SEISMIC PERFORMANCE OF PLAN IRREGULAR RC-FRAMED BUILDINGS WITH SOFT STOREY

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE AWARD OF THE DEGREE

OF

MASTER OF TECHNOLOGY

IN

(STRUCTURAL ENGINEERING)

UNDER THE SUPERVISION OF

Dr. ALOK VERMA

Submitted By

KAILASH PRAKASH

University Roll No-2K17/STE/05

DEPARTMENT OF CIVIL ENGINEERING

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

Bawana Road, Delhi, India-110042

JULY,2019

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

Bawana Road,Delhi,India-110042

CANDIDATE`S DECLARATION

I **KAILASH PRAKASH**, Roll no **2K17/STE/05** student of **M.Tech**, Structural Engineering, hereby declare that the project dissertation titled "**SEISMIC PERFORMANCE OF PLAN IRREGULAR RC-FRAMED BUILDINGS WITH SOFT STOREY**" which is submitted by me to the Department of Civil Engineering, Delhi Technological university, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associateship or any similar title or recognition.

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Date:

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

Bawana Road, Delhi, India-110042

CERTIFICATE

I hereby certify that the project Dissertation Titled "**SEISMIC PERFORMANCE OF PLAN IRREGULAR RC-FRAMED BUILDINGS WITH SOFT STOREY**" which is submitted by **KAILASH PRAKASH**, Roll no: **2K17/STE/05**, Civil Engineering Department, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is a record of project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this university or elsewhere.

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ABSTRACT

In building, Vertical irregularities are very common feature in urban area, vertical irregular buildings are available in large number in modern urban infrastructures. In Multi-story building comes Soft storey building in which one storey is kept open for the purpose of vehicle parking, shops, commercial purposes etc. This project work done for the study of seismic performance of plan irregular rc-framed buildings with soft storey seismic response at different level.

The study followed the modeling of a G+5 storied irregular RC building with soft storey. The drawing and elevation of building is created in AutoCAD 2016 and then imported in STAAD.Pro V8i for analysis and Design using IS codes. In this study collected displacement, stress and base shear have been carried out using equivalent static analysis to investigate the influence of these parameter on the seismic behaviour of buildings with soft storey. For the selected building, analysed 2 cases A case for irregularity and B case for soft storey. Irregularity building have 2 cases, first case has number of column 25 NOS and second case have number of column 26 NOS. 25 and 26 columns have same cross section area.

After these analysis and design, compared max bending moment, max. shear force, concrete and steel area for all cases.

ACKNOWLEDGEMENT

"It is not possible to work upon a project without the assistance & encouragement of other people. This one is certainly no exception."

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Thanking You

KAILASH PRAKASH

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The structural failure begins at points of weakness during an earthquake and its deficiency occurs owing to weight discontinuity, rigidity and structural geometry. These discontinuity structures are called irregular structures. Much of the urban infrastructure is supported by irregular constructions. One of the principal factors for structural errors during earthquakes is vertical irregularity. Structures with smooth flooring, for instance, were the most remarkable collapsing buildings. So, the vertical irregularities have a foremost impact on the seismic performance of constructions of building. The modifications in rigidity and mass in height make these dynamic features of the building. [1]

The soft story has irregularity that will be relates to the presence of a building floor. It has a considerably reduced stiffness by removing walls and other elements than the others, subsequently it is additionally called flexible storey. This is generated unconsciously with the aid of removing or lowering the variety of rigid non-structural walls on one of the flooring of a building, or with the aid of not thinking about the structural plan and analysis, the restriction of free deformation that enforces on the relaxation of the floors, the attachment of inflexible factors to the structural components that have been no longer at first taken into consideration.[2]

In building changes produced by irregular components of structure on the seismic performance of the building. These terms nonintentionally non-structural has been assigned to these components. This process is using since the end of the 1980's (Guevara, 1989). The ASCE/SEI 7-10 documents, that are defines soft story as irregularity. The outcome due to soft storey is not foreseen on the structural design, it means irreversible damage will commonly be present on both the structural and non-structural components of that floor due to irregularity. [3]

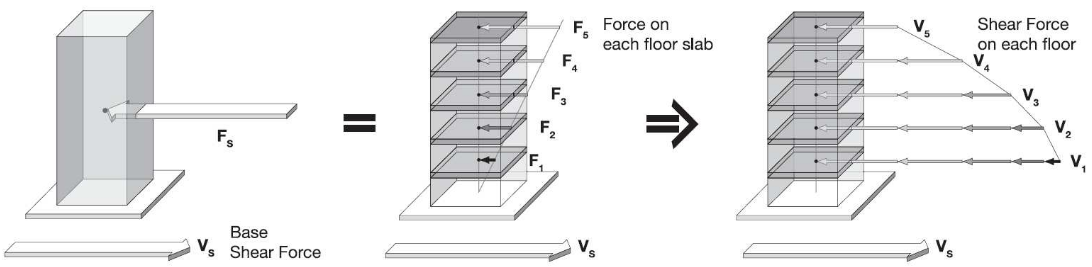


Fig. 1.1 After ground motion Lateral forces and shear forces generated in buildings [1]

This may also reason the local collapse and in several instances even the complete cave in of the building, the smooth first storey is the one of the most frequent feature of soft storey irregularity. It commonly is existing in contemporary body buildings when a large quantity of non-structural inflexible components. Like Masonary walls are connected to the columns of the apex flooring of a reinforced concrete frame structure whilst the first story is left vacant of partitions or with a reduced variety of walls in evaluation to the upper floors.

The inflexible non-structural elements restriction the capacity to deform of the columns, modifying the structural performance of the building to horizontal forces. In a normal building, the earthquake shear forces amplify closer to the first story. The total displacement (ΔT) caused with the aid of an earthquake be likely to bifurcate homogeneously in every flooring at some point of the top of the building. Deformation in each floor would be analogous to each other.

In the structure of building regularity may be due to improper bifurcation in their strength, mass and stiffness along the height of constructed structure. When any buildings are constructed in severe seismic zones then the analysis and design will be very tangled. The fundamental objective of past and current seismic design codes is to provide solutions towards the good performance of a building in standard conditions, whilst maintaining its integrity against extraordinary events.[4]

Global integrity must be guaranteed in order to preserve human lives, even allowing non-repairable damage to occur. Thus, this design philosophy envisions the structure to undergo large deformations in the event of a high intensity earthquake, sustaining severe amounts of controlled damage, while maintaining an acceptable working condition during low to medium intensity events.[5]

Conceptual difficulties arise in establishing a rigorous basis to guarantee adequate performance and global integrity of a structure, this is currently accomplished in the performance-based design codes by establishing performance objectives. Performance objectives are thus a selection of design criteria which include: selection of structural system, representative delimitation of seismic hazard, and appropriately chosen indices which are representative of a certain damage state of the structure. The latter criteria are known as "limit states" and set thresholds upon engineering demand parameters such as drift, ductility, etc. [6]

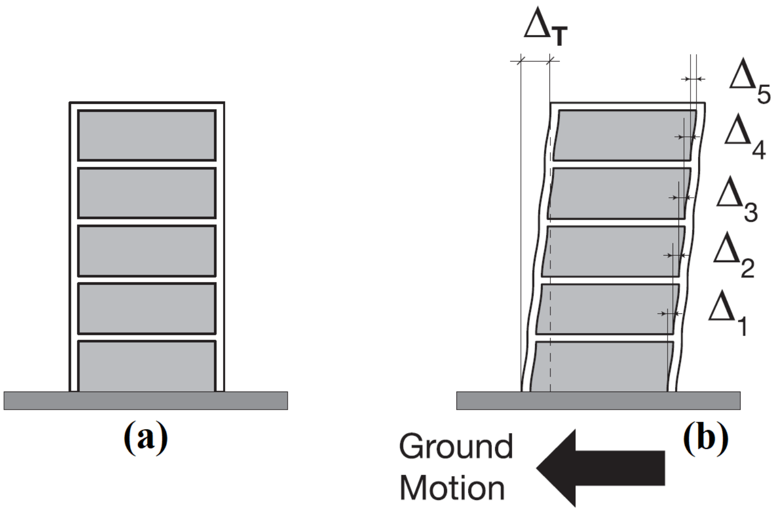


Fig. 1.2 (a) and (b) After ground motion Lateral forces and shear forces generated in regular buildings [2]

Limit states which comply with safety on high intensity seismic are called "ultimate" (ULS), while the ones attending performance on normal working conditions are named "serviceability limit states" (SLS). Satisfying a certain performance objective is complying with a series of limit states at different levels of seismic demand. [7]

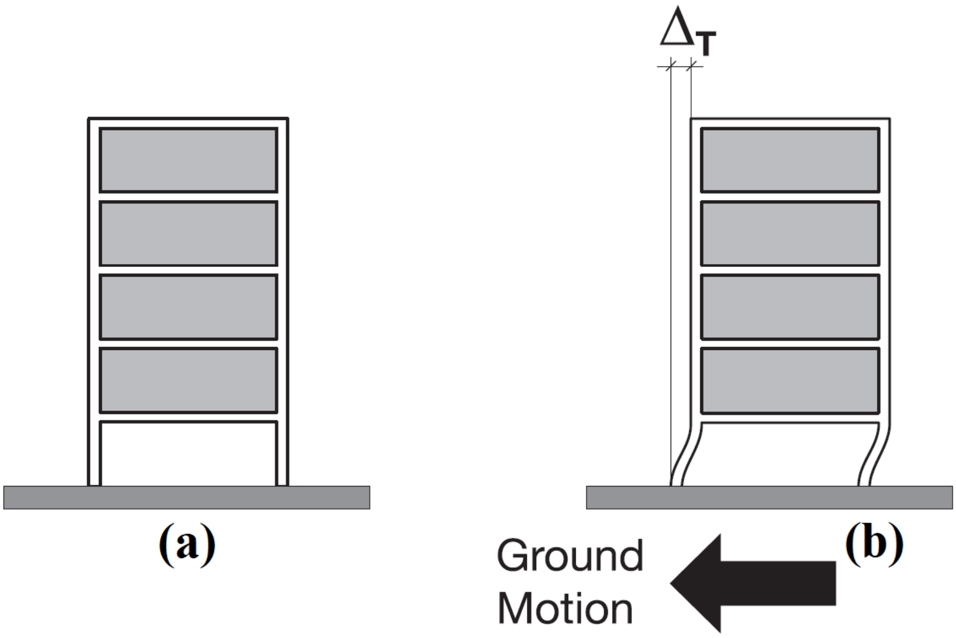


Fig. 1.3 (a) and (b) After ground motion Lateral forces and shear forces generated in soft irregular buildings [2]

The bulk of the strength will be immersed by the decrease notably huge bendy storey whilst the minute the rest of strength will be dispensed amongst the higher greater inflexible storeys, producing on the most flexible floor, large relative displacement between the decrease and the top slab of the smooth storey (inter storey drift) and therefore, the columns of this ground will be subjected to huge deformations as shown in Fig. 1.2 (a), (b) and Fig. 1.3 (a), (b).[8]

1.2 Types of irregularities

There are five types of irregularities-
1. Stiffness Irregularities
2. Weight (Mass) Irregularities.
3. Vertical geometry Irregularities.
4. In-Plan Discontinuity in Vertical Lateral Force Resisting Elements
5. Discontinuity in Capacity - Weak Story

1.2.1 Stiffness irregularity

There are 2 types of stiffness irregularities-
A-Soft Storey
B- Extreme Soft Storey

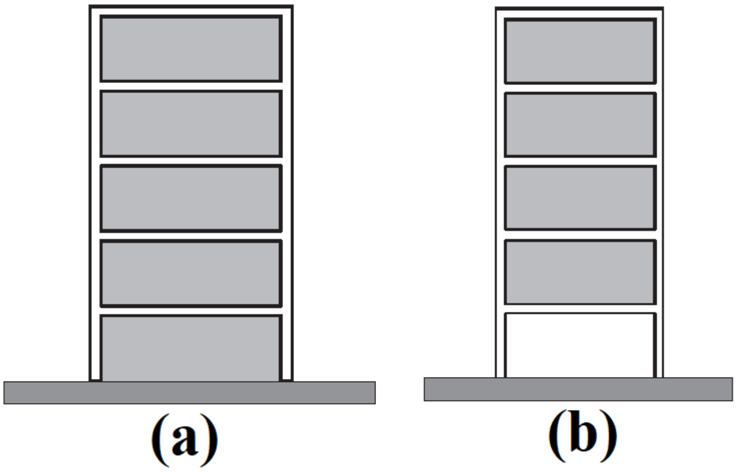


Fig. 1.4 (a) Regular building, (b) Soft Storey irregular buildings[3]

A Soft storey

A soft storey is one in which the lateral stiffness is less than the storey above or less than 80 % of the average lateral stiffness of the three storeys above. [8] Regular building shows in Fig. 1.4 (a) and Soft storey irregular building shows in Fig. 1.4 (b).

B Extreme soft storey

An extreme soft storey is one in which the lateral stiffness is less than 60 percentage of that in the storey above or less than 70 percentage of the average stiffness of the three storeys above. Example of extreme soft storey shows in Fig. 1.5. [9]

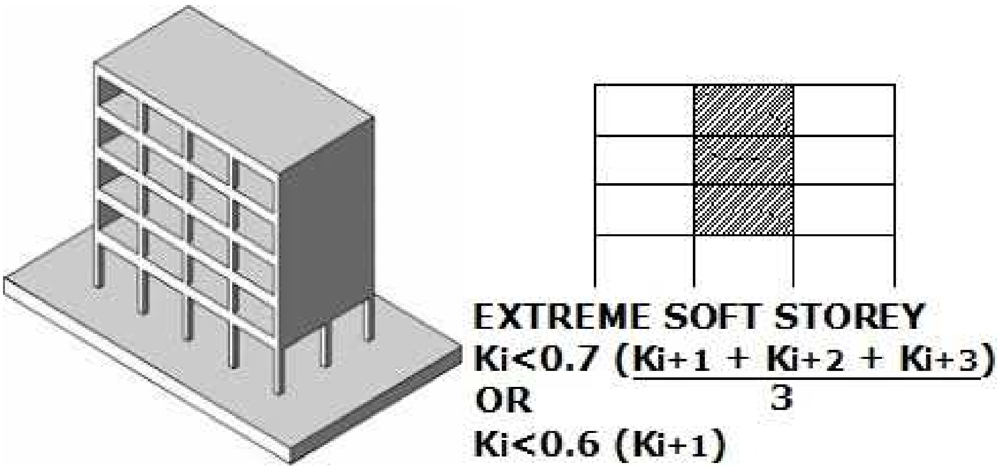


Fig. 1.5 Extreme soft storey[5]

1.2.2 Weight (mass) stiffness irregularity

Mass irregularity shall be considered to exist where the seismic weight of any storey is more than 200 percentage of that of its adjacent storeys. In the roof case there is no need to consider the irregularity. Example of mass stiffness irregularity shows in Fig. 1.6. [10]

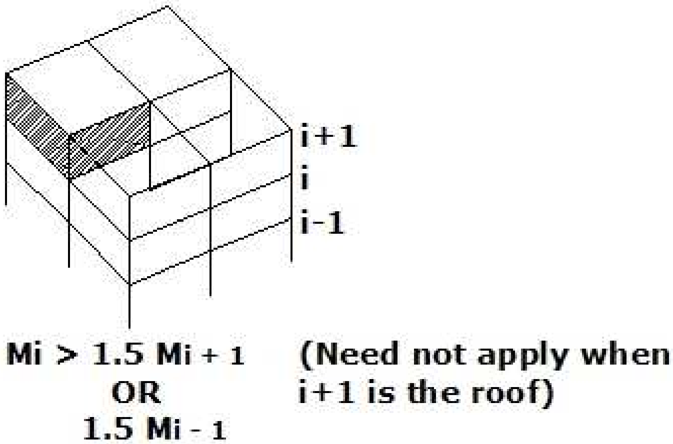


Fig. 1.6 Mass stiffness irregular buildings [7]

1.2.3 Vertical geometric irregularity

A structure is considered to be Vertical geometric irregular when the horizontal dimension of the lateral force resisting system in any storey is more than 150 percent of that in its adjacent storey. Example of Vertical geometric irregularity can be seen in Fig. 1.7. [11]

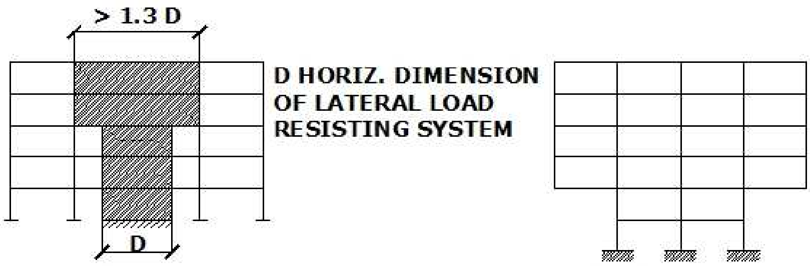


Fig. 1.7 Mass stiffness irregular buildings[9]

1.2.4 In-Plane discontinuity in vertical elements resisting lateral force

An in-plane offset of the lateral force resisting elements greater than the length of those elements. Example of Vertical geometric irregularity shows in Fig. 1.8.

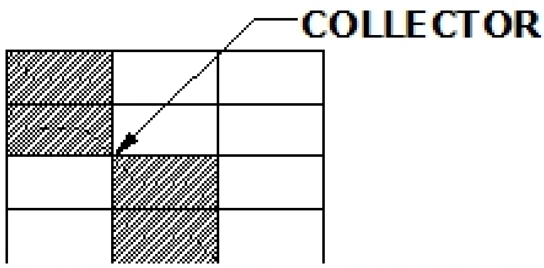


Fig. 1.8 In-Plane discontinuity in vertical elements resisting lateral force [9]

1.2.5 Discontinuity in capacity

Weak Storey-A weak storey is that one in which the story lateral strength is less than 80 percentage of that in the story above. As per IS 1893, Part 1 Linear static analaysis of structures can be used for regular structures of limited height as in this process lateral forces are deliberate as per code based fundamental time period of the structure. Linear dynamic analaysis is an advancement over linear static analaysis, as this analysis produces the effect of the higher modes of vibration and the actual bifurcation of forces in the elastic range in a better way. [13] [14]

1.3 Dissertation layout

This dissertation is divided in 5 chapters.

Chapter 1 Comprises the introduction about regular and irregular type building. In this discussed about types of irregularity such as Stiffness Irregularities, Weight (Mass) Irregularities, Vertical geometry Irregularities, in-plan Discontinuity in Vertical Lateral Force Resisting Elements and Discontinuity in Capacity - Weak Story.

Chapter 2 Consists of the literature review about the irregularity and regularity in building and about the analysis and design of multi-storeyed and high-rise building, its results.

Chapter 3 Describes about the methodology used for Plan, Elevation view creation using AutoCAD and STAAD.Pro for analysis and design of building applied load and boundary conditions according Indian Standards.

Chapter 4 Describes the detailed results and discussion of Case A, Case B, Case 1 and Case 2 of G+5 Floor building used in this study. These results consist of displacement, Von mises stress, shear force, max. bending moment, concrete and steel area. In this chapter all cases results are compared of G+5 Floor building.

Chapter 5 provides the conclusion drives from this study and suggested future scope.

CHAPTER 2

LITERATURE REVIEW

2.1 LITERATUTRE REVIEW

Dr. S.K. Dubey & P.D. Sangamnerkar [1] Building with irregularities is reported to be susceptible to earthquake harm, as is evident from many events, Because traditional codes do not offer streamlined analytical instruments for uneven buildings structure. This is vital to develop an easy analytical procedure on the basis of stringent calculations and seismic response tests for irregular structures of buiding. A 3D building assessment using computer-analytic programs for general purposes can look after' e' eccentricity, but without displaying its size. However, there is no general computer program to be able to account for the eccentricities of the building, since on every floor and floor. There is no direct method to calculate the center of rigidity or the center of Shear for the building.

Gaurav Joshi et. al. [2] Various geometrical and seismic parameters are used to study performance of building frames. All the results of this parametric study show that moments and shear forces are always maximum when first storey is soft for all types of buildings structure. Similarly, axial forces and drifts are also found to depend on Structural and geometrical parameters, result will be very helpful for design engineers in fast and reliable assessment of the effects of soft storeys.

Devendra Dohare & Dr.Savita Maru [3] RC body constructions with tender story are considered to operate poorly at some point of in robust earthquake shaking. Because the stiffness at decrease flooring is 70% lesser than stiffness at storey above it inflicting the smooth storey to happen. For a constructing that is no longer supplied any lateral load resistance thing such as shear wall or bracing, the power is reflect on consideration on very vulnerable and easily fail at some stage in earthquake. In such a situation, an investigation has been made to learn about the seismic behavior of such structures subjected to earthquake load so that some tenet ought to be developed to limit the hazard concerned in such type of buildings.

Sagar R Padol & Rajashekhar S. Talikoti [4] Seismic analysis of the RCC constructions with one of a kind irregularity such as mass irregularity, stiffness and vertical geometry irregularity. Whenever a structure having extraordinary irregularity, it is necessary to analyze the constructing in various earthquake zones. From many past researches it is clear that impact of earthquake on structure can be minimize with the aid of offering shear wall, base isolation etc.

M.P. Mishra & Dr. S. K. Dubey [5] For drift and damage control study will be for the first story drift demand by conducting nonlinear analysis for the model representing soft story with keeping first story strength balance along the height as analysis variable. Since lateral deflection and drift affects the entire building or structure, design of non-structural element is also designed to allow the expected movement of structural system otherwise it will have adverse effect on whole system Hence for the optimization the performance of RCC Building to control the damage judging criteria to control drift of whole structure by performing the different modeling of the whole building using STAAD-Pro for different conditions for soft story building.

B.Rajesh et. al. [6] Static evaluation gives greater values for most displacement of the memories in both X and Y direction. The base shear cost due to RS analysis and static evaluation will be considerably enlarge at greater stories. The dynamic RS evaluation produces storey shear in each instructions whilst the static analysis solely produces storey shear in the route of loading. Base shear values acquired by means of manual evaluation are barely higher than software analysis. Static evaluation is not ample for high upward thrust buildings and it's quintessential to supply dynamic analysis. The outcomes of equivalent static analysis are approximately uneconomical because values of displacement are greater than dynamic analysis. Building with re-entrant corners skilled extra lateral flow and discount in base shear ability in contrast to everyday building.

Snehal S. Pawar et. al. [7] The Yield force is extra in case of everyday shape & much less in case of irregular structure whilst the yield Displacement price is also more in normal shape & less in irregular structure. Therefore, it has been concluded that irregular structure can't sustain greater pressure as compared to everyday structure consequently shape turns into damage. The analysis proves that irregularities are detrimental for the constructions and it is essential to have simpler and ordinary shapes of frames as nicely as uniform load distribution around the building.

Pathan Irfan Khan & Dr. Mrs. N.R.Dhamge [8] Seismic evaluation of the RCC buildings with one of a kind irregularities such as mass irregularity, stiffness and vertical geometry irregularity. Whenever a shape having one of a kind irregularity, it is critical to analyze the building in various earthquake zones. From many past studies it is clear that effect of earthquake on shape can be minimize by way of presenting shear wall, base isolation etc. The lateral displacement of the constructing is decreased as the percentage of irregularity increase.

Silpa Rani M V& Aiswarya S [9] The seismic response of an irregular RC constructing of G+6 with gentle storey at special levels. After evaluation the conclusions which received are as follows: Soft storey at ground level is a ordinary feature in the modern-day multistorey constructions in city India. Such elements are distinctly undesirable in constructions built in seismically lively areas this has been validated in severa experiences of sturdy shaking during the past earthquakes. Though multistorey constructions with open (soft) floor flooring are inherently prone to collapse due to earthquake load. In structures with tender first storey, the higher storeys being stiff, undergo smaller inter-storey drifts.

Bhavya B S & Jisha P [10] Floating column building indicates terrible performance during earthquake. RC body buildings with open first storeys are recognized to perform poorly for the duration of in strong earthquake shaking. The Drift and the power demand in the first storey columns are very large for buildings with tender ground storeys. It is now not very handy to furnish such capacities in the columns of the first storey. Thus, it is clear that such structures will exhibit bad performance at some point of a sturdy shaking. This hazardous function of Indian RC frame buildings needs to be recognized immediately, and fundamental measures taken to improve the performance of the building. The displacement of constructing will increase from lower zones to greater zones, because the magnitude of intensity will be more for greater zones, similarly for drift, due to the fact it is correlated with the displacement. In all models.

Mrs. Pragya Singhal [11] It is concluded that each floor of asymmetrical building (asymmetrical in more than one direction) is subjected to higher horizontal displacement in comparison of each floor of building having asymmetry in only one direction. It is also observed that, the storey drift values in the building is high in bottom floors than top floors as shear is dominating then the bending. In case of higher asymmetrical building, drift values are comparatively higher than drift values in less asymmetrical building. In case of reduction in stiffness or mass in a building, a sudden jump can be observed in drift values.

Gauri G. Kakpure & Ashok R. Mundhada [12] The evaluation of static and dynamic evaluation multistoried building. Design parameters such as Displacement, bending moment, Base shear, Storey drift, Torsion, Axial Force had been the center of attention of the study. It was once located that difference of values of displacement between static and dynamic evaluation is insignificant for lower memories however the distinction is improved in higher stories and static analysis offers higher values than dynamic analysis. Static evaluation is not enough for high upward jostle buildings and it's crucial to grant dynamic analysis. Building with re-entrant corners experienced greater lateral waft and discount in base shear potential compared to ordinary building.

Oman Sayyed [13] The performance and behavior of regular and vertical irregular G+10 reinforced concrete Buildings under seismic loading, the following conclusions are drawn. The storey displacement in case of stiffness irregular buildings is more than that of the regular building. Considering storey displacement, ground soft storey (S1) is the most critical case because its displacement is 1.5 times more than that of regular building (B1) in the ground storey. The result shows that the top node displacement in case of setback irregular buildings is more than that of the regular building, except in case of model G1.

Shamshad Ali et. Al [14] The seismic response of RC body building of G+6 with & except smooth storey at specific storey levels. After analysis the conclusion which acquired are as follows; The constructing without tender storey is located to be safer at some stage in sturdy floor motions as in contrast to building having tender storey at any floor. The building having smooth storey at any floor is susceptible for harm for the duration of earthquake due to lack of stiffness of smooth storey. The float is most at the floor having gentle storey as in contrast to adjoining flooring levels. This type of RCC body constructing can safely withstand against seismic endeavor by way of supplying shear wall or metal bracing or dampers.

Nilesh J. Jain & Sunil M. Rangari [15] It is proposed that buildings with irregularities are prone to earthquake damage, observed in many earthquake occurrences as compare to symmetric structures. Soft storey are more prone to seismic damages, hence it is more ideal to build masonry walls or RCC walls in ground storey to avoid such damages. Earthquake produces significant deflection which is also serious factor leading to major damage or complete breakdown of structures. It is, therefore, necessary that irregular buildings should be carefully analyzed for deflection.

Hariharan. S et. al. [16] Three types of irregularities which are vertical geometry irregularity, stiffness irregularity and mass irregularity were Contemplate. All 3 category of single pier irregular RC constructing frames had graph conformity. Finite factor evaluation was performed for every one category type of irregularity and the storey shear forces acquired have been in contrast with that of a Regular structure.
3 types of ground movement with miscellaneous frequency content, i.e., low (imperial), intemediate (IS code), excesssive (San Francisco) frequency were considered.

Sumit Gurjar & Lovish Pamecha [17] The frames considered for flow values comply with a similar route alongside storey top with most value lying someplace close to the thirteenth to fifteenth storey. From flow point of view, frame 1, 2 and 3 are within permissible limits in region IV and sector V though at some storeys frame 2 and 3 exceeds marginally. But frame four in zone V exceeds permissible limits generally after tenth storey. In zone II and III all the frames are within permissible limit, for this reason there is no requirement of shear wall in these zones. From displacement view point, only in zone II all the frames are inside permissible limit. In zone III body 1, 2 and 3 are in permissible restrict but frame 4 requires shear wall to manipulate the limit. In zone IV solely frame 1 is within permissible limit, all other exceeds limits largely. And in quarter V all the frames exceed largely.

Mahapara Firdous & Sakshi Gupta [18] The soft storey buildings suggest the use of shear walls to prevent collapse during earthquakes. The analysis is done on buildings with soft storeys such as nonlinear static, dynamic and response spectrum analysis. From the above studies, it can be concluded that the use of circular columns should be avoided as they increase the base shear. Also, the ground storey columns should have high strength and stiffness to avoid failure. The orientation of columns affects the sidewise stiffnesss of the building. Hence orientations and soft storey should be introduced in a way that the lateral and vertical stiffness irregularity is not created in the building. The requirement for the study has grow in the recent years because of the new trend of building open ground storey and the intensifying demand of using diverse shapes and orientation of columns for visual purpose.

Dhananjay Shrivastava & Dr. Sudhir Singh Bhaduria [19] Considering above Inferences made on analysis of Regular and Irregular structures, it is concluded that regular geometry shows less force and perform well during the effect of earthquake. The analysis proves that irregularities are harmful for the structures and it is important to have regular shapes of frames as well as uniform load distribution around the building. Since the regular shape building shows more safety, serviceability and is economic then irregular building when constructed in the earthquake prone zones. Therefore, as far as possible irregularities in a building must be avoided.

Akhil R & Aswathy S Kumar [20] Response spectrum approach lets in a clear appreciation of the contributions of one of a kind mode of vibration. It is additionally useful for approximate comparison of seismic reliability of structures. Comparing the most base shear for both everyday building and irregular constructing the maximum shear is obtained for everyday building. Time length is maximum for H-shaped plan configuration. Average Frequency was once most for Irregular Buildings. Maximum displacement for everyday shapes and minimum for irregular shapes. Regular with U fashioned vertical irregular building have maximum displacement compared to other shapes.

Mayur R. Rethaliya et. al. [21] Provisions of old seismic codes IS 1893-1984 and IS 1893-2002.Majority of researchers have made comparison of lateral forces, base shears, story moments, etc. by - changing seismic zones changing number of stories, introducing vertical mass irregularity, introducing horizontal mass irregularity Introducing vertical stiffness irregularity, changing structural system, OMRF, SMRF, etc. Few researchers have carried out comparison of horizontal seismic forces (base shear) computed by equivalent lateral force method using new Chinese Seismic Code- GB50011-2010, American Code - ASCE/SE17-05 and European Code-Euro code 8. The results show that the base shear values computed from Chinese Seismic Code- GB50011-2010, is largest followed by American Code - ASCE/SE17-05 and European Code- Euro code 8.

Mujeeb Ul Hasan & Dr. Vivek Garg [22] Evaluating the effect of shear wall on seismic performance of building resting on sloping ground. The inclusion of shear wall is very effective to reduce the displacements, storey drift and torsion Moments in building. Shear wall at center is found to be more effective as compared to shear wall at corner. Displacements, support reactions and member forces vary with change in slope.

T. Jayakrishna et. al. [23] Compared to vertical irregular model lateral displacement is less in regular model. Almost the base shear is same in regular and irregular models, max base shear in zone 5 in regular is 1372.3 KN and in irregular 1349.5 KN. Compare to irregular model the regular model shows less displacement with a max displacement of 55.16mm in zone 5. The behavior of the structure is different for the different shape of the structure. Thus, the structure should be analyzed for each particular angle, and it should be intended for the maximum value of shear force and maximum moments.

Shridhar Chandrakant Dubule & Darshana Ainchwar [24] The storey shear pressure is maximum for the first storey and it decreases to minimal in the pinnacle storey. The stiffness irregular structure experiences lesser base shear than similar normal structures. The mass irregular structures experiences larger base shear than comparable normal structures. Vertical irregular constructions can be designed accurately and economically for earthquake resistance Building the use of STAAD.pro v8i and ETABS software.

Syed Shaheen Sultan & T.Ashok Reddy [25] 3 different types of irregularities mainly vertical geometry irregularity, stiffness irregularity and mass irregularity had been taken. RSA used to be conducted for every kind of irregularity and the storey shear forces bought have been in disparity with that of ordinary structure. 3 sorts of flooring action with diverse frequency content, i.e., low (imperiial), intemediate (IS code), excesssive (San Francisco) frequency had been taken. Time records evaluation (THA) used to be performed for every one form of irregularity analogous to the aforesaid flooring motions and nodal displacements had been compared. Finally, graph of abovementioned irregular developing frames was once once conceded out analogous to ESA and THA and the outcome had been compared.

Kolukula Sai Kiran & G Suresh [26] Analysis & a number pushover curves of everyday & irregular frames it is viewed that the yield force is more in case of normal structure & much less in case of irregular structure whilst the yield displacement price is also more in ordinary shape & much less in irregular structure. Therefore, it has been concluded that irregular structure cannot preserve greater force as compared to regular shape subsequently shape will become damage. The analysis proves that irregularities are harmful for the buildings and it is vital to have less complicated and everyday shapes of frames as properly as uniform load distribution round the building. Therefore, as a long way as possible irregularities in a building must be avoided. But, if Irregularities have to be introducing for any reason, they must be designed properly.

Amol varpe & P V Kharmale [27] Soft story effect discussed in brief. The infill wall attempts various researcher but they Are reducing the soft story effect. Scope of work reduce dynamic action of soft story. The researcher focusses on Combination of measure adopted on the structure to reduce effect through seismic and dynamic action analysis. The Parameter studied in this researcher are story drift, axial & shear force, bending moment, displacement. In this Researcher also discuss effect of infill wall and its effect on building.

2.2 Gaps from literature review

Gaps from the available study are following as:

1- Mostly study done with each floor irregularity. In our study used same irregularity for each floor that will give a precise output for regular and irregular building.

2- Mostly study done with different cross section of column.

2.3 Aims and objective

In the current work, authors have used different cross section for analysis. Created same cross section for the column that gave precise results for difference between regular and irregular building using more efficient drawing and design tools like AutoCAD 2016 and STAAD.Pro.
The main aim of this study is to investigate about the results of regular building and irregular building under seismic load.

1. Creation of plan, elevation view G+5 floor regular and irregular building using AutoCAD 2016.

2. Imported plan, elevation view G+5 floor regular and irregular building in STAAD.Pro 8Vi.

3. Apply boundary and loading conditions using Indian standards for Seismic, wind, live and dead load. Codes used for the load IS 1893, IS 875.

4. Analysis and Design of building structure like as column, beam using Indian concrete design codes IS 456 by STAAD.Pro Solver and collection of directional displacement, max. bending moment, steel area.

