Sesmic Performance of Rcc Building with Shear Wall and Without Shear Wall

Mayank Vashisht[1], Assistant Professor Sumit Jain[2]
Gateway Institute of Technology, Sonipath

Abstract- In India, very few buildings are designed properly by structural engineers. Proper analysis and design of building structures that are subjected to static and dynamic loads is very important. Another important factor in the analysis of these systems is obtaining acceptable accuracy in the results. The object of this study is to model and analyze shear wall-frame structures having different thickness and location of wall in the structure and we will also discuss effect of soft storey and opening in shear wall.

Key word- RC wall, masonry wall, framed structure, Seismic analysis, Shear wall,

I. INTRODUCTION

The economic growth and rapid urbanization in hilly region has accelerated the real estate development and resulted in increase in population density in the hilly region enormously. Therefore, there is popular and pressing demand for the construction of multi-storey buildings in that region. A scarcity of plain ground in hilly area compels the construction activity on sloping ground. Hill buildings behave different from those in plains when subjected to lateral loads due to earthquake. Such buildings have mass and stiffness varying along the vertical and horizontal planes, resulting the centre of mass and centre of rigidity do not coincide on various floors. Also due to hilly slope these buildings step back towards the hill slope and at the same time they may have setback also, having unequal heights at the same floor level the column of hill building rests at different levels on the slope. The seismic response of multi-storey buildings can be improved by incorporating a shear wall. Shear walls systems are one of the most commonly used lateral load resisting systems in high-rise buildings. Shearwalls have very high in plane stiffness and strength, which can be used to simultaneously resist large horizontal loads and support gravity loads, making them quite advantageous.

Adequate stiffness is to be ensured in high rise buildings for resistance to lateral loads induced by wind or seismic events. Reinforced concrete shear walls are designed for buildings located in seismic areas, because of their high bearing capacity, high ductility and rigidity. In high rise buildings, beam and column dimensions work out large and reinforcement at the beam-column joins are quite heavy, so that, there is a lot of clogging at these joints and it is difficult to place and vibrate concrete at these places which does not contribute to the safety of buildings. These practical difficulties call for introduction of shear walls in High rise buildings.

II. METHODOLOGY

The IS 1893 (Part 1): 2002 recommends 3D modelling for dynamic analysis (Response Spectrum analyses and Time History analyses) of irregular buildings higher than 12m in zone IV and V, and those greater than 40m in height in zone II and III. 3D analysis including torsional effect has been carried out by using response spectrum method for this study. Dynamic response of these buildings, in terms of base shear, fundamental time period, roof displacement and member forces is presented, and compared within the considered configuration of shear walls as well as with model without shear walls on plain and sloping ground and at the end, efficient positioning of shear walls configuration to be used is suggested.

The seismic analysis of all buildings is carried by Response Spectrum Method in accordance with IS: 1893 (Part 1): 2002. As per codal provisions dynamic results are normalized by multiplying with a base shear ratio Vb/VB , where Vb is the base shear evaluation based on time period given by empirical equation and, VB is the base shear from dynamic analysis , if Vb/VB ratio is more than one. Damping considered for all modes of vibration was five percent. For determining the seismic response of the buildings in different directions for ground motion the response spectrum analysis was conducted in longitudinal and transverse direction (X and Y). The other parameters used in seismic analysis were, severe seismic zone (IV), zone factor 0.24, importance factor 1, special moment resisting frame (SMRF) for all models with a response reduction factor of 5. The default number of modes (i.e. 12) in software was used and the modal responses were combined using CQC method. The response spectra for medium soil sites with 5% damping as per IS 1893 (Part1):2002 is utilized in response spectrum analysis.

The following models of building are considered on plain ground.

Model 1 without shear wall
Model 2 with straight shape shear walls
Model 3 with L shape shear walls
Model 4 with C shape shear walls
Model 5 with combined straight, L and C shape shear walls

The following models of building are considered on sloping ground.

