© 2017 IJSRSET | Volume 3 | Issue 2 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

Analysis on Seismic Induced Vibration Control by Dampers in Tall Buildings Using ETABS Software

Fasalulla CM*1, Vineesh P*2
*1PG Student, Department of Civil Engineering, AWH engineering College, Calicut, Kerala, India
*2Assistant Professor, Department of Civil Engineering, AWH engineering College, Calicut, Kerala, India

ABSTRACT

The Need for taller structure in construction and real estate industry is on a tremendous increase over the world. Vibration creates problem to serviceability requirement of the structure and also reduces structural integrity with possibilities of failure. Current trends use several techniques to reduce earthquake induced structural vibration. This thesis presents comprehensive researches on earthquake-induced vibration control technologies that are applied to high-rise structures; Damper is widely used to control structural vibration under earthquake load. First, earthquake effect on high-rise structures is analysed, and earthquake-induced responses of high-rise structures are analyse. second, optimal parameters of damper installed on structures are deduced, which carefully consider the interactions between the main structure and the damping system, The efficiency of the passive control system is evaluated by the performance of the building will be studied considering building with damper and without damper by using ETABS Software. to find out the seismic response (storey drift, storey displacement, story stiffness and story force) of building with and without any damping device. This thesis work different model with different shape of structure, different locations of damper and different height of structure of building have been modelled. Under this work first of all, the structure has been done without any damping device and secondly the same building with different shape of structure, different locations of damper and different height of structure. These are the result obtained from ETABS Software by comparing the values with and without damper.

Keywords: Damper, ETABS, Story drift, Story displacement, Story stiffness, Story force

I. INTRODUCTION

Super-tall buildings are landmarks of cities. They are closely related to the process of urbanization and industrialization. Economic growth, dense population and the shortage of land resources in urban areas demand developing and constructing high-rise structures . Vibration creates problem to serviceability requirement of the structure and also reduces structural integrity with possibilities of failure. Current trends use several techniques to reduce wind and Earthquake induced structural vibration. Earthquakes are natural hazards under which disasters are mainly caused by damage or collapse of buildings and other man-made structures. These loads are causes more damage than wind loads. This thesis presents comprehensive researches on earthquake-induced vibration control technologies that are applied to high-rise structures. First, earthquake effect on high-rise structures is analyzed, and earthquake-induced responses of high-rise structures are introduced to build a basis for this study. Second, optimal parameters of Damper installed on structures are deduced. which carefully considers the interactions between the main structure and the damping system, is built to evaluate the efficiency of the passive control system. The performance of the building will be studied considering building with damper and without damper. To find out the seismic response (storey displacement, storey drift, story stiffness and story force) of building with and without any damping device using ETABS software. With different shape of structure, different locations of damper and different height of structure. The result obtained from software analysis, building with and without any damping device and compare result with each other.

II. MODELLING OF THE BUILDING

A typical reinforced concrete building is three dimensional, comprising floor slabs, columns, beams and footings which are monolithically connected and act integrally to resist gravity loads (dead loads, live loads) and lateral loads (wind loads and earthquake load). From the view point of modelling for the limit state in flexure it is required to find out the maximum (positive as well as negative) bending moment under the most combination of factored loads.

Model 1 : 50 storey square shape building
Model 2.1 : 30 storey square shape building
Model 2.2 : 30 storey square shape building
Model 3 : 30 storey L- shape building
Model 4 : 30 storey Circular shape building

TABLE 1: SALIENT FEATURES

Salient features	
Utility of building	commercial complex
Type of construction	R.C.C frame structure
Number of stories	26,30,50
Types of walls	brick wall

TABLE 2: GEOMETRY DETAILS

Geometry details	
Height of the building	90,105,150
Height of the floor	3,3.5 m

TABLE 3: MATERIALS

Materials	
Grade of Concrete	M_{30}
Grade of Steel	Fe 415

Loads Considered

Dead Load

Dead load is taken as prescribe by the IS: 875 -1987 (Part-I) Code of Practice Design Loads for Buildings and structure.

