Response of Building for Different Braces using E-TABS

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***Abstract*—India is developing country, Nowadays our Indian population is increasing day by day. According to some sources our Indian population is reached nearly 138 cores, this rapid increase in population forced engineers to adopt for high rise building. Damage caused by lateral load is need to be control. There are so many methods to control the damage of building by lateral loads, we are adopting one of method, providing the different types of bracings to the building.**

In present study, we have used conventional building with 16mx10m along X and Y direction. We carried out the equivalent static linear analysis by using ETABS software, then comparing the results of displacement, storey drift, base shear b\w the bare building and Braced building.

Keywords—Bracing, Displacements, Storey Drift, Base shear, E-TABS etc.

I.INTRODUCTION

India is developing country. According to 2020census our Indian population is reached nearly 138,00,00,4385(138 corers). This sudden increase in population and low availability of the land have forced us (engineers) to go for high rise building. Tall building or high rise building are exposed to various forces or load due to various forces the displacement and moments are generated. To avoid these problems we are chosen.

Bracings, to observe the vibrations the devices or any material are placed which is called as Bracings. There are many ways to providing bracings to improve the building performance. There are different types of bracings namely Diagonal Bracing, V Bracing, Inverted V Bracing and X Bracing. The primary function of Bracing is to provide stability and resist lateral load either from diagonal steel members or from concrete core. For bracing frame, to only support vertical loads beams and columns are designed since all the lateral loads are carried by bracings systems. A braced frame is really strong structure subject to lateral load and wind load, frame are generally made by steel structure, which can work effectively both tension and compression.

1.1 Different types of Bracings

A braced frame is a really strong structural system commonly used in structures subject to lateral loads such as wind and seismic pressure. The members in braced frame are generally made of steel structures and RCC structures which can work effectively both in tension and compression.

Types of bracing system used as follow:

- Diagonal Bracing
- V Bracing
- Inverted V Bracing
- X Bracing

- Diagonal Bracing: structural component of any building just above it is a diagonal bracing. To add a strength wooden case member or crate member placed in adjacent angle.
- V Bracing: Two Diagonal members forming a V shape extend downwards from the top two corners of a horizontal members and meet at a centre point on the lower horizontal member its known as V Bracing.
- Inverted V Bracing: Inverted v bracing are also know as chevron bracing. Two diagonal members forming a V shape extended upwards from the bottom two corners of a horizontal members and meet at a centre point on the upper horizontal member its know as Inverted V Bracing
- X Bracing**:** X bracing uses two diagonal members crossing each other. These only need to be resist to tension, one brace at a time acting to resist sideways forces, depending on the direction of loading. As a result, steel cables can also be used for cross-bracing.

II. OBJECTIVE

In this project G+11 story RCC structure is analyzed to reduce the displacement and movement of the structure.

- To compare the response of high rise building, with and with and without bracing.
- To determine the displacement, story drift and base shear for bare building.
- To determine the displacement, story drift and base shear after introduction of the bracing.
- To analyze the structure for different orientation of column and compare their results.
- To select the best bracing among Diagonal Bracing, Inverted V Bracing, V Bracing and X Bracing. Types of structure analyzed:

III.METHADOLOGY

3.1 Step by step as per the below procedure:

- After the study of various literature reviews, we found our project objectives.
- In this project we are considering G+ 11 stories. The building dimension 16mx10m.

- Comparing strength and stability of bare building with the braced building.
- Analyse all models using E-tabs software by applying the selected loads on building as per the IS code book (IS 875).

3.2 GEOMETRICAL DATA:

- Number of stories: G+11
- Type of building use: Commercial
- Plane dimension: 16m x 10m
- Typical story height: 3m
- Bottom story height: 3m
- Height of structure: 36m

3.3 MATERIALS USED:

- Grade of concrete: M25 for slab, M30 for beams and columns.
- Grade of steel: Fe500
- Grade of bracing: ISMB500

3.4 LOADING DATA:

- Dead load:It is defined automatically by software (Table 2, IS875 (part 1) ; 1987)
- Live load:For commercial building as per (Table, IS875 (part-2), live load is taken as 2KN/m^2.
- Floor finish: 1.5KN/m^2.
- Wall load: 12.42KN\m.

