BEAM SWAY SHEAR CALCULATION (DUCTILE DESIGN)

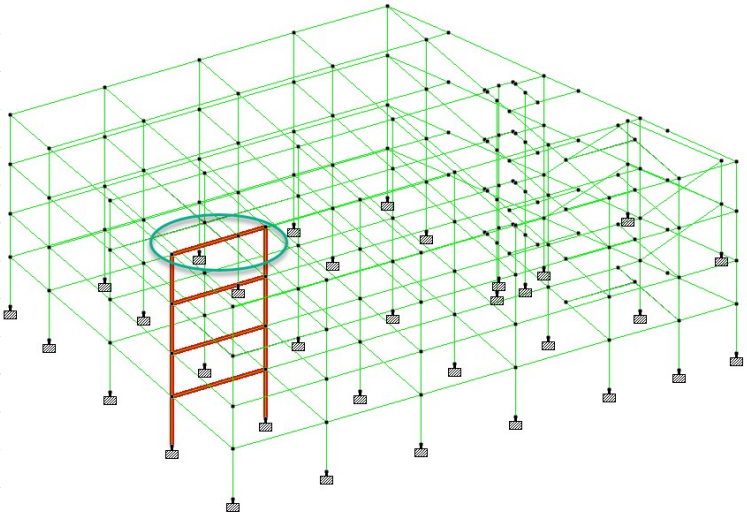
DESIGN CODE IS 13920-2016

Input / Defaults

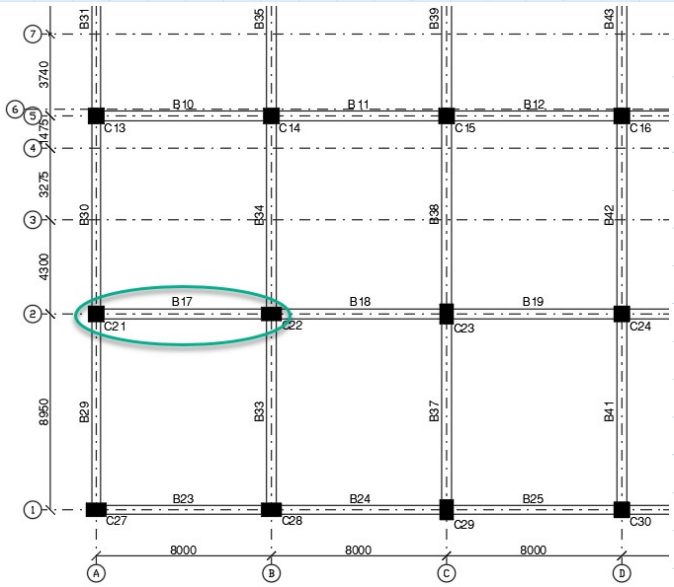
$BeamNo$: B17

$Location$: Left & Right Zone

$B := 450\ mm$	----------	Width of the Beam
$D := 800\ mm$	----------	Depth of the Beam
$L\_Clear := 7200\ mm$	----------	Clear Span of the Beam
$L\_Span := 8000\ mm$	----------	c/c Span of the Beam
$fck := 25\ MPa$	----------	Grade of Concrete (Cylindrical Strength)
$fy := 415\ MPa$	----------	Grade of Main Reinforcement
$fsy := 415\ MPa$	----------	Grade of Shear Reinforcement
$Cc := 25\ mm$	----------	Nominal Cover to Beam Tension Reinforcement
$Es := 200000\ MPa$	----------	Elastic Modulus of Reinforcement



Beam Location in STAAD



Beam Location in RCDC

Tension reinforcement Provided

Left Top

$\phi 1 := 20\ mm$ ---------- Diameter of Tension Reinforcement at Bottom Most layer