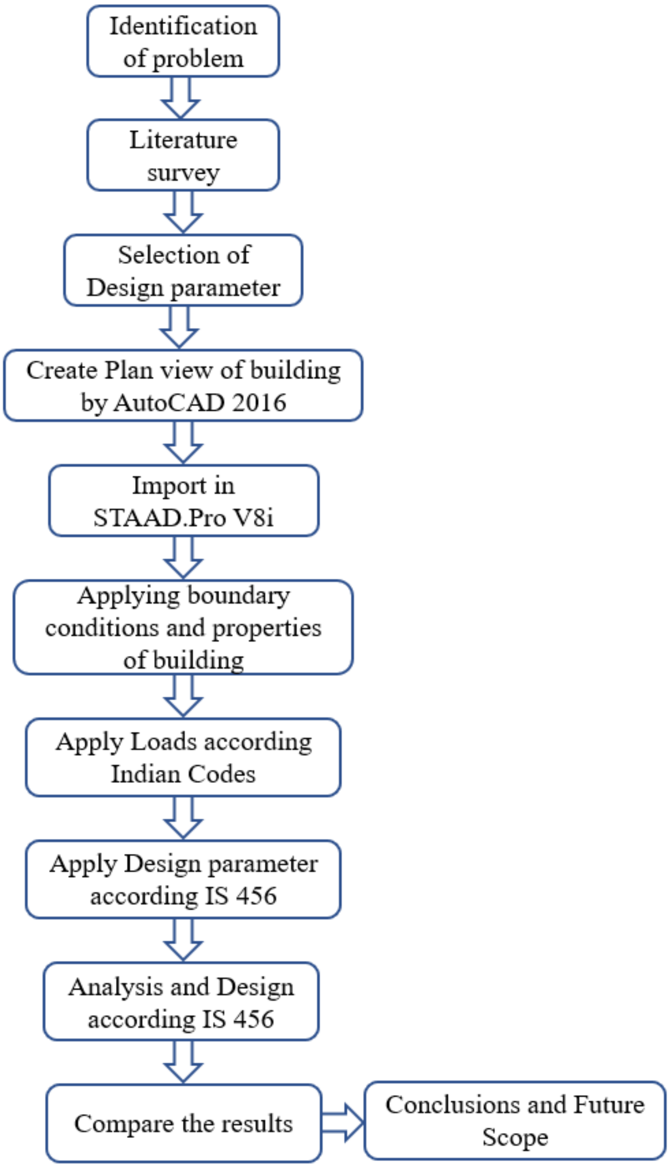
5. Comparison of all analysis results with all types cases that we created.

CHAPTER 3

METHODOLOGY

3.1 METHODOLOGY

In this project, created plan view, elevation view and 3D frame using AutoCAD 2016 and then imported in STAAD.Pro V8i for analysis and design. Before simulation, applied all required inputs, material properties, design parameter, analysis parameter and boundary conditions according Indian standard for Civil Engineering. There are some steps to solve simulation as following



FLOW CHART

3.2 Identification of problem

In this section, the goals according to the problem are identified. The ultimate objective is to find out max bending moment, max shear force, support reaction, concrete and steel area under seismic and other required loads according Indian Codes on G+5 floor building using all parameter of structure.

3.3 Literature survey

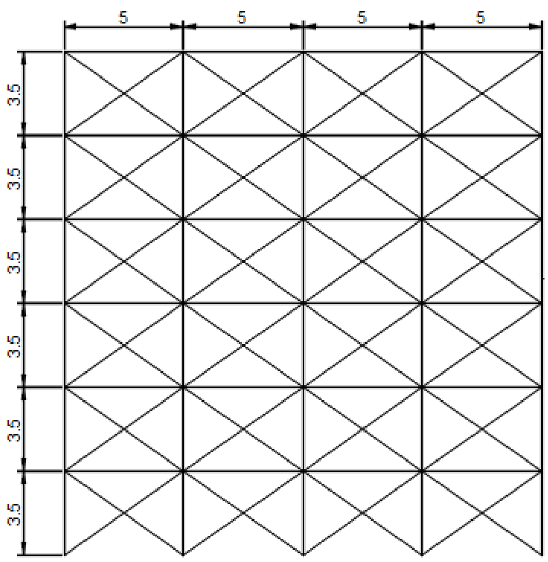
For about latest research available study knowledge, we collected a lot of articles and then filters required articles for our study. Using these articles, we got proper input for our projects that help to complete our project.

3.4 Selection of Design parameter

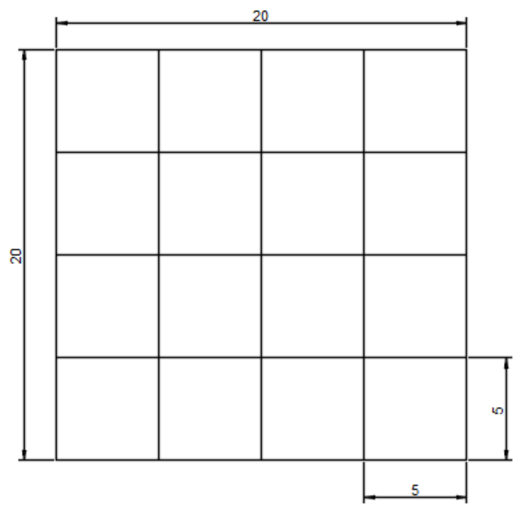
Using filtered articles and authentic data of construction industry we got data. We used materials properties, plan, elevation view, 3D Frame data, analysis data such as like area of floor and length of beam, column, wall, slab.

3.5 Create plan view of building by AutoCAD 2016

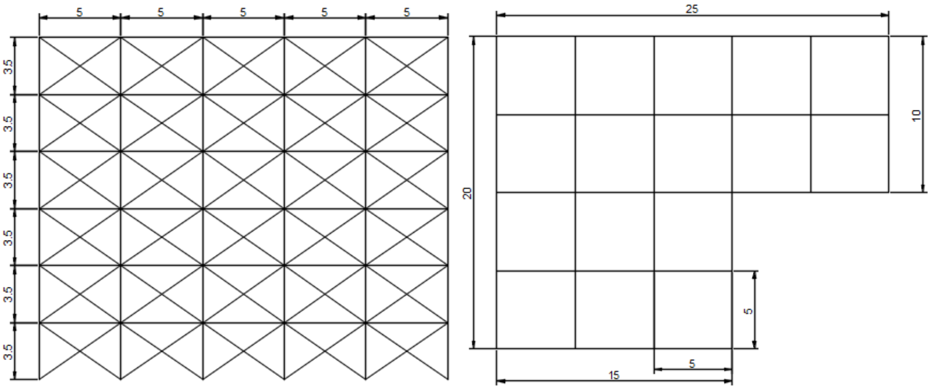
Created plan view, elevation view, 3D frame of G+5 floor building using AutoCAD 2016. AutoCAD software developed by AutoDESK company 1984 and 1986 AutoCAD famous in world for drawing and 3d modeling. AutoDESK founded by John Walker in 1982 and AutoDESK headquarter is available in USA. Creation this plan view we used line, offset, copy, trim, extend, move, dimension etc. command. AutoCAD file extension name is .dwg. After creation of drawing data saved in .dxf format for import in STAAD.Pro. Created four cases, that are following as-



Case A Elevation View



Case A Plan View



Case B Elevation View   Case B Plan View

Fig. 3.1 Case A and B Elevation, Plan View

Case A

Case 1

In this case 25 number of column available per side. All columns are of 0.700m X 0.700m cross section.

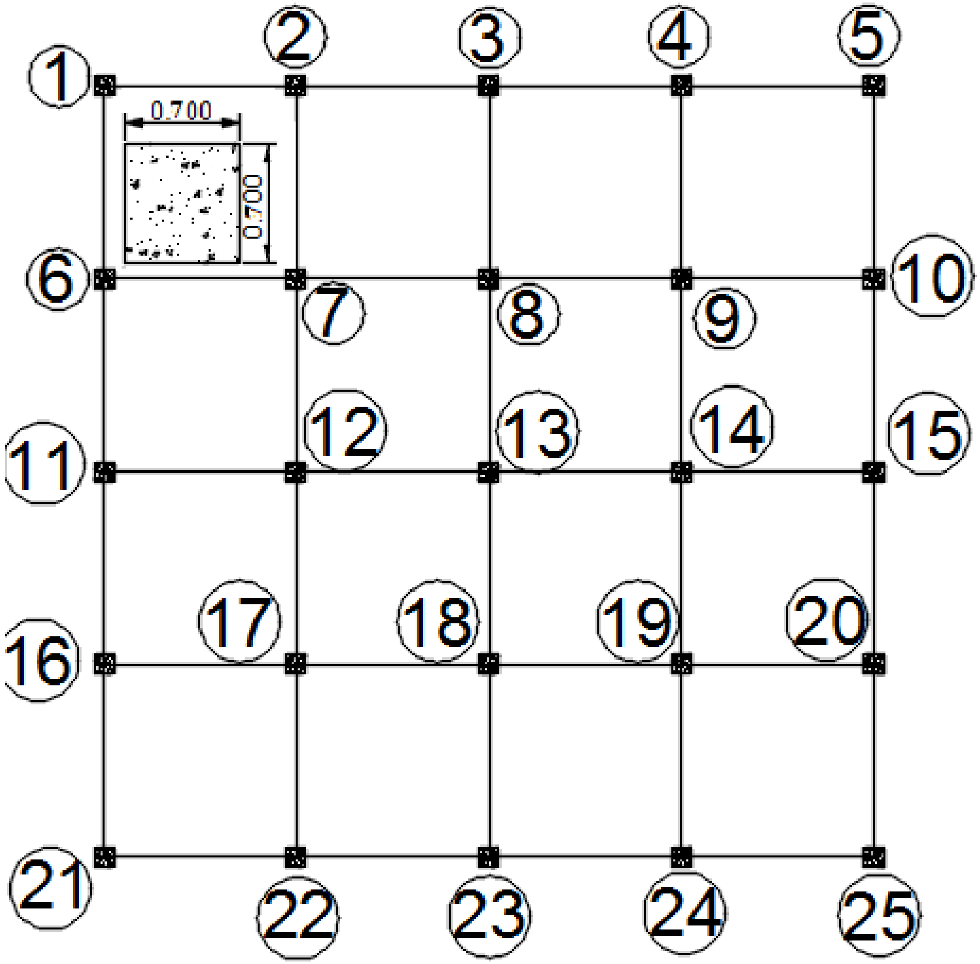


Fig. 3.2 Case A 1 Plan View

Case 2

In this case 26 number of column available per side. Except column number 25 and 26 all other are of 0.700mX0.700m and column number 25 and 26 are of 0.500mX0.500m cross section.

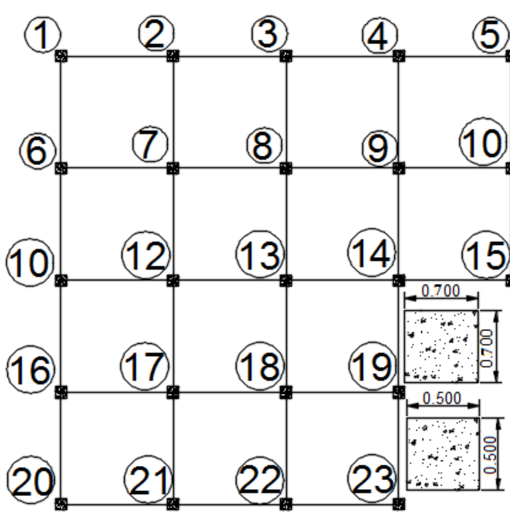


Fig. 3.3 Case A 2 Plan View

Case B

Case 1

In this case ground floor soft storey.

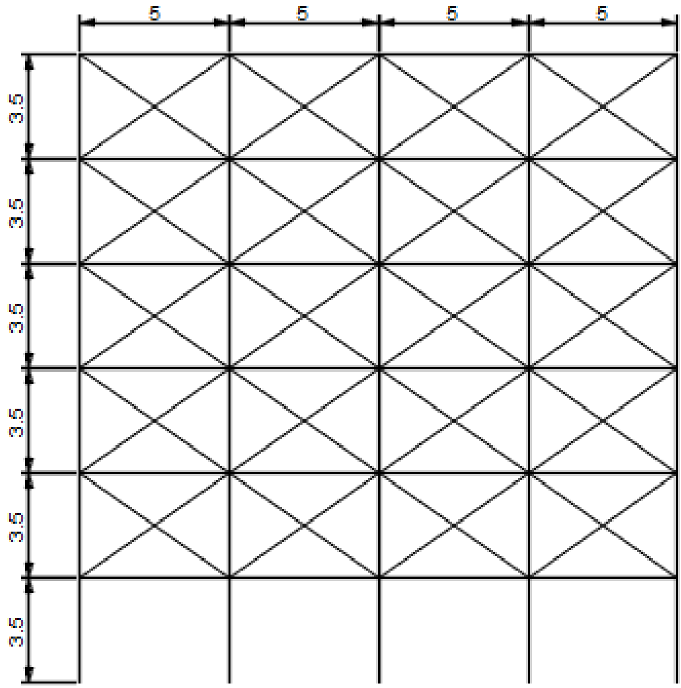


Fig. 3.4 Case B 1 Plan View

Case 2

In this case ground floor soft storey.

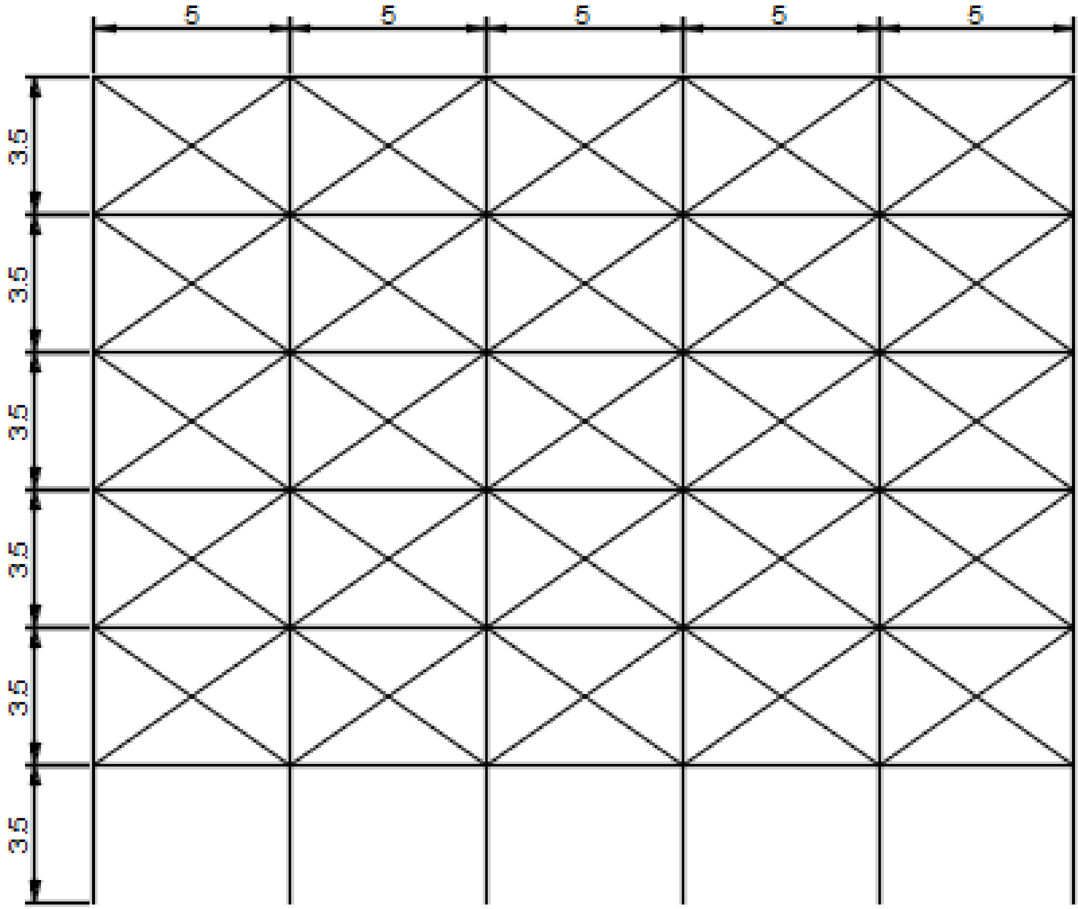


Fig 3.5 Case B 2 Plan View

3.6 Import in STAAD.Pro V8i

After creation all drawing data AutoCAD 2016, imported .dxf file in STAAD.Pro for the analysis and design. .dxf means Design exchange format.

Working with STAAD.Pro

Input Generation

The Graphical user interface GUI (or user) communiicates with the STAAD analaysis engine through the STD key file, enter file is a textual content file incorporate of a cycle of commands which are consummate sequentially. The STAAD.Pro commands involve both guiding principle or data pertaining to analaysis and/or design. The STAAD enter case can be produced thru a textual content editor or the GUI Modeling ability. In genaral, any text editor might also be utilized to edit/construct the STD input file. The GUI Modeling ability creates the input file via an interactive menudriven graphics slanting method.

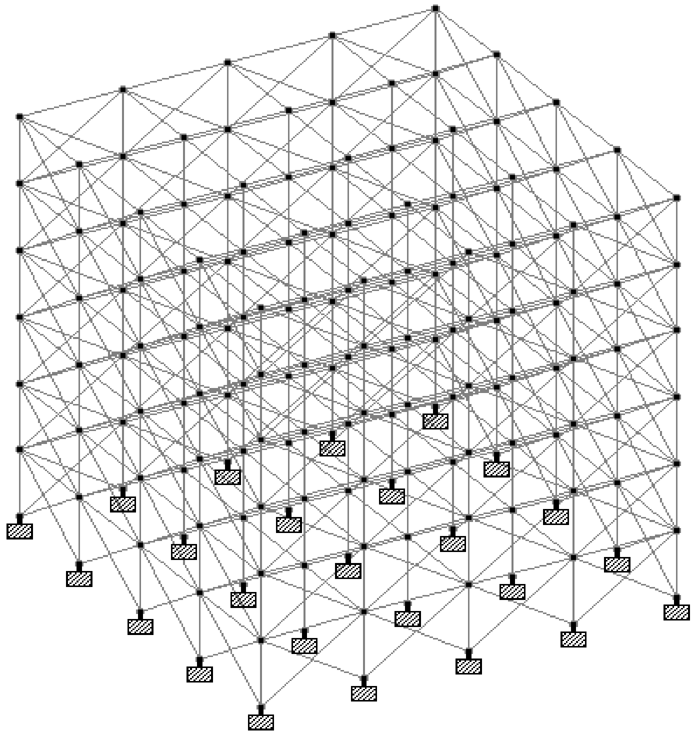


Fig. 3.6 STAAD input file

Types of Structures

A STRUCTURE can be definite as an assemblage of elements. STAAD is succesful of inspecting and designing structures comprising of frame, plate/shell and stable elements. Almost every kind of shape can be analyzed with the aid of STAAD.

A SPACE structure can be definite as a 3-Dimensional frame structure with loads functional in any plane, is the most wide-ranging.

A PLANE structure can be definite as which structure bound by a global X-Y co-ordinate system with loads in the identical plane.

A TRUSS structure can be definite as which structure comprises of truss members which can have merely axial member forces and there will be no bending in the members.

A FLOOR structure can be definite as a 2 or 3-dimensional structure having no horizontal (global X or Z) movement of the structure [F_X, F_Z & M_Y are restrained at every joint] called as floor structure, The floor framing (in global X-Z plane) of a structure is an ultimate exemplar of a FLOOR structure. Columns can also be modeled with the flooor in a FLOOR structure provided that the structure has no horizontal loading. If there is any horizotal load, it must be analaysed as a SPACE structure.

Generation of the structure

The structure may be created from the input file or indicating the co-ordinates in the GUI. The figure beneath shows the GUI genration method.

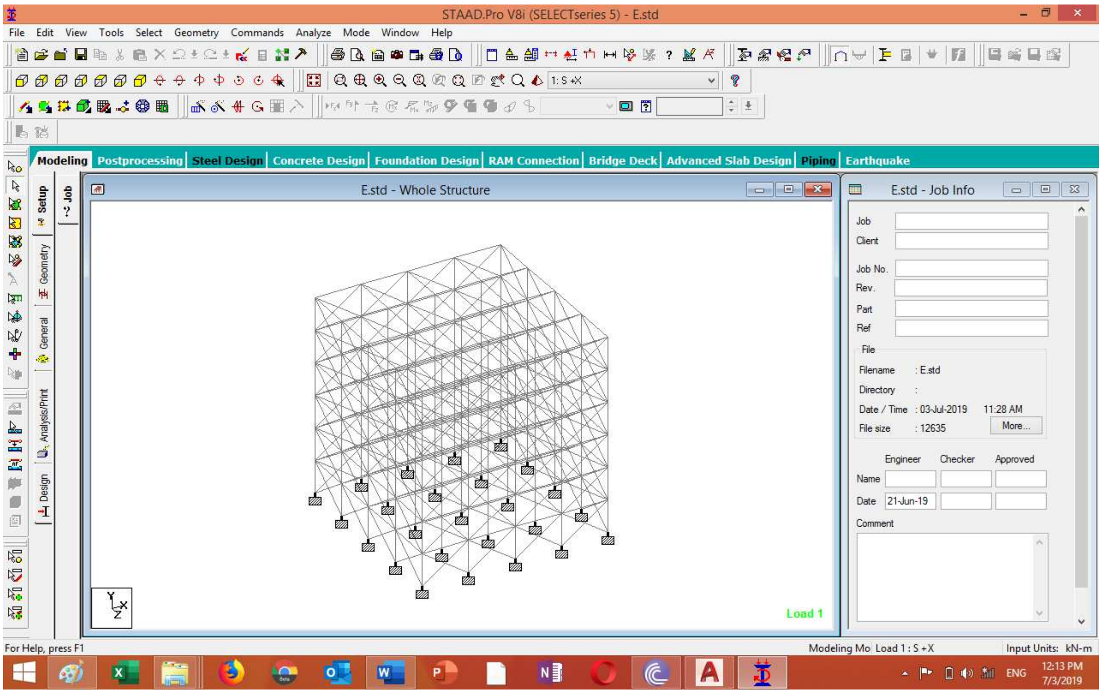


Fig. 3.7 Generation of structure through GUI

Material Constants

The fabric constants be: weight density (‘ρ’); Poisson's ratio (‘µ’); modulus of elasticity (‘E’); Composite Damping Ratio, co-efficient of thermal expansion (‘α’), , and beta angle (‘β’) or coordinates for any reference (REF) point. ‘E’ fee for contributors need to be abounding or the analaysis will no longer be performed. Weight density (‘ρ’) is used exclusively when self-weight of the structure is to be taken into account. Poisson's ratio (‘µ’) is used to calculate the shear modulus (frequently known as ‘G’) via the formula,

$$\mathbf{G = 0.5 \times E / (1 + \mu)}$$

If Poisson's ratio is now not provided, STAAD will anticipate a price for this quantity based totally on the price of E. Coefficient of thermal enlargement (‘α’) is used to calculate the expansion of the individuals if temperature hundreds are applied. The temperature unit for temperature load and ‘α’ has to be the same.

Supports

In the STAAD.pro available many kinds of Supports one is PINNED, second one is FIXED and other one FIXED with one of a type releases that is called as FIXED BUT support. A point in 3D have 6 degree of freedom. A pinned assist has restraints towards every translational action and none beside rotational movement. In diverse words, a pinned guide will include reactions for all forces however will look up to no moments. A constant support has restraints against every instructions of movement. Rotational and Translational springs can additionally be specified. The springs can be represented by their spring constnts. A translational spring steady is defined as the pressure to relocate a aid joint one span unit in the targeted international direction. in the same way, a rotational spring regular is defined as the pressure to rotate the help joint one diploma around the besieged global direction.

3.7 Applying boundary conditions and propertied of building

All bottom nodes are fixed, it means all degree and freedoms are blocked. Three linear and 3 rotational motion are blocked as shows in Fig. 3.8. Column sizes used in this analysis that are 0.700mX0.700m and 0.500mX.500m. Beam sizes used in these analyses that is 0.450mX0.350m. Walls thickness is 0.230m used, floor thickness is 0.120m used.

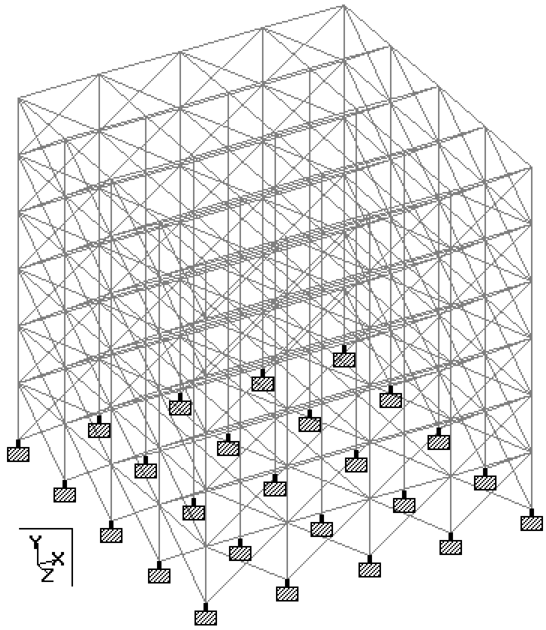


Fig. 3.8 Fixed support applied on bottom nodes

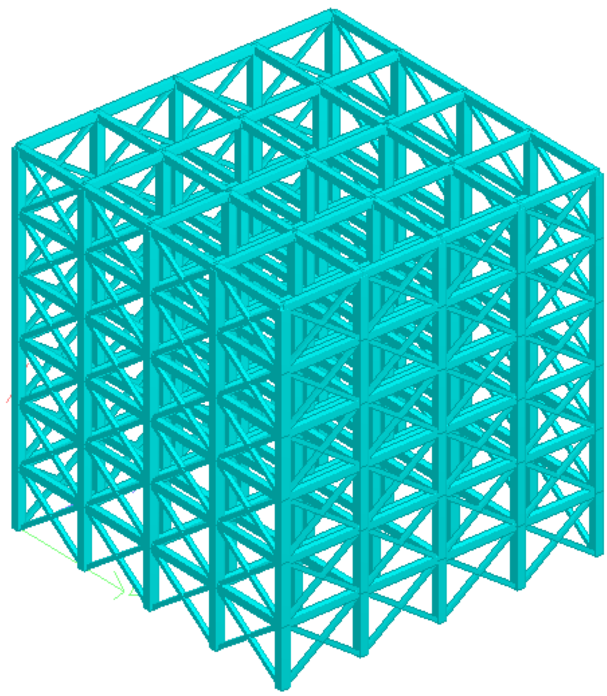


Fig. 3.9 3D rendering view of CASE A1

Fig. 3.9, 3.10, 3.11 and 3.12 shows the 3D rendering view of CASE A1, A2, B1 and B2 respectively that is created in STAAD.Pro software. Magenta colors areas shows walls and floor of building and cyan color areas shows column and beam of building.

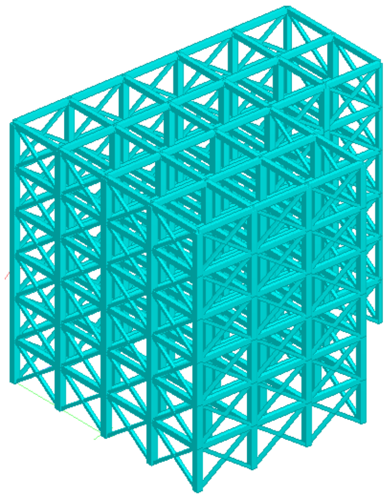


Fig. 3.10 3D rendering view of CASE A2

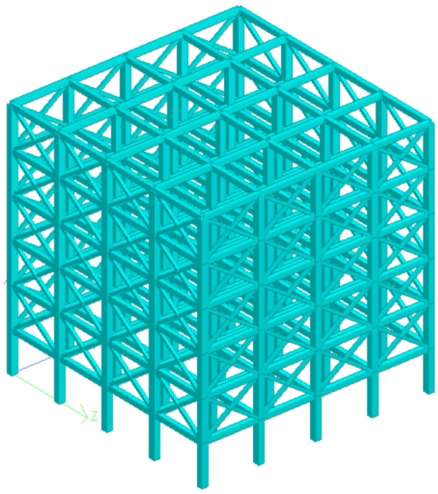


Fig. 3.11 3D rendering view of CASE B1

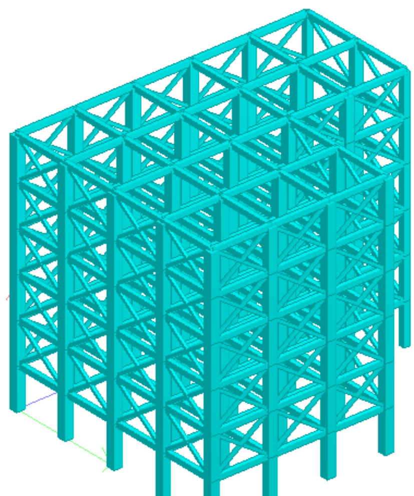


Fig. 3.12 3D rendering view of CASE B2

3.8 Applying loads according Indian Codes

3.8.1 Dead Load

All everlasting constructions of the building form the useless loads. The dead load will be the weights of walls, partitions floor finishes, false ceilings, false floors and the extra permanent constructions in the buildings. The lifeless load hundreds might also be calculated from the dimensions of a number of individuals and their unit weiights. each unit weights of simple concrete and bolstered concrete made with sand and gravel or beaten natural stone aggregate can also be taken as 24 kN/m and 25 kN/m respectively.

3.8.2 Imposed Load

Imposed load is produced with the aid of the supposed use or occupancy of a building such as the weight of movable partitions, disbursed and concentrated loads, load due to have an effect on and vibration and dust loads. Imposed loads do now not consist of loads due to wind, seismic activity, snow, and loads imposed due to temperature changes to which the shape will be subjected to, creep and shrinkage of the structure, the differential settlements to which the structure may additionally undergo.

3.8.3 SEISMIC LOAD

Seismic analysis

Seismic analysis is a most important tool in earthquake engineering which is used to distinguish the response of structural due to a lot of seismic excitations in a fewer complicated manner. In the past the structure were designed just for gravity loads only now a days seismic analysis is a latest advancement. It is a sector of structural evaluation and a sector of structural graph where earthquake is prevalent.
There are one-of-a-kind methods of earthquake analysis. Some of them used in the task are

I. Equivalent Static Analysis
II. Time History Analysis
III. Response Spectrum Analysis

Equivalent static analysis

The equivalant static analysis technique is surely an elastic format system. It is, however, easy to observe than the multimodel response method, with the absolute simplifying assumptions being possibly extra consistent with former assumptions absolute someplace else in the format procedure.
The equivalent static analysis process consists the steps are as follows:
1. Calculate approximately first mode response length of the build from the graph of response spectra.

2. Utilize the specific format response spectra to conclude that the lateral base shear of the whole build is steady with the extent of post-elastic (ductility) response held.
3. Share out the base shear amid a number of lumped mass levels normally based on an overturned triangular shear allocation of 90% of the base shear regularly, with 10% of the base shear is being forced at the top point to allow for superior mode effects.

Response spectrum analysis

This method approves the more than one mode of response of a buildiing to be occupied into account. This is mandatory in many constructing codes for all barring for especially easy or extremely complicated structures. The structural response can also be definite as a mixture of many modes. Computer analaysis can be used to establish these modes for those structures. For every mode, a response is got from the plan spectrum, analogous to the modal frequency and the modal mass, and afterwards they are mixed to estimate the whole response of the structure. In this the amount of forces in all directisons is calculated and afterwards results on the building is observed.

Time history analysis

Time-history evaluation strategies involves the step-to-step answer in the time domain of the multi degree-of-freedom equations of motion which characterize the true response of a buildiing. It is the best sophisticated analaysis technique on hand to a structural engineer. Its response is a direct work of the earthquake floor movement chosen as an enter parameter for a unique building.

Design Lateral Force

The plan lateral force shall be firstly computed for the constructing as a whole. This design lateral force shall afterward be distributed to the more than a few flooring levels. The ordinary graph seismic pressure as a result bought at each ground stage shall then be dispensed to man or woman lateral load resisting elements relying on the floor diaphragm action.

Design Seismic Base Shear

The total design lateral force or design seismic base shear (V_b) along any principal direction shall be determined by the following expression:

$$V_b = A_h W$$

here,
A_h = horizontal acceleration spectrum
W = seismic weight of all the floors .

Fundamental Natural Period

The estimated fundamental natural length of vibration ('T'), in seconds, of a moment-resisting body constructing barring brick in the panels can also be estimated by means of the empirical expression:
T_a=0.075 $h^{0.75}$ for RC frame constructing
T_a=0.085 $h^{0.75}$ for metal body constructing
here,
h = Height of building, in meter. This excludes the basement storeys, the place basement walls are related with the floor flooring deck or fitted among the building columns. But it consists of the basement storeys, when they are at present not so connected. The approximate quintessential natural length of vibration (T,), in seconds, of all other buildings, including moment-resisting body structures with brick lintel panels, may also be estimated by means of the empirical Expression:

$$T=.09H/\sqrt{D}$$

here,
h= Height of building
d= Base dimension of the building at the plinth level in meter, along the considered direction of the lateral force.

Distribution of Design Force

Vertical allocation of Base Shear to diverse Floor Level
The diagram base shear (V) shall be allotted alongside the top of the building as per the following expression:
Q_i= the design lateral force at ground i,
W_i=Seismic weight of floor 'i',
h_i=Height of floor i measured from base
n=Number of storeys in the building is the quantity of levels at which the loads are positioned.
allocation of Horizontal Design Lateral Force to diverse Lateral Force Resisting Elements in case of structures whose floors are competent of providing rigid horizontal diaphragm action, the complete shear in every horizontal aircraft shall be allotted to the a range of vertical elements of lateral pressure resisting system, assuming the floors to be infinitely rigid in the horizontal plane.

Dynamic Analysis

Dynamic analysis could be performed to acquire the format seismic force, and its allocation to unique levels beside the top of the building and to the more than a few lateral load resisting elements, for the following Buildings:
a) Regular buildings -Those higher than 40 m in height in Zones IV and V and those Greater than 90 m in height in Zones II and III.
b) Irregular constructions – All framed buildings greater than 12m in Zones IV and V and those greater than 40m in top in Zones II and III.

3.9 Applying Design parameter according IS 456

Applied design parameter using STAAD.Pro library according IS 456.

3.10 Analysis and Design according IS 456

After creating model of all four cases, applied all required parameter in STAAD.pro and done analysis also in STAAD.Pro.

3.11 Compare the results

Compared all four cases results. After analysis STAAD.Pro obtained directional displacement, max. bending moment, steel area.

3.12 Conclusions and Future Scope

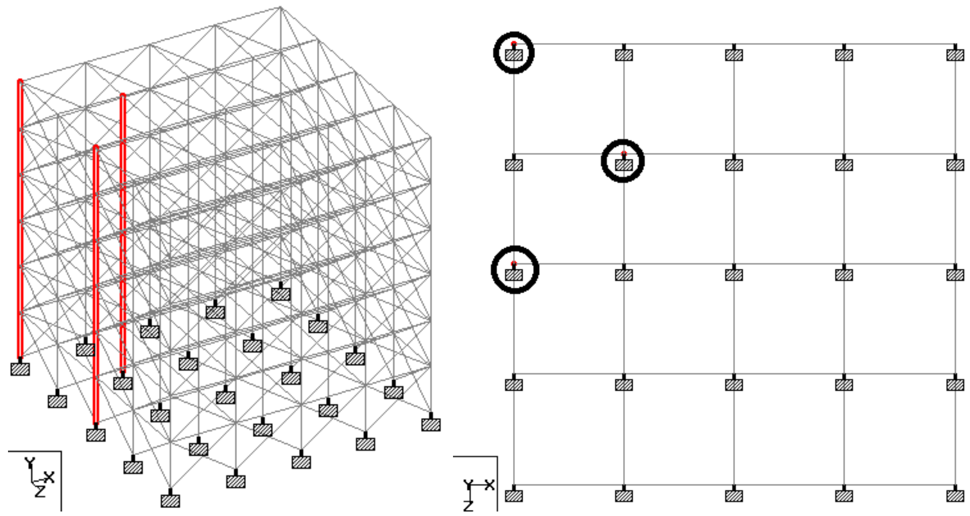
After review all cases results created a conclusion according all results. Described future work for the same study.

