BEHAVIOUR OF R.C BEAM SUBJECTED TO SHEAR:

1. A rectangular beam section of 300mm width and 450mm effective depth is reinforced with 4 bars of 20mm diameter. Determine the shear reinforcement required to resist shear force of 40kN. Consider concrete of grade M20 and steel of grade Fe415

GIVEN:

Width, $b = 300mm$, Effective depth, $d = 450mm$

$A_{st} = 4 \times \pi/4 \times 20^2 = 1256.6mm^2$

Factored shear force $= 1.5 \times 40 \times 10^3 = 60 \times 10^3 N$

$f_{ck} = 20N/mm^2$, $f_y = 415\ N/mm^2$

SOLUTION:

$\tau_c = \frac{V_u}{bd}$ (pg.no: 72)

Shear resisted by concrete, $V_{uc} = \tau_{ac} \times bd$

$$P_t = \frac{100 A_{st}}{bd} = \frac{100 \times 1256.6}{300 \times 450} = 0.93\%$$

pg.no - 73, Table 19.

P_t	τ_c (M20)
$x_1 = 0.75$	$y_1 = 0.56$
$x_2 = 1.00$	$y_2 = 0.62$
$x = 0.93$	$y = ?$

$$\frac{x - x_1}{y - y_1} = \frac{x_2 - x_1}{y_2 - y_1} \Rightarrow y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$

$$y = y_1 + \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$

$$y = 0.56 + \frac{0.62 - 0.56}{1 - 0.75}(0.93 - 0.75) = 0.6032\ N/mm^2$$

$\tau_c = 0.6032\ N/mm^2$

$V_{uc} = 0.6032 \times 300 \times 450 = 81432\ N = 81.432\ kN > V_u$

Hence, minimum shear reinforcement shall be provided.

Provide 2 legged - 8mm ϕ stirrups.

pg.no - 48 $\Rightarrow$ $\frac{A_{sv}}{bS_v} \geq \frac{0.4}{0.87 f_y}$

(i) $S_v = \frac{0.87 f_y A_{sv}}{0.4 b} = \frac{2.175 f_y A_{sv}}{b}$

$= \frac{2.175 \times 415 \times 2 \times \pi/4 \times 8^2}{300} = 302.47mm.$

pg.no - 47 $\Rightarrow$ $S_v = 0.75 d$

$= 0.75 \times 450$

$= 337.5\ mm$

$\Rightarrow S_v = 300mm.$

Provide 2 legged - 8mm diameter at 300mm c/c stirrups.

2. A rectangular beam section of 300mm width and 450mm effective depth is reinforced with 4 bars of 20mm diameter. Determine the shear reinforcement required to resist shear force of 140KN. Consider concrete of grade M20 and steel of grade Fe415.

GIVEN:

$b = 300MM$, $d = 450mm$. $Ast = 4 - 20mm\ \phi$

$Ast = 4 \times \pi/4 \times 20^2 = 1256.6mm^2$

Factored shear force , $Vu = 1.5 \times 140 \times 10^3 = 210 \times 10^3 N = 210 kN$

$fck = 20N/mm^2$, $fy = 415\ N/mm^2$

SOLUTION:

Shear resisted by concrete , $Vuc = \tau uc \times bd$.

$$P_t = \frac{100\,Ast}{bd} = \frac{100 \times 1256.6}{300 \times 450} = 0.93\%$$

Pg.no - 73, Table 19.

P_t	τ_c (M20)
$x_1 = 0.75$	$y_1 = 0.56$
$x_2 = 1.00$	$y_2 = 0.62$
$x = 0.93$	$y = ?$

$$y = y_1 + \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$

$$= 0.56 + \frac{0.62 - 0.56}{1 - 0.75}(0.93 - 0.75) = 0.6032\ N/mm^2$$

$\tau_c = 0.6032\ N/mm^2$

$Vuc = 0.6032 \times 300 \times 450 = 81432N = 81.432kN < Vu$

Hence, shear reinforcement is required.

Shear to be resisted by steel $\Big\}$ $V_{us} = V_u - V_{uc}$

$V_{us} = 210 - 81.432 = 128.568\,kN$

Provide 2 legged 8mm diameter stirrups.

Spacing between shear reinforcement can be calculated by

i) $S_v = \dfrac{0.87 f_y A_{sv} d}{V_{us}}$

$= \dfrac{0.8 \times 415 \times 2 \times \pi/4 \times 8^2 \times 450}{128.568 \times 10^3} = 126.37\,mm$

ii) $S_v = 2.175\, A_{sv} f_y / b = 2.175 \times 2 \times \pi/4 \times 8^2 \times 415/300$

$= 300.875\,mm$

iii) $S_v = 0.75d = 337.5\,mm$

iv) $S_v = 300\,mm.$

Provide 2 legged 8mm diameter stirrups at 125mm c/c