Comparative Study on an RC Frame Building For Various Seismic Zones

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Abstract- Any structure must undergo a structural study as well as an earthquake or seismic analysis before construction can begin. Seismic analysis, also known as earthquake response analysis, involves estimating a structure's behaviour when exposed to seismic activity. A variety of seismic data is required to perform the seismic analysis of the structures. In this study, seismic analysis of a structural system is used to determine the storey drift and base shear induced by the applied loads on a residential G+4 RC frame building using the STAAD.Pro Connect Edition software and the structure are engineered by IS 1893:2016(Part 1). The main aim of this study is to compare total displacements, storey drifts, and the base shear of the G+4 RC frame building for the various seismic zones as per Indian standard code IS 1893:2016(Part 1). It is determined that the storey drifts and base shear is increasing from Zone II to Zone V.

Keywords- Seismic analysis, seismic zones, RC frame, STAAD.Pro Connect Edition.

I. INTRODUCTION

Numerous studies have been done on this subject, and more are being done because the more we strive to learn, the more we can do to reduce the harm and save lives. As per seismology studies, tectonic forces are responsible for 90% of earthquakes[1]. When it comes to civil engineering, an engineer's responsibility is to preserve economy and provide the highest level of safety in the structures they build. One important tool in earthquake engineering is seismic analysis, which helps simplify the understanding of how buildings react to seismic excitations. Buildings were previously just intended to withstand gravity loads; seismic analysis is a more recent addition. In areas of structural design and analysis where earthquakes are common, this is a component.

For low-rise building structures, reinforced cement concrete members appear to be the finest design option and are frequently utilized as structural components in India. RCC members, however, are no longer appropriate for high-rise structures due to their increased dead load, restricted span length, and decreased stiffness. Structural engineers are making the best use of a variety of materials to address these flaws[4]. Steel has the potential to be employed in construction at much higher volumes because it is an alternative building material. For large civil structures, the composite section made of steel enclosed in concrete is a useful solution[8].

the lateral force analysis provides the design forces and moments along with the forces and moments resulting from live and dead loads in accordance with the load combinations specified in IS 1893(Part 1): 2016. In light of it, we use IS 456:2000 to stabilize the structure before doing a seismic study[7]. A building's performance for a particular seismic hazard is suggested by performance-based seismic design. Selecting a performance aim is the first step in performance-based design. Next, a preliminary design is created, and if the building doesn't achieve the goal, revision and reassessment are necessary.

The fact that this earthquake struck a multi-story building demonstrates that poorly designed and built structures lack the necessary strength, which ultimately causes them to collapse completely[3].It is therefore necessary to study seismic analysis in order to construct earthquake-resistant structures in order to provide safety against the seismic forces of multi-story buildings.

II. HISTORY OF STADD PRO

STAAD stands for structural analysis and design in its entirety. One of the best programmes for analysing structures is STAAD Pro, which can also be used to design structures utilising the results of analyses. We select STAAD Pro because it offers the following advantages.
Ease of use, Compliance with Indian Standard Codes Versatility in solving any type of problem, Increase efficiency and save time, the precision of the solution etc.

III. OBJECTIVE OF THE STUDY

There are following objectives of this study:

- The designing and analysis should be done using IS codes 456:2000 and IS 1893:2016 (Part1).
- The modeling should be done in STAAD.Pro Connect Edition.
- Comparison of total displacements, storey drifts, and base shear of RC frame building for various seismic zones.
- To find out the maximum deflections and forces in the building.

IV. METHODOLOGY

According to the approach, the G+4 Residential building should be planned, and STAAD.Pro Connect Edition analysis should be performed for the building by providing different load conditions for different zones.

$$V = (A_h) \times (W)$$

V is design seismic force, also called design base shear Ah is the base shear coefficient

$$A_h = (Z/2). (I/R). (Sa/g)$$

- Z is Seismic zone factor as per IS 1893 (part 1):2016 given in table 1
- I is importance factor=1
- R is response reduction factor=5
- Sa/g is spectral acceleration coefficient for type II, Medium soil.

