Analysis and Design of Mono Column Building

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***Abstract*— Mono column structure are the structures supported on a single column. They are the most suitable structures that can be constructed at the flood occurring regions. The structure provides large serviceable area as compare to RCC and steel frame structures. They provide large serviceable floor space compared to framed structures with many columns. They require less area for providing foundation and gives more space for parking. In this project describes planning, structural analysis, design and drawing. The mono column supports whole structure and other members will act as cantilevers. Structural analysis by ETABS.**

***Keywords*— Mono column**

I. INTRODUCTION

Mono column building is the structure supported on a single column which provides large serviceable area as compare to RCC and steel frame structure. Mono column building supported on a single column has more aesthetic view compared to other frame structures. The requires less area for providing foundation and gives more space for parking. They are also unique. Mono column structures are constructed with RCC or Steel. Mono column structures are complicated one, compare with the other framed structures, mono column supports entire structure, all other members will act as cantilevers and mono column structure is the individual one. Eccentric loading will cause failure of structure. These structures provide more proper spaces for offices and parking. Mono column provides maximum serviceability. They are also good at the place where flood occurs. Mono column buildings decrease the excavation area of the land and saving money. This project describes planning, structural analysis, design and drawings with various components of the whole building.

In India the state like Kerala facing flood in the monsoon season. The water level reaches approximately to the first floor of the building. The best solution of this problem is rising the living area higher from the ground level. Mono column buildings are very effective to control flood. Some of the two mono column structures are Astra Tower, Hamburg. Germany and L & T's Construction Headquarters at Manapakkam in Chennai.

II. OBJECTIVES

Rise in population have increased the demand of high-rise structures in the cities. Multistorey buildings aim to increase the floor area of the building without increasing the area of the land and saving money. These multi storey buildings, sky scrapers are built not just for economy of space they are considered icons of a city's economic power and the city's identity. Thousands of multi storey building is being built all over the world with steel as well as reinforced concrete. The main objectives of the study are

- To analyse and design a mono column building
- To compare the different shaped mono columns like rectangular and circular etc.
- To compare the serviceable floor space with structure supported on many column

III. SUMMARY OF LITERATURE REVIEW

From literature review, it is found that Mono column buildings has unique structure. They have good aesthetic view. Mono column structure can withstand all loads including earthquake loads and wind loads. Mono column building save ground space as requires less area for proving foundations and providing more space for parking.

IV. METHODOLOGY

The building contains four stories including the mono column. The plan is prepared using auto CADD. All the supports are fixed. The ground storey is designed and analysed. The height of mono column is 3m from the ground level. Each storey is 3m height. Two types of models are analysed using ETABS software. The first one is rectangular type mono column which support the entire structure. Another one is a circular mono column with same cross-section as that of the rectangular column. The structure is a residential building with four stories. The four stories supported by the 3m height mono column. The mono column extends to bottom to the top of the building.

