L-3/T-1/WRE **Date : 14/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2015-2016

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**.

Assume any reasonable value of missing data.

1. (a) A 6-storied RC hospital building has a plan dimension of 150 ft × 120 ft and typical floor-to-floor height of the building is 12 ft except the ground floor. The height of the ground floor is 15 ft. The building is an intermediate moment resisting frame having slab thickness of 8 inch. Floor finish, partition wall load, service live load are 30 psf, 70 psf and 60 psf, respectively. Draw shear force and bending moment distributions along the height of the building for Earthquake resistant design. Given: R = 5, I = 1.50, Soil type SC and Z = 0.28. **(38)**

   (b) Calculate the force in the member FH of the truss as shown in Figure 1. Note that the horizontal load of 4 kN is applied at the joint C. **($8\frac{2}{3}$)**

2. (a) The parabolic arch ($y = 0.0311\ x^2$) shown in Figure 2 carries a uniformly distributed load of intensity 10 kN/m over the portion AC of its span. Calculate the values of normal force, shear force and bending moment at the point D which is located at a distance 7.5 m from the left support. **(36)**

   (b) Determine the bar forces in members "x" and "y" of the truss shown in Figure 3 assuming that the diagonals cannot support compressive forces. **($10\frac{2}{3}$)**

3. (a) Draw the shear force and bending moment diagrams for the building frame loaded as shown in Figure 4. **(30)**

   (b) Draw the axial force, shear force and bending moment diagrams of the column ABC of the millbent as shown in Figure 5. **($16\frac{2}{3}$)**

4. Using Cantilever method, draw the axial force, shear force and bending moment diagrams of the beams and columns for the building as shown in Figure 6. Relative column cross-sectional areas are given beside the columns. **($46\frac{2}{3}$)**

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 'E' of the frame due to the loads as shown in Fig. 7. All the members have properties as follows: $E = 29 \times 10^3$ ksi, $I = 54$ in^4, $A = 18$ in^2. **(30)**

   (b) For the frame in Fig. 7, draw the influence lines for all the reactions at 'F' if the load can only move between point 'B' to point 'E'. Also draw influence line for shear of the member 'DF'. **($16\frac{2}{3}$)**

6. (a) Determine vertical deflection of point 'g' in the truss shown in Fig. 8(a) due to the combined effect of the following: **(30)**

   (i) the loads shown in Fig. 8(a).

   (ii) a rise in temperature by 40° F in the top chord only, $a_t = 1/150000$ per °F.

   (iii) a horizontal displacement of support 'a' by 3 inch to the right, a vertical displacement of support 'd' by 2 inch upwards and a horizontal movement of 'd' by 1 inch to the right.

   Given that, $E = 29 \times 10^3$ ksi; $A = 1$ in^2 for all the members.

   (b) Determine the absolute maximum bending moment for the simply supported beam due to the moving wheel loads as shown in Fig. 8(b). **($16\frac{2}{3}$)**

7. (a) Draw influence lines for axial force in members 'cd', 'id' and 'ij' of the truss shown in Fig. 9(a). Unit load moves along the bottom chord of the truss. Also determine the maximum axial force in the member 'id' for a uniform load of 2 k/ft. **(23)**

   (b) Determine maximum positive bending moment and shear at section a-a of the beam due to the series of wheel loads shown in Fig. 9(b). **($23\frac{2}{3}$)**

8. (a) Draw influence lines for reactions at A, B of the plate girder shown in Fig. 10(a). Also draw influence lines for $V_{2\text{-}3}$ and M_3. **(20)**

   (b) For the truss shown in Fig. 10(b), is it justified to use the counter member 'bh' (shown in dashed line)? Assume that dead load and live load on the bottom chord is 5 k/ft and 6 k/ft respectively. **(7)**

   (c) A suspension bridge with a stiffening girder is shown in Fig. 10(c). Draw the bending moment and shear force diagram of the left part of the girder due to the loads shown. **($19\frac{2}{3}$)**

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

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

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

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

Structure type	C_t	m
Concrete moment-resisting frames	0.0466	0.9
Steel moment-resisting frames	0.0724	0.8
Eccentrically braced steel frame	0.0731	0.75
All other structural systems	0.0488	0.75

