An analysis of the impact of wind load and seismic activity on low-rise and high-rise multistory structures, based on the BNBC 2020 standards, using the ETABS software.

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering

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Section: (20B)
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“An analysis of the impact of wind load and seismic activity on low-rise and high-rise multistory structures, based on the BNBC 2020 standards, using the ETABS software". has been performed under the supervision of M.A. BASHAR BHUIYAN Lecturer, Department of Civil Engineering, Sonargaon University (SU), Dhaka. To the best of our knowledge and belief, the thesis report contains on material previously published or written by another person expect where due referee is made in the report itself. We further undertake to indemnify the university against any loss or damage arising from breach of the foregoing obligations.

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ABSTRACT

The general requirements for structural, architectural, and design elements in Bangladesh are outlined and governed by the Bangladesh National Building Code (BNBC)-2020. Civil engineering methods, materials, and design parameters have evolved over the past thirty years in response to changing needs. As a result, BNBC 2020 was drafted to account for the change. A systematic and parametric structural analysis utilizing BNBC 2020 was conducted on a Five-story (low-rise) and Twelve-story (high-rise) residential structure using ETABS 16.0 software. In this project, the lateral loads of wind and earthquakes impact the structural analysis and high-rise infrastructure design for the city of Dhaka. According to BNBC 2020, tale drift, wind and seismic shear, base shear for seismic forces, and tremor and wind forces are the decision-making factors for structural analysis and design. The maximum story displacement of a low-rise to high-rise multistory structure in this study is, respectively, 121.84%, 287.05%, 219.72%, and 450% for the loads EQX, EQY, WX, and WY. Furthermore, the maximum story drift for a low-rise to high-rise multistory structure is 60.44%, 66.58%, 113.08%, and 100.488%, respectively, for load EQX, EQY, WX, and WY. The standards of BNBC 2020 typically result in a less cost-effective design with a higher safety margin when comparing the seismic effect and wind load on low-rise and high-rise multistory structures.

ABSTRACT

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CHAPTER 1

INTRODUCTION

1.1 Introduction & Background

The nation's socioeconomic advancement depends on building. A nation cannot advance without constructing. For instance, we need computers to create a digital nation, but we also need structures to house these computers. There are numerous items that are connected to the construction of buildings. All people want to be comfortable and attractive. One can presume, say, or calculate that a person typically spends two-thirds of his life in a house. Therefore, calmness envies the responsible sense. Humans require housing in order to be protected from different types of risk, including animals and natural disasters. These are the main causes of the person's extreme efforts and sacrifices of hard-earned savings to become a home owner. Every engineering portable must adhere to the most recent seismic requirements during design and construction in order to preserve human safety. Many structures in Bangladesh incur significant damage during earthquakes and wind loads throughout the design and construction phases because they do not adhere to the country's current seismic and wind load regulations. In order to achieve the design criteria for earthquake resistance, the reinforced concrete structure (RC), which is prone to seismic excitation, must be acceptable in terms of strength, ductility, and stiffness. The basic structural components' placement for durability and stiffness can control how laterally loaded structures react, and incorrect placement of these components was largely to blame for the damage seen in earthquake-prone structures. It is not a viable approach to take into account the growing population and lack of horizontal growth. Many structural problems, like lateral loads, side shifting, stiffness, and so forth, arise during the design of homes and apartments. In general, wind load is significant for high-rise structures in addition to earthquake stress. Thus, on many levels, different loads and their accompanying impacts on buildings must be taken into account. It is crucial to consider the impact of lateral loads when accounting for wind and seismic stresses. Bangladesh is located close to the world's largest mountain range, the Himalayas, and is prone to powerful earthquakes due to its location inside an active tectonic zone. Table l provides lists of some of the significant earthquakes that have affected Bangladesh. The aftermath of an earthquake is more severe in our densely populated, impoverished country than in other developed nations. Many structural problems, including the impact of lateral load, lateral movement, and rigidity on the structure, arise in high-rise buildings. In general, wind loads and tremors are significant for high-rise structures. In high risk seismic zone the seismic performance of structures are considered as the primary importance on the other hand which influence seismic performance, may be the effect of impact forces resulting from earth movement greater than the forces caused by wind loads and consequently, Seismic loading determines form and final design of the structure. [1] Thus, for a tall building, it is essential to comprehend several loads and their impact on structures. It is crucial to take into account the impact of lateral loads, such as wind and seismic stresses. Because modern modeling and computational facilities are unavailable in Bangladesh and other developing countries, the method of earthquake and wind analysis is employed in a static analysis. The code for design, detailing, and construction is becoming more and more important as the number of high-rise buildings increases. In order to include the knowledge and advancements in structural engineering over the past 20 years, BNBC 2020 has undergone significant changes. In light of the Dynamic actions are caused on buildings by both wind and earthquakes. But, design for wind forces and for earthquake effects are distinctly different. The intuitive philosophy of structural design uses force as the basis, which is consistent in wind design, wherein the building is subjected to a pressure on its exposed surface area; this is force type loading. However, in earthquake design, the building is subjected to random motion of the ground at its base, which induces inertia forces in the building that in turn cause stresses; this is displacement-type loading recommendations of other international building standards, BNBC 1993 was updated and released as BNBC 2020. Different kinds of building structures are typically constructed in our nation. The goal of the study is to design and analyze a Five-story residential structure made of reinforced concrete for wind and seismic performance. The building is located in Dhaka and is a combination of low- and high-rise construction. In order to design the components under the Bangladesh National Building Code (BNBC), a thorough review is first conducted utilizing the RAJUK standard rules and regulations for building construction. As per BNBC 2020, the equivalent static lateral force approach is employed for applying wind and earthquake loads. Because the building was not designed, the specifications of its reinforcement were not known. Dead, live, seismic, and wind loads are applied in the preparation of the design for both structural spans. This facilitates the estimation of the reinforcement needed for each construction component—such as the slab, column, beam, and footing—using a manual calculation process that is subsequently based on governing moments, axial, and shear effects. The building is analyzed and designed by ETABS 16.0 (Extended 3D Analysis of Building Structure). In order to compare seismic and wind load analyses for low-rise and high-rise multistory buildings by BNBC 2020, this study was conducted.

Table 1.1: List of major earthquakes affecting Bangladesh

Date	Name of Earthquake	Magnitude	Epicenter
8 July,1918	Srimangal earthquake border	7.3	Bangladesh Tripura
9 September,1923 Border (Meghalaya)	Meghalaya earthquake	7.1	Bangladesh India
2 September,1930	Dubri earthquake	7.1	Dabigiri
6 March,] 93	India Bangladesh earthquake Border	7.6	India Bangladesh
15 January, 1934	Bihar Nepal Earthquake	8.3	Bihar Nepal border
11 February, 1936	Bihar earthquake	7.5	North Bihar
16 August, 1938	Manipur Earthquake Bangladesh	7.2	Monipur near of
23 October, 1943	Assam earthquake	7.2	Hojai Assam
21 March, 1994	Monipur-Mayanmar Earthquake	7.4	Monipur
21 November,1997	Bandarban earthquake	7.1	Mizoram Mayanmar border
26 December,2004	Cox's Bazar earthquake	7.0	Bonda

The Bangladesh National Building Code (BNBC) was created in 1993 to provide guidelines for the design and execution of modern projects that are seismically prone and would lessen the risk to all buildings. Examining the provisions of this code and determining whether the most recent upgrade code needs to be modified to reflect changes in the design and analysis of the different structures is an intriguing area of research. The rules that govern infrastructure design, detailing, and construction are modified frequently to take into account new practices as tall structures become more common. Wind is a dynamic phenomenon that is dependent on time and speed and changes quickly. The reason for this is the wind shifting from a high-pressure to a low-pressure state. The 1993 publication of the Bangladesh National Building Code (BNBC) saw the modification of its projected wind provision in 2017. Before it was officially put into effect in 2006, the previously developed Bangladesh Building Code (BNBC) was not changed for a very long period of time. Given that construction may inevitably take place in unfavorable conditions, such as tectonically strong zones, consideration of the interaction of wind force and earthquakes has become crucial in seismic analysis and building design. A comparative analysis was conducted to identify the significant differences between the BNBC 1993 and the proposed BNBC 2012 in comparison to the previous one. Once more, using the most recent code, BNBC 2020, this research project will establish a system for comparing wind load and seismic analysis for low-rise and high-rise multistory buildings. The international community considers our country's population and economic situation when deciding how many safety precautions against wind disasters to take.

1.2 Research Objectives

The objectives of the study are:

- Using ETABS, compare the impact of wind loads on high-rise and low-rise multistory constructions as per BNBC 2020.
- To use ETABS to compare the seismic effects on low-rise and high-rise multistory constructions in accordance with BNBC 2020

1.3 General Approach

- Getting an architectural design of a RCC Residential Five—<Storied building.
- Project on RCC Residential Building in Dhaka.
- To establish the structural system for the ground and repeated floors of the building.
- Analysis of building, wind resisting system, and type of foundations
- Will be determined taking into consideration the architectural drawings.

1.4 Statement of project Salient features:

Table 1.2: Statement of Project Salient features

Utility of Building	Residential Purpose	
Number of Stories	Five Storied	Twelve
Shape of Building	Rectangle	Rectangle
Number of Staircase & Lift	01	01
Types of Construction	R.C.C framed Structure	R.C.C framed Structure
Types of Walls	Bricks wall	Bricks wall

Geometric Details:

Table 1.3: Statement of project Geometric Details

1.Ground Floor	10 ft
2.Floor to Floor height	10ft
3.Height of plinth	2.5ft

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Over the past twenty years, a great deal of progress has been made in the fields of wind and seismic engineering. Below is a discussion of the various comparisons that researchers have made between the wind load and quack of these earths.

2.2 Previous Background of the Study

Since its introduction in 1993, the Bangladesh National Building Code (BNBC) has not been amended. Since Bangladesh is situated in an area that is prone to earthquake activity and is close to the border between the Indian and Eurasian plates, earthquake design provisions are crucial. The last twenty years have seen several developments in the field of seismic engineering research. John D. Holmes et al. (2008) examined low, medium, and high-rise constructions.Wind has two aspects- the first beneficial one is that its energy can be utilized to generate power, sail boats and cool down the temperature on a hot day and on the other hand, the parasitic one is that it loads any and every object that comes in its way. [1] All buildings' significant resonant dynamic response to wind makes it more challenging to assess base shear, bending moments, and accelerations at the top. With a range of 14% to 18%, the coefficient of variation for both wind and cross-wind reflexes was comparatively low. A study on the effect of wind on low-rise structures when high-rises are integrated into an existing development was reported in Juliya Mironova et al.'s (2020) publication [2]. The aim of the research is to simulate wind patterns in order to ascertain the highest possible aerodynamic wind impact on multi-story structures and the areas around them. Numerical experiments were conducted in this study to estimate the wind flow distribution for an existing low-rise building in a virtual wind tunnel. Their findings indicate that a rising coefficient. A comparative study of wind forces on high-rise structures. He used ETABS software, which has six different wind speeds and four terrain classifications, for analysis. He completed the analysis for the 60- and 120-meter buildings. The shear forces and bending moments provided by both buildings in the static analysis are almost equal. In comparison to the IS draft code, the IS current code yields higher base shear values. The IS Draft code estimate reaction parameters like acceleration and forces more precisely and directly than the current code does. In some cases, the wind load is dominant than earthquake load which depends on area and zone factor defined by codes. Wind as a moving air has an effect on effect on building structures. Wind actions fluctuate with time, hence its effect on different situations and structures should be carefully analyzed. [3] In comparison to SMRF structures, OMRF structures are subject to substantially greater forces. Conventional design for seismic loads on a structure has to ensure the safety of the inhabitants of the building. This has always historically been, and always should be, the focus of design for all structures. Conventional design for seismic loads on a structure has to ensure the safety of the inhabitants of the building. This has always historically been, and always should be, the focus of design for all structures. [4] The study utilized the E-TABS program for analysis. He noted that seismic lateral forces and shear forces can reach values of 230 kN and 2000 kN, respectively. The mass of the building being designed controls seismic design in addition to the building stiffness, because earthquake induces inertia forces that are proportional to the building mass. Designing buildings to behave elastically during earthquakes without damage may render the project economically unviable. [6] The positive feature of wind is that its energy may be used to generate power, sail boats, and reduce temperatures on hot days; on the other hand, the parasitic aspect is that wind loads everything in its path. The building structure must have complete horizontal and vertical load-resisting systems that are strong, stiff, and capable of withstanding the designed earthquake within the allowable deflection. [7] In India, the necessity for larger buildings due to land constraints has brought to light the importance of wind energy. The number of taller structures, both residential and commercial, has significantly increased recently. It is therefore vital to design the structure ideally for lateral forces, story drift, and moments. As the height of the building increases, the forces operating on the structure likewise rise along with it, affecting the stiffness and stability of the building. Consequently, it is critical that the structure resist lateral loads with appropriate stiffness and be strong enough against vertical loads.

