International Journal of Engineering, Science and Mathematics
Vol. 9Issue 8, August 2020,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

"ANALYSIS OF A REGULAR AND IRREGULAR GEOMETRY STRUCTURE CONSIDERING FLOATING COLUMNS AT DIFFERENT FLOORS CONSIDERING LATERAL FORCES "

PRASHANT KUMAR [1] AND KAPIL SONI[2]

[1] *Research Scholar, Civil Engineering Dept., Rabindranath Tagore University, Raisen-464993, Madhya Pradesh, India (corresponding author).*

[2] *Assistant Professor and Head, Civil Engineering Dept., Rabindranath Tagore University, Raisen-464993, Madhya Pradesh, India.*

ABSTRACT:

Now a days, in India having open first story in urban multi-storey building as an unusual feature. Primarily this space is adopted for parking purpose or used for reception lobbies in first storey, at the time of earthquake total seismic base shear is experienced by a building depend on its natural period, this seismic force distribution of building is dependent on the distribution of mass and stiffness along the height of building.

In India there are many places where floating columns are used above the ground floor of building. In that structure some special girder are used like I- girder, etc. this girder transfer the load easily to the ground and there are more space available for parking purpose or for large hall purpose in ground floor. In earthquake zone the girders are designed with care and according to condition. In this beam load of floating column is act as a point load or concentrated load. In this analysis the floating column is pinned; so structure made monolithic structure.

In this study we are analyzing a regular and irregular structure considering seismic zone II and V, soil type soft and Hard using analysis tool staad.pro. to determine the variation in structures in terms of forces, displacement and drift.

KEYWORDS: Staad, structural analysis, forces, drift, displacement, irregular shape.

INTRODUCTION:

Now a days, in India having open first story in urban multi-storey building as an unusual feature. Primarily this space is adopted for parking purpose or used for reception lobbies in first storey, at the time of earthquake total seismic base shear is experienced by a building depend on its natural period, this seismic force distribution of building is dependent on the distribution of mass and stiffness along the height of building.

In multi- storey building if there are some column and wall in a particular storey or any tell building is tend to damage the building storey at the time of Gujarat earthquake in 2001 in Bhuj. There are some buildings having ground basement for parking purpose is collapsed. Some building having floating column that hang on the beam and do not go all the way to foundation have variation in the path of load transfer.

A vertical member which start from the foundation level is known as column, this transfer the load to the ground and the floating column is also a vertical member which is started from the horizontal member called beam. i. e. floating column is not started from the ground. It is footing less vertical member. It is rest upon the beam on multistory building.

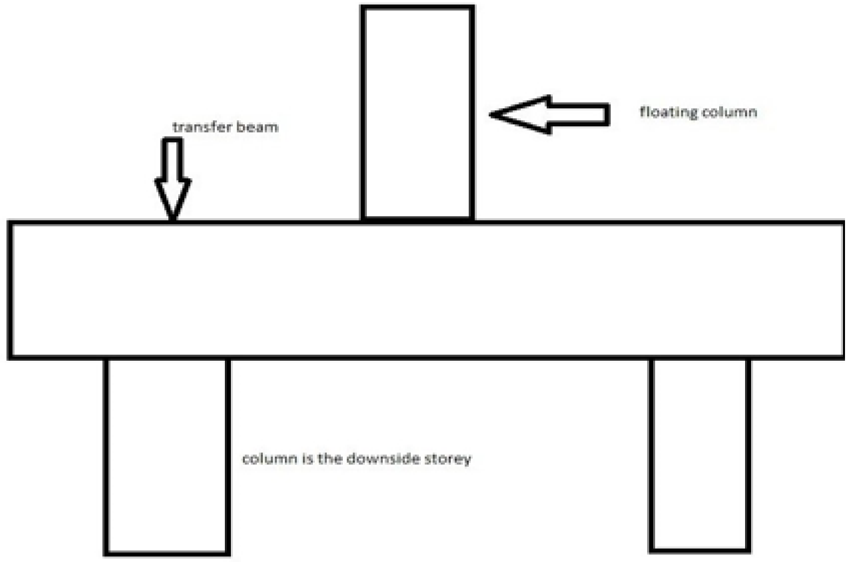


Fig 1: Floating column

Seismic Zone:

At the time of earthquake, response of the building in seismic analysis is a part of structural engineering or structural analysis. At the places where earthquake are prevalent, it is the part of process of earthquake engineering, structural design, retrofit and structural assessment in region.

The earthquake are located vary close to the tectonic plate which covers the surface of the earth globe. These tectonic plates moves one – another and some friction are generated under the epicenter point and there are suddenly move take place, this general waves propagate over the earth surface and create movement at the base of building structure. This wave reduces according to the distance from the epicenter. Near the epicenter the waves are generated less but having high intensity for destruction of structure and when the waves generated far away from the epicenter plates that are less dangerous.

Objectives of the study:

The main objectives of this study is to evaluate the performance of floating column building. Followings are the specific objectives of this study.

1. To study the behavior of regular and irregular building with floating columns.
2. To determine the effect of seismic forces over a tall structure with two different type of soil conditions.
3. To determine the utilization of analysis tool staad.pro in analysis of tall structures.
4. To determine the variation in structures with regular and irregular geometries.

LITERATURE REVIEW:

KapilDev Mishra and Dr A. K. Jain (2018) the research paper considered analysis of a multi storied Plaza building of storey (G+2+3) having different position of floating columns (4 columns of mid ordinate axis or 4 columns of diagonal axis) at different height of building (at the level above second floor) at two different zones (ZONE III and ZONE IV). The plan area of building up to second floor was 30m×30m and above this floor area was reduced to 20m×20m. Height up to second floor of the building was used for parking or commercial shops having floor height of 4m and above this it was used for residential and office purpose. Floating columns was provided at office floor.

The results stated that Maximum Bending Moments as well as Maximum Support Reaction for the structures having floating columns was higher than that of structures without floating columns. Maximum Bending Moments at seismic Zone IV was greater than that of Zone III. Structures having floating column constructed in Zone IV was more affected by earthquake than Zone III.

