ANALYSIS AND COMPARISION OF HIGH RISE BUILDING WITH DIFFERENT GEOMETRICAL SHAPE USING VISCO ELASTIC DAMPERS

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Abstract: **One of the nature's catastrophic events is earthquake. And it effect is certain areas. With the occurrence of earthquake, it tends to huge loss and damage to the buildings, people and sometimes results in human deaths. So in order to avoid such losses, we must work on the stability of the structure. In this work, with the help of computational tool SAP 2000, dynamic analysis on the structure is analyzed and examined on a multi storey building. In the superstructure buildings, seismic analysis and response spectrum analysis were performed. Three architectural planes were chosen for the investigation. On seismic analysis and spectrum analysis where compared for individual storey displacement, storey drift, storey stiffness and base shear. The analysis is performed using two standard seismic codes which are IS456 and IS1893-2002. The stiffness of the structure and reduction of base shear is the main aim of this work. Building planes such as L, square and C shapes building planes are used for this project. To shun cracks and diagonal moments occurring due to seismic tremors, structure dampers are introduced and it has huge demand in recent days for this advantage. In three different types of building, with and without visco-elastic damper are chosen and considered for this work.**

Keywords: SAP2000, Seismic Analysis, Spectrum Analysis, L shapes, C shapes.

1. INTRODUCTION

Over the centuries, Earthquakes have been Responsible for Millions of Deaths and an incalculable amount of damage to property. Depending on their intensity, Earthquakes can topple Buildings and Bridges, Rupture Gas pipe Lines and Other Infrastructure. These Phenomena are primarily responsible for deaths and injuries.

An Earthquake is the sudden movement of the Earth's tectonic plates, causes shaking of the ground. Due to sudden shaking of ground damage various structures such as buildings and further breakdown of the Earth's surface.

Conventionally constructed building follows an old logic the stronger and stiffer the building the more structural it has but past example prove that the common reinforced concrete or RC Buildings fall apart during strong earthquake shaking. Structural Designs are to reduce Vibrations caused by external factors for example wind, Tsunami, and Earthquakes. It is one of the main concerns for engineers. The seismic movements often give undue energy to the structures and therefore change in response to sudden lesions. The current structural practices allow the structures of these outer huge energies to absorb without disintegrate. This is obtained by providing regular periodic deformations in areas with specific structural details. This strategy works but can lead to irreplaceable structures. Given the nature of the dynamics of environmental factors, new technologies have emerged for the preservation of structures. Research in recent years has focused on reducing the response of structures to external forces using special safety systems. These methods not only reduce damage but increase the integrity of the body. These safety systems work according to the following ideologies: Seismic motion transfers potential and kinetic energy to a structure, causing it to vibrate. Part of this energy is also absorbed by the damping properties inherent in the structure. The protection system prevents energy from entering the structure and increases the energy dissipation capacity. The basic isolation system is designed to prevent energy from entering the filter structure. On the other hand, the energy dissipation system absorbs energy and reaches the structure of a special device called Dampers.

1.1 Dampers:-

Dampers are the device which is used to resist lateral forces coming on the structure. Damping plays an important role in design of earthquake resistant structure which reduces the response of the structure when they are subjected to lateral loads.

1.1.1 Types of Seismic Dampers:

1) Viscous Dampers 2) Friction Dampers 3) Tuned mass Dampers 4) Visco-Elastic Damper

