ANALYSIS AND DESIGN OF G+7 RC BUILDING IN SEISMIC ZONE III & IV OF INDIA: A REVIEW

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Abstract: **A structure should be design in such a way that it can stand during all gravity and horizontal forces and should be economically in cost also. Horizontal forces caused by due to wind, earthquake, dynamic motion of equipment or motors etc. So, the main aim of this research was to compare the difference between the variation of steel percentage, forces between seismic zone III & IV of India by analysis a G+7 RC structure using SAP2000 v23.1.0 software and Indian code IS 1893:2016. There was increase in forces of structure, steel percentage etc in seismic zone IV of India as compared to seismic zone III of India when analysis same structure in SAP2000 v23.1.0 software by using Indian seismic code.**

Keywords: **SAP2000 v23.1.0, Steel percentage, Bending moments & Shear forces, maximum deflections, seismic zone III & IV**

I. INTRODUCTION

A structure is said to be economically designed structure if the structure is safe for all vertical gravity loads and horizontal forces and in overall cost of the structure also. The vertical loads are due to self- weight of the structure, live loads on the different floors of the structure, equipment dead loads, furniture's dead load, vehicle dead load, tiles dead load etc. and the horizontal forces are due to blowing wind by different speed in different wind zones, due to the earthquake forces by the different impact on structure on different seismic zone. Earthquake forces and wind forces try to tilt the building by generating moment at the base of the structure about the centre of gravity of structure. So due to these horizontal forces building try to overturn about its weak axis and try to slide also about the weak axis of the structure. To resist these forces and to stand the structure safely against these forces, the building is designed in such a way that there is a sufficient lever arm at bottom of structure, foundation, sufficient percentage of steel, sufficient foundation size, sufficient concrete grade, sufficient cement grade, sufficient reinforcement etc need. So, to study the effect of horizontal forces due to seismic forces in different seismic zone III & IV of India, we analyse the G+7 RC building in SAP 2000 v23.1.0 software by using the Indian seismic code IS 1893:2016 and concrete design code IS 456:2000. Seismic zone IV has high damage risk and we can say that its high risk zone as compared to zone III. The effects of horizontal forces are more in zone four as compared to zone three of India. We analyse the G+7 RC building of same dimensions in both seismic zones and compared the results between both seismic zones. By analyses the structure in SAP2000 it is observed that, the structure which analysed in higher seismic zone has more impact of seismic forces as compared to lower zone. The forces like maximum bending moments, maximum shear forces, maximum deflections, maximum drifts, maximum interaction ratios, percentage of reinforcement or steel, grade of concrete, overall cost of the building, grade of cement, size of members, size of foundations, failure of structure against overturning, sliding, uplift etc increased in higher seismic zone in place of lower seismic zone. These all forces are less in lower seismic zone. Therefore, the increase in these forces cause more bending moment in members and try to bend the member more.

The main objectives of this research are given below:

1). To check how to behave the RC structure during seismic forces when analysis by response spectrum method.

2). After analysis same dimension RC structure in two different seismic zones of India, compared the change in percentage of reinforcement, steel between seismic zone III & IV.

3). By analysis RC structure in two seismic zone III & IV of India, compared the variations in forces like bending moment, shear forces, torsions etc.

4). To know the variation in deflection, drifts, crack width etc between two seismic zones by analysis the same dimension RC structure in SAP 2000 software.

5). To check the variation of total cost of same RC structure when designed in two different seismic zones.

In this research we have discussed all above mentioned objectives with brief by comparing the results of both structures.

Scope of this research: The most important scope of this research is to provide the knowledge about the variations of forces, percentage of reinforcement, change in deflections, change in drifts, change in torsions, change in size of members etc when analysis a G+7 RC structure of same dimensions in two different seismic zones III & IV of India by using Indian seismic codes and SAP 2000 software. There is total five numbers of seismic zones in Indian map out of which zone first was neglected because of no risk and hazards, so now in India seismic zone second, third, fourth and fifth exist. Fifth seismic zone have very high risk and hazards due to large impact of earthquakes and fourth seismic zone has less risk and hazards as compared to the fifth zone. So, in this

