International Journal of Application or Innovation in Engineering & Management (IJAIEM)
Web Site: www.ijaiem.org Email: editor@ijaiem.org
Volume 7, Issue 12, December 2018 ISSN 2319 - 4847

COMPARISON OF SEISMIC BEHAVIOUR OF TYPICAL RC BRACED MULTISTOREY STRUCTURE WITH COMPOSITE STRUCTURE

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ABSTRACT

In this modern period, it is necessary to design the structure such that it is capable of resisting the lateral forces which are acting on it. There are several ways to make the structure seismic resistant. Now-a-days providing bracings to the structure has become effective as it resists lateral loads efficiently. Bracings frameworks are one of the horizontal load opposing framework which has auxiliary significance extraordinarily in high rise structures. Distinctive supporting frameworks are sufficiently proficient for seismic reactions. To know the significance of various propping frameworks in multistorey RC outline structure. The present study deals with the study of seismic behavior of 3 models with different types of bracings i.e X, V, Inverted V type and analyzed by dynamic method i.e Response Spectrum by ETABS programming .Results, for example, seismic base shear , story displacements, story overturning moments, story shear, story drifts and selfweight of the structure have been assessed and compared with bare frame model and composite structure. X braced model is indicating better seismic execution out of the considerable number of models.

Key words: RC Structures, Composite structures and bracings

1. INTRODUCTION

1.1 BRACING SYSTEMS

The existing RC structures which are designed without considering the seismic criteria can undergo remarkable damage during the earthquakes. Also, the behavior of the structure in the absence of ductile detailing gives rise to inadequate transverse reinforcement in the beams & columns. Within the sight of these inadequacies the redesigning of seismic execution might be acknowledged with two distinctive methodologies,

i. Providing the RC structures with steel bracings or RC shear walls.

ii. Using the concrete, steel & fibre reinforced plastic to strengthen the structural elements.

The first method comprises of providing steel braces or RC shear walls to the structures. But providing steel braces to the RC structures helps in having practical as well as economic advantages.

Bracings have been successfully demonstrated to oppose the seismic loads and also these bracings increase the stiffness of the structures. The bracing increases the energy dissipation capacity & reduces the storey displacement of the structures. The horizontal forces such as seismic forces and wind forces are resisted by these bracing systems. They transmit these forces to the foundation of the structure. These bracings can be provided in various forms & they carry tension & compression present in the RC components. Such bracings avoid the bending moments in the columns. Various types of bracing systems are available the widely used bracings are X, V Inverted V, eccentric forward , eccentric backward etc.

1.2 INTRODUCTION TO COMPOSITE STRUCTURES

In India, RCC individuals are normally utilized as an auxiliary part and there by all accounts the best outline answer for low rise structure. Considering the parameters such as dead load, span length & stiffness reinforced concrete members are not suitable for the construction of high rise buildings. Hence there is a need to find an alternate method to overcome such defects. The best alternative material for the construction is steel. Using the composite section i.e steel surrounded with concrete has become the most effective in the construction of the high rise buildings and other civil structures. In recent times the composite construction has become very popular due to its lower self weights & higher strengths**.**

1.3 OBJECTIVES

1. To study the seismic behavior of RC framed structure with different types of bracings such as X, V and Inverted V under the dynamic loading conditions.
2. To analyze the response of the braced structure and unbraced structure which are subjected to the seismic loads.
3. To recognize the most suitable bracing system to resist the wind and earthquake forces very efficiently.
4. To compare the obtained results in terms of storey displacements, storey drifts, storey shear, base shear and overturning moments.
5. To compare the two multistory structures – Braced RC Structure with Composite Structure

2. METHODOLOGY

3.1 STRUCTURAL MODELING

In the present study a G+10 residential building is modeled. Total five such models are created. The software used for modeling is ETABS 2015. First model is bare frame i.e normal conventional RCC structure. Second, third and fourth models are X braced, V braced and Inverted V braced respectively. The fifth model is Composite structure. The parameters such as number of stories, sizes of RC elements and loading cases being the same for all the five models. Dynamic method i.e Response Spectrum analysis method is used for analyzing the structures.

3.2 DETAILS OF BUILDING

A G+10 storey residential building assumed to be located in seismic zone V and for earthquake loading IS:1893(part 1)-2002 is considered. The building plan has dimensions of 36X27m. Along X direction the plan is divided into 8 bays and along Y it has 6 bays. Each bay is 4.5m. The height of each storey is 3m. For braced, bare frame and composite structure analysis is done by Response spectrum method and the results are tabulated.

