BEAM SWAY SHEAR CALCULATION (SPECIAL DUCTILE FRAME)

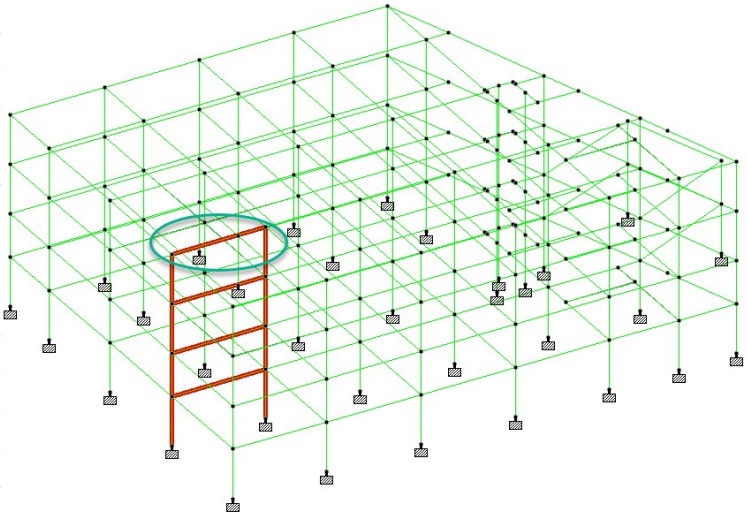
DESIGN CODE ACI 318M-2014

Input / Defaults

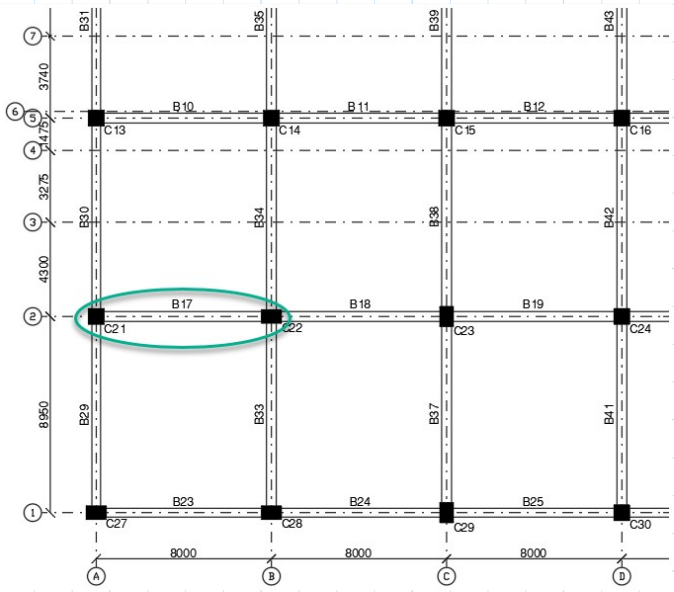
$BeamNo$: B17

$Location$: Left & Right Zone

$TypeOfBeam := 2$	----------	1- for Regular/Intermediate, 2 for Special Frame
$B := 450\ mm$	----------	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
$f'c := 20\ MPa$	----------	Grade of Concrete (Cylindrical Strength)
$fy := 420\ MPa$	----------	Grade of Main Reinforcement
$fsy := 420\ MPa$	----------	Grade of Shear Reinforcement
$Cc := 40\ mm$	----------	Nominal Cover to Beam Tension Reinforcement
$\lambda := 1$	----------	Modification factor



Beam Location in STAAD



Beam Location in RCDC

Tension reinforcement Provided

Left Top

$\phi 1 := 19.1\ mm$ ---------- 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

$Ast1 := \frac{\pi \cdot \phi 1^2}{4} \cdot N1 + \frac{\pi \cdot \phi 2^2}{4} \cdot N2 = 1146.084\ mm^2$ ---------- Area of Tension Reinforcement Provided

Left Bottom

$\phi 1 := 12.7\ mm$ ---------- Diameter of Tension Reinforcement at Bottom Most layer

$N1 := 5$ ---------- 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

$Ast2 := \frac{\pi \cdot \phi 1^2}{4} \cdot N1 + \frac{\pi \cdot \phi 2^2}{4} \cdot N2 = 633.384\ mm^2$ ---------- Area of Tension Reinforcement Provided

Right Top

$\phi 1 := 25.4\ mm$ ---------- 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

