Journal of Advanced Engineering Research
ISSN: 2393-8447
Volume 9, Issue 1, 2022, pp.47-52

Review: Seismic Performance in High Rise Structure with Shear Wall Both with and without an Opening

Radhika Hande[1*], Prof. V.R. Harne[1]

Shri Ramdeobaba College of Engineering and Management, Nagpur, India

*Corresponding author email: handerp@rknec.edu

ABSTRACT

In the seismic performance of high-rise buildings, Shear walls are one of the most inventive earthquake-resistant design strategies. A shear wall is a vertical element or structure which resists lateral load caused due to wind and earthquakes and can protect buildings from collapse. The shear wall can resist large horizontal forces and support gravity load simultaneously. A shear wall can provide adequate strength and stiffness to the building. In this paper, we have aimed to study various research done for improving the performance of buildings having shear walls with opening and shear walls without opening with different locations, Shapes, Sizes and different parameters like displacement, storey shear, storey drift, stiffness, and bending moment shear force. Earlier work was done on the symmetric building having shear walls with opening and without an opening outline of the project work is a seismic analysis of shear walls with opening and without opening by using the response spectrum method by using software with irregular buildings with different parameters like storey drift, story stiffness, lateral displacement, shear force and bending moment.

Keywords: shear wall, openings, displacement, storey drift.

1. INTRODUCTION

A shear wall is a vertical plate-like RC structure which resists lateral load caused due to wind and earthquakes and it can protect buildings from collapse. The shear wall's main purpose is to make the structure more rigid, strong, and stiff. During an earthquake, the shear wall absorbs moments and shear forces and reduces torsional response. The shear wall is one of the most important structural elements installed in high-rise structures located in an earthquake zone since they must withstand lateral forces that are applied to the structure. The shear wall can be constructed from the foundation to throughout a building's height.

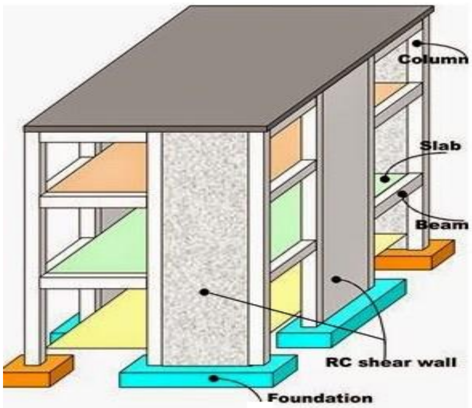

Figure 1. Shear wall

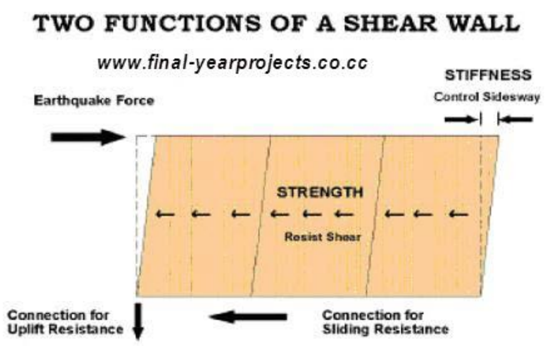

Figure 2. Function of shear wall

The majority of the structures in India are low-rise. As a result of their simplicity in construction and affordability, RCC members are frequently used. However, high-rise construction is expanding in tandem with population expansion. It has been shown that high-rise structures perform significantly better and cost less when composite construction is used instead of RCC structure. Because the dimension of the beams and columns are so large and the amount of steel required is higher for high-rise structures, there is a lot of congestion at the joints, which makes it challenging to vibrate concrete at the joints and also causes a larger displacement. **(Akansha Dwivedi et.al 2020).**

In a structure, a shear wall placed strategically can serve as an effective lateral force resisting system while also serving additional purposes. The number of shear walls can bear gravity loads as well as resist lateral pressures when the floor space of the structure is permanently divided into all storeys (**Mahdi Hosseini et.al 2017**).

Buildings with regular geometry will sustain more damage than those with irregular geometry because of the absence of formal distributed mass, stiffness, and height (**Wesam Al-Agha et.al.2020**)

Connect the shear wall piers with spandrels in the event of openings to increase the effectiveness of the shear walls. The spandrel is the segment of the shear wall above the opening, while the pier is the section of the shear wall between two openings. A connected shear wall, which was created by linking spandrels of piers of shear walls, appeared as the final wall (**V. Naresh Kumar Varma et.al 2020**).

