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# Comparative analysis of a High Rise Building Frame Considering Two Different Seismic Regions using ETABS A Review

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**ABSTRACT**

Structural developments are increasing rapidly now-a-days throughout the world. Natural calamities like earthquake are happening frequently around the world, hence, the structure has to be designed for the same. The critical seismic analysis of reinforced concrete building, specifically involves the understanding behavior of structure under lateral loads unlike the usual gravity loads such as dead loads and the live loads. Multistorey building would be the greater part influenced by quake constrains to seismic prone areas. The major concern in the design of the multi-storey building is the structure to have enough lateral stability to resist lateral forces, buckling, to control lateral drift and displacement of the building.

In this paper presenting review of literatures related to different seismic regions.

Keywords — Base shear, storey displacement, special moment resisting frame, static analysis and Etabs.

## I. INTRODUCTION

The unique concept used in earthquake engineering is the equivalent lateral force. In structures maximum displacement or member stresses are determined by the Dynamics analysis which further changes to partly dynamic and partly static analysis. There are different types of lateral loads in buildings like wind loads and earthquake loads and their behaviour varies with the type of soil. These types are Hard soil, Medium soil and Soft soil. When seismic waves pass through these soil layers their effects are different .When structure is exhibited to earthquakes it is influenced with the foundation and soil mass. Thus, it changes the movement of the earth .This indicates that the type of soil ,and also depends on the type of structure ,influences the movement of the entire system of ground structures. Because seismic waves are generated from the ground, they consist of changes in the properties of the soil and work in different ways in accordance with the correlate to the properties of the soil. Vibrations that distract the earth's surface caused due to waves generated in the earth are called earthquakes. It is mentioned that earthquakes do not kill human life, but structures that are not built taking into account the forces of an earthquake. Earthquake resistant structures in India currently attach great importance to human life and its security. India’s geographical location is such that it comes under the subcontinent area so that’s why India is having more than 60% earthquake prone area. Generally buildings are constructed in India design with permanent ,semi – permanent moving loads keeps in mind.

According to IS 1893 2016 code (Clause 6.3.5.3) soil condition is classified into following three types

Type I - Hard Soil: Sand gravel and well graded gravel and sand gravel mixtures without or with clay binder, and poorly graded clayey sands or sand clay mixtures (GB, CW, SB, SW, and SC) having value of N above 30, where N indicates the : standard penetration value.

Type II - Medium Soil :All soils having N between 10 and 30, and gravelly sands or poorly graded sands with little or no fines (SP) with N>15.

Type III - Soft Soil :All soils except SP with N

## II. Literature Survey

Research paper from different authors are summarized in this section who have focused towards analyzing multi storey high rise structures considering seismic loads with different zones and soil condition these authors have used analytical application such as STAAD.pro, SAP 2000 and ETABS for the purpose of modelling and analysis and even presented manual calculations.

### 2.2 Summary of Literature Survey

Abhishek Mishra et.al (2022) research paper analyzed and compared the seismic response of a G+15 storey RCC frame structure with variable soil conditions (Hard and Soft soil) for seismic Zone IV. Both models were analysed in STAAD Pro V8i software using the Equivalent Static method of seismic analysis and the response of the model was examined in terms of the maximum storey displacement, base shear and story drift.

When compared to both Soft and Hard soil, the base shear value was more in the soft soil. When compared to both soft and hard soil the story drift value is more in the soft soil. The value of storey displacement increases as the stiffness property of the soil stratum decreases, so it was highest for model M1 with soft soil and lowest for model M2 with hard soil.

B. Ramakrishna et.al (2022) research paper aimed to present the analysis of a multi-stored building [G+5] using STAAD Pro by considering different seismic zones for all type of loads (Seismic load, Dead load, Live load and Wind load) and possible load combinations was performed as per Indian codes. The seismic analysis was done under different zones which are Zone-II, Zone-III, Zone-IV, Zone-V and also zone factor values was considered as per IS 1893-2002 (Part-1). Results were compared on the values of shear, bending moment and deflection for different zones.

Results stated that shear force, bending moment and deflection values for Zone III increased by 60% when compared to Zone II. Shear force, bending moment and deflection values for Zone IV increased by 24% when compared to Zone III. Shear force, bending moment and deflection values for Zone V increased by 50% when compared to Zone IV. For the same loading condition Zone V having more shear force, bending moment and deflection values. As comparing the results zone II having lower shear force, bending moment and deflection values.

Gourav B N et.al (2021) research paper conducted time history, response spectrum and p-delta analyses using Etabs software to study the effects of different soil types and seismic zones for a high-rise building of G+ 30 storey. In the research, a total of 12 models were analyzed for various soils types and seismic zones are systematically compared and discussed for a seismic performance of multistory building. The obtained results were analyzed and compared to determine the most suitable condition for the construction of a given high-rise building to have maximum service life.

Results stated that as the seismicity of the building increases care should be taken by the structural engineers to counter the seismic energy and to safeguard the building. With the change in soil property from hard to medium and from hard to soft the lateral deflection was increased. In Seismic Zone - 2, 3 & 5 the values of maximum Shear forces & maximum bending moment are decreasing in hard soil strata when compared with soft soil strata & found the least for the same.

