

Seismic Analysis of Irregular L-Shape Building in Various Zones

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ABSTRACT: Irregular structures pose particular design challenges for structural engineers, especially if situated in seismically active regions. It depends on mass, stiffness of structure. From the previous earthquake data it is observed that buildings having certain vertical configuration are more prone to damage in earthquake than others. It does not depend on which construction material or material systems used. The main intention of this study is to understand irregularity and to analyze L-shape building under earthquake forces. The irregular high rise buildings which the plan is L-shape are carried on response spectrum through the e-tabs analysis software. In the present study it is proposed to study a thirty two meter height storey reinforced concrete building using response spectrum method for different zones and there by comparing results.

KEYWORDS: Storey drift, displacement, Response spectrum

I. INTRODUCTION

In the world everyone is aware that many natural disasters such as earthquakes, flood, tornadoes, hurricanes, drought and volcanic eruption occur. Of all natural disasters the most destructive are earthquakes. The destruction caused due to earthquake are too many in the world they not only cause great destruction in terms of human loss but also have a huge economic impact on the affected area. There is a crucial need to provide safety against terrible natural disasters. By experiencing all these disasters, it is not possible to build an earthquake proof structure. The seismic analysis and the design of buildings focuses on reducing the risk of life in the most severe earthquake. Building codes have developed their provisions on the historic performance of buildings and their deficiencies. They have developed provisions for life safety concerns, to prevent collapse under the most intense earthquake expected at a site during the life of structure. 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.

Decisions made at the planning stage on building configuration are more important or are known to have made greater difference, than the accurate determination of code specified design forces on structure. The shape and proportions of the building have a major effect on the distribution of earthquake forces as they work their way through the buildings. Earthquake resistant design of reinforced concrete building is a continuing area of research. Geometric configurations, type of structural members, details of connections, and materials of construction all have a profound effect on the structural dynamic response of building in spite of all the weakness in the structure, either code imperfection or error in analysis and design, the structural configuration has played a vital role in catastrophe.

II RELATED WORK

- 1) **A. Dogangun, A. Ural and R. Livaoglu (2008)** this paper focuses on seismic code requirements are discussed together with observed damages occurred during the earthquakes. Many structural deficiencies are highlighted by the earthquake damages including: large opening in load bearing walls, lack of especially vertical confining elements, poor quality mortar, heavy balconies and unconfined gable walls. Effective seismic strengthening method must be developed and performed for these buildings.

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- 2) **Warudkaret et al (2009)** studied the effect of torsional stiffness on the dynamic response of RC structures. In order to study the effect of torsional stiffness on final response, two unsymmetrical three storied non-prestressed RC framed structure models were dynamically analyzed for seismic loading for two cases, analysis with stiffness in five degrees of freedom. It can be deduced that torsional can be ignored in the analysis for non prestressed RC framed structures. However, a minimum torsion reinforced should be provided which can have determined as that required for 50% of the cracking torsion moment of the cross section in design in addition to the reinforcement required from other considerations during pre and post cracking stages to avoid brittle mode failure.
- 3) **MD.rashedul kabir, debnashish sen and md.mashiquil islam (2015)** The aim of this paper is to assess the seismic vulnerability and response of regular and irregular shaped multi-storey building of identical weight. Both static and dynamic (response spectrum) analysis has been performed to study the influence of the building on its response on various loading. It is important to design structures appropriately to reduce damage of structures and life. The main intention of this paper is impact of shape and configuration on earthquake response of building. The shape of different model and corresponding dimensions are so selected to maintain uniform weight in each case. Difference in response for regular and irregular shaped building is observed.

III. OBJECTIVES

The objective of the present work is to study the behavior of a g+9 storey building asymmetrical in plan, under earthquake load by adopting linear dynamic analysis. (response spectrum method) to evaluate storey drift and displacements. The present study is limited to reinforced concrete (rc) multi-storied residential building. The building model in the study has ten storeys with constant storey typical floor height of 3.2m and ground floor height 3.2m. Number of bays and bay-width along two horizontal directions are kept constant for all the models for convenience.

