“SEISMIC ANALYSIS OF RC FRAMED BUILDINGS”

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Submitted by

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CANDIDATE'S DECLARATION

I, Mohd Junaid Malik, Roll No. 2K16/STE/11 Student of M Tech. (Structural Engineering), hereby declare that the project Dissertation titled "**Seismic Analysis of RC Framed Buildings**" which is submitted by me to the Department of Civil Engineering, Delhi Technological University, Delhi in partial fulfilment of the requirement for the award of the degree of Master of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associateship, Fellowship or other similar title or recognition.

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CERTIFICATE

I hereby certify that the Project Dissertation titled "**Seismic Analysis of RC Framed Buildings**" which is submitted by Mohd Junaid Malik, Roll No 2K16/STE/11, Department of Civil Engineering, Delhi Technological University, Delhi in partial fulfilment of the requirement for the award of the degree of Master of Technology, is a record of the project work carried out by the students under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

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ABSTRACT

Lateral load resisting systems like shear walls, bracing systems etc. greatly affect and improve the performance of structures which are subjected to lateral forces due to wind and seismic activities. The behaviour of building is strongly affected by the arrangement of shear walls, the rigidity of floors, bracing systems used and the type of structural system used like tubular structure, bundled tube structure, outrigger forms etc. Building with structural shear walls improves the lateral load resistance.

In this project, an analytical parameter study is done for the structural shear walls with varying locations to find the best location for shear wall for the given models. A comparative analytical study has been done between bare frame models and models with shear walls for different floors and heights. Different buildings with varying floor levels and varying in different zones of seismic activity and in varying soil i.e. soft, medium and hard soil have been analysed and compared. Load combinations that have been considered are as per IS 1893 (Part-1):2002 and IS 875. The result in terms of axial forces, lateral displacement and bending moment in the structural shear walls with varying height are compared for different building models considered.

It has been found that shear wall greatly improves the performance of the structure both in terms of serviceability as well as improving the load resistance.

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MOHD JUNAID MALIK

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1: INTRODUCTION

1.1 GENERAL

Earthquake is defined as sudden release of elastic energy by sudden slip on a fault which results in shaking of ground. Main effects of earthquake are shaking and ground rupture. Every year around 1 lakh earthquake of magnitude more than 3 hit the surface of earth. Moreover India, particularly the north-eastern region is one of the most earthquakes-prone regions of the world.

In India, IS 1893(Part 1): 2002, is used to calculate earthquake loads on the structures. Three methods of analysis have been given. In first method, static earthquake loads are obtained at each floor of building using empirical time period. This method is termed as Equivalent Static Analysis (ESA), it is very easy to use and is based on empirical time period and empirical distribution of earthquake loads on each floor along the height of the building. Second method is Response Spectrum Analysis (RSA), wherein, from the structural model of building, natural frequencies and natural modes are obtained. For this purpose, free vibration analysis is performed, wherein mass of structure is to be properly modelled. The third method is Time History Analysis (THA) in which dynamic response is obtained by using either modal superposition method or numerical integration method. Here time history of ground acceleration is used and dynamic response in the form of time history of response is obtained.

Lateral loads from earthquakes causes vibration, high stresses, and produce sway movement. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces. Shear walls are constructed to counter the effects of lateral loads acting on the structure. Reinforced concrete shear wall is best suited in building at especially in high seismic zone prone area because it provides adequate stiffer connection between structural elements and avoids the numerous hazards on building. Seismic behaviour of building depends on location of shear wall in building and many research papers have not mentioned the exact location of shear wall in building to improve the maximum stiffness and strength against lateral force.

1.2 LATERAL LOAD RESISTING SYSTEM

1.2.1 REINFORCED CONCRETE SHEAR WALL

Shear wall is the best lateral load resisting system in tall building at high seismic zone areas. It is a concrete cantilever wall provided in a RC frame building to give flexural stiffness and strength to the structural members against earthquake. Shear walls resist in plane loads that are applied along its height. Construction of shear wall in building is economical only up to limited stories. Shear wall will give rigid connection between wall and frame members and it is usually provided in lift core, stair case and instead of conventional load bearing walls.

1.2.2 BRACING SYSTEM

Bracing is a most efficient and economical lateral load resisting system in tall building either of steel or R.C frame to give better performance against earthquake different types of bracings are available like single diagonal bracing, double diagonal bracing, K bracing, V-bracing and Knee bracing are available. Diagonal bracings installed between two lines of column not only does it transfer the horizontal loads to the foundation but also helps in withstanding the overall sway of the structure. Cross diagonal bracings are slender and withstand tension forces only and they do not resist compressive forces. Whereas single diagonal bracing are designed to resist both tensile as well as compressive forces. Bracing elements are commonly placed at nearly 45 degree so that they offer strong and compact connections between bracing member and beam column junction. Also if the bracing member inclination is smaller than 45 degree then the sway sensitivity of the structure is increased whereas wider bracing arrangement provides greater structural stability. It is advised to place the vertical bracing planes at the furthest point of the structure to withstand torsion forces that may occur due to horizontal forces.

1.3 LITERATURE REVIEW

1. Mohd. Atif: In this paper, they have analyzed and compared G +15 building with shear wall and three different patterns of bracings in 3 different locations, considering all the four zones for earthquake. Parameter like displacement, axial force, bending moments of columns and shear moment, torsion for beams are calculated. They have adopted Linear Static Analysis method. They have concluded that shear wall elements are very effective in reducing lateral displacement of frame than that induced in braced frame and plane frame. The lateral displacements of building studied are reduced by the using X-type bracing system.
2. Varsha R. Harne: Models were prepared in Staad pro by using different cross sections of RC shear wall i.e. Boxed type, L-type and Cross type shear wall and these are located at different locations such as along periphery, at corner and at middle position. It is concluded that building with shear wall along periphery is more efficient than all other types of shear wall.
3. Prof. Bhosale Ashwini Tanaji: They have used the various types of concrete bracings i.e. K-type, Diagonal, V-type and X-type of bracings and calculated the storey drift and displacement of building. They have concluded that the storey displacement of building is reduced by the use of concrete bracings; also X-type of bracing reduces maximum displacement. The storey drift of concrete braced system is less as compared to the unbraced building thus the overall response of the building decreases.
4. MD. Samdhani Azad: This paper focuses on the building behaviour against seismic forces either by shear wall or steel bracing. The analysis of both systems either shear wall or steel bracing systems was done using ETABS Software and analyzed to determine the behaviour and performance of each models. According to their results, they have compared the maximum displacement and storey drift of models. They concluded that the model, shear wall at mid portion is the safest among the other models assessed in the research purpose.
5. Abhijeet Bairikar and Kanehan Kanagali: In this paper square grid building models of different heights were considered with different lateral load resisting system i.e. shear wall and bracing. Response like deformation, base shear and storey drift were analysed for different soil conditions as per IS 1893-2002 for high seismic zones of V. They concluded that the base shear and storey drift gradually increase in different soil condition. Time period in a bare frame building is high but after providing shear wall and bracing in the building time period, storey drift and nodal displacement are reduced.
6. Verma S.K, Roshan Lal and Raman Kumar (2014): 10 and 15 storied RC frames were modelled in STAAD-Pro with shear wall at different location like internal frame, external frame, central frame and combine external internal frame. Seismic analysis carried out in STAAD-PRO using seismic response method and then compared the results of storey drift, average displacement of model with 4 different location of shear wall in building to arrive at the ideal location of shear wall. It was concluded that in terms of location; shear wall at corner gives better performance and is most efficient in reducing the storey drift and displacement of the building.

7. Ugale Ashish B. and Raut Harshlata R conducted an analysis on behaviour of shear wall in G+6 building located in seismic zone III and compared it with a building frame without any shear wall. The building with shear wall showed very less deflection, shear force and bending moment and overall stiffness was found to be increased. It was found that Steel plate shear walls occupy less space than RCC Shear wall.

8. V. Abhinav has performed seismic analysis of multi-storey building with the shear wall on 11 floored RCC building in zone 5 and earthquake load has been calculated by seismic coefficient method using IS 1893 (Part I): 2002. 3 models of the building analysed were, model with the shear wall at corner, model with shear wall along periphery and model with shear wall at the middle of the building. The comparative analysis for deflection of the building with and without a shear wall was carried out in X and Z directions. The lateral deflection for building with the shear wall along periphery is reduced in comparison to other models. Hence, it has been concluded that the building with the shear wall along periphery seems to be more efficient than all other models with a shear wall.

9. Md. Samdani Azad has performed a comparative study of seismic analysis of multi-storey buildings with shear walls and bracing systems. Numerical approach to show dissimilarity between the shear wall system and steel bracing system has bee done. The overall analysis has been carried out using the ETABS9.7 software. Six models were prepared for a comparative study. The First model was having a shear wall at a middle portion, second model was having a shear wall at a side portion, third model was having bracing at a centre, fourth model was having bracing at a side, the fifth model was having floor bracing at middle and sixth model was having floor bracing at a side. It has been concluded from the results that model one was the safest among the six models.

10. Shubham R. Kasat have performed a comparative study of a multi-storey building under the action of a shear wall using ETAB software for achieving economy in reinforced concrete building structures. The design of critical section is carefully done to get reasonable concrete sizes and optimum steel consumption in members. A regular plan of 20 m X 20 m size is considered for 18 storey building with 4 m storey height and 2 m for the base storey. The models of 18 storey building are made with and without shear wall by static analysis method for earthquake zone III. The building is analyzed using ETAB v9.2.0 software. The results are compared in terms of displacement, storey drift, and base shear. It is concluded that buildings with shear wall are economical as compared to without shear wall.

1.4 MODELLING OF STRUCTURE

1.4.1 DESCRIPTION OF THE BUILDING

Size of the building in plan: 28 m × 28 m
Type of structure: Multi-storeyed RC structure
Storey height: 3.2 m
Following models have been considered for the analysis:

TABLE 1.1 Models Analysed

	WITHOUT SHEAR WALL			WITH SHEAR WALL		
	HARD SOIL	MEDIUM SOIL	SOFT SOIL	HARD SOIL	MEDIUM SOIL	SOFT SOIL
ZONE 2	G+5	G+5	G+5	G+5	G+5	G+5
	G+10	G+10	G+10	G+10	G+10	G+10
	G+15	G+15	G+15	G+15	G+15	G+15
ZONE 3	G+5	G+5	G+5	G+5	G+5	G+5
	G+10	G+10	G+10	G+10	G+10	G+10
	G+15	G+15	G+15	G+15	G+15	G+15
ZONE 4	G+5	G+5	G+5	G+5	G+5	G+5
	G+10	G+10	G+10	G+10	G+10	G+10
	G+15	G+15	G+15	G+15	G+15	G+15
ZONE 5	G+5	G+5	G+5	G+5	G+5	G+5
	G+10	G+10	G+10	G+10	G+10	G+10
	G+15	G+15	G+15	G+15	G+15	G+15

1.4.2 MEMBER DIMENSIONS

Slab thickness: 125 mm
Beam size: 200 mm × 200 mm
Shear Wall thickness: 200 mm
Bracings: ISMB 200
All the supports are assumed to be fixed in nature.

1.4.3 MODEL OF STRUCTURE

The modelling and analysis are done using STAAD ProV8i software, and then the nodal displacements, storey drift, bending moments and axial forces have been obtained after the analysis of buildings in different seismic zones and soil condition for different floor levels i.e. G+5, G+10 and G+15.

1.5 LOADS CONSIDERED

Loads and load combinations are considered as per Indian Standards (IS 875:1987, IS 1893:2002 and IS 800:2007).

1.5.1 GRAVITY LOADING

Floor load and Dead loads are calculated as per general considerations as per IS 875 Part- I.
Floor Finish – 1 kN/m^2
Live load –3 kN/m^2
Wall load – 14.72 KN/m

1.5.2 SEISMIC LOADING

The design horizontal seismic coefficient A_h for a structure shall be determined by the following expression:

$$A_h = \frac{ZIS_a}{2Rg}$$

Where,
Z: Zone factor given in (Table 2)
I: Importance factor, depending upon the functional use of the structures, characterised by hazardous consequences of its failure, post-earthquake functional needs, historical value, or economic importance (Table 6).
R: Response reduction factor, depending on the perceived seismic damage performance of the structure, characterised by ductile or brittle deformations (Table 7)
Sa/g: Average response acceleration coefficient

1.5.2.1 DESIGN SEISMIC BASE SHEAR

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

$$\mathbf{V_b = A_h \times W}$$

Where,
Ah = Design horizontal acceleration spectrum value
W = Seismic weight of the building

1.5.2.2 FUNDAMENTAL NATURAL PERIOD

The approximate fundamental natural period of vibration (Ta), in seconds, of a moment-resisting frame building without brick infill panels may be estimated by the empirical expression: $\mathbf{T = 0.075\ h^{0.75}}$

1.5.2.3 VERTICAL DISTRIBUTION OF BASE SHEAR TO DIFFERENT FLOOR LEVEL

The design base shear (V) shall be distributed along the height of the building as per the following expression:

$$Q_i = V_b \frac{W_i h_i^2}{\sum Wjh_j^2}$$

Qi =Design lateral force at floor
W_i =Seismic weight of floor i,
h_i =Height of floor i measured from base,
And n=Number of storeys in the building is the number of levels at which the masses are located.

CHAPTER 2: BARE FRAME MODELS

Framed buildings with only beams, columns and slabs and without any shear wall and bracings were modelled and analysed in STAAD-PRO for different floor levels i.e. G+5, G+10, G+15, in different seismic zones i.e. zone 2, zone 3, zone 4, and zone 5 and in different soil condition i.e. soft, medium and hard soil to compare them for different parameters like seismic base shear, distribution of base shear to different floors, storey shear, top storey displacement and storey drift.

2.1 LOADS CONSIDERED

2.1.1 DEAD AND LIVE LOADS

Following loadings were considered:

1. SELFWEIGHT
2. FLOOR FINISH: 1 kN/m^2
3. LOAD FROM THE BRICK WALLS: 14.72 kN/m
4. LIVE LOAD: 3 kN/m^2

2.1.2 SEISMIC LOADS

Building models were loaded with seismic loads and the following parameters were considered:

Importance Factor (I): 1

Response Reduction Factor (R): 5

Other parameters were considered as per floor height and as per the seismic zones in which the building is being modelled.

2.2 DISTRIBUTION OF BASE SHEAR TO DIFFERENT FLOORS

2.2.1 DISTRIBUTION OF BASE SHEAR IN HARD SOIL

2.2.1.1 G+5 BUILDING MODELS

Seismic calculations for G+5 building in hard soil are as follows:

A. ZONE 2

TABLE 2.1 Base Shear Distributions of G+5 Building in Hard Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	3709	19.2	1367285.8	154.3	145.0
4	5661	16	1449216.0	163.6	187.3
3	6891	12.8	1129021.4	127.4	119.8
2	6891	9.6	635074.6	71.7	67.4
1	6895	6.4	282419.2	31.9	30.0
G	6896	3.2	70615.0	8.0	7.5
SUM			4933632	556.9	556.9

B. ZONE 3

TABLE 2.2 Base Shear Distributions of G+5 Building in Hard Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	3709	19.2	1367285.8	246.9	232.0
4	5661	16	1449216.0	261.7	299.7
3	6891	12.8	1129021.4	203.9	191.6
2	6891	9.6	635074.6	114.7	107.8
1	6895	6.4	282419.2	51.0	47.9
G	6896	3.2	70615.0	12.8	12.0
SUM			4933632	891.0	891.0

C. ZONE 4

TABLE 2.3 Base Shear Distributions of G+5 Building in Hard Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	3709	19.2	1367285.8	370.4	348.7
4	5661	16	1449216.0	392.6	450.3
3	6891	12.8	1129021.4	305.9	288.0
2	6891	9.6	635074.6	172.0	162.2
1	6895	6.4	282419.2	76.5	72.2
G	6896	3.2	70615.0	19.1	18.1
SUM			4933632	1336.6	1339.5

D. ZONE 5

TABLE 2.4 Base Shear Distributions of G+5 Building in Hard Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	3709	19.2	1367255.6	559.9	533.2
4	5669	16	1451374.6	594.3	689.4
3	6911	12.8	1132300.4	463.6	442.4
2	6933	9.6	638930.1	261.6	249.7
1	6975	6.4	285687.0	117.0	111.4
G	7048	3.2	72176.3	29.6	28.1
SUM			4947724.03	2026.0	2054.3

2.2.1.2 G+10 BUILDING MODELS

Seismic calculations for G+10 building in hard soil are as follows:

A. ZONE 2

TABLE 2.5 Base Shear Distributions of G+10 Building in Hard Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	3718	35.2	4606734.8	102.5	108.0
9	5670	32.0	5806078.9	129.2	158.2
8	6891	28.8	5715346.2	127.2	127.8
7	6891	25.6	4515829.1	100.5	101.0
6	6891	22.4	3457431.6	77.0	77.3
5	6897	19.2	2542661.2	56.6	56.9
4	6907	16.0	1768203.7	39.4	39.5
3	6940	12.8	1137129.5	25.3	25.3
2	6961	9.6	641550.7	14.3	14.3
1	6962	6.4	285156.9	6.3	6.4
G	6974	3.2	71415.0	1.6	1.6
SUM			30547537.5	680.0	716.4

B. ZONE 3

TABLE 2.6 Base Shear Distributions of G+10 Building in Hard Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	3718	35.2	4606734.8	164.0	172.9
9	5670	32.0	5806078.9	206.7	253.1
8	6891	28.8	5715346.2	203.4	204.5
7	6891	25.6	4515829.1	160.7	161.6
6	6891	22.4	3457716.0	123.1	123.7
5	6899	19.2	2543288.1	90.5	91.0
4	6911	16.0	1769219.4	63.0	63.3
3	6938	12.8	1136789.0	40.5	40.6
2	6956	9.6	641098.0	22.8	22.9
1	6962	6.4	285156.9	10.1	10.2
G	6974	3.2	71415.0	2.5	2.6
SUM			30548671.2	1087.3	1146.3

C. ZONE 4

TABLE 2.7 Base Shear Distributions of G+10 Building in Hard Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	3718	35.2	4606734.8	244.9	279.9
9	5670	32.0	5806078.9	308.7	409.2
8	7069	28.8	5863438.1	311.7	332.4
7	7120	25.6	4666271.7	248.1	264.4
6	6993	22.4	3508623.9	186.5	202.5
5	6994	19.2	2578252.1	137.1	148.8
4	6997	16.0	1791130.0	95.2	103.4
3	7022	12.8	1150440.2	61.2	66.2
2	7026	9.6	647488.3	34.4	37.2
1	7016	6.4	287366.3	15.3	16.6
G	7050	3.2	72186.9	3.8	4.2
SUM			30978011.2	1646.9	1864.6

D. ZONE 5

TABLE 2.8 Base Shear Distributions of G+10 Building in Hard Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	3728	35.2	4618673.9	370.2	391.7
9	5705	32.0	5842064.4	468.2	574.8
8	6942	28.8	5757658.2	461.5	465.7
7	6958	25.6	4559785.6	365.4	368.8
6	6986	22.4	3505448.1	280.9	283.3
5	7014	19.2	2585565.2	207.2	209.0
4	7030	16.0	1799691.0	144.2	145.4
3	7034	12.8	1152514.2	92.4	93.1
2	7054	9.6	650135.0	52.1	52.5
1	7075	6.4	289800.1	23.2	23.4
G	7095	3.2	72657.0	5.8	5.9
SUM			30833992.7	2471.2	2613.7

2.2.1.3 G+15 BUILDING MODELS

Seismic calculations for G+15 building in hard soil are as follows:

A. ZONE 2

TABLE 2.9 Base Shear Distributions of G+15 Building in Hard Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	3728	51.2	9771739.7	78.0	75.7
14	5705	48.0	13144645.0	104.9	123.9
13	6942	44.8	13932111.1	111.2	107.9
12	6942	41.6	12012891.7	95.9	93.1
11	6942	38.4	10235836.7	81.7	79.3
10	6942	35.2	8600946.1	68.6	66.6
9	6942	32.0	7108219.9	56.7	55.1
8	6942	28.8	5757658.2	45.9	44.6
7	6942	25.6	4549260.8	36.3	35.3
6	6970	22.4	3497153.1	27.9	27.1
5	6998	19.2	2579714.7	20.6	20.0
4	7003	16.0	1792822.8	14.3	13.9
3	7060	12.8	1156724.1	9.2	9.0
2	7115	9.6	655689.5	5.2	5.1
1	7149	6.4	292810.5	2.3	2.3
G	7183	3.2	73550.9	0.6	0.6
SUM			95161774.8	759.4	759.4

B. ZONE 3

TABLE 2.10 Base Shear Distributions of G+15 Building in Hard Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	3728	51.2	9771739.7	124.8	121.1
14	5705	48.0	13144645.0	167.8	198.3
13	6942	44.8	13932111.1	177.9	172.7
12	6942	41.6	12012891.7	153.4	148.9
11	6942	38.4	10235836.7	130.7	126.9
10	6942	35.2	8600946.1	109.8	106.6
9	6942	32.0	7108219.9	90.8	88.1
8	6942	28.8	5757658.2	73.5	71.4
7	6944	25.6	4550746.6	58.1	56.4
6	6972	22.4	3498290.7	44.7	43.4
5	6998	19.2	2579714.7	32.9	32.0
4	7003	16.0	1792822.8	22.9	22.2
3	7060	12.8	1156724.1	14.8	14.3
2	7115	9.6	655689.5	8.4	8.1
1	7149	6.4	292810.5	3.7	3.6
G	7183	3.2	73550.9	0.9	0.9
SUM			95164398.3	1215.1	1215.0

C. ZONE 4

TABLE 2.11 Base Shear Distributions of G+15 Building in Hard Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	3728	51.2	9771739.7	187.2	181.7
14	5705	48.0	13144645.0	251.8	297.5
13	6942	44.8	13932111.1	266.9	259.1
12	6942	41.6	12012891.7	230.1	223.4
11	6942	38.4	10235836.7	196.1	190.3
10	6944	35.2	8603755.3	164.8	160.0
9	6948	32.0	7114701.2	136.3	132.3
8	6954	28.8	5768001.1	110.5	107.3
7	6961	25.6	4562200.1	87.4	84.8
6	6984	22.4	3504168.3	67.1	65.2
5	7004	19.2	2581908.6	49.5	48.0
4	7009	16.0	1794177.1	34.4	33.4
3	7062	12.8	1157049.2	22.2	21.5
2	7115	9.6	655689.5	12.6	12.2
1	7149	6.4	292810.5	5.6	5.4
G	7183	3.2	73550.9	1.4	1.4
SUM			95205236.0	1823.7	1823.5

D. ZONE 5

TABLE 2.12 Base Shear Distributions of G+15 Building in Hard Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	3728	51.2	9771739.7	282.1	273.9
14	5705	48.0	13144645.0	379.4	448.3
13	6942	44.8	13932111.1	402.2	390.5
12	6969	41.6	12060465.1	348.1	338.0
11	6999	38.4	10320808.9	297.9	289.3
10	7007	35.2	8682178.6	250.6	243.4
9	7021	32.0	7189284.1	207.5	201.5
8	7031	28.8	5831939.2	168.3	163.5
7	7037	25.6	4612038.1	133.1	129.3
6	7082	22.4	3553417.2	102.6	99.6
5	7128	19.2	2627772.8	75.9	73.6
4	7131	16.0	1825519.3	52.7	51.1
3	7154	12.8	1172047.0	33.8	32.9
2	7181	9.6	661827.4	19.1	18.6
1	7207	6.4	295190.2	8.5	8.3
G	7297	3.2	74725.2	2.2	2.1
SUM			95755708.9	2764.1	2763.8

2.2.2 DISTRIBUTION OF BASE SHEAR IN MEDIUM SOIL

2.2.2.1 G+5 BUILDING MODELS

Seismic calculations for G+5 building in medium soil are as follows:

A. ZONE 2

TABLE 2.13 Base Shear Distributions of G+5 Building in medium Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	3709	19.2	1367285.8	209.9	197.2
4	5661	16	1449216.0	222.5	254.7
3	6891	12.8	1129021.4	173.3	162.9
2	6891	9.6	635074.6	97.5	91.6
1	6895	6.4	282419.2	43.4	40.7
G	6896	3.2	70615.0	10.8	10.2
SUM			4933632	757.4	757.4

B. ZONE 3

TABLE 2.14 Base Shear Distributions of G+5 Building in medium Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	3709	19.2	1367285.8	335.8	315.6
4	5661	16	1449216.0	356.0	407.6
3	6891	12.8	1129021.4	277.3	260.6
2	6891	9.6	635074.6	156.0	146.6
1	6895	6.4	282419.2	69.4	65.2
G	6896	3.2	70615.0	17.3	16.3
SUM			4933632.0	1211.8	1211.8

C. ZONE 4

TABLE 2.15 Base Shear Distributions of G+5 Building in medium Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	3709	19.2	1367285.8	503.8	474.2
4	5661	16.0	1449216.0	533.9	612.4
3	6891	12.8	1129021.4	416.0	391.7
2	6891	9.6	635074.6	234.0	220.6
1	6895	6.4	282419.2	104.1	98.2
G	6896	3.2	70615.0	26.0	24.6
SUM			4933632.0	1817.7	1821.8

D. ZONE 5

TABLE 2.16 Base Shear Distributions of G+5 Building in medium Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	3709	19.2	1367255.6	761.4	725.1
4	5669	16.0	1451374.6	808.3	937.6
3	6911	12.8	1132300.4	630.6	601.7
2	6933	9.6	638930.1	355.8	339.5
1	6975	6.4	285687.0	159.1	151.5
G	7048	3.2	72176.3	40.2	38.3
SUM			4947724.0	2755.3	2793.8

2.2.2.2 G+10 BUILDING MODELS

Seismic calculations for G+10 buildings in medium soil are as follows:

A. ZONE 2

TABLE 2.17 Base Shear Distributions of G+10 Building in medium Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	3718	35.2	4606734.8	139.5	146.9
9	5670	32.0	5806078.9	175.8	215.1
8	6891	28.8	5715346.2	173.0	173.9
7	6891	25.6	4515829.1	136.7	137.4
6	6891	22.4	3457431.6	104.7	105.2
5	6897	19.2	2542661.2	77.0	77.3
4	6907	16.0	1768203.7	53.5	53.8
3	6940	12.8	1137129.5	34.4	34.5
2	6961	9.6	641550.7	19.4	19.4
1	6962	6.4	285156.9	8.6	8.7
G	6974	3.2	71415.0	2.2	2.2
SUM			30547537.5	924.8	974.3

B. ZONE 3

TABLE 2.18 Base Shear Distributions of G+10 Building in medium Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	3718	35.2	4606734.8	223.0	235.1
9	5670	32.0	5806078.9	281.1	344.2
8	6891	28.8	5715346.2	276.7	278.2
7	6891	25.6	4515829.1	218.6	219.8
6	6891	22.4	3457716.0	167.4	168.3
5	6899	19.2	2543288.1	123.1	123.8
4	6911	16.0	1769219.4	85.6	86.1
3	6938	12.8	1136789.0	55.0	55.1
2	6956	9.6	641098.0	31.0	31.1
1	6962	6.4	285156.9	13.8	13.9
G	6974	3.2	71415.0	3.5	3.5
SUM			30548671.2	1478.8	1559.0

C. ZONE 4

TABLE 2.19 Base Shear Distributions of G+10 Building in medium Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	3718	35.2	4606734.8	333.1	380.7
9	5670	32.0	5806078.9	419.8	556.5
8	7069	28.8	5863438.1	424.0	452.0
7	7120	25.6	4666271.7	337.4	359.6
6	6993	22.4	3508623.9	253.7	275.3
5	6994	19.2	2578252.1	186.4	202.3
4	6997	16.0	1791130.0	129.5	140.6
3	7022	12.8	1150440.2	83.2	90.0
2	7026	9.6	647488.3	46.8	50.7
1	7016	6.4	287366.3	20.8	22.5
G	7050	3.2	72186.9	5.2	5.6
SUM			30978011.2	2239.8	2535.9

