Seismic and Wind Analysis of RCC Building with and without Shear Wall

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***Abstract*: The structure in high seismic areas may be susceptible to the severe damage. Along with gravity load structure has to withstand to lateral load which can develop high stresses. Now a day, shear wall in RCC structure and steel bracings in steel structure are most popular system to resist lateral load due to earthquake, wind, blast etc. The shear wall is one of the best lateral load resisting systems which is widely used in construction world but use of steel bracing will be the viable solution for enhancing earthquake resistance. In this study R.C.C. building with G+15 is modelled and analysed in two Parts that are model with shear wall and model without shear wall system.**
The computer aided analysis is done by using E-TABS to find out the effective lateral load system during earthquake in high seismic areas. The performance of the building is evaluated in terms of Lateral Displacement, Storey Drifts and Base shear (Performance point). According to the analysis and comparison that have been done in the project the performance of regular building is found better than irregular building.

Keywords: Shear walls, Sesmic effects, Wind effects, Analysis.

1. INTRODUCTION

Shear wall are one of the excellent means of providing earthquake resistance to multi- storeyed reinforced concrete building. The structure is still damaged due to some or the other reason during earthquakes. Behaviour of structure during earthquake motion depends on distribution of weight, stiffness and strength in both horizontal and planes of building. To reduce the effect of earthquake reinforced concrete shear walls are used in the building. These can be used for improving seismic response of buildings. Structural design of buildings for seismic loading is primarily concerned with structural safety during major Earthquakes, in tall buildings, it is very important to ensure adequate lateral stiffness to resist lateral load. The provision of shear wall in building to achieve rigidity has been found effective and economical. When building is tall, beam, column sizes are quite heavy and steel required is large. So, there is lot of congestion at these joint and it is difficult to place and vibrate concrete at these place and displacement is quite

heavy. Shear walls are usually used in tall building to avoid collapse of buildings. When shear wall is situated in advantageous positions in the building, they can form an efficient lateral force resisting system.

2.HOW DO EARTHQUAKES AFFECT BUILDINGS?

Ground shaking is the primary cause of earthquake damage to man-made structures. Many factors influence the strength of earthquake shaking at a site including the earthquake's magnitude, the site's proximity to the fault, the local geology, and the soil type. More than 250 structures throughout the United States have been outfitted with seismic sensors by the USGS National Strong Motion Project (NSMP) to improve the overall
understanding of earthquakes and their effects on the built environment. The instrumentation and monitoring of structures by NSMP is only one part of USGS efforts to protect people's lives and property from earthquake hazards in all of the Nation's seismically active regions.

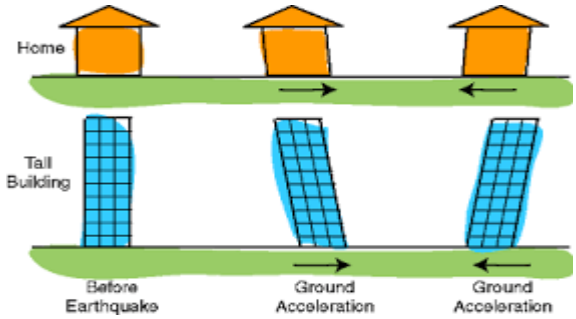


Figure 1. The displacement of buildings as well as ground acceleration during the earthquake.

3.SHEAR WALL

Shear walls are vertical elements of the horizontal force resisting system. **Shear walls** are constructed to counter the effects of lateral load acting on a structure. In residential construction, shear walls are straight external walls that typically form a box which provides all of the lateral support for the building. When shear walls are designed and constructed properly, and they will have the strength and stiffness to resist the horizontal forces.
For slender walls where the bending deformation is more, Shear wall resists the loads due to Cantilever Action. In building construction, a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. Examples are the reinforced-concrete wall. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants; create powerful twisting (torsional) forces. This leads to the failure of the structures by shear.
Shear walls are especially important in high-rise buildings subject to lateral wind and seismic forces. Generally, shear walls are either plane or flanged in section, while core walls consist of channel sections. They also provide adequate strength and stiffness to control lateral displacements. In the last two decades, shear walls became an important part of mid and high-rise residential buildings. As part of an earthquake

resistant building design, these walls are placed in building plans reducing lateral displacements under earthquake loads. So, shear-wall frame structures are obtained.

