DYNAMIC ANALYSIS OF STRUCTURE WITH BASEMENT

A
PROJECT REPORT

Submitted in partial fulfilment of the requirements for the award of the degree
Of

BACHELOR OF TECHNOLOGY
IN
CIVIL ENGINEERING

Under the supervision
of

Mr. Kaushal Kumar
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By

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to

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STUDENT'S DECLARATION

I hereby declare that the work presented in the Project report entitled **“Dynamic Analysis of Structure with Basement”** submitted IN partial fulfilment of the requirements for the degree of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat (H.P.)** is an authentic record of my work carried out under the supervision of **Mr. Kaushal Kumar**. This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.

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CERTIFICATE

This is to certify that the work which is being presented in the project report titled **“DYNAMIC ANALYSIS OF STRUCTURE WITH BASEMENT”** in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat** is an authentic record of work carried out by **Aditya Srivastava (171612), Manik Thapa(171613) and Rohit Sharma(161682)** during a period from August, 2020 to May, 2021 under the supervision of **Mr. Kaushal Kumar**, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

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

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ABSTRACT

Structural analysis is a branch which involves determination of behavior of structures in order to predict the responses of real structures such as buildings, bridges, trusses etc., with economy, elegance, serviceability and durability of structure. Structural engineers are facing the challenge of striving for the most efficient and economical design with accuracy in solution, while ensuring that the final design of a building must be serviceable for its intended function over its design lifetime. Construction of building requires proper planning and management. Building are subjected to various loads such as dead load, live load, wind load and seismic load. Today, tall buildings are a worldwide architectural phenomenon. The behavior of the structures during seismic and wind loads definitely has a major role, not only from structural point of view , but also safety of humans living in the structure. It is a major challenge to study the impact and performance of tall structures under wind and seismic loading . [*Keywords:* seismic loading, wind loading, economical design, serviceable.]

CHAPTER 1

INTRODUCTION

1.1 General

- Structural analysis entails determining a structure's overall shape as well as all of its precise dimensions in order for it to serve the purpose for which it was designed and to safely withstand the forces that will operate on it during its useful life. The population boom and the start of the industrial revolution resulted in a mass migration of people from villages to cities, necessitating the development of multi-story buildings for both residential and commercial purposes. Vehicle parking and other basic amenity space are two of the most difficult issues that have been encountered. As a result, underground basements can be found in both residential and industrial buildings. Natural disasters such as earthquakes, droughts, floods, and cyclones are all common on the Indian subcontinent. The majority of states and territories are vulnerable to one or more disasters. Every year, these natural disasters result in a large number of deaths and property losses. Earthquakes are the most dangerous natural disaster. As a result, it is important to learn to cope with these occurrences. More than 60% of India is vulnerable to earthquakes, according to the seismic code IS: 1893(Part I): 2000. Property loss can be restored to some degree after an earthquake, but life loss cannot. The collapse of buildings is the leading cause of death. It is said that earthquakes do not destroy people; it is buildings that are poorly built that do. Wind has two major impacts on tall buildings in general. 1) The structure and its cladding are subjected to forces and moments. 2) It distributes air in and around the structure, which is referred to as wind pressure. During certain wind storms, the unpredictable nature of the wind can take a destructive shape. As a result, it's critical to properly assess the structure for earthquake and wind impacts. The primary goal of this project is to compare the responses of a structure without a basement and a structure with a basement to dynamic forces in order to determine specific design parameters.

1.2 Objectives: The main objective of our project is:

1. To make a study to calculate different parameters like story shear, lateral deflections, story drift, etc.
2. Analysing the design of the structure with basement on structural analysis software STAAD Pro.

CHAPTER 2

REVIEW OF LITERATURE

2.1 Review of Technical Papers

Much of literature has been presented in the form of technical papers on dynamic analysis of water tanks. Some of them are listed below:

2.1.1 E.Pavan Kumar, A.Naresh, M.Nagajyothi, M. Rajasekhar et. Al. (2014)

The seismic analysis of structures for static and dynamic analysis in ordinary and special moment resisting frames is presented in this paper. The approaches used in structural seismic analysis are equivalent static analysis and response spectrum analysis. For the seismic study, they used a residential building with a B+G+15-story tower that is located in zone II. Using the STAAD.PRO programme, the entire structure was analysed by machine.

2.1.2 K. Rama Raju, M.I. Shereef, Nagesh R Iyer, S.Gopalakrishnan et. al. (2013)

The limit state method of analysis and design of a 3B+G+40-story reinforced concrete highrise building under seismic and wind loads is defined using IS codes of IS 1893(Part 1):2002 and IS 875(Part 3):1987. Allowable limits for base shear, roof displacements, inter-story drifts, accelerations recommended in codes of practise, and other applicable references in literature on the effects of earthquake and wind loads on buildings are compared to the structure's safety.

2.1.3 Brajesh Kumar Tandon and Dr.S.Needhidasan (2018)

The paper discusses how a building responds when it is exposed to a seismic load, as shown by storey drift and base shear. STAAD Pro software was used to conduct seismic analysis on the (G+8) building, which is situated in zones 2 and 4. IS 1893 PART 1 was used to conduct the study (2002). A number of considerations go into the construction of earthquake-resistant structures. Normal frequency of the structure, damping factor, importance of the structure, and ductility of the structure are the factors. As the seismic zone moves from 2 to 4, the base shear, lateral force, storey shear, overall storey displacement, and overturning moment all increase in both directions.

2.1.4 K.N.V.J Suryanarayana Raju , Potnuru Manoj and Dr.Shaik Yajdani 2016

The present study describes the effect of wind on a multi storied building. It deals with the analysis of G+10 multi storied framed structure for different wind speeds such as 33m/sec, 39m/sec, 44m/sec, 47m/sec, 50m/sec, 55m/sec using Staad-pro. Four different frames are considered, two in longitudinal direction and two in transverse direction. The height of each storey is taken as 3.45m; making to height of structure is 37m. Loads considered are taken in accordance with IS-875(part1, part2) IS-1893(2002) code. It is concluded that the bending moment ,shear force ,displacement in beams and columns for the basic wind speed of 55 m/sec is more when compared to basic wind speeds 33m/sec,39m/sec, 44m/sec , 47m/sec , 50m/sec.

2.1.5 D.G.Lee and H.S.Kim (2001)

The paper compares the analysis of a structure with a basement to the analysis of a structure that does not have a basement. Response Spectrum system with STAAD pro software and rigid diaphragm model with ETABS software were used in the study. The basement, it is concluded, gives the structure more stability, resulting in greater lateral displacements and longer vibration times. The effect of the basement on the seismic response was found to be more important in the case of building structures with shear walls.

2.1.6 M.Arun Kumar, B.Raghava Maheedkar , G.Janakiram Goud (2018)

The present study used Strap (structural analysis programme) software to perform seismic analysis on a G+12 storey building with and without basement walls with two basements. Roof displacements are significantly decreased due to the presence of basement walls. As basement walls are installed, there is no lateral deflection in the basements since the building is believed to be fixed only at ground level. The need for ductility has been decreased. Roof displacements and base shears are also decreased due to basement walls when seismic forces are applied.

2.1.7 Priyanka Soni et. al.,2016

This paper discusses the study and analysis of various research projects involving shear wall enhancement and their behaviour under lateral loads. Since shear walls resist the majority of lateral loads in the lower portion of the building and the frame supports the lateral loads in the upper portion of the building, it is suitable for soft storey high rise buildings, such as those built in India. As in India, the lower floors are used for parking and garages, while the upper floors are used for residences. Shear walls are structural mechanisms that protect structures from lateral loads such as wind and earthquakes. Reinforced concrete, plywood/timber unreinforced masonry, and reinforced masonry are used to build these structural structures, which are subdivided into coupled shear walls, shear wall frames, shear panels, and staggered walls.

2.1.8 Dr. K. R. C. Reddy, Sandip A. Tupat et. al. (2014)

A comparative analysis of wind and earthquake loads was presented in order to determine the design loads of a multistory building. In that multistory building, earthquake loads in various zones are analysed using IS 1893, and wind loads are analysed using IS 875. The wind loads are calculated using a 20 percent difference in the zone's design wind speed. The wind loads that were collected on the structure were compared to earthquake loads. Finally, it is discovered that in most situations, wind loads are more important than earthquake loads.

2.2. Conclusion based upon literature survey

Analysis & design of structures against earthquake and wind effect is of considerable importance. These structures must remain functional even after an earthquake or a heavy wind storm. After detailed study of all the papers, following points are to be considered at the time of dynamic analysis of structure with basement:

1. The procedures for the earthquake analysis of the structures are : Linear static and Linear Dynamic(Response spectrum method, time history analysis, etc.)
2. The effect of the presence of Basement Wall/Shear Wall to be considered or studied carefully.
3. Seismic forces are directly proportional to seismic zones and inversely proportional to the height of the supporting system.
4. The effect of wind load must be considered in the analysis.
5. The provisions should be taken according the IS Codes IS:1893:2002 & IS:875 .

CHAPTER 3

WORK METHODOLOGY

3.1 Introduction

The critical factors for seismic analysis of structures are selected using appropriate methodology and structural modelling that accurately represents the system's actual behaviour. A brief introduction and literature survey relevant to the nature of this study are presented in the previous section of this chapter.

We are conducting a comparative review of the following systems for modelling and analysis:

1.) A building without a basement (G+9 storeys) and a building with a basement (2B+G+9 storeys).

2.) A basement structure (2B+G+9 storeys) with Basement Wall and a basement structure (2B+G+9 storeys) without Basement Wall.

