iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 Issue: XII Month of publication: December 2024

DOI: https://doi.org/10.22214/ijraset.2024.66065

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue XII Dec 2024- Available at www.ijraset.com

Comparison of Reinforcement of High Rise Structure in Different Seismic Zones Using Staad Pro

Neetesh Jain[1], Rakesh Grover[2]
[1]PG Student, [2]Professor Department of Civil Engineering, Jabalpur Engineering College, MP

Abstract: In this research design of G+10 High Rise Structure has been analyzed. The earthquake is most dangerous natural hazard in manmade structure. The demand of earthquake resisting building has been increased which can be fulfilled by providing the shear wall , Structure reinforcement and the appropriate sizing of beams and columns in the structure for resisting lateral forces. Shear walls also have high stiffness and strength which can be used to resist horizontal loads and gravity loads making useful in various structural engineering design. The study focuses on G+ 10 high rise structures located in seismic zones II, III, IV and V of India with shear walls at corners of the external walls . A Comparison of reinforcement for both flexural and compression members across different seismic zone is included . The analysis is done by using STAAD-Pro Connect Edition V22 software. The IS codes used for the analysis and designing is IS 1893 (Part-1):2016 (criteria for earthquake resistant design of structures), IS 456:2000 (plain and reinforced concrete) and SP 16: 1980 (design aids for reinforced concrete to IS : 456)
Keywords: STAAD Pro Connect Edition V22, Shear Wall, Seismic Analysis, High Rise Building, Lateral Force, Area of Reinforcement, Weight of reinforcement

I. INTRODUCTION

Now a days earthquake has become the biggest disaster, so many of them are threatening some of them are still suffering from this fatal incident. As the population continues to grow incrementally, the demand for the survival resources also escalates. Consequently, it is imperative to ensure the safety and comfort of every individual affected by these seismic events.

II. OBJECTIVE

The present work is to analyze High Rise Structures with RCC structure building against siesmic zone II , zone III , zone IV , zone V. The components of objectives are as follows:

1) To design and evaluate the seismic behavior of RCC building having different siesmic zone.
2) To obtain and analyze the various loads acting on the structure.
3) To study the variations in parameters such as Shear Force, Bending moment and Displacement in all seismic zones as per IS 1893 (Part-1):2016.
4) To compare the area & weight of the reinforcement required in flexural and compression member in all seismic zones as per IS 1893(Part-1):2016.

III. SCOPE OF THE STUDY

1) Any structural engineer can use this paper as a guide line for seismic analysis of any multistory building.
2) The study highlights the effect of seismic zone factor in different zones i.e. Zone II, Zone III, Zone IV and Zone V which is considered in the seismic performance evaluation of buildings.
3) The design of structures must incorporate appropriate features for resisting earthquakes, thereby ensuring their capability to withstand lateral forces exerted during seismic events across various seismic zones.Additionally, it is essential to consider both the cost- effectiveness and efficiency of these measures in mitigating potential earthquake- related damage to the structures.

IV. LITERATURE REVIEW

1) Sonkar Ankit , Verma Srishti In their study they compare & analyze of high rise buildings, specifically examining the impacts of seismic activity and wind forces. In past years many research has done on Analysis of building with and without shear walls. All the same they work for little Analysis of high rise building (G+ 10) with & without shear walls.

The current work consist the correlation between framed & framed with shear wall building in presence of the wind force, earthquake force etc, for seismic design of buildings, reinforcement concrete structural walls or shear walls are higher earthquake resisting members which abstain from lateral load resistance.

2) Saha Purnachandra, Teja P.Prabhu & P Kumar Vijay (2012) This research is mainly focuses on variation in percentage of steel when building is designed for different seismic zones. As per their research work they concluded that percentage variation of steel in beams are not varying much as compared to columns. Variation is around 0.07% in columns and overall variation is around 0.91% from Zone-2 to Zone-5.
3) Babu B. Giresh (June 2017) has done a seismic analysis and Design of G + 7 Residential Building using STAAD Pro. Earthquake, or Seismic analysis, to calculate the response of a structure subjected to earthquake excitation. He collected various necessary seismic data to carry out the seismic analysis of the structure. In this study, the structures seismic response was investigated under earthquake excitation expressed in member forces, join displacement, support reaction, and story drift.
4) Kankuntala Rani. (2018) They used STAAD Pro to design and assess the G + 4 Building. It was a three dimensional framed design that included load calculations and STAAD Pro analysis of the entire structure. Limit State Design was utilized in the STAAD-Pro analysis, which followed the Indian Standard Code of Practice. The outcomes were extremely accurate.

