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Seismic analysis of G+3 building using ETABS

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Abstract- When a structure is subjected to earthquake, it responds by vibrating. An earthquake force can be resolved into three mutually perpendicular directions-the two horizontal directions (x and y) and the vertical direction (z). This motion causes the structure to vibrate or shake in all three directions; the predominant direction of shaking is horizontal. It is very essential to consider the effects of lateral loads induced from wind and earthquakes in the analysis of reinforced concrete structures, especially for high-rise buildings. The basic intent of analysis for earthquake resistant structures is that buildings should be able to resist minor earthquakes without damage. It resists moderate earthquakes without structural damage but sometimes non-structural damage will resist major earthquakes without collapse the major structure. To avoid collapse during a major earthquake, members must be ductile enough to absorb and dissipate energy by post-elastic deformation. Redundancy in the structural system permits redistribution of internal forces in the failure of key elements. When the primary element or system yields or fails, the lateral force certainly redistributed to a secondary system to prevent progressive failure. The objectives of the present work is to study the behavior of a multi storied RC building irregular in plan subjected to earth quake load by adopting Response spectrum analysis.

The present investigation is restricted to strengthened cement (RC) multi-celebrated business working with FOUR unique zones II, III, IV and V. The examination is carried out the assistance of FEM programming's E-Tabs. The structure model in the examination has twenty stories' with consistent story stature of 3m. FOUR models are utilized to dissect with various cove lengths and the quantity of Bays and the straight width along two flat bearings are kept steady in each model for accommodation. Various estimations of SEISMIC ZONE FACTOR are taken and their comparing impacts are deciphered in the outcomes.

Keywords – E-tabs, Seismic Zone Factor, Response Spectrum Analysis.

I. INTRODUCTION

The successful plan and development of seismic tremor safe structures have a lot more prominent significance in everywhere throughout the world in this way designs are attempting to utilize various materials to further their best potential benefit keeping in see the exceptional properties of every material basically powerful and stylishly satisfying structure are being built by joining the best properties at singular material and simultaneously meeting the particular prerequisites of huge length, building load, soil condition, time, adaptability and economy tall structures are most appropriate arrangement.

The Design of buildings wherein there is no damage during the strong but rare earthquake is called earthquake-proof design. The engineers do not attempt to make earthquake proof buildings that will not get damaged even during the rare but strong earthquake. Such buildings will be too robust and also too expensive. The aim of the earthquake resistant design is to have structures that will behave elastically and survive without collapse under major earthquakes that might occur during the life of the structure. To avoid collapse during a major earthquake, structural members must be ductile enough to absorb and dissipate energy by post-elastic deformation.

Many researchers have been conducted on this topic and still, it is continuing because more we try to learn more we can minimize the damages and save the lives. According to studies that have been made on the seismology about 90% earthquake happens due to tectonics. If we come to civil engineering an engineer's job is to provide maximum safety in the structures designed and maintain the economy.

Prior to the analysis and design of any structure, necessary information regarding supporting soil has to be collected by means of geotechnical investigation. A geotechnical site investigation is a process of collecting information and evaluating the conditions of the site for the purpose of designing and constructing the foundation for a structure. Structural engineers are facing the challenges of striving for most efficient and economical design with accuracy in solution while ensuring that the final design of a building and the building must be serviceable for its intended function over its design lifetime. Now a day's various software packages are available in the market for analyzing and designing practically all types of structures viz. RISA, STAADPRO, ETABS, STRUDL, MIDAS, SAP and RAM, etc.

The latest version of the seismic zoning map of India given in the earthquake resistant design code of India [IS 1893 (Part1) 2002] assigns four levels of seismicity for India in terms of zone factors. In other words, the earthquake-zoning map of India divides India into 4 seismic zones (Zone 2, 3, 4 and 5) unlike its previous version, which consisted of five or six zones for the country. According to the present zoning map, Zone 5 expects the highest level of seismicity whereas Zone 2 is associated with the lowest level of seismicity.

