Seismic Evaluation of Building on Plain & Elevated Ground

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Abstract - *This research emphasize the seismic evaluation of building on plain & elevated grounds, on elevated ground buildings are comparatively different then the plain ground buildings. Due to various type of structures on sloped ground structures are comes under irregularity and asymmetricity. Structures on slope leads to seismic cases. The damages to the structures are determined and acceptable safety can be provided. For the analysis five types of buildings are modelled on both plain & elevated ground with Seismic zone V & medium Soil (II) using "ETABS 2016" to get the behavior of structure due to change in column height in lower storeys due to elevated ground. The analytical model of the building includes all important components that influence the mass, strength, stiffness and deformability of the structure. To study the effect of infill and concrete shear wall during earthquake, seismic analysis using elastic and method of analyses i.e., linear static (equivalent static method), linear dynamic (response spectrum method) has been performed.*

Key Words: "ETABS 2016" Seismic evaluation equivalent static analysis, response spectrum analysis, shear wall

1. INTRODUCTION

The structures which are design and construct as per earlier code provision do not have satisfied requirements for current earthquakes. Thus many of the structures in seismic areas are suffering from hazards. Therefore the new code provisions are made for such cases.

High rise R.C. framed buildings are getting popular in hilly areas because of increase in land cost and in unavoidable circumstances. Thus the structures in the hilly areas should have adequate strength to avoid the failure of structure during earthquakes.

Indian subcontinent has been experienced with some of the most earthquakes in the world. The youngest mountain series of Himalayas covers whole northeast boundary regions of India. The tectonic activities are still continuing which may result into severe earthquake in future as anticipated by many scientists and researchers. More than 50% of our land is seismically prone and is being visited by earthquakes time and again incurring socio-economic losses in huge proportions and at the same time reminding us the need of earthquake resistant design.

The concepts of earthquake resist The latest seismic zoning map of BIS 1893:2002 shows that 12% of our land area is in zone V i.e., MSK IX or more (it means that more than 50% of reinforced concrete buildings would suffer large cracks, gaps in walls leading to collapse of parts of buildings whereas masonry and adobe structures may even collapse), 18% in zone IV i.e., MSK VII and 27% in zone III i.e., MSK VII. All these are damaging earthquake Intensities and the structures coming up in these regions has to have special earthquake resistant features.

Therefore it is essential to seismically evaluate the many existing building structures as per code current requirements.

The buildings found inadequate for resisting future earthquake needs to be retrofitted Design needs nonlinear analysis to get damages for different levels of earthquakes. In performance based ideas reactions of building for different levels of motion are specified. In this dissertation, hypothetical high rise buildings (i.e., twenty storeyed with concrete shear wall, concrete core wall, and infill and without infill) assumed in zone v of medium soil site analysed and designed as for load combinations given by code.

1.1. Seismic Design

The general aim of seismic design can be defined as providing adequate safety levels with respect to collapse during exceptionally intense earthquakes as well as with respect to adjacent buildings. Further it aims to protect structures against excessive material damage under the action of moderate intensity earthquakes. Importance is given to safeguard the safety and the comfort of the occupants by limiting the structural response to a predefined tolerable limit. Panic caused due to the earthquake induced shaking among the occupants which can be hazardous, is another aspect to be covered in a good seismic design. Principles underlying the earthquake resistant design of buildings have been to achieve the objectives stated above and striving for better understanding of the structural responses to the earthquake induced ground motions.

a) Analysis Procedures There are two types of analysis procedures, linear and nonlinear. Further the liner analysis is divided into linear static and linear dynamic procedure and nonlinear analysis is divided into nonlinear static and nonlinear dynamic procedure.

b) Linear Static Procedures In linear static procedures structure is modelled as equivalent single degree of freedom system with linear static stiffness and an equivalent viscous damping. The inputs are modelled by an equivalent lateral forces to found same stresses and strains as earthquake may give. From first fundamental frequency of structure using Rayleigh's method, spectral acceleration Sa is calculated from the appropriate response spectrum, which is, multiply by mass of the building M, results in the equivalent lateral force, V,

$$V = S_a.M.\sum_{i}^{n} C_i$$

The coefficient Ci takes into account to issue order effects, stiffness degradation also force reduction due to inelastic behaviour. These lateral forces are distributed along height of building. The internal forces and displacements are determined using linear elastic analysis. This procedure is used for design purposes and incorporated in more codes. Their expenditure is very less. However their applicability is restricted to regular structure.

c) Linear Dynamic Procedures

In linear dynamic procedure structure is modelled as a multi degree of freedom with linear elastic stiffness matrix and equivalent viscous damping matrix. The input is modelled as time history analysis. Time-history analysis based on a time step-by-step evaluation of building characteristic's by recording synthetic ground motion. In this case internal forces and displacements are determined by linear elastic analyses.

The scope of this procedure is higher modes can be considered which makes it suitable for irregular structures.

e) Nonlinear Static Procedures In this procedure the modelled incorporate directly to the nonlinear force deformation characteristics of every part of structure due to inelastic reaction of various parts of structure. Several methods of nonlinear static procedure exists Clearly, the advantage of these procedures with respect to the linear procedures is that they take into account directly the effects of nonlinear material response and hence the calculated internal forces and deformations will be more reasonable approximations of those expected during an earthquake. However, only the first mode of vibration is considered and hence these methods are not suitable for irregular buildings for which higher modes become important.

f) Nonlinear Dynamic Procedures In this procedure same modelled is used as in nonlinear static procedure by directly introducing inelastic reaction using finite modelled using a time history analyses elements.

The main difference is seismic input is This method is most valuable to get internal forces and displacements under seismic input but the calculated responses are very sensitive to individual ground motion used as seismic input.

2.OBJECTIVES OF THE STUDY

The above dissertation study is aim to evaluate hypothetical existing framed with following objectives:

1. Generation of 3D modelled for elastic analysis.
2. Study on the influence of one full brick infill masonry wall on behaviour of modelled in contact with the bilateral forces.
3. Determination of deflections and storey drifts at each storey using Equivalent Static method, Response Spectrum method
4. Study the influence of central service concrete shear wall in the building.
5. Study the influence of concrete shear wall provided at the corners of the building.
6. To study the effect of vertical irregularity on the fundamental natural period of the building and its effect on performance of the structure during earthquake for different building models selected.
7. To find causes of collapse on plain ground and elevated ground to resist earthquake.
8. To get the strength of modelled during earthquake.

