Seismic Load analysis of Shear Wall, Damper & Bracing System in Multistorey Irregular Building

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Abstract— In seismically active places, earthquake restrictions would provide a difficulty to the majority of multistory buildings. The fundamental issue in the design of the multi-story building is lateral stability, which is required to control lateral drift and displacement, withstand lateral pressures, and avoid buckling. Reinforced concrete (RCC) structures usually utilise a damper, bracing, and shear wall system to mitigate the impacts of seismic activity. Both systems have significant structural performance. Despite the fact that both technologies are used for the same purposes, their effects and behaviour in response to seismic load differ.The G+15 storey building, shear wall and bracings will all be considered in this project's analysis. The following criteria will be used to evaluate the building's performance: base shear, storey displacement, and storey drift. This research includes dampers, shear walls, and bracings at various places, and the Etabs 2018 programme will be utilised for the entire analysis.

I. INTRODUCTION

In these demand for construction of high rise building increases day by day due rapidurbanization and shortage of land in urban areas. For tall building there is always need of proper structural system to transfer lateral and gravity loads to foundation system. There are number of structural system available which usually used for stabilization of high rise building some of them are as follow: outrigger system, tube system, bundled tube system, core shear wall system, bracing system, damper system…etc. Among them lateral bracing system frequently used for structures up to 30 to 40 story building in order to increase its lateral strength and stiffness to fulfill serviceability and design criteria. Mainly there are two types of bracing concentric bracing and eccentric bracing. Concentric bracing can be in various shape such as X-bracing, V-bracing and inverted V-bracing.

II. BRACING SYSTEM

Steel bracing is a highly effective structural technique for transmitting lateral forces to columns. Steel bracing transfers lateral stresses, such as earthquakes and wind, by tension-compression action. As a result, it makes use of the axial load bearing capability of the bracing while requiring the smallest possible member size. Steel bracing has historically been used to stabilise high-rise buildings against lateral stresses. When compared to a core shear wall structural system, this system has less base shear. Also, bracing systems are one of the most effective techniques used in building retrofitting to increase lateral load carrying capacity and reduce lateral deflection. The slenderness ratio of a steel bracing system is an important factor in the overall performance of the structure; bracing with a low slenderness ratio results in poor structural system performance, while bracing with a high slenderness ratio makes the system too rigid and attracts more earthquake forces. As a result, the slenderness ratio of bracing must be optimised for improved structural system performance. There are two types of bracing systems in general: concentric bracing systems and eccentric bracing systems. Eccentric bracing is utilised when beams have a high flexural stiffness and strength. Concentric bracing can take numerous forms, including X-bracing, V-bracing, inverted V-bracing, and so on. The simplest form is X-bracing, which is commonly employed as a lateral load resisting structure.

III. DAMPER

Dampers are a very effective energy dissipation method that is frequently employed nowadays for lateral load resisting systems. Though this new technique is more expensive than other structural systems, it dissipates energy and reduces base shear significantly more than core shear walls, bracing, and other structural systems. There are several types of dampers available, including pall friction dampers, fluid viscous dampers, PVD dampers, friction dampers, and TMD dampers.

IV. SHEAR WALL

Adequate stiffness is critical in high-rise buildings to withstand lateral stresses caused by wind or seismic occurrences. Because of its great strength, stiffness, and ductility, RC shear walls are ideal for structures in seismic zones. A large percentage of the lateral load on a structure, as well as the shear force caused by load, is frequently attributed to RCC structural components. Shear walls have a high in-plane stiffness, allowing them to withstand lateral loads and manage deflection well. If inter-storey deflections induced by lateral loadings have to be managed, shear walls or its equivalent must be utilised in some high-rise structures. Shear walls that are properly constructed not only provide safety, but also a suitable level of protection against expensive structural and non-structural damage during seismic activity. Shear walls provide structures a lot of stiffness and strength, which helps to limit lateral displacement and thereby damage to the structure. Shear walls are one of the most important structural components used in multi-story structures in seismic zones because they have a high resistance to lateral earthquake stresses. RC shear walls should be ductile enough to avoid brittle fracture when subjected to strong lateral seismic stresses.

