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DYNAMIC ANALYSIS OF MULTI STOREY STRUCTURE FOR DIFFERENT SHAPES

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Abstract— ***Extinct earthquakes events demonstrate that, buildings with irregularity are prone to earthquake damages. Thus as it's essential to identify the unstable response of the structure even in high seismic zones to chop back the seismic damages in buildings. Modern buildings have efficient structural systems, and utilize high-strength materials, resulting in reduced building height, and thus, become more slender and flexible with low damping. These flexible buildings are very sensitive to wind excitation and earthquake load causing discomfort to the building occupants. Reinforced concrete multi storey buildings are subjected to most dangerous earthquakes. It was found that main reason for failure of RC building is irregularity in its plan dimension and its lateral force resisting system. This project aims at studying of the seismic analysis and design on structural behaviour of multi-storey building (G+12) for different plan configurations like Rectangular, C- shape, T-Shape, O-Shape Buildings using ETABS v9.7.1 computer program. A detailed parametric study is carried out to investigate the effect of various parameters on the building structure by non-linear dynamic analysis for medium soil at zone V. Finally the results are observed to study the effect of structural displacements, drifts, story shear, overturning moments. Comparison of the results of non linear dynamic analysis for different structure is done. The whole models were analysed with the help of ETABS 9.7.1 version. Within the gift study, Comparative Dynamic analysis for all four cases is investigated to gauge the deformation of the structure.***

Keywords: completely different shapes, Dynamic analysis, Multi-storey, Building and ETABS.

I. INTRODUCTION

A. General

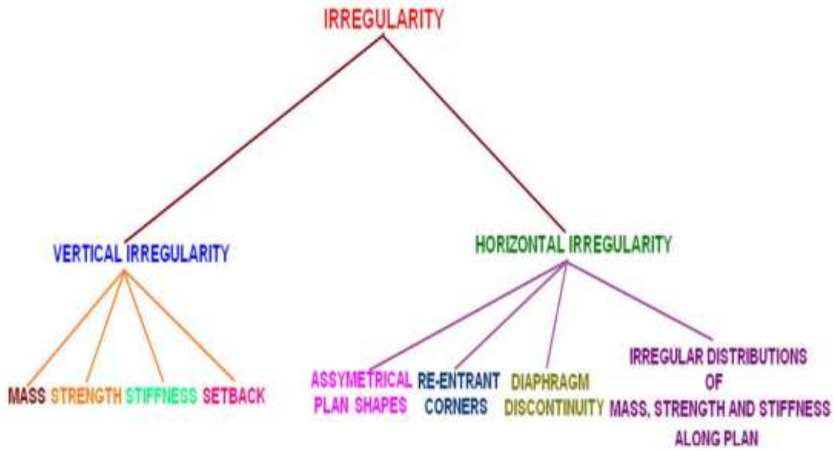
In order to design a structure to resist wind and earthquake loads, the forces on the structure must be specified. The exact forces that will occur during the life of the structure cannot be anticipated. Most National Building Codes identify some factors according to the boundary conditions of each building considered in the analysis to provide for life safety. A realistic estimate for these factors is important; however the cost of construction and therefore the In order to design a structure to resist wind and earthquake loads, the forces on the structure must be specified. The exact forces that will occur during the life of the structure cannot be anticipated. Most National Building Codes identify some factors according to the boundary conditions of each building considered in the analysis to provide for life safety. A realistic estimate for these factors is important.

