Seismic Resistant Design and analysis of (G+15), (G+20) and (G+25) Residential Building and Comparison of the Seismic Effects on Them

Asadullah Dost[1], Asst. Prof. Anil Kumar Chaudhary[2]

[1]*Student of M.Tech Structural Engineering, School of Civil Engineering, Galgotias University, UP, India*

[2]*Asst.Prof. Anil Chaudhary, School of Civil Engineering Galgotias University, UP, India*

***Abstract*: The primary goal of this research is to conduct an earthquake analysis of G+15, G+20, and G+25 residential buildings using Indian standard codes of practice IS 1893(Part 1):2002. In general, seismic forces on a structure are calculated assuming the structure is in zone IV. The member forces are calculated using load combinations according to IS 456: 2000's Limit State Method. According to IS 875(Part 1, Part 2):1987, the structure is subjected to dead load, self-weight, and live load. With the help of the ETAB software, the structure was designed in accordance with seismic code IS-1893:2002 under seismic zone IV. So, for structural engineers, the interesting part is that the design of a high-rise building involves a lot of parameters. A high-rise multi-story building, from the perspective of a structural engineer, is one that is affected by lateral forces to the extent that they play a significant role in the structure's design due to its height. Wind and seismic loads are critical in multi-story buildings of this type (i.e., G+15, G+20, G+25). As a result, lateral stability is important for tall buildings in general.**

***Index Terms*: High rise Buildings, Seismic Forces, Wind loads, ETABS**

I. INTRODUCTION

Due to a lack of space in urban areas, vertical growth has resulted in the development of low-rise, medium-rise, and tall buildings. These buildings are usually made of framed structures. They are loaded vertically and laterally. The design is governed by lateral loads caused by wing and earthquakes rather than vertical loads. Buildings designed to withstand vertical loads may not be able to withstand lateral loads. The lateral loads are the most important because, unlike vertical loads, which are expected to increase linearly with height, lateral loads are highly variable and rapidly increase with height. Vertical-designed structures may not be able to withstand lateral loads. Because, unlike vertical loads, which are expected to increase linearly with height, lateral loads are highly variable and rapidly increase with height, they are the most important. These lateral forces cause the frame to sway. There have been several instances of buildings failing in seismically prone areas because they were not designed to withstand earthquake loads. All of these reactions highlight the importance of studying the effects of lateral loads. The frame action obtained by the interaction of slabs, beams, and columns, or a pure rigid frame system, is insufficient. For buildings taller than 15 to 20 (50m to 60m), the frame alone is insufficient to provide the required lateral stiffness. The building deflects excessively due to the shear taking component of deflection caused by the bending of columns and slab. There are two options for meeting these criteria. The first is to increase the size of members beyond the strength requirements, and the second is to change the structure’s form to one that is more rigid and stable in order to limit deformation. The first approach has its limitations, whereas the second is more elegant, increasing the structure’s rigidity and stability while also limiting the deformation requirement. The structure is designed for critical force conditions among the load combinations in earthquake engineering. [1]

In today’s India, many urban high-rise buildings have an unavoidable open first storey. The first storey is mostly being changed to make room for parking and reception areas. While a building’s total seismic base shear is determined by its natural period, the seismic force distribution is determined by the stiffness and mass distribution along with the height. The overall shape, size, and geometry of a building, as well as, how earthquake forces are carried to the ground, have a significant impact on its behaviors during earthquakes. The shortest path must be used to bring the earthquake forces developed at different floor levels in a building down to the ground; any deviation or break in this load transfer path causes the building to underperform. At the discontinuity level, vertical setbacks on buildings (such as hotel buildings with a few storeys wider than the rest) cause a sharp increase in earthquake forces. Buildings with fewer columns or walls in one storey or unusually tall storeys are more likely to suffer damage or collapse in that storey. During the 2001 Bhuj earthquake in Gujrat, many structures with an open ground floor designed for parking collapsed or suffered severe damage. There are discontinuities in the load transfer path in structures where columns hang or float on the beam at a middle storey and don't go to the foundation. [2]

The traditional design for earthquake loading on a structure should always protect the lives of the building's occupants. This should always be the primary design concern for all buildings. However, due to the demand on the structure, a structure under earthquake loading may be significantly damaged following a major earthquake. When a building was hit by a large earthquake, it did not collapse if it was properly designed, but it required extensive repairs before it could be considered reusable. Engineers began to devise methods to reduce the requirements that affects structures in order to minimize the damage, as this was extremely costly. The primary goal was to reduce the structure's accelerations and displacements. There is a wide range of creative approaches that can be used to accomplish this. Many are now in use in practice. Many are still in the works. This can be accomplished in one of two ways; tuned mass dampers were one method for dissipating energy and reducing acceleration. The base isolation technique, that separates the building from its foundation, was the second technique, minimizing and stress and displacement. This study begins with a look at the effects of earthquake loading on buildings. It then looks into the specifics of base isolation before moving on to tuned mass dampers. [3]