$$S_a = \frac{2}{3}\frac{ZI}{R}C_s$$

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

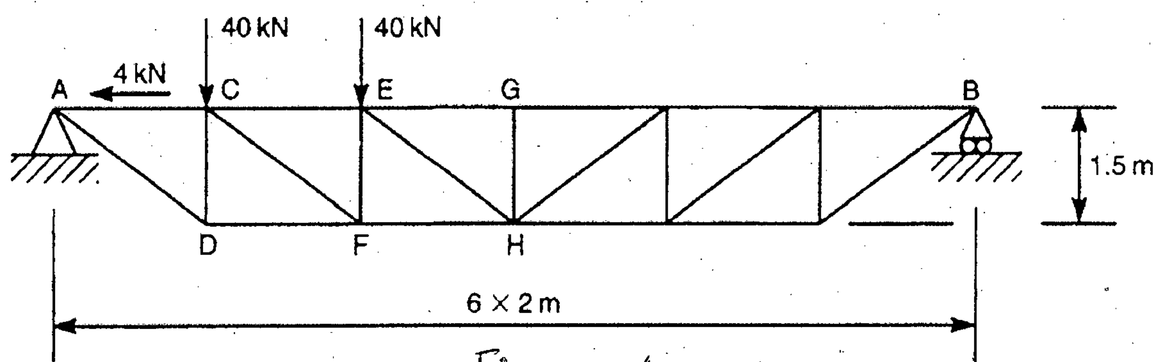


Figure 1

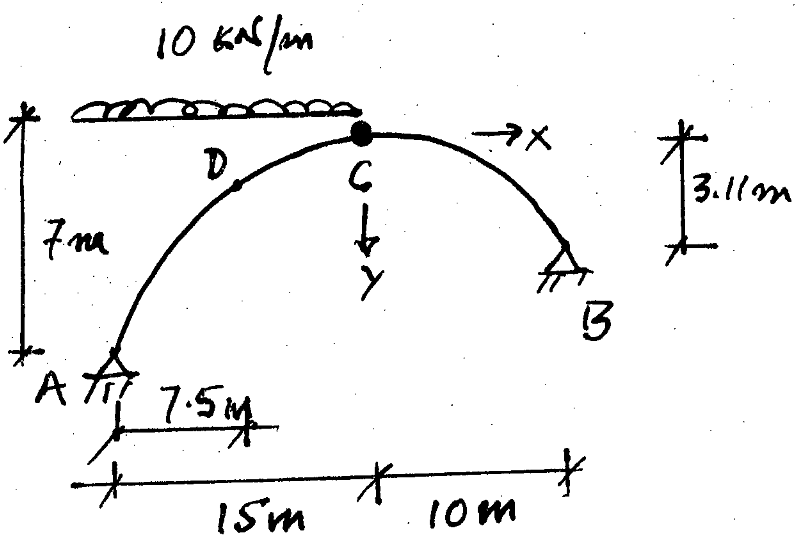


Figure 2

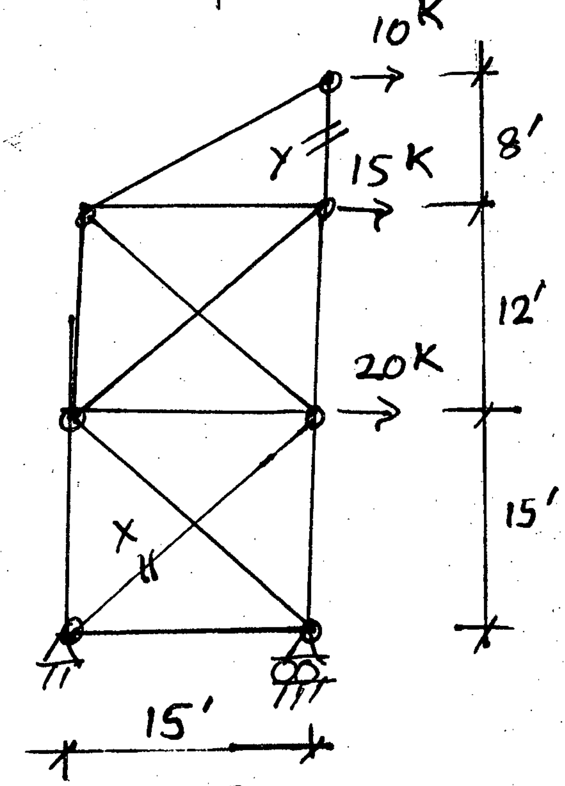


Figure 3

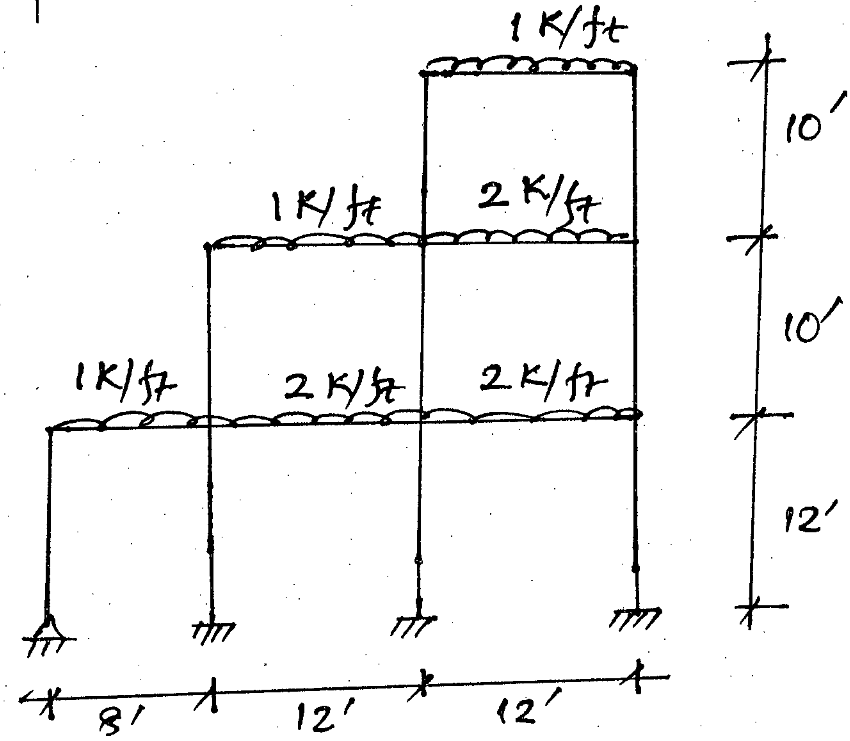


Figure 4

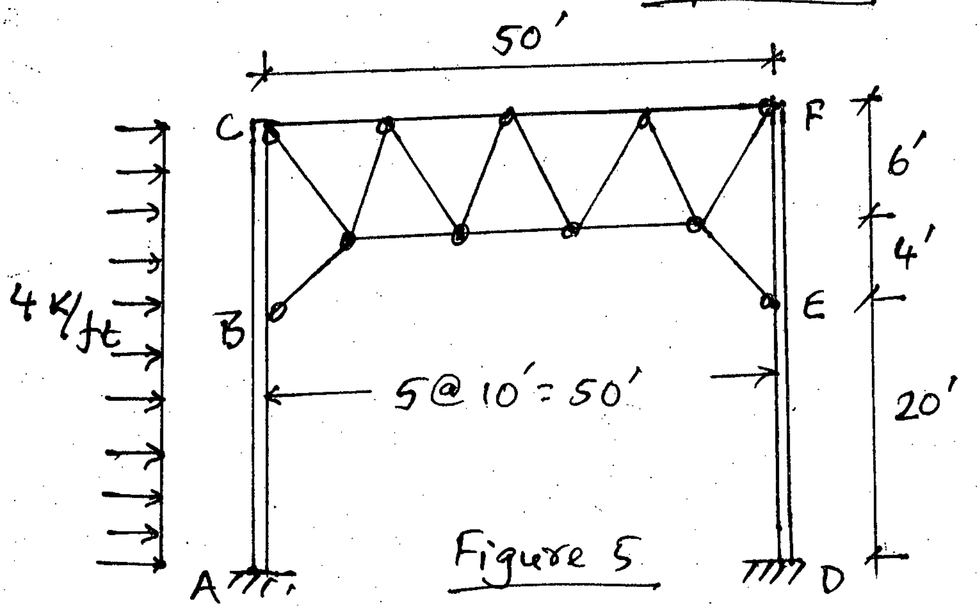


Figure 5

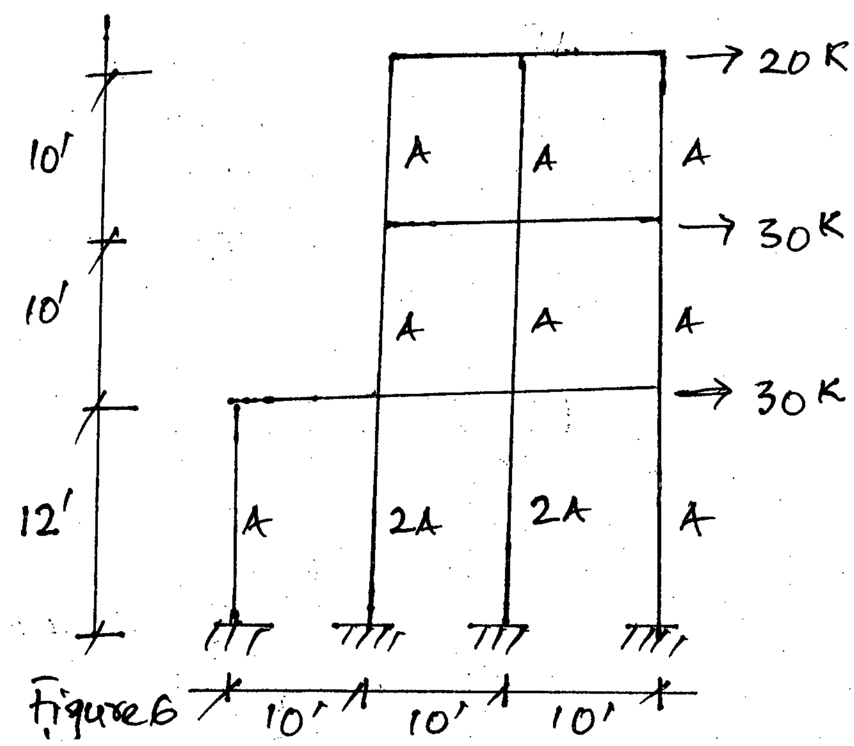


Figure 6

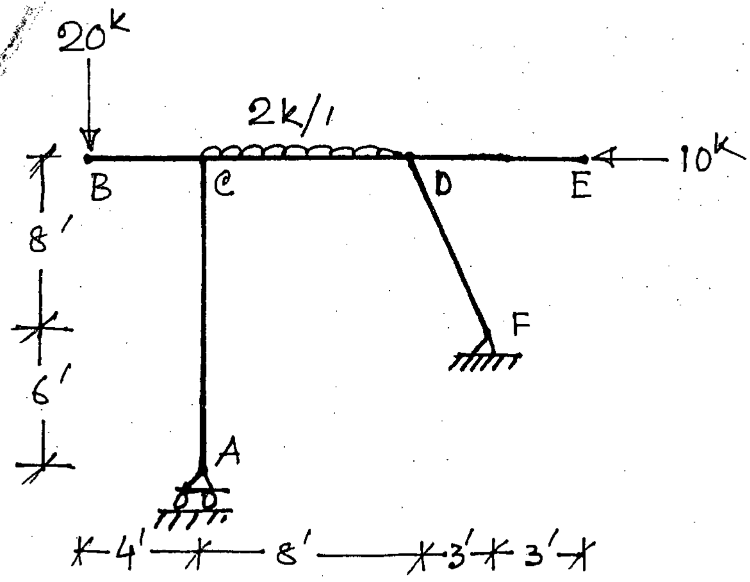


Figure ~~1~~ 7

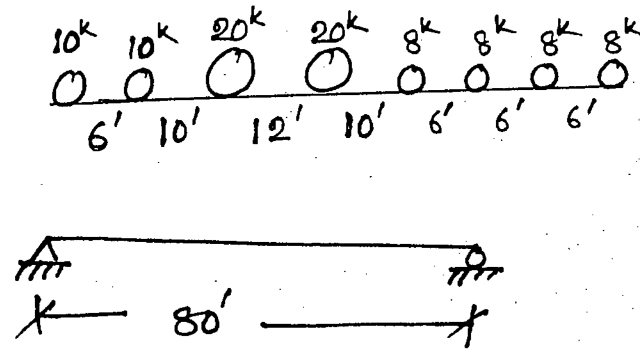
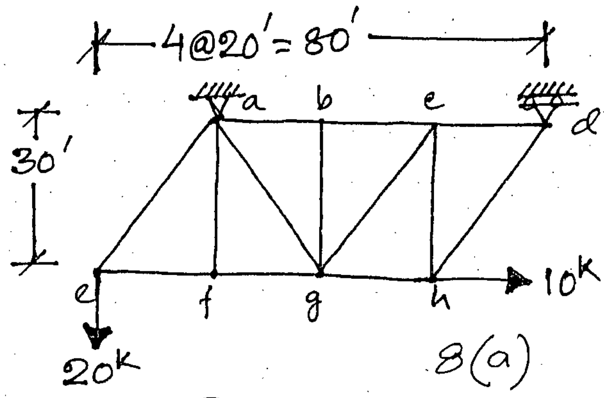


Figure ~~2(b)~~ 8(b)



8(a)

Figure ~~2(a)~~

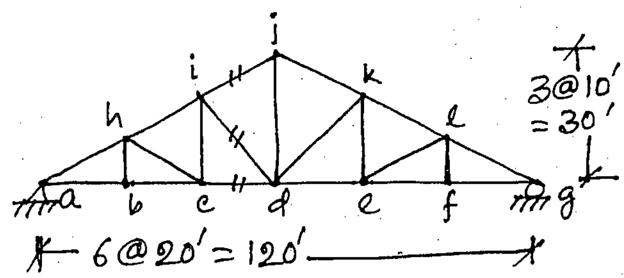


Figure ~~3(a)~~ 9(a)

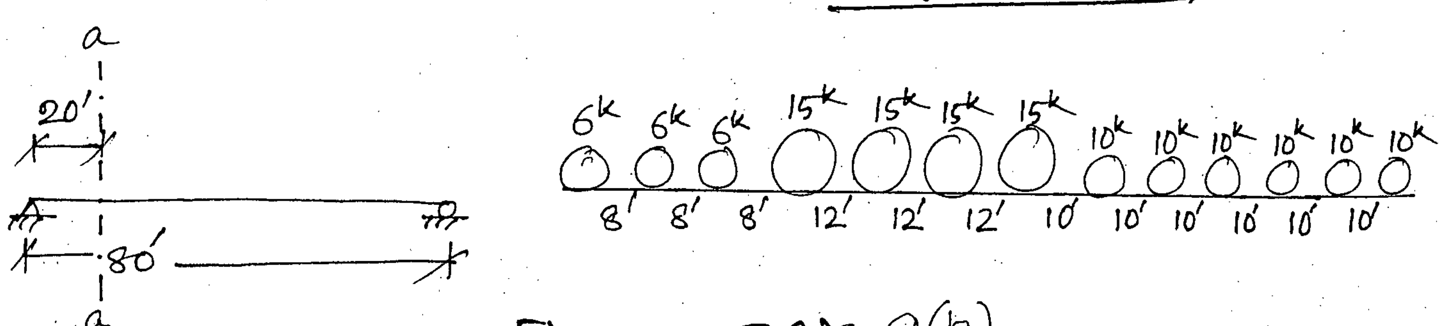


Figure – ~~3(b)~~ 9(b)

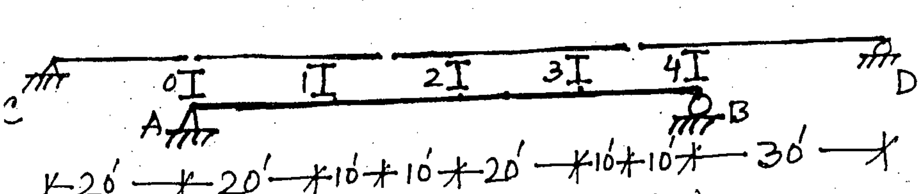


Figure ~~4(a)~~ 10(a)

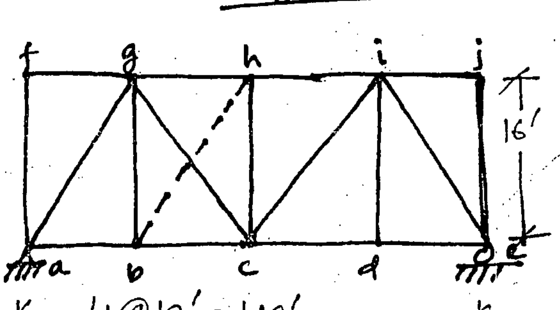


Figure ~~4(b)~~ 10(b)

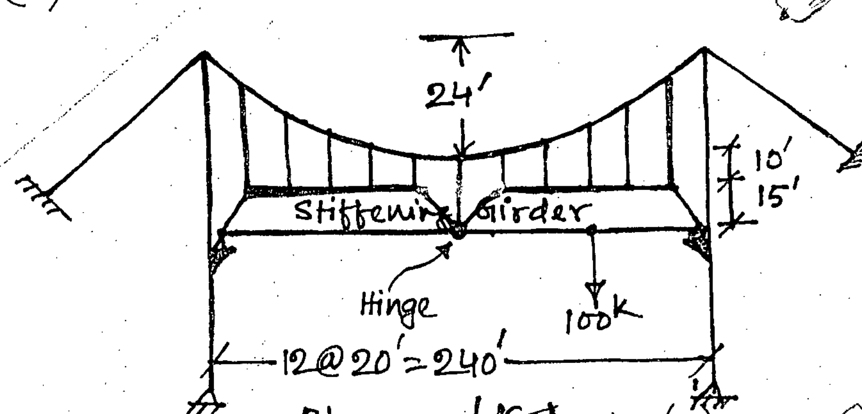


Figure ~~4(c)~~ 10(c)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2015-2016

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 reasonable value if data is not given.

1. (a) Find the relation between Manning's roughness value (n) and friction factor (f) for an open channel flow. **(10)**

   (b) A trapezoidal channel has side slopes z = 2, bottom width b = 6 m and channel slope S = 0.0016. If the channel carries discharge of 11.5 m^3/s, determine (i) the normal depth and (ii) critical slope for same discharge. **(20)**