KandukuriSunitha and Kiran Kumar Reddy (2017) the research paper presentedthe analysis of a G+4,G+9,G+14 storey normal building and a G+4,G+9,G+14 storey floating column building for external lateral forces. The analysis was done by the use of ETABS. The intensities of the past earthquakes i.e., applying the ground motions to the structures, from that displacement time history values was compared with the primary aim to identify whether the structure was safe or unsafe with floating column when built in seismically active areas and also to find floating column building was economical or not.

The results concluded that by the maximum displacement and storey drift values was increasing for floating columns. The drift ratios stated that by increasing the height of the building the deflection and storey drift drastically changed. The axial forces increased in the columns other than floating columns due to transfer of loads of the floating columns to the conventional columns. Shear walls building prove to present safe behavior in every parameter of building safety but shear walls cannot be considered economical for building with lesser height. The building with bracing system worked well in case of smaller height than in high rise building; difference was stated in higher stories of the building. The bending moment in columns was greater in the top stories and lesser in the bottom stories.

AvinashPardhi et al (2016) the research paper presented the seismic performance of building with and without floating columns in terms of various parameters such as displacement, storey drift, maximum column forces, time period of vibration etc. The building having various locations of floating columns i.e. floating columns starting from different stories were considered for the study. The building was modeled using finite element software ETABS. The beams and columns were modeled as two nodded element with six degrees of freedom at each node. The slab was modeled as membrane element with three degrees of freedom at each node. Equivalent static analysis and response spectra dynamic analysis was performed on the various buildings and their seismic performance is evaluated. The primary motive was to evaluate the seismic response of building with floating columns and compare it with the normal building.

The conclusion stated that, by using floating columns large functional space can be provided which can be utilize for storage and parking In some situations floating columns may prove to be economical in some cases. The floating columns were not suitable in high seismic zone since abrupt change in stiffness. There was a requirement of a large size of girder beam to support floating column. Floating columns leads to stiffness irregularities in building. Flow of load path increases by providing floating columns. The load from structural members was transferred to the foundation by the shortest possible path.

Outcome of the Literature:

Many solutions have been developed in the past few decades following the introduction of new seismic necessities and the availability of advanced materials in the field of civil engineering. Specific evaluation methods and strategies and performance targets have also been developed and adopted by many advanced countries. Floating column technology is based on increasing the size or space requirement through the use of this technique where we remove the column located to have proper space.

This technology is used to develop a innovative method wherever architectural requirement is important with structure safety.

METHODOLOGY:

In this study we are adopting followings steps one by one to complete the study:

Step-1 In this step we reviewed publications and research works available on citations and in google scholar to review them briefly to prepare our study scope and boundary conditions.

Step-2 In this step we started preparing geometry of regular and irregular structures using structure wizard tool in staad.pro

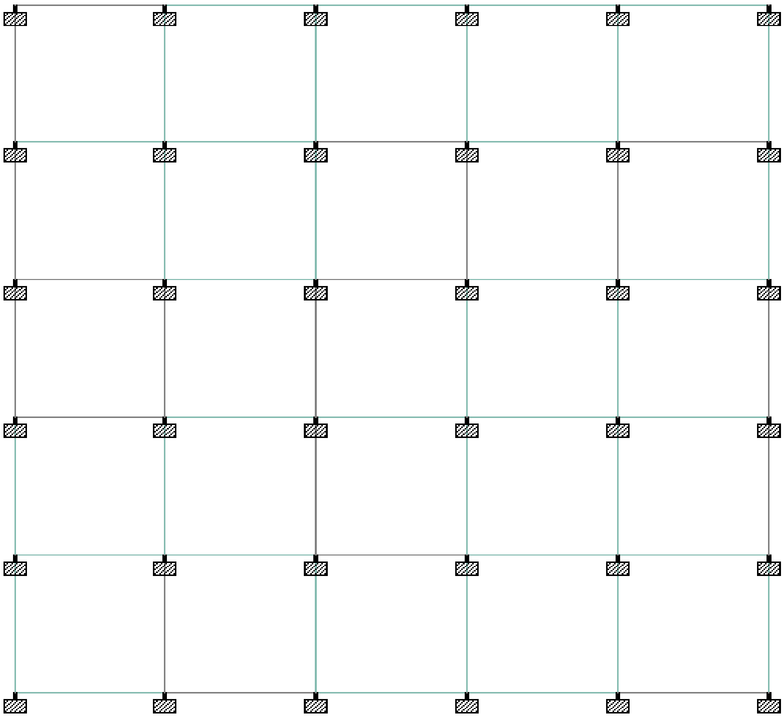


Fig a: Plan of symmetrical shape structure

Fig. b: plan of unsymmetrical structure

Fig 2: Plan of structures

Step-3: Assigning material descriptions and member sizes to the structure using property wizard in staad.pro