Table 1 Details of the Project

Plan dimension		36m X 27m
Height of each storey		3 m
Height of parapet		1 m
Thickness of slab		0.125 m
Thickness of wall		0.23 m
Floor finish		1 KN/m
Live load	Storey	2 KN/m
	Roof	1.5KN/m
Density of concrete		25 KN/m
Density of brick		20 KN/m
Grade of reinforce steel		Fe415
Grade of concrete		M25
Seismic zone		V
Soil condition		Medium soil
Importance factor		1
Zone factor		0.36
Damping ratio		5%
Beam size RCC		230mm x 450mm
Column size composite		230mm x 600mm
		ISHB400-2
Beam size composite		ISWB400

3.3 ANALYSIS OF MODELS:

The models shown above are analyzed by dynamic method i.e Response spectrum method in ETABS. After the analysis the parameters such as base shear, storey displacement, storey drift, storey shear and overturning moments are studied and compared. For dead and live loads IS 875(part 1 & 2) are considered and for earthquake loading IS 1893(part 1)-2002 is considered.

4. RESULTS AND DISCUSSIONS

4.1 STOREY DISPLACEMENTS

Table 2. Storey displacement in X direction

	Storey displacement (mm) in X direction				
Storey No.	**Bare Frame**	**X Braced**	**V Braced**	**Inverted V Braced**	**Composite Structure**
10	18.29	10.888	15.548	12.394	26.013
9	17.885	10.572	15.095	12.021	25.613
8	17.098	10.053	14.367	11.432	24.863
7	15.93	9.341	13.366	10.63	23.722
6	14.419	8.458	12.122	9.637	22.215
5	12.605	7.426	10.665	8.477	20.376
4	10.523	6.268	9.025	7.176	18.23
3	8.203	5.007	7.232	5.76	15.786
2	5.682	3.676	5.317	4.262	13.036
1	3.019	2.301	3.344	2.73	9.91
GF	0.461	0.906	1.175	1.137	6.062
Base	0	0	0	0	0

