BEAM DESIGN CALCULATION

Project Name	:	a
Client Name	:	a
Engineer Name	:	a
Analysis File	:	D:\Scube\000 RCDC 2010\10.0.0\Standard model for Demo\Staad\RCDC-Staad-Demo -with RCC wall.std
Analysis Last Modified	:	12/31/2019 3:19:44 PM
Level Designed	:	16.258m

Sr.No.	Symbol		Definitions
1	α	=	Angle formed with horizontal line along length of Beam
2	Ach	=	Cross sectional area of structural member measures to the outside edge of transverse reinforcement in 'sqmm'
3	Ag	=	Cross sectional area of concrete in 'sqmm'
4	Ash	=	Total cross sectional area transverse reinforcement (including cross ties) within spacing S in 'sqmm'
5	Avd	=	Area of diagonal reinforcement in coupler beam in 'sqmm'
6	As	=	Area of Tension reinforcement required in 'sqmm'
7	As,min	=	Minimum area of flexural reinforcement in 'sqmm'
8	As,nominal	=	Nominal area of reinforcement in 'sqmm'
9	Al	=	Area of longitudinal reinforcement required to resist torsion in 'sqmm'
10	Al,face	=	Area of longitudinal reinforcement required on each face to resist torsion in 'sqmm'
11	At Torsion	=	Area of closed stirrups resisting torsion in 'sqmm'
12	AstPrv	=	Area of longitudinal reinforcement provided at given section in 'sqmm'
13	Av	=	Area of shear reinforcement required per meter length in 'sqmm'
14	Av,min	=	Minimum area of shear reinforcement in as per clause 11.4.6.1 in 'sqmm'
15	Al,min	=	Minimum area of longitudinal torsional reinforcement as per clause 11.5.5.3 in 'sqmm'
16	Av Total Reqd	=	Total area of shear reinforcement required, including that for torsion in 'sqmm'
17	Av Total Prv	=	Total area of shear reinforcement provided, including that for torsion in 'sqmm'
18	Ao	=	Gross area enclosed by shear flow path in 'sqmm'
19	Aoh	=	Area enclosed by centerline of the outermost closed transverse torsional reinforcement as per clause 11.5.3.1 in 'sqmm'
20	Ast	=	Total area of longitudinal reinforcement calculated at a given section in 'sqmm'
21	Asr	=	Area of Skin reinforcement calculated for given section in 'sqmm'
22	Asc	=	

			Area of Compression reinforcement required for doubly reinforced section or if torsion exists in 'sqmm'
23	b	=	Width of the Beam in 'mm'
24	bw	=	Width of Web (For flanged Beam) in 'mm'
25	b'	=	C/C distance between longitudinal reinforcement along B in 'mm'
26	bc	=	Oustside dimension of transverse reinforcement in 'mm'
27	Cc	=	Effective Cover to tension reinforcement in 'mm'
28	Cmin	=	Clear cover in 'mm'
29	c'	=	Effective cover to reinforcement at compression face in 'mm'
30	d	=	Effective depth of Beam in 'mm'
31	d'	=	C/C distance between longitudinal reinforcement along D in 'mm'
32	D	=	Depth of Beam in 'mm'
33	Es	=	Modulus of elasticity of steel in 'N/sqmm'
34	f'c	=	Specified compressive strength of concrete in cylinder in 'N/sqmm'
35	fs	=	Calculated tensile stress in reinforcement at service loads, 'N/sqmm'
36	Hf	=	Thickness of Flange in 'mm'
37	hx	=	Maximum C/C horizontal spacing of hoops legs on all faces in 'mm'
38	Icr	=	Moment Of Inertia Of concrete crack section
39	l	=	Effective Length Of Beam (Clear Span) in 'mm'
40	Legs	=	Number Of legs Of the shear reinforcement
41	Mcr	=	Cracking Moment
42	Mpr1	=	Hogging moments Of resistance Of member at the joint faces in 'kNm'
43	Mpr2	=	Sagging moments Of resistance Of member at the joint faces in 'kNm'
44	Mu	=	Factored Bending Moment at a section in 'kNm'
45	Mubal	=	Nominal flexural strength Of Singly Reinforced Section At Balance Neutral Axis in 'kNm'
46	Ptmin	=	Minimum percentage steel As per clause 10.5
47	PtPrv	=	Provided percentage steel
48	Stirrup	=	Bar mark representing shear stirrup
49	S	=	spacing Of confining links in 'mm'
50	SCalc	=	Stirrup spacing calculated As per Asv in 'mm'
51	Sprv	=	Stirrup spacing provided in 'mm'
52	Tcr	=	Cracking torque under pure Torsion in 'kNm'
53	Tu	=	Factored Torsional Moment at a section in 'kNm'
54	Ve	=	Earthquake induced shear in 'kNm'
55	φVc	=	Reduced Shear strength provided by concrete in 'kN'
56	Vu	=	Factored Shear Force at a section in 'kN'
57	Vu-A1(sway Left)	=	V^{D+L}_{left} - ($Mpr1_{left}$ + $Mpr2_{right}$ / L) in 'kN'

