Mujeeb Ul Hasan et al. 2017, Volume 5 Issue 5
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

International Journal of Science, Engineering and Technology
An Open Access Journal

# Effect of RC Shear Wall on Seismic Performance of Building Resting on Sloping Ground

[1]Mujeeb Ul Hasan, [2]Dr. Vivek Garg

**Abstract**

The scarcity of plain ground in hilly areas compels construction activity on sloping ground resulting in various important buildings such as reinforced concrete framed structures resting on hilly slopes. The buildings situated on hilly areas in earthquake prone areas are generally irregular and torsionally coupled, hence subjected to severe damage when affected by earthquake ground motion. In present study the analysis of G+10 storey building frame with and without shear wall at different slopes of ground (i.e. 00 and 100) is studied. It is assumed that the columns are fixed at base and building is situated in seismic zone-IV. The different models are analyzed by means of Staad-pro software. The comparison of maximum values of storey displacements, storey drift, support reactions, forces in beams and columns has been carried out for useful interpretation of results. The use of shear wall in building frame reduces nodal displacements in the floors, storey drift and critical values of shear force, bending moment and torsion in structural members.

**Keywords:** shear wall, seismic response, sloping ground

## Introduction

Earthquake is the most disastrous and unpredictable phenomenon of nature. When a structure is subjected to seismic forces it does not cause loss to human lives directly but due to the damage cause to the structures that leads to the collapse of the building and hence to the occupants and the property. Shear wall might be used at the same time to resist large horizontal stacks and hold gravity masses. There is significant improvement observed in seismic performance of building on leveled ground as well as on slopes by providing shear walls with different configurations since lateral displacement and member forces reduces considerably in building due to provision of shear walls.

## Modelling of Proposed Problems

The following six models are analyzed using STAAD.PRO software

i) Model I: Building without shear wall at plane ground ($0^0$ slope)

ii) Model II: Building with shear wall at centre at plane ground ($0^0$ slope).

iii) Model III: Building with shear wall at corner at plane ground ($0^0$ slope).

iv) Model IV: Building without shear wall ($10^0$ slope)

v) Model V: Building with shear wall at centre ($10^0$ slope)

vi) Model VI: Building with shear wall at corner ($10^0$ slope)

## Material and Geometrical Properties

The parameters used in the analysis of formulation of problem is given in table-1 and the geometry of structure is depicted in fig 1 to 2

Table 1 Data/parameters used in the analysis of problem:

| Parameter | Data/Value |
|---|---|
| Type of structure | Residential building (G+10) |
| Plan dimensions | 12 m X 12 m |
| Total height of building | 36m |
| Height of each storey | 3m |

| | |
|---|---|
| Depth of foundation | 1.6m |
| Type of supports | Fixed |
| Bay width in longitudinal direction | 3m |
| Bay width in transverse direction | 3m |
| Size of beams | 200 mm X 350 mm |
| Size of columns (upto G+4) | 450 mm X 450 mm |
| Size of columns (above G+4) | 350 mm X 350 mm |
| Thickness of slab | 150mm |
| Thickness of walls | 230 mm |
| Seismic zone | IV |
| Soil condition | Hard (type I) |
| Response reduction factor | 5 |
| Importance factor | 1 |
| Floor finishes | 1 kN/m2 |
| Live load at all floors | 3 kN/m2 |
| Grade of Concrete | M-30 |
| Grade of Steel | Fe 415 |
| Density of Concrete | 25 kN/m3 |
| Density of brick masonry | 20 kN/m3 |

