L-3/T-1/CE Date : 14/01/2017

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

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

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **EIGHT** questions in this section. Answer any **SIX**.

Assume reasonable values of any data, if missing.

1. Samples taken from a uniform deposit of granular soil are found to have a unit weight of 19.6 kN/m^3 and an angle of internal friction of 35°. What is the shearing strength of the soil on a horizontal plane at a point 4 m below the ground surface? **($23\frac{1}{3}$)**

   A proposed structure will cause the vertical stress to increase by 60 kN/m^2 at the 4 m depth. Assume that the weight of the structure also causes the shearing stress to increase to 52 kN/m^2 on a horizontal plane at this depth. Does this shearing stress exceed the shearing strength of the soil? Calculate the factor of safety against shear failure.

2. A normally consolidated clay sample is subjected to a triaxial test where pore pressure measurements are made. A consolidated undrained type of test is performed. The sample fails when the total all-around confining pressure is 45 kPa and the total axial pressure is 97 kPa. At failure, the recorded pore pressure is 20 kPa. Determine the angle of internal friction ϕ_{CD} for the effective stress strength envelope and also the value of ϕ_{cu}. **($23\frac{1}{3}$)**

3. A commercial truck parks in a house driveway to complete a delivery. The driveway borders one side of the house. Estimate the resultant lateral force imposed on to the masonry basement wall by the truck's rear wheel closest to the house if the wall is 3 m high. The axle wheel is positioned 1.5 m from the house, and the wheel load is 100 kN. **($23\frac{1}{3}$)**

4. A three layer soil system behind an 11 m high retaining wall has the following descriptions. **($23\frac{1}{3}$)**

   Top Layer Thickness = 3.0 m $c = 10$, $\phi = 30°$ and $\gamma = 15$ kN/m^3

   Middle Layer Thickness = 2.0 m $c = 0$, $\phi = 32°$ and $\gamma = 16$ kN/m^3

   Bottom Layer Thickness = 4.0 m $c = 0$, $\phi = 32°$ and $\gamma = 18$ kN/m^3

   Water table is at 5 m from ground surface. Estimate the design lateral thrust assuming that the wall would move sufficiently in the outward direction to cause failure due to lateral expansion of backfill soil.

Contd P/2

CE 341

5. The following are the test results of a soil sample. Test whether the soil is organic or inorganic. Classify the soil as per USCS and AASHTO. **($23\frac{1}{3}$)**

% passing 4.75 mm sieve	= 98
% passing 2.00 mm sieve	= 80
% passing 0.425 mm sieve	= 70
% passing 0.075 mm sieve	= 52
Liquid limit of air dried soil	= 55
Liquid limit of oven dried soil	= 45
Plastic limit of air dried soil	= 33

6. A smooth back vertical retaining wall has a height of 6 m. The backfill soil has the following properties: $c = 0$, $\phi = 33°$ and $\gamma = 18\ kN/m^3$. Use Culmann's graphical method to determine the passive pressure on the wall. Compare the result with that obtained from Coulomb's method. **($23\frac{1}{3}$)**

7. It is desired to obtain information about the in situ strength parameters *c* and ϕ for a saturated clay soil, and also the pre-consolidation pressure. Direct shear tests under consolidated undrained condition were performed on six identical samples of the clay. The following results were obtained. Estimate the value of insitu cohesion c, ϕ_{cu} and also pre-consolidation pressure. **($23\frac{1}{3}$)**

Sample	Normal stress (kN/m^2)	Shear stress at failure (kN/m^2)
1	15	15
2	30	18.5
3	50	23
4	80	32
5	100	40
6	120	48

8. (a) Distinguish between soil structure and fabric. Describe various types of soil structures. **($13\frac{1}{3}$)**

(b) Derive expression for shrinkage limit soil for unknown specific gravity of soil solids. **(10)**

Contd P/3

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.
Assume reasonable value (values) for missing data.

9. (a) (i) "There are two ways of specifying compaction of earth work", Explain. What is zero air void line? **($10\frac{2}{3}$+8+8=$26\frac{2}{3}$)**

(ii) A standard proctor compaction test is carried out on the soil sample (G_S = 2.74) collected from an earthwork and the compaction curve is shown in **Fig. 1**. Draw the zero air void curve on the same figure. (**Please attach Fig. 1 with the answer script**).

(iii) The compaction specifications require that the earthwork be compacted to a relative compaction of at least 95% with respect of the standard Proctor compaction and the water content be within +/- (plus minus) 1.5% of the optimum moisture content. A field density test later carried out to check the quality of compaction. A hole was dug in the compacted earthwork and 957 gm of soil was removed. The volume of the hole was measured as 450 cm^3. A 26.3 gm soil sample that was removed from the hole was then dried in the oven and has a mass of 22.8 gm. Does the compaction meet the specifications.

(b) Earth is required to be excavated from borrow pit for the construction of an embankment. The unit weight of borrow soil is 18 kN/m^3 at a moisture content of 8%. The specific gravity of soil skeleton of borrow area is 2.67. In order to build a 4.0 m high embankment with top width 2.0 m and side slope 1:1, **(20)**

(i) Estimate the volume of earth required to be excavated per meter length of embankment. The dry weight required in the embankment is 15 kN/m^3 with a moisture content of 10%.

(ii) Calculate the void ratio, and degree of saturation in both the undisturbed and remolded state.

(iii) After six months of embankment construction, it was observed that it has experienced a settlement of 120 mm. What is the new void ratio? Assume the average height of embankment is 3.0 m.

10. (a) Write down the step by step procedure for calculating rate of settlement (Time vs. Settlement) due to consolidation. **($16\frac{2}{3}$)**

(b) Two undisturbed clay samples were taken from the middle of the O.C and N.C clay layers as shown in **Fig. 2**. The water table is at the top of the O.C clay layer. Consolidation tests were carried out on the two samples and the results were summarizes as: **(30)**

	O.C Clay	N.C Clay
Natural water content	20%	29%
Preconsolidation Pressure (kPa)	50.0	---
Compression Index	0.55	0.60
Swell Index	0.06	---
Coefficient of Consolidation (m^2/year)	13.0	2.5

Contd P/4

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Contd ... Q. No. 10(b)

Assume that the unit weight of sand above and below water are 160 and 19.0 kN/m^3 respectively. Specific gravity of clay soil grains is 2.70. A 2.0 m high compacted fill with a unit weight of 20 kN/m^3 is placed at the ground level.

(i) What would be the magnitude of settlement associated with primary consolidation?

(ii) What would be the consolidation settlement after one month?

(iii) Plot the variation of consolidation with time (say 1, 6, 12, 24, 36, 60 months, etc.). Also calculate the time required to attain 200 mm of consolidation settlement.

11. (a) What is the principle of effective stress? Discuss its role in Geotechnical Engineering problems. How can you estimate the coefficient of permeability of clayey soil? Give its typical value for sand clay in cm/sec. **($16\frac{2}{3}$)**

(b) Water flows through a 100 mm diameter granular soil specimen as shown in **Fig. 3**. The water levels on both sides are maintained constant during the test, and the void ratio of the soil is 0.82, and G_S = 2.68. **(15)**

(i) What is the maximum possible value for "h" such that the soil does not reach quick condition?

