By using ETABS, Study and Design the Lateral Resistance System to Reducing the Displacement in Multistory Buildings

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Abstract: ***In the twentieth century, the term "Earth Quake" became common throughout the world. It is related to protection, so we must be concerned with planning and analyzing the Earth quakes. Since the past Earthquake, fast events have occurred in predicted countries in estimated parts of the continent. Natural hazards have evolved over time, and indeed nature has been affected by time, but in the new century and advancement of science, there is no certainty of when disasters will occur; instead, we must be prepared to care for and defend humanity. When we learn about Earth quakes, we must remember that we are dealing with human lives, and there are only 2 choices: death or life. As engineers, we studied in college about engineering fundamentals, particularly in civil engineering. When designing buildings, we must retain three constant concepts in mind: protection, architecture, and economics. So I do recall and obey my occupational morals. Due to the importance of wind and earthquake analysis in overall structures, I initially chose a G+22 storey structure in Visakhapatnam. ETABS intends to conduct seismic analysis and architecture in collaboration with IS and UBC CODE. So the key goal of my thesis is to compare IS CODE and UBC 97 in Seismic and Wind structural analysis using ETABS.***

Keywords: Earthquake, Shear Wall, Displacement, seismic, ETABS, resisting seismic loads, lateral resisting system, Wind Load, Live Load, Dead Load

1. Introductions

Most of the multi storey buildings in our country are not constructed in favor of seismic code due to various reasons like lack of awareness of damage due to earth quakes, economic considerations etc. But if suddenly severe earthquake occurs then maximum number of structures has a chance to collapse which are seismic deficient structures, which may leads to human loss and property loss. Generally the importance given to the structures is that it must safe against gravity loads. These structures can also take lateral loads up to some limit due to its strength and stiffness.. Some there is a need to retrofit for post-earth quake with damage of structural elements, some may total collapse with human loss. If earth quake occurs then our structure must be able to resist earth quake loads and structure must at least life safe even it may not operational for further use. For this they are various retrofit techniques to resist lateral loads, Installation of steel bracing is the effective technique in those.

Steel bracings are diagonal members which are active in the event of earth quake to take seismic or lateral loads and will transfers those loads into ground with (or) without minor structural damage. Bracings are made of concrete or steel.
Actually buildings are subjected to two types of loads (1) vertical load due to gravity. (2) Lateral loads due to wind and earthquake.

1.1 Objective of the Work

The main objective of this work is to reduce the displacements of the structure in the event of earth quake by introducing lateral resisting system. By Evolution of response of the structure with various bracing systems subjected to seismic loads and to identify the suitable bracing system for resisting seismic loads; which gives way in the reduction of human loss and property loss in the event of earth quake.

1.2 Description of the Model

The construction is planned as eight blocks. Each block is planned as different floor plans with required space. But in this work, block 8 building is taken. Using floor plan, structure plan is prepared to give good design using ETABS. The building plan area is 30 m X 46m. the plan area can see at below.

Figure 1: Building Floor plan

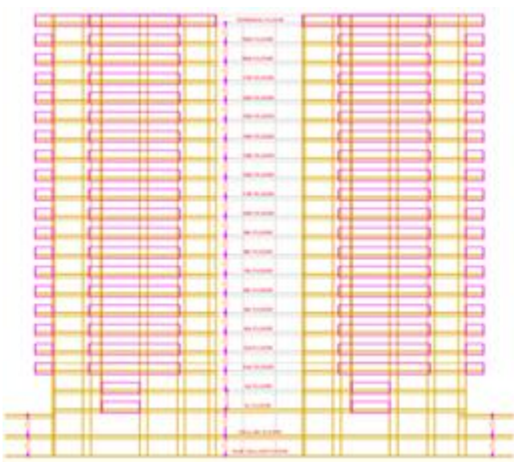


Figure 2: Building Elevation

G + 22 building		
	Without Shear Wall	With Shear Wall
Beam Size	450 X 230	0.45X0.3
Column Size	1050X300	0.45X0.3
Slab Thickness	0.15	0.15
Floor Load	3 kn/m2	3 kn/m2
Vehicle Load	20 kn/m2	20 kn/m2
Wall Weight	13.5 kn/m	13.5 kn/m