IV. METHODOLOGY

The methodology is proposed to quantify irregularity limits for a range of degrees of irregularity. Define an engineering demand parameter that characterizes structural damage. Inner storey drift provides the best indicator of the ultimate limit state being reached and will therefore be used in this paper. Choose a set of inner storey drift capacities that span the range of values that could be used by designers (e.g. from 0.5% to 3%), then for each target inter storey drift capacity and degree of irregularity. Design a regular structure using the ES to the target inter storey drift capacity. Introduce the desired irregularity into the structure and use the ES method to design this new structure to the target inter storey drift.

- IS1893(PART-1) code recommends that detailed dynamic analysis or pseudo static analysis should be carried out depending on the importance of the problem.
- IS 1893(PART-1): 2002 recommends use of modal analysis using response spectrum method and equivalent lateral force method for building of height less than 40m in all seismic zones.
- Response spectrum method- this method shall be performed using the design spectrum specified in code or by a site-specific design spectrum for a structure prepared at a project site. According to IS 1893:2002, high rise and irregular buildings must be analyzed by response spectrum method using response spectra shown in Fig 3.3. Sufficient modes to capture at least 90% of the participating mass of the building (in each of two orthogonal principal horizontal directions) have to be considered in the analysis. If base shear calculated from the response spectrum analysis (V_B) is less than the design base shear (V_B), the response quantities (member forces, displacements, storey shears and base reactions) have to be scaled up by the factor V_B . Response quantities (member forces, displacements, storey forces, and storey shears and base reactions) for each mode of response shall be combined by either the SRSS (square root sum of squares) or the CQC (complete quadratic combination) rule.

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PLAN DETAILS

The thirty two-meter height building in different zones analyzed by response spectrum method. Different load combinations are taken and the results are compared with static and dynamic analysis.

No. of storeys		G+9
Type of Building		Residential
Plan dimension		30m X 35m
Height of each floor		3.2m
Thickness of the slab		150mm
Wall thickness	Walls	230mm
Beams		300mm X 375mm
Columns		500mm X 500mm
Self-weight		$0.15 \times 25 = 3.75 \text{Kn/m}^2$
Floor finish		1Kn/m^2
Unexpected load		1Kn/m^2
Cement grade		M25
Steel grade		Fe 415