CHAPTER 4

RESULT AND DISCUSSIONS

4.1 CASE A

Applied Loads in all cases according Indian Standards as shows in Fig. 4.1. Column cross section is 0.700m X 0.700m, 0.500m X 0.500m and for beam is 0.350m (W) X 0. 45m (H). Concrete grade M25 and Steel Fe415 used for this study.



(a) (b)

Fig. 4.1 Considered column for comparison

4.1.1 CASE A1

In this study corner column are considered for study, seven columns are connected through Node 1,2,3,4,5,6 and 7, rest of the column are connected from node to node in the same fashion.

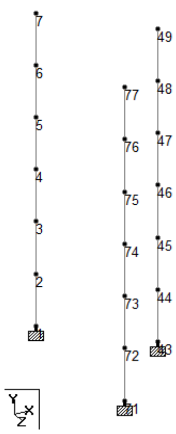


Fig. 4.2 Considered Nodes for comparison

Fig. 4.3 shows connection of column (vertical members) through node to node.

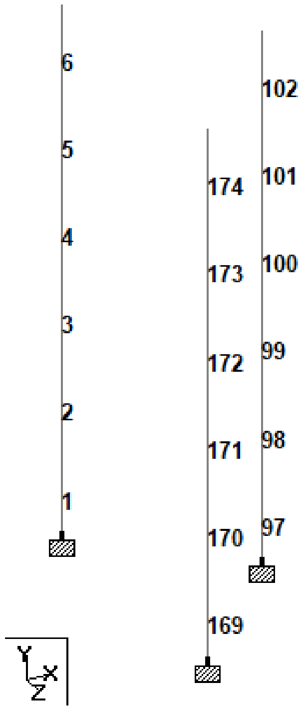


Fig. 4.3 Column of structure for comparison

Fig. 4.4 shows displacement of building structure into X- direction, black lines shows the building structure before analysis and green lines shows displacement of building structure after the analysis.

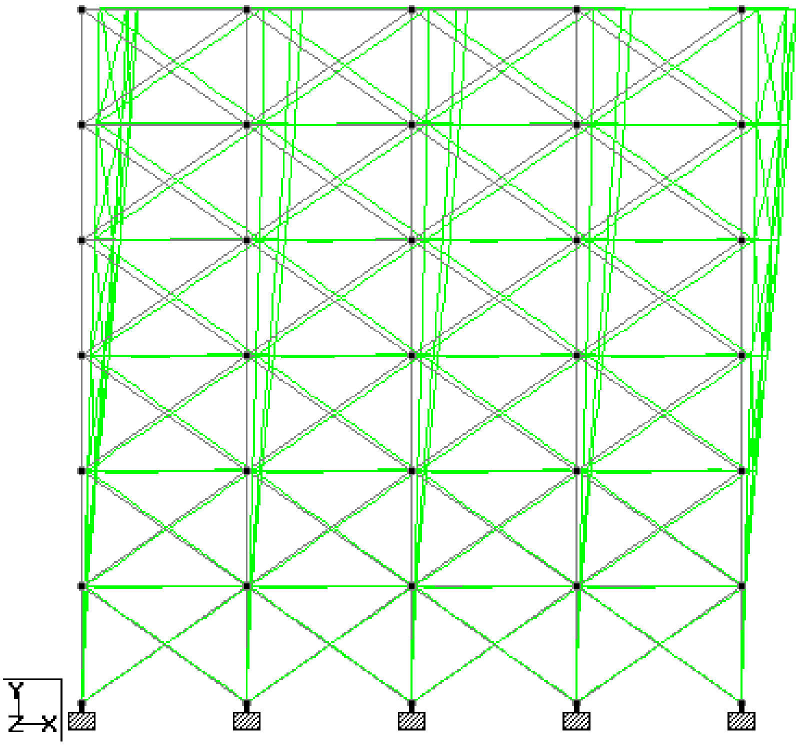


Fig. 4.4 Directional displacement for Case A1

Table 4.1 Displacement of node number 1,2,3,4,5,6,7, 43,44,45,46,47,48,49 71,72,73,74,75,76,77 for Case A1

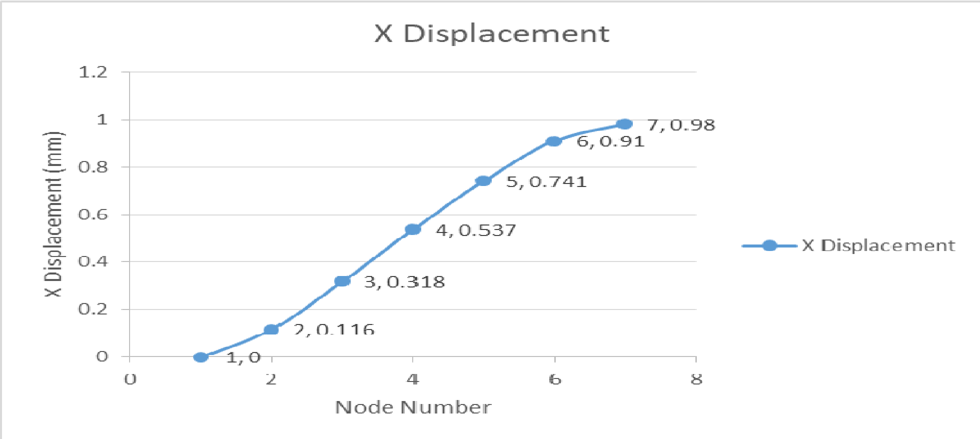
N0DE	L/C	X-Trans (mm)	Y-Trans (mm)	Z-Trans (mm)	Absolute (mm)
1	1 S +X	0	0	0	0
	2 S –X	0	0	0	0
	3 S +Z	0	0	0	0
	4 S –Z	0	0	0	0
	5 LIVE L0AD	0	0	0	0
	6 DEAD L0AD	0	0	0	0
	7 MODE SHAPES	0	0	0	0
	8 COMBINATION	0	0	0	0
2	1 S +X	0.116	0.022	0	0.118
	2 S –X	-0.201	-0.018	-0.003	0.202
	3 S +Z	0	0.022	0.116	0.118
	4 S –Z	-0.003	-0.018	-0.201	0.202
	5 LIVE L0AD	-0.011	-0.027	-0.011	0.031
	6 DEAD L0AD	-0.1	-0.279	-0.1	0.313
	7 MODE SHAPES	1.592	0.493	1.592	2.304
	8 COMBINATION	0.196	0.049	0.196	0.282
3	1 S +X	0.318	0.04	0	0.321
	2 S –X	-0.438	-0.031	-0.005	0.439
	3 S +Z	0	0.04	0.318	0.321
	4 S –Z	-0.005	-0.031	-0.438	0.439
	5 LIVE L0AD	-0.011	-0.048	-0.011	0.05
	6 DEAD L0AD	-0.098	-0.506	-0.098	0.525
	7 MODE SHAPES	4.114	0.896	4.114	5.886
	8 COMBINATION	0.537	0.091	0.537	0.765
4	1 S +X	0.537	0.054	0	0.539
	2 S –X	-0.65	-0.038	-0.007	0.651
	3 S +Z	0	0.054	0.537	0.539
	4 S –Z	-0.007	-0.038	-0.65	0.651
	5 LIVE L0AD	-0.008	-0.064	-0.008	0.065
	6 DEAD L0AD	-0.072	-0.68	-0.072	0.688
	7 MODE SHAPES	6.551	1.178	6.551	9.339
	8 COMBINATION	0.895	0.121	0.895	1.271
5	1 S +X	0.741	0.064	0.001	0.744
	2 S –X	-0.835	-0.042	-0.009	0.836
	3 S +Z	0.001	0.064	0.741	0.744
	4 S –Z	-0.009	-0.042	-0.835	0.836
	5 LIVE L0AD	-0.006	-0.075	-0.006	0.075
	6 DEAD L0AD	-0.049	-0.799	-0.049	0.802
	7 MODE SHAPES	8.592	1.351	8.592	12.226
	8 COMBINATION	1.217	0.14	1.217	1.726
6	1 S +X	0.91	0.069	0.004	0.912

	2 S –X	-0.975	-0.043	-0.01	0.976
	3 S +Z	0.004	0.069	0.91	0.912
	4 S –Z	-0.01	-0.043	-0.975	0.976
	5 LIVE L0AD	-0.001	-0.08	-0.001	0.08
	6 DEAD L0AD	-0.01	-0.863	-0.01	0.863
	7 MODE SHAPES	10.103	1.44	10.103	14.36
	8 COMBINATION	1.47	0.15	1.47	2.084
7	1 S +X	1.031	0.071	0.012	1.034
	2 S –X	-1.067	-0.043	-0.012	1.068
	3 S +Z	0.012	0.071	1.031	1.034
	4 S –Z	-0.012	-0.043	-1.067	1.068
	5 LIVE L0AD	0.006	-0.08	0.006	0.081
	6 DEAD L0AD	0.052	-0.873	0.052	0.877
	7 MODE SHAPES	11.095	1.471	11.095	15.759
	8 COMBINATION	1.644	0.153	1.644	2.33
43	1 S +X	0	0	0	0
	2 S –X	0	0	0	0
	3 S +Z	0	0	0	0
	4 S –Z	0	0	0	0
	5 LIVE L0AD	0	0	0	0
	6 DEAD L0AD	0	0	0	0
	7 MODE SHAPES	0	0	0	0
	8 COMBINATION	0	0	0	0
44	1 S +X	0.245	0	0	0.245
	2 S –X	-0.246	0	0	0.246
	3 S +Z	0	0	0.245	0.245
	4 S –Z	0	0	-0.246	0.246
	5 LIVE L0AD	-0.002	-0.081	-0.002	0.081
	6 DEAD L0AD	-0.009	-0.528	-0.009	0.528
	7 MODE SHAPES	3.876	0.077	3.876	5.483
	8 COMBINATION	0.61	0.001	0.61	0.863
45	1 S +X	0.746	0	-0.001	0.746
	2 S –X	-0.747	0	0	0.747
	3 S +Z	-0.001	0	0.746	0.746
	4 S –Z	0	0	-0.747	0.747
	5 LIVE L0AD	-0.001	-0.145	-0.001	0.145
	6 DEAD L0AD	-0.003	-0.954	-0.003	0.954
	7 MODE SHAPES	10.562	0.143	10.562	14.938
	8 COMBINATION	1.816	0.001	1.816	2.568
46	1 S +X	1.323	0.001	-0.001	1.323
	2 S –X	-1.324	0	0	1.324
	3 S +Z	-0.001	0.001	1.323	1.323
	4 S –Z	0	0	-1.324	1.324
	5 LIVE L0AD	0	-0.193	0	0.193
	6 DEAD L0AD	-0.002	-1.281	-0.002	1.281

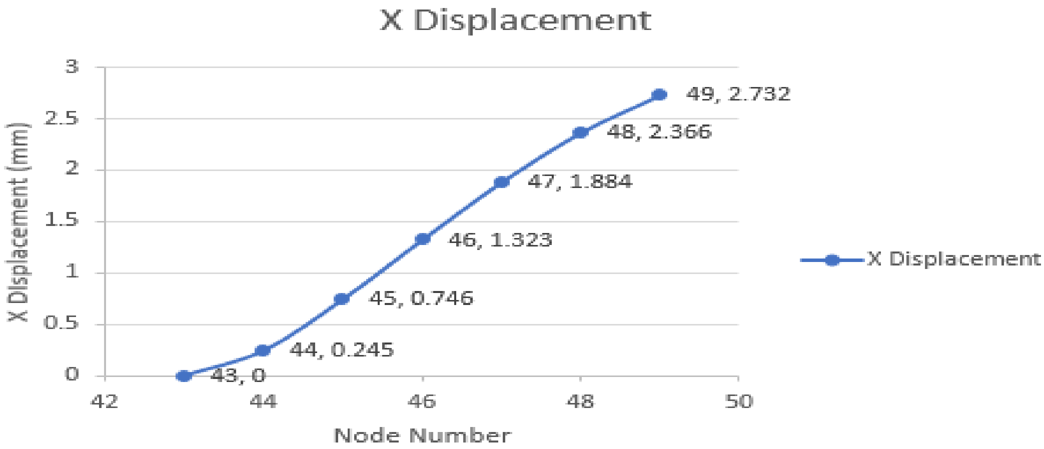
	7 MODE SHAPES	16.808	0.196	16.808	23.771
	8 COMBINATION	3.122	0.002	3.122	4.415
47	1 S +X	1.884	0.001	-0.001	1.884
	2 S –X	-1.884	0	0.001	1.884
	3 S +Z	-0.001	0.001	1.884	1.884
	4 S –Z	0.001	0	-1.884	1.884
	5 LIVE L0AD	0	-0.225	0	0.225
	6 DEAD L0AD	-0.002	-1.507	-0.002	1.507
	7 MODE SHAPES	21.662	0.236	21.662	30.635
	8 COMBINATION	4.286	0.002	4.286	6.061
48	1 S +X	2.366	0.001	-0.001	2.366
	2 S –X	-2.367	0	0.001	2.367
	3 S +Z	-0.001	0.001	2.366	2.366
	4 S –Z	0.001	0	-2.367	2.367
	5 LIVE L0AD	0.002	-0.24	0.002	0.24
	6 DEAD L0AD	0.006	-1.634	0.006	1.634
	7 MODE SHAPES	25.045	0.263	25.045	35.42
	8 COMBINATION	5.194	0.002	5.194	7.345
49	1 S +X	2.732	0.001	-0.001	2.732
	2 S –X	-2.732	0	0.001	2.732
	3 S +Z	-0.001	0.001	2.732	2.732
	4 S –Z	0.001	0	-2.732	2.732
	5 LIVE L0AD	0.004	-0.24	0.004	0.24
	6 DEAD L0AD	0.028	-1.661	0.028	1.661
	7 MODE SHAPES	27.247	0.277	27.247	38.534
	8 COMBINATION	5.828	0.003	5.828	8.242
71	1 S +X	0	0	0	0
	2 S –X	0	0	0	0
	3 S +Z	0	0	0	0
	4 S –Z	0	0	0	0
	5 LIVE L0AD	0	0	0	0
	6 DEAD L0AD	0	0	0	0
	7 MODE SHAPES	0	0	0	0
	8 COMBINATION	0	0	0	0
72	1 S +X	0.296	0.008	0	0.296
	2 S –X	-0.296	-0.008	0	0.296
	3 S +Z	0	0.004	0.156	0.157
	4 S –Z	0	0.004	-0.156	0.157
	5 LIVE L0AD	-0.003	-0.039	0	0.039
	6 DEAD L0AD	-0.017	-0.357	0	0.357
	7 MODE SHAPES	4.557	0.184	2.064	5.006
	8 COMBINATION	0.797	0.019	0.265	0.84
73	1 S +X	0.909	0.015	0	0.91
	2 S –X	-0.909	-0.014	0	0.909
	3 S +Z	0	0.009	0.376	0.377

	4 S –Z	0	0.009	-0.376	0.377
	5 LIVE L0AD	0	-0.071	0	0.071
	6 DEAD L0AD	-0.002	-0.649	0	0.649
	7 MODE SHAPES	12.632	0.348	4.713	13.487
	8 COMBINATION	2.388	0.036	0.633	2.47
74	1 S +X	1.62	0.021	0	1.62
	2 S –X	-1.62	-0.019	0	1.62
	3 S +Z	0	0.013	0.594	0.594
	4 S –Z	0	0.013	-0.594	0.594
	5 LIVE L0AD	0	-0.095	0	0.095
	6 DEAD L0AD	-0.001	-0.873	0	0.873
	7 MODE SHAPES	20.32	0.474	7.053	21.514
	8 COMBINATION	4.119	0.048	0.986	4.236
75	1 S +X	2.313	0.024	0	2.313
	2 S –X	-2.312	-0.023	0	2.312
	3 S +Z	0	0.017	0.789	0.789
	4 S –Z	0	0.017	-0.789	0.789
	5 LIVE L0AD	0	-0.111	0	0.111
	6 DEAD L0AD	-0.003	-1.027	0	1.027
	7 MODE SHAPES	26.383	0.564	8.932	27.859
	8 COMBINATION	5.672	0.057	1.29	5.817
76	1 S +X	2.907	0.027	0	2.907
	2 S –X	-2.906	-0.025	0	2.906
	3 S +Z	0	0.02	0.944	0.944
	4 S –Z	0	0.02	-0.944	0.944
	5 LIVE L0AD	0.005	-0.119	0	0.119
	6 DEAD L0AD	0.013	-1.113	0	1.113
	7 MODE SHAPES	30.642	0.623	10.268	32.323
	8 COMBINATION	6.885	0.063	1.52	7.051
77	1 S +X	3.358	0.028	0	3.358
	2 S –X	-3.358	-0.026	0	3.358
	3 S +Z	0	0.022	1.046	1.046
	4 S –Z	0	0.022	-1.046	1.046
	5 LIVE L0AD	0.007	-0.119	0	0.119
	6 DEAD L0AD	0.052	-1.129	0	1.13
	7 MODE SHAPES	33.436	0.655	11.054	35.222
	8 COMBINATION	7.738	0.066	1.665	7.916

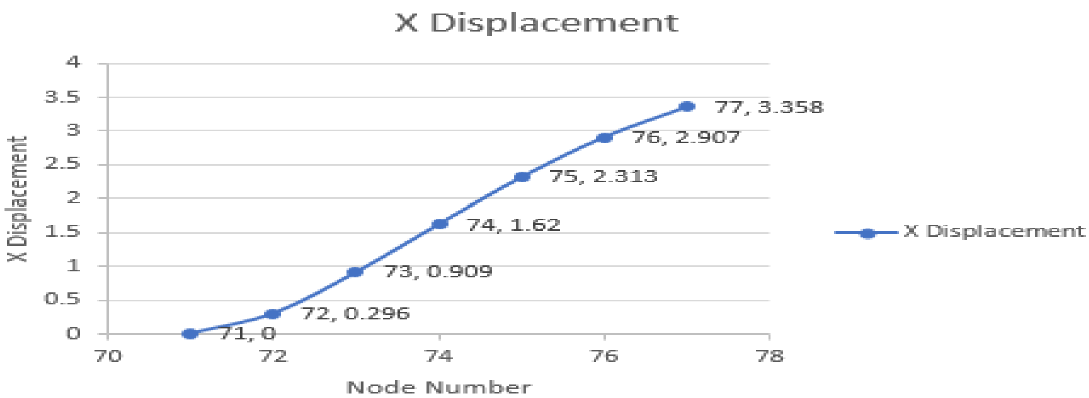
Fig. 4.5(a), 4.5(b), and 4.5(c) Shows Node Number vs Displacement Graph for columns in X-direction, this graph shows that displacement have higher values for columns which are built at top floor of the building. Fig. (a) shows displacement for column number 1, 2, 3, 4, 5, 6 and Fig. (b) shows displacement for column number 43, 44, 45, 46, 47, 48, 49 and Fig. (c) shows displacement for column number 71, 72, 73, 74, 75, 76, 77. Displacement results also shows deeply in Table 4.1.



(a)



(b)



(c)

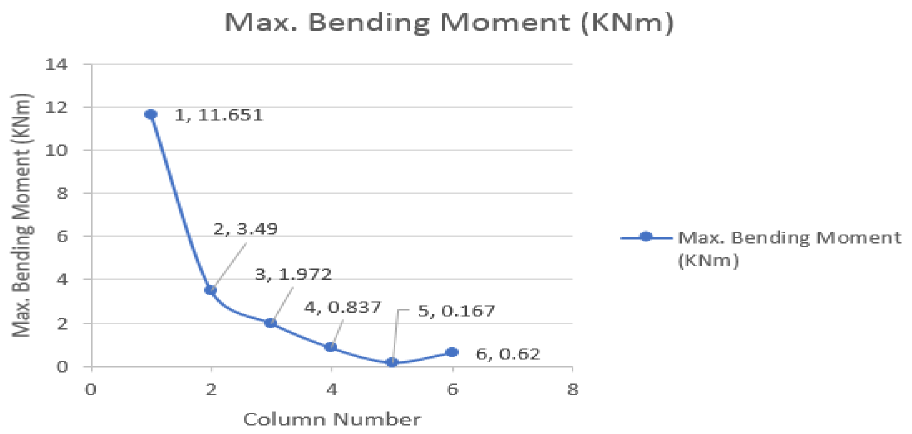
Fig. 4.5 Directional displacement Graph for Case A 1 nodes (a) for node number 1, 2, 3, 4, 5, 6, 7 (b) for column number 43, 44, 45, 46, 47, 48, 49 (c) for column number 71, 72, 73, 74, 75, 76, 77

Table 4.2 Maximum bending moment of beam 1,2,3,4,5,6,97,98,99,100,101,102, 169,170,171,172,173,174 for Case A1

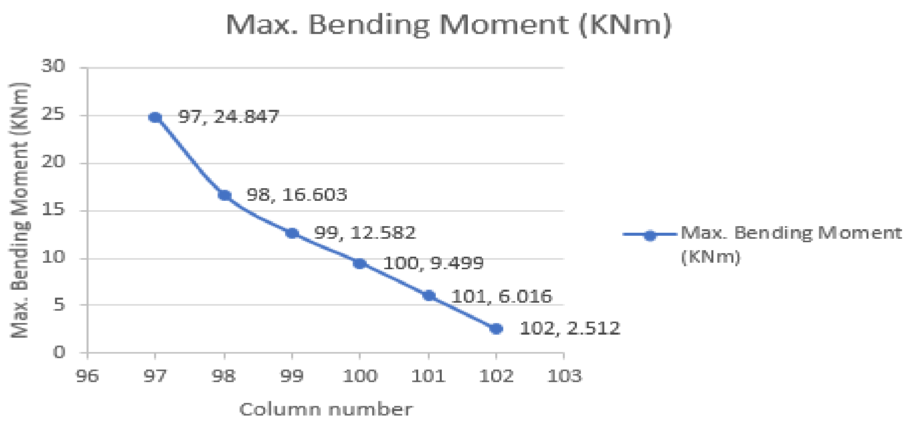
Beam	L/C	Dist (m)	F_x (kN)	F_y (kN)	Fz (kN)	M_x (kN-m)	M_y (kN-m)	M_z (kN-m)
1	1 S +X	0	-66.425	3.136	0.029	-2.016	-0.045	11.651
		0.875	-66.425	3.136	0.029	-2.016	-0.02	8.908
		1.75	-66.425	3.136	0.029	-2.016	0.005	6.164
		2.625	-66.425	3.136	0.029	-2.016	0.03	3.421
		3.5	-66.425	3.136	0.029	-2.016	0.055	0.677
2	1 S +X	0	-56.61	1.298	0.086	-2.618	-0.117	3.49
		0.875	-56.61	1.298	0.086	-2.618	-0.042	2.355
		1.75	-56.61	1.298	0.086	-2.618	0.033	1.219
		2.625	-56.61	1.298	0.086	-2.618	0.108	0.083
		3.5	-56.61	1.298	0.086	-2.618	0.183	-1.053
3	1 S +X	0	-42.247	1.138	0.086	-2.98	-0.117	1.972
		0.875	-42.247	1.138	0.086	-2.98	-0.042	0.976
		1.75	-42.247	1.138	0.086	-2.98	0.033	-0.02
		2.625	-42.247	1.138	0.086	-2.98	0.108	-1.016
		3.5	-42.247	1.138	0.086	-2.98	0.182	-2.012
4	1 S +X	0	-28.21	0.963	0.123	-2.937	-0.205	0.837
		0.875	-28.21	0.963	0.123	-2.937	-0.097	-0.005
		1.75	-28.21	0.963	0.123	-2.937	0.011	-0.848
		2.625	-28.21	0.963	0.123	-2.937	0.118	-1.691
		3.5	-28.21	0.963	0.123	-2.937	0.226	-2.533
6	1 S +X	0	-7.068	-0.10	0.062	-1.592	0.099	-1.384
		0.875	-7.068	-0.10	0.062	-1.592	0.153	-1.29
		1.75	-7.068	-0.10	0.062	-1.592	0.208	-1.197
		2.625	-7.068	-0.10	0.062	-1.592	0.262	-1.103
		3.5	-7.068	-0.10	0.062	-1.592	0.316	-1.009
97	1 S +X	0	-0.723	6.437	0.024	-1.122	-0.045	24.487
		0.875	-0.723	6.437	0.024	-1.122	-0.025	18.854
		1.75	-0.723	6.437	0.024	-1.122	-0.004	13.222
		2.625	-0.723	6.437	0.024	-1.122	0.017	7.589
		3.5	-0.723	6.437	0.024	-1.122	0.038	1.957
98	1 S +X	0	-0.722	6.814	0.037	-1.766	-0.054	16.603
		0.875	-0.722	6.814	0.037	-1.766	-0.021	10.64
		1.75	-0.722	6.814	0.037	-1.766	0.011	4.678
		2.625	-0.722	6.814	0.037	-1.766	0.044	-1.284
		3.5	-0.722	6.814	0.037	-1.766	0.077	-7.246
99	1 S +X	0	-0.675	6.764	0.061	-2.149	-0.099	12.582
		0.875	-0.675	6.764	0.061	-2.149	-0.045	6.664
		1.75	-0.675	6.764	0.061	-2.149	0.008	0.745
		2.625	-0.675	6.764	0.061	-2.149	0.062	-5.173
		3.5	-0.675	6.764	0.061	-2.149	0.116	-11.092
100	1 S +X	0	-0.566	6.349	0.082	-2.174	-0.138	9.499

		0.875	-0.566	6.349	0.082	-2.174	-0.066	3.943
		1.75	-0.566	6.349	0.082	-2.174	0.006	-1.612
		2.625	-0.566	6.349	0.082	-2.174	0.077	-7.168
		3.5	-0.566	6.349	0.082	-2.174	0.149	-12.723
101	1 S +X	0	-0.399	5.298	0.102	-1.884	-0.171	6.016
		0.875	-0.399	5.298	0.102	-1.884	-0.082	1.38
		1.75	-0.399	5.298	0.102	-1.884	0.007	-3.256
		2.625	-0.399	5.298	0.102	-1.884	0.097	-7.892
		3.5	-0.399	5.298	0.102	-1.884	0.186	-12.528
102	1 S +X	0	-0.166	3.753	0.147	-1.266	-0.183	2.512
		0.875	-0.166	3.753	0.147	-1.266	-0.054	-0.772
		1.75	-0.166	3.753	0.147	-1.266	0.074	-4.056
		2.625	-0.166	3.753	0.147	-1.266	0.203	-7.34
		3.5	-0.166	3.753	0.147	-1.266	0.331	-10.624
169	1 S +X	0	-24.899	6.237	0	0	0	27.892
		0.875	-24.899	6.237	0	0	0	22.435
		1.75	-24.899	6.237	0	0	0	16.978
		2.625	-24.899	6.237	0	0	0	11.521
		3.5	-24.899	6.237	0	0	0	6.064
170	1 S +X	0	-21.334	5.275	0	0	0	15.364
		0.875	-21.334	5.275	0	0	0	10.749
		1.75	-21.334	5.275	0	0	0	6.133
		2.625	-21.334	5.275	0	0	0	1.517
		3.5	-21.334	5.275	0	0	0	-3.098
171	1 S +X	0	-16.499	4.846	0	0	0	9.533
		0.875	-16.499	4.846	0	0	0	5.292
		1.75	-16.499	4.846	0	0	0	1.052
		2.625	-16.499	4.846	0	0	0	-3.189
		3.5	-16.499	4.846	0	0	0	-7.429
172	1 S +X	0	-11.461	4.458	0	0	0	5.728
		0.875	-11.461	4.458	0	0	0	1.828
		1.75	-11.461	4.458	0	0	0	-2.073
		2.625	-11.461	4.458	0	0	0	-5.973
		3.5	-11.461	4.458	0	0	0	-9.873
173	1 S +X	0	-6.888	3.739	0	0	0	2.081
		0.875	-6.888	3.739	0	0	0	-1.191
		1.75	-6.888	3.739	0	0	0	-4.463
		2.625	-6.888	3.739	0	0	0	-7.735
		3.5	-6.888	3.739	0	0	0	-11.007
174	1 S +X	0	-3.695	1.536	0	0	0	-1.539
		0.875	-3.695	1.536	0	0	0	-2.883
		1.75	-3.695	1.536	0	0	0	-4.227
		2.625	-3.695	1.536	0	0	0	-5.571
		3.5	-3.695	1.536	0	0	0	-6.915

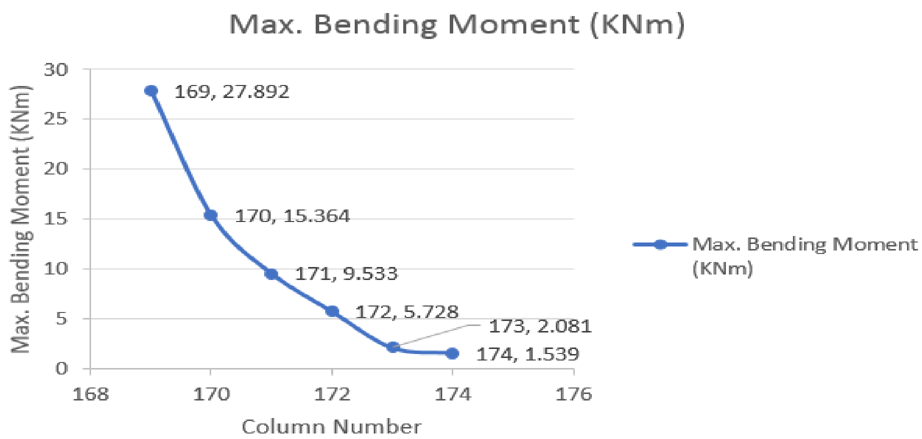
Fig. 4.6 Shows max. Bending moment graph for columns of the building, it shows that possibility of bending is max. For columns which are built at lower part of the building. Fig. (a) shows bending moment for column number 1, 2, 3, 4, 5, 6 and Fig. (b) shows bending moment for column number 97, 98, 99, 100, 101, 102 and Fig. (c) shows bending moment for column number 169, 170, 171, 172, 173, 174. Bending moment results also shows deeply in Table 4.2



(a)

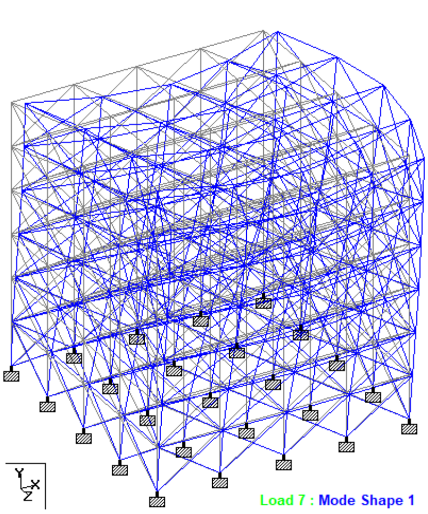


(b)

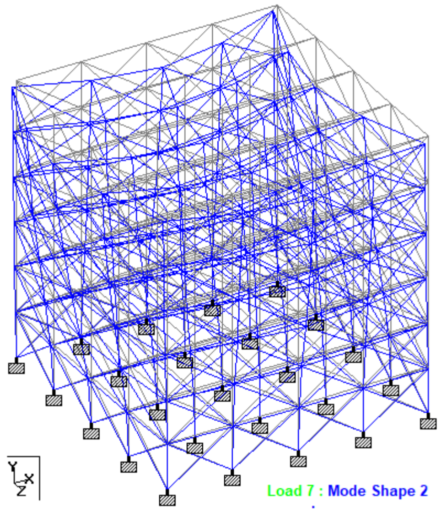


(c)

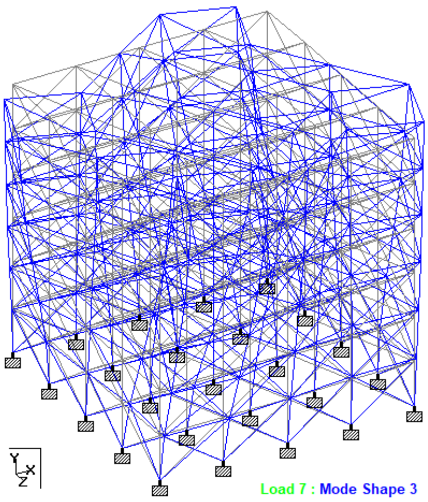
Fig. 4.6 Max. Bending Moment Graph for Columns for Case A 1 (a) for column number 1, 2, 3, 4, 5, 6 (b) for column number 97, 98, 99, 100, 101, 102 (c) for column number 169, 170, 171, 172, 173, 174



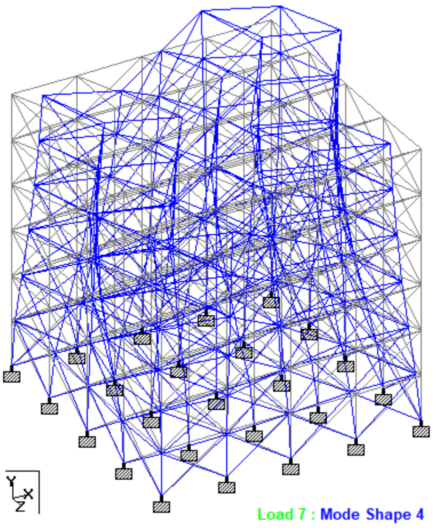
(a)



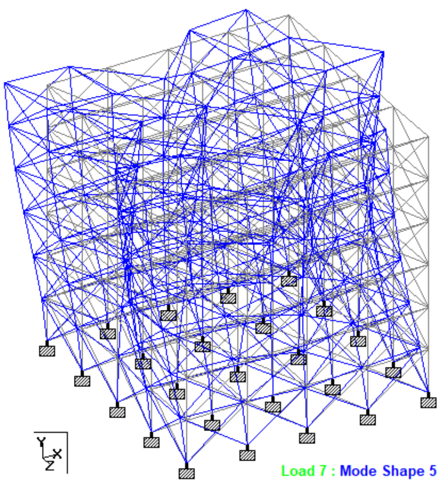
(b)



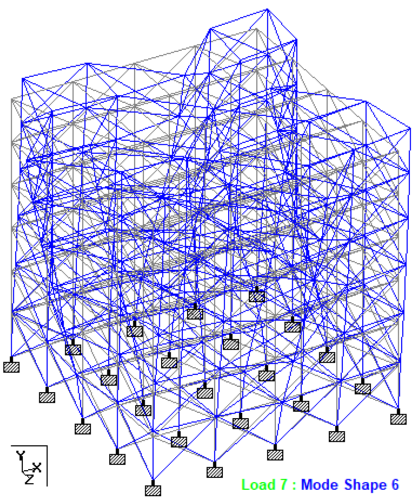
(c)



(d)



(e)



(f)

Fig. 4.7 Mode Shapes for Case A1, (a) Mode shape I, (b) Mode shape II, (c) Mode shape III, (d) Mode shape IV, (e) Mode shape V and (f) Mode shape VI

Fig. 4.7 shows mode shape for Case A1, Fig. (a) shows mode shape 1st, Fig. (b) shows mode shape 2nd, Fig. (c) shows mode shape 3rd, Fig. (d) shows mode shape 4th, Fig. (e) shows mode shape 5th, Fig. (f) shows mode shape 6th.

