"SEISMIC ANALYSIS OF PLAN IRREGULAR BUILDING- A COMPARATIVE STUDY"

Pranaybarman

Final Year Student, Bachelor of Technology in Civil Engineering,

ICFAI UNIVERSITY Tripura,

Agartala, Kamalghat-799210, India.

Abstract: Multi-storey structures construction by Reinforced Concrete are subjected to most dangerous seismic waves during earthquakes. The main reason found that RCC building failure is caused due to irregularity in its plan dimension and lateral force distribution. In this study paper is made to find the Response of the Regular and Irregular Structures having plan irregularity located in zone V. In the present study, Analysis has been made by taking 10 storey building by Linear Static method using ETABS 2017 and IS Code 1893:2002(part-1). Analysis can be performed for Regular and Irregular buildings and a height of 31 m in zone V by Linear Static Analysis method. Behavior of structures will be found by comparing the responses in the form of storey displacement, storey drift, storey shear, base force reaction, storey forces, Torque and Stiffness during earthquake. Presently there are seven models. One is Regular structure and remaining are irregular structural models, all models have different in shape.

Keywords: Plan Irregularity, Linear Static, ETABS 2017, IS 1893:2002, storey displacement, storey drift, storey shear, Earthquake load.

I. INTRODUCTION

At the Earth's surface, earthquakes manifest themselves by shaking and sometimes displacement of the ground. Earthquakes are the most undesirable and distressing of all natural calamities A building with discontinuity is subjected to concentration of forces and deformations at the point of discontinuity which may leads to the failure of members at the junction and collapse of building when the epicenter of a large earthquake is located offshore, the sea bed may be displaced sufficiently to cause a tsunami. Earthquakes can also trigger landslides, and occasionally volcanic activity. An earthquake (also known as a quake, tremor or temblor) is the vibrating of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that creates seismic waves. Earthquakes can range in size from those that are so weak that they cannot be felt to those violent enough to pitch people around and destroy whole cities. Earthquakes are usually caused when rock underground suddenly breaks along a fault. This sudden release of energy causes the seismic waves that make the ground shake. When two blocks of rock or two plates are rubbing against each other, they stick a little. They don't just slide smoothly; the rocks catch on each other. The rocks are still pushing against each other, but not moving. After a while, the rocks break because of all the pressure that's built up. When the rocks break, the earthquake occurs. During the earthquake and afterward, the plates or blocks of rock start moving, and they continue to move until they get stuck again.

Irregularities in building structures imply a non-uniform response to a structure due to non-uniform distribution of structural features. Plan irregularity makes structures vulnerable under seismic loading tensional irregularity overturning moment can rise abruptly having irregularity in a structure. During a seismic event the result can be a soft floor process. In this topic different types of irregular buildings are analyzed like C, L, T, I, U, + shape. Different types of plan irregularity are (i) torsional irregularity (ii) re-entrant corners (iii) non parallel systems and (iv) Diaphragm Discontinuity.

II. OBJECTIVE OF THE STUDY

- To perform the seismic analysis over a regular building as well as different plan irregular buildings.
- To obtain the structural responses of the concern building models that is Regular building, U, C, L, I, T & + etc. by using linear static analysis.
- To compare the behavior of the said Regular building with Plan irregular building models.
- To study the various of structural responses for the plan irregular structures with the regular one.

III. MODEL OF THE STRUCTURES

3.1 Parameters Consider

The present study focuses on the static analysis of Regular structure and L, U, C, T, +, I shape plan irregular structures. The properties of the considered building configurations in the present study are summarized below.

Table No 1: - Parameters Considered for the building design

Parameters	Value/Type
Grade of concrete	M30
Grade of Steel	Fe415
Height of typical story	3 m
Height of ground story	4 m
Height of building	31 m
Number of stories	10
Column Size	300 mm x 600 mm
Beam Size	250 mm x 500 mm
Thickness of Slab	150 mm
Thickness of Wall	200 mm
Live Load on Terrace	1.5 KN/m^2
Live load on Typical floors	4 KN/m^2
Dead Load on Terrace	10 KN/m^2
Dead Load on Typical Floors	12 KN/m^2
Type of Soil	Medium
Earth quake Zone	V
Zone Factor, Z	0.36
Importance Factor	1.5
Response Reduction Factor	5

3.2 ANALYSIS OF THE STRUCTURES

Following models are analysed using Linear Static Analysis Method.

