Bapatla Engineering College

Department of Civil Engineering

Scheme for Evaluation

IV/IV B.Tech (Regular/Supplementary) Degree Examination

November, 2022

Name of the Subject : Prestressed Concrete

Subject Code : 18CED31

Signature of the H.O.D

Prepared by:

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IV/IV B.Tech (Regular/Supplementary) DEGREE EXAMINATION

November, 2022 **Civil Engineering**

Seventh Semester **Prestressed Concrete**

Time: Three Hours **Maximum:** 50 Marks

Answer Question No.1 compulsorily. (10X1 = 10 Marks)

Answer ONE question from each unit. (4X10=40 Marks)

1.	a) List the various strength requirements of steel used for prestressing systems.	CO1	L1	1M
	b) What are tendons? How are they used in prestressing systems?	CO1	L2	1M
	c) What is pressure or thrust line?	CO1	L3	1M
	d) How do you compute loss of stress due to shrinkage of concrete as per IS 1343: 2012?	CO2	L2	1M
	e) Define is anchorage slip?	CO2	L4	1M
	f) What are the factors that influence the deflections of prestressed concrete members?	CO2	L4	1M
	g) What do you mean by failure of under reinforced sections?	CO3	L2	1M
	h) Define effective reinforcement ratio?	CO3	L3	1M
	i) How do you compute bond stress between hose and concrete?	CO4	L2	1M
	j) How do you compute bursting tension in accordance with IS: 1343: 2012?	CO4	L1	1M

Unit -I

2.	What is the need of high strength and concrete in prestressing? Explain their advantages.	CO1	L1	10M

(OR)

3.	A rectangular concrete beam, 100 mm wide by 250 mm deep, spanning over 8 m is prestressed by a straight cable carrying an effective prestressing force of 200 kN located at an eccentricity of 40 mm. The beam supports a live load of 1.2 kN/m. (a) Calculate the resultant stress distribution for the central cross section of the beam. The density of concrete is 24 kN/m^2. (b) Find the magnitude of the prestressing force with an eccentricity of 40 mm which can balance the stresses due to dead and live loads at the bottom fibre of the central section of the beam.	CO1	L2	10M

Unit -II

4.	Explain the various types of loss of prestress in pretensioned and post-tensioned members.	CO2	L2	10M

(OR)

5.	The deck of a prestressed concrete culvert is made up of a slab 500 mm thick. The slab is spanning over 10.4 m and supports a total uniformly distributed load comprising the dead and live loads of 23.5 kN/m^2. The modulus of elasticity of concrete is 38 kN/mm^2. The concrete slab is prestressed by straight cables each containing 12 high tensile wires of 7 mm diameter stressed to 1200 N/mm^2 at a constant eccentricity of 195 mm. The cables are spaced at 328 mm intervals in the transverse direction. Estimate the instantaneous deflection of the slab at centre of span under prestress and the imposed loads.	CO2	L3	10M

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Unit -III

6.	A pretensioned, T-section has a flange 1200 mm wide and 150 mm thick. The width and depth of the rib are 300 and 1500 mm respectively. The high tensile steel has an area of 4700 mm^2 and is located at an effective depth of 1600 mm. If the characteristic cube strength of the concrete and the tensile strength of steel are 40 and 1600 N/mm^2, calculate the flexural strength of the T-section.	CO3	L4	10M

(OR)

7.	A prestressed girder of rectangular section 150 mm wide and 300 mm deep, is to be designed to support an ultimate shear force of 130 kN. The uniform prestress across the section is 5 N/mm^2. Given the characteristic cube strength of concrete as 40 N/mm^2 and Fe-415 HYSD bars of 8 mm diameter, design suitable spacing for the stirrups conforming to the Indian standard code IS: 1343 recommendations. Assume cover to the reinforcement as 50 mm.	CO3	L2	10M

Unit -IV

8.	A pretensioned beam, 160 mm wide by 320 mm deep, is prestressed by four plain wires of 7 mm diameter at an eccentricity of 100 mm. If the cube strength of concrete at transfer is 40 N/mm^2, estimate the transmission length at the ends of the pretensioned units using IS: 1343 code provisions.	CO4	L1	10M

(OR)

9.	The end block of a post-tensioned beam is 80 mm wide and 160 mm deep. A prestressing wire, 7 mm in diameter, stressed to 1200 N/mm^2 has to be anchored against the end block at the centre. The anchorage plate is 50 mm by 50 mm. The wire bears on the plate through a female cone of 20 mm diameter. Given the permissible stress in concrete at transfer, f_{ct}, as 20 N/mm^2 and the permissible shear in steel as 94.5 N/mm^2, determine the thickness of the anchorage plate.	CO4	L3	10M

(Page No: iv)

1.

