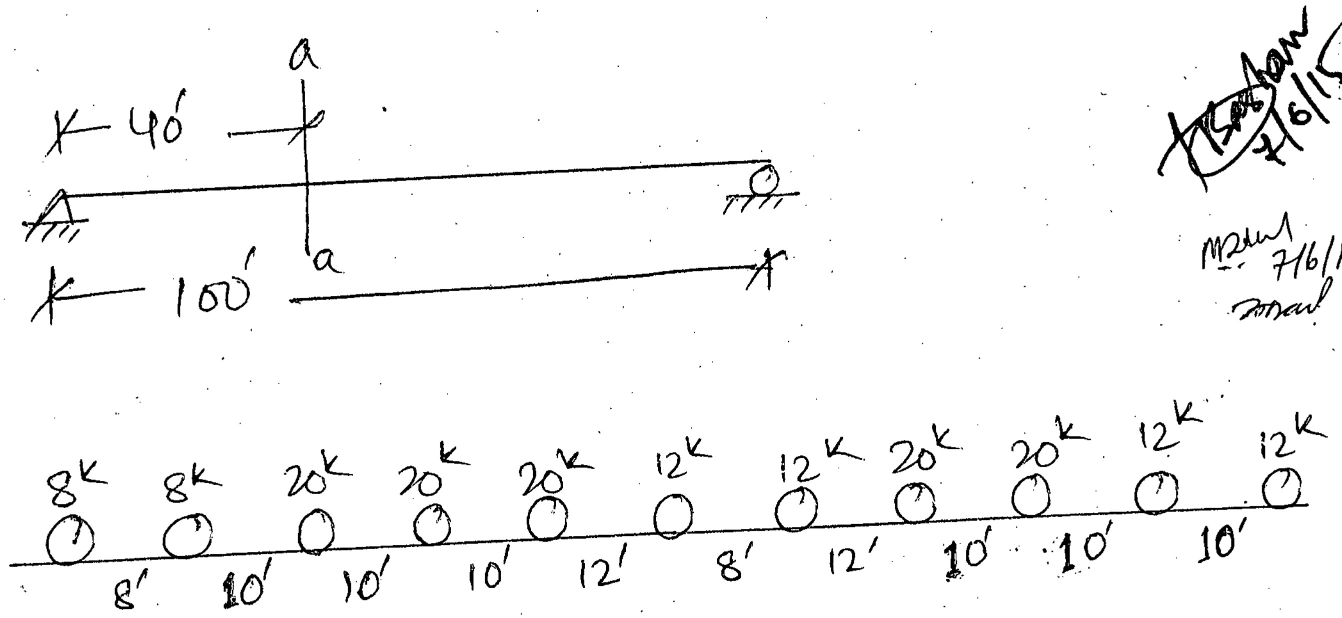

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Fig. ~~3(a)~~ 8(a)

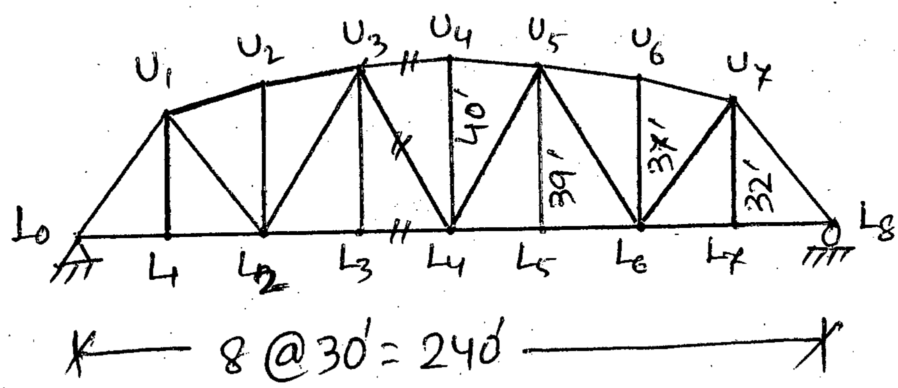

Fig. ~~3(b)~~ 8(b)

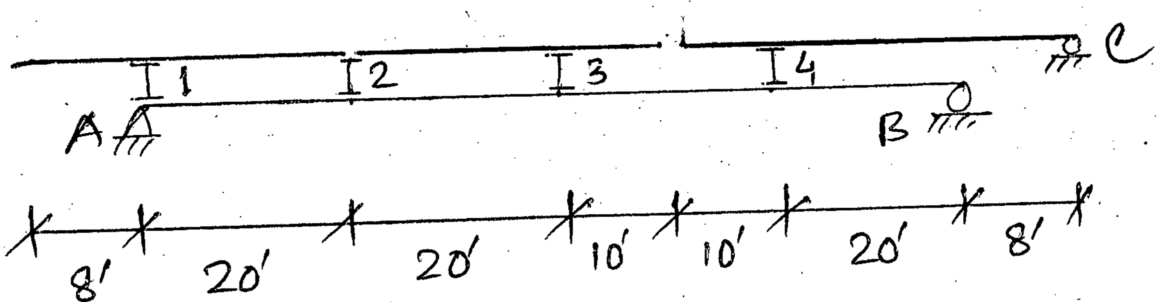

Fig. ~~4(a)~~ 9(a)

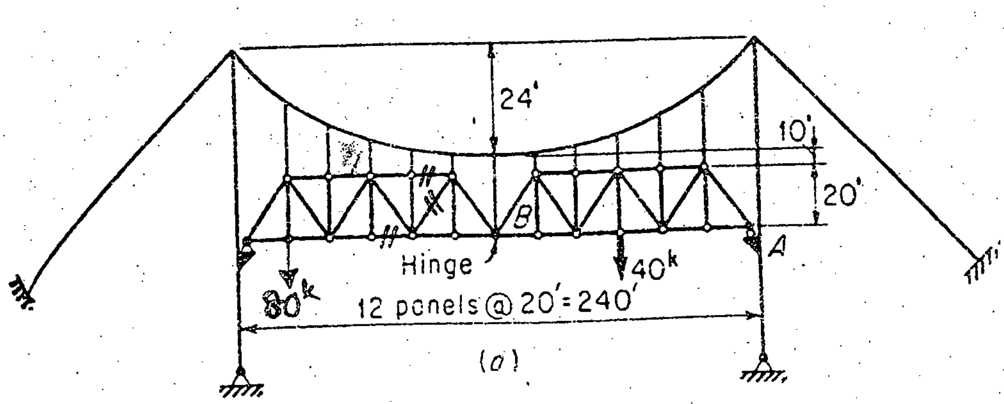

Fig. ~~4(b)~~ 9(b)

L-3/T-1/WRE **Date : 30/07/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

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

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 any reasonable data, 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 when the depth of flow is 4.8 m. **($10\frac{2}{3}$)**

z (m)	0.0	0.70	1.40	2.10	2.80	3.50	4.20	4.80
u (m/s)	0.0	0.97	1.86	2.75	3.61	3.12	2.11	1.04

(b) Compute and compare the velocity, area, hydraulic radius and hydraulic depth of a trapezoidal (b = 2.5 m, y = 1.3 m and z = 2) channel with a triangular (y = 2.8 m and z = 3) channel. For both the channels discharge is 5 m^3/s. **(8)**