TABLE 4: DEAD LOAD

Type of load	Unit Weight of	Load
Dead Load	RCC	25 kN/m³
	Brick masonry	19 kN/m³
	Floor Finish	1.5 kN/m²
	Wall Load	12 kN/m

Live Load

TABLE 5: LIVE LOAD

Type of load	Floor Detaille	Load
Live Load	1 to 14th Floor	3 kN/m²
	14 to 20th Floor	1.5 kN/m²

Wind Load

The wind speed (Vb) of any locality can be obtained from IS 875(Part 3 -1987) .The wind load depends up on Risk level terrain roughness, height and size of structure,

- Wind speed = 44 m/s
- Terrain category = 4
- Structure class = C
- Risk coefficient (k1) = 1
- Topography (k3) = 1

Seismic load

In the present work the building is assumed to be located in ZONE II,IV,V . Using the IS 1893 – 2002 the following are the various values for the building considered.

A. Zone factor (Z):

It is an element to get the look spectrum depending on (lie perceived most unstable risk characterized by most thought-about Earthquake (MCE) within the zone within which the structure is found. the fundamental zone factors enclosed during this standard are affordable estimate of effective peak ground acceleration. ZONE II=0.10, ZONE IV= 0.24, ZONE V = 0.36

B. Response reduction factor R :

It is the issue by that the particular base-shear force that will be generated if the structure were to stay elastic throughout its response to the look Basis Earthquake (DBE) shaking, shall by reduced to get the look lateral force.
Response reduction factor for =5.0 from IS 1893-2002

C. Importance factor (I) :

It is an element accustomed acquire the planning seismic force reckoning on the purposeful use of the structure, characterized by hazardous consequences of post-earthquake purposeful would like, historical worth, or economic importance.
Importance factor (1) = 1 (from IS 1893-2002 (Part-I),Table-6).

D. Soil type :

Soil site factor (1 for hard soil, 2 for medium soil, and 3 for soft soil) depending on type of soil average response acceleration coefficient Sa/g is calculated corresponding to 5% damping (Clause 6.4.5 of IS 1893-2002). In the present work three type of soil are used.

The damping device is arranged on different configuration. They are, without any damping device, Damping device corner, Damping device Exterior, Damping device interior, Damping device all, Damping device exterior alternate story, Damping device alternate exterior, Damping device alternate interior shown in bellow,

Model 1 : 0,400,600,600,1200 nos of damper
Model 2.1: 0,240,780,2130,2910 nos of damper
Model 2.1: 390 numbers of damper
Model 3 : 390 numbers of damper
Model 4 : 390 numbers of damper

