iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VII **Month of publication:** July 2023

DOI: https://doi.org/10.22214/ijraset.2023.54755

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VII Jul 2023- Available at www.ijraset.com

Study on Reinforced Concrete Building with and without Floating Column Configurations under Earthquake Loading

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Abstract: In the present scenario, due to a lack of available space and an increase in population, open space is typically designated on the bottom level of multi-story buildings (both residential and commercial) for parking, gathering spaces, or theatre uses in the current situation. Floating columns were developed to meet the demand for big open areas with little or little usage of columns. Columns without a foundation are known as floating columns since they rely on beams. Since these columns provide a continuous channel for weight transmission, they are regarded as being unstable during an earthquake. Throughout the study, multiple writers examine various floating column designs. For various seismic zonal zones, their impact on the structure is compared to structures without floating columns, and the safest arrangement is determined.
Keywords- Floating Column., Storey Drift, Storey Shear, Storey Displacement, Equivalent Static Analysis.

I. INTRODUCTION

A column is intended to be a vertical element that transfers weight to the earth from the foundation level up. The floating column is a vertical member as well, but it begins at the lower story level and is unable to carry the weight all the way to the foundation. It is supported by a transfer beam, which transmits stresses to the column underneath it. Standard civil engineering structures are created using stiffness and strength standards. The need for ductility arises in the event of seismic forces. Greater the structure's ability to flex plastically without collapsing, the more ductility and energy is dissipated as a result. The result is a decrease in the power of an earthquake.

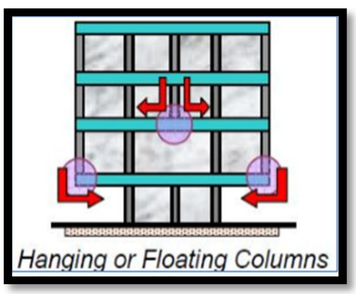


Fig 1: Floating Columns

A. Floating Columns

The floating column is a vertical member which rest on a beam and doesn’t have a foundation. The floating column act as a point load on the beam and this beam transfers the load to the columns below it.

B. Transfer Beam

In Frame as load carrying system when column is not allowed to continue downward due to some restriction, problem is resolved by using transfer beam. A transfer beam carries the load of an especially heavy load, typically a column. It is used to transfer the load of a column above to two separate columns below. This is often needed in cases where you need different or larger column spacing. One example where we often see transfer beams is in high rise buildings. These buildings often have retail spaces and parking garages at the lower levels and residential or office units on the upper levels. At the transfer beam , the column applies point load which is then transferred to the columns below (generally having larger cross section).

II. IRREGULARITIES

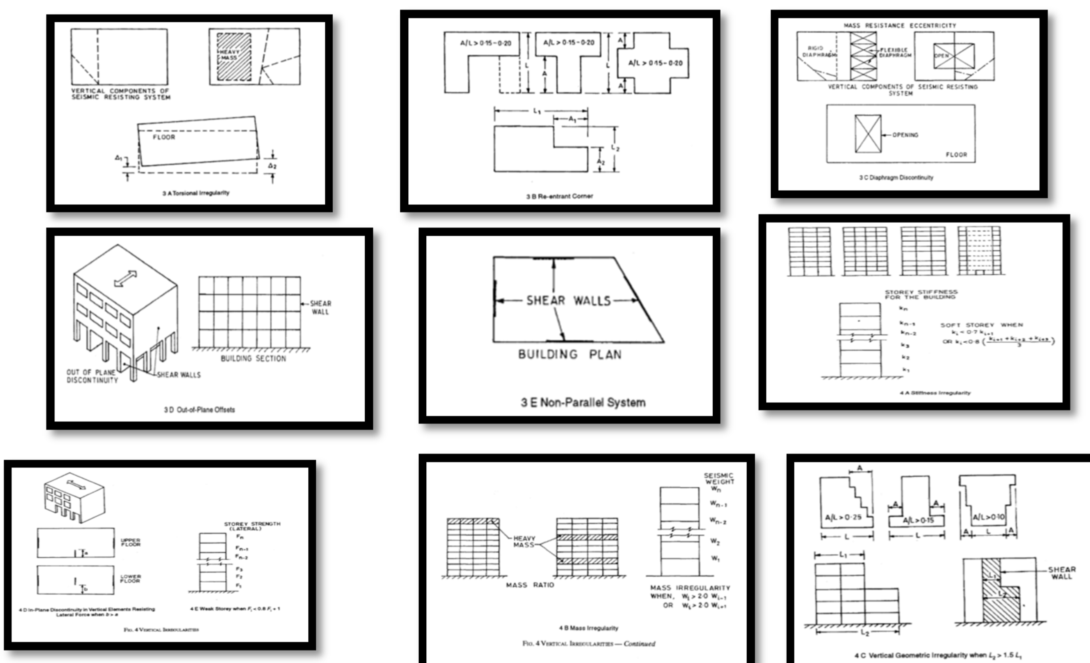
A. Plan Irregularity

1) *Torsion Irregularity:* Torsional irregularity to be considered to exist when the maximum storey drift, computed with design eccentricity, at one end of the structures transverse to an axis is more than 1.2 times the average of the storey drifts at the two ends of the structure.
2) *Re-entrant Corners:* Plan configurations of a structure and its lateral force resisting system contain re-entrant corners, where both projections of the structure beyond the re-entrant corner are greater than 15 percent of its plan dimension in the given direction.
3) *Diaphragm Discontinuity:* Diaphragms with abrupt discontinuities or variations in stiffness, including those having cut-out or open areas greater than 50 percent of the gross enclosed diaphragm area, or changes in effective diaphragm stiffness of more than 50 percent from one storey to the next.
4) *Out-of-Plane Offsets:* Discontinuities in a lateral force resistance path, such as out-of-plane offsets of vertical elements.
5) *Non-Parallel Systems:* The vertical elements resisting the lateral force are not parallel to or symmetric about the major orthogonal axes or the lateral force resisting elements.

