# Seismic Analysis of a Multi-storey (G+8) RCC Frame Building for Different Seismic Zones in Nagpur.(M.H.)

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**Abstract** -*Structural designing requires structural analysis and earthquake or seismic analysis of any structure prior to construction. Earthquake or seismic analysis is the calculation of the response of a structure subjected to earthquake excitation. Various seismic data are necessary to carry out the seismic analysis of the structures. In this study, the seismic analysis of a structural system is to determine the deformations and forces induced by applied loads on a residential G+8 RC frame building is analysed by the linear analysis approaches using STAAD PRO V8i designing software*

*in seismic Zone II, Zone III, Zone IV, Zone V.. Response of the structures is investigated under earthquake excitation expressed in the form of member forces, joint displacement, support reaction and story drift. Analysis is done in terms of Base shear, Displacement, Axial load, Moments in Y and Z direction in columns and shear forces, maximum bending moments, max Torsion in beams. The Lateral seismic forces of RC frame is carried out using linear static method as per IS 1893(part 1) : 2002 for different earthquake zones. The scope of present work is to understand that the structures need to have suitable Earthquake resisting features to safely resist large lateral forces that are imposed on them during Earthquake in different seismic zones, and also construction material, cost and effectiveness in minimizing Earthquake damage in structure.*

***Key Words***: Seismic analysis, STAAD PRO V8i, Seismic zones, IS 1893 (part 1), Lateral Force, Base Shear and OMRF.

## 1. INTRODUCTION

At present people are facing problems of lad scarcity, cost of land. The population explosion and advent of industrial revolution led to the exodus of people from villages to urban areas i.e. construction of multi-storied buildings has become inevitable both for residential and as well as office purposes. The high raised structures are not properly designed for the resistance of lateral forces. It may cause to the complete failure of the structures. The earthquake resistance structures are designed based on the some factors. The factors are natural frequency of the structure, damping factor, type of foundation, importance of the building and ductility of the structure. The structures designed for ductility need to be designed for less lateral loads as it has better moment distribution qualities. This aspect is taken care of by response reduction factor R for different type of structure [1].

This Earthquake occurred in multistoried building shows that if the structures are not well designed and constructed with and adequate strength it leads to the complete collapse of the structures. To ensure safety against seismic forces of multi-storied building hence, there is need to study of seismic analysis to design earthquake resistance structures. In seismic analysis the response reduction was considered for two cases both Ordinary moment resisting frame and Special moment resisting frame. The main objective this paper is to study the seismic analysis of structure for static and dynamic analysis in ordinary moment resisting frame and special moment resisting frame. Equivalent static analysis and response spectrum analysis are the methods used in structural seismic analysis..

### 1.1 Present Scenario

We considered the residential building of G+ 8 storied structures for the seismic analysis and it is located in Nagpur city in zone II. The total structure was analyzed by computer with using STAAD.PRO software. We observed the response reduction of cases ordinary moment resisting frame and special moment resisting frame values with deflection diagrams in static and dynamic analysis. The special moment of resisting frame structured is good in resisting the seismic loads [3].

### 1.2 Ordinary Moment Resisting Frame:

The moment resisting frame which are designed without any special attention towards ductile nature of the frame are called ordinary moment resisting frame.

### 1.3 Special Moment Resisting Frame:

The moment resisting frame which are designed to have ductile nature are called as special moment resisting frames. The design is done according to the requirements specified in IS-13920. The earthquake resistant designs of structures are considering the following magnitudes of a earthquake.

## 2. METHODS OF ANALYSIS

**2.1 Equivalent Static Analysis:** It is one of the method for calculating the seismic loads. The high rise structures are not considered for the design simple static method. In practical as it does not take into account all the factors that are the importance of the foundation condition. The equivalent static analysis is used to design only for the small structures. In this method only one mode is considered for each direction. The earthquake resistant designing for the low rise structures the equivalent static method is enough. Tall structures are needed more than two modes and mass weight of each story to design earthquake resistant loads. This is not suitable to design those structures and dynamic analysis method to be used for high rise structures.