3.5 MODELING AND STRUCTURE

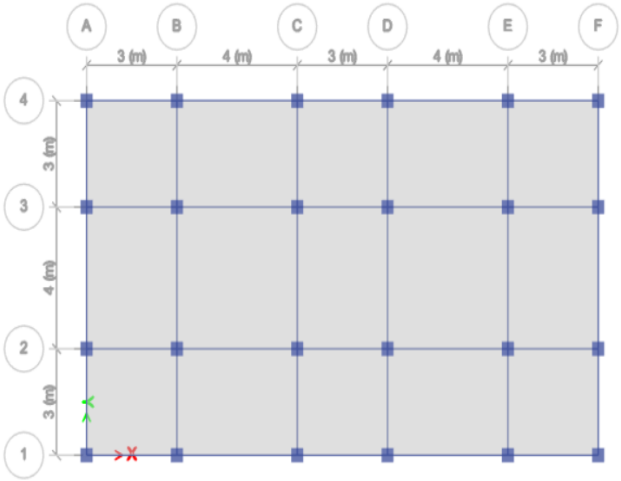

Fig 1: Plan of the model

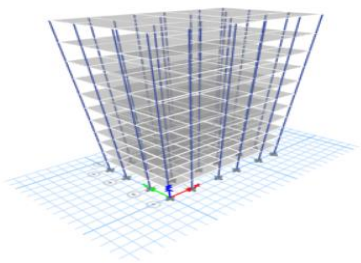

Fig-2 Unbraced building (3D view)

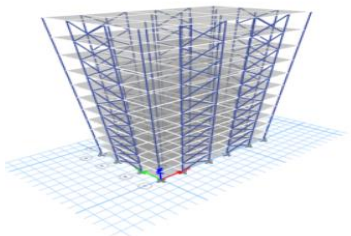

FIG-3 X Bracing (3D view)

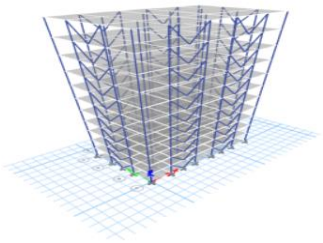

Fig-4 V Bracing (3D view)

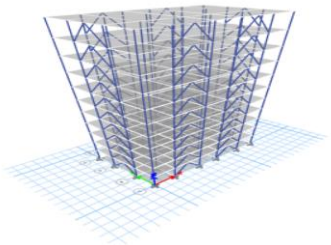

Fig-5 Inverted v bracing (3D view)

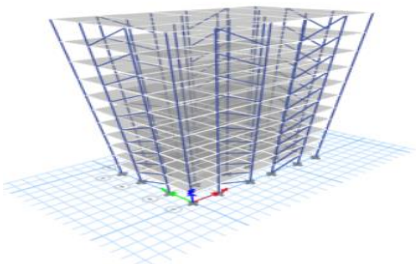

Fig-6 Diagonal bracing (3D view)

IV. RESULT AND DISCUSSION

4.1 Maximum storey displacement with 1.5(DL+LL+EQX) along X – direction.

Table-1 Maximum storey displacement in X- direction

story	Bare building	Diagonal bracing	V Bracing	Inverted V	X Bracing
Base	0	0	0	0	0
Story1	2.603	1.386	1.28	0.988	0.935
Story2	7.386	3.493	3.455	2.793	2.645
Story3	12.749	5.957	5.951	4.978	4.823
Story4	18.247	8.687	8.731	7.508	7.353
Story5	23.705	11.581	11.67	10.264	10.111
Story6	29.008	14.545	14.673	13.135	12.983
Story7	34.046	17.496	17.651	16.026	15.868
Story8	38.698	20.357	20.52	18.85	18.673
Story9	42.828	23.058	23.202	21.538	21.317
Story10	46.278	25.556	25.626	24.027	23.724
Story11	48.843	27.797	27.737	26.298	25.863
Story12	50.255	29.64	29.397	28.25	27.563