3. ANALYTICAL MODELLING

The building codes are provide different method of analysis depends upon regularity or irregularity of building. The most codes suggested to use static analysis for symmetric buildings and dynamic analysis for irregular building.

The infill walls present in structures are normally considered as non-structural elements but they interact with frame when subjected to lateral loads.

3.1.Description of the Sample Building

The plan layout for building on a plain and on elevated ground models are shown in below figures.

The angle of elevation of ground is taken as 20 degree for the analysis of building on elevated ground which is not to more or less

Column height of each storey is 3m for all models

Model 1: Building has no walls in the first storey and one brick infill masonry walls (230mm) thick in the upper stories. Building is modelled as bare frame .However, masses of the walls are considered.

Model 2: Building has no walls in the first storey and brick infill masonry walls (230 mm thick) in the upper stories. Stiffness and mass of the walls are considered.

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Model 3:

Building has no walls in the first storey and brick infill masonry walls (230mm thick) in the upper stories and L-shaped shear walls (230mm thick) are provided at the corners. Stiffness and masses of the walls are considered.

Model 4: Building has no walls in the first storey and one full brick infill masonry walls (230mm thick) in the upper stories, L-shaped shear walls (230mm thick) are provided at the corners and a central service concrete core wall (230mm thick) is provided. Stiffness and masses of the walls are considered.

Model 5: Building has no walls in the first storey and brick infill masonry walls (230mm thick) in the upper stories and shear walls (230mm thick) are provided at the centre and outer walls. Stiffness and masses of the walls are considered.

a) Building Models On Plain Ground

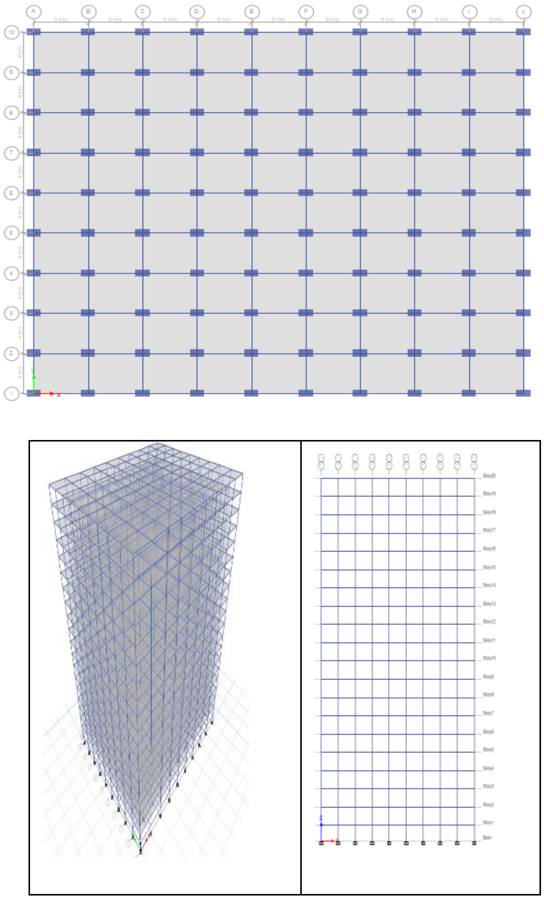


Figure-1: Plan layout, 3D and Elevation view of Model-1.

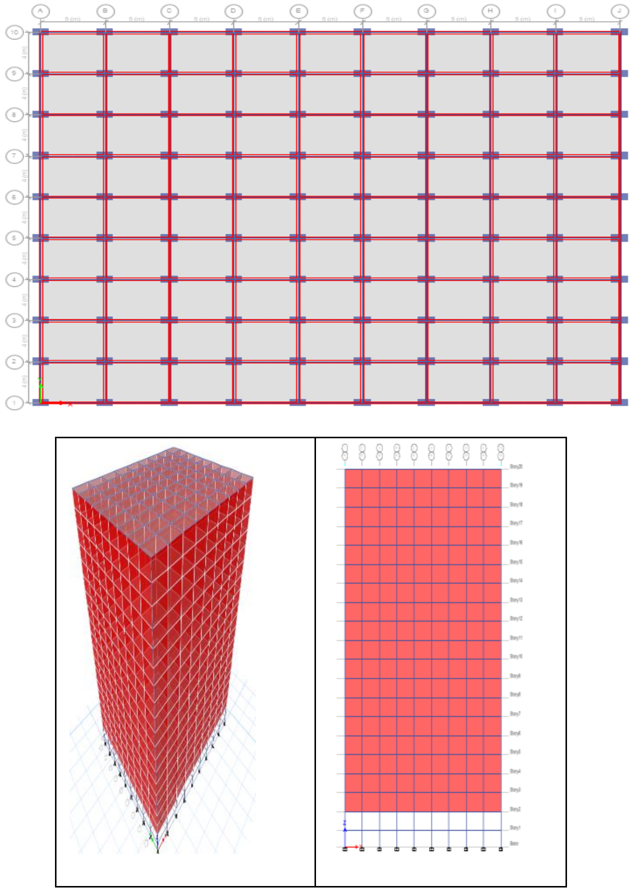
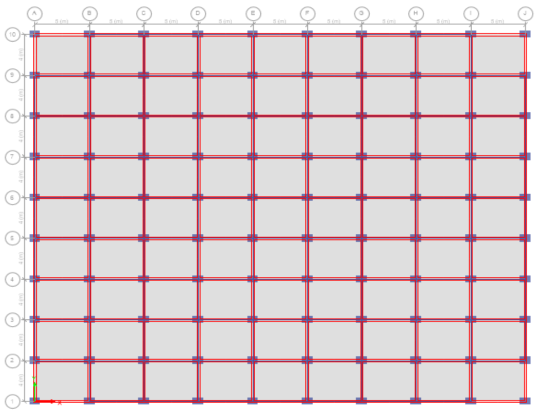


Figure-2:Plan layout, 3D and Elevation of Model-2.