ade Concrete	30 x 10^6 kN/m^2
Density of Reinforced Concrete	25 kN/m^3

2. Introduction to Shear wall

A shear wall is a wind-resistant functional feature for multi-story or high-rise structures as well as regular structures in high wind flow environments. This wall normally starts at the base point and run along the width and length of the structure. In high structures their width can range from 150 to 400 mm; they act as vertically directed large spans that bear the seismic loading to the base.

2.1 Materials used for Shear Wall Construction

A shear walls is typically built as a stiffened moment-resisting structure consisting of structural steel or a concrete walls structure. It can also be constructed out of hardboard or stonework. The Braced Frame is utilized as a base shear. As a shear wall, a moment - resistant frame (steel) is installed.

2.2 Advantages of shear wall

Fast building pace , Dramatically decreases lateral sway, The shear wall is extremely light, Shear wall is a form of thin wall, Simple to design and execute, Enough well-distributed reinforcements, The cost-effectiveness of shear walls in terms of earthquakes, Destruction to structural and non - structural elements was minimized, High stiffness and strength in the path of alignment. Low building expense and efficiency in reducing earthquake risk, Shear walls are often found in rising structures that are exposed to lateral wind and seismic forces, The Shear wall repels forces due to Cantilever Action on slender walls where bending distortion is greater.

2.3 Disadvantages of Shear Wall

Shear walls are difficult to construct, they have a flimsy appearance, Also, loud banging sounds associated with buckling of web plates, it has low stiffness and energy dissipation capacity, Also, requires large moment connections.

3. Literature Review

P. P Chandurkar [1] did a detail study to decide the answer for shear wall area in multi-story working with the assistance of four distinct models. The structures were demonstrated utilizing programming ETAB Nonlinear v 9.5.0.After examining ten story working for tremor situated in Zone II, Zone III, Zone IV and Zone V fundamental boundaries like parallel displacement, story float and complete expense needed for ground floor were found in both the cases by replacing column with shear wall and end was drawn that shear wall in limited capacity to focus corner (model 4) is efficient as contrasted and other models. It was seen that shear wall is prudent and successful in tall structures and giving shear dividers at sufficient areas considerably decreases the relocation because of earthquake. If the elements of shear wall are enormous at that point significant measure of forces in horizontal direction are taken by shear wall.

Varsha R. Harne [2] used STAAD Pro to analyse a six-story building exposed to earthquake charging in zone II and measured earthquake load utilizing the seismic coefficient tool (IS 1893 Part II). Four separate cases were studied: a structure without a shear wall, a framework with an L-shaped shear wall, a configuration with a shear wall around the perimeter, and a structure with a cross-shaped shear wall.As opposed to other forms of shear walls, the lateral deflection of a column for a building with a shear wall around the perimeter is minimised. It was discovered that the shear wall across the circumference is the most effective of all the shear walls studied.

3.1 Theoretical Solution

The building is having 22 floors are each floors are named as Sub cellar floor+ cellar floor+ground floor+19 floors. Each floor area is 942.8m^2.

Individual floor weight is calculated using dead load, live load, vehicle load, wall weight.

