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A Comparative Study on Behavior of Multistoried Building with Different Types and Arrangements of Bracing Systems

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Abstract

When a tall building is subjected to lateral or torsional deflections under the action of lateral loads, the resulting oscillatory movement can induce a wide range of responses in the building. As a result, lateral stiffness is a major consideration in the design of tall buildings. Bracing is a highly efficient and economical method of resisting lateral forces in a frame structure because the diagonals work in axial stress and therefore call for minimum member sizes in providing the stiffness and strength against horizontal shear. In this research study, four different types of bracing systems have been investigated for the use in tall building in order to provide lateral stiffness. The use of bracings has potential advantage over other scheme, the bracings are provided for peripheral columns. A sixteen story (G+15) building is situated at seismic zone 2 and is subjected to a wind speed of 220kmph. The building models are analyse by equivalent static analysis as per IS 1983:2002 using Staad ProV8i software and wind loads are calculated as per IS:875(part 3)-1987. The main parameters consider in this paper to compare the seismic analysis of buildings are lateral displacement, story drift, axial force, base shear. It is found that the x-type of bracings significantly contributes to the structural stiffness and reduces the maximum inter storey drift of R.C.C building than other bracing system. The peripheral column moments are also reduced as compared to the column moments to unbraced structure. The axial force on the columns for x king of bracings and minimum for system without any bracing similarly the base shear is more compared to any type of bracings. A comparative study between behaviour of concrete and steel bracings was also done performance of steel x bracing was 2.15% more efficient than that of reinforced concrete bracing, the complete weight of the structure was increased by 3.5% on using concrete bracings.
Keywords: High rise buildings, Bracings, Storey drift, Base shear, Nodal displacemnts

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I. INTRODUCTION

A Multi-storey is a building that has multiple floors above ground in the building. Multi-storey buildings aim to increase the floor area of the building without increasing the area of the land the building is built on, hence saving land and, in most cases, money (depending on material used and land prices in the area). It is a more efficient use of land space, particularly where space is limited or expensive. Lower cost of construction per square foot of floor space is another advantage. The upper floors are often mere repetition of lower floors. Upper stories are more free from street noises, odours and dirt. The major concern in the design of multi-storied building is to have good lateral load resisting system along with gravity load system because it also governs the design. When a tall building is subjected to lateral or torsional deflections under the action of fluctuating lateral loads, the resulting oscillatory movement can induce a wide range of responses in the building. As far as the ultimate limit state is concerned, lateral deflections must be limited to prevent second-order p-delta effect due to gravity loading being of such a magnitude which may be sufficient to precipitate collapse.

The simple parameter that is used to estimate the lateral stiffness of a building is the story drift defined as the ratio of the maximum deflections at the top of the building to the total height. Different structural forms of tall buildings can be used to improve the lateral stiffness and to reduce the drift. In this research the study is conducted for braced frame structures. Bracing is a highly efficient and economical method to laterally stiffen the frame structures against wind and seismic loads. A braced bent consists of usual columns and girders whose primary purpose is to support the gravity loading, and diagonal bracing members that are connected so that total set of members forms a vertical cantilever truss to resist the horizontal forces. Bracing is efficient because the diagonals work in axial stress and therefore call for minimum member sizes in providing the stiffness and strength against horizontal shear .With the increase in trend of constructing tall buildings, there is need to find cost effective structural forms of bracing system to be used in tall buildings against lateral loads.

II. METHODS OF ANALYSIS

Code based procedure for seismic analysis and wind analysis

A. IS-1893 :2002 and IS -875 part -3:

In the present study four different Models of steel building designated with different bracing systems are considered for the analysis, design and computing results like joint displacement, story drift, axial loads and moments on the peripheral columns and interior columns, base shear of each building and total self-weight of each structure are also computed.

A grid system with 6 number of bays both in x and z directions are considered for a problem statement the number of floors takes are 16 in number, the centre to centre height between two floors is 3m. Grade of concrete used is M30 and grade of steel used is Fe 415 both for primary and secondary reinforcement.

1) Model 1:

1) Model 1.1 is a multi-storeyed building modelled as per the above problem statement. The dimension of columns and beams are 0.6mx0.6m, 0.45mx0.45m respectively. The bracing system used in this case is ISA 200x200x25 back to back angle section. The bracings are provided diagonally between two floors as shown in figures. The length of centre line of the bracing is 5.831m and its inclination is 30.96□ to the horizontal.
2) Model 1.2 is a multi-storeyed building modelled as per the above problem statement. The dimension of columns and beams are 0.6mx0.6m, 0.45mx0.45m respectively. The bracing system used in this case is Reinforced inclined member with cross section dimensions 0.35mx0.35m . The bracings are provided diagonally between two floors as shown in figures. The length of centre line of the bracing is 5.831m and its inclination is 30.96□ to the horizontal.

2) Model 2:

1) Model 2.1 is a multi-storeyed building modelled as per the above problem statement. The dimension of columns and beams are 0.6mx0.6m, 0.45mx0.45m respectively. The bracing system used in this case is ISA 200x200x25 back to back angle section. The bracings are provided diagonally in both ways between two floors such that cross each other to form an x bracing as shown in figures. The length of centre line of the bracings is 5.831m and its inclination is 30.96□ to the horizontal in both directions.
2) Model 2.2 is a multi-storeyed building modelled as per the above problem statement. The dimension of columns and beams are 0.6mx0.6m, 0.45mx0.45m respectively. The bracing system used in this case is Reinforced inclined member with cross section dimensions 0.35mx0.35m . The bracings are provided diagonally in both ways between two floors such that cross each other to form an x bracing as shown in figures. The length of centre line of the bracings is 5.831m and its inclination is 30.96□ to the horizontal in both directions

3) Model 3:

1) Model 3.1 is a multi-storeyed building modelled as per the above problem statement. The dimension of columns and beams are 0.6mx0.6m, 0.45mx0.45m respectively. The bracing system used in this case is ISA 200x200x25 back to back angle section. The bracings are provided in the shape of v between two floors as shown in figures. The length of centre line of the bracing is 3.905m and its inclination is 50.19□ to the horizontal.
2) Model 3.2 is a multi-storeyed building modelled as per the above problem statement. The dimension of columns and beams are 0.6mx0.6m, 0.45mx0.45m respectively. The bracing system used in this case is Reinforced inclined member with cross section dimensions 0.35mx0.35m . The bracings are provided in the shape of v as shown in figures. The length of centre line of the bracing is 3.905m and its inclination is 50.19□ to the horizontal.

4) Model 4:

1) Model 4.1 is a multi-storeyed building modelled as per the above problem statement. The dimension of columns and beams are 0.6mx0.6m, 0.45mx0.45m respectively. The bracing system used in this case is ISA 200x200x25 back to back angle section. The bracings are provided in the shape of inverted v between two floors as shown in figures. The length of centre line of the bracing is 3.905m and its inclination is 50.19□ to the horizontal.
2) Model 4.2 is a multi-storeyed building modelled as per the above problem statement. The dimension of columns and beams are 0.6mx0.6m, 0.45mx0.45m respectively. The bracing system used in this case is Reinforced inclined member with cross section dimensions 0.35mx0.35m . The bracings are provided in the shape of inverted v as shown in figures. The length of centre line of the bracing is 3.905m and its inclination is 50.19□ to the horizontal.

The STAAD Pro is the next generation software of the structural analysis and design software from research engineers. The STAAD engine provides the general purpose structural analysis and integrates steel / concrete / timber. STAAD Pro V8i is simple to use and user friendly. The entire input data may be generated either graphically or by typing simple English language based commands. STAAD uses analysis command as perform analysis. The four structures are designed by following IS: 800-2007 and IS: 456-2000. Loads considered in analysis are dead load, live load and wind loads along with the various combinations as specified in IS: 800-1984. Dead load is taken according to

IS: 875 (Part 1)-1987. Live load is taken according to IS: 875 (Part 2)-1987. Wind load is taken according to IS: 875 (Part 3)-1987. Analysis results like joint displacement, story drift, axial loads and moments on the peripheral columns and interior columns, base shear of each building and total self-weight of each structure are also compared.