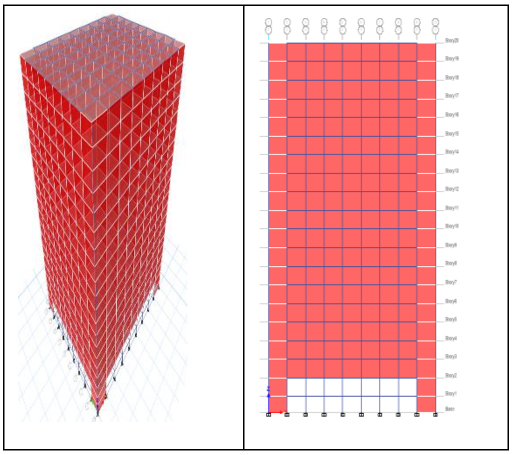
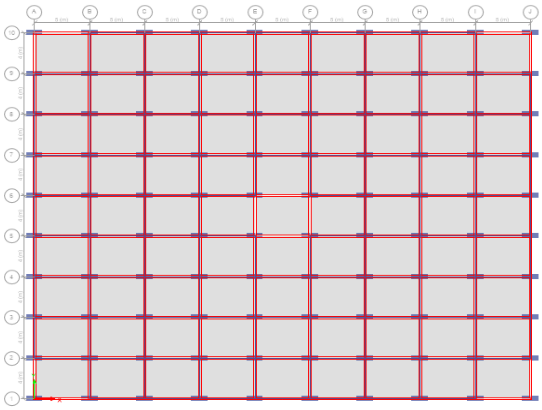


Figure-3: Plan layout, 3D and Elevation view of Model-3.



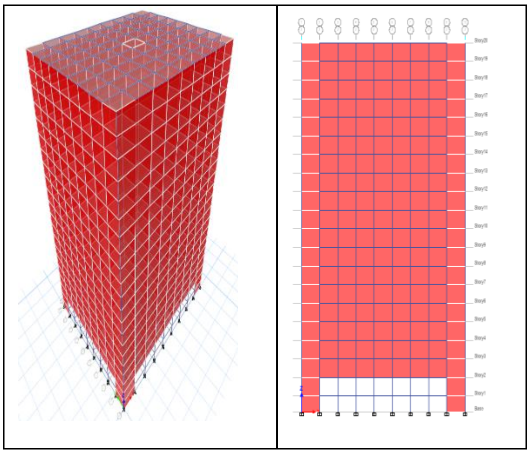
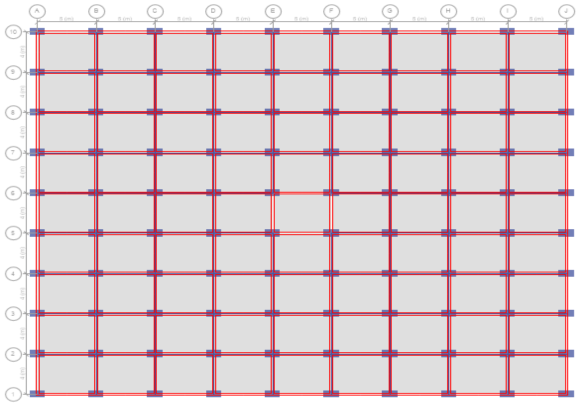


Figure-4: Plan layout, 3D and Elevation view of Model-4.



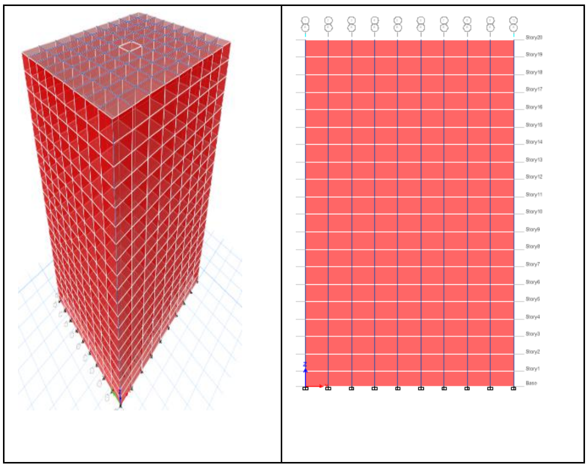
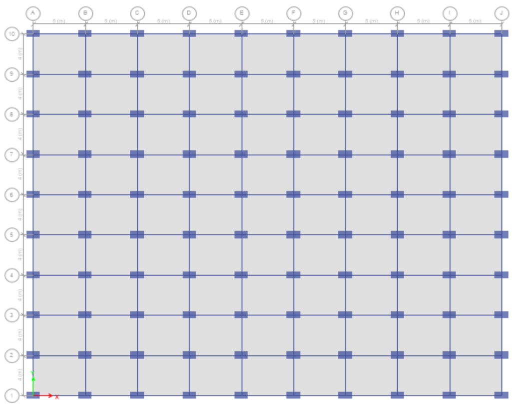


Figure-5:Plan layout, 3D and Elevation view of Model-5.

b) Building Models On elevated ground

Asymmetric building models are similar to the symmetric building models except that the column storey height varies in ground storey along longitudinal direction as shown in the following figures. The angle elevation considered is 20deg