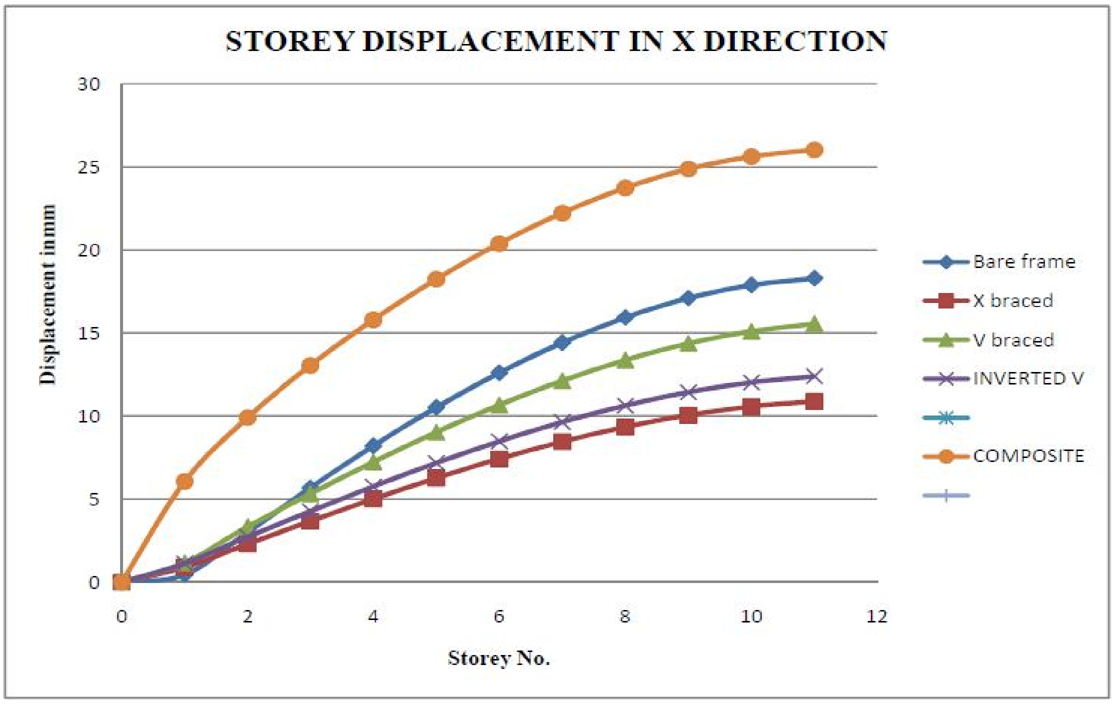

Fig 3. Variation of storey displacement in X direction

From the above graph it is observed that the storey displacements are least for braced models compared to the bare frame and composite model. The composite model experiences even higher displacements than bare frame. As the stiffness of braced models is higher, they are less prone to the storey displacements. Among the three braced models X braced model performs better than other two braced models.

Table 3. Storey displacement inY direction

Storey No.	Bare Frame	X Braced	V Braced	Inverted V Braced	Composite Structure
10	32.343	14.865	19.691	15.05	32.46
9	31.803	14.416	19.13	14.597	32.112
8	30.509	13.715	18.271	13.915	31.323
7	28.543	12.801	17.138	13.022	30.078
6	25.986	11.694	15.761	11.94	28.413
5	22.897	10.419	14.173	10.693	26.358
4	19.315	9	12.403	9.304	23.942
3	15.272	7.462	10.482	7.8	21.185
2	10.786	5.831	8.427	6.211	18.098
1	5.883	4.156	6.331	4.578	14.665
GF	3.879	2.469	2.87	2.81	10.439
Base	0	0	0	0	0

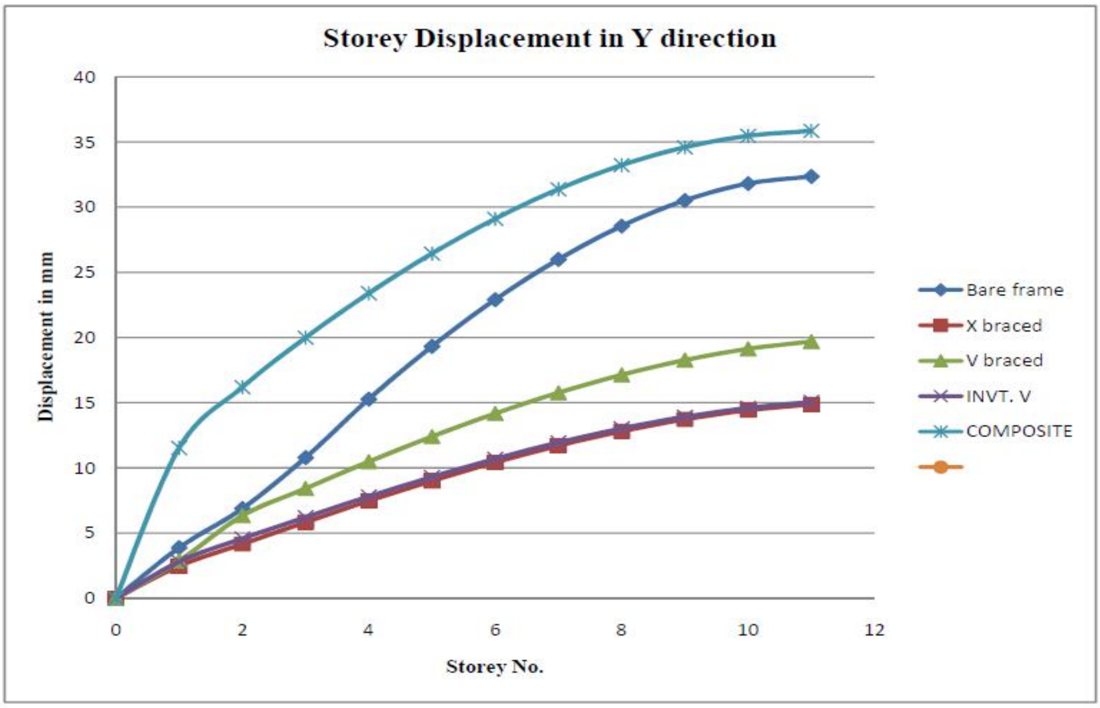

Fig 4. Variation of storey displacement in Y direction

From the above graph it is clear that, the storey displacement in Y direction is in accordance with X direction i.e. braced models experience less displacements than bare frame and composite models. Among the braced models X braced and inverted V braced models show nearly equal and better displacement than V braced model.