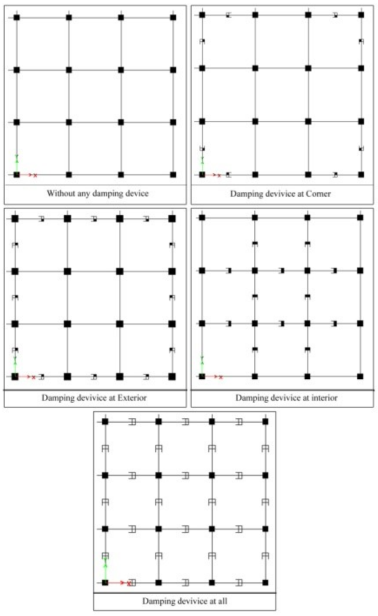

Figure 1: Model 1

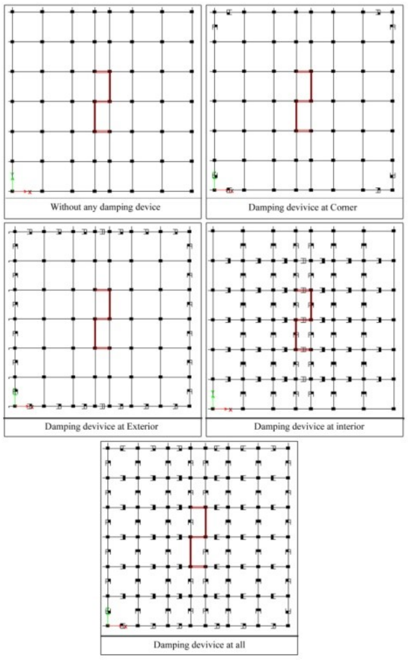

Figure 2: Model 2.1

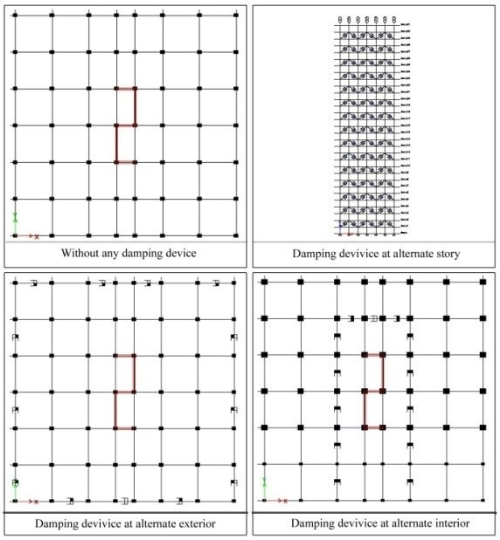

Figure 3: Model 2.2

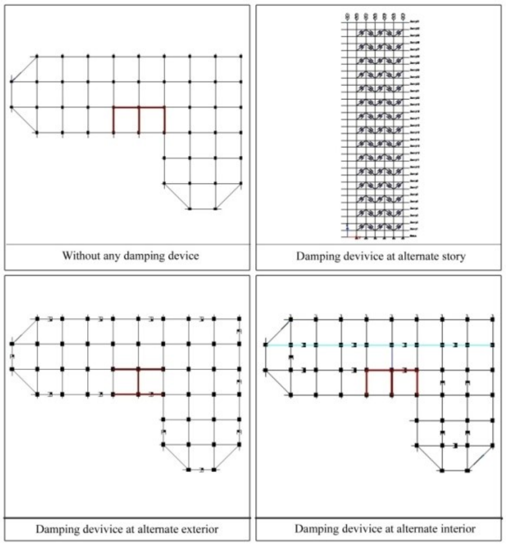

Figure 4: Model 3

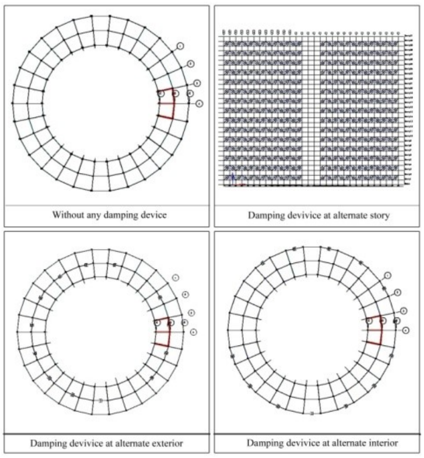

Figure 5: Model 4

III. RESULTS AND DISCUSSION

From the analysis of building. the storey displacement, story drift, story stiffness and story force are find out using ETABS software. Story Displacement is very less in damping device at all. Because of number of damper is huge as compared to others. the graph plotted displacement on different stories.

