Effect of Shear Wall on Seismic Performance of RC Open Ground Storey Frame Building

Samarjit Singh [1], Rohit Rai [2]

[1]*Post Graduate Student, Structural Engineering, Maharashi University Of Information Technology, Lucknow, Uttar Pradesh, India*
[2]*Assistant Professor, Dept of Civil Engg. Maharashi University of Information Technology, Lucknow, Uttar Pradesh, India*

---***---

Abstract - *Buildings with an open ground story are commonly used in India as urban areas have very important parking spaces. However, the seismic performance of the buildings indicated by previous earthquakes is consistently inferior. Several references indicate that the use of shear walls can enhance the performance of such buildings without impeding the free movement of the vehicle within the parking lot. This research is an effort to investigate the performance in this direction when powerful open ground shops and building earthquake resistant walls are in one or two directions. Apart from this, this study strengthens the open ground store and various scenarios by implementing several plans of qualitative factors for comparative purposes according to the proposed approach of IS 1893 (2002). The study shows that the shear wall increases the Basis which listens to the capacity of the OGS building greatly, but the comparison cost is slightly higher on the higher side.*

Key Words: **Open Ground Storey Building, Reinforced concrete shear wall, Multiplication Factor, Linear Static Analysis, Nonlinear Static Analysis (Pushover Analysis).**

1. INTRODUCTION

The idea of an open ground layer (OGS) building was introduced mainly due to the need for parking in the urban provinces. Due to the special features of providing parking facilities on the ground floor of this building, numerous open ground floor buildings have been constructed and are housed in different cities, especially in different countries of the country for residential purposes. In the actual sense, if you keep open the existing reinforced concrete building without providing a masonry wall as a partition wall in the meantime, you will have to provide a parking lot on the ground floor, open this type of structure Building that can be treated as ground or soft layer. The most important problem can prove that the ground floor is inherently very flexible in comparison with other high-floors of this building. This literally means that the relative stair drift of the ground floor is quite large with respect to the upper floor of other buildings during an earthquake. As a result, the ground floor is very weak against other high earthquakes that normally exist on the ground floor of the building. In many parts of the world, in many earthquakes that occurred in recent years, the irregularities and the number of stiffness and strength of the ground floor and the ground floor are enormous. In the past few years, one of the major cities in India where many irrelevant parts of India were built like Ahemdabad consisted mainly of approximately 25,000 five-story buildings and approximately 15,100 story buildings It was. Basically, most of them are open story buildings. In addition, the open-ground building of a huge building is about to build a high-rise residential building with this function. It already exists in different towns and cities in the country which are in moderate high earthquake activity area like the standard in India. Studies after the Bhuj earthquake in Ahemdabad in 2001 clearly show that the open basement building is not safe and very vulnerable to earthquake shaking. Due to the presence of masonry, the upper floors of the wall became much harder than the ground floor. Therefore, the horizontal drift on the ground floor is relatively large, and the upper floor of this building is replaced like a single block. Thereafter, if the pillars of the ground are not strong enough to withstand large horizontal loads like seismic forces, and they do not have sufficient ductility, they are very damaged and may lead to catastrophic collapse of such buildings

1.1 Reinforced Concrete Shear Wall

Theoretical Background

There are intelligent people, such as engineers and scientists, there is no doubt that there are many types of side-effects systems, basically, most are divided into three sections.

1. Reinforced concrete frame

2. Shear Wall System

Dual system, shear wall frame system

From a engineering perspective, the most preferred system for the design of the Gazprombers is a sheer wall frame system. Generally, the thorn walls are usually built on the base level and constantly follow the building height. The thickness specification ends at a maximum height of 150mm and maximum 400 mm in a high standard structure. These structural walls are usually provided in both directions of the building. The thorn wall supports the cosmic load sand due to the effect of diaphragm as well as to prevent the load and transmit the foundation.

