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STABILITY CERTIFICATE

Date : 10/06/2026

The detailed engineering and structure design of the proposed building comprising of Stilt+5 Floors at – Madurai Corporation – Ward No. XXIII, Block S.No.26 -T.S. Nos. 16/6A, 17/3A & 17/3B – (Ponmeni Village R.S. Nos. 177pt & 179/6Apt) Madurai west Taluk, Madurai District. Site area 3520.00 Sq.m Proposal of residential building (Stilt+5 Floors) for FSI area of 7613.40 SQ.M (2 Blocks) has been done by me/us based on the report of geotechnical investigation (soil test) done by Geomatrix Report No. 371/RB/GMC/25-26 Dated 22/01/26 and considering the functional requirement of the building.

2.It is certified that among other factors, the proposed building has been designed to resist earthquake. I/We have checked various parameters and found that the proposed building would be safe.

3. I/We further certify that:

(i) The minimum grade of concrete is M20

(ii) The design and analysis has been done using the code of practice for plain and reinforced concrete as per IS 456, design loads as per IS Codes No IS 875 and design of earthquake resistant structure as per IS Code No IS 1893

4.The building will be safe and sound when used for the purpose for which it is designed.

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Encl.: Structural Design Calculation

Stamp and Signature

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Date : 10/06/2026

CERTIFICATE FOR STRUCTURAL DESIGN SUFFICIENCY AND SAFE & SOUND

With respect to the proposed construction of Residential unit in

Residential Building Madurai West Taluk – Madurai Corporation – Ward No. XXIII, Block No.26 -T.S. Nos. 16/6A, 17/3A & 17/3B – (Ponmeni Village R.S. Nos. 177pt & 179/6Apt) –Site area 3520.00 Sq.m Proposal of residential building (Stilt+5 Floors) for FSI area of 7613.40 SQ.M (2 Blocks).

We certify that the designs are being done after detailed soil investigation and the design is being done to meet all the structural stability requirements as stipulated in IS 456,IS 875 and other relevant codes, and it is structurally safe & sound.

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Date: 10/06/2026

STRUCTURAL DESIGN STABILITY CERTIFICATE

This is to certify that the PROPOSED NEW CONSTRUCTION OF RESIDENTIAL Units in Madurai West Taluk – Madurai Corporation – Ward No. XXIII, Block No.26 -T.S. Nos. 16/6A, 17/3A & 17/3B – (Ponmeni Village R.S. Nos. 177pt & 179/6Apt) Site area 3520.00 Sq.m Proposal of residential building (Stilt +5 Floors) for FSI area of 7613.40 SQ.M (2 Blocks). Is designed as per the following IS Codes

1. IS: 456:2000,code of practice for plain and reinforced concrete
2. IS:875-1987,code of practice for design loads for building and structures.
3. IS:1893-2016,criteria for earthquake resistant design of structures.

The building Designed by me consists of Stilt + 5 floors + Stair Case Head Room, and Water Tank, the R.C.C .building frame of the structure is designed as per the Indian Standard code of practice for concrete and loadings. The loading stress parameters are within limits of practice of National Building Code and other Bureau of Indian standards code.

The Structure will be Constructed as per our structural Design and detailing of reinforcements given in our drawing from foundation to roof slab. Regular Site Inspection will be done to ensure Quality of Work and Materials used.

As per calculations & Detailing the above said building is structurally safe.

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STRUCTURAL DESIGNCALCULATIONS

(LOAD CALCULATIONS)

Date : 10/06/2026

STRUCTURE:

The proposed Building has been en visages R.C Framed Structure with Stilt + 5 floors. The Stilt + 5 floors is intended for Residential Utility.

ANALYSIS&DESIGN:

The Structure has been idealized as 3D Frame, with R.C Slab &Beam. All Beams are inter connecting with Columns .The design of all R.C components is done using Limit State Method.

The following codes of the Indian Standards are adopted in the Structural Design:

IS: 456-2000	Plain and Rein forced Concrete-code of Practice(Fourth Revision)
IS:875-1987	Code of Practice for Design loads (other than Earthquake) for Building sand Structures. Part(1) – Dead Loads –Unit Weights of Building Materials and Stored Materials (second revision) Part(2)- Impact Loads (second revision) Part(3) – Wind Loads (second revision) Part(4) – Snow Loads (second revision) Part(5) – Special Loads and Load Combinations.
IS:1893-2002	Criteria for Earthquake Resistant Design of Structures (Fifth Revision).

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IS:13920-1993		Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces- Code of Practice.
SP7:1983		National Building Code of India1983.
SP:34(S&T)-1987	-	Hand Book on Concrete Rein for cement and Detailing.
SP:23(S&T)-1982	-	Hand Book on Concrete Mixes.
SP:16(S&T)-1980	-	Design Aids for Rein forced Concrete to IS: 456-1978.

The concrete grade assumed for all R.CC members is .The Steel grade considered in the design is Fe500.

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FOOTING DESIGN CALCULATIONS

Project Name	:	Unassigned
Client Name	:	Unassigned
Engineer Name	:	Unassigned
Design File	:	E:\Arun\Jobs\checking\For Current Checking\6231 ETABS\RCDC\6231 Footings.rcdx
Analysis File	:	E:\Arun\Jobs\checking\For Current Checking\6231 ETABS\6231_Visvas_190626.accdb
Analysis Last Modified	:	19-06-2026 14:55:17

Definitions:

1.	α	=	Coefficient of Thermal Expansion
2.	ε1	=	Strain at level considered, Calculated ignoring the stiffening of the concrete in tension zone
3.	εm	=	Average steel strain at level considered
4.	ρact	=	Percentage steel provided
5.	ρcrit	=	Percentage steel critical as per code
6.	A	=	Plan area of footing base
7.	Acr	=	Distance from the point considered to the surface of the nearest longitudinal bar
8.	AstPrv	=	Area of tensile reinforcement provided
9.	Astrqd	=	Area of tensile reinforcement required
10.	Asv	=	Area of shear reinforcement required
11.	AsvPrv	=	Area of shear reinforcement provided
12.	A1	=	Bearing area of footing at slope of 1:2
13.	A2	=	C/s Area of column
14.	B	=	Width of footing base
15.	Beff	=	Effective width of footing
16.	BoffB	=	Footing offset along B below column in plan
17.	BoffT	=	Footing offset along B above column in plan
18.	B1	=	Width of sloped footing at top
19.	ColOff	=	Column offset in sloped footing
20.	D	=	Depth of footing
21.	Deff	=	Effective Depth of footing
22.	Df	=	Depth of founding layer
23.	Dw	=	Ground water level
24.	Ec	=	Modulus of elasticity of concrete
25.	Es	=	Modulus of elasticity of steel
26.	Foss	=	Safety factor against sliding
27.	Fosu	=	Safety factor against uplift
28.	Fst	=	Stress in steel
29.	L	=	Length of footing base
30.	Leff	=	Effective length of footing
31.	LoffL	=	Footing offset along L on left side of column
32.	LoffR	=	Footing offset along L on right side of column
33.	L1	=	Length of sloped footing at top
34.	Mx	=	Bending Moment along column D
35.	Mx'	=	Bending Moment along column D due to odd shaped column
36.	Mex	=	Eccentricity moment along column D

