IJSRD - International Journal for Scientific Research & Development| Vol. 5, Issue 09, 2017 | ISSN (online): 2321-0613

Design of Tall Building under Low SBC using ETABS and Safe

MK Kareemulla Khan[1] Dr. MD Subhan[2]
[1]M.Tech Student [2]Professor
[1,2]Department of Civil Engineering
[1,2]AVN Institute of Engineering and Technology, Ramdaspally, Telangana, India

Abstract— The present scenario aims to construction tall building in a pollution free areas and also friendly environment, people focusing on a rural areas to be developed as all the offices and commercial places are constructed nearby so, with this issue the rural areas observed to be having Low SBC and structural engineers are aimed to have pile foundation and other hydraulics jack dampers technology to make the structures determinate and stiffened. This terminology has proved that the tall buildings using these methods are structurally strong and durable to resist the lateral loads such as seismic, wind, etc. Indian cities are observing a massive expansions due to construction of multinational companies in rural areas aiming for pollution and environmental free campuses leading urban trend & housing demand etc. considering economy of a project, I have been focused on a 40 floors commercial project on a low SBC and carried out with etabs and safe foundation software's on raft foundation & different environment conditions on earthquake and wind parameters. The title named "Design of Tall Building under Low SBC using ETABS and Safe".

Key words: SBC, ETABS, Lateral Forces, Earth Quake Loads

I. INTRODUCTION

Tall buildings all over the world are becoming popular day by day. With the beginning of up to date construction technology and computers, the basic aim has been to construct safe structures keeping in the view of overall economics of the project. High rise building is defined as a building 35 meters or more in height, which is divided at regular intervals in to occupiable levels. To be considered a high rise building a structure must be based on solid ground and fabricate along its full height through purposeful process. Cut off between high rise and low rise building is 35 meters. There is no absolute definition of what constitutes a "Tall Building." It is a building that exhibits some element of "Tallness" in one or more of the following categories:

A. *Height Relative to Context:*

It is not just about height, but about the context in which it exists. Thus whereas a 14-storey building may not be considered a tall building in a high-rise city such as Hyderabad or Bombay, in a provincial Indian city or a suburb this may be distinctly taller than the urban norm.

B. *Proportion:*

Again, a tall building is not just about height but also about proportion. There are numerous buildings which are not particularly high, but are slender enough to give the appearance of a tall building, especially against low urban backgrounds. Conversely, there are numerous big/large footprint buildings which are quite tall but their size/floor area rules them out as being classed as a tall building.

C. *Tall Building Technologies:*

Number of floors is a poor indicator of defining a tall building due to the changing floor to floor height between differing buildings and functions (e.g. office versus residential usage), a building of perhaps 14 or more stories (or over 50 meters/165 feet in height) could perhaps be used as a threshold for considering it a "Tall Building."

The interacting wall-frame combination is appropriate for the building in the 40-60 storey range, well beyond that rigid frames or shear walls alone. India's rapid growth and urbanization have led to the need for Tall Buildings and High-Rise Structures in the region. With 50% of India's population expected to live in the urban areas by 2030, there is a great demand for tall buildings and high-rise structures in the residential and commercial space. Therefore, the Indian real-estate industry is now exploring the vertical space to overcome challenges in land acquisition, space and costs. India is set to be the next big home for the Tallest Skyscrapers in the world, with the Indian Government beginning to focus on regulatory measures for high-rise structures. Shear walls take mainly horizontal loads. They are important for earthquake design of smaller buildings. If you compare it with a lattice work, the shear wall replaces the diagonal. If there are high shear forces, there are limitations to the place and size of openings in a shear wall. Masonry shear walls work well for buildings with a few floors. If there are higher loads, one can also make them in reinforced concrete. In the context of structural design, we talk of a core as a concrete part in a building that goes vertically through the whole building. For high rise it consists normally of the elevator shafts, escapes stair cases and may be wash rooms. For high rise buildings, the core is located in the centre. The core acts as a cantilever beam coming from the basement and it stabilizes the building mainly with regard to horizontal forces like wind and earthquake. Due to the height, it has shear forces and bending moments.

II. METHODOLOGY

In modern world buildings with shear wall having a low SBC & distinctive qualities in the modern multi-storey construction in urban India. So such typical construction are highly undesirable in high building built in seismically active areas. Here we study the importance of recognizing the presence of the shear wall in the analysis of building. "Design of Tall Building under Low SBC Using Etabs and Safe" & structural elements will also be perform as per IS-456 2000 for the building with shear wall.

A numerical study will perform using Etabs and Safe Software will be used for multi storey 3D frames with low SBC to gain the knowledge and responses of the building structure under seismic and wind loads. Shear force, Bending moment, axial force, inter storey drift, base shear, storey shear, storey moment will be computed for the buildings having low SBC and comparing the design results graphically.

III. STRUCTURAL SYSTEMS

In the early structures at the beginning of the 20th century, structural members were assumed to carry primarily the gravity loads. Today, however, by the advances in structural design/systems and high-strength materials, building weight is reduced, and slenderness is increased, which necessitates taking into consideration mainly the lateral loads such as wind and earthquake. Understandably, especially for the Tall Buildings, as the slenderness, and so the flexibility increases, buildings suffer from the lateral loads resulting from wind and earthquake more and more. As a general rule, when other things being equal, the taller the building, the more necessary it is to identify the proper structural system for resisting the lateral loads. Currently, there are many structural systems that can be used for the lateral resistance of tall buildings. In this context, authors classify these systems based on the basic reaction mechanism/structural behavior for resisting the lateral loads.

Structural systems for tall buildings:

1) Rigid frame systems
2) Braced frame and shear-walled frame systems
3) Braced frame systems
4) Shear-walled frame systems
5) Outrigger systems
6) Framed-tube systems
7) Braced-tube systems
8) Bundled-tube systems

Structural systems of tall buildings can be divided into two broad categories: interior structures and exterior structures. This classification is based on the distribution of the components of the primary lateral load-resisting system over the building. A system is categorized as an interior structure when the major part of the lateral load resisting system is located within the interior of the building. Likewise, if the major part of the lateral load-resisting system is located at the building perimeter, a system is categorized as an exterior structure. It should be noted, however, that any interior structure is likely to have some minor components of the lateral load-resisting system at the building perimeter, and any exterior structure may have some minor components within the interior of the building.

IV. SEISMIC AND WIND EFFECTS

A. *Lateral Forces:*

Very often the Design of Tall Structures is governed by lateral load resistance requirements in connection with gravity loads. Lateral forces due to seismic loading must be considered in design of structures along with gravity forces. The magnitude of the lateral force on a structure is not only dependent on the acceleration of the ground but it will also depend on the type of the structure.

The word lateral loads describes the effect of seismic forces and wind, even though in the recent past it integrated any horizontal applied forces, this terms seeks to differentiate lateral loads from the downward acting gravity loads, even though in reality the seismic and wind forces can act in both horizontal and vertical directions. Certainly, present Building codes require that wind be applied perpendicular to roof surfaces-nearly upward for shallow roofs-and that a percentage of earthquake loading be applied vertically.

The wind forces produced are external and their effects depend on the shape and dimensions of the structure. Earthquakes are on the other hand, damage structures because of the internal inertial forces, which depend on such factors as the structures mass and type of construction. The magnitude of both wind and earthquake forces are greatly influenced by the structures location.

The two types of lateral loads significantly vary and at times the requirements may be differing. For example one strategy to reduce vibration of Tall Structures due to wind load is to increase its mass where as increase in mass usually causes increase in the lateral load due to earthquake. It is consequently very important to understand the relative significance of earthquake and wind on a structure located at a particular site.

B. *Wind Loads:*

The most common types of wind flow around Tall Buildings that need to be accounted for during and after construction are categorized as:

a) Down-draughts
b) Separation
c) Vortices
d) Funneling
e) Wakes

The effects of the air flow and wind pressure around and through the building during construction also need to be considered at the design stage. The designer must consider:

1) The time and period of construction;
2) The construction method to minimize moderate wind loading on the structural elements of the building during construction;
3) The effect that wind loading will have on structural members and components during construction;
4) The effect that the building structure will have on the framed local wind speeds around the site.

The effects of wind on high raised building structures are still not perfectly understood and our knowledge in this area is constantly improving with the periodic revisions of the applicable wind code provisions. High winds can cause structural damages which are stated as

1) Collapse
2) partial collapse
3) over damage
4) Sliding

Pressure coefficients used in the high raised building practice have frequently been obtained experimentally by testing models of different types of structures in wind tunnels. When wind interacts with a structure, both positive and negative pressures occur simultaneously.

C. *Earth Quake Loads:*

Rigorousness of ground shaking at a given location during an earthquake can be minor, strong and moderate. Relatively speaking, minor shaking occurs frequently, moderate shaking occasionally and strong shaking rarely. For instance, on average annually about 800 earthquakes of magnitude 5.0-5.9 occur in the world while the number is only about 18 for magnitude range 7.0-7.9 So, we should build a high raised building to oppose that rare earthquake shaking. Since it costs money to provide additional earthquake safety in buildings. Two important technologies are used to protect high raised buildings from damaging earthquake effects. These are Base Isolation Devices and Seismic Dampers. The thought behind base isolation footing is to detach (isolate) the building a high raised building from the ground in such a way that earthquake motions are not transmitted up through the building, or at least greatly reduced. Seismic dampers are special devices introduced in the high raised building to absorb the energy provided by the ground motion to the building.

V. ANALYTICAL MODELS AND DESIGN PROCEDURES PROPERTIES

Name	E	N	A	G	Unit Weight	Unit Mass	Fc	Light weight?
	kN/mm^2		1/C	kN/mm^2	kN/mm^3	$kN\text{-}s^2/mm^4$	kN/mm^2	
M 35	29.58	0.2	0.000099	12.325	0.00000025	0	0.035	No

Table 1: Material Properties Concrete

LENGTH OF BUILDING, L1 = 22.5 m
BREADTH OF BUILDING, L2 = 14.00 m
HEIGHT OF BUILDING = 122.5 m

A. *Beam Sizes*

BEAM1-500X600
BEAM2-350X550
BEAM3-450X550
BEAM4-400X600
BEAM5-400X550
BBEAM6-500X650
BEAM7--300X500
BEAM-R2--300X400
CONFINEMENT BEAM 230X180

B. *Column Sizes*

COLUMN-400X1000
COLUMN2-500X1000
COLUMN-EXTERNAL 350X900
COLUMN INTERNAL 450X1000

C. *Shear Wall and Slab Thickness*

Name	Design Type	Element Type	Material	Total Thickness Mm
SHEARWALL550	Wall	Shell-Thin	M35	550
RETAINING WALL400	Wall	Shell-Thin	M35	400
SLAB11800TW	Slab	Membrane	M35	180
SLAB2L180TW	Slab	Membrane	M35	180
SLAB3L180OW	Slab	Membrane	M35	180
SLAB4180LCANT	Slab	Membrane	M35	180
SHEAR400	Wall	Shell-Thin	STEEL	400
SHEARWALL400	Wall	Shell-Thin	M35	400

Table 2: Shell Sections – Summary

D. *Load Calculations:*

Name	Type	Self Weight Multiplier	Auto Load
LIVE	Live	0	
WINDXX	Wind	0	Indian IS875:1987
WINDYY	Wind	0	Indian IS875:1987
DEAD	Dead	1	
EQXPEY	Seismic	0	IS1893 2002
EQXNEY	Seismic	0	IS1893 2002
EQYPEX	Seismic	0	IS1893 2002
EQYNEX	Seismic	0	IS1893 2002
DEADWALL	Superimposed Dead	0	
PARAPET WALL	Superimposed Dead	0	
FLOORFINISH	Superimposed Dead	0	
SOLPRESS	Live	0	

Table 3: Load Patterns

E. *Assigned Loads to the Structure*

1) *Dead Load*

FLOOR FINISH = 1.5KN / Sqm

2) *Live Load*

FOR ALL FLOORS = 2.00 KN/ Sqm
FOR TERRACE = 1.5KN / Sqm

3) *Wall Load*

WALL LOAD FOR ALL BEAMS = 6.5 KN / m
PARAPET WALL BEAMS = 1KN / m

4) *Retaining Wall Load*

SOIL PRESSURE LOAD = 58KN / Sqm
SOIL PRESSURE ON MAT = 38KN / Sqm

5) *Wind Load Calculations*

Basic Wind Speed Vb = 44 m/sec
Height of Building above G.L = 122.5 M
Width of Building = 14.00 M
Length of Building = 22.5 M
Design Wind Speed Vz = Vb. K1. K2. K3
K1=Probability Factor = 1
K2=Terrain, Height, structure size factor
(IS875(part3)-1987,Class B and Category 2) = 1.125
K3 =Topography Factor = 1
Design Wind Speed Vz = Vb. K1. K2. K3 = 49.5 m/ Sec
Design Wind Pressure Pz = 0.6 Vz2 = 1470 .2 N/ Sqm
= 1.47 KN/m^2

6) *Seismic Parameters*

FROM IS 1893 (PART-1) - 2002

Zone Factor (Z) (Seismic Zone 2 - Table-2 Clause 6.4.2) = 0.10
Importance Factor (I) (Table-6 Clause 6.4.2) = 1.5
Response Reduction Factor (R) (Table 7 Clause 6.4.2) = 5.0
Structural Soil (SS) (Fig 2 Type III Soft Soil) = 1.0
Structure Type (ST) (RC Frame Building) = 3.0
Damping Ratio (Dmp) = 0.05
Depth of Foundation (DT) = 2 m

7) Calculation of Horizontal Seismic Coefficient for 40 Story Building

a) X Direction

Base dimension in x-direction (D) = 14m
Height of building(H) = 122.5 m
$T = 0.075\ h^{0.75} = 5.28$
(Cl: 7.6.1 IS 1893-2002)
(Sa/g) = 1.035
(From Fig 2 IS 1893 -2002)

$$Ah = \text{Horizontal Seismic Coefficient} = \frac{ZI}{2R} \cdot \frac{S_a}{g}$$

Z = Zone Factor = 0.16 (From Annex E)
I = Importance Factor = 1.5 (From Table 6.0)
R = Response Reduction Factor = 5 (From Table 7.0)
Ah = Horizontal Seismic Coefficient = 0.16 x 1 x 1.035 / (2x 5) = 0.010

b) Y Direction

Base dimension in Y-direction(D) = 22.5 m
Height of building(H) = 122.5 m
$T = 0.075\ h^{0.75}$ = 5.268
(Cl:7.6.1 IS 1893-2002)
(Sa/g) = 0.0418
(From Fig 2 IS 1893 - 2002)

$$Ah = \text{Horizontal Seismic Coefficient} = \frac{ZI}{2R} \cdot \frac{S_a}{g}$$

Z = Zone Factor = 0.16 (From Annex E)
I = Importance Factor = 1.5 (From Table 6.0)
R = Response Reduction Factor = 5 (From Table 7.0)
Ah = Horizontal Seismic Coefficient = 0.16 x 1 x 1.035/ (2 x 5) = 0.010

8) Load Combination

1. 1.5 (DL + LL) 2. 1.5 (DL+ EQ X)
3. 1.5 (DL – EQ X) 4. 1.5 (DL + EQ Y)
5. 1.5 (DL - EQ Y) 6. 1.2 (DL + LL + EQ X)
7. 1.2 (DL + LL – EQ X) 8. 1.2 (DL + LL + EQ Y)
9. 1.2 (DL + LL – EQ Y) 10. 0.9 DL + 1.5 EQ X
11. 0.9 DL - 1.5 EQ X 12. 0.9 DL + 1.5 EQ Y
13. 0.9 DL - 1.5 EQ Y

9) Wind Load Combinations

14. 1.5 (DL + WL X) 15. 1.5 (DL – WL X)
16. 1.5 (DL + WL Y) 17. 1.5 (DL – WL Y)
18. 1.2 (DL + LL + WL X) 19. 1.2 (DL + LL –WL X)
20. 1.2 (DL + LL + WL Y) 21. 1.2 (DL +LL – WL Y)
22. 0.9 DL + 1.5 WL X 23. 0.9 DL - 1.5 WL X
24. 0.9 DL + 1.5 WLY 25. 0.9 DL - 1.5 WL Y

10) Un-Factored Load & Service Load Combinations

a) Gravity Load Combinations

26. 1.0 (DL + LL)

b) Seismic Load Combinations

27. 1.0 (DL + EQ X) 28. 1.0 (DL – EQ X)
29. 1.0 (DL + EQ Y) 30. 1.0 (DL – EQ Y)
31. 1.0 DL + 0.8 (LL+ EQ X) 32. 1.0 DL + 0.8 (LL – EQ X)
33. 1.0 DL + 0.8 (LL+ EQ Y) 34. 1.0 DL + 0.8 (LL – EQ Y)

c) Wind Load Combinations

35. 1.0 (DL + WL X) 36. 1.0 (DL – WL X)
37. 1.0 (DL + WL Y) 38. 1.0 (DL – WL Y)
39. 1.0 DL + 0.8 (LL+ WL X) 40. 1.0 DL+0.8 (LL– WL X)
41. 1.0 DL + 0.8 (LL + WL Y) 42. 1.0 DL+0.8 (LL–WL Y)

Following combinations are to be considered as per Clause 6.3.2.2 of IS 1893 (Part 1):2002

d) Gravity Load Combinations

43. 1.2(DL+LL) +EQ X +0.36 EQY 44. 1.2(DL+LL)–EQ X + 0.36 EQY
45. 1.2 (DL+LL) +EQX - 0.36 EQY 46. 1.2 (DL + LL) – EQ X - 0.36 EQY
47. 1.5 (DL + EQ X) + 0.45 EQY 48. 1.5 (DL – EQ X) + 0.45 EQ Y
49. 1.5 (DL – EQ X) - 0.45 EQ Y 50. 1.5 (DL + EQ Y) + 0.45 EQ X
51. 1.5 (DL – EQ Y) + 0.45 EQ X 52. 1.5 (DL – EQ Y) - 0.45 EQ X
53. 1.0DL+0.8(LL+EQX)+0.3EQY 54 1.0 (DL +0.8 (LL+EQX)-0.3 EQY
55. 1.0DL+0.8(LL+EQY)+0.3EQX 56 1.0 DL+ 0.8 (LL+EQY) - 0.3EQX
57. 1.0 (DL + EQ X) + 0.3 EQ Y 58. 1.0 (DL –EQ X) + 0.3 EQ Y
59. 1.0 (DL+ EQ X) - 0.3 EQ Y 60. 1.0(DL – EQ X - 0.3 EQ Y
61. 1.0 (DL + EQ Y) + 0.3 EQ X 62. 1.0 (DL + EQ Y) - 0.3 EQ X
63. 1.0 (DL – EQ Y) + 0.3 EQ X 64. 1.0 (DL – EQ Y) - 0.3 EQ X

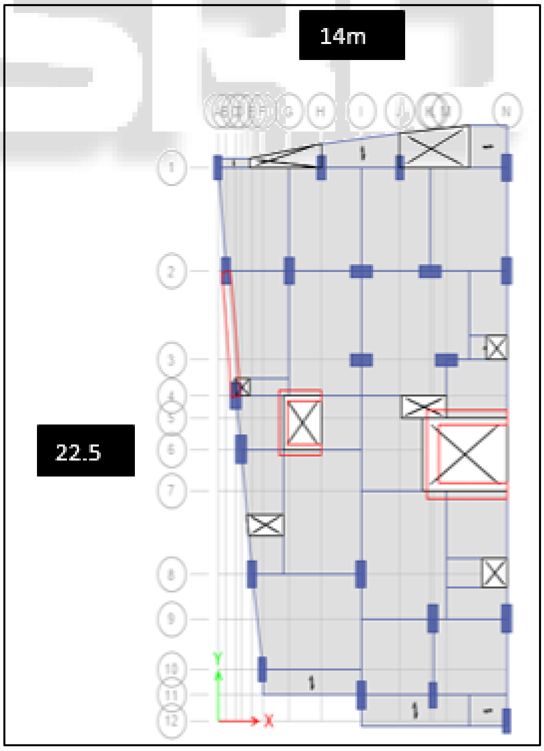


Fig. 1: Plan View of High Rise Structure

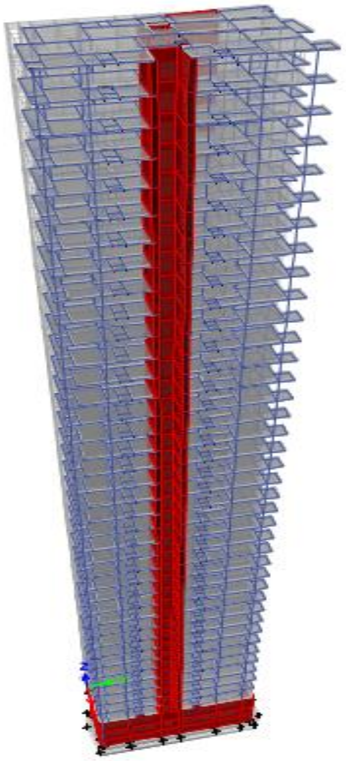


Fig. 2: 3-D View of the Structure

VI. RESULTS AND DISCUSSION

A. Displacements:

The analysis is carried out for study of Rigid Core and Floor Rigidity of Irregular Shape Building. The analysis is carried with all the load combinations. But the wind load is governing. Out of that, the load case (0.9 DL + 1.5 WL X) is giving maximum values. Hence the above load case is considered for taking the values of forces, moments and the load case (D.L+0.8(LL+WLX) considered for taking the values of Displacement and drift.

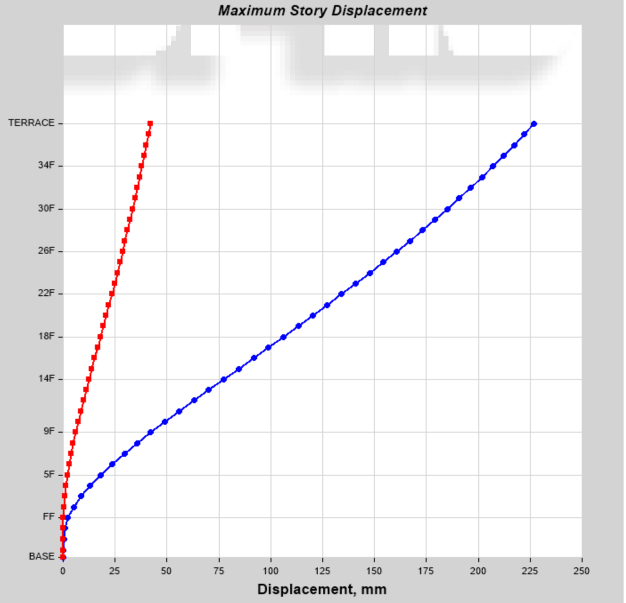
Story Response - Maximum Story Displacement

Summary Description

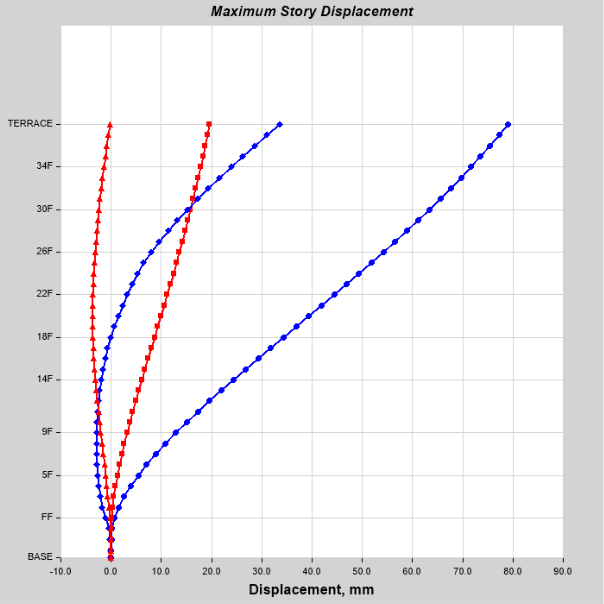
Input Data

Name	Story Response		
Display Type	Max story displacement	Story Range	All Stories
Load Case	WIND X-direction	Top Story	TERRACE
		Bottom Story	BASE

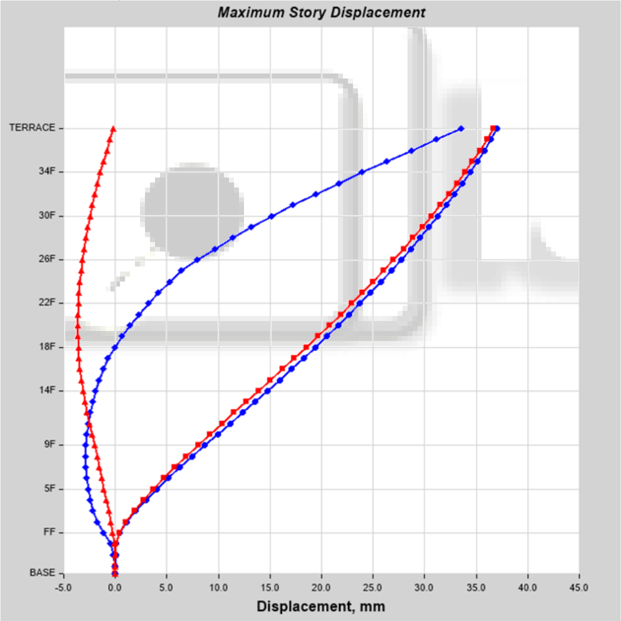
Story	Elevation	Location	X-Dir	Y-Dir
	Mm		Mm	Mm
TERRACE	122200	Top	227	42.1
37F	119200	Top	222.1	41.1
36F	116200	Top	217.2	40
35F	113200	Top	212.1	39
34F	110200	Top	207	37.9
33F	107200	Top	201.7	36.8
32F	104200	Top	196.3	35.7
31F	101200	Top	190.7	34.6
30F	98200	Top	185	33.4
29F	95200	Top	179.1	32.3
28F	92200	Top	173.1	31.1
27F	89200	Top	166.9	29.8
26F	86200	Top	160.6	28.6
25F	83200	Top	154.2	27.3
24F	80200	Top	147.6	26.1
23F	77200	Top	141	24.8
22F	74200	Top	134.2	23.4
21F	71200	Top	127.3	22.1
20F	68200	Top	120.3	20.7
19F	65200	Top	113.3	19.4
18F	62200	Top	106.1	18
17F	59200	Top	99	16.6
16F	56200	Top	91.7	15.2
15F	53200	Top	84.5	13.8
14F	50200	Top	77.3	12.5
13F	47200	Top	70.1	11.1
12F	44200	Top	63	9.8
11F	41200	Top	55.9	8.4
10F	38200	Top	49	7.2
9F	35200	Top	42.3	6
8F	32200	Top	35.7	4.9
7F	29200	Top	29.4	3.8
6F	26200	Top	23.5	2.9
5F	23200	Top	18.1	2.1
4F	20200	Top	13.1	1.4
3F	17200	Top	8.7	0.8
2F	14200	Top	5.1	0.5
FF	11200	Top	2.3	0.2
GF	8200	Top	0.7	0.04122
BASE2	5000	Top	0.3	0.01585
BASE1	2000	Top	0.1	0.002875
BASE	0	Top	0	0



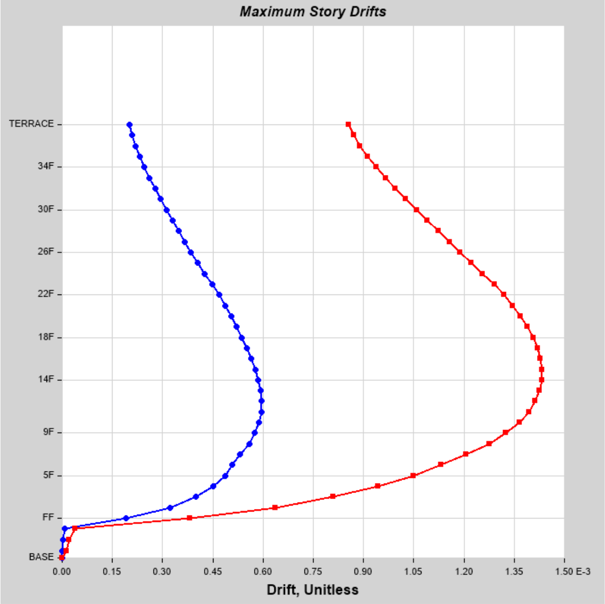
Display Type	Max story displacement
Load Case	Earth Quake X Negative Eccentricity Y-direction



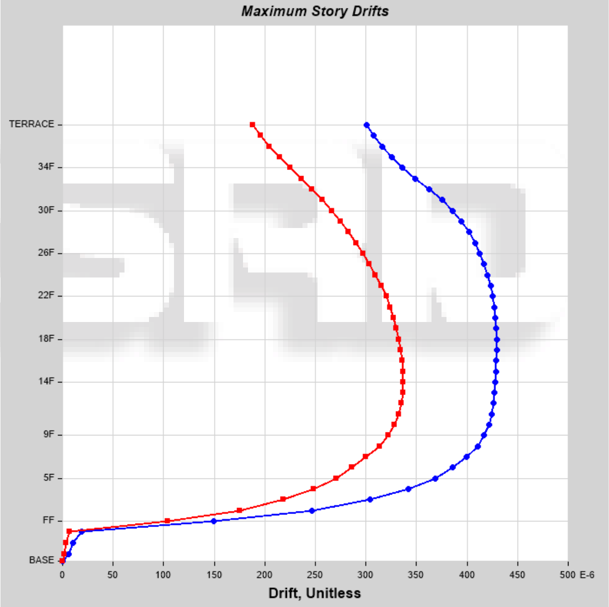
Name STORY RESPONSE
Display Type Max story displacement Story Range All Stories
Load Case DYANAMIC Y-DIRECTION Top Story TERRACE
Bottom Story BASE



STORY DRIFTS:
Name StoryResp2
Display Type Max story drifts Story Range All Stories
Load Case WIND FORCE Top Story TERRACE
Bottom Story BASE



Name StoryResp2
Display Type Max story drifts Story Range All Stories
Load Case DYNAMIC FORCE Top Story TERRACE
Bottom Story BASE



VII. CONCLUSIONS

The project has been executed and designed as per the codal provisions and comparative study on isolated footing and combined footing are being performed to find the effect of storey drifts on low SBC and In lateral direction with floor rigidity, storey shears and BM.

From the analysis of the Data the following conclusions have been made.

1) With the effects of storey drifts and usages of shear walls on their core areas, the structure is stiffened and also reflected in storey displacements shows the durability of the building.

   However, additional stiffness in floor diaphragm is increasing storey axial force and storey moment even though drift and displacement are reduced.
2) It can be concluded that floor rigidity is not required to be increased beyond that required for the load carrying

of Dead load and Live load on floors. Also beam helps transfer lateral forces to the double shear wall. Hence the moments in column nearer core are reduced.

3) Building with raft foundations and combined footing structures achieves the low SBC soils into durable and determinate structure and safer.

REFERENCES

[1] Chopra A.K. (2005):"-Dynamics of structures Theory and applications to Earthquake Engineering", Second edition.
[2] P.Jayachandran, "Design of tall buildings preliminary design and optimization" for National work shop on High rise & Tall buildings, University of Hyderabad, India, May, 2009, Keynote Lecture.
[3] IS-1893 (part 1), "Criteria for Earthquake Resistant Design of Structures" Bureau of Indian Standards, New Delhi, 2002.
[4] IS: 456 - 2000 - Code of practice for plain and Rein forced concrete
[5] IS: 875(part 1)–1987: Code of practice for design loads (Other than earthquake) for buildings and structures - Dead loads.
[6] IS: 875 (part 2)–1987: Code of practice for design loads (Other than earthquake) for buildings and structures – Imposed loads.
[7] IS: 875(part 3) - 1987: Code of practice for design loads (Other than Earthquake) for buildings and structures - Wind loads.