3.2 Floor Plan

The floor plan chosen for analysis is same for all the structures. It is shown in **Fig 3.1.**

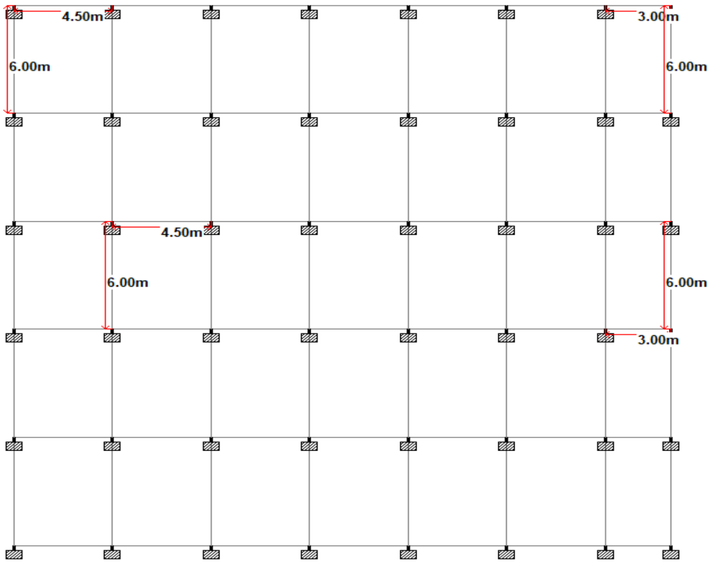


Fig. 3.1 Floor Plan for the analysis

3.3 Dynamic Analysis

For the following buildings, a dynamic analysis will be conducted to determine the design seismic force and its distribution in different levels along the height of the building, as well as in various lateral load resisting elements: Regular and Irregular.

The dynamic analysis of the model for abnormal building configurations can accurately model the types of irregularities present in the structure. The TIME HISTORY METHOD or the RESPONSE SPECTRUM METHOD may be used to perform dynamic analysis.

3.4 Calculation of Base Shear

The Indian code divides the country into four seismic zones for the purpose of assessing design seismic powers (II, III, IV, and V). Previously, there were five zones, but in the fifth revision of the code, Zones I and II were combined into Zone II. The horizontal seismic forces coefficient Ah for a structure must be calculated using the formula below. $A_h = \frac{ZIS_a}{2Rg}$

Z = zone factor for the maximum considerable earthquake (MCE) and service life of the structure in a zone. Factor 2 in denominator is to reduce the MCE to design basis earthquake (DBE).

I = importance factor , depending on the functional purpose of the building, characterized by hazardous consequences of its failure , post-earthquake functional needs, historical value , or economic importance.

R = response reduction factor, depending upon the perceived seismic damage performance of the structure, characterized by ductile or brittle deformations however the ratio *I/R* shall not be greater than1.

$\frac{Sa}{g}$= average response acceleration coefficient. **(Fig 3.1)**

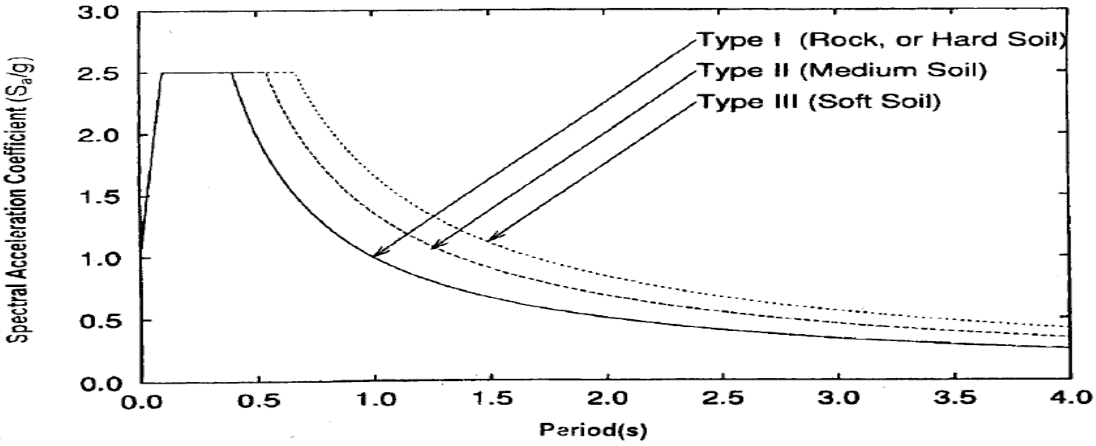


Fig 3.2 Design response spectra curve as per IS: 1893-2002 code.

3.5 Design Lateral Force

The following expression determines the total design lateral force or design seismic base shear (Vb) in every principal direction of the building.

$$\mathbf{Vb = A_h \text{ x } W}$$

Where, *Ah* is the horizontal seismic forces coefficient and *W* is the seismic weight of building.

3.5.1. Distribution of Design Force

The design base shear, *Vb* computed above shall be distributed along the height of the building as per the following expression,

$$Q_i = \frac{W_i h_i^2}{\sum_{-1}^{n} W_j h_{jj}^2}$$

Where,

Q_i = design lateral force at ith floor

W_i= seismic weight of i_{th} floor

h_i = height of i_{th} floor measured from base, and

n = numbers of storey in the building is the number of the levels at which the masses are located

In case of buildings whose floors are capable of providing rigid horizontal diaphragm action, the total shear in any horizontal plane shall be distributed to the various vertical elements of lateral force resisting system, assuming the floors to be infinitely rigid in the horizontal plane.

3.6 Seismic Zones in India

Based on scientific inputs relating to seismicity, past earthquakes, and tectonic setup of the area, the Indian subcontinent is divided into four seismic zones (II, III, IV, and V). The country was previously divided into five seismic zones based on the intensity of the earthquakes, but the Bureau of Indian Standards [IS 1893 (Part I):2002] grouped the country into four seismic zones; the first and second seismic zones were merged.

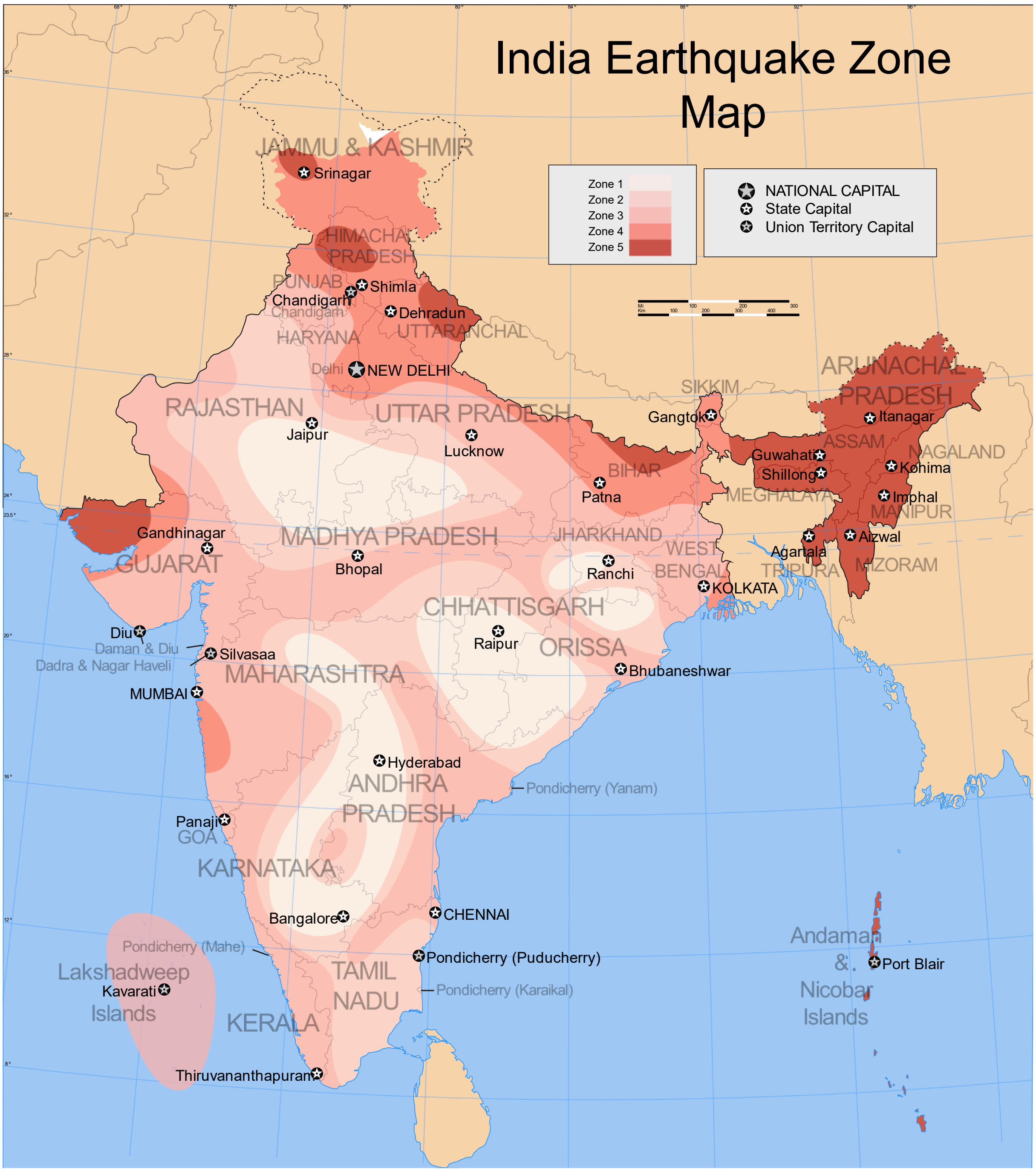
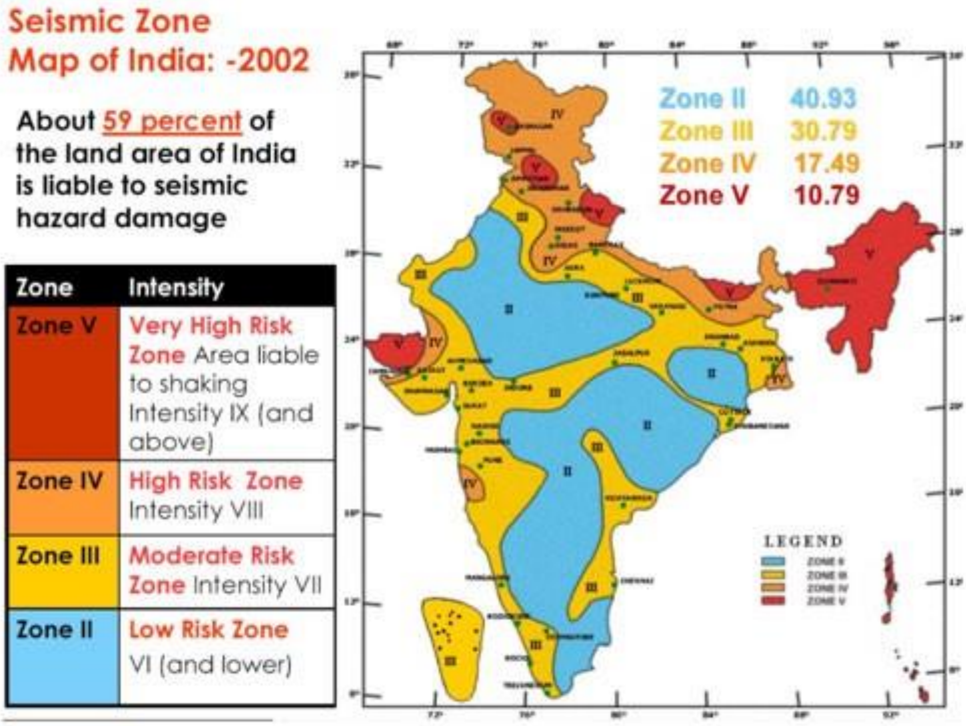