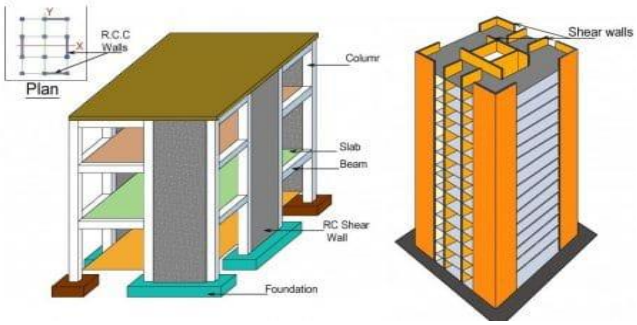


Figure 2. Shear walls

4.PURPOSE OF CONSTRUCTING SHEAR WALLS

Shear walls are not only designed to resist gravity / vertical loads (due to its self-weight and other living / moving loads), but they are also designed for lateral loads of earthquakes / wind. The shear walls are structurally integrated with roofs / floors (diaphragms) and other lateral walls running across at right angles, thereby giving the three-dimensional stability for the building structures.

Shear wall structural systems are more stable. Because, their supporting area (total cross-sectional area of all shear walls) with reference to total plans area of building, is comparatively more, unlike in the case of RCC framed structures.

5.FUNCTIONS OF SHEAR WALL

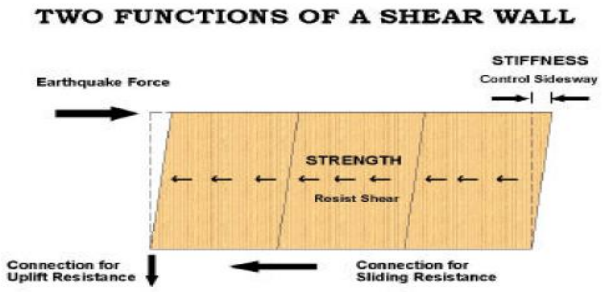


Figure 3. Showing Two function of Shear Wall

Shear walls must provide the necessary lateral strength to resist horizontal earthquake forces. When shear walls are strong enough, they will transfer these horizontal forces to the next element in the load path below them. These other components in the load path may be other shear walls, floors, foundation walls, slabs or footings.

Shear walls also provide lateral stiffness to prevent the roof or floor above from excessive side-sway. When shear walls are stiff enough, they will prevent floor and roof framing members from moving off their supports. Also, buildings that are sufficiently stiff will usually suffer less non-structural damage.

6.LOCATION OF SHEAR WALLS

Shear walls should be located on each level of the structure including the crawl space. To form an effective box structure, equal length shear walls should be placed symmetrically on all four exterior walls of the building.

Shear walls should be added to the building interior when the exterior walls cannot provide sufficient strength and stiffness. Shear walls are most efficient when they are aligned vertically and are supported on foundation walls or footings. When exterior shear walls do not provide sufficient strength, other parts of the building will need additional strengthening. Consider the common case of an interior wall supported by a sub floor over a crawl space and there is no continuous footing beneath the wall. For this wall to be used as shear wall, the sub floor and its connections will have to be strengthened near the wall. For Retrofit work, existing floor construction is not easily changed. That's the reason why most retrofit work uses walls with continuous footings underneath them as shear walls.

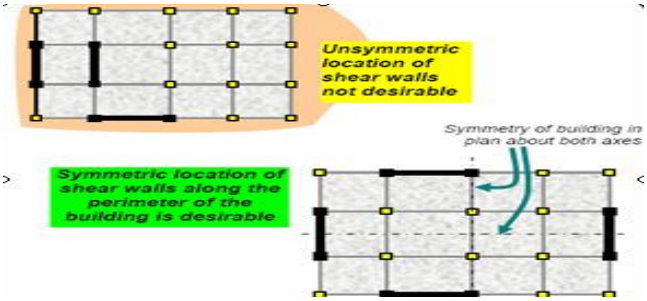


Figure 4. Location of shear walls

7.CLASSIFICATION OF SHEAR WALLS

- Simple rectangular types.
- Coupled shear walls
- Rigid frame shear walls
- Framed walls with in filled frames
- Column supported shear walls
- Core type shear walls

