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SEISMIC PERFORMANANCE OF REINFORCED CONCRETE SHEAR WALLS

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Abstract: E-tabs means extended three-dimensional analysis of the building system. ETABS integrates every aspect for the engineering design process. In the current situation of the housing industry, the buildings that are being built are generally those with the most efficient results, which are elevated features such as beam and columns in multi-story RC structures. This software is mainly used for structures such as high-raised concrete and steel structures. The aim of the work is to investigate high-raised G+ 15 floors with respect to seismic, dead and live loads.
Shear walls are generally used in areas with a high incidence of earthquakes because they are highly effective in carrying lateral loads. These shears walls effectively resisted not only earthquake loads but also wind loads, which are quite high in some zones. For two decades, the principle of structural design has not changed, now the limit state method is changing to a conventional method, it is no longer considered a modern design principle. In addition to elastic design, there is also a modern and futuristic method that includes design beyond the scope of inelastic materials and is known as "performance-based design" for a multi-story building.
The results are compared. And also, to analyze story drift, lateral displacement, base reaction at different flows and for different zones for models with and without partition wall.

***Index Terms* – Shear walls, Seismic loads, Wind loads, Response spectrum, Seismic analysis, High rise building.**

1. INTRODUCTION

An increase in the population, during which there is a deficit of land and a high-rise structure is chosen to overcome it. These types of high-rise buildings are influenced by a natural phenomenon. Such as earthquake and wind pressure are the most dangerous means of damage and influence caused to the structural element and that cannot be controlled [1]. These natural calamities cause damage to structures and interpretations in the development of a normal life cycle. Since this is a global concern, most of the analysis should be ascertained and provided with the result to make the structure ready for the period. With the advancement of technology, man tries to fight these natural phenomena in various ways such as developing early warning system of disasters, adopting new preventive measures, proper assistance and rescue measures. However, this does not apply to purely natural disasters [2]. The hazard maps show that the seismic zones in the seismic zone code as per (IS 1893:2016) are revised from time to time, resulting in additional base shear requirements for existing buildings. Structural collapse can be reduced if the following points are considered. Most building structures contain elements such as beams, columns, shear wall stiffeners, and floor slabs. Floor slabs in multi-story buildings, which generally transfer gravity loads to the structural system, are required to transfer lateral initial forces to the structural system.[3]
Shear Wall - It is a vertical member of a seismic resisting system designed to resist in-plane lateral forces, typically wind and seismic loads.
Wind Load - The force acting on a structure resulting from wind acting on it
Seismic Loads – These are lateral loads or the force or disturbance induced by an earthquake on a building. This usually occurs at the contact surface with either the ground or adjacent structures.

2. METHODOLOGY

In this study, a G+ 15 story building is analyzed in all seismic zones for wind and earthquake forces, a 3D model is prepared of seismic zones using ETABS-19.
It is a plot of the peak or study state response of a series of oscillations of different natural frequencies that are forced into motion by the same fundamental vibration or shock. The resulting plot can then be used to sum the response of any linear system with respect to its natural frequency of oscillation. One such application is in the assessment of the peak response of buildings to earthquakes. Strong ground motion science can use some values from the ground spectrum to correlate with seismic damage.
A response spectrum can also be used in evaluating the response of a linear system with multiple modes of oscillation, although they are only accurate for low damping levels. Model analysis is performed to identify the modes and the response in these modes can be selected from the response spectrum. These peak responses are then combined to estimate the total response.

Analysis of loads acting on a multi-story building: The loading of a tall building differs from a low-rise building in many ways, such as the large accumulation of gravity loads on the floors from bottom to top, the increased importance of wind loads, and the great importance of seismic effects. Therefore, multi-storey structures need proper load assessment for safe and economical design. Apart from dead load, the load assessment cannot be done accurately. Live loads can be approximately predicted from a combination of experience and previous field observations. Wind loads and earthquakes are random in nature and difficult to predict. They are estimated based on a probabilistic approach. The following discussion describes most of the common types of loading on multistory structures.

