USN :

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

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

Date: 20 May 2021
Time: 11:00 AM - 12:30 PM
Max Marks: 50

Instructions to Students :

Answer all questions

Answer All Questions

Q.No		Marks	CO	PO	BT/CL
1	Distinguish between pretensioning and post tensioning	10	CO2	PO2	L1
2	Explain with neat sketch "Hoyers" long line system of pre-tensioning	10	CO2	PO2	L1
3	A concrete beam of symmetric I section supports a superimposed load of 3 kN/m over a span of 8 m. It is prestressed by a straight cable carrying a force of 120 kN at an eccentricity of 150 mm at the mid-span section. The bottom and top flanges of 250 mm wide and 80 mm deep. , the thickness of the web is 80 mm and overall depth is 450mm. Determine the resultant stresses at the midspan section for the following cases i) Prestress + Self-weight ii) Prestress + Self-weight + Live load Take density of concrete = 25 kN/m3	10	CO1,CO2	PO2	L3
4	In a prestressed pre-tensioned concrete beam, of cross-section 200 mm x 300 mm depth and a span of 6m, with an initial prestressing force of 400 kN, at an eccentricity of 70 mm by the tendon of area 400 mm2. assume Es = 2 x 10^5 N/mm2 , Ec = 0.33 x 10^5 N/mm2, Creep coefficient = 2 , Total Shrinkage strain of concrete = 0.0002, Relaxa_on of steel = 3% of Initial Prestressing force, Find the percentage loss in prestress.	10	CO2	PO1	L3
5	A pre-tensioned beam, 200 mm wide and 400 mm deep, is prestressed by 10 wires of 7 mm diameter initially stressed to 1500 N/mm2, with their centroids located 100 mm from the soffit. Find the maximum stress in concrete immediately after the transfer, allowing only for elastic shortening of concrete. If the concrete undergoes a further shortening due to creep and shrinkage while there is a relaxation of five per cent of steel stress, estimate the final percentage loss of stress in the wires using the Indian Standard Code IS: 1343 regulations and the following data: Es = 2 x 10^5 N/mm2 Ec = 0.33 x 10^5 N/mm2 Creep coefficient = 1.6 Total Shrinkage strain of concrete = 0.0003	10	CO3	PO2	L3

PSC

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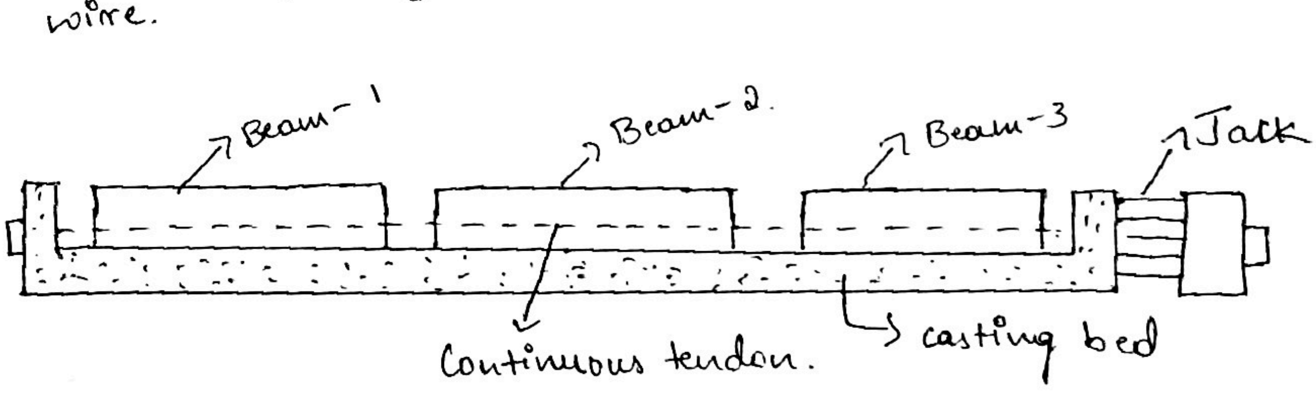
JAMUNA. G. M
1CR17CV021