2. Shear wall – frame Interaction

Thin wall of this system and R.C. The frame has a combination and prevents lateral load. The probability of formation of wall structure depends entirely on the level of horizontal interaction, which is controlled by coated concrete frames and the relative strength of the shear wall and building height. Structure height and firmness of the RC frame, greater interaction. The RC frame is flushed on the thorn wall with a thorn wall when the thorn wall responds to the bending of the cantilever. The structural compatibility of the lateral reflection creates an interaction between them. Therefore, the combined work of structural elements is really based on both the relative and relative energy of their respective modes. R.C. The horizontal diagram of the thorn wall is similar to the cantilevered column in the same way. Below, the thorn wall works relatively stiffly, so the surface of the floor is less than half the height of the floor surface. Due to the combined effect of the plank wall rotation, the lateral reflections increase very easily. On the other hand, RC frame adopts a shear mode. Basically, the relative reflection of the bottom will be based on the value of the shear force applied to the floor of each floor. When the current system, the thorn wall-frame system, is connected by the use of strong diaphragm action, the non-uniform shear forces grown between them. As a result, as a result of a more financially structured system of general interactions.

2.1 Design details of all the frames

In this study, a 4-crocodile frame of 5 meters width and 4 meter height and a 5 meter column height of 3.2 meters. Basically, all of the moment frames have been designed for ISIL93 (2002) with a moderate soil condition (n standard 10 to 30), which is the maximum for seismic activity zones (which is 0.36g zone V in PGA). Here, concrete and reinforced steel are designed with M25 and Fe415 respectively. It is considered considering all of the gravity and lateral loads of analysis scene, hardening and masonry walls, such as Indian values, from the point of ignition energy, such as the design of Risin frame elements such as beams and columns. Accepted and refined according to IS 456 (2000) IS 13920 (1993). In order to investigate the impact of the radius shear wall on the seismic performance of the concrete building, the reinforced concrete Shear wall design will not be described in detail in accordance with the guidelines and IS456 (2000) and IS13920 (1993) guidelines. For simplicity, such as B F (Naked Frame) O (Open Ground Floor), (in the complete filled frame), all frames are considered in the current study, respectively, in order to apply several floor application of different floor to a coefficient value of open ground story of different quality building. The MF value on the corresponding floor represents, different names are used in combination with different OGS frames.

For example, the X, with the YMCA, refers to the open land, which is used for the first classification of "three-dimensional" and "Y" on the ground floor. Linear static analysis, maximum gravity and lateral load is defined in 1893 (2002) for empty frames and an open basement. It has been a brick without the wall to fill the wall of the Rhesine Shear wall having four loads of composition, it is considered for the impact. Currently, C is load loaded, IL burden loads, and El is seismic load here, C (Deal + IL), 1.5 (DL + EL), 1.5 (DL + EL) and 0.9 DL + DL are loaded.

Table 1: Sections and Reinforcement details for Columns

Frame Configuration	Floor	Width (mm)	Depth (mm)	Reinforcement Details
B 1.0	1	350	350	8–20φ
	2–4	350	350	8–18φ
F 1.0	1	350	350	8–20φ
	2–4	350	350	8–18φ
O 1.0	1	350	350	8–20φ
	2–4	350	350	8–18φ
O S 1.0	1	350	350	8–20φ
	2–4	350	350	8–18φ
O S R1.0	1–2	300	300	4–20φ
	3–4	300	300	4–20φ
O 1.5	1	425	425	8–22φ
	2–4	350	350	8–18φ
O 2.0	1	425	425	8–25φ
	2–4	350	350	8–18φ
O 2.5	1	475	475	12–25φ
	2–4	350	350	8–18φ
O 3.0	1	600	600	16–25φ
	2–4	350	350	8–18φ
O 1.5,1.5	1–2	425	425	8–22φ
	3–4	350	350	8–18φ
O 2.0,2.0	1–2	425	425	8–25φ
	3–4	350	350	8–18φ
O 2.5,2.5	1–2	475	475	12–25φ
	3–4	350	350	8–18φ
O 3.0,3.0	1–2	600	600	16–25φ
	3–4	350	350	8–18φ

Table 2: Sections and Reinforcement details for Beams with One Multiplication Factor

Frame Configuration	Floor	Width (mm)	Depth (mm)	Reinforcement Details Top — Bottom
B 1.0	1–2	300	375	5–20φ — 4–20φ
	3	300	375	4–20φ — 3–20φ
	4	300	325	4–20φ — 3–20φ
F 1.0	1–2	300	375	5–20φ — 4–20φ
	3	300	375	4–20φ — 3–20φ
	4	300	325	4–20φ — 3–20φ