III. MODELLING AND ANALYSIS

For the analysis of multi storied building following dimensions are considered which are elaborated below.

Table - 1
Design Data of Multistoried Building

PLAN AREA	*25mx25m*
NO OF BAYS	*6 in x dir & z dir*
MEMBER LOAD	*10KN/m*
DEAD LOAD	*3KN/m^2*
LIVE LOAD	*2KN/m^2*
ZONE	*0.1*
RESPONSE REDUCTION FACTOR	*3*
IMPORTANCE FACTOR	*1*
DAMPING FACTOR	*0.05*
DEPTH OF FOUNDATION	*3*
WIND SPEED	*200kmph*

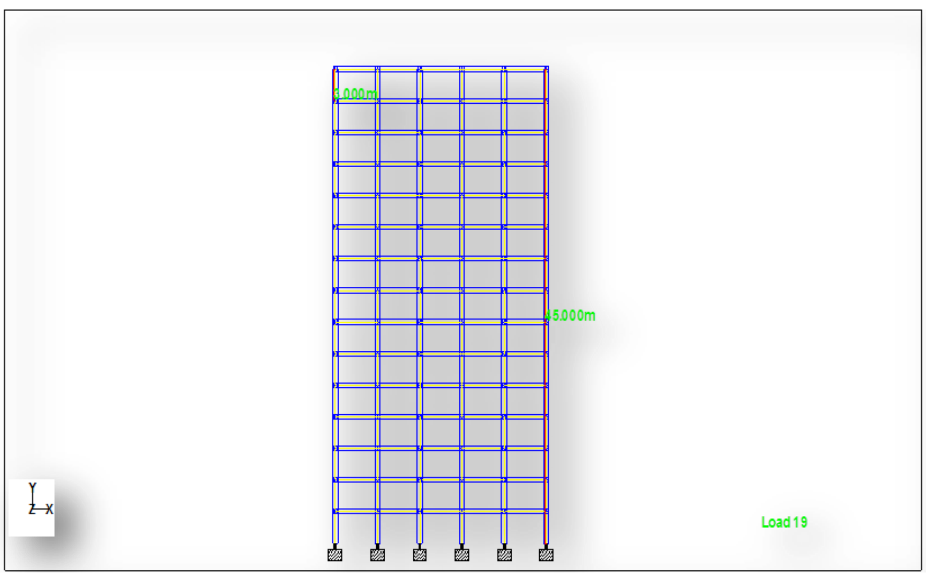

Fig. 1: Elevation of G+15 Multi-Storeyed Building

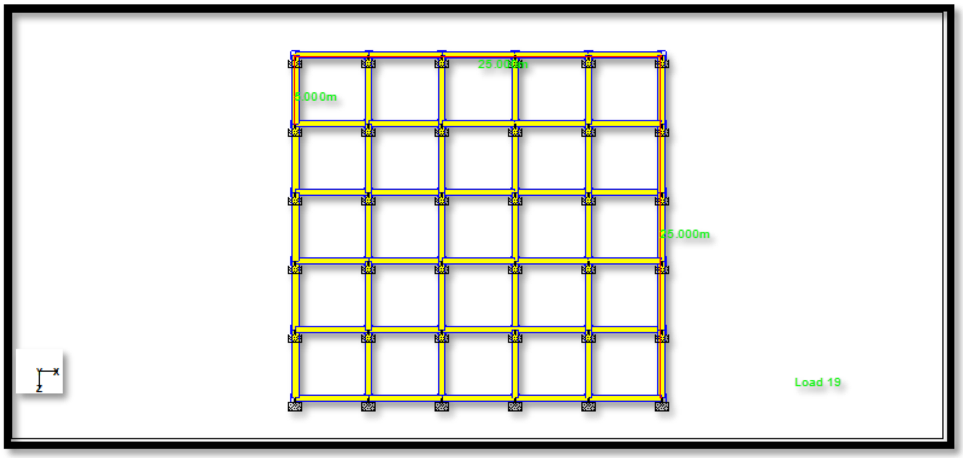

Fig. 2: Plan of G+15 multi-storeyed building

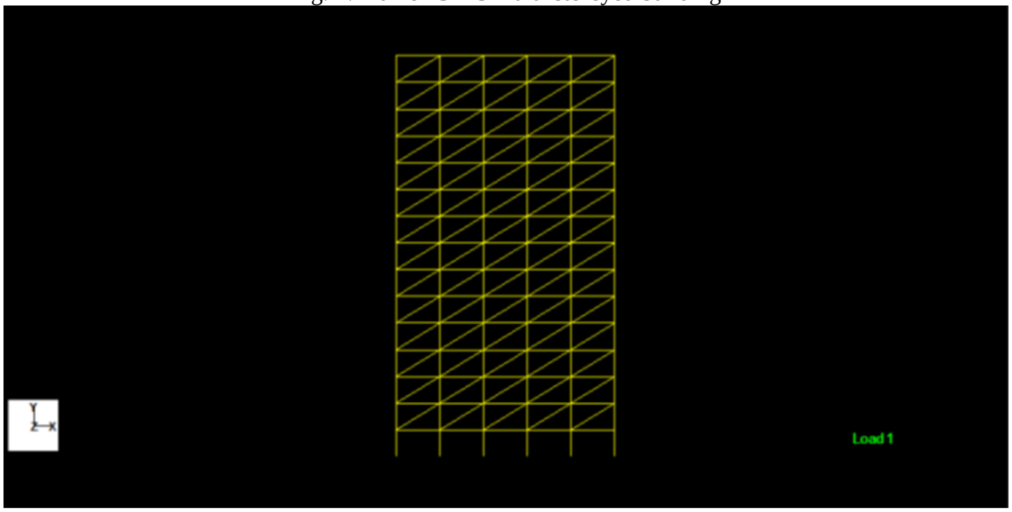

Fig. 3: Elevation of Multi-Storeyed Building with Diagonal Bracings

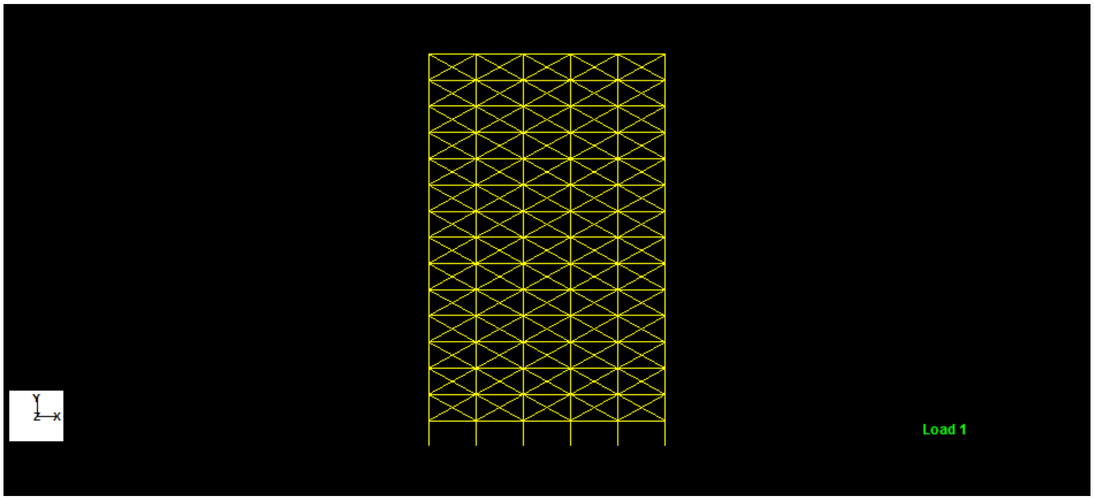

Fig. 4: Elevation of Multi-Storeyed Building With Cross (X) Bracings

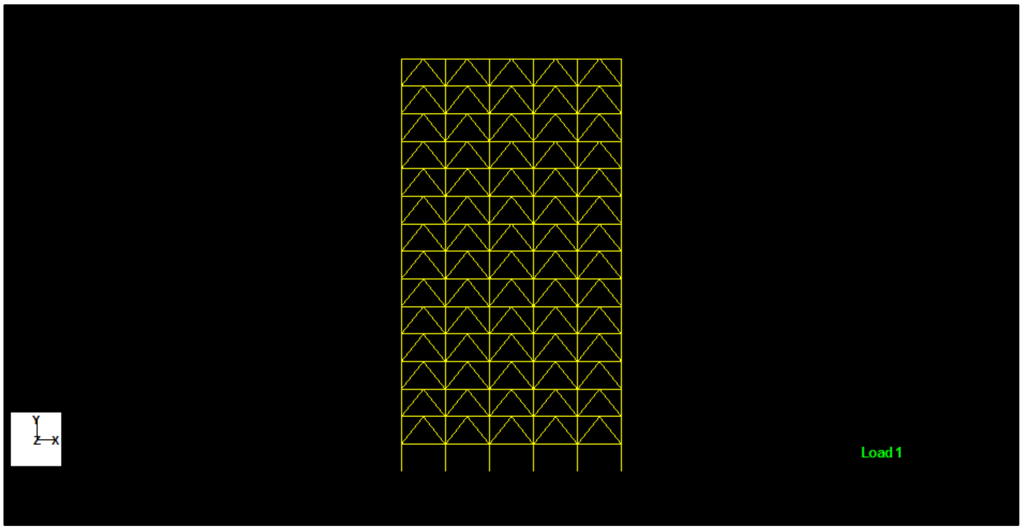