2.3 Methods for analyzing a frame structure

A few techniques exist for frame analysis. The process of analyzing portal frames with statistical indeterminacy

1. Method of flexibility coefficients.
2. Slope displacements methods (iterative methods)
3. Moment distribution method
4. Cantilever method
5. Portal method
6. Matrix method

2.3.1Methods of flexibility Co-efficient:

For arch dams, the macroevolution of shape, safety, and economy is commonly implemented using the flexibility coefficient. Often called the force or flexibility method, the method of consistent deformations is one of various methods for analyzing indeterminate structures. This method's notion for studying structures with single or double degrees of indeterminacy that are extremally indeterminate is described in the following approach. The analytical technique comprises reducing the hyper static structure to a definite form using the following methods: Cutting off the unnecessary support and adding hinges or suitable cuts

2.3.2 Slope displacement equations:

George A. Many first introduced the slope deflection method, a structural analysis technique for beams and frames, in J 914. Before the moment distribution method was created, the slope deflection method was in use for more than ten years. Applying joint and shear equilibrium criteria and solving slope deflection equations yields slope angles. Member end moments may be easily found by substituting them back into the slope deflection calculations.
Displacement is used for those cases which are given below:

1. General Case
2. Stiffness Coemcients
3. Stiffness Coefficients Derivation
4. Fixed-End Moments
5. Pin-Supported End Span

Displacement is used for those cases which are given below:

6. Typical Problems
7. Analysis of Beams
8. Analysis of Frames: No Sideway
9. Analysis of Frames: Sideway
10. A solution of simultaneous equations makes methods tedious for manual computations.
11. This method is not recommended for frames larger than two bays and two stories.

2.3.3 Moment Distribution method:

Hardy Cross devised a structural analysis technique for statically indeterminate beams and frames called the moment distribution approach. The technique only takes flexural effects into account, ignoring shear and axial effects. The moment distribution approach was most commonly employed in structural design and analysis until the 1930s, when computers started to be used extensively. In order to develop the fixed-end moments, the moment distribution method fixes each joint in the structure that needs to be evaluated. Next, until equilibrium is reached, the fixed-end moments
are transferred to neighboring members while the fixed joint is gradually released. The procedure of solving a set of simultaneous equations by repetition can be used to illustrate the moment distribution approach in mathematical mathematics.

2.3.4 Cantilever method:

The cantilever method was designed to compute and examine shear moments and forces that are developed in different parts of a frame or structure, such as beams and columns, as a result of lateral loads. When planning the buildings, the lateral loads—such as wind and seismic loads—must be taken into account. The direct stresses in the columns are proportionate to their distances from the centroid axis, and the point of contraflexure is placed at the midpoint of the horizontal and vertical members, according to the assumptions made for this approach. The frame is examined step-by-step, and the final diagram helps to explain the details. The technique is quite flexible and can be applied to study the frame of a given number of floors or stores. The areas of the end and intermediate columns are used to calculate the centriole axis's position. Regarded as one of the two approximations for indeterminate structural analysis of frames for lateral loads, the approach is used.

2.3.5 Portal method:

A portal frame is one that is utilized in a structure to transfer loads applied laterally along its sides to the supports located at the frame's base. Portal frames are frequently made with the assurance that they can support lateral stresses. As a result, a large number of portal frames are extremely statically indeterminate; these frames are frequently utilized in buildings, industries, and bridges due to their capacity to withstand horizontal loading. The portal approach can be used to examine the approximation analysis of portal frames. Prior to the analysis, several presumptions must be established.

1. A point of inflection is located at the center of each member of the Portal frame.
2. For each story of the frame, the interior columns bear twice as much shear as the exterior columns
3. Lateral forces resisted by frame action.
4. Inflection points at mid-height of columns.
5. Inflection points at mid-span of beams.
6. Column shear is based on tributary area.
7. Overturn is resisted by exterior columns only.

CHAPTER 3

METHODOLOGY

3.1 Introduction:

The methodology of the work has been covered in this chapter. The majority of this project is based on software.

1. ETABS 2016
2. Auto CAD 2018

The required data for analysis and the model built up with ETABS (16) are discussed in detail here. Analysis has been done for Zone 2 (Dhaka). The designed data was picked from BNBC 2020.

A regular structure stability building was built. Simply frame structure system with shear wall in stair case has been introduced and analysed. Design considerations were kept same to obtain floor (2-D) geometry against the lateral load.

The study of deflection analysis for this paper was developed using a determinist methodology, with some probabilistic elements in its conception. In order to facilitate this study, it was divided in four phases of analyses.

3.2 Different types of loads in structure:

In order to support specified loads, structural members must be developed. Sutures should be adjusted for specific forces, which are known as loads. Typically, loads can be categorized as

1.Dead Loads
2.Imposed loads or live load
3.Wind Loads
4.Earthquake loads

3.2.1 Dead Load:

consist of the permanent construction material loads that compress the fixed equipment, finishes, and roof, floor, and wall systems. The entire weight of all the building's components—such as the concrete floors, roofing material, columns, and bricks—that typically do not change over time is known as the "dead load." When a member's property is provided, ETABS automatically assigns the dead load. We have a feature in the load case called self-weight that uses the density of the material to automatically generate weights. The floor finish, partition wall, and slab self-weight are the three types of dead loads on the slab in this study. In addition to the slab's inherent weight, a total of 25 psf of vertical load is imparted to the floor finish and 30 psf to the random wall.

3.2.2 Live Load:

consist of the permanent construction material loads that compress the fixed equipment, finishes, and roof, floor, and wall systems. The entire weight of all the building's components—such as the concrete floors, roofing material, columns, and bricks—that typically do not change over time is known as the "dead load." When a member's property is provided, ETABS automatically assigns the dead load. We have a feature in the load case called self-weight that uses the density of the material to automatically generate weights. The floor finish, partition wall, and slab self-weight are the three types of dead loads on the slab in this study. In addition to the slab's inherent weight, a total of 25 psf of vertical load is imparted to the floor finish and 30 psf to the random wall.

3.2.3 Wind Load:

As a result, all components and cladding of buildings and other structures, including the main Wind-Force Resisting System (MWFRS), must be designed and built to withstand wind loads in accordance with the guidelines provided below. Acceptable practices: Thus, one of the following methods must be used to determine the design wind load for buildings and other structures, including the MWFRS and component and cladding elements.

There are two methods for wind load analysis, namely, the quasi-static method and detailed dynamic analysis. The former is applied to structures whose structural properties do not make them susceptible to dynamic exaltation. The latter is applied to structures which are likely to be susceptible to dynamic excitation. The choice of the above two methods depends on the value of the structure of their dynamic coefficient he dynamic coefficient depends on the type of structure, the height of the structure and its breadth.

$Qz = Cc\ Ci\ Cz\ V^2b$……………. (if Vb=km/h) ……………………….(i)

- qz = Sustained wind pressure at height z, kN/m^2
- C_1 = Structure importance Coefficient
- Cc = Velocity to pressure conversion coefficient
- Cz = Combined height and exposure coefficient (Calculate based on height)
- Vb = Basic wind speed, km/h

Velocity pressure:

Velocity pressure, qz evaluated at height z shall be calculated by the following equation:

$Qz=(0.0006130\ V^2)Kz\ Kzt\ Kd\ I$,……..($kn/m^2$) V in m/s ………………….(ii)

From the above equation, design wind pressure, pzis calculated as followed

$P_z= C_G C_p Q_z$……………… (If Vb=km/h)……………………….(iii)

$P_z= C_t C_G C_p Q_z$……………..(If Vb=mile/h)……..………………..(iv)

P_z=Design wind pressure at height z, kN/m^2

C_o= Gust coincident (calculated based on building height)

C_p= Pressure coefficient

Q_z=Sustained wind pressure at height z, KN/m^2

C_t= in plain train local topography coefficient=1

Total wind force is calculated by projected area method using the formula:

F_Z = {PzAz} ………………………………………………………….(v)

F_Z =Total wind force, KN

P_z = Design wind pressure (kN/m^2)

A_z = Projected frontal Area, m

Basic Wind Equation p=q x G x C……………………..……………..(vi)

p = Wind Pressure

q = Velocity Pressure

G = Gust Effect Factor

Cp = Pressure Coefficient / Shape Factor

Wind Loads (BNBC-2020)

Sign Convention: Negative pressure acts away from the surface, while positive pressure acts toward it.

Critical Load Condition: The most critical load will be determined by combining the values of the internal and extremal pressures algebraically.

Tributary Areas Greater than 65 m^2: It will be acceptable to design components and cladding elements according to the guidelines for MWFRS if their tributary areas exceed 65 m^2.

Main wind-force resisting systems

Rigid structures of all heights: The following formula should be used to calculate the design wind pressures for the MWFRS of structures of all heights:

p= q GCp — qi (GCpi) (kN/m^2)……………………………………………(vii)

Where,

q=	qz for windward walls evaluated at height z above the ground
q=	qh for leeward walls, side walls, and roofs, evaluated at height h
qi=	qh for windward walls, side walls, leeward walls, and roofs of enclosed Buildings and for negative Internal pressure evaluation in partially enclosed buildings
qi=	qz for positive internal pressure evaluation in partially enclosed buildings where height zis defined as the level of the highest opening in the building that could.

impact the internal pressure that is positive. When a building is located in an area where wind is likely to cause debris, any glazing that is not protected by an impact-resistant covering or is not impact-resistant itself will be considered an opening under Section

For positive internal pressure evaluation, qi may conservatively be evaluated at h— (Qi— qh)

G =	gust effect factor
C_p =	external pressure coefficient
GC_{pi}=	internal pressure coefficient

Low-Rise Building: Alliteratively, the design wind pressures for the MWFRS of low-rise buildings shall be determined by the following equation:

$P=qh\ [(GCpf\text{-}9GCpi)]\ (KN/m^2)$……………………………………………(viii)

Where,

qh = velocity pressure evaluated at mean roof height h using exposure

GC_{pf} = external pressure coefficient

G_{cpi} = internal pressure coefficient

Flexible Buildings: The design wind pressures for the MWFRS of flexible buildings shall be determined from the following equation:

$P= qGfCp\text{-}q_i(GCpi)\ (kN/m^2)$……………………….(ix)

Parapets: The following formula will yield the design wind pressure for the parapet's impact on the mass fraction at risk (MWFRS) of stiff, low-rise, or flexible buildings with flat, gable, or hip roofs:

$Pp = QpGCpn\ (kN/mm^2)$ ………………………..(x)

Where,

Pp = combined net pressure on the parapet due to the combination of the net pressures from the front and back parapet surfaces. Plus (and minus) signs signify net pressure acting toward (and away from) the front (exterior) side of the parapet.

Qp = Velocity pressure evaluated at the top of the parapet

GCpn = Combined net pressure coefficients

= +1.5 for windward parapet

= -1 .0 for leeward parapet

3.2.4 Drift and Building Separation (BNBC-2020)

Drift the Limitation: The displacement of a level in relation to a level below it as a result of lateral forces in design is known as story drift. Unless otherwise allowed, tale drift must adhere to the following specifications and incorporate translation and torsional deflections:

a) Story drift A Shall be Limited as follows.

$< 0.005h$ for $T < 0.7$ Sec

$<<0.004h$ for $T>0.7$

$<0.0025h$ for unreinforced masonry structure

Where h = Hight of the building or Structure. The period T used in Calculation Shall be the same as that used determining the base shear.