(ii) For h = 150 mm, 175 ml (175 cm^3) of water was collected in 15 minutes. Find the permeability of the soil and the effective stress at "A", 220 mm below the top of the sample.

(c) A sheet pile is driven into sandy silt and seepage takes place under the head difference of 9.0 m as shown in **Fig. 4**. The permeability of soil is given as 1.6×10^{-4} cm/sec and the water content of the soil is 33%. Assume G_S = 2.66. Using the flow net diagram shown in **Fig. 4**, compute the following: **(15)**

(i) Seepage loss in m^3/day per meter run

(ii) Pore water pressure at "A", and

(iii) Factor of safety with respect to piping using Terzaghi's and Harza's criterion.

(Please attach Fig. 4 with the answer script)

12. (a) Write short notes on: **($16\frac{2}{3}$)**

(i) Compression Index,

(ii) Coefficient of Volume Compressibility, and

(iii) Pre-consolidation pressure.

(b) The area shown in the **Fig. 5** carries a uniform pressure of 200 kPa. Find the increase in vertical stress at 5.0 m below the point "A" both analytically and graphically (Newmark's Chart). **(15+15=30)**

L-3/T-1/CE **Date : 18/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **CE 301** (Professional Practice and Communication)

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) Describe the steps that are followed in tender evaluation. **(20)**

   (b) With the help of a flow-chart, describe the tendering process for procurement. **(15)**

2. (a) Describe the essential elements of a tender document with brief description of each element. **(20)**

   (b) Describe the basic conditions to be fulfilled for accepting a JV contractor. **(5)**

   (c) Describe the GCC and PCC clauses pertaining to timely completion of contract. **(10)**

3. (a) In a standard format prepare a BoQ for concrete work to be used in the foundation mat of a high-rise building. **(15)**

   (b) If an essential item is not included in the BoQ what provision of the contract may be used to resolve the problem. **(10)**

   (c) Describe e-GP as a means of eliminating tendering malpractices. **(10)**

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

   (b) Write five necessary outcomes of civil engineering education under professional category. **(5)**

   (c) Briefly describe five attributes of civil engineering profession. **(10)**

   (d) What are activities one needs to follow while dealing with contract risk? **(10)**

   (e) What are the elements of risk management? **(5)**

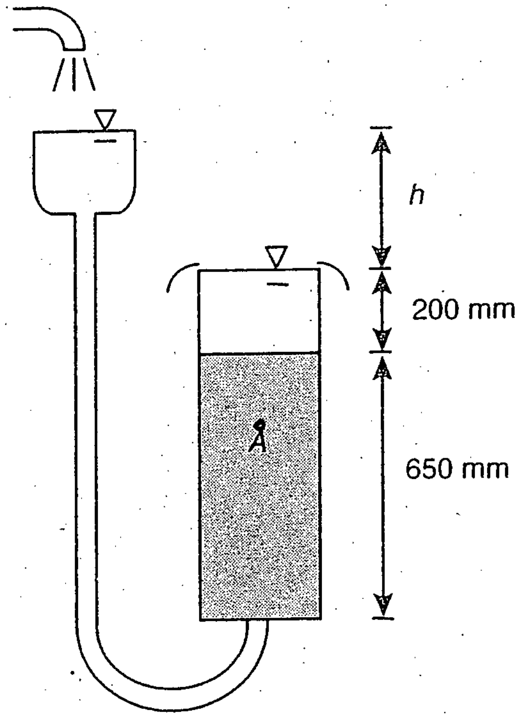
SECTION – B

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

5. (a) Define communication. Briefly explain the importance and necessity of communication in business. Briefly describe the different types of communication activities in an organization. **(18)**

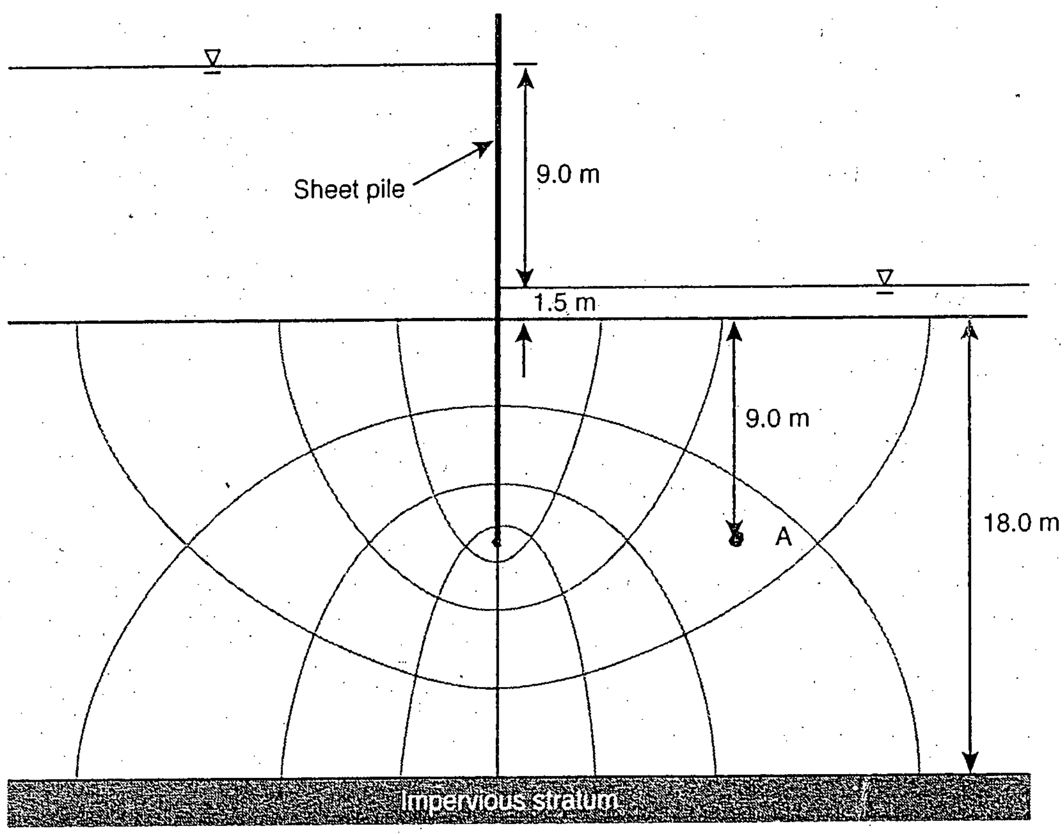
   (b) Describe in brief the main concepts of the seven C's of effective communication. **(17)**