Model 1 without shear wall

Model 2 with straight shape shear walls

Model 3 with L shape shear walls

Model 4 with C shape shear walls

Model 5 with combined straight, L and C shape shear walls

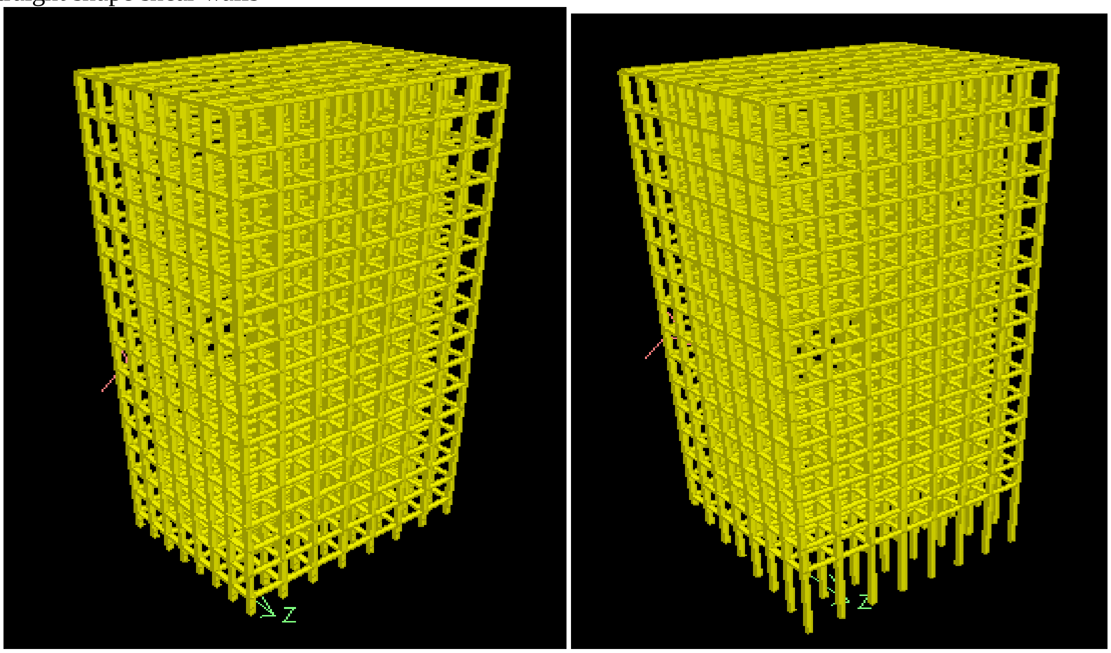


Fig.1: Building without shear wall on plain and sloping ground

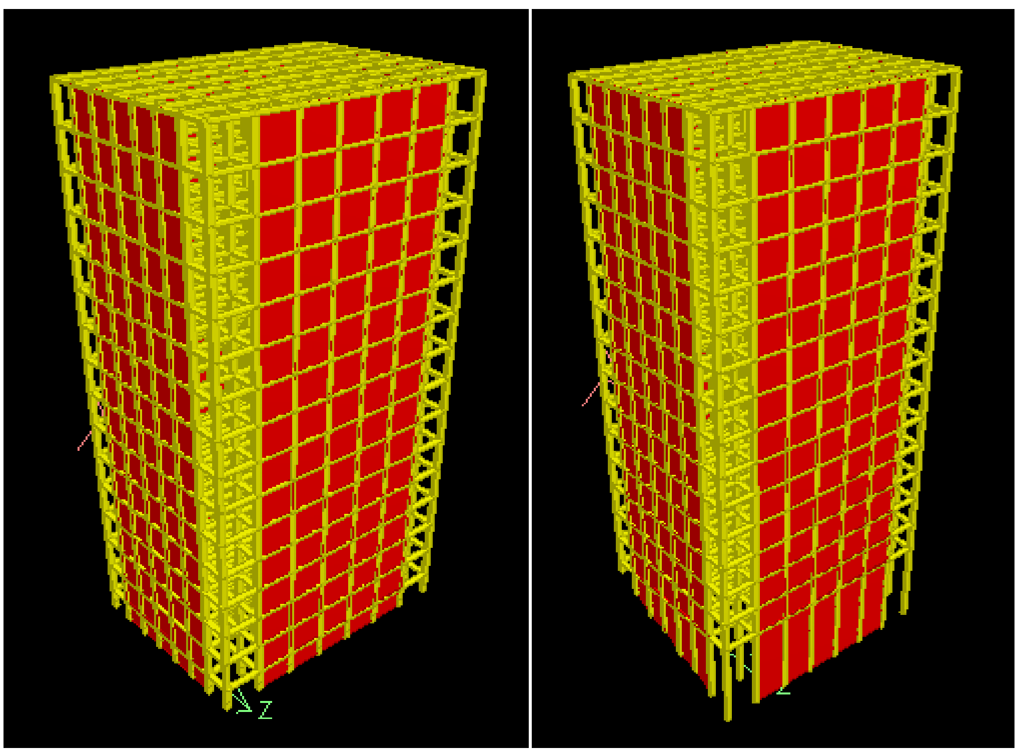


Fig.2: Building with straight shape shear wall on plain and sloping ground