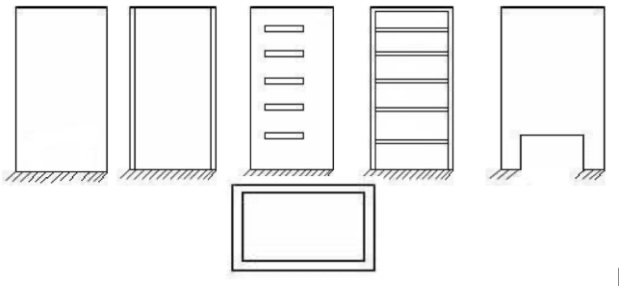


Figure 5. shows classifications of shear wall

8.SEISMIC LOAD

Seismic waves are created in the earth lithosphere causing from the sudden release of energy in the earth. It happens due to the mass shifting in bedrock.

These generated seismic waves will travel through the soil. The wave propagation in the soil will stimulate the structure which turns in to vary input motion by its movement of relative to the ground. The structural analysis has been carried out using **ETABS** which is a product of structural analysis and design programmed and is analyzed for seismic loads **using IS 1893 Code book.**

9.WIND LOAD

Wind has two aspects. The first one a beneficial – is that its energy can be utilized to generate power, sail boats and cool down the temperature on a hot day. The other one a parasitical one – is that it loads any and every object that comes in its way. The latter is the aspect an engineer is concerned with, since the load caused has to be sustained by a structure with the specified safety. All civil and industrial structures above ground have thus to be designed to resist wind loads **using IS 875 -1987-part 3 codebook.**

10.PARAMETRIC STUDIES

The present work is on the analysis of symmetrical and multi-storey R.C.C building, that is G+15 storey bare frame with fixed support under wind and seismic conditions i.e., with shear walls, without shear walls and with bracing.
The conditions are as mentioned below.
Case (1): Without shear wall for multi storey building.
Case (2): With shear wall, these walls generally start at foundation level and are continuous throughout the building height. Their thickness can be as low as 200mm, or as high as 400mm in high rise buildings. They are usually provided along both width and length.
Case (3): With bracing steel, a bracing system improves the seismic performance of the frame by increasing its lateral stiffness and capacity.

11.OBJECTIVES

- Study and analyses wind and earth quick effects on residential RCC building.
-Analysis of seismic and wind on building with and without shear walls.
- Analysis the building using bracing such as (V) bracing.
- Comparative study of building with and without shear walls.

12.METHODOLGY

12.1. METHODS OF SHEAR WALL DESIGN

Types of design methods:
There are three types of design methods
- Segmented shear wall method
- Force transfer –ground openings method
- Perforated shear wall method

The segmented shear wall method uses full height shear wall segments that comply with ratio requirements and are usually restrained against overturning by hold down devices at the ends of each segment.
The second method force transfer-ground openings method consider the entire shear wall with openings and the wall piers adjacent to openings are segments. The method requires the forces around the perimeter of the openings to be analysed, designed, and detailed. With this method, the hold-down devices generally occur at the ends of the shear wall, not at each wall pier, and special reinforcement around the opening is often required. .
The third and newest method is the perforated shear wall method which is an empirical approach that does not require special detailing for force transfer adjacent to the openings. The perforated shear wall method, however, specifically requires hold-down devices at each end of the perforated shear wall.

12.2. Step by step procedure

Step - 1: Defining of property.
Step-2: Assigning of Property After defining the property we draw the structural components.
Step - 3: Assigning of Supports.
Step - 4: Defining of loads.
Step -5: Assigning of load combination
Step -6: Run analysis
after the completion of all the above steps we have performed the analysis and checked for errors
Step -7: Result and discussion.
Step –8: Conclusion.

