

## International Journal of Innovative Research in Science, Engineering and Technology

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# A Comparative Study on High rise Building Subjected to Lateral Loads in Different Earthquake Zones by Varying Height Using Etabs

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**ABSTRACT:** High rise buildings become common in the modern growing cities as the height of the building increase for the given width, the building frame becomes more flexible particularly in the case of frames with heights above 15 stories slenderness becomes more and fundamental frequency of the frames becomes less. In the present project a residential building with different heights is analysed for wind as well as for earthquake loads for different load combinations. Considering a building with height of 20m, 40m, 60m i.e., in ZONE-II,III,IV & SOIL-III with lateral load resisting systems. Results of Displacement, Storey Shear, Moment are compared for load combinations in both static & dynamic analysis. Results are tabulated and a optimum solution is concluded.

**KEYWORDS:** High-rise building, Etabs2013, Dynamic Analysis, Response Spectrum Analysis.

### I. INTRODUCTION

Mankind has always had a fascination for height and throughout our history we have constantly sought to metaphorically reach for the stars. From the ancient pyramids to today's modern skyscraper, a civilization's power and wealth has been repeatedly expressed through spectacular and monumental structures. Today the symbol of economic power and leadership is the skyscraper. There has been a demonstrated competitiveness that exists in mankind to proclaim to have the tallest building in the world. This undying quest for height has laid out incredible opportunities for the building profession. From the early moment frames to today's ultra-efficient mega-braced structures, the structural engineering profession has come a long way. The recent development of structural analysis and design software coupled with advances in the finite element method has allowed the creation of many structural and architecturally innovative forms. However, increased reliance on computer analysis is not the solution to the challenges that lie ahead in the profession.

The basic understanding of structural behaviour while leveraging on computing tools are the elements that will change the way structures are designed and built. The design of skyscrapers is usually governed by the lateral loads imposed on the structure. As buildings have taller and narrower, the structural engineer has been increasingly challenged to meet the imposed drift requirements while minimizing the architectural impact of the structure. In response to this challenge, the profession has proposed a multitude of lateral schemes that are now spoken in tall buildings across the globe. This study seeks to understand the evolution of the different lateral systems that have emerged and its associated structural behaviour, for each lateral scheme examined, its advantages and disadvantages will be looked at.

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## II. OUTLINE OF THESIS

The present project work deals with the analysis of wind on multi story composite buildings for different heights, study also contributed for analysis the various effect caused due to wind loads like Displacement, Shear, Moment in both Static & Dynamic analysis. The different loads have considered to analysis the structure like:

a) Dead load consider from Indian Standard Code of Practice for Design loads (other than Earthquake) for Buildings and Structures, IS: 875(Part 1)-1987

b) Imposed load consider from Indian Standard Code of Practice for Design loads (other than Earthquake) for Buildings and Structures, IS: 875(Part 2)-1987.

c) Wind load consider from Indian Standard Code of Practice for Design loads (other than Earthquake) for Buildings and Structures, IS: 875(Part 3)-1987 The intensity of Basic wind speed ( $V_b$ ), Design wind speed ( $V_z$ ), based on the Indian standard and parameters in correlation to these standards have considered in design and provided as a input through ETABS in analysis the structures. Basic Wind speed ( $V_b$ ) is taken from (IS 875: part 3) as 50 m/s. 38 | P a g e By using the following formula the design wind speed is calculated.  $V_z = V_b * K_1 * K_2 * K_3$  Where,  $K_1$ = Probability Factor (Risk Co-efficient)  $K_2$ = Terrain, Height and Structure size Factor  $K_3$ = Topography Factor After calculating of design wind speed than calculate the design wind pressure. By using following formula the design wind pressure is calculated.  $P_z = 0.6(V_z)^2$  Where,  $P_z$  = design wind pressure in  $N/mm^2$  at height  $z$   $V_z$  = Design wind velocity in m/s For calculating the wind load on individual member such as roof, cladding and walls, it is important to take the pressure difference between opposite faces.

## III. NUMERICAL MODELLING

A notion of 45.95mx14.55m plan is taken into idea having 4x13 bays on each the sides. The excessive rise constructing of 20M, 40M, 60M height buildng inside which flooring to flooring top is taken as 3m and ground to ground peak is 3.5m for all of the models. These building items area unit analyzed, mistreatment Etabs 2013 program process using Response Spectrum method as per IS 1893 (part I): 2002.

In this be taught a 30 storey building having equal plan in distinctive kind of zones (as per IS 1893 (part I): 2002) and extraordinary type of soils is taken. The tall constructing with distinctive types of braces introduce in the primary region in two bays is remember to learn the effect of lateral deflection, base shear, bending second, shear force and axial force triggered as a result of lateral load . As a result of earth quake load (each static and dynamic loads)

The place of the constructing is believed to be at distinct zones and extraordinary varieties of soil. An elevation and plan view of a natural constitution. The ETABS software is used to develop 3D model and to carry out the analysis. The lateral loads to be applied on the buildings are based on the Indian standards. The study is performed for seismic Zone-II,III and IV as per IS 456 (Dead load, Live Load) IS 1893:2002 (Earthquake load), IS875: 1987(Wind Load) in soil-III.

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S. No	Description Parameter	
1	Depth of foundation	3.0m
2	Floor to Floor height	3.0 m
3	Ground floor height	3.5 m
4	Grade of concrete	M-30
5	Type of steel	Fe-500
6	Unit weight of brick masonry	20 kN/m <sup>3</sup>
7	Slab thickness	120mm
8	External wall thickness	230mm
9	Internal wall thickness	125mm

### Column Sizes & Beam Sizes for 20m Height Building

Column size : 450mm X 600 mm

Beam size : 350mm X 450 mm

### Column Sizes & Beam Sizes for 40m Height Building

Column size : 450mm X 700 mm

Beam size : 400mm X 550 mm

### Column Sizes & Beam Sizes for 60m Height Building

Column size : 550mmX850mm,450mmX600mm

Beam size : 400mmX550mm,350mmX450mm

### Steel Bracings

Slab thickness: 110mm,

Live load: 3kN/M<sup>2</sup>

Floor Finish: 1kN,(1.5KN if it is with water proofing agent)

Windward Coefficient : 0.8

Leeward coefficient : 0.5

### LOADS CONSIDERED:

#### DEAD LOADS:

S.No	Materials	Unit Weight kN/m <sup>3</sup>
1	Plain concrete	24
2	Reinforced concrete	25
3	Brick masonry , cement plaster	20
4	Stone masonry	24
5	Wood	8
6	Steel	78.5
7	Floor finish	0.6-1.2

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### LIVE LOADS (OR) IMPOSED LOADS:

S.No	Type of Floors	Minimum Live Load kN/m <sup>2</sup>
1	Floors in dwelling houses, tenements, hospitals wards, hostels and dormitories	2
2	Office floors other than entrance halls, floors of light	2.5-4.0
3	Floors of banking halls , office entrance halls and reading rooms	3
4	Shops ,educational buildings, assembly buildings, restaurants	4
5	Office floors for storage ,assembly floor space without fixed seating, public rooms in hotels, dance halls and waiting halls	5
6	Ware houses, workshops and factories	
	a) Light weight loads	5
	b) Medium weight loads	7.5
	c) Heavy weight loads	10
7	Garages(light handling vehicles of weight <25KN)	4
	Garages(heavy vehicles of weight >25KN)	7.5
8	Stairs, landings, balconies and corridors for floors mentioned in 1, but not liable to overcrowding and for all other floors	3
9	Flat slabs, sloped roofs	5
	a)access provided	1.5
	b)access not provided	0.75

### EARTHQUAKE LOADS:

Seismic Zone	II	III	IV	V
Seismic Intensity	low	moderate	severe	very severe
Zone Factor (Z)	0.10	0.16	0.24	0.36

### WIND LOADS :

Wind loads IS: 875; (part-3)-1987

Design wind speed,  $V_z = V_b K_1 .K_2.K_3$

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Where

$K_1$  = probability facts [risk at any height  $z$  in m/sec]

$K_2$  = terrain height and structure size factor **clause [5.3.2]**

$K_3$  = topography factor **clause [5.3.3]**

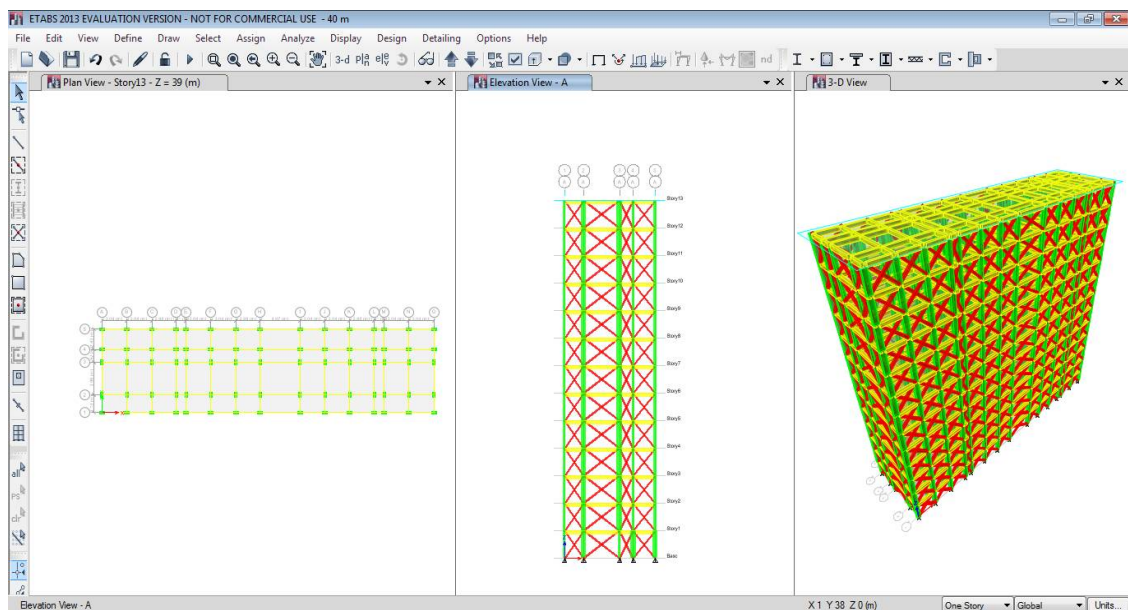
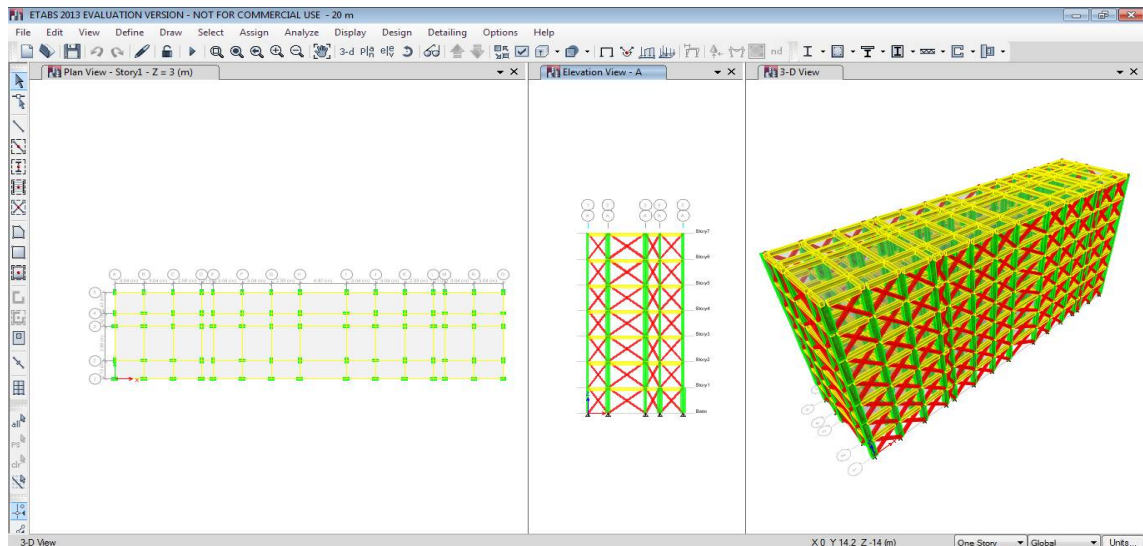
**NOTE:**

Design wind speed up to 10m height from mean G.L shall be considered constant.

$K_2$  = Category 3

For  $k_1$  = basic wind speed =44 m/sec

**MODELS:**

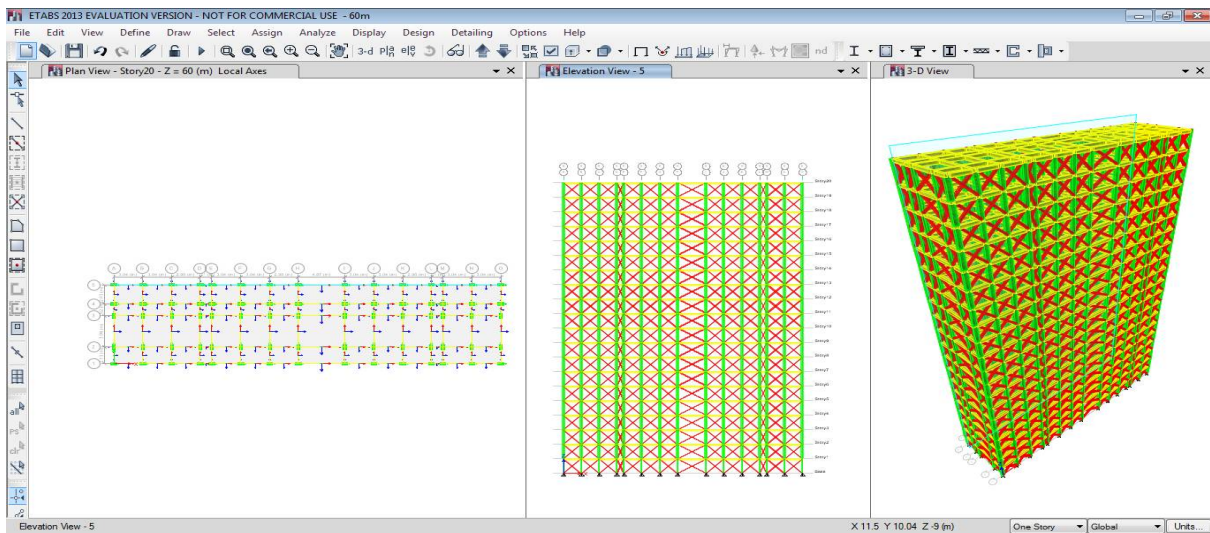


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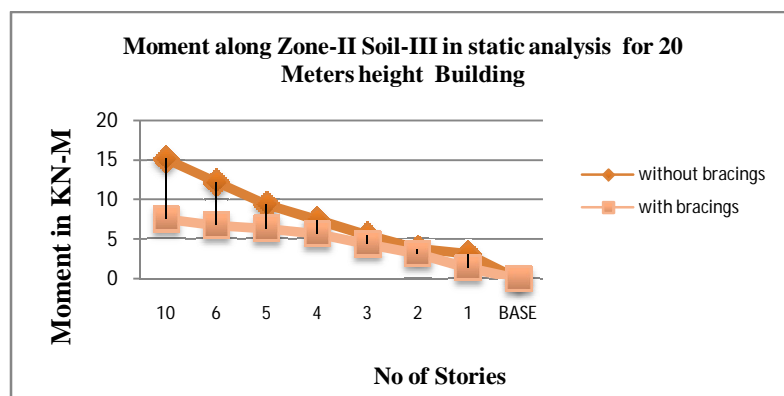
## IV. EXPERIMENTAL RESULTS

Moment comparison in Zone-II Zone-III Zone-IV Soil-III for 20m,40m,60m height buildings in Static analysis.

Table 4.1. Comparative values of Moment of 20m height building in Zone-II Soil-III in Static Analysis.

STOREY	WITHOUT BRACINGS	WITH BRACINGS
7	15.12	7.56
6	12.192	6.78
5	9.378	6.36
4	7.416	5.7
3	5.52	4.38
2	3.78	3.18
1	3.12	1.38
BASE	0	0

Graph 4.1. Moment variation of 20m height building in Zone-II Soil-III in Static Analysis.





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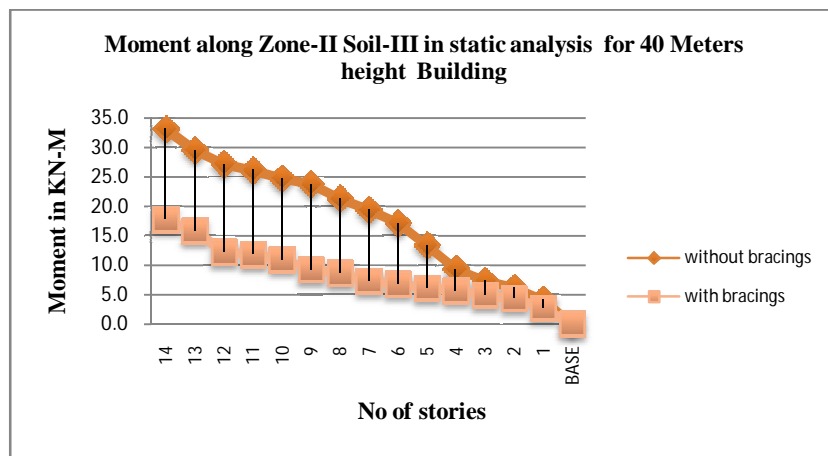
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**Table 4.2. Comparative values of Moment of 40m height building in Zone-II Soil-III in Static Analysis**

STOREY	WITHOUT BRACINGS	WITH BRACINGS
14	33.2	17.78
13	29.6	15.82
12	27.2	12.22
11	26.2	11.78
10	24.8	10.92
9	23.8	9.18
8	21.4	8.62
7	19.4	7.26
6	17.2	6.78
5	13.4	6.06
4	9.4	5.64
3	7.4	4.86
2	6.2	4.32
1	4.1	2.70
BASE	0	0

**Graph 4.2. Moment variation of 40m height building in Zone-II Soil-III in Static Analysis.**



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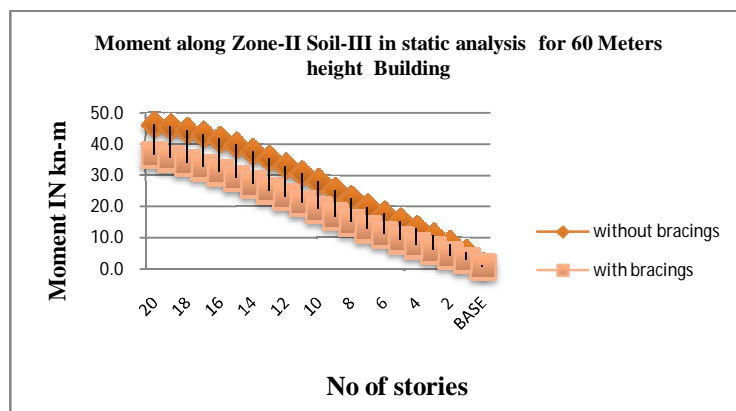
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**Table 4.3. Comparative values of Moment of 60m height building in Zone-II Soil-III in Static Analysis.**

STOREY	WITHOUT BRACINGS	WITH BRACINGS
20	46.3	36.7
19	45.5	35.5
18	44.5	34.2
17	43.2	32.6
16	41.6	31.0
15	39.7	29.1
14	37.7	27.2
13	35.5	25.2
12	33.1	23.2
11	30.5	21.1
10	28.0	19.0
9	25.3	16.9
8	22.6	14.8
7	19.8	12.8
6	17.5	11.1
5	15.2	9.3
4	12.9	7.6
3	10.6	6.0
2	8.0	4.3
1	5.2	2.8
BASE	0	0

**Graph 4.3. Moment variation of 60m height building in Zone-II Soil-III in Static Analysis.**





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Table 4.4. Comparative values of moment of different heights of high rise building in Zone-II Soil-III in static Analysis.

MOMENT		
ZONE-II SOIL-III		
BUILDING HEIGHT	WITHOUT BRACINGS	WITH BRACINGS
20	15.12	7.56
40	33.18	17.778
60	46.32	36.678

Graph 4.4. Moment variation of different heights of high rise building in Zone-II Soil-III in Static Analysis.

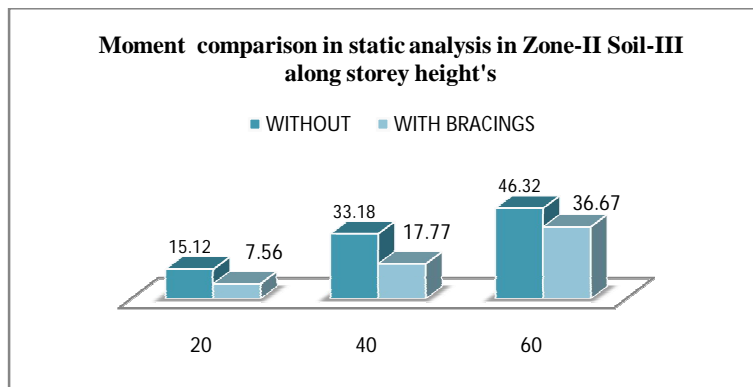


Table 4.5. Comparative values of Moment of 20m height building in Zone-III Soil-III in Static Analysis.

STOREY	WITHOUT BRACINGS	WITH BRACINGS
7	30.24	15.12
6	24.384	13.56
5	18.756	12.72
4	14.832	11.4
3	11.04	8.76
2	7.56	6.36
1	6.24	2.76
BASE	0	0

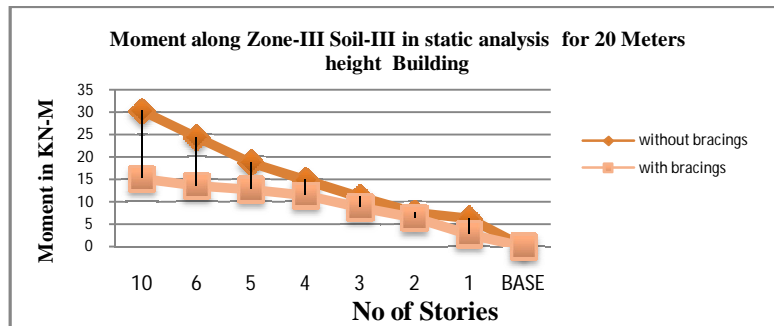
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**Graph 4.5. Moment variation of 20m height building in Zone-III Soil-III in Static Analysis.**



**Table 4.6. Comparative values of Moment of 40m height building in Zone-III Soil-III in Static Analysis.**

STOREY	WITHOUT BRACINGS	WITH BRACINGS
14	66.4	35.56
13	59.2	31.63
12	54.4	24.43
11	52.3	23.56
10	49.6	21.84
9	47.6	18.36
8	42.7	17.23
7	38.8	14.52
6	34.3	13.56
5	26.8	12.12
4	18.7	11.28
3	14.8	9.72
2	12.4	8.64
1	8.3	5.40
BASE	0	0

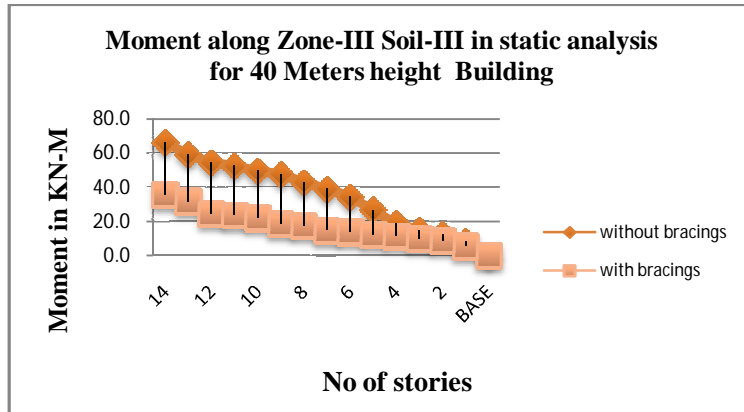
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**Graph 4.6. Moment variation of 40m height building in Zone-III Soil-III in Static Analysis.**



**Table 4.7. Comparative values of Moment of 60m height building in Zone-III Soil-III in Static Analysis.**

STOREY	WITHOUT BRACINGS	WITH BRACINGS
20	92.6	73.4
19	91.1	71.1
18	89.0	68.3
17	86.4	65.2
16	83.2	62.0
15	79.4	58.2
14	75.4	54.4
13	70.9	50.4
12	66.1	46.4
11	61.1	42.2
10	55.9	38.0
9	50.5	33.8
8	45.1	29.7
7	39.6	25.6
6	35.0	22.1
5	30.5	18.5
4	25.8	15.2
3	21.1	11.9
2	16.1	8.7
1	10.4	5.6
BASE	0	0

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Graph 4.7. Moment variation of 60m height building in Zone-III Soil-III in Static Analysis.

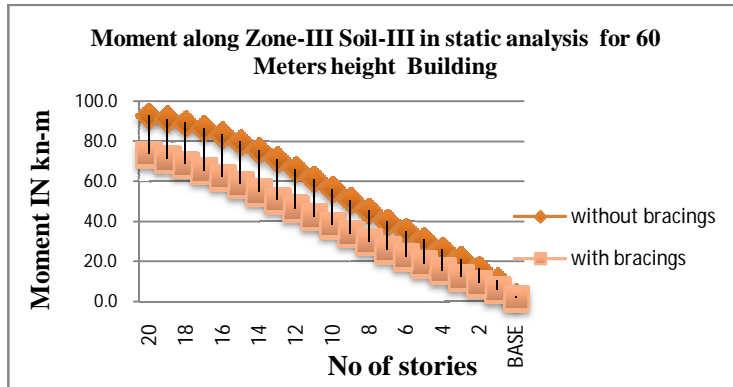
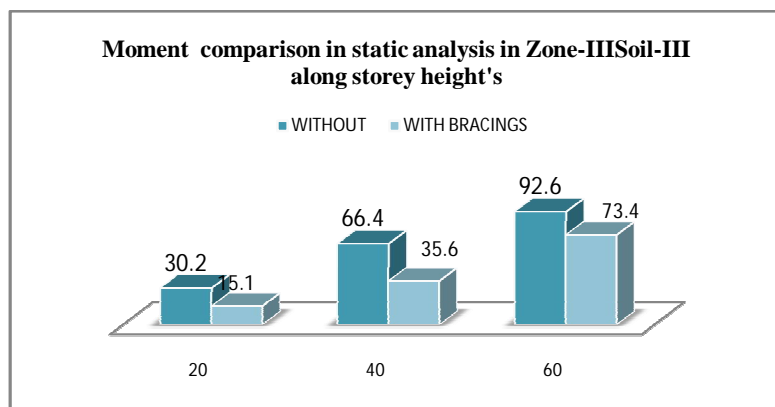


Table 4.8. Comparative values of moment of different heights of high rise building in Zone-III Soil-III in Static Analysis.

MOMENT		
ZONE-III SOIL-III		
BUILDING HEIGHT	WITHOUT BRACINGS	WITH BRACINGS
20	30.2	15.1
40	66.4	35.6
60	92.6	73.4

Graph 4.8. Moment variation of different heights of high rise building in Zone-III Soil-III in Static Analysis.



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## V. CONCLUSION

1. The structural performance is analyzed in different 20m,40m,60m heights of building i.e. without bracings, With X Bracing.
2. By providing the bracings the stiffness of the structure is increased and storey shear is decreased with increase in height of structure.
3. Moment is also compared for both the models, moment of 45% is reduced when x bracings are provided.
4. By providing lateral systems in the framed structures the reduction in the displacement, shear, moment thereby increasing the stiffness of the structure for resisting lateral loads due to earth quakes.

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