Fig 3.3 Older version of seismic zones



Zone	Intensity
Zone V	Very High Risk Zone Area liable to shaking Intensity IX (and above)
Zone IV	High Risk Zone Intensity VIII
Zone III	Moderate Risk Zone Intensity VII
Zone II	Low Risk Zone VI (and lower)

Fig 3.4 Revised version of seismic zones in India

3.7 Structural Modelling & Analysis

The structural modelling and analysis software Staad Pro is used to perform a comparative study between structures in order to obtain results such as Story Shear, Storey Displacement, Lateral Deflections, and so on.

CHAPTER 4

DESIGN & ANALYSIS

4.1 A Structure without basement (G+9 storeys) and a Structure with Basement (2B+G+9 storeys).

4.1.1 Building Plan Details:

Table 4.1 Detailing of the structure

Structural Part	Dimension
Building	All General Building
Length in X- direction	30 m
Length in Y- direction	30 m
Floor to floor height	3.2 m
Bottom Storey Height	3.2 m
Total height of Building	32 m (above ground level)
Column Size	230 x 450 mm
Beam Size	230 x 450 mm
Seismic Zone(Z)	III
Importance Factor (I)	1
Response reduction factor (R)	5
Soil Type	Medium Soil
Damping	5%
Live load	2 KN/m^2
IS Criteria For Earthquake Resistant Design of Structures	IS 1893-2002

4.1.2 3-D View of Structure

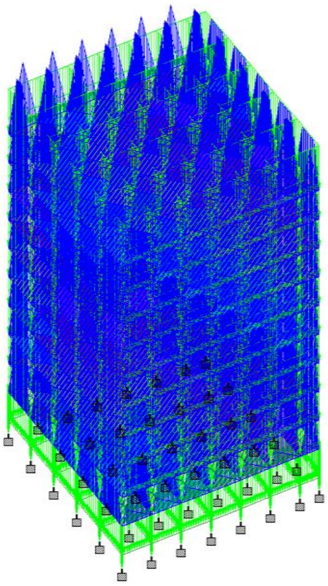


Fig 4.1 Isometric View with floor load (without basement)

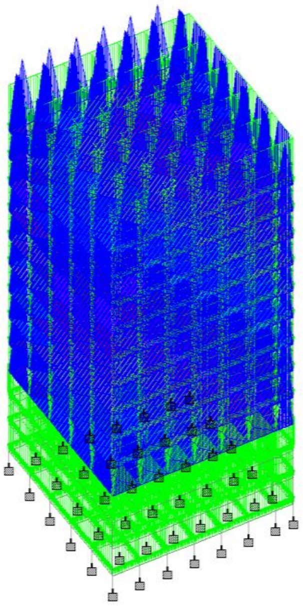


Fig 4.2 Isometric View with floor load (with basement)

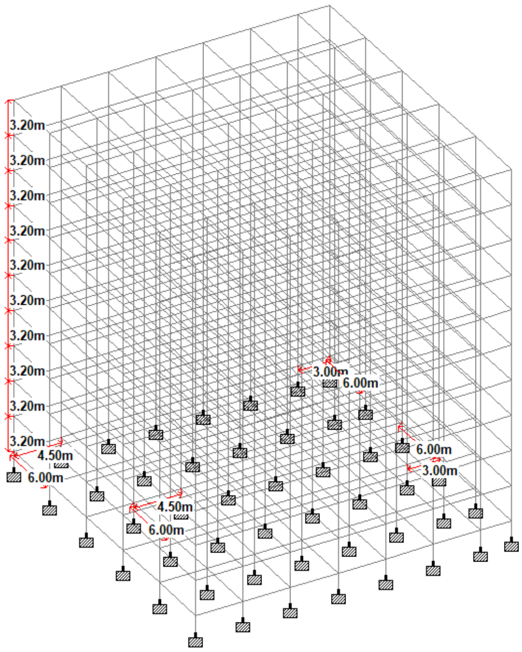


Fig 4.3 Isometric view (Structure without basement)

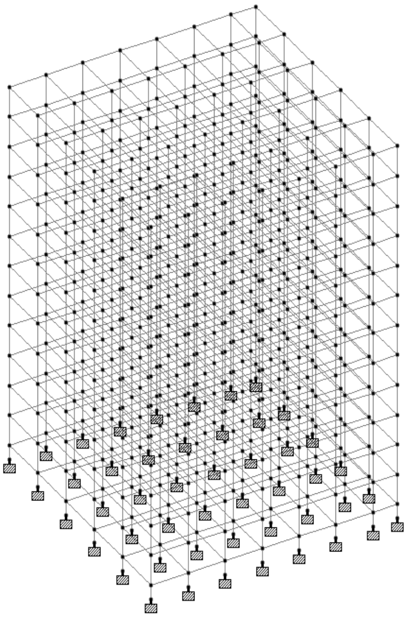


Fig 4.4 Isometric view (structure with basement)

4.1.3 Natural Period (TN)

Following is the maximum natural period of one complete cycle of oscillation of multi-storey structures in seismic zone III

Table 4.2 Maximum Time period variation

Model	Maximum Natural Period
1) Structure Without Basement	**1.92 sec**
2) Structure With Basement	**2.21 sec**

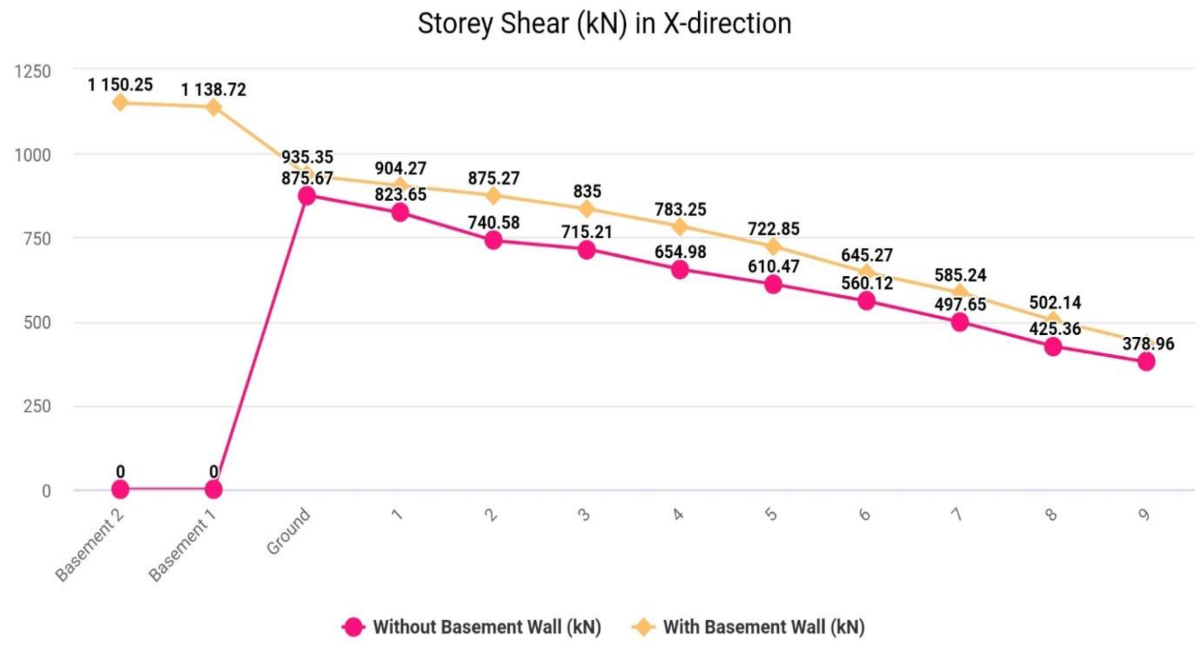
4.1.4 Storey Shear (kN) :

It is the lateral force acting on a storey as a result of forces such as earthquakes and wind. It is measured for each storey, with the lowest value at the top and the highest value at the bottom of the house.