   (c) Deduce the expression of hydraulic exponent (N) for uniform flow using the Manning equation. What will be the value of N for equilateral triangular channel with vertex at the bottom? **($16\frac{2}{3}$)**

2. (a) Define tractive force and tractive force ratio. Derive the expression of tractive force ratio. **(10)**

   (b) An open channel is to be designed to carry 1 m^3/s at a slope of 0.0065. The channel material has Manning's roughness value 0.011. Find the best hydraulic trapezoidal section. **($16\frac{2}{3}$)**

   (c) Design a channel to carry 42 m^3/s of clear water through a 1.0 mm sand bed (angle of repose = 35 degree) on a slope of 10^{-4}. The channel has to be trapezoidal with side slope 1V : 2H. Take dimensionless critical tractive stress = 0.045. Assume reasonable value if not given. **(20)**

3. (a) Derive the dynamic equation of gradually varied flow in terms of depth for wide rectangular channel. Use the Chezy equation. **(15)**

   (b) Sketch the possible flow profile (with types) in the following serial arrangement of the channels. The flow is from left to right. **(15)**

   (i) Steep-steeper-mild

   (ii) Mild-Milder-steep

   (iii) Critical-horizontal-steep

   (c) Determine the upstream profile of a backwater curve due to flow obstruction by a dam of height 4.0 m. Given that Q = 10 m^3/s, b = 3.5 m, S_0 = 0.0001, n = 0.025 and y_n = 2.65 m. Use at least 4 steps and use any method of computation. **($16\frac{2}{3}$)**

