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Seismic Response Reduction of Multistoried Building using Dampers

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Abstract: Earthquakes are the most devastating natural hazards in terms life and property loss of any region. The response of the structure during earthquake greatly depends on the discontinuity in mass, stiffness and geometry of the structure. Mass irregularity is considered to exist where the seismic weight of any storey is more than 200 percent of that of its adjacent storey. This is introduced by increasing the weight of some floors relative to the other floors. The effect of irregularity depends on the structural model used, location of irregularity and analysis method Structural control is the one of the areas of current research aims to reduce structural vibrations during loading such as earthquakes and strong winds. In seismic structures upgrading, one of the lateral force reduction caused by the earthquake is use of dampers. Dampers are the energy dissipation devices which will reduce the vibrations and helps to reduce the buckling. In the present study a six storied RCC regular and mass irregular building were modelled. Modelling is done by using response spectrum analysis in ETABS 2016.By identifying the mass irregular building to be more prone to earthquake the building is provided with three different dampers(fluid viscous ,friction and visco elastic damper) at two different location(at corners on all stories, along all bays on all stories) .Then storey displacement ,base shear and time period values for the six models are compared to find out out the best damper.
Keywords: Dampers, storey displacement, storeyshear, Time period, mass irregular building

I. INTRODUCTION

Earthquakes are the most devastating natural hazards in terms of life and property loss of any region. The response of the structure during earthquake greatly depends on the discontinuity stiffness and geometry of the structure. Vertical irregularities are one of the major reasons for failure of structures during earthquake. Mass irregularity is considered to exist where the seismic weight of any storey is more than 200 percent of that of its adjacent storey. Mass irregularity is an important factor which affects the response of the structure under seismic loads. This is introduced by increasing the weight of some floors relative to the other floors. The effect of irregularity depends on the structural model used, location of irregularity and analysis method. In this thesis, analysis will be carried out by ETABS software. In seismic structures upgrading, one of the lateral force reduction caused by the earthquake is use of dampers. During an earthquake, high energy is applied to the structure. This energy is applied in two types of kinetic and potential (strain) to structure and it is absorbed or amortized. Damping increasing is possible by using various methods such as the flow of a soft metal, two metal friction on each other and a piston motion within a slimy substance or viscoelastic behavior in materials such rubber-like substances.

A. Energy Dissipation Using Dampers

It is a mechanical system which dissipate earthquake energy into specialized devices which deforms or yield during earthquakes Dampers are used to resist lateral forces coming on the structure. Dampers are the energy dissipating devices which also resist displacement of RC building during earthquake. These dampers help the structure to reduce the buckling of columns and beams.

1) *Fluid Viscousdamper*: Viscous dampers are hydraulic devices that dissipate the kinetic energy of seismic events and cushion the impact between structures. They are versatile and can be designed to allow free movement as well as controlled damping of a structure to protect from wind load, thermal motion or seismicevents.

2) *Visco Elastic Damper*: Another type of damper is visco-elastic dampers which stretch an elastomer in combination with metalparts.
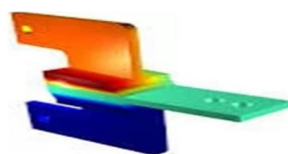

Fig 1.1 Visco elastic damper

3) *Friction Damper:* Friction dampers use metal or other surfaces in friction; and energy is absorbed by surfaces with fiction between them rubbing against each other.

Fig.2: Friction damper

II.   NEED FOR THE STUDY

Structures which are subjected to lateral loads must have adequate stiffness and strength which helps to controlling the deflection and prevent any damage which may occur. Studies have proved that mass irregular buildings are more prone to storey displacement and storey drift as compared to a regular building. So damping is found to be efficient in dissipating the earthquake energy

III.SCOPE AND OBJECTIVES.

The scope of the present study is to perform linear dynamic response spectrum analysis of a regular building and mass irregular building with and without damper at different location using ETABS.

The objectives are:
1) To conduct response spectrum analysis of a regular building and mass irregular building and analyzing their seismic response.
2) To conduct response spectrum analysis of regular and irregular building using dampers at different location.
3) Comparison to find out the best damper.

