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Seisimic Analysis of a High Rise Unsymmetrical Building with Dampers Using ETABS

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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. Study is made on the different structural arrangement to find out the most optimized solution to produce an efficient safe earthquake resistant building. The basic design 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: Seisimic Analysis, ETABS, Viscoelastic Dampers, MCE

I. INTRODUCTION

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 in all such disasters that's connected with in progress tectonic process; it suddenly comes for seconds and causes nice 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 associate existing structure throughout future earthquakes. 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 normal IS 1893 part 1 2002 is being revised from time to time that ends up in increase in elastic demands on existing buildings.

INDIAN SEISMIC CODE IS 1893

“IS 1893-1962 Recommendations for earthquake resistant design of structures “was initial disclosed in 1962 for the design of buildings in earthquake prone areas. The code was revised for five times 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 normal is meant for the earthquake resistant design of traditional structures, and for the earthquake resistant design of special structures viz., dams, long-span bridges, major industrial projects etc, site-specific elaborated investigation ought to be undertaken.

The traditional approach to unstable design has been based mostly upon providing a mix of strength and ductility to resist the obligatory loads. The new techniques within the seismic style of structures or retrofitting of the present buildings are supported ever-changing the dynamic characteristics of the system is to receive less seismic force and energy to dissipate the energy with little damage and deformation in the structural elements. Therefore, several new and innovative ideas of structural protection are advanced and are at varied stages of development, one among them is passive energy dissipation methodology**.** The basic role of passive energy dissipation devices once incorporated into a structure is to soak up or consume a little of the input energy, thereby reducing energy dissipation demand on primary structural elements and minimizing the structural damage. These energy dissipation devices include viscoelastic dampers, friction devices and plastically deforming metals. Among the range of energy-dissipation devices, viscoelastic dampers (VE) area unit one among the successful devices utilized for seismic hazard mitigation application.

II. METHODS AND MATERIAL

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. Earthquake load is generated from the placement seismicity, mass of the structures, importance of buildings, degree of unstable 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.

Due to the variability of structural condition of building, it's onerous to develop typical rules for retrofitting. every building has completely different approaches reckoning on the structural deficiencies. Hence, engineers are required to arrange and style the retrofitting approaches. within the style of retrofitting approach, the engineer should fits the building codes.

Description of Work

A structure may be outlined as a body which may resist the applied loads while not considerable deformations. Engineering structures are created to serve functions like human habitation, transportation, bridges, storage etc. with a safe and economical method. A structure is AN assemblage of individual components like pinned components (truss components) beam element, column, shear wall block cable or arch. Structural engineering thinks about with the look, planning and therefore the construction of structures. Structure analysis involves the determination of the forces and displacements of the structures or components of a structure. Design method involves the choice and description of the parts that conjure the structural system. The main object of ferroconcrete design is to realize a structure which will lead to a secure economical resolution.

Details of the Structure

The present work is carried out on the unstable resistant high-rise building. For analysis we are using software E-TABS 2013 we designed a multistoried building of G+20

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.

SALIENT FEATURES

Utility of building	:	Commercial Complex
No of Stories	:	G+20
Type of Construction	:	R.C.C Frame 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
Steel Grade	:	Fe 415

Size of Structural Members

COLUMN SIZES:

From ground floor to tenth floor: 750 mm X 900 mm

From eleventh floor to twentieth floor: 450 mm X 750 mm

BEAM SIZES: 400 mm X 600 mm

SLAB THICKNESS: 120 mm

Viscous Dampers on Each Elevation

Loads Considered

1. **Live load**
   Live load from 1st floor to 14th floor = 3 Kn/M^2
   Live load on 14th floor =1.5 kN/m^2
2. **Dead load**
   Dead load is taken as prescribe by the IS: 875 -1987 (Part-I) Code of Practice Design Loads (other than earthquake) for Buildings and structure.
   Unit wt of R.C.C = 25 kN/m^3
   Unit wt of brick masonry = 19 kN/m^3
   Floor finish = 1.5 kN/m^2
   Wall load = 12 kN/m
3. **Wind load**