B. Vertical Irregularities

1) *Stiffness Irregularity:* Soft storey: A soft storey is one in which the lateral stiffness is less than 70% of that in the storey above or less than 80% of the average lateral stiffness of the three storeys above. Extreme Soft Storey: An extreme soft storey is one in which the lateral stiffness is less than 60% of that in the storey above or less than 70% of the average stiffness of the three storeys above. For example, buildings on stilts will fall under this category.
2) *Mass Irregularity:* Mass irregularities are considered to exist where the effective mass of any storey is more than 150% of effective mass of an adjacent storey.
3) *Vertical Geometric Irregularity:* Geometric irregularity exists, when the horizontal dimension of the lateral force resisting system in any storey is more than 150% of that in an adjacent storey.
4) *Discontinuity in Capacity:* Weak Storey: A weak storey is one in which the storey lateral strength is less than 80% of that in the storey above, the storey lateral strength is the total strength of all seismic force-resisting elements sharing the storey shear in the considered direction.
5) *In-Plane Discontinuity:* An in-Vertical Elements Resisting Lateral Force An in-plane offset of the lateral force resisting elements greater than the length of those elements.

Illustrative diagrams for the above irregularities are shown in the following pictures.



III. OBJECTIVE

A thorough examination of the floating columns' many characteristics is done in the review paper. The main topic of this study is how to best arrange floating columns in a building from the standpoint of structural strength. These are the objectives of this paper:

1) Study of various configurations of floating columns in a building.
2) Analyse both structures by Linear Static Analysis using ETABS.
3) Compare the responses of building with floating columns and building without floating columns.
4) Make a comparison of storey drift, storey shear and storey displacement for buildings with and without floating columns.

IV. LITERATURE REVIEW

Shiwli Roy et al. in August 2021 performed analysis on “Comparative studies of Floating Column of different multistoried building” studied about the floating columns in different multistoried buildings. Floating columns in G+3 , G+5 and G+10 structures were analyzed. Comparison was done on bending moment and shear force between these structures. Analysis of the frame structures was done on STAAD PRO V8i.

Isha Rohilla et al. 2021 carried out a “Seismic Response of Multi-storey Irregular Building with Floating Column”. In this paper, the critical position of floating column in vertically irregular buildings was discussed for G+5 and G+7 RC buildings for zone II and zone V. medium soil conditions were used for analysis. Also the effect of size of beams and columns carrying the load of floating column had been assessed. The response of building such as storey drift, storey displacement and storey shear had been found. To evaluate the results ETABS software was used. From the analysis the author concluded that: Floating columns should be avoided in high rise building in zone 5 because of its poor performance while they are safe in zone2. Storey displacement and storey drift increases due to presence of floating column. Storey shear decreases in presence of floating column because of reduction mass of column in structure. Increase in size of beams and columns improve the performance of building with floating column by reducing the values of storey displacement and storey drift. Increasing dimensions of beams and columns of only one floor does not decrease storey displacement and storey drift in upper floors so dimensions should be increased in two consecutive floors for better performance of building.

Umesh Patil et al. in July 2020, did a “Seismic Analysis of G+5 Framed Structures with and Without Floating Columns Using ETABS-2013 Software”. In the paper G+5 storey RCC structure was considered for earthquake analysis. For comparison three models were used, one with normal structure, second with shear walls and third with masonry infill walls. Three methods Equivalent static method, response spectrum and time history method were used for analysis using ETABS2013 Software. The structure was assumed to be situated in earthquake Zone III on a medium soil(type II). The parameters evaluated were Base shear, Storey drift and Displacement. Out of all the three methods used to evaluate base shear and storey drift ,Multi-storey building with shear walls has performed exceedingly well when compared with normal multi-storey and shear walls. While in case of displacement, building with masonry infill walls has performed better.

Prerna Nautiyal et al. in February 2020, performed “Seismic Response Evaluation of RC frame building with Floating Column considering different Soil Conditions”. .This paper aims to study the effect of a floating column under earthquake excitation for various soil conditions. Also there is no provision or magnification factor specified in I.S. Code, hence the determination of such factors for safe and economical design of a building having floating column. Linear Dynamic Analysis is done for 2D multi storey frame with and without floating column to achieve the above aims. For the analysis purpose two models have been considered as: Model A: Four storied (G+3) special Moment Resisting Frame (Case 1) Model B: Six storied (G+5) special Moment Resisting Frame.

Y.Abhinay et al. 2019 made a “Comparison of Seismic Analysis of a Floating Column Building and a Normal Building”. In the analysis, residential buildings with 6 Storeys and 12 Storeys are analyzed with column, Beams & Slabs. The buildings are analyzed & designed with and without edge columns at base storey. The Buildings are analyzed in two earthquake zones III and V according to IS 1893-2002 with soil type I and III. Static Load combinations and Response Spectrum Analysis is done to compare the results. Results are compared in the form of Storey displacements, Storey Shear, Storey Over turning Moments with & without columns at base storey in both Static and Dynamic Analysis. ETABS 2013 has been utilized for analyzing the above Building Structure. Zone wise results are presented using tables and graphs. Three cases were made , Case 1: Normal building without floating column, Case 2:Building with floating column, Case 3: Building with floating column and with changed dimensions of beams and columns. It was found that the displacement, shear and moment is more when the floating column is provided to reduce the displacement the section properties of the building are changed for better performance. Floating column building will suffer extreme soft storey effect. So the Floating column building is unsafe. After the analysis of buildings, comparison of quantity of steel and concrete are calculated from which it is to be identified that floating column building with change in dimensions has 40 % more quantity of rebar steel and 42 % more concrete quantity than Normal building. So the Floating column building is uneconomical to that of a Normal building.

SK. Abdul Rehman et al. in March 2018 performed a "Seismic Analysis of Framed Structures with and without Floating Columns" . A G+5 modeled framed structure was assumed in earthquake zone III.

In the first model , no floating columns were kept while in the second model, floating column was introduced at the ground floor. On ETABS software, equivalent static method , response spectrum method and time history method observations for base shear , storey drift and displacement were found out . The results were compared using Bar Graphs. Analysis found that buildings with floating column are not safe under earthquake loading.

