Roll No.												

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST – 1

Sem & AY: Odd Sem. 2019-20 **Date**: 27.09.2019

Course Code: CIV 307 **Time**: 9:30 AM to 10:30 AM

Course Name: ELEMENTS OF PRESTRESSED CONCRETE STRUCTURES **Max Marks**: 40

Program & Sem: B.Tech (Civil) & VII DE **Weightage**: 20%

Instructions:

(i) Read the question properly and answer accordingly

(ii) Scientific and Non-programmable calculators are permitted

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Part A (Memory Recall Questions)

Answer all the Questions. Each question carries five marks. (2Qx5M=10M)

1. Explain the following terms:
   a. Moderate prestressing
   b. Bonded prestressed concrete
   c. Non-bonded prestressed concrete
   d. Hydrogen embrittlement
   e. Concordant prestressing. (C.O.NO 1)[Knowledge]

2. What are the advantages and disadvantages of using prestressed concrete?
(C.O.NO 1)[Knowledge]

Part B (Thought Provoking Questions)

Answer both the Questions. Each question carries six marks. (2Qx6M=12M)

3. Precast concrete is a concrete member that's cast offsite typically by a manufacturer and then assembled at the site. Precast members can either be 'pre-tensioned' or 'post-tensioned'. Explain these two methods?
(C.O.NO 1) [Comprehension]

4. The location and profile of the prestressing cable greatly influences the prestressing force required to balance the given load or obtain desired stress at specified location of a concrete member. Show concentric and eccentric prestressing along a beam span with a neat sketch.

(C.O.NO 1) [Comprehension]

Part C (Problem Solving Questions)

Answer both the Questions. Each question carries six marks. (2Qx9M=18M)

5. The resultant stresses in concrete (f_b and f_t) at any section are obtained by superposing the effect of prestress and the flexural stresses developed due to the loads. A concrete beam of rectangular section having a width of 250 mm and depth 500 mm, is prestressed by a cable carrying a force of 600 kN at an eccentricity of 100 mm. If the beam supports a live load of 20 kN/m over an effective span of 8m, estimate the resultant stress at the top and bottom fibers at mid-span section due to the effect of prestress, dead and live loads. Assume unit weight of concrete is 24 kN/m^3. (C.O.NO 1) [Comprehension]

6. In concordant prestressing method the cables follow a concordant profile (BMD shape) for load balancing. A prestressed concrete beam of rectangular cross-section 200 mm wide and 600 mm deep supports a live load of 4kN/m spanning over 10m. Find the effective prestressing force in the parabolic cable having an eccentricity of 100 mm at the centre of span and zero at the supports for the following load conditions:
   a. If the bending effect of the prestressing force is nullified by the imposed load for the mid-span section (*neglecting the self-weight of the beam*), and
   b. If the resultant stress due to self-weight, live load and prestressing force is zero at the bottom of the beam at mid-span. Assume unit weight of concrete is 24 kN/m^3.

(C.O.NO 1) [Comprehension]

SCHOOL OF ENGINEERING

TEST – 1 SOLUTION

Semester: VII

Course Code: CIV 307

Course Name: Elements of Prestressed Concrete Structures

Branch & Sem: B.Tech Civil, VII Sem, IV Year

Date: 27-09-2019 (Fri)

Time: 9:30 AM to 10:30 AM

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 [10 M] [Knowledge]	Thought provoking type [12 M] [Comprehension]	Problem solving type [18 M] [Comprehension]	Total Marks
			K	C	C	
1	1	1 – Introduction, Pre-stressing systems, Analysis of PSC Beams	5			5
2	1		5			5
3	1			6		6
4	1			6		6
5	1				9	9
6	1				9	9
	Total Marks		10	12	18	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 guide lines. Dr. Nakul Ramanna]

Reviewers' Comments

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE REACH GREATER HEIGHTS

TEST - 1 SOLUTION

Semester: VII

Course Code: CIV 307

Course Name: Elements of Prestressed Concrete Structures

Branch & Sem: B.Tech Civil, VII Sem, IV Year

Date: 27-09-2019

Time: 9:30 AM to 10:30 AM

Max Marks: 40

Weightage: 20%

Part A (2Q x 5M = 10 Marks)

