DESIGN OF CONCRETE STRUCTURES – I

MODEL ANSWERS OF MID-SEMESTER EXAM Dated 16/05/2019.

Q1) (a) (II)

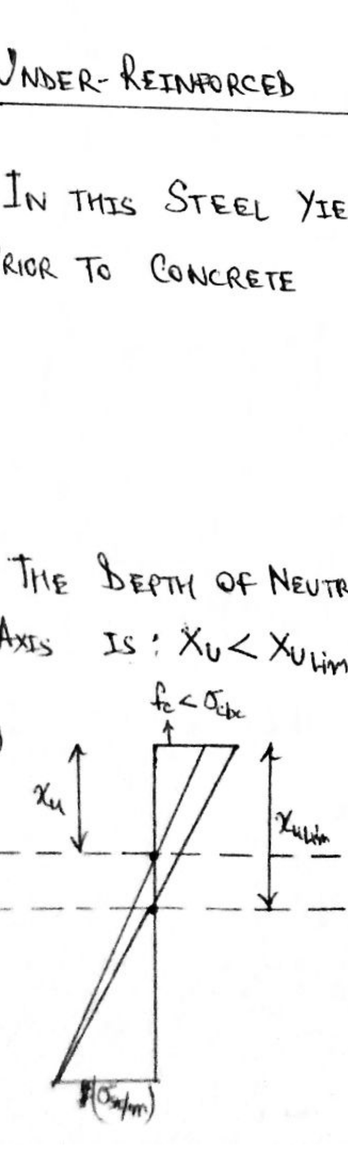
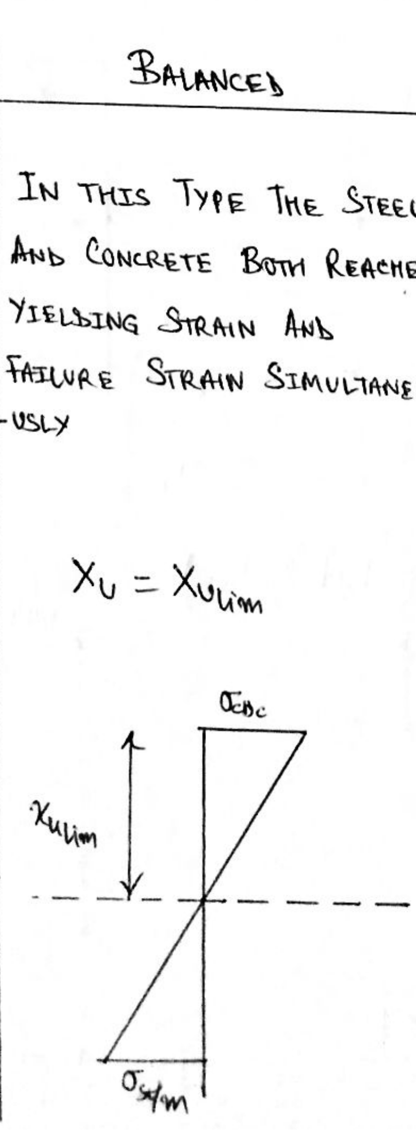
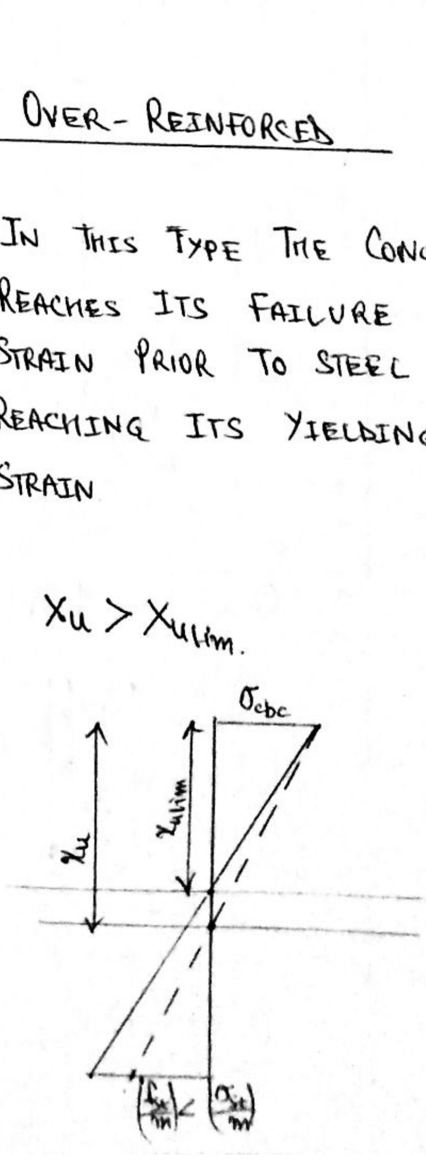
(b) (IV)