Shehal Ashok Bhoyar et al. in 2017 carried an analysis on "Effect of Floating Column on Building Performance subjected to Lateral Load" on a framed structure of G+5 regular and irregular plan with and without floating columns .This project is only focused on the corner floating columns. This was done for external lateral forces .Using ETABS , shear base , story drift and lateral displacement of both the buildings were compared . The method adopted for above analysis is equivalent static method. It was found the buildings with floating column (both regular and irregular) are more prone to failure. Performance of the building varies to according to position and orientation of floating column.

Ms. Waykule S.B. et al. in January 2017, performed an analysis of "Comparative Study of Floating Column of multi storey building by using software". In this paper , analysis of G+5 building is done with and without floating column in highly seismic zone for hard soil . Linear static method and time history methods were carried out to compare the result between both models . From linear static method , time period , base shear , storey displacement , storey drift were calculated . With the help of time history , response of all the models were plotted using SAP 2000 V17 software .4 models are created such that floating column were created at 1st ,2nd ,3rd floor building and without floating column building .It was observed that as the floating column shifts from 1st storey towards the top , time period , base shear , storey drift and storey displacement is increased.

Trupanshu Patel et al. in May 2017 performed "Effect of floating column on RCC building with and without infill wall subjected to seismic force". Author the behavior of G+3 building with floating column. The entire work consisted of 29 models, modeled and analyzed using SAP 2000. Analysis was done for the location of Surat city which belongs to zone III, medium soil condition. The 29 models were divided into 4 categories : a) Model 1: without floating column and infill walls. b) Floating columns at corner, internal and center locations of GF, FF, SF. c) Increment in live load on ¼ portion of typical floor above the discontinued columns on the corner, internal and centre floating columns at GF, FF, SF. d)Similar as model 1-10 with infill walls.

Bhavya BS et al. in 2016, performed an analysis of "Reinforced Concrete unsymmetrical building with Floating Columns and Soft Storey considering different configuration" on a G+7 structure situated in seismic zone III and V on a medium soil (type II). The plan was remodeled into 12 different models . Equivalent seismic analysis and Response Spectrum Method were used for analysis by ETABS 15.2.0 software. The effect of shear wall , infill walls with diagonal structure and bracings were introduced in the building to improve the seismic performance of building along with floating column in seismic areas. The results found that the displacement and storey shear of building increases from lower zones to higher zones. Storey shear reduces in the building with floating column. The building with shear wall configuration exhibits more stiffness compared to other models. On comparison with other configurations, building with shear wall is much preferred.

KV. Sudheer et al. in 2015, carried the "Design and Analysis a high rise building with and without Floating Column". A 16 storey building is analyzed for storey shear , lateral displacement and storey drift using ETABS . Floating columns were introduced from 11th storey . By applying various loads and combinations study is done to find out whether the structure is safe or not . Extreme storey drift was calculated at 5th and 6th stories of the building also floating column building was found uneconomical.

V. MODELLING

A. Equivalent Static Analysis

The methodology worked out to achieve the above-mentioned objectives is as follows:

1) Review of the existing literature and IS Code 1893:2002(Part 1) code provision for designing the building was done.
2) A symmetrical regular building layout was made
3) The plan was defined with columns.
4) The plan was re-modified with floating columns and new sizes of beams and columns were introduced in the second model to obtain two configurations as below:

Table 5.1

Floating Column	0.3m x0.45m
Transfer beam	0.3m x0.6m
Columns below floating column	0.3m x0.6m

5) The configured plans were modeled using ETABS, two different models wereobtained.
6) The models will then be analysed for seismic load by Linear Static Analysis.
7) Story drift, Story displacement, Story shear were reported in tabulated form.
8) Comparative results are shown for both the buildings with and withoutfloating columns.

B. Response Spectrum Analysis

The methodology worked out to achieve the above mentioned objectives is as follows:
1) Review of the existing literature and IS Code 1893:2002 (Part1) codeprovision for designing the building.
2) An asymmetrical irregular building layout was made.
3) The plan was defined with columns.

The plan was re-modified with floating columns and new sizes of beams andcolumns were introduced to obtain 4 configurations as shown in table below.

Table 5.2

Floating Column	0.3m x0.5 m
Transfer beam	0.5m x0.8 m
Columns below floating column	0.5m x1 m
Columns throughout the building	0.3m x0.6 m
Beams throughout the building	0.3m x0.6 m

a) The configured plans were modeled using ETABS, 4 different models wereobtained.
b) The models will then be analysed for seismic load by Linear DynamicAnalysis.
c) Storey Drift, Storey Shear, Base shear, Storey Displacement was calculated byResponse Spectrum Method in ETABS 2015.
d) Comparative study of the results would be obtained which will show the safestconfiguration among all.