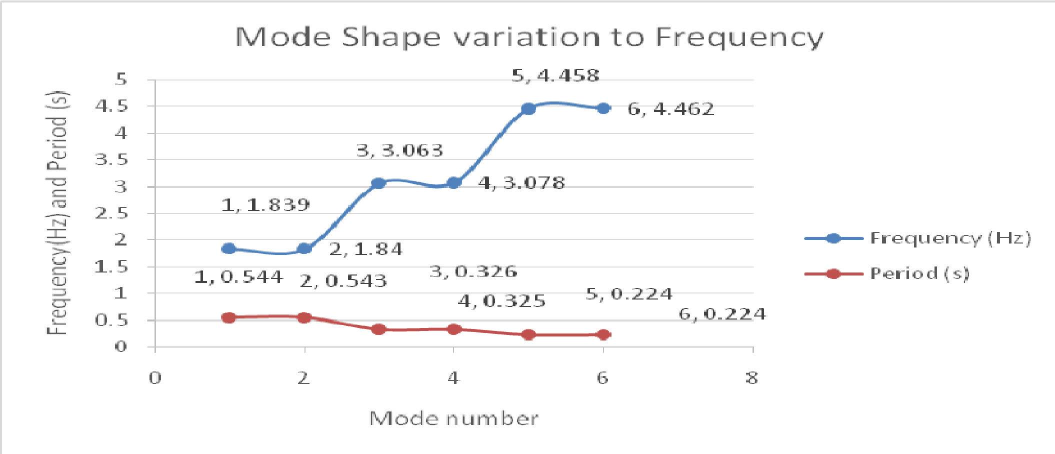


Fig. 4.8 Graph of Frequency and period for mode shape 1, 2, 3, 4, 5, 6

Fig. 4.8 shows variation of frequency with respect to different time period (sec.) for Mode Shape 1st, Mode Shape 2nd, Mode Shape 3rd, Mode Shape 4th, Mode Shape 5th and Mode Shape 6th. Table 4.17 also shows same results.

Table. 4.3 Frequency/Time for Case A1 at each modes

M0DE	Frequency (Hz)	Period (seconds)	Participation (X %)	Participation (Y %)	Participation (Z %)	Type
1	1.839	0.544	32.975	0	32.975	Elastic
2	1.84	0.543	32.951	0	32.951	Elastic
3	3.063	0.326	0	0	0	Elastic
4	3.078	0.325	0	0	0	Elastic
5	4.458	0.224	4.014	0.006	4.014	Elastic
6	4.462	0.224	3.99	0	3.99	Elastic

Fig. 4.9 shows Peak story shear in X-direction (N) for Mode Shape 1st, Mode Shape 2nd, Mode Shape 3rd, Mode Shape 4th, Mode Shape 5th and Mode Shape 6th. It shows that peak story shear is maximum at the base and minimum at the top. Table 4.18 also shows same results.

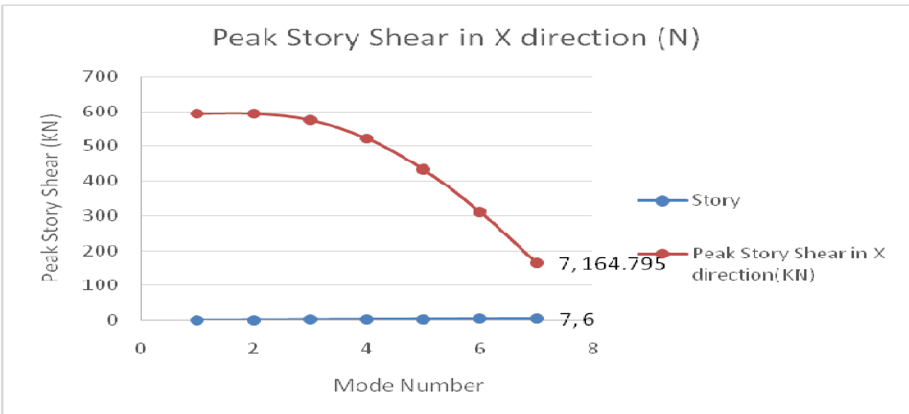


Fig. 4.9 Graph of Peak story shear for Case A1

Table. 4.4 Peak Storey Shear for Case A1

STORY	LEVEL IN METER	PEAK STOREY SHEAR (kN)	
-----------------------	-----------------------	X	Z
0	0	593.928	0
1	3.5	593.928	0
2	7	575.759	0
3	10.5	523.209	0
4	14	433.925	0
5	17.5	312.024	0
6	21	164.795	0

Fig. 4.10 shows base shear in X-direction for (KN) for Mode Shape 1st, Mode Shape 2nd, Mode Shape 3rd, Mode Shape 4th, Mode Shape 5th and Mode Shape 6th. It shows that mode shape 1, 2 have max. Base shear while mode shape 3, 4 have very minute (almost zero) base shear and mode shape 5, 6 have minimum base shear in comparison to mode shape 1 and 2. Table 4.5 also shows same results.

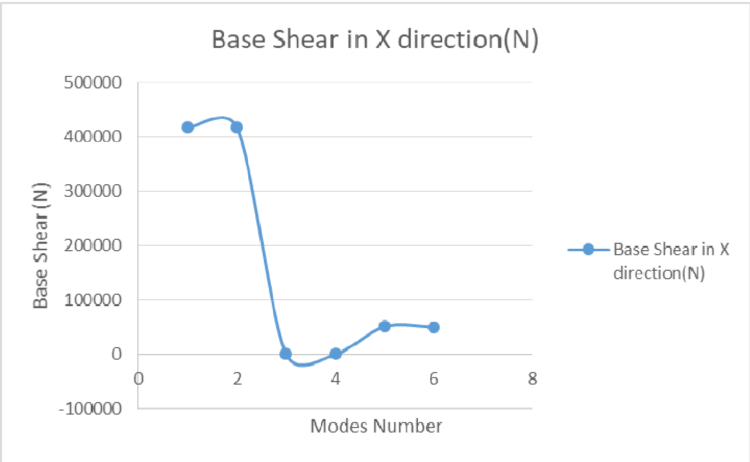
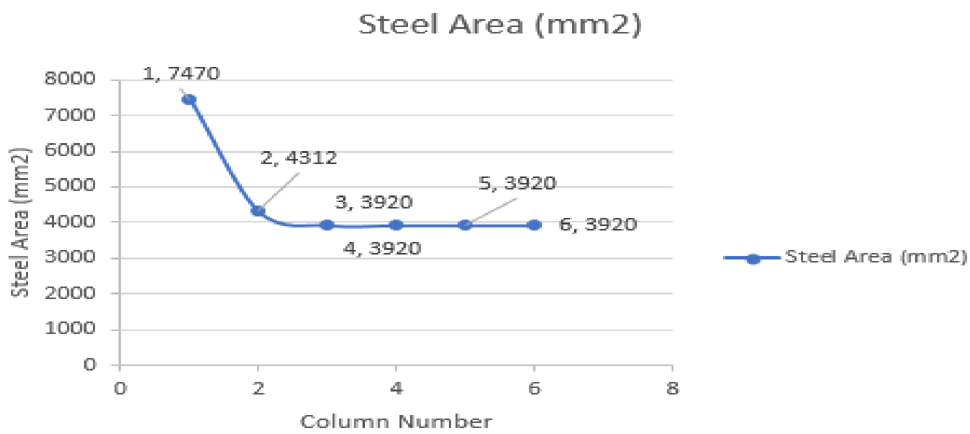


Fig. 4.10 Graph of Base shear for Case A1

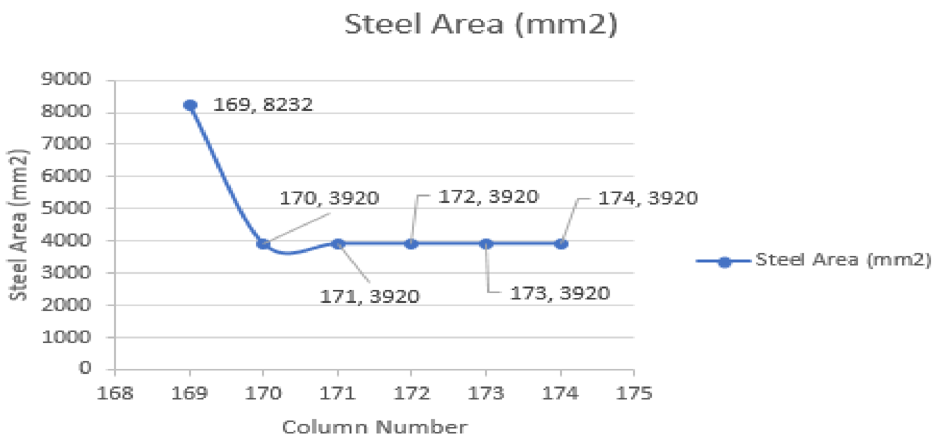
Table. 4.5 Base Shear for Case A1

	MASS PARTICIPATION FACTORS IN PERCENT						BASE SHEAR IN NEWT		
MODE	X	Y	Z	SUMM-X	SUMM-Y	SUMM-Z	X	Y	Z
1	32.97	0.00	32.97	32.975	0.000	32.975	417060.39	0.00	0.00
2	32.95	0.00	32.95	65.926	0.000	65.926	416758.54	0.00	0.00
3	0.00	0.00	0.00	65.926	0.000	65.926	0.14	0.00	0.00
4	0.00	0.00	0.00	65.926	0.000	65.926	0.06	0.00	0.00
5	4.01	0.01	4.01	69.940	0.006	69.940	50770.62	0.00	0.00
6	3.99	0.00	3.99	73.930	0.006	73.930	50460.09	0.00	0.00
				TOTAL SRSS		SHEAR	593928.38	0.00	0.00
				TOTAL 10PCT		SHEAR	839941.46	0.00	0.00
				TOTAL ABS		SHEAR	935049.84	0.00	0.00
				TOTAL CSM		SHEAR	935049.84	0.00	0.00

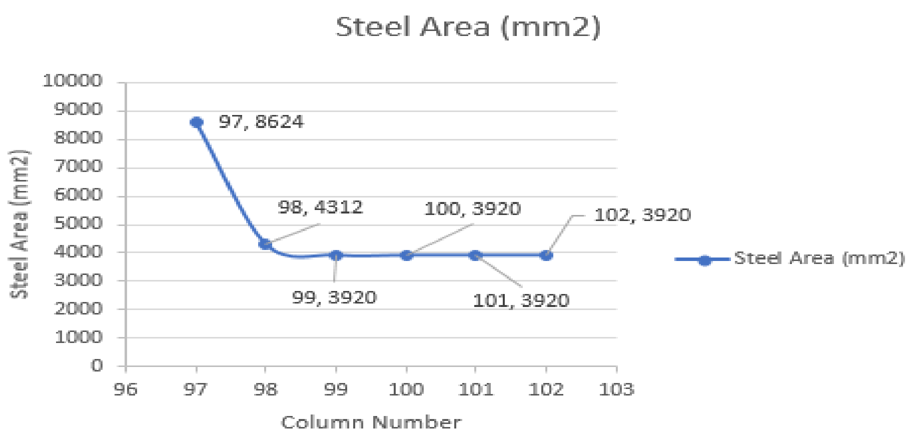
Fig. 4.11 shows steel area for columns, it shows that steel area for all the columns is almost same but 6th number columns have higher reinforcement to bear max. load impact and avoid bending moment thus such columns have higher value of steel area. Fig (a) shows steel requirement for column number 1, 2, 3, 4, 5, 6. Fig. (b) shows steel requirement for column number 169, 170, 171, 172, 173, 174. Fig. (c) shows steel requirement for column number 97, 98, 99, 100, 101, 102.



(a)



(b)

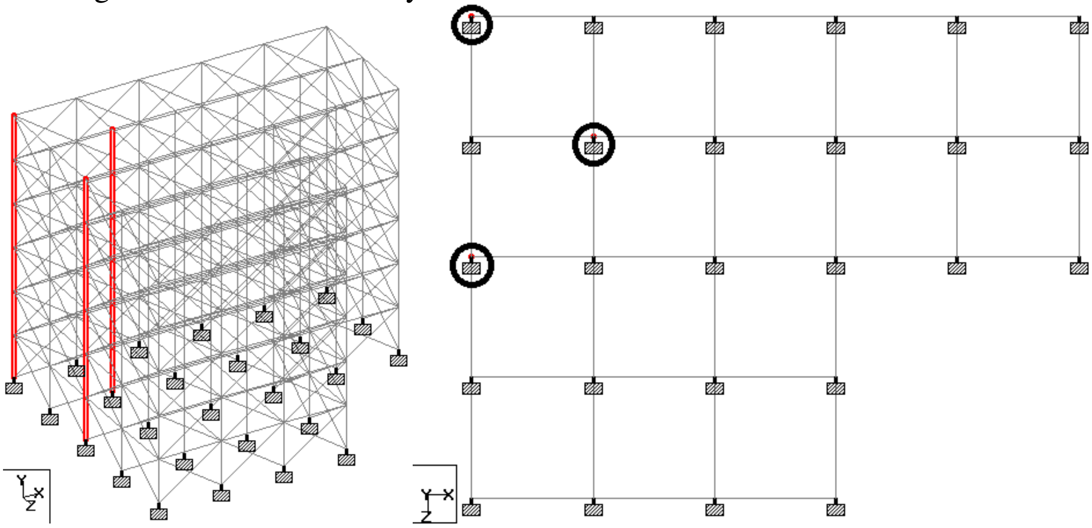


(C)

Fig. 4.11 Steel Area Graph for Columns for Case A 1 (a) for column number 1, 2, 3, 4, 5, 6 (b) for column number 169, 170, 171, 172, 173, 174 (c) for column number 97, 98, 99, 100, 101, 102

4.1.2 CASE A 2

Fig. 4.12 shows displacement of building structure into X- direction, black lines shows the building structure before analysis and green lines shows displacement of building structure after the analysis.



(a) (b)

Fig. 4.12 Considered column for comparison Case A2

In this study corner column are considered for study, seven columns are connected through Node 1,2,3,4,5,6 and 7, rest of the column are connected from node to node in the same fashion.

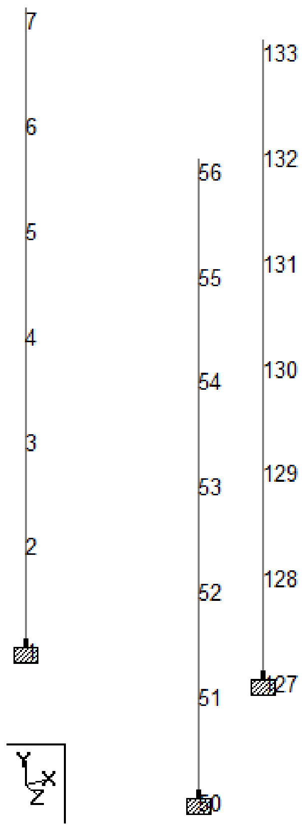


Fig. 4.13 Considered Nodes for comparison Case A2

Fig. 4.13 shows connection of column (vertical members) through node to node for Case A2.

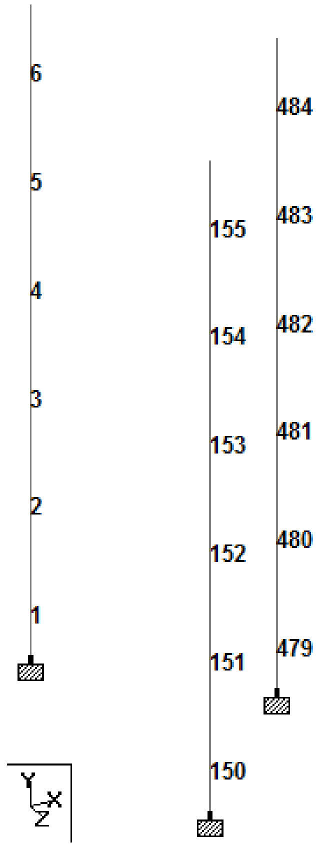


Fig. 4.14 Column of structure for Case A2

Fig. 4.15 shows displacement of building structure into X- direction, black lines shows the building structure before analysis and green lines shows displacement of building structure after the analysis.

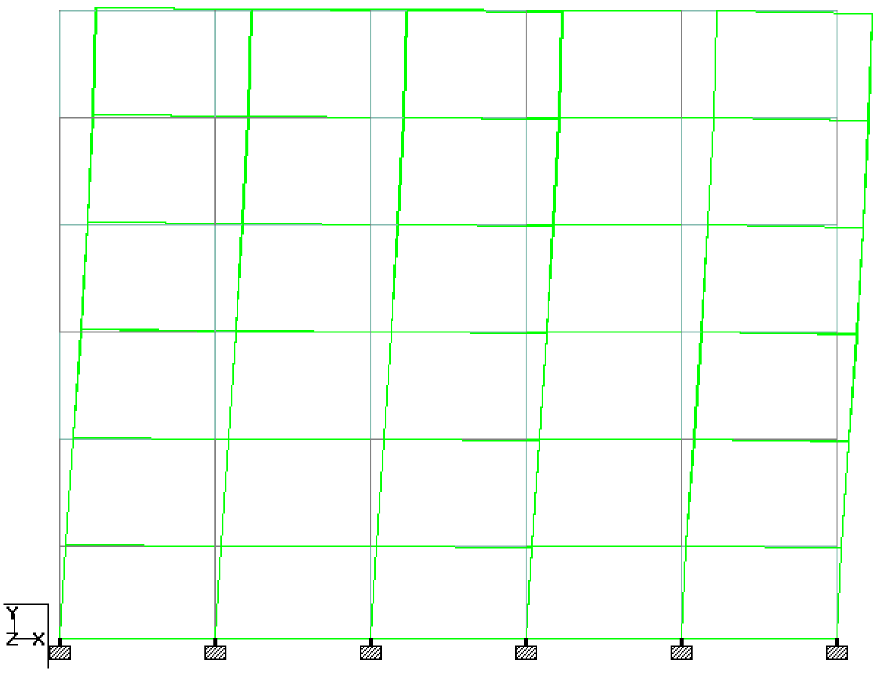


Fig. 4.15 Directional displacement for Case A 2

Table 4.6 Displacement of node number 1,2,3,4,5,6,7,50,51,52,53,54,55,56,127,128,129,130,131,132,133 for Case A2

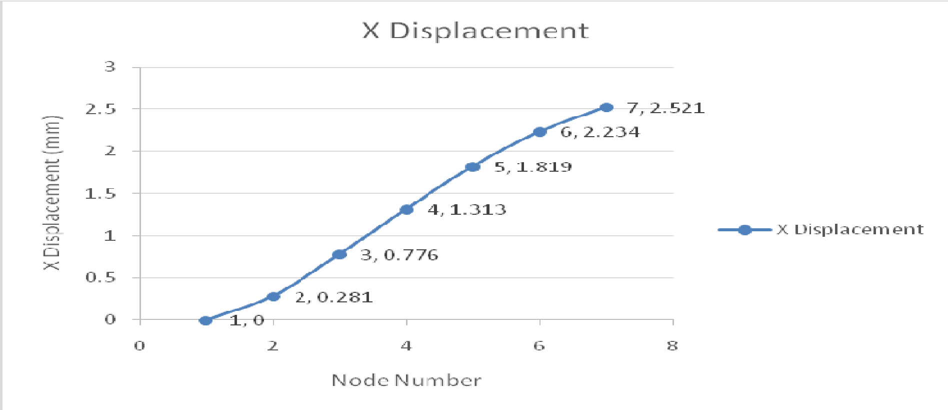
N0DE	L/C	X-Trans (mm)	Y-Trans (mm)	Z-Trans (mm)	Absolute (mm)
1	1 S +X	0	0	0	0
	2 S –X	0	0	0	0
	3 S +Z	0	0	0	0
	4 S –Z	0	0	0	0
	5 LIVE L0AD	0	0	0	0
	6 DEAD L0AD	0	0	0	0
	7 MODE SHAPES	0	0	0	0
	8 COMBINATION	0	0	0	0
2	1 S +X	0.281	0.054	0.012	0.286
	2 S –X	-0.529	-0.045	-0.008	0.53
	3 S +Z	0.013	0.047	0.249	0.254
	4 S –Z	-0.007	-0.039	-0.433	0.434
	5 LIVE L0AD	-0.116	-0.346	-0.12	0.384
	6 DEAD L0AD	-0.014	-0.032	-0.014	0.038
	7 MODE SHAPES	3.079	1.001	3.529	4.789
	8 COMBINATION	0.269	0.035	0.085	0.284
3	1 S +X	0.776	0.099	0.022	0.782
	2 S –X	-1.139	-0.075	-0.017	1.142
	3 S +Z	0.025	0.087	0.685	0.691
	4 S –Z	-0.016	-0.065	-0.944	0.946
	5 LIVE L0AD	-0.1	-0.626	-0.123	0.646
	6 DEAD L0AD	-0.013	-0.059	-0.015	0.062
	7 MODE SHAPES	7.822	1.808	9.038	12.089
	8 COMBINATION	0.735	0.065	0.238	0.775
4	1 S +X	1.313	0.133	0.031	1.32
	2 S –X	-1.67	-0.093	-0.025	1.673
	3 S +Z	0.033	0.116	1.154	1.16
	4 S –Z	-0.023	-0.081	-1.398	1.4
	5 LIVE L0AD	-0.036	-0.841	-0.095	0.847
	6 DEAD L0AD	-0.007	-0.08	-0.014	0.082
	7 MODE SHAPES	12.296	2.361	14.269	18.984
	8 COMBINATION	1.218	0.086	0.399	1.285
5	1 S +X	1.819	0.156	0.037	1.826
	2 S –X	-2.125	-0.102	-0.033	2.128
	3 S +Z	0.038	0.135	1.59	1.596
	4 S –Z	-0.028	-0.088	-1.79	1.792
	5 LIVE L0AD	0.047	-0.991	-0.067	0.994
	6 DEAD L0AD	0.001	-0.095	-0.013	0.096
	7 MODE SHAPES	15.945	2.692	18.56	24.616
	8 COMBINATION	1.642	0.098	0.544	1.732
6	1 S +X	2.234	0.169	0.046	2.241

	2 S –X	-2.463	-0.104	-0.039	2.466
	3 S +Z	0.045	0.146	1.945	1.951
	4 S –Z	-0.03	-0.09	-2.084	2.086
	5 LIVE L0AD	0.15	-1.073	-0.025	1.084
	6 DEAD L0AD	0.009	-0.105	-0.011	0.106
	7 MODE SHAPES	18.533	2.851	21.637	28.631
	8 COMBINATION	1.957	0.104	0.654	2.066
7	1 S +X	2.521	0.174	0.069	2.528
	2 S –X	-2.673	-0.104	-0.046	2.676
	3 S +Z	0.066	0.151	2.19	2.197
	4 S –Z	-0.031	-0.09	-2.268	2.27
	5 LIVE L0AD	0.256	-1.09	0.041	1.121
	6 DEAD L0AD	0.033	-0.109	0.007	0.114
	7 MODE SHAPES	20.081	2.9	23.516	31.059
	8 COMBINATION	2.151	0.106	0.724	2.272
50	1 S +X	0	0	0	0
	2 S –X	0	0	0	0
	3 S +Z	0	0	0	0
	4 S –Z	0	0	0	0
	5 LIVE L0AD	0	0	0	0
	6 DEAD L0AD	0	0	0	0
	7 MODE SHAPES	0	0	0	0
	8 COMBINATION	0	0	0	0
51	1 S +X	0.601	0.015	0.013	0.601
	2 S –X	-0.699	-0.014	-0.003	0.699
	3 S +Z	0.02	0.009	0.337	0.338
	4 S –Z	-0.024	0.008	-0.337	0.338
	5 LIVE L0AD	-0.056	-0.427	-0.003	0.431
	6 DEAD L0AD	-0.01	-0.047	-0.001	0.048
	7 MODE SHAPES	6.402	0.349	4.573	7.875
	8 COMBINATION	0.871	0.014	0.122	0.879
52	1 S +X	1.728	0.028	0.025	1.728
	2 S –X	-1.909	-0.025	-0.007	1.909
	3 S +Z	0.072	0.021	0.81	0.813
	4 S –Z	-0.081	0.017	-0.81	0.814
	5 LIVE L0AD	-0.07	-0.777	-0.006	0.78
	6 DEAD L0AD	-0.015	-0.087	-0.001	0.088
	7 MODE SHAPES	16.94	0.664	10.358	19.866
	8 COMBINATION	2.437	0.024	0.292	2.455
53	1 S +X	2.927	0.038	0.034	2.928
	2 S –X	-3.129	-0.034	-0.011	3.129
	3 S +Z	0.149	0.031	1.275	1.284
	4 S –Z	-0.158	0.026	-1.276	1.286
	5 LIVE L0AD	-0.088	-1.046	-0.008	1.05
	6 DEAD L0AD	-0.025	-0.118	-0.002	0.121

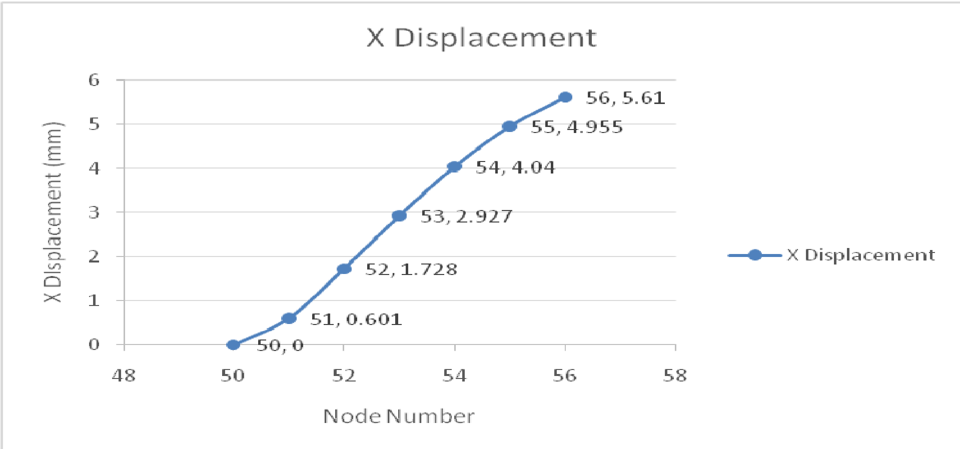
	7 MODE SHAPES	26.618	0.905	15.371	30.751
	8 COMBINATION	3.967	0.031	0.455	3.993
54	1 S +X	4.04	0.045	0.039	4.04
	2 S –X	-4.243	-0.04	-0.016	4.244
	3 S +Z	0.244	0.04	1.69	1.708
	4 S –Z	-0.251	0.034	-1.692	1.711
	5 LIVE L0AD	-0.114	-1.233	-0.01	1.238
	6 DEAD L0AD	-0.041	-0.142	-0.003	0.148
	7 MODE SHAPES	34.451	1.081	19.303	39.505
	8 COMBINATION	5.207	0.034	0.593	5.24
55	1 S +X	4.955	0.05	0.042	4.955
	2 S –X	-5.159	-0.043	-0.019	5.159
	3 S +Z	0.346	0.046	2.015	2.045
	4 S –Z	-0.351	0.04	-2.017	2.048
	5 LIVE L0AD	-0.121	-1.338	-0.011	1.344
	6 DEAD L0AD	-0.06	-0.158	-0.003	0.169
	7 MODE SHAPES	40.24	1.192	22.006	45.88
	8 COMBINATION	6.036	0.036	0.696	6.076
56	1 S +X	5.61	0.052	0.042	5.611
	2 S –X	-5.815	-0.044	-0.021	5.816
	3 S +Z	0.442	0.051	2.219	2.263
	4 S –Z	-0.441	0.044	-2.223	2.267
	5 LIVE L0AD	-0.098	-1.36	-0.011	1.364
	6 DEAD L0AD	-0.046	-0.166	-0.003	0.173
	7 MODE SHAPES	44.033	1.246	23.477	49.916
	8 COMBINATION	6.463	0.036	0.76	6.508
127	1 S +X	0	0	0	0
	2 S –X	0	0	0	0
	3 S +Z	0	0	0	0
	4 S –Z	0	0	0	0
	5 LIVE L0AD	0	0	0	0
	6 DEAD L0AD	0	0	0	0
	7 MODE SHAPES	0	0	0	0
	8 COMBINATION	0	0	0	0
128	1 S +X	0.55	0.001	0.012	0.55
	2 S –X	-0.562	0	-0.011	0.562
	3 S +Z	0.014	0	0.508	0.508
	4 S –Z	-0.012	0	-0.511	0.511
	5 LIVE L0AD	-0.013	-0.6	-0.021	0.601
	6 DEAD L0AD	-0.004	-0.097	-0.004	0.097
	7 MODE SHAPES	6.641	0.155	7.879	10.306
	8 COMBINATION	0.847	0	0.286	0.894
129	1 S +X	1.656	0.001	0.035	1.656
	2 S –X	-1.687	0	-0.032	1.688
	3 S +Z	0.043	0.001	1.543	1.544

	4 S –Z	-0.038	0	-1.551	1.551
	5 LIVE L0AD	-0.006	-1.087	-0.041	1.088
	6 DEAD L0AD	-0.006	-0.177	-0.008	0.177
	7 MODE SHAPES	17.572	0.285	21.242	27.57
	8 COMBINATION	2.442	0.001	0.829	2.579
130	1 S +X	2.909	0.002	0.061	2.91
	2 S –X	-2.958	0	-0.057	2.959
	3 S +Z	0.08	0.001	2.729	2.73
	4 S –Z	-0.072	0	-2.74	2.741
	5 LIVE L0AD	0	-1.459	-0.07	1.461
	6 DEAD L0AD	-0.009	-0.241	-0.014	0.242
	7 MODE SHAPES	27.219	0.39	33.381	43.074
	8 COMBINATION	4.03	0.001	1.375	4.258
131	1 S +X	4.108	0.002	0.085	4.109
	2 S –X	-4.174	0	-0.081	4.175
	3 S +Z	0.119	0.002	3.867	3.869
	4 S –Z	-0.109	0	-3.882	3.884
	5 LIVE L0AD	0.007	-1.719	-0.099	1.722
	6 DEAD L0AD	-0.015	-0.289	-0.021	0.29
	7 MODE SHAPES	34.242	0.467	42.38	54.487
	8 COMBINATION	5.243	0.002	1.794	5.542
132	1 S +X	5.111	0.003	0.105	5.112
	2 S –X	-5.193	0	-0.101	5.194
	3 S +Z	0.156	0.002	4.819	4.822
	4 S –Z	-0.144	0	-4.838	4.84
	5 LIVE L0AD	0.029	-1.866	-0.116	1.869
	6 DEAD L0AD	-0.019	-0.321	-0.027	0.323
	7 MODE SHAPES	38.683	0.517	48.124	61.747
	8 COMBINATION	5.93	0.002	2.032	6.269
133	1 S +X	5.834	0.003	0.121	5.836
	2 S –X	-5.93	0	-0.116	5.931
	3 S +Z	0.188	0.002	5.51	5.514
	4 S –Z	-0.172	0	-5.531	5.534
	5 LIVE L0AD	0.073	-1.899	-0.113	1.904
	6 DEAD L0AD	-0.006	-0.338	-0.019	0.338
	7 MODE SHAPES	41.117	0.539	51.329	65.769
	8 COMBINATION	6.167	0.002	2.118	6.521

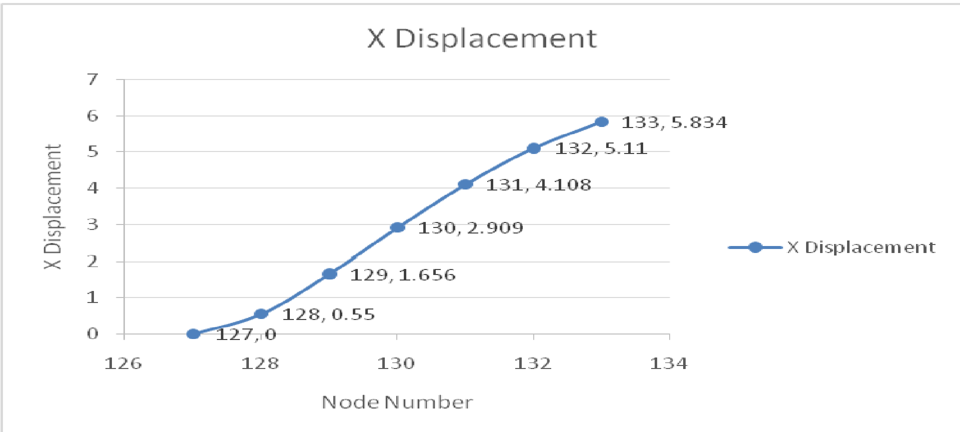
Fig. 4.16 (a), 4.16 (b), and 4.16 (c) Shows Node Number vs Displacement Graph for columns in X-direction, this graph shows that displacement have higher values for columns which are built at top floor of the building. Fig. (a) shows displacement for node number 1, 2, 3, 4, 5, 6, 7 and Fig. (b) shows displacement for node number 50, 51, 52, 53, 54, 55, 56 and Fig. (c) shows displacement for column number 127, 128, 129, 130, 131, 132, 133. Displacement results also shows deeply in Table 4.6



(a)



(b)



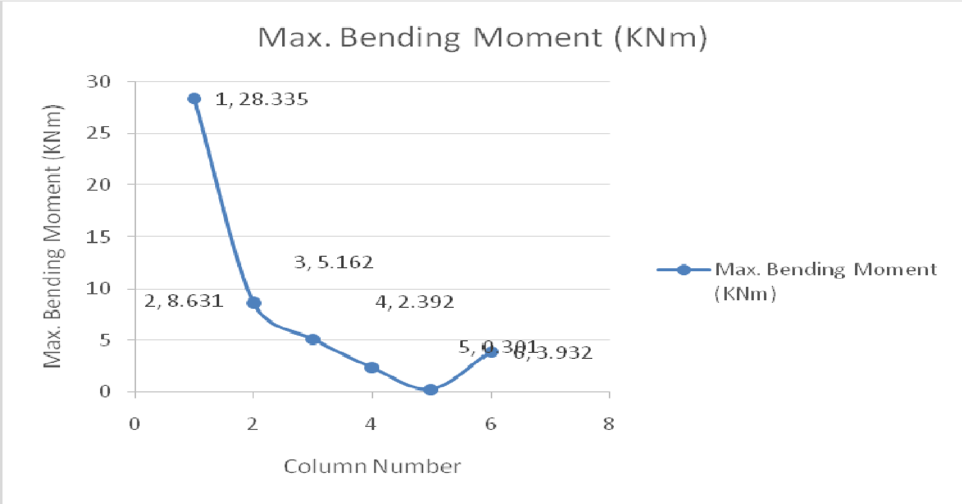
(c)

