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Seisimic Analysis Of A High Rise Building With Viscous Dampers Using Etabs

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ABSTRACT

For a decade, many strong earthquakes have occurred one after another in many countries. These earthquakes have caused severe damages to large-scale infrastructures. To protect structures from significant damage and response reduction of structures under such severe earthquakes has become an important topic in structural engineering. Conventionally, structures are designed to resist dynamic forces through a combination of strength, deformability and energy absorption. These structures may deform well beyond the elastic limit, for example, in a severe earthquake. It indicates that structures designed with these methods are sometimes vulnerable to strong earthquake motions. In order to avoid such critical damages, structural engineers are working to figure out different types of structural systems that are robust and can withstand strong motions.

Alternatively, some types of structural protective systems may be implemented to mitigate the damaging effects of these dynamic forces. These systems work by absorbing or reflecting a portion of the input energy that would otherwise be transmitted to the structure itself.

In such a scenario, structural control techniques are believed to be one of the promising technologies for earthquake resistance design. The concept of structural control is to absorb vibration energy of the structure by introducing supplemental devices.

Various types of structural control theories and devices have been recently developed and introduced to large-scale civil engineering structures. Viscous dampers (VD), when used in high-rise buildings in seismic areas, should reduce the vibrations induced by both strong winds and earthquakes.

In the present study, a residential building with 20 floors is analyzed with columns; columns with viscous dampers at different locations were for all the 2 cases. The building is analyzed in Zone 3 & Zone 5 with three soils in both static & Dynamic Analysis using software ETABS2013. Moments, Shear, Displacement was compared for all the cases. It is observed that the deflection was reduced by providing the viscous dampers.

INTRODUCTION

1.1 Background

Natural disasters are inevitable and it is not possible to get full control over them. The history of human civilization reveals that man has been combating with natural disasters from its origin but natural disasters like floods, cyclones, earthquakes, volcanic eruptions have various times not only disturbed the normal life pattern but also caused huge losses to life and property and interrupted the process of development. With the technological advancement man tried to combat with these natural disasters through various ways like developing early warning systems for disasters, adopting new prevention measures, proper relief and rescue measures. But unfortunately it is not true for all natural disasters. Earthquakes are one of such disaster that is related with ongoing tectonic process; it suddenly comes for seconds and causes great loss of life and property. So earthquake disaster prevention and reduction strategy is a global concern today. Hazard maps indicating seismic zones in seismic code are revised from time to time which leads to additional base shear demand on existing buildings. Retrofitting reduces the vulnerability of damage of an existing structure during future earthquakes. It aims to strengthen a structure to satisfy the requirements of the current codes for seismic design. In this thesis, a methodology has been proposed for retrofit of existing buildings for additional base shear demand and serviceability requirement using viscoelastic dampers. Seismic zone map in Indian standard IS 1893 Part 1 2002 is being revised from time to time which leads to increase in elastic demands on existing buildings. Base shears for a typical low rise (three storey) and high rise (twenty storey) buildings for zone 2, zone 3, zone 4 and zone 5 for hard soil condition are estimated using seismic coefficient method and time history analysis with spectrum compatible acceleration. Number of viscoelastic dampers and damping ratio required for different cases are worked out and the comparisons are made. The common practice to strengthen existing buildings is to strengthen members and joints with concrete or steel jacketing and to increase the size of the structural members so as to meet the new design requirements. However, it is a time-consuming process and requires demolition of plastering of members, further it may cause pollution to the environment. Considering the above disadvantages, earthquake resistant design and retrofit of structures using energy absorption devices have received desirable attention in recent years (Soong and Dargush 1997). Primary objective of adding energy passive dissipaters is to enhance the damping of the structure and to bring down the demand on structural members without the help of external power supply and to minimize structural damage. Number of passive energy dissipaters are employed in structural design viz., friction dampers, metallic dampers, viscoelastic dampers and dampers made out of smart materials.

Among the available devices, viscoelastic dampers are chosen for the present study which is known to be effective in reducing vibrations of structures at all environmental temperatures under mild and moderate earthquake ground motions. In the present study, methodology has been proposed to enhance the capacity of building to meet additional base shear demand due to zone up gradation using viscoelastic dampers. Methodology is demonstrated for a typical high rise (twenty storey) building to increase the seismic capacity of the buildings from zone 2 to zone 3, zone 3 to zone 4 and zone 4 to zone 5 by the addition of viscoelastic dampers (designated as VE hereafter).

1.2 Revisions of Indian Seismic code IS 1893

"IS 1893-1962 Recommendations for earthquake resistant design of structures"was first published in 1962 for the design of buildings in earthquake prone areas. The code was revised for five times namely in 1966, 1970, 1975, 1984 and 2002 based on the additional seismic data collected. It is mentioned in IS 1893-2002 (Part 1) that, this standard is intended for the earthquake resistant design of normal structures, and for the earthquake resistant design of special structures viz., dams, long-span bridges, major industrial projects etc, site-specific detailed investigation should be undertaken.

The traditional approach to seismic design has been based upon providing a combination of strength and ductility to resist the imposed loads. The new techniques in the seismic design of structures or retrofitting of the existing buildings are based on changing the dynamic characteristics of the system to receive less earthquake input force and energy and to dissipate the energy with lower damage and deformation in the structural components. Therefore, many new and innovative concepts of structural protection have been advanced and are at various stages of development, one of them is passive energy dissipation method. The basic role of passive energy dissipation devices when incorporated into a structure is to absorb or consume a portion of the input energy, thereby reducing energy dissipation demand on primary structural members and minimizing possible structural damage. These energy dissipation devices include: viscoelastic dampers, friction devices and plastically deforming metals. Among the variety of energy-dissipation devices, viscoelastic dampers (VE) are one of the successful devices employed for seismic hazard mitigation application.

Most of the buildings were designed according to older versions of the seismic codes, and some were designed such that seismic resistance was not taken into consideration. While these types of buildings were very vulnerable to unexpected earthquakes, some modifications to structural configurations and material properties showed improvement in seismic performance. Therefore, seismic retrofitting was suggested and practitioners applied various seismic intervention techniques to structural systems found to be deficient. Retrofitting procedures could be selected and applied so that the performance objective of the retrofit depends upon the importance of the structure and the desired structural performance during a seismic event with a particular recurrence interval.