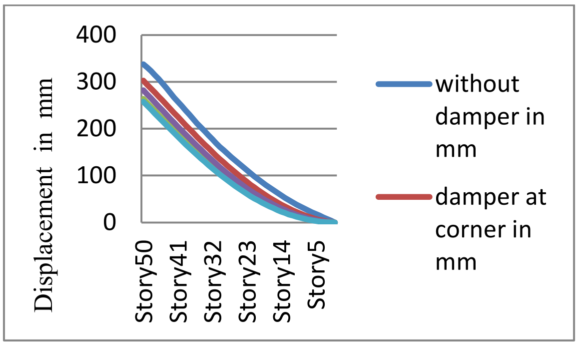

Figure 6 : Displacement graph on model 1

Figure 7 shows the displacement of building on different zone like Zone II,IV,V; value having damping device at exterior. It demonstrates that the maximum displacement Zone V is 128 mm, Zone IV is 90.8 mm and Zone II is 53.5 mm , the results are expected.

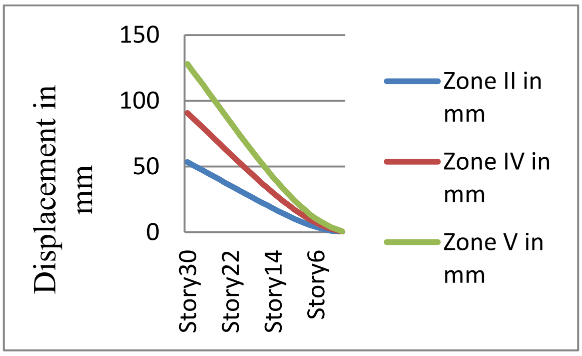

Figure 7 : displacement of different earthquake zones on model 2.1

Figure 8 shows the maximum displacement of structures on 3m and 3.5m height of building (building height is 90m and 105m), value having damping device at exterior and Zone V. It demonstrates that the maximum displacement 3 m is 128 mm and 3.5 m is 161.8 mm.

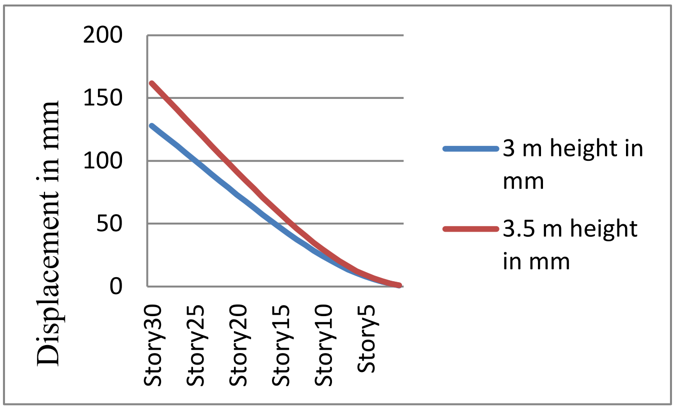

Figure 8 : displacement of different story height on model 2.1

The Figure 9 shows story displacement of 30 stories square-shaped building (3 m story height and 90 meter building height) with 390 numbers of damping device arranged with different configuration. In this study, the damping device at exterior alternate story is displacement only 153.1 mm (30% displacement reduces compared to without any damping device), damping device at alternate exterior is 182.9 mm (15.28% displacement reduces compared to without any damping device) and damping device at alternate interior is 219.8 mm (1.66% displacement reduces compared to without any damping device).

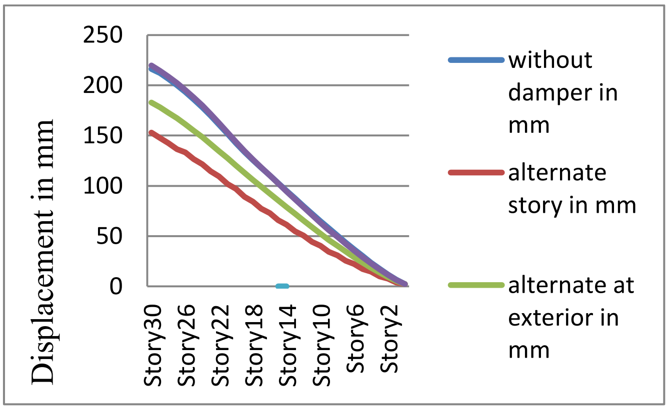

Figure 9 : displacement on model 2.2

The Figure 10 shows story displacement of 30 stories square-shaped building (3.76 m story height and 90 meter building height) with 390 numbers of damping device arranged with different configuration. In this study, the damping device at exterior alternate story is displacement only 153.1 mm (30% displacement reduces compared to without any damping device), damping device at alternate exterior is 182.9 mm (15.28% displacement reduces compared to without any damping device) and damping device at alternate interior is 219.8 mm (1.66% displacement reduces compared to without any damping device).

