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Behavior of R. C. Shearwall in High Rise Residential Building Using ETABS

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ABSTRACT

Besides, food and clothing, shelter is a basic human need. India has been successful in meeting the food and clothing requirements of its vast population; however the problem of providing shelter of all is defying solutions. While there has been an impressive growth in the total housing stock from 65 million in 1947 to 187.05 million in 2001, a large gap still exists between the demand and supply of housing units. The Working Group on Housing for the 9th five-year plan estimated the housing shortage in 2001 at 19.4 million units- 12.76 million in rural area and 6.64 million in urban area. The shortage of housing is acutely felt in urban areas more so in the 35 Indian cities, which according to the2001 census have a population of more than a million. Hence in order to overcome this problem construction process should be quick, tall and effective to accommodate huge population in a given area. So we have chosen this topic of BEHAVIOUR OF SHEARWALL IN HIGH RISE RESIDENTIAL BUILDING USING ETABS. This type of shear wall construction helps to build tall structure of about 18 floors within no time. Hence the construction process will become much quicker and efficient. Constructions made of shear walls are high in strength ,they majorly resist the seismic force, wind forces and even can be build on soils of weak bases by adopting various ground improvement techniques. In the present analysis a building with a height of 50 meters is analyzed in ZONE-2 & ZONE-5 with three different soils. Displacement, shears, moments is compared with different zones & soils in both Static & Dynamic analysis. We are verifying and designing this structure using Extended Three Dimension Analysis of Buildings (ETABS) 2013software.

Keywords: Shear Wall, Simply Supported Beam, Reinforced Steel Concrete, Momemts, Shear, Deflection, ETABS

I. INTRODUCTION

SHEAR WALL STRUCTURES:

Adequate stiffness is to be ensured in high rise buildings for resistance to lateral loads induced by wind or seismic events. Reinforced concrete shear walls are designed for buildings located in seismic areas, because of their high bearing capacity, high ductility and rigidity. Concrete or masonry continuous vertical walls may serve both architecturally as partitions and structurally to carry gravity and lateral loading. There will be no architectural difficulty in extending them through the height of the building; their very high in plane stiffness and strength had proved them to be ideally suited for resisting lateral loads. Compared to frame type structures, shear-wall structures offer less distortion and less damage to non structural elements. Care shall be taken to have symmetrical configuration of walls in the building so that torsion effect in plan could be avoided.

II. BRIEF HISTORY

Reinforced concrete tall buildings were introduced more or less two decades after the first steel tall buildings. The earlier concrete buildings were subjective in form by the skeletal, column and girder arrangements of their steel counterpart. But they differed in depending on the inherent rigid frame action of concrete construction to resist horizontal loading. Afterward, the flat slab and flat plate were introduced and later the moment resistant frame continued as the main repertoire of RC high rise structural form until the late 1940s.

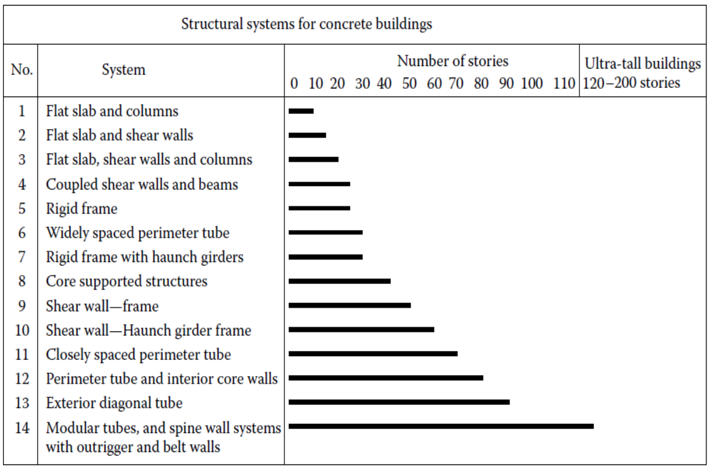
III. STRUCTURAL FORMS

Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important to have sufficient strength for the structure against vertical loads. Earthquake and wind forces are the only major lateral forces that affect the buildings. The function of lateral load resisting systems or structure form is to absorb the energy induced by these lateral forces by moving or deforming without collapse. The selection of structural forms is strongly influenced by the following range of factors that has to be taken into account:

1. The internal planning
2. The material and the method of construction
3. The nature and magnitude of the horizontal loading
4. The external architectural treatment
5. The height and proportions of the building and
6. The planned location and routing of the service systems

The taller and more the slender a structure, the more important the structural factors become and the more necessary it is to choose an appropriate structural form or the lateral loading system for the building. In high rise buildings which are designed for a similar purpose and of the same height and material, the efficiency of the structures can be compared by their weight per unit floor area.