Contd P/2

4. (a) Define (i) Transitional depth and (ii) Critical slope and Limit slope. **(10)**

(b) What do you mean by channel control? Give examples (with sketches) of water surface profiles with control points. **($16\frac{2}{3}$)**

(c) A sluice gate discharges 11 m^3/s into a rectangular channel having bottom width 6 m. The depth at the vena contracta is equal to 0.17 m. The channel downstream has a slope of 0.01 and n = 0.015. Find the type of water surface profile formed downstream of the vena contracta and sketch the profile. **(20)**

SECTION – B

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

5. (a) Explain velocity distribution in a rectangular channel with neat sketch. Derive an equation for computation of momentum co-efficient. **(15)**

(b) Waves of small amplitude are created at the center of a circular-shaped pond of radius 50 m. The waves are found to reach the edge of the pond in 10 seconds. Estimate the approximate volume of water in the pond assuming that the depth of water in the pond is same everywhere. Assume, the pond as a wide channel. **(10)**

(c) For the velocity distribution given in Figure 1. Find α and β. **($15\frac{2}{3}$)**

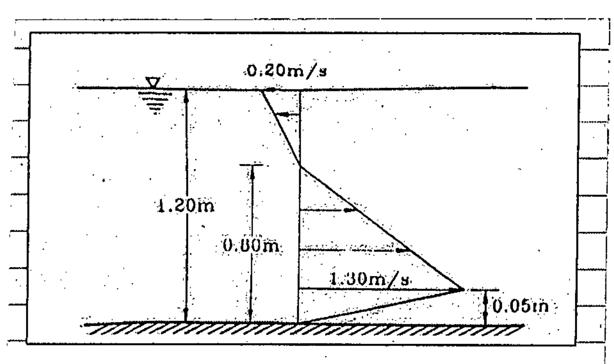


Figure: 1

(d) What is rapidly varied flow? Sketch and show gradually varied and rapidly varied flow zone in a single setup. **(6)**

6. (a) Describe characteristics of specific energy curve with sketch. **(8)**

(b) Water is flowing at a velocity of 2 m/s and a depth of 2.5 m in a long rectangular channel 6 m wide. Compute (a) the height of a smooth upward step in the channel bed to produce critical flow, and (b) the depth and the change in water level produced by (i) a smooth upward step of 0.40 m, (ii) a smooth upward step of 0.80 m, and (iii) a smooth downward step of 0.40 m. In all cases, neglect energy losses and take $\alpha = 1$. **(20)**

(c) Derive an expression of hydraulic exponent for critical flow computation and use it to determine the value of hydraulic exponent for parabolic channel. **(12)**

(d) How a control structure in mild or subcritical sloping channel controls the upstream flow behavior? Explain with figure. **($6\frac{2}{3}$)**

Contd P/3

WRE 301

7. (a) Derive Euler equation of motion for an open channel for all conditions. **(12)**

   (b) For a trapezoidal channel of b = 6 m and z = 2 m. Compute the critical depth using method of Bi-section. **($12\frac{2}{3}$)**

   (c) Derive relation between two conjugate depths for hydraulic jump in horizontal rectangular channel. **(10)**

   (d) Compute the maximum discharge that may be carried by a channel for a specific energy 2 m. When the channel is triangular with z = 1. **(12)**

8. (a) List the applications of hydraulic jump. Classify and sketch the hydraulic jumps according to USBR. **(10)**

   (b) A hydraulic jump occurs in a 6 m wide rectangular channel at a flow depth of 1.0 m. The discharge through the channel is 20 m^3/s. Determine the downstream depth after the jump Fr_1, Fr_2, q, V_1, V_2, h_j and the energy loss of the jump. **($16\frac{2}{3}$)**

   (c) Write short note on the following topics: **(20)**

   (i) Rigid and mobile boundary channel.
   (ii) Regimes of flow.
   (iii) Specific force.
   (iv) Parallel flow in a sloping channel.
   (v) Hydraulic jump as an energy dissipater.

L-3/T-1/CSE Date : 24/01/2017

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2015-2016

Sub : **CSE 309** (Compiler)

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) Most languages are case sensitive, so keywords can be written in only one way, and the regular expressions describing their lexeme is very simple. However, some languages, like SQL, are case insensitive, so a keyword can be written either in lowercase or in uppercase, or in any mixture of cases. Thus, the SQL keywords SELECT can also be written select, Select, or sElEcT, for instance. Show how to write a regular expression for a keyword in a case-insensitive language. Illustrate the idea by writing the regular definition for the select keyword. **(5)**

   (b) Explain in detail the relative advantages and disadvantages of having individual and class tokens for the operators. **(10)**

   (c) What would have happened if instead of buffer pairs lexical analysis, we decided to use a single buffer keeping the pointers same as those in buffer pair? Provide necessary diagram. **(10)**

   (d) Write a Lex program that copies a file, replacing each non-empty sequence of white space by a single blank. **(10)**

2. (a) Eliminate left-recursion from the following grammar: **(20)**

   $S \rightarrow Sc \mid Ta \mid Ub \mid b$

   $T \rightarrow Tc \mid Sd \mid d$

   $U \rightarrow Ua \mid Td \mid Sb \mid b$

   (b) Write a YACC program which takes a sum series of numbers as input and prints the sum of squares of the numbers as output. That is, if the sum series, 3.2 + 5.1 + 2.0 + 10.67, is given as input, it will print the arithmetic result of $3.2^2 + 5.1^2 + 2.0^2 + 10.67^2$ as output. First, mention the grammar which you are going to use to parse the input sentences (terminated by newlines). Then develop a YACC program to carry out the intended task. You can leave out the Lex part assuming that tokenization has already been done, but you should use the appropriate tokens in your YACC program. Providing only the middle (second) portion of the YACC program should suffice. **(15)**

Contd P/2

CSE 309

3. (a) Enumerate with necessary justification, the rules used to find the FOLLOW sets in a grammar. **(15)**

   (b) Construct procedure based recursive-descent parsers, starting with each of the following grammars: **(20)**

   (i) $S \rightarrow S(S)S \mid \epsilon$

   (ii) $S \rightarrow 0S1 \mid 01$

4. (a) Find the FIRST and FOLLOW sets for the non-terminals in the following grammars: **(3+12)**

   (i) $S \rightarrow cSbS \mid dSaS \mid \epsilon$

   (ii) $S \rightarrow aSbB \mid gA,\ A \rightarrow CB \mid cAh,\ B \rightarrow d \mid fC \mid C,\ C \rightarrow \epsilon$

   (b) Explain clearly the role of FOLLOW in deciding whether to use empty production rules in predictive parsing. **(10)**

   (c) What does multiple entries in a cell of predictive parsing table mean? Why? **(10)**

SECTION – B

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

5. (a) What is a syntax-directed definition? Explain S-attributed and L-attributed definitions with examples. **(10)**

   (b) What is an abstract syntax tree? Write S-attributed definitions to generate the abstract syntax tree for the following context free grammar where the symbols have their usual meanings: **(10)**

   $S \rightarrow \textbf{id} := E$

   $E \rightarrow E_1 + T \mid E_1 - T \mid T$

   $T \rightarrow T_1 * \textbf{id} \mid T_1 / \textbf{id} \mid \textbf{id}$

   (c) The following syntax-directed definition generates binary strings where (one of) the attributes gives the number represented by the string. The non-terminals are *B* and *D*; the terminals are 0 and 1. The symbol *B* stands for binary expansion and the symbol **D** stands for digit. **(4+1+8+2=15)**

$B \rightarrow DB1$	B.pos := $B1$.pos + 1
	B.val := $B1$.val + D.val
	D.pow := $B1$.pos
$B \rightarrow D$	B.pos := 1
	B.val := D.val
	D.pow := 0
$D \rightarrow 0$	D.val := 0
$D \rightarrow 1$	D.val := 2D.pow

Contd P/3

CSE 309

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

(i) Identify the synthesized and inherited attributes.

(ii) Is the syntax-directed definition S-attributed or L-attributed?

(iii) Show the annotated parse tree for the following sentence with dependency graph:

101011

(iv) Find a topological ordering of the dependency graph.