Table 4.3 Storey Shear

Storey	Without Basement (kN)	With Basement(kN)	Quantitative Increment (%)
Basement 2	-	1150.25	-
Basement 1	-	1138.72	-
Ground	875.67	935.35	6.81%
1	823.65	904.27	9.78%
2	740.58	875.91	18.2%
3	715.21	835.00	16.74%
4	654.98	783.25	19.58%
5	610.47	722.85	18.40%

6	560.12	645.27	15.20%
7	497.65	585.24	17.60%
8	425.36	502.14	18.05%
9	378.96	435.37	14.88%

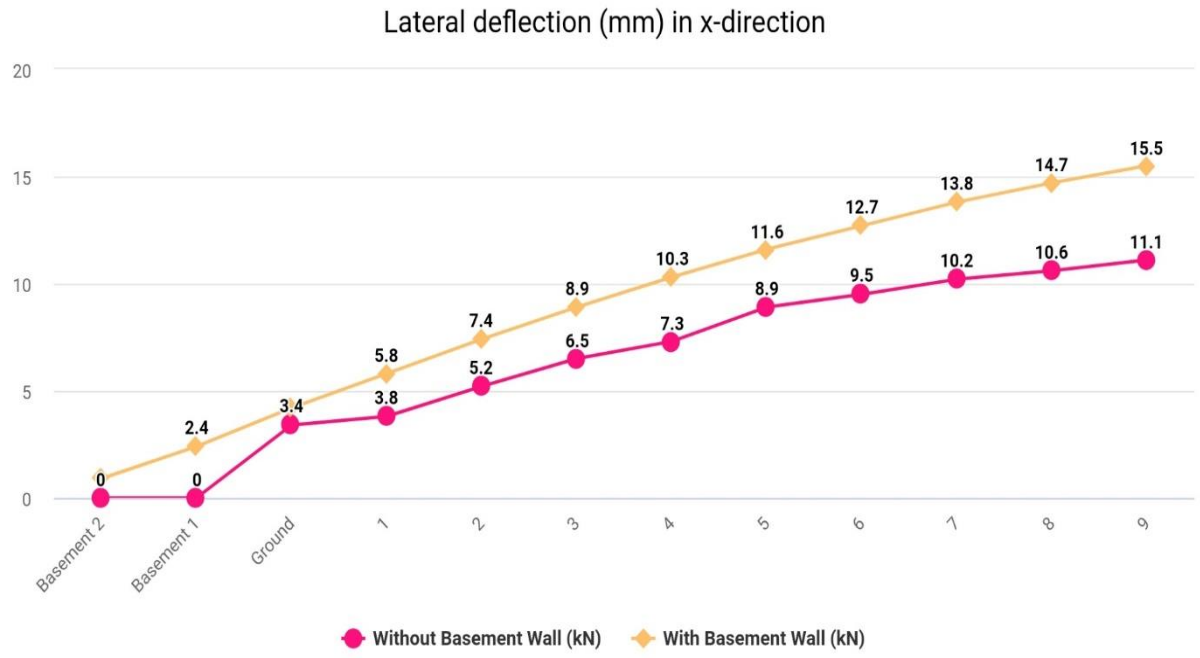


4.1.5 Lateral Deflections (mm):

The elastic displacement is the absolute lateral displacement of any point in the structure relative to its base under strength-level design earthquake forces.

Table 4.4 Lateral Deflections

Storey	Without Basement (mm)	With Basement(mm)	Quantitative Increment (%)
Basement 2	**-**	**0.9**	**-**
Basement 1	**-**	**2.4**	**-**
Ground	**3.4**	**4.2**	**23.52%**
1	**3.8**	**5.8**	**52.63%**
2	**5.2**	**7.4**	**42.30%**
3	**6.5**	**8.9**	**36.92%**
4	**7.3**	**10.3**	**41.09%**
5	**8.9**	**11.6**	**30.33%**
6	**9.5**	**12.7**	**33.68%**
7	**10.2**	**13.8**	**35.29%**
8	**10.6**	**14.7**	**38.67%**
9	**11.1**	**15.5**	**39.63%**

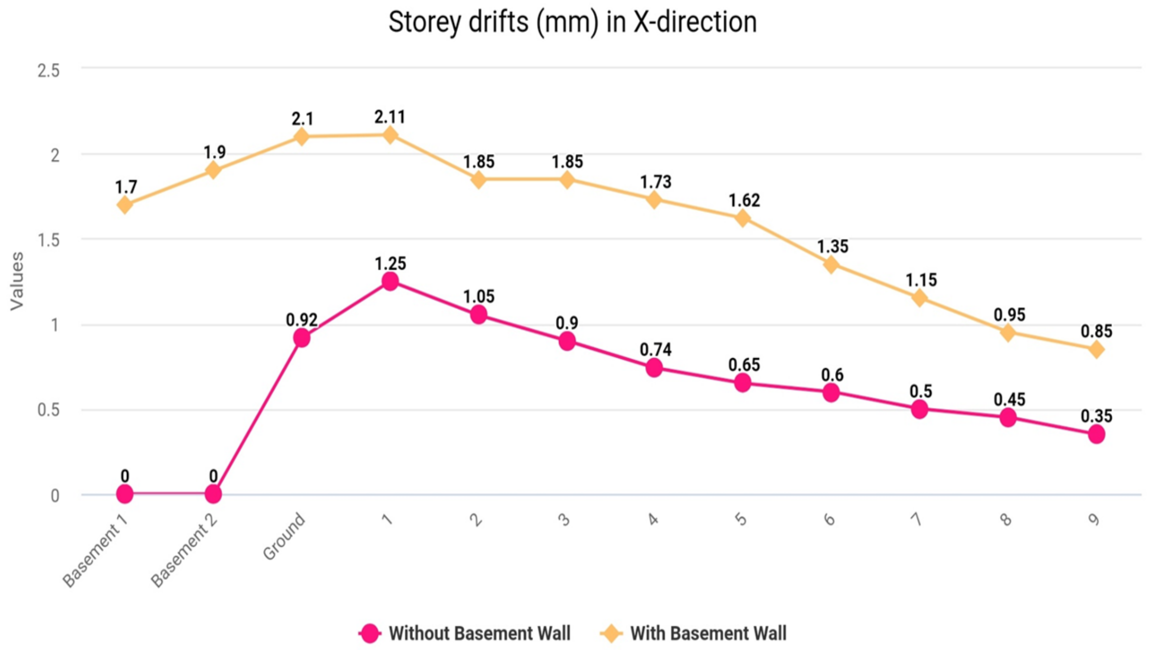

Lateral deflection (mm) in x-direction
20
15
10
5
0
Basement 2
Basement 1
Ground
1
2
3
4
5
6
7
8
9
0
0
2.4
3.4
3.8
5.8
5.2
7.4
6.5
8.9
7.3
10.3
8.9
11.6
9.5
12.7
10.2
13.8
10.6
14.7
11.1
15.5
Without Basement Wall (kN)
With Basement Wall (kN)

4.1.6 Storey Drifts (mm):

Storey Drift is defined as a ratio of displacement of two consecutive floor to height of that floor. It is very important term used for research purpose in earthquake engineering. It is an important criterion to represent the performance of the structure as per IS 1893: 2002 Part 1, Clause 7.11.1, page 28, the storey drift should be less than 0.004 times the height of the storey under consideration.

Table 4.5 Storey Drifts

Storey	Without Basement (mm)	With Basement(mm)	Quantitative Increment (%)
Basement 2	**-**	**1.7**	**-**
Basement 1	**-**	**1.9**	**-**
Ground	**0.92**	**2.1**	**128.26%**
1	**1.25**	**2.11**	**68.80%**
2	**1.05**	**1.85**	**76.19%**
3	**0.90**	**1.85**	**105.55%**
4	**0.74**	**1.73**	**133.78%**
5	**0.65**	**1.62**	**149.23%**
6	**0.60**	**1.35**	**125.00%**
7	**0.50**	**1.15**	**130.00%**
8	**0.45**	**0.95**	**111.11%**
9	**0.35**	**0.85**	**142.85%**



4.1.7 Storey Displacement

It is total displacement of i th storey with respect to ground. Maximum horizontal displacement variations in seismic zones III building

Table 4.6 Storey Displacement variation

Model	**Storey displacement at 5th storey**
1) Structure without Basement	**234 mm**
2) Structure with Basement	**367 mm**

4.2 A Structure with Basement (2B+G+9 storeys) having Basement Wall and a Structure with Basement (2B+G+9 storeys) without having Basement Wall.

(SEISMIC ZONE III)

4.2.1 Building Plan Details of Seismic Zone III structure:

Table 4.7 Detailing of the structure

Structural Part	Dimension
Building	All General Building
Floor to floor height	3.2 m
Bottom Storey Height	3.2 m
Total height of Building	32 m (above ground level)
Column Size	230 x 450 mm
Beam Size	230 x 450 mm
Thickness of Basement Wall	200 mm
Thickness of Slab	150 mm
Seismic Zone(Z)	III
Importance Factor (I)	1
Response reduction factor (R)	5
Soil Type	Medium Soil
Damping	5%
Live load	2 KN/m^2
IS Criteria For Earthquake Resistant Design of Structures	IS 1893-2002

4.2.2 3-D View of the Structure:

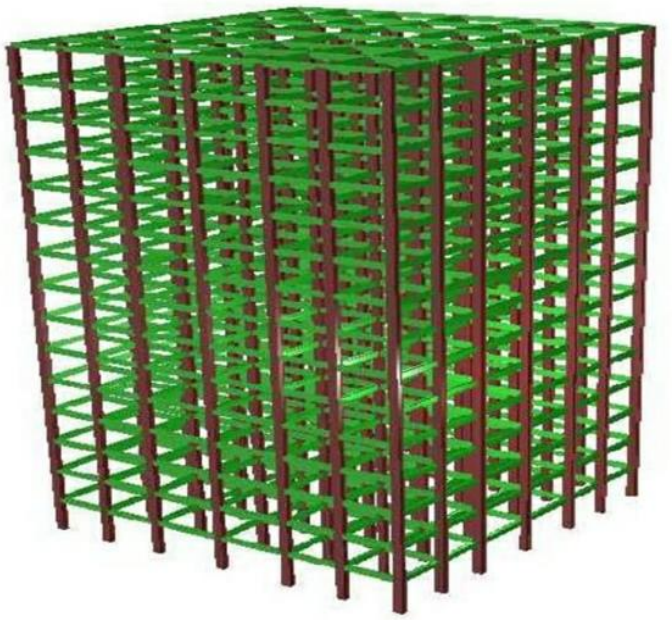


Fig 4.1 Structure without basement wall

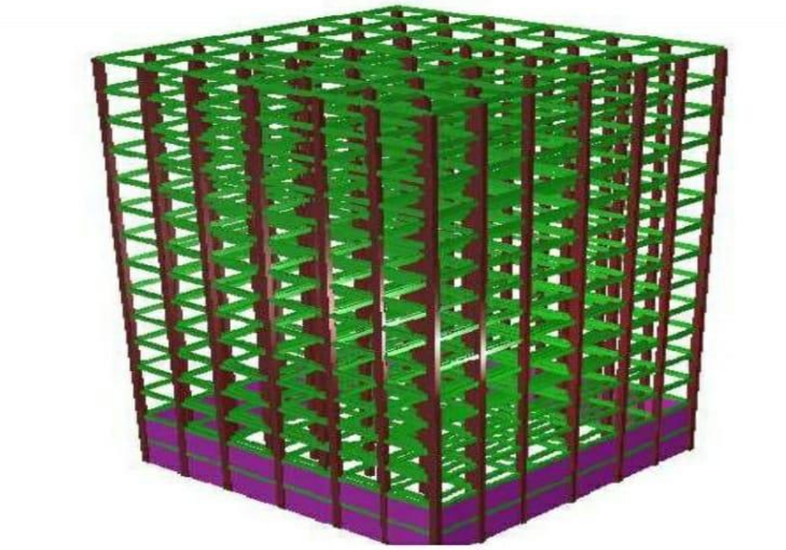


Fig 4.2 Structure with basement wall

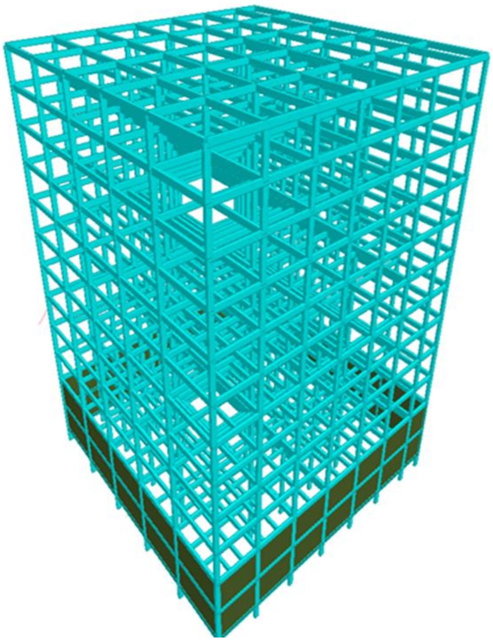


Fig 4.3 3D view of Structure with basement wall

4.2.3 Storey Shear (kN):

It is the lateral force acting on a storey due to the forces such as seismic and wind force. It is calculated for each storey, changes from minimum at the top to maximum at the bottom of the building.

Table 4.8 Storey shear in X direction

Storey	Without Basement Wall (kN)	With Basement Wall (kN)	Quantitative decrement (%)
Basement 2	1150.25	1032.15	10.26%
Basement 1	1138.72	1031.37	9.42%
Ground	935.35	925.75	1.02%
1	904.27	875.45	3.18%

2	**875.91**	**835.21**	**4.64%**
3	**835.00**	**822.24**	**1.52%**
4	**783.25**	**760.35**	**2.92%**
5	**722.85**	**702.32**	**2.84%**
6	**645.27**	**622.45**	**3.53%**
7	**585.24**	**535.37**	**8.52%**
8	**502.14**	**485.24**	**3.36%**
9	**435.37**	**407.25**	**6.45%**

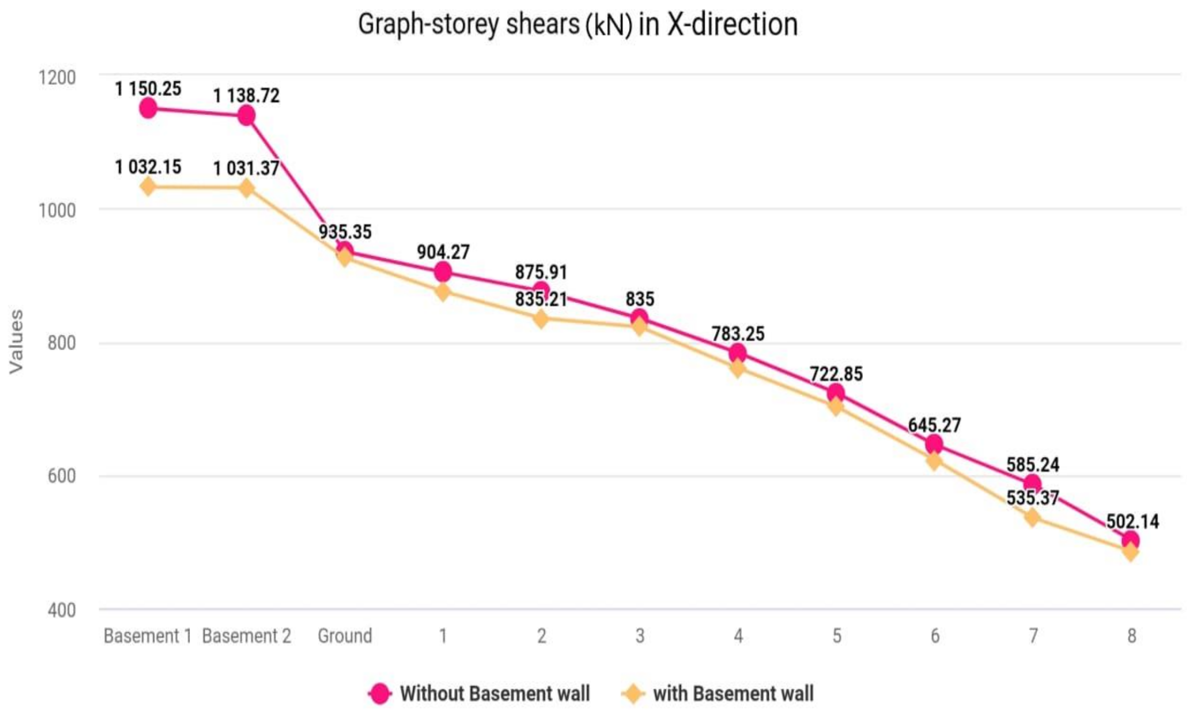
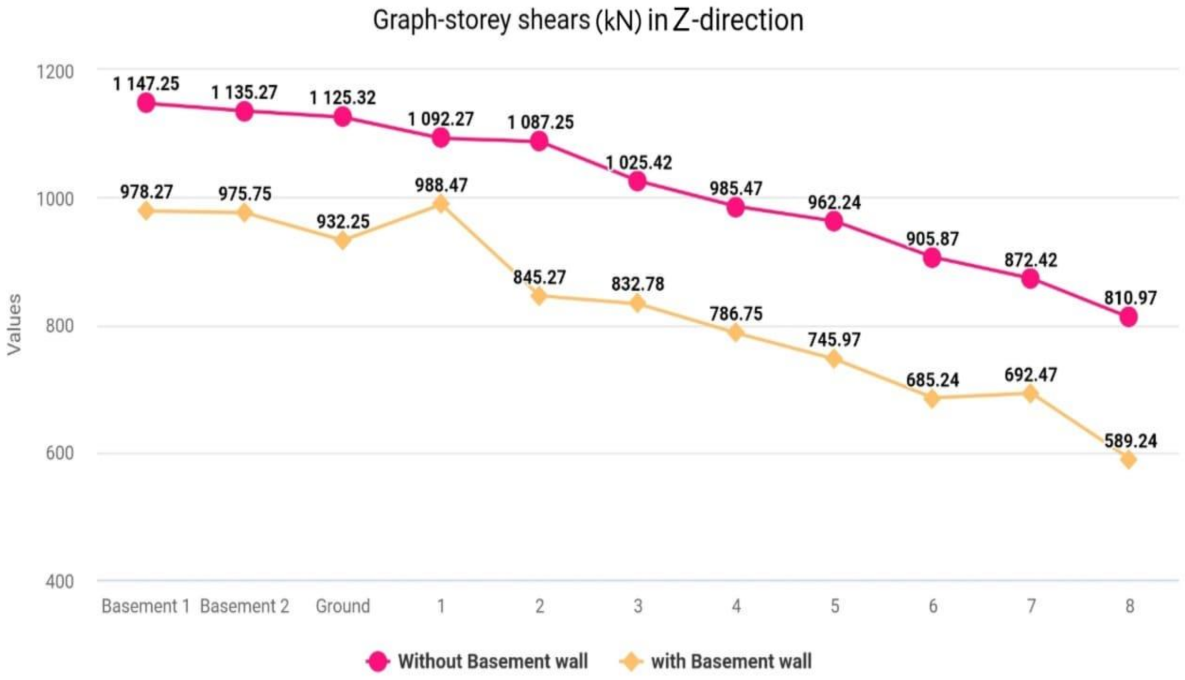


Table 4.9 Story Shear in Z-Direction

Storey	Without Basement Wall(mm)	With Basement Wall(mm)	Quantitative decrement (%)
Basement 2	1147.25	978.27	14.72%
Basement 1	1135.27	975.75	14.05%
Ground	1125.32	932.25	17.15%
1	1092.27	988.47	9.503%
2	1087.25	845.27	22.25%
3	1025.42	832.78	18.78%
4	985.47	786.75	20.16%
5	962.24	745.97	22.47%
6	905.87	685.24	24.35%
7	872.42	692.47	20.62%
8	810.97	589.24	27.34%
9	732.57	542.25	25.97%



4.2.4 Lateral Deflections (mm):

The elastic displacement is the absolute lateral displacement of any point in the structure relative to its base under strength-level design earthquake forces.

