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Design & Analysis With A Response Spectrum Of Seismic For RCC Commercial Building By Using STAAD Pro.

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Abstract
Design and analysis of commercial building G+15 floors using STAAD Pro. includes advanced structural engineering software to ensure structural integrity and safety of the building. The design process begins as per Indian Standard Codes and by-laws to select the site and collect information on soil properties. We have to analyze a typical G+15 commercial building and find various parameters like shear force, bending moment, deflection, maximum absolute displacement and various structural components including total load calculation and reinforcement details. Moreover, project work includes planning, analysis, models and drawings of a typical multi-storied building. This project endeavor was undertaken for design and analysis of G+15 storey commercial building with seismic resistance. R.C.C framed structure is used for commercial buildings. Structural design should be done using limit state method. This design takes commercial buildings like office, banks, hotels etc. The project also considers integration facilities such as parking facilities, green spaces and recreational areas to enhance overall user experiences.

Keywords*: Commercial Building G+15, STAAD Pro, Force of Actions, Seismic Load, Concrete Design*.

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I. Introduction

One of the most important things when designing an earthquake resistant building is the ability of the building to not only resist the force acting on it, but also to be flexible enough to transfer this force and dissipate it. And this ability depends on the details of the structure, the better it is detailed, the more likely it is to withstand earthquakes. There are some strategies that are used during earthquake resistant building to ensure the safety of the structure during earthquake action. Floors to transfer the horizontal forces on the slabs and floor to the vertical parts of the building like beams. Earthquake-proof design is the design of buildings that will not suffer any damage during a strong but rare earthquake. Engineers don't try to make earthquake-proof buildings that won't be damaged even during a rare but strong earthquake. The goal of seismic design is to have structures that behave elastically without collapsing in major earthquakes that may occur during the lifetime of the structure. To avoid collapse during a major earthquake, structural members must be ductile enough to absorb and dissipate energy through post-elastic deformation. The latest version of India Seismic Zoning Map [IS 1893 (Part1) 2002] given in India's earthquake resistant design code [IS 1893 (Part1) 2002] assigns four levels of seismicity to India in terms of zone factors. This zone is classified as moderate damage risk zone. The IS code assigns a zone factor of 0.16 for zone 3[2].

Seismic zone in India

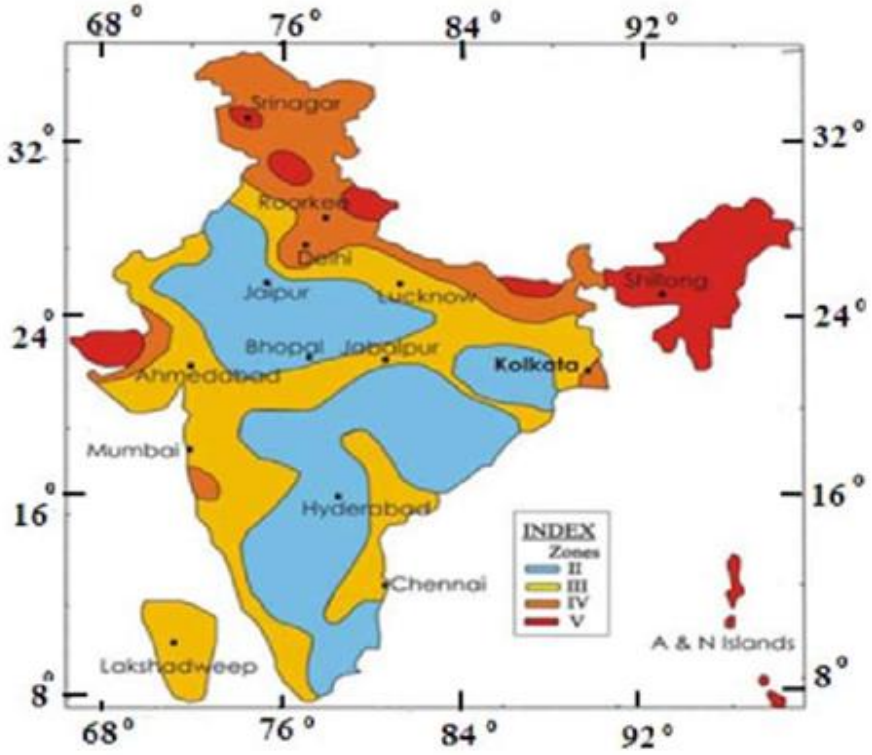

Figure 1 Seismic zone in India [6]

1.1 Objective of the Study

1. Generation of structural planning.
2. Creating the layout of a commercial building on AutoCAD Software and a model of structure on STAAD Pro.
3. To find out various load Actions due to Dead load, Live load, and Seismic load applied on structure.
4. Analysis and design RCC of the structure.
5. Understand the flexibility of High framed Structures.

