iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VIII **Month of publication:** August 2021

DOI: https://doi.org/10.22214/ijraset.2021.37409

Impact of Variation in Plan Configuration on Structural Behaviour of Reinforced Concrete Building

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***Abstract:** Nowadays high rise building is a new trend in India because day by day population increase and it's a problem to accommodate large number of people in small place. To resolve this problem only one option is good which is vertical growth of building. Due to architectural purpose some building's plan like L, C, E and + etc. cause plan irregularities and in elevation like vertical set-back type building cause vertical irregularities. These kind of shapes are creating problem for structural engineers because it demands serious damage in earthquake. In this study the main objective is to understand demand of lateral load on different plan aspect ratio and with varying heights of 18, 33 and 48meter. Modelling of varying heights OF 18, 33 and 48 meter R.C.C. framed building is done on the ETABS software for analysis. Post analysis of the structure, Centre of mass, Centre of resistance of building, maximum storey displacement, storey drift and base shear are computed and then compared for all the analyzed cases.*
***Keywords:** Plan Irregularities, L-shaped Building, aspect ratio, Centre of mass, Centre of resistance*

I. INTRODUCTION

Nowadays in high rise building due to architectural requirements some irregularities are generated. (plan irregularities and vertical irregularities) Due to plan irregularities, building behave differently with compared to regular buildings. For that, we need to improve structural system which gives comfort to people. Due to plan irregularities we need a good structural system to mitigate storey displacement and torsion to keep building under limitation of IS code provisions.

The aim of the present study is to examine the effects of wind and earthquake on different height of structures under different plan configuration having same parameters. Modern construction demands the architects to make asymmetrical buildings in plan and elevation. The structural engineer on the other side has a major responsibility to make the structure safe against all external forces. When such irregular buildings are constructed in a high seismic zone, the structural engineer's role becomes further challenging.

The objective of this study is to grasp seismic performance for plan irregular building in a form of L – shaped buildings through the evaluation of the earthquake forces, wind forces, torsion effects, storey displacement, design bending moments, shear forces and axial forces of columns. So the seismic performance in terms of lateral story displacement, story drift, centre of mass displacement and torsional irregularity for different aspect ratio models is investigated and compared to that of regular model which have plan symmetry.

II. LITERATURE STUDY

Studied the seismic performance of a(G+10) storey residential building with three different types of plan configuration – rectangular, L shape and C shape. The buildings were analysed both statically and dynamically using the software SAP 2000. The time history method made use of the previous earthquake data of BHUJ, UTTARKHASI and CHAMOLI. In this study storey shear and top joint deflections were evaluated and it was found that among all the three plan configurations, the L shape building gave higher values of displacement and storey shear. Studied the structural behavior of multi-storey building for different plan configurations like rectangular, C, L and I shape and compared. A 15 storey RC frame building is modelled and analysed using ETABS software. After analysis of the structure maximum shear forces, bending moments and maximum storey displacement are computed and then compared for all the analysed cases and from the results it was noticeable that the irregular plan structure had more values compared to regular building. Modelled a 20 stories irregular building and analysed using software's ETABS and SAP 2000 for seismic zone V in India. This paper also deals with the effect of the variation of the building height on the structural response of the shear wall building. Dynamic analysis is carried out under the earthquakes EL-CENTRO 1949 and CHI-CHI Taiwan 1999. In this paper the accuracy of the non-linear dynamic method (Time History analysis) is compared with linear static and dynamic methods (Equivalent Static and Response Spectrum method respectively) and the following conclusions were drawn: (i) Static method gave higher displacement values than dynamic method, (ii) Time history method is the most ideal method for the seismic analysis of buildings, (iii) Dynamic analysis should be performed for high rise structures to obtain accurate results, (iv)

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VIII Aug 2021- Available at www.ijraset.com

There is no much difference in displacement values between both methods for the lower stories whereas the higher stories shows higher displacement values, the displacement values increases along the height, (v) As the displacement values obtained from equivalent static analysis are higher, it is not considered as an economical method.

III. RESEARCH OBJECTIVE

A. The main objective of this study to see the effect of lateral loads on high rise building with different plan aspect ratios.
B. Study the effect of Storey Drift, Storey Displacement, Storey Shear, Overturning moment, CG and CR for various aspect ratios of building.
C. Perform dynamic analysis and compare various aspect ratios of building with the regular building.

IV. METHODOLOGY

Analysis methods are mainly defined as linear and nonlinear static and dynamic. The main difference between the equivalent static method and dynamic analysis method lies in the magnitude and distribution of lateral forces over the height of the buildings. In the dynamic analysis procedure, the lateral forces are based on properties of the natural vibration modes of the building, which are determined by the distribution of mass and stiffness over height.