Zone 5 covers the areas with the highest risks zone that suffers earthquakes of intensity MSK IX or greater. The IS code assigns zone factor of 0.36 for Zone 5. Structural designers use this factor for earthquake resistant design of structures in Zone 5. The zone factor of 0.36 is indicative of effective (zero periods) level earthquake in this zone. It is referred to as the Very High Damage Risk Zone. The region of Kashmir, the western and central Himalayas, North and Middle Bihar, the North-East Indian region and the Rann of Kutch fall in this Zone.

Zone 4 is called the High Damage Risk Zone and covers areas liable to MSK VIII. The IS code assigns zone factor of 0.24 for Zone 4. The Indo-Gangetic basin and the capital of the country (Delhi), Jammu and Kashmir fall in Zone 4. In Maharashtra, the Patan area (Koyananager) is also in Zone no 4. In Bihar, the northern part of the state like- Raksaul, near the border of India and Nepal, is also in Zone no 4.

Zone 3, the Andaman and Nicobar Islands, parts of Kashmir, Western Himalayas fall under this Zone. This zone is classified as Moderate Damage Risk Zone, which is liable to MSK VII. The IS code assigns zone factor of 0.16 for Zone 3.

Zone 2 is liable to MSK VI or less and is classified as the Low Damage Risk Zone. The IS code assigns zone factor of (maximum horizontal acceleration that can be experienced by a structure in this Zone) is 10% of gravitational acceleration for Zone 2

II. OBJECTIVE

The present work aims at the study of following objectives:

1. How the seismic evaluation of a building should be carried out.

2. To study the behavior of a building under the action of seismic loads and wind loads.
3. To compare various analysis results of building under Zone II, III, IV and Zone V using ETABS Software.
4. The building model in the study has four storey's with constant storey height of 3m. Five models are used to analyze with constant bay lengths and the number of Bays and the bay width along two horizontal directions are kept constant in each model for convenience.
5. Different values of zone factor are taken and their corresponding effects are interpreted in the results.
6. Different values of wind speeds are taken for wind analysis and their corresponding effects of building structure are interpreted in the results.

III. LITERATURE REVIEW

1. **Structural Analysis of a Multi-Storeyed Building using ETABS for different Plan Configurations {AbhayGuleria};** in this paper, the case study mainly emphasizes on structural behavior of multi- story building for different plan configurations like rectangular, C, L and I-shape. Modeling of 15-story R.C.C. framed building is done on the ETABS software for analysis. Post analysis of the structure, maximum shear forces, bending moments and maximum story displacement are computed and then compared for all the analyzed cases.

Conclusions

- The analysis of the multi-Storeyed building reflected that the story overturning moment varies inversely with story height. Moreover, L-shape, I-shape type buildings give almost similar response against the overturning moment.
- Story drift displacement increased with story height, up to 6th story reaching to maximum value and then started decreasing.
- From dynamic analysis, mode shapes are generated and it can be concluded that asymmetrical plans undergo more deformation than symmetrical plans.

2. **Seismic Analysis of Multistoreyed Building, {Mahesh N. Patil and Yogesh N. Sonawane};** in this paper, the earthquake response of symmetric multi-storeyed building is studied by manual calculation and with the help of ETABS 9.7.1 software. The method includes seismic coefficient method as recommended by IS 1893:2002. The

responses obtained by manual analysis as well as by soft computing are compared. This paper provides complete guide line for manual as well as software analysis of seismic coefficient method.

Conclusions

- Seismic analysis was done by using ETABS software and successfully verified manually as per IS 1893-2002.
- There is a gradual increase in the value of lateral forces from bottom floor to top floor in both manual as well as software analysis
- There is slight variation in the values of base shear in manual analysis as well as software analysis
- Base shear values obtained by manual analysis are slightly higher than software analysis.

IV. METHODOLOGY

1. ***Seismic analysis as per IS Code***

At the point when a structure is exposed to seismic tremor, it reacts by vibrating. A seismic tremor power can be settled into three commonly opposite bearings the two even headings (x and y) and the vertical course (z). This movement makes the structure vibrate or shake in every one of the three bearings; the overwhelming heading of shaking is even. Every one of the structures is basically intended for gravity loads-power equivalent to mass time's gravity in the vertical heading. In light of the natural factor of wellbeing utilized in the plan particulars, most structures will in general be enough secured against vertical shaking. Vertical increasing speed ought to likewise be considered in structures with huge ranges, those in which dependability for plan, or for generally speaking strength examination of structures.