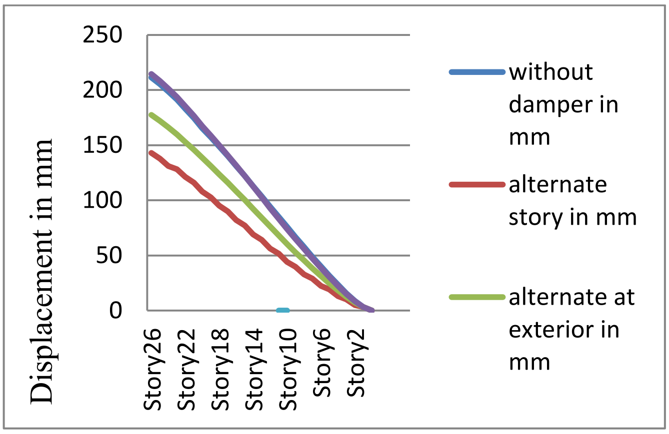

Figure 10 : displacement on model 2.2

Figure 11 shows the maximum displacement of structures on 3m and 3.5m height of building (building height is 90 m), value having damping device at exterior alternate story and Zone V. It demonstrates that the maximum displacement 3 m is 153.1 mm and 3.5 m is 142.8 mm because of number of stories increasing with increase in displacement.

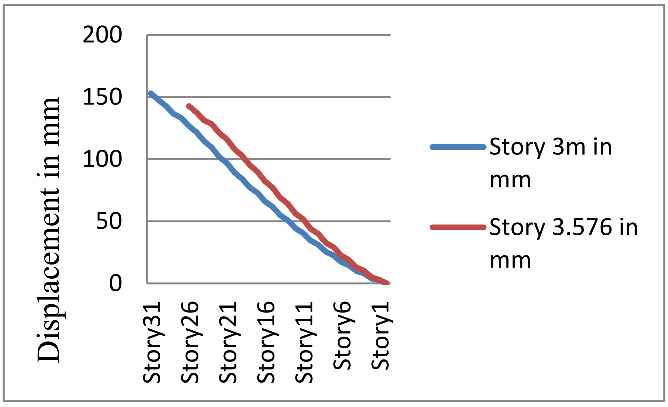

Figure 11 : displacement of different story height on model 2.2

The Figure 12 shows story displacement of 30 stories L-shaped building with 390 numbers of damping device arranged with different configuration. In this study, the damping device at exterior alternate story is displacement only 181.2 mm (40% displacement reduces compared to without any damping device), damping device at alternate exterior is 257.2 mm (15.28% displacement reduces compared to without any damping device) and damping device at alternate interior is 274.9 mm (9.45 % displacement reduces compared to without any damping device).

