INSTITUTE OF TECHNOLOGY	USN											CMR

Internal Assesment Test – 3

Sub:	Design of Pre-stressed Concrete Structures (PSC)							Code:	10CV74
Date:	18/ 11 / 2017	Duration:	90 mins	Max Marks:	50	Sem:	7	Branch:	CIVIL

Answer any FIVE Full questions , USE of IS 1343 -1980 is Permitted , Density of Concrete = 25 KN/ Cu. M

		Marks	OBE CO	OBE RBT
1	Using Two Critical Conditions (Max Prestress at Minimum Moment And Min Prestress at Maximum Load) Derive the mathematical Expression to Find Minimum Section Modulus , Prestressing Force and Eccenticity of Cable.	[10]	CO4	L3
2	Explain Limiting Zone For Pre- stressing Force and Give 4 equations for calculation of Eccentricity.	[10]	CO4	L2
3	Sketch the classification of Zones of failure under Shear for a cracked beam? Explain reasons for formation of Web Shear Cracks?	[10]	CO3	L2
4	A PSC rectangular beam 250mm x 450mm deep is prestressed by a parabolic cable having an eccentricity of +75mm at center span and -25mm at support. Effective prestressing force = 400KN , span = 9m , beam supports a Live load of 3 KN / M in addition to self weight. If Ec = 38Kn/ mm^2 , calculate (a) short term deflection at center span due to LL +DL+PS (b) Long term deflection take loss ratio = 0.8 , creep coefficient = 1.6	[10]	CO3	L3

5	A Pre tensioned, PSC rectangular beam 500mm x 900mm (effective depth) have Ap = 3200 sq.mm , effective prestress in the steel after all losses is 1100 N/ sq.mm , Fck = 40N / sq.mm . estimate ultimate moment of resistance of section using IS 1343-1980	[10]	CO3	L3
6.	A Concrete beam of rectangular section 200mm x 650mm depth is pre-stressed by a parabolic cable located at an eccentricity of 120mm at mid span and zero at support. If the beam has a span of 12m and carries a UDL Live load of 4.5KN/M , find the Effective Pre-stressing force necessary for ZERO Shear stress at the support section. For this conditions calculate the principal stresses . the density of concrete = 24KN/ Cum. Take Load factor = 1.5	[10]	CO3	L3
7.	The support Section of a PSC Beam is 150mm x 300mm is to resist a shear of 100KN. The prestress at centroidal axis is 5N/Sq.mm. Fck = 40N/Sq.mm . the cover to tension reinforcement is 45mm. Check the section for Shear and Design suitable shear reinforcement . USE IS 1343-1980	[10]	CO2	L3
8.	A post tensioned PSC Beam 300mm wide is to be designed as a rectangular beam to support a Live Load of **18 Kn/ M.** Beam is simply supported over a span of **20m**. the load factor for Live Load and Dead load is 1.5. The stresses in Concrete must not exceed at all stages , for compression is 15 N/sqmm and for Tension it is ZERO. , Loss factor is 0.8 , ultimate tensile stress in steel is 1600N/ Sq.mm , partial safety factor for steel = 1.15. Use 11wire strand of 7mm dia. Design the beam and determine Zmin , P min , Eccentricity e and Number of Tendons	[10]	CO4	L4

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2017_18 III Test PSC.

$$f_{sup} = \cancel{\eta f_{ct}} + \frac{M_g}{Z_t} = -1.2 - \frac{537.5\,kN\text{-}m \times 10^6}{63375000}$$

CIVIL

$$= \underline{-9.68\ N/mm^2}$$

1 marks

$$f_{inf} = \frac{1}{\eta}\left[f_{tw} + \frac{M_g}{Z_b} + \frac{M_q}{Z_b}\right]$$

$$= \frac{1}{0.82}\left[-1.2 + \frac{(537.47 + 810)\times 10^6}{63375000}\right]$$

