SET Z

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2012
Program: B. Sc. Engineering (Civil)

Course Title: Design of Concrete Structures II Credit Hours: 3.0 Course Code: CE 317
Time: 3 hours Full Marks: 100

(Answer **any 5 (Five)** of the following 7 questions)

Full Marks: 100 [=5×20]

[Given: $f_c' = 4$ ksi, $f_y = 60$ ksi, $f_s = 24$ ksi for all questions]

1.(a) Fig.1 shows a two way edge supported slab, whose middle strip mid span and support moment (unfactored) are given below. Calculate the required reinforcements and show them in a neat sketch. Show corner reinforcements also. Draw plan and sections showing the reinforcements. Use **WSD** method. [10]

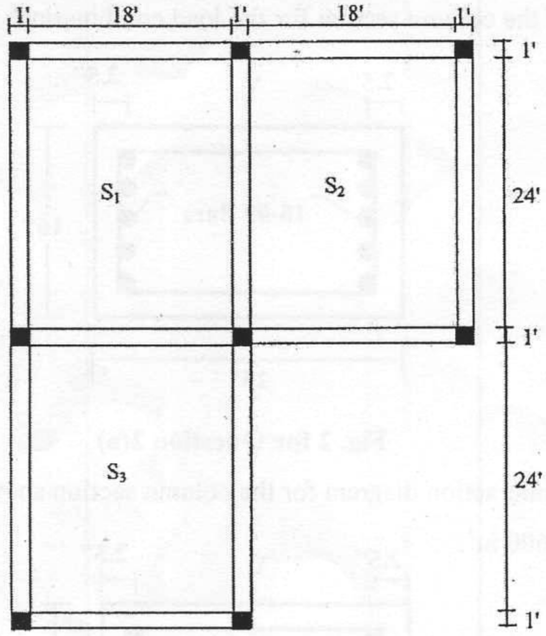

Fig. 1 for Question 1

Given: Slab thickness, t= 6″
Unfactored moments are as follows:

Slab	Moment in short direction (k-ft/ft)		Moment in long direction (k-ft/ft)	
	At Mid span	At support	At Mid span	At support
S_1	+2.88	-4.75	+1.56	-2.7
S_2	+3.15	-5.5	+1.48	---
S_3	+3.28	---	+2.25	-2.8

1.(b) Why does ACI recommend to design a rectangular slab supported on all sides as a one way slab if the side ratio of the slab spans is more than 2? Justify your answer with mathematical logic. [05]

1.(c) Why is special arrangement of reinforcement needed at the exterior corners of a two-way slab system? Discuss the possible special arrangements. [05]

2.(a) A section with the embedded reinforcements of an exterior column of a three storied building is shown in Fig.2. It was found that the column shall be subjected to either of the three combinations of DL, LL and W (all unfactored) as following, [06]

CASE I: P_{DL}= 250 kips P_{LL}= 200 kips
M_{DL}= 60 k-ft M_{LL}= 100 k-ft

CASE II: P_{DL}= 250 kips P_{LL}= 200 kips P_W= 50 kips
M_{DL}= 60 k-ft M_{LL}= 100 k-ft M_W= 140 k-ft

CASE III: P_{DL}= 250 kips P_{LL}= 100 kips P_W= 50 kips
M_{DL}= 60 k-ft M_{LL}= 100 k-ft M_W= 140 k-ft

All moments about Y-Y axis.
ACI code recommends load combination to be as follows,
(DL +LL)
OR 0.75(DL+LL+W) and

Load factors to be: for DL= 1.4 and for LL and W=1.7

Check the adequacy of the column section for the load combinations using USD [Relevant charts or figures provided].

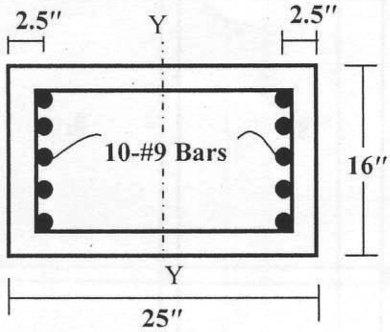

Fig. 2 for Question 2(a)

(b) Use WSD to draw the interaction diagram for the column section shown in Fig.3. [06]

Given: e_b= 9.8″, S_{ut}= 2600 in^3.