1.2 Visco-Elastic Damper:

There are two types of Visco – Elastic elastomer: a) Solid Visco – Elastic device and (b) Fluid Visco – Elastic elastomer. Solid Visco - Elastic impact consists of a layer of polymeric material that can degrade performance if cut between two or more steel plates. When incorporated into the structure, the vibration of the structure causes proportional movement between the plates, which deforms the cut shape of the Visco - Elastic material and energy is dissipated. To simplify the analysis, the Kelvin model can be used to model the strength and stress properties of theseVisco – Elastic devices. On the other hand, fluidVisco – Elasticdevices operate on the concept of resistance to the flow of viscous fluid through the communication port. Some fluid damper liquids distort the high-viscosity fluid in the shear, dispersing energy and providing stiffness. However, this research focuses only on the fluid orifice dampers. Energy loss is caused by the conversion of mechanical energy into thermal energy when the piston pushes a viscous liquid into the enclosed space. The force-deformation properties of these devices can be designed to act as a linear viscous damper in which the force is proportional only to the deformation rate. This is the standard form of viscous damper widely used in analytical research. These dampers produce deformation and deformation- reliant forces which produce out-of-phase damping forces. Therefore, it does not contribute to the maximum force generated by the structural element. This is very effective in reducing anomalies. However, some liquid orifice dampers provide system resistance and stiffness at high frequencies and may not be designed correctly in traditional speed dependent designs. Various mathematical models have been proposed to determine the behavior in the analysis.

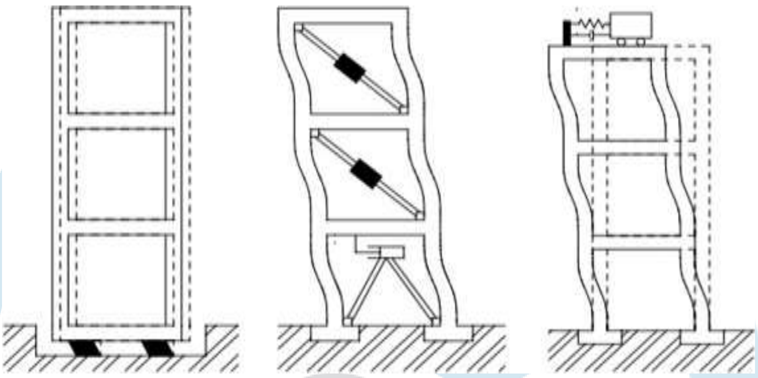

Figure 1.1 Passive response control systems,
(a) Seismic Isolation, (b) Energy Dissipation Devices,(c) Dynamic Vibration Absorbers.

1.3 RESPONSE SPECTRUM

Response Spectrum, peak graph, or static response (Displacement, Velocity, or Acceleration) is a set of Oscillators with various Natural Frequencies moving at the same fundamental or Impulse Frequency. You can use the resulting system to select the response of each linear system to the natural frequency of the oscillations. One such use is to assess the maximum response of a building to an Earthquake. A solid understanding of soil Kinematics can be conveyed to seismic damage using ground response spectral values (calculated from seismograph movement records).
If the input used to calculate the response spectrum is a cyclic steady state, the steady state outputs where noted. There should be damping in this situation. If it does not exist, the reaction is unlimited. Peak response is provided to a temporary input (e.g. ground movement). It is generally thought that there is some damping, but that value can be obtained without damping.
Response spectra can also be used to evaluate the response of linear systems with multiple oscillation modes (multi-degree-of-freedom systems), although they are only accurate for low damping levels. Modal analysis is performed to identify the pattern, and the response in that pattern can be selected from the response spectrum. These peak responses are then combined to estimate the total response. A typical combination method is the square root of the sum of squares (SRSS) when the modal frequencies are not near to the value. The result is usually different from the result calculated directly from the input because the phase information is lost in the process of generating the response spectrum.
The main disadvantage of the response spectrum is that it can only be used globally in linear systems. Response spectra can be produced for nonlinear systems, but only nonlinear systems, but attempts have been made to develop non-stratified seismic design spectra using a wide range of structural applications. Results cannot be directly linked to multi-step responses.
The response spectra of seismic engineering equipment are very useful for analyzing the performance of structures and equipment during an earthquake. Many of them essentially act as simple oscillators (also known as single degree of freedom system). So, if you know the natural frequency of the structure, you can estimate the peak response of the building by reading the appropriate frequency response spectrum value. In most building codes in seismic areas, this value becomes the basis for calculating the force a structure must withstand (Seismic Analysis).
As already said, that the ground response spectrum of the feedback diagram generated at ground. Severe seismic damage can occur if the building's response is "tuned" to a component of seismic motion (resonance) that can be determined from the response spectrum. This was observed during the Mexico City earthquake in 1985. In this earthquake, the deep-sea tidal earthquake resembled the natural frequency of a middle-rise concrete building, causing enormous damage. Short (hard) and tall (flexible) buildings take less damage.

