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Seismic Response Control of a Building Using Metallic Dampers

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Abstract: **Now a day's Dampers are more popular in construction of high-rise buildings as a vibration control device and also for its economical design, safety and easy to installation. This paper presents research work to the behaviors of structure without damper and metallic & friction damper, and how to control seismic response of building. Also there is a Comparison of displacement due to metallic dampers, friction dampers and structure without installation of dampers. This should be analyzing by using NON-Linear analysis software (ETABS 2015).**

Keywords: **response of RCC structure with metallic & friction damper& reduction in displacement.**

I. INTRODUCTION

An earthquake is the perceptible shrinkage and vibration of the surface of the earth, resulting from the sudden release of energy in the earth's crust that creates seismic wave. Vibration produces by the earthquake and seismic waves. All the factors accounted for any building design but seismic waves are the most important part of that design. In conventional method base widening and providing massive structure at bottom techniques are used for avoiding earthquake effect but this is not possible for high rise buildings in modern techniques. In modern techniques dampers are provided for avoiding earthquake effects on building. Damper are the modern instrument which is allows to structure to displace at some distance so that its eliminate the formation of cracking in structure and also reducing in vibrations. Numbers of dampers are used to effective reduction of vibration caused by earthquake.

II. ANALYSIS OF STRUCTURE

A. TECHNIQUES TO RESIST EARTHQUAKE:

The most important advanced techniques of earthquake resistant design and construction are:

1) Base Isolation: Acceleration is decreased because the base isolation system lengthens a building's period of vibration, the time it takes for the building to rock back and forth and then back again. And in general, structures with longer periods of vibration tend to reduce acceleration, while those with shorter periods tend to increase or amplify acceleration

2) Energy Dissipation Devices.

a) Active control system: this system needs external power source for work

b) Passive control system: This system includes movable mass which is set to the spring and it is added to damping components. No need of any external power source.

c) Hybrid / semi-active control system: The term of hybrid control systems is used for a hybrid using of active and passive control systems. Semi-active systems are extracted from active control systems. In this cases, the required output energy is lower than active control system.

B. ***TYPES OF DAMPERS:***

Friction Dampers , Visco-Elastic Dampers ,Metallic Dampers ,Lead Injection Dampers ,Viscous Dampers ,Mass Dampers.

For this research work metallic damper and friction dampers are used. Metallic dampers are distinguishing in following type:

a. X shape metallic dampers (XMD) :-

b. Strip Metallic dampers (SMD):-

c. Round hole metallic dampers (RHMD):-

d. Double X shape Metallic dampers (DXMD):-

As per previous research done by **Gang Li** and **Hong-Nan LI** in **Experimental study and application in steel structure of "Dual Function" Metallic damper** paper they found that **Round Hole Metallic Damper** and **Double X Shape Metallic Damper** is having large initial stiffness, but also is of excellent energy dissipation capability. Therefore, for reduction of displacement in a structure **"Double X Shape Metallic Damper"** is selected for research work.