The wind speed (V_b) of any locality can be obtained from IS 875(Part 3 -1987)

- The wind load depends up on Risk level terrain roughness, height and size of structure,
- Vz = Vb K1.K2.K3
  Where,
  Vz = basic wind load at any height **z** in m/s
  K1 = risk coefficient
  K2 = height and structure and size factor
  K3 = topography factor
  Wind Exposure parameters
  - Windward Coefficient. = 0.8
  - Leeward Coefficien = 0.5

Wind coefficients

- Wind speed = 44 m/s
- Terrain category = 4
- Structure class = C
- Risk coefficient (k1) = 1
- Topography (k3) = 1

4. **Seismic loading**

In the present work the building is assumed to be located in ZONE II & ZONE V .

- Using the IS 1893 – 2002 the following are the various values for the building considered.

a. ZONE FACTOR (Z):

It is an element to get the look spectrum depending on (lie perceived most unstable risk characterised by most thought-about Earthquake (MCE) within the zone within which the structure is found. the fundamental zone factors enclosed during this standard are affordable estimate of effective peak ground acceleration.

ZONE-II = 0.10, ZONE V = 0.36

b. RESPONSE REDUCTION FACTOR R :

It is the issue by that the particular base-shear force that will be generated if the structure were to stay elastic throughout its response to the look Basis Earthquake (DBE) shaking, shall by reduced to get the look lateral force.

Response reduction factor for ZONE II= 3 & for ZONE V =5.0 from IS 1893-2002

c. IMPORTANCE FACTOR (I):

It is an element accustomed acquire the planning seismal force reckoning on the purposeful use of the structure, characterised by hazardous consequences of post-earthquake purposeful would like, historical worth, or economic importance.

Importance factor (1) = 1 (from IS 1893-2002 (Part-I),Table-6).

d. SOIL TYPE:

Soil site factor (1 for hard soil, 2 for medium soil, and 3 for soft soil) depending on type of soil average response acceleration coefficient Sa/g is calculated corresponding to 5% damping (Clause 6.4.5 of IS 1893-2002). In the present work three type of soil are used.

e. DAMPING:

It is the effect of internal friction, imperfect elasticity of material, slipping, sliding etc in reducing the amplitude of vibration and is expressed as a percentage critical damping.