1.2 Scope of the present research

1. The software can assist in designing the foundation system of the building, considering factors like soil properties, building loads, and local building codes.
2. The scope of the present study is limited to reinforced concrete framed structure designed for earthquake load for Tirupati.
3. The seismic behaviour for G+15 of commercial building.
4. STAAD Pro can perform rigorous structural analysis to determine the behaviour of the building under various loads such as gravity loads and seismic loads.
5. Building was analyzed using response spectrum method analysis.

II. METHODOLOGY

Current working structural factors must be collected or assumed based on Indian Standard Codes (National Ankura Code) such as building type, dimensions, soil type, nature and loads on the structure, dead load, live load and seismic load data. An RCC G+15 structure is designed using a structural analysis and design program called STAAD Pro and is analyzed and designed by considering the seismic force for the subject of this research. Response spectrum method is used for seismic analysis. Loads like dead load, live load, seismic load and load combination are taken as per IS 875-1987 Part 1, IS 875-1987 Part 2, IS 875-2015 Part 3 and IS1893 (Part 1): 2002. respectively. Table 1 shows general and technical specifications of framed flexural high-rise structure 2 & 3 shows 3D view, plan, isometric view and loading actions on G+15 structural frame. To execute STAAD program with application of seismic forces as shown in figure 4 in X + ve and Z + ve.

2.1 Design considerations

Table 1 G+15 RCC commercial building details

1	**Building Details**	
i.	Structure	Commercial Building
ii.	Number of stories	G+15
iii.	Type of the building	Symmetrical and regular
iv.	Plot Area	56 m x 46 m
v.	Buildup Area	936m2
vi.	Height of the building	64 m
vii.	Storey height	4 m
viii.	Supports	Fixed
2	**Material properties**	
i.	Grade of concrete	M30
ii.	Grade of steel	Fe500
3	**Types of load & intensity**	
i.	Floor Finish	1 KN/m2
ii.	Live load on floor	5KN/m2
4	**Seismic Load**	
i.	Zone factor	0.16
ii.	Importance factor	1.5
iii.	Response Reduction Factor	3
iv.	Damping Ratio	0.05
v.	Type Of Structure	1
vi.	Along X Direction Tax	1.69 sec
vii.	Along X Direction Taz	0.015 sec
viii.	Buildup Area	936 m2