Table 1. Seismic zone factors

Zone	II	III	IV	V
Seismic zone factor	0.10	0.16	0.24	0.36

Design parameters of the building-

Table 2. Building Specifications

S No.	Design parameters	Design data
1	Building cross section	18m x 18m
2	No. of bays	6
3	number of stories	5
4	floor height	3m
5	Beam cross section	300mmx 300mm
6	column cross section	450mmx450mm
7	slab thickness	125mm
8	concrete	M25
9	steel	Fe415
10	specific weight of RCC	$25KN/M^2$
11	Earthquake directions	X,Z,-X and -Z
12	seismic zones	II,III,IV and V
13	soil type	Medium soil
14	Earthquake loads	As per IS 1893:2016 (Part1)
15	Damping ratio	5%
16	Response reduction factor	5
17	Importance Factor	1

A G+4 RC frame building will be modelled and analyzed in the STAAD.Pro Connect Edition software for various types of seismic zone as per Indian standard codes IS 1893:2016 Part1 and IS 456:2000.

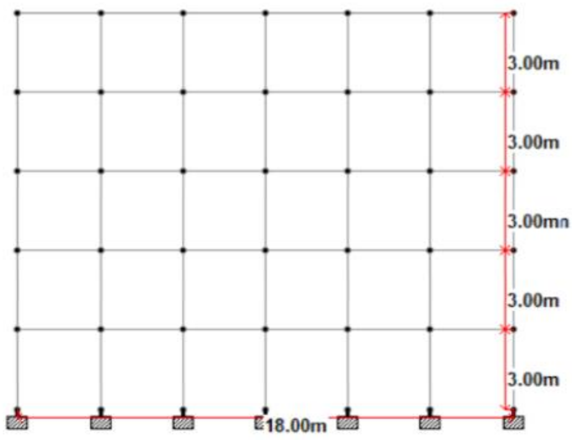

