ANALYSIS & DESIGN OF G+15 BUILDING IN DIFFERENT SEISMIC ZONES OF INDIA

P.Neeraja
Assistant Professor, Department of Civil Engineering, MGIT, Hyderabad, India
cneeraja2009@gmail.com

ABSTRACT

Structure planning and design is an art and science of design with economy elegance and durable structure. The entire process of structural planning and design not only requires imagination and conceptual thinking but also sound knowledge of structural analysis.

Designing a structure in such a way that reducing damage during an earthquake makes the structure quite uneconomical, as the earthquake might or might not occur in its life time and is a rare phenomenon. In this study a G+15 RCC framed structure has been analysed and designed using STAAD.PRO V8i. The building is designed as per IS 1893(Part 1):2002 for earthquake forces in different seismic zones.

The main objectives of this project are to compare the variation of design parameters for a structure when it is studied in various seismic zones, steel percentage, maximum shear force, maximum bending moment, maximum deflection and base shear varied drastically in different seismic zone. The steel percentage, maximum shear force, maximum bending moment, maximum deflection is increases from zone II to zone V.

KEY WORDS: Seismic Zones, Response Spectrum, Shear Force Bending Moment, Deflection, Base shear, Storey Drift.

INTRODUCTION:

In general for design of tall buildings both wind as well as earthquake loads need to be considered. Governing criteria for carrying out dynamic analyses for earthquake loads are different from wind loads. According to the provisions of Bureau of Indian Standards for earthquake load, IS 1893(Par1):2002, height of the structure, seismic zone, vertical and horizontal irregularities, soft and weak storey necessitates dynamic analysis for earthquake load. The contribution of the higher mode effects are included in arriving at the distribution of lateral forces along the height of the building. As per IS875(Part3):1987, when wind interacts with a building, both positive and negative pressures occur simultaneously, the building must have sufficient strength to resist the applied loads from these pressures to prevent wind induced building failure. I will be considered for the IS 456:2000. Load exerted on the building envelope are transferred to the structural system and they in turn must be transferred through the foundation into the ground, the magnitude of the wind pressure is a function of exposed basic wind speed, topography, building height, internal pressure, and building shape.

LITERATURE REVIEW

Prakash Sangamnerkar et. al. has done the comparative study on the static and dynamic behaviour of reinforced concrete framed regular building. Comparison of static and vibrant behaviour of a six storey's structure is considered in this paper and it is analysed by using computerized solution available in all four seismic zones i.e. II, III, IV and V. It is observed that parameters like base shear, nodal displacements and beam ends forces varies in the same ratio as described above, hence it is very important conclusion derived in the analysis.

Mohit Sharma et. al. considered a G+30 storied regular reinforced concrete framed building. Dynamic analysis of multi-storeyed

Building was carried out. These buildings have the plan area of 25m x 45m with a storey height 3.6m each and depth of foundation is 2.4m & total height of chosen building including depth of foundation is 114 m. The static and dynamic analysis has done on computer with the help of STAAD-Pro software using the parameters for the design as per the IS-1893- 2002-Part-1 for the zones-2 and 3. It was concluded that not much difference in the values of Axial Forces as obtained by Static and Dynamic Analysis.

M. S. Aainawala et. al. done the comparative study of multi-storeyed R.C.C. Buildings with and without Shear Walls. They applied the earthquake load to a building for G+12, G+25, G+38 located in zone II, zone III, zone IV and zone V for different cases of shear wall position. They calculated the lateral displacement and story drift in all the cases. It was observed that Multi-storeyed R.C.C. Buildings with shear wall is economical as compared to without shear wall. As per analysis, it was concluded that displacement at different level in multi-storeyed building with shear wall is comparatively lesser as compared to R.C.C. building without shear wall.