(c) (III)

(d) (IV)

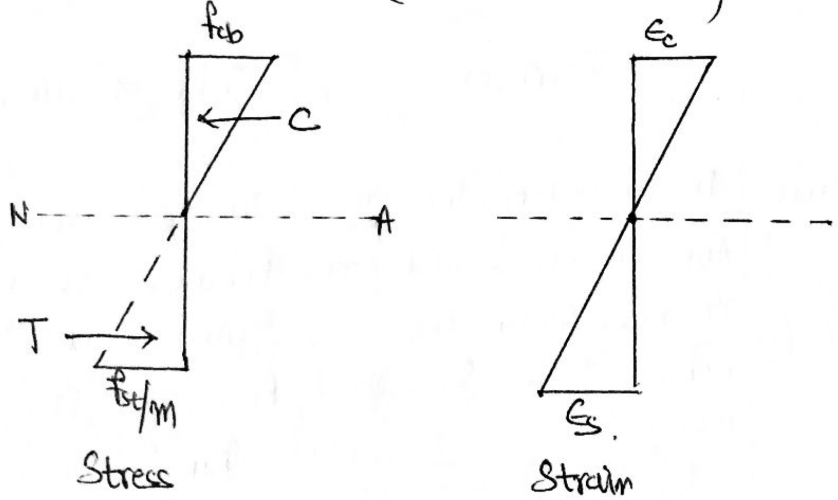
(e) (I)

Q2) (a)

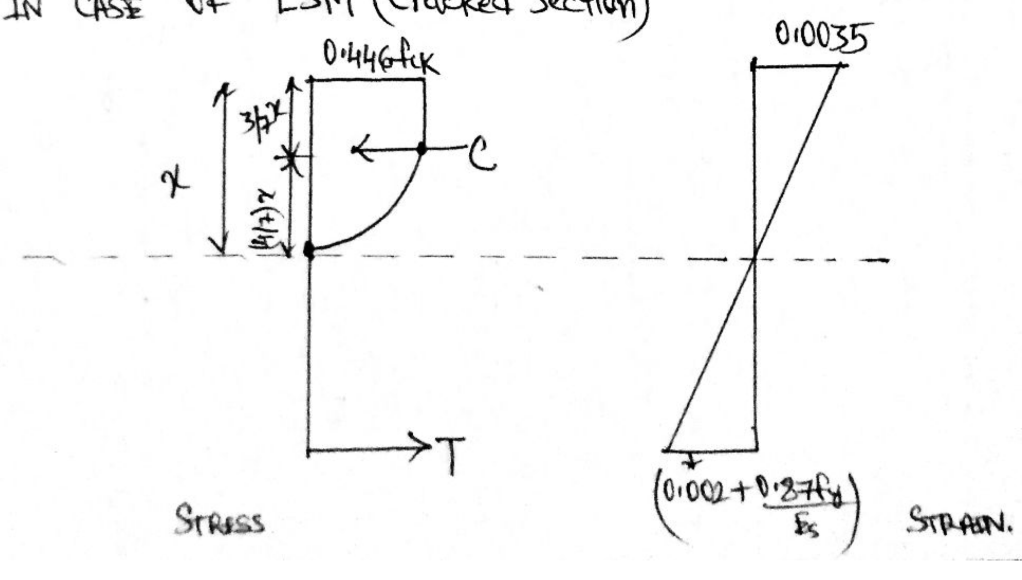
	UNDER-REINFORCED	BALANCED	OVER-REINFORCED
(i)	IN THIS STEEL YIELDS PRIOR TO CONCRETE	IN THIS TYPE THE STEEL AND CONCRETE BOTH REACHES YIELDING STRAIN AND FAILURE STRAIN SIMULTANEOUSLY	IN THIS TYPE THE CONCRETE REACHES ITS FAILURE STRAIN PRIOR TO STEEL REACHING ITS YIELDING STRAIN
(ii)	THE DEPTH OF NEUTRAL AXIS IS : $X_U < X_{U lim}$	$X_U = X_{U lim}$	$X_U > X_{U lim}$.
(iii)			

