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Siesmic Analysis of Multi-Storeyed Building (G+10) With Plan Irregularity

Engineering

KEYWORDS : Symmetric building, Asymmetric building, Static and Dynamic analysis, Torsion, Response spectrum, Strong column, Shear wall.

Prof Tanveer Asif Zerdi — Director, Professor & H.O.D Civil Engineering Dept, K.C.T.Engg College, C/o Dr Meenaz hospital, H No 5-408/40/1&2, Near KBNI Medical sciences, Madeena colony, Kalaburagi.

Mohammed Shahid Ali Aejaz — U.G Student Dept of Civil Engineering, V.T.U University, K.C.T.E.C, Kalaburagi ,Karnataka.

Mudassar Jamal — U.G Student Dept of Civil Engineering, V.T.U University, K.C.T.E.C, Kalaburagi ,Karnataka.

Mohammad Tayyab Ali — U.G Student Dept of Civil Engineering, V.T.U University, K.C.T.E.C, Kalaburagi, Karnataka.

ABSTRACT

Earthquake is a major concern in high seismic areas. 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. The structure which lies in seismic zones is to be specially designed. In this paper an analytical study is made to find response of different regular and irregular structures located in severe zone. Analysis has been made by taking 10 storey building by static and dynamic methods using ETABS. The factors which influence the earthquake resistance in a structure is shear wall, strong column, base isolation and use of dampers. The effects of torsion on buildings are investigated for both symmetric and asymmetric building. Study also shows that there is increase in shear, in columns and the columns at outer frame need some special attention for both the structure, especially for asymmetric building .The results showed that it was important to select a suitable criteria for asymmetric building rather than symmetric building and displacement was also found to be more for asymmetric type of building.

Introduction: One of Earth's greatest natural calamities are earthquakes. This natural calamity has bought untold misery and hardship to mankind. The Indian subcontinent has been a victim to some of the most severe earthquakes in the world. The main purpose of civil engineer is that structure should be safe, durable, serviceable with the development of technology in the computing field and also economical with respect to initial cost and maintenance cost. A civil engineer can dare to tackle much more large and complex structures subjected to various types of loading conditions. Earlier the loads acting on the structures are considered as static or pseudo static. Now a day due to the advancement in technology many software are available to design the structure with the easier way .Earthquake disaster had always been one of the great natural calamities upon the mankind since time immemorial. This study is based on the concept of the static analysis and dynamic analysis method.

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 [7]. 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]. 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	350mmx500mm
Dimension of column	350mmx900mm
Thickness of Slab	150mm
Thickness of outside wall	230mm
Thickness of inner wall	150mm
Height of each storey	3.5m
No of storey	G+20
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 compared with L shaped building, the base shear in the rectangular shaped building is much more than that of l shaped 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	+ Shape Building	Rect Shape Building	+ Shape Building	Rect Shape Building
10	164.64	207.78	145.93	186.04
9	332.4	429.56	286.67	371.14
8	445.33	581.33	380.58	494.66
7	519.22	684.21	446.01	581.11
6	573.28	760.33	497.39	648.86
5	624.61	830.39	544.43	710.4
4	682.92	907.91	593.22	774.31
3	748.43	992.29	645.66	842.95
2	806.49	1067.04	695.1	907.23
1	834.93	1105.41	723.12	943.43

Chart No – 1(a)

