Seismic Performance of Open Ground Storey Building Strengthened with Reinforced Concrete Shear Wall

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Abstract: *The Open Ground Story building is very useful to city because of the provision of excessive parking space in the urban areas. However, earthquake efficiencies of such buildings are found to be regularly poor as seen by previous earthquakes. To enhance this an attempt is made to analyse the multi-storey structure with and without shear walls. The performance of the building with different function of shear walls was studied. The objective of this study is to model and analyze shear wall-frame structures having different location of wall in the structure. Shear wall has high in plane stiffness and strength which may be used to at the same time resist large horizontal loads and support gravity loads. Seismic analysis of building is carried out using structural design and analysis software Staad Pro V8i (SS4). So, to enhance the seismic performance of building the shear walls plays important role.*

Key word- Open ground storey building, RC shear wall, Seismic analysis, Static analysis, Staad Pro.

1. INTRODUCTION

Stability of earth is always disturbed due to internal forces and as a result of such disturbance, vibration or jerks in earth crust takes place which is known as earthquake. The fundamental design concept of earthquake resistance design of building is to make strong column and weak beam but many buildings that collapse during past earthquake exhibited exactly opposite strong beam and weak column behavior, means column failed before the beam yielding mainly due to soft storey effect.

Numerous such buildings constructed in recent times have a special feature – the ground storey is left open, which means the columns in the ground storey do not have any partition walls between them. These types of buildings having no infill walls in ground storey, but having infill walls in all upper storeys are called as “Open Ground Storey” (OGS) buildings. The open ground storey buildings are generally analysed as bare frame structures i.e. without considering structural contribution of masonry infill walls in the upper stories, this calls for assessment. Because the presence of infill walls in all upper stories except in the ground storey makes the upper stories much stiffer as compared to the open ground storey hence the upper stories move almost together as a single block and most of the horizontal displacement of the buildings occurs in the open ground storey itself.

2. METHODOLOGY

Shear wall has high in plane stiffness and strength which may be used to at the same time resist large horizontal loads and support gravity loads. For the buildings on sloping ground, the peak of columns below plinth level isn't same that affects the performance of building throughout earthquake. So to enhance the seismic performance of building on sloping ground the shear walls play important role.

Hence during this study, we have analyse the open ground storey buildings with and while not shear walls. The performance of the building with numerous configurations of shear walls was studied. For all shear walls configurations under issues the length of shear wall in dual principal directions is kept equal. The RCC building models having G+15 storeys with shear walls and without shear walls are deliberate for the study. The response spectrum analysis of building is applied using structural engineering software system Staad pro V8i (SS4) and also the seismic performance of building with numerous shear walls configurations is compared with reference to parameters like base shear, lateral displacement, period of time and member forces.

3D analysis as well as torsional impact has been allotted by using response spectrum technique for this study. Dynamic response of those buildings, in terms of base shear, basic period, roof displacement and member forces is given, and compared inside the thought of configuration of shear walls further like model while not shear walls, efficient positioning of shear walls configuration to be used is recommended.

The seismic analysis of all buildings is carried by Response Spectrum technique 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 , wherever Vb is that the base shear analysis supported period given by empirical equation and, VB is that the base shear from dynamic analysis , if Vb/VB ratio is over one. Damping thought of for all modes of vibration was 5 %. For crucial the seismic response of the buildings in numerous directions for ground motion the response spectrum analysis was conducted in longitudinal and transverse direction (X and Y). Building analysis is finished seismic zone 4 & 5.

The following models of building are considered.