V. METHOD & DESCRIPTION

In this study the behavior of G+10 High Rise Structure as residential building under seismic loads have been analyzed for various location of India in seismic zone like zone II, zone III, zone IV, zone V with shear walls at different corners . An analysis of structure has been carried out for comparison of reinforcement for the flexural and compression member beam B 485 and B492, column C540 and C545 in different seismic zone. The analysis of the building has been carried out by static coefficient method or equivalent lateral force method approach using STAAD-Pro Connect Edition V22. The size of the building plan is 20mX16m and height of structure is 38.5 m.

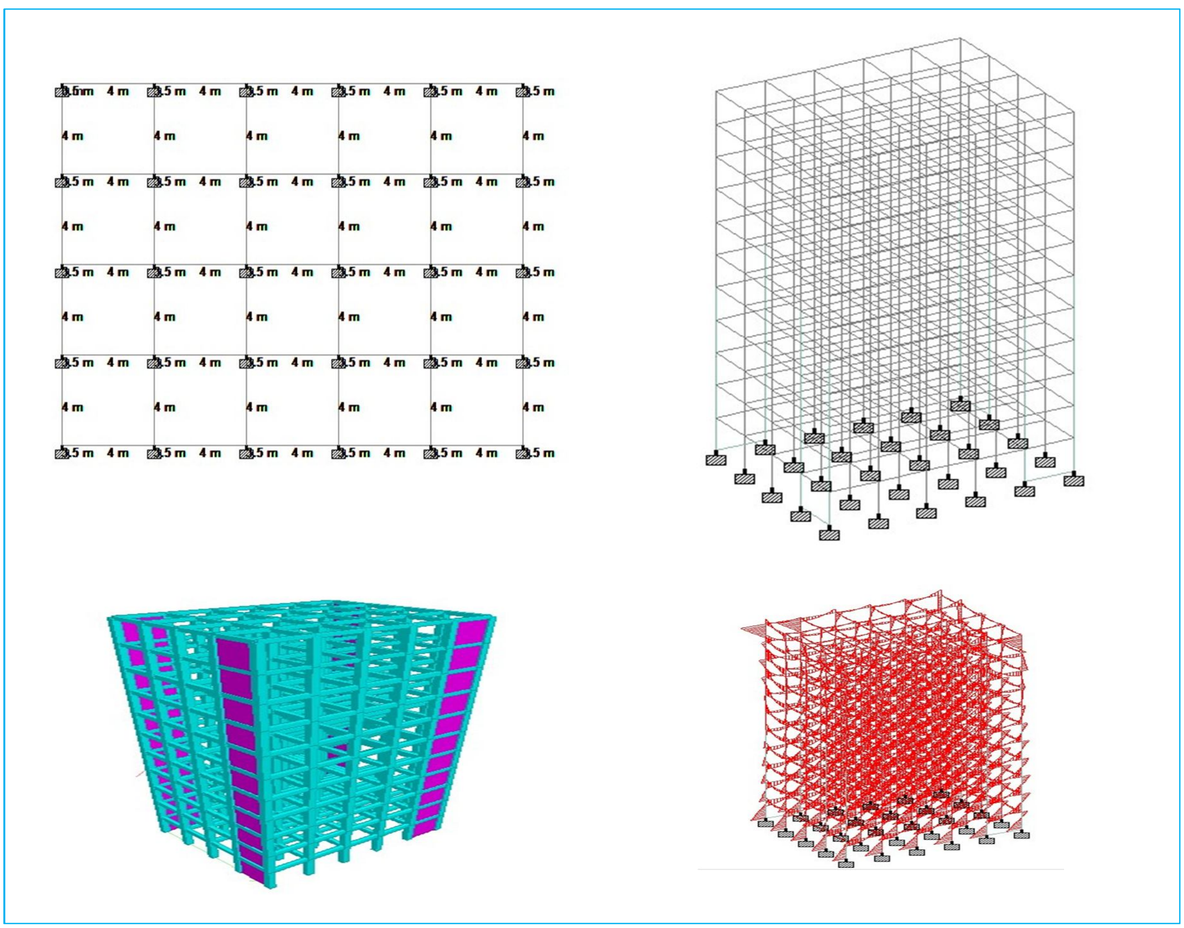


Fig. 1 Staad Pro Plan , Elevation, 3D rendering View, Bending Moment Diagram

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue XII Dec 2024- Available at www.ijraset.com

