ANALYZING THE SEISMIC BEHAVIOUR OF A G+7 REINFORCED CONCRETE BUILDING LIES UNDER SEISMIC ZONES III AND IV IN CONSIDERATION OF MOST EFFICIENT AND COST-EFFECTIVE

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Abstract: The structure is designed to be resistant to all forces, including lateral and gravitational ones, and ought to be adequate in terms of economics. Earthquakes and high winds both contribute to the creation of lateral forces. The self-weight of the structure, as well as dead load, live load, and other elements, are all contributors to the gravitational forces that operate on it. The lateral force that is caused by an earthquake causes a bending moment in the structure at the bottom of the structure. In order for the structure to be able to withstand this moment, the structure needs to have the ideal size of its members, the appropriate percentage of reinforcement in a reinforced concrete structure, the appropriate beam to depth ratio, and so on. The use of response spectrum analysis is one of the methods that we put to use in this thesis in order to analyses the seismic behavior of a reinforced concrete structure. In addition, in this study, a comparative investigation of the variations in shear forces and bending moments from seismic zone III to seismic zone IV was carried out. In addition, we compared the multiple parametric results acquired by the different models that were examined (e.g., Storey drift and Storey forces, percent of steel from zone III to zone IV). Also taken into account is the possibility of achieving the configuration that is both the most efficient and the most cost-effective one feasible. Analyzing a G+7 reinforced concrete building in India's seismic zones III and IV with the help of the Indian seismic code IS 1893-2016 and the SAP2000 v23.1.10 software, the purpose of this study is to determine variations in the percentage of reinforcement, maximum deflection, shear force, and bending moment. These variables will be determined by analyzing the building using the Indian seismic code.

Keywords: Seismic, G+7 reinforced concrete, seismic zones III, Earthquakes, seismic zones IV

I. INTRODUCTION

The construction is intended to withstand all forces (lateral as well as gravitational) and should be sufficient in terms of economics. Lateral forces are caused by earthquakes and strong winds.

Gravity forces are caused by the self-weight of the building, dead load, living load, and other factors.

The lateral force caused by an earthquake causes a bending moment in the structure at the bottom of the structure, and in order to resist this moment, the structure must have the perfect size of members, the proper percentage of reinforcement in a reinforced concrete structure, the proper beam to depth ratio, and so on.

According to the Indian seismic code IS 1893-2016, there are four seismic zones: zones II, III, IV, and V. Zone II is the most seismically active zone. Zone I is underappreciated. Different seismic zones have varying effects on the building as a result of earthquake forces. As a result, the G+7 RC building in India's seismic zones III and IV is being evaluated and developed in order to understand the behaviour of the structure while earthquake shaking forces are applied.

SEISMIC ANALYSIS

The seismic analysis is carried out in order to take into account lateral pressures on the structure in the appropriate seismic zone in order to build a safe and cost-effective construction. An earthquake in the applicable seismic zone should not cause damage to a building, and it should stay safe throughout the shaking. Lateral forces caused by the earthquake result in a bending moment at the bottom of the structure, which attempts to deflect the structure from its original position.

TYPES OF ANALYSIS

The techniques of structural analysis may be classified into the five categories listed below.
i) Equivalent Static Analysis
ii) Response Spectrum Analysis
iii) Equivalent Static Analysis Dynamical Analysis of Linear Systems, Part IV. Nonlinear Static Analysis (version
v). Nonlinear Dynamic Analysis is a kind of dynamic analysis that is nonlinear in nature.
this G+7 RC structure is performed by Response Spectrum Analysis method.
MODELLING AND ANALYSIS

II. MODELLING PROCEDURE IN SAP2000

A seven-story reinforced concrete skyscraper is being explored for the purpose of studying seismic effects in various regions of India. The measurements of the building are presented in further detail below.

A seven-story skyscraper with a storey height of 3.0m on each level and a total height of 10.0m.