UNDER-REINFORCED	BALANCED	OVER-REINFORCED
(iv) UNDER THIS CASE THE SECTION SUFFERS LARGE SCALE DEFLECTION AND CRACKING. THUS THE USERS GET SUFFICIENT TIME TO VACATE THE ROOM BEFORE COMPLETE FAILURE OCCURS. This is the most preferred section in practice.	SINCE THE STEEL YIELDS THUS THE OCCUPANTS ~~GIVE~~ GET SOME TIME ~~TO~~ FOR SAFE EXIT. HENCE THIS TYPE OF SECTION MAY BE DESIGNED.	IN THIS CASE STEEL IN THE TENSION ZONE DOES NOT YIELDS SUFFICIENTLY SO AS TO GIVE PROPER WARNING TO THE OCCUPANTS. HENCE SUCH SECTIONS ARE NOT DESIGNED IN PRACTICE.

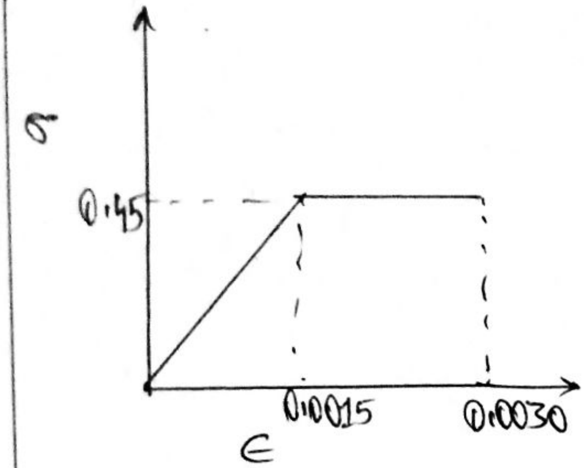
Q2) (b) IN CASE OF WSM (CRACKED SECTION)

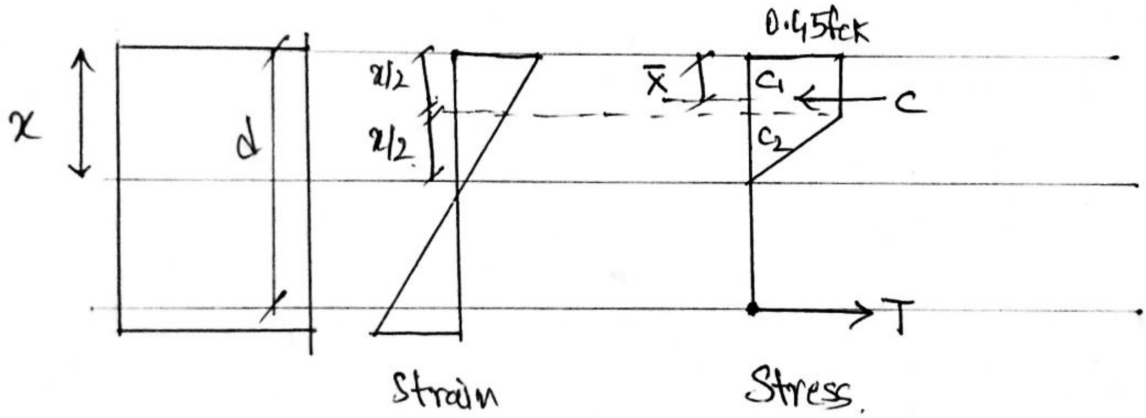


IN CASE OF LSM (Cracked Section)



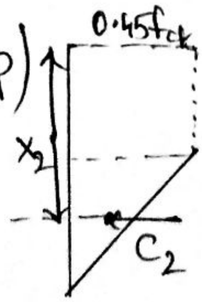
Q2)) (OR)





$C_1 = 0.45 f_{ck} \times \left(\frac{x}{2}\right) b = 0.225 f_{ck} b x$, $\bar{x}_1 = (x/4)$ (from top)

$C_2 = \frac{1}{2} \times \left(\frac{x}{2}\right) \times (0.45 f_{ck}) \times b = 0.1125 f_{ck} b x$, $\bar{x}_2 = \frac{2}{3} x$



$C = C_1 + C_2 = 0.3375 f_{ck} b x$

$$\bar{X} = \left(\frac{C_1 \bar{x}_1 + C_2 \bar{x}_2}{C_1 + C_2}\right) = 0.388x$$

Thus, Stress Block Parameters = $C = (0.3375 f_{ck} b x)$

Lever Arm $(z) = (d - 0.388x)$

Q3) Given Data.