The main earthquake resistant members in building seismic design are shear walls. Structural walls are an efficient bracing system with a lot of lateral load resistance potential. Shear walls are built to withstand both gravity and lateral loads. Shear walls were included due to its capability to lessen lateral drifts, simplicity of design, and previous earthquake performance. Shear walls have a large in-plane stiffness, which keeps the building from lateral drifting when subjected to lateral loads. The purpose of the design of shear wall is to act elastically throughout the wind and moderate earthquake loadings in order to avoid non-structural harm. During less frequent, severe earthquakes, however, the walls are expected to be subjected to inelastic deformation. Shear walls should therefore be able to handle plastic deformation even while still carrying a load and dissipating energy. Structural and non-structural harm is anticipated during severe earthquakes; even so, collapse prohibition and life safety are the primary concerns. According to post-earthquake evaluations, shear walls are very effective at limiting damage. The amount of damage seen is determined by the structure and wall configuration. All of the early design codes for shear walls were based on their strength. However, for the majority of buildings with shear wall systems, strict detailing requirements caused code requirements to be overly conservative. A vertical structural member with a length seven or more times greater than its thickness is known as a shear wall. Shear walls have been studied experimentally and theoretically for the past fifty years as the major lateral load resistant units in multi-story building structures. [4]

II. BRIEF OVERVIEW ON PROVISIONS OF IS 1893: 2002

Vibrations in the structure are caused by earthquake motion, resulting in inertia forces. As a result, the structure must be capable of conveniently transmitting the inertia forces generated in the superstructure to the ground via the foundation. As a result, earthquake-resistant design for most ordinary structures necessitates making sure that the structure has a sufficient lateral load-carrying capacity. Seismic codes will assist a designer in designing a structure that is safe for its intended use. Seismic codes are specific to a specific area or country. IS 1893 is the main code in India that outlines how to calculate seismic design force. The mass and seismic coefficient of the structure are determined by factors such as the seismic zone in which it is located, the importance of the structure, its own stiffness, the soil that it rests, and its ductility. Part I of IS 1893:2002 (hereafter referred to as the code) deals with seismic load assessments for various structures and buildings. The entire code is focused on calculating base shear and distributing it over height. The type of analysis, such as static or dynamic, is performed depending on the height of the structure and the zone to which it belongs. STATIC ANALYSIS was used in this dissertation to analyze the structure.

III. ETABS SOFTWARE

Computers and Structures Inc. has released "ETABS-Extended 3D Analysis of Building Systems." It's a type of engineering software that's used in the construction industry. It has sophisticated structure analysis and design software tailored to multi-story building systems. Modeling tools and templates, code-based load prescriptions, analysis methods, and solution techniques are all part of the integrated system. It can handle the most complex and large building models and configurations. The ETABS software includes CAD-like drawing tools with a grid representation and an object-based interface. In the construction, design, and modelling industries, ETABS software has the following implications:

1. It's a version of construction software. It tests the load-bearing capacity of building structures and analyses and assesses seismic performance.
2. You can view and manipulate the analytical model with great precision using this software. At every grid line, plans and elevation views are generated automatically.
3. For the analysis of concrete shear walls and concrete moment frames, ETABS software is used. It is well-known for static and dynamic analyses of multi-story frame and shear wall structures.
4. It is one of the most widely used civil design tools in the construction industry, and it helps structural engineers work more efficiently. It also saves time and money by avoiding the use of general-purpose software.
5. ETABS' input, output, and numerical solution techniques are specifically designed to take advantage of the unique physical and numerical properties of building type structures. As a result, data preparation, output interpretation, and overall execution are all sped up with this analysis and design tool. [5]

IV. ADVANTAGES OF ETABS SOFTWARE

ETABS Software has been recognized as the industry-standard software for building design analysis for nearly 30 years. The following are some of the benefits of using ETABS software:

- It shows a 3D axonometric view of the model, as well as a plan view, elevation view, elevation development view, and a user-defined custom view.
- It allows you to input cross-sections of any geometry and material graphically (Section Designer).
- It can copy and paste a model's geometry into and out of spreadsheets.
- The model geometry can be easily exported to dxf files.
- It's compatible with EC – Praxis 3J for steel connection analysis and design.
- A model can also have an infinite number of grid systems. They can be positioned at any point in the model and rotated in any direction.

Engineers' modelling experience is enhanced by ETABS' built-in drawing and drafting utilities. In fact, the software includes many common industry shortcuts and controls.

V. LITERATURE REVIEW

Mohd Aleem Uddin, Sathya Prakash, Mohammed Ahmed,2018 [6] This study looks at the negative effects of floating columns in buildings where structural members are added in stages as the building is constructed in a sequential order. Equivalent static analysis and Construction Sequence Analysis (CSA) were used to compare seismic analysis and design of multi-story buildings with and without floating columns using ETABS 2016. For a G+10 storey building, results such as storey drift, storey displacement, base shear, axial force, and building torsion are investigated.

Hongli Wang, 2017 [7] Three spatial structure analysis programs were used for structural analysis of elastic wave field artificial selection of two group III sites on seismic waves, as well as three sets of "seismic safety evaluation report" provided by the structure of the elastic time history analysis, and the results of response spectrum analysis in envelope design. The corresponding measures should be taken in order to understand the seismic performance of the key components. According to the situation, the analysis considered the effect of additional P- over height may bring, to determine the structure can meet the second stage of seismic fortification requirements, and the corresponding measures are formulated to strengthen the weak component, using the SATWE EPDA&PUSH module and ABAQUS under rare earthquake static and dynamic elastoplastic analysis. West Tower is a high-rise building with super B height that can be drawn using calculations and analysis. The structure and layout of the overall structure of the design process is optimized, as appropriate, to strengthen the structural measures in the corresponding treatment of the important components, resulting in good seismic performance.