Four bays are located in the X direction and two bays are located in the Y direction, with a plan size of 20 metres by eight metres.

Table.1: Properties of the Structure

Beam size	0.3m x 0.45m
Beam size	0.3m x 0.5m
Column size	0.5m x 0.5m
Slab thickness	0.150m
Unit weight of concrete	25.0 KN/m^3
Floor finish	2.0 KN/m^2
Live load	3.0 KN/m^2
Live load on roof	1.5 KN/m2

The construction is 20 metres long in the X-direction and 8.0 metres broad in the Y-direction, with a height of 21 metres above the ground. There are four bays in the x-direction, each of which is 5.0m wide, and two bays in the y-direction, each of which is 4.0m wide.

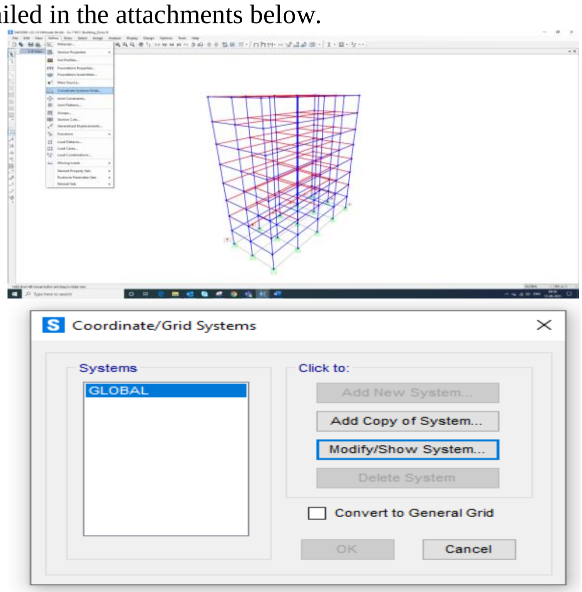
We looked at two alternative models with the identical dimensions, one in seismic zone III and the other in seismic zone IV, and compared them. The foundation of the structure is made of medium-strength soil. When calculating seismic weights, 25 percent of the floor live loads are taken into account in order to determine base shear.
Using SAP2000, the following technique will walk you through the process of modelling and analysing the case study structure step by step.

1. Setting the modelDimension

Set the number of units that you want for the building.

2. Grid Spacing and Location of Joints

Calculate the number of grid lines and the space between each grid line in order to determine the building's joints. The grid system is specified by selecting "Define" and then "coordinate systems/grids" from the drop-down menu. The technique is detailed in the attachments below.



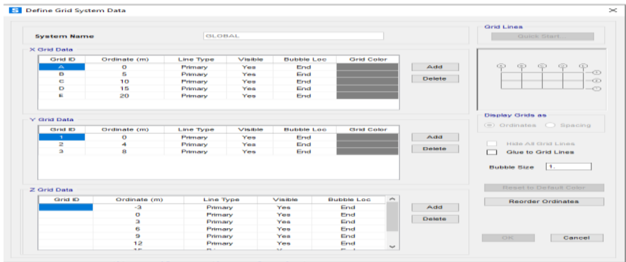


Fig. 1: Grid Data Definition

Define Area Elements

The slab element is defined by selecting 'AreaSections' from the Define drop-down menu in the Design window.
For the floor slabs on each story and the roof, a slab with a thickness of 150mm has been given.
The slab is made of M30 material.
The self-weight of the slab is taken into consideration throughout the building design process, as is the 2.0 kn/m2 floor finish.
The following diagram illustrates the step-by-step approach for creating an area element in SAP2000.