V. MODELLING AND ANALYSIS

A. Geometry of the building & Seismic Data to be considered in Model

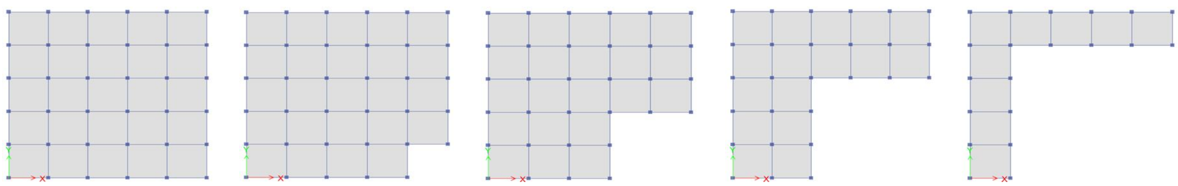
TABLE 1 BASIC DESIGN DATA OF MODEL

Building Dimension (m)	25 X 25	25 X 25	25 X 25
Number of storey	G+5	G+10	G+15
Building height (m)	18	33	48
Storey height (m)	3	3	3
Slab thickness (mm)	150		
Dead load (kN/m^2)	Self-weight + floor finish = 4.75		
Floor finish on Roof including water proofing (kN/m^2)	2.5		
Live Load (kN/m^2)	3		
Live load on roof (kN/m^2)	1.5		
Wall load (230 thk) (kN/m)	11		
Parapet Wall (kN/m)	3		
Seismic Zone	III		
Zone Factor	0.16		
Importance Factor	1.2		
Response Reduction Factor	5		
Soil Type	Medium (II)		
Concrete Grade	M25		
Steel Grade (including stirrups)	FE 500 & FE 415 (stirrups)		
Damping	5%		
Beam Sizes (mm)			
For 18m building	300 X 600		
For 33m building	450 X 600		
For 48m Building	450 X 600		
Column Sizes (mm)			
For 18m building	500 X 500		
For 33m building	650 X 650		
For 48m Building	750 X 750		

(Sizes of beams and columns decided by restrict maximum percentage of steel in column is 3% and in Beams 1.5 %)

Due to gradual reduction in building plan, square to L- shape diaphragm effects considered as semi rigid. Seismic analysis and design of reinforced concrete structures are performed based on linear response, however it is accepted that under severe earthquakes inelastic response and cracking is accepted. Therefore, element properties of beams and columns should be reduced $0.35I_b$ and $0.7I_c$ as per IS Code 1893 (part 1):2016. Column and Beam sizes fixed without stiffness modifiers and apply that same sizes to with stiffness modifiers. In ETABS while applying Earthquake load basic data assumed which showed in Table 1. Time period calculate as per clause 7.6.2 IS 1893(part1):2016. Here in mass source data Dead load consider full but live load consider 0.25% as per table 10, IS 1893(part1):2016. P-delta effects also considered in models. Hinge supports considered for all type of models.

B. *Change the Parameters*



0.0 0.2 0.4 0.6 0.8

FIGURE 1 ASPECT RATIO (A/L)

VI. RESULTS AND DISCUSION

A. *Models of 18 m height*

TABLE 2 VALUE OF DISPLACEMENTS IN MM

Total Height of Building is 18 m					
Aspect Ratio	0.0	0.2	0.4	0.6	0.8
Storey hight					
0	0	0	0	0	0
3	3.012	3.205	3.913	5.577	10.02
6	4.927	5.269	6.468	9.305	17.08
9	6.307	6.748	8.298	11.99	22.26
12	7.278	7.789	9.586	13.88	25.95
15	7.887	8.441	10.4	15.08	28.36
18	8.198	8.775	10.82	15.72	29.73

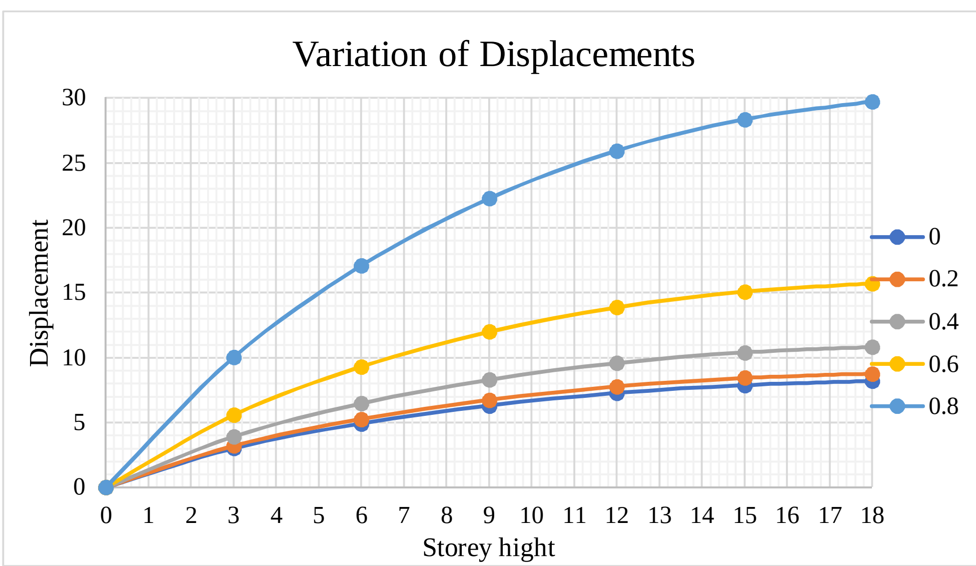


FIGURE 2 GRAPH OF DISPLACEMENTS

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VIII Aug 2021- Available at www.ijraset.com