3D View of G+15 **Plan of Building**

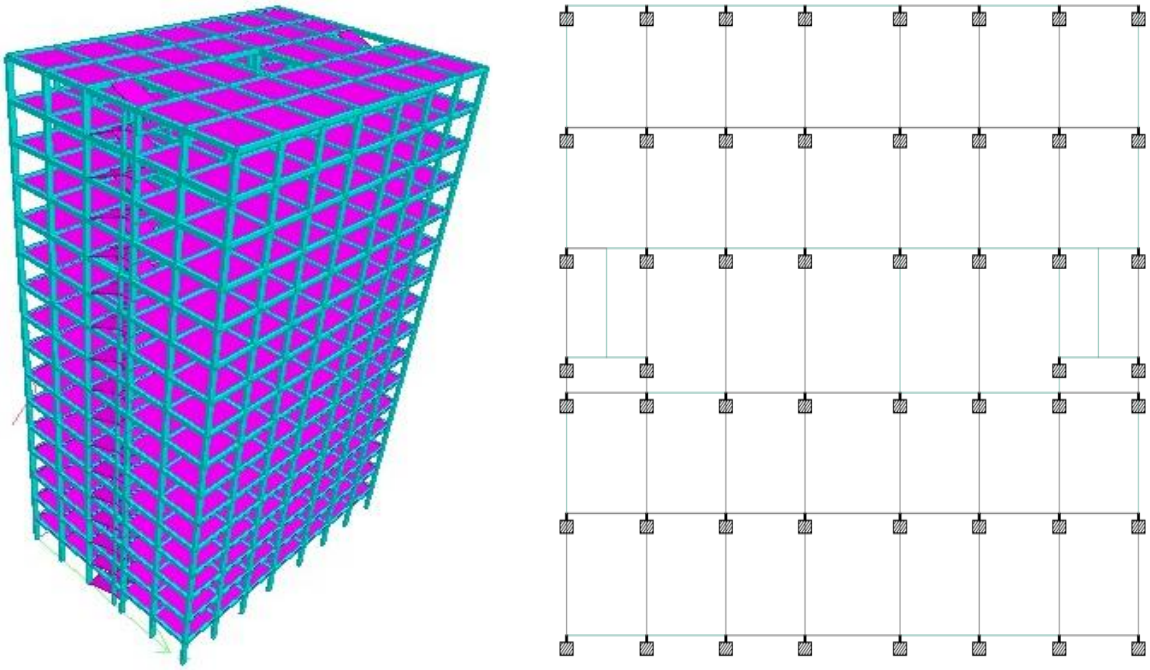

Figure 2 3D and top view of building

Isometric view of G+15 building **Live load on each floor**

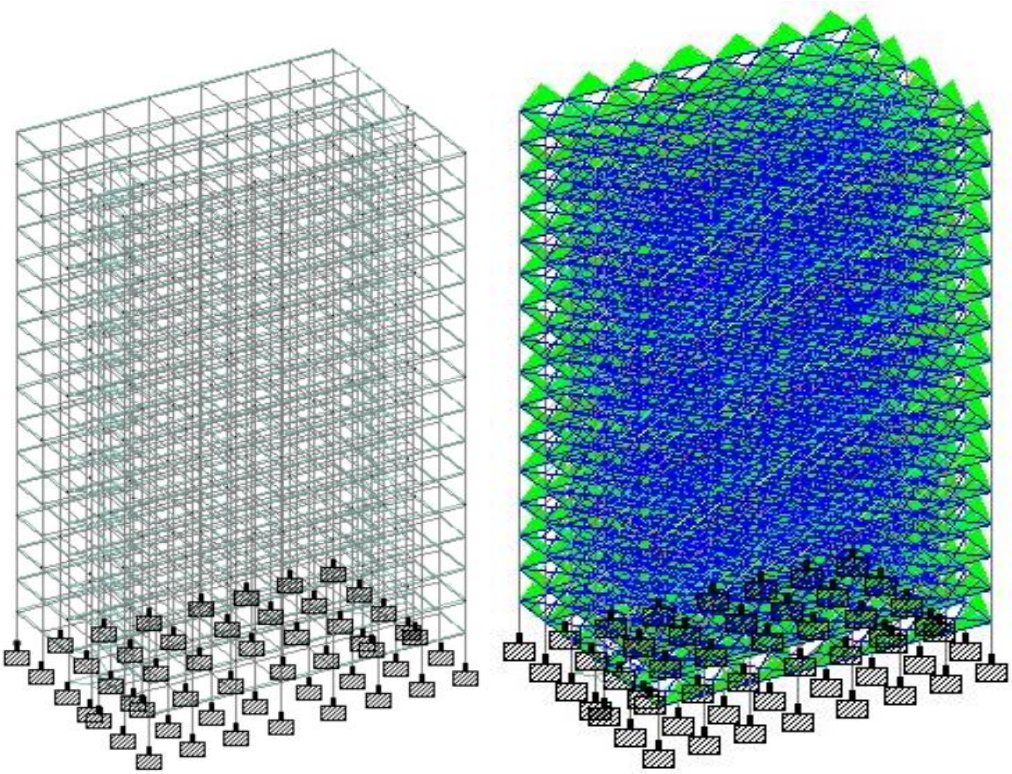

Figure 3 Isometric view and Live load on G+15 building

Seismic force in X+ direction **Seismic force in Z+ direction**

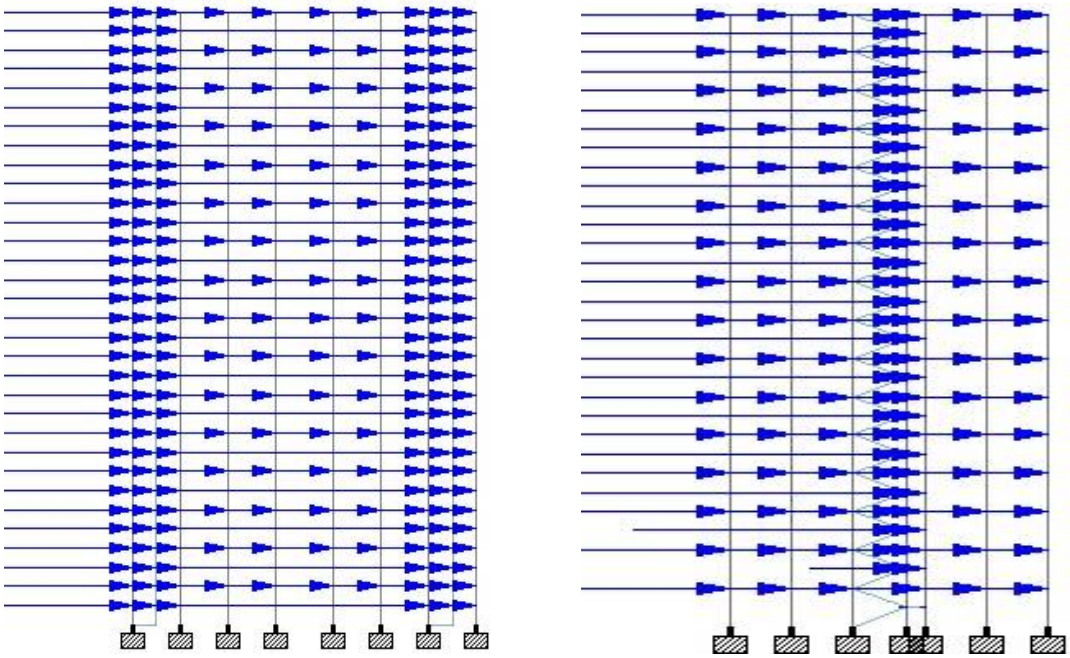

Figure 4 Seismic forces in X+ and Z+ directions

III. RESULTS AND DISCUSSIONS

By running the STAAD program, the following results are obtained. Figure 5 shows the successful running of the STAAD program with seismic activity. Figure 6 & 7 show axial force and shear force action due to dead load, live lead, seismic force in vertical directions, maximum axial force value 5876 KN and minimum axial force value 283.1 KN and maximum shear force value 26.6 KN and minimum shear force value 14.828 KN. Seismic load respectively. Figure 8 & 9 shows the bending moment in Z and Y direction respectively due to dead load, live load, seismic force in vertical directions. The figure 10 & 11 shows the maximum value of 611.1 mm and minimum value 41.8 mm of horizontal displacement, maximum value 0.091 MPa & minimum value 0.084 MPa absolute stress due to dead load, live load, seismic force lateral directions respectively. Figure 5 shows the design reinforcement and concrete due to seismic force for G+15.

