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Analyze and Design of a High Rise Unsymmetrical Building with Dampers

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Abstract - **Earthquake load is changing into an excellent concern in our country as a result of not one zone may be selected as earthquake resistant zone. One of the most important aspects is to construct a building structure, which can resist the seismic force efficiently. The basic designs for vertical and lateral loads i.e. wind & seismic are the same for low, medium or high rise buildings. The vertical loads increase in direct proportion to the floor area and number of floors. In distinction to the current, the result of lateral loads on a building isn't linear and increase quickly with increase in height. Due to these lateral loads, moments on steel components will be very high. By providing viscous dampers these moments can be reduced.**

In the present analysis, 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 2 & Zone 5 with three soils in both static & Dynamic Analysis. Moments, Shear, Displacement was compared for all the cases. It is observed that the deflection was reduced by providing the viscous dampers. A commercial package ETABS2013 has been utilized for analyzing high-rise building of 60m height and for zone-II & zone-V. The result has been compared using tables & graph to find out the most optimized solution. Concluding remark has been made on the basis of this analysis & comparison tables.
Keywords : **High-Rise Unsymmetrical, Earthquake, Dampers**

I. INTRODUCTION

Many parts of the country have suffered earthquake in the 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 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.

A. 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.

B. Fluid Viscous Devices

Fluid viscous devices are piston/cylinder devices that utilize fluid flow through orifices to provide a reaction that is a function of the velocity applied to the aforesaid piston. The orifices are located in the piston head and this allows the fluid to move back and forth between two chambers. The cylinder is filled with a silicon fluid selected for its rheological stability and its being non-corrosive. The force generated by

These devices are the result of a pressure differential across the piston head. These devices are equipped with spherical hinges at both ends to keep the transmitted load aligned along the main axis. This detail is of major importance to yield reliable performance: it prevents the piston rod from bending and thus the sealing system from failing. High-strength steel components are used for the vessel and the plated piston rod so as to withstand the actions imposed by dynamic loads. The anchoring details depend only on the structure to which they are anchored: for example, the tang plate/clevis system illustrated in below figure

A very important issue related to the utilization of the technology entails the correct numerical modelling of the devices as integrated into the structural model The most appropriate mathematical model to represent the behaviour of viscous devices is to use a Maxwell constitutive law characterized by a linear spring in series to a non-linear dashpot element The first element represents the elasticity of the device and the second, its damping properties. Device elasticity, represented by the stiffness K, is mainly due to the compressibility of the fluid, whilst the damping parameters C and α depend upon the hydraulic circuit used with the particular unit.

Typical anchoring configuration of a fluid viscous device (photo taken during the installation).

Fig.1 Typical Anchoring Configuration of a Fluid Viscos Device

II. DETAILS OF THE STRUCTURE

The present project deals with the earthquake resistant multistoried building. 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.

The plan of multistoried building is 24 x 24 m, here 24m is the length of the plan and 24m 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 there is a 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	Commercial 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	Fe500 grade

Size of Structural Members
Column Size:

From ground floor to tenth floor: 750 mm X 900 mm
From eleventh floor to twentieth floor: 450 mm X 750 mm
Beam Size: 400 mm X 600 mm
Slab Thickness: 120 mm
Viscous dampers on each elevation
Grade of Concrete and Steel: M30; Fe 415 Steel

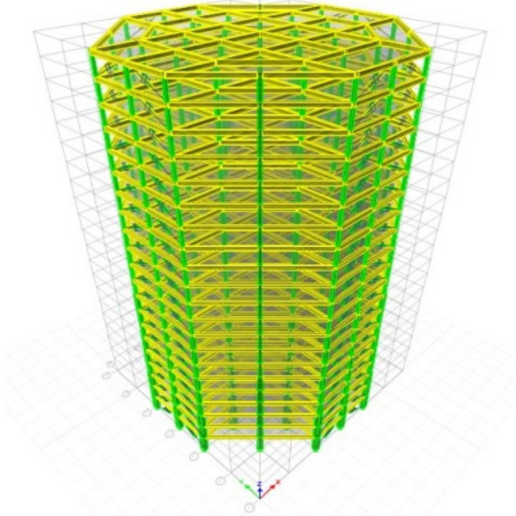

Fig.2 Showing 3d view of high rise building with dampers

Load combinations

Model can be analyzed in both static & dynamic analysis.
Static load cases are

a. 1.5(Dead load + Live load)
b. 1.2(Dead load + Live load + Lateral load in X direction)
c. 1.2(Dead load + Live load - Lateral load in X direction)
d. 1.2(Dead load + Live load + Lateral load in Y direction)
e. 1.2(Dead load + Live load - Lateral load in Y direction)
f. 1.5(Dead load + Lateral load in X direction)
g. 1.5(Dead load - Lateral load in X direction

h. 1.5(Dead load + Lateral load in Y direction)
i. 1.5(Dead load - Lateral load in Y direction)
j. 0.9(Dead load) + 1.5(Lateral load in X direction)
k. 0.9(Dead load) - 1.5(Lateral load in X direction)
l. 0.9(Dead load) + 1.5(Lateral load in Y direction)
m. 9(Dead load) - 1.5(Lateral load in Y direction)