Q No	Solution	Scheme of Marking	Max. Time for each Question
1	Moderate prestressing In this type, no limit is imposed upon the magnitude of the tensile stresses at working loads. According to Leonhardt, this form of construction is not really prestressed concrete but is to be regarded as reinforced concrete with reduced cracking and the sections should be analyzed according to the rules of reinforced concrete, as a case of bending combined with axial force. Bonded prestressed concrete Concrete in which prestress is imparted to concrete through bond between the tendons and surrounding concrete. Pretensioned members belong to this group. Non-bonded prestressed concrete Method of construction in which the tendons are not bonded to surrounding concrete but anchored in place. The tendons may be placed in ducts formed in concrete members or they may be placed outside the concrete section. Post-tensioned members belong to this group. Hydrogen embrittlement Hydrogen penetrates into steel surface and makes it brittle and fracture prone. Use of high alumina and slag cement, which are rich in sulphides, for making prestressed concrete can cause hydrogen embrittlement. Use of dissimilar metals such as Aluminium and Zinc for sheath to house high tensile steel wires can cause hydrogen embrittlement. Protective coating and covering during transport reduces chance of contamination. Concordant prestressing Prestressing of members in which cables follow a concordant profile for load balancing.	5M	10 mins

2	<u>Advantages of prestressed concrete</u> 1. Lower construction cost 2. Thinner slabs, which are especially important in high-rise buildings where floor thickness savings can translate into additional floors for the same or lower cost. 3. Fewer joints since the distance that can be spanned by post-tensioned slabs exceeds that of reinforced construction with the same thickness 4. Longer span lengths increase the usable unencumbered floor space in buildings and parking structures. 5. Fewer joints lead to lower maintenance costs over the design life of structure, since the joints are the major locus of weakness in concrete buildings. <u>Disadvantages of prestressed concrete</u> 1. Requires specialized construction equipment like jacks, anchorage etc. 2. Advanced technological knowledge and strict supervision is very important 3. High tensile reinforcement bars are needs which are expensive 4. Requires highly skilled labour.	5M	8 mins

Part B (2Q x 6M = 12 Marks)

Q No	Solution	Scheme of Marking	Max. Time for each Question
3	<u>Pre-tensioned Concrete</u> A method of prestressing concrete in which the tendons are tensioned before the concrete is placed. In this method, the prestress is imparted to concrete by bond between steel and concrete. <u>Post-tensioned Concrete</u> A method of prestressing concrete by tensioning the tendons against hardened concrete. In this method, the prestress is imparted to concrete by bearing or end anchors.	6M	5 mins

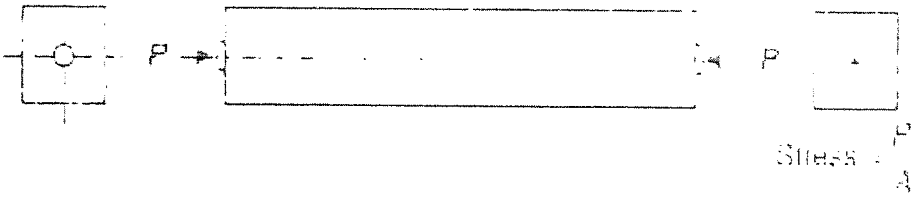
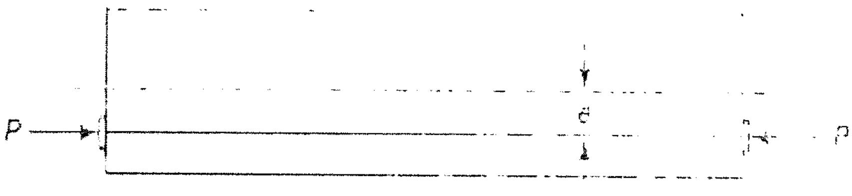
<table>
<tr><td>4</td><td>

Fig. 4.1 Concentric Prestressing



Eccentric Prestressing</td><td>6M</td><td>8 mins</td></tr>
</table>

Part C (2Q x 9M = 18 Marks)

<table>
<tr><th>Q No</th><th>Solution</th><th>Scheme of Marking</th><th>Max. Time for each Question</th></tr>
<tr><td>5</td><td>

$$f_b = \frac{P}{A} + \frac{Pe}{Z} - \frac{M_{DL}}{Z} - \frac{M_{LL}}{Z}$$

$$f_t = \frac{P}{A} - \frac{Pe}{Z} + \frac{M_{DL}}{Z} + \frac{M_{LL}}{Z}$$

P = 600 kN
A = 250 * 500 = 125 x10^3 mm^2
e = 100 mm
Z = 250*500^2/6 = 10.42x10^6 mm^3
DL = 0.25*0.50*24 = 3 kN/m