**2.2 Response Spectrum Analysis:** The seismic forces strikes the foundation of a structure will move with the ground motion. It shows that structure movement is generally more than the ground motion. The movement of the structure as compared to the ground is refused as the dynamic amplification. It depends on the natural frequency of vibration, damping, type of foundation, method of detailing of the structure. The response "design acceleration spectrum" which refers to the max acceleration called spectral acceleration coefficient Sa/g, as a function of the structure for a specified damping ratio for earthquake excitation at the base for a single degree freedom system. The revised IS 1893-2002 uses the dynamic analysis by response spectrum. In this method takes into account all the five important engineering properties

## 3. METHODOLOGY

The methodology involves that the planning of G=8 Residential building and STAAD.ProV8i analysis should be done for the planned building by giving various loads condition for different zones.

1. MODELLING: (G+8) Residential building.

2. LOADS: Dead load and live load, Wind load, Combination load, 1.5 (Live Load+ Dead Load+ wind load).

3. ANALYSIS: Analysis of RCC framed structure. Shear Force and Bending Moment calculations [4].

## 4. THEORETICAL CONCEPT

### 4.1 Seismic force

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

V is design seismic force, also called design base shear

$A_h$ is base shear coefficient

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

- Z is Seismic zone factor as per IS 1893 part 1:2002 given in table 1
- I is importance factor=1
- R is response reduction factor=3
- $S_a/g$ is spectral acceleration coefficient for type II, Medium soil.

**Table 1:** Seismic zone factor

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

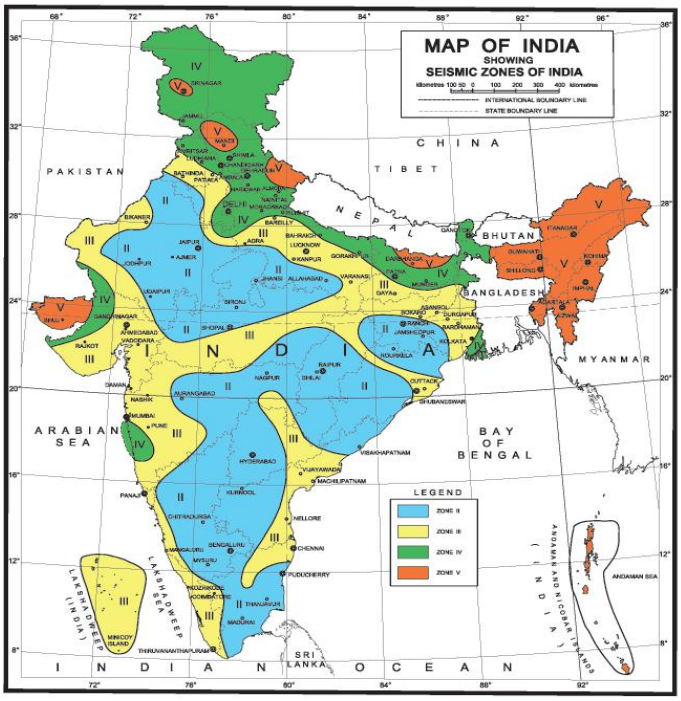



**Fig.-1:** SEISMIC ZONES OF INDIA

## 5. ANALYSIS

### 5.1 Statement of the Project

**Table 2:** Building specifications

| **Sr. No.** | **Parameter** | **Design Value** |
|---|---|---|
| 1 | Number of stories | 9. G+8 |
| 2 | Floor height | 3 m |
| 3 | Dead load DL | 6 kN/ $m^2$ |
| 4 | Live load, LL | 4 kN/$m^2$ |
| 5 | Materials Concrete | M 20 |
| 6 | Reinforcement | Fe 415. |
| 7 | Depth of slab | 150 mm thick |
| 8 | Specific weight of RCC | 25 kN/m3. |
| 9 | Partition and floor finishing load | 2 kN/m2 |
| 10 | Earthquake Direction | X and Y |
| 11 | Seismic Zone | II, III, IV and V |
| 12 | Soil type | Type II (Medium Soil) |
| 13 | Earthquake Load | As Per IS: 1893-2002 (Part-1) |