TABLE 3 VALUES OF DRIFT IN MM

Total Height of Building is 18 m					
Aspect Ratio	0.0	0.2	0.4	0.6	0.8
Storey hight					
0	c	0	0	0	0
3	1.004	1.068	1.304	1.859	3.012
6	0.6431	0.6903	0.8536	1.244	4.927
9	0.46	0.4929	0.6098	0.8936	6.307
12	0.3237	0.3468	0.4295	0.6313	7.278
15	0.2029	0.2175	0.2702	0.4003	7.887
18	0.1035	0.1112	0.1398	0.2128	8.198

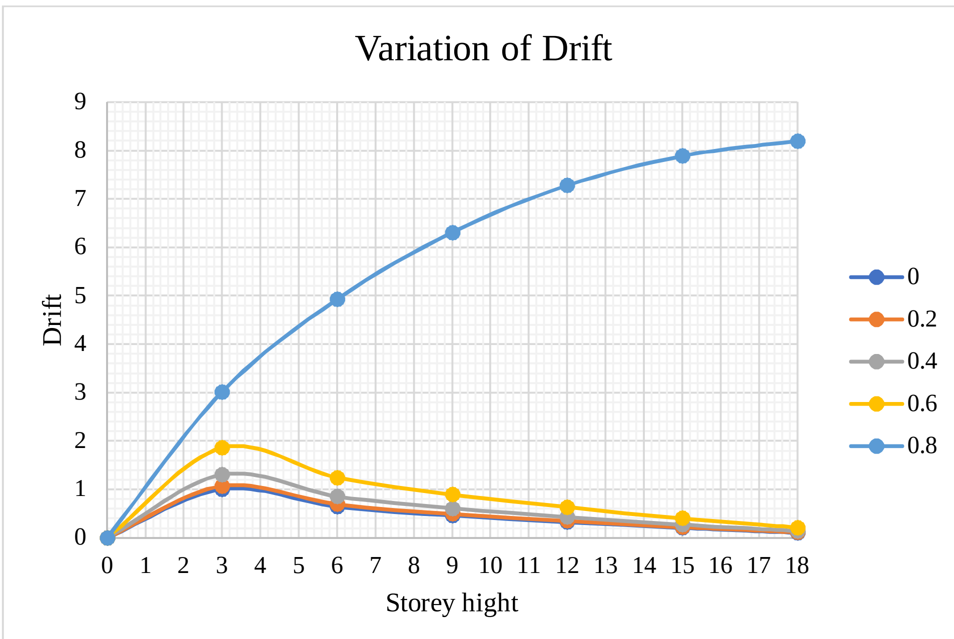


FIGURE 3 GRAPH OF DRIFT

TABLE 4 VALUES OF BASE SHEAR IN KN

Total Height of Building is 18 m					
Aspect Ratio	0.0	0.2	0.4	0.6	0.8
Storey hight					
0	0	0	0	0	0
3	229.4	221.2	196.9	156.5	99.9
6	227.7	219.5	195.4	155.2	99.1
9	216.1	208.4	185.4	147.3	93.9
12	190.2	183.3	163.1	129.5	82.4
15	144.1	138.8	123.4	97.8	62
18	72.1	69.2	61.3	48.2	30