Girum Mindaye1, Dr. Shaik Yajdani : The analysis of a structural system to work out the deformations and forces elicited by applied hundreds or ground excitation is an important step within the style of a structure to resist earthquake. there's a variety of strategies from a linear analysis to a classy nonlinear analysis counting on the aim of the analysis within the style method. during this paper seismic response of a residential G+10 RC frame building is analysed by the linear analysis approaches of Equivalent Static Lateral Force and Response Spectrum strategies exploitation ETABS final 2015 code as per the IS1893-2002-Part-1. These analysis square measure allotted by considering completely different seismic zones,
medium soil sort for all zones and for zone II & III exploitation OMRF frame sort and for those of the remainder zones exploitation OMRF & SMRF frame sort

METHODOLOGY

Modelling

Create the frames of both symmetrical and asymmetrical shaped building by run structure wizard and select frame model and then bay frame. Give length of frame as 17.67m and number of bays along length as 5. Likewise give the height of building as 3m and number of bays along height as1and width as14.7m no. of bays along width as 4.

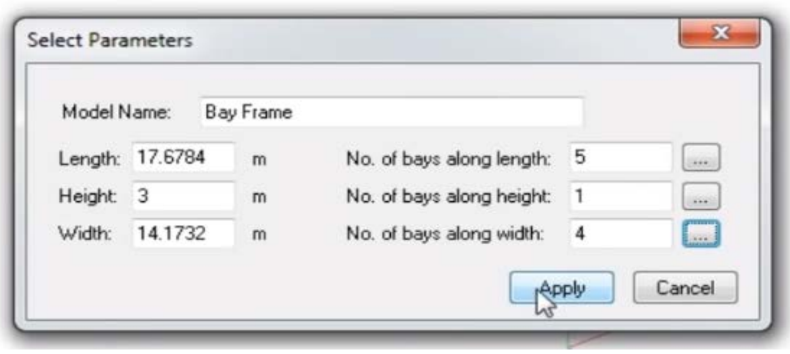


Fig 1 Grid data

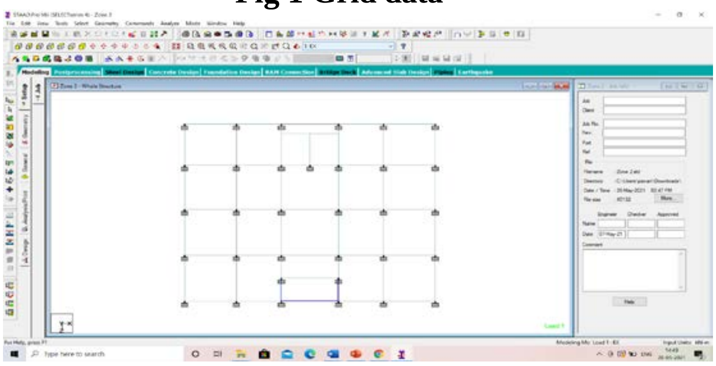


Fig 2: plan of building in all Zones

Definition of material properties:

Using Material command define the material properties. Define the grade of concrete as M30 and Grade of Steel as Fe500.

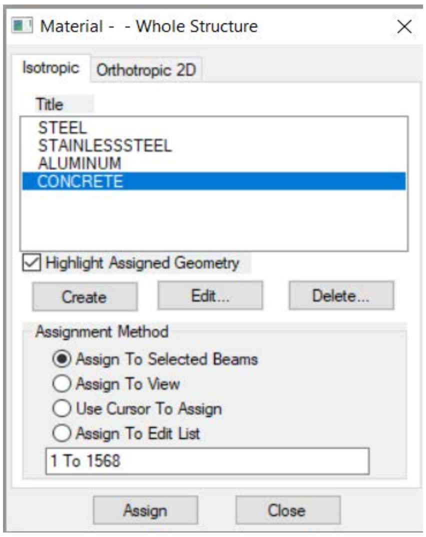


Fig 3 Material properties

Loadin

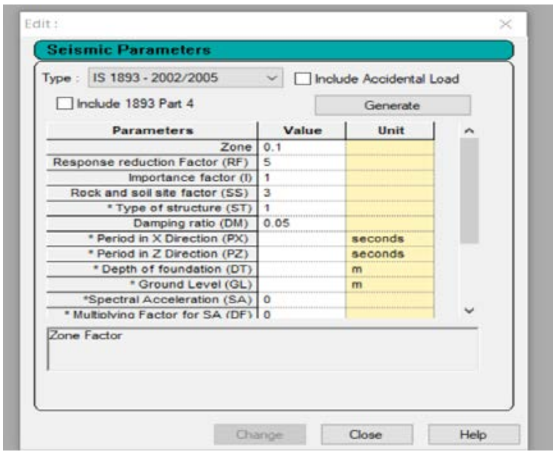


Fig 4. seismic parameters in Zone 2.