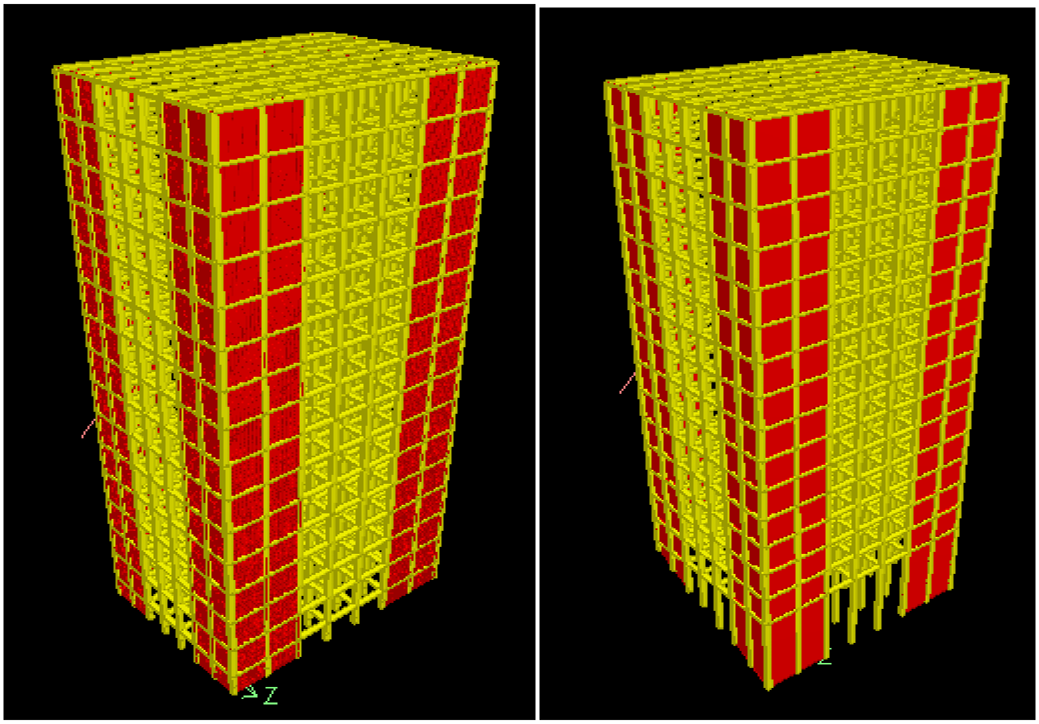


Fig.3: Building with L shape shear wall on plain and sloping ground

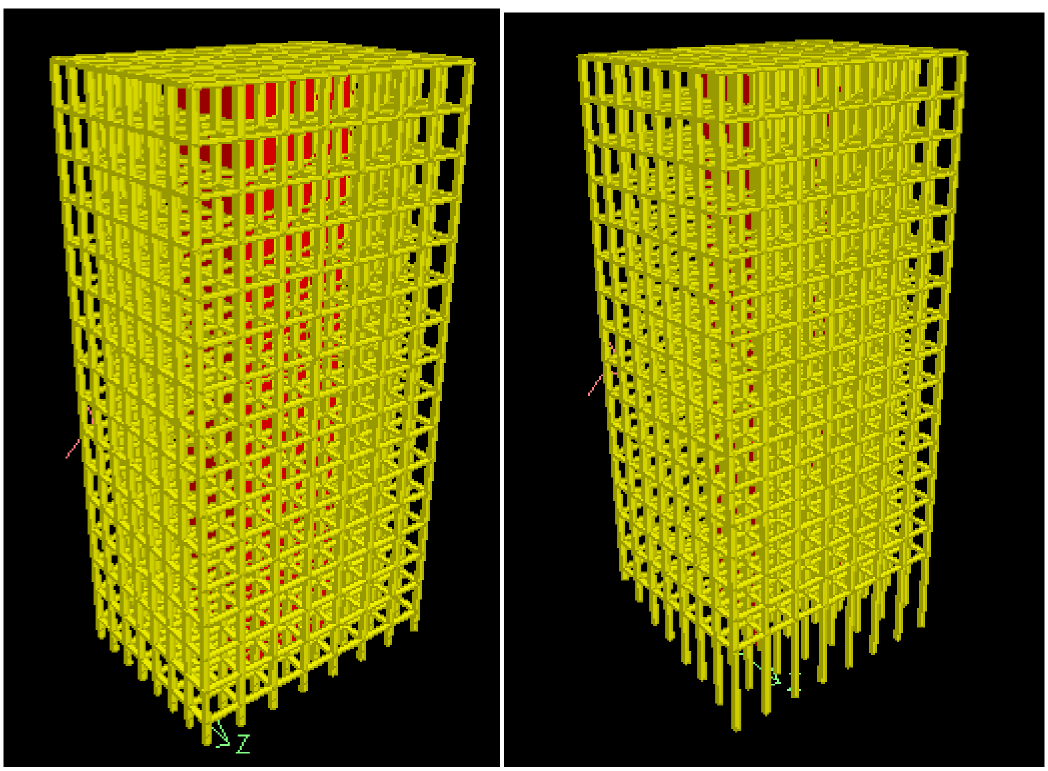


Fig.4: Building with C shape shear wall on plain and sloping ground

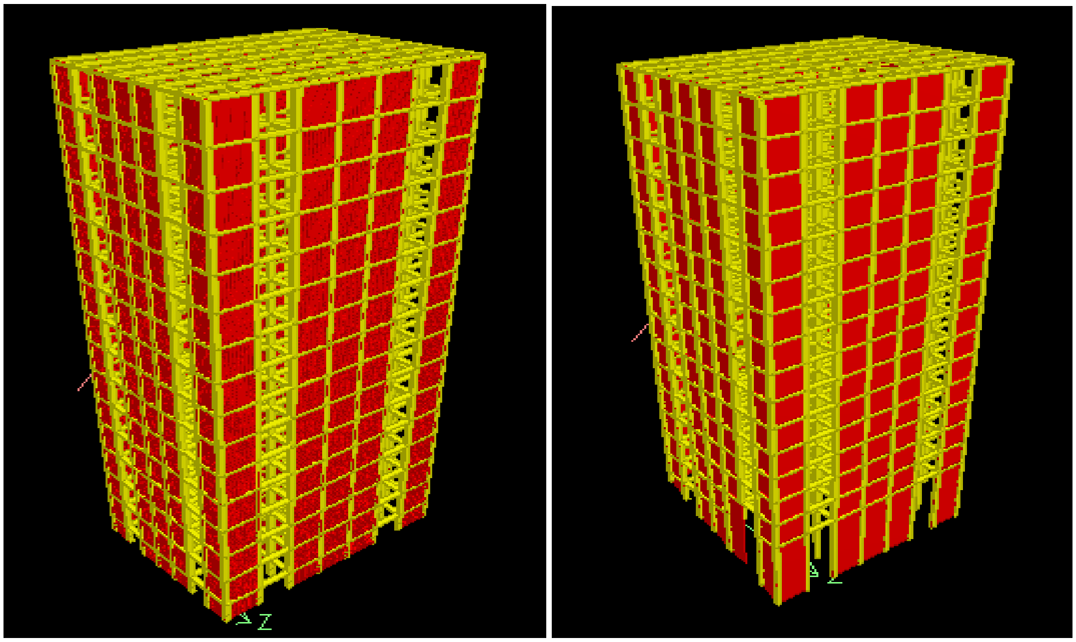


Fig.5: Building with combined straight, L and C shape shear wall on plain and sloping ground