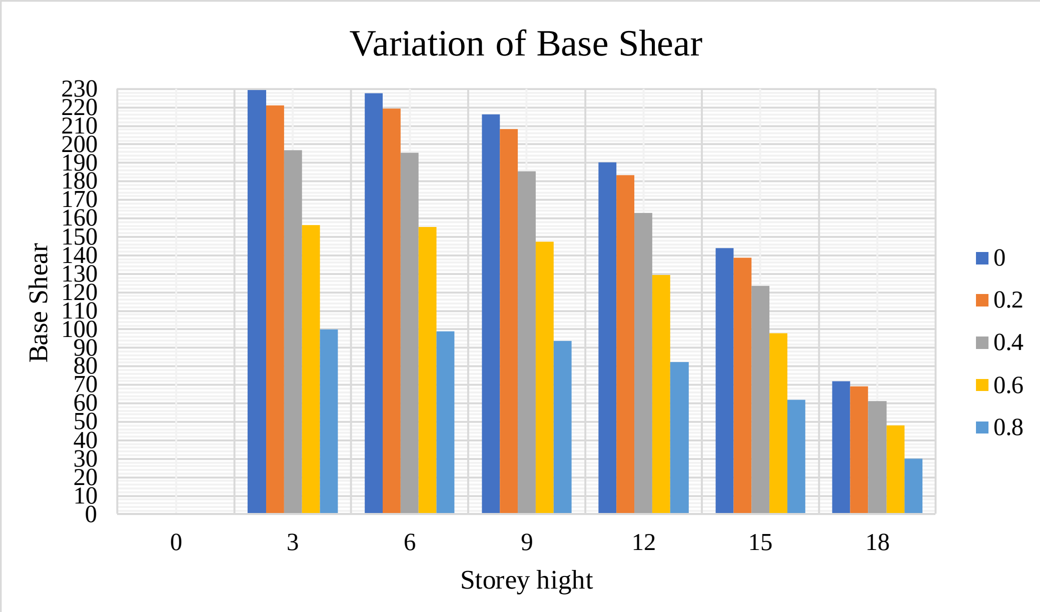


FIGURE 4 VARIATION OF BASE SHEAR

TABLE 5 CG AND CR FOR 18 M HEIGHT OF BUILDING

Aspect Ratio	Centre of mass and Centre of resistance of building (m)				Maximum Eccentricity (m)
	XCM	XCR	YCM	YCR	
0.0	12.50	12.50	12.50	12.50	0.00
0.2	12.1	12.1	12.9	12.9	0.00
0.4	11.1	11	13.9	14	0.10
0.6	9.7	9.5	15.3	15.5	0.20
0.8	8.1	7.2	16.8	17.80	0.90

B. Models of 33 m Height

TABLE 6 VALUE OF DISPLACEMENTS IN MM

Total Height of Building is 33 m					
Aspect Ratio	0.0	0.2	0.4	0.6	0.8
Storey hight					
0	0	0	0	0	0
3	4.372	4.654	5.683	8.133	6.308
6	7.4	7.911	9.711	14.02	11.11
9	9.855	10.54	12.96	18.78	15.23
12	11.95	12.78	15.74	22.86	18.8
15	13.76	14.72	18.13	26.4	21.92
18	15.3	16.37	20.17	29.41	24.62
21	16.57	17.73	21.86	31.91	26.92
24	17.58	18.8	23.2	33.9	28.81
27	18.32	19.59	24.18	35.39	30.3
30	18.8	20.11	24.84	36.39	31.43
33	19.08	20.41	25.22	37.01	32.27

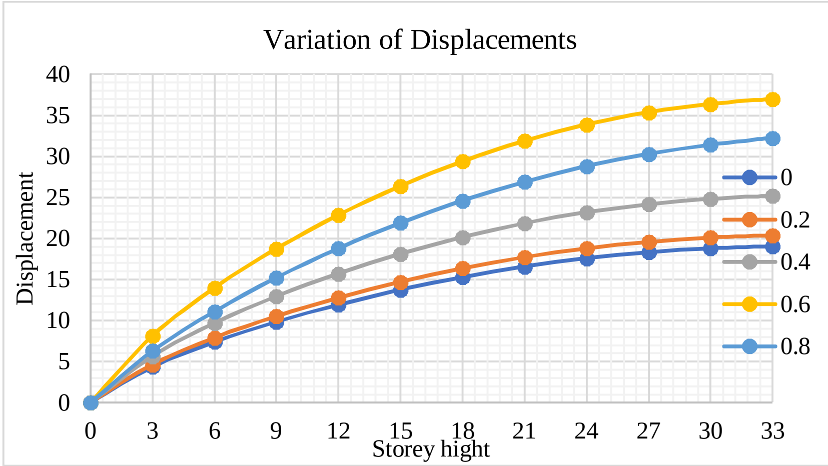


FIGURE 5 GRAPH OF DISPLACEMENTS

TABLE 7 VALUES OF DRIFT IN MM

Total Height of Building is 33 m					
Aspect Ratio	0.0	0.2	0.4	0.6	0.8
Storey hight					
0	0	0	0	0	0
3	1.457	1.551	1.894	2.711	2.103
6	1.016	1.089	1.345	1.964	1.602
9	0.8182	0.8759	1.083	1.589	1.372
12	0.6995	0.7487	0.9259	1.361	1.19
15	0.6034	0.6458	0.7991	1.177	1.04
18	0.513	0.549	0.68	1.004	0.9015
21	0.4237	0.4534	0.5625	0.8339	0.7655
24	0.3346	0.358	0.4451	0.6638	0.6304
27	0.2461	0.2633	0.3287	0.4954	0.4981
30	0.1617	0.1729	0.2176	0.3353	0.3755
33	0.09237	0.09884	0.127	0.2055	0.2804

