Result Analysis of Multistorey Building by Using Response Spectrum Method for Floating Column

Prateek Kumar[1], Jitendra Singh Yadav[2]

[1]M.tech Scholar, Department of Civil Engineering, IES Institute of Technology & Management, Bhopal, MP, India
[2]Asst. Professor, Department of Civil Engineering, IES Institute of Technology & Management, Bhopal, MP, India

---***---

Abstract - *The aim was to obtain effective space utilization at the base of the building based on calculations of various parameters such as base shear, support reactions, bending moment etc. The modelling of structure and the analysis is carried out using Staad Pro. Software tool which shows the maximum and minimum values of above parameters in ZONE III and ZONE IV in addition with calculations are performed for the quantity of steel and concrete utilized. Also a comparative study is also performed from the results to find the best location of floating column. And seismic analyses for the RC building is done based on the Response Spectrum Method (RSM). From the results; the conclusions found that model 3 (+ shaped structure) showed the least value for displacement , support reaction, & bending moment compared to remaining models, whereas parameters for base shear was similar to other models.*

Key Words: seismic zone, floating column, base shear, bending moment etc.…

1. INTRODUCTION

Conventional civil engineering structures are planned on the idea of strength and stiffness criteria. Just in case of earthquake forces the demand is for ductility. Larger is that the capability of the structure to deform plastically while not collapse; additional is that the ensuing ductility and therefore the energy dissipation. This reasons decrease in effective earthquake forces. The performance of a building throughout earthquakes depends principally on its overall form, size and geometry, as well to however the earthquake forces are supported to the ground. The earthquake forces developed at completely different floor levels during a building ought to be brought down on the peak to the ground by the shortest path; any deviance or discontinuity for the duration of this load transfer path leads to poor performance of the building. Buildings that have smaller amount columns or walls during a precise construction or with unusually tall construction tend to loss or collapse that is introduced in this construction. India may be a developing country, wherever urbanization is at the quicker rate within the country like adopting the ways and sort of constructing buildings that is below vast development within the past few decades. As a part of urbanization multi-storey buildings with field complexities are forced to be made. These complexities are nothing however soft construction, floating column, heavy load, the reduction in stiffness, etc. currently a day's most of the urban multi-storey buildings have open initial storey as an inevitable feature. Accommodation of parking or reception lobbies is that the primary use of this open 1st story within the multistory buildings made. However standard civil engineering structures are designed on the idea of strength and stiffness criteria. Typically the ground construction is kept free with none constructions, except the columns that transfer the building weight to the ground. This research work implements the multi-storey building with a field difficulty. The complication of a multi-storey building with "Floating column" and hence the performance of the building in higher seismic areas is determined and assumed of some recommendations.

2. BACKGROUND

The result of variable the situation of floating columns floor wise and among the ground of multi storied RC building on numerous structural response numbers of the building using response spectrum analysis is planned within the software system ETABS 2015. The most objective here is to review the seismic response of building with floating columns and to search out the most appropriate configuration for providing floating columns. numerous parameters like total base shear force, story displacement, story drift, story acceleration of a building are studied with reference to totally different configurations of floating columns [1]. . Totally different cases of the building are studied by variable the situation of floating column and increasing the column size. The results showed that story displacement multiplied by 56.96% in floating column building compared to traditional building. Torsional irregularity was found once floating column was introduced unsymmetrically. it had been additionally found that elementary period of time was increasing in floating column building and lateral stiffness was decreasing in floating column building. Once the lost cross sectional space because of floating columns were distributed among ground floor columns then it had been found that story displacement additionally as elementary period of time decreased and lateral stiffness increased [2]. Focused on the outcome of the floating column position on multi storied RCC structures subjected to dynamic loads and also the building models are investigated by means of time history analysis with the idea that the structure are subjected to all the loads or full load during a single stretch once the entire structure is made fully [3]. The result of earthquake forces on numerous building models for numerous parameters is projected to be administered with the help of RSA (Response Spectrum Analysis). This work contains investigation of structure by using ETABS software system (Extended 3 Dimensional Analysis of Building Systems) [4]. Examined the results of the structural irregularity that is made by the separation of a column during a building affected to earthquake masses. During this paper static analysis and dynamic analysis using response spectrum methodology is completed for a multi-storied building with and while not floating columns. By variable of locations the various cases of building of floating column floor wise and among the ground. The structural response of the building representations with reference to elementary period of time, Spectral acceleration, Base shear, story drift and story displacements is studied. The investigation is administered using software STAAD pro V8i software [5].

3. METHODOLOGY

In this study, different location of floating column is used on seismic response in order to fix the generalized position of the structure where it can with stand the least chance of failure and mainly comprises of regular column placed in square shaped' T-shaped, L-shaped, plus-shaped for floating column. The complete results are carried out in Staad Pro. Software tool.

3.1 Steps of methodology

3.1.1 Selection of Study Area: Response spectrum on floating columns on multistory building was considered for the area of research and study.

