Retrofitting of Multistoried Building Using Infills in Open Ground Storey

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Abstract - Analysis of damages incurred in open ground storey for parking RC frame structures subjected to past earthquake show that failure may be due to utilization of concrete not having sufficient resistance, soft storey, beam column joint failure for weak reinforcements or improper anchorage, column failure causing storey mechanism. Beam-column connection is considered to be one of the potentially weaker components when a structure is subjected to seismic loading. In this study seismic analysis is carried out using response spectra method and its devastations are mentioned. Analysis is mentioned to check safety against collapse and steel bracings infills are used at open ground story in frames to provide sufficient stiffness.

Key Words: Open Ground Storey, Beam Column Joint, Response spectra Method, Steel bracings, Infills.

1. INTRODUCTION

Earthquake causes enormous damage to the structures. The objective of seismic analysis is that the critical stresses in a structure and in addition cause lateral sway of the structure. For usual loads like dead load, live load. Wind load, etc., the structure remain within elastic range of the material structure should be able to sustain minor shaking intensity without any damage, and makes the structure serviceable even after such event. Structure need to have suitable earthquake resistant features to safely resist large lateral forces which are imposed on them during earthquake. Ordinary structures are usually built to safely carry their own weights and therefore perform poorly under large lateral forces caused by even moderate size earthquake. These lateral forces can produce the during service stage. It is neither practical nor economically viable to design structures to remain within elastic limits during earthquakes. Hence it is need to design moment resisting structure which have high ductility capacity.

Open ground storey buildings are relatively flexible i.e. horizontal displacement are more in stories due to absence of brick infill in weak storey. Therefore, it is interested to analyze and compare displacement, stiffness, story drift, storey shear, etc. of the same frame, first modeling with masonry infills and then with shear wall and secondly with cross bracing providing at different positions

2. METHODOLOGY

A (G+15) storied RC frame building with open ground storey and brick infilled top storey is considered with the storey heights as 3m and 3.5m for the top and the ground storey respectively. The frame is assumed to be fixed against translation in all directions and rotation about all axes at the bottom nodes. The design lateral force on the infilled frame was estimated using the Indian Seismic Code [IS: 1893, 2016]. The frame was modeled in ETAB 2016 and linear Elastic analysis was carried out under the lateral force. The frame members were designed and detailed for the corresponding stress resultants as per Indian Concrete code [IS 456, 2000].

The details of beam and column are as shown in table1.

Table No. 1: Details of Building.

Particulars Details/values	
Type of building	Residential
No. of storey	G + 15
Each storey height	3m
Open ground storey height	3.5m
Size of columns	250 x 350 mm
Size of beams	250 x 350mm
Grade of concrete	M30
Slab thickness	150mm
Grade of Steel	Fe500
Thickness of brick infill	230mm
Thickness of RC Wall	200mm
Size of steel bracing section	ISMC 300

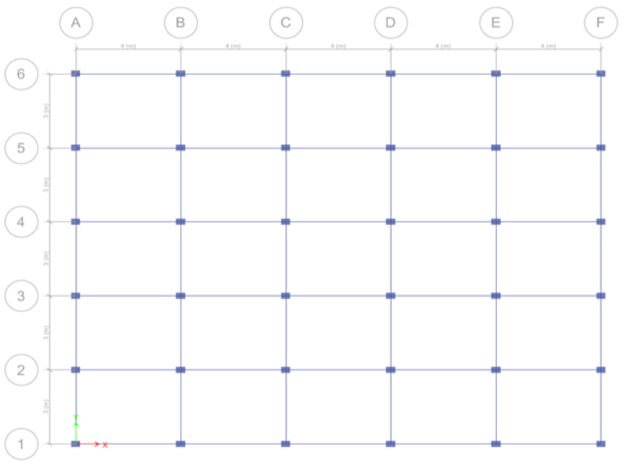

Figure1: Plan of G+15 structure

The model OGS was strengthened by the following retrofitting schemes. Each of them as modeled in ETAB 2016 and subjected to seismic analysis for estimating their limiting characteristics.

1) Brick Masonry Infill:

The open ground story panel was filled with 230mm thick brick masonry. Thus, in the model BMI, an additional strut was introduced in the frame in lace of ground story panel.

2) Structural Wall:

Basically, the structural wall was introduced in the open panel of the ground storey. A single layer of reinforcement was provided for the 200 mm thick RC structural wall designed as per the Indian standard for ductile detailing [IS13920, 1993].

