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Performance of regular and sloped buildings using seismic loads

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Abstract
Earthquake is the shaking of the surface of the earth and it is one of the most disaster causing and unpredictable phenomenon of the nature. Earthquake is caused by plate tectonic movements, volcanic eruptions or man made explosions, which last for a short period, usually less than a minute. One of the greatest challenges facing a structural engineer in to efficiency design the structural system of a buildings so that it can resist the earthquake loads effectively. The choice of structural system should also consider economy and hence a study covering the effectiveness of the structural system should also include the cost aspect of it.
In this study the analysis of multi storied buildings (G+10 and G+15) of regular and sloped shapes were considered. Seven different models where used in the study and the buildings were modeled in E-Tabs-2013. For sloped buildings, the ground surface were assumed to be sloped at 37°. The different models were analyzed and displacement and stresses were obtained for each. The seismic analysis by response spectrum have been carried out as per IS 1893 (part-1):2002. In the regular and sloped buildings (G+10 and G+15) for seven different models was considered: They are, moment frame, structural core at center, two separate structural walls, two combined structural walls, structural wall in inner bays, structural wall at periphery and structural wall core infill at center. The structural systems were compared for their drift ratio, base shear, storey force and storey stiffness. Based on the comparative study for regular and sloped buildings, the best structural system was arrived at.
Keywords: *ETABS 2013,Sloped Buildings, Regular Buildings,Moment frame, Structural core at center, two separate structural walls, two combined structural walls, structural wall in inner bays, structural wall at periphery and structural wall core infill at center, Drift Ratio, Base Shear, Storey Force and Storey Stiffness.*

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I. INTRODUCTION

Reinforced cement concrete Although (RCC) structures are popular because to their ease of construction, there is a need for a large number of medium and high rise structures in developing countries to accommodate the expanding urban population. The amount of land accessible in metropolitan areas is quite limited, making it impossible to accommodate the rising population. Many reinforced concrete buildings in urban areas that are in active seismic zones could be harmed. Ground vibrations cause moderate to severe damage. Buildings with shear walls are commonly utilized to withstand lateral loads caused by earthquakes. During earthquakes, the structure is still harmed for several reasons. The behavior of a structure during an earthquake is determined by the distribution of weight, stiffness, and strength in the building's horizontal and vertical planes. Buildings with reinforced concrete frames are capable of withstanding both vertical and horizontal loads.

II. METHODOLOGY

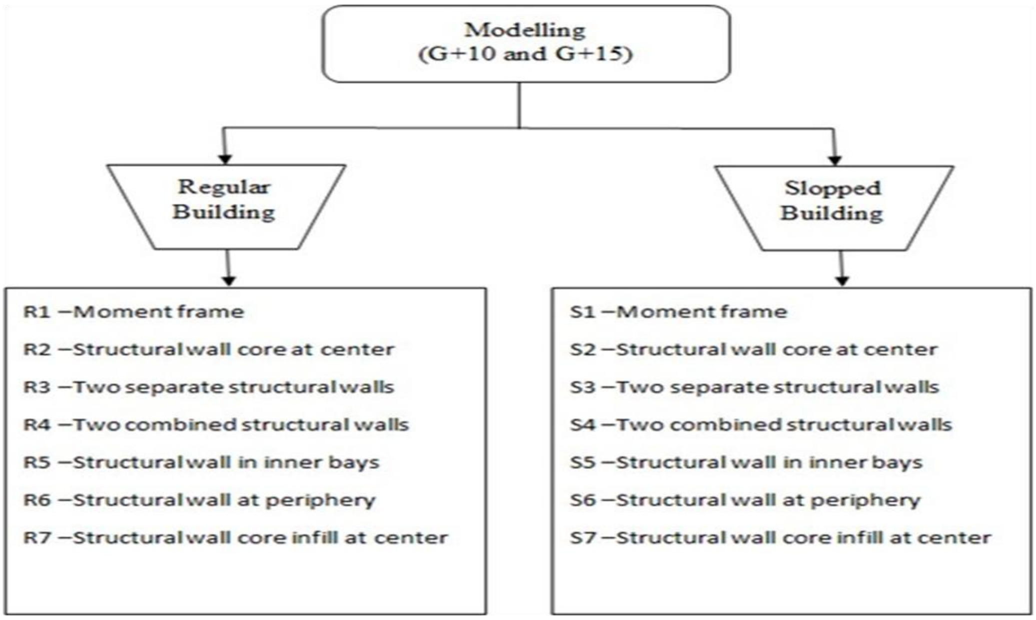

Figure 2.1: Different models considered in analysis

III. RESULT AND DISCUSSION

The results obtained are as discussed below

Introduction

The different models of regular and sloped buildings as discussed in chapter 2 were modeled and analyzed in E-Tabs-2013 after application of the necessary boundary conditions. The analyzed models were individually examined to obtain the response characteristics to enable a comparison between different structural systems. The results and discussion of the analysis is presented in the following sections with Special Forces on storey drift, base shear, storey force and storey stiffness.

Analyzed model

After analysis of the models in E-Tabs-2013, the values of displacements, stress and strain for each were obtained providing deeper insight into the response of the structure. The deformed shape of the building along the x-direction super imposed with the contour plot is given in figures shown below

The plot corresponds for G+10 building with structural wall at the periphery for a load combination of DCon9. As evident from the plot, the periphery of the building wherethe walls are provided, the deflections are less giving it a saner shape. The maximum vertical deflection is 2mm for this case. Fig. 3.1

The plot corresponds for G+10 building with structural wall in inner bays for a load combination of DCon9. As evident from the plot, the inner bays of the building wherethe walls are provided, the deflections are less giving it a saner shape. The maximum vertical deflection is 2mm for this case. Fig. 3.2

The plot corresponds for G+15 building with structural wall core at center for a load combination of DCon9. As evident from the plot, the core at center of the building where the walls are provided, the deflections are less giving it a saner shape. The maximum vertical deflection is 2mm for this case. Fig. 3.2