$$= \underline{24.46\ N/mm^2}$$

Minimum prestressing Force

$$P = \frac{A\left[Z_b f_{inf} + Z_t f_{sup}\right]}{(Z_t + Z_b)}$$

$$\boxed{P = 2883.052\ KN}$$

2 marks

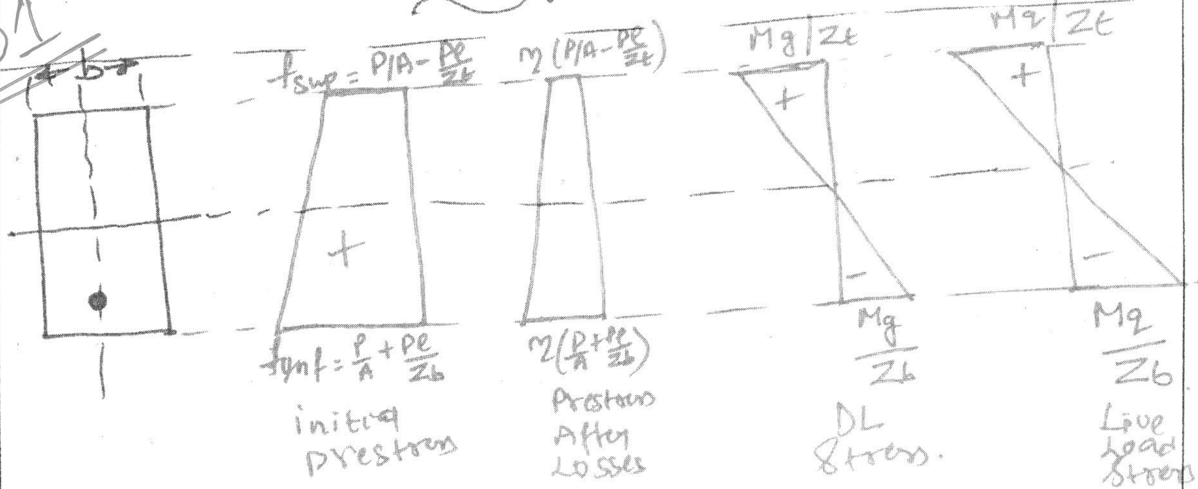
Eccentricity

$$e = \frac{Z_t Z_b (f_{inf} - f_{sup})}{A(f_{sup}.Z_t + f_{inf} Z_b)}$$

$$\boxed{e = 375\ mm.}$$

2 marks

Q NO 1 (b)



1 mark

→ Assumption's

Prestressed section under the action of flexure should satisfy the limit specified for permissible stresses @ the stage of transfer of PS and @ Servile Loads.

— Max prestressing force At transfer together with Min moments sustained by the section. — 2-marks.

— Min prestressing force after all Losses in combination with max design moment for the serviceability limit state.

→ i) At transfer (PS + DL)

f_{top} $f_{sup} + \frac{M_g}{Z_t} \geq f_{tt}$ = Allowable tensile stress in concrete @ initial transfer of prestress.

f_{bot} $f_{inf} - \frac{M_g}{Z_t} \leq f_{ct}$ = Allowable compressive stress in concrete @ initial transfer of prestress.

2 marks.

ii) At working → PS + LL + DL

$\eta f_{sup} + \frac{M_g}{Z_t} + \frac{M_q}{Z_t} \leq f_{cw}$ — Allowable comp stress in concrete under service loads.

$\eta f_{inf} - \frac{M_g}{Z_b} - \frac{M_q}{Z_b} \geq f_{tw}$ — Allowable tensile stress in concrete under service loads.

Based on above formulation, students to arrive following results.

a) Range of stress @ top fibre $f_{tr} \geq (f_{cw} - \eta f_{tt}) \geq \frac{(M_q + (1-\eta) M_g)}{Z_t}$.

ⓑ Range of stress @ bottom fibre $f_{br} \geq (\eta f_{ct} - f_{tw}) \geq \frac{M_q + (1-\eta) M_g}{Z_b}$.

ⓒ. Section Modulus.

$$Z_t \geq \frac{(M_q + (1-\eta) M_g)}{f_{tr}}$$

$$Z_b \geq \frac{(M_q + (1-\eta) M_g)}{f_{br}}.$$

1 mark.

ⓓ Prestressing force.

$$P = A_c * \frac{\{f_{inf} * Z_b + f_{sup} * Z_t\}}{(Z_b + Z_t)}$$ — 2 mark.

