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Analysis and Design of G+6 Building in Different Seismic Zones of India

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ABSTRACT: 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 existing 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, steel percentage, Maximum Shear force, Maximum Bending Moment, Maximum Deflection, Seismic zones.

I. INTRODUCTION

Many researches 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 highest risks zone that suffers earthquakes of intensity MSK IX or 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.

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Zone 2 is liable to MSK VI or less and is classified as the Low Damage Risk Zone. The IS code assigns zone factor of 0.10 (maximum horizontal acceleration that can be experienced by a structure in this zone is 10% of gravitational acceleration) for Zone 2.
Since the current division of India into earthquake hazard zones Zone 1 does not use, no area of India is classed as Zone 1.Future changes in the classification system may or may not return this zone to use.

II. RELATED WORK

Papa Rao and Kiran Kumar (2013): 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.

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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 seismic evaluation for the existing residential building is carried out for different seismic zones by an equivalent static analysis method using STAAD.Pro software.

Table 1 - 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	3.2m
Plinth height	0.8m
Size of column	0.2X0.5m & 0.2X0.4m
Size of beam	0.2X0.45m
Earthquake load	As per IS:1893:2002
Slab thickness	0.125M
Wall thickness	0.200M
Live load including floor finish	3.5 KN/M^2
Floor finishes	As per IS: part-I
Seismic zones	All five seismic zones of India
Type of soil taken	Hardy rocky
SBC of soil taken	200KN/M

Table 2 - MATERIAL PROPERTIES

These are the properties of material used in building designing

MATERIAL PROPERTIES	
Grade of concrete	M30
Young's modulus of (M30) concrete, E	27.386KN/M^2
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/m^3
Grade of reinforcing steel	Fe415
Young's modulus of steel E	2E5
Poisson's ratio of Steel	0.286

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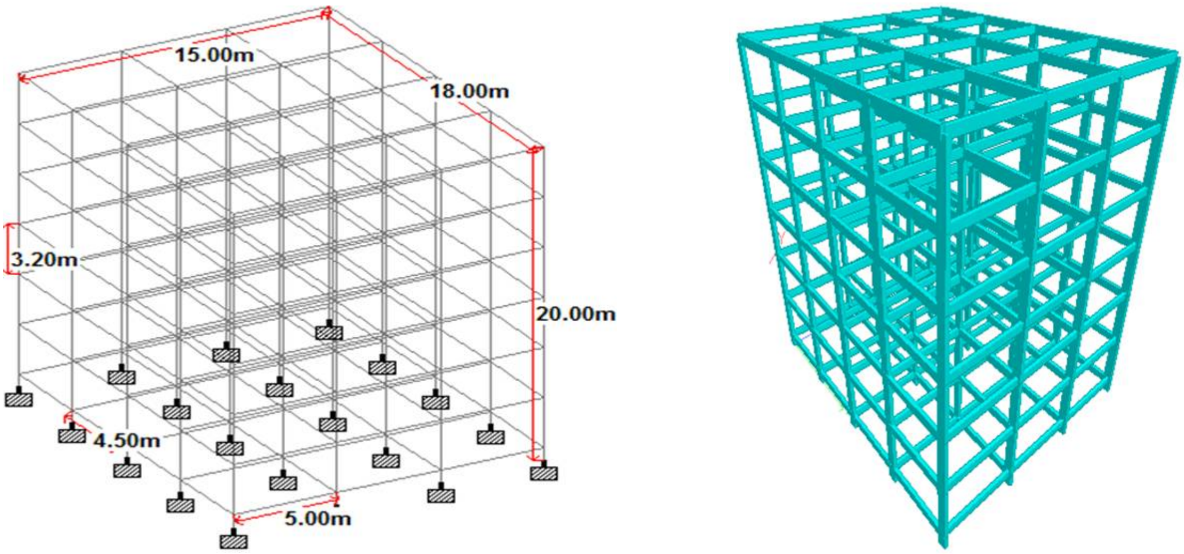