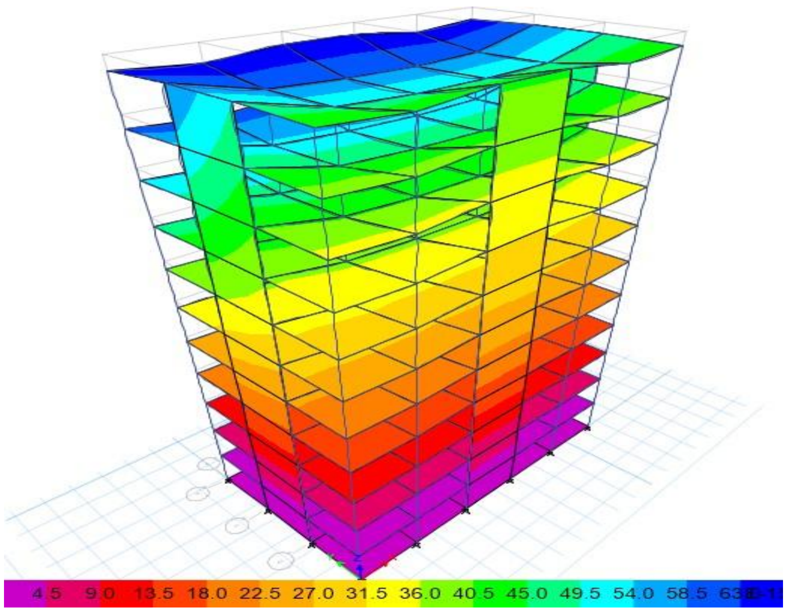

Figure 3.1: Analysis of G+10 regular building for structural wall at periphery

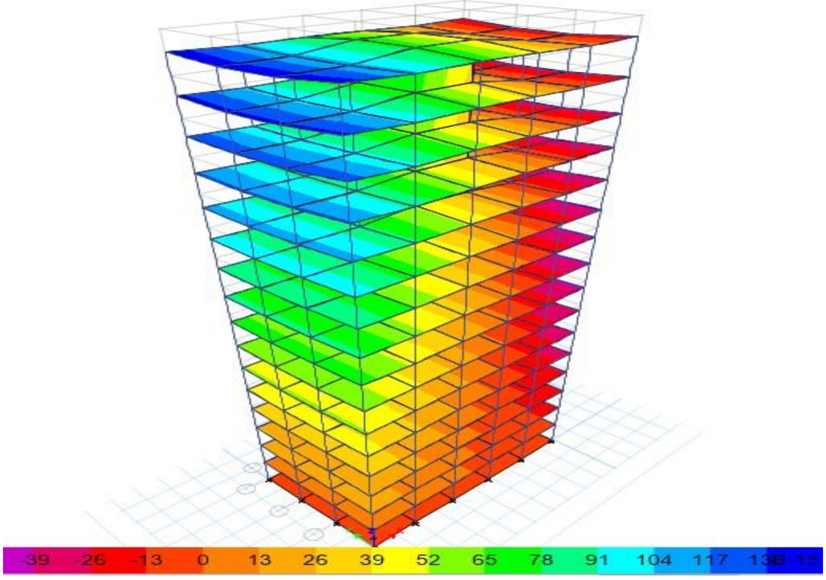

Figure 3.2: Analysis of G+10 regular building for structural wall in inner bays

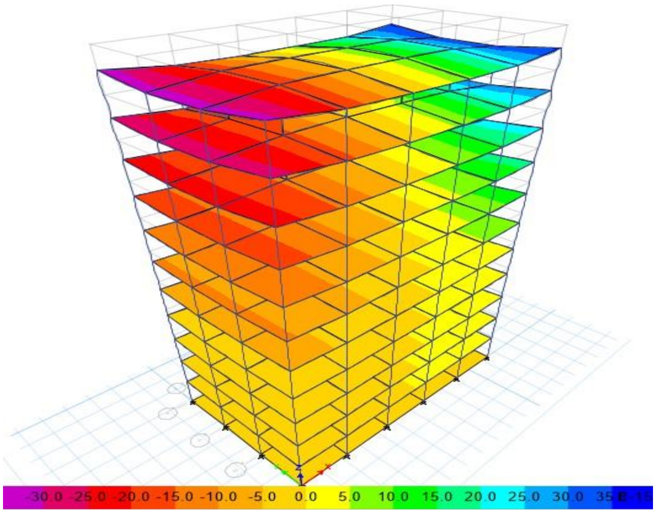

Figure 3.3: Analysis of G+10 regular building for structural wall core at center

Storey drift

Storey drift is the displacement of one level relative to other level above or below. Storeydrift ratio is defined on the difference between displacements of two stories to the height of one storey. The storey drift for different models have been compared and presented in section 3.1.1 to 3.1.4. For comparison, the maximum value of storey drift obtained considering all the service load combination (DCon9 to DCon13) as specified in section 2.2 of chapter2 as been used.

Drift ratio for G+10 regular building

The plot of drift ratio with storey number for each of the seven structural systems modeled with (G+10) storey is shown in Fig. 3.4. The definition of R1 to R7 is asper the terminology stated in fig.2.1. From the figure it is observed that the maximum value of drift ratio is 0.0248 for model R4 and minimum value of drift ratio is 0.0018 for model R2. Also it is noticed that, application of core at center (R2) for building reduces the drift ratio compared to other six models. The models R5 and R6 also symmetrically reduced the drift ratio with their values only marginally above those obtained for R2.

Drift ratio for G+15 regular building

The plot of drift ratio with storey number for each of the seven structural systemsmodeled with (G+15) storey is shown in Fig. 3.5. From the figure it is observed

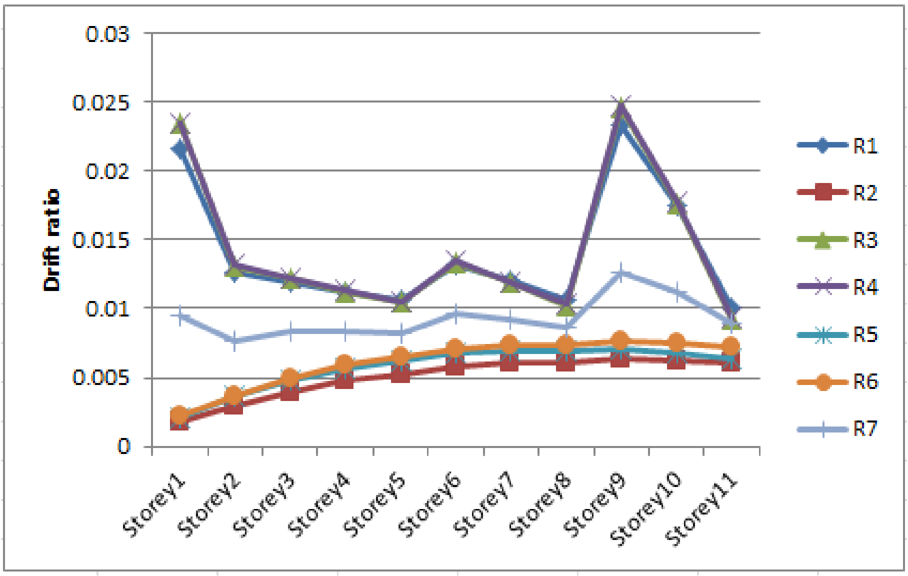

Figure 3.4: Drift ratio for G+10 regular building

that the maximum value of drift ratio is 0.0307 for model R1 and minimum value ofdrift ratio is 0.0027 for model R2. Also it is noticed that, application of core at center (R2) for building reduces the drift ratio compared to other six models and R5, R6, this models also reduces drift ratio compared to R1, R3, R4 model.
It is observed that from fig 3.2 the unlike fig 3.1, the graphs of R1, R3 and R4 arecoming in contact with other graphs at some storeys. Therefore, it is inferred that the advantage of using R2, R5 and R6 as structural system reducer when used for G+15 building as compared to g+10 building.

Drift ratio for G+10 sloped building

The plot of drift ratio with storey number for each of the seven structural systems modeled with (G+10) storey is shown in Fig. 3.6. The definition of S1 to S7 is as per the terminology stated in fig.2.1. From the figure it is observed that the maximumvalue of drift ratio is 0.0196 for model S4 and minimum value of drift ratio is 0 for allmodel . Also it is noticed that, application of core at center (S2) for building reduces the drift ratio compared to other six models and S5, S6, this models also reduces drift ratio compared to S1, S3 and S4 model. In storey 3 for models (S2 and S7) drift valueis small and storey 1,2,4 and 5 is zero because of models S2 and S7 introduce core wallat center.