Fig. 4.16 Directional displacement Graph for node for Case A 2 (a) for node number 1, 2, 3, 4, 5, 6, 7 (b) for node number 50, 51, 52, 53, 54, 55, 56 (c) for node number 127, 128, 129, 130, 131, 132,133

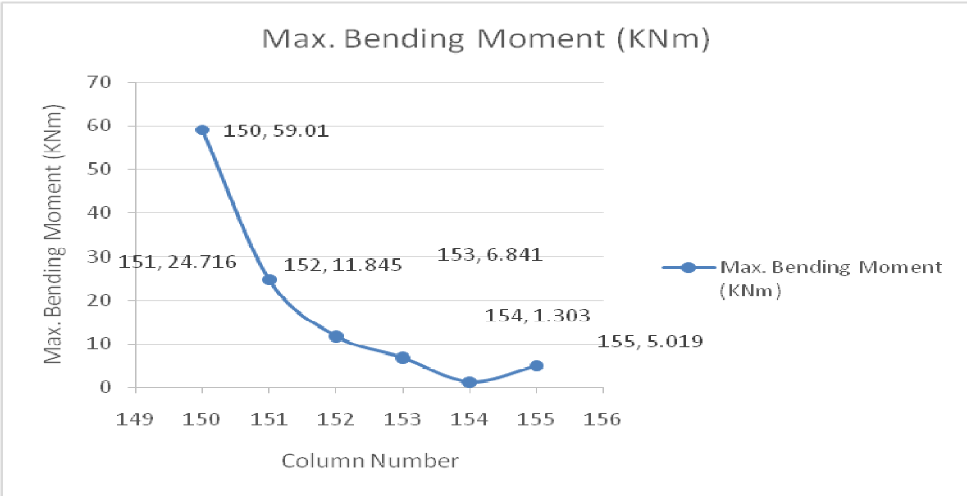
Table 4.7 Maximum bending moment of beam 1, 2, 3,4,5,6,150,151,152,153,154,155,479,480,481,482,483,484 for Case A2

Beam	L/C	Dist (m)	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)
1	1 S +X	0	-163.47	7.625	-0.488	-4.398	1.37	28.335
		0.875	-163.47	7.625	-0.488	-4.398	0.943	21.663
		1.75	-163.47	7.625	-0.488	-4.398	0.516	14.991
		2.625	-163.47	7.625	-0.488	-4.398	0.09	8.319
		3.5	-163.47	7.625	-0.488	-4.398	-0.337	1.647
2	1 S +X	0	-138.90	3.177	0.234	-5.588	-0.536	8.631
		0.875	-138.90	3.177	0.234	-5.588	-0.331	5.85
		1.75	-138.90	3.177	0.234	-5.588	-0.126	3.07
		2.625	-138.90	3.177	0.234	-5.588	0.079	0.29
		3.5	-138.90	3.177	0.234	-5.588	0.284	-2.49
3	1 S +X	0	-103.53	2.894	0.203	-6.23	-0.385	5.162
		0.875	-103.53	2.894	0.203	-6.23	-0.207	2.63
		1.75	-103.53	2.894	0.203	-6.23	-0.029	0.098
		2.625	-103.53	2.894	0.203	-6.23	0.148	-2.434
		3.5	-103.53	2.894	0.203	-6.23	0.326	-4.966
4	1 S +X	0	-68.828	2.542	0.335	-6.015	-0.642	2.392
		0.875	-68.828	2.542	0.335	-6.015	-0.349	0.168
		1.75	-68.828	2.542	0.335	-6.015	-0.056	-2.056
		2.625	-68.828	2.542	0.335	-6.015	0.237	-4.28
		3.5	-68.828	2.542	0.335	-6.015	0.529	-6.504
5	1 S +X	0	-38.708	2.217	0.555	-4.967	-0.644	-0.301
		0.875	-38.708	2.217	0.555	-4.967	-0.158	-2.242
		1.75	-38.708	2.217	0.555	-4.967	0.328	-4.182
		2.625	-38.708	2.217	0.555	-4.967	0.813	-6.122
		3.5	-38.708	2.217	0.555	-4.967	1.299	-8.062
6	1 S +X	0	-16.599	-0.406	0.187	-3.096	0.201	-3.932
		0.875	-16.599	-0.406	0.187	-3.096	0.365	-3.577
		1.75	-16.599	-0.406	0.187	-3.096	0.529	-3.221
		2.625	-16.599	-0.406	0.187	-3.096	0.693	-2.866
		3.5	-16.599	-0.406	0.187	-3.096	0.857	-2.511
150	1 S +X	0	-46.415	14.856	-0.619	0.085	1.581	59.01
		0.875	-46.415	14.856	-0.619	0.085	1.039	46.011
		1.75	-46.415	14.856	-0.619	0.085	0.497	33.012
		2.625	-46.415	14.856	-0.619	0.085	-0.045	20.013
		3.5	-46.415	14.856	-0.619	0.085	-0.587	7.013
151	1 S +X	0	-39.268	9.769	-0.076	0.091	-0.035	24.716
		0.875	-39.268	9.769	-0.076	0.091	-0.102	16.168
		1.75	-39.268	9.769	-0.076	0.091	-0.168	7.62
		2.625	-39.268	9.769	-0.076	0.091	-0.234	-0.929
		3.5	-39.268	9.769	-0.076	0.091	-0.301	-9.477
152	1 S +X	0	-30.33	7.289	-0.101	0.067	0.059	11.845
		0.875	-30.33	7.289	-0.101	0.067	-0.029	5.467
		1.75	-30.33	7.289	-0.101	0.067	-0.117	-0.911

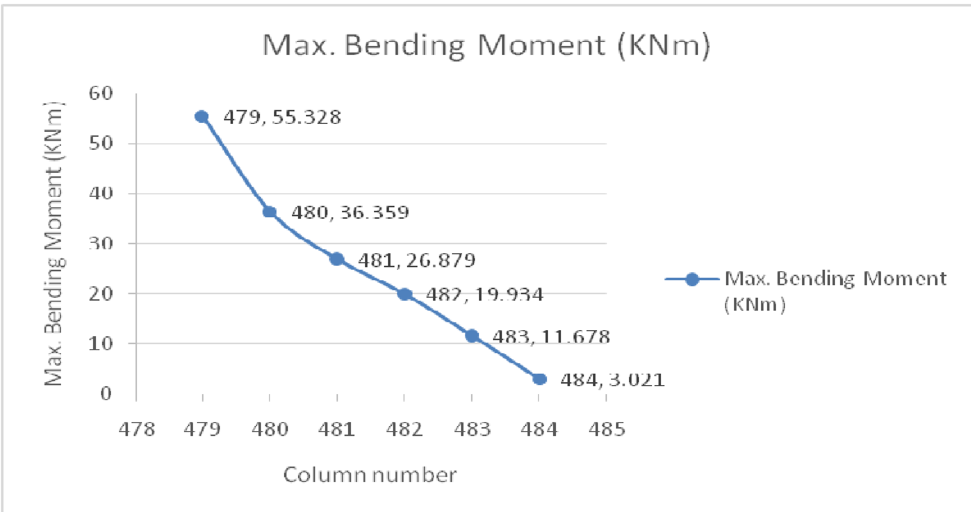
		2.625	-30.33	7.289	-0.101	0.067	-0.205	-7.289
		3.5	-30.33	7.289	-0.101	0.067	-0.293	-13.66
153	1 S +X	0	-21.416	6.664	-0.017	0.038	-0.051	6.841
		0.875	-21.416	6.664	-0.017	0.038	-0.066	1.01
		1.75	-21.416	6.664	-0.017	0.038	-0.081	-4.821
		2.625	-21.416	6.664	-0.017	0.038	-0.095	-10.65
		3.5	-21.416	6.664	-0.017	0.038	-0.11	-16.48
154	1 S +X	0	-13.225	5.591	-0.068	0.011	0.043	1.303
		0.875	-13.225	5.591	-0.068	0.011	-0.016	-3.589
		1.75	-13.225	5.591	-0.068	0.011	-0.075	-8.482
		2.625	-13.225	5.591	-0.068	0.011	-0.135	-13.37
		3.5	-13.225	5.591	-0.068	0.011	-0.194	-18.26
155	1 S +X	0	-6.821	1.194	0.03	-0.006	-0.118	-5.019
		0.875	-6.821	1.194	0.03	-0.006	-0.092	-6.064
		1.75	-6.821	1.194	0.03	-0.006	-0.066	-7.109
		2.625	-6.821	1.194	0.03	-0.006	-0.039	-8.155
		3.5	-6.821	1.194	0.03	-0.006	-0.013	-9.2
479	1 S +X	0	-1.793	14.79	-0.27	-1.666	1.114	55.328
		0.875	-1.793	14.79	-0.27	-1.666	0.878	42.387
		1.75	-1.793	14.79	-0.27	-1.666	0.642	29.447
		2.625	-1.793	14.79	-0.27	-1.666	0.406	16.506
		3.5	-1.793	14.79	-0.27	-1.666	0.17	3.565
480	1 S +X	0	-1.784	15.22	-0.238	-2.402	0.641	36.359
		0.875	-1.784	15.22	-0.238	-2.402	0.433	23.041
		1.75	-1.784	15.22	-0.238	-2.402	0.225	9.724
		2.625	-1.784	15.22	-0.238	-2.402	0.017	-3.594
		3.5	-1.784	15.22	-0.238	-2.402	-0.191	-16.91
481	1 S +X	0	-1.667	14.795	-0.154	-2.618	0.284	26.879
		0.875	-1.667	14.795	-0.154	-2.618	0.15	13.934
		1.75	-1.667	14.795	-0.154	-2.618	0.015	0.988
		2.625	-1.667	14.795	-0.154	-2.618	-0.119	-11.95
		3.5	-1.667	14.795	-0.154	-2.618	-0.254	-24.90
482	1 S +X	0	-1.401	13.79	-0.06	-2.442	0.01	19.934
		0.875	-1.401	13.79	-0.06	-2.442	-0.043	7.868
		1.75	-1.401	13.79	-0.06	-2.442	-0.095	-4.198
		2.625	-1.401	13.79	-0.06	-2.442	-0.148	-16.26
		3.5	-1.401	13.79	-0.06	-2.442	-0.201	-28.33
483	1 S +X	0	-0.993	11.271	0.051	-2.004	-0.232	11.678
		0.875	-0.993	11.271	0.051	-2.004	-0.187	1.815
		1.75	-0.993	11.271	0.051	-2.004	-0.143	-8.047
		2.625	-0.993	11.271	0.051	-2.004	-0.098	-17.90
		3.5	-0.993	11.271	0.051	-2.004	-0.053	-27.77
484	1 S +X	0	-0.432	6.833	0.23	-1.303	-0.388	3.021
		0.875	-0.432	6.833	0.23	-1.303	-0.187	-2.958
		1.75	-0.432	6.833	0.23	-1.303	0.014	-8.937
		2.625	-0.432	6.833	0.23	-1.303	0.216	-14.91
		3.5	-0.432	6.833	0.23	-1.303	0.417	-20.89



(a)



(b)



(c)

Fig. 4.17 Max. Bending Moment Graph for Columns for Case A 2 (a) for column number 1, 2, 3, 4, 5, 6 (b) for column number 150, 151, 152, 153, 154, 155 (c) for column number 479, 480, 481, 482, 483, 484

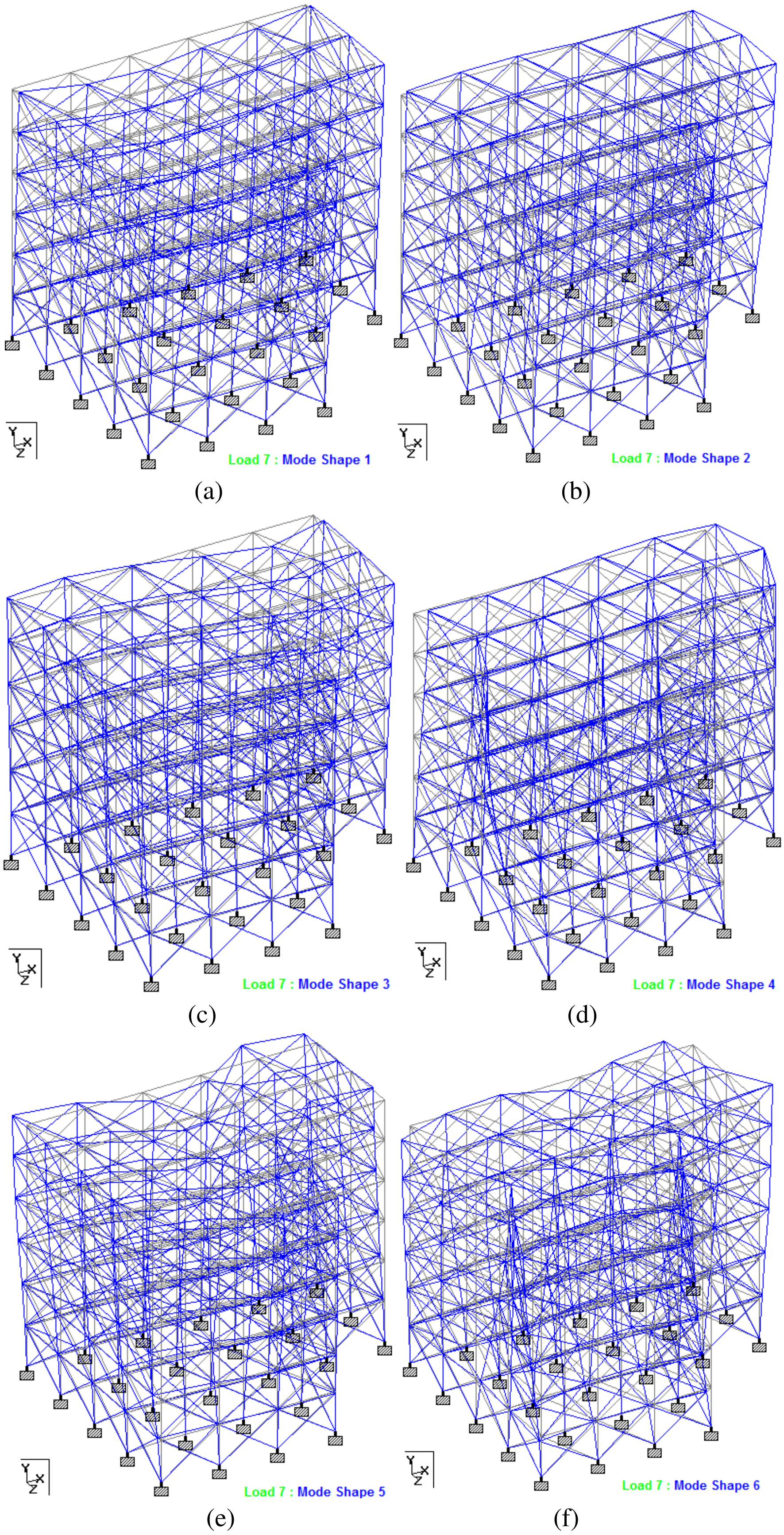


Fig. 4.18 Mode Shapes for Case A2, (a) Mode shape I, (b) Mode shape II, (c) Mode shape III, (d) Mode shape IV, (e) Mode shape V and (f) Mode shape VI

Fig. 4.18 shows mode shape for Case A2, Fig. (a) shows mode shape 1st, Fig. (b) shows mode shape 2nd, Fig. (c) shows mode shape 3rd, Fig. (d) shows mode shape 4th, Fig. (e) Shows mode shape 5th, Fig. (f) shows mode shape 6th.

Table. 4.8 Frequency/Time for Case A 2 at each modes

M0DE	Frequency (Hz)	Period (seconds)	Participation (X %)	Participation (Y %)	Participation (Z %)	Type
1	1.946	0.514	1.864	0.002	65.173	Elastic
2	2.223	0.45	68.455	0.001	1.755	Elastic
3	2.671	0.374	0.434	0.001	3.808	Elastic
4	2.943	0.34	0.002	0	0.039	Elastic
5	3.514	0.285	0.356	0.001	3.325	Elastic
6	4.205	0.238	4.412	0.001	0.003	Elastic

Fig. 4.19 shows variation of frequency with respect to different time period (sec.) for Mode Shape 1st, Mode Shape 2nd, Mode Shape 3rd, Mode Shape 4th, Mode Shape 5th and Mode Shape 6th. Table 4.8 also shows same results.

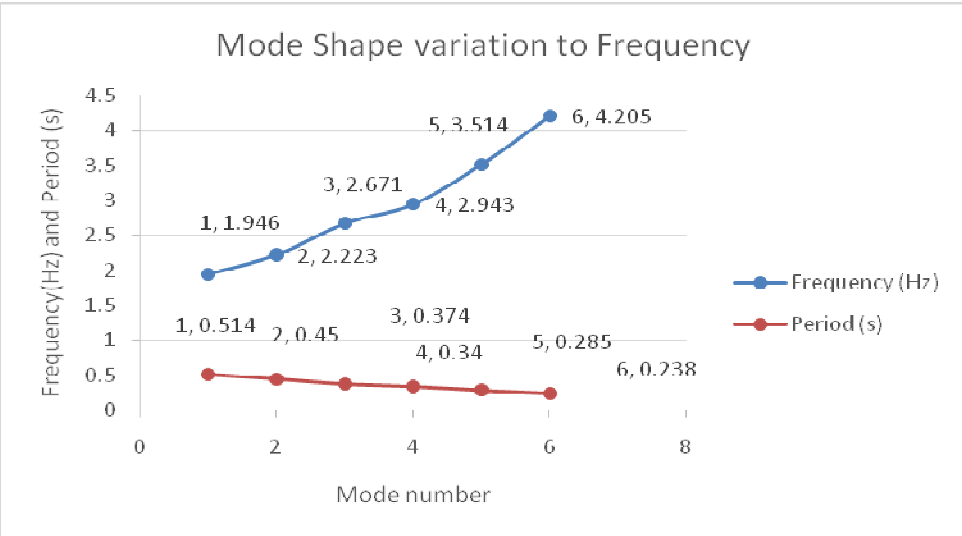


Fig. 4.19 Graph of Mode Shapes variations to frequency for Case A2

Fig. 4.20 shows Peak story shear in X-direction (N) for Mode Shape 1st, Mode Shape 2nd, Mode Shape 3rd, Mode Shape 4th, Mode Shape 5th and Mode Shape 6th. It shows that peak story shear is maximum at the base and minimum at the top. Table 4.38 also shows same results.

Table. 4.9 Peak Story Shear for Case A 2 at each modes

STORY	LEVEL IN METER	PEAK STORY SHEAR IN KN	
		X	Z
6	21.0	123.4	0
5	17.5	443.33	0
4	14.0	723.13	0
3	10.5	937.98	0
2	7.0	1070.64	0
1	3.5	1119.45	0
BASE	0.0	1119.45	0

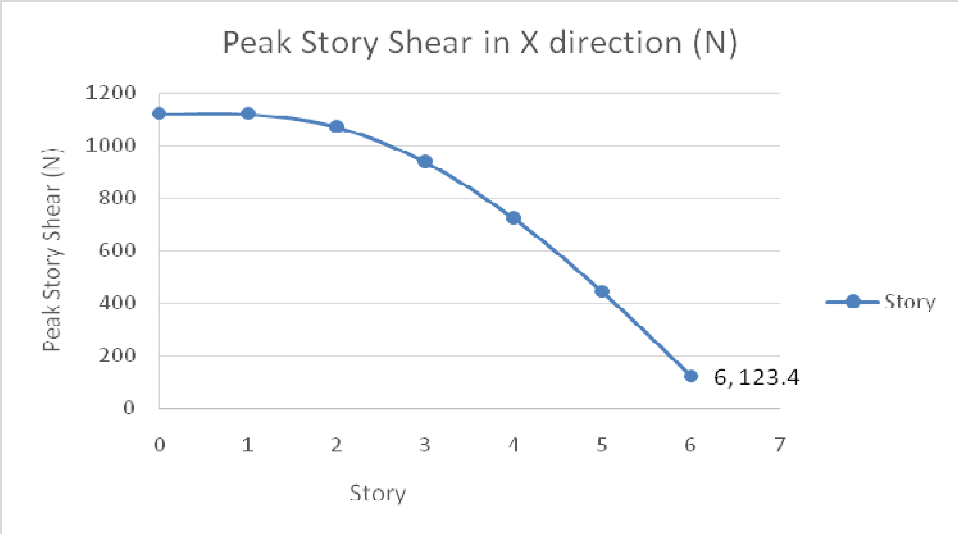


Fig. 4.20 Graph of Peak story shear for Case A2

Fig. 4.21 shows base shear in X-direction for (N) for Mode Shape 1st, Mode Shape 2nd, Mode Shape 3rd, Mode Shape 4th, Mode Shape 5th and Mode Shape 6th. It shows that mode shape 1, 2 have max. Base shear while mode shape 3, 4 have very minute (almost zero) base shear and mode shape 5, 6 have minimum base shear in comparison to mode shape 1 and 2. Table 4.10 also shows same results.

Table. 4.10 Base Shear for Case A 2 at each modes

	MASS PARTICIPATION FACTORS IN PERCENT						BASE SHEAR IN KN		
MODE	X	Y	Z	SUMM-X	SUMM-Y	SUMM-Z	X	Y	Z
1	4.77	0.00	70.05	4.773	0.002	70.047	74.77	0.00	0.00
2	72.09	0.00	5.14	76.867	0.003	75.184	1129.33	0.00	0.00
3	0.04	0.00	0.19	76.906	0.003	75.372	0.61	0.00	0.00
4	0.63	0.00	0.20	77.533	0.003	75.568	9.81	0.00	0.00
5	0.32	0.00	7.10	77.856	0.004	82.671	5.06	0.00	0.00
6	5.06	0.00	0.31	82.918	0.004	82.985	79.30	0.00	0.00
				TOTAL SRSS		SHEAR	1134.63	0.00	0.00
				TOTAL 10PCT		SHEAR	1206.76	0.00	0.00
				TOTAL ABS		SHEAR	1298.88	0.00	0.00
				TOTAL CSM		SHEAR	1217.12	0.00	0.00

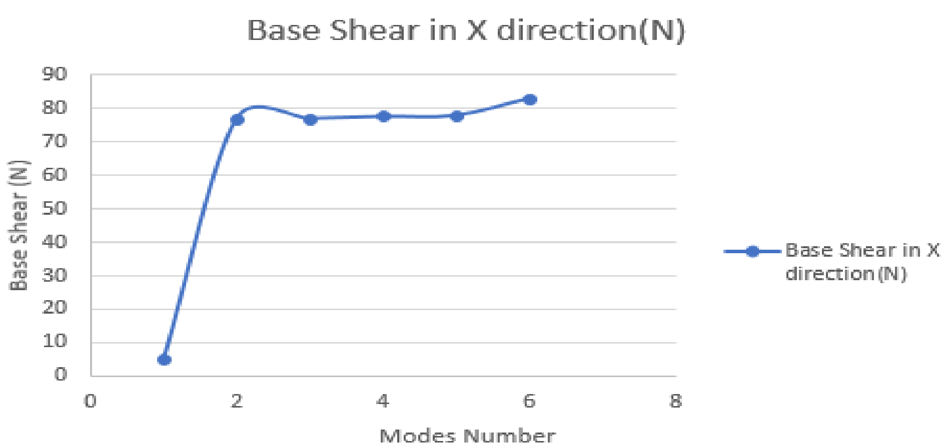
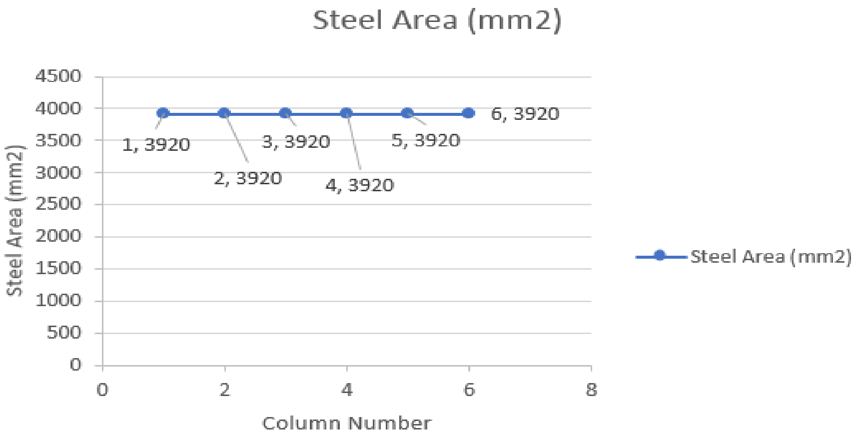
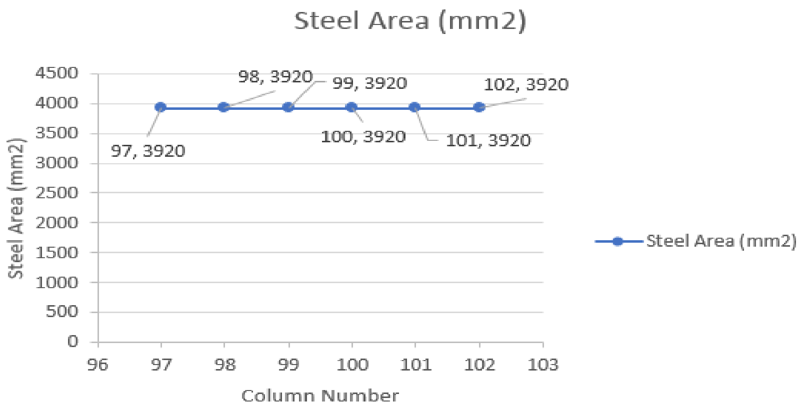


Fig. 4.21 Graph of Base shear for Case A2

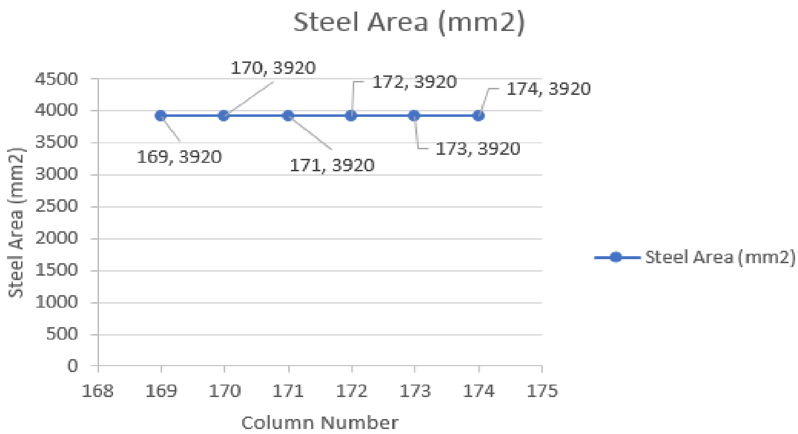
Fig. 4.22 shows steel area for columns, it shows that steel area for all the columns is almost same but 6th number columns have higher reinforcement to bear max. load impact and avoid bending moment thus such columns have higher value of steel area. Fig (a) shows steel requirement for column number 1, 2, 3, 4, 5, 6. Fig. (b) shows steel requirement for column number 97, 98, 99, 100, 101, 102. Fig. (c) shows steel requirement for column number 169, 170, 171, 172, 173, 174.



(a)



(b)



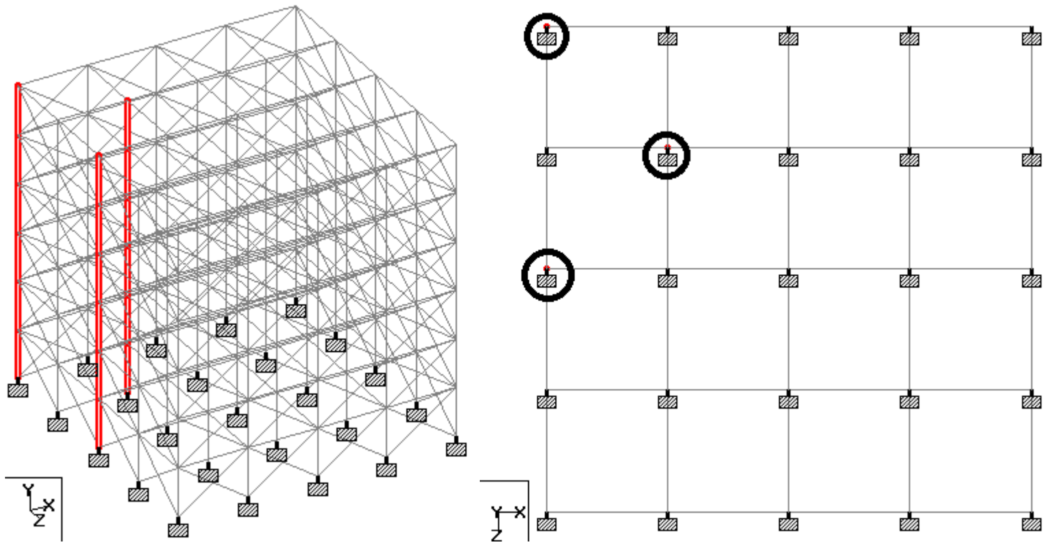
(C)

Fig. 4.22 Steel Area Graph for Columns for Case A 2 (a) for column number 1, 2, 3, 4, 5, 6 (b) for column number 97, 98, 99, 100, 101, 102 (c) for column number 169, 170, 171, 172, 173, 174

4.2 CASE B

4.2.1 CASE B1

Applied Loads in all cases according Indian Standards as shows in Fig. 4.1. Column cross section is 0.700m X 0.700m, 0.500m X 0.500m and for beam is 0.350m (W) X 0. 45m (H). Concrete grade M25 and Steel Fe415 used for this study.



(a) (b)

Fig. 4.23 Considered column for comparison

4.1.1 CASE B1

In this study corner column are considered for study, seven columns are connected through Node 1,2,3,4,5,6 and 7, rest of the column are connected from node to node in the same fashion.

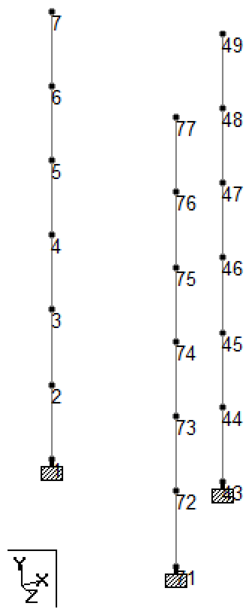


Fig. 4.24 Considered Nodes for comparison

Fig. 4.24 shows connection of column (vertical members) through node to node.

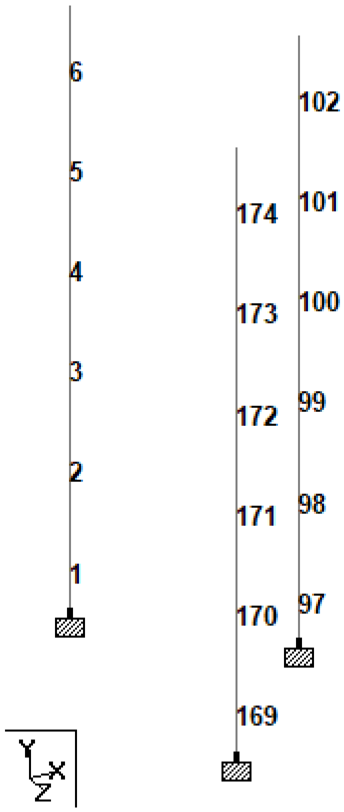


Fig. 4.25 Column of structure for comparison

Fig. 4.26 shows displacement of building structure into X- direction, black lines shows the building structure before analysis and green lines shows displacement of building structure after the analysis.