Figure 1:- Typical 3D view and Rendering View of Building

IV. RESULTS & DISCUSSIONS

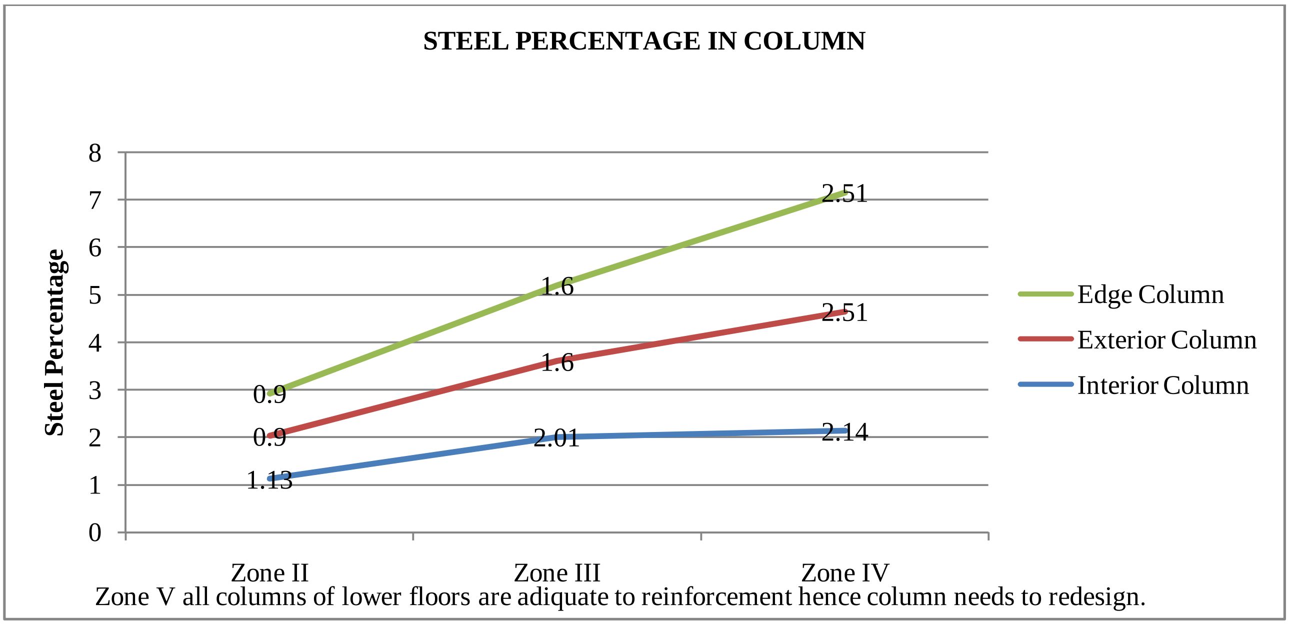

Figure 2:- Maximum Percentage of Steel in Columns

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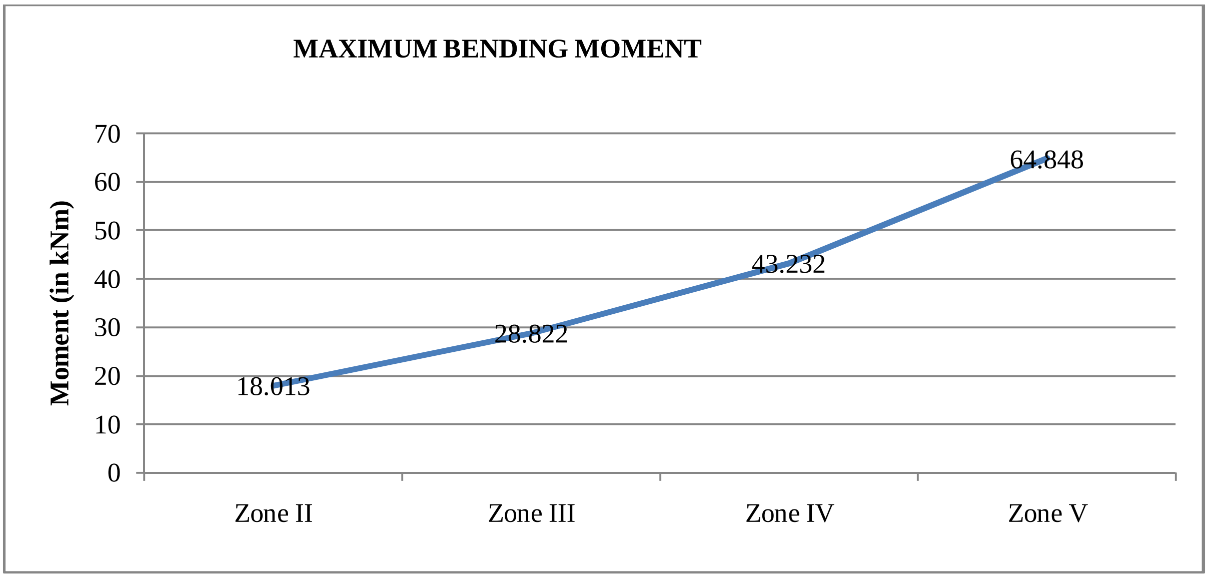