13.Figures of ETABS work:

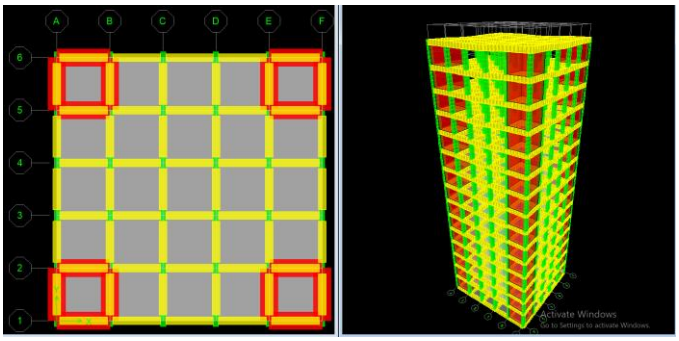


Fig.1 Regular building with Shear Wall before displacement

(Plan) (Undeformed shape)

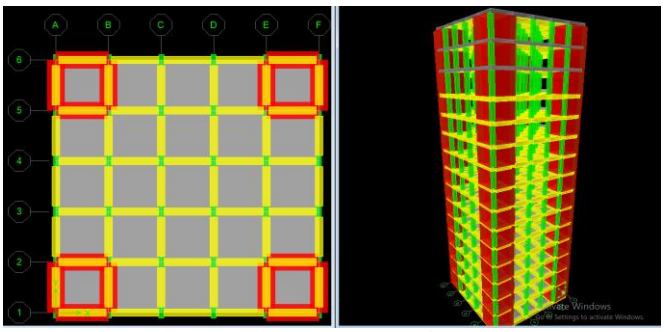


Fig.2 Regular building with Shear Wall after displacemnt

(Plan) (Deformed shape)

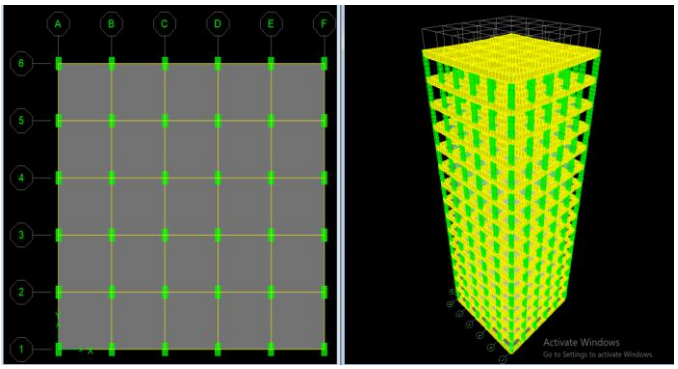


Fig.3 Regular building without Shear Wall before displacement

(Plan) (Deformed shape)

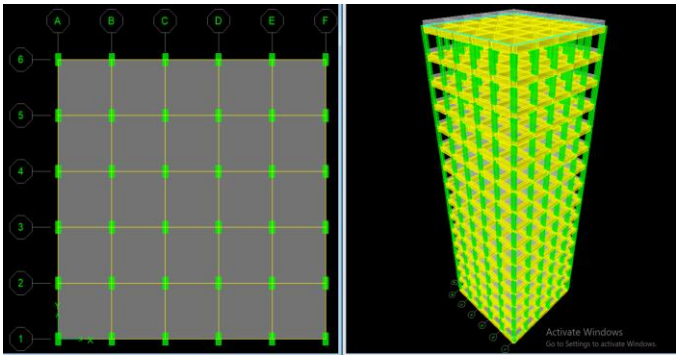


Fig.4 Regular building without Shear Wall after displacement

(Plan) (Deformed shape)

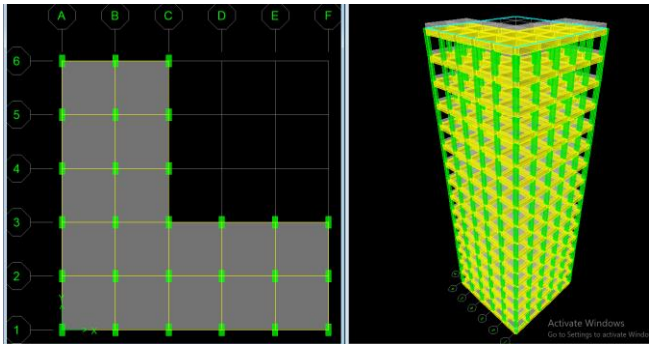


Fig.5 Irregular with shear Walls before displacemen (Plan)
(Deformed shape)

