International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)
Web Site: www.ijettcs.org Email: editor@ijettcs.org, editorijettcs@gmail.com
Volume 7, Issue 2, March - April 2018 **ISSN 2278-6856**

Analysis Of Shear Wall Core And Pherify Using E Tabs

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Abstract: ***In recent decades, shear wall and tube structures are the most appropriate structural forms, which have caused the height of concrete buildings to be soared. So, recent RC tall buildings would have more complicated structural behavior than before. In the seismic design of buildings, reinforced concrete structural walls, or shear walls, act as major earthquake resisting members. Structural walls provide an efficient bracing system and offer great potential for lateral load resistance. Reinforced concrete (RC) buildings after have vertical plate like RC walls called Shear walls in addition to slab, beams and columns. These walls generally start at foundation level and are continuous throughout the building height. The Properties of these seismic shear walls dominate the response of the buildings, and therefore, it is important to evaluate the seismic response of the walls appropriately. In this present study, main focus is to determine the solution for shear wall location in multi-storey building. Effectiveness of shear wall will be studied with the help of four different models. Model one is bare frame structural system and other three models are dual type structural system. An earthquake load is applied to a buildings of ten stories located in zone III. Parameters like time Period, mode shape, lateral displacement, storey shear and storey drift.***

Keywords: Analysis, Shear Wall, Core,Pherify, E Tabs

1. INTRODUCTION

There has been a considerable increase in the construction of tall buildings both residential and commercial and the modern trend is towards more tall and slender structures. Thus the effects of lateral loads like wind loads, earthquake loads and blast forces are attaining increasing importance and almost every designer is faced with the problems of providing adequate strength and stability against lateral loads. In modern tall buildings, shear walls are commonly used as a vertical structural element for resisting the lateral loads that may be induced by the effect of wind and earthquakes which cause the failure of structure.Shear wall are one of the excellent means of providing earthquake resistance to multistoried reinforced concrete building. The structure is still damaged due to some or the other reason during earthquakes. Behaviour of structure during earthquake motion depends on distribution of weight, stiffness and strength in both horizontal and planes of building. To reduce the effect of earthquake reinforced concrete shear walls are used in the building. These can be used for improving seismic response of buildings. Structural design of buildings for seismic loading is primarily concerned with structural safety during major Earthquakes, in tall buildings, it is very important to ensure adequate lateral stiffness to resist lateral load. The provision of shear wall in building to achieve rigidity has been found effective and economical. When buildings are tall, beam, column sizes are quite heavy and steel required is large. So there is lot of congestion at these joint and it is difficult to place and vibrate concrete at these place and displacement is quite heavy.

2. METHODOLOGY

Figure 1. Shows the methodology adopted in this study

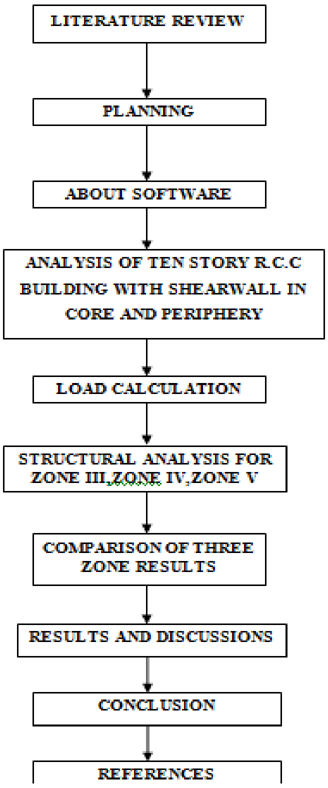

Figure 1 Methodology

3. PROJECT DESCRIPTION

3.1 Different Arrangements of Model

Model 1 – Framed structure.
Model 2 – The building with shear walls on Periphery.
Model 3 – The building with shear walls on core.
Model 4 – The building with shear walls at Periphery and Core.

Figure 2 shows the Model I, Model II, Model III, Model IV.