Fig. 5: Elevation of Multi-Storeyed Building with Inverted V Bracings

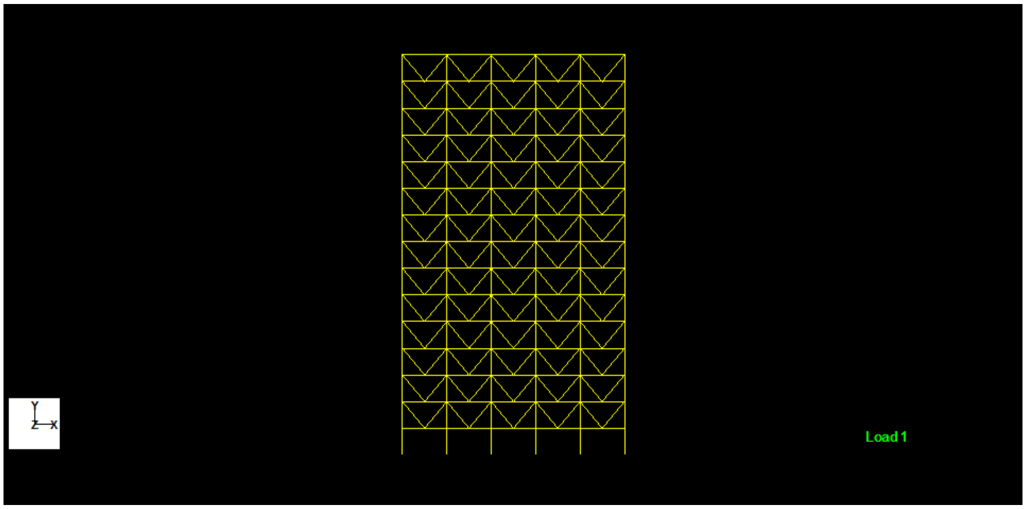

Fig. 6: Elevation of Multi-Storeyed Building with V Bracings

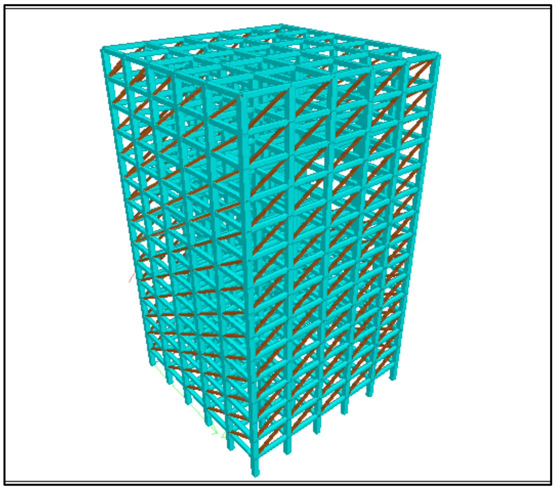

Fig. 7: 3-3D View of Multi-Storeyed Building with Diagonal Steel Bracings

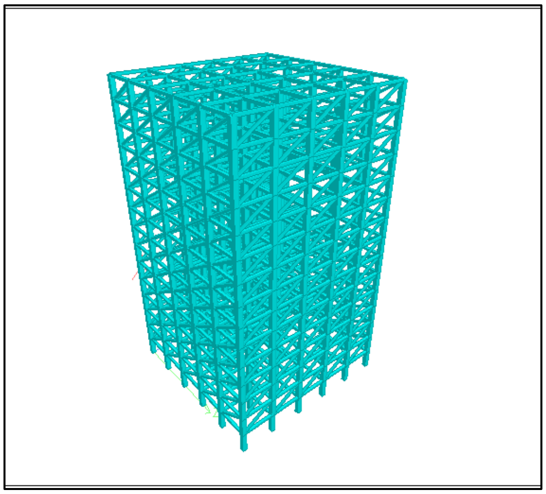

Fig. 8: 3-D View of Multi-Storeyed Building with Diagonal Concrete Bracings

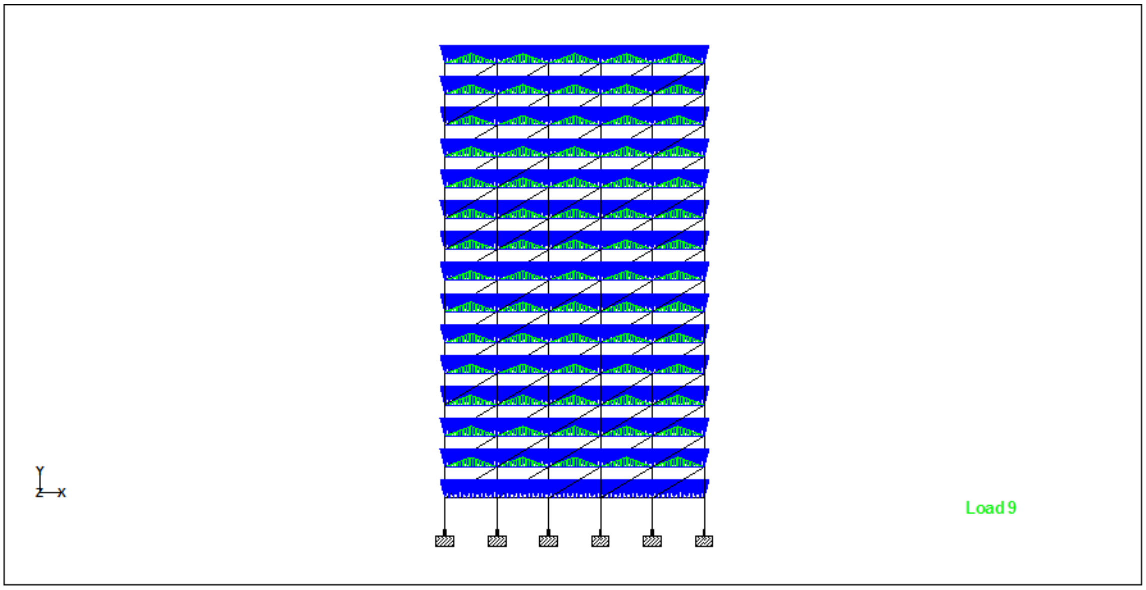

Fig. 9: Frame Subjected To Dead Load

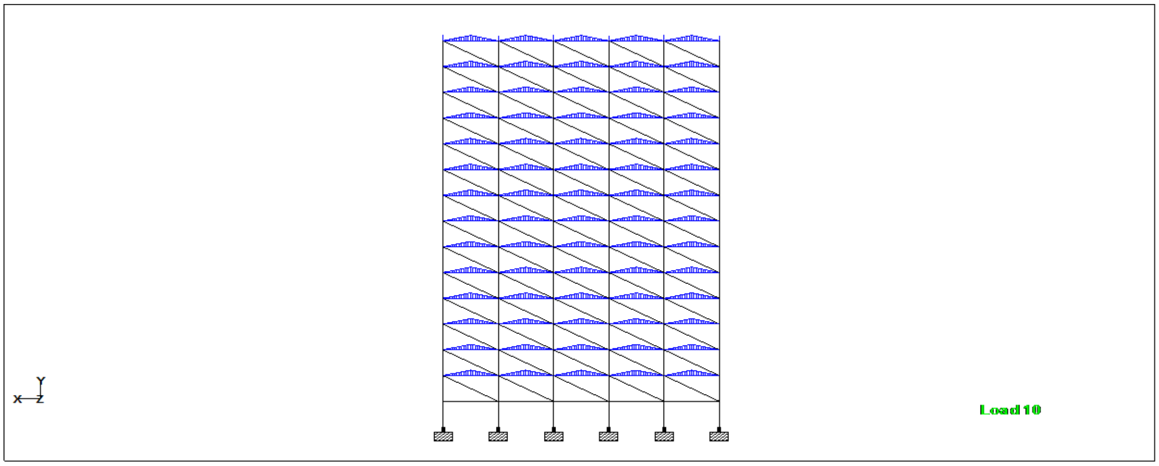

Fig. 10: ELEVATION 3D-Frame Subjected to live Load

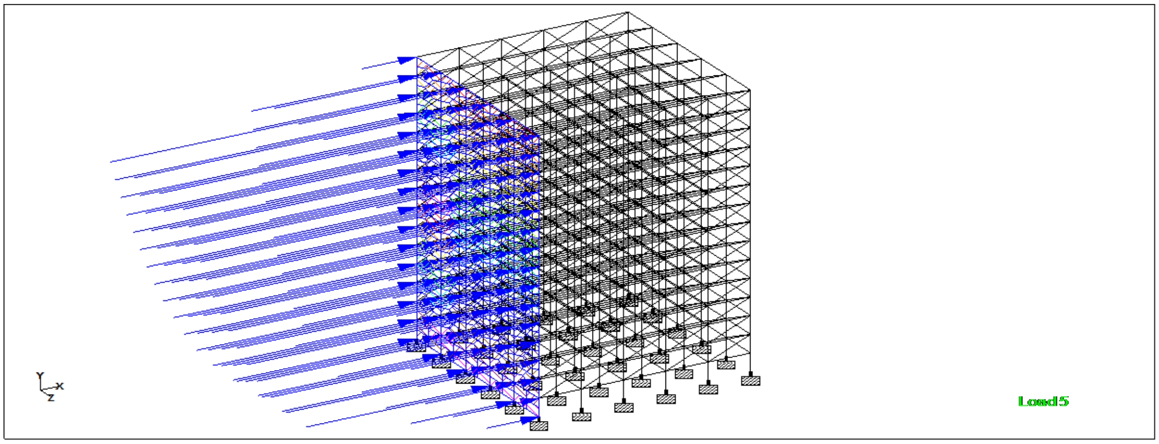

Fig. 11: 3D-Frame Subjected To Wind Load

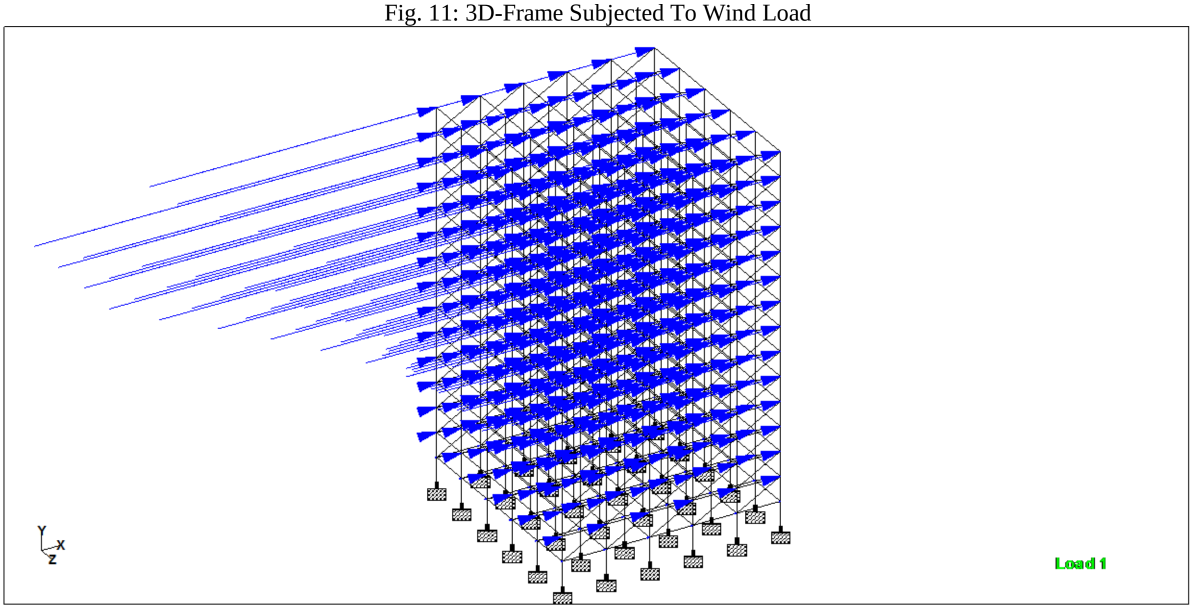

Fig. 12: 3D-Frame Subjected To Earth Quake Load

IV. RESULTS AND DISCUSSIONS

Table - 2
NODAL DISPLACEMENTS VS STOREY LEVEL (STEEL BRACINGS)