M_{DL} = 3 * 8000^2/8 = 24x10^6 N-mm
M_{LL} = 20 * 8000^2/8 = 160x10^6 N-mm

$$f_b = \frac{600 * 1000}{125\ x10^3} + \frac{600 * 1000 * 100}{10.42x10^6} - \frac{24x10^6}{10.42x10^6} - \frac{160x10^6}{10.42x10^6}$$

f_b = 4.8 + 5.76 − 2.30 − 15.35
f_b = -7.10 N/mm^2 (tensile)
</td><td>9M</td><td>10 mins</td></tr>
</table>

	$$f_t = \frac{600 * 1000}{125 \text{ x}10^3} - \frac{600 * 1000 * 100}{10.42\text{x}10^6} + \frac{24\text{x}10^6}{10.42\text{x}10^6} + \frac{160\text{x}10^6}{10.42\text{x}10^6}$$ f_t = 4.8 - 5.76 + 2.30 + 15.35 f_t = 16.70 N/mm^2 (Compression)		
6a 6b	P = $wl^2/8e$ = 4x10000^2/(8*100) = 500000 N or 500 kN. A = 12x10^4 mm^2 Z = 12x10^6 mm^3 LL = 4 kN/m DL = 0.2*0.6*24 = 2.88 k/m Total load on the beam = 2.88 + 4 = 6.88 kN/m. BM at the center of span = 0.125*6.88*10^2 = 86 kN-m For the bottom stress to be zero. P/A + Pe/Z = M/Z (P/12x10^4) + (P*100/12x10^6) = (86x10^6) / (12x10^6) Hence P = 430 kN	9M	10 mins

Roll No.

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST – 2

Sem & AY: Odd Sem 2019-20 **Date**: 16.11.2019

Course Code: CIV 307 **Time**: 9:30 AM to 10:30 AM

Course Name: ELEMENTS OF PRESTRESSED CONCRETE STRUCTURES **Max Marks**: 40

Program & Sem: B.Tech (Civil) & VII DE **Weightage**: 20%

Instructions:

(i) IS 1343 code book is not required. Data provided in the questions

(ii) Scientific and Non-programmable calculators are permitted

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Part A [Memory Recall Questions]

Answer both the Questions. Each Question carries five marks. (2Qx5M=10M)

1. High strength steel is required to offset the prestress losses incurred which can be as high as 25%. List various types of loss of prestress in pre-tensioned and post-tensioned members. (C.O.NO.2)[Knowledge]

2. IS 1343 code restricts the total deflection caused due to prestress, dead load, live load, creep and shrinkage to no more than Span / 250. Differentiate between short-term and long-term deflections of prestressed concrete beams. (C.O.NO.2)[Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries six marks. (3Qx6M=18M)

3. A prestressed concrete girder is post-tensioned using a cable concentric at supports and having an eccentricity of 200 mm at the center of span. The effective span of the girder is 18m. The initial force in the cable is 300 kN at the jacking end. Determine the loss of force in the cable due to friction. Take μ = 0.30 and k = 0.0043/m.
   [$P_x = P_o\, e^{-(\mu\alpha+kx)}$] (C.O.NO.2)[Application]

4. A pre-tensioned prestressed concrete sleeper 300 mm wide and 300 mm deep is prestressed using nine wires of 8 mm diameter. Four wires are located at top and five wires are located near the soffit. The effective cover is 40 mm. The initial stress in the wires is 1250 N/mm^2. Assuming the modular ratio as 6, estimate the percentage loss of stress in bottom wires only due to elastic deformation of concrete.

