STEP 7 : CHECK DEFLECTION

Slenderness ratio $= \frac{l}{d} = \frac{4300}{360}$

$= 11.94$

$\therefore$ Safe.

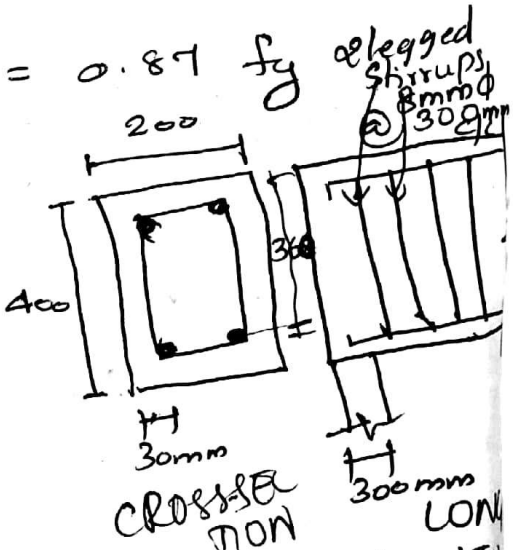
STEP 8 : CHECK FOR DEVELOPMENT LENGTH

From cl. 26.2.1 of IS 456:2000

$L_d = \frac{\phi \sigma_s}{4 \tau_{bd}}$ $\quad \sigma_s = 0.87 f_y$

$= \frac{12 \times 0.87 f_y}{4 \times 12}$

$=$



26.08.19
Monday

Design a balanced singly reinforced beam for an applied moment of 60 KNm the width of the beam is limited to 175mm. Use M20 concrete & Fe 415 steel.

Soln: $b = 175mm$

$M = 60 KNm \quad M_u = 60 \times 1.5 KNm$

$f_y = 415 N/mm^2$

$f_{ck} = 20 N/mm^2$

Annex. cl. G.1.1.c of IS 456:2000 Balanced → $x_u = x_{umax}$

Skipping first 4 steps.

$$Mu_{limit} = 0.36 \frac{x_{umax}}{d}\left[1 - 0.42 \frac{x_{umax}}{d}\right] bd^2 f_{ck}$$

$$60 \times 1.5 \times 10^6 = 0.36 \times \frac{0.48}{} \left[1 - 0.42 \times 0.48\right] 175 \times d^2 \times 20$$

$d = 385.75$ ~~385.75~~ 431.83 mm

Assume a clear cover of 30 mm & $\phi_b = 16$ mm

$$D = d + c + \phi/2$$

$$D = 431.83 + 30 + 16/2$$

$$= 469.83$$

$$D \approx 470 \text{ mm}$$

$$d = 470 - 30 - 8 = 432 \text{ mm}$$

cl. G.1.1.b of IS 456:2000

$$Mu = 0.87 f_y A_{st} d\left[1 - \frac{A_{st} f_y}{b d f_{ck}}\right]$$

$$60 \times 1.5 \times 10^6 = 0.87 \times 415 \; A_{st} \times 432\left[1 - \frac{A_{st} \times 415}{175 \times 432 \times 20}\right]$$

$$577.02 = A_{st} - \frac{A_{st}^2 \, 415}{175 \times 432 \times 20}$$

$$577.02 = A_{st} - 2.74 \times 10^{-4} A_{st}^2$$

$$2.74 \times 10^{-4} A_{st}^2 - A_{st} + 577.02 = 0$$

$A_{st} = 2931.18$, ~~718.451~~ 718.79 mm^2

pg. 46 Cl. 26.5.1.1.(a)