(a) (i) Characteristic tensile strength (minimum) : 980 N/mm²

(ii) Proof stress : Not less than that 80 percent of the minimum specified tensile strength

(iii) Elongation at rupture on a gauge length of 5.65A (minimum) : 10 percent
A is area of c/s.

(b) Tendons are the stretched elements used in a concrete member of structure to import prestress to the concrete. Generally, high-tensile steel wires, bars cables or strands are used as tendons.

(c) The locus of the points of application of this resultant force in any structure is termed as the 'pressure or thrust line'.

(d) As per Cl. 6.2.4.

$$\varepsilon_{cs} = \varepsilon_{cd} + \varepsilon_{ca}$$

Loss of stress = $\varepsilon_{cs} \times E_s$

ε_{cs} = total shrinkage strain ; ε_{ca} = autogenous shrinkage strain.

E_s = modulus of elasticity of steel; ε_{cd} = drying shrinkage strain.

(e) In post-tensioned members, when the prestress is transferred to the concrete, the wedges slip through a little distance before they get properly seated in the conical space i.e, said to be anchorage slip.

(f.) ① Imposed load and self-weight ② Cable Profile
③ Magnitude of the prestressing force ④ span of the member
etc...

(g.) The member approaches failure due to the gradual reduction of the compression zone, exhibiting large deflections and cracks, which develop at the soffit and progress towards the compression face.

(h.) Effective reinforcement ratio $= \frac{A_p f_p}{b d f_{ck}}$

A_p = area of prestressing tendons; b = width of member
f_p = characteristic tensile strength of the prestressing steel.
d = effective depth; f_{ck} = characteristic strength of concrete.

(i) Bond stress $\tau_b = \frac{\alpha_e A_s y V}{I \Sigma u}$

α_e = modular ratio; A_s = area of steel;
y = distance of the tendon from the centroidal axis;
V = shear force; I = second moment of area of the section;
Σu = total perimeter of the tendons.

(j) According to IS 1343 : 2012 Cl. No: 19.6.

Bursting tension force $F_{bst} = P_0\left[0.32 - 0.3\frac{y_{po}}{y_o}\right]$

P_0 = load in the tendon assessed
y_{po} = side of loaded area
y_o = side of end block.

- P.T.O -

(2)

Necessity of using high-strength steel and concrete –

Need of high strength steel –

✓ The normal loss of stress in steel is generally about 100 to 240 N/mm^2 and it is apparent that if this loss of stress is to be a small portion of the initial stress, the stress in steel in the initial stages must be very high, about 1200 to 2000 N/mm^2. These high stress ranges are possible only with the use of high-strength steel.

Advantages of using high strength steel –

✓ Here with the reduced dead-weight of the material, longer spans become technically and economically practicable.

Need of using high strength concrete –

✓ High-strength concrete is necessary in prestressed concrete, as the material offers high resistance in tension, shear, bond and bearing. In the zone of anchorages, the bearing stresses being higher, high-strength concrete is invariably preferred to minimise costs.

Advantages of using high strength concrete –

✓ High strength concrete is less liable to shrinkage cracks, and has a higher modulus of elasticity and smaller ⇒

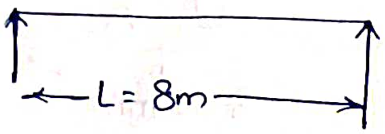
P.T.O

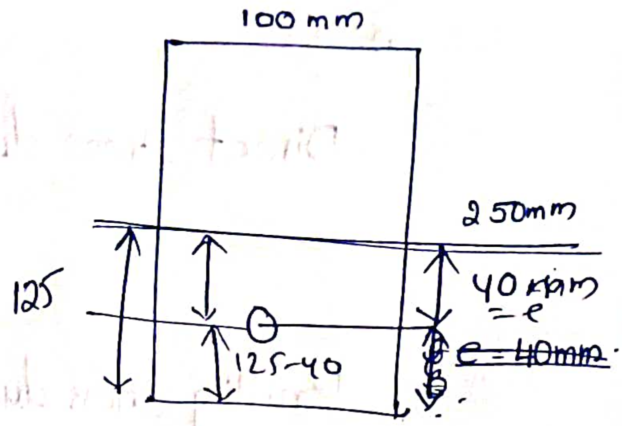
loss of prestress in steel.

