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ANALYSIS AND DESIGN OF G+6 BUILDING IN DIFFERENT SEISMIC ZONES OF INDIA USING STAAD PRO

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ABSTRACT

Structural planning and design is an art and science of designing with economy and elegance, serviceable and durable structure. The entire process of structural planning and designing requires not only imagination and conceptual thinking but also sound knowledge of science of structural engineering besides knowledge of practical aspects, such as relevant design codes and byelaws backed up by example experience. The process of design commence with planning of structural primarily to meet the defined as he is not aware of various implications involved in the process of planning and design. The functional requirements and aspects of aesthetics are locked into normally be the architect while the aspect of the safety, serviceability, durability and economy of the structure are attended by structural designer. 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 paper a G+6 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 the paper are to compare the variation of steel percentage, maximum shear force, maximum bending moment, and maximum deflection in different seismic zone. Variations are drastically higher from zone II to zone v. The steel percentage, maximum shear force, maximum bending moment, maximum deflection is increases from zone II to zone v.

Keywords: *Staad Pro, Siesmic Zones, Earth Quake, Wind Load*

I. INTRODUCTION

A typical RC building is made of horizontal members (beams and slabs) and vertical members (columns and walls), and supported by foundations that rest on ground. The system comprises of RC frame. The RC frame participates in resting the earthquake forces. Earthquake shaking generates inertia forces in the building which are proportional to the building mass. Since most of the building mass is present at floor levels, earthquake induced inertia forces primarily develop at the floor levels. These forces travel downwards – through slabs and beams to columns and walls, and then to foundations from where they are dispersed to ground. As inertia forces accumulate downwards from the top of the building, the columns and walls at lower storey experience higher earthquake- induced forces and are therefore designed to be stronger than those in storey above.

Many researchers have been conducted on this topic and still it is continuing, because more we try to learn more we can minimize the damages and save the lives. According to studies have been made on the seismology about 90% earthquake happens due to tectonics. If we come to civil engineering an engineer's job is to provide maximum safety in the structures designed and maintain the economy.

The latest version of seismic zoning map of India given in the earthquake resistant design code of India [IS 1893 (Part 1) 2002] assigns four levels of seismicity for India in terms of zone factors. In other words, the earthquake-zoning map of India divides India into 4 seismic zones (Zone 2, 3, 4 and 5) unlike its previous version, which consisted of five or six zones for the country. According to the present zoning map, Zone 5 expects the highest level of seismicity whereas Zone 2 is associated with the lowest level of seismicity. Zone 5 covers the areas with the

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highest risks zone that suffers earthquakes of intensity greater. The IS code assigns zone factor of 0.36 for Zone 5. Structural designers use this factor for earthquake resistant design of structures in Zone 5. The zone factor of 0.36 is indicative of effective (zero periods) level earthquake in this zone. It is referred to as the Very High Damage Risk Zone. The region of Kashmir, the western and central Himalayas, North and Middle Bihar, the North-East Indian region and the Rann of Kutch fall in this zone.

Zone 4 is called the High Damage Risk Zone and covers areas liable to MSK VIII. The IS code assigns zone factor of 0.24 for Zone 4. The Indo-Gangetic basin and the capital of the country (Delhi), Jammu and Kashmir fall in Zone 4. In Maharashtra, the Patan area (Koyananager) is also in zone no 4. In Bihar the northern part of the state like-Raksaul, near the border of India and Nepal, is also in zone no 4. Zone 3, the Andaman and Nicobar Islands, parts of Kashmir, Western Himalayas fall under this zone. This zone is classified as Moderate Damage Risk Zone, which is liable to MSK VII. The IS code assigns zone factor of 0.16 for Zone 3.

In The present study we are using Staad pro software to design the Building in different seismic zones and to different the property and its results.