During an earthquake, failure of structure starts at points of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structure. The structures having this discontinuity are termed as Irregular structures. Irregular structures contribute a large portion of urban infrastructure. Vertical irregularities are one of the major reasons of failures of structures during earthquakes. For example structures with soft storey were the most notable structures which collapsed. So, the effect of vertically irregularities in the seismic performance of structures becomes really important. Height-wise changes in stiffness and mass render the dynamic characteristics of these buildings different from the "regular' building. IS 1893 definition of Vertically Irregular structures:

The irregularity in the building structures may be due to irregular distributions in their mass, strength and stiffness along the height of building. When such buildings are constructed in high seismic zones, the analysis and design becomes more complicated. There are two types of irregularities-

The component of the building, which resists the seismic forces, is known as lateral force resisting system (L.F.R.S). The L.F.R.S of the building may be of different types. The most common forms of these systems in a structure are special moment resisting frames, shear walls and frame-shear wall dual systems. The damage in a structure generally initiates at location of the structural weak planes present in the building systems. These weaknesses trigger further structural deterioration which leads to the structural collapse. These weaknesses often occur due to presence of the structural irregularities in stiffness, strength and mass in a building system. The structural irregularity can be broadly classified as plan and vertical irregularities. A structure can be classified as vertically irregular if it contains irregular distribution of mass, strength and stiffness along the building height. As per IS 1893:2002, a storey in a building is said to contain mass irregularity if its mass exceeds 200% than that of the adjacent storey. If stiffness of a storey is less than 60% of the adjacent storey, then a storey is termed as „weak storey". If stiffness of a storey is less than 70% or above as compared to the adjacent storey, then the storey is termed as "soft storey".

In reality, many existing buildings contain irregularity, and some of them have been designed initially to be irregular to fulfil different functions e.g. basements for commercial purposes created by eliminating central columns. Also, reduction of size of beams and columns in the upper storeys to fulfil functional requirements and for other commercial purposes like storing heavy mechanical appliances etc. This difference in usage of a specific floor with respect to the adjacent floors results in irregular distributions of mass, stiffness and strength along the building height. In addition, many other buildings are accidentally rendered irregular due to variety of reasons like non-uniformity in construction practices and material used. The building can have irregular distributions of mass, strength and stiffness along plan also. In such a case it can be said that the building has a horizontal irregularity. The detailed classification of structural irregularity is presented in Figure 1.1 and code limits have been shown in Table 1.1 and Table 1.2. From review of code limits it can be clearly said that majority of the codes prescribe similar guidelines for the irregularities based on magnitude ignoring the aspect of irregularity location which is unrealistic. The different types of irregularities are presented below figures.



B.Objective of the study

To calculate the design lateral forces on regular and irregular buildings using non linear dynamic analysis and to compare the results of different irregular structures. To study three irregularities in structures namely mass, stiffness and vertical geometry irregularities.

C.Scope of the study

1. Only RC buildings are considered.
2. Only vertical irregularity was studied.
3. Non linear dynamic analysis was done on the structures.
4. Column was modelled as fixed to the base.
5. The contribution of infill wall to the stiffness was not considered.
6. The effect of soil structure interaction is ignored

II. PROBLEM FORMULATION

The structures are acted upon by different loads such as dead load (DL), Live load and Earthquake load (EL).

A. Self-weight of the structure comprises of the weight of the beams, columns and slab of the structure.

B. Dead load of the structure according to (IS 875(Part1)).

1) Dead load for column: unit weight of concrete X thickness of column X width of the wall = 25 KN/m^3 X 0.6m X 0.6m=9 KN/m.

2) Dead load for beam: unit weight of concrete X thickness of beam X width of the beam = 25 KN/m^3 X 0.45m X 0.45m=5.0625 KN/m.

C. Live load: It consist of Floor load which is taken as 3.5KN/m^2 , according to (IS 875 (Part 2).

D. Seismic Load: The different seismic parameters are taken as follows, IS 1893(Part-1):2002.

- Seismic zone: V (Z=0.36).
- Soil type: II.
- Importance factor: 1.
- Response reduction factor:
- Damping: 5%.