1.4 AIM AND OBJECTIVE

In this work, the main aim is to produce fundamental research data on the quake performance of building structure which has passive damping devices

1.5 OBJECTIVES OF THE STUDY

- Study damping system for the building structure and create computer models
- Parameters such as damper configuration, damper properties and quake type's effects are studied.
- Use the reviewed articles to present to reduce the earthquake effects my improving the damping system.
- Software such as FEM is used for simulation, of the building to analyze five types of seismic effects
- The damping mechanism is designed with a combination of damping consisting of a linear spring and a dash pot placed in parallel with the VE damper, a couple of friction parameter contacts of friction resistance and VY
- Size and material properties of the building, damping properties, setup area, dampers position and types, were boundaries in this examination and the impact of these was considered.

2 LITERATURE REVIEW

Alireza Heysami (2014) investigates forms of dampers and their effects when there is an earthquake. And also investigated the tall structures present and damper performance has been analyzed. In the work, the results show that along with dampers, lateral forces have seismic behavior like wind and earthquake forces. In seismic structures enhancement, the reduction in lateral force reduction by the earthquake is because of dampers. During tremors the structure is subjected to high energy. Two types of energy such as potential and kinetic energy is applied to the tall building and the energy will be absorbed or released. If the structure doesn't have damping, there will be spontaneous vibration but because of the material damping present the vibrations are pretty much reduced. The increasing of damping will reduce the structural response (acceleration and displacement) damping effect at minimum frequency and it doesn't have effect on spectrum amount. In high frequency, response acceleration has low effect. Dampers are categorized based on their performance of friction, metal (flowing), viscous, Visco - Elastic; shape memory alloys (SMA) and mass dampers. Among the benefits of using dampers we will infer to high absorption of energy, easy to add and replace them also as arranged to other structure members.

Raheel Kazi., *et.al* (2014) the relative analysis on the seismic execution of building underlying framework having passive damping tool called Visco - Elastic damper. Dynamic conduct of the structure for wind and seismic tremor loads as for response spectrum investigation is done. Changes in the response of displacement, speed, accelerator, and drift for the damped structure are shown delineating the effectiveness of dampers. The model was examined utilizing E-TABS 2013 and result did for the separate directions of wind and quake force against displacement, float, speed, and velocity. At the point when mix of different loads was thought of. Before the examination of this model a 20 storey building was considered. The outcomes show that the displacement and acceleration were around 15% and19%. So, the effectiveness of dampers increases with respect to elevation.

Durgesh C. Rai (2000) this work manages future patterns in seismic tremor safe designs of the structures. It is genuinely very much acknowledged that tremors will proceed to happen and cause fiascos on the off chance that we are not ready. Surveying seismic tremor hazard and improving designing methodologies to alleviate harms are the solitary alternatives for us. Geologists, seismologists and civil engineers are proceeding with their endeavors to meet the necessities of improved zoning maps, valid data sets of tremor measures and their effects; better comprehension of site attributes and advancement of quake safe plan (EQRD).

Vajreshwari Umachagi., *et.al.* (2013) presents an outline on uses of dampers for vibration control of constructions. This work incorporates various sorts of dampers like metallic dampers, Visco - Elastic dampers, and frictional dampers and so on. It reasons that utilization of seismic control frameworks has expanded however picking best damper and introducing it into a structure is vital for reducing vibration in structures when exposed to seismic loads. The controlling devices reduce damage fundamentally by expanding the safety for the structure, functionality and keep the structure from collapse during the tremor. Subsequently, many researches are being completed to locate the best solution. This paper suggests giving an outline of various sorts of seismic reaction control device, and features a portion of the new improvement. The analytical and experimental analysis did by different scientists to exhibit that the seismic control strategy has the potential for improving the seismic execution of structure.