- **Properties of double x shape metallic damper:**

Thickness of steel plate :- 50 mm

Elastic lateral stiffness :- 102.5kN/mm

Yielding strength :- 410 kN

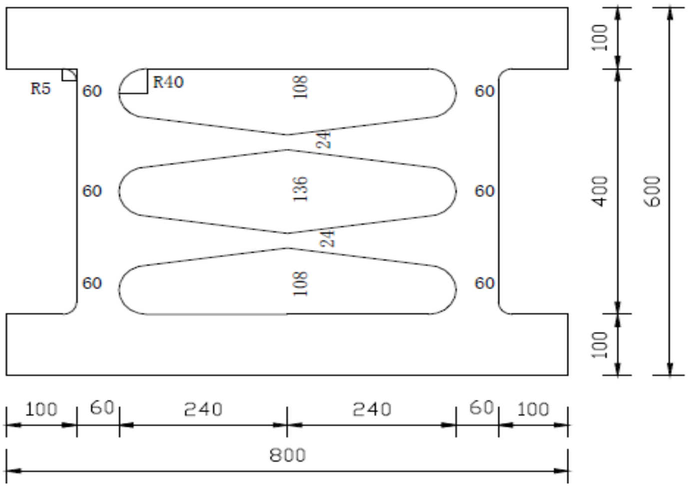

fig. 1 Details of Double x shape metallic damper

C. Plan view of structure:

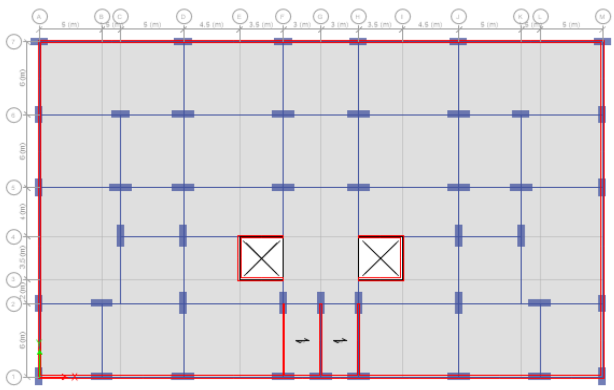

fig 2 :Parking (G+ 3)

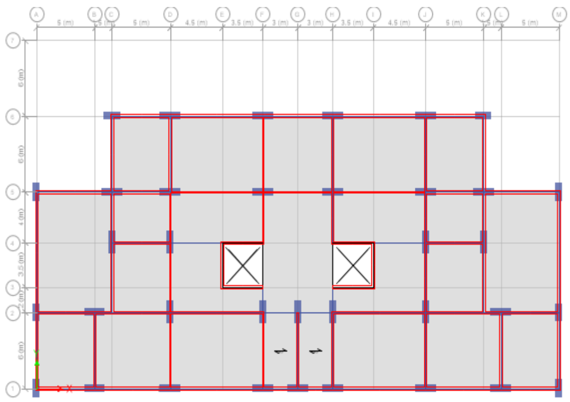

Fig 3: 6 to 10

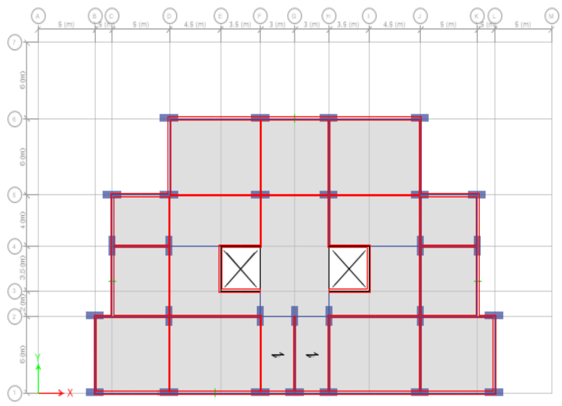

Fig 4 : 11 to 51

D. Seismic response of a structure without damper.

- Time period :3.625 sec
- Base shear :8508.15 KN (in X direction)
- Max Story Displacement of Structure due to :-

Wind x in x direction: 110.16 mm

Wind y in y direction: 353.94 mm

EQ x in X direction: 113.45 mm

EQ y in direction: 158.21 mm

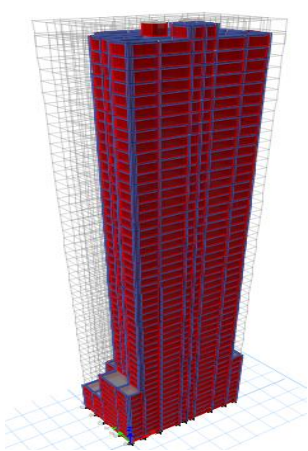

Fig.5 3D structural view

E. LOCATION OF DAMPERS:

After the analysis of structure maximum deflection is found on top stories. For reduction in displacement firstly dampers are placed at a bottom stories (11to 25). But that is not effective because of width of structure is more at a bottom so reduction in displacement is less, similarly dampers are provided at middle stories (25to35) but there is a case of failure due to high wind speed and terrain class C. if dampers are placed at middle stories then after 35 stories there is a sudden increase in wind speed and cause a problem of failure of column so at last after the changing various location found that dampers are placed at top stories gives maximum reduction and also no case of failure.