Contd P/2



h
200 mm
650 mm
A

Fig. 3



Sheet pile
9.0 m
1.5 m
9.0 m
A
18.0 m
Impervious stratum

Fig. 4

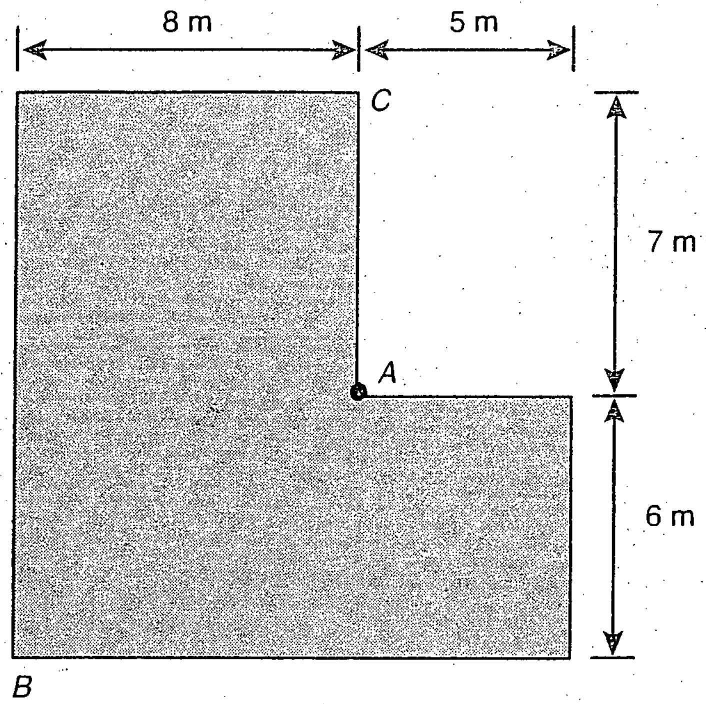
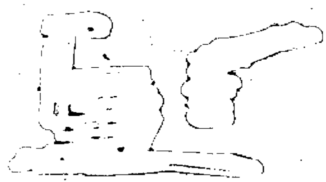
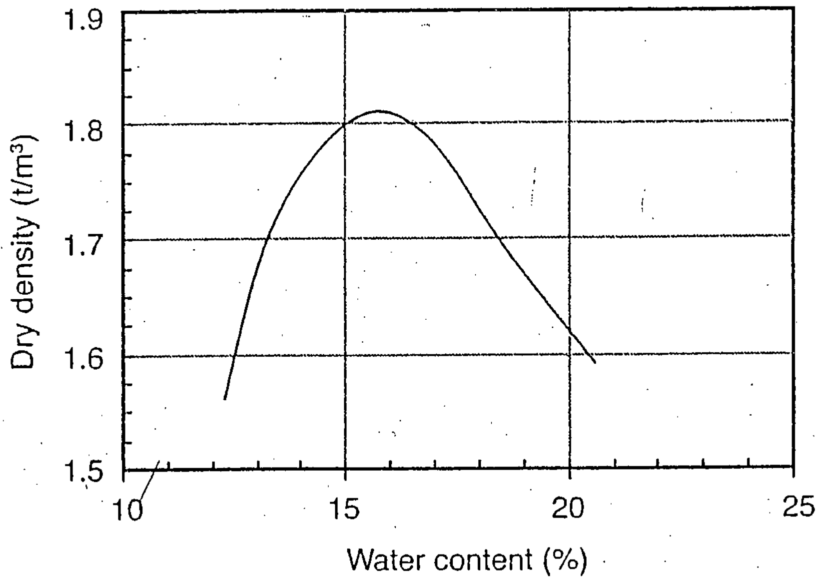


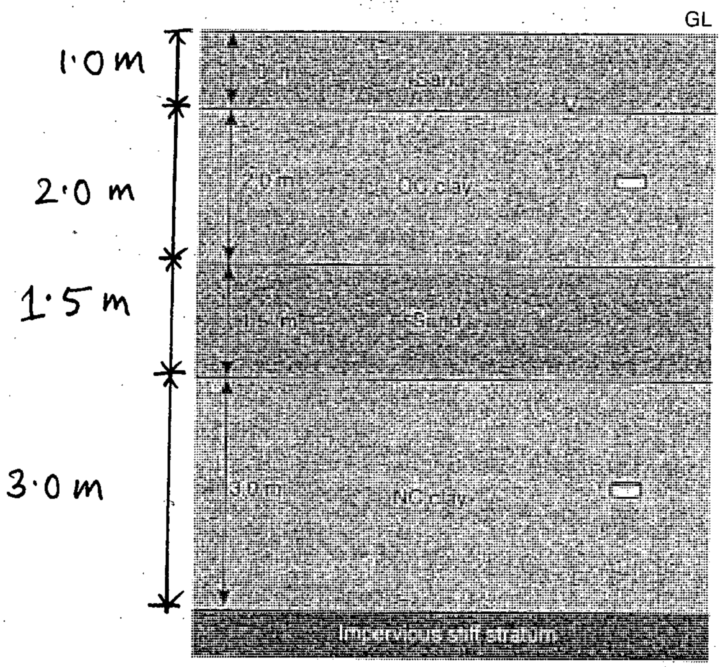
Fig. 5





1.9
1.8
1.7
1.6
1.5
Dry density (t/m^3)
10
15
20
25
Water content (%)

Fig. 1



GL
1·0 m
Sand
2·0 m
OC clay
1·5 m
Sand
3·0 m
NC clay
Impervious stiff stratum

Fig. 2

CE 301

6. (a) Define a report. Why are reports important? Briefly describe the steps to be followed in writing a short report? **(18)**

   (b) Answer the following with reference to the code of Ethics for Engineers document as supplied to you. **(5×3+1×2=17)**

   (i) For compensation of those engaged in engineering work, what principle should the Engineer uphold?

   (ii) The Engineer should not associate with what kind of enterprise or which type of engineers?

   (iii) How should the Engineer cooperate with other engineers and students?

   (iv) When will an Engineer undertake engineering assignments?

   (v) What should an Engineer do if his judgement is overruled by non-technical authority?

   (vi) What kind of conduct or practice will the Engineer avoid?

7. (a) Define project. Briefly describe three measures of project activity. Draw the flow of work in project development. **(18)**

   (b) What are the 'Think twice' contract clauses? Mention names of the professional/people/organization of four different groups of project development? **(17)**

8. (a) Name different types of project delivery system, procurement method and contract format. What are the specific concerns of professional liability insurance? **(18)**

   (b) Briefly describe the following: **(1×5+3×4=17)**

   (i) Common types of bond

   (ii) Fiduciary risk

   (iii) Model contracts

   (iv) DBB

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

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Write short notes on: (i) Ecology and Environment; (ii) Green house gases an its effects; (iii) Biodiversity; and (iv) Transmission of diseases from faeces. **(18)**

   (b) What do you mean by the term "per capita demand of water"? The population of a city was 25 million in 1970, 28.5 million in 1980, 39 million in 1990, 54 million in 2000 and 75 million in 2010. Estimate the probable population of the city in 2030 by the geometric progression method and the change in increase rate method, respectively. Determine also the water demand for fire fighting for the city in 2020. **(17)**

2. (a) What are the different sources of water for water supply system? Show the essential elements of a surface water based supply system with a neat sketch. Why is the hydrologic cycle important? Explain with a diagram. **(21)**

   (b) State the hydraulics of groundwater flow towards a well. Deduce the mathematical expression for the yield of a well in a confined aquifer. **(14)**

3. (a) What are the advantages of "Parallel Inclined Plate Separator" in a Plain Sedimentation Process? Explain with a diagram. What is the significance of 'SOR' in a Plain Sedimentation Process? Draw a neat sketch of reverse rotary recirculation method of drilling of wells. **(17)**

   (b) Design a tubewell with the following sieve analysis data of a soil sample: **(18)**

Sieve No.	Sieve Size (mm)	Wt of material retained (gm)
30	0.60	0.5
40	0.425	2.5
50	0.30	13.1
100	0.15	71.8
200	0.075	12.0
Pan	---	0.1

The diameter of the strainer is 100 mm and the opening area of the strainer is 12% of the total surface area of the strainer.