Figure 3:- Maximum Bending Moment in Beams

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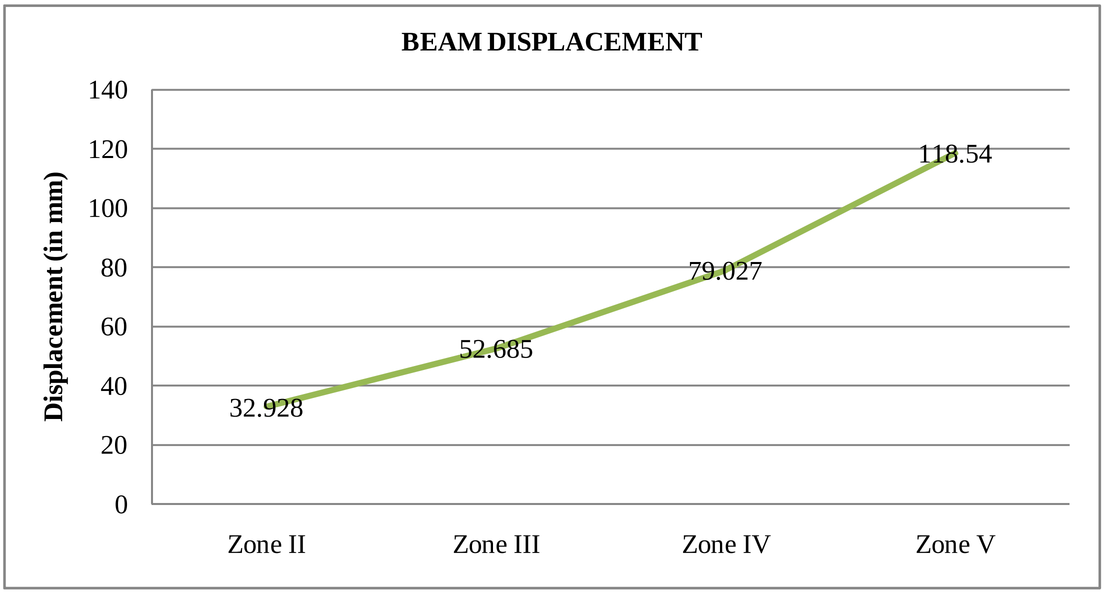

