The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 9 Issue 1, 2021
pp: 65 - 71

# Seismic Behaviour of Asymmentric Structures "H, L, U" Shape (G+5)

**[1]M. Hima Bindu, [2]Y. Malarchana, [3]K. Kavya**
[1,2,3,4] UG Student, Department of Civil Engineering,
Dr K V Subba Reddy College Of Engineering For Women, Kurnool, Andhra Pradesh, India

**Abstract**
Due to their functionality, asymmetric structures are increasingly utilized in contemporary architectural designs. The horizontal irregularity that makes an asymmetrical building (e.g., L-, T-, U-, and F) or discontinuities in horizontal resisting elements (diapharagms) such as large cutouts fall under the irregular configuration of buildings.

The horizontal irregularity that gives an asymmetric building its asymmetrical plan shapes (like L, T, U, and F) or discontinuities in horizontal resisting elements (diapharagms) like cutouts, large openings, re-entrant corners, and other abrupt changes that cause torsion and stress concentration are all examples of irregular configurations. The behavior of an asymmetric building under seismic load is depicted in this paper. The analysis is carried out using the same static and dynamic analysis techniques.

During earthquakes, buildings with a plan that has an asymmetric distribution of strength and stiffness experience coupled lateral and torsional motions. The center of mass and the center of resistance do not always align in many buildings. To reduce torsional effects, reduce the distance between the center of stiffness and the center of mass. The building structure's dynamic response is controlled by its stiffness characteristics. In the conceptual design phase, a crucial step is selecting structures' stiffness characteristics. A lateral load resisting system that is evenly distributed can help the structure behave well. The histories of base shear and torque (BST) are used to consider the inelastic seismic behavior of buildings with asymmetrical plans. It is suggested how to construct the system's BST surface with any number of resisting elements in the direction of asymmetry and ground motion. A system's inelastic properties are described by the BST surface; however, a non-linear static or dynamic analysis is required to calculate the inelastic deformation. The system's strength eccentricity, lateral and torsional capacity, planwise stiffness distribution, and excitation are the factors that influence the seismic response

## 1. Introduction

The analysis of structure by considering separate sets of mutually orthogonal planer frames and subjected to horizontal components of base motion parallel to their respective planes assumes no interaction between the forces acting on members common to two perpendicular frames and neglects torsional effect. In addition, a two dimensional analysis can allow only for an approximate consideration of the stiffness contribution of elements lying normal to the plane considered. Such an approach is consistent with present design practice and should yield reasonable results for most cases, particularly if a predominantly linear response can be assumed and no appreciable torsional effects are present.

In considering inelastic response however the interaction of forces resulting from components of motion parallel to each of the principle planes in a structure may cause early yielding in some members and modify the response of the structure significantly. The determination of the interaction effects in such a case will require a three dimensional analysis of the response of the entire structure. A study of the earthquake response of a simple, single story, three dimensional frame model showed that the interaction of moments along two mutually perpendicular directions resulted in early yielding in the columns with a consequent reduction in the input energy and the response velocity. The interaction also tended to produce greater permanent lateral displacement.

The study of dynamic torsional effects in buildings, particularly in multi-storey structures where this effect is more pronounced has been possible only with the recent development of programme for the dynamic analysis of three dimensional frame structures. Torsion occurs when the centre of mass does not coincide with the centre of rigidity in a story level. This can be a result of a lack of symmetry in the building plan or random disposition of live loads in an otherwise symmetrical structure. Torsion can also be included in symmetrical structures by the rotational components of ground motions. Structural symmetry can be a major reason for a buildings poor performance under severe seismic loading, asymmetry contributes significantly to the potential for translational-torsional coupling in the structures dynamic behaviour which can lead to increased lateral deflections, increased member forces and ultimately the buildings collapse. The buildings with L, Y, U, H, or T shaped plans which built integrally as units; large forces may develop at the junction of the arms as a result of vibrational components directed normal to the axes of the arms. In addition, there is horizontal torsional effect on each arm arising from the differential lateral displacements of the two ends of each arm.