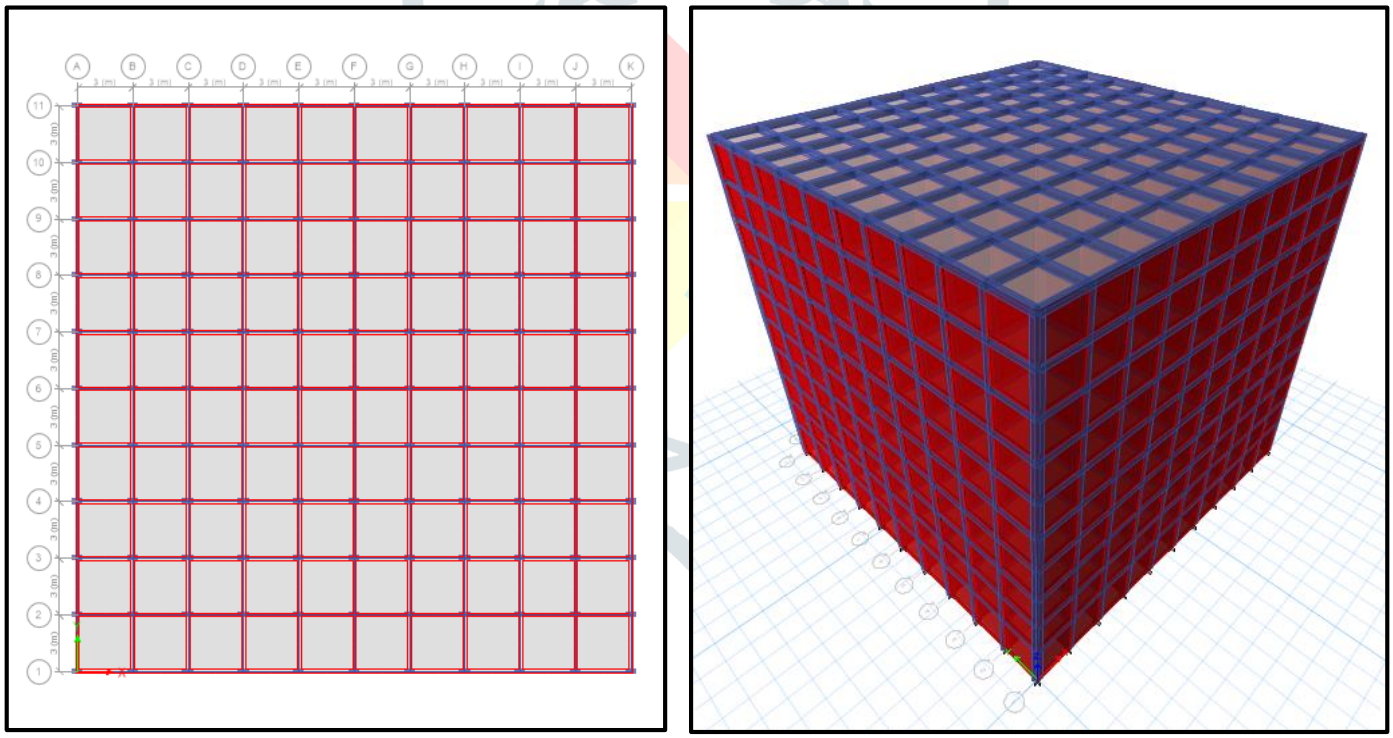


Fig1: -Plan and 3D view of Regular Building

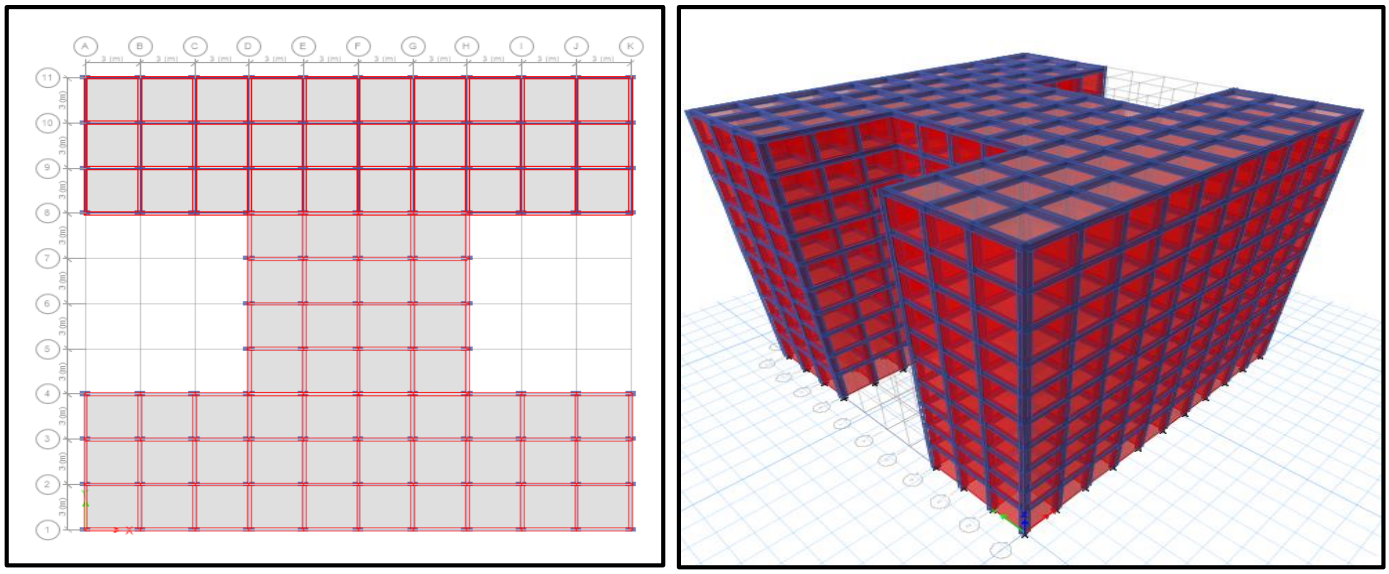


Fig2: -Plan and 3D view of I Shape Building

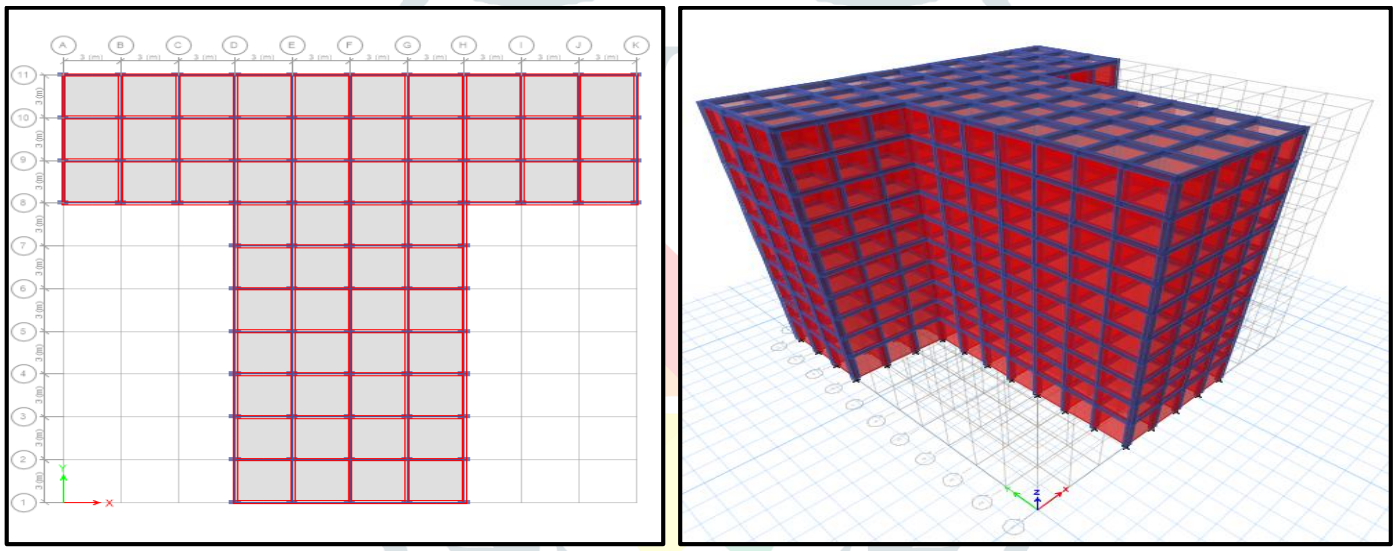


Fig3: -Plan and 3D view of T Shape Building

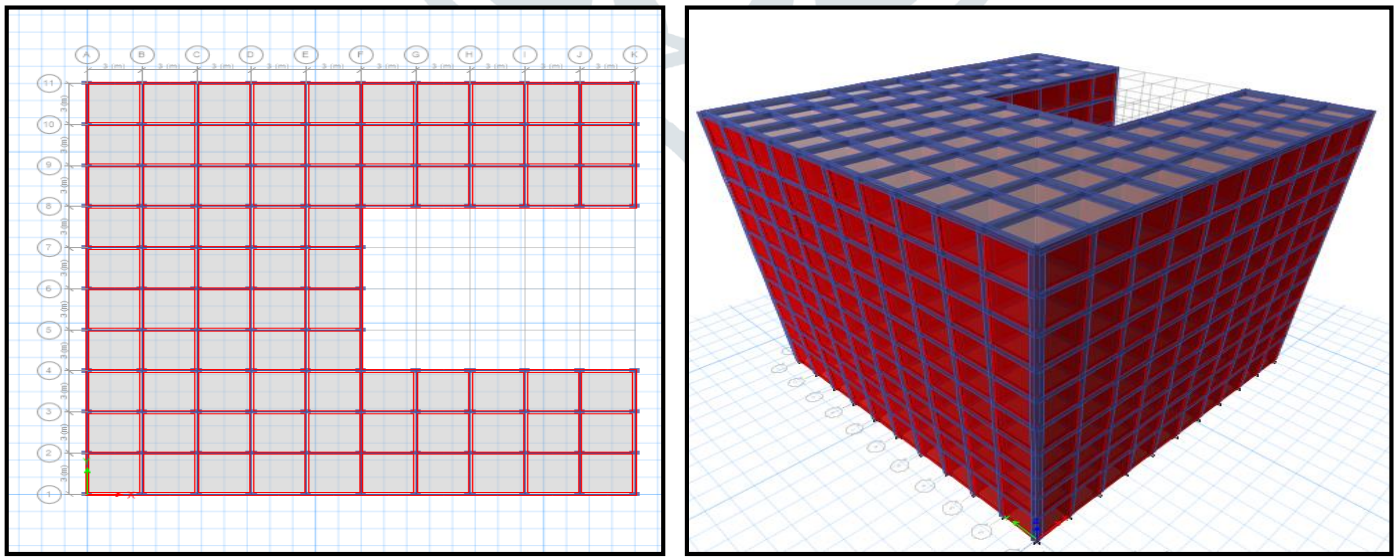


Fig4: -Plan and 3D view of C Shape Building

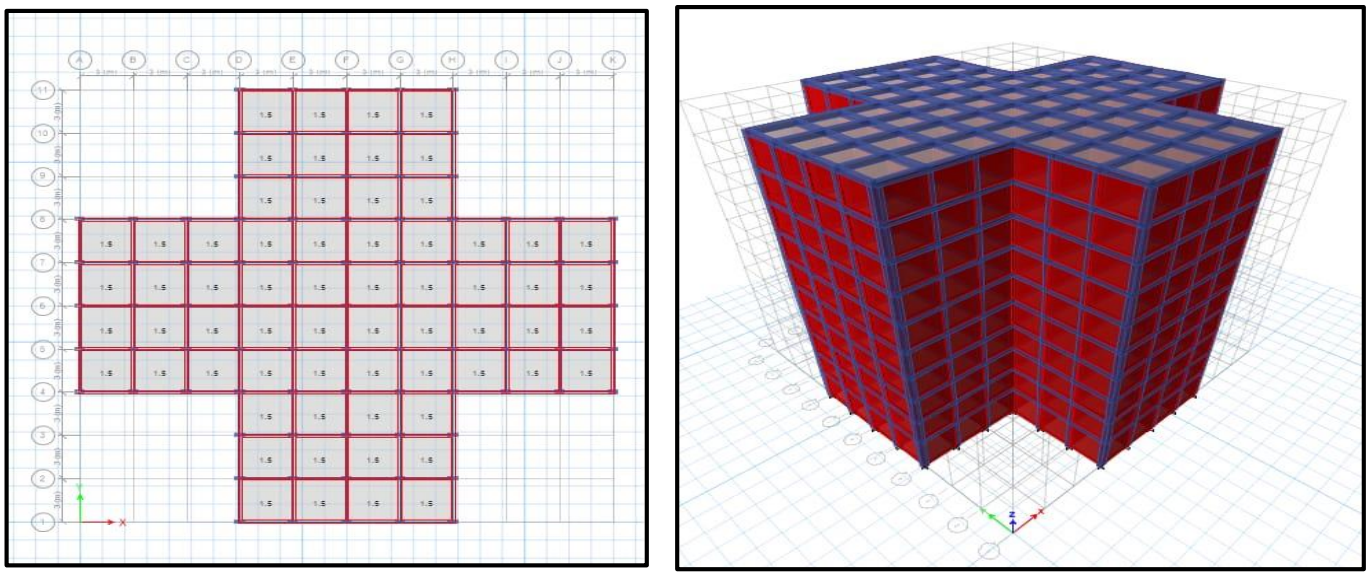