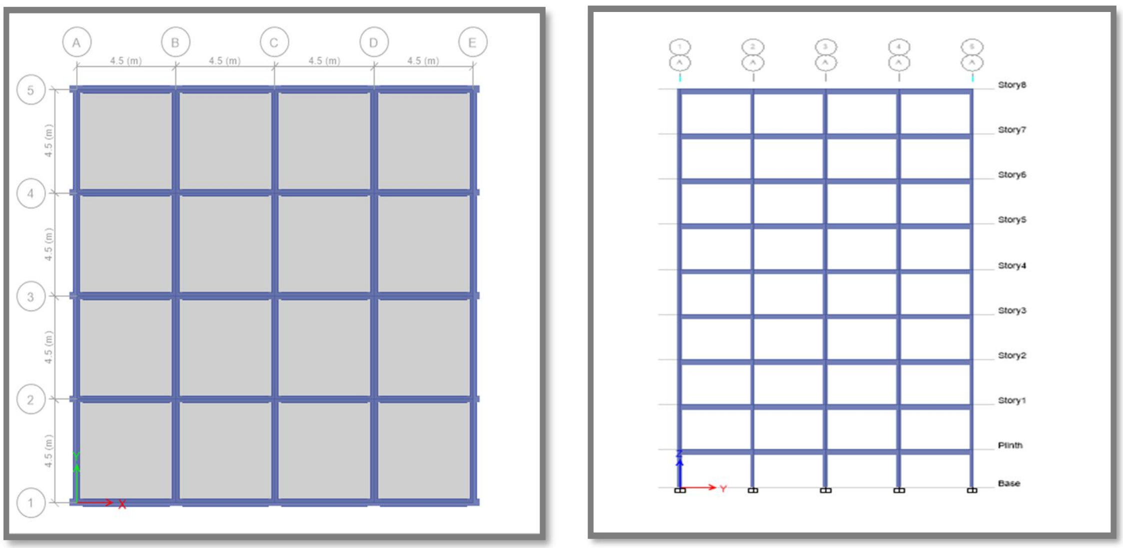
VI. DETAILS OF THE STRUCTURE

A. Regular Building

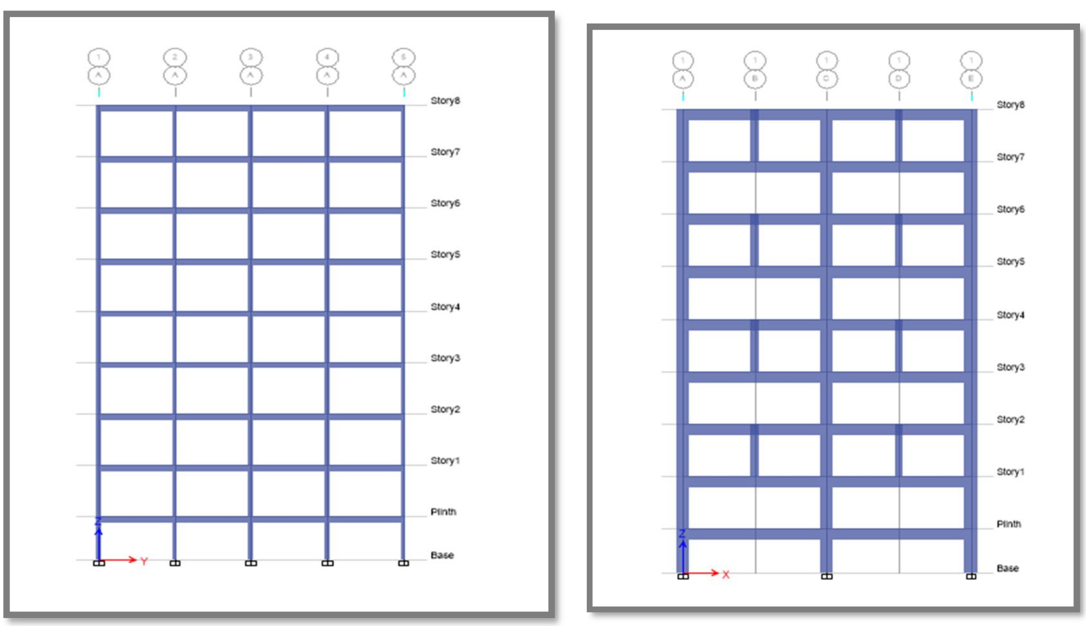
Table 5.3

Building Dimensions	18m x18m
Height of the building	29.25m
Storey Height	3.6m
C/C Distance between columns	4.5m
Grade of Concrete used	M30
Grade of steel used	HYSD500
Size of Columns	0.3x0.6m
Size of floating columns	0.3x0.45m
Size of beams	0.3x0.6m
Depth of slab	200mm
Thickness of external walls	0.20 m
Thickness of internal walls	0.12 m

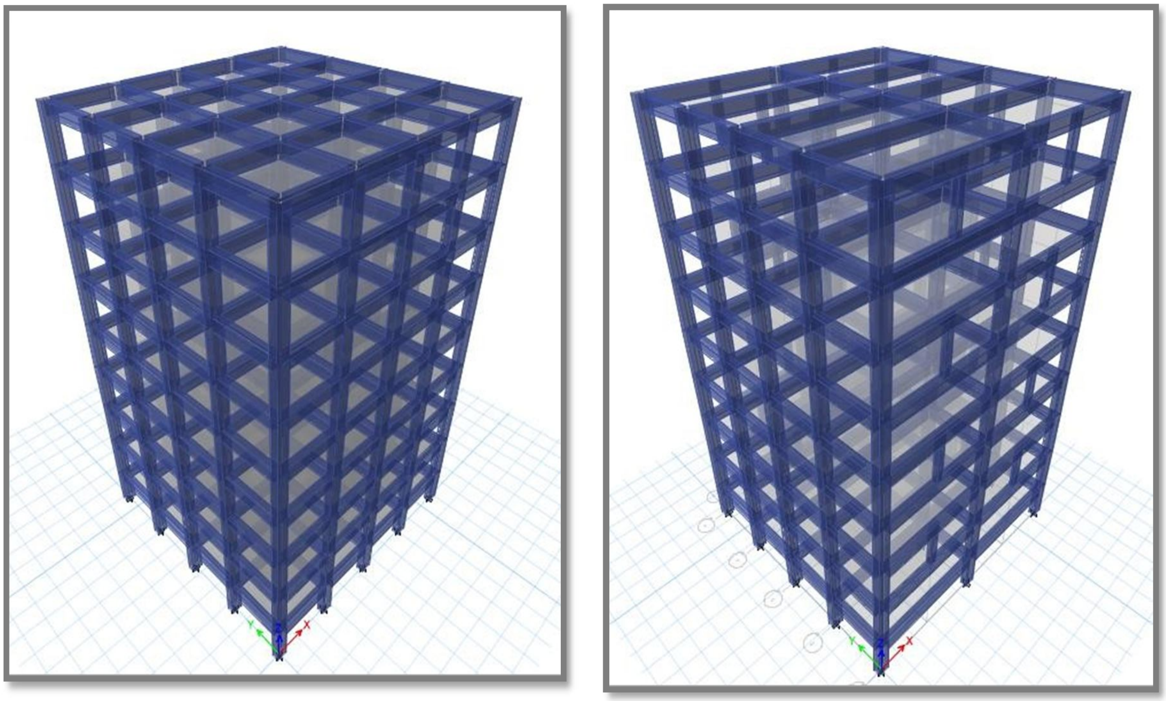
Soil type	III
Seismic Zone	V
Importance Factor	1
Dead load on slab	5 KN/m2
Live load on slab	4 KN/m2
Wall load on external beams	14.4 KN/m
Wall load on internal beams	8.64 KN/m
Type Of Building	Office Building



