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A Review on Seismic Performance of Asymmetric Buildings with Shear Walls

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Abstract:- There is an increasing trend in the construction field to build structures that are asymmetric both horizontally and vertically due to the need for unique aesthetic appearance. Also, the increase in population forces people to build structures in densely populated cities leading to scarcity of land for construction. Many other circumstances pave the way for structures to be irregular in nature. These structures have to be made seismically resistant in order to avoid loss of life and property. Shear walls are one among the solutions to conditions that don't satisfy seismic resistance. They have high stiffness which counteracts the lateral loads of the building due to earthquake forces. This study aims at providing insight to major findings about the behavior of asymmetric structures with different locations of shear walls in terms of seismic response parameters.

Keywords:- *Asymmetric Structure, Shear Wall, Seismic Response.*

I. INTRODUCTION

Rapid urbanization and population rate have led to the construction of buildings in congested areas as a solution to housing problems. This leads to complete utilization of the area allotted for construction purposes, raising the structures that are unsymmetrical both horizontally and vertically. Indian grounds are becoming highly vulnerable to ground motions in recent years which paves the necessity for assessing the buildings for seismic resistance. Asymmetric structures behave differently compared to symmetric ones during an earthquake event. They undergo coupled lateral and torsional motions, creating increased displacements. Shear wall acts as one of the solutions to make the structure more seismic resistant than it was without before. Provision of shear walls without optimal placing gives only minimum benefit. But, the location of shear walls influences the seismic response parameters like base shear, storey shear, overturning moments etc.

- Kamalroop Kaur ,Balwinder Singh.,2021 "Seismic Analysis of Symmetric and Asymmetric Structures with and without Shear wall using Etabs software" IOP Conf. Series: Earth and Environmental Science.

This study examined how different irregularity arrangements in reinforced concrete structures responded to seismic loads. Six distinct examples were created by modifying a 16-story normal frame to include various irregularities in plan and elevation as well as shear walls. Response spectrum analysis is used to determine each case's response in terms of displacement, drift, and base shear.

According to the result, all the cases have responded more when seismic loads were applied than the regular configuration does. The irregular models using shear walls have elicited the greatest response among these situations. Shear walls cause a certain amount of displacement to be reduced and increase storey shear in the models.

- R.C. Bush, A.I. Shirkol, J.S. Sruthi et al.2022 "Study of seismic analysis of asymmetric building with different shapes of staggered openings and without openings in Shear Wall", Materials Today: Proceedings.

This study used ETabs software to conduct a seismic analysis of a ten-story asymmetric building with different kinds of openings in shear walls in response to an earthquake. Six models were taken into consideration, all of which were situated in seismic zone V and consisting of vertical openings with different locations and shapes in shear walls with varying shapes and placements. Storey displacement, storey drift, storey stiffness, and storey shear were all studied through analysis.

The findings of this study indicated that shear walls featuring staggered openings exhibit greater rigidity in comparison to those with uniform openings. The model with the largest base shear was the one with rectangular openings whose corners were lined up with the shear wall's centerline. The models featuring staggered openings in square and rectangular shapes showed the least displacement. While staggered openings in the form of triangles were not the greatest shape for openings, they were nevertheless preferable

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than uniform openings in shear walls. It was concluded that staggered vertical openings, squares and rectangular openings will function better in seismic occurrences.

- M. Barser, B. Rc and Anoop I Shirkol.,2023 "Performance analysis of asymmetrical RC structures using different configurations of shear wall", Materials Today: Proceedings.

The response of a 10-story building to seismic loads was examined in this article using ETabs software. Twelve various building layouts, including L, H, U, and E, with three different shear wall shapes, were examined. The Equivalent Static Method and the Response Spectrum Method were used to analyze the models. For modeling the shear walls and slabs, a thin shell element was employed.

In all four shapes of models, it was deduced that the models with the T-shaped shear wall provided the least amount of displacement in the x direction. The T-shaped shear wall provided the least amount of displacement in the y direction within the L-shaped structure. The H and E shaped buildings had the least amount of displacement while using an open box shaped shear wall. The models exhibiting T-shaped shear walls had the highest degree of storey stiffness in the x-direction. It was stated that torsional moments might be reduced by carefully placing the shear walls at critical points.