(c) Compute the values of the distribution coefficients α and β and the ratio $(\alpha-1)/(\beta-1)$ for the velocity distribution $u = 3 + 4z/y$ along a vertical in a wide channel when the depth of flow in the channel is 6.0 m. **(11)**

(d) Show the pressure distribution for parallel flow in horizontal and in sloping channel. **(8)**

(e) Define: (i) depth of flow section, (ii) non-prismatic channel and (iii) alluvial channel. **(9)**

2. (a) A rectangular channel has a bottom width of 3.0 m. Construct the specific energy curve for Q = 12 m^3/s and determine the critical depth. Also find the minimum value of the specific energy from the curve constructed in the plain graph paper. **(8)**

(b) Derive the hydraulic exponent for the critical flow computation. **($8\frac{2}{3}$)**

(c) Water is flowing at a velocity of 1.60 m/s and a depth of 1.30 m in a long rectangular channel 2.5 m wide. Compute (i) the height of a smooth upward step in the channel bed that will produce critical flow in the channel, and (ii) the depth and change in water level produced by (a) a smooth upward step of 0.35 m (b) a smooth upward step of 0.85 m. In all cases, neglect energy losses and take $\alpha = 1.05$. **(18)**

(d) A trapezoidal channel is given with b = 1.8 m, z = 2.0 and Q = 8 m^3/s. Calculate the critical depth and velocity by trial and error method. Given $\alpha = 1.08$. **(12)**

Contd P/2

WRE 301

3. (a) The values of initial depth and initial velocity in connection with a hydraulic jump in a horizontal rectangular channel are 0.18 m and 22.0 m/s respectively. Compute the values of y_2 (m), V_2 (m/s), q (m^2/s), Fr_1, Fr_2 and h_L. **(12)**

(b) Prove that for a hydraulic jump in a horizontal rectangular channel the energy loss h_L can be computed by using the initial and sequent depth only. **(9)**

(c) Define: (i) stilling basin, (ii) length of the jump, and (iii) efficiency of a jump. **(9)**

(d) A horizontal trapezoidal channel having b = 2.0 m, z = 2 carries a discharge of 10 m^3/s at a depth of 0.6 m. Compute the downstream depth that will form a hydraulic jump. Given $\bar{z} = \frac{y}{6}\left(\frac{3b + 2zy}{b + zy}\right)$. **($16\frac{2}{3}$)**

4. (a) Explain why the concept of best hydraulic section comes into the design of rigid boundary channel. **(8)**

(b) Why best hydraulic sections are not always economical? **(4)**

(c) A lined channel with n = 0.025 is to be laid on a slope of 1 in 1500. The side slope of the channel is to be maintained at 2.0H : 1.0V. Determine the section dimensions of a practical trapezoidal section with rounded corners to carry a discharge of 60.0 m^3/s when the maximum permissible velocity is 3.0 m/s. **(12)**

(d) What are the limitations of Kennedy's method of channel design? **(4)**

(e) Using the Lacey method, design a stable alluvial channel when d_{50} = 6.0 mm and Q = 12 m^3/s. **(10)**

(f) Write down the design steps for the design of a trapezoidal channel by "Tractive Force Method". **($8\frac{2}{3}$)**

SECTION – B

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

5. (a) State the types of open channel flow for the following: **(6)**

   (i) Flood flow in river

   (ii) Flow in roadside gutter

(b) Water flows in a circular channel 1.23 m diameter at a depth of 0.51 m and a velocity 2.16 m/s. Determine the state of flow. **(14)**

(c) A trapezoidal channel with b = 6 m, z = 2.5, Chezy's C = 47 $m^{1/2}$/s and S_0 = 0.002. Compute the normal depth and velocity if Q = 35 m^3/s. **(16)**

(d) Explain the different terms in the Prandtl-Von Karman velocity distribution equation with respect to different surfaces. **($10\frac{2}{3}$)**

6. (a) State why flow cannot be uniform in an adverse slope channel. **(4)**

(b) Deduce the general expression for hydraulic exponent for uniform flow computation based on the Maninng's formula and then determine the numerical value of the exponent for triangular channel. **(16)**

(c) A triangular channel with z = 1, n = 0.025 and S_0 = 0.25% carries a discharge of 5 m^3/s. Compute the normal depth. **(10)**

(d) Compute the flood discharge of a river reach of 1215 m using the following data: **($16\frac{2}{3}$)**

$A_1 = 2260\ m^2$, $P_1 = 570$ m, $n_1 = 0.027$, $\alpha_1 = 1.13$

$A_2 = 3250\ m^2$, $P_2 = 712$ m, $n_2 = 0.025$, $\alpha_2 = 1.12$

The fall of water surface in the river reach is 0.92 m.

7. (a) Explain why H1 profile is not physically possible. **(6)**

(b) Draw the possible flow profiles in the following serial arrangement of channels: **(20)**

(i) Mild-Critical-Steep

(ii) Horizontal-Critical-Mild

(iii) Steep-Critical-Mild-Milder mild

(iv) Critical-Horizontal-Steep-Free overfall

(v) Adverse-Horizontal-Mild

(c) A rectangular channel 7.50 m wide and having n = 0.024 has three reaches arranged serially. The bottom slopes of these reaches are 0.0095, 0.0085 and 0.0090 respectively. For a discharge of 25 m^3/s in this channel sketch the resulting flow profiles. **($12\frac{2}{3}$)**

(d) draw possible flow profiles produced on the upstream and downstream of a sluice gate in (i) mild slope channel and (ii) steep slope channel. **(8)**

8. (a) differentiate between direct step method and standard step method. **(6)**

(b) A vertical sluice gate having a coefficient of contraction 0.61 and gate opening 1.0 m, discharge 25 m^3/s into a horizontal rectangular channel 5 m wide. Compute the length of the flow profile between the vena contracta and the location where the depth is 0.75 m. Take n = 0.015, α = 1.12. **(18)**

(c) A trapezoidal channel with b = 6 m and z = 2 is laid on a slope 0.0025 and n = 0.025. The normal depth of the channel is 1.55 m. At the downstream end of this channel there is a dam for which the water depth immediately upstream of the dam is 2.50 m. compute the resulting flow profile taking α = 1.12. **($22\frac{2}{3}$)**

L-3/T-1/WRE **Date : 04/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **CE 381** (Principles of Soil Mechanics)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

Assume any reasonable value of missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Explain the difference between the active, at-rest, and passive earth pressure conditions. Which of three earth pressure conditions should be used to design a rigid basement wall? Why? **(12+4)**

(b) State the assumptions of Rankine's theory of lateral pressure for cohesionless soil. Show graphically the effect of wall movement on lateral earth pressure. **(6+6+10)**

An 8-ft tall basement wall retains a soil that has following properties: $c' = 0$, $\phi' = 35°$, $\gamma = 127$ pcf, OCR = 2. The ground surface is horizontal and level with the top of the wall. The ground water table is well below the bottom of the wall. Consider the soil to be in the at-rest condition and compute the force that acts between the wall and the soil.