(C.O.NO.2)[Application]

5. A post-tensioned prestressed concrete beam of span 8m with a rectangular section 300 mm wide x 350 mm deep, is prestressed by high tensile wires of c/s area 2000 mm^2 and stressed to 1000 N/mm^2. Modulus of elasticity of concrete is 35 kN/mm^2 and its density is 24 kN/m^3. If the beam supports live load of 20 kN/m excluding its self-weight, compute the initial deflection due to prestress, self-weight and live loads, for a parabolic cable with an eccentricity of 100 mm at mid-span and concentric at supports:

[$\delta_p = -(5PeL^2) / (48EI)$; $\delta_{DL+LL} = (5\ W_{DL+LL}\ L^4) / (384\ E\ I)$]

(C.O.NO.2)[Comprehension]

Part C (Problem Solving Questions)

Answer the Question. The Question carries twelve marks. (1Qx12M=12M)

6. A post tensioned prestressed beam of span-length of 10m has a rectangular section 300 mm wide and 600 mm deep. The beam is prestressed by a parabolic cable concentric at supports and with an eccentricity of 150 mm at the center of span. The cross-sectional area of high tensile wires in the cable is 500mm^2. The wires are stressed by a jack at the left end so that the initial force in the cable at the right end is 200 kN. Using the following data, calculate the total loss of stress in the wires:
Anchorage slip at jacking end = 3mm, Relaxation of steel stress = 4%, Shrinkage of concrete = 0.0002, creep coefficient = 2, E_s = 210 kN/mm^2, modular ratio = 6

(C.O.NO.2)[Application]

SCHOOL OF ENGINEERING

TEST – 2 SOLUTION

Semester: VII DE | **Date:** 16-11-2019

Course Code: CIV 307 | **Time:** 9:30 AM to 10:30 AM

Course Name: ELEMENTS OF PRESTRESSED CONCRETE STRUCTURES | **Max Marks:** 40

Branch & Sem: B.Tech Civil, VII Sem, IV Year | **Weightage:** 20%

Extract of question distribution [outcome wise & level wise]

Q.NO	C.O.NO	Unit/Module Number / Unit/Module Title	Memory recall type [10 M] [Knowledge]	Thought provoking type [18 M] [Application, Comprehension]	Problem solving type [12 M] [Application]	Total Marks
			K	A, C	A	
1	2	2 – Losses of pre-stress, Deflection of pre-stressed concrete members	5			5
2	2		5			5
3	2			6 (A)		6
4	2			6 (A)		6
5	2			6 (C)		6
6	2				12	12
Total Marks			10	18	12	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. Nakul .R]

Reviewer's Comments:

SCHOOL OF ENGINEERING

TEST - 2 SOLUTION

Semester: VII DE
Date: 16-11-2019
Course Code: CIV 307
Time: 9:30 AM to 10:30 AM
Course Name: ELEMENTS OF PRESTRESSED CONCRETE STRUCTURES
Max Marks: 40
Branch & Sem: B.Tech Civil, VII Sem, IV Year
Weightage: 20%

Part A (2Q x 5M = 10 Marks)

Q No	Solution	Scheme of Marking	Max. Time for each Question
1	**Losses of prestress** **Pre-tensioned Members** / **Post-tensioned Members**: Loss due to elastic deformation of concrete / Loss due to elastic deformation of concrete Loss due to shrinkage of concrete / Loss due to shrinkage of concrete Loss due to creep of concrete / Loss due to creep of concrete Loss due to relaxation of steel / Loss due to relaxation of steel - / Loss due to friction - / Loss due to anchorage slip	5M	6 mins
2	Short term or instantaneous deflections are governed by the bending moment distribution along the span and the flexural rigidity of members. Mohr's moment area theorems are used to estimate deflections due to prestressing force, self-weight and imposed loads. The deformation of prestressed members change with time as a result of creep and shrinkage of concrete and relaxation of steel. This is referred as long-term deflection and can be computed relative to the datum, if the magnitude and longitudinal distribution of curvatures for the beam span are known for that instant, based on load history.	5M	5 mins

Losses of prestress (Q1 detail):

Pre-tensioned Members	Post-tensioned Members
Loss due to elastic deformation of concrete	Loss due to elastic deformation of concrete
Loss due to shrinkage of concrete	Loss due to shrinkage of concrete
Loss due to creep of concrete	Loss due to creep of concrete
Loss due to relaxation of steel	Loss due to relaxation of steel
-	Loss due to friction
-	Loss due to anchorage slip

Part B (3Q x 6M = 18 Marks)

Q No	Solution	Scheme of Marking	Max. Time for each Question
3	$P_x = P_o e^{-(\mu\alpha+kx)}$	6M	10 mins