O 1.0	1-2	300	375	5-20φ — 4-20φ
	3	300	375	4-20φ — 3-20φ
	4	300	325	4-20φ — 3-20φ
O S 1.0	1-2	300	375	5-20φ — 4-20φ
	3	300	375	4-20φ — 3-20φ
	4	300	325	4-20φ — 3-20φ
O S R1.0	1-2	300	325	4-20φ — 3-20φ
	3	300	325	4-20φ — 3-20φ
	4	300	300	3-20φ — 2-20φ

Table 3: Sections and Reinforcement details for Beams with different Multiplication Factor for Ground and First Storey Only

Frame Configuration	Floor	Width (mm)	Depth (mm)	Reinforcement details Top — Bottom
O 1.5	1-2	300	375	5-20φ — 4-20φ
	3	300	375	4-20φ — 3-20φ
	4	300	325	4-20φ — 3-20φ
O 2.0	1-2	300	375	5-20φ — 4-20φ
	3	300	375	4-20φ — 3-20φ
	4	300	325	4-20φ — 3-20φ
O 2.5	1-2	300	375	5-20φ — 4-20φ
	3	300	375	4-20φ — 3-20φ
	4	300	325	4-20φ — 3-20φ
O 3.0	1-2	300	375	5-20φ — 4-20φ
	3	300	375	4-20φ — 3-20φ
	4	300	325	4-20φ — 3-20φ
O 1.5,1.5	1-2	300	375	5-20φ — 4-20φ
	3	300	375	4-20φ — 3-20φ
	4	300	325	4-20φ — 3-20φ
O 2.0,2.0	1-2	300	375	5-20φ — 4-20φ
	3	300	375	4-20φ — 3-20φ
	4	300	325	4-20φ — 3-20φ
O 2.5,2.5	1-2	300	375	5-20φ — 4-20φ
	3	300	375	4-20φ — 3-20φ
	4	300	325	4-20φ — 3-20φ
O 3.0,3.0	1-2	300	375	5-20φ — 4-20φ
	3	300	375	4-20φ — 3-20φ
	4	300	325	4-20φ — 3-20φ

3. Performance Criteria

In the era of performance-based engineering, researchers and engineers are important to identify at this moment when reaching the limited conditions (such as non-structural damage, structural damage, fall). In this study, the following performance values are defined.

Performance limits (PL1) - Steel strains (positive) compared to the proportion of the steel component ratio is more stringent than strain testing. This parameter has been set to a value of 0.0038, which is shown here in the table.

Performance limit (PL 2) - You can test the concrete concrete of the concrete (negative) by observing the concrete strains freely, which is larger than the final crushing strain of tidy concrete components. Currently, a value of 0.005 is accepted and these parameters are available in the table.

Performance limit (PL3) - Core concrete crusher can be detected by examining the core concrete strain (negative) more than the final crushing strain of concrete concrete components. Here, the current value of -0.002 is accepted and shown in this parameter table.

3.1 Compare the power limits to the performance of PL1

The power of all frames refers to the power of relatively open groundforms, the PL1 performance level O1.0. The base shear reference value is obtained as approximately 618.78 kN and similar lateral displacement is 0.031 m.

1. Base value is achieved in the first yield reinforced steel, in the resin shear walls, under the seismic load, the corporation displacement of open soil frames with increase of 88.73%, increase to 51.62%.

2. Apply different modes in the underground part of an open basement frame, from 1.5 to 3.0 in 0.5 inches distance. When the base price is recognized the rehabilitation of the first breakdown steel of the hair, each and the lateral displacement increases from 31.05% to 73.32% while maintaining a fixed standard of 19.35%.

3. By applying various underground properties, we first place an open basement frame of 1.5 in the first paragraph 1.5, 1.5 to 3.0, 3.0 and 0.5. The first yield point of shear base is established in the reinforcement steel is improved without exhibiting changes of the literal displacement standard of 19,35%, which is developed up to 78,20% to 32.82%.

4. In the empty frame, the reinforcement steel yield is usually made at 486.56kN at least base shear, in less than 21.36%, 65.55% relative to the lateral displacement of the open-bottom stairs frames increased greatly.

5. Replacement steel parallel displacement volume 32.25%, 91.14% has a large bases shear capacity when complete masonry fill wall frame, the yield reduces compared to the first open frames.