3) Steel Bracing

The open ground story column beam junction where steel brace I section of size ISMC300

3. MODELING

PROBLEM STATEMENT

A RC framed building plan (Seismic Zone III) is selected for the present study. The building is fairly symmetric in plan and in elevation. This building is a G+15 storied building and is made of Reinforced Concrete (RC) Special Moment Resisting Frames (SMRF). The concrete slab is 150mm thick at each floor level. The brick wall thicknesses are 230 mm for external and internal walls. Imposed load is taken as 2.5 KN/ M^2 for all floors. Roof live load is taken as 1.5 KN/ M^2 for roof. The cross sections of the structural members are equal in all frames and all stories.

Seven models have been considered for the purpose of the study.

- ***Model 1- (G+15) storied building as bare frame with open ground storey.***
- ***Model 2- (G+15) storied building with brick infill wall and open ground storey.***
- ***Model 3- (G+15) storied building with brick infill wall and infill wall in open ground storey.***
- ***Model 4- (G+15) storied building with infill wall and shear wall in open ground storey.***
- ***Model 5- (G+15) storied building with infill wall and diagonal steel bracing in open ground storey.***
- ***Model 6- (G+15) storied building with infill wall and shear wall with brick infill in open ground storey.***
- ***Model 7- (G+15) storied building with infill wall and diagonal steel bracing with brick infill in open ground storey.***

4.2 Defining the material properties, structural components and modeling the structure:

Beam, column and slab specifications are as follows:

Column 500mm x 250mm

Beam 300mm x 250mm

Slab thickness 150mm

Shear wall thickness 200mm

Bracing ISMC 300

The required material properties like mass, weight density, modulus of elasticity, shear modulus and design values of the material used can be modified as per requirements or default values can be accepted.

Beams and column members have been defined as 'frame elements' with the appropriate dimensions and reinforcement.

Soil structure interaction has not been considered and the columns have been restrained in all six degrees of freedom at the base.

Slabs are defined as area elements having the properties of shell elements with the required thickness. Slabs have been modeled as rigid

4. FIGURES

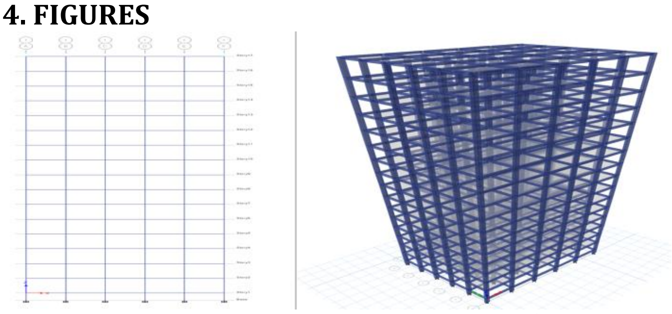

Figure 4.1- (G+15) storied building as bare frame with open ground storey.

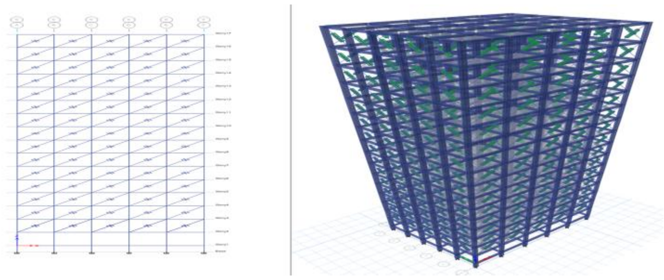

Figure 4.2- (G+15) storied building with brick infill wall and open ground storey.

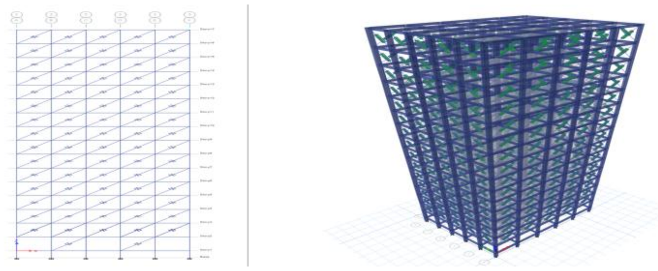

Figure 4.3- (G+15) storied building with brick infill wall and infill wall in open ground storey.

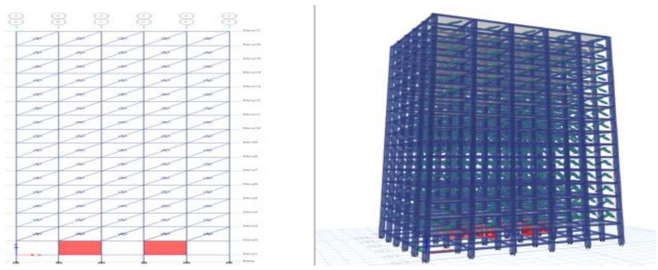

Figure 4.4- (G+15) storied building with infill wall and shear wall in open ground storey.