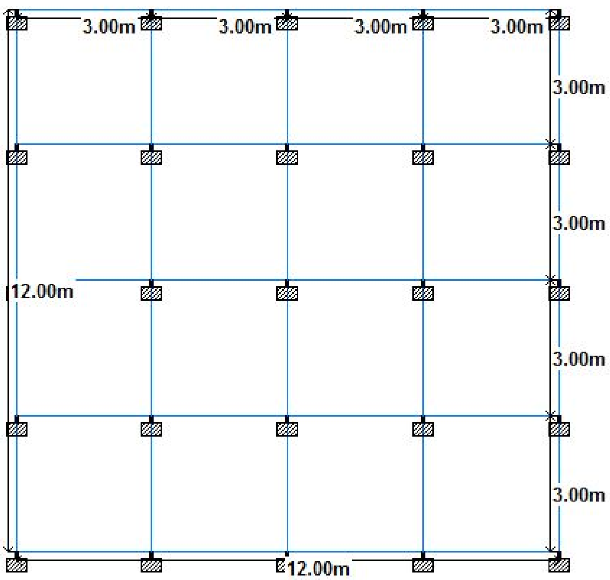

Figure 1: Plan of building frame


Figure 2: Building with shear wall at corner and centre location

## Results and Discussions

This study presents the comparison of earthquake behavior (as per IS 1893 (part I) – 2002) on G+10 building frame with and without shear wall at different slopes of ground (i.e. $0^0$ and $10^0$)

**Nodal displacement:** The comparison of nodal displacement of building with and without shear wall at different slopes is shown in fig 3 to 6

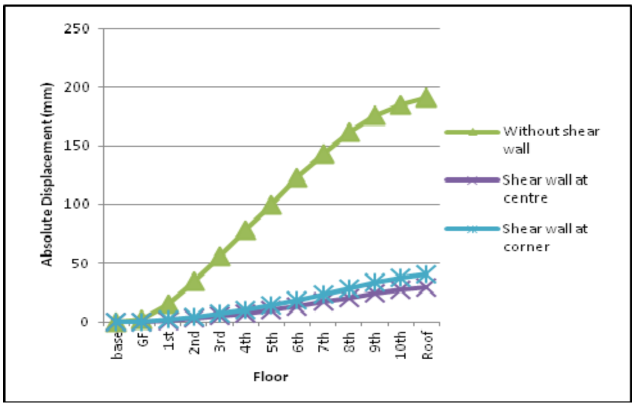


Figure 3: Maximum nodal displacement along the slope with and without shear wall at $0^0$ slope.

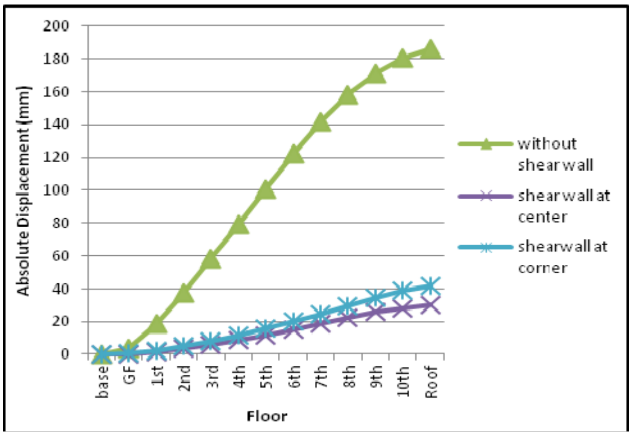


Figure 4: Maximum nodal displacement along the slope with and without shear wall at $10^0$ slope

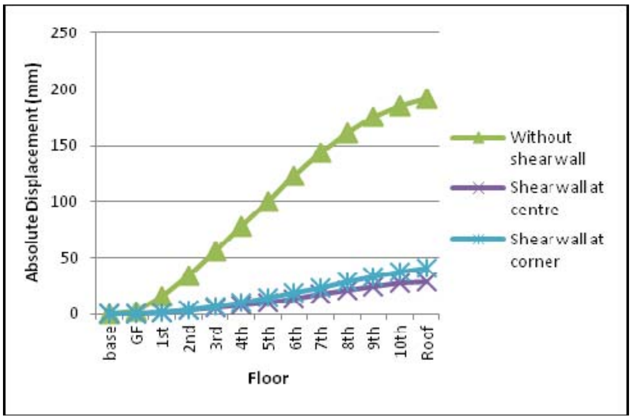


Figure 5: Maximum nodal displacement transverse to the slope with and without shear wall at $0^0$ slope.