1.3 Scope and Objectives of the present study

- To develop a methodology for retrofitting of existing buildings with viscoelastic dampers.
- To estimate the base shear demand of typical high rise (twenty storey) and high rise (twenty storeys) buildings with and without infill for change in zone by seismic coefficient method and time history analysis.
- To perform response spectrum analysis of twenty storey building to estimate the number of viscoelastic dampers and percentage of damping required to meet additional base shear demand and serviceability limit states.
- To study the effect of infill in framed buildings in terms of difference in time period, base shear demand, amount of damping required for retrofitting.
- To compare the response of the building with and without dampers in terms of base shear, acceleration, axial load, roof displacement.

Literature Review

2.1 Introduction

In this chapter, brief review of literature on the effect of infill and retrofitting of existing building with viscoelastic dampers is presented. Seismic retrofitting is the modification of existing structures to make them more resistant to seismic activity, ground motion, or soil failure due to earthquakes. RC framed buildings are generally designed without considering the structural action of masonry infill walls that are present. These walls are widely used as partitions and considered as non-structural elements. But they affect both the structural and non-structural performance of the RC buildings during earthquakes.

2.2 Literature Review

➢ Weng et al., (1) proposed a simplified seismic design procedure for retrofitting earthquake damaged frames with viscous dampers. Various dampers or energy dissipation devices have been widely used in building structures for enhancing their performance during earthquakes, windstorm and other severe loading scenarios. With the scheme of designing the main frame and the supplemental viscous dampers respectively, the seismic analysis model of damped structure with viscous dampers and braces was studied. The expected damping forces for damped frame were first obtained based on storey shear forces; and then they were optimized to meet different storey drift requirements. A retrofit project of a RC frame school building damaged in the 2008, Wenchuan earthquake was introduced as a case study. This building was retrofitted by using viscous dampers designed through the simplified design procedure. It is concluded that this simplified design procedure can be effectively used to make seismic retrofit design of earthquake-damaged RC frames with viscous dampers. It is also stated that design procedure proposed can be used not only for the retrofit design of earthquake-damaged frame structures, but also for the damping design of new building or existing buildings.

- Garcia and Soong (2), have explored a simple approach for the design of optimal damper configurations. This practical method is designated as simplified sequential search algorithm (SSSA). The SSSA is applied to several regular building models with different natural periods, numbers of storey, levels of added damping, and different ground motions. Only one type of passive energy dissipation device is considered linear viscous dampers. It is concluded that, in the case of regular buildings, the SSSA will generally lead to efficient damper configurations, particularly for low-to-medium-rise buildings and for a number of dampers equal to or greater than 1.5–2 times the number of storey. In this study, it is stated that the resulting damper configurations are found to be sensitive to ground motion characteristics, especially for low levels of supplemental damping. Four recorded seismic ground motions are used to perform the numerical simulations. It is reported that, for this study, two ground motions recorded on rock and two ground motions recorded on the soft soil are used out of which one has shorter epicentral distance and the other has longer epicentral distance. It is stated to be observed that damper configurations obtained for different ground motions are not equal to each other, but very similar. It is concluded that, while the SSSA does not provide a unique damper configuration, it nevertheless indicates a consistent pattern and hence in real-case applications, differences among damper configurations corresponding to different ground motions are minor enough to be resolved by engineering judgment.
- Chang et al., (4) proposed a seismic design procedure for structures with added viscoelastic dampers (VED) with an example illustrating the proposed design procedure. A summary on the experimental and analytical study of VE dampers as energy dissipation devices in seismic structural applications is described in this paper. Comparisons on the seismic performance between the viscoelastically damped structure and a conventionally designed special moment resisting frame are carried out in this paper. Analytical studies show that the modal strain energy method can be used to reliably predict the equivalent structural damping of the structure and that the seismic response of the viscoelastically damped structure can be accurately simulated by conventional modal analysis techniques. Based on these studies, the modal strain energy method has been incorporated into the computer programs ETABS and DRAIN2D+ for seismic analysis and design of structures with added VE dampers. The proposed design procedure provides an alternative safe and economic solution for earthquake resistant structures under seismic design regulations. A sufficiently large design damping ratio, such as 15% is used in this study. It has been shown in this report that structures with added VE dampers and with such a large design damping ratio may remain elastic or experience only minor yielding under most current design earthquakes.

- Min et al., (5) proposed a design procedure for viscoelastic dampers and experimental test results of a 5-storey single bay steel structure with added viscoelastic dampers. In this paper, the mechanical properties of viscoelastic dampers and the dynamic characteristics of the model structure were obtained from experiments using harmonic excitation, and the results were used in the design process. The additional damping ratios required to reduce the maximum response of the structure to a desired level were obtained first. Then the size of dampers to realize the required damping ratio was determined using the modal strain energy method by observing the change in modal damping ratio due to the change in damper stiffness. In this study, designed viscoelastic dampers were installed in the first and the second stories of the model structure. On observing the results from experiments using harmonic and band limited random noise they had concluded that after the installation of dampers, the dynamic response of the full-scale model structure reduced as desired in the design process.

- Tsai (6), in this paper, the features of energy-absorbing capacities of the viscoelastic damper and its effect on the structure during earthquakes are investigated. To clarify the behavior of the structure with added viscoelastic dampers, Tsai (1994) modeled a new analytical model for the viscoelastic damper taking into consideration the earthquake like loading and the temperature effect, in good agreement with experimental results, and an advanced finite element formulation for the viscoelastic damper was developed. The proposed method could be implemented easily in the finite element program. In this study the behavior of a 10-story building equipped with viscoelastic dampers was examined while it was subjected to earthquake ground motions. Both analytical and experimental results show that the energy-absorbing capacity of the viscoelastic damper decreases with increasing the ambient temperature. Tsai (1994) concluded that the proposed analytical model accurately describe the behavior of viscoelastic dampers subjected to earthquake like loadings at different temperatures. The capacity of the energy-absorption of the viscoelastic damper decreases with the increase of the ambient temperature. Not only displacements but also stresses of the structure are significantly reduced by the added viscoelastic dampers during earthquakes.

