"SEISMIC ANALYSIS OF FLOATING COLUMN BUILDING"

A Thesis

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF TECHNOLOGY

IN

CIVIL ENGINEERING

With specialization in

STRUCTURAL ENGINEERING

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HIMACHAL PRADESH, INDIA

May-2018

CERTIFICATE

This is to certify that the work which is being presented in the thesis titled **"Seismic Analysis of Floating Column Building"** in partial contentment of the necessities for the award of the degree of Master of Technology in Civil Engineering with specialization in "**Structural Engineering**" and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is a real record of work carried out by **Ashish Kumar** (Enrolment No. 162661) throughout a period from July 2017 to May 2018 under the supervision of **Dr. Ashok Kumar Gupta**(Head of Department) and **Mr. Kaushal Kumar**(Assistant Professor), Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

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ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my project guides **Dr. Ashok Kumar Gupta** and **Mr. Kaushal Kumar** for the constant support of my thesis work, for his patience, inspiration, enthusiasm, and enormous knowledge. His supervision has helped me in all the time of this study and writing of this thesis. I could not have imagined having a better advisor and mentor for my thesis study. I would also like to thank him for giving me his precious time when I went to him.

I am highly thankful to **Prof. Ashok Kumar Gupta,** Head of the Civil Engineering Department, for all the services provided.

I am also very grateful to all the faculty members of the department, for their constant praise during the project.

I also take the opportunity to thank all my friends who have directly or indirectly helped me in my project work.

Last but not the least I would like to thank my parents, who taught me the value of hard work by their own example.

Date: - May -2018 **Ashish Kumar**

ABSTRACT

A column is an upright associate member which starts from ground level & transferring the various loads to foundation. Similarly, floating (hanging) column is also an upright component which (due to site situation / architectural appearance) at its bottom level (end) rests on a girder which is as we know a horizontal section. The girder or beam ultimately transmit the vertical loads to other upright components such as columns underneath it. There are numerous planned projects where the floating columns were accepted, chiefly over the ground and first floor, where transference beams are used, thus supplementary exposed space is obtainable in the ground level.

Regarding the analysis, the column is frequently supposed to be held at the base level and is hence reserved as a static load on transference beam. SAP2000 software is used to perform the examination of the typically built structures. Floating columns are capable of countering the effects of gravity loading but transfer girder must be of adequate dimensions (Stiffness) with very minimal deflection. Modal study, response spectrum investigation and time history study are carried out on various prepared models by changing the position of the floating column from first floor to top floor. In a response-spectrum case, for a given direction of acceleration, the maximum forces, stresses, and displacements were calculated throughout the structure for each and every mode of the vibration. These modal results for a given response amount are combined to yield a single, positive outcome for the given particular direction of acceleration using any one of the modal combination tactics. Array06-2 data file has been used as an input for carrying time history investigations. The results are calculated and a comparison is made among these models.

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CHAPTER-1

INTRODUCTION

1.1 General

Most of the urban multi-storey building constructed in India today has open base storey as an unescapable feature. It is largely being approved to accommodate reception lobbies or parking in the opening storey. However, the base shear practiced by a structure in an earthquake is totally reliant on building's natural period and the distribution of seismic force depends on the stiffness dispersal and structured mass along the building height.

The behaviour of a structure in an earthquake basically depends critically on its total size, profile and the geometry, in accumulation to by what means the seismic (quake) forces are transferred to the foundation. The earthquake forces produced at various floor heights in a building required to be carried down lengthwise the height to the foundation by the shortest possible path; and any eccentricity or deviation or disjointedness in this transference route results in deprived presentation of the structural building.

Structures with vertical obstructions such as setbacks in the restaurant or hotel buildings in which some storeys are wider as compared to the others, results in an abrupt change in earthquake forces at that level or floor of discontinuity. Structural buildings which have very rarer columns (pillars) or walls in the specific storey or have an oddly tall or giant storey, have a tendency to harm or damage which is started in that specific storey. Many high-rise buildings with an exposed ground or first storey planned for car parks distorted or were harshly dented during the Bhuj quake in Gujrat, 2001. Buildings having columns that hangs or suspect or float on girders at a middle storey and do not run altogether to the footing, have gaps in the load transmission pathway.

1.2 Floating Column

A column is an upright associate member which starts from ground level & transferring the various loads to foundation. Similarly, floating (hanging) column is also an upright component which (due to site situation / architectural appearance) at its bottom level (end) rests on a girder which is as we know a horizontal section. The girder or beam ultimately transmit the vertical loads to other upright components such as columns underneath it.

There are numerous schematic projects where the floating columns were adopted, particularly over the ground and first floor, where transference beams are used, thus additional exposed space is obtainable in the ground level.

These exposed places may be essential for assembly, meeting room or car parks purposes. The transmission girders must be detailed and designed suitably, specifically in quake regions. The column is a point load upon the beam which provides support to the column.

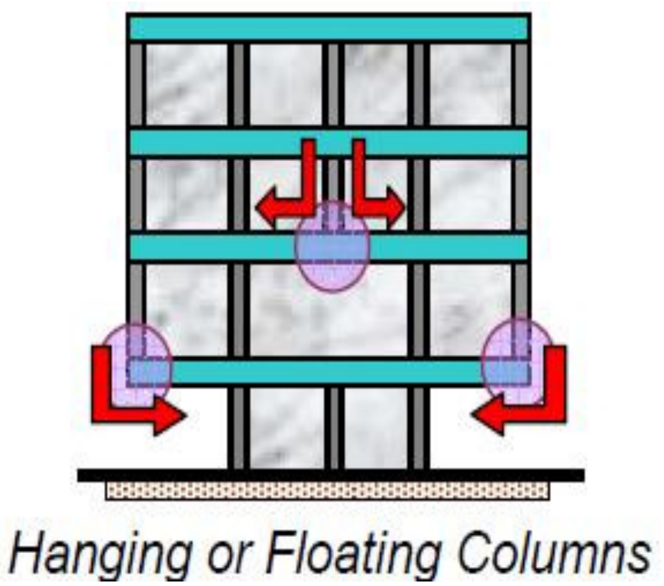

Fig 1.1: - Floating or Hanging Column

Regarding the investigation, the column is frequently supposed to be held at the base level and is hence reserved as a static load on transference beam. Software such as ETABS, STAAD Pro, and SAP2000 can be used to perform the examination of these kind of structures. Hanging columns are sufficiently strong and durable to take care of gravitational loading but the girders essentially be of suitable proportions i.e. of satisfactory stiffness value with very negligible deflection.

In advanced state of progression, people will still prefer to construct house buildings fascinating than the uninteresting. Though, this requirement should not be done on the cost of deprived response behaviour and quake care of structures. Architectural structural features which are damaging to quake response of structures must be evaded as far and as long as possible and If not possible then, they should be minimalized. When irregular structural features are involved in constructions, a noticeably use of advanced level of structural engineering is vital in the planning and yet the building structure might not stay as decent as one with regular features.

Thus, the assemblies before now built with such kinds of disjointed and discontinuous associates are threatened in earthquake areas. But those constructions can't be devastated, rather training can be carried out to reinforce the assembly or few other counteractive ways can be proposed for such kind of building structures. Pillars of the initial first or ground storey could be built stronger, the stiffness of such first-floor posts may be improved by retrofitting or they might be used in construction along with brisk bracing to reduce the sideways deflection of the structures.

Fig 1.2: - 240 Park Avenue South in New York, United States

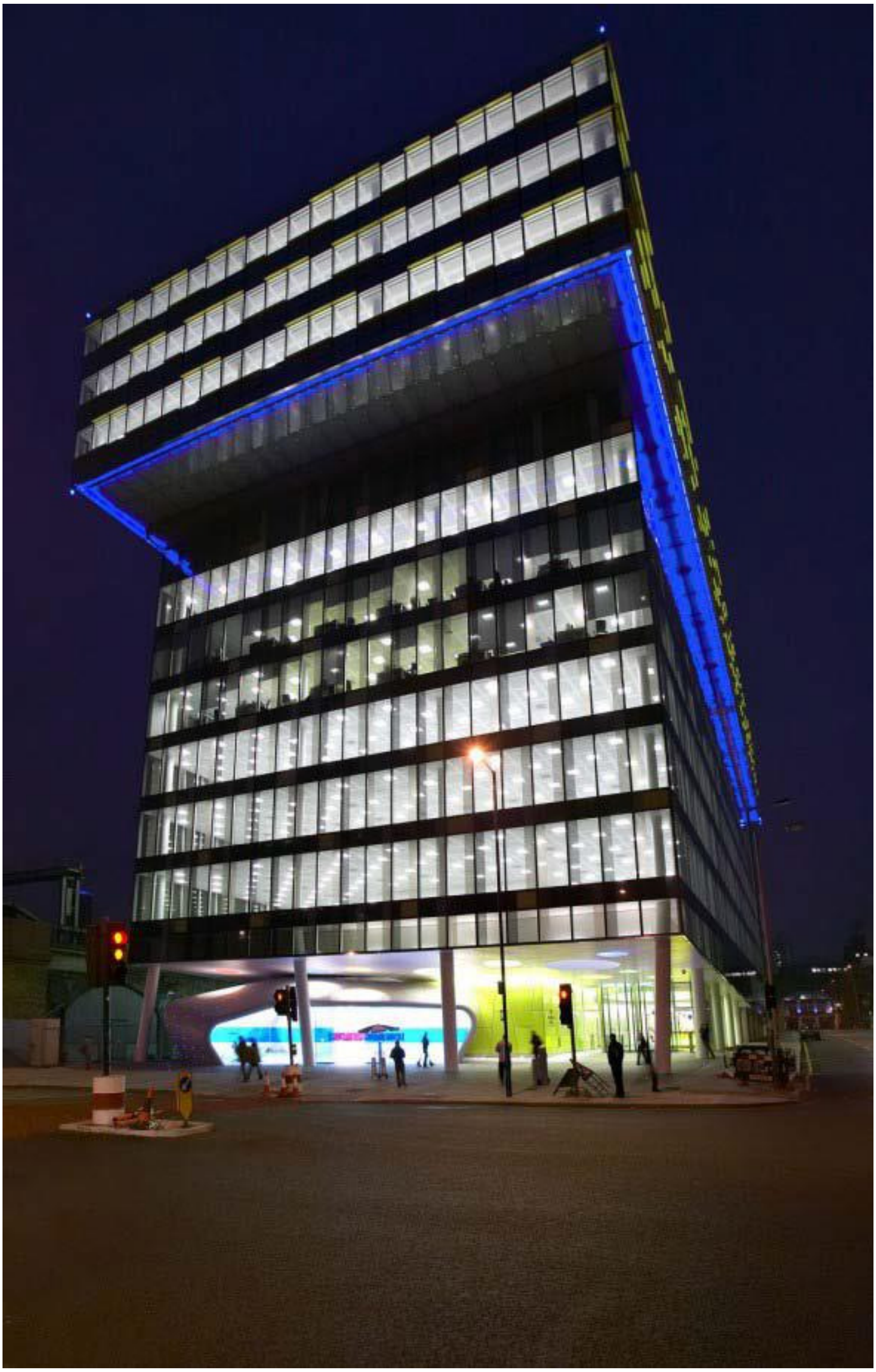

Fig 1.3: - Palestra in London, United Kingdom

Fig 1.4: - Chongqing Library in Chong

Fig 1.5: - One-Housing-Group-by-Stock-Woolstencroft-in-London-United

CHAPTER-2

LITERATURE REVIEW

2.1 Literature Review

Behela S (2012), in his paper studied the behaviour of multi-storey buildings with floating columns under the action of seismic excitations. Finite element technique is used to explain the calculations and equations, under various earthquake loading of fluctuating frequency content Linear time history investigations are performed for the buildings. To advance the solution in time Newmark Integration approach is used. He determined, with the rise in ground level column, inter storey displacement and various drifts of the different storeys starts dipping also overturning moments and shearing base reaction fluctuates with column dimensions.

Poonam, et al (2012), in their study of response of structurally asymmetrical buildings performed the seismic analysis of building frames considering several irregularities like mass irregularity and stiffness irregularities. They derived conclusions about the effects of such irregularities on storey shear forces, storey drifts and deflection of girders. Various building models with same sizes were organized and analysed using ETABS. They concluded that irregularities are injurious for the structures, but if provided they must be detailed and designed appropriately and joint junctions must be made ductile.