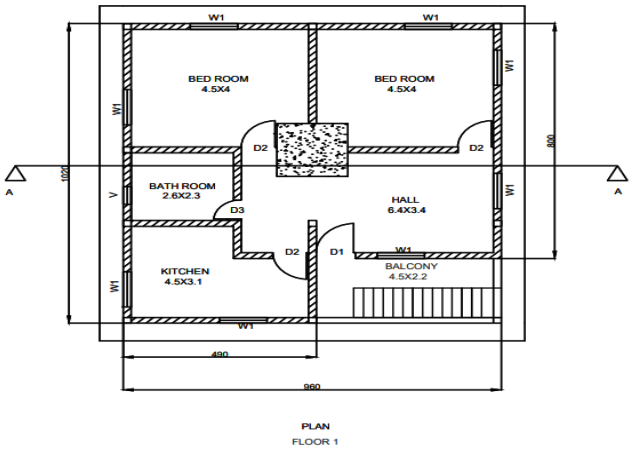

Fig.1. Plan of floor 1

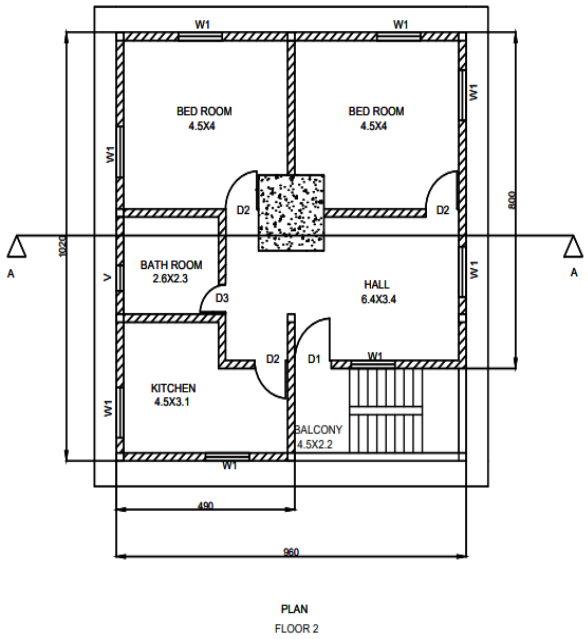

Fig 2. Plan of floor 2

The figure 1 and figure 2 shows the floor plan of first and second stories respectively. The third and fourth stories has the same plan as that of the second story. The figure 3 is the elevation of the entire building.

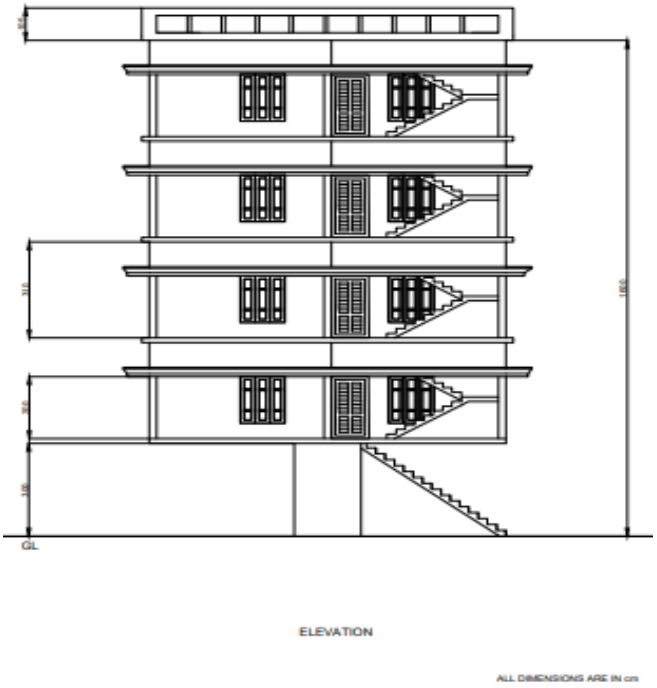

Fig 3. Elevation

A. RECTANGULAR MONO COLUMN

The first model of the study consists of the mono column with rectangular cross section. The single column size is 1.8mx1.8m.

TABLE 1. Details of rectangular mono column building

Content	Description
Mono column size	1.8 x 1.8 m
Normal column size	600 x 600 mm
Beam 1	230 x 400 mm
Beam 2	600 x 600 mm
Slab thickness	150 mm
Mono column type	Rectangular