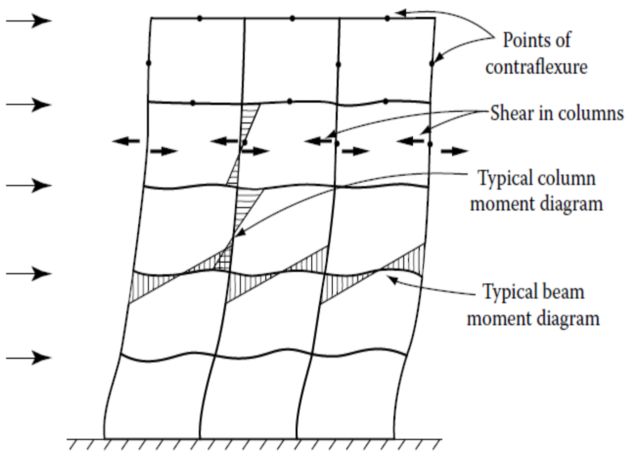
The typical storey height required to accommodate the extra depth required is in the range of 3.5m or more. In the case of residential building or hotel, the services then can be run vertically adjacent to the columns and walls or in a separate shafts to emerge in each storey either very close or to be distributed horizontally from where to where required, along the corridor ceiling spaces.



Therefore, the ceiling space is not required with the exception of the corridors. So, the typical storey height to be kept down approximately 3m or more. A 30-storey residential building is, therefore, generally of notably less height than a 30-storey office building.

IV. RIGID FRAME STRUCTURES

Rigid frame structures consist of girders and columns joined by moment resisting connections. For a rigid frame bent the lateral stiffness depends on the bending stiffness of the columns, girders, and connections in the plane of the bent. The main advantage of the rigid fame structure is its open rectangular arrangement, which allows the choice of planning and simple fitting of doors and windows.



Rigid frame-Forces and Deformations

V. IN-FILLED FRAME STRUCTURES

In filled frame structures are the most common form of construction for high rise buildings up to 30 stories in height. Column and girder framing of reinforced concrete is in filled by panels of brickwork, block work or cast-in-place concrete.

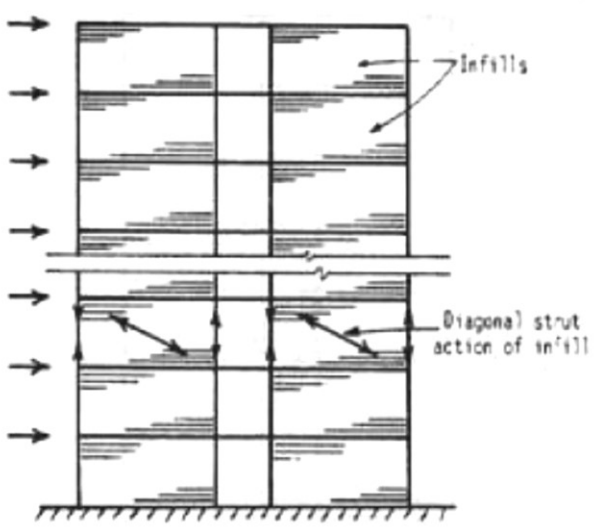
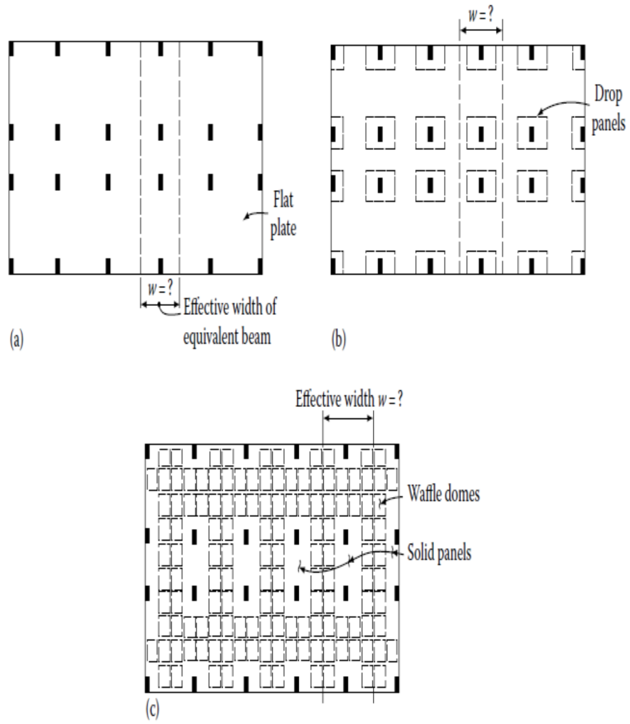