Basic Wind Speeds, V, For Selected Locations in Bangladesh (BNBNC 2020)

Location	Basic Wind Speed(m/S)	Location	Basic Wind Speed(m/S)
Angarpota	47.8	Lalmonirhat	63.70
Bagerhat	77.5	Madaripur	68.10
Bandarban	62.5	Magura	65.00
Barguna	80.0	Manikganj	58.20
Barisal	78.7	Meherpur	58.20
Bhola	69.5	Maheshkhali	80.00
Bogra	61.9	Moulvibazar	53.00
Brahmanbaria	56.7	Munshiganj	57.10
Chandpur	50.6	Mymensingh	67.40
Chapai Nawabganj	41.4	Naogaon	55.20
Chittagong	80.0	Narail	68.60
Chuadanga	61.9	Narayanganj	61.10
Comilla	61.4	Narsinghdi	59.70
Cox's Bazar	80.0	Natore	61.90
Dahagram	47.8	Netrokona	65.60
Dhaka	65.7	Nilphamari	44.70
Dinajpur	41.4	Noakhali	57.10
Faridpur	63.1	Pabna	63.10
Feni	64. 1	Panchagarh	41.40
Gaibandha	65.6	Patuakhali	80.00
Gazipur	66.5	Pirojpur	80.00
Gopalganj	74.5	Rajbari	59.10
Habiganj	54.2	Rajshahi	49.20
Hatiya	80.0	Rangamati	56.70
Ishurdi	69.5	Rangpur	65.30
Joypurhat	56.7	Satkhira	57.60
Jamalpur	56.7	Shariatpur	61.90
Jessore	64. 1	Sherpur	62.50
Jhalakati	80.0	Sirajganj	50.60
Jhenaidah	65.0	Srimangal	50.60
Khagrachhari	56.7	St. Martin's Island	80.00
Khulna	73.3	Sunamganj	61.10
Kutubdia	80.0	Sylhet	61.10
Kishoreganj	64.7	Sandwip	80.00
Kurigram	65.6	Tangail	50.60
Kushtia	66.9	Tcknaf	80.00
Lakshmipur	51.2	Thakurgaon	41.40

3.2.5 Earthquake Load (BNBC-2020)

Based on BNBC-2020, the computer has computed the earthquake loading and applied it to the building's mass center. Different "lumped masses" (i.e., story levels) are given equivalent horizontal forces that are proportional to their weight (and therefore their mass) and displacement (and thus their acceleration). This is how the "Equivalent Static Analysis" of seismic vibration figures out the inertia forces at those different levels. At the base of the structure, a base shear balances the accumulation of these focused forces.

Design Base Shear:

The total design base shear in a given direction is determined from the following relation:

$$V=S_a W$$

Where,

Sa = Lateral seismic f0Ne coefficient calculated

W = Total seismic weight of building defined.

As an alternative, the seismic design base share can be computed using ASCE 7-02 and the seismic design parameters listed in Appendix C for buildings with a natural period of less than or equal to 2.0 seconds. But Sa shouldn't have a minimum value of less than 0.044 SDSI. The SDS values are given in Appendix C.

Structure Period

One of the following approaches can be used to calculate the structure's fundamental period value:

Method A:

For all buildings the value of T may be approximated by the following formula:

$$C=C_t (h_n) m$$

Where,

Ct = 0.0724 for steel moment resisting frames

= 0.0731 for reinforced concrete moment resisting frames, and eccentric braced steel Frames.

= 0.0466 for reinforced concrete moment

= 0.0488 for all other structural systems

Hn= height in meters above the base to level n.

A different approach would be to use 0.031/Ac as the value of Ct for structures with shear walls made of concrete or masonry. From the relation, the value of Ac will be determined.

$$A_c = A_e[O.2+ (D_e/h_n)^2 \ldots\ldots\ldots (xi)$$

Where,

Ae = the effective horizontal cross-sectional area, in square meters, of a shear wall in the first story of the structure.

De = the length, in meters, of a shear wall element in the first story in the direction parallel to the applied forces.

The value of De/hn should not exceed 0.9.

Method B:

The structural qualities and deformational traits of the resisting elements can be used in a well-supported study to determine the basic period. I. Utilizing the following formula, this condition can be met: According to the principles, every lateral force distributed approximately is represented by the values of fi.

$$T = {}^{2\pi}\sqrt{\sum_{i=1}^{n} \omega.\delta^2 / g \sum_{i=1}^{n} f.\delta} \ldots\ldots\ldots\ldots\ldots\ldots \text{(xii)}$$

Table 3.1: Seismic Zone Coefficient, Z

Semic Zone	**Zone Coefficient**
1	0.12
2	0.20
3	0.28
4	0.36

Table 3.2: Structural Importance Coefficient, I

Structural Importance Category	Structural Importance Coefficient	
	I	I’
I Essential Facilities	1.25	1.50
II Hazardous Facilities	1.25	1.50
III Special Occu anc Strictures	1.00	1.00
IV Standard Occu anc Structures	1.00	1.00
V Low-risk Structures	1.00	1.00

Table 3.3: Description of Seismic Zone

Seismic Zone	**Location**	**Seismic Intensity**	**Seismic Zone Coefficient, Z**
1	Southwestern part including Barisal, Khulna, Jessore, Rajshahi	Low	0.12
2	Lower Central and Northwestern part including Noakhali, Dhaka, Pabna, Dinajpur, as well as Southwestern corner including Sundarbans	Moderate	0.2
3	Upper Central and Northwestern part including Brahmanbaria, Sirajganj, Rangpur	Severe	0.28
4	Northeastern part including Sylhet, Mymensingh, Kurigram	Very Severe	0.36

Table 3.5: Site Dependent Soil Factor and Other Parameters Defining Elastic Response Spectrum

Soil Type	S	Tu(S)	Tc(S)	Tu(S)
SA	1.0	0.15	0.40	2.0
SB	1.2	0.15	0.50	2.0
SC	1.115	0.20	0.60	2.0
SD	1.35	0.20	0.80	2.0
SE	1.4	0.15	0.50	2.0

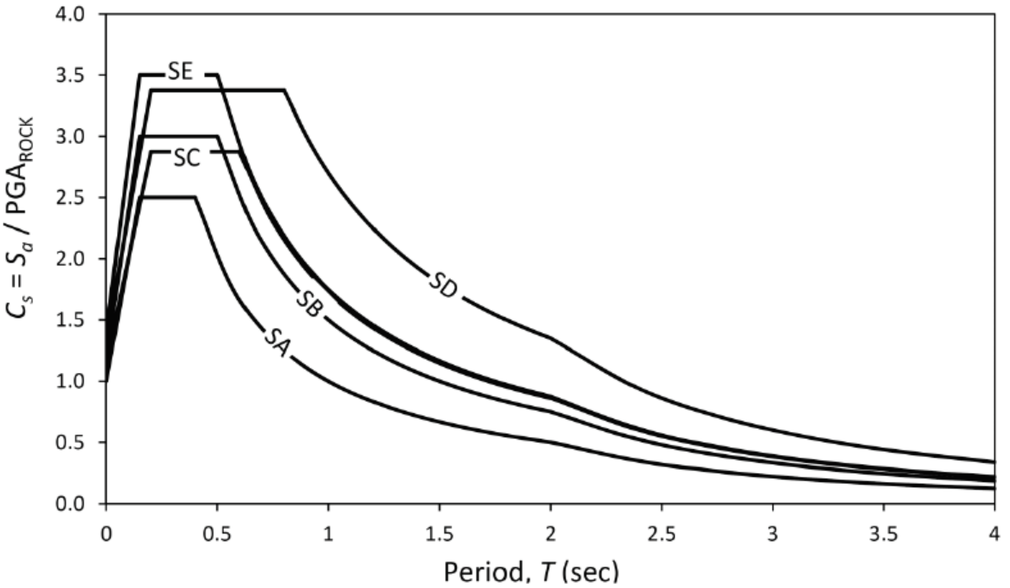


Figure: 3.1: Normalized design acceleration response spectrum for different site classes.

Building Categories

Important Factors for Building Categories According to the effects of collapse on human life, the significance of a building for public safety and civil protection in the immediate aftermath of an earthquake, and the social and economic ramifications of collapse, buildings are categorized into four occupation groups in Chapter 1 (Table 6.1.1). Buildings may be designed for higher seismic forces with factors greater than one, depending on the occupancy type. The significance factor that corresponds to each occupancy category is defined in Table 6.2.17

Table 3.6: Importance Factors for Building and Structures for Earthquake design

Occupancy Category	Importance Factor I
I,II	1.00
III	1.25
IV	1.50

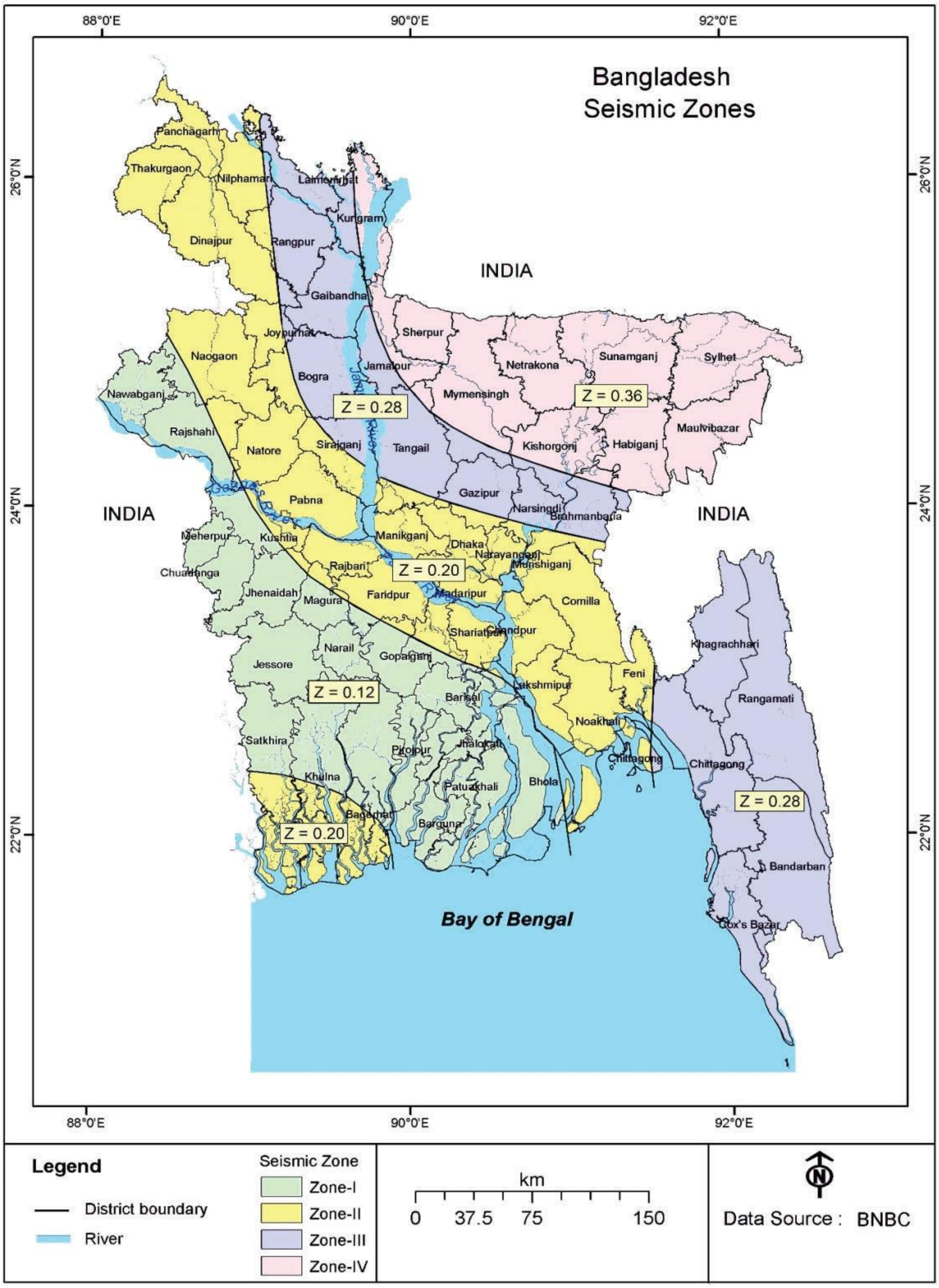


Table 3.9: Sesmic zone of Bangladesh

Table 3.10: Values for Coefficients to Estimate Approximate Period

Structure	c1m	
Concrete moment-resisting frames	0.04660.9	Note: Consider moment resisting frames as frames which resist 100% of seismic force and are not enclosed or adjoined by components that are more rigid and will prcvent the frarnes from deflecting under seismic forces.
Steel moment-resisting frames	0.07240.8	
Eccentrically braced steel frame	0.07310.75	
All other structural systems	0.04880.75	

Table 3.11: Response Reduction Factor, Deflection Amplification Factor and

Seismic Force-Resisting System	Response Reductin Factor,R	System Overstrength Factor,$\Omega_\circ$	Deflection Amplification Factor,Cd	Selsmlc Design Category B	Selsmlc Design Category C	Selsmlc Design Category D
				Height limit (m)		
1.Special reinforced concrete moment frames	8	3	5.5	NL	NL	NL
2. Intermediate reinforced concrete moment frames	5	3	4.5	NL	NL	NP
3.Ordinary reinforced concrete moment frames	3	3	2.5	NL	NP	NP

Height Limitations for Different Structural Systems

DUAL SYSTEMS: SPECIAL MOMENT FRAMES CAPABLE OF RESISTING AT LEAST 25% OF PRESCRIBED SEISMIC FORCES (with bracing or shear wall)

1.Steel eccentrically braced frames	8	2.5	4	NL	NL	NL
2.Special steel concentrically braced frames	7	2.5	5.5	NL	NL	NL
3.Special reinforced concrete shear walls	7	2.5	5.5	NL	NL	NL
4.Ordinary reinforced concrete shear walls	6	2.5	5	NL	NL	NP

DUAL SYSTEMS: INTERMEDIATE MOMENT FRAMES CAPABLE OF RESISTING AT LEAST 25% OF PRESCRIBED SEISMIC FORCES (with bracing or shear wall)

1.Special steel concentrically braced frames	6	2.5	5	NL	NL	11
2. Special reinforced concrete shear walls	6.5	2.5	5	NL	NL	50
3. Ordinary reinforced masonry shear walls	3	3	3	NL	50	NP

B.BUILDING FRAME SYSTEMS (with bracing or shear wall)

4. Ordinary reinforced concrete shear walls	5.5	2.5	4.5	NL	NL	NP
F.DUAL SHEAR WALL- FRAME SYSTEM: ORDINARY REINFORCED CONCRETE MOMENT FRAMES AND ORDINARY REINFORCED CONCRETE b. SHEAR WALLS	4.5	2.5	4	NL	NP	NP
G. STEEL SYSTEMS NOT SPECIFICALLY DETAILED FOR SEISMIC RESISTANCE	3	3	3	NL	NL	NP

Notes:

1.Seismic design category, NL = No height restriction, NP = Not permitted. Number represents maximum allowable height (m).