Malaviya P, Saurav (2014), had done their research work on comparative learning of effects of floating columns on the overall cost investigation of a building designed on STADD PROV8i. Various different models were prepared and analysed. They determined that in framed structures without any floating columns the nodal displacements are least with uniform dispersal of stresses at all columns and beams.

Sekhar TR, Prasad PV (2014), studied "The behaviour of seismic analysis of multi-storied building with and without floating column" in consideration with static loads, free vibration and forced tremor conditions. The consequences of the study were presented in graphs for both the buildings with and without hanging column by relating their time history of base shear and floor displacements. He carried out the equivalent static-analysis using the STAAD Pro V8i and the evaluation of these prepared models has been obtained. He suggested that with the increase in base floor column the extreme movement is decreasing and base shear fluctuates with the different sizes of the columns.

Mundada AP and Sawdatkar SG (2014), studied the comparative seismic analysis of multi-storey building having floating columns at various heights with the building doesn't having any floating column. He selected existing residential building structures for carrying out the project work. The load dispersal on the floating columns and numerous properties due to it with the reputation and things due to stroke of action of force are considered. The equivalent motionless static investigation was approved on the whole project mathematical 3D model by means of the software. The results of the investigation advocates that the chances of failure of buildings with floating column are much higher as compared to the buildings without floating column and by using struts in the building having floating columns, the lateral deflection can be minimised to a great extent.

Nanabala SG, et al. (2014) in their research work of the seismic investigation of a standard conventional building and hanging (floating) column building carried out with an objective to discover that whether the structure is unsafe or safe with floating column when constructed in earthquake prone zones and similarly to discover whether floating column structure is cost-effective or not. Intensities of the previous year's earthquakes were applied to both the normal and floating column building and displacement time history results are compared.

Nautiyal P. (2014) studied "Seismic response evaluation of RC frame building with floating column considering different-different soil conditions". Linear Dynamic analysis is performed for 2Dmultistorey frame and responses are calculated and analysed for safe and economical design of RC building under different earthquake accelerations. According to the results, the base shear requirements from response spectrum study for RC frames without floating column are found to be slightly higher than that of RC frames having floating column.

Banerjee S. and Sanjaya K Patro (2014) in their research on approximation of park-Ang demage catalogue for building with infill wall considering floating column and concluded that infill walls provide seismic strengthening of structures with floating column and damage index is little higher because of the infill wall effect but it helps to lessen the formation of cracks on the higher storeys. Base shear is higher as infill wall provides further stiffness to the structure.

Sudheer KV (2015) published a paper to study the behaviour of G+15 multi storey building. Extended Three-Dimensional Analysis of Building Systems (ETABS) software was used for designing and analysis purposes. The analysis of the multi-storey buildings with & without hanging columns is completed and various results are compared. Based on the conclusions of his study, floating column building is going to experience very risky storey displacement or drift when compared with conventional one and storey shear is also high due to the use of additional amount of materials than a conventional building.

Roy S, de Danda G (2015) analysed the various building models considering floating columns. Comparisons is done in between these structural models on the basis of bending moments and shear forces. It is concluded that, with the orientation and alignment of the column and condition, the column shear varies and bending moments at all single floors rises and shearing force also rises but it is identical for each and every floor column.

Rohilla I, Gupta SM, Saini B (2015) studied the seismic response of multi-storey irregular building. He investigated the dangerous spot of floating column in vertically uneven or asymmetric buildings for G+7 and G+5 concrete structures for various seismic sectors. The response of building like displacement, storey drift and shear in a specific storey was used to assess the final outcomes attained by means of ETABS. With increasing the size of the beams and column storey displacement starts decreasing while the storey shear tends to increase. Drift of a particular storey increases due to the existence of floating column in the structure.

Bhensdadia H. (2015) studied pushover analysis of frames with FC and soft storey in various earthquake areas. Push-over analysis will reflect the performance level of buildings, for designed capacity approved till the occurrence of failure, it aids in finding the collapse or failure load and ductile capacity of the framed building structures. For carrying studies on the performance response levels of the building, the analysis is done through both linear-static and non-linear static systems in agreement with IS:1893-2002 (part-1). ETABS, a finite element method based structural database is used for analysis and design purposes. Results advocates that push over analysis is precise and well-organized method of analysis, and also the drift and movement of building starts increasing from minor quake prone regions to major quake prone regions.

Udhav B, et al (2015) in their paper analysis of multi-storey building with floating column studied the behaviour of an existing structure which was a G+10 residential building. Various building models were created using STAAD Pro software and analysis was done using static method. The systematic building models comprises of all the modules which effect the mass, deformability, stiffness and finally the strength of structure. The structural building system consists of a column, block, wall, beam, elevator, staircase, slab, footing and retaining wall. The results shows that the column-shear changes in accordance with the condition and location of column, also the curvature at every single floor or storey rises and shear force gradually rises but it is almost equivalent at every floor for respective columns.

Rahman A. (2015) in "Effect of floating columns on seismic response of multi-storeyed RC framed buildings" explores the effects of the abnormality which is formed by disjointedness or cut-offs of a column in a building exposed to seismic forces. Dynamic and static analysis using response-spectrum method were performed for a high-rise G+6 storey building by fluctuating the location of floating columns floor-wise. It has been noted that by introducing a floating column in a RC building the time period increases and this is generally due to the decrease in the stiffness. It also decreases the base reaction and spectral acceleration.

Ms. Waykule S.B, et al (2016) in their study of performance of floating column for seismic analysis of multistorey concrete building performed the analysis and evaluation of building with and without floating column in highly seismic prone zone v. 4-models were created by changing the place of floating column. Linear static and time history analysis were performed on all the four models and the results were compared with each other. From time history analysis, response of all the 4-models were plotted. In this paper, they concluded that, the floating column at dissimilar position results into dissimilarity in dynamic response and building with floating column has much more storey drift in comparison with conventional one.

Mohamed Aqeeb Ulla, et al (2016) studied earthquake behaviour of reinforced concrete buildings by means of non-linear static analysis by considering presence of floating columns. Linear analysis practices of structures give a decent suggestion of elastic ability of the structures and designate where first yielding will occur. Using nonlinear analysis procedure, the model integrates directly the force-deformation characteristics of individual parts of structures and fundamentals due to in-elastic physical behaviour and response. Several models were prepared and analysed for non-linear responses. They concluded that overall strength capacity of the building totally depends on the applied forces and the base-shear capacity. It was considered that, shear of the storey depends on the mass of the structural model.

Sasidhar T, et al (2017) performed the analysis of buildings using program ETABS. They considered a housing building G+5 and different cases of elimination of columns in dissimilar positions and in various floors of the housing building. Equivalent analysis is done on a mathematical model and results are related or compared with the existing building model. It was concluded that, the use of floating columns results in increased shear, increased bending moments and increased steel requirements of the buildings.

2.2 Objectives of the Study

1.To study the behaviour of floating columns and non-floating columns with seismic behaviour.

2.To find out the effects of floating column in buildings with reference to support of strut and without strut.

3.To study flow of forces and variations in column forces in a building by varying locations of floating column floor wise.

4.Design of the floating column building for improving overall seismic performance of structure.

2.3 Scope

1.Provision of floating column with strut support in buildings.

2.Computation of dynamic response parameters on a high and low-rise multi-storey building with floating column in various seismic zones and different soil state using software.

3.Modeling and analysis of floating column building in software SAP2000.

4.Study of variation in the dimensions of floating column and its effects on the response parameters.

5.Response Spectrum and Time History analysis in SAP2000.

CHAPTER-3

METHODOLOGY

1.Modeling of floating column using SAP2000.

2.Dynamic response spectrum analysis (RSA) using SAP2000.

3.Comparison of the response parameters of floating column building with normal building.

3.1 Modeling of Floating Column and Building in SAP2000

The modeling of the building and application of floating column to building is done by using SAP2000 software

3.2 Dynamic Analysis

Dynamic analysis is a portion of analysing structure which studies the flexible elastic structural behaviour when a dynamic load is acting. Load which is dynamic in nature continuously varies with time. Dynamic load includes the wind, earthquake load, live load etc. Thus, practically all realistic difficulties can be examined dynamically.

Generally, these loads vary progressively and the overall response of the structure possibly will be approximated by a static-method in which inertia forces are likely to be ignored. However, if the load values fluctuate rapidly, the response needed to be

calculated with the use of dynamic inspection in which inertial force cannot be neglected which is equivalent to mass times acceleration (2nd law of motion).
Mathematically,

$$f = m \times a$$

Where, f = force of inertia,

m = mass(inertial), and

a = acceleration.

Moreover, stresses and displacements are generally much greater in comparison with the equivalent static movements for identical amplitude input, specifically at the resonant situations of structure.

The realistic structures have numerous displacements. So, the greatest critical part of structural investigation is to generate a typical computerized model, consisting less members, fixed quantity of masses and limited quantity of displacements of various nodes which in turn governs the actual behaviour of buildings or any other structures. One more problematic part of dynamic structure analysis is to estimate dissipation amount of energy and the boundary condition. Accordingly, it is tricky to analyse structure for seismic loads and wind loads. The occurred difficulties can be minimised by means of various advanced program design practices.

3.2.1 Response Spectrum Analysis

Response spectrum analysis is a dynamic linear arithmetical analysis process which ascertain the involvement from individual natural means of tremor to postulate the expected maximum or extreme earthquake response of a fundamentally or primarily flexible assembly. Response spectrum approach offers an idea into dynamic performance by calculating pseudo spectral velocity, acceleration, or pseudo-displacement in terms of structural period for given time-history. The amount of damping may vary for distinct structures. It is practical, to envelope response spectra such that a smooth or flat curve signifies the highest response for each and every recognition of structural time period.

RSA is useful for design method selection because it compares physical type-assortment with dynamic act. Structures of minor period practice larger acceleration, whereas those of higher period practice more displacement. Structural performance aims should be considered during original design and response-spectrum analysis of the structure.

RSA provides insight to how the damping ratio affects response of structures. A family or group of response curves may be established by varying the levels of damping. As damping rises, spectrum shifts downward.

The International Building Code (IBC) is generally based on five percent (5%) damping. This accounts for subsidiary damping from hysteretic performance, which is not clearly demonstrated during RSA.

Viscous type of dampers does not affect structural stiffness and are not modelled during RSA. Also, they are not applicable for in the IBC provision for five percent damping.

For irregular or complex buildings which don't have evidently definite orthogonal guidelines, it can be uncertain as to by what method the orientation of response spectrum study would be functional. In a research paper titled Orthogonal Effects in RSA by Dr.Wilson, he clarifies that, collective or mutual guiding properties may be accounted more efficiently by means of an another scheme having the SRSS grouping combination of dual 100% spectra analyses is practiced in any of the directions, or along any other orthogonal axis. This system is effective as design forces and outcomes does not depend on the reference system which is in use. This technique also accounts for simultaneous and independent base signals which usually arise typical to those along the major route.

When static or inert force is practiced in the horizontal X-direction, net overall response in the Y-direction will be nil, still specific discrete forces can be non-zero, as they depend on the kind of structures. For illustration, let a single-story frame with 4-columns, organized in a rectangular plot through interlocking girders at the level of roof, is exposed to a parallel concentrated load in the most important principal direction at the highest point of one column, twisting will result in parallel support reactions in the direction orthogonal to the applied forces.

For a dynamic loading state, overall reactions stay in balance state for both practical loading and forces of inertia. Once the structural centre of stiffness slightly different from the centre of mass, in the X direction the applied loading may produce signal in the Y-direction. This signal will be interrelated with conventional force of inertia and reactions at the supports perpendicular to applied load direction.

Maximum non-symmetric building assemblies show normal responses and response numbers when they are exposed to either dynamic or static type of load. This behaviour indeed arises in structures as it creates equilibrium. Structural design should interpret for these normal forces, along with all others forces resulted from the application of various loads.

The deflected shape of a structure endangered to a load combination which comprises of a response-spectrum load case is worthless since displacement sign convention is lost in modal combination.