### 5.2 Model Lay-out

We considered a residential building of 2BHK plan with y-axis consisted of G+8 floors. The ground floor and rest of the 8 floor had a height of 3m each. the supports at the base of the structure were also specified as fixed. The structure was subjected to self-weight, dead load, live load values considering by the specifications of IS 875 part-1 and part-2. The wind load values were generated by STAAD.PRO considering the given wind intensities at different heights and strictly abiding by the specifications of IS 875 part-3. The Seismic load calculations of Static and Dynamic analysis were done following IS 1893-2002 part-1.

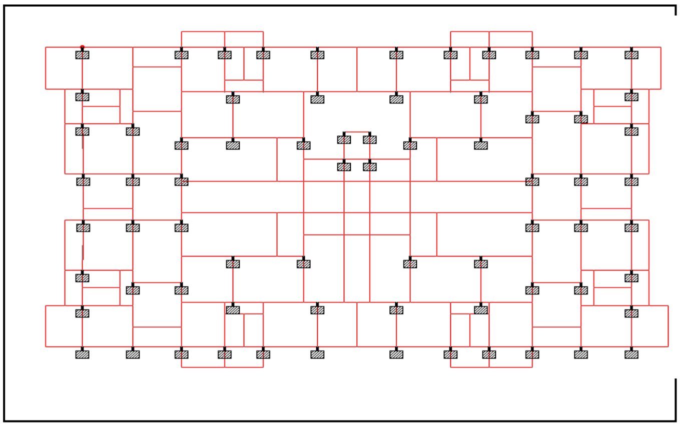


**Fig. - 2:** Typical Beam and Column Layout

This Residential G+8 RC building in Nagpur city has been modeled as 3D Space frame model with six degree of freedom at each node using STAAD - PRO, software for stimulation of behavior under gravity and seismic loading. The isometric 3D view and plan of the building model is shown as figure 3. The support condition is considered as fully fixed.