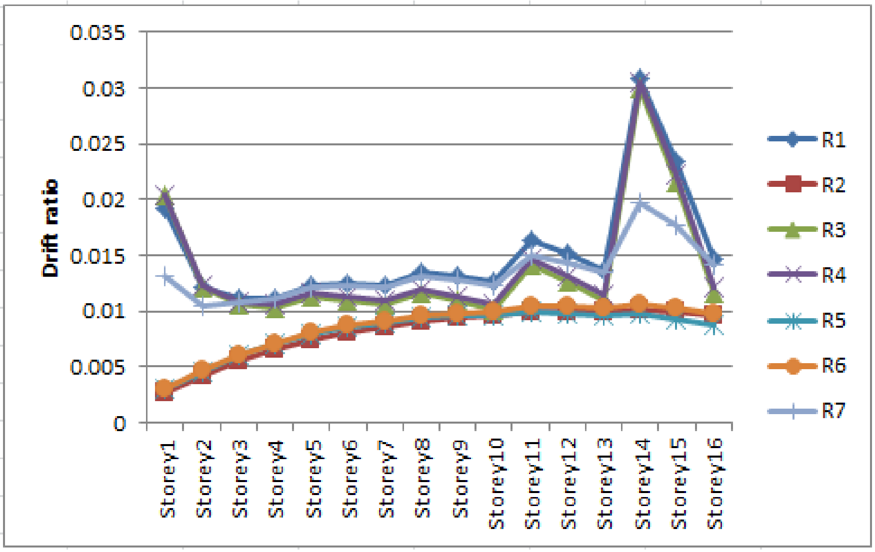

Figure 3.5: Drift ratio for G+15 regular building

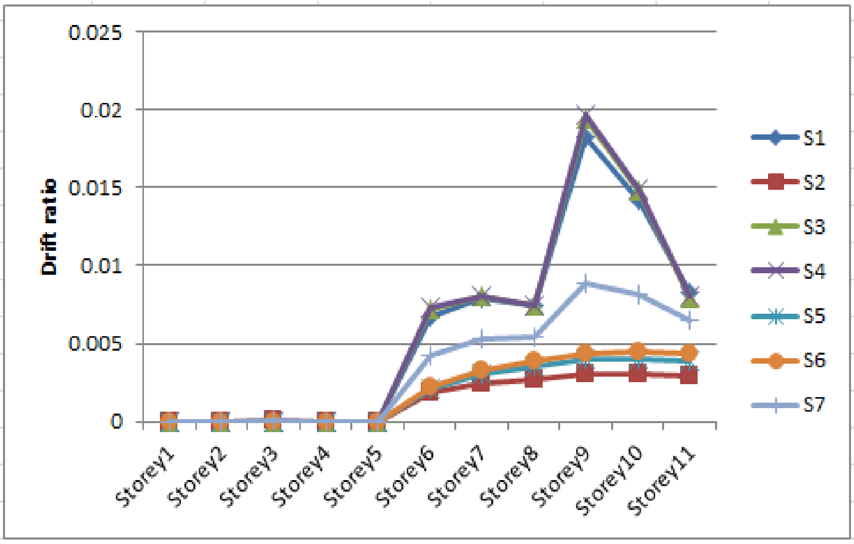

Figure 3.6: Drift ratio for G+10 sloped building

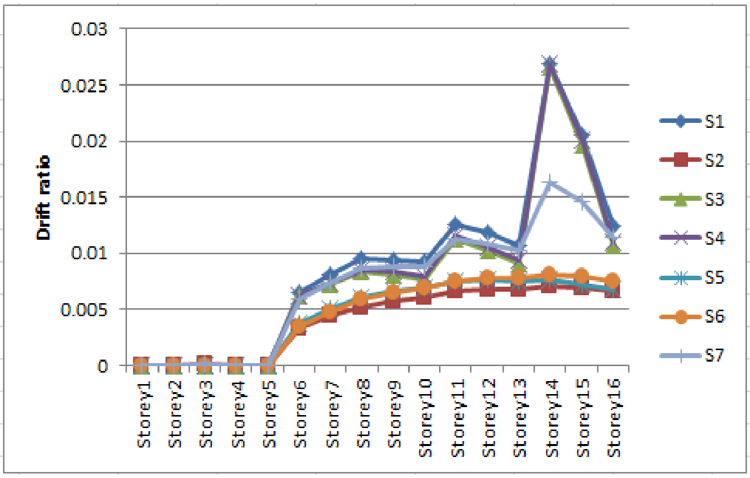

Figure 3.7: Drift ratio for G+15 sloped building

Drift ratio for G+15 sloped building

From the Fig. 3.7 it is observed that the maximum value of drift ratio is 0.0268 for model S4 and minimum value of drift ratio is 0 for all model . Also it is noticed that, application of core at center (S2) for building reduces the drift ratio compared to other six models and RS, S6, this models also reduces drift ratio compared to S1, S3 and S4model. In storey 3 for models (S2 and S7) drift value is small and for stories 1, 2.4 and5 is zero because of models S2 and S7 introduce core wall at center.

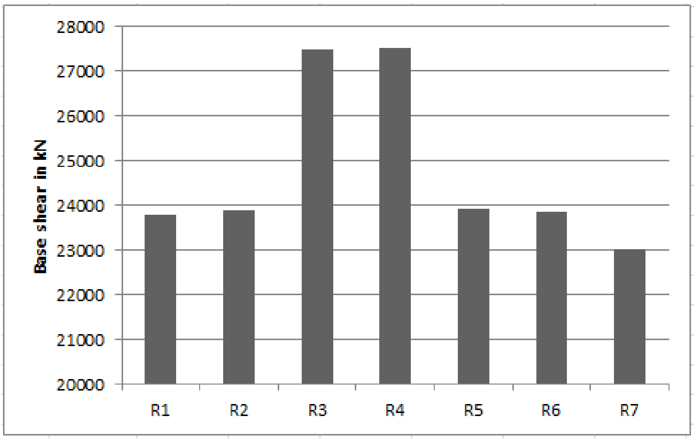

Figure 3.8: Base shear for G+10 regular building

Base shear

Base shear is the maximum lateral force that will occur due to seismic ground motion at the base of a structure. Calculation of base shear depends on soil conditions at the site. The base shear obtained for different models were compared after analysis themfor the parameters mentioned in chapter2.

Base shear for G+10 regular building

The plot of maximum base shear after considering all load combinations for different structural systems is presented in Fig. 3.8. From the figure, it is observable that the maximum base shear was obtained for R4 (27529kN) falling very close to the value obtained for R3 (27499kN). The base shear for R1,R2,R5 and R6 lie in close layer ofeach other and the maximum was obtained for R7(23018kN). It indicates that structural wall with core infill at center leads to lesser base shear compared to other models.

Base shear for G+15 regular building

The plot of maximum base shear after considering all load combinations for different structural systems is presented in Fig. 3.9. From the figure, it is observable that the maximum base shear was obtained for R3 (45607kN) falling very close to the value obtained for R4 (245518kN).The base shear for R2,R5,R6 and R7 lie in close layer ofeach other and the maximum was obtained for R7(23018kN). It indicates that moment frame leads to lesser base shear compared to other models.

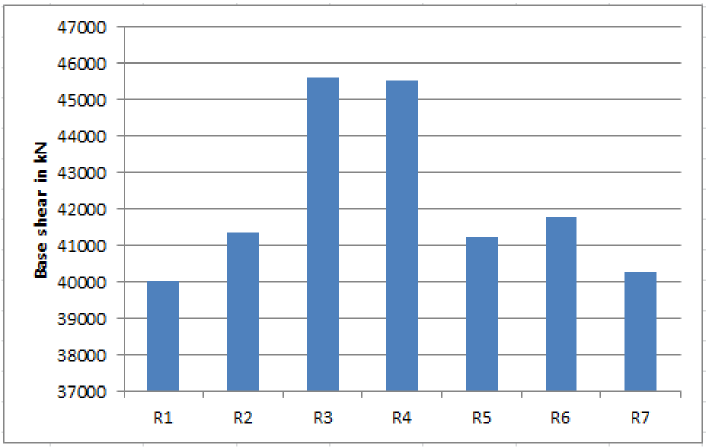

Figure 3.9: Base shear for G+15 regular building

Unlike the G+10 building, the base shear obtained for R1,R2,R5 and R6 are different from each other, indicating the effect of changing the building from G+10 to G+15.

Base shear for G+10 sloped building

The plot of maximum base shear after considering all load combinations for different structural systems is presented in Fig. 3.10. From the figure, it is observable that the maximum base shear was obtained for S6 (5534kN) falling very close to the value obtained for S5 (4811kN).The base shear for S2,S3,S4 and S7 lie in close layer of each other and the maximum was obtained for S1(23018kN). It indicates that moment frame leads to lesser base shear compared to other models.

Base shear for G+15 sloped building

The plot of maximum base shear after considering all load combinations for different structural systems is presented in Fig. 3.11. From the figure, it is observable that the maximum base shear was obtained for S6 (11049kN) falling very close to the value obtained for S3 (9694kN).The base shear for S2,S3,S4 and S7 lie in close layer of each other and the maximum was obtained for S1(23018kN). It indicates that moment frame leads to lesser base shear compared to other models.

A prominent feature of the base shear of sloped buildings (fig3.10 and fig3.11) when compared with the regular building (fig3.8 and fig3.9) is the increases in the base shear of S6 and S7 as compared to R6 and R7 relative to other models. Hence the models with structural wall at periphery and structural wall core infill at center leads to a relativelly higher base shear when the ground on which the building rests is changed from regular to sloped.