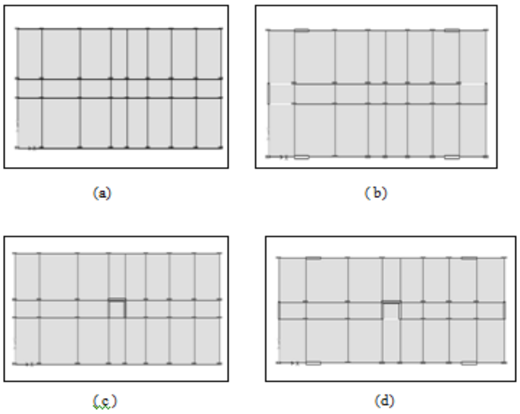

Figure 2 (a) Model I, (b)Model II, (c) Model III, (d)Model IV

3.2 Building Description

Size of the building - 31m x 12m
No. of stories - 10
Floor to floor height - 3m
Beam size - 0.23m x 0.45m
Column size - 0.23m x 0.75m
Thickness of slab - 0.15m
Thickness of wall - 0.23m
Shear wall - 0.23m x 2.00m
Grade of concrete and steel-M25 and Fe450

3.3 Load Details

3.3.1 Dead Loads & Live Loads

Following loads are considered under this load case as shown in table. Self-weight of modeled members is automatically computed by analysis program.Table 1 shows the dead loads & live loads.

Table 1: Dead loads & live loads

SL.NO	LOAD TYPE	DENSITY/ WEIGHT	AS IS 1893(PART 1) :2002
1	Weight of Slab	25 kN/m^2	Table 8(Clause 7.3.1)
2	Infill/Parapet weight	20 kN/m^3	
3	Floor Finish	1 kN/m^2	
4	Water Proofing	2 kN/m^2	
5	Roof Finish	1 kN/m^2	
6	Floor Load	5 kN/m^2	
7	Roof Load	3 kN/m^2	

Table 2 shows the load combination for designing the frames

Table 2: Loads combination for designing the frames

S No	Load Case	Description	Name
1	1	SEISMIC LOAD(+X DIR)	SEIS +X
2	2	SEISMIC LOAD(-X DIR)	SEIS -X
3	3	SEISMIC LOAD(+Z DIR)	SEIS +Z
4	4	SEISMIC LOAD(-Z DIR)	SEIS -Z
5	5	DEAD LOAD	DL
6	6	LIVE LOAD	LL

3.4 Zone Factor (Z)

It is a factor to obtain the design spectrum depending on the perceived maximum seismic risk characterized by maximum seismic risk characterized by Maximum considered Earthquake (MCE) in the zone in which the structure is located. The basis zone factors included in this standard are reasonable estimate of effective peak ground acceleration.

3.5 Response Reduction Factor (R)

It is the factor by which the actual base shear force that would be generated if the structure were to remain elastic during its response to the Design Basis Earthquake (DBE) shaking, shall be reduced to obtain the design lateral force.

3.6 Importance Factor (I)

It is a factor used to obtain the design seismic force depending on the functional use of the structure, characterized by hazardous consequences of its failure, its post – earthquake functional need, historic value or economic importance.

3.7 Damping

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

4. SEISMIC EFFECTS ON STRUCTURES

4.1 Inertia Forces in Structures

Earthquake causes shaking of the ground. So the building resting on it will experience motion at its base. From Newton's I Law of Motion, even though the base of the building moves with the ground, the roof has a tendency to stay in its original position. But since the walls and columns are connected to it, they drag the roof along with them. This tendency of the roof to continue to remain its previous position is known as inertia. In the building, since the walls or columns are flexible, the motion of the roof is different from that of the ground.

4.2 Horizontal and Vertical Shaking

Earthquake causes shaking of the ground in all three directions- along two horizontal directions (x &y) and the vertical direction (z). During the earthquake, the ground shakes randomly back and forth along each of these directions. All structures are primarily designed to carry the gravity loads in the vertical direction. Hence, most structures tend to be adequate against vertical shaking. However, horizontal shaking along x and y directions remains a concern. Structures designed for gravity loads, in general, may not be able to safely sustain the effects of horizontal earthquake shaking. Hence it is necessary to ensure adequacy of the structures against horizontal earthquake effects.