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37.	Mxx	=	Total Bending Moment along column D (Mx + Mx' + Mex)
38.	My	=	Bending Moment along column B
39.	My'	=	Bending Moment along column B due to odd shaped column
40.	Mey	=	Eccentricity moment along column B
41.	Myy	=	Total Bending Moment along column B (My + My' + Mey)
42.	Muy	=	Factored moment along column B
43.	Muy'	=	Factored Moment along column B due to odd shaped column
44.	Mux	=	Factored moment along column D
45.	Mux'	=	Factored Moment along column D due to odd shaped column
46.	Netdown	=	Net downward load
47.	OB	=	Maximum permissible offset on bottom side of column in plan
48.	OL	=	Maximum permissible offset on left side of column in plan
49.	OR	=	Maximum permissible offset on right side of column in plan
50.	OT	=	Maximum permissible offset on top side of column in plan
51.	P	=	Axial load for footing sizing
52.	P1	=	Soil pressure at corner 1
53.	P2	=	Soil pressure at corner 2
54.	P3	=	Soil pressure at corner 3
55.	P4	=	Soil pressure at corner 4
56.	Pdelta	=	Column Load to be transferred by reinforcement
57.	Pt	=	Calculated percentage tensile reinforcement
58.	Pu	=	Factored axial load
59.	q	=	Surcharge Load
60.	sp	=	Spacing Between bars at outer most layer
61.	SPu	=	Upward Soil Pressure
62.	SPuL	=	Upward Soil Pressure from left
63.	SPuR	=	Upward Soil Pressure from right
64.	SPuB	=	Upward Soil Pressure from bottom
65.	SPuT	=	Upward Soil Pressure from top
66.	Tc	=	Design shear strength of concrete
67.	Temp1	=	Peak Hydration temperature
68.	Temp2	=	Seasonal Temperature Variations
69.	Tv	=	Nominal shear stress
70.	Vu	=	Design shear force
71.	Vus	=	Strength of shear reinforcement
72.	Vx	=	Shear along major axis
73.	Vy	=	Shear along minor axis
74.	Waterpr	=	Upward water pressure
75.	Waterup	=	Upward force due to water
76.	Wcr	=	Surface Crack Width
77.	WFoot	=	Add. Wt. due to difference in concrete and soil density
78.	WFootc	=	Weight of footing and column with concrete density
79.	WSoil	=	Weight of soil covering footing area
80.	Zx	=	Section modulus of footing base along L
81.	Zy	=	Section modulus of footing base along B

Code References:

IS 456

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	Parameter		Reference
1.	Ptmax	:	Cl. 26.5.2.1
2.	Ptmin	:	Cl. 26.5.2.1
3.	Pt	:	Cl. 38
4.	Tc	:	Cl. 40.2.1
5.	Tcmax	:	Cl. 40.2.3
6.	Asv	:	Cl. 40.4
7.	Min Shear Reinf	:	Cl. 26.5.1.6
8.	Max Stirrup Spacing	:	Cl. 26.5.1.5
9.	Punching Shear design	:	Cl. 31.6.3
10.	Load transfer	:	Cl. 34.4
11.	Ptnominal	:	Cl. 34.5.2
12.	Crack width calculation	:	Annex-F
13.	Cracking	:	Cl. 35.3.2

BS 8007 (For Early / Initial Thermal Cracking)

1.	Surface Zone for suspended slab	:	Figure A.1
2.	Surface Zone for ground slab	:	Figure A.2
3.	Factors for the calculation of minimum reinforcement	:	Table A.1

Design Code	:	IS 456 : 2000 + IS 13920 : 2016	
Footing No	:	FC20	
Column No	:	C20	(205 mm X 460 mm)
Analysis No	:	C20	
Concrete Grade	:	M25	N/sqmm
Steel Grade	:	Fe500	N/sqmm
Clear Cover	:	40	mm
Df	:	4 M	
Dw	:	1 M	
Density of Soil	=	18	kN/cum
Soil Bearing Capacity	=	250	kN/sqm
Permissible SBC Increase for EQ	=	25	%
Permissible SBC Increase for Wind	=	25	%
Live Load Reduction	=	50	%
Design cross section by	:	Average pressure	
Footing Type	:	Sloped	
Footing Size (Lx B x D)	:	2100mm X 1850mm X 625mm, d = 300mm.	
Column Offset	:	50 mm	
Without considering Effect of Water Table			
Footing Self Wt., F1	=	42.33 kN	
Soil Weight, S1	=	0.00 kN	

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Total Weight, W1	=	F1 + S1	
	=	42.33	kN
Offset Along L (Loff)	=	820	mm
Offset Along B (Boff)	=	822.5	mm

Check For Maximum Soil Pressure:

Critical Analysis Load Combination	=	1(DL+LL)	
Critical Load Combination	=	[2] : (BRICKWALL) +(DEAD) +(FLOORFINISH) +(STAIRCASEDEAD) +(LIVE) + (STAIRCASELIVE)	
Pcomb	=	894.24	kN
P	=	Pcomb + W1	
P	=	936.57	kN
Mx	=	0	kNm
My	=	0	kNm
P/A	=	241.07	kN/sqm
Mx/Zx	=	0	kN/sqm
My/Zy	=	0	kN/sqm
Maximum Soil Pressure	=	241.07	kN/sqm
Allowable Soil Pressure	=	1x250	kN/sqm
	=	250	kN/sqm

Check For Minimum Soil Pressure:

Critical Analysis Load Combination	=	1(DL+LL)	
Critical Load Combination	=	[2] : (BRICKWALL) + (DEAD) +(FLOORFINISH) + (STAIRCASEDEAD) + (LIVE) +(STAIRCASELIVE)	
Pcomb	=	894.24	kN
P	=	Pcomb + W1	
P	=	936.57	kN
Mx	=	0	kNm
My	=	0	kNm
P/A	=	241.07	kN/sqm
Mx/Zx	=	0	kN/sqm
My/Zy	=	0	kN/sqm
Minimum Soil Pressure	=	241.07	kN/sqm
	>	0	

Design For Bending:

Bottom Reinforcement Along L:

Critical Analysis Load Combination	=	1.5(DL+LL)	
Critical Load Combination	=	[3] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Pu	=	1341.36	kN
Mux	=	0	kNm
Muy	=	0	kNm
P/A	=	345.27	kN/sqm
Mx/Zx	=	0	kN/sqm

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My/Zy	=	0	kN/sqm
Deff	=	577	mm
Beff	=	498.13	mm
SPu	=	345.27	kN/sqm
Mu	=	SPu X B X Loff X Loff / 2	
	=	214.75	kNm
Pt	=	0.318	%
Ast Rqd (BM)	=	914	sqmm
Ast Prv (Distributed Across Total Width)	=	12 - 10Y @ 170	
	=	942	sqmm

Top Reinforcement Along L:

(D+dmin) /2	=	462.50	mm
	<=	1000	mm, Hence
Ast	=	Min Pt for Top Reinforcement X [(D+dmin)/2] X B	
	=	0.06% X 463 X 1850	
	=	513	sqmm
Ast Prv (Distributed Across Total Width)	=	9 - 10Y @ 300 c/c	
	=	628	sqmm

Bottom Reinforcement Along B:

