Roll No.													

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Sem & AY: Odd Sem 2019-20
Course Code: CIV 317
Course Name: ADVANCED RCC STRUCTURES
Program & Sem: B.Tech (Civil) & VII DE

Date: 30.09.2019
Time: 9:30 AM to 10:30 AM
Max Marks: 40
Weightage: 20%

Instructions:

(i) Write legibly and draw clear diagrams wherever required.
(ii) Diagrams to be drawing using a pencil and scale only. Pen diagrams will be penalized.
(iii) Scientific and non-programmable calculators are permitted.
(iv) Assume missing data.
(v) IS 456-2000 & Design aids for RCC (SP-16) design charts are permitted in the exam.

Problem:-

A roof of 8m wide hall is supported on a portal frame spaced at 4m intervals. The height of the portal frame is 4m, the continuous slab is of 120mm thick, live load on the roof or slab is 2.5 kN/m^2. The columns are connected with plinth beam and base of the columns may be assumed as fixed. Adopt M20 grade of concrete and Fe415 grade of steel. Answer the questions in part A and part B.

Part A [Problem Solving Questions]

Answer the Question. The Question carries twenty marks. (1Qx20M=20M)

1. Analyse the portal frame by calculating the load on it and draw the Bending Moment Diagram (BDM). (CO.NO.1) [Application]

Part B [Problem Solving Questions]

Answer the Question. The Question carries twenty marks. (1Qx20M=20M)

2. After analysis of the portal frame in part A, design the column. (CO.NO.1) [Application]

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: 7th

Course Code: CIV 317

Course Name: Advanced RCC

Branch & Sem: Civil, 7th

Date: 30 September 2019

Time: 1 hr

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			A			
1	CO1	Module – 1							20	20		40
	Total Marks								20	20		40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I here certify that All the questions are set as per the above lines Dr S.B Anadinni]

Annexure- II: Format of Answer Scheme

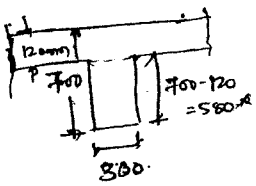
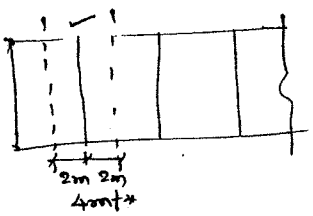
SCHOOL OF ENGINEERING

SOLUTION

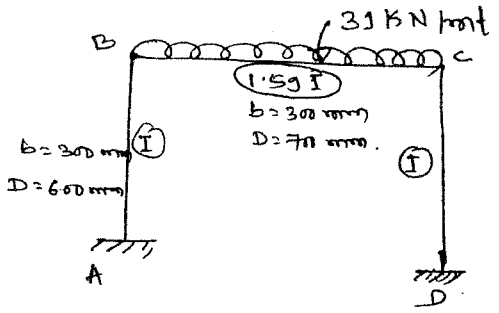
Semester: 7TH
Course Code: CIV 317
Course Name: Advanced RCC
Branch & Sem: Civil, 7th

Date: 30 September 2019
Time: 1 hr
Max Marks: 40
Weightage: 20%

Part A (1Q x 10M = 10 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1a	Design of portal frame effective span of portal frame = 8 mt effective depth of beam = d = $\frac{\text{eff span}}{12}$ $= \frac{8000}{12} = 666$ mm. Provide the following dimensions. Beam – Adopt d = 650 mm, D = 700 mm, b = 300 mm. Column – Adopt b = 300 mm, D = 600 mm. Calculation of Load on portal frame Intensity of the load on slab = w = wd + wl $= 4 + 2.5 = 6.5$ KN/m² ∴ Load from the slab = 4 × 6.5 = 26 KN/mt self wt of web or rib = 0.30 × 0.58 × 25 = 4.35 KN/mt   Total load on a portal frame = w = 26 + 4.35 w = 30.35 KN/mt ≈ 31 KN/mt. 	5 marks	30 min

		5 marks	



⑥

$$\frac{I_{AB}}{I_{BC}} = \frac{\frac{300(600)^3}{12}}{\frac{3000(700)^3}{12}} = 0.63.$$