$b = 300\,mm$ M20, Fe415.

$d = 550\,mm$

$L_{eff} = 8m.$

$W = 40\,kN/m$

$X_{ulim} = 0.48d = 264\,mm$

~~$X_u = 0.$~~

$M_{ulim} = 0.138 f_{ck} b d^2 = 250.47\,kNm$

M_u (External) $= \left(\dfrac{W l_{eff}^2}{8}\right) = 320\,kNm$

$\because M_u > M_{ulim} \Rightarrow$ SECTION WILL BE DESIGNED AS DOUBLY -REINFORCED SECTION.

Assume $d' = 50\,mm$.

$$A_{st_1} = A_{st\,lim} = \frac{M_{ulim}}{0.87 f_y (d - 0.42 x_{ulim})} = 1579.8 \approx 1580\,mm^2$$

$$A_{st_2} = \frac{M_u - M_{ulim}}{0.87 f_y (d - d')} = 385\,mm^2$$

$$A_{sc} = \frac{M_u - M_{ulim}}{(f_{sc} - f_{cc})(d - d')}$$

$f_{cc} = 0.45 f_{ck}$, However, 'f_{sc}' will depend on the strain at $\frac{0.0035(x_{ulim} - d')}{x_{ulim}}$

$\because$ 'f_{sc}' table is not supplied, hence, calculation of A_{sc} need not be done.

Main tensile Reinforcement = $1580 + 385 = 1965 \, mm^2$

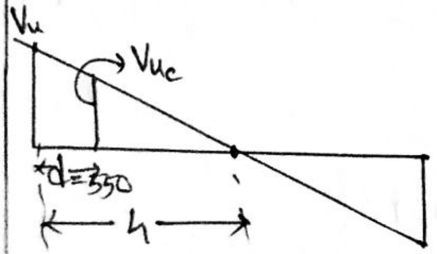
Adopt 2 – 22ϕ & 4 – 20ϕ in two layers.

<u>Check for the Development at supports.</u>

Near the support $\not<$ 50% tensile Reinforcement is continued, hence M (Approx) = 160 kNm.

Max Shear force, $V_u = \left(\frac{W l_{eff}}{2}\right) = 160 \, kN$

Critical section at 'd' from supports.



$V_{uc} = 138 \, kN.$

At simple supports

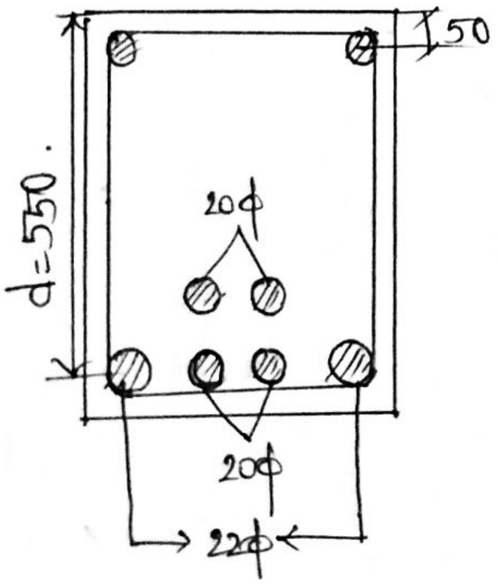
$1.3\left(\frac{M}{V}\right) + l_0 \not< L_d.$

$$\frac{\phi \times (0.87 \times 415)}{(4 \times 1.6 \times 1.2)} \leq \left(\frac{1.3 \times 160 \times 10^3}{138}\right) + l_0$$

$$940 \leq 1507.24 + l_0$$

l_0 turns out to be negative.