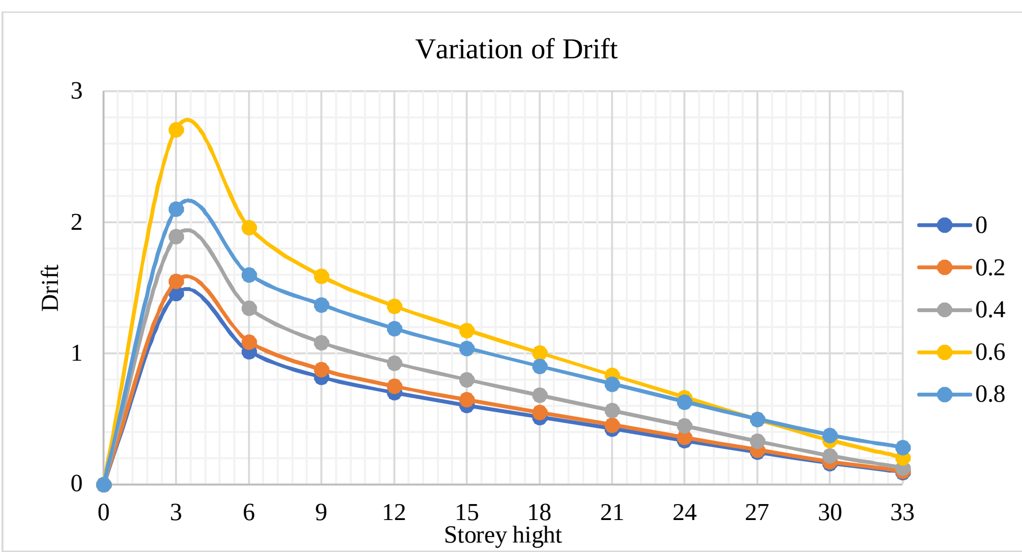


FIGURE 6 GRAPH OF DRIFT

TABLE 8 VALUES OF BASE SHEAR IN KN

Total Height of Building is 33 m					
Aspect Ratio	0.0	0.2	0.4	0.6	0.8
Storey hight					
0	0	0	0	0	0
3	452	436.1	388.7	309.8	199.3
6	451.4	435.5	388.2	309.3	199
9	447.5	431.8	384.9	306.7	197.3
12	438.9	423.5	377.4	300.7	193.5
15	423.5	408.6	364.2	290.2	186.6
18	399.5	385.4	343.5	273.6	175.9
21	364.9	352	313.7	249.8	160.5
24	317.8	306.6	273.1	217.4	139.6
27	256.4	247.2	220.1	175.1	112.2
30	178.5	172	153	121.5	77.5
33	82.5	79.3	70.2	55.4	34.7

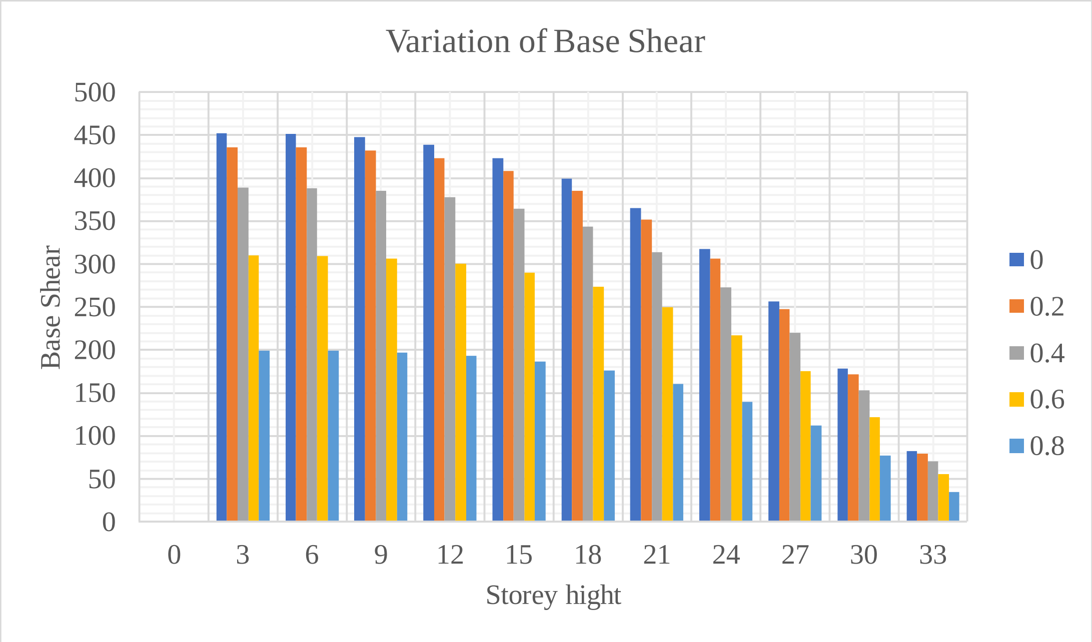


FIGURE 7 VARIATION OF BASE SHEAR

TABLE 9 CG AND CR FOR 33 M HEIGHT OF BUILDING

Aspect Ratio	Centre of mass and Centre of resistance of building (m)				Maximum Eccentricity (m)
	XCM	XCR	YCM	YCR	
0.0	12.5	12.5	12.5	12.5	0.00
0.2	12.1	12.1	12.9	12.9	0.00
0.4	11.1	11	13.9	14	0.10
0.6	9.7	9.2	15.3	15.8	0.50
0.8	8.1	6.4	16.9	18.6	1.70