K. Sugimoto & H. Katsumata, H. Fukuyama & T. Saito, T. Kabeyasawa,2012 [8] The outline of experimental studies on the earthquake resistant performance of high-rise RC buildings under long-period ground motions is described in this paper. Two series of tests were planned to verify the effects of long-period ground motions. Two series of tests were planned to verify the effects of long-period ground motions. The main one was a shaking table test of a 1/4 scaled 20 storey RC specimen, and the other series of static loading tests were carried out to support this project and to verify the performance of some members comprising the shaking table test specimen. Static loading test specimens included two spans and one storey plane frames with three columns and two beams. The main parameters were the beam and column reinforcement ratios, as well as the loading program, which included both normal and severe cyclic loading paths for simulating the hysteresis of high-rise RC buildings that have been subjected to long-period ground motions. The capacity and/or ductility of the frames were improved by increasing the reinforcement ratio, and the skeleton curve of storey shear force and storey drift relationship in this test series was unaffected by changing the loading program. Three spans in the longitudinal direction and two spans in the transverse direction made up the shaking table test specimen.

Sean Wilkinson, Gordon Hurdman, Adrian Crowther,2005 [9] Earthquakes cause some of the most violent loading situations a structure can face, and if a structure fails under these loads, human life is inevitably endangered. The connection between beam and column is one of the most common places for a structure to fail under seismic loading. This kind of failure can lead to structural failure and the collapse of floors, if not entire buildings.

The following are the three criteria for establishing a connection in an SMRF in a seismic area:

1. The connection must be strong enough to allow the beam to develop its full plastic moment.
2. The connection must be stiff enough to meet the requirement of being a fully rigid connection.
3. The connection must be able to withstand significant post-yield deformation without losing strength.

These criteria are effectively met by transferring the plastic hinge from the connection to the beam when reducing the plastic modulus of the beam near the beam–column connection. The connection is easy to put together and has excellent seismic resistance. Furthermore, because it does not increase the moment in the connected column (as with reinforced connections) and only requires access to the bottom flange of the beam, it is particularly useful for building retrofitting.

AKASH KUMAR, ER. KUNDAN KULBHUSHAN, 2019[10] In India, reinforced concrete frames are the most common construction method. The goal of this research is to look at how a high-rise structure responds to lateral loads using static and dynamic seismic loads as well as static wind loads. This analysis procedure is based on IS codes for structural design analysis. I studied the G+21 multi-story reinforced cement concrete building for earthquake resistance. The structure is inspected in India's earthquake zone III (LUCKNOW). This area is located in India's moderate risk earthquake zone. ETABS software was used to create this structure. These projects classify seismic analysis with lateral forces based on earthquake effects. The design and construction of an earthquake-resistant structure are becoming increasingly important to everyone around the world. The goal of this project is to learn how to design various building elements such as beams, columns, slabs, foundations, and stairs using relevant Indian standard codes. Analysis of all storey components of buildings subjected to seismic action within the bounds of Indian standard code provisions.

Virendra K. Tembhare, Prof. Dilip L. Budhalani, 2019 [11] The analysis and design of high-rise buildings under wind and seismic loads as recommended by IS codes are presented in this paper. According to IS 1893(Part1):2002 and IS 875(Part3):1987 codes, seismic analysis with response spectrum method and wind load analysis with gust factor method were used to analyze a B+G+10-story RCC high rise building. STAAD Pro software was used to create a 3D model of the structure. The B+G+10 storied building is considered in this analysis, and various loads such as static load, wind load, and earthquake load are applied, with the results studied and the building designed. The building height in this analysis is approximately 38.5 meters. Allowable limits in inter-storey drifts, base shear in codes of practice described, and other literature for earthquake and wind are checked to ensure the structure's safety. All dynamic parameters are analyzed and their governing conditions are summarized, including torsion in column, change in column reinforcement, displacement of mass C.G., change in bending moment, shear force and axial force in column, and change in stresses of beam.

Parhad Priyanka, Dr. Kansale A, Prof. Kadlag V.A,2020[12] Using the software STAAD PRO V8i, this study explains the seismic analysis of a multi-story building with floating column built in seismically active areas, observing its reaction to external lateral forces exerted on the building in various seismic zones. When compared to the response spectrum method, the highlighting of alternative measures involving in improving the non-uniform distribution in irregular buildings such as multi-story buildings with floating column, and the best results come from recommending the safer design of such buildings in seismically active areas, taking into account the results of storey drift, storey displacement, and base shear.

Ms. Waykule.S. B, Mr. Kadam.S. S, Ms. Lale S.V,2016[13] This paper presents a study on G+5 analysis. Buildings with and without floating columns in highly seismic zones v. four models are created, including buildings with floating columns on the first, second, and third floors, as well as buildings without floating columns. All four models are subjected to linear static and time history analysis. Compare all of the models' results in terms of seismic parameters such as time period, base shear, storey displacement, and storey drift using linear static analysis. and plot the responses of all the models using time history analysis SAP 2000v17 software was used for modelling and analysis.

Chandan Nirmal, Dr. S K Jaiswal, 2018 [14] As a result, the following conclusions were reached:

- Joint displacement is lower in light-weight concrete structural members when axial and lateral loads are applied as a result of seismic forces.
- Shear forces and bending moments applied by seismic forces are lower in light weight concrete structural members.
- Because light weight concrete has a lower density, it dampens seismic vibrations and reduces the risk of structural collapse due to base shear.
- The amount of reinforcement that is needed in the reinforcement area of a light weight concrete structure made up of different grades, such as M35, will be smaller the lower the grade.
- Lightweight concrete structures require less reinforcement than normal concrete structures.