58	Vu-A2(sway Left)	=	V^{D+L}_{left} + ($Mpr2_{left}$ + $Mpr1_{right}$ / L) in 'kN'
59	Vu-B1(sway Right)	=	V^{DL}_{Right} - ($Mpr1_{left}$ + $Mpr2_{right}$ / L) in 'kN'
60	Vu-B2(sway Right)	=	V^{DL}_{Right} + ($Mpr2_{left}$ + $Mpr1_{right}$ / L) in 'kN'
61	Vud	=	Design Shear Force in 'kN'
62	Vs	=	Nominal shear strength provided by shear reinforcement in 'kN'
63	Vu sway	=	Max (Vu-A1,Vu-A2) & (Vu-B1,Vu-B2) in 'kN'
64	y	=	Neutral axis depth.
65	Φ	=	Strength reduction factor

All Forces are in 'kN', 'kNm', Stress in 'N/sqmm' & Dimension are in 'mm'.

Code References

ACI 318M - 2014

Sr.No.	Item		Clause / Table
1.	Ptmax	:	7.3.3.1, 8.3.3.1, 9.3.3.1
2.	As,min (flex) (B)	:	9.6.1.1, 9.6.1.2
3.	As,min	:	9.6.1.3
4.	Vc	:	22.5
5.	Asv	:	22.5.10.5 & 22.6.7
6.	Min Shear Reinf	:	9.6.3.1
7.	Max Stirrup Spacing	:	9.7.62
8.	Shear Reinf - Torsion	:	22.7.3.1
9.	Side Face Reinforcement	:	9.7.2.3
10.	Tcr	:	9.5.4.1
11.	fs,perm	:	10.6.4
12.	fc,perm	:	10.2.7.1
13.	Wcr	:	Eq 4.2(a)

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Sr.No.	Item		Clause / Table
1.	Ptmin	:	18.6.3.1
2.	Asmin	:	18.6.3.1
3.	Sclc	:	18.6.4.1 & 18.6.4.4

Group	**: G6**	
Beam No	**: B16**	
Analysis Reference (Member)	16.258m : 7014	
Beam Length	: 8000	mm
Breadth (B)	: 300	mm

Depth (D)	: 900	mm
Effective Depth (d)	: 830	mm
Design Code	: ACI 318M - 2014	
Beam Type	: Ductile Beam (Special Frame)	
Grade Of Concrete (f'c)	: C20	N/sqmm
Grade Of Steel	: Fy420	N/sqmm
Clear Cover (Cmin)	: 40	mm
Es	: 2x10^5	N/sqmm
Mubal	: 1046.76	kNm
As,min (flex) (B)	: 830	sqmm
As,nominal (Bn)	: 323.7	sqmm
As,min(user input)(B')	: 323.7	sqmm