C. Models of 48 m height

TABLE 10 VALUE OF DISPLACEMENTS IN MM

Total Height of Building is 48 m					
Aspect Ratio	0.0	0.2	0.4	0.6	0.8
Storey hight					
0	0	0	0	0	0
3	5.546	5.885	7.206	10.382	2.272
6	9.693	10.32	12.697	18.43	4.244
9	13.21	14.07	17.338	25.266	6.254
12	16.35	17.43	21.489	31.396	8.212
15	19.22	20.49	25.279	37.005	10.15
18	21.84	23.29	28.751	42.157	12.08
21	24.23	25.84	31.916	46.869	14.01
24	26.39	28.14	34.776	51.144	15.91
27	28.31	30.19	37.328	54.975	17.77
30	29.99	31.99	39.569	58.357	19.57
33	31.43	33.53	41.494	61.282	21.28
36	32.63	34.81	43.102	63.749	22.9
39	33.59	35.83	44.396	65.76	24.4
42	34.32	36.61	45.381	67.326	25.78
45	34.83	37.15	46.081	68.479	27.04
48	35.17	37.51	46.553	69.309	28.22

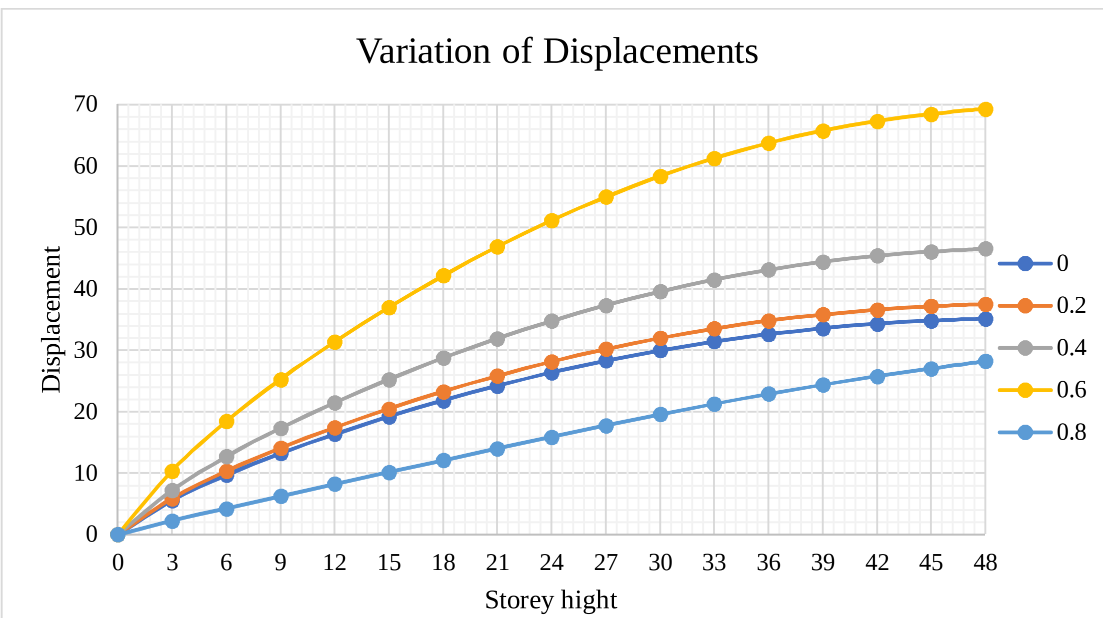


FIGURE 8 GRAPH OF DISPLACEMENTS

TABLE 11 VALUES OF DRIFT IN MM

Total Height of Building is 48 m					
Aspect Ratio	0.0	0.2	0.4	0.6	0.8
Storey hight					
0	0	0	0	0	0
3	1.849	1.962	2.402	3.461	0.7572
6	1.391	1.485	1.835	2.687	0.6576
9	1.172	1.251	1.547	2.279	0.6699
12	1.048	1.118	1.384	2.043	0.6527
15	0.9556	1.02	1.263	1.87	0.6465
18	0.8744	0.9333	1.157	1.717	0.6444
21	0.7962	0.85	1.055	1.571	0.6411
24	0.7184	0.7671	0.953	1.425	0.6335
27	0.64	0.6834	0.851	1.277	0.62
30	0.5607	0.5987	0.747	1.127	0.5997
33	0.4807	0.5132	0.642	0.975	0.5724
36	0.4004	0.4274	0.536	0.822	0.5387
39	0.3205	0.3421	0.431	0.67	0.4999
42	0.2424	0.2587	0.329	0.522	0.4588
45	0.1697	0.1809	0.233	0.384	0.4208
48	0.1118	0.1191	0.158	0.277	0.3944