$Ast3 := \frac{\pi \cdot \phi 1^2}{4} \cdot N1 + \frac{\pi \cdot \phi 2^2}{4} \cdot N2 = 2026.83\ mm^2$ ---------- Area of Tension Reinforcement Provided

Right Bottom

$\phi 1 := 12.7\ mm$ ---------- Diameter of Tension Reinforcement at Bottom Most layer

$N1 := 5$ ---------- No of Rebar at Bottom most Layer

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

$N2 := 2$ ---------- No of Rebar at Inner Layer

$Ast4 := \frac{\pi \cdot \phi 1^2}{4} \cdot N1 + \frac{\pi \cdot \phi 2^2}{4} \cdot N2 = 886.738\ mm^2$ ---------- Area of Tension Reinforcement Provided

Reinforcement Grades as per Table 20.2.2.4(a)

$$fy\_M := \left| \begin{array}{l} \text{if } fy > 550\ MPa \\ \quad 550 \\ \text{else} \\ \quad fy \end{array} \right| = 420\ MPa$$

---------- Grade of reinforcement used for Bending of Special Frame Members. Table 20.2.2.4(a)

$deff := 730\ mm$ ---------- 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)

$M\_LH\_DL := 138.49\ kN \cdot m$ ---------- Moment due to Dead Load at Left End from Analysis forces

$M\_RH\_DL := 256.76\ kN \cdot m$ ---------- Moment due to Dead Load at Right End from Analysis forces

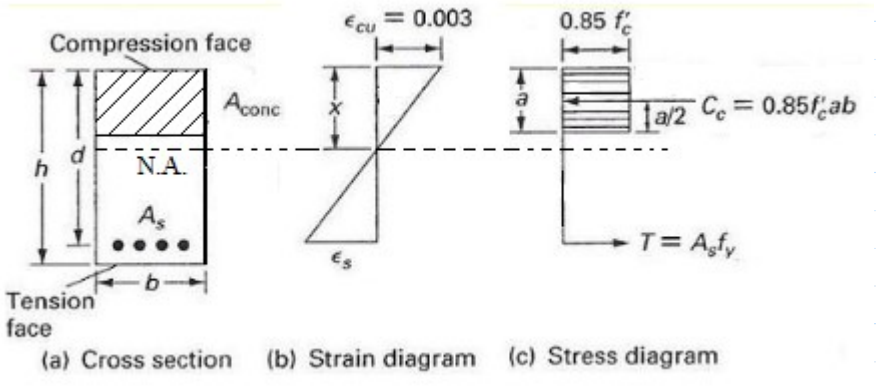
$M\_LH\_LL := 34.64\ kN \cdot m$ ---------- Moment due to Live Load at Left End from Analysis forces

$M\_RH\_LL := 35.21\ kN \cdot m$ ---------- Moment due to Live Load at Right End from Analysis forces

$$Reinf\_Factor := \left\| \begin{array}{l} \text{if } TypeOfBeam < 2 \\ \quad 1 \\ \text{else} \\ \quad 1.25 \end{array} \right. = 1.25$$

Notes on Fig. R18.6.5 (2)

Calculation of Compression block(a)



Where

Fy = fy_M (Main Reinforcement Grade)

b = B (Width of Beam)

As = Ast1 (Area of Tension reinforcement Provided)

$$a\_leftTop := Ast1 \cdot Reinf\_Factor \cdot \frac{fy\_M}{0.85 \cdot B \cdot f'c} = 78.653\ mm$$

$$a\_leftBot := Ast2 \cdot Reinf\_Factor \cdot \frac{fy\_M}{0.85 \cdot B \cdot f'c} = 43.468\ mm$$

$$a\_RightTop := Ast3 \cdot Reinf\_Factor \cdot \frac{fy\_M}{0.85 \cdot B \cdot f'c} = 139.096\ mm$$

$$a\_RightBot := Ast4 \cdot Reinf\_Factor \cdot \frac{fy\_M}{0.85 \cdot B \cdot f'c} = 60.855\ mm$$