4.3 Behavior of Brick Masonry Wall

Masonry buildings are brittle structures and one of the most vulnerable of the entire building stock under strong earthquake shaking. Thus, it is very important to improve the seismic behavior of masonry buildings. A number of earthquake-resistant features can be introduced to achieve this objective. Ground vibrations during earthquakes causes inertia forces at locations of mass in the building. These forces travel through the roof and walls to the foundation. The main emphasis is on ensuring that these forces reach the ground without causing major damage or collapse. Of the three components of a masonry building (roof, wall and foundation, Fig1 (a)), the walls are most vulnerable to damage caused by horizontal forces due to earthquake. A wall topples down easily if pushed horizontally at the top in the direction perpendicular to the plane (termed weak direction), but offers much greater resistance if pushed along its length (termed strong direction. Horizontal inertia forces developed at the roof transfers to the wall acting either in the weak or in the strong direction. If all the walls are not tied together like a box, the walls loaded in their weak direction tend to topple. To ensure good seismic performance, all walls must be joined properly to the adjacent walls. In this way, walls loaded in the weak direction can take advantage of the good lateral resistance offered by walls loaded in strong direction. Further, walls also need to be tied to the roof and foundation to preserve their overall integrity.

4.4 Shaking and Ground Rupture

Shaking and ground rupture are the main effects created by earthquakes, principally resulting in more or less severe damage to buildings and other rigid structures. The severity of the local effects depends on the complex combination of the earthquake magnitude, the distance from the epicenter, and the local geological and geomorphological conditions, which may amplify or reduce wave propagation. The ground-shaking is measured by ground acceleration. Specific local geological, geomorphological, and geo structural features can induce high levels of shaking on the ground surface even from low-intensity earthquakes. Ground rupture is a visible breaking and displacement of the Earth's surface along the trace of the fault, which may be of the order of several meters in the case of major earthquakes. Ground rupture is a major risk for large engineering structures such as dams, bridges and nuclear power stations and requires careful mapping of existing faults to identify any which are likely to break the ground surface within the life of the structure. This effect is called site or local amplification.

4.5 Landslides and Avalanches

Earthquakes, along with severe storms, volcanic activity, coastal wave attack, and wildfires, can produce slope instability leading to landslides, a major geological hazard. Landslide danger may persist while emergency personnel are attempting rescue.

4.6 Fires

Earthquakes can cause fires by damaging electrical power or gas lines. In the event of water mains rupturing and a loss of pressure, it may also become difficult to stop the spread of a fire once it has started.

4.7 Soil Liquefaction

Soil liquefaction occurs when, because of the shaking, water-saturated granular material (such as sand) temporarily loses its strength and transforms from a solid to a liquid. Soil liquefaction may cause rigid structures, like buildings and bridges, to tilt or sink into the liquefied deposits.

4.8 Tsunami

Tsunamis are long-wavelength, long-period sea waves produced by the sudden or abrupt movement of large volumes of water. In the open ocean the distance between wave crests can surpass 100 kilometers (62 mi), and the wave periods can vary from five minutes to one hour. Such tsunamis travel 600-800 kilometers per hour (373–497 miles per hour), depending on water depth. Large waves produced by an earthquake or a submarine landslide can overrun nearby coastal areas in a matter of minutes. Tsunamis can also travel thousands of kilometers across open ocean and wreak destruction on far shores hours after the earthquake that generated them.

4.9 Human Impacts

An earthquake may cause injury and loss of life, road and bridge damage, general property damage, and collapse or destabilization (potentially leading to future collapse) of buildings. The aftermath may bring disease, lack of basic necessities, mental consequences such as panic attacks, depression to survivors, and higher insurance premiums.

4.10 Causes of Earthquake Damage

The conventional masonry, particularly in unreinforced and non- engineered structures, being very weak in resisting tensile and shear stresses, leads to disastrous collapse of the entire building/ structure, causing heavy damage to property and loss of lives. The main deficiencies in the conventional non- engineered/ un-reinforced masonry construction and other reasons for the extensive damage in such buildings are:

- Heavy dead weight and very stiff buildings, attracting large seismic inertia forces.