3.1.2 Literature Review: The various type of previous work done by different researchers in the field of floating columns were studied and based on which information was collected.

3.1.3 Selection of Seismic Zones and Parameters: for this study seismic zones; ZONE III and ZONE IV has been taken.

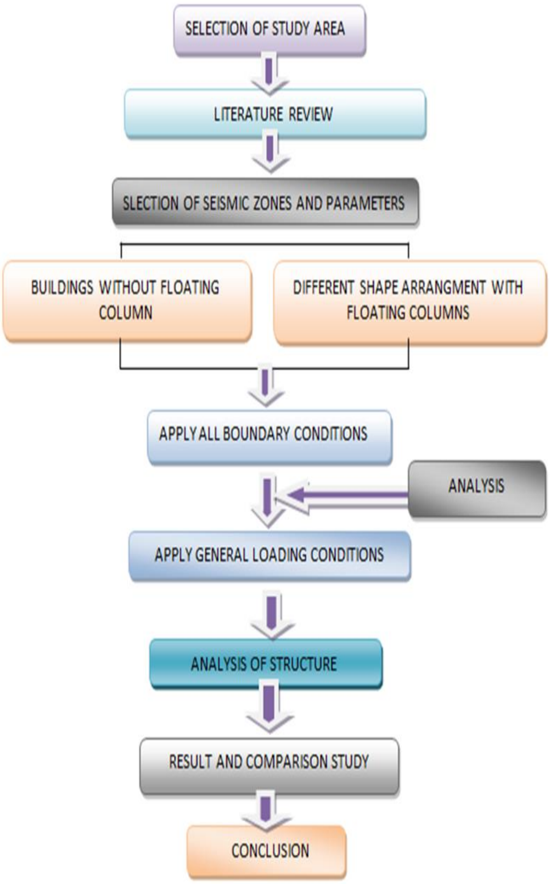

Fig-1: Flow chart of methodology

Below cases are considered in the analysis and following sequence has been followed to analyze them using STAAD PRO. In the Current Study four different structures were considered for the study purpose. All the considered structures are mentioned below:

1. 1ststructure: Square Shape Structure (Without Floating Column)
2. 2nd structure: L-Shaped Structure (Regular Columns Placed in L-Shape)
3. 3rd structure: Plus (+) Shaped Structure (Regular Columns Placed in Plus (+) Shape
4. 4th structure: T Shaped Structure (Regular Columns Placed in T-Shape)

Description of 1st Structure: Square Shape Structure (without Floating Column) shows fig.2

Description of 2nd Structure: L-Shaped Structure (Regular column placed in L-shape) shows fig.3

Description of 3rd Structure: Plus (+) Shaped Structure (Regular column placed in plus shape) shows fig.4

Description of 4th Structure: T Shaped Structure (Regular column placed in T-shape) shows fig.5