Calculation of Moment Capacity for Provided Reinforcement

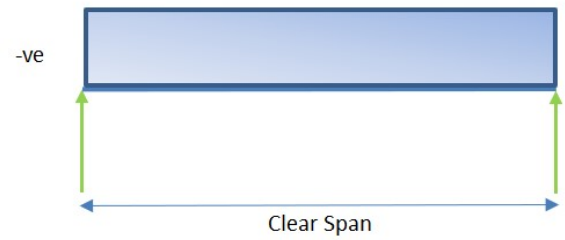
$$Mh\_left := Ast1 \cdot Reinf\_Factor \cdot fy\_M \cdot \left(deff - \frac{a\_leftTop}{2} \right) = 415.574\ kN \cdot m$$

$$Ms\_left := -1 \cdot Ast2 \cdot Reinf\_Factor \cdot fy\_M \cdot \left(deff - \frac{a\_leftBot}{2} \right) = -235.517 \ kN \cdot m$$

$$Mh\_right := Ast3 \cdot Reinf\_Factor \cdot fy\_M \cdot \left(deff - \frac{a\_RightTop}{2} \right) = 702.777 \ kN \cdot m$$

$$Ms\_right := -1 \cdot Ast4 \cdot Reinf\_Factor \cdot fy\_M \cdot \left(deff - \frac{a\_RightBot}{2} \right) = -325.677 \ kN \cdot m$$

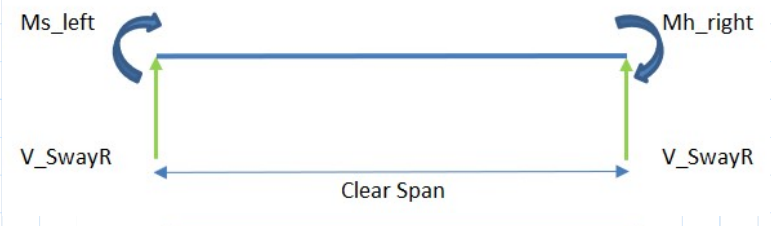
Calculation of Shear Caused by End Moments



$$V\_DLMoment := \frac{(M\_LH\_DL - M\_RH\_DL)}{L\_Clear} = -16.426 \ kN$$

$$V\_LLMoment := \frac{(M\_LH\_LL - M\_RH\_LL)}{L\_Clear} = -0.079 \ kN$$

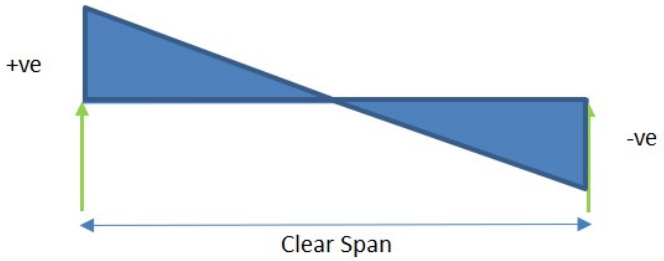
Shear Causing End Moments due to Sway Left and Right



$$V\_SwayR := \frac{(Ms\_left - Mh\_right)}{L\_Clear} = -130.319 \ kN$$

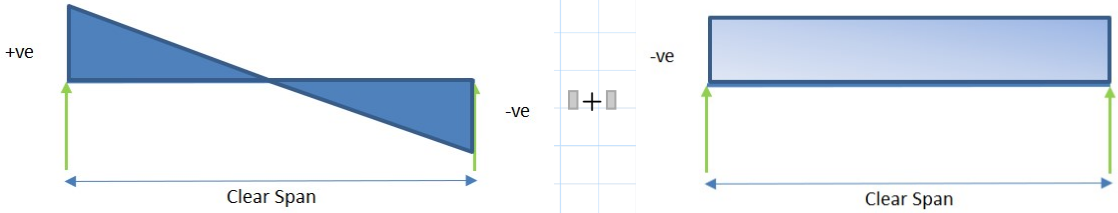
$$V\_SwayL := \frac{(Mh\_left - Ms\_right)}{L\_Clear} = 102.952 \ kN$$