- Irfanullah and Vishwanath (7), in this paper, the influence of masonry infills of a building in seismic analysis are studied. RC framed buildings are generally designed without considering the structural action of masonry infill walls present. These walls are widely used as partitions and considered as non-structural elements. But they affect both the structural and non-structural performance of the RC buildings during earthquakes. RC framed building with open first storey is known as soft storey, which performs poorly during earthquakes. To observe the effect of masonry infill panel, it is modelled as an equivalent diagonal strut. In this paper an investigation has been made to study the behaviour of RC frames with various arrangement of infill when subjected to earthquake loading. The results of bare frame, frame with infill, soft ground floor, soft basement and infill in swastika pattern in ground floor are compared and conclusions are made. The conclusion of the study is that, by providing infill below plinth and in swastika pattern in the ground floor improves earthquake resistant behaviour of the structure when compared to soft basement.

- Wakchaure and Ped (8), in this study, the effect of masonry infill panel on the response of RC frames subjected to seismic action. In analysis infill walls are modeled as equivalent strut approach with various formulae derived by research scholars and scientist for width of strut and modelling. The infill behaves like compression strut between column and beam and compression forces are transferred from one node to another. In this study the effect of masonry walls on high rise building is studied. Linear dynamic analysis on high rise building with different arrangement is carried out. For the analysis G+9 R.C.C. framed building is modelled. Earthquake time history is applied to the models. The width of strut is calculated by using equivalent strut method. Various cases of analysis are taken. All analysis is carried out by software ETABS. Base shear, storey displacement, story drift are calculated and compared for all models and concluded that infill walls reduce displacements, time period and increases base shear. So it is essential to consider the effect of masonry infill for the seismic evaluation of moment resisting reinforced concrete frame.

However, only limited work has been reported, on the use of VE damper for strength enhancement of existing building with and without infill which have undergone zone up gradation for Indian conditions. Hence an effort has been made in this study to develop a methodology for retrofitting of existing building with VE dampers and the methodology has been demonstrated for a low-rise building and a high rise building.

Methodology For Retrofitting Of Existing Building

3.1 Introduction

Many parts of the country have suffered earthquake in last three decades. Many R.C.C buildings have also collapsed and are found unsafe due to faulty workmanship. Many other causes are responsible for major collapse and damage to the R.C.C structures. It may be noted that seismic zone map of earlier of Indian codes of practice for earthquake resistant design of structures (Is 1893:1984) had five seismic zones which has been modified to four zones in the latest version (IS 1893:2002 (part 1)). Similar revisions are possible in near future, Hence it is required to review of the existing buildings for any possible enhancement of base shear demand due to revision of seismic zone, the same has been addressed in this thesis. A methodology has been proposed to enhance base shear capacity of buildings with and without infill by addition of viscoelastic dampers.

3.2 Concept of retrofitting

Retrofitting is technical interventions in structural system of a building that improve the resistance to earthquake by optimizing the strength, ductility and earthquake loads. Strength of the building is generated from the structural dimensions, materials, shape, and number of structural elements, etc. Ductility of the building is generated from good detailing, materials used, degree of seismic resistant, etc. Earthquake load is generated from the site seismicity, mass of the structures, importance of buildings, degree of seismic resistant, etc. Seismic retrofit of an existing building most often would be more challenging than designing a new one. The first step of seismic evaluation aims at detecting the deficiencies of the building. Seismic retrofitting of existing structures is one of the most effective methods of reducing the risk of human life and damage of the buildings. Retrofitting procedures could be selected and applied so that the performance objective of the retrofit depends upon the importance of the structure and the desired structural performance during a seismic event with a particular recurrence interval.

Due to the variety of structural condition of building, it is hard to develop typical rules for retrofitting. Each building has different approaches depending on the structural deficiencies. Hence, engineers are needed to prepare and design the retrofitting approaches. In the design of retrofitting approach, the engineer must comply with the building codes. The results generated by the adopted retrofitting techniques must fulfill the minimum requirements on the buildings codes, such as deformation, detailing, strength, etc.

3.3 Causes of failure

Following were the main causes of failure and damages to the buildings India.

1. Old buildings constructed without considering engineering principles or modern construction practices
2. New Buildings not being designed to Indian earthquake codes
3. Lack of knowledge, understanding or training in the use of these codes by local engineers
4. Buildings erected without owners seeking proper engineering advice
5. Improper detailing of masonry and reinforced structures
6. Poor materials, construction and workmanship used, particularly in commercial buildings
7. Alterations and extensions being carried out without proper regard for effects on structure during an earthquake.
8. Buildings having poor quality foundations or foundations built on poor soils.
9. Little or no regularity authority administering or policing the codes.

3.4 **Methods of retrofitting**

a) Addition of RC structural walls
b) Steel jacketing
c) Concrete jacketing
d) FRP wrapping etc.

3.5 Recent Retrofitting Methods

There are many relatively new technologies developed for seismic Retrofitting which are based on “Response control”. These techniques includes providing additional damping using dampers (Elastoplastic dampers, friction dampers, tuned mass and tuned liquid dampers, viscoelastic dampers, lead extrusion dampers etc.) and techniques such as base isolation which are introduced to take care of seismic control. Among these the addition of viscoelastic dampers are adopted because due to their smaller sizes, which make them more applicable specially for retrofitting of existing buildings, and their stiffness, which have very important role on regulating of the flexibility rate of the flexible frame and stability control of the system. The benefits of retrofitting include the reduction in the loss of lives and damage of the essential facilities, and functional continuity of the life line structures. For an existing structure of good condition, the cost of retrofitting tends to be smaller than the replacement cost. Thus, the retrofitting of structures is an essential component of long term disaster mitigation.

