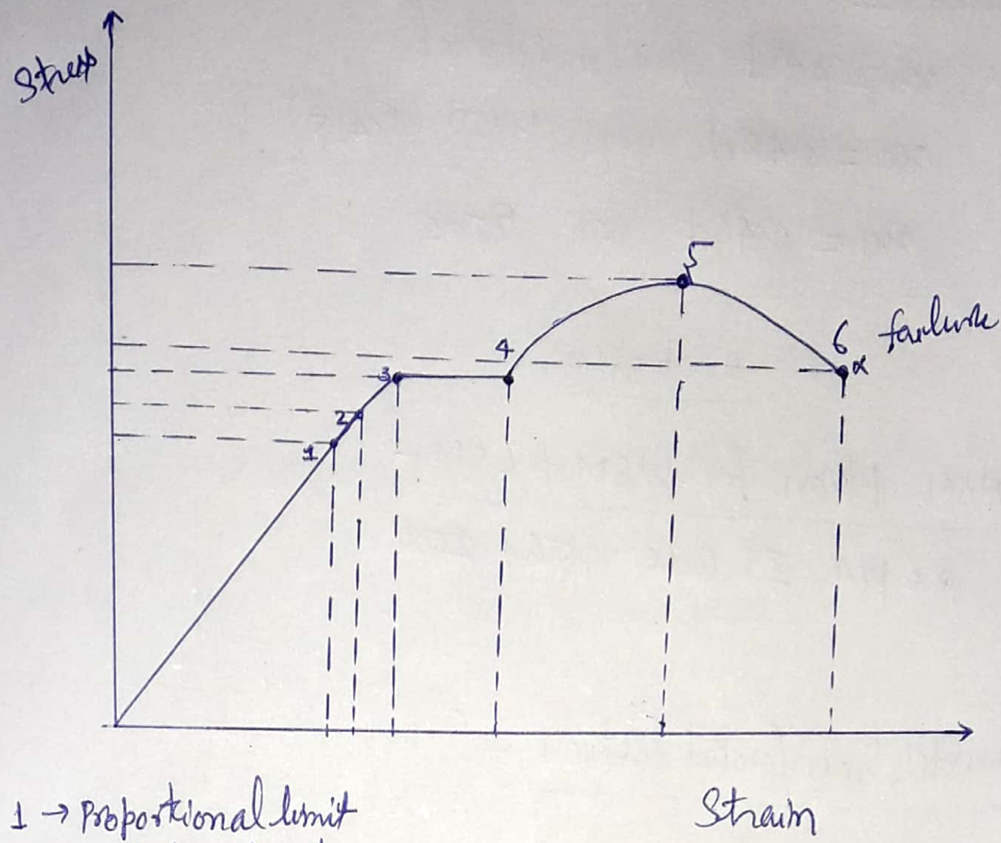
Ques 1 (a) - Design of structure-II (RCE-601)



1 → Proportional limit
2 → elastic limit
3 → yeild limit
5 → ultimate stress

1(b) ⇒ Factor of safety -

	WSM	LSM
for concrete	3	1.5
for steel	1.78	1.15

1(c) ⇒ Modular ratio (m) -

$$m = \frac{E_s}{E_c} = \frac{280}{3\sigma_{cbc}}$$

1(d) ⇒ characteristic strength of concrete ⇒ It means the value of the strength of the material below which not more than 5 percent of the test results are expected to fail.

1(c) ⇒ **Neutral axis** –

$x_u = 0.53d$ for mild steel

$x_u = 0.48d$ for HYSD (Fe415)

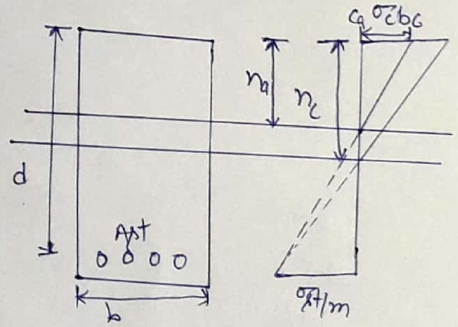
$x_u = 0.46d$ for Fe500

Section (B).

2(a) ⇒ **Assumption for WSM & LSM** –

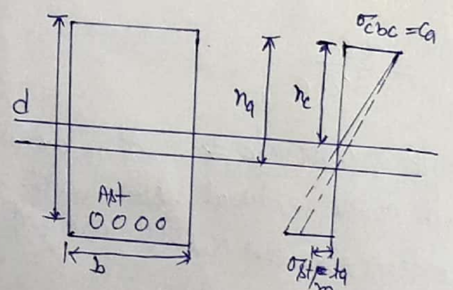
As per IS Code 456 : 2000

2(b) – **Under Reinforced Section** –



$x_c > x_a$
$t_a = \sigma_{st}$
$\sigma_{cbc} > c_a$

Over Reinforced Section –



$x_a > x_c$
$\sigma_{cbc} = c_a$
$\sigma_{st} > t_a$

2(c) ⇒ **Given** –

$b = 300mm$ $\quad d = 450mm$

$A_{st} = 4\text{-}16mm\ \phi$ $\quad \sigma_{cbc} = 7\ N/mm^2$

$\sigma_{st} = 230\ N/mm^2$ $\quad m = 13.33$

$$\frac{\sigma_{cbc}}{n} = \frac{\sigma_{st}/m}{d-n}$$

$$\frac{7}{n} = \frac{230/13.33}{450-n} \qquad n_c = 129.87\ mm$$

by area moment method –

$b \times n \times n/2 = A_{st} \times m \times (d-n)$

$300 \times n \times n/2 = 4 \times \frac{\pi}{4} \times 16^2 \times 13.33 \times (450-n)$

$$\boxed{n_a = 147.27mm}$$

$n_a > n_c$ (over reinf^n)