Fig.1. Side view of RC frame building

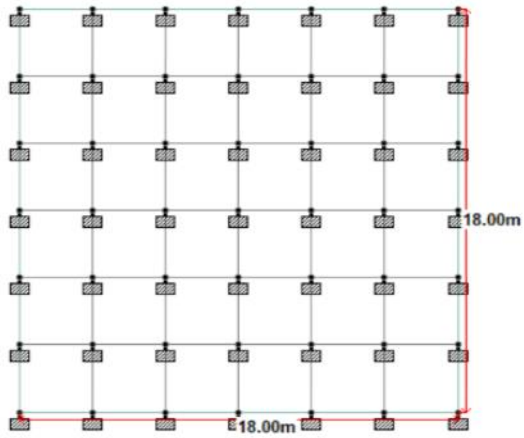

Fig.2. Top view of RC frame building

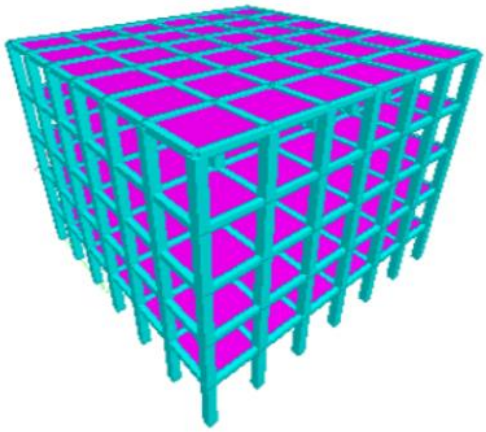

Fig. 3. 3D model of RC frame building

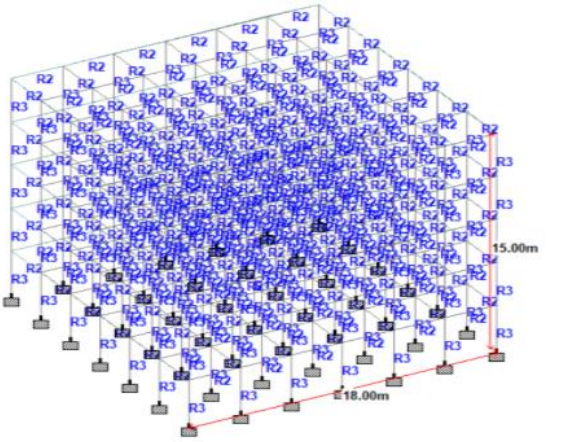

Fig. 4. Geometry of RC frame building

Here, figure 1 and Figure 2 shows the side view and top view of the RC frame building respectively or figure 3 and figure 4 shows the 3D model and the geometry of the building respectively. In geometry, R_1 shows the slab thickness, R_2 shows the beam dimensions and R_3 represents the column dimensions.

V. RESULT AND DISCUSSION

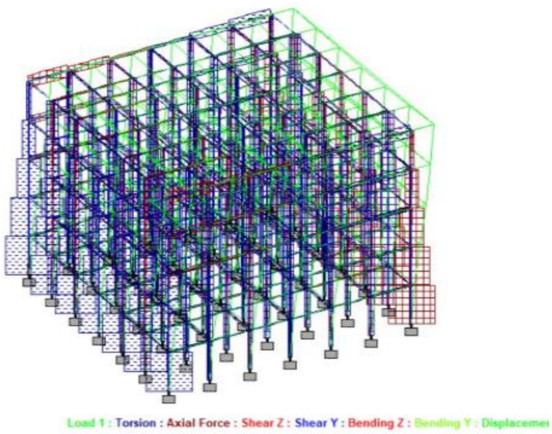

Fig. 5. Outcomes of RC frame building for Zone 2.

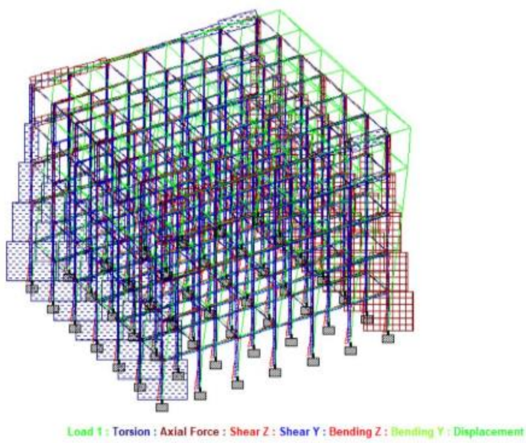

Fig. 6. Outcomes of RC frame building for Zone 3.

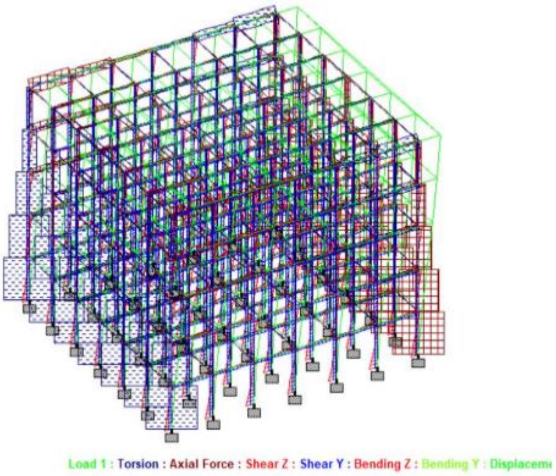

Fig. 7. Outcomes of RC frame building for Zone 4.