W1 weight =942 X

W1, w2 =…….=w5 = (12.8 x 12.8) x (12+5) = 2785.28

W6 = (12.8 x 12.8) x (10+1) = 1802.24

Ta = 0.075 x (22.5)^(0.75) = 0.07

Sa/g = 1.36/0.07 =1.76

Ah = Z/2 X I/R X Sa/g = 0.16/2 X 0.15/5 X 1.76 = 0.04224

Vb = Ah X W = 0.04224 X 18513.92 = 782

$$Qi = \frac{wi \times hi2}{\Sigma(\mathrm{wi} \times \mathrm{h2})} \times \mathrm{Vb}$$

= 1802.24 X (22.4 X 22.4) / 3499.727 X 782 = 202.0604

4. Modelling of Structure

The following parameters influence the design of the retaining wall: wall height, soil type, and sloping land below and/or above the retaining wall, loads above and behind the retaining wall. Satisfying the external stability criteria is primarily based on the section giving the required factor of safety. The ratio of resisting forces to the disturbing forces is the factor of safety and this factor of safety should always be greater than 1.5 for the structure to be safe against failure with respect to that particular criteria. Different modes of failure have different factor of safety.

ETABS is general-purpose civil-engineering software ideal for the analysis and design of any type of structural system. Basic and advanced systems, ranging from 2D to 3D, of simple geometry to complex, may be modeled, analyzed, designed, and optimized using a practical and intuitive object-based modeling environment that simplifies and streamlines the engineering process. The SAP Fire Analysis Engine integral to ETABS drives a sophisticated finite-element analysis procedure. An additional suite of advanced analysis features are available to users engaging state-of-the-art practice with nonlinear and dynamic consideration. Created by engineers for effective engineering, ETABS is the ideal software tool for users of any experience level, designing any structural system.

Total ETABS procedure can be divided as
1) Modeling
2) Loading
3) Analysis
4) Design and output

4.1 Modeling

Built-in modeling templates, a versatile and user-friendly interface, intuitive controls and features all combine to simplify and expedite a sophisticated object-based modeling process. A broad range of modeling options provide for methods and technologies at the forefront of structural engineering. Model domain may be component, system, or global-level in scope, while encompassing sub-grade components and soil-structure interaction. Grid line, snap, and replication tools are a few of the many practical features which make the modeling environment and process accessible to beginners and sophisticated for advanced users.

Linear or curved members, cables and post-tensioned tendons, link elements to model springs, dampers, isolators, and the associated nonlinear and hysteretic behavior, framing, shell or multi-layered shell, solid elements with isoperimetric formulation and nonlinear response are all modeling options for object assembly in ETABS. When preferred structural members are not provided in the extensive libraries of ETABS, Section Designer is available for custom cross-section design.

4.2 Loading

Powerful built-in templates also simplify and expedite the load-application process. Seismic, wind, vehicle, wave, and thermal forces may all be automatically generated and assigned according to a suite of code-based guidelines. Users are free to define and envelope an unlimited number of load cases and combinations.

Moving-load-generation features and a library of AASHTO vehicle applications provide for evaluation of transportation infrastructure systems. For marine systems, wave-load-generation features consider the static and dynamic response of wave, current, buoyancy, and wind while capturing inertial effects. Enveloped load conditions may be coupled with certain advanced analysis and construction techniques (P-Delta effect, segmental construction, etc.) for additional insight into structural response.

4.3 Analysis

A range of innovative analysis techniques are integrated into the capabilities of ETABS. Users are free to supplement the standard yet sophisticated analysis process by implementing advanced features for nonlinear and dynamic consideration. This versatility makes ETABS a practical and productive tool for any analysis type ranging from simple static, linear-elastic to more complex dynamic, nonlinear-inelastic. To begin, the SAP Fire Analysis Engine drives analysis optimization with multiple 64-bit solvers. Options include Eigen analysis (with auto shifting for ill-conditioned relations) and Ritz analysis (for expedited convergence).

P-delta effect captures geometric nonlinearity. Buckling analyses provide insight into structural stability through methods characterizing linear buckling (which considers multiple buckling modes under nonlinear-static or dynamic application), nonlinear buckling (which considers P-delta and large-deflection effects), snap-through buckling, and progressive collapse.