Damping – 5%

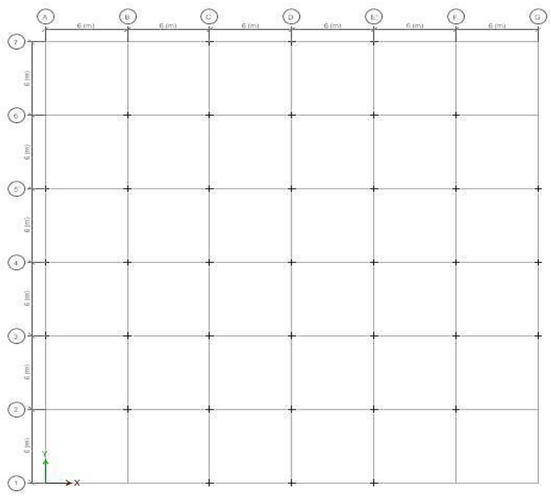


Figure 1. Plan view of HIGHRISE building

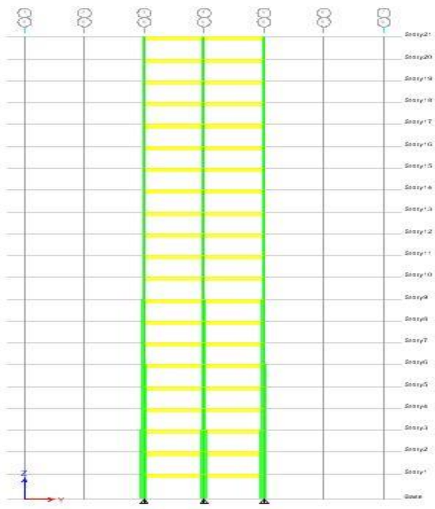


Figure 2. Elevation view of high rise buiding without DAMPERS

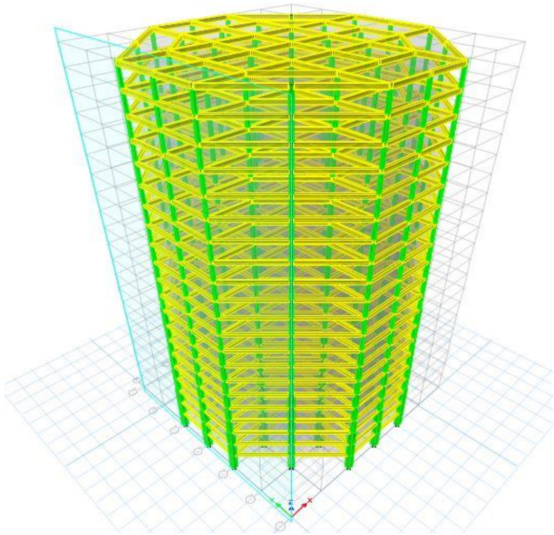


Figure 3. 3D view of high rise building without DAMPERS

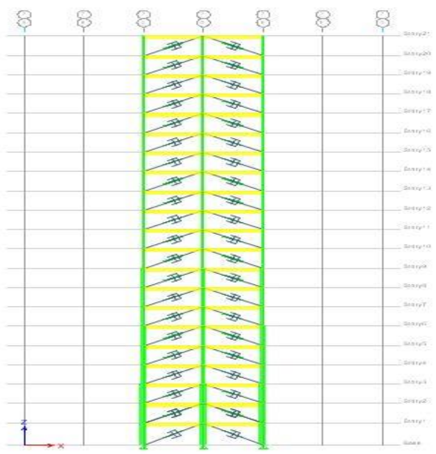


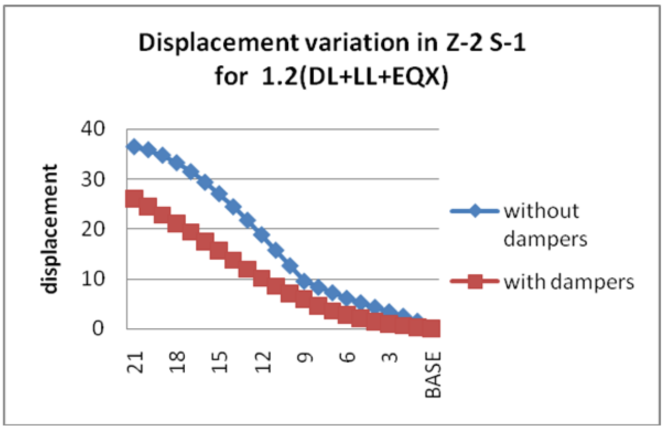
Figure 4. Elevation view of highrise building with DAMPERS

III. RESULT AND DISCUSSION

Case-1: Displacement Comparison Values & Graphs in Static Analysis

Table-1 Comparative values of displacement in Z-II S-I

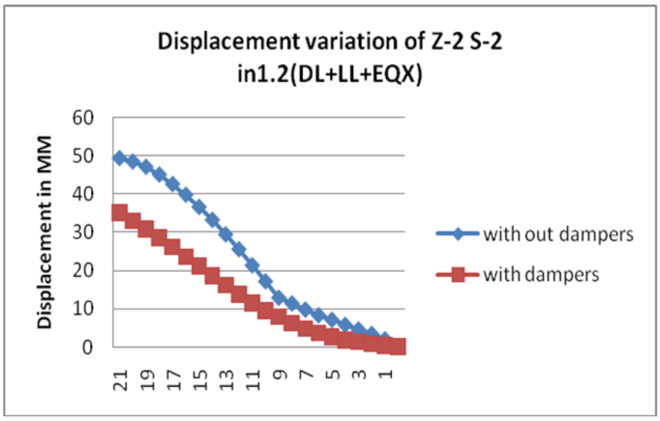
Storey	without dampers	with dampers
21	36.4	26
20	35.8	24.4
19	34.7	22.7
18	33.2	21
17	31.4	19.3
16	29.3	17.4
15	27	15.6
14	24.4	13.7
13	21.7	11.9
12	18.8	10.1
11	15.7	8.5
10	12.6	7
9	9.5	5.9
8	8.3	4.6
7	7.2	3.5
6	6.1	2.7
5	5.2	2
4	4.3	1.4
3	3.4	1
2	2.5	0.6
1	1.5	0.3
BASE	0	0