- Dead load
- Live load
- Earthquake load

3. METHOD OF ANALYZING OF STRUCTURE

In this study, the lateral design forces are determined by the response spectrum method as per IS 1893 (Part 1): 2016 provisional document for the building models to be considered in the study. Buildings analyzed based on building results for different zones for different load combinations to conclude the importance of taking care of seismic analysis. This work is extended to study these effects on building models by performing lateral load analysis. In this work, seismic effects on different zones on building models are considered in zone III, VI and V.

4. MODELING AND ANALYSIS

There is a resurgence in the construction of high-rise buildings and ultra-tall buildings around the world. The design of these tall buildings in a seismically active area varies dramatically from region to region, with rigorous assessment required in many countries including Nepal and China, some other countries requiring nothing more than traditional design based on force reduction factors. Recent trends in high-rise commercial construction have led to a number of unusual configurations, innovative structural systems and high-performance materials that challenge current construction practice.

One of the goals of this model design is to ensure that the model represents the characteristics of the housing structure. Today, a tall elevated structure is demanding in terms of shape, height and function. This makes each building's properties different from the others. There are certain standards for each kind of tall buildings like residential, office, commercial. The seismic design of modern tall buildings, defined as a building exceeding 170 feet in height, introduces a number of changes that must be met through consideration of scientific, engineering, modelling and analysis-specific issues, and acceptance criteria appropriate to this unique structural system. Therefore, major factors such as flow shape, floor height and column and beam are taken into account when designing the model. Six models with the same number of floors with G+15 floors with the same floor plan of 20.5 m x 15.3 m were considered for the study. The building floor height was considered 3 m for all floors and the elevation is shown in the figure. The following six models are used in the G+15 high lift study.

The modelling of the structure has been done using the structures software ETABS as per the data.

4.1 Description of the building

Type of the structure: Multi-Storey RC frame structure and Multi-Storey shear wall structure.
Number of stories: G+ 15
Story height: 3 m
Grade of concrete: M25
Density of concrete: 25kn/m^2
Modulus of elasticity of concrete: 5000 √fck as per IS 456:2000
Beam size: 300 X 600mm, 450 x 600mm, 450 x 750mm
Column size: 300 x 600mm, 450 x750mm
Slab thickness: 150 mm
Wall thickness: 200mm