III.RESEARCH METHODOLOGY

A.Plan Details

The structure is 27m in x-direction & 24m in y-direction with columns spaced at 3m from center to center. The storey height is kept as 3m. Basically model consists of multiple bay thirteen storey building, each bay having width of 3m. The storey height between two floors is 3.0m with beam size of 0.45x0.45m and column sizes of 0.6x0.6m respectively and also the slab thickness is taken as 0.125m.Shape of the building for all the cases is shown in figure.

a. The material Properties and Geometry of the model are described below

1) Length X width: 27m X 24m
2) Number of stories: 13
3) Support conditions: Fixed
4) Storey height: 3 m
5) Grade of concrete: 30 Mpa
6) Grade of steel: Fe415
7) Size of columns from all storey: 600mm x 600mm
8) Size of beams: 450mm x 450mm

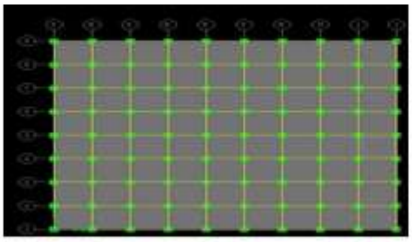


Fig: Rectangular Shape

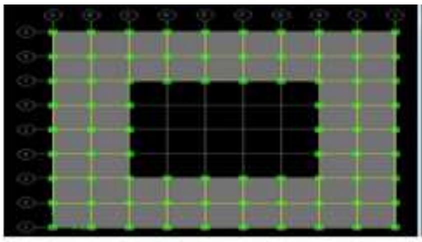


Fig: O Shape

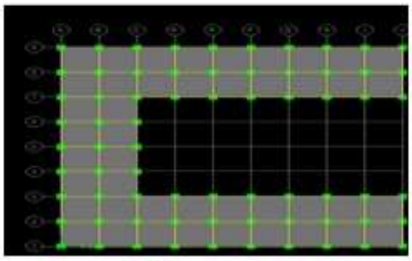


Fig: C Shape

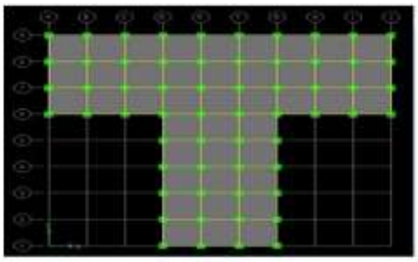


Fig: T Shape

IV.RESULTS AND ANALYSIS

For determining the most stable structure among all models that we have studied, graphs and tables have drawn for different shape structures. Results for Storey Drift, Storey Shear, Bending moment, Building Overturning moment are shown here.

Storey Drift:

Storey Drift in X Direction:

Story	Drift X in General Building	Drift X in O Shape Building	Drift X in T Shape Building	Drift X in C Shape Building
STORY13	0.00049	0.000534	0.000712	0.000471
STORY12	0.000746	0.000765	0.000954	0.000693
STORY11	0.001011	0.001007	0.001209	0.000924
STORY10	0.001264	0.001237	0.001451	0.001143
STORY9	0.001502	0.00145	0.001675	0.001347
STORY8	0.001723	0.001647	0.001881	0.001535
STORY7	0.001929	0.001829	0.002068	0.001708
STORY6	0.002122	0.001995	0.002237	0.001867
STORY5	0.0023	0.002146	0.002386	0.002012
STORY4	0.002462	0.002278	0.002512	0.00214
STORY3	0.002585	0.00237	0.002589	0.002232
STORY2	0.002563	0.002322	0.002504	0.002195
STORY1	0.00171	0.001516	0.001597	0.001446