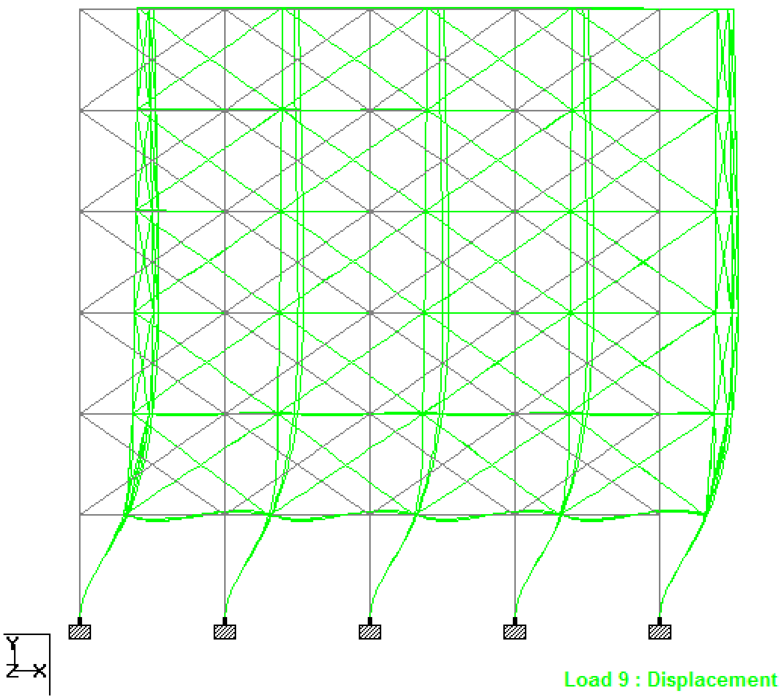


Fig. 4.26 Directional displacement for Case B1

Table 4.11 Displacement of node number 1,2,3,4,5,6,7,43,44,45,46,47,48,49,71,72,73,74,75,76,77 for Case B1

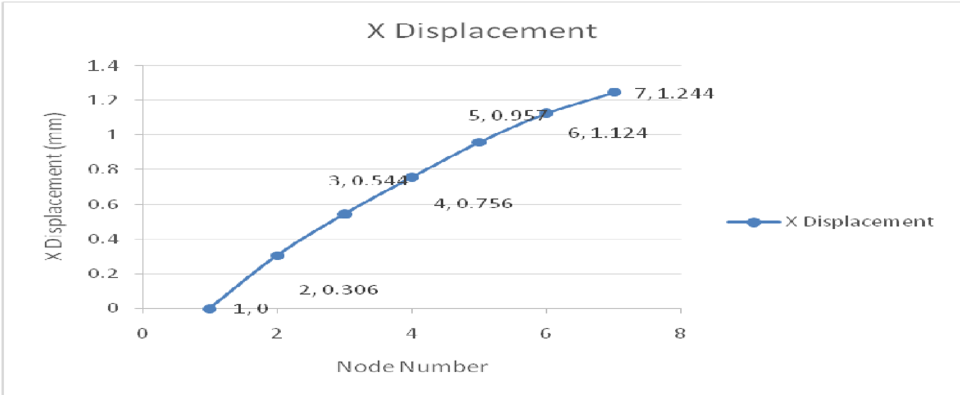
N0DE	L/C	X-Trans (mm)	Y-Trans (mm)	Z-Trans (mm)	Absolute (mm)
1	1 S +X	0	0	0	0
	2 S –X	0	0	0	0
	3 S +Z	0	0	0	0
	4 S –Z	0	0	0	0
	5 LIVE L0AD	0	0	0	0
	6 DEAD L0AD	0	0	0	0
	7 MODE SHAPES	0	0	0	0
	8 COMBINATION	0	0	0	0
2	1 S +X	0.306	0.02	0	0.306
	2 S –X	-0.383	-0.02	0	0.383
	3 S +Z	0	0.02	0.306	0.306
	4 S –Z	0	-0.02	-0.383	0.383
	5 LIVE L0AD	-0.011	-0.027	-0.011	0.031
	6 DEAD L0AD	-0.09	-0.287	-0.09	0.313
	7 MODE SHAPES	3.98	0.443	3.98	5.646
	8 COMBINATION	0.751	0.046	0.006	0.753
3	1 S +X	0.544	0.039	-0.001	0.545
	2 S –X	-0.665	-0.032	-0.004	0.666
	3 S +Z	-0.001	0.039	0.544	0.545
	4 S –Z	-0.004	-0.032	-0.665	0.666
	5 LIVE L0AD	-0.011	-0.049	-0.011	0.051
	6 DEAD L0AD	-0.096	-0.514	-0.096	0.532
	7 MODE SHAPES	6.942	0.86	6.942	9.855
	8 COMBINATION	1.328	0.089	0.027	1.331
4	1 S +X	0.756	0.053	0	0.757
	2 S –X	-0.868	-0.04	-0.006	0.869
	3 S +Z	0	0.053	0.756	0.757
	4 S –Z	-0.006	-0.04	-0.868	0.869
	5 LIVE L0AD	-0.008	-0.065	-0.008	0.066
	6 DEAD L0AD	-0.072	-0.689	-0.072	0.696
	7 MODE SHAPES	9.304	1.135	9.304	13.207
	8 COMBINATION	1.826	0.12	0.042	1.83
5	1 S +X	0.957	0.062	0.001	0.959
	2 S –X	-1.049	-0.043	-0.008	1.05
	3 S +Z	0.001	0.062	0.957	0.959
	4 S –Z	-0.008	-0.043	-1.049	1.05
	5 LIVE L0AD	-0.006	-0.076	-0.006	0.076
	6 DEAD L0AD	-0.049	-0.808	-0.049	0.811
	7 MODE SHAPES	11.311	1.306	11.311	16.049
	8 COMBINATION	2.281	0.139	0.049	2.286
6	1 S +X	1.124	0.067	0.004	1.126

	2 S –X	-1.188	-0.044	-0.01	1.189
	3 S +Z	0.004	0.067	1.124	1.126
	4 S –Z	-0.01	-0.044	-1.188	1.189
	5 LIVE L0AD	-0.001	-0.081	-0.001	0.081
	6 DEAD L0AD	-0.01	-0.872	-0.01	0.872
	7 MODE SHAPES	12.799	1.393	12.799	18.154
	8 COMBINATION	2.652	0.149	0.047	2.657
7	1 S +X	1.244	0.069	0.012	1.246
	2 S –X	-1.279	-0.044	-0.012	1.28
	3 S +Z	0.012	0.069	1.244	1.246
	4 S –Z	-0.012	-0.044	-1.279	1.28
	5 LIVE L0AD	0.006	-0.081	0.006	0.081
	6 DEAD L0AD	0.053	-0.882	0.053	0.886
	7 MODE SHAPES	13.779	1.424	13.779	19.538
	8 COMBINATION	2.895	0.148	0.042	2.899
43	1 S +X	0	0	0	0
	2 S –X	0	0	0	0
	3 S +Z	0	0	0	0
	4 S –Z	0	0	0	0
	5 LIVE L0AD	0	0	0	0
	6 DEAD L0AD	0	0	0	0
	7 MODE SHAPES	0	0	0	0
	8 COMBINATION	0	0	0	0
44	1 S +X	0.277	0	0	0.277
	2 S –X	-0.277	0	0	0.277
	3 S +Z	0	0	0.277	0.277
	4 S –Z	0	0	-0.277	0.277
	5 LIVE L0AD	-0.002	-0.081	-0.002	0.081
	6 DEAD L0AD	-0.009	-0.528	-0.009	0.528
	7 MODE SHAPES	4.279	0.077	4.279	6.051
	8 COMBINATION	0.946	0	0.003	0.946
45	1 S +X	0.826	0	0	0.826
	2 S –X	-0.827	0	0	0.827
	3 S +Z	0	0	0.826	0.826
	4 S –Z	0	0	-0.827	0.827
	5 LIVE L0AD	-0.001	-0.145	-0.001	0.145
	6 DEAD L0AD	-0.003	-0.955	-0.003	0.955
	7 MODE SHAPES	11.576	0.141	11.576	16.371
	8 COMBINATION	2.777	0.001	0.008	2.777
46	1 S +X	1.441	0.001	-0.001	1.441
	2 S –X	-1.442	0	0	1.442
	3 S +Z	-0.001	0.001	1.441	1.441
	4 S –Z	0	0	-1.442	1.442
	5 LIVE L0AD	0	-0.193	0	0.193
	6 DEAD L0AD	-0.002	-1.281	-0.002	1.281

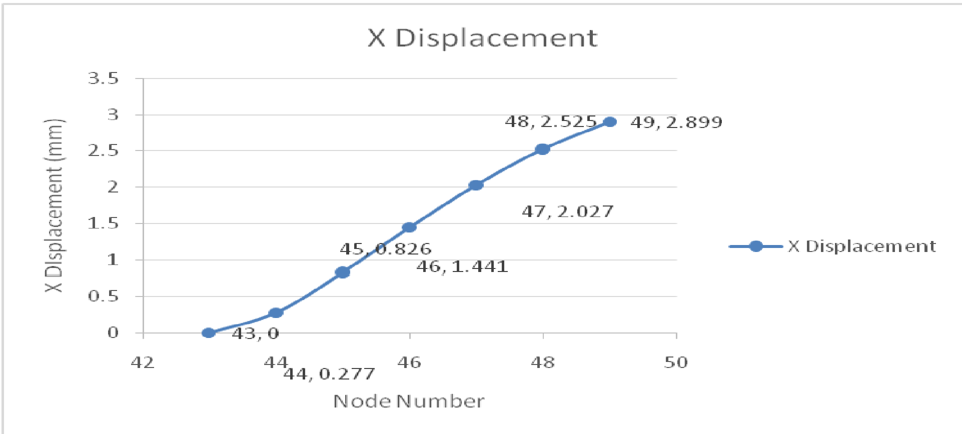
	7 MODE SHAPES	18.3	0.194	18.3	25.881
	8 COMBINATION	4.719	0.001	0.014	4.719
47	1 S +X	2.027	0.001	-0.001	2.027
	2 S –X	-2.027	0	0.001	2.027
	3 S +Z	-0.001	0.001	2.027	2.027
	4 S –Z	0.001	0	-2.027	2.027
	5 LIVE L0AD	0	-0.225	0	0.225
	6 DEAD L0AD	-0.002	-1.508	-0.002	1.508
	7 MODE SHAPES	23.472	0.234	23.472	33.195
	8 COMBINATION	6.426	0.002	0.022	6.426
48	1 S +X	2.525	0.001	-0.001	2.525
	2 S –X	-2.525	0	0.001	2.525
	3 S +Z	-0.001	0.001	2.525	2.525
	4 S –Z	0.001	0	-2.525	2.525
	5 LIVE L0AD	0.002	-0.24	0.002	0.24
	6 DEAD L0AD	0.006	-1.634	0.006	1.635
	7 MODE SHAPES	27.051	0.261	27.051	38.257
	8 COMBINATION	7.744	0.002	0.03	7.744
49	1 S +X	2.899	0.001	-0.001	2.899
	2 S –X	-2.899	0	0.001	2.899
	3 S +Z	-0.001	0.001	2.899	2.899
	4 S –Z	0.001	0	-2.899	2.899
	5 LIVE L0AD	0.004	-0.24	0.004	0.24
	6 DEAD L0AD	0.028	-1.662	0.028	1.662
	7 MODE SHAPES	29.37	0.274	29.37	41.536
	8 COMBINATION	8.659	0.002	0.036	8.659
71	1 S +X	0	0	0	0
	2 S –X	0	0	0	0
	3 S +Z	0	0	0	0
	4 S –Z	0	0	0	0
	5 LIVE L0AD	0	0	0	0
	6 DEAD L0AD	0	0	0	0
	7 MODE SHAPES	0	0	0	0
	8 COMBINATION	0	0	0	0
72	1 S +X	0.312	0.008	0	0.313
	2 S –X	-0.312	-0.008	0	0.312
	3 S +Z	0	0	0.356	0.356
	4 S –Z	0	0	-0.356	0.356
	5 LIVE L0AD	-0.003	-0.041	0	0.041
	6 DEAD L0AD	-0.017	-0.371	0	0.371
	7 MODE SHAPES	4.764	0.133	4.567	6.601
	8 COMBINATION	1.162	0.026	0.005	1.162
73	1 S +X	0.958	0.016	0	0.959
	2 S –X	-0.958	-0.015	0	0.958
	3 S +Z	0	0.005	0.601	0.601

	4 S –Z	0	0.005	-0.601	0.601
	5 LIVE L0AD	0	-0.072	0	0.072
	6 DEAD L0AD	-0.002	-0.663	0	0.663
	7 MODE SHAPES	13.255	0.312	7.537	15.252
	8 COMBINATION	3.481	0.047	0.017	3.482
74	1 S +X	1.703	0.021	0	1.703
	2 S –X	-1.703	-0.02	0	1.703
	3 S +Z	0	0.01	0.812	0.812
	4 S –Z	0	0.01	-0.812	0.812
	5 LIVE L0AD	0	-0.096	0	0.096
	6 DEAD L0AD	-0.001	-0.886	0	0.886
	7 MODE SHAPES	21.379	0.438	9.802	23.523
	8 COMBINATION	6.001	0.062	0.023	6.001
75	1 S +X	2.424	0.025	0	2.424
	2 S –X	-2.424	-0.024	0	2.424
	3 S +Z	0	0.014	1.004	1.004
	4 S –Z	0	0.014	-1.004	1.004
	5 LIVE L0AD	0	-0.112	0	0.112
	6 DEAD L0AD	-0.003	-1.04	0	1.04
	7 MODE SHAPES	27.802	0.529	11.649	30.149
	8 COMBINATION	8.25	0.072	0.022	8.251
76	1 S +X	3.038	0.027	0	3.038
	2 S –X	-3.038	-0.026	0	3.038
	3 S +Z	0	0.017	1.157	1.158
	4 S –Z	0	0.017	-1.157	1.158
	5 LIVE L0AD	0.005	-0.12	0	0.12
	6 DEAD L0AD	0.013	-1.126	0	1.126
	7 MODE SHAPES	32.319	0.588	12.965	34.828
	8 COMBINATION	10	0.078	0.015	10.001
77	1 S +X	3.503	0.029	0	3.503
	2 S –X	-3.503	-0.027	0	3.503
	3 S +Z	0	0.019	1.258	1.258
	4 S –Z	0	0.019	-1.258	1.258
	5 LIVE L0AD	0.007	-0.12	0	0.12
	6 DEAD L0AD	0.051	-1.142	0	1.143
	7 MODE SHAPES	35.281	0.62	13.742	37.867
	8 COMBINATION	11.229	0.08	0.014	11.229

Fig. 4.27 (a), 4.16 (b), and 4.16 (c) Shows Node Number vs Displacement Graph for columns in X-direction, this graph shows that displacement have higher values for columns which are built at top floor of the building. Fig. (a) shows displacement for node number 1, 2, 3, 4, 5, 6, 7 and Fig. (b) shows displacement for node number 43, 44, 45, 46, 47, 48, 49 and Fig. (c) shows displacement for column number 71, 72, 73, 74, 75, 76, 77. Displacement results also shows deeply in Table 4.11



(a)



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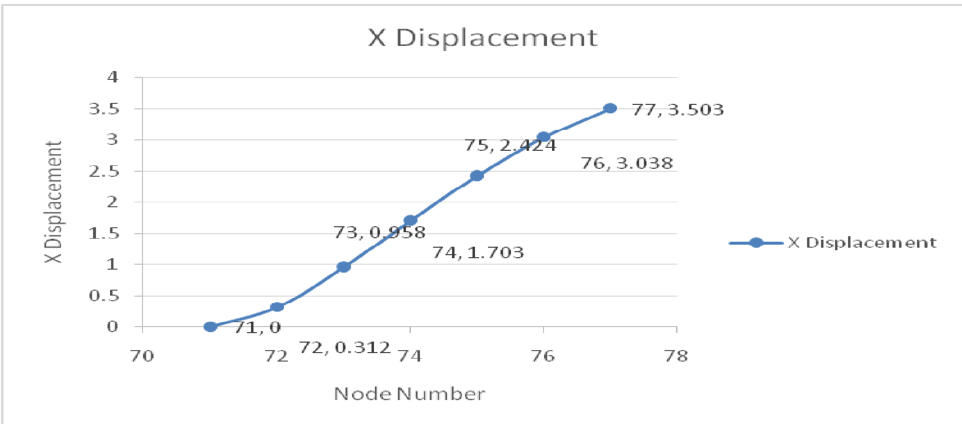


(c)

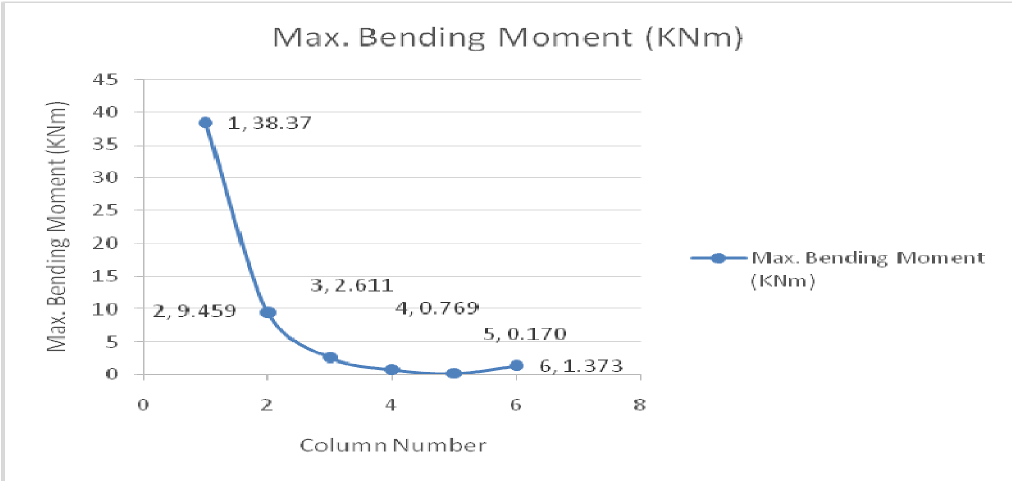
Fig. 4.27 Directional displacement Graph for Columns for Case A 1 (a) for node number 1, 2, 3, 4, 5, 6, 7 (b) for node number 43, 44, 45, 46, 47, 48, 49 (c) for node number 71, 72, 73, 74, 75, 76, 77

Table 4.12 Maximum bending moment of beam 1, 2, 3, 4, 5, 6 ,97, 98, 99, 100, 101, 102,169, 170, 171, 172, 173, 174 for Case B1

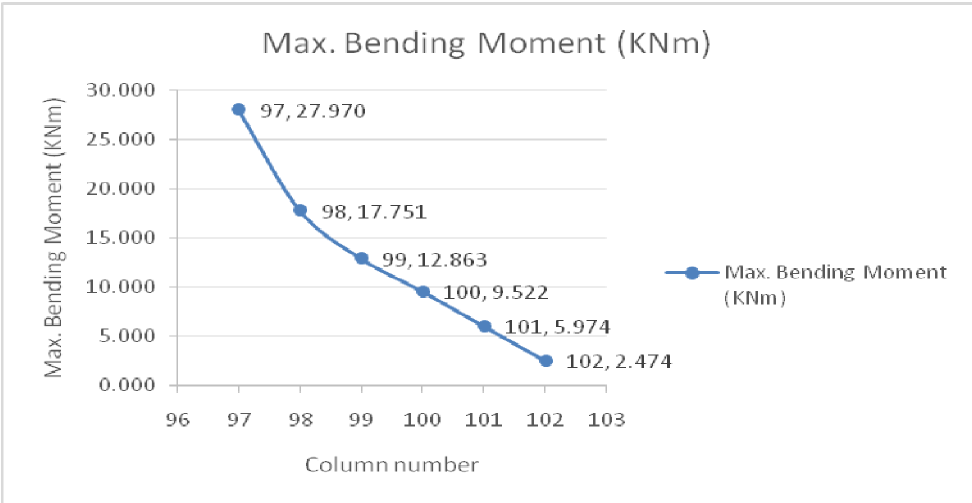
Beam	L/C	Dist (m)	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)
1	1 S +X	0	-60.38	15.468	0.023	-1.201	-0.046	38.752
		0.875	-60.38	15.468	0.023	-1.201	-0.026	25.217
		1.75	-60.38	15.468	0.023	-1.201	-0.006	11.682
		2.625	-60.38	15.468	0.023	-1.201	0.014	-1.853
		3.5	-60.38	15.468	0.023	-1.201	0.033	-15.38
2	1 S +X	0	-58.15	-2.691	0.089	-2.408	-0.116	-9.45
		0.875	-58.15	-2.691	0.089	-2.408	-0.038	-7.104
		1.75	-58.15	-2.691	0.089	-2.408	0.04	-4.75
		2.625	-58.15	-2.691	0.089	-2.408	0.118	-2.395
		3.5	-58.15	-2.691	0.089	-2.408	0.196	-0.041
3	1 S +X	0	-41.35	1.304	0.071	-3.091	-0.083	2.611
		0.875	-41.35	1.304	0.071	-3.091	-0.022	1.47
		1.75	-41.35	1.304	0.071	-3.091	0.04	0.329
		2.625	-41.35	1.304	0.071	-3.091	0.102	-0.811
		3.5	-41.35	1.304	0.071	-3.091	0.164	-1.952
4	1 S +X	0	-27.78	0.915	0.115	-3.104	-0.194	0.769
		0.875	-27.78	0.915	0.115	-3.104	-0.093	-0.032
		1.75	-27.78	0.915	0.115	-3.104	0.008	-0.834
		2.625	-27.78	0.915	0.115	-3.104	0.108	-1.635
		3.5	-27.78	0.915	0.115	-3.104	0.209	-2.436
5	1 S +X	0	-15.83	0.781	0.195	-2.62	-0.208	-0.17
		0.875	-15.83	0.781	0.195	-2.62	-0.037	-0.853
		1.75	-15.83	0.781	0.195	-2.62	0.134	-1.537
		2.625	-15.83	0.781	0.195	-2.62	0.304	-2.22
		3.5	-15.83	0.781	0.195	-2.62	0.475	-2.903
6	1 S +X	0	-6.929	-0.116	0.058	-1.668	0.092	-1.373
		0.875	-6.929	-0.116	0.058	-1.668	0.143	-1.272
		1.75	-6.929	-0.116	0.058	-1.668	0.194	-1.17
		2.625	-6.929	-0.116	0.058	-1.668	0.246	-1.069
		3.5	-6.929	-0.116	0.058	-1.668	0.297	-0.967
97	1 S +X	0	-0.607	7.547	0.012	-0.532	-0.03	27.97

		0.875	-0.607	7.547	0.012	-0.532	-0.019	21.367
		1.75	-0.607	7.547	0.012	-0.532	-0.008	14.764
		2.625	-0.607	7.547	0.012	-0.532	0.002	8.16
		3.5	-0.607	7.547	0.012	-0.532	0.013	1.557
98	1 S +X	0	-0.635	7.539	0.025	-1.641	-0.03	17.751
		0.875	-0.635	7.539	0.025	-1.641	-0.008	11.154
		1.75	-0.635	7.539	0.025	-1.641	0.013	4.558
		2.625	-0.635	7.539	0.025	-1.641	0.035	-2.039
		3.5	-0.635	7.539	0.025	-1.641	0.056	-8.636
99	1 S +X	0	-0.609	7.165	0.051	-2.237	-0.081	12.863
		0.875	-0.609	7.165	0.051	-2.237	-0.037	6.593
		1.75	-0.609	7.165	0.051	-2.237	0.007	0.324
		2.625	-0.609	7.165	0.051	-2.237	0.052	-5.946
		3.5	-0.609	7.165	0.051	-2.237	0.096	-12.21
100	1 S +X	0	-0.519	6.573	0.071	-2.292	-0.119	9.522
		0.875	-0.519	6.573	0.071	-2.292	-0.057	3.771
		1.75	-0.519	6.573	0.071	-2.292	0.005	-1.98
		2.625	-0.519	6.573	0.071	-2.292	0.068	-7.732
		3.5	-0.519	6.573	0.071	-2.292	0.13	-13.48
101	1 S +X	0	-0.368	5.418	0.091	-1.98	-0.151	5.974
		0.875	-0.368	5.418	0.091	-1.98	-0.072	1.233
		1.75	-0.368	5.418	0.091	-1.98	0.007	-3.508
		2.625	-0.368	5.418	0.091	-1.98	0.087	-8.249
		3.5	-0.368	5.418	0.091	-1.98	0.166	-12.99
102	1 S +X	0	-0.151	3.817	0.132	-1.323	-0.163	2.474
		0.875	-0.151	3.817	0.132	-1.323	-0.048	-0.865
		1.75	-0.151	3.817	0.132	-1.323	0.067	-4.204
		2.625	-0.151	3.817	0.132	-1.323	0.183	-7.544
		3.5	-0.151	3.817	0.132	-1.323	0.298	-10.88
169	1 S +X	0	-25.69	6.568	0	0	0	29.41
		0.875	-25.69	6.568	0	0	0	23.662
		1.75	-25.69	6.568	0	0	0	17.915
		2.625	-25.69	6.568	0	0	0	12.167

		3.5	-25.69	6.568	0	0	0	6.42
170	1 S +X	0	-21.93	5.579	0	0	0	16.149
		0.875	-21.93	5.579	0	0	0	11.266
		1.75	-21.93	5.579	0	0	0	6.384
		2.625	-21.93	5.579	0	0	0	1.502
		3.5	-21.93	5.579	0	0	0	-3.38
171	1 S +X	0	-16.85	5.091	0	0	0	9.852
		0.875	-16.85	5.091	0	0	0	5.397
		1.75	-16.85	5.091	0	0	0	0.943
		2.625	-16.85	5.091	0	0	0	-3.512
		3.5	-16.85	5.091	0	0	0	-7.967
172	1 S +X	0	-11.58	4.626	0	0	0	5.765
		0.875	-11.58	4.626	0	0	0	1.718
		1.75	-11.58	4.626	0	0	0	-2.33
		2.625	-11.58	4.626	0	0	0	-6.377
		3.5	-11.58	4.626	0	0	0	-10.42
173	1 S +X	0	-6.938	3.837	0	0	0	1.979
		0.875	-6.938	3.837	0	0	0	-1.378
		1.75	-6.938	3.837	0	0	0	-4.736
		2.625	-6.938	3.837	0	0	0	-8.093
		3.5	-6.938	3.837	0	0	0	-11.45
174	1 S +X	0	-3.685	1.554	0	0	0	-1.678
		0.875	-3.685	1.554	0	0	0	-3.038
		1.75	-3.685	1.554	0	0	0	-4.398
		2.625	-3.685	1.554	0	0	0	-5.758
		3.5	-3.685	1.554	0	0	0	-7.118



(a)



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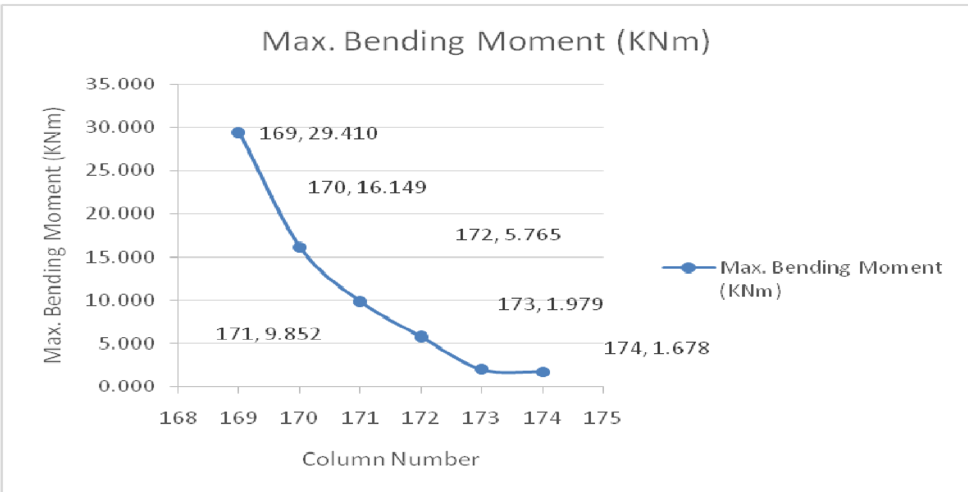


(c)

Fig. 4.28 Max. Bending Moment Graph for Columns for Case B 1 (a) for column number 1, 2, 3, 4, 5, 6 (b) for column number 97, 98, 99, 100, 101, 102 (c) for column number 169, 170, 171, 172, 173, 174

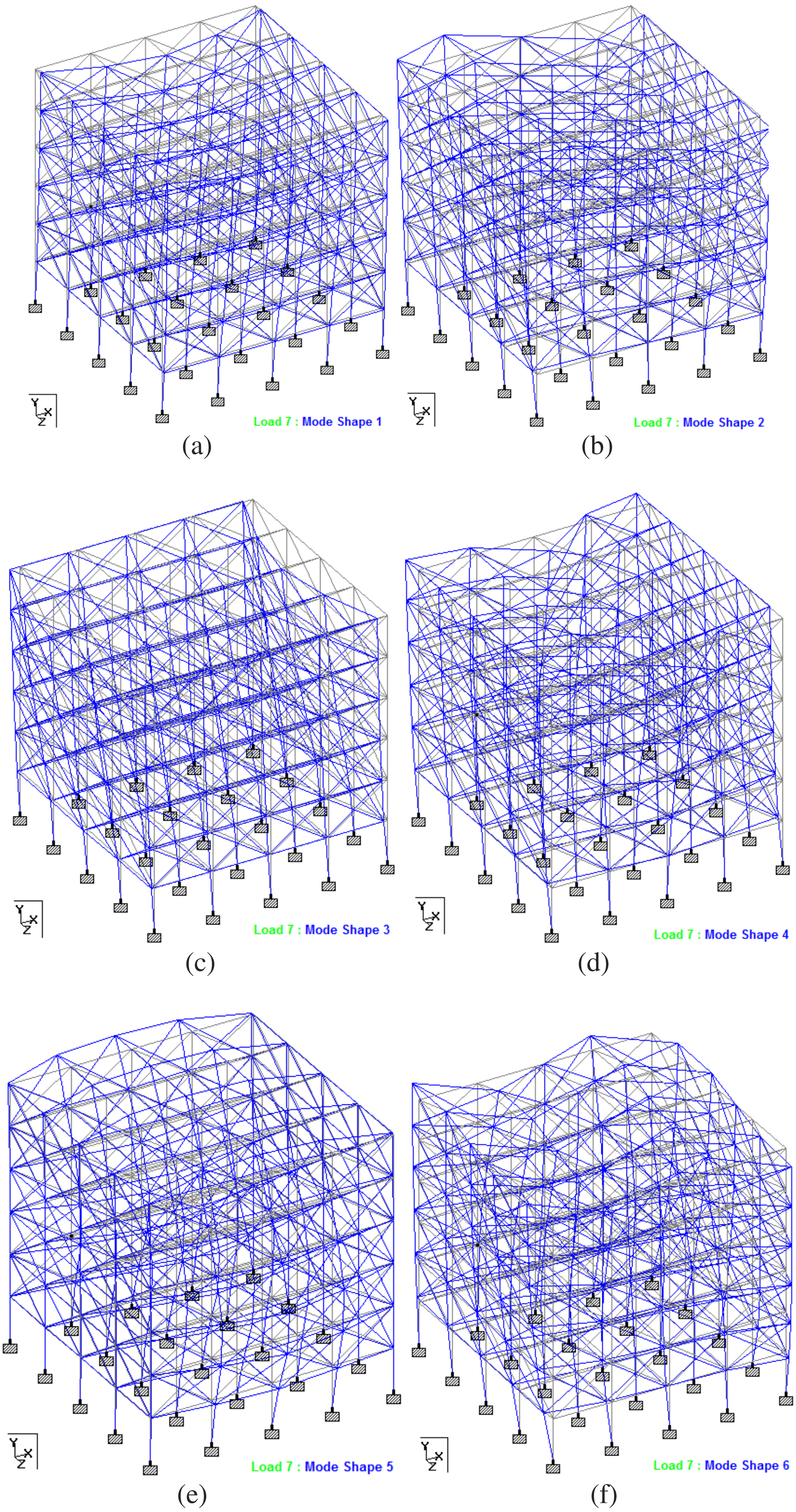


Fig. 4.29 Mode Shapes for Case B1, (a) Mode shape I, (b) Mode shape II, (c) Mode shape III, (d) Mode shape IV, (e) Mode shape V and (f) Mode shape VI

Table. 4.13 Frequency/Time for Case B1 at each modes

M0DE	Frequency (Hz)	Period (seconds)	Participation (X %)	Participation (Y %)	Participation (Z %)	Type
1	0.893	1.119	0	0	69.863	Elastic
2	1.47	0.68	0.001	0	0	Elastic
3	1.794	0.557	69.406	0	0	Elastic
4	2.136	0.468	0	0	9.348	Elastic
5	2.303	0.434	0	0	7.288	Elastic
6	2.665	0.375	0	0	0.001	Elastic

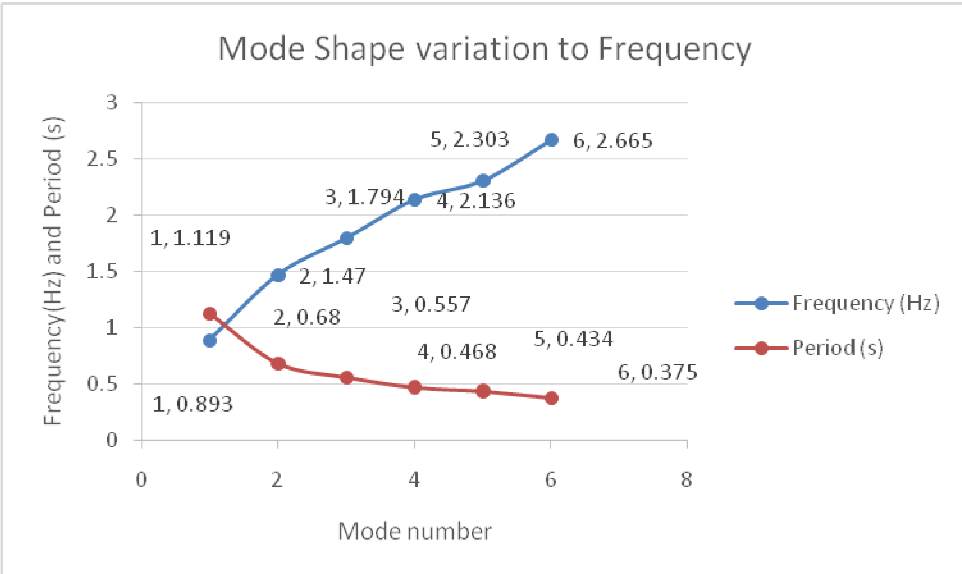


Fig. 4.30 Graph of Frequency and period for mode shape 1, 2, 3, 4, 5, 6 for case B1

Table. 4.14 Peak Story Shear for Case B1 at each modes

STORY	LEVEL IN METER	PEAK STORY SHEAR	
-----------------------		X	Z
0	0.0	856.93	0
1	3.5	856.93	0
2	7.0	827.289	0
3	10.5	748.654	0
4	14.0	618.887	0
5	17.5	443.945	0
6	21.0	234.064	0

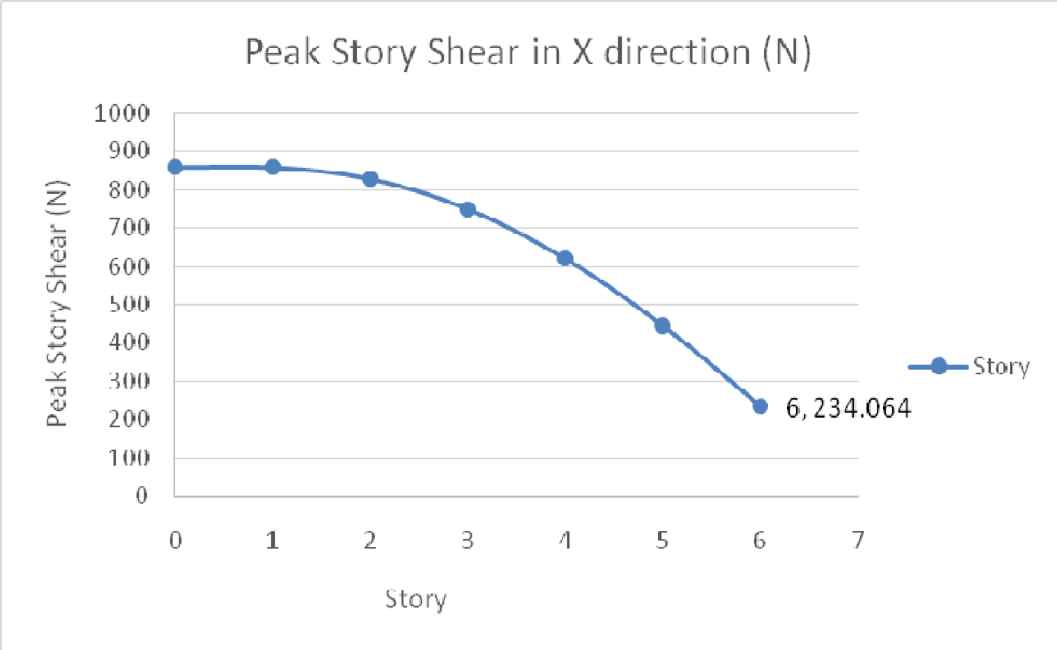


Fig. 4.31 Graph of Peak story shear for Case B1

Table. 4.15 Base Shear for Case B1 at each modes

	MASS PARTICIPATION FACTORS IN PERCENT						BASE SHEAR IN NEWT		
MODE	X	Y	Z	SUMM-X	SUMM-Y	SUMM-Z	X	Y	Z
1	0.00	0.00	69.86	0.000	0.000	69.863	0.06	0.00	0.00
2	0.00	0.00	0.00	0.001	0.000	69.863	7.27	0.00	0.00
3	69.41	0.00	0.00	69.406	0.000	69.863	856930.80	0.00	0.00
4	0.00	0.00	9.35	69.406	0.000	79.211	1.64	0.00	0.00
5	0.00	0.00	7.29	69.406	0.000	86.498	0.00	0.00	0.00
6	0.00	0.00	0.00	69.407	0.000	86.499	1.39	0.00	0.00
				TOTAL SRSS		SHEAR	856930.80	0.00	0.00
				TOTAL 10PCT		SHEAR	856930.80	0.00	0.00
				TOTAL ABS		SHEAR	856941.15	0.00	0.00
				TOTAL CSM		SHEAR	856930.80	0.00	0.00