In a response-spectrum case, for a given direction of acceleration, the maximum forces, stresses, and displacements were calculated throughout the structure for each and every mode of the vibration. These modal results for a given response amount are combined to yield a single, positive outcome for the given particular direction of acceleration using any one of the modal combination tactics. As soon as a response-spectrum case is added to a load combination, it is converted into a double-valued combination, one with all the positive values and other with the negative values, for the spectrum results. When deformed shape is shown for a multi-valued load combination, it is based on the minimum or maximum displacement at each and individual degree of freedom, whichever has the higher absolute value. Depending on the sign of the supplementary loads considered in the combination of loads, the resultant displacement can be in either the negative direction or in the positive direction, even for the adjacent joints in a structure.

Base reactions of response spectrum will not match the summation of separate joint reactions because of the variation in their formulations. Base reactions were determined for every single mode before modes were combined by means of the SRSS or CQC modal-combination. Various joint reactions, on the other hand, were computed using different-different modal combinations which were applied to all individual joints.

3.3 Time History Analysis

Time history (linear) analysis overwhelms all the shortcomings of modal spectrum study, as long as non-linear behaviour of structures is not under consideration. The method necessitates larger scheming and calculation efforts for determining the response at distinct time intervals. One exciting benefit of this type of technique is that the comparative signs of response potentials are well-maintained in the various response histories. It plays a vital role specially during the involvement of collaboration properties in design between various stress vectors.

CHAPTER-4

MODELING AND ANALYSIS OF FLOATING COLUMN BUILDING

4.1 Problem Definition

- This is a typical low rise RCC building. All principal necessities for gravity, wind, and seismic design have been considered. It was designed for a typical live load of 3 KN/m^2.
- The floor finish load (dead load) is assumed to be of 1 KN/m^2.
- This is a Five-storey RCC building which consists of 4-bays @ 5m along x-axis and 3-bays @ 5m along y - axis.
- The storey height is 3.10 meters.
- Slab thickness is taken as 0.150 meters.
- Density of concrete - 25 KN/m^3
- Floor to Floor height – 3.10 m
- Size of the beams- 0.300 x 0.500 m
- Size of the columns – 0.500 x 0.600m
- Concrete of grade M30.
- Steel of grade Fe415.
- Support condition - Rigid