- Very low tensile strength, particularly with poor mortars.
- Low shear strength, particularly with poor mortars.
- Brittle behavior in tension as well as compression.
- Weak connection between wall and wall.
- Weak connection between roof and wall.
- Stress concentration at corners of doors and windows.
- Overall un symmetry in plan and elevation of the building
- Unsymmetry due to imbalance in the sizes and positions of openings in the wall.
- Defects in construction, such as use of substandard materials, unfilled joints between bricks.

5. ABOUT SOFTWARE

5.1 E-Tabs Software

Early releases of E-TABS provided input, output and numerical solution techniques that look into consideration the characteristics unique to building type structures, providing a tool that offered significant savings in time and increased accuracy over general purpose programs.

As computers and computer interfaces involved, E-TABS added computationally complex analytical options such as dynamic nonlinear behavior, and powerful cad-like drawing tools in a graphical and object based interface. Although E-TABS looks radically different from its predecessors of 30years ago, its mission remains the same to provide the profession with the most efficient and comprehensive software for the analysis and design of the buildings.

- Most buildings are of straight forward geometry with horizontal beams and columns. Although any building configuration is possible with E-TABS, in most cases a simple grid system defined by horizontal floors and vertical column lines can establish building geometry with minimal effort.
- Many of the floors levels in the buildings are similar. This commonality can be used numerically to reduce computational effort.
- The input and output connections used correspond to common building terminology. With E-TABS, the models are defined logically floor-by-floor, column-by-column, bay-by-bay and wall-by-wall and not as a stream of non-descript nodes and elements as in general purpose programs. Thus the structural definition is simple, concise and meaningful.
- In most buildings, the dimensions of the members are large in relation to the bay width and storey heights. Those dimensions have a significant effect on the stiffness of the frames. E-TABS corrects for such effects in the formulation of the member stiffness, unlike most general-purpose programs that work on centerline-to-centerline dimensions.
- The results produced by the programs should be in a form directly usable by the engineer. General-purpose computer programs produce results in a general form that may need additional processing before they are usable in structural design.
- The input, output and numerical solution techniques of ETABS are specifically designed to take advantage of the unique physical and numerical characteristics associated with building type structures. As a result, this analysis and design tool expedites data preparation, output interpretation and execution throughput.
- The need for special purpose programs has never been more evident as Structural Engineers put non-linear dynamic analysis into practice and use the greater computer power available today to create larger analytical models.
- Over the past two decades, ETABS has numerous mega-projects to its credit and has established itself as the standard of the industry. ETABS software is clearly recognised as the most practical and efficient tool for the static and dynamic analysis of multistorey frame and shear wall buildings.

6. RESULTS AND DISCUSSIONS

6.1 E-Tabs Report

ZONE – III:

Module I - Framed structure
Module II - The building with shear walls on Periphery
Module III -The building with shear walls on core
Module IV -The building with shear walls at Periphery and Core

ZONE – IV:

Module I - Framed structure
Module II - The building with shear walls on Periphery
Module III - The building with shear walls on core
Module IV- The building with shear walls at Periphery and Core

ZONE – V

Module I - Framed structure
Module II - The building with shear walls on Periphery
Module III - The building with shear walls on core
Module IV - The building with shear walls at Periphery and Core