III. RESULTS AND DISCUSSION

Displacement Comparison Values &Graphs for High Rise Building

Showing comparison values of displacement in z-2S-1

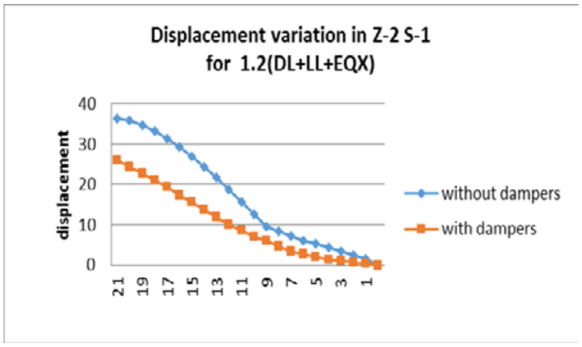

Fig.3 Showing displacement variation in z-2S-1

From the above Fig.3, we can conclude that for zone-2 soil type-1, displacement variation throughout storey (i.e.,from base to 21 stories) is increased linearly. Building without dampers has more displacement from Base to 21 stories it is observed that 0 at base and 36.4mm at top. Building with dampers has less displacement when compared with without dampers building i.e., from Base to 21 stories it is observed that 0 at base and 26 mm at top.

Showing comparison values of displacement in z-2S-2

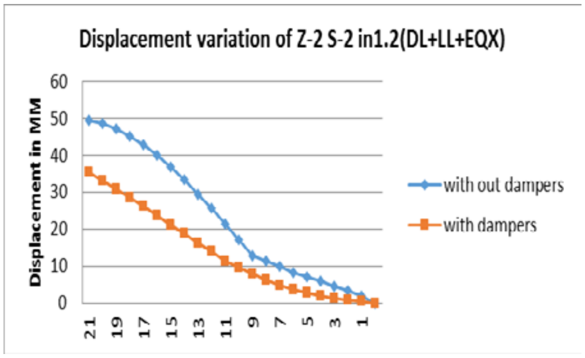

Fig.4 Showing comparison values of displacement in z-2S-2

From the above Fig.4, we can conclude that for zone-2 soil type-2, displacement variation throughout storey (i.e., from base to 21 stories) is increased linearly. Building without dampers has more displacement from Base to 21 stories it is observed that 0 at base and 49.50mm at top. Building with dampers has less displacement when compared with without dampers building i.e., from Base to 21 stories it is observed that 0 at base and 35.30 mm at top.

Showing comparison values of displacement in z-2S-3

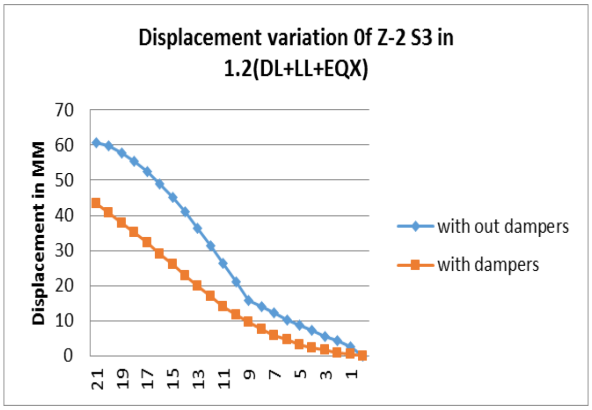

Fig.5 Showing displacement variation in z-2S-3

From the above Fig.5, we can conclude that for zone-2 soil type-3, displacement variation throughout storey (i.e., from base to 21 stories) is increased linearly. Building without dampers has more displacement from Base to 21 stories it is observed that 0 at base and 60.80mm at top. Building with dampers has less displacement when compared with without dampers building i.e., from Base to 21 stories it is observed that 0 at base and 43.40 mm at top.