3.6 Viscoelastic damper

The application of viscoelastic materials to vibration control can be dated back to the 1950s when it was first used on aircraft as means of controlling vibration-induced fatigue in airframes. Since that time, it has been widely used in aircrafts and aerospace structures for vibration reduction. Its application to civil engineering structures appears to have begun in 1969 when 10,000 viscoelastic dampers were installed in each of the twin towers of the World Trade Centre in New York to help resist wind loads. Seismic applications of viscoelastic dampers have a more recent origin. Forces generated due to earthquake are more and larger damping is required for vibration control compared to damping required for control of wind-induced vibrations. Furthermore, during earthquake shaking, energy input into the structure is usually spread over a wider frequency range, requiring more effective use of the viscoelastic materials. Extensive analytical and experimental studies in the seismic domain have led to the first seismic retrofit of an existing building using viscoelastic dampers (designated as VED here after) in the U.S. in 1993.

3.7 Applications of Viscoelastic dampers

VEDs have been installed in four buildings in the United States for the minimization of wind-induced vibrations, with the earliest installation being the World Trade Center Towers in New York.

In Japan, VEDS have been used to reduce the wind-induced response of several buildings: Seavans South Tower in Tokyo (1991), the Old Wooden Temple, Konohanaku Symbol Tower (1999), ENIX Headquarter Building, the Sogo Gymnasium in Chiba (1993), the Goushoku Hyogo Port Distribution Center (1998) with viscoelastic joint dampers which reduce the seismic response by one half, and the Torishima Riverside Hill Symbol Tower, whose 1999 installation features 8 VEDs per story for the 1st to 19th floors and reduces to 4 VEDs per story for the 20th to 38th stories. In addition, the Chientan Railroad Station in Taipei, Taiwan has also been equipped with 8 viscoelastic units to control the wind-induced vibrations of its unique suspended dragon boat roof.

Although the use of VEDs to control excitations due to wind has been commonplace for over 20 years, their use in seismic applications has just begun to flourish. Their installation in the form of rubber-asphalt attached to the walls in one direction of every floor of a 24 story building was found to improve the structural responses under earthquake conditions by 30%. There have been numerous other seismic applications, particularly in the area of retrofitting, in the United States, including the Santa Clara Civic Center Office Building.

3.**8 Advantages and Disadvantages**

In general, friction, viscoelastic, viscous fluid and hysteretic dampers reduce the seismic response of structures and minimize structural and non-structural damage. They are easy to install and do not impact the foundation design. They are attractive for the upgrading of existing buildings. The problems are the following: first, dampers are effective only for flexible structures that may be subjected to large deformations. Also, they encumber the design procedure and make it more expensive. For instance, several alternatives have to be considered to find their optimum number and location.

3.9 **Methodology**

In the present study, a methodology is proposed for the selection of dampers to enhance the base shear capacity of building in order to meet the additional demand due to zone up-gradation. The base shear demands for different zones are estimated using seismic coefficient method as per IS 1893-2002 (Part 1). In addition, since linear time history analysis is the most accurate procedure to estimate the dynamic response of the building, response spectrum analyses are carried out using ETABS 2013 (Computers and Structures Inc., 2011) to determine base shears, acceleration and displacement responses of the structures using spectrum compatible time histories. The response of the structure is obtained for given input earthquake ground motion acceleration. To study the effectiveness of the dampers, peak base shears, maximum displacements and accelerations are determined from the response of the damped buildings subjected to earthquake ground motion acceleration and the comparison has been made with those of the undamped buildings. The damping devices used in this study are viscoelastic dampers. The dampers are placed in chevron bracing of the framed building. In the present study this methodology is followed to retrofit a typical low rise building and high rise building with the viscoelastic dampers to increase the seismic capacity of the buildings. Fig.3.1 shows the methodology for retrofitting of existing building with VE dampers.

4.1 DESCRIPTION OF PROJECT:

A structure can be defined as a body which can resist the applied loads without appreciable deformations.

Civil engineering structures are created to serve some specific functions like human habitation, transportation, bridges, storage etc. in a safe and economical way. A structure is an assemblage of individual elements like pinned elements (truss elements) beam element, column, shear wall slab cable or arch. Structural engineering is concerned with the planning, designing and the construction of structures.

Structure analysis involves the determination of the forces and displacements of the structures or components of a structure. Design process involves the selection and detailing of the components that make up the structural system. The main object of reinforced concrete design is to achieve a structure that will result in a safe economical solution.

4.2 DETAILS OF THE STRUCTURE:

Our project deals with the earthquake resistant multistoried building, here the multistoried building is of earthquake resistant .For analysis we have to use software which is known as E-TABS 2013. Though E-TABS, is used to analyze the columns and beam of multistoried building , here through E-TABS , we designed a multistoried building of G+20 floors buildings which is known as G +20 multistoried buildings. In the G + 4 multistoried buildings design a lift section in both the corner side of the storey

The plan of multistoried building is 24 x 24 m, here 24 is the length of the plan and 24 is the width of the plan and have a lift section design in the building. There are 6 flats in the ground floor and it is similar in the upper most part of the building and in the entry of the building one hall is have and in that hall we have given a lift section from bottom to upper part of the building.

Statement of project

Salient features

Utility of building	Residential complex
No of stories	G+20
Type of construction	R.C.C framed structure
Types of walls	Brick wall

Geometry Details

Width of the building	:	24m
Height of building	:	60m
Height of the floor	:	3m

Materials

Concrete grade	:	M30
All steel grades	:	HYSD 500

Size of Structural Members

Column Size:

From ground floor to eighth floor: 600 mm X 450 mm

From ninth floor to twentieth floor: 300 mm X 500 mm

Beam Size:

From ground floor to fifth floor: 300 mm X 600 mm

From sixth floor to tenth floor: 500 mm X 230 mm

From eleventh floor to twentieth floor: 400 mm X 230 mm

Slab Thickness: 120 mm

Viscous dampers on each elevation

Grade of Concrete and Steel: M30; HYSD 500 Steel

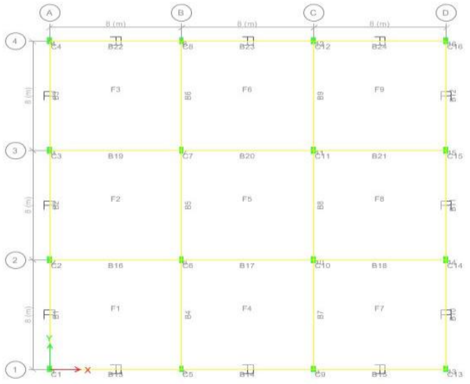


Fig-1 showing plan view of high rise building

Fig-1 showing elevation view of high rise building without dampers

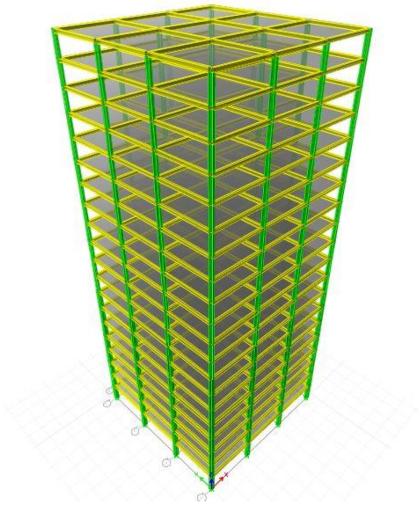


Fig-1 showing 3d view of high rise building without dampers

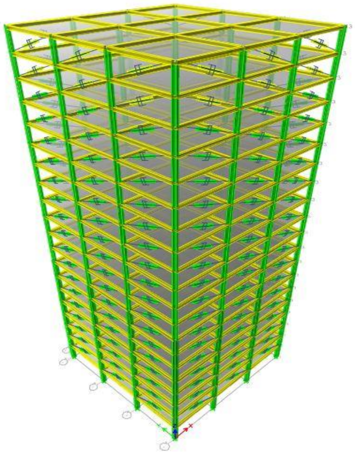


Fig-1 showing 3d view of high rise building with dampers

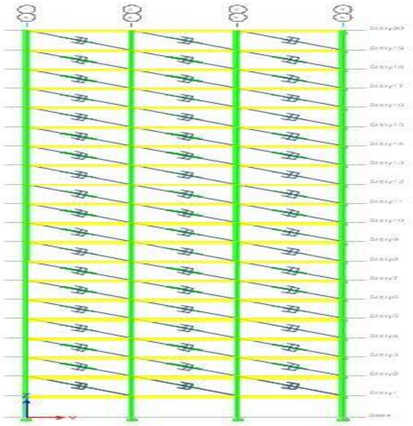


Fig-1 showing 3d view of high rise building with dampers

Fig-1 showing elevation view of high rise building with dampers

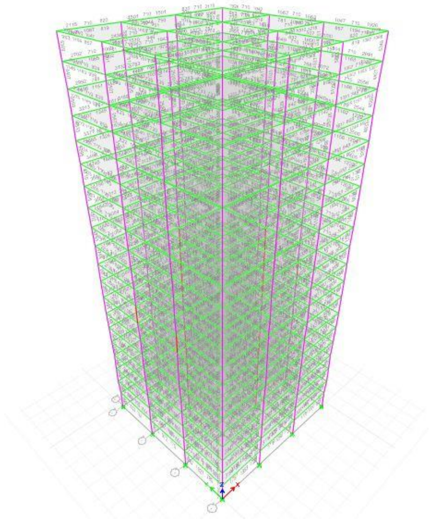
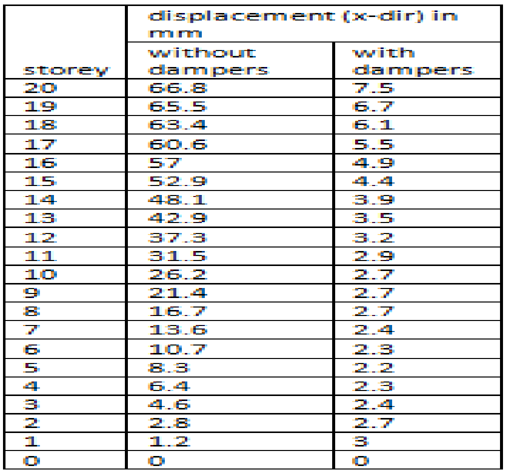


Fig – 6 showing high rise building after the design check

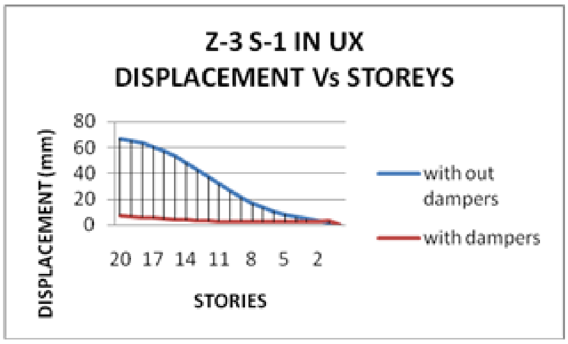
RESULTS

Case-1: Displacement Comparison Values & Graphs for High Rise Building

Table-1 Showing comparison values of displacement in z-3 s-1

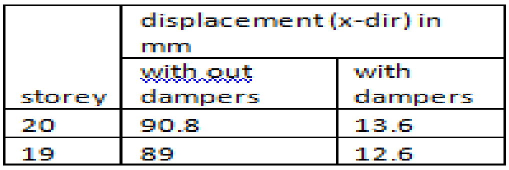


storey	displacement (x-dir) in mm	
	without dampers	with dampers
20	66.8	7.5
19	65.5	6.7
18	63.4	6.1
17	60.6	5.5
16	57	4.9
15	52.9	4.4
14	48.1	3.9
13	42.9	3.5
12	37.3	3.2
11	31.5	2.9
10	26.2	2.7
9	21.4	2.7
8	16.7	2.7
7	13.6	2.4
6	10.7	2.3
5	8.3	2.2
4	6.4	2.3
3	4.6	2.4
2	2.8	2.7
1	1.2	3
0	0	0