4.2 STOREY DRIFT

Table 3 Storey drift (mm) in X direction

Storey No.	Bare Frame	X Braced	V Braced	Inverted V Braced	Composite Structure
10	0.000153	0.000115	0.00016	0.000141	0.00017
9	0.000303	0.000183	0.000263	0.000216	0.000314
8	0.00044	0.00025	0.000361	0.000289	0.000464
7	0.000553	0.000307	0.000442	0.000351	0.000592
6	0.000645	0.000355	0.00051	0.000404	0.000696
5	0.000723	0.000395	0.000565	0.000448	0.000783
4	0.00079	0.000426	0.00061	0.000483	0.000861
3	0.000848	0.000447	0.000645	0.000508	0.000942
2	0.000891	0.000471	0.00066	0.000529	0.001054
1	0.000853	0.000559	0.000723	0.000646	0.001291
GF	0.0014	0.000604	0.000784	0.000738	0.002021
Base	0	0	0	0	0

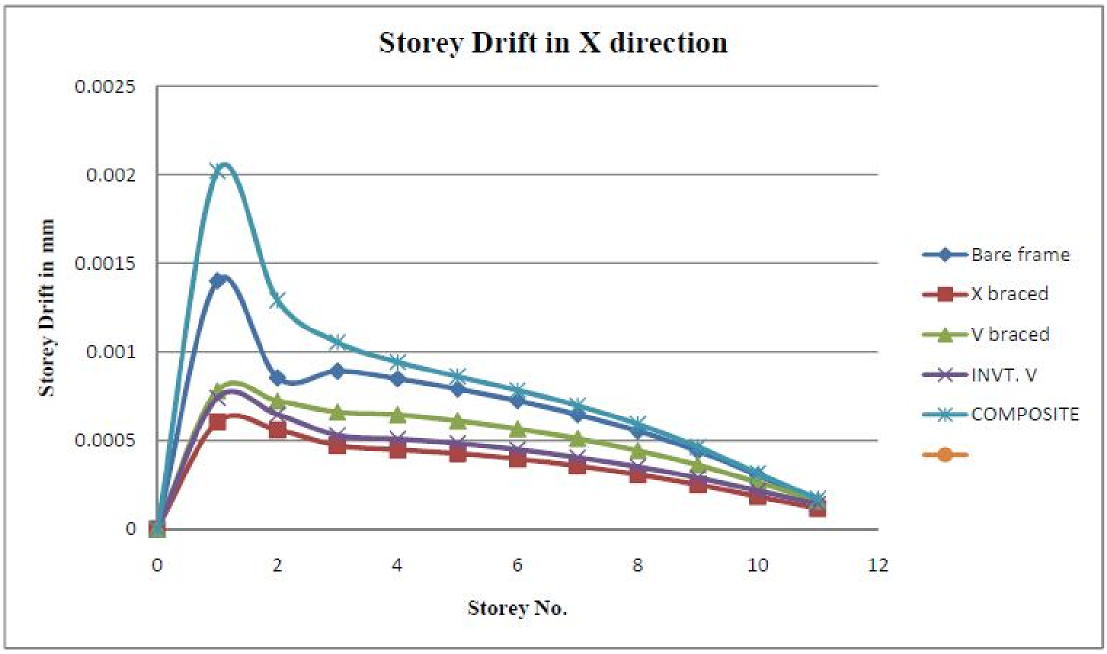

Fig 5 Variation of storey drift in X direction

From the above graph, we can conclude that the drift for composite structure is maximum compared to the bare frame and braced models. As the stiffness of the braced model is high these structure experience less drifts compared to the bare frame and composite structure. Among the braced structures X braced structure performance is better than V braced and Inverted V braced structures.