Fig5: -Plan and 3D view of + Shape Building

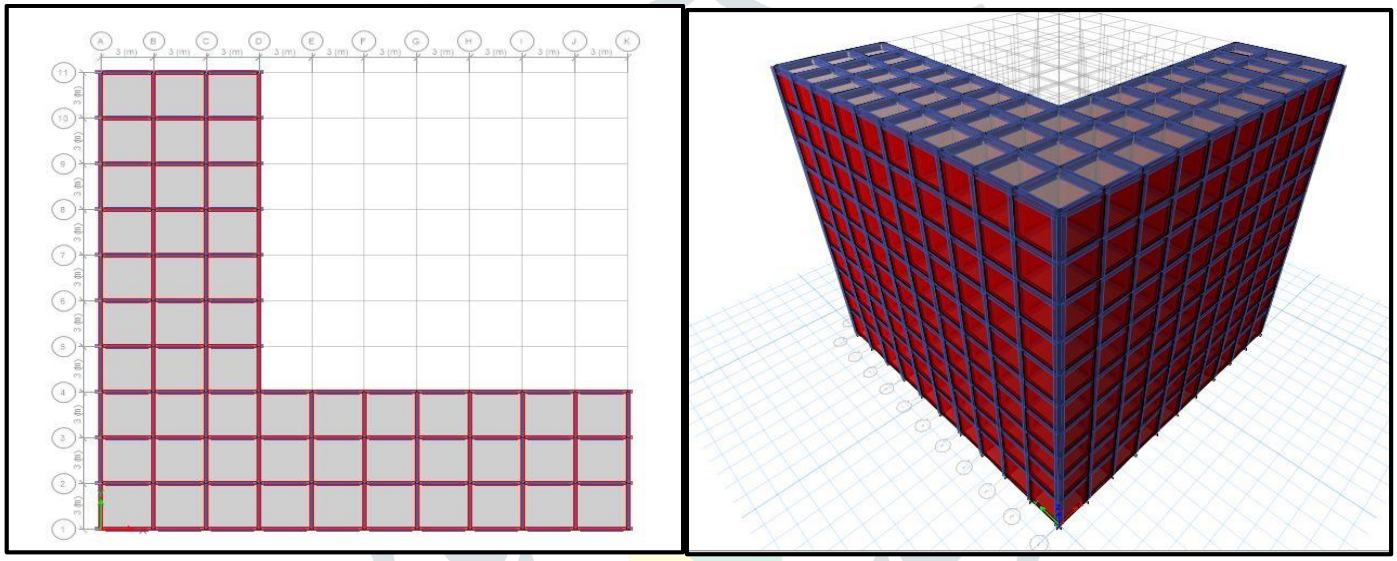


Fig6: -Plan and 3D view of L Shape Building

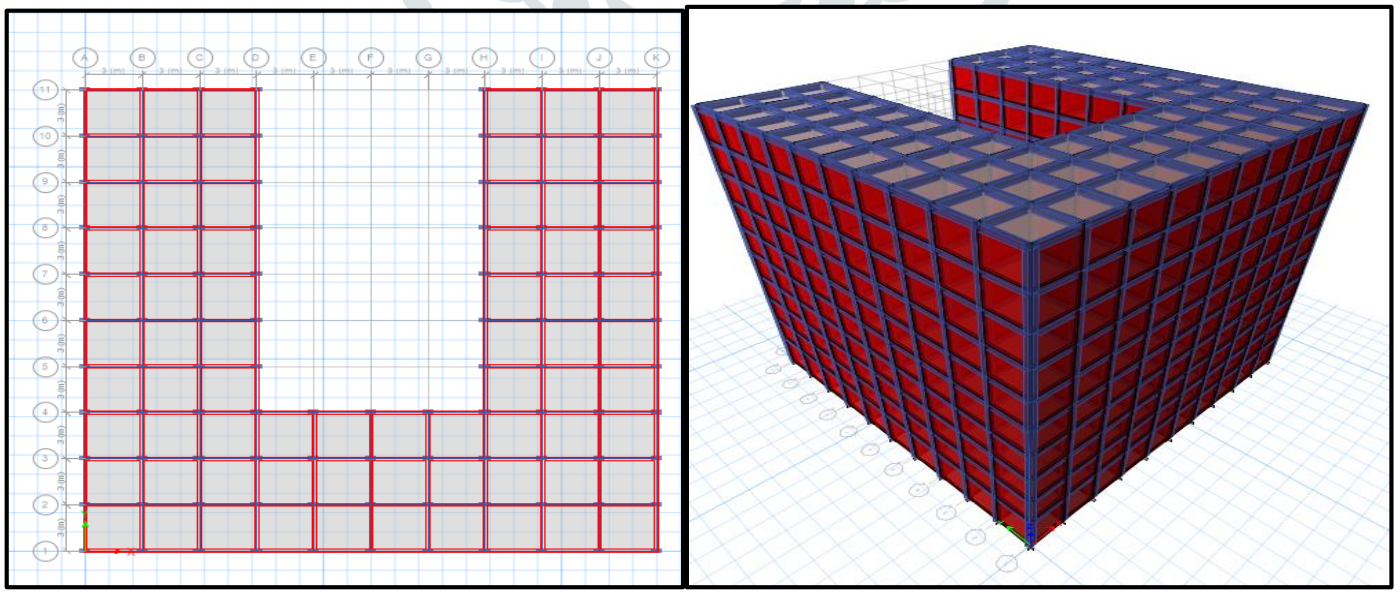


Fig7: -Plan and 3D view of U Shape Building

IV. RESULTS

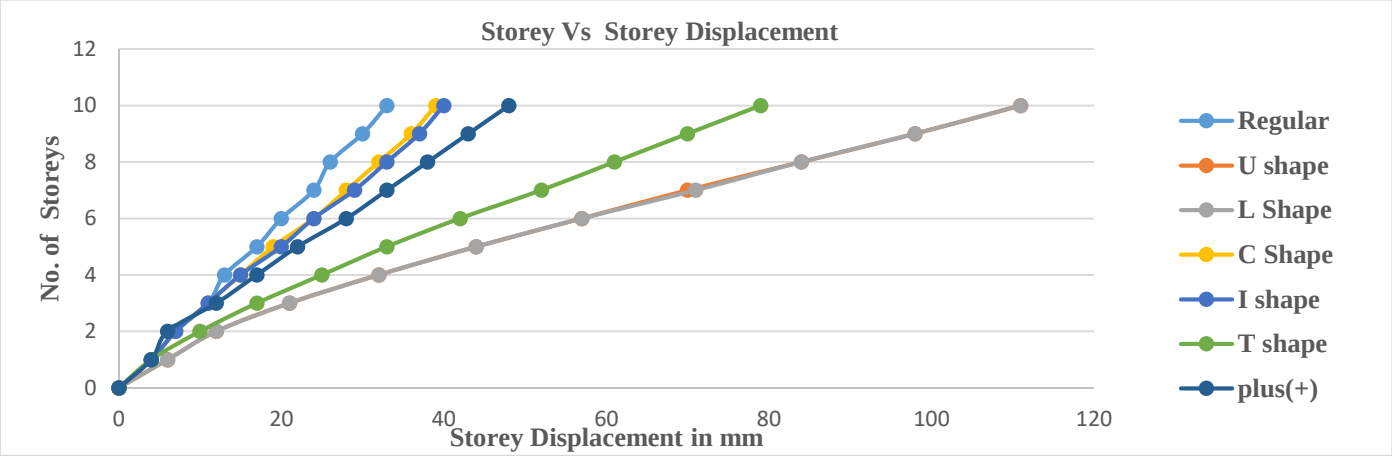
The results of the study are being illustrated using the graphs below which explain the structural behaviour of both types structures (regular and irregular) in terms of Storey Displacement, Storey Drift, Storey Forces, Base Force Reaction, Storey Shear and Torque.

4.1 Story Displacement of all models

Story displacement is of all models, along X and Y direction are listed below and compared.

Table No4.1A: - Story Displacement of all models in X-Direction in mm.