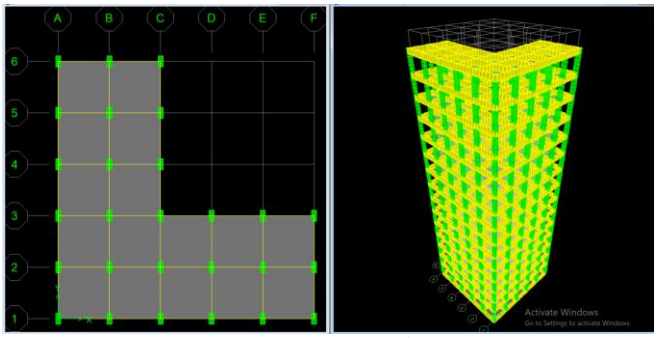


Fig.6 Irregular with shear Walls after displacement
(Plan) (Deformed shape)

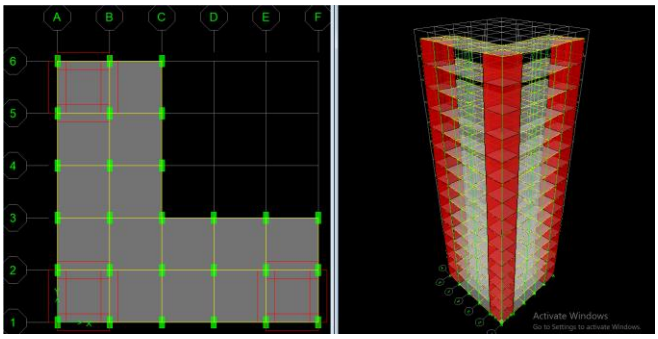


Fig.7 Irregular with shear Walls before displacement
(Plan) (Deformed shape)

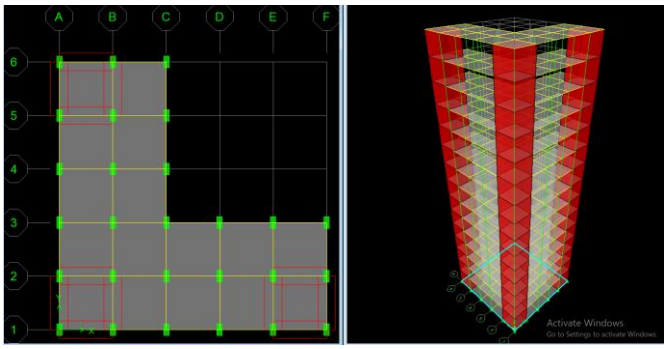
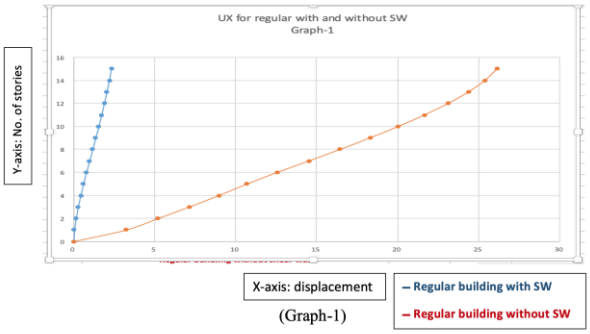


Fig.8 Irregular with shear Walls after displacement
(Plan) (Deformed shape)

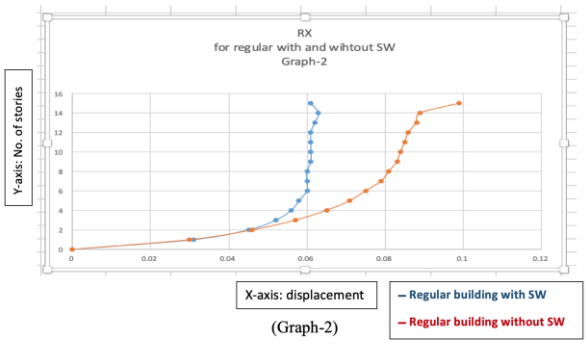
14.Graphs from Excel:



(Graph-1)

As per graph-1 the displacement percentage of a regular building with and without shear wall under the effect of wind was found to be = 91%

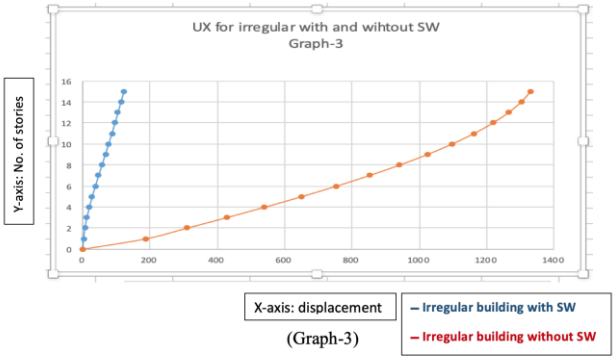
Graph.1



(Graph-2)