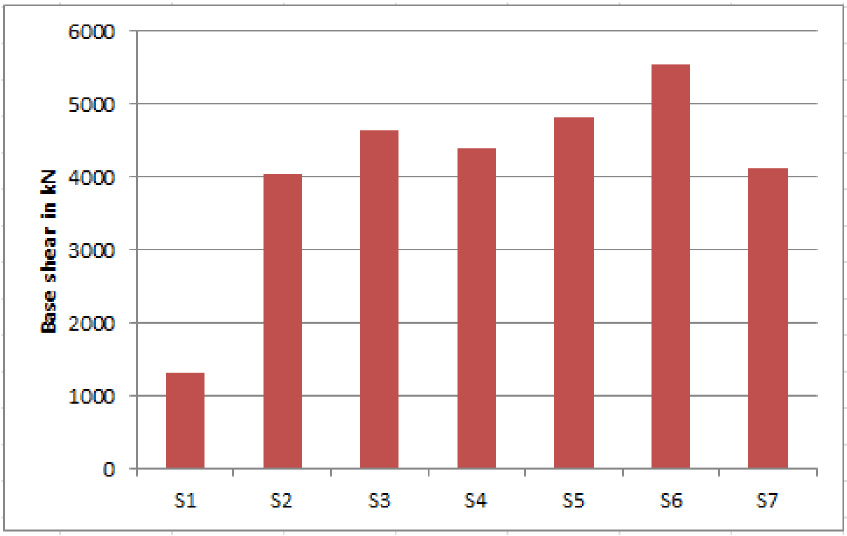

Figure 3.10: Base shear for G+10 sloped building

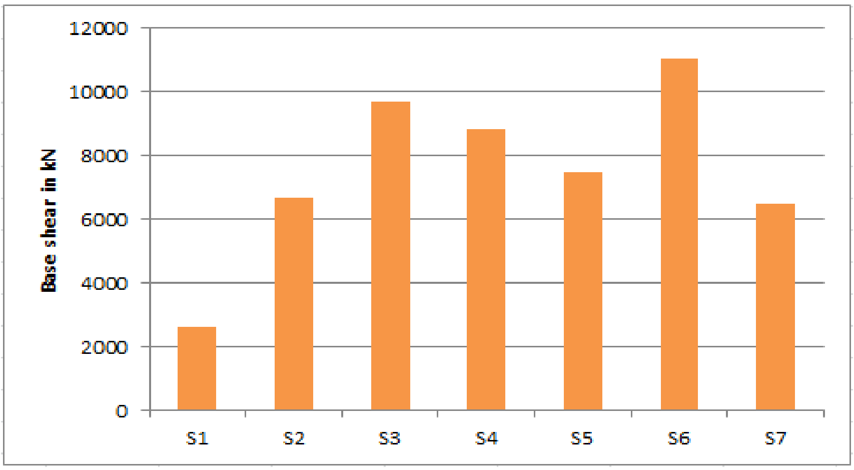

Figure 3.11: Base shear for G+15 sloped building

Storey force

The storey force obtained for different models were compared and the summary isprovided in section 3.3.1 to 3.3.4 for comparison the maximum value considering allload combinations were used.

Storey force for G+10 regular building

The maximum storey force for all the structural system were plotted in Fig. 3.12. From the figure, it is evident that the overall variation of storey force across stories is parabolic in nature. As expected the minimum storey shear was obtained at roof and maximum storey shear was obtained at ground floor level. The storey force at the roof for all the models converged to a value less than 4400kN. The maximum value of storey force was 27529kN obtained for R4. It is interesting to note that the values of storey shear for R6 and R7 toggle between minimum at the base to maximum at the roof.

Storey force for G+15 regular building

The maximum storey force for all the structural system was plotted in Fig. 3.13. From the figure, it is evident that the overall variation of storey force across stories is parabolic in nature. The maximum value of storey force was 45607kN obtained for R3. Unlike G+10 building (fig12), a lesser spread was observed for G+15 building (fig3.13) indicating that the difference between the structural system defining on the storey height increases. The maximum storey shear at roof level was obtained for R3 with a value of 45067kN.

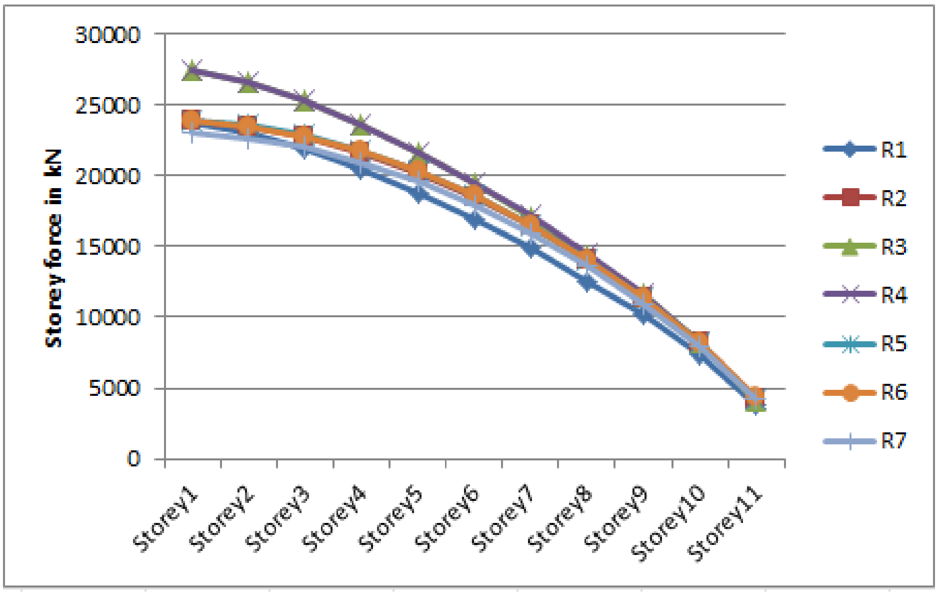

Figure 3.12: Storey force for G+10 regular building

Storey force for G+10 sloped building

Fig. 3.14 provides a comparison of storey force (kN) for the seven different structural system modeled as a G+10 building on a sloping ground due to the sloping nature ofthe ground the total area covering the lower stories is significant ally reduced, This has a significant effect. An storey shear at 5th storey which shows a significant spike in value to compensate for the lost shear in lower stories. this spike is especially prominent in the case of S7 (17727kN), S6(17485kN) and S5(17371kN). The parabolic nature of varition on observed in regular buildings is restored after 6th storey in sloped buildings the efect of sloping ground does not lead to a reduction in area of stories.

Storey force for G+15 sloped building

From the Fig. 3.15 it is observed that the maximum value of storey force is 33547.59 kN for model S2 and the minimum value of storey force is 44.4405 kN for model S5. Also it is notice that application of bare frame is less force compared to other six models. The reduction in spread of the value of G+15 as compared to G+10 regular building has manifested itself as reduction in spike of S7,S6 and S5 models at 5th floor where the peak was obtained.