Critical Analysis Load Combination	=	1.5(DL+LL)	
Critical Load Combination	=	[3] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Pu	=	1341.36	kN
Mux	=	0	kNm
Muy	=	0	kNm
P/A	=	345.27	kN/sqm
Mx/Zx	=	0	kN/sqm
My/Zy	=	0	kN/sqm
Deff	=	561	mm
Leff	=	752.5	mm
SPu	=	345.27	kN/sqm
Mu	=	SPu X L X Boff X Boff / 2	
	=	245.25	kNm
Pt	=	0.251	%
Ast Rqd (BM)	=	1058	sqmm
Ast Prv (Distributed Across Total Length)	=	14 - 10Y @ 165	
	=	1100	sqmm

Top Reinforcement Along B:

(D+dmin) /2	=	463	mm
	<=	1000	mm, Hence
Ast	=	Min Pt for Top Reinforcement X [(D+dmin)/2] X L	
	=	0.06% X 463 X 2100	

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	=	583	sqmm
Ast Prv (Distributed Across Total Length)	=	9 - 10Y @ 300 c/c	
	=	707	sqmm

Design For Shear:

One Way Shear Along L:

Critical Section @ d from Column Face

	=	577	mm
Critical Analysis Load Combination	=	1.5(DL+LL)	
Critical Load Combination	=	[3] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Pu	=	1341.36	kN
Mux	=	0	kNm
Muy	=	0	kNm
P/A	=	345.27	kN/sqm
Mx/Zx	=	0	kN/sqm
My/Zy	=	0	kN/sqm
Deff	=	355	mm
Beff	=	1362.42	mm
SPu	=	345.27	kN/sqm
Vu	=	SPu X (Loff - d) X B	
	=	155.21	kN
Tv	=	Vu / (Beff X Deff)	
	=	0.32	N/sqmm
Tc	=	0.4	N/sqmm
Tv	<	Tc	

One Way Shear Along B:

Critical Section @ d from Column Face

	=	561	mm
Critical Analysis Load Combination	=	1.5(DL+LL)	
Critical Load Combination	=	[3] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Pu	=	1341.36	kN
Mux	=	0	kNm
Muy	=	0	kNm
P/A	=	345.27	kN/sqm
Mx/Zx	=	0	kN/sqm
My/Zy	=	0	kN/sqm
Deff	=	346	mm
Leff	=	1578.69	mm
SPu	=	345.27	kN/sqm
Vu	=	SPu X (Boff - d) X L	

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	=	189.60	kN
Tv	=	Vu / (Leff X Deff)	
	=	0.35	N/sqmm
Tc	=	0.37	N/sqmm
Tv	<	Tc	

Design For Punching Shear:

Critical Section @ d/2 from Column Face

	=	284	mm
Critical Analysis Load Combination	=	1.5(DL+LL)	
Critical Load Combination	=	[3] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Pu	=	1341.36	kN
Mux	=	0	kNm
Muy	=	0	kNm
P/A	=	345.27	kN/sqm
Mx/Zx	=	0	kN/sqm
My/Zy	=	0	kN/sqm
Deff	=	470	mm
Leff	=	1029	mm
Beff	=	774	mm
Punching Perimeter	=	3606	mm
Punching Area	=	1696046.04	sqmm
SPu	=	Average Pressure	
	=	345.27	kN/sqm
Vu	=	SPu X ((L X B)-(Leff X Beff))	
	=	1066.37	kN
Tv	=	Vu / Punching Area	
	=	0.629	N/sqmm
Tc	=	1.182	N/sqmm
Tv	<	Tc	

Load Transfer Check For Load Transfer From Column To Footing

Critical Analysis Load Combination	=	1.5(DL+LL)	
Critical Load Combination	=	[3] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Pu	=	1341.36	kN
A2	=	0.09	sqm
A1	=	8.01	sqm
Base Area	=	3.89	sqm
A1	>	Base Area	
Thus, A1	=	3.89	
Modification Factor	=	SquareRoot(A1/A2) <= 2	
SquareRoot(A1/A2)	=	6.5744	

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Thus, Modification Factor	=	2	
Concrete Bearing Capacity	=	0.45 X Fck X Modification Factor X Column Area	
	=	2121.75	kN
Concrete Bearing Capacity	>	Pu, Hence Safe.	

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COLUMN DESIGN CALCULATIONS

Project Name	:	Unassigned
Client Name	:	Unassigned
Engineer Name	:	Unassigned
Analysis File	:	E:\Arun\Jobs\checking\For Current Checking\6231 ETABS\6231_Visvas_190626.accdb
Analysis Last Modified	:	19-06-2026 14:55:17

Definitions Of Terms:

All forces in units kN and m

All reinforcement details like area, spacing are mm

Grade Of steel for 6 mm dia. bars is Fe250. It is irrespective of the grade of steel defined by user in column design.

Neutral axis angle for resultant design moment is with respect to local major axis.

1	β	=	Stiffness proportion factor at joint (column stiffness/sum of stiffness of all members connected at joint)
2	Δu	=	Elastically computed first order lateral deflection. (Relative deflections)
3	ε1	=	Strain at level considered, Calculated ignoring the stiffening of the concrete in tension zone
4	εm	=	Average steel strain at level considered
5	acr	=	Distance from the point considered to the surface of the nearest longitudinal bar
6	Ag	=	Gross area of the column cross section
7	Aeff	=	Effective area of column / wall considered for shear check in sqmm
8	Ak	=	Area of confined concrete core
9	Ash	=	Area of link cross section
10	b	=	Effective Width of Column in mm
11	beff	=	Effective Width of Column in mm
12	B	=	Width / Smaller Dimension of Column in mm
13	d	=	Effective Depth of Column in mm
14	deff	=	Effective Depth of Column in mm
15	D	=	Depth / Larger Dimension of Column OR Diameter of Circular Column in mm
16	Dk	=	Diameter Of core measured to the outside of circular link
17	Ec	=	Modulus of elasticity of concrete
18	Es	=	Modulus of elasticity of steel
19	FcPerm	=	Permissible Stress in Concrete required in N/ (sqmm)
20	Fst	=	Stress in steel
21	FstPerm	=	Permissible Stress in Steel required in N/ (sqmm)
22	Fck	=	Characteristic compressive strength of concrete cube in N/sqmm
23	Fy	=	Yield Stress Of Steel in N/sqmm
24	h	=	Longer dimension of rectangular link measured to its outer face
25	Hu	=	Total lateral force acting with the section (Shear)
26	Hs	=	Height of the story (Floor height)
27	k	=	Reduction factor for slenderness moments

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28	Max	=	Additional moment due to slenderness about major axis (Along D)
29	May	=	Additional moment due to slenderness about minor axis (Along B)
30	Mminx	=	Moment due to minimum eccentricity along D
31	Mminy	=	Moment due to minimum eccentricity along B
32	Muv	=	Moment capacity of web portion of wall as per clause 9.4.2 and Annes A of IS 13920 - 2016
33	Mux	=	Factored moment Along D (Momemt About Major Axis)
34	Muy	=	Factored moment Along B (Momemt About Minor Axis)
35	MCap	=	Moment capacity of section for NA angle at design Pu
36	MRes	=	Resultant design moment at angle to local major axis
37	Pb	=	Axial capacity of column along B as defined in 39.7.1.1
38	Pd	=	Axial capacity of column along D as defined in 39.7.1.1
39	Pu	=	Factored axial force
40	Puz	=	Axial load on column as defined in 39.6
41	Pu_Total	=	Sum of Axial loads on all column in the story (Gravity Load)
42	Q	=	Stability Index (factor for checking sway/ non sway condition for a given story)
43	S	=	Link Spacing
44	Shear Strength Enhancement Factor	=	Multiplying factor for shear strength of concrete as per 40.2.2
45	Vur	=	Factored resultant shear force acting on the column
46	Vux	=	Factored shear force Along B
47	Vuy	=	Factored shear force Along D
48	Wcr	=	Surface Crack Width
49	WcrPerm	=	Permissible Crack Width required in mm
50	β	=	It is a Neutral Axis angle corresponding to load angle to find out MCap