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

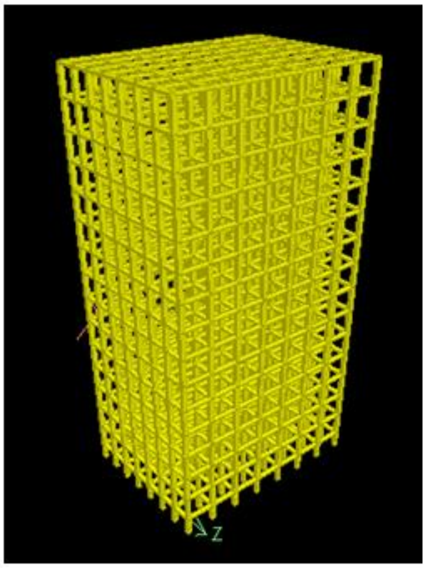


Fig. 1: Building without shear wall

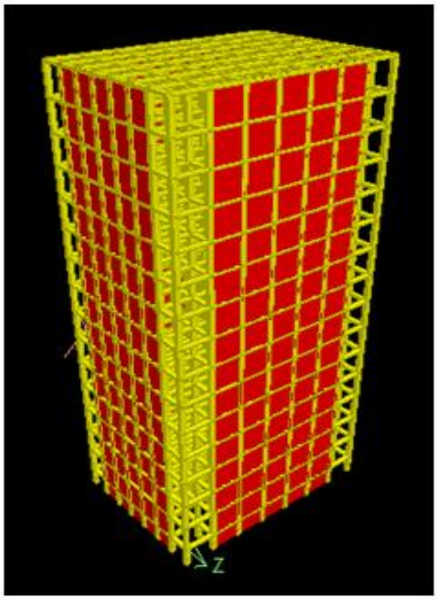


Fig. 2: Building with straight shape shear wall

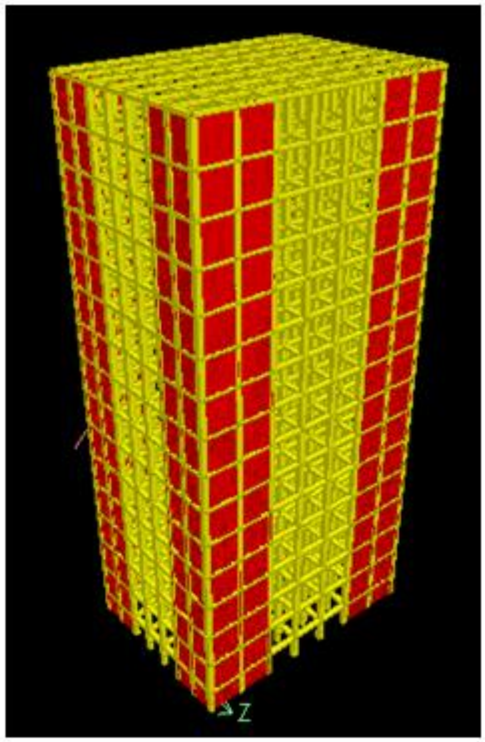


Fig. 3: Building with L shape shear wall