Plan and elevation of G+15 Building

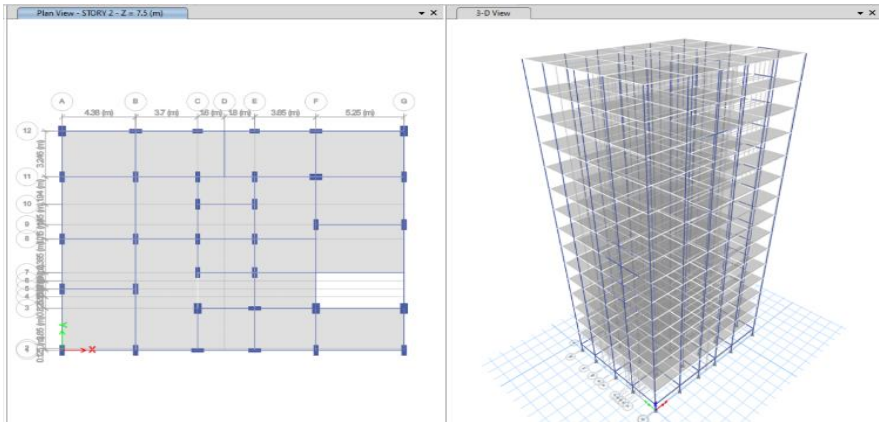

Fig 4.1 Column Layout and Elevation of framed Structure

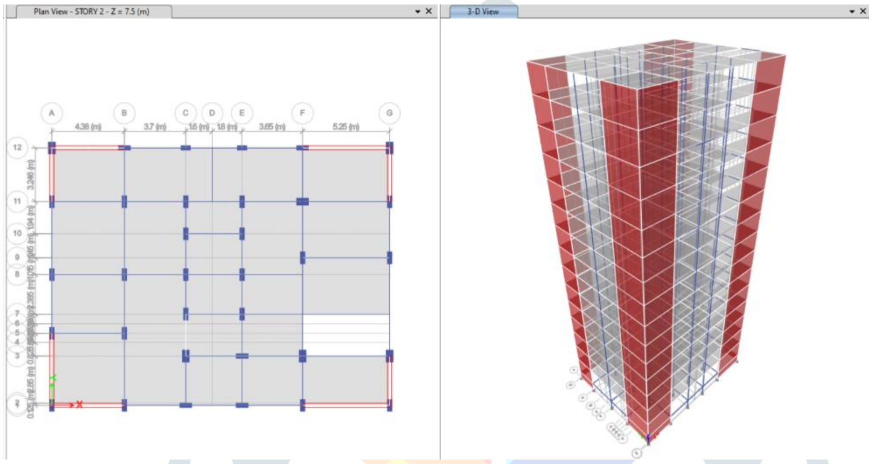

Fig 4.2 Shear Wall Layout and Elevation of Shear Wall Structure

4.2 Load Calculation

Dead Load

- The self-weight of the structural member is taken care in the software.
- Floor finish load: 1kn/m^2

Live Load

- Live load on roof is 3kn/m^2

Seismic Load

- Seismic Zone: III, IV and V as per IS 1893 (part 1) 2016
- Height of the building 46.5 m
- Damping ratio: 5% for RC frame structure
- Seismic zone factor (Z): 0.16, 0.24, and 0.36 (Table 2 of is 1893 (part 1) :2016)
- Importance of factor(I): As per IS 1893 (Part 1) 2016
- Response reaction factor (R): 5.0 as per IS 1893 (Part 1) 2016
- Foundation Soil type: Type 2 (Medium soil) as per is 1893 (Part 1) 2016

5.RESULTS AND DISCUSSION

For every seismic zone the software gives six possible seismic load cases and two combination load cases that is maximum and minimum. The six possible load cases depend upon the load acting on a structure and their behavior will be analyses and compared in terms of the following parameter of tables:

- Maximum Displacement
- Story Drift
- Base Reaction

The comparison of results in terms of the above parameter will give in terms of graph.