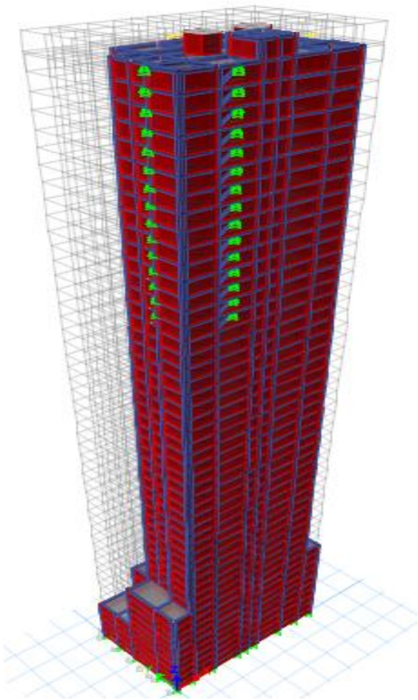

Fig 6. Location of dampers

Total height of structure is 186.6 m And floor to floor height is 3.6m**.** After the analysis of structure, maximum displacement found at the top of storey's therefore metallic dampers are installed at 36 to 51 storey's to reduced the displacement of a structure.

*(Note- In fig 6 green marking is the actual location of dampers which is provided all 4 facieses of building)

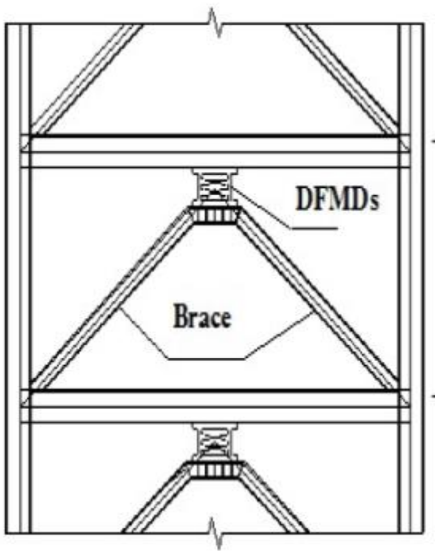

Fig. 7 Installation of metallic damper in structure

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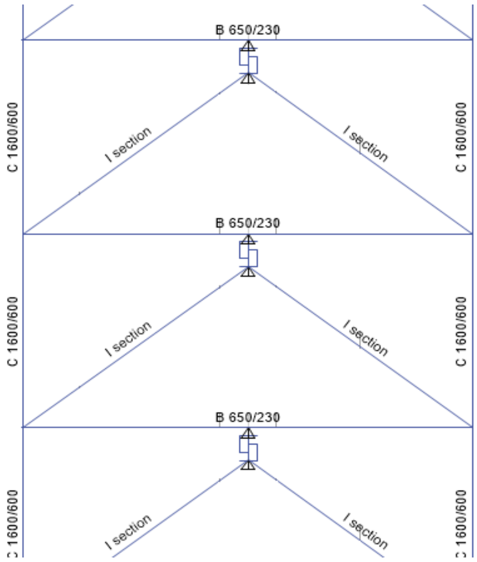


