RESEARCH ARTICLE OPEN ACCESS

A Review on Unsymmetrical Shape of Structure Having Belt Wall at Outer Boundary

Tabssum Bano [1], Mohsin Khan Agwan [2]

[1] M.Tech Scholar, Department of Civil Engineering, Arya College of Engineering and Research Centre, Jaipur, Rajasthan, India

[2] Assistant Professor, Department of Civil Engineering, Arya College of Engineering, Jaipur, Rajasthan, India

ABSTRACT

The construction sector, and particularly civil engineers, face new challenges every day in this fast-rising nation due to the hectic atmosphere of today. Many scholars have worked hard and created a variety of novel techniques based on challenging circumstances in order to achieve these needs. Struts, stabilizers, tape walls, seismic walls, base insulation, shock absorbers, seismic mantles, and other innovations are among these technologies. Using stabilizer equipment or systems is one of the tested solutions we use to evaluate this issue. The impact of wind and pressures on skyscrapers and structures. On this subject, numerous research projects have been undertaken, and various systems have each been examined for particular contexts and constraints. In order to understand the current issues better, the study studied and examined a number of research publications.

I. INTRODUCTION

Conventional structures that are measured using standard techniques for design only slightly deform elastically in response to expected seismic forces and lose the majority of their energy internally through inelastic deformation. This inelastic deformation is a necessary consequence of the element's effective stiffness decreasing, which also affects the entire structural system. Although it is technically possible to build structures that can withstand very large (and uncommon) earthquakes, traditional structures can't afford to use this design due to its high cost. Additionally, the site has become more seismic as a result of subsequent design code amendments, so some existing structures may need to endure greater seismic forces than they were intended. Sometimes, remodeling an existing structure is more feasible and cost-effective than starting from scratch.

The terrible situation brought on by the earthquake has now become a major issue. Numerous individuals have been killed or injured by earthquakes in Asia and on other continents. This is unexpected because uncertainty is a natural part of everything. The most deadly and damaging disaster is an earthquake. And it can occur anywhere, at any moment. He made no concessions and obliterated everything in his way when he was in his pure form. However, life doesn't end; it must continue on indefinitely. To address these uncertainties more successfully, engineers work to determine all existing research and employ all available knowledge and theory. Modern techniques are used in building construction to satisfy a variety of necessary design and architectural requirements. As a result, during the design phase, earthquake effects must be considered and the relevant projections must be created. This is due to the danger of catastrophic earthquake damage to buildings. The specifications for constructing a system to dissipate seismic energy differ from nation to nation.

II. PREVENTION OF EARTHQUAKE

To create simpler ways to better understand earthquake effects, much experience and research are required. Engineers are looking for fresh ideas to increase the adaptability, affordability, and usability of organizations. The alternative that provides the user with the most benefits is the superior one. Vibrations caused by ground tremors have an impact on the building's stability and operational state. As control measures, window frames, taped walls, foundation insulation, and shock absorbers are employed. In actuality, this mismatch increases the unbalanced loads and must, if necessary, be adjusted. The building becomes unstable as a result. However, attention must be paid while employing floating columns due to better ways of getting rid of uneven loads and the need for them.

III. BELT WALL ADVANTAGES

- A distributed ring wall system has been developed as a ground-breaking architectural approach to resist lateral stresses in concrete high-rise buildings.
- The ring walls covering the area between the column edges are dispersed separately along the entire height of the structure, in contrast to the conventional ring system.

- Bracing, usually referred to as wall beams or truss systems, is by far the most widely utilised technique in tall buildings. The parts at the ends of the structure are connected by this system.
- Bracing systems refer to the outer margins of columns with connecting structures, typically containing trusses or shear walls. Additionally, loads are passed from every component to the connecting structure.

IV. LITERATURE REVIEW

Tarak Banerjee, Arya Banerjee (2021)

Engineers assessed the presence of abnormalities in plan, reentrant corner, and torsional inconsistency, which have the greatest impact on seismic response. The re-entrant corners of U, H, V, E, and plus-shaped buildings, which were built according to architectural requirements, have been severely damaged. These structures were divided into sections to minimize the negative effects of re-entrant corners. Re-entrant corners are extremely critical in plus shaped tall, multistory buildings because they exceed the code's stated limits. Shear walls in strong seismic areas require unique details, and the placement of shear walls has an impact on the structure's efficiency during dynamic loads. Changing the placements of shear walls for with this plus-shaped building can achieve wonders without modifying the parameters of a shear wall.