- Maximum Displacement

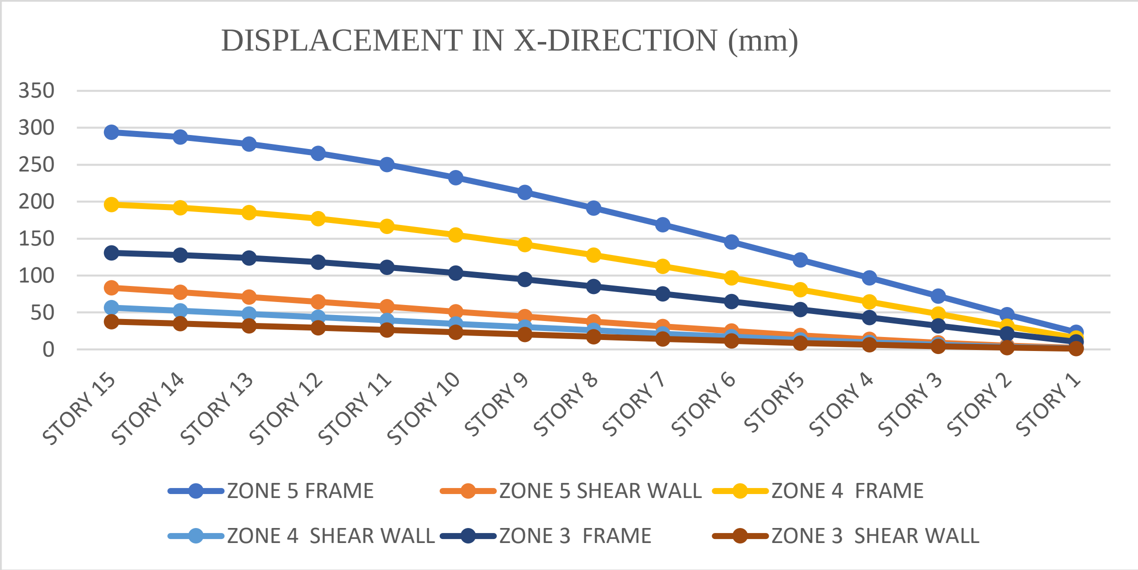

Fig 5.1 Displacements of X-direction

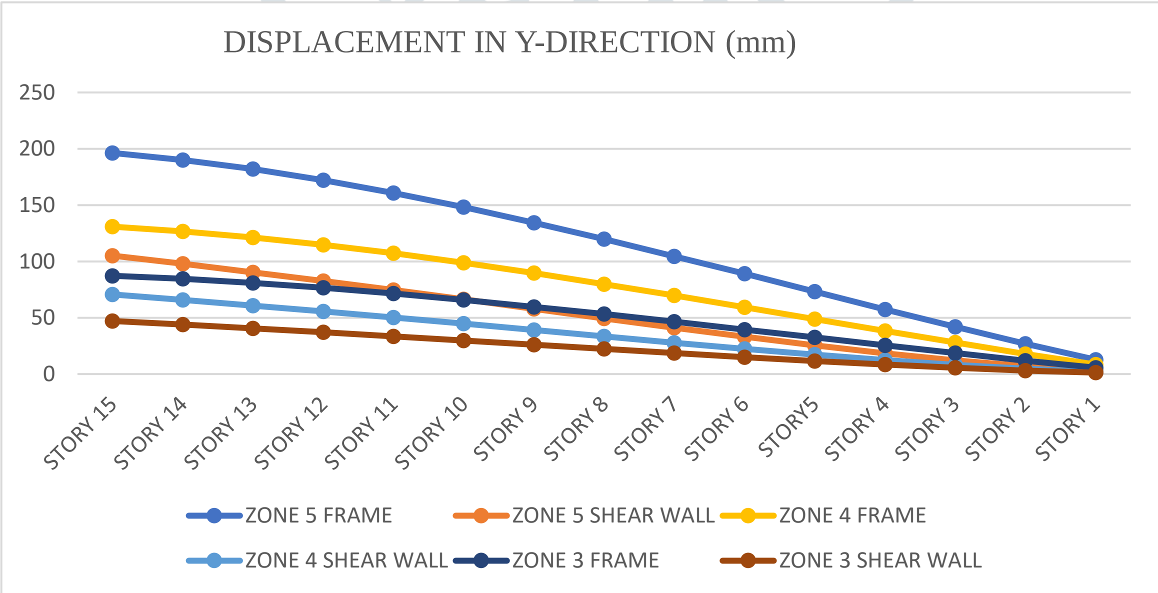

Fig 5.2 Displacements of Y-direction

- Story Drift

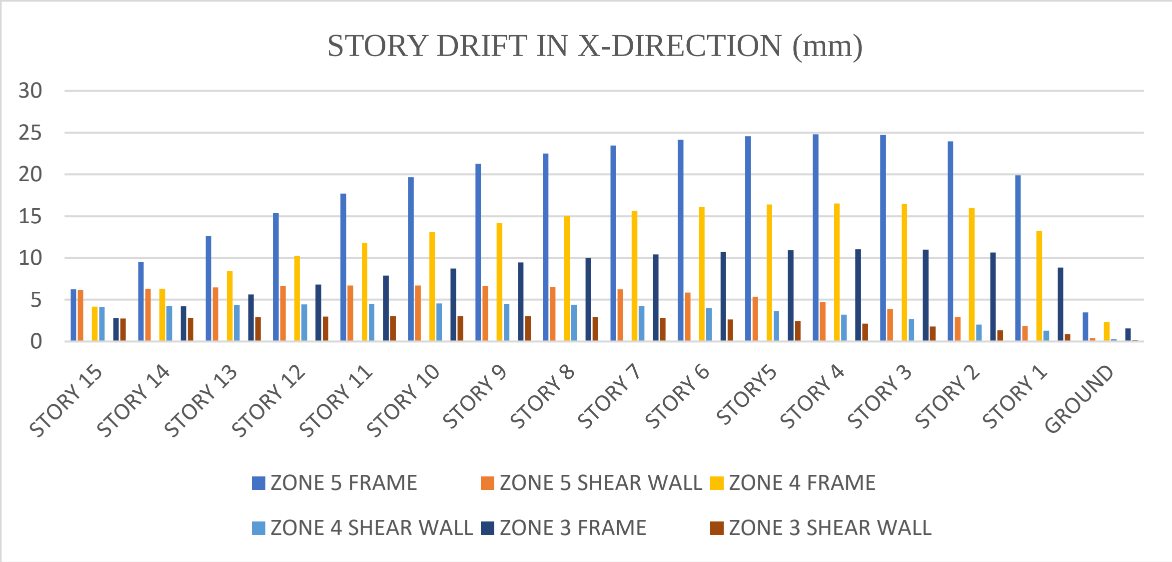

Fig 5.3 Storey Drift at X-direction

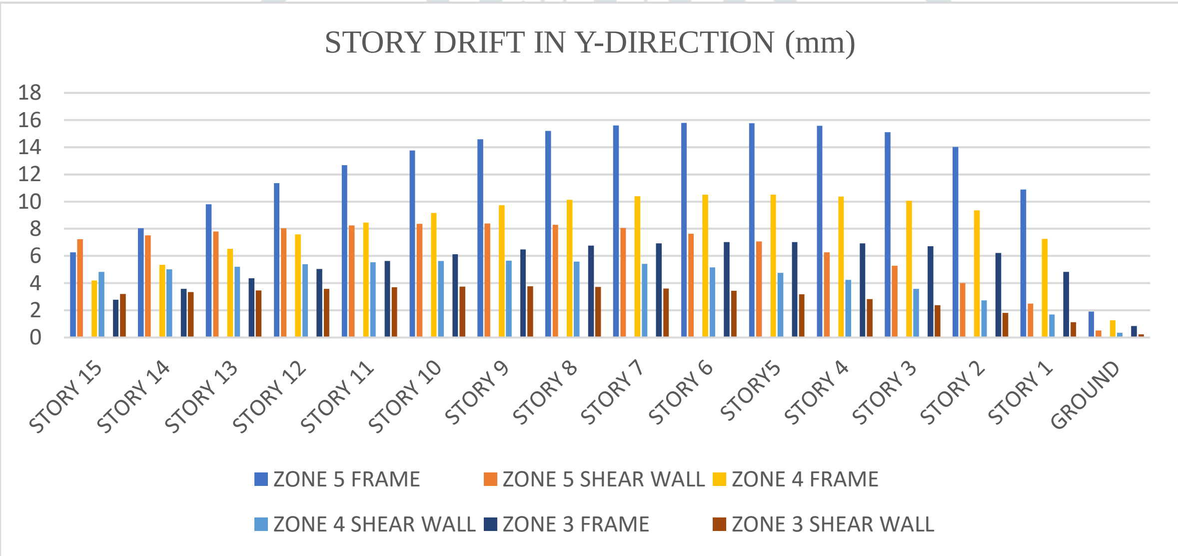

Fig 5.4 Storey Drift at Y-direction

- Base Reaction

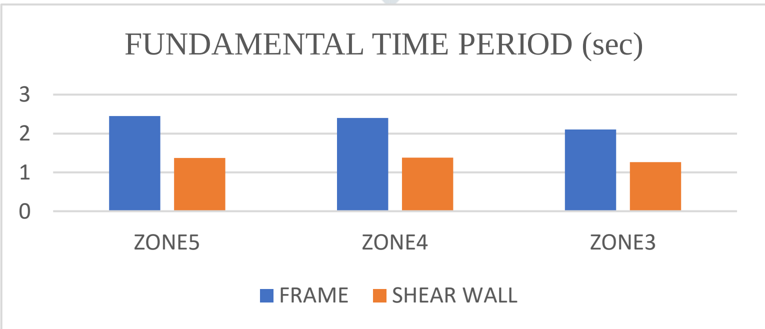

Fig 5.5 Fundamental time period

In selected building plan in EQX direction when shear walls are provided about 72% in reduction of displacement is observed, And in EQY direction when shear walls are provided about 46% of reduction in displacement is observed. It is observed that from zone III to zone IV about 33.4 % of displacement has increased at the top floor when the share walls are introduced, and from zone 3 to zone 5 about 54.9 % of increase in displacement has been observed. It is found that from zone IV to zone V about 32.28 percentage of increase in displacement at top floor in case of shear wall structure. The maximum story displacement of a frame and structure in zone 4 and zone 5 is 195.9 mm and 293.2 mm but the allowable limit as per IS 1893 (part-1) 2016 is 186 mm (H/250 where H is the height of the building). After introduction of share wall, the maximum displacement of zone 4 and zone 5 is decreased to 56.49 mm and 83.42 mm so it clearly shows that after the introduction of shear walls that displacement comes under the limiting value. The maximum story displacement in zone III is 130.6 mm and for a share wall structure is 37.63 mm and the allowable limit is 186 mm so it clearly shows that shear wall is not necessary for zone III.