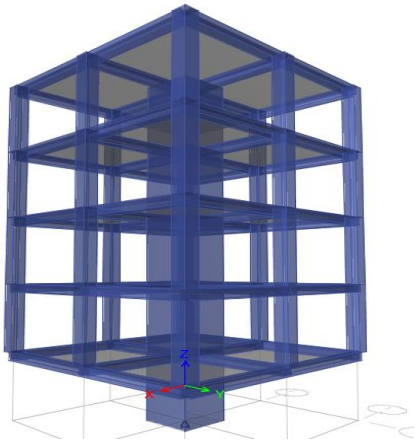

Fig 3. 3D view – rectangular mono column

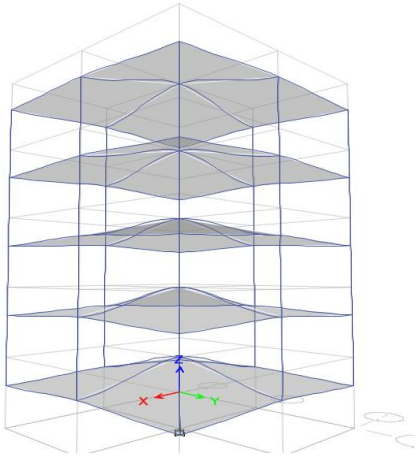

Fig 4. Deflection- rectangular mono column

B. CIRCULAR MONO COLUMN

The second model of the study consists of the mono column with circular cross section. The diameter of the circular mono column is 2.03 m. The circular mono column has the same cross-sectional area of rectangular mono column.

TABLE 2. Details of rectangular mono column building

Content	Description
Mono column size (diameter)	2.03 m
Normal column size	600 x 600 mm
Beam 1	230 x 400 mm
Beam 2	600 x 600 mm
Slab thickness	150 mm
Mono column type	circular

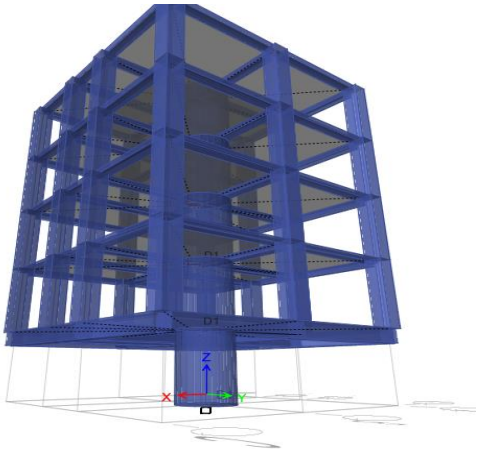

Fig 5. 3D view – circular mono column

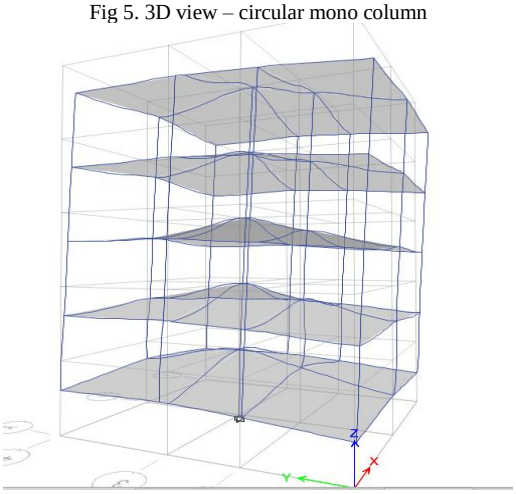

Fig 6. Deflection- circular mono column

TABLE 3. The default load combinations

Name	Load	Scale	Name	Load	Scale
DCon1	Dead	1.5	DCon14	Dead	0.9
DCon2	Dead	1.5	DCon14	wy	-1.5
DCon2	Live	1.5	DCon15	Dead	1.2
DCon3	Dead	1.2	DCon15	Live	1.2
DCon3	Live	1.2	DCon15	ex	1.2
DCon3	wx	1.2	DCon16	Dead	1.2
DCon4	Dead	1.2	DCon16	Live	1.2
DCon4	Live	1.2	DCon16	ex	-1.2
DCon4	wx	-1.2	DCon17	Dead	1.2
DCon5	Dead	1.2	DCon17	Live	1.2
DCon5	Live	1.2	DCon17	ey	1.2
DCon5	wy	1.2	DCon18	Dead	1.2
DCon6	Dead	1.2	DCon18	Live	1.2
DCon6	Live	1.2	DCon18	ey	-1.2
DCon6	wy	-1.2	DCon19	Dead	1.5
DCon7	Dead	1.5	DCon19	ex	1.5
DCon7	wx	1.5	DCon20	Dead	1.5
DCon8	Dead	1.5	DCon20	ex	-1.5
DCon8	wx	-1.5	DCon21	Dead	1.5
DCon9	Dead	1.5	DCon21	ey	1.5
DCon9	wy	1.5	DCon22	Dead	1.5
DCon10	Dead	1.5	DCon22	ey	-1.5
DCon10	wy	-1.5	DCon23	Dead	0.9
DCon11	Dead	0.9	DCon23	ex	1.5
DCon11	wx	1.5	DCon24	Dead	0.9
DCon12	Dead	0.9	DCon24	ex	-1.5
DCon12	wx	-1.5	DCon25	Dead	0.9
DCon13	Dead	0.9	DCon25	ey	1.5
DCon13	wy	1.5	DCon26	Dead	0.9
			DCon26	ey	-1.5