✓ The use of high-strength concrete results in a reduction in the cross-sectional dimensions of prestressed concrete structural elements.

③

Given data





b = 100 mm.

D = 250 mm = d

e = 40 mm

q = 1.2 kN/m.

density of concrete = 24 kN/m²

∴ Dead load g = 24 × 0.10 × 0.25

= 0.6 kN/m.

Here $I = \frac{bd^3}{12} = 13 \times 10^7 \text{ mm}^4$

$Z_b = Z_t = \frac{I}{y_t \text{ or } y_b} = \frac{13 \times 10^7}{125}$

$= 1.04 \times 10^6 \text{ mm}^3$

$M_g = \frac{wL^2}{8} = \frac{gL^2}{8} = \frac{0.6 \times 8^2}{8}$

$= 4.8 \text{ kNm}$

$M_q = \frac{qL^2}{8} = \frac{1.2 \times 8^2}{8}$

$= 9.6 \text{ kNm}.$

P.T.O

(a)

Direct stress due to bending $= \frac{P}{A}$

$= 8\ N/mm^2$

Bending stress due to prestress $= \frac{Pe}{Z_t\ or\ Z_b} = 7.69\ N/mm^2$

Self weight stress $\frac{M_g}{Z} = \frac{4.8\times10^6}{1.04\times10^6} = 4.615\ N/mm^2$

Live load stress $\frac{M_q}{Z} = \frac{9.6\times10^6}{1.04\times10^6} = 9.23\ N/mm^2$

∴ Resultant stress at the top of the section

$f_{top} = \frac{P}{A} - \frac{Pe}{Z_t} + \frac{M_g}{Z_t} + \frac{M_q}{Z_t} = 14.155\ N/mm^2$

∴ Resultant stress at the bottom of the section

$f_{inf} = \frac{P}{A} + \frac{Pe}{Z_b} - \frac{M_g}{Z_b} - \frac{M_q}{Z_b} = 1.845\ N/mm^2$

(b) Condition is $f_{inf} = 0$ then $P = ?$

$\frac{P}{A} + \frac{Pe}{Z_b} = \frac{M_g}{Z_b} + \frac{M_q}{Z_b}$

4×10^{-5}

3.846×10^{5}

$P\left[\frac{1}{A} + \frac{e}{Z_b}\right] = 13.845$

$P = \frac{13.845\times10^5}{7.846} = 176.45\ kN$

P.T.O

(4)

Types of loss of prestress in pretensioned members-

1. Elastic deformation of concrete
2. Relaxation of stress in steel
3. Shrinkage of concrete
4. Creep of concrete.

Explaining any two type of loses can carries 5 marks (2½ marks each)

Types of loss of prestress in post-tensioned members-

1. (a) No loss if simultaneously tensioned due to elastic deformation.
   (b) Loss due to elastic deformation if successively tensioned.
2. Relaxation of stress in steel
3. Shrinkage of concrete
4. Creep of concrete
5. Friction
6. Anchorage slip

Explaining any two type of loses can carries 5marks (2½ marks each)

(5)

Consider the 1m width of the cable, the properties of the c/s are compared

→ Thickness of slab d = 500 mm

Width of slab b = 1000 mm

Length of slab L = 10.4 m

∴ Moment of inertia $I = \frac{bd^3}{12} = \frac{1000 \times 500^3}{12}$

$= 1.041 \times 10^{10} mm^4$

→ Force in each cable $= \frac{12 \times 38.5 \times 1200}{1000}$

$= 554.18 kN$

Spacing of cables in the transverse direction = 328 mm

∴ Hence prestressing force per metre width of slab is computed as

$P = \frac{554.18 \times 1000}{328} = 1689.6 kN$

Eccentricity $e = 195 mm$

P.T.O

∴ Total UDL on the beam = 23.5 kN/m

(1m width considered)

