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Seismic Analysis of Multi-Storeyed Building (G+15) With Regular and Irregular Frame Structure

KEYWORDS: Liner static, Response spectrum analysis, Torsion, base shear, storey drift and displacement.

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ABSTRACT *In urban areas, increase in population and scarcity of land, the horizontal development gets restricted that's why most of the owners, building contractors, engineers are adopting vertical development of buildings for the construction. Natural hazard like earthquake affects the stability of such structures. Therefore, it is need of time to analyses & designs such hazard resisting structures so as to save human life and avoid property damage. The behavior of a building during earthquakes depends critically on its overall shape, size and geometry. In this Study, a multi- storey reinforced concrete build¬ing has been modelled and performed by using software ETABS program with different plan shapes regular (Rect¬angular shaped) and irregular (T –shaped) and plane dimension (16X15) m with 15 storeys resting on plan ground. The models have been conducted and analyzed by using equivalent linear static method and response spec¬trum method for comparing and investigating the changes in structural behavior and the irregularity effect in plan.*

Introduction

An important feature in building configuration is its regularity and symmetry in the plane. One of the major contributors to structural damage during strong earthquake is the discontinuities and irregularities in the load path or load transfer. The lateral load such as earthquake is to be classified as live horizontal force acting on the structure depending on the building's geographic location, height, shape and structural materials. Earthquake codes are periodically revised and updated depending on the improvements in the representation of ground motions, soils and structures .In this present work two types of structures considered are reinforced concrete regular and irregular multistory buildings. Here 15 storey buildings are analyzed by above methods by using IS 1893-2002 (part1). There are many earth quake resistant factors which can be considered while designing a structure. Some of the factors are Strong column, weak beam, Shear wall, Base isolation. The behaviors of each of these factors are unique. The performance of a structure for these factors can be studied analytically and experimentally.

Behavior of a simple structure for these factors will give a good vision about the importance of these factors. An ideal multistory building designed to resist lateral loads due to earthquake would consist of only symmetric distribution of mass and stiffness in plan at every storey and a uniform distribution along height of the building[2]. Asymmetric building structures are almost unavoidable in modern construction due to various types of functional and architectural requirements. Torsion in buildings during earthquake shaking may be caused from a variety of reasons, the most common of which are non-symmetric distributions of mass and stiffness [6]. In buildings mass asymmetry is usually present at different floor level This mass asymmetry may be due to water tank provided at top of building, any heavy weight machine placed at any level, etc. Due to this mass asymmetry in building center of mass is shifted from center of stiffness causing eccentricity. As this eccentricity increases, torsion in building also increases[3].

Case Study Details:

Dimension of beam	500mmx700mm
Dimension of column	500mmx1200mm
Thickness of Slab	150mm
Thickness of outside wall	230mm
Thickness of inner wall	150mm
Height of	3.5m
No of storey	G+15
Live Load	3kN/m2
Floor Finish	1kN/m2
Grade of reinforcing steel	Fe415
Grade of concrete	M 25
Density of concrete	25 kN/m3
Density of infill	20kN/m3
Seismic Zone	II
Importance factor	1
Zone factor	0.16
Damping ratio	5%

1. **Base shear:** It is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure. It can be seen from results given in table that base shear depends upon seismic zone, terrain nature, base condition, and building height and shape. When a regular rectangular building is

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compared with T shaped building, the base shear in the T shaped building is seems to be lesser than that of rectangular building in the lower storeys and gets reduces as the building height is increased. Plot of building height vs base shear for zone II are shown in figure.

Table no-1

	Base Shear in X Direction		Base Shear in Y Direction	
Storey level	T Shape Building	Rect Shape Building	T Shape Building	Rect Shape Building
15	163.27	157.6	141	140.34
14	371.44	362.69	322.79	319.93
13	528.58	521.35	460.59	455.37
12	640.95	638.31	560.8	553.39
11	722.17	725.74	637.71	627.91
10	782.31	792.62	700.2	687.55
9	828.53	845.17	751.76	736.12
8	871.24	892.66	798.17	780
7	920.84	944.66	846.16	826.3
6	980.23	1004.17	897.14	876.54
5	1046.95	1069.21	949.99	929.47
4	1118.3	1137.6	1006.04	985.85
3	1186.8	1202.99	1062.68	1042.29
2	1236.15	1250.44	1105.99	1084.75
1	1253	1266.9	1121.4	1099.59

Chart no-1(a)