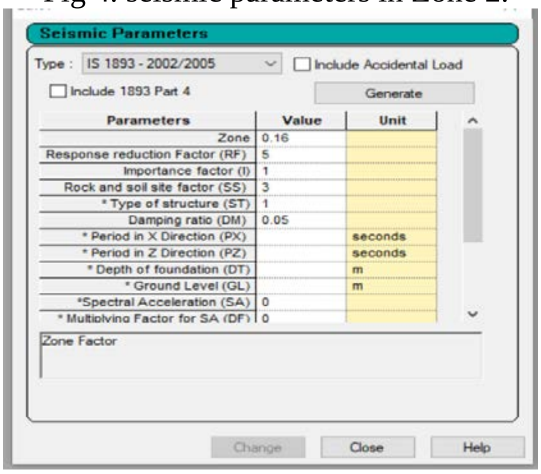


Fig 5. seismic parameters in Zone

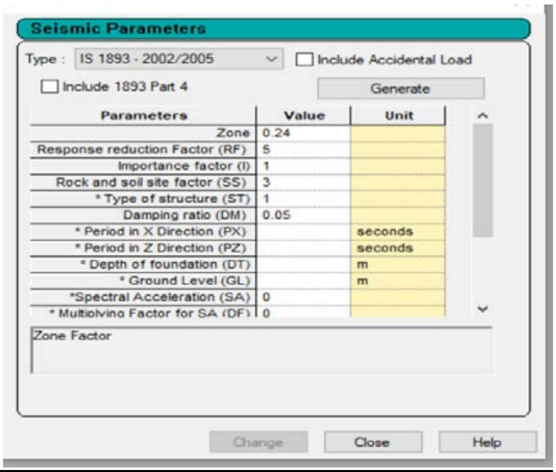


Fig 6. seismic parameters in Zone 4.

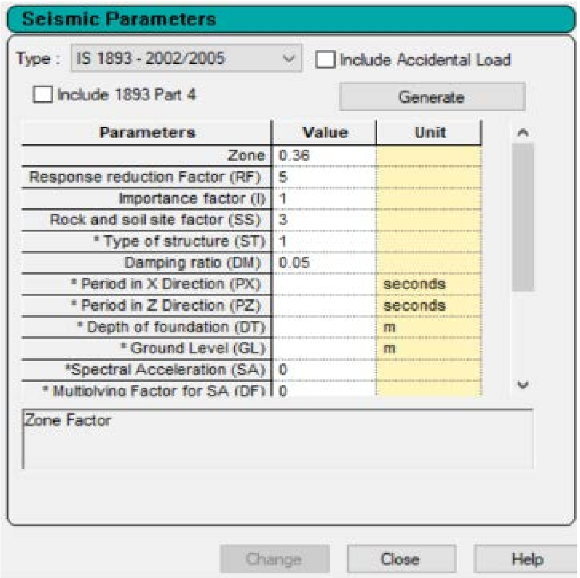


Fig 7 seismic parameters in Zone 5

Wind Load:

In Zone2,3,4 we have considered max wind speed as 50m/s for >10 m height and this value is used in calculation.

In Zone 5, We have considered Max Wind speed as 55m/s for >10 m height and this value is used in calculation.