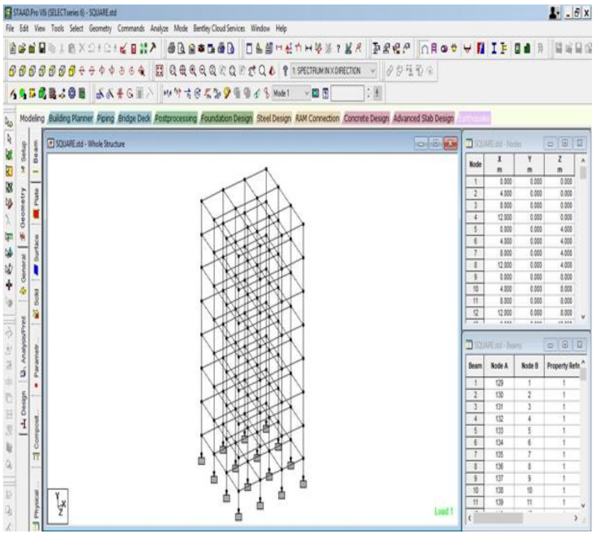

Fig-2: Geometry of Square Shape Model Structure

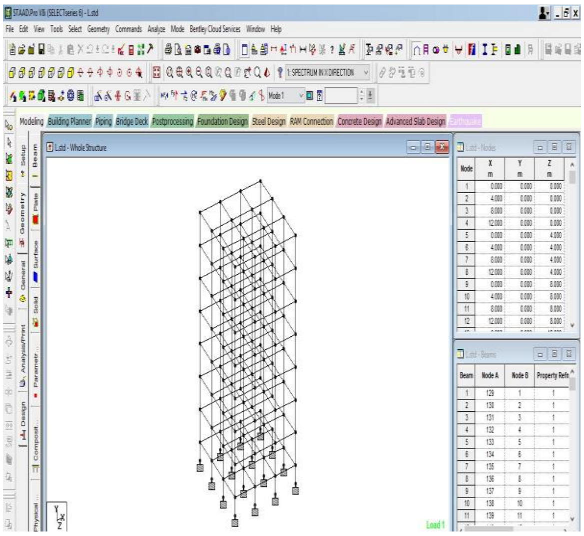

Fig-3: Geometry of L-Shaped Model Structure

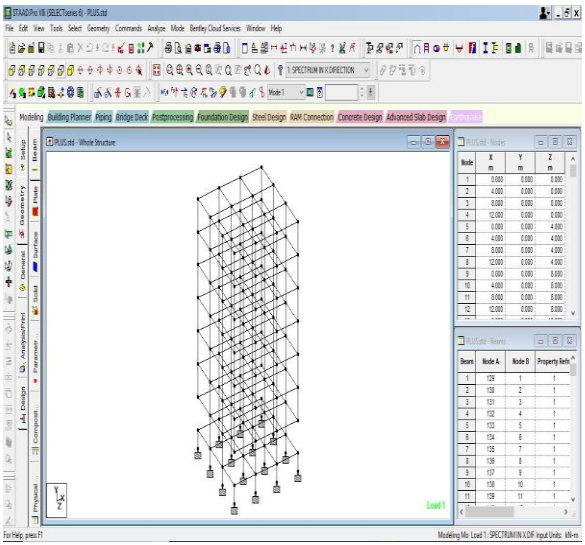

Fig-4: Geometry of Plus (+) Shaped Model Structure

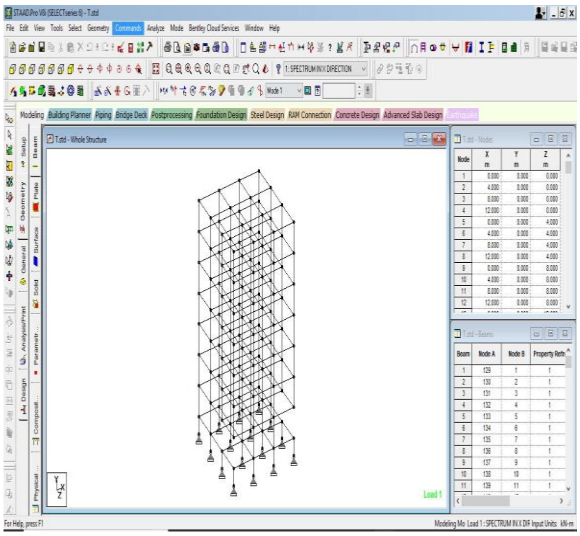

Fig-5: Geometry of T Shaped Model Structure

4. STRUCTURAL ANALYSIS: IMPLEMENTATION WORK

4.1 Structure Detail of the Plaza Building

At Plan area- (12x12) m^2
Span (center to center spacing)--4m
Column size-(0.65x0.55) m^2
Beam size-(0.5x0.4) m^2
Here whole study is distributed into two Zones (Zone3 and Zone4) and it is extra separated into building structure design.
Floor height up to (G+6) – 3.6m
Parapet height-1m
Depth of foundation- -1.8m
Support type- Fixed

4.2 Load Case Details

In the analysis of structure various types of loading conditions studied are given below

(1) STATIC LOAD
(a) Dead load (IS 875 Part1)

Dead loads are exterior loadings act vertically downward and arise because of self-load of the structure.
These consist of self-weight of beams columns, slabs floor finish wall load etc.
These are calculated by multiplying cross sectional area by their densities.
Densities of the following material are used:
Density of RCC member: 25 kN/m^3
Density of brick wall: 19.2kN/m^3

(i) Self weight of frame.
(ii) Member Load (Masonry full wall load) up to G+6: (19x0.2x3.2) + ((0.015+0.012)24+3.6) =14.49 kN/
(iii) Masonry roof wall load: (19.2x0.2x1) + ((0.015+0.012)24+3.6) = 4.45 kN/m^2
(iv) Floor condition (Considering 130mm thick slab): 25x0.13=3.25 kN/ m^2
(v) Floor Finish = 1.25 kN/ m^2
(b) Live load (IS875, Part II and IV)

The load which changes their position and magnitude and act vertically downward on the structure are called live load such as load on roof etc.

Live load in floor: 3 kN/ m^2

(c) Load combinations according to: (IS 1893 Part 2-2002)
Combination of loadings which may include dead load, live load and seismic load in X and Z direction given the total effect on structure are given below.

1) 1.5 (DL + IL)
2) 1.2 (DL + IL ± EL)
3) 1.5 (DL ± EL)
4) 0.9 DL ± 1.5 EL

(d) Seismic load (IS 1893:2002)

When ground motion is subjected to structure, structure responds in shaking fashion .The motion of structure in random in all possible direction and for analysis it is resolved in two directions horizontal(X) and vertical directions(Y).Because of this motion structure vibrate in all three directions.

The seismic force is evaluated as per IS1893:2002.
Here Zone III and Zone IV are selected with following details.