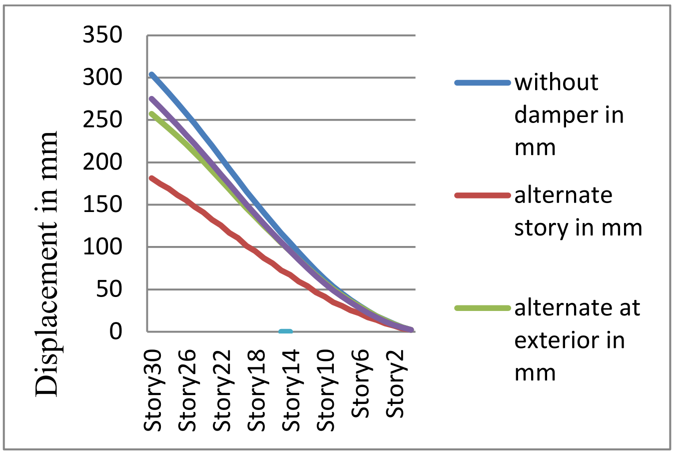

Figure 12 : displacement on model 3

The Figure 13 shows story displacement of 30 stories circular-shaped building with 390 numbers of damping device arranged with different configuration. In this study, the damping device at exterior alternate story is displacement only 124.7 mm (37.65% displacement reduces compared to without any damping device), damping device at alternate exterior is 155 mm (22.5% displacement reduces compared to without any damping device) and damping device at alternate interior is 156.5 mm (21.75 % displacement reduces compared to without any damping device).

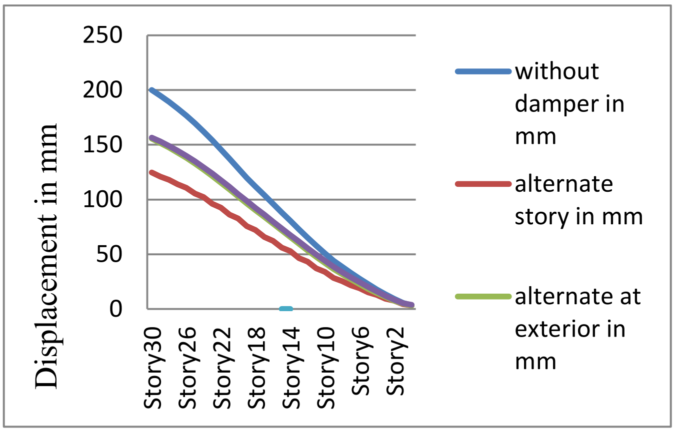

Figure 13 : displacement on model 4

In this thesis work, the maximum story displacement of different shaped buildings like square shaped, L-shaped and Circular shaped building with 390 numbers of damping device arranged at different configuration as Exterior alternate story, alternate exterior and alternate interior are shown bellow,

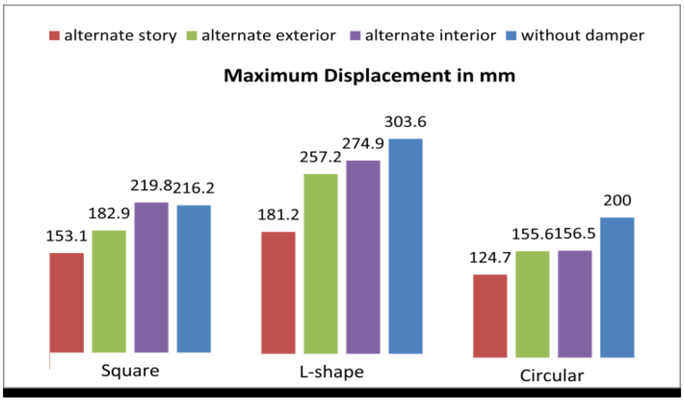

Figure 14 : Maximum displacement on model 2.2,3,4

The maximum Story drift of square shaped, L-shaped and Circular shaped building with 390 numbers of damping device arranged at different configuration are shown bellow,

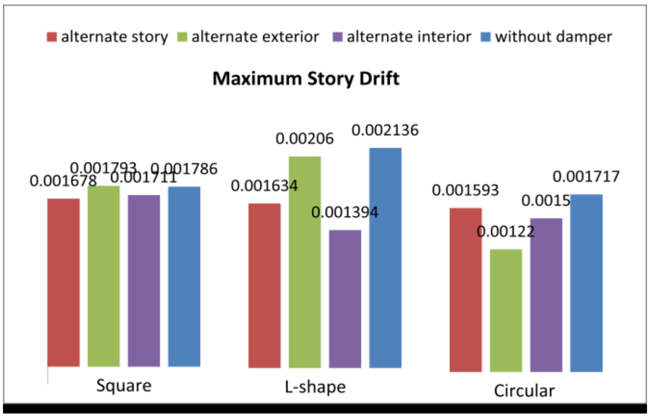

Figure 15 : Maximum Story Drift on model 2.2,3,4

The maximum Story stiffness of square shaped, L-shaped and Circular shaped building with 390 numbers of damping device arranged at different configuration are shown bellow,