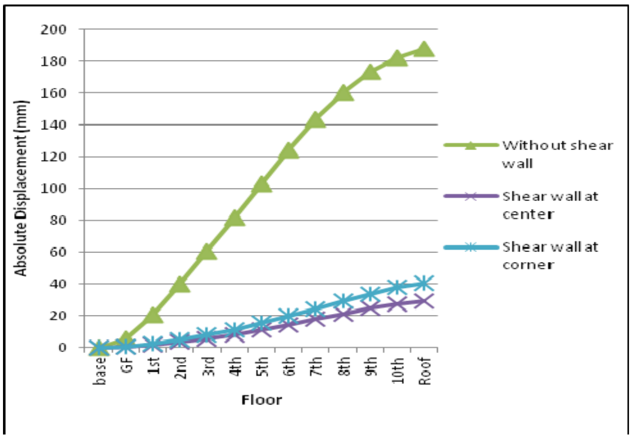


Figure 6: Maximum nodal displacement transverse to the slope with and without shear wall at $10^0$ slope

- The nodal displacement along and transverse to the slope at different floors reduces significantly with inclusion of shear wall in structure compared to without shear wall structure and also shear wall at centre is more effective as compared to shear wall at corner.

- Maximum nodal displacement along the slope at top floor decreases with increase in ground slope and displacement at ground storey increases with increase in the ground slope. Maximum displacement transverse to the slope at top floor is not affected by increase in the ground slopes and displacement at ground storey is increases by increase in the various ground slopes.

**Storey drift:** The comparison of storey drift of building with and without shear wall at different slopes is shown in fig 7 to 10

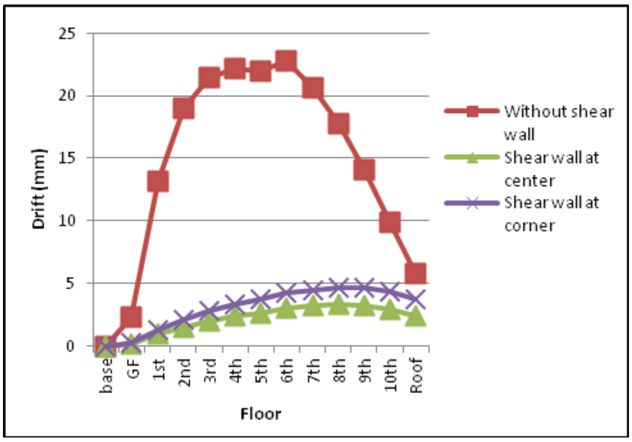


Figure 7: Storey drift along the slope with and without shear wall at $0^0$ slope

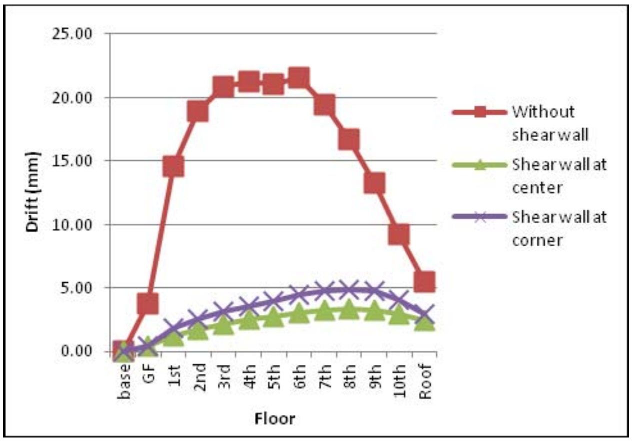


Figure 8: Storey drift along the slope with and without shear wall at $10^0$ slope