The plan and elevation of Model 1. No Floating Columns are provided



The plan and elevation of Model 2. Floating Columns areprovided at alternate stories



3-D view of both the Models

V. RESULTS AND DISCUSSIONS

A. Graphical Representation of Results of Equivalent Static Analysis

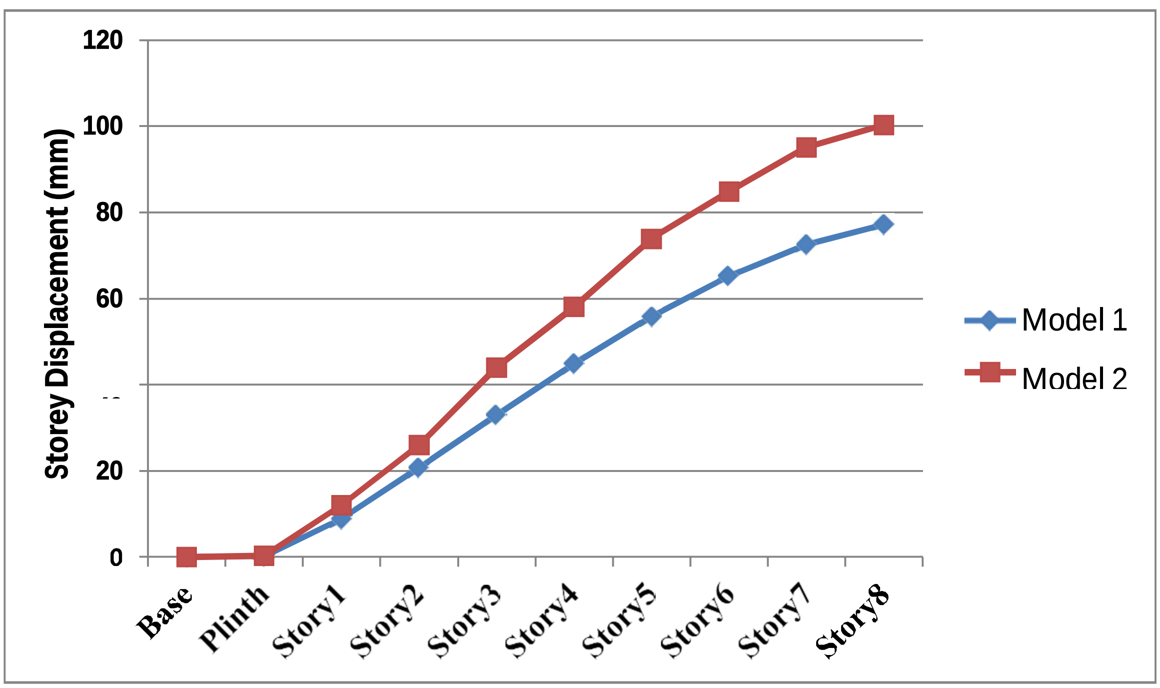


Fig 6.1 Storey Displacement in X-Direction

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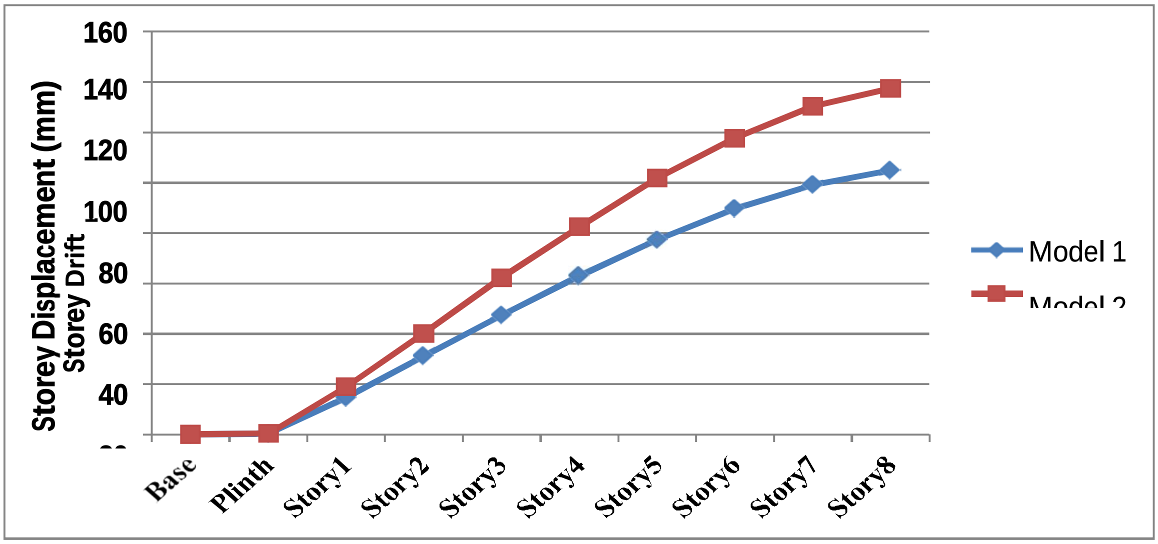