When there is a storey in a building without a shear wall or shear wall with proper openings, it is known as a soft storey building. The opening area of the shear wall should be 30 per cent of the total area of that particular shear wall, reducing the ill effects of twists in buildings. When shear walls are situated with a proper opening in the building, they can create an efficient lateral force resisting system by reducing lateral displacement (**Md. Maksudul Haque et.al 2018**).

The various architectural purposes such as doors and windows, we need to provide openings in a large concrete shear wall at different locations. From an architectural perspective, opening sizes and locations may differ. The shear wall behaviour is affected by the piercing, which alters the way forces are transferred, reduces stiffness and strength, and lowers the amount of ductility in the material. Since lateral forces are applied to each shear wall individually based on their relative stiffness, the relative stiffness of shear walls is crucial **(Dr Asif Husain et. al 2017)**.

2. LITERATURE REVIEW

The shear wall is a vertical element, it resists lateral force caused by wind, blasting and earthquake(**WesamAl-Agha et.al.2020**). A shear wall is a wall that strengthens the building so that it can support the loads placed on the structure (**V. Naresh Kumar Varma et.al 2020**). A shear wall serves as a barrier against the shear caused by lateral forces (**Priya Kewatet. al 2020**). Shear wall is a term used to describe an element that resists horizontal stress and earthquake **(Akansha Dwivedi et.al 2020)**. Improvements to the lateral load resistance system against earthquake and wind loads are made using the shear wall construction. **(Amitkumar Yadav et.al 2019)**. A shear wall is a vertical structural part that is capable of withstanding the combination of the shear, moment, and axial load brought about by the transfer of gravity force as well as lateral stress to the wall from other structural members (**Md. Maksudul Haque et.al 2018**). The structural component known as the shear wall represents horizontal or lateral forces. **(T.Subramani et.al 2018).**For lateral load resisting systems in high-rise structures, the shear wall is one of the most often utilized walls **(Dr Asif Husain et. al 2017).** Shear walls are walls which contribute to the stiffness and strength during earthquakes **(Rajat Bongilwar et.al2017)**. Shear walls are frequently used as a vertical structural feature to resist lateral load that may be caused by the impact of wind and earthquakes **(Ashok Kankuntla et.al 2016)**. Shear walls are one of the best ways to protect high-reinforced (RC) structures from lateral loads **(Saleem Malik Yarnal et.al 2015)**. A shear wall is a wall which acts like an earthquake resisting member **(P. P. Chandurkar et.al 2013).** Shear walls are frequently used as a vertical structural component to counteract lateral forces that may be brought on by the effects of wind and earthquakes **(Sharmin Reza Chowdhury et.al 2012)**. To resist the effects of lateral forces acting on a building, a shear wall is a wall made of braced panels with hard concrete surrounding it **(Anand, N. Mightraj et.al 2010)**.

2.1 Significance and behaviour

A shear wall is used to prevent the structure from collapsing under seismic stresses. Damage will occur to buildings with regular geometry that lack formal distributed mass and stiffness as well as elevation. Compared to damage in irregular buildings, this damage is far smaller (**WesamAl-Agha et.al.2020**). shear walls to strengthen the structure and make it able to withstand loads placed on it For practical reasons, these shear walls feature window openings to prevent the passage of seismic loads (**V. Naresh Kumar Varma et.al 2020**). The shear wall gives stiffness to the building (**Priya Kewatet. al 2020**). Shear walls are important earthquake-resistant structural components that provide lateral load resistance by acting as an effective bracing system **(Akansha Dwivedi et.al 2020)**. A shear wall's basic purpose is to improve stiffness for lateral load resistance (**Md. Maksudul Haque et.al 2018**). During seismic excitation, the shear wall contributes to absorbing moments and shear forces and reduces the torsional effect **(Dr Asif Husain et. al 2017).** Shearwall significantly affects the vulnerability of structure **(Rajat Bongilwar et.al 2017).** Shear walls have great load-resisting properties and stiffness of building **(Ashok Kankuntla et.al 2016)** Because shear walls make a major contribution to the lateral load-resisting system, shear walls play an important role in enhancing the stiffness of the structure, especially in non-linear structural analysis **(Saleem Malik Yarnal et.al 2015).** It's essential to properly determine the seismic responses of the walls since the characteristics of these seismic shear walls influence the response of the structures **(P. P. Chandurkar et.al 2013)**. Because its major purpose is to improve stiffness for lateral load resistance, a shear wall provides a structurally effective way to strengthen a building's structural structure **(Sharmin Reza Chowdhury et.al 2012).**