ⓔ Eccentricity $e = \frac{Z_t Z_b (f_{inf} - f_{sup})}{A (f_{sup} Z_t + f_{inf} Z_b)}$ 2 mark.

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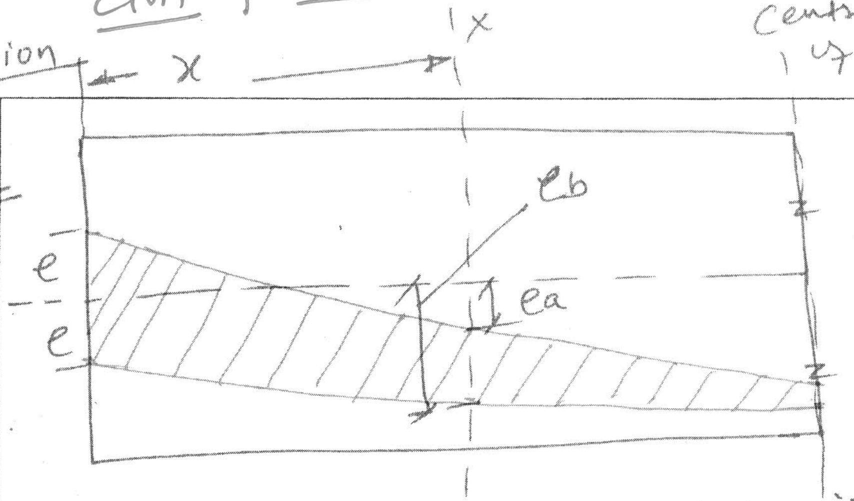
Original

Solution

Q NO 2 a



limiting zone for prestressing force. 1 mark

The prestress along the length of the beam is generally adjusted by varying the eccentricity of the post tensioned members. Pre-stressing force. — After having once determined the magnitude of the prestressing force for the critical section, It is possible to fix up the limiting zone for the force bounded by the upper limits & lower limits expressed as a function of the min moments, max moments, and sectional properties, prestressing force P @ transfer permissible stresses in concrete and working loads. 2 mark

$$e_1 \le \left[-\frac{Z_t f_{tt}}{P} + \frac{Z_t}{A} + \frac{M_{min}}{P}\right]$$

$$e_2 \le \left[\frac{Z_b f_{ct}}{P} - \frac{Z_b}{A} + \frac{M_{min}}{P}\right]$$

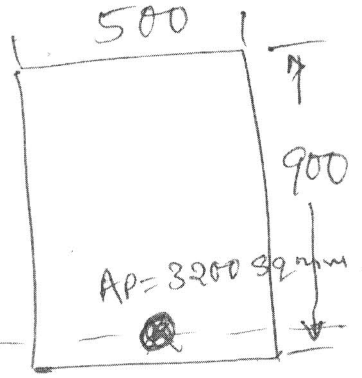
$$e_3 \ge \left[-\frac{Z_t f_{cw}}{\eta P} + \frac{Z_t}{A} + \frac{M_d}{\eta P}\right]$$

$$e_4 \ge \left[\frac{Z_b f_{tw}}{\eta P} - \frac{Z_b}{A} + \frac{M_d}{\eta P}\right]$$

1 mark

III test 2017-18

Q5



$p_i = 1100\ N/mm^2$

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

$M_R = ?$

pretensioned

use $\boxed{M_R = f_{pu} A_p (d - 0.42 x_u)}$ 2

Table no 11, IS 1343 - 1980.

$\frac{A_p f_p}{b d f_{ck}} = \frac{3200 \times 1100}{500 \times 900 \times 40} = 0.1956$ 2

$\frac{A_p f_p}{b d f_{ck}}$	pretens. $\frac{f_{pu}}{0.87 f_p}$	$\frac{x_u}{d}$
0.15	1.00	0.326
$\boxed{0.1956}$	$\boxed{1.00}$	$0.326 + 0.099408 = \boxed{0.425408}$
0.2	1.00	0.435

2

$0.1956 - 0.15 = \boxed{0.0456}$

$0.05 \rightarrow 0.109$

for $0.0456 \rightarrow ?\ \boxed{0.099408}$

$\therefore x_u = 0.4251 \times 900$

$= 382.59\ mm.$ 2

$f_{pu} = (1.0)(0.87)(1100)$

$= 957\ N/mm^2$

$M_R = \frac{(957)(3200)(900 - 0.42 \times 382.59)}{10^6}$ KN-m.