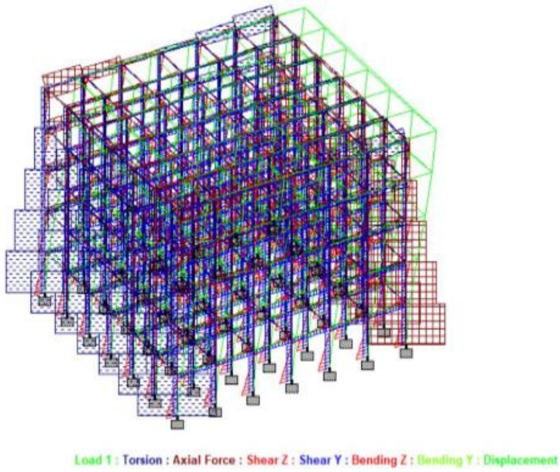

Fig. 8. Outcomes of RC frame building for Zone 5.

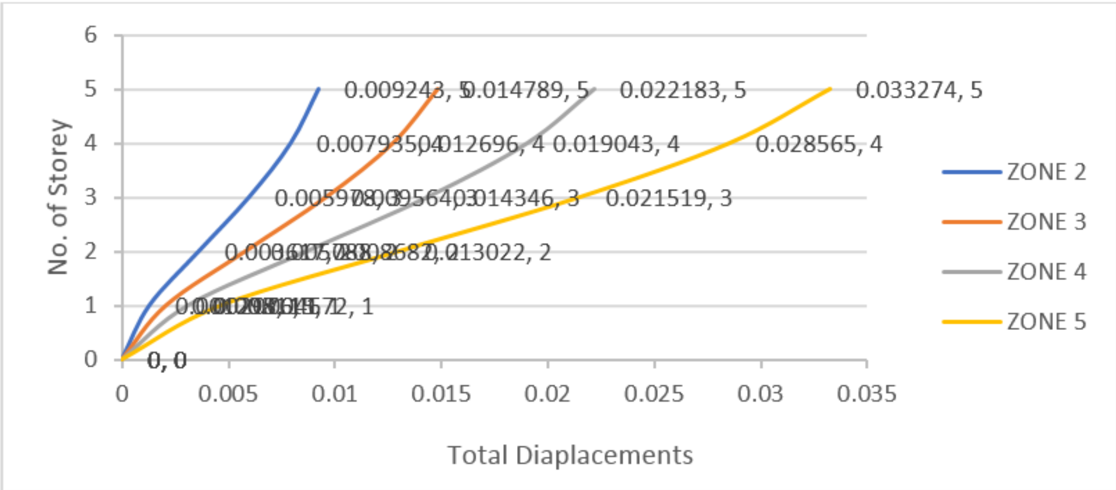

Fig 9. Comparison of total displacements of RC frame building with different types of seismic zones