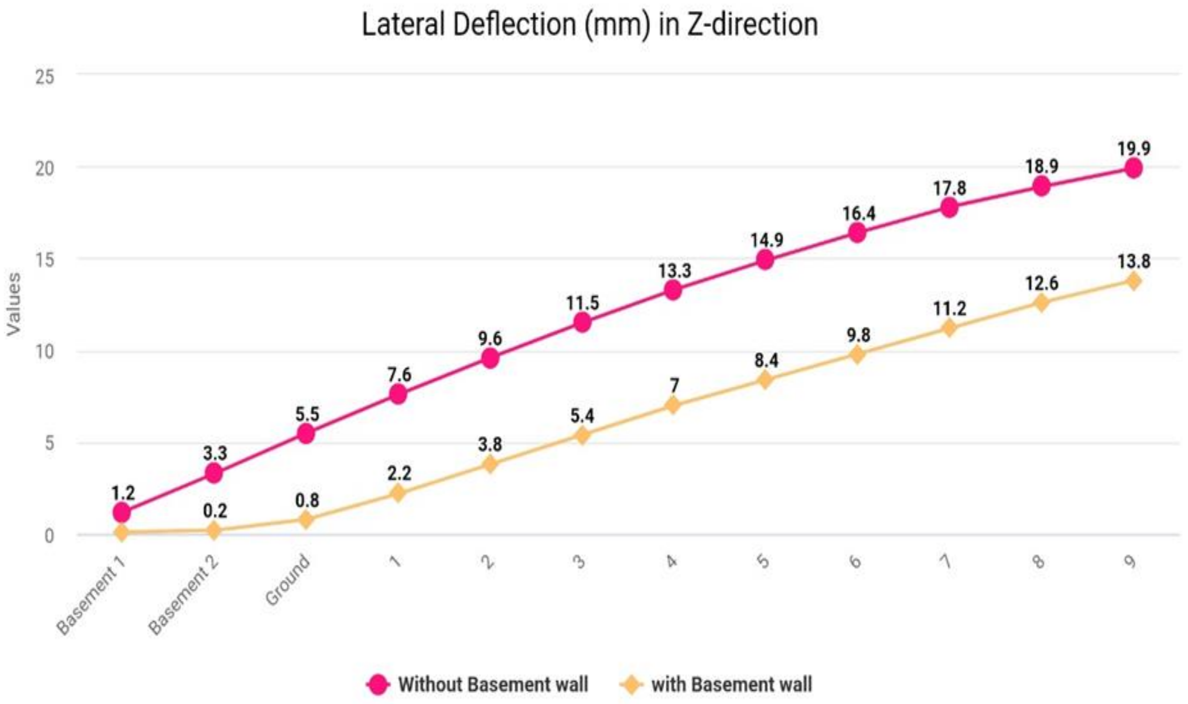
Table 4.9 Lateral Deflections in X-direction

Storey	**Without Basement Wall(mm)**	**With Basement Wall(mm)**	**Quantitative decrement (%)**
Basement 2	**0.9**	**0.2**	**77.77**
Basement 1	**2.4**	**0.3**	**87.50**
Ground	**4.2**	**0.7**	**83.33**
1	**5.8**	**1.9**	**67.24**

2	**7.4**	**3.3**	**55.40**
3	**8.9**	**4.7**	**47.19**
4	**10.3**	**6.1**	**40.77**
5	**11.6**	**7.4**	**36.20**
6	**12.7**	**8.6**	**32.28**
7	**13.8**	**9.8**	**28.98**
8	**14.7**	**10.8**	**26.53**
9	**15.5**	**11.8**	**23.87**

Table 4.10 Lateral Deflections in Z-direction

Storey	Without Basement Wall(mm)	With Basement Wall(mm)	Quantitative decrement (%)
Basement 2	1.2	0.1	91.66%
Basement 1	3.3	0.2	93.93%
Ground	5.5	0.8	85.45%
1	7.6	2.2	71.05%
2	9.6	3.8	60.41%
3	11.5	5.4	53.04%
4	13.3	7.0	47.36%
5	14.9	8.4	43.62%
6	16.4	9.8	40.24%
7	17.8	11.2	37.07%
8	18.9	12.6	33.33%
9	19.9	13.8	30.65%



4.2.5 Storey Drifts(mm):

Storey Drift is defined as a ratio of displacement of two consecutive floor to height of that floor. It is very important term used for research purpose in earthquake engineering. It is an important criteria to represent the performance of the structure as per IS 1893: 2002 Part 1, Clause 7.11.1, page 28, the storey drift should be less than 0.004 times the height of the storey under consideration.

Table 4.11 Storey Drifts in X-direction

Storey	Without Basement Wall(mm)	With Basement Wall(mm)	Quantitative decrement (%)
Basement 2	1.7	0.1	94.11
Basement 1	1.9	0.2	89.47
Ground	2.1	0.8	61.90
1	2.11	1.9	9.952
2	1.85	1.75	5.405
3	1.85	1.52	17.83
4	1.73	1.65	4.624
5	1.62	1.51	6.790
6	1.35	1.35	0
7	1.15	0.95	17.39
8	0.95	0.85	10.52
9	0.85	0.75	11.76

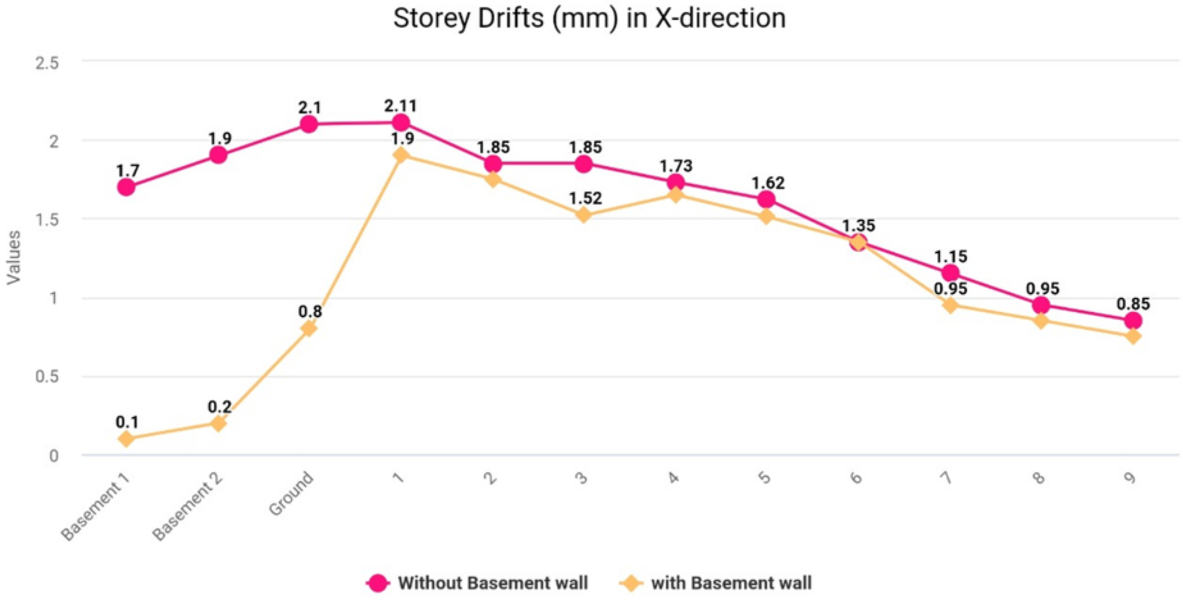
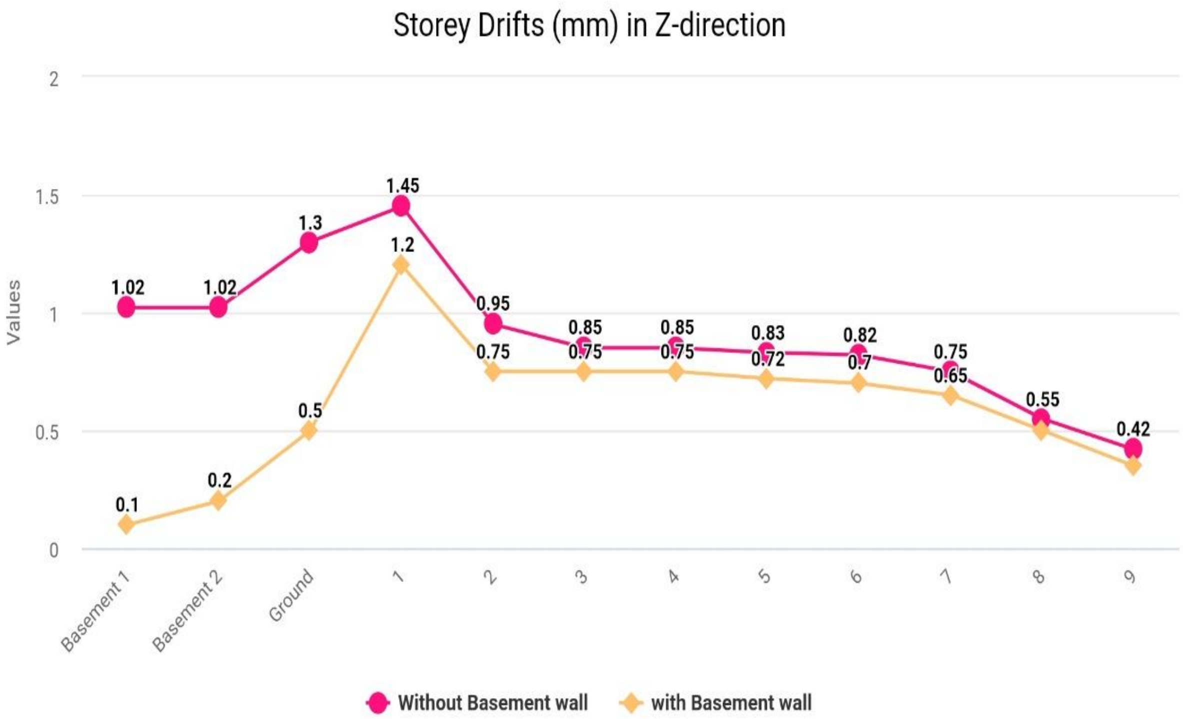


Table 4.12 Storey Drifts in Z-direction

Storey	Without Basement Wall(mm)	With Basement Wall(mm)	Quantitative decrement (%)
Basement 2	1.02	0.1	90.19
Basement 1	1.02	0.2	80.39
Ground	1.30	0.50	61.53
1	1.45	1.20	17.24
2	0.95	0.75	21.05
3	0.85	0.75	11.76
4	0.85	0.75	11.76
5	0.83	0.72	13.25
6	0.82	0.70	14.63
7	0.75	0.65	13.33
8	0.55	0.50	9.090
9	0.42	0.35	16.66


Storey Drifts (mm) in Z-direction
Values
2
1.5
1
0.5
0
1.02
1.02
1.3
1.45
1.2
0.95
0.75
0.85
0.75
0.85
0.75
0.83
0.72
0.82
0.7
0.75
0.65
0.55
0.42
0.5
0.1
0.2
Basement 1
Basement 2
Ground
1
2
3
4
5
6
7
8
9
Without Basement wall
with Basement wall

4.3 A Structure with Basement (2B+G+9 storeys) having Basement Wall and a Structure with Basement (2B+G+9 storeys) without having Basement Wall.