Tension and compression-only springs may be assigned with limits and nonlinear attributes to simulate support plasticity. Static and dynamic methods are available for earthquake simulation. Nonlinear-static-pushover analyses may consider modal, uniform, or user-defined lateral load patterns, plastic-hinging behaviour of slender elements, inelastic response of shear walls, floor slabs, and steel plates, and then formulate demand-capacity, damping, and performance-point calculations with customizable summary reports.

Dynamic methods include response-spectrum (for likely maximum seismic response given pseudo-spectral acceleration vs. structural period curve), power-spectral-density and steady-state (for fatigue behaviour with optional damping and complex impedance properties), and time-history analyses. Time histories may follow modal or direct-integration methods, and they may

4.4 Design and Output

Design is fully integrated with the analysis process, enveloping results before automatically sizing steel members and designing reinforced-concrete sections. Automatic steel, concrete, aluminium and cold-formed-framing design code checks ensure that structures meet criteria of American, Canadian, and a variety of international standards.

Output and display options are intuitive and practical. Finalized member design, deformed geometry per load combination or mode shape, moment, shear, and axial-force diagrams, section-cut response displays, and animation of time-dependent displacements outline a few of the graphics available upon conclusion of analysis. ETABS automatically generates reports for

4.5 Modelling of Structure

In this chapter the grid lattice structure have been modeled and analyzed in ETABS.

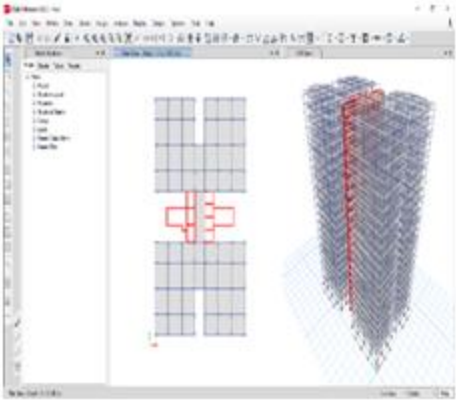


Figure 3: Building plan and elevation without shear wall

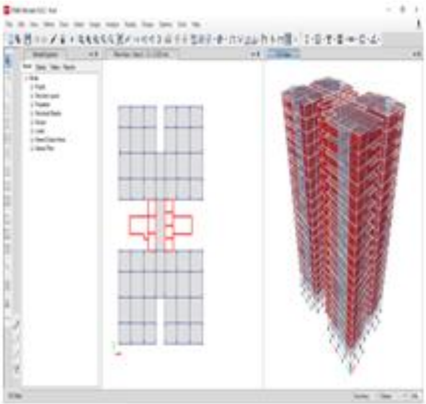


Figure 4: Building plan and elevation with shear wall

The above image in fig3 shows the building plan and elevation. Here red color shows the shear wall and blue color shows the frame and columns.

The above image in fig4 shows the building plan and elevation. Here red color shows the shear wall and blue color shows the frame and columns.

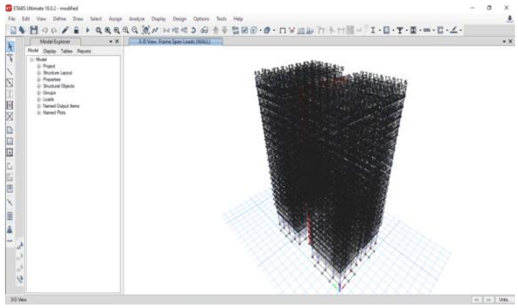


Figure 5: Wall weight assigned on the beams

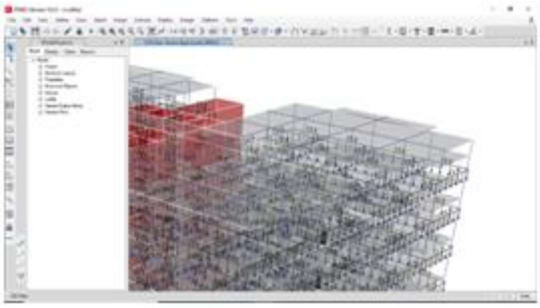


Figure 6: Wall load assigning on building ith detail view

- Go to assign and click on Frame loads.
- Select uniform loads.
- Load pattern name is Wall load.