The reduction of the story drift is approximately found at the H/2 of the structure where H is the height of the structure The drift is reduced in the building after the application of Shear wall. The maximum story drift of frame structures in zone V is 24.8 mm but the allowable limit as per IS 1893 (Part-1) 2016 is 12 mm i.e., 0.04 Story height (0.004x3000=12mm). The maximum story drift of a shear wall structure in zone V is 8.4 mm, so it clearly observes that after the introduction of shear wall the maximum story drift comes under an allowable limit. In case of zone IV the maximum drift in framed structure is 16.54 mm and in case of shear wall structure is 5.64 mm so there is a reduction of 10.9 mm In case of zone III the maximum drift in frame structure is 11 mm and she was structure is 3.74 mm. Where the values are under the allowable limit this shows that the shear wall is not necessary in case of zone III structures.

It was found that the Fundamental time period of the frame section buildings is more, regardless of the building shapes. shear walls in buildings have shown some shortening of the time period with respect to different zones.

6. CONCLUSION

The current study of analysis seeks to understand the effect of the shear wall on the structure located in the zone prone to earthquakes.

The following are the conclusions drawn from the analysis carried away:

1. Shear walls significantly increase stiffness and strength frame structures are therefore neglected in the analysis & structural design will lead to failure due to stiffness irregularity.
2. The key factor is the symmetry of the position of the shear wall in the floor plan to achieve the required performance of the shear wall structure.
3. The increase in the number of floors forms the frame of the building more vulnerable and therefore the shear wall becomes the need to save damage caused in high-rise buildings earthquake.
4. Increasing number of floors results in increasing lateral movement causing a greater displacement of the palate and therefore we have found that high-rise buildings without shear walls are prone to collapse under seismic loading and dangerous both life and property.