For Longitudinal Reinf

	Beam Bottom			Beam Top		
	Left	**Mid**	**Right**	**Left**	**Mid**	**Right**
Critical L/C - RCDC	8	2	-	5	8	4
Mu (kNm)	56.56	199.83	-	279.98	24.32	383.08
As (flex) (sqmm) (C)	181.9	658.43	-	935.85	77.82	1305.57
Asc (flex) (sqmm) (A)	-	-	-	-	-	-
Tu (kNm)	1.02	1.67	-	1.65	1.02	1.52
Tcr/4 (kNm)	8.46	8.46	-	8.46	8.46	8.46
Al, min(sqmm)(Tor.) (D)	-	-	-	-	-	-
Al (sqmm) (Tor.) (E)	-	-	-	-	-	-
Al (Dist) (sqmm) (D)	-	-	-	-	-	-
Ast (sqmm)	323.7	830	694.96	935.85	323.7	1305.58
AstPrv (sqmm)	506.72	1013.44	760.08	1520.13	380.04	1520.13
Reinforcement	4-#13	4-#13 4-#13	4-#13 2-#13	3-#25	3-#13	3-#25

Note: Calculation of Ast

Ast	=	Max {B, C+D, A+D} (for Mu > 0 and C x 1.33 > B)
Ast	=	Max{B', C x 1.33 + D, A+D} (for Mu > 0 and C x 1.33 < B)
Ast	=	Bn (for Mu = 0)

Where,

A	=	Asc (flex)	=	Compression reinforcement required for bending moment
B	=	As,min (flex)	=	Min area of flexural reinforcement
Bn	=	As,nominal	=	Nominal area of reinforcement
C	=	As (flex)	=	Total area of longitudinal reinforcement calculated at a given section
D	=	Al (Dist)	=	Distributed longitudinal torsional reinforcement at section considered
Ast (Dist) (sqmm)			=	Max(Al,min (Tor), Al (Tor)) x ((2B) / (2B + 2D))

For Transverse Reinf			
	Left	**Mid**	**Right**
Critical L/C - RCDC	5	4	4
PtPrv (%)	0.61	0.153	0.61
Vu (kN)	178.37	153.61	204.63
Mu-Sect (kNm)	279.98	13.34	383.08
V^{D+L} (kN)	148.28	0	145.84
Mh (kNm)	599.95	0	599.95
Ms (kNm)	213.86	0	315.59
Sway-Right (kN)	35.25	0	258.87
Sway-Left (kN)	275.44	0	18.68
Vu-Sway (kN)	275.44	0	258.87
Vud (kN)	275.44	0	258.87
Φ Vc (kN)	0	0	0
Vs (kN)	297.28	256.01	341.04
Av (sqmm/m)	852.78	734.39	978.32
Tu (kNm)	1.65	1.52	1.52
Aoh (sqmm)	-	-	-
At (sqmm/m)	-	-	-
Legs	2	2	2
Stirrup Rebar	10	10	10
At Torsion (sqmm/m)	0	0	0
Av Total Reqd (sqmm/m)	852.78	734.39	978.32
Asv Reqd (sqmm/m)	1316.86	734.39	1237.68
SCalc (mm)	75	190	75
SPrv (mm)	75	190	75
Av Total Prv (sqmm/m)	1890.13	746.11	1890.13

Maximum Spacing Criteria

Basic

Spc1 = 415 mm

Spc2 = 300 mm

For Torsion

(X1 = 229.5, Y1 = 829.5)

Spc3 = 300 mm

Spc4=(X1+Y1)/4 = 265 mm

For Ductility (Special Frames)

Left Section, Right Section

Spc5 = 6 x Small Longitudinal Dia = 76 mm

Spc6 = d / 4 = 208 mm

Spc7	=	150	mm
Provided Spacing	=	75	mm

Mid Section

Provided Spacing	=	300	mm

Skin reinforcement

Beam Width	= 300	mm
Beam Depth	= 900	mm
Depth	= 900 <= 900,	Hence Skin Reinforcement is not required.