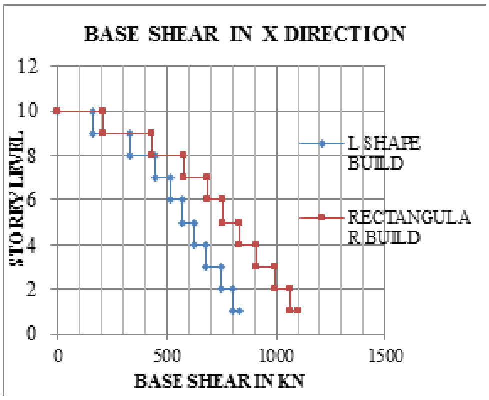
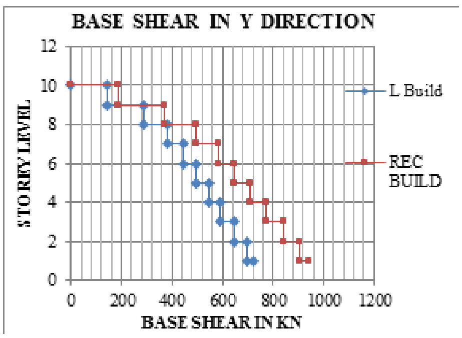


Chart No – 1(b)



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 L shaped Building as compare to rectangular Building.

Table No -2

	Storey Displacement in X Direction		Storey Displacement in Y Direction	
Storey level	L Shape Building	Rect Shape Building	L Shape Building	Rect Shape Building
10	21.21395	18.1559	19.30931	20.69367
9	20.26865	17.49321	18.65385	19.99107
8	18.9264	16.45308	17.59484	18.85881
7	17.17092	15.03285	16.12269	17.27957
6	15.04788	13.27818	14.28278	15.29885
5	12.59908	11.22466	12.11125	12.95582
4	9.856718	8.892872	9.630812	10.27792
3	6.875833	6.313039	6.871195	7.30376
2	3.813032	3.590316	3.933677	4.154523
1	1.114335	1.088359	1.200189	1.255199

Chart No – 2(a)

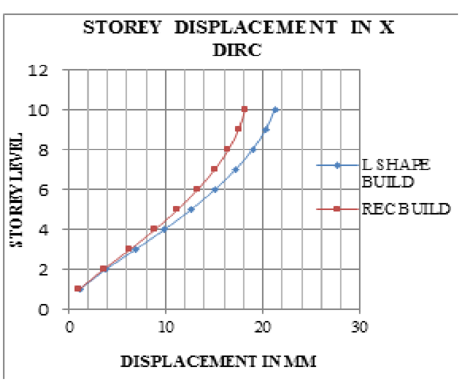
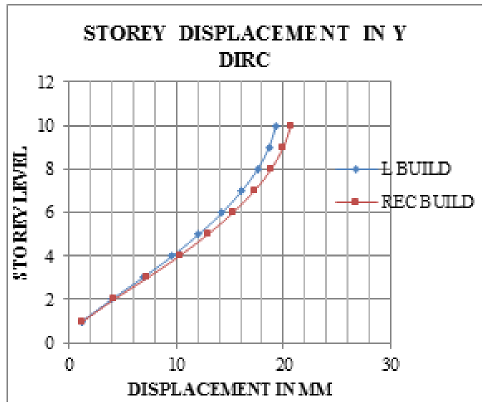


Chart No – 2(b)



3. Inter-storey Drift: Drift is the lateral displacement of a storey. Storey drift is the drift of one level of a multistory building relative to the level below. 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. As a result shows the storey drift in sloping ground is less than that of normal ground.

Table No -2

	Storey Drift in X Direction		Storey Drift in Y Direction	
Storey level	L Shape Building	Rect Shape Building	L Shape Building	Rect Shape Building
10	0.000324	0.000242	0.000254	0.000271
9	0.000464	0.000377	0.000397	0.000422
8	0.000593	0.000496	0.000522	0.000557
7	0.00069	0.000584	0.000617	0.00066
6	0.000762	0.000649	0.00069	0.000742
5	0.000821	0.000705	0.000754	0.000811
4	0.000868	0.000755	0.000811	0.000873
3	0.00088	0.000784	0.000847	0.000908
2	0.000772	0.000716	0.000782	0.000829
1	0.000371	0.000363	0.0004	0.000418

Chart No – 3(a)