6.2 Comparison of Three Zones (III,IV,V)

6.2.1 Module I

Figure 3 shows the framed structure of the building

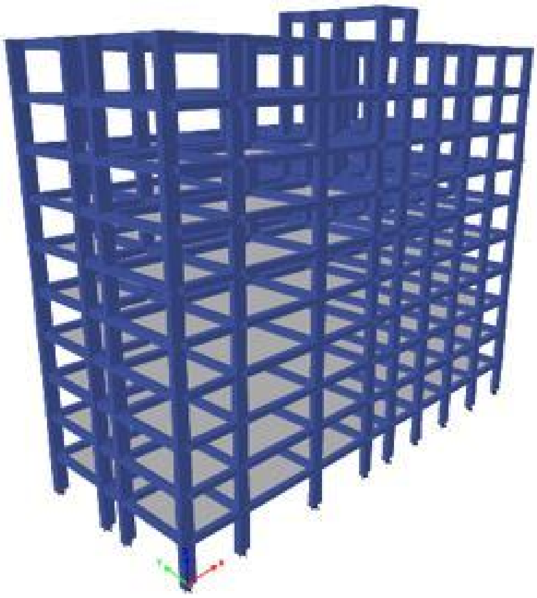

Figure3 Framed structure

6.2.2 Module II

Figure 4 shows building with shear walls on periphery

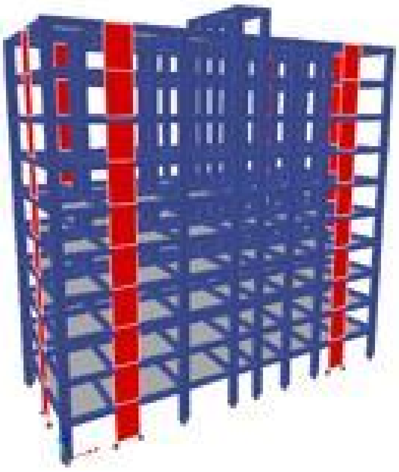

Figure 4 Building with shear walls on periphery

6.2.3 Module III

Figure 5 shows the building with shear walls on core

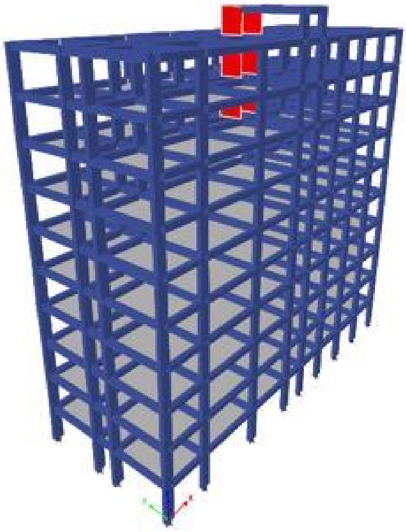

Figure 5 Building with shear walls on core

6.2.4 Module IV

Figure 6 shows the building with shear walls at periphery and core

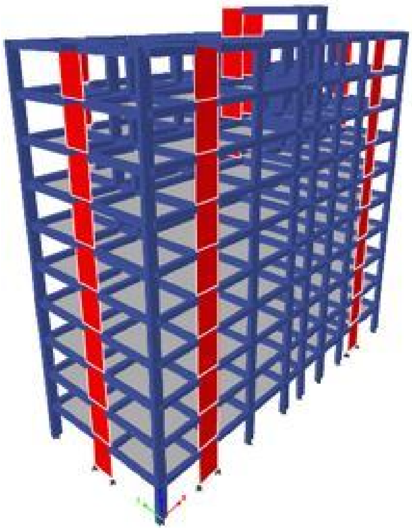

Figure6 Building with shear walls at periphery and core

Figure 7shows the comparison of bending moment & max.bm for zone IV

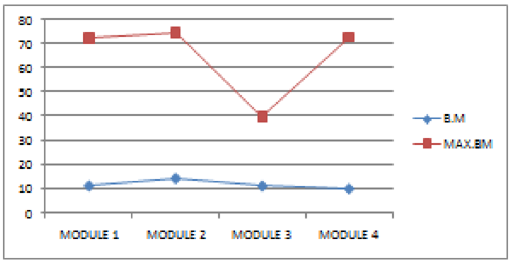

Figure 7 Comparison of bending moment & max.bm for zone IV

Through this result the deflection will be decreased in shear wall used model compared to without shearwall model.Shearwall structures will help to reduce the deformation.