As per graph-2 the displacement percentage of a regular building with and without shear wall under the effect of earthquake was found to be = 38.38%

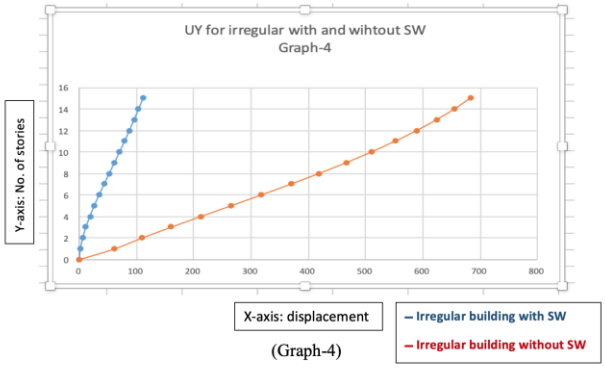
Graph.2



(Graph-3)

As per graph-3 the displacement percentage of an irregular building with and without shear wall under the effect of wind in X-axis was found to be = 90.84%

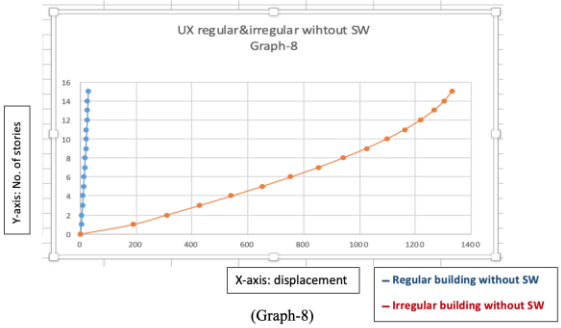
Graph.3



(Graph-4)

As per graph-4 the displacement percentage of an irregular building with and without shear wall under the effect of wind in Y-axis was found to be = 83.76%

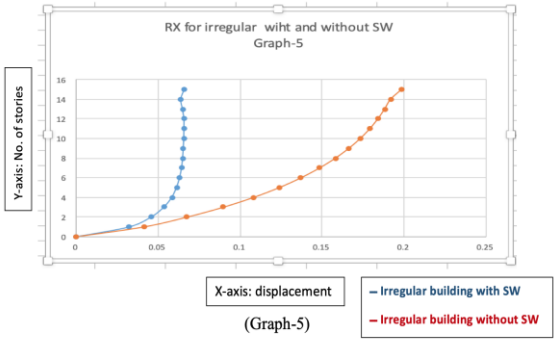
Graph.4



(Graph-8)

As per graph-8 the displacement percentage of a regular and irregular building without shear wall under the effect of wind in X-axis was found to be = 98.04%

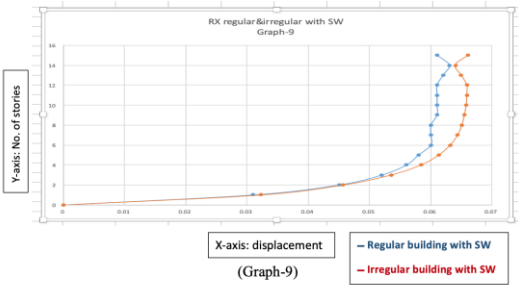
Graph.8



(Graph-5)

As per graph-5 the displacement percentage of an irregular building with and without shear wall under the effect of earthquake in X-axis was found to be = 66.69%

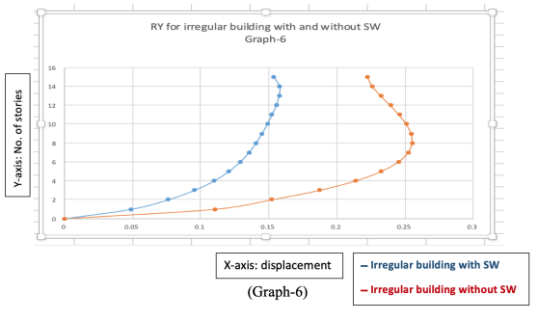
Graph.5



(Graph-9)