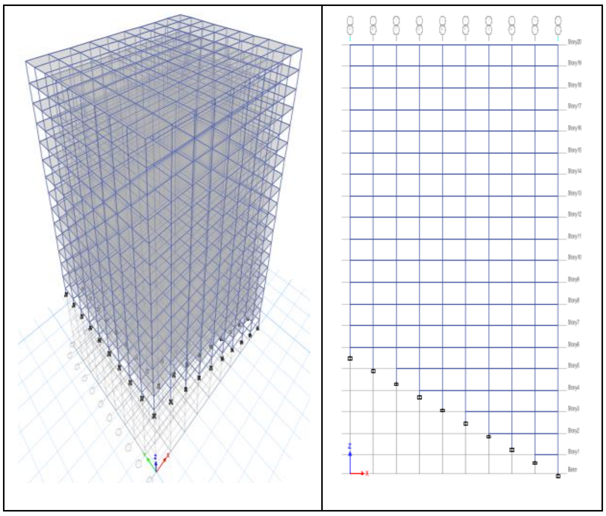
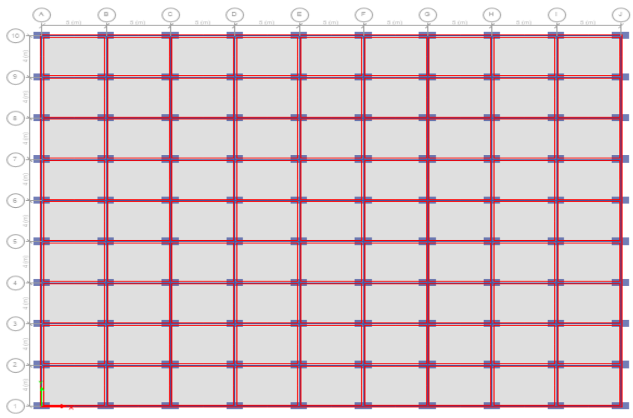


Figure-6 :Plan layout, 3D and Elevation view of Model-1.



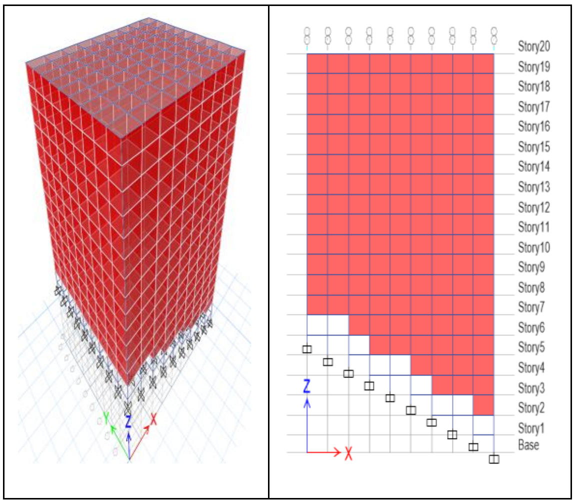
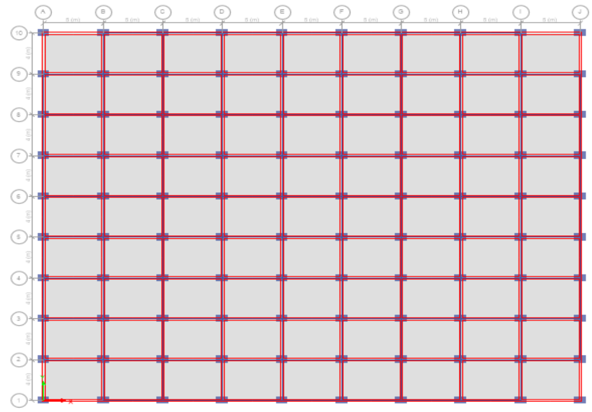


Figure-7: Plan layout, 3D and Elevation view of Model-2.



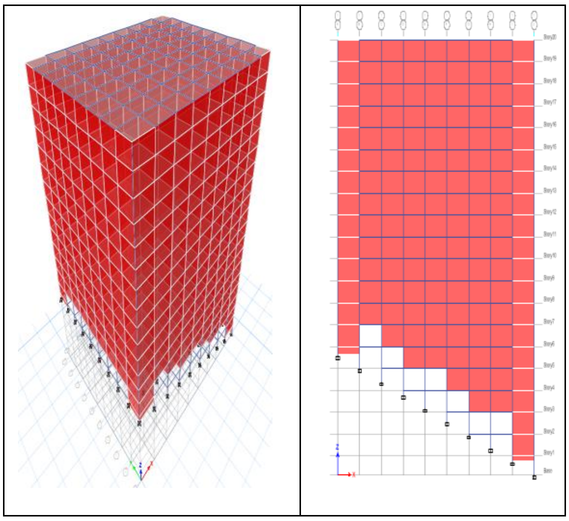
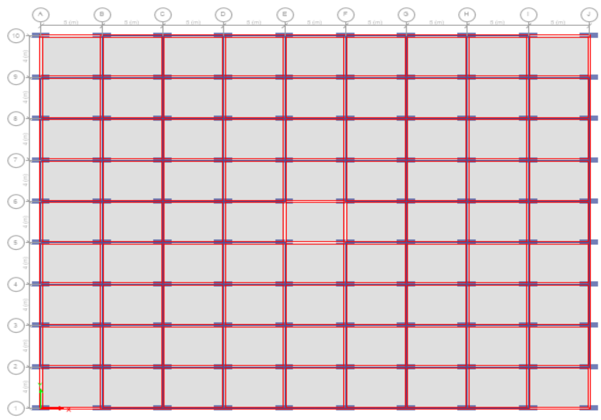


Figure-8:Plan layout, 3D and Elevation view of Model-3.



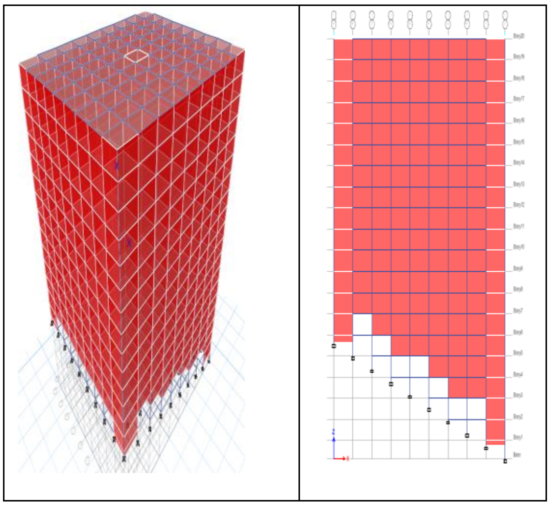
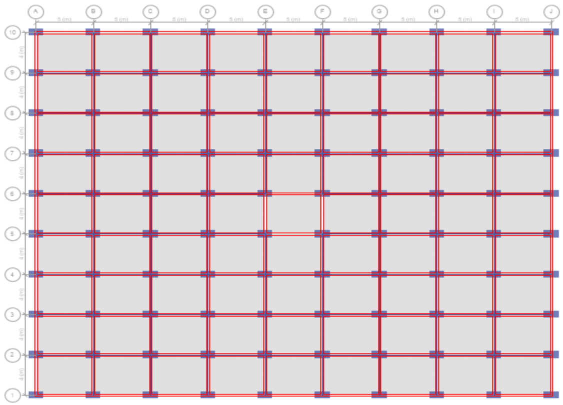


Figure-9: Plan layout, 3D and Elevation view of Model-4.