Sagar Laxman Belgaonkar et.al (2021) research paper presented the analysis of the structure G+9 story using ETABS 2013 for different types of seismic zones and soil types as per IS 1893:2016 on parameters such as natural period, displacement, base shear and story stiffness.

It was observed that the displacement was higher for models under soft soils. Displacement was higher on the upper stories, due to the effects of different seismic zones and soil types. Displacements for models with soil type III are almost 1.67 times higher than that of Models with Soil Type I. Models with seismic zone II were the least affected with the seismic forces as compared to the other models.

Tejaswini Wagh et.al (2021) research paper presented seismic analysis and design of a G+9 RCC building applying dead and live loads, using analytical application STAAD.Pro. Comparison of results of earthquake load applied on the structure by STAAD-Pro and manual calculations both by an equivalent static method and the responses, shear forces, bending moment, seismic forces, and node displacement, and restrict them by applying appropriate properties and materials were evaluated.

Results stated that STADD Pro is a versatile software that can calculate the reinforcement needed for any concrete section depending on its loading as well as nodal deflections against lateral forces. Here in the case study the structure was found stable.

Tennu Syriac (2021) research paper investigated the performance and behaviour of regular and vertical irregular G+12 storied buildings under seismic loading considering two types of irregularities namely vertical irregularities and horizontal irregularities. Total ten regular and irregular buildings was modelled and seismic analysis was carried out in Staad Pro and the results were compared.

It was concluded that as the amount of setback increases, the critical shear force also increases. The regular building frames possess low shear force compared to setback irregular frames. The critical bending moment of irregular frames was more than the regular frame for all building heights. Compared to irregular models, lateral displacement is less in regular models. Comparing the node displacements for both regular and irregular building the maximum displacement is obtained for Regular (U Shape) and minimum is obtained for Regular with stepped.

Vinay Kumar (2021) research paper presented analysis of twelve storey reinforced concrete (RC) multi-storied marketable structure with FOUR different zones II, III, IV & V using E-Tabs Software with constant storey height of 3m. Four models were used to analyze with different bay lengths and the number of Bays and the bay-width along two horizontal directions were kept constant in each model for suitability.

Results stated that for RSx, the maximum displacement arises In the Terrace Roof floor of the structure. The displacement at the ZONE II was 9.527mm and ZONE V was 46.385mm. This meant displacement rises by more than 20% for RSx. if seismic ZONE changes from II to V.

Kaveri et.al (2019) research paper focused on evaluating the performance of multistoreyed with and without infill walls under various seismic zones and soil conditions considering equivalent static force method using ETABS software on the parameters of shear force, bending moment, and base shear.

Results stated that base shear was maximum in soil type II without infill wall compared to the soil type I. The moments in a building increases gradually according to seismic zones. In both cases, the shear force, i.e., with infill and without infill, increases as the seismic zone increases.

P. HariharaVenkata Nagasai et.al (2019) research paper presented analysing and design of G+7 (Hostel building) & compaed the support reaction of a seismic and non-seismic analysis of the multi-storey building by using SAP2000 & the loads were assigned as per the IS codal provisions and by using the support reaction further proceed to the different type of footings, various soil parameters. The site conditions considered was AMARAVTI the new capital city of A.P located over zone III and soil type was mostly black cotton soil.

Results concluded that the bending moment, shear force, axial force and displacement values were drastically higher in the seismic analysis. To restrain the additional seismic loads of the structure, relevant design method is to be adapted like using seismic design strategies and devices in the construction.

Rahul Kumar Thakur et.al (2019) author analyzed the Seismic analysis of RC (G+13) Multi-storey building frame structure in different seismic zones by using Linear Static Methods in a Staad Pro V8i. Different soil conditions and different parameters like size of column 450x450mm, size of beam 230x450mm, thickness of slab 150mm, height of each floors 3m were considered and comparative analysis of the building frame was conducted in the term of Node displacement, Maximum Shear Force, Maximum Bending Moment, Maximum Axial forces.

Results stated that maximum node displacement, shear force and bending moment in zone V in soft soil while minimum at zone II and hard soil. It means that, as soon as the zone increases, the node displacement also increases. The results in the term of support reaction shows that zone II, III & IV are the same with all type of soils but increased with change from IV to zone V with soft soil. The maximum storey-wise displacement was found in zone V with soft soil and minimum at zone II with hard soil.

Atif Mehmood and Parveen Singh (2018) research paper investigated the effect of Seismic waves on multistory building is studied for different masonry building designed as per IS code 13920. The maximum story displacement was tested for G+5, G+7 and G+9 floors.

The conclusion drawn from the research of seismic analysis of multistory building that the reason of failure behind the multistory buildings are lack of structural integrity, improper construction practice, heavy mass and low strength of mortar etc. the most commonly used technique of ascertaining ductile and strong connections between horizontal diaphragm and walls is to give seismic lands at plinth level, roof and lintels. So, to overcome the failure of multistory building, there was a need to follow up the proper guidelines provided by the Indian Standards, codes etc.