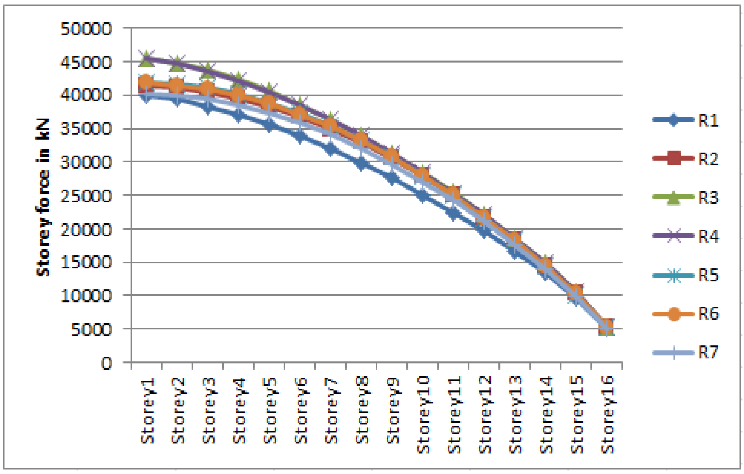

Figure 3.13: Storey force for G+15 regular building

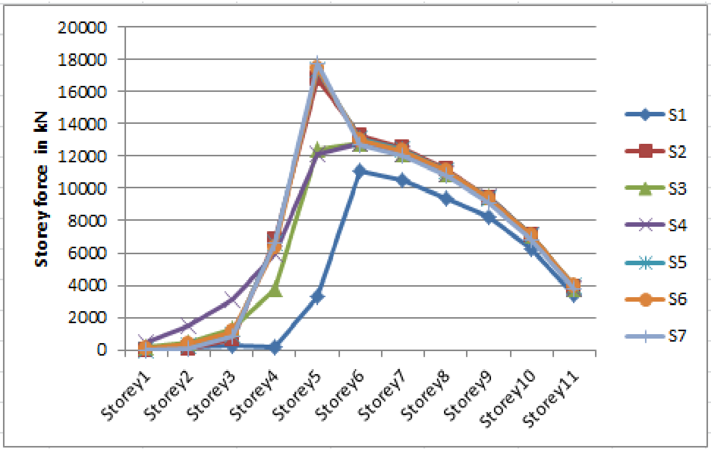

Figure 3.14: Storey force for G+10 sloped building

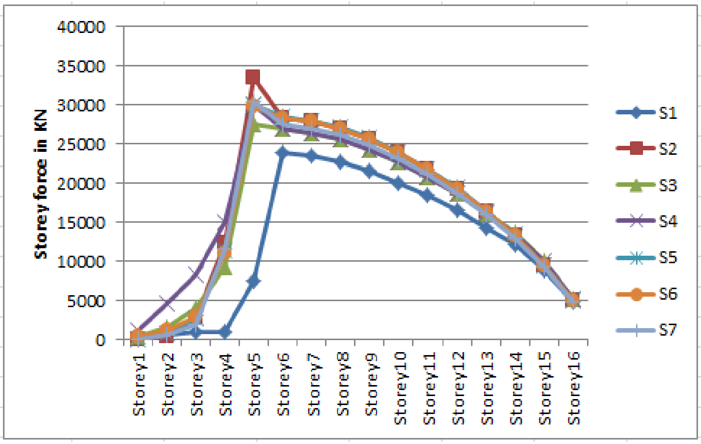

Figure 3.15: Storey force for G+15 sloped building

Storey stiffness

Stiffness of each storey refers to the resistance that the storey offers to lateral loads. Based on the analysis, the maximum value of storey stiffness considering the 13 load combinations of storey stiffness for each structure has been compared and discussed in section 3.4.1 to 3.4.4.

Storey stiffness for G+10 regular building

The plot of storey stiffness for each case for the G+10 regular building is presented in Fig. 3.16. The plot present an interesting variation pattern with all the structural types converging to a common point at the roof level (storey11). From ground level to roof, the different structural system exhibited great variation. The maximum storey stiffness at ground floor was observed for R4 (two separate structural walls) with a value of

8224661kN/m. The minimum storey stiffness at ground floor was observed for R1 (moment frame) with a value of 139464kN/m. Other structural system converged toa closes range of value with the median for R2 (structural wall core at center) with a value of around 4414151kN/m at storey1.

Storey stiffness for G+15 regular building

The plot of storey stiffness for each case for the G+15 regular building is presented in Fig. 3.17. The plot present an interesting variation pattern with all the structural types

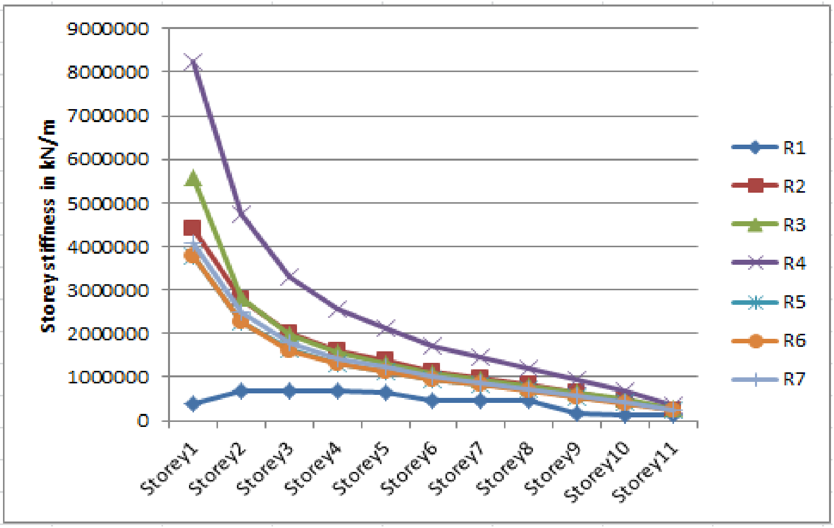

Figure 3.16: Storey stiffness for G+10 regular building

converging to a common point at the roof level (storey11). From ground level to roof, the different structural system exhibited great variation. The maximum storey stiffness at ground floor was observed for R4 (two separate structural walls) with a value of 8809893kN/m. The minimum storey stiffness at ground floor was observed for R1 (moment frame) with a value of 740110kN/m. Other structural system converged to a closes range of value with the median for R2 (structural wall core at center) with a value of around 5206017kN/m at storey1. The spread of storey stiffness for a G+15 regular building (fig.3.17) as compared to that of a G+10 regular building was lesser similar to the effect seen in the case of storey force where the spread of values diminished with increasing number of stories.

Storey stiffness for G+10 sloped building

The storey stiffness for G+10 sloped buildings is shown in Fig. 3.18 comparing the seven different structural systems considered in this study. The significant aspect of the graph which stands out is spike in storey stiffness for structural system S2 and S7 with values of 7254109kN/m and 7410063kN/m respectively at storey despite the value at storey 2 and 4 being zero. The reason for this observation is that the shear wall extends to storey3 despite minimal floor matrrid. Fig. 3.19

The maximum value of storey stiffness other than the value stated above was obtained for S4 at storey 6 with a value of 5160500kN/m.