3. DESCRIPTION OF THE LITERATURE

Using the Equivalent Static and Response Spectrum approach by the finite element program m (ETABS V16.2), the seismic performance of a building with a G+9 irregular configuration was investigated. The structure was intended to withstand a seismic zone III. ETABS software was used to produce the results. Models were compared using the Equivalent Static Method and the Response Spectrum Method. The Response Spectrum Method outperformed the Equivalent Static Method in both directions for base shear and bending moment values (X, Y) (**WesamAl-Agha et.al.2020**). A residential building with a G+10-storey height was taken into account for the seismic zone IV study. Results were obtained using the ETABS software, which provided a shear wall at the building's corner with and without an opening. A shear wall gave the structure more strength by increasing stiffness and decreasing storey drift and displacement values. It was found that placing a shear wall at the corner was more successful than placing one in the middle (**V. Naresh Kumar Varma et.al 2020)** The building of the G+11 story was taken into consideration for study, and T and C shape shear walls with varied thicknesses of 150mm, 250mm, and 350mm were given at the corner, at the edge, and the centre. Staad.Pro V8i software was used to calculate results for seismic loads in zone V. With an increase in shear wall thickness, the value of storey drift and displacement was reduced. C shape shear walls performed better than T shape shear walls in the shear wall's centre and edge positions. While T shape shear walls outperformed C shape shear walls in the corner location (**Priya Kewatet. al 2020**). ETABS software seismic zone IV study of a G+19 storey skyscraper. Techniques for response spectrum analysis and static analysis were employed. RCC constructions in Models 1 and 2 without shear walls, whereas Model 3 was a building with composite columns but no shear wall and Model 4 was a building with composite columns but a shear wall. In the case of the RCC-framed building, the lateral displacement was exceedingly high. It was demonstrated that the presence of a shear wall causes the displacement at the top of RCC and composite columns to reduce by around 40% in the case of static analysis and 47% in the case of response spectrum analysis. In the case of static analysis, the drift at the top was shown to be decreased by 13% and in the case of response spectrum analysis, by 23% in the presence of a shear wall. Comparing composite column construction to RCC column construction, the drift was decreased by around 25%. When compared to RCC column construction, the structure was more rigid when composite columns were used. Consequently, the shear wall improved the building's rigidity **(Akansha Dwivedi et.al 2020)**. The 15-storey building was analyzed by using ETABS software for seismic zone II. Rectangular and triangular openings were provided for 30% of the total area of the shear wall considered for the opening. The deflection value was more in the triangular opening as compared to the rectangular opening. The shear force and bending moment value were more rectangular as compared to the triangle (**Md. Maksudul Haque et.al 2018**). G+9storey building was analysed by using SAP2000.v.17.1.1 software. It was observed that work was done in two parts, in the first part, the centre opening of variable sizes from 0%,7%,13%,27%, and 40% of the area of the shear wall. In the second part, the same size of opening but location was changed in the horizontal direction from 0.5m to 1.5m. The maximum displacement at the top storey in the response spectrum method was found 21% more value in 40% opening area of the shear wall than without opening shear wall. The decrease in the value of stiffness with an increase in the value of the opening of the shear wall of the building **(Dr Asif Husain et. al 2017).** Using ETABS software for seismic zone II, the G+8 storey building was taken into account for analyses with and without shear walls. Compared to the base shear value without the shear wall model, the base shear value increased by 146%. In comparison to the case without the shear wall model, the displacement value dropped by 90.97% in the X direction and 87.14% in the Y direction. When compared to a model without a shear wall, the value of storey drift fell by 90.20 per cent in the X direction and 84.78 per cent in the Y direction. Compared to a model without a shear wall, the bending moment and shear force were lower in the model with a shear wall **(Rajat Bongilwar et.al2017).** G +14storeybuilding with various types of opening and different shapes of the opening were analyzed by using SAP software for seismic zone V. The maximum Column Moments and axial force were observed in the 1.5(Dead + EQx) case **(Ashok Kankuntla et.al 2016).** G+11 storey building was analyzed for shear wall with and without opening by using ETABS 2013 software for seismic zone III. Shear wall with opening 10%,20%,30%,40% were considered for analysis. Base shear value and storey drift value was greater in the shear wall with the opening as compared to the shear wall without an opening **(Saleem Malik Yarnal et.al 2015).** ETABS software was used to assess the G+9 story building for seismic zones II, III, IV, and V. Four models were taken into account during the study. Model 1: The bare-frame structure's floor layout. Model 2: Dual system floor layout with a shear wall on either side. Model 3: Dual system floor layout with a 4.5-meter-long shear wall on the corner Model 4: Dual system floor layout with a 2 m-long shear wall at the corner. When compared to zone V, displacement was reduced by 40% in zones II, III, and IV. At zone V, storey drift was greatest, while at zone II, it was lowest **(P. P. Chandurkar et.al 2013).** G+5-storey building was analyzed by using ETABS software. Displacement was increased with an increase in the size openings of doors and windows **(Sharmin Reza Chowdhury et.al 2012).**