Fig 6.2 Storey Displacement in Y-Direction

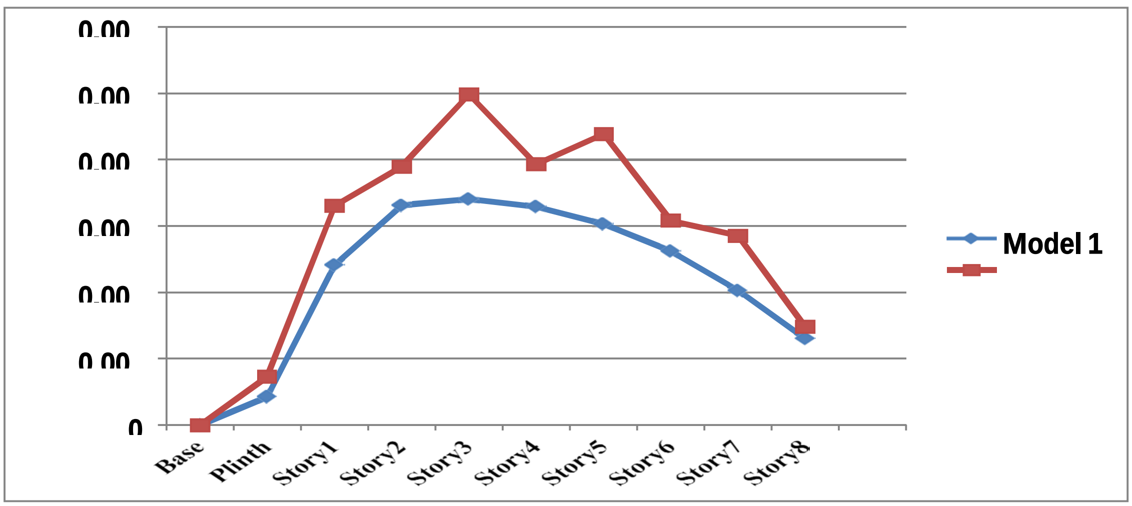


Fig 6.3 Storey Drift in X-Direction

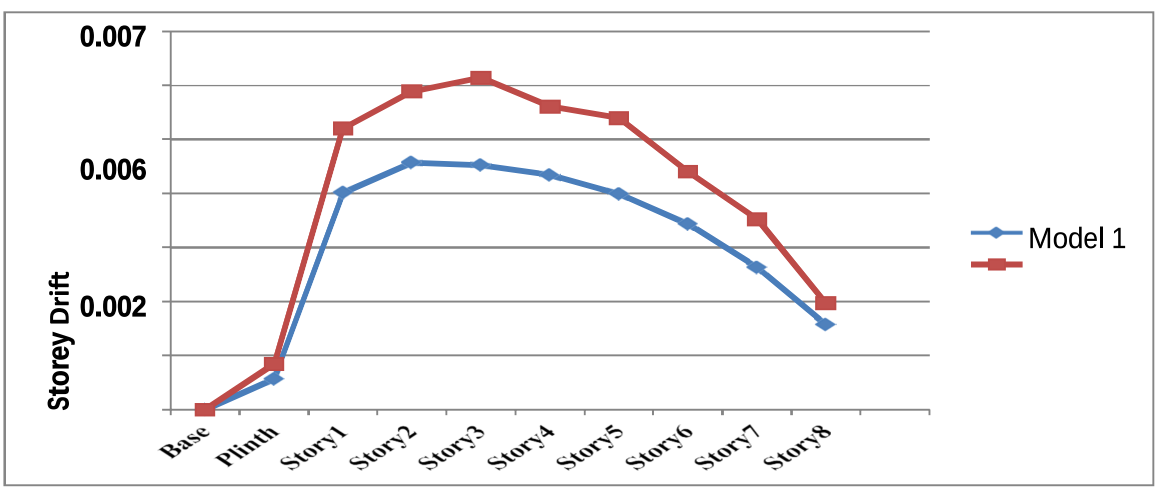


Fig 6.4 Storey Drift in Y-Direction

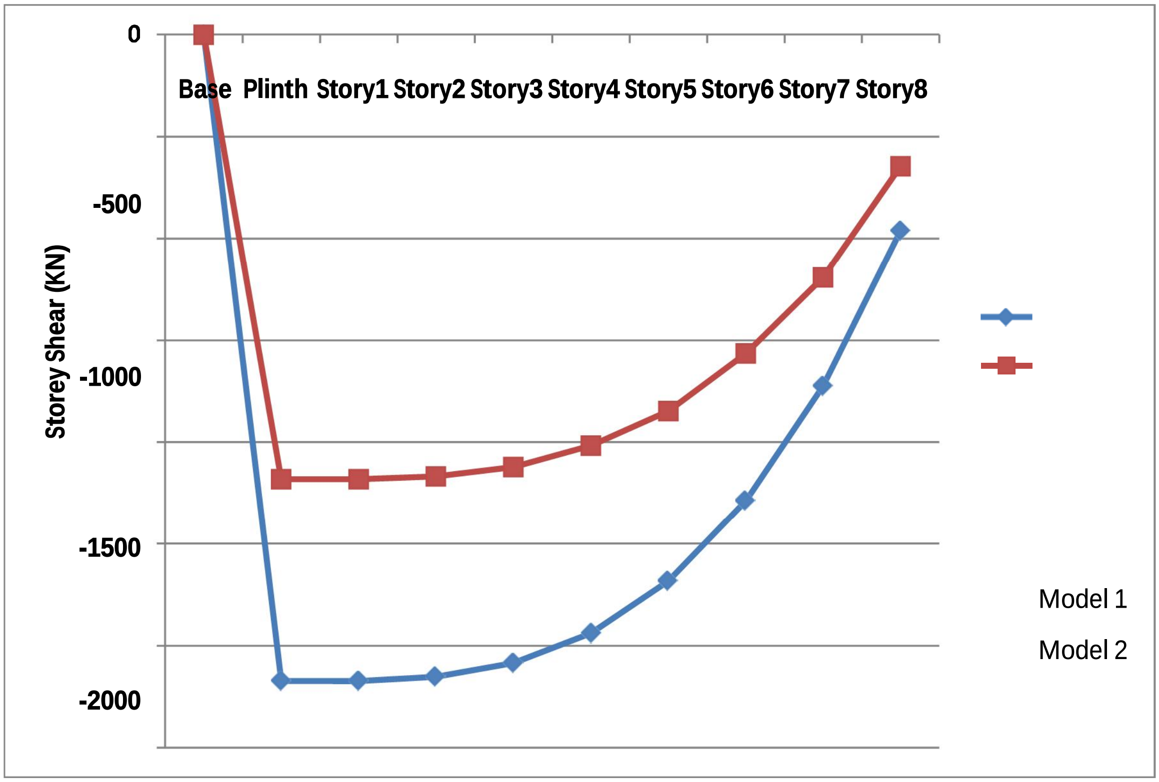


Fig 6.5 Storey Shear in X-Direction

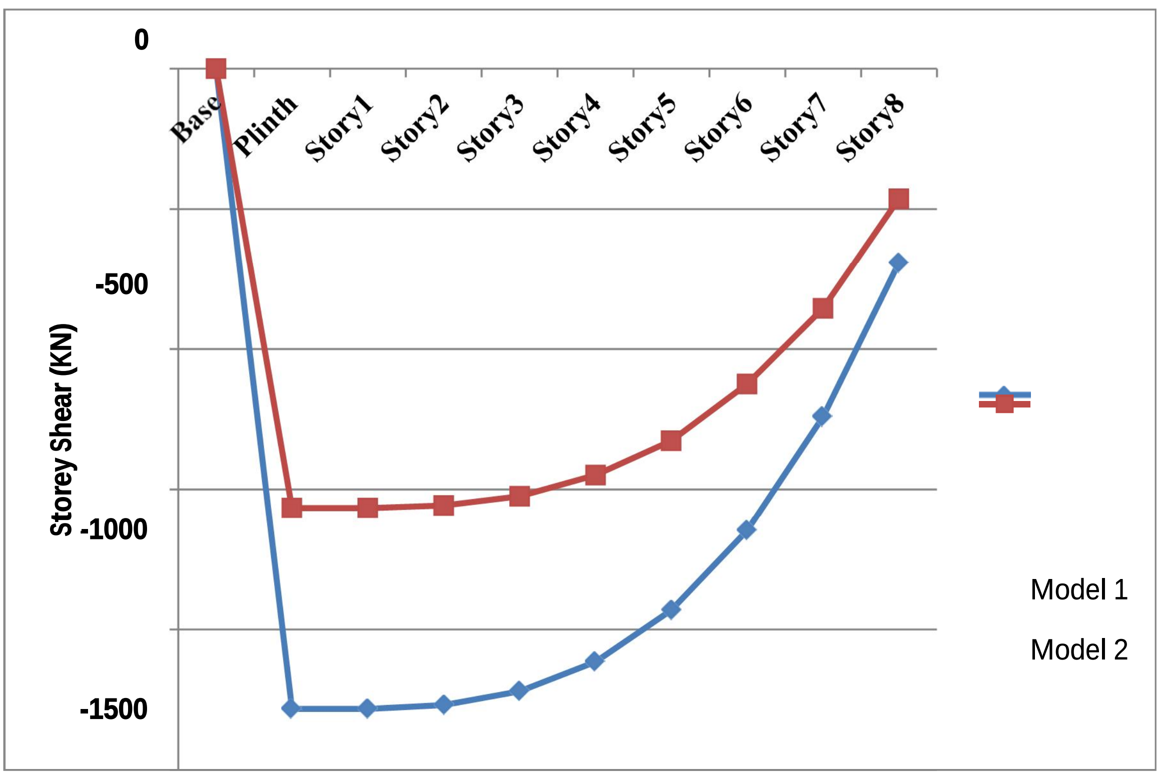


Fig 6.6 Storey Shear in Y-Direction

VI. EQUIVALENT STATIC ANALYSIS

1) *Storey Displacement:* It is the lateral displacement of a storey due to earthquakeforces in X- Direction or Y- Direction.
2) *Storey Drift:* It is the displacement of one level relative to the other level above orbelow.
3) *Storey Shear:* It is the sum of design lateral forces at all levels above the storey underconsideration.

a) Storey Displacement and Story drift is more in model 2 as compared to model 1 i.e. building with floating columns gives more drift and displacement in eachstorey as the stiffness is more in normal building as compared to floating column building.
b) Storey displacement is increases with height because the magnitude of intensity will be more at the higher zones.
c) In both the models, storey drift is least at the plinth level. Then storey drift gradually increases till third storey and then decreases again. This is because the maximum difference lies between the displacements of second and third storey.
d) In model 1, storey drift is most at the third floor in X direction while it is highest at second floor in Y direction.
e) In Model 2, storey drift is most at third storey in both directions.
f) Storey displacement increases elevation in both the models in both X and Y directions, as the distance from base increases storey displacement increases.