Avinash Kumar Sharma, Rahul Krishna K. R, Ankush Kumar Jain,2017 [15] Based on the findings of the investigation, the following conclusions were drawn:

- The provision of a braced frame system improved the structure's performance in terms of Shear force, node displacement, and axial force.
- In terms of support reactions and bending moment, the model with shear wall is found to be the most efficient.
- The use of an X-braced frame reduced S.F., N.D., and A.F. by 3%, 49%, and 3%, respectively.
- By 61 percent, shear wall-controlled B.M was provided, and by 78 percent, maximum support reaction was provided.
- In terms of structural strength and stiffness, the X braced system was found to be the most efficient.

S SIBGATHULLAH, B BHANUPRIYA, A RAMAKRISHNAIAH, 2017[16] This research compares various parameters of a building under lateral loads, such as storey drift, storey shear, deflection, and so on, using strategic positioning of shear walls. In this project, a parametric model of a symmetric building configuration was chosen for investigation, and six models of various structural configurations, combining frame and shear walls, were created. At each successive floor level, models included a bare frame model, a planar shear wall model with x and y orientation, corner L shaped shear walls, and a central core wall with and without openings. ETABS2016 was used to create all mathematical models. All earthquake parameters have been thoroughly investigated, including lateral displacement, inter-storey drift ratios, seismic base shear, and dynamic parameters such as fundamental natural time periods, Modal mass participation factors, fundamental modes, and modes shapes. The results of the bare frames model were compared to all other models, and important conclusions were drawn.

Amruth Hiriyur, Sushma C K,2019[17] Ductility is emphasized in every structural design because it has the ability to absorb energy without failing catastrophically. When ductile members are used to construct a structure, it can withstand massive deformations before failing. This is a benefit for structures that are subjected to overloading because it undergoes large deformations before failing, giving enough time to take preventive measures. As a result, significant loss of life is reduced. The proportions of a building are critical in an earthquake-resistant design. For a tall structure, as the height increases, the level of response to earthquake forces changes, so the building proportions in both length and height, as well as the Aspect ratio, must be carefully studied.

Manish Dubey, Dr. Pankaj Singh, Niraj Kumar Soni, Goutam Varma,2018[18] The main goal of this research is to find out how shear wall configuration affects the seismic performance of flat slab buildings. Flat slab buildings with various configurations and the same plan have been subjected to a time history analysis**.** To determine the effect of shear wall configuration on seismic performance of flat slab buildings, the top storey displacements for all models were obtained and compared to one another. As a result of the research conducted throughout the work, the following conclusions were reached: According to the discussion of the results, the introduction of a shear wall results in a marginal reduction in displacement. However, by introducing a shear wall at each corner, the displacement is reduced in both directions.

1. The maximum drift limitation of 0.004 as per IS code is satisfied for all the Shear Wall Models of the building using Electro earthquake, as per IS 1893-1-2002CL:7.11.1 page no 27.
2. The attraction of forces is affected by the position of the shear wall, so it must be in the proper position.
3. Shear walls absorb a significant number of horizontal forces if their dimensions are large.
4. The displacements caused by earthquakes are significantly reduced when shear walls are installed in appropriate locations.

Nataliya Y. Vorontsova 2012 [19]: This paper investigated various methods for providing seismic resistance to structures, including traditional tactics for increasing structure bearing capacity, as well as a technique for adapting or altering the dynamic performance of structures and providing access to seismic isolation features and damping. Despite the fact that there are numerous proposals for renovating or strengthening structures that could be used in architectural monuments, not all of them have been tested on specific structures and verified by earthquakes.

Kamran, Shakeel Ahmad et al. 2016 [20] A heritage brick masonry structure's seismic performance was investigated. In this case, a nonlinear time history analysis was performed using SAP 2000, taking into account the material's nonlinearity. Various mode shapes were achieved, along with their natural frequencies and stresses (normal and shear). These stresses were compared to the permissible stresses for unreinforced masonry structures in a code of practice (IS1905-1987).

K. Ramaraju, M.I. Shereef et, al. (2013) Using Structural Engineering software, evaluated the response of a 40-story high Reinforced Concrete (RC) building under wind and seismic loads according to IS codes of practice, using the limit state method of analysis and design. Allowable limits for base shear, roof displacements, inter-story drifts, and accelerations were checked against allowable limits in codes of practice and other relevant literature references. The identification of the sensitivity of the building's base shear with respect to the location of the building in different wind zones in India is investigated, as they objected in their study for a large scope regarding wind and seismic loads.

Dr. SHRIRAM. H. MAHURE, KHAN MD. MUHATESHEM AZHAR, 2018 [21] This paper compares the effects of four different shape configurations with the same area: RECTANGULAR, SQUARE, TRIANGULAR, and CIRCULAR. Buildings of various shapes and geometries react to earthquakes in different ways. Using SAP2000 software, the effect of various structure shapes was investigated. There are several factors that influence how a building behaves, and base shear and lateral displacement are important in understanding how a structure behaves. The findings are presented using tables and bar charts. According to the findings, a triangular shape is better for base shear than a rectangular, square, or circular shape.

VI. METHODOLOGY

The purpose of this study is to analyze three model of high-rise buildings (i.e., G+15, G+20, G+25) storeys against seismic forces and wind loads based on IS 1893(Part 1):2002 using ETABS software.

The three models are assumed to be located in zone IV; the member forces are calculated using load combinations according to IS 456: 2000's Limit State Method. The models are subjected to self-weight, dead load, and live load according to IS 875(Part 1, Part 2):1987. In this analysis we are comparing the seismic effects on each model using response spectrum method with the help of ETABS software.