Contd P/2

CE 331

4. (a) What are the sanitary significance of the following impurities in water? **(8)**

   (i) CO_2, (ii) O_2, (iii) F and (iv) Pesticides

   (b) Explain very briefly with a diagram the "Theory of flocculation, sedimentation and adsorption process" during flow through granular filter media. How bacteria is removed in a slow sand filtration process? When is "Re-carbonation" of water required in a water treatment process? What are the advantages of "Two-stage re-carbonation" over "Single stage re-carbonation process? **(17)**

   (c) Explain with diagram and equation the process of "Catalytic Contact Oxidation" process for the removal of soluble metal ions from water. **(10)**

SECTION – B

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

5. (a) What are the sources of origin and WHO guide line values of the following impurities in water? **(10)**

   (i) Colour, (ii) Odour, (iii) Taste and (iv) Arsenic

   (b) How does destabilization of colloidal particles through "Double Layer Compression" can be achieved in a coagulation process? Provide practical example of this process happening in nature? What is the significance of "CAMP Number" in a coagulation process? **(18)**

   (c) What are the advantages of Activated Carbon Filtration Process in water treatment? **(7)**

6. (a) What are the advantages of "Break Point Chlorination Process" and how formation of Trihalomethane (THM) problem can be minimized in a chlorination process? **(15)**

   (b) What are the objectives of Aeration of Ground water in a water treatment process and how the aeration process between Air-water interface can be optimized? **(10)**

   (c) Discuss briefly the operational curves for centrifugal pumps with sketches. **(10)**

7. (a) Discuss briefly the factors that induce corrosion of metal pipes. How corrosion of metal pipes can be controlled? **(15)**

   (b) Describe briefly the procedure of laying large underground water pipes in the city areas. **(8)**

   (c) Describe the various layouts of water distribution networks with their advantages and disadvantages. **(12)**

8. (a) What are the objectives of water safety plan? State with a sketch the major steps in developing and implementing a water safety plan for BUET campus. **(20)**

   (b) Describe different categories of likelihood and impact of determining risk scores for water safety plan. State semi-quantative risk scoring (risk matrix) system for water safety plan. **(15)**

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

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **CE 311** (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**.

Assume reasonable values for any missing data.

1. The beams of the frame shown in Fig. 1 are subjected to vertical loads of 4 kip/ft. Using approximate method, draw bending moment diagrams for all the beams and columns of the frame. EI is constant and same for all the columns. Also draw axial force diagrams for the columns. **(28)**

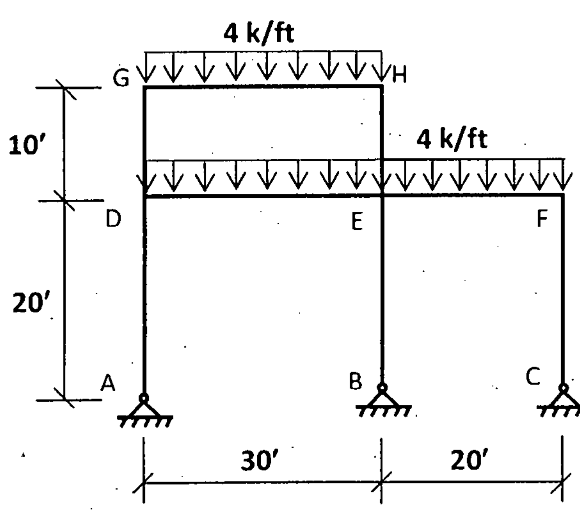


Fig. 1

2. Calculate the vertical distribution of earthquake forces on a 18m high 6-storied fire brigade building with story height 3 m each and located in Sylhet town. The concrete building has a square plan 20m × 20m and the basic structural system is developed using Intermediate Moment Resisting Frames in Concrete (R = 8). Soil boring revealed a dense, stiff soil condition upto 70m depth ($S = S_2 = 1.2$). Dead load including partitions = 10 kN/m^2. Z = 0.25 for Sylhet. Given: $C_t = 0.073$, I = 1.25, C < 2.75 and C/R > 0.075. Notations convey usual meanings. Use equivalent static force method of BNBC. **(28)**

3. Draw the shear and bending moment diagrams for the frame shown in Fig. 2. Given: Shear at E = –16 kip. **(28)**

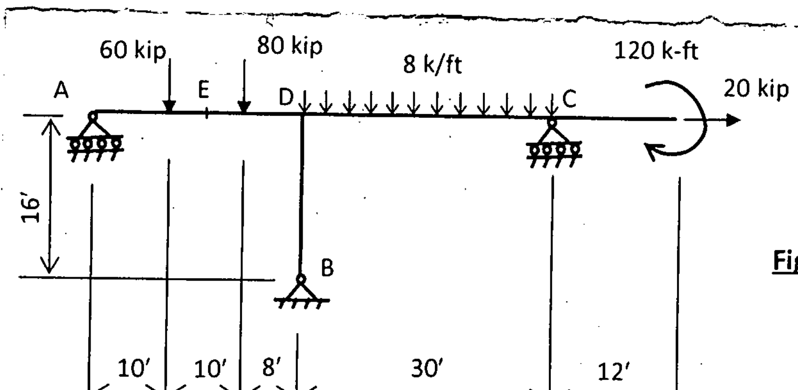


Fig. 2

Contd P/2

CE 311

4. For the truss shown in Fig. 3, find the forces in members HJ, HR, RC and RK. **(28)**

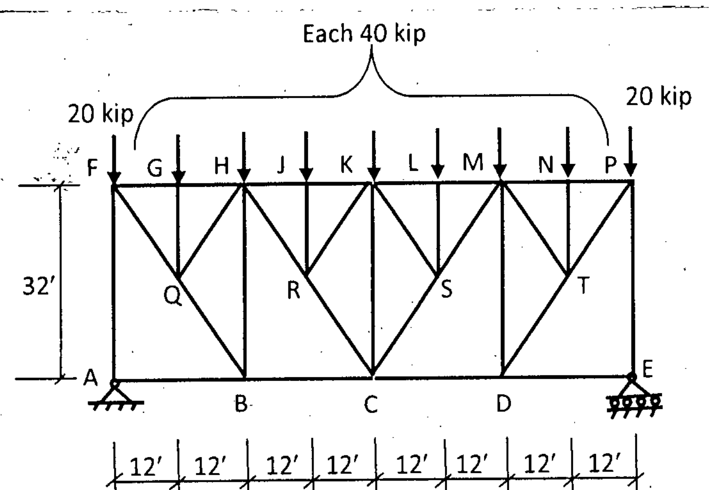


Fig. 3

5. Using approximate method, determine bar forces in all members of the X-braced truss shown in Fig. 4. Diagonals can carry both tension and compression. **(28)**