research we discussed the study of rc structure between two seismic zones III & IV and compared the results obtained from both structure after analysis in SAP 2000 software by using Indian seismic code and concrete design code. For reference, we have attached the figure of Indian Seismic Zones which contains a briefly about seismic locations and types and impacts. According to attached seismic map, red area indicated the very high-risk locations in Indian map. Orange area indicated the high-risk locations of earthquake in map, yellow area indicated the moderate risk locations of earthquake in map and sky-blue area indicated the low-risk locations of earthquake in this seismic map. About total 59.5 percentage (marked in red, orange, yellow colour) of total land of India has risk of hazards due to earthquake and approximately 40.5 percentage (marked in sky-blue colour) of total land area has very low risk of earthquake impact. Red marked area which has high risk of hazards due to earthquake forces comes in mountains area or hilly stations and Shy-blue marked area which has very low risk of hazards due to earthquake exists inside the territory of Indian map and its mostly levelled area, no hills exist in this area. The complete study of seismic map is given in IS 1893:2016 code and all design criteria also given in this cod according to the site locations and building dimensions which helps to design a safe and economical structure in required seismic zone.

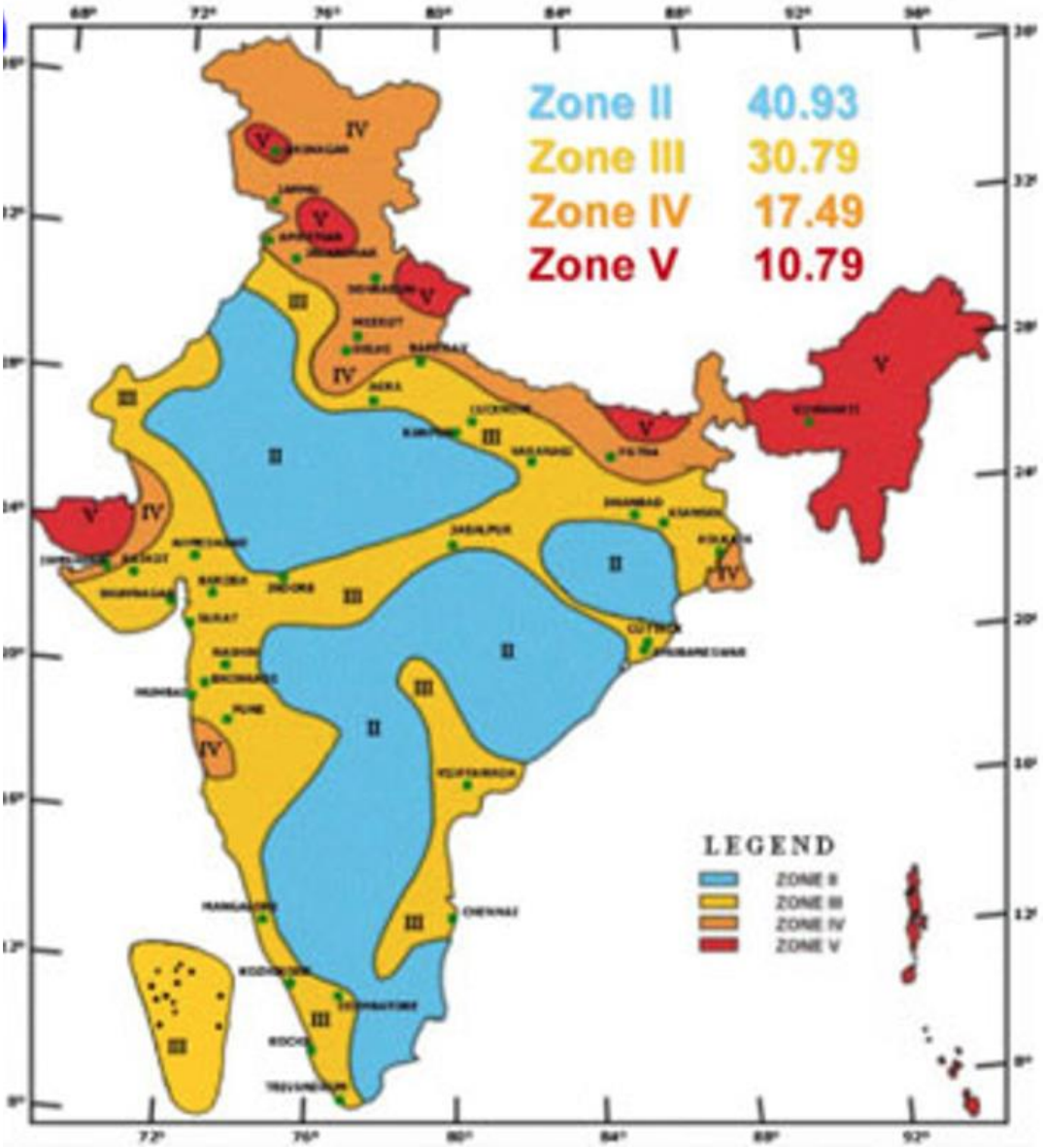

Fig. Map for Seismic zones of India

II. REVIEW OF LITERATURE

Before the starting of this research, we reviewed the related literatures and research which helps to increase our knowledge and to know the disadvantages, mistakes etc to complete the study. There are a lot of literatures written related to this study, out of which we will discuss one by one some literature which we reviewed for this study. The main importance of reviewing the past related literatures is that it provides us the idea of research and also helps us to save the time for our research. Some scientists have already studied to know the behaviour of seismic effects on buildings during the shaking of earthquake forces on different zones with different intensities and provides some conclusions of their research or study by which we can understand the behaviour of building or structure. Past studies also help to compare our results after analysis of structure and to compare the results o maximum deflections, drifts, forces etc of the structure. Our structure has seven storey and past structures which has already studies and more

the seven storey and less than seven storeys. In past studies, the RC structures and steel structures both have studied and provided their results which help to this research to compare our results with past studies. One thing is common in all past studies related to this topic that there is increase in forces, deflections, drifts etc in higher seismic zone as compared to lower seismic zone when analysis the structure in different seismic zones by using Indian seismic code and Indian design code and Staad, SAP 2000, Etabs software. In this study we will discuss some past literatures one by one which are related to our study and which help to our study.