---

Code References:

IS 456

	ELEMENT		CLAUSE / table
1	Max area of reinforcement	:	26.5.3.1-a & b
2	Min area of reinforcement	:	26.5.3.1-a & b
3	Min number of bars	:	26.5.3.1-c
4	Minimum Eccentricity Calc	:	25.4 & 39.2
5	Effective Length	:	25.2
6	Slenderness Moments	:	25.3 & 39.7
7	Design for axial loads	:	39.3
8	Design for axial loads And uniaxial bending	:	39.5
9	Design for axial loads And Biaxial bending	:	39.6
10	Design of horizontal links	:	26.5.3.2
11	Design shear strength	:	40.2
12	Stiffness Proportion Factor, β	:	E-1

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13	Stability(Index, Q)	:	E -2
14	Crack width calculation	:	3.8
15	Multiplying factor to Beam Stiffness for effective length calculation	:	SP 24 1983 APPENDIX D

IS 13920 - 2016

	ELEMENT		CLAUSE / table
1	Spacing of special confining reinforcement	:	10.4 and 7.6
2	C/s area of special confining reinforcement	:	7.6.1
3	Applicability of boundary element	:	10.4.1
4	Muv-Moment Capacity of Web	:	Annex
5	Additional Compressive Force in BE	:	10.4.2
6	Check for BE in tension and compression	:	10.4.2.1 and 10.4.3
7	Shear include due to Beam	:	7.5
8	Minimum Flexural Strength of Column	:	7.2
9	Shear Check at Column Joint	:	9.1
10	Length of wall to thickness ratio	:	10.1.3
11	Type of wall & Minimum reinforcement	:	10.1.4
12	Largest diameter of longitudinal steel bar	:	10.1.8
13	Shear reinforcement in RC wall	:	10.2.3
14	Special confinement reinforcement in Boundary Element	:	10.4.4
15	Minimum vertical reinforcement across horizontal construction joint	:	10.7

General Data

Column No.	:	C20	
Level	:	FDN To PB	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel (Main)	=	Fe500	N/sqmm
Grade Of Steel (Shear)	=	Fe415	N/sqmm
Grade Of Steel - Flexural Design	=	Fe500	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	205	mm
Column D	=	460	mm
Clear Cover	=	50	mm
Clear Floor Height @ B	=	1980	mm
Clear Floor Height @ D	=	1980	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	Braced	
Minimum eccentricity check	:	One Axis at a Time	
Code defined D/B ratio	:	4	
D/B Ratio	:	2.24 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

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Analysis Reference No.	=	C20	
Critical Analysis Load Combination	:	1.5(DL+LL)	
Load Combination	=	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Critical Location	=	Top Joint	
Put (top joint)	=	1334.46	kN
Muxt (top joint)	=	1.61	kNm
Muyt (top joint)	=	16.61	kNm
Vuxt (top joint)	=	-8.38	kN
Vuyt (top joint)	=	-0.81	kN
Pub (bottom joint)	=	1341.36	kN
Muxb (bottom joint)	=	0	kNm
Muyb (bottom joint)	=	0	kNm
Vuxb (bottom joint)	=	-8.38	kN
Vuyb (bottom joint)	=	-0.81	kN

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in Y-direction

Minimum Eccentricity Along B :

Minimum Eccentricity	=	Unsupported Length / 500 + B / 30	
	=	10.79	mm
MminY (top)	=	Pu x Minimum Eccentricity	
	=	26.69	kNm
MminY (bottom)	=	Pu x Minimum Eccentricity	
	=	26.83	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	9.66	
	<	60	(Hence Ok)

Column Is Braced Along D

Slenderness Check Along D:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / D	
	=	4.3, Column not Slender Along D	

Column Is Braced Along B

Slenderness Check Along B:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / B	
	=	9.66, Column Not Slender Along B	

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Minit	Mdesign
	A	B	C	D	E	F

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Major Axis Mux (top)	1.61	---	1.61	---	0	1.61
Major Axis Mux (bottom)	0	---	0	---	0	0
Minor Axis Muy (top)	16.61	26.69	26.69	---	0	26.69
Minor Axis Muy (bottom)	0	26.83	-26.83	---	0	-26.83

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

D = Initial moment = 0.4 x Min (top, bottom) ± 0.6 x Max (top, bottom) [As per sign requirement]

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	1334.46	kN
Mux	=	1.61	kNm
Muy	=	26.69	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	2.19	
Reinforcement Provided	=	4-20Y + 4-16Y	
Load Angle	=	$Tan^{-1}(Muy/Mux)$	
	=	86.55	deg
MRes	=	26.74	kNm
MCap	=	28.83	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.93 <= 1	

Shear Calculation	Along D	Along B
Critical Analysis Load Combination	1.5(DL+LL)	1.5(DL+LL)
Critical Load Combination	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)
Design shear force, Vu (kN)	-0.8125	-8.3751
Pu (kN)	1334.46	1334.46
Deff , Beff (mm)	400	145
Aeff (sqmm)	82000	66700
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	0.0099	0.1256
Pt (%)	1.093	1.093
Design shear strength, Tc (N/sqmm)	0.6628	0.6628
Shear Strength Enhancement	1 + 3 x Pu / (B x D x Fck)	

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Factor (Compressive Force)		
	2.9529	3.4008
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.5	1.5
Enhanced shear strength, Tc-e (N/sqmm)	0.9942	0.9942
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links Not Required**

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	=	8	mm
	>	Max. longitudinal bar dia / 4	
	=	5	mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16	=	256	mm
Min. dimension of column	=	205	mm
Max. 300 mm	=	300	mm
Provided spacing	=	200	mm

Table For Links

	Required			Provided	
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone**	**Ductile Zone**
Link Dia.	8	---	---	8	---
Spacing	200	---	---	200	---

General Data

Column No.	:	C20
Level	:	PB To 1F
Frame Type	=	Non-Ductile
Response Reduction Factor	=	3
Design Code	=	IS 456 : 2000 + IS 13920 : 2016
Grade Of Concrete	=	M25 N/sqmm
Grade Of Steel (Main)	=	Fe500 N/sqmm
Grade Of Steel (Shear)	=	Fe415 N/sqmm
Grade Of Steel - Flexural Design	=	Fe500 N/sqmm
Grade Of Steel - Shear Design	=	Fe415 N/sqmm

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Column B	=	205	mm
Column D	=	460	mm
Clear Cover	=	50	mm
Clear Floor Height @ B	=	2360	mm
Clear Floor Height @ D	=	2665	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	Braced	
Minimum eccentricity check	:	One Axis at a Time	
Code defined D/B ratio	:	4	
D/B Ratio	:	2.24 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	C20	
Critical Analysis Load Combination	:	1.5(DL+LL)	
Load Combination	=	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Critical Location	=	Bottom Joint	
Put (top joint)	=	1131.57	kN
Muxt (top joint)	=	-5	kNm
Muyt (top joint)	=	17.03	kNm
Vuxt (top joint)	=	-20.75	kN
Vuyt (top joint)	=	0.44	kN
Pub (bottom joint)	=	1139.79	kN
Muxb (bottom joint)	=	-3.97	kNm
Muyb (bottom joint)	=	-32	kNm
Vuxb (bottom joint)	=	-20.75	kN
Vuyb (bottom joint)	=	0.44	kN