4. RESULT AND INTERPRETATION

As per the above graph (Fig (c)), it can be observed that the displacement value ranges from 0.1 to 51 mm, which means that it is within the permissible range according to the IS code. Shear walls are more effective when placed at corners rather than in the middle of a structure. Maximum and minimum displacement values were reported in zones V and II, respectively. By evaluating structures with and without shear walls, displacement values are reduced by 50.87 %, 80%, 90.9 %, and 51 %, respectively.

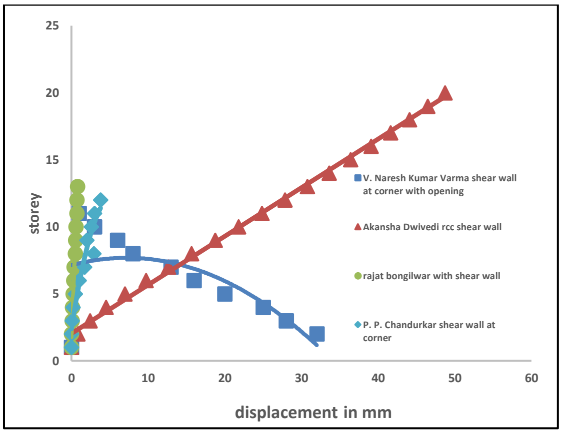

Figure 3. Displacement

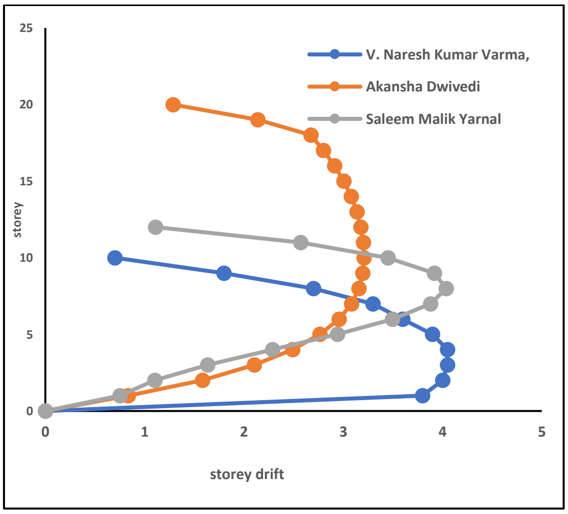

Figure 4. Storey drift

As per the above graph (Fig (d)), it can be observed that the value of storey drifts ranges from 0.7mm to 4mm, which means that it is within the permissible range according to the IS code. All the graphs are plotted for building with the shear wall. The values are taken for different zones. Comparing structures with shear walls with those without one reduces the value by 36.67%, 43.63%, and 52%.

5. CONCLUSION

As per the above literature

- A shear wall with an opening and a shear wall without an opening with adequate size shape, location, an important role, window opening of size 1.2m*1.2m more effective than 1.8m*1.8m, providing the rectangular shape was considered more effective than the triangular shape of the opening, placing the shear wall at the corner is more effective than the periphery of the building.
- The maximum displacement was observed at 20% opening of the total area of the shear wall.
- The maximum storey drift was observed at 10% opening of the total area of the shear wall.
- The maximum stiffness was observed at 10% opening of the total area of the shear wall.
- Shear wall increases strength and stiffness of building, as per above literature it ranges from 361815.448kn/m to 6903487.03 kn/m. It increases strength by 18.7% for building with shear walls than building without shear walls.
- Base shear value decreases by 81.2% by applying a shear wall in a building.
- Displacement is less in buildings having shear walls as compared to buildings without shear walls, it reduced up to 90%.
- Storey drift value building with a shear wall decreases 30 to 70% than building without a shear wall.
- A shear wall reduces the earthquake or wind effect coming on the structure.