(c) According to the result from a consolidation test, the pre-consolidation stress for a certain soil sample is 850 psf. The in-situ vertical effective stress at the sample location is 797 psf, and the proposed load will cause σ_z to increase by 500 psf. Which equation should be used to compute the consolidation settlement? Why? **($8\frac{2}{3}$)**

2. (a) Define normally consolidated and over-consolidated clay. State the steps of the logarithm-of-time method to determine the coefficient of consolidation. **($5\frac{2}{3}$+10)**

(b) What are assumptions to Terzaghi's first theory to derive time rate of consolidation for saturated clays? **(5+12+3×2)**

Using the above assumptions, derive the differential equation: $\frac{\partial u}{\partial t} = C_v \frac{\partial^2 u}{\partial z^2}$ as one-dimensional time rate of consolidation (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 with T_v and z/H_{dr} and (ii) average degree of consolidation, U (%) with T_v.

(c) For a laboratory consolidation test on a clay (drained on both sides), the following results were obtained: **(8)**

The thickness of the clay soil = 25 mm

$\sigma'_1 = 50$ kPa, $e_1 = 0.92$;

$\sigma'_2 = 120$ kPa, $e_2 = 78$;

Time for 50% consolidation = 2.5 min

Determine the hydraulic conductivity of the clay for the loading range stated above.

Contd P/2

CE 381/WRE

3. (a) Write short note on: Dynamic compaction technique and depth of influence zone of compaction. **(6⅔)**

(b) State how do the following factors affecting the mechanical compaction process of soil at shallow depth: **(12)**

(i) Soil type;

(ii) Moisture content;

(iii) List thickness; and

(iv) Number of roller passes.

(c) A sample of soil compacted according to the standard Proctor test has a density of 2.06 g/cm^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+12)**

In the above question, two saturated states are described for the same soil specimen. Describe them with phase diagram. Also, state whether they are possible to occur practically.

4. (a) A 1.20 m thick strata of sand has a void ratio of 1.81. A contractor passes a vibratory roller over the strata, which densifies it and reduces its void ratio to 1.23. Compute its new thickness. **(10)**

(b) A soil constant moisture content shows the following properties when compacted: **(12)**

Degree of saturation, S (%)	γ_d (lb/ft^3)
40	92.1
70	113.7

Determine moisture content and G_s.

(c) State the method of determining Plastic limit using fall-cone method. Define graphically shrinkage limit. **(10+6⅔+8)**

A saturated soil used to determine the shrinkage limit has initial volume V_i = 20.2 cm^3, final volume, V_f = 14.3 cm^3, mass of wet soil, M_1 = 34 g, and mass of dry soil, M_2 = 24 g. Determine the shrinkage limit.

SECTION – B

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

5. (a) The particle size characteristics of a soil are given in Table 1. Draw the particle size distribution curve. Determine the followings: **(20)**

(i) Coefficient of uniformity and coefficient of curvature.

(ii) Percentage of gravel, sand, slit and clay according to AASHTO system and BNBC (2006).

Contd P/3

CE 381/WRE

Contd ... Q. No. 5(a)

Table 1 : Particle size characteristics

Size (mm)	Percent finer
0.425	100
0.07	90
0.046	80
0.034	70
0.026	60
0.019	50
0.014	40
0.009	30
0.0054	20
0.0019	10

(b) A hydrometer test on a soil sample has the following results: **(10)**

- Specific gravity, $G_s = 2.68$
- Temperature of water = 24°C
- L = 9.2 cm at 60 minutes after the start of sedimentation
- A relevant table is supplied

Determine the diameter of the smallest-size particles that have settled beyond the zone of measurement at that time (i.e., t = 60 min).

(c) What is U-line? What is its significance? Classify the soils A and B shown in Table 2 using the Unified Soil Classification system. **($16\frac{2}{3}$)**

Table 2 : Characteristics of the soils

Soil	Sieve analysis (%) finer		Liquid limit	Plasticity index
	# 4	# 200		
A	80	52	30	8
B	79	45	26	4

6. (a) Explain with sketches the difference between confined and unconfined aquifer. **(10)**

(b) For a variable-head permeability test, the following are given: **(15)**

- Length of the soil specimen = 20 inch
- Area of soil specimen = 2.5 $inch^2$
- Area of standpipe = 0.15 $inch^2$
- Head difference at time t = 0 is 30 inch
- Head difference at time t = 8 min is 16 inch

Determine the hydraulic conductivity of the soil in cm/sec and comment on the type of soil.

Contd P/4

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Contd ... Q. No. 6

(c) Grain size distribution of a soil sample is presented in Table 3. Estimate the hydraulic conductivity of the soil using the following equation if the void ratio of the soil is 0.60 and shape factor, SF = 7. **(12)**

$$k = 35\left(\frac{e^3}{1+e}\right)C_u^{\,0.6}\,(D_{10})^{2.32}$$

where, k is permeability in cm/sec, C_u is uniformity coefficient, D_{10} is effective size and e is void ratio.

Table 3 : Particle size characteristics of the soil

Sieve No.	Sieve Opening (cm)	Percent Passing
30	0.06	100
40	0.0425	96
60	0.02	84
100	0.015	50
200	0.0075	0

(d) Derive the following continuity equation for two-dimensional flow. **($9\frac{2}{3}$)**

$$\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial z^2} = 0$$

7. (a) Write down the purpose of flow net. Draw typical flow net on a plain graph paper under a dam with toe filter. **(12)**

(b) Define: (i) total stress, (ii) effective stress, (iii) pore water pressure. **(12)**

(c) List the laboratory tests for determining shear strength parameters. **(5)**

(d) Test results of four drained direct shear tests on an over consolidated clay are presented in Table 4. Diameter of the specimen is 50 mm and height of the specimen is 25 mm. Plot the variation of shear stress and effective normal stress on a graph paper and determine the followings: **($17\frac{2}{3}$)**

(i) Relationships for peak shear strength (τ_f) and residual shear strength (τ_r).

(ii) Determine the shear strength parameters in both cases.

Table 4 : Direct shear test result

Test No.	Normal force, N	Shear force at failure, S_{peak} (N)	Residual shear force, $S_{residual}$ (N)
1	150	157.5	44.2
2	250	199.9	56.6
3	350	257.6	102.9
4	550	363.4	144.5

Contd P/5

CE 381/WRE

8. (a) What is Coulomb's equation for shear strength of soil? **(6)**

(b) What are the inherent shortcomings of the direct shear test and unconfined compression tests? **(12)**