III. RESULT

PLAIN GROUND

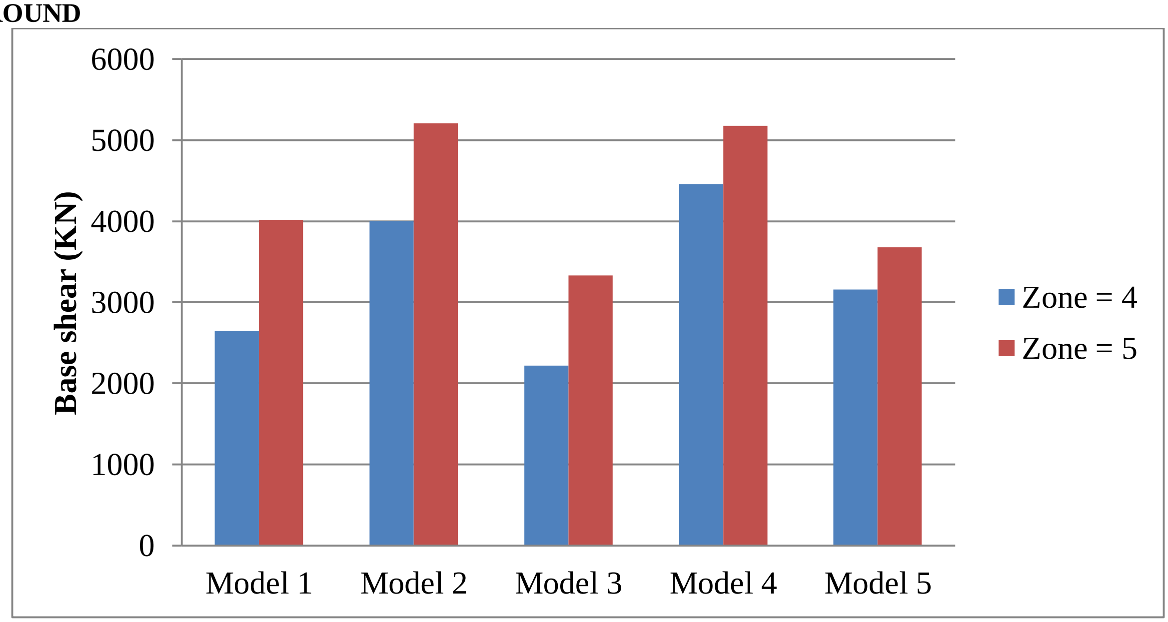


Fig.6: Variation of base shear for building on levelled ground

2) Fundamental time period

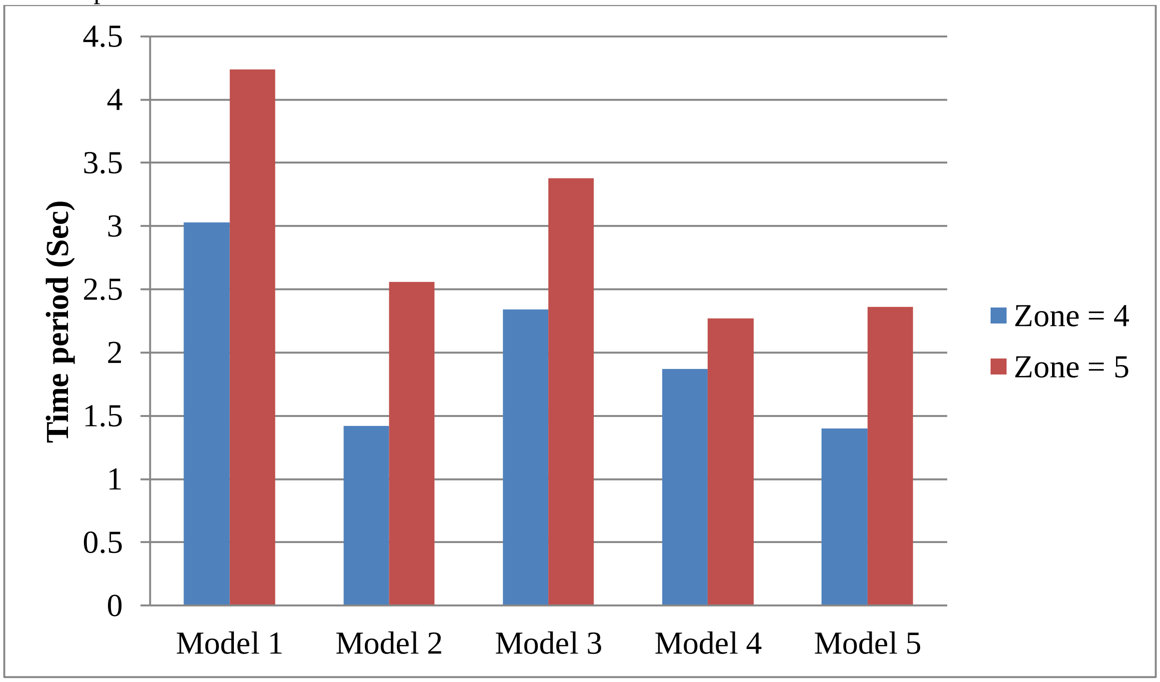
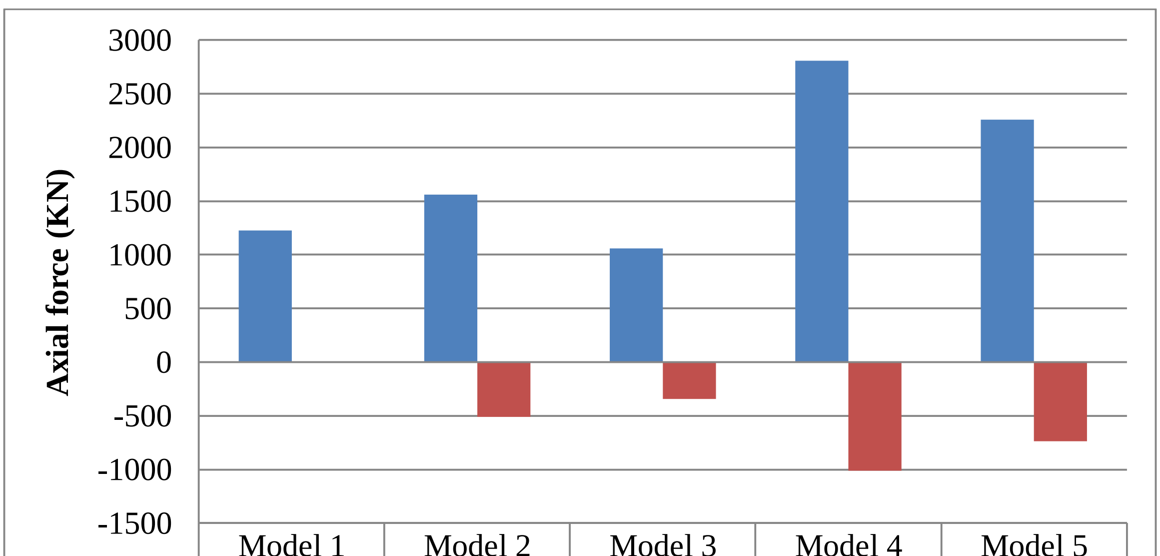


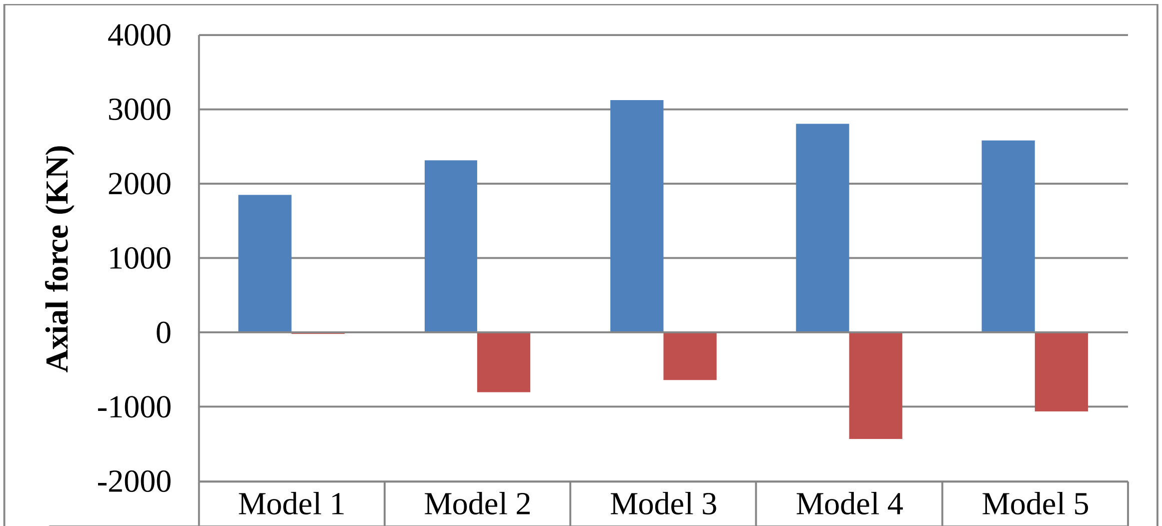
Fig.7: Variation of time period for building on levelled ground

3) Member forces



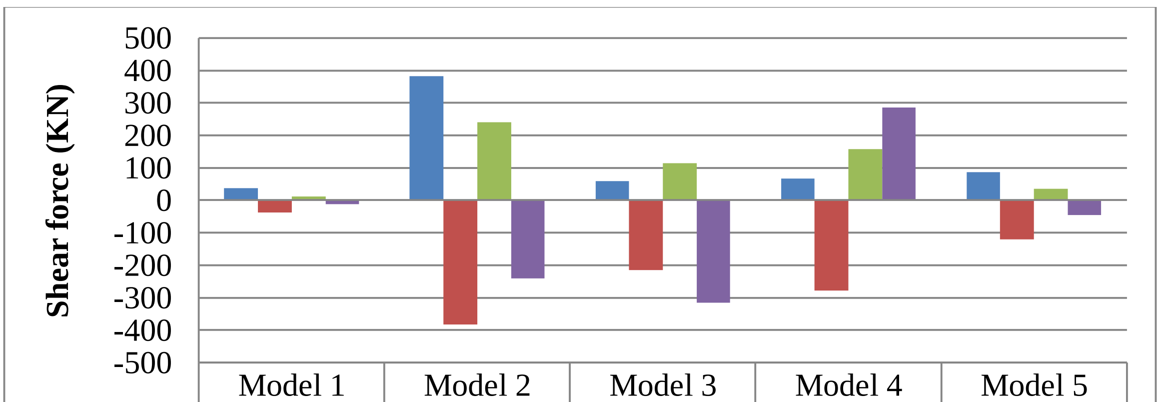
	Model 1	Model 2	Model 3	Model 4	Model 5
Max Fx (in kN)	1228.99	1561.52	1057.07	2804.59	2255.89
Min Fx (in kN)	-6.205	-512.19	-345.32	-1012.41	-738.6

Fig.8: Axial forces in column for building on levelled ground for zone 4



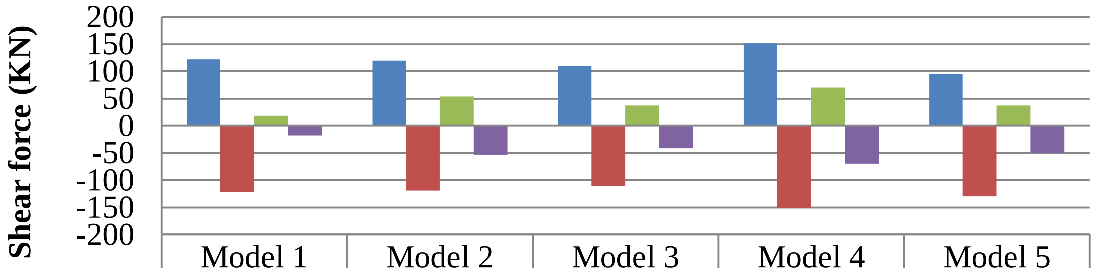
	Model 1	Model 2	Model 3	Model 4	Model 5
Max Fx (in kN)	1848.49	2312.11	3129.61	2804.59	2580.85
Min Fx (in kN)	-17.77	-800.4	-638.85	-1428.36	-1063.59

