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Effects of Various Bracing in Building with Circular Columns

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ABSTRACT*:* R.C. bracing system is used in multistoreyed building against the lateral loading. In this paper, the seismic analysis of reinforced concrete (RC) buildings with different types of bracing (V-type, inverted V-type, X-type) are provided. Eight storey (G+8) building is considered for the seismic analysis. The building models are situated in zone III and analyzed by using equivalent static analysis as per recommendation given by IS 1893:2002 using Staad Pro V8i software. In this analysis of multistoried building with considering the circular columns with different types of bracing are compared.

KEYWORDS*:* Multistorey building, Circular column, R.C. bracing, Seismic zone.

I. INTRODUCTION

Civil engineering is a wide-ranging profession, including several separate specialized sub-disciplines, its history is linked to knowledge of structures, material science, geography, geology, soils, hydrology, environment, mechanics and other fields. Structural engineering is concerned with the structural design and structural analysis of building, bridges, towers, flyovers, tunnels, off shore structures like oil and gas fields in the sea, aero structure and other structure. Structural engineering is a field of engineering dealing with the analysis and design of structures that support or resist loads. Structural engineering is usually considered a specialty within civil engineering, but it can also be studied in its own right.

India at present is fast developing country which requires demands in increase of infrastructure facilities along with the growth of population. Due to increased population, the demand for land for housing is increasing day by day. To fulfill the need of the land for housing and other commercial offices, vertical development that is multistory buildings are the only option. This type of development requires safety because these multistory buildings are highly susceptible to additional lateral loads due to an earthquake and a wind. A reinforced concrete building should be designed to have a capacity to carry combined loads at certain safety level and at certain degree of reliability so, when this design is finally executed in the construction process, the expected performance of the structural building should come into satisfaction.[3] Bracings hold the structure stable by transferring the loads sideways(not gravity, but wind or earthquake loads)down to the ground and are used to resist lateral loads, thereby preventing sway of the structure.[1] Diagonal braces are efficient elements for developing stiffness and resistance to wind loads. There are different types of bracing systems in common use such as single diagonal bracing, X bracing, V bracing, K bracing, inverted V bracing.

II. RELATED WORK

2.1 Building Description

In this study, A G+8 storey reinforced concrete building of 3 bays have been considered for investigating the effect of Unbraced, X type, V type and inverted V type bracings and there arrangements in the middle bay of the building. The building having 3 bays in X direction and 3 bays in Z direction with the plan dimension is (15 m × 15 m) and in Y direction dimension is 3 m.

- Seismic Analysis of RC multistoreyed building of circular columns with unbraced, X type, V type & inverted V type bracing which is situated in zone III by using STAAD.Pro V8i.
- Bending moments, shear forces, storey displacements, story drifts and axial forces are compared for all type of structural systems.

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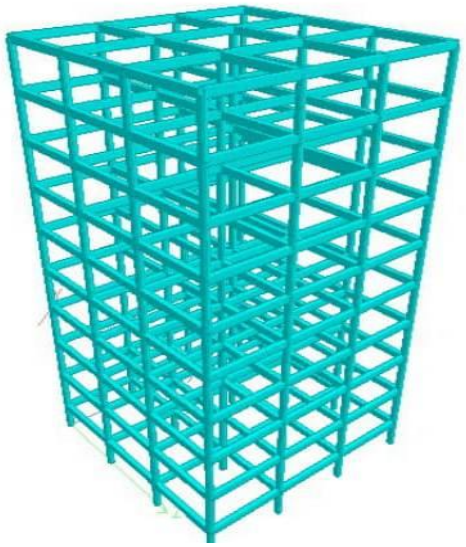
Table 2.1 RC Multistoried Building of Circular Columns