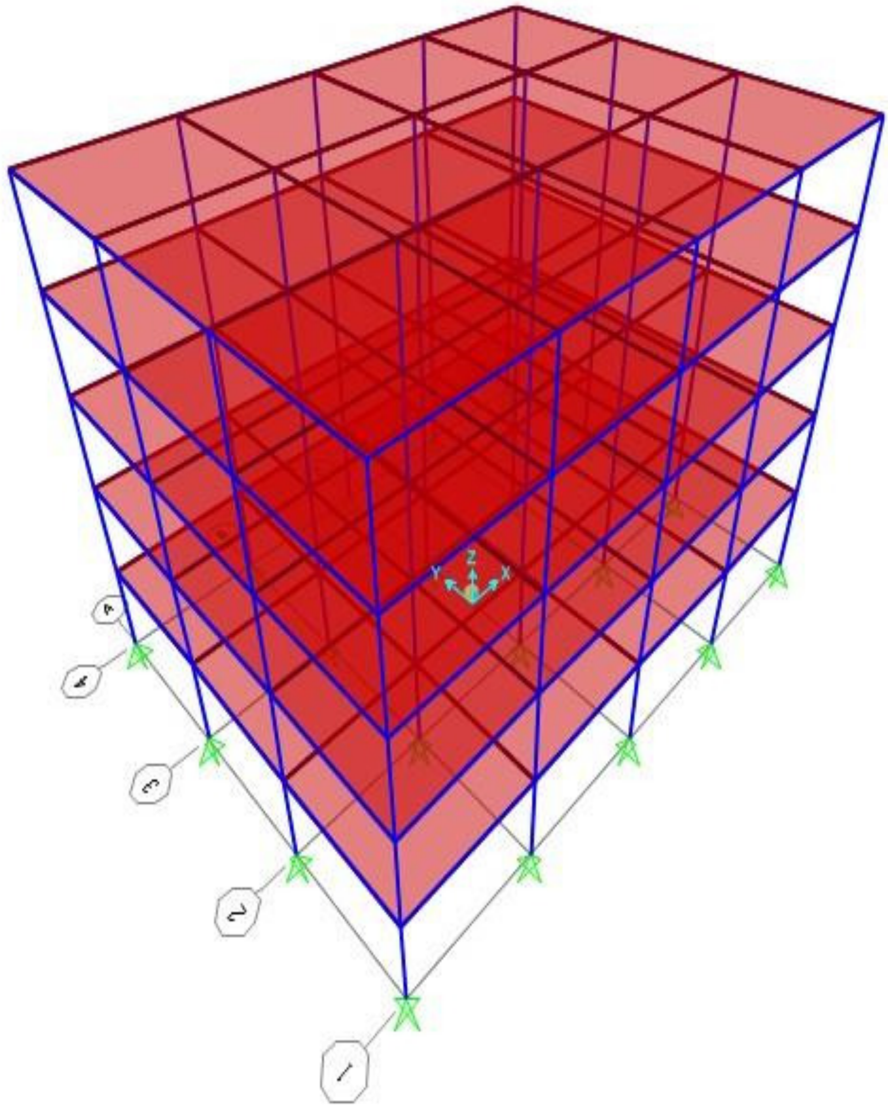

Fig 4.1: - 3D view of model

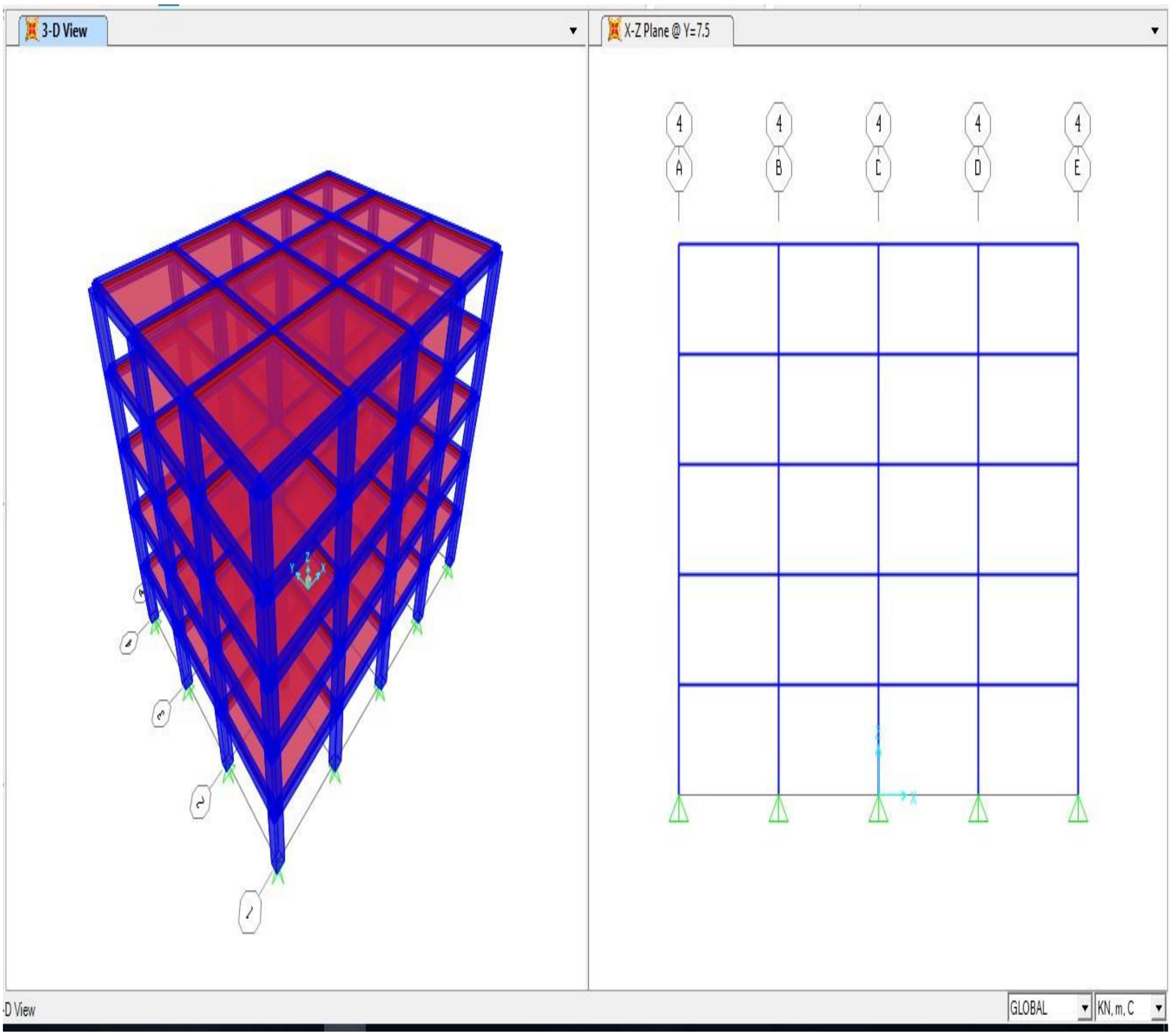

Fig 4.2: - Extruded 3D view of model showing building without floating column

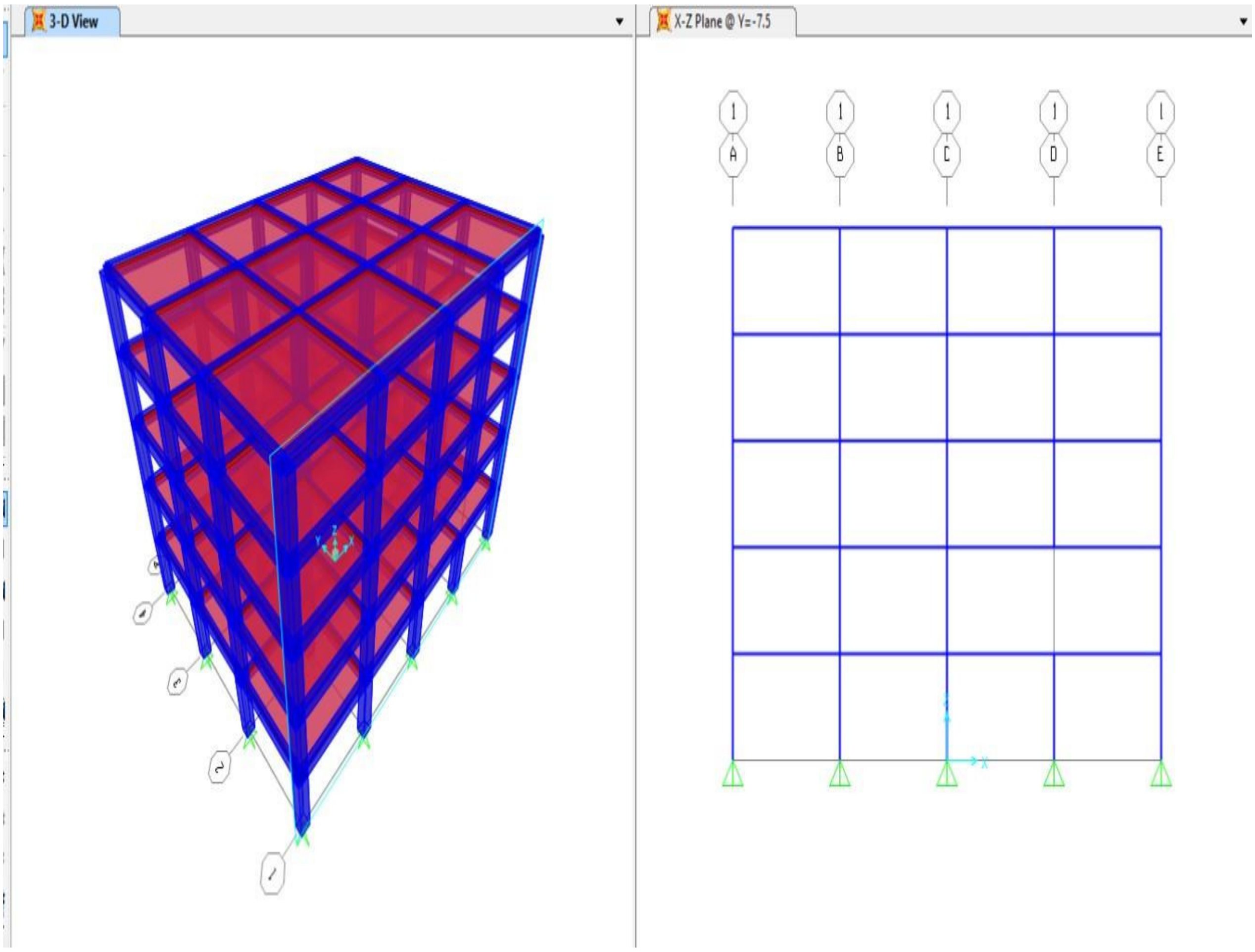

Fig 4.3: - Extruded 3D view of model showing floating column at 1st floor

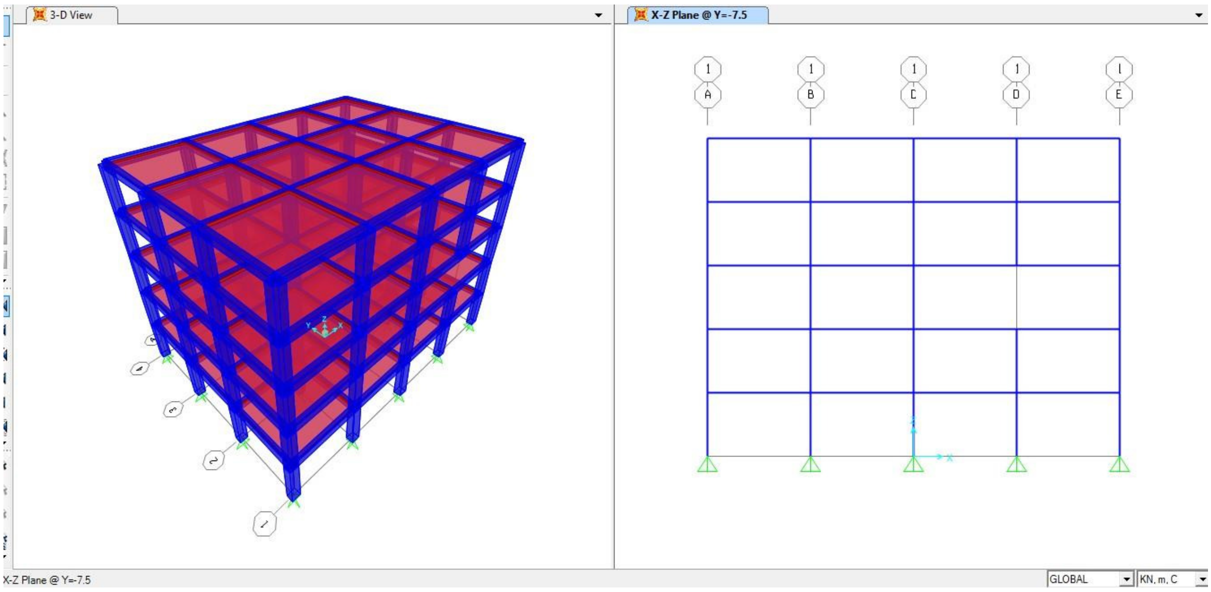

Fig 4.4: - Extruded 3D view of model showing floating column at 2nd floor

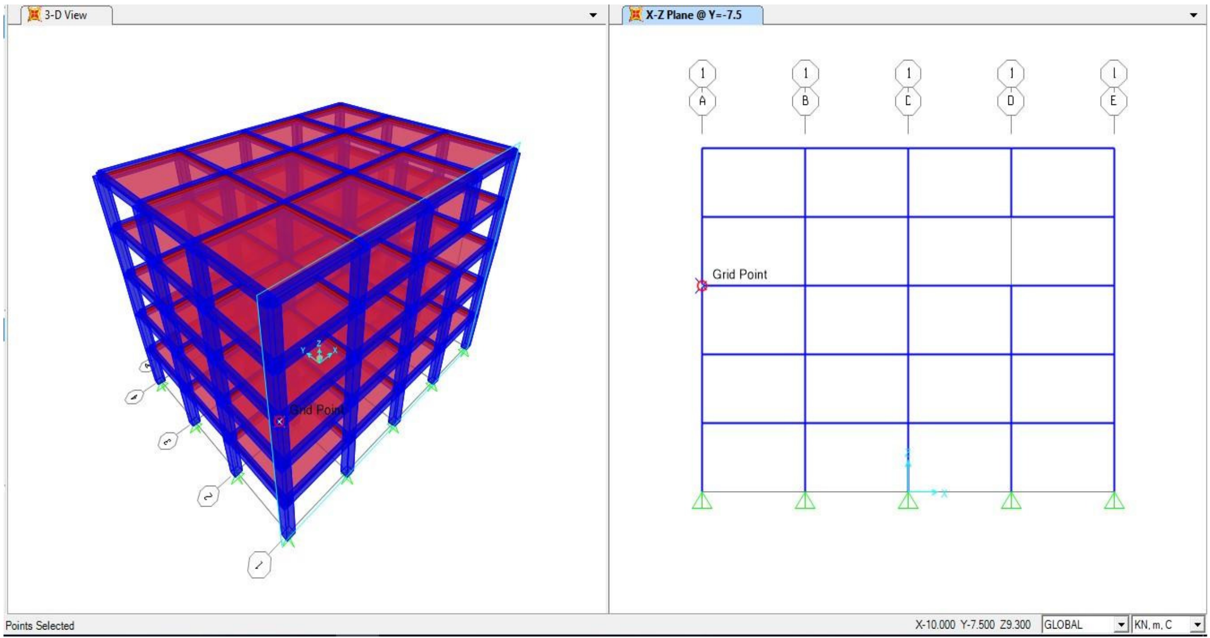

Fig 4.5: - Extruded 3D view of model showing floating column at 3rd floor

4.2 Modal Analysis

What is a modal analysis?

It is basically a procedure which governs the vibrational characteristics of a structure.

- Natural fundamental frequencies
- Mode shapes
- Mode participation factors i.e. how much a given mode contributes in a particular direction.
- Most vital of all the dynamic analysis types.

Procedure: -

Step by step procedure to carry out modal analysis:

- Creation of model.
- Assigning materials properties to the model.
- Create step (procedure type – linear perturbation)
- Application of various boundary conditions.
- Define meshing size and finding results.

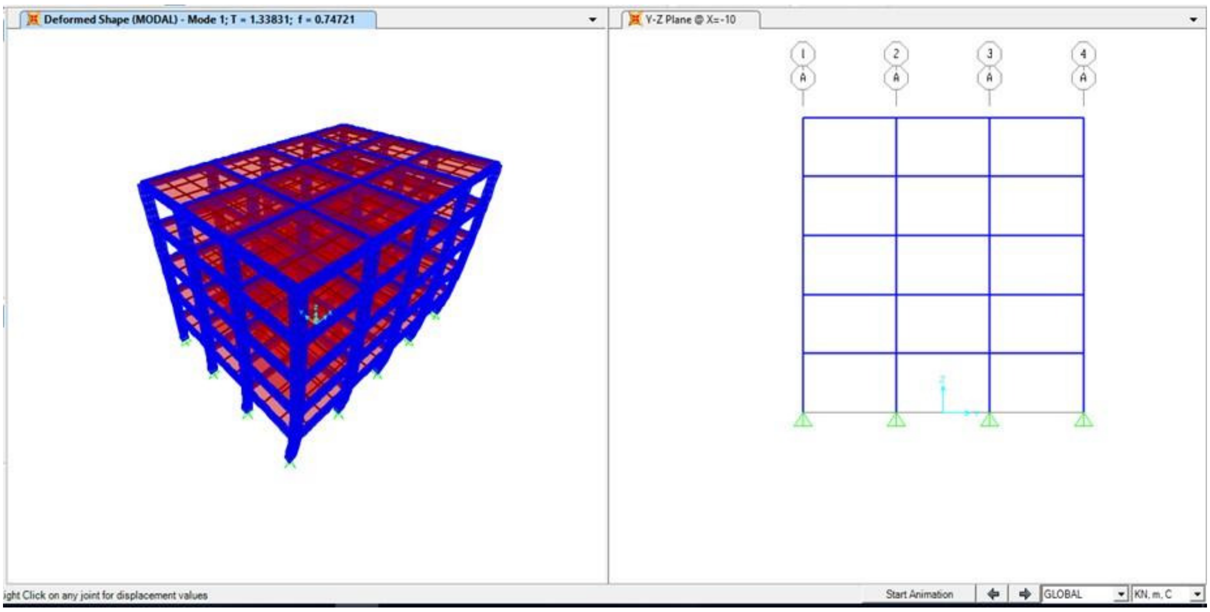

Fig 4.6: - Deformed Shape (MODAL); Mode 1 (without FC)

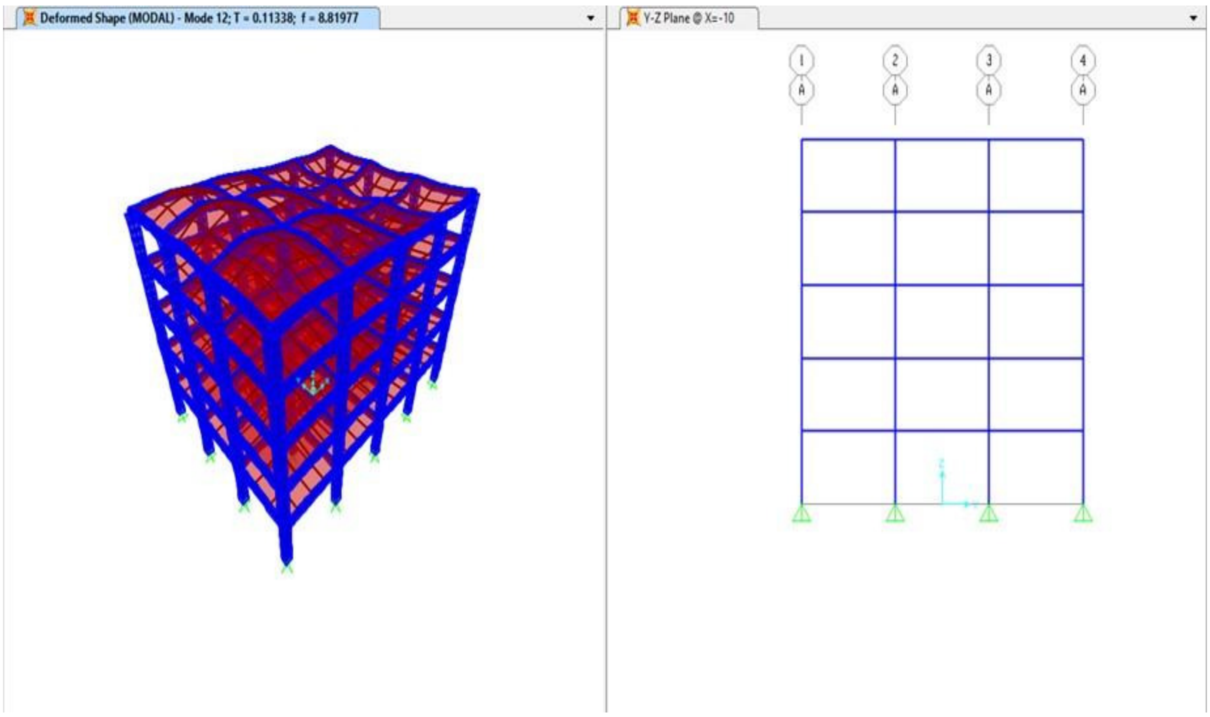

Fig 4.7: - Deformed Shape (MODAL); Mode 12 (without FC)

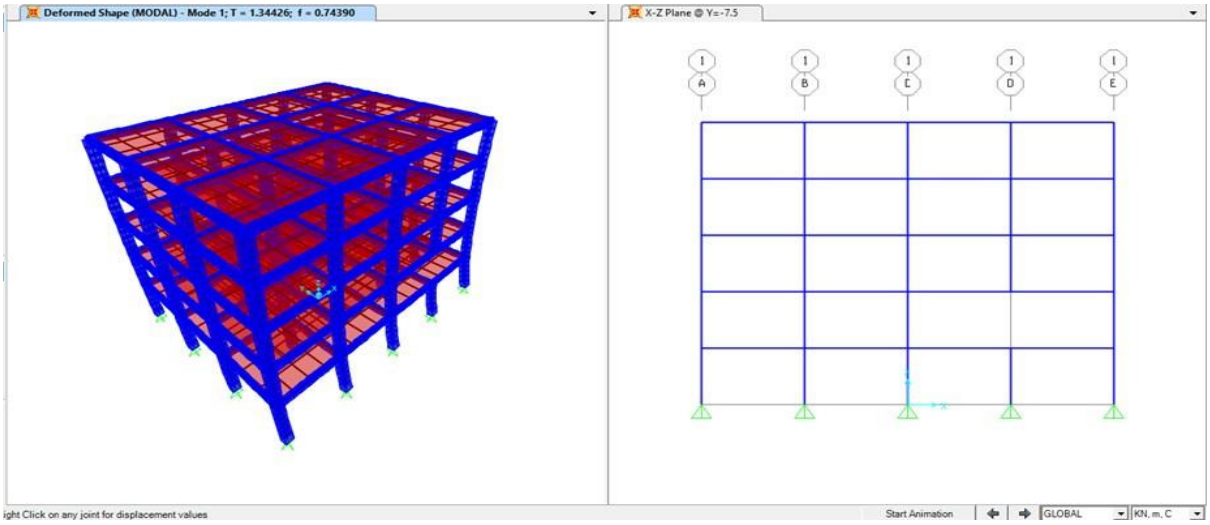

Fig 4.8: - Deformed Shape (MODAL); Mode 1 (FC at 1st floor)

4.3 Time History Analysis

For carrying out time history analysis data is used from file ARRAY06-2.