2.Dual Systems include buildings which consist of both moment resisting frame and shear walls (or braced frame) where both systems resist the total design forces in proportion to their lateral stiffness.

3.See Sec. 10.20 of Chapter 10 of this Part for additional values of R and Ca and height limits for some other types of steel structures not covered in this Table.

4.Where data specific to a structure type is not available in this Table, reference may be made to Table 12.2-1 of ASCE 7-05.

BNBC-2020 Table 6.C.1: Parameters Ss and S, for Different Seismic Zones

Parameters	Zone-1	Zone-2	Zone-3	Zone-4
S_s	0.3	0.5	0.7	0.9
S_1	0.12	0.2	0.28	0.36

S_1=0.4S_s, not independent of Ss, as in ASCE 7-05

S_1=MCE-level PGA=Z,Z,Seismic Zone Coefficient

3.3 Load Group:

To determine the proper live load reduction factors, all potential live loads applied to a building's floors and roof due to different occupancies and uses must be classified into three load groups, as explained below.

Load Group 1: Printing plants, vaults, strong rooms, and armories, as well as machinery and equipment for which special live load allowances have been made, areas with uniformly distributed live loads of 5.0 kN/m or less, and occupancies and two uses or assembly occupancies, shall all be classified under load group 1. Members of this load group, or any portion thereof, are not permitted to reduce their live load. For member 2, a reduction factor of R-1.0 will be applied.
Load Group 2: Uniformity distributed live loads from occupations or uses of
(i) Assembly areas with a uniformly distributed live load greater than 5.0 kN/m and
(ii) storage, mercantile, industrial, and retail stores shall be classified under Load Group 2. A live load reduction factor of 1.0 <R< 0.7 shall be applied to this load group depending on the tributary area of the floors or roof supported by the member as specified.

Load Group 3: All evenly distributed live loads resulting from uses and occupancies other than those of Load Group I and Load Group 2 will be combined into Load Group 3. This load group's tributary areas will be subject to the live load reduction factor, which is 1.0 <R<O.5, as stated.
Tributary Area: The tributary area of a structural member supporting floors or a roof shall be determined as follows:

a) Tributary Area for Wall, Column, Pier, Footing, and the Like: The tribute areas of these members shall consist of portions of the areas of all floors, roofs, or combinations thereof that contribute live loads to the member concerned.

b) Tributary Area for Beam, Girder, Flat Plate, and Flat Slab: The tribute area for such a member shall consist of the portion of the roof or a floor at any single level that contributes loads to the member concerned.

Exposure Category: A building's or structure's terrain exposure will be evaluated to determine whether it falls into one of the following categories:

Exposure A: Urban and suburban areas, industrial areas, forested areas, hilly terrain, or any other terrain that makes up at least 20% of the whole area and has impediments rising to a height of six meters or more and that extends from the site for at least 500 meters, or ten times the structure's height, whichever is higher.

Exposure B: Open terrain includes sporadic obstacles stretching 800 meters or more from the location in any quadrant, with most of them being less than 10 meters high. This group includes grasslands, airfields, open parklands, and the sporadically developed periphery of towns.
Exposure C: Open spaces that are level and unobstructed, as well as riverbanks and coastal regions that face wide bodies of water that are 1.5 km or wider. Exposure
C stretches 400 meters inland from the shoreline, or ten times the structure's height, whichever is higher.

3.4 Load Combinations:

The following load scenarios need to be taken into account for analysis in accordance with BNBC 2020, Chapter 2, Part 6 (Clause 11027.5):

U=1.4 D.L

U=1.4 D. L+1.2 L.L

U=1.05 D. L+1.275 L. L+1.4025 E.L

U=1.05 D. L+1.4025 E.L

U=0.9 D. L+1.4025 E.L

U=1.05 D. L+1.275 L. L+1.275 W.L

U=1.05 D. L+1.275 W.L

U=0.9 D. LE 1.3 W. L

Considerations for +X, -X, +Y, and —Y directions include earthquake load and wind load. Therefore, it is necessary to take into account the 26 examples listed in Table 3.6, as +EL + WL above suggests 24 cases. Software is used to examine all 26-Joad combinations.

Design Load

Load Consideration	: BNBC 2020 for Zone 2
3.5.1 Dead Load	: (for zone 2)
Floor Finish (FF)	: 25psf
Random Wall	: 30psf
Parapet Wall	: 150psf (3ft)
Partition Wall (PW)	: 450 Ib/ft(9.5ft)

3.5.2 Live Load:

Floor	: 2KN/m2 or 41.76psf
Stair	:4.8KN/m’ or 100psf
Roof Over	:4.8KN/m’ or 100psf
Head Water Tank	:312psf(6ft)

3.5.3 Wind Pressure (BNBC 2020)

Location	: Dhaka
Basic Wind speed V	:147 mpa
Structural Important Coefficient	:1.0
Expose Category	: B
Gust Factor	:0.85
Directionally Factor, KD	:0.85

3.5.4. Earthquake Category Base Shear (BNBC 2020)

Seismic Zone	: Zone 11
Seismic Zone factor(Z)	: 0.20
Response Modification Coefficient, R	: 5
System Over strength. 'Ω (omega)	: 3
Deflection Amplification, Cd: 4.5	
Structural Importance Factor (I)	: 1.0
Spectral Response Acceleration, Ss'	: 0.5
Spectral Response Acceleration, Si	: 0.2
Site Coefficient, Fa	: 1.15
Site Coefficient, Fv	: 1.725
Time Period, T	: 0.78 sec

Material Properties:

Unit weight of concrete	: 150 Ib/ft

Compressive Strength:

For slab, fc	: 4000 psi
For beam, fc'	: 4000 psi
For Column: fc'	: 4000 psi
Steel: Yield strength of Steel, fy	: 60 ksi

3.6 Auto CAD Model

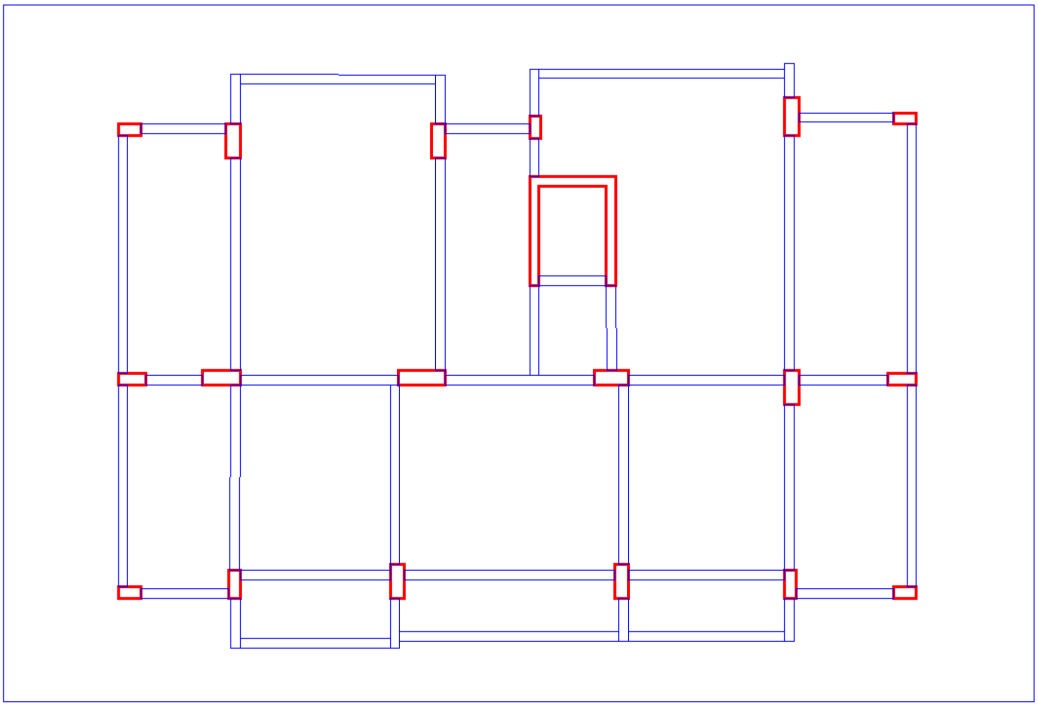
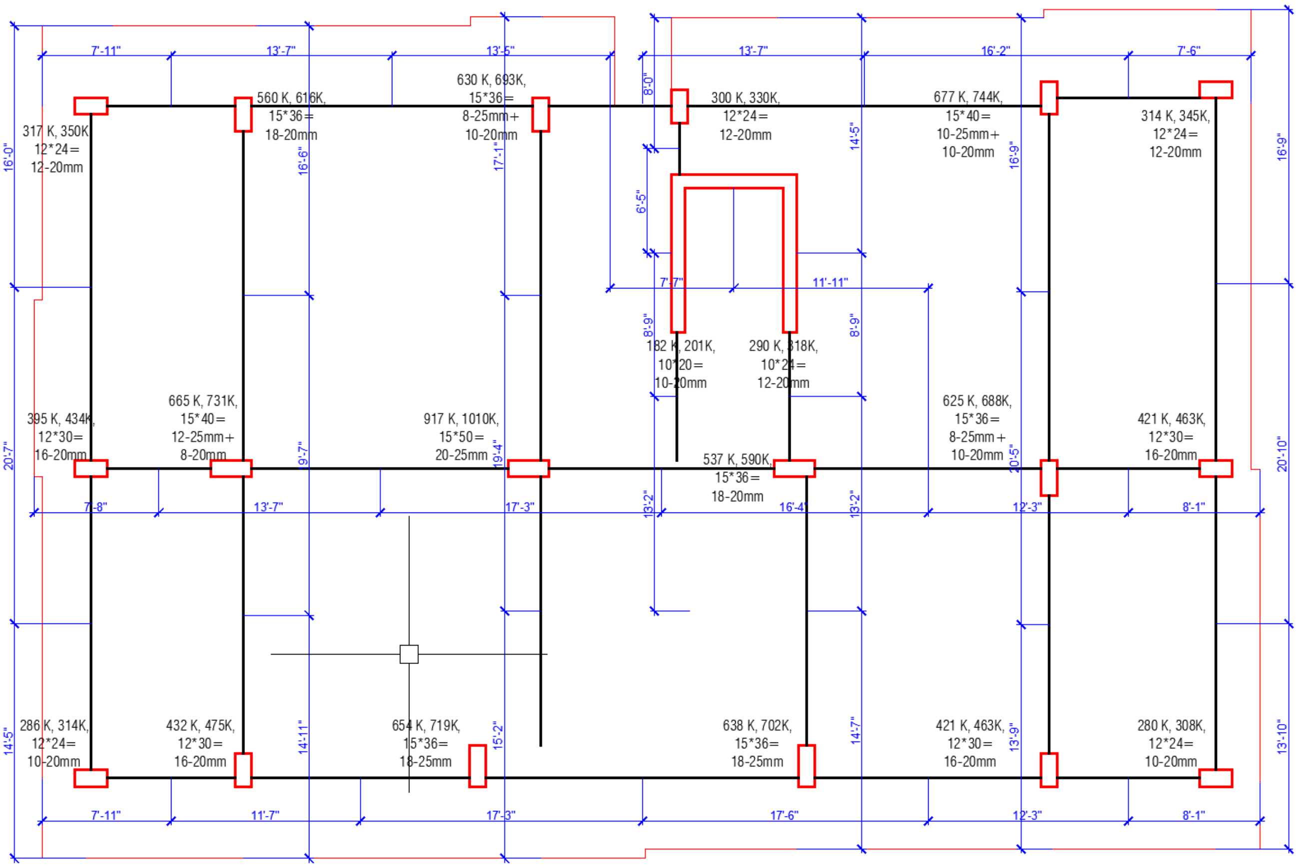
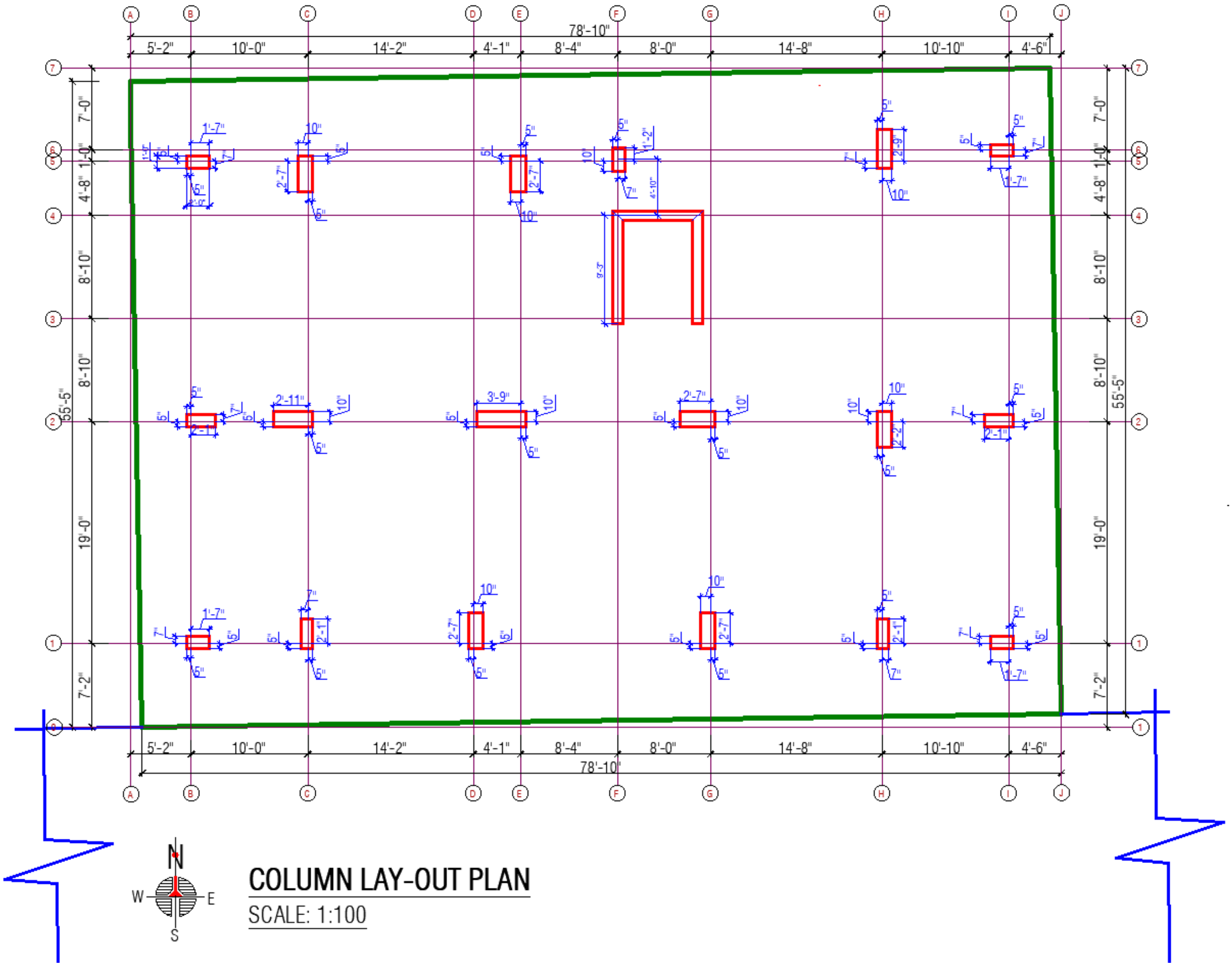