Table 1: Details of the three models

Particulars	Model-1	Model-2	Model-3
Plan Dimension	(40X50) m	(50X50) m	(50X40) m
No of Storey	15	20	25
Height of Each Storey	3m	3m	3m
Total Height	48m	63	88
Depth of Footing	2.5m	2.5m	2.5m
Dimension of Column	350mmX800 mm	350mmX800 mm	350mmX800 mm
Dimension of Beam	350mmX800 mm	350mmX800 mm	350mmX800 mm
Slab Thickness	125mm	125mm	125mm
Dead Load	1KN/m^2	1KN/m^2	1KN/m^2
Live Load	2KN/m^2	2KN/m^2	2KN/m^2
Seismic Zone	IV	IV	IV
Soil Type	II	II	II
Response Reduction Factor	5	5	5
Importance Factor	1	1	1
Zone Factor	0.24	0.24	0.24
Grade of Concrete	M35	M35	M35
Grade of Reinforcing Steel	Fe500	Fe500	Fe500
Density of Concrete	25KN/m^2	25KN/m^2	25KN/m^2
Density of Brick Masonry	20KN/m^2	20KN/m^2	20KN/m^2
Damping Ratio	5%	5%	5%

VII. RESULTS AND DISCUSSIONS

Response spectrum and seismic response of the buildings are studied by ETABS 2018 using dynamic analysis. The results of maximum storey displacement are taken from software. The results are shown for seismic zone IV with soil Type II and the comparison between all three model for mentioned parameter presented in below graphs.

Model-1 including Shear walls: The below graph shows maximum lateral displacement due to seismic forces occurred in the top floor (16th storey) and maximum storey displacement is 16.0.32 mm.

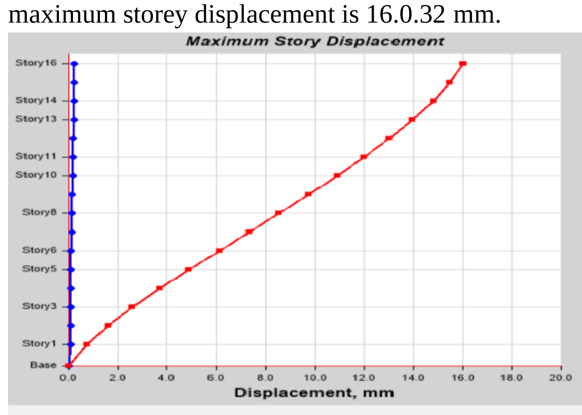

Figure 1: Max storey displacement for G+15 storeys building due to seismic forces

The below graph shows maximum lateral displacement due to wind load occurred in the top floor (16th storey) and maximum storey displacement is 0.6812mm.

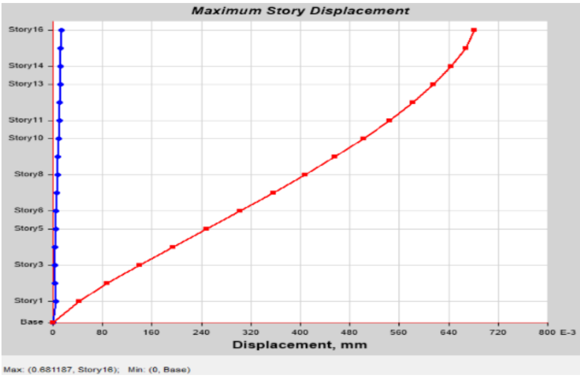

Figure 2: Max storey displacement for G+15 storeys building due to wind load

Model-1 Without Shear walls: The below graph shows maximum lateral displacement due to seismic forces occurred in the top floor (16th storey) and maximum storey displacement is 17.9345mm.

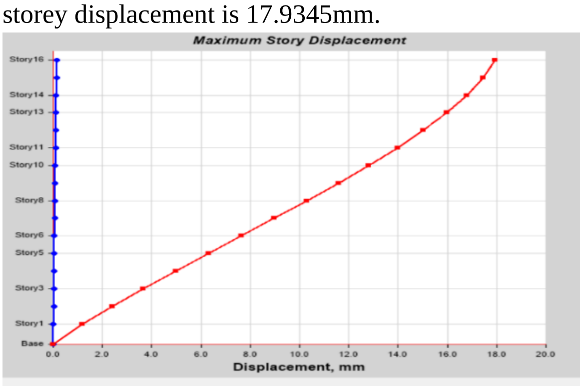

Figure 3: Max storey displacement for G+15 storeys building due to seismic forces

The below graph shows maximum lateral displacement due to wind load occurred in the top floor (16th storey) and maximum storey displacement is 0.9753mm.

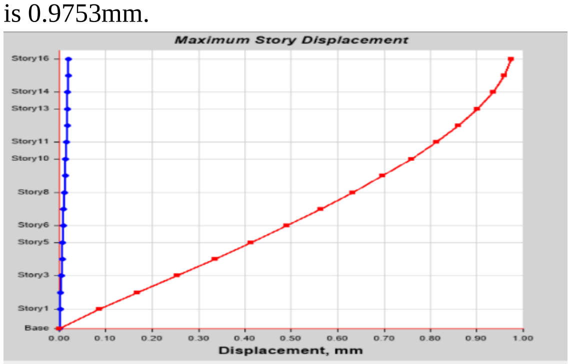

Figure 4: Max storey displacement for G+15 storeys building due to wind load

Comparing the above results for model-1, lateral displacement is maximum occurred in the top storey, as well as, lateral displacement is more in a building without shear walls due to earthquake and wind load than a building including shear walls.