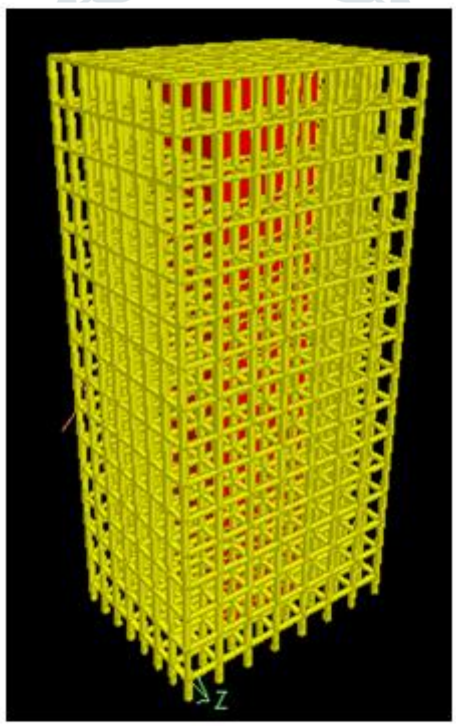


Fig. 4: Building with C shape shear wall

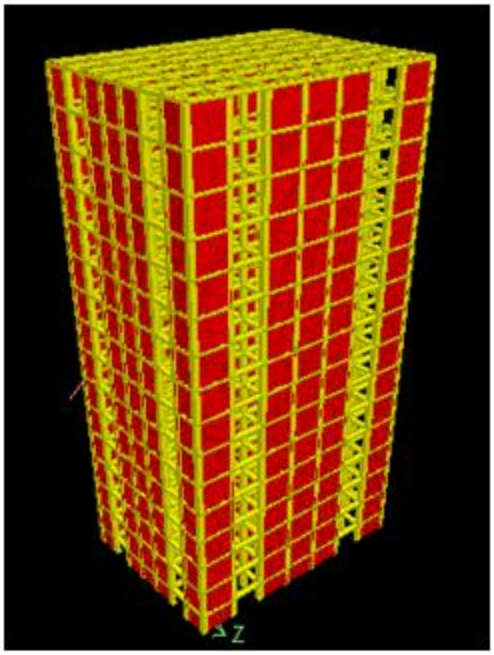


Fig. 5: Building with combined straight, L and C shape shear wall

3. RESULT

1) Base Shear

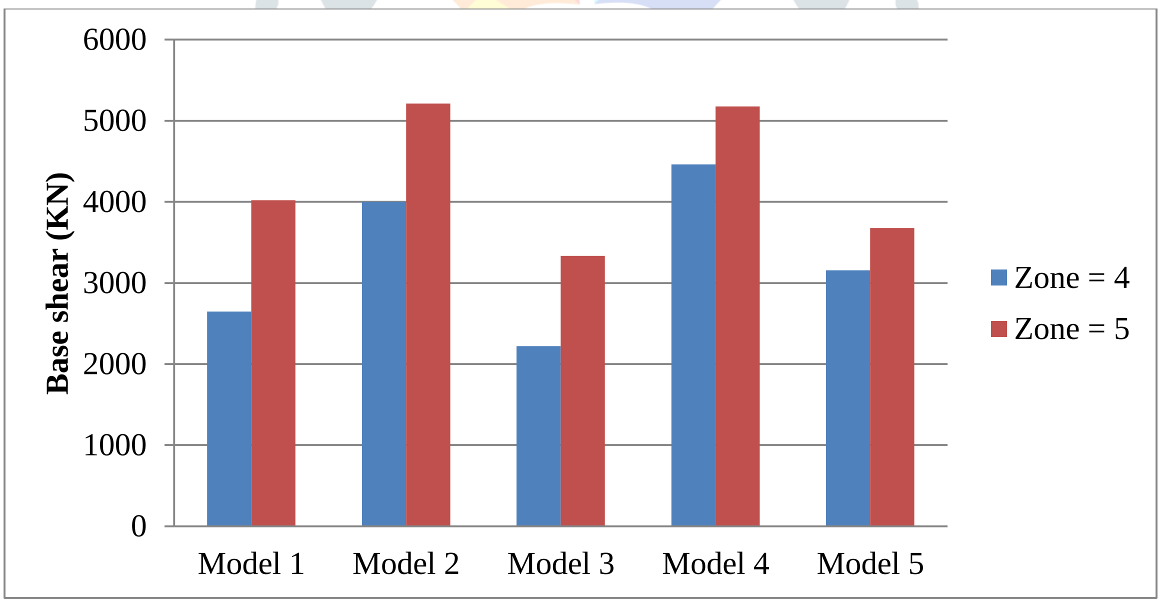