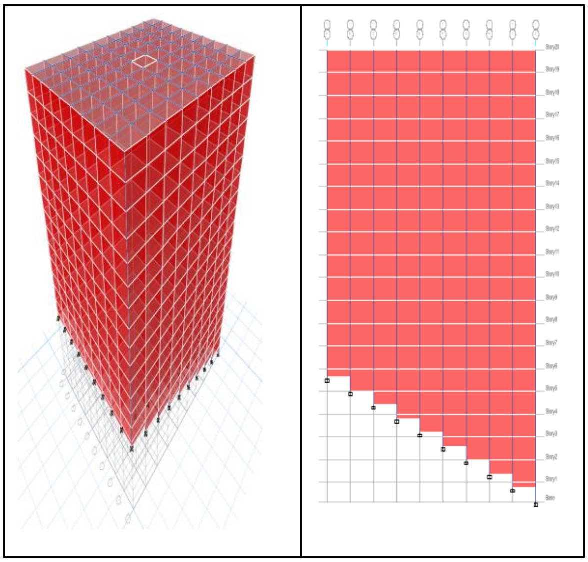


Figure-10: Plan layout, 3D and Elevation view of Model-5.

3.2.Design Data

Material Properties:

Grade of concrete	= M25 (for beams and slab)
	= M30 (for column)
Grade of steel	= Fe550
Brick density	=21.2kN/m3
Member properties	
Spacing in x direction	= 5m
Spacing in Y direction	= 4m
Number of storeys	= 20
Bottom storey height	= 2.5m
Typical storey height	= 3m
Column size	= 700mm*1000mm
Beam size	= 300mm*450mm
Thickness of shear wall	= 230mm
Thickness of masonry wall	= 230mm
Load intensities	
Live load	= 3kN/m^2
Floor fininish	= 1kN/m^2
Brick density	= 21.2kN/m3
Seismic design consideration	
Seismic Zone	= V
Zone factor	= 0.36
Importance factor	= 1
Response reduction factor	= 5

Table 1: Distribution of lateral seismic shear forces for building on plain ground for Model 1

storey number	VX(KN)	VY(KN)
S20	521.1077	540.9817
S19	1022.326	1061.316
S18	916.6428	951.6017
S17	816.724	847.8722
S16	722.5697	750.1271
S15	634.1801	658.3664
S14	551.5549	572.5901
S13	474.6943	492.7982
S12	403.5982	418.9907
S11	338.2667	351.1675
S10	278.6998	289.3288
S9	224.8973	233.4745
S8	176.8595	183.6045
S7	134.5861	139.719
S6	98.0773	101.8178
S5	67.3331	69.901
S4	42.3534	43.9687
S3	23.1382	24.0207
S2	9.6876	10.0571
S1	0.5467	0.5676

Table 2: Distribution of lateral seismic shear forces for building on plain ground for Model 2

storey number	VX(KN)	VY(KN)
S20	4412.222	3995.125
S19	6099.039	5522.484
S18	5468.548	4951.595
S17	4872.448	4411.846
S16	4310.739	3903.236
S15	3783.42	3425.765
S14	3290.491	2979.434
S13	2831.952	2564.242
S12	2407.804	2180.19
S11	2018.047	1827.277
S10	1662.679	1505.503
S9	1341.703	1214.869
S8	1055.116	955.3737
S7	802.9199	727.0182
S6	585.1141	529.8021
S5	401.6988	363.7253
S4	252.6738	228.788
S3	138.0392	124.99
S2	45.2091	40.9354
S1	3.0837	2.7922

Table 3: Distribution of lateral seismic shear forces for building on plain ground for Model 3

storey number	VX(KN)	VY(KN)
S20	4406.44	4406.44
S19	6107.763	6107.763
S18	5476.37	5476.37
S17	4879.418	4879.418
S16	4316.905	4316.905
S15	3788.831	3788.831
S14	3295.198	3295.198
S13	2836.003	2836.003
S12	2411.248	2411.248
S11	2020.933	2020.933
S10	1665.058	1665.058
S9	1343.622	1343.622
S8	1056.625	1056.625
S7	804.0684	804.0684
S6	585.9511	585.9511
S5	402.2733	402.2733
S4	253.0352	253.0352
S3	138.2366	138.2366
S2	45.832	45.832
S1	3.2955	3.2955

Table 4: Distribution of lateral seismic shear forces for building on plain ground for Model 4

storey number	VX(KN)	VY(KN)
S20	4398.009	4398.009
S19	6103.509	6103.509
S18	5472.557	5472.557
S17	4876.02	4876.02
S16	4313.899	4313.899
S15	3786.193	3786.193
S14	3292.903	3292.903
S13	2834.028	2834.028
S12	2409.569	2409.569
S11	2019.526	2019.526
S10	1663.898	1663.898
S9	1342.686	1342.686
S8	1055.889	1055.889
S7	803.5084	803.5084
S6	585.543	585.543
S5	401.9932	401.9932
S4	252.859	252.859
S3	138.1404	138.1404
S2	45.9309	45.9309
S1	3.4012	3.4012