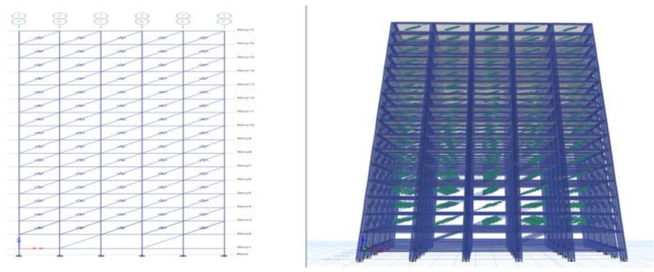

Figure 4.5- (G+15) storied building with infill wall and diagonal steel bracing in open ground storey

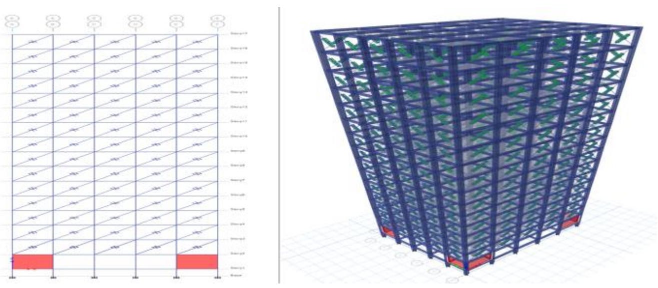

Figure 4.6- (G+15) storied building with infill wall and shear wall with brick infill in open ground storey.

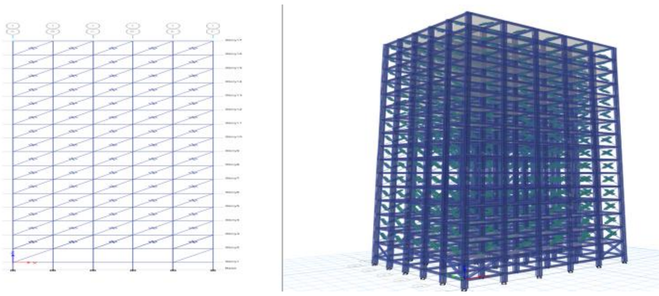

Figure 4.7- (G+15) storied building with infill wall and diagonal steel bracing with brick infill in open ground storey.

Figure 4.8- Plan of (G+15) storied building with brick infill wall and infill wall in open ground storey.

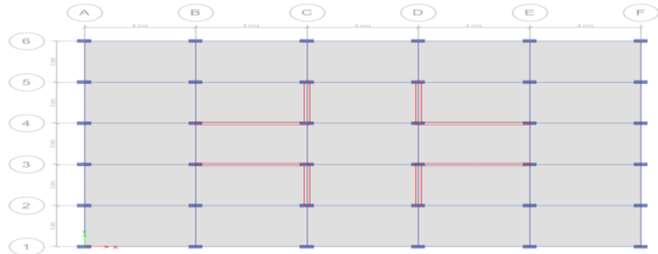

Figure 4.9- Plan of (G+15) storied building with infill wall and shear wall/steel bracing in open ground storey.

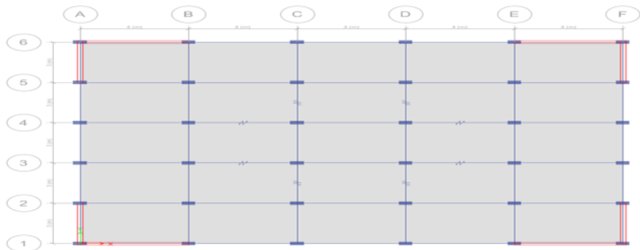

Figure 4.10- (G+15) storied building with infill wall and shear wall/diagonal steel bracing with brick infill in open ground storey

5. RESULT

A 16 storied RCC building in zone III models are analyzed and designed as per the specifications of Indian Standard codes IS 1893:2016 IS and IS 456: 2000. The response spectrum method had been used to find the design lateral forces along the storey in X and Y direction of the building.

Maximum base shear is shown in figure.

