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Study on Torsional Response of Irregualr Buildings Under Seismic Loading

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Abstract - *The demand for aesthetics and the scarcity of available land have led to an increase in the trends of building irregular structures in the modern world. Under seismic action, a structure's torsional reaction caused by abnormalities in the structural arrangement results in severe damage and early failure. One of the many irregularities that might occur in a structure and have a disastrous impact when an earthquake is triggered is torsional irregularity. The purpose of this study is to comprehend how irregular structures respond to torsional loads caused by earthquakes and how bracing can be used to control torsional irregularity. ETABS 19 programme is used to model and analyse a rectangle, L shape, T shape, and two models with vertical setback. Seismic analysis uses linear static and linear dynamic approaches.*

Key Words: Early Failure, Torsional Irregularity.

1. INTRODUCTION

A system that is torsionally balanced will have its centre of mass and centre of rigidity coincide. Due to the uneven distribution of stiffness throughout the plan, when the centre of stiffness and centre of stiffness are not coincident, the system will tend to spin about the stiffness centre under seismic activity. This type of system is known as a torsionally coupled system. Buildings with irregular shapes will shift their centre of stiffness away from the centre of mass during an earthquake, creating a substantially bigger displacement to the flexible side compared to the stiffer side. The floor diaphragm will undergo a rigid body rotation as a result of this relative displacement, which will cause large stress concentrations at corner and edge columns. The building codes refer to the measurement of the torsional reaction as torsional irregularity. For diagnosing and controlling torsional irregularity, multiple codes describe distinct requirements. A schematic depiction of a torsionally coupled system is shown in Figure 1. The centre of mass of the building is where the quake's force strikes it, and the centre of stiffness is where the structure's reaction force strikes it. Due to the eccentricity, these two forces will combine to create rotation as well as translation in the earthquake's direction.

2. METHODS OF SEISMIC ANALYSIS

Methods which are used in this study for the seismic analysis are Equivalent Lateral Force (ELF) method and Response Spectrum Analysis (RSA) method.

There are various methods that are used for seismic analysis of structure. They can be classified based on its complexity. They are

- Equivalent Static Analysis
- Response Spectrum analysis
- Push Over analysis
- Time History Analysis

Static methods of analysis specified in the building codes are based on single mode response with simple corrections for including higher mode effects. While appropriate for simple regular structures, the simplified procedures do not take into account the full range of seismic behaviour of complex structures. Therefore, dynamic analysis is the preferred for the design of building with unusual or irregular geometry.

3. TORSIONAL IRREGULARITY

For quantifying the torsional irregularity of a structure, many codes around the world provide varying criteria. The 2016 revision of the Indian Code IS 1893 (Part 1) includes a provision for assessing torsional irregularity. According to the 2016 code, a building is deemed torsionally irregular when: a) Any floor's maximum horizontal displacement in the direction of the lateral force at one end of the floor is greater than 1.5 times its minimum horizontal displacement in that direction at the opposite end of the same floor. b) The fundamental torsional mode of oscillation has a longer natural period than the first two translational modes of oscillation along each major plan direction.

4. TORSIONAL RESPONSE OF IRREGULAR STRUCTURES

The impact of plan configuration irregularity of buildings when subjected to the variable angle of the input response spectrum was assessed by Bharat Khanal and Hemchandra Chaulagain (2020). One conventional building frame and six variant L-shaped RC building frames were modelled and examined. The structural reactions were measured using the inter-story drift ratio, story displacement, torsional diaphragm rotation, torsional irregularity ratio, normalized base shear force, and overturning moment. They found that structures with irregular plan layouts are more sensitive to changes in the angle of the input ground motion than the symmetrical building model. A significant increase in the demand for seismic response was observed when the models were subjected to a 135-degree angle of seismic incidence as compared to a zero-degree angle of seismic incidence.

In their study, M.Uzun, et. al (2018) analysed the structures with various shear wall locations. Each of the three earthquake study procedures listed in the Turkish Earthquake Code-2007 was applied to these buildings individually (TEC-2007). The variation of the torsional irregularity was investigated using the earthquake analysis approach. They found that the base shear forces predicted by the EL technique in the structure with significant torsional irregularity increase by about 50% for every additional story. Additionally, EL should not be used on constructions with significant torsional aberrations, according to the investigations' conclusions. According to the findings of the investigations, the EL technique should not be applied to structures with severe torsional irregularities.

The inelastic torsional response of multistory RC ductile buildings with varied plan shapes and varying degrees of the soft first story was studied by Hareen CH. B. V and Mohan SC (2020). The modelling process used force-based fibre beam-column elements to predict the inelastic response of the structures. They discovered that in torsionally uneven, ductile buildings with soft first stories, the seismic demand on the flexible side corner columns is higher. As the torsional response grows at the bottom story, infill wall contact, there are large displacements near the flexible side and smaller displacements close to the stiff side. The results of the study indicate that the column at the flexible side corner of plan asymmetric structures with a soft first story can be conservatively constructed for 1.5 times the design forces obtained.

Arun Menon and Rohan Bhasker (2020) A dependable torsional irregularity index has been investigated in order to quantify the sensitivity of a building to torsional effects at all seismic intensity levels. First, under various seismic stimulation intensities, the link between the maximum interstorey drift requirements and common torsional irregularity measures is examined. The numerical analysis was based on thirteen three-story gravity-designed RC moment frame buildings that were subjected to bidirectional earthquake excitation. The study's conclusions demonstrated that no scalar indicator from the collection of irregularity measurements gathered had a reasonable correlation with the seismic demand across the board. $\Delta max/\Delta min$ and ev/B are discovered to be the most efficient scalar irregularity indices at low and high levels of inelasticity, respectively. When an earthquake's shaking intensity is low to moderate

Over the past ten years, there has been an increase in interest in learning more about how reinforced concrete building structures respond to earthquakes. The torsional reaction of the buildings has been identified as one of the main causes of collapse in RC framed structures in damage reports from previous earthquakes. Geometric imperfections in the structures' plans can cause the floor diaphragm to accidentally twist under seismic load. Due to lateral load, the discrepancy between the diaphragm's centre of mass and centre of stiffness will result in extremely strong extra forces. With two objectives in mind, seismic provisions normally define requirements for the construction of new structures exposed to seismic loads 1) Reduce the threat to human life posed by all sorts of structures, and develop structures whose performance is predictable even while they pose a serious risk to the public. 2) Developed the predictable performance of structures having an essential public hazard due to the specific occupancy or use.

As a result of non-uniform mass, stiffness, strength, structural shape, or a grouping of these in the horizontal or vertical directions, no practical construction today is totally regular. Additionally, very irregular structures have the potential to behave drastically differently from regular structures. This unusual behaviour could lead to higher demands and irregular structures that are less secure. Therefore, the majority of international codes for the construction of concrete buildings include requirements and safety measures for the design of RC structures with structural irregularity.

A lateral load that is sudden, random, and devastating is an earthquake. Buildings are intricate constructions made up of numerous structural components, each of which has a unique mechanical behavior. Due to its intricacy, a number of factors, including structural imperfections, affect a building's ability to bend elastically and inelastically when it is subjected to seismic loads. Improper applications that cause irregularities on structures result in a structural system behavior that is more complex. On irregular constructions subjected to diverse stress patterns, unexpected effects can be seen. On irregular structures, earthquake loads increase torsion, shear, and other forces. As a result, structural imperfections drastically reduce a building's seismic performance. Torsion impacts on irregular structures will cause them to sustain significant damage if they are not built-in segments with separation distances. or structural elements' twisting effects on them will cause severe damage.

Numerous exterior factors, like earthquake, wind, and snow, should be taken into account when designing buildings. Even though the materials utilised to create the buildings are of a high calibre, design errors can result in unforeseen structural behaviours of the entire system.

Even though the concrete design complies with current standards, production and external elements are nevertheless very important.

Generally speaking, the building is planned with the need for economy, aesthetics, and safety in mind. To assure the structure's safety, that is, to offer dependability in the case of collapse, excluding displacement and section cracks under the typical loads, is therefore more crucial than other concerns. When there is an earthquake, inertial forces cause such displacements to occur. All of this resulted in the creation of modern earthquake rules. In principle, all international earthquake laws strive to ensure that the structure is easily repairable in relatively less severe earthquakes, that it does not collapse in strong earthquakes, and that no lives are lost.

5. Conclusions

The goal of this research is to describe the state of the art regarding the increased susceptibility of irregular and asymmetrical buildings. The investigation starts out with the introduction of several failures of structures as reported in recent damage surveys compared to previously recorded earthquakes. Asymmetrical buildings, nevertheless have significantly captured the interest of researchers simplified idealization, despite the fact that comparatively few investigations have been attempted. to comprehend how erratic structures behave. This can be seen from a quick statistical analysis presented at starting point. The study attempts to categorize and define the asymmetrical structures and the buildings with various inconsistencies due to the lack of widely agreed, precise categories information on them was accessible. The limitations of the current code provisions for these kinds of organizations are also highlighted. In different sections, a thorough literature review on asymmetrical and irregular structures is presented.

Also listed are the constructions with additional irregularities not included in the classification. Additionally, research has been given on supposedly symmetric structures that act asymmetrically unintentionally. There are hints concerning the way the study may go as well as the potential changes that could be made to code provisions.

9. REFERENCES

[1] Bharat Khanal, Hemchandra Chaulagain , "Seismic elastic performance of L-shaped building frames through plan Irregularities," Structures, ELSEVIER, 2018, vol. 27, 22–36, https://doi.org/10.1016/j.istruc.2020.05.017.

[2] Chia-Hung Fang, Roberto T. Leon, "Seismic Behavior of Symmetric and Asymmetric Steel Structures with Rigid and Semirigid Diaphragms," Journal of Structural Engineering, DOI: 10.1061/(ASCE)ST.1943-541X.0002123.

[3] Hareen CH.B.V., Mohan S.C, "Evaluation of seismic torsional response of ductile RC buildings with soft first story," *Structures*, 29, 1640–1654. 2021, vol. 29, https://doi.org/10.1016/j.istruc.2020.12.031.

[4] Marius Florin Botis and Camelia Cerbu. "A Method for Reducing of the Overall Torsion for Reinforced Concrete Multi-Storey Irregular Structures." Appl. Sci. 2020, 10, 5555; doi:10.3390/app10165555.

[5] M.Uzun, A. Unal, Kamanli, M.T. Cogurcu, "Investigation of the effect of torsional irregularity on earthquake behaviour," Journal of Engineering Research and Applied Science, Volume 7 (1), June 2018, pp 753-758 .

[6] Halûk Sucuo glu, Kaan Kaatsız, "Torsional ductility spectrum for predicting ductility distribution in simple asymmetric-plan structures," Earthquake Engineering and Structural Dynamics, 2022, DOI: 10.1002/eqe.3345.