V. STRUCTURE PARAMETERS

Table 1 Geometrical parameter

Type of Structure	Column size in mm	Beam size in mm	Total height in m	Story height in m	Slab thickness in mm	Shear wall Thickness mm	Damper Property (kN)	Bracing size is ISA (mm)	Grade of concrete	Grade of steel
General Model	600x600	300x550	48	3	150	-	-	-	M30	Fe500
Tunned Mass Damper	600x600	300x550	48	3	150	-	980.67	-	M30	Fe500
Shear Wall	600x600	300x550	48	3	150	200	-	-	M30	Fe500
Bracing	600x600	300x550	48	3	150	-	-	75x75 x6	M30	Fe500 & Fe250(Bracing)

Table 2 Load Combination

Load combination	DL	LL	EQ X	EQ Y
DL+LL	1.0	1.0	-	-
1.5(DL+LL)	1.5	1.5	-	-
1.2(DL+LL+EQ X)	1.2	1.2	1.2	-
1.2(DL+LL-EQ X)	1.2	1.2	1.2	-

1.2(DL+LL+EQ Y)	1.2	1.2	-	1.2
1.2(DL+LL-EQ Y)	1.2	1.2	-	1.2
1.5(DL+EQ X)	1.5	-	1.5	-
1.5(DL-EQ X)	1.5	-	1.5	-
1.5(DL+EQ Y)	1.5	-	-	1.5
1.5(DL-EQ Y)	1.5	-	-	1.5
0.9DL+1.5EQX	0.9	-	1.5	-
0.9DL-1.5EQX	0.9	-	1.5	-
0.9DL+1.5EQY	0.9	-	-	1.5
0.9DL-1.5EQY	0.9	-	-	1.5

Table 3 Loading

Sr.no	Live load in kN/m^2	Super dead load in kN/m^2	Wall load kN/m
1	1.5 (terrace), 3(floor)	3.75	12.19

Table 4 Seismic parameters

Sr.no	Importance factor(I)	Zone factor(Z)	Response reduction factor(R)	Type of soil medium	Damping ratio
1	1	0.16	5	Medium (II)	0.05

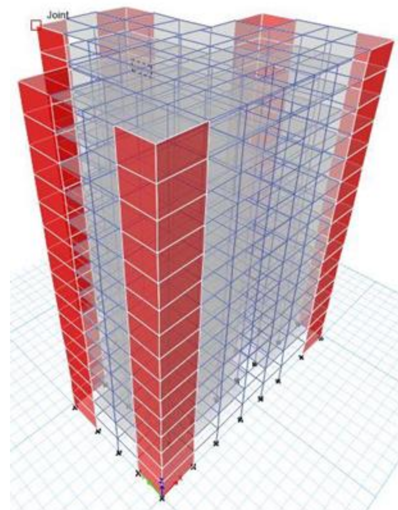


Figure 2. Shear wall Model

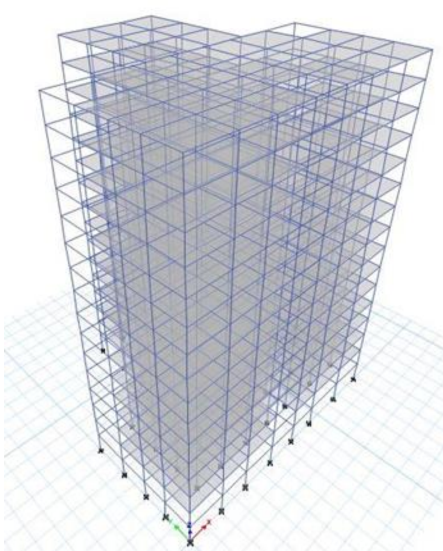


Figure 1. Bare Frame/General Model

Figure 3. Tunned Mass Damper Model

Figure 4. Bracing model.

Four models are designed for different changes in structural parameter

· Model1= Bare frame/ General Model
· Model 2= TMD Damper
· Model 3 = Shear wall system
· Model 4= Bracing System

VI. RESULT AND DISCUSSION

The structural analysis is done on software ETABS 2018. The results after the analysis are formulated in graphical format to get a proper overview of the results.

