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Q.N. 1

Properly Reinforced	Over Reinforced
1) Properly reinforced beams starts deflecting	1) Over reinforced beams will fail and collapse suddently
2) $\varepsilon_s \geq \varepsilon_y$ $f_s = f_y$	2) $\varepsilon_s < \varepsilon_y$ $f_s < f_y$
3) Before it fails, beam provide warning.	3) No sign of warning is given before failure.

Q.N. 2

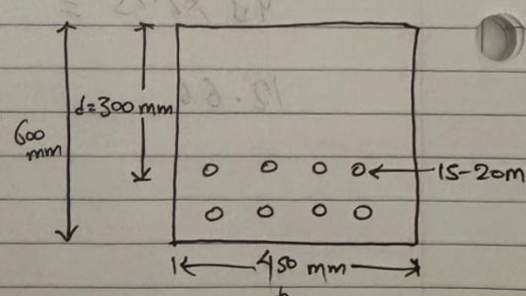
=> Solution:-

$f'_c = 30$ MPa

$f_y = 400$ MPa

$E_s = 200000$ MPa

Factored Moment resistance (M_r) = ?



* Calculate Area

$A_s = 15 \times 300 mm^2 = 4500 mm^2$

$d = 300 mm$

* Calculate a

$T_r = \phi_s f_y A_s$

$= 0.85 \times 400$ MPa $\times 4500 mm^2 = 1530 \times 10^3$ N

$= 1530$ kN

$\therefore C_r = T_r$

$C_r \Rightarrow \alpha_1 \phi_c f'_c ab = T_r$

$$\therefore a = \frac{T_r}{\alpha_1 \phi_c f'_c b} = \frac{1530 \times 10^3 N}{0.8 \times 0.65 \times 30 MPa \times 450 mm}$$

$$= 217.95 mm$$

wrong

* Calculate M_r

$$M_r = T_r \left(d - \frac{a}{2} \right)$$

$$= 1530 \times 10^3 N \left(300 mm - \frac{217.95 mm}{2} \right)$$

$$\boxed{= 292.27 \times 10^6 N \cdot mm} \Rightarrow 292 kN \cdot m$$ which is wrong

Q.N-2 (Re-do)

⇒ Soln

In order to find whether the beam is properly reinforced or over reinforced

Calculate c

$$C = \frac{a}{\beta'} = \frac{217.95}{0.9} = 242.167 \text{ mm}$$

Now

$$\frac{\varepsilon_{c\,max}}{c} = \frac{\varepsilon_{c\,max} + \varepsilon_s}{d}$$

$$\frac{0.0035}{242.167 \text{ mm}} = \frac{0.0035 + \varepsilon_s}{300 \text{ mm}}$$

$$\varepsilon_s = 0.000835$$

$$\varepsilon_y = \frac{400 \text{ MPa}}{200000 \text{ MPa}} = 0.002$$

Since $\varepsilon_s < \varepsilon_y$, its over reinforced

Calculation of new a:

$$\frac{\alpha_1 \phi_c f'_c b}{\varepsilon_{c\,max} \phi_s \varepsilon_s A_s} a^2 + a - d\beta_1 = 0$$

or $$\frac{0.8 \times 0.65 \times 30 \text{ mpa} \times 450 \text{ mm}}{0.0035 \times 0.85 \times 200000 \times 4500} a^2 + a - 300 \times 0.9 = 0$$

or $2.62 \times 10^{-3} a^2 + a - 270 = 0$

or a C $= 183$ mm

N.A depth

$$C = \frac{a}{\beta_1} = \frac{183}{0.9} = 203.33 \text{ mm}$$

$$\frac{\varepsilon_{c\,max}}{c} = \frac{\varepsilon_{c\,max} + \varepsilon_s}{d} \Rightarrow \frac{0.0035}{203.33} = \frac{0.0035 + \varepsilon_s}{300}$$

$\Rightarrow \varepsilon_s = 0.0016$ which is smaller than

$$f_s = \varepsilon_s E_s$$
$$= 0.0016 \times 200000$$
$$= 320 \text{ MPa}$$

$$T_r = \phi_s f_s A_s$$
$$= 0.85 \times 320 \times 4500$$
$$= 1224000 \text{ N} = 1224 \text{ kN}$$

Now $\Rightarrow$: $M_r = T_r \left(d - \frac{a}{2}\right)$

$$= 1224 \times \left(300 - \frac{183}{2}\right)$$
$$= 255.204 \text{ kN.m}$$

Q. N. 3

⇒ Solution:-

Given

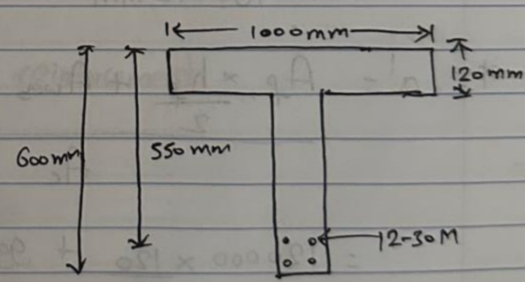
$f'_c = 25$ MPa

$f_y = 400$ MPa

$E_s = 200000$ MPa

Reinforcement = 12-30 M

$M_r = ?$



According to the question, we can assume the beam as properly reinforced

* $A_s = 12 \times 700$ mm
$= 8400$ mm^2

* $a = \dfrac{\phi_s f_y A_s}{\alpha_1 \phi_c f'_c b} = \dfrac{0.85 \times 400 \text{ MPa} \times 8400 \text{ mm}^2}{0.8 \times 0.65 \times 25 \text{ MPa} \times 1000 \text{ mm}} = 219.69$ mm