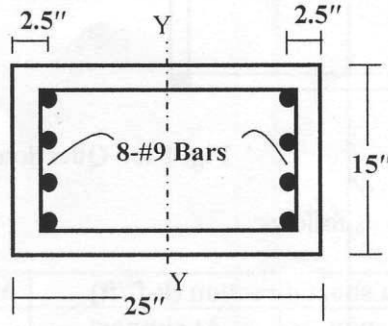

Fig. 3 for Question 2(b)

(c) Discuss ACI code safety provisions for columns explaining different φ and α values under different conditions. What does the horizontal cut-off in the ACI design strength interaction diagram represent? [04]

(d) Why are ties provided in columns? Write down the design procedures and rules for placing ties in tied column according to ACI. Make necessary sketches if necessary. [04]

3.(a) The plan and section of a rectangular footing is shown in Fig. 4. The 24″×24″ column carries working load P_{DL}= 250 kips, P_{LL}= 150 kips. The total thickness of the footing is 30″ which is adequate for shears. Calculate the reinforcements necessary for the footing and make a net sketch showing the details of reinforcement. Use USD method. [10]

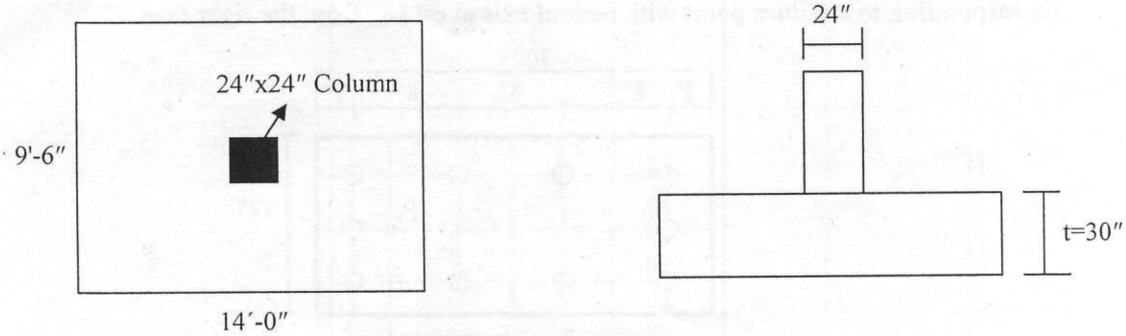

Fig. 4 for Question 3(a)

(b) Design the dowels for load transfer from a 14″×14″ column to a 13′×13′ footing with a P_u=750 k. The column has 8#8 bars. [05]

(c) For the flat plate structures, when punching resistance of slab-column connection is found inadequate, describe in brief what are the possible ways to increase the punching resistance? [05]

4.(a) A combined footing supporting two columns A and B (with working loads as given) is shown in Fig. 5. Effective depth of the footing is 30″. Use USD method to [12]

- (i) Check the adequacy against punching shear under column A and B.
- (ii) Design the transverse beam under both the columns.
- (iii) Show the designed reinforcements in a longitudinal section of the footing.

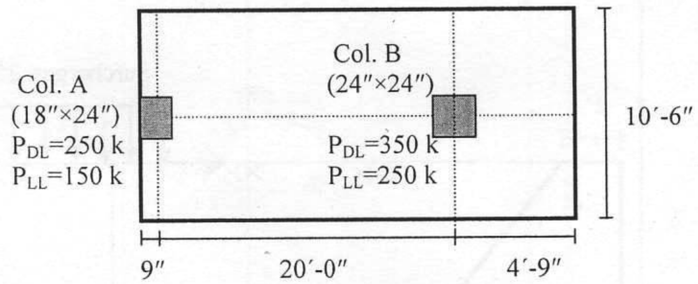

Fig. 5 for Question 4(a)

4.(b) The plan of a square footing is shown in Fig. 6. The factored net upward pressure is 3.5 ksf. Check the adequacy of the footing against punching shear, beam shear and moment. Use USD method. [08]