STAAD Pro. output file for Seismic Analysis and Design

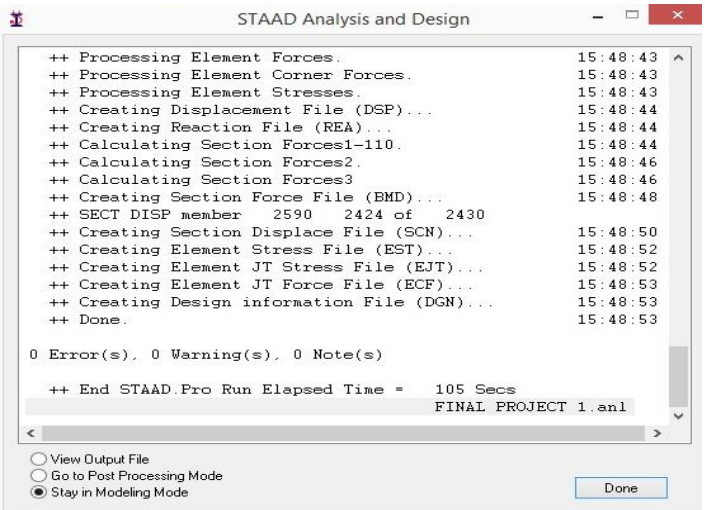

Figure 5 STAAD Pro. file for seismic forces

Axial force due to Seismic load

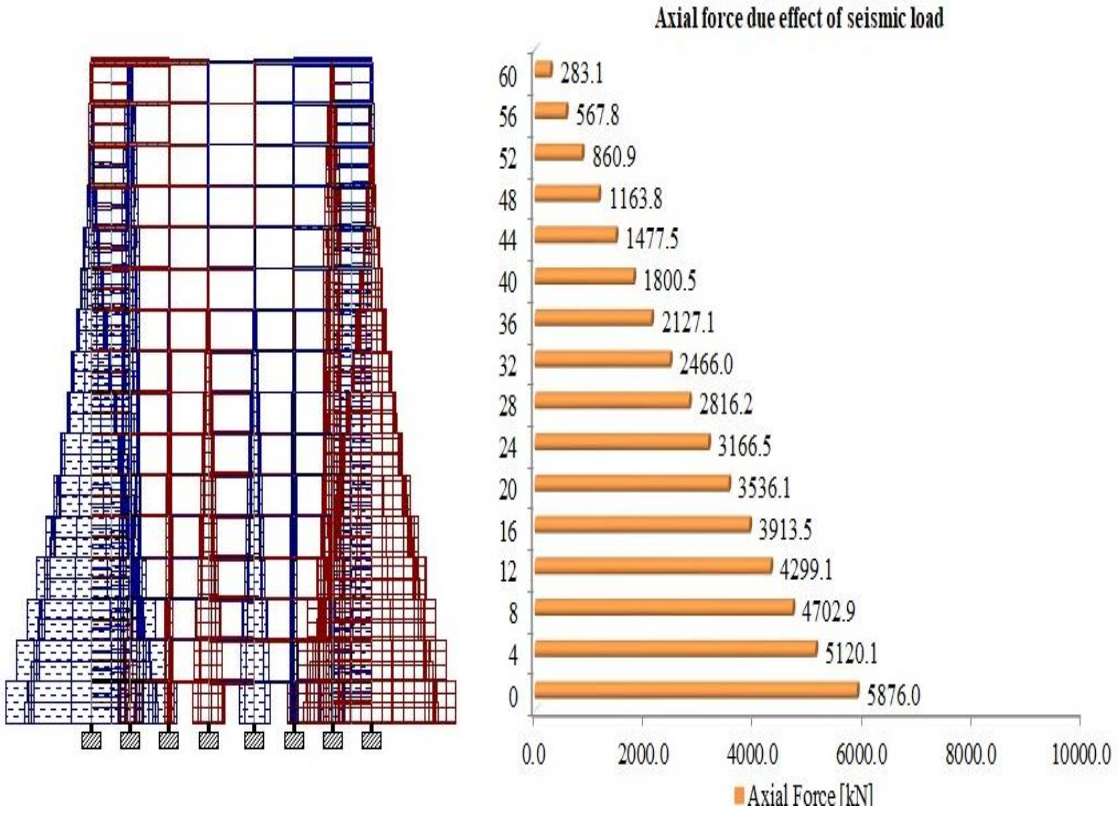

Figure 6 Axial force due to seismic forces

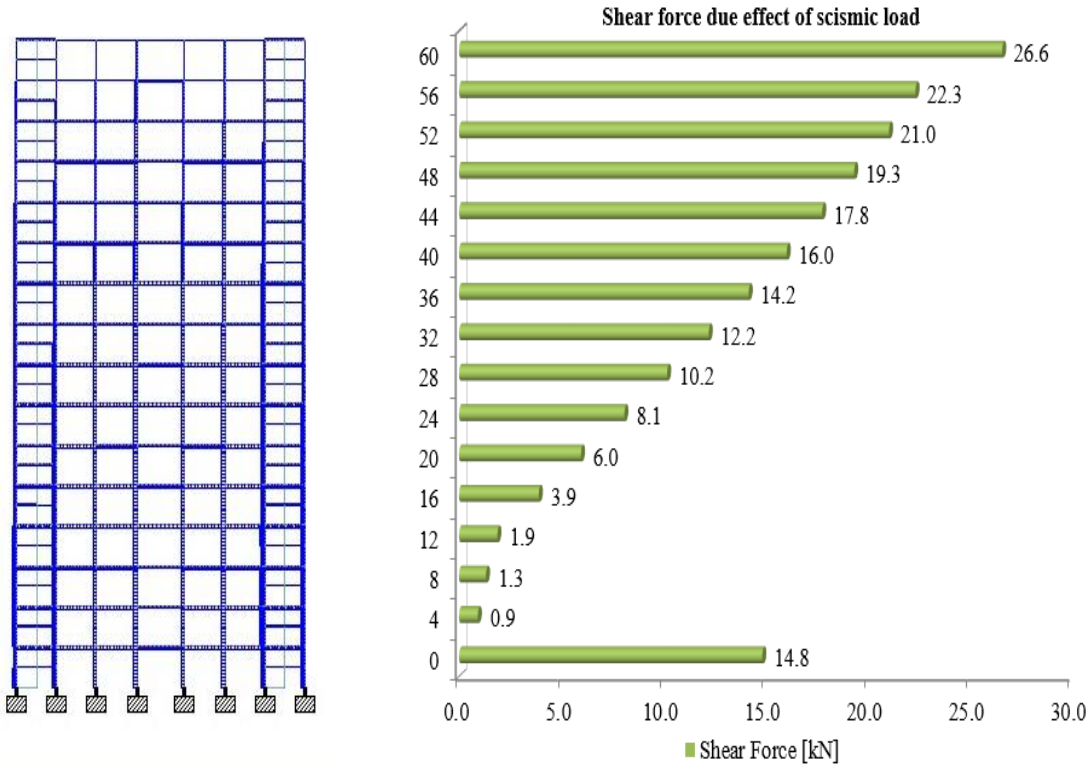

Figure 7 Shear force due to seismic and wind forces

Bending moment due to seismic force in Z direction

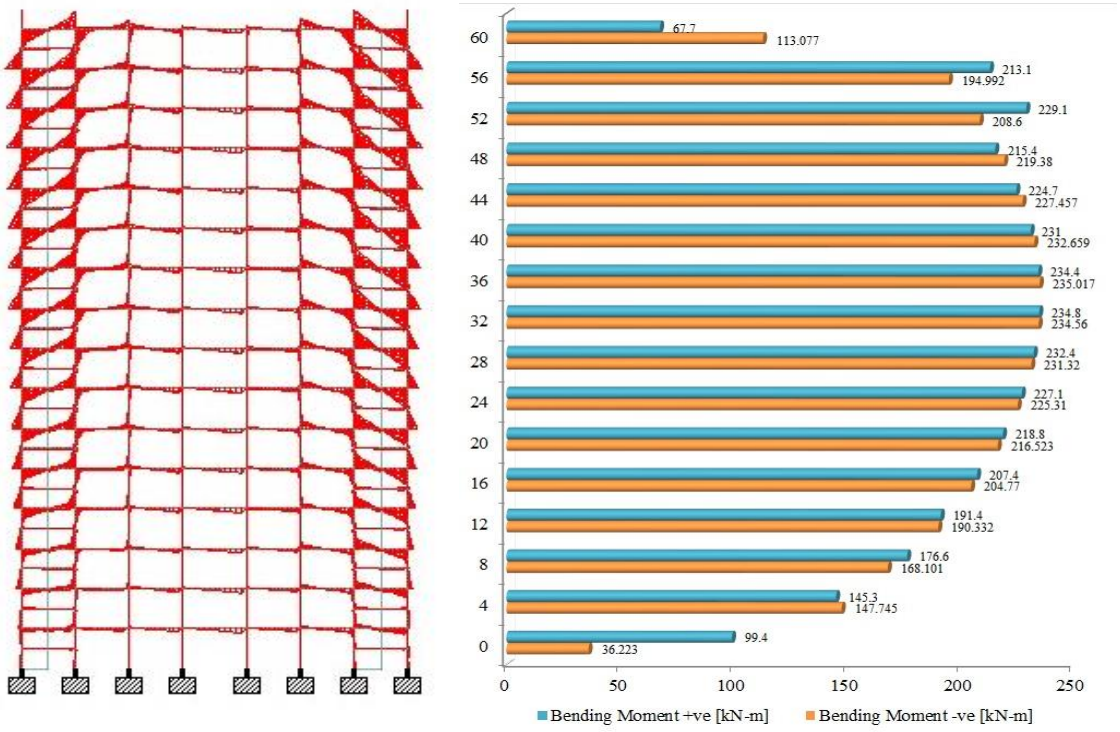

Figure 8 Bending moment due to seismic force in Z direction

Bending moment due to seismic force in Y direction

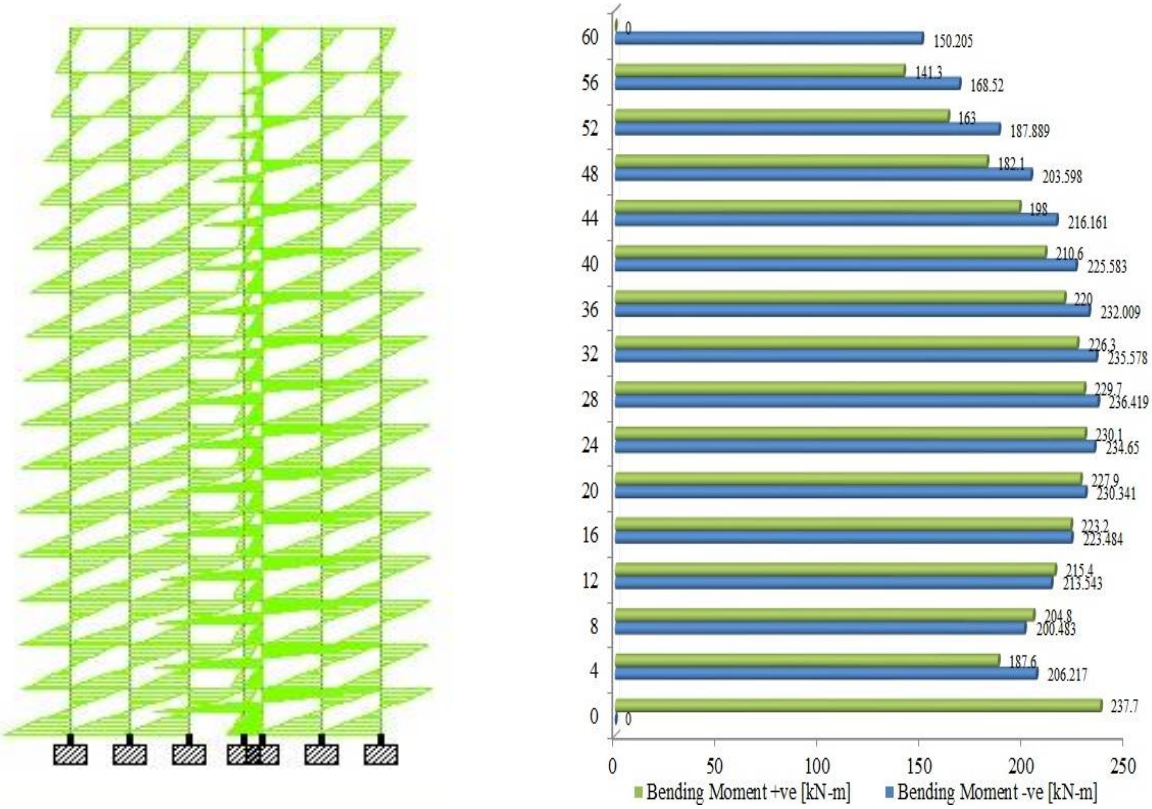

Figure 9 Bending moment due to seismic force in Y direction

Displacement due effect of seismic load

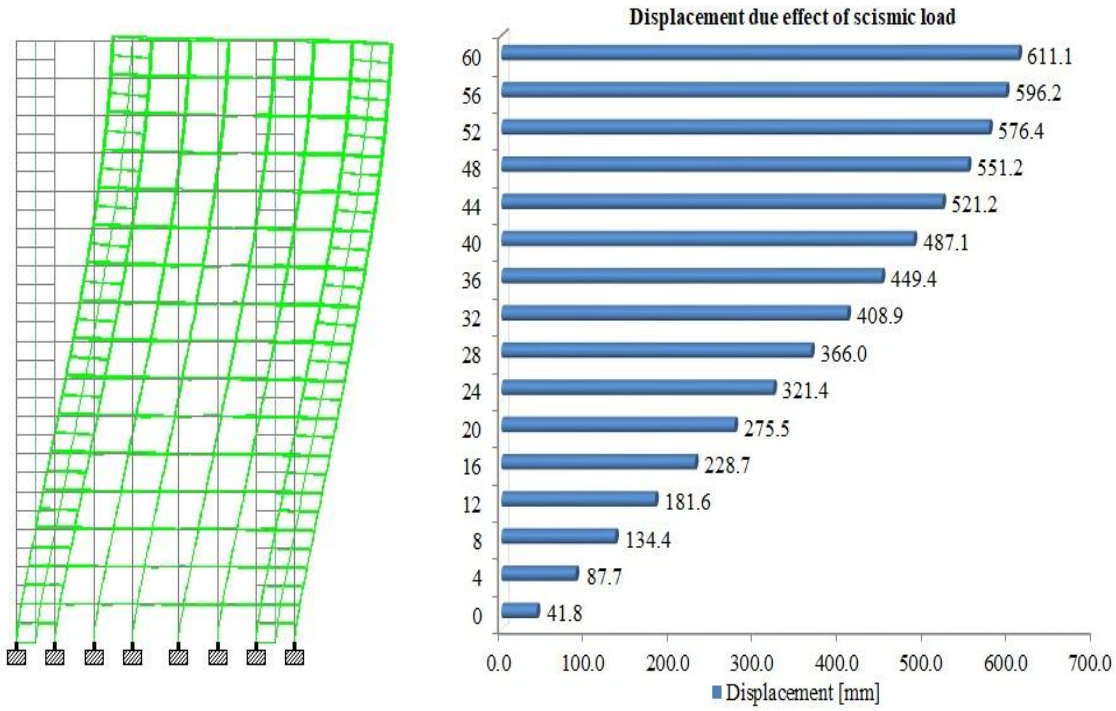

Figure 10 Displacement due to seismic in Y direction

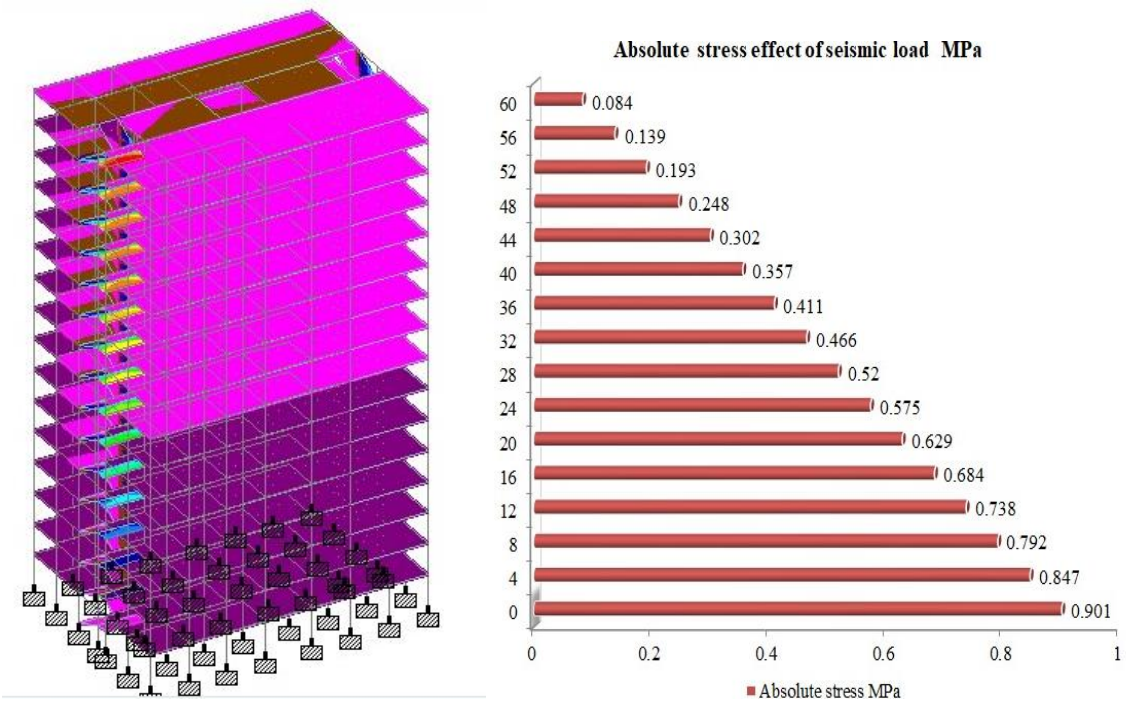

Figure 11 Absolute stress due to seismic force in the slab

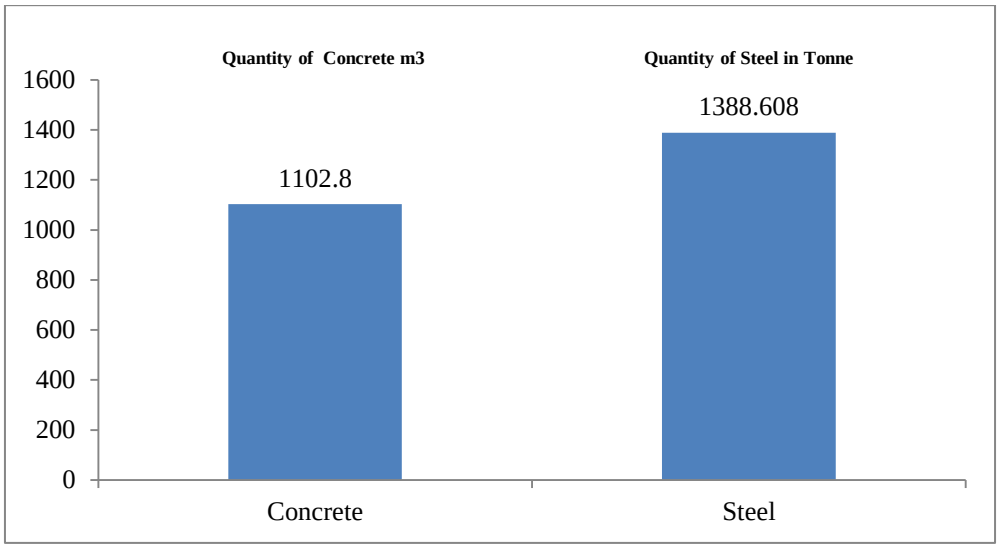