Table 1.a : Storey Drift in X direction for different shape Buildings

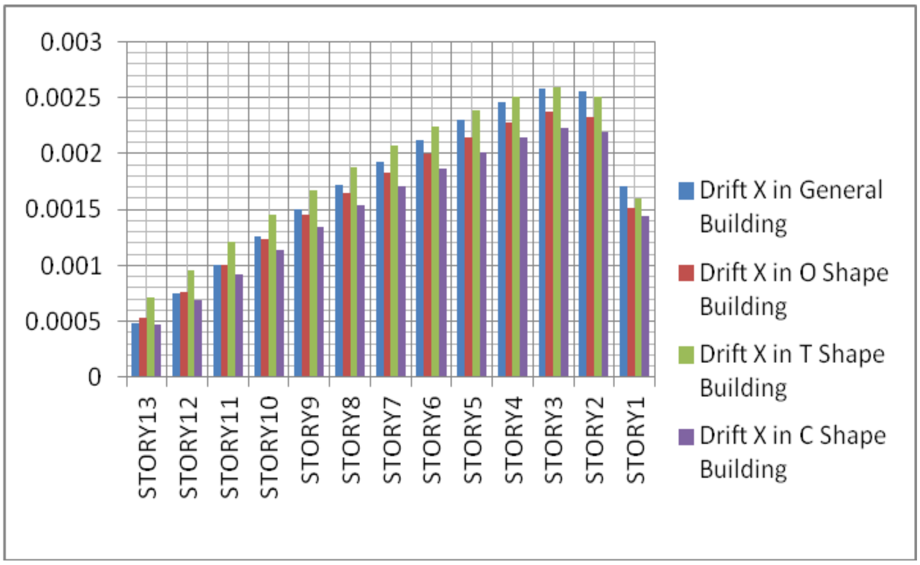


Figure 1.b : Comparison of Storey Drift in X direction for different shape Buildings.

Storey Drift in Y-Direction:

Story	Drift Y in General Building	Drift Y in O Shape Building	Drift Y in T Shape Building	Drift Y in C Shape Building
STORY13	0.000519	0.000604	0.000606	0.001133
STORY12	0.000775	0.000838	0.000846	0.001367
STORY11	0.001042	0.001083	0.001097	0.001616
STORY10	0.001297	0.001316	0.001336	0.001849
STORY9	0.001536	0.001532	0.001558	0.002061
STORY8	0.001758	0.001732	0.001762	0.002249
STORY7	0.001965	0.001914	0.00195	0.002413
STORY6	0.002157	0.00208	0.002122	0.002552
STORY5	0.002336	0.002229	0.002277	0.002663
STORY4	0.002496	0.002357	0.002411	0.002741
STORY3	0.002617	0.002442	0.002503	0.002754
STORY2	0.002588	0.002378	0.002444	0.00258
STORY1	0.00172	0.001537	0.001588	0.001565

Table 2.a : Storey Drift in Y direction for different shape Buildings

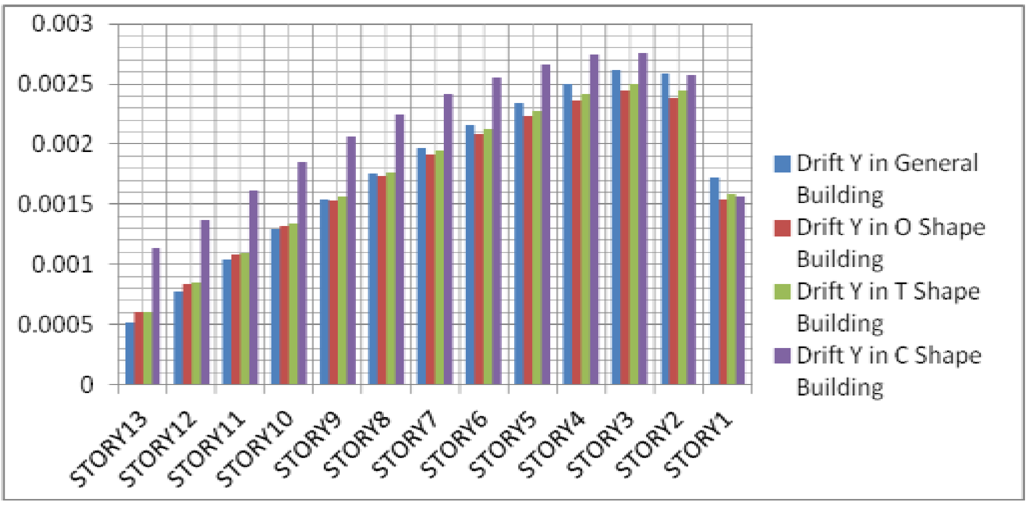


Figure 2.b: Comparison of Storey Drift in Y direction for different shape Buildings