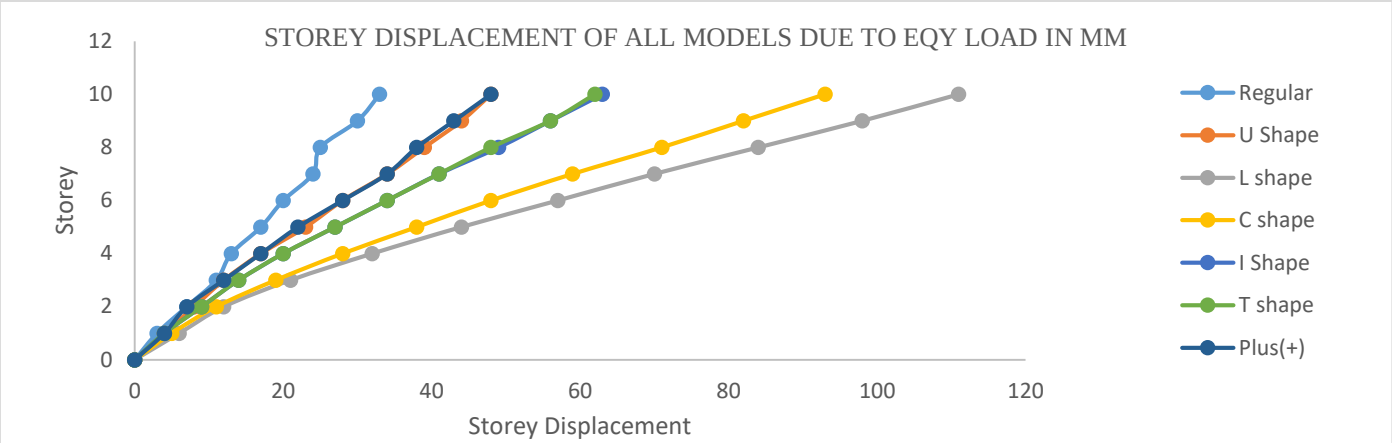
Storey	Regular shape building with fixed base	Irregular Building with fixed base					
		U shape	L shape	C shape	I shape	T shape	+ shape
Storey10	33	111	111	39	40	79	48
Storey9	30	98	98	36	37	70	43
Storey8	26	84	84	32	33	61	38
Storey7	24	70	71	28	29	52	33
Storey6	20	57	57	24	24	42	28
Storey5	17	44	44	19	20	33	22
Storey4	13	32	32	15	15	25	17
Storey3	11	21	21	11	11	17	12
Storey2	7	12	12	7	7	10	6
Storey1	4	6	6	4	4	4	4
Base	0	0	0	0	0	0	0



Graph No4.1A: - Story Displacement (all models in mm.)

Table No4.1B: - Story Displacement of all models in Y-Direction in mm.

Storey	Regular shape building with fixed base	Irregular Building with fixed base					
		U shape	L shape	C shape	I shape	T shape	+ shape
Storey10	33	48	111	93	63	62	48
Storey9	30	44	98	82	56	56	43
Storey8	25	39	84	71	49	48	38
Storey7	24	34	70	59	41	41	34
Storey6	20	28	57	48	34	34	28
Storey5	17	23	44	38	27	27	22
Storey4	13	17	32	28	20	20	17
Storey3	11	12	21	19	14	14	12
Storey2	7	8	12	11	9	9	7
Storey1	3	4	6	5	4	4	4
Base	0	0	0	0	0	0	0



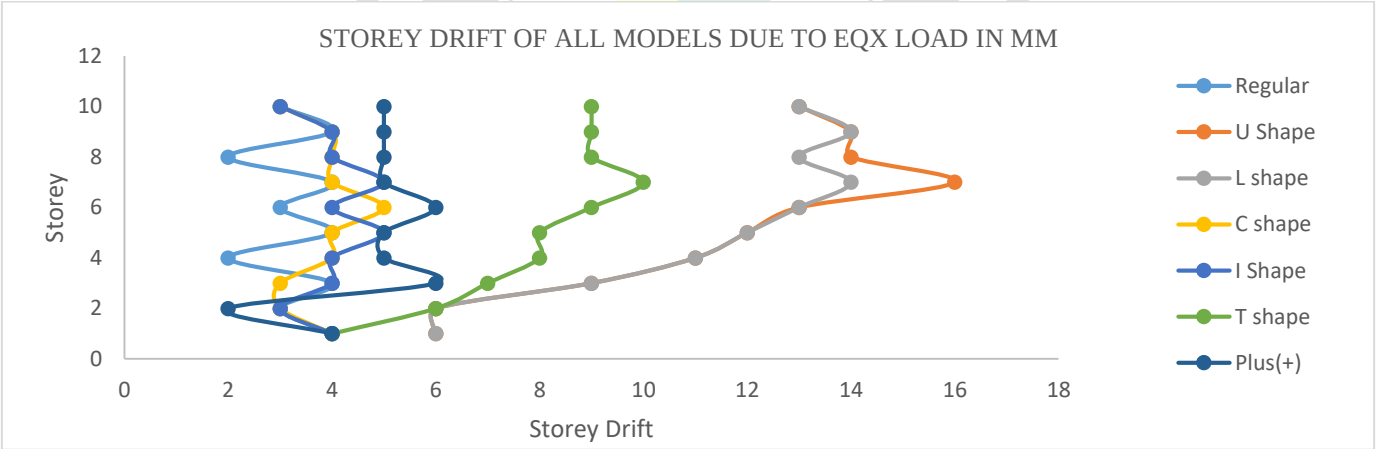
Graph No4.1B: - Storey Displacement (all models in mm)

4.2 Storey Drift of all models

Storey Drift of all models, along X and Y direction are listed below and compared.

Table No4.2A: - Storey Drift of all models in X-Direction.

Storey	Regular shape building with fixed base	Irregular Building with fixed base					
		U shape	L shape	C shape	I shape	T shape	+ shape
Storey10	3	13	13	3	3	9	5
Storey9	4	14	14	4	4	9	5
Storey8	2	14	13	4	4	9	5
Storey7	4	16	14	4	5	10	5
Storey6	3	13	13	5	4	9	6
Storey5	4	12	12	4	5	8	5
Storey4	2	11	11	4	4	8	5
Storey3	4	9	9	3	4	7	6
Storey2	3	6	6	3	3	6	2
Storey1	4	6	6	4	4	4	4

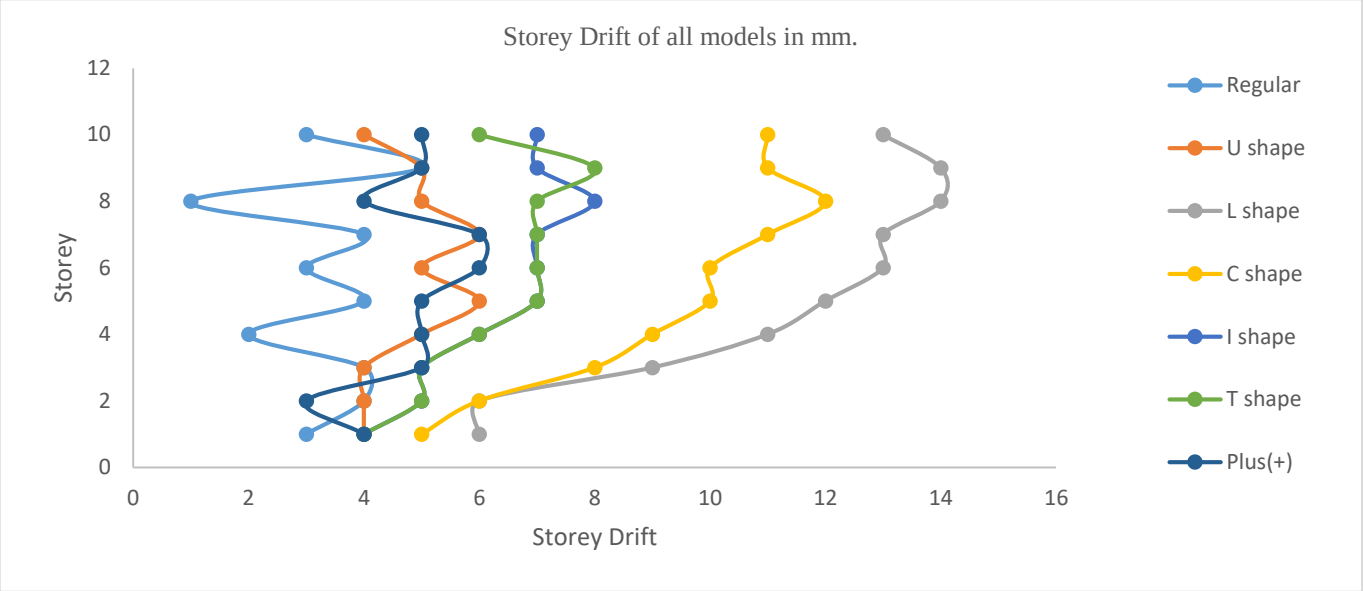


Graph No4.2A: - Storey Drift of all models in X-Direction.