Table 1. Showing the number of zones in different years

Year of Release of Zone Maps			
1962	**1966**	**1984**	**2002**
0	0	I	II
I	I		
II	II	II	
III	III	III	III
IV	IV	VI	IV
V	V	V	V
VI	VI		

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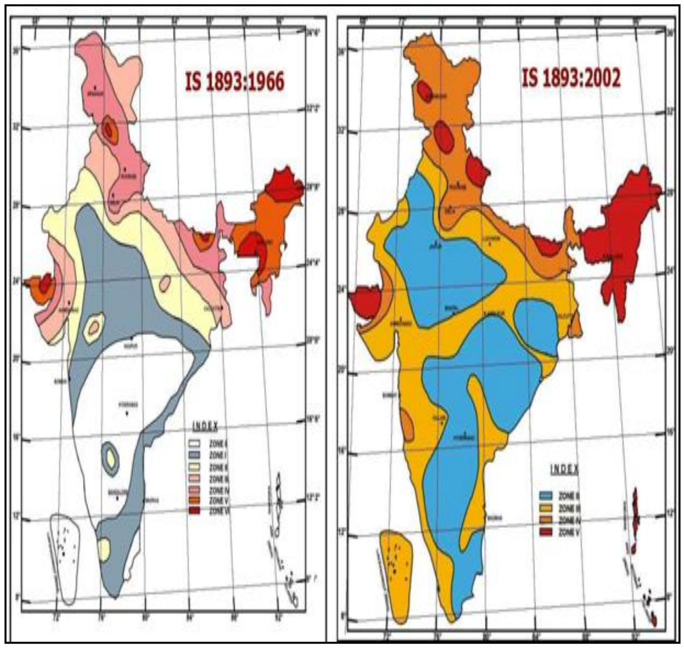

Fig: 1. Seismic zoning maps of India I. S.1893:1966 and IS1893:2002

Objective of study

The Aim of the study is to compare and analysis framed building in two different seismic zones and draw the following differences.

- steel percentage,
- maximum shear force
- maximum bending moment,
- Maximum deflection is increases from zone II to zone V.

II. LITERATURE REVIEW

Papa Rao: The author's researches on the changes in the percentage of steel and volume of concrete for the RCC framed structure for various seismic zones of India. They have designed the structure for gravity load and seismic forces, which might be effect on building. According to their research, they concluded that the variation in support reactions for exterior columns increased from 11.59% to 41.71% and in case of edge columns, it is 17.72% to 63.7% from Zone II to Zone V and as in the case of interior columns, it is very less. In case of concrete quantities, volume of concrete has been increased for exterior and edge columns from Zone III to Zone V because of increase in support reactions with the effect of lateral forces and variation is very small in interior columns. Percentage variations of steel in external beams are 0.54% to 1.23% and in internal beams, it is noted 0.78% to 1.4%. The bottom reinforcement is not changed for seismic and non-seismic design.

Perla Karunakar (2014): The author put his efforts to find out the performance and variation in steel percentage and concrete quantities in various seismic zones and impact on overall cost of construction. According to his research, the concrete quantities are increased in exterior and edge columns due to increase in support reactions however; variation is very small in interior column footings. Reinforcement variation for whole structure between gravity and seismic loads are 12.96, 18.35, 41.39, 89.05%.the cost variation for ductile vs. non-ductile detailing are 4.06%.

Salahuddin Shakeeb S M, Prof Brij Bhushan S, Prof Maneeth P D, Prof Shaik Abdulla (2015): In the work attempt is made to find the percentages required for various seismic zones by considering the effects of infill and without infill. For the study a symmetrical building plan is used with 13 storey's and analyzed and designed by using structure analysis software tool ETABS-2013. The study also includes the determination of base shear, displacement, moment and shear and the results are compared between gravity loads and various seismic zones. These parameters have also considers the effect of masonry infill's. In the research he concluded that the total variation in percentage steel in columns for infill case with maximum loading from seismic zone-2 to zone-5 are 1.935% to 51.612% compared to gravity loads. and the total variation in percentage steel in columns for without infill case with maximum loading from seismic zone-2 to zone-5 are 1.24% to 9.12% compared to gravity loads. The amount of variation of percentage steel in beams for infill case with maximum loading from zone-2 to zone-5 are 2.7% to 16.21% compared to gravity load and the variation in percentage steel in beams for non infill case with maximum loading from seismic zone-2 to zone-5 are 16.66% to 68.75% compared to gravity loads.