V. RESULTS

The different load combinations are applied and the base reactions, maximum deflection of stories, shear force and bending moments are obtained.

A. RECTANGULAR MONO COLUMN

TABLE 4. Base reactions- rectangular

Load Case/Combo	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m
Dead	-66	-66	10107.86	48762.69	-46122	-38.1
Live	0	0	1057.5	4970.25	-4758.75	0
ex	-855.064	0	528.75	2485.125	-10998.3	4037.962
ey	0	-855.064	0	8618.891	0	-3844.9
wx	-127.783	0	0	0	-1080.44	600.5795
wy	0	-122.345	0	1034.463	0	-550.554
DCon1	-99	-99	15161.79	73144.03	-69183	-57.15
DCon2	-99	-99	16748.04	80599.41	-76321.2	-57.15
DCon3	-232.54	-79.2	13398.43	64479.53	-62353.5	674.9754
DCon4	74.1395	-79.2	13398.43	64479.53	-59760.4	-766.415
DCon5	-79.2	-226.014	13398.43	65720.88	-61056.9	-706.385
DCon6	-79.2	67.6144	13398.43	63238.17	-61056.9	614.9447
DCon7	-290.674	-99	15161.79	73144.03	-70803.7	843.7193
DCon8	92.6743	-99	15161.79	73144.03	-67562.4	-958.019
DCon9	-99	-282.518	15161.79	74695.73	-69183	-882.981
DCon10	-99	84.518	15161.79	71592.34	-69183	768.6808
DCon11	-251.074	-59.4	9097.073	43886.42	-43130.5	866.5793
DCon12	132.2743	-59.4	9097.073	43886.42	-39889.2	-935.159
DCon13	-59.4	-242.918	9097.073	45438.11	-41509.8	-860.121
DCon14	-59.4	124.118	9097.073	42334.72	-41509.8	791.5408
DCon15	-1105.28	-79.2	14032.93	67461.68	-74254.9	4799.834
DCon16	946.8763	-79.2	12763.93	61497.38	-47859	-4891.27
DCon17	-79.2	-1105.28	13398.43	74822.19	-61056.9	-4659.59
DCon18	-79.2	946.8763	13398.43	54136.86	-61056.9	4568.155
DCon19	-1381.6	-99	15954.91	76871.72	-85680.4	5999.793
DCon20	1183.595	-99	14368.66	69416.34	-52685.6	-6114.09
DCon21	-99	-1381.6	15161.79	86072.37	-69183	-5824.49
DCon22	-99	1183.595	15161.79	60215.69	-69183	5710.193
DCon23	-1342	-59.4	9890.198	47614.11	-58007.2	6022.653
DCon24	1223.195	-59.4	8303.948	40158.73	-25012.4	-6091.23
DCon25	-59.4	-1342	9097.073	56814.76	-41509.8	-5801.63
DCon26	-59.4	1223.195	9097.073	30958.08	-41509.8	5733.053

TABLE 5. Maximum deflection in Y direction-rectangular

Story	Load	Direction	Deflection (mm)
Story5	DCon22	Y	54.586
Story4	DCon22	Y	40.28
Story3	DCon22	Y	26.52
Story2	DCon22	Y	14.155
Story1	DCon22	Y	4.08