Table No4.2B: - Storey Drift of all models in Y-Direction.

Storey	Regular shape building with fixed base	Irregular Building with fixed base					
		U shape	L shape	C shape	I shape	T shape	+ shape
Storey10	3	4	13	11	7	6	5
Storey9	5	5	14	11	7	8	5
Storey8	1	5	14	12	8	7	4
Storey7	4	6	13	11	7	7	6
Storey6	3	5	13	10	7	7	6
Storey5	4	6	12	10	7	7	5
Storey4	2	5	11	9	6	6	5

Storey3	4	4	9	8	5	5	5
Storey2	4	4	6	6	5	5	3
Storey1	3	4	6	5	4	4	4



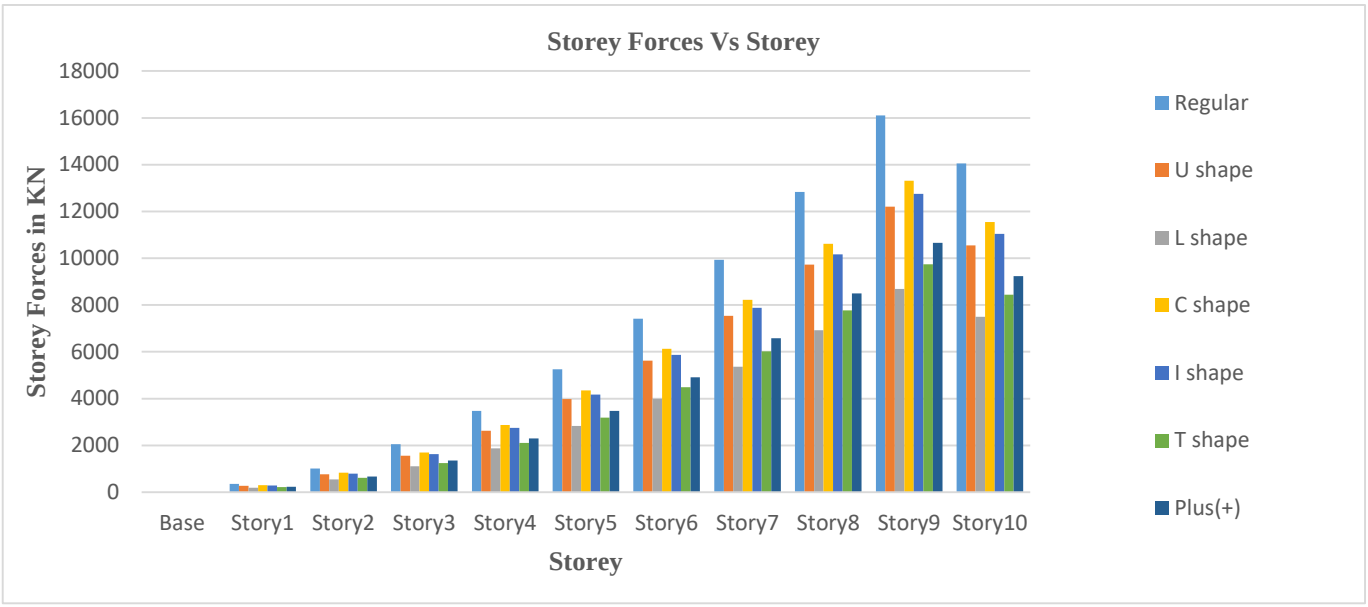
Graph No4.2B: - Storey Drift of all models in Y-Direction.

4.3 Storey Forces of all models

Storey Forces of all models, along X and Y direction are listed below and compared.

Table no 4.3A: - Storey Forces in X direction in KN

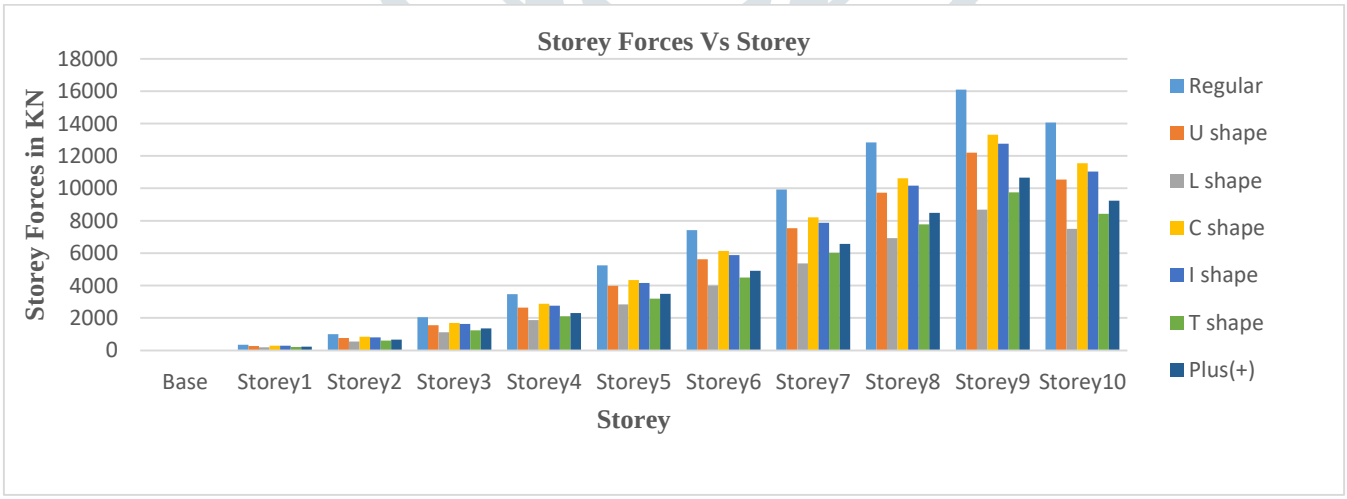
Storey	Regular shape building with fixed base	Irregular Building with fixed base					
		U shape	L shape	C shape	I shape	T shape	+ shape
Storey10	14054.7389	10548.9142	7501.4863	11546.2918	11044.5838	8437.6878	9240.1372
Storey9	16098.4428	12203.024	8687.4429	13312.5319	12755.3548	9746.151	10653.6176
Storey8	12833.58	9728.176	6925.5763	10612.6689	10168.4908	7769.5719	8492.9987
Storey7	9938.3244	7533.4995	5363.1663	8218.4508	7874.4792	6016.7565	6576.9782
Storey6	7412.6758	5618.9945	4000.2129	6129.8776	5873.3203	4487.7047	4905.556
Storey5	5256.6344	3984.6609	2836.716	4346.9492	4165.0138	3182.4167	3478.7323
Storey4	3470.2	2630.4988	1872.6758	2869.6657	2749.5599	2100.8922	2296.5068
Storey3	2053.3728	1556.5082	1108.0922	1698.027	1626.9585	1243.1315	1358.8798
Storey2	1006.1527	762.689	542.9652	832.0332	797.2097	609.1344	665.8511
Storey1	355.2578	270.0538	192.3122	294.3271	282.1412	215.5898	235.5422
Base	0	0	0	0	0	0	0