6. (a) Below is a grammar for understanding simple arithmetic expressions: **(10)**

$$E \rightarrow E * E \mid E + E \mid (E) \mid \textbf{int}$$

Assuming that precedence and associativity have been handled, what translation actions would you add to the grammar to get it to print out the input expression in a postfix notation? For example, (3 + 5) * 4 would print out as 3 5 + 4 *.

(b) What are strongly typed and weakly typed languages? What are statically typed and dynamically typed languages? **(10)**

(c) Construct three address code for the following code snippet and put them in Indirect Triples data structure: **(15)**

```
i := k + n * 2
k := 2*3 + i
while i do
        i := k + i
        k := 2 + i
```

Use the following production rules and semantic rules for code generation:

Productions	Semantic rules
$S \rightarrow$ **id** := E	S.code := E.code || *gen*(**id**.place ':=' E.place); S.begin := S.after := nil
$S \rightarrow$ **while** E **do** S_1	S.begin := *newlabel*()
	S.after := *newlabel*()
	S.code := *gen*(S.begin ':') ||
	E.code ||
	gen('if' E.place '=' '0' 'goto' S.after) ||
	S_1.code ||
	gen('goto' S.begin) ||
	gen(S.after ':')
$E \rightarrow E_1 + E_2$	E.place := *newtemp*();
	E.code := E_1.code || E_2.code || *gen*(E.place ':=' E_1.place '+' E_2.place)
$E \rightarrow E_1 * E_2$	E.place := *newtemp*();
	E.code := E_1.code || E_2.code || *gen*(E.place ':=' E_1.place '*' E_2.place)
$E \rightarrow - E_1$	E.place := *newtemp*();
	E.code := E_1.code || *gen*(E.place ':=' 'uminus' E_1.place)
$E \rightarrow (E_1)$	E.place := E_1.place
	E.code := E_1.code
$E \rightarrow$ **id**	E.place := **id**.name
	E.code := ' '
$E \rightarrow$ **num**	E.place := *newtemp*();
	E.code := *gen*(E.place ':=' **num**.value)

Note: assume the two functions *newtemp*() and *newlabel*() return temporary variables and labels with starting index from 1 respectively.

CSE 309

7. (a) What is type inference? Determine the type for the following function written in **ML** using type inference rules: **(10)**

   fun *length*(*x*) = **if** *null*(*x*) **then** 0 **else** *length*(*tl*(*x*)) + 1

   (b) What is an activation record? Write down the names and purposes of the fields that might appear in a general activation record of a function. **(10)**

   (c) Write static type-checking semantic rules both as Post system rules and semantic rules for the following production rules (the symbols have their usual meanings): **(15)**

   (i) $E \rightarrow E_1\ (E_2)$

   (ii) $S \rightarrow S_1\ ;\ S_2$

   (iii) $E \rightarrow E_1$ **and** E_2

   (iv) $E \rightarrow E_1\ [\ E_2\ ]$

   (v) $E \rightarrow E_1\ \hat{}$

8. (a) What is runtime environment? What are the issues that the runtime environment needs to incorporate? **(10)**

   (b) What is a semantics-preserving optimization in code optimization phase? Explain each of the following transformations with examples: **(10)**

   (i) Dead code elimination
   (ii) Interchange of statements
   (iii) Algebraic transformation
   (iv) Common sub-expression elimination

   (c) What is a basic block of the intermediate codes? What is a loop of basic block? Write the partitioning algorithm to determine the basic blocks. Find out the flow graph and the loops in the basic blocks from the following codes: **(15)**

```
(1) i = 1
(2) j = 1
(3) t1 10 * i
(4) t2 t1 + j
(5) t3 8 * t2
(6) t4 t3 – 88
(7) a[t4] = 0.0
(8) j = j + 1
(9) if j <= 10 goto (3)
(10) i = i + 1
(11) if i <= 10 goto (2)
(12) i = 1
(13) t5 = i – 1
(14) t6 = 88 *t5
(15) a[t6] = 1.0
(16) i = i + 1
(17) if i <= 10 goto (13)
```

L-3/T-1/WRE **Date : 24/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2015-2016

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 any reasonable value of missing data, if any.

1. (a) What are the assumptions of Terzaghi's first theory used to derive time rate of consolidation for saturated clays? 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). **($21\frac{2}{3}$)**

   (b) The in-situ void ratio of a saturated clay layer, 3-m thick, existing at a depth of 5 m below the ground surface is 1.12. Due to construction of a new building, the average effective pressure at the clay layer is expected to increase by 100 kN/m^2 which would change the void ratio of clay to 1.07. Estimate the probable final settlement of the proposed building. Also, find the average coefficient of compressibility and coefficient of volume change for the clay. If the coefficient of consolidation is 1.695×10^{-3} cm^3/s, what is the permeability of clay? **(15)**

   (c) Define normally consolidated and over-consolidate clay. State the procedure to determine the pre-consolidation pressure σ_c' from the laboratory e~log σ' plot. **(10)**

2. (a) How does dry unit weight, γ_d, differ from the unit weight γ? Why is the Proctor method of assessing soil compaction based on the dry unit weight and not the unit weight? Write short notes on: Vibro-flotation technique and suitability index. **(15)**

   (b) 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 unti 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 $G_s = 2.67$. **($16\frac{2}{3}$)**

   (c) A 5.0 m thick fill with a unit weight of 19.5 kN/m^3 is to be placed on the soil profile shown below. Calculate at point A located 4.8 m below in the clay layer: total stress σ_v, effective stress σ_v' and pore water pressure u (i) before placing the surcharge, (ii) immediately after placing the surcharge, and (iii) after the consolidation is completed. **(15)**

Contd P/2

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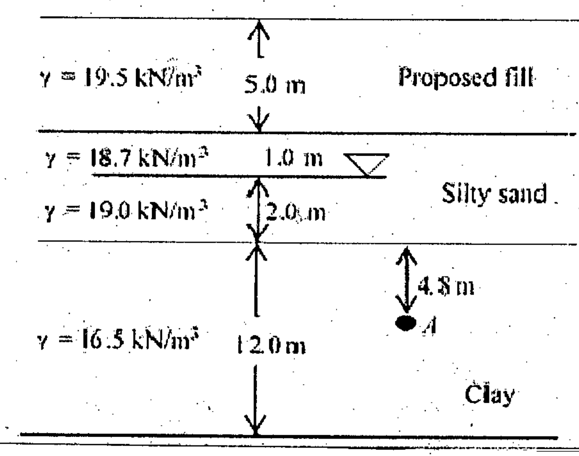
Contd ... Q. No. 2(c)

Fig. 1



3. (a) A proposed earth embankment is required to be compacted to 95% of standard Proctor dry density. Tests on the material to be used for the embankment give γ_{max} = 19.5 kN/m^3 at an optimum water content of 12%. The borrow pit material in its natural conditions has a void ratio of 0.60. If G_s = 2.65, what is the minimum volume of the borrow-soil required to make 1 Cu-m of acceptable compacted fill? **(15)**

(b) A field density test was conducted by sand cone method. The observation data are given below: **(15)**

Mass of jar with cone and sand (before use) = 4950 g
Mass of jar with cone and sand (after use) = 2280 g
Mass of soil from the hole = 2925 g
Dry density of sand = 1.48 g/cc
Water content of field soil = 12%

Determine the dry unit weight of compacted soil.

(c) A loose, un-compacted sand fill 2 m in depth has a relative density of 40%. Laboratory tests indicated that the minimum and maximum void ratios of the sand are 0.46 and 0.90, respectively. The specific gravity of the solids of the sand is 2.65. Compute: **($16\frac{2}{3}$)**

(i) dry unit weight of the sand
(ii) if the sand is compacted to a relative density of 75%, what is the decrease in thickness of the 2-m fill?