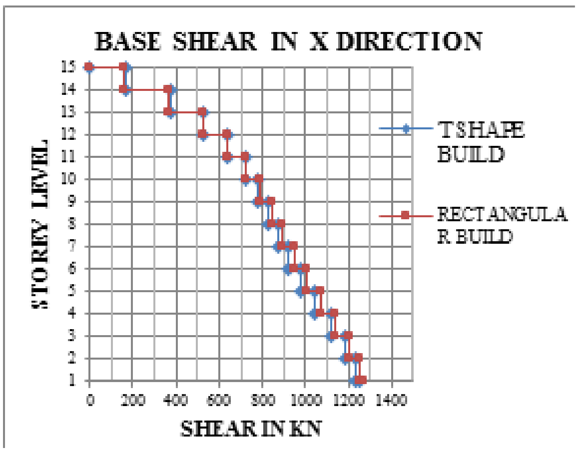
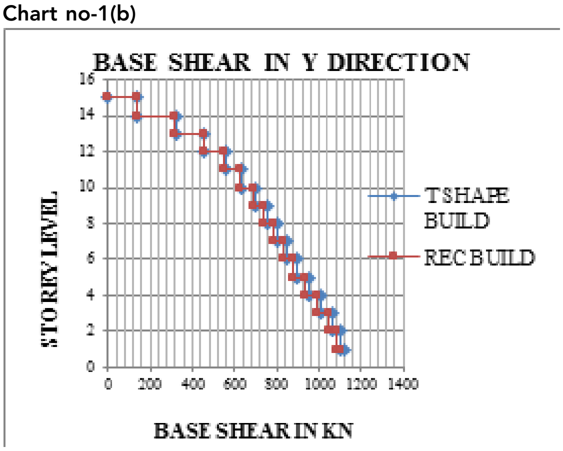


Chart no-1(b)



2 .Storey displacement: It can be seen from the results that the displacement increases with increase in floor level of building. It can also be seen that the storey displacement is more in T shaped building as compare to rectangular shaped building.

Table no-2

	Storey Displacement in X Direction		Storey Displacement in Y Direction	
Storey level	T Shape Building	Rect Shape Building	T Shape Building	Rect Shape Building
15	0.016767	0.013446	0.000135	0.000144
14	0.016109	0.013021	0.000188	0.000195
13	0.015339	0.012485	0.000241	0.000246
12	0.014449	0.011838	0.000283	0.000287
11	0.01345	0.011092	0.000316	0.000318
10	0.01236	0.010263	0.000341	0.000342
9	0.011193	0.009364	0.00036	0.000359
8	0.009961	0.008401	0.000376	0.000374
7	0.008669	0.00738	0.000391	0.000387
6	0.007321	0.006302	0.000406	0.0004
5	0.005924	0.005168	0.000419	0.000412
4	0.004488	0.003984	0.000431	0.000422
3	0.00304	0.002762	0.000432	0.000419
2	0.001645	0.001545	0.000386	0.000368
1	0.000477	0.00047	0.000198	0.000185

Chart No-2(a)

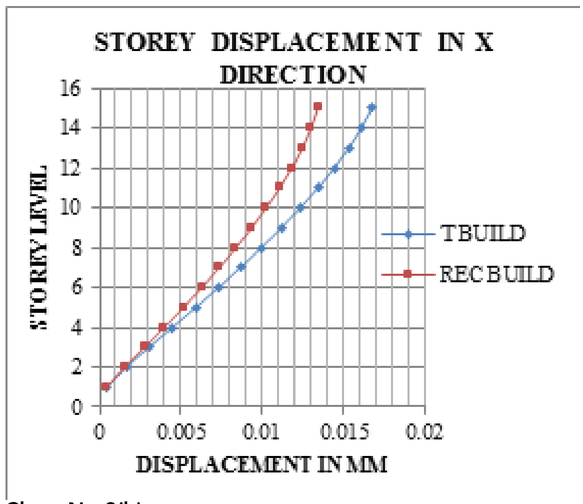
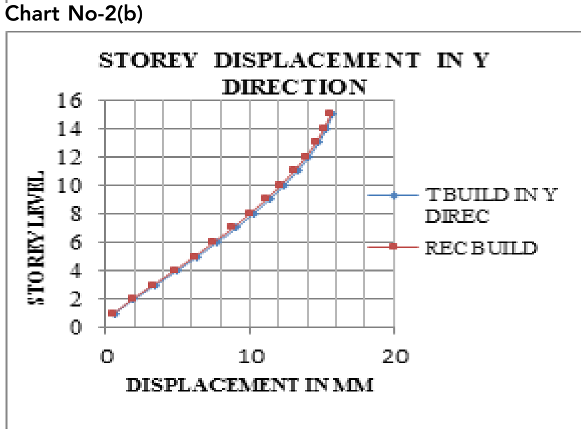


Chart No-2(b)



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3.Inter-storey Drift: Inter storey drift is the difference between the roof and floor displacement of any given storey as building sways during the earthquake, normalized by the storey height. The greater the drift, the greater likelihood of damage .