Showing comparison values of displacement in z-5 S-1

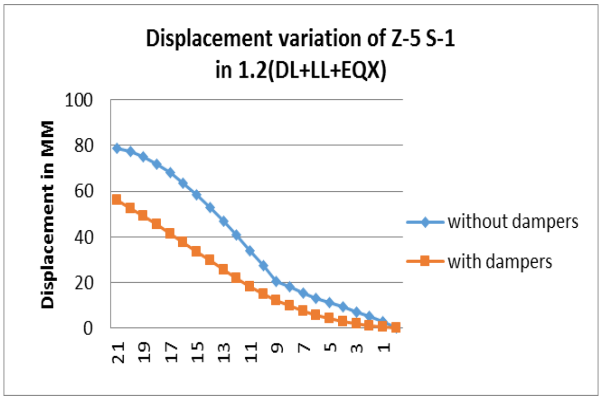

Fig.6 Showing displacement variation in z-5 S-1

From the above Fig.6 , we can conclude that for zone-5 soil type-1, displacement variation throughout storey(i.e.,from base to 21 stories) is increased linearly. Building without dampers has more displacement from Base to 21 stories it is observed that 0 at base and 78.60mm at top. Building with dampers has less displacement when compared with without dampers building i.e., from Base to 21 stories it is observed that 0 at base and 56.00 mm at top.

Showing comparison values of displacement in z-5 S-2

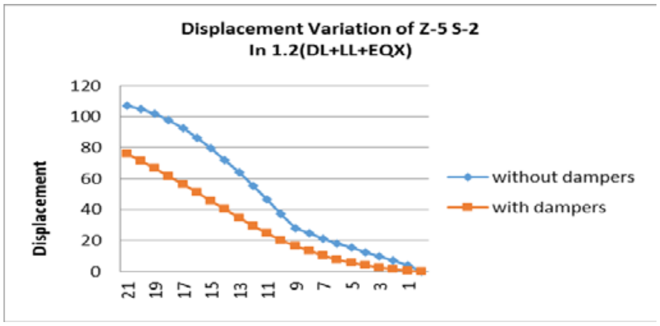

Fig.7 Showing displacement variation in z-5 S-2

From the above Fig.7 , we can conclude that for zone-5 soil type-2, displacement variation throughout storey(i.e., from base to 21 stories) is increased linearly. Building without dampers has more displacement from Base to 21 stories it is observed that 0 at base and 106.90mm at top. Building with dampers has less displacement when compared with without dampers building i.e., from Base to 21 stories it is observed that 0 at base and 76.20 mm at top.

Showing comparison values of displacement in z-5 S-3

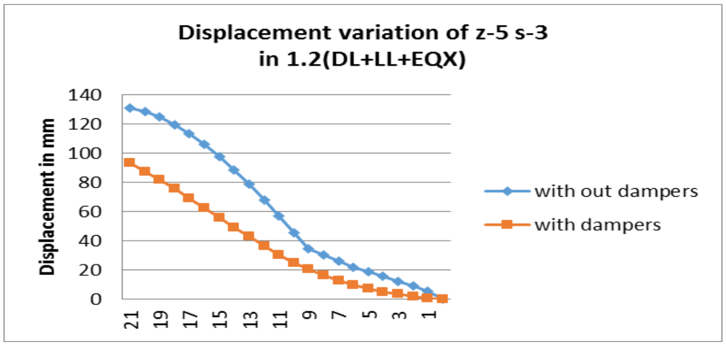

Fig.8 Showing displacement variation in z-5 S-3

From the above Fig.8 , we can conclude that for zone-5 soil type-3, displacement variation throughout storey(i.e., from base to 21 stories) is increased linearly. Building without dampers has more displacement from Base to 21 stories it is observed that 0 at base and 131.30mm at top. Building with dampers has less displacement when compared with without dampers building i.e., from Base to 21 stories it is observed that 0 at base and 93.50 mm at top.

Zone wise comparison of displacement
Showing zone wise displacement comparison values &Graphs of soil-1

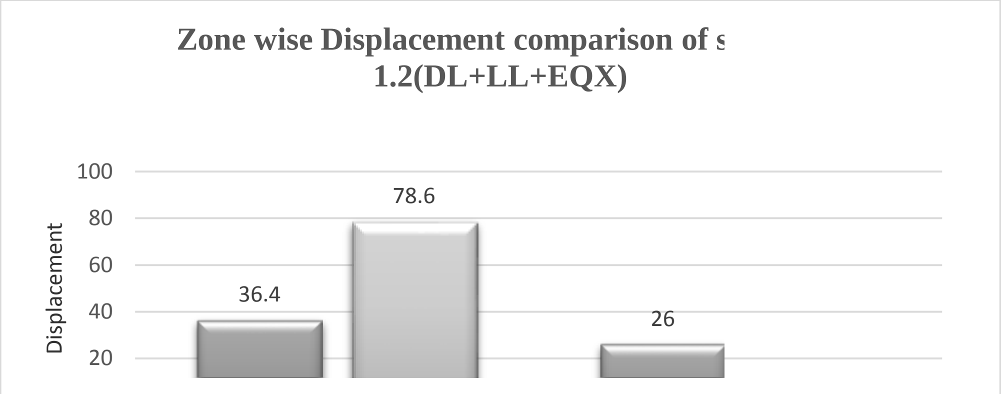

Fig.9 Showing zone wise displacement variation in soil-1

From the above Fig.9, we can conclude that zone wise comparison is made for soil-1 in zone-2 & zone-5, the displacement values for the building without dampers is more when compared to the building with dampers we can observe that from the above graph. For soil-1 in zone-2 & zone -5 the values of displacement are 36.4 mm & 78.6mm when dampers are not provided, and the values of displacement when dampers are provided to elevations are 26mm & 56mm.