Figure 12 Design reinforcement and concrete due to seismic force for G+15

IV. CONCLUSIONS

Conclusions drawn from the analysis and design of G+15 high-rise commercial structures with respect to seismic loads are as follows,

1. As per IS codes that have been studied about seismic load for a tall building.
2. The design is done for the G+15 Commercial building and also analyses the various results of bending moment, shear force, axial force displacement, etc. And also plotted the graphs
3. The maximum value of seismic force is 5876KN concerning the axial forces of storeys in the Y direction for building G+15 respectively.
4. The minimum value of seismic force is 283.1KN concerning the axial forces of storeys in the Y direction for building G+15 respectively.
5. The maximum values of seismic force are 26.6KN for storey shear forces in the Y direction for building G+15 respectively.
6. The minimum values of seismic force are 14.828KN for storey shear forces in Y direction for building G+15 respectively.
7. The maximum value of seismic force G+15 vertical floor displacement for building in Y direction is 611.1mm for respective seismic forces.
8. The minimum value of seismic force G+15 vertical floor displacement for building in Y direction is 41.8mm for respective seismic forces.
9. The maximum value of seismic force G+15 Absolute stress of storeys in plates for building in Y direction is 0.091MPa to respective seismic forces.
10. The minimum value of seismic force G+15 Absolute stress of storeys in plates for building in Y direction is 0.084MPa concerning respective seismic forces.
11. The maximum positive bending moments of floors for G+15 building with maximum values of seismic force with respect to Z direction is 234.8kN-m.
12. The minimum positive bending moments of floors for G+15 building with maximum values of seismic force with respect to Z direction is67.7kN-m.
13. The maximum negative bending moments of storeys for G+15 building with maximum values of seismic force with respect to Z direction is 235.017kN-m.
14. The minimum negative bending moments of storeys for G+15 building with maximum values of seismic force with respect to Z direction is 36.23kN-m.
15. The maximum positive bending moments of floors for G+15 building with maximum values of seismic force is 237.7kN-m with respect to Y direction.
16. The minimum positive bending moments of floors for G+15 building with maximum values of seismic force is 0kN-m with respect to Y direction.
17. The maximum negative bending moments of floors for G+15 building with maximum values of seismic force is 26.419kN-m with respect to Y direction.
18. The minimum negative bending moments of floors for G+15 building with maximum values of seismic force is 0kN-m with respect to Y direction.

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