Storey	*Unbraced (Cm)*	*Diagonal bracings (Cm)*	*X Bracings(Cm)*	*Inverted V bracings (Cm)*	*V Bracings(Cm)*
GF	*0*	*0*	*0*	*0*	*0*
2	*0.49*	*0.28*	*0.284*	*0.286*	*0.3301*
3	*1.42*	*0.48*	*0.4668*	*0.5063*	*0.5229*
4	*2.47*	*0.68*	*0.6445*	*0.6881*	*0.713*
5	*3.55*	*0.89*	*0.8188*	*0.8703*	*0.903*
6	*4.64*	*1.09*	*0.9906*	*1.0523*	*1.0936*
7	*5.71*	*1.3*	*1.1629*	*1.2355*	*1.2848*
8	*6.75*	*1.52*	*1.3371*	*1.4205*	*1.4776*
9	*7.75*	*1.73*	*1.5134*	*1.6067*	*1.6714*
10	*8.71*	*1.95*	*1.6909*	*1.7926*	*1.8648*
11	*9.59*	*2.16*	*1.8675*	*1.9758*	*2.0554*
12	*10.38*	*2.37*	*2.0402*	*2.1528*	*2.2398*
13	*11.07*	*2.57*	*2.2046*	*2.3191*	*2.4134*
14	*11.63*	*2.74*	*2.3552*	*2.4692*	*2.5708*
15	*12.06*	*2.81*	*2.4857*	*2.5968*	*2.7055*
16	*12.35*	*3.01*	*2.5923*	*2.699*	*2.9318*

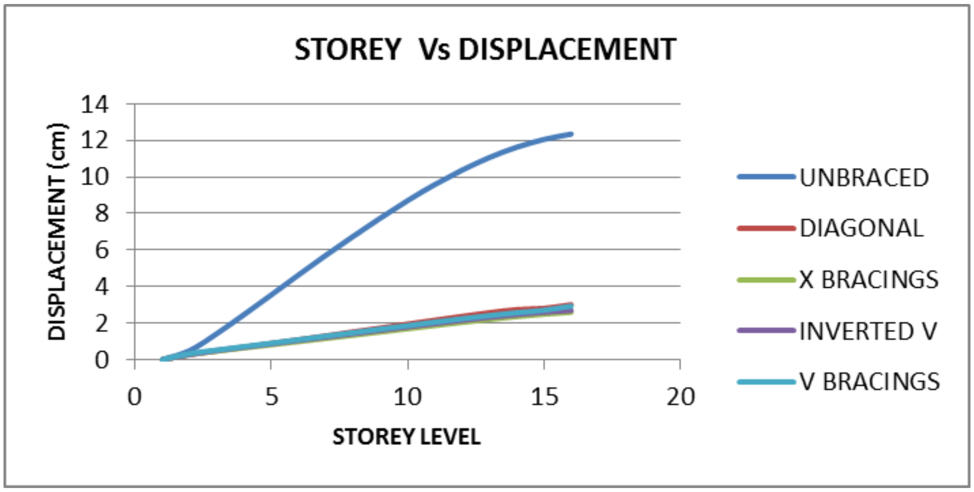

Fig. 14: Graph Plotted Between Nodal Displacement Vs Storey Level (Steel Bracings)