REFERENCES

[1] WesamAl-Agha, Nambiappan Umamaheswari (2020), “Analytical study of irregular reinforced concrete building with shear wall and dual Framed-Shear wall system by using Equivalent Static and Response Spectrum Method” *Materials Today: Proceedings*.Volume 43, Part 2, 2021, Pages 2232-2241.

[2] V. Naresh Kumar Varma, Uppuluri Praveen Kumar (2020), “Seismic response on the multi-storied building having shear walls with and without openings”, *Materials Today: Proceedings*, Volume 37, Part 2, 2021, Pages 801-805.

[3] Priya Kewat, Kavita Golghate (2020), “Effect of Shear Walls at Different Locations with Varying Thickness in Multistorey Buildings”, *International Research Journal of Engineering and Technology*

[4] 1Akansha Dwivedi,2 B.S Tyagi.“Seismic Analysis of Building with and Without Shear Wall for Building with RCC and Composite Column”, *International Journal of Engineering Research & Technology (IJERT)* http://www.ijert.org ISSN: 2278-0181 Vol. 9 Issue 06, June-2020.

[5] Prafoolla Thakre, Sagar Jamle, Kundan Meshram, “Opening Area Effect of Shear Wall in Multistorey Building under Seismic Loading”, *International Journal of Advanced Engineering Research and Science*, Vol-7, ISSN: 2349-6495(P) | 2456-1908(O)

[6] DrDr. Prashant Hiwase, Sushant G. Kute, Dr Prasad P. Dahale, UdaysinghPatil(2019), “Seismic Behavior of L-Shape RC Building and Effect of the Shear wall” *Helix* Vol. 9 (6): 5771-5774.

[7] Amitkumar Yadav, Dr Vikram Patil, SomanagoudaTakkalaki (2019), “Analysis of Tall Structures with and without Openings in Shear Walls”, *International Journal of Innovative Science, Engineering & Technology*, Vol. 6 Issue 5.

[8] Md. Maksudul Haque, Md. Hasibulhasan Rahat, Rifat-Al-Saif, S. Reza Chowdhury, “Numerical Analysis Of High Rise Rcc Buildings With Shear Walls Having Opening Of Different Shapes”.*International Journal of Advances in Mechanical and Civil Engineering*, ISSN: 2394-2827 Volume-5, Issue-2, Apr.-2018.

[9] Dr. Asif Husain, Jabbar Ahmad, Abdul Mujeeb, Hammad Ahsan,” Seismic Analysis Of Rc Shear Wall Frame Buildings With And Without Openings In Shear Wall”, *International Journal of Innovative Research in science and Engineering*, Vol no 3, Issue 04,2017

[10] Vivek Pal, Gaikwad Yogesh, Pawar Chetan, Vishwajeet Kadlag, Nikhil Maske, “Seismic Analysis of RCC building with shear walls using staad pro”, *IJARIIE*-ISSN(O), 2018, 2395-4396.

[11] Rajat Bongilwar, V R Harne* and Aditya Chopade, “Significance of Shear Wall in Multi-Storey Structure With Seismic Analysis”, *ICRAMMCE*, 2017

[12] Ashok Kankuntla, PrakarshSangave, Reshma Chavan,“ Effects of Openings in Shear

Wall".*Journal of Mechanical and Civil Engineering*, Volume 13, Issue 1 Ver. II (Jan. - Feb. 2016), PP 01-06.

[13] Saleem Malik Yarnal,Sagar S Allagi.Prashant M Topalakatti.Arif Ahmed Mulla, "Non-Linear Analysis of Asymmetric Shear Wall with Openings" *International Journal of Engineering Research & Technology (IJERT)* ISSN: 2278-0181 Vol. 4 Issue 08, 2015.

[14] P.PChandurkar, dr.P.S.Pajgade, "Seismic analysis of RCC Building With And Without Shear wall", *IJMERS*, Vol. 3,ISSN-2244-6645, 2013.

[15] Sharmin Reza Chowdhury, M.A. Rahman, M.J.Islam, A.K.Das, "Effects of Openings in Shear Wall on Seismic Response of Structures", *International Journal of Computer Applications* (0975 – 8887) Volume 59– No.1., 2012

[16] Ruchi Sharma, Jignesh A. Amin, "Effects of opening in sheer walls of 30- storey building", *Journal Of Materials And Engineering Structures* 2, 2015

[17] Anand N., Mightraj C., Prince Arulraj G. "Seismic Behaviour of RCC Shear Wall Under Different Soil Conditions", *Proceedings of Indian Geotechnical Conference*, Organized by IGS Mumbai Chapter & IIT Bombay, 2015