Table 5: Distribution of lateral seismic shear forces for building on plain ground for Model 5

storey number	VX(KN)	VY(KN)
S20	6574.441	6574.441
S19	9214.061	9214.061
S18	8261.554	8261.554
S17	7361.002	7361.002
S16	6512.405	6512.405
S15	5715.763	5715.763
S14	4971.076	4971.076
S13	4278.343	4278.343
S12	3637.566	3637.566
S11	3048.744	3048.744
S10	2511.876	2511.876
S9	2026.964	2026.964
S8	1594.006	1594.006
S7	1213.003	1213.003
S6	883.9552	883.9552
S5	606.8623	606.8623
S4	381.7243	381.7243
S3	208.5413	208.5413
S2	72.5123	72.5123
S1	6.2235	6.2235

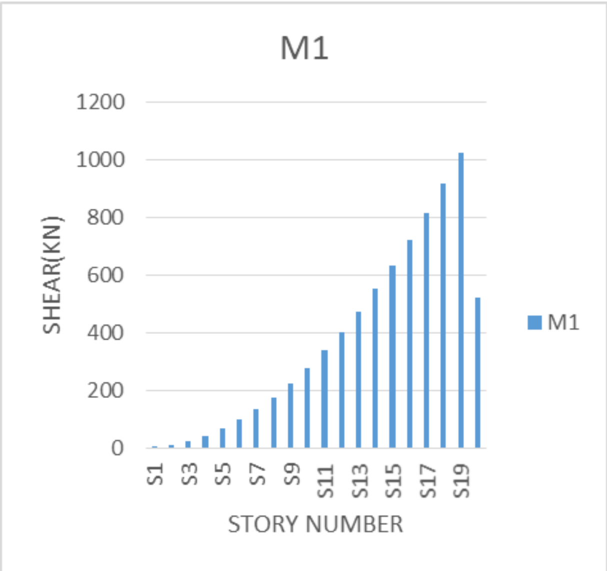


Figure-11: Shear forces along longitudinal direction for Model1

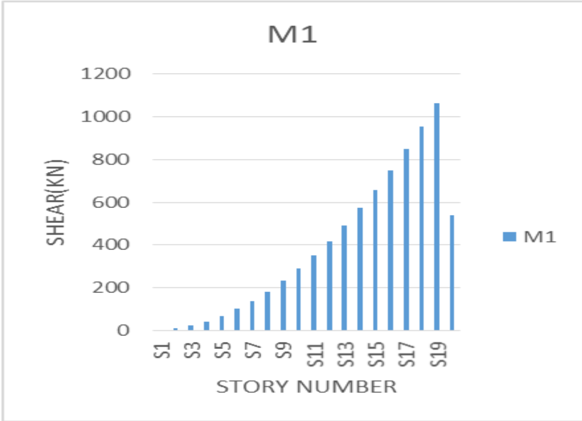


Figure-12: Shear forces along Transverse direction for Model 1

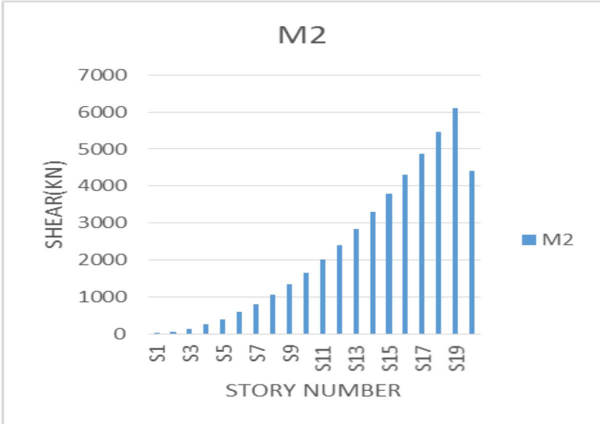


Figure-13: Shear forces along longitudinal direction for Model 2

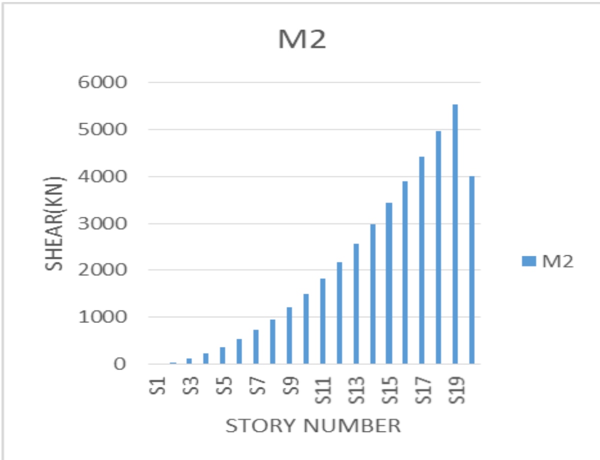


Figure-14: Shear forces along Transverse direction for Model 2

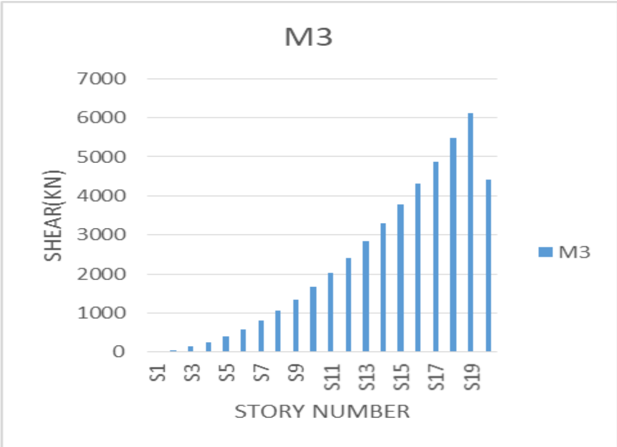


Figure-15: Shear forces along Longitudinal direction for Model3

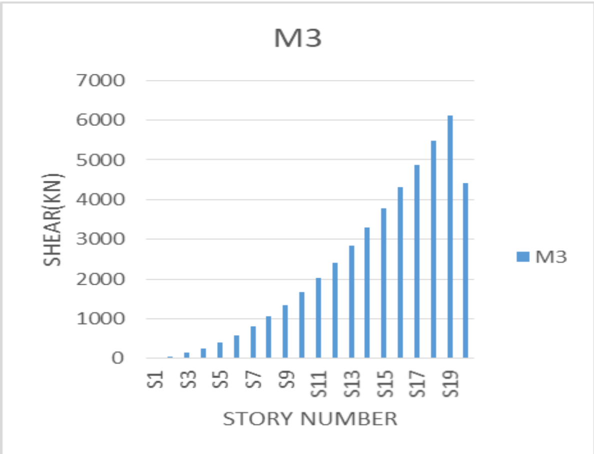


Figure16: Shear forces along Transverse direction for Model 3

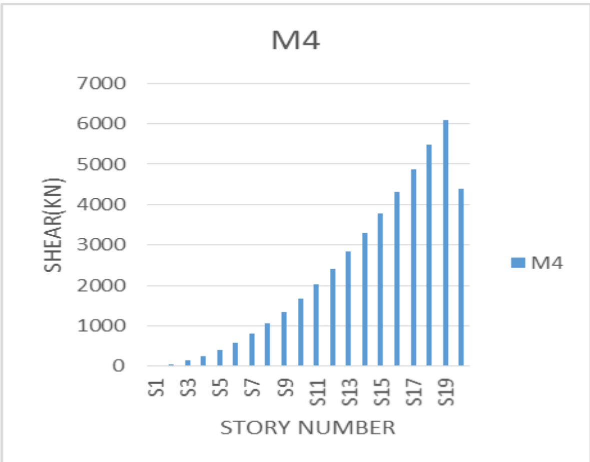


Figure-17: Shear forces along Longitudinal direction for Model4

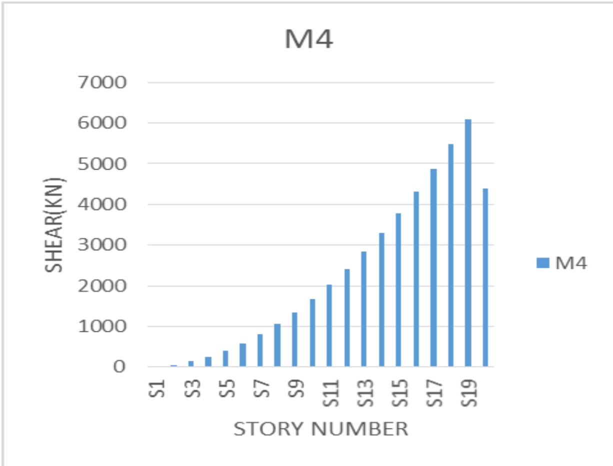


