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# Seismic Analysis of High Raised Building with Vertical Mass Irregularity with Shear Walls

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**ABSTRACT:** The seismic activities which have taken place in various parts of the globe have caused tremendous damages to the buildings, structures and also were responsible for the loss of enormous lives. In order to address this structural engineer has to take care during the design stage by including the certain elements which can absorb or resist the earthquake to maximum extent. This way we can reduce the loss of properties and lives at least. In order to design such elements design codes are already made the provisions. so we as a design engineer has to consider into account these code provisions while designing the structure. Practical knowledge will also matter a lot while designing the structure. so in order to gain such knowledge in this project we have considered an ordinary moment resist frame with Basement + G + 10 building. We have assumed this building to be present in seismic zone V as per Indian seismic zone. Basically, basement is considered as parking area and rest of the floor are meant for commercial purpose. The building is provided with shear wall around the lift. The building is modelled and analysis is performed using E-tabs software.

**KEYWORDS:** Storey drift, Storey displacement, Base shear, Response spectrum analysis, Mode shapes,

## I. INTRODUCTION

In recent days varieties of different shaped, very complicated buildings are structurally designed and executed worldwide. Structural design of the tall or high-rise buildings obviously includes analysis, structural design which can be in different stages. While designing the structure design engineer has to keep in mind the criteria like structure's serviceability, it's stability and its strength and also how comfortable it is to use. Strength criteria can be achieved by taking the stresses developed whereas the serviceability criteria can be satisfied by limiting the maximum allowable drift less than 0.004. The stability can be achieved by providing sufficient factor of safety which addresses buckling of columns deflection of beams, p-delta effects. As per Indian Standard a factor of safety of 150% is considered for a load combination of dead load and imposed load. This factor of safety is considered while designing the structural elements like slab, beams, staircase, columns etc. While sizing the foundations un-factored load combinations are considered, but while designing the reinforcement diameter and spacing again factored load combination which is the worst among all the load combinations is considered. While structural design is performed for any high raised structures dynamic analysis has to be done by taking into account the lateral load like wind loads and seismic loads. Performing analysis specially which takes into account the lateral loads like wind and seismic loads for various load combinations both factored and un-factored and then designing the structure manually is a very tedious job. Apart from this any changes may be from architectural point of view or from MEP services point of view will affect the entire analysis and design. In order to take care of this nowadays computer programs have evolved of any number of revisions as per the need. After the analysis and design task is completed one can easily check each and every structural element for its strength, stability safety and economy.

### 1.1 Objectives

The primary objectives of this project are

1. Creation of 3D analysis models of building, one with shear wall and another without shear wall around the lift and staircase using E-tabs software. Hence, we will have five models in total for this project.
2. Performing the time history model for all the five models created.
3. To carry out the comparison of various analysis parameters like Deflection shape, Base reaction, Maximum story Drift, Story response plot and Maximum story Displacement etc.
4. To gain knowledge and self confidence in analyzing buildings which will help in future career to perform the analysis and design of such buildings.



### 1.2 Scope of The Study

In recent times the frequency of cyclic activities has increased a lot due to varieties of reasons like changes in climatic conditions, changes in Earth's core, variation in temperature inside the earth, drawing of water from the water table by human, land sliding, increase in water level in oceans etc. Performing analysis and design of buildings for the structures by considering earthquake and its intensity is primarily to which time the earthquake effects by taking care of safety, durability the building and also to avoid losses of lives. One of the ways to address this is introducing shearwall in an effective way and symmetrical to the building.

## II. STRUCTURAL DETAILS

To study the time history analysis of steel structure, G+9 multi-storied building is considered. The modelling and analysis of work is done by using STAAD.PRO software. Story shear, story drifts and story Displacement is compared for different types of braced structural system.

### 2.1 Model description

#### ABOUT E-TABS MODELS

- Model 1 = With Fixed Base for GROUND + 10 R.C.C OMRF Building
- Model 2 = With LRB for GROUND + 10 OMRF Building

#### BUILDING DETAILS

- Structure Type =RCC(Ordinary Moment Resistance Frame)
- Shape of the building = Rectangular shape Structure
- Building Dimension = explained in architectural drawings
- Total Height of Building from Plinth (B+9+ Terrace+ Head Room) = 49.20m
- Basement floor height = 3.5m
- Height of typical Storey: 4.0m
- In X-direction = 3 bays of varying dimensions
- InY-direction = 4 bays of varying dimensions

#### MATERIAL DETAILS

- Concrete = M40: foundation & columns: M30: other members
- Steel = Fe550
- Concrete density = 25KN/m<sup>3</sup>

#### SECTIONAL DETAILS

- RCC Beam size = 600mmx600mm, 400mmx600mm, 300mmX750mm
- RCCColumn = 300mmx1000mm, 1000mmx1000mm
- RCC Slab Thickness = 125mm & 180mm
- Wall Thickness = 200mm, 100mm

#### LOADS TAKEN

- Floor Finish-1.0kN/sqm,Partition wall load on slab1.0kN/sqm,
- Water Proofing @the terrace-1.0kN/sqm
- Live Load-4.0kN/sq mat floors and1.5kN/sqm at terrace
- Main Wall Load

Density of brick [0.23m thk] = 17.65*0.20	= 3.53kN/sqm
Density of Mortar [0.012+0.02] =20.40* 0.032	= 0.65 kN/sqm
<b>Total</b>	<b>= 4.18kN/sqm</b>
Between floor height	= 3.81 m
Depth of beam	= 0.6 m
Wall height = 3.81 - 0.6	= 3.40 m

**Main Wall UDL = 4.18\*3.4 = 14.21kN/m = 14.25kN/m (say)**



- Inside Wall Load

Density of brick [0.115m thick [= 18.85*0.115	= 2.17 KN/sqm
Density of Mortar [0.012+0.012] =20.40* 0.024	= 0.49 kN/sqm
<b>Total</b>	<b>= 2.66 kN/sqm</b>
Between floor height	= 4
Depth of beam	= 0.6 m
Wall height = 3.81 - 0.6	= 3.40 m

**Inside Wall = 2.26\*3.4 = 7.68kN/m**

**GRAVITY LOAD**

- Dead load -- Column, Beam, Slab
- Live load -- 4.0 KN/m<sup>2</sup>, 1.5 KN/m<sup>2</sup>
- Floor Finish -- 1.0 KN/m<sup>2</sup>

**RESPONSE SPECTRUM ANALYSIS FOR LATERAL LOAD**

Soil Profile -- Medium

Zone Factor -- Zone 4

Response Reduction Factor -- 5.0

Importance Factor -- 1.0

Damping -- 5.0 %

**2.2 Loading**

**a. dead loads:** as per IS875 part-1 1987

**b. live loads:** as per IS875 part-2 1987. For seismic live load taken by IS1893-2002

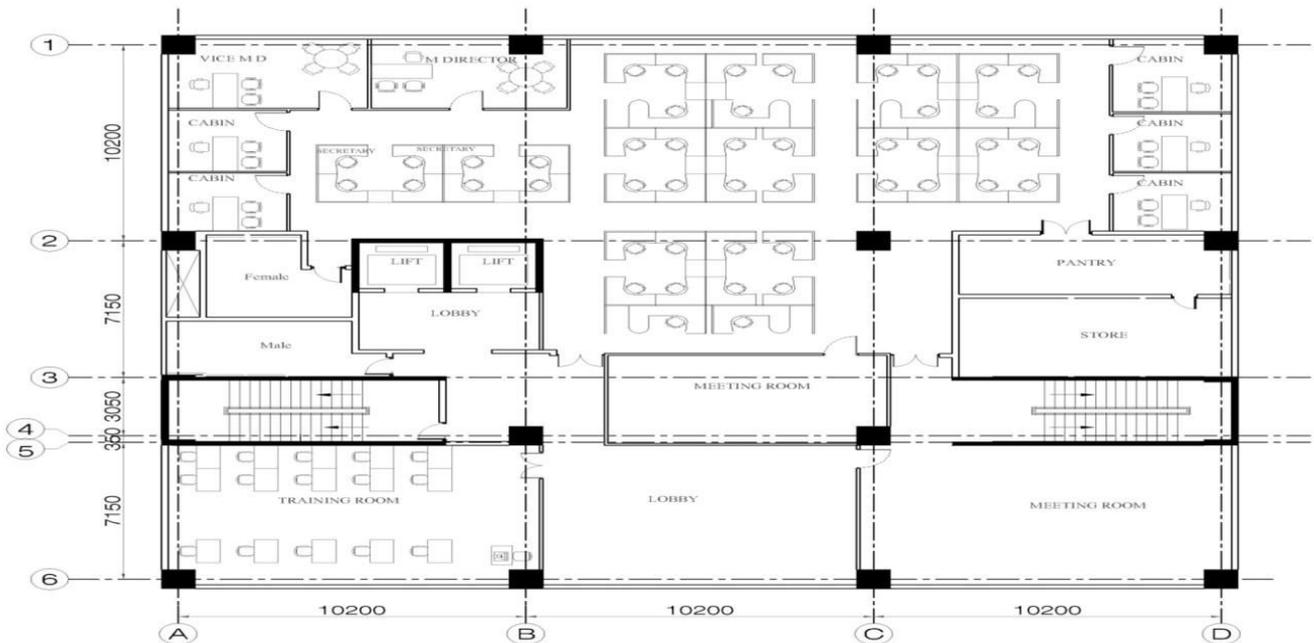
**c. earthquake loads:** All frames are analyzed for zone 3. The earthquake load calculation is as per IS1893-2002

**d. seismic factors for lateral load analysis**

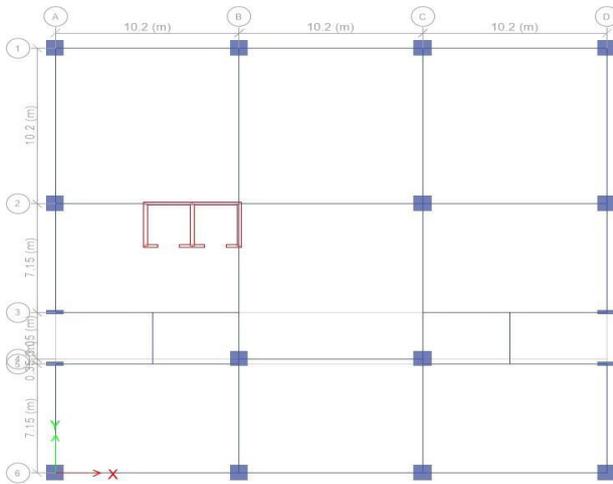
**III. ANALYSIS AND MODELING**

**3.1 Modeling**

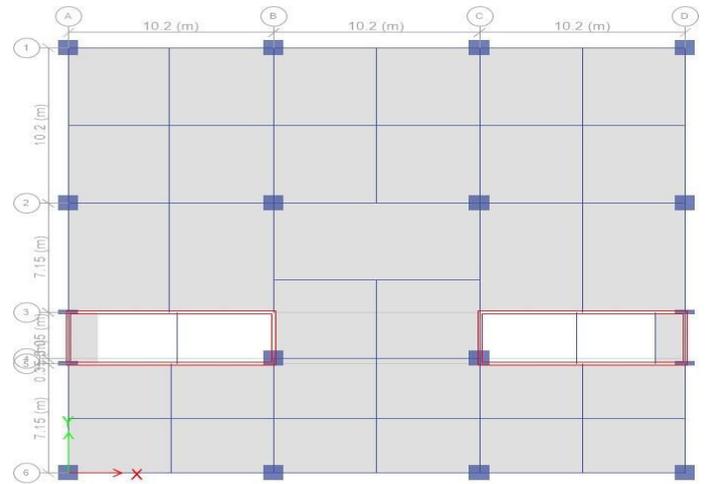
The analyzes are carried out using the framework of dynamic analysis in E-TABS2017. E-TABS2017 model calculated storey shear, acceleration values, and displacements. Such methods include continuing with the Research.



**Typical floor plan**

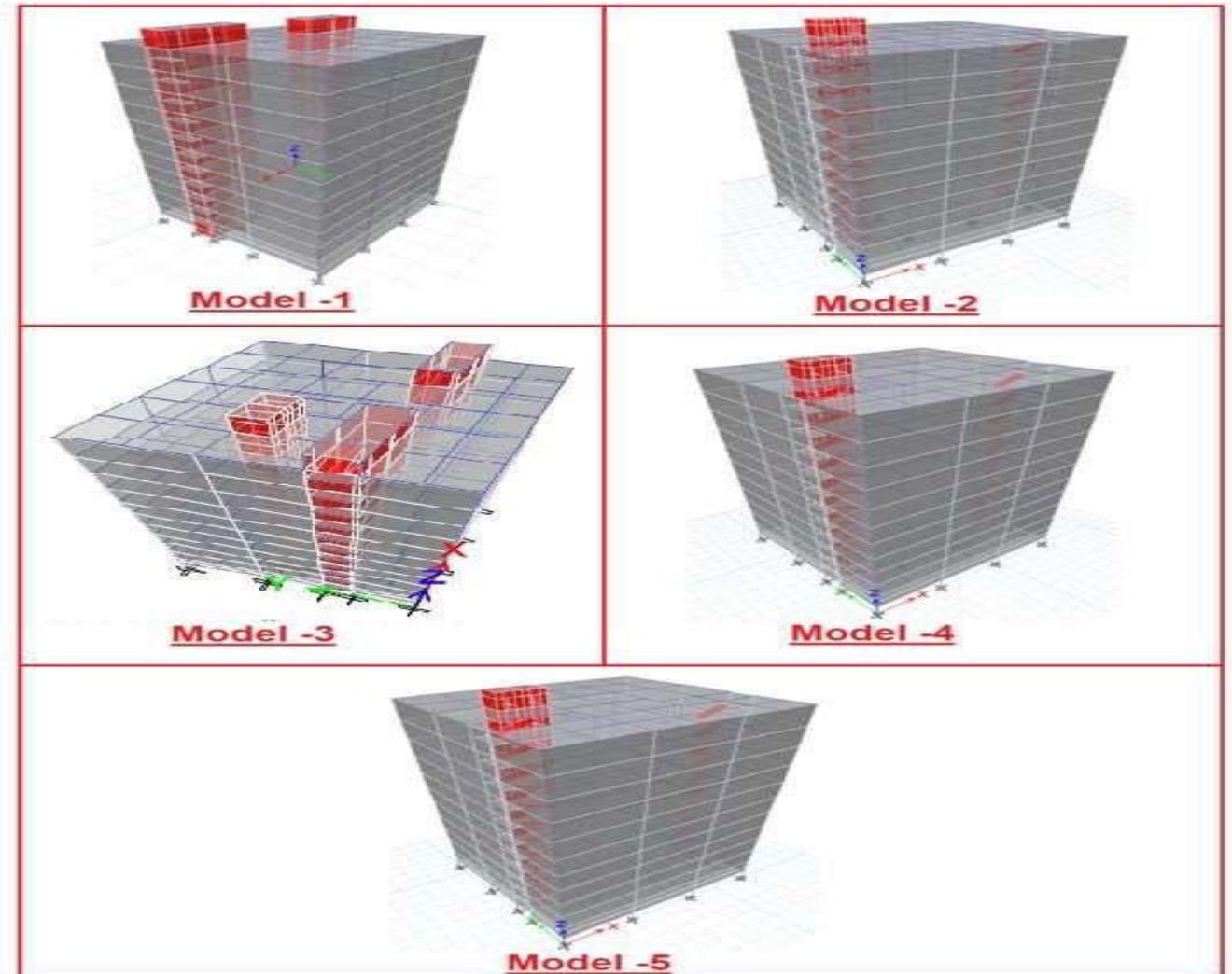


COLOUMN PLAN



BEAM PLAN

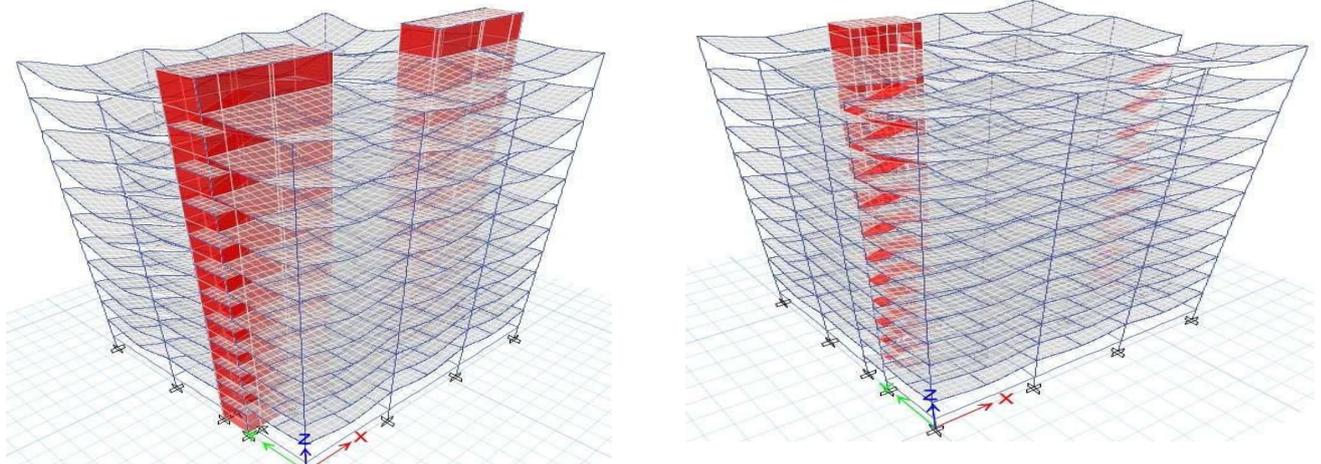
3D VIEW OF ALL BUILDINGS





III. RESULTS AND DISCUSSION

DEFLECTION SHAPE FOR 1.0DL + 0.8LL + 0.8RSX

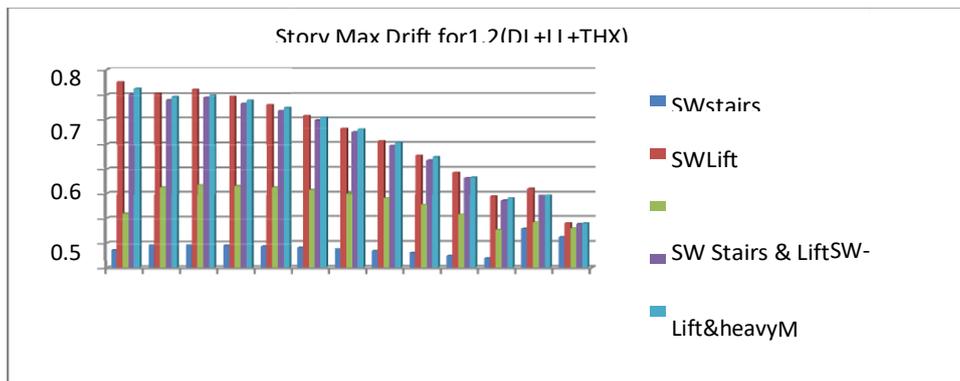


Deflection for both buildings

STORY FORCES

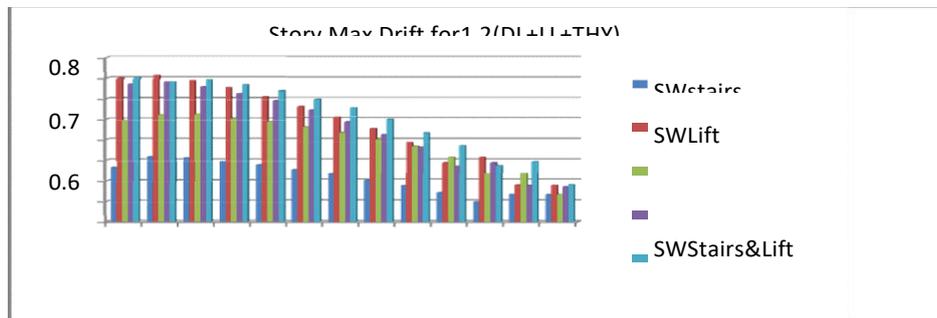
Story Forces, kN for 1.2(DL+LL+THX)					
Story	SWstairs	SWLift	SWStairs&Lift	SW-Lift&heavyMass@flr2	SW-Lift&heavyMass@flr3
Terrace	16992.5654	14150.9058	17867.2308	12386.5719	15128.9219
9thF	35464.0759	31612.9495	36451.1457	28117.0322	33764.5722
8thF	53935.5864	49074.9933	55035.0606	43847.4924	52400.2225
7thF	72407.0969	66537.0371	73618.9755	59577.9527	71035.8729
6thF	90878.6073	83999.0809	92202.8904	75308.4129	89671.5232
5thF	109350.1178	101461.125	110786.8053	91038.8732	108307.1735
4thF	127821.6283	118923.169	129370.7202	106769.3335	126942.8238
3rdF	146293.1388	136385.212	147954.6351	122499.7937	147165.759
2ndF	165351.1793	154979.276	167037.87	140632.1019	166744.7594
1stF	184688.8048	173940.135	186487.8999	157861.3772	186629.4222
GF	203923.9683	192742.677	205711.4581	176202.1636	207978.9989

STORY MAX DRIFT





Story Max Drift for 1.2(DL+LL+THX)					
Story	SW stairs	W Lift	SWStairs&Lift	SW-Lift&heavy Mass@flr2	SW-Lift&heavy Mass@flr3
Head Room	0.069	0.75	0.218	0.701	0.724
Terrace	0.088	0.705	0.324	0.676	0.689
9thF	0.09	0.72	0.333	0.686	0.699
8thF	0.087	0.692	0.33	0.662	0.675
7thF	0.084	0.657	0.324	0.633	0.645
6thF	0.08	0.614	0.313	0.595	0.606
5thF	0.074	0.562	0.298	0.548	0.558
4thF	0.067	0.511	0.278	0.492	0.504
3rdF	0.059	0.453	0.252	0.433	0.446
2ndF	0.048	0.384	0.213	0.362	0.364
1stF	0.037	0.285	0.151	0.269	0.278
GF	0.156	0.319	0.181	0.291	0.292
Basement	0.122	0.178	0.158	0.174	0.177



IV. CONCLUSIONS

- Base reaction for load case 1.2(DL+LL+THX) in x direction for model -1,2,3,4 & 5 are 7629.788kN, 3161.617kN, 7766.86kN, 3627.68kN & 3566.75kN respectively. The base shear value of model 1 is higher than the model 2 by 58.6% due to additional weight from the shearwall around staircase. Whereas this value has lesser in model 2 by 145.66% in comparison with model 3 as the model 3 has shearwall around lift and staircase as well. This value has reduced again in model 4 & 5 in comparison with model 3 by 53.3% since the last two models don't have shearwall around staircase. However, model 4 & 5 base reaction is slightly higher in comparison with model 2 due to additional weight at 2<sup>nd</sup> floor in model 4 & at 3<sup>rd</sup> floor in model 5.
- Maximum story displacement for load case 1.2 (DL+LL+THX) in x direction for model -1,2,3,4 & 5 are 2.53mm, 6.04mm, 4.84mm, 5.76mm & 5.76mm. From these values we can see that the first model with shear all around the staircase has least displacement whereas it is the maximum in case of second model with shearwall around lift. The difference is first and second model is 138.74%, whereas it has reduced between model 2 & 3 by 20% as the second model is the combination of 1<sup>st</sup> two models. However, this has increased again from model 3 to 4 and model 3 to 5 by 19%. This is because of additional mass at 2<sup>nd</sup> floor in model 4 & at 3<sup>rd</sup> floor in model 5.
- Maximum story drift for mode 1 -1,2,3,4 & 5 are 0.000086, 0.00228, 0.00164, 0.0217 and 0.0217. From these values we can see that the first model with shear all around the staircase has least story drift whereas it is the maximum in case



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