Table 3 shows the Shear force comparison for zone IV modules

Table 3: Shear force comparison for zone IV modules

S.NO	MODULE	MAX.SHEAR FORCE
1.	MODULE I	783.5KN
2.	MODULE II	520.94KN
3.	MODULE III	146.97KN
4.	MODULE IV	168.26KN

Figure 8 shows the shear force comparison for zone IV modules

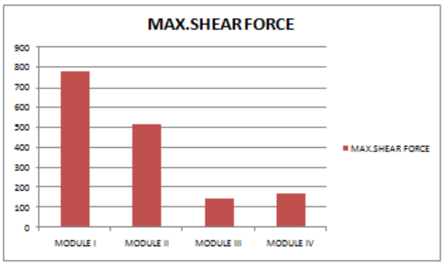

Figure 8 Shear force comparison for zone IV modules

6.3 Storey Displacement

6.3.1 Differention on Module I for Three Zones

Figure 9 shows the storey displacement foe zone III

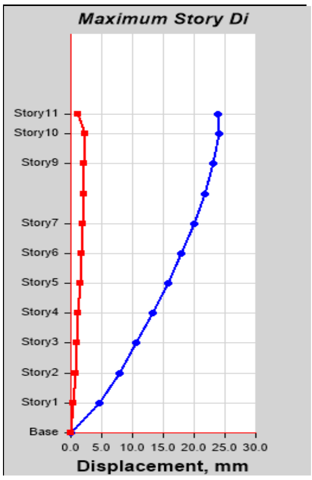

Figure 9 Storey displacement for zone III

Figure 10 shows the storey displacement for zone IV, zoneV

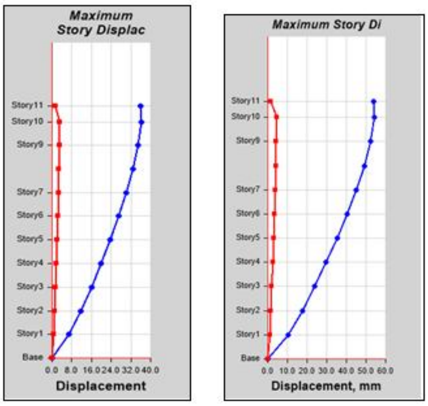

Figure 10: Storey displacement for zone IV, zoneV

Table 4 shows the storey displacement

Table 4: Storey displacement

S.NO	ZONE	X-DIR	Y-DIR
1.	ZONE III	0.0001954	0.01947
2.	ZONE IV	0.0001954	0.01947
3.	ZONE V	0.0001954	0.01947

Figure 11 shows the graph of storey displacement comparison

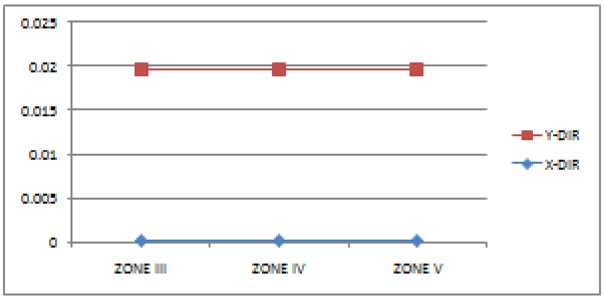

Figure 11 Storey displacementcomparison

6.4 Storey Drift

6.4.1 Differention on Module I for Three Zones

Figure 12 shows the storey drift for zone III

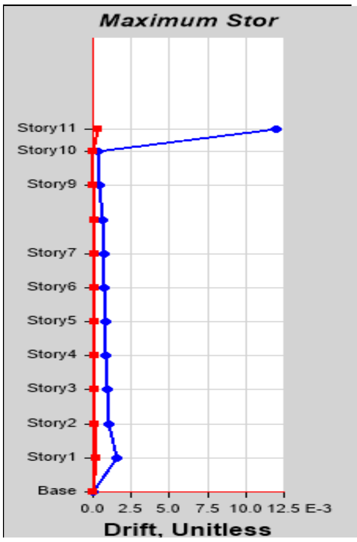

Figure12 Storey drift for zone III

Figure 13 shows the storey drift for zone IV, zone V

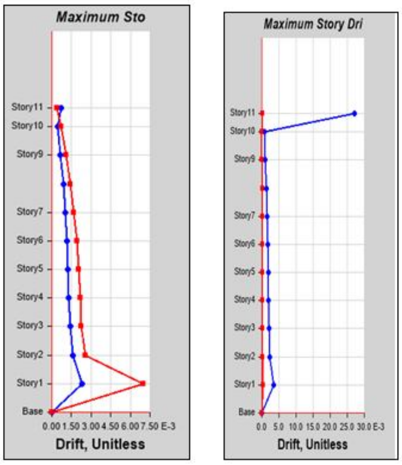

Figure13 Storey drift for zone IV, zone V

6.5 Overturning Moments

6.5.1 Differention on Module I for Three Zones

Figure 14 shows the storey overturning moments for zone III, zone IV

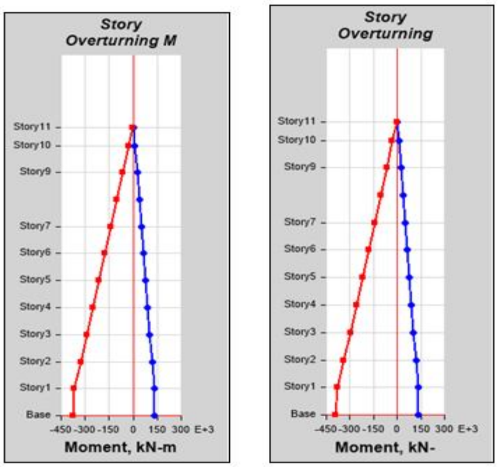

Figure14 Storey overturning moments for zone III, zone IV