$N1 := 4$ ---------- No of Rebar at Bottom most Layer

$\phi 2 := 25.4\ mm$ ---------- Diameter of Tension Reinforcement at Inner layer

$N2 := 0$ ---------- No of Rebar at Inner Layer

$Ast1 := \frac{\pi \cdot \phi 1^2}{4} \cdot N1 + \frac{\pi \cdot \phi 2^2}{4} \cdot N2 = 1256.637\ mm^2$ ---------- Area of Tension Reinforcement Provided

Left Bottom

$\phi 1 := 20\ mm$ ---------- Diameter of Tension Reinforcement at Bottom Most layer

$N1 := 4$ ---------- No of Rebar at Bottom most Layer

$\phi 2 := 25.4\ mm$ ---------- Diameter of Tension Reinforcement at Inner layer

$N2 := 0$ ---------- No of Rebar at Inner Layer

$Ast2 := \frac{\pi \cdot \phi 1^2}{4} \cdot N1 + \frac{\pi \cdot \phi 2^2}{4} \cdot N2 = 1256.637\ mm^2$ ---------- Area of Tension Reinforcement Provided

Right Top

$\phi 1 := 25\ mm$ ---------- Diameter of Tension Reinforcement at Bottom Most layer

$N1 := 4$ ---------- No of Rebar at Bottom most Layer

$\phi 2 := 12.7\ mm$ ---------- Diameter of Tension Reinforcement at Inner layer

$N2 := 0$ ---------- No of Rebar at Inner Layer

$Ast3 := \frac{\pi \cdot \phi 1^2}{4} \cdot N1 + \frac{\pi \cdot \phi 2^2}{4} \cdot N2 = 1963.495\ mm^2$ ---------- Area of Tension Reinforcement Provided

Right Bottom

$\phi 1 := 20\ mm$ ---------- Diameter of Tension Reinforcement at Bottom Most layer

$N1 := 4$ ---------- No of Rebar at Bottom most Layer

$\phi 2 := 12.7\ mm$ ---------- Diameter of Tension Reinforcement at Inner layer

$N2 := 0$ ---------- No of Rebar at Inner Layer

$Ast4 := \frac{\pi \cdot \phi 1^2}{4} \cdot N1 + \frac{\pi \cdot \phi 2^2}{4} \cdot N2 = 1256.637\ mm^2$ ---------- Area of Tension Reinforcement Provided

$deff := 745\ mm$ ---------- Effective Depth of the Section

$LengthOfEachStatio := \frac{L\_Span}{12} = 666.667\ mm$ ---------- Each Beam is divided in to 12 stations

$ShearEndZone := 2 \cdot D = 1600\ mm$ ---------- End zone length as per User input

$ShearEndZone\_Actual := 2000\ mm$ ---------- End Zone length adjusted as per each station length

End Moments from Analysis Forces for Dead and Live load (See forces from analysis at end of document)

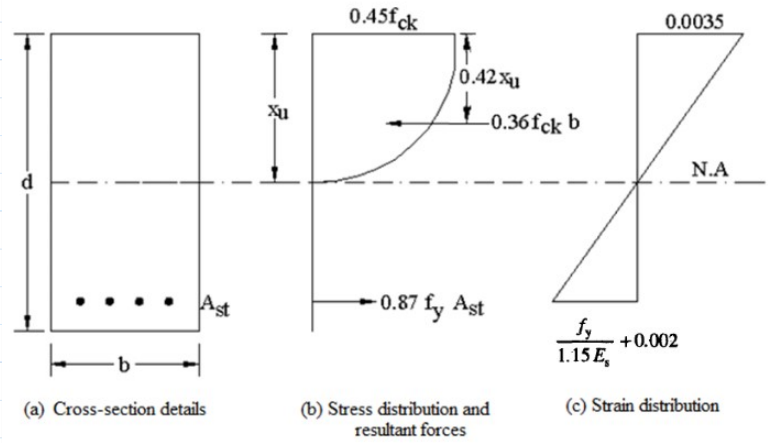
$M\_LH\_DL := 138.81\ kN \cdot m$ ---------- Moment due to Dead Load at Left End from Analysis forces