Figure-18: Shear forces along Transverse direction for Model 4

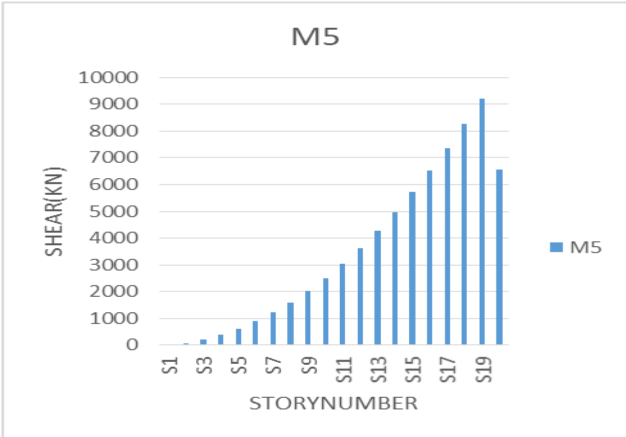


Figure19: Shear forces along longitudinal direction for Model 5

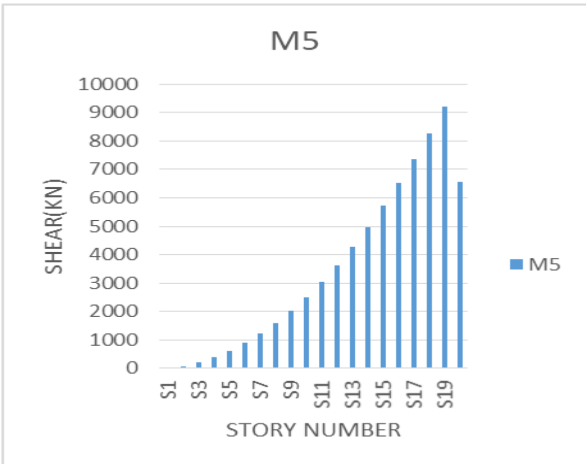


Figure-20: Shear forces along Transverse direction for Model 5

Table 6: Distribution of lateral seismic shear force for building on elevated ground for model-1

storey number	VX(KN)	VY(KN)
S20	627.2351	604.1056
S19	1230.53	1185.154
S18	1103.324	1062.638
S17	983.0558	946.8054
S16	869.7264	837.655
S15	763.3355	735.1873
S14	663.8831	639.4022
S13	571.3693	550.2999
S12	485.794	467.8802
S11	407.1572	392.1432
S10	335.459	323.0889
S9	270.6993	260.7172
S8	212.8782	205.0282
S7	161.9956	156.0219
S6	100.7501	97.0349
S5	57.7081	55.5801
S4	26.8574	25.867
S3	10.8367	10.4371
S2	2.3347	2.2486
S1	0.1122	0.108

Table 7: Distribution of lateral seismic shear force for building on elevated ground for model-2

storey number	VX(KN)	VY(KN)
S20	3856.011	3856.011
S19	5330.185	5330.185
S18	4779.175	4779.175
S17	4258.22	4258.22
S16	3767.321	3767.321
S15	3306.476	3306.476
S14	2875.687	2875.687
S13	2474.952	2474.952
S12	2104.273	2104.273
S11	1763.649	1763.649
S10	1453.08	1453.08
S9	1172.566	1172.566
S8	922.1065	922.1065
S7	669.2545	669.2545
S6	422.7526	422.7526
S5	233.1503	233.1503
S4	110.5353	110.5353
S3	41.1901	41.1901
S2	8.3198	8.3198
S1	0.4594	0.4594