Table - 3
Nodal Displacements Vs Storey Level (Reinforced Concrete Bracings

Storey	Unbraced (Cm)	Diagonal bracings (Cm)	X Bracings(Cm)	Inverted V bracings (Cm)	V Bracings (Cm)
GF	0	0	0	0	0
2	0.49	0.2976	0.2941	0.2947	0.3391
3	1.42	0.5314	0.4998	0.5393	0.5565
4	2.47	0.7643	0.7006	0.745	0.7707
5	3.55	1.0011	0.8989	0.9517	0.9558
6	4.64	1.2398	1.0948	1.158	1.2003
7	5.71	1.4819	1.2908	1.3651	1.4154
8	6.75	1.727	1.4882	1.5733	1.6314
9	7.75	1.9738	1.6867	1.7817	1.8474
10	8.71	2.2197	1.8851	1.9884	2.0615
11	9.59	2.4606	2.0811	2.1907	2.2711
12	10.38	2.6916	2.271	2.3846	2.4723
13	11.07	2.9064	2.4503	2.5655	2.6604
14	11.63	3.0973	2.6128	2.7273	2.8293
15	12.06	3.1682	2.7519	2.8636	2.9725
16	12.35	3.3784	2.8638	2.971	3.2005

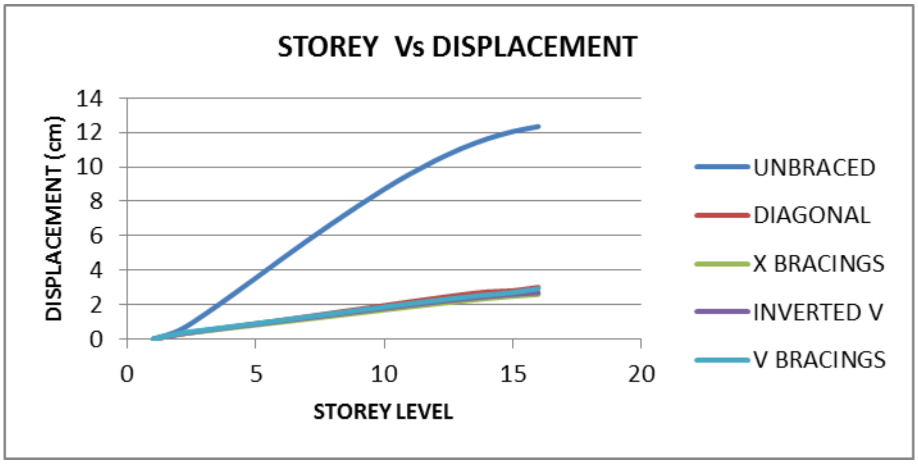

Fig. 15: Graph Plotted Between Nodal Displacement Vs Storey Level (Reinforced Concrete Bracings)

Table - 4
Axial Loads on Peripheral Columns Vs Storey Level (Steel Bracings)

STOREY	UNBRACED(KN)	DIAGONAL BRACING (KN)	X BRACINGS(KN)	INVERTED V BRACING(KN)	V BRACINGS(KN)
1	4025.56	5443.83	5417.04	5185.57	5349.4
2	3796.87	4783.89	4588.21	4585.23	4877.74
3	3516.24	4369.06	4159.06	4198.82	4404.7

4	*3227.04*	*3933.43*	*3801.57*	*3809.71*	*4030.82*
5	*2934.66*	*3517.39*	*3461.44*	*3432.31*	*3653.04*
6	*2641.3*	*3113.42*	*3121.84*	*3060.62*	*3282.02*
7	*2348.41*	*2721*	*2779.67*	*2693.63*	*2914.98*
8	*2057.32*	*2339.95*	*2435.74*	*2331.04*	*2552.29*
9	*1769.51*	*1970.97*	*2092.06*	*1973.41*	*2194.64*
10	*1486.57*	*1615.5*	*1750.82*	*1621.87*	*1843.36*
11	*1210.29*	*1275.7*	*1414.19*	*1278.34*	*1500.35*
12	*942.58*	*954.73*	*1084.71*	*945.99*	*1168.26*
13	*685.43*	*657.57*	*765.65*	*630.33*	*850.59*
14	*402.26*	*391.31*	*645.21*	*341.44*	*553.84*
15	*171.38*	*134.5*	*156.5*	*64.06*	*236.71*

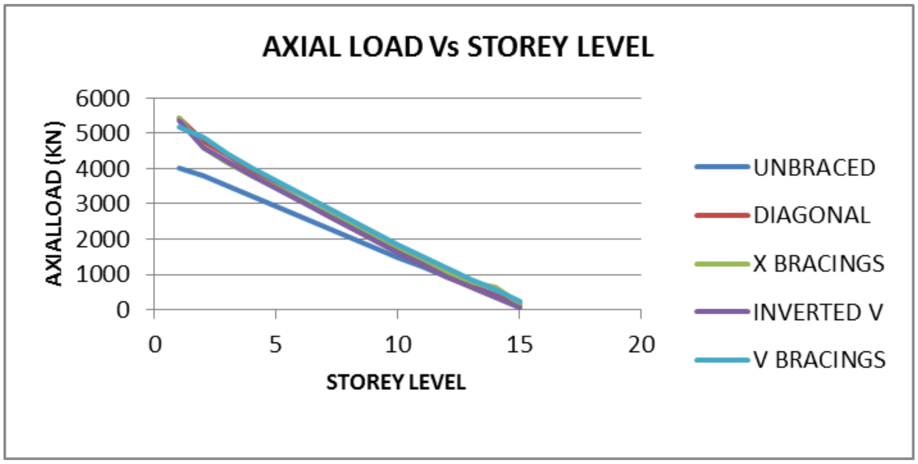

Fig. 16: Graph Plotted Between Axial Loads on Peripheral Columns Vs Storey Level (Steel Bracings)

Table - 5
Axial Loads on Peripheral Columns Vs Storey Level (Reinforced Concrete Bracings)

STOREY	*UNBRACED(KN)*	*DIAGONAL BRACING (KN)*	*X BRACINGS(KN)*	*INVERTED V BRACING(KN)*	*V BRACINGS*
1	*4025.56*	*5613.7*	*5772.74*	*5396.18*	*5433.93*
2	*3796.87*	*4969.28*	*5004.76*	*5175.21*	*5114.48*
3	*3516.24*	*4533.77*	*4534.51*	*4803.72*	*4633.1*
4	*3227.04*	*4084.82*	*4135.85*	*4432.66*	*4234.58*
5	*2934.66*	*3652.3*	*3751.34*	*4062.05*	*3834.42*
6	*2641.3*	*3231.83*	*3370.94*	*3691.82*	*3440.74*
7	*2348.41*	*2823.1*	*2991.3*	*3321.93*	*3052*
8	*2057.32*	*2426.33*	*2612.97*	*2952.39*	*2668.6*
9	*1769.51*	*2042.5*	*2237.51*	*2583.15*	*2291.39*
10	*1486.57*	*1673.26*	*1886.9*	*2214.18*	*1921.81*
11	*1210.29*	*1320.95*	*1503.43*	*1845.46*	*1561.94*
12	*942.58*	*988.71*	*1149.93*	*1476.92*	*1241.54*
13	*685.43*	*680.96*	*810.17*	*1180.57*	*883.26*
14	*402.26*	*404.73*	*491.66*	*740.61*	*574.13*
15	*171.38*	*135.24*	*167.13*	*371.8*	*246.98*