1. Storey Displacement

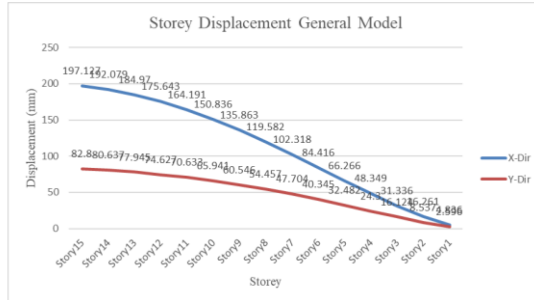


Figure 5. Storey Displacement Graph of General Model

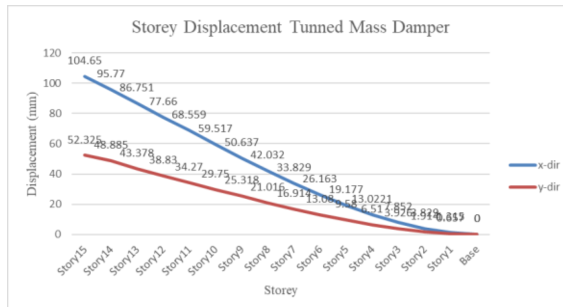


Figure 6. Storey Displacement Graph of Tunned Mass Damper

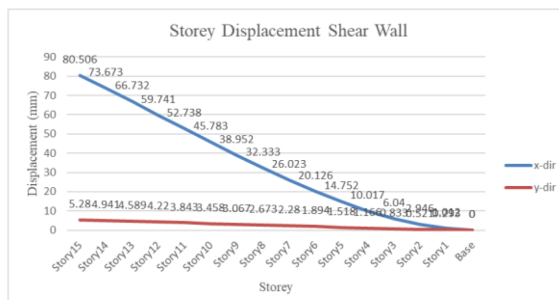


Figure 7. Storey Displacement Graph of Shear Wall

Figure 8. Storey Displacement Graph of Bracing

2. Storey Drift

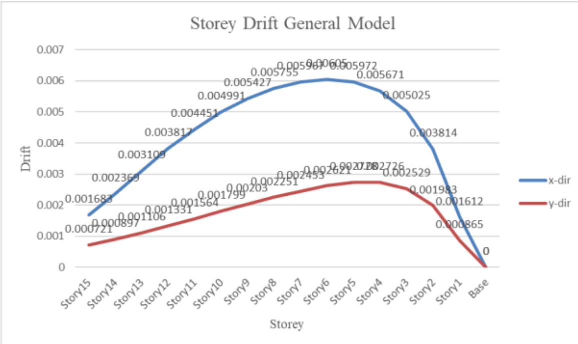


Figure 9. Storey Drift Graph of General Model

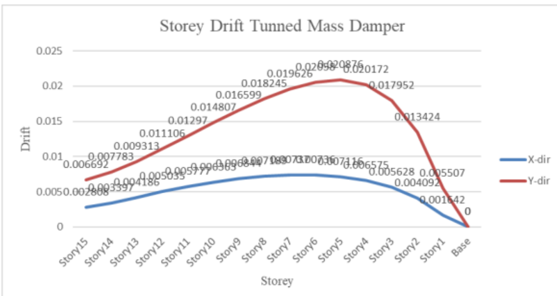


Figure 10. Storey Drift Graph of Tunned Mass Damper

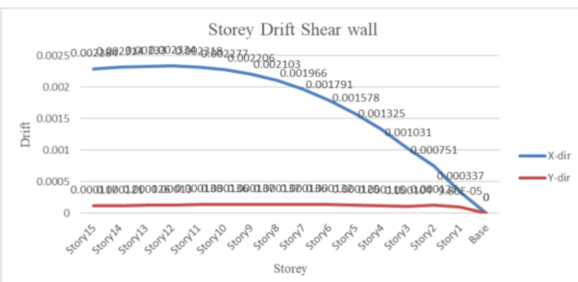


Figure 11. Storey Drift Graph of Shear wall

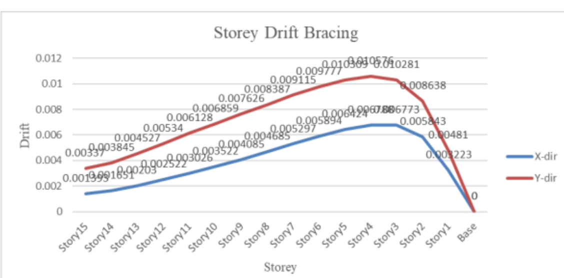


Figure 12. Storey Drift Graph of Bracing

3. Storey Shear

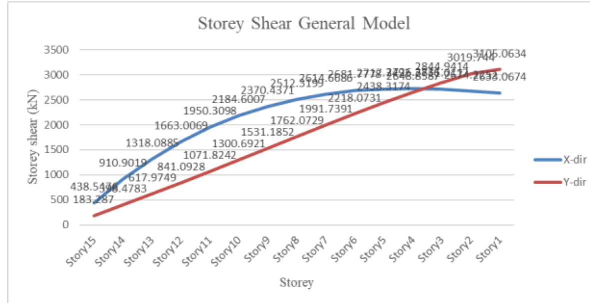


Figure 13. Storey Shear Graph of general model

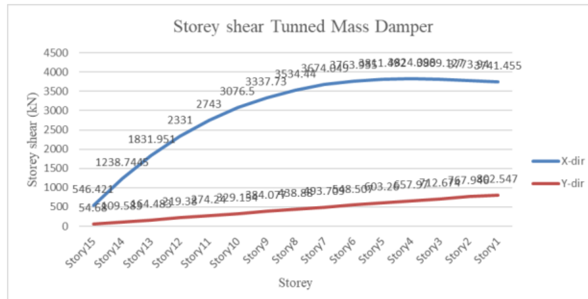


Figure 14. Storey Shear Graph of Tunned Mass Damper

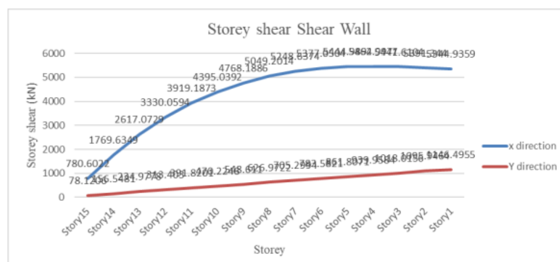
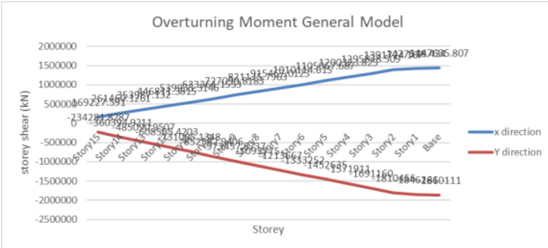
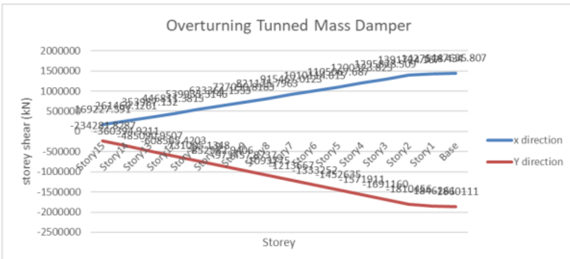


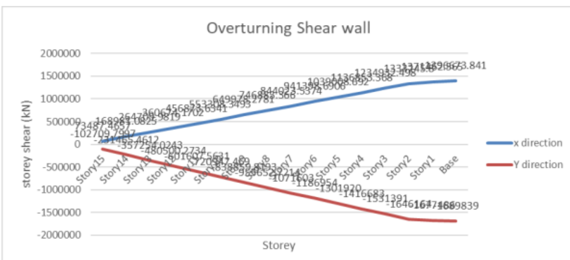
Figure 15. Storey Shear Graph of Shear Wall