$w = 0.0235$ kN/mm

∴ Deflection due to prestressing force is given by

$$= \frac{-PeL^2}{8EI}$$

$$= \frac{1689.6 \times 195 \times (10.4 \times 1000)^2}{8 \times 38 \times 1.041 \times 10^{10}}$$

$= -11.26$ mm (Upwards)

Deflection due to live loads $= \frac{5wL^4}{384EI}$

$$= \frac{5 \times 0.0235 \times (10.4 \times 1000)^4}{384 \times 38 \times 1.041 \times 10^{10}}$$

$= 9.049$ mm (downwards)

∴ Resultant Deflection $= 9.049 - 11.26$

$= -2.2$ mm (upwards)

P.T.O

(6) Given data

$A_p = 4700 mm^2$

$f_{ck} = 40 N/mm^2$

$b = 1200 mm$

$b_w = 300 mm$

$d = 1600 mm$

$D_f = 150 mm$

$A_p = A_{pw} + A_{pf}$

$A_{pf} = 0.45 f_{ck} (b - b_w) \left[\frac{D_f}{f_p}\right]$

$= 0.45 \times 40 (1200-300) \left(\frac{150}{1600}\right)$

$= 1518 mm^2$

$A_{pw} = 4700 - 1518 = 3182 mm^2$

Also $\frac{A_{pw} f_p}{b_w d f_{ck}} = \left[\frac{3182 \times 1600}{300 \times 1600 \times 40}\right]$

$= 0.265$

From table No: 11 IS 1343

$\frac{f_{pu}}{0.87 f_p} = 1.00 \Rightarrow f_{pu} = 1392 N/mm^2$

P.T.O

$$\frac{x_u}{d} = 0.56$$

$$\Rightarrow \quad x_u = 896\ mm$$

$$M_u = f_{pu} A_{pw} (d - 0.42 x_u) + 0.45 f_{ck} (b - b_w) D_f (d - 0.5 D_f)$$

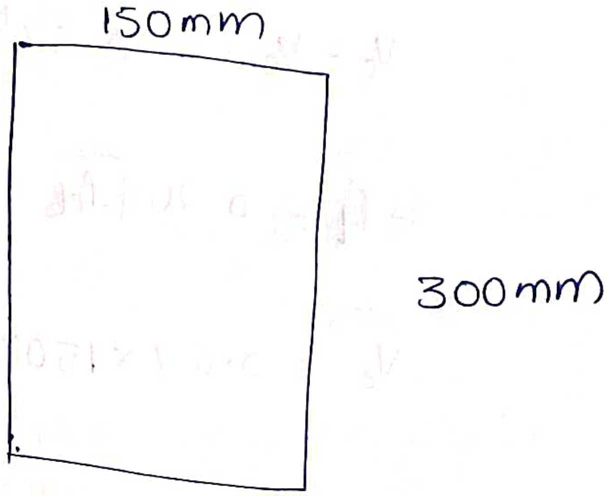
$$= 1392 \times 3182 (1600 - 0.42 \times 896)$$

$$+ 0.45 \times 40 \times 900 \times 150 (1600 - 75)$$

$$\boxed{M_u = 9125\ kNm}$$

(7)

Given data



$b = 150mm$

$D = 300mm$

Ultimate shear force $V = 130 kN$

$f_{cp} = 5 N/mm^2$

$f_{ck} = 40 N/mm^2$

Spacing for stirrups = ?

diameter of the bar $\phi = 8mm$

$f_y = 415 N/mm^2$

cover = 50mm

$\therefore d = (300-50) mm$

$= 250mm$.