$= 2264.0\cancel{7}$ KN-m. 2

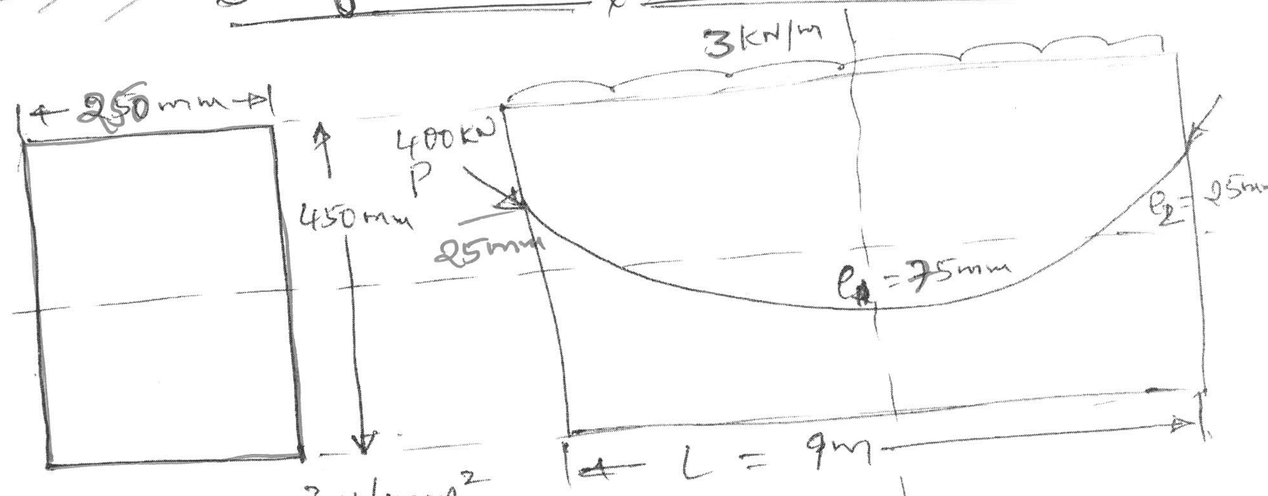
10

2017_18 ~~Improvement Test~~ IAST – III 10CV74 GMRIT Civil

Solution. Scheme

Design of prestressed Concrete Structure.

Q no 4



$E_c = 38 \times 10^3\ N/mm^2$

$\eta = 0.8, \quad \phi = 1.6$

a) Short term deflection $= \delta_{LL} + \delta_{DL} + \delta_{PS}$

$I = \frac{250 \times 450^3}{12} = 1898.4375 \times 10^6\ mm^4$

$$\delta_{PS} = \frac{PL^2}{48EI}(-5e_1 + e_2)$$

$$= \frac{(400\times10^3)(9\times1000)^2 \times (-5\times75+25)}{(48)(38\times10^3)(1898.4375\times10^6)}$$

$= -3.275\ mm \uparrow$ upwards

(2)

$W_d = 0.25 \times 0.45 \times 24 = 2.7\ kN/m$

$$\delta_{DL} = \frac{(W_d)\,l^4}{EI} \times 5/384$$

$$= \frac{2.7 \times (9000)^4}{(38\times10^3)(1898.4375)\times10^6} \times 5/384 = 3.197\ mm \downarrow$$

(2)

$$\delta_{LL} = \frac{3 \times 9000^4}{(38\times10^3)(1898.4375)\times10^6} \times 5/384 = 3.553\ mm \downarrow$$

(2)

(10)

Short term deflection $= 3.197 + 3.553 - 3.275$

$= 3.475\ mm \downarrow$.