Ankit Panjwan, Vipin Kumar Tiwari (2021)

The significant modifications in construction techniques have tended to make tall and flexible structures more vulnerable to wind influence. Wind loadings are becoming more relevant in relation to the other forces acting on structures, and are thus becoming a key factor in the design of both low and tall flexible structures. Wind generates a random time-dependent load with mean and variable components. Due to the variable element (gustiness) of wind, all structures experience dynamic oscillations. These fluctuations are small in shorter rigid structures; therefore they can be viewed as having an equivalent static pressure. The majority of Codes and Standards use this technique.

Sajan K Jose, Anjali G S (2021)

The need for multi-story buildings is becoming more prevalent these days. They are, nevertheless, more vulnerable to earthquake damage. One of the most potent weapons in the passive structural vibration reduction arsenal is base isolation. By introducing a system that allows the structure to float above the ground, it is protected from the effects of earthquake forces. This research uses the Response Spectrum Method and ETABS software to analyze ten-story RCC, steel, and composite structures of various shapes with and without base isolation in various seismic zones. For base isolation, lead rubber bearings built according to UBC97 were employed. For RC structures, the plus form was found to be the most suited for base isolation, whilst rectangle and hollow shapes were found to be the most ideal for steel and composite structures. In comparison to other structures, concrete structures function better when the base is separated.

Ayush Pathak, Prof. Anubhav Rai, Prof. Vedant Shrivastava (2021)

Over the last few years, research has been conducted on a variety of earthquake-related concerns. People nowadays reside in multistory buildings, therefore if an earthquake knocks out the populated areas, it will result in huge damage. As a result, earthquake analysis is important for analyzing the structure's safety against collapse and designing the structure to be safe from Earthquakes that occur over the structure's lifetime. In this work, we used Staad Pro to build a G+16 structure with several plan configurations such as L-Shape, T-Shape, I-Shape, and Rectangular Shape, as well as analyze the Earthquake analysis of the structure in two different seismic zones III in India. The comparative research of RC multistory building framework structure in terms of Highest Bending Moment, Maximum Shear Force, Maximum Axial Forces, Story wise Displacement, and Base Reactions is presented in this paper.

Wael Alhaddad, YahiaHalabi, Hu Xu, and Hong Gang Lei (2020)

This article is part of a series of comprehensive reviews on the design of stabilizer and belt truss systems for high-rise buildings. This section provides guidance on the topology and optimization of the stabilizer system by presenting and analyzing as many relevant resources as possible. - This guide provides explanations and descriptions of the theories, hypotheses, concepts and methods used in the article to ensure the best topology and volumes. Finally, this section concludes with a summary of the results of the studies examined, useful for the influence of various parameters on the topology and on the optimization of buildings at height with stabilizers and stabilizers.

Mohammed ArsalaanWajid, Dr. S. AmareshBabu (2020)

In today's ever-changing world, high-altitude structures with innovative designs are the norm. Although these facilities are great, they have problems. Going up, the force of the wind becomes an important obstacle that must be effectively overcome to ensure the safety of the occupants. After extensive research and testing, many creative solutions have emerged to combat the effects of wind energy. This study aims to effectively reduce lateral displacement caused by wind forces through the use of belt walls, optimally positioned stabilizers and suitable supports. In this study we tried to evaluate an economic technique to reduce the lateral displacement of the structure due to the wind forces with the aid of an arm / zone / reinforcement system. The structure with an elliptical height of about 320 m is included, there are 78 floors above ground and 2 under the structure. It consists of an elliptical core as a side load support system. The thickness of the retaining wall / belt varies from 300 mm to 500 m in sections of 100. The retaining wall / belt system is provided at different heights and in some cases at two different heights. Cantilever / Belt Walls are only provided on Factory Floors / Paved Floors / Mechanical Floors. This study also shows that the lateral displacement of the structure can be minimized by increasing the size of the central core or, in other words, by increasing the stiffness of the building. The disadvantage of this method, however, is the exponential increase in the cost of the structure, which makes it very large, since the increase in the size of the core leads to a direct increase in the amount of concrete used, negligible in the system suggested in this study.

Bharat Khanal, HemchandraChaulagain (2020)

Because of the aesthetic and limiting supply of land, the popularity of irregular building construction has exploded. Structures having irregular configurations have been proven to be destroyed by severe ground motion in previous investigations. Structural irregularities are major variables that reduce a structure's seismic performance. Structures with structural abnormalities have an inequality in the distribution of storey drift, excessive torsion, and may fail during an earthquake, depending on the type of irregularity. The presence of re-entrant corners and torsional irregularity, for example, produces stress concentration in structures due to rapid variations in stiffness and torsion amplification. In this regard, the current research examines the impact of plan layout irregularity when the input response spectrum is subjected to various angles. For numerical study, one regular and six distinct L-shaped RC building frames were modeled. An equivalent static lateral force approach and response spectrum analysis was used in the analysis (dynamic analysis).

