The Structural Behaviour of Lateral Load Resisting System induced in Tall Buildings - A Comparitive Study

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ABSTRACT

Conceptual in current circumstance, worldwide the need and need of tall building improvement has been quickly expanding. It makes the engineers to meet new challenges in order to make an judgment. The major cause for the lateral movement of tall building are caused due to the lateral loads for all modern tall building. Seismic load cause diminish in solidness of the building, in this way examination did to inspect the most widely recognized auxiliary frameworks that are utilized for tall structures under the activity of gravity and wind loads. These frameworks incorporate; i) Rigid frame ii) Shear wall with opening iii) Framed tube system. This relative examination pointed on investigation of conduct of auxiliary frameworks for different stories subjected to sidelong loads. This comparative analysis aimed on study of behaviour of structural systems for various stories subjected to lateral loads. The parameter of the systems is measured by storey displacement, drift, stiffness by using ETABS Software.

KEY WORDS: Lateral Displacement, Lateral Loads, Structural System, Tall Buildings.

1. INTRODUCTION

During seismic activity, the adjustment in development of ground activity happens because of disfigurements occur in the components of the heap bearing framework. Because of these disfigurement, relocation shows up in the building and inward strengths create in the components of the heap bearing framework. Due to these deformation, displacement appears in the building and internal forces develop in the elements of the load-bearing system. The stiffness and mass of the tall building are the resultant displacement that occurs in the building. On the contrary, displacement demands are to increase. On the other hand, each building has a specific displacement capacity. Collapsing limit should be maintained when the building is subjected to horizontal displacement. The displacement demand can be reduced by means of strengthening the displacement capacity by adopting structural system. Therefore structural systems are provided in the building.

Structural System:

Rigid Frame System: Rigid Frame System (Figure.1) comprises of minute safe associations in which section and braces are joined immovably. It consists of moment resistant connections in which column and girders are joined firmly. The lateral stiffness of a rigid-frame bent depends on the bending stiffness of the columns, girders and connections in the plane of the bent.

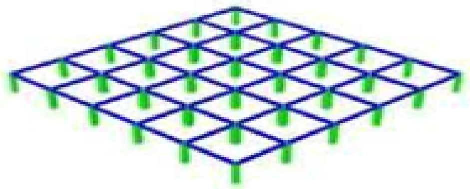

Figure.1. Rigid Frame System

Braced Frame System: Braced frame system mostly used in steel construction. The bracings which is given in the tall structures will practically wipe out the bending of sections and columns by opposing lateral loads basically, hence taking into consideration slenderer components. A very well-known example of braced frame structural system can be seen in the Empire State Building. Figure.2, shows the braced framed structure.

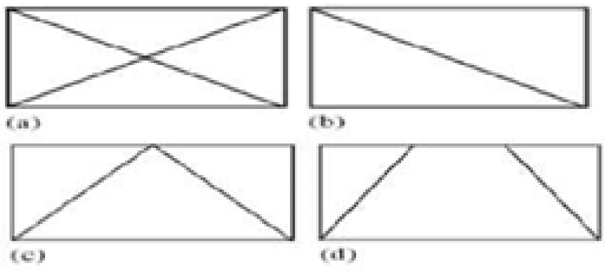

Figure.2. Braced Frame System

Frame Tube System: Frame tube system has emerged from the development of bracing configuration in which much gravity load on the exterior columns will nullify and counteract the overturning effects of lateral loads.

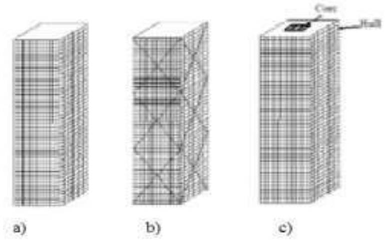

Figure.3. Frame Tube Systems

2. METHODOLOGY

The three dimensional structure has been modeled and designed to gravity loading such as dead load, live load and floor load. Then the analysis has been done with above mentioned structural systems.

Details of the Model
Structure type – OMRF
No. of Stories – G+40
Typical Storey height – 3m
Model is regular shaped building with symmetrical plan dimension with 45m x 45 m

Section Properties
Grade of Concrete – M40
Grade of Steel – Fe 415
Beam Size – 0.45 m X 0.5 m
Column Details - Storey 1-10 (0.8 m X 0.8 m); Storey 11-20 (0.7 m X 0.7 m); Storey 21-30 (0.6 m X 0.6 m); Storey 31-40 (0.5 m X 0.5 m)
Slab Thickness – 0.2 m

Bracings	Frame Tube
Type of Bracing – Inverted V	Beam Size – 0.7 m X 0.7 m
Size of Bracing – 200X200X12 mm	Size of Frame Tube – 200X200X12 mm

Loadings	
Gravity Loads	Dead Load – For rigid frame and bracing – 4.375 kN/m For frame tube – 8.75 Kn/M
	Self–weight of slab with floor finishes - 7.5kN/m^2
	Live Load–Thus for office buildings the Indian Code of practice suggest 4kN/m^2
Wind Load (IS: 875-Part 3)	Mumbai
	Wind Speed–39 m/s
	Terrain Category –3
	Structure Class–B
	Diaphragms–Rigid
Earthquake Load (IS: 1893 –Part 1)	Mumbai
	Zone IV –0.24
	Importance Factor –1
	Reduction Factor – 3
	Period of Vibration T_a–0.075 (h) $^{0.75}$
	h –Height of the building in m, the period of vibration in 1.6 sec