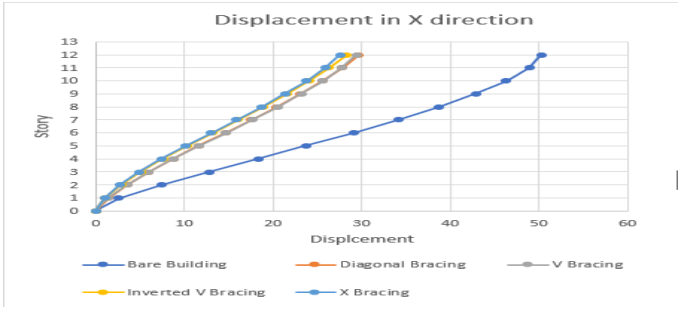

Fig-7 Maximum storey displacement of the building along X direction.

According to the above graph, bare building shows maximum displacement compare to different braced building in X direction.

Diagonal bracing shows 41.02% lesser displacement then the Bare building. V Bracing shows 41.50% lesser displacement than the bare building. Inverted V Bracing shows 43.78% lesser displacement than the bare building. X bracing shows 45.15% displacement. when compared with other bracings X bracing shows least displacement and more stable.

4.2 Maximum storey displacement 1.5(DL+LL+EQY) along y- direction

4.3

Table -2 Maximum storey displacement of the building along Y- direction.

Story	Bare Building	Diagonal Bracing	V Bracing	Inverted Bracing	X Bracing
Base	0	0	0	0	0
Story1	2.659	1.748	1.322	1.258	1.321
Story2	7.658	4.573	3.751	3.606	3.869
Story3	13.37	7.885	6.732	6.575	6.913
Story4	19.291	11.534	10.161	9.988	10.343
Story5	25.216	15.389	13.874	13.686	14.013
Story6	31.015	19.329	17.727	17.523	17.796
Story7	36.565	23.244	21.593	21.368	21.574
Story8	41.731	27.032	25.359	25.102	25.236
Story9	46.358	30.599	28.928	28.617	28.677
Story10	50.24	33.872	32.221	31.817	31.797
Story11	53.027	36.729	35.153	34.574	34.475
Story12	54.574	38.986	37.585	36.705	36.522

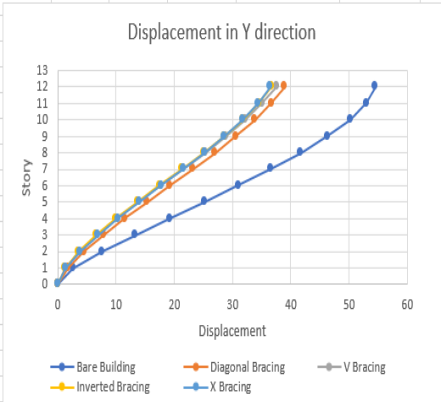

Fig-8 Maximum storey displacement of the building along Y- direction.

According to above graph, bare building shows maximum displacement compare to different braced building in Y direction. Diagonal Bracing shows 28.56% lesser displacement compared to the bare building. V Bracing shows 31.13% lesser displacement compared to the bare building. Inverted V Bracing shows 32.74% lesser displacement compared to the bare building. X Bracing shows 33.07% lesser displacement.

4.3 Maximum storey drift 1.5(DL+LL+EQX) in X direction.

Table-3 Max storey drift of the building in X direction.