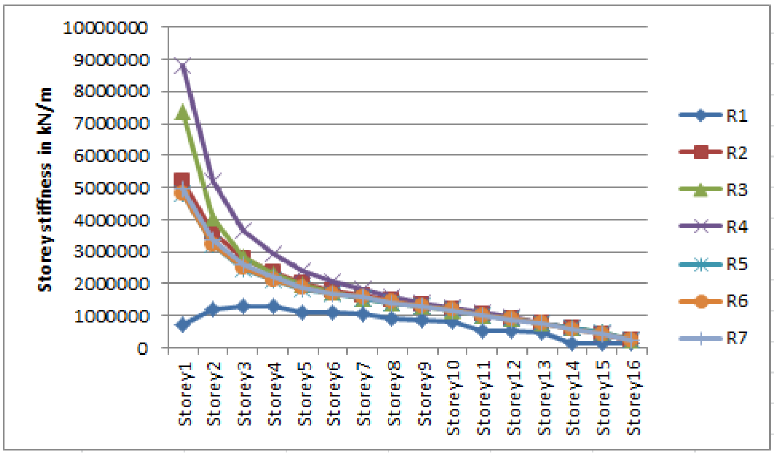

Figure 3.17: Storey stiffness for G+15 regular building

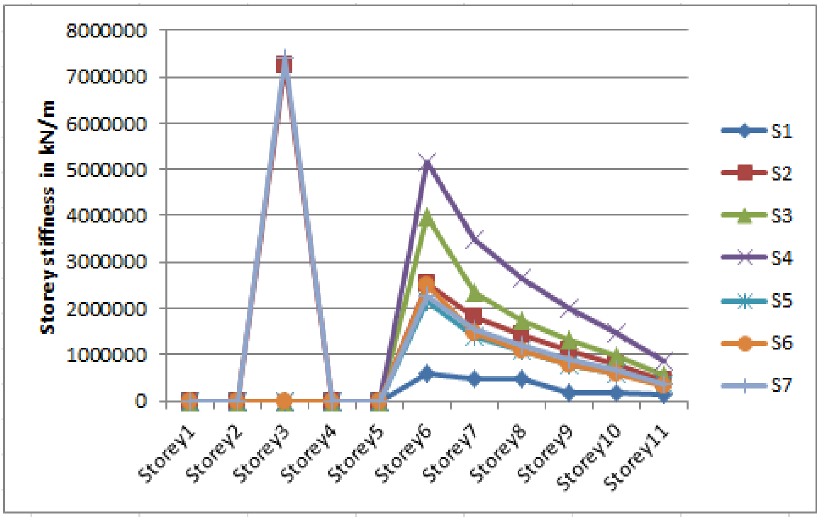

Figure 3.18: Storey stiffness for G+10 sloped building

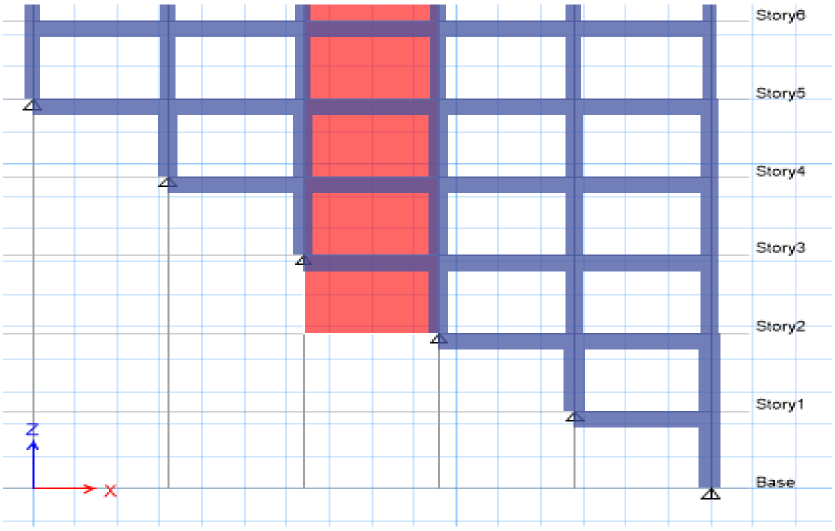

Figure 3.19: Elevation of sloped building

Storey stiffness for G+15 sloped building

The storey stiffness for G+15 sloped buildings is shown in Fig. 3.20 comparing the seven different structural systems considered in this study. The significant aspect ofthe graph which stands out is spike in storey stiffness for structural system S2 and S7 with values of 11019245kN/m and 11776649kN/m respectively at storey despite the value at storey 2 and 4 being zero. The reason for this observation is that the shear wall extends to storey3 despite minimal floor matrrid. The maximum value of storey stiffness other than the value stated above was obtained for S4 at storey 6 with a value of 5246732kN/m. The observable difference of G+15 building with respect to G+10 building is that the spike at storey3 for S2 and S7 is more distant from the spike at storey6 for S4.

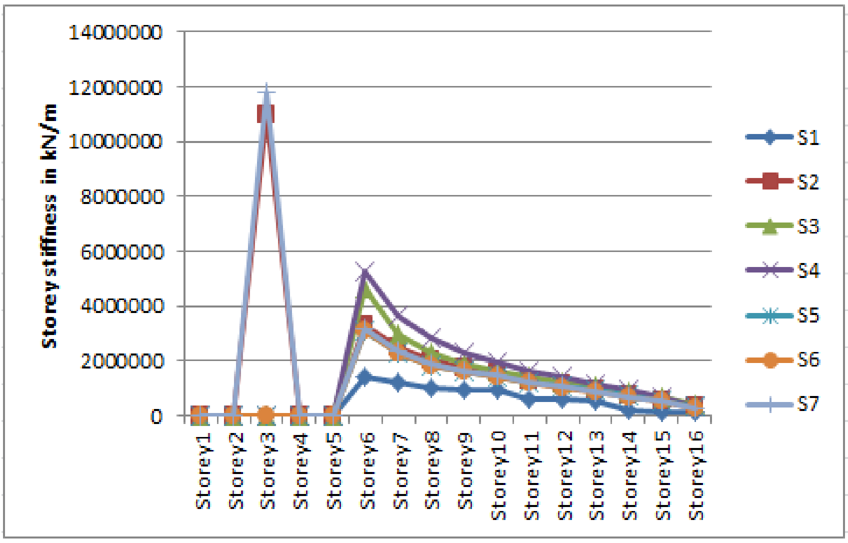

Figure 3.20: Storey stiffness for G+15 sloped building

IV. CONCLUSION

In this project compare effect of shear wall and core wall on regular buildings andslopped buildings was considering two structural stories (G+10 and G+15) for seven models.

1. Upon comparison of the maximum and minimum values of drift ratio for regular and sloped buildings, it was found that the minimum drift ratio was obtained for the model with structural wall core at center indicating a cleaease in average drift by 48% for G+10 regular building and 29% for G+15 regular building.
2. Upon comparison of the maximum and minimum values of drift ratio for regular and sloped buildings, it was found that the minimum drift ratio was obtained for the model with structural wall core at center indicating a cleaease in average drift by 61% for G+10 sloped building and 35% for G+15 sloped building.
3. Upon comparison of the maximum and minimum values of base shear for regular and sloped buildings, it was found that the minimum base shear was obtained for the model with structural wall core at center indicating a cleaease in average drift by 7.1% for G+10 regular building and 5.3% for G+15 regular building.
4. Upon comparison of the maximum and minimum values of base shear for regular and sloped buildings, it was found that the minimum base shear was obtained for the model with structural wall core at center indicating a cleaease in average drift by 68% for G+10 sloped building and 65% for G+15 sloped building.
5. Upon comparison of the maximum and minimum values of storey force for regular and sloped buildings, it was found that the minimum storey force was obtainedfor the model with structural wall core at center indicating a cleaease in average drift by 7% for G+10 regular building and 7% for G+15 regular building.
6. Upon comparison of the maximum and minimum values of storey force for regular and sloped buildings, it was found that the minimum storey force was obtainedfor the model with structural wall core at center indicating a cleaease in average drift by 30% for G+10 sloped building and 22% for G+15 sloped building.
7. Upon comparison of the maximum and minimum values of storey stiffness for regular and sloped buildings, it was found that the minimum storey stiffness was obtained for the model with structural wall core at center indicating a cleaease in average drift by 68.4% for G+10 regular building and 52.3% for G+15 regular building.
8. Upon comparison of the maximum and minimum values of storey stiffness for regular and sloped buildings, it was found that the minimum storey stiffness was obtained for the model with structural wall core at center indicating a cleaease in average drift by 80.2% for G+10 sloped building and 59.82% for G+15 sloped building.

APPENDIX A

APPDX A

The time period of all the regular buildings models are given in appendix. Among allthe models analyzed, the minimum time period of first mode shape was obtained for
0.543 in sec. The maximum time period of first mode was obtained for 1.096 in sec.

Table A.1: time period for G+10 building with moment frame

Case	Mode	Time Period in sec	Frequency in cyc/sec
Modal	1	0.902	1.109
Modal	2	0.86	1.162
Modal	3	0.78	1.281
Modal	4	0.385	2.597
Modal	5	0.375	2.668
Modal	6	0.343	2.912
Modal	7	0.214	4.679
Modal	8	0.208	4.801
Modal	9	0.192	5.206
Modal	10	0.152	6.561
Modal	11	0.15	6.659
Modal	12	0.138	7.267

Table A.2: Time period for G+10 building with structural wall core at center

Case	Mode	time Period in sec	Frequency in cyc/sec
Modal	1	0.543	1.842
Modal	2	0.525	1.906
Modal	3	0.467	2.139
Modal	4	0.171	5.832
Modal	5	0.15	6.686
Modal	6	0.149	6.728
Modal	7	0.104	9.66
Modal	8	0.073	13.731
Modal	9	0.07	14.299
Modal	10	0.07	14.324
Modal	11	0.058	17.39
Modal	12	0.047	21.054

Table A.3: Time period for G+10 building with two separate structural walls

Case	Mode	time Period in sec	Frequency in cyc/sec
Modal	1	0.908	1.101
Modal	2	0.522	1.918
Modal	3	0.422	2.37
Modal	4	0.397	2.522
Modal	5	0.222	4.51
Modal	6	0.16	6.248
Modal	7	0.143	7.003
Modal	8	0.123	8.158
Modal	9	0.114	8.744
Modal	10	0.109	9.198
Modal	11	0.084	11.871
Modal	12	0.065	15.365