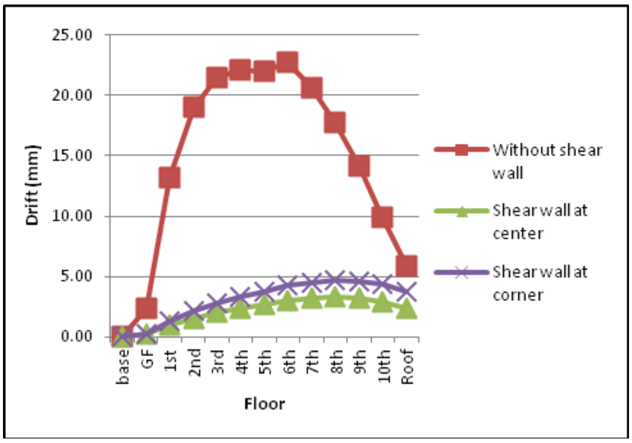


Figure 9: Storey drift transverse to the slope with and without shear wall at $0^0$ slope

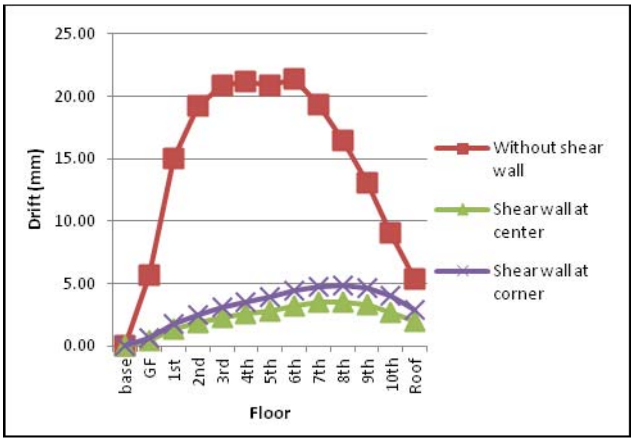


Figure 10: Storey drift transverse to the slope with and without shear wall at $10^0$ slope

- The storey drift along and transverse to the slope at different floors reduces significantly with inclusion of shear wall in structure compared to without shear wall structure and also shear wall at centre is more effective as compared to shear wall at corner.

- Maximum storey drift is found at sixth floor for building frames resting on various ground slopes under critical load along and transverse to the slope.

Maximum storey drift decreases with increase in ground slopes in all floors except ground storey under critical load along and transverse to the slope.

**Support reactions:** The comparison of support reactions of building with and without shear wall at different slopes is shown in fig 11 to 12.

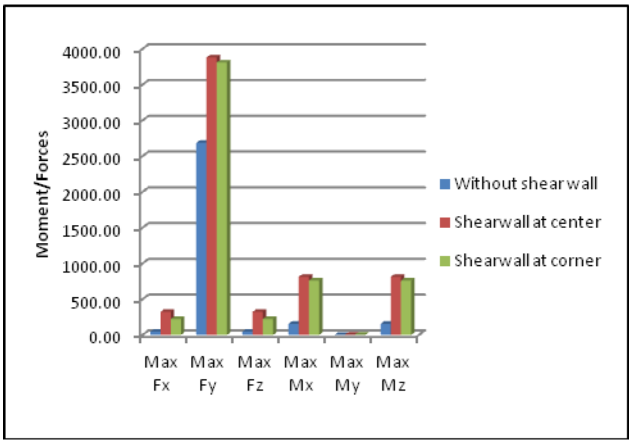


Figure 11: Maximum values of support reactions with and without shear wall at $0^0$ slope.

Note: Forces are in kN and Moments are in kN-m

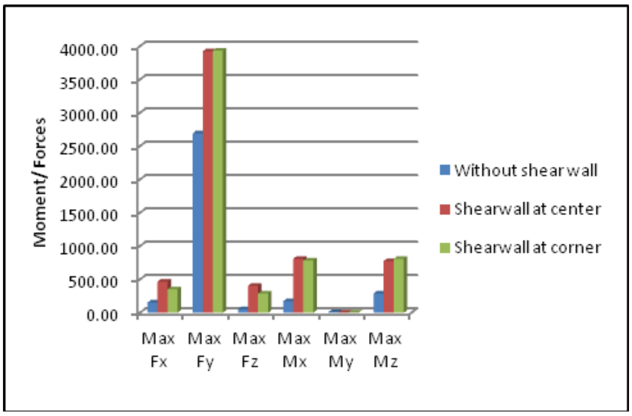


Figure 12: Maximum values of support reactions with and without shear wall at $10^0$ slope.