Showing zone wise displacement comparison values &Graphs of soil-2

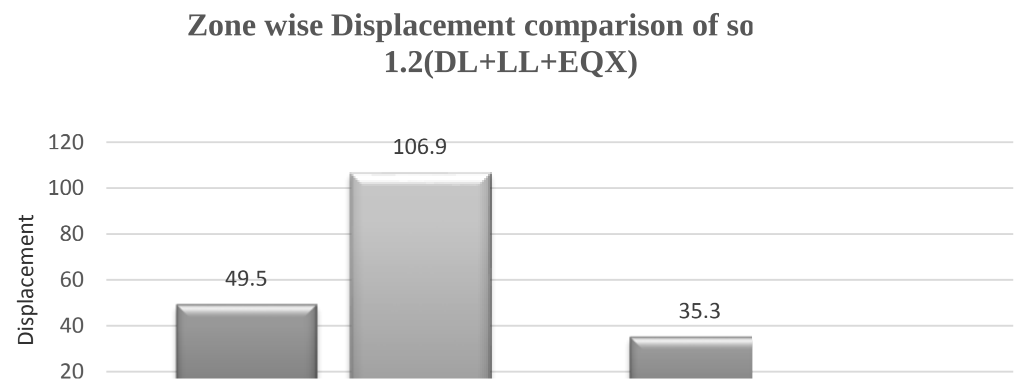

Fig.10 Showing zone wise displacement variation in soil-2

From the above Fig.10, we can conclude that zone wise comparison is made for soil-2 in zone-2 & zone-5, the displacement values for the building without dampers is more when compared to the building with dampers we can observe that from the above graph. For soil-1 in zone-2 & zone -5 the values of displacement are 49.5 mm &106.90mm when dampers are not provided, and the values of displacement when dampers are provided to elevations are 35.30mm & 76.20mm.

Showing zone wise displacement comparison values &Graphs of soil-3

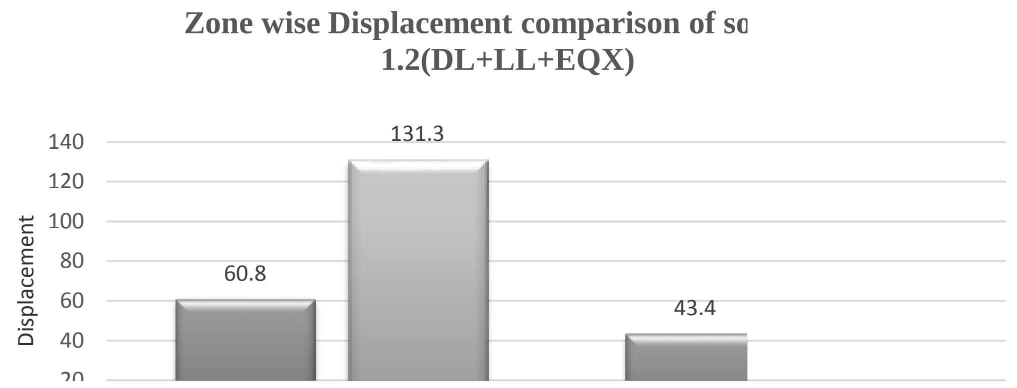

Fig.11 Showing zone wise displacement variation in soil-3

From the above Fig.11, we can conclude that zone wise comparison is made for soil-3 in zone-2 & zone-5, the displacement values for the building without dampers is more when compared to the building with dampers we can observe that from the above graph. For soil-1 in zone-2 & zone -5 the values of displacement are 60.80 mm & 131.3mm when dampers are not provided, and the values of displacement when dampers are provided to elevations are 43.40mm & 93.50mm.

V.SUMMARY

Displacement is compared in both the models i.e., without dampers & with dampers and it is observed that 40% displacement is reduced when the dampers are provided in each elevation.

VI. CONCLUSION

Displacement is compared for two models i.e., without dampers & with dampers at top storey of a high rise building in zone-2& zone -5 in each soil and it is observed that 50% displacement is reduced when the dampers are provided at each elevation.

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

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