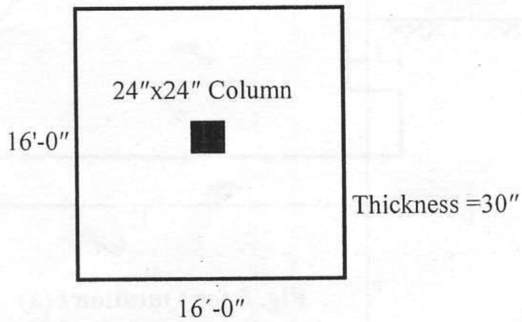

Fig. 6 for Question 4(b)

5.(a) The column in Fig. 7 is reinforced with 10-#9 bars distributed around the perimeter as shown. Load P_n will be applied with eccentricity e about the strong axis. Determine the load and moment corresponding to a failure point with neutral axis at c= 18″ from the right face. [10]

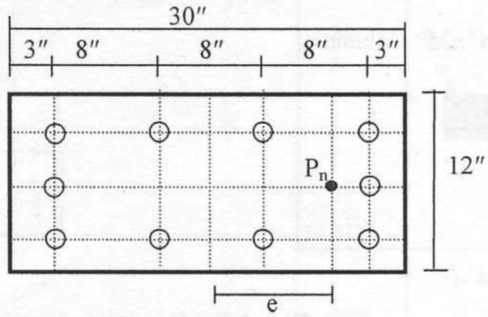

Fig. 7 for Question 5(a)

(b) A column carries a working DL=350 k and working LL=250k. Design the column by WSD using reasonable percentage of steel. [05]

(c) Using the same percentages of reinforcement as in 5(b), design the column (by USD) for working loads in 5(b). [05]

6(a) A trial section of a gravity type retaining wall as shown in the Fig.8 was made to support the soil behind the wall and the surcharge on the ground surface. Check the external stability of the section against sliding and overturning. Also check the soil pressure under the base. [10]
Given: Unit weight of soil, γ_s= 120 pcf, φ=30^0 , Base friction coefficient, f_{base}=0.5, Allowable bearing pressure= 8 ksf.

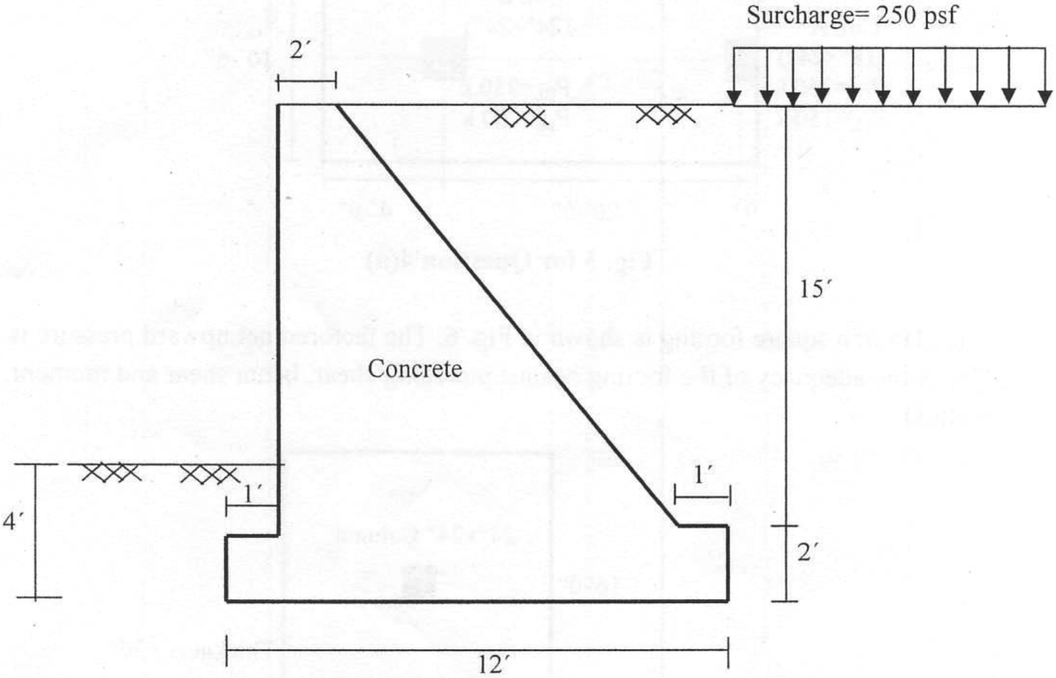

Fig. 8 for Question 6(a)