The above image in fig6 shows the Wall load assigning window. Here 13.5 KN/m load is assigned to the floor beams of building.

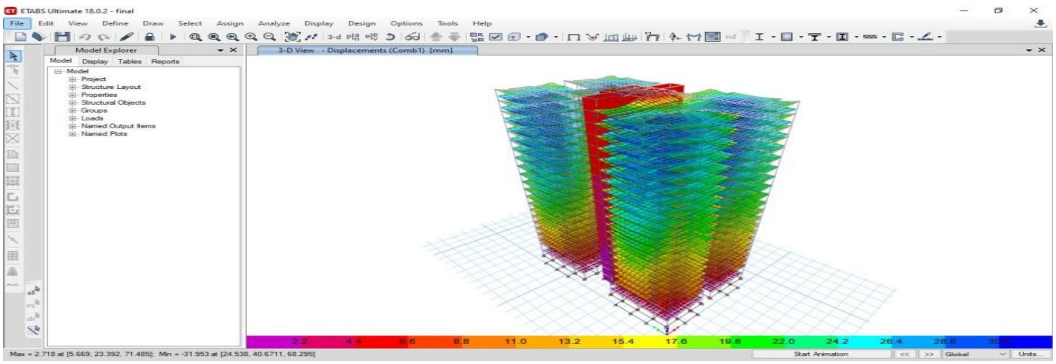


Figure 7: Combine load deflection on without shear wall condition

In the above image shows the total deformation of combine load deflection on without shear wall condition.

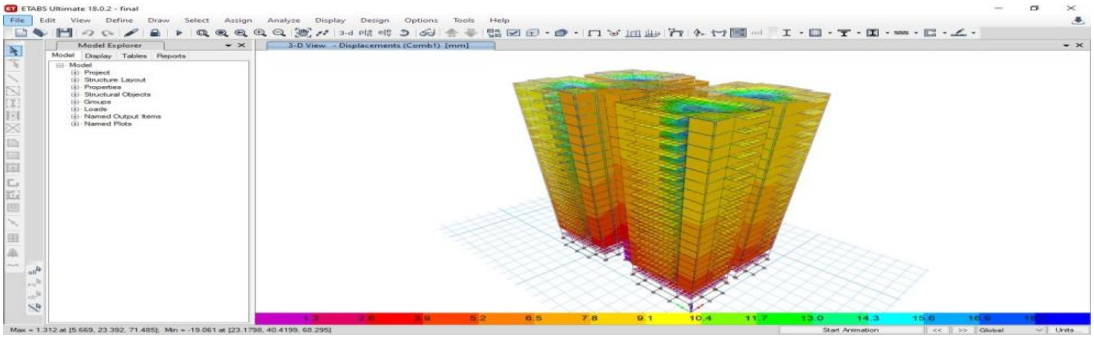


Figure 8: Combine load deflection on with shear wall condition

In the above image shows the total deformation of Combine load deflection on with shear wall condition.combine load applied on entire structure and the red indicate the minimum deformation and blue indicates maximum deformation.