(2)

(b) Long term deflection

$\Delta_{LT} = [\Delta_{LL} + \Delta_{DL} + \Delta_{PS} \times \text{loss factor}](1+\phi)$

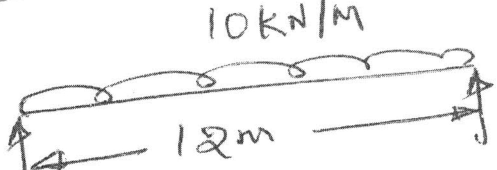
$= (3.553 + 3.197 - 3.275 \times 0.8)(1+1.6)$

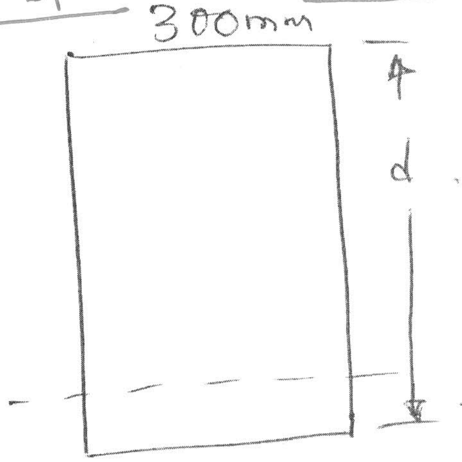
$= 10.738\ mm \downarrow$.

(2)

PSC 2017-18 Test no 3 CMRIT Civil

Q8 Q8





factor of safety
LL & DL = 1.5

$f_{cw} = f_{ct} = 15 N/mm^2$

$f_{tt} = f_{tw} = 0$

$\eta = 0$

$f_{pu} = 1600 N/mm^2$, $\gamma_d = 1.15$

Steel — 11 ply 7 ϕ

Design the beam — Z, P & e, No of strands = ?

Step-I Moment due to dead Load $M_g = 1.5 \times b \times d \times 24 \times \frac{12^2}{8}$

$= 648 \times bd$ N-mm

$= 684 \times 300\, d$ N-mm.

$= \underline{194400d}$ N-mm.

Live Load Moment

$M_q = 10 \times \frac{144}{8} \times 1.5 = 270$ KN-m

$= 270 \times 10^6$ N-mm.

Section modulus = $Z = \frac{bd^2}{6} = \frac{300}{6} d^2 = 50d^2$ mm^3

NOW

$Z_b = \frac{(M_q + (1-\eta) M_g)}{(\eta f_{ct} - f_{tw})} = \frac{(270 \times 10^6 + 0.2 \times 194400d)}{0.8 \times 15 - 0}$

$= 50d^2$

$d^2 - 64.80d - 450000 = 0.$

$\frac{64.80 \pm \sqrt{(64.80)^2 - 4(1)(-450000)}}{2 \times 1}$

$d = \underline{1408 mm}.$ Provide $\underline{1450 mm}$ / or $\underline{1500 mm}$

2

$$Z_{provided} = \frac{300 \times 1500^2}{6}$$

$$= \cancel{1125} \ 112.5 \times 10^6 \ mm^3$$

$$A_c = 300 \times 1500 = 450000 \ mm^2$$

<u>To Find P.</u>

$$f_{sup} = f_{tt} - \frac{M_g}{Z_t}$$

$$= 0 - \frac{194400 \times 1500}{\cancel{450000} \ 112.5 \times 10^6}$$

$$= -2.592 \ N/mm^2$$

$$f_{inf} = \frac{1}{\eta}\left[f_{tw} + \frac{M_g + M_q}{Z_b}\right]$$

$$= \frac{1}{0.8}\left[0 + \frac{270 \times 10^6 + 291600000}{112.5 \times 10^6}\right]$$

$$= 6.24 \ N/mm^2$$

$$P = \frac{A_c}{2}\{f_{inf} + f_{sup}\}.$$

$$= \frac{450000}{2}\{6.24 - 2.592\}.$$

$$= \underline{820.8 \ kN}.$$

$$\underline{Nr} \text{ of Strands} = \frac{820.8 \times 10^3}{11 \times \frac{\pi}{4} \times 49 \times \frac{1860}{1.15}} = 1.3935 \ \underline{\underline{\approx 2 nos}}$$

2

2

2

$$e = \frac{Z}{A} \times \left\{ \frac{f_{sup} - f_{inf}}{f_{inf} + f_{sup}} \right\}$$