(b) A cross section of a retaining wall is shown in Fig. 9. If the vertical component of the reaction is equal to 34k and acts at a distance 9.5 ft from the toe as shown, design the footing of the retaining wall, using WSD method. Given: Unit weight of soil, γ_s= 120 pcf. [10]

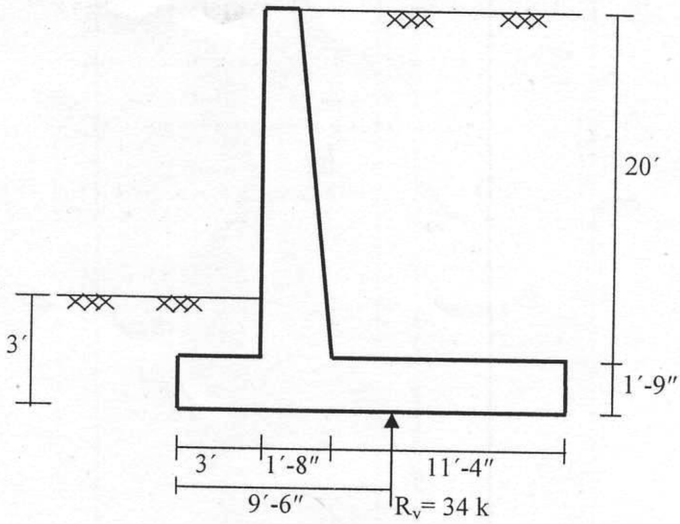

Fig. 9 for Question 6(b)

7.(a) What are the limitations in ACI code for using semi-empirical direct design method (DDM) to determine moments in two-way slabs? [05]

(b) An office building is planned using a flat plate floor system with the column layout as shown in the Fig.10. No beams, drop panels or column capitals are permitted. The columns are 18 inch square and floor to floor height of the building is 12.0 ft. Other design conditions are given below: [15]

FF= 25 psf, Partition wall load= 40 psf and LL=80 psf.

Design an interior panel by USD, following the steps mentioned below:

(i) Calculation for minimum slab thickness
(ii) Check for punching shear- around interior column
(iii) Calculation for design moments (in long direction only)
(iv) Check for slab thickness- moment consideration
(v) Calculation for flexural reinforcements (in long direction)
(vi) Neat sketches for reinforcements (in long direction only)

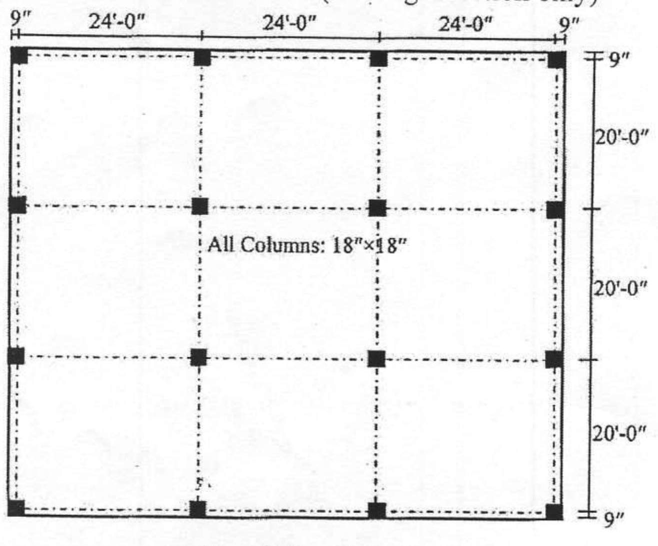

Fig. 10 for Question 7(b)

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PART A

[Answer **any 7 (seven)** of the following 10 questions]

[Given: $f_c{}' = 3$ ksi, $f_y = 50$ ksi for all questions except Question No. 10]

1. The floor plan in Fig. 1 includes a RC flat slab *FS* supported on 18″-diameter columns, with 5″ thick brick walls along all column lines. Floor loads also include working FF = 25 psf, RW = 50 psf.

