USN :

CMR Institute of Technology, Bangalore
DEPARTMENT OF CIVIL ENGINEERING
III - INTERNAL ASSESSMENT

Semester: 8-CBCS 2017
Subject: DESIGN OF PRE STRESSED CONCRETE ELEMENTS (17CV82)
Faculty: Ms Sreelakshmi G

Date: 17 Jul 2021
Time: 01:00 PM - 03:40 PM
Max Marks: 50

Instructions to Students :

Answer all the questions

Answer All Questions

Q.No		Marks	CO	PO	BT/CL
1	Explain three ways of improving the shear resistance of structural concrete.	3	CO4	PO4	L1
2	A pre-stressed concrete beam of span 10m, cross-section 120mm x 300mm is prestressed by a cable carrying a force of 180 kN the beam support a UDL 5 kN/m including self-weight compare to the magnitude of principal tension with and without axial pre-stress. Estimate the reduction in principal stress. Also find % reduction if a parabolic cable used with e = 50 mm at mid span and zero at support.	14	CO5	PO4	L3
3	A PSC beam 250mm wide 150mm deep is subjected to Shear Force 900 kN fibre stress under working load is 4 N/mm^2 with effective pre-stress is 1000 N/mm^2 and area of cable is 1500 mm^2. Design shear reinforcement if the slope of cable at support is 1/6.	15	CO5	PO5	L3
4	Explain composite construction in PSC members.	3	CO4	PO10	L1
5	A rectangular pre-tensioned concrete beam of 100 mm x 230 mm and the prestress after all losses occurred is 12 N/mm^2 at the soffit and zero at the top. The beam is incorporated in a composite T beam by casting a top flange of breadth 300 mm and depth 50mm. calculate the max UDL live load that can be supported on a simply supported span of 4.5 m without any tensile stresses occurring. If a) the slab is externally supported while casting b) the pretensioned beam supports the weight of the slab casting.	15	CO5	PO3	L4

PSC

IAT-03

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1CR17CV062
8th 'B'
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1. 1. Horizontal or axial prestressing
2. Prestressing by inclined or sloping cables
3. Vertical or transverse prestressing.

- Axial prestressing reduces the principal stresses considerably when compared with the members without prestressing.
- In addition to axial prestressing, transverse or vertical prestressing is used, it is possible to nullify the principal tension itself.
- In case the cables are placed as per the profile obtained by a load balancing approach it results in the most desirable system of forces in concrete.

2. $A = 120 \times 300 = 36000\ mm^2 = 36 \times 10^3\ mm^2$

$P = 180\ kN$

$w = 5\ kN/m$

$L = 10\ m$

Max. shear stress developed in a rectangular beam,

$$\tau_{vmax} = \frac{3V}{2bh}$$

Max. SF at supports, $V = \frac{wL}{2} = \frac{50 \times 10}{2} = 25\ kN$

Max. shear stress, $\tau_{vmax} = \frac{3 \times 25 \times 10^3}{2 \times 120 \times 300} = 1.042\ N/mm^2$

i) with prestress

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

$$f_x = \frac{180 \times 10^3}{120 \times 300} = 5\ N/mm^2$$

$f_{max,min} = \frac{5}{2} \pm \frac{1}{2}\sqrt{(5^2+4\times 1.042^2)}$

$= 2.5 \pm 2.71$

$f_{max} = 5.21\ N/mm^2$ (comp), $f_{min} = -0.21\ N/mm^2$ (tensile)

Principal tension $= f_{min} = -0.21\ N/mm^2$

(ii) without prestress

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

$f_x = f_y = 0$

$f_{max,min} = 0 \pm \frac{1}{2}\sqrt{0^2+4\times 1.042^2}$

$= \pm 1.042\ N/mm^2$

Principal tension $= f_{min} = -1.042\ N/mm^2$

Since with the actual prestress, principal tension is reduced from $1.042\ N/mm^2$ to $0.21\ N/mm^2$.

$\frac{1.042-0.21}{1.042} \times 100 = 79.85\%$.

4. - In a composite construction, precast prestressed members are used in conjunction with the concrete cast in situ, so that the members behave as monolithic unit under service loads.

- Generally, high-strength prestressed units are used in the tension zone while the concrete, which is cast in situ of relatively lower compressive strength is used in the compression zone of the composite members.

- The composite action b/w the two components is achieved by roughening the surface of the prestressed unit on to which the concrete is cast in situ, thus giving a better frictional resistance.

The phenomenon of differential shrinkage b/w the concrete cast in situ & the prestressed units also contributes to the monolithic action of the composite member.

Advantages:

1. Appreciable saving in the cost of steel in a composite ~~mater~~ member compared with a reinforced or prestressed concrete member.
2. Sizes of precast prestressed units can be reduced due to the effect of composite action.
3. Low ratio of size of the precast unit to that of the whole composite member.
4. Composite members are ideally suited for constructing bridge decks without the distruption of normal traffic.

3. $V = 900\,kN$

$f_{cp} = 4\,N/mm^2$

Prestress $= 1000\,N/mm^2$

$A = 1500\,mm^2$

(a) External S.F

Ultimate SF $= V_u = 1.5 \times 900$

$V_u = 1350\,kN$

(b) Ultimate shear resistance

$V_{co} = 0.67bD\sqrt{f_t^2 + 0.8 f_{cp} f_t} + P\sin\theta$

$f_t = 0.24\sqrt{f_{ck}} = 0.24\sqrt{40} = 1.51\,N/mm^2$

$P = 1000 \times 1500$

$P = 1.5 \times 10^6\,N$

$\sin\theta = \frac{1}{6}$

$V_{co} = 0.67 \times 250 \times 1500 \sqrt{(1.52)^2 + 0.8 \times 4 \times 1.52} + (1.5 \times 10^6 \times \frac{1}{6})$

$V_{co} = 922.36\ kN$

(c) Comparing $V_{co} < V_u$

Provide shear reinforcement

Using 4L 8mm dia. stirrups

$A_{sv} = 4 \times \frac{\pi}{4}(8^2)$

$= 201.06\ mm^2$

$S_v = \frac{A_{sv} \times 0.87 \times f_y \times d_p}{(V_u - V_{co})}$

$= \frac{201.06 \times 0.87 \times 415 \times 1400}{(1350 - 922.36) \times 10^3}$

$= 237.65\ mm$

But min shear, $S_v = \frac{A_{sv} \times 0.87 f_y}{0.4b}$

$= \frac{201.06 \times 0.87 \times 415}{0.4 \times 250}$

$S_v = 725.92\ mm$

Also, max. spacing

$0.75 d_p = 0.75 \times 1400 = 1050\ mm.$

∴ Provide 4L #8mm v.s @ 230mm c/c at supports and 725 mm c/c at midspan.

5. $b = 100mm$

$d = 230\ mm$

$f_p = 12 N/mm^2$

$A = 100 \times 230 = 23000\ mm^2$

$I = \frac{bd^3}{12} = \frac{100 \times 230^2}{12} = 101.39 \times 10^6\ mm^4$

$Z_t = Z_b - I/y = \frac{101.36 \times 10^6}{230/2} = 881.67 \times 10^3\ mm^3$

$y_t = \frac{(300 \times 50 \times 25) + (100 \times 230 \times 165)}{(300 \times 50) + (100 \times 230)} = 109.74\ mm$

$y_s = 280 - 109.74 = 170.26\ mm$

$I = \frac{200 \times 50^3}{12} + (300 \times 50) \times (109.74 - \frac{50}{2})^2 + \frac{100 \times 200^2}{12} + (100 \times 300 \times (170.26 - \frac{230}{2})^2$

$I = 282.46 \times 10^6\ mm^4$

$Z_t = I/y_b = 1.66 \times 10^6\ mm^3$

$Z_t = I/y_t = 2.57 \times 10^6\ mm^3$

Self wt. of cast in situ slab is

$= 0.3 \times 0.05 \times 25 = 0.375\ kN/m$

Moment due to self wt. of slab $= \frac{wl^2}{12} = \frac{0.375 \times 4.8^2}{12} = 0.633\ kN\text{-}m$

(i) Slab is extremely supported

Stress @ bottom of the beam due to self wt. of cast insitu slab

$\frac{M}{Z_b} = \frac{0.633 \times 10^6}{1.66 \times 10^6} = 0.38\ N/mm^2$

Stress at soffit of beam $= 12 N/mm^2$

Net stresses available at bottom $= 12 - 0.38 = 11.62 N/mm^2$

Moment due to UDL @ zero stress at bottom

$M = f \times Z_b = 11.62 \times 1.66 \times 10^6 = 19.28 \times 10^6\ N\text{-}mm$

Live Load $= \frac{19.28 \times 10^6 \times 8}{4500^2} = 7.62\ kN/m$

(ii) The pretensioned beam of beam support the wt. of slab

$$\frac{M}{Z_{precast}} = \frac{0.633 \times 10^6}{881.67 \times 10^3} = 0.718 \text{ N/mm}$$

Net stress available $= 12 - 0.718 = 11.282 \text{ N/mm}^2$