(SEISMIC ZONE V)

4.3.1 Building Plan Details of Seismic Zone V structure:

Table 4.13 Detailing of the structure

Structural Part	Dimension
Building	All General Building
Floor to floor height	3.2 m
Bottom Storey Height	3.2 m
Total height of Building	32 m (above ground level)
Column Size	230 x 450 mm
Beam Size	230 x 450 mm
Thickness of Basement Wall	200 mm
Thickness of Slab	150 mm
Seismic Zone(Z)	V
Importance Factor (I)	1
Response reduction factor (R)	5
Soil Type	Medium Soil
Damping	5%
Live load	2 KN/m^2
IS Criteria For Earthquake Resistant Design of Structures	IS 1893-2002

4.3.2 3-D View of the Structure:

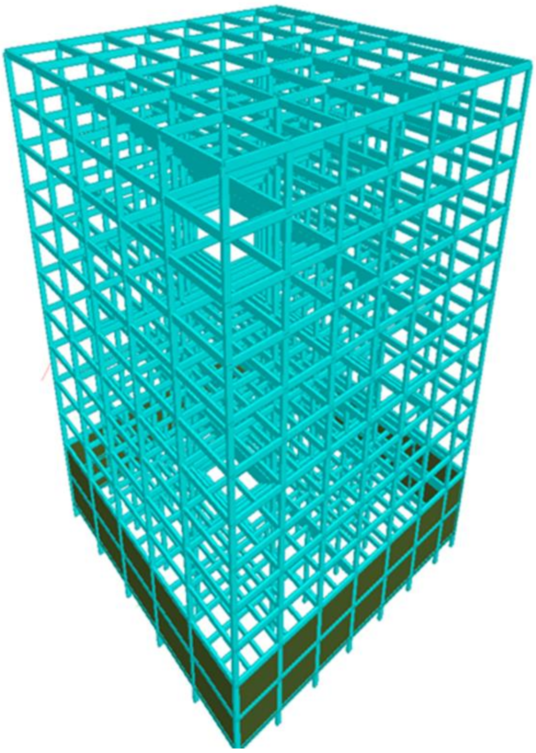


Fig 4.4 3D view of Structure with basement wall

4.3.3 Storey Shear (kN):

It is the lateral force acting on a storey due to the forces such as seismic and wind force. It is calculated for each storey, changes from minimum at the top to maximum at the bottom of the building.

Table 4.14 Storey shear in X-direction

Storey	Without Basement Wall (kN)	With Basement Wall (kN)	Quantitative decrement(%)
Basement 2	**1225.43**	**1182.45**	**3.50**

Basement 1	**1207.34**	**1150.47**	**4.71**
Ground	**1172.25**	**1072.24**	**8.53**
1	**1150.34**	**1052.75**	**8.48**
2	**985.31**	**1024.72**	**-3.9**
3	**952.37**	**985.42**	**-3.4**
4	**921.42**	**875.41**	**4.99**
5	**905.20**	**845.21**	**6.62**
6	**874.86**	**727.35**	**16.8**
7	**854.32**	**692.45**	**18.9**
8	**802.79**	**675.24**	**15.8**
9	**782.42**	**642.19**	**17.9**

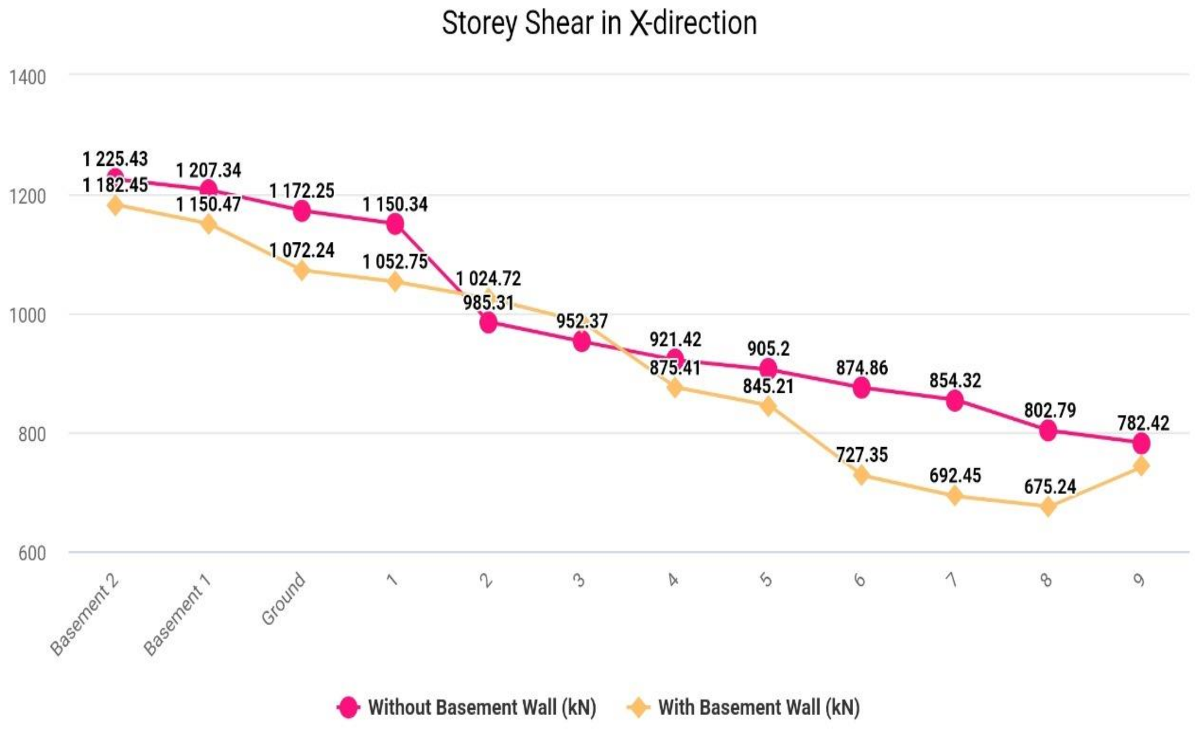
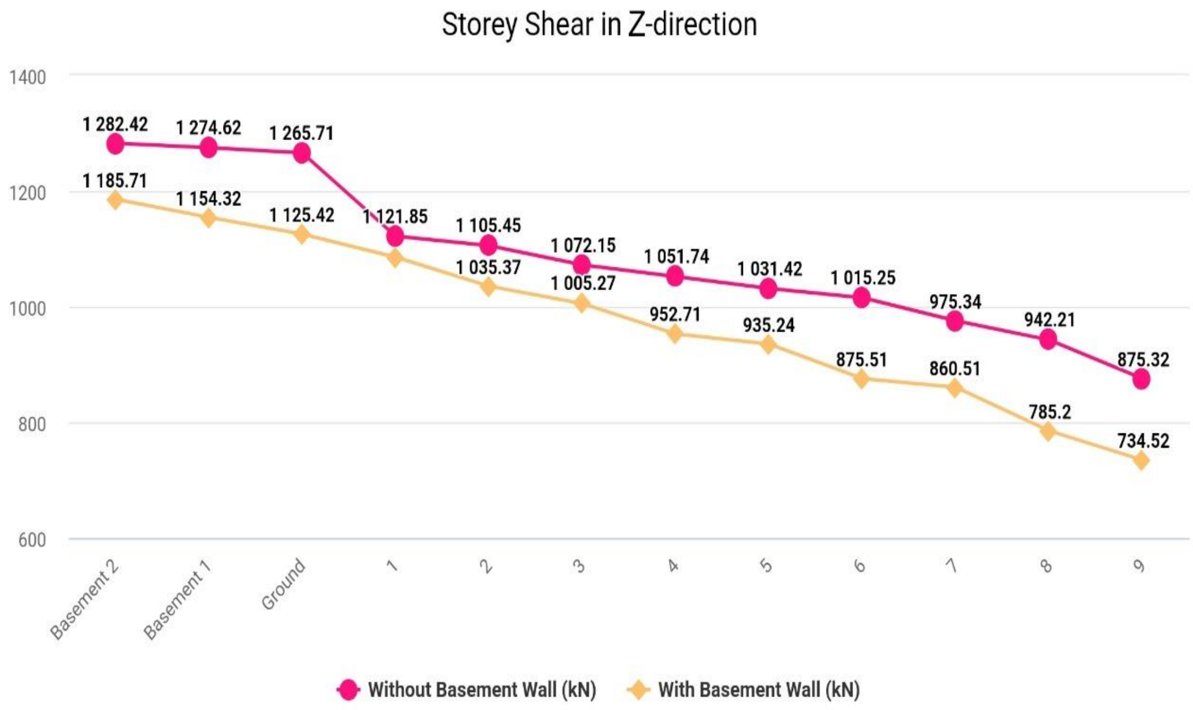


Table 4.15 Story shear in Z-direction

Storey	Without Basement Wall(kN)	With Basement Wall(kN)	Quantitative decrement (%)
Basement 2	1282.45	1185.71	7.543374
Basement 1	1274.62	1154.32	9.438107
Ground	1265.71	1125.42	11.0839
1	1121.85	1085.52	3.238401
2	1105.45	1035.37	6.3395
3	1072.15	1005.27	6.237933
4	1051.74	952.71	9.415825
5	1031.42	935.24	9.325008
6	1015.25	875.51	13.7641
7	975.34	860.51	11.77333
8	942.21	785.20	16.66401
9	875.32	734.52	16.08555


Storey Shear in Z-direction
1400
1200
1000
800
600
1 282.42
1 274.62
1 265.71
1 121.85
1 105.45
1 072.15
1 051.74
1 031.42
1 015.25
975.34
942.21
875.32
1 185.71
1 154.32
1 125.42
1 035.37
1 005.27
952.71
935.24
875.51
860.51
785.2
734.52
Basement 2
Basement 1
Ground
1
2
3
4
5
6
7
8
9
Without Basement Wall (kN)
With Basement Wall (kN)

4.3.4 Lateral Deflections (mm):

The elastic displacement is the absolute lateral displacement of any point in the structure relative to its base under strength-level design earthquake forces.

