Design of Torsion Reinforcement

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Step I	Calculate the factored shear force, Bending Moment and Torsion Moment.
Step II	Calculate Mulim of given Section.
Step III	If $Mu \leq Mu,lim$ $$Ast = \frac{0.5 f_{ck}}{f_y} bd \left[1 - \sqrt{1 - \frac{4.6\ BMu}{f_{ck}\ bd^2}}\right]$$
Step IV	Calculate Equivalent shear force and Equivalent nominal stress $$V_{ue} = V_u + 1.6\ \frac{T_u}{b}$$ $$\tau_{ve} = \frac{V_{ue}}{bd}$$ $$\tau_{ve} \leq \tau_{c,max}$$
Step V	Calculate τ_c from table 19 of IS 456 corresponding to Ast of step III and grade of concrete.
Step VI	a) If $\tau_{ve} < \tau_c$, then longitudinal r/f is provided for Mu only and nominal shear r/f is provided. $$\frac{A_{sv}}{bS_v} \geq \frac{0.4}{0.87 f_y}$$ b) If $\tau_{ve} > \tau_c$, then longitudinal r/f is provided for M_{e1} & M_{e2} and shear reinforcement is to be designed for $(\tau_{ve} - \tau_c)bd$
Step VII	Longitudinal R/F design $$M_{e1} = T \times LA = 0.87 f_y Ast(d - 0.42X_u)$$ For X_u C=T Or, Compute Ast by formula if $M_{e1} < Mu,lim$ $$M_{e2} = 0.87 f_y Ast(d - d')$$
Step VIII	Design for Transverse R/f - Assume Suitable size of Shear Reinforcement - Only the outer two legs of the stirrup to be consider for resistance of torsion.
	Check the shear r/f for spacing a) $V_{use} = 0.87 f_y Asv(d/sv)$

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$$(\tau_{ve} - \tau_c)bd \leq 0.87 f_y Asv(d/sv)$$

Sv is calculated.

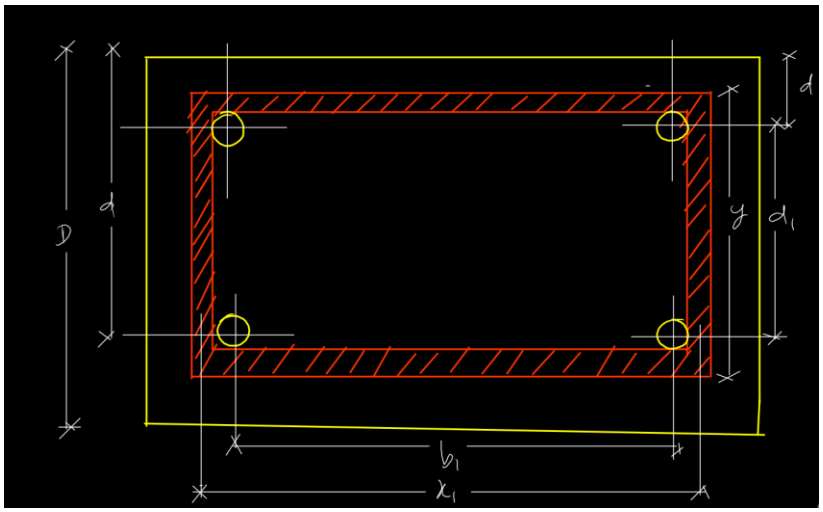
c) Asv = $\frac{T_u\, Sv}{b_1 d_1 (0.87 f_y)} + \frac{V_u Sv}{2.5\, d_1 (0.87 f_y)}$

$$0.87 f_y Asv\left(\frac{d}{sv}\right) = \frac{T_u}{b_1} + \frac{V_u}{2.5}$$

Asv = Area of 2 legged stirrups

b_1 = c/c distance between the corner bar along the width.

d_1 = c/c distance between the corner the corner bar along the depth.



Note : Here there is no restriction on characteristics strength of shear reinforcement i.e. fy>415 (fy can be greater than 415 N/mm^2)

Shear reinforcement shall be closed stirrups.

c) Spacing between the stirrups shall not exceed minimum of ,

$$Sv \leq \min of \left\{x_1, \frac{x_1 + y_1}{4}, 300mm\right\}$$

x_1 = c/c distance of the legs of shear r/f along shorter dimensions.

y_1 = c/c distance of the legs of shear r/f along longer dimensions