Fig: In filled frame

The complex interactive performance of the infill in the frame, and rather random quality of masonry, has made it complicated to predict with accuracy the stiffness and strength of an infill wall.

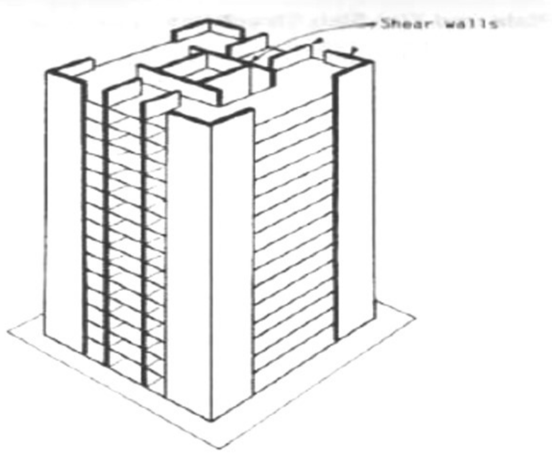
VI. FLAT-PLATE AND FLAT-SLAB STRUCTURES

The simplest structural framing techniques for a concrete building consist of a two way floor slab framing directly into columns without beams. The system, which is essentially of reinforced concrete, is very economical in having a flat soffit requiring the most uncomplicated formwork.



Flat-plate and Flat-slab structures

The behaviour of flat plate structure is similar to that of a rigid frame under lateral loading. The lateral stiffness of the components depends on the flexural stiffness on the components and their connections with the slabs corresponding to the girders of rigid frame.



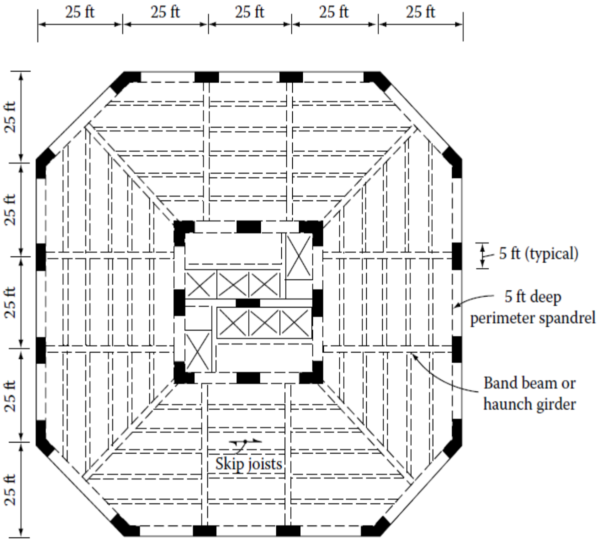
Shear wall structure

It is very important to note that shear walls meant to resist earthquakes and wind forces should be designed for ductility. Where a concrete frame is designed to resist lateral forces and then a stiff but brittle masonry filler wall is positioned within this frame there is a very great possibility that because of its greater stiffness, it will draw more of the earthquake forces and fill in shear when the brittle masonry fails.