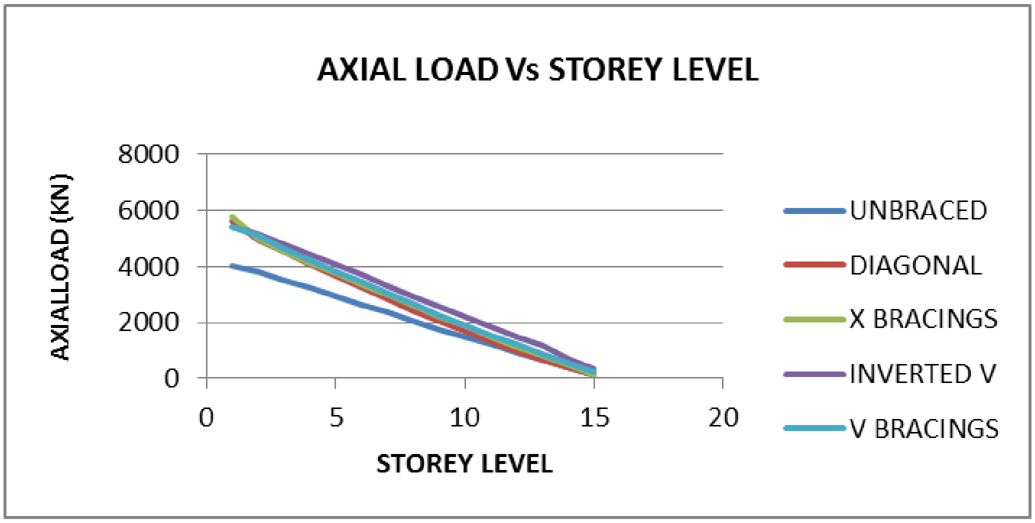

Fig. 17: Graph Plotted Between Axial Loads on Peripheral Columns Vs Storey Level (Reinforced Concrete Bracings)

Table - 6
Moments on Peripheral Columns Vs Storey Level (Steelbracings)

STOREY	UNBRACED (KNm)	DIAGONAL BRACINGS (KNm)	X BRACINGS (KNm)	INVERTED V BRACINGS (KNm)	V BRACINGS (KNm)
1	382.46	712.8	698.5	624.51	619.48
2	227.92	257.29	262.84	236.58	189.09
3	187.79	76.2	76.87	1.69	88.26
4	173.11	39.15	30.47	23.58	49.79
5	166.82	41.13	37.75	16.86	51.25
6	161.68	40.24	37.07	14.55	47.23
7	155.58	39.08	36.9	11.98	43.69
8	147.77	37.76	36.4	9.69	39.94
9	137.91	36.25	35.76	7.57	36.12
10	125.73	34.5	35.01	5.62	32.27
11	111.05	32.53	34.19	3.84	28.4
12	93.73	30.33	33.32	2.26	24.53
13	74.16	27.82	32.41	0.98	20.77
14	122.02	24.34	30.33	0.22	15.72
15	112.71	53.49	62.68	14.1	57.4

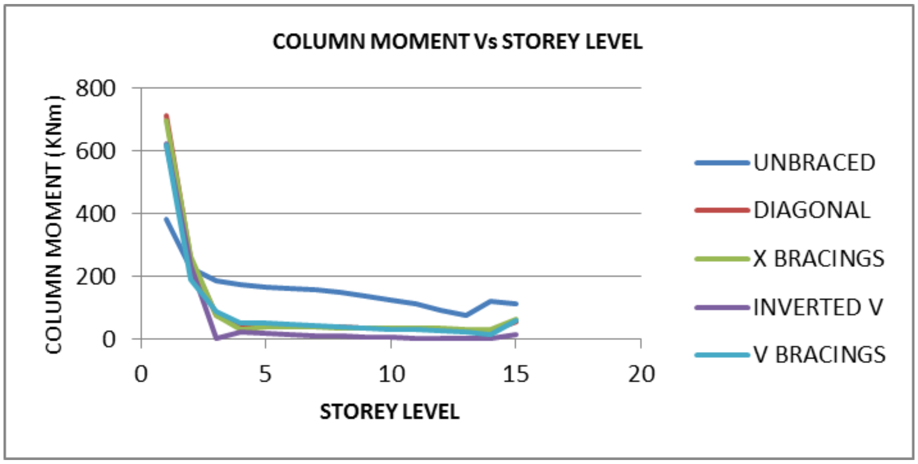

Fig. 18: Graph Plotted Between Moments on Peripheral Columns Vs Storey Level (Steel Bracings)

Table - 7
Moments on Peripheral Columns Vs Storey Level (Reinforced Concrete Bracings)

STOREY	UNBRACED (KNm)	DIAGONAL BRACINGS (KNm)	X BRACINGS (KNm)	INVERTED V BRACINGS (KNm)	V BRACINGS (KNm)
1	382.46	700.65	691.6	625.47	621.34
2	227.92	218.19	233.96	216.39	173.03

3	187.79	74.85	78.6	0.88	87.59
4	173.11	50.2	39.75	16.41	56.92
5	166.82	49.59	45.53	11.3	56.23
6	161.68	48.73	44.9	8.74	52.19
7	155.58	47.18	44.55	6.25	48.27
8	147.77	45.44	43.82	4.03	44.16
9	137.91	43.39	42.9	2.02	39.95
10	125.73	41.04	41.82	0.22	35.64
11	111.05	38.39	40.16	1.35	31.28
12	93.73	35.43	39.3	2.67	26.86
13	74.16	32.05	37.83	3.6	22.44
14	122.02	27.71	35.4	4	17
15	112.71	54.48	65.37	16.89	55.1

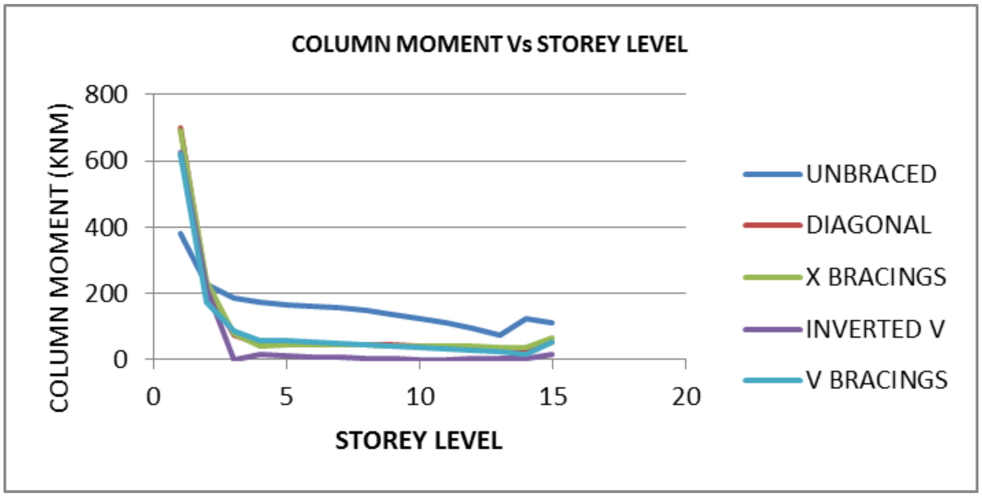

Fig. 19: Graph Plotted Between Moments on Peripheral Columns Vs Storey Level (Reinforced Concrete Bracings)

Table - 8
Axial Loads on Interior Columns Vs Storey Level (Steel Bracings)

STOREY	UNBRACED (KN)	DIAGONAL BRACING (KN)	X BRACING (KN)	INVERTD V BRACING (KN)	V BRACINGS (KN)
1	5432.31	5388.87	5393.37	5388.58	5396.15
2	5173.08	5167.98	5172.45	5167.7	5175.15
3	4801.62	4796.64	4801	4796.37	4803.63
4	4430.59	4425.79	4430.01	4425.55	4432.54
5	4060.05	4055.47	4059.51	4055.26	4061.91
6	3689.92	3685.6	3689.41	3685.41	3691.64
7	3320.16	3316.16	3319.69	3316	3321.74
8	2950.76	2947.12	2950.33	2946.99	2952.17
9	2581.68	2578.44	2581.3	2578.35	2582.92
10	2212.89	2210.1	2212.57	2210.04	2213.94
11	1844.34	1842.05	1844.1	1842.01	1845.2
12	1476	1474.23	1475.84	1474.23	1476.67
13	1107.83	1106.62	1107.77	1106.66	1108.32
14	740.08	739.46	740.12	739.52	740.36
15	333.31	371.46	371.63	371.54	371.6