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in Y-direction

Minimum Eccentricity Along B :

Minimum Eccentricity	=	Unsupported Length / 500 + B / 30	
	=	11.55	mm
Minimum Eccentricity	>	20	mm
MminY (top)	=	Pu x Minimum Eccentricity	
	=	22.63	kNm
MminY (bottom)	=	Pu x Minimum Eccentricity	
	=	22.8	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	11.51	
	<	60	(Hence Ok)

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- Column Is Braced Along D

Slenderness Check Along D:

Effective Length Factor	=	1
Slenderness Ratio	=	Effective Length / D
	=	5.79, Column not Slender Along D

Column Is Braced Along B

Slenderness Check Along B:

Effective Length Factor	=	1
Slenderness Ratio	=	Effective Length / B
	=	11.51, Column Not Slender Along B

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Minit	Mslndx (Abs)	Mdesign-final
	A	B	C	D	E	F
Major Axis Mux (top)	-5	---	-5	---	0	-5
Major Axis Mux (bottom)	-3.97	---	-3.97	---	0	-3.97
Minor Axis Muy (top)	17.03	22.63	22.63	---	0	22.63
Minor Axis Muy (bottom)	-32	22.8	-32	---	0	-32

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

D = Initial moment = 0.4 x Min (top, bottom) ± 0.6 x Max (top, bottom) [As per sign requirement]

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	1139.79	kN
Mux	=	-3.97	kNm
Muy	=	-32	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	2.19	
Reinforcement Provided	=	4-20Y + 4-16Y	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	82.93	deg
MRes	=	32.24	kNm
MCap	=	36.42	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.89 <= 1	

Shear Calculation	Along D	Along B
Critical Analysis Load Combination	1.5(DL+LL)	1.5(DL+LL)

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Critical Load Combination	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)
Design shear force, Vu (kN)	0.4368	-20.7455
Pu (kN)	1131.57	1131.57
Deff , Beff (mm)	400	145
Aeff (sqmm)	82000	66700
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	0.0053	0.311
Pt (%)	1.093	1.093
Design shear strength, Tc (N/sqmm)	0.6628	0.6628
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	2.656	3.0358
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.5	1.5
Enhanced shear strength, Tc-e (N/sqmm)	0.9942	0.9942
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links Not Required**

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	=	8	mm
	>	Max. longitudinal bar dia / 4	
	=	5	mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16	=	256	mm
Min. dimension of column	=	205	mm
Max. 300 mm	=	300	mm
Provided spacing	=	200	mm

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Table For Links

	Required	Provided

	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	---	8	---
Spacing	200	---	---	200	---

General Data

Column No.	:	C20	
Level	:	1F To 2F	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel (Main)	=	Fe500	N/sqmm
Grade Of Steel (Shear)	=	Fe415	N/sqmm
Grade Of Steel - Flexural Design	=	Fe500	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	205	mm
Column D	=	460	mm
Clear Cover	=	50	mm
Clear Floor Height @ B	=	2588	mm
Clear Floor Height @ D	=	2893	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	Braced	
Minimum eccentricity check	:	One Axis at a Time	
Code defined D/B ratio	:	4	
D/B Ratio	:	2.24 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	C20	
Critical Analysis Load Combination	:	1.5(DL+LL)	
Load Combination	=	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Critical Location	=	Top Joint	
Put (top joint)	=	933.64	kN
Muxt (top joint)	=	-12.9	kNm
Muyt (top joint)	=	16.11	kNm
Vuxt (top joint)	=	-14.72	kN
Vuyt (top joint)	=	11.98	kN
Pub (bottom joint)	=	942.66	kN
Muxb (bottom joint)	=	18.13	kNm
Muyb (bottom joint)	=	-22.03	kNm
Vuxb (bottom joint)	=	-14.72	kN
Vuyb (bottom joint)	=	11.98	kN

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Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in Y-direction

Minimum Eccentricity Along B :

Minimum Eccentricity	=	Unsupported Length / 500 + B / 30	
	=	12.01	mm
Minimum Eccentricity	>	20	mm
MminY (top)	=	Pu x Minimum Eccentricity	
	=	18.67	kNm
MminY (bottom)	=	Pu x Minimum Eccentricity	
	=	18.85	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	12.62	
	<	60	(Hence Ok)

Column Is Braced Along D

Slenderness Check Along D:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / D	
	=	6.29, Column not Slender Along D	

Column Is Braced Along B

Slenderness Check Along B:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / B	
	=	12.62, Column Slender Along B	
Slenderness moment along B	=	(Pu B/ 2000) (Ley/B)^2	
	=	15.25	kNm

Design slenderness moment along B

Puz	=	1307.72	kN
Pb	=	360.83	kN
Reduction factor 'k' for slenderness moment	=	(Puz - Pu) / (Puz - Pb) < = 1	
	=	0.4 < = 1, Hence k=0.4	
Mslndy	=	k x 15.25	
	=	6.03	kNm

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Minit	Mslndx (Abs)	Mdesign-final
	A	B	C	D	E	F
Major Axis Mux (top)	-12.9	---	-12.9	---	0	-12.9
Major Axis Mux (bottom)	18.13	---	18.13	---	0	18.13
Minor Axis Muy (top)	16.11	18.67	18.67	-20.69	6.03	26.71
Minor Axis Muy (bottom)	-22.03	18.85	-22.03	-20.69	5.94	26.61

Where

A = Moments directly from analysis

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- B = Moments due to minimum eccentricity
  C = Maximum of analysis moment and min. eccentricity = Max (A,B)
  D = Initial moment = 0.4 x Min (top, bottom) ± 0.6 x Max (top, bottom) [As per sign requirement]
  E = Moment due to slenderness effect
  F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	933.64	kN
Mux	=	-12.9	kNm
Muy	=	-26.71	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.72	
Reinforcement Provided	=	6-12Y	
Load Angle	=	$Tan^{-1}(Muy/Mux)$	
	=	64.22	deg
MRes	=	29.66	kNm
MCap	=	30.79	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.96 <= 1	

Shear Calculation	Along D	Along B
Critical Analysis Load Combination	1.5(DL+LL)	1.5(DL+LL)
Critical Load Combination	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)
Design shear force, Vu (kN)	11.9757	-14.7185
Pu (kN)	933.64	933.64
Deff , Beff (mm)	404	149
Aeff (sqmm)	82820	68540
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	0.1446	0.2147
Pt (%)	0.36	0.36
Design shear strength, Tc (N/sqmm)	0.4264	0.4264
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	2.3528	2.6346
Shear Strength Enhancement Factor (Tensile Force)	-	-

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Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.5	1.5
Enhanced shear strength, Tc-e (N/sqmm)	0.6396	0.6396
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links Not Required**

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	=	8	mm
	>	Max. longitudinal bar dia / 4	
	=	3	mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16	=	192	mm
Min. dimension of column	=	205	mm
Max. 300 mm	=	300	mm
Provided spacing	=	175	mm