$M\_RH\_DL := 256.44\ kN \cdot m$ ---------- Moment due to Dead Load at Right End from Analysis forces

$M\_LH\_LL := 34.7\ kN \cdot m$ ---------- Moment due to Live Load at Left End from Analysis forces

$M\_RH\_LL := 35.16\ kN \cdot m$ ---------- Moment due to Live Load at Right End from Analysis forces

Calculation of Moment Capacity of Section



Where
Fy = Longitudinal Reinforcement Grade)
b = B (Width of Beam)
Ast = Area of Tension reinforcement Provided

$$Xu\_maxbyDeff := \frac{0.0035}{\left(0.0055 + \left(\frac{fy}{1.15 \cdot Es}\right)\right)} = 0.479$$

$$\frac{x_{u,max}}{d} = \frac{0{\cdot}003\,5}{(0{\cdot}005\,5 + 0{\cdot}87\,f_y/E_s)}$$

$$Xu\_max := Xu\_maxbyDeff \cdot deff = 356.979\ mm$$

$$Fc\_max := Xu\_max \cdot 0.36 \cdot fck \cdot B = 1445.766\ kN$$

$$Mu\_lim := Fc\_max \cdot \left(D - \left(Cc + 10 \cdot mm + 0.416 \cdot Xu\_max\right)\right) = 891.31\ m \cdot kN$$

$$Tensile\_Force1 := Ast1 \cdot 0.87 \cdot fy = 453.709\ kN$$
$$Tensile\_Force2 := Ast2 \cdot 0.87 \cdot fy = 453.709\ kN$$
$$Tensile\_Force3 := Ast3 \cdot 0.87 \cdot fy = 708.92\ kN$$
$$Tensile\_Force4 := Ast4 \cdot 0.87 \cdot fy = 453.709\ kN$$

$$Xact\_1 := \begin{cases} \text{if } Tensile\_Force1 > Fc\_max \\ \quad Xu\_max \\ \text{else} \\ \quad \dfrac{Tensile\_Force1}{0.36 \cdot fck \cdot B} \end{cases} = 112.027\ mm$$

$$Xact\_2 := \begin{cases} \text{if } Tensile\_Force2 > Fc\_max \\ \quad Xu\_max \\ \text{else} \\ \quad \dfrac{Tensile\_Force2}{0.36 \cdot fck \cdot B} \end{cases} = 112.027\ mm$$

$$Xact\_3 := \begin{cases} \text{if } Tensile\_Force3 > Fc\_max \\ \quad Xu\_max \\ \text{else} \\ \quad \dfrac{Tensile\_Force3}{0.36 \cdot fck \cdot B} \end{cases} = 175.042\ mm$$

$$Xact\_4 := \begin{cases} \text{if } Tensile\_Force4 > Fc\_max \\ \quad Xu\_max \\ \text{else} \\ \quad \dfrac{Tensile\_Force4}{0.36 \cdot fck \cdot B} \end{cases} = 112.027\ mm$$

Calculation of Moment Capacity for Provided Reinforcement

$$Mh\_left := \begin{cases} \text{if } Tensile\_Force1 > Fc\_max \\ \quad Mu\_lim + (Tensile\_Force1 - Fc\_max) \cdot (deff - Cc - 10 \cdot mm) \\ \text{else} \\ \quad Tensile\_Force1 \cdot (deff - (0.416 \cdot Xact\_1)) \end{cases} = 316.869\ kN \cdot m$$

$$Ms\_left := \begin{cases} \text{if } Tensile\_Force2 > Fc\_max \\ \quad Mu\_lim + (Tensile\_Force2 - Fc\_max) \cdot (deff - Cc - 10 \cdot mm) \\ \text{else} \\ \quad Tensile\_Force2 \cdot (deff - (0.416 \cdot Xact\_2)) \end{cases} = 316.869\ kN \cdot m$$