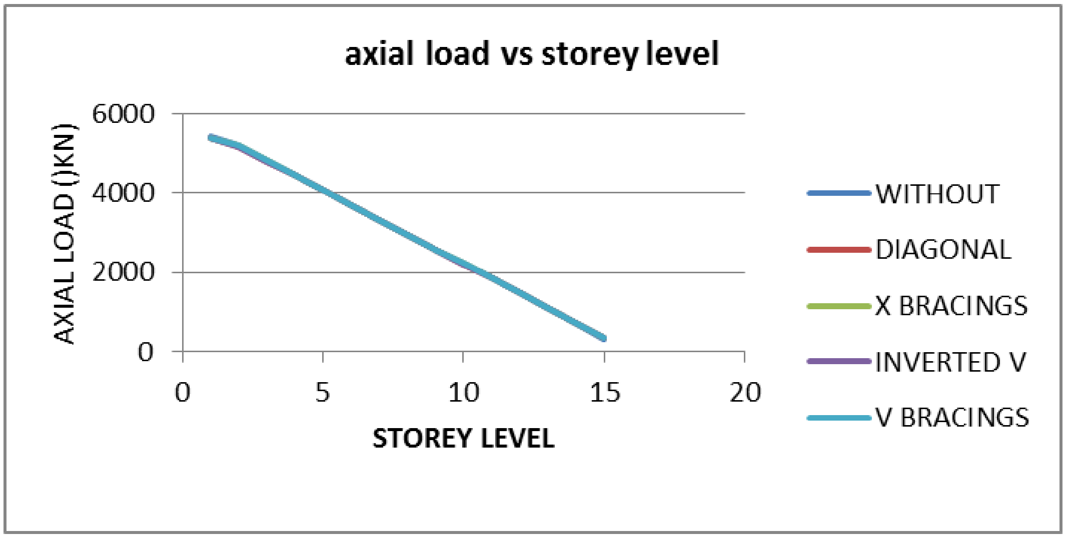

Fig. 20: Graph Plotted Between Axial Loads on Interior Columns Vs Storey Level (Steel Bracings)

Table - 9
Axial Loads on Interior Columns Vs Storey Level (Reinforced Concrete Bracings)

STOREY	UNBRACED(KN)	DIAGONAL BRACING (KN)	X BRACINGS(KN)	INVERTED V BRACING(KN)	V BRACINGS(KN)
1	5432.31	5394.8	5444.13	5396.18	5442.32
2	5173.08	5173.85	5184.88	5175.21	5183.06
3	4801.62	4802.38	4813.17	4803.72	4811.36
4	4430.59	4431.34	4441.78	4432.66	4440.02
5	4060.5	4060.78	4070.76	4062.05	4069.05
6	3689.92	3690.6	3700	3691.82	3698.37
7	3320.16	3320.79	3329.51	3321.93	3327.98
8	2950.76	2951.33	2959.26	2952.39	2957.85
9	2581.68	2582.19	2589.24	2583.15	2587.96
10	2212.89	2213.34	2219.43	2214.18	2218.29
11	1844.34	1844.73	1849.79	1845.46	1848.41
12	1476	1476.33	1480.29	1476.92	1479.49
13	1107.83	1108.12	1110.93	1180.57	1110.31
14	740.08	740.3	741.9	740.61	741.48
15	333.31	371.66	372.07	371.8	371.87

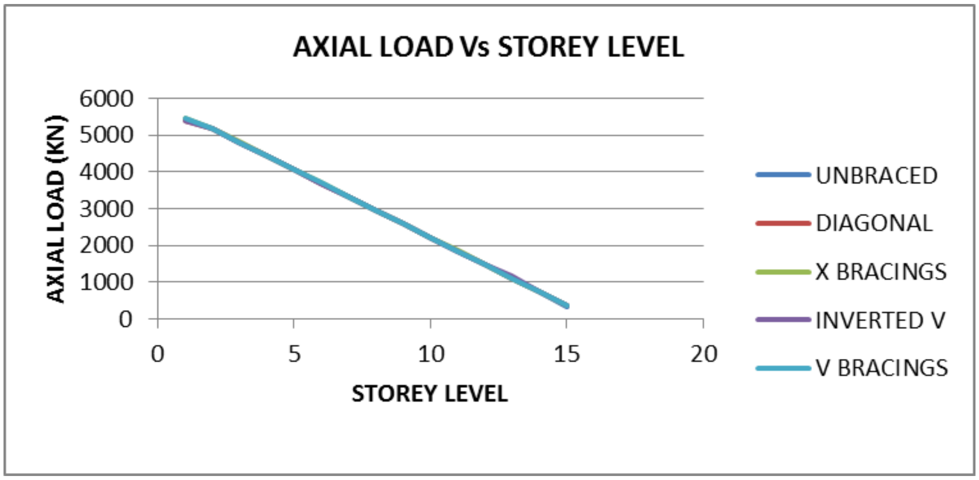

Fig. 21: Graph Plotted Between Axial Loads on Interior Columns Vs Storey Level (Reinforced Concrete Bracings)

Table - 10

Moments on Interior Columns Vs Storey Level (Steel Bracings)

STOREY	UNBRACED (KNm)	DIAGONAL BRACINGS (KNm)	X BRACINGS (KNm)	INVERTED V BRACINGS (KNm)	V BRACINGS (KNm)
1	411.67	18.5	17.1	18.41	18.6
2	306.97	81.11	73.96	79	81.12
3	278.72	71.99	64.46	69.77	71.66
4	269.11	68.58	60.42	66.19	67.94
5	263.55	67.91	59.18	65.21	66.87
6	257.26	68.76	59.62	65.68	67.26
7	248.41	70.03	60.69	66.61	68.11
8	236.59	71	61.73	67.34	68.78
9	220.91	71.1	62.21	67.35	68.75
10	201.05	69.8	61.64	66.12	67.49
11	176.6	66.52	59.45	63.09	64.46
12	147.24	60.61	54.99	57.6	58.99
13	112.98	51.44	47.62	49.05	50.49
14	75.67	39.49	37.76	37.92	39.34
15	103.09	22.79	23.66	22.11	24.02

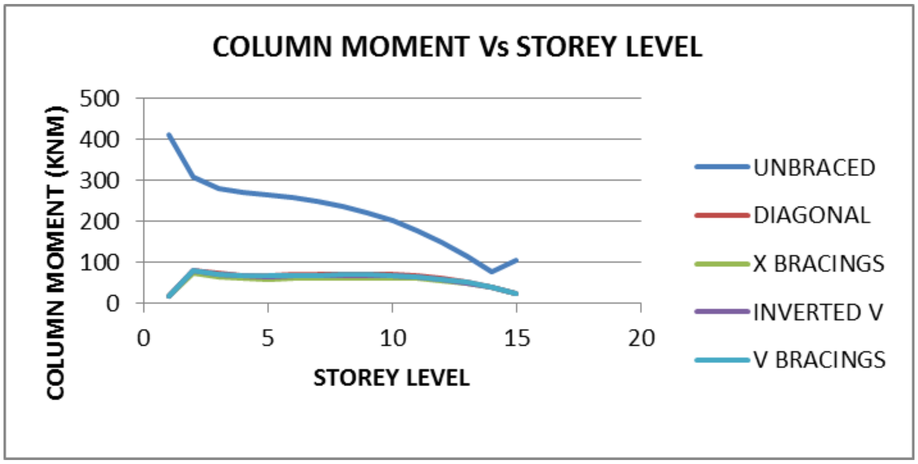

Fig. 22: Graph Plotted Between Moments on Interior Columns Vs Storey Level (Steelbracings)

Table - 11
Moments on Interior Columns Vs Storey Level (Reinforced Concrete Bracings)