IS 1893 (section 1) code suggests that point by point dynamic examination, or pseudo static investigation ought to be completed relying upon the significance of the issue. IS 1893(part1): 2002 suggests utilization of modular investigation utilizing reaction range technique and proportionate sidelong power strategy for working of tallness under 40 m in every single seismic Zone.

2. ***Wind Analysis***

The basic wind speed map of India, as applicable at 10 m height above mean ground level for different Zones of the country selected from the code.

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$V_z = V_b\, k_1 k_2\, k_3$

Where, V_z = design wind speed at any height z in m/s,

V_b = Basic wind speed in m/s,

k_1 = probability factor (risk coefficient),

k_2 = terrain roughness and height factor and

k_3 = topography factor.

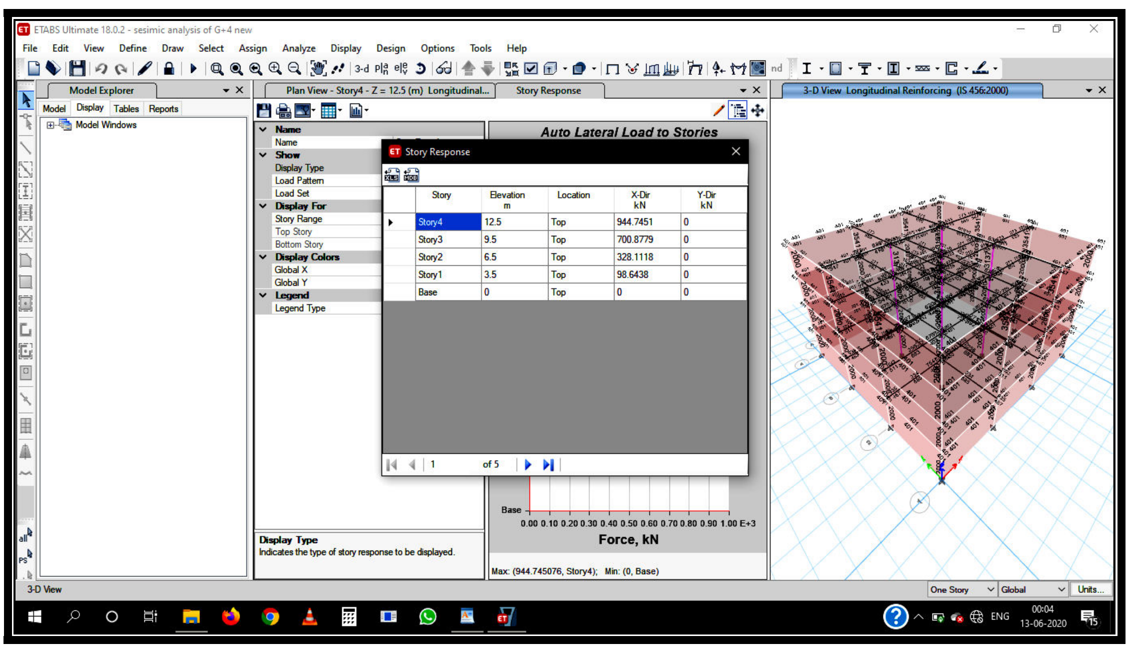
The design wind pressure at any height above mean ground level shall be obtained by the following relationship between wind pressure and wind velocity.

$P_z = 0.6\, V_z^2$

Where, P_z = wind pressure in N/m^2 at height z and

V_z = design wind speed in m/s at height z.