Type of Building	**Residential**
No. of Storeys	**G+8**
Grade of Concrete	**M25**
Grade of Reinforced Steel	**Fe500**
Density of RCC	**25 kN/m^3**
Beam Size	**0.3m X 0.45m**
Column Size (Ø)	**0.41m**
Size of Bracings	**0.2m X 0.2m**
Thickness of Slab	**130mm**
Floor Finishing Load	**1 kN/m^2**
Live Load Intensity	**3.0 kN/m^2**
Seismic Loads	**As per IS 1893**
Seismic Zone	**III**
Zone factor, (Z)	**0.16**
Importance Factor, (I)	**1**
Response Reduction Factor, (R)	**5**
Soil Conditions	**Medium Stiff Gravel Soil**
Damping Ratio	**5 %**
Structure	**SMRF**
Foundation System	**Isolated Foundation**

Fig. (a): Plan of Building
Fig. (b): Unbraced **(**Bare frame) RC building
Fig. (c): Building has RC X type braced in outrigger patterns in the middle bay of every storey in all the four sides.

Fig. (d): Building has RC V type braced in outrigger patterns in the middle bay of every storey in all the four sides.
Fig. (e): Building has RC inverted V (chevron) type braced in outrigger patterns in the middle bay of every storey in all the four sides.



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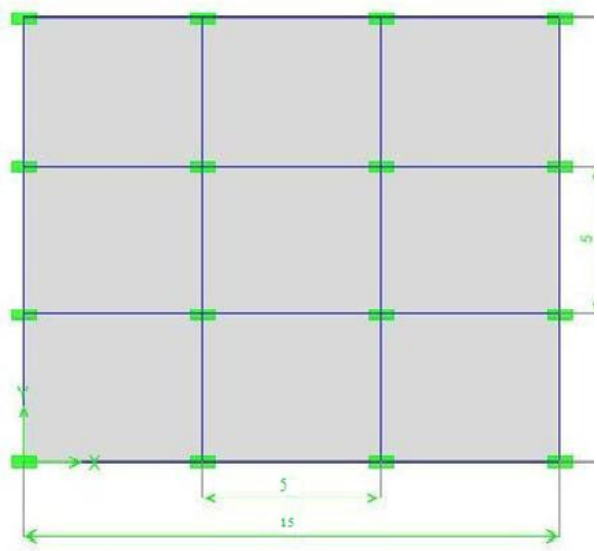

(a)

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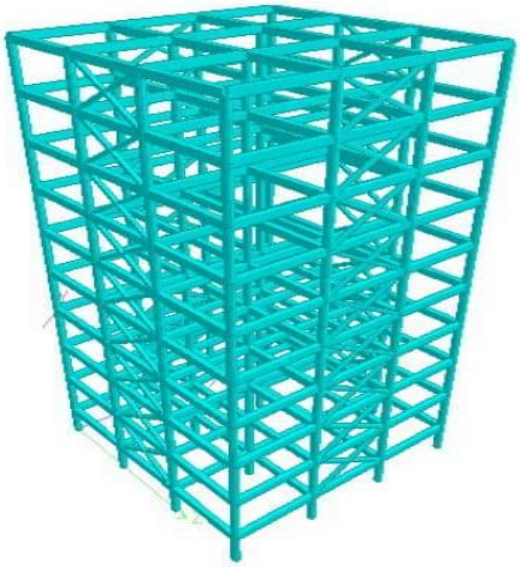

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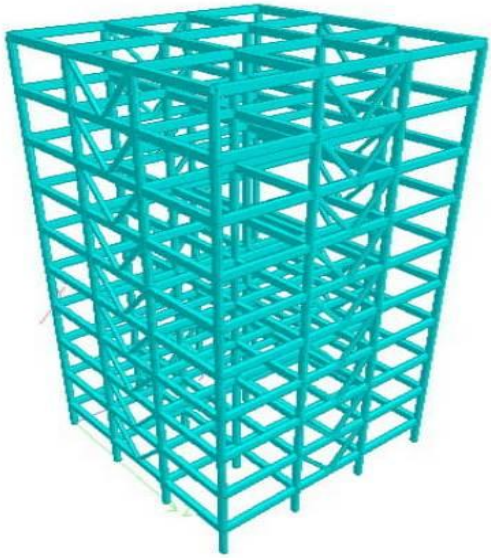