$$Mh\_right := \begin{cases} \text{if } Tensile\_Force3 > Fc\_max \\ \quad Mu\_lim + (Tensile\_Force3 - Fc\_max) \cdot (deff - Cc - 10 \cdot mm) \\ \text{else} \\ \quad Tensile\_Force3 \cdot (deff - (0.416 \cdot Xact\_3)) \end{cases} = 476.524\ kN \cdot m$$

$$Ms\_right := \begin{cases} \text{if } Tensile\_Force4 > Fc\_max \\ \quad Mu\_lim + (Tensile\_Force4 - Fc\_max) \cdot (deff - Cc - 10 \cdot mm) \\ \text{else} \\ \quad Tensile\_Force4 \cdot (deff - (0.416 \cdot Xact\_4)) \end{cases} = 316.869\ kN \cdot m$$

Calculation of Shear Caused by End Moments

$$V\_DLMoment := \frac{(M\_LH\_DL - M\_RH\_DL)}{L\_Clear} = -16.338\ \textbf{kN}$$

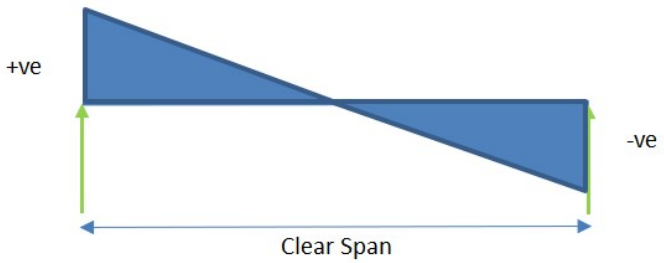
$$V\_LLMoment := \frac{(M\_LH\_LL - M\_RH\_LL)}{L\_Clear} = -0.064\ \textbf{kN}$$

Shear Causing End Moments due to Sway Left and Right

$$V\_SwayR := \frac{(-Ms\_left - Mh\_right)}{L\_Clear} = -110.193\ \textbf{kN}$$

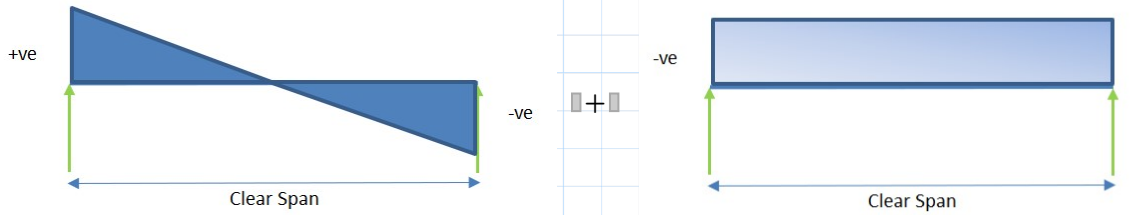
$$V\_SwayL := \frac{(Mh\_left - (-Ms\_right))}{L\_Clear} = 88.019\ \textbf{kN}$$

End Shear from Analysis Forces for Dead and Live load(See forces from analysis at end of document)



$V\_DL\_L := 135.27\ \textbf{kN}$
$V\_DL\_R := -164.85\ \textbf{kN}$
$V\_LL\_L := 23.94\ \textbf{kN}$
$V\_LL\_R := -24.08\ \textbf{kN}$