Table For Links

	Required			Provided	
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone**	**Ductile Zone**
Link Dia.	8	---	---	8	---
Spacing	175	---	---	175	---

General Data

Column No.	:	C20	
Level	:	2F To 3F	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel (Main)	=	Fe500	N/sqmm
Grade Of Steel (Shear)	=	Fe415	N/sqmm
Grade Of Steel - Flexural Design	=	Fe500	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	205	mm
Column D	=	460	mm
Clear Cover	=	50	mm
Clear Floor Height @ B	=	2588	mm
Clear Floor Height @ D	=	2893	mm
No Of Floors	=	1	

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No Of Columns In Group	=	1	
Column Type	:	Braced	
Minimum eccentricity check	:	One Axis at a Time	
Code defined D/B ratio	:	4	
D/B Ratio	:	2.24 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	C20	
Critical Analysis Load Combination	:	1.5(DL+LL)	
Load Combination	=	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Critical Location	=	Top Joint	
Put (top joint)	=	753.45	kN
Muxt (top joint)	=	-17.38	kNm
Muyt (top joint)	=	16.14	kNm
Vuxt (top joint)	=	-14.99	kN
Vuyt (top joint)	=	16.22	kN
Pub (bottom joint)	=	762.46	kN
Muxb (bottom joint)	=	24.65	kNm
Muyb (bottom joint)	=	-22.71	kNm
Vuxb (bottom joint)	=	-14.99	kN
Vuyb (bottom joint)	=	16.22	kN

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in X-direction

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	21.12	mm
Minimum Eccentricity	>	20	mm
Mminx (top)	=	Pu x Minimum Eccentricity	
	=	15.91	kNm
Mminx (bottom)	=	Pu x Minimum Eccentricity	
	=	16.1	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	12.62	
	<	60	(Hence Ok)

Column Is Braced Along D

Slenderness Check Along D:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / D	
	=	6.29, Column not Slender Along D	

Column Is Braced Along B

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- Slenderness Check Along B:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / B	
	=	12.62, Column Slender Along B	
Slenderness moment along B	=	(Pu B/ 2000) (Ley/B)^2	
	=	12.31	kNm
Design slenderness moment along B			
Puz	=	1307.72	kN
Pb	=	360.83	kN
Reduction factor 'k' for slenderness moment	=	(Puz - Pu) / (Puz - Pb) < = 1	
	=	0.59 < = 1, Hence k=0.59	
Mslndy	=	k x 12.31	
	=	7.2	kNm

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Minit	Mslndx (Abs)	Mdesign-final
	A	B	C	D	E	F
Major Axis Mux (top)	-17.38	15.91	-17.38	---	0	-17.38
Major Axis Mux (bottom)	24.65	16.1	24.65	---	0	24.65
Minor Axis Muy (top)	16.14	---	16.14	-20.08	7.2	-27.29
Minor Axis Muy (bottom)	-22.71	---	-22.71	-20.08	7.17	-27.25

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

D = Initial moment = 0.4 x Min (top, bottom) ± 0.6 x Max (top, bottom) [As per sign requirement]

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	753.45	kN
Mux	=	-17.38	kNm
Muy	=	-27.29	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.72	
Reinforcement Provided	=	6-12Y	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	57.5	deg
MRes	=	32.35	kNm
MCap	=	43.31	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.75 <= 1	

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Shear Calculation	Along D	Along B
Critical Analysis Load Combination	1.5(DL+LL)	1.5(DL+LL)
Critical Load Combination	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)
Design shear force, Vu (kN)	16.2228	-14.9943
Pu (kN)	753.45	753.45
Deff , Beff (mm)	404	149
Aeff (sqmm)	82820	68540
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	0.1959	0.2188
Pt (%)	0.36	0.36
Design shear strength, Tc (N/sqmm)	0.4264	0.4264
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	2.0917	2.3191
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.5	1.5
Enhanced shear strength, Tc-e (N/sqmm)	0.6396	0.6396
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links Not Required**

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	=	8	mm
	>	Max. longitudinal bar dia / 4	
	=	3	mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16	=	192	mm
Min. dimension of column	=	205	mm
Max. 300 mm	=	300	mm
Provided spacing	=	175	mm

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Table For Links

	Required			Provided	
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone**	**Ductile Zone**
Link Dia.	8	---	---	8	---
Spacing	175	---	---	175	---

General Data

Column No.	:	C20	
Level	:	3F To 4F	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel (Main)	=	Fe500	N/sqmm
Grade Of Steel (Shear)	=	Fe415	N/sqmm
Grade Of Steel - Flexural Design	=	Fe500	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	205	mm
Column D	=	460	mm
Clear Cover	=	50	mm
Clear Floor Height @ B	=	2588	mm
Clear Floor Height @ D	=	2893	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	Braced	
Minimum eccentricity check	:	One Axis at a Time	
Code defined D/B ratio	:	4	
D/B Ratio	:	2.24 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	C20	
Critical Analysis Load Combination	:	1.5(DL+LL)	
Load Combination	=	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Critical Location	=	Top Joint	
Put (top joint)	=	596.64	kN
Muxt (top joint)	=	-20.44	kNm
Muyt (top joint)	=	16.84	kNm
Vuxt (top joint)	=	-15.66	kN
Vuyt (top joint)	=	18.65	kN
Pub (bottom joint)	=	605.65	kN
Muxb (bottom joint)	=	27.89	kNm
Muyb (bottom joint)	=	-23.74	kNm

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Vuxb (bottom joint)	=	-15.66	kN
Vuyb (bottom joint)	=	18.65	kN

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in X-direction

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	21.12	mm
Minimum Eccentricity	>	20	mm
Mminx (top)	=	Pu x Minimum Eccentricity	
	=	12.6	kNm
Mminx (bottom)	=	Pu x Minimum Eccentricity	
	=	12.79	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	12.62	
	<	60	(Hence Ok)

Column Is Braced Along D

Slenderness Check Along D:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / D	
	=	6.29, Column not Slender Along D	

Column Is Braced Along B

Slenderness Check Along B:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / B	
	=	12.62, Column Slender Along B	
Slenderness moment along B	=	(Pu B/ 2000) (Ley/B)^2	
	=	9.75	kNm

Design slenderness moment along B

Puz	=	1307.72	kN
Pb	=	360.83	kN
Reduction factor 'k' for slenderness moment	=	(Puz - Pu) / (Puz - Pb) < = 1	
	=	0.75 < = 1, Hence k=0.75	
Mslndy	=	k x 9.75	
	=	7.32	kNm

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Minit	Mslndx (Abs)	Mdesign-final
	A	B	C	D	E	F
Major Axis Mux (top)	-20.44	12.6	-20.44	-20.44	20.44	-20.44
Major Axis Mux (bottom)	27.89	12.79	27.89	27.89	27.89	27.89
Minor Axis Muy (top)	16.84	---	16.84	-20.98	7.32	-20.98
Minor Axis Muy (bottom)	-23.74	---	-23.74	-20.98	7.34	-23.74

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Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

D = Initial moment = 0.4 x Min (top, bottom) ± 0.6 x Max (top, bottom) [As per sign requirement]

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	596.64	kN
Mux	=	-20.44	kNm
Muy	=	-28.3	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.72	
Reinforcement Provided	=	6-12Y	
Load Angle	=	$Tan^{-1}(Muy/Mux)$	
	=	54.16	deg
MRes	=	34.91	kNm
MCap	=	50.39	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.69 <= 1	