(i) Response Reduction factor: 5
(ii) Importance factor: 1
(iii) Damping: 5%
(iv) Soil type: Medium Soil

4.3 Load Case Details

Cases for Zone III

CASE1-(Seismic analysis of Square Shape Structure)
In this case seismic analysis of the Square Shape Structure building is performed using the software STAD-Pro having the values according to ZONE III Conditions.

CASE2- (Seismic analysis of L-Shaped Structure (Regular Columns Placed in L-Shape))
In this case seismic analysis is performed for the building having L-Shaped Structure (Regular Columns Placed in L-Shape) having the values according to ZONE III Conditions.

CASE3- (Seismic analysis of Plus (+) Shaped Structure (Regular Columns Placed in Plus (+) Shape) In this case seismic analysis is performed for the building having Plus (+) Shaped Structure (Regular Columns Placed in Plus (+) Shape) having the values according to ZONE III Conditions.

CASE4- (Seismic analysis of T Shaped Structure (Regular Columns Placed in T-Shape))
In this case seismic analysis is performed for the building having T Shaped Structure (Regular Columns Placed in T-Shape) having the values according to ZONE III Conditions.

Cases for Zone IV

CASE1-(Seismic analysis of Square Shape Structure)
In this case seismic analysis of the Square Shape Structure building is performed using the software STAD-Pro having the values according to ZONE IV Conditions.

CASE2- (Seismic analysis of L-Shaped Structure (Regular Columns Placed in L-Shape))
In this case seismic analysis is performed for the building having L-Shaped Structure (Regular Columns Placed in L-Shape) having the values according to ZONE IV Conditions.

CASE3- (Seismic analysis of Plus (+) Shaped Structure (Regular Columns Placed in Plus (+) Shape) In this case seismic analysis is performed for the building having Plus (+) Shaped Structure (Regular Columns Placed in Plus (+) Shape) having the values according to ZONE IV Conditions.

CASE4- (Seismic analysis of T Shaped Structure (Regular Columns Placed in T-Shape))
In this case seismic analysis is performed for the building having T Shaped Structure (Regular Columns Placed in T-Shape) having the values according to ZONE IV Conditions.

4.4 Structural Details

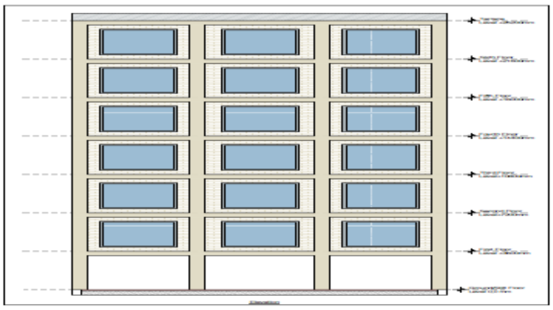

Fig-6: Elevation of building (G+6) considered in the study

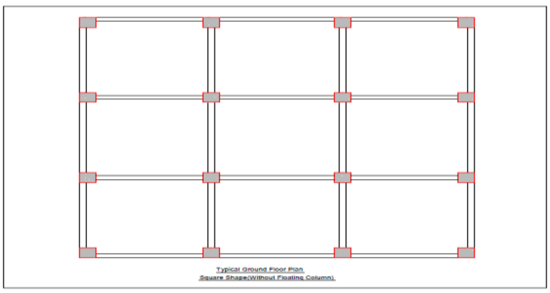

Fig-7: Typical floor plan of Square shape (Without Floating Column)

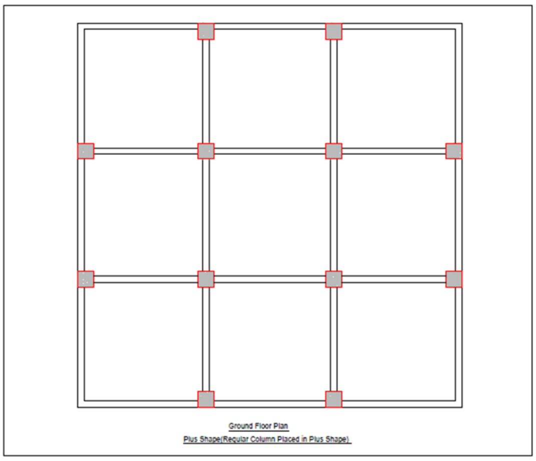

Fig.-8: Ground floor plan of Plus shape
(Regular Columns placed in Plus Shape)

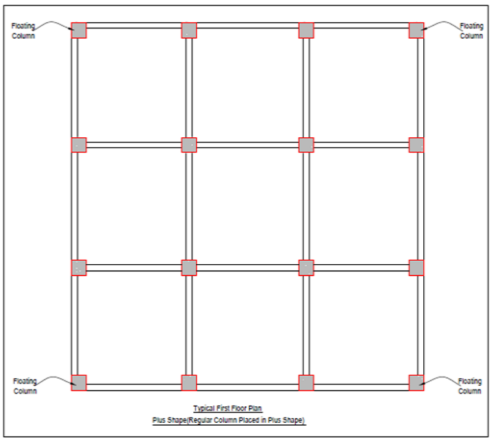

Fig-9: Typical First floor plan of Plus shape
(With Floating Column).