Inchara K P, Ashwini G (2016): The main objectives of this study were to study the performance and variation in steel percentage and quantities concrete in R.C framed irregular building in gravity load and different seismic zones And to know the comparison of steel reinforcement percentage and quantities of concrete when the building is designed as per IS 456:2000 for gravity loads and when the building is designed as per IS 1893(Part 1):2002for earthquake forces in different seismic zones. In this study five (G+4) models were considered. All the four models were modelled and analysed for gravity loads and earthquake forces in different seismic zones. ETABS software was used for the analysis of the models. According to their research, it can be inferred that support reactions tended to increase as the zone varied from II to V which in turn increased volume of concrete and weight of steel reinforcement in footings and in case of beams percentage of steel reinforcement increased through zones II to V.

III. METHODOLOGY

Seismic analysis of the structures is carried out on the basis of lateral force assumed to act along with the gravity loads. In this project framed residential Apartment building is carried out for two different seismic zones by an equivalent static analysis method using STAAD.Pro software.

Table 2. Structural properties used for building
PRELIMINARY DATA OF THE STRUCTURE CONSIDERED FOR ANALYSIS AND DESIGN

STRUCTURAL PROPERTIES of RCC FRAMED STRUCTURE	
Number of stories	G+6
Floor to floor height	3.0 m
Plinth height from bottom	3.0 m
Size of column	0.23 x 0.45 m
Size of beam	0.23 x 0.38 m
Earthquake load	As per IS:1893:2002
Slab thickness	0.125M
Live load including floor finish	3 KN/M2
Floor finishes	As per IS: part-I

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Seismic zones	seismic zones II & V
Type of soil taken	Soft soil
SBC of soil taken	100 KN/M

IV. MATERIAL PROPERTIES

Table 3. Material properties

These are the properties of material used in building designing

Grade of concrete	M25
Young's modulus of (M25) concrete,	E 27.386KN/M2
Poisson's ratio of Concrete	0.15
Coefficient of thermal expansion of concrete	170E-3
Coefficient of thermal expansion of steel	300E-3
Density of Reinforced Concrete	25 KN/m3
Grade of reinforcing steel	Fe415
Young's modulus of steel E	2E5
Poisson's ratio of Steel	0.286

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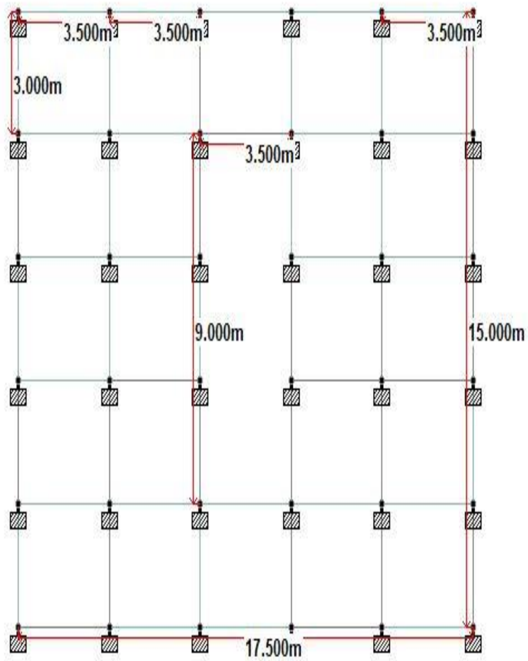