IV.   METHODOLOGY

An eight storied RCC regular and mass irregular building which located in seismic zone V is considered for the analysis. The 2 types of frame used for the analysis are:

A. Regular building
B. Mass irregular building
1) Mass irregular building without damper
2) Mass irregular building with friction damper
a) Friction damper on all bays along all stories
b) Friction damper in all bays in all stories
3) Mass irregular building with fluid viscous damper
a) Fluid viscous damper at corners
b) Fluid viscous damper in all bays along all stories
4) Mass irregular building with viscoelastic damper
a) Visco elastic damper in all bays on all stories
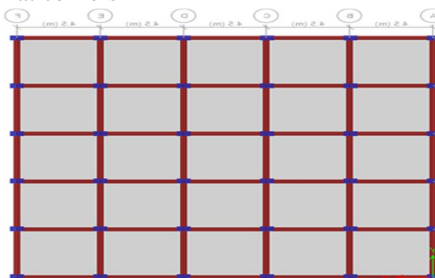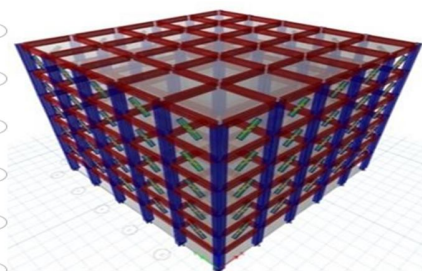b) Visco elastic damper at corners

Fig .3: Building plan

Fig. 4: Fvd on all bays on all stories

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1) Material properties

a) Concrete

Weight per unit volume	=	25kN/m^3
Poisson ratio	=	0.2
Modulus of elasticity (M25)	=	25000.68Mpa
Modulus of elasticity (M30)	=	27386.13MPa

b) Steel

Weight per unit volume	=	77kN/m3
Poisson ratio	=	0.3
Modulus of elasticity	=	200GPa

Table 1 Building Description

Type	SMRF
Number of storey	6
Zone	v
Importance factor	1.5
Response reduction factor	5
Storey height	3.5m
Size of column	450 x 750mm
Size of beam	300 x 600mm
Grade of concrete	M30 andM25
Grade of steel	Fe 415
Live load on floor	3 KN/m2
Live load on roof	1.5 KN/m2
Live load due to swimming pool	32 KN/m2

Table 2 Damper Properties

Type of damper	Weight (KN)	Mass (Kg)	Effective stiffness (Knm)	Effective damping (KNs/ m)
Fluid viscous	0.173	1700	20,000	10,000
Friction	0.225	2200	20,000	4000
Visco elastic	0.203	2000	30,000	10,000

V. RESULT AND DISCUSSION

The response spectrum analysis was performed on mass irregular building with fluid viscous, friction and visco elastic damper at corners and on all bays and stories. After the analysis, maximum storey displacement, maximum storey drift and time period for different frames are obtained.

A. Maximum Storey Displacement

A plot which showing the maximum displacement at each of the storey is obtained after response spectrum analysis.
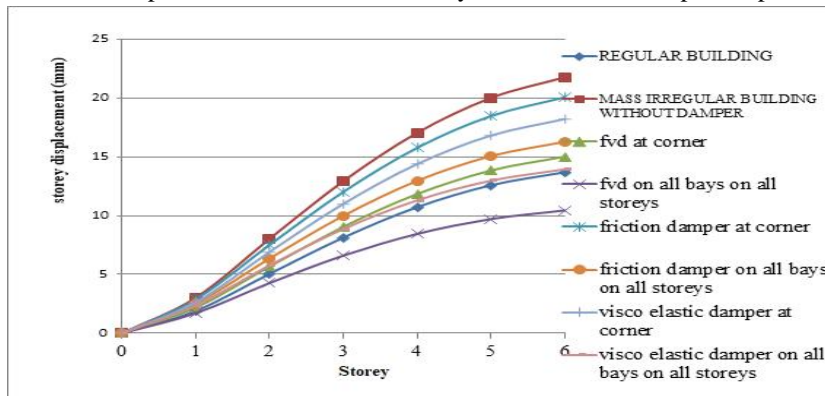

Fig. 5: Comparison of storey displacement values for different models

Figure 5 shows maximum storey displacement for different models obtained after response spectrum analysis. From the above figure it is clear that displacement is more in the case of mass irregular building with another frame without damper. Also, it has been observed that as floor height increases, lateral displacement increases. By the provision of damper that of building mass irregular building frame educes the storey displacement as without damper. By the increase of mode period, it will increase compared to that without damper. from fig 7, it is found that the mass irregular building provided with fluid viscous damper shows large increase in the time period as compared to that of mass irregular building with types of dampers. So it is found that the use of damper can increase the time period of the structure as compared to that without damper.

B. Base Shear

A plot which showing the base shear for the storey is obtained after response spectrum analysis. From Fig.6, it can be observed that by comparing eight models after response spectrum analysis, mass irregular with fluid viscous damper have least base shear as compared to that of other models. Here the damper tries to reduce base shear more than in the case of building without damper.
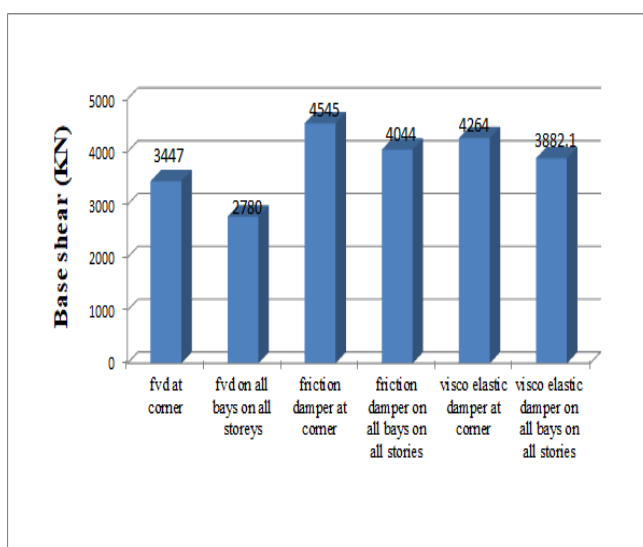

Fig 6: Comparison of base shear values for different models

C. Time period

A plot which showing the time period for the storey is obtained after response spectrum analysis.
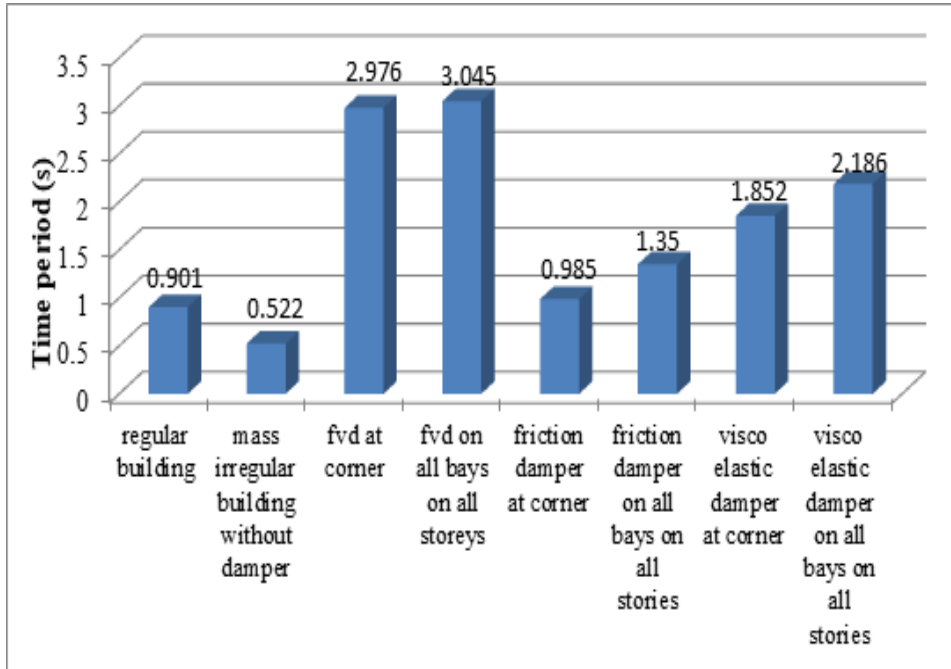

Fig 7: Comparison of time period values for different models

From fig 7, it is found that the mass irregular building provided obtained after response spectrum analysis. From the above figure it is with fluid viscous damper shows large increase in the time clear that displacement is more in the case of mass irregular building period as compared to that of mass irregular building with another frame without damper. Also, it has been observed that as floor height types of dampers. So, it is found that the use of damper can increase increases, lateral displacement increases. By the provision of damper, the time period of the structure as compared to that of building

VI. CONCLUSIONS

The linear dynamic response spectrum analysis of RCC frames with and without damper for finding out various parameters such as storey displacement, base shear, storey shear and time period. Eight types of structures are considered for analysis. They are regular frame without damper , mass irregular building without damper, mass irregular building with fvd at corner and on all bays on all stories ,mass irregular building with friction damper on corners and on all bays on all stories ,mass irregular building with visco elastic damper at corner and on all bays on all stories . The following conclusions can be made:

A. While comparing the storey displacement it is found that for mass irregular building shows about 37 % more displacement as compared to regular building frame.by using fvd at corner it helps to reduce about 31% of lateral displacement and fvd on all bays on all stories shows about 52% of reduction in storey displacement value. FVD shows much better performance than building frames with another damper

B. While comparing base shear, it is found that mass irregular building shows about 52% more base shear than regular building this is mainly because of mass irregularity provided at the 2nd and 4th floor of building.by using fvd at corner it helps to reduce about 43% base shear and by providing fvd on all bays on all stories, displacement reduced by 54%.

C. While comparing time period mass irregular building frame shows lesser time period.so the number of oscillations will be more in that case.by providing fvd on all bays on all storeys it increases time period by 70% and helps to reduce more energy in the form of heat.

VII. ACKNOWLEDGMENT

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