- Sammelan Pokharel, S. Lakshmi Ganesh, G. Sabarish .,2019 "Seismic Performance of Symmetric and Asymmetric Multi-Storied Buildings." (IJRTE) ISSN: 2277-3878, Volume-8 Issue-1S3.

By contrasting L and T-shaped structures with the addition of shear walls, this study assessed the seismic performance of a G+4 and a G+10 reinforced concrete building. Four shear walls of 150mm thickness were provided in each building. Response of structure in terms of story displacement, story shear, overturning moments were discussed for each case.

For L-shaped and T-shaped buildings, the overturning moment was determined to be 12.70% and 17.05%, respectively. It was discovered that the maximum storey displacement of a T-shaped building was nearly identical to that of a symmetric structure, but that the maximum storey displacement of an L-shaped structure was 11.17% greater than that of a symmetric structure. It was observed that the base shear of the L and T-shaped buildings was 13% higher than that of the symmetric building. The provision of a shear wall resulted in a 50% reduction in the maximum shear force and a 54% reduction in the maximum moment in columns. In the L-shaped building and the T-shaped building, the percentage decrease in the maximum storey displacement caused by the shear wall was found to be 26% and 22%, respectively.

- Gagandeep and Aditya Kumar Tiwary.,2018 "Analysis of Asymmetrical Building with Shear Wall under Seismic Loading" (IJESI) Volume 7 Issue 6 Version III.

The optimal positioning of shear walls within a building as well as their impact on asymmetrical building frames were examined in this paper. Shear walls in the external and interior frames of 12, 8, and 6 story-tall RC-framed T-shaped building models were examined. They were also examined utilizing spring base conditions to determine the impact of soil flexibility.

The external frame of the building had shear walls, which decreased the axial forces in the columns by 10 to 15 percent. The axial forces in the columns rose from 1–15% when the SSI effect in the structure with shear walls in the exterior frame was taken into account. A 45–50% reduction in time and a 90–100% rise in Sa/g value were noted when shear walls were included in the external or interior frame.

- Patil A. G,Prof. Hamane A. A.,2018.,"Analysis of Shear wall at Different Location for Asymmetric High Rise Building" IJSDR, Volume 3, Issue 7.

A 12-story RC asymmetric structure with unique moment-resisting RC frames and shear wall-resisting systems was examined in this study. Under Response Spectrum Analysis, the L-shaped building with shear walls at the center, corner, and peripheral was examined.

The maximum storey displacement is lowest when the shear wall is positioned in a corner and bigger when it is positioned in the center, according to the analytical results of several models. When a shear wall is positioned in the center of the building, the maximum storey shear is at its lowest. In an asymmetric construction, a shear wall at the corner will provide the best protection against earthquake damage.

- Shagun Chaddha,Navpreet Soni.,2017 "Effect of Shear Wall on Asymmetric Building with Variation in Support Condition", IJCIET Volume 8, Issue 7.

A 24 m total height H-shaped RC building with 21 m x 21 m plan dimensions with shear walls was modeled in StaadPro V8i, and certain parameters were compared including drift, average displacement, shear force, and bending moment.150 mm thick shear walls at the internal and external frames and at the center of the building were modeled.

Models were also developed to examine the influence of support conditions such as pinned and fixed support.

The maximum axial force was found to be higher when shear walls were present at the exterior frame as opposed to other locations. In every condition, the maximum shear force

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in fixed support is greater than that in pinned support. When a shear wall is present in the middle, the maximum bending moment increases. In cases where a shear wall is present at the center, drift and bending moment increase. When the exterior frame had shear walls, the maximum axial and shear force was seen.

- Osama Ahmed, Dr.s.Amaresh Babu.,2019 "Analysis Of Asymmetrical Buildings With Base Isolator, Shear Wall And Bracing System Located At Near Fault Region Using Non Linear Time History" IJEDR Volume 7, Issue 4

Nonlinear time history analysis was used to assess the seismic response of the L-shaped building, which has reentrant corners which is asymmetric in both the x and y directions. The models that were taken into consideration were five, ten, and fifteen story reinforced concrete ordinary moment resisting frames with the same column dimensions, base isolators, shear walls, and bracings.