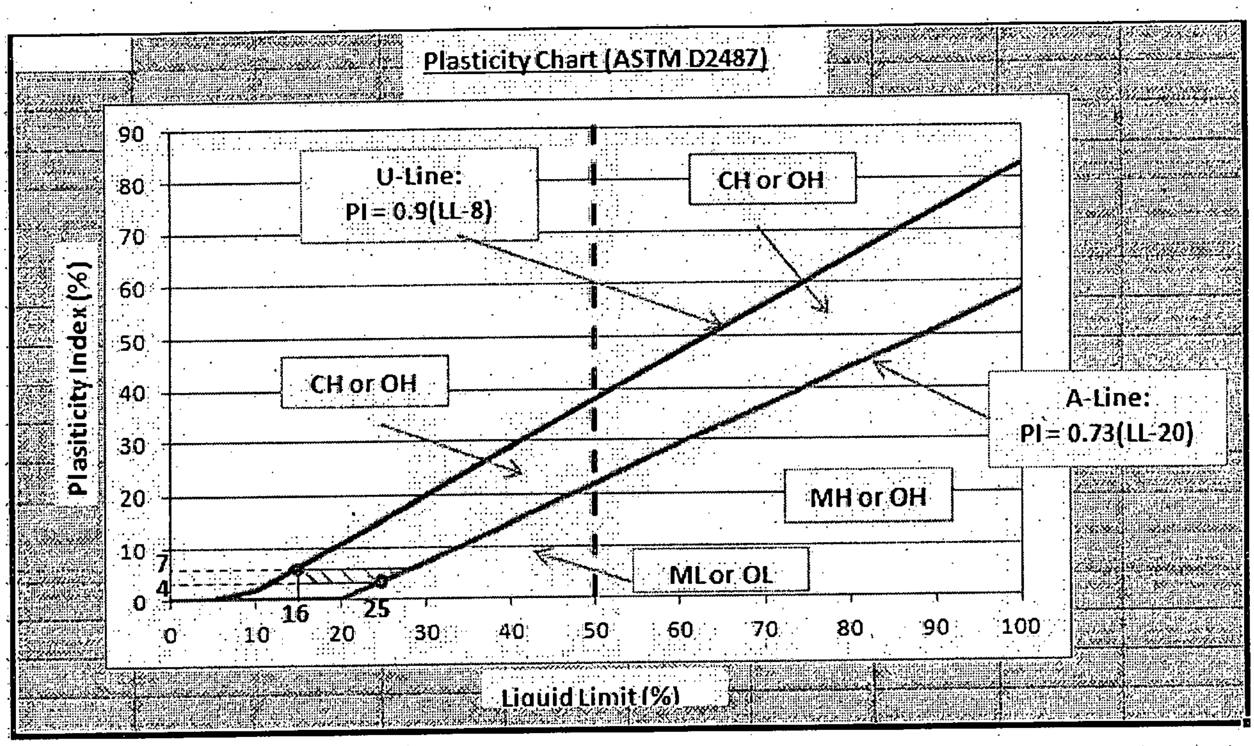
(c) Draw typical: (i) shear stress vs. shear displacement graph for loose and dense sand and (ii) change in height of specimen vs. shear displacement for loose sand and dense sand in case of direct shear test. **(12)**

(d) A specimen of saturated sand was consolidated under an all-around pressure of 84 kN/m^2. The axial stress was then increased and drainage was prevented. The specimen failed when axial deviatoric stress reached 64 kN/m^2. The pore water pressure at failure was 50 kN/m^2. Determine: (a) consolidated-undrained angle of shearing resistance, ϕ and drained friction angle, ϕ'. Draw failure envelopes and Mohr's circles. **($16\frac{2}{3}$)**

Values of *K*

Temperature (°C)	G_s 2.45	2.50	2.55	2.60	2.65	2.70	2.75	2.80
16	0.01510	0.01505	0.01481	0.01457	0.01435	0.01414	0.01394	0.01374
17	0.01511	0.01486	0.01462	0.01439	0.01417	0.01396	0.01376	0.01356
18	0.01492	0.01467	0.01443	0.01421	0.01399	0.01378	0.01359	0.01339
19	0.01474	0.01449	0.01425	0.01403	0.01382	0.01361	0.01342	0.01323
20	0.01456	0.01431	0.01408	0.01386	0.01365	0.01344	0.01325	0.01307
21	0.01438	0.01414	0.01391	0.01369	0.01348	0.01328	0.01309	0.01291
22	0.01421	0.01397	0.01374	0.01353	0.01332	0.01312	0.01294	0.01276
23	0.01405	0.01381	0.01358	0.01337	0.01317	0.01297	0.01279	0.01261
24	0.01388	0.01365	0.01342	0.01321	0.01301	0.01282	0.01264	0.01246
25	0.01372	0.01349	0.01327	0.01306	0.01286	0.01267	0.01249	0.01232
26	0.01357	0.01334	0.01312	0.01291	0.01272	0.01253	0.01235	0.01218
27	0.01342	0.01319	0.01297	0.01277	0.01258	0.01239	0.01221	0.01204
28	0.01327	0.01304	0.01283	0.01264	0.01244	0.01225	0.01208	0.01191
29	0.01312	0.01290	0.01269	0.01249	0.01230	0.01212	0.01195	0.01178
30	0.01298	0.01276	0.01256	0.01236	0.01217	0.01199	0.01182	0.01169

* After ASTM (1999)



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CE 381 (WRE)

=7=

Unified Classification System (Based on Material Passing 75 mm (3 in.) Sieve (Based on ASTM-2487)

Major division		Group symbol	Criteria
$F_{200} < 50$	Gravels	GW	$F_{200} < 5$; $C_u \geq 4$; $1 \leq C_c \leq 3$
	$\frac{R_4}{R_{200}} > 0.5$	GP	$F_{200} < 5$; Not meeting the GW criteria of C_u and C_c
		GM	$F_{200} > 12$; $PI < 4$ or plots *below* *A*-line (Fig. 4.2)
		GC	$F_{200} > 12$; $PI > 7$ and plots *on or above* *A*-line (Fig. 4.2)
		GM-GC	$F_{200} > 12$; *PI* plots in the hatched area (Fig. 4.2)
		GW-GM	$5 \leq F_{200} \leq 12$; satisfies C_u and C_c criteria of GW and meets the *PI* criteria for GM
		GW-GC	$5 \leq F_{200} \leq 12$; satisfies C_u and C_c criteria of GW and meets the *PI* criteria for GC
		GP-GM	$5 \leq F_{200} \leq 12$; does not satisfy C_u and C_c criteria of GW and meets the *PI* criteria for GM
		GP-GC	$5 \leq F_{200} \leq 12$; does not satisfy C_u and C_c criteria of GW and meets the *PI* criteria for GC
	Sands	SW	$F_{200} < 5$; $C_u \geq 6$; $1 \leq C_c \leq 3$
	$\frac{R_4}{R_{200}} \leq 0.5$	SP	$F_{200} < 5$; Not meeting the SW criteria of C_u and C_c
		SM	$F_{200} > 12$; $PI < 4$ or plots *below* *A*-line (Fig. 4.2)
		SC	$F_{200} > 12$; $PI > 7$ and plots *on or above* *A*-line (Fig. 4.2)
		SM-SC	$F_{200} > 12$; *PI* plots in the hatched area (Fig. 4.2)
		SW-SM	$5 \leq F_{200} \leq 12$; satisfies C_u and C_c criteria of SW and meets the *PI* criteria for SM
		SW-SC	$5 \leq F_{200} \leq 12$; satisfies C_u and C_c criteria of SW and meets the *PI* criteria for SC
		SP-SM	$5 \leq F_{200} \leq 12$; does not satisfy C_u and C_c criteria of SW and meets the *PI* criteria for SM
		SP-SC	$5 \leq F_{200} \leq 12$; does not satisfy C_u and C_c criteria of SW and meets the *PI* criteria for SC

L-3/T-1/WRE **Date : 08/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **CE 323** (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**.