Figure 3.3: Beam Layout

Auto Cad Model





COLUMN LAY-OUT PLAN

SCALE: 1:100

2.4.2 AutoCAD 2016

AutoCAD is a software program that is sold for use in 2D and 3D computer-aided design (CAD) and drafting. It was first made accessible as a desktop application in 1982, and since 2010, it has also been available as a mobile online and cloud service called AutoCAD360. Autodesk, Inc. created and sold AutoCAD at the time of its initial release in December 1982. The majority of commercial CAD programs operated on mainframes or minicomputers before AutoCAD was introduced, and each CAD operator, or user, used a different graphics terminal. Professionals such as architects, project managers, engineers, designers, and others use AutoCAD in a variety of industries. We drew the building's elevation and plan using AutoCAD. To display the reinforcing details and design features of the retaining wall, staircase, beam, slab, water tank, foundation, etc., we also used AutoCAD. AutoCAD is an extremely user-friendly, easily learned software that anyone can pick up quickly. It takes knowledge of specific instructions to draw in AutoCAD.

Table 3.7: Site Dependent Soil Factor and Other Parameters Defining Elastic Response Spectrum.

Soil Type	S	TB(S)	TC(S)	TD(S)
SA	1.0	0.15	0.40	2.0
SB	1.2	0.15	0.50	2.0
SC	1.15	0.20	0.60	2.0
SD	1.35	0.20	0.80	2.0
SE	1.4	0.15	0.50	2.0

Table 3.8: Importance Factors for Buildings and Structures for Earthquake Design

Occupancy Category	Importance factor I
I,II	1.00
III	1.25
IV	1.50

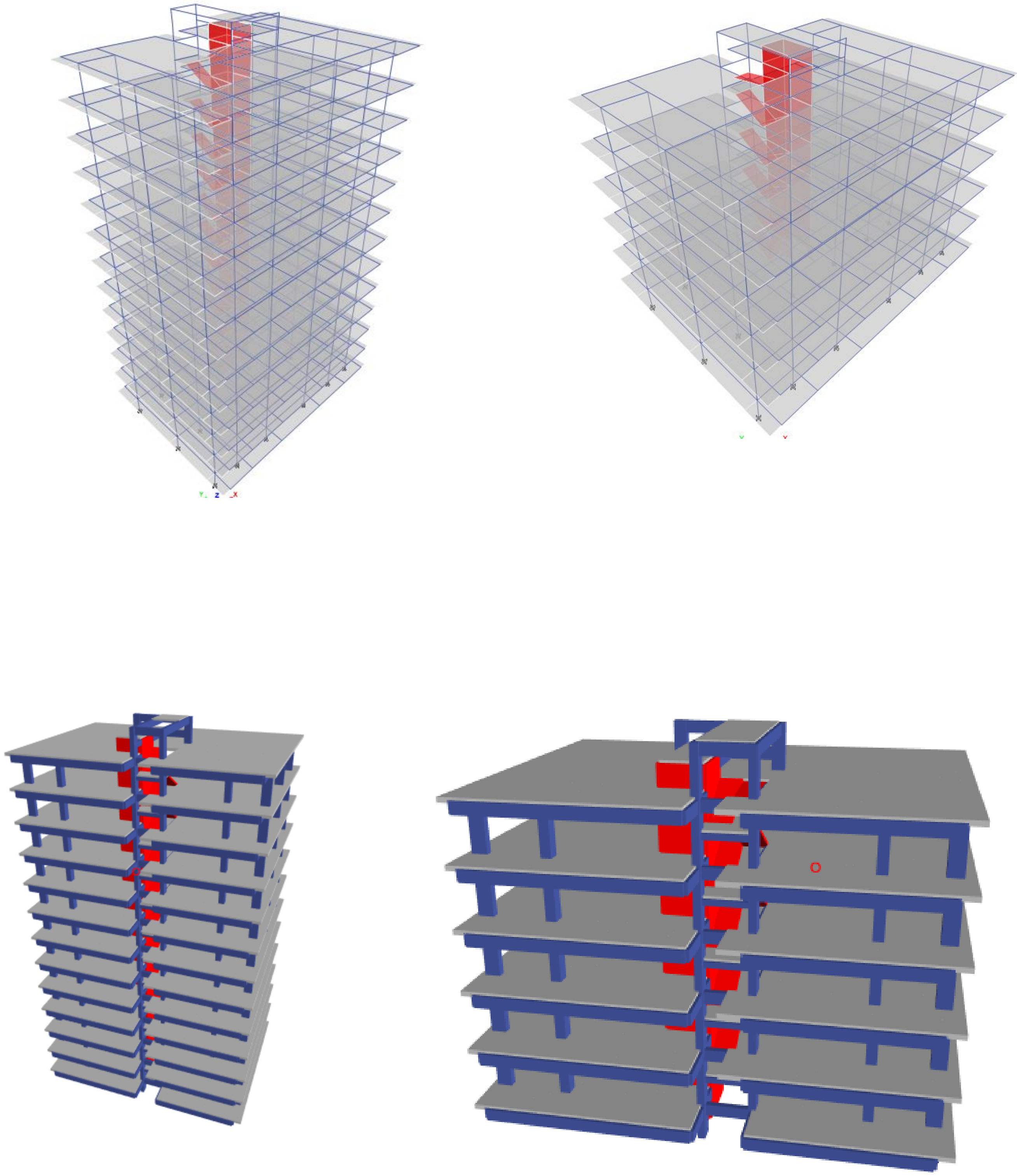


Fig 3.5: FEM MODEL OF High-raised (12 Storied) and Low-raised (5 Storied Building)