STOREY	UNBRACED (KNm)	DIAGONAL BRACINGS (KNm)	X BRACINGS (KNm)	INVERTED V BRACINGS (KNm)	V BRACINGS (KNm)
1	411.67	20.71	108.89	20.05	118.41
2	306.97	90.3	80.63	85.7	87.89
3	278.72	80.2	70.4	75.7	77.64
4	269.11	76.34	66	71.74	73.51
5	263.55	75.38	64.5	70.45	72.11
6	257.26	75.9	64.66	70.62	72.18
7	248.41	76.76	65.42	71.22	72.7
8	236.59	77.22	66.09	71.58	72.99
9	220.91	76.7	66.12	71.16	72.52
10	201.05	74.66	65	69.43	70.75
11	176.6	70.53	62.16	65.82	67.12
12	147.24	63.65	56.96	59.66	60.98
13	112.98	53.42	48.74	50.36	51.72
14	75.67	40.28	37.8	38.3	39.65
15	103.09	22.71	23.08	21.73	23.63

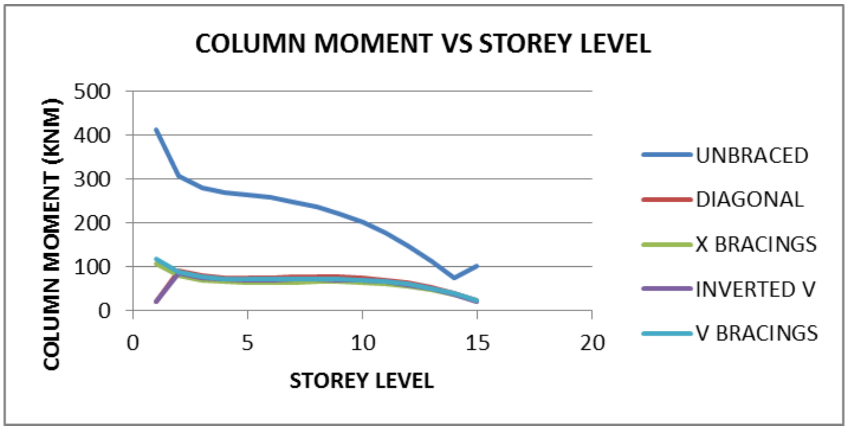

Fig. 23: Graph Plotted Between Moments on Interior Columns Vs Storey Level (Reinforced Concrete Bracings)

Table - 12
Various Arrangements of Bracings Vs Weight Of Structure (Steel Bracings)

VARIOUS ARRANGEMENTS OF BRACINGS	*UNBRACED (KN)*	*DIAGONAL BRACINGS(KN)*	*X BRACINGS (KN)*	*INVERTED V BRACINGS (KN)*	*V BRACINGS (KN)*
WEIGHT(KN)	*123961.63*	*126322.05*	*128682.47*	*127123*	*127123*

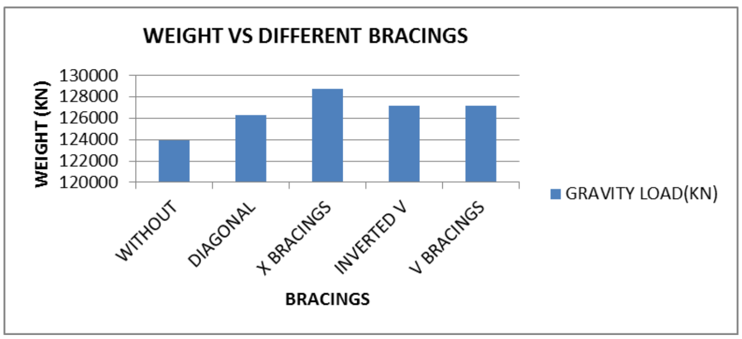

Fig. 24: Graph Plotted Various Arrangements of Bracings Vs Weight of Structure (Steel Bracings)

Table - 13
Various Arrangements of Bracings Vs Weight of Structure (Reinforced Concrete Bracings)

VARIOUS ARRANGEMENTS OF BRACINGS	*UNBRACED (KN)*	*DIAGONAL BRACINGS (KN)*	*X BRACINGS (KN)*	*INVERTED V BRACINGS (KN)*	*V BRACINGS (KN)*
WEIGHT(KN)	*123961.63*	*128673.99*	*133386.3*	*130273*	*130273*

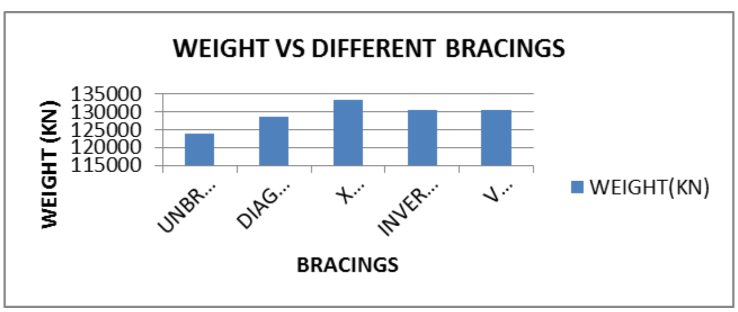

Fig. 25: Graph Plotted Between Various Arrangements of Bracings Vs Weight of Structure (Reinforced Concrete Bracings)

Table - 14
Various Arrangements of Bracings Vs Base Shear (Steel Bracings)

VARIOUS ARRANGEMENTS OF BRACINGS	*UNBRACED (KN)*	*DIAGONAL BRACINGS(KN)*	*X BRACINGS (KN)*	*INVERTED V BRACINGS (KN)*	*V BRACINGS (KN)*
WEIGHT(KN)	*123961.63*	*126322.05*	*128682.47*	*127123*	*127123*

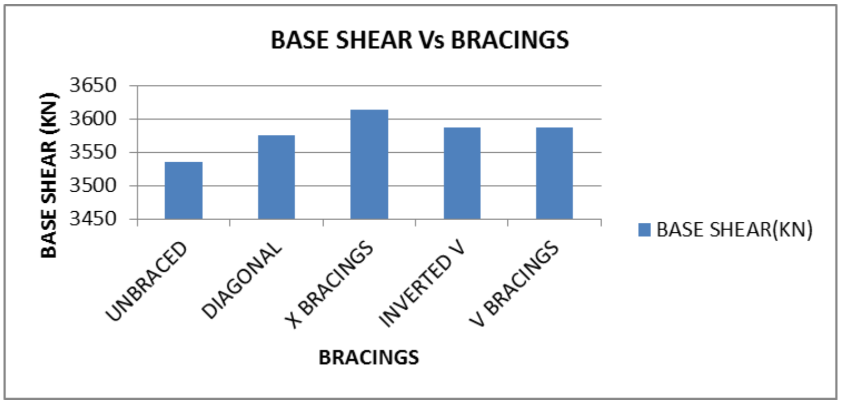

Fig. 26: Graph Plotted Between Various Arrangements of Bracings Vs Base Shear (Steel Bracings

V. CONCLUSIONS

All types of bracings helped in reducing the nodal displacements and storey drift of the multistoried structure compared to a unbraced multistoried structure.

1) The efficiency of x bracing is maximum as the nodal deflection was reduced to minimum of 80% and of 75% by using diagonal steel bracings.
2) Steel bracing using a back to back angle section reduced the deflection by 3.2% when compared to reinforced concrete bracing of the same type of bracings system.
3) The axial loads on the peripheral columns increased due to self-weight of the bracings. The axial loads increase in their value by 25.69% and 30.2%by using X type reinforced concrete bracings and X steel bracings respectively.
4) The axial load on the peripheral column is more when a reinforced concrete bracing was used instead of a steel bracing and the increase in axial load is 4.5% more by using reinforced bracing over steel bracings.
5) The axial load on the interior columns increased by 11.5% irrespective of kind and type of bracings used.
6) The column moments on the peripheral columns have reduced by using bracings by 11.5% but the column moments on the interior columns have drastically reduced by 77.8%
7) The overall weight of the structure is increased by 3.8% and 7.6% by using steel X bracings X reinforced bracings respectively.
8) The increase in weight and base shear of structure by using V and inverted V bracings does not show any significant difference.
9) The base shear also showed signs of increment by 2.2% in case of X type steel bracings and 4.4% by using X type reinforced concrete bracings

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