Story	Bare building	Diagonal Bracing	V Bracing	X Bracing	inverted v
Base	0	0	0	0	0
Story1	0.000868	0.000427	0.000453	0.000329	0.000312
Story2	0.001594	0.000727	0.000704	0.000602	0.00057
Story3	0.001788	0.000844	0.000822	0.000733	0.000726
Story4	0.001833	0.000934	0.000911	0.000849	0.000844
Story5	0.00182	0.000986	0.000965	0.000924	0.00092
Story6	0.001768	0.001007	0.000989	0.000963	0.000958
Story7	0.001679	0.000999	0.000985	0.000969	0.000962
Story8	0.001551	0.000963	0.000955	0.000947	0.000935
Story9	0.001377	0.000902	0.000903	0.000901	0.000882
Story10	0.001151	0.000819	0.000833	0.000838	0.000806
Story11	0.000856	0.000723	0.000754	0.000768	0.000716
Story12	0.000471	0.000553	0.000615	0.00065	0.000567

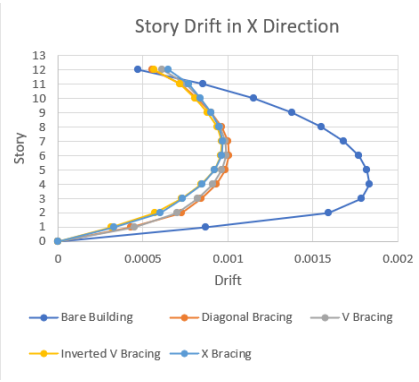

Fig- 9 maximum storey drift of the building in X- direction

According to above graph, bare building shows maximum drift compare to different braced building in X direction. Diagonal bracing shows 45.06% lesser drift compared to the bare building. V Bracing shows 46.04% lesser drift compared to the Bare building. V Bracing shows 47% lesser drift compared to the bare building. X Bracing shows 47.67% lesser drift when compared to other bracings.

4.4 Maximum storey drift 1.5(DL+LL+EQY) in Y direction.

Table -4 Maximum storey drift of the building in y-direction.

Story	Bare Building	Diagonal Bracing	V Bracing	Inverted V Bracing	X bracing
Base	0	0	0	0	0
Story1	0.00088	0.00057	0.00044	0.00041	0.0004
Story2	0.00166	0.00094	0.0008	0.00078	0.0008
Story3	0.00190	0.00110	0.001	0.0009	0.0010
Story4	0.00197	0.00121	0.00114	0.00113	0.0011
Story5	0.00197	0.00128	0.00124	0.00123	0.0012
Story6	0.00193	0.00131	0.00128	0.00128	0.0012
Story7	0.0018	0.00130	0.00129	0.00129	0.0012
Story8	0.00172	0.00126	0.0012	0.00125	0.0012
Story9	0.00154	0.00119	0.00119	0.0011	0.0011
Story10	0.00129	0.00109	0.00110	0.0010	0.0010
Story11	0.0009	0.00095	0.00098	0.00093	0.0009
Story12	0.00051	0.000752	0.00081	0.00073	0.0006

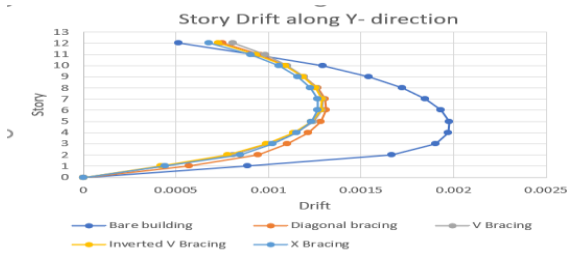

Fig-10 Maximum storey drift of the building in y- direction.

According to above graph, bare building shows maximum drift compare to different braced building in Y direction. Diagonal Bracing shows 33.4% lesser drift, V Bracing shows 34.5% lesser drift, Inverted V Bracing shows 34.7% lesser drift and X Bracing shows 36% lesser drift when compared to the bare building.