TABLE 6. Maximum deflection in X direction-rectangular

Story	Load	Direction	Deflection (mm)
Story5	DCon19	X	36.006
Story5	DCon19	Y	26.202
Story4	DCon19	X	26.892
Story4	DCon19	Y	19.641
Story3	DCon19	X	17.935
Story3	DCon19	Y	13.342
Story2	DCon19	X	9.797
Story2	DCon19	Y	7.593
Story1	DCon19	X	3.456
Story1	DCon19	Y	2.564

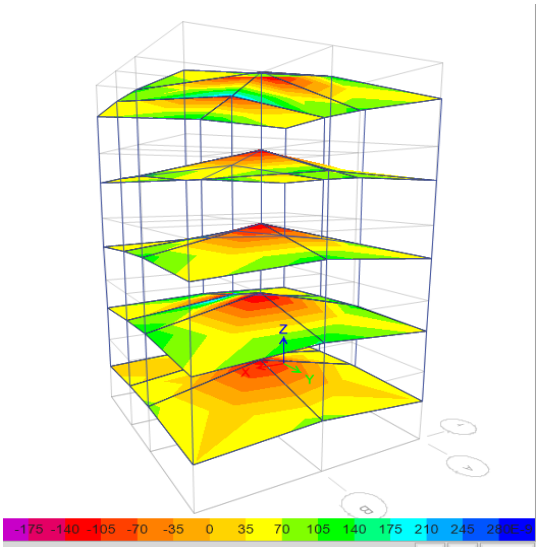

Fig 6. Maximum bending moment- rectangular

TABLE 7. Shear force in x direction- rectangular

Story	Load	Location	VX (KN)
Story 1	DCon20	Top	1260.476
Story 1	DCon20	Bottom	1260.476

TABLE 8. Shear force in Y direction- rectangular

Story	Load	Location	VY (KN)
Story 1	DCon25	Top	-1425.94
Story 1	DCon25	Bottom	-1425.94
Story 1	DCon26	Top	1308.936
Story 1	DCon26	Bottom	1308.936

B. CIRCULAR MONO COLUMN

TABLE 9. Maximum deflection in Y direction-circular

Story	Load	Direction	Deflection(mm)
Story5	UDCon22	Y	57.619
Story4	UDCon22	Y	42.527
Story3	UDCon22	Y	28.008
Story2	UDCon22	Y	14.943
Story1	UDCon22	Y	4.294

TABLE 10. Maximum deflection in X direction-circular

Storey	Load	Direction	Deflection (mm)
Story5	UDCon19	X	37.321
Story5	UDCon19	Y	26.304
Story4	UDCon19	X	27.828
Story4	UDCon19	Y	19.696
Story3	UDCon19	X	18.512
Story3	UDCon19	Y	13.356
Story2	UDCon19	X	10.052
Story2	UDCon19	Y	7.564
Story1	UDCon19	X	3.45
Story1	UDCon19	Y	2.498