Fig. 6: Variation of base shear for building

2) Fundamental time period

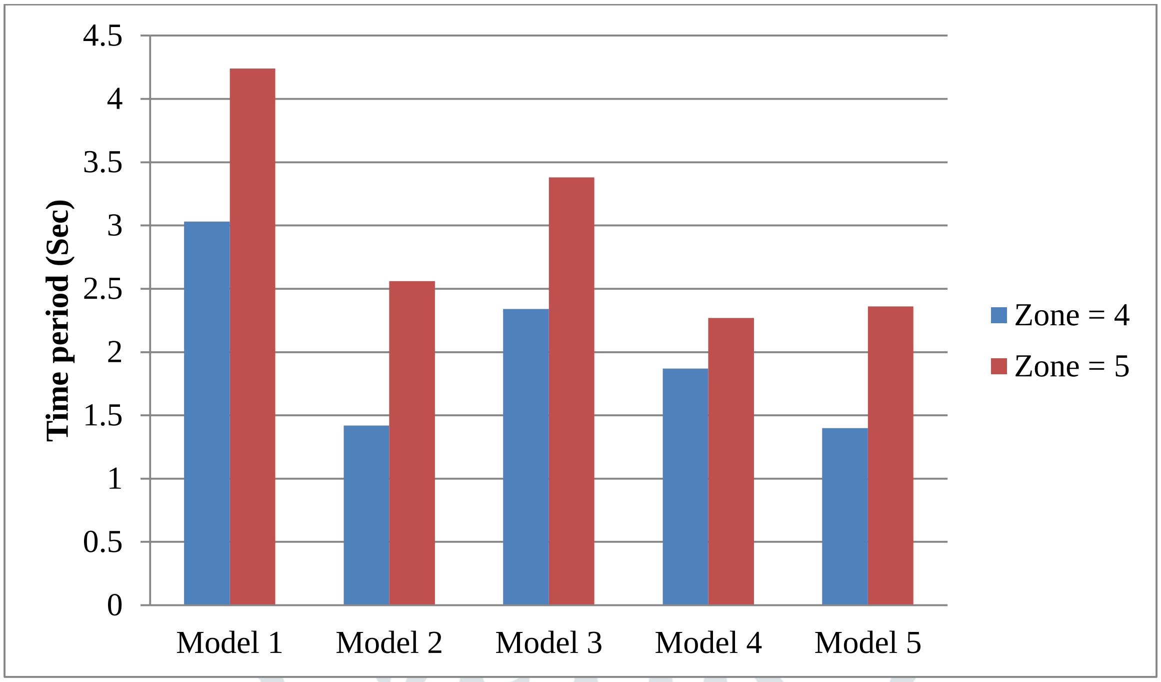


Fig. 7: Variation of time period for building

3) Member forces

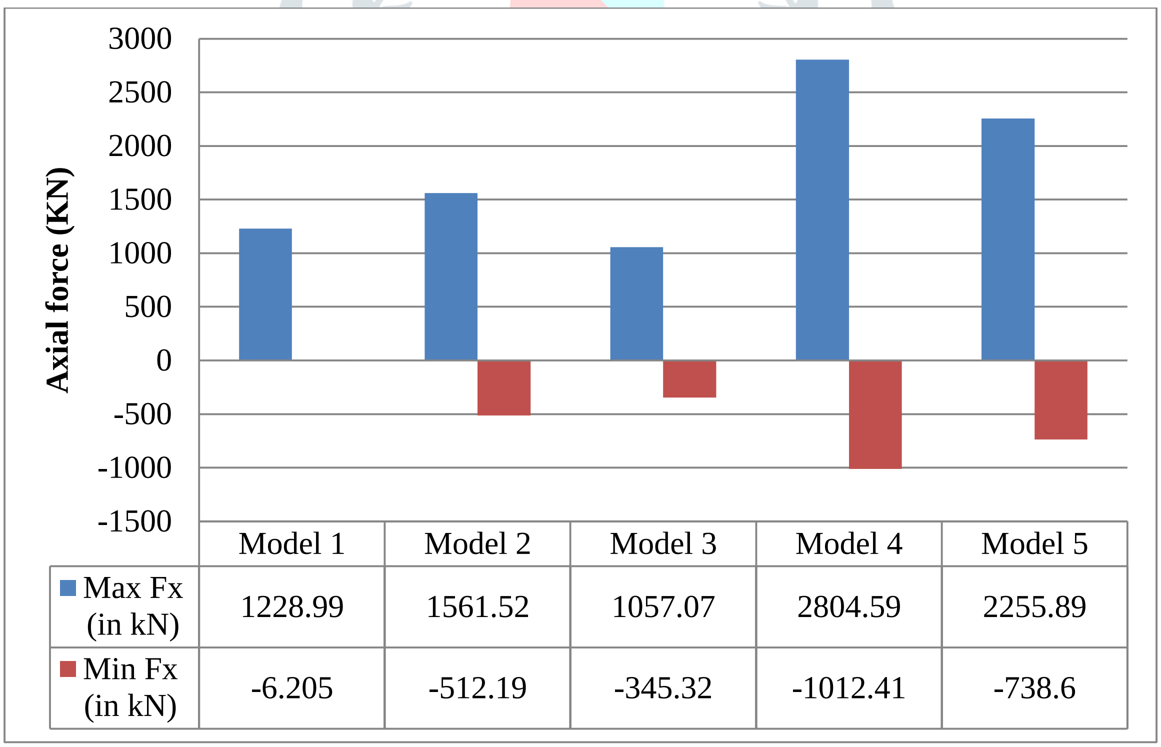
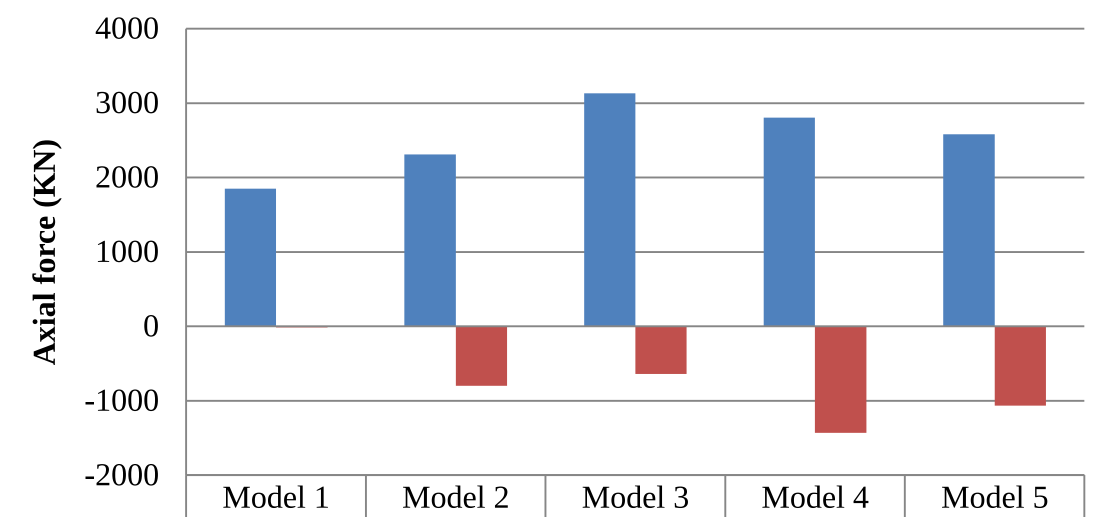
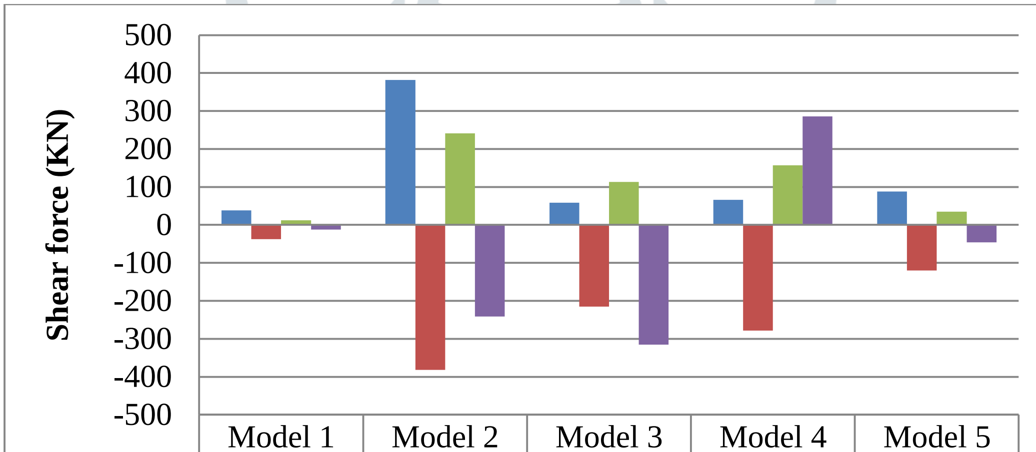