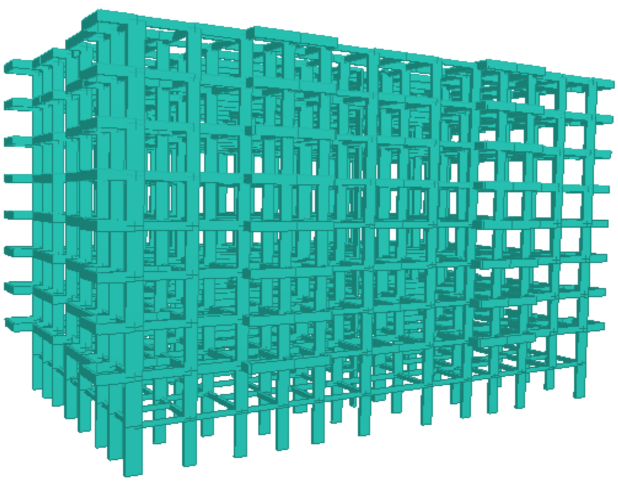


**Fig. - 3:** 3D model of building generated in Staad.pro.v8i

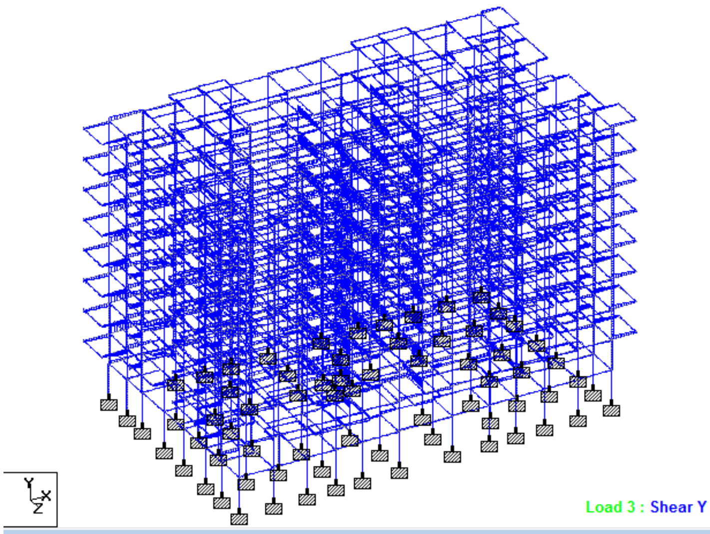



**Fig. - 4:** Shear in Y-Direction

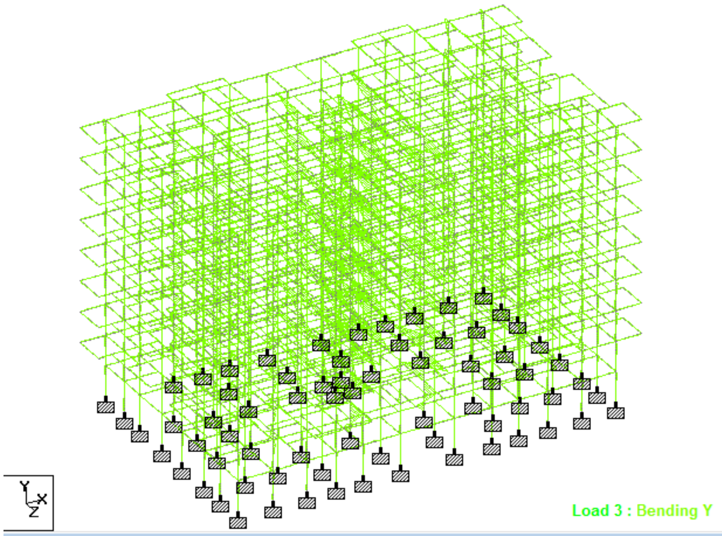
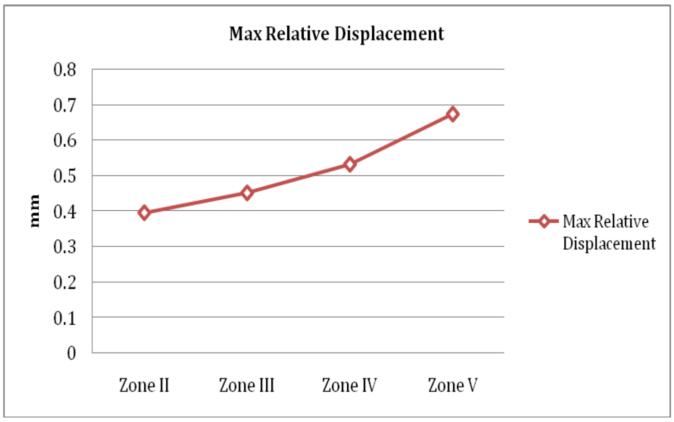



**Fig. - 5:** Bending Moment Y-Direction

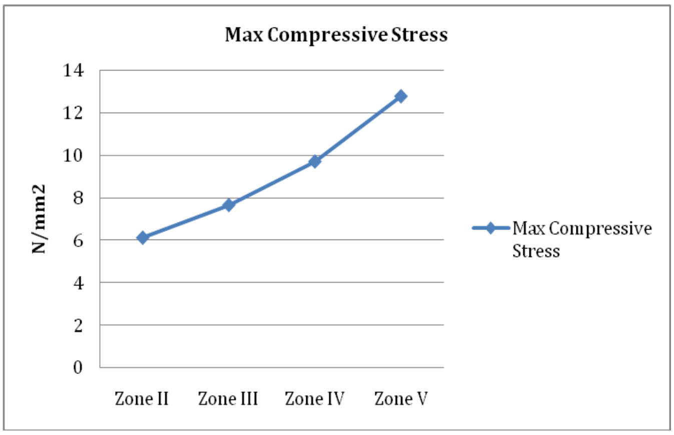
## 6. RESULTS

**Table -3:** Max Relative Displacement and Max Compressive Stress

| Zone | Max Relative Displacement | Max Compressive Stress |
|---|---|---|
| II | 0.395 mm | 6.123 N/ mm$^2$ |
| III | 0.451 mm | 7.659 N/ mm$^2$ |
| IV | 0.532 mm | 9.706 N/ mm$^2$ |
| V | 0.674 mm | 12.775 N/ mm$^2$ |