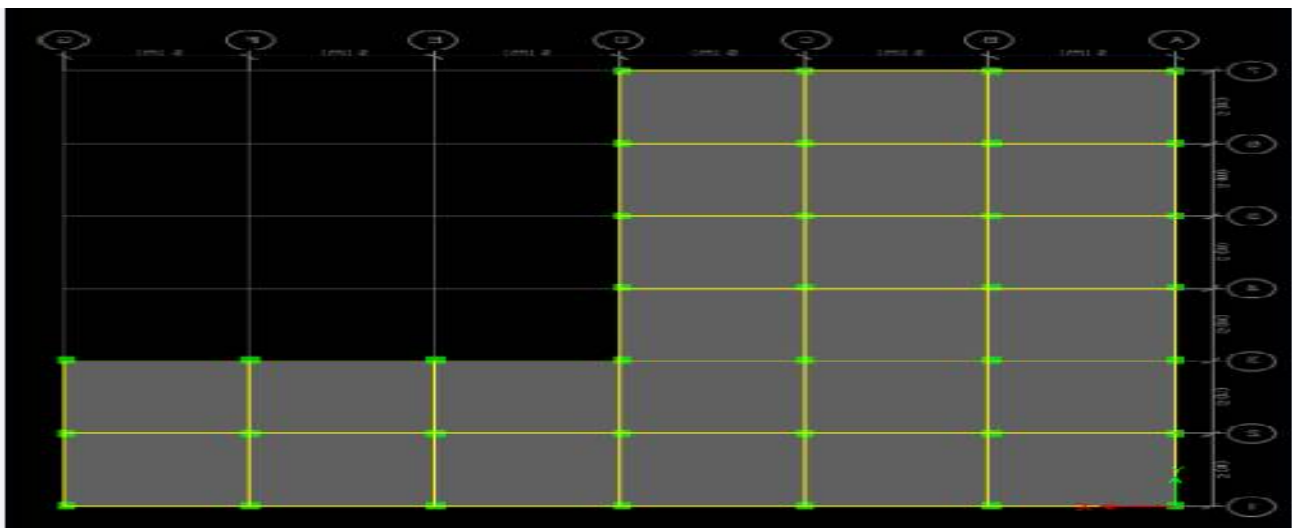


Fig-1:plan view of the model

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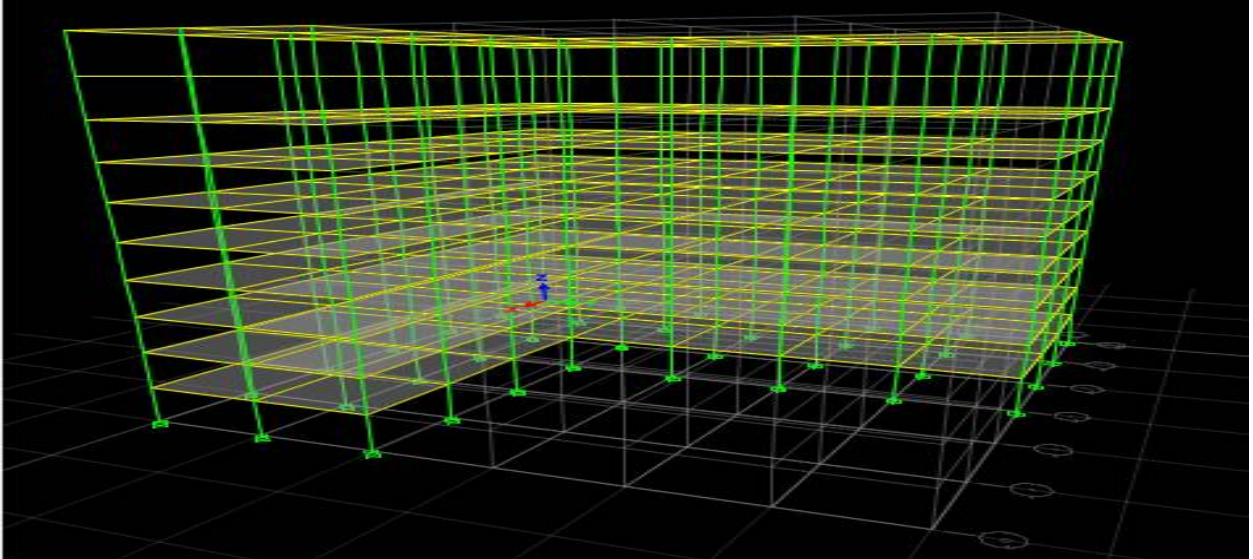


Fig-1:3Dview of the model

IV. RESULTS AND DISCUSSION

4.1 DISPLACEMENTS

COMPARISON OF DISPLACEMENTS IN X- DIRECTION IN DIFFERENT ZONE

storey	Zone2	Zone3	Zone4	Zone5
storey1	0.7	1.2	1.8	2.6
Story2	2.1	3.4	5	7.6
Story3	3.6	5.7	8.5	12.8
Story4	4.9	7.9	11.8	17.8
storey 5	6.2	9.9	14.8	22.2
storey6	7.3	11.6	17.4	26.1
storey 7	8.2	13.1	19.6	29.4
storey8	8.9	14.2	21.3	32
storey9	9.4	15	22.6	33.8
storey10	9.7	15.5	23.3	35

Table 1: From the above table it shows that the displacement increases from ground floor to top floor. It is clearly shown in the graph given below.

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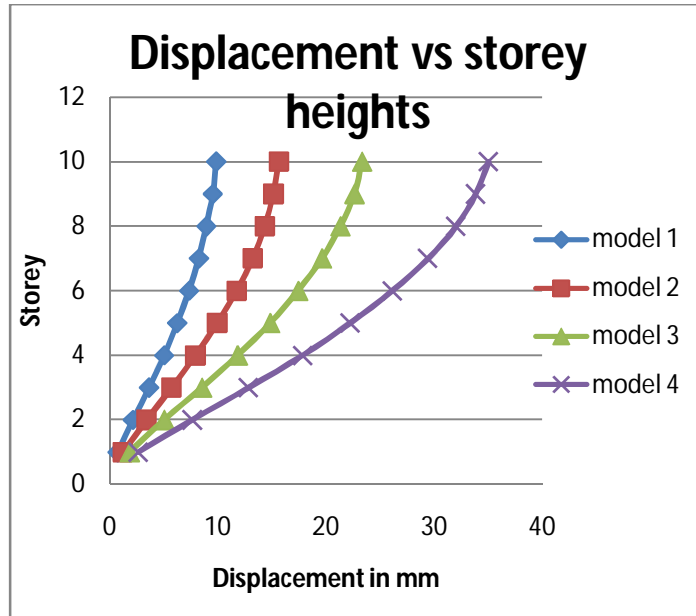