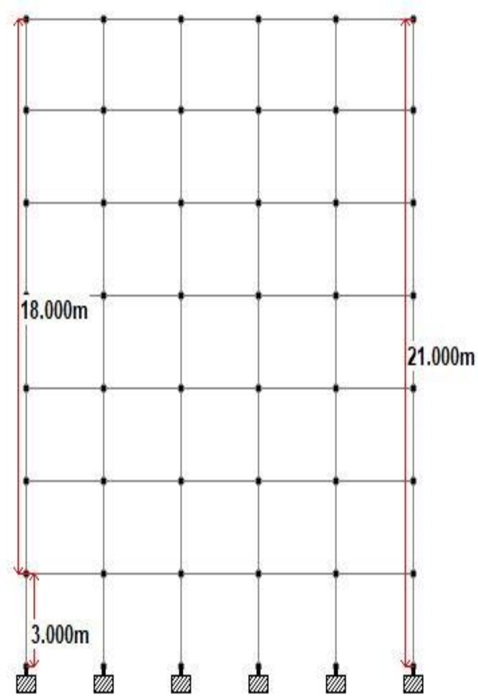

Fig 3. Plan, Elevation and 3D model of the Structure

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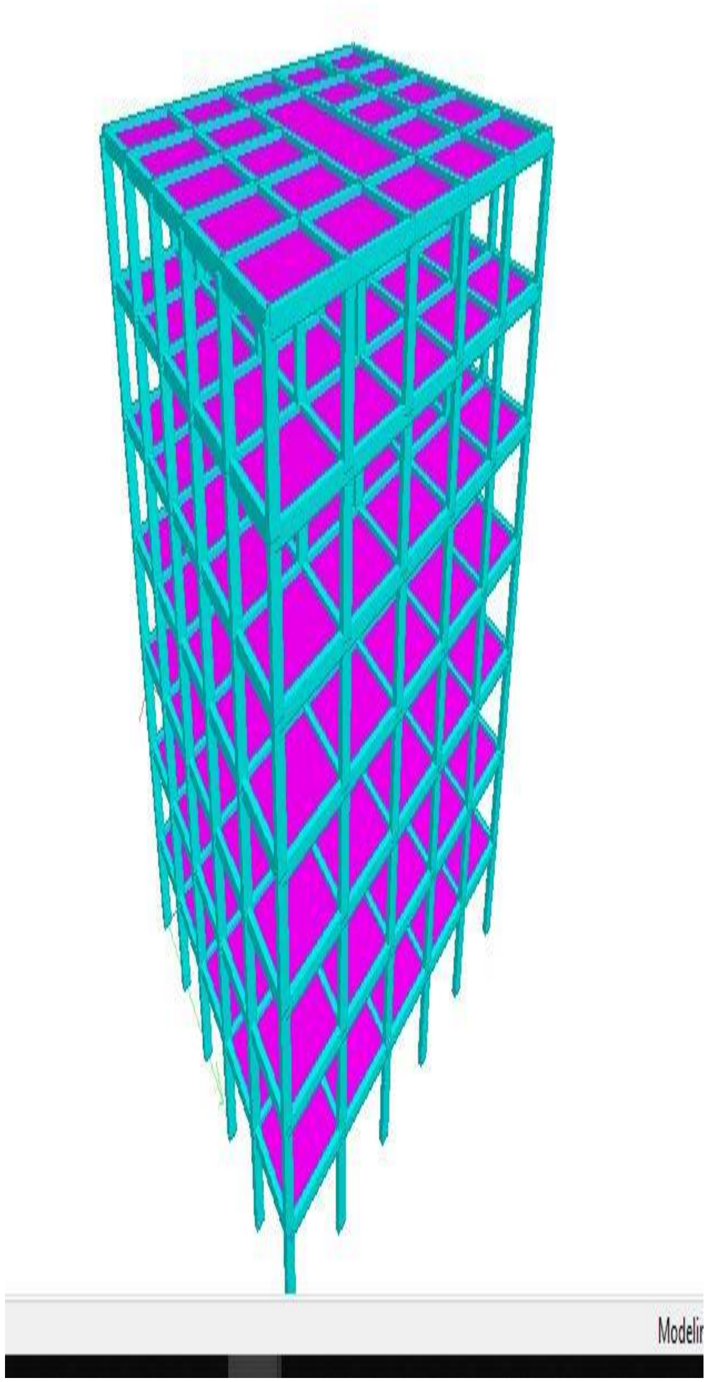