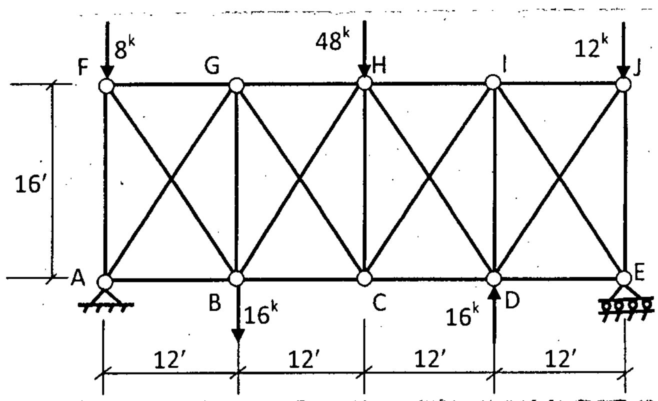


Fig. 4

6. For the truss shown in Fig. 5, find the stresses in members BC, JC, JG and FG. **(28)**

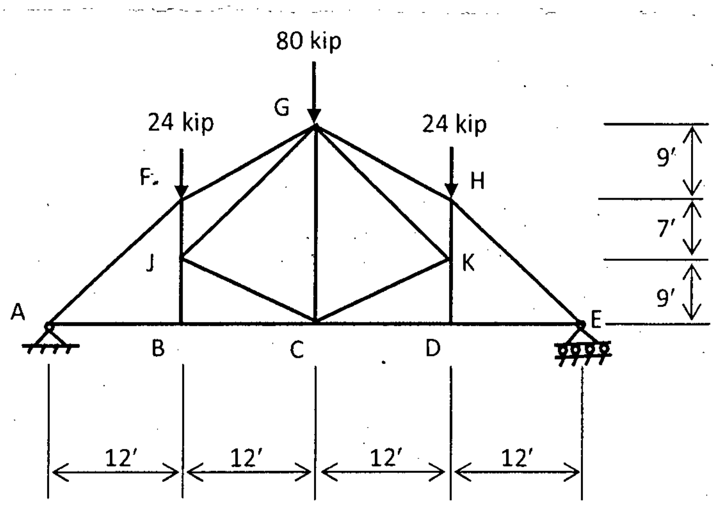


Fig. 5

CE 311

7. Using portal method, draw bending moment diagrams for all the beams and columns of the frame shown in Fig. 6. **(28)**

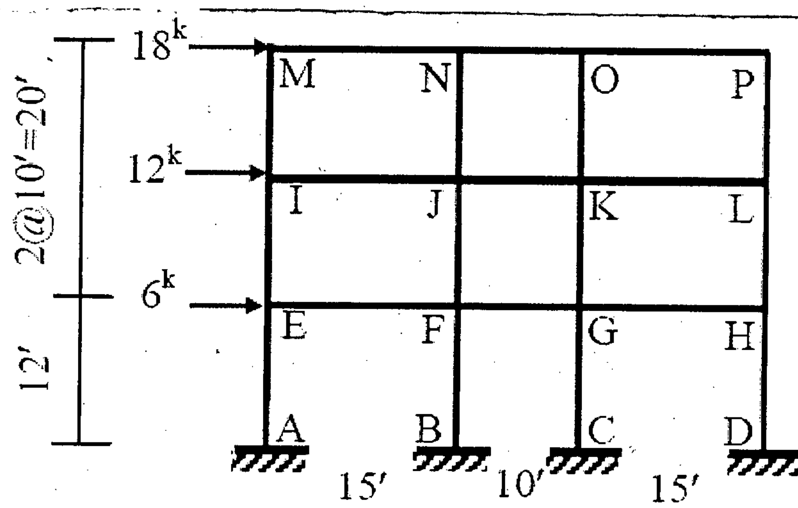


Fig. 6

SECTION – B

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

8. Draw influence line diagram for (a) Reaction at D (b) Shear just left of D (c) Moment at E (d) Moment at D of the beam shown in Fig. 7. **(28)**

9. For the truss shown in Fig. 8, draw influence line diagram for bar force in members "a", "b", "c" and "d". **(28)**

10. Calculate change in slope at "D" of the beam shown in Fig. 9. Given $I_1 = 200\ in^4$ (AB), $I_2 = 100\ in^4$ (BD) and E = 30,000 ksi. **(28)**

11. Compute vertical deflection at "F" of the frame shown in Fig. 10. Given: $A = 10\ in^2$, $I = 300\ in^4$ for all members and E = 30,000 ksi. **(28)**

12. Determine maximum shear at one-third point of a simply supported beam of 66 ft due to the wheel loads shown in Fig. 11. **(28)**

13. Find maximum moment at quarter point of a simply supported beam of 80 ft. Consider wheel loads as shown in Fig. 11. **(28)**