1. (a) Discuss the behavior of reinforced concrete rectangular beam in flexure under increasing load by drawing neat sketches of strain and stress distribution of uncracked, cracked and ultimate conditions. **(9)**

(b) What is the difference between under-reinforced and over-reinforced beam? Which one is preferable and why? **(6)**

(c) A singly reinforced RC beam section as shown in Fig. 1 has a width of 12 in., effective depth of 24 in. and total depth of 27 in. The tension reinforcement consists of three No. 10 bars in one row,

Given: $f_c' = 4$ ksi, $f_y = 60$ ksi, $f_s = 24$ ksi, $f_r = 7.5\sqrt{f_c'}$ psi, $n = 8$.

(i) Cracking moment **(10)**

(ii) Stresses in concrete and steel caused by a bending moment M = 125 kip-ft. **(10)**

2. (a) What are sources of uncertainties in analysis, design and construction of RC structures? Discuss how safety is ensured against these uncertainties in USD method. **(9)**

(b) 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 beam) on a 20 ft span as shown in Fig. 2. The beam will have a cross-section of 12″ × 24″ for architectural reasons. **(14)**

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

Design the beam for flexure using USD method.

(c) A rectangular beam has width 14 in. and effective depth 27 in. as shown in Fig. 3. It is reinforced with six No. 8 bars in two rows (d=27″, d_t = 28.5″). If f_y 60 ksi and $f_c' = 5$ ksi, what is the nominal flexure strength M_n and what is the maximum moment φM_n that can be utilized in the design? Also, check maximum and minimum reinforcement limits. **(12)**

Contd P/2

3. (a) Why is concrete cover over reinforcement important? What are the recommended values of 'cover' as per ACI/BNBC code? **(6)**

(b) What is the justification of selecting strength reduction factor φ based on net tensile strain ε_t? Discuss the variation of φ with ε_t as given in ACI/BNBC code. Also explain how ε_t controls maximum reinforcement ratio. **(9)**

(c) A beam section is limited to a width b = 14 in. and total depth, h = 26 in. and has to resist a factored moment M_u of 625 kip=ft. Calculate the required reinforcements. **(20)**

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

4. (a) A floor system consists of a 3 in. slab supported by continuous T-beam with 26 ft span, 50 in. on centers as shown in Fig. 4. Web dimensions as determined by negative moment requirement at the support are, b_w = 12 in. and d = 24 in. What tensile area is required at midspan to resist a factored moment of M_u = 700 kip-ft. **(15)**

Given: $f_c' = 3\,\text{ksi}, f_y = 60\,\text{ksi}$.

(b) A rectangular RC beam as shown in Fig. 5 measures 12 in. wide and has an effective depth of 25 in. Tension steel consists of six No. 9 bars in two layers (d = 25 in and d_t = 26.5 in.) and compression steel consisting of three No. 9 bars is located 2.5 in. from the compression face. If $f_c' = 3\,\text{ksi}, f_y = 60\,\text{ksi}$, what is the design moment capacity of the beam according to ACI/BNBC code. Check the yielding of compression steel. **(20)**

SECTION – B

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

Symbols carry their usual meaning. Assume reasonable values for missing data, if any.

5. (a) Describe the mechanism of shear resistance in a RC beam with vertical stirrups? **(8)**

(b) Design the shear reinforcement of the beam shown in Fig. 6. The loads shown in the figure are factored loads. Neglect self weight of the beam. Show the shear reinforcement details in a neat sketch. Given: $f_c' = 3\,\text{ksi}, f_y = 60\,\text{ksi}$. **(22)**

(c) Why does development length in tension differ from that in compression? **(5)**

6. (a) Discuss why and how temperature and shrinkage reinforcement is provided in one-way slab.? What are the ACI/BNBC recommended ratios for such steel? **(7)**

(b) Why is minimum thickness necessary for slabs? Write down minimum thickness for RC one-way slabs for different end conditions as per ACI/BNBC code. **(7)**

Contd P/3

CE 323/WRE

Contd... Q. No. 6

(c) A 6.5″ thick one-way slab is supported on brick wall as shown in Fig. 7. The slab is subjected to FF = 25 psf, permanent partition wall, pW = 50 psf and live load, LL = 60 psf in addition to self weight. The live load can occupy any position on the slab.calculate the critical design moments and find reinforcements. Show all reinforcements in sketch. Given: $f'_c = 3\,\text{ksi}, f_y = 60\,\text{ksi}$. **(21)**

7. (a) Describe with neat sketches four RC floor systems commonly used in Bangladesh. **(8)**

(b) For the slab shown in Fig. 8, calculate design moments using Moment Coefficient Method and determine corresponding reinforcements. Show all the reinforcements in neat sketches. Given: LL = 80 psf, FF = 25 psf, pW = 40 psf, $f'_c = 3\,\text{ksi}, f_y = 60\,\text{ksi}$. **(27)**

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

(b) Show with neat sketches cut off or bend point for bars in approximately equal spans with uniformly distributed load. **(8)**

(c) Use simplified equation to calculate development length of tension bars of No. 8 and No. 5 sizes when used as **(12)**

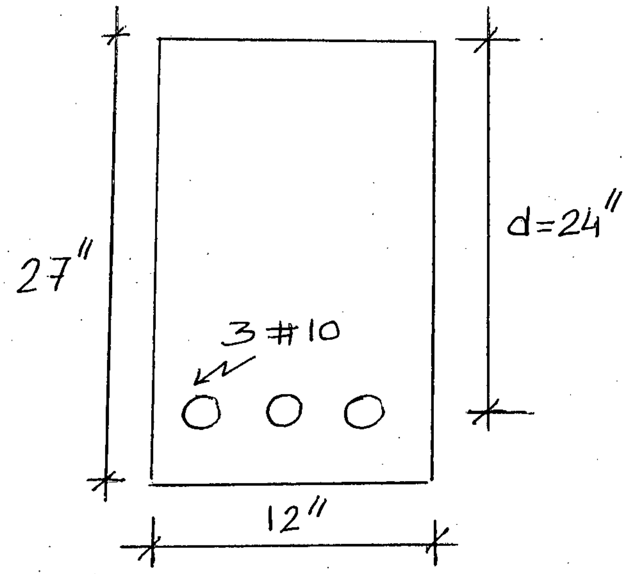
(i) top bars in a 20″ deep beam

(ii) bottom bars.

Given: $f'_c = 3.5\,\text{ksi}, f_y = 60\,\text{ksi}$.

Assume clear spacing and cover greater than $2d_b$.