Table 4 Storey drift (mm) in Y direction

Storey No.	Bare Frame	X Braced	V Braced	Inverted V Braced	Composite Structure
10	0.000247	0.000159	0.000199	0.000175	0.00035
9	0.000593	0.000254	0.000317	0.000259	0.00084
8	0.00084	0.000332	0.000421	0.000333	0.00126
7	0.001022	0.000397	0.000506	0.000395	0.0016
6	0.001171	0.000451	0.000573	0.000447	0.00187
5	0.001303	0.000494	0.000626	0.000488	0.00207
4	0.001423	0.000528	0.000667	0.000521	0.00222
3	0.001537	0.000553	0.000701	0.000546	0.00232
2	0.001649	0.000577	0.000707	0.000562	0.0024
1	0.00172	0.000778	0.000819	0.000778	0.00019
GF	0.000506	0.001646	0.002586	0.001873	0.004
Base	0	0	0	0	0

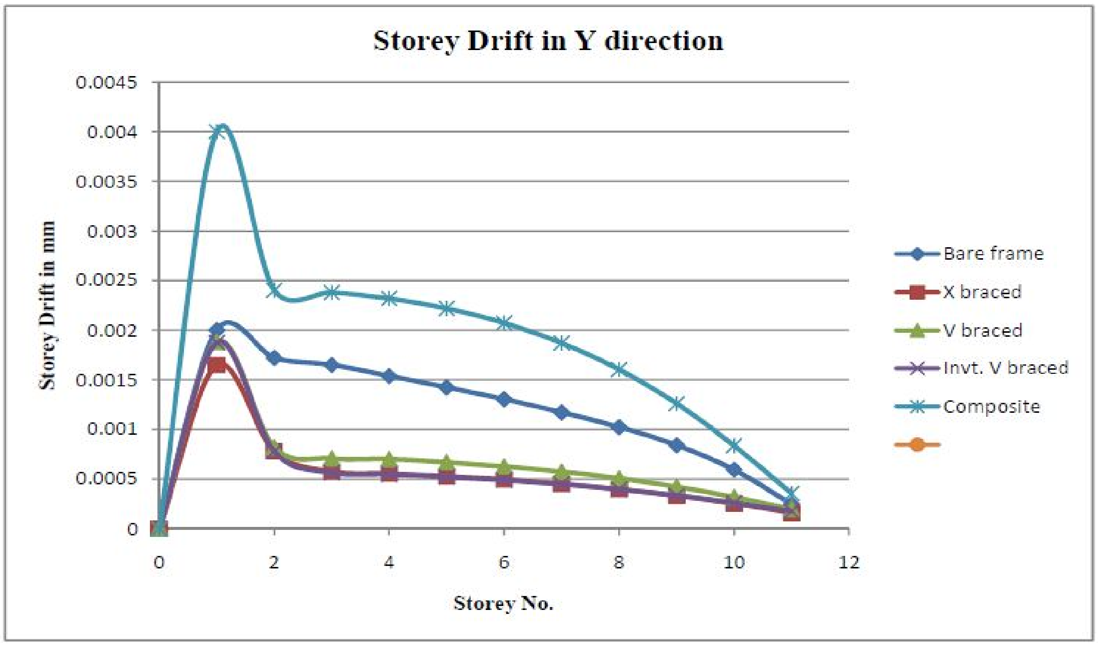

Fig 6 Variation of storey drift inY direction

From the above graph it is clear that storey drift in Y direction is in accordance with X direction i.e the drift is maximum for composite model compared to the bare frame and braced models. But among the braced models the performance of X braced and inverted V braced models is nearly equal and better than V braced model.

4.3 OVERTURNING MOMENTS

Table 6 Overturning moments in X direction

Storey No.	Bare Frame	X Braced	V Braced	Inverted V Braced	Composite Structure
10	0	0	0	0	0
9	759.1337	1161.9858	1231.8872	1345.0825	519.5648
8	2856.9306	4648.7411	4904.837	4491.3397	2123.3558
7	5820.0744	10114.2977	10610.8884	9173.3418	4617.1423
6	9361.4503	17232.8602	17950.9744	15144.9493	7819.9182
5	13344.6532	25732.4851	26590.4585	22199.4052	11595.3854
4	17717.4694	35397.9156	36279.1304	30173.3346	15853.4822
3	22460.1575	46065.1226	46852.5265	38942.8903	20539.1513
2	27565.0825	57608.1093	58218.6992	48414.5762	25620.9269
1	33037.9224	69920.1286	70333.3344	58510.8762	31086.2763
GF	38878.4983	82891.116	83171.9674	69155.1686	36943.0818
Base	41910.156	89588.5479	89888.2155	74663.4723	43219.4711