4. (a) State the assumptions of Rankine's theory of lateral pressure for cohesionless soil. Explain the term 'lateral pressure is at-rest condition'. **(10)**

(b) The soil under the footing, resting on the surface of a column consists of coarse sand having an angle of shearing resistance of 35 degrees and it is subjected to an average vertical pressure of 120 kPa. When an excavation was being carried out around the footing in the proximity of the footing, the footing settled and the underlying soil failed in shear. Estimate the lateral stress of the soil at the time of failure. Also, justify your answer. **(10)**

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(c) Draw qualitative diagrams for the following: **(26⅔)**

(i) A Mohr's circle to describe the state of stress at a point in soil behind a rigid and unyielding wall representing at-rest condition.

(ii) The failure envelops of the same soil element. Explain whether Mohr's circle of step (i) touches the failure envelop.

(iii) Changes in stress conditions in the soil as it transitions from the at-rest condition to the active condition. Also, state the theoretically possible ways of the soil element to achieve the active condition from step (i).

(iv) Changes in stress conditions in the soil as it transitions from the at-rest condition to the passive condition. Also, state the theoretically possible ways of the soil element to achieve the passive condition from step (i).

(v) And, hence using step (iv) evaluate $K_p = tan^2\ (45° + \phi/2)$ for passive lateral earth pressure condition in granular soil.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.
Use attached chart where necessary. Assume reasonable value of missing data, if any.

5. (a) Liquid limit test was done on a soil sample using Casagrande's apparatus and the following data were obtained. **(15)**

No. of blows (N)	16	20	25	30	35
Water content (%)	57.1	55.0	53.7	52.5	50.6

Plot the flow curve and determine the liquid limit of the soil. Also, calculate the value of toughness index if plastic limit of the soil is 24%.

(b) Define the following: **(12)**

(i) Shrinkage limit (ii) consistency index
(iii) Sensitivity (iv) Critical hydraulic gradient
(v) Critical void ratio (vi) Undrained shear strength

(c) Draw neatly the plasticity chart according to Unified Soil Classification System (USCS) showing the classifications of different soil deposits. **(9)**

(d) What are the assumptions made in developing Boussinesq's stress distribution theory? A point load of magnitude 700 kN acts on the surface of ground. Compute the vertical stress increment due to the point load at a depth of 5 m along the vertical line having a radial distance of 6 m from the line of action of the point load. **(10⅔)**

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6. (a) Classify the following two inorganic soils according to USCS: **(13)**

Soil A: Percent finer No. 200 sieve (0.075 mm) = 95
Liquid limit = 53%
Plastic limit = 32%

Soil B: Percent finer No. 4 sieve (4.75 mm) = 90
Percent finer No. 200 sieve (0.075 mm) = 11
D_{60} = 1.8 mm, D_{30} = 0.4 mm, D_{10} = 0.07 mm
Liquid limit = 37%
Plastic limit = 21%

(b) Mention the boundary conditions which have been used for drawing the flow net of the masonry dam as shown in Fig. 2. Also find the following: **(17)**

(i) Quantity of seepage if the value of coefficient of permeability, $k = 5 \times 10^{-5}$ m/sec.

(ii) Seepage pressure at point A located 8 m below the surface of the soil layer.

(iii) Hydrostatic pressure at A.

(c) In a clay deposit, it has been proposed to adopt a circular raft foundation of diameter 6 m for an oil tank at a depth of 2 m below the ground level. If the foundation is subjected to a loading intensity of 75 kN/m^2, calculate the vertical stress along a vertical line passing through the centre of the foundation at a depth of 10 m from the ground level. **(8)**

(d) Mention the merits and demerits of direct shear test. **($8\frac{2}{3}$)**

7. (a) For a soil, the following results were obtained from grain size distribution and Atterberg limit test: **(10)**

% finer No. 200 sieve (0.075 mm) = 70
Liquid limit = 49%
Plastic limit = 24%

Classify the soil based on AASHTO Classification System.

(b) Describe briefly the behaviour of saturated clay samples in consolidated drained (CD) triaxial compression test. **($11\frac{2}{3}$)**

(c) A specimen of saturated normally consolidated clay sample was fully consolidated in the triaxial cell under a cell pressure of 100 kN/m^2. Pore pressure within specimen at the end of consolidation was zero. Deviator stress was then applied under undrained condition and increased until failure took place. The values of deviator stress and pore pressure at failure were found to be 90 kN/m^2 and 65 kN/m^2, respectively. A second specimen of the same clay sample was fully consolidated in the triaxial cell under a cell pressure of 250 kN/m^2. Pore pressure within this specimen at the end of consolidation was zero. Deviator stress was then applied under undrained condition and increased until failure took place. Calculate the following: **(14)**

(i) Values of ϕ_u and ϕ' of the sample.

(ii) Values of pore pressure at failure (u_f) and pore pressure parameter A at failure (A_f) of the second specimen.

Contd P/5

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Contd ... Q. No. 7

(d) A rectangular footing 6 m by 4 m, transmits a uniform pressure of 50 kN/m^2 to the underlying soil. Determine the vertical stress at a depth of 5 m below the footing at a point within the loaded area located 3 m away from the short edge and 2 m away from the long edge of the footing. Use Fadum's Chart. **(11)**

8. (a) The following results were obtained at failure in consolidated undrained (CU) triaxial compression tests conducted on two specimen of a saturated clay sample. **(14)**

Specimen No.	Cell pressure (kN/m^2)	Deviator stress (kN/m^2)	Pore pressure (kN/m^2)
1	150	250	30
2	300	430	65

Draw Mohr's circles in a plain graph paper in terms of effective stresses and hence estimate the values of effective shear strength parameters c' and ϕ'. Write down the Mohr-Coulomb failure equation for the effective stress failure envelope.

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

(i) Pore pressure versus axial strain for saturated samples of normally consolidated and overconsolidated clays in CU triaxial compression tests where consolidation were carried out using back pressure and cell pressure.

(ii) Variation of pore pressure parameter B with degree of saturation.

(iii) Variation of pore pressure parameter A with axial strain for saturated samples of normally consolidated and overconsolidated clays in CU triaxial compression tests.

(c) What is meant by "quick sand condition"? A large open excavation was made in a stratum of clay (saturated unit weight = 20 kN/m^3). When the depth of excavation reached 4 m, the bottom rose gradually, cracked and was flooded from below by a mixture of sand and water. Subsequent borings showed that the clay was underlain by a bed of sand with its surface at a depth of 6 m. Locate the position of the ground water table before the excavation. **(12)**

(d) Write a short note on Vane shear test for the measurement of undrained shear strength of soft clays. **(10)**

=6=

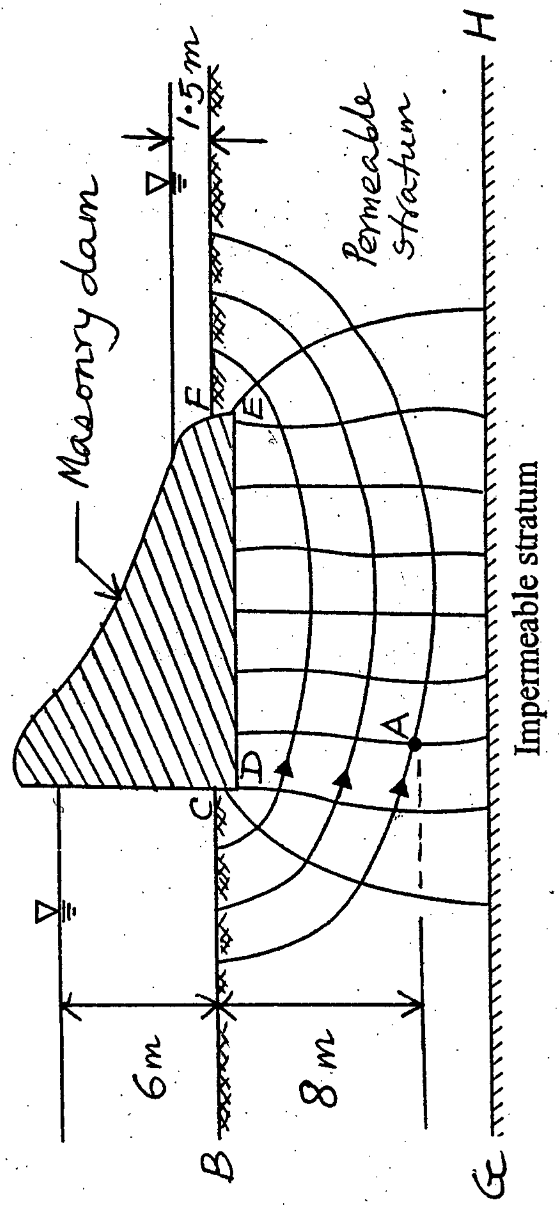

Fig: 2

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)