As per graph-9 the displacement percentage of a regular and irregular building with shear wall under the effect of earthquake in X-axis was found to be = 7.72%

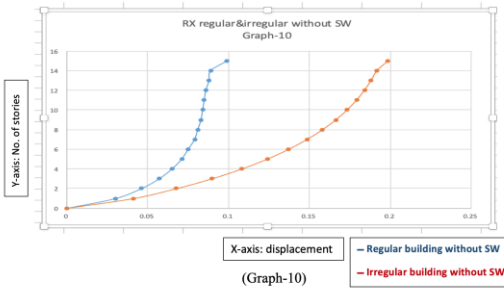
Graph.9



(Graph-6)

As per graph-5 the displacement percentage of an irregular building with and without shear wall under the effect of earthquake in Y-axis was found to be = 30.89%

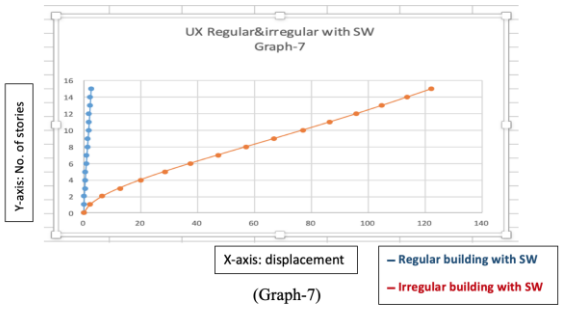
Graph.6



(Graph-10)

As per graph-10 the displacement percentage of a regular and irregular building without shear wall under the effect of earthquake in X-axis was found to be = 50.11%

Graph.10



(Graph-7)

As per graph-7 the displacement percentage of a regular and irregular building with shear wall under the effect of wind in X-axis was found to be = 98.07%

Graph.7

15.SCOPE OF FUTURE WORK

Shear walls are considered to be a gift to the future construction industry.

Scope of shear walls in construction field is immense, it's since their arrival in market their topic was always a topic of interest.

*Shear walls are the structures usually build to balance lateral loads acting on the structure, where the lateral loads are most predominantly wind and earth quake loads.

*Earthquakes are becoming more intense due to the key reason that is ground water displacement; hence in order to overcome the diverse effects of earthquake it's always best to save ourselves from future disasters.

*Shear walls resist horizontal lateral force and provide earthquake resistance

* Shear walls are helpful in controlling deflection and RCC shear walls are easy to construct -reinforcement detailing.

*Shear walls minimize earthquake damage to structural damage and non-structural damages.
*Well-designed shear walls not only provide adequate safety but also provide great measure of Protection against costly non-structural damage during moderate seismic damages.
*Shear walls in high seismic regions require special detailing. However, in past earthquakes, even buildings with sufficient number of walls that were not specially detailed for seismic performance (but had enough well-distributed reinforcement) were saved from collapse.
*Shear wall buildings are a popular choice in many earthquake prone countries, like Chile, New Zealand and USA.
*Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight-forward and therefore easily implemented at site.
*Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structural and non-structural elements (like glass windows and building contents).
*This study will help further referencing for dynamic analysis of plan irregular buildings.
*By providing shear walls with steel bracing systems we can analyze the plan irregular buildings and this will be analyzed for vertical irregular buildings.

16.CONCLUSION

- In this current project states that as NO of stories increases the displacement in earthquake and wind analysis.
-As per the analysis that has been done by ETABS and from the graph 9&10, we got a compression that the displacement for regular and irregular building with shear walls is more less than without shear wall. As it shows the percentage of (7.72%) with providing shear walls and a percentage of (50.11%) without providing shear walls.
-As shown in graph No 7&8 the displacement for regular and irregular building without shear walls is more compare with shear walls.
-we got to know that a building with shear wall can provide a high resistance for the effect of wind and seismic forces compare to without shear walls.

ACKNOWLEDGEMENTS

I would like to express my special thanks of gratitude to my professor Prathibha Reddy who gave me the golden opportunity to do this wonderful paper on the topic of Seismic and wind analysis of RCC building with and without shear walls, which also helped me in doing a lot of Researches and I came to know about so many new things. I am really thankful to her.

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