International Journal of Scientific Research & Engineering Trends
Volume 7, Issue 2, March-April-2021, ISSN (Online): 2395-566X

Response of Shear Wall in Open Storey Building under Seismic Excitation

Shaik Mohammed Imran, Asst. Prof. D.C. Anajaya Reddy
Department of Civil Engineering
Sri Sunflower College of Engineering & Technology

***Abstract*- The Open Ground Storey buildings are very commonly found in India due to provision3 for considerably needed parking lot in urban areas. However, seismic performance of this sort of buildings is found to be consistently poor as demonstrated by the past earthquakes. A number of the literatures indicate that use of shear walls may enhance the performance of this type of buildings without obstructing the free movement of vehicles within the parking zone . This study is an effort during this direction to review the performance of Open Ground Storey buildings strengthened with shear walls during a bay or two. additionally thereto , the study considers a special scenarios of Open Ground storey buildings strengthened by applying various schemes of multiplication factors in line with the approach proposed by IS 1893 (2002) for the comparison purpose. Study shows that the shear walls significantly increases the bottom shear capacity of OGS buildings however the comparative cost is slightly on the upper side.**

***Keywords*- Storey buildings , Open Ground , shear capacity etc.**

I.INTRODUCTION

The idea of open ground storey (OGS) building has been introduced mainly due to the necessity for parking in urban localities. Thanks to the special feature of providing parking facility within the ground storey of this building, an outsized number of open ground storey buildings are built and accommodated especially for residential purposes throughout the various cities of the country. In actual sense, when the columns of a ferroconcrete building are left open without providing any masonry infill wall as partition wall up between them to possess parking lot within the ground storey then this sort of structure are often treated as open ground storey or soft storey building.

The foremost important issue is often verified that the bottom storey is sort of flexible in nature in comparisons to the opposite upper storeys of this building. This literally means the relative storey drift of the bottom storey is sort of larger with reference to the opposite upper storeys of such buildings when subjected to earthquake loads. Consequently, the bottom storey is exceptionally weak against other upper storeys to resist large earthquake forces usually present at the bottom storey of the building.

Throughout the planet, open ground storey buildings consistently performed poorly under many earthquakes which happened within the recent years due to the irregularity of stiffness and strength within the ground storey and upper storeys of this building and an enormous number of them got collapsed easily. In past years, an outsized number of open ground storey buildings had been constructed in several parts of the India like in Ahemdabad, one among the most cities of India consists of mainly around 25,000 five-storey buildings and about 15, 00 eleven-storey buildings.

Basically, most of them are open ground storey buildings. additionally thereto , an enormous construction of open ground storey goes on to create high-rise residential buildings having this feature i.e open ground storey and already exists in several towns and cities of the country located in moderate to highly seismic active areas as per Indian Standard.

The study after Bhuj earthquake happened in 2001 at Ahemdabad has explicitly mentioned that open ground storey building is unsafe and highly susceptible to earthquake shaking. Thanks to the presence of masonry infill wall up upper storeys made them much stiffer than the bottom storey. Therefore, it creates difference of stiffness between the bottom storey and upper storeys of open ground storey building. Thus, the horizontal drift of ground storey is sort of large relatively and therefore the upper storeys of this building displace sort of a single block. Subsequently, if the columns of ground storey aren't strong enough to resist large horizontal loads like earthquake forces and isn't provided adequate ductility then they'll get highly damaged which can cause the catastrophic collapse of such buildings.

II. OPEN GROUND STOREY BUILDING WITH RC SHEAR WALL

Details of the four storey OGS frame for the present study are presented in the first part of this chapter. The OGS frames are considered to be strengthened and re-designed

© 2021 IJSRET

using shear walls. In order to understand the comparative performance ofOGS frames designed using various multiplication factors, they are also included inthe group. Design details of all frames are provided in the first part of this Chapter. Second part of this Chapter provides the nonlinear modelling and performance criteria considered in the pushover analysis. Subsequently, it presents displacement profiles from linear static analyses. A comparison of pushover curves of all the frames and a comparative cost analysis of each frame is reported.