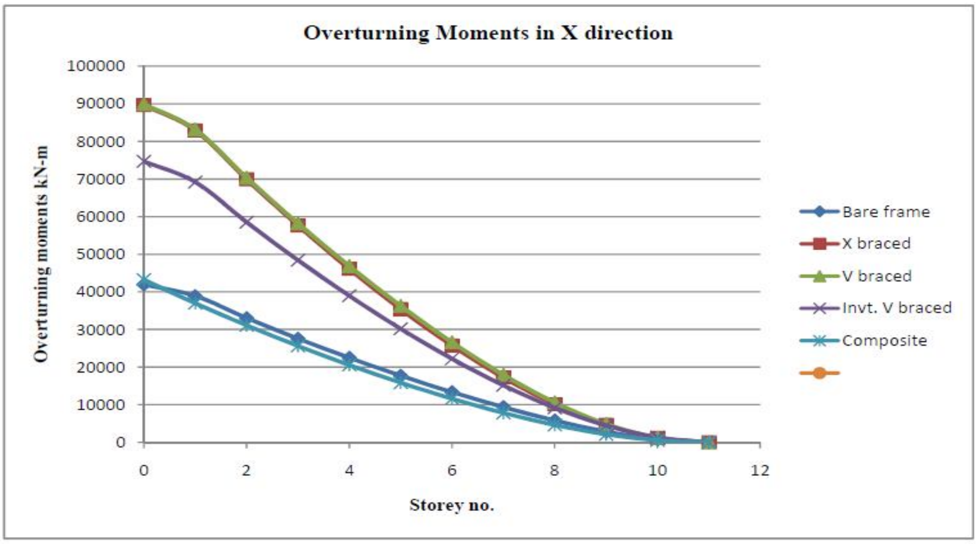

Fig 7 Variation of overturning moments in X direction

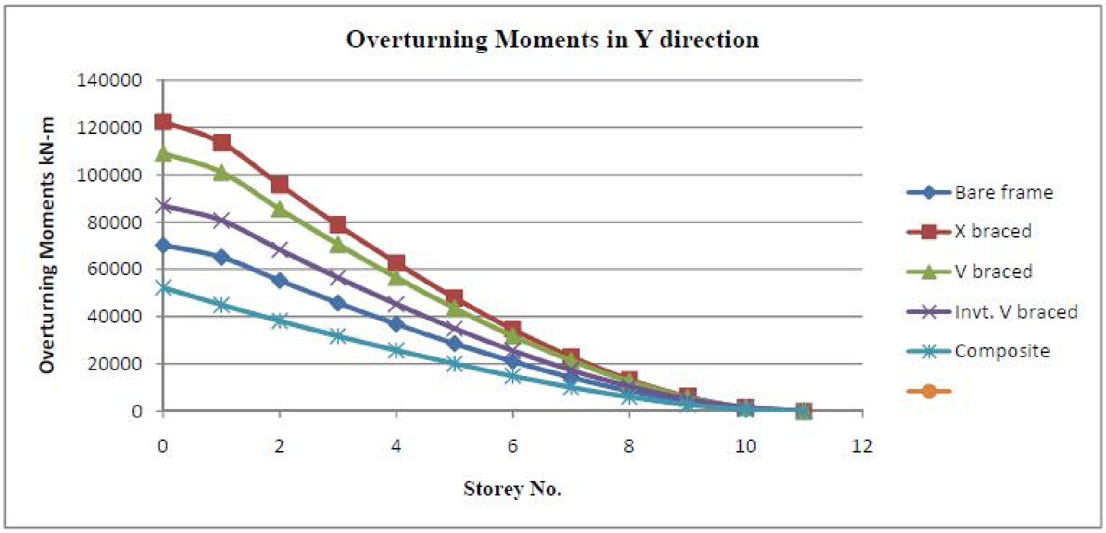

Fig 8 Variation of overturning moments in Ydirection

4.4 Storey Shear

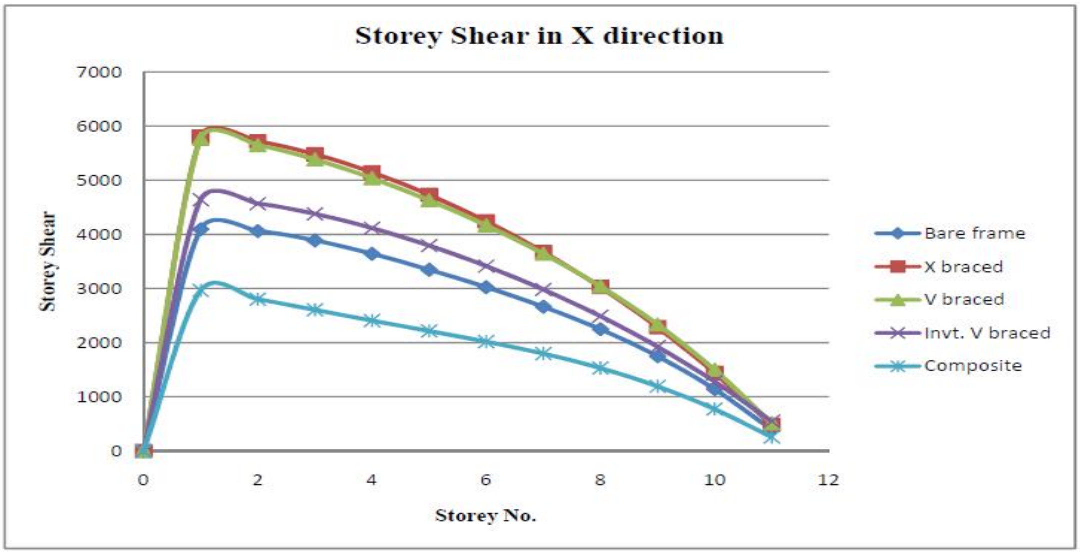

Fig 9 Variation of storey shear in X direction

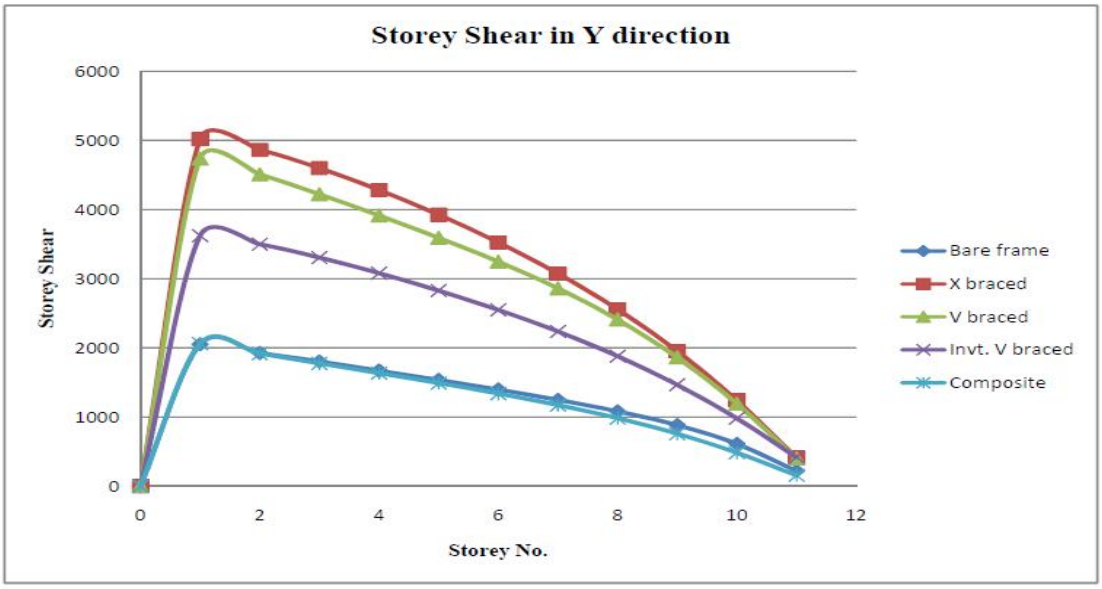

Fig 10 Variation of storey shear in Y direction

4. CONCLUSION

1. The braced structure experience less displacements depending upon the various types of bracing systems employed, compared to the composite structure and bare frame structure.
2. Compared to the composite structure and bare frame model the storey drift decreases for the braced structures which in turn reduces the overall response of the structure.
3. There is increase in base shear about 50% for the braced structure as compared to the composite structure in X direction & about 58% increase in Y direction.
4. Based on the analytical results X braced structure is most suitable to resist the lateral loads efficiently compared to the V braced and Inverted V braced structures.
5. Self weight of the steel-concrete composite building is reduced by 10% as compared to braced RC building which reduces the cost of foundation.
6. The base over-turning moments is maximum for the X braced structure compared to composite & bare frame structure.

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