4.5 Base Shear 1.5(DL+LL+EQX) in X- direction:

Table : 5 Base shear for different braced building.

Bracings	Fx	Fy	Fz	Mx	My
without	-120.8	-312	56974.96	2.93E+08	-515781
Diagonal	-1863.5	-312	58215.8	298795	-543245
V Bracing	-2023.8	-312	58764.85	301540	-552053
Inverted V	-1899.8	-312	58764.88	301540	-548848
X bracing	-2044.0	-312	59457.43	305703	-558459

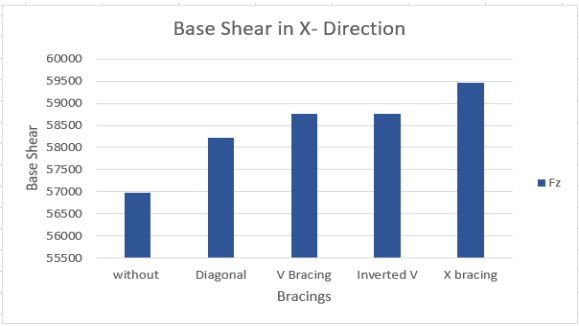

Fig: 11 Base shear for different braced building.

The Base shear of the bare building is minimum when compared with braced building. Among the all types of bracing X Bracing shows maximum Base shear.

4.6 Base shear 1.5(DL+LL+EQY) along Y –direction.

Table :6 Base shear for different braced building.

Bracings	Fz	Mx	My
without	56974.17	294745.7	-492620
Diagonal	58215.8	300953.9	-503174
V Bracing	58764.88	303699.3	-507841
Inverted V	58764.88	303699.3	-507841
X bracing	59457.43	307162.1	-513728

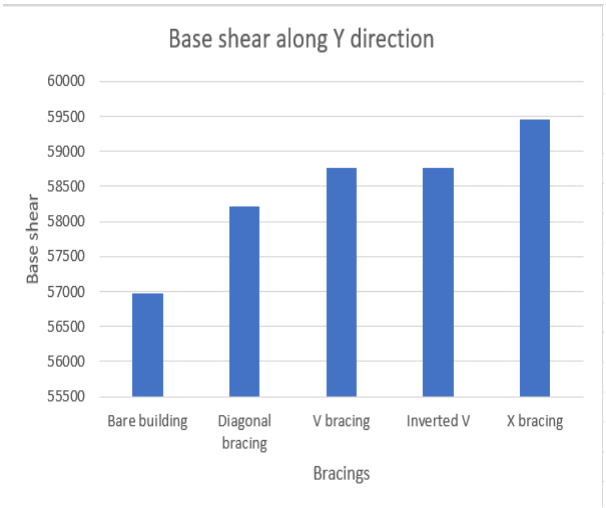

Fig : 12 Base shear for different braced building.

The Base shear of the bare building is minimum when compared with braced building. Among the all types of bracing X Bracing shows maximum Base shear.

4.7 Lateral displacement due to Wind Load 1.5(DL+LL+WX) along X direction

Table: 7 Lateral displacement due to wind load along X direction

Story	Bare building	Diagonal bracing	V Bracing	Inverted V	X bracing
	mm	mm	mm	mm	mm
Base	0	0	0	0	0
Story1	0.643	0.223	0.148	0.14	0.0546
Story2	1.776	0.549	0.479	0.394	0.15366
Story3	3.032	0.934	0.794	0.709	0.27651
Story4	4.335	1.371	1.169	1.087	0.42393
Story5	5.665	1.85	1.591	1.514	0.59046
Story6	7.013	2.36	2.05	1.978	0.77142
Story7	8.374	2.893	2.535	2.47	0.9633
Story8	9.744	3.443	3.037	2.979	1.16181
Story9	11.111	4.001	3.547	3.497	1.36383
Story10	12.446	4.567	4.054	4.013	1.56507
Story11	13.63	5.121	4.558	4.528	1.76592
Story12	14.304	5.569	4.994	4.928	1.92192