Fig. 8: Axial forces in column for building for zone 4



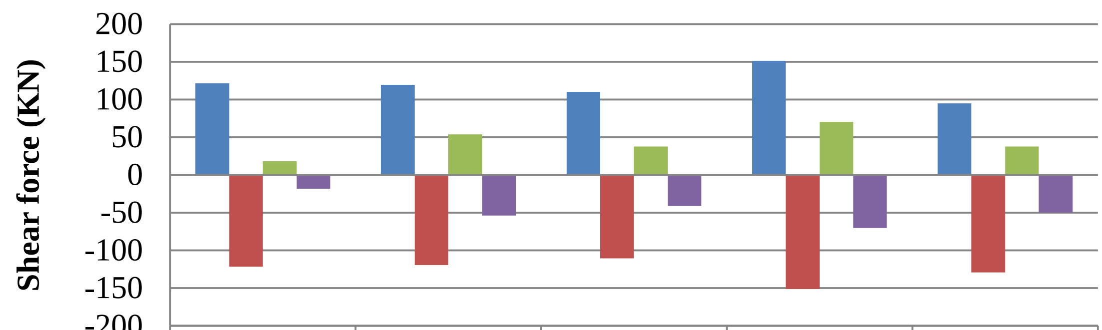
	Model 1	Model 2	Model 3	Model 4	Model 5
Max Fx (in kN)	1848.49	2312.11	3129.61	2804.59	2580.85
Min Fx (in kN)	-17.77	-800.4	-638.85	-1428.36	-1063.59