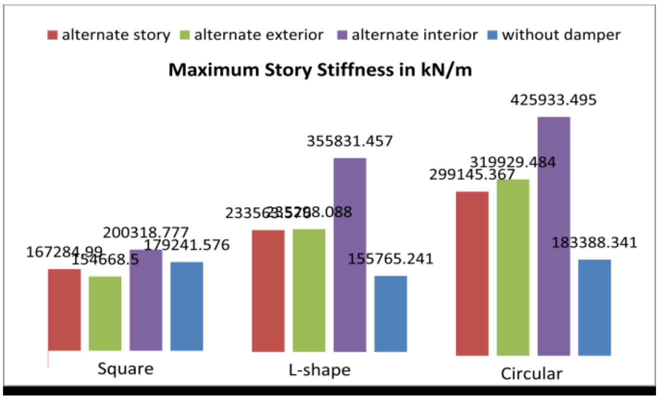

Figure 16 : Maximum story stiffness on model 2.2,3,4

The maximum Story force of square shaped, L-shaped and Circular shaped building with 390 numbers of damping device arranged at different configuration are shown Figure 17, Story force is very high without any damping device, damping device at interior, damping device at exterior and damping device at exterior alternate story as follows. Because of exterior damper is more strengthen than others.

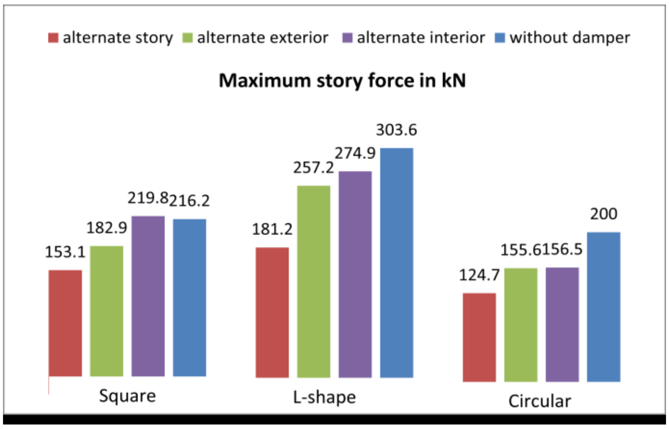

Figure 17 : Maximum story force on model 2.2,3,4

IV.CONCLUSION

The analytical study on the effect of Mass Damper in high rise structures has been done. The parameters like storey displacement, Story drift, Story Stiffness and Story force have been compared with and without any damping device installed. Following conclusions are made based on the analysis

1. The arrangement in which dampers are provided at exterior alternate story 181.2 mm is found to be more effective than others arrangement of damper in L-shape structure.
2. The square section is 30% displacement reduces in exterior alternate story, 15.28% alternate exterior displacement reduces and 1.66% alternate interior displacement reduces
3. The L-section is 40% displacement reduces in exterior alternate story, 15.28% alternate exterior displacement reduces and 9.45% alternate interior displacement reduces
4. The Circular-section is 37.65% displacement reduces in exterior alternate story, 22.5% alternate exterior displacement reduces and 21.75% alternate interior displacement reduces

5. Damper is found to be more effective in reducing displacement in L-shaped building (40.34% less) than circular building (37.65%), square building (30 %)
6. Circular building displacement less than other shape of building having same cross-section area.
7. Damping device at alternate interior is most effective on circular building which is 21.75%
8. Increase in story height causes increase in the story displacement for a given height of building
9. As number of damper increases story drift, Story Stiffness and Story force of building are found to be increasing.