Gang Li and Hong-Nan Li (2013) different sort of metallic damper is introduced in this investigation. It is supposed as "double function" metallic damper, since it has two qualities of high initial stiffness and better energy dissipating ability. Its initial stiffness is expanded through making it bearing outside in-plane force, and its energy-scattering ability is improved through making it various shapes. Semi static tests with scale and full-scale models of the metallic Dampers examples planned with above thought are completed, separately. Two remarkable metallic dampers named circular opening metallic damper (RHMD) and twofold X-formed metallic damper (DXMD) were chosen and the DXMD was applied in a genuine steel construction to improve beginning solidness of unique design under typical use or recurrence seismic tremor and to disperse contributing energy during extraordinary quakes.

3 DESIGN PARAMETERS OF MULTI STOREY BUILDING

In this present work seismic analysis and response spectrum analysis is performed for different shape of multi storey building. Here to improve the resistance of earth quake displacement, three types of building shapes are considered.

Table 3.1 Specifications of the Building

Description	Square Shape	C Shape	L Shape
Beam Size	0.4m × 0.25m	0.4m × 0.25m	0.4m × 0.25m
Column Size	0.4m × 0.4m	0.4m × 0.4m	0.4m × 0.4m
Slab Thickness	0.15m	0.15m	0.15m
Super Dead Load	1.5 kN/m^2	1.5 kN/m^2	1.5 kN /m^2
Live Load	3 kN /m^2	3 kN /m^2	3 kN /m^2
Roof Load	2 kN /m^2	2 kN /m^2	2 kN /m^2
Floor Area	1296 m^2	1080 m^2	720 m^2

4 MODELING ANALYSIS OF BUILDING

Modeling and analysis work has done in SAP 2000 software. Here version 19.0 is used. Initially Square Shape Building is prepared using grid concept in Software. According to Plan of Structure Building is created. After completed the plan replicate option is used to transfer the plan to all storey.

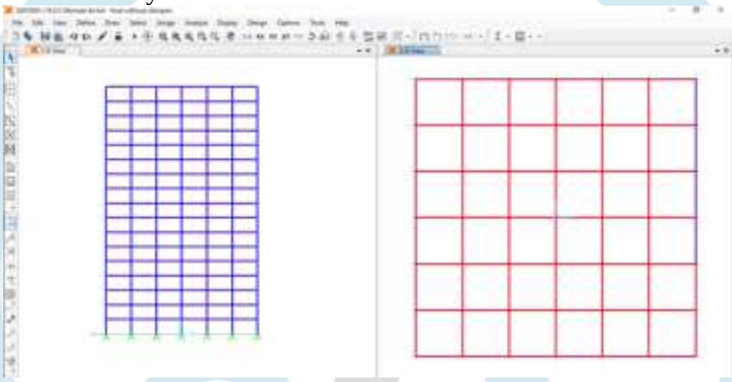

Fig 4.1: square shape building plan and elevation.