Fig.9: Axial forces in column for building on levelled ground for zone 5



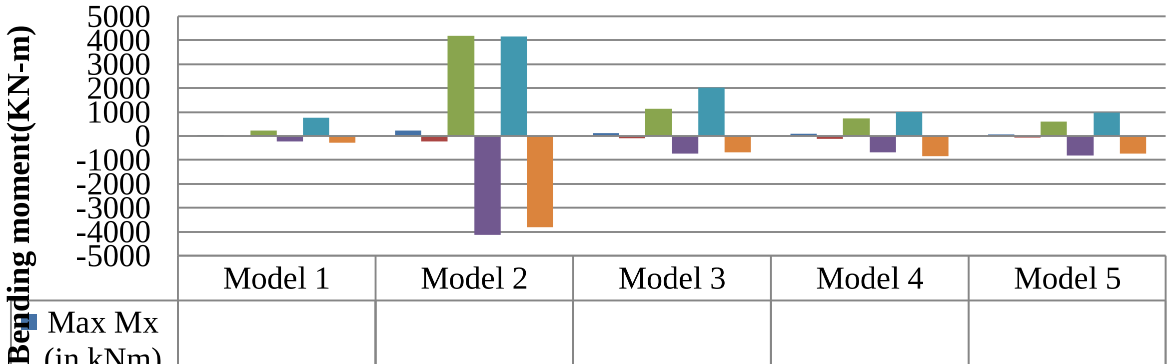
	Model 1	Model 2	Model 3	Model 4	Model 5
Max Fy (in kN)	37.86	382	58.23	66.24	87.64
Min Fy (in kN)	-37.86	-381.97	-215.11	-278.24	-119.89
Max Fz (in kN)	12.01	240.92	113.62	156.87	35.18
Min Fz (in kN)	-12.01	-240.92	-315.44	285.62	-46.25

Fig.10: Shear forces in column for building on levelled ground for zone 4



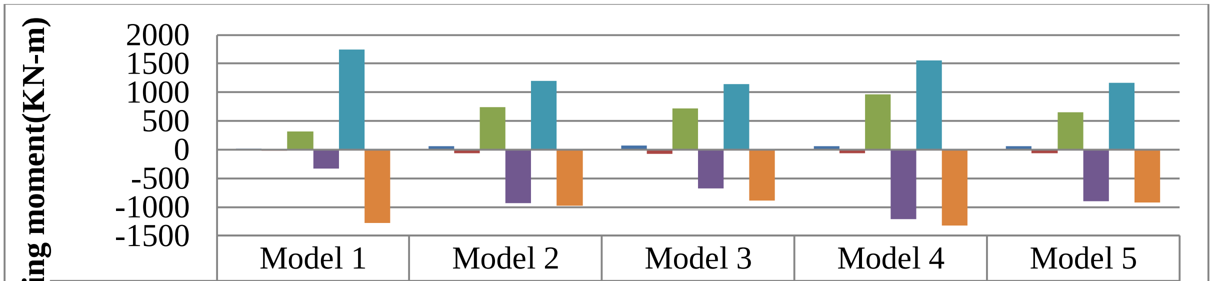
	Model 1	Model 2	Model 3	Model 4	Model 5
Max Fy (in kN)	121.59	119.35	109.97	151.16	95.13
Min Fy (in kN)	-121.59	-119.35	-110.52	-151.18	-129.26
Max Fz (in kN)	18.29	53.85	37.67	70.32	37.63
Min Fz (in kN)	-18.29	-53.85	-41.12	-70.31	-50

Fig.11: Shear forces in column for building on levelled ground for zone 5



	Model 1	Model 2	Model 3	Model 4	Model 5
Max Mx (in kNm)	9.93	229.8	114.26	87.21	57.96
Min Mx (in kNm)	-9.93	-229	-84.23	-110.14	-57.9
Max My (in kNm)	216.6	4181.9	1141.24	745.34	605
Min My (in kNm)	-216.6	-4144.7	-742.3	-671.6	-827
Max Mz (in kNm)	771.1	4171.03	2023.11	1013.58	984.9
Min Mz (in kN)	-284.1	-3814	-684.1	-842.3	-744.4

Fig.12: Bending moment in column for building on levelled ground for zone 4



	Model 1	Model 2	Model 3	Model 4	Model 5
Max Mx (in kNm)	15.13	61.43	69.71	65.39	63.45
Min Mx (in kNm)	-15	-61.4	-69.7	-65.3	-63.4
Max My (in kNm)	321.2	736.85	715.06	967.6	655.01
Min My (in kNm)	-329.8	-930.8	-672.5	-1210	-894
Max Mz (in kNm)	1742.37	1197.28	1145.7	1554.4	1163.59
Min Mz (in kN)	-1274	-976	-882.2	-1323	-922.9