Table 4.16 Lateral Deflections in X-direction

Storey	Without Basement Wall(mm)	With Basement Wall(mm)	Quantitative decrement (%)
Basement 2	1.2	0.8	33.33
Basement 1	3.8	1.4	63.15
Ground	5.6	2.1	62.50
1	7.2	4.5	37.50
2	8.4	5.2	38.09
3	9.2	6.1	33.69
4	12.5	7.4	40.80
5	14.6	8.9	39.04
6	16.7	9.7	41.91
7	17.4	10.5	39.65
8	18.5	11.2	39.45
9	19.4	12.5	35.56

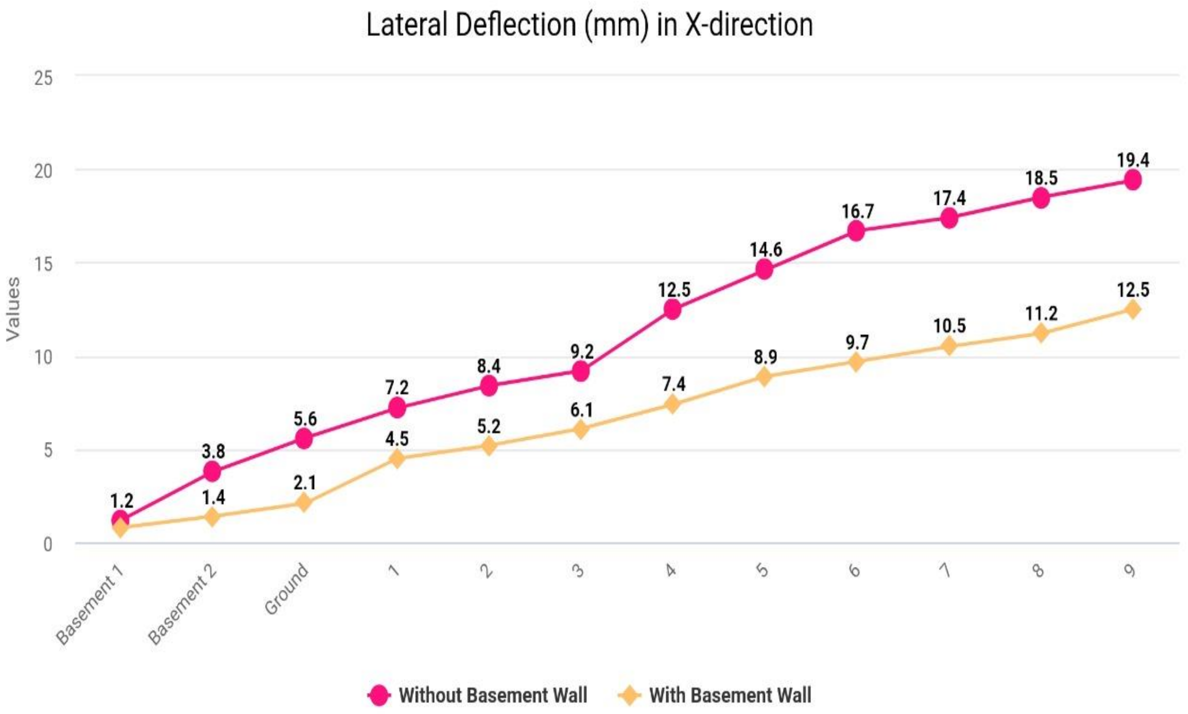
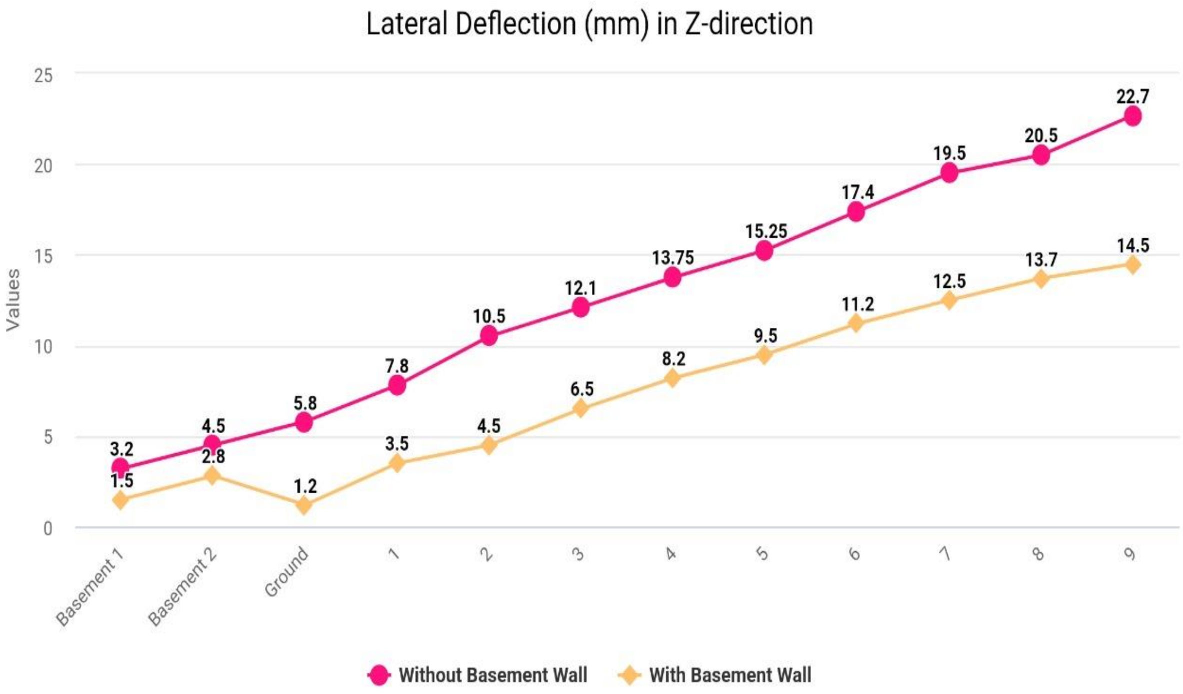

Lateral Deflection (mm) in X-direction
Values
0
5
10
15
20
25
Basement 1
Basement 2
Ground
1
2
3
4
5
6
7
8
9
1.2
3.8
5.6
7.2
8.4
9.2
12.5
14.6
16.7
17.4
18.5
19.4
1.4
2.1
4.5
5.2
6.1
7.4
8.9
9.7
10.5
11.2
12.5
Without Basement Wall
With Basement Wall

Table 4.17 Lateral Deflections in Z-direction

Storey	**Without Basement Wall(mm)**	**With Basement Wall(mm)**	**Quantitative decrement (%)**
Basement 2	**3.2**	**1.5**	**53.12**
Basement 1	**4.5**	**2.8**	**37.77**
Ground	**5.8**	**12**	**79.31**
1	**7.8**	**3.5**	**55.12**
2	**10.5**	**4.5**	**57.14**
3	**12.1**	**6.5**	**46.28**
4	**13.75**	**8.2**	**40.36**
5	**15.25**	**9.5**	**37.70**
6	**17.4**	**11.2**	**35.63**
7	**19.5**	**12.5**	**35.89**
8	**20.5**	**13.7**	**33.17**
9	**22.7**	**14.5**	**36.12**



4.3.5 Storey Drifts(mm):

Storey Drift is defined as a ratio of displacement of two consecutive floor to height of that floor. It is very important term used for research purpose in earthquake engineering. It is an important criterion to represent the performance of the structure as per IS 1893: 2002 Part 1, Clause 7.11.1, page 28, the storey drift should be less than 0.004 times the height of the storey under consideration.

Table 4.18 Storey Drifts in X-direction

Storey	Without Basement Wall(mm)	With Basement Wall(mm)	Quantitative decrement (%)
Basement 2	2.1	1.5	28.57
Basement 1	2.5	1.4	44.00
Ground	2.9	1.1	62.06
1	3.5	2.5	28.57
2	2.4	2.2	8.333
3	2.1	1.9	9.523
4	1.8	1.7	5.555
5	1.7	1.65	2.941
6	1.6	1.51	5.625
7	1.3	1.25	3.846
8	1.1	0.9	18.18
9	1.0	0.85	15.00

Table 4.19 Storey Drifts in Z-direction

Storey	Without Basement Wall(mm)	With Basement Wall(mm)	Quantitative decrement (%)
Basement 2	2.15	0.4	81.39
Basement 1	2.21	0.6	72.85
Ground	2.45	0.75	69.38
1	2.75	1.45	47.27
2	1.95	1.25	35.89
3	1.75	1.15	34.28
4	1.65	1.10	33.33
5	1.45	1.01	30.34
6	1.25	0.90	28.00
7	1.15	0.75	34.78
8	1.05	0.65	38.09

9	**0.95**	**0.35**	**63.15**

CHAPTER 5

RESULTS & CONCLUSION

Based on the different analyses carried out above:

- It is concluded that the basement introduces flexibility to the structure resulting in larger lateral displacements and longer vibration periods. Lateral loads affect not only the response of the super structure but also that of the basement structure. Therefore, it is necessary to include the effect of basement in the design and analysis of high-rise building structures .
- It is concluded that due to the inclusion of basement walls it is observed that there is a change in the behavior of basement columns. The requirement of ductility demand is reduced. It is observed that due to basement walls roof displacements and base shear are reduced under seismic forces. Therefore, the effect of soft story damage is less observed in building with basement walls due to the stiffness obtained by the basement walls.

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