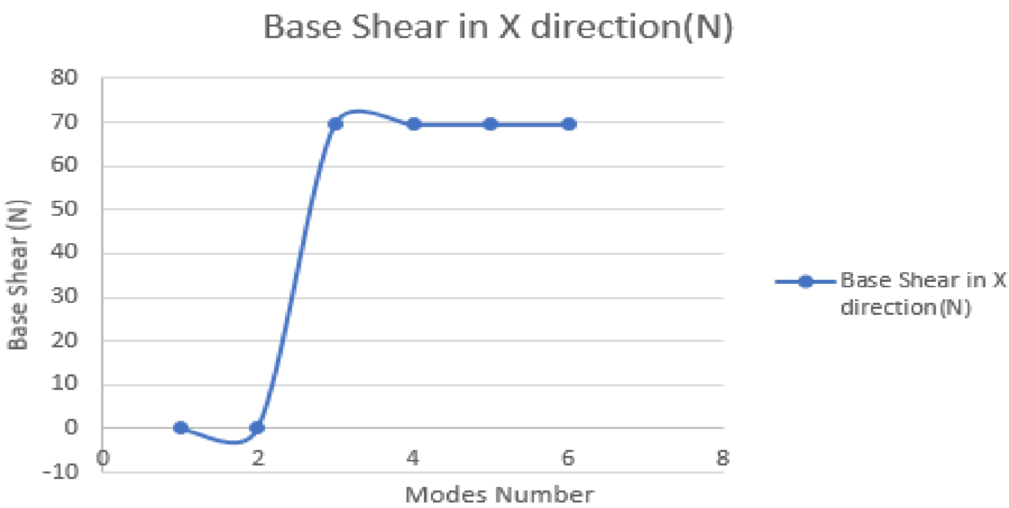
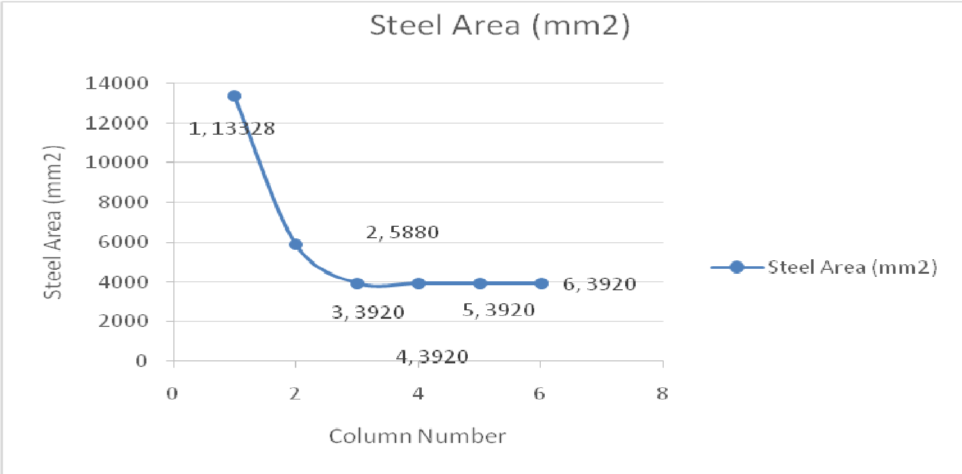
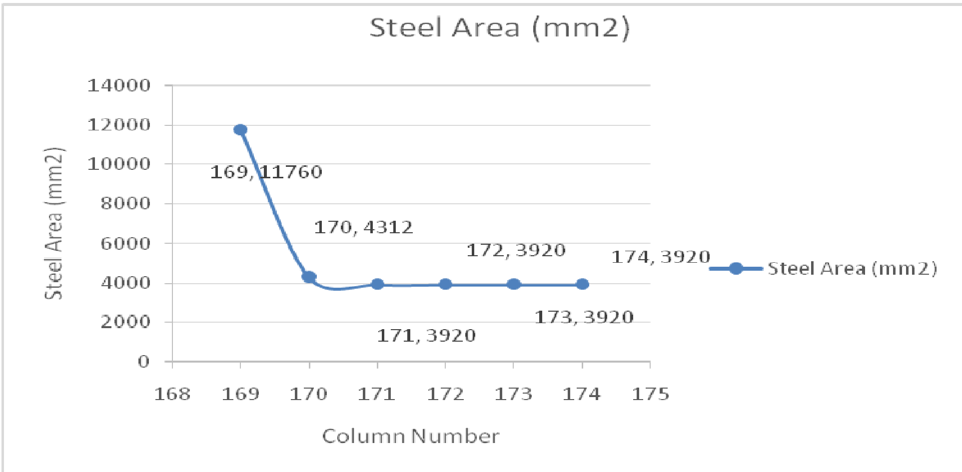


Fig. 4.32 Graph of Base shear for Case B1

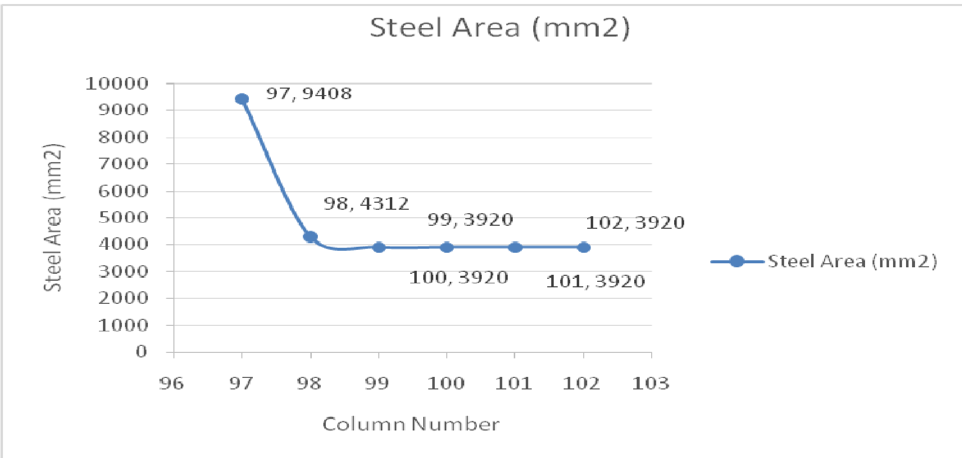
Fig. 4.33 shows steel area for columns, it shows that steel area for all the columns is almost same but some columns have higher reinforcement to bear max. load, impact and avoid bending moment thus such columns have higher value of steel area.



(a)



(b)

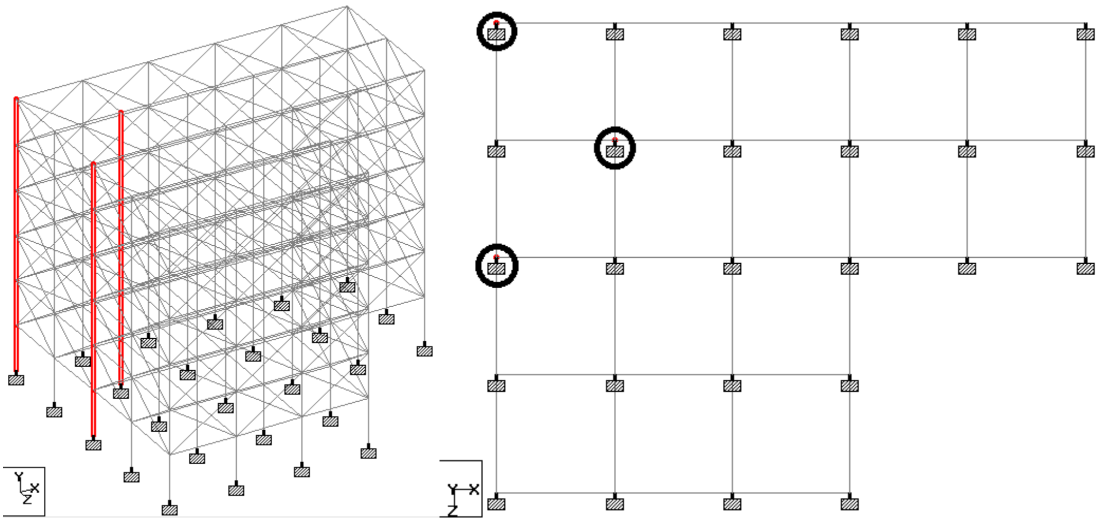


(c)

Fig. 4.33 Steel Area Graph for Columns for Case B1 (a) for column number 1, 2, 3, 4, 5, 6 (b) for column number 169, 170, 171, 172, 173, 174 (c) for column number 97, 98, 99, 100, 101, 102

4.2.2 CASE B2

Fig. 4.22 shows displacement of building structure into X- direction, black lines shows the building structure before analysis and green lines shows displacement of building structure after the analysis.



(a) (b)

Fig. 4.34 Considered column for comparison

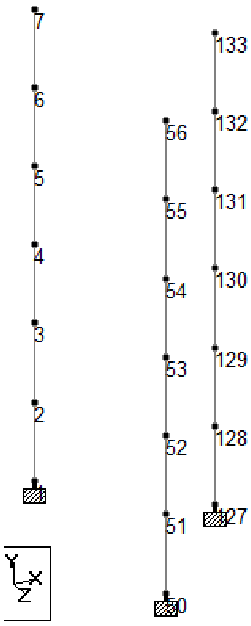


Fig. 4.35 Considered Nodes for comparison

Fig. 4.35 shows connection of column (vertical members) through node to node.

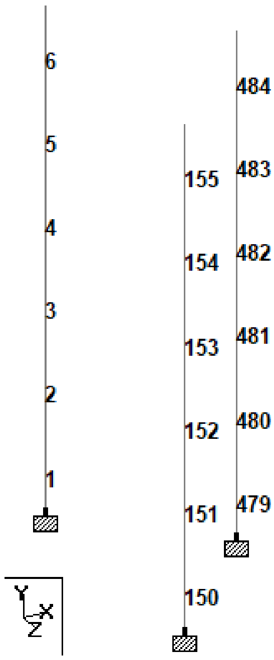


Fig. 4.36 Column of structure for comparison

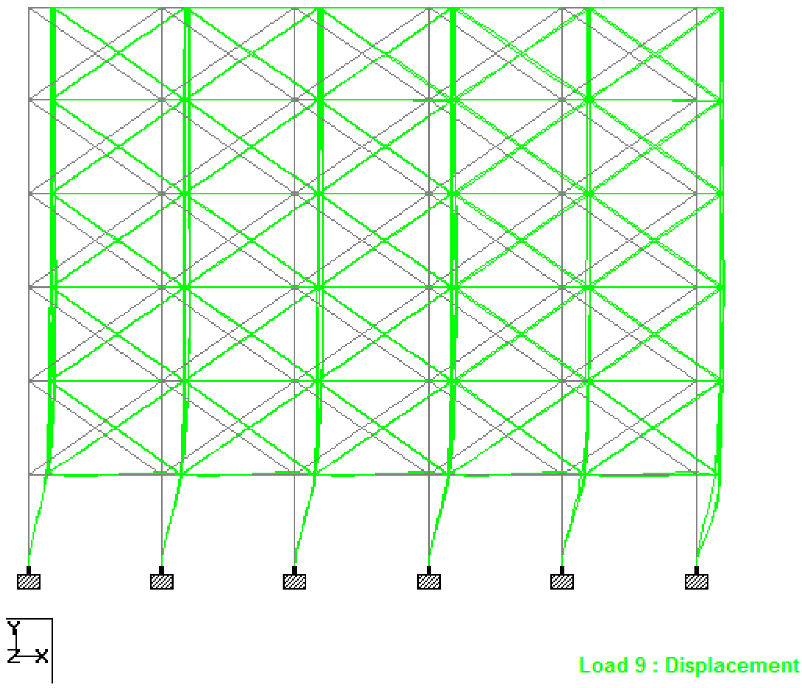


Fig. 4.37 Directional displacement for Case B 2

Table 4.16 Displacement of node number 1,2,3,4,5,6,7,50,51,52,53,54,55,127,128,129,130,131,132,133 for Case B2

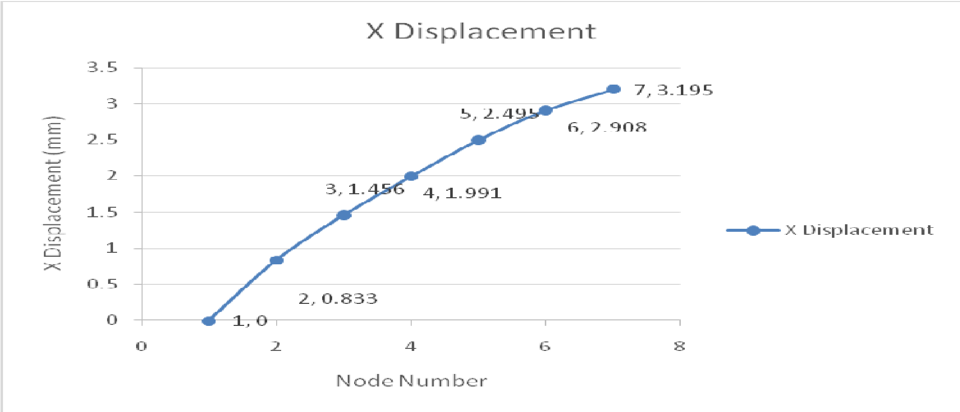
N0DE	L/C	X-Trans (mm)	Y-Trans (mm)	Z-Trans (mm)	Absolute (mm)
1	1 S +X	0	0	0	0
	2 S –X	0	0	0	0
	3 S +Z	0	0	0	0
	4 S –Z	0	0	0	0
	5 LIVE L0AD	0	0	0	0
	6 DEAD L0AD	0	0	0	0
	7 MODE SHAPES	0	0	0	0
	8 COMBINATION	0	0	0	0
2	1 S +X	0.833	0.05	0.009	0.834
	2 S –X	-1.057	-0.05	-0.006	1.058
	3 S +Z	0.019	0.043	0.661	0.663
	4 S –Z	-0.015	-0.042	-0.827	0.828
	5 LIVE L0AD	-0.098	-0.355	-0.113	0.385
	6 DEAD L0AD	-0.014	-0.033	-0.015	0.039
	7 MODE SHAPES	8.546	0.912	8.894	12.368
	8 COMBINATION	0.915	0.037	0.298	0.963
3	1 S +X	1.456	0.098	0.018	1.46
	2 S –X	-1.802	-0.079	-0.02	1.804
	3 S +Z	0.037	0.084	1.174	1.178
	4 S –Z	-0.031	-0.068	-1.436	1.438
	5 LIVE L0AD	-0.092	-0.636	-0.13	0.655
	6 DEAD L0AD	-0.014	-0.06	-0.017	0.063
	7 MODE SHAPES	14.58	1.761	15.395	21.276
	8 COMBINATION	1.576	0.072	0.511	1.658
4	1 S +X	1.991	0.132	0.025	1.996
	2 S –X	-2.312	-0.097	-0.029	2.314
	3 S +Z	0.047	0.113	1.631	1.636
	4 S –Z	-0.04	-0.084	-1.872	1.875
	5 LIVE L0AD	-0.028	-0.851	-0.103	0.858
	6 DEAD L0AD	-0.007	-0.081	-0.015	0.083
	7 MODE SHAPES	19.057	2.304	20.465	28.059
	8 COMBINATION	2.107	0.094	0.689	2.218
5	1 S +X	2.495	0.154	0.031	2.5
	2 S –X	-2.76	-0.105	-0.036	2.762
	3 S +Z	0.053	0.132	2.062	2.067
	4 S –Z	-0.045	-0.091	-2.258	2.261
	5 LIVE L0AD	0.057	-1.001	-0.075	1.005
	6 DEAD L0AD	0.001	-0.096	-0.014	0.097
	7 MODE SHAPES	22.71	2.631	24.686	33.646
	8 COMBINATION	2.567	0.108	0.849	2.706
6	1 S +X	2.908	0.167	0.039	2.913

	2 S –X	-3.095	-0.108	-0.04	3.098
	3 S +Z	0.06	0.142	2.414	2.419
	4 S –Z	-0.047	-0.093	-2.549	2.551
	5 LIVE L0AD	0.162	-1.084	-0.032	1.096
	6 DEAD L0AD	0.01	-0.106	-0.012	0.107
	7 MODE SHAPES	25.297	2.788	27.718	37.629
	8 COMBINATION	2.906	0.114	0.969	3.066
7	1 S +X	3.195	0.172	0.062	3.2
	2 S –X	-3.303	-0.107	-0.046	3.305
	3 S +Z	0.081	0.147	2.657	2.663
	4 S –Z	-0.049	-0.093	-2.731	2.733
	5 LIVE L0AD	0.269	-1.101	0.034	1.134
	6 DEAD L0AD	0.033	-0.11	0.006	0.115
	7 MODE SHAPES	26.85	2.836	29.575	40.046
	8 COMBINATION	3.114	0.116	1.043	3.286
50	1 S +X	0	0	0	0
	2 S –X	0	0	0	0
	3 S +Z	0	0	0	0
	4 S –Z	0	0	0	0
	5 LIVE L0AD	0	0	0	0
	6 DEAD L0AD	0	0	0	0
	7 MODE SHAPES	0	0	0	0
	8 COMBINATION	0	0	0	0
51	1 S +X	0.93	0.016	0.011	0.93
	2 S –X	-0.973	-0.016	-0.009	0.973
	3 S +Z	0.015	0	0.768	0.768
	4 S –Z	-0.018	-0.002	-0.768	0.768
	5 LIVE L0AD	-0.023	-0.444	-0.012	0.445
	6 DEAD L0AD	-0.004	-0.049	-0.002	0.049
	7 MODE SHAPES	9.497	0.239	10.184	13.927
	8 COMBINATION	1.402	0.018	0.346	1.444
52	1 S +X	2.306	0.029	0.021	2.306
	2 S –X	-2.399	-0.027	-0.012	2.4
	3 S +Z	0.062	0.013	1.297	1.299
	4 S –Z	-0.068	0.01	-1.297	1.299
	5 LIVE L0AD	-0.026	-0.793	-0.015	0.794
	6 DEAD L0AD	-0.007	-0.088	-0.003	0.089
	7 MODE SHAPES	22.34	0.581	16.696	27.896
	8 COMBINATION	3.383	0.028	0.569	3.431
53	1 S +X	3.545	0.039	0.028	3.546
	2 S –X	-3.656	-0.036	-0.016	3.657
	3 S +Z	0.136	0.023	1.75	1.756
	4 S –Z	-0.142	0.019	-1.751	1.757
	5 LIVE L0AD	-0.048	-1.062	-0.017	1.063
	6 DEAD L0AD	-0.018	-0.12	-0.004	0.122

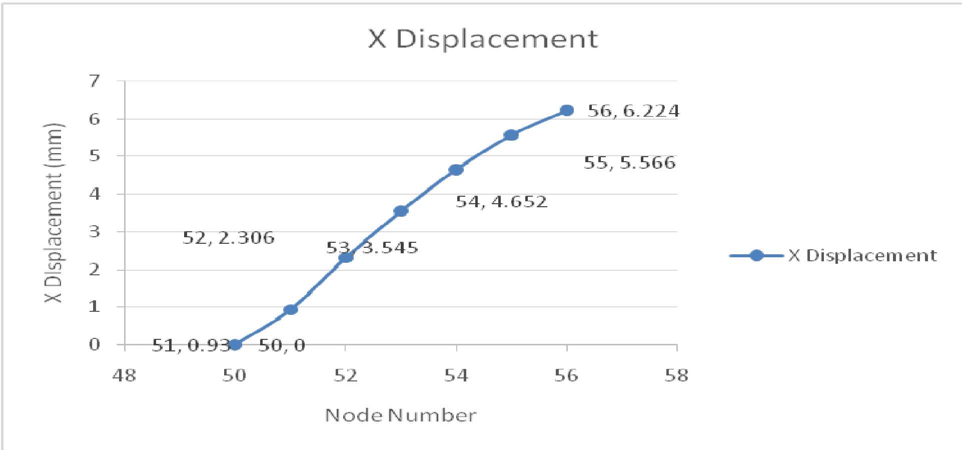
	7 MODE SHAPES	32.344	0.82	21.549	38.874
	8 COMBINATION	4.986	0.035	0.749	5.042
54	1 S +X	4.652	0.046	0.032	4.652
	2 S –X	-4.767	-0.041	-0.019	4.767
	3 S +Z	0.228	0.032	2.161	2.173
	4 S –Z	-0.232	0.026	-2.162	2.174
	5 LIVE L0AD	-0.075	-1.249	-0.018	1.251
	6 DEAD L0AD	-0.034	-0.144	-0.004	0.148
	7 MODE SHAPES	40.072	0.995	25.417	47.463
	8 COMBINATION	6.207	0.038	0.901	6.272
55	1 S +X	5.566	0.051	0.035	5.567
	2 S –X	-5.682	-0.045	-0.021	5.682
	3 S +Z	0.328	0.039	2.482	2.504
	4 S –Z	-0.33	0.033	-2.483	2.505
	5 LIVE L0AD	-0.082	-1.353	-0.019	1.356
	6 DEAD L0AD	-0.053	-0.16	-0.005	0.169
	7 MODE SHAPES	45.809	1.106	28.078	53.741
	8 COMBINATION	7.017	0.04	1.012	7.09
56	1 S +X	6.224	0.053	0.035	6.224
	2 S –X	-6.339	-0.046	-0.022	6.339
	3 S +Z	0.421	0.043	2.685	2.719
	4 S –Z	-0.418	0.037	-2.687	2.72
	5 LIVE L0AD	-0.058	-1.376	-0.018	1.377
	6 DEAD L0AD	-0.04	-0.168	-0.005	0.173
	7 MODE SHAPES	49.586	1.16	29.532	57.725
	8 COMBINATION	7.432	0.04	1.079	7.51
127	1 S +X	0	0	0	0
	2 S –X	0	0	0	0
	3 S +Z	0	0	0	0
	4 S –Z	0	0	0	0
	5 LIVE L0AD	0	0	0	0
	6 DEAD L0AD	0	0	0	0
	7 MODE SHAPES	0	0	0	0
	8 COMBINATION	0	0	0	0
128	1 S +X	0.696	0	0.011	0.696
	2 S –X	-0.694	0	-0.012	0.694
	3 S +Z	0.014	0	0.583	0.584
	4 S –Z	-0.013	0	-0.585	0.585
	5 LIVE L0AD	-0.007	-0.601	-0.021	0.601
	6 DEAD L0AD	-0.003	-0.097	-0.004	0.097
	7 MODE SHAPES	8.056	0.153	8.858	11.974
	8 COMBINATION	1.07	0	0.335	1.121
129	1 S +X	2.013	0.001	0.034	2.014
	2 S –X	-2.01	0	-0.035	2.01
	3 S +Z	0.044	0.001	1.736	1.737

	4 S –Z	-0.04	0	-1.739	1.74
	5 LIVE L0AD	0.007	-1.087	-0.04	1.088
	6 DEAD L0AD	-0.004	-0.177	-0.008	0.177
	7 MODE SHAPES	21.024	0.282	23.742	31.714
	8 COMBINATION	2.995	0.001	0.96	3.145
130	1 S +X	3.412	0.002	0.06	3.413
	2 S –X	-3.411	0	-0.061	3.411
	3 S +Z	0.081	0.001	3.016	3.017
	4 S –Z	-0.073	0	-3.02	3.021
	5 LIVE L0AD	0.019	-1.46	-0.068	1.462
	6 DEAD L0AD	-0.006	-0.241	-0.014	0.242
	7 MODE SHAPES	32.069	0.385	37.092	49.035
	8 COMBINATION	4.813	0.001	1.576	5.065
131	1 S +X	4.69	0.002	0.084	4.691
	2 S –X	-4.696	0	-0.085	4.697
	3 S +Z	0.119	0.002	4.216	4.218
	4 S –Z	-0.109	0	-4.222	4.223
	5 LIVE L0AD	0.03	-1.72	-0.096	1.723
	6 DEAD L0AD	-0.011	-0.289	-0.02	0.29
	7 MODE SHAPES	39.846	0.462	46.894	61.538
	8 COMBINATION	6.149	0.002	2.047	6.481
132	1 S +X	5.731	0.002	0.103	5.732
	2 S –X	-5.749	0	-0.105	5.75
	3 S +Z	0.155	0.002	5.206	5.209
	4 S –Z	-0.143	0	-5.214	5.215
	5 LIVE L0AD	0.055	-1.866	-0.113	1.871
	6 DEAD L0AD	-0.015	-0.321	-0.026	0.323
	7 MODE SHAPES	44.642	0.512	53.121	69.39
	8 COMBINATION	6.89	0.002	2.321	7.271
133	1 S +X	6.473	0.002	0.119	6.474
	2 S –X	-6.5	0	-0.12	6.501
	3 S +Z	0.187	0.002	5.919	5.922
	4 S –Z	-0.171	0	-5.927	5.93
	5 LIVE L0AD	0.099	-1.9	-0.109	1.906
	6 DEAD L0AD	-0.002	-0.338	-0.019	0.338
	7 MODE SHAPES	47.239	0.533	56.604	73.727
	8 COMBINATION	7.151	0.002	2.428	7.552

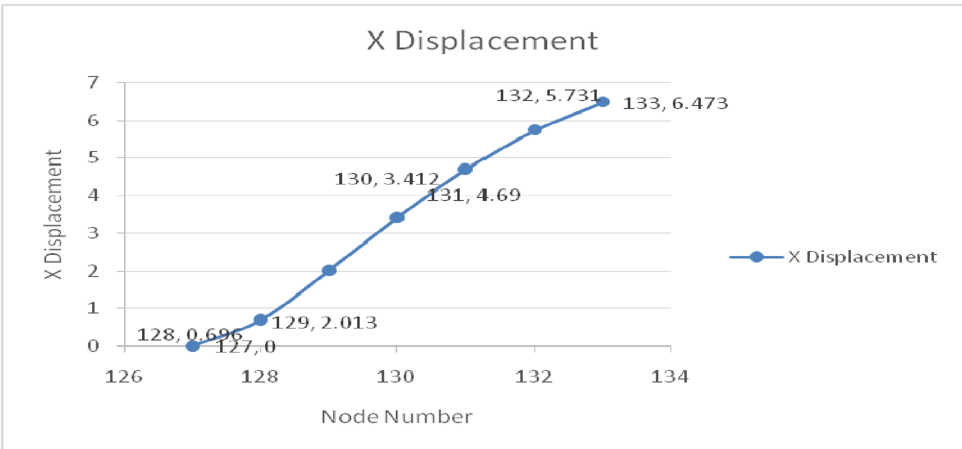
Fig. 4.38(a), 4.38(b), and 4.38(c) Shows Node Number vs Displacement Graph for columns in X-direction, Fig. (a) shows displacement for column number 1, 2, 3, 4, 5, 6 and Fig. (b) shows displacement for column number 50,51,52,53,54,55,56, and Fig. (c) shows displacement for column number 127,128,129,130,131,132,133. Displacement results also shows deeply in Table 4.16



(a)



(b)



(c)

Fig. 4.38 Directional displacement Graph for Case B2 nodes (a) for node number 1, 2, 3, 4, 5, 6, 7 (b) for column number 50,51,52,53,54,55,56 (c) for column number 127,128,129,130,131,132,133

Table 4.17 Maximum bending moment of beam 1,2,3,4,5,6,97,98,99,100,101,102, 169,170,171,172,173,174 for Case B2

Beam	L/C	Dist (m)	F_x (kN)	F_y (kN)	F_z (kN)	M_x (kN-m)	M_y (kN-m)	M_z (kN-m)
1	1 S +X	0	-152.628	42.63	-0.382	-2.296	1.077	106.07
		0.875	-152.628	42.63	-0.382	-2.296	0.743	68.769
		1.75	-152.628	42.63	-0.382	-2.296	0.409	31.468
		2.625	-152.628	42.63	-0.382	-2.296	0.075	-5.833
		3.5	-152.628	42.63	-0.382	-2.296	-0.259	-43.135
2	1 S +X	0	-146.098	-7.502	0.218	-5.233	-0.454	-26.955
		0.875	-146.098	-7.502	0.218	-5.233	-0.263	-20.391
		1.75	-146.098	-7.502	0.218	-5.233	-0.072	-13.826
		2.625	-146.098	-7.502	0.218	-5.233	0.119	-7.262
		3.5	-146.098	-7.502	0.218	-5.233	0.31	-0.697
3	1 S +X	0	-101.981	3.255	0.194	-6.746	-0.351	6.256
		0.875	-101.981	3.255	0.194	-6.746	-0.181	3.408
		1.75	-101.981	3.255	0.194	-6.746	-0.011	0.559
		2.625	-101.981	3.255	0.194	-6.746	0.158	-2.289
		3.5	-101.981	3.255	0.194	-6.746	0.328	-5.137
4	1 S +X	0	-67.961	2.376	0.326	-6.601	-0.612	1.98
		0.875	-67.961	2.376	0.326	-6.601	-0.328	-0.099
		1.75	-67.961	2.376	0.326	-6.601	-0.043	-2.178
		2.625	-67.961	2.376	0.326	-6.601	0.242	-4.258
		3.5	-67.961	2.376	0.326	-6.601	0.527	-6.337
5	1 S +X	0	-38.167	2.168	0.535	-5.383	-0.607	-0.344
		0.875	-38.167	2.168	0.535	-5.383	-0.14	-2.241
		1.75	-38.167	2.168	0.535	-5.383	0.328	-4.138
		2.625	-38.167	2.168	0.535	-5.383	0.796	-6.035
		3.5	-38.167	2.168	0.535	-5.383	1.264	-7.931
6	1 S +X	0	-16.301	-0.43	0.175	-3.306	0.209	-3.932
		0.875	-16.301	-0.43	0.175	-3.306	0.361	-3.555
		1.75	-16.301	-0.43	0.175	-3.306	0.514	-3.179
		2.625	-16.301	-0.43	0.175	-3.306	0.667	-2.802
		3.5	-16.301	-0.43	0.175	-3.306	0.82	-2.425
150	1 S +X	0	-49.573	30.892	-0.519	0.146	1.332	100.042

		0.875	-49.573	30.892	-0.519	0.146	0.878	73.012
		1.75	-49.573	30.892	-0.519	0.146	0.423	45.982
		2.625	-49.573	30.892	-0.519	0.146	-0.031	18.952
		3.5	-49.573	30.892	-0.519	0.146	-0.486	-8.078
151	1 S +X	0	-39.835	10.453	-0.07	0.162	-0.022	17.175
		0.875	-39.835	10.453	-0.07	0.162	-0.083	8.029
		1.75	-39.835	10.453	-0.07	0.162	-0.145	-1.118
		2.625	-39.835	10.453	-0.07	0.162	-0.206	-10.264
		3.5	-39.835	10.453	-0.07	0.162	-0.267	-19.41
152	1 S +X	0	-30.216	5.162	-0.079	0.128	0.032	3.892
		0.875	-30.216	5.162	-0.079	0.128	-0.037	-0.624
		1.75	-30.216	5.162	-0.079	0.128	-0.106	-5.141
		2.625	-30.216	5.162	-0.079	0.128	-0.176	-9.657
		3.5	-30.216	5.162	-0.079	0.128	-0.245	-14.174
153	1 S +X	0	-21.451	6.25	-0.006	0.084	-0.056	5.959
		0.875	-21.451	6.25	-0.006	0.084	-0.061	0.491
		1.75	-21.451	6.25	-0.006	0.084	-0.067	-4.977
		2.625	-21.451	6.25	-0.006	0.084	-0.072	-10.446
		3.5	-21.451	6.25	-0.006	0.084	-0.078	-15.914
154	1 S +X	0	-13.34	5.633	-0.057	0.041	0.04	1.586
		0.875	-13.34	5.633	-0.057	0.041	-0.01	-3.343
		1.75	-13.34	5.633	-0.057	0.041	-0.06	-8.272
		2.625	-13.34	5.633	-0.057	0.041	-0.11	-13.2
		3.5	-13.34	5.633	-0.057	0.041	-0.16	-18.129
155	1 S +X	0	-6.833	1.214	0.027	0.009	-0.103	-4.945
		0.875	-6.833	1.214	0.027	0.009	-0.078	-6.008
		1.75	-6.833	1.214	0.027	0.009	-0.054	-7.07
		2.625	-6.833	1.214	0.027	0.009	-0.03	-8.133
		3.5	-6.833	1.214	0.027	0.009	-0.006	-9.195
479	1 S +X	0	-1.505	20.062	-0.289	-1.09	1.124	71.511
		0.875	-1.505	20.062	-0.289	-1.09	0.872	53.957
		1.75	-1.505	20.062	-0.289	-1.09	0.619	36.403
		2.625	-1.505	20.062	-0.289	-1.09	0.366	18.849

		3.5	-1.505	20.062	-0.289	-1.09	0.113	1.295
480	1 S +X	0	-1.586	18.499	-0.264	-2.556	0.692	41.042
		0.875	-1.586	18.499	-0.264	-2.556	0.461	24.855
		1.75	-1.586	18.499	-0.264	-2.556	0.23	8.669
		2.625	-1.586	18.499	-0.264	-2.556	-0.001	-7.518
		3.5	-1.586	18.499	-0.264	-2.556	-0.232	-23.705
481	1 S +X	0	-1.534	16.242	-0.175	-2.731	0.319	27.009
		0.875	-1.534	16.242	-0.175	-2.731	0.166	12.798
		1.75	-1.534	16.242	-0.175	-2.731	0.012	-1.414
		2.625	-1.534	16.242	-0.175	-2.731	-0.141	-15.625
		3.5	-1.534	16.242	-0.175	-2.731	-0.294	-29.837
482	1 S +X	0	-1.312	14.35	-0.081	-2.45	0.046	19.175
		0.875	-1.312	14.35	-0.081	-2.45	-0.025	6.619
		1.75	-1.312	14.35	-0.081	-2.45	-0.096	-5.938
		2.625	-1.312	14.35	-0.081	-2.45	-0.166	-18.494
		3.5	-1.312	14.35	-0.081	-2.45	-0.237	-31.051
483	1 S +X	0	-0.936	11.45	0.03	-2.002	-0.194	11.05
		0.875	-0.936	11.45	0.03	-2.002	-0.168	1.031
		1.75	-0.936	11.45	0.03	-2.002	-0.141	-8.988
		2.625	-0.936	11.45	0.03	-2.002	-0.115	-19.006
		3.5	-0.936	11.45	0.03	-2.002	-0.088	-29.025
484	1 S +X	0	-0.403	6.886	0.2	-1.306	-0.348	2.72
		0.875	-0.403	6.886	0.2	-1.306	-0.173	-3.305
		1.75	-0.403	6.886	0.2	-1.306	0.002	-9.33
		2.625	-0.403	6.886	0.2	-1.306	0.177	-15.355
		3.5	-0.403	6.886	0.2	-1.306	0.352	-21.379