Dheeraj Kaul, Sagar Jamle, Lalit Balhar (2020)

Investigations on irregular buildings with shapes such as H-shaped, L-shaped, T-shaped, V-shaped, U-shaped, and so on, with different factors being researched and compared on structures with regular frames, have led to the current research plan. Further research can be conducted by including irregularities in structures by constructing floors in different orientations, such as east, west, north, and south, as well as varying concrete grades.

Deepak Kumar Ahirwar, K. Divya, Lokesh Singh (2020)

The resistance of tall structures to lateral loads is the primary determining factor in the development of unique basic structural frameworks, which result from structural engineers' constant efforts to increase building height while keeping deflection within acceptable points of confinement and restricts the amount of materials used. An analytical research will be conducted on technologies such as outrigger structures with core shear walls and hex grid systems in order to establish their structural effectiveness in safely transmitting lateral loads to the ground in this presented design. We provide a survey of journals pertaining to high-rise analysis of structures in this work.

N. Y. Mithbhakare, P. D. Kumbhar (2020)

High-rise constructions have become emblems of economic power and leadership in recent years. Developing countries, such as India, are also becoming hotbeds for new high-rise construction. The purpose of this work is to review the literature and explore the fundamental ideas of various outrigger systems, as well as their effects on the behavior of high-rise buildings. The study outlines future research opportunities for assessing multi-story buildings employing various materials for outrigger system elements, including dampers and base isolation techniques, as well as blast loading for seismic analysis.

Mohammad Fahmy (2020)

As the court-yarded house typologies that completed the vernacular picture of desert architecture were rejected in the early twentieth century, urban expansion in Egypt has extended far from the distinguishing compact dry built environment since the mid-1970s. This has sparked interest in Egypt's urban microclimate study. Initially, the primary goal was to improve outdoor thermal comfort. As a result, Egyptian study began by evaluating several current patterns in order to develop climate-responsive and sustainable urban design practices that are low carbon, thermally comfortable, and energy efficient in such arid climate.

Mohsen ZakerEsteghamati, Alireza Farzampour (2020)

The findings reveal that butterfly-shaped fusing increase the structure's performance in all drift-related damage states, with the enhancement being more obvious in severe damage states. The danger of exceeding complete damage condition during the lifecycle of the modified structure is lowered to about one-fourth of the original building's capabilities. Furthermore, due to their substantial energy dissipation and ductility, shear fuses efficiently reduce weak storey formation at lower tales. Because of the enhanced drift-related performance, the drift-induced loss of structural and non-structural assemblies is reduced, resulting in a 44.64 percent lower overall annual loss for the building under study. Furthermore, while butterfly-shaped fuses minimize the likelihood of surpassing the moderate damage state for the floor acceleration, their effect is insignificant for higher acceleration-related types of defects.

Md. Rashedur Rahman, TohurAhmed and Afia Anjum UlkaMony (2020)

The goal of this study is to compare the seismic and wind performance of multistory structures with Rectangular columns to multistory buildings with specially shaped columns. In Dhaka city, the proposed building is examined using equivalent static analysis for zone II. The parameters include column moment of inertia, maximum narrative drift, lateral displacement, and so on. In the computer-aided analysis conducted by ETABS 2016, the Bangladesh National Building Code (BNBC) of 2006 was taken into account. The comparable static force approach was used to conduct the seismic study. Based on the findings, estimates are made to show the efficacy of various column shapes underneath the influence of seismic stresses.

Roopendra Singh Baghel, Rakesh Patel, Deepak Bandewar (2020)

In this study, a G+12 multi-story building with a strategy evaluation of 63.20mx29.50m m is shown and dismembered in Etab transformation composed structure diagram programming with the goal of distinguishing a consistent strong structure utilizing customary sections against a structural system planned with unique molded segments considering seismic loads. The structure is subjected to a proportionate static inspection and dynamic response range testing.