take $I_{AB} = I$

$\therefore I_{BC} = \frac{I_{AB}}{0.63} = 1.59\,I$

Analysis of portal frame

① Fixed end moments -

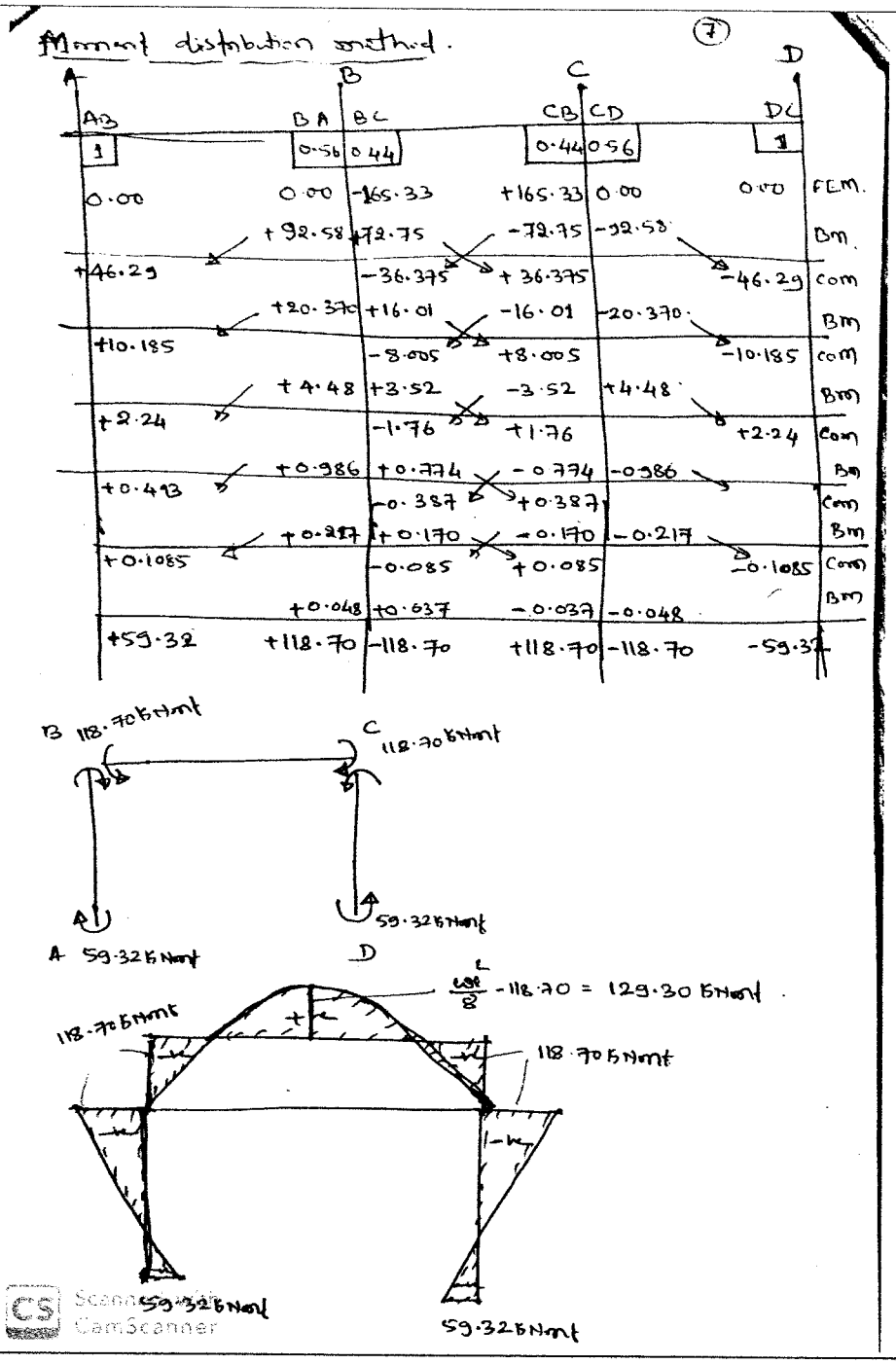
$M_{FAB} = M_{FBA} = 0,$

$M_{FBC} = M_{FCB} = \mp \frac{wl^2}{12} = \mp \frac{31(8)^2}{12} = \mp 165.33$ KNmt.

$M_{FCD} = M_{FDC} = 0.$

Distribution factors

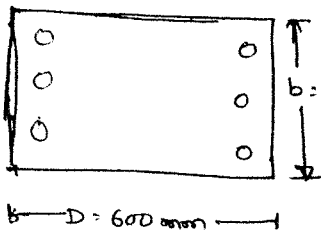
Joint	member	K	ΣK	D.F = $\frac{K}{\Sigma K}$
B	BA	$\frac{I}{4} = 0.25I$	0.45I	0.56
	BC	$\frac{1.5I}{8} = 0.20I$		0.44
C	CB	$\frac{1.5I}{8} = 0.20I$	0.45I	0.44
	CD	$\frac{I}{4} = 0.25I$		0.56.

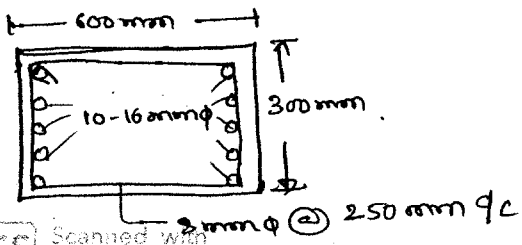
	Moment distribution method. (7)  	10 marks	

Part B

(1Q x 15M = 15 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question

1b	Design of columns (17) $M_u = 1.5 \times 119.70 = 178.05$ kNm $P_u = 1.5 \cdot \frac{19 \times L}{2} = 1.5 \times \frac{31 \times 8}{2} = 186$ kN.  $d' = 50$ mm. $\therefore d = 550$ mm. $\frac{d'}{D} = \frac{50}{600} = 0.083 \approx 0.1$ Refer chart -32. $\frac{M_u}{f_{ck} b D^2} = \frac{178.05 \times 10^6}{20 \times 300 \times 600^2} = 0.086$ $\frac{P_u}{f_{ck} b D} = \frac{186 \times 10^3}{20 \times 300 \times 600} = 0.052.$ $\frac{p}{f_{ck}} = 0.05$ $\therefore p = 0.05 \times 20 = 1\%$. [min % steel — 0.6% to 0.8%] $\therefore$ Area of main steel $= \frac{1}{100} \times 300 \times 600$ $= 1800$ mm^2. No. of 16 mm $\phi = \frac{1800}{\pi/4 (16)^2} = 8.95$ Nos. Provide 10 – 16 mm ϕ → 5 bars on each face of the column. 	15 marks	30 mins

	Lateral ties (18) Dia of Lateral ties: diameter of the Lateral ties shall not be less than the following i) $\frac{1}{4}$ dia of the main bar. = $\frac{1}{4} \times 16 = 4$ mm. ii) 6 mm ∴ provide 8 mm ϕ Spacing of the Lateral ties. Spacing of the lateral ties shall not be more than the following. i) Least lateral dimension of the compression member → 300 mm ii) 16 ϕ of smallest dia of the main bar. $16 \times 16 = 256$ mm. iii) 300 mm. ∴ Provide 8 mm ϕ @ 250 mm c/c.  	5 marks	

Roll No.													