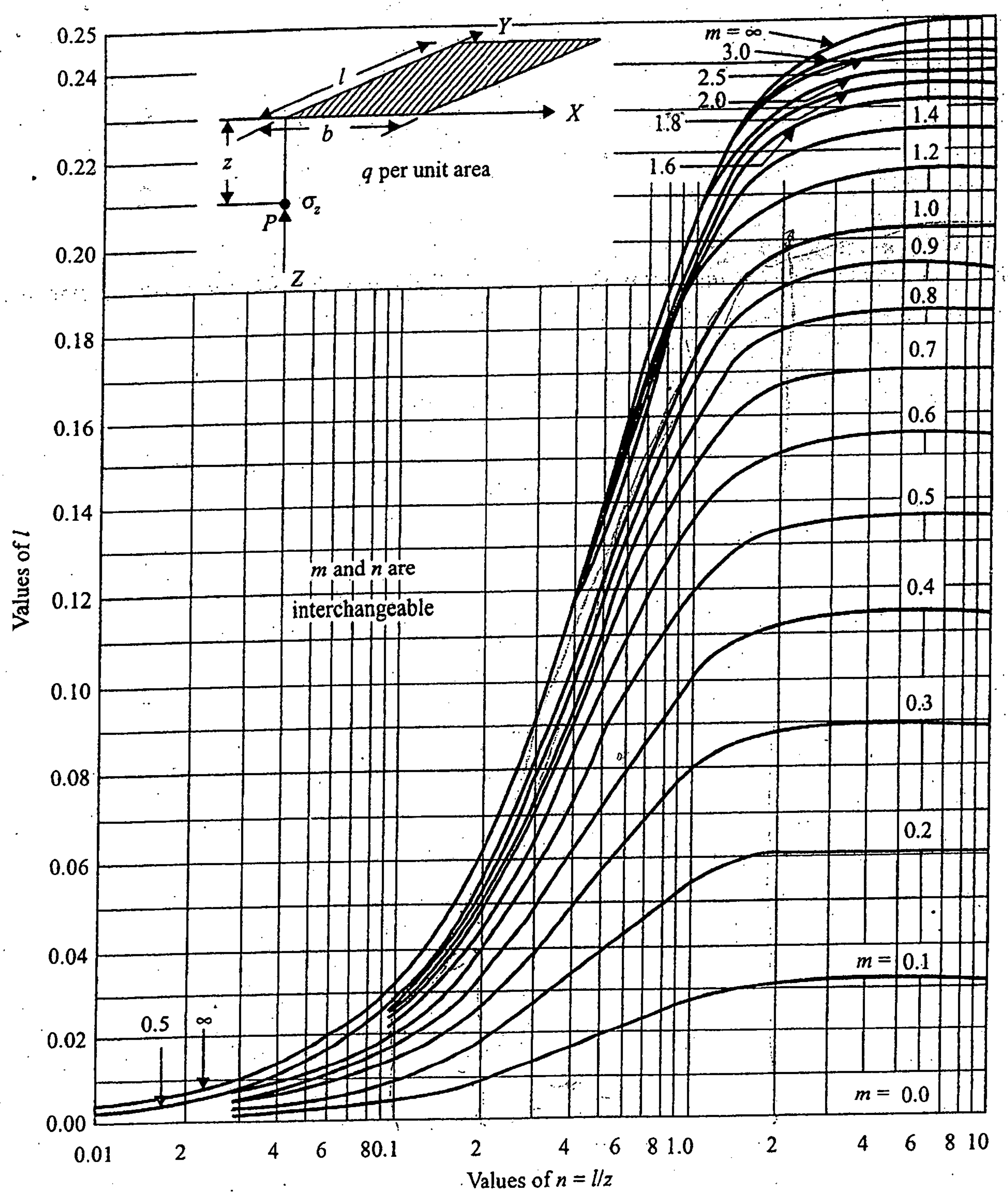

Chart 2 Fadum's chart for obtaining Newmark's influence coefficient, I in terms of m and n.

L-3/T-1/WRE **Date : 29/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2015-2016

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**.

Assume values for missing data, if any.

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

(b) What are the sources of uncertainties in analysis, design and construction of RC structures? Discuss how safety is ensured against these uncertainties in design. **(7)**

(c) A singly reinforced RC beam section has a width of 12 in, effective depth of 25 in and total depth of 28 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, $f_r = 7.5\sqrt{f_c'}$, n = 8. Find:

(i) Cracking moment. **(9)**

(ii) Stresses in concrete and steel caused by a bending moment M = 90 kip-ft. **(10)**

2. (a) A rectangular beam carries a service live load of 1.0 kip/ft and an unfactored superimposed dead load of 0.8 kip/ft in addition to self weight of the beam on a 28 ft simple span as shown in Figure 1. Given, $f_c' = 3$ ksi; $f_y = 40$ ksi; n = 9, width of the beam = 12 inch. Design the beam for flexure as a singly reinforced beam. **(21)**

(b) Why is cover over rebar important? What are the recommended values of 'cover' as per ACI code? **(7)**

(c)Explain the meaning of 'over-reinforced' and 'under reinforced' beam. **(7)**

3. (a) What is the purpose of providing minimum reinforcement of flexural steel in a beam? Write ACI provisions for minimum reinforcement ratio. **(8)**

(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 code. **(7)**

(c) A beam section is limited to width b = 12″ and total depth h = 24 in. Calculate the required reinforcement if the beam has to resist a factored moment M_u = 375 kip-ft. Assume two layer of tensile reinforcement with d = 20 in and d_t = 21.5 in. Also assume d′ = 2.5 in. if compression steel is required. Given $f_c' = 3$ ksi and $f_y = 50$ ksi. **(20)**

Contd P/2

4. (a) What are the code requirements for determination of effective width of a T beam? **(5)**

   (b) How the location of neutral axis indicates whether the beam should be analyzed considering T-beam or rectangular beam. **(5)**

   (c) A floor slab 4″ thick is supported by reinforced concrete beams, 10 feet centre to centre, which together with slab act as T-beams. The cross-section of each beam below the slab is 12″ × 20″ as shown in Figure 2. The beams are simply supported and their span is 25 ft. The effective depth will be taken 4 inch less than total depth. The slab supports a service live load of 100 psf and a superimposed dead load (for floor finish and partition wall) of 75 psf. in addition to self weight. Given, $f'_c = 3$ ksi; $f_y = 60$ ksi; find

   (i) The effective flage width. **(5)**

   (ii) The tensile steel area and select bars for a typical interior beam. **(20)**

SECTION – B

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

5. (a) Design shear reinforcement of the beam shown in Figure 3. The loads shown in Figure 3 are factored. Neglect self weight of the beam. Show the reinforcement details in a neat sketch. Given : $f'_c = 3$ ksi, $f_y = 50$ ksi. **(22)**

   (b) Explain the behavior of web reinforced concrete beam. **(8)**

   (c) Why is it a good practice to provide stirrup in region of beam even when it is not required? **(5)**

6. (a) Explain briefly the factors which affect the development length of tension rebars. **(7)**

   (b) Explain briefly the class A and class B splices for tension rebars. **(8)**

   (c) Calculate the development length (for tension rebars) for # 6 and # 9 bars when used as (i) top bars (ii) other bars. Compare the values, when these rebars are 90° hooked. Given: $f'_c = 4000$ psi; $f_y = 60000$ psi. Uncoated rebar and beam section is 12″ × 20″. Use the simplified formula. **(20)**

7. (a) A reinforced concrete one-way slab is built integrally with its support and consists of two equal spans, each with a clean span of 16 ft. The service live load on the slab is 120 psf. Design the slab following provision of ACI code. Show reinforcement with neat sketches. Given: $f'_c = 3$ ksi and $f_y = 60$ ksi. **(20)**