Q) 1) Ans

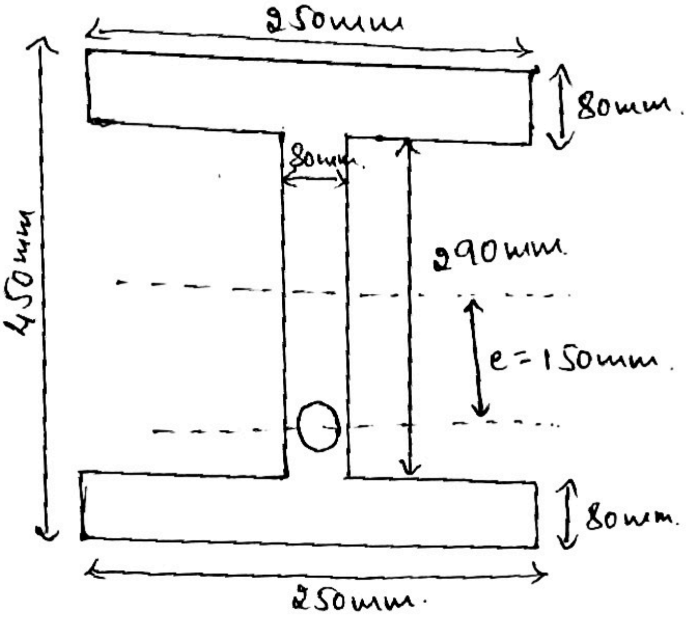
Pretensioning	Post tensioning
1. Concrete is prestressed with tendon before it is placed in position.	1. Prestressing is done after concrete attains sufficient strength
2. Pretensioning is developed due to bonding between steel and concrete	2. Post tensioning is developed due to bearing.
3. Preferred for small structural element and easy to transport	3. Preferred for large structural element & difficult to transport.
4. Similar structural members are casted.	4. Members are casted according to market requirements.
5. Casted in moulds.	5. Cables are used in place of wires and jack for stretching.
6. Greater certainty about the prestressing force	6. More economical to use a few cables or bars with large forces in than many small ones.
7. Suitable for bulk production.	7. 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.

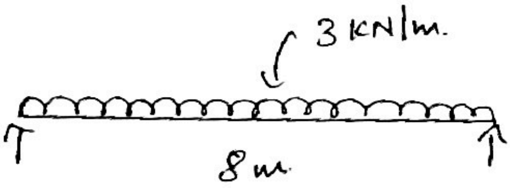
Q) 2) Ans

-> 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 & is used in almost all pre-tensioning factories.
-> For tensioning, a hydraulic jack is used.
-> wires are gripped at the bulk heads, using split-cone wedges.
-> These wedges are made from tapered conical pins.
-> Flat surface of the pin carries serrations to grip the wire.



Q) 3) Ans





Step-1:- Calculation of section modulus

Since it is a symmetrical section.

y, centroid $= \frac{450}{2} = 225$ mm. $= y_t = y_b$.

→ Moment of Inertia, $I_{xx} = \frac{BD^3}{12} - \frac{bd^3}{12}$

$$= \frac{250 \times 450^3}{12} - \frac{170 \times 290^3}{12}$$

$$I_{xx} = 1552.927 \times 10^6 \text{ mm}^4$$

$$Z_t = Z_b = \frac{I_{xx}}{y} = \frac{1552.927 \times 10^6}{225} = 6.902 \times 10^6 \text{ mm}^4.$$

BM @ Midspan due to external load. =

Step-2 :- Moment calculation

Self weight of I section w_d = Area × density of conc.

Area of the I section $= 2 \times (80 \times 250) + (290 \times 80)$

$= 63200 \text{ mm}^2$

$= 0.0632 \text{ m}^2.$

$w_d = 0.0632 \times 25$
$= 1.58 \text{ kN/m}$

Moment due to self weight $M_d = \frac{w_d l^2}{8}$ $\quad L = 8m$ (given)

$= \frac{1.58 \times 8^2}{8}$

$= 12.64 \text{ kNm}$

Moment due to live load, $M_l = \frac{w_l l^2}{8}$ $\quad$ given $w_l = 3 \text{ kN/m}$

$= \frac{3 \times 8^2}{8} = 24 \text{ kNm}$

Step-3 :: Resultant stresses.