D. ZONE 5

TABLE 2.20 Base Shear Distributions of G+10 Building in medium Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	3728	35.2	4618673.9	503.4	532.7
9	5705	32.0	5842064.4	636.8	781.7
8	6942	28.8	5757658.2	627.6	633.4
7	6958	25.6	4559785.6	497.0	501.6
6	6986	22.4	3505448.1	382.1	385.4
5	7014	19.2	2585565.2	281.8	284.2
4	7030	16.0	1799691.0	196.2	197.8
3	7034	12.8	1152514.2	125.6	126.6
2	7054	9.6	650135.0	70.9	71.4
1	7075	6.4	289800.1	31.6	31.8
G	7095	3.2	72657.0	7.9	8.0
SUM			30833992.7	3360.8	3554.6

2.2.2.3 G+15 BUILDING MODELS

A. ZONE 2

TABLE 2.21 Base Shear Distributions of G+15 Building in medium Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	3728	51.2	9771739.7	106.1	103.0
14	5705	48.0	13144645.0	142.7	168.5
13	6942	44.8	13932111.1	151.2	146.8
12	6942	41.6	12012891.7	130.4	126.6
11	6942	38.4	10235836.7	111.1	107.9
10	6942	35.2	8600946.1	93.3	90.6
9	6942	32.0	7108219.9	77.1	74.9
8	6942	28.8	5757658.2	62.5	60.7
7	6942	25.6	4549260.8	49.4	48.0
6	6970	22.4	3497153.1	38.0	36.9
5	6998	19.2	2579714.7	28.0	27.2
4	7003	16.0	1792822.8	19.5	18.9
3	7060	12.8	1156724.1	12.6	12.2
2	7115	9.6	655689.5	7.1	6.9
1	7149	6.4	292810.5	3.2	3.1
G	7183	3.2	73550.9	0.8	0.8
SUM			95161774.8	1032.8	1032.8

B. ZONE 3

TABLE 2.22 Base Shear Distributions of G+15 Building in medium Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	3728	51.2	9771739.7	169.7	164.7
14	5705	48.0	13144645.0	228.3	269.7
13	6942	44.8	13932111.1	241.9	234.9
12	6942	41.6	12012891.7	208.6	202.5
11	6942	38.4	10235836.7	177.7	172.6
10	6942	35.2	8600946.1	149.4	145.0
9	6942	32.0	7108219.9	123.4	119.8
8	6942	28.8	5757658.2	100.0	97.1
7	6944	25.6	4550746.6	79.0	76.7
6	6972	22.4	3498290.7	60.7	59.0
5	6998	19.2	2579714.7	44.8	43.5
4	7003	16.0	1792822.8	31.1	30.2
3	7060	12.8	1156724.1	20.1	19.5
2	7115	9.6	655689.5	11.4	11.1
1	7149	6.4	292810.5	5.1	4.9
G	7183	3.2	73550.9	1.3	1.2
SUM			95164398.3	1652.5	1652.5

C. ZONE 4

TABLE 2.23 Base Shear Distributions of G+15 Building in medium Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	3728	51.2	9771739.7	254.6	247.2
14	5705	48.0	13144645.0	342.4	404.5
13	6942	44.8	13932111.1	363.0	352.4
12	6942	41.6	12012891.7	313.0	303.9
11	6942	38.4	10235836.7	266.7	258.9
10	6944	35.2	8603755.3	224.1	217.6
9	6948	32.0	7114701.2	185.3	180.0
8	6954	28.8	5768001.1	150.3	145.9
7	6961	25.6	4562200.1	118.9	115.4
6	6984	22.4	3504168.3	91.3	88.6
5	7004	19.2	2581908.6	67.3	65.3
4	7009	16.0	1794177.1	46.7	45.4
3	7062	12.8	1157049.2	30.1	29.3
2	7115	9.6	655689.5	17.1	16.6
1	7149	6.4	292810.5	7.6	7.4
G	7183	3.2	73550.9	1.9	1.9
SUM			95205236.0	2480.3	2480.2

D. ZONE 5

TABLE 2.24 Base Shear Distributions of G+15 Building in medium Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	3728	51.2	9771739.7	383.6	372.5
14	5705	48.0	13144645.0	516.0	609.7
13	6942	44.8	13932111.1	547.0	531.1
12	6969	41.6	12060465.1	473.5	459.8
11	6999	38.4	10320808.9	405.2	393.4
10	7007	35.2	8682178.6	340.8	331.0
9	7021	32.0	7189284.1	282.2	274.1
8	7031	28.8	5831939.2	229.0	222.3
7	7037	25.6	4612038.1	181.1	175.8
6	7082	22.4	3553417.2	139.5	135.5
5	7128	19.2	2627772.8	103.2	100.1
4	7131	16.0	1825519.3	71.7	69.5
3	7154	12.8	1172047.0	46.0	44.7
2	7181	9.6	661827.4	26.0	25.2
1	7207	6.4	295190.2	11.6	11.3
G	7297	3.2	74725.2	2.9	2.8
SUM			95755708.9	3759.2	3758.8

2.2.3 DISTRIBUTION OF BASE SHEAR IN SOFT SOIL

2.2.3.1 G+5 BUILDING MODELS

Seismic calculations for G+5 building in soft soil are as follows:

A. ZONE 2

TABLE 2.25 Base Shear Distributions of G+5 Building in soft Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	3709	19.2	1367285.8	257.7	242.2
4	5661	16	1449216.0	273.2	312.8
3	6891	12.8	1129021.4	212.8	200.0
2	6891	9.6	635074.6	119.7	112.5
1	6895	6.4	282419.2	53.2	50.0
G	6896	3.2	70615.0	13.3	12.5
SUM			4933632	930.0	930.0

B. ZONE 3

TABLE 2.26 Base Shear Distributions of G+5 Building in soft Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	3709	19.2	1367285.8	412.4	387.5
4	5661	16	1449216.0	437.1	500.5
3	6891	12.8	1129021.4	340.5	320.0
2	6891	9.6	635074.6	191.5	180.0
1	6895	6.4	282419.2	85.2	80.0
G	6896	3.2	70615.0	21.3	20.0
SUM			4933632	1488.0	1488.0

C. ZONE 4

TABLE 2.27 Base Shear Distributions of G+5 Building in soft Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	3709	19.2	1367285.8	618.6	582.3
4	5661	16	1449216.0	655.6	752.1
3	6891	12.8	1129021.4	510.8	481.0
2	6891	9.6	635074.6	287.3	270.9
1	6895	6.4	282419.2	127.8	120.6
G	6896	3.2	70615.0	31.9	30.2
SUM			4933632	2232.1	2237.0

D. ZONE 5

TABLE 2.28 Base Shear Distributions of G+5 Building in soft Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	3709	19.2	1367255.6	935.0	890.4
4	5669	16	1451374.6	992.5	1151.4
3	6911	12.8	1132300.4	774.3	738.9
2	6933	9.6	638930.1	436.9	416.9
1	6975	6.4	285687.0	195.4	186.1
G	7048	3.2	72176.3	49.4	47.0
SUM			4947724.0	3383.4	3430.6

2.2.3.2 G+10 BUILDING MODELS

Seismic calculations for G+10 building in soft soil are as follows:

A. ZONE 2

TABLE 2.29 Base Shear Distributions of G+10 Building in soft Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	3718	35.2	4606734.8	171.3	180.4
9	5670	32.0	5806078.9	215.8	264.1
8	6891	28.8	5715346.2	212.5	213.5
7	6891	25.6	4515829.1	167.9	168.7
6	6891	22.4	3457431.6	128.5	129.1
5	6897	19.2	2542661.2	94.5	95.0
4	6907	16.0	1768203.7	65.7	66.0
3	6940	12.8	1137129.5	42.3	42.3
2	6961	9.6	641550.7	23.8	23.9
1	6962	6.4	285156.9	10.6	10.6
G	6974	3.2	71415.0	2.7	2.7
SUM			30547537.5	1135.6	1196.3

B. ZONE 3

TABLE 2.30 Base Shear Distributions of G+10 Building in soft Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	3718	35.2	4606734.8	273.8	288.7
9	5670	32.0	5806078.9	345.1	422.6
8	6891	28.8	5715346.2	339.7	341.6
7	6891	25.6	4515829.1	268.4	269.9
6	6891	22.4	3457716.0	205.5	206.7
5	6899	19.2	2543288.1	151.2	152.0
4	6911	16.0	1769219.4	105.2	105.7
3	6938	12.8	1136789.0	67.6	67.7
2	6956	9.6	641098.0	38.1	38.2
1	6962	6.4	285156.9	17.0	17.0
G	6974	3.2	71415.0	4.2	4.3
SUM			30548671.2	1815.9	1914.4

C. ZONE 4

TABLE 2.31 Base Shear Distributions of G+10 Building in soft Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	3718	35.2	4606734.8	409.0	467.5
9	5670	32.0	5806078.9	515.5	683.3
8	7069	28.8	5863438.1	520.6	555.1
7	7120	25.6	4666271.7	414.3	441.6
6	6993	22.4	3508623.9	311.5	338.1
5	6994	19.2	2578252.1	228.9	248.5
4	6997	16.0	1791130.0	159.0	172.6
3	7022	12.8	1150440.2	102.1	110.5
2	7026	9.6	647488.3	57.5	62.2
1	7016	6.4	287366.3	25.5	27.7
G	7050	3.2	72186.9	6.4	6.9
SUM			30978011.2	2750.4	3113.9

D. ZONE 5

TABLE 2.32 Base Shear Distributions of G+10 Building in soft Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	3728	35.2	4618673.9	618.2	654.1
9	5705	32.0	5842064.4	781.9	959.9
8	6942	28.8	5757658.2	770.6	777.8
7	6958	25.6	4559785.6	610.3	615.9
6	6986	22.4	3505448.1	469.2	473.2
5	7014	19.2	2585565.2	346.1	348.9
4	7030	16.0	1799691.0	240.9	242.9
3	7034	12.8	1152514.2	154.3	155.5
2	7054	9.6	650135.0	87.0	87.7
1	7075	6.4	289800.1	38.8	39.1
G	7095	3.2	72657.0	9.7	9.8
SUM			30833992.7	4126.9	4364.8

2.2.3.3 G+15 BUILDING MODELS

Seismic calculations for G+15 building in soft soil are as follows:

A. ZONE 2

TABLE 2.33 Base Shear Distributions of G+15 Building in soft Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	3728	51.2	9771739.7	130.2	126.4
14	5705	48.0	13144645.0	175.2	206.9
13	6942	44.8	13932111.1	185.7	180.3
12	6942	41.6	12012891.7	160.1	155.4
11	6942	38.4	10235836.7	136.4	132.4
10	6942	35.2	8600946.1	114.6	111.3
9	6942	32.0	7108219.9	94.7	92.0
8	6942	28.8	5757658.2	76.7	74.5
7	6942	25.6	4549260.8	60.6	58.9
6	6970	22.4	3497153.1	46.6	45.3
5	6998	19.2	2579714.7	34.4	33.4
4	7003	16.0	1792822.8	23.9	23.2
3	7060	12.8	1156724.1	15.4	15.0
2	7115	9.6	655689.5	8.7	8.5
1	7149	6.4	292810.5	3.9	3.8
G	7183	3.2	73550.9	1.0	1.0
SUM			95161774.8	1268.2	1268.2

B. ZONE 3

TABLE 2.34 Base Shear Distributions of G+15 Building in soft Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	3728	51.2	9771739.7	208.4	202.3
14	5705	48.0	13144645.0	280.3	331.1
13	6942	44.8	13932111.1	297.1	288.4
12	6942	41.6	12012891.7	256.2	248.7
11	6942	38.4	10235836.7	218.3	211.9
10	6942	35.2	8600946.1	183.4	178.1
9	6942	32.0	7108219.9	151.6	147.2
8	6942	28.8	5757658.2	122.8	119.2
7	6944	25.6	4550746.6	97.0	94.2
6	6972	22.4	3498290.7	74.6	72.4
5	6998	19.2	2579714.7	55.0	53.4
4	7003	16.0	1792822.8	38.2	37.1
3	7060	12.8	1156724.1	24.7	23.9
2	7115	9.6	655689.5	14.0	13.6
1	7149	6.4	292810.5	6.2	6.1
G	7183	3.2	73550.9	1.6	1.5
SUM			95164398.3	2029.2	2029.2

C. ZONE 4

TABLE 2.35 Base Shear Distributions of G+15 Building in soft Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	3728	51.2	9771739.7	312.6	303.5
14	5705	48.0	13144645.0	420.5	496.8
13	6942	44.8	13932111.1	445.7	432.7
12	6942	41.6	12012891.7	384.3	373.1
11	6942	38.4	10235836.7	327.4	317.9
10	6944	35.2	8603755.3	275.2	267.2
9	6948	32.0	7114701.2	227.6	221.0
8	6954	28.8	5768001.1	184.5	179.2
7	6961	25.6	4562200.1	145.9	141.7
6	6984	22.4	3504168.3	112.1	108.8
5	7004	19.2	2581908.6	82.6	80.2
4	7009	16.0	1794177.1	57.4	55.7
3	7062	12.8	1157049.2	37.0	35.9
2	7115	9.6	655689.5	21.0	20.4
1	7149	6.4	292810.5	9.4	9.1
G	7183	3.2	73550.9	2.4	2.3
SUM			95205236.0	3045.6	3045.5

D. ZONE 5

TABLE 2.36 Base Shear Distributions of G+15 Building in soft Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	3728	51.2	9771739.7	471.1	457.4
14	5705	48.0	13144645.0	633.7	748.7
13	6942	44.8	13932111.1	671.6	652.2
12	6969	41.6	12060465.1	581.4	564.6
11	6999	38.4	10320808.9	497.5	483.1
10	7007	35.2	8682178.6	418.5	406.4
9	7021	32.0	7189284.1	346.6	336.5
8	7031	28.8	5831939.2	281.1	273.0
7	7037	25.6	4612038.1	222.3	215.9
6	7082	22.4	3553417.2	171.3	166.3
5	7128	19.2	2627772.8	126.7	122.9
4	7131	16.0	1825519.3	88.0	85.4
3	7154	12.8	1172047.0	56.5	54.9
2	7181	9.6	661827.4	31.9	31.0
1	7207	6.4	295190.2	14.2	13.8
G	7297	3.2	74725.2	3.6	3.5
SUM			95755708.9	4616.1	4615.5

2.3 SEISMIC BASE SHEAR V_b

2.3.1 BASE SHEAR V_b IN DIFFERENT SOIL

2.3.1.1 BASE SHEAR IN HARD SOIL

Variations of Base Shear in different zone of buildings with different floor levels in hard soil are as follows:

TABLE 2.37 Base Shear in Hard Soil (in KN)

	ZONE 2	ZONE 3	ZONE 4	ZONE 5
G+5	556	891	1339	2054
G+10	716	1146	1864	2613
G+15	759	1215	1823	2763

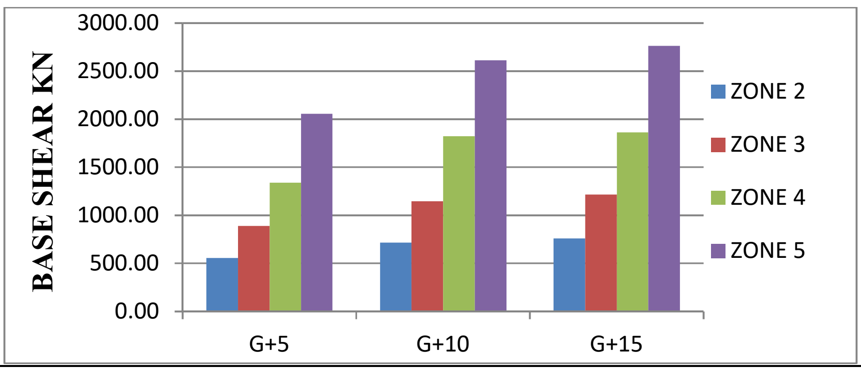

FIG 2.1 Base Shear in Hard Soil

2.3.1.2 BASE SHEAR IN MEDIUM SOIL

Variations of Base Shear in different zone of buildings with different floor levels in medium soil are as follows:

TABLE 2.38 Base Shear in medium Soil (in KN)

	ZONE 2	ZONE 3	ZONE 4	ZONE 5
G+5	757	1212	1822	2794
G+10	974	1559	2536	3554
G+15	1033	1653	2480	3759

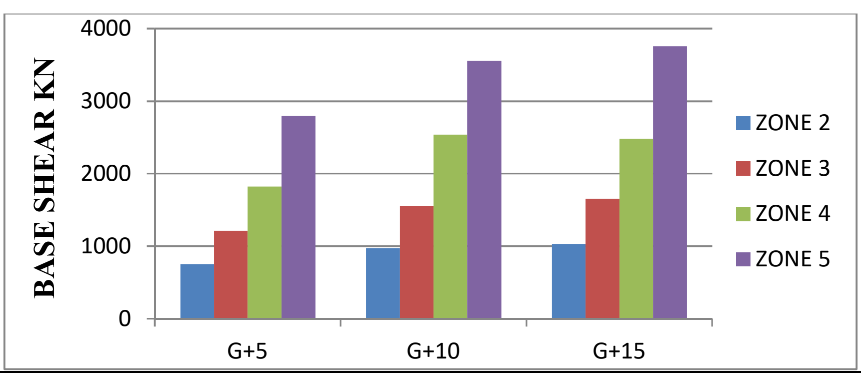

FIG 2.2 Base Shear in medium Soil

2.3.1.3 BASE SHEAR IN SOFT SOIL

Variations of Base Shear in different zone of buildings with different floor levels in soft soil are as follows:

TABLE 2.39 Base Shear in Soft Soil (in KN)

	ZONE 2	ZONE 3	ZONE 4	ZONE 5
G+5	930	1488	2237	3430
G+10	1196	1914	3113	4364
G+15	1268	2029	3145	4615

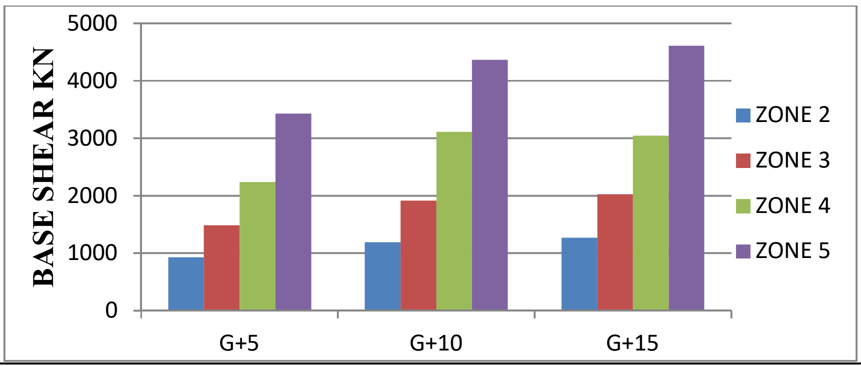

FIG 2.3 Base Shear in Soft Soil

2.3.2 BASE SHEAR V_b FOR DIFFERENT FLOORS

2.3.2.1 BASE SHEAR IN G+5 BUILDINGS

TABLE 2.40 Base Shear of G+5 buildings (in KN)

	HARD SOIL	MEDIUM SOIL	SOFT SOIL
ZONE 2	556	757	930
ZONE 3	891	1212	1488
ZONE 4	1339	1822	2237
ZONE 5	2054	2794	3430

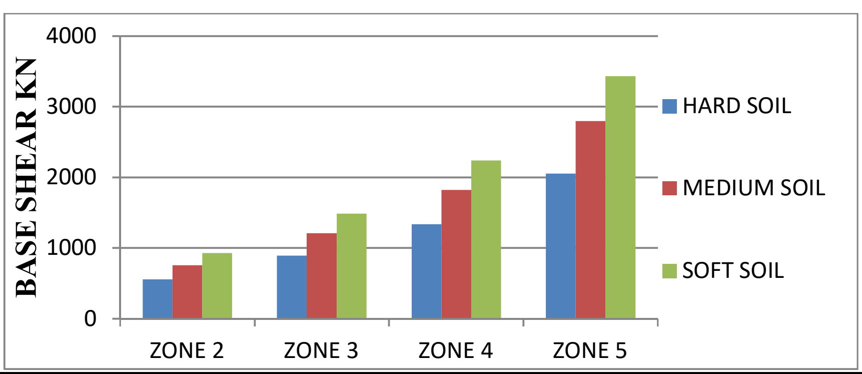

FIG 2.4 Base Shear of G+5 buildings

2.3.2.2 BASE SHEAR IN G+10 BUILDINGS

TABLE 2.41 Base Shear of G+10 buildings (in KN)

	HARD SOIL	MEDIUM SOIL	SOFT SOIL
ZONE 2	716	974	1196
ZONE 3	1146	1559	1914
ZONE 4	1864	2536	3113
ZONE 5	2613	3554	4364

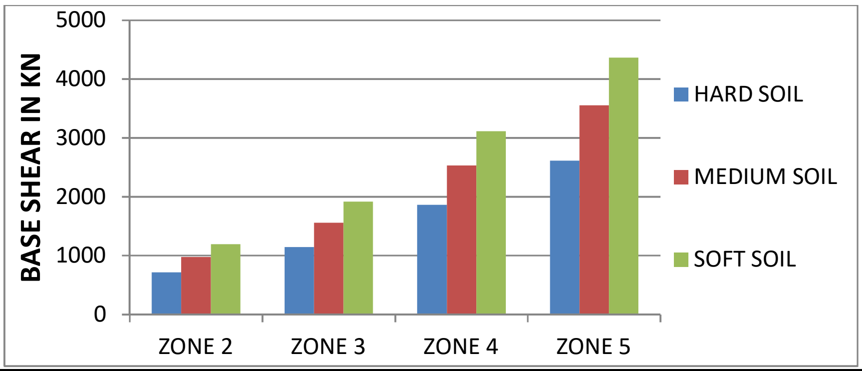

FIG 2.5 Base Shear of G+10 buildings

2.3.2.3 BASE SHEAR IN G+15 BUILDINGS

TABLE 2.42 Base Shear of G+15 buildings (in KN)

	HARD SOIL	MEDIUM SOIL	SOFT SOIL
ZONE 2	759	1033	1268
ZONE 3	1215	1653	2029
ZONE 4	1823	2480	3045
ZONE 5	2763	3759	4615

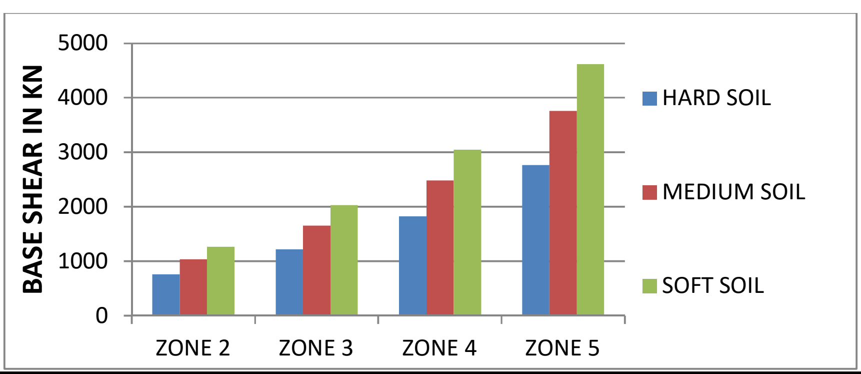

FIG 2.6 Base Shear of G+15 buildings

2.4 STOREY SHEAR

2.4.1 STOREY SHEAR FOR G+5 BUILDINGS

2.4.1.1 STOREY SHEAR IN HARD SOIL

Variations of Storey Shear in different zone of G+5 buildings in hard soil are as follows:

TABLE 2.43 Storey Shear for G+5 buildings in hard soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
5	145.0	232.0	348.7	533.2
4	308.6	531.7	799.0	1222.6
3	436.1	723.3	1087.0	1665.0
2	507.7	831.1	1249.2	1914.7
1	539.6	879.0	1321.4	2026.1
G	547.6	891.0	1339.5	2054.3

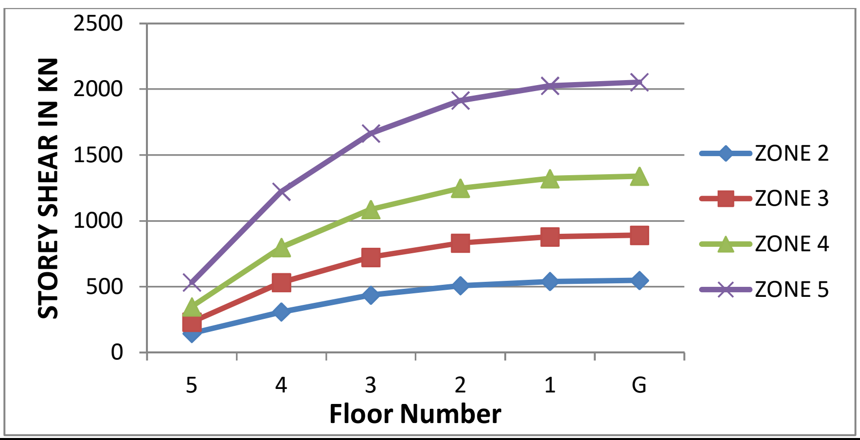

FIG 2.7 Storey Shear for G+5 buildings in hard soil

TRENDLINE EQUATIONS

ZONE 5: $y = -82.679x^2 + 872.06x - 228.92$
ZONE 4: $y = -54.004x^2 + 568.98x - 148.24$
ZONE 3: $y = -35.952x^2 + 378.65x - 98.67$
ZONE 2: $y = -20.721x^2 + 224.41x - 57.06$
COMMON EQUATION: $y = -48.339x^2 + 511.025x – 133.222$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

2.4.1.2 STOREY SHEAR IN MEDIUM SOIL

Variations of Storey Shear in different zone of G+5 buildings in medium soil are as follows:

TABLE 2.44 Storey Shear for G+5 buildings in medium soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
5	197.2	315.6	474.2	725.1
4	452.0	723.2	1086.7	1662.8
3	614.8	983.7	1478.4	2264.5
2	706.5	1130.3	1698.9	2604.0
1	747.2	1195.5	1797.1	2755.5
G	757.4	1211.8	1821.8	2793.8

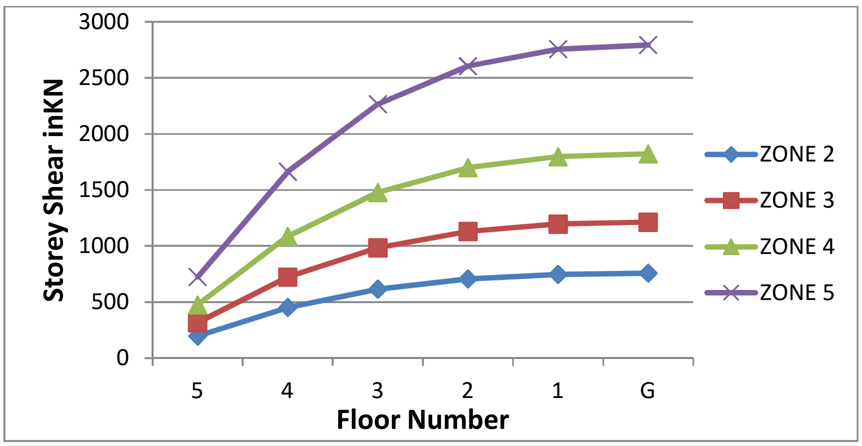

FIG 2.8 Storey Shear for G+5 buildings in medium soil

TRENDLINE EQUATIONS

ZONE 5: $y = -112.46x^2 + 1186.1x - 311.46$
ZONE 4: $y = -73.446x^2 + 773.83x - 201.62$
ZONE 3: $y = -48.888x^2 + 514.91x - 134.05$
ZONE 2: $y = -30.561x^2 + 321.88x - 83.88$
COMMON EQUATION: $y = -66.339x^2 + 699.18x – 182.752$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

2.4.1.3 STOREY SHEAR IN SOFT SOIL

Variations of Storey Shear in different zone of G+5 buildings in soft soil are as follows:

TABLE 2.45 Storey Shear for G+5 buildings in soft soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
5	242.2	387.5	582.3	890.4
4	555.0	888.0	1334.4	2041.8
3	755.0	1208.0	1815.3	2780.6
2	867.5	1388.0	2086.2	3197.6
1	917.5	1468.0	2206.8	3383.6
G	930.0	1488.0	2237.0	3430.6

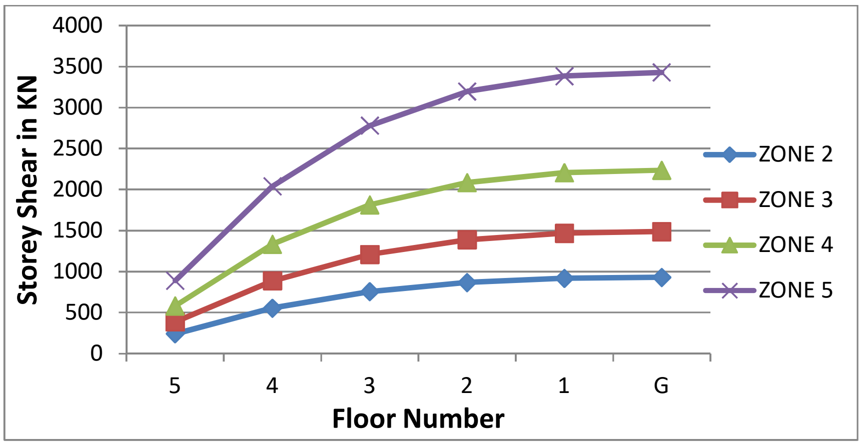

FIG 2.9 Storey Shear for G+5 buildings in soft soil

TRENDLINE EQUATIONS

ZONE 5: $y = -138.09x^2 + 1456.5x - 382.44$
ZONE 4: $y = -90.191x^2 + 950.24x - 247.61$
ZONE 3: $y = -60.045x^2 + 632.38x - 164.75$
ZONE 2: $y = -37.527x^2 + 395.23x - 102.95$
COMMON EQUATION: $y = -80.963x^2 + 858.587x – 224.437$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

2.4.2 STOREY SHEAR FOR G+10 BUILDINGS

2.4.2.1 STOREY SHEAR IN HARD SOIL

Variations of Storey Shear in different zone of G+10 buildings in hard soil are as follows:

TABLE 2.46 Storey Shear for G+10 buildings in hard soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
10	108.0	172.9	279.9	391.7
9	266.2	425.9	689.1	966.5
8	394.0	630.5	1021.5	1432.2
7	495.0	792.1	1285.9	1801.0
6	572.4	915.8	1488.4	2084.4
5	629.2	1006.9	1637.1	2293.4
4	668.8	1070.2	1740.5	2438.8
3	694.1	1110.7	1806.7	2531.9
2	708.4	1133.6	1843.9	2584.4
1	714.8	1143.8	1860.5	2607.8
G	716.4	1146.3	1864.6	2613.7

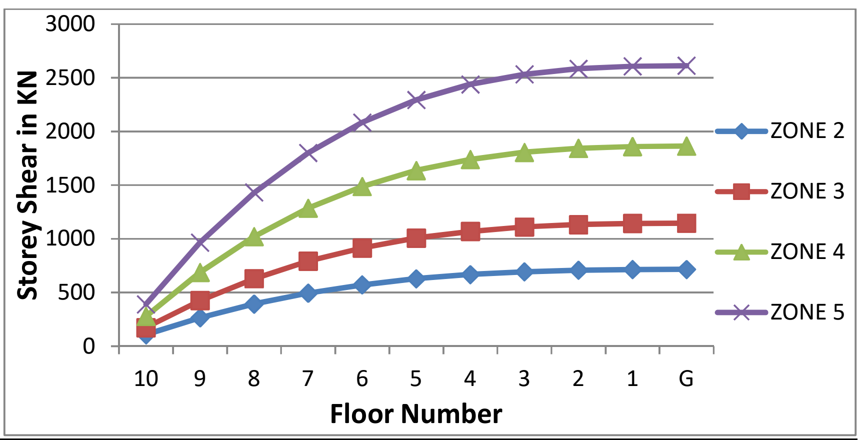

FIG 2.10 Storey Shear for G+10 buildings in hard soil

TRENDLINE EQUATIONS

ZONE 5: $y = -31.62x^2 + 588.06x - 96.939$
ZONE 4: $y = -22.596x^2 + 419.97x - 69.658$
ZONE 3: $y = -13.89x^2 + 257.95x - 40.688$
ZONE 2: $y = -8.6804x^2 + 161.2x - 25.438$
COMMON EQUATION: $y = -19.195x^2 + 356.795x – 58.181$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

2.4.2.2 STOREY SHEAR IN MEDIUM SOIL

Variations of Storey Shear in different zone of G+10 buildings in medium soil are as follows:

TABLE 2.47 Storey Shear for G+10 buildings in medium soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
10	146.9	235.1	380.7	532.7
9	362.0	579.3	937.2	1314.4
8	535.9	857.5	1389.2	1947.8
7	673.3	1077.2	1748.8	2449.4
6	778.4	1245.5	2024.2	2834.7
5	855.8	1369.3	2226.5	3118.9
4	909.5	1455.4	2367.0	3316.7
3	944.0	1510.6	2457.1	3443.3
2	963.4	1541.7	2507.7	3514.7
1	972.1	1555.5	2530.3	3546.6
G	974.3	1559.0	2535.9	3554.6

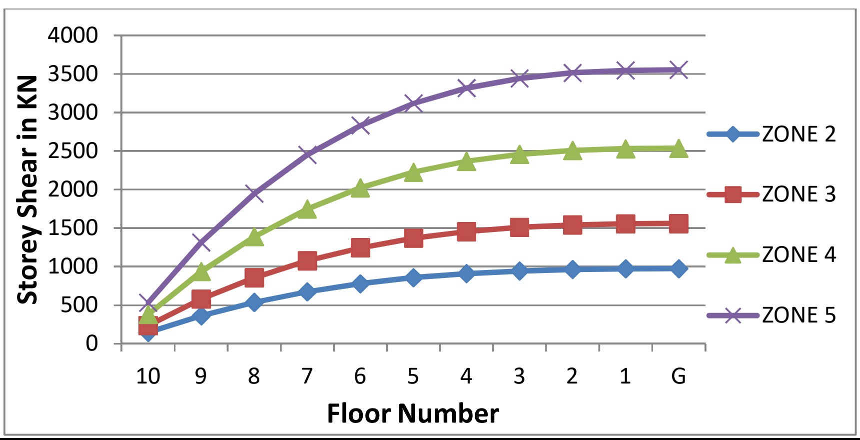

FIG 2.11 Storey Shear for G+10 buildings in medium soil

TRENDLINE EQUATIONS

ZONE 5: $y = -43.001x^2 + 799.73x - 131.8$
ZONE 4: $y = -30.727x^2 + 571.12x - 94.674$
ZONE 3: $y = -18.889x^2 + 350.79x - 55.302$
ZONE 2: $y = -11.806x^2 + 219.24x - 34.579$
COMMON EQUATION: $y = -26.105x^2 + 485.22x - 79.088$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

2.4.2.3 STOREY SHEAR IN SOFT SOIL

Variations of Storey Shear in different zone of G+10 buildings in soft soil are as follows:

TABLE 2.48 Storey Shear for G+10 buildings in soft soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
10	180.4	288.7	467.5	654.1
9	444.6	711.3	1150.8	1614.0
8	658.0	1052.9	1705.8	2391.8
7	826.7	1322.8	2147.4	3007.7
6	955.9	1529.4	2485.6	3480.9
5	1050.8	1681.4	2734.0	3829.8
4	1116.9	1787.2	2906.6	4072.7
3	1159.2	1854.9	3017.1	4228.2
2	1183.0	1893.1	3079.3	4315.9
1	1193.7	1910.1	3107.0	4355.0
G	1196.3	1914.4	3113.9	4364.8

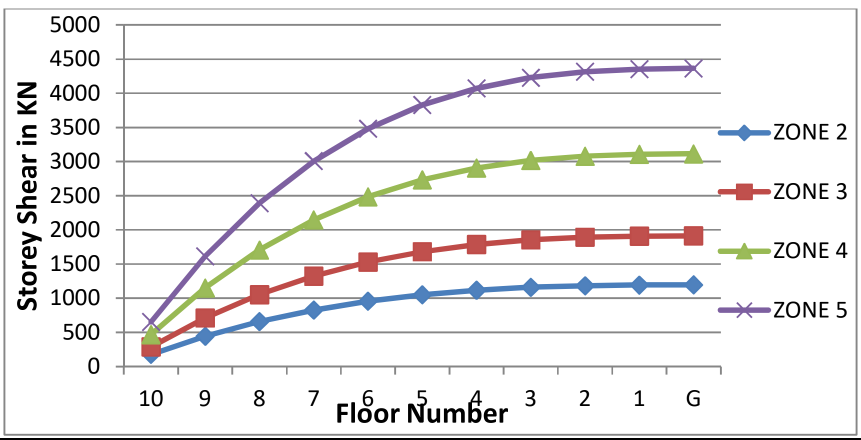

FIG 2.12 Storey Shear for G+10 buildings in soft soil

TRENDLINE EQUATIONS

ZONE 5: $y = -52.804x^2 + 982.04x - 161.88$
ZONE 4: $y = -37.732x^2 + 701.31x - 116.27$
ZONE 3: $y = -23.194x^2 + 430.75x - 67.922$
ZONE 2: $y = -14.498x^2 + 269.22x - 42.461$
COMMON EQUATION: $y = -32.057x^2 + 595.83x - 97.133$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

2.4.3 STOREY SHEAR FOR G+15

2.4.3.1 STOREY SHEAR IN HARD SOIL

Variations of Storey Shear in different zone of G+15 buildings in hard soil are as follows:

TABLE 2.49 Storey Shear for G+15 buildings in hard soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
15	75.7	121.1	181.7	273.9
14	199.6	319.4	479.2	722.2
13	307.6	492.1	738.3	1112.7
12	400.7	641.1	961.7	1450.7
11	480.0	768.0	1152.0	1740.0
10	546.6	874.6	1312.0	1983.4
9	601.7	962.7	1444.3	2184.9
8	646.3	1034.1	1551.6	2348.4
7	681.6	1090.5	1636.4	2477.7
6	708.7	1133.9	1701.6	2577.3
5	728.7	1165.9	1749.6	2650.9
4	742.5	1188.1	1783.0	2702.0
3	751.5	1202.4	1804.5	2734.9
2	756.6	1210.5	1816.7	2753.5
1	758.9	1214.1	1822.1	2761.7
G	759.4	1215.0	1823.5	2763.8

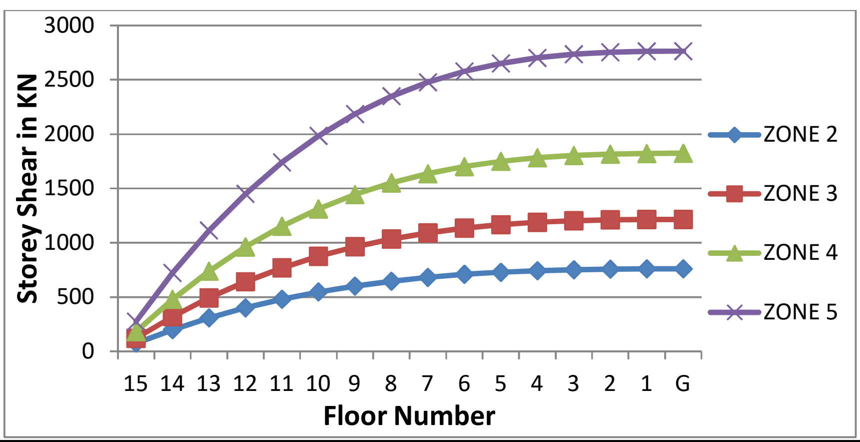

FIG 2.13 Storey Shear for G+15 buildings in hard soil

TRENDLINE EQUATIONS

ZONE 5: $y = -15.972x^2 + 425.71x - 47.768$
ZONE 4: $y = -10.56x^2 + 280.99x - 28.618$
ZONE 3: $y = -7.0409x^2 + 187.28x - 19.002$
ZONE 2: $y = -4.4x^2 + 117.05x - 11.856$
COMMON EQUATION: $y = -9.493x^2 + 252.757x – 26.811$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

2.4.3.2 STOREY SHEAR IN MEDIUM SOIL

Variations of Storey Shear in different zone of G+15 buildings in medium soil are as follows:

TABLE 2.50 Storey Shear for G+15 buildings in medium soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
15	103.0	164.7	247.2	372.5
14	271.5	434.4	651.7	982.2
13	418.3	669.3	1004.1	1513.3
12	544.9	871.8	1308.0	1973.1
11	652.8	1044.4	1566.9	2366.5
10	743.4	1189.4	1784.5	2697.5
9	818.3	1309.3	1964.5	2971.5
8	879.0	1406.3	2110.4	3193.8
7	926.9	1483.1	2225.8	3369.7
6	963.8	1542.0	2314.4	3505.1
5	991.0	1585.5	2379.7	3605.2
4	1009.9	1615.8	2425.1	3674.7
3	1022.0	1635.3	2454.4	3719.4
2	1029.0	1646.3	2470.9	3744.7
1	1032.0	1651.3	2478.3	3755.9
G	1032.8	1652.5	2480.2	3758.8

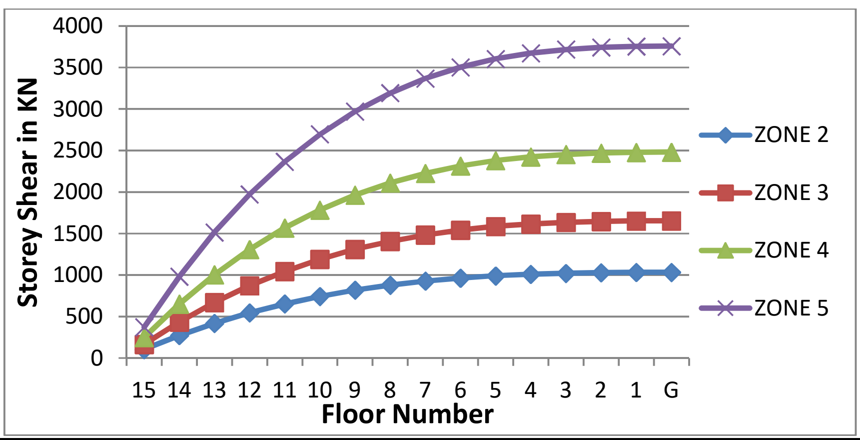

FIG 2.14 Storey Shear for G+15 buildings in medium soil

TRENDLINE EQUATIONS

ZONE 5: $y = -21.722x^2 + 578.96x - 64.911$
ZONE 4: $y = -14.364x^2 + 382.2x - 38.968$
ZONE 3: $y = -9.5732x^2 + 254.67x - 25.778$
ZONE 2: $y = -5.9837x^2 + 159.17x - 16.095$
COMMON EQUATION: $y = -12.911x^2 + 343.75x - 36.438$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

2.4.3.3 STOREY SHEAR IN SOFT SOIL

Variations of Storey Shear in different zone of G+15 buildings in soft soil are as follows:

TABLE 2.51 Storey Shear for G+15 buildings in soft soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
15	126.4	202.3	303.5	457.4
14	333.4	533.4	800.3	1206.1
13	513.7	821.9	1233.0	1858.2
12	669.1	1070.6	1606.1	2422.8
11	801.5	1282.5	1924.0	2905.9
10	912.8	1460.5	2191.3	3312.3
9	1004.8	1607.7	2412.2	3648.9
8	1079.3	1726.9	2591.4	3921.9
7	1138.2	1821.1	2733.1	4137.7
6	1183.5	1893.5	2841.9	4304.1
5	1216.8	1947.0	2922.1	4427.0
4	1240.0	1984.1	2977.9	4512.4
3	1255.0	2008.0	3013.8	4567.2
2	1263.5	2021.6	3034.2	4598.2
1	1267.3	2027.7	3043.3	4612.0
G	1268.2	2029.2	3045.5	4615.5

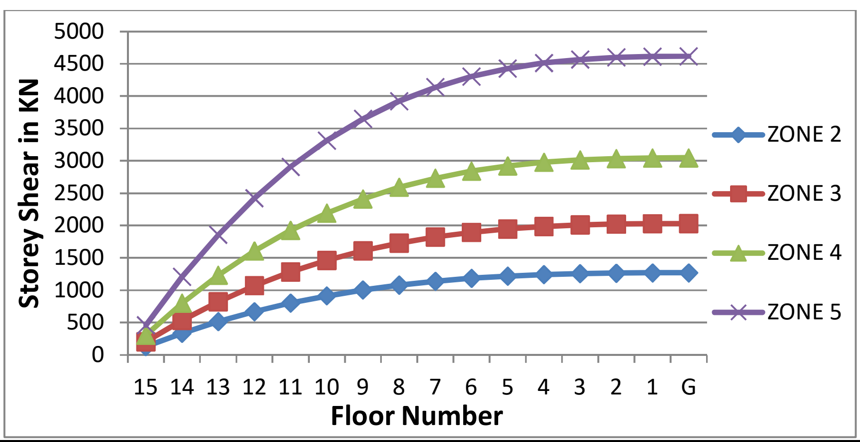

FIG 2.15 Storey Shear for G+15 buildings in soft soil

TRENDLINE EQUATIONS

ZONE 5: $y = -26.674x^2 + 710.95x - 79.767$
ZONE 4: $y = -17.637x^2 + 469.3x - 47.829$
ZONE 3: $y = -11.755x^2 + 312.71x - 31.602$
ZONE 2: $y = -7.347x^2 + 195.45x - 19.769$
COMMON EQUATION: $y = -15.851x^2 + 422.09x - 44.742$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

2.5 STOREY DRIFT

2.5.1 STOREY DRIFT OF G+5 BUILDINGS

2.5.1.1 STOREY DRIFT IN HARD SOIL

Variations of Storey drift in different zones of G+5 buildings in hard soil are as follows:

TABLE 2.52 Storey Drift for G+5 buildings in hard soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
5	2.489	3.98	5.956	8.988
4	4.871	7.794	11.669	16.962
3	6.659	10.656	15.782	21.275
2	7.662	12.258	17.651	23.595
1	7.748	12.397	17.346	19.865
G	5.193	8.309	10.546	8.237

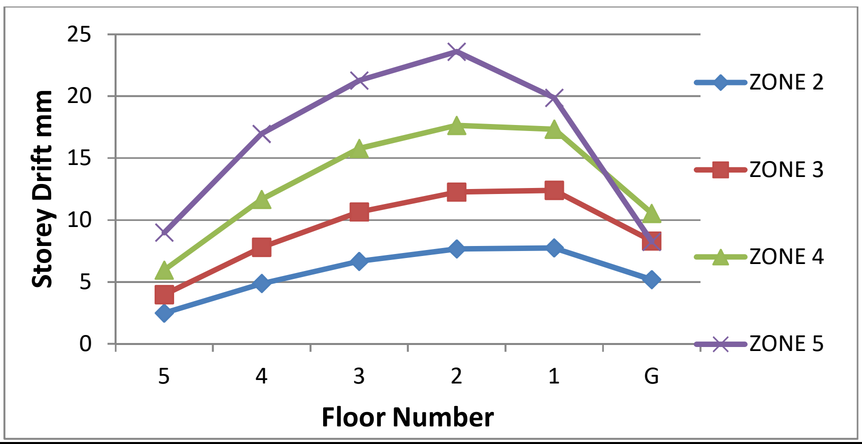

FIG 2.16 Storey Drift for G+5 buildings in hard soil

TRENDLINE EQUATIONS

ZONE 5: $y = -2.3247x^2 + 16.481x - 5.9374$
ZONE 4: $y = -1.4328x^2 + 11.225x - 4.3995$
ZONE 3: $y = -0.9x^2 + 7.359x - 2.8736$
ZONE 2: $y = -0.5624x^2 + 4.5982x - 1.7939$
COMMON EQUATION: $y = -1.2959x^2 + 9.9158x - 3.7511$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

2.5.1.2 STOREY DRIFT IN MEDIUM SOIL

Variations of Storey drift in different zones of G+5 buildings in medium soil are as follows:

TABLE 2.53 Storey Drift for G+5 buildings in medium soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
5	3.383	5.415	8.101	12.225
4	6.625	10.599	15.87	23.076
3	9.057	14.492	21.464	28.858
2	10.42	16.67	24.004	31.818
1	10.538	16.861	23.591	27.035
G	7.062	11.3	14.343	11.254

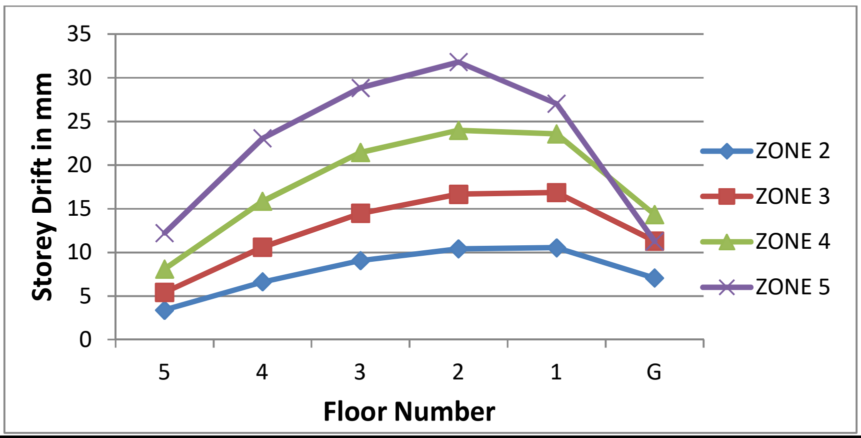

FIG 2.17 Storey Drift for G+5 buildings in medium soil

TRENDLINE EQUATIONS

ZONE 5: $y = -3.1325x^2 + 22.213x - 7.8572$
ZONE 4: $y = -1.9484x^2 + 15.265x - 5.9813$
ZONE 3: $y = -1.2238x^2 + 10.006x - 3.9049$
ZONE 2: $y = -0.7651x^2 + 6.2557x - 2.4432$
COMMON EQUATION: $y = -1.812x^2 + 13.435x – 5.046$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

2.5.1.3 STOREY DRIFT IN SOFT SOIL

Variations of Storey drift in different zones of G+5 buildings in soft soil are as follows:

TABLE 2.54 Storey Drift for G+5 buildings in soft soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
5	4.155	6.648	9.947	15.008
4	8.135	13.376	19.487	28.329
3	11.122	17.435	26.357	35.528
2	12.794	20.47	29.476	39.404
1	12.94	20.704	28.968	33.174
G	8.672	13.876	17.612	13.756

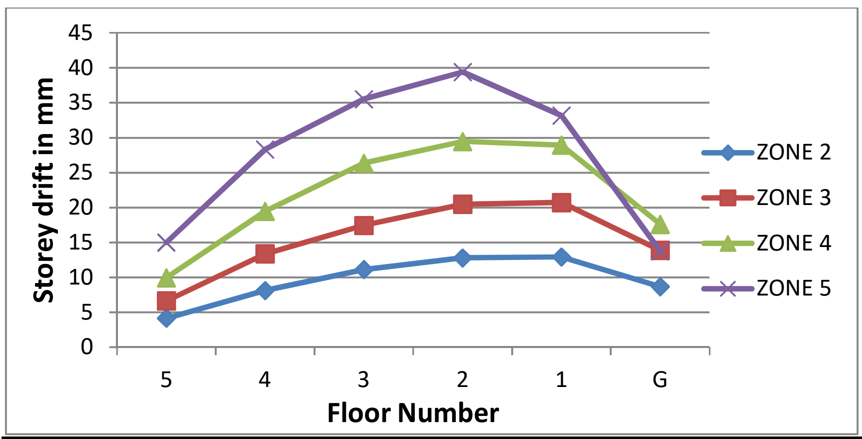

FIG 2.18 Storey Drift for G+5 buildings in soft soil

TRENDLINE EQUATIONS

ZONE 5: $y = -3.8823x^2 + 27.524x - 9.9171$
ZONE 4: $y = -2.3927x^2 + 18.746x - 7.3462$
ZONE 3: $y = -1.4836x^2 + 12.132x - 4.5444$
ZONE 2: $y = -0.9394x^2 + 7.6804x - 2.9982$
COMMON EQUATION: $y = -2.1744x^2 + 16.5206x - 6.2015$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

2.5.2 STOREY DRIFT OF G+10 BUILDING MODELS

2.5.2.1 STOREY DRIFT IN HARD SOIL

Variations of Storey drift in different zones of G+10 buildings in hard soil are as follows:

TABLE 2.55 Storey Drift for G+10 buildings in hard soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
10	1.789	2.86	4.345	5.603
9	4.04	6.462	10.209	11.072
8	5.888	9.42	11.018	15.784
7	7.334	11.718	13.559	17.816
6	8.421	13.291	15.584	19.277
5	8.543	13.328	16.808	20.482
4	8.709	13.308	17.506	21.594
3	8.567	13.66	17.639	21.903
2	7.591	12.147	17.752	21.257
1	7.159	11.454	16.177	19.443
G	4.748	7.598	10.405	11.02

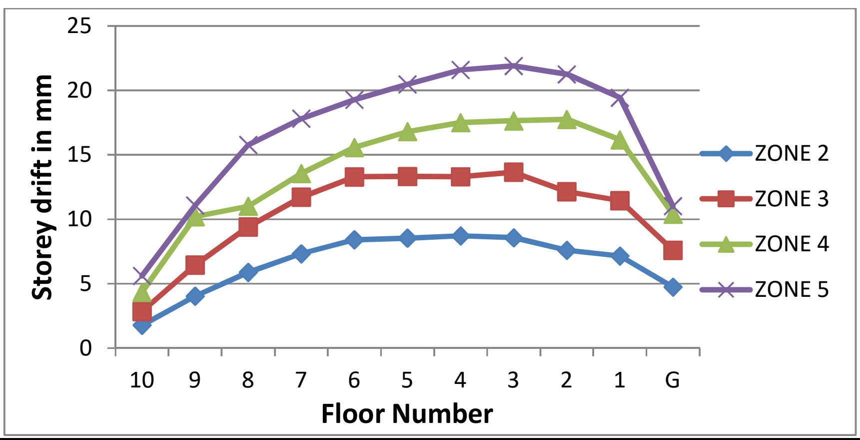

FIG 2.19 Storey Drift for G+10 buildings in hard soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.4844x^2 + 6.6076x - 0.5239$
ZONE 4: $y = -0.3523x^2 + 4.9955x - 0.0393$
ZONE 3: $y = -0.3288x^2 + 4.4527x - 1.1132$
ZONE 2: $y = -0.2136x^2 + 2.8821x - 0.8518$
COMMON EQUATION: $y = -0.3448x^2 + 4.7345x - 0.632$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

2.5.2.2 STOREY DRIFT IN MEDIUM SOIL

Variations of Storey drift in different zones of G+10 buildings in medium soil are as follows:

TABLE 2.56 Storey Drift for G+10 buildings in medium soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
10	2.432	3.889	5.91	7.621
9	5.495	8.79	13.884	15.059
8	8.008	12.81	14.985	21.483
7	9.975	15.938	18.44	24.998
6	11.452	18.075	21.195	26.208
5	11.618	18.127	22.86	27.853
4	11.845	18.098	24.013	29.365
3	11.65	18.577	23.782	29.786
2	10.326	16.523	24.158	28.91
1	9.734	15.575	22.195	26.461
G	6.464	10.343	14.187	15.004

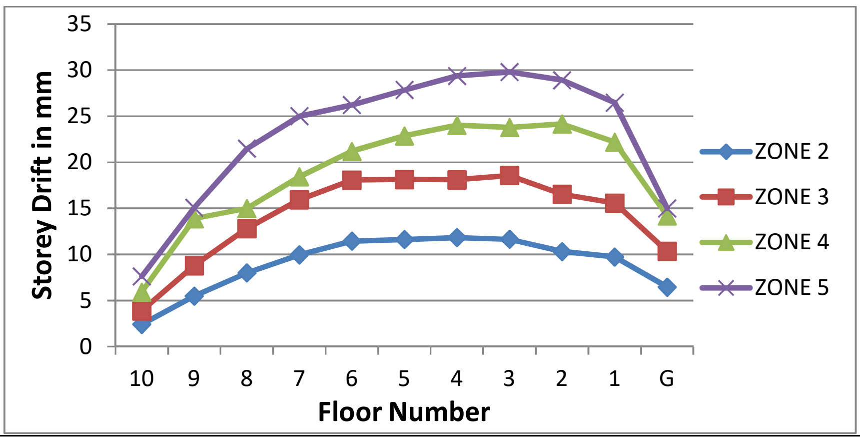

FIG 2.20 Storey Drift for G+10 buildings in medium soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.6635x^2 + 9.0306x - 0.6852$
ZONE 4: $y = -0.4779x^2 + 6.7859x - 0.0412$
ZONE 3: $y = -0.4471x^2 + 6.0543x - 1.5114$
ZONE 2: $y = -0.2904x^2 + 3.9189x - 1.1573$
COMMON EQUATION: $y = -0.4697x^2 + 6.4474x – 0.8488$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

2.5.2.3 STOREY DRIFT IN SOFT SOIL

Variations of Storey drift in different zones of G+10 buildings in soft soil are as follows:

TABLE 2.57 Storey Drift for G+10 buildings in soft soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
10	2.987	4.776	7.257	9.356
9	6.747	10.792	17.049	18.49
8	9.833	15.731	18.4	26.36
7	12.248	19.57	22.643	29.753
6	14.063	22.195	26.026	32.192
5	14.266	22.259	28.07	34.205
4	14.545	22.223	29.234	36.063
3	14.306	22.813	29.457	36.623
2	12.677	20.284	29.646	35.453
1	11.955	19.129	27.016	32.471
G	7.93	12.689	17.376	18.403

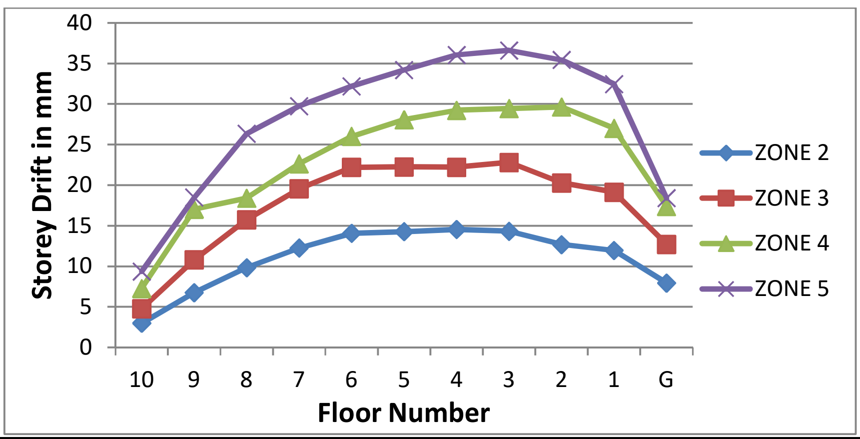

FIG 2.21 Storey Drift for G+10 buildings in soft soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.8092x^2 + 11.038x - 0.8801$
ZONE 4: $y = -0.5883x^2 + 8.3423x - 0.065$
ZONE 3: $y = -0.5491x^2 + 7.4359x - 1.8587$
ZONE 2: $y = -0.3566x^2 + 4.8131x - 1.4226$
COMMON EQUATION: $y = -0.5758x^2 + 7.907x – 1.0566$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

2.5.3 STOREY DRIFT OF G+15 BUILDING MODELS

2.5.3.1 STOREY DRIFT IN HARD SOIL

Variations of Storey drift in different zones of G+15 buildings in hard soil are as follows:

TABLE 2.58 Storey Drift for G+15 buildings in hard soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
15	1.73	2.767	4.132	5.98
14	3.19	5.105	7.64	11.275
13	4.671	7.473	11.192	16.567
12	5.969	9.551	14.306	19.866
11	7.077	11.322	16.94	22.985
10	8.002	12.805	18.971	25.247
9	8.762	14.018	20.466	26.691
8	9.363	14.981	21.244	28.333
7	9.75	15.6	22.15	29.493
6	9.537	15.258	22.174	29.01
5	9.708	15.534	22.552	29.65
4	9.581	15.329	22.629	29.77
3	8.578	13.726	20.552	28.047
2	8.18	13.087	19.634	25.352
1	6.737	10.779	16.176	18.309
G	3.501	5.602	8.406	7.418

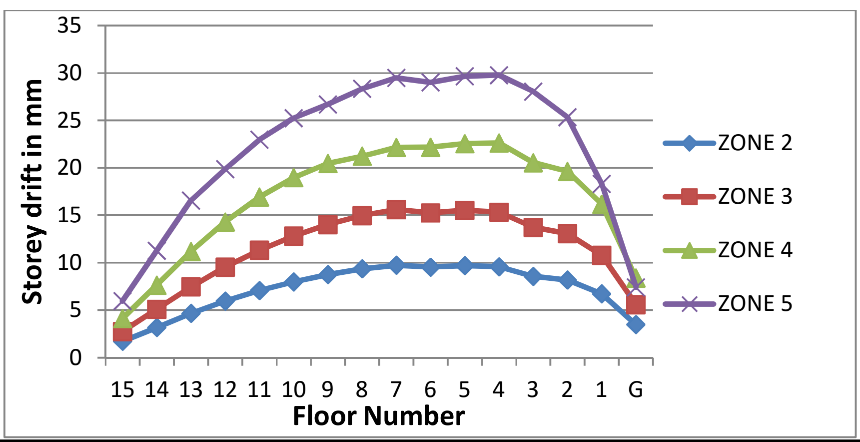

FIG 2.22 Storey Drift for G+15 buildings in hard soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.3766x^2 + 6.9336x - 1.5953$
ZONE 4: $y = -0.2659x^2 + 5.0909x - 1.5874$
ZONE 3: $y = -0.1882x^2 + 3.5846x - 1.4366$
ZONE 2: $y = -0.1176x^2 + 2.2404x - 0.8977$
COMMON EQUATION: $-0.2371x^2 + 4.4624x – 1.3792$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

2.5.3.2 STOREY DRIFT IN MEDIUM SOIL

Variations of Storey drift in different zones of G+15 buildings in medium soil are as follows:

TABLE 2.59 Storey Drift for G+15 buildings in medium soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
15	2.352	3.763	5.619	8.132
14	4.34	6.943	10.39	15.334
13	6.352	10.164	15.219	22.531
12	8.118	12.988	19.456	27.017
11	9.624	15.399	23.038	31.258
10	10.884	17.414	25.799	34.335
9	11.915	19.065	27.835	36.277
8	12.735	20.375	28.884	38.332
7	13.259	21.215	29.915	39.869
6	12.97	20.752	30.139	39.451
5	13.204	21.126	30.67	40.32
4	13.029	20.847	30.776	40.489
3	11.667	18.667	27.951	38.147
2	11.124	17.799	26.702	34.481
1	9.163	14.66	21.999	24.902
G	4.761	7.618	11.433	10.089

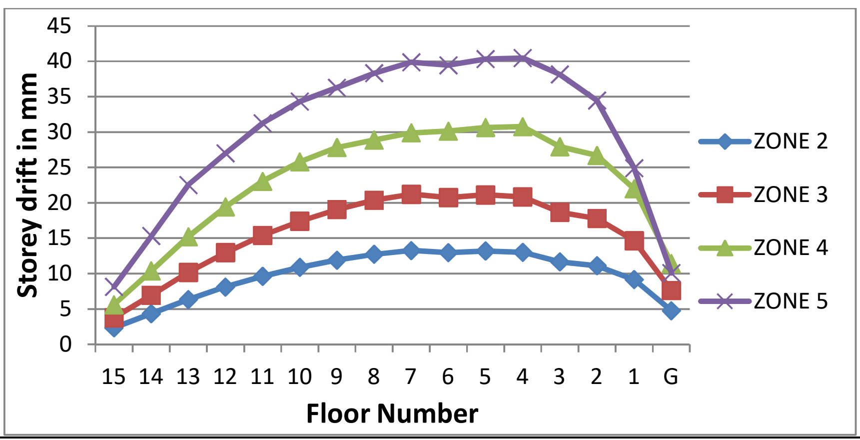

FIG 2.23 Storey Drift for G+15 buildings in medium soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.5105x^2 + 9.4005x - 2.1122$
ZONE 4: $y = -0.3608x^2 + 6.9088x - 2.1277$
ZONE 3: $y = -0.256x^2 + 4.8751x - 1.9538$
ZONE 2: $y = -0.16x^2 + 3.0469x - 1.2209$
COMMON EQUATION: $y = -0.3218x^2 + 6.0578x - 1.8536$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

2.5.3.3 STOREY DRIFT IN SOFT SOIL

TABLE 2.60 Storey Drift for G+15 buildings in soft soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
15	2.888	4.621	6.9	9.987
14	5.329	8.526	12.759	18.829
13	7.8	12.48	18.69	27.668
12	9.968	15.949	23.891	33.176
11	11.818	18.908	28.29	38.384
10	13.365	21.384	31.681	42.163
9	14.631	23.41	34.178	44.574
8	15.637	25.02	35.478	47.316
7	16.283	26.051	36.991	49.253
6	15.925	25.481	37.03	48.448
5	16.214	25.942	37.662	49.514
4	15.999	25.599	37.791	49.716
3	14.326	22.922	34.322	46.839
2	13.66	21.855	32.788	42.339
1	11.251	18.002	27.013	30.575
G	5.847	9.355	14.039	12.388

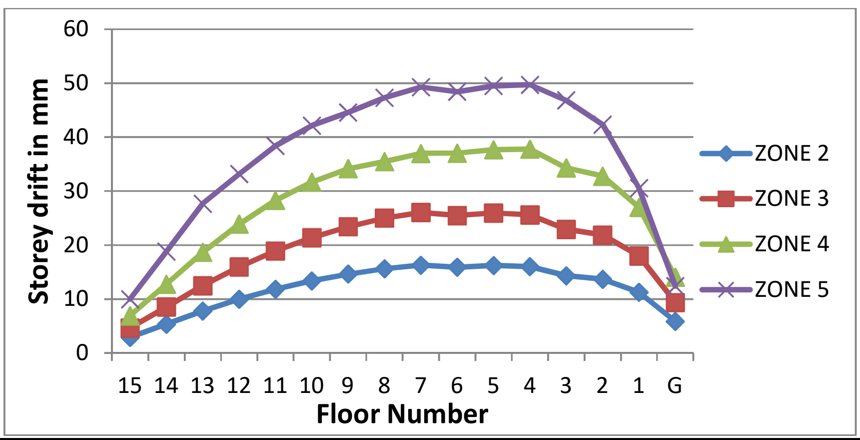

FIG 2.24 Storey Drift for G+15 buildings in soft soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.629x^2 + 11.579x - 2.6639$
ZONE 4: $y = -0.4441x^2 + 8.5018x - 2.6513$
ZONE 3: $y = -0.3143x^2 + 5.9863x - 2.3989$
ZONE 2: $y = -0.1965x^2 + 3.7414x - 1.4992$
COMMON EQUATION: $y = -0.396x^2 + 7.4519x – 2.3033$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

2.6 TOP STOREY DISPLACEMENT

2.6.1 TOP STOREY DISPLACEMENT OF G+5 BUILDINGS

Displacement of top storey in G+5 buildings is as follows:

TABLE 2.61 Top storey displacement of G+5 buildings (in mm)

	ZONE 2	ZONE 3	ZONE 4	ZONE 5
HARD SOIL	34.622	55.394	78.95	98.922
MEDIUM SOIL	47.085	75.337	107.373	134.266
SOFT SOIL	57.818	92.509	131.847	165.199

2.6.2 TOP STOREY DISPLACEMENT OF G+10 BUILDINGS

Displacement of top storey in G+10 buildings is as follows:

TABLE 2.62 Top storey displacement of G+10 buildings (in mm)

	ZONE 2	ZONE 3	ZONE 4	ZONE 5
HARD SOIL	72.789	115.246	151.002	185.251
MEDIUM SOIL	98.999	156.745	205.609	252.748
SOFT SOIL	121.557	192.461	252.174	309.369

2.6.3 TOP STOREY DISPLACEMENT OF G+15 BUILDINGS

Displacement of top storey in G+15 buildings is as follows:

TABLE 2.63 Top storey displacement of G+15 buildings (in mm)

	ZONE 2	ZONE 3	ZONE 4	ZONE 5
HARD SOIL	114.336	182.937	269.164	353.993
MEDIUM SOIL	155.497	248.795	365.825	480.964
SOFT SOIL	190.941	305.505	449.503	591.169

CHAPTER 3: BUILDINGS WITH SHEAR WALL

3.1 LOADS CONSIDERED

3.1.1 DEAD AND LIVE LOADS

Following loadings were considered:

1. SELFWEIGHT
2. FLOOR FINISH: 1 kN/m^2
3. LOAD FROM THE BRICK WALLS: 14.72 kN/m
4. LIVE LOAD: 3 kN/m^2

3.1.2 SEISMIC LOADS

Building models were loaded with seismic loads and the following parameters were considered:

Importance Factor (I): 1

Response Reduction Factor (R): 5

Other parameters were considered as per floor height and as per the seismic zones in which the building is being modelled.

3.2 DISTRIBUTION OF BASE SHEAR TO DIFFERENT FLOORS

3.2.1 DISTRIBUTION OF BASE SHEAR IN HARD SOIL

3.2.1.1 G+5 BUILDING MODELS

Seismic calculations for G+5 building in hard soil are as follows:

A. ZONE 2

TABLE 3.1 Base Shear Distributions of G+5 Building In Hard Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	4266	19.2	1572790.9	164.1	146.8
4	7314	16.0	1872339.2	195.3	189.7
3	7314	12.8	1198297.1	125.0	121.3
2	7314	9.6	674042.1	70.3	68.2
1	7323	6.4	299945.7	31.3	30.3
G	7318	3.2	74940.0	7.8	7.9
SUM			5692355.0	593.8	564.2

B. ZONE 3

TABLE 3.2 Base Shear Distributions of G+5 Building In Hard Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	4266	19.2	1572790.9	262.5	234.9
4	7314	16.0	1872339.2	312.5	303.5
3	7314	12.8	1198297.1	200.0	194.0
2	7314	9.6	674042.1	112.5	109.1
1	7323	6.4	299945.7	50.1	48.5
G	7318	3.2	74940.0	12.5	12.1
SUM			5692355.0	950.1	902.2

C. ZONE 4

TABLE 3.3 Base Shear Distributions of G+5 Building In Hard Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	4266	19.2	1572790.9	394.4	352.3
4	7314	16.0	1872339.2	469.5	455.2
3	7317	12.8	1198854.3	300.6	291.0
2	7330	9.6	675504.7	169.4	163.7
1	7343	6.4	300781.5	75.4	72.8
G	7364	3.2	75404.3	18.9	18.2
SUM			5695675.0	1428.1	1353.3

D. ZONE 5

TABLE 3.4 Base Shear Distributions of G+5 Building In Hard Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	4690	19.2	1728805.5	610.7	528.5
4	7754	16.0	1985035.7	701.2	682.8
3	7788	12.8	1276025.8	450.8	436.6
2	7798	9.6	718635.1	253.9	245.6
1	7845	6.4	321320.4	113.5	109.2
G	7964	3.2	81554.8	28.8	27.3
SUM			6111377.2	2158.9	2029.9

3.2.1.2 G+10 BUILDING MODELS

Seismic calculations for G+10 building in hard soil are as follows:

A. ZONE 2

TABLE 3.5 Base Shear Distributions of G+10 Building In Hard Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	4294	35.2	5320971.6	111.6	108.9
9	7314	32.0	7489356.8	157.1	159.6
8	7314	28.8	6066379.0	127.3	129.0
7	7314	25.6	4793188.3	100.6	101.9
6	7314	22.4	3669784.8	77.0	78.0
5	7327	19.2	2701183.2	56.7	57.4
4	7333	16.0	1877272.7	39.4	39.9
3	7342	12.8	1202940.4	25.2	25.6
2	7375	9.6	679648.9	14.3	14.4
1	7393	6.4	302809.1	6.4	6.4
G	7399	3.2	75768.1	1.6	1.6
SUM			34179302.8	717.1	722.7

B. ZONE 3

TABLE 3.6 Base Shear Distributions of G+10 Building In Hard Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	4718	35.2	5845354.0	185.9	174.3
9	7737	32.0	7922730.6	251.9	255.3
8	7737	28.8	6417411.8	204.1	206.4
7	7737	25.6	5070547.6	161.2	163.1
6	7737	22.4	3882138.0	123.4	124.8
5	7751	19.2	2857197.8	90.9	91.8
4	7756	16.0	1985616.1	63.1	63.8
3	7765	12.8	1272280.2	40.5	40.9
2	7798	9.6	718652.5	22.9	23.1
1	7816	6.4	320144.1	10.2	10.3
G	7847	3.2	80349.4	2.6	2.6
SUM			36372422.1	1156.5	1156.4

C. ZONE 4

TABLE 3.7 Base Shear Distributions of G+10 Building In Hard Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	4708	35.2	5833180.8	278.6	261.5
9	7737	32.0	7922730.6	378.4	383.0
8	7839	28.8	6502035.8	310.6	309.5
7	7839	25.6	5137411.0	245.4	244.6
6	7839	22.4	3933330.3	187.9	187.3
5	7842	19.2	2890768.8	138.1	137.7
4	7844	16.0	2008155.5	95.9	95.8
3	7850	12.8	1286086.2	61.4	61.3
2	7852	9.6	723667.3	34.6	34.6
1	7872	6.4	322442.5	15.4	15.4
G	7873	3.2	80624.2	3.9	3.9
SUM			36640432.82	1750.0	1734.5

D. ZONE 5

TABLE 3.8 Base Shear Distributions of G+10 Building In Hard Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	4346	35.2	5385114.8	410.6	392.2
9	7365	32.0	7541593.8	575.0	574.5
8	7371	28.8	6113392.3	466.1	464.3
7	7397	25.6	4847669.6	369.6	366.9
6	7422	22.4	3724105.5	283.9	280.9
5	7452	19.2	2747082.1	209.4	206.6
4	7455	16.0	1908373.1	145.5	143.6
3	7461	12.8	1222349.3	93.2	92.0
2	7507	9.6	691889.8	52.7	51.9
1	7516	6.4	307847.1	23.5	23.2
G	7596	3.2	77782.1	5.9	5.8
SUM			34567199.5	2635.4	2601.8

3.2.1.3 G+15 BUILDING MODELS

Seismic calculations for G+15 building in hard soil are as follows:

A. ZONE 2

TABLE 3.9 Base Shear Distributions of G+15 Building In Hard Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	4364	51.2	11440848.1	87.8	76.3
14	7365	48.0	16968586.0	130.2	124.9
13	7365	44.8	14781523.8	113.5	108.8
12	7365	41.6	12745293.5	97.8	93.8
11	7365	38.4	10859895.0	83.4	79.9
10	7365	35.2	9125328.5	70.0	67.2
9	7365	32.0	7541593.8	57.9	55.5
8	7365	28.8	6108691.0	46.9	45.0
7	7365	25.6	4826620.0	37.0	35.5
6	7421	22.4	3723631.5	28.6	27.3
5	7421	19.2	2735729.3	21.0	20.1
4	7432	16.0	1902520.6	14.6	14.0
3	7535	12.8	1234514.8	9.5	9.1
2	7541	9.6	694971.7	5.3	5.1
1	7603	6.4	311414.7	2.4	2.3
G	7609	3.2	77915.6	0.6	0.6
SUM			105079077.8	806.6	765.4

B. ZONE 3

TABLE 3.10 Base Shear Distributions of G+15 Building In Hard Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	WiHi^2	Qi (KN)	Qi FROM STAAD (KN)
15	4788	51.2	12550285.1	145.2	122.9
14	7788	48.0	17943677.2	207.6	200.5
13	7788	44.8	15630936.5	180.8	173.9
12	7788	41.6	13477695.3	155.9	149.9
11	7788	38.4	11483953.4	132.8	127.8
10	7788	35.2	9649710.8	111.6	107.4
9	7788	32.0	7974967.6	92.3	88.7
8	7788	28.8	6459723.8	74.7	71.9
7	7793	25.6	5106951.0	59.1	56.8
6	7844	22.4	3935984.7	45.5	43.7
5	7844	19.2	2891743.9	33.5	32.2
4	7855	16.0	2010864.0	23.3	22.4
3	7958	12.8	1303854.6	15.1	14.4
2	7964	9.6	733975.4	8.5	8.2
1	8026	6.4	328749.6	3.8	3.7
G	8032	3.2	82249.3	1.0	0.9
SUM			111565322	1290.6	1225.2

C. ZONE 4

TABLE 3.11 Base Shear Distributions of G+15 Building In Hard Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	WiHi^2	Qi (KN)	Qi FROM STAAD (KN)
15	4812	51.2	12613681.5	218.8	185.0
14	7788	48.0	17943677.2	311.2	301.4
13	7788	44.8	15630936.5	271.1	261.0
12	7788	41.6	13477695.3	233.8	225.0
11	7788	38.4	11483953.4	199.2	191.8
10	7793	35.2	9655329.2	167.5	161.2
9	7796	32.0	7983286.9	138.5	133.3
8	7805	28.8	6473671.1	112.3	108.1
7	7811	25.6	5118837.8	88.8	85.5
6	7850	22.4	3938639.1	68.3	65.6
5	7851	19.2	2894181.6	50.2	48.6
4	7859	16.0	2011879.8	34.9	33.6
3	7958	12.8	1303854.6	22.6	21.7
2	7981	9.6	735507.7	12.8	12.3
1	8040	6.4	329306.8	5.7	5.5
G	8093	3.2	82872.3	1.4	1.4
SUM			111677310.6	1936.9	1841.0

D. ZONE 5

TABLE 3.12 Base Shear Distributions of G+15 Building In Hard Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	4346	51.2	11393300.8	316.2	277.7
14	7365	48.0	16968586.0	471.0	453.6
13	7365	44.8	14781523.8	410.3	394.0
12	7420	41.6	12840440.3	356.4	341.0
11	7425	38.4	10948767.6	303.9	291.8
10	7436	35.2	9213115.7	255.7	245.5
9	7452	32.0	7631170.6	211.8	203.3
8	7456	28.8	6184695.8	171.7	164.9
7	7465	25.6	4892121.4	135.8	130.4
6	7545	22.4	3786010.3	105.1	100.5
5	7545	19.2	2781558.6	77.2	74.2
4	7560	16.0	1935410.6	53.7	51.6
3	7617	12.8	1247887.4	34.6	33.2
2	7636	9.6	703765.0	19.5	18.8
1	7715	6.4	315996.0	8.8	8.4
G	7911	3.2	81011.1	2.2	2.1
SUM			10570361	2934.0	2791.0

3.2.2 DISTRIBUTION OF BASE SHEAR IN MEDIUM SOIL

3.2.2.1 G+5 BUILDING MODELS

Seismic calculations for G+5 building in medium soil are as follows:

A. ZONE 2

TABLE 3.13 Base Shear Distributions of G+5 Building In Medium Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	4266	19.2	1572790.9	223.1	199.6
4	7314	16.0	1872339.2	265.6	257.9
3	7314	12.8	1198297.1	170.0	164.9
2	7314	9.6	674042.1	95.6	92.8
1	7323	6.4	299945.7	42.6	41.3
G	7318	3.2	74940.0	10.6	10.3
SUM			5692355.0	807.6	766.9

B. ZONE 3

TABLE 3.14 Base Shear Distributions of G+5 Building In Medium Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	4266	19.2	1572790.9	357.0	323.7
4	7314	16.0	1872339.2	425.0	418.2
3	7314	12.8	1198297.1	272.0	267.4
2	7314	9.6	674042.1	153.0	150.4
1	7323	6.4	299945.7	68.1	66.9
0	7318	3.2	74940.0	17.0	16.7
SUM			5692355.0	1292.2	1243.3

C. ZONE 4

TABLE 3.15 Base Shear Distributions of G+5 Building In Medium Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	4266	19.2	1572790.9	536.3	486.3
4	7314	16.0	1872339.2	638.5	628.3
3	7317	12.8	1198854.3	408.8	401.8
2	7330	9.6	675504.7	230.4	226.3
1	7343	6.4	300781.5	102.6	100.8
G	7364	3.2	75404.3	25.7	25.3
SUM			5695675.0	1942.3	1868.8

D. ZONE 5

TABLE 3.16 Base Shear Distributions of G+5 Building In Medium Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	4690	19.2	1728805.5	830.6	733.9
4	7754	16.0	1985035.7	953.7	949.4
3	7788	12.8	1276025.8	613.0	609.3
2	7798	9.6	718635.1	345.3	343.8
1	7845	6.4	321320.4	154.4	153.4
G	7964	3.2	81554.8	39.2	38.3
SUM			6111377.21	2936.1	2828.1

3.2.2.2 G+10 BUILDING MODELS

Seismic calculations for G+10 building in medium soil are as follows:

A. ZONE 2

TABLE 3.17 Base Shear Distributions of G+10 Building In Medium Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	4294	35.2	5320971.6	151.8	148.3
9	7314	32.0	7489356.8	213.7	217.1
8	7314	28.8	6066379.0	173.1	175.4
7	7314	25.6	4793188.3	136.8	138.6
6	7314	22.4	3669784.8	104.7	106.1
5	7327	19.2	2701183.2	77.1	78.0
4	7333	16.0	1877272.7	53.6	54.2
3	7342	12.8	1202940.4	34.3	34.8
2	7375	9.6	679648.9	19.4	19.6
1	7393	6.4	302809.1	8.6	8.7
G	7399	3.2	75768.1	2.2	2.2
SUM			34179302.8	975.3	983.0

B. ZONE 3

TABLE 3.18 Base Shear Distributions of G+10 Building In Medium Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	4718	35.2	5845354.0	252.8	237.4
9	7737	32.0	7922730.6	342.6	347.5
8	7737	28.8	6417411.8	277.5	280.7
7	7737	25.6	5070547.6	219.3	221.8
6	7737	22.4	3882138.0	167.9	169.8
5	7751	19.2	2857197.8	123.6	124.9
4	7756	16.0	1985616.1	85.9	86.8
3	7765	12.8	1272280.2	55.0	55.6
2	7798	9.6	718652.5	31.1	31.4
1	7816	6.4	320144.1	13.8	14.0
G	7847	3.2	80349.4	3.5	3.5
SUM			36372422.1	1572.9	1573.3

C. ZONE 4

TABLE 3.19 Base Shear Distributions of G+10 Building In Medium Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	4708	35.2	5833180.8	378.9	357.4
9	7737	32.0	7922730.6	514.6	522.8
8	7839	28.8	6502035.8	422.3	424.7
7	7839	25.6	5137411.0	333.7	337.9
6	7839	22.4	3933330.3	255.5	258.7
5	7842	19.2	2890768.8	187.8	190.1
4	7844	16.0	2008155.5	130.4	132.0
3	7850	12.8	1286086.2	83.5	84.6
2	7852	9.6	723667.3	47.0	47.6
1	7872	6.4	322442.5	20.9	21.2
G	7873	3.2	80624.2	5.2	5.3
SUM			36640432.8	2380.0	2382.2

D. ZONE 5

TABLE 3.20 Base Shear Distributions of G+10 Building In Medium Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	4346	35.2	5385114.8	558.4	539.8
9	7365	32.0	7541593.8	782.0	790.9
8	7371	28.8	6113392.3	633.9	639.0
7	7397	25.6	4847669.6	502.6	506.0
6	7422	22.4	3724105.5	386.1	388.7
5	7452	19.2	2747082.1	284.8	286.7
4	7455	16.0	1908373.1	197.9	199.5
3	7461	12.8	1222349.3	126.7	127.8
2	7507	9.6	691889.8	71.7	72.1
1	7516	6.4	307847.1	31.9	32.2
G	7596	3.2	77782.1	8.1	8.1
SUM			34567199.5	3584.1	3590.7

3.2.2.3 G+15 BUILDING MODELS

A. ZONE 2

TABLE 3.21 Base Shear Distributions of G+15 Building In Medium Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	4364	51.2	11440848.1	119.4	104.5
14	7365	48.0	16968586.0	177.1	170.4
13	7365	44.8	14781523.8	154.3	147.8
12	7365	41.6	12745293.5	133.1	127.5
11	7365	38.4	10859895.0	113.4	108.6
10	7365	35.2	9125328.5	95.3	91.3
9	7365	32.0	7541593.8	78.7	75.4
8	7365	28.8	6108691.0	63.8	61.1
7	7365	25.6	4826620.0	50.4	48.3
6	7421	22.4	3723631.5	38.9	37.1
5	7421	19.2	2735729.3	28.6	27.4
4	7432	16.0	1902520.6	19.9	19.0
3	7535	12.8	1234514.8	12.9	12.3
2	7541	9.6	694971.7	7.3	7.0
1	7603	6.4	311414.7	3.3	3.1
G	7609	3.2	77915.6	0.8	0.8
SUM			105079077.8	1096.9	1041.4

B. ZONE 3

TABLE 3.22 Base Shear Distributions of G+15 Building In Medium Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	4788	51.2	12550285.1	197.4	167.1
14	7788	48.0	17943677.2	282.3	272.7
13	7788	44.8	15630936.5	245.9	236.5
12	7788	41.6	13477695.3	212.0	203.9
11	7788	38.4	11483953.4	180.7	173.8
10	7788	35.2	9649710.8	151.8	146.0
9	7788	32.0	7974967.6	125.5	120.7
8	7788	28.8	6459723.8	101.6	97.7
7	7793	25.6	5106951.0	80.3	77.3
6	7844	22.4	3935984.7	61.9	59.4
5	7844	19.2	2891743.9	45.5	43.8
4	7855	16.0	2010864.0	31.6	30.4
3	7958	12.8	1303854.6	20.5	19.6
2	7964	9.6	733975.4	11.5	11.1
1	8026	6.4	328749.6	5.2	5.0
G	8032	3.2	82249.3	1.3	1.2
SUM			111565322.2	1755.2	1666.2

C. ZONE 4

TABLE 3.23 Base Shear Distributions of G+15 Building In Medium Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	4812	51.2	12613681.5	297.5	251.7
14	7788	48.0	17943677.2	423.3	409.9
13	7788	44.8	15630936.5	368.7	355.0
12	7788	41.6	13477695.3	317.9	306.1
11	7788	38.4	11483953.4	270.9	260.8
10	7793	35.2	9655329.2	227.7	219.2
9	7796	32.0	7983286.9	188.3	181.3
8	7805	28.8	6473671.1	152.7	147.0
7	7811	25.6	5118837.8	120.7	116.2
6	7850	22.4	3938639.1	92.9	89.3
5	7851	19.2	2894181.6	68.3	65.8
4	7859	16.0	2011879.8	47.5	45.7
3	7958	12.8	1303854.6	30.8	29.5
2	7981	9.6	735507.7	17.3	16.7
1	8040	6.4	329306.8	7.8	7.5
G	8093	3.2	82872.3	2.0	1.9
SUM			111677310.6	2634.2	2503.3

D. ZONE 5

TABLE 3.24 Base Shear Distributions of G+15 Building In Medium Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	4346	51.2	11393300.8	430.1	377.7
14	7365	48.0	16968586.0	640.5	616.9
13	7365	44.8	14781523.8	558.0	535.8
12	7420	41.6	12840440.3	484.7	463.8
11	7425	38.4	10948767.6	413.3	396.9
10	7436	35.2	9213115.7	347.8	333.9
9	7452	32.0	7631170.6	288.1	276.5
8	7456	28.8	6184695.8	233.5	224.3
7	7465	25.6	4892121.4	184.7	177.3
6	7545	22.4	3786010.3	142.9	136.6
5	7545	19.2	2781558.6	105.0	101.0
4	7560	16.0	1935410.6	73.1	70.2
3	7617	12.8	1247887.4	47.1	45.1
2	7636	9.6	703765.0	26.6	25.5
1	7715	6.4	315996.0	11.9	11.4
G	7911	3.2	81011.1	3.1	2.9
SUM			105705361.1	3990.2	3795.8

3.2.3 DISTRIBUTION OF BASE SHEAR IN SOFT SOIL

3.2.3.1 G+5 BUILDING MODELS

Seismic calculations for G+5 building in soft soil are as follows:

A. ZONE 2

TABLE 3.25 Base Shear Distributions of G+5 Building In Soft Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	4266	19.2	1572790.9	274.0	245.2
4	7314	16.0	1872339.2	326.2	316.7
3	7314	12.8	1198297.1	208.8	202.5
2	7314	9.6	674042.1	117.4	113.9
1	7323	6.4	299945.7	52.3	50.7
G	7318	3.2	74940.0	13.1	12.7
SUM			5692355.0	991.7	991.7

B. ZONE 3

TABLE 3.26 Base Shear Distributions of G+5 Building In Soft Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	4266	19.2	1572790.9	438.4	392.2
4	7314	16.0	1872339.2	521.9	506.8
3	7314	12.8	1198297.1	334.0	324.0
2	7314	9.6	674042.1	187.9	182.3
1	7323	6.4	299945.7	83.6	81.1
G	7318	3.2	74940.0	20.9	20.3
SUM			5692355.0	1586.7	1586.7

C. ZONE 4

TABLE 3.27 Base Shear Distributions of G+5 Building In Soft Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	4266	19.2	1572790.9	658.6	588.4
4	7314	16.0	1872339.2	784.0	760.2
3	7317	12.8	1198854.3	502.0	486.0
2	7330	9.6	675504.7	282.9	273.4
1	7343	6.4	300781.5	125.9	121.6
G	7364	3.2	75404.3	31.6	30.4
SUM			5695675.0	2385.0	2380.0

D. ZONE 5

TABLE 3.28 Base Shear Distributions of G+5 Building In Soft Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
5	4690	19.2	1728805.5	1019.9	882.6
4	7754	16.0	1985035.7	1171.1	1140.3
3	7788	12.8	1276025.8	752.8	729.1
2	7798	9.6	718635.1	424.0	410.1
1	7845	6.4	321320.4	189.6	182.4
G	7964	3.2	81554.8	48.1	45.6
SUM			6111377.2	3605.4	3390.0

3.2.3.2 G+10 BUILDING MODELS

Seismic calculations for G+10 building in soft soil are as follows:

A. ZONE 2

TABLE 3.29 Base Shear Distributions of G+10 Building In Soft Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	4294	35.2	5320971.6	186.4	181.9
9	7314	32.0	7489356.8	262.4	266.5
8	7314	28.8	6066379.0	212.6	215.4
7	7314	25.6	4793188.3	167.9	170.2
6	7314	22.4	3669784.8	128.6	130.3
5	7327	19.2	2701183.2	94.6	95.8
4	7333	16.0	1877272.7	65.8	66.6
3	7342	12.8	1202940.4	42.1	42.7
2	7375	9.6	679648.9	23.8	24.1
1	7393	6.4	302809.1	10.6	10.7
0	7399	3.2	75768.1	2.7	2.7
SUM			34179302.8	1197.6	1268.1

B. ZONE 3

TABLE 3.30 Base Shear Distributions of G+10 Building In Soft Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	4718	35.2	5845354.0	310.4	291.1
9	7737	32.0	7922730.6	420.7	426.4
8	7737	28.8	6417411.8	340.8	344.6
7	7737	25.6	5070547.6	269.3	272.3
6	7737	22.4	3882138.0	206.1	208.5
5	7751	19.2	2857197.8	151.7	153.3
4	7756	16.0	1985616.1	105.4	106.6
3	7765	12.8	1272280.2	67.6	68.3
2	7798	9.6	718652.5	38.2	38.5
1	7816	6.4	320144.1	17.0	17.2
G	7847	3.2	80349.4	4.3	4.3
SUM			36372422.1	1931.4	1931.1

C. ZONE 4

TABLE 3.31 Base Shear Distributions of G+10 Building In Soft Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	4708	35.2	5833180.8	465.3	436.6
9	7737	32.0	7922730.6	631.9	639.6
8	7839	28.8	6502035.8	518.6	516.9
7	7839	25.6	5137411.0	409.8	408.5
6	7839	22.4	3933330.3	313.7	312.7
5	7842	19.2	2890768.8	230.6	230.0
4	7844	16.0	2008155.5	160.2	159.9
3	7850	12.8	1286086.2	102.6	102.4
2	7852	9.6	723667.3	57.7	57.8
1	7872	6.4	322442.5	25.7	25.8
G	7873	3.2	80624.2	6.4	6.5
SUM			36640432.8	2922.5	3043.4

D. ZONE 5

TABLE 3.32 Base Shear Distributions of G+10 Building In Soft Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
10	4346	35.2	5385114.8	685.6	655.0
9	7365	32.0	7541593.8	960.2	959.4
8	7371	28.8	6113392.3	778.4	775.4
7	7397	25.6	4847669.6	617.2	612.7
6	7422	22.4	3724105.5	474.2	469.1
5	7452	19.2	2747082.1	349.8	344.9
4	7455	16.0	1908373.1	243.0	239.9
3	7461	12.8	1222349.3	155.6	153.7
2	7507	9.6	691889.8	88.1	86.7
1	7516	6.4	307847.1	39.2	38.7
G	7596	3.2	77782.1	9.9	9.7
SUM			34567199.5	4401.1	4345.0

3.2.3.3 G+15 BUILDING MODELS

Seismic calculations for G+15 building in soft soil are as follows:

A. ZONE 2

TABLE 3.33 Base Shear Distributions of G+15 Building In Soft Soil in zone 2

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	4364	51.2	11440848.1	146.7	127.4
14	7365	48.0	16968586.0	217.5	208.6
13	7365	44.8	14781523.8	189.5	181.7
12	7365	41.6	12745293.5	163.4	156.6
11	7365	38.4	10859895.0	139.2	133.5
10	7365	35.2	9125328.5	117.0	112.2
9	7365	32.0	7541593.8	96.7	92.7
8	7365	28.8	6108691.0	78.3	75.1
7	7365	25.6	4826620.0	61.9	59.3
6	7421	22.4	3723631.5	47.7	45.6
5	7421	19.2	2735729.3	35.1	33.6
4	7432	16.0	1902520.6	24.4	23.4
3	7535	12.8	1234514.8	15.8	15.1
2	7541	9.6	694971.7	8.9	8.5
1	7603	6.4	311414.7	4.0	3.8
G	7609	3.2	77915.6	1.0	1.0
SUM			105079077.8	1347.0	1347.0

B. ZONE 3

TABLE 3.34 Base Shear Distributions of G+15 Building In Soft Soil in zone 3

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	4788	51.2	12550285.1	242.5	205.2
14	7788	48.0	17943677.2	346.6	334.8
13	7788	44.8	15630936.5	302.0	290.4
12	7788	41.6	13477695.3	260.4	250.4
11	7788	38.4	11483953.4	221.9	213.4
10	7788	35.2	9649710.8	186.4	179.3
9	7788	32.0	7974967.6	154.1	148.2
8	7788	28.8	6459723.8	124.8	120.0
7	7793	25.6	5106951.0	98.7	94.9
6	7844	22.4	3935984.7	76.0	72.9
5	7844	19.2	2891743.9	55.9	53.8
4	7855	16.0	2010864.0	38.8	37.4
3	7958	12.8	1303854.6	25.2	24.1
2	7964	9.6	733975.4	14.2	13.7
1	8026	6.4	328749.6	6.4	6.1
G	8032	3.2	82249.3	1.6	1.5
SUM			111565322	2155.3	2156.3

C. ZONE 4

TABLE 3.35 Base Shear Distributions of G+15 Building In Soft Soil in zone 4

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	4812	51.2	12613681.5	365.3	309.0
14	7788	48.0	17943677.2	519.7	503.4
13	7788	44.8	15630936.5	452.7	435.9
12	7788	41.6	13477695.3	390.4	375.8
11	7788	38.4	11483953.4	332.6	320.2
10	7793	35.2	9655329.2	279.7	269.2
9	7796	32.0	7983286.9	231.2	222.6
8	7805	28.8	6473671.1	187.5	180.4
7	7811	25.6	5118837.8	148.3	142.7
6	7850	22.4	3938639.1	114.1	109.6
5	7851	19.2	2894181.6	83.8	80.8
4	7859	16.0	2011879.8	58.3	56.1
3	7958	12.8	1303854.6	37.8	36.2
2	7981	9.6	735507.7	21.3	20.5
1	8040	6.4	329306.8	9.5	9.2
G	8093	3.2	82872.3	2.4	2.3
SUM			111677310.6	3234.7	3239.2

D. ZONE 5

TABLE 3.36 Base Shear Distributions of G+15 Building In Soft Soil in zone 5

FLOOR	Wi (KN)	Hi (m)	$WiHi^2$	Qi (KN)	Qi FROM STAAD (KN)
15	4346	51.2	11393300.8	528.1	463.8
14	7365	48.0	16968586.0	786.5	757.5
13	7365	44.8	14781523.8	685.2	657.9
12	7420	41.6	12840440.3	595.2	569.5
11	7425	38.4	10948767.6	507.5	487.3
10	7436	35.2	9213115.7	427.1	410.0
9	7452	32.0	7631170.6	353.7	339.5
8	7456	28.8	6184695.8	286.7	275.4
7	7465	25.6	4892121.4	226.8	217.8
6	7545	22.4	3786010.3	175.5	167.8
5	7545	19.2	2781558.6	128.9	124.0
4	7560	16.0	1935410.6	89.7	86.2
3	7617	12.8	1247887.4	57.8	55.4
2	7636	9.6	703765.0	32.6	31.3
1	7715	6.4	315996.0	14.6	14.0
G	7911	3.2	81011.1	3.8	3.6
SUM			105705361	4899.7	4661.0

3.3 SEISMIC BASE SHEAR V_b

3.3.1 VARIATION OF Vb IN DIFFERENT SOIL

3.3.1.1 BASE SHEAR IN HARD SOIL

Variation of Base shear in hard soil is as follows:

TABLE 3.37 Base Shear in hard soil (in KN)

	ZONE 2	ZONE 3	ZONE 4	ZONE 5
G+5	593	950	1425	2137
G+10	759	1214	1822	2733
G+15	806	1291	1939	2940

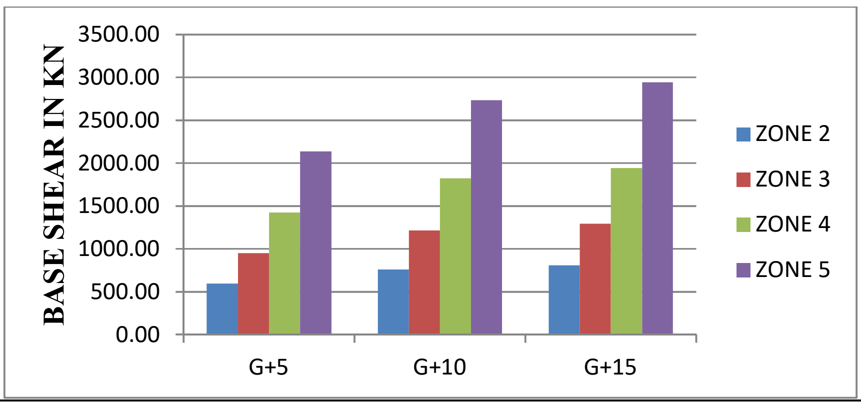

FIG 5.1 Base Shear in hard soil

3.3.1.2 BASE SHEAR IN MEDIUM SOIL

Variation of Base shear in medium soil is as follows:

TABLE 3.38 Base Shear in medium soil (in KN)

	ZONE 2	ZONE 3	ZONE 4	ZONE 5
G+5	808	1309	1968	2978
G+10	1033	1653	2502	3771
G+15	1097	1756	2638	3999

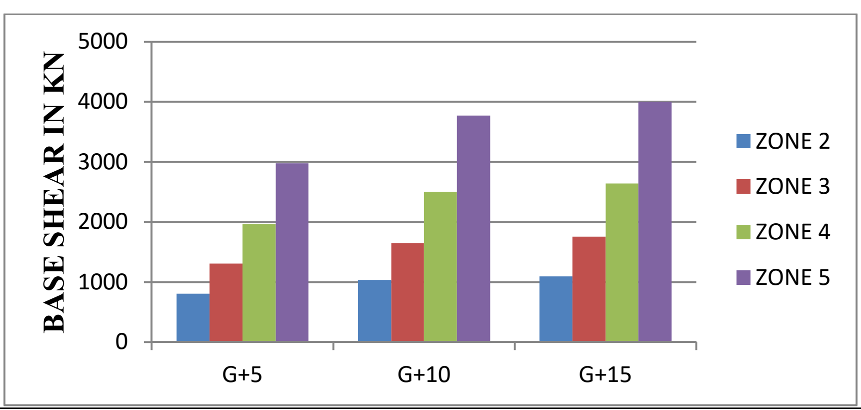

FIG 3.2 Base Shear in medium soil

3.3.1.3 BASE SHEAR IN SOFT SOIL

Variation of Base shear in soft soil is as follows:

TABLE 3.39 Base Shear in soft soil (in KN)

	ZONE 2	ZONE 3	ZONE 4	ZONE 5
G+5	991	1586	2379	3569
G+10	1268	2028	3043	4565
G+15	1347	2156	3239	4910

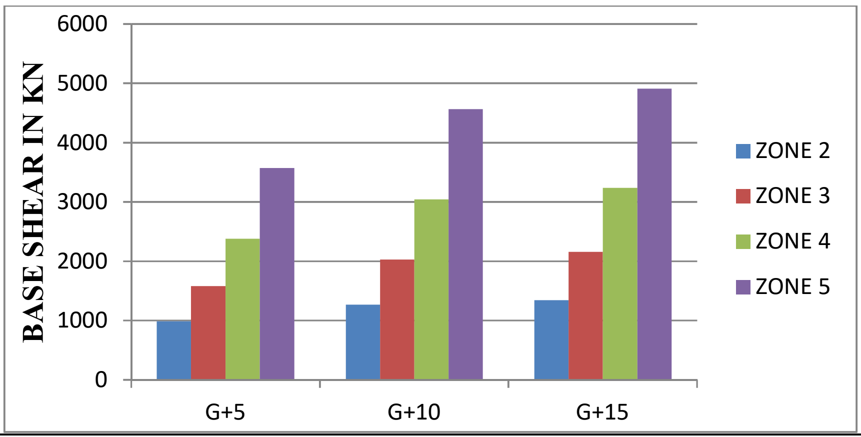

FIG 3.3 Base Shear in soft soil

3.3.2 VARIATION OF V_b IN DIFFERENT FLOORS

3.3.2.1 BASE SHEAR IN G+5 BUILDINGS

TABLE 3.40 Base Shear in G+5 Buildings (in KN)

	HARD SOIL	MEDIUM SOIL	SOFT SOIL
ZONE 2	594	808	992
ZONE 3	950	1309	1587
ZONE 4	1425	1968	2380
ZONE 5	2138	2978	3570

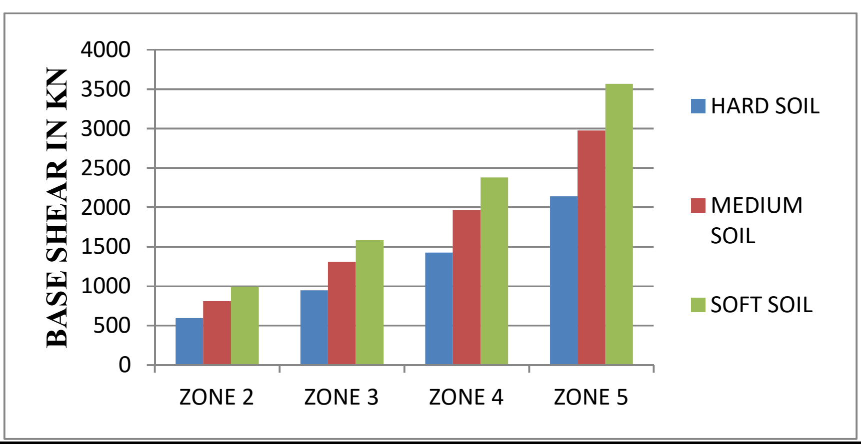

FIG 3.4 Base Shear of G+5 Buildings in KN

3.3.2.2 BASE SHEAR IN G+10

Variation of Base Shear in G+10 buildings is as follows:

TABLE 3.41 Base Shear of G+10 Buildings (in KN)

	HARD SOIL	MEDIUM SOIL	SOFT SOIL
ZONE 2	759	1033	1268
ZONE 3	1215	1653	2029
ZONE 4	1822	2502	3043
ZONE 5	2734	3771	4565

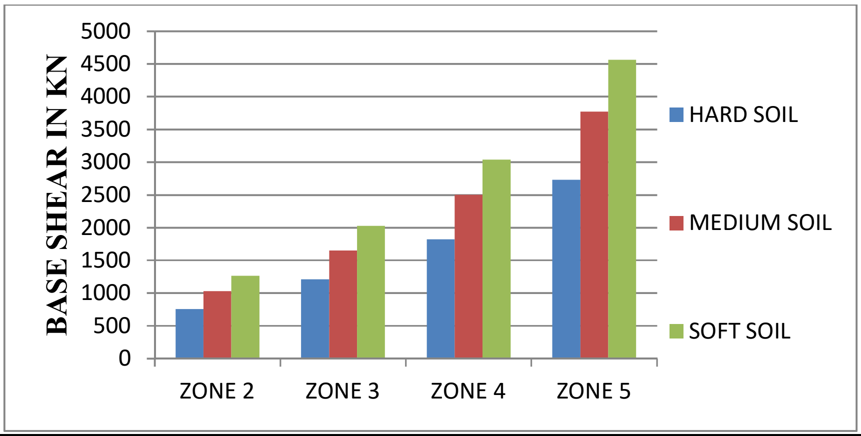

FIG 3.5 Base Shear of G+10 Buildings

3.3.2.3 BASE SHEAR IN G+15

TABLE 3.42 Base Shear of G+15 Buildings (in KN)

	HARD SOIL	MEDIUM SOIL	SOFT SOIL
ZONE 2	807	1097	1347
ZONE 3	1291	1756	2156
ZONE 4	1940	2638	3239
ZONE 5	2941	3999	4911

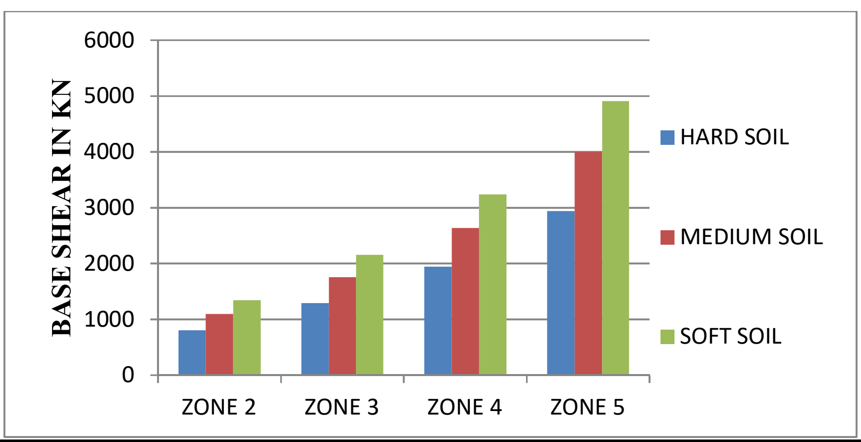

FIG 3.6 Base Shear of G+15 Buildings

3.4 STOREY SHEAR

3.4.1 STOREY SHEAR IN G+5

3.4.1.1 STOREY SHEAR IN HARD SOIL

Variation of storey shear in G+5 buildings in hard soil is as follows:

TABLE 3.43 Storey Shear of G+5 Buildings in hard soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
5	146.8	234.9	352.3	528.5
4	336.5	538.3	807.5	1211.3
3	457.8	732.4	1098.6	1647.8
2	526.0	841.5	1262.3	1893.4
1	556.3	890.1	1335.1	2002.6
G	564.2	902.2	1353.3	2029.9

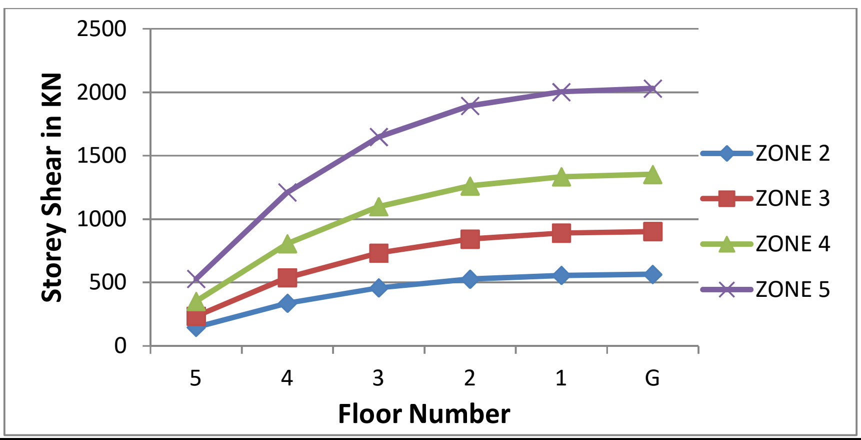

FIG 3.7 Storey Shear of G+5 Buildings in hard soil

TRENDLINE EQUATIONS

ZONE 5: $y = -81.905x^2 + 862.67x - 224.85$
ZONE 4: $y = -54.611x^2 + 575.17x - 150$
ZONE 3: $y = -36.402x^2 + 383.41x - 99.95$
ZONE 2: $y = -22.732x^2 + 239.54x - 62.36$
COMMON EQUATION: $y = -48.9125x^2 + 515.1975x – 134.29$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

3.4.1.2 STOREY SHEAR IN MEDIUM SOIL

Variation of storey shear in G+5 buildings in medium soil is as follows:

TABLE 3.44 Storey Shear of G+5 Buildings in medium soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
5	199.6	323.7	486.3	733.9
4	457.6	741.9	1114.7	1683.4
3	622.5	1009.2	1516.5	2292.6
2	715.3	1159.6	1742.8	2636.4
1	756.5	1226.5	1843.6	2789.8
G	766.9	1243.3	1868.8	2828.1

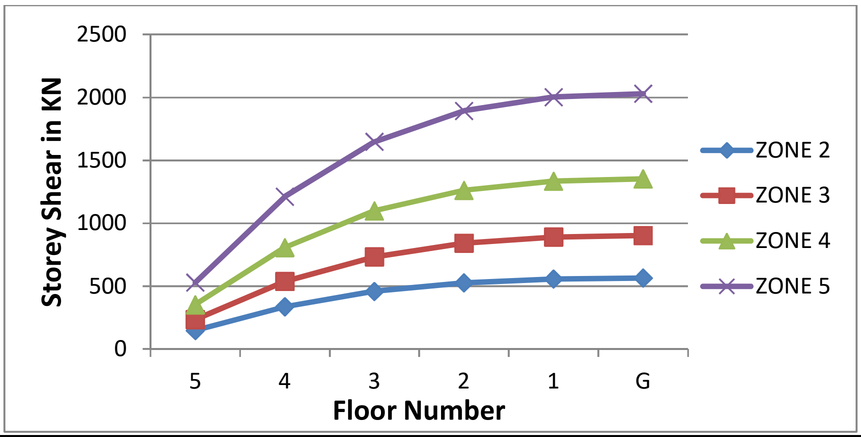

FIG 3.8 Storey Shear of G+5 Buildings in medium soil

TRENDLINE EQUATIONS

ZONE 5: $y = -113.91x^2 + 1201.2x - 315.9$
ZONE 4: $y = -75.357x^2 + 793.94x - 207.1$
ZONE 3: $y = -50.154x^2 + 528.28x - 137.62$
ZONE 2: $y = -30.943x^2 + 325.91x - 85$
COMMON EQUATION: $y = -67.591x^2 + 712.3325x - 186.405$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

3.4.1.3 STOREY SHEAR IN SOFT SOIL

Variation of storey shear in G+5 buildings in soft soil is as follows:

TABLE 3.45 Storey Shear of G+5 Buildings in soft soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
5	245.2	392.2	588.4	882.6
4	561.9	899.0	1348.6	2022.8
3	764.4	1223.1	1834.6	2751.9
2	878.3	1405.3	2108.0	3162.0
1	929.0	1486.4	2229.6	3344.4
G	941.7	1506.7	2260.0	3390.0

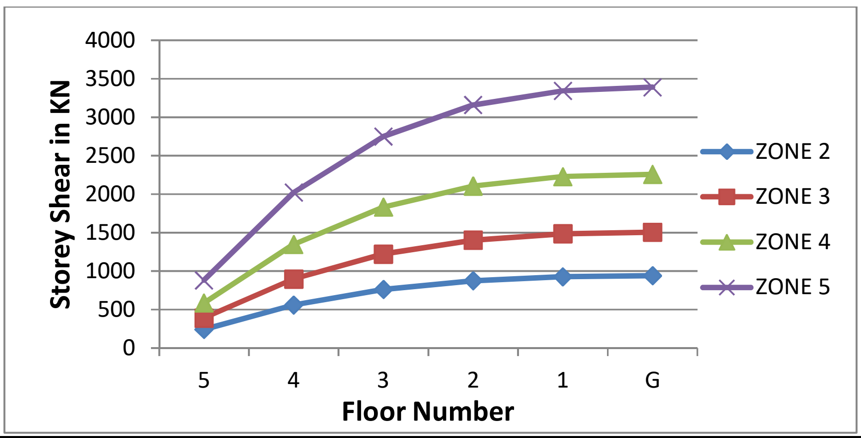

FIG 3.9 Storey Shear (in KN) of G+5 Buildings in soft soil

TRENDLINE EQUATIONS

ZONE 5: $y = -136.78x^2 + 1440.7x - 375.54$
ZONE 4: $y = -91.189x^2 + 960.45x - 250.34$
ZONE 3: $y = -60.795x^2 + 640.33x - 166.99$
ZONE 2: $y = -37.986x^2 + 400.12x - 104.22$
COMMON EQUATION: $y = -81.687x^2 + 860.4x – 224.2725$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

3.4.2 STOREY SHEAR IN G+10

3.4.2.1 STOREY SHEAR IN HARD SOIL

Variation of storey shear in G+10 buildings in hard soil is as follows:

TABLE 3.46 Storey Shear of G+10 Buildings in hard soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
10	108.9	174.3	261.5	392.2
9	268.5	429.6	644.4	966.7
8	397.5	636.0	954.0	1431.0
7	499.4	799.1	1198.6	1797.9
6	577.4	923.9	1385.8	2078.8
5	634.8	1015.7	1523.5	2285.3
4	674.7	1079.5	1619.3	2428.9
3	700.3	1120.4	1680.6	2521.0
2	714.7	1143.5	1715.2	2572.9
1	721.1	1153.8	1730.7	2596.0
G	722.7	1156.4	1734.5	2601.8

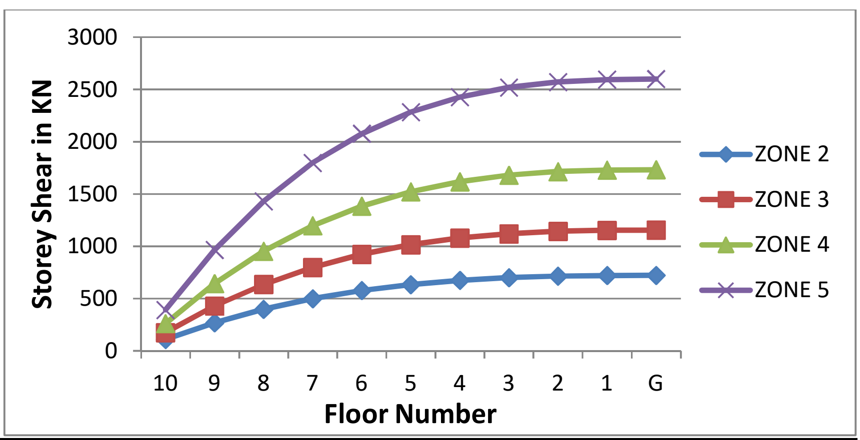

FIG 3.10 Storey Shear of G+10 Buildings in hard soil

TRENDLINE EQUATIONS

ZONE 5: $y = -31.531x^2 + 585.53x - 92.511$
ZONE 4: $y = -21.019x^2 + 390.34x - 61.659$
ZONE 3: $y = -14.013x^2 + 260.23x - 41.121$
ZONE 2: $y = -8.7596x^2 + 162.66x - 25.754$
COMMON EQUATION: $y = -18.8305x^2 + 349.69x - 46.004$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

3.4.2.2 STOREY SHEAR IN MEDIUM SOIL

Variation of storey shear in G+10 buildings in medium soil is as follows:

TABLE 3.47 Storey Shear of G+10 Buildings in medium soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
10	148.3	237.4	357.4	539.8
9	365.4	584.9	880.2	1330.7
8	540.8	865.5	1304.9	1969.7
7	679.4	1087.3	1642.8	2475.7
6	785.5	1257.1	1901.5	2864.4
5	863.5	1381.9	2091.5	3151.1
4	917.7	1468.8	2223.6	3350.6
3	952.5	1524.4	2308.1	3478.3
2	972.1	1555.8	2355.7	3550.5
1	980.8	1569.8	2376.9	3582.6
G	983.0	1573.3	2382.2	3590.7

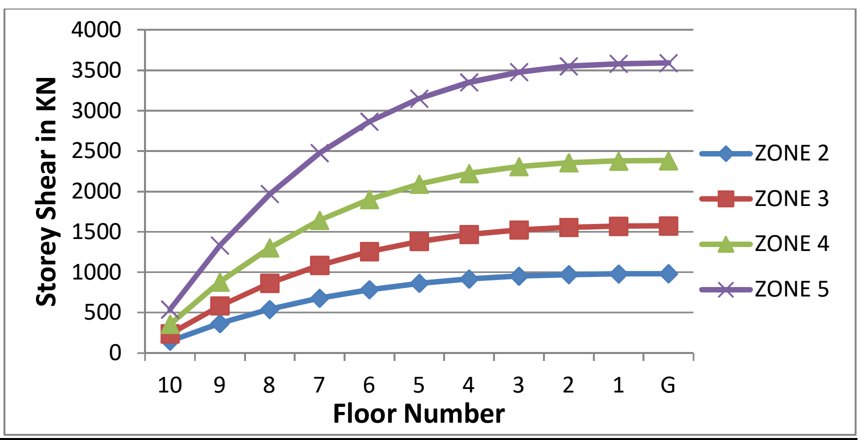

FIG 3.11 Storey Shear of G+10 Buildings in medium soil

TRENDLINE EQUATIONS

ZONE 5: $y = -43.418x^2 + 807.35x - 130.1$
ZONE 4: $y = -28.87x^2 + 536.58x - 89.228$
ZONE 3: $y = -19.062x^2 + 353.98x - 55.543$
ZONE 2: $y = -11.913x^2 + 221.21x - 34.779$
COMMON EQUATION: $y = -25.816x^2 + 479.78x - 77.4125$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

3.4.2.3 STOREY SHEAR IN SOFT SOIL

Variation of storey shear in G+10 buildings in soft soil is as follows:

TABLE 3.48 Storey Shear of G+10 Buildings in soft soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
10	181.9	291.1	436.6	655.0
9	448.4	717.5	1076.2	1614.3
8	663.8	1062.1	1593.2	2389.7
7	834.0	1334.4	2001.6	3002.4
6	964.3	1542.9	2314.3	3471.5
5	1060.1	1696.2	2544.3	3816.5
4	1126.8	1802.8	2704.2	4056.3
3	1169.4	1871.1	2806.7	4210.0
2	1193.5	1909.6	2864.4	4296.7
1	1204.3	1926.8	2890.2	4335.3
G	1206.9	1931.1	2896.7	4345.0

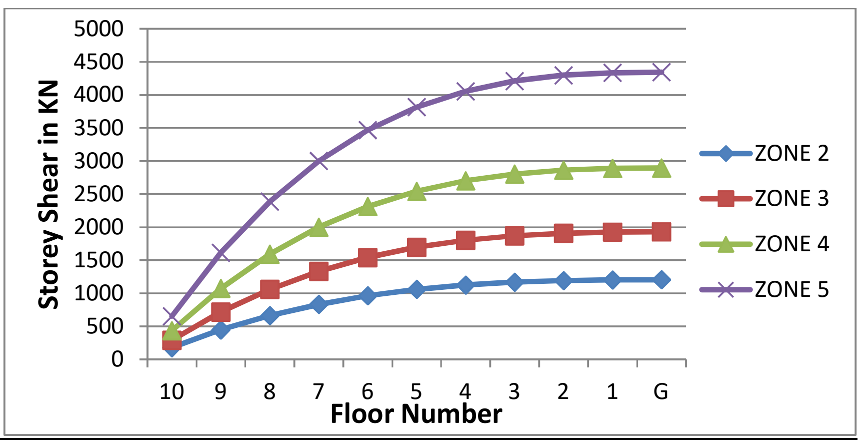

FIG 3.12 Storey Shear of G+10 Buildings in soft soil (in KN)

TRENDLINE EQUATIONS

ZONE 5: $y = -52.655x^2 + 977.82x - 154.52$
ZONE 4: $y = -35.104x^2 + 651.88x - 103.04$
ZONE 3: $y = -23.402x^2 + 434.58x - 68.661$
ZONE 2: $y = -14.628x^2 + 271.63x - 42.97$
COMMON EQUATION: $y = -26.447x^2 + 583.977x – 92.298$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

3.4.3 STOREY SHEAR IN G+15

3.4.3.1 STOREY SHEAR IN HARD SOIL

Variation of storey shear in G+15 buildings in hard soil is as follows:

TABLE 3.49 Storey Shear of G+15 Buildings in hard soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
15	76.3	122.9	185.0	277.7
14	201.1	323.4	486.5	731.4
13	309.9	497.3	747.5	1125.3
12	403.7	647.2	972.5	1466.3
11	483.7	775.0	1164.3	1758.1
10	550.8	882.3	1325.4	2003.6
9	606.3	971.1	1458.7	2206.9
8	651.3	1042.9	1566.8	2371.8
7	686.8	1099.7	1652.2	2502.2
6	714.1	1143.4	1717.9	2602.7
5	734.3	1175.6	1766.5	2676.9
4	748.3	1198.0	1800.1	2728.5
3	757.4	1212.4	1821.8	2761.7
2	762.5	1220.6	1834.1	2780.5
1	764.8	1224.3	1839.6	2788.9
G	765.4	1225.2	1841.0	2791.0

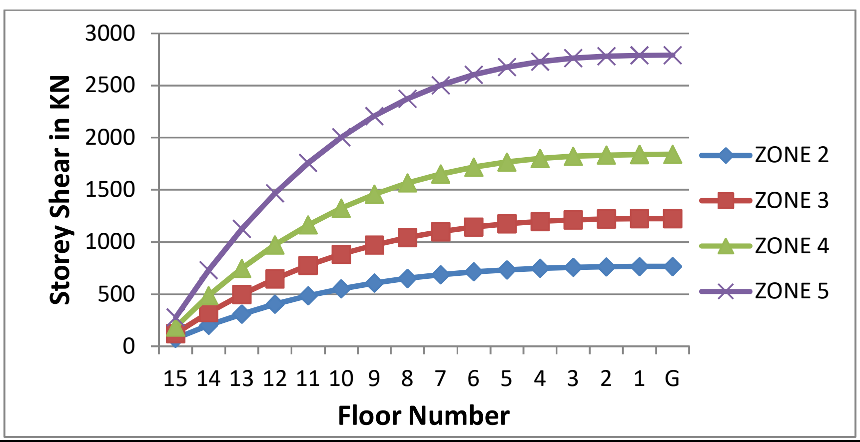

FIG 3.13 Storey Shear of G+15 Buildings in hard soil

TRENDLINE EQUATIONS

ZONE 5: $y = -16.118x^2 + 429.59x - 46.068$
ZONE 4: $y = -10.647x^2 + 283.27x - 26.062$
ZONE 3: $y = -7.0919x^2 + 188.64x - 17.737$
ZONE 2: $y = -4.4325x^2 + 117.93x - 11.951$
COMMON EQUATION: $y = -9.572x^2 + 254.85x – 25.454$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

3.4.3.2 STOREY SHEAR IN MEDIUM SOIL

Variation of storey shear in G+15 buildings in medium soil is as follows:

TABLE 3.50 Storey Shear of G+15 Buildings in medium soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
15	104.5	167.1	251.7	377.7
14	274.9	439.8	661.6	994.6
13	422.7	676.3	1016.5	1530.4
12	550.1	880.2	1322.6	1994.2
11	658.7	1054.0	1583.4	2391.1
10	750.0	1200.0	1802.6	2724.9
9	825.4	1320.7	1983.8	3001.4
8	886.5	1418.4	2130.8	3225.7
7	934.8	1495.6	2247.0	3403.0
6	971.9	1555.0	2336.3	3539.6
5	999.3	1598.8	2402.1	3640.6
4	1018.3	1629.3	2447.8	3710.8
3	1030.6	1648.9	2477.3	3755.9
2	1037.5	1660.0	2494.0	3781.4
1	1040.6	1665.0	2501.4	3792.8
G	1041.4	1666.2	2503.3	3795.8

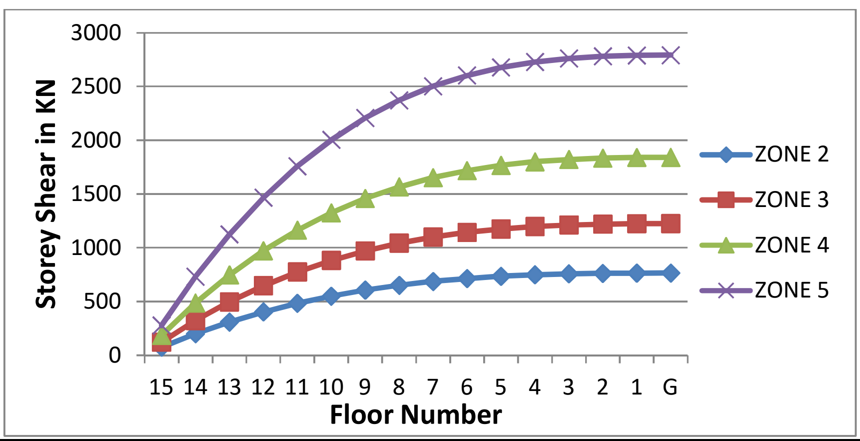

FIG 3.14 Storey Shear of G+15 Buildings in medium soil

TRENDLINE EQUATIONS

ZONE 5: $y = -21.922x^2 + 584.25x - 62.677$
ZONE 4: $y = -14.483x^2 + 385.26x - 35.451$
ZONE 3: $y = -9.6464x^2 + 256.57x - 24.188$
ZONE 2: $y = -6.0286x^2 + 160.35x - 15.089$
COMMON EQUATION: $y = -13.02x^2 + 346.607x - 34.351$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

3.4.3.3 STOREY SHEAR IN SOFT SOIL

Variation of storey shear in G+15 buildings in soft soil is as follows:

TABLE 3.51 Storey Shear of G+15 Buildings in soft soil (in KN)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
15	127.4	205.2	309.0	463.8
14	335.9	540.1	812.4	1221.4
13	517.6	830.5	1248.3	1879.3
12	674.2	1080.9	1624.1	2448.8
11	807.7	1294.2	1944.3	2936.1
10	919.9	1473.5	2213.5	3346.1
9	1012.6	1621.7	2436.0	3685.5
8	1087.6	1741.7	2616.5	3960.9
7	1147.0	1836.6	2759.2	4178.7
6	1192.6	1909.5	2868.8	4346.5
5	1226.2	1963.3	2949.6	4470.4
4	1249.6	2000.6	3005.7	4556.6
3	1264.7	2024.7	3041.9	4612.0
2	1273.2	2038.4	3062.5	4643.4
1	1277.0	2044.5	3071.6	4657.4
G	1278.0	2046.0	3073.9	4661.0

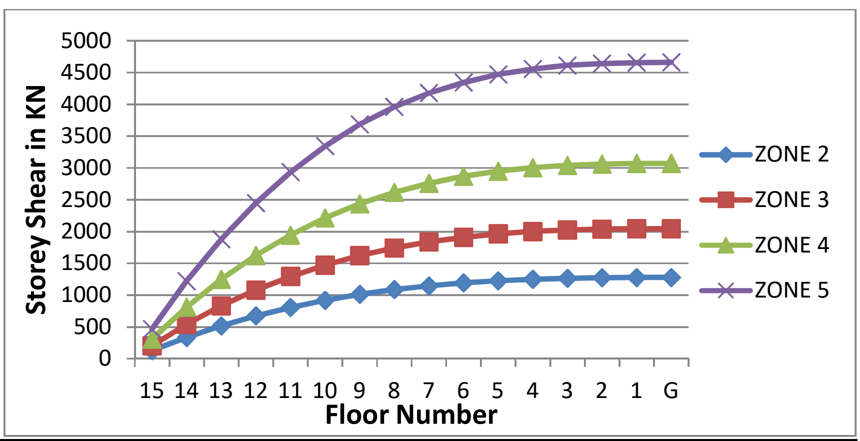

FIG 3.15 Storey Shear of G+15 Buildings in soft soil (in KN)

TRENDLINE EQUATIONS

ZONE 5: $y = -26.918x^2 + 717.41x - 76.891$
ZONE 4: $y = -17.784x^2 + 473.07x - 43.526$
ZONE 3: $y = -11.845x^2 + 315.05x - 29.667$
ZONE 2: $y = -7.4045x^2 + 196.97x - 19.974$
COMMON EQUATION: $y = -15.988x^2 + 425.625x – 42.5145$

Where, y is storey shear in KN
And, x is the floor number starting from top of the building

3.5 STOREY DRIFT

3.5.1 STOREY DRIFTS OF G+5 BUILDINGS

3.5.1.1 STOREY DRIFT IN HARD SOIL

Variation of storey drift in G+5 buildings in hard soil is as follows:

TABLE 3.52 Storey drift of G+5 buildings in hard soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
5	0.243	0.389	0.584	0.876
4	0.295	0.472	0.707	1.062
3	0.296	0.473	0.711	1.066
2	0.277	0.444	0.665	0.997
1	0.244	0.39	0.585	0.878
G	0.202	0.323	0.485	0.727

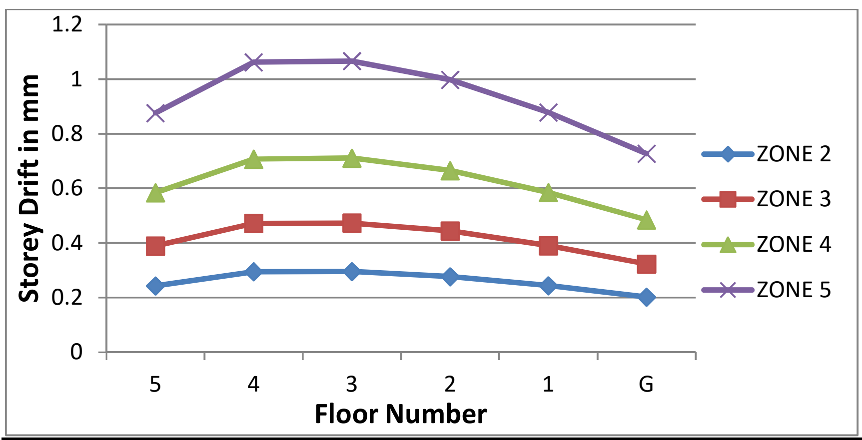

FIG 3.16 Storey drifts of G+5 buildings in hard soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.0389x^2 + 0.2331x + 0.7081$
ZONE 4: $y = -0.0259x^2 + 0.1555x + 0.4717$
ZONE 3: $y = -0.0173x^2 + 0.104x + 0.314$
ZONE 2: $y = -0.0108x^2 + 0.065x + 0.1962$
COMMON EQUATION: $y = -0.0232x^2 + 0.1394x + 0.4225$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

3.5.1.2 STOREY DRIFT IN MEDIUM SOIL

Variation of storey drift in G+5 buildings in medium soil is as follows:

TABLE 3.53 Storey drift of G+5 buildings in medium soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
5	0.331	0.529	0.794	1.191
4	0.401	0.642	0.963	1.444
3	0.403	0.644	0.966	1.45
2	0.377	0.603	0.905	1.357
1	0.331	0.531	0.796	1.193
G	0.275	0.439	0.659	0.989

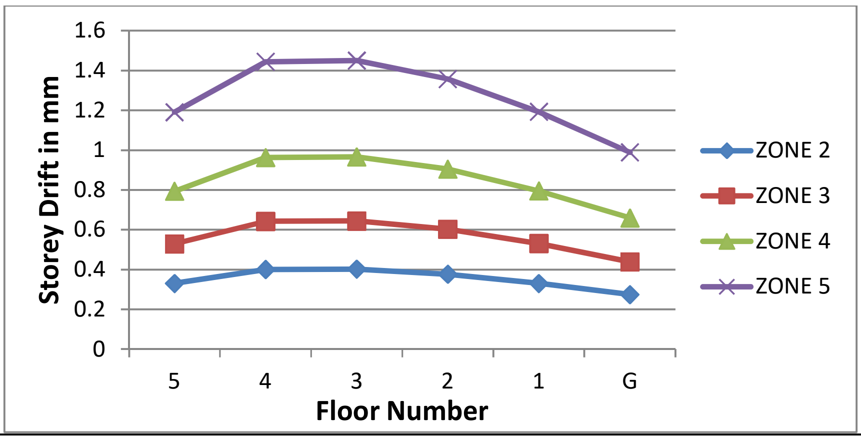

FIG 3.17 Storey drifts of G+5 buildings in medium soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.0529x^2 + 0.3176x + 0.9621$
ZONE 4: $y = -0.0353x^2 + 0.2119x + 0.6412$
ZONE 3: $y = -0.0236x^2 + 0.1416x + 0.4269$
ZONE 2: $y = -0.0147x^2 + 0.088x + 0.2676$
COMMON EQUATION: $y = -0.0316x^2 + 0.1897x + 0.5744$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

3.5.1.3 STOREY DRIFT IN SOFT SOIL

Variation of storey drift in G+5 buildings in soft soil is as follows:

TABLE 3.54 Storey drift of G+5 buildings in soft soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
5	0.406	0.65	0.975	1.463
4	0.492	0.788	1.182	1.773
3	0.495	0.791	1.187	1.78
2	0.463	0.741	1.111	1.666
1	0.407	0.652	0.977	1.466
G	0.337	0.539	0.809	1.214

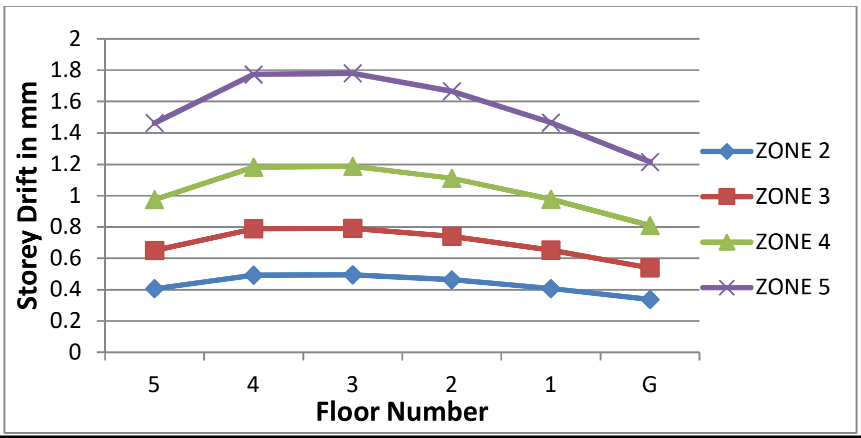

FIG 3.18 Storey drifts of G+5 buildings in soft soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.065x^2 + 0.3896x + 1.182$
ZONE 4: $y = -0.0434x^2 + 0.2604x + 0.7871$
ZONE 3: $y = -0.029x^2 + 0.1739x + 0.5243$
ZONE 2: $y = -0.0181x^2 + 0.1089x + 0.3272$
COMMON EQUATION: $y = -0.0389x^2 + 0.2332x + 0.7051$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

3.5.2 STOREY DRIFTS OF G+10 BUILDINGS

3.5.2.1 STOREY DRIFT IN HARD SOIL

Variation of storey drift in G+10 buildings in hard soil is as follows:

TABLE 3.55 Storey drift of G+10 buildings in hard soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
10	0.661	1.058	1.587	2.381
9	0.733	1.173	1.76	2.64
8	0.74	1.183	1.775	2.662
7	0.739	1.184	1.775	2.662
6	0.726	1.161	1.741	2.612
5	0.69	1.105	1.657	2.486
4	0.645	1.03	1.546	2.319
3	0.58	0.928	1.392	2.088
2	0.49	0.785	1.177	1.766
1	0.404	0.646	0.969	1.454
G	0.298	0.477	0.716	1.073

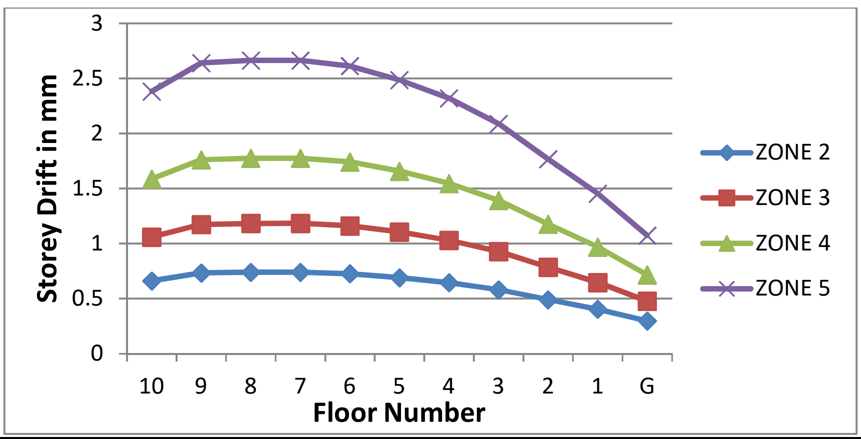

FIG 3.19 Storey drifts of G+10 buildings in hard soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.0301x^2 + 0.2206x + 2.2539$
ZONE 4: $y = -0.02x^2 + 0.147x + 1.5027$
ZONE 3: $y = -0.0134x^2 + 0.0981x + 1.0015$
ZONE 2: $y = -0.0084x^2 + 0.0615x + 0.6256$
COMMON EQUATION: $y = -0.0179x^2 + 0.1318x + 1.3459$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

3.5.2.2 STOREY DRIFT IN MEDIUM SOIL

Variation of storey drift in G+10 buildings in medium soil is as follows:

TABLE 3.56 Storey drift of G+10 buildings in medium soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
10	0.9	1.439	2.158	3.238
9	0.997	1.596	2.393	3.59
8	1.006	1.609	2.414	3.62
7	1.006	1.609	2.414	3.621
6	0.987	1.579	2.368	3.553
5	0.939	1.503	2.254	3.381
4	0.876	1.401	2.103	3.153
3	0.789	1.262	1.893	2.84
2	0.667	1.068	1.601	2.402
1	0.549	0.878	1.318	1.976
G	0.406	0.649	0.973	1.46

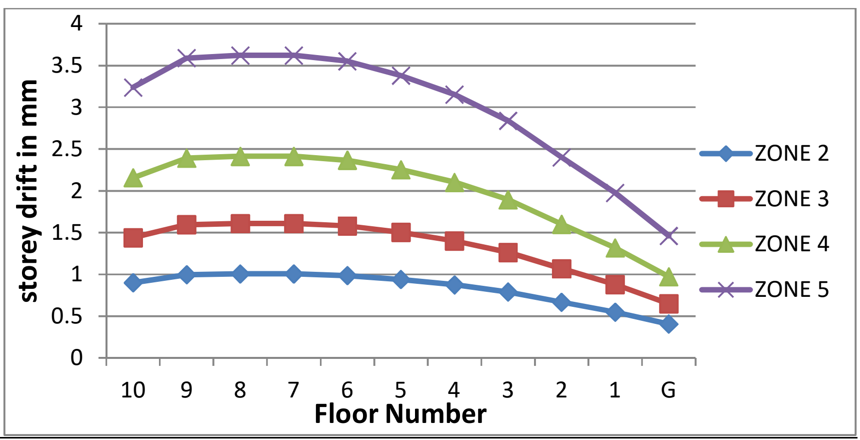

FIG 3.20 Storey drifts of G+10 buildings in medium soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.0409x^2 + 0.3001x + 3.0651$
ZONE 4: $y = -0.0273x^2 + 0.2003x + 2.0427$
ZONE 3: $y = -0.0182x^2 + 0.1333x + 1.3624$
ZONE 2: $y = -0.0113x^2 + 0.0832x + 0.852$
COMMON EQUATION: $y = -0.0244x^2 + 0.179x + 1.8305$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

3.5.2.3 STOREY DRIFT IN SOFT SOIL

Variation of storey drift in G+10 buildings in soft soil is as follows:

TABLE 3.57 Storey drift of G+10 buildings in soft soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
10	1.105	1.767	2.651	3.976
9	1.224	1.959	2.938	4.408
8	1.235	1.976	2.965	4.446
7	1.235	1.976	2.964	4.446
6	1.212	1.939	2.908	4.362
5	1.153	1.845	2.768	4.152
4	1.076	1.721	2.581	3.872
3	0.969	1.55	2.325	3.487
2	0.819	1.311	1.966	2.949
1	0.674	1.078	1.618	2.427
G	0.498	0.797	1.195	1.793

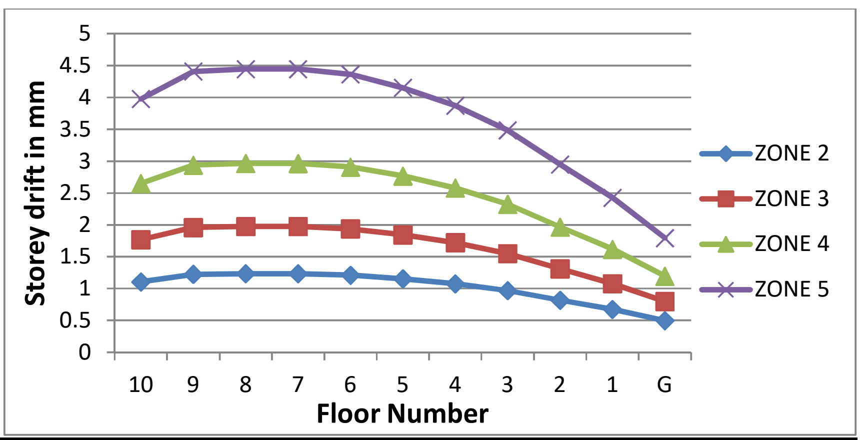

FIG 3.21 Storey drifts of G+10 buildings in soft soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.0502x^2 + 0.3685x + 3.7639$
ZONE 4: $y = -0.0335x^2 + 0.2457x + 2.5094$
ZONE 3: $y = -0.0223x^2 + 0.1639x + 1.6726$
ZONE 2: $y = -0.0139x^2 + 0.1024x + 1.0456$
COMMON EQUATION: $y = -0.0300x^2 + 0.2201x + 2.2479$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

3.5.3 STOREY DRIFTS OF G+15 BULDINGS

3.5.3.1 STOREY DRIFT IN HARD SOIL

Variation of storey drift in G+15 buildings in hard soil is as follows:

TABLE 3.58 Storey drift of G+15 buildings in hard soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
15	1.161	1.836	2.714	3.938
14	1.237	1.99	2.96	4.244
13	1.25	1.996	2.964	4.28
12	1.258	2.013	2.989	4.294
11	1.257	2.011	2.987	4.308
10	1.246	1.993	2.96	4.258
9	1.221	1.953	2.902	4.181
8	1.181	1.89	2.813	4.069
7	1.129	1.806	2.701	3.913
6	1.055	1.687	2.525	3.651
5	0.973	1.558	2.328	3.399
4	0.88	1.408	2.105	3.065
3	0.753	1.205	1.806	2.659
2	0.634	1.014	1.517	2.27
1	0.507	0.811	1.25	1.862
G	0.327	0.524	0.735	0.94

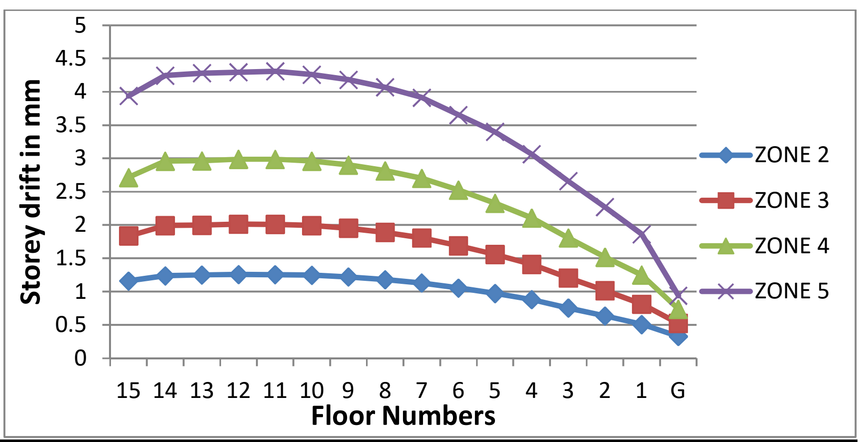

FIG 3.22 Storey drifts of G+15 buildings in hard soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.0257x^2 + 0.2491x + 3.7423$
ZONE 4: $y = -0.0174x^2 + 0.1649x + 2.6167$
ZONE 3: $y = -0.0115x^2 + 0.1062x + 1.7754$
ZONE 2: $y = -0.0071x^2 + 0.0652x + 1.115$
COMMON EQUATION: $y = -0.0154x^2 + 0.1463x + 2.3123$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

3.5.3.2 STOREY DRIFT IN MEDIUM SOIL

Variation of storey drift in G+15 buildings in medium soil is as follows:

TABLE 3.59 Storey drift of G+15 buildings in medium soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
15	1.578	0.497	3.691	2.356
14	1.684	2.706	4.026	5.771
13	1.699	2.715	4.031	5.822
12	1.711	2.737	4.064	5.839
11	1.71	2.736	4.063	5.86
10	1.695	2.71	4.025	5.79
9	1.66	2.656	3.947	5.686
8	1.606	2.57	3.825	5.534
7	1.535	2.456	3.674	5.321
6	1.435	2.295	3.434	4.965
5	1.324	2.119	3.166	4.623
4	1.197	1.915	2.863	4.169
3	1.023	1.638	2.546	3.616
2	0.862	1.379	1.973	3.087
1	0.69	1.104	1.7	2.532
G	0.445	0.712	1	1.279

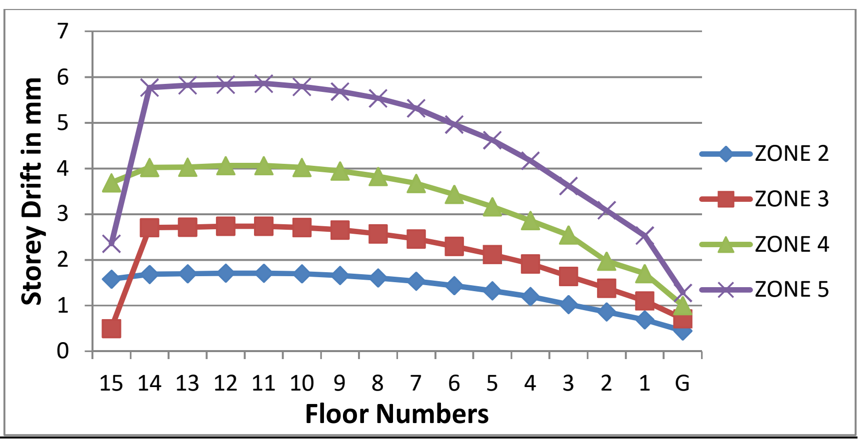

FIG 3.23 Storey drift of G+15 buildings in medium soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.0533x^2 + 0.7173x + 3.4022$
ZONE 4: $y = -0.0238x^2 + 0.2266x + 3.553$
ZONE 3: $y = -0.0279x^2 + 0.397x + 1.2895$
ZONE 2: $y = -0.0097x^2 + 0.0887x + 1.5165$
COMMON EQUATION: $y = -0.0287x^2 + 0.3574x + 2.4403$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

3.5.3.3 STOREY DRIFT IN SOFT SOIL

Variation of storey drift in G+15 buildings in soft soil is as follows:

TABLE 3.60 Storey drift of G+15 buildings in soft soil (in mm)

FLOOR	ZONE 2	ZONE 3	ZONE 4	ZONE 5
15	1.938	3.067	4.533	6.576
14	2.067	3.323	4.944	7.087
13	2.086	3.334	4.949	7.149
12	2.101	3.36	4.991	7.169
11	2.101	3.36	4.989	7.196
10	2.08	3.328	4.942	7.11
9	2.039	3.261	4.847	6.982
8	1.972	3.156	4.697	6.796
7	1.885	3.016	4.511	6.534
6	1.762	2.818	4.217	6.097
5	1.626	2.601	3.888	5.676
4	1.469	2.352	3.516	5.119
3	1.257	2.011	3.015	4.441
2	1.059	1.694	2.534	3.791
1	0.846	1.355	2.087	3.108
G	0.547	0.875	1.228	1.571

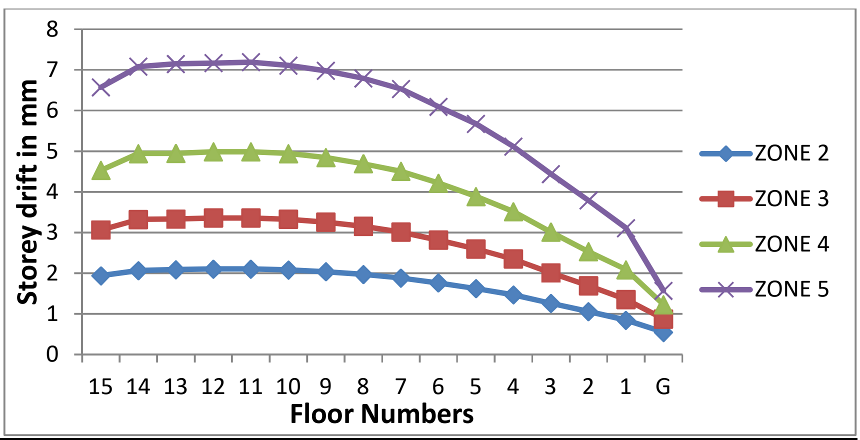

FIG 3.24 Storey drifts of G+15 buildings in soft soil

TRENDLINE EQUATIONS

ZONE 5: $y = -0.0429x^2 + 0.416x + 6.2494$
ZONE 4: $y = -0.0291x^2 + 0.2752x + 4.3703$
ZONE 3: $y = -0.0191x^2 + 0.1773x + 2.9655$
ZONE 2: $y = -0.0119x^2 + 0.1089x + 1.862$
COMMON EQUATION: $y = -0.0257x^2 + 0.2443x + 3.8618$

Where, y is storey drift in mm
And, x is the floor number starting from top of the building

3.6 TOP STOREY DISPLACEMENT

3.6.1 TOP STOREY DISPLACEMENTS OF G+5 BUILDINGS

Variation of top storey displacements in G+5 buildings is as follows:

TABLE 3.61 Top Storey Displacements of G+5 buildings (in mm)

	ZONE 2	ZONE 3	ZONE 4	ZONE 5
HARD SOIL	1.557	2.491	3.737	5.606
MEDIUM SOIL	2.118	3.388	5.083	7.624
SOFT SOIL	2.6	4.161	6.241	9.362

3.6.2 TOP STOREY DISPLACEMENTS G+10 BUILDINGS

Variation of top storey displacements in G+5 buildings is as follows:

TABLE 3.62 Top Storey Displacements of G+10 buildings (in mm)

	ZONE 2	ZONE 3	ZONE 4	ZONE 5
HARD SOIL	6.706	10.73	16.095	24.143
MEDIUM SOIL	9.122	14.593	21.889	32.834
SOFT SOIL	11.2	17.919	26.879	40.318

3.6.3 TOP STOREY DISPLACEMENTS G+15 BUILDINGS

Variation of top storey displacements in G+5 buildings is as follows:

TABLE 3.63 Top Storey Displacements of G+15 buildings (in mm)

	ZONE 2	ZONE 3	ZONE 4	ZONE 5
HARD SOIL	16.069	25.695	38.256	55.331
MEDIUM SOIL	21.854	32.945	52.028	72.25
SOFT SOIL	11.2	17.919	26.879	40.318

CHAPTER 4: CONSIDERATION OF SHEAR WALL AT DIFFERENT LOCATIONS

Reinforced Concrete Shear Wall of thickness 0.2 m was placed at different locations of the building and analysed to get the storey drift, axial forces, shear forces, bending moment and torsion values of different members of the structures and comparative analysis was done for these parameters to find the ideal location of the shear wall.

4.1 MODELS CONSIDERED

Following models were considered:

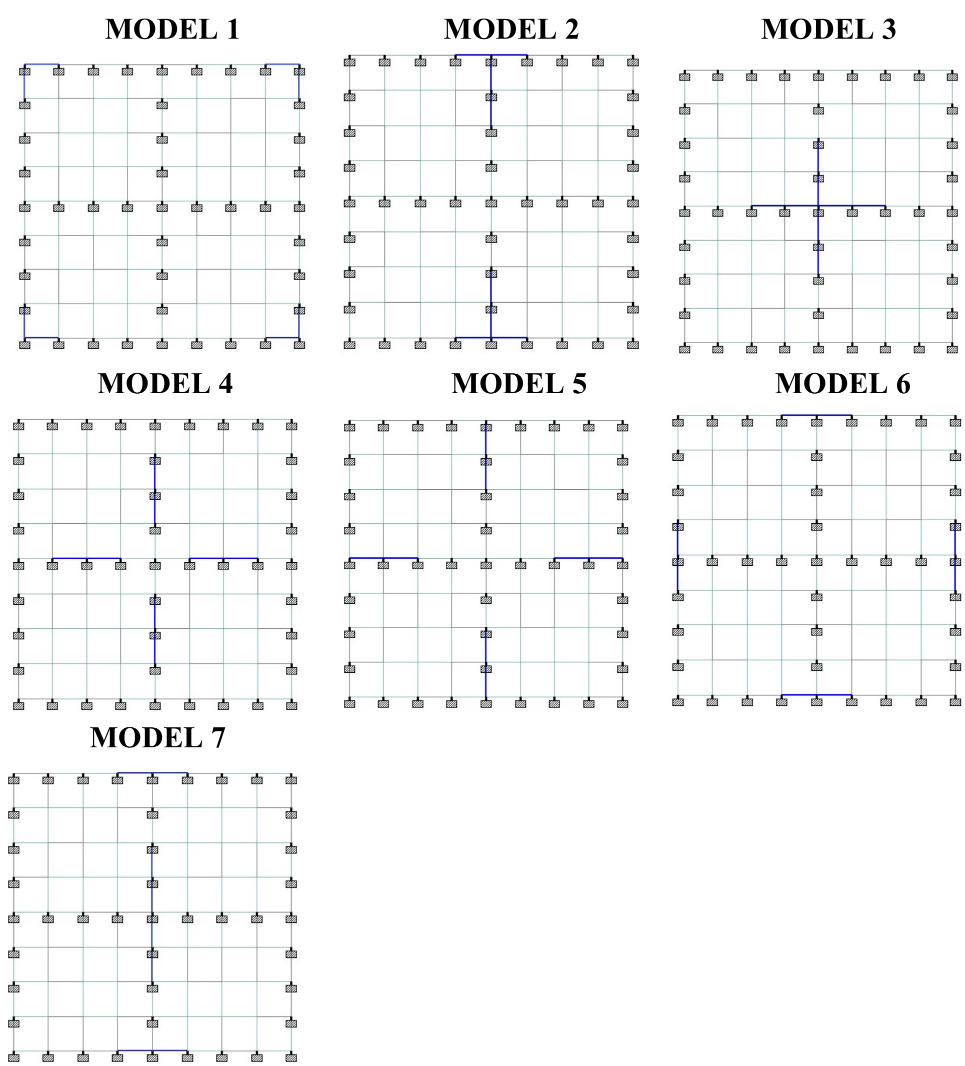

FIG 4.1 Models considered

4.2 STOREY DRIFT

The above models were analysed and storey drift in x and z directions were found out.

4.2.1 STOREY DRIFTS IN X DIRECTION

The following table shows the value of storey drift in x direction for 7 different models with shear wall at different location.

TABLE 4.1 Storey Drift In X Direction (in mm)

FLOOR	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7
10	3.467	2.532	0.900	2.059	2.351	2.520	2.516
9	3.573	2.683	0.997	2.245	2.546	2.674	2.669
8	3.627	2.694	1.006	2.262	2.550	2.684	2.681
7	3.634	2.685	1.006	2.271	2.539	2.676	2.672
6	3.569	2.630	0.987	2.239	2.483	2.621	2.618
5	3.411	2.499	0.939	2.140	2.355	2.493	2.489
4	3.162	2.315	0.876	1.992	2.173	2.310	2.307
3	2.804	2.058	0.789	1.785	1.932	2.055	2.054
2	2.339	1.715	0.667	1.484	1.595	1.715	1.713
1	1.765	1.332	0.549	1.160	1.236	1.333	1.332
0	0.964	0.786	0.406	0.694	0.726	0.776	0.776
MAX DRIFT	3.634	2.694	1.006	2.271	2.550	2.684	2.681

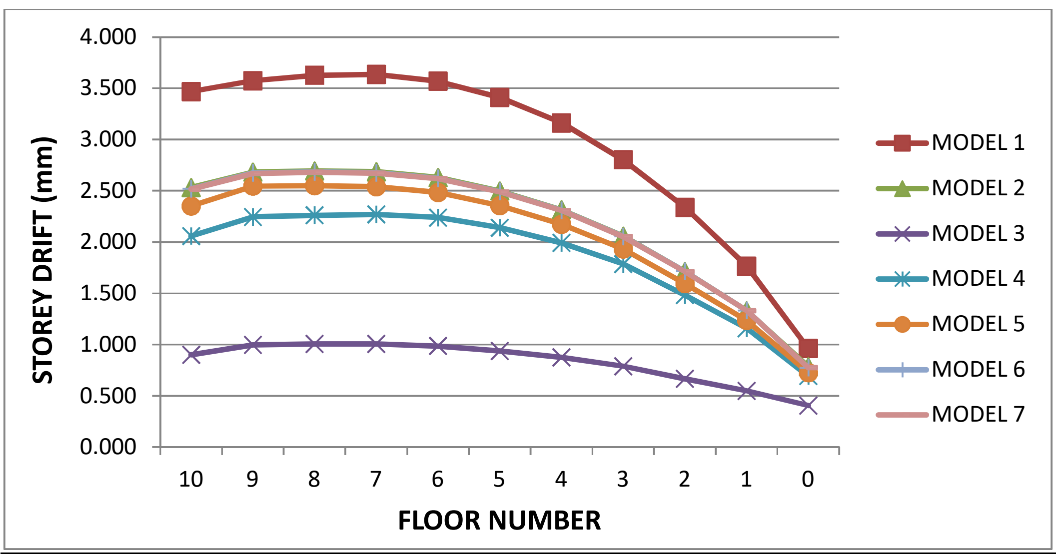

FIG 4.2 Storey Drifts In X Direction (in mm)

4.2.2 STOREY DRIFTS IN Z DIRECTION

The following table shows the value of storey drift in z direction for 7 different models with shear wall at different location.

TABLE 4.2 Storey Drift in Z Direction (in mm)

FLOOR	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7
10	3.467	1.332	0.881	1.960	2.251	2.399	0.876
9	3.573	1.448	0.976	2.140	2.446	2.552	0.970
8	3.627	1.457	0.988	2.165	2.457	2.569	0.982
7	3.634	1.454	0.988	2.178	2.451	2.568	0.983
6	3.569	1.422	0.970	2.150	2.311	2.519	0.965
5	3.411	1.355	0.927	2.066	2.379	2.409	0.922
4	3.162	1.258	0.864	1.929	2.118	2.238	0.860
3	2.804	1.125	0.775	1.728	1.878	1.992	0.772
2	2.339	0.955	0.664	1.455	1.570	1.678	0.662
1	1.765	0.759	0.543	1.131	1.210	1.298	0.541
0	0.964	0.504	0.401	0.678	0.715	0.759	0.403
MAX DRIFT	3.634	1.457	0.988	2.178	2.457	2.569	0.983

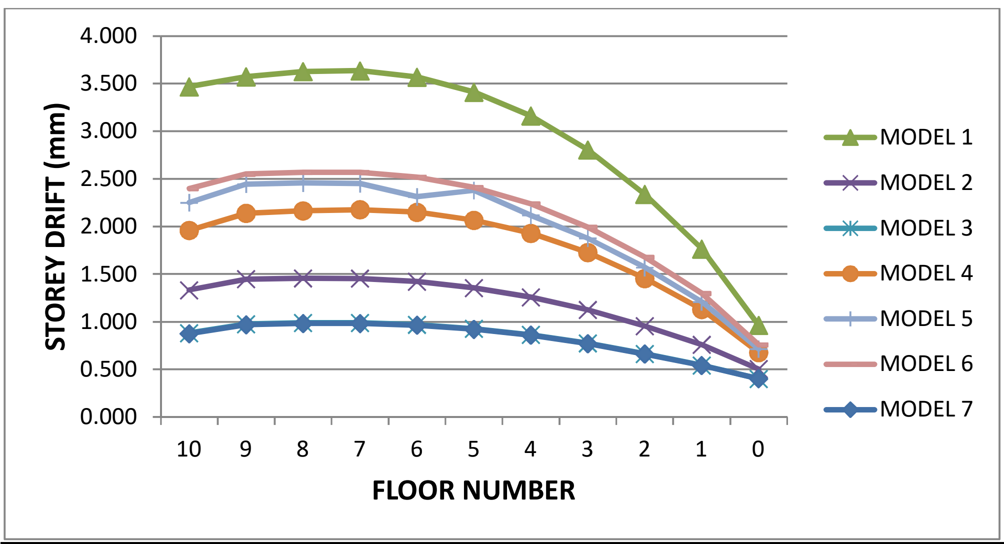

FIG 4.3 Storey Drifts In Z Direction

4.2.3 DISCUSSION

From the above table and chart for the storey drift in x and z direction, it can be seen that model 3 and model 7 gives lowest value of storey drift in x and z direction respectively for the building so it may be inferred that location of shear wall would be ideal if it is placed at the same location as in model 3 and model 7 respectively if storey drift in x and z direction is considered.

4.3 TOP STOREY DISPLACEMENTS

4.3.1 TOP STOREY DISPLACEMENTS IN X DIRECTION

Nodal Displacements of the top storey of all 7 different models in x direction were recorded as follows:

TABLE 4.3 Top Storey Displacements In X Direction (in mm)

MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7
32.315	23.929	9.122	20.331	22.486	23.857	23.827

4.3.2 TOP STOREY DISPLACEMENTS IN Z DIRECTION

Nodal Displacements of the top storey of all 7 different models in z direction were recorded as follows:

TABLE 4.4 Top Storey Displacements in Z Direction (in mm)

MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7
32.315	13.069	8.977	19.58	21.786	22.981	8.936

4.3.3 DISCUSSION

From the above tables considering the top storey displacement in x and z direction it can be seen that at the location of shear wall for model 3 least top storey displacement in x direction was there likewise at the location of shear wall for model 7 least top storey displacement in z direction is there.

4.4 VARIATION OF AXIAL FORCES IN COLUMN

Axial forces in all the 7 different models were taken from the staad analysis to find the model which has least values of axial forces among all other models to find the ideal location of the shear wall.

4.4.1 VARIATION OF AXIAL FORCE IN DIFFERENT MODELS

Axial Forces in all 7 different models in corner, edge and middle columns have been recorded as follows:

4.4.1.1 MODEL 1

TABLE 4.5 Variation of Axial Force (in KN) In Model 1

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	256	816	1572
1	91	765	1472
2	90	706	1360
3	83	641	1234
4	84	574	1093
5	82	500	952
6	78	421	804
7	71	338	648
8	58	251	484
9	36	163	316
10	2	67	140

4.4.1.2 MODEL 2

TABLE 4.6 Variation of Axial Force (in KN) In Model 2

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	481	837	1446
1	451	786	1351
2	414	724	1244
3	376	658	1125
4	336	589	994
5	292	513	864
6	245	432	728
7	196	346	587
8	144	257	440
9	92	166	289
10	34	68	134

4.4.1.3 MODEL 3

Axial Forces in model 3 in corner, edge and middle columns is as follows:

TABLE 4.7 Variation of Axial Force (in KN) In Model 3

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	509	818	1147
1	477	767	425
2	438	705	367
3	398	640	331
4	355	572	251
5	308	497	215
6	259	418	179
7	207	335	141
8	152	249	100
9	97	162	57
10	36	69	18

4.4.1.4 MODEL 4

Axial Forces in model 4 in corner, edge and middle columns is as follows:

TABLE 4.8 Variation of Axial Force (in KN) In Model 4

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	490	535	773
1	459	491	681
2	422	442	591
3	384	396	508
4	343	349	428
5	298	301	356
6	250	251	289
7	200	201	226
8	148	149	164
9	94	96	104
10	35	38	42

4.4.1.5 MODEL 5

Axial Forces in model 5 in corner, edge and middle columns is as follows:

TABLE 4.9 Variation of Axial Force (in KN) In Model 5

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	486	261	1354
1	455	111	1261
2	418	107	1159
3	380	111	1048
4	339	122	928
5	295	128	806
6	248	127	679
7	198	117	547
8	146	96	411
9	93	65	273
10	35	32	131

4.4.1.6 MODEL 6

Axial Forces in model 6 in corner, edge and middle columns is as follows:

TABLE 4.10 Variation of Axial Force (in KN) In Model 6

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	478	619	1579
1	448	290	1480
2	411	240	1367
3	374	186	1240
4	334	163	1099
5	290	141	958
6	243	117	809
7	194	93	652
8	144	68	487
9	92	41	318
10	34	13	141

4.4.1.7 MODEL 7

Axial Forces in model 7 in corner, edge and middle columns is as follows:

TABLE 4.11 Variation of Axial Force (in KN) In Model 7

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	481	840	1171
1	451	789	498
2	413	727	413
3	376	661	366
4	336	591	281
5	292	515	240
6	245	433	200
7	196	348	159
8	145	258	114
9	92	167	68
10	34	68	31

4.4.2 VARIATION OF AXIAL FORCES IN CORNER COLUMNS

Axial Force in the columns located at the corner of the building for all the 7 different models and in the bare frame models were recorded as follows:

TABLE 4.12 Axial Forces in Corner Columns (in KN)

FLOOR	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7	BFM
G	256	481	509	490	486	478	481	978
1	91	451	477	459	455	448	451	908
2	90	414	438	422	418	411	413	830
3	83	376	398	384	380	374	376	751
4	84	336	355	343	339	334	336	667
5	82	292	308	298	295	290	292	577
6	78	245	259	250	248	243	245	483
7	71	196	207	200	198	194	196	384
8	58	144	152	148	146	144	145	279
9	36	92	97	94	93	92	92	167
10	2	34	36	35	35	34	34	43

4.4.3 VARIATION OF AXIAL FORCES IN EDGE COLUMNS

Axial Force in the columns located at the edge of the building for all the 7 different models and in the bare frame models were recorded as follows:

TABLE 4.13 Axial Forces in Edge Columns (in KN)

FLOOR	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7	BFM
G	816	837	818	535	261	619	840	1582
1	765	786	767	491	111	290	789	1463
2	706	724	705	442	107	240	727	1335
3	641	658	640	396	111	186	661	1203
4	574	589	572	349	122	163	591	1065
5	500	513	497	301	128	141	515	918
6	421	432	418	251	127	117	433	765
7	338	346	335	201	117	93	348	606
8	251	257	249	149	96	68	258	438
9	163	166	162	96	65	41	167	262
10	67	68	69	38	32	13	68	72

4.4.4 VARIATION OF AXIAL FORCES IN MIDDLE COLUMNS

Axial Force in the columns located at the middle of the building for all the 7 different models and in the bare frame models were recorded as follows:

TABLE 4.14 Axial Forces in Middle Columns (in KN)

FLOOR	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7	BFM
G	1572	1446	1147	773	1354	1579	1171	2724
1	1472	1351	425	681	1261	1480	498	2495
2	1360	1244	367	591	1159	1367	413	2260
3	1234	1125	331	508	1048	1240	366	2013
4	1093	994	251	428	928	1099	281	1754
5	952	864	215	356	806	958	240	1500
6	804	728	179	289	679	809	200	1240
7	648	587	141	226	547	652	159	973
8	484	440	100	164	411	487	114	698
9	316	289	57	104	273	318	68	419
10	140	134	18	42	131	141	31	129

CHAPTER 5: CONSIDERATION OF BRACINGS AT DIFFERENT LOCATIONS

Bracings of ISMB 200 were placed at different locations of the building and analysed to get the storey drift and the model which gave the minimum value of the storey drift may be termed as the ideal location of the bracings.

5.1 MODELS CONSIDERED

Following Models were considered:

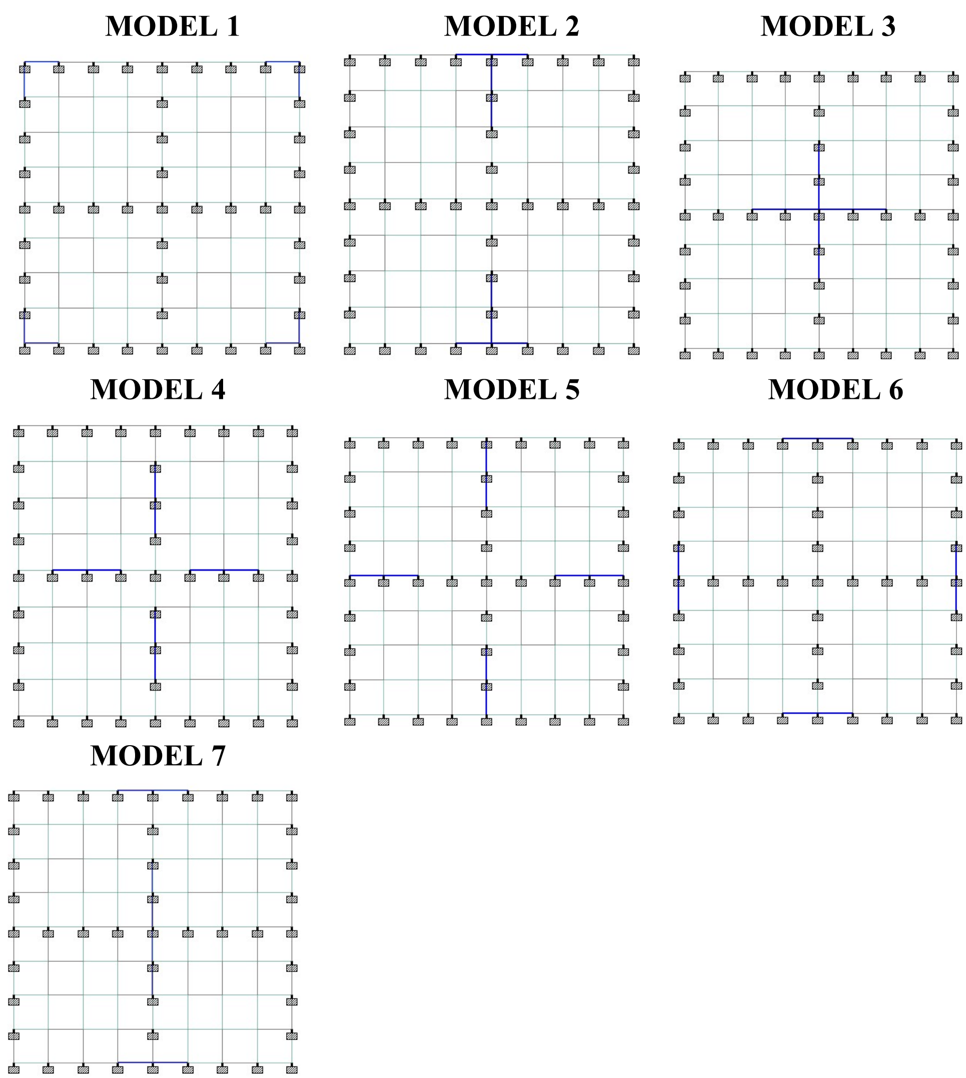

FIG 5.1 Models considered

5.2 STOREY DRIFT

The above models were analysed and storey drift in x and z directions were found out. The models giving least value of the storey drift can be considered to be the ideal location of the bracing system and that model can be used for further modelling and analysis in different zones.

5.2.1 STOREY DRIFT IN X DIRECTION

The following table shows the value of storey drift in x direction for 7 different models with bracings at different location.

TABLE 5.1 Storey Drift In X Direction (In mm)

FLOOR	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7
10	4.419	3.439	1.787	2.472	3.194	3.434	3.437
9	5.032	4.075	2.291	3.094	3.846	4.070	4.074
8	5.507	4.417	2.560	3.447	4.172	4.412	4.415
7	5.871	4.68	2.754	3.733	4.421	4.676	4.679
6	6.064	4.818	2.858	3.910	4.540	4.813	4.816
5	5.970	4.712	2.817	3.891	4.433	4.708	4.711
4	5.693	4.491	2.734	3.755	4.207	4.487	4.489
3	5.153	4.089	2.558	3.484	3.838	4.087	4.089
2	4.354	3.459	2.251	2.979	3.236	3.456	3.458
1	3.423	2.817	2.011	2.499	2.667	2.816	2.817
0	2.015	1.816	1.503	1.690	1.746	1.815	1.816
MAX DRIFT	6.064	4.818	2.858	3.91	4.54	4.813	4.816

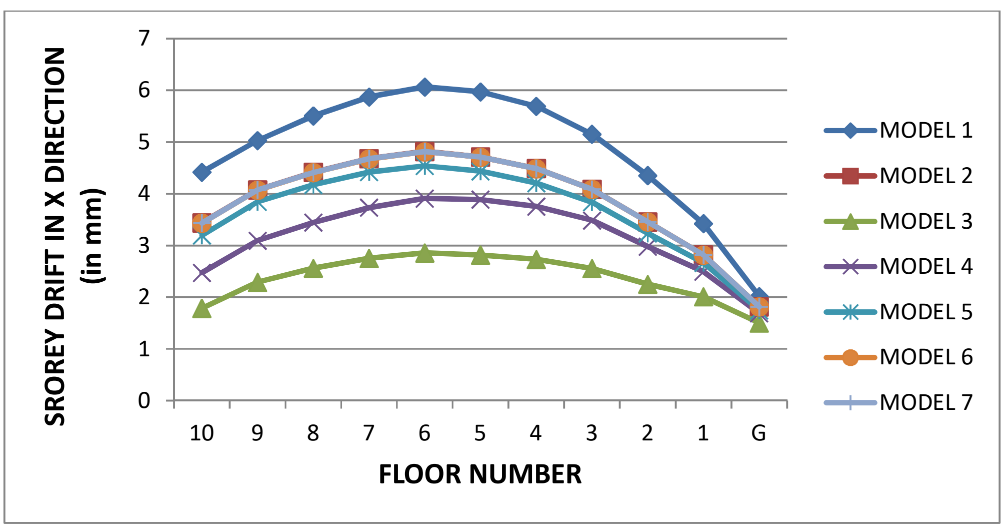

FIG 5.2 Storey Drift In X Direction

5.2.2 STOREY DRIFT IN Z DIRECTION

The following table shows the value of storey drift in z direction for 7 different models with bracings at different location:

TABLE 5.2 Storey Drift in Z Direction (In mm)

FLOOR	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7
10	4.419	2.415	1.787	2.472	3.194	3.434	1.679
9	5.032	2.949	2.291	3.094	3.846	4.07	2.147
8	5.507	3.254	2.56	3.447	4.172	4.412	2.419
7	5.871	3.478	2.754	3.733	4.421	4.676	2.615
6	6.064	3.589	2.858	3.91	4.54	4.813	2.721
5	5.97	3.562	2.817	3.891	4.433	4.708	2.719
4	5.693	3.421	2.734	3.755	4.207	4.487	2.643
3	5.153	3.152	2.558	3.484	3.838	4.087	2.474
2	4.354	2.782	2.251	2.979	3.236	3.456	2.239
1	3.423	2.335	2.011	2.499	2.667	2.816	1.972
0	2.015	1.57	1.503	1.69	1.746	1.815	1.454
MAX DRIFT	6.064	3.589	2.858	3.91	4.54	4.813	2.721

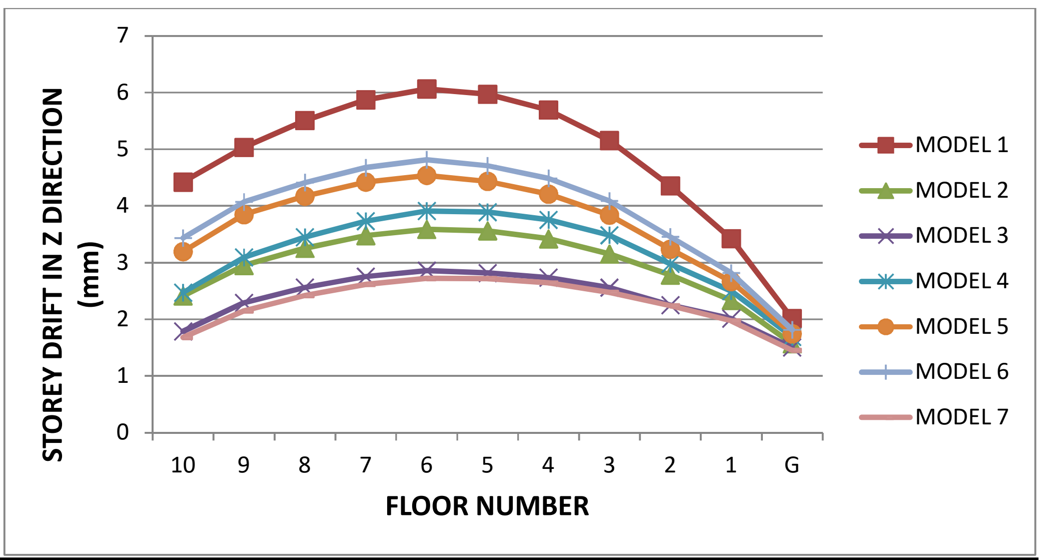

FIG 5.3 Storey Drift In Z Direction

5.2.3 Discussion

From the above values of storey drift it can be interpreted that model 4 is giving the least value of storey drift so it may be used for further modelling and analysis of building in different seismic zones.

5.3 TOP STOREY DISPLACEMENT

5.3.1 TOP STOREY DISPLACEMENT IN X DIRECTION

Nodal Displacements of the top storey of all 7 different models in x direction were recorded as follows:

TABLE 5.3 Top Storey Displacements in X Direction (in mm)

MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7
53.500	42.812	26.122	34.952	40.298	42.773	42.800

5.3.2 TOP STOREY DISPLACEMENT IN Z DIRECTION

Nodal Displacements of the top storey of all 7 different models in z direction were recorded as follows:

TABLE 5.4 Top Storey Displacements in Z Direction (in mm)

MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7
53.500	22.356	26.122	34.952	40.298	42.773	24.652

5.3.3 DISCUSSION

From the above tables considering the top storey displacement in x and z direction it can be seen that at the location of bracings for model 3 least top storey displacement in x direction was there likewise at the location of shear wall for model 7 least top storey displacement in z direction is there.

5.4 VARIATION OF AXIAL FORCES IN COLUMN

Axial forces in all the 7 different models were taken from the staad analysis to find the model which has least values of axial forces among all other models to find the ideal location of the bracings.

5.4.1VARIATIONS OF AXIAL FORCES IN DIFFERENT MODELS

Variation of Axial Forces in corner, edge and middle columns of all the 7 different models in all the floors are as follows:

5.4.1.1 MODEL 1

TABLE 5.5 Axial Forces in Model 1 (In KN)

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	351	771	1569
1	449	726	1470
2	491	672	1358
3	479	614	1231
4	471	552	1091
5	447	483	950
6	414	409	802
7	371	330	646
8	308	247	483
9	215	161	316
10	74	67	140

5.4.1.2 MODEL 2

TABLE 5.6 Axial Forces in Model 2 (In KN)

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	441	795	1514
1	414	749	1416
2	382	692	1306
3	349	631	1183
4	313	567	1047
5	273	495	912
6	231	418	769
7	186	337	620
8	138	252	464
9	89	163	304
10	33	67	137

5.4.1.3 MODEL 3

Variation of Axial Forces in corner, edge and middle columns in model 3 is as follows:

TABLE 5.7 Axial Forces in Model 3 (In KN)

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	470	800	2126
1	442	752	1966
2	407	694	1802
3	371	632	1643
4	333	566	1414
5	290	493	1222
6	244	415	1059
7	196	334	859
8	145	249	640
9	93	161	404
10	34	67	141

5.4.1.4 MODEL 4

Variation of Axial Forces in corner, edge and middle columns in model 4 is as follows:

TABLE 5.8 Axial Forces in Model 4 (In KN)

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	454	715	1584
1	427	671	1484
2	394	621	1373
3	359	568	1248
4	323	512	1110
5	282	451	970
6	238	384	821
7	192	312	663
8	142	234	498
9	92	153	327
10	34	63	150

5.4.1.5 MODEL 5

Variation of Axial Forces in corner, edge and middle columns in model 5 is as follows:

TABLE 5.9 Axial Forces in Model 5 (In KN)

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	446	668	1480
1	419	774	1383
2	386	825	1275
3	352	844	1154
4	316	837	1023
5	276	810	890
6	233	752	751
7	187	664	605
8	139	537	453
9	89	363	297
10	33	128	135

5.4.1.6 MODEL 6

Variation of Axial Forces in corner, edge and middle columns in model 6 is as follows:

TABLE 5.10 Axial Forces in Model 6 (In KN)

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	440	954	1569
1	413	908	1470
2	381	835	1358
3	347	733	1231
4	312	653	1091
5	272	566	950
6	230	476	802
7	185	381	646
8	137	283	483
9	89	177	316
10	33	63	140

5.4.1.7 MODEL 7

Variation of Axial Forces in corner, edge and middle columns in model 7 is as follows:

TABLE 5.11 Axial Forces in Model 7 (In KN)

FLOOR	CORNER COLUMN	EDGE COLUMN	MIDDLE COLUMN
G	440	794	2017
1	413	747	1882
2	381	691	1730
3	348	630	1572
4	312	566	1368
5	273	494	1184
6	230	417	1014
7	185	337	819
8	138	251	608
9	89	163	383
10	32	67	139

5.4.2 VARIATION OF AXIAL FORCES IN CORNER COLUMNS

TABLE 5.12 Axial Forces in Corner Columns (In KN)

FLOOR	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7	BFM
G	351	441	470	454	446	440	440	978
1	449	414	442	427	419	413	413	908
2	491	382	407	394	386	381	381	830
3	479	349	371	359	352	347	348	751
4	471	313	333	323	316	312	312	667
5	447	273	290	282	276	272	273	577
6	414	231	244	238	233	230	230	483
7	371	186	196	192	187	185	185	384
8	308	138	145	142	139	137	138	279
9	215	89	93	92	89	89	89	167
10	74	33	34	34	33	33	32	43

5.4.3 VARIATION OF AXIAL FORCES IN EDGE COLUMNS

TABLE 5.13 Axial Forces in Edge Columns (In KN)

FLOOR	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7	BFM
G	771	795	800	715	668	954	794	1582
1	726	749	752	671	774	908	747	1463
2	672	692	694	621	825	835	691	1335
3	614	631	632	568	844	733	630	1203
4	552	567	566	512	837	653	566	1065
5	483	495	493	451	810	566	494	918
6	409	418	415	384	752	476	417	765
7	330	337	334	312	664	381	337	606
8	247	252	249	234	537	283	251	438
9	161	163	161	153	363	177	163	262
10	67	67	67	63	128	63	67	72

5.4.4 VARIATION OF AXIAL FORCES IN MIDDLE COLUMNS

TABLE 5.14 Axial Forces in Middle Columns (in KN)

FLOOR	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7	BFM
G	1569	1514	2126	1584	1480	1569	2017	2724
1	1470	1416	1966	1484	1383	1470	1882	2495
2	1358	1306	1802	1373	1275	1358	1730	2260
3	1231	1183	1643	1248	1154	1231	1572	2013
4	1091	1047	1414	1110	1023	1091	1368	1754
5	950	912	1222	970	890	950	1184	1500
6	802	769	1059	821	751	802	1014	1240
7	646	620	859	663	605	646	819	973
8	483	464	640	498	453	483	608	698
9	316	304	404	327	297	316	383	419
10	140	137	141	150	135	140	139	129

CHAPTER 6: DISCUSSION OF RESULTS

Buildings with shear wall on 7 different locations in seismic zone 2 and medium soil condition were analysed and storey drift characteristics of these models were recorded and it was observed that model 3 (with shear walls at centre of the building in both x and z direction) gave the minimum value of storey drift and top storey displacement so it can be considered as the most effective location of the building.

While considering shear wall and bracing at different locations of the building it is observed that shear walls seems to be better than bracing in reducing the storey drift and nodal displacement.

From the above analysis it can also be concluded that shear walls greatly reduce the storey drift and top storey displacement of the buildings and significantly helps in controlling seismic forces and hence is a very good alternative especially for buildings in high seismic zones.

From the above analysis it can also be seen that for various parameters like nodal displacement, storey drift, top storey displacement, seismic base shear and storey shear values tends to increase as we change the seismic zone from zone 2 to further high seismic zones i.e. zone 3, zone 4, and zone 5. Likewise the values also increase as we change the soil from hard soil to medium soil and then to soft soil.

6.1 SEISMIC BASE SHEAR

6.1.1 SEISMIC BASE SHEAR IN HARD SOIL

Seismic Base Shear values of buildings of different floor levels and in different zones with and without shear walls in hard soil have been compared in the table and chart below.

TABLE 6.1 Seismic Base Shear in Hard Soil (in KN)

	G+5		G+10		G+15	
	WITHOUT SW	WITH SW	WITHOUT SW	WITH SW	WITHOUT SW	WITH SW
ZONE 2	556	593	716	759	759	806
ZONE 3	891	950	1146	1214	1215	1291
ZONE 4	1339	1425	1864	1822	1823	1939
ZONE 5	2054	2137	2613	2733	2763	2940

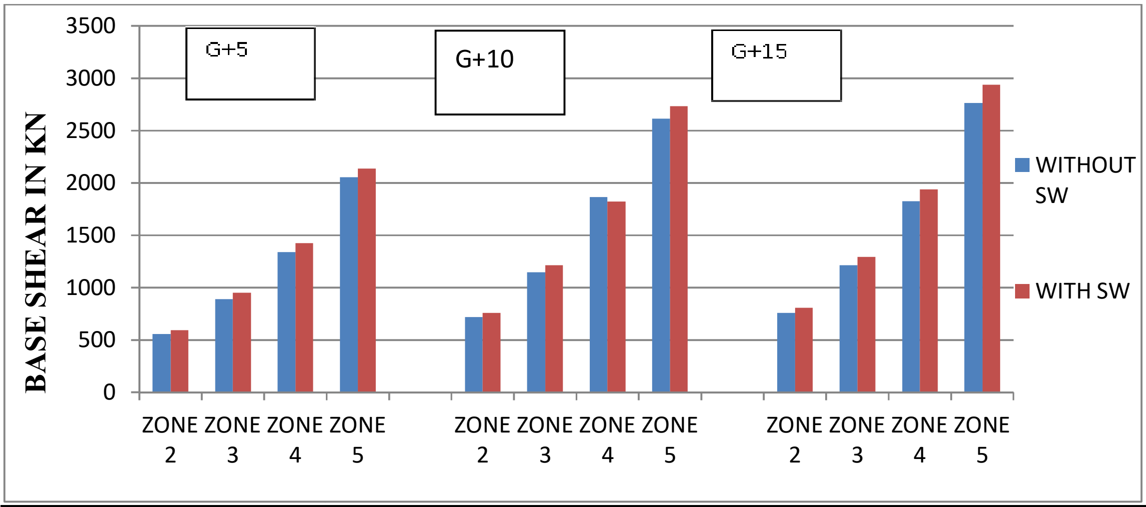

FIG 6.1 Seismic Base shear in hard soil

6.1.2 SEISMIC BASE SHEAR IN MEDIUM SOIL

Seismic Base Shear values of buildings of different floor levels and in different zones with and without shear walls in medium soil have been compared in the table and chart below.

TABLE 6.2 Seismic Base Shear in Medium Soil (in KN)

	G+5		G+10		G+15	
	WITHOUT SW	WITH SW	WITHOUT SW	WITH SW	WITHOUT SW	WITH SW
ZONE 2	757	808	974	1033	1033	1097
ZONE 3	1212	1309	1559	1653	1653	1756
ZONE 4	1822	1968	2536	2502	2480	2638
ZONE 5	2794	2978	3554	3771	3759	3999

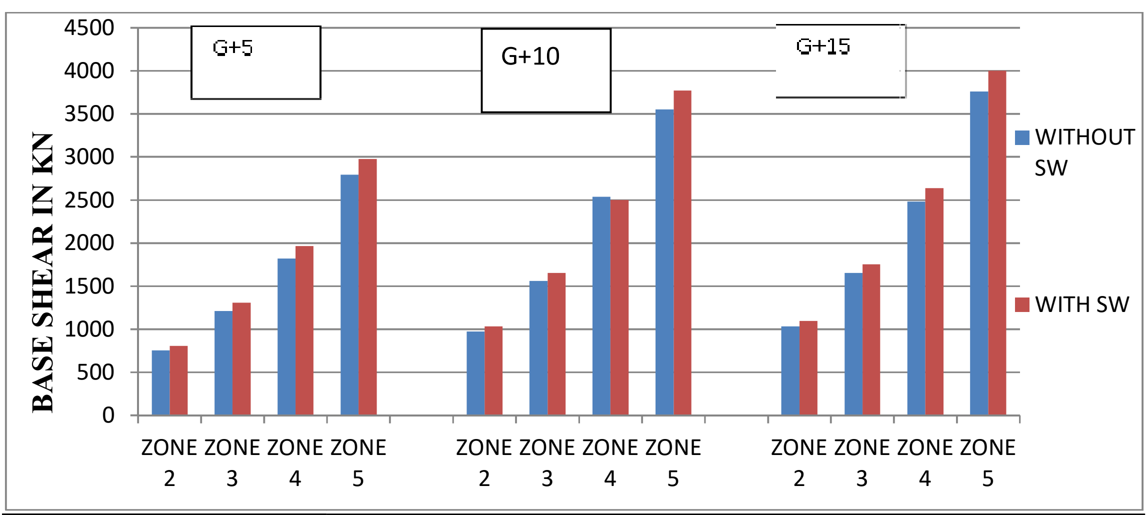

FIG 6.2 Seismic Base shear in medium soil

6.1.3 SEISMIC BASE SHEAR IN SOFT SOIL

Seismic Base Shear values of buildings of different floor levels and in different zones with and without shear walls in soft soil have been compared in the table and chart below.

TABLE 6.3 Seismic Base Shear in Soft Soil (in KN)

	G+5		G+10		G+15	
	WITHOUT SW	WITH SW	WITHOUT SW	WITH SW	WITHOUT SW	WITH SW
ZONE 2	930	991	1196	1268	1268	1347
ZONE 3	1488	1586	1914	2028	2029	2156
ZONE 4	2237	2379	3113	3043	3145	3239
ZONE 5	3430	3569	4364	4565	4615	4910

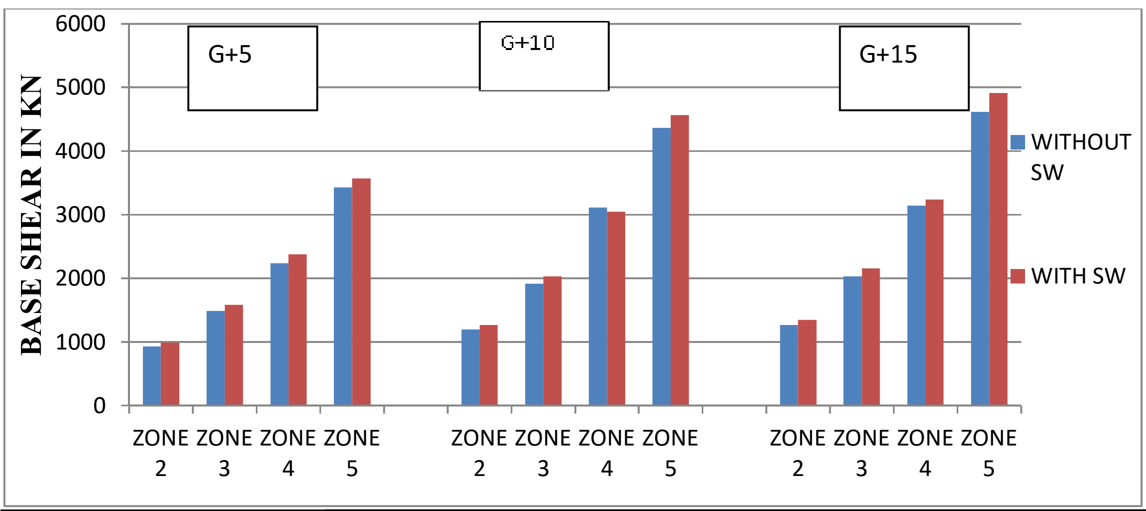

FIG 6.3 Seismic Base shear in soft soil

6.2 TOP STOREY DISPLACEMENT

Displacement of top storey for buildings of different floor levels in different seismic zones and different soil conditions are observed and recorded in the following tables:

6.2.1 HARD SOIL

Displacements of top storey for buildings in different seismic zones in hard soil are given in the following tables:

TABLE 6.4 Top Storey Displacements in Hard Soil (in mm)

	G+5		G+10		G+15	
	WITHOUT SW	WITH SW	WITHOUT SW	WITH SW	WITHOUT SW	WITH SW
ZONE 2	34.622	1.557	72.789	2.118	114.336	2.6
ZONE 3	55.394	2.491	115.246	3.388	182.937	4.161
ZONE 4	78.95	3.737	151.002	5.083	269.164	6.241
ZONE 5	98.922	5.606	185.251	7.624	353.993	9.362

6.2.2 MEDIUM SOIL

Displacements of top storey for buildings in different seismic zones in hard soil are given in the following tables:

TABLE 6.5 Top Storey Displacements in Medium Soil (in mm)

	G+5		G+10		G+15	
	WITHOUT SW	WITH SW	WITHOUT SW	WITH SW	WITHOUT SW	WITH SW
ZONE 2	47.085	6.706	98.999	9.122	155.497	11.2
ZONE 3	75.337	10.73	156.745	14.593	248.795	17.919
ZONE 4	107.373	16.095	205.609	21.889	365.825	26.879
ZONE 5	134.266	24.143	252.748	32.834	480.964	40.318

6.2.3 SOFT SOIL

Displacements of top storey for buildings in different seismic zones in hard soil are given in the following tables:

TABLE 6.6 Top Storey Displacements in Soft Soil

	G+5		G+10		G+15	
	WITHOUT SW	WITH SW	WITHOUT SW	WITH SW	WITHOUT SW	WITH SW
ZONE 2	57.818	16.069	121.557	21.854	190.941	11.2
ZONE 3	92.509	25.695	192.461	32.945	305.505	17.919
ZONE 4	131.847	38.256	252.174	52.028	449.503	26.879
ZONE 5	165.199	55.331	309.369	72.25	591.169	40.318

7. CONCLUSIONS & FURTHER SCOPE OF STUDY

Following conclusions can be drawn from the study.

1. Location of shear wall symmetrically placed at the center of the building as in model 3 seems to be better as it is most effective in reducing the nodal displacement and storey drift.
2. Displacements are greatly reduced in the buildings with shear wall as compared to that of building without shear wall.
3. Displacements seems to increase as the seismic zone is changed from zone 2 to further above zones like zone 3, zone 4 and zone 5.
4. Displacements seem to increase as the condition of soil is changed from hard soil to medium soil and then to soft soil.
5. Various seismic parameters like storey shear and base shear values also change as the seismic zone is changed from zone 2 to further above zones like zone 3, zone 4 and zone 5.
6. Various seismic parameters like storey shear and base shear values also increase as the soil condition is changed from hard soil to medium soil and then to soft soil.
7. While comparing shear wall and bracings at different location of the building it can be concluded that shear wall seems to be a better structural system compared to bracings if nodal displacement and storey drifts are considered.
8. Trend line equations have been developed to find the storey shears and storey drift of the buildings in different seismic zones and in different soil conditions.
9. These trend line equations can be interpolated and extrapolated to find the storey shears and storey drift of the building for different floor levels.

Following is the further scope of study:

1. Same study can be used for other stiffening devices.
2. Same study can be used for other types of buildings.
3. Other methods of analysis can be used for such buildings.

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