Yielding in corner column or end shear wall in buildings due to torsional stresses tends to destroy the symmetry in an originally symmetrical building or increase the eccentricity in an unsymmetrical building, as the centre of resistance moves away from the yielding member. The increase in the eccentricity causes yielding to develop further. This tendency towards magnification of torsional effects by yielding in corner or at end elements suggests that such elements should be designed more conservatively than other member where torsional vibrations can be significant.

Structure has been prone to earthquake since first structure was built. Earthquake resistant building has taken a more scientific turn and still a major area of research .The higher the rise greater the fall in urban areas tall structures are build and they are more susceptible to damage during earthquake. The limitation of space in urban cities has caused many new changes in structure of building. The design having more functionality provides more utility makes structure asymmetric. Seismic surveys prove that the asymmetric structures are most vulnerable structure during earthquake hence it is important to know behaviour of earthquake under seismic load. The component of building that resist the

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 9 Issue 1, 2021
pp: 65 - 71

seismic forces is known as lateral force resisting system (LFRS). The damage in the structure generally initiates at location of structural weak planes present in the building system the weakness triggered furthur damage during earthquakke which leads to structure collapse.

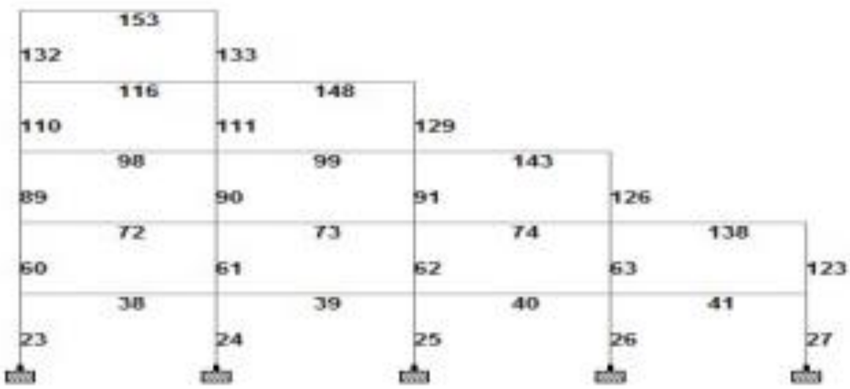


**Fig.1** Frame size

## 2. Literature Review

Narayan malviya, sumit pahawa presented paper on seismic analysis of high rise building with IS code 1893-2002 and IS code 1893-2016.In this they modeled two different building as per the above two codes specification and analyzed in SAP 2000 commercial software .They concluded that new code is more efficient as compared to old code. The deflection value less as per revised code design. Shear force and bending moment also shows less values as compared to old code .Response spectrum result concluded that acceleration against time is higher in the case of new code.

BK raghuprasad, Vinay s amarnathK represented seismic analysis of buildings symmetric and asymmetric in plan. In this paper effort to check torsional effect in asymmetric plan building. They modeled the frame in two ways fist one is spring model and second one is column model in spring model column replaced by spring. By dynamic analysis of structure they concluded that natural frequency of asymmetric spring model is greater than of symmetric spring model. Maximum displacent occurs in asymmetric spring model as compared to symmetric spring model the base shear is also more than the symmetric spring model.

Desai RM, khurd V.G, patil SP, Bavane N.U presented paper on” Behavior of symmetric and asymmetric structure in high seismic zone”. In this paper they modeled three building G+3,G+6 and G+9 and effort is made to study the effect of eccentricity between centre of mass and centre of rigidity .By sap 2000 commercial software they analyzed as low rise mid rise and high rise building they concluded that symmetrical building has more time period as compared to asymmetrical building .Natural time period increases as height increases The time period of high rise is more as compared to low rise and mid rise building The time period decreases as the no of storey decreases.

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 9 Issue 1, 2021
pp: 65 - 71

Chaithra S, Anue marry Mathew presented paper on "Behaviourial analysis of asymmetric building with solid coupled and shear wall with staggered openings". In this they modeled 3 building in seismic zone V the number of storey height was 10, 20, 40 and floor height of each storey is taken as 3m, varying depth of coupling beam and staggered opening shear wals. The first building analyzed without shear wall and second one analyzed with shear wall the building modeled and analyzed in ETABS software. They concluded that the building having shear walls with regular openings brittle failure is observed where as building having shear wall with staggered opening ductile failure was analyzed. The solid shear wall is most stable form of shear wall.