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST – 2

Sem & AY: Odd Sem 2019-20
Course Code: CIV 317
Course Name: ADVANCED RCC
Program & Sem: B. Tech. (Civil) & VII Sem

Date: 18.11.2019
Time: 9.30 AM to 10.30 AM
Max Marks: 40
Weightage: 20%

Instructions:

(i) *Write legibly and draw clear diagrams wherever required.*
(ii) *Diagrams to be drawing using a pencil and scale only. Pen diagrams will be penalized.*
(iii) *Scientific and non-programmable calculators are permitted.*
(iv) *Assume missing data.*
(v) *IS 456-2000 design charts are permitted in the exam.*

1. An interior panel of flat slab for a live load of 5.5 kN/m^2, drop shall be provided and all the panels are 6m x 6m in size, use M20 and Fe415 grade of concrete and steel respectively. Assume missing data. Analyze and design the flat slab for the following questions:

Part A [Memory Recall Questions]

Answer the question. The question carry ten marks. (1Qx10M=10M)

a. Calculate the total load on the flat slab and fix the dimensions of all the elements. (C.O.NO.2)[Application]

Part B [Thought Provoking Questions]

Answer the question. The question carry fifteen marks. (1Qx15M=15M)

b. Calculate the total design moment, distribution of moments in column strip and middle strip. Also, check for shear. (C.O.NO.2)[Application]

Part C [Problem Solving Questions]

Answer the question. The question carry fifteen marks. (1Qx15M=15M)

c. Calculate the required steel and its spacing in column strip and middle strip. (C.O.NO.2)[Application]

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: 7th

Course Code: CIV 317

Course Name: Advanced RCC

Branch & Sem: Civil, 7th

Date: 18 November 2019

Time: 1 hr

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			A			
1	CO2	Module – 2							10	15	15	40
	Total Marks								10	15	15	40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines. Dr. S.B. Anadinni

Reviewer's Comments:

Annexure- II: Format of Answer Scheme

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SCHOOL OF ENGINEERING

SOLUTION

Semester: 7TH
Course Code: CIV 317
Course Name: Advanced RCC
Branch & Sem: Civil, 7th

Date: 18 November 2019
Time: 1 hr
Max Marks: 40
Weightage: 20%

Part A (1Q x 10M = 10 Marks)

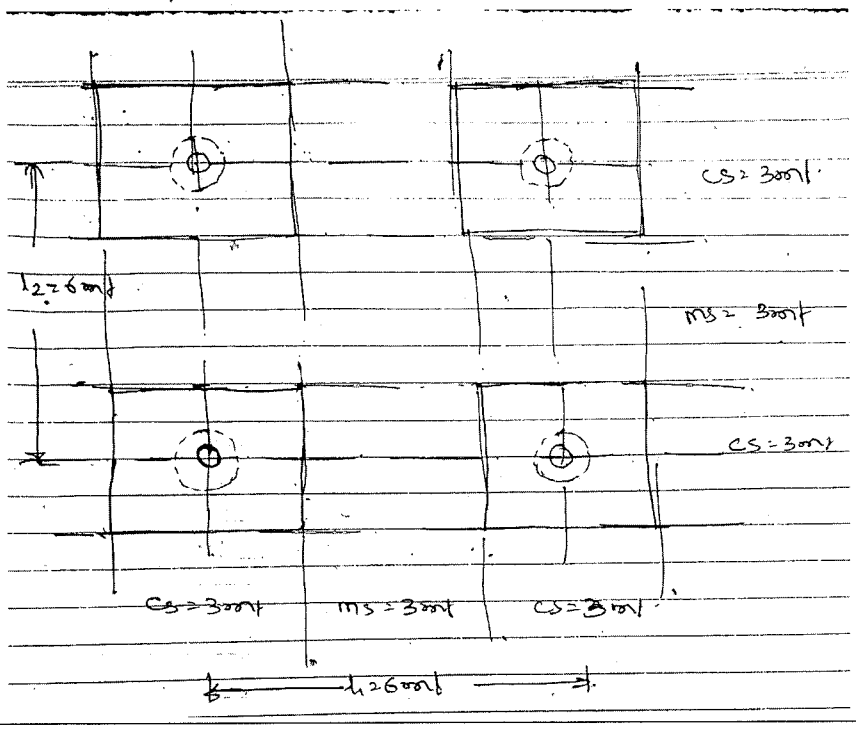
Q No	Solution	Scheme of Marking	Max. Time required for each Question
1a	Given Data: $h = 6m$ $l_e = 6m$ $W_l = 6.5 kN/m^2$ $f_{ck} = 20 N/mm^2$ $f_y = 415 N/mm^2$ PART-A: Thickness of slab: Thickness of the slab shall not be less than the following. (i) 125mm (ii) $\frac{L}{40} = \frac{6000}{40} = 150mm$ Provide thickness of slab = 200mm Thickness of drop = $1.25 \times 200 = 250mm$ Calculation of Load: $W_d = 0.20 \times 25 = 5 kN/m^2$ $W_l = 6 kN/m^2$ Floor Finish $= 1.0 kN/m^2$ Total Load $= 12 kN/m^2$	5 marks	10 mins