Graph-1 Showing displacement variation in z-3 s-1

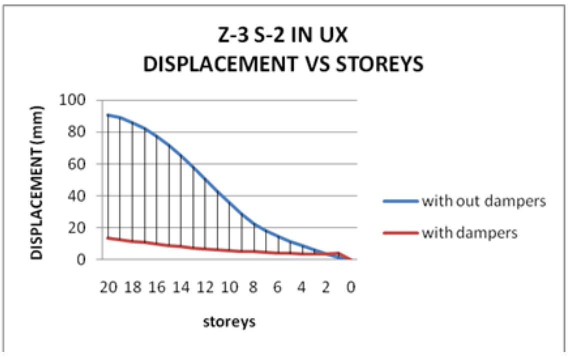
Table-2Showing comparison values of displacement in z-3 s-2



storey	displacement (x-dir) in mm	
	with out dampers	with dampers
20	90.8	13.6
19	89	12.6

Table-1 Showing comparison values of displacement in z-3 s-2

Storey	Displacement (X-Dir) In Mm	
	With Out Dampers	With Dampers
20	90.8	13.6
19	89	12.6
18	86.2	11.7
17	82.4	10.8
16	77.6	9.9
15	71.9	9.1
14	65.5	8.3
13	58.4	7.5
12	50.8	6.9
11	42.9	6.3
10	35.6	5.8
9	29.1	5.4
8	22.7	5.2
7	18.5	4.7
6	14.6	4.3
5	11.3	4
4	8.7	3.9
3	6.2	3.8
2	3.8	3.9
1	1.7	4.2
0	0	0



Graph-1 Showing displacement variation in z-3 s-2

Table 2 -Showing comparison values of displacement in z-3 s-3

Storey	Displacements(X-Dir) In Mm	
	With Out Dampers	With Dampers
20	111.4	22.9
19	109.3	21.6
18	105.9	20.4
17	101.2	19.1
16	95.2	17.8
15	88.3	16.6
14	80.4	15.3
13	71.7	14.1
12	62.4	13
11	52.6	11.9
10	43.7	10.8
9	35.8	9.9
8	27.8	9.1
7	22.7	8.2
6	17.9	7.4
5	13.9	6.6
4	10.6	6.1
3	7.6	5.7
2	4.7	5.4
1	2	5.2
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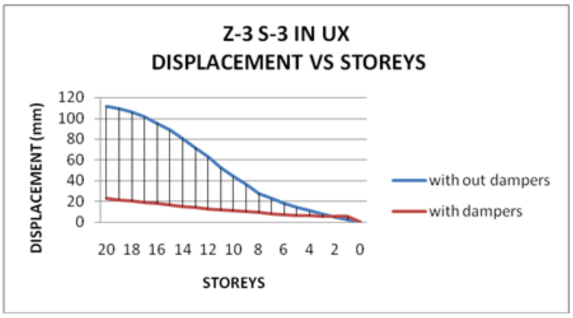

Graph 2 Showing displacement variation in z-3 s-3

Table 3 Showing comparison values of displacement in z-5 s-3

Storey	Displacement (X-Dir) In Mm	
	With Out Dampers	With Dampers
20	150.4	29
19	147.6	27.3
18	143	25.6
17	136.6	24
16	128.6	22.3
15	119.2	20.7
14	108.5	19.1
13	96.8	17.6
12	84.2	16.1
11	71	14.7
10	59	13.5
9	48.3	12.4
8	37.6	11.5
7	30.7	10.3
6	24.1	9.3
5	18.7	8.5
4	14.4	7.8
3	10.3	7.4
2	6.3	7.1
1	2.7	7
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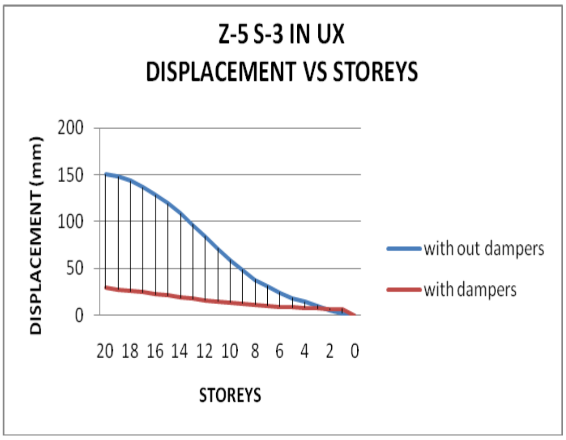
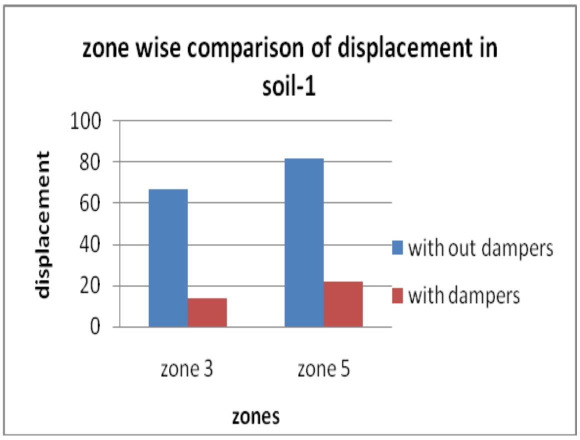


Graph-2 Showing displacement variation in z-5 s-3

Case 2: Zone wise comparison of displacement

Table-3 : Showing zone wise displacement comparison values & graphs of soil-1

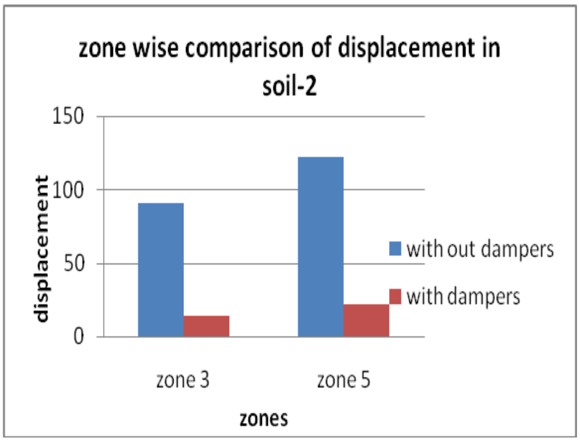
zones	soil-1	
	with out dampers	with dampers
zone 3	66.8	7.5
zone 5	81.8	10.5