- The maximum value of support reactions increases significantly with inclusion of shear wall in structure compared to without shear wall structure and also the values of support reactions increases by inclusion of shear wall and the increase in reactions is more in case of shear wall at centre as compared to shear wall at corner.

It is found that torsion in support increases with change in slope.

**Forces in column:** The comparison of maximum forces in column of building with and without shear wall at different slopes is shown in fig 13 to 14

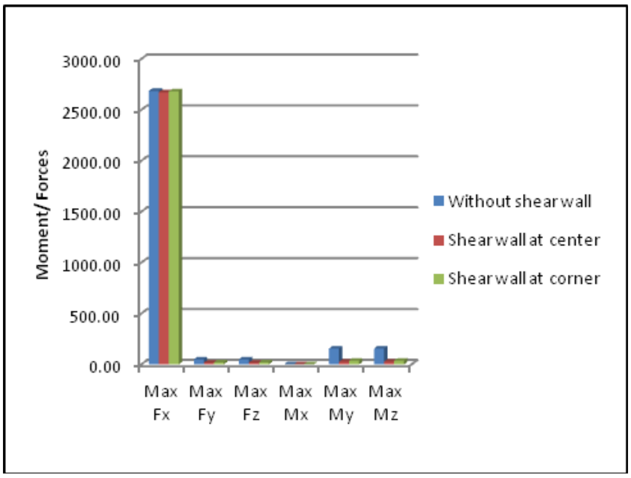


Figure 13: Maximum values of forces in columns with and without shear wall at $0^0$ slope

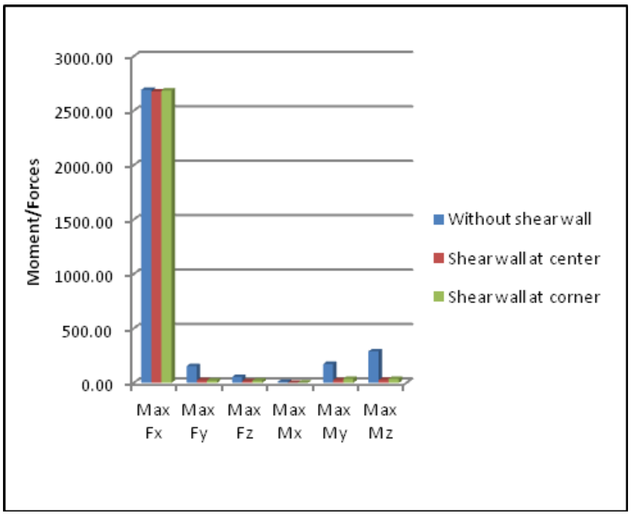


Figure 14: Maximum values of forces in columns with and without shear wall at $10^0$ slope

- The maximum value of force in columns reduces slightly with inclusion of shear wall in structure compared to without shear wall structure and the reduction in values of forces in columns are more in case of shear wall at centre as compared to shear wall at corner.

- It is found that torsion in column increases with change in slope.

**Forces in beam:** The comparison of nodal displacement of building with and without shear wall at different slopes is shown in fig 15 to 16

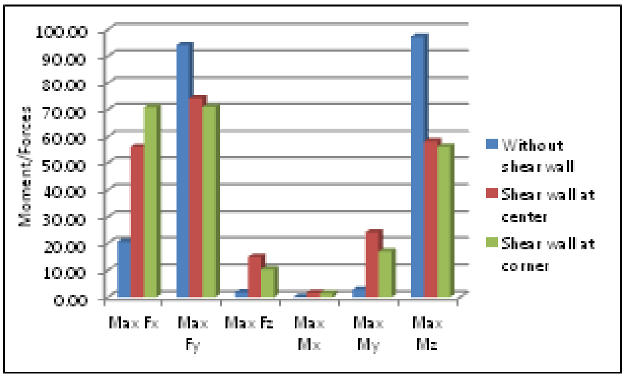


Figure 15: Maximum values of forces in beams with and without shear wall at $0^0$ slope