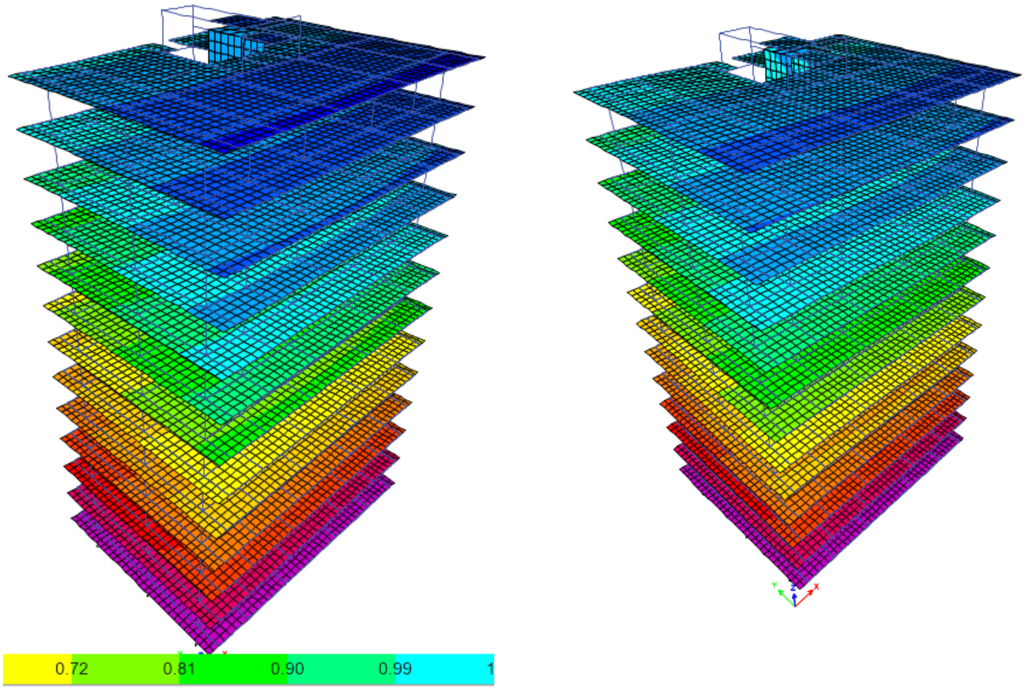


Fig 3.6: Deform shape of high-raised building for Wind Load and X & Y Direction

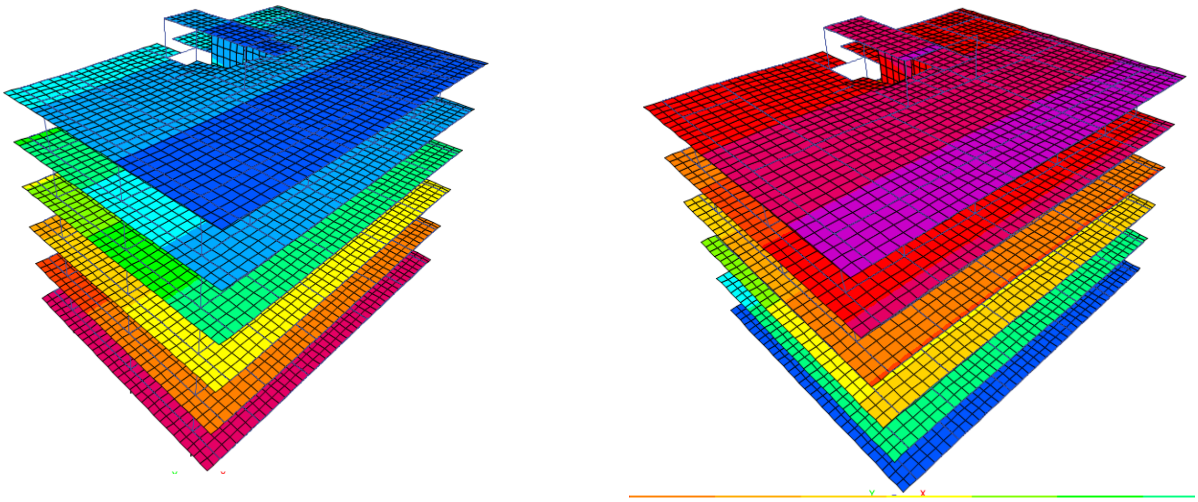


Fig 3.7: Deform shape of Low-raised building for Wind Load and X & Y Direction

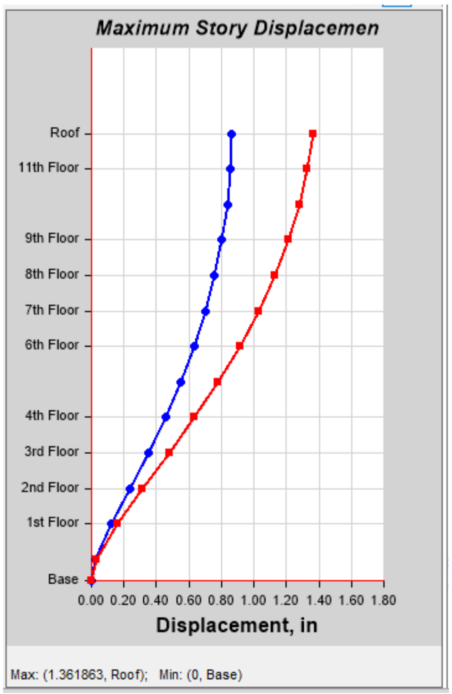
CHAPTER 04

RESULT AND DISCUSSION

Wind Effect

4.1 Lateral Deflection Effect on building for wind Load

Lateral Deflection (Sway) for Wind Load		
	Maximum Deflection along X-Direction (inch)	Maximum Deflection along Y-Direction (inch)
High Rise Building	1.36	1.44
Low Rise Building	0.17	0.18



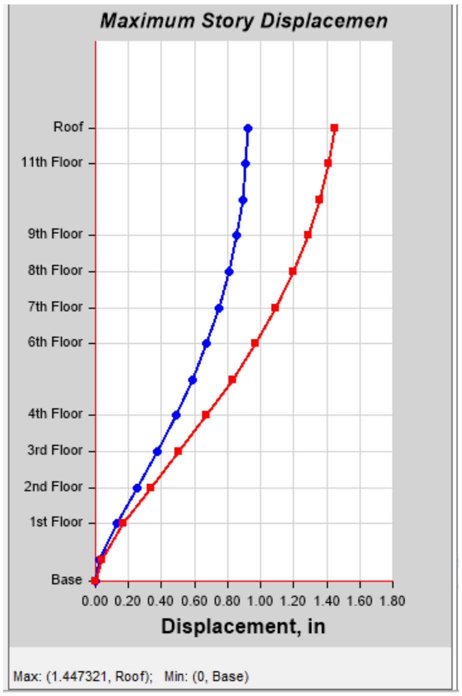


Fig 3.8 : Displacement for high rise (12 Storied Building)

Above Graph shows maximum story **Displacement in X & Y direction** for high rise building which has simulate in **LSA** (Linear Static analysis) By ETABS. The maximum value is **1.44** inch which occurred in **Roof.**

Fig 3.9: Displacement for low rise (5 Storied Building)

Above Graph shows maximum story **Displacement in X & Y direction** for Low rise building which has simulate in **LSA** (Linear Static analysis) By ETABS. The maximum value is **0.1789** inch which occurred in **Roof.**

3.10 Effect of Story Drift on High Rise & Low-Rise Building for wind Load

Story Drift for Wind Load		
	Maximum story Drift along X-Direction	Maximum story Drift along Y-Direction
High Rise Building	0.002043	0.002099
Low Rise Building	0.000527	0.000529

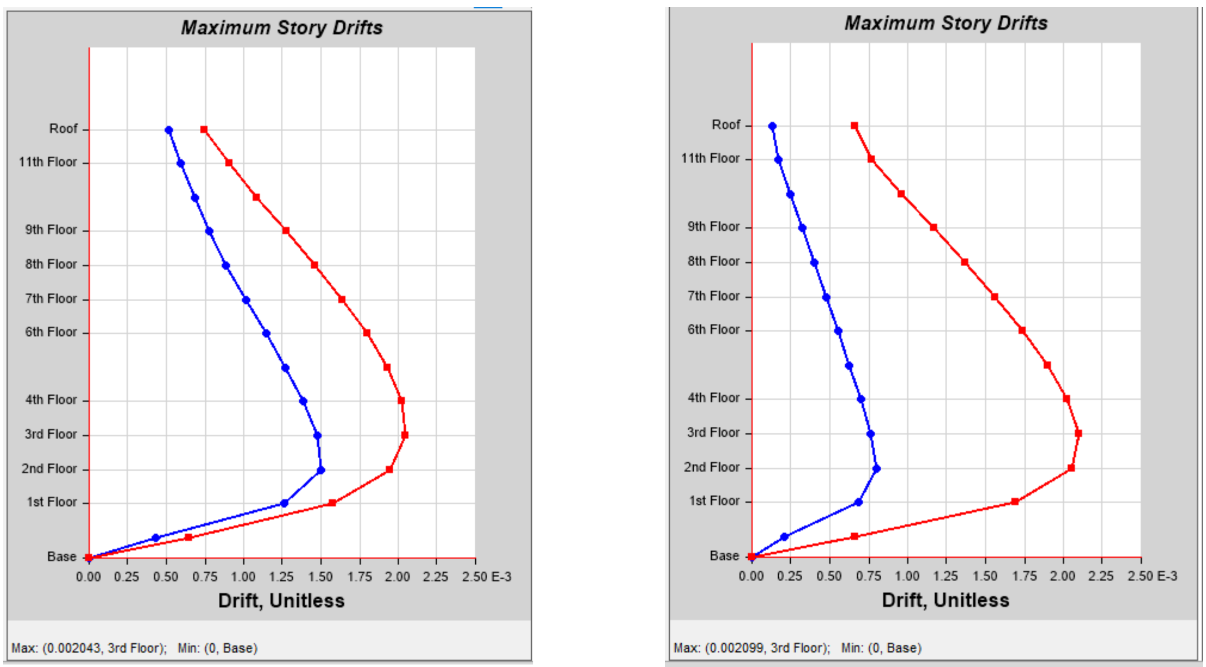


Fig 3.10: Story Drift on High Rise Building

Above Graph shows maximum story **Drift in X&Y direction** for High Rise Building which has simulate in **LSA** (Linear Static Analysis) By ETABS. The maximum value is **0.002099** which occurred in **3rd floor**.

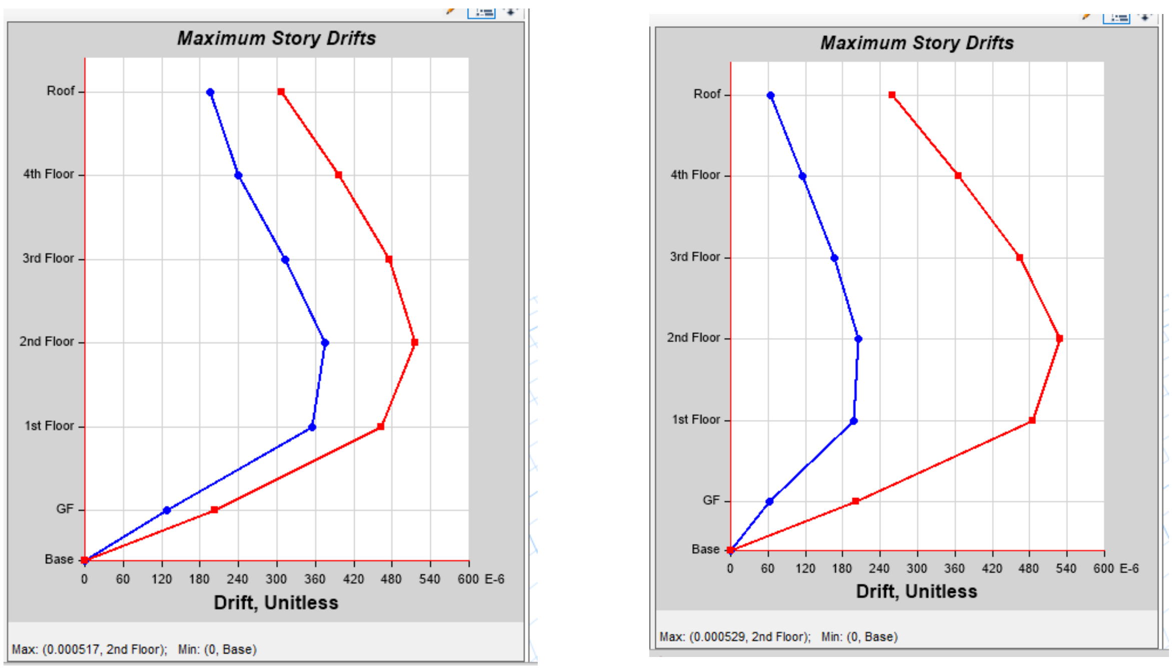


Fig 3.11 : Story Drift on Low-Rise Building

Above Graph shows maximum story Drift in X&Y direction for Low Rise Building which has simulate in LSA (Linear Static Analysis) By ETABS. The maximum value is 0.00529 which occurred in 2nd floor.

3.12 Base Shear for Wind Load

Base Shear		
	Base shear along X-Direction	Base shear along Y-Direction
High Rise Building	321.881	428.699
Low Rise Building	116.574	155.26

Load Case/Combo	FX kip	FY kip
WX 1	-321.881	0
WX 2	0	-428.699

Load Case/Combo	FX kip	FY kip
WX 1	-116.574	0
WX 2	0	-155.26

Snapshot of Base Shear for wind load from ETABS.