Graph-1 Variation of displacement variation in Z-II S-I

Table-2 Comparative values of displacement in Z-II S-II

storey	without dampers	with dampers
21	49.5	35.3
20	48.6	33.1
19	47.2	30.9
18	45.2	28.6
17	42.7	26.2
16	39.9	23.7
15	36.7	21.2
14	33.3	18.7
13	29.5	16.2
12	25.6	13.8
11	21.4	11.5
10	17.2	9.5
9	12.9	7.9
8	11.4	6.2
7	9.8	4.8
6	8.3	3.7
5	7.1	2.7
4	5.8	1.8
3	4.6	1.3
2	3.4	0.8
1	2	0.4
BASE	0	0

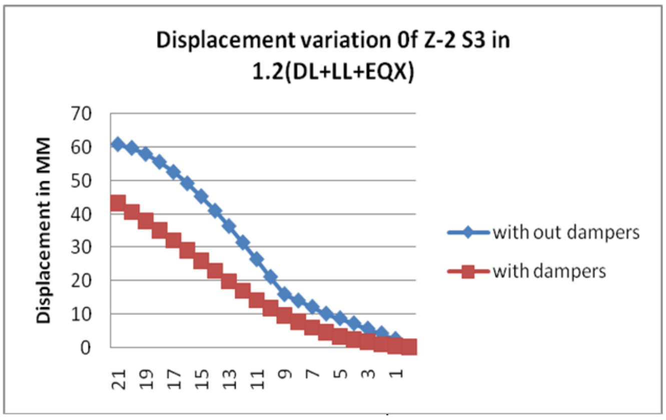


Graph-2 Variation of displacement variation in Z-II S-II

Table-3 Comparative values of displacement in Z-II S-III

storey	with out dampers	with dampers
21	60.8	43.4

20	59.7	40.7
19	57.9	37.9
18	55.5	35.1
17	52.5	32.1
16	49.1	29.1
15	45.2	26
14	40.9	22.9
13	36.3	19.8
12	31.4	16.9
11	26.4	14.1
10	21.1	11.7
9	15.9	9.6
8	14	7.6
7	12.1	5.9
6	10.1	4.5
5	8.7	3.2
4	7.2	2.3
3	5.6	1.6
2	4.2	0.9
1	2.5	0.4
BASE	0	0



Graph-3 Variation of displacement variation in Z-II S-III

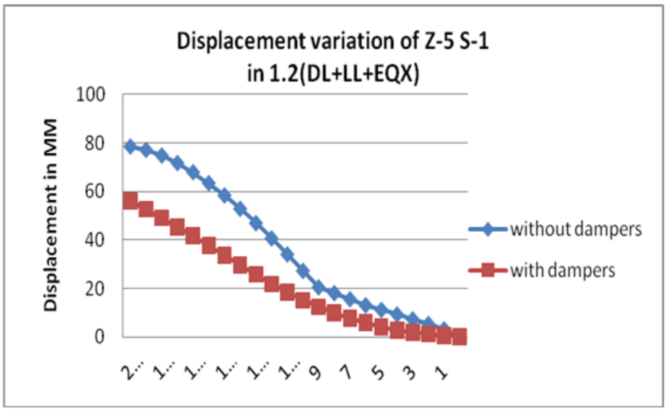
Table-4 Comparative values of displacement in z-5 S-I

storey	without dampers	with dampers
21	78.6	56
20	77.2	52.6
19	74.9	49
18	71.8	45.3
17	68	41.5
16	63.5	37.6
15	58.4	33.6
14	52.9	29.6
13	47	25.7
12	40.7	21.8
11	34.1	18.3
10	27.3	15.1
9	20.5	12.4
8	18.1	9.8
7	15.6	7.6
6	13.1	5.8
5	11.2	4.2
4	9.3	2.9
3	7.3	2
2	5.4	1.2
1	3.2	0.5
BASE	0	0