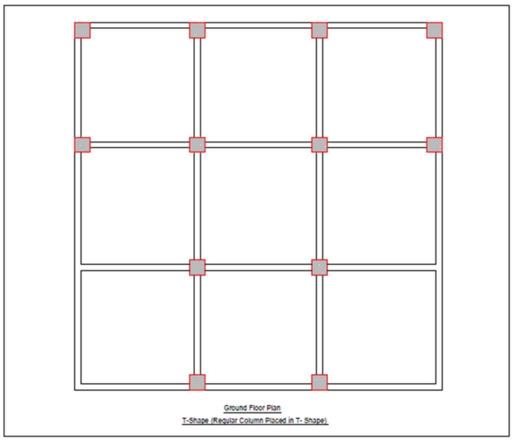

Fig-10: Ground floor plan of T-shape
(With Regular Columns placed in Plus Shape)

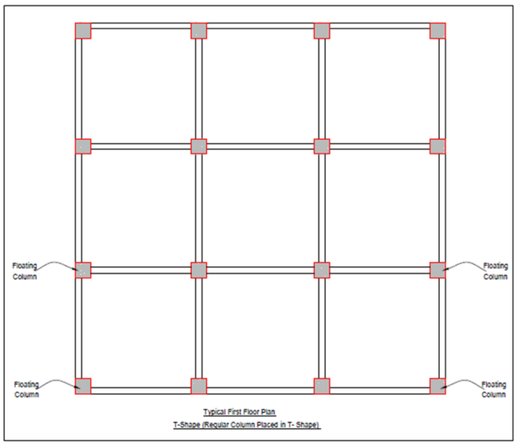

Fig-11: Typical First floor plan of T-shape
(With Floating Column)

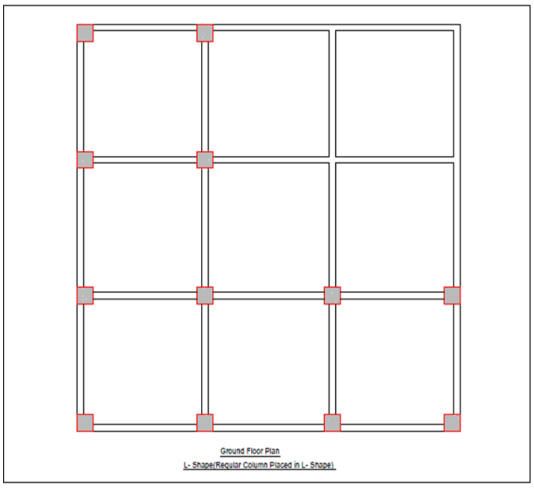

Fig.12 Ground floor plan of L-shape
(With Regular Columns placed in Plus Shape)

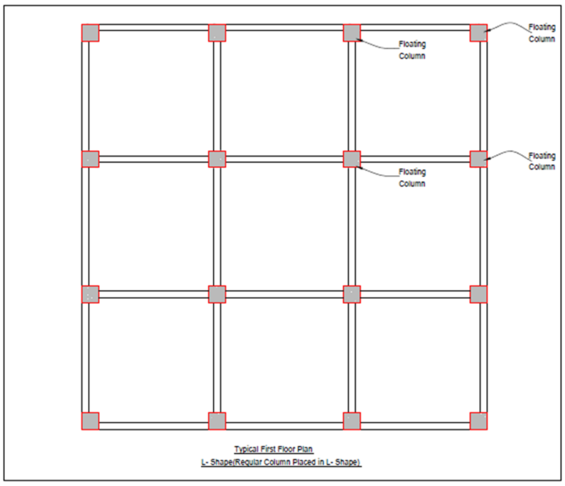

Fig.13 Typical First floor plan of L-shape
(With Floating Column)

5. RESULT

The result cases are plotted in terms of maximum support reaction, maximum bending moment, maximum base shear, maximum shear force, check for story drift, volume of concrete used and quantity of steel used with respect to ZONE III and ZONE IV.

Table-1 Max. Support Reaction

Structure Type	Zone III	ZONE IV
Square Shape Structure	2484 KN	2484KN
L-Shaped Structure (Regular Columns Placed in L-Shape)	5168 KN	5168 KN
Plus (+) Shaped Structure (Regular Columns Placed in Plus (+) Shape)	2609 KN	2609 KN
T Shaped Structure (Regular Columns Placed in T-Shape)	3421 KN	3421 KN