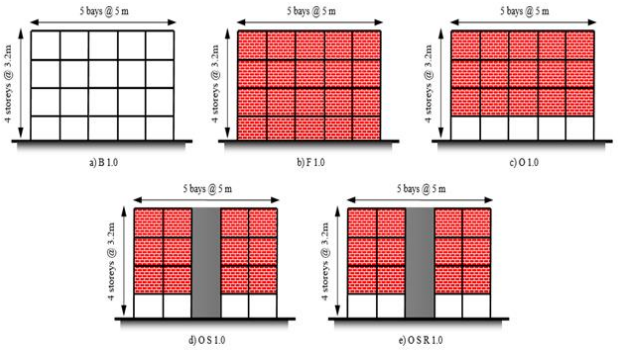

Fig 1. Storey RC Frames with One Multiplication Factor (Fundamental Models).

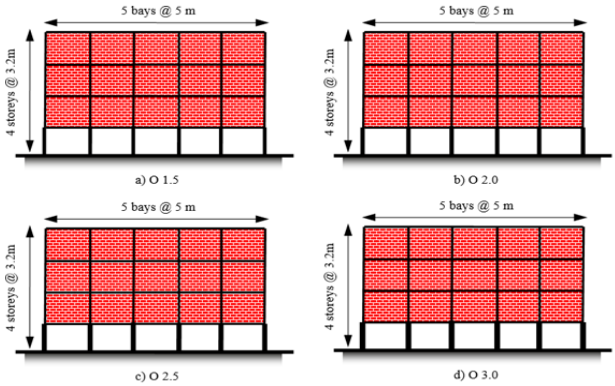

Fig 2. Storey RC Frames with different Multiplication Factor for Ground Only.

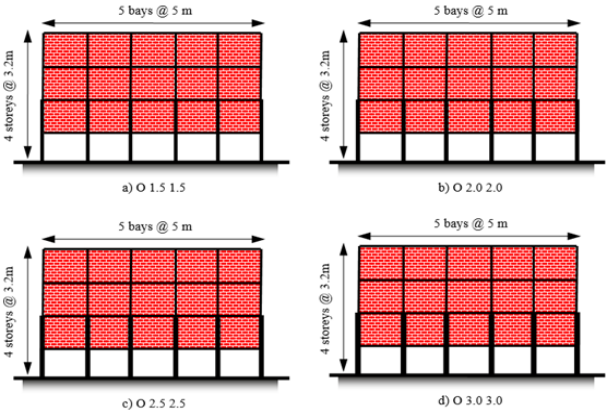

Fig 3. Storey RC Frames with different Multiplication Factor for Ground and First Storey Only.

Table 1. Fundamental Time Period of the Structures.

Frame Storey	Computational		IS 1893(2002)	
	Time period (sec)	Frequency (Hertz)	Time period (sec)	Frequency (Hertz)
B 1.0	0.330	3.02	0.507	19.7
O 1.0	0.316	3.15	-	-
F 1.0	0.080	12.45	0.230	4.34
O S 1.0	0.070	14.14	-	-
O S R 1.0	0.074	13.36	-	-
O 1.5	0.239	4.17	-	-
O 2.0	0.235	4.24	-	-
O 2.5	0.201	4.95	-	-
O 3.0	0.154	6.46	-	-
O 1.5,1.5	0.235	4.24	-	-
O 2.0,2.0	0.231	4.31	-	-

Table 2. 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 R 1.0	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
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

© 2021 IJSRET

International Journal of Scientific Research & Engineering Trends
Volume 7, Issue 2, March-April-2021, ISSN (Online): 2395-566X

Table 3. 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 R 1.0	1–2	300	325	4–20φ — 3–20φ
	3	300	325	4–20φ — 3–20φ
	4	300	300	3–20φ — 2–20φ

Table 4. 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

Table 5. Maximum Lateral Storey Displacement - Linear static analysis.