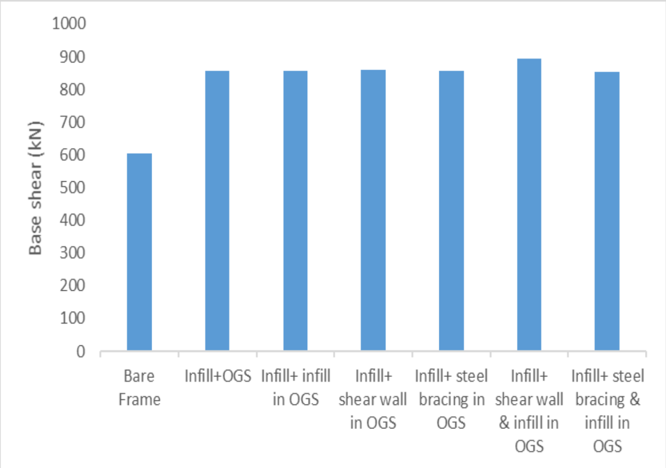

Fig. 5.1- Maximum base shear in X direction

From above table and graph, it is observed that base shear is maximum for building with shear wall and infill wall in OGS and minimum for bare frame. Hence retrofitting of OGS with infill wall, shear wall and steel bracings increases base shear up to 40% in building.

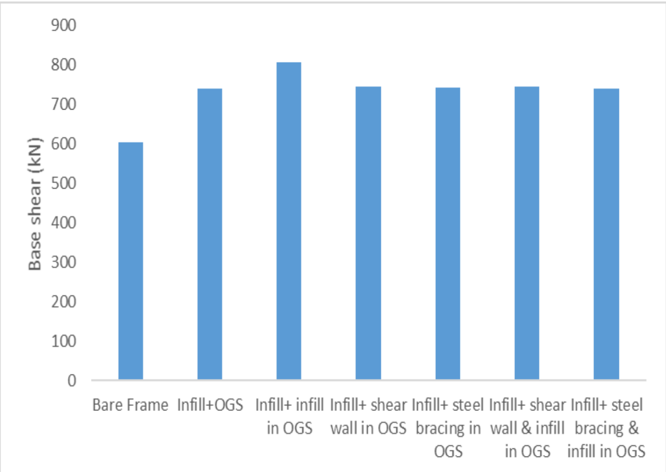

Fig. 5.2- Maximum base shear in Y direction

From above table and graph, it is observed that base shear is maximum for building with infill wall in OGS and minimum for bare frame. Hence retrofitting of OGS with infill wall, shear wall and steel bracings increases base shear up to 35% in building.

Storey drift is shown in figure.

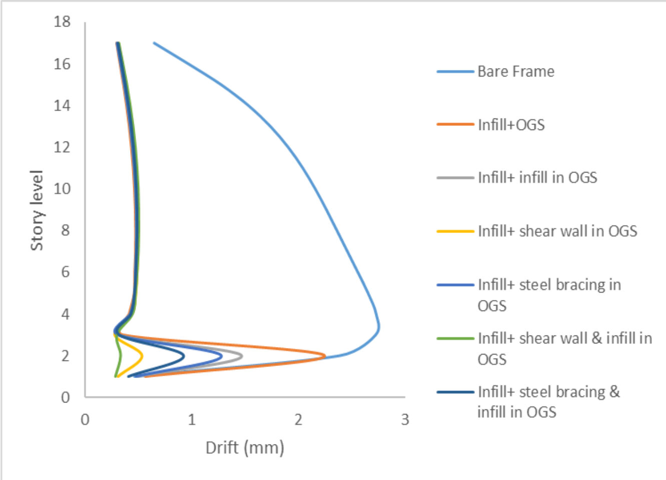

Fig. 5.3- Storey drift in X direction

From above graph it is observed that storey drift is maximum for bare frame and minimum for building with shear wall and infill wall in OGS. Drift in OGS before retrofitting is high. Hence retrofitting of OGS with infill wall, shear wall and steel bracings reduces storey drift up to 80% in building.

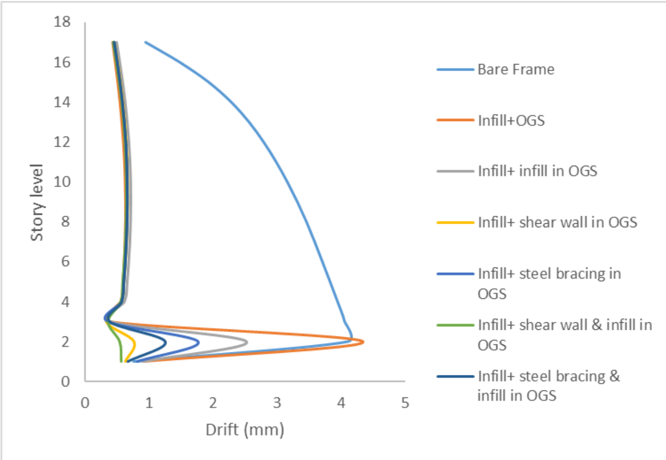

Fig. 5.4- Storey drift in Y direction

From above table and graph, it is observed that storey drift is maximum for bare frame and minimum for building with shear wall and infill wall in OGS. Drift in OGS before retrofitting is high. Hence retrofitting of OGS with infill wall, shear wall and steel bracings reduces storey drift up to 80% in building.