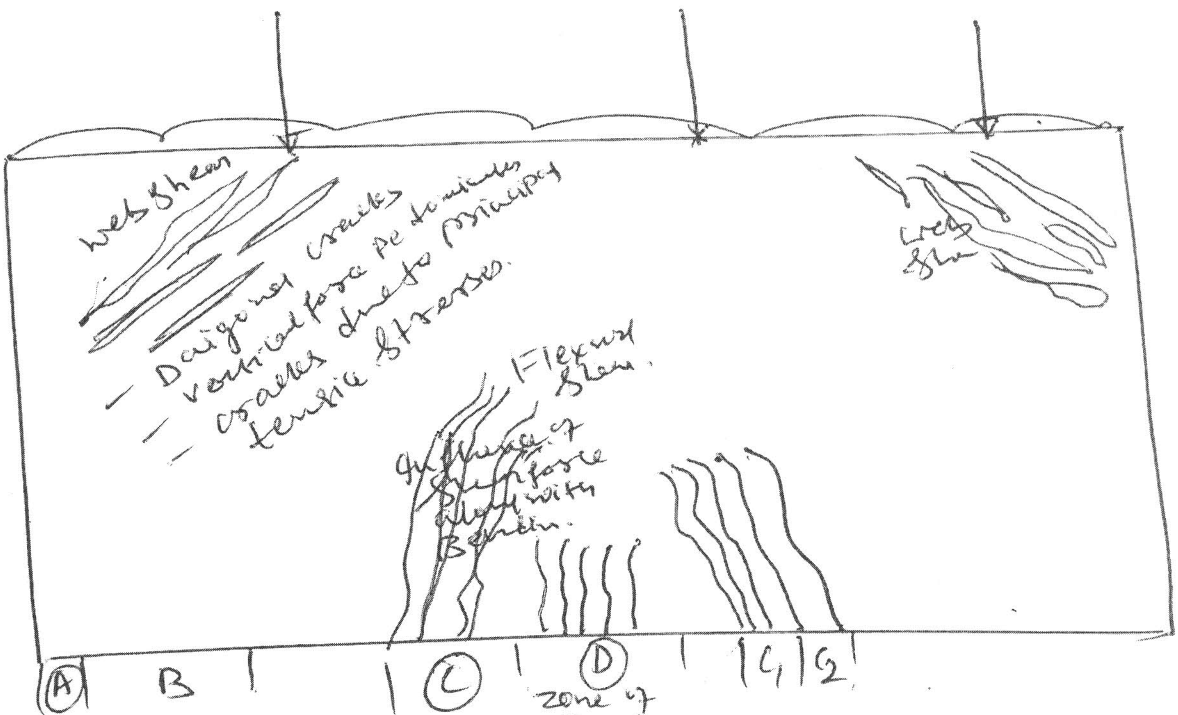
10

$$= \frac{112500000}{450000} \times \left\{ \frac{6.24 - (-2.592)}{6.24 + (-2.592)} \right\}$$

$$= 605.2632 \text{ say } \underline{\underline{606 \text{ mm}}}$$

2

Q3



10

Classification of Zones In a cracked Beam

(A) NO crack Zone
(B) web Shear crack Zone
(C) flexural Shear crack Zone.
(D) flexural crack Zone.
(D) flexural with parallel cracks.
(C1) Zone with parallel cracks
(C2) Zone with convergin cracks

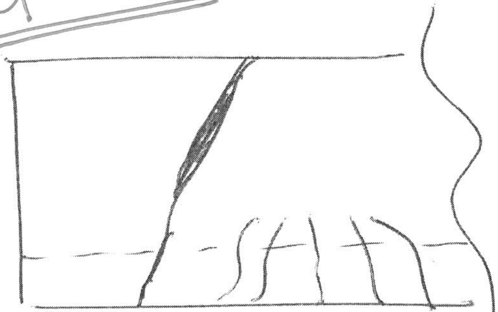
6+4 = 10

— In the Zone where the vertical force (Equilibrating forces) pre dominates the cracks develop in the in the Section web Some where in the middle where Shear Stress Intensity is high, This is due to principal tensile Stresses & ~~that~~ this Zone is Shear crack Zone.