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



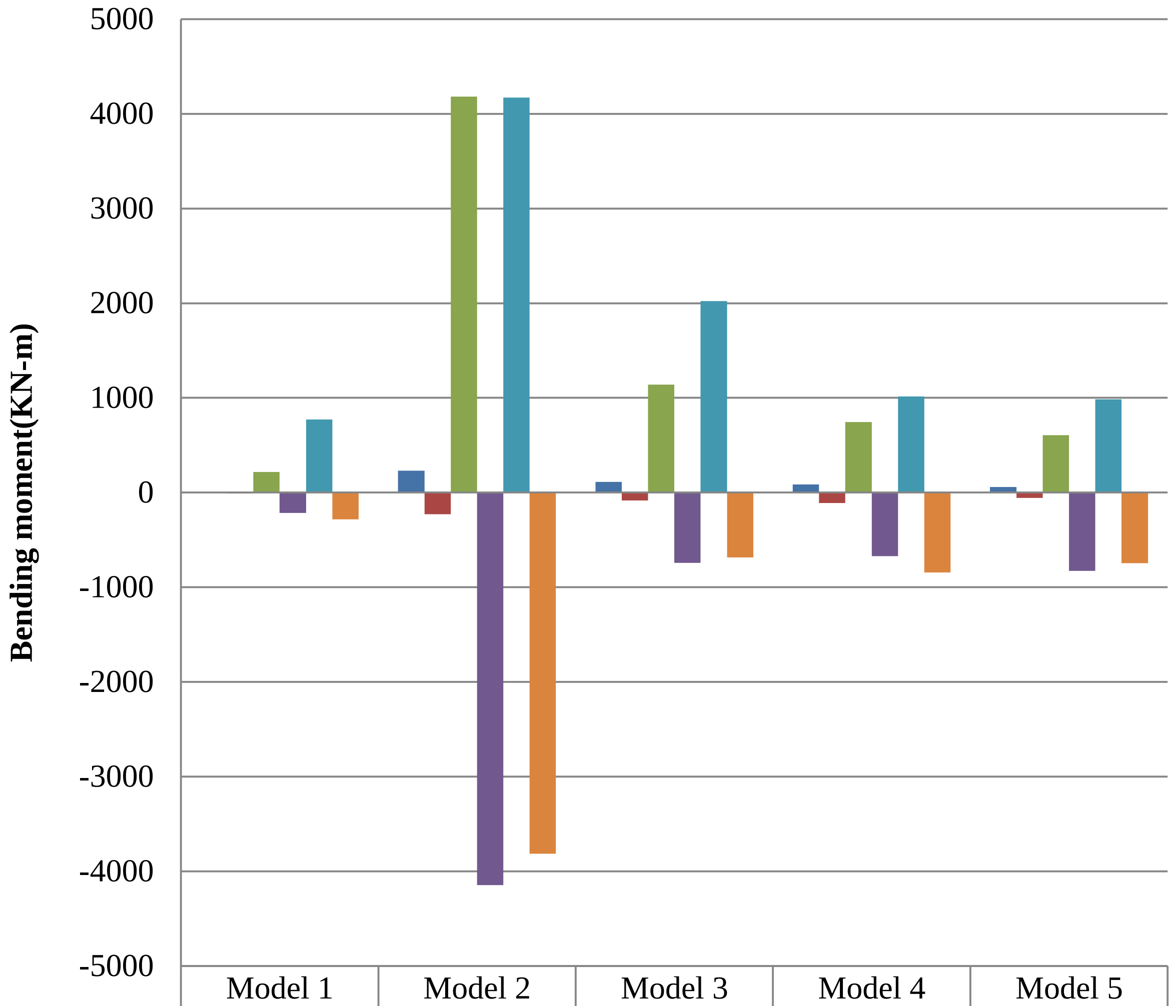
	Model 1	Model 2	Model 3	Model 4	Model 5
Max Fy (in kN)	37.86	382	58.23	66.24	87.64
Min Fy (in kN)	-37.86	-381.97	-215.11	-278.24	-119.89
Max Fz (in kN)	12.01	240.92	113.62	156.87	35.18
Min Fz (in kN)	-12.01	-240.92	-315.44	285.62	-46.25