V. FINDINGS

- Re-entrant corners can be insulated from the negative impact caused by these imperfections by adding shear walls. [1]
- Because re-entrant corners surpass the code's specified limitations, they are particularly important in plus-shaped, tall, multistory buildings. The placement of shear walls affects the way a structure performs under dynamic loads, and shear walls in seismically active areas call for special details. [2]
- It was discovered that the plus shape worked best for base isolation in RC structures, while hollow and rectangle shapes worked best for steel and composite structures. [3]
- In the case of comparing the displacement by plan configuration, the I - shape model yields the smallest displacement, the L shape model yields the average displacement, the T shape yields the greatest displacement, and the rectangular shape model yields the maximum displacement. This implies that the planned configuration of the structures affects the earthquake effect as well. [4]
- This study also demonstrates that by simply making the building more rigid or by increasing the size of the central core, the lateral displacement of the structure can be reduced. [6]
- In comparison to the symmetrical building model, buildings with irregular plan configurations are more sensitive to alterations in the angle of the input parameter response spectrum. When the finite element models were angled at 135 degrees instead of the zero-degree angle of seismic incidence, a notable rise in the need for seismic response was seen. [7]
- You can create irregularities in the buildings by creating floors facing various directions, like the east, west, north, and south. [8]
- To ensure a safe design, seismic force resistivity lateral resisting members are required. [9]
- Whenever building outrigger components of a system, structural steel and reinforced concrete are more frequently used. The outrigger system's use of dampers enhances the

structure's ability to withstand lateral loads. 10]

- Storey-based fragility curves demonstrate that lower floors, which experience higher seismic drift demand, are more affected by BF fuses. Under the MCE danger level, the examined butterfly-shaped fuses stop the weak story formation that was seen at the EBF system's initial story. [12]
- Specifically designed columns provide a room's corner with more usable floor space than a rectangular column in a reinforced concrete structure. In the event that a column has an unusual form, the offset of the column will not cause any issues. [13]
- A suitable static assessment and dynamic response spectrum analysis are carried out on the building. [14]
- Considerations for the shear design of the belt walls reinforced by high-strength pre-stressing fibers are provided based on this study. [15]
- In all the building shapes, the cross form is the most stable, while the L shape is most vulnerable to stability. [16]

VI. OUTCOMES

- The model showing reduced torsional moment values is the one with shear walls at the edges and re-entrant corners. By constructing shear walls at re-entrant corners, torsional moments are significantly reduced. [1]
- The plus shape value with a value above 50500KN is the highest on the plus shape graph. An L-shape with a weight well over 49,000 KN is the lowest. Between the plus and L shapes on a graph with less than 5050 kN is the T-shape. [2]
- In comparison to other structures, concrete structures show optimal performance when their bases are isolated. It has been discovered that steel structures are the least ideal for base isolation. [3]
- The low displacement in medium soil conditions and the maximum displacement in higher soil conditions indicate that the displacement decreases as the soil condition increases. [4]
- The lateral displacement of the structure is reduced to acceptable limits by using bracing of various cross-sectional areas; however, the bracing fails in axial stresses. [6]
- The analysis reveals that, as compared to a finite element technique, the basic time period of the structure based on standard code displays a lower value. It is determined that the current code requirements need to be modified in order to sufficiently irregularities found within the buildings. [7]
- The study found that lateral stability increases a structure's stability and safety by reducing bending moments and forces brought on by loads and aging. [9]
- In tall RCC buildings, concrete outriggers are shown to be more effective than steel ones at reducing the lateral storey displacement. It has been found that virtual outrigger systems are more effective than traditional outriggers at giving high-rise buildings greater strength and stiffness to withstand the lateral loads brought on by earthquakes. [10]
- Future studies can compare using butterfly-shaped shear fuses with other retrofitting options for improving existing steel multi-story buildings in highly seismic zones. The proposed modeling approach can be easily incorporated into community resilience-based evaluation. [12]
- The relative stiffness of the frame affects displacement. According to this study, the seismic load causes the most displacement in a building with rectangle columns. The square column has the lowest moment of inertia, which explains why. Radius of gyration is another feature of a section that is impacted by moments of inertia. It determines the section's strength. Building using a specially designed column is safer and takes every situation into consideration. Story drift occurs in column structures with unique shapes that are less common than rectangular ones. [13]
- Because the axial force is calculated under the same loading conditions in all scenarios, it is noted that there is a very slight variance in that force. [14]
- The quantity and configuration of belt walls affect the dispersed belt wall system's performance. [15]
- The overall comparison revealed that the L-shaped building is more susceptible than the other types of buildings. Considering cross-shape buildings in all other shapes listed, it has been discovered that they perform well. It has been discovered that an I-shaped building experiences the smallest overturning moment, whereas a U-shaped building experiences the maximum. [16]

REFERENCES

1. Banerjee, Tarak, and Arya Banerjee. "A Study on Optimizing the Positioning of

Shear Walls for a Plus Shaped Irregular Building." (2021).

2. Deepram Meena, Mohsin Khan Agwan, Hemant Kumar Sain, "An Experimental Study on the Behaviour of Concrete by Partial Replacement for Rice Hush Ash, Silica Fume & Iron Slag with Cement", International Journal of Engineering Trends and Applications (IJETA), Vol. 10, 2023.
3. Panjwani, Ankit, and Vipin Kumar Tiwari. "Literature Review on Analysis of Tall Buildings Subjected to Wind Loads By Using Gust Factor Method."
4. Jose, Sajan K., et al. "Fixed and Base Isolated Framed Structures: A Comparative Study." Journal of Physics: Conference Series. Vol. 2070. No. 1. IOP Publishing, 2021.
5. Pathak, Ayush, Anubhav Rai, and Vedant Shrivastava. "Seismic Behavior of RC Multistory Building Frame Structure with Different Plan Configuration." (2021).
6. Wael Alhaddad, YahiaHalabi, Hu Xu, HongGang Lei, "Outrigger and Belt-Truss System Design for High-Rise Buildings: A Comprehensive Review Part II—Guideline for Optimum Topology and Size Design", Advances in Civil Engineering, vol. 2020, Article ID 2589735, 30 pages, 2020.
7. Mohammed ArsalaanWajid, Dr. S. AmareshBabu, "Use Of Outrigger, Belt Wall And Bracing Systems In High Rise Building Subjected To Wind Loads", International Journal of Engineering Development and Research (IJEDR), ISSN:2321-9939, Vol.8, Issue 1, pp.75-81, January 2020.
8. Khanal, Bharat, and Hemchandra Chaulagain. "Seismic elastic performance of L-shaped building frames through plan irregularities." Structures. Vol. 27. Elsevier, 2020.
9. Kaul, Dheeraj, Sagar Jamle, and Lalit Balhar. "An Immense Review on Comparative Analysis between Regular and Irregular Multistoried Building under Seismic Loading." (2020).
10. Ahirwar, Deepak Kumar, K. Divya, and Lokesh Singh. "Design Analysis of Outrigger and Hexagrid System in High Rise Buildings: A Review." (2020).
11. Mithbhakare, N., and P. Kumbhar. "Review on Behavior of Outrigger System in High Rise Building." (2020): 1-5.
12. Hemant Kumar Sain, Basant Kumar Meena, "An experimental analysis on concrete containing GGBFS and meta kaolin with CCR", AIP Conference Proceedings 2901(1), 050008, pp. 1-13, 2023. https://doi.org/10.1063/5.0179528
13. Nitesh Kanwat, Hemant Kumar Sain, Mr. Kapil Karadia, "A Study Of Different Type Of Industrial Roof Truss With Applications Of Various Load Combinations", International Research Journal of Modernization in Engineering Technology and Science, Vol. 04, Issue. 11, November 2022.
14. Hemant Kumar Sain, Vishakha Sharma, Bazila Nisar, "Effect of Rock Cracks on RC Structures", AIP Conference Proceedings 2901(1), 050005, pp. 1-5, 2023. https://doi.org/10.1063/5.0179724
15. Fahmy, Mohammad, et al. "A review and insights for eleven years of urban microclimate research towards a new Egyptian era of low carbon, comfortable and energy-efficient housing typologies." Atmosphere 11.3 (2020): 236.
16. Esteghamati, Mohsen Zaker, and Alireza Farzampour. "Probabilistic seismic performance and loss evaluation of a multi-story steel building equipped with butterfly-shaped fuses." Journal of Constructional Steel Research 172 (2020): 106187.
17. Nitesh Kanwat, Hemant Kumar Sain, Mr. Kapil Karadia, "An Advance Study On Industrial Roof Truss With Consideration Of Irc Loading", International Research Journal of Modernization in Engineering Technology and Science, Vol. 04, Issue. 11, November 2022.
18. Kusum Choudhary and Hemant Kumar Sain, "Seismic Behavioural Analysis of One Bay Structure With Composite Beam and RCC Columns", International Journal of Engineering Research and Generic Science (IJERGS), Vol. 7, Issue. 6, pp. 27-36, 2021.
19. Rahman, Md Rashedur, Tohur Ahmed, and Afia Anjum Ulka Mony. "Comparative Study between Rectangular and Specially Shaped Rc Column On Seismic Response For Multistoried Building."
20. Baghel, Roopendra Singh, Rakesh Patel, and Deepak Bandewar. "Utilization of Advance Technology and Techniques in Analysis of a Tall Structure." (2020).