g) Storey displacement in floating column building is found approximately 23% more than the non floating column building at the eighth floor in both X and Ydirections. This is because the irregularity of the structure.
h) Storey Shear is lesser in model 2 as compared to model 1 as the seismicweight decreases in model 2.
i) Storey shear is always highest at the plinth.
j) As the mass increases, storey shear increases so it is more for floating column building.

VII. CONCLUSIONS

Large open spaces may be attained extremely effectively by using floating columns. To close the gaps, much study has been done. Some of them include the use of shear walls, infill walls, and horizontal and diagonal struts. In high intensity seismic zones, floating columns are not advised to be utilised, but if they are necessary, they can be fitted with bracings or shear walls that are efficiently constructed in accordance with IS: 13920:1993. As much as possible, structures should be regular, but if irregularities must be introduced for any reason, they must be designed properly in accordance with the requirements of IS 1893 (Part 1): 2002 and IS 456: 2000, and joints should be made ductile in accordance with IS 13920:1993.

REFERENCES

[1] Snehal Ashok Bhoyar "Effect Of Floating Column On Building Performance Subjected To Lateral Load" VJER-Vishwakarma Journal of Engineering Research Volume 1 Issue 2, June 2017, pp. 134-143.

[2] Bhavya B S, Jisha P "Seismic Evaluation of RC Unsymmetrical Building with Floating Columns & Soft storey Considering Different Configuration" Vol. 5, Issue 8, August 2016, pp. 15456-15465.

[3] Ms.Waykule, .S.B, Dr.C.P.Pise, Mr. C.M. Deshmukh, et al. "Comparative Study of floating column of multi storey building by using software" Int. Journal of Engineering Research and Application Vol. 7, Issue 1, (Part -3) January 2017, pp.31-38.