Table 1: Structural Modeling For the Project Models

Descriptions	Value
Grade of Concrete	M30
Grade of Steel	Fe500
Bays in X-direction and Length	5 bays of 4m each = 20m
Bays in Z-direction and Width	4 bays of 4m each = 16m
Floor to Floor Height	11 bays of 3.5m each = 38.5m
Number of Storey	G+10
Column Size	600mmx600mm
Beam Size	10^{th} & 9^{th} Floor - 300mmx450mm
	8^{th},7^{th}, 6^{th}, 5^{th},4^{th} ,3^{th} , 2^{nd} , 1^{st} ,Ground Floor -400mmx600mm
Floor to Floor Height	3.5m
Thickness of Slab	150mm
Live Load on Roof	1.5 KN/m^2
Live Load on Floors	3 KN/m^2
Thickness of External Wall	230mm
Thickness of Internal Wall	115mm
External Plaster	15mm
Internal Plaster	12mm
Density of Concrete	25 KN/m^3
Density of Plaster	18 KN/m^3
Density of Brickwork	19 KN/m^3
Thickness of Shear Wall	230mm

Table 2 : Seismic Parameters

Seismic Zone	**Zone II**	**Zone III**	**Zone IV**	**Zone V**
Zone Factor (Z)	0.10	0.16	0.24	0.36
Importance Factor(I) All other building	1.2			
Response Reduction Factor Ordinary Shear Wall With SMRF (R)	4			
Type Of Soil	MEDIUM SOIL TYPE II			
Damping Percent	5%			
Natural Time Period (Ta) SEC X Direction	0.7747			
Natural Time Period (Ta) Z Direction	0.8662			
Sa/g X Direction	1.291			
Sa/g Z Direction	1.154			
Cefficient of Horizontal Acceleration Ah X Direction	0.0194	0.0310	0.0465	0.0697
Z Direction	0.0173	0.0277	0.0416	0.0623

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue XII Dec 2024- Available at www.ijraset.com

Load Assignment

i. Dead load ii. Live load iii. Seismic Load

Types of seismic analysis methods -

1) Static Analysis

Equivalent Lateral Force Method & Pushover Analysis

2) Dynamic Analysis

Response Spectrum Method & Time History Analysis

We using Static Analysis of Equivalent Lateral Force Method for this research.

a) Calculation of Load –

DL of slab = 0.15 x 1 x 25 = 3.75 KN/m^2

- DL of outer brick wall = 0.23 x (3.5-0.45) x 19 = 13.32 KN/m
  DL of plaster = (0.015+0.012) x 3.5 x 18 = 1.70 KN/m

Total DL for outer wall = 13.32+1.70 = 15.02 KN/m

- DL of outer brick wall = 0.23 x (3.5-0.6) x 19= 12.67 KN/m
  DL of plaster = (0.015+0.012) x 3.5 x 18 = 1.70 KN/m

Total DL for outer wall = 12.67+1.10 = 14.37 KN/m

- DL of inner brick wall = 0.115 x (3.5-0.45) x 19 = 6.66 KN/m
  DL of plaster = (0.012+0.012) x 3.5 x 18 = 1.51 KN/m
  Total DL for inner wall = 6.66+1.51=8.17 KN/m
- DL of inner brick wall = 0.115 x (3.5-0.6) x 19 = 6.33 KN/m
  DL of plaster = (0.012+0.012) x 3.5 x 18 = 1.51 KN/m