Seismic Effect

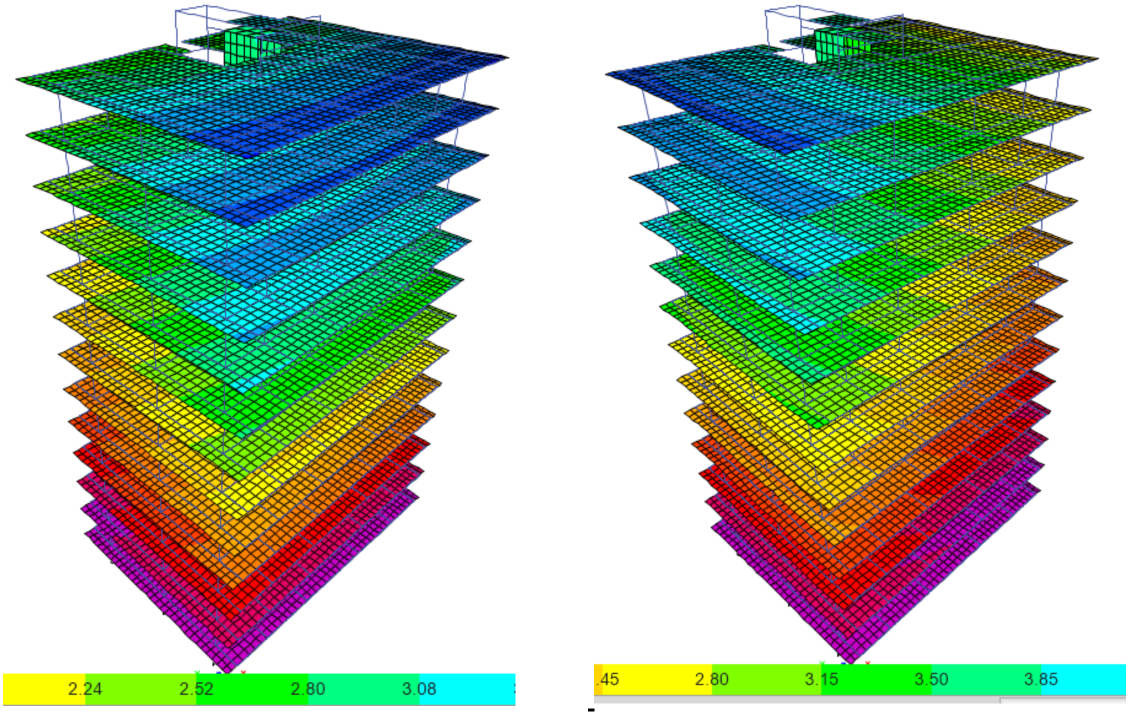


Fig 3.12: Deform shape of high-raised building for Earthquake Load and X & Y Direction

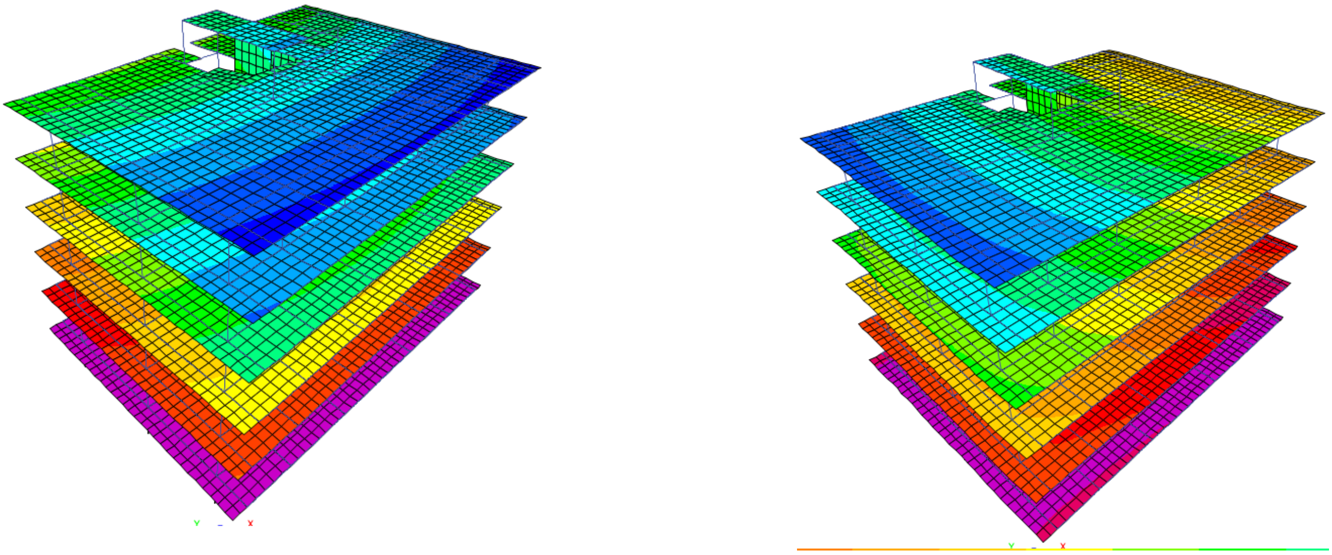


Fig 3.13 : Deform shape of Low-raised building for Earthquake Load and X & Y Direction

3.13 Base Shear for Earthquake Load

Base Shear		
	Base shear along X-Direction	Base shear along Y-Direction
High Rise Building	710.894	710.894
Low Rise Building	404.745	404.745

Load Case/Combo	FX kip	FY kip
EX 1	-710.894	0
EX 2	-710.894	0
EX 3	-710.894	0
EY 1	0	-710.894
EY 2	0	-710.894
EY 3	0	-710.894

Table of Base Shear from ETABS For High Rise Building

Load Case/Combo	FX kip	FY kip
EX 1	-404.745	0
EX 2	-404.745	0
EX 3	-404.745	0
EY 1	0	-404.745
EY 2	0	-404.745
EY 3	0	-404.745

Table of Base Shear from ETABS For Low Rise Building

Snapshot of Base Shear for Earthquake load from ETABS.

3.14 Effect of Story Drift on High Rise & Low-Rise Building for Earthquake Load

Story Drift for Earthquake Load		
	Maximum story Drift along X-Direction	Maximum story Drift along Y-Direction
High Rise Building	0.001905	0.00341
Low Rise Building	0.001157	0.001231

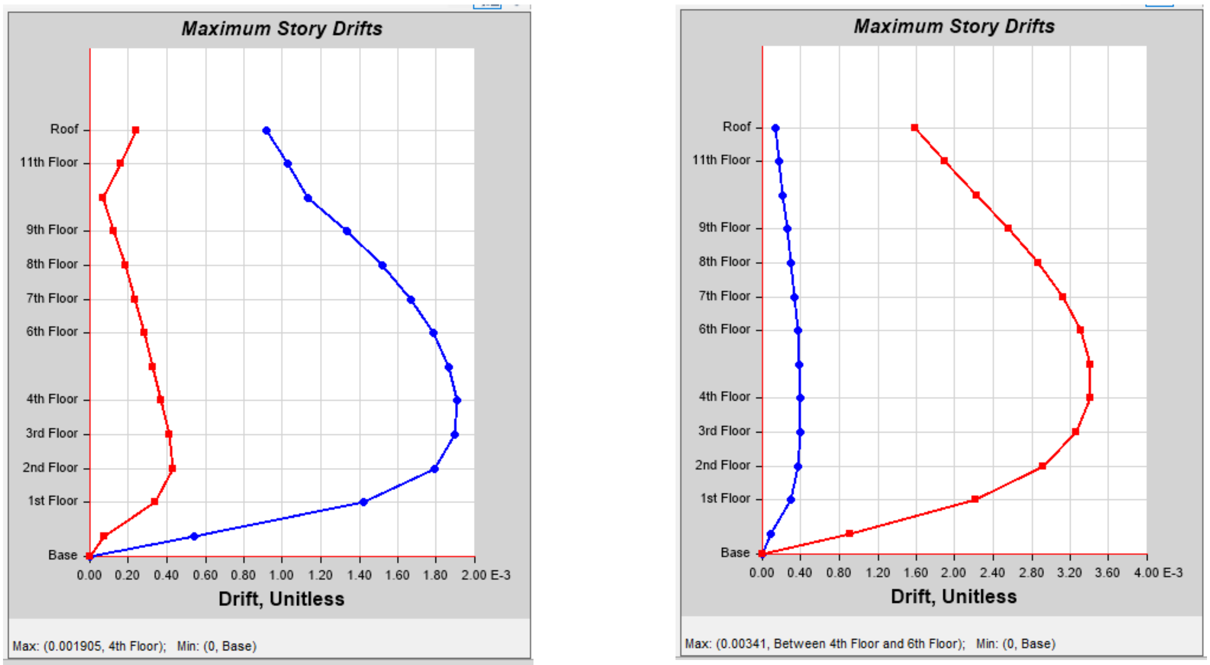


Fig 3.14 : Story Drift on High Rise Building

Above Graph shows maximum story **Drift in X&Y direction** for High Rise Building which has simulate in **LSA** (Linear Static Analysis) By ETABS. The maximum value is **0.00341** which occurred in **between 4th and 6th floor**

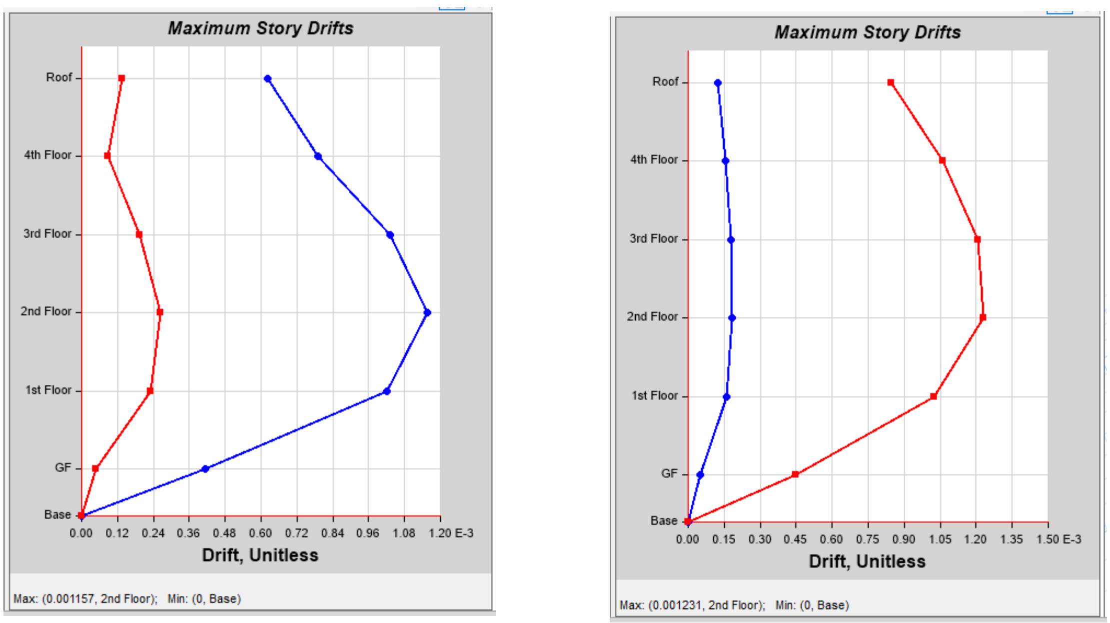


Fig 3.15 : Story Drift on Low Rise Building

Above Graph shows maximum story **Drift in X&Y direction** for Low Rise Building which has simulate in **LSA** (Linear Static Analysis) By ETABS. The maximum value is **0.001231** which occurred in **2nd Floor**.

3.15 Torsional Irregularity for high rise & low-rise building:

Story	Load Case/Combo	Direction	Maximum in	Average in	Ratio
2nd Floor	EX 3	X	0.447259	0.359063	1.246
1st Floor	EX 3	X	0.221844	0.178654	1.242
3rd Floor	EX 3	X	0.686709	0.555048	1.237
4th Floor	EX 3	X	0.928215	0.756848	1.226
5th Floor	EX 3	X	1.165185	0.958178	1.216
6th Floor	EX 3	X	1.392539999999...	1.154038	1.207
7th Floor	EX 3	X	1.605649	1.340064	1.198
8th Floor	EX 3	X	1.800084	1.51236	1.19
GF	EX 3	X	0.042762	0.036124	1.184
9th Floor	EX 3	X	1.971629	1.667516	1.182
10th Floor	EX 3	X	2.11649	1.802806	1.174
11th Floor	EX 3	X	2.232043	1.91672	1.165
2nd Floor	EX 1	X	0.406822	0.352478	1.154
Roof	EX 3	X	2.319359	2.009823	1.154
1st Floor	EX 1	X	0.201617	0.175472	1.149
3rd Floor	EX 1	X	0.625516	0.545401	1.147
4th Floor	EX 1	X	0.846705	0.744635	1.137
5th Floor	EX 1	X	1.06426	0.94386	1.128
6th Floor	EX 1	X	1.273439	1.138029	1.119
7th Floor	EX 1	X	1.469944	1.322763	1.111
8th Floor	EX 1	X	1.649691	1.494189	1.104

Table: Torsional irregularities for High Raised Building along X-Direction

Above Table Represent Values of torsional irregularity for high rise building along X-direction from ETABS.