5.2 SLOPING GROUND

1) Base shear

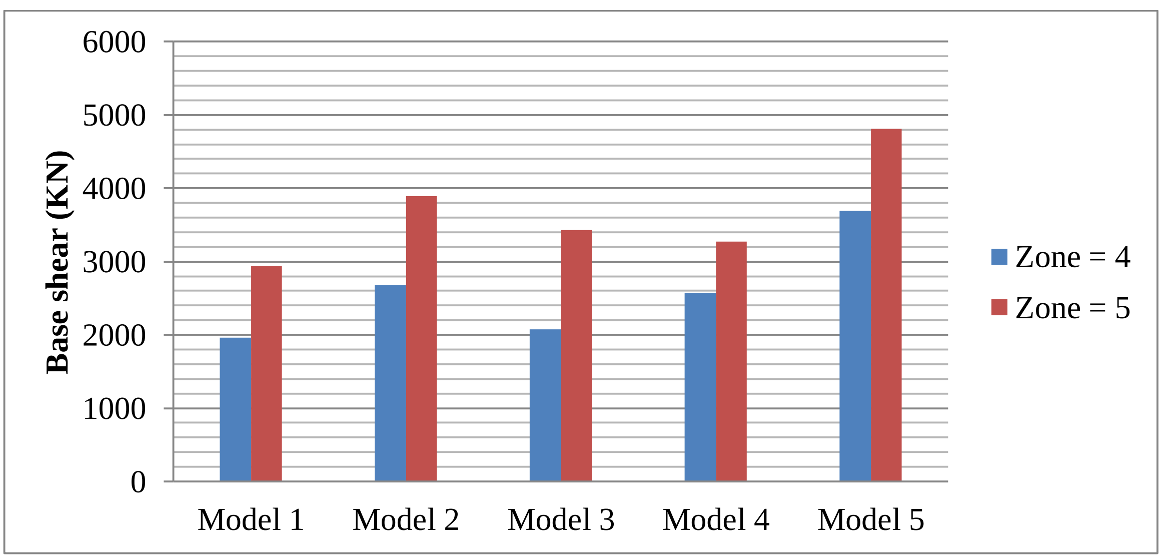


Fig.13: Variation of base shear for building on slopping ground

2) Fundamental time period

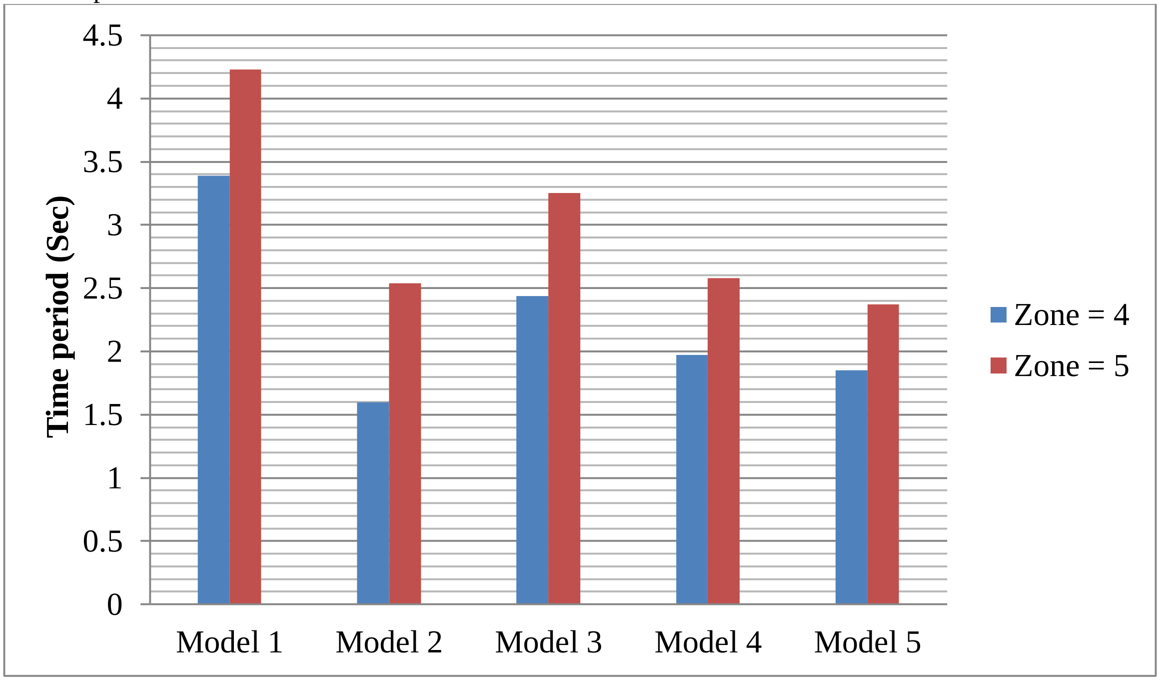


Fig.14: Variation of time period for building on slopping ground

3) Member forces

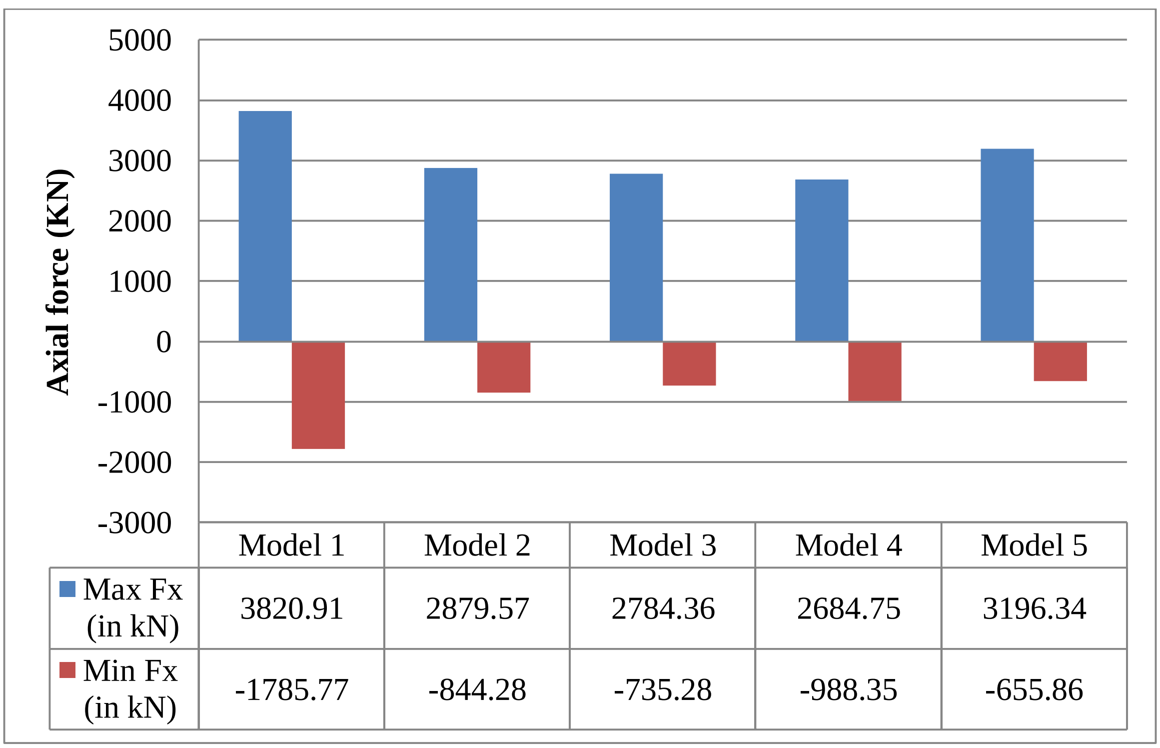
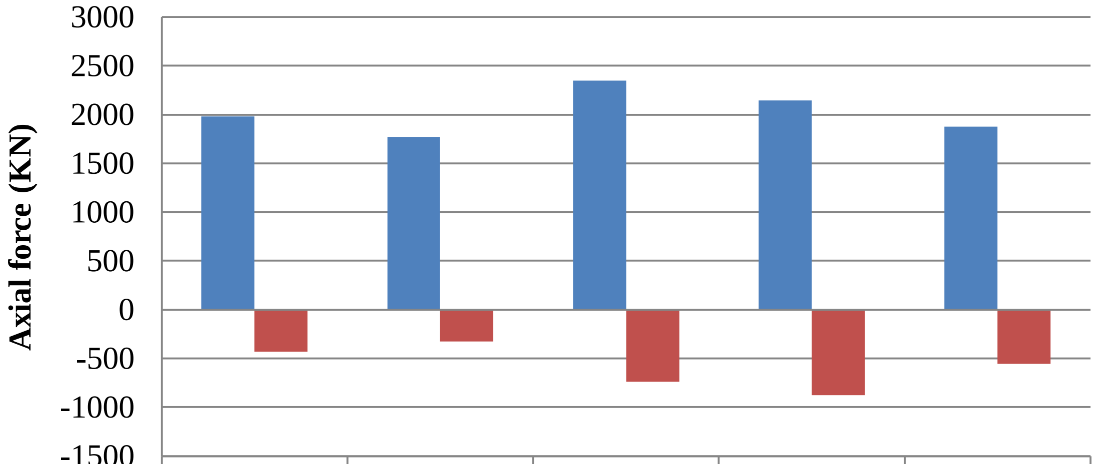
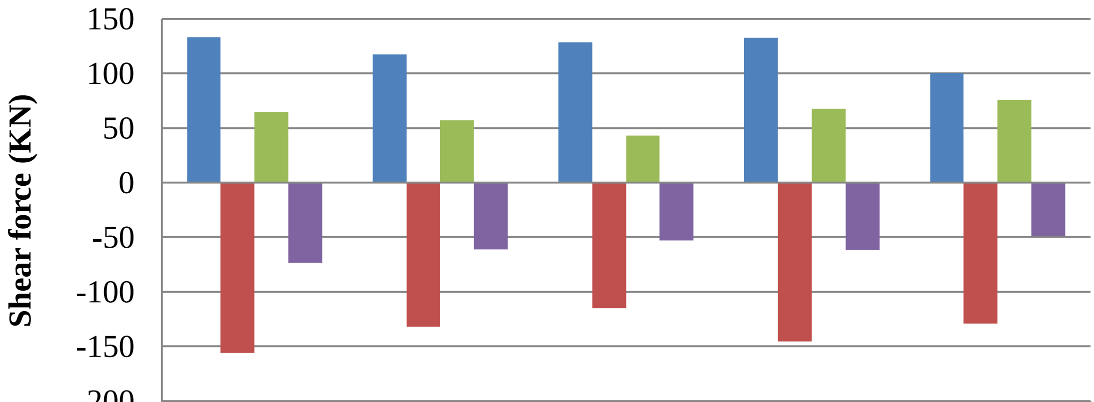