Total DL for inner wall = 6.33 + 1.51 = 7.84 KN/m

- DL of parapet wall = 0.23 x 1 x 19 = 4.37 KN/m
  DL of plaster = (0.015+0.015) x 1 x 18 = 0.54 KN/m
  Total DL for parapet wall = 4.6 + 0.54 = 4.91 KN/m

b) Calculation of Seismic Weight-

As per IS 1893 (Part 1):2016 table 3.1 in clause 7.3.1 of "Percentage of imposed load to be considered in seismic weight calculation"

Total seismic weight floors = 3.75 + (0.25 x3) = 4.5 KN/m^2

Total seismic weight roof floors = 3.75+0 KN/m^2

VI. RESULT & DISCUSSION

In this Research, bending moment, shear force, area of Steel required for Beam B-485 & B-492 in ground floor and first floor respectively and area of steel for column C 540 & C-545 in ground floor and weight of steel for all the floors extracted from STAAD-Pro Connect Edition V22 are obtained using referred IS 1893(Part 1):2016, IS 456:2000 and IS 13920: 2016 for using criteria and limitations..

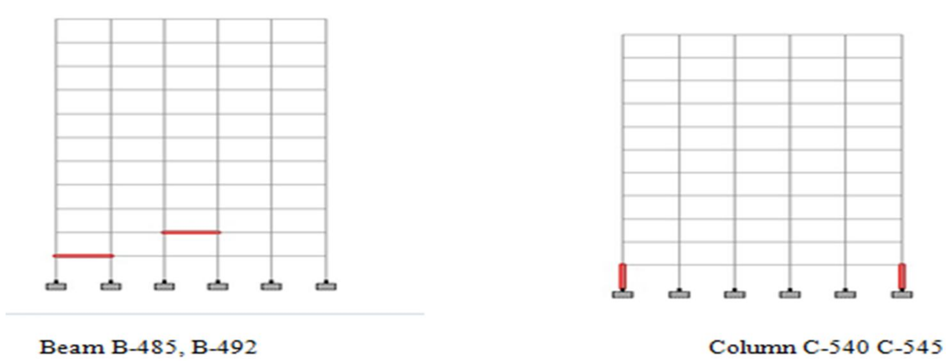


Fig. 2 Beam and Column Section in the model

In this study G+10 High Rise Structure at ground floor beam worst load combination obtained by STAAD-Pro Connect Edition V22. Design calculations at specific sections for the reinforcement of beam B-485 & B-492 and column C-540 and C-545 are shown in figure. The bending moments, shear force and axial force are obtained by STAAD-Pro Connect Edition V22 software. Bending moment and shear force in beam number B-485 & B-492 at various section like start section 0 m and end section 4 m is given in the table below also Bending moment and axial force for column C-540 and C-545 are given in the table below :-

A. *Bending Moment & Shear forces is Beam Section:-*

Table 3: Beam BM & SF

Seismic Zone II				
	B – 485		B – 492	
	Start Section 0 m	End Section 4m	Start Section 0 m	End Section 4m
Moment Top –ve (KN-m)	152	117	149	141
Moment Bottom +ve (KN-m)	61.2	62.3	64.7	69.3
Shear Force kN	122	109	122	118
Seismic Zone III				
	B – 485		B – 492	
	Start Section 0 m	End Section 4m	Start Section 0 m	End Section 4m
Moment Top –ve (KN-m)	207	166	207	198
Moment Bottom +ve (KN-m)	111	112	123	127
Shear Force kN	148	135	151	147
Seismic Zone IV				
	B – 485		B – 492	
	Start Section 0 m	End Section 4m	Start Section 0 m	End Section 4m
Moment Top –ve (KN-m)	281	233	284	275
Moment Bottom +ve (KN-m)	184	178	200	204
Shear Force kN	183	170	189	185
Seismic Zone V				
	B – 485		B – 492	
	Start Section 0 m	End Section 4m	Start Section 0 m	End Section 4m
Moment Top –ve (KN-m)	391	332	400	391
Moment Bottom +ve (KN-m)	294	278	316	319
Shear Force kN	235	222	247	243