Figure 15 shows the storey overturning moments for zone V

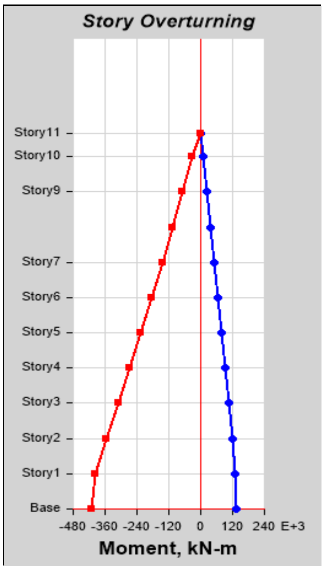

Figure15 Storey overturning moments for zone V

6.6 Response Spectrum Curves

6.6.1 Differention on Module I for Three Zones

Figure 16 shows the response spectrum curves for zone III

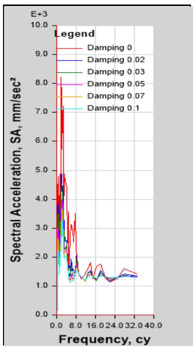

Figure 16 Response spectrum curves for zoneIII

Figure 17 shows the response spectrum curves for zone IV, zone V

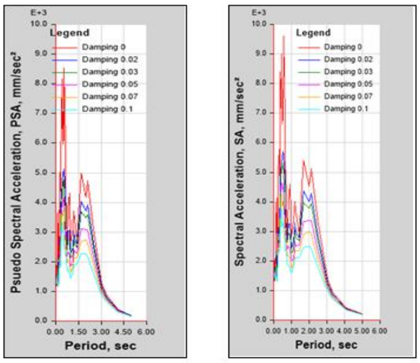

Figure 17 Response spectrum curves for zone IV, zone V

Table 5 shows the dumping for zone III, zone IV, and zone V

Table 5: Damping for zone III, zone IV, zone V

S.NO	ZONE	PERIOD (SEC)	DAMPING (0.05)
1.	ZONE III	0.03	567.92
2.	ZONE IV	0.03	497.65
3.	ZONE V	0.03	565.11

6.7 Time History Functions

6.7.1 Differention on Module I for Three Zones

Figure 18 shows the time history functions for zone III, zone IV

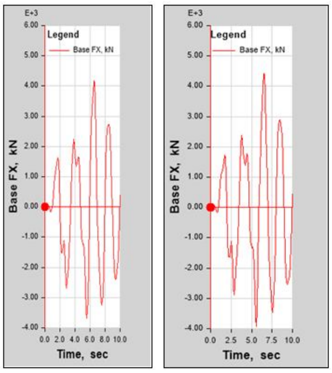

Figure 18 Time history functions for zone III, zone IV

Figure 19 shows the time history functions for zone V

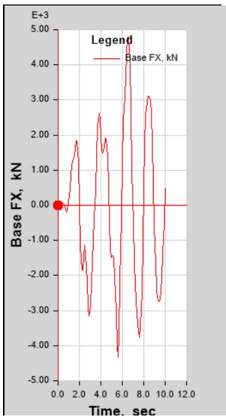

Figure19 Time history functions for zone V

Table 6 shows the time history plots comparison for three zones to module IV

Table 6: Time history plots comparison for three zones to module IV

S.NO	ZONE	Time (s)	Base FX (KN)
1.	ZONE III	1	219.6801
2.	ZONE IV	1	-0521.0627
3.	ZONE V	1	-1805.5771

Figure 20 shows the time history plot comparison for zoneIII

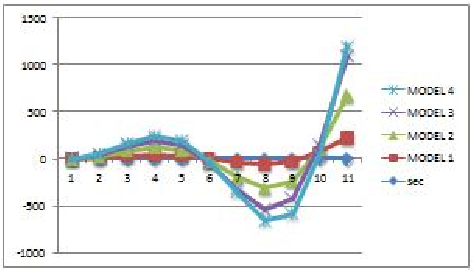

Figure 20 Time history plot comparison for zone III

6.8 Pushover Curve

6.8.1 Differention on Module I for Three Zones