   Use the USD to

   (i) Calculate the

   (a) Required thickness of the slab *FS* from deflection considerations,

   (b) Ultimate bending moment capacity for this slab thickness (using maximum steel ratio $\rho_s = 0.25\rho_b$),

   (c) Corresponding live load (LL) on the slab

   (ii) Check the slab for punching shear around the corner column C_3 and calculate shear reinforcements (showing neat sketches of 45° bent stirrups).

   [Given: Distribution Factors applied to Moment M_0 for exterior slab are (0.00, +0.63, –0.75)].

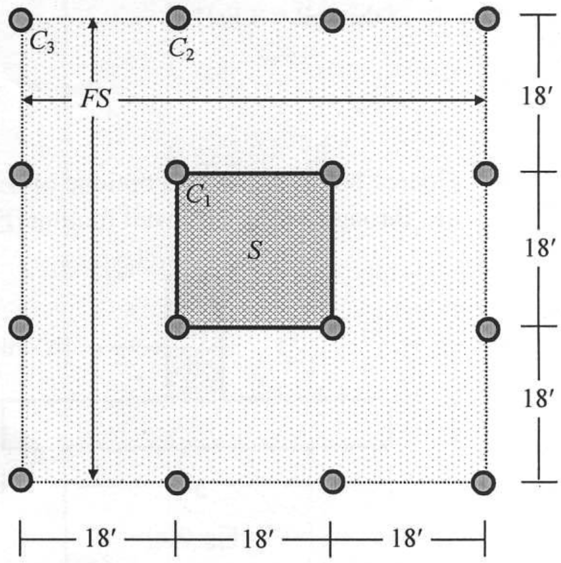

Fig. 1

2. Fig. 1 shows a floor plan consisting of the RC slab *S*, supported on 12″ × 15″ beams and 18″-diameter columns, with 5″ thick brick walls along all column lines.
   Floor loads also include working FF = 25 psf, RW = 50 psf.

   Use the USD to

   (i) Calculate the

   (a) Required thickness of the slab *S* from deflection considerations,

   (b) Ultimate bending moment capacity for this slab thickness (using maximum $\rho_s = 0.25\rho_b$), and

   (c) Corresponding live load (LL) on the slab.

   (ii) Design the slab with neat sketches of reinforcements
   [Given: $C_{a(D)+} = C_{b(D)+} = 0.018$, $C_{a(L)+} = C_{b(L)+} = 0.027$, $C_{a-} = C_{b-} = 0.045$].

3. Fig. 1 shows the floor plan of a 6-storied RC structure, consisting of 5″ thick slab *S* (supported on 12″ × 15″ beams), 6″ thick flat-slab *FS* and 5″ thick partition walls along all column lines.

   Floor loads also include working FF = 25 psf, RW = 50 psf and LL = 40 psf.

   Use the WSD

   (i) To design the circular column C_1 (and its spiral reinforcements), if it is subjected to axial force only.

   (ii) Use the section C_1 obtained in (i) to calculate the allowable equal biaxial moments $M_x = M_y$ (about the *x*- and *y*-axes) on column C_3, in addition to axial force.

4. For the floor plan shown in Fig. 1 and described in Question 3, use the USD to

   (i) Design a circular column C_2 (and its spiral reinforcements) only for the axial force it is subjected to.

   (ii) Determine the size and thickness of a square footing supporting the column C_2
   [Given: Allowable bearing capacity of the soil = 3 ksf].

5. Fig. 2 shows the axial force and bending moment on (12″ × 12″) column C_1 and (18″ × 18″) column C_2.

Calculate the

(i) Maximum and minimum soil pressure under footing F_1 (supporting C_1) and footing F_2 (supporting C_2)

(ii) Required length, width and thickness (considering punching shear around C_2 only for USD) of a combined footing supporting C_1 and C_2 [Given: Allowable bearing capacity of the soil = 3 ksf].