Model-2 including Shear walls: The below graph shows maximum lateral displacement due to seismic forces occurred in the top floor (20th storey) and maximum storey displacement is 18.78 mm.

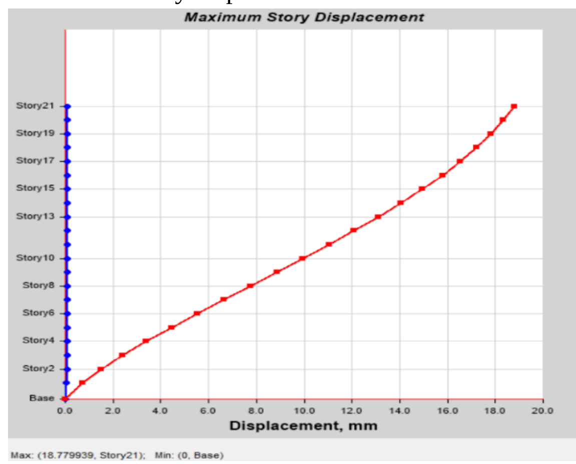

Figure 5: Max storey displacement for G+20 storeys building due to seismic forces

The below graph shows maximum lateral displacement due to wind load occurred in the top floor (20th storey) and maximum storey displacement is 1.1258mm.

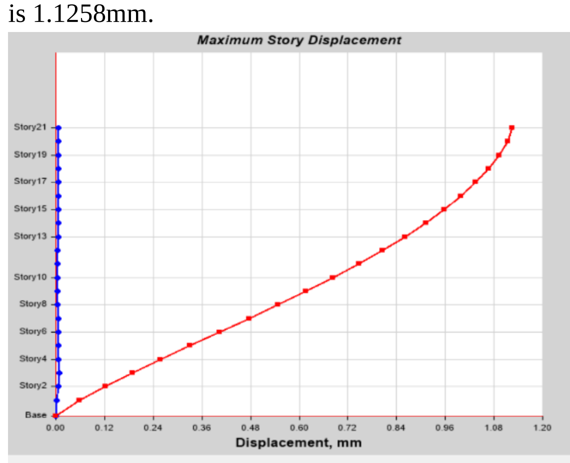

Figure 6: Max storey displacement for G+20 storeys building due to wind loads

Model-2 Without Shear walls: The below graph shows maximum lateral displacement due to seismic forces occurred in the top floor (20th storey) and maximum storey displacement is 19.735 mm.

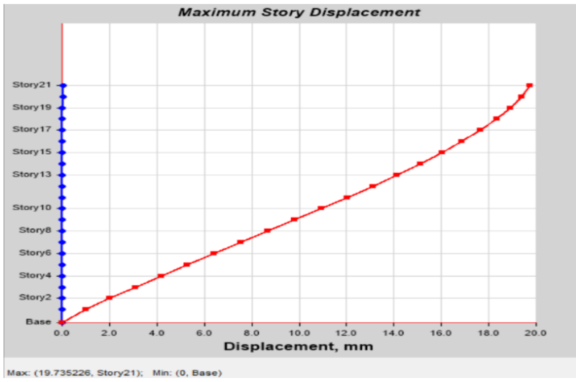

Figure 7: Max storey displacement for G+20 storeys building due to seismic forces

The below graph shows maximum lateral displacement due to wind load occurred in the top floor (20th storey) and maximum storey displacement is 1.352 mm.

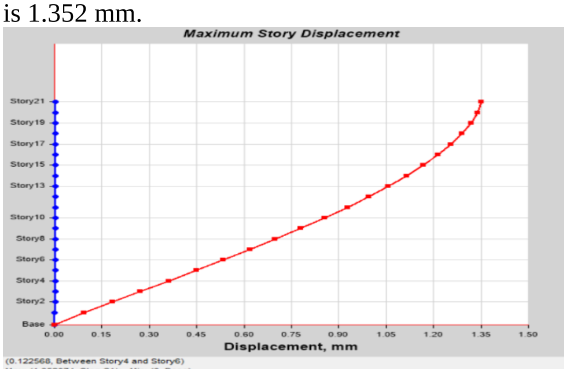

Figure 8: Max storey displacement for G+20 storeys building due to wind load

Comparing the above results for model-2, lateral displacement is maximum occurred in the top storey, as well as, lateral displacement is more in a building without shear walls due to earthquake and wind load than a building including shear walls.

Model-3 including Shear walls: The below graph shows maximum lateral displacement due to seismic forces occurred in the top floor (25th storey) and maximum storey displacement is 29.23 mm.

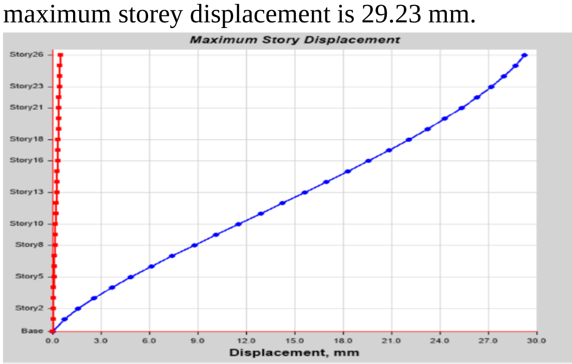

Figure 9: Max storey displacement for G+25 storeys building due to seismic forces

The below graph shows maximum lateral displacement due to wind load occurred in the top floor (25th storey) and maximum storey displacement is 3.6692 mm.