* $A_c = \frac{\phi_s f_y A_s}{\alpha_1 \phi_c f'_c} = \frac{0.85 \times 400\,mpa \times 8400\,mm^2}{0.8 \times 0.65 \times 25\,mpa} = 219692.31\,mm^2$

* $A_f = b_f \times h_f$
$= 1000 \times 120$
$= 120000\,mm^2$

* $a = h_f + \frac{A_c - A_f}{b_{web}} = 120 + \frac{219692.31\,mm^2 - 120000\,mm^2}{300}$
$= 452.31\,mm$

Now,

$A_{web} = b_{web}\,(a - h_f)$

$= 300\,(452.04 - 120)$
$= 99612\,mm^2$

* $a' = \frac{A_f \times \frac{h_f}{2} + A_{web}\left(h_f + \frac{a - h_f}{2}\right)}{A_c}$

$= \frac{120000 \times \frac{120}{2} + 99612 \times \left(120 + \frac{452.31 - 120}{2}\right)}{219692.31\,mm^2}$

$= 265.06\,mm$

And

$M_r = T_r\,(d - a') = \phi_s F_y A_s\,(d - a')$

$= 0.85 \times 400\,mpa \times 8400\,mm^2\,(550 - 265.06)$

$\boxed{= 813.79\ KNm}$

Q.N. 4

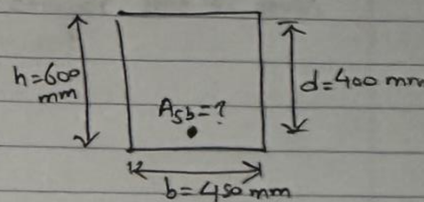
⇒ Solution:-

Given:-

$f'_c = 25$ MPa

$f_y = 400$ MPa

$E_s = 200000$ MPa



* Calculate depth (a)

$$\frac{c}{d} = \frac{0.0035}{0.0035 + \varepsilon_y}$$

$$c = \frac{400 \times 0.0035}{0.0035 + \frac{400 \text{ MPa}}{200000 \text{ MPa}}}$$

$$= 254.55 \text{ mm}$$

We know

$$a = \beta_1 c = 0.9 \times 254.55 \text{ mm} = 230 \text{ mm}$$

* Calculate the area of balanced reinforcement

$$C_r = T_r$$

$$C_r = \phi_s f_y A_{sb}$$

$$A_{sb} = \frac{C_r}{\phi_s f_y} = \frac{\alpha_1 \phi_c f'_c ab}{\phi_s f_y}$$

$$\therefore A_{sb} = \frac{0.85 \times 0.65 \times 25 \times 230 \times 450}{0.85 \times 400}$$

$$= 3957 \text{ mm}^2 \approx 4000 \text{ mm}^2 \text{ (approx)}$$

Given Bar size = 20 M

$= 300\ mm^2$

Num of bars required $= \dfrac{4000\ mm^2}{300\ mm^2}$

$= 13.34 \simeq 14$ bars

$= 14 - 20M$

$= 14 \times 300\ mm^2$

$\therefore\ A_{sf} = 4200\ mm^2$

And

$P_{balanle} = \dfrac{A_{sf}}{bd} = \dfrac{4200}{450 \times 400} = 0.0239$

$= 2.39\ \%$

* Calculate M_r

$M_r = T_r \times \left(d - \dfrac{a}{2}\right)$

$= 0.85 \times \underset{mpa}{400} \times 4200\ mm^2 \times \left(400mm - \dfrac{230mm}{2}\right)$

$= 406.98 \times 10^6\ N \cdot mm$

$\boxed{= 406.98\ kN \cdot m}$

Q·No5

⇒ Solution:-

Area of Tension bar = $4580\ mm^2$

Bar type = 30M ⇒ $700\ mm^2$

Num. of bars = ?

Now

A_s = Num. of bars × Bar type

$$\frac{4580\ mm^2}{700\ mm^2} = \text{Num. of Bars}$$

$\boxed{\therefore \text{ Number of Bars} = 6.54 \cong 7 \text{ bars}}$

Q·N·6

⇒ Solution:-

Width = 600 mm

Height = 700 mm

Length = 8 m = 8000 mm

$\therefore$ Area of beam = width × depth

= 600 mm × 700 mm

= 420000 mm^2 ⇒ 0.42 m^2

$\therefore$ Self weight = Density × Area

= 24 kN/m^3 × 0.42 m^2

$\boxed{= 10.08 \text{ kN/m}}$