Table 8: Distribution of lateral seismic shear force for building on elevated ground for model-3

storey number	VX(KN)	VY(KN)
S20	3849.714	3849.714
S19	5326.864	5326.864
S18	4767.929	4767.929
S17	4248.2	4248.2
S16	3758.456	3758.456
S15	3298.696	3298.696
S14	2868.92	2868.92
S13	2469.129	2469.129
S12	2099.322	2099.322
S11	1759.499	1759.499
S10	1449.66	1449.66
S9	1169.806	1169.806
S8	919.9367	919.9367
S7	671.5691	671.5691
S6	426.537	426.537
S5	232.8105	232.8105
S4	110.2756	110.2756
S3	41.0238	41.0238
S2	8.5272	8.5272
S1	0.5367	0.5367

Table 9: Distribution of lateral seismic shear force for building on elevated ground for model-4

storey number	VX(KN)	VY(KN)
S20	3849.08	3849.08
S19	5341.514	5341.514
S18	4788.413	4788.413
S17	4266.451	4266.451
S16	3774.603	3774.603
S15	3312.867	3312.867
S14	2881.245	2881.245
S13	2479.736	2479.736
S12	2108.34	2108.34
S11	1767.058	1767.058
S10	1455.888	1455.888
S9	1174.832	1174.832
S8	923.8889	923.8889
S7	674.0671	674.0671
S6	427.9317	427.9317
S5	235.0152	235.0152
S4	113.0518	113.0518
S3	41.6369	41.6369
S2	8.582	8.582
S1	0.5374	0.5374

Table 10: Distribution of lateral seismic shear force for building on elevated ground for model-5

storey number	VX(KN)	VY(KN)
S20	3832.446	3832.446
S19	5371.163	5371.163
S18	4815.917	4815.917
S17	4290.957	4290.957
S16	3796.283	3796.283
S15	3331.896	3331.896
S14	2897.795	2897.795
S13	2493.979	2493.979
S12	2120.45	2120.45
S11	1777.208	1777.208
S10	1464.251	1464.251
S9	1181.58	1181.58
S8	929.1956	929.1956
S7	685.0272	685.0272
S6	441.0449	441.0449
S5	241.4563	241.4563
S4	116.5281	116.5281
S3	43.1789	43.1789
S2	9.4159	9.4159
S1	0.688	0.688

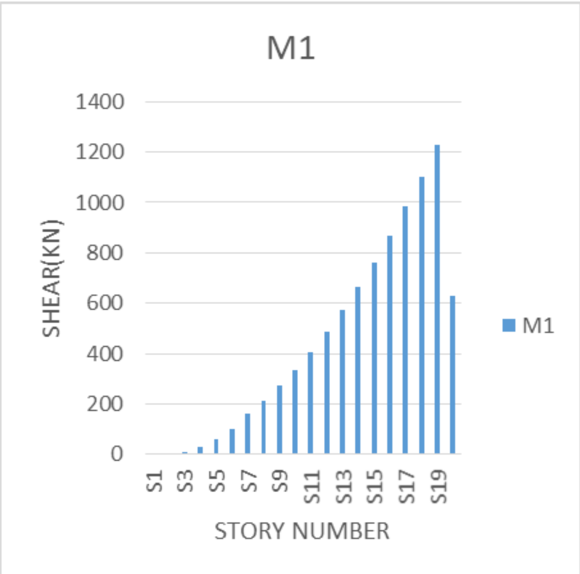


Figure-21: Shear force along longitudinal direction for Model 1

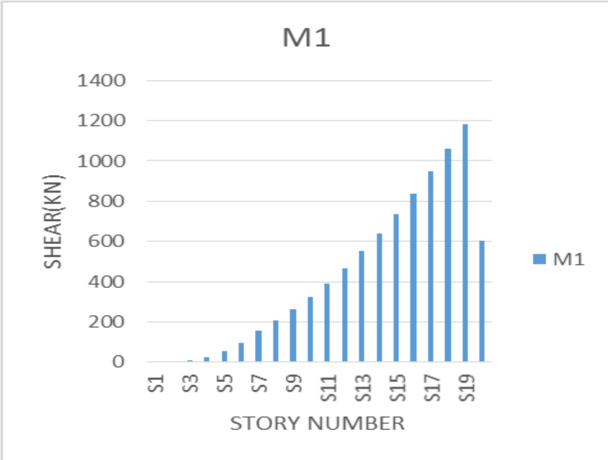


Figure-22: Shear force along Transverse direction for Model 1

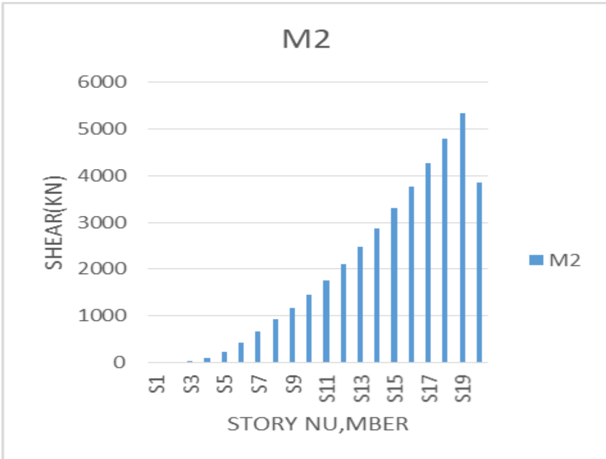


Figure-23: Shear force along longitudinal direction for Model 2

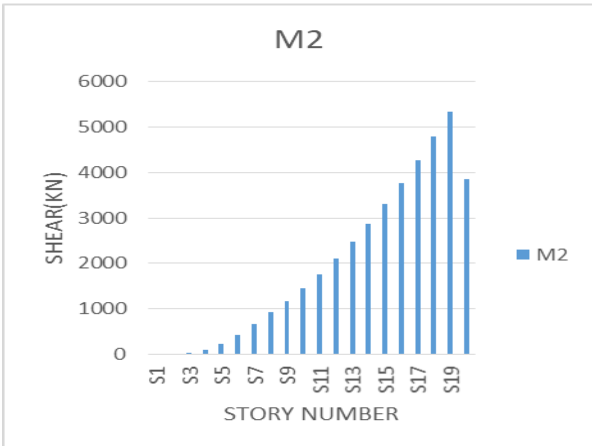