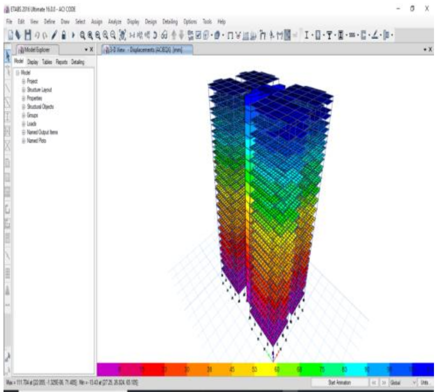


Figure 9: Storey displacement due to UBC 97 EQ loading

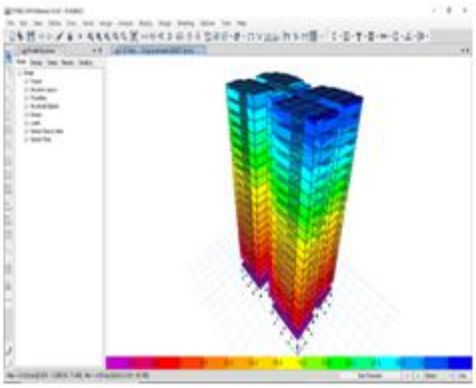


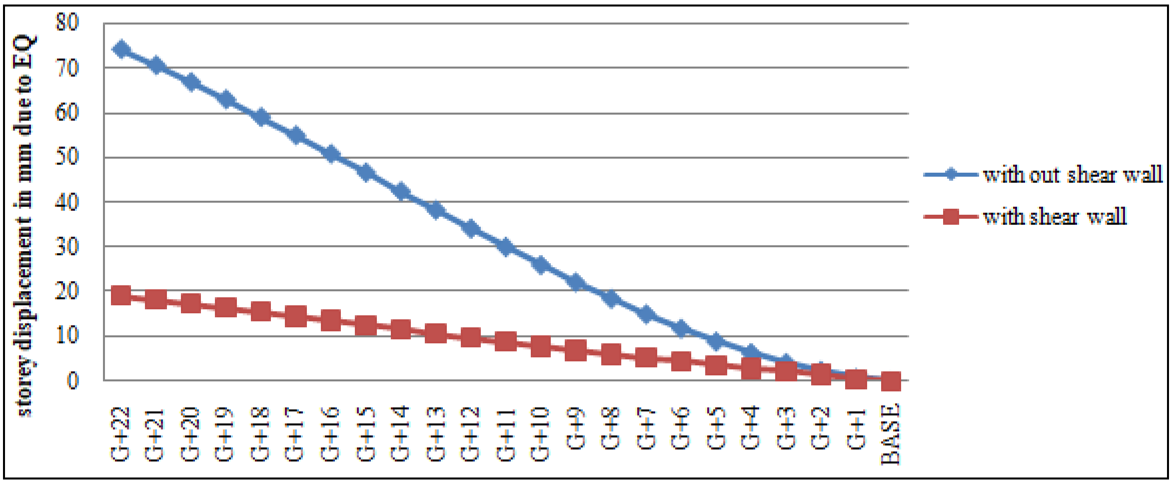
Figure 10: Storey displacement of shear wall due to UBC 97 EQ loading

5. Results and discussion

The objective of this project is to check& design of the seismic response of multi-storied building using Etabs. Here IS code and UBC97 code are used to perform the seismic and wind analysis. Another object is to analysis of forces, base shear, &deformation or deflection for a complex structural system. To make the building earthquake resistant against seismic effect.In this work initially frame is considered in 30m X 46 m area. And shear wall is introduced at boundary of building. For importance frame model results are noted from Etabs software and discussion has done as below.