	Slope = 4e/L = 4*200 / 18000 = 0.044 α = 2*0.044 = 0.088 P_x = 300*1000 $e^{-(0.3*0.088+0.0043*18)}$ = 270.42x10^3 N or 270.4 kN Loss = 300 – 270.4 = 29.6 kN % Loss = 9.9%		
4	Y = (5*40 + 4*260) / (4+5) = 137.8 mm e = 150-137.8 = 12.22 mm y = 150 – 40 = 110 mm I = b*d^3/12 = 300*300^3/12 = 675x10^6 mm^4 A = 300*300 = 90 x10^3 mm^2 P = 1250*9*π*8^2/4 = 565.5x10^3 N At bottom, fc = (P/A) + (Pey/I) = (565.5x10^3 / 90 x10^3) + (565.5x10^3*12.22*110 / 675x10^6) = 6.28 + 1.13 = 7.4 N/mm^2 Loss of stress due to elastic deformation = 6*7.4 = 44.5 N/mm^2 % Loss = 44.5 / 1250 = 3.56%	6M	10 mins
5	P = 1000 * 2000 = 2x10^6 N I = bd^3/12 = 300*350^3/12 = 1.07x10^9 mm^4 LL = 20 kN/m DL = 0.3*0.35*24 = 2.52 kN/m W_{DL+LL} = 22.52 kN/m Deflection due to prestress, a_p = -(5PeL^2) / (48EI) a_p = - (5*2x10^6*100*8000^2) / (48*35*1000*1.07 x 10^9) a_p = - 35.60 mm (upwards) Deflection due to self-weight and LL, a_{dl+LL} = (5W_{DL+LL} L^4) / (384EI) a_{dl+ll} = (5*22.52*8000^4) / (384*35*1000*1.07 x 10^9) a_{dl+ll} = 32.07 mm (downwards) Total deflection due to prestress + DL + LL = -35.60 + 32.07 = -3.53 mm	6M	10 mins

Part C (1Q x 12M = 12 Marks)

Q No	Solution	Scheme of Marking	Max. Time for each Question
6	$$f_c = \frac{P}{A} + \frac{Pey}{I}$$ P = 200 kN A = 300*600 = 180000 mm^2 I = $b*d^3/12$ = $300*600^3/12$ = $5.4x10^9$ mm^4 Stress in the cable = P/A_s = 200 * 1000/ 500 = 400 N/mm^2 $$f_c = \frac{200*1000}{180000} + \frac{200*1000*150*150}{5.4x10^9}$$ f_c = 1.11 + 0.83 f_c = 1.94 N/mm^2 Loss due to elastic deformation = 6*1.94 = 11.64 N/mm^2 Loss due to creep of concrete = 2*6*1.94 = 23.28 N/mm^2 Loss due to relaxation of steel = (4/100) * 400 = 16 N/mm^2 Loss due to shrinkage = 0.0002 * $210x10^3$ = 42 N/mm^2 Loss due to anchorage slip = 3*210 $x10^3$/ 10000 = 63 N/mm^2 Total Loss = 155.92 N/mm^2 % Loss = (155.92 / 400) * 100 = 39%	12M	15 mins

Roll No												

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019 - 20 | **Date**: 20 December 2019

Course Code: CIV 307 | **Time**: 9:30 AM to 12:30 PM

Course Name: ELEMENTS OF PRESTRESSED CONCRETE STRUCTURES | **Max Marks**: 80

Program & Sem: B.Tech (CIV), VII (DE-III) | **Weightage**: 40%

Instructions:

(i) Read questions carefully and answer accordingly.
(ii) Scientific and Non-programmable calculator permitted

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 4 marks. (5Qx4M=20M)

1. Differentiate between Full Prestressing and Limited Prestressing? (C.O.No.1) [Knowledge]
2. Strain compatibility method is a rigorous method of estimating the flexural strength of prestressed concrete section. List the assumptions of strain compatibility method. (C.O.No.2) [Knowledge]
3. Explain types of shear cracks with sketch. (C.O.No.3) [Knowledge]
4. What is end-zone reinforcement? (C.O.No.4) [Knowledge]
5. Bond between prestressing cable and surrounding concrete influences the transmission length of the pretensioned member. Explain Bond Stresses in pre-tensioned beams with a neat sketch? (C.O.No.4) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries 10 marks. (3Qx10M=30M)

6. A prestressed concrete beam of 12 m span and rectangular cross-section, 150 mm wide and 300 mm deep, is axially prestressed by a straight cable carrying an effective force of 200 kN. The maximum shear force on the beam is 42 kN. Compare the magnitude of principal tensile stress developed in the beam with and without axial prestress. (C.O.No.3) [Comprehension]

$$f_{max,min} = \left[\frac{f_x + f_y}{2} \pm \frac{1}{2}\sqrt{(f_x - f_y)^2 + 4\zeta_v{}^2}\right]$$