Fig. 8 Installation of metallic damper in software

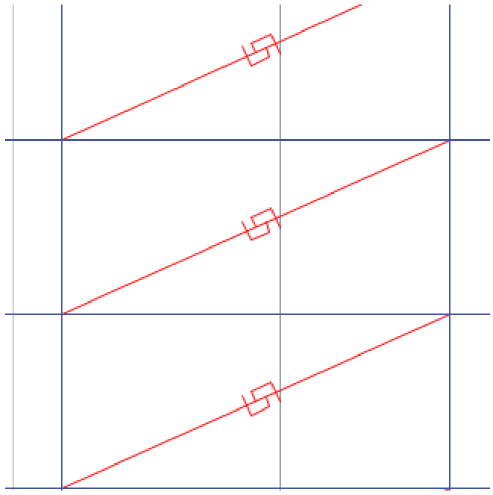
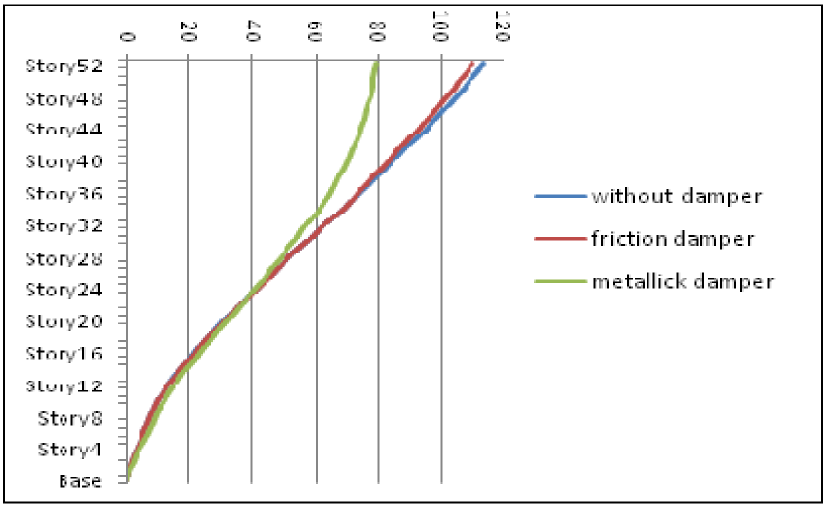


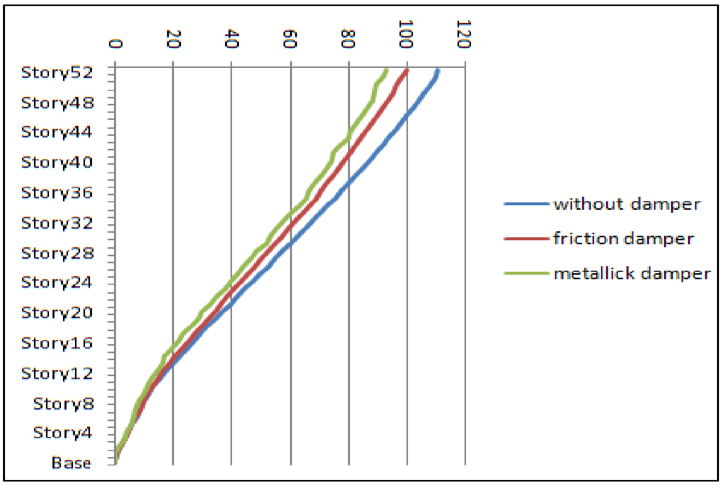
Fig. 9 Installation of friction damper in software

III. RESULTS

Story displacement at 37 to 51 floors due to earthquake and wind from x direction