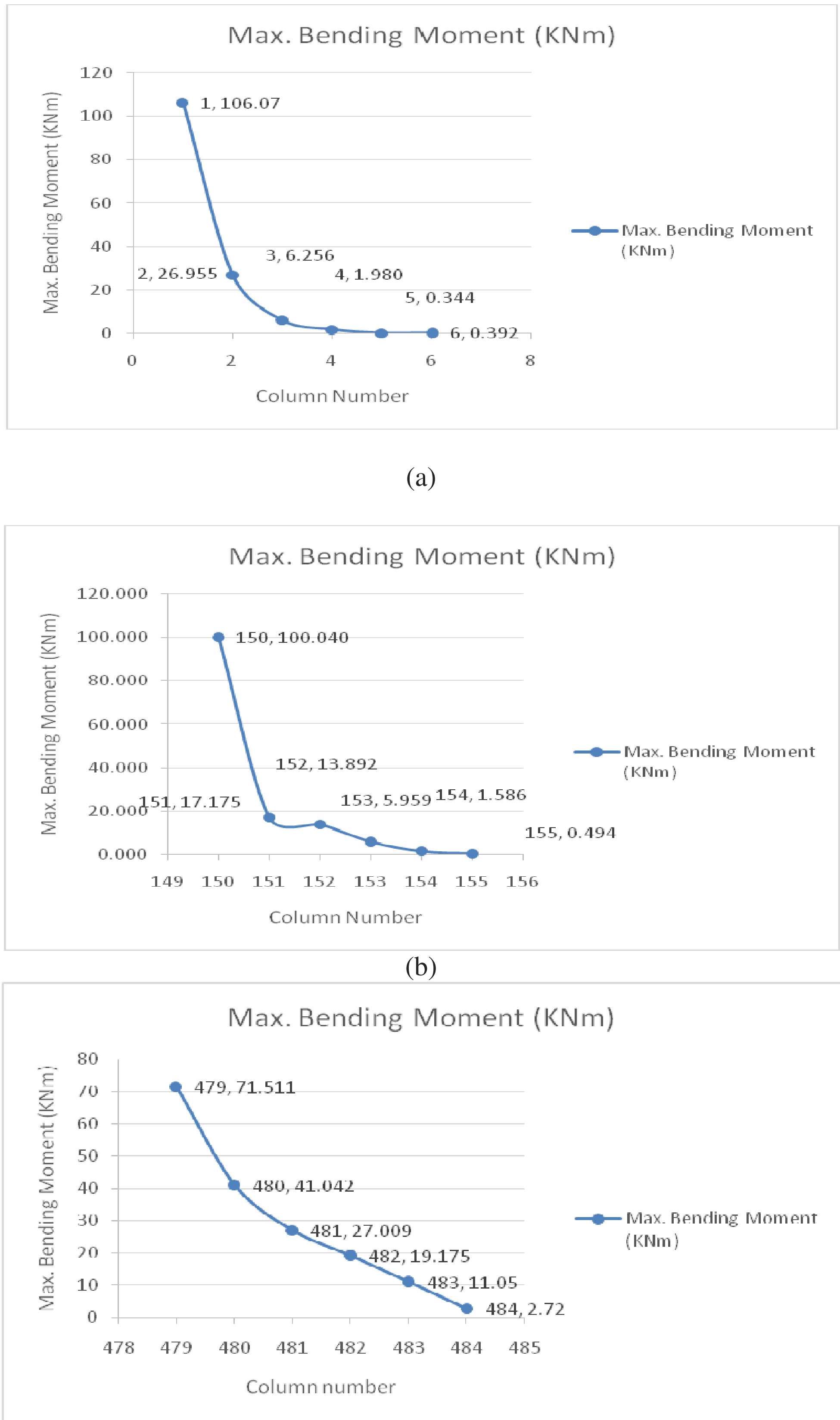


Fig. 4.39 Max. Bending Moment Graph for Columns for Case B2 (a) for column number 1, 2, 3, 4, 5, 6 (b) for column number 150,151,152,153,154,155 (c) for column number 479,480,481,482,483,484

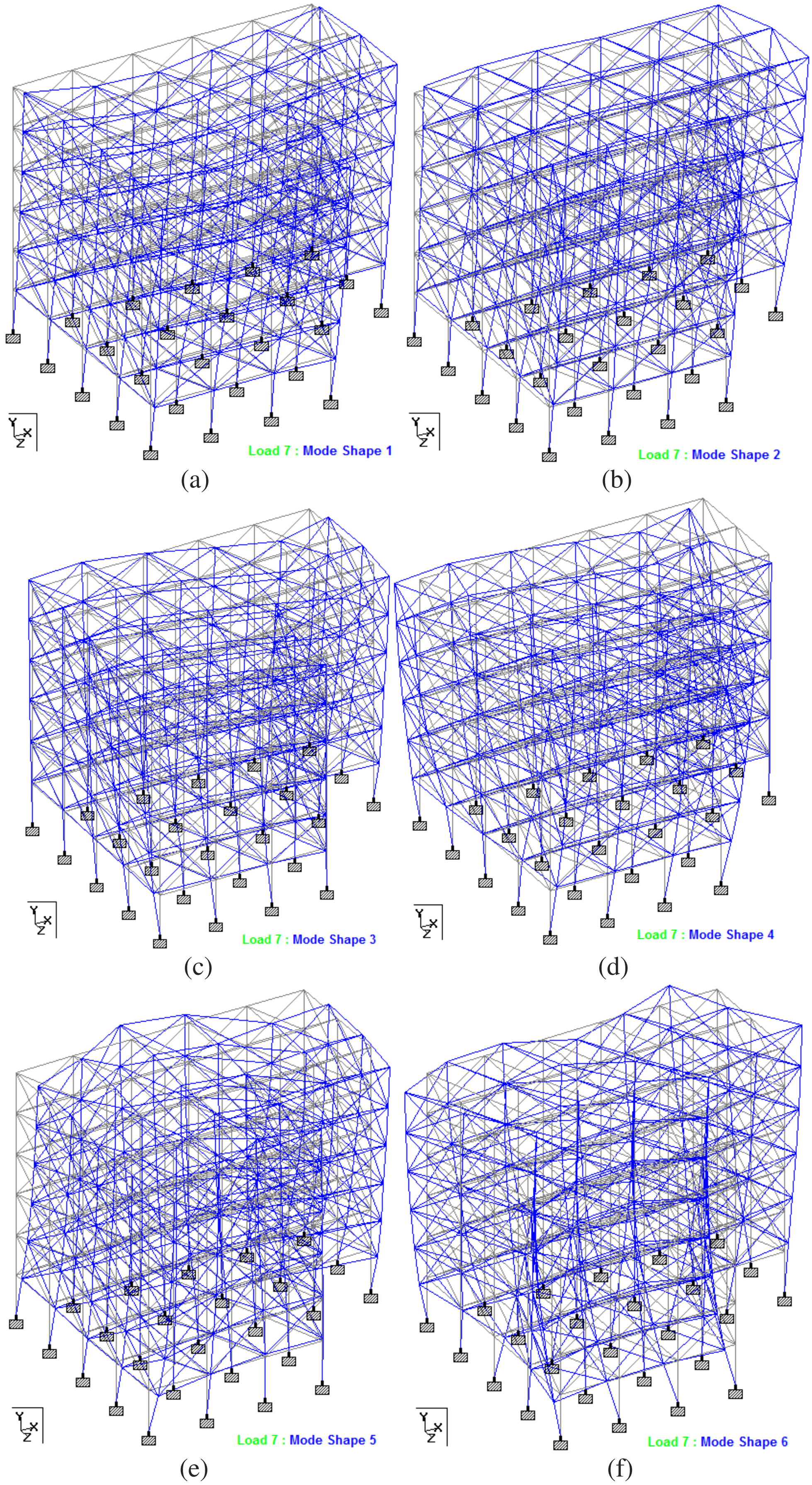


Fig. 4.40 Mode Shapes for Case B2, (a) Mode shape I, (b) Mode shape II, (c) Mode shape III, (d) Mode shape IV, (e) Mode shape V and (f) Mode shape VI

Table. 4.18 Frequency/Time for Case B2 at each mode.

M0DE	Frequency (Hz)	Period (seconds)	Participation (X %)	Participation (Y %)	Participation (Z %)	Type
1	1.859	0.538	2.372	0.001	70.532	Elastic
2	2.068	0.484	74.17	0.001	2.607	Elastic
3	2.476	0.404	0.056	0	2.179	Elastic
4	2.781	0.36	0.001	0	0.216	Elastic
5	3.255	0.307	0.851	0	3.566	Elastic
6	3.803	0.263	4.507	0	0.249	Elastic

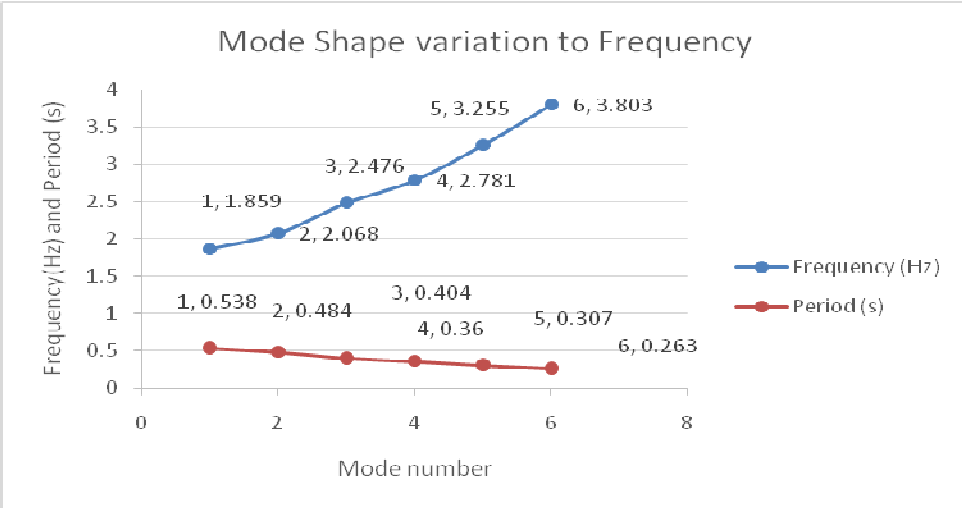


Fig. 4.41 Graph of Frequency and period for mode shape 1, 2, 3, 4, 5, 6

Table. 4.19 Peak Storey Shear for Case B2

STORY	LEVEL IN METER	PEAK STORY SHEAR IN KN	
----------	----------	X	Z
BASE	0	1212.84	0
1	3.5	1212.84	0
2	7	1143.77	0
3	10.5	987.13	0
4	14	752.42	0
5	17.5	458.07	0
6	21	127.24	0

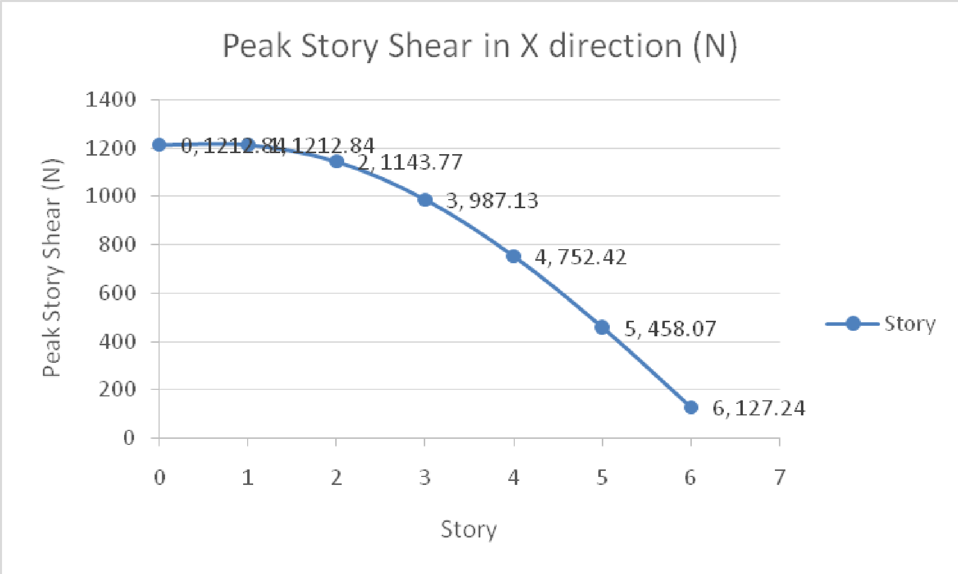


Fig. 4.42 Graph of Peak story shear for Case B2

Table. 4.20 Base Shear for Case B2

	MASS PARTICIPATION FACTORS IN PERCENT						BASE SHEAR IN KN		
MODE	X	Y	Z	SUMM-X	SUMM-Y	SUMM-Z	X	Y	Z
1	3.95	0.00	63.76	3.946	0.003	63.763	63.55	0.00	0.00
2	65.70	0.00	3.93	69.642	0.006	67.696	1058.16	0.00	0.00
3	0.35	0.00	0.90	69.991	0.006	68.599	5.62	0.00	0.00
4	0.75	0.00	0.14	70.737	0.006	68.740	12.02	0.00	0.00
5	0.13	0.00	7.27	70.870	0.009	76.008	2.15	0.00	0.00
6	4.15	0.00	0.60	75.017	0.009	76.610	66.80	0.00	0.00
				TOTAL SRSS		SHEAR	1062.25	0.00	0.00
				TOTAL 10PCT		SHEAR	1062.32	0.00	0.00
				TOTAL ABS		SHEAR	1208.29	0.00	0.00
				TOTAL CSM		SHEAR	1062.32	0.00	0.00

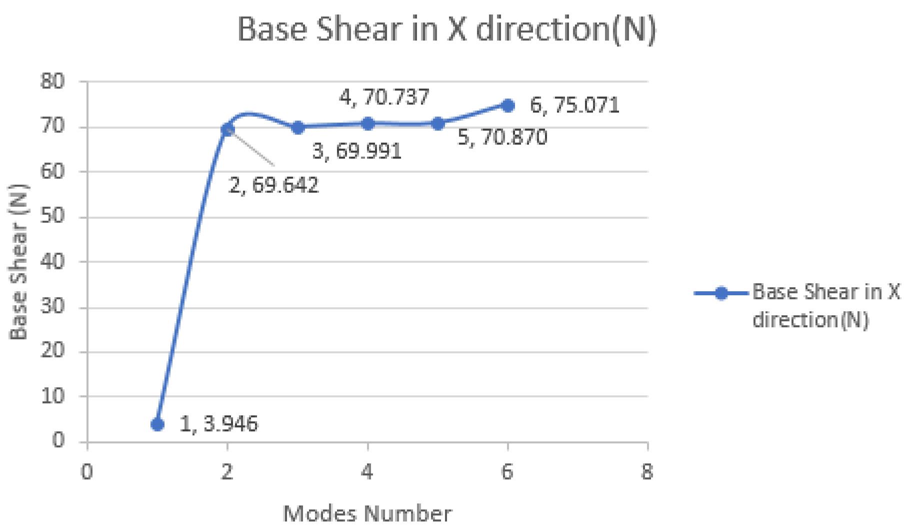
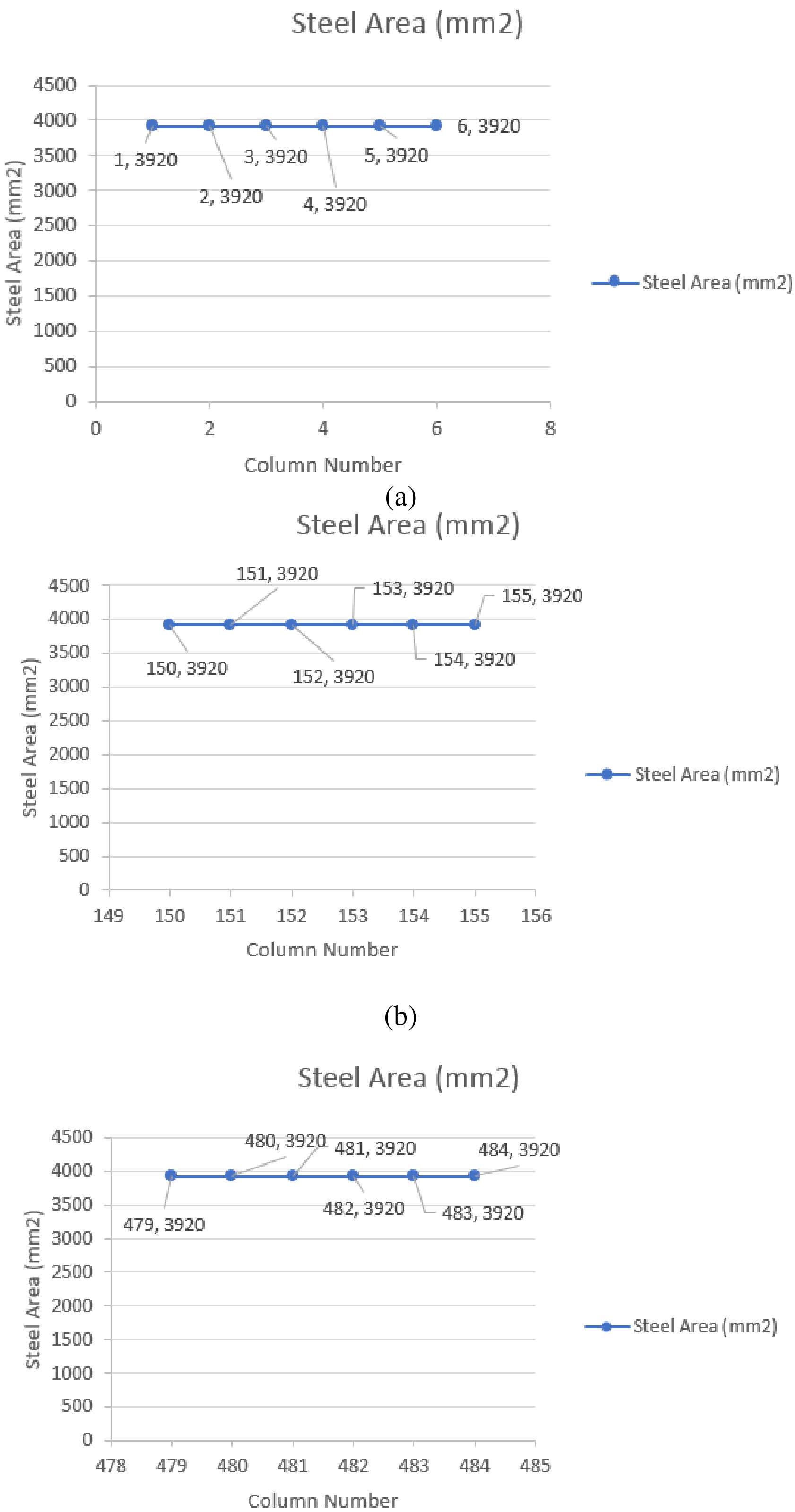


Fig. 4.43 Graph of Base shear for Case B2



(a)

(b)

(c)

Fig. 4.44 Steel Area Graph for Columns for Case B2 (a) for column number 1, 2, 3, 4, 5, 6 (b) for column number 150,151,152,153,154,155 (c) for column number 479,480,481,482,483,484

Fig. 4.45 This study found that Case B2 have max. displacement and so max. displacement is in following order Case A1<Case B1<Case A2<Case B2 at node number 7. At node number 2 have variations in displacement so for this node following this series A1(0.98mm) <B1(1.244mm) <A2(2.521mm) <B2(3.195mm).

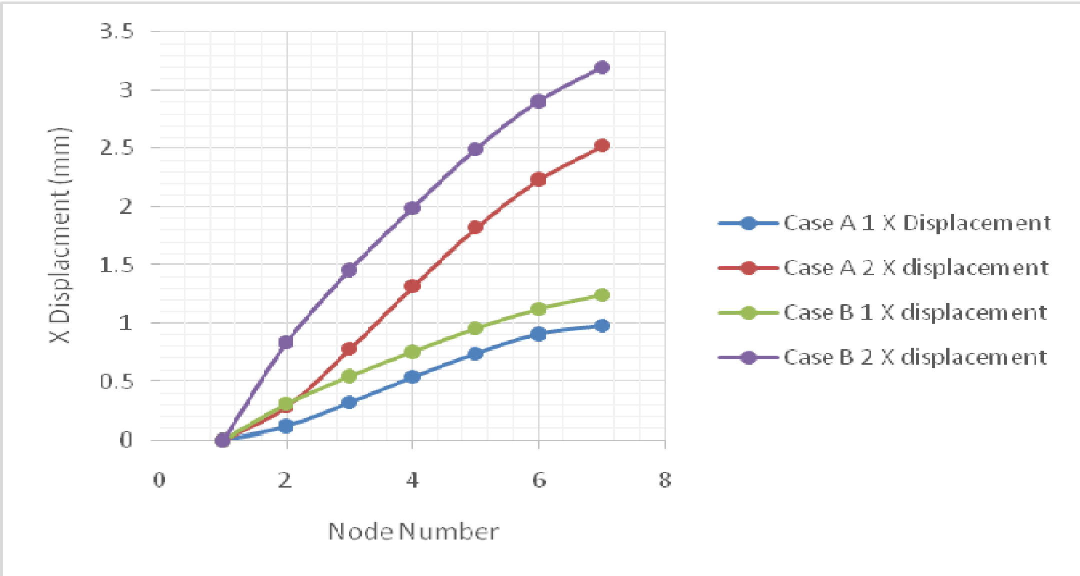


Fig. 4.45 Displacement in X-direction for all cases

Fig. 4.46 This study found that in case B2 max. bending moment is 106.07 KNm in column number 1.

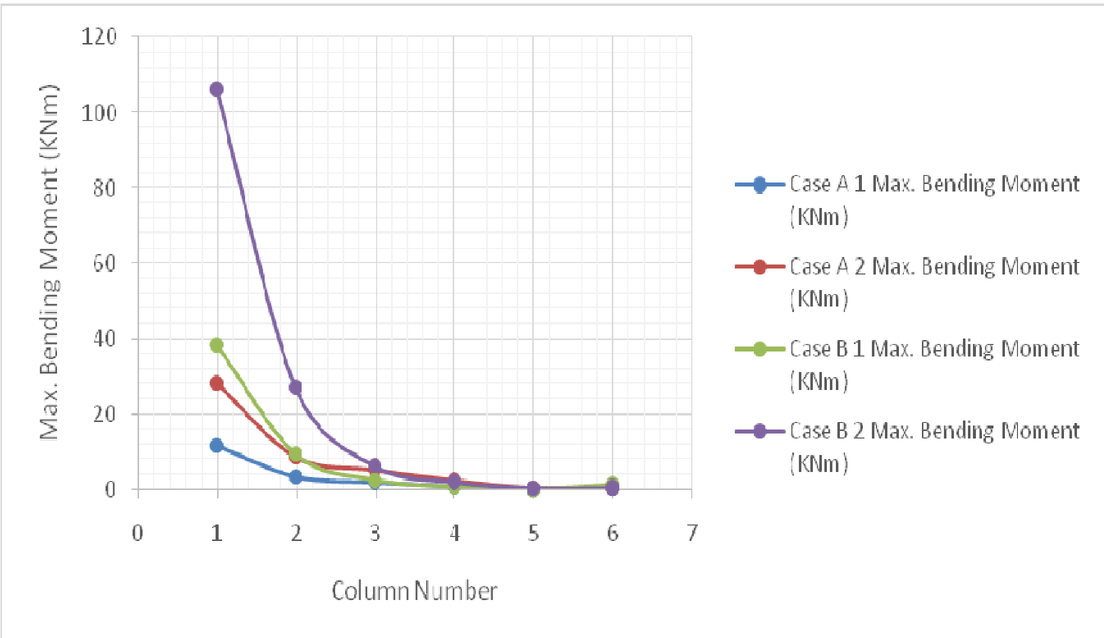


Fig. 4.46 Comparative study of Max. bending Moment for all cases

Fig. 4.47 This study found that column number 1,2,3,4,5 and 6 have steel required in case A1 is 27462mm^2, Case A2 is 23520mm^2, Case B1 is 34888mm^2 and Case B2 is 23520mm^2.

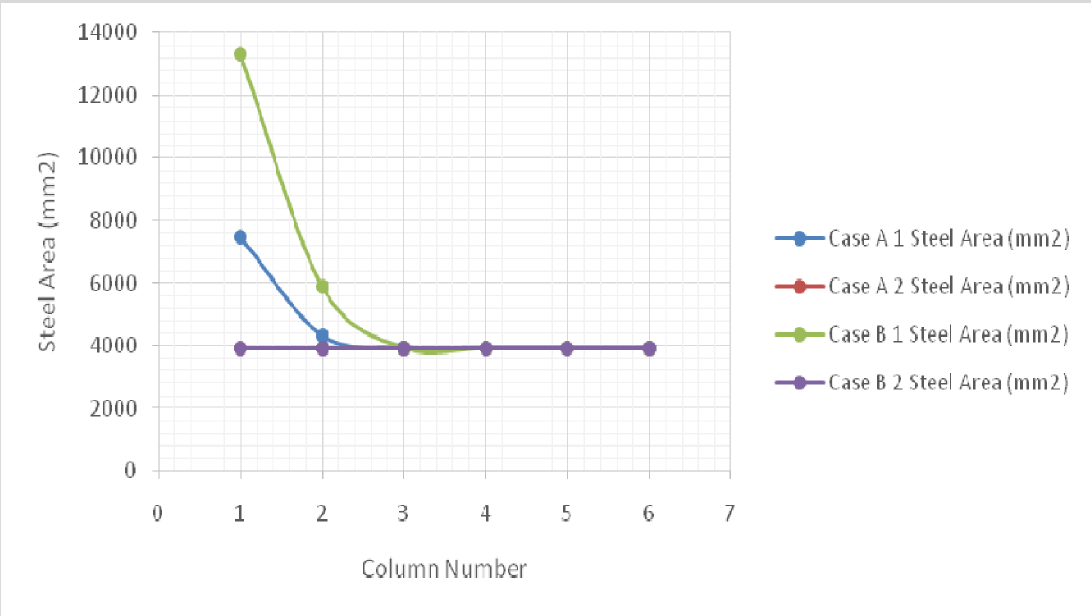


Fig. 4.47 Comparison of Steel requirement for all cases

In this study found that Case A2 have max base shear 82.918 N as comparing to other cases in mode number 6.

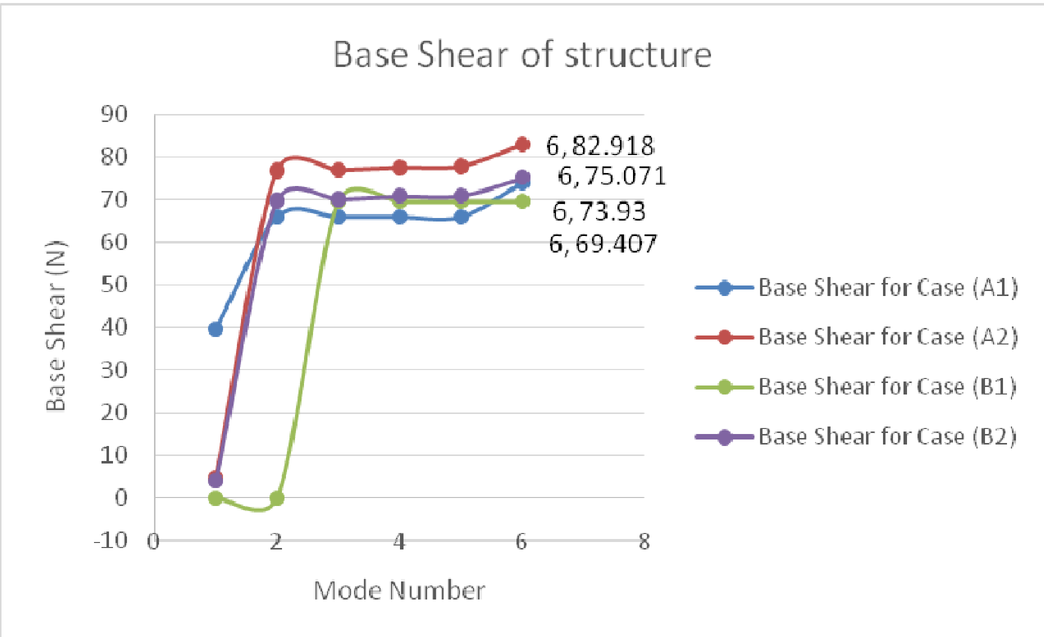


Fig. 4.48 Comparison of Base Shear for all cases

In this study found that Case A1 have max frequency 7.855 Hz as comparing to other cases in mode number 6.

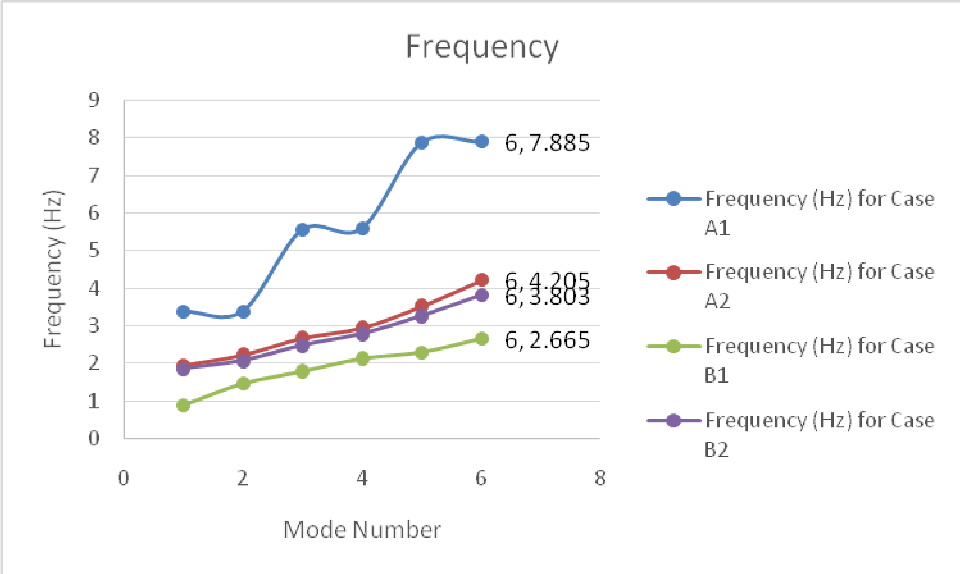


Fig. 4.49 Comparison of Frequency with the mode number for all cases

In this study found that Case B2 have max storey shear 1212.84 kN as comparing to other cases at the base

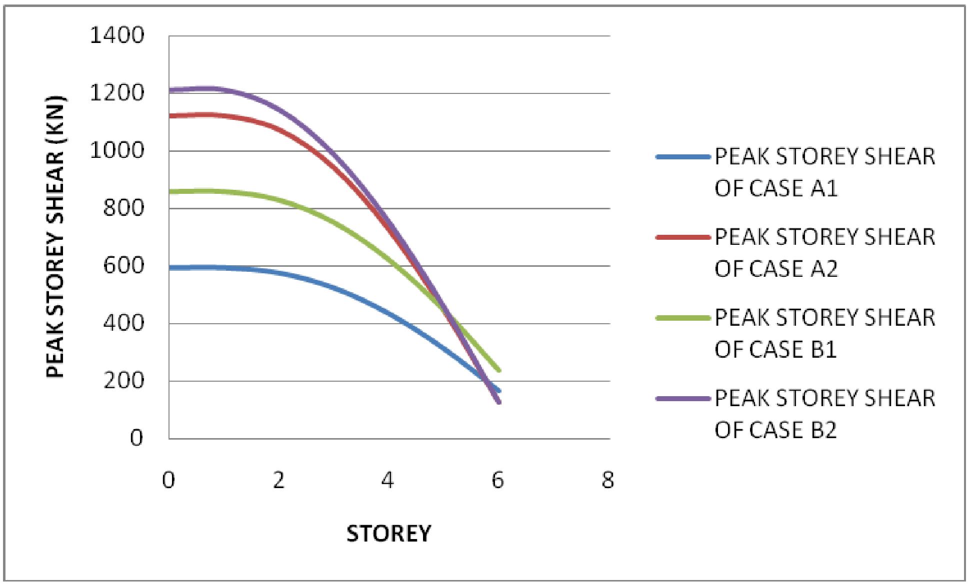


Fig. 4.50 Comparison of Peak storey shear with the storey for all cases

CHAPTER 5

CONCLUSIONS AND FUTURE SCOPE

5.1 Conclusions

After Analysis and Design all these four cases obtained results as displacement, max. bending moment and steel area for column. Applied all loads like Seismic, wind, live, dead load according to Indian standard and compared for seismic load in x direction. After all these studies following conclusion are found which are mentioned below

1. This study found that Case B2 have maximum displacement 3.195 mm at node number 7, For Case A2 have maximum displacement 2.521 mm at node number 7, For Case B1 have maximum displacement is 1.244 mm at node number 7 and for Case A1 maximum displacement 0.98 mm at node number 7 so max. displacement is in following order Case A1<Case B1<Case A2< Case B2. These results found at node number 7.

2. This study found that for Y direction and Z direction displacement is very minimum almost zero so displacement for Y and Z direction is neglected.

3. This study found that column number 1 have different steel required in case A1, A2, B1 and B2 and are as follows 7420 mm^2,3920 mm^2,13328 mm^2, 3920 mm^2.

4. This study found that column number 1,2,3,4,5 and 6 have steel required in case A1 is 27462mm^2, Case A2 is 23520mm^2, Case B1 is 34888mm^2 and Case B2 is 23520mm^2.

5. This study found that in Case B2 maximum bending moment is 106.07 KN-m, in column number 1 for Case B1 maximum bending moment is 38.37 KN-m, For Case A2 maximum bending moment is 28.335 KN-m and for Case A1 maximum bending moment is 11.651 KN-m so maximum bending moment is in following order Case A1<Case A2<Case B1< Case B2. It means Case A1 is better option for max. bending moment cause is have less value. These results found at column number 3.

6. In this study found that Case A1 have max frequency 7.855 Hz as comparing to other cases in mode number 5.

7. In this study found that Case A2 have max base shear 82.981 N as comparing to other cases in mode number 6.

8. In this study found that case B2 have maximum peak storey shear 1212.84kN at the base in comparison to all other cases.

9. STAAD.Pro is an analysis software which helps in finding the displacement of building, max. bending moment and steel area in all three X, Y and Z direction for all kind of load.

10. In STAAD.Pro software combination load of dead load, live load and wind load can be applied as well as these loads can be applied individually with calculated Factor of Safety.

11. In STAAD.Pro software building or structure can be subjected to seismic load. Seismic load can be applied according to Zone or City in which construction of building is planned.

12. By help of all these data buildings can analysed and designed considering all possible factors which may cause harm to human life as well as to building or structure that is planned to be build, so using STAAD.Pro software one can save money and time.

5.2 Future Scope

1. Do study for high rise building.

2. Apply different types of cross section of column and beam.

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