	Distribution moments -ve Design moments = $0.65 M_0 = 245.875$ kNmt. +ve Design moment = $0.35 M_0 = 132.3945$ kNmt. Design moments in cs -ve Design moment in cs = $0.75 \times 245.875 = 184.40$ kNmt +ve Design moment in cs = $0.60 \times 132.39 = 79.434$ kNmt Design moments in ms. -ve Design moment in ms = $0.25 \times 245.875 = 61.47$ kNmt. +ve Design moment in ms = $0.40 \times 132.39 = 52.96$ kNmt.	5 marks	
	Check for depth of slab:- Drop portion: $M_u = 245.875$ kNmt $MR = 0.138 f_{ck} b d^2$ $M.R = M_u$ $d = \sqrt{\frac{245.875 \times 10^6}{0.138 \times 20 \times 3000}} = 172.32$ mm d provided = 229 mm d provided > d required Hence it is safe Slab portion: $M_u = 79.434 \times 10^6$ N mm $MR = 0.138 f_{ck} b d^2$ $\therefore d = \sqrt{\frac{79.434 \times 10^6}{0.138 \times 20 \times 3000}} = 97.94$ mm Provided d = 179 mm Hence it is ok	5 marks	
	Check for shear $\tau_v = \frac{V_u}{b_0 d}$, $V_u = 18\left[6 \times 6 - \pi/4 (1.729)^2\right]$ $= 605.73$ kN. $b_0 = \pi D = \pi \times 1.729 = 5.431$ mt. $\tau_v = \frac{605.73 \times 10^3}{5431 \times 229} = 0.48$ N/mm^2. $\tau_c' = k_s \tau_c = 1 \times 0.25\sqrt{20} = 1.12$ N/mm^2 $\tau_v < \tau_c'$ — Hence it is OK.	2 marks	

Part C

(1Q x 15M = 15 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question

	$w_u = 1.5 \times 12 = 18\ kN/m^2$ Length and width of the drop $= 6/2 = 3m$ Diameter of column head $= l/4 = 6/4 = 1.5m$ width of CS $= 0.25 l_2 = 0.25 \times 6 = 1.5m$ width of MS $= 0.25 l_2 = 0.5 \times 6 = 3m$  	5 marks	

Part B (1Q x 15M = 15 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1b	Part - B $M_o = \frac{W l_n}{8}$, $l_n = 6 - \frac{1.33}{2} - \frac{1.33}{2} = 4.67m$ $M_o = \frac{18 \times 6 \times 6 \times 4.67}{8} = 378.27\ kNm$	3 marks	20 mins

1c	PART - C Note:- Since the given flat slab is square, therefore same reinforcement can be provided in y-direction also.	15 marks	30 mins

Description	column strip		middle strip	
	-ve Moment	+ve Moment	-ve Moment	+ve Moment
BM in kNm	184.400	79.436	61.467	52.956
d in mm	229.mm	179 mm	179 mm	179 mm
Area of steel in mm^2	2388.17	1287.87	985.537	844.72
spacing of bottup bars (12mm)	300 mm	300 mm	300 mm	300 mm
spacing of straight bars (10mm)	300 mm	300 mm		

Roll No												

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019 - 20

Course Code: CIV 317

Course Name: ADVANCED RCC STRUCTURES

Program & Sem: B.Tech (CIV) & VII (DE-IV)

Date: 24 December 2019

Time: 9:30 AM to 12:30 PM

Max Marks: 80

Weightage: 40%

Instructions:

(i) Read the all questions carefully and answer accordingly.
(ii) Write legibly and draw clear diagrams wherever required.
(iii) Diagrams to be drawing using a pencil and scale only. Pen diagrams will be penalized.
(iv) Scientific and non-programmable calculators are permitted.
(v) IS 456:2000 is permitted.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 3 marks. **(5Qx3M=15M)**

1. Write an expression to find an absolute sum of the positive and negative moment in a flat slab and describe the notations used. (C.O.No.2) [Knowledge]

2. Draw a neat sketch for the division of column strip and middle strip in a square interior panel of a flat slab with span L_1 and L_2. (C.O.No.2) [Knowledge]

3. Explain the concept used to make pressure intensity uniform at the base of the footing in a geometrical design of combined foundation. (C.O.No.3) [Knowledge]

4. Explain the procedure to check for two-way shear or punching shear in footing. (C.O.No.1) [Knowledge]

5. Define flat slab and draw a typical flat slab with all the components. (C.O.No.2) [Knowledge]

Part B [Thought Provoking Questions]

Answer the Question. The Question carries 30 marks. **(1Qx30M=30M)**

6. Design and interior panel of flat slab for a live load of 6 kN/m^2, drop shall be provided and all the panel are 6m x 6m in size. Use M20 and Fe415 grade of concrete and steel. Show the plan and cross-sectional elevation in column strip and middle strip which shows reinforcement details. (C.O.No.2) [Application]

Part C [Problem Solving Questions]