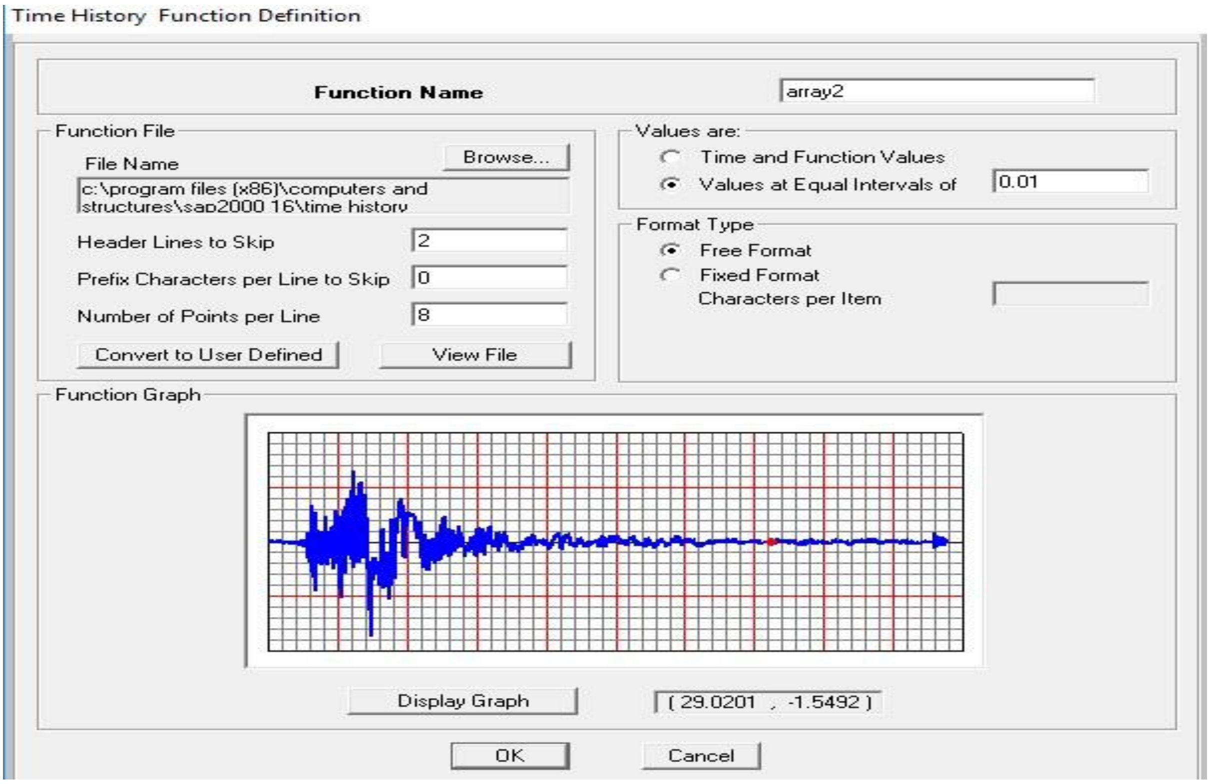

Fig 4.9: - Time history function definition

CHAPTER-5

RESULTS AND DISCUSSIONS

In present study, evaluation and comparison of seismic response parameter like time period, storey displacements, base shear, and dynamic response are done by changing the position of floating column level wise or floor wise by using linear static analysis. Result are associated in tabular form and also graphs are prepared for the analysis of building models with and without floating column.

5.1 Modal Analysis

Modal analysis generally gives the deformed mode shape, time period and frequency for the given structure. The result of the investigation is as below.

5.1.1 Time Period (in sec)

The time period of the structure for a specific mode shape is the time required essential to complete the oscillation for corresponding mode shape. After providing unit displacement to the structure and when freeing the displacement suddenly the structure tends to move in back and forth motion having some time period which is termed as fundamental time period of the structure.

Time period founded for building with floating column and building without floating column for various models are given in the *Table 5.1,* also variation in time period is shown in *fig. 5.1* graphically.

Table 5.1: - Time Period (in sec) for various models

Mode	Building without FC (model1)	Building with FC at 1st Floor (model2)	Building with FC at 2nd Floor (model3)	Building with FC at 3rd Floor (model4)
1	1.330	1.344	1.340	1.338
2	1.232	1.237	1.234	1.232
3	1.280	1.132	1.129	1.127
4	0.381	0.386	0.386	0.385
5	0.346	0.347	0.347	0.348
6	0.318	0.319	0.320	0.320
7	0.193	0.199	0.201	0.201
8	0.171	0.194	0.190	0.186
9	0.161	0.172	0.173	0.172
10	0.121	0.161	0.161	0.160
11	0.117	0.122	0.121	0.121
12	0.113	0.117	0.1167	0.117

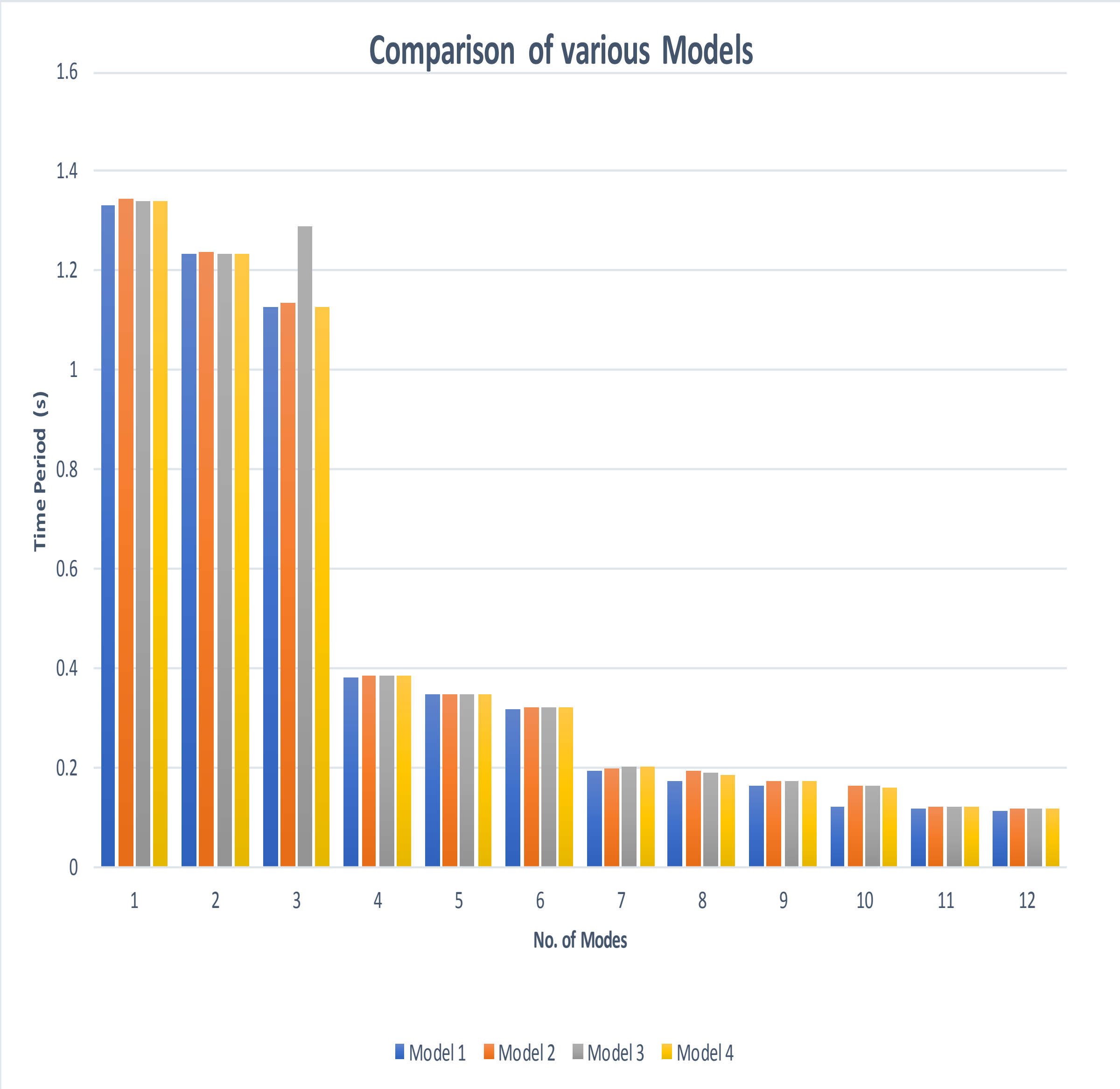

Fig 5.1: - Comparison of time period for no. of modes and for various models

5.2 Response Spectrum Analysis

5.2.1 Base Reaction (in KN)

Base shear defined as horizontal reaction at the base in contrast to horizontal quake load. This base shear acts at base or at the support level of the structure or at the fixed ends of structures.

The distinction in base shear due to the different position of floating or hanging column floor wise are tabulated in *Table 5.2*, also variation in base shear are shown through graph in *fig 5.2*.