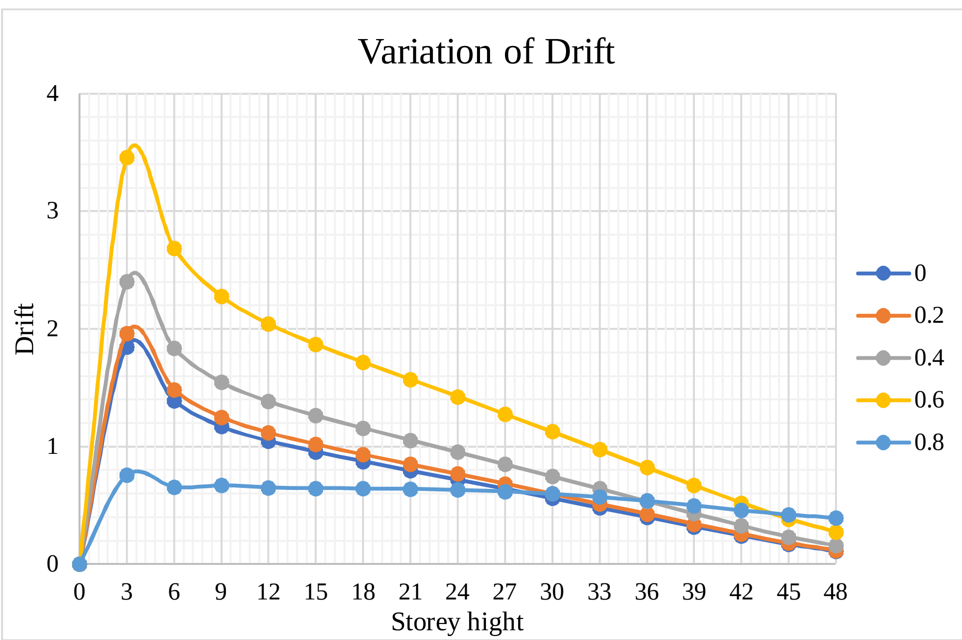


FIGURE 9 GRAPH OF DRIFT

TABLE 12 VALUES OF BASE SHEAR IN KN

Total Height of Building is 48 m					
Aspect Ratio	0.0	0.2	0.4	0.6	0.8
Storey hight					
0	0	0	0	0	0
3	494	470.1	417.687	327.503	216.7
6	493.8	469.9	417.485	327.342	216.6
9	492.4	468.6	416.311	326.421	216
12	489.3	465.6	413.671	324.349	214.6
15	483.7	460.3	408.976	320.666	212.2
18	475	452	401.641	314.912	208.4
21	462.5	440.2	391.079	306.625	202.9
24	445.5	424	376.702	295.346	195.4
27	423.2	402.9	357.924	280.615	185.7
30	395	376.1	334.158	261.97	173.3
33	360.3	343.1	304.818	238.952	158
36	318.2	303.2	269.316	211.1	139.6
39	268.1	255.6	227.066	177.954	117.6
42	209.3	199.8	177.48	139.054	91.8
45	141.1	135.1	119.973	93.938	61.9
48	62.9	60.8	53.957	42.147	27.6