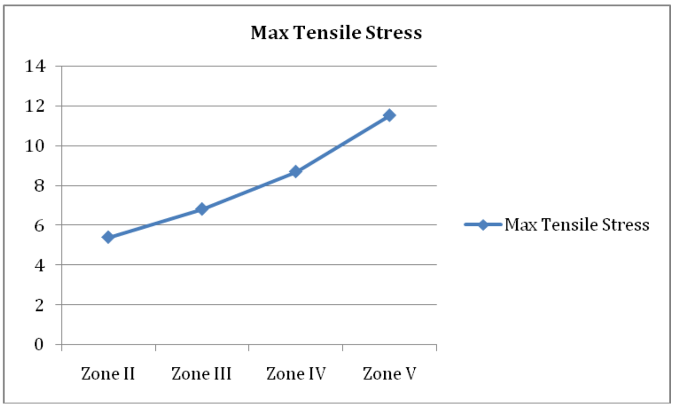

**Graph -1:** Max. Relative displacement



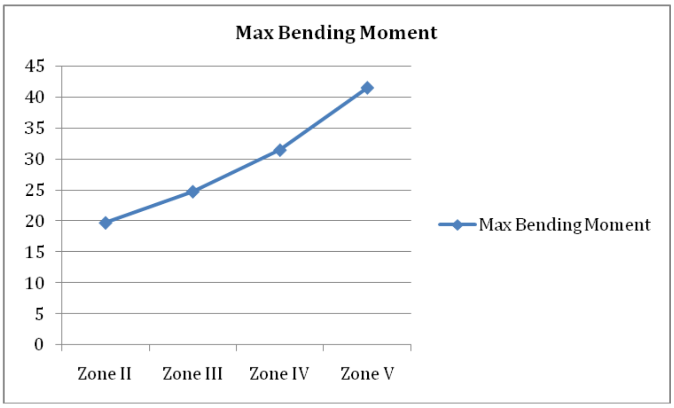

**Graph -2:** Max Compressive Stress

**Table -4:** Max Tensile Stress and Max Bending Moment

| Zone | Max Tensile Stress | Max Bending Moment |
|---|---|---|
| II | 5.396 N/ $mm^2$ | 19.752 KN m |
| III | 6.815 N/ $mm^2$ | 24.77 KN m |
| IV | 8.706 N/ $mm^2$ | 31.46 KN m |
| V | 11.543 N/ $mm^2$ | 41.495 KN m |