Considering the frame of the shear walls, the value of the base breaks the first breakdown of the base when the hair decreased, exactly the same parallel displacement increases 86,70% of the capacity, 51.62% and the open ground frame does not have a resin shear wall.

Table 4: Comparison of capacities at Performance limit PL1

Frame Model	Base Shear (kN)	% Base shear Capacity	Roof Displacement (m)	% in Roof Displacement Capacity
B 1.0	486.56	21.36	0.090	65.55
O 1.0	618.78	-	0.031	-
F 1.0	6983.77	91.14	0.021	32.25
O S 1.0	5492.07	88.73	0.015	51.62
O S R 1.0	4655.54	86.70	0.015	51.62
O 1.5	897.37	31.05	0.025	19.35
O 2.0	1037.96	40.38	0.025	19.35
O 2.5	1503.83	58.85	0.025	19.35
O 3.0	2311.60	73.23	0.025	19.35
O 1.5,1.5	921.15	32.82	0.025	19.35
O 2.0,2.0	1078.70	42.64	0.025	19.35
O 2.5,2.5	1654.84	62.60	0.025	19.35
O 3.0,3.0	2838.55	78.20	0.025	19.35

3.2 Comparison of capacities at Performance limit PL2

The power of all frames refers to the power of relatively open groundforms, the PL1 performance level O1.0. The base shear reference value is approximately 648.75 KN and similar lateral displacement is obtained as 0.061 m.

1. The primary spalling of the base part was possible to concrete concrete, the value in the parallel displacement of the open ground frame with the Rhesine Shear wall, it increased 91,92% and decreased to f32.78%.

2. Using different quality factors for open ground floor frames, in the range of 1.5, 3.0, 0.5, the interval range. Based on the first spalling value-based shear compressed concrete, 76.10% increase from 76.10% to 34.80% is the corresponding diagonal displacement volume, which is defined as the top, consistent with the first open frames, respectively, 16,39%

3. First create a open basement frame of 1.5 with a different factor factor on the ground, 1.5 to 3.0, 3.0 with an interval of 0.5, 0.5 increment each. When first spalling of unconfined concrete recognized, the base shear capacity gradually increases from The relative parallel displacement capacity ranges from 21.46% to 80.25%, is consistent with the fixed open land frames and then decreases by 24.59% per second.

4. In the frame frame, the incompatible concrete primary crusher is usually less than 10.50% in 580.62 KN base sarees and the significant increase in lateral displacement for open basement frames is 62.35%.

5. The complete conductive filling wall frame holds 92.18% of the capacity of a huge base building and reduces the lateral displacement of 42.62% compared to the open field frame at the first stage of the concrete concrete.

6. Considering the new design of the frame with the thorn wall, the condition value, which is the first spelling of non-limited concrete, increases by 90.68% and the lateral isolation capacity decreases 24.59%

Table 5: Comparison of capacities at Performance limit PL2

Frame Model	Base Shear (kN)	% in Capacity	Roof Displacement(m)	% in Capacity
B 1.0	580.62	10.52	0.162	62.35
O 1.0	648.75	-	0.061	-
F 1.0	8302.88	92.18	0.035	42.62
O S 1.0	8035.97	91.92	0.041	32.78
O S R 1.0	6967.26	90.68	0.046	24.59
O 1.5	995.08	34.80	0.061	0.00
O 2.0	1203.44	46.09	0.056	8.19
O 2.5	1817.07	64.30	0.051	16.39
O 3.0	2714.68	76.10	0.051	16.39
O 1.5,1.5	826.11	21.46	0.061	0.00
O 2.0,2.0	1213.95	46.55	0.056	8.19
O 2.5,2.5	1909.94	66.03	0.051	16.39
O 3.0,3.0	3284.37	80.25	0.046	24.59

3.3 Comparison of capacities at Performance limit PL3

The power of all frames is compared to the power of the PL1 functional level OPL Open Field referring to this capability. The base shear reference value is obtained as 512.99 kN and corresponding lateral displacement 0.148 m.

1. Increased Rasine Shear wall 9.75% of the horizontal displacement of the open ground frames, the base value of the fur is found in the concrete trapped in the first crack of 91.55%.