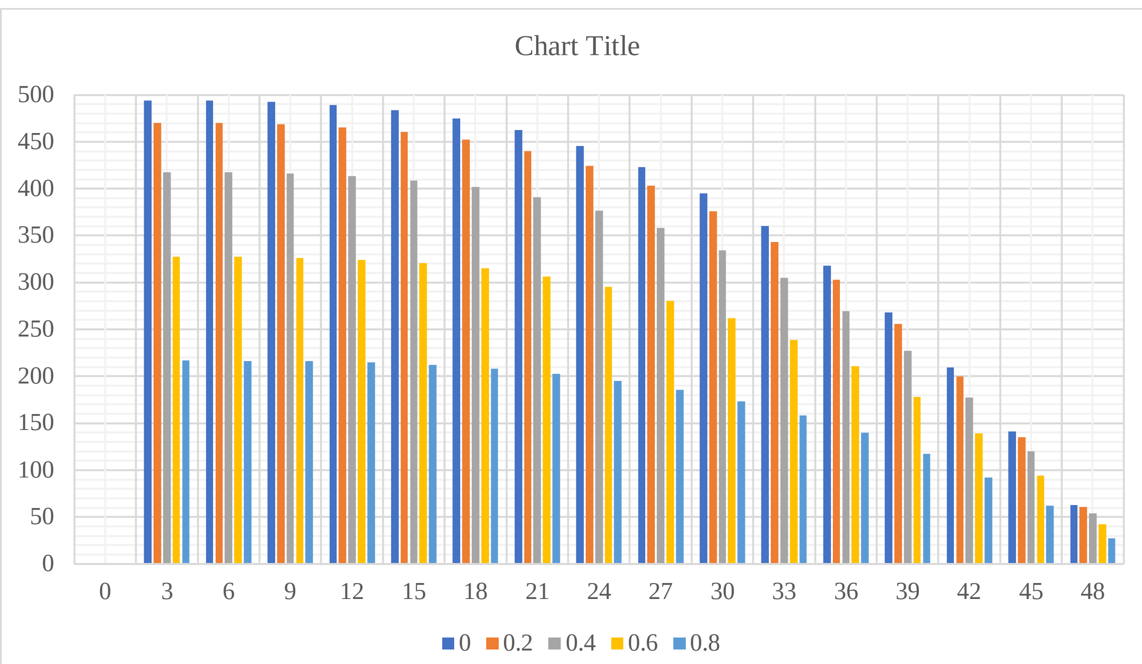


FIGURE 10 VARIATION OF BASE SHEAR

TABLE 13 CG AND CR FOR 48 M HEIGHT OF BUILDING

Aspect Ratio	Centre of mass and Centre of resistance of building (m)				Maximum Eccentricity (m)
	XCM	XCR	YCM	YCR	
0.0	12.5	12.5	12.5	12.5	0.00
0.2	12.1	12.1	12.9	12.9	0.0
0.4	11.1	10.9	13.9	14.1	0.2
0.6	9.7	8.9	15.3	16.1	0.8
0.8	8.1	5.9	16.9	19.1	2.2

VII. CONCLUSIONS

The evaluation of L-shaped buildings is performed through comparison with square reference model(RM). The influence of the configuration irregularity effects on the seismic behaviour of building structures is investigated.

Five types of buildings are considered, one symmetrical reference model and then decreasing frames on both the sides simultaneously in form of L-shaped asymmetrical building, where the seismic performance of re-entrant corner buildings as irregular plan configuration are compared to that of reference building model (RM). In this study, assimilation of seismic behaviour for irregular buildings with re-entrant corner by using Response Spectrum (RS) analysis techniques, which are adopted in the Indian code for earthquake resistant design of structures, IS 1893 (Part1): 2016.

As per above graphs, it has been concluded that corner columns and re-entrant columns are more critical in L-shaped building. The lateral shear force demands in vertical resisting elements located on the outer periphery of the structure are significantly increased in comparison with the corresponding values for a regular (RM) building. It is concluded that for particular ranges of the key parameters defining the structural system, torsion in L-shaped building induces a significant amplification of earthquake forces which should be accounted for in their design.

The analysis demonstrates that plan irregularity has a significant effect on the seismic response of buildings compared to the typical assumption in which floor-plan irregularity would be neglected in conventional design national codes. When the floor is not stiff enough as the case of L-shaped Floor, the dynamic response of the structure will be influenced significantly by the distribution of the lateral forces at its level because of the lateral differential deformation that happened plus torsion action which may cause local damage to the corner, edge and re-entrant corner columns in building.

VIII. SCOPE OF WORK

A. For understand the behaviour of Lateral Forces (Earthquake force and wind force) total three different heights of models prepared in ETABS and in each height there are five different aspect ratios as per re-entrant corner (A/L) clause given. Aspect Ratios(A/L) are 0.0, 0.2, 0.4, 0.6 & 0.8.

B. Aspect ratio(A/L) 0.0 is a reference model and other models results compared with this model only.

C. In this project compare design moment and design shear force with increasing eccentricity in building.

BIBLIOGRAPHY

[1] Amin Alavi, Prof. P.Srinivasa Rao. “Effects of Plan Irregular RC Buildings in High Seismic Zones, .” Australian Journal of Basic and Applied Science (2013).
[2] C., Shreyasvi. “Seismic Vulnerability of RC frames with Re-entrant Corners.” (2014-2015).
[3] “Criteria for Earthquake Resistant Design of Structures.” IS 1893 (Part 1) -2016. New Delhi: Bureau Of Indian Standards, 2016. Document.
[4] Divyashree M, Gopi Siddappa. “Seismic behaviour of RC Buildings with Re-entrant Corners and Strengthening .” IOSR journal of Mechanical and Civil Engineering (2014): 63-69.
[5] Momen M. M. Ahmed, Shehata E. Abdel Raheem, Mohamed M. Ahmed and Aly G. A. Abdel-Shafy. “IRREGULARITY EFFECTS ON THE SEISMIC PERFORMANCE OF L-SHAPED MULTI-STORY BUILDINGS.” Journal of Engineering Sciences, Assiut University. (2016). Document.
[6] Vanaza, Prajapati P.B. and Prof. M. G. (2014).