Answer the Question. The Question carries 35 marks. **(1Qx35M=35M)**

7. Design a combined foundation for two columns carrying an axial load of 1200 kN on column A and 1500 kN on column B. Column 'A' is 40cm x 40cm in size and column 'B' is 45cm in diameter. The columns are spaced 4m apart as shown in figure 1. The SBC of soil is 150 kN/m^2. Use M20 and Fe415 grade of concrete and steel. Draw top and bottom plan which shows the reinforcement details. (C.O.No.3) [Application]

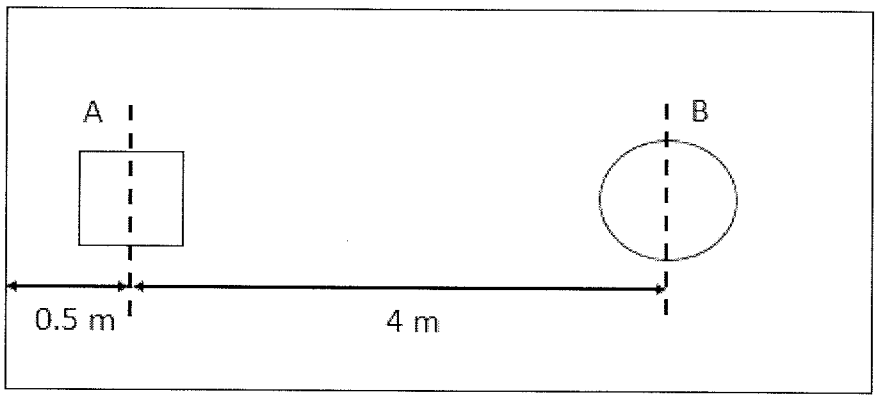


Figure 1

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO (% age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1	CO 2	MODULE 2	3			3
2	CO 2	MODULE 2	3			3
3	CO 3	MODULE 3	3			3
4	CO 1	MODULE 1	3			3
5	CO 2	MODULE 2	3			3
6	CO 2	MODULE 2			30	30
7	CO 3	MODULE 3			35	35
	Total Marks		15		65	80

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

Faculty Signature:

Reviewer Commend:

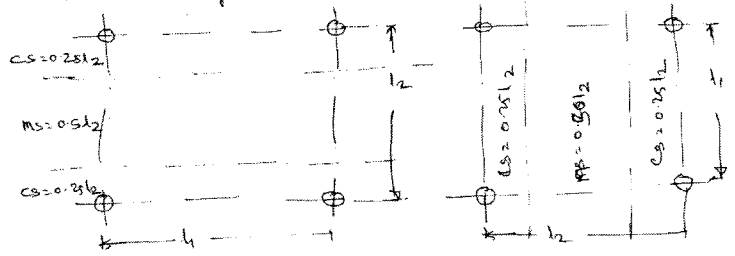
Format of Answer Scheme

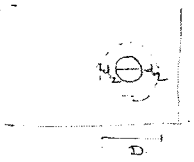
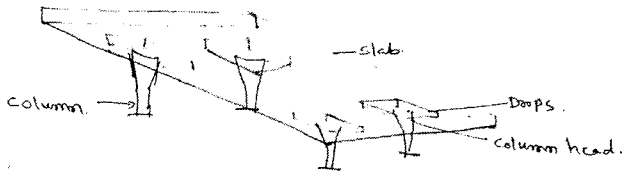
SCHOOL OF ENGINEERING

SOLUTION

Semester:	Odd Sem. 2019-20	**Date:**	24.12.2019
Course Code:	CIV 317	**Time:**	9:30AM to 12:30AM
Course Name:	ADVANCED RCC STRUCTURES	**Max Marks:**	80
Program & Sem:	B.TECH (CIVIL) & 7TH (DE-IV)	**Weightage:**	40%

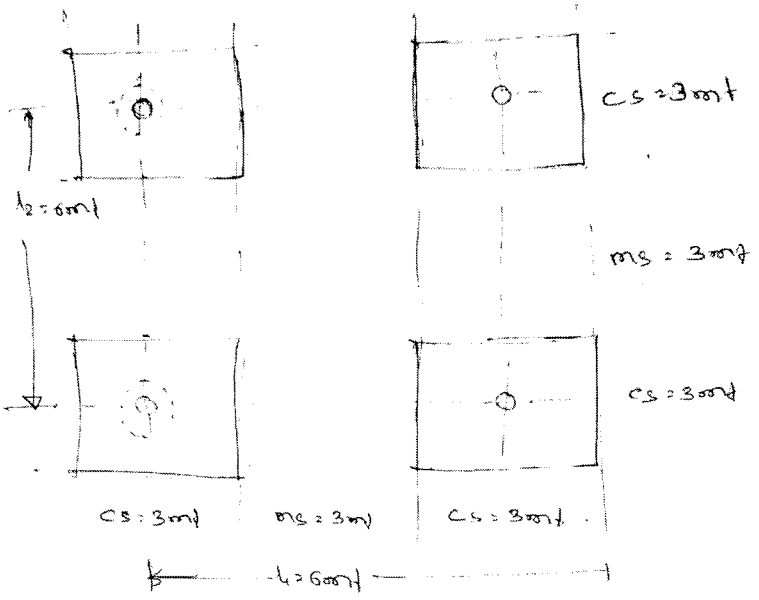
Part A (5Q x 3M = 15Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	PART - A ① The absolute sum of the +ve & -ve moments in an interior panel of flat slab $= M_0 = \frac{W \times l_n}{8}$ where $W = w_u \times l_1 \times l_2$ l_n = clear span along the span. $l_n = a/2 + a/2$ where a = Diameter of the column head or column.	3M	5 mins
2	② Division of Flat slab along x & y-direction. 	3M	5 mins
3	③ To make soil pressure intensity uniform throughout at its base of the footing, resultant of the two load should pass through the centroid of the footing area.	3M	5 mins