B. Bending Moment & Axial Force in Column section :-

Table 4 : Column BM & Axial Force

Seismic Zone II		
	C -540	C – 545
Moment Mz (KN-m)	18.12	100
Moment My (KN-m)	88.72	18.80
Axial Force Pu (kN)	2296.31	2346.90
Seismic Zone III		
Moment Mz (KN-m)	17.46	158.12
Moment My (KN-m)	141.27	17.87
Axial Force Pu (kN)	2584.40	2661.43
Seismic Zone IV		
Moment Mz (KN-m)	14.17	230.54
Moment My (KN-m)	209.50	16.29
Axial Force Pu (kN)	-67.70	-164.32
Seismic Zone V		
Moment Mz (KN-m)	15.5	346.81
Moment My (KN-m)	314.59	18.28
Axial Force Pu (kN)	-645.89	-793.81

C. Area of Reinforcement at Staring & End Section of Beam:-

Table 5 : Beam & Column Reinforcement

Zone II				
Beam Result	B – 485		B – 492	
	Area of Steel Required by Staad Pro	Area of Steel Provided and Number	Area of Steel Required by Staad Pro	Area of Steel Provided and Number
Top of start section steel area (mm^2)	763.73	942.48 3#20	789.19	942.48 3#20
Bottom of start section steel area (mm^2)	410.47	942.48 3#20	428.43	942.48 3#20
Top of end section steel area (mm^2)	691.03	942.48 3#20	789.19	942.48 3#20
Bottom of end section steel area (mm^2)	380.80	942.48 3#20	428.43	942.48 3#20
Column Result	C – 540		C – 545	
End section steel area (mm^2)	1372	3600 12#20	1403.23	3600 12#20
Zone III				
Beam Result	B – 485		B – 492	
	Area of Steel	Area of Steel	Area of Steel	Area of Steel

	Required by Staad Pro	Provided and Number	Required by Staad Pro	Provided and Number
Top of start section steel area (mm^2)	915.06	942.48 3#20	916.42	942.48 3#20
Bottom of start section steel area (mm^2)	472.91	942.48 3#20	524.96	942.48 3#20
Top of end section steel area (mm^2)	726.18	942.48 3#20	873.17	942.48 3#20
Bottom of end section steel area (mm^2)	477.40	942.48 3#20	545.09	942.48 3#20
Column Result	C – 540		C – 545	
End section steel area (mm^2)	1545.83	3600 12#20	1591.29	3600 12#20
Zone IV				
Beam Result	B – 485		B – 492	
	Area of Steel Required by Staad Pro	Area of Steel Provided and Number	Area of Steel Required by Staad Pro	Area of Steel Provided and Number
Top of start section steel area (mm^2)	1282	1570.80 3#25	1303.69	1570.8 5#20
Bottom of start section steel area (mm^2)	806.69	942.48 3#20	878.83	942.48 3#20
Top of end section steel area (mm^2)	1045.46	1570.80 3#25	1254.91	1570.8 5#20
Bottom of end section steel area (mm^2)	777.13	942.48 3#20	899.13	942.48 3#20
Column Result	C – 540		C – 545	
End section steel area (mm^2)	2162.98	3600 12#20	2585.79	3600 12#20
Zone V				
Beam Result	B – 485		B – 492	
	Area of Steel Required by Staad Pro	Area of Steel Provided and Number	Area of Steel Required by Staad Pro	Area of Steel Provided and Number
Top of start section steel area (mm^2)	1865.33	2827.44 9#20	1935.65	2827.44 9#20
Bottom of start section steel area (mm^2)	1352.29	2199.12 7#20	1454.73	2827.44 9#20
Top of end section steel area (mm^2)	1546.70	2513.28 8#20	1876.69	2199.12 7#20
Bottom of end section steel area (mm^2)	1266.27	1884.96 6#20	1475.50	2199.12 7#20
Column Result	C – 540		C - 545	
End section steel area (mm^2)	4454	5026.56 16#20	5290	5890.50 12#25

