USN		

Internal Assessment Test I – May.2022

Sub	Design of Prestressed concrete			Sub Code:	18CV81/ 17CV82	Branch:	Civil Engg
Date:	14.05.2022	Duration:	90 min's	Max Marks: 50	Sem/Sec:	8th sem /All sections	OBE

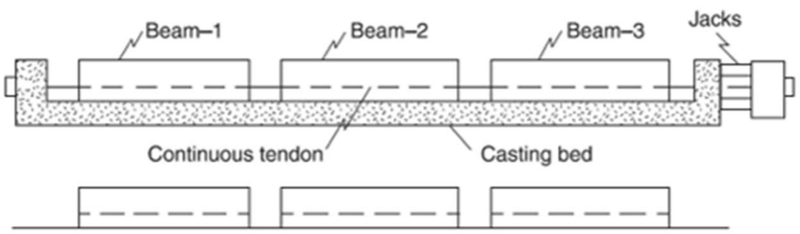
Answer any FIVE FULL Questions

1. Distinguish between pre-tensioning and post tensioning.

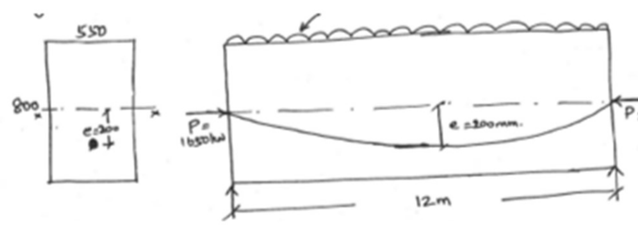
PRE-TENSIONING	POST TENSIONING
Concrete is prestressed with tendon before it is placed in position	Prestressing is done after concrete attains sufficient strength
Pretensioning is developed due to bonding between steel and concrete	Post tensioning is developed due to bearing
Preferred for small structural element and easy to transport	Preferred for large structural element and difficult to transport
Similar structural members are casted	Members are casted according to market requirements
Casted in moulds	Cables are used in place of wires and jacks for stretching
Greater certainty about the prestressing force	More economical to use a few cables or bars with large forces in than many small ones
Suitable for bulk production	Suited for medium to long-span in situ work where the tensioning cost is only a small proportion of the cost of the whole job

2. Explain with neat sketch "Hoyers" long line system of pre-tensioning.

- **Hoyer system**
  - ✓ Hoyer system or long line method is often adopted in pre-tensioning.
  - ✓ Two bulk heads or abutments independently anchored to the ground are provided several meters apart, say, 100m. wires are stretched between the bulkheads.
  - ✓ Moulds are placed enclosing the wires.
  - ✓ Concrete is placed surrounding the wires.
  - ✓ With this Hoyer system, several members can be produced along one line.
  - ✓ This method is economical and is used in almost all pre-tensioning factories.
  - ✓ For tensioning, a hydraulic jack is used.
  - ✓ Wires are gripped at the bulkheads, using split-cone wedges.
  - ✓ These wedges are made from tapered conical pins.
  - ✓ Flat surface of the pin carries serrations to grip the wire.



3. A simply supported beam of span 12m and section 550 mm x 800 mm is prestressed by a parabolic cable having an eccentricity of 200 mm at centre of span and zero at supports with prestressing force of 1650kN. If the beam supports a UDL of 30kN/m. Find the extreme fibre stresses at mid-section.



A = 550 x 800 = 440000mm^2

$Z_t = Z_b = \frac{bD^2}{6}$ = 58.67 x 10^6 mm^3

M_L = 30 x 12^2 /8 = kNm

w_D = 0.8 X 0.55 X 25 = , M_D = kNm

Total Moment $M_L + M_D$ = 738 kNm

Direct stress , $\frac{P}{A}$ = 3.75 N/mm^2

Stress due to dead load = 2.56 N/mm^2

Stress due to eccentric prestressing force = 5.625 N/mm^2

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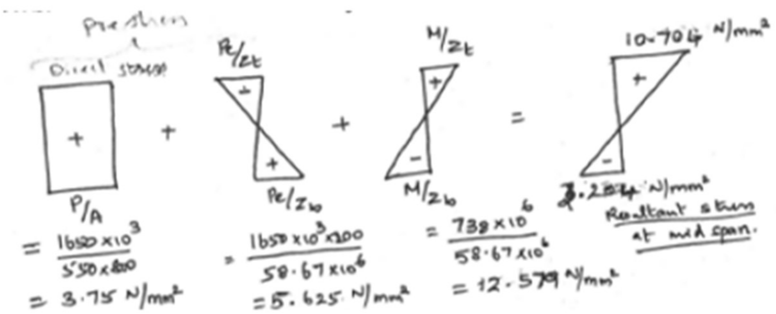
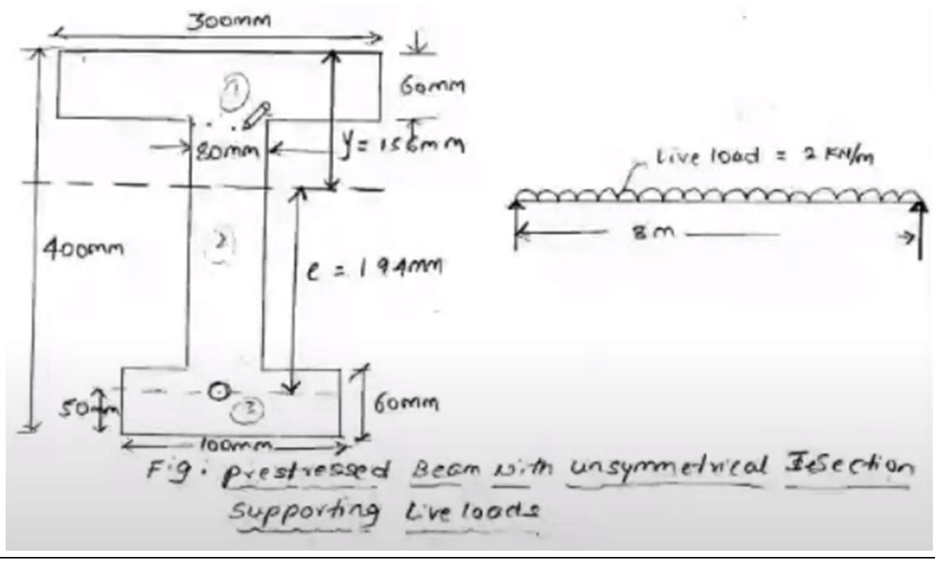


4. An unsymmetrical I section beam is used to support an imposed load of 2kN/m over a span of 8m. The sectional details are top flange 300mm wide and 60mm thick; bottom flange 100mm wide and 60mm thick; thickness of web 80mm; overall depth of the beam = 400mm. At the centre of the span, the effective prestressing force of 100 kN is located at 50mm from the soffit of the beam. Estimate the stresses at the centre of the span section of the beam for the following load conditions:

(a) Prestress + self weight (At transfer)

(b) Prestress + selfweight + Live load (At service)



prestressing force, $P = 100\,kN = 100 \times 10^3\,N$

Area of cross section, $A = (300 \times 60) + (80 \times 280) + (100 \times 60)$

$A = 46400\,mm^2$

Distance of centroid from top $\bar{y} = \dfrac{a_1 y_1 + a_2 y_2 + a_3 y_3}{a_1 + a_2 + a_3}$

$$y_t = \frac{(300 \times 60)(30) + (80 \times 280)\left(\frac{280}{2} + 60\right) + (100 \times 60)\left(\frac{60}{2} \ldots\right)}{(300 \times 60) + (80 \times 280) + (100 \times 60)}$$

$y_t = 156.03\,mm$

eccentricity, $e = 350 - 156.03$

$e = 194\,mm$

Second moment of Area

$$I_{xx} = \left[I_{1xx} + a_1(y_1 - \bar{y})^2\right] + \left[I_{2xx} + a_2(y_2 - y)^2\right] + \left[I_{3xx} + a_3(y_3 - y)^2\right]$$

$$= \left[\frac{300 \times 60^3}{12} + (300 \times 60)(30 - 156)^2\right] + \left[\frac{80 \times 280^3}{12} + (80 \times 280)(200 - 156)^2\right] + \left[\frac{100 \times 60^3}{12} + (100 \times 60)(370 - 156)^2\right]$$

$(291.168 \times 10^6) + (189.713 \times 10^6)$

$I_{xx} = 757.46 \times 10^6\,mm^4$ (276.576×10^6)

Section Modulus $z_t = \dfrac{I}{y_t} = \dfrac{757.46 \times 10^6}{156.03} = 4.854 \times 10^6\,mm^3$

$z_b = \dfrac{I}{y_b} = \dfrac{757.46 \times 10^6}{243.96} = 3.10 \times 10^6\,mm^3$

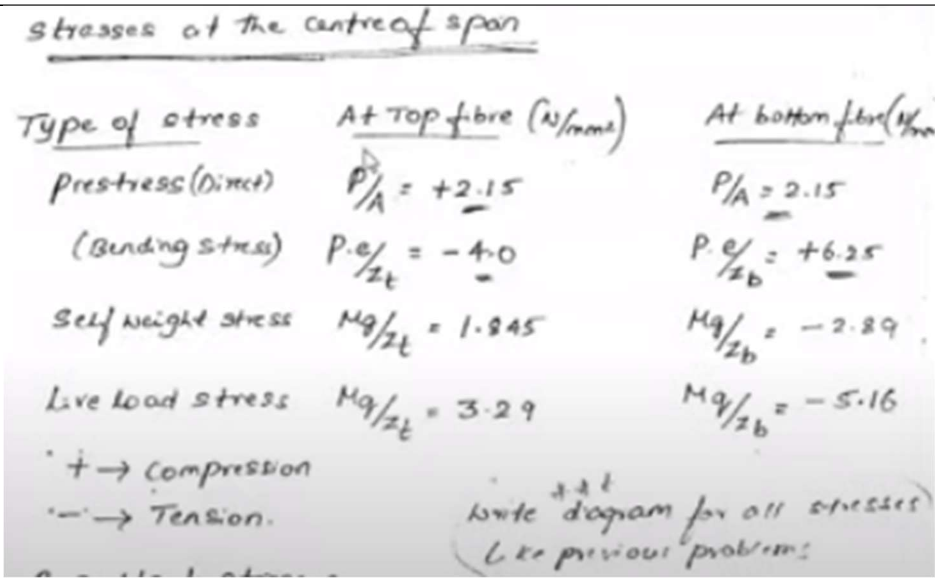
Self weight of beam = C/S Area × Density of concrete

$w_g = \dfrac{46400}{(10^3)^2}$ (or) $0.0464 \times 24 = 1.12\,kN/m$

Dead load (or) self wt moment, $M_g = \dfrac{1.12 \times 8^2}{8} = 8.96\,kNm$

Live load Moment $M_q = \dfrac{2 \times 8^2}{8} = 16\,kNm$

stresses at the centre of span



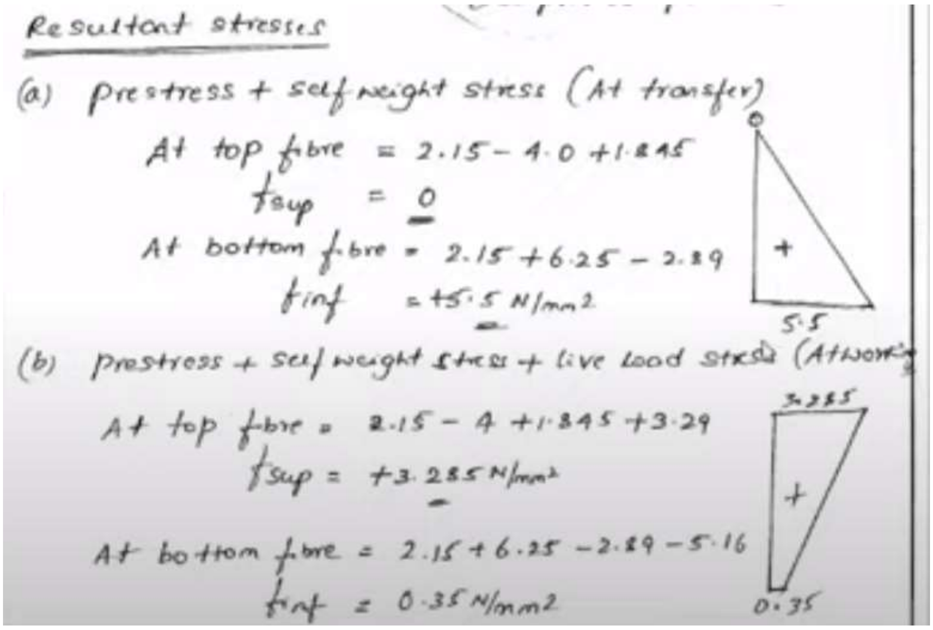
Stresses at the centre of span

Type of stress	At Top fibre (N/mm^2)	At bottom fibre (N/mm^2)
Prestress (Direct)	$P/A = +2.15$	$P/A = 2.15$
(Bending stress)	$P.e/Z_t = -4.0$	$P.e/Z_b = +6.25$
Self weight stress	$M_g/Z_t = 1.845$	$M_g/Z_b = -2.89$
Live load stress	$M_q/Z_t = 3.29$	$M_q/Z_b = -5.16$

'+' → Compression

'−' → Tension.

Write diagram for all stresses like previous problems



Resultant stresses

(a) Prestress + self weight stress (At transfer)

At top fibre $= 2.15 - 4.0 + 1.845$

$f_{sup} = 0$

At bottom fibre $= 2.15 + 6.25 - 2.89$

$f_{inf} = +5.5\ N/mm^2$

(b) Prestress + self weight stress + live load stress (At working)

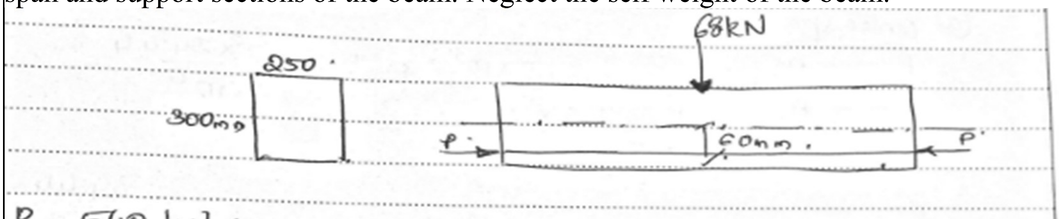
At top fibre $= 2.15 - 4 + 1.845 + 3.29$

$f_{sup} = +3.285\ N/mm^2$

At bottom fibre $= 2.15 + 6.25 - 2.89 - 5.16$

$f_{inf} = 0.35\ N/mm^2$

5 A rectangular concrete beam 250 mm wide by 300mm deep is prestressed by force of 540 kN at a constant eccentricity of 60 mm. The beam supports a concentrated load of 68 KN at the center of a span of 3 m. Determine the location of the pressure line at the center, quarter span and support sections of the beam. Neglect the self weight of the beam.



P = 540 kN

e = 60mm

c/s Area = 250 × 300 = $75 \times 10^3\ mm^2$

Second Moment of Area $I = \frac{250 \times 300^3}{12} = 0.5625 \times 10^9 \, mm^4$

Section Modulus, $Z = 3.75 \times 10^6 \, mm^3 = Z_t = Z_b$.

Stress due to external load

@ the centre of span

$$M = \frac{wL}{4} = \frac{68 \times 3}{4} = 51 \, kN\text{-}m.$$

@ Quarter Span

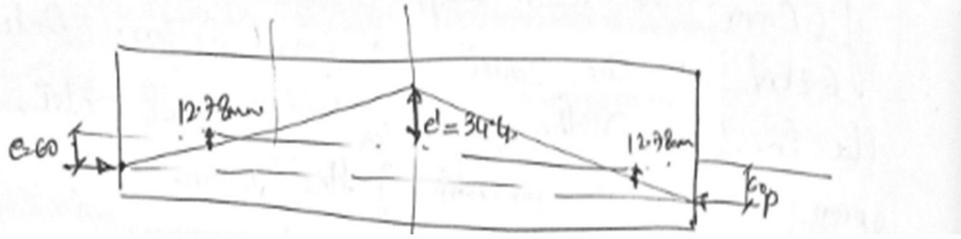
$$M = \frac{wL}{8} = \frac{68 \times 3}{8} = 25.5 \, kN\text{-}m$$

Shift of pressure line in central span

$$e' = \frac{M}{P} - e = \frac{51 \times 10^6}{540 \times 10^3} - 60 = 34.44 \, mm$$

Shift of pressure line at quarter span

$$e' = \frac{M}{P} - e = \frac{25.5 \times 10^6}{540 \times 10^3} - 60 = -12.78$$



@ centre span

$$f_t = \frac{P}{A} + \frac{Pe'}{Z_t} = \frac{540\times10^3}{75\times10^3} + \frac{540\times10^3\times34.44}{3.75\times10^6}$$

$$= 12.15\ N/mm^2$$

$$f_b = \frac{P}{A} - \frac{Pe'}{Z_b} = \frac{540\times10^3}{75\times10^3} - \frac{540\times10^3\times(34}{3.75\times10^6}$$

$$= 7.19\ N/mm^2$$

@ quarter span

$$f_t = \frac{P}{A} + \frac{Pe'}{Z_t} = \frac{540\times10^3}{75\times10^3} + \frac{540\times10^3\times(-12.78)}{3.75\times10^6}$$

$$f_b = \frac{P}{A} - \frac{Pe'}{Z_b} = \frac{540\times10^3}{75\times10^3} - \frac{540\times10^3\times(-12.78}{3.75\times10^6}$$