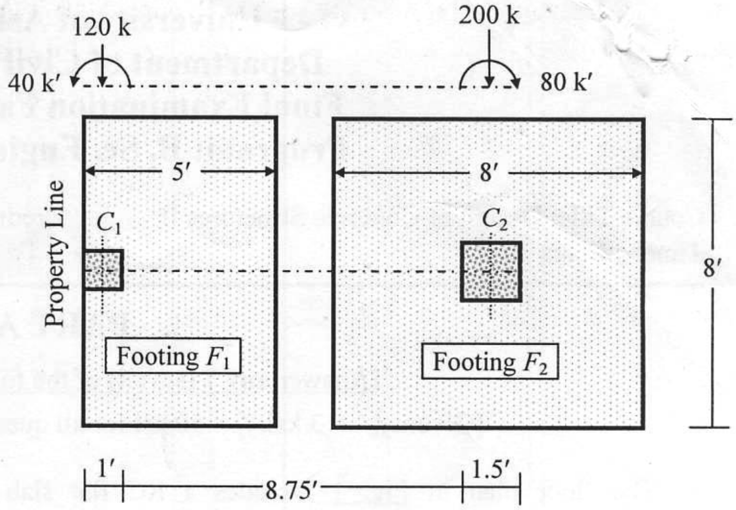

Fig. 2

6. Figures below show two options of transferring a vertical load of P = 150 kip, to the soil underneath; i.e., through a (5′ × 10′) wall footing [Fig. 3(a)] and a (5′ × 10′) column footing [Fig. 3(b)].

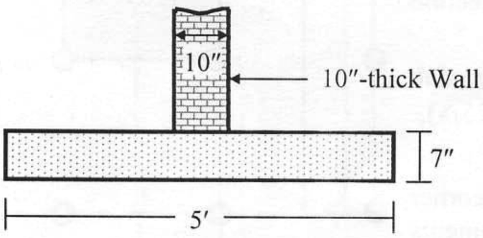

Fig. 3(a)

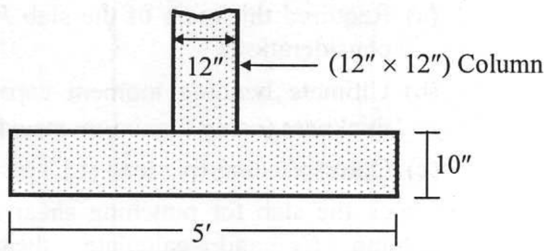

Fig. 3(b)

Use the WSD to calculate and show the reinforcements required (in both directions) for the (i) 7″-thick wall footing, (ii) 10″-thick column footing.

7. For the cantilever type retaining wall shown below

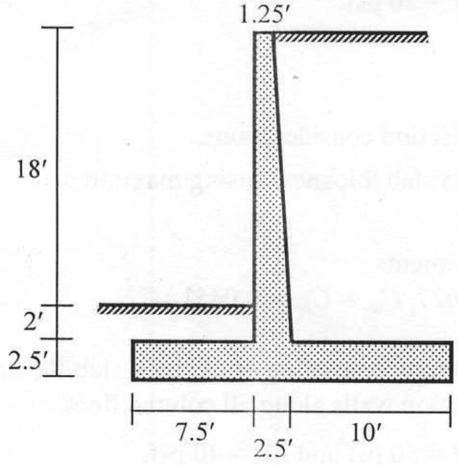

Fig. 4(a)

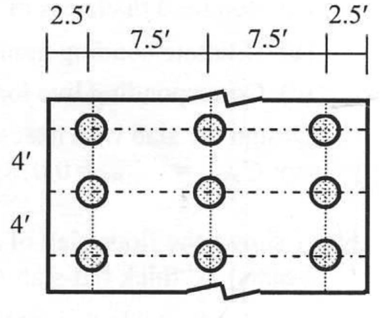

Fig. 4(b)

(i) Draw the pressure diagrams to be used for the heel and toe of the wall [shown in Fig. 4(a)].

(ii) Use WSD to calculate the maximum force and corresponding length of the pile shown in the pile group arranged as in Fig. 4(b) below the foundation of the wall.

[Given: Unit weight of concrete = 150 lb/ft^3, Unit weight of soil = 110 lb/ft^3, Angle of friction (ϕ) for the soil = 30°, Allowable bearing capacity of the soil = 1.5 ksf].

8. (i) Use the USD to design the stem of the retaining wall shown in Fig. 4(a) [described in Question 7],

(ii) Show the reinforcements calculated in (i) (as well as bar cut-off details) with neat sketches.