Maximum lateral displacement is shown in figure.

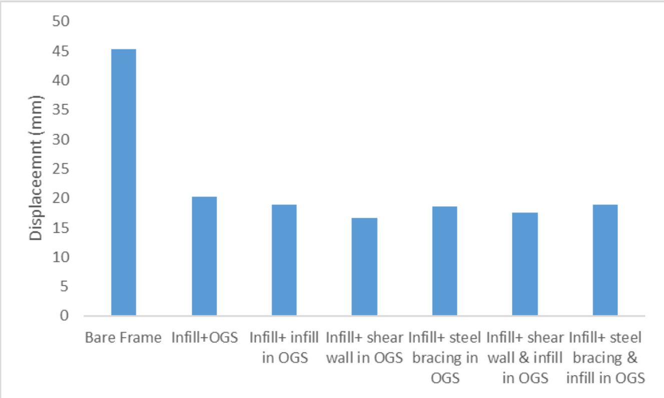

Fig. 5.5- Maximum lateral displacement in X direction

From above graph, it is observed that maximum lateral displacement is maximum for bare frame and minimum for building with shear wall and infill wall in OGS. Displacement in OGS before retrofitting is high. Hence retrofitting of OGS with infill wall, shear wall and steel bracings reduces lateral displacement up to 20% in building.

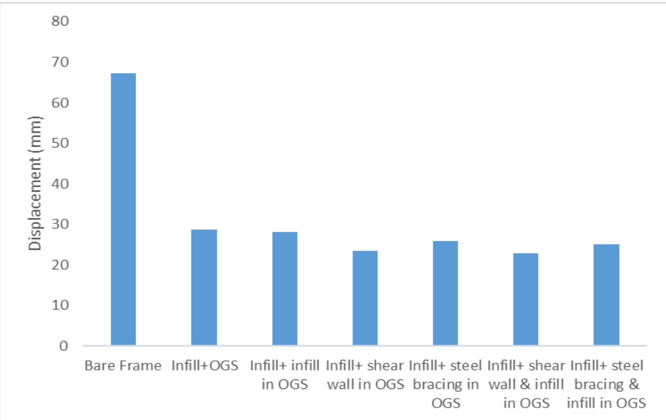

Fig. 5.6- Maximum lateral displacement in Y direction

From above graph, it is observed that maximum lateral displacement is maximum for bare frame and minimum for building with shear wall and infill wall in OGS. Displacement in OGS before retrofitting is high. Hence retrofitting of OGS with infill wall, shear wall and steel bracings reduces lateral displacement up to 60% in building.

6. CONCLUSIONS

1. The design base shear increases with increase in mass and stiffness of infill wall and vice versa.
2. In X direction, base shear is maximum by adding both masonry infill wall and shear wall in open ground storey while in Y direction, base shear is maximum by adding masonry infill wall in open ground storey.
3. It is observed that displacement of bare frame and open ground storey are more as compare to frame with infills but this displacement is within permissible limit.
4. Infill walls increases lateral stiffness of the building, measured in terms of ground storey displacement thereby reducing displacement in all storey levels compared to OGS building model.
5. There is reduction of storey drift and displacement if we provide infill wall at the parking in the building.
6. The displacement and storey drift are reduced drastically by the provision of shear wall and infill wall in the building

REFERENCES

[1] R. Davis, D. Menon, A. M. Prasad," Evaluation of magnification factors for open ground storey buildings using nonlinear analyses", The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China

[2] Amol Karemore, A Shrinivas Rayadub," Study on Effect of Zone on Magnification Factor for Open Ground Storey Buildings", International Journal of Innovative and Emerging Research in Engineering Volume 2, Issue 5,

[3] Akhilesh Yadav, Dr. A. K. Mishra," Earthquake resistant design of open ground storey low rise building", International Journal of Science Technology and management, 2017.

[4] IS:1893 (Part 1):2016, Criteria for Earthquake Resistant Design of Structures, sixth edition 2016.

[5] IS: 456:2000, Plain and Reinforced Concrete Code of Practice, July 2000.

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