(d) In Moment Coefficient Method, positive moment coefficients are different for dead and live loads — explain. **(7)**



Given:

$f_c' = 4$ ksi

$f_y = 60$ ksi

$f_s = 24$ ksi

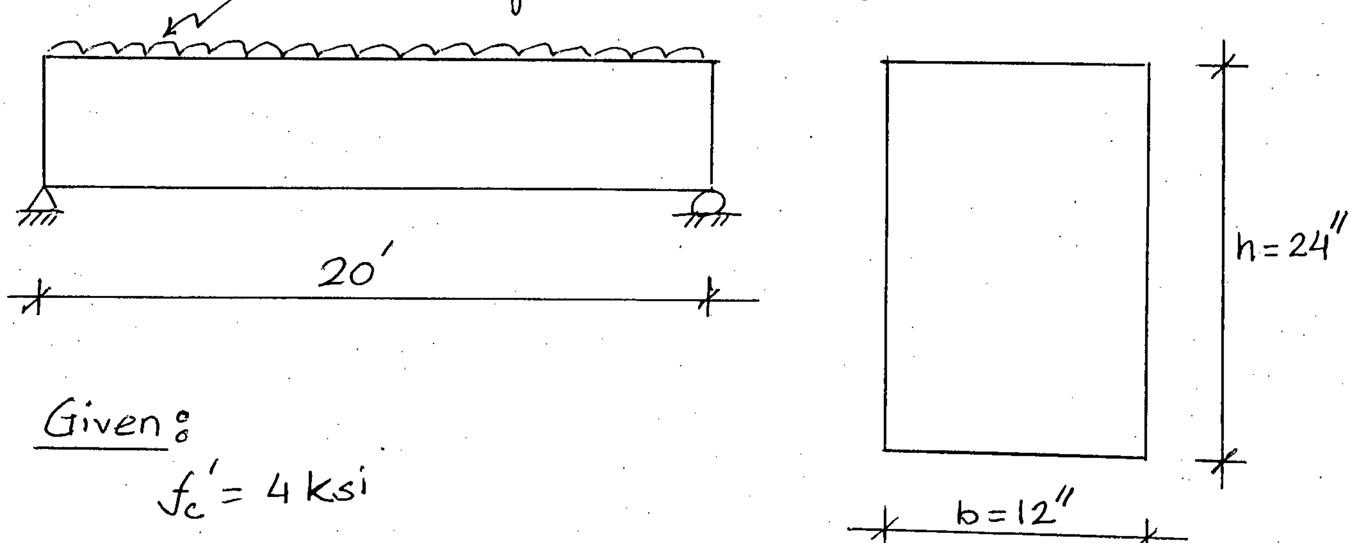
$f_r = 7.5\sqrt{f_c'}$ psi

$n = 8$

Fig. 1

Service Live load = 2.0 kip/ft

Unfactored superimposed Dead load = 1.0 kip/ft (excluding self wt of beam)

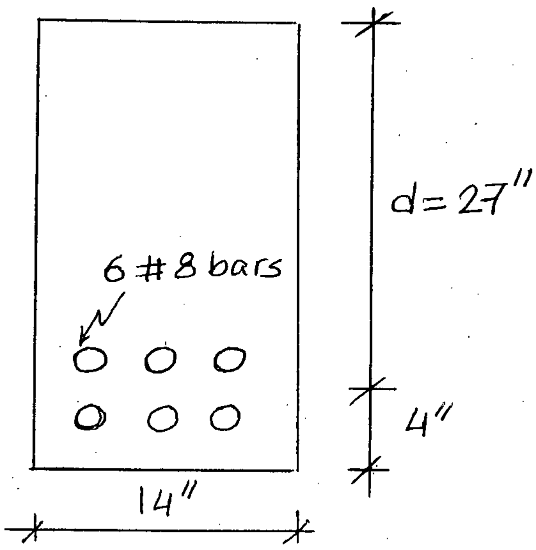


Given:

$f_c' = 4$ ksi

$f_y = 60$ ksi

Fig. 2



Given:

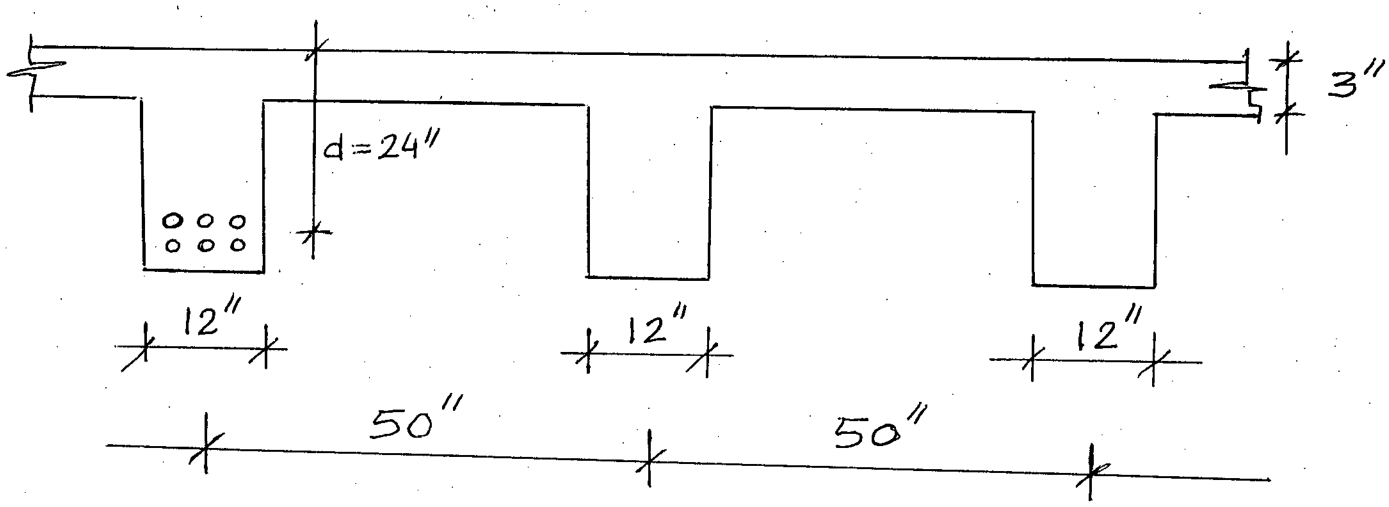
$f_c' = 5$ ksi

$f_y = 60$ ksi

$d = 27''$

$d_t = 28.5''$

Fig. 3



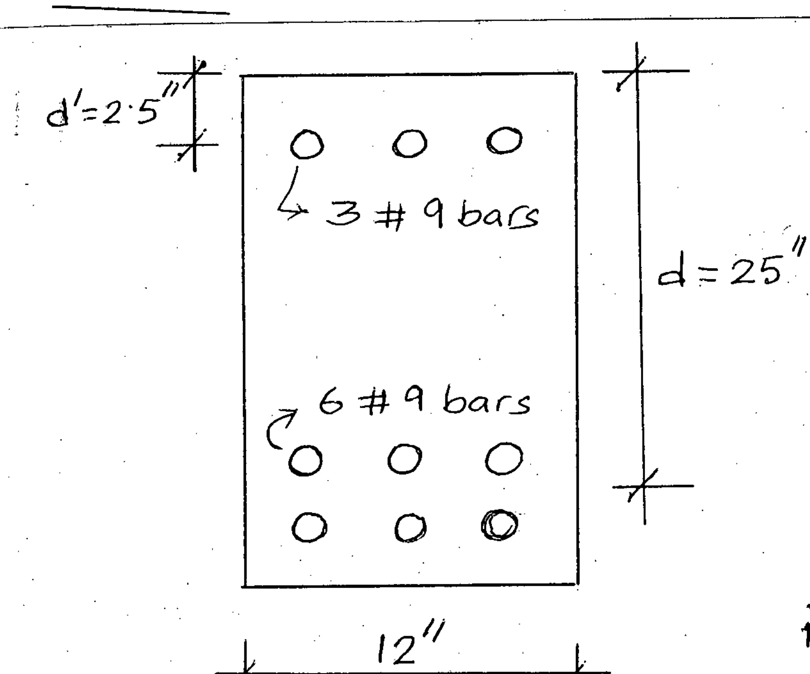
Given:

$f_c' = 3$ ksi , $f_y = 60$ ksi

Beam span = 26 ft

$M_u = 700$ kip-ft

Fig. 4



Given:

$f_c' = 3$ ksi

$f_y = 60$ ksi

$d = 25''$

$d_t = 26.5''$

Fig. 5

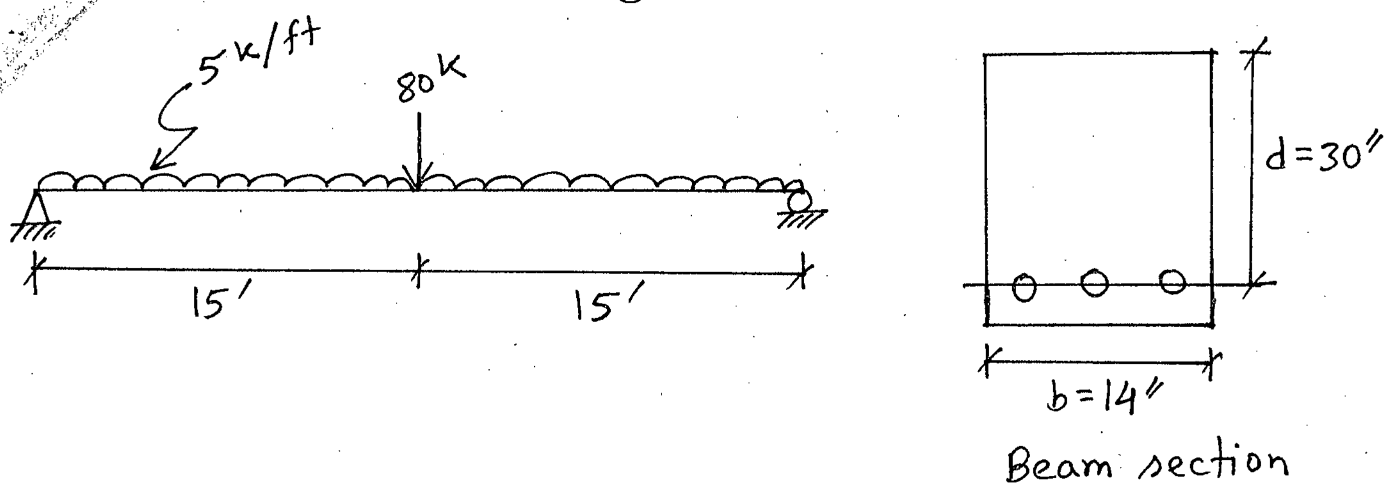


Fig. ~~1~~ 6

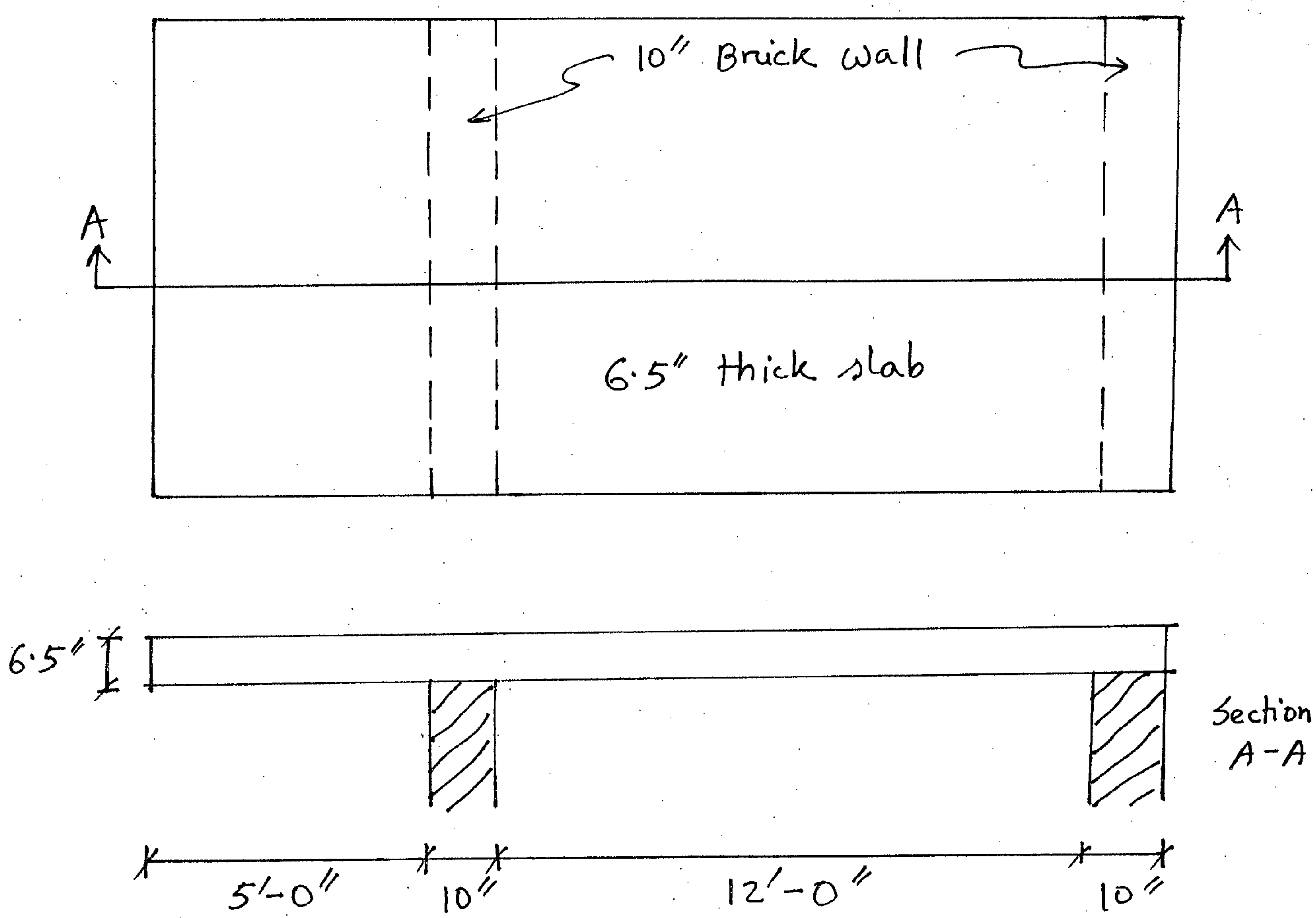


Fig. 7

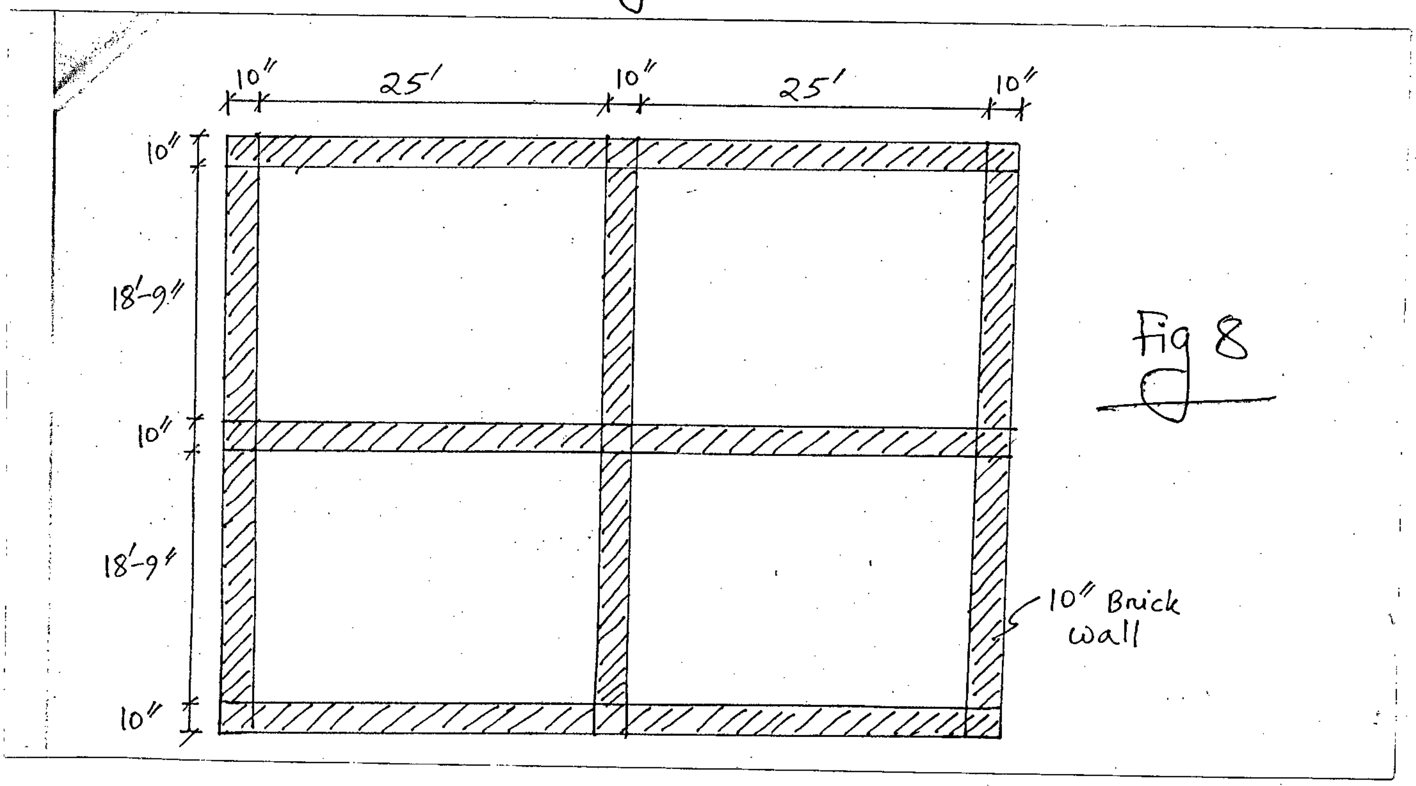


Fig 8

Table 12.3 Coefficients for negative moments in slabs[a]

$M_{a,neg} = C_{a,neg} w l_a^2$ where w = total uniform dead plus live load
$M_{b,neg} = C_{b,neg} w l_b^2$

Ratio $m = \frac{l_a}{l_b}$		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] 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 12.4 Coefficients for dead load positive moments in slabs[a]

$M_{a,pos,dl} = C_{a,dl} w l_a^2$ where w = total uniform dead load
$M_{b,pos,dl} = C_{b,dl} w l_b^2$

Ratio $m = \frac{l_a}{l_b}$		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	0.025
	$C_{b,dl}$	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	0.032
	$C_{b,dl}$	0.006	0.002	0.007	0.004	0.001	0.003	0.007	0.004	0.002

[a] 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 12.5 Coefficients for live load positive moments in slabs[a]

$M_{a,pos,ll} = C_{a,ll} w l_a^2$ where w = total uniform live load

$M_{b,pos,ll} = C_{b,ll} w l_b^2$

Ratio $m = \frac{l_a}{l_b}$		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] 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 12.6 Ratio of load W in l_a and l_b directions for shear in slab and load on supports[a]