Graph-3 Showing zone wise displacement variation in soil-1

Table-4 Showing zone wise displacement comparison values & graphs of soil-2

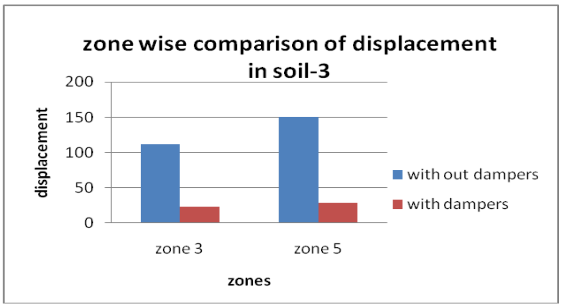
zones	soil-2	
	with out dampers	with dampers
zone 3	90.8	13.6
zone 5	122.5	21.8



Graph-4 Showing zone wise displacement variation in soil-2

Table-5 Showing zone wise displacement comparison values & graphs of soil-3

zones	soil-3	
	with out dampers	with dampers
zone 3	111.4	22.9
zone 5	150.4	29



Graph-5 Showing zone wise displacement variation in soil-3

Summary:

Displacement is compared in both the models i.e,, without dampers & with dampers it is observed that 60% displacement is reduced when the dampers are provided in each elevation.

Case-3: Shear Comparison values & graphs in static analysis

Table-6 Showing comparison values of shear in z-3 s-1

Storey	Shear (X-Dir) In Kn	
	Without Dampers	With Dampers
20	-75.31	-57.06
19	-45.73	-36.32
18	-48.47	-40.72
17	-45.22	-39.91
16	-43.24	-40.17
15	-41.13	-40.21
14	-39.12	-40.25
13	-37.23	-40.39
12	-34.8	-40.52
11	-34.4	-40
10	-36.8	-41.76
9	-16.89	-30.29
8	-61.47	-59.59
7	-36.89	-44.42
6	-47.25	-53.27
5	-54.1	-55.36
4	-47.49	-59.93
3	-42.56	-47.25
2	-42.8	-108.47
1	-3.71	74.24
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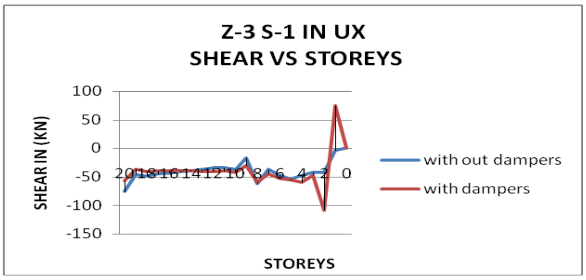
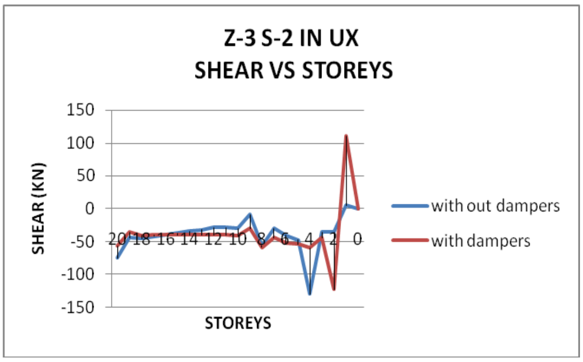


Graph-6 Showing shear variation in z-3 s-1

Table-7 Showing comparison values of shear in z-3 s-2

Storey	Shear (X-Dir) In Kn	
	With Out Dampers	With Dampers
20	-74.66	-56.96
19	-44.05	-36.21
18	-46.06	-40.57
17	-42.12	-39.74
16	-39.54	-39.98
15	-36.89	-40.01
14	-34.42	-40.02
13	-32.42	-40.15
12	-29.27	-40.28
11	-28.45	-39.68
10	-30.62	-41.35
9	-9.56	-29.87
8	-56.23	-58.83
7	-30.12	-43.87
6	-40.88	-52.88
5	-47.93	-53.92
4	-129.65	-59.6
3	-35.77	-43.82
2	-35.93	-122.65
1	5.02	110.325
0	0	0



Graph-7 Showing shear variation in z-3 s-2

Table-8 Showing comparison values of shear in z-3 s-3

storey	shear (x-dir) in KN	
	with out dampers	with dampers
20	-74.1	-31.74
19	-42.61	-20.09
18	-43.98	-22.45
17	-39.45	-21.9
16	-36.35	-21.96
15	-33.25	-21.92
14	-30.37	-21.83
13	-27.74	-21.88
12	-24.51	-21.83
11	-23.33	-21.61
10	-25.26	-22.63
9	-3.25	-15.98
8	-51.73	-31.98
7	-24.28	-23.52
6	-35.39	-29.49
5	-42.63	-27.31
4	-35.14	-34.75
3	-29.92	-16.56
2	-30.01	-104.81
1	12.53	152.29
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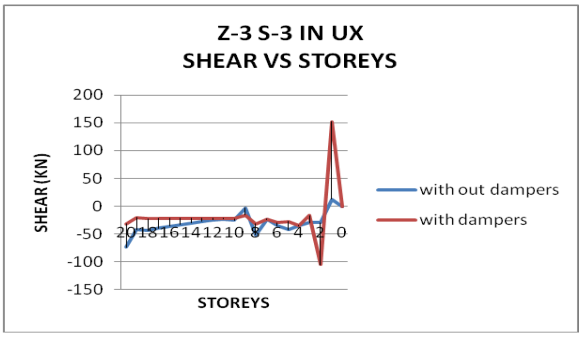
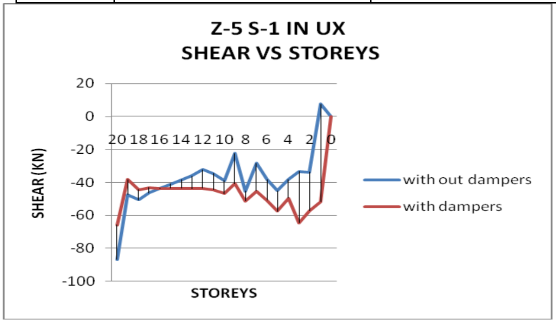