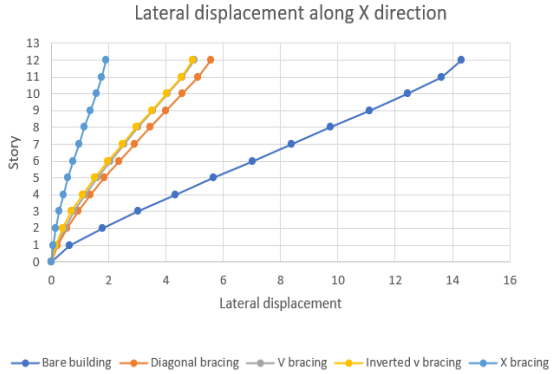

Fig :13 Shows the lateral displacement due to wind load along X direction.

According to the above graph, bare building shows maximum displacement compare to different braced building in X direction.

Diagonal bracing shows 61% lesser displacement then the Bare building. V Bracing shows 65.08% lesser displacement than the bare building. Inverted V Bracing shows 65.54% lesser displacement than the bare building. X bracing shows 80.05% displacement. when compared with other bracings X bracing shows least displacement and more stable.

4.8 Lateral displacement due to Wind load 1.5(DL+LL+WY) along Y direction.

Table:8 Lateral displacement due to Wind load along Y direction.

Story	Bare building	Diagonal bracing	V bracing	Inverted V	X bracing
	mm	mm	mm	mm	mm
Base	0	0	0	0	0
Story1	0.926	0.45	0.323	0.315	0.085
Story2	2.5	1.101	0.902	0.827	0.34
Story3	4.261	1.865	1.547	1.469	0.761
Story4	6.103	2.725	2.31	2.229	1.339
Story5	7.994	3.66	3.161	3.078	2.042
Story6	9.92	4.65	4.076	3.995	2.846
Story7	11.869	5.678	5.034	4.957	3.731
Story8	13.829	6.729	6.017	5.947	4.679
Story9	15.772	7.787	7.006	6.946	5.671
Story10	17.608	8.834	7.981	7.934	6.68
Story11	19.033	9.784	8.877	8.823	7.603
Story12	19.739	10.467	9.574	9.439	8.247

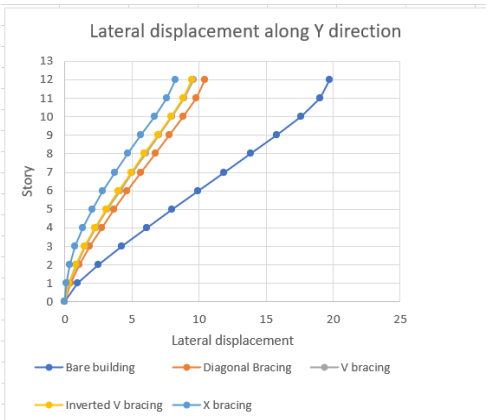

Fig:14 Shows the displacement along Y direction due to Wind load

According to above graph, bare building shows maximum displacement compare to different braced building in Y direction. Diagonal Bracing shows 46.97% lesser displacement compared to the bare building. V Bracing shows 51.49% lesser displacement compared to the bare building. Inverted V Bracing shows 52.18% lesser displacement compared to the bare building. X Bracing shows 58.21% lesser displacement.

4.9 Storey Drift due to Wind load 1.5(DL+LL+WX) along X direction.

Table :9 Story drift along X direction.