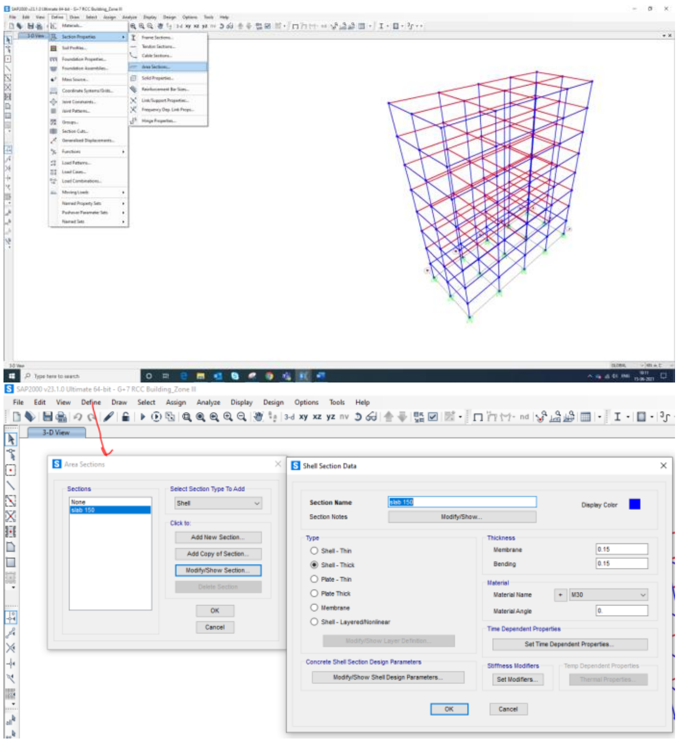


Fig. 2: Define Area Elements

Draw frame elements

After defining the frame elements, use the 'draw frame/cable/tendon' command from the 'Draw' menu to link all of the nodal points. After drawing the frame elements, save the file.

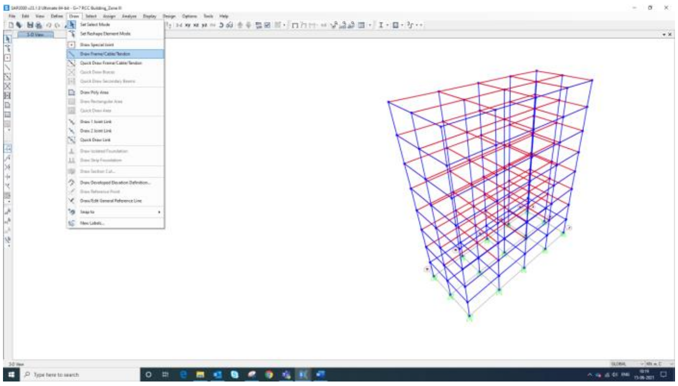


Fig. 3: Draw frame elements

Draw Area Elements

The area element is drawn once it has been defined by selecting 'draw poly area' from the Draw menu, as seen in the following illustration.