Table A.4: Time period for G+10 building with two combined structural walls

Case	Mode	time Period in sec	Frequency in cyc/sec
Modal	1	0.91	1.099
Modal	2	0.421	2.375
Modal	3	0.397	2.518
Modal	4	0.334	2.995
Modal	5	0.222	4.505
Modal	6	0.16	6.236
Modal	7	0.123	8.144
Modal	8	0.109	9.168
Modal	9	0.106	9.418
Modal	10	0.085	11.764
Modal	11	0.084	11.855
Modal	12	0.064	15.683

Table A.5: Time period for G+10 building with structural wall in inner bays

Case	Mode	time Period in sec	Frequency in cyc/sec
Modal	1	0.582	1.72
Modal	2	0.571	1.752
Modal	3	0.544	1.839
Modal	4	0.182	5.499
Modal	5	0.177	5.658
Modal	6	0.175	5.699
Modal	7	0.09	11.064
Modal	8	0.084	11.896
Modal	9	0.084	11.971
Modal	10	0.056	17.959
Modal	11	0.051	19.603
Modal	12	0.051	19.644

Table A.6: Time period for G+10 building with structural wall at periphery

Case	Mode	time Period in sec	Frequency in cyc/sec
Modal	1	0.599	1.671
Modal	2	0.574	1.743
Modal	3	0.424	2.36
Modal	4	0.18	5.562
Modal	5	0.178	5.618
Modal	6	0.124	8.068
Modal	7	0.084	11.843
Modal	8	0.084	11.871
Modal	9	0.057	17.392
Modal	10	0.051	19.546
Modal	11	0.051	19.588
Modal	12	0.036	27.967

Table A.7: Time period for G+10 building with structural wall core infill at center

Case	Mode	Time Period in sec	Frequency in cyc/sec
Modal	1	0.908	1.101
Modal	2	0.522	1.918
Modal	3	0.422	2.37

Modal	4	0.397	2.522
Modal	5	0.222	4.51
Modal	6	0.16	6.248
Modal	7	0.143	7.003
Modal	8	0.123	8.158
Modal	9	0.114	8.744
Modal	10	0.109	9.198
Modal	11	0.084	11.871
Modal	12	0.065	15.365

Table A.8: Time period for G+15 building with moment frame

Case	Mode	Time Period in sec	Frequency in cyc/sec
Modal	1	1.096	0.913
Modal	2	1.013	0.987
Modal	3	0.901	1.11
Modal	4	0.465	2.152
Modal	5	0.45	2.222
Modal	6	0.412	2.43
Modal	7	0.27	3.702
Modal	8	0.262	3.821
Modal	9	0.241	4.149
Modal	10	0.183	5.469
Modal	11	0.179	5.586
Modal	12	0.165	6.044

Table A.9: Time period for G+15 building with structural wall core at center

Case	Mode	Time Period in sec	Frequency in cyc/sec
Modal	1	0.826	1.211
Modal	2	0.748	1.337
Modal	3	0.641	1.561
Modal	4	0.245	4.075
Modal	5	0.239	4.176
Modal	6	0.239	4.181
Modal	7	0.145	6.878
Modal	8	0.118	8.504
Modal	9	0.117	8.553
Modal	10	0.104	9.618
Modal	11	0.08	12.522
Modal	12	0.073	13.679

Table A.10: Time period for G+15 building with two separate structural walls

Case	Mode	Time Period in sec	Frequency in cyc/sec
Modal	1	1.04	0.961
Modal	2	0.749	1.336
Modal	3	0.585	1.709
Modal	4	0.469	2.132
Modal	5	0.274	3.645
Modal	6	0.219	4.574
Modal	7	0.189	5.299

Modal	8	0.177	5.637
Modal	9	0.157	6.361
Modal	10	0.123	8.133
Modal	11	0.115	8.713
Modal	12	0.105	9.518

Table A.11: Time period for G+15 building with two combined structural walls

Case	Mode	Time Period in sec	Frequency in cyc/sec
Modal	1	1.044	0.958
Modal	2	0.706	1.417
Modal	3	0.533	1.876
Modal	4	0.47	2.129
Modal	5	0.275	3.64
Modal	6	0.189	5.295
Modal	7	0.186	5.385
Modal	8	0.157	6.357
Modal	9	0.148	6.75
Modal	10	0.123	8.13
Modal	11	0.115	8.711
Modal	12	0.09	11.07

Table A.12: Time period for G+15 building with structural wall in inner bays

Case	Mode	Time Period in sec	Frequency in cyc/sec
Modal	1	0.834	1.199
Modal	2	0.765	1.307
Modal	3	0.702	1.425
Modal	4	0.264	3.789
Modal	5	0.261	3.831
Modal	6	0.256	3.91
Modal	7	0.138	7.239
Modal	8	0.134	7.436
Modal	9	0.133	7.506
Modal	10	0.089	11.211
Modal	11	0.084	11.868
Modal	12	0.084	11.944

Table A.13: Time period for G+15 building with structural wall at peripery

Case	Mode	Time Period in sec	Frequency in cyc/sec
Modal	1	0.849	1.178
Modal	2	0.764	1.308
Modal	3	0.57	1.753
Modal	4	0.274	3.65
Modal	5	0.265	3.78
Modal	6	0.191	5.231
Modal	7	0.137	7.312
Modal	8	0.136	7.377
Modal	9	0.096	10.42
Modal	10	0.085	11.768
Modal	11	0.085	11.822
Modal	12	0.059	16.867

Table A.14: Time period for G+15 building with structural wall core infill at center

Case	Mode	Time Period in sec	Frequency in cyc/sec
Modal	1	0.931	1.074
Modal	2	0.758	1.32
Modal	3	0.755	1.325
Modal	4	0.38	2.633
Modal	5	0.254	3.945
Modal	6	0.25	3.994
Modal	7	0.222	4.512
Modal	8	0.148	6.734
Modal	9	0.13	7.706
Modal	10	0.125	8.009
Modal	11	0.11	9.116
Modal	12	0.09	11.092

APPENDIX B

APPDX B

In this project compare effect of shear wall and core wall on regular buildings and slopped buildings was considering two structural stories (G+10 and G+15) for seven models. From the analysis of drift ratio, base shear, storey force and storey stiffness for regular and sloped buildings shows the Fig. B.1, Fig. B.2, Fig. B.3 and Fig. B.4.