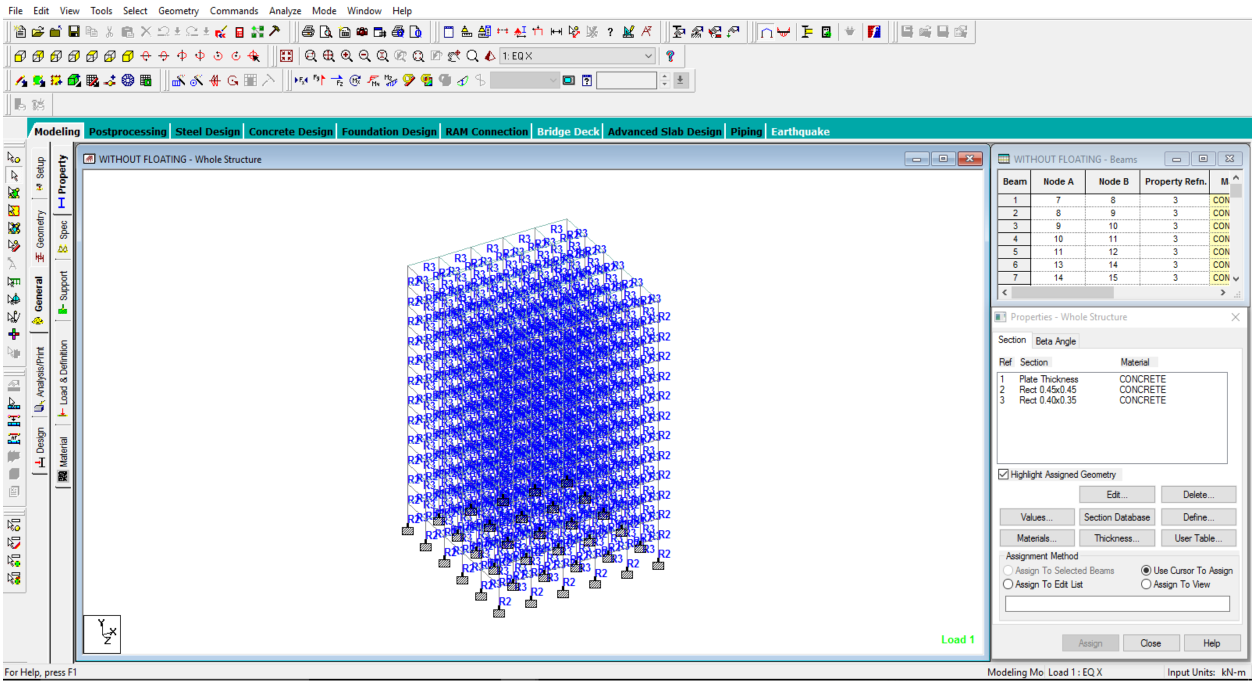


Fig 3: Material and size of structural members

Step-4: Assigning fixed end support condition to the structure.