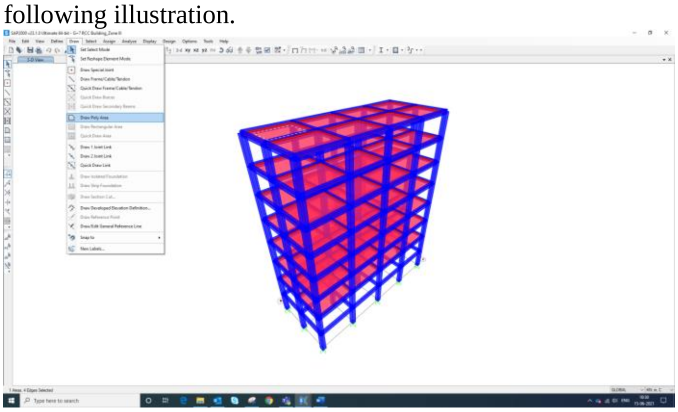


Fig. 4: Draw Area Elements

The plan and 3D view of the structure are shown below

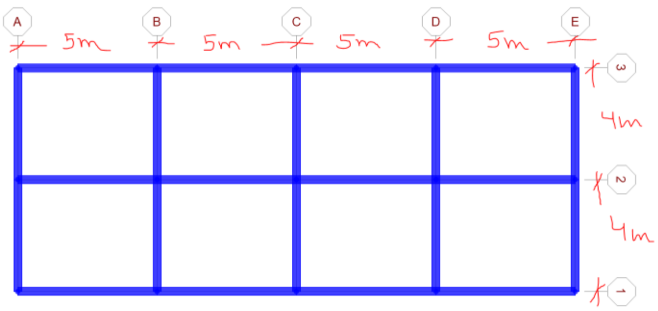


Fig. 5: Plan of case study structure

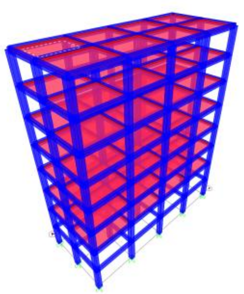


Fig. 6: 3D model of case study structure

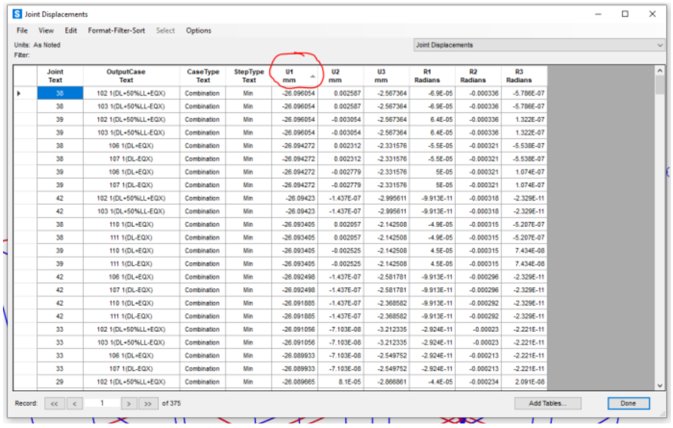


Fig. 7: Structure in zone IV

Table 2: Comparison of drifts between seismic zone III & IV

	Node	Load case number	Max.Drift in Zone III	Max.Drift in Zone IV
U1 (X)	38	102	17.40	26.096
U2 (Y)	20	108	20.116	30.174

When the identical structure is analysed in two separate seismic zones III and IV, it is discovered that the top drifts of the columns are 1.5 times greater in seismic zone IV than in seismic zone III, as compared to seismic zone III.

The maximum deflections in beams of both structures investigated in Zones III and IV are shown in the table below for load case 201 (1.5(DL+LL)) and the maximum deflections in beams of both structures analysed in Zones III and IV.

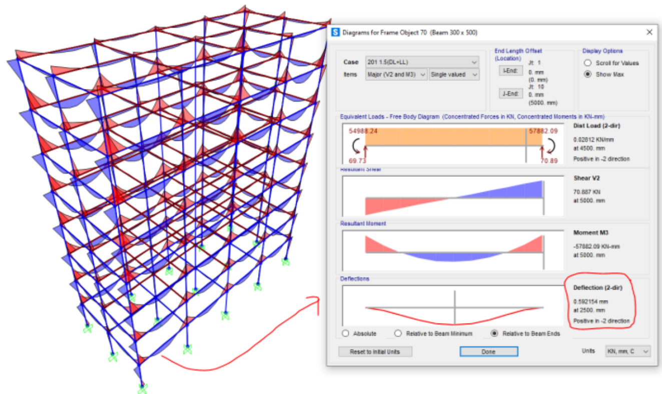


Fig. 8: Structure deflection in zone III

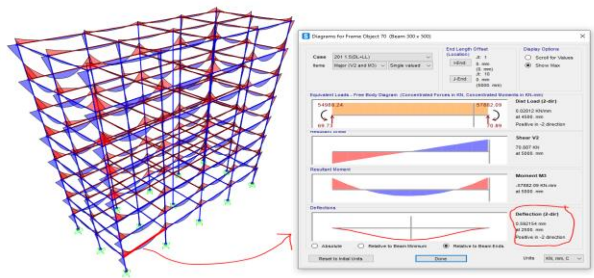


Fig. 9: Structure deflection in zone IV Bending Moments

The next table shows the change of maximum bending moment in beams and columns of the identical structure evaluated in Zones III and IV for load instances 210 (1.5(DL+EQX)).Percentage of steel