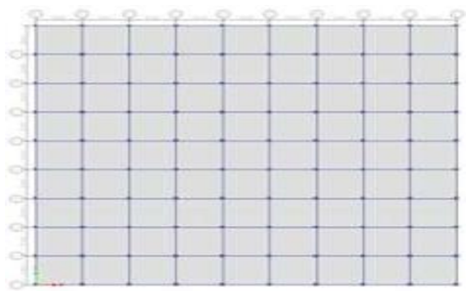

Figure.4. Plan View

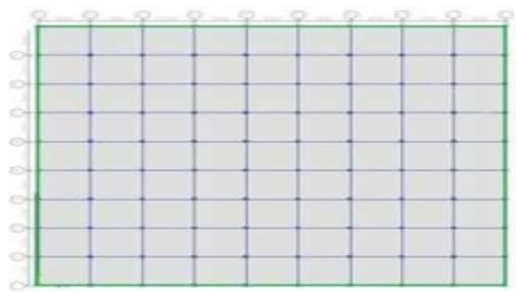

Figure.5. Frame Tube System in Top Storey

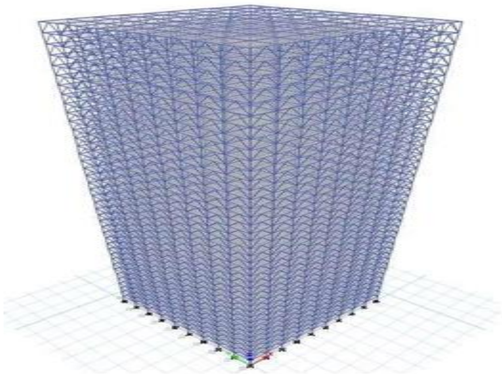

Figure.6. 3D View of Bracing systems

3. RESULTS AND DISCUSSION

The results obtained from analysis are compared and discussed as follows.

Table.1. Displacement Results for Seismic Force

Storey Height	Displacement (mm)		
	Rigid frame	Frame Tube	Bracing
10	42.4	22.6	23.5
20	92.1	51.5	50.7
30	136.9	82.1	75.7
40	163.9	105.1	91.7

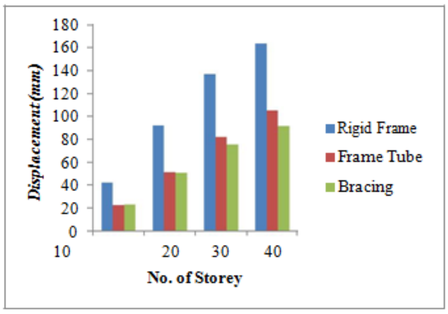

Fig.7. Storey vs Displacement for Seismic Force

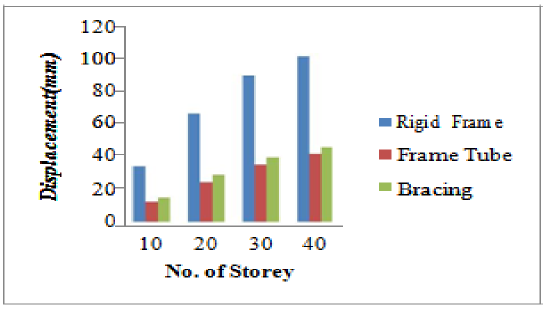

Fig.8. Storey vs Displacement for Wind Force

Table.2. Displacement Results for Wind Force

Storey Height	Displacement (mm)		
	Rigid frame	Frame Tube	Bracing
10	34.5	12.1	15.1
20	67.7	24.7	29.5
30	91.8	35.6	40.4
40	103.7	42.7	46.6

Table.3. Drift Results for Seismic Force

Storey Height	Drift		
	Rigid frame	Frame Tube	Bracing
10	0.001628	0.000765	0.000871
20	0.001594	0.000625	0.000724
30	0.001255	0.000481	0.000531
40	0.00035	0.000304	0.000308

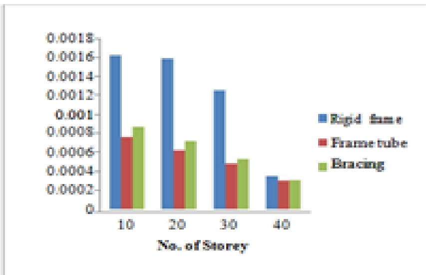

Figure.9. Storey vs Drift for Seismic Force

The chart is plotted for seismic constrain and wind force for displacement and drift against number of storey. Lateral displacement at top of the working of rigid frame system can be diminished to 35.87% while utilizing frame tube and 44.05% while using bracing system. Drift can be lessened upto 13.14% while utilizing frame tube and 12% while utilizing bracing system.

4. CONCLUSION

The most significant parameter monitored throughout the whole analysis process was displacement, drift and stiffness of the building. The figure which was given in the results and discussions shows the variation of displacement, stiffness and drift.

The following concludes are made from the present study;

In accordance with the structural systems, displacement is controlled by using bracing system than by using rigid frame and frame tube system.

Stiffness parameter is achieved through frame tube system compared to the rigid frame and bracing system.

On provision of bracing system, the structure will be subjected to minimum drift.

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