After the assignment of wind load the structure looks as shown in figure

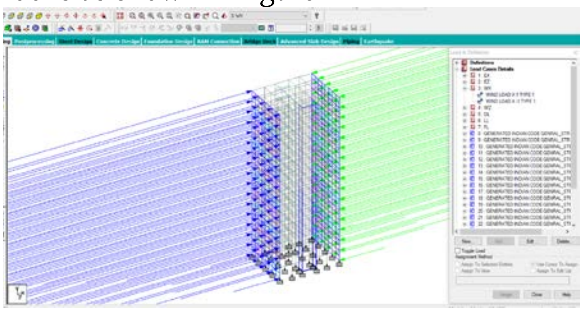


Fig 8 Wind load in Zone 2

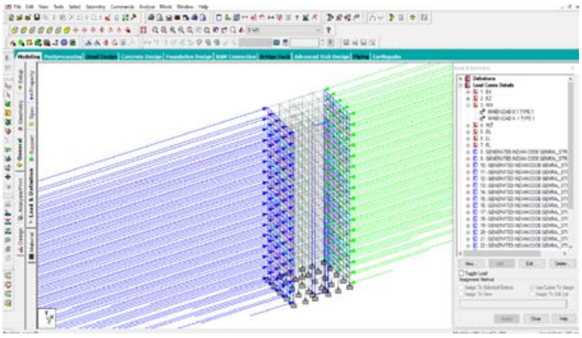


Fig 9 Wind load in Zone 3

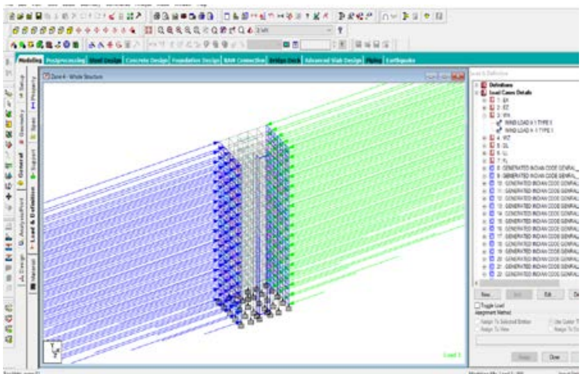


Fig 10 Wind load in Zone 4

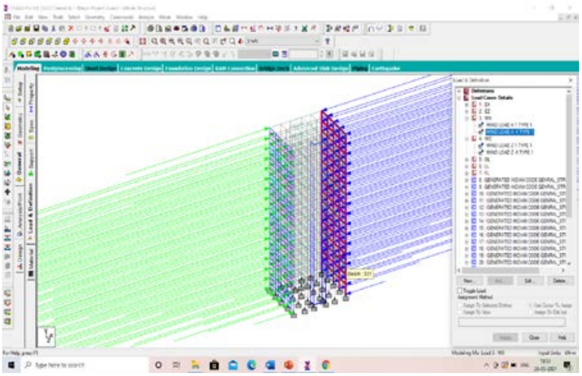


Fig 11 Wind load in Zone 5

Load combinations:

All the load cases are tested by taking load factors and analysing the building in different load combination as per IS456 and analysed the building for all the load combinations and results are taken and maximum load combination is selected for the design. Load factors as per **IS: 456-2000** are given below:

LIVE LOAD	DEAD LOAD	WIND LOAD
1.5	1.5	0
1.2	1.2	1.2
0.9	0.9	0.9

When the building is designed for both wind and seismic loads maximum of both is taken because wind and seismic do not come at same time as per code.

The combinations of loads shall be as given in IS 875(Part 5)
IS 875 (Part 5) states that:
A judicious combination of the loads, keeping in view the probability of:

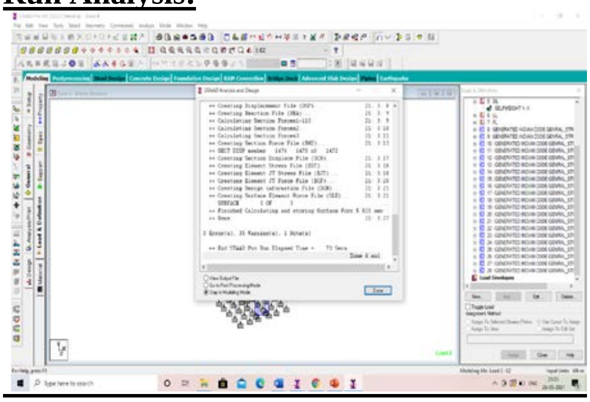
a. their acting together, and

b. their disposition in relation to other loads and severity of stresses or deformations caused by combinations of the various loads is necessary to ensure the required safety and economy in the design of a structure.