Akaash Panchal, Ravi Dvivedi studied (2017) on RC G+7 structure by analysis & design of this structure on different seismic zones of India. For analysis and design, the author used the staad pro software and Indian seismic code and design code. The author analysis the structure by using response spectrum analysis of seismic design method. By analysis RC structure in staad software using Indian seismic code IS 1893: 2002, author found that the is increase in steel percentage or reinforcement, increase in maximum deflection, increase in maximum drifts, increase in maximum bending moments, increase in maximum shear force in higher seismic zone as compared to lower seismic zone of India. Author has checked all results are under the permissible values given in seismic code and design code. The total cost of the structures also increased in seismic zone five as compared to fourth zone when analysis same dimension building in different seismic zone. The total cost is increased due to increase in size of members, increase in steel percentage or reinforcement, grade of concrete or cement etc which affects the overall cost of the structure. The author has also observed that its almost 1.5 times increase in forces in higher seismic zone as compared to lower seismic zone and some structures have less than 1.5 times, because it's also varies zone to zone and different dimensions of structure.

Papa Rao and Kirann Kumar (2014) was researched on the variations of steel percentage/ reinforcement, overall cost of building etc from seismic zone two to seismic zone five of India. The author analysis and design the RC structure in etaabs software by using Indian seismic code IS 1893:2002 and design code IS 456:2000, to know the difference between the seismic zone five and three by comparing results of both zones like the change in forces, change in bending moments, change in maximum shear force, change in maximum deflection, change in maximum drifts, change in base reactions, change in member sizes, change in crack width, change in foundation sizes, change in cement/ concrete grade etc. the author also compared the results of base reactions obtained after analysis of same structure in two different seismic zone and found that base reaction is increased in seismic zone five in case of seismic zone three. The lateral forces in x & y direction increased in base reaction and the vertical forces due to gravity like self-weight of the structure, live load on the structure, furniture dead load, tiles dead load etc are nearly same in both the structure analysis in both different seismic zones. The conclusion of authors study was that there was also increase of forces in higher seismic zone in case of the lower seismic zone. The author also noticed that the nearly 1.25 more reinforcement needed when the same dimension building analysis in fifth seismic zone of India as compared to fourth seismic zone of India. He observed that the outer columns and beams has more increase in forces in case of the middle members, that's why the reinforcement needed more in outer members as compared to middle members.