Fig-3 comparison of displacements in X- direction at various zones

Table 2: Comparison of displacements in Y- direction in various Zones

storey	Zone2	Zone3	Zone4	Zone5
storey1	0.7	1.2	1.8	2.7
Story2	2.1	3.4	5.1	7.6
Story3	3.6	5.7	8.6	12.9
Story4	5	7.9	11.9	17.9
storey 5	6.2	9.9	14.9	22.4
storey6	7.3	11.7	17.5	26.3
storey 7	8.2	13.2	19.7	29.6
storey8	8.9	14.3	21.5	32.2
storey9	9.5	15.1	22.7	34
storey10	9.8	15.6	23.5	35.2

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Table 3: From the above table it shows that the displacement increases from ground floor to top floor.it is clearly shown in below the graph

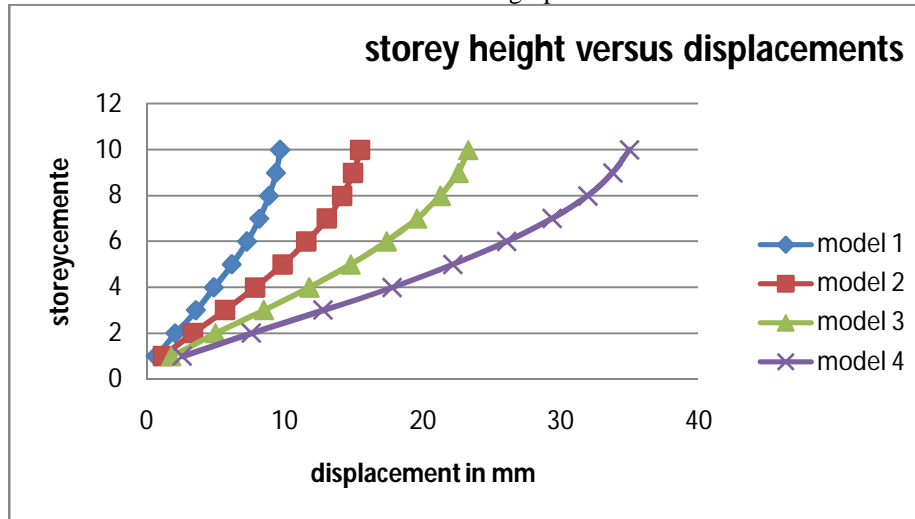


Fig-4 comparison of Displacements in Y- direction at various zones

4.2 STOREY DRIFTS

TABLE4: Comparison of storey drifts in X- direction in various zones

Storey n	Zone2	Zone3	Zone4	Zone5
storey1	0.7	1.2	1.8	2.6
Story2	2.1	3.4	5	7.6
Story3	3.6	5.7	8.5	12.8
Story4	4.9	7.9	11.8	17.8
storey 5	6.2	9.9	14.8	22.2
storey6	7.3	11.6	17.4	26.1
storey 7	8.2	13.1	19.6	29.4
storey8	8.9	14.2	21.3	32
storey9	9.4	15	22.6	33.8
storey10	9.7	15.5	23.3	35

From the above table it shows that the drift increases from ground floor upto a maximum at third storeys.

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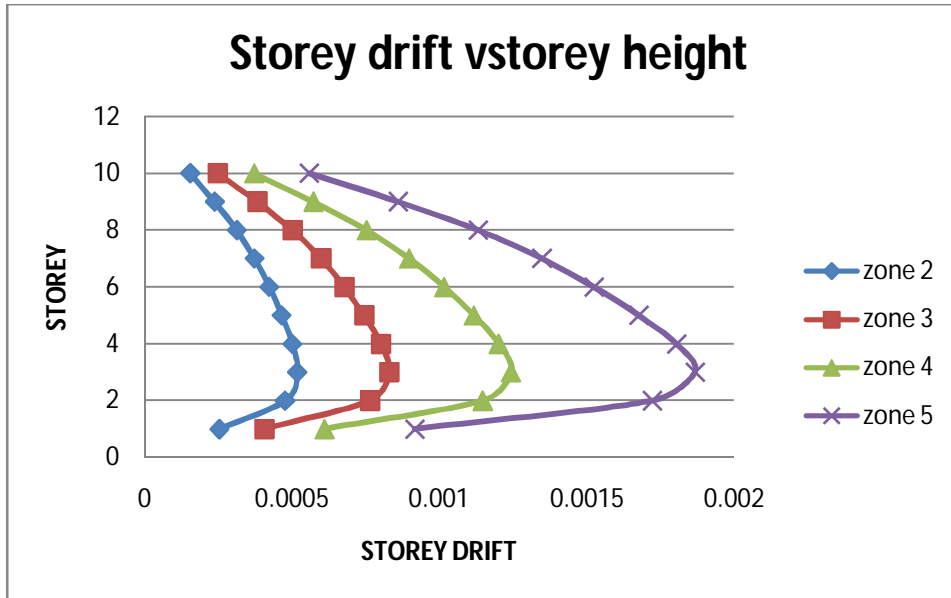


Fig-10 comparison of storey drift in X- direction at various zones

TABLE 5: Comparison of storey drifts in Y-direction in various zone

Storey	zone2	zone3	zone4	zone5
storey1	0.000253	0.000405	0.000607	0.000911
storey 2	0.000477	0.000764	0.001145	0.001718
storey 3	0.000519	0.00083	0.001245	0.001867
storey 4	0.000502	0.000803	0.001204	0.001807
storey 5	0.000467	0.000747	0.001121	0.001681
storey 6	0.000425	0.00068	0.00102	0.00153
storey 7	0.000376	0.000601	0.000902	0.001352
storey 8	0.000315	0.000505	0.000757	0.001135
storey 9	0.00024	0.000384	0.000577	0.000865
storey10	0.000157	0.000251	0.000377	0.000565

From the above table it shows that the drift increases from ground floor upto a maximum at thirdstorey.from the graph it is clear.

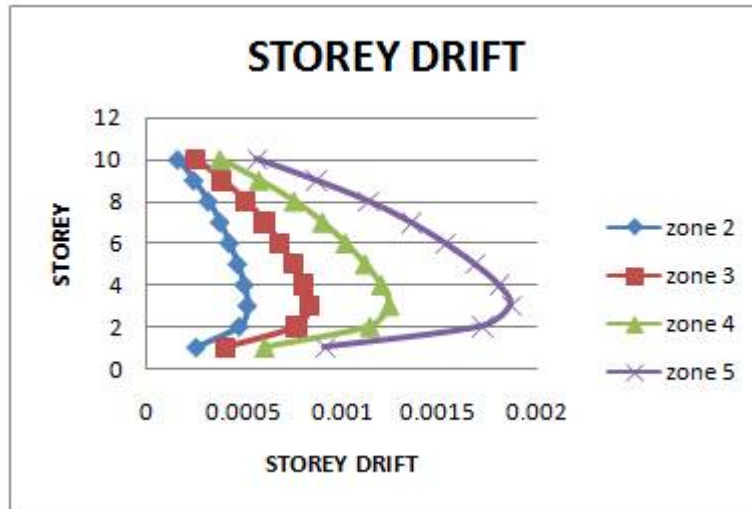


Fig-10 comparison of storey drift in Y- direction at various zones

V. CONCLUSIONS

The following conclusions are based on selected columns and results are compared with static and dynamic analysis.

- 1) Total story drift responses ratio increases as the floor plan irregularity gradually increases upto third floor.
- 2) Story drift response along the height of the building shows that the middle stories are more affected than Lower and upper stories.
- 3) Displacements gradually increases from ground storey to top storey.
- 4) Lower stories display minute variation but variation in maximum displacements significantly increases with the increase in height of different shaped building.
- 6) The analysis demonstrates that plan irregularity has a significant effect on the seismic response of buildings.
- 7) In y-direction the comparison of displacement in different zones is 59.18%, 9.656% and 49.78% .
- 8) In x-direction the comparison of displacement in different zones is 59.79, 50.32 and 50.21.

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