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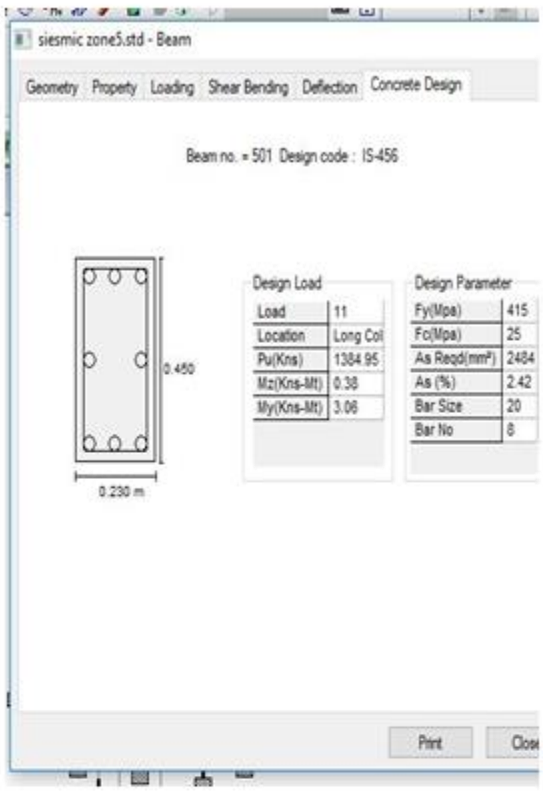
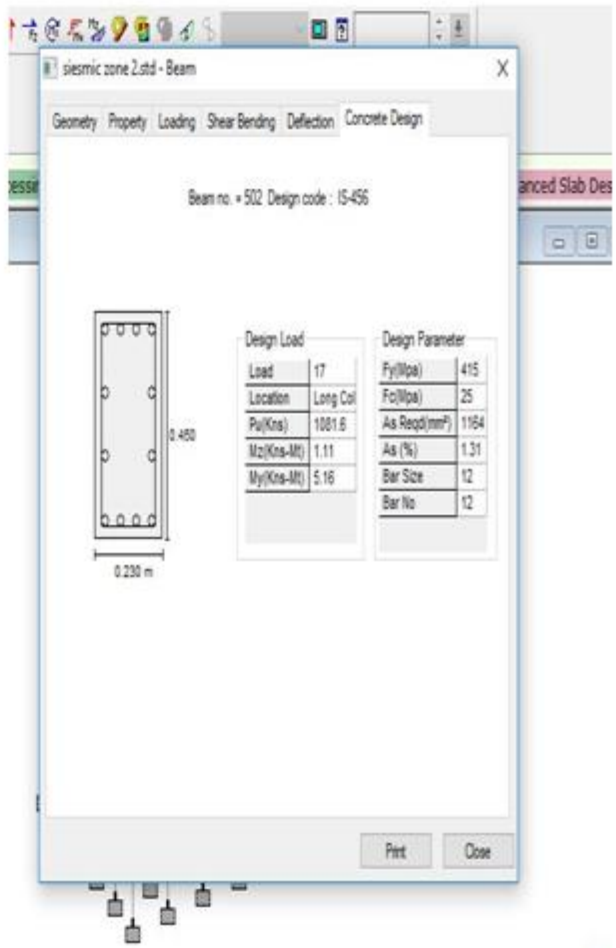
V. RESULTS & DISCUSSIONS

1. Steel Percentages in Different Seismic Zones





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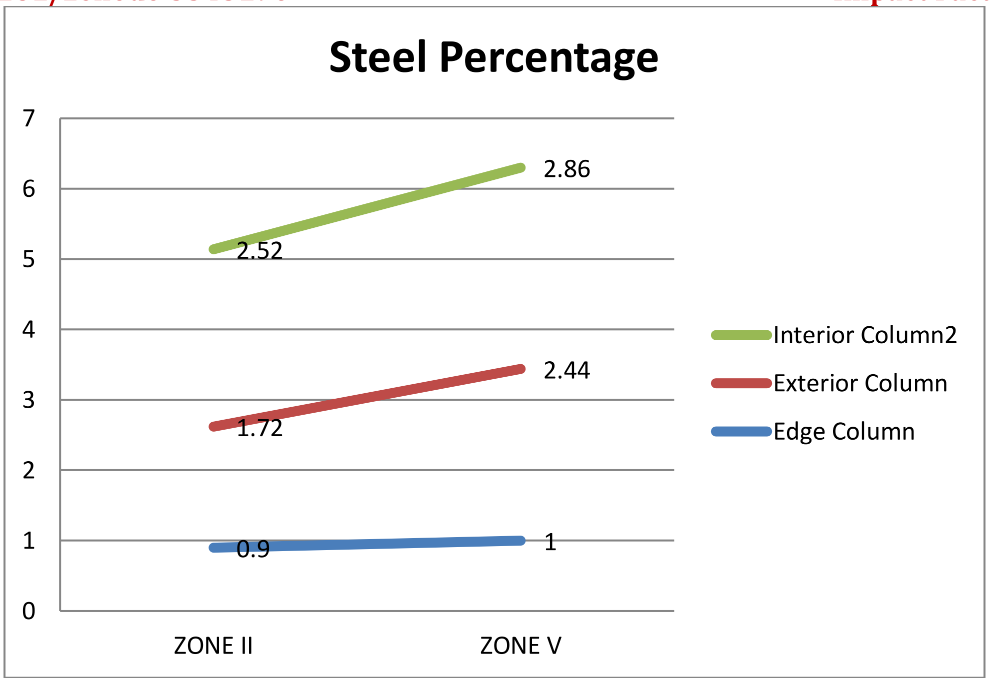