Fig.15: Axial force results for structure on sloping ground for zone 4



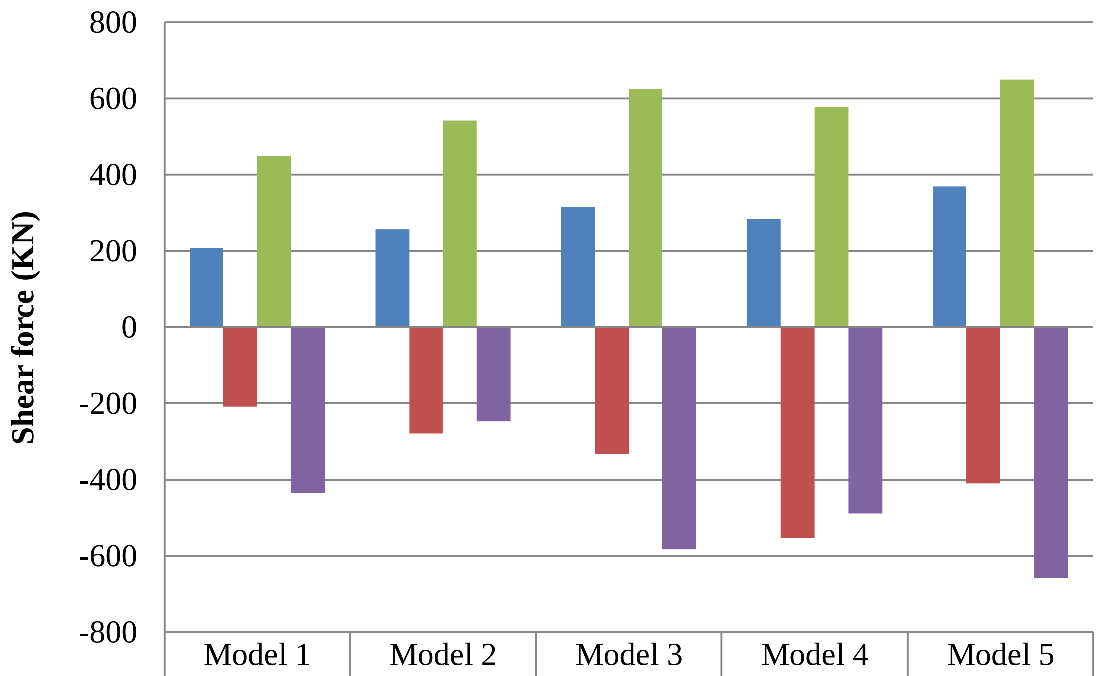
	Model 1	Model 2	Model 3	Model 4	Model 5
Max Fx (in kN)	1981.08	1769.24	2349.87	2145.34	1874.38
Min Fx (in kN)	-432.22	-325.36	-737.24	-874.25	-556.61

Fig.16: Axial force results for structure on sloping ground for zone 5



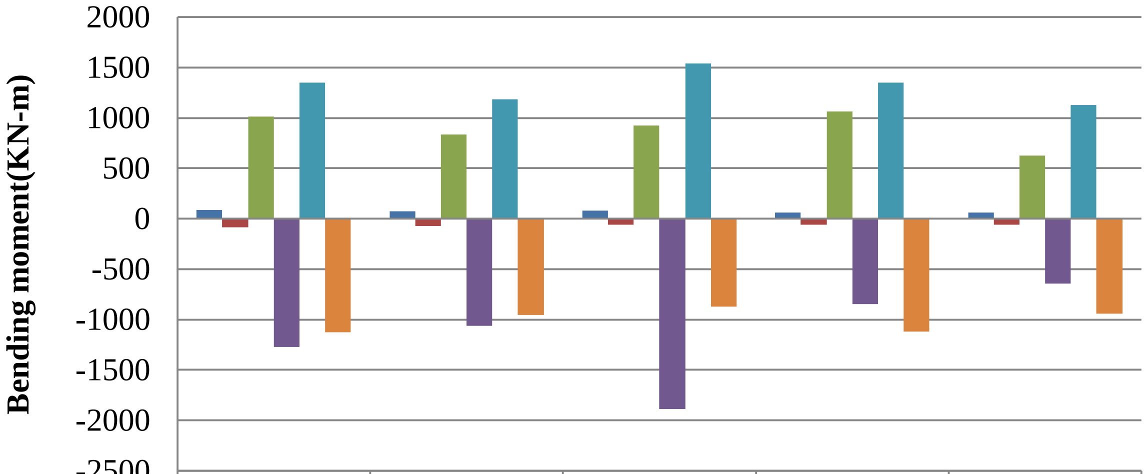
	Model 1	Model 2	Model 3	Model 4	Model 5
Max Fy (in kN)	132.96	117.61	128.74	132.79	100.22
Min Fy (in kN)	-156.29	-132.2	-115.24	-145.81	-128.98
Max Fz (in kN)	64.74	56.82	42.78	67.41	75.63
Min Fz (in kN)	-73.73	-61.22	-53.21	-61.61	-48.7