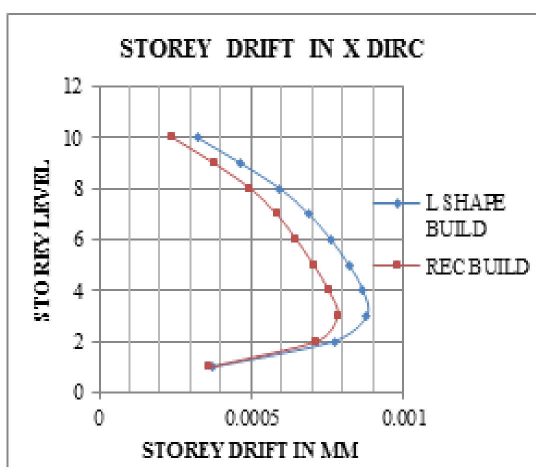


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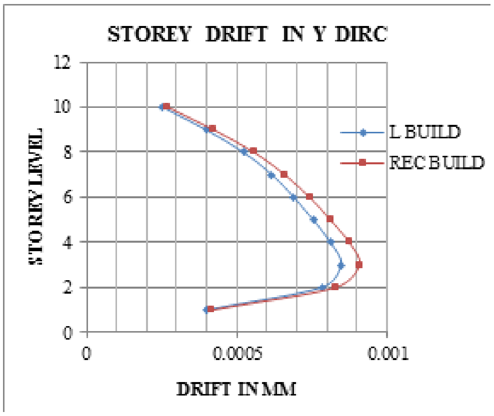
Chart No – 3(b)

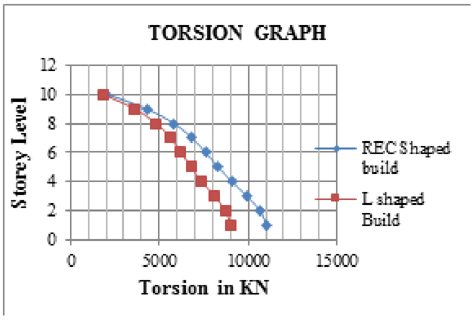


4. Torsion: Torsion in buildings during earthquake shaking may be caused from a variety of reasons, the most common of which are non-symmetric distributions of mass and stiffness. The lateral-torsional coupling due to eccentricity between centre of mass (CM) and centre of rigidity (CR) in asymmetric 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 -4

Building Torsion		
Storey level	L Shape Building	Rect Shape Building
10	1832.334	2077.757
9	3618.298	4295.638
8	4830.492	5813.338
7	5629.178	6842.057
6	6219.474	7603.297
5	6774.628	8303.869
4	7395.332	9079.074
3	8094.771	9922.92
2	8724.31	10670.41
1	9048.48	11054.1

Chart No – 4

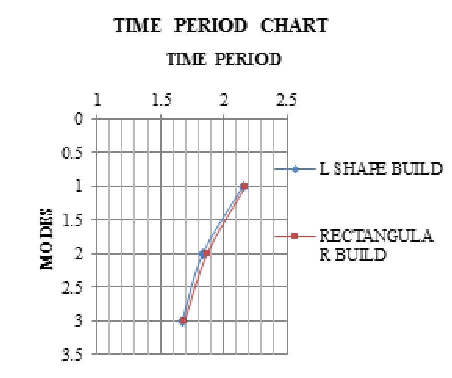


5. Time period: It can be seen from the results that the time period depends upon the terrain nature, building height and does not depend upon seismic zone. I t can also be seen that time period for normal ground is more than sloping for their respective mode. This increase in time period decreases lateral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

Table No -5

No of Modes	Time Period (Sec)	
	L Shape Building	Rect Shape Building
1	2.154	2.174
2	1.835	1.87
3	1.673	1.692

Chart No –5



CONCLUSIONS :

- The plan configurations of structure has significant impact on the seismic response of structure in terms of displacement, story drift, story shear
- Large displacement was observed in the L shape building. It indicates that building with severe irregularity shows maximum displacement and storey drift.
- Base shear at first hinge is less and displacement at first hinge is more for asymmetric bare frame model and vice versa for other models.

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