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



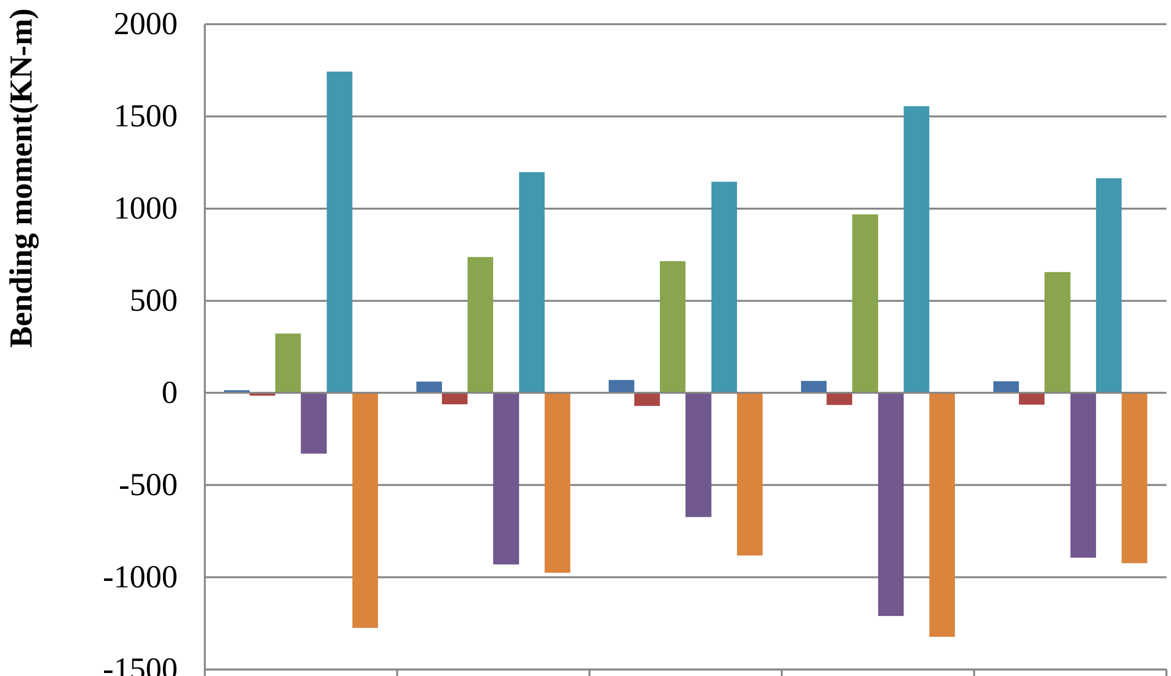
	Model 1	Model 2	Model 3	Model 4	Model 5
Max Fy (in kN)	121.59	119.35	109.97	151.16	95.13
Min Fy (in kN)	-121.59	-119.35	-110.52	-151.18	-129.26
Max Fz (in kN)	18.29	53.85	37.67	70.32	37.63
Min Fz (in kN)	-18.29	-53.85	-41.12	-70.31	-50

Fig. 11: Shear forces in column for building 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 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

Fig. 13: Bending moment in column for building for zone 5

4. CONCLUSION

From the above discussion following conclusions can be made:

1. Results from this analysis demonstrate that the introduction of shear wall into the RCC frame raises the base shear by growing lateral rigidity.
2. The structure time span is shortened and the lateral framework displacement is therefore considerably reduced. That is why, as we adjust Zone 4 to Zone 5, the addition of the shear wall raises the base shear. The minimal value of base shear is seen in model 3 (L-shape) for the zone 4 and zone 5 in all other shear wall configurations.
3. All the models with shear walls have approximately time-span of about 60% less than Model 1. Model 2 (straight form) has the less time span for both zone 4 &5.
4. It is observed that maximum axial forces are seen in model 1 (without shear wall) for zone 4 and zone 5. From all the models, model 3 (L - shape) shown min axial forces for zone 4 and zone 5.

5. It is observed that maximum shear forces are seen in model 2 (straight shape) for zone 4 and zone 5. From all the models, model 3 (L-shape) shown min shear forces for zone 4 and zone 5.
6. It is observed that maximum flexural moments are seen in model 2 (straight shape) for zone 4 and zone 5. From all the models, model 3 (L-shape) shown min shear forces for zone 4 and zone 5.
7. Hence L-shape shear wall perform best.

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