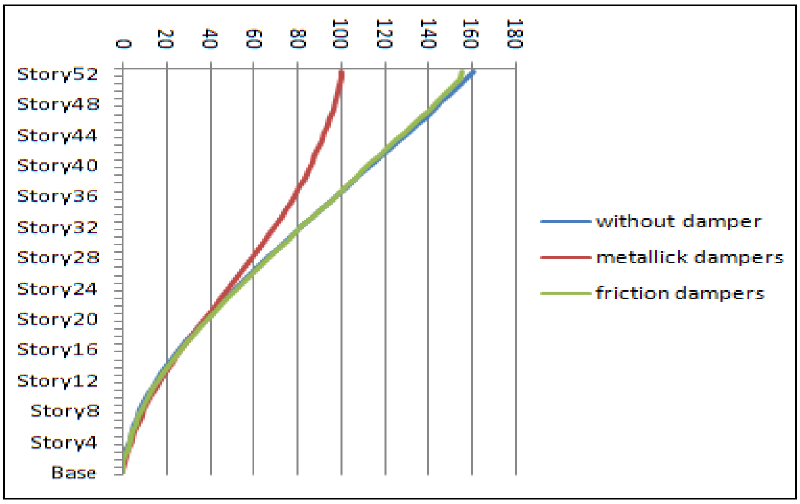
Graph1. Earthquake force in X direction



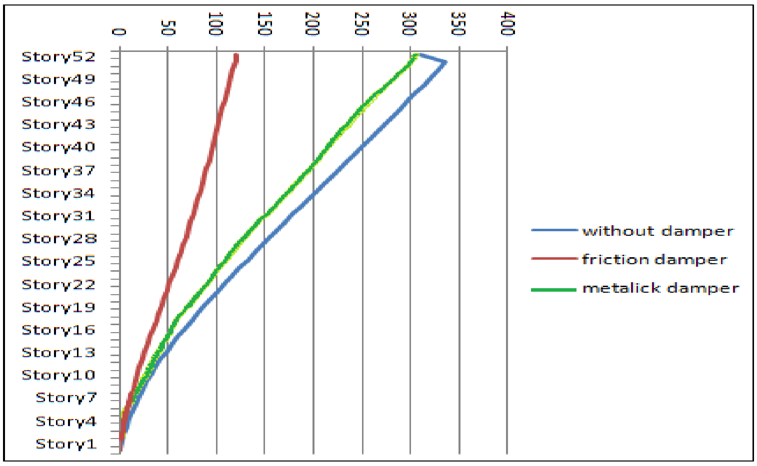
Graph2. Wind force in X direction

Table 1. Story displacement at 37 to 51 floors due to earthquake and wind from y direction

	Without damper	*Metallic damper*	*Friction damper*
EQX	*113.45mm*	*79.16mm*	*109.14mm*
Wind x	*110.16mm*	*93.99mm*	*100.18mm*



Graph 3. . Earthquake force in Y direction



Graph 4. Wind force in X direction

Table 2 This are the results and % of reduction as per the maximum displacement at top stories

	Without damper	Metallic damper	Friction damper
EQY	158.21mm	100.31mm	155.50mm
Wind y	335.94mm	310.02mm	120.13mm

Table 3

	DISPLACEMENT DUE TO WITHOUT DAMPER	DISPLACEMENT DUE TO METALLIC DAMPER	DISPLACEMENT DUE TO FRICTION DAMPER	% OF REDUCTION DUE TO METALLIC DAMPER	% OF REDECTION DUE TO FRICTION DAMPER
EQX	113.45 mm	79.16 mm	109.14 mm	29.01	3.79
EQY	158.21 mm	100.31 mm	155.50 mm	36.59	1.71
WIND X	110.16 mm	93.99 mm	100.18 mm	14.68	9.06
WIND Y	335.94 mm	310.02 mm	120.13 mm	7.11	64.24

IV. CONCLUSION

- Metallic Dampers provided at top stories (36 to 51) having laser reduction in displacement while wind force consider in X direction and Y direction.
- Top stories metallic dampers are more effective for reduction in displacement when Earthquake force consider in X direction and Y direction.
- After comparison study done between metallic dampers and friction dampers, Observed that metallic dampers are much effective than friction damper when earthquake forces comes in X and Y direction amd also for wind force from x direction.
- Friction damper are more effective for wind force which is comes from y direction. after the analysis found that friction dampers reduce maximum displacement in y direction as compare to metallic damper.
- For a studied structure, metallic damper is the most suitable type of structure for a balance reduction in a displacement.

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