Load Combinations: Keeping the aspect specified above, the various loads should, therefore, be combined in accordance with the stipulations in the relevant design codes. In the absence of such recommendations, the following loading combinations, whichever combination produces the most unfavourable effect in the building, foundation or structural member concerned may be adopted (as a general guidance). It should also be recognized in load combinations that the simultaneous occurrence of maximum values of wind, earthquake, imposed and snow loads is not likely.

LOAD CASE NO.	LOAD CASE DETAILS
1	DL
2	LL
3	WL+X
4	WL-X
5	WL+Z
6	WL-Z
7	EQ+X
8	EQ-X
9	EQ+Z
10	EQ-Z
11	1.5(DL+LL)
12	1.5(DL+WLX)
13	1.5(DL+WLZ)
14	1.5(DL+EQX)
15	1.5(DL+EQZ)
16	1.2(DL+LL+EQX)
17	1.2(DL+LL+EQZ)
18	1.2(DL+LL+WLX)
19	1.2(DL+LL+WLZ)
20	0.9DL+1.5WLX
21	0.9DL+1.5WLZ
22	0.9DL+1.5EQX
23	0.9DL+1.5EQZ
24	1(DL+LL)
25	1(DL+WLX)
26	1(DL+WLZ)
27	1(DL+EQX)
28	1(DL+EQZ)
29	1DL+0.8(LL+WLX)
30	1DL+0.8(LL+WLZ)
31	1DL+0.8(LL+EQX)
32	1DL+0.8(LL+EQZ)

Run Analysis:



RESULTS AND DISCUSSION.

Base shear:

Base shear is an estimate of the maximum expected lateral force on the base of the structure due to seismic activity. It is calculated using the seismic zone, soil material, and building code lateral force equations.

The following table represents the base shear values of similar type of building in different seismic zones of India.

S NO	TYPE OF ZONES	BASE SHEAR (KN) X - direction	BASE SHEAR (KN) Y - direction
1	ZONE 2	1408.53	867.68
2	ZONE 3	2526.73	1716.90
3	ZONE 4	3792.61	2559.44
4	ZONE 5	5688.92	3839.18

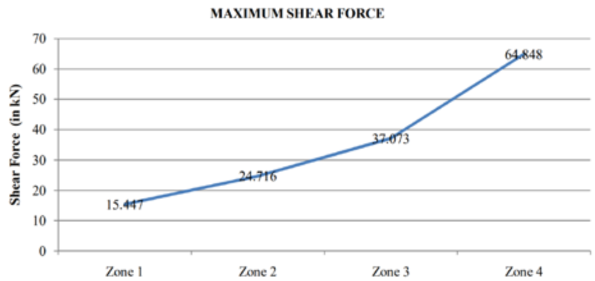
Table 1 Base Shear Values in different Seismic Zones

From the above data we can say that the value of Max Base Shear in X and Y directions is obtained in Zone 5 as **5688.92KN** and **38939.18KN** respectively.

Comparison of Results:

After analysis, the results are obtained are represented in the form of graphs. The comparison graphs are as follows:

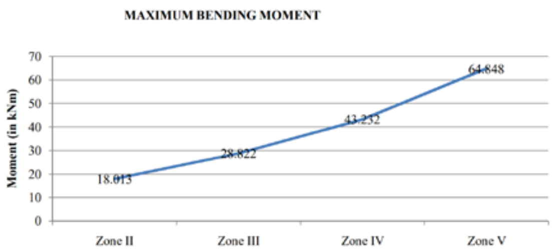
Comparison of Maximum Shear Force:



Graph 1 Maximum Shear Force

- The maximum Shear Force occurred in Zone.
- The maximum value of Shear Force is **64.848KN**

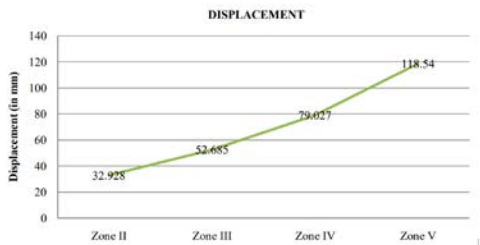
Comparison of Maximum Bending Moment Results:



Graph 2 Maximum Bending Moment

- The maximum value of Bending moment in Zone II is **18.103 KN-M**, zone III is **28.822KN-M** ZoneIV is **43.232** KN-M and in **ZoneV 64.848KN-M**.
- The maximum Bending Moment is occurred in ZoneV as the seismic intensity in Zone V is higher compared to the remaining seismic zones of India.