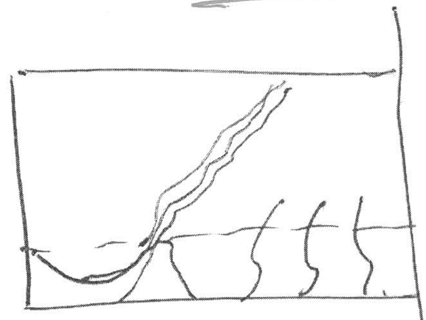
Q no 3

PSC Test no 3

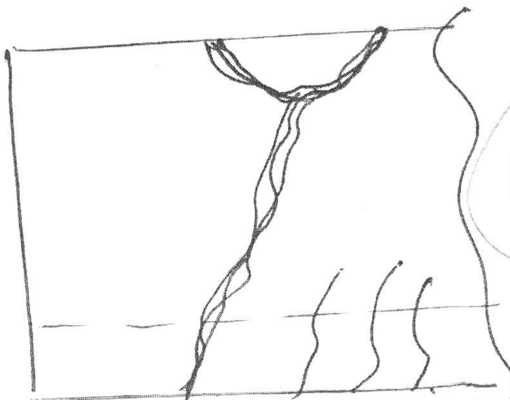
6



Diagonal tension crack failure.



Anchorage failure.



Shear compression failure.

5x2=10

web compression failure.

10

Crack due to eccentric compression.

compression Thrust line.

ARCH RIB failure.

Test no3 CMRIT Civil 2017-18

Q.7

$P = ?$

Zero shear @ support.

σ_1 & σ_2 ?

Concrete density = 24 kN/m³

Load Factor = 1.5.

Solution

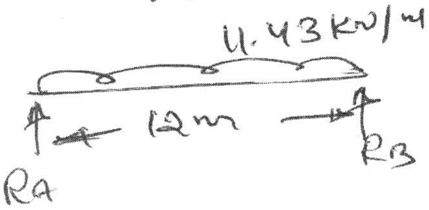
Dead Load = $0.2 \times 0.65 \times 24$ = 3.12 kN/m

Live Load = 4.5 kN/m.

Total load 7.62 kN/m ↓

∴ Ultimate Load = 7.62×1.5 = 11.43 kN/m.

2

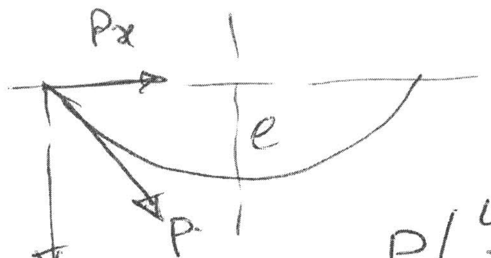


$R_A = R_B = \frac{11.43 \times 12}{2} = 68.58$ kN↑

SF @ support = SF due LL+DL + SF due to prestress.

$= 68.58 + P_y$.

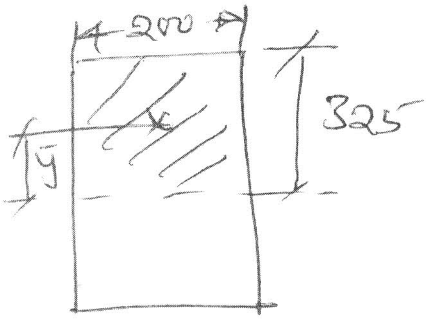
2



$P_y = P\sin\theta = P\left(\frac{4e}{l}\right) = P\left(\frac{4 \times 120}{12000}\right) = 0.04P.$

$V_u = (68.58 - 0.04P)$

Net Shear Stress @ Support $= \tau_v = \frac{V_u \cdot A\bar{y}}{I \times b} = 0.$



$$I = \frac{bd^3}{12} = \frac{200 \times 650^3}{12}$$

$$= 4.6 \times 10^9 \text{ mm}^4$$

$b = 200\text{ mm}$

$$A\bar{y} = 200 \times 325 \times \frac{325}{2}$$

$$= 10.56 \times 10^6 \text{ mm}^3.$$

Now

$$0 = \frac{\left(68.58 - 0.04P\right)_{kN} \left(10.56 \times 10^6\right) \text{mm}^3}{\left(4.6 \times 10^9\right) \text{mm}^4 \times 200\text{ mm}.}$$

$$\boxed{\therefore P = 1714.5 \text{ kN}.}$$ 2 —— 6.