Shear Calculation	Along D	Along B
Critical Analysis Load Combination	1.5(DL+LL)	1.5(DL+LL)
Critical Load Combination	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)
Design shear force, Vu (kN)	18.6549	-15.6616
Pu (kN)	596.64	596.64
Deff , Beff (mm)	404	149
Aeff (sqmm)	82820	68540
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	0.2252	0.2285
Pt (%)	0.36	0.36
Design shear strength, Tc (N/sqmm)	0.4264	0.4264
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	1.8645	2.0446

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Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.5	1.5
Enhanced shear strength, Tc-e (N/sqmm)	0.6396	0.6396
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links Not Required**

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	=	8	mm
	>	Max. longitudinal bar dia / 4	
	=	3	mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16	=	192	mm
Min. dimension of column	=	205	mm
Max. 300 mm	=	300	mm
Provided spacing	=	175	mm

Table For Links

	Required			Provided	
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone**	**Ductile Zone**
Link Dia.	8	---	---	8	---
Spacing	175	---	---	175	---

General Data

Column No.	:	C20	
Level	:	4F To 5F	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel (Main)	=	Fe500	N/sqmm
Grade Of Steel (Shear)	=	Fe415	N/sqmm
Grade Of Steel - Flexural Design	=	Fe500	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	205	mm
Column D	=	460	mm
Clear Cover	=	50	mm

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Clear Floor Height @ B	=	2588	mm
Clear Floor Height @ D	=	2893	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	Braced	
Minimum eccentricity check	:	One Axis at a Time	
Code defined D/B ratio	:	4	
D/B Ratio	:	2.24 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	C20	
Critical Analysis Load Combination	:	1.5(DL+LL)	
Load Combination	=	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Critical Location	=	Top Joint	
Put (top joint)	=	449.11	kN
Muxt (top joint)	=	-21.51	kNm
Muyt (top joint)	=	17.25	kNm
Vuxt (top joint)	=	-16.3	kN
Vuyt (top joint)	=	19.74	kN
Pub (bottom joint)	=	458.12	kN
Muxb (bottom joint)	=	29.63	kNm
Muyb (bottom joint)	=	-24.97	kNm
Vuxb (bottom joint)	=	-16.3	kN
Vuyb (bottom joint)	=	19.74	kN

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in X-direction

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	21.12	mm
Minimum Eccentricity	>	20	mm
Mminx (top)	=	Pu x Minimum Eccentricity	
	=	9.48	kNm
Mminx (bottom)	=	Pu x Minimum Eccentricity	
	=	9.68	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	12.62	
	<	60	(Hence Ok)

Column Is Braced Along D

Slenderness Check Along D:

Effective Length Factor	=	1	

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Slenderness Ratio	=	Effective Length / D	
	=	6.29, Column not Slender Along D	

Column Is Braced Along B

Slenderness Check Along B:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / B	
	=	12.62, Column Slender Along B	
Slenderness moment along B	=	(Pu B/ 2000) (Ley/B)^2	
	=	7.34	kNm

Design slenderness moment along B

Puz	=	1307.72	kN
Pb	=	360.83	kN
Reduction factor 'k' for slenderness moment	=	(Puz - Pu) / (Puz - Pb) < = 1	
	=	0.91 < = 1, Hence k=0.91	
Mslndy	=	k x 7.34	
	=	6.65	kNm

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Minit	Mslndx (Abs)	Mdesign-final
	A	B	C	D	E	F
Major Axis Mux (top)	-21.51	9.48	-21.51	---	0	-21.51
Major Axis Mux (bottom)	29.63	9.68	29.63	---	0	29.63
Minor Axis Muy (top)	17.25	---	17.25	-21.88	6.65	-28.54
Minor Axis Muy (bottom)	-24.97	---	-24.97	-21.88	6.71	-28.6

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

D = Initial moment = 0.4 x Min (top, bottom) ± 0.6 x Max (top, bottom) [As per sign requirement]

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	449.11	kN
Mux	=	-21.51	kNm
Muy	=	-28.54	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.72	
Reinforcement Provided	=	6-12Y	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	53	Deg
MRes	=	35.73	kNm

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MCap = 53.06 kNm

Capacity Ratio = MRes/ MCap

= 0.67 <= 1

Shear Calculation	Along D	Along B
Critical Analysis Load Combination	1.5(DL+LL)	1.5(DL+LL)
Critical Load Combination	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)
Design shear force, Vu (kN)	19.7351	-16.2969
Pu (kN)	449.11	449.11
Deff , Beff (mm)	404	149
Aeff (sqmm)	82820	68540
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	0.2383	0.2378
Pt (%)	0.36	0.36
Design shear strength, Tc (N/sqmm)	0.4264	0.4264
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	1.6507	1.7863
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.5	1.5
Enhanced shear strength, Tc-e (N/sqmm)	0.6396	0.6396
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links Not Required**

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link = 8 mm

> Max. longitudinal bar dia / 4

= 3 mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16 = 192 mm

Min. dimension of column = 205 mm

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Max. 300 mm	=	300	mm
Provided spacing	=	175	mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	---	8	---
Spacing	175	---	---	175	---

General Data

Column No.	:	C20	
Level	:	5F To TERRACE	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel (Main)	=	Fe500	N/sqmm
Grade Of Steel (Shear)	=	Fe415	N/sqmm
Grade Of Steel - Flexural Design	=	Fe500	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	205	mm
Column D	=	460	mm
Clear Cover	=	50	mm
Clear Floor Height @ B	=	2588	mm
Clear Floor Height @ D	=	2893	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	Braced	
Minimum eccentricity check	:	One Axis at a Time	
Code defined D/B ratio	:	4	
D/B Ratio	:	2.24 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	C20	
Critical Analysis Load Combination	:	1.5(DL+LL)	
Load Combination	=	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Critical Location	=	Top Joint	
Put (top joint)	=	314.65	kN
Muxt (top joint)	=	-27.85	kNm
Muyt (top joint)	=	23.43	kNm
Vuxt (top joint)	=	-20.92	kN
Vuyt (top joint)	=	23.78	kN

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Pub (bottom joint)	=	323.66	kN
Muxb (bottom joint)	=	33.78	kNm
Muyb (bottom joint)	=	-30.76	kNm
Vuxb (bottom joint)	=	-20.92	kN
Vuyb (bottom joint)	=	23.78	kN

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in X-direction

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	21.12	mm
Minimum Eccentricity	>	20	mm
Mminx (top)	=	Pu x Minimum Eccentricity	
	=	6.65	kNm
Mminx (bottom)	=	Pu x Minimum Eccentricity	
	=	6.84	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	12.62	
	<	60	(Hence Ok)

Column Is Braced Along D

Slenderness Check Along D:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / D	
	=	6.29, Column not Slender Along D	

Column Is Braced Along B

Slenderness Check Along B:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / B	
	=	12.62, Column Slender Along B	
Slenderness moment along B	=	(Pu B/ 2000) (Ley/B)^2	
	=	5.14	kNm

Design slenderness moment along B

Puz	=	1307.72	kN
Pb	=	360.83	kN
Reduction factor 'k' for slenderness moment	=	(Puz - Pu) / (Puz - Pb) < = 1	
	=	1.05 > = 1, Hence k=1	
Mslndy	=	k x 5.14	
	=	5.14	kNm