The following table shows the variation in the maximum percentage of longitudinal reinforcement in beams and columns of the same structure when analysed in two different seismic Zones III and IV.

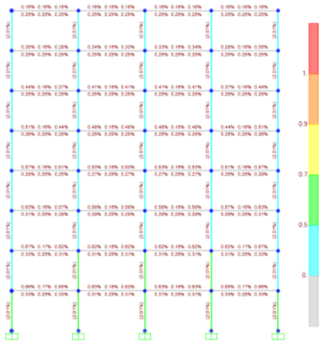


Fig. 10: Structure's columns & beams max. percentage of longitudinal reinforcement (axis-1&3) in zone III

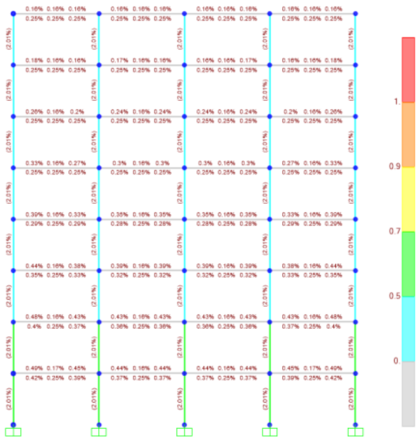


Fig.11: Structure's columns & beams max. percentage of longitudinal reinforcement (axis-2) in zone III

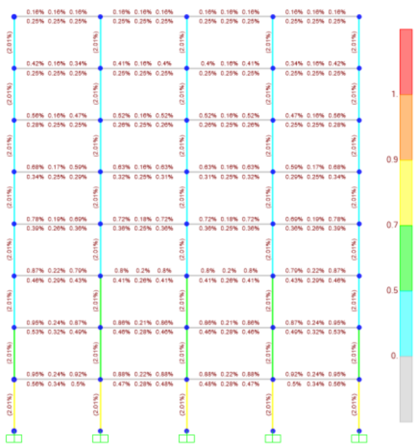


Fig.12: Structure's columns & beams max. percentage of longitudinal reinforcement (axis-1&3) in zone IV

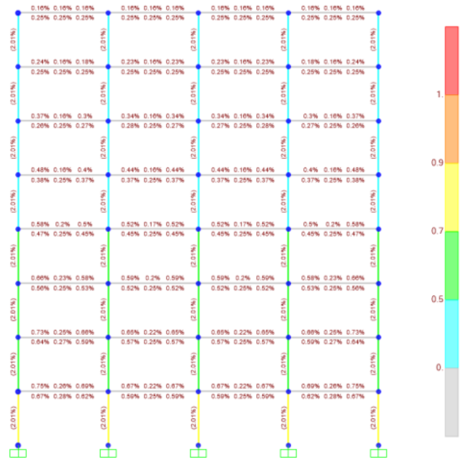


Fig.13: Structure's columns & beams max. percentage of longitudinal reinforcement (axis-2) in zone IV

As a result, by examining the identical building in two distinct seismic zones III and IV, it is discovered that the proportion of steel in columns and beams increases in seismic zone IV when compared to seismic zone III.

Column P-M-M Interaction Ratio

The interaction between the columns P-M-M is represented by the variation of the columns. The following table shows the ratios of the same structure examined in two separate seismic Zones III and IV.