2. Using different quality factors for open ground floor frames, in the range of 1.5, 3.0, 0.5, the interval range. The first crusher base shear sealed concrete ensures, increasing the value of 40.55% to 80.89% of the corresponding lateral displacement volume increases initially 3.89%, then decreases consistently up to 23,64% of the respective.

3. Clear quality factor accepted on the ground, 1.5, 1.5, from the first to the 3.0 version, both open one-storied frames laying an additional 0.5,0.5. When the sealing concrete first crusher recognized, the basic shear capacity gradually defined as the top of the capacity of the lateral displacement, consistent with the first open field frames, from 83.35% to 41.56%, then each has consistently decreased to 23.64%.

4. Naked frame, primarily limited concrete crack, base shear 547.63kN slightly, 632% less, lateral displacement 46,37% is significantly increased with respect to open ground frames.

5. Full masonry filling wall frame, when initial 62,16, limited concrete crushing decreases 90% of the parallel displacement capacity compared to open ground frames during sheath capacity of a massive base of 94,02%.

Considering the new form of frames having a shear wall, the base shear crack occurs at the first compressed concrete, the increase of 90,02% increase in lateral displacement can be 37.83%.

Table 6: Comparison of capacities at Performance limit PL3

Frame Model	Base Shear (kN)	% Capacity	Roof Displacement (m)	Capacity
B 1.0	547.63	6.32	0.276	+46.37
O 1.0	512.99	-	0.148	-
F 1.0	8587.90	94.02	0.056	-62.16
O S 1.0	5862.53	91.25	0.164	+9.75
O S R 1.0	5135.87	90.02	0.092	-37.83
O 1.5	868.75	40.95	0.154	+3.89
O 2.0	1053.54	51.30	0.138	-6.75
O 2.5	1805.82	71.59	0.138	-6.75
O 3.0	2684.65	80.89	0.113	-23.64
O 1.5,1.5	877.95	41.56	0.148	0.00
O 2.0,2.0	1043.83	50.85	0.138	-6 75
O 2.5,2.5	1703.84	69.89	0.117	-20.94
O 3.0,3.0	3082.38	83.35	0.113	-23.64

4. Cost analysis

Items and labor costs are calculated for each frame. The maximum base cost ratio for each frame of the base division is calculated. The ratio of the maximum base share ratio is the total base cost ratio it can be seen that F1.0 has more ratios, which means this frame is more profitable. However, this frame can not fulfill the purpose of parking under the building. Among all the other frames that offer parking space beneath, OS 1.0 and OSR 1.0 are the most profitable frames. Cost analysis shows that the maximum value of the basic shear ratio of OGS frames imposed on the thorn wall is 9 times or more than the OGS frame. OGS frames are redesigned with thorn walls, the ratio is about 8 times the OGS frames. Following the method proposed by IS 1893 (2002), after applying the multiplier factor of various projects to strengthen the story building of the Opus Ground, the highest basic shear of the proportional price is about 3 times the OGS frames.

1. The OGS frame has the maximum proportion of OGS frames, the basic proportion of basic shields, 9 times larger than the OGS frame.

2. The maximum proportion of the basic shield value of the redesigned OGS frame in the thorn wall is about 8 times the OGS frame.

3. With the introduction of the minor factor, according to the IS code method, the refinery scheme can achieve only 3 times the maximum basic shear compared to the OGS frame.

5. Conclusion

The following are the major conclusions from the present study

5.1 OGS frames strengthened with shear wall

1. The maximum capacities of base shear and roof displacement of the OGS frame strengthened with shear wall is increased by about 93% and 40% respectively.

2. The maximum capacities of base shear and roof displacement of the OGS frame strengthened with shear wall is increased by about 5% and 37% respectively compared to a RC frame infilled in all storeys.

5.2 OGS frames re-designed with shear wall

1.Designed with 91% and 42% of the thorn wall respectively, the OGS frame's base shear and maximum capacity of roof displacement.

2. The most basic shear capacity of the redesigned OGS frame on the shoulder wall is reduced by approximately 16% and the separation capacity of all floors increases by about 39%.

3. The most basic shear power of the redesigned OGS frame in the thorn wall reduces by 20% compared to the OGS frame over the shoulder wall and the capacity of the dispensation increases by about 4%.