RESULT FOR SOFTWARE ANALYSIS



Storey Response for Zone-V

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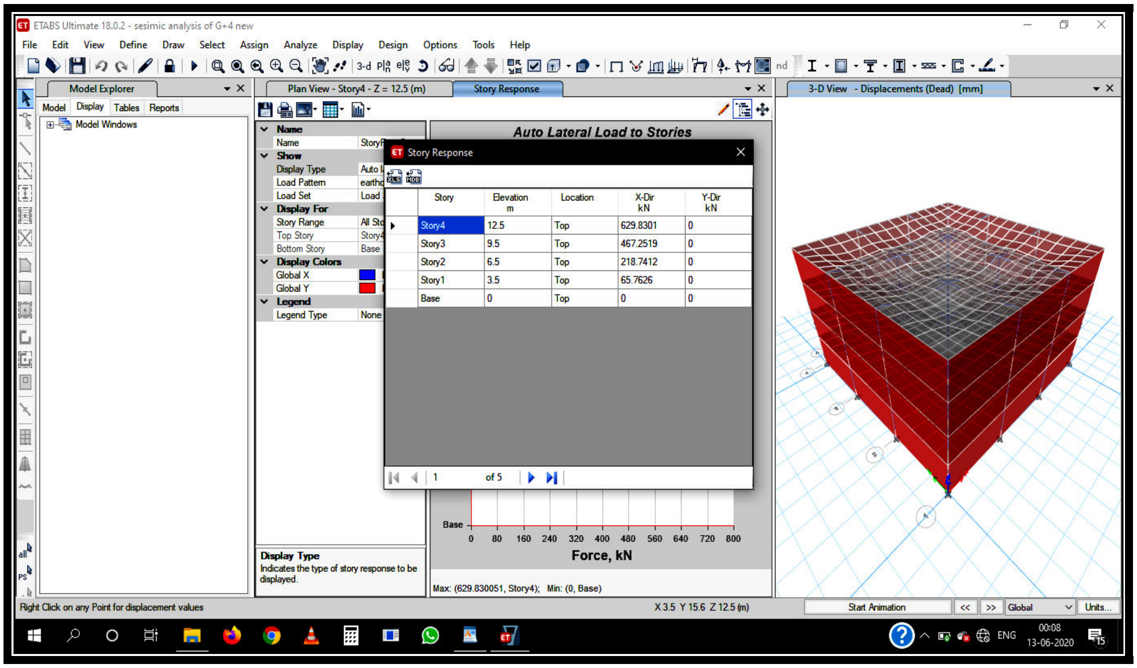
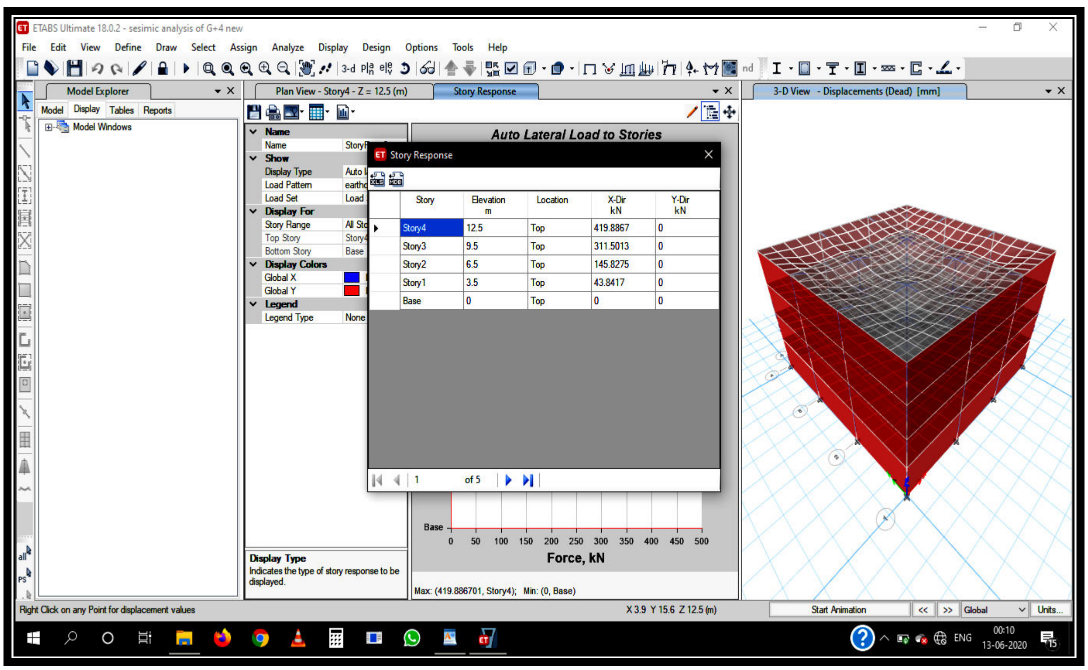
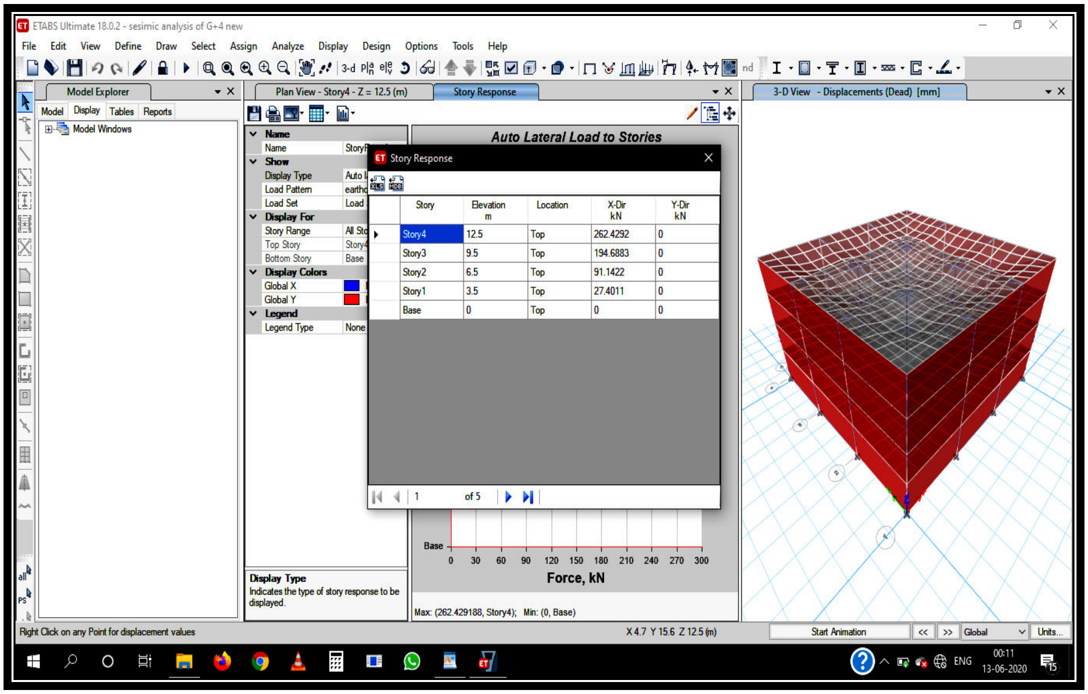