5. The basic shear for a structure with a shear wall in the corners is larger than other structure. Therefore, it is feasible ensure that the shear walls in the corners in higher earthquake prone areas
6. Floor displacement for a construction with a shear wall u there are fewer corners than in the structure without shear wall. Therefore, it is possible to create a shear wall.

SHEAR WALL HAVING MULTI-DIMENSIONAL BENEFITS

1. The higher level of rigidness in their own plane easily can limit the adverse deflection effectively.
2. Acts as fire compartment walls, ability to resist side wind the effect on the superstructure and the effect of ground movement in the sub structure. However, for low and medium-rise buildings (less than 10-storey), the construction of shear walls takes more time demanding and less accurate in dimensions than steel. In general, RC walls obtain satisfactory strength and stiffness to resist lateral load system. Shear walls contain little ductility and may not meet energy requirements necessary during a strong earthquake.

7.SCOPE OF FURTHER STUDY

In general, RC walls obtain satisfactory strength and stiffness to resist lateral load system Shear walls contain little ductility and may not meet energy requirements necessary during a strong earthquake. Care must be taken ductile shear wall constructions that are used for resistance earthquake loading. Steel shear walls are also sometimes used, by connecting them to the frame by welding or high strength screws. Masonry shear walls are also used, with full walls and grouted cavity masonry to carry shears and moments, with encapsulated stiffeners. The high-level rigidness in their own plane easily can limit the adverse deflection effectively.

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