Graph No4.3A: - Storey Forces of all models in X-Direction in KN

Table no4.3B: - Storey Forces in Y direction in KN

Storey	Regular shape building with fixed base	Irregular Building with fixed base					
		U shape	L shape	C shape	I shape	T shape	+ shape
Storey10	14054.7389	10548.9142	7501.4863	11546.2918	11044.5838	8437.6878	9240.1372
Storey9	16098.4428	12203.024	8687.4429	13312.5319	12755.3548	9746.151	10653.6176
Storey8	12833.58	9728.176	6925.5763	10612.6689	10168.4908	7769.5719	8492.9987
Storey7	9938.3244	7533.4995	5363.1663	8218.4508	7874.4792	6016.7565	6576.9782
Storey6	7412.6758	5618.9945	4000.2129	6129.8776	5873.3203	4487.7047	4905.556
Storey5	5256.6344	3984.6609	2836.716	4346.9492	4165.0138	3182.4167	3478.7323
Storey4	3470.2	2630.4988	1872.6758	2869.6657	2749.5599	2100.8922	2296.5068
Storey3	2053.3728	1556.5082	1108.0922	1698.027	1626.9585	1243.1315	1358.8798
Storey2	1006.1527	762.689	542.9652	832.0332	797.2097	609.1344	665.8511
Story1	355.2578	270.0538	192.3122	294.3271	282.1412	215.5898	235.5422
Base	0	0	0	0	0	0	0



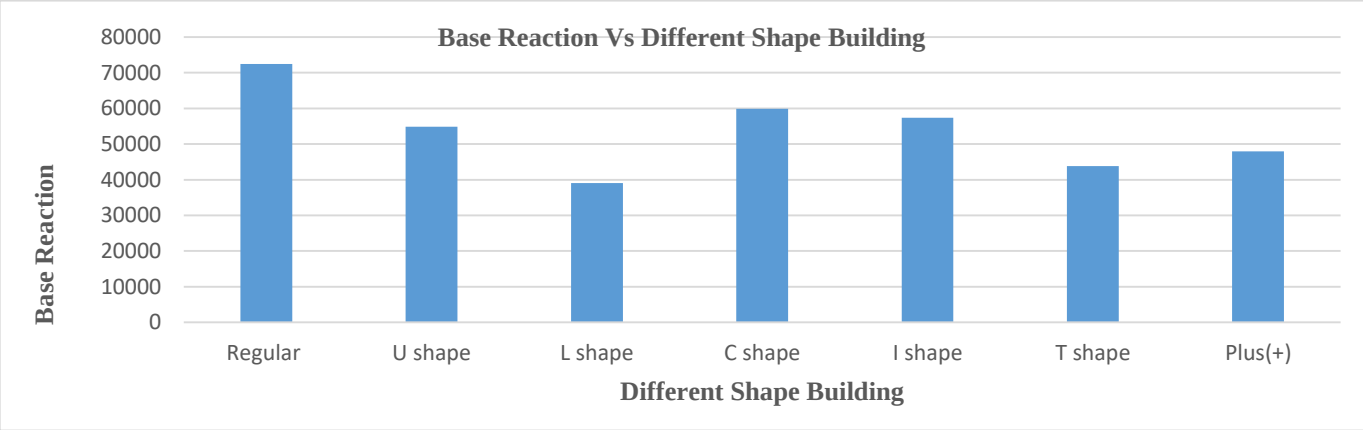
Graph No4.3B: - Storey Forces of all models in Y-Direction in KN

4.4 Base Force Reaction of all models

Base Force Reaction of all models, along X and Y direction are listed below and compared.

Table no6.4A: - Base Force Reaction in X & Y direction in KN

Storey	Regular shape building with fixed base	Irregular Building with fixed base					
		U shape	L shape	C shape	I shape	T shape	+ shape
Base	72479.3795	54837.0189	39030.6461	59860.8233	57337.1121	43809.0366	47904.7999



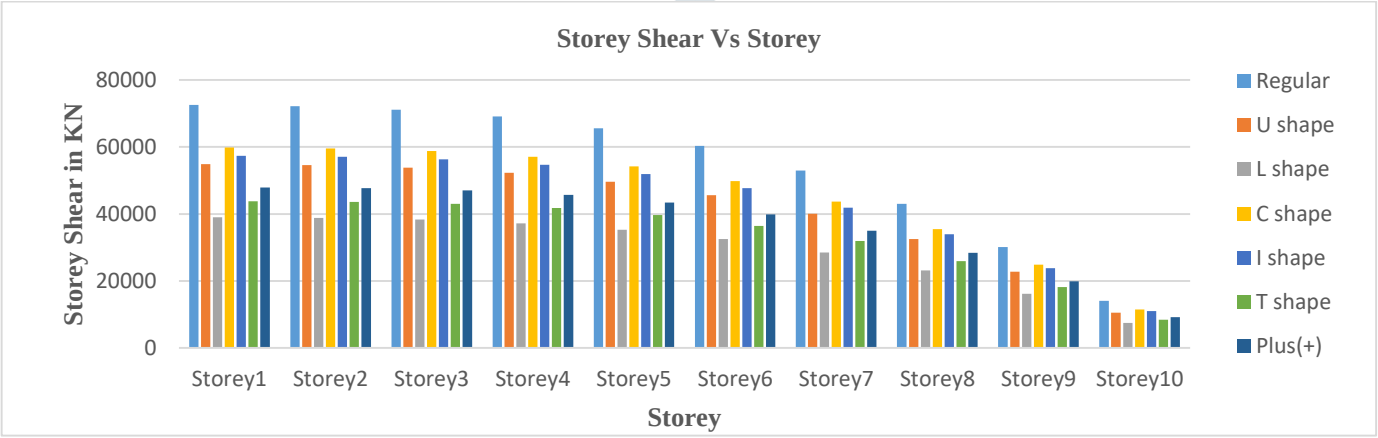
Graph No4.4A: - Base Forces Reaction of all models in X-Direction in KN

4.5 Storey Shear of all models

Storey Shear of all models, along X and Y direction are listed below and compared.

Table no4.5A: - Storey Shear in X &Y direction in KN

Storey	Regular shape building with fixed base	Irregular Building with fixed base					
		U shape	L shape	C shape	I shape	T shape	+ shape
Storey10	14054.7389	10548.9142	7501.4863	11546.2918	11044.5838	8437.6878	9240.1372
Storey9	30153.1817	22751.9382	16188.9292	24858.8237	23799.9387	18183.8388	19893.7548
Storey8	42986.7617	32480.1142	23114.5055	35471.4927	33968.4294	25953.4107	28386.7535
Storey7	52925.0861	40013.6137	28477.6718	43689.9435	41842.9087	31970.1672	34963.7317
Storey6	60337.7619	45632.6082	32477.8847	49819.8211	47716.2289	36457.872	39869.2877
Storey5	65594.3962	49617.2691	35314.6007	54166.7703	51881.2428	39640.2886	43348.02
Storey4	69064.5963	52247.7679	37187.2765	57036.436	54630.8027	41741.1809	45644.5268
Storey3	71117.9691	53804.276	38295.3687	58734.463	56257.7612	42984.3124	47003.4066
Storey2	72124.1218	54566.965	38838.3339	59566.4962	57054.9709	43593.4468	47669.2577
Storey1	72479.3795	54837.0189	39030.6461	59860.8233	57337.1121	43809.0366	47904.7999



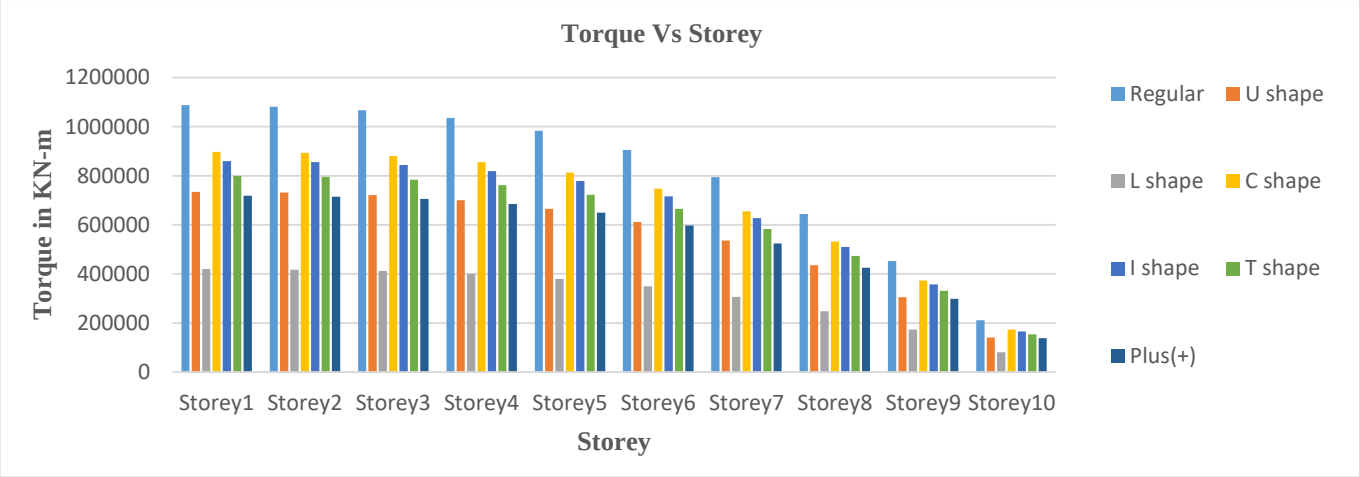
Graph No4.5A: - Storey Shear of all models in X-Direction in KN

4.6 Torque of all models

Torque of all models, along X and Y direction are listed below and compared.

Table no4.6A: - Torque in X & Y direction in KN-m

Storey	Regular shape building with fixed base	Irregular Building with fixed base					
		U shape	L shape	C shape	I shape	T shape	+ shape
Storey10	210821.0837	141085.333	80572.0919	173194.3771	165668.7577	153940.461	138602.0581
Storey9	452297.7252	304655.3434	174002.8323	372882.356	356999.08	331732.5252	298406.3216
Storey8	644801.4254	435052.3543	248485.2465	532072.3901	509526.4415	473467.2701	425801.3021
Storey7	793876.2908	536031.7995	306164.428	655349.1526	627643.6302	583226.6567	524455.9749
Storey6	905066.4281	611349.113	349185.4705	747297.3163	715743.4342	665092.6454	598039.3156
Storey5	983915.9437	664759.7286	379693.4673	812501.5543	778218.6415	723147.1969	650220.2996
Storey4	1035968.9442	700019.0804	399833.5121	855546.5395	819462.04	761472.272	684667.9024
Storey3	1066769.5363	720882.6021	411750.6984	881016.945	843866.4178	784149.8312	705051.0992
Storey2	1081861.8263	731105.7277	417590.1197	893497.4437	855824.563	795261.8352	715038.8657
Storey1	1087190.6932	734727.8133	419659.1467	897912.35	860056.6813	799194.5421	718571.9985



Graph No4.6A: - Torque of all models in X-Direction in KN-m

V. CONCLUSIONS

- The analytic study is carried out in order to compare the behavior of regular structure with Plan irregular structure. The structures are subjected to equivalent static seismic loading; from the study the following conclusions are obtained.
- Among the two structures considered (Regular and Plan irregularity), Regular structure shown minimum displacement and drift in equivalent static analysis compared to plan irregularity structures.
- Buildings with irregular plan configurations causes severe damage than the regular building during earthquake in high seismic zones are caused due to increase in the drifts and displacements.
- Base force Reaction is maximum for Regular structure compared to other structures.
- Storey force is maximum for Regular structure compared to plan irregular structures.

VI. REFERENCES

- Dheekshith, K., & S, N. K. M. (2018). Comparative Study on Seismic Analysis of Two Rc Buildings with Irregularities Under Varying Seismic Zones. 81–88
- Philip, A., & Elavenil, D. S. (2017). Seismic Analysis of High Rise Buildings with Plan Irregularity. *International Journal of Civil Engineering and Technology (IJCIET)*, *8*(4), 1365-1375.
- Roudgar, M., Brunazzi, E., Galletti, C., & Mauri, R. (2012). Numerical Study of Split T-Micromixers. *Chemical Engineering and Technology*, *35*(7), 1291–1299. https://doi.org/10.1002/ceat.201100611