Perla Karunakarr (2015) has also researched on related topic to know the exact behaviour of building of same size by analysis and design in different seismic zone. He used staad pro software to model and analysis the structure in seismic zones of India by response spectrum method of earthquake analysis using Indian seismic code IS 1893:2002 & concrete design code IS 456:2000 and relevant codes. The author also studied on the comparative results and total cost of both the structures, he observed that the cost of the structure increase in seismic zone five in case of the seismic zone fourth. Means the total cost of the building was observed to increase in higher zone in case of the lower zone. He found that the increase in deflections of the beams and column, increase in drifts of the column, increase in maximum bending moment of the beams and column, increase in maximum shear force in beam and column, increase in base reactions of the structure when analysis same dimensions structure in fifth seismic zone of India as compared to fourth seismic zone. All things are increased in higher zone in case of lower zone. He analysis the model by taking design criteria given in seismic code and concrete design code and after analysis compared the results, all values are under the permissible values given in design code. The overall cost of the complete building also affected and increased.

Salahuudeen Shakeeb S M, proff shaike abdulla (2016): the author used staad software to analysis and design of 13 storey RC building to check the performance of the structure in different seismic zones of India. He observed that he structure is vibrating more during the earthquake shaking when analysis the same dimension structure in seismic zone five as compared to seismic zone two and due to these vibrating or shaking of structure due to earthquake forces the horizontal forces or reactions increased in bottom of the structure which results increase in shear force, increase in bending moment, increase in deflections, increase in drifts and increase in base reactions at the bottom of the structure. Due to increase in these all forces the overall cost of the building also got increased and it could be nearly 1.3 times. The deflections and drifts are increased due to increase in lateral forces due to earthquake shaking due to more intensity of earthquake. Author studied that drifts are more in upper floor of the building as compared to the lower floor of the building. In upper floor the columns tried to move horizontally during earthquake shaking and results increase in bending moment at joints of beam and column.

Zeeyauula , Narayanna Syaide Ahmad Raja (2015) studied the behaviour of 12 storey RC structure when analysis the structure in different earthquake zones by using ETAABS software and India earthquake code IS 1893:2002 and Indian concrete design code IS 456:2000, he found that nearly 1.4 times increase in forces when analysis the same structure in higher earthquake zone as compared to the lower earthquake zone. It was also noticed by author that the outer member of this structure has more impact of the earthquake in case of the middle members and due to which the forces are more in outer members and which results increase in bending moment, increase in shear forces, drifts of the members, deflections of the members, base reactions of the overall complete structure, etc got increased in higher earthquake zone. There was nearly 1.4time steel percentage increased and overall price or cost of the structure also got increased due to high intensity of the earthquake when analysis the structure in higher earthquake zone as compared to the low earthquake zone of India. There is total five numbers of earthquake zone exist in Indian earthquake map out of which earthquake zone first neglected due to no risk of hazards and very low intensity of the earthquake forces.

Incharra and Ashveeny (2014): The main aim of the calculating this research was to check the performance of the structure during the shaking of earthquake forces when analysis the same dimension model in different earthquake zone with different

intensity of earthquake forces. The author recorded that when analysis the same model in different intensity of earthquake forces, the structure cause more forces due to high intensity of seismic forces in higher seismic zone and due to which the size of members got increased, steel percentage/ reinforcement also increased, bending moment & shear forces in member also increased, deflections & drifts also increased in higher earthquake zone as compared to lower earthquake zone. The author analysis & design the model by the help of ETAABS software and used Indian earthquake code for reference of minimum seismic design criteria and for concrete design used Indian concrete design code IS 456:2000. He recorded by comparing the results of both the structure analysis in different zone that the overall cost of the structure was also affected and its increased.

Umeash R Birraderr, Shivaraz Mannglgy (2014) The aim of the preparing this study was to check the performance of the RC building during the shaking of seismic forces when analysis the same dimension model in different earthquake zones with different intensities of earthquake forces. The model was analysis in Staad software by using the reference of seismic code IS 1893:2002.

III. CONCLUSION

In this research we studied the performance of G+7 RC structure by analysis and design of the same structure in two different earthquake zones (IV & III) by using SAP2000 software and Indian earthquake code IS 1893:2016 and Indian concrete design code IS 456:2000. By comparing the results of both the structures after analysis we found that there is 1.5times increase in base reactions in earthquake zone IV in case of zone III. In zone IV, deflections & drifts are also recorded to increased 1.5times in case of zone III. The bending moment of beams and column are recorded to increased nearly 1.5times in zone IV in case of zone III.

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