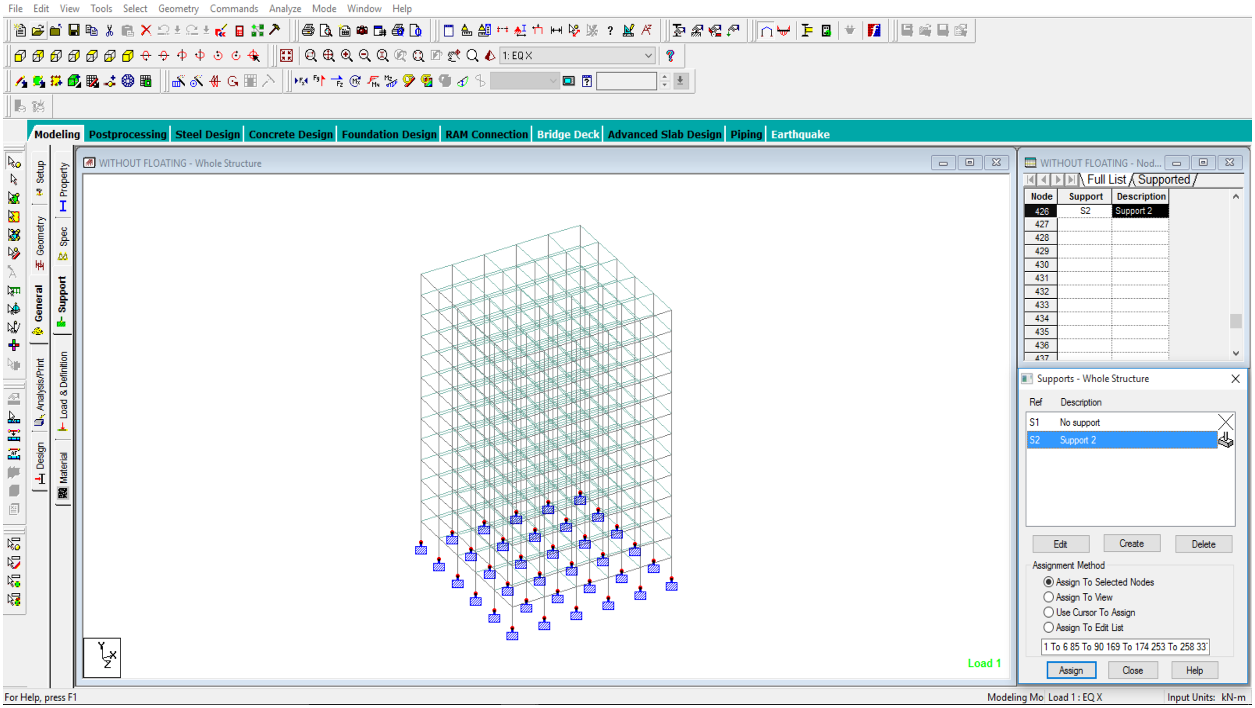


Fig 4: Support Condition

Step-5: Defining Load conditions as per Indian Standards

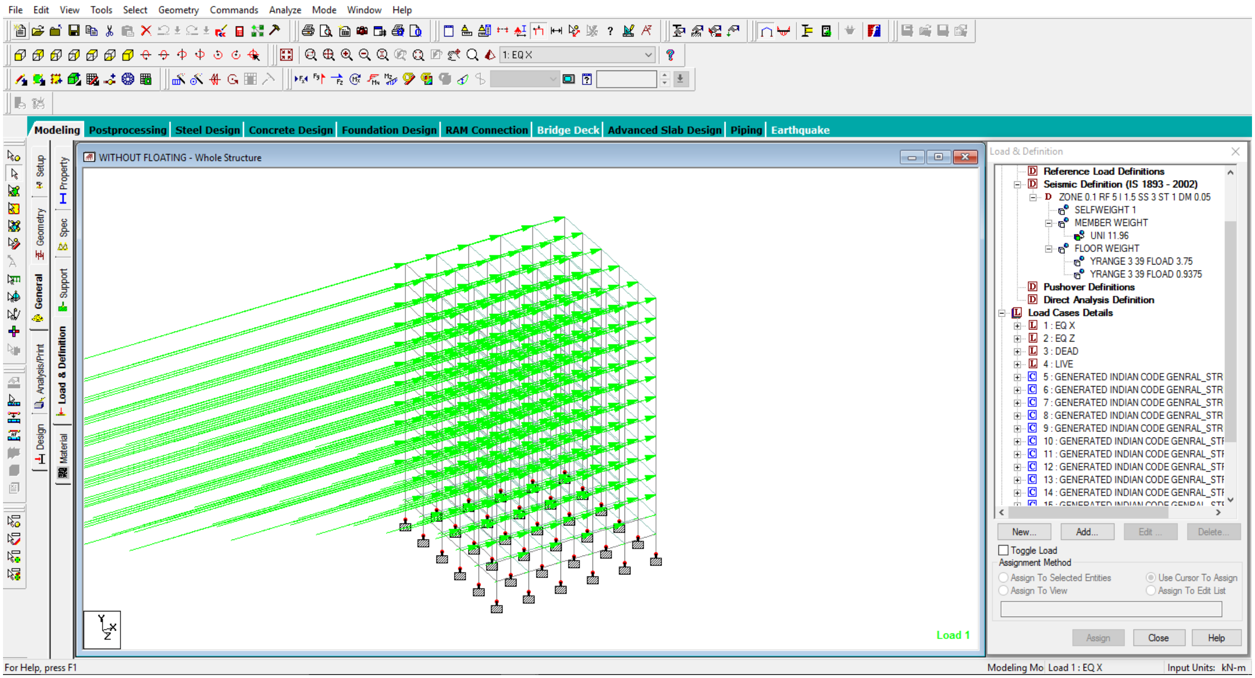


Fig 5: Assigning load cases

Step-6: Performing Analysis

In this comparative analysis we have performed seismic analysis of structures considering two different seismic zones and two different type of soils. In this study we are performing finite element analysis.

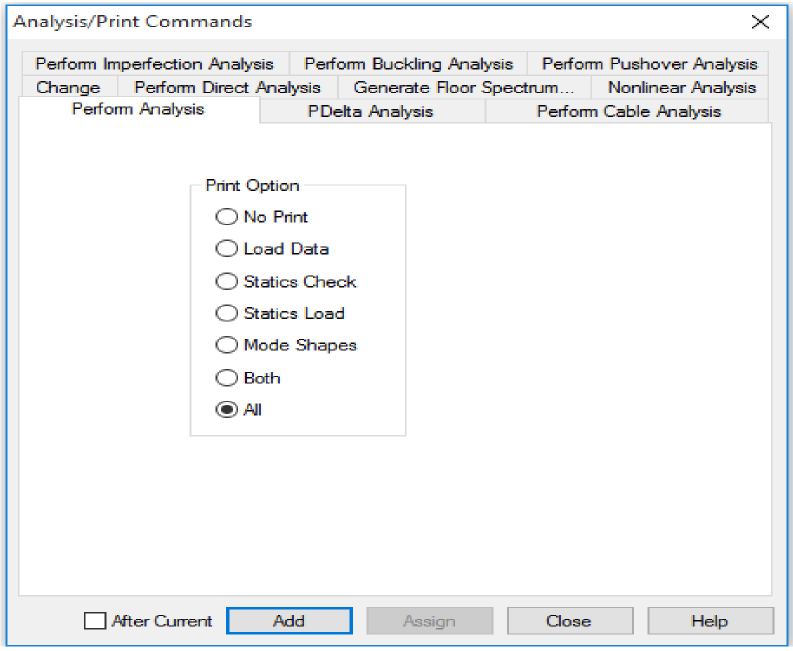


Fig 6: Analysis of the structure

Step-7: Analyzing results in terms of forces, moment and displacement.

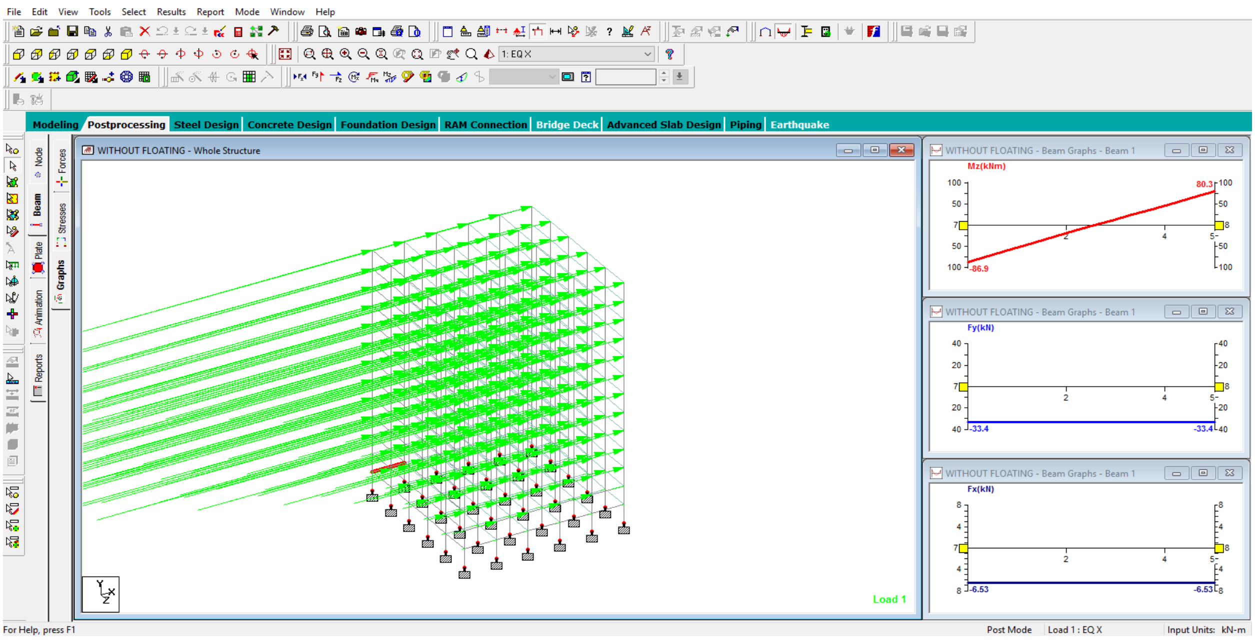


Fig 7: Analysis output

Flow Chart of the study:

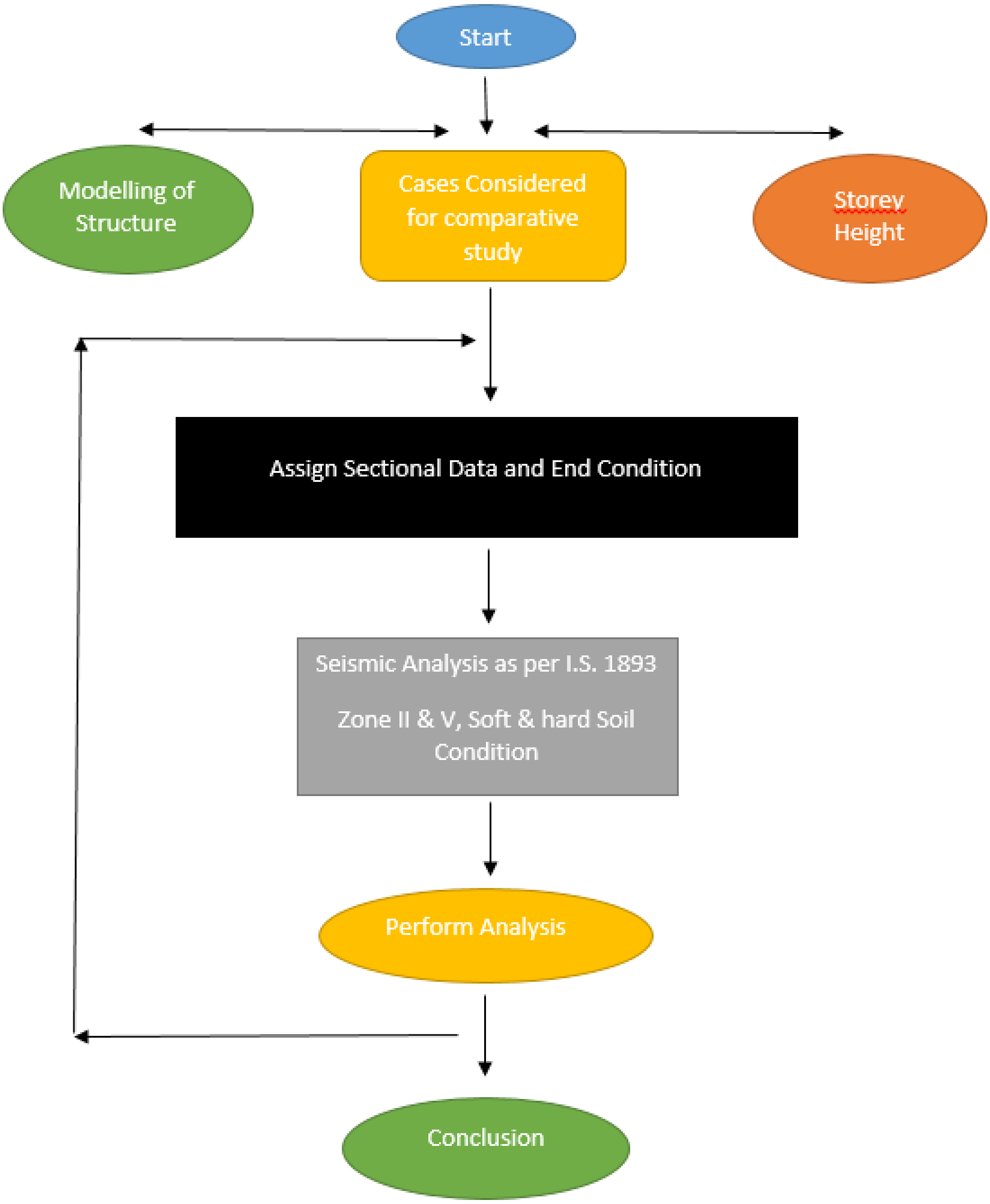


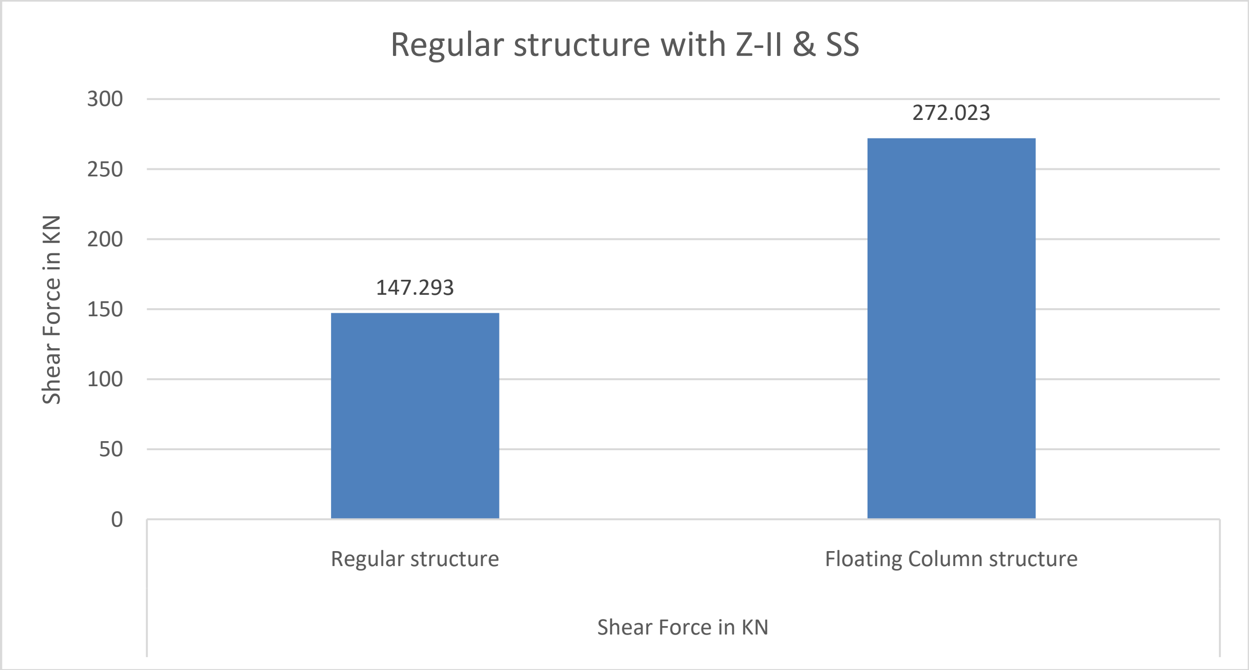
Fig 8: Flow Chart

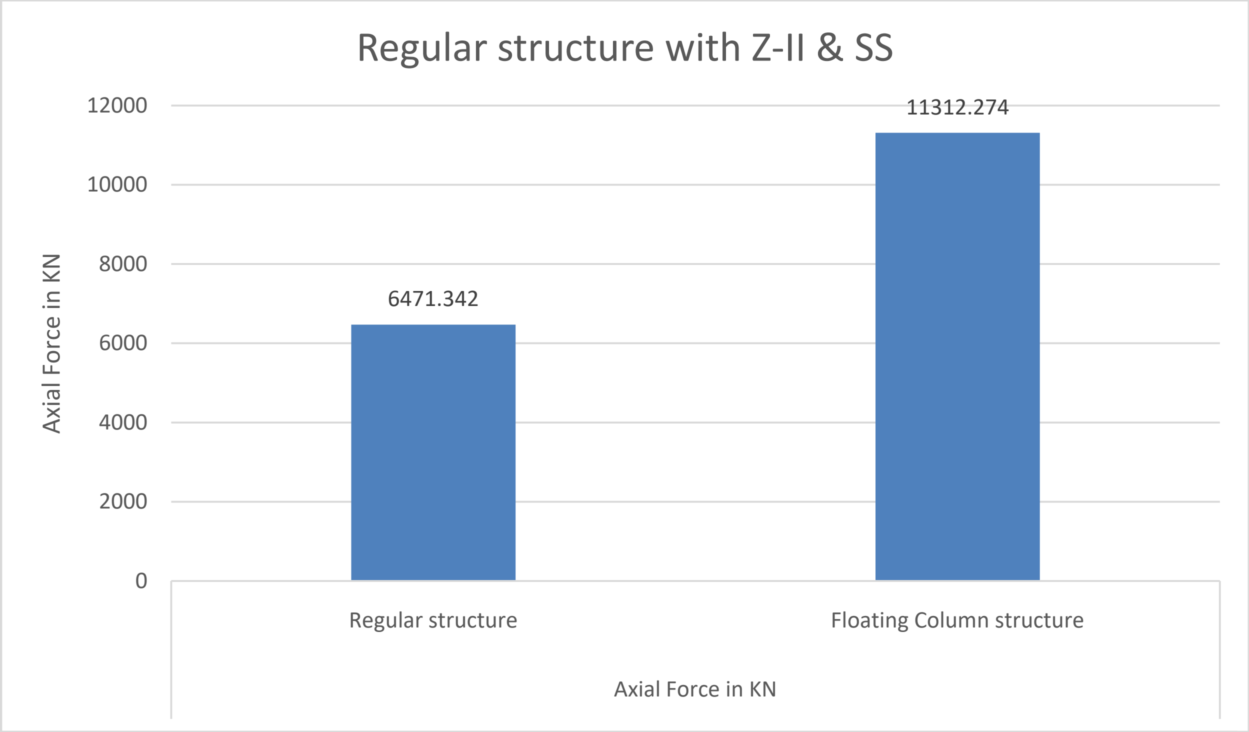