Storey Shear:
Shear Force in X-Direction
:

Story	Shear force VX in General Building	Shear force VX in O Shape Building	Shear force VX in T Shape Building	Shear force VX in C Shape Building
STORY13	-1871.92	-1401.38	-1106.5	-1209.86
STORY12	-3782.68	-2845	-2243.2	-2460.2
STORY11	-5570.36	-4189.65	-3304.61	-3622.22
STORY10	-7245.56	-5443.85	-4297.2	-4703.53
STORY9	-8818.91	-6616.13	-5227.48	-5711.76
STORY8	-10301	-7715.04	-6101.93	-6654.52
STORY7	-11702.4	-8749.1	-6927.05	-7539.41
STORY6	-13033.9	-9726.85	-7709.32	-8374.06
STORY5	-14305.9	-10656.8	-8455.24	-9166.07
STORY4	-15529	-11547.5	-9171.3	-9923.06
STORY3	-16714	-12407.5	-9863.99	-10652.6
STORY2	-17871.4	-13245.4	-10539.8	-11362.4
STORY1	-19012	-14069.6	-11205.3	-12060.1

Table 3.a : Shear Force in X direction for different shape Buildings

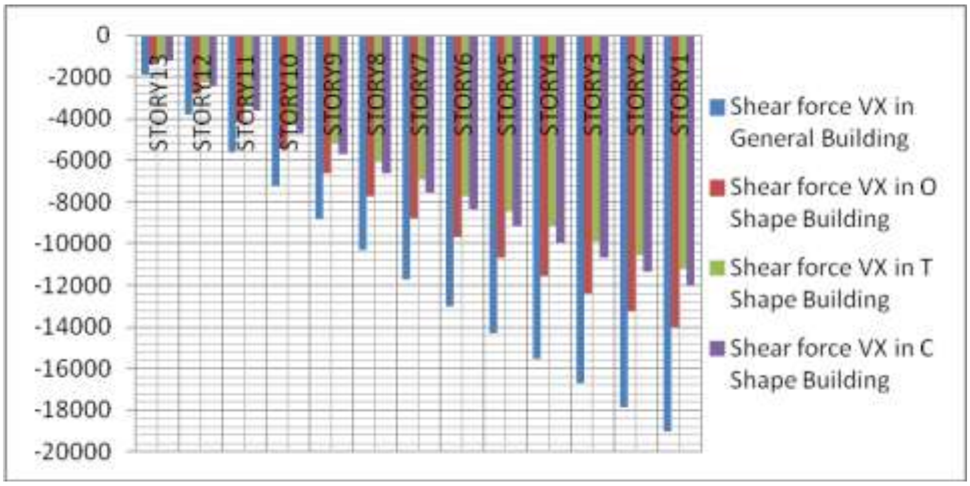


Figure 3.b : Comparison of Shear Force in X direction for different shape Buildings

Shear Force in Y-Direction:

Story	Shear force VY in General Building	Shear force VY in O Shape Building	Shear force VY in T Shape Building	Shear force VY C Shape Building
STORY13	-1865.43	-1388.57	-1108.79	-1146.15
STORY12	-3769.37	-2818.45	-2247.95	-2327.79
STORY11	-5551.3	-4151.53	-3311.41	-3432
STORY10	-7221.75	-5396.16	-4305.72	-4465.45
STORY9	-8791.23	-6560.68	-5237.38	-5434.82
STORY8	-10270.3	-7653.43	-6112.93	-6346.79
STORY7	-11669.4	-8682.76	-6938.89	-7208.04
STORY6	-12999	-9657.01	-7721.78	-8025.22
STORY5	-14269.8	-10584.5	-8468.14	-8805.03
STORY4	-15492.2	-11473.7	-9184.48	-9554.13
STORY3	-16676.8	-12332.8	-9877.33	-10279.2
STORY2	-17833.9	-13170.2	-10553.2	-10986.9
STORY1	-18974.4	-13994.3	-11218.8	-11684