P.T.O

∴ For the support section

$V_c = V_{cw} = 0.67 b_w h \sqrt{f_t^2 + 0.8 f_{cp} f_t}$

$f_t = 0.24\sqrt{f_{ck}} = 0.24\sqrt{40} = 1.517 N/mm^2$

$\therefore V_c = 0.67 \times 150 \times 300 \sqrt{1.517^2 + (0.8 \times 5 \times 1.517)}$

2.301 + 6.068

$= 0.67 \times 150 \times 300 \times 2.89$

$= 87.221 kN$

∴ Balance shear $= V - V_c = 130 - 87.22$

$= 42.78 kN$

Adopt using 8mm diameter two-legged stirrups,

the spacing obtained as — $A_{sv} = 2 \times \frac{\pi}{4} \times 8^2 = 100.53 mm^2$

$S_v = \frac{A_{sv} 0.87 f_y d}{V - V_c} = \frac{100.53 \times 0.87 \times 415 \times 250}{42780}$

$= 212.110 mm$

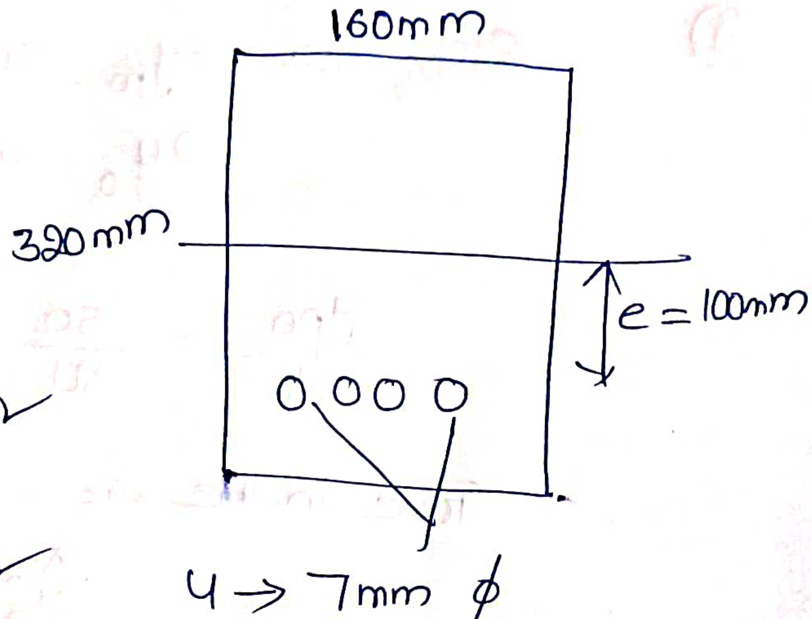
Maximum permissible spacing $= 0.75d = 0.75 \times 250$

$= 187.5 mm.$

∴ Adopt 8mm diameter two legged stirrups at 187.5mm centres.

P.T.O

⑧ Given data



$f_{ck} = 40N/mm^2$

$b = 160mm^2$

$D = 320mm^2$

diameter of the bar ϕ = 7mm

Surface & characteristic feature of the bar is plain wires

From IS1343:2012 for plain and intended wires

Transmission length is given as = 100ϕ

$= 100 \times 7$

$= 700mm$.

P.T.O

(9) Given data: $2y_{po} = 50mm$

$2y_o = 80mm$ (shorter dimension)

$$\frac{y_{po}}{y_o} = \frac{50}{80} = 0.625$$

∴ Force in the wire $= \frac{A_{ps} \times 1200}{1000}$

$\frac{\pi}{4} \times 7^2$

$$= \frac{38.5 \times 1200}{1000}$$

$= 46.2 kN$

∴ Average stress, $f_c = \frac{46.2 \times 10^3}{80 \times 80}$

From IS1343 $= 7.25 N/mm^2$

Permissible bearing pressure

$$= 0.48 f_{ci} \sqrt{\frac{A_{block}}{A_{plate}}}$$

$$= 0.48 \times 20 \sqrt{\frac{80 \times 80}{50 \times 50}}$$

$= 15.36 N/mm^2$

(or) $0.8 f_{ci} = 0.8 \times 20 = 16 N/mm^2$

whichever is smaller.

The actual bearing stress is only $7.25 N/mm^2$

P.T.O

Female cone diameter = 20mm

$\therefore$ Punching circumference $= \pi \times 20$

$= 62.86mm$

If t = thickness of anchorage plate,

$(62.86 \times 94.5 \times t) = 46.2 \times 10^3$

$\therefore$ **t = 7.8 mm**

Hence adopt using an anchorage plate of 8mm thickness.

— THE END —

Scheme of Evaluation is verified by:

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