Fig 4. Showing the Steel Percentage According to Seismic Zone II and Zone V

2. Maximum bending moments

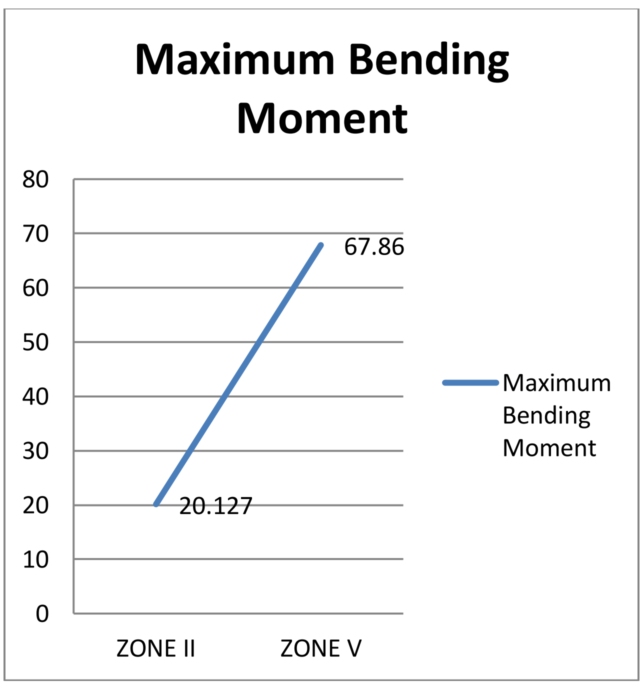

Fig 5. Graph showing the Maximum Bending Moment

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3. **Beam displacement**

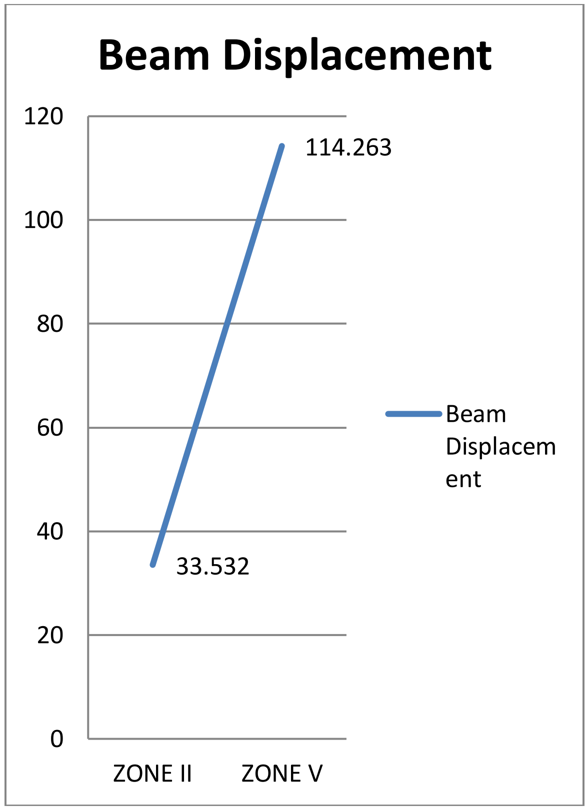

Fig 6. Graph showing the Beam displacement

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4. **Maximum shear force**

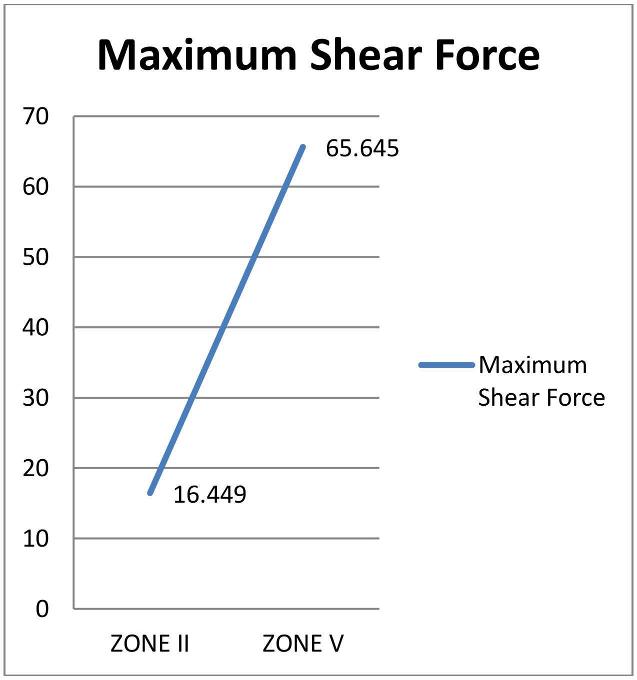

Fig 6. Graph showing the Maximum Shear force

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5. **Support reaction**

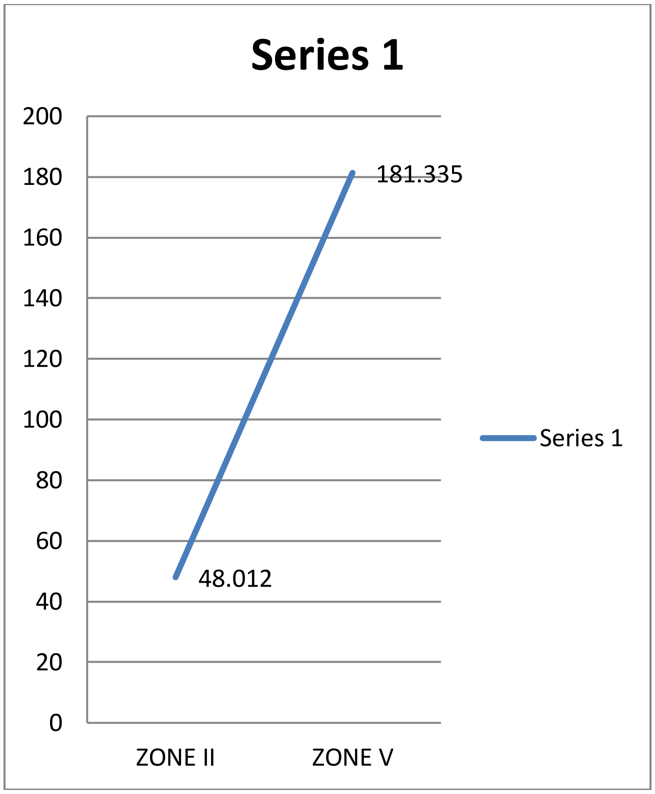

Fig 6. Graph showing the Support Reaction

VI. CONCLUSION

Steel Percentage of column:

- Variations are drastically higher from zone II to zone V.
- In Exterior columns steel percentage from zone II to zone IV varies from 1.72%, to 2.44% respectively.
- In Edge columns steel percentage from zone II to zone IV varies from 0.9%, 1% respectively.
- In Interior columns steel percentage from zone II to zone IV varies from 2.52%, 2.86 % respectively.

Beam Displacement:
Maximum Displacement in beam varies from 33.532 to 114.268 mm from zone II to zone V.

Maximum Bending Moment:
Maximum bending moment in beam varies from 20.127 to 67.86 from zone II to zone V.

Maximum Shear Force:
Maximum shear force in building varies from 16.449 to 65.645 mm from zone II to zone V.

Maximum Support Reaction:
Maximum support reaction in building varies from 48.012 to 181.335 from zone II to zone V.

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