When compared to the basic model in near-fault ground motions, the results indicated that the variation of base shear for a ten-story building was increased by 66% in the X direction and by 51% in the Y direction.For five and ten story buildings, the largest reduction in storey drift was 90% and 94% in the model with shear walls.It was determined that shear walls are an efficient way to prevent story drift in low- and medium-rise buildings through the use of Nonlinear Time History Analysis.

- Manoj Chougule, Prof V.V Nair.,2023 "Capacity Spectrum Analysis of RCC Structure with & without shear wall in plan symmetry & asymmetry." IJRTI Volume 8, Issue 4

Using a capacity spectrum analysis, the response of a computer model of a ten-story reinforced concrete building to a set of ground motion records with varying seismic intensities has been evaluated. Analysis was done on a nine-story, L-shaped, asymmetric building with 250mm-wide shear walls.

Comparing the asymmetrical building without shear walls to the building with shear walls, the capacity curve for the former has a smaller peak. The asymmetrical structure with shear walls had a larger capacity curve, demonstrating the substantial improvement in the building's seismic performance brought about by the shear walls. In comparison to an asymmetric model with a shear wall, there is a 57% reduction in displacement in the asymmetrical model. Compared to an asymmetric model without a shear wall, the performance point in the asymmetrical model with a shear wall is 15.44% lower. Compared to an asymmetric model without a shear wall, drift is 60% less in the asymmetrical model with a shear wall. In comparison to the symmetrical construction, the analysis also revealed that the asymmetrical building was more susceptible to seismic loads.

- Asif Momin, V. M. Bogar.,2019 "Seismic Analysis of Asymmetric Multi-Storied Frame-Shear Wall Building Including Soil Structure-Interaction" IRJET Vol 6, Issue7

In this work, ETabs2016 was used to assess G+ 30 story asymmetrical building models for various plans and shear wall placement at various sites, both with and without the inclusion of soil structure interaction. Models in the C, T, and L shapes were examined using response spectrum analysis.

For all models, the SSI structure's lateral story displacement reduces as shear walls are added. In addition to making the structure more stiff in the lateral direction—which is necessary, the addition of shear walls also reduces lateral deflection. Buildings with flexible bases had lower base shear values than those with fixed bases. In soft, medium, and hard soil with and without SSI, the maximum story displacement in an L-shaped building was higher than in a C- and T-shaped building.

- Mohammad Aminnia, Mahmood Hosseini.,International Journal of Civil and Environmental Engineering Vol 9, No10.

This study examined the seismic behavior of multi-story reinforced concrete vertically chamfered buildings with 7, 10, 12, and 15 stories by utilizing more suitable shear wall forms and arrangements. Forms and configurations that were taken into consideration included L, T, U, Z, and rectangular plans that were either inside the core or outside the frames. Based on a set of chosen earthquake recordings and the outcomes of several nonlinear time history analyses, a comparison of the seismic behavior of the buildings, including roof displacement, plastic hinge development, and their distribution structures, was carried out.

The study determined that the outer frames of the structure with Z & T shaped shear walls produced a more reliable response; however, the Z form has certain practical constraints.

- Basu Dhakal,Richika Rathore.,2022 "Seismic Analysis of Vertically Irregular RC Building Frame with and without shear wall using NBC 105 : 2020" IJIREM Vol 9, Issue 5

In this study, ETABS Software was used to assess a ten-story structure under seismic stresses that had shear walls on the outer periphery of the system. Comparisons were made between the reactions with respect to displacements, overturning moments, member forces, base shear, and storey shear.

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It was determined that a shear wall can lessen structural displacement by roughly 78%.The overturning moment is increased by 23% in comparison to models that do not have a shear wall. In comparison to the other models, the shear wall model has a stronger base shear. When implemented, shear walls lessen a structure's storey drift.

- Sachin Kumar Dangi, Saleem Akhtar.,2019 "Seismic analysis of a RC building on sloping ground with shear wall at different positions" IP Conf. Proc. 2158, 020030

This study examined how a G+6 structure behaved under seismic forces on sloping ground with and without shear walls at varying inclinations (15°, 30°, and 45°). Using StaadPro, 20 examples with shear wall placements at the core, corner, and periphery were examined.