Table no-3

	Storey Drift in X Direction		Storey Drift in Y Direction	
Storey level	T Shape Building	Rect Shape Building	T Shape Building	Rect Shape Building
15	0.000205	0.000135	0.000135	0.000144
14	0.000248	0.000178	0.000188	0.000195

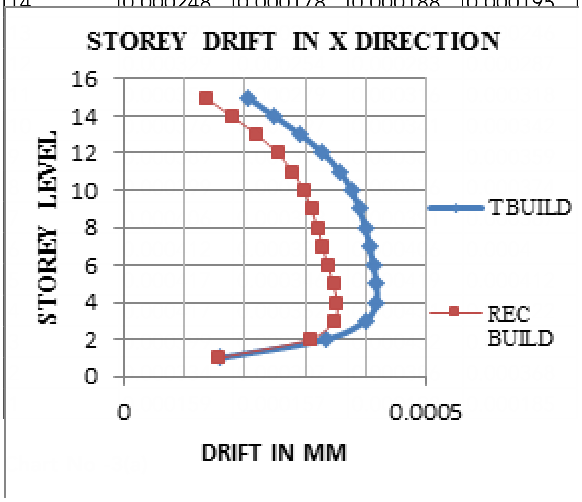
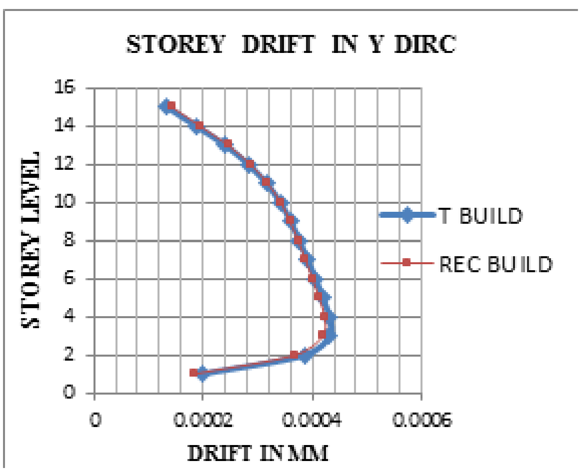


Chart No -3(b)

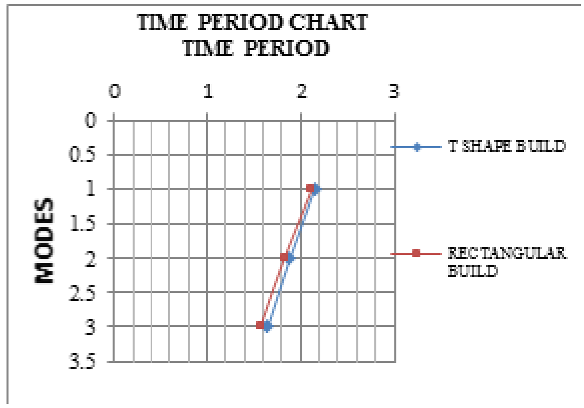


4. Time period: It can be seen from the results that the time period depends upon the terrain nature, building height and does not depend upon seismic zone. I t can also be seen that time period for normal ground is more than sloping for their respective mode. This increase in time period decreases lateral inertia force developed in the building due to earthquake significantly.

Table No -4

No of Modes	Time Period (Sec)	
	T Shape Building	Rect Shape Building
1	2.148	2.121
2	1.886	1.824
3	1.651	1.569

Chart No -4

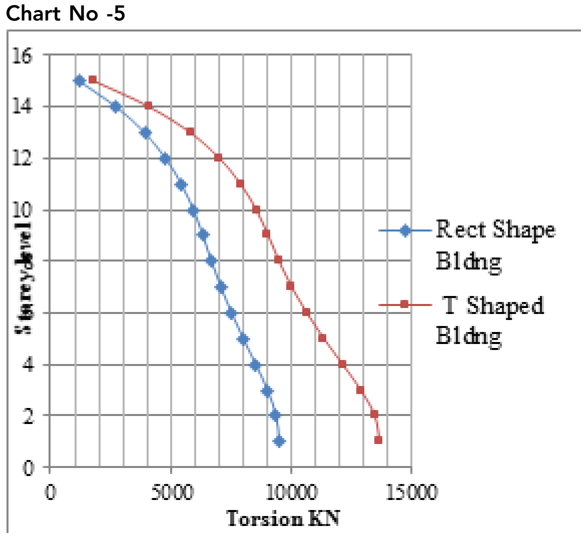


5. Torsion: Torsion in buildings during earthquake shaking may be caused from a variety of reasons, the most common of which are non-symmetric distributions of mass and stiffness. The lateral-torsional coupling due to eccentricity between centre of mass and centre of rigidity in asymmetric building structures generates torsional vibration even under purely translational ground shaking. During seismic shaking of the structural systems, inertia force acts through the centre of mass while the resistive force acts through the centre of rigidity.

Table No -5

Building Torsion					
Storey level	T Shape Building	Rect Shape Building	Storey level	T Shape Building	Rect Shape Building
15	1806.901	1181.956	7	10025.33	7084.968
14	4104.569	2720.152	6	10657.4	7531.263
13	5818.622	3910.093	5	11368.27	8019.038
12	7027.752	4787.375	4	12139.73	8532.024
11	7901.397	5443.085	3	12902.72	9022.441
10	8552.852	5944.601	2	13468.75	9378.269
9	9049.17	6338.764	1	13666.6	9501.781
8	9500.101	6694.936			

Chart No -5



CONCLUSIONS :

1. The plan configurations of structure has significant impact on the seismic response of structure in terms of displacement, story drift, story shear
2. Large displacement was observed in the T shape

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building. It indicates that building with severe irregularity shows maximum displacement and storey drift.

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