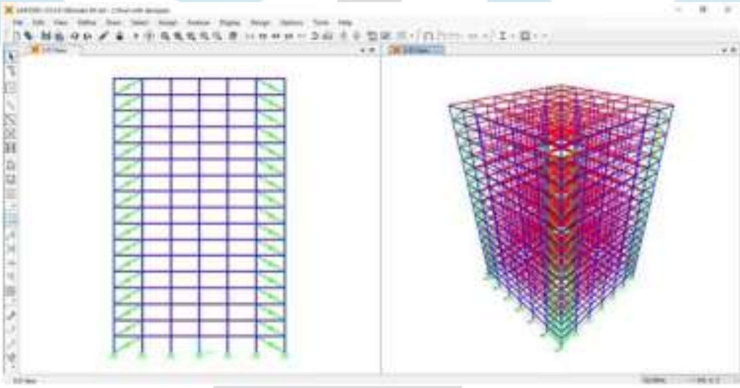

Figure 4.2: 3D View of structure

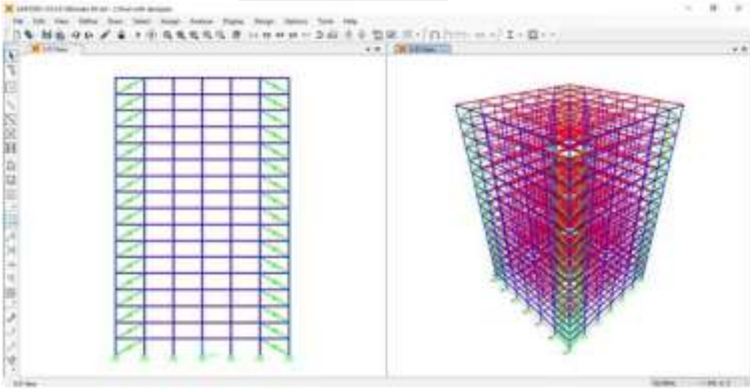

Figure 4.3: 3D view of Damped structure

5 RESULTS AND DISCUSSION

Table 5.1 Square Building with Dampers

STOREY	HEIGHT	DISPLACEMENT		DRIFT		MOMENT	
		EQ	RES	EQ	RES	EQ	RES
0	3.5	0.0151	0.0127	0.002142857	0.001742857	0.00152	0.00126
1	3.5	0.0226	0.0188	0.001885714	0.001514286	0.00105	0.00084
2	3.5	0.0292	0.0241	0.001885714	0.001428571	0.00107	0.00083
3	3.5	0.0358	0.0291	0.001885714	0.0014	0.00108	0.00082
4	3.5	0.0424	0.034	0.001857143	0.001314286	0.00109	0.0008
5	3.5	0.0489	0.0386	0.0018	0.0012	0.0011	0.00078
6	3.5	0.0552	0.0428	0.0018	0.001228571	0.00109	0.00075
7	3.5	0.0615	0.0471	0.001714286	0.001085714	0.00107	0.00071
8	3.5	0.0675	0.0509	0.001628571	0.001	0.00104	0.00067
9	3.5	0.0732	0.0544	0.001514286	0.000914286	0.00099	0.00063
10	3.5	0.0785	0.0576	0.0014	0.0008	0.00093	0.00058
11	3.5	0.0834	0.0604	0.001257143	0.000685714	0.00086	0.00053
12	3.5	0.0878	0.0628	0.001028571	0.000542857	0.00077	0.00047
13	3.5	0.0914	0.0647	0.000857143	0.000457143	0.00067	0.0004
14	3.5	0.0944	0.0663	0.0006	0.000314286	0.00055	0.00033
15	3.5	0.0965	0.0674	0.000342857	0.0002	0.0004	0.00025
16	3.5	0.0977	0.0681	0	0	0.00034	0.00021

5.1 DISPLACEMENT

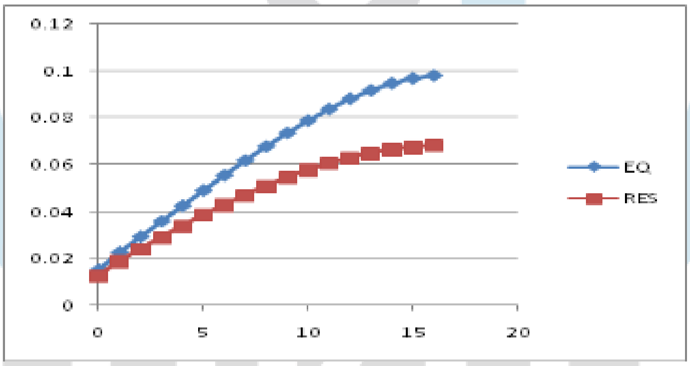

Figure 5.1 Square shapes Building with Dampers Displacement

The square building with dampers displacement has minimum earthquake value is 0.015 and the maximum value is 0.1 and for response the minimum value 0.012 and maximum value 0.068.