Storey Response for Zone-IV



Storey Response for Zone-III



Storey Response for Zone-II

CONCLUSION

1. The Structure analyzed in different seismic Zones of India, than we find out the results in base shear of the building is more in seismic Zone-V has compare to Zone-II, Zone-III and Zone-IV.

2. Base shear of seismic Zone-V is higher than 72.2%, 55.56% and 33.33% as compared to Zone-II, Zone-III, and Zone-IV respectively.

3. Coming to Floor Displacements Zone-V as higher displacements than Zone-II, Zone-III and Zone-IV.

4. In Maximum Floor Displacements seismic Zone-V is higher than 39.79 mm, 30.77 mm, 18.52 mm as compared to Zone-II, Zone-III, and Zone-IV respectively.

5. Support reactions Zone-V as higher value as compare to Zone-II, Zone-III, and Zone-IV.

6. Steel quantity of seismic Zone-V is higher than 53.84%, 13.89% and 8.31% as compared to Zone-II, Zone-III and Zone-IV.

7. From the above results Zone-V is critical for the G+3 structure.

8. Seismic force acts on the structure it reflects additional force acting on the structure, Because of these addition forces structure behave different way than normal condition.

9. Comes to seismic zones Zone-V has higher zone factor than other zones. So Zone-V values are more than as to compare other zones.

10. Base shear, Displacements, support reactions and steel quantity are Depends on zone factor, so these values are more in Zone-V.

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