TABLE 11. Base reactions- circular

Load Case/Combo	FX	FY	FZ	MX	MY	MZ
	kN	kN	kN	kN-m	kN-m	kN-m
Dead	-66	-66	10294	49606.1	-46959.7	-38.1
Live	0	0	1057.5	4970.25	-4758.75	0
EX	-854.428	0	0	0	-8611.41	4034.528
EY	0	-854.428	0	8611.409	0	-3842.04
WX	-127.783	0	0	0	-1080.44	600.5795
WY	0	-122.345	0	1034.463	0	-550.554
UDCon1	-99	-99	15441.01	74409.16	-70439.5	-57.15
UDCon2	-99	-99	17027.26	81864.53	-77577.7	-57.15
UDCon3	-232.54	-79.2	13621.81	65491.63	-63358.6	674.9754
UDCon4	74.1395	-79.2	13621.81	65491.63	-60765.6	-766.415
UDCon5	-79.2	-226.014	13621.81	66732.98	-62062.1	-706.385
UDCon6	-79.2	67.6144	13621.81	64250.27	-62062.1	614.9447
UDCon7	-290.674	-99	15441.01	74409.16	-72060.2	843.7193
UDCon8	92.6743	-99	15441.01	74409.16	-68818.9	-958.019
UDCon9	-99	-282.518	15441.01	75960.85	-70439.5	-882.981
UDCon10	-99	84.518	15441.01	72857.46	-70439.5	768.6808
UDCon11	-251.074	-59.4	9264.604	44645.49	-43884.4	866.5793
UDCon12	132.2743	-59.4	9264.604	44645.49	-40643.1	-935.159
UDCon13	-59.4	-242.918	9264.604	46197.19	-42263.7	-860.121
UDCon14	-59.4	124.118	9264.604	43093.8	-42263.7	791.5408
UDCon15	-1104.51	-79.2	13621.81	65491.63	-72395.8	4795.713
UDCon16	946.1136	-79.2	13621.81	65491.63	-51728.4	-4887.15
UDCon17	-79.2	-1104.51	13621.81	75825.32	-62062.1	-4656.16
UDCon18	-79.2	946.1136	13621.81	55157.93	-62062.1	4564.724
UDCon19	-1380.64	-99	15441.01	74409.16	-83356.6	5994.641
UDCon20	1182.642	-99	15441.01	74409.16	-57522.4	-6108.94
UDCon21	-99	-1380.64	15441.01	87326.27	-70439.5	-5820.2
UDCon22	-99	1182.642	15441.01	61492.04	-70439.5	5705.905
UDCon23	-1341.04	-59.4	9264.604	44645.49	-55180.8	6017.501
UDCon24	1222.242	-59.4	9264.604	44645.49	-29346.6	-6086.08
UDCon25	-59.4	-1341.04	9264.604	57562.61	-42263.7	-5797.34
UDCon26	-59.4	1222.242	9264.604	31728.38	-42263.7	5728.765

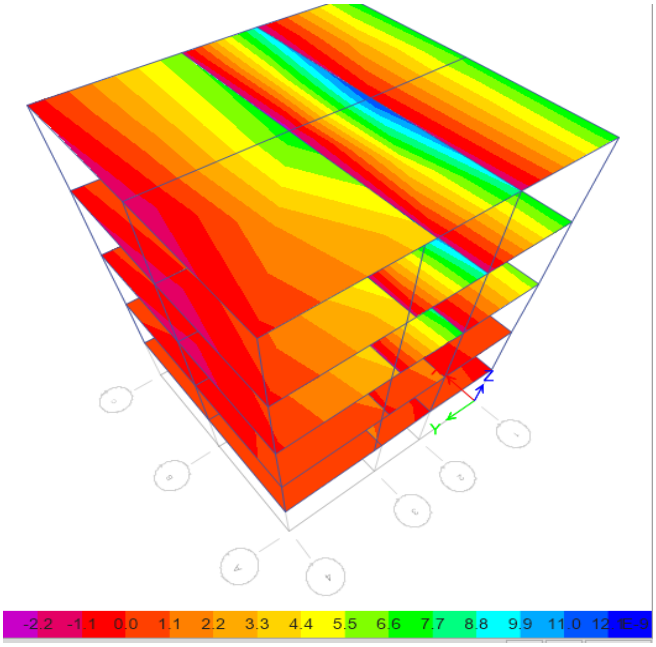

Fig 7. Maximum bending moment- circular

TABLE 12. Shear force in x direction- circular

Story	Load	Location	VX (KN)
Story 1	DCon24	Top	1223.142
Story 1	DCon24	Bottom	1223.142

TABLE 12. Shear force in Y direction- circular

Story	Load	Location	VY (KN)
Story 1	DCon26	Top	1223.142
Story 1	DCon26	Bottom	1223.142

VI. CONCLUSIONS

A rectangular mono column (1.8 m x1.8 m) building analyzed. The maximum displacement is 54.58 mm in Y direction and 36 mm in X direction. The maximum shear force in X direction is 1260.5 kN and 1308.9 kN in Y direction. A circular mono column (d = 2.03m) building also analyzed. The maximum displacement is 57.6 mm in Y direction and 37.3 mm in X direction. The maximum shear force in X direction is 1223 kN and 1223 kN in Y direction. The study shows that the rectangular mono column structure has less deformation than circular mono column structure.

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