1) Required Area of Reinforcement Tension Zone at Starting Section 0m of Beam :-

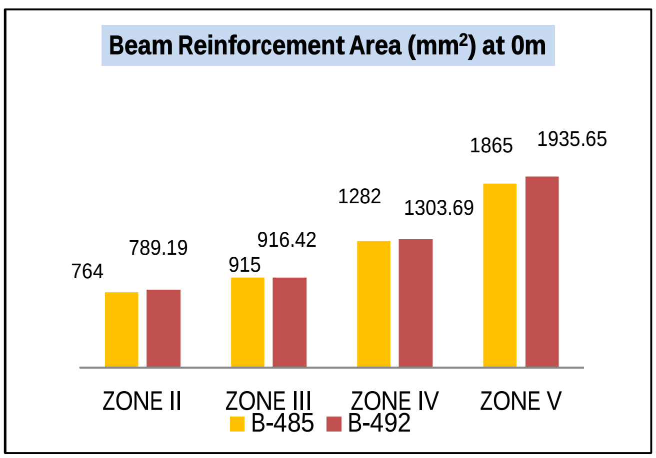
Table 6 : Beam Reinforcement at Starting Section

Zone	B – 485	B – 492
	Ast req mm^2	Ast req mm^2
II	763.73	789.19
III	915.06	916.42
IV	1282	1303.69
V	1865.33	1935.65

2) Required Area of Reinforcement Tension Zone at End Section 4m of Beam :-

Table 7 : Beam Reinforcement at End Section

Zone	B – 485	B – 492
	Ast req mm^2	Ast req mm^2
II	691.03	789.19
III	726.18	873.17
IV	1045.46	1254.91
V	1546.70	1876.69



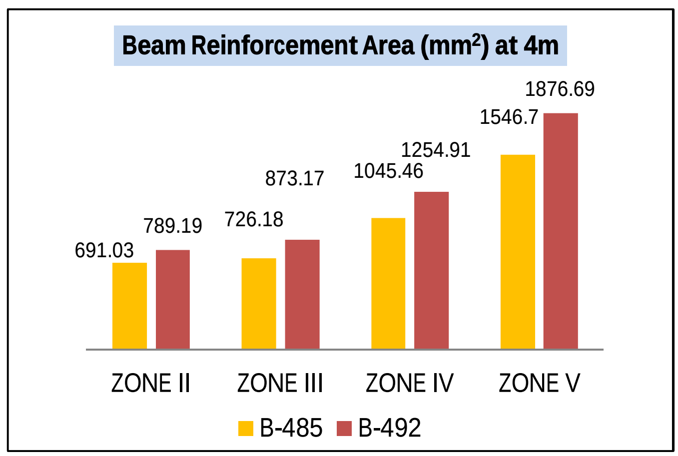


Fig. 3 Beam Reinforcement at Starting & End Section B-485 & B-492

3) Required Area of Reinforcement in Column section :-

Table 8 : Column Reinforcement at End Section

Zone	C-540	C-545
	Ast req mm^2	Ast req mm^2
II	1372	1403.23
III	1545.83	1591.30
IV	2162.98	2585.2
V	4454	5290

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue XII Dec 2024- Available at www.ijraset.com