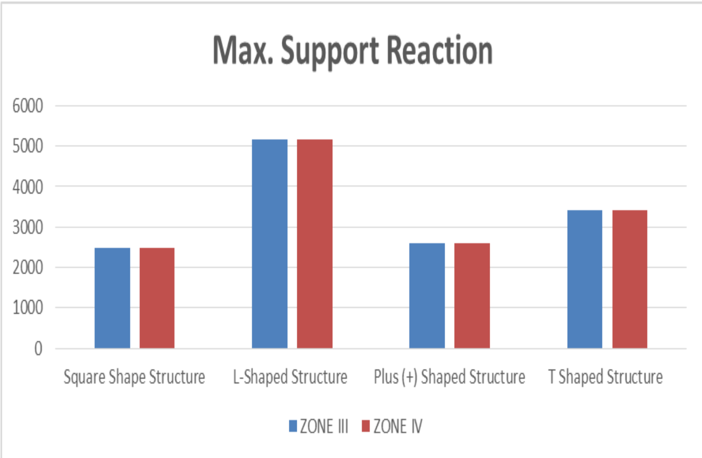

Chart-1: Max. Support Reaction for different structures in Zone III and Zone IV

Table-2: Max. Bending Moment

Structure Type	Zone III	ZONE IV
Square Shape Structure	238 KN/m	321 KN/m
L-Shaped Structure (Regular Columns Placed in L-Shape)	1288 KN/m	1366 KN/m
Plus (+) Shaped Structure (Regular Columns Placed in Plus (+) Shape)	447 KN/m	499 KN/m
T Shaped Structure (Regular Columns Placed in T-Shape)	702 KN/m	750 KN/m

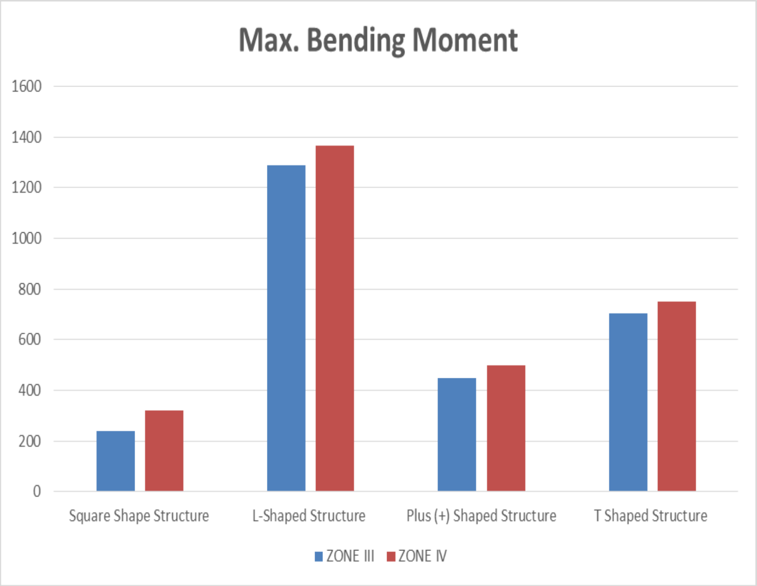

Chart-2: Max. Bending Moment for different structures in Zone III and Zone IV

Table-3: Max. Base Shear

Structure Type	Zone III	ZONE IV
Square Shape Structure	831.20 KN	1246.90 KN
L-Shaped Structure (Regular Columns Placed in L-Shape)	822.20 KN	1233.31 KN
Plus (+) Shaped Structure (Regular Columns Placed in Plus (+) Shape)	822.20 KN	1233.31 KN
T Shaped Structure (Regular Columns Placed in T-Shape)	822.20 KN	1233.31 KN

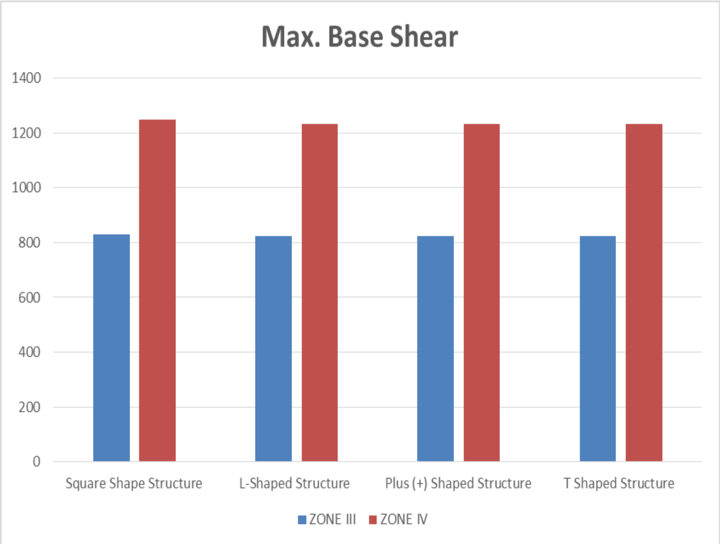

Chart-3: Max. Base Shear for different structures in Zone III and Zone IV

Table-4: Max. Shear Force

Structure Type	Zone III	ZONE IV
Square Shape Structure	171 KN	211 KN
L-Shaped Structure (Regular Columns Placed in L-Shape)	644 KN	679 KN
Plus (+) Shaped Structure (Regular Columns Placed in Plus (+) Shape)	268 KN	294 KN
T Shaped Structure (Regular Columns Placed in T-Shape)	394 KN	413 KN