case i) Prestress + self weight

at top

$$f_t = \frac{P}{A} - \frac{Pe}{Z_t} + \frac{M_D}{Z_t} \quad e = 150 \text{mm}.$$

$$f_t = \frac{120 \times 10^3}{63200} - \frac{120 \times 10^3 \times 150}{6.902 \times 10^6} + \frac{12.64 \times 10^6}{6.902 \times 10^6}$$

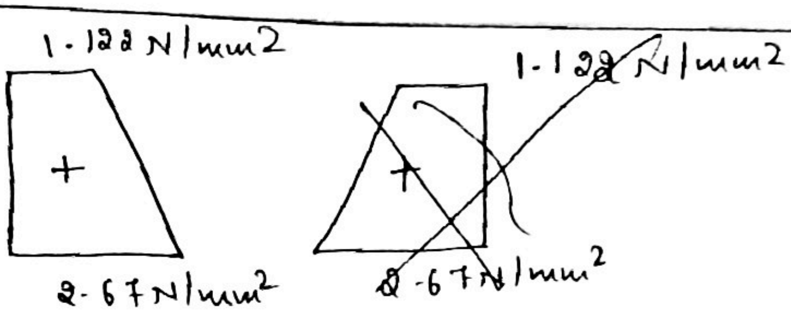
$f_t = 1.122 \text{ N/mm}^2$ (compression)

at bottom

$$f_b = \frac{P}{A} + \frac{Pe}{Z_b} - \frac{M_D}{Z_b}$$

$$f_b = \frac{120 \times 10^3}{63200} + \frac{120 \times 10^3 \times 150}{6.902 \times 10^6} - \frac{12.64 \times 10^6}{6.902 \times 10^6}$$

$f_b = 2.67 \text{ N/mm}^2$ (compression)



case (ii) Prestress + Self weight + Live load

at top

$$f_t = \frac{P}{A} - \frac{Pe}{Z_t} + \frac{M_D}{Z_t} + \frac{M_l}{Z_t}$$

$$= \frac{120\times10^3}{63200} - \frac{120\times10^3\times150}{6.902\times10^3} + \frac{12.64\times10^6}{6.902\times10^6} + \frac{24\times10^6}{6.902\times10^6}$$

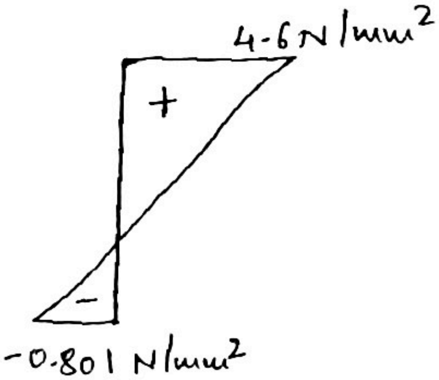
$f_t = 4.6\ N/mm^2$ (compression)

at bottom

$$f_b = \frac{P}{A} + \frac{Pe}{Z_b} - \frac{M_D}{Z_t} - \frac{M_l}{Z_b}$$

$$= \frac{120\times10^3}{63200} + \frac{120\times10^3\times150}{6.902\times10^6} - \frac{12.64\times10^6}{6.902\times10^6} - \frac{24\times10^6}{6.902\times10^6}$$

$f_b = -0.801\ N/mm^2$ (Tension)



Q) 4) Ans:

$A = 200 \times 300\ mm^2 = 6 \times 10^4\ mm^2$

$L = 6m$

$P_i = 400\ KN$

$e = 70mm$

$A_s = 400\ mm^2$

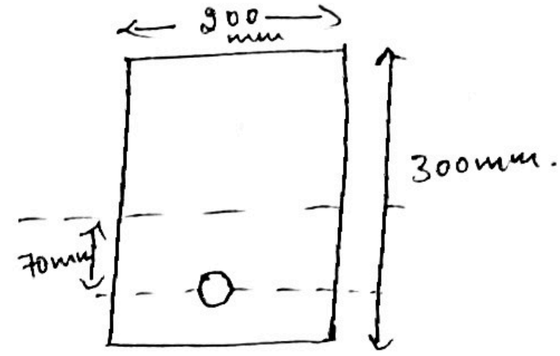
$E_s = 2 \times 10^5\ N/mm^2$

$E_c = 0.33 \times 10^5\ N/mm^2$

$C_c = 2$

$\delta_c = 0.0002$

relaxation of steel = 3% inital stress



initial prestress $= \frac{400 \times 10^3}{400}$

$= 1000\ N/mm^2$

$A = 6 \times 10^4\ mm^2$

$P = 400 \times 10^3\ N$

$I_{xx} = \frac{bd^3}{12} = \frac{200 \times 300^3}{12} = 450 \times 10^6\ mm^4$

$m = \frac{E_s}{E_c} = \frac{2 \times 10^5}{0.33 \times 10^5} = 6.06$

stress in concrete at the level of steel.