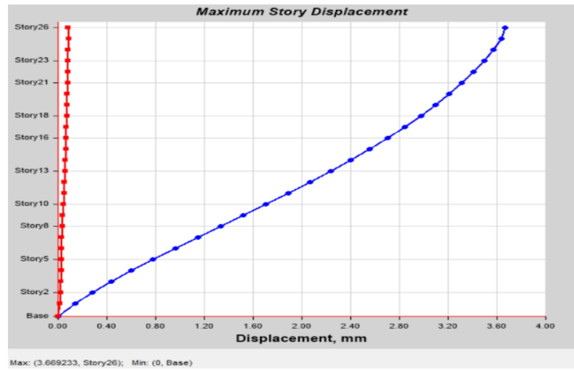

Figure 10: Max storey displacement for G+25 storeys building due to wind load

Model-3 without Shear walls: The below graph shows maximum lateral displacement due to seismic forces occurred in the top floor (25th storey) and maximum storey displacement is 32.0715 mm.

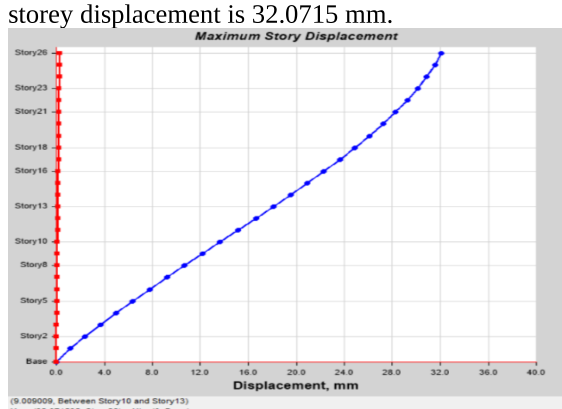

Figure 11: Max storey displacement for G+25 storeys building due to seismic forces

The below graph shows maximum lateral displacement due to wind load occurred in the top floor (25th storey) and maximum storey displacement is 4.89095mm.

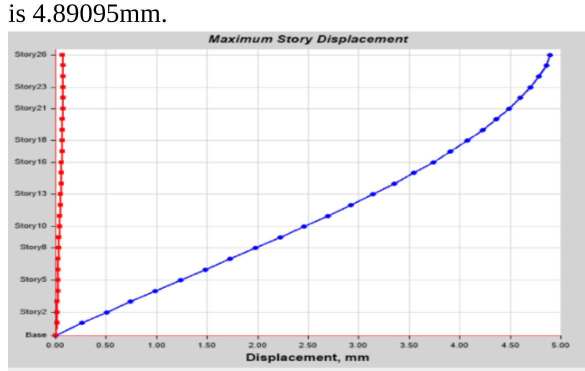

Figure 12: Max storey displacement for G+25 storeys building due to wind load

Comparing the above results for model-3, lateral displacement is maximum occurred in the top storey, as well as, lateral displacement is more in a building without shear walls due to earthquake and wind load than a building including shear walls.

Looking to above all results of the three models, maximum lateral displacement occurred in model-3 (i.e., G+25 storeys building), Model-2(i.e., G+20 Storeys building) has experienced less lateral displacement than model-1, as well as, Model-3(i.e., G+15) has experienced less lateral displacement than Model-2 and model-3 respectively, also, lateral displacement was more in structures without shear walls than those structures that were having shear walls. As the shapes and heights were not equal for all the models, but stiffness and sizes of columns and beams were equal, but there is a big difference in lateral displacements, so we reach to a result, that lateral displacement is directly affected by height/ number of storeys and geometry of the structure, as structural irregularities in a building reduces stability of structure against seismic forces and loads.

VIII CONCLUSION

As the title indicates, a detailed study on Seismic Resistant Design and Analysis of (G+15), (G+20), and (G+25) storeys Residential Building has been carried out. The buildings are modeled as 3d space frames using ETABS Software. In this thesis only reinforced concrete buildings are considered. Various ways of lateral force resisting structures for reinforced concrete buildings are discussed.

The seismic analysis is carried out for reinforced concrete structures and response spectrum analysis has been done. Three models are analyzed respectively, first, we analyzed each model including shear walls and took the result, then we removed shear walls and analyzed it again and took the result, after that we compared the result for both including shear walls model and without shear walls model.

Response spectrum analysis are carried out for RCC building (assumed to be located in zone IV). The corresponding zone and zone factor are taken from the IS 1893(Part 1): 2002 code book. Separate analysis was done for each model with or without shear walls, the result of each model of lateral displacement due to seismic forces and displacement due to wind loads are taken.

For Model-1(40mX50m, G+15 storeys) including shear walls, the maximum lateral displacement due to seismic occurred in 16th stories which was 16.032mm and due wind load maximum lateral displacement occurred in 16th storeys which was 0.6812.

For Model-1(40mX50m, G+15 storeys) without shear wall, maximum lateral displacement due to seismic force occurred in 16th storey which 17.9345mm and maximum lateral displacement due to wind load occurred in 16th storey which was 0.9753mm.

For Model-2(50mX50m, G+20 storeys) including shear walls, the maximum lateral displacement due to seismic forces occurred in 21th storey which was 18.78mm and maximum latera displacement due to wind loads occurred in 21th which was 1.1258mm.