Frame Storey	B 1.0				O S 1.0			
	C-1	C-2	C-3	C-4	C-1	C-2	C-3	C-4
Base	0	0	0	0	0	0	0	0
1	0	5.3	6.6	6.6	0	0.2	0.2	0.2
2	0	12.7	15.8	15.8	0	0.6	0.7	0.7
3	0	18.9	23.7	23.7	0	1.1	1.3	1.3
4	0	22.9	28.6	28.6	0	1.6	1.9	1.9

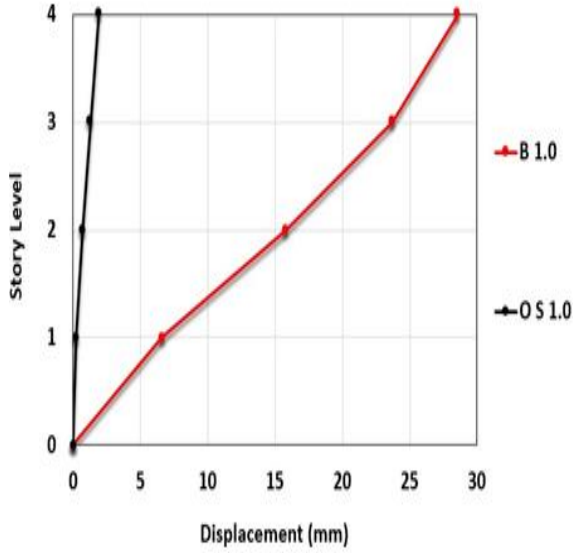

Fig 4. Storey displacements- Linear Static Analysis.

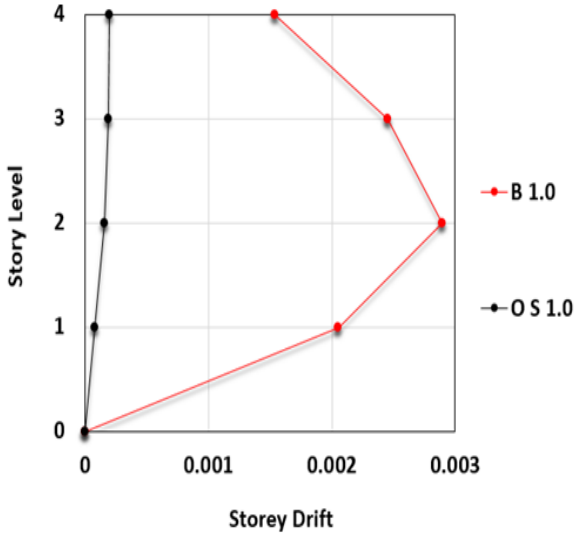

Fig 5. Maximum storey drift of the 4-storey frames.

© 2021 IJSRET

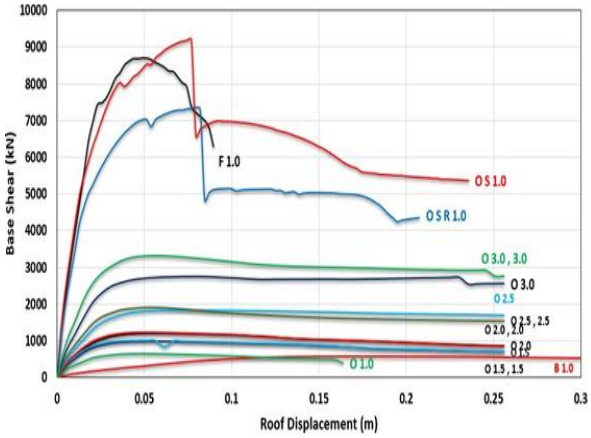

Fig 6. Pushover curves of all the 4 Storey Frames.

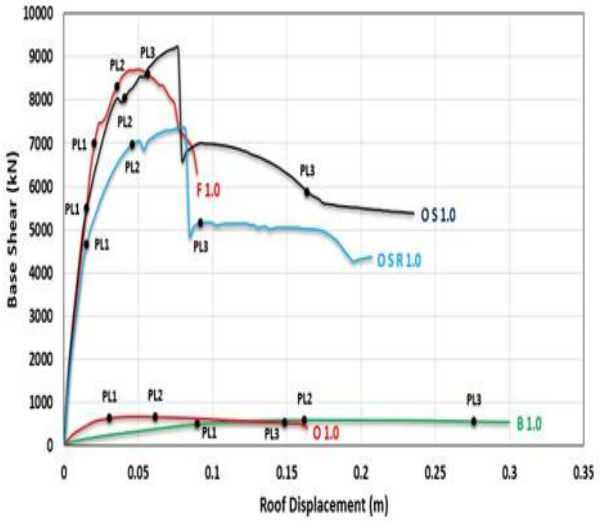

Fig 7. Pushover curves of the 4 Storey Frames with One Multiplication Factor.