Table 5.2: - Base Reaction (in KN) for various models

Model Description	**Base Reaction (in KN)**
Building without FC (Model-1)	1308.901
Building with FC at 1st Floor (Model-2)	1300.962
Building with FC at 2nd Floor (Model-3)	1303.483
Building with FC at 3rd Floor (Model-4)	1305.468

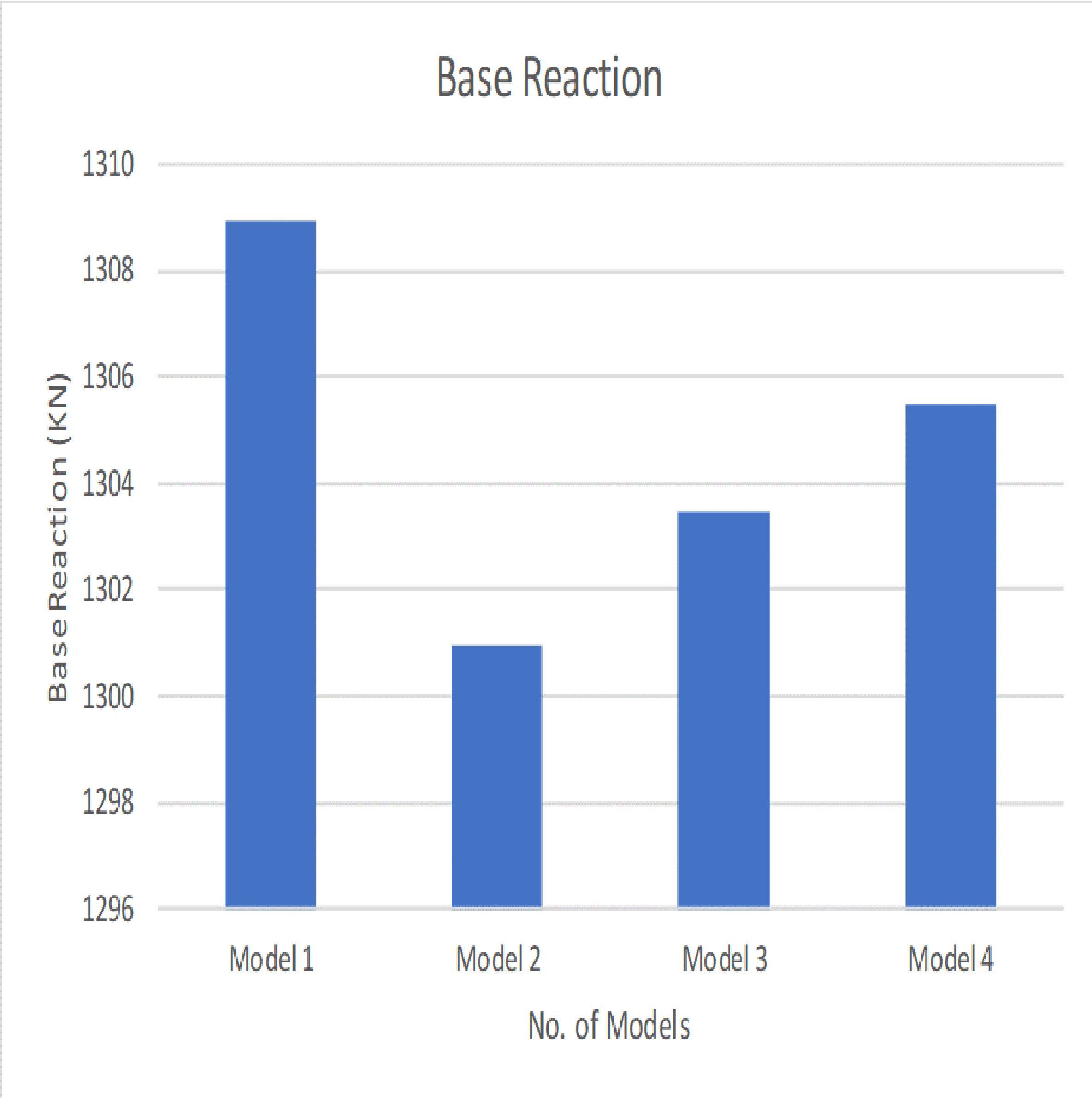

Fig 5.2: - Comparison of Base Reaction for various models

5.2.2 Storey Displacement

Table 5.3: - Displacement of Various Models along X-Direction (in mm)

S. No.	Height of Structure	Displacement in Direction-X (mm)			
		Model-1	Model-2	Model-3	Model-4
1.	0	0	0	0	0
2.	3.1	7.000	7.700	7.500	7.510
3.	6.2	12.000	12.500	12.100	12.110
4.	9.3	15.300	15.700	15.500	15.310
5.	12.4	17.000	17.900	17.700	17.600
6.	15.5	18.001	19.200	19.100	18.990

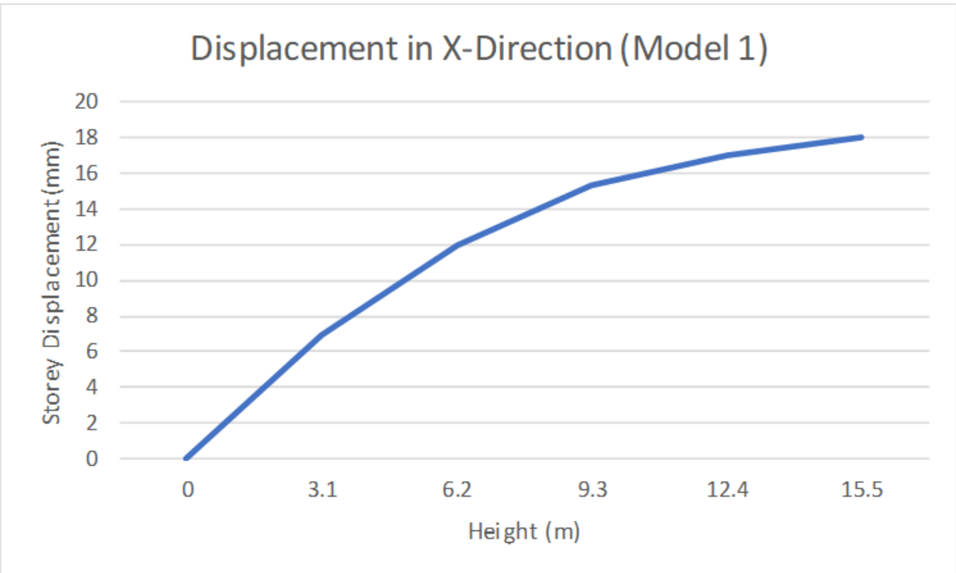

Fig 5.3: - Model-1, Storey Displacement in X-direction

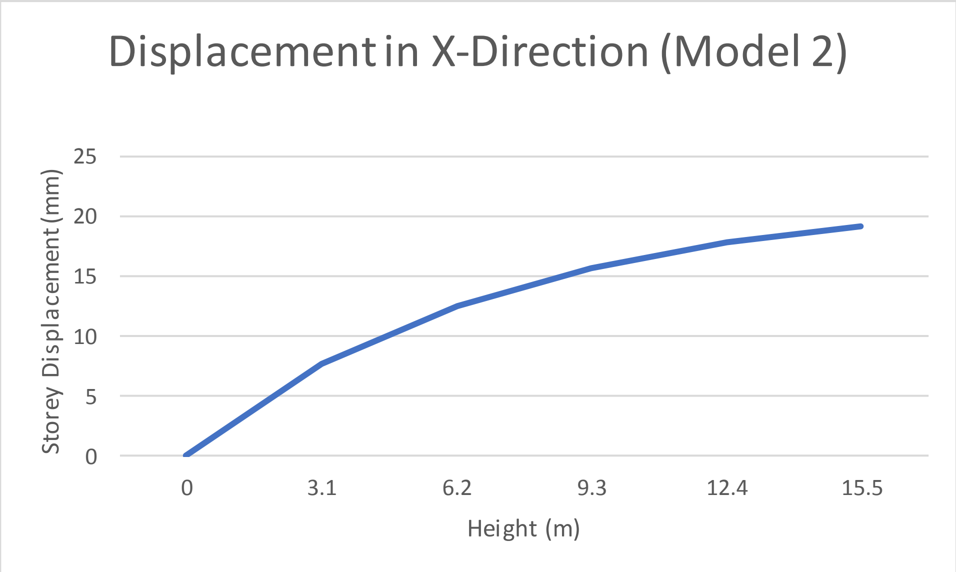

Fig 5.4: - Model-2, Storey Displacement in Direction-X

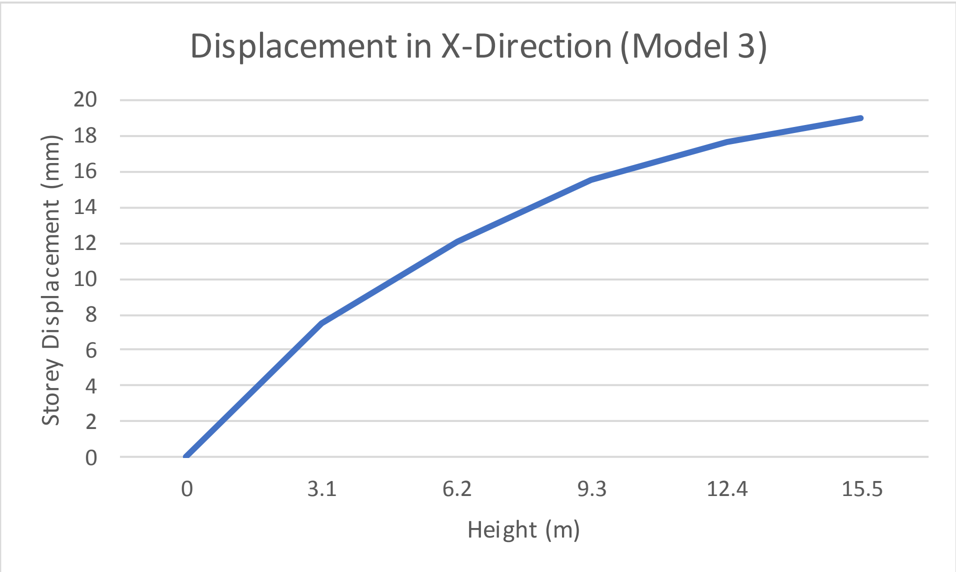

Fig 5.5: - Model-3, Storey Displacement in Direction-X

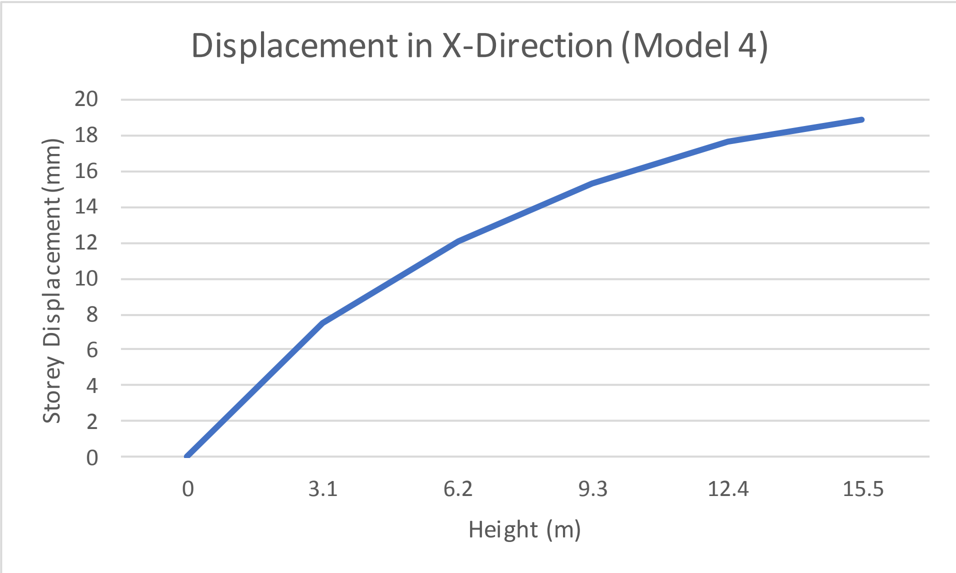

Fig 5.6: - Model-4, Storey Displacement in X-Direction

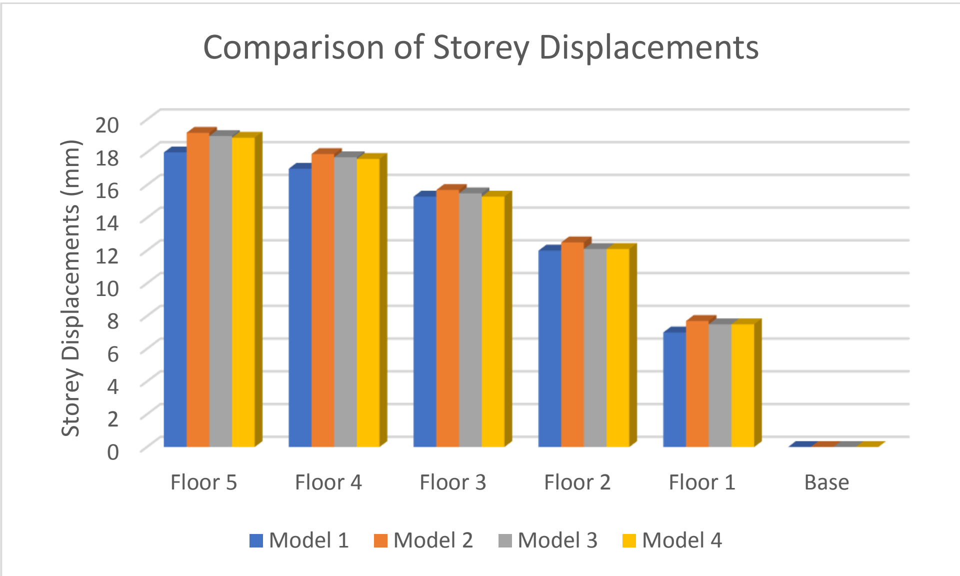

Fig 5.7: - Comparison of Storey Displacement of various models

5.3 Time History Analysis

Table 5.4: - Comparison of Base Reaction (in KN) of Various Models

S. No.	Model Description	Base Reaction (KN)
1.	Building without FC (Model-1)	1675.160
2.	Building with FC at 1st Floor (Model-2)	1692.040
3.	Building with FC at 2nd Floor (Model-3)	1687.560
4.	Building with FC at 3rd Floor (Model-4)	1686.100