Table 4.a : Shear Force in Y direction for different shape Buildings

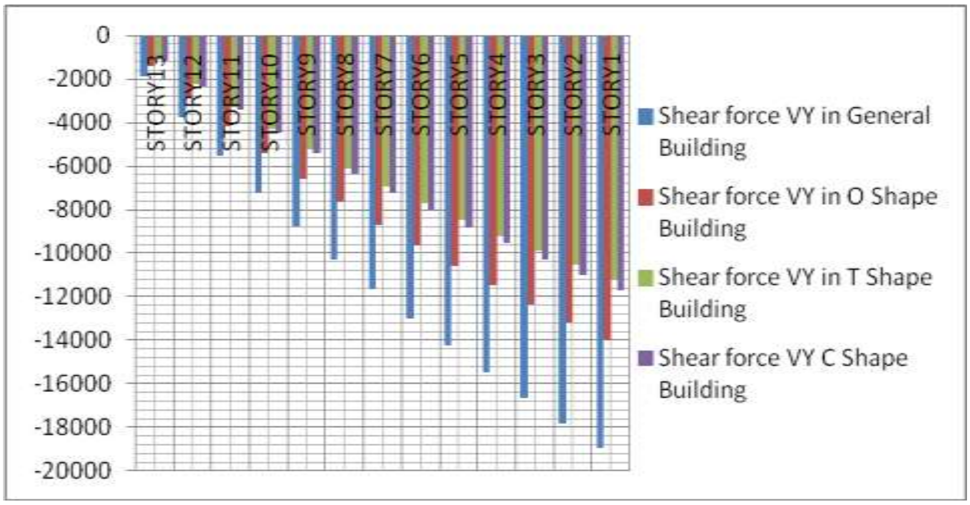


Figure 4.b : Comparison of Shear Force in Y direction for different shape Buildings

Building Overturning Moment:

Story	Building over turning in General Building	Building over turning in O Shape Building	Building over turning in T Shape Building	Building over turning in C Shape Building
STORY13	22462.99	16816.53	16794.4	14518.36
STORY12	45392.17	34140	34033.77	29522.36
STORY11	66844.32	50275.74	50136.18	43466.59
STORY10	86946.77	65326.15	65199.64	56442.41
STORY9	105826.9	79393.61	79322.16	68541.16
STORY8	123611.9	92580.52	92601.77	79854.23
STORY7	140429.3	104989.3	105136.5	90472.95
STORY6	156406.2	116722.2	117024.3	100488.7
STORY5	171670.2	127881.8	128363.2	109992.8
STORY4	186348.4	138570.4	139251.2	119076.7
STORY3	200568.2	148890.4	149786.5	127831.7
STORY2	214456.9	158944.2	160066.8	136349.2
STORY1	228143.4	168835.4	170191.6	144721.6

Table 5.a : Building Overturning moment for different shape Buildings

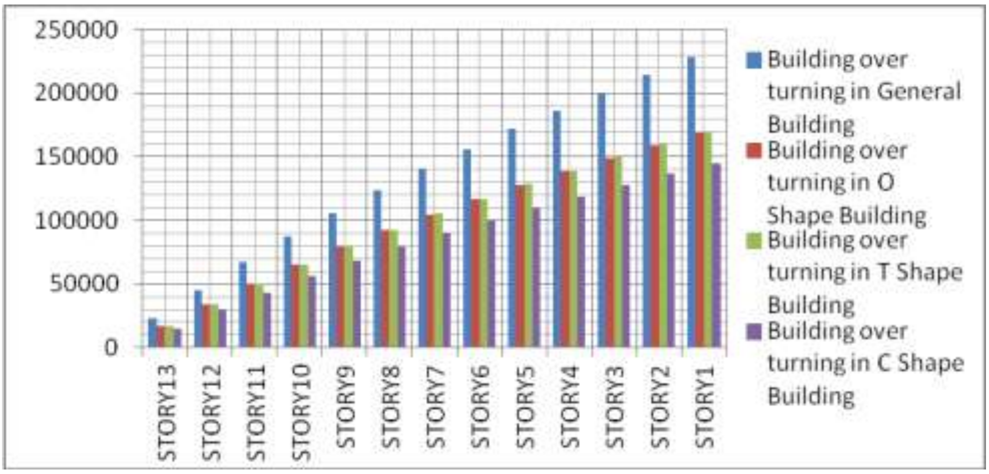


Figure 5.b : Comparison of Building Overturning moment values for different shape Buildings

Bending Moment in X-Direction

Story	Bending moment MX in General Building	Bending moment MX in O Shape l Building	Bending moment MX in T Shape Building	Bending moment MX in C Shape Building
STORY13	5596.292	4165.701	3326.382	3438.462
STORY12	16904.4	12621.05	10070.23	10421.83
STORY11	33558.31	25075.64	20004.47	20717.82
STORY10	55223.56	41264.12	32921.62	34114.17
STORY9	81597.25	60946.15	48633.75	50418.65
STORY8	112408	83906.43	66972.54	69459.03
STORY7	147416.1	109954.7	87789.2	91083.14
STORY6	186413.2	138925.7	110954.5	115158.8
STORY5	229222.6	170679.4	136359	141573.9
STORY4	275699.3	205100.4	163912.4	170236.3
STORY3	325729.5	242098.7	193544.4	201073.9
STORY2	379231.4	281609.2	225204.1	234034.7
STORY1	441847	327790.5	262225.9	272592

Table 6.a : Bending Moment in X direction for different shape Buildings

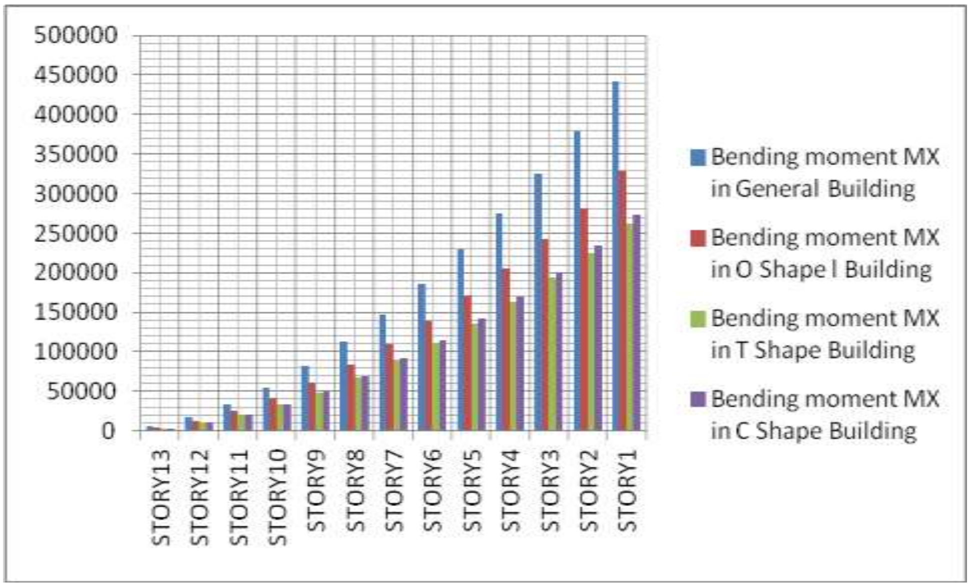


Figure 6.b : Comparison of Bending Moment in X direction for different shape Buildings

Bending Moment in Y-Direction

Story	Bending moment MY in General Building	Bending moment MY in O Shape l Building	Bending moment MY in T Shape Building	Bending moment MY in C Shape Building
STORY13	-5615.75	-4204.13	-3319.5	-3629.59
STORY12	-16963.8	-12739.1	-10049.1	-11010.2
STORY11	-33674.9	-25308.1	-19962.9	-21876.8
STORY10	-55411.6	-41639.6	-32854.5	-35987.4
STORY9	-81868.3	-61488	-48537	-53122.7
STORY8	-112771	-84633.1	-66842.8	-73086.3
STORY7	-147879	-110880	-87623.9	-95704.5
STORY6	-186980	-140061	-110752	-120827
STORY5	-229898	-172031	-136118	-148325
STORY4	-276485	-206674	-163631	-178094
STORY3	-326627	-243897	-193223	-210052
STORY2	-380241	-283633	-224843	-244139
STORY1	-442980	-330062	-261820	-283938

Table 7.a: Bending Moment in Y direction for different shape Buildings

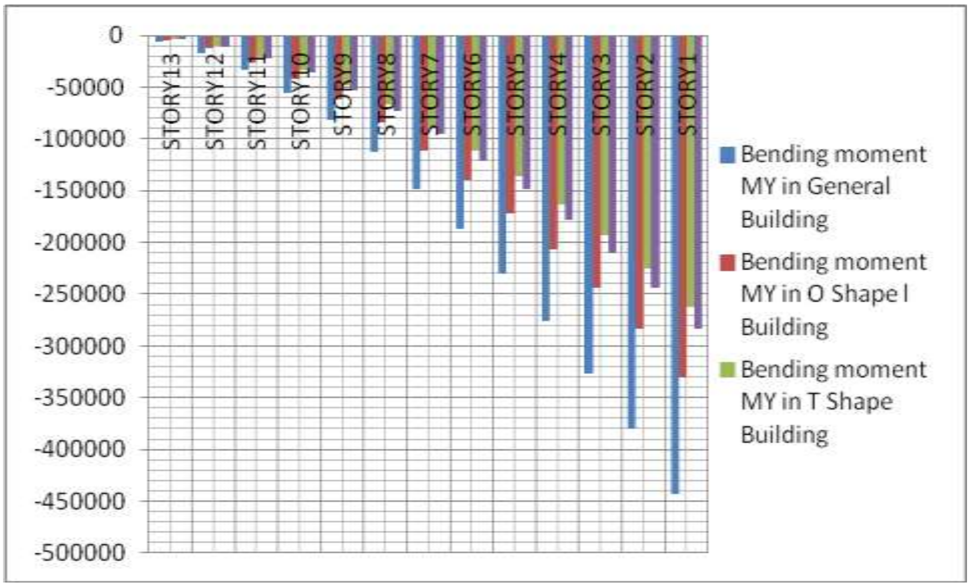


Figure 7.b : Comparison of Bending Moment in Y direction for different shape Buildings

V.CONCLUSIONS

From the results and discussions the following conclusions were obtained

1. For the Drift (Lateral Displacement point of view) in X-Direction the C Shape Building is having better results than other cases (General buildings, O Shape buildings, T Shape buildings).
2. For the Drift (Lateral Displacement point of view) in Y-Direction the O Shape Building is having better results than other cases (General buildings, C Shape buildings, T Shape buildings).
3. For the Shear force point of view the minimum value of shear force was obtained for T Shape buildings than other cases (General buildings, O Shape buildings, C Shape building) in both X and Y Directions.
4. For the Bending moment point of view the minimum value of Bending moment was obtained for T Shape buildings than other cases (General buildings, O Shape buildings, T Shape building) in both X and Y Directions.
5. For the Building overturning the C Shape buildings has less values than other cases
6. Results have been proved that C shape building is more vulnerable compare to all other different shapes.

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