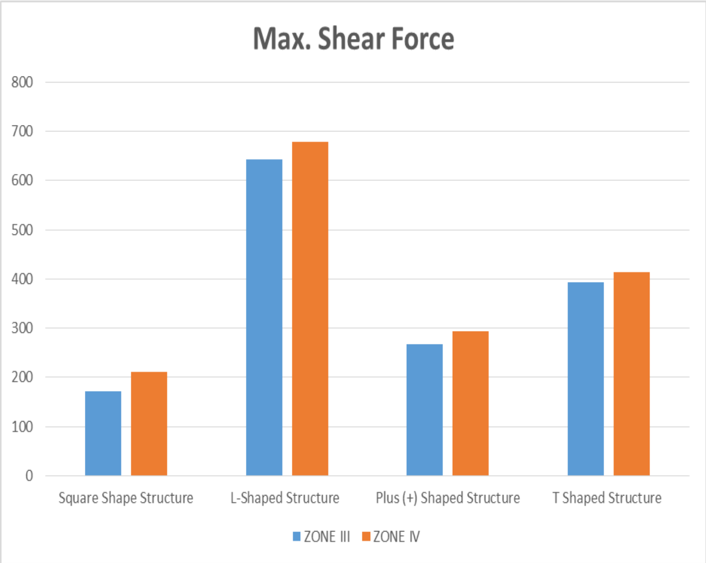

Chart-4 Max. Shear Force for different structures in Zone III and Zone IV

Table-5: Check for Story drift

Structure Type	Zone III	ZONE IV
Square Shape Structure	Pass	Pass
L-Shaped Structure (Regular Columns Placed in L-Shape)	Pass	Pass
Plus (+) Shaped Structure (Regular Columns Placed in Plus (+) Shape)	Pass	Pass
T Shaped Structure (Regular Columns Placed in T-Shape)	Pass	Pass

Table-6: Check for Soft Story

Structure Type	Zone III	ZONE IV
Square Shape Structure	ok	ok
L-Shaped Structure (Regular Columns Placed in L-Shape)	ok	ok
Plus (+) Shaped Structure (Regular Columns Placed in Plus (+) Shape)	ok	ok
T Shaped Structure (Regular Columns Placed in T-Shape)	ok	ok

Table-7: Volume of concrete (Cum)

Structure Type	Zone III	ZONE IV
Square Shape Structure	309.02 Cum	309.02 Cum
L-Shaped Structure (Regular Columns Placed in L-Shape)	296.7 Cum	304.0 Cum
Plus (+) Shaped Structure (Regular Columns Placed in Plus (+) Shape)	304.0 Cum	304.0 Cum
T Shaped Structure (Regular Columns Placed in T-Shape)	304.0 Cum	304.0 Cum

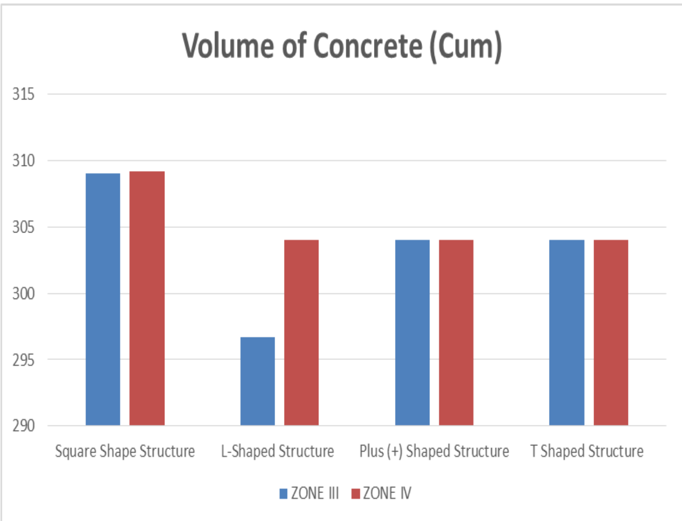

Chart-5: Max. Volume of Concrete for different structures in Zone III and Zone IV

Table-8: Quantity of Steel (Tonne)

Structure Type	Zone III	ZONE IV
Square Shape Structure	21.44 T	20.44 T
L-Shaped Structure (Regular Columns Placed in L-Shape)	29.65 T	23.78 T
Plus (+) Shaped Structure (Regular Columns Placed in Plus (+) Shape)	22.69 T	20.83 T
T Shaped Structure (Regular Columns Placed in T-Shape)	24.49 T	21.64 T