$MOR = \frac{1}{2}\sigma_{cbc} \times b \times n \times (d - n/3) = \frac{1}{2} \times 7 \times 300 \times 147.27 \times (450 - \frac{147.27}{3})$

$= 61.99\ KNm$

3(a) ⇒ **Section C**

Given – $b = 350\ mm$ $\quad \sigma_{cbc} = 7N/mm^2$

$l = 6.25m$ $\quad \sigma_{st} = 230N/mm^2$

$W = 16.3\ KN/m$ $\quad m = 13.33$

Find – $A_{st} = ?$, $d = ?$

$$\frac{B}{D} = \frac{2}{3}$$

$D = 525\ mm$

$d = 475mm$

dead load $= \gamma BD = 25 \times .35 \times .525 = 4.593\ KN/m$

Total load $= 20.89\ KN/m$

$BM = \frac{wl^2}{8} = \frac{20.89 \times 6.25^2}{8} = 102\ KNm$

MOR = BM

$102 \times 10^6 = \sigma_{st} \times A_{st} \times (d - n/3)$

$\frac{\sigma_{cbc}}{n} = \frac{\sigma_{st}/m}{d-n}$

$\frac{7}{n} = 230/13.33$

$n = 137.08$ mm

$102 \times 10^6 = 230 \times A_{st} \times (475 - \frac{137.08}{3})$

$A_{st} = 1033\ mm^2$

3(b) ⇒ Design procedure for doubly Reinforced beam –

Step 1 – first find load.

factored load = 1.5 × total load

Step 2 – find BM using formula.

$BM = \frac{w_u l^2}{8}$

Step 3 – Calculate the x_u by using IS code

$x_u = 0.53d$

$x_u = 0.48d$

$x_u = 0.46d$

Step 4 – Calculate MR balance

$M_{ulim} = 0.36 f_{ck} \times b \times x_u \times (d - 0.42 x_u)$

Step 5 – If MR balance < BM

Design Doubly Reinfn.

Step 6 – $A_{st_1} = \frac{M_{ulim}}{0.87 f_y \times (d - 0.42 x_u)}$

$A_{st_2} = \frac{M_{u2}}{0.87 f_y (d - d')}$

Step 7 – $A_{sc} = \frac{M_{u2}}{(f_{sc} - f_{c}) \times (d - d')}$

4(a) – $l = 4m$

Dead load = 15 KN/m

Live load = 12 KN/m

M_{25}, Fe 500

$\frac{l}{D} = 10$ $\quad D = 400$ mm

$\frac{4000}{10} = D$

$d = 400 - 50 = 350$ mm

$B = \frac{2}{3} D = \frac{2}{3} \times 400 = 266.67$ mm ≈ 270 mm

self weight $= \gamma \times B \times D = 25 \times 0.27 \times .40$

$= 2.7$ KN/m

Total load $= 15 + 14 + 2.7 = 29.7$ KN/m

$BM = \frac{wl^2}{8} = \frac{29.7 \times 4^2}{8} = 59.4$ KNm

$x_c = \left[\frac{m \sigma_{cbc}}{m \sigma_{cbc} + \sigma_{st}}\right] d = \frac{8.5 \times 10.98 \times 350}{10.98 \times 8.5 + 275}$

$= 88.68$ mm

$59.4 \times 10^6 = 275 \times A_{st} \times (350 - \frac{88.68}{3})$

$A_{st} = 267.81\ mm^2$

4(b) $b_f = 750$ mm $\quad d_f = 120$ mm $\quad b_w = 500$ mm

$D = 500$ mm $\quad d' = 50$ mm

M_{20} of Fe 415

$x_{ulim} = 0.48 \times d = 216$ mm

Assuming A_{st} = 3-20mm φ

$0.36 f_{ck} \times b \times x_u = 0.87 f_y \times A_{st}$

$x_u = 63\,mm$

$\therefore x_u < d_f$

$MOR = 0.36 f_{ck} \times b \times x_u \times (d - 0.42 x_u)$

$= 0.36 \times 20 \times 750 \times 63 \times (450 - 0.42 \times 63)$

MOR = 144.088 kNm

5(b) ⇒ **Step 1** - Determination of neutral axis

① x_{ulim}

from IS 456: 2000

f_y	x_{umax}/d
250	0.53
415	0.48
500	0.46

② actual neutral axis -

$C = T$

$0.36 f_{ck} \times b \times x_u = 0.87 f_y \times A_{st}$

$$x_u = \frac{0.87 f_y A_{st}}{0.36 f_{ck} \times b}$$

Step 2 - Compare actual and limit ~~and~~ neutral axis -

if $x_u > x_{ulim}$, over reinf^n

if $x_u < x_{ulim}$, under reinf^n

if $x_u = x_{ulim}$, Balanced

Step 3 - Determination of MOR -

$MOR = C \times LA$

$MOR = 0.36 f_{ck} \times b \times x_u \times (d - 0.42 x_u)$

$MOR = T \times LA$

$= 0.87 f_y A_{st} \times (d - 0.42 x_u)$