Table: Storey Displacement due to earth quake

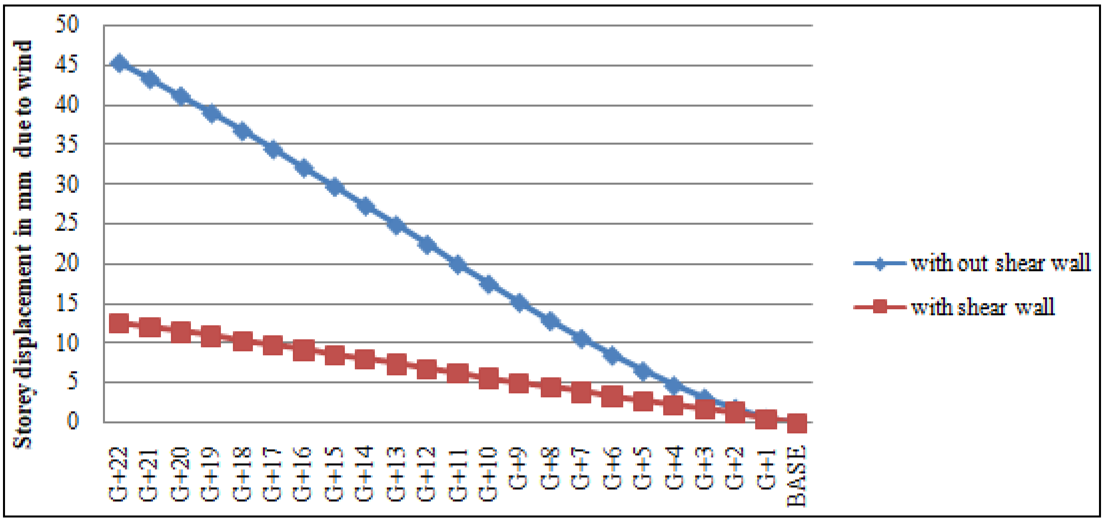
Storey No	Without Shear Wall	With Shear Wall
G+22	74.41	19.08
G+21	70.8	18.2
G+20	67.03	17.3
G+19	63.15	16.39
G+18	59.16	15.45
G+17	55.09	14.51
G+16	50.94	13.55
G+15	46.74	12.59
G+14	42.53	11.62
G+13	38.33	10.66
G+12	34.16	9.7
G+11	30.06	8.75
G+10	26.07	7.81
G+9	22.21	6.9
G+8	18.52	6.02
G+7	15.04	5.16
G+6	11.81	4.35
G+5	8.89	3.57
G+4	6.34	2.84
G+3	4.13	2.16
G+2	2.36	1.53
G+1	0.69	0.45
BASE	0	0



Graph 1: Storey Displacement due to earth quake

Table: Storey displacement due to wind load

Storey No	Without Shear Wall	With Shear Wall
G+22	45.39	12.54
G+21	43.34	12.01
G+20	41.2	11.46
G+19	39.03	10.91
G+18	36.79	10.35
G+17	34.49	9.78
G+16	32.15	9.2
G+15	29.76	8.61
G+14	27.34	8.02
G+13	24.9	7.43
G+12	22.45	6.83
G+11	20.01	6.23
G+10	17.55	5.64
G+9	15.21	5.05
G+8	12.89	4.46
G+7	10.65	3.89
G+6	8.52	3.34
G+5	6.53	2.81
G+4	4.71	2.3
G+3	3.14	1.8
G+2	1.84	1.35
G+1	0.56	0.42
BASE	0	0



Graph 2: Storey displacement due to wind load

The main of this project is to provide urban life, amenities at low cost and spacious floor plan. The project is having 8 blocks. Each block has individual floor plans. The bottom two floors are for cellar parking. The remaining floors are for residential purposes. The main aim of this work is to reduce the construction cost and to provide optimum cost. According to Indian concrete codes and also UBC codes, building structure is designed once all frame sections are passed and structure results are noted. Same is done with shear wall. The structural results like displacement and drift are reduced with shear wall RCC frame. The stiffness is also increased. When compared to earthquake, damage due to wind is less. Using UBC code, the structure is getting more displacement and base shear as compared to IS code. The results are having good agreement.

6. Conclusion

In this work, initially floor plan is gathered from Visakhi construction. The project is under construction in Madurawada, Visakhapatnam. The main of this project is to provide urban life, amenities at low cost and spacious floor plan. The project is having 8 blocks. Each block has individual floor plans. The bottom two floors are for cellar parking. The remaining floors are for residential purposes. The main aim of this work is to reduce the construction cost and to provide optimum cost. According to Indian concrete codes and also UBC codes, building structure is designed once all frame sections are passed and structure results are noted. Same is done with shear wall. The structural results like displacement and drift are reduced with shear wall RCC frame. The stiffness is also increased. When compared to earthquake, damage due to wind is less. Using UBC code, the structure is getting more displacement and base shear as compared to IS code. The results are having good agreement.

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