$$\frac{A_{st\,min}}{bd} = \frac{0.85}{f_y}$$

$$A_{stmin} = \frac{0.85 \times 175 \times 432}{415}$$

$$A_{stmin} = 154.843\ mm^2$$

Cl. 26.5.1.1.b

$$A_{stmax} = 0.04\,bD$$

$$= 0.04 \times 175 \times 470$$

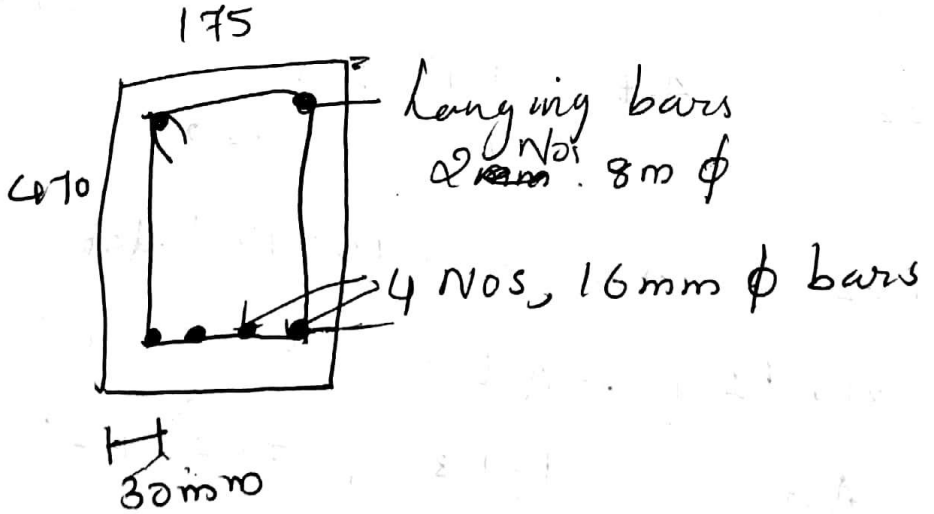
$$= 3290\ mm^2$$

ϕ 8, 12, 20, 24, 32

$$\therefore A_{st\,min} < A_{st} < A_{st\,max}$$

$$\text{No. of Bar} = \frac{A_{st}}{\text{Area of 1 bar}} = \frac{718.479}{\frac{\pi}{4} \times 16^2}$$

$$= 3.57 \approx 4\ \text{No.s}$$



Q:- Find the reinforcement for the beam of effective depth 500mm, width 175mm applied moment 60kNm Use M20 concrete & Fe415 steel.

$d = 500mm$

$b = 175mm$

$M = 60kNm$

$M_u = 60 \times 1.5 \text{ (FOS)} \ kNm = 90 \ kNm \Rightarrow$ ultimate moment

$f_{ck} = 20 \ N/mm^2$

$f_y = 415 \ N/mm^2$

From cl. G.1.1.c of IS 456:2000

$$M_{ulimit} = 0.36 \frac{x_{umax}}{d}\left[1 - 0.42 \frac{x_{umax}}{d}\right] bd^2 f_{ck}$$

$$= 0.36 \times 0.48 \left[1 - 0.42 \times 0.48\right] 175 \times 500^2 \times 20$$

25.09.2019 WEDNESDAY

$= 120.718080$ (6 decimal shift)

$M_u < M_{ulimit}$

∴ It is a singly reinforced section.

(4) Check whether under reinforced $x_u < x_{umax}$

From cl. G.1.1.c of IS 456:2000

$$M_u = 0.36 \frac{x_u}{d}\left[1 - 0.42 \frac{x_u}{d}\right] bd^2 f_{ck}$$

$$90 \times 10^6 \ Nmm = 0.36 \frac{x_u}{d}\left[1 - 0.42 \frac{x_u}{d}\right] 175 \times 500^2 \times 20$$

$$\frac{x_u}{d} - 0.4\left(\frac{x_u}{d}\right)^2 = 0.2857$$

$$-0.4\left(\frac{x_u}{d}\right)^2 + \frac{x_u}{d} - 0.2857 = 0$$

$$x = d\ \underline{0.328},\ 2.171$$

$$\frac{x_u}{d} = 0.33$$

$$\frac{x_{umax}}{d} = 0.48 \qquad \frac{x_u}{d} < \frac{x_{umax}}{d}$$

It is under reinforced

The section is safe

* Reinforcement = ?

Ast = ?

From Cl. G-1.1.b

$$M_u = 0.87 f_y A_{st} d \left[1 - \frac{A_{st} f_y}{b d f_{ck}}\right]$$

$$90 \times 10^6 = 0.87 \times 415 \times A_{st} \times 500 \left[\frac{1 - A_{st}\ 41}{175 \times 500 \times 20}\right.$$

$$498.546 = A_{st}\left[1 - \frac{A_{st}\ 415}{175 \times 500 \times 20}\right]$$

~~$A_{st} - A_{st}^2 - 87245$~~

$$A_{st} - 2.371 \times 10^{-4} A_{st}^2 - 498.546 = 0$$

$A_{st} = 577.66,\ 2139.91$

$A_{st} = 577.66 mm^2$

Cl. 26.5.1.1.a

$$\frac{A_{stmin}}{bd} = \frac{0.85}{f_y}$$

$$A_{stmin} = \frac{0.85 \times 175 \times 500}{415}$$

$$= 179.219 mm^2$$

Cl. 26.5.1.1.b

$A_{stmax} = 0.04 bD$

$D = d + c + \phi_2$ (Assumption) $= 500 + 30 + \frac{16}{2}$

$= 538$

$= 0.04 \times 538 \times 175$

$= 3766 mm^2$

$A_{stmin} < A_{st} < A_{stmax}$

179.219 < 577

A_{st} safe.

No. of bars $= \frac{A_{st}}{\text{Area of 1 bar}} = \frac{577}{\frac{\pi}{4} \times 16^2} = 2.86$

$= 3$ No.s

Q: A RC beam is supported on 2 walls 750mm thick spaced at a clear distance of 6m the beam carries a superimposed load of 9.8 kN/m Design the beam using 4 HYSD bars of Fe415 steel