Fig.17: Axial force results for structure on sloping ground for zone 4



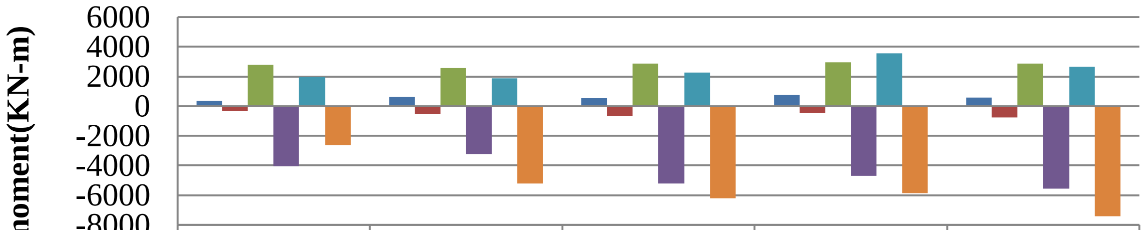
	Model 1	Model 2	Model 3	Model 4	Model 5
Max Fy (in kN)	208.22	256.54	315.85	284.33	368.49
Min Fy (in kN)	-208.41	-279.21	-333.02	-552.39	-410.02
Max Fz (in kN)	449.47	542.61	624.63	578.29	649.82
Min Fz (in kN)	-434.46	-247.91	-582.24	-489.2	-659.31

Fig.18: Axial force results for structure on sloping ground for zone 5



	Model 1	Model 2	Model 3	Model 4	Model 5
Max Mx (in kNm)	83.06	70.55	79.45	60.15	63.15
Min Mx (in kNm)	-83.02	-70.53	-62.58	-60.16	-63.12
Max My (in kNm)	1010.8	836.25	923.24	1061.46	627.2
Min My (in kNm)	-1273.3	-1060.4	-1887.4	-849.2	-645.1
Max Mz (in kNm)	1350.73	1183.3	1542.28	1349.4	1125.1
Min Mz (in kN)	-1124.6	-952.3	-874.3	-1122.2	-943.9

Fig. 19: Bending moment results for structure on sloping ground for zone 4



	Model 1	Model 2	Model 3	Model 4	Model 5
Max Mx (in kNm)	349.02	623.47	532.88	745.51	556.74
Min Mx (in kNm)	-349.03	-551.01	-674.21	-448.3	-749.1
Max My (in kNm)	2783.32	2562.11	2874.36	2971.32	2868.41
Min My (in kNm)	-4053.2	-3229.1	-5233.2	-4721.3	-5584.3
Max Mz (in kNm)	1970.8	1874.1	2246.2	3541.9	2642.5
Min Mz (in kN)	-2645.1	-5231.2	-6233.7	-5888.7	-7424.6

Fig.20: Bending moment results for structure on sloping ground for zone 5

IV. CONCLUSION

From the above discussion following conclusions can be made:

Plain ground

1. From the results obtained from this study it can be observed that the incorporation of shear wall in RCC frame increases the base shear due to increase in lateral stiffness.
2. The time period of structure reduces and there is considerable reduction in lateral displacement of structure also. Hence it can be said that the incorporation of shear wall increases the base shear this effect is also seen in when we change the zone 4 to zone 5.
3. The model 3 (C-shape) has minimum value of base shear among all other shear walls configurations in case of zone 4 and zone 5.
4. All the models with shear walls have approximately 60% less time period as compared with model 1. Model 2 (C shape) has minimum time period for both zone 4 and 5.
5. It is observed that maximum axial forces are seen in model 1 for zone 4 and zone 5. From all the models, model 3 shown min axial forces for zone 4 and zone 5.
6. It is observed that maximum shear forces are seen in model 2 for zone 4 and zone 5. From all the models, model 3 shown min shear forces for zone 4 and zone 5.
7. It is observed that maximum bending moments are seen in model 2 for zone 4 and zone 5. From all the models, model 3 shown min shear forces for zone 4 and zone 5.
8. Hence in case of plain ground building with C-shape shear wall perform best.

Slopping ground

1. From the results obtained from this study it can be observed that the incorporation of shear wall in RCC frame increases the base shear due to increase in lateral stiffness.
2. The time period of structure reduces and there is considerable reduction in lateral displacement of

structure also. Hence it can be said that the incorporation of shear wall increases the base shear this effect is also seen in when we change the zone 4 to zone 5.

3. The model 3 (C-shape) has minimum value of base shear among all other shear walls configurations in case of zone 4 and zone 5.
4. All the models with shear walls have approximately 60% less time period as compared with model 1. Model 3 (L shape) has minimum time period for both zone 4 and 5.
5. It is observed that maximum axial forces are seen in model 1 for zone 4 and zone 5. From all the models, model 3 shown min axial forces for zone 4 and zone 5.
6. It is observed that maximum shear forces are seen in model 3 for zone 4 and zone 5. From all the models, model 2 shown minimum shear forces for zone 4 and zone 5.
7. It is observed that maximum bending moments are seen in model 1 for zone 4 and zone 5. From all the models, model 3 shown min shear forces for zone 4 and zone 5.
8. In terms of nodal deflection model 1 (without shear wall) for plain ground shows max. deflection as compared to other models for zone 4 whereas model 3 with c-shear wall shows max. deflection as compared to other models for zone 5.

V. REFERENCE

[1]. Asnhuman.S, Dipendu Bhunia, Bhavin Ranjiyani (2011), “Solution of shear wall location in multi-storey building” International Journal of Civil and Structural Engineering Research.

[2]. Shaik Kamal Mohammed Azam, Vinod Hosur (2013), “Seismic performance evaluation of multistoried RC framed buildings with shear wall.” Journal of Scientific & Engineering Research, Volume 4, Issue 1.

[3]. P.P.Chandurkar, Dr.P.S.Pajgade (2013), “Seismic analysis of RCC building with and without shear wall.” International Journal of Modern Engineering Research, Vol.3.

[4]. Chaitanya Kumar J.D., Lute Venkat (2013), “Analysis of multi storey building with precast load bearing walls” International Journal of Civil and Structural Engineering, Volume 4.

[5]. Lakshmi K.O., Prof.Jayasree Ramanujan, Mrs. Bindu Sunil, Dr.Laju Kottallil, Prof.Mercy Joseph Poweth (2014), “Effect of shear wall location in buildings subjected to seismic loads.” ISOI Journal of Engineering and Computer Science.

[6]. M.S.Aainawala, Dr.P.S.Pajgade (2014) “Design of multistoried R.C.C. buildings with and without shear walls.” International Journal of Engineering Sciences and Research Technology.

[7]. Tarun shrivastava, Prof. Anubhav Rai, Prof. Yogesh Kumar Bajpai (2015), “Effectiveness of shear wall-frame structure subjected to wind loading in multi-storey building.” International Journal of Computational Engineering Research, Vol.5.

[8]. Mohd Atif, Prof. Laxmikant Vairagade, Vikrant Nair (2015), “Comparative study on seismic analysis of multi storey building stiffened with bracing and shear wall” International Research Journal of Engineering and Technology, Vol. 2.

[9]. Prasad Ramesh Vaidya (2015), “Seismic analysis of building with shear wall on sloping ground” International Journal of Civil and Structural Engineering Research, Vol.2.

[10]. Jamal Ali, Abdul Qadir Bhatti, Mansoor Khalid, Junaid Waheed and Shaqran Zuberi (2015), “Analyze the effectiveness of shear walls in controlling lateral drift for medium to high rise structures (10 – 25 Storeys).” International Conference on Geological and Civil Engineering.