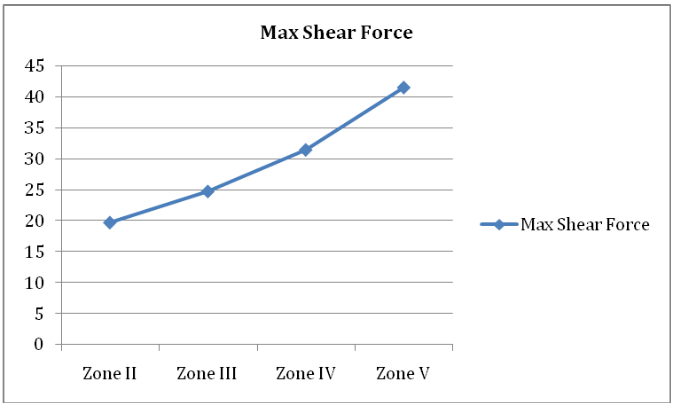

**Graph -3:** Max Tensile Stress



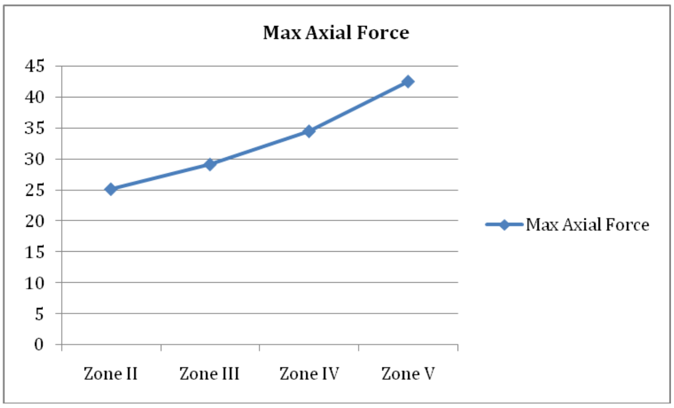

**Graph -4:** Max Bending Moment

**Table -5:** Max Shear Force and Max Axial Force

| Zone | Max Shear Force | Max Axial Force |
|---|---|---|
| II | 19.782 KN | 25.152 KN |
| III | 24.77 KN | 29.141 KN |
| IV | 31.46 KN | 34.496 KN |
| V | 41.495 KN | 42.528 KN |




**Graph -5:** Max Shear Force

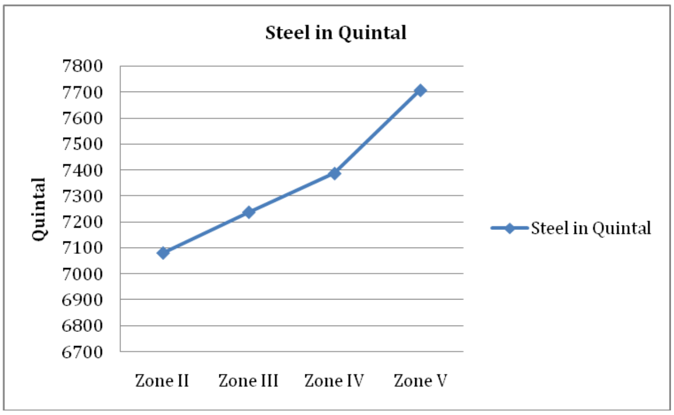



**Graph -6:** Max Axial Force

In the earthquake resistant design of G+8 RC framed building the steel quantity increase in different zones

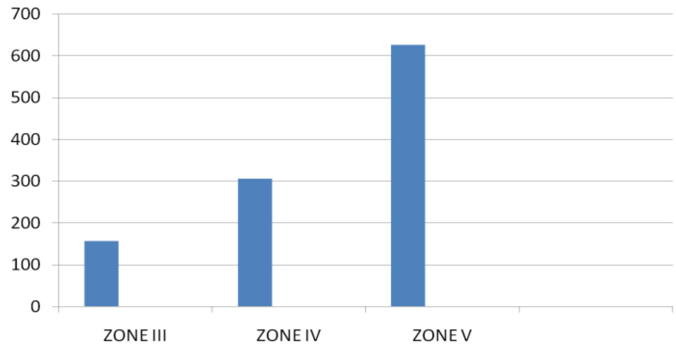
**Table -6:** Quantity of steel in Quintal

| Seismic Zone | Steel in Quintal |
|---|---|
| Zone II | 7082.17 |
| Zone III | 7238.93 |
| Zone IV | 7387.88 |
| Zone V | 7707.93 |




**Graph -7:** Steel in Quintal

Graph showing increase in steel under critical zone as compare to zone II -




**Graph -8:** increase in steel compare to zone II

## 7. CONCLUSION

Comparison is done on the basis of relative displacement, maximum shear force, maximum axial force, max. bending moment, maximum tensile stress , maximum compressive stress in different seismic zones

In all models the displacement values are less for lower zones and it goes on increases for higher zones.

In the earthquake resistant design of G+8 RC framed building the steel quantity increased in zone II, III, IV and V to the convention concrete design. The steel quantity increased in the structure ground floor to higher floor i.e G+8 level of the structure.

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