14. Compute maximum tension in member "a" of the truss shown in Fig. 8. The wheel loads are shown in Fig. 12. **(28)**

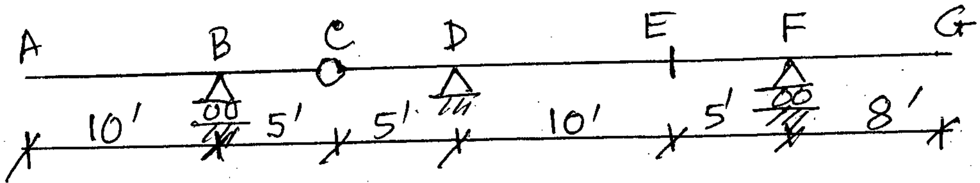


Fig. 7

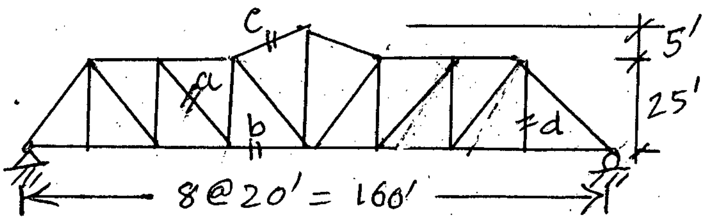


Fig. 8

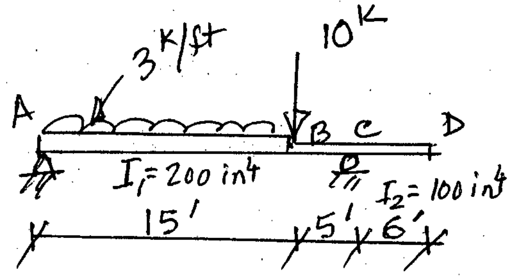


Fig. 9

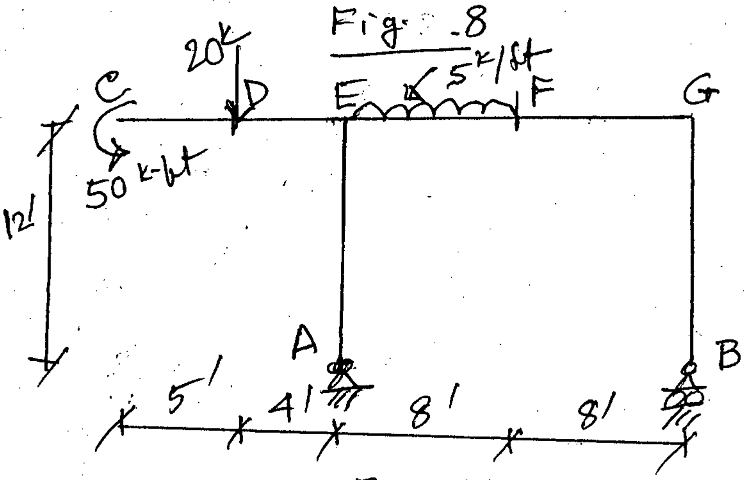


Fig. 10

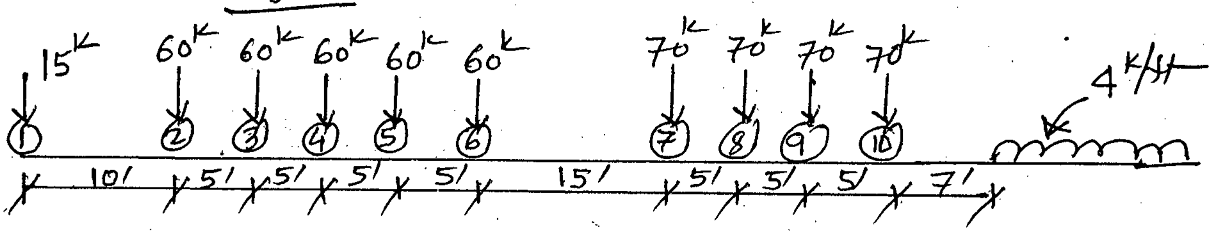


Fig. 11

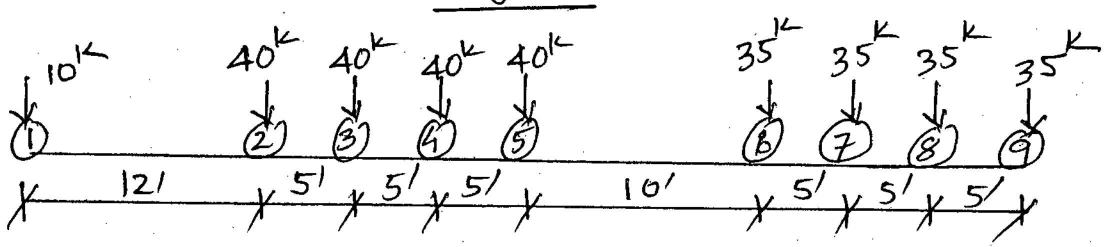


Fig. 12

L-3/T-1/CE Date : 04/02/2017

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **CE 315** (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**.

Use **USD Method** of Design. Assume reasonable value for any missing data.

1. (a) What are the sources of uncertainties in analysis, design and construction of RC structure? Discuss how safety is ensured against these uncertainties in USD method. **(7)**

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

(c) A singly reinforced RC beam section, as shown in Fig. 1, 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 and $f_y = 60$ ksi, $f_s = 24$ ksi, $f_r = 7.5\sqrt{f_c'}$ psi, $n = 8$.

Find:

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

(ii) Stresses in concrete and steel caused by bending moment M = 100 kip-ft. **(10)**

2. (a) What is the purpose of providing minimum amount of flexural steel in beam? Write ACI/BNBC code provisions for minimum reinforcement ratios. **(5)**

(b) Discuss how a minimum tensile strain ($\varepsilon_t = 0.004$) at failure is ensured by not exceeding maximum reinforcement ratio. Also discuss the variation of φ with ε_t as given in ACI/BNBC code. **(10)**

(c) A beam section is limited to width b = 12 in. and total depth h = 25 in. Calculate the required reinforcement if the beam has to resist a factored moment $M_u = 475$ kip-ft. **(20)**

Assume two layer tensile reinforcement with d = 21 in. and $d_t = 22.5$ in. Also assume $d' =$ 2.5 in. if compression steel is required.

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

3. (a) A floor system consists of a 3 in. slab supported by continuous T-beams with 25 ft span, 48 in. on centres as shown in Fig. 2. Web dimensions as determined by negative moment requirements at support are $b_w = 12.$ and d = 21 in. What tensile reinforcement is required at midspan to resist a factored moment $M_u = 550$ kip-ft? Also, check minimum reinforcement and ε_t. Given: $f_c' = 3$ ksi, $f_y = 60$ ksi. **(15)**

Contd P/2

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Contd ... Q. No. 3

(b) A rectangular RC beam as shown in Fig. 3 measures 14 in. wide and has an effective depth of 27 in. Tension steel consist of eight No. 8 bars in two layers (d = 27 in. d_t = 28.5 in.) and compression steel consist of four No. 8 bars is located 2.5 in. from the compression face. What is the design moment capacity of the beam according to ACI/BNBC code? Check for yielding of compression steel and ε_t. **(20)**

Given: f'_c = 3.5 ksi, f_y = 60 ksi.

4. (a) A rectangular beam carries a service live load (unfactored) of 2.0 kip/ft and an unfactored superimposed dead load of 1.0 kip/ft (in addition to self-weight of beam) on a 20 ft simple span as shown in Fig. 4. The beam will have a cross-section of 12″ × 24″ for architectural reason. Design the beam for flexure using USD method. **(15)**

Given: f'_c = 3.0 ksi, f_y = 60 ksi.

(b) A rectangular beam has width 14 in. and effective depth 24 in. as shown in Fig. 5. It is reinforced with eight No. 9 bars in two rows (d = 24″, d_t = 25.5″). What is the nominal flexural strength M_n and what is the maximum moment φM_n that can be utilized in the design? **(15)**

Given f'_c = 5.0 ksi, f_y = 60 ksi.

(c) What is the difference between under-reinforced and over-reinforced beam? Which one is preferable and why? **(5)**

SECTION – B

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

Assume appropriate value(s) for any missing data.