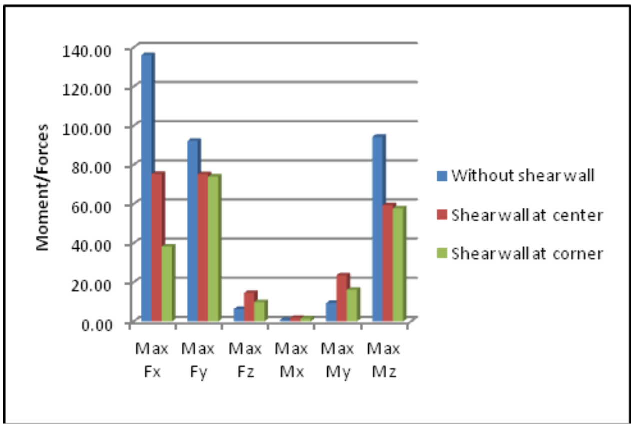


Figure 16: Maximum values of forces in beams with and without shear wall at $10^0$ slope

- The maximum value of force in beams decreases significantly with inclusion of shear wall in structure compared to without shear wall structure and also the reduction in values of shear force and bending moment in beams are more in case of shear wall at corner as compared to shear wall at centre.

- It is found that torsion in beam increases with change in slope

**Conclusions**

The following points have been concluded as a result of present work for evaluating the effect of shear wall on seismic performance of building resting on sloping ground.

- The inclusion of shear wall is very effective to reduce the displacements, storey drift and torsion moments in building. Shear wall at centre is found to be more effective as compared to shear wall at corner.
- Displacements, support reactions and member forces vary with change in slope.

**References**

1. Birajdar B.G. and Nalawde S. S. (2004), Seismic analysis of buildings resting on sloping ground, 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada, Paper No. 1472.

2. Sarkan and Biswal (2010), Design of earthquake resistant multistoried RCC building on sloping ground, ISSE Journal, 13(1).

3. Pandey A.D., Kumar P. and Sharma S. (2011), Seismic soil structure interaction of buildings on hill slopes, International journal of civil and structural engineering Volume 2, No 2.

4. Singh Y. and Phani Gade (2011), Seismic Behavior of Buildings Located on Slopes, An Analytical Study and Some Observations From Sikkim Earthquake of September 18, 15th World Conference on Earthquake Engineering Journal 2012.

5. Sharhrin R. and Hossain T.R (2011)., Seismic performance evaluation of residential buildings in Dhaka city by using pushover analysis, 4th Annual Paper Meet and 1st Civil Engineering Congress, December 22-24.

6. Nagargoje S.M. and Sable K.S. (2012), Seismic performance of multi-Storied building on sloping ground, Elixir International Journal.

7. Khadiranaikar R.B. and Masali A. (2014), Seismic performance of buildings resting on sloping ground–A review, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 11, Issue 3 Ver. III (May- Jun. 2014), pp 12-19.

8. Kumar P. and Kumar A. (2014), Comparison of Seismic Response of Buildings on Slopes, National conference on emerging trends in engineering science & technology (NCETEST-2014) March 29th -30th, College of Engineering Roorkee (COER), Roorkee, India.

9. Hirde S.K. and. Shelar N.K. (2015), Effect of various positions of reinforced concrete shear walls on seismic performance of building having soft bottom storey, ISSE Journal, 11(1)

**Author's Details**

[1]M.Tech (Structures) Student at Civil Engineering Department, Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh, INDIA. Email: mujeeb.hasan42@gmail.com

[2]Assistant Professor, Civil Engineering Department, Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh, INDIA. Email: vivek_garg5@yahoo.co.in