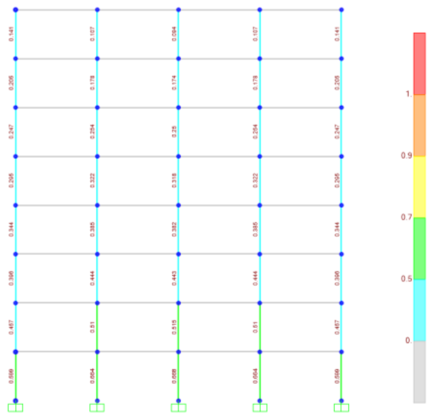


Fig.14: Structure's columns P-M-M Interaction Ratio (axis-1&3) in zone III

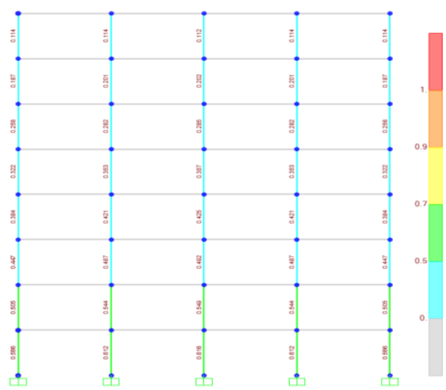


Fig.15: Structure's columns P-M-M Interaction Ratio (axis-2) in zone III

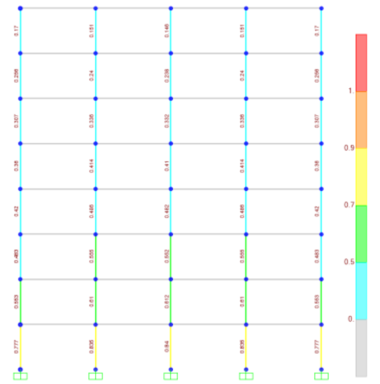


Fig.16: Structure's columns P-M-M Interaction Ratio (axis-1&3) in zone IV

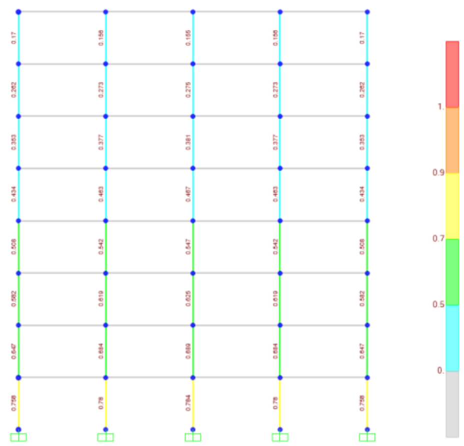


Fig.17: Structure's columns P-M-M Interaction Ratio (axis-2) in zone IV

It has been discovered that the columns P-M-M Interaction Ratio in seismic zone IV increases about 1.3 times when compared to seismic zone III, as determined by evaluating the identical structure in the two separate seismic zones III and IV, respectively.

III. CONCLUSIONS

With the help of the Indian seismic code IS 1893:2016 and the SAP 2000 software, we were able to investigate the behavior of a reinforced concrete G+7 building in two separate seismic zones III and IV of India.

- When comparing India's seismic zone IV to its seismic zone III, the base responses of a structure are amplified by a factor of 1.5 times.
- Drifts and deflections are found to be 1.5 times greater in zone IV than in zone III, which is a significant finding.
- The bending moment of columns is raised by 1.5 times in zone IV when compared to zone III, while the bending moment of beams is increased by more than 1.5 times when compared to zone III in zone IV.
- Furthermore, it was discovered that the shear force of beams and columns is higher in seismic zone IV when compared with seismic zone III.
- When the same structure is analyzed in two separate seismic zones III and IV, it is discovered that the proportion of steel in columns and beams increases in seismic zone IV when compared to seismic zone III.
- It has been discovered that the P-M-M Interaction Ratio of columns in seismic zone IV is about 1.3 times greater than that of columns in seismic zone III, according to research.

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