Story	Bare building	Diagonal bracing	Vbracing	Inverted V	X bracing
Base	0	0	0	0	0
Story1	0.000214	0.000073	0.000101	0.000049	0.000047
Story2	0.000378	0.000109	0.000094	0.000111	0.000085
Story3	0.000418	0.000128	0.000042	0.00011	0.000107
Story4	0.000435	0.000146	0.00002	0.00013	0.000128
Story5	0.000443	0.00016	0.000054	0.000146	0.000144
Story6	0.000449	0.00017	0.000082	0.000158	0.000157
Story7	0.000454	0.000178	0.000107	0.000167	0.000166
Story8	0.000457	0.000183	0.000128	0.000173	0.000172
Story9	0.000456	0.000187	0.000147	0.000176	0.000175
Story10	0.000445	0.000189	0.000164	0.000177	0.000176
Story11	0.000396	0.000191	0.00018	0.000179	0.000175
Story12	0.000225	0.000149	0.00014	0.000146	0.000133

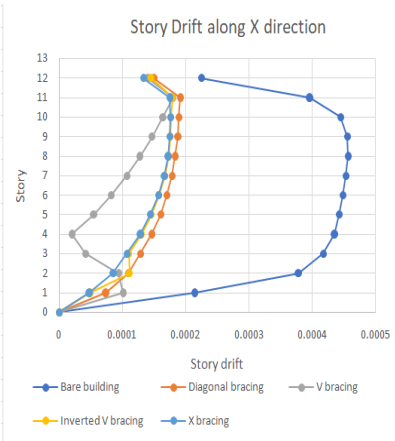

Fig:15 shows the story drift due to wind load along X direction

According to above graph, bare building shows maximum drift compare to different braced building in X direction. Diagonal bracing shows 58.64% lesser drift compared to the bare building. V Bracing shows 60.61% lesser drift compared to the Bare building. V Bracing shows 60.83% lesser drift compared to the bare building. X Bracing shows 62% lesser drift when compared to other bracings.

4.10 Story drift due to Wind load 1.5(DL+LL+WY) along Y direction.

Table :10 Story drift along Y direction

Story	Bare building	Diagonal bracing	V bracing	Inverted V bracing	X bracing
Base	0	0	0	0	0
Story1	0.000309	0.000105	0.000148	0.000028	0.000108
Story2	0.000525	0.00017	0.000218	0.000085	0.000193
Story3	0.000587	0.000215	0.000255	0.000143	0.000221
Story4	0.000614	0.000254	0.000287	0.000195	0.000259
Story5	0.00063	0.000285	0.000312	0.000236	0.000288
Story6	0.000642	0.00031	0.00033	0.000269	0.000309
Story7	0.00065	0.000329	0.000343	0.000296	0.000324
Story8	0.000654	0.000343	0.00035	0.000317	0.000332
Story9	0.000648	0.000351	0.000353	0.000332	0.000334
Story10	0.000612	0.000354	0.00035	0.00034	0.00033
Story11	0.000476	0.000322	0.00032	0.000314	0.000308
Story12	0.000235	0.000237	0.000227	0.000215	0.000232

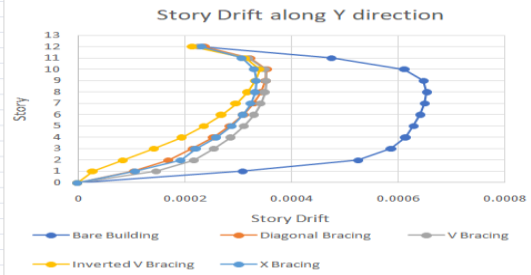

Fig :16 shows the story drift due to wind load along Y direction.

According to above graph, bare building shows maximum drift compare to different braced building in Y direction. Diagonal Bracing shows 45.87% lesser drift, V Bracing shows 46.48% lesser drift, Inverted V Bracing shows 48.08% lesser drift and X Bracing shows 49% lesser drift when compared to the bare building.

4.11 Base shear for wind load:

Table :11 Table show base shear due to wind load.