Table 1: Geometrical details

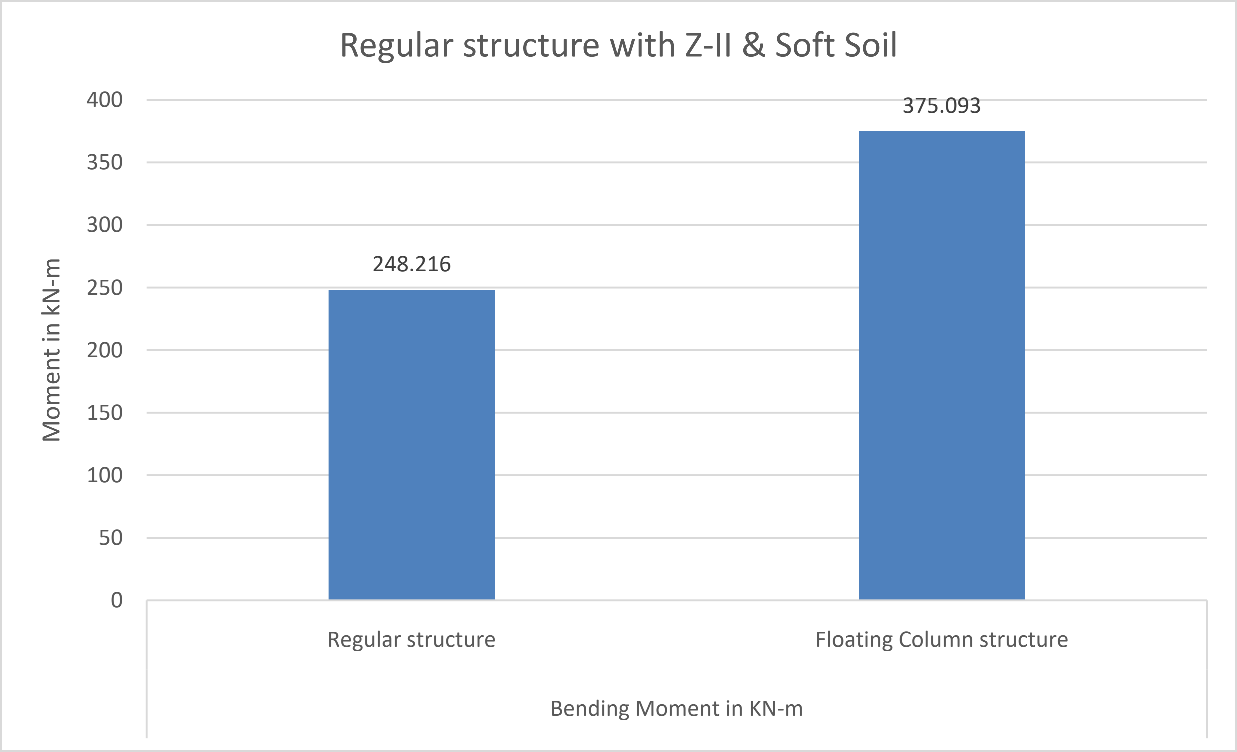
S. No.	Description	Value
1	Area of building	625 m^2
2	Length	25 m
3	Breadth	25 m