4	(4) Two way shear or Punching shear. Critical section for Two way shear is taken at distance $d/2$ from the face of the column. Fig. -  $\tau_v = \frac{V_u}{b_o d}$ = Nominal shear stress. V_u = ultimate shear force at critical section b_o = Perimeter of critical section d = depth of slab at critical section. Nominal shear stress should be less the τ_c' $\therefore \tau_c' = k \tau_c$ $k = 0.5 + \beta_c$ $\tau_c = 0.25\sqrt{f_{ck}}$.	3M	5 mins
5	(5) Flat slab consists of an RCC slab built monolithically with supporting columns and reinforced in two or more directions. Beams are not provided to support the slabs. The load carried by the slab is directly supported by the columns. The typical section of flat slab as shown below.  	3M	5 mins

Part B (1Q x 30M = 30 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question

6	**Flat slab** $l_1 = 6m$, $l_2 = 6m$, $w_{ll} = 6\ kN/m^2$ $f_{ck} = 20\ N/mm^2$, $f_y = 415\ N/mm^2$. **Solu** Thickness of slab: Thickness of the slab shall not be less than the following. i) 125mm ii) $\frac{l}{40} = \frac{6000}{40} = 150mm$. Provide thickness of slab = 200mm. Thickness of drop = $1.25 \times 200 = 250mm$. **Calculation of Load.** $w_d = 0.20 \times 25 = 5\ kN/m^2$ $w_l = 6\ kN/m^2$ Floor finish $= 1\ kN/m^2$ $w = 12\ kN/m^2$ $w_u = 1.5 \times 12 = 18\ kN/m^2$	3M	65 mins
	Length and width of the drop = $\frac{6}{2} = 3m$. Diameter of column head = $\frac{l}{4} = 6/4 = 1.5m$ width of C.S = $0.25 l_2 = 0.25 \times 6 = 1.5m$ width of M.S = $0.5 l_2 = 0.5 \times 6 = 3m$.  	3M	

Calculation of Absolute +ve & -ve BM $= M_0 = \frac{Wl_n}{8}$

$$l_n = 6 - \frac{1.33}{2} - \frac{1.33}{2} = 4.67 \text{ m}$$

$$M_0 = \frac{18 \times 6 \times 6 \times 4.67}{8} = 378.27 \text{ kNm}$$

Distribution of moments

-ve design moment $= 0.65 M_0 = 245.875$ kNm

+ve design moment $= 0.35 M_0 = 132.395$ kNm

Design moment in CS

-ve Design moment in CS $= 0.75 \times 245.875 = 184.40$ kNm

+ve Design moment in CS $= 0.60 \times 132.395 = 79.434$ kNm

Design moment in MS

-ve Design moment in MS $= 0.25 \times 245.875 = 61.47$ kNm

+ve Design moment in MS $= 0.40 \times 132.39 = 52.96$ kNm

6M

Checks for depth of slab

Beam portion

$M_u = 184.875$ kNm

$M_R = 0.138 f_{ck} b d^2$

$M_u = M_R$

$d = \sqrt{\frac{184.875 \times 10^6}{0.138 \times 20 \times 3000}} = 149.39$ mm

d Provided $= 229$ mm

d Provided $>$ d required

Hence it is adequate.

Slab portion

$M_u = 79.434 \times 10^6$ Nmm

$M_R = 0.138 f_{ck} b d^2$

$d = \sqrt{\frac{79.434 \times 10^6}{0.138 \times 20 \times 3000}}$

$= 97.94$ mm

Provided $d = 179$ mm

Hence it is OK.

4M

Check for shear (Punching shear)

$\tau_v = \frac{V_u}{b_o d}$

$V_u = 18\left[6 \times 6 - \pi/4 (1.729)^2\right] = 605.73$ kN

$b_o = \pi D = \pi \times 1.729 = 5.431$ mm

$\tau_v = \frac{605.73 \times 10^3}{5431 \times 229} = 0.48 \text{ N/mm}^2$

$\tau_c' = K_s \tau_c = 1 \times 0.25 \sqrt{20} = 1.11 \text{ N/mm}^2$

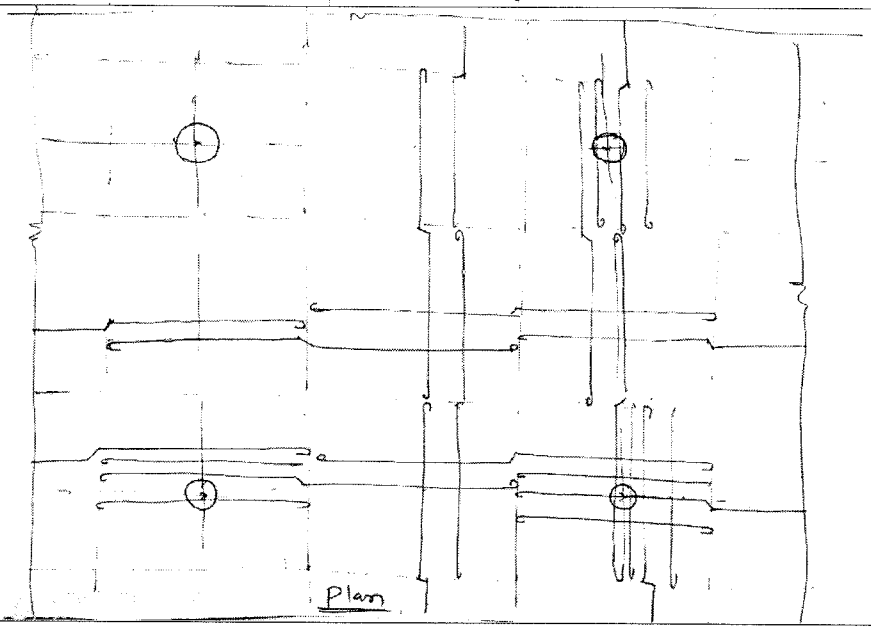
$\tau_v < \tau_c'$ — Hence it is OK.