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Minfl	Mdesign Final
	A	B	C	D	(Abs)
Major Axis Mux (top)	-27.85	6.65	-27.85	---	0 27.85
Major Axis Mux (bottom)	33.78	6.84	33.78	---	0 33.78

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Minor Axis Muy (top)	23.43	---	23.43	-27.83	5.14	-32.97
Minor Axis Muy (bottom)	-30.76	---	-30.76	-27.83	5.29	-33.12

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

D = Initial moment = 0.4 x Min (top, bottom) ± 0.6 x Max (top, bottom) [As per sign requirement]

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	314.65	kN
Mux	=	-27.85	kNm
Muy	=	-32.97	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.72	
Reinforcement Provided	=	6-12Y	
Load Angle	=	$Tan^{-1}(Muy/Mux)$	
	=	49.81	deg
MRes	=	43.16	kNm
MCap	=	54.62	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.79 <= 1	

Shear Calculation	Along D	Along B
Critical Analysis Load Combination	1.5(DL+LL)	1.5(DL+LL)
Critical Load Combination	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)
Design shear force, Vu (kN)	23.7845	-20.9177
Pu (kN)	314.65	314.65
Deff , Beff (mm)	404	149
Aeff (sqmm)	82820	68540
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	0.2872	0.3052
Pt (%)	0.36	0.36
Design shear strength, Tc (N/sqmm)	0.4264	0.4264
Shear Strength Enhancement Factor	1 + 3 x Pu / (B x D x Fck)	

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(Compressive Force)		
	1.4559	1.5509
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.4559	1.5
Enhanced shear strength, Tc-e (N/sqmm)	0.6208	0.6396
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links Not Required**

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	=	8	mm
	>	Max. longitudinal bar dia / 4	
	=	3	mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16	=	192	mm
Min. dimension of column	=	205	mm
Max. 300 mm	=	300	mm
Provided spacing	=	175	mm

Table For Links

	Required			Provided	
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone**	**Ductile Zone**
Link Dia.	8	---	---	8	---
Spacing	175	---	---	175	---

General Data

Column No.	:	C20	
Level	:	TERRACE To HR	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M25	N/sqmm
Grade Of Steel (Main)	=	Fe500	N/sqmm
Grade Of Steel (Shear)	=	Fe415	N/sqmm
Grade Of Steel - Flexural Design	=	Fe500	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	205	mm

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Column D	=	460	mm
Clear Cover	=	50	mm
Clear Floor Height @ B	=	2430	mm
Clear Floor Height @ D	=	2430	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	Braced	
Minimum eccentricity check	:	One Axis at a Time	
Code defined D/B ratio	:	4	
D/B Ratio	:	2.24 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	C20	
Critical Analysis Load Combination	:	1.5(DL+LL)	
Load Combination	=	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5 (FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	
Critical Location	=	Bottom Joint	
Put (top joint)	=	136.83	kN
Muxt (top joint)	=	-15.72	kNm
Muyt (top joint)	=	18.96	kNm
Vuxt (top joint)	=	-19.25	kN
Vuyt (top joint)	=	12.51	kN
Pub (bottom joint)	=	145.29	kN
Muxb (bottom joint)	=	14.72	kNm
Muyb (bottom joint)	=	-27.89	kNm
Vuxb (bottom joint)	=	-19.25	kN
Vuyb (bottom joint)	=	12.51	kN

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in X-direction

Minimum Eccentricity Along D:

Minimum Eccentricity	=	Unsupported Length / 500 + D / 30	
	=	20.19	mm
Minimum Eccentricity	>	20	mm
Mminx (top)	=	Pu x Minimum Eccentricity	
	=	2.76	kNm
Mminx (bottom)	=	Pu x Minimum Eccentricity	
	=	2.93	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	11.85	
	<	60	(Hence Ok)

Column Is Braced Along D

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- Slenderness Check Along D:

Effective Length Factor	=	1
Slenderness Ratio	=	Effective Length / D
	=	5.28, Column not Slender Along D

Column Is Braced Along B

Slenderness Check Along B:

Effective Length Factor	=	1
Slenderness Ratio	=	Effective Length / B
	=	11.85, Column Not Slender Along B

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Minit	MsIndx (Abs)	Mdesign-final
	A	B	C	D	E	F
Major Axis Mux (top)	-15.72	2.76	-15.72	---	0	-15.72
Major Axis Mux (bottom)	14.72	2.93	14.72	---	0	14.72
Minor Axis Muy (top)	18.96	---	18.96	---	0	18.96
Minor Axis Muy (bottom)	-27.89	---	-27.89	---	0	-27.89

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

D = Initial moment = 0.4 x Min (top, bottom) ± 0.6 x Max (top, bottom) [As per sign requirement]

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	145.29	kN
Mux	=	14.72	kNm
Muy	=	-27.89	kNm

Resultant Moment (Combined Action)

Moment Capacity Check

Pt Calculated	=	0.72	
Reinforcement Provided	=	6-12Y	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	62.18	deg
MRes	=	31.54	kNm
MCap	=	38.84	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.81 <= 1	

Shear Calculation	Along D	Along B
Critical Analysis Load Combination	1.5(DL+LL)	1.5(DL+LL)
Critical Load Combination	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5	[1] : 1.5 (BRICKWALL) +1.5 (DEAD) +1.5

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	(FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)	(FLOORFINISH) +1.5 (STAIRCASEDEAD) +1.5 (LIVE) +1.5 (STAIRCASELIVE)
Design shear force, Vu (kN)	12.5112	-19.2548
Pu (kN)	136.83	136.83
Deff , Beff (mm)	404	149
Aeff (sqmm)	82820	68540
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	0.1511	0.2809
Pt (%)	0.36	0.36
Design shear strength, Tc (N/sqmm)	0.4264	0.4264
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	1.1983	1.2396
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.1983	1.2396
Enhanced shear strength, Tc-e (N/sqmm)	0.5109	0.5285
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links Not Required**

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	=	8	mm
	>	Max. longitudinal bar dia / 4	
	=	3	mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16	=	192	mm
Min. dimension of column	=	205	mm
Max. 300 mm	=	300	mm
Provided spacing	=	175	mm

Table For Links

	Required			Provided
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone** / **Ductile Zone**

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Link Dia.	8	---	---	8	---
Spacing	175	---	---	175	---

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MDTCP

GOVERNMENT OF TAMILNADU
TOWN AND COUNTRY PLANNING DEPARTMENT
MADURAI DISTRICT OFFICE

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PROFESSIONAL REGISTRATION CERTIFICATE

Roc. No.1433/2019/CC **dated :28.04.2022**

This is to certify that **THIRU.R.MANIVANNAN** has enrolled as **STRUCTURAL ENGINEER GRADE-I (SE)** with Madurai District Town and Country Planning (**MDTCP**), who has the qualification of **Degree of Master of Engineering in Civil Engineering (A) Structural Engineering** and experience in the relevant field for **5 years above.**

He has been given the **Registration No.SE. 03/2022 (Gr.I) on 28.04.2022.** He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide **G.O.(Ms)No.18, MAWS (MA1) Department, Dated: 04.02.2019.**

This Registration is valid upto **27.04.2027**



28 APR 2022

ASSISTANT DIRECTOR /
MEMBER SECRETARY (I/C),
DISTRICT TOWN AND COUNTRY
PLANNING OFFICE,
MADURAI DISTRICT.

28.04.2022 28.4.2022