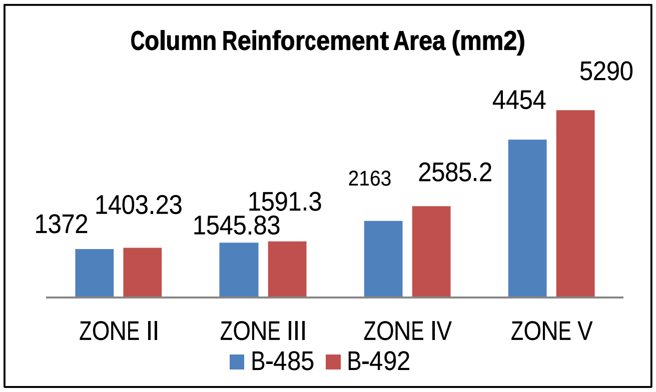


Fig..4 Column Reinforcement at End Section C-540 & C-545

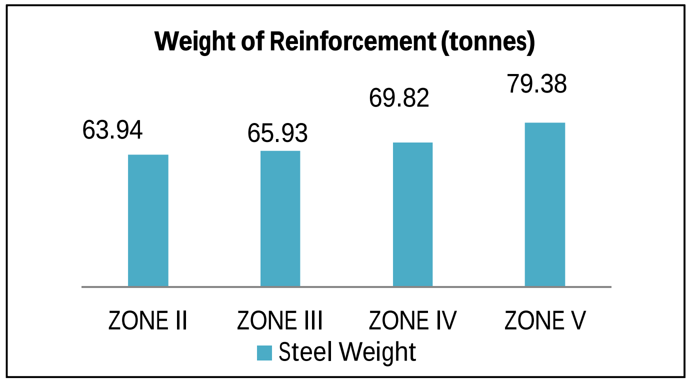


Fig..5 Weight of Reinforcement of Structure

D. Weight of Reinforcement :-

Reinforcing steel quantity of beams and columns is obtained by Staad pro

Table 9 : Weight of Reinforcement of Structure

Zone	Weight obtained by Staad Pro (kN)	Weight (tonnes)
II	627.25	63.94
III	646.77	65.93
IV	684.93	69.82
V	778.71	79.38

- Required area of reinforcement is increasing from seismic zone II to zone V.
- Area of reinforcement is more at start and end of section in top and bottom portion due to maximum positive and negative bending moment.
- Calculation of required areas of reinforcement is obtained by STAAD-Pro Connect Edition V22 for the Seismic zone II , zone III , zone IV and zone V
- Maximum area of steel required for flexural member in zone V for beam B-485 is 1865.33 mm^2 at starting and 1546.70 mm^2 at end Section .
- Maximum area of steel required for flexural member in zone V for beam B-492 is 1935.65 mm^2 at starting and 1876.69 mm^2 at end Section .
- Maximum area of steel required for compression member in zone V for column C-540 is 4454 mm^2 and column C-545 is 5290 mm^2.
- Maximum weight of steel in Zone V is 79.38 tonnes is obtained by STAAD-Pro Connect Edition V22.

VII. CONCLUSION

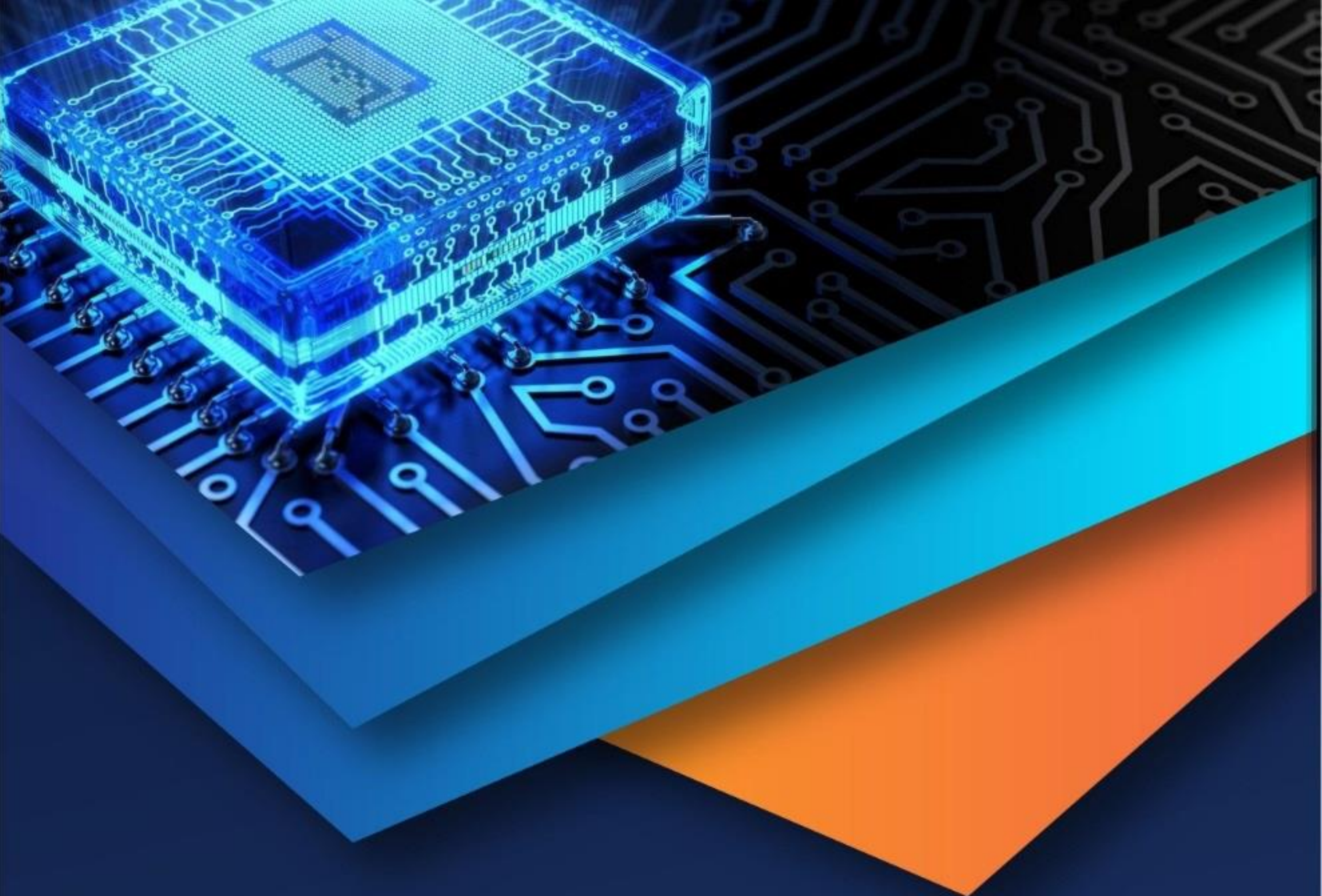
In this research our main aim is to compare area and weight of reinforcement in Seismic zone II , zone III , zone IV & zone V by providing shear wall at all corners in different positions of the building. The data revealed by STAAD-Pro Connect Edition V22 software using seismic coefficient method and various loading combinations following conclusions are obtained :-