Graph-4 Variation of displacement variation in Z-V S-I

Table-5 Comparative values of displacement in z-5 S-II

storey	without dampers	with dampers
21	106.9	76.2
20	105	71.4
19	101.9	66.6
18	97.7	61.6
17	92.5	56.4
16	86.4	51.1
15	79.5	45.7
14	72	40.2
13	64	34.9
12	55.4	29.7
11	46.5	24.8
10	37.2	20.4
9	28	16.8
8	24.6	13.3
7	21.3	10.3
6	17.9	7.8
5	15.3	5.7
4	12.6	3.9
3	9.9	2.7
2	7.3	1.6
1	4.4	0.7
BASE	0	0



Graph-4 Variation of displacement variation in Z-V S-I

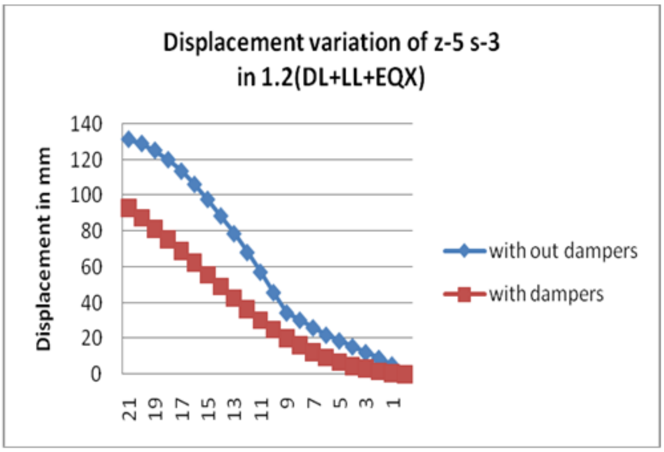
Table-6 Comparative values of displacement in z-5 S-II

storey	without dampers	with dampers
21	106.9	76.2
20	105	71.4
19	101.9	66.6
18	97.7	61.6
17	92.5	56.4
16	86.4	51.1
15	79.5	45.7
14	72	40.2
13	64	34.9
12	55.4	29.7
11	46.5	24.8
10	37.2	20.4
9	28	16.8
8	24.6	13.3
7	21.3	10.3
6	17.9	7.8
5	15.3	5.7
4	12.6	3.9
3	9.9	2.7
2	7.3	1.6
1	4.4	0.7
BASE	0	0

Graph-5 Variation of displacement variation in Z-V S-II

Comparative values of displacement in z-5 S-III

storey	without dampers	with dampers
21	131.3	93.5
20	128.9	87.7
19	125.1	81.7
18	119.9	75.6
17	113.5	69.2
16	106.1	62.7
15	97.7	56
14	88.5	49.4
13	78.6	42.8
12	68.1	36.5
11	57.1	30.5
10	45.7	25.1
9	34.4	20.5
8	30.3	16.3
7	26.1	12.7
6	22	9.6
5	18.8	7
4	15.5	4.8
3	12.2	3.3
2	9	1.9
1	5.4	0.8
BASE	0	0