Calculation of steel

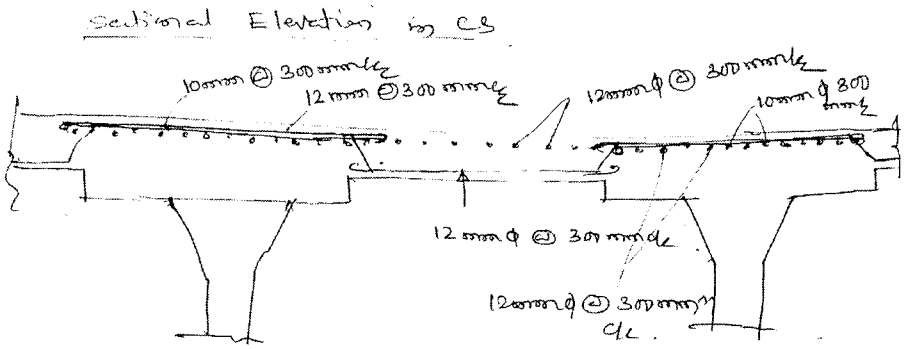
Description	column strip		middle strip	
	-ve moment	+ve moment	-ve moment	+ve moment
Bm m kNm	184.40	79.436	61.49	52.56
d in mm	229 mm	179 mm	179 mm	179 mm
Area of steel in mm^2	2388.19	1287.87	985.539	844.72
spacing of bent up bars in mm (12mm ϕ)	300	300	300	300
Spacing of straight bars in mm (12mm ϕ)	300	—	—	—

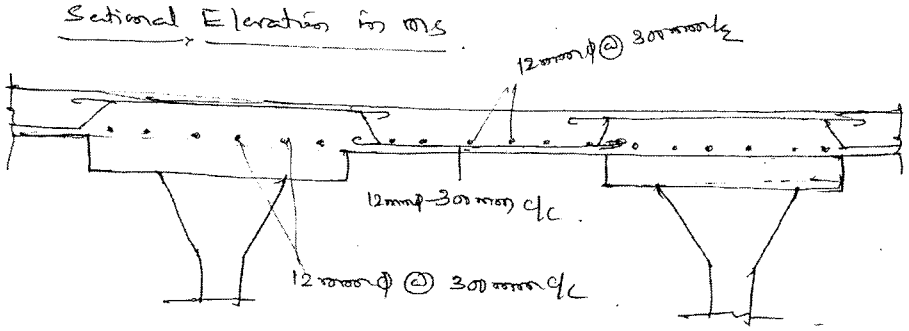
Note:- since the given flat slab is square panel, Therefore same amount reinforcement can be provided in y direction also.

7M



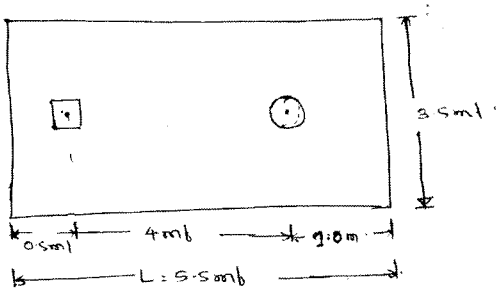
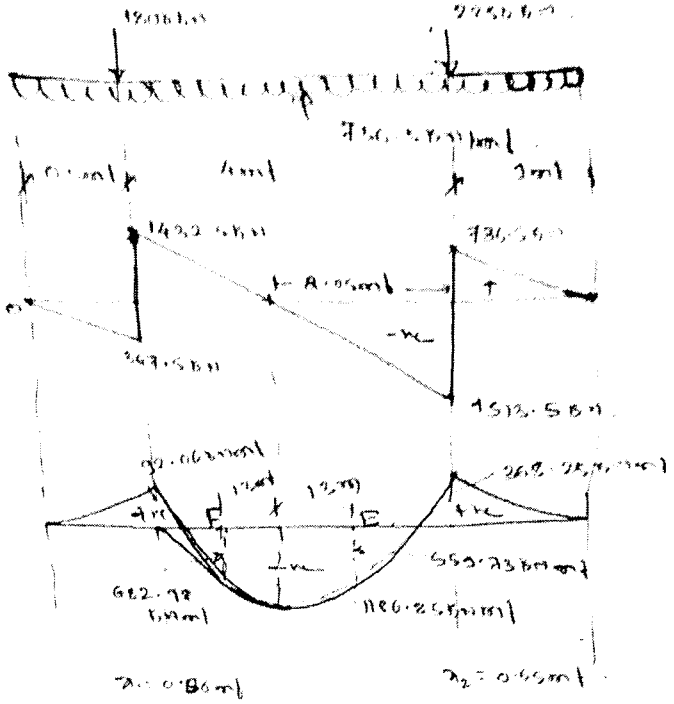
7M