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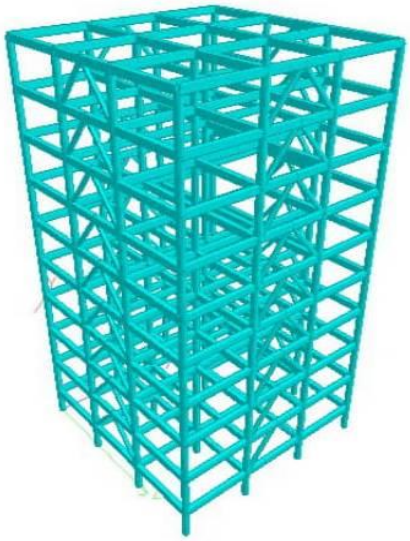

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III. METHODOLOGY

3.1 General

Behaviour of the structures with circular columns subjected to earthquake loading is a complicated phenomenon. There are several numbers of factors affecting the behavior of building out of which the axial loading, moment, shear force, etc. are considered. The 3D analysis is carried out in all the building models. The equivalent static analysis method is carried out on all the 3D models using the software STAAD.Pro V8i. The results obtained from the analysis are discussed in this paper.

3.2 Method of Analysis

Equivalent static analysis is carried out on all the four models. The results are presented in the form of tables and graphs. The loads are calculated and the results obtained are compared with respect to the following parameters like bending moment, shear force, storey drift, storey displacement and axial force.

Table 3.1 Shear Force (kN) in Circular Column

Floors	Height	Nodes	Unbraced	X-Braced	V-Braced	Inv. V-Braced
Base	0	133	13.96	15.83	13.19	14.19
Ground	2	137	13.95	14.2	13.52	14.65
1	5	141	15.61	15.38	15.27	17.4
2	8	145	17.05	17.06	16.94	18.18
3	11	149	18.27	18.28	18.34	19.24

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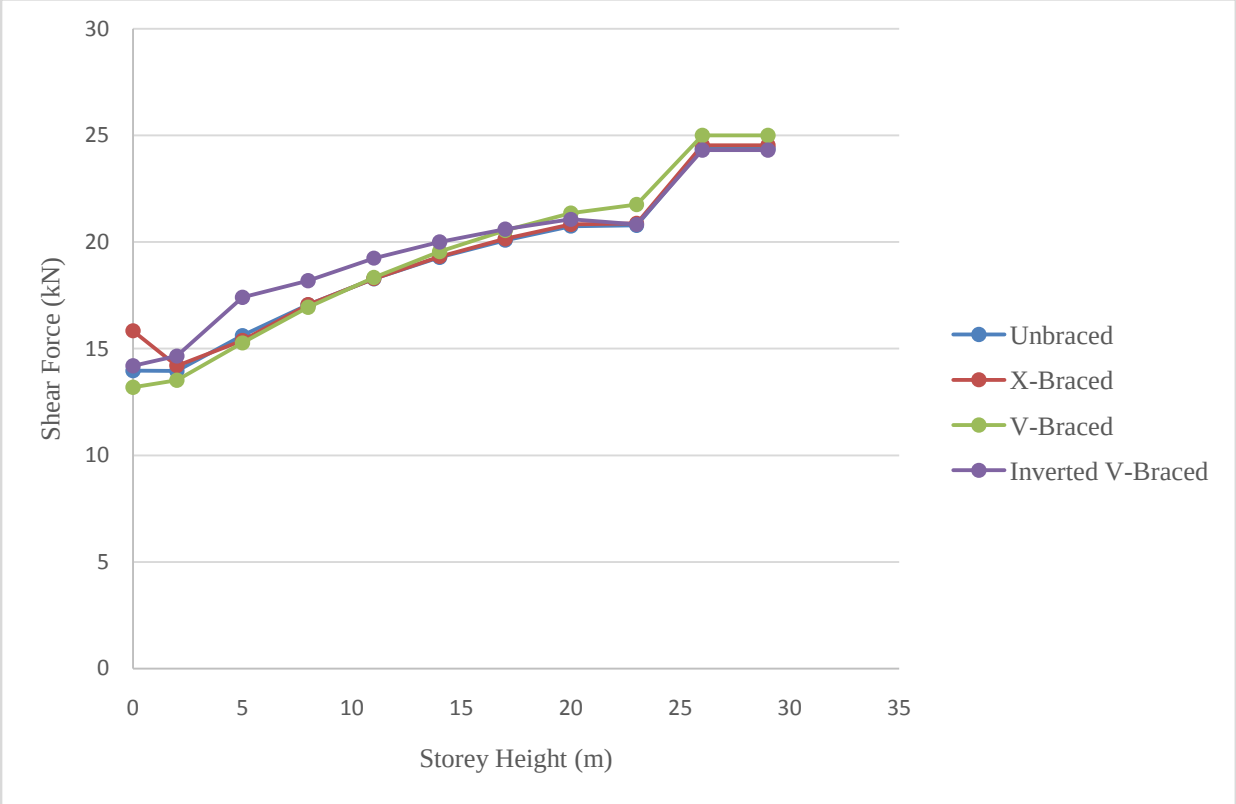
4	14	153	19.28	19.32	19.55	20
5	17	157	20.08	20.15	20.54	20.6
6	20	161	20.74	20.82	21.36	21.06
7	23	165	20.78	20.87	21.76	20.82
8	26	169	24.38	24.53	25	24.31
9	29	173	24.38	24.53	25	24.31