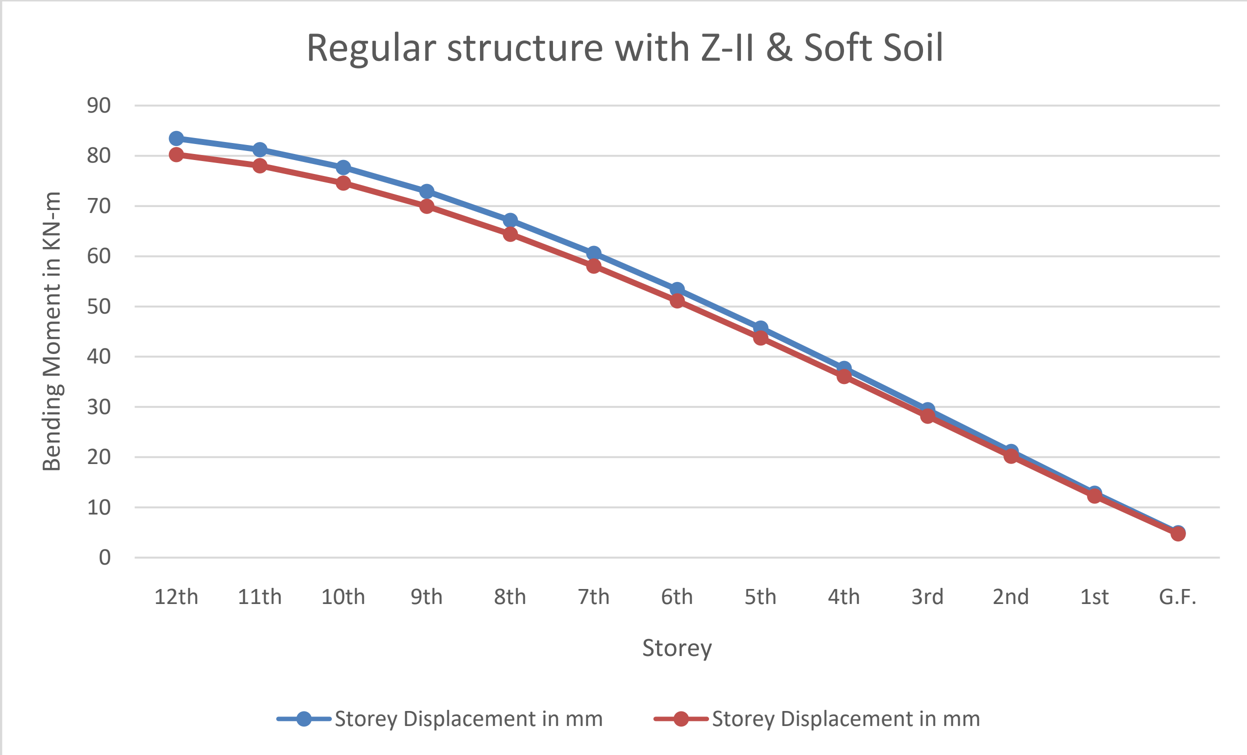
4	**Storey height**	**3.0 m**
5	**Height of the column below plinth level**	**2.0 m**
6	**Size of the column**	**450 mm x 450 mm**
7	**Size of beam for 5m span**	**400 mm x 350 mm**
8	**Thickness of slab**	**150 mm**
9	**Support condition**	**fixed**

Analysis Result:




Regular structure with Z-II & SS
Axial Force in KN
12000
10000
8000
6000
4000
2000
0
6471.342
11312.274
Regular structure
Floating Column structure
Axial Force in KN


Regular structure with Z-II & Soft Soil
Moment in kN-m
400
350
300
250
200
150
100
50
0
248.216
375.093
Regular structure
Floating Column structure
Bending Moment in KN-m