5.2 DRIFT

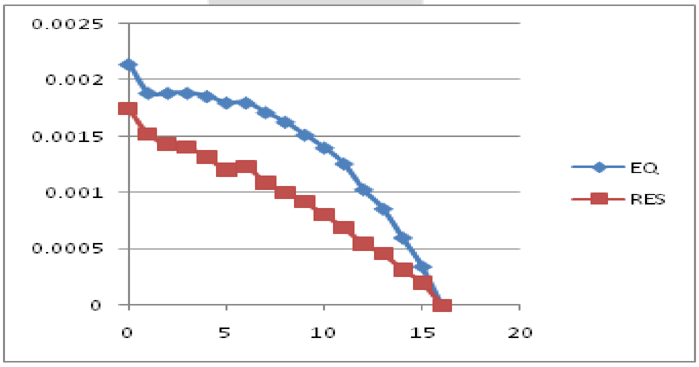

Figure 5.2 Square shapes Building with Dampers Drift

The square building with dampers drift has minimum earthquake value is 0 and the maximum value is 0.0021 and for response the minimum value is 0 and maximum value is 0.0017.

5.3 MOMENT

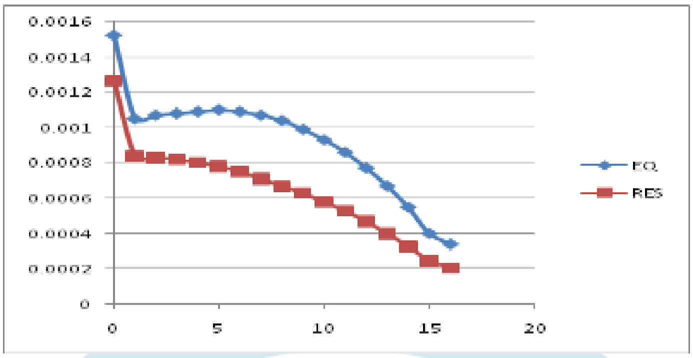

Figure 5.3 Square shapes Building with Dampers Moment

The square building with dampers moment has minimum earthquake value is 0.00034 and the maximum value is 0.0015 and for response the minimum value 0.00021 and maximum value 0.00126.

6 CONCLUSION

- Multi-storey buildings are booming in construction industries and people prefer to stay in multi storey buildings in recent years. The multi-storey building uses small space with lot of floors. Architects have used different plans to develop a structure and also they design in esthetic way.
- For this work, regular multi storey building shapes are chosen. The commonly used building shapes are L, C and square shapes in very common shapes.
- With the help of earthquake codes, analysis is done on different load level presented on the structure. Tremors are unavoidable calamity and it mostly results in building collapse. Parameters such stiffness of the structure, storey drift, deformation and bending moment are considered for this work.
- With the help of response spectrum analysis and seismic analysis, these parameters are analyzed.
- Using seismic analysis, stiffness parameter of the structure is very much reduced. Where as in response spectrum analysis; drift, deformation and bending moment are reduced. And at the structure’s base there won’t be any changes whereas at the building top, these parameters will drastically reduce.
- With the help of Visco - Elastic damper, buildings such as hospitals, malls, theatres etc are constructed to avoid the damages happened due to tremors.
- The Visco - Elastic dampers are places at every corner of the building and it is found that the raisin reduction up to 15% in deflection, movement and the drift. Ultimately from this work, we conclude that with the help of Visco - Elastic dampers, the structures can be protected from seismic tremors.

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