7. A prestressed girder of rectangular section 100 mm x 200 mm deep, is to be designed to support an ultimate shear force of 90 kN. The uniform prestress across section is 5 N/mm^2. Given the characteristic cube strength of concrete as 40 N/mm^2 and Fe-415 HYSD bars of 8mm diameter, design suitable spacing for the stirrups conforming to the Indian standard code IS: 1343 recommendations. Assume cover to the reinforcement as 50 mm. (C.O.No.3) [Application]

8. A pre-tensioned beam, 200 mm wide and 400 mm deep is prestressed by seven wire 12 mm diameter strands at an effective eccentricity of 100 mm. The effective stress in the strands is 1200 N/mm^2. The cube strength of concrete at transfer is 40 N/mm^2. Estimate the transmission length and average bond stress for strands per IS 1343 codal provisions. (C.O.No.4) [Comprehension]

Part C [Problem Solving Questions]

Answer all the Questions. Each Question carries 10 marks. (3Qx10M=30M)

9. A prestressed beam of rectangular section, 200 mm wide and 400 mm deep is pre-tensioned by eight high-tensile wires of 7mm diameter located at an eccentricity of 100 mm. The maximum shear force is 175 kN. If the modular ratio is 6, compute the bond stress developed assuming - (a) The section is uncracked; (b) The section is cracked. Take z = 7/8th of effective depth. [$\zeta_b = Vy\alpha A_s / \Sigma uI$; $\zeta_b = Vy\alpha\Phi / 4I$, $\zeta_b = V/(z^*\Sigma u)$] (C.O.No.4) [Comprehension]

10. A pre-tensioned beam of 10 m span has a symmetrical I section. The flanges are 200 mm wide and 60 mm thick. The web thickness is 80 mm and the overall depth of girder is 400 mm. The member is prestressed by 8 wires of 5 mm diameter located on the tension side such that the effective eccentricity is 100 mm. The initial stress in the wires is 1200 N/mm^2 and the cube strength of concrete at transfer is 40 N/mm^2. Section properties are as follows: A = 45000 mm^2, I = 7.5×10^8 mm^4, Z = 4.5×10^6 mm^3.
    (a) Determine the maximum vertical tensile stress developed in the transfer zone.
    (b) Design suitable mild steel reinforcement using 6 mm diameter stirrups. Take the permissible stress in steel as 125 N/mm^2. [$f_{v(max)} = 10M / (b_w h L_t)$ and $A_{sv} = 2.5M/(f_s h)$] (C.O.No.4) [Comprehension]

11. The end block of a prestressed concrete girder is 200mm wide and 200 mm deep. The beam is post-tensioned by two freyssinet anchorages each of 100 mm diameter with their centers located at 75 mm from the top and bottom of the beam. The force transmitted by each anchorage is 2000 kN. Compute the bursting force and design suitable anchorage reinforcement per IS 1343 codal provisions, using 10mm diameter mild steel rebar with 260 N/mm^2 yield stress. (C.O.No.4) [Comprehension]

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	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Level	Thought provoking type [Marks allotted] Bloom's Level	Problem Solving type [Marks allotted] Bloom's Level	Total Marks
			K	C	A	
1	CO1	Module 1	4			4
2	CO2	Module 2	4			4
3	CO3	Module 2		4		4
4	CO4	Module 3	4			4
5	CO4	Module 3		4		4
6	CO3	Module 2		10		10
7	CO3	Module 2			10	10
8	CO4	Module 3		10		10
9	CO4	Module 3		10		10
10	CO4	Module 3		10		10
11	CO4	Module 3		10		10
	Total Marks		12	58	10	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 Comment:

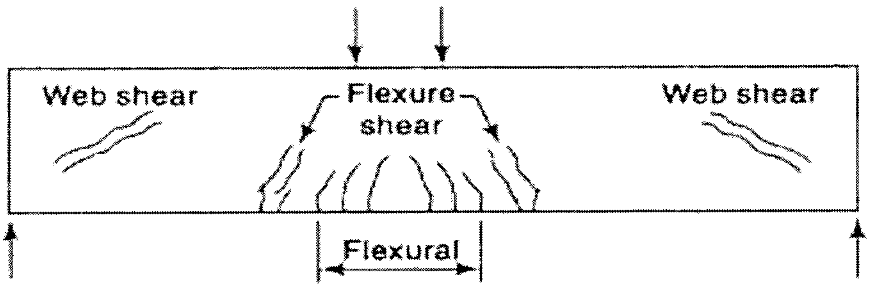
SCHOOL OF ENGINEERING

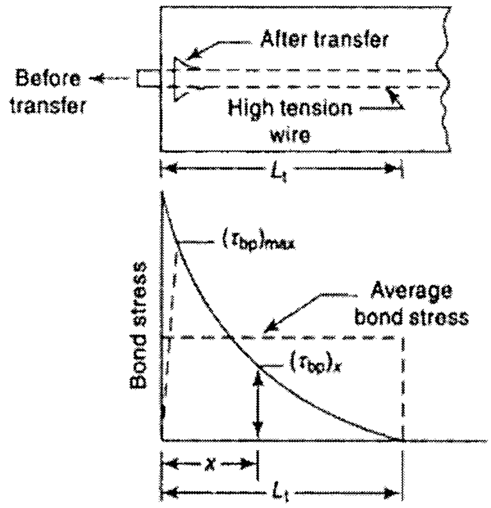
SOLUTION

Semester: Odd Sem. 2019-20
Course Code: CIV 307
Course Name: Elements of Prestressed Concrete Structures
Program & Sem: B.Tech (Civil), VII, DE

Date: 20.12.2019
Time: 9:30 AM to 12:30 PM
Max Marks: 80
Weightage: 40%

Part A (5Q x 4M = 20Marks)

Q No	Solution	Scheme of Marking	Max. Time required for ear Question
1	Full Prestressing - Prestressed concrete in which tensile stresses in the concrete are entirely obviated at working loads by having sufficiently high prestress in the members. Limited prestressing – Also called partial prestressing. The degree of prestress applied to concrete in which the tensile stressed to a limited degree are permitted in concrete under working loads. Used for crack control.	4M	6 min
2	Assumptions of Strain Compatibility Method 1. Stress distribution in the compression zone of concrete can be defined as coefficients applied to the compressive strength and avg. compressive stress. 2. Plane section remains plane even after bending 3. The resistance of concrete in tension is neglected 4. The max compressive strain in concrete at failure reaches a particular value.	4M	6 min
3	Type of shear cracks 1. Web-shear crack 2. Flexure-shear crack  Web-shear cracks generally start from an interior point, when the local principal tensile stress exceeds the tensile strength of concrete. Web-shear cracks are likely to develop in highly prestressed beams with thin webs,	4M	10 min

	particularly when the beam is subjected to large concentrated loads near a simple support. Flexure-shear cracks develop when combined shear and flexural tensile stresses produce a principal tensile stress exceeding tensile strength of concrete. In members without shear reinforcement, the inclined shear cracks extend to the compression face resulting in sudden explosive failures. This is also referred as the diagonal tensile mode of failure.		
4	<u>End Zone reinforcement</u> In the transfer zone of pretensioned beams, transverse reinforcements are necessary to prevent the failure of end zones due to the cracking of concrete as a consequence of large transverse tensile stresses, which often exceed the tensile strength of concrete. For purposes of design of end reinforcement, a linear variation of tensile stress over half the transmission length has been assumed to compute the splitting tensile force. Reinforcement is provided in the form of closed stirrups enclosing all the tendons. Wherever single-leg stirrups are used, care should be taken to anchor the stirrups to the bottom and top tendons with cross-pieces. The first stirrup should be placed as close to the end face as possible with due regard to the min. cover requirements. About half of the total reinforcement is preferable located within a length equal to one-third of the transmission length from the end, the rest being distributed in the remaining distance.	4M	6 min
5	<u>Bond Stresses in Pre-tensioned beams</u> Magnitude of bond stress developed between concrete and steel and its variation in the transfer zone is fig. Bond stress is 0 at ends but builds up rapidly to max over a very short length. It decreases as the stress in wire builds up. At a distance equal to transmission length, bond stress is 0, while stress in concrete and steel reaches their max.  **Fig. 9.2** *Based Strees in Pretensioned Beams*	4M	10 min