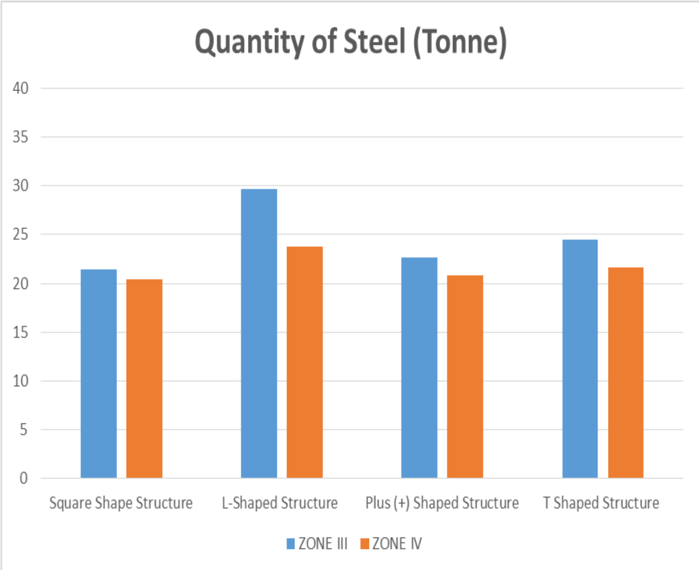

Chart-6: Max. Quantity for different structures in Zone III and Zone IV

6. CONCLUSIONS

From the above parameters analyzed in the work; the following set of conclusions are obtained:

For the cases discussed base shear is not much affected in Zone III and Zone IV and almost similar values are obtained in **Square Shape structure**, **L-Shaped Structure** (Regular Columns Placed in L-Shape), **Plus (+) Shaped Structure** (Regular Columns Placed in Plus (+) Shape), **T Shaped Structure** (Regular Columns Placed in T-Shape). In Zone III Max. Support Reaction is obtained for **L-Shaped Structure** (Regular Columns Placed in L-Shape) and Minimum for **Square Shape structure**. In Zone IV Max. Support Reaction is obtained for **L-Shaped Structure** (Regular Columns Placed in L-Shape) and Minimum for **Square Shape structure**. The values of Max. Support Reaction is higher in Asymmetric structures and lower in symmetric structures.

The findings of above study discussed values of maximum bending moments in seismic ZONE IV are higher than in seismic ZONE III. Max. Bending stress for Zone III during seismic analysis is obtained for **L-Shaped Structure** (Regular Columns Placed in L-Shape) and Min. for **Square Shape Structure.** Max. Bending stress for Zone IV during seismic analysis is obtained for **L-Shaped Structure** (Regular Columns Placed in L-Shape) and Min. for **Square Shape Structure.** The values of maximum bending moments for the structures without floating columns are lesser than the structures with floating columns.

REFERENCES

[1] Prasannan P. and Mathew A., "Seismic Performance of RC Floating Column Considering Different Configurations," Int. J. Eng. Res. Technol., vol. 6, no. 05, pp. 100–108, 2017.

[2] Maitra K. and Serker N. H. M. K., "Evaluation of Seismic Performance of Floating Column Building," vol. 6, no. 2, pp. 55–59, 2018.

[3] Udaygowda M. L. and Karthik S., "Effect Of Floating Column Position On Multi Storied RCC Structure Subjected To Dynamic Load," pp. 162–171, 2018.

[4] Chaudhari A. N. and Talikoti R. S., "Study of Seismic Behavior of Building with Different Positions and Types of Floating Column," vol. 7, no. 7, pp. 14056–14063, 2017.

[5] Ashwini M., "Comparison Of Buildings With And Without Floating Columns By Using Staad Pro," vol. 04, no. 14, pp. 1184–1187, 2017.

[6] M. W. S.B et al., "Comparative Study of floating column of multi storey building by using software," Int. J. Eng. Res. Appl., vol. 7, no. 1, pp. 31–38, 2017.

[7] Patel T., Gadhiya J., and Bhatt A., "Effect of floating column on RCC building with and without infill wall subjected seismic force," vol. 47, no. 4, pp. 206–212, 2017.

[8] K V. K. and Rajeeva S. V, "Seismic Behavior Of RC And Steel-Concrete Composite Multi-Storey Building With Floating Columns With And Without Shear Walls," pp. 104–111, 2017.

[9] Bhoyar S. A., "Effect Of Floating Column On Building Performance Subjected To Lateral Load," vol. 1, no. 2, pp. 134–143, 2017.

[10] Reddy T. A., "Comparative Seismic Study on Strengthening," no. 5, pp. 65–71, 2016.

[11] Sharma R. K. and Shelke N. L., "Dynamic Analysis of RCC Frame Structure with floating Column," vol. 3, no. 6, pp. 2302–2308, 2016.

[12] Bhavya B. S. and Jisha P., "Seismic Evaluation of RC Unsymmetrical Building with Floating Columns & Soft storey considering Different Configuration," pp. 15456–15465, 2016.

[13] Kumar G. V., "Seismic Analysis of Multistorey Building," vol. 3, no. 6, pp. 6–10, 2016.

[14] Motghare M. P. D., "Numerical Studies of RCC Frame With Different," no. 1, pp. 8–13, 2016