$$f_c = \frac{P}{A} + \frac{Pe}{I}y$$

$$= \frac{400 \times 10^3}{6 \times 10^4} + \frac{400 \times 10^3 \times 70^2}{450 \times 10^6}$$

$f_c = 11.02\ N/mm^2$

i) loss due to elastic shortening $= m f_c$

$= 6.06 \times 11.02$

$= 66.78 \ N/mm^2$

ii) loss due to relaxation of steel = 3% of initial stress

$= \frac{3}{100} \times \frac{400 \times 10^3}{400}$

$= 30 \ N/mm^2$

iii) loss due to creep $= C_c m f_c$

$= 2 \times 66.78$

$= 133.56 \ N/mm^2$

iv) Loss due to shrinkage: $\delta_s E_s$

$= 0.0002 \times 2 \times 10^5$

$= 40 \ N/mm^2$

Total loss $= 66.78 + 30 + 133.56 + 40$

$= 270.34 \ N/mm^2$

percentage loss $= \frac{270.34}{1000} \times 100$

$= 27.03\%$

Q) 5) Ans:

Given:-

$E_s = 2 \times 10^5 \, N/mm^2$

$E_c = 0.33 \times 10^5 \, N/mm^2$

$C_c = \phi = 1.6$

Total shrinkage strain of concrete = 0.0003. = δ_s

$A_c = 200 \times 400 = 8 \times 10^4 \, mm^2$.

$I = \frac{bd^3}{12} = \frac{200 \times 400^3}{12} = 1066.67 \times 10^6 \, mm^4$

$m = \alpha_c = \frac{E_s}{E_c}$

$= \frac{2 \times 10^5}{0.33 \times 10^5}$

$m = \alpha_c = 6.06$

$P = 1500 \left(10 \times \frac{\pi}{4} \times 7^2\right)$

$P = 577267.65 \, N$

$P = 577.26 \, KN$

Stress in concrete at the level of steel is

$f_c = \frac{P}{A} + \frac{Pe}{I} y$

$= \left[\frac{577.26 \times 10^3}{8 \times 10^4} + \frac{577.26 \times 10^3}{1066.67 \times 10^6} \times 100^2\right]$

$f_c = 12.62 \, N/mm^2$

Loss of stress due to elastic deformation of concrete

$= m f_c$

$= 6.06 \times 12.62$

~~= 0.72.~~

$= 76.47\ N/mm^2$

Force in wire immediately after transfer (P)

$= (1500 - 76.47) \times \frac{\pi}{4} \times 7^2 \times 10$

$P = 547838.85\ N$ = ~~547 kN~~.

$547.8\ kN$

Stress in concrete at steel level.

$$f_c = \left[\frac{P}{A} + \frac{Pe}{I} \times y\right]$$

~~$= \left[\frac{54783.85}{8\times10^4} + \frac{54783.85 \times 100^2}{1066.67 \times 10^6}\right]$~~

~~$f_c = 1.19\ N/mm^2$~~

$$= \frac{547.8\times10^3}{8\times10^4} + \frac{547.8\times10^3 \times 100^2}{1066.67\times10^6}$$

$f_c = 11.98\ N/mm^2$

Creep of concrete $= m f_c C_c$

$= 76.47 \times 1.6$

$= 122.35\ N/mm^2$

Shrinkage loss $= \delta_s E_s = 0.0003 \times 2 \times 10^5$

$= 60\ N/mm^2$

Total loss = 76.47 + 122.35 + 60

= 258.82 N/mm^2

Percentage loss = $\frac{258.82}{1500} \times 100$

= 17.25 %

Loss due to Relaxation of steel = 5 % 1500.

= 75 N/mm^2

Total loss = 76.47 + 122.35 + 60 + 75

= 333.82 N/mm^2

Percentage loss = $\frac{333.82}{1500} \times 100$

= 22.25 %