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Analysis and Design of Thin High-rise Buildings with Lateral Load Resisting Systems Using ETABS

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ABSTRACT: From the ancient time we know earthquake is a disaster causing occasion. Up to date days constructions are fitting increasingly narrow and extra inclined to sway and consequently detrimental within the earthquake. Researchers and engineers have worked out within the past to make the constructions as earthquake resistant. After many functional reports it has proven that use of lateral load resisting methods in the constructing configuration has drastically increased the performance of the structure in earthquake. In the present analysis, a thin building is analyzed with a height of 60m, width of the building is taken as 15m the building is analyzed with X bracings at optimum places and finding out the results of displacement, shear, moment, in all the zones in loose soil a total of 8 models are made for finding the results in both static & response spectrum analysis.

KEYWORDS: ETABS, High-rise Building, Response spectrum analysis, lateral load resisting systems.

I. INTRODUCTION

Seismology is the investigation of the era, spread and recording of versatile waves in the earth and the sources that create them. A quake is a sudden tremor or development of the world's hull, which starts stun waves caused by atomic tests, Man-made blasts and so on. Around 90% of all seismic tremors comes about because of structural occasions, principally developments on the flaws. The remaining is identified with volcanism, crumple of underground pits or man-made impacts.

The epicenters of tremors are not haphazardly conveyed over the world's surface. The epicenters of 99% tremors are circulated along limit zones of insert seismic action. The rest of thought to be a seismic. As per the hypothesis of plate tectonics, the peripheral layer of the earth, known as lithosphere, is broken into various portions or plates. The covering and highest mantle down to a profundity of around 70-100 km under profound sea bowls and 100-50 km under landmasses is unbending, shaping a hard external shell called the lithosphere. Underneath the lithosphere lies the asthenosphere, which is thick in nature, a layer in which seismic speeds frequently diminishes, recommending lower unbending nature. It is around 150km thick; it assumes an imperative part in plate tectonics, since it makes conceivable the relative movement of the overlying lithosphere plates. The diverse sorts of lithosphere plates involving both outside layer and upper mantle move in respect to each different over the surface of the globe. There are three sorts of plate

Edges:

- Constructive plate edge/Divergent limits – where new outside layer is produced as the plates pull far from each other.
- Destructive plate edge/Convergent limits – where outside is annihilated as one plate drives under another.

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- Conservative plate edge/Transform limits – where outside is neither created nor annihilated as the plate slide on a level plane past each other.

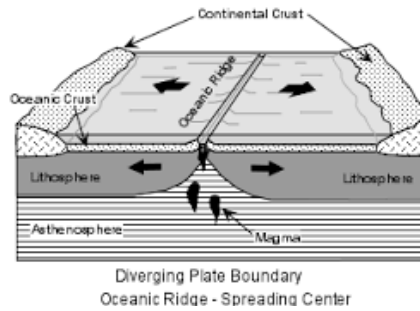


Figure 1.1 : Schematic representation of divergence boundary

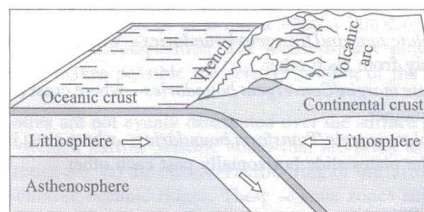


Figure 1.2 : Schematic representation of oceanic-continental convergence

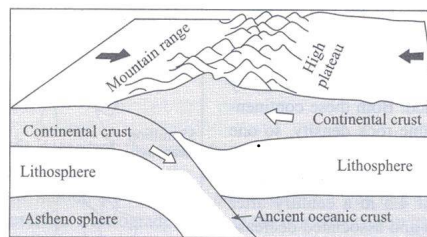


Figure 1.3 : Schematic representation of transform boundary.

II. MODELLING

PLAN CONSIDERED:

In this study an 35 storey building having same plan in different type of zones (as per IS 1893 (Part I): 2002) and different type of soils is taken. The tall building with X braces introduce in the central location in two bays is consider to study the effect of lateral deflection, bending moment, shear force caused due to lateral load. i.e. due to quake load (both static and dynamic).

BUILDING DIMENSIONS:

The building of 15m x 60m in plan and columns are placed at 5m from centre to centre floor height of 3.0m is taken.

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Size of Structural Members

Column Size:

From ground floor to fifteenth floor: 1000 mm X 900 mm

From sixteenth floor to thirty fifth floor: 900 mm X 600 mm

Beam Size: 400 mm X 600 mm

Slab Thickness: 120 mm

Brace Members Size: 230 mm X 230 mm

Grade of Concrete and Steel: M30; HYSD 500

PLAN AND ELEVATION OF MODEL:

A simple plan of 150m X 60m is taken, with 5 bays of 8 m each as shown in Fig.

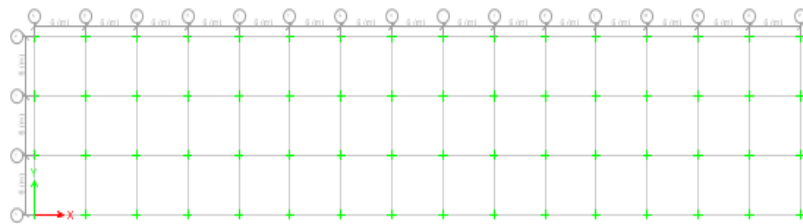


Figure 2.1 : Building plan dimension(Common to all floors, all models, units m^o).

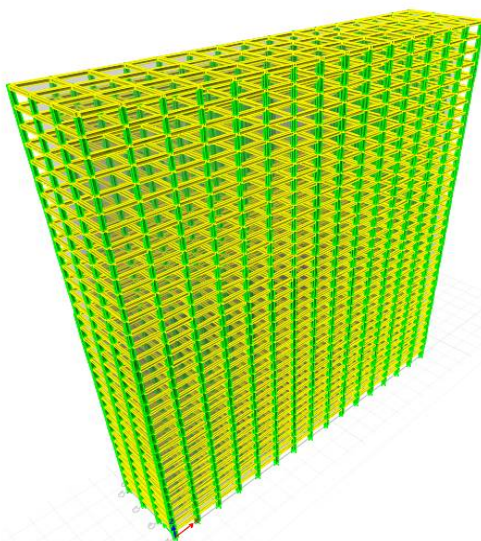


Figure 2.2 Storey Height (Common to all models; units, m^o)

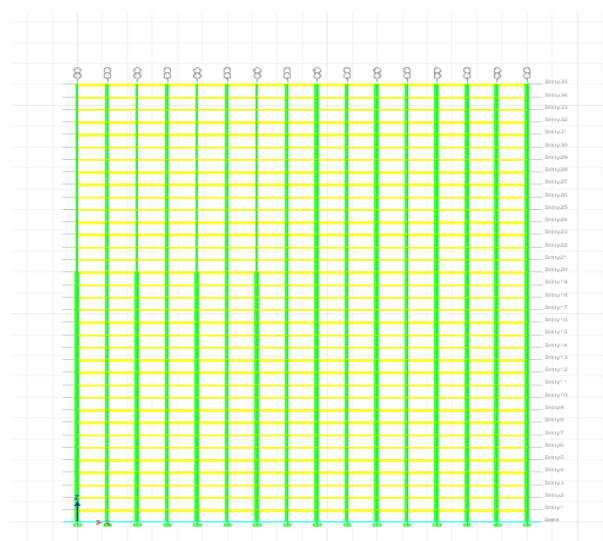


Figure 2.3 Showing elevation view of high rise building with out X Bracings

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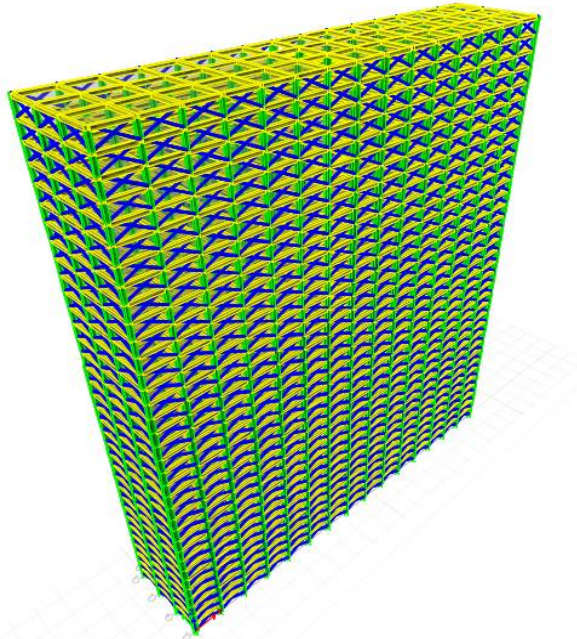


Figure 2.4 Showing 3d view of high rise building with X Bracings

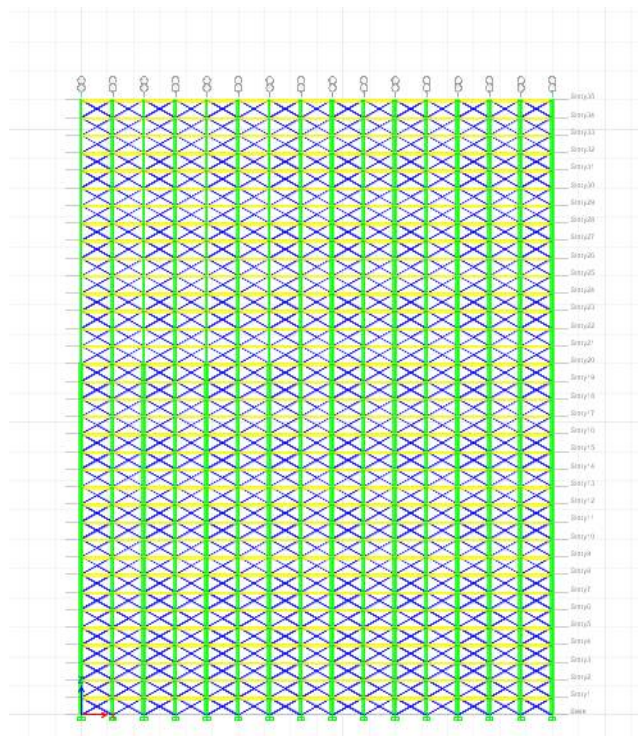


Figure 2.5 Showing elevation view of high rise building with X Bracings

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III. LOADS CONSIDERED

Live Load

Live load is assumed as per IS 875(part 2-imposed loads) table 1. Since the building is assumed to be a office building the live load was taken as 3KN/m^2 for all floors except the top floor where the live load is taken as 2KN/m^2 . Also a slab dead load is applied assuming a 120mm thick concrete slab on all floors (to avoid complicated load calculations involving composite floor systems). These slab panels are assumed to behave as a rigid diaphragm.

Quake Load

Quake load in this study is established in accordance with IS 1893(part 1)-2002. The buildings models are prepared in all seismic zones i.e. in Z3, and Z5. Therefore the value of Z is taken as, 0.16, and 0.36 respectively. The importance factor (I) of the building is taken as 1.0. On the other hand the models are made in all types of soils i.e., Hard/ Rocky (Type I), Medium soil (Type II) and in Loose

Soil (Type III). The response reduction factor R is taken as 3.0 for zone 3& 5 for zone 5.

IV. RESULTS

Comparison of shear along X-Direction in Static analysis

Table-1 Comparative values of shear in Z-3 S-3 in 1.2(DL+LL+EQX)

Storey	Without bracings	With Bracings
Storey35	55.5	28.5
Storey34	52.4	22.3
Storey33	61.1	25.1
Storey32	60.4	23.5
Storey31	60.06	23.5
Storey30	59.5	23.7
Storey29	58.86	24.1
Storey28	58.12	24.4
Storey27	57.2	24.5
Storey26	56.3	25.2
Storey25	55.2	25.5
Storey24	54.1	25.9
Storey23	52.6	26.2
Storey22	41.5	26.4
Storey21	59.4	27.3
Storey20	57.6	22.6
Storey19	57.4	38.5
Storey18	55.1	31.1
Storey17	53.3	32.6
Storey16	51.8	32.7
Storey15	50.2	32.8
Storey14	48.5	32.7
Storey13	46.7	32.4

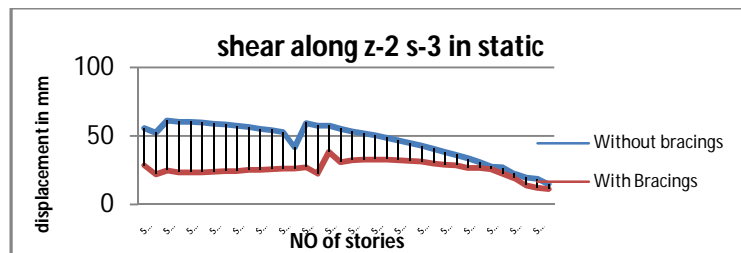
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Storey12	44.8	32
Storey11	42.7	31.6
Storey10	40.6	30.2
Storey9	38.3	29.2
Storey8	35.9	28.7
Storey7	33.4	26.9
Storey6	30.7	26.9
Storey5	27.7	25.9
Storey4	26.9	22.4
Storey3	22.4	19.3
storey2	19.6	14.2
Storey1	18.5	12.3
Base	14.5	11.4



Graph 1 Showing variation of shear in Z-2 S-3

Table-2 Comparative values of shear in Z-3 S-3 in 1.2(DL+LL+EQX)

Storey	Without bracings	With Bracings
Storey35	79.5	30.76
Storey34	58.7	21.84
Storey33	61.1	22.9
Storey32	60.4	22.8
Storey31	60.06	22.9
Storey30	59.5	23.16
Storey29	58.86	23.38
Storey28	58.12	23.62
Storey27	57.2	23.87
Storey26	56.3	24.11
Storey25	55.2	24.33
Storey24	54.1	24.56
Storey23	52.6	24.67
Storey22	41.5	25.4
Storey21	59.4	21.11
Storey20	57.6	35.46
Storey19	57.4	28.59
Storey18	55.1	29.9
Storey17	53.3	29.88
Storey16	51.8	29.96
Storey15	50.2	29.98

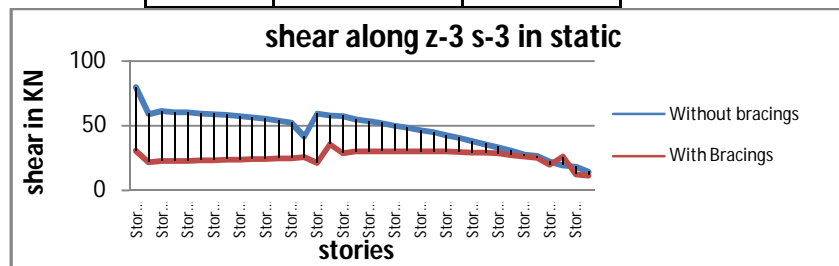
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Storey14	48.5	29.97
Storey13	46.7	29.94
Storey12	44.8	29.85
Storey11	42.7	29.92
Storey10	40.6	29.53
Storey9	38.3	29.3
Storey8	35.9	28.9
Storey7	33.4	28.42
Storey6	30.7	27.01
Storey5	27.7	25.99
Storey4	26.9	25.01
Storey3	22.4	19.72
storey2	19.6	25.97
Storey1	18.5	12.3
Base	14.5	11.4



Graph 2 Showing variation of shear in Z-3 S-3

Table-3 Comparative values of shear in Z-4 S-3 in 1.2(DL+LL+EQX)

Storey	Without bracings	With Bracings
Storey35	85.45	35.3
Storey34	67.34	21
Storey33	61.1	24
Storey32	61	23.4
Storey31	60.06	23.5
Storey30	60.1	23.1
Storey29	59.1	24.1
Storey28	58.12	24.4
Storey27	57.2	24.5
Storey26	57	25.2
Storey25	55.2	25.5
Storey24	54.1	25.9
Storey23	52.6	26.2
Storey22	48.34	26.4
Storey21	59.4	27.3
Storey20	57.6	28.34
Storey19	57.4	38.5
Storey18	55.1	31.1
Storey17	55	32.6
Storey16	51.8	32.7

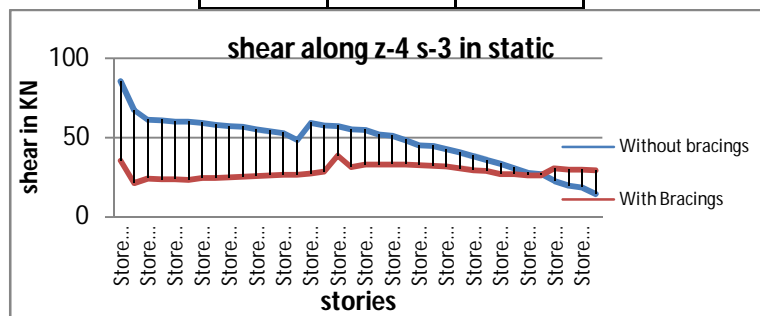
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Storey15	51	32.8
Storey14	48.5	32.7
Storey13	45	32.4
Storey12	44.8	32
Storey11	42.7	31.6
Storey10	40.6	30.2
Storey9	38.3	29.2
Storey8	35.9	28.7
Storey7	33.4	26.9
Storey6	30.7	26.9
Storey5	27.7	25.9
Storey4	26.9	25.9
Storey3	22.4	30.2
storey2	19.6	29.5
Storey1	18.5	29.5
Base	14.5	29.2



Graph 3 Showing variation of shear in Z-5 S-3

Table-4 Comparative values of shear in Z-5 S-3 in 1.2(DL+LL+EQX)

Storey	Without bracings	With Bracings
Storey35	94.5	40.9
Storey34	80.65	25.37
Storey33	59.65	26.4
Storey32	61.1	24.67
Storey31	60.4	23.5
Storey30	60	23.7
Storey29	59.5	24.1
Storey28	58.3	24.4
Storey27	58.1	24.5
Storey26	57.2	25.2
Storey25	58.3	25.5
Storey24	55.2	25.9
Storey23	54.1	26.2
Storey22	52	26.4
Storey21	52.4	27.3
Storey20	41.6	22.6
Storey19	69.5	38.5
Storey18	57.5	31.1
Storey17	57.4	32.6
Storey16	56.1	32.7
Storey15	54.7	32.8
Storey14	53.4	32.7
Storey13	51.3	32.4

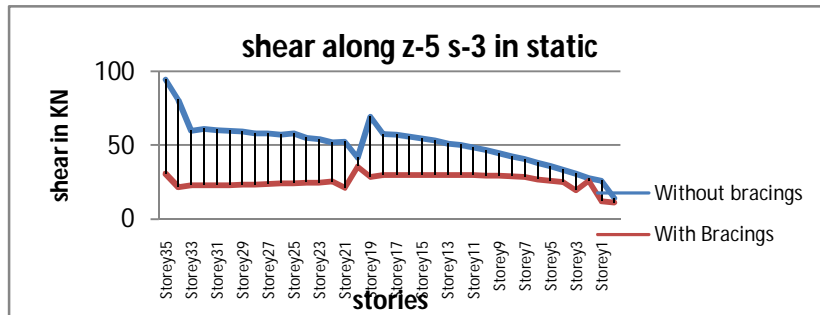
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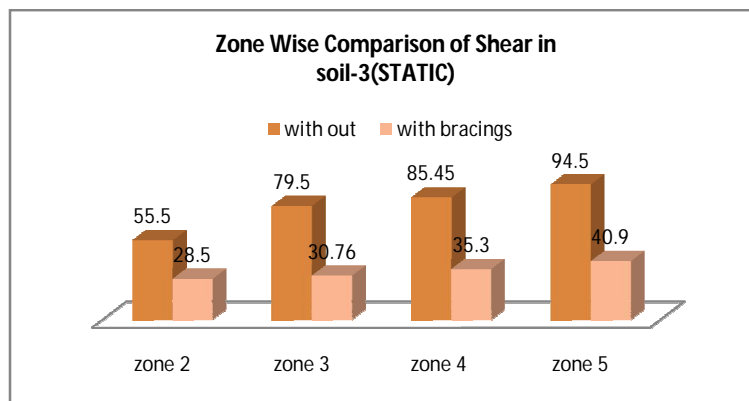
Storey12	50.2	32
Storey11	48.5	31.6
Storey10	46.7	30.2
Storey9	44.8	29.2
Storey8	42.7	28.7
Storey7	40.6	26.9
Storey6	38.3	26.9
Storey5	35.9	25.9
Storey4	33.4	22.4
Storey3	30.7	19.3
storey2	27.7	14.2
Storey1	25.9	12.3
Base	14.4	11.4



Graph 4 Showing variation of shear in Z-5 S-3

Table-5 Zone Wise Comparison of shear in S-3 in 1.2(DL+LL+EQX)

shear		
zones	with out	with bracings
zone 2	55.5	28.5
zone 3	79.5	30.76
zone 4	85.45	35.3
zone 5	94.5	40.9



Graph 5 Showing zone wise variation of shear in S-3

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V. CONCLUSIONS

1. Shear is also analyzed for both the models, Shear of 30% is reduced when the lateral systems i.e., X bracings are provided.
2. By providing the bracings the stiffness of the structure is increased and storey shear is decreased with increase in height of structure.
3. 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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