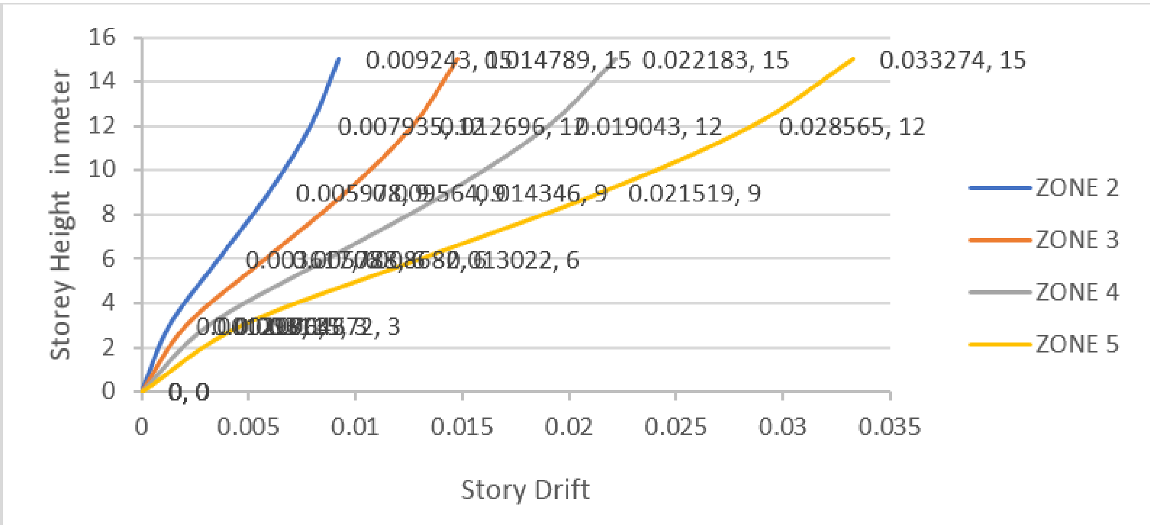

Fig 10. Comparison of Storey drift of RC frame building for different types of seismic zones.

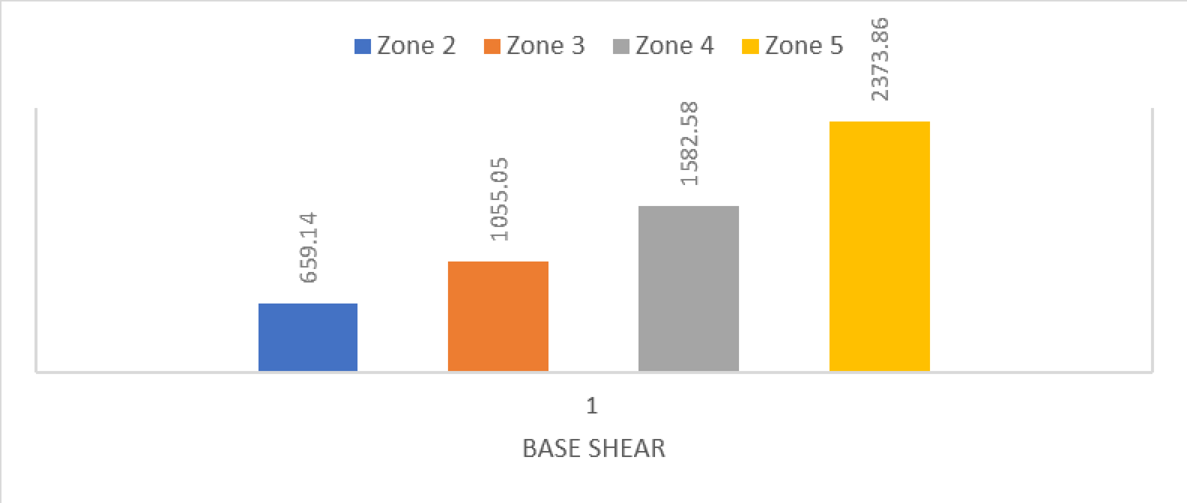

Fig 11. Comparison of Base shear of RC frame building from zone II to zone V.

By analyzing and designing the RC frame building in the designing software STAAD.Pro Connect Edition, it is found that the story drift and base shear is increasing from zone II to zone V. Figures 5, 6, 7 and 8 represent the torsion, axial force, shear force, bending moments and displacement diagrams of the building respectively. Here, Figure 10 represents the story drift of the RC frame building from Zone II to Zone V. Base shear plays an important role in the structure. Figure 11 shows the comparison of the base shear of the building from zone II to zone V.

VI. CONCLUSIONS

Transitioning from seismic Zone II to Zone V in the design of an RC frame building using STAAD.Pro Connect Edition necessitates careful consideration of increased seismic forces, revised structural design parameters, compliance with code requirements, and potential impacts on construction costs. It also highlights the importance of utilizing advanced analysis techniques to accurately assess the structure's performance under seismic loading conditions. The key findings of the study are:

- The storey drift of the RC frame building is decreasing more for X type of bracing systems other than all the bracing systems after comparing with all the seismic zones.
- The base shear of the RC frame building is increasing more for X type of bracing systems other than all bracing systems after comparing with all the seismic zones.
- The magnitudes of maximum shear force and maximum bending moment will be increasing from zone II to zone V.

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