Net Shear from DL/LL and Moment



$$V\_DL\_L\_SS := V\_DL\_L - V\_DLMoment = 151.608 \ kN$$

$$V\_DL\_R\_SS := V\_DL\_R - V\_DLMoment = -148.513 \ kN$$

$$V\_LL\_L\_SS := V\_LL\_L - V\_LLMoment = 24.004 \ kN$$

$$V\_LL\_R\_SS := V\_LL\_R - V\_LLMoment = -24.016 \ kN$$

End Shear Due to Dead load+Live load and Sway (Clause 6.3.3)

$$DL\_LL\_L\_SwayR := 1.2 \cdot (V\_DL\_L\_SS + V\_LL\_L\_SS) + 1.4 \cdot V\_SwayR = 56.463 \ kN$$

$$DL\_LL\_R\_SwayR := 1.2 \cdot (V\_DL\_R\_SS + V\_LL\_R\_SS) + 1.4 \ V\_SwayR = -361.305 \ kN$$

$$DL\_LL\_L\_SwayL := 1.2 \cdot (V\_DL\_L\_SS + V\_LL\_L\_SS) + 1.4 \cdot V\_SwayL = 333.96 \ kN$$

$$DL\_LL\_R\_SwayL := 1.2 \cdot (V\_DL\_R\_SS + V\_LL\_R\_SS) + 1.4 \cdot V\_SwayL = -83.808 \ kN$$

Final Shear

$$Vu\_Sway\_L := \max(|DL\_LL\_L\_SwayR|, |DL\_LL\_L\_SwayL|) = 333.96 \ kN$$

$$Vu\_Sway\_R := \max(|DL\_LL\_R\_SwayR|, |DL\_LL\_R\_SwayL|) = 361.305 \ kN$$

RCDC Output - Design Calculation Report

Group	:	**G6**
Beam No	:	**B17**
Analysis Reference (Member)	:	7014 (16.258 m)
Beam Length	:	8000 mm
Breadth (B)	:	450 mm
Depth (D)	:	800 mm
Effective Depth (d)	:	745 mm
Design Code	:	IS 456 : 2000 + IS 13920 : 2016
Beam Type	:	Ductile Beam
Grade Of Concrete (Fck)	:	M25 N/sqmm
Grade Of Steel (Main)	:	Fe415 N/sqmm
Grade Of Steel (Shear)	:	Fe415 N/sqmm
Top/Bottom Clear Cover (Cmin)	:	25 mm
Side Clear Cover	:	25 mm
Es	:	2x10^5 N/sqmm
Ptnominal (%) (Bn)	:	0.2 %

Flexure Design						
	Beam Bottom			Beam Top		
	Left	Mid	Right	Left	Mid	Right
Critical L/C - RCDC	6	1	11	7	10	6
Mu (kNm)	99.13	293.26	11.04	299.8	16.96	473.8
Tu (kNm)	0	0	0	0	0	0
M_{Tu} (kNm)	0	0	0	0	0	0
Mud (kNm)	99.13	293.26	11.04	299.8	16.96	473.8
MuLim (kNm)	862	862	862	862	862	862
R	0.397	1.174	0.044	1.2	0.068	1.897
Ptmin (%) (A)	0.289	0.289	0.289	0.289	0.289	0.289
Ptclc (%) (B')	0.289	0.345	0.3	0.353	0.289	0.582
Pcclc (%) (C)	0	0	0	0	0	0
PtPrv (%)	0.375	0.375	0.375	0.375	0.375	0.586
AstCalc (sqmm)	969.4	1156.86	1005.3	1184.37	969.4	1950.82
AstPrv (sqmm)	1256.64	1256.64	1256.64	1256.64	1256.64	1963.48
Reinforcement Provided	4-T20	4-T20	4-T20	4-T20	4-T20	4-T25