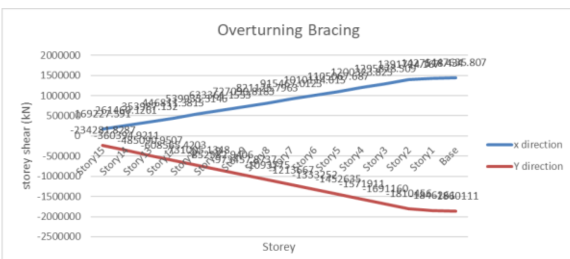
Figure 16. Storey Shear Graph of Shear Wall

4. Overturning Moment

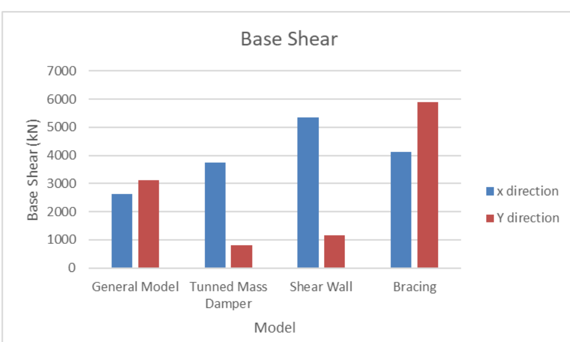








5. Base Shear



CONCLUSION

On the bases of present study following result has been constructed:

1- To boost the lateral strength and stiffness of high-rise structures, a good lateral load resisting system is necessary.
2- In present study three types of systems i.e. bracing, shear wall and damper are used as a lateral load resisting system which reduced lateral displacement from 197 mm in bare frame to 105mm in tunned mass damper, 80.5mm in shear wall model & 120mm in bracing. Here the shear wall reduced the displacement to a greater extend and makes structure more lateral load resistant.
3- In storey shear the model of shear wall has storey shear which is at the base so the base shear and storey shear at the bottom shows 5345 kN and for bracing which is the highest at 5887kN which is not desirable for bracing.
4- Overall the shear wall model has better results and can be more effective as compared to damper or bracing for making the structure lateral load resistant.

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