Ratio $m = \frac{l_a}{l_b}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
1.00	W_a	0.50	0.50	0.17	0.50	0.83	0.71	0.29	0.33	0.67
	W_b	0.50	0.50	0.83	0.50	0.17	0.29	0.71	0.67	0.33
0.95	W_a	0.55	0.55	0.20	0.55	0.86	0.75	0.33	0.38	0.71
	W_b	0.45	0.45	0.80	0.45	0.14	0.25	0.67	0.62	0.29
0.90	W_a	0.60	0.60	0.23	0.60	0.88	0.79	0.38	0.43	0.75
	W_b	0.40	0.40	0.77	0.40	0.12	0.21	0.62	0.57	0.25
0.85	W_a	0.66	0.66	0.28	0.66	0.90	0.83	0.43	0.49	0.79
	W_b	0.34	0.34	0.72	0.34	0.10	0.17	0.57	0.51	0.21
0.80	W_a	0.71	0.71	0.33	0.71	0.92	0.86	0.49	0.55	0.83
	W_b	0.29	0.29	0.67	0.29	0.08	0.14	0.51	0.45	0.17
0.75	W_a	0.76	0.76	0.39	0.76	0.94	0.88	0.56	0.61	0.86
	W_b	0.24	0.24	0.61	0.24	0.06	0.12	0.44	0.39	0.14
0.70	W_a	0.81	0.81	0.45	0.81	0.95	0.91	0.62	0.68	0.89
	W_b	0.19	0.19	0.55	0.19	0.05	0.09	0.38	0.32	0.11
0.65	W_a	0.85	0.85	0.53	0.85	0.96	0.93	0.69	0.74	0.92
	W_b	0.15	0.15	0.47	0.15	0.04	0.07	0.31	0.26	0.08
0.60	W_a	0.89	0.89	0.61	0.89	0.97	0.95	0.76	0.80	0.94
	W_b	0.11	0.11	0.39	0.11	0.03	0.05	0.24	0.20	0.06
0.55	W_a	0.92	0.92	0.69	0.92	0.98	0.96	0.81	0.85	0.95
	W_b	0.08	0.08	0.31	0.08	0.02	0.04	0.19	0.15	0.05
0.50	W_a	0.94	0.94	0.76	0.94	0.99	0.97	0.86	0.89	0.97
	W_b	0.06	0.06	0.24	0.06	0.01	0.03	0.14	0.11	0.03

[a] 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.