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(b) What is meant by temperature and shrinkage reinforcement? Discuss their importance. Also mention the minimum amount and spacing for such reinforcement as per ACI/BNBC code. **(10)**

(c) Write down the minimum thickness for RC one way slab for different end conditions. **(5)**

8. (a) In moment coefficient method, positive moment coefficients are different for dead and live loads – explain. **(5)**

(b) Design the slab system shown in Figure 4. The slab is to carry a service live load of 60 psf; as for dead load assume floor finish load to be 25 psf and permanent partition wall load to be 60 psf in addition to self weight of slab. Given, f'_c = 3 ksi and f_y = 60 ksi. Use moment coefficient method. Show all reinforcements in sketches. **(30)**

4

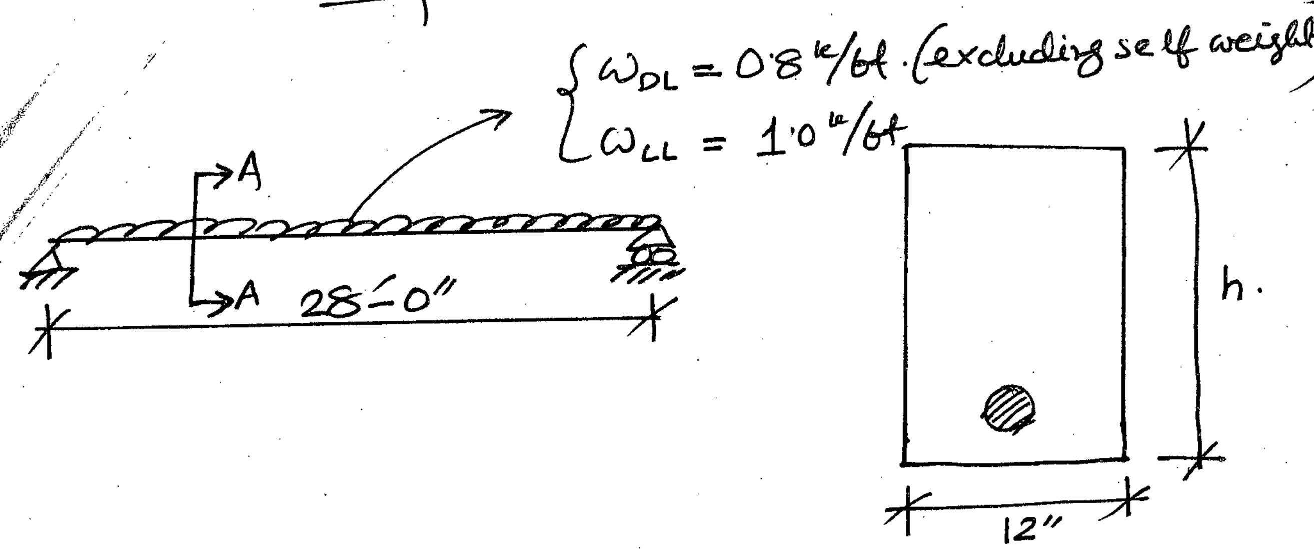


figure 1

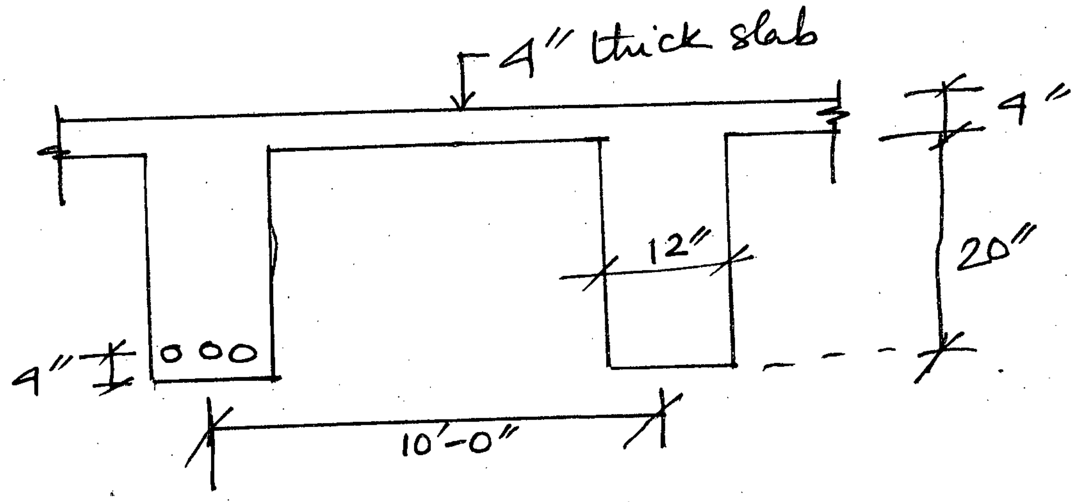


figure 2

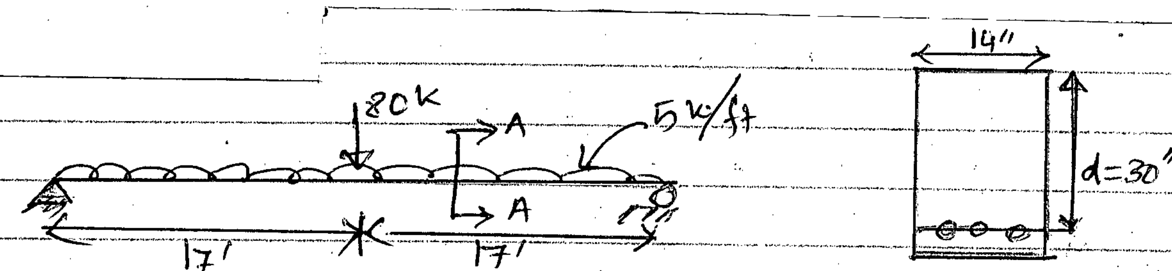
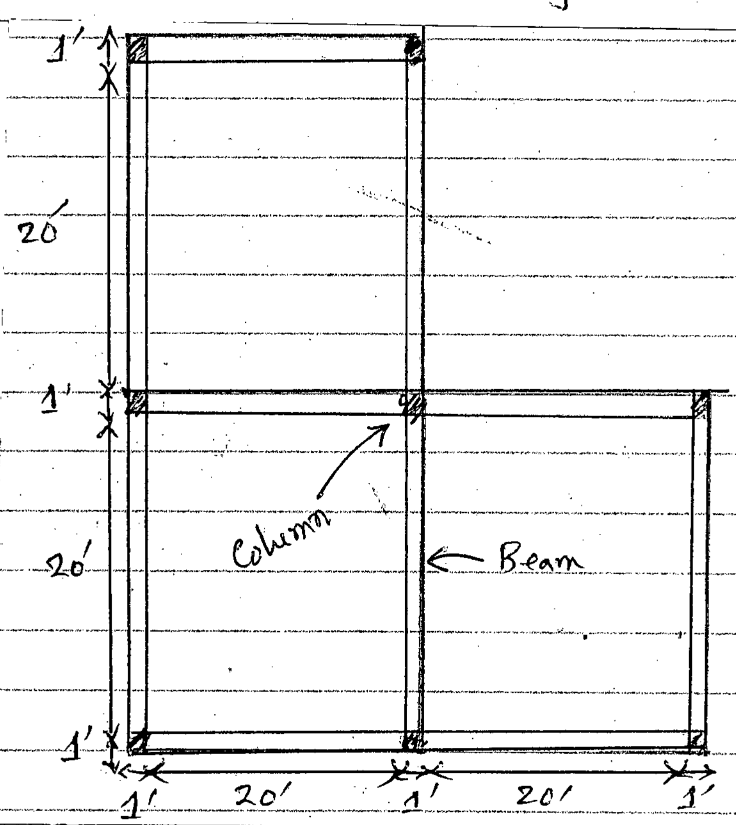


Figure 3 Sec A-A



LL = 60psf
FF = 25 psf
partition = 60psf
$f_c' = 3$ ksi
$f_y = 60$ ksi

Figure-4

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	0.026
	$C_{b,dl}$	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] 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.

TABLE 12.1
Moment and shear values using ACI coefficients†

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

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