Principal Stresses

$\tau_v = 0$ No vertical prestressing.

$f_y = 0.$

$$f_x = P/A = \frac{1714 \times 10^3}{200 \times 650} = 13.18 \text{ N/mm}^2$$

$$\sigma_{max/min} = \frac{f_x + f_y}{2} \pm \frac{1}{2}\sqrt{(f_x - f_y)^2 + 4\tau_v^2}$$

$$= \frac{13.18 + 0}{2} \pm \frac{1}{2}\sqrt{(13.18 - 0)^2 + 4(0)}$$

4

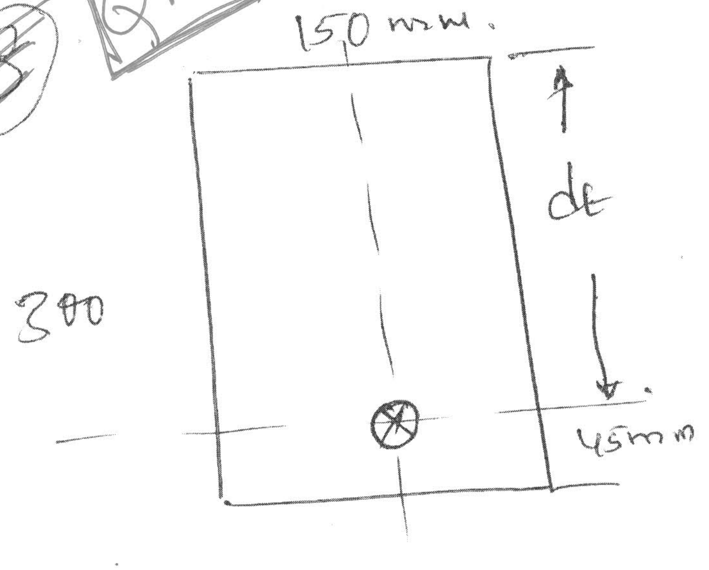
$\sigma_1 = 13.18 \text{ N/mm}^2$ Comp.

$\sigma_2 = 0.$

6+4 = 10

2017-18

8 Q no 7



SF = 100 kN.
f_{cp} = 5 N/mm²
f_{ck} = 40 kN/mm²
Cover = 45mm.

$\therefore d_t = 300 - 45 = 255$ mm.

f_t = tensile stress = 1.5 N/mm²

I ultimate SF = V_u = 1.5 × 100 = 150 kN. (1)

II Internal shear resistance = V_{co}.

$$V_{co} = 0.67\, b\, D \sqrt{f_t^2 + 0.8 f_{cp} f_t}$$ pg 46 IS 1343 -1980.

$$= 0.67 \times 150 \times 300 \times \sqrt{(1.5)^2 + 0.8 \times 5 \times 1.5}$$

V_{co} = 86.59 kN. (1)

Now $\boxed{V_{co} < V_u}$ Case II provide shear reinforcem.

III using 2 legged - 8 mm ϕ vertical stirrups.

$$A_{sv} = 2 \times \frac{\pi}{4} \times 64 = 100.53 \text{ mm}^2$$

$$\frac{A_{sv}}{S_v} = \frac{(V_u - V_{co})}{0.87 f_y d_t}$$ — Cl 22.4.3.2 pg 48

$$\frac{100.53}{S_v} = \frac{(150 \times 10^3 - 86.59 \times 10^3)}{0.87 \times 415 \times 255}$$

S_v = 145.96 mm c/c. (2)

Q no 7

Min Shear @ Centre.

Cl 22.4.3.1 pg 48

IS. 1343-1980

10

$$\frac{A_{sv}}{b \cdot S_v} = \frac{0.4}{0.87 f_y}$$

$$\frac{100.53}{150 \times S_v} = \frac{0.4}{0.87 \times 415}$$

$$S_v = 604.9 \text{ mm}$$

2

Also from max spacing conditions.

max spacing $\leq$ 0.75dt & 4x web thk.

0.75x255 & 4x150.

= 191.25mm & 600mm

Consider least value.

At support section provide spacing of 140mm c/c.

@ centre span provide spacing @ 190mm c/c.

2