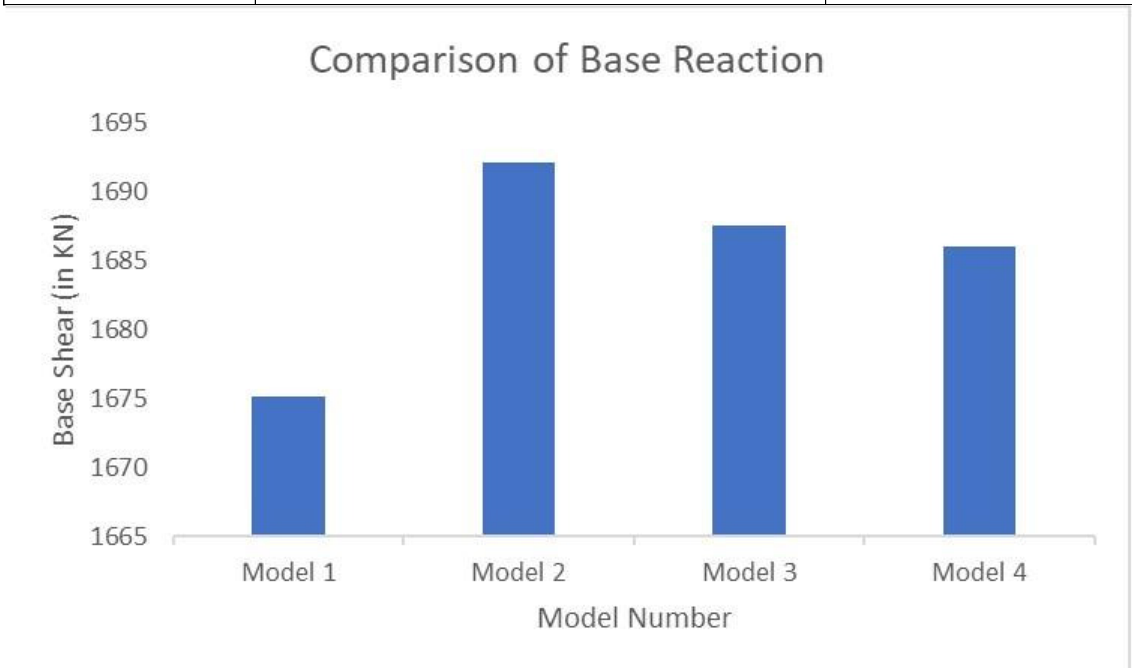

Fig 5.8: - Comparison of Max. Base Reaction (KN) of Various Models

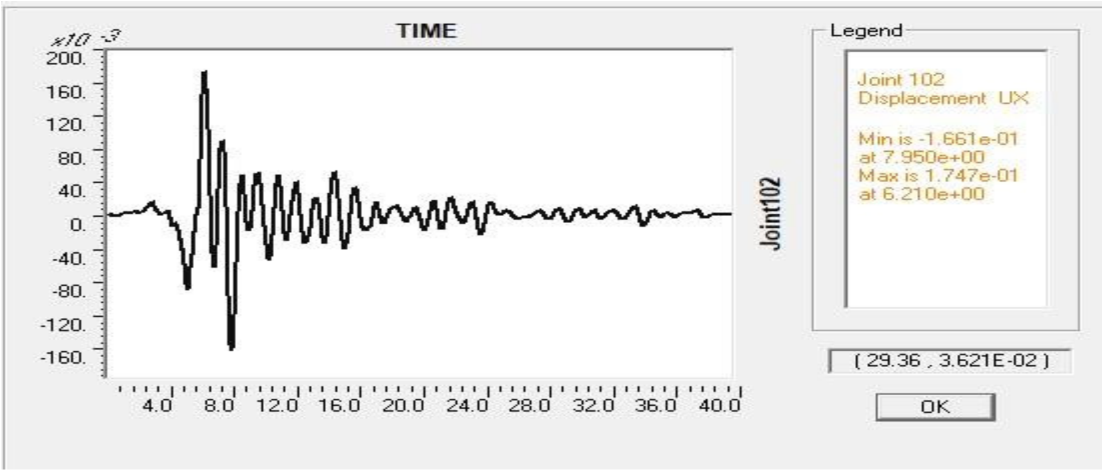

Fig 5.9: - Displacement v/s Time (Plot) for Model-1 (without Floating Column)

From *fig. 5.9*, this is clear that at the time of occurrence of earthquake on structure, the output we get from the building is similar to that of input. The topmost displacement of building is found to be 0.174 m.

At Joint 74

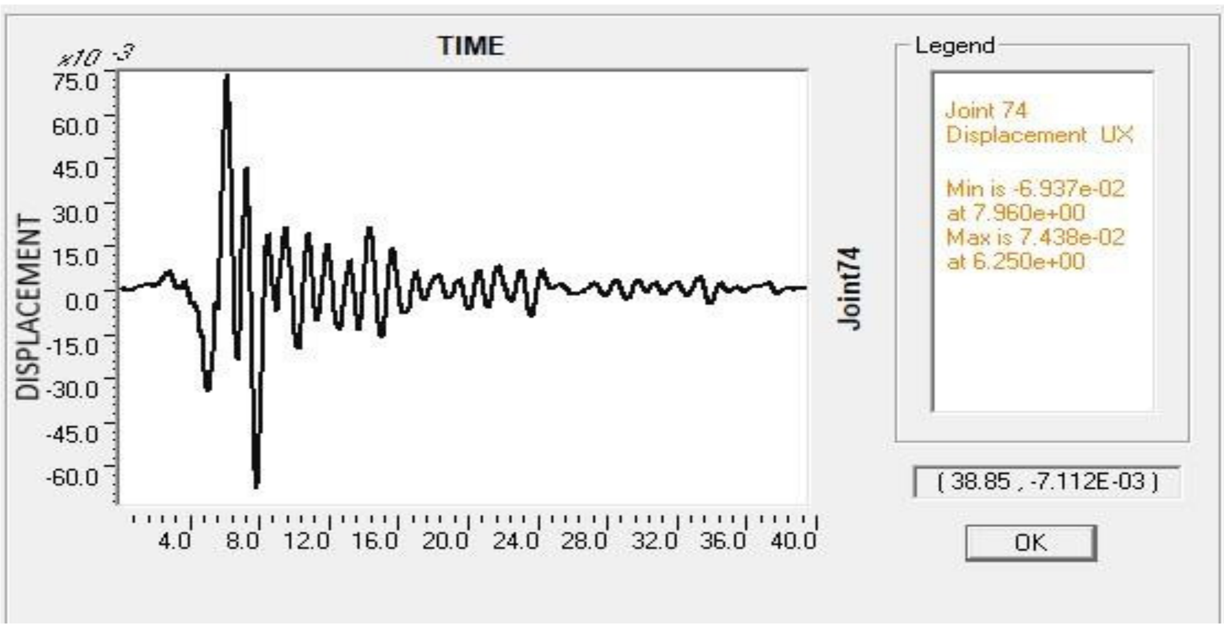

Fig 5.10: - Displacement v/s Time (Plot) for Model-2 (Floating Column at 1st Floor)

From *fig 5.10*, it is concluded that when earthquake strikes on a building, building output is same as that of input provided. The highest displacement of joint 74 is found to be 74.4 mm.