Shear Design			
	Left	Mid	Right
Critical L/C - RCDC	1	1	1
PtPrv (%)	0.375	0.375	0.586
Vu (kN)	238.96	197.72	283.25
Tu (kNm)	0	0	0
V_{Tu} (kN)	0	0	0
Vut (kN)	238.96	197.72	283.25
V^{D+L} (kN)	210.85		206.92
Mh (kNm)	316.88		476.54
Ms (kNm)	316.88		316.88
Sway-Right (kN)	56.57		361.19
Sway-Left (kN)	334.08		83.69
Vu-Sway (kN)	334.08		361.19
Vud (kN)	334.08	197.72	361.19
Tv (N/sqmm)	1	0.59	1.08
Tc (N/sqmm)	0	0	0
Vc (kN)	0	0	0
Vus=Vud-Vc (kN)	334.08	197.72	361.19
Legs	4	4	4
Stirrup Rebar	8	8	8
Asv Torsion (sqmm)	-	-	-
Asv Torsion Prv (sqmm)	-	-	-
Asv Reqd (sqmm/m)	1242	735.06	1342.82
SvCalc (mm)	100	270	100
SvPrv (mm)	100	270	100
Asv Total Prv (sqmm)	2010.8	744.74	2010.8

Member Forces Table from RCDC

Beam	Analysis No	Load Case	Location	P	Mx	My	ShearX	ShearY	Torsion
			(m)	(kN)	(kNm)	(kNm)	(kN)	(kN)	(kNm)
B17	7014	LOAD 1: LOAD CASE 1	0	57.45	-0.41	138.81	0.06	135.35	0
		LOAD 1: LOAD CASE 1	0.67	57.45	-0.37	52.1	0.06	124.85	0
		LOAD 1: LOAD CASE 1	1.33	57.45	-0.33	-25.11	0.06	103.84	0
		LOAD 1: LOAD CASE 1	2	57.45	-0.29	-88.82	0.06	84.33	0
		LOAD 1: LOAD CASE 1	2.67	57.45	-0.25	-136.52	0.06	61.82	0
		LOAD 1: LOAD CASE 1	3.33	57.45	-0.21	-163.73	0.06	16.81	0
		LOAD 1: LOAD CASE 1	4	57.45	-0.17	-166.43	0.06	-14.71	0
		LOAD 1: LOAD CASE 1	4.67	57.45	-0.13	-144.12	0.06	-46.22	0
		LOAD 1: LOAD CASE 1	5.33	57.45	-0.1	-97.31	0.06	-91.24	0
		LOAD 1: LOAD CASE 1	6	57.45	-0.06	-30	0.06	-113.75	0
		LOAD 1: LOAD CASE 1	6.67	57.45	-0.02	53.31	0.06	-133.25	0
		LOAD 1: LOAD CASE 1	7.33	57.45	0.02	150.12	0.06	-154.26	0
		LOAD 1: LOAD CASE 1	8	57.45	0.06	256.44	0.06	-164.77	0
		LOAD 2: LOAD CASE 2	0	17.97	0.07	34.7	-0.05	23.95	0
		LOAD 2: LOAD CASE 2	0.67	17.97	0.04	18.86	-0.05	23.58	0
		LOAD 2: LOAD CASE 2	1.33	17.97	0.01	3.89	-0.05	20.58	0
		LOAD 2: LOAD CASE 2	2	17.97	-0.02	-9.19	-0.05	17.95	0
		LOAD 2: LOAD CASE 2	2.67	17.97	-0.05	-19.78	-0.05	14.57	0
		LOAD 2: LOAD CASE 2	3.33	17.97	-0.08	-26.74	-0.05	5.57	0
		LOAD 2: LOAD CASE 2	4	17.97	-0.11	-29.08	-0.05	-0.06	0
		LOAD 2: LOAD CASE 2	4.67	17.97	-0.14	-26.67	-0.05	-5.68	0
		LOAD 2: LOAD CASE 2	5.33	17.97	-0.17	-19.63	-0.05	-14.69	0
		LOAD 2: LOAD CASE 2	6	17.97	-0.2	-8.96	-0.05	-18.06	0
		LOAD 2: LOAD CASE 2	6.67	17.97	-0.23	4.2	-0.05	-20.69	0
		LOAD 2: LOAD CASE 2	7.33	17.97	-0.26	19.24	-0.05	-23.69	0
		LOAD 2: LOAD CASE 2	8	17.97	-0.29	35.16	-0.05	-24.07	0