VII. FRAMED TUBE STRUCTURES

The frames consist of closely spaced columns that are 2 to 4 meters center to center that are joined by deep spandrel girders. The lateral resistance of framed-tube structures is provided by very stiff moment resisting frames that form a 'tube' around the perimeter of the building. The gravity loading is shared between the tube and interior columns or walls along with the lateral loading. The perimeter frames aligned in the direction of lateral loading acts as the 'webs' of the massive tube cantilever, and those normal to the direction of lateral loading acts as the 'flanges' when the lateral load acts on them.

The closely spacing of the columns throughout the height of the building is usually undesirable at the entrance level. As a solution for this the columns are merged or terminated on a transfer beam, a few stories above the base so that only a few, larger, more widely spaced columns continue to the base. The tube form is mainly designed for the buildings which are in rectangular configurations and it is appropriate for other plans shaped like circular and triangular configurations. The tube structures high in structural efficiency but still leaves scope for improvement because the 'flange' frames tend to suffer from 'shear lag'. The term tube systems are closely spaced columns say, 2.43–4.57 m, tied together with a relatively deep spandrel. However, for buildings with compact plans, it is possible to achieve tube action with moderately widely spaced columns interconnected with deep spandrels. As an example, the plan of a 28-story building constructed in New Orleans is shown in the below figure. Lateral resistance is provided by a perimeter frame consisting of columns 1.5 m wide, spaced at 7.62 m c **7**

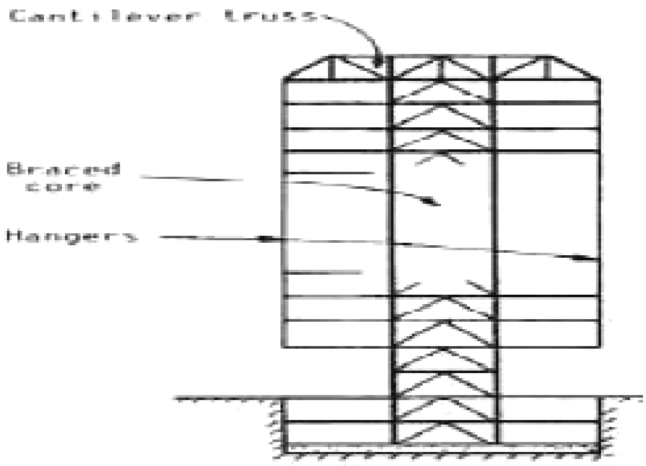


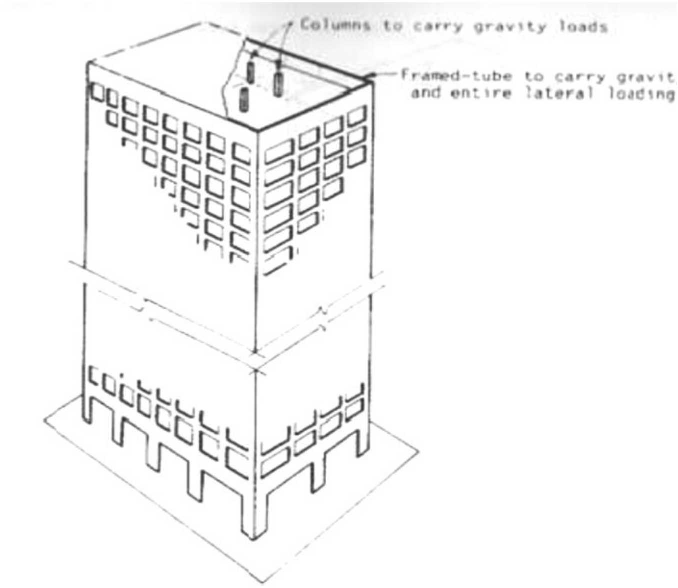
VIII. OUTRIGGER BRACED STRUCTURES

Outrigger braced structural form is efficient form and consists of a central core, comprising either braced frames or shear walls, with horizontal cantilever outrigger trusses or girders connecting the core to the outer column. When the structure is affected by lateral loading vertical rotation of the planes is restricted by the outriggers through tension in the windward columns and compression in the leeward columns. The effective structural depth of the building is greatly increased, thus augmenting the lateral stiffness of the structure and reducing the deflections and moments in the core. This makes the outriggers join the columns to the core to make the structure behave as a partly composite cantilever.