M R Vyas and Dr. S P Siddh (2018) research paper conducted analysis on two high rise structure, (27 meters) symmetric and asymmetric in shape, considering all four earthquake zones as per seismic code (Zone II, III, IV, and V) and also for hard, medium and soft type of soil. The modelling and analysis was done by the linear analysis approach of Equivalent Static Force method using STAAD.pro software as per IS1893-2002-Part-1.The parameters selected for comparison were deflection, storey drift, storey shear, base shear, bending moment and shear force.

The results stated that as structure is made on the higher zone the value of SF increases by minimum 14%(for each zone) while the values for bending moment increases by around 27% (for each zone) considering all different types of soil. Maximum Storey Drift increase by 37% for zone II to III while the increment percentage reduces to 33% for higher zone.

Mukesh Sharma et.al (2018) research paper presented analyze of G+6 multi-storey building with and without shear walls using STAAD. Pro. 2 to identify the effect of RC shear walls on structures when provided at various locations. The results were obtained by analysis for base shear, storey shear, drifts, displacements etc. for various models.
Results concluded that by providing shear walls the structure becomes more stable and resistant to lateral loads. The displacement of structure, storey drift, bending moments in beams, columns gets reduced with provision of shear walls. Building model-III with shear walls along periphery is more effective and efficient than other models.

Archna Tiwari and Richa Agarwal (2017) research paper dealt with the comparison of base shear of multi storied buildings with dimensions 22.5m X 22.5m at Earthquake zone III and different types of soils as per IS:1893(part: I):2002 and the buildings were analyzed by software STAAD Pro. The results were obtained in terms of percentage change in base shear and peak story shear.
Results stated that as peak story shear and base shear increases from soft soil as compared to medium soil as well as medium soil compared to hard soil for the six storey building in earthquake zone III when the building analyzed by software STAAD Pro.

Atul N.Kolekar et.al (2017) research paper conducted dynamic analysis of G+12 RC multi-storey framed building considering for Koyna and Bhuj earthquake by response spectrum analysis and time history analysis and responses of such building were comparatively investigated with the help of SAP2000 software. Two time histories (i.e. koyna and Bhuj) were used to develop different acceptable criteria (base shear, storey displacement, storey drift).
Results stated that the seismic response such as base shear for Bhuj earthquake was found to be more by 45.44% than Koyna earthquake by using time history analysis. The base shear of Koyna and Bhuj earthquake by response spectrum method is found to be 37.01% and 41.30% higher than time history method. The top story displacement of Koyna and Bhuj earthquake by response spectrum method is found to be 33.15% and 34.26% higher than time history method. The values of the storey drifts for all the stories for all the effects were found to be within the permissible limits specified as per IS: 1893-2002 (Part I). Results concluded that building used for pushover analysis is seismically safe because performance point base shear is greater than design base shear for both koyna and Bhuj earthquakes. The demand curve intersects the capacity curve near the elastic range; the structure has a good resistance and high safety against collapse.

Ch.Sandeep Reddy and V.Aparna Reddy (2017) research paper focused on the building when is designed for earthquake forces in different seismic zones as per IS 1893:2002.A five storied R.C.C framed structure has been analysed and designed using STAAD ProV8i software tool.
Results stated that variation of support reactions in exterior columns increased from 11.60% to 41.75% and in edge columns increasing from 17.72% to 64.0% in seismic Zones II to V. However the variations of support reactions are very small in interior columns. The volume of concrete in exterior and edge column footings increased in seismic zones III, IV and V due to increase of support reactions with the effect of lateral forces. However the variation is very small in interior column footings. The percentage variation of steel in edge, exterior and interior columns varies from 0.8-3%, 0.8-4% and 1.1-4.0% between gravity loads to seismic zone V respectively. In the external

and internal beams, the percentage of bottom middle reinforcement was almost the same for both earthquake and non-earthquake designs. Percentage variation of total concrete quantity for the whole structure, between gravity load and seismic zones II, III, IV and V varies as 1.4, 2.0, 2.7 and 4.0 respectively.

Pallavi G. A and Nagaraja C (2017) research paper presented analysis of G+9 storey building, along with shear wall and bracings. The performance of the building will be evaluated on the basis of following parameters as storey displacement, storey drift and base shear. In the research, the shear walls and bracings was provided at different locations with the overall analysis to be carried out using Etabs 9.7 software.

Result stated that location of shear wall at corners are effective in reducing actions induced in frame with less deflection and drift. Storey drift for Zone-V decreased by 64.9% and in Zone-IV it decreased by 64.93% for placing of shear wall at corners when compared with bare model frame. Storey displacement for Zone-V decreased by 35.33% and in Zone-IV, it decreased by 24.56% for placing of shear wall at corners when compared with bare model frame. Base shear value for Zone-V increased by 41.24% and in Zone-IV, it increased by 52.47% for placing of shear wall at corners compared to bare model frame. Hence results concluded that providing shear wall at corner gives more strength when compared with bare model frame and also with bracings.

## III. CONCLUSION

Here authors determined the utilization of analysis tool and different analysis methods. Authors examined structures considering different conditions and explained.

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