Figure 4:- Maximum Displacement in Beams

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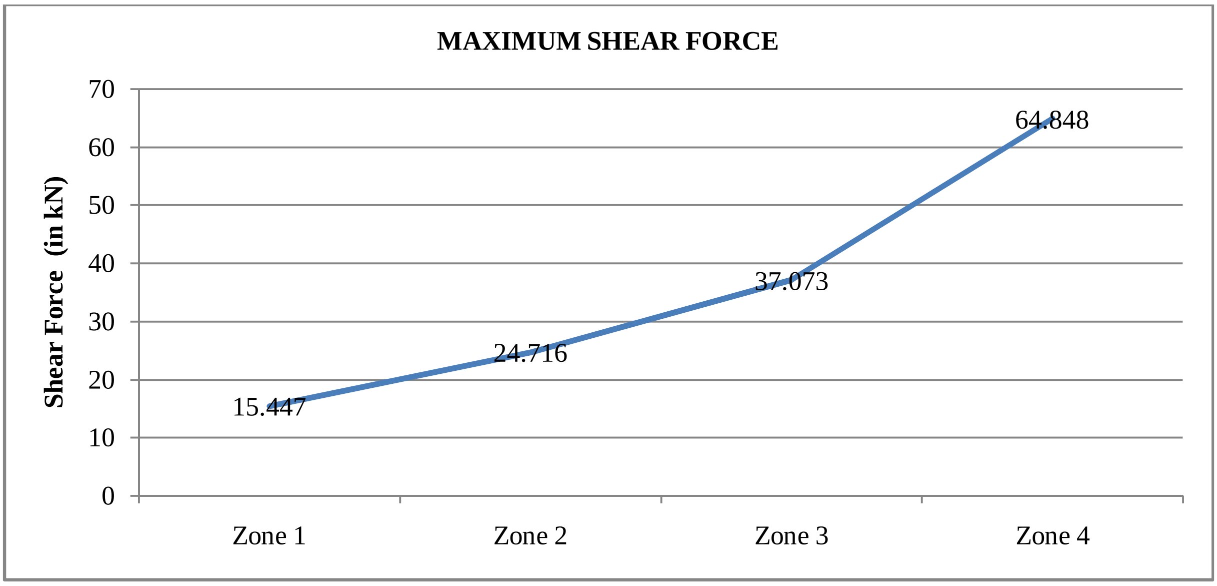