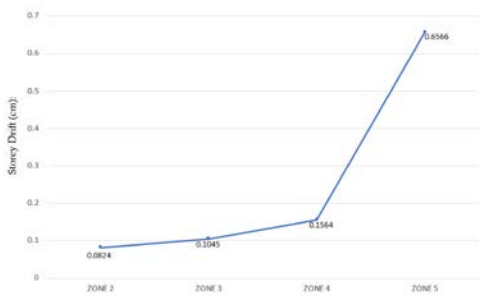
Comparison of Maximum Displacement:



Graph 3 Maximum Displacement

- The maximum Shear Force is increases from ZoneII to ZoneV
- The maximum value of displacement is **118.54mm.** **Comparison of Storey Drift:**

Storey drift:



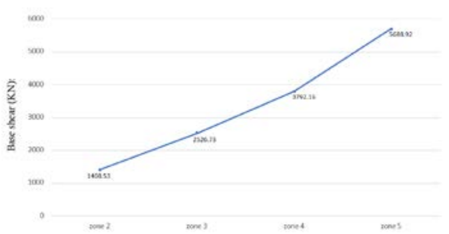
Graph 4 Maximum Storey Drift

- The Maximum Storey Drift value in Zone2 is 0.0824cm, Zone3 is 0.1045cm, zone3 is 0.1564cm and in Zone 5 is 0.6566cm
- The Maximum Storey Drift Value is Higher in top Storey due to impact of lateral loads.

Comparison of Base Shear:

S NO	TYPE OF ZONES	BASE SHEAR (KN) X - direction	BASE SHEAR (KN) Y - direction
1	ZONE 2	1408.53	867.68
2	ZONE 3	2526.73	1716.90
3	ZONE 4	3792.61	2559.44
4	ZONE 5	5688.92	3839.18

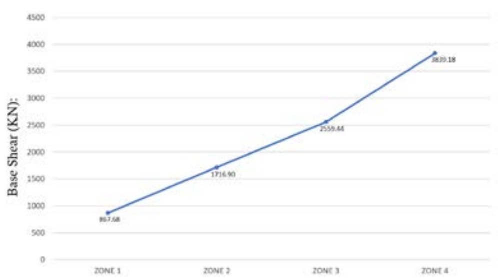
Base shear:



Graph 5 Maximum Base Shear in X Direction

- The maximum Base Shear in X direction is obtained in Zone5 as 5688.92KN at a height of 48m.

Base Shear:



Graph 6 Maximum Base Shear in Y Direction

- The Maximum Base shear value in Y direction in Zone1 as 867.68KN, Zone2as 1716.90KN, Zone3 as 2559.44KN and Zone5 as 3839.18KN.

- Among all Zones the Maximum Value is obtained in Zone 2 due to greater seismic intensity.

CONCLUSIONS

From the above analysis work and result obtained from STAAD Pro, it was found that

1. The Shear Force has increased in a magnitude of 76.18% from Zone II to Zone V.

2. The Bending Moment has increased in a range of 58.33% from Zone II to Zone V.

3. The Displacement has increased in a magnitude of 72.22% from Zone II to Zone V.

4. The Base Shear of structure has increased in a range of 75.24% from Zone II to Zone V.

5. The Storey Drift of structure has increased in a range of 87.45% from Zone II to Zone V. The Maximum value of Storey Drift is obtained at top of the structure in all the zones.

6. All the building constructed in Earthquakes Zones in line with the IS 1893-2002 to counter the seismic energy and to safe guard the building.

7. It can be concluded that by using shear walls, dampers, rubber pads, spring we can reduce damage of seismic effect of an R C building resting on high seismic zone.

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