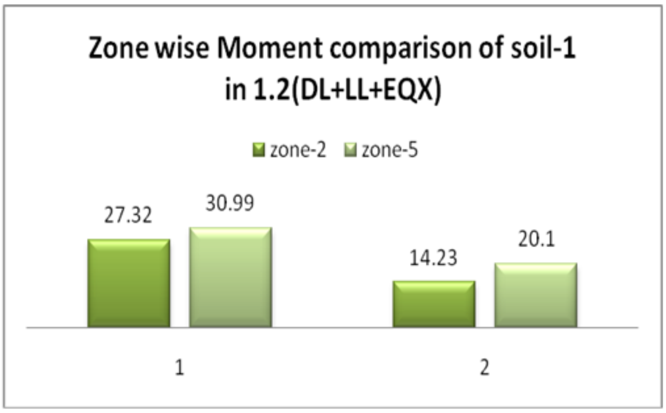


Graph-6 Variation of displacement variation in Z-V S-III

CASE 2 : Zone wise comparison of displacement

Table-7 Zone Wise Comparative values of displacement of soil-1

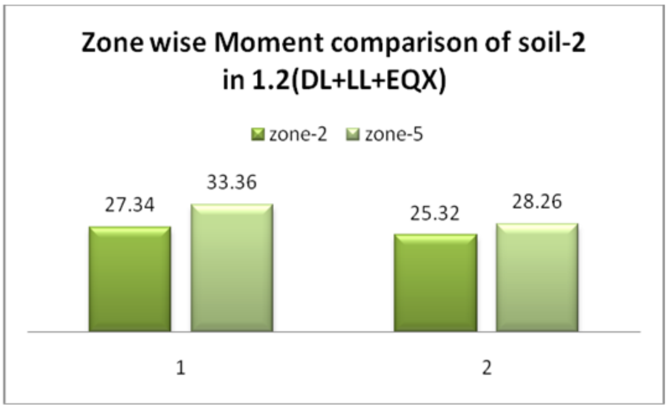
ZONES	without dampers	with dampers
zone-2	27.32	14.23
zone-5	30.99	20.1



Graph-7 Showing zone wise displacement variation in soil-1

Table-8 Zone Wise Comparative values of displacement of soil-2

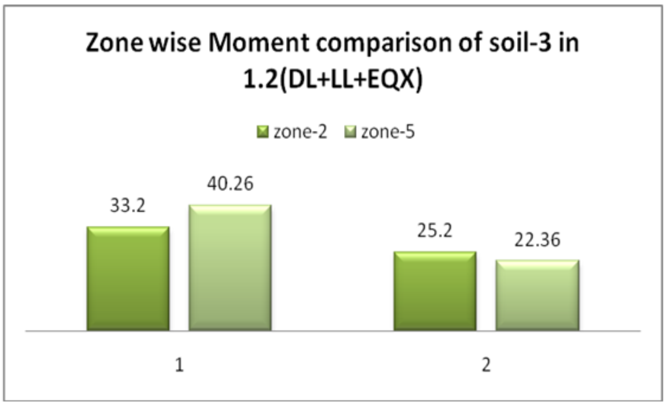
ZONES	without dampers	with dampers
zone-2	27.34	25.32
zone-5	33.36	28.26



Graph-8 Showing zone wise displacement variation in soil-2

Table-9 Zone Wise Comparative values of displacement of soil-3

ZONES	without dampers	with dampers
zone-2	33.2	25.2
zone-5	40.26	22.36



Graph-9 Showing zone wise displacement variation in soil-3

IV. CONCLUSION

Displacement is compared in STATIC ANALYSIS & Displacement is compared for two models i.e. without dampers & with dampers the following conclusions are made :

1. By providing dampers the stiffness of the structure was improved.
2. At top storey of a high rise building the displacement of 36.4 mm is observed in **ZONE-II SOIL-1** before retrofitting and displacement is reduced by 26 mm after retrofitting the high-rise building with **VISCOUS DAMPERS.**
3. In **ZONE-II SOIL-II** the displacement of 49.5 mm is observed at top storey and it is reduced by 35.3 mm after retrofitting.
4. In **ZONE-II SOIL-III** the displacement of 60.8 mm is observed at top storey and it is reduced by 45.34 mm after retrofitting.
5. In **ZONE-V SOIL-I** the displacement of 78.6 mm is observed at top storey and it is reduced by 56 mm after retrofitting.
6. In **ZONE-V SOIL-II** the displacement of 106.9 mm is observed at top storey and it is reduced by 76.2 mm after retrofitting.
7. In **ZONE-V SOIL-III** the displacement of 131.3 mm is observed at top storey and it is reduced by 93.5 mm after retrofitting.
8. By providing VISCOELASTIC DAMPERS 50% of displacement can be reduced.

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