[4] SK. Abdul Rehaman, M. Suresh Babu "Seismic Analysis Of Framed Structures With And Without Floating Columns" International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 3, March, pp. 1070-1076.

[5] Shiwli Roy, Gargi Danda de "Comparative studies of Floating Column of different multistoried building" International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 3 Issue VIII, August 2015,pp.474-482.

[6] Trupanshu Patel, Jasmin Gadhiya, Aditya Bhatt "Effect of floating columnon RCC building with and without infill wall subjected seismic force" International Journal of Engineering Trends and Technology (IJETT),Volume 47 Number 4 May 2017.

[7] Umesh P. Patil, Shivanand S Hallur "Seismic Analysis of G+5 Framed Structures with and Without Floating Columns Using ETABS-2013 Software" International Research Journal of Engineering and Technology (IRJET) Volume: 02 Issue: 04 , July-2015, pp.1482-1489.

[8] Prerna Nautiyal , Akhtar Saleem, Batham Geeta,(2014),"Seismic ResponseEvaluation of RC frame building with Floating Column considering different Soil Condition", International Journal of Current Engineering and Technology", Vol.4, pp. 132-138.

[9] Isha Rohilla, S.M. Gupta, Babita Saini "Seismic Response Of Multi-Storey Irregular Building With Floating Column" IJRET: International Journal of Research in Engineering and Technology, pp. 506-518.

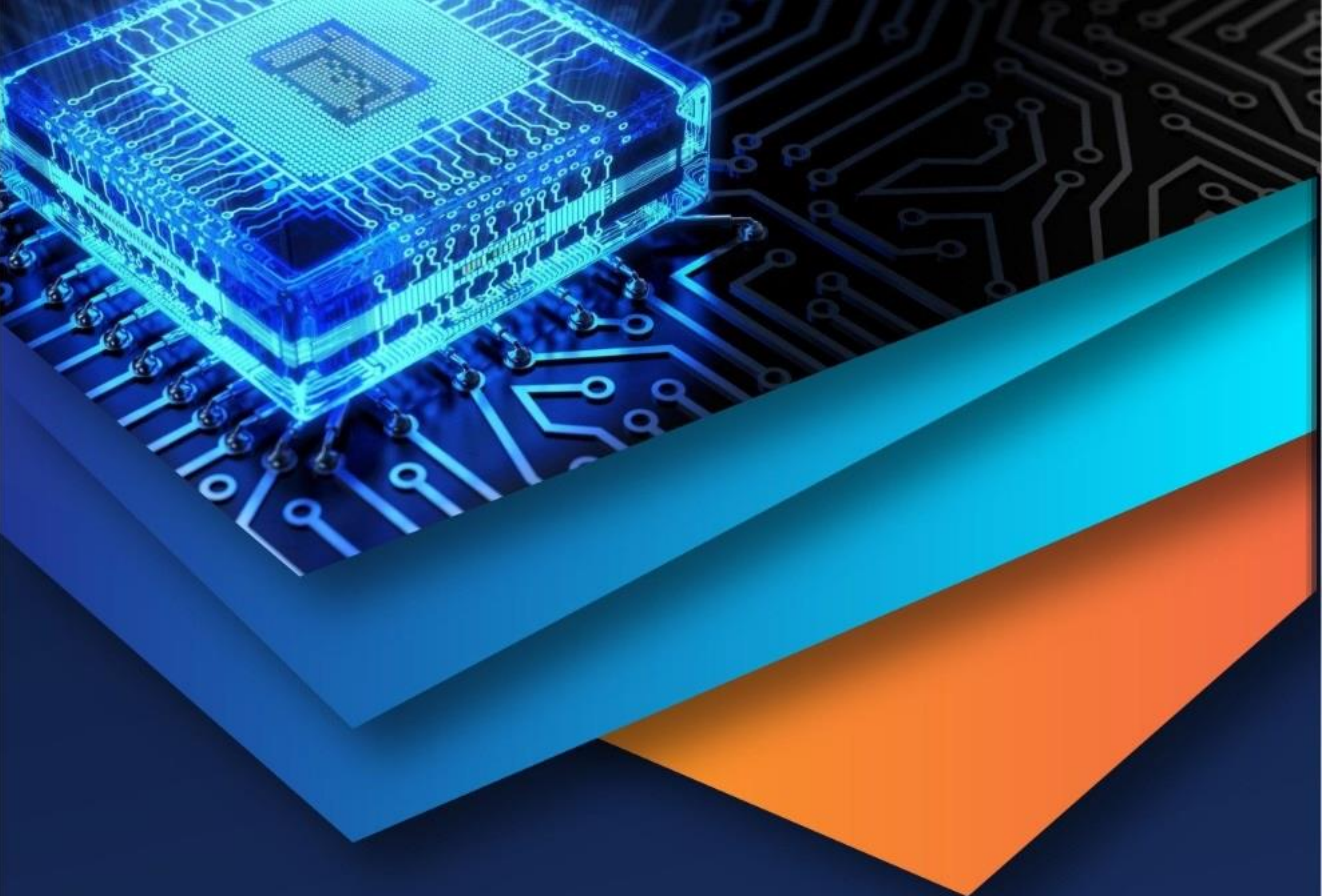
[10] Y.Abhinay, Dr. H.Sudarsana Rao and Dr. Vaishali G Ghorpade "Comparison of Seismic Analysis of a Floating Column Building and a Normal Building" International Journal of Materials Science, Volume 12, Number 3 (2017), pp. 421-431.

[11] Priya Prasannan, Ancy Mathew "Seismic Performance of RC Floating Column Considering Different Configurations" International Journal of Engineering Research & Technology, Vol. 6 Issue 05, May – 2017.

[12] IS 1893 Part 1: (2002).Indian Standard Criteria for Earthquake Resistant Design of Structures.

[13] IS 456:2000 Plain and Reinforced Concrete code of Practice.

[14] Agarwal Pankaj, Shrikhande Manish (2009), "Earthquake resistant design of structures", PHI learning private limited, New Delhi.



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