Graph-8 Showing shear variation in z-3 s-3

Table-9 Showing comparison values of shear in z-5 s-1

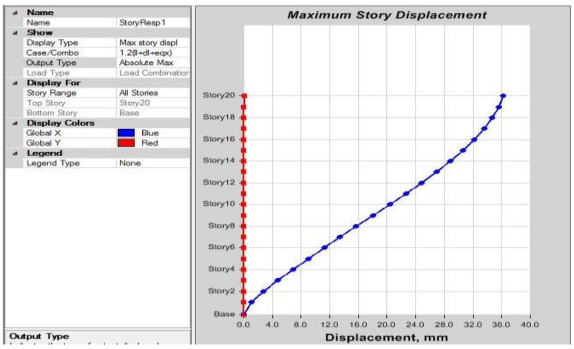
storey	shear (x-dir) in KN	
	with out dampers	with dampers
20	-86.69	-65.72
19	-47.27	-38.14
18	-50.53	-44.33
17	-46.38	-43.05
16	-43.75	-43.4
15	-41.05	-43.43
14	-38.48	-43.36
13	-36.14	-43.71
12	-32.22	-43.4
11	-34.51	-44.46
10	-38.85	-46.65
9	-22.43	-40.69
8	-45.32	-51.25
7	-28.35	-45.28
6	-38.14	-50.61
5	-45.04	-57.34
4	-38.14	-49.46
3	-33.27	-64.5
2	-33.65	-57.28
1	7.53	-51.44
0	0	0



Graph-9 Showing shear variation in z-5 s-1

Summary:

Moment is compared in both the models i.e., without dampers & with dampers it is observed that 50% Shear is reduced when the dampers are provided in each elevation.



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Case/Combo	1.2(ll+dl+eqx)
Output Type	Absolute Max
Load Type	Load Combination
Display For	
Story Range	All Stories
Top Story	Story20
Bottom Story	Base
Display Colors	
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Global Y	🟥 Red
Legend	
Legend Type	None

Output Type

Fig-1 Showing displacement of high rise building

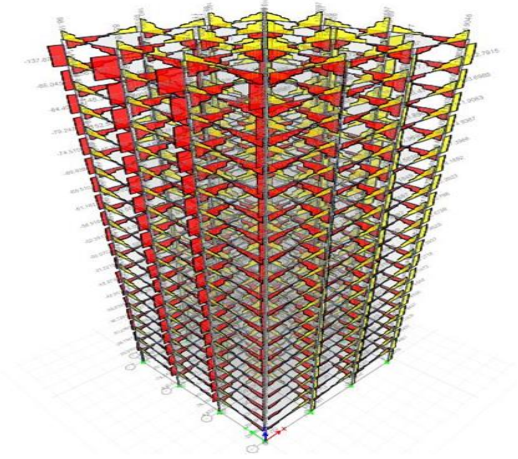

Fig-1 **Showing shear diagram of highrise building in 3D**

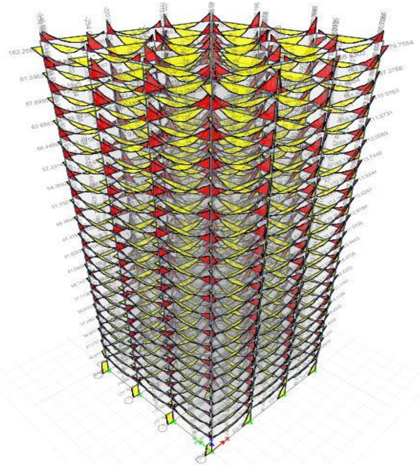

Fig-1 Showing moment diagram of high rise building in 3d view

Fig-1 **Showing axial force diagram of high rise building in 3d view**

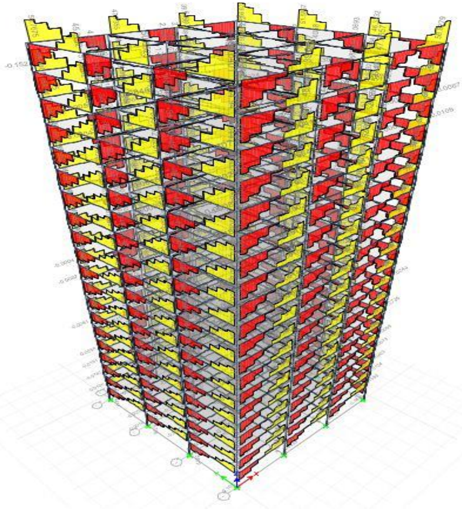

Fig-1 Showing torsion diagram of high rise building in 3d view

Conclusions:

1. Displacement is compared for two models i.e.,, without dampers & with dampers at top storey of a high rise building in zone-3 & zone -5 in each soil it is observed that 50% displacement is reduced when the dampers are provided at each elevation.

2. Shear is compared for two models i.e.,, without dampers & with dampers at top storey of a high rise building in zone-3 & zone -5 in each soil it is observed that 40% shear is reduced when the dampers are provided at each elevation.

3. Moment is compared for two models i.e.,, without dampers & with dampers at top storey of a high rise building in zone-3 & zone -5 in each soil it is observed that 45% moment is reduced when the dampers are provided at each elevation.

4. Displacement is also compared in dynamic analysis for zone-3 & zone-5 at each soil.

   At soil-1, 50% of displacement is reduced from zone-3 to zone -5.
   At soil-2, 60% of displacement is reduced from zone-3 to zone -5.
   At soil-3, 65% of displacement is reduced from zone-3 to zone -5.

5. Shear is also compared in dynamic analysis for zone-3 & zone-5 at each soil.

   At soil-1, 30% of shear is reduced from zone-3 to zone -5.
   At soil-2, 50% of shear is reduced from zone-3 to zone -5.
   At soil-3, 55% of shear is reduced from zone-3 to zone -5.

6. Moment is also compared in dynamic analysis for zone-3 & zone-5 at each soil.

   At soil-1, 40% of moment is reduced from zone-3 to zone -5.
   At soil-2, 55% of moment is reduced from zone-3 to zone -5.
   At soil-3, 65% of moment is reduced from zone-3 to zone -5.

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