Part B (3Q x 10M = 30 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
6	$$f_{max,min} = \left[\frac{f_x + f_y}{2} \pm \frac{1}{2}\sqrt{(f_x - f_y)^2 + 4\zeta_v{}^2}\right]$$ A = 150*300 = 45000 mm^2 I = 150*300^3/12 = 337.5x10^6 mm^4	10M	20 min

	V = 42 kN Max. shear stress at support, ζ_v = 3V/2bh = (3*42000) / (2*150*300) = 1.4 N/mm^2 Principal stresses = ± 0.5*sqrt($4\zeta_v^2$) = ± 0.5*sqrt($4 * 1.4^2$) = $\pm$1.4 N/mm^2 Axial prestress = 200*1000 / 45000 = 4.44 N/mm^2 Max and Min principal stress = $f_{max,min} = \left[\frac{4.44}{2} \pm \frac{1}{2}\sqrt{4.44^2 + 4 * 1.4^2}\right]$ f_{max} = 4.84 N/mm^2 (Compression) and f_{min} = -0.43 N/mm^2 (tension) Hence with axial prestress, the principal tension is reduced by, (1.4 - 0.43/ 1.4)*100 = 69.3%		
7	f_t = 0.24*sqrt(f_{ck}) = 0.24*sqrt(40) = 1.52 N/mm^2 V_c = Vco = $0.67bD\sqrt{{f_t}^2 + 0.8 f_{cp} f_t}$ V_c = Vco = $0.67*100*200\sqrt{1.52^2 + (0.8 * 5 * 1.52)}$ V_c = 38814.7 N or 38.81 kN $V > V_c$ So, S_v = (A_{sv}*0.87*f_y*d) / (V-V_c) Using 8mm diameter two-legged stirrups, the spacing of the stirrups is: S_v = (2*50.26*0.87*415*150) / (90000-38814.7) = 106.35 mm Maximum permissible spacing = 0.75d = 0.75*150 = 112.5 mm Also V > 1.8V_c (70kN), So maximum permissible spacing to be reduced to = 0.5d = 0.50*150 = 75 mm Adopt 8mm diameter two-legged stirrups at 75 mm c/c	10M	20 min
8	Transmission length = 30*Φ = 30*12 = 360 mm $\zeta_{bp(avg)}$ = 1200*π*12^2/4 / (π*12*360) = 10 N/mm^2	10M	10 min

Part C (3Q x 10M = 30Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
9	<u>Section uncracked</u> Bond Stress, $\zeta_b = V y \alpha_c \Phi / 4I$ I = 200*400^3/12 = 1066.67x10^6 mm^4	10M	20 min

	ζ_b = (175000*100*6*7) / (4*1066.67x10^6) = 0.173 N/mm^2 <u>Section cracked</u> ζ_b = V/(z*Σu) = 175000 / (262.5*175.93) = 3.79 N/mm^2 z = (7/8)*300 = 262.5 mm Σu = n*π*d = 8*π*7 = 175.93 mm		
10	Total prestressing force, P = (1200*8*π*5^2/4 = 188.495.5 kN Stress at the bottom fiber = P/A + Pe/Z = (188.495*1000/45000) + (188.495*1000*100/4.5x10^6) = 8.4 N/mm^2 Stress at the top fiber = P/A - Pe/Z = (188.495*1000/45000) - (188.495*1000*100/4.5x10^6) = 0 N/mm^2 M = [(200*60*0.63*170) + (140*80*2.73*70)] = 3.4255x10^6 N-mm L_t = 100*Φ = 100*5 = 500 mm (for wires) Maximum vertical tensile stress near the end face = (10M)/($b_w h L_t$) f_v = (10*3.4255x10^6) / (80*400*500) = 2.14 N/mm^2 Area of vertical reinforcement, A_{sv} = (2.5M) / (f_sh) = (2.5*3.4255x10^6) / (100*400) A_{sv} = 214.1 mm^2 Provide 4 bars of 6 mm diameter stirrups (two-legged) in the transfer zone.	10M	20 min
11	P_k = 2000 kN Equivalent side of a square, y_{po} = √(π*100^2/4) = 89 mm y_o = 150 mm Bursting tensile force, F_{bst} = P_k*[0.32-0.3(y_{po}/ y_o)] F_{bst} = 2000*[0.32-0.3(89/150)] = 286 kN Using 10mm dia bars, No of bars = (286*1000) / (0.87*260*79) = 16 So, provide 16 bars of 10mm diameter and f_y = 260 N/mm^2	10M	15 min