9. Calculate the factor of safety against sliding and overturning for the retaining wall shown in Fig. 5, if

(i) Water table is at c, and surcharge $w = 200$ psf is at a, or b [whichever is more critical]

(ii) Surcharge $w = 0$, and water table is at surface level b [There is no drainage facility]

[Given: Unit weight of brick = 120 lb/ft^3, Unit weight of soil = 110 lb/ft^3,
Angle of friction (ϕ) for the soil = 30°, Friction factor (f) between soil and base of wall = 0.5].

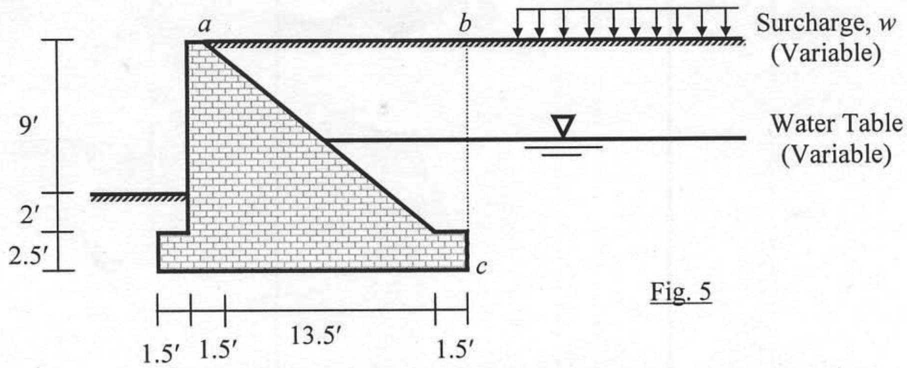

Fig. 5

10. Fig. 6 shows a simply-supported concrete beam subjected to pre-stressing force of 250 kips that reduces to 200 kips after losses. For both sections of the beam (i.e., Section1 and Section 2),

(i) Calculate the extreme fiber stresses at midspan of the beam at working condition (i.e., with effective prestress and beam self-weight)

(ii) Check the stresses calculated in (i) with the allowable tensile and compressive stresses in concrete

(iii) Calculate the cracking moment and corresponding load F on the beam

[Given: $f_c' = 5$ ksi, $f_{ci} = 3.5$ ksi].

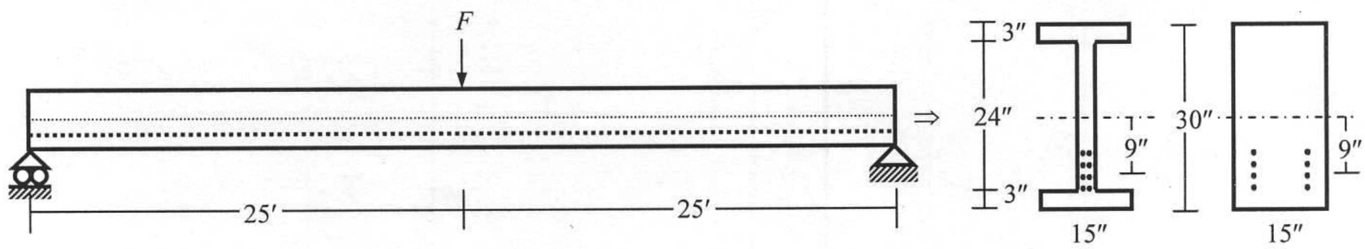

Fig. 6

Section 1

Section 2

PART B

[Answer **any 3 (three)** of the following 4 questions]

11. (i) Explain why the application of compressive load may increase or decrease the moment capacity of columns.

(ii) Outline the procedure for the structural design of piles and pile caps.

12. (i) Specify the minimum reinforcements required in the design of wall footings and column footings.

(ii) What is Transverse Beam in combined footings? Narrate how it is designed.

13. (i) Name different types of retaining walls and explain their relative advantages.

(ii) Narrate the distinctive features of the concrete and steel used in pre-stressed concrete.

14. (i) What are corner reinforcements in two-way slabs?
Mention the ACI provisions for corner reinforcements.

(ii) Define the factors α, β_t and explain their effect on the structural analysis of flat slabs.