Part C (1Q x 35M = 35Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question

7	PART - B Load on column A – 1200 KN Load on column B – 1500 KN. Size of column A – 400 mm x 400 mm Size of column B – 450 mm ϕ f_{ck} = 20 N/mm², f_y = 415 N/mm² SBC = 150 KN/m² Geometrical Design  L = 5.5m. Total Load = 2835 KN. Area required = $\frac{2835}{150}$ = 18.9 m² ∴ B = $\frac{18.9}{5.5}$ = 3.436 m. Provided area = 19.25 m² > 18.9 m². ultimate upward pressure intensity at the base of footing = $p_u = \frac{1.5 \times 2700}{3.5 \times 5.5}$ = 210.33 KN/m²	4M	90 mins
		8M	

Depth of footing

$M_u = 1186.85 \times 10^6$ N mm

$M_R = 0.138 f_{ck} b d^2$

$d_{required} = 338.46$ mm

$d = 700$ mm Provided

$D = 750$ mm Provided.

Calculation of steel in Longitudinal direction

$M_u = 1186.85 \times 10^6$ N mm,

$M_R = 0.87 f_y A_{st} d \left(1 - \frac{f_y A_{st}}{f_{ck} b d}\right)$

$A_{st} = 4339.31$ mm^2

min $A_{st} = 3150$ mm^2

Provide 16 - 20 mm ϕ

Curtailment of Longitudinal reinforcement

Curtailment is done at 1.3m from the Point of maximum BM.

BM at E = 559.73 KNm, $A_{st} = 2257.85$ mm^2

Provide 8 - 20mm ϕ

BM at F = 682.98 KNm. $A_{st} = 2767.19$ mm^2

Provide 9 - 20mm ϕ

reinforcement can be curtailed at a distance 0.45m from left edge & 1.05m from right edge.

Calculation of Reinforcement for the moment

$M_u = 368.25$ KNm.

$A_{st} = 1475.49$ mm^2, $A_{st\,min} = 3150$ mm^2

Provide - 10 - 20 mm ϕ

8M

Checks for one way shear

$V_u = 850.65$ KN

$\tau_v = \frac{V_u}{bd} = 0.36$ N/mm^2 $\tau_c = 0.36$ N/mm^2

$\tau_v < \tau_c$ → Hence it is safe.

Checks for two way shear

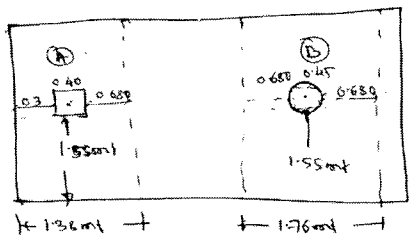
$V_u = 2031.49$ KN.

$\tau_v = \frac{V_u}{bd} = 0.80$ N/mm^2, $\tau_c' = K_s \tau_c = 1.11$ N/mm^2

$\tau_v < \tau_c'$ → Hence it is safe.

5M

Transverse reinforcement.



Design of footing under the column A

$p_u = \frac{1800}{1.38 \times 3.5} = 372.67 \text{ KN/mm}^2$

$M_u = 617.78 \text{ KNm}$ $A_{st} = 2674.46 \text{ mm}^2$

Provide 9 - 20mm ϕ

Design of footing under the column B.

$p_u = \frac{2250}{1.76 \times 3.5} = 365.25 \text{ KN/mm}^2$

$M_u = 772.21 \text{ KNm}$, $A_{st} = 3338.69 \text{ mm}^2$

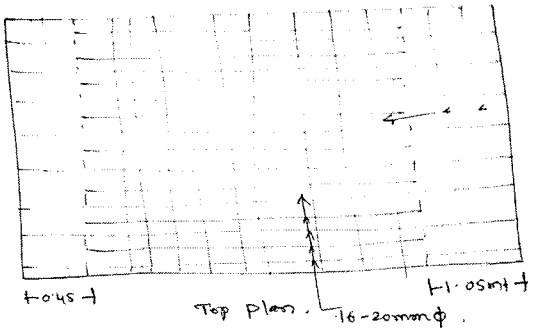
Provide 11 - 20mm ϕ

Distribution steel.

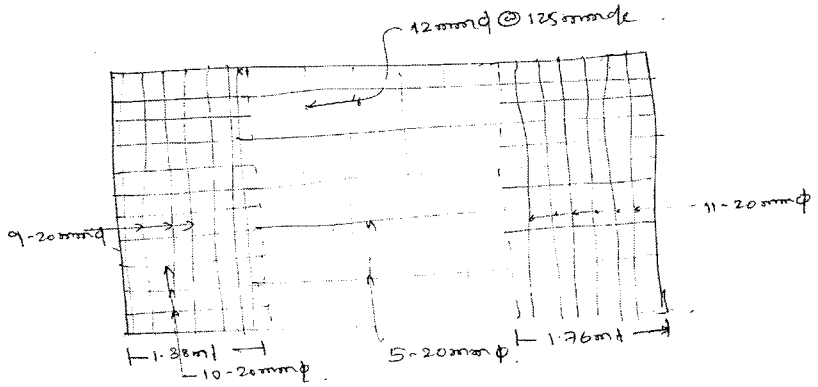
$A_{st} = 900 \text{ mm}^2$

Provide 12mm ϕ @ 125mm c/c

5M



12mm ϕ @ 125mm c/c.



5M