V. REFERENCES

[1] Winston Chai and Maria Q. Feng, (1997), “Vibration Control Of Super Tall Buildings Subjected To Wind Loads” Int J. Non-Lmear Mechanics, Vol. 32, No. 4, pp 657-668

[2] Khaldoon A. Bani-Hani (2005), “Vibration control of wind-induced response of tall buildings with an active tuned mass damper using neural networks” Struct. Control Health Monit.

[3] Mr. Ashish A. Mohite1, Prof. G.R. Patil (2015), “Earthquake Analysis of Tall Building with Tuned Mass Damper” IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), PP 113-122

[4] SHANG Guoqing (2013), “Wind Induced Vibration Control Study of High-rise Structures with TMD and AMD/HMD”

[5] Alex Y. Tuan and G. Q. Shang (2014), “Vibration Control in a 101-Storey Building Using a Tuned Mass Damper” Journal of Applied Science and Engineering, Vol. 17, No. 2, pp. 141-156

[6] Mohammad Ali Issa (2012), “Study of Vibration Control in R.C Building Structures Subject to Seismic loads Using Viscoelastic Dampers”

[7] Ming Gu (2009), “study on wind loads and responses of tall buildings and structures” The Seventh Asia-Pacific Conference on Wind Engineering, November 8-12, 2009

[8] Eero Virtanen (2015), “Assessment Of Vibration Comfort Criteria For Tall buildings”

[9] K C. Kwok, B Samali, G Hu, and K T. Tse (2014), “Wind-induced response reduction of a tall building with an innovative façade system” 23rd Australasian Conference on the Mechanics of Structures and Materials (ACMSM23), vol. II, Byron Bay, pp. 993-998

[10] S. Shamshad Begum and Dr. G. Vani (2016), “ Seisimic Analysis of a High Rise Unsymmetrical Building with Dampers Using ETABS, IJSRST , Volume 2 , Issue 3 Print ISSN: 2395-6011

[11] James O. Malley (2010) “Evaluating Effects of Viscous Dampers on optimizing Seismic Behavior of Structures”, International Journal of Current Engineering and Technology ISSN 2277 – 4106

[12] P. Jayachandran (2009) “ Design of Tall Buildings Preliminary Design and Optimization”, National Workshop on High-rise and Tall Buildings

[13] Jack P. Moehle (2014), “ Stability Analysis of Rigid Steel Frames With and Without Bracing Systems under the Effect of Seismic and Wind Loads” Vol. 2, Issue 1, pp. 137-142

[14] Femy Mariya Thomas, Binu M. Issac and Jessymol George (2015), “Performance Evaluation Of Tall Buildings With Steel Diagrid System” pp 2242-2256

[15] Paramananda kundu (2012), “Analysis and Design of Multi Storied Building by Using Etabs Software”, Ijsr - International Journal Of Scientific Research, Volume : 4, Issue : 7 , July 2015 , ISSN No 2277 – 8179

[16] Samuele Infanti1, Jamieson Robinson2, Rob Smith (2008), “Viscous Dampers For High-Rise Buildings”, The 14th World Conference on Earthquake Engineering

[17] Yukihiro Tokuda and Kenzo Taga (2008), “A Case Of Structural Design In which Viscous Dampers Are Used To Enhance Earthquake Resisting Performance Of A Building”

[18] Chiara Passoni , rea Belleri Alessandra Marini and Paolo Riva (2014), “Existing Structures Connected With Dampers: State Of The Art And Future Developments”

[19] Masaaki TSUJI, Yasuyuki NAGANO, Makoto OHSAKI and Koji UETANI (2000), “Optimum Design Method For High-Rise Building Frame With Viscous Dampers”

[20] Dayang Wanga, Tim K.T. Tseb, Yun Zhoua & Qingxiang Lic (2014), “Structural Performance and cost analysis of wind induced vibration control scheme for tall buildings”