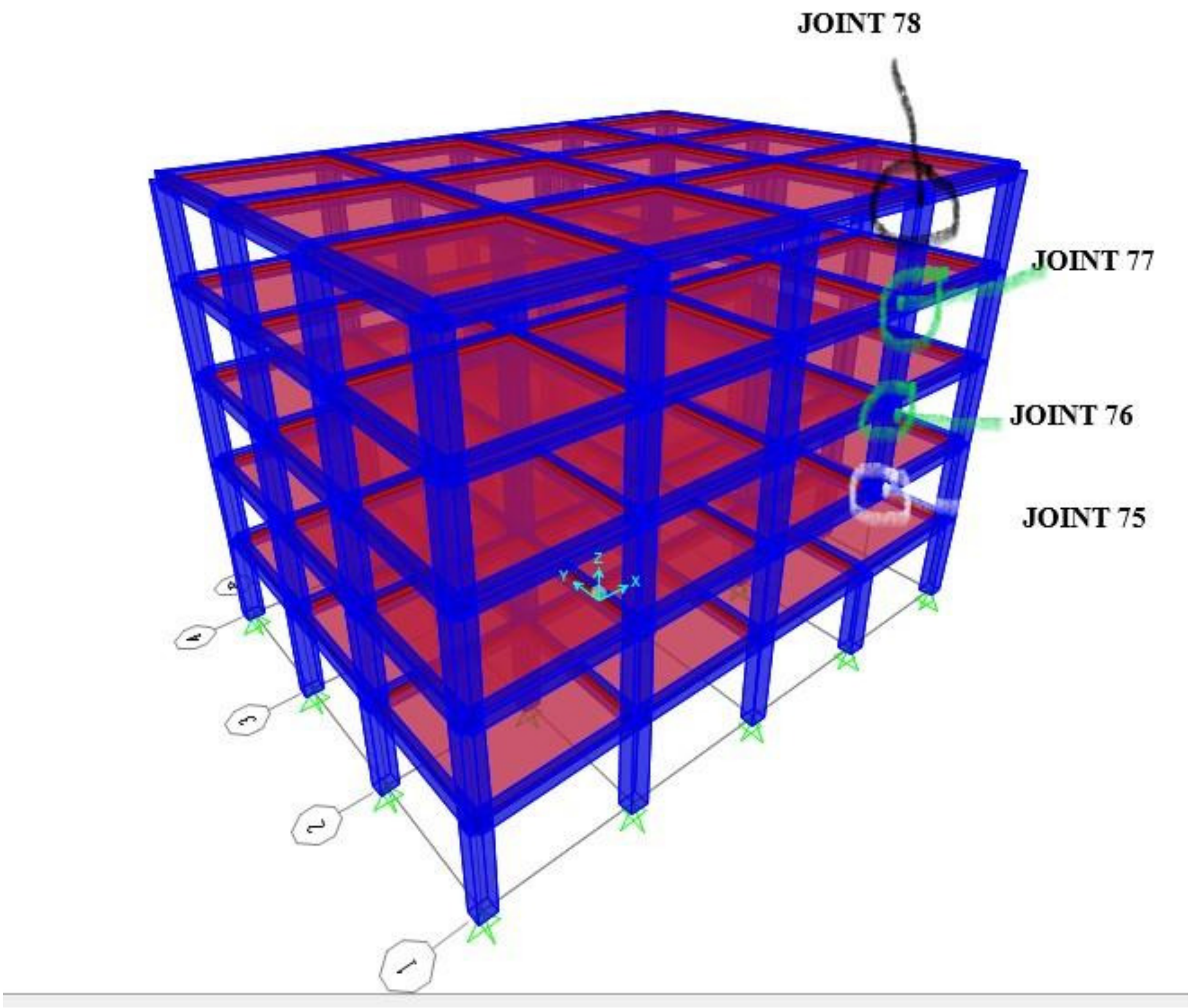

Fig 5.11: - Joint detailing of 3D Model

For Joint 75

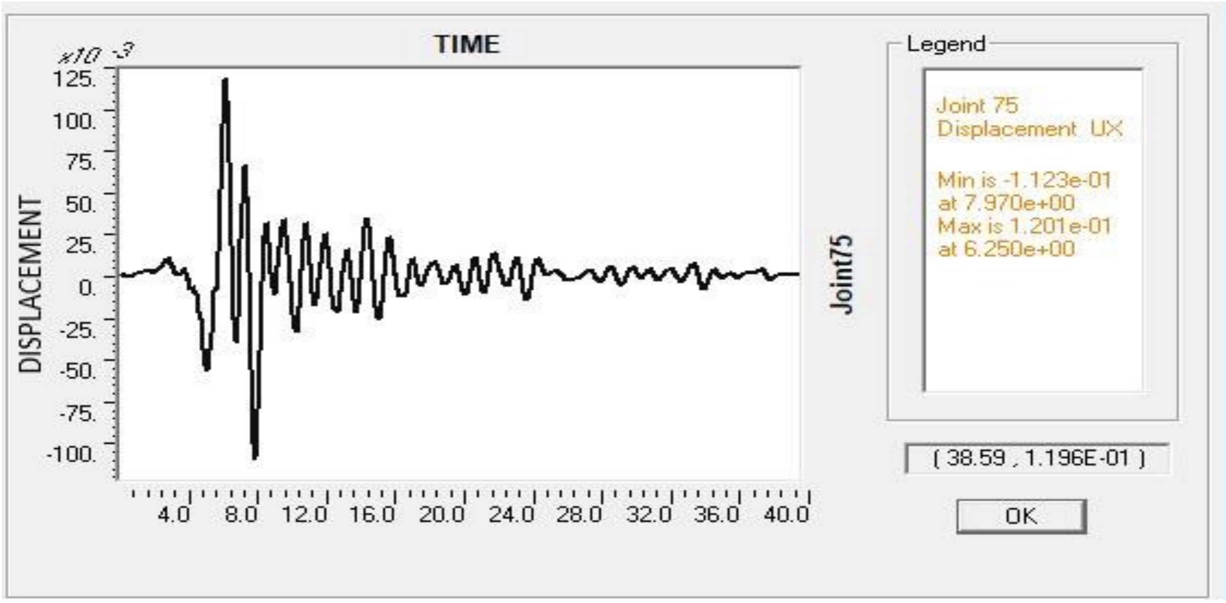

Fig. 5.12: - Displacement v/s Time (Plot), for Model-2, Joint 75

From the above figure we can see that the peak displacement of the joint 75 is 120mm.

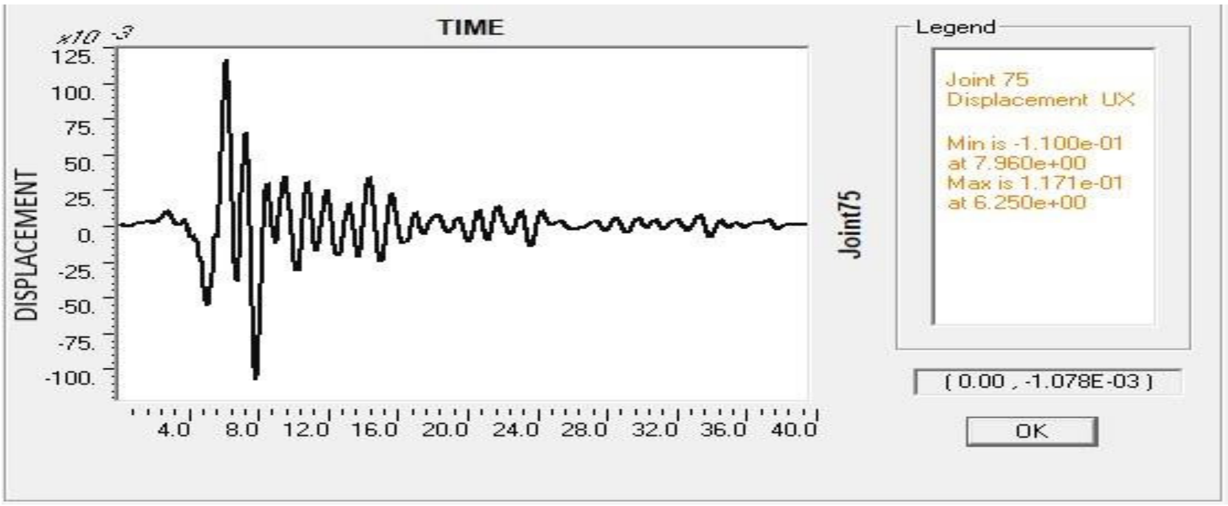

Fig 5.13: - Displacement v/s Time (Plot) for Model-3 (Floating Column at 2nd Floor), Joint 75.

From the *figure 5.13*, this is directly seen that at the time of earthquake, the supreme displacement of joint 75 along x-direction is 0.117 m.

Joint 76

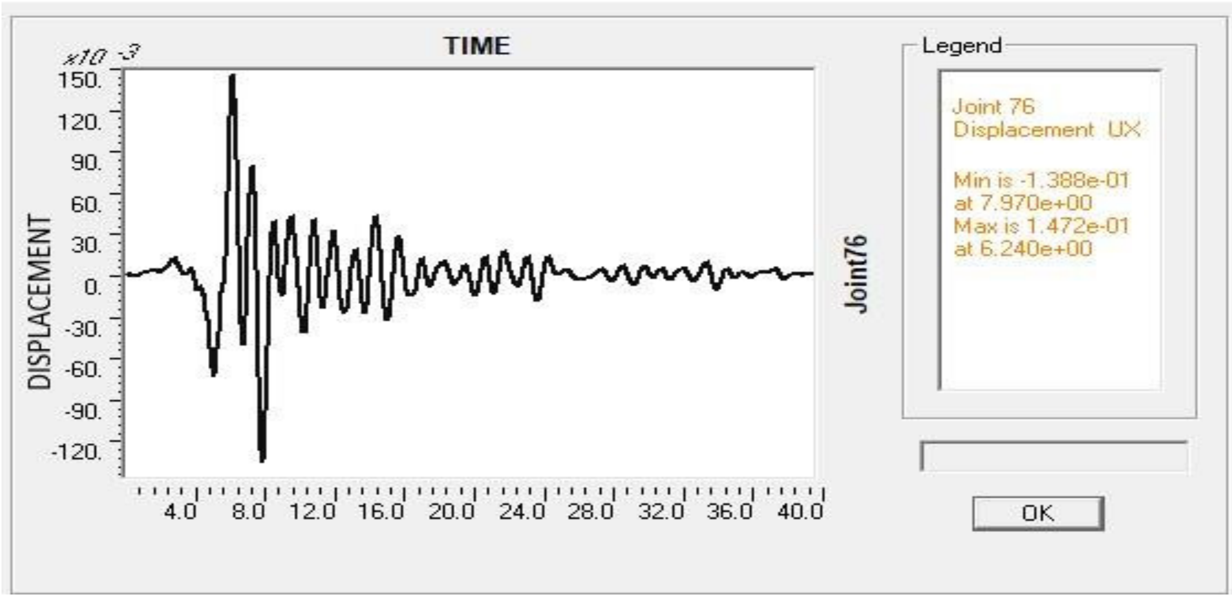

Fig 5.14: - Displacement v/s Time (Plot) for Model-3 (Floating Column at 2nd Floor)

From *figure 5.14*, it is cleared that the peak displacement of joint 76 is 0.1472 m.

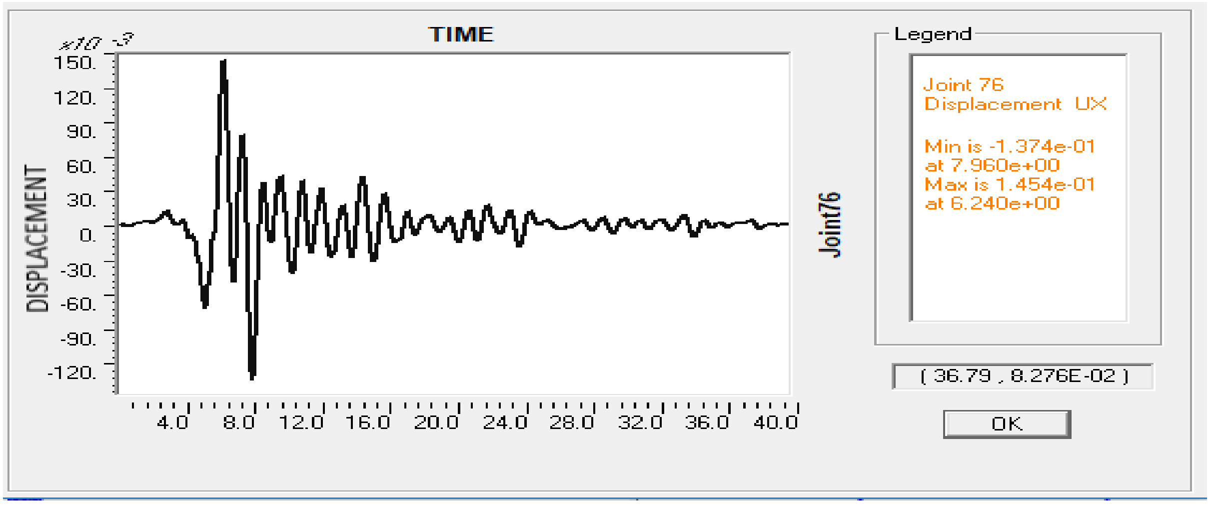

Fig 5.15: - Displacement v/s Time Plot, for Model-4 (Floating Column at 3rd Floor)

It is concluded from the above plot that the maximum displacement of the joint is 0.1454m.

Joint 78

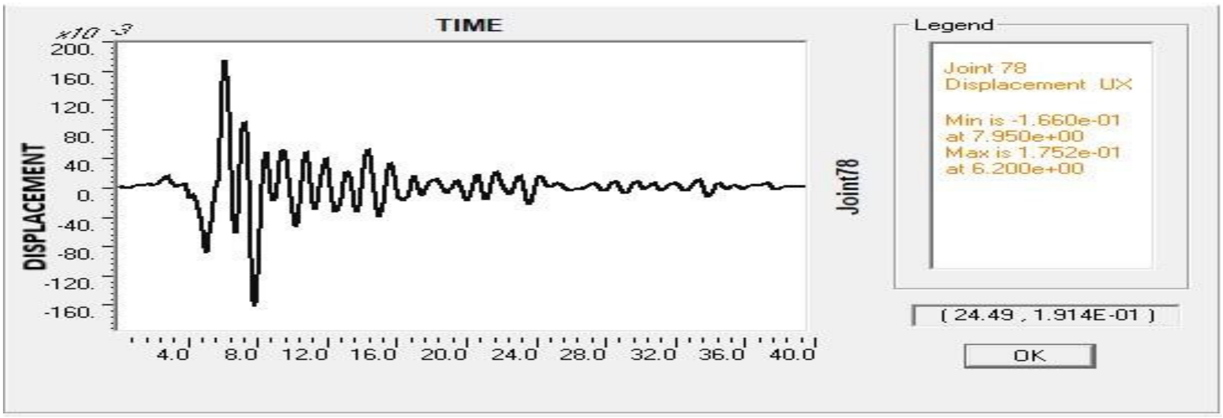

Fig 5.16: - Displacement v/s Time Plot, for Model-4 (Floating Column at 3rd Floor)

CHAPTER-6

CONCLUSIONS AND FUTURE SCOPE

6.1 Conclusions

Following conclusions are drawn from the present study;

- Time period of the building without floating column is less and is maximum when floating column is near the basement. It tends to decrease when hanging column is present in the upward floors.
- Displacements of various floors in longitudinal direction i.e. x-direction is determined and it has been seen that when floating column is provided storey displacement is slightly higher than the normally constructed building without considering any discontinuity.
- From the response spectrum analysis, base reaction of the building rises when we move floating column to the upper floors being lowest for the first floor and maximum when there is no such floating column.
- Drift of a particular storey increases due to the existence of floating column in the structure.
- It has been seen that chances of failure of buildings with floating column are much higher as compared to the buildings without floating column.

6.2 Suggestion for Future Work

The present study depends upon few approximations and assumptions which can be improved through advanced research. Few technical aspects might be considered for the future study to be presented, as given below;

1. Effect of strut supports in various location on the building with floating column can be studied as it can be helpful in minimization of deflection.

2. Non-linear properties can be considered in analysis for assessing the behaviour of building with irregularities when subjected to various quake excitations.

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