Sharath Irappa kumar,Tejas D.joshi presented "Non linear static analysis of asymmetric building with and without shear wall". In this paper effort is made to study the behavior of structure with re-entrant corners under gravity and seismic loading .They modeled T shape building with and without shear wall in SAP2000 commercial software and also analyzed in this and concluded that the addition of shear wall significantly reduces displacement in structure when compared to structure without shear wall. Shear wall resist earthquake forces greater extent because base shear is less as compared to structurewithout shear wall. Building having re-entrant corner are more prone to earthquake damage.

K.Bindunathi,K.Rajasekhar Presented"comparision of percentage of steel quantities and cost of asymmetric commercial building under gravity loads and seismic loads" . In this paper asymmetric commercial building modeled in Etabs software. As per IS 456:2000 gravity loads and live load estimated. Seismic analysis of the structures is carried out on the basis of lateral force assumed to act along with the gravity loads .Building is type of G+4 and main objective of analysis is to study the different forces like moments, Shear forces and axial forces acting on building. They concluded that the variation of percentage of steel of seismic loading when compare to gravity loading is 21.93%.The variation of estimated cost of structural member analyzed and design under seismic loading is 23.99% is greater.

M.D. Bensalah, M.benasaibi.A.Modaressi presented paper on"assessment of the torsion Effect in asymmetric Building under seismic Load". The main objective of the paper is to estimate the influence of torsion effects induced on the behavior of an asymmetrical structure. The dynamic analysis is done with finite element software GEFDYN by making asymmetrical and symmetrical modeled. They concluded that lateral yielding strength of the asymmetrical structure is higher than the one of the symmetrical structure. The ductility increase with increase in input motion and decrease with increasing predominant period with significant variation in asymmetrical structure than those symmetrical structures. The normalized eccentricity increase when increase in input motion. The reduction factor decreases he of earthquake

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 9 Issue 1, 2021
pp: 65 - 71

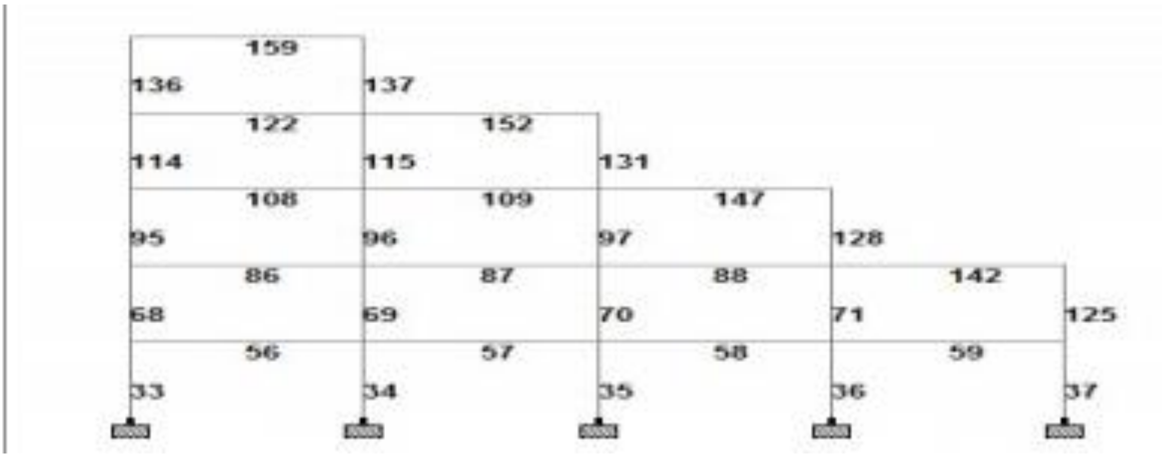


**Fig.2** Frame at (x,z, 10.0)

## 3. Proposed System

Slabs are plate elements forming floors and roofs of building and carrying distributed loads primarily by flexure. A slab may be supported by beams of walls and may be used as the flange of a T or L beam. The common shapes of slabs are square, rectangular, triangular and circular

Slabs are designed by using the theories of bending and shear. The following methods of analysis are commonly used for the design of slabs.

- Elastic analysis-idealization in strips or beams
- Semi empirical coefficients
- Yield line theory

**Slabs are classified mainly into four types:**

1. One-way slab
2. Two-way slab
3. One way slab continuous
4. Two way slab continuous

**1. ONE-WAY SLABS:**

When the aspect ratio $L_Y/L_x$ is greater than 2, one way slabs are those supported continuously on the two opposite sides so that the loads are only distributed in one direction. The span is the direction in which the load is carried in a one-way slab. It could go in a short or long direction. Since the corresponding bending moments and shear forces are least, one-way slabs typically span in the short direction. Steel is used in both the transverse and span directions of the main reinforcements to spread out any unevenness that might occur during loading and to account for temperature and shrinkage effects in that direction. Secondary reinforcement or distribution steel are the names given to the steel. The bending moment is taken into account when calculating the main steel, and it should never be less than the minimum required by the code for such reinforcement.

**2. SLABS IN TWO WAYS:**

Two-way slabs are those that have main steel reinforcement in both directions and are supported continuously on all four sides and have dimensions such that the loads are carried to the supports in both directions. When the aspect ratio of $L_y$ to $L_x$ is less than 2, slabs are typically constructed as two-way slabs. In most cases, two-way slabs are less expensive than one-way slabs.

### 3. SLABS CONTINUOUS IN ONE WAY:

One-way continuous slabs are an option when the span is greater than 4.5 meters in any one direction.

### 4. SLABS CONTINUOUS IN TWO WAYS:

Two-way continuous slabs are an option when the span in any one direction is greater than 4.5 meters.

The maximum permissible span length of slabs is considered as follows:

| Support condition | Cantilever | | Simply supported | | Fixed/continuous | |
|---|---|---|---|---|---|---|
| Slab type | One way | Two way | One way | Two way | One way | Two way |
| Max span (m) | 1.5 | 2.0 | 3.5 | 4.5 | 4.5 | 6.0 |

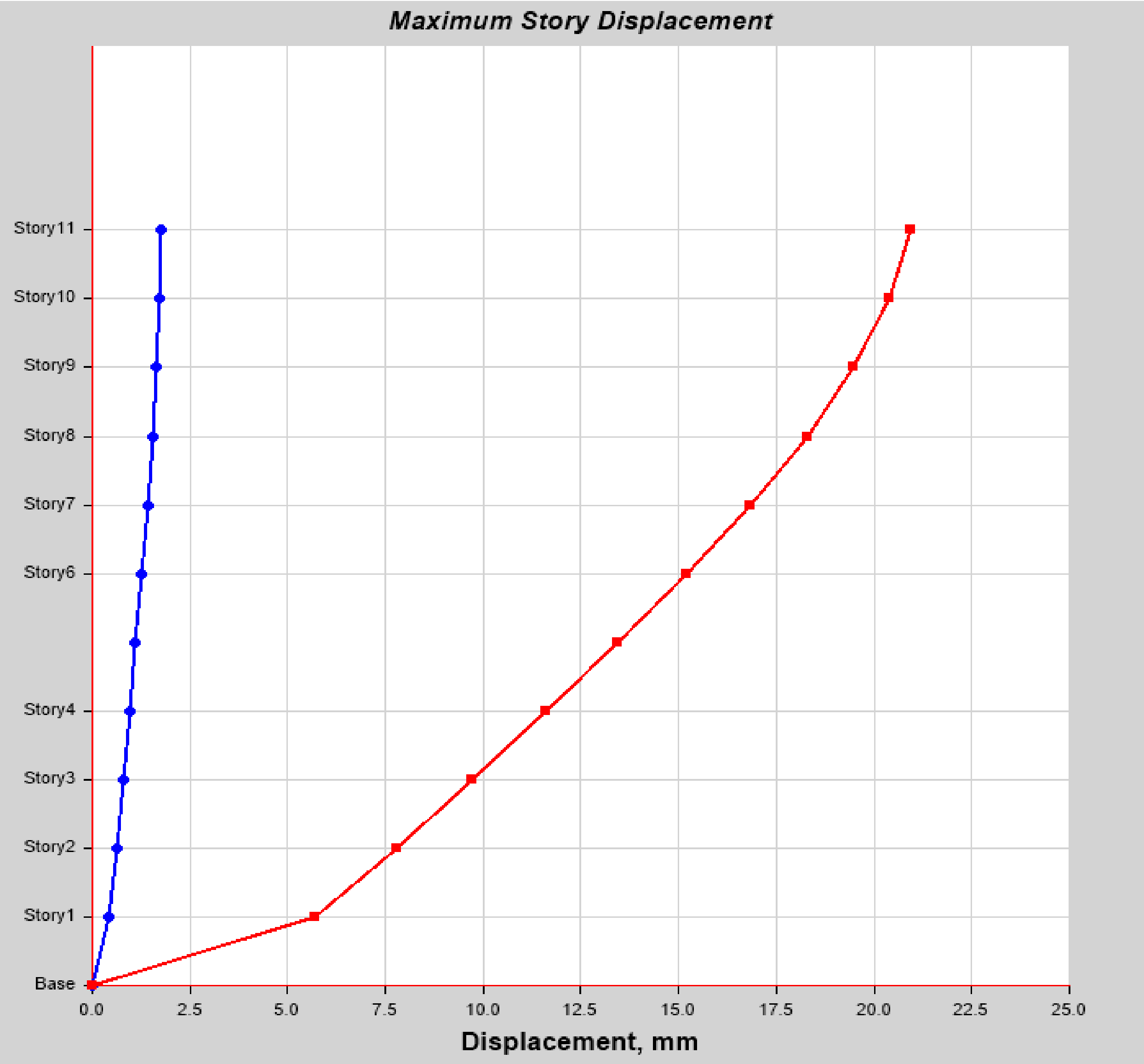


**Fig.3** Proposed Displacement Method

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 9 Issue 1, 2021
pp: 65 - 71

## 4. Conclusion

Frame analysis was done by Etabs. Slab and beams were designed as per IS Code 456-2000.The properties such as shear, deflection, development, torsions are with the IS Code provisions. Designs of columns has been done as per IS Code 456-2000 along with SP-16 design charts. The shear load carrying capacity etc., are within the IS Code 456-2000.

Design of footing is also done as per IS Code 456 – 2000 .The checks like one way shear. Two way shear are within the IS Code limits. Frame analysis, columns & beams were designed by using Etabs, Computer Software

## References

1. Akiyama H., Goto S. and Nakazawa A. (1996) Shear Strength of Large Reinforced Concrete Circular Slabs under Uniformly Distributed Load, Proceedings of the Japan Concrete Institute, Vol. 18, No. 2, pp. 1097-1102 (in Japanese)
2. Iguro M., Shioya T., Nojiri Y. and Akiyama H. (1985) Experimental Studies on Shear Strength of Large Reinforced Concrete Beams under Uniformly Distributed Load, JSCE, Concrete Library International, No. 5, August, pp. 137-154
3. Iwaki R., Akiyama H., Okada T. and Shioya T. (1985) Shear Strength of Reinforced Concrete Circular Slabs, Proceedings of JSCE, No. 360N-3, August, pp. 155-164
4. JSCE (1991) Standard Specification for Design and Construction of Concrete Structures. Part 1 (Design)
5. Nakano M., Goto S., Nakazawa A. and Kuroda M. ( 1996) Water pressure test of actual bottom slabs of 140,000kl LNG under-ground tanks, JSCE Animal Convention, Vol. 6, pp. 528-529 (in Japanese)
6. Okamura H. and Higai T. (1980) Proposed Design Equation for Shear Strength of Reinforced Concrete Beams without Web Reinforcement, Proceedings of JSCE, No. 300, pp. 131- 141.
7. Sejima A., Nakano M., Kawamura Y., Sugino F. and Fukuda Y. ( 1996) Water pressure test of actual bottom slabs of 200,000kl LNG in ground tanks, JSCE Annual Convention, Vol. 6, pp. 530-531 ( in Japanese)