5. (a) Fig. 6 shows the slab system of a building. Design the two-way slab "S-1" of Fig. 6 which is supported on 10″ brick wall. The slab is to carry a service live load (LL) of 60 psf in addition to its self-weight. Assume floor finish (FF) load of 25 psf and partition wall (PW) load of 50 psf. Given: slab thickness = 6″; f'_c = 3.5 ksi and f_y = 60 ksi. Use moment co-efficient method. Show the reinforcements with neat sketches. **(20)**

(b) Explain briefly the class A and class B splices for tension rebars. **(7)**

(c) Describe in brief the factors which affect the development length of tension rebars. **(8)**

Contd P/3

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6. (a) Design the one-way slabs S-2 and S-3 of Fig. 6. Given: slab thickness = 6″; LL = 60 psf; FF = 25 psf; PW = 50 psf; $f_c' = 3.5$ ksi and $f_y = 60$ ksi. Use ACI moment co-efficients and show the reinforcements in plan and section. **(20)**

   (b) Why temperature and shrinkage reinforcements are required in one-way slab? What are the ACI/BNBC recommended ratios for such steel? **(9)**

   (c) Why is it essential to provide minimum thickness for slabs? **(6)**

7. (a) Determine the tension steel (and compression steel, if required) for the simply supported beam B1 as shown in Fig. 6. The beam B1 is to carry the load from slab given in question 7(a) above. The total depth of the beam is restricted to 18″ from architectural considerations. Given: b = 12″; $f_c' = 3.5$ ksi and $f_y = 60$ ksi. Assume d = 15″ and d′ = 2.5″. **(20)**

   (b) Show with neat sketches the location of bar cut-off and bent points for beams for nearly equal span and uniformly distributed load. **(8)**

   (c) Why is concrete cover over rebar important? What are the code recommended values of cover for beams and slabs? **(7)**

8. (a) Determine the total depth and tensile reinforcement for the simply supported beam shown in Fig. 7. All loads are factored. Assume b = 12″; $\rho = 0.6\ \rho_{max}$; $f_c' = 4$ ksi and $f_y = 60$ ksi. **(17)**

   (b) Design the stirrups for the beam shown in Fig. 7. Calculate the stirrups with 3 sets of spacing. Show the stirrups in a neat sketch. **(18)**

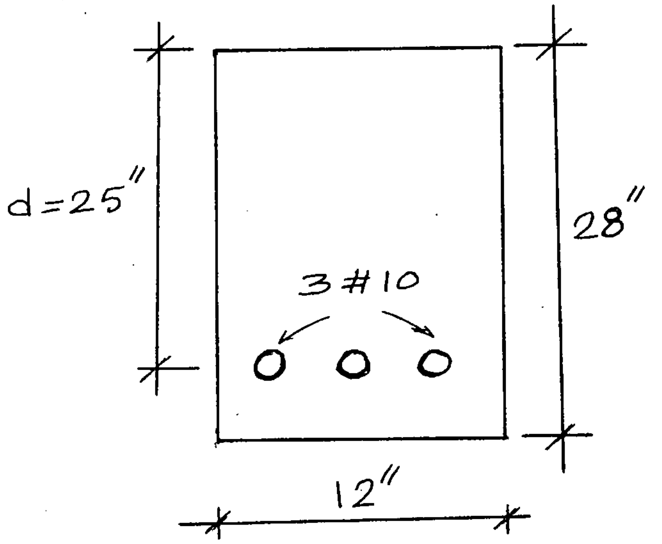


Fig. 1

Given:

$f'_c = 4\,ksi$

$f_y = 60\,ksi$

$f_s = 24\,ksi$

$f_r = 7.5\sqrt{f'_c}\ psi$

$n = 8$

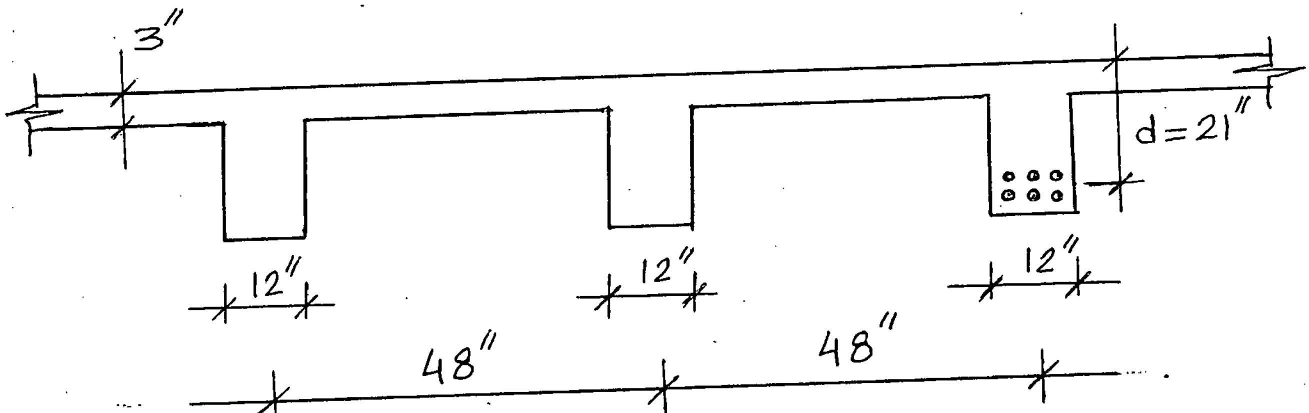


Fig. 2

Given: $f'_c = 3\,ksi$, $f_y = 60\,ksi$

Beam span = 25 ft

$M_u = 550$ kip-ft

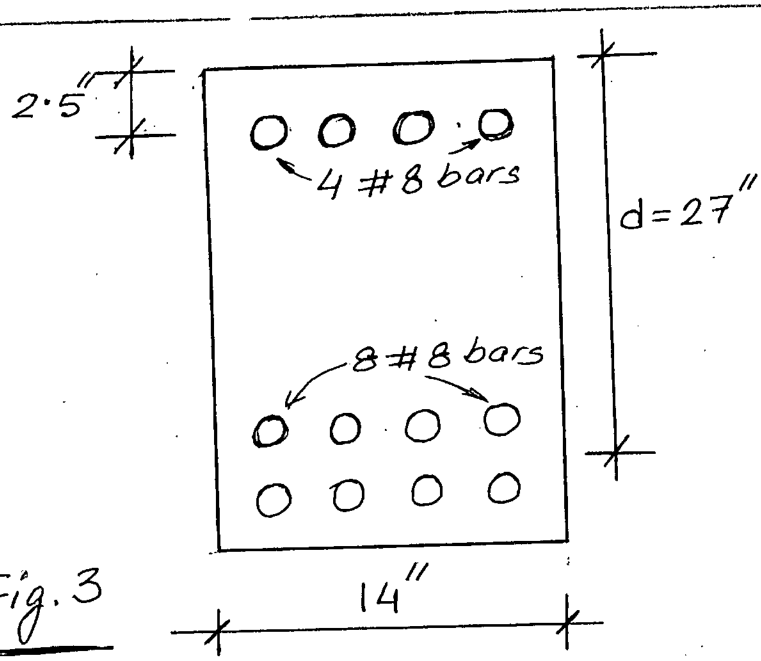


Fig. 3

Given:

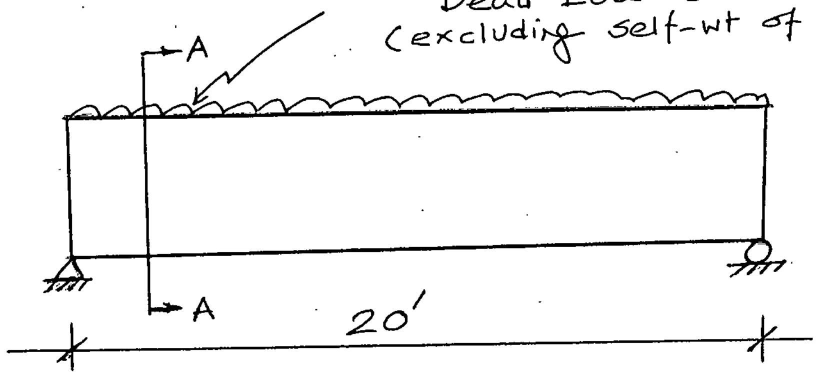
$f'_c = 3.5\,ksi$

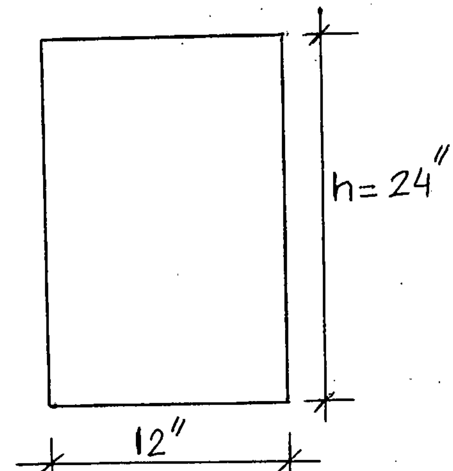
$f_y = 60\,ksi$

$d = 27''$

$d_t = 28.5''$

Service Live Load = 2 kip/ft
Unfactored superimposed Dead Load = 1.0 kip/ft
(excluding self-wt of beam)





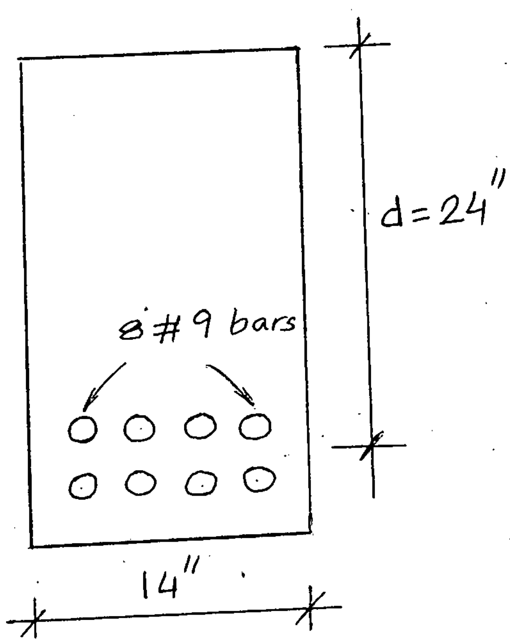
Section A-A

Fig. 4

Given:

$f_c' = 3$ ksi

$f_y = 60$ ksi



Given:

$f_c' = 5$ ksi

$f_y = 60$ ksi.

$d = 24''$

$d_t = 25.5''$

Fig. 5

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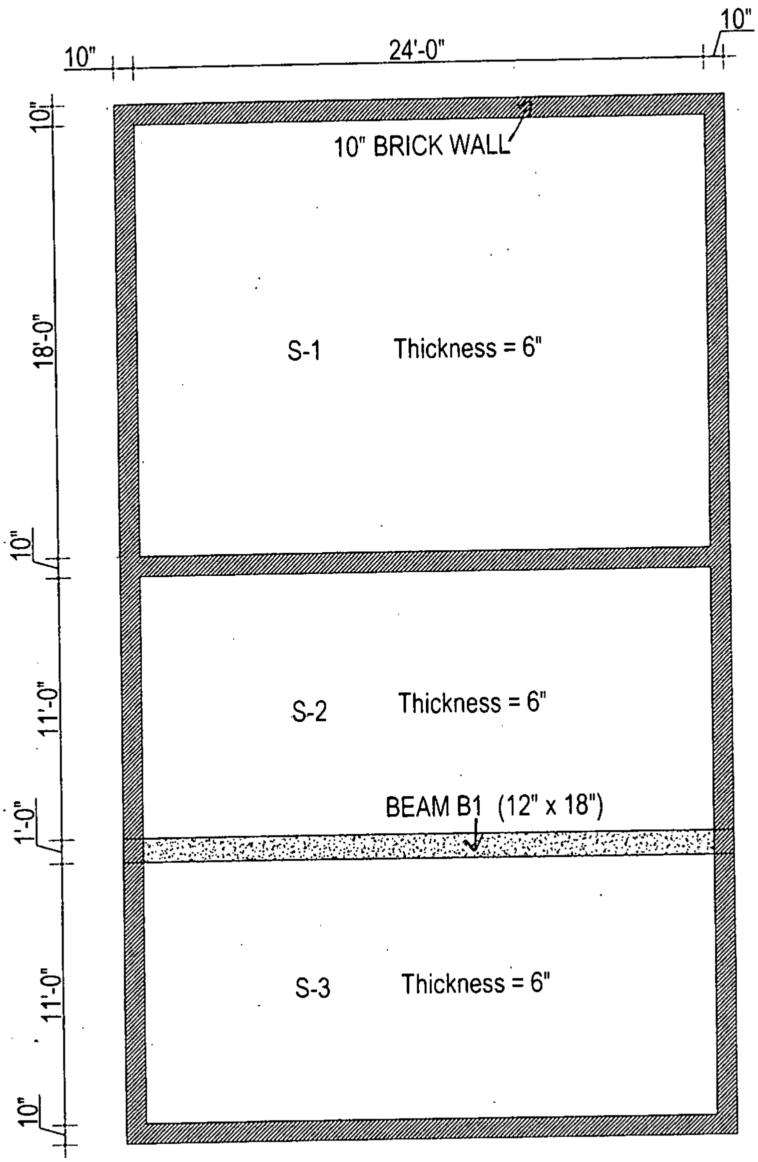
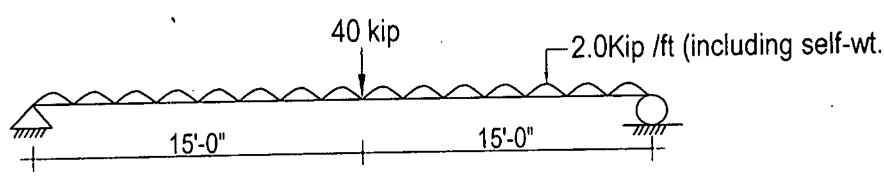


Fig-6



ALL LOADS ARE FACTORED

Fig-7

(*) Design of Concrete Structures - A. H. Nilson
12th Edition, Pages 408 – 411.

TABLE 12.3
Coefficients for negative moments in slabs[a]

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

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]

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

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.

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TABLE 12.5

Coefficients for live load positive moments in slabs[a]

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

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.

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Summary of ACI moment coefficients: (*a*) beams with more than two spans; (*b*) beams with two spans only; (*c*) slabs with spans not exceeding 10 ft; (*d*) beams in which the sum of column stiffnesses exceeds 8 times the sum of beam stiffnesses at each end of the span.