Figure 21 shows the pushover curve for zone III

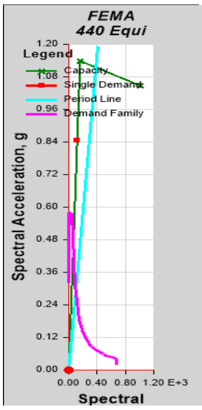

Figure21 Pushover curve for zone III

Figure 22 shows the pushover curve for zone IV, zone V

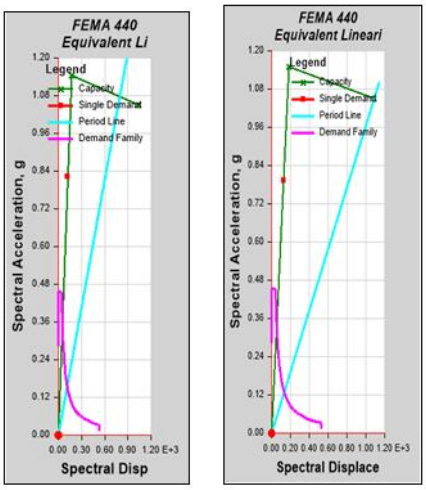

Figure22 Pushover curve for zone IV, zone V

Table 7 shows the pushover curve comparison for three zones to module IV

Table 7: Pushover curve comparison for three zones to module IV

S.NO	ZONE	SPECT.DISPLACEMENT(mm)	SPEC.ACC (g)	PERIOD(SEC)
1.	ZONE III	64.8	1.38438	0.434
2.	ZONE IV	71	1.382385	0.455
3.	ZONE V	177.6	1.364609	0.484

Figure 23 shows the comparison of pushover curve

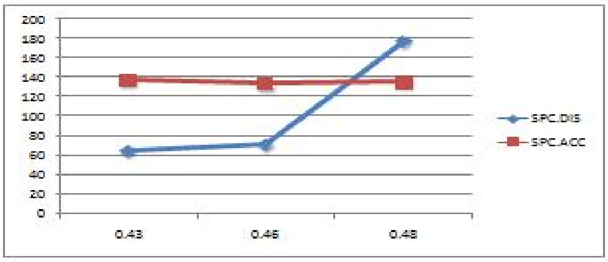

Figure23 Comparison of pushover curve

7. CONCLUSION

In general, the provision of shear wall has significant influence on lateral strength in taller buildings while it has less influence on lateral stiffness in taller buildings. The provision of shear wall has significant influence on lateral stiffness in buildings of shorter height while it has less influence on lateral strength. The influence of shear walls is significant in terms of the damping characteristics and period at the performance point for tall buildings. The structural configuration of model-4 has exhibited superior structural performance in terms of both the stiffness and strength in the elastic as well as in the nonlinear range up to performance point.

- RCC Structure with Shear Wall is more stable and resistant to Base Shear and Displacement than that of normal RCC Frame.
- An RCC Shear walled Structure can resist 19.9% more base shear than that of a normal RCC Frame.

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