Figure 5:- Maximum Shear Force in Beams

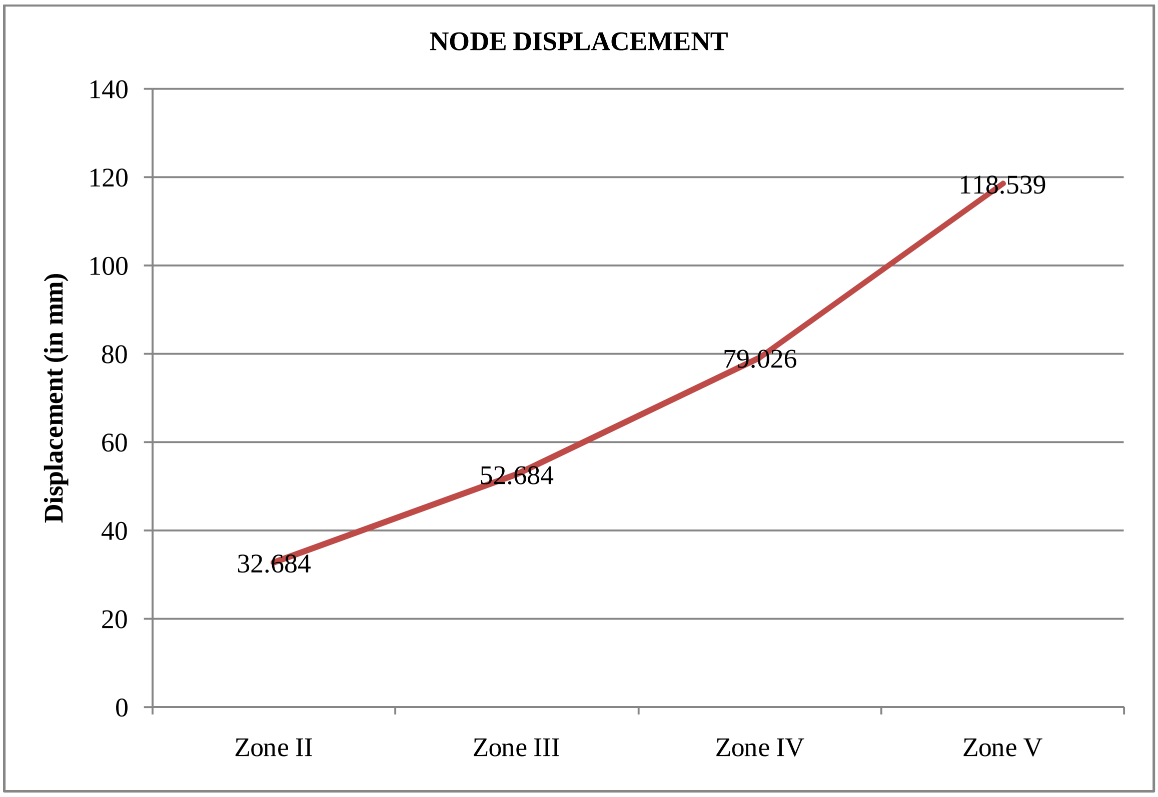

Figure 6:- Maximum Node Displacements

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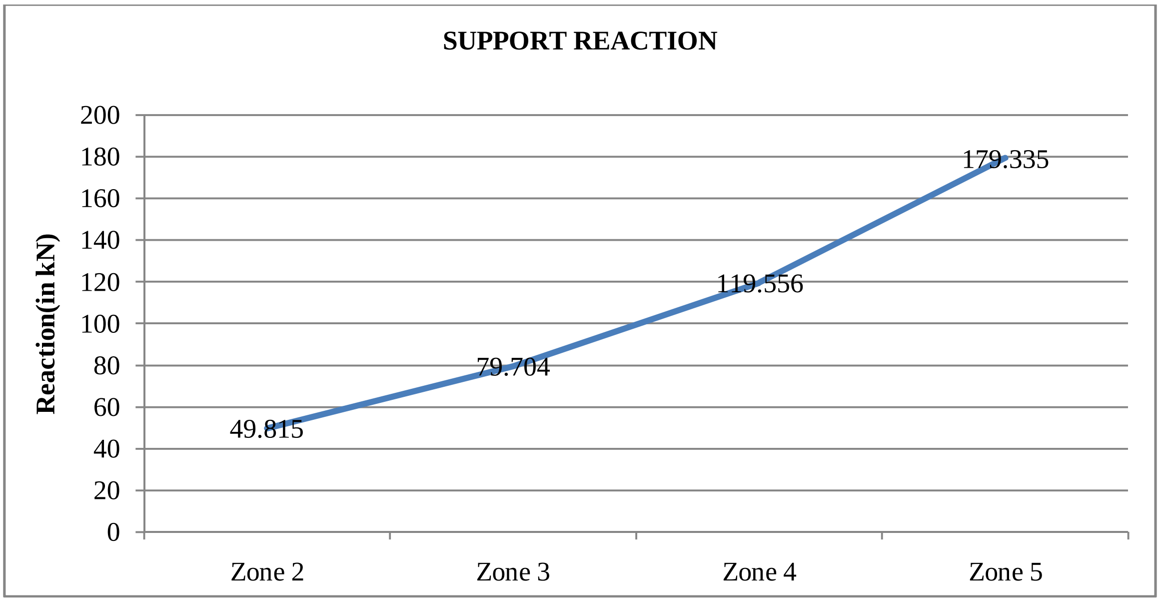

Figure 7:- Maximum Support Reactions

V. 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 0.9%, 1.6%, and 2.51% respectively.
- In Edge columns steel percentage from zone II to zone IV varies from 0.9%, 1.6%, and 2.51% respectively.
- In Exterior and Edge columns difference in steel percentage are same from zones.
- In Interior columns steel percentage from zone II to zone IV varies from 1.13%, 2.01%, and 2.1% respectively.

Beam Displacement:

- Maximum Displacement in beam varies from 32.928, 52.685, 79.027 & 118.54 mm from zone II to zone V.

Maximum Bending Moment:

- Maximum bending moment in beam varies from 18.013, 2.822, 43.232 & 64.848 from zone II to zone V.

Maximum Shear Force:

- Maximum shear force in building varies from 15.447, 24.716, 37.073 & 64.848mm from zone II to zone V.

Node Displacement:

- Maximum node displacement in building varies from 32.684, 52.684, 79.026 & 118.539 mm from zone II to zone V.

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Maximum Support Reaction:

- Maximum support reaction in building varies from 49.815, 79.704, 119.556 & 179.335 from zone II to zone V.

Limitations / Constraint:

- For zone V, all exterior, edge & interior columns of lower floors are failed to design because section is not adequate and unable to accommodate required reinforcement.
- Hence, the column needs to redesign

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