3.16 Table: Torsional irregularities for High Raised Building along Y-Direction

Story	Load Case/Combo	Direction	Maximum in	Average in	Ratio
1st Floor	EY 3	Y	0.393985	0.280545	1.404
2nd Floor	EY 3	Y	0.805126	0.58119	1.385
GF	EY 3	Y	0.078711	0.056988	1.381
3rd Floor	EY 3	Y	1.260579	0.92396	1.364
4th Floor	EY 3	Y	1.732922	1.286357	1.347
5th Floor	EY 3	Y	2.203478	1.652247	1.334
6th Floor	EY 3	Y	2.65822	2.009531	1.323
7th Floor	EY 3	Y	3.086007	2.348803	1.314
8th Floor	EY 3	Y	3.477879	2.662751	1.306
9th Floor	EY 3	Y	3.826961	2.946044	1.299
10th Floor	EY 3	Y	4.128874	3.195657	1.292
11th Floor	EY 3	Y	4.383154	3.412093	1.285
Roof	EY 3	Y	4.593163	3.598353	1.276
1st Floor	EY 1	Y	0.327509	0.275796	1.188
2nd Floor	EY 1	Y	0.673498	0.571834	1.178
GF	EY 1	Y	0.065589	0.056148	1.168
3rd Floor	EY 1	Y	1.061073	0.910074	1.166
4th Floor	EY 1	Y	1.466039	1.268175	1.156
5th Floor	EY 1	Y	1.871562	1.63007	1.148
6th Floor	EY 1	Y	2.26501	1.98371	1.142
7th Floor	EY 1	Y	2.636441	2.319742	1.137
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Above Table Represent Values of torsional irregularity for high rise building along Y-direction from ETABS.

3.17 Table: Torsional irregularities for Low Raised Building along X-Direction

Story	Load Case/Combo	Direction	Maximum in	Average in	Ratio
2nd Floor	EX 3	X	0.309293	0.250343	1.235
1st Floor	EX 3	X	0.162321	0.131843	1.231
3rd Floor	EX 3	X	0.441534	0.360994	1.223
4th Floor	EX 3	X	0.544229	0.45252	1.203
Roof	EX 3	X	0.611995	0.519624	1.178
GF	EX 3	X	0.032676	0.028045	1.165
2nd Floor	EX 1	X	0.280169	0.24637	1.137
1st Floor	EX 1	X	0.147001	0.129833	1.132
3rd Floor	EX 1	X	0.400438	0.355782	1.126
4th Floor	EX 1	X	0.494413	0.447088	1.106
Stair Room	EX 3	X	0.557824	0.506769	1.101
Roof	EX 1	X	0.557161	0.514972	1.082
GF	EX 1	X	0.029717	0.027842	1.067
Stair Room	EX 1	X	0.549064	0.524939	1.046
2nd Floor	EX 2	X	0.251046	0.242398	1.036
GF	EX 2	X	0.028521	0.02764	1.032
1st Floor	EX 2	X	0.131681	0.127823	1.03
3rd Floor	EX 2	X	0.359343	0.350571	1.025
Roof	EX 2	X	0.518312	0.510319	1.016
4th Floor	EX 2	X	0.444598	0.441657	1.007

Above Table Represent Values of torsional irregularity for Low rise building along X-direction from ETABS.

3.18 Table: Torsional irregularities for Low Raised Building along Y-Direction

Story	Load Case/Combo	Direction	Maximum in	Average in	Ratio
1st Floor	EY 3	Y	0.185005	0.128629	1.438
2nd Floor	EY 3	Y	0.358857	0.252088	1.424
3rd Floor	EY 3	Y	0.527507	0.375931	1.403
GF	EY 3	Y	0.038809	0.027675	1.402
4th Floor	EY 3	Y	0.673261	0.486997	1.382
Roof	EY 3	Y	0.787657	0.578772	1.361
1st Floor	EY 1	Y	0.153245	0.1261	1.215
2nd Floor	EY 1	Y	0.298882	0.247256	1.209
3rd Floor	EY 1	Y	0.442109	0.369085	1.198
4th Floor	EY 1	Y	0.567845	0.478613	1.186
GF	EY 1	Y	0.032287	0.027217	1.186
Roof	EY 1	Y	0.668678	0.569406	1.174
Stair Room	EY 3	Y	0.67052	0.642707	1.043
Machine Room	EY 3	Y	0.602884	0.58091	1.038
GF	EY 2	Y	0.027751	0.026759	1.037
Stair Room	EY 1	Y	0.638729	0.624173	1.023
Machine Room	EY 1	Y	0.598115	0.587236	1.019
Roof	EY 2	Y	0.570379	0.560039	1.018
4th Floor	EY 2	Y	0.478031	0.47023	1.017
1st Floor	EY 2	Y	0.125655	0.12357	1.017

Above Table Represent Values of torsional irregularity for Low rise building along Y-direction from ETABS.

3.19. Story Stiffness on High Rise & Low-Rise Building for Earthquake Load

Story Drift for Earthquake Load		
	Maximum story Stiffness along X-Direction (Kip/in)	Maximum story Stiffness along Y-Direction (Kip/in)
High Rise Building	12117.54	12660.98
Low Rise Building	14578.99	14871.01

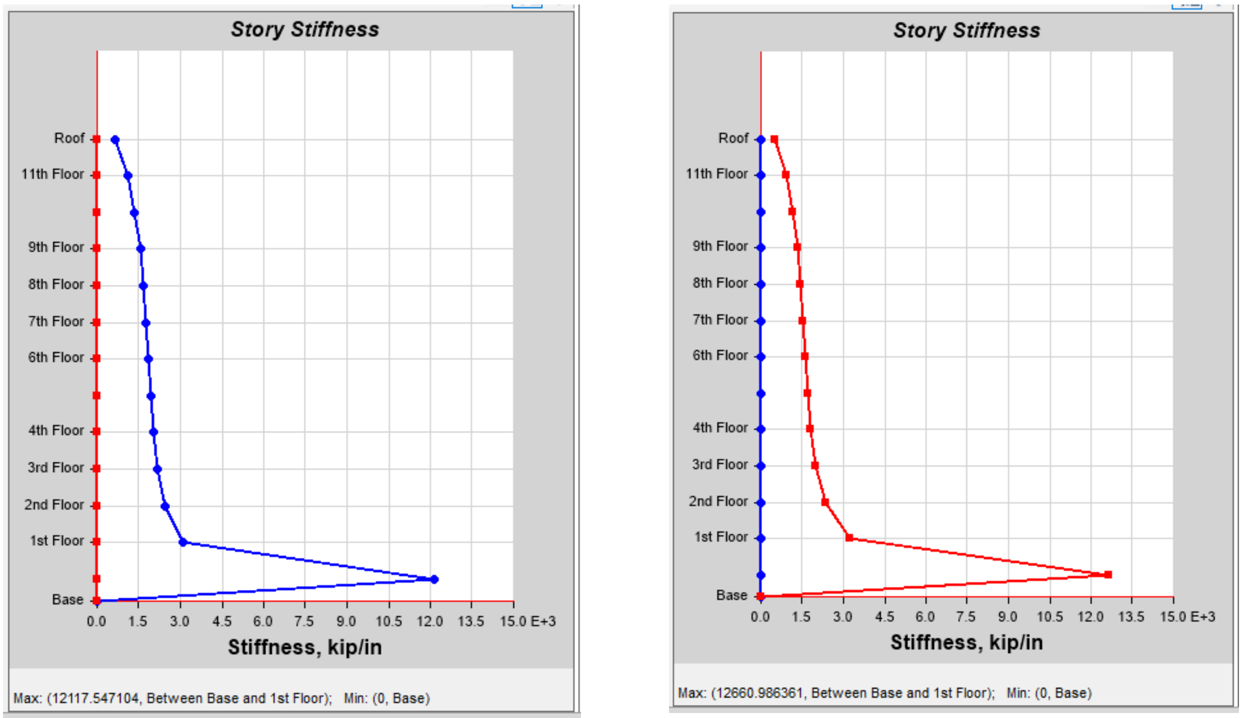


Fig 3.16 : Story Stiffness of High-Rise Building

Above Graph shows maximum Stiffness **in X&Y direction** for High Rise Building which has simulate in **LSA** (Linear Static Analysis) By ETABS. The maximum value is 12661 Kip/in which occurred in **Base.**

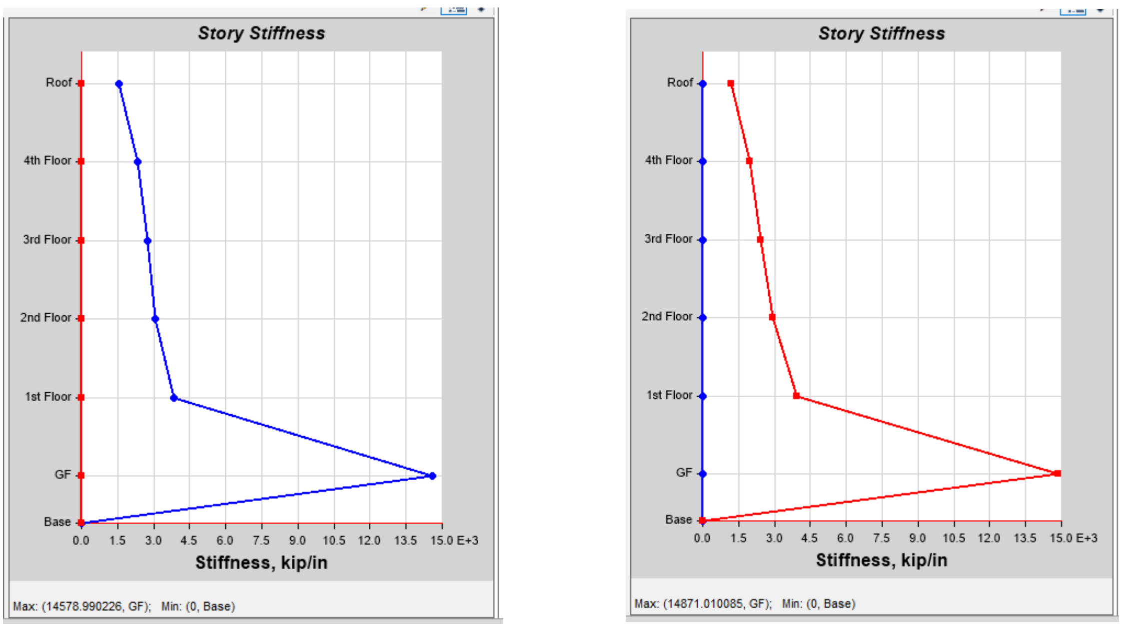


Fig 3.17 : Story Stiffness of Low-Rise Building

Above Graph shows maximum Stiffness **in X&Y direction** for Low Rise Building which has simulate in **LSA** (Linear Static Analysis) By ETABS. The maximum value is 14871 Kip/in which occurred in **Base**

4.2: Result Comparison and Discussion

This chapter presents and discusses the output results of the. The remaining comparisons demonstrate the stark differences in design techniques and formulas between low-rise and high-rise buildings as determined by BNBC 2020, utilizing by ETABS.

Finally, we get this result for lateral load

1.Earthquake effect on X-direction of high rise Building is greater than Low rise Building.

2.Earthquake effect on Y-direction of high rise Building is greater than Low rise Building

3. Wind effect on X-direction High Rise Building is greater than Low rise Building.

4.Wind effect on X-direction High Rise Building is greater than Low rise Building

The decision-making parameters for structural analysis and design are tremor and wind forces, story drift, wind and seismic shear and base shear for seismic forces according to BNBC 2020. In this study, the maximum story displacement of low rise to high rise multistory structure is 121.84%,287.05%, 219.72% and 450% for load EQX, EQY, WX and WY respectively. And the maximum story drift of low rise to high rise multistory structure is 60.44%, 66.58%, 113.08%, and 100.488%for load EQX, EQY, WX and WY respectively. The comparison of the aforesaid design parameters is depicted graphically, and relevant tables are presented in this research article. In comparison of wind load and seismic effect on low rise and high-rise multistory structures, the requirements of BNBC 2020 usually result in a less cost-effective design with a higher safety margin.

CHAPTER 5

CONCLUSION AND RECOMMANDATION

5.1 Conclusions and Future Works From the study is observed that.

1. Analysis can be done by using software ETABS in detail
2. Finding displacement by response spectrum method.
3. Low rise multistory structures are three times more affected due to earthquake than wind forces. The low rise stories are unaffected by wind forces.
4. When earthquake force effects observed on the buildings, the low rise buildings shows higher influence to earthquake forces when compared to high rise building.
5. It was observed that with the increment of wind speed displacement and drift both increased.
6. Shear walls are proved to have best resistance to lateral loads whereas X-bracings with least resistance; while combination bracing is on par with shear wall bracing system.
7. Earthquake load should be considered in high-rise buildings.
8. There is no problem if Earthquake is not calculated in low rise buildings.

5.2 Limitations and Recommendations for Future Works

1. The building is fully analyzed for seismic loads wind loads by preliminary and detailed design procedure.
2. In this study, only the ETABS software is used for the analysis.
3. If the analysis results compare with the actual hand calculation data, then more reliable results will be found. It should be done in the future work.
4. The building is not designed for any expansion (Horizontally or vertically) in future

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