By adding shear walls in various configurations, buildings on sloping terrain can significantly improve their seismic performance. This is because it significantly reduces lateral displacement and member forces. The maximum displacement was recorded on a 45° slope without a shear wall, indicating that the risk rises as the slope becomes more inclined. The most effective locations for shear walls to resist axial and lateral loads respectively are at the corners and on the periphery. Because of the shear wall's dead load, base shear is maximum.

- Buddharatna Ingole, Prof.Bharti Changode.,2022 "Seismic Analysis of Positioning of RC Shear Wall and Bracing on Lateral Performance of Building Having Re-Entrant Corners" IJARSCT Volume 2, Issue 9

This study used the STAAD - PRO program to assess the angles of the input components in the seismic analysis of the placement of the RC shear wall and the lateral characteristics of the L & T shaped building. At the front side and center of the re-entrant corner building, shear walls were placed. Compared to other models, the model with a shear wall at the core showed the greatest horizontal reaction. Additionally, the same model showed the lowest plate stresses.

- Gaikwad Ujwala Vithal.,2017 "Effect of Shear Wall on Seismic Behavior of Unsymmetrical Reinforced Concrete Structure" IJRSI Vol IV, Issue X

In this work, an 11-story horizontally asymmetrical structure was analyzed using the Response Spectrum approach and shear wall was used to reduce torsion. There were five distinct cases: two walls parallel to the X axis and three walls parallel to the Y axis, and four concentric walls at lift, parallel to the X axis, parallel to the Y axis, and at the outside corners. In each of these instances, various shear wall thicknesses of 150 mm, 200 mm, 300 mm, and 400 mm were employed.

It was found that, in both directions, the base shear for a concentric shear wall was less than that of a building without a shear wall. Because of EQX & EQY, there was no apparent change in base shear or torsion when the shear walls were kept parallel to the Y direction.EQX and EQY had a reduction in base shear to 28% to 35% when shear walls were positioned at the exteripredges. In all five situations, increasing the thickness of the shear wall did not yield much strength, making the design uneconomical. Minimum base shear and torsion was seen in the case of shear walls positioned at corners.

II. CONCLUSIONS

Based on the above literature review, the study concludes several points as below.

- Using shear walls, storey shear is increased and displacement is reduced.
- Shear wall position at center gives lower maximum storey displacement, more drift and more bending moment.
- Shear wall at core gives lowest maximum storey shear.

REFERENCES

[1]. Kamalroop Kaur and Balwinder Singh., "Seismic Analysis of Symmetric and Asymmetric Structures with and without Shear wall using Etabs software,"IOP Conf Series,Earth and Environmental Science 889,2021, 012043 , doi:10.1088/1755-1315/889/1/012043.

[2]. Bush R.C.Research Scholar a, Shirkol A.I. a, Sruthi J.S. b, Ajay Kumar c., "Study of seismic analysis of asymmetric building with different shapes of staggered openings and without openings in Shear Wall", Elsevier, Volume 64,Part 2,2022, https://doi.org/10.1016/j.matpr.2022.05.073.

[3]. Mayank Barser,Bush Rc, Anoop I Shirkol., "Performance analysis of asymmetrical RC structures using different configurations of shear wall,", Elsevier, Volume 88, Part 1, 2023, https://doi.org/10.1016/j.matpr.2023.04.493.

[4]. Sammelan Pokharel, S. Lakshmi Ganesh, G. Sabarish., "Seismic Performance of Symmetric and Asymmetric Multi-Storied Buildings, "International Journal of Recent Technology and Engineering (IJRTE),ISSN: 2277-3878, Volume-8 Issue-1S3, June 2019,Retrieval Number: A10660681S319/19©BEIESP.

[5]. Gagandeep and Aditya Kumar Tiwary., "Analysis of Asymmetrical Building with Shear Wall under Seismic Loading, "International Journal of Engineering Science Invention (IJESI),ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726,Volume 7, Issue 6 Ver III ,June 2018, https://www.researchgate.net/publication/326547655_Analysis_of_Asymmetrical_Building_with_Shear_Wall_under_Seismic_Loading.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24MAY457

[6]. Patil A. G.,Prof. Hamane A. A.,"Analysis of Shear wall at Different Location for Asymmetric High Rise Building" International Journal of Science & Engineering Development Research (www.ijsdr.org), ISSN:2455-2631, Vol.3, Issue 7, page no.250 - 255, July-2018, Available :http://www.ijsdr.org/papers/IJSDR1807042.pdf.

[7]. Shagun Chaddha and Navpreet Soni.,"Effect of Shear Wall on Asymmetrical Building with Variation in Support Condition. International Journal of Civil Engineering and Technology, 8(7),ISSN Print: 0976-6308 and ISSN Online: 0976-6316, 2017, pp. 730–741, http://iaeme.com/Home/issue/IJCIET?Volume=8&Issue=7.

[8]. Osama Ahmed, Dr.s.Amaresh Babu., "Analysis Of Asymmetrical Buildings With Base Isolator, Shear Wall And Bracing System Located At Near Fault Region Using Non Linear Time History," IJEDR, Volume 7, Issue 4 ,ISSN: 2321-9939,2019, https://www.ijedr.org/papers/IJEDR1904102.pdf.

[9]. Manoj Chougule, Prof V.V Nair., "Capacity Spectrum Analysis of R.C.C Structure with & without shear wall in plan symmetry & asymmetry," IJRTI ,Volume 8, Issue 4,ISSN: 2456-3315, 2023,https://www.ijrti.org/papers/IJRTI2304066.pdf.

[10]. Asif Momin, V. M. Bogar.,"Seismic Analysis of Asymmetric Multi-Storied Frame-Shear Wall Building Including Soil Structure-Interaction "International Research Journal of Engineering and Technology (IRJET) ,e-ISSN: 2395-0056,p-ISSN: 2395-0072,Volume: 06, Issue: 07 ,July 2019, https://www.irjet.net/archives/V6/i7/IRJET-V6I7339.pdf.

[11]. Mohammad Aminnia, Mahmood Hosseini., "The Effects of Placement and Cross-Section Shape of Shear Walls in Multi-Story RC Buildings with Plan Irregularity on Their Seismic Behavior by Using Nonlinear Time History Analyses"World Academy of Science, Engineering and Technology, "International Journal of Civil and Environmental Engineering,Vol:9, No:10, 2015, scholar.waset.org/1307-6892/10002559.

[12]. Basu Dhakal, and Richika Rathore., "Seismic Analysis of Vertically Irregular RC Building Frame With and Without Shear Wall Using NBC 105:2020,"International Journal of Innovative Research in Engineering & Management (IJIREM) ISSN: 2350-0557, Volume-9, Issue-5, October 2022, https://doi.org/10.55524/ijirem.2022.9.5.23.

[13]. Sachin Kumar Dangia and Saleem Akhtar., "Seismic analysis of a RC building on sloping ground with shear wall at different positions "Proceedings of the International Conference on Sustainable Materials and Structures for Civil Infrastructures (SMSCI2019) AIP Conf. Proc. 2158, 020030-1–020030-10,SMSCI2019, https://doi.org/10.1063/1.5127154.

[14]. Mr. Buddharatna Ingole and Prof. Bharti Changode., "Seismic Analysis of Positioning of RC Shear Wall and Bracing on Lateral Performance of Building Having Re-Entrant Corners, "International Journal of Advanced Research in Science, Communication and Technology (IJARSCT),ISSN (Online) 2581-9429,Volume 2, Issue 9, June 2022, DOI: 10.48175/568,https://ijarsct.co.in/Paper5196.pdf.

[15]. Gaikwad Ujwala Vithal., "Effect of Shear Wall on Seismic Behavior of Unsymmetrical Reinforced Concrete Structure" International Journal of Research and Scientific Innovation (IJRSI) | Volume IV, Issue X, ISSN 2321–2705, October 2017, https://www.rsisinternational.org/IJRSI/Issue47/61-81.pdf.

[16]. Proving shear walls at eccentric positions can increase force and torsion on structure. This can lead to uneconomical structure.