For Model-2(50mX50m, G+20 storeys) without shear wall, maximum lateral displacement due to seismic forces occurred in 21th storey which was 19.735mm and maximum lateral displacement due to wind load occurred in 21th which was 1.352mm.

For Model-3(50mX40m, G+25 storeys) including shear walls, maximum lateral displacement due to seismic forces occurred in 26th storey which was 29.23mm, and maximum lateral displacement due wind loads occurred in 26th which was 3.6692mm.

For Model-3(50mX40m, G+25 storeys) without shear walls, maximum lateral displacement due to seismic forces occurred in 26th storey which was 32.0715mm, and maximum lateral displacement due to wind load occurred in 26th storey which was 4.891mm.

The result shows that lateral displacement is influenced by the height/number of storeys and geometry of the structure, as structural irregularities in a building reduce the stability of the structure against seismic forces and loads, as well as, lateral displacement is affected by shear walls, as we got the result from analysis that when we removed shear walls from each model, the lateral displacement was increased.

REFERENCES

[1] Navyashree K, Sahana T.S “USE OF FLAT SLABS IN MULTI-STOREY COMMERCIAL BUILDING SITUATED IN HIGH SEISMIC ZONE” (IRJET).

[2] FLOATING COLUMNS BY CONSTRUCTION SEQUENCE ANALYSIS AND COMPARISON WITH EQUIVALENT STATIC ANALYSIS” (IRJET), Nov 2018.

[3] Shilpa M. Samrutwar, Deepa P. Telang “A Review on Response of Seismic Loading on Regular High Rise Building with and without Damper Using ETABS” Dec 2017.

[4] Manish Dubey, Dr. Pankaj Singh, Niraj Kumar Soni, Goutam Varma “Seismic analysis of flat slab multi-storey Building with varying Shear wall indices” ((IRJET), Apr-2018

[5] https://www.skyfilabs.com/blog/etabs-software-for-civil-engineering students#:~:text=%E2% 80 %9CETABS%2DExtended%203D%20analysis %20of,that%20is%20used%20in%20constructio n.&text=ETABS%20software%20has%20the%2 0following,a%20software%20used%20in%20co nstruction.

[6] Mohd Aleem Uddin, Sathya Prakash, Mohammed Ahmed “ANALYSIS OF MULTI STOREY BUILDING WITH AND WITHOUT FLOATING COLUMNS BY CONSTRUCTION SEQUENCE ANALYSIS AND COMPARISON WITH EQUIVALENT STATIC ANALYSIS” (IRJET), Nov-2018.

[7] Hongli Wang “Research on Design of High-Rise Building Based on Seismic Design Theory” (IRJET), 2017.

[8] K. Sugimoto & H. Katsumata, H. Fukuyama & T. Saito, T. “Kabeyasawa Earthquake Resistant Performance of High-Rise Reinforced Concrete Buildings under Long-Period Ground Motions” (15WCEE),2012

[9] Sean Wilkinson, Gordon Hurdman, Adrian Crowther “A moment resisting connection for earthquake resistant structures” (ELSEVIER), July,2005.

[10] AKASH KUMAR, ER. KUNDAN KULBHUSHAN “DESIGN OF EARTHQUAKE RESISTANT STRUCTURE OF MULTI-STORY RCC BUILDING” (IRJET), June-2019.

[11] Virendra K. Tembhare, Prof. Dilip L. Budhalani “Analysis and Design of B+G+10 Commercial High-rise Building under Seismic Load and Wind Load by Using Software” (IRJET), June,2019.

[12] Parhad Priyanka, Dr. Kansale A, Prof. Kadlag V.A “SEISMIC ASSESEMENT OF MULTISTOTIED BUILDING WITH FLOATIN COLUMN” (IRJET), Aug-2020.

[13] Ms. Waykule.S. B, Mr. Kadam.S. S, Ms. Lale S.V “STUDY OF BEHAVIOUR OF FLOATING COLUMN FOR SEISMIC ANALYSIS OF MULTISTOREY BUILDING, (IRJET), Aug-2016.

[14] Chandan Nirmal, Dr. S K Jaiswal “Dynamic Analysis of High-Rise Building Structure with Lightweight concrete” (IRJET), Sep-2018.

[15] Avinash Kumar Sharma, Rahul Krishna K. R, Ankush Kumar Jain “Seismic Analysis of a Regular High-Rise Structure Subjected to Various Load Resisting Systems” (IRJET), June-2017.

[16] S SIBGATHULLAH, B BHANUPRIYA, A RAMAKRISHNAIAH “Effect of Shear wall on overall performance of multi-storey buildings” (IRJET), Nov-2017.

[17] Amruth Hiriyur, Sushma C K “Evaluation of Ductility Demand in a Multi Storey Building having Symmetrical Plan in High Seismic Zone” (IRJET), July-2019.

[18] Manish Dubey, Dr. Pankaj Singh, Niraj Kumar Soni, Goutam Varma “Seismic analysis of flat slab multi-storey Building with varying Shear wall indices” (IRJET), Apr-2018.

[19] Nataliya Y. Vorontsova (2012), “Strengthening of Historical Monuments in Seismic Regions” 15 WCEE, LISBOA 2012.

[20] Kamran, Shakeel Ahmad et al. (2016), “Seismic Performance of a heritage school building”,11th International symposium on Plasticity and impact mechanics, implast.

[21] Dr. SHRIRAM. H. MAHURE, KHAN MD. MUHATESHEM AZHAR “ANALYSIS OF DIFFERENT SHAPE OF BUILDING WITH SAME AREA” (IRJET), Nov-2018