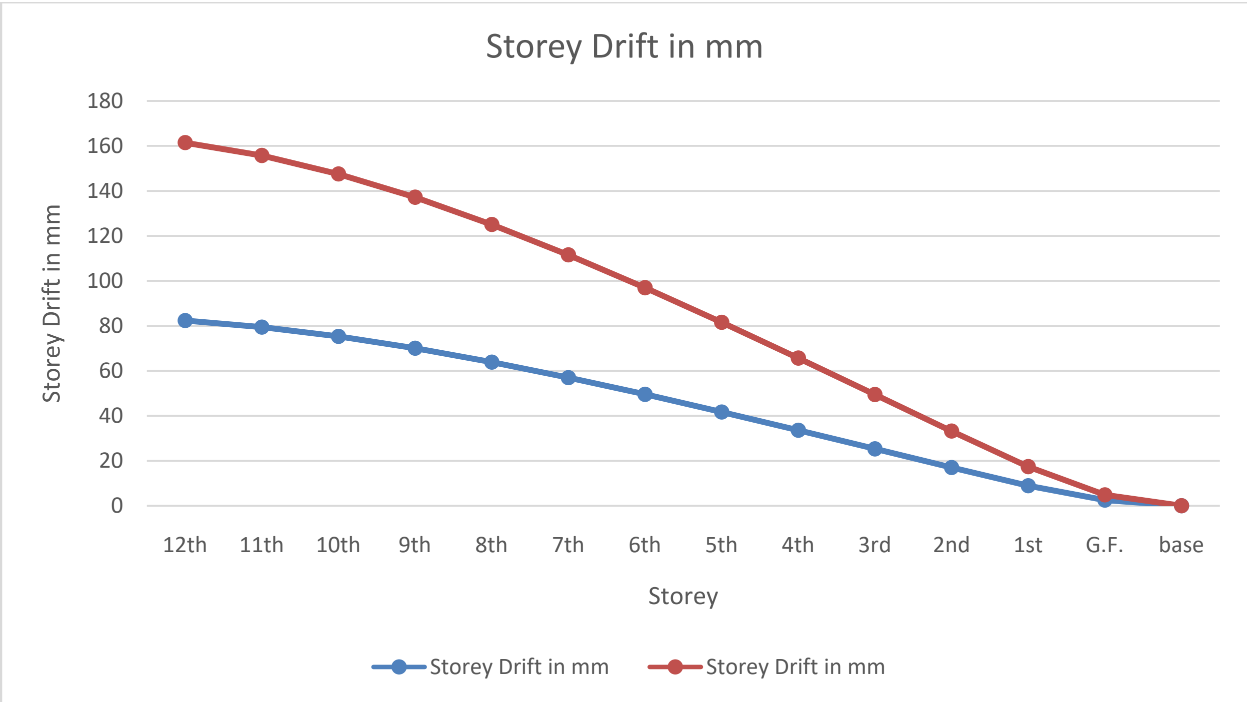


Table 2: Base shear calculation for symmetrical structure

SYMMETRICAL BUILDING				
S.NO.	**ZONE**	**SOIL TYPE**	**VB (BASE SHEAR) (without floating column)**	**VB (BASE SHEAR) (with floating column)**

1	**II**	**S.S.**	**2744.19 KN**	**2720.29 KN**
2	**II**	**H.S.**	**1643.23 KN**	**1628.92 KN**
3	**V**	**S.S.**	**9879.08 KN**	**9793.06 KN**
4	**V**	**H.S.**	**5915.62 KN**	**5864.11 KN**

Table 3: Base shear calculation for un-symmetrical structure

UN-SYMMETRICAL BUILDING				
S.NO.	**ZONE**	**SOIL TYPE**	**VB (BASE SHEAR) (without floating column)**	**VB (BASE SHEAR) (with floating column)**
1	**II**	**S.S.**	**1848.47 KN**	**1820.59 KN**
2	**II**	**H.S.**	**1106.87 KN**	**1090.17 KN**
3	**V**	**S.S.**	**6654.48 KN**	**6554.12 KN**
4	**V**	**H.S.**	**3984.72 KN**	**3924.62 KN**

CONCLUSION:

Shear force

Due to floating column distribution of forces in beams caries with span length which results In increase in shear force. Shear force in structure with floating column increases by 42% in regular structure in zone II with soft soil condition, whereas in hard soil type it increases by 36.5% where as in zone V unbalance forces increases in floating column case by 47% where as with hard soil limited to 45.2%. In usymmetrical structure shear force increases by 29.5% in zone II soft soil condition whereas in hard soil condition increases by 27% whereas for seismic zone V it increases by 41% in soft soil case and 38% in hard soil condition. The results further stated that soil placed an important role in the deflection of the structure.

Axial force

Axial force in all cases increases in floating column condition due to column position which causes to distribute vertical pressure with less number of column which rises axial forces. In all cases variation observed is approximately by 33% to 40%. The axial forces were found imbalanced in unsymmetrical structure in soft soil in comparison to hard soil.

Bending Moment increases due to increament of moment in beams which causes heavy reinforcement requirement for stability of the structure.

In floating column condition in regular and unsymmetrical condition storey displacement increases due to instability of members.

Utility

Usually people want to construct their home with new and innovative interior design suggested by architects but at some cases for structure safety. However, no provision was made in the structural design of the structure with floating column for interior and spacious design. The present study investigates the structural behavior of an RC frame under the floating column concept for regular and irregular shaped building. The above analysis helps to know the variations develop due to floating column.

FUTURE SCOPE:

1. In this study floating column at outer edges are considered whereas in future inner columns can also be consider in analysis
2. In this study seismic analysis is considered whereas in future wind forces can be consider.
3. Cost comparison of different strengthening techniques can be studied.
4. The strengthening requirement for irregular geometry of the structures can be evaluated.

REFERENCES:

1. **Agarwal Pankaj, Shrikhande Manish (2009), "Earthquake resistant design of structures", PHI learning private limited, New Delhi edition 1st-2009.**
2. **ArlekarJaswant N, Jain Sudhir K. and Murty C.V.R, (1997), "Seismic Response of RC Frame Buildings with Soft First Storey". Proceedings of the CBRI Golden Jubilee Conference on Natural Hazards in Urban Habitat, 1997, New Delhi.**
3. **James L. Stratta, Manual of seismic design, published by Pearson education, first edition, ISBN 81-297-0180-4, 2003.**
4. **B.c.Punmia, Ashok ku. Jain, at.el. Theory of structure, Laxmi publication (p) LDT. 2013.**
5. **Awkar J. C. and Lui E.M, "Seismic analysis and response of multistory semi-rigid frames", Journal of Engineering Structures, Volume 21, Issue 5, Page no: 425-442, 1997.**
6. **Prasannan and matew (2017)- seismic performance of rc floating column considering different configuration. IJERT, vol.6, issue 9, may 2017, pp. 100-107.**
7. **Sukumarbehera, NIT, ROURKELA (2012)- report about floating column in seismic zone, dept. Of civil engineering, NIT, Rourkela, 769008, may 2012.**
8. **Waykule and pise (2016)- study of behavior of floating column for seismic analysis of multi-storeybuilding.IJCIET, vol.7 issue 6, nov.-dec. 2016, pp. 676-685.**
9. **Nanabala and ramancharla (2004)- seismic analysis of a normal building and floating column building. IJERT, vol. 3, issue 9, sep. 2014, pp. 981-987.**
10. **SOR PWD for taking values of concrete and reinforcement rate. Addendum no. 05, chapter 13, w.e.f. 01-08-2014.**
11. **IS456- 2000, plain and reinforced concrete - code of practice, fourth revision, July 2000.**
12. **IS1893-2002, criteria for earthquake resistant design of structures, part 1, fifth revision, BIS 2002.**