Graph 3.1 Storey Height Vs Shear Force

Table 3.2 Bending Moment (kN-m) in Circular Column

Floors	Height	Nodes	Unbraced	X-Braced	V-Braced	Inv. V-Braced
Base	0	133	8.93	11.19	8.44	9.57
Ground	2	137	20.43	20.6	19.71	20.6
1	5	141	23.01	22.56	22.43	26
2	8	145	25.23	25.25	25	26.94
3	11	149	27.11	27.12	27.18	28.64
4	14	153	28.68	28.74	29.04	29.84

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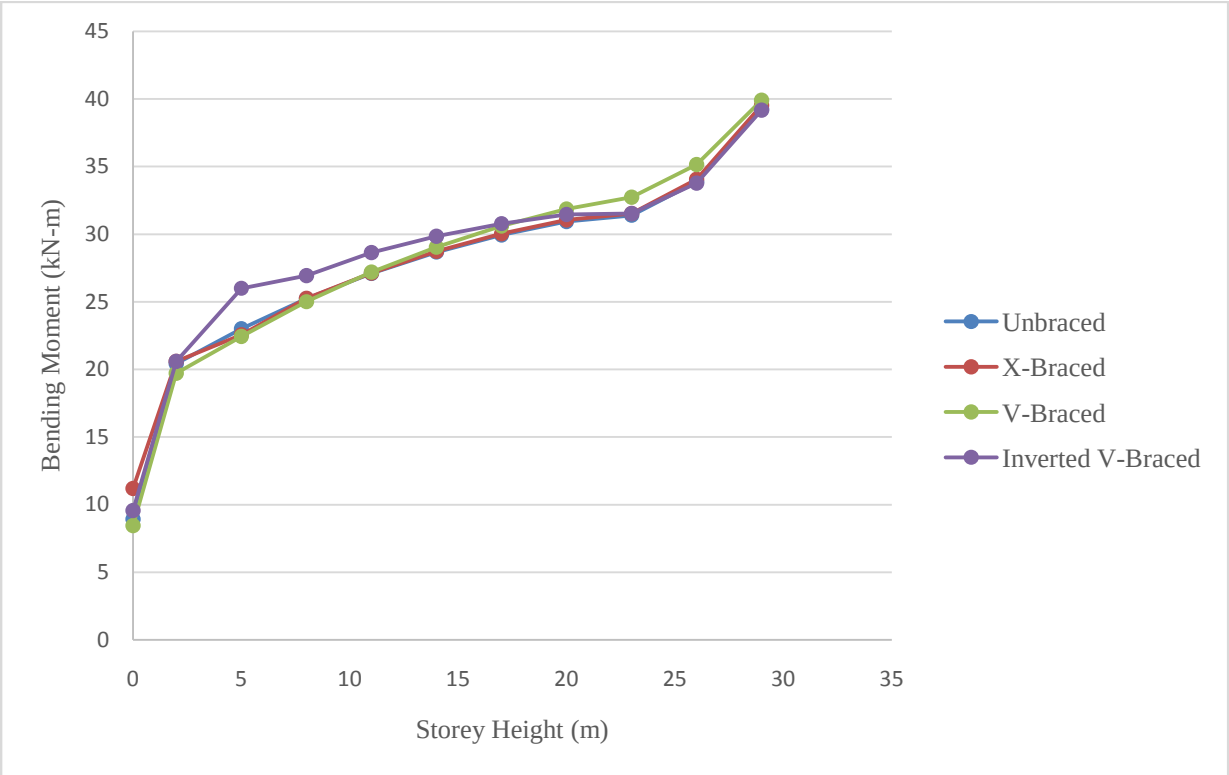
5	17	157	29.95	30.04	30.59	30.78
6	20	161	30.94	31.05	31.85	31.46
7	23	165	31.4	31.53	32.72	31.52
8	26	169	33.88	34.06	35.14	33.77
9	29	173	39.25	39.53	39.9	39.17