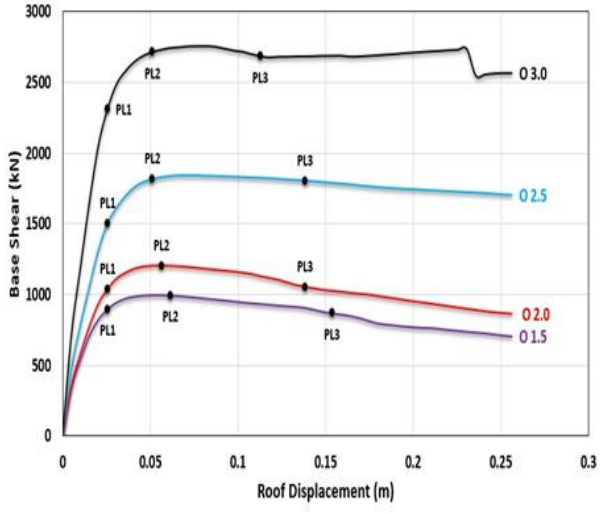

Fig 8. Pushover curves of the 4 Storey Frames with different Multiplication Factor for Ground Storey Only.

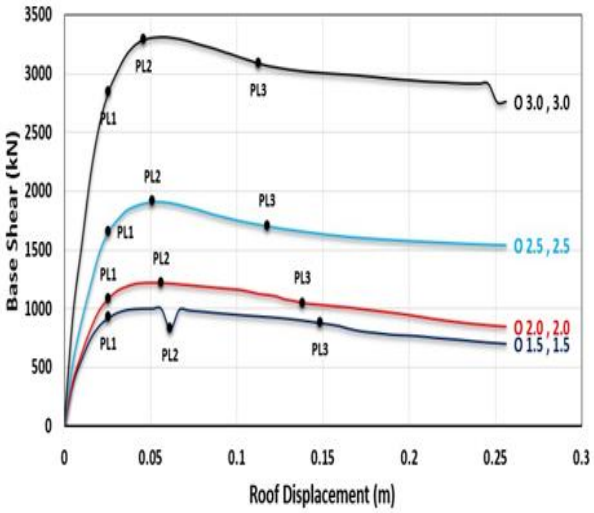

Fig 9. Pushover curves of the 4 Storey Frames with different Multiplication Factor for Ground and First Storey Only.

III. CONCLUSIONS

The greatest limits of base shear and rooftop relocation of the OGS outline reinforced with shear divider is expanded by about 93% and 40% individually.

The greatest limits of base shear and rooftop relocation of the OGS outline fortified with shear divider is expanded by about 5% and 37% individually contrasted with a RC outline infilled on the whole stories. OGS outlines re-planned with shear divider

The most extreme limits of base shear and rooftop relocation of the OGS outline re-planned with shear divider is expanded by about 91% and 42% individually.
3.The most extreme base shear limit of the OGS outline re-planned with shear divider is diminished by about 16% and the uprooting limit is expanded by about 39% contrasted with a RC outline infilled on the whole stories.
The most extreme base shear limit of the OGS outline re-planned with shear divider is diminished by about 20% and the dislodging limit is expanded by about 4% contrasted with an OGS outlines re-planned with shear divider.

Cost Analysis
The most extreme base shear to cost investigation proportion for OGS outlines reinforced with shear divider is more by around multiple times that of OGS outline.

The most extreme base shear to cost investigation proportion for OGS outlines re-planned with shear divider is more by around multiple times that of OGS outline.

The reinforcing plans in accordance with IS code strategy of applying increase factor could accomplish just a most

© 2021 IJSRET

extreme base shear to cost proportion of multiple times that of OGS outlines.

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, Rupen Goswami, 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-storey rc 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 infill walls: an effective alternative for seismic strengthening of low-rise reinforced concrete building structures. In 14th World Conference on 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 Journal of 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.

© 2021 IJSRET