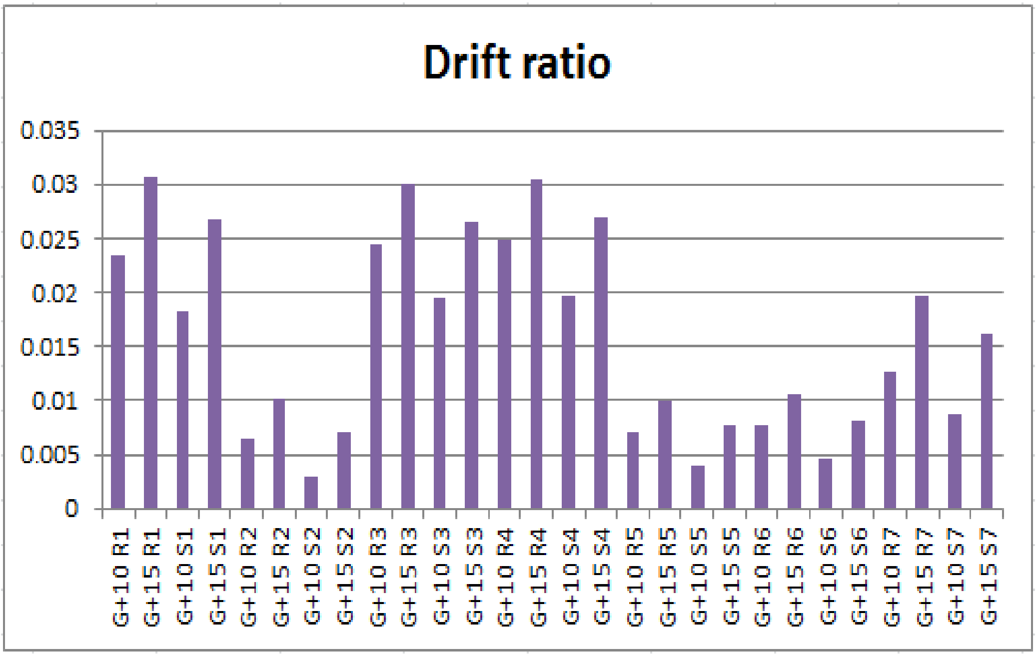

Figure B.1: Drift ratio for regular and sloped buildings

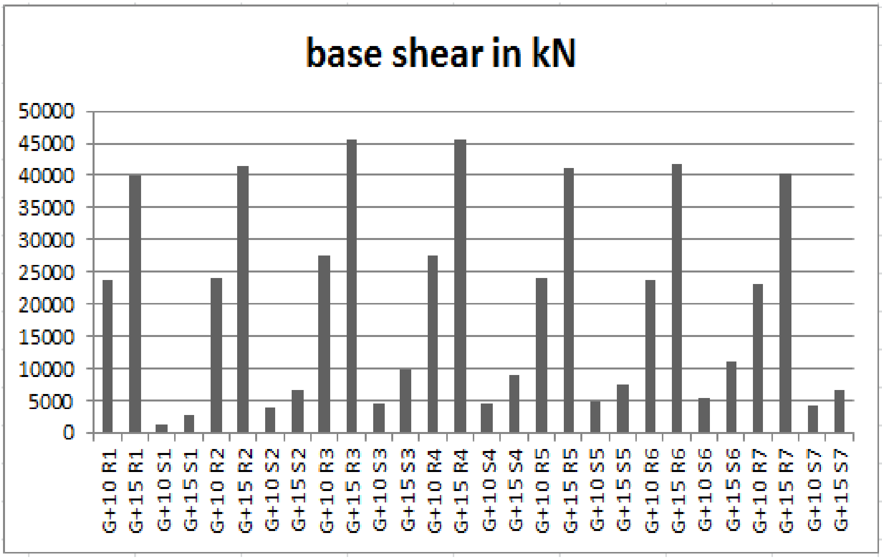

Figure B.2: Base shear for regular and sloped buildings

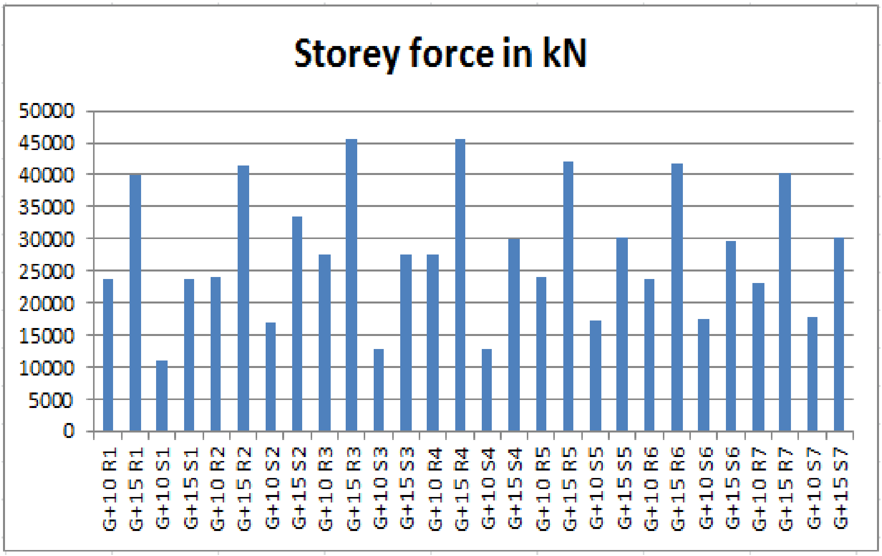

Figure B.3: Storey force for regular and sloped buildings

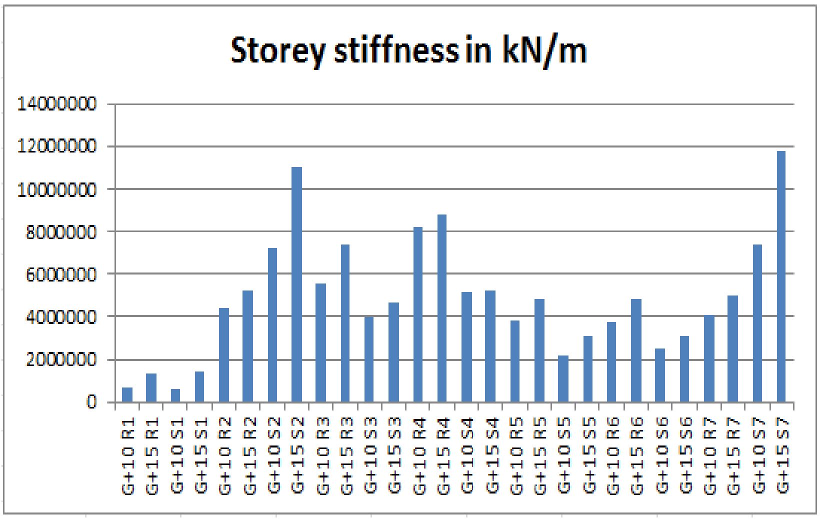

Figure B.4: Storey stiffness for regular and sloped buildings

REFERENCES

[1]. Ahmed, A. (2016). "Dynamic analysis of multi-storey rcc building frames." *Conference on Inter Disciplinary Research in Engineering and Technology*, Vol. 89, 94.

[2]. BABU, N. J. (2012). "Pushover analysis of unsymmetrical framed structures on sloping ground." Ph.D. thesis, GITAM UNIVERSITY, GITAM UNIVERSITY.

[3]. Birajdar, B., Nalawade, S., et al. (2004). "Seismic analysis of buildings resting on sloping ground." *Thirteenth World Conference on Earthquake Engineering (13WCEE)*.

[4]. Chandurkar, P. and Pajgade, D. P. (2013). "Seismic analysis of rcc building with and without shear wall." *International journal of modern engineering research*, 3(3), 1805– 1810.

[5]. Halkude, S., Konapure, C., and Birajdar, S. (2015). "Effect of location of shear walls on seismic performance of buildings." *International Journal of Current Engineering and Technology*, 5(2), 826–833.

[6]. Khadiranaikar, R. and Masali, A. (2014). "Seismic performance of buildings resting on sloping ground–a review." *IOSR J Mech Civ Eng (IOSR-JMCE)*, 11(3), 12–19.

[7]. Manjunath, P. and Holebsgilu, Y. R. (2016). "Seismic analysis of multi storey building with flat slab resting on plain and sloping ground." *Bonfring International Journal of Man Machine Interface*, 4(Special Issue Special Issue on Computer Aided Analysis and Design of Structures— Editors: Dr. DK Kulkarni, Dr. RJ Fernandes, Dr. SB Kulkarni), 20–25.

[8]. Mohammad, Z., Baqi, A., and Arif, M. (2017). "Seismic response of rc framed buildings resting on hill slopes." *Procedia engineering*, 173, 1792–1799.

[9]. Nagargoje, S. and Sable, K. (2012). "Seismic performance of multi-storeyed buildingon sloping ground." *Elixir International Journal*, 7.

[10]. Patel, M. U. F., Kulkarni, A., and Inamdar, N. (2014). "A performance study and seismic evaluation of rc frame buildings on sloping ground." *IOSR Journal of Mechanical andCivil Engineering (IOSR-JMCE) e-ISSN*, 2278–1684.

[11]. Ravikumar, C., Babu Narayan, K., Sujith, B., and Venkat Reddy, D. (2012). "Effect of irregular configurations on seismic vulnerability of rc buildings." *Architecture Research*, 2(3), 20–26.

[12]. Singh, Y., Gade, P., Lang, D., and Erduran, E. (2012). "Seismic behavior of buildings located on slopes-an analytical study and some observations from sikkim earthquake of september 18, 2011." *Proc. 15th World Conference on Earthquake Engineering(15WCEE)*, 24–28.

[13]. Suresh, G. and Arunakanthi, D. E. (2014). "Seismic analysis of buildings resting on sloping ground and considering bracing system." *International Journal of Engineering Research & Technology, ISSN*, 2278–0181.

[14]. T, K. and Jayaramappa, N. (2017). "Seismic performance of RC frame buildings restingon sloping ground." *IOSR Journal of Mechanical and Civil Engineering*, 14(02), 67–74.