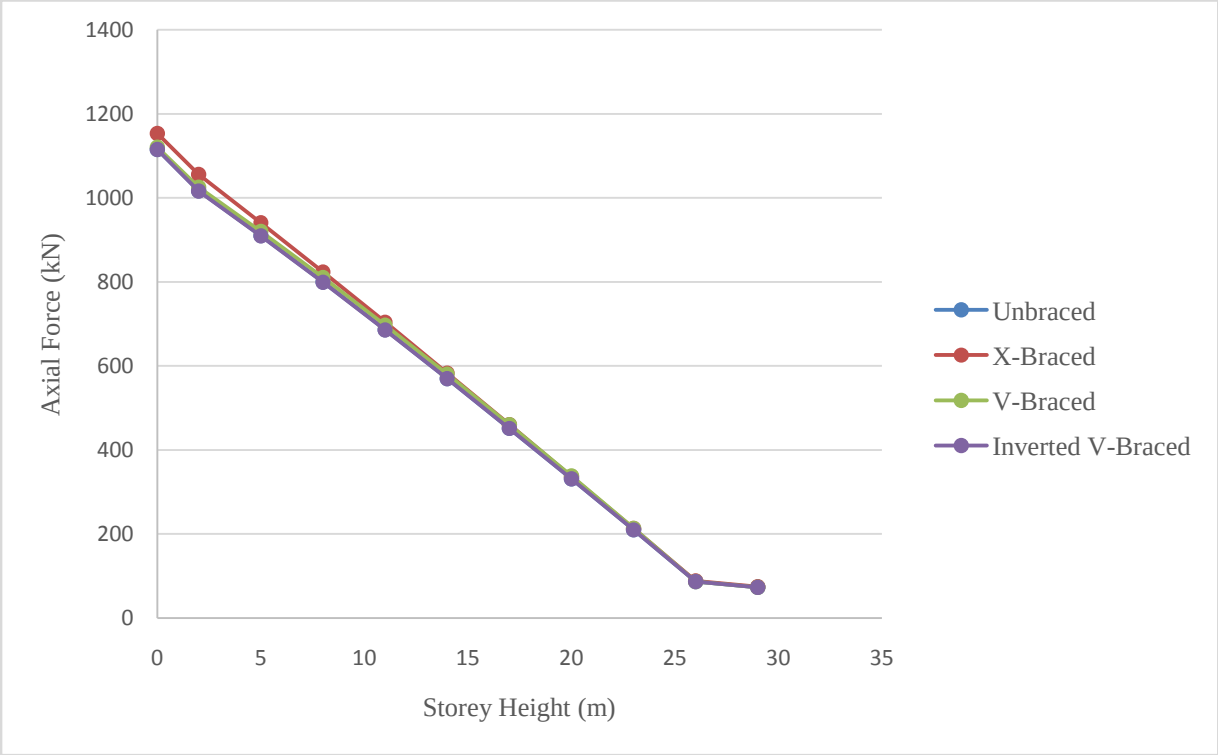


Graph 3.2 Storey Height Vs Bending Moment

Table 3.3 Axial Force (kN) in Circular Column

Floors	Height	Nodes	Unbraced	X-Braced	V-Braced	Inv. V-Braced
Base	0	133	1115.16	1153.32	1120.53	1115.06
Ground	2	137	1016.92	1055.79	1025.04	1015.8
1	5	141	910.09	940.79	920.03	909.18
2	8	145	799.6	823.75	810.6	799.12
3	11	149	686	704.41	697.21	685.74
4	14	153	569.72	583.22	580.38	569.65

5	17	157	451.3	460.66	460.61	451.33
6	20	161	331.18	337.19	338.37	331.28
7	23	165	209.9	213.36	214.17	210.02
8	26	169	87.12	88.91	87.46	87.26
9	29	173	73.12	74.91	73.46	73.26