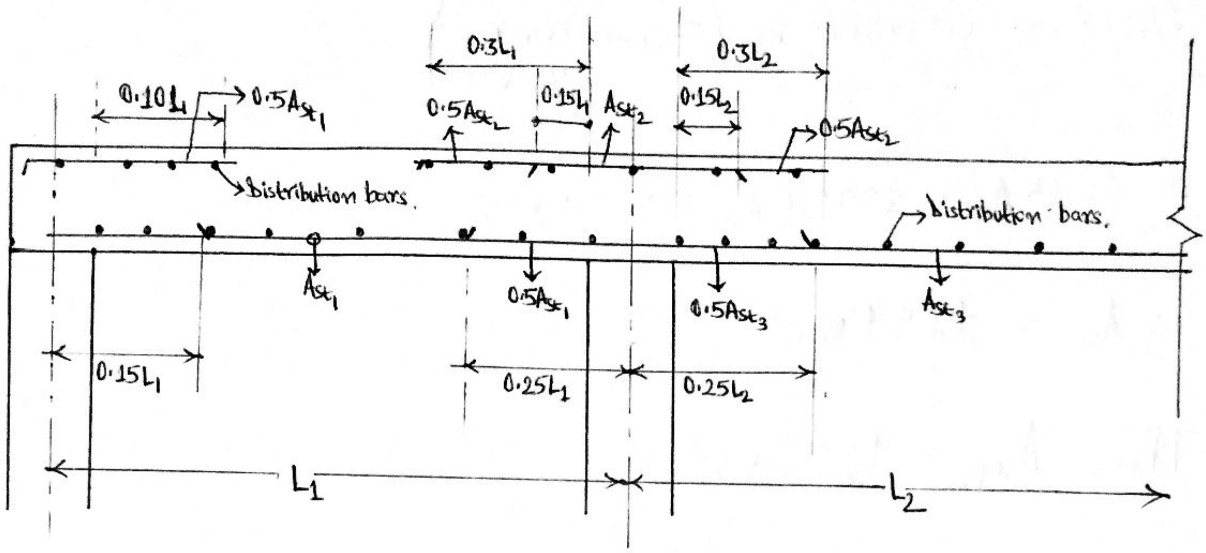
- Hence Anchoring beyond the centre of support is not needed.
- However bars must be continued ~~from~~ to a distance of $(L_d/3)$ from the face of support.



Bond Requirement is satisfied.

NOTE:

Q4) (a)



Q4)

(b) Given Data: $b = 300$ mm

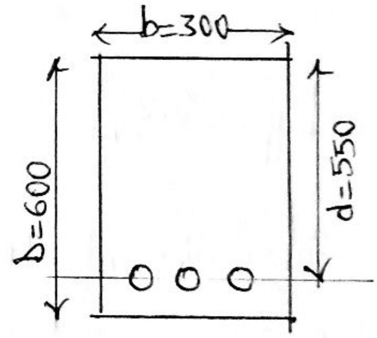
$d = 550$ mm

$D = 600$ mm.

M20, Fe500.

$L = 8$ m

Width of support =



$$\frac{x_{ulim}}{d} = 0.46 \quad (\text{for Fe500})$$

$$M_{ulim} = 0.36 f_{ck}\left(\frac{x_{ulim}}{d}\right)\left(1 - 0.42\left(\frac{x_{ulim}}{d}\right)\right) bd^2$$

$$M_{ulim} = 242.50 \text{ kNm}$$

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$$M_{ulim} = 0.87 f_y A_{st}\left(d - \frac{0.42 \times 0.87 f_y A_{st}}{0.36 f_{ck} b}\right)$$

$$M_{ulim} = 242.5 \text{ kNm}.$$

$$242.5 = 0.87 \times 500 \times A_{st}\left(550 - \frac{500 A_{st}}{300 \times 20}\right)$$

$$\Rightarrow 36.25 A_{st}^2 - 239250 A_{st} + 242.5 \times 10^6 = 0$$

$$\Rightarrow A_{st} = 1251 \text{ mm}^2$$

Thus $A_{st\,lim} = 1251 \text{ mm}^2$

Effective span of Beam $= \text{Min}\begin{cases} l_c + d \\ l_c + W \end{cases} = \text{Min}\begin{cases} 8 + 0.55 \\ 8 + 0.3 \end{cases}$

Thus $L_{eff} = 8.3 \text{ m}$

For Calculation of IMPOSED LOAD

$$\frac{W l^2}{8} = M_{u\,lim}$$

$$\frac{W \times (8.3)^2}{8} = 242.50 \times 1 \quad \Rightarrow \quad W = 28.16 \text{ kN/m}$$

→ This Load is Factored

→ Neglecting the Self-Weight factor, Working Load $= \left(\frac{W}{1.5}\right) = 18.78$

ANSWERS: $A_{st\,lim} = 1251 \text{ mm}^2$

$W_{working} = 18.78 \text{ kN/m}$