Bracings	Fz	Mx	My
without	56974.17	290659.6	-492620
Diagonal	58215.8	296867.7	-503174
V Bracing	58764.88	299613.1	-507841
Inverted V	58764.88	303351.6	-507841
X bracing	59457.43	306814.4	-513728

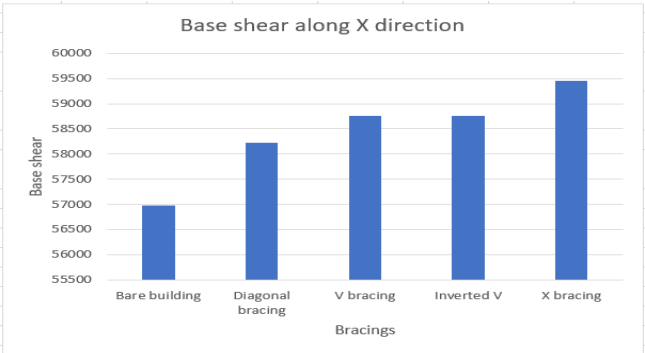

Fig:17 shows the base shear due to wind load in X direction.

The Base shear of the bare building is minimum when compared with braced building. Among the all types of bracing X Bracing shows maximum Base shear.

4.12 Base shear due to wind load in Y direction.

Table : 12 Base shear due to wind load in Y direction.

Bracings	Fz	Mx	My
without	56974.17	294745.7	-492620
Diagonal	58215.8	300953.9	-503174
V Bracing	58764.88	303699.3	-507841
Inverted V	58764.88	303699.3	-507841
X bracing	59457.43	307162.1	-513728

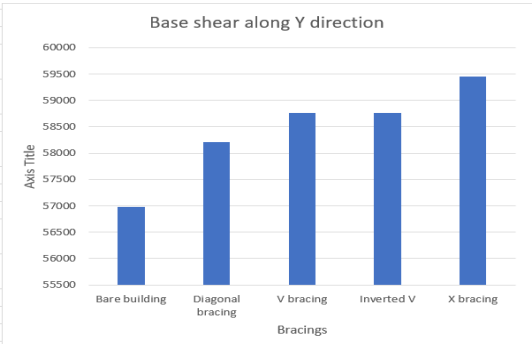

Fig :18 Shows the base shear due to Wind load in Y direction.

The Base shear of the bare building is minimum when compared with braced building. Among the all types of bracing X Bracing shows maximum Base shear.

V. CONCLUSION

From this study, analyzed the variation of the lateral displacement, story drift and base shear along X and Y directions. This present study is concluded with the following conclusions.

- In ESM for the load combinations 1.5(DL+LL+EQX) and 1.5(DL+LL+EQY). The variation of the lateral displacement of the building is compared with the bare building along X and Y direction. The displacement is minimum in X Braced building and maximum in bare building.
- The ESM for the load combinations 1.5(DL+LL+WX) and 1.5(DL+LL+WY). The variation of lateral displacement of the building is compared with the bare building along X and Y direction. The displacement is minimum in X braced building and maximum in bare building.
- The ESM for the load combinations 1.5(DL+LL+EQX) and 1.5(DL+LL+EQY). The variation of the story drift of bare building is compared with different types braced building along X and Y direction. The story drift is maximum in bare building and minimum in X braced building.
- The ESM for the load combinations 1.5(DL+LL+WX) and 1.5(DL+LL+WY). The variation of the story drift of bare building is compared with different types of braced building along X and Y direction. The story drift is maximum in bare building and minimum in X braced building.
- The ESM for the load combinations 1.5(DL+LL+EQX) and 1.5(DL+LL+EQY). The variation of the base shear of the bare building is compared with the different types of the braced building along X and Y direction. The base shear is minimum in bare building and maximum in X braced building.
- The ESm for the load combinations 1.5(DL+LL+WX) and 1.5(DL+LL+WY). The variation of the base shear of the bare building is compared with the different types of the braced building along X and Y direction. The base shear is minimum in bare building and maximum in X braced building.
- From the overall result the displacement and story drift is minimum in braced building and base shear is maximum in Braced building compare to bare building.

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