Graph 3.3 Storey Height Vs Axial Force

Table 3.4 Storey Displacement (cm) in Circular Column

Floors	Height	Nodes	Unbraced	X-Braced	V-Braced	Inv. V-Braced
Base	0	133	0	0	0	0
Ground	2	137	0.232	0.177	0.182	0.177
1	5	141	1.028	0.459	0.505	0.458
2	8	145	1.877	0.77	0.856	0.771
3	11	149	2.729	1.105	1.227	1.107
4	14	153	3.552	1.455	1.608	1.456
5	17	157	4.322	1.81	1.989	1.808

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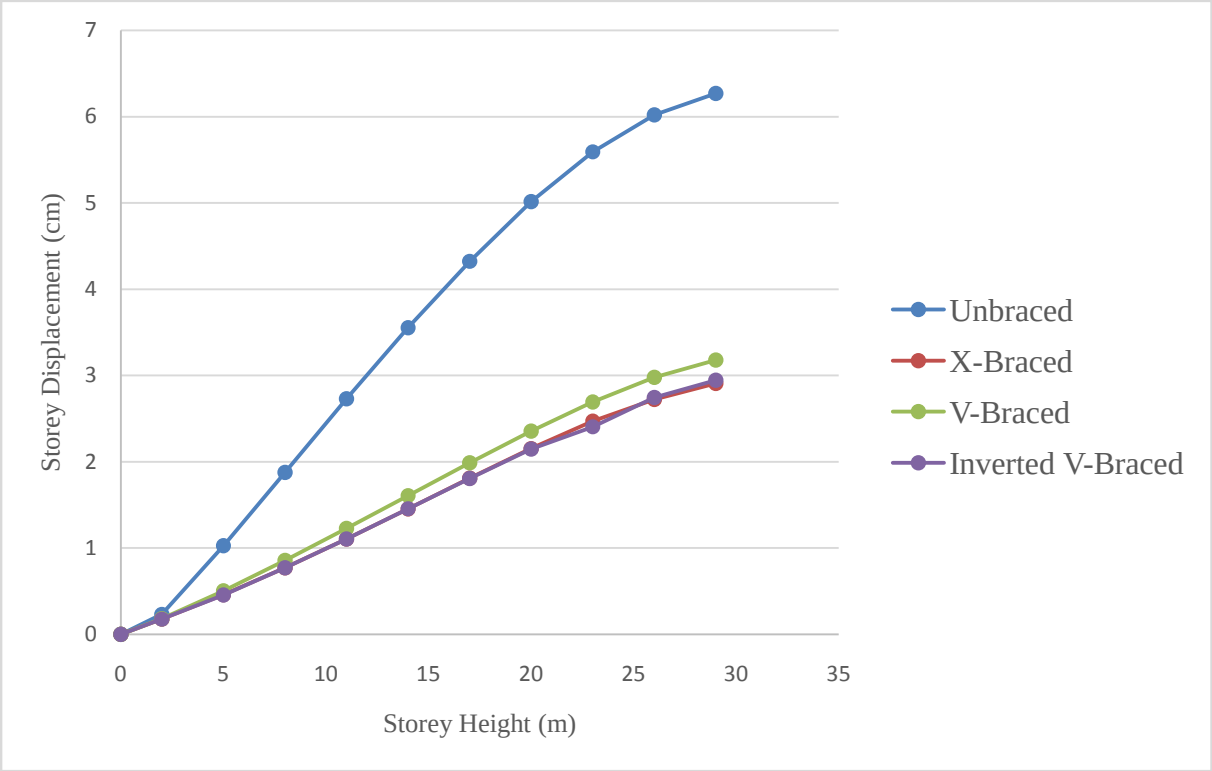
6	20	161	5.012	2.154	2.356	2.149
7	23	165	5.59	2.473	2.693	2.406
8	26	169	6.017	2.722	2.977	2.745
9	29	173	6.267	2.909	3.179	2.946



Graph 3.4 Storey Height Vs Story Displacement

Table 3.5 Storey Drift (cm) in Circular Column

Floors	Height	Nodes	Unbraced	X-Braced	V-Braced	Inv. V-Braced
Base	0	133	0	0	0	0
Ground	2	137	0.232	0.177	0.182	0.177
1	5	141	0.7882	0.281	0.322	0.281
2	8	145	0.856	0.311	0.35	0.312
3	11	149	0.851	0.335	0.37	0.335
4	14	153	0.822	0.35	0.381	0.349
5	17	157	0.77	0.354	0.38	0.352

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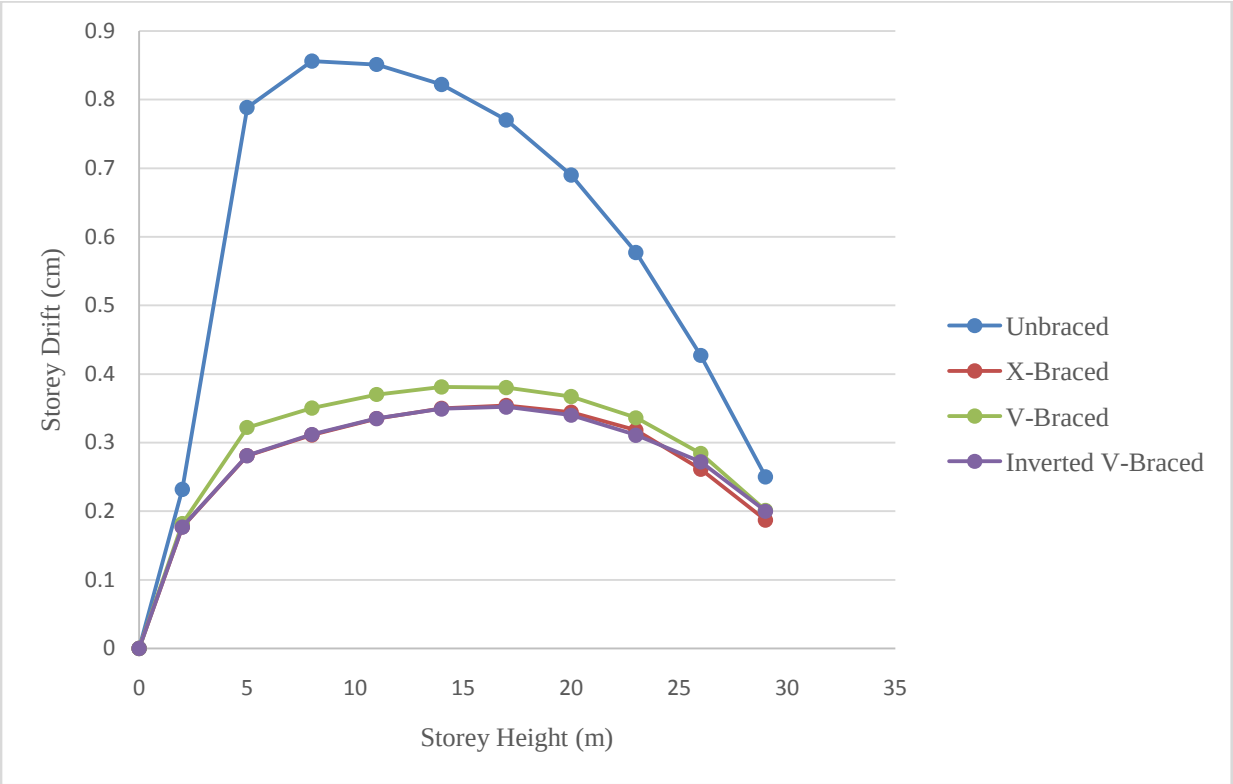
6	20	161	0.69	0.344	0.367	0.34
7	23	165	0.577	0.318	0.336	0.311
8	26	169	0.427	0.261	0.284	0.272
9	29	173	0.25	0.187	0.201	0.2



Graph 3.5 Storey Height Vs Story Drift

IV. RESULTS ANALYSIS

➢ Table 3.1 shows the shear forces at top and ground storeys for all the structural systems i.e. unbraced, X-braced, V-braced and inverted V-braced structural systems for circular columns models respectively. The shear forces of the structure for various types of bracing systems are compared. It can be seen that the shear forces at top levels in circular column models are 13.96 kN, 15.83 kN, 13.19 kN, 14.19 kN for unbraced, X-braced, V-braced and inverted V-braced structural systems respectively. It can also be seen that the shear forces at base levels in circular column models are 24.38 kN, 24.53 kN, 25 kN, 24.31 kN for unbraced, X-braced, V-braced and inverted V-braced structural systems respectively.

➢ Table 3.2 shows the bending moment at top and ground stories for all the structural systems i.e. unbraced, X-braced, V-braced and inverted V-braced structural systems for circular columns models respectively. The bending moments of the structure for various types of bracing systems are compared. It can be seen that the bending moment at top levels in circular column models are 8.93 kN-m, 11.19 kN-m, 8.44 kN-m, 9.57 kN-m for unbraced, X-braced, V-braced and inverted V-braced structural systems respectively. It can also be seen that the bending moment at base levels in circular column models are 39.25 kN-m, 39.53 kN-m, 39.9 kN-m, 39.17 kN-m for unbraced, X-braced, V-braced and inverted V-braced structural systems respectively.

➢ Table 3.3 shows the axial force at top and ground stories for all the structural systems i.e. unbraced, X-braced, V-braced and inverted V-braced structural systems for circular columns models respectively. The axial forces of the

structure for various types of bracing systems are compared. It can be seen that the axial forces at top levels in circular column models are 1115.16 kN, 1153.32 kN, 1120.53 kN, 1115.06 kN for unbraced, X-braced, V-braced and inverted V-braced structural systems respectively. It can also be seen that the axial forces at base levels in circular column models are 73.12 kN, 74.91 kN, 73.46 kN, 73.26 kN for unbraced, X-braced, V-braced and inverted V-braced structural systems respectively.

- Table 3.4 shows the maximum storey displacement for seismic load for all the structural systems i.e. unbraced, X-braced, V-braced and inverted V-braced structural systems for circular columns models respectively. The storey displacements of the structure for various types of bracing systems are compared. It can be seen that the storey displacement at top levels in circular column models are 6.267cm, 2.909cm, 3.179cm, 2.946cm for unbraced, X-braced, V-braced and inverted V-braced structural systems respectively.
- Table 3.5 shows the storey drifts for seismic load for all the structural systems i.e. unbraced, X-braced, V-braced and inverted V-braced structural systems for circular columns models respectively. The storey drifts of the structure for various types of bracing systems are compared. It can be seen that the storey drift at top levels in circular column models are 0.25cm, 0.187cm, 0.201cm, 0.20cm for unbraced, X-braced, V-braced and inverted V-braced structural systems respectively.

V. CONCLUSION

Bracing system is one of the important systems used against lateral loading. Bracing system increases stiffness in the column. Building model with X-bracing system having more axial loading compare with different types of specified bracing system. Performance of the building increases after the application of X-type bracing system. In this paper, it can conclude that building model having X-type bracing system is better than other types of bracing system mentioned.

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