1) Seismic analysis was done by Staad Pro software as per IS 1893-(Part 1) :2016 ..
2) Among all the load combinations, the load combination LC 1.5 (DL+LL), LC 1.5(DL+EQX), LC 0.9DL-1.5EQX, LC 0.9DL+1.5EQZ, LC 0.9DL-1.5EQZ are critical combination for all the seismic zone
3) Area of reinforcement is increased by 19.81%, 67.86%, 144.23% in zone III, IV and V respectively compare with respect to zone II in Beam B- 485 at starting section 0m for tension zone.

4) Area of reinforcement is increased by 5.08%, 51.29%, 123.82% in zone III, IV and V respectively compare with respect to zone II in Beam B- 485 at end section 4m for tension zone.
5) Area of reinforcement is increased by 12.67% , 57.65% 224.63% in zone III, IV and V respectively compare with respect to zone II at end section of column C- 540
6) Area of reinforcement is increased by 13.40% , 84.23 % , 276.98 % in zone III, IV and V respectively compare with respect to zone II at end section of column C- 545
7) Weight of reinforcement is increased by 3.11%, 9.20%,24.14% in zone III, IV and V respectively compare with respect to zone II for all the floor
8) Cost of the structure is increasing from zone II to zone V with respect to reinforcemenr required.

REFERENCES

[1] IS 875 (part-1)1987 "Code of Practice for Design Loads (Other Than Earthquake) For Building and Structures", Dead load.
[2] IS 875 (part-2)1987 "Code of Practice for Design Loads (Other Than Earthquake) For Building and Structures", Imposed loads.
[3] IS 1893:2016 (Part 1), "Criteria for Earthquake Resistant Design of Structures", Fifth revision, Bureau of Indian Standards.
[4] IS 456:2000, "Plain and Reinforced Concrete Code of Practice", Fourth revision, Bureau of Indian Standards.
[5] SP 16: 1980 (design aids for reinforced concrete to IS : 456: 2000
[6] IS 13920:2016 "Ductile detailing of reinforced concrete structures subjected to seismic forces" Code of practice.
[7] Rahangdale Himalee , Satone S.R., (2013) "Design And Analysis Of Multi-storeyed Building With Effect Of Shear Wall", International Journal of Engineering Research and Applications (IJERA), Vol. 3, Issue 3, May-Jun 2013.
[8] B. Srikanth, V.Ramesh, "Comparative Study of Seismic Response for Seismic Coefficient and Response Spectrum Methods", Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 3, Issue 5,Sep-Oct2013,pp.1919-1924.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY