Seismic Behavior of RC Multistory Building Frame Structure with Different Plan Configuration

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Abstract - *Todays world facing some of the major problems causing by the nature. One of the major natural disasters is the Earthquake. We never know the Direction of the attack and magnitude of the Earthquake, so it will be the challenge the science and Technology. Past few years research done on the various issues of Earthquake. Now a Days people live in Multi-story Buildings such case when Earthquake knockout the populated areas it will be cause massive loss of Damage. Hence Earthquake analysis get importance to Analysis the structure safe against the collapse and Design the structure to safe against Earthquake occur during the life time of the structure. In this study model a G+16 Structure with different plan configuration like as L-Shape, T-shape and I-Shape and Rectangular Shape in Staad Pro and Analysis the Earthquake analysis of the Structure in Two Different seismic zones III with Soft and Medium soil of India. In this work, in this study, the comparative analysis of RC multistory building framed structure in the term of Maximum Bending Moment, Maximum Shear Force, Maximum Axial Forces, Story wise Displacement, Base Reaction*

Key Words**: *Seismic zone, Soil type, Multistory RC Building, Staad Pro Software etc.***

1. INTRODUCTION

The earth Shape is spheroid and it consists of the three layers such as crust, mantle and core. The earthquakes are occur in the crust layer only, crust layer dived into two parts Lithosphere and asthenosphere. Lithosphere is a rigid plate and it can be dividing into seven major parts and several minor parts. Asthenosphere is a semi rigid part and Lithosphere is float on the Asthenosphere, Because of the convection currents plates of Lithosphere plates are movements takes place, when two plates are hit each other the large amount of energy is released in the form of waves. The waves are hit the earth surface in the form of vibrations that vibrations lead to Earthquakes. Tremor vibrations are formed at the point of initiation of rupture to in all directions in the form of elastic waves,these waves are mainly divide into primary waves or p waves, secondary waves or s waves and surface waves. Generally Earthquakes are formed due to the rupture in the plates, where rupture takes place that is place for origin of the earthquake that place is called as the focus or Hypocenter. The place just above the earth surface is called as the Epicenter. The Distance from focus to Epicenter is known as the focal depth. Earthquake size can be determined by both magnitude and Intensity, magnitude means the amount of Energy is released during the rupture takes place.

Structures are the intricate framework and various things must be thought of. Henceforth at the arranging stage itself, draftsmen and basic specialists must cooperate to guarantee that the negative highlights are kept away from and great structure arrangement is picked. On the off chance that we have a helpless design to begin with, every one of that specialists can do is to give a Band-Aid for example improve an essentially helpless arrangement as most ideal as. Then again, on the off chance that we start off with a decent arrangement and sensible encircling framework, even a helpless architect can't hurt its definitive execution to an extreme. In any case, developments can endure assorted harms when they put under seismic excitations, despite the fact that for same auxiliary setup, area, EQ harms in the frameworks are neither lopsided nor homogenous. A craving to make a stylish and practically productive structure drives engineers to consider awesome and creative structures. Once in a while the state of building grabs the attention of guest, at times the basic framework offers, and in different events both shape and auxiliary framework cooperate to make the structure a Marvel. In any case, every one of these selections of shapes and structure has huge bearing on the presentation of working during solid seismic tremor. So the evenness and normality are typically suggested. The conduct of working during tremor relies fundamentally upon its general shape, size and geometry. Structures with sporadic geometry react distinctively against seismic activity. Plan geometry is the boundary which chooses its presentation against various stacking conditions. The impacts of inconsistency (plan and shape) on structure have been done by utilizing auxiliary examination programming STAAD Pro. V8i. Tremors, brought about by developments on the earth surface, bring about various degrees of ground shaking prompting harm and breakdown of structures and common infra-structures. The structure ought to withstand moderate degree of seismic tremor ground movement without auxiliary harm, however perhaps with some basic just as nonstructural harm. This breaking point state may compare to tremor power equivalent to the most grounded either experienced or figure at the site.

1.1 Problem Definition

A RCC Structure is for the most part a gathering of Beams, Columns, Slabs and establishment interconnected to one another as a solitary unit. By and large the exchange of burden in these structures is from section to bar, from bar to segment lastly segment to establishment which thus moves the whole burden to the dirt. In this examination, we have embraced three cases by expecting various shapes for the structure displayed utilizing STAAD-Pro. We have embraced three cases by expecting distinctive arrangement shapes, for example, I-Shape, L-Shape, T-Shape and Rectangular- Shape

Proposed Building Plan:

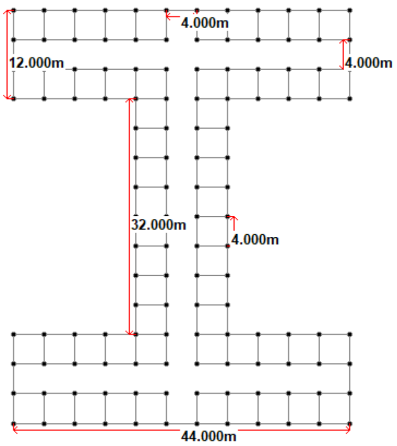


Fig.1.1 I-Shape Plan

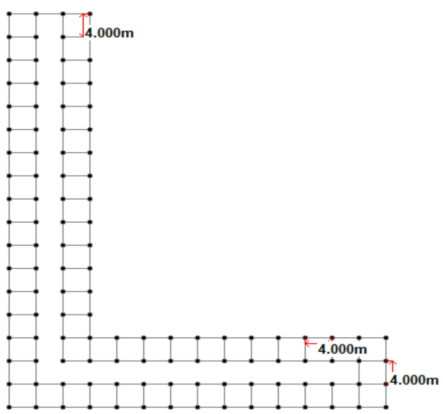


Fig.1.2 L-Shape Plan

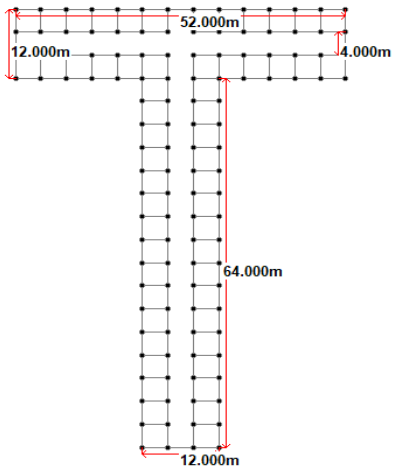


Fig.1.3 T-Shape Plan

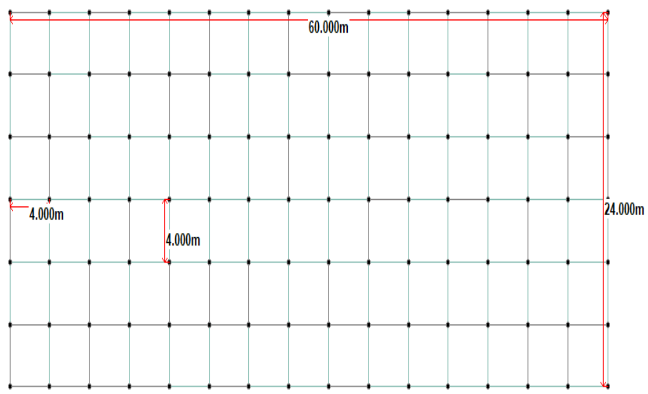


Fig.1.4: Rectangular -Shape Plan

1.2 Objective of Work

Various irregular organized structures with different foundation levels are worked with locally open standard material in rough inclinations in light of nonattendance of level land in slanting regions. Because of people thickness, enthusiasm for such kind of working, in lopsided inclinations has extended. As the masses on rough zones are extending in this manner to settle that people high rise structures are required at this point in view of nonappearance of plain ground availability on lopsided zones improvement is to be done on slanting ground thusly the examination of seismic tremor safe structure on inclines with different sort of soils is required to prevent the loss of life, property during shudder ground development.

1. Comparative seismic analysis of RC frame structure on different configuration.
2. Comparative seismic analysis of RC frame structure on different soil conditions.
3. To know about the Effect on Structure due to Earthquake in Zone-III.

2. REVIEW OF SURVEY

Dr. P. P. Saklecha etc. al {1}:- He studied that the Seismic analysis of RC multistory building with different seismic zone with different shapes of building plan such as rectangular shape plan, C-shape Plan, L-shape plan and H-shape plan by using Staad Pro. He analyzed the structure in all type of soil as per the Indian Standard code IS:1893:2002 by Response spectrum and time history method. He observed that the maximum storey drift in L-shape, bending H-shape, max axial force H-shape while minimum storey drift and displacement in rectangular shape. **Sitesh Kumar Singh, Rajat Shrivastava :-** He analyzed and designed the multistory (G+9) framed structure for seismic zone II (Delhi) by using Staad Pro. He worked seismic investigation of RCC structure, utilizing Response Spectrum method considering mass irregularity with the help of structural software. He found that the segment subtleties made under the little twisting doubt are up 'til now significant for structures encountering immense deformations, which inside and out unravel the states of congruity. An essential structure is addressed by a graph to intentionally develop the regulating states of agreement for general systems. Two computational progressions are portrayed in the graphical examination. One is the forward way gathering that is used to recover the Cartesian nodal expulsions from relative nodal evacuating sand explores a graph from the hub center point towards the terminal centers. The other is the backward way progression that is used to recover the nodal controls in the relative encourage system from the known nodal controls in obviously the driving force structure and crosses from the terminal center towards the base center points.

Dr. Sudhir Singh Bhaduria and Dhananjay Shrivastava :- He analyzed the structural behavior of multistory G+25 RCC building with different plan configuration such as I and L shape by using Linear and Dynamic analysis. He considerd the different seismic zone as Zone IV and V with different type soil condition like Soft, Medium and Hard soil conditions and analyzed the structure, lateral displacements, story drift, base shear, maximum bending moment and design results are also computed and compared for all the cases. **Milind V. Mohod {P15} [2015] –** He analyzed the impacts of plan and shape design on sporadic molded structures. Structures structure with sporadic geometry reacts diversely against tremor activity. Plan geometry is the boundary which chooses its presentation against various stacking conditions. The impacts of inconsistency (plan and shape) on structure have been completed by utilizing basic examination programming STAAD Pro. V8i. There are a few elements which influence the conduct of working from which story float and horizontal dislodging assume a significant job in understanding the conduct of structure. He saw that straightforward arrangement and design must be received at the arranging stage to limit the impact of quake. Thinking about the impact of parallel dislodging on various states of the structure of the structure. it has been seen that, Plus-shape, L-shape ,H-shape, E shape, T-shape and C-shape building have dislodged more both way (X and Y) in contrast with other staying basic formed structure (Core-square shape, Core-square, Regular structure). The story float being the significant boundary to comprehend the float request of the structure is thought of while gathering the outcomes from both the product according to (IS 1893-2002), constraining estimation of float for the structure according to is 16 cm, which isn't surpassed in any of the structure however L-formed and C-molded models demonstrated bigger float than other formed models. Considering all these above ends made on examination of sporadic structures, we may at last say that basic geometry draws in less power and perform well during the impact of seismic tremor. It is inescapable to discard complex geometries yet these can be arranged into less difficult one by giving seismic joint to diminish tremor impact. **Akhil R, Awasthi {P21} [2017] –** He assessed the examination plans to the seismic reaction of different vertical abnormality structures. The venture is finished by Response range investigation (RSA) of vertically unpredictable RC building. This investigation incorporates the displaying of customary and H-shape plan sporadic structure having territory of 25X25m and stature of 3.5 m from each G+10 story. Reaction range strategy permits an away from of the commitments of various methods of vibration and helpful for inexact assessment of seismic unwavering quality of structures. Watched the most extreme base shear for both standard structure and unpredictable structure the greatest shear is gotten for ordinary structure and Time period is most extreme for H-formed arrangement setup. Normal Frequency was most extreme for Irregular Buildings. Greatest relocation for normal shapes and least for sporadic shapes. Ordinary with U formed vertical sporadic structure has most extreme relocation contrasted with different shapes.

3. METHODOLOGY

In This research work deals with relative study of different earthquake behavior on tall building structures G+16 of different plan configuration. These building frame structure of I-shape, L-shape, T-shape and Rectangular- Shape two soil condition and two seismic zone under the Earthquake effect as per IS 1893(part I) -2002 static analysis. Comparative Analysis is done in the term of study of analysis in terms of Max. Node displacements, Max. Bending moment, Max. Storey Displacement, Max shear force and axial forces has been carried out.

In this work included various steps:

Step-1 Modeling of building frame in structure wizard with different type of soils of G+16 in I, L, T and Rectangular shape.

Step-2 Creating 3D frame structure of I-shape, L-shape ,T shape and Rectangular Shape.

Step-3 Providing seismic zone as per IS-1893 (part-I):2000

Step-4 Applied various type load and load combination

Step-5 Analysis seeing different types of building shape planes frames providing different seismic zones. Fig & Fig shows seismic load in x and z direction.

Step-6 After analysis the structure compared all the results of Max. B.M., SF. Def;ection, displacement, storey displacement etc.

4. PROBLEM DESCRIPTION

In this work, the proposed building frame structure with various input parameter such as Type of Building: Reinforced Concrete Framed Structure Plan Configuration- I-Shape, T-Shape, L-Shape, Rectangular- Shape Number of Floor: G+16, Size of Column = 600mmx600mm, Beam = 450x330mm, Height of each floor = 3.5m, Thickness of Slab= 150mm, Density of RCC: 25 kN/m³, Density of Masonry: 18.0kN/m³

Seismic Parameter: As per IS 1893-2002

Seismic Zone- III , Type of soil- Medium and Soft Soil, Damping = 5% (as per table-3 clause 6.4.2), , Zone factor for zone III, Z=0.16, Importance Factor I=1.5 (Important structure as per Table-6), Response Reduction Factor R=5 for Special RC moment resisting frame (Table-7), Sa/g= Average acceleration coefficient (depend on Natural fundamental period). Live Load on typical floors = 3.0kN/m²

Live Load seismic calculation = 0.75kN/m².

LOADING CONDITIONS

Following loading is adopted for analysis:-

Table 4.1: Values of dead load

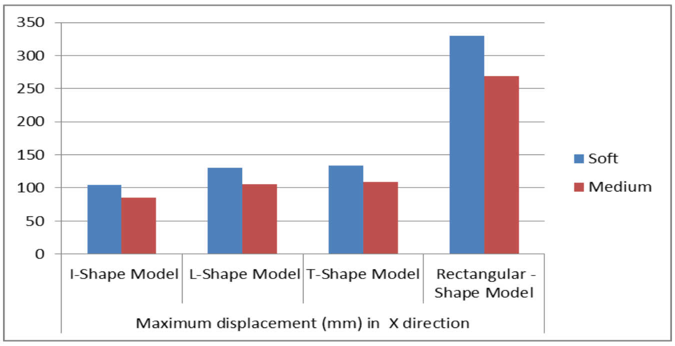
Masonry-load					Remark
For floor height 3 m	=	0.33 m x (3.5 -0 .45) m x 20kN/m³	20.13	kN/m	
Parapet wall	=	0.23 m x (1) m x 20kN/m³	4.6	kN/m	
Floor Load					
Slab Load	=	0.150 m x 25kN/m³	6.25	kN/m²	Slab thick. 150 mm assumed
Floor Finish	=		1.0	kN/m²	
Total Load	=		7.25	kN/m²	

5. RESULTS ANALYSIS

5.1.1 Node Displacement in X direction

Table 5.1.1 Node Displacement in X direction

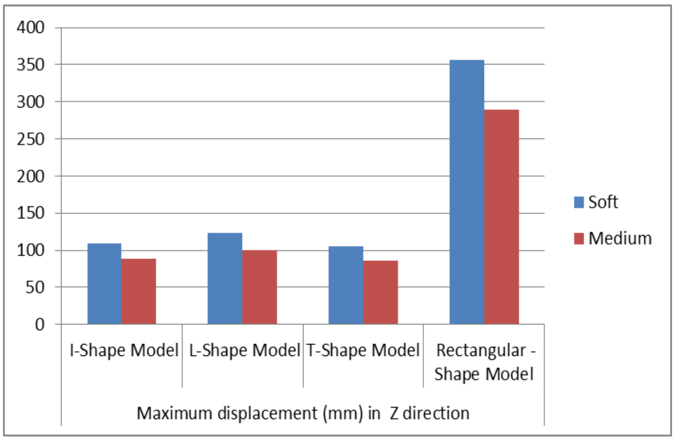
Soil Type	Maximum displacement (mm) in X direction			
	I-Shape Model	L-Shape Model	T-Shape Model	Rectangular -Shape Model
Soft	104.484	129.856	133.978	330.109
Medium	85.095	105.817	109.115	268.874



5.1.2 Node Displacement in Z direction

Table 5.1.2 Node Displacement in X direction

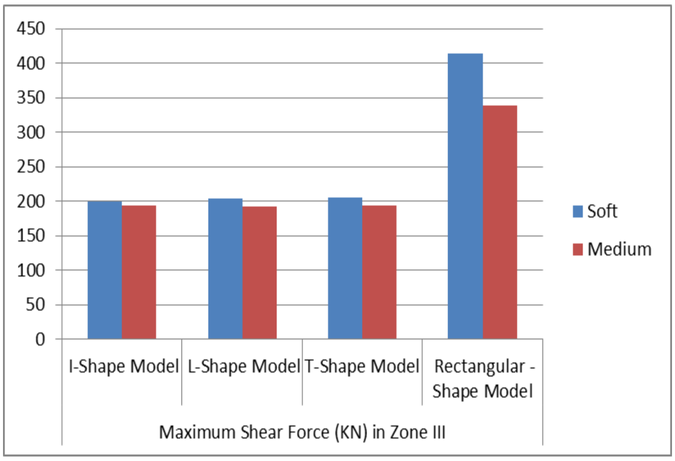
Soil Type	Maximum displacement (mm) in Z direction			
	I-Shape Model	L-Shape Model	T-Shape Model	Rectangular -Shape Model
Soft	108.814	122.951	105.799	356.153
Medium	88.646	100.275	86.407	290.055



5.2 Maximum Shear force

Table 5.2 Maximum Shear force

Soil Type	Maximum Shear Force (KN) in Zone III			
	I-Shape Model	L-Shape Model	T-Shape Model	Rectangular -Shape Model
Soft	199.602	203.25	205.057	414.608
Medium	193.913	192.581	194.016	339.238



5.3 Maximum Axial Force

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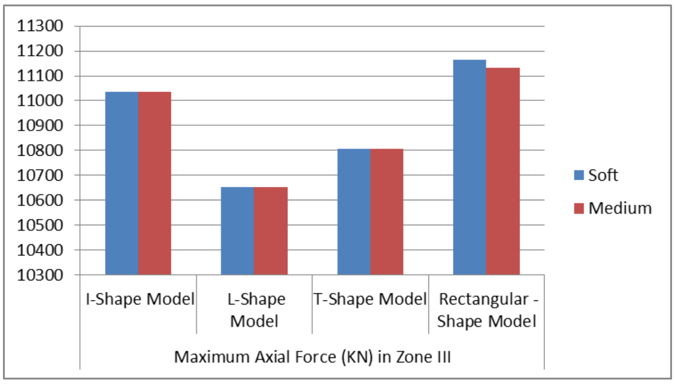
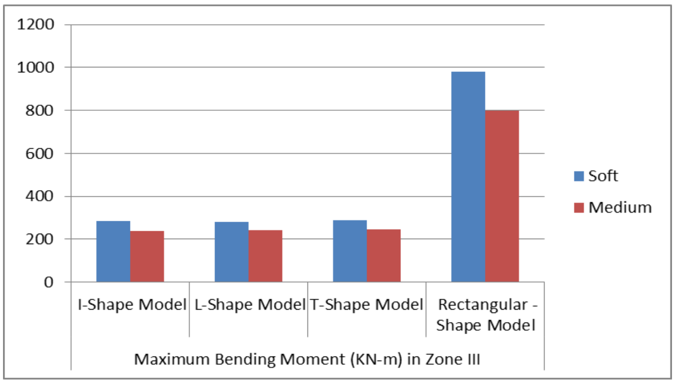
Soil Type	Maximum Axial Force (KN) in Zone III			
	I-Shape Model	L-Shape Model	T-Shape Model	Rectangular -Shape Model
Soft	11034.004	10651.792	10805.373	11165.268
Medium	11034.004	10651.792	10805.373	11133.01



5.4 Maximum Bending Moment

Table 5.4 Maximum Bending Moment

Soil Type	Maximum Bending Moment (KN-m) in Zone III			
	I-Shape Model	L-Shape Model	T-Shape Model	Rectangular -Shape Model
Soft	286.438	282.27	289.765	979.151
Medium	236.741	241.573	244.539	798.066

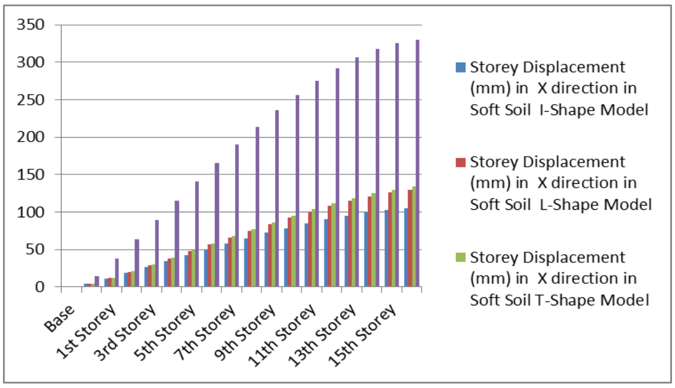


5.5.1 Story Displacement in X Dir. with Soft soil

Table 5.5.1 Story Displacement in X Dir. with Soft soil

Storey	Storey Displacement (mm) in X direction in Soft Soil			
	I-Shape Model	L-Shape Model	T-Shape Model	Rectangular -Shape Model
Base	0	0	0	0
GF	4.117	4.151	4.265	14.14
1st Storey	11.13	11.649	11.968	37.797

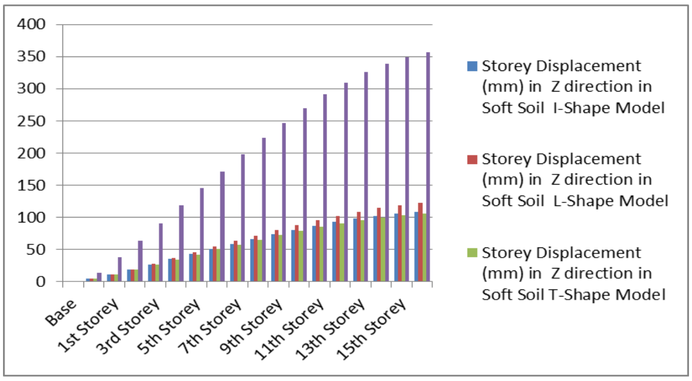
2nd Storey	18.788	20.126	20.674	63.354
3rd Storey	26.605	29.008	29.8	89.248
4th Storey	34.454	38.119	39.17	115.077
5th Storey	42.266	47.362	48.687	140.633
6th Storey	49.984	56.652	58.263	165.721
7th Storey	57.544	65.898	67.807	190.124
8th Storey	64.88	75.009	77.222	213.597
9th Storey	71.913	83.884	86.403	235.864
10th Storey	78.546	92.416	95.237	256.621
11th Storey	84.682	100.494	103.608	275.534
12th Storey	90.217	108	111.389	292.243
13th Storey	95.044	114.81	118.448	306.358
14th Storey	99.048	120.796	124.642	317.485
15th Storey	102.153	125.824	129.83	325.27
16th Storey	104.484	129.856	133.978	330.109



5.5.2 Story Displacement in Z Dir. with Soft soil

Table 5.5.2 Story Displacement in Z Dir. with Soft soil

Storey	Storey Displacement (mm) in Z direction in Soft Soil			
	I-Shape Model	L-Shape Model	T-Shape Model	Rectangular -Shape Model
Base	0	0	0	0
GF	4.118	4.156	4.148	14.039
1st Storey	11.115	11.216	11.155	37.988
2nd Storey	18.899	19.372	18.818	64.19
3rd Storey	26.864	27.897	26.659	91.027
4th Storey	34.905	36.613	34.547	118.039
5th Storey	42.949	45.425	42.412	144.982
6th Storey	50.928	54.251	50.196	171.63
7th Storey	58.774	63.008	57.829	197.74
8th Storey	66.409	71.608	65.237	223.042
9th Storey	73.748	79.959	72.338	247.239
10th Storey	80.699	87.964	79.044	270.005
11th Storey	87.162	95.519	85.26	290.987
12th Storey	93.032	102.521	90.88	309.807
13th Storey	98.195	108.863	95.793	326.064
14th Storey	102.535	114.44	99.904	339.352
15th Storey	106.021	119.148	103.189	349.326
16th Storey	108.814	122.951	105.799	356.153

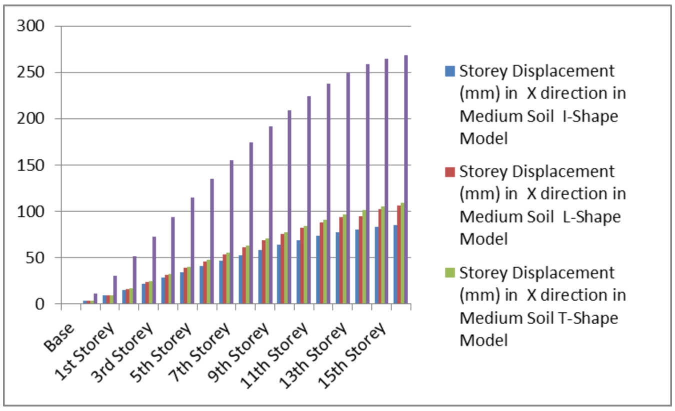


5.5.3 Story Displacement in X Dir. with Medium soil

Table 5.5.3 Story Displacement in X Dir. with Medium soil

Storey	Storey Displacement (mm) in X direction in Medium Soil			
	I-Shape Model	L-Shape Model	T-Shape Model	Rectangular -Shape Model
Base	0	0	0	0

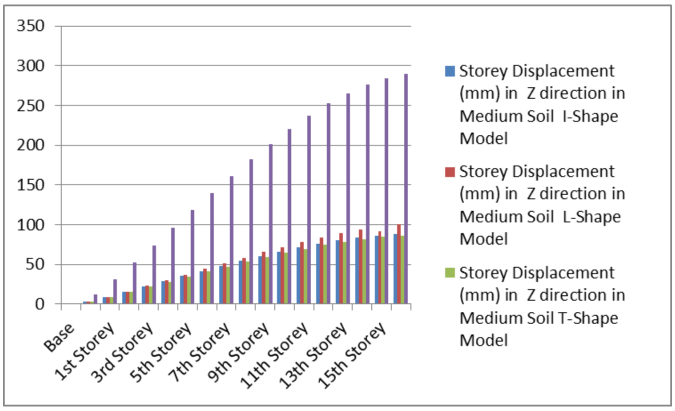
GF	3.356	3.383	3.474	11.516
1st Storey	9.067	9.493	9.747	30.783
2nd Storey	15.303	16.4	16.837	51.596
3rd Storey	21.669	23.638	24.269	72.684
4th Storey	28.06	31.062	31.9	93.718
5th Storey	34.422	38.594	39.65	114.53
6th Storey	40.707	46.163	47.448	134.961
7th Storey	46.864	53.698	55.22	154.834
8th Storey	52.838	61.122	62.888	173.949
9th Storey	58.564	68.354	70.364	192.082
10th Storey	63.966	75.306	77.559	208.946
11th Storey	68.962	81.888	84.375	224.388
12th Storey	73.47	88.004	90.712	237.995
13th Storey	77.401	93.552	96.46	249.49
14th Storey	80.662	94.428	101.505	258.552
15th Storey	83.193	102.527	105.732	264.891
16th Storey	85.095	105.817	109.115	268.874



5.5.4 Story Displacement in Z Dir. with Medium soil

Table 5.5.4 Story Displacement in Z Dir. with Medium soil

Storey	Storey Displacement (mm) in Z direction in Medium Soil			
	I-Shape Model	L-Shape Model	T-Shape Model	Rectangular - Shape Model
Base	0	0	0	0
GF	3.356	3.388	3.381	11.434
1st Storey	9.087	9.144	9.088	30.937
2nd Storey	15.393	15.793	15.335	52.275
3rd Storey	21.879	22.743	21.729	74.13
4th Storey	28.427	29.85	28.164	96.129
5th Storey	34.978	37.035	34.584	118.07
6th Storey	41.476	44.232	40.938	139.771
7th Storey	47.865	51.374	47.17	161.034
8th Storey	54.083	58.388	53.221	181.64
9th Storey	60.059	65.2	59.023	201.345
10th Storey	65.72	71.729	64.505	219.884
11th Storey	70.983	77.893	69.589	236.972
12th Storey	75.763	83.605	74.188	252.298
13th Storey	79.968	88.777	78.212	265.538
14th Storey	83.502	93.325	81.58	276.359
15th Storey	86.352	91.167	84.27	284.484
16th Storey	88.646	100.275	86.407	290.055



6. CONCLUSIONS

- It is seen that the minimum displacement in medium soil condition and max in soil condition means increase the soil condition lower to higher soil condition the displacement is decreased.
- Overall comparing the displacement by plan configuration, minimum displacement is found in I-shape model, average in L-shape model and in T-shape, maximum in Rectangular shape model. It means that the earthquake effect also depend on the plan configuration of the structures.
- It is seen that the minimum bending moment in medium soil condition and max in soil condition means increase the soil condition lower to higher soil condition the bending moment is decreased.
- Overall comparing the bending moment by plan configuration, minimum bending moment is found in I-shape model, average in L-shape model and T-shape model, maximum in rectangular shape model. It means that the earthquake effect also depend on the plan configuration of the structures.

- It is seen that the minimum Shear Force in medium soil condition and max in soil condition means increase the soil condition lower to higher soil condition the Shear Force is decreased.
- Overall comparing the Shear Force by plan configuration, minimum Shear Force is found in I-shape model, average in L-shape model and T-shape model, maximum in rectangular shape. It means that the earthquake effect also depend on the plan configuration of the structures.
- It is observed the storey displacement at base is zero and gradually increase the displacement increase with the storey height of the structure.
- It is seen that the minimum storey displacement in medium soil condition and max in soil condition means increase the soil condition lower to higher soil condition the storey displacement is decreased.
- Overall comparing the Shear Force by plan configuration, minimum storey displacement is found in T-shape model, average in I-shape model and L-shape model, maximum in rectangular shape. It means that the earthquake effect also depend on the plan configuration of the structures.

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