IX. SUSPENDED STRUCTURES

The suspended structures consists of a central core, or cores, with horizontal cantilevers at roof level, to which vertical hangers of steel cable, rod, or plate are attached. The floor slabs are suspended from the hangers. The advantages of this structural form mainly concern with architectural advantages. The ground story is entirely free from vertical members, thereby allowing an open concourse. The structural disadvantages of this type of structural form are that it is ineffective in first transmitting the gravity loads upwards to the roof level cantilevers before returning them to through the core to the ground. And also the structural width of the building at the base is restricted to the relatively narrow depth of the core, which intern restricts the systems to the limited height.





X. NEED FOR THE STUDY:

Earthquakes are occurring frequently now-a-days. The seismic analysis and design of buildings has traditionally focused on reducing the risk of loss of life in the largest expected earthquake. To reduce the effects caused by these earth quakes and wind loads different lateral loading systems are introduced in the structures. Shear walls are one of the lateral loading systems commonly constructed in high rise buildings below 35 stories. Position of shear walls in unsymmetrical buildings has due

XI. FACTORS AFFECTING EARTHQUAKE DESIGN OF STRUCTURE:

There are many factors of the building that affect the behavior of the building when subjected to an earthquake. The following factors are considered of major importance.

1. Natural frequency of the building
2. Damping factor of the structure
3. Type of foundation of the structure
4. Importance of the building

Ductility of the structure

Frames that are specially designed for ductility are known as special moment resisting frames; where as those detailed with fewer considerations are known as ordinary moment resisting frames. For satisfactory performance, if a building is designed as SMRF frame, it needs to be designed for only lesser forces than if it is designed as on OMRF frame.

The analysis can be carried out on the basis of the external action, the behaviour of the structure or structural materials, and the type of structural model selected. Based on the height of the structure and zone to which it belongs, type of analysis is selected. In all the methods of analyzing multi-storey buildings recommended in the code, the structure is treated as discrete system having concentrated masses at floor levels, which include half that of columns and walls above and below the floor. In addition, suitable amount of live load at this floor is also lumped with it. Earthquake analysis of buildings; two of them are presented here:

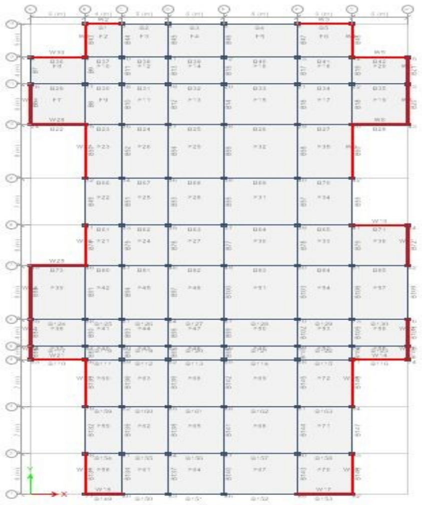
a. Equivalent Static Lateral Force Method (pseudo static method).
b. Dynamic analysis.
    (1) Response spectrum method.
    (2) Time history method

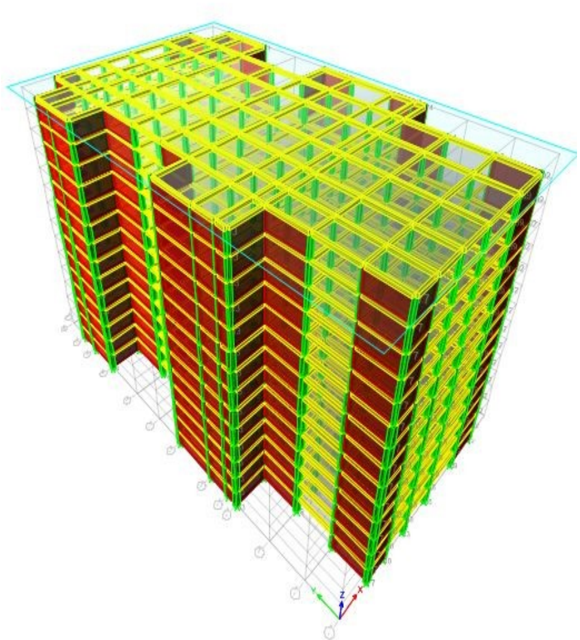
XII. VARIATION OF DISPLACEMENT FOR DIFFERENT ZONES & SOILS:

In this case the reduction of Displacement is observed when the lateral systems i.e. when bracings are provided in both directions UX & UY. The displacement for 23 storey building along UX direction is compared with zone 3 & each soil i.e. zone factor on X axis & displacement on Y axis, is to be noted that displacement of 40% is reduced from Z-2 to Z-5.Displacement in Y direction from it is to be noted that displacement of 40 % is reduced from Z-2 to Z-5.

VARIATION OF SHEAR FOR DIFFERENT ZONES & SOILS:

In this case the reduction of Shear is observed when the lateral systems i.e. when bracings under static load for both directions UX & UY. The Storey Shear for 23 storey building along UX direction is compared with each zone & each soil i.e. zone factor on X axis & Storey Shear on Y axis, from is to be noted that Storey Shear of 35% is reduced from Z-2 to Z-5. Storey Shear in Y direction it is to be noted that Storey Shear of 45% is reduced from Z-2 to Z-





VARIATION OF MOMENT FOR DIFFERENT ZONES & SOILS:

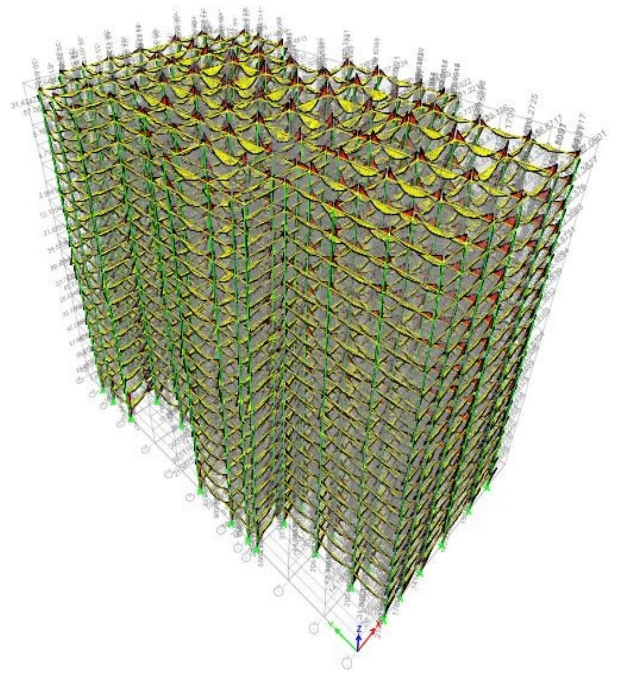
In this case Moment is analyzed in dynamic load and it is observed that Moment is increases with increase in zone factor. Taking different soils on X- axis & Moment on Y-axis and analyzed for each zone from Graph it is to be noted that Moment is decreased 40% from Z-2 to Z-5. Moment along Y from it is to be noted that Moment is increased 46% from Z-2 to Z-5.

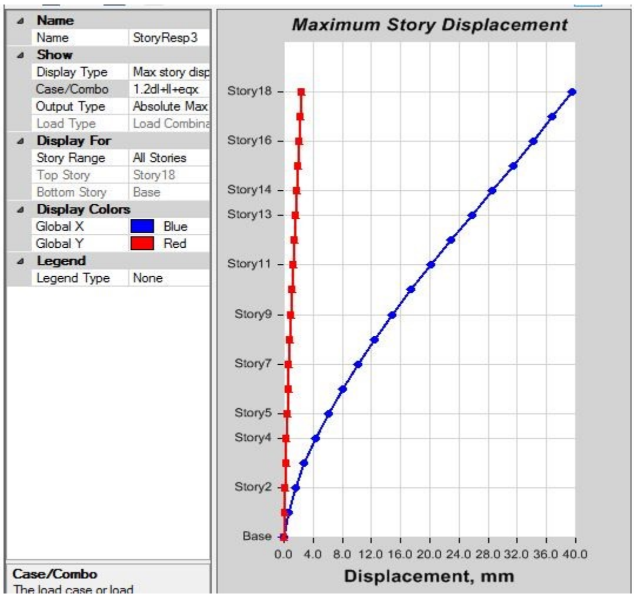
VARIATION OF BASE SHEAR FOR DIFFERENT ZONES & SOILS:

In this case Moment is analyzed in dynamic load and it is observed that Moment is increases with increase in zone factor. Taking different soils on X- axis & Moment on Y-axis and analyzed for each zone from Graph. It is to be noted that Moment is decreased 40% from Z-2 to Z-5.

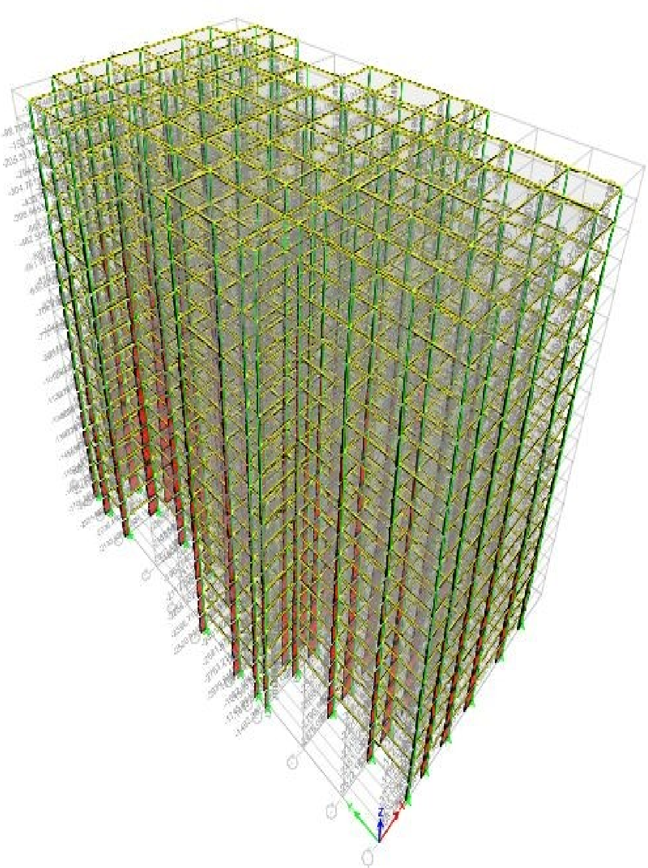
VARIATION OF BASE MOMENT FOR DIFFERENT ZONES & SOILS:

In this case Moment is analyzed in dynamic load and it is observed that Moment is decreases with increase in zone factor. Taking different soils on X- axis & Moment on Y-axis and analyzed for each zone from Graph. It is to be noted that Moment is decreased by 25% from Z-2 to Z-5.





Showing moment variation



XIII. CONCLUSION

1- The center of mass and center of rigidity is influenced by adding and positioning of shear wall. It can be concluded that all models are symmetric about x-direction and there is no effect of torsion due to center of mass and center of rigidity in x-direction. The performance of structure with shear wall is better than structure without shear wall because center of mass and center of rigidity become closer.
2- Provision of shear wall generally results in reducing the displacement because the shear wall increases the stiffness of building and sustains the lateral forces. The better performance is observed and displacement is reduced in both x and y directions and shows better performances with respect to displacement when analysis is carried out by using response spectrum method.
3- The shear force resisted by the column frame is decreasing by placing the shear wall and the shear force resisted by the shear wall is increasing. This can be concluded indirectly by observing the maximum column shear force and moment in both directions.

The moment resisting frame with shear walls are very good in lateral force such as earthquake and wind force. The shear walls provide lateral load distribution by transferring the wind and earthquake loads to the foundation. And also impact on the lateral stiffness of system and also carry gravity loads.

4- It is evident that shear walls which are provided from foundation to the roof top, are one of the excellent mean for

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