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



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

Net Shear from DL/LL and Moment



$$V\_DL\_L\_SS := V\_DL\_L - V\_DLMoment = 151.696 \ kN$$

$$V\_DL\_R\_SS := V\_DL\_R - V\_DLMoment = -148.424 \ kN$$

$$V\_LL\_L\_SS := V\_LL\_L - V\_LLMoment = 24.019 \ kN$$

$$V\_LL\_R\_SS := V\_LL\_R - V\_LLMoment = -24.001 \ kN$$

End Shear Due to Dead load+Live load and Sway (Fig R18.6.5)

$$DL\_LL\_L\_SwayR := 1.2 \cdot V\_DL\_L\_SS + V\_LL\_L\_SS + V\_SwayR = 75.736 \ kN$$

$$DL\_LL\_R\_SwayR := (1.2) \cdot (V\_DL\_R\_SS) + V\_LL\_R\_SS + V\_SwayR = -332.428 \ kN$$

$$DL\_LL\_L\_SwayL := 1.2 \cdot V\_DL\_L\_SS + V\_LL\_L\_SS + V\_SwayL = 309.006 \ kN$$

$$DL\_LL\_R\_SwayL := 1.2 \cdot V\_DL\_R\_SS + V\_LL\_R\_SS + V\_SwayL = -99.158 \ kN$$

Final Shear

$$Vu\_Sway\_L := \max(|DL\_LL\_L\_SwayR|, |DL\_LL\_L\_SwayL|) = 309.006 \ kN$$

$$Vu\_Sway\_R := \max(|DL\_LL\_R\_SwayR|, |DL\_LL\_R\_SwayL|) = 332.428 \ kN$$

RCDC Output - Design Calculation Report

Group	:	**G6**
Beam No	:	**B17**
Analysis Reference (Member)	:	(16.258 m)
Beam Length	:	8000 mm
Breadth (B)	:	450 mm
Depth (D)	:	800 mm
Effective Depth (d)	:	730 mm
Design Code	:	ACI 318M - 14
Beam Type	:	Ductile Beam (Special Frame)
Grade Of Concrete (f'c)	:	C20 N/sqmm
Grade Of Steel (Main)	:	Fy420 N/sqmm
Grade Of Steel (Shear)	:	Fy420 N/sqmm
Grade Of Steel - Flexural Design	:	Fy420 N/sqmm
Grade Of Steel - Shear Design	:	Fy420 N/sqmm
Grade Of Steel - Torsion Design	:	Fy420 N/sqmm
Top/Bottom Clear Cover (Cmin)	:	40 mm
Side Clear Cover	:	40 mm
Es	:	2x10^5 N/sqmm
Mubal	:	1214.58 kNm
As,min (flex) (B)	:	1095 sqmm
As,nominal (Bn)	:	427.05 sqmm
As,min(user input)(B')	:	427.05 sqmm
Maximum percentage steel (User Defined)	:	4 %
Maximum percentage steel (Special Frame)	:	Min (4 , 2.5)
	:	2.5 %
Strength Reduction Factor φ (Shear)	:	0.6

For Longitudinal Reinf

	Beam Bottom			Beam Top		
	Left	**Mid**	**Right**	**Left**	**Mid**	**Right**
Critical L/C - RCDC	4	2	-	5	8	4
Mu (kNm)	67.71	246.24	-	262.18	2.59	403.04
As (flex) (sqmm) (C)	247.69	924.53	-	986.76	9.39	1551.07
Asc (flex) (sqmm) (A)	-	-	-	-	-	-
Tu (kNm)	-	-	-	-	-	-
Tcr/4 (kNm)	-	-	-	-	-	-
Al, min(sqmm)(Tor.) (D)	-	-	-	-	-	-
Al (sqmm) (Tor.) (E)	-	-	-	-	-	-
Al (Dist) (sqmm) (D)	-	-	-	-	-	-
Ast (sqmm)	570.06	1095	813.1	1095	427.05	1551.07
AstPrv (sqmm)	633.4	1140.12	886.76	1146.08	506.72	2026.84
Reinforcement Provided	5-#13	5-#13 4-#13	5-#13 2-#13	4-#19	4-#13	4-#25

For Transverse Reinf			
	Left	Mid	Right
Critical L/C - RCDC	5	4	4
PtPrv (%)	0.349	0.347	0.617
Vu (kN)	201.4	169.81	237.04
Mu-Sect (kNm)	262.18	15.3	403.04
Φ Vc (kN)	0	0	0
Vs (kN)	335.67	283.02	395.06
Aoh (sqmm)	-	-	-
At (sqmm/m)	-	-	-
Av (sqmm/m)	1094.82	923.08	1288.52
Tu (kNm)	0	0	0
At Torsion (sqmm/m)	-	-	-
Av Total Reqd (sqmm/m)	1094.82	923.08	1288.52
Asv Reqd (sqmm/m)	1094.82	923.08	1288.52
For Sway Shear			
V^{D+L} (kN)	206.06	134.88	202.11
Mh (kNm)	415.57	0	702.78
Ms (kNm)	235.52	0	325.69
Sway-Right (kN)	75.74	265.2	332.43
Sway-Left (kN)	309.01	31.93	99.15
Vu-Sway (kN)	309.01	265.2	332.43
Vud (kN)	309.01	265.2	332.43
Φ Vc Sway(kN)	0	0	0
Vs Sway(kN)	515.01	442	554.05
Asv Reqd Sway(sqmm/m)	1679.76	1441.62	1807.06
Asv Reqd Final = max (Asv Reqd , Asv Reqd Sway) (sqmm/m)	1679.76	1441.62	1807.06
Legs	2	2	2
Stirrup Rebar	10	10	10
SCalc (mm)	75	95	75
SPrv (mm)	75	95	75
Av Total Prv (sqmm/m)	1890.13	1492.21	1890.13

Member Forces Table from RCDC

Beam	Analysis No	Load Case	Location (m)	P (kN)	Mx (kNm)	My (kNm)	ShearX (kN)	ShearY (kN)	Torsion (kNm)
B17	7014	LOAD 1: LOAD CASE 1	0	57.34	0.73	138.49	-0.31	135.27	0
		LOAD 1: LOAD CASE 1	0.67	57.34	0.52	51.83	-0.31	124.77	0
		LOAD 1: LOAD CASE 1	1.33	57.34	0.32	-25.33	-0.31	103.76	0
		LOAD 1: LOAD CASE 1	2	57.34	0.12	-88.98	-0.31	84.25	0
		LOAD 1: LOAD CASE 1	2.67	57.34	-0.09	-136.63	-0.31	61.74	0
		LOAD 1: LOAD CASE 1	3.33	57.34	-0.29	-163.78	-0.31	16.73	0
		LOAD 1: LOAD CASE 1	4	57.34	-0.5	-166.43	-0.31	-14.79	0
		LOAD 1: LOAD CASE 1	4.67	57.34	-0.7	-144.07	-0.31	-46.3	0
		LOAD 1: LOAD CASE 1	5.33	57.34	-0.9	-97.21	-0.31	-91.32	0
		LOAD 1: LOAD CASE 1	6	57.34	-1.11	-29.85	-0.31	-113.83	0
		LOAD 1: LOAD CASE 1	6.67	57.34	-1.31	53.52	-0.31	-133.33	0
		LOAD 1: LOAD CASE 1	7.33	57.34	-1.52	150.39	-0.31	-154.34	0
		LOAD 1: LOAD CASE 1	8	57.34	-1.72	256.76	-0.31	-164.85	0
		LOAD 2: LOAD CASE 2	0	17.96	0.27	34.64	-0.11	23.94	0
		LOAD 2: LOAD CASE 2	0.67	17.96	0.2	18.81	-0.11	23.56	0
		LOAD 2: LOAD CASE 2	1.33	17.96	0.13	3.86	-0.11	20.56	0
		LOAD 2: LOAD CASE 2	2	17.96	0.05	-9.22	-0.11	17.94	0
		LOAD 2: LOAD CASE 2	2.67	17.96	-0.02	-19.8	-0.11	14.56	0
		LOAD 2: LOAD CASE 2	3.33	17.96	-0.09	-26.75	-0.11	5.56	0
		LOAD 2: LOAD CASE 2	4	17.96	-0.16	-29.08	-0.11	-0.07	0
		LOAD 2: LOAD CASE 2	4.67	17.96	-0.24	-26.66	-0.11	-5.7	0
		LOAD 2: LOAD CASE 2	5.33	17.96	-0.31	-19.61	-0.11	-14.7	0
		LOAD 2: LOAD CASE 2	6	17.96	-0.38	-8.94	-0.11	-18.08	0
		LOAD 2: LOAD CASE 2	6.67	17.96	-0.45	4.24	-0.11	-20.7	0
		LOAD 2: LOAD CASE 2	7.33	17.96	-0.53	19.29	-0.11	-23.71	0
		LOAD 2: LOAD CASE 2	8	17.96	-0.6	35.21	-0.11	-24.08	0