REFERENCES

[1] Apurba Mondal, Siddhartha Ghosh, and GR Reddy. Performance-based evaluation of the response reduction factor for ductile rc frames. Engineering structures, 56:1808–1819, 2013.

[2] CVR Murty. IITK-BMTPC Earthquake Tips: Learning Earthquake Design and Construction. National Information Centre of Earthquake Engineering, Indian Institute of Technology Kanpur,2005.

[3] Bungale S Taranath. Reinforced concrete design of tall buildings. CRC Press,2009.

[4] CVR Murty, RupenGoswami, AR Vijayanarayanan, and Vipul V Mehta. Some concepts in earthquake behaviour of buildings. Gujarat State Disaster Management Authority, Government of Gujarat,2012.

[5] CVR Murty and Sudhir K Jain. Beneficial influence of masonry infill walls on seismic performance of rc frame buildings. In 12th World Conference on Earthquake Engineering (Auckland, New Zealand, January 30),2000.

[6] Robin Davis, Praseetha Krishnan, Devdas Menon, and A Meher Prasad. Effect of infill stiffness on seismic performance of multi-storeyrc framed buildings in india. In 13 th World Conference on Earthquake Engineering. Vancouver, BC, Canada, 2004.

[7] Hemant B Kaushik, Durgesh C Rai, and Sudhir K Jain. Stress-strain characteristics of clay brick masonry under uniaxial compression. Journal of materials in Civil Engineering, 19(9):728–739, 2007.

[8]Santiago Pujol, Amadeo Benavent-Climent, Mario E Rodriguez, and J Paul Smith-Pardo. Masonry infillwalls: aneffective alternative for seismic strengthening of low-rise reinforced concrete building structures. In14th World Conferenceon Earthquake Engineering (Beijing, China, Unknown Month October 12), 2008.

[9] GV Mulgund and AB Kulkarni. Seismic assessment of rc frame buildings with brick masonry infills. International Journal of advanced engineering sciences and technologies, 2(2):140–147, 2011.

[10] J Prakashvel, C UmaRani, K Muthumani, and N Gopalakrishnan. Earthquake response of reinforced concrete frame with open ground storey. Bonfring International Journalof Industrial Engineering and Management Science, 2(4):91–101, 2012.

[11] N Sivakumar, S Karthik, S Thangaraj, S Saravanan, and CK Shidhardhan. Seismic vulnerability of open ground floor columns in multi storey buildings. International Journal of Scientific Engineering and Research (IJSER), 2013.

[12] MS Lopes. Experimental shear-dominated response of rc walls: Part i: Objectives, methodology and results. Engineering Structures, 23(3):229–239, 2001.

[13] Rahul Rana, Limin Jin, and AtilaZekioglu. Pushover analysis of a 19 story concrete shear wall building. In 13th World Conference on Earthquake Engineering Vancouver, BC, Canada August 1-6, 2004 Paper No, volume 133, 2004.

[14] Han-Seon Lee and Dong-Woo Ko. Seismic response characteristics of high-rise rc wall buildings having different irregularities in lower stories. Engineering structures, 29(11):3149–3167, 2007.

[15] OEsmaili, SEpackachi, MSamadzad, and SR Mirghaderi. Study of structural rc shear wall system in a 56-story rc tall building. In The 14th world conference earthquake engineering, 2008.

[16] YM Fahjan, J Kubin, and MT Tan. Nonlinear analysis methods for reinforced concrete buildings with shearwalls.14th conference in Earthquake Engineering, 2010.

[17] H Gonzales and Francisco L´opez-Almansa. Seismic performance of buildings with thin rc bearing walls. Engineering Structures, 34:244–258, 2012.

[18] Luca Martinelli, Paolo Martinelli, and Maria Gabriella Mulas. Performance of fiber beam–column elements in the seismic analysis of a lightly reinforced shear wall. Engineering Structures, 49:345–359, 2013.

[19] C Todut, D Dan, and V Stoian. Theoretical and experimental study on precast reinforced concrete wall panels subjected to shear force. Engineering Structures, 80:323–338, 2014.

[20] Xinzheng Lu, Lin lin Xie, Hong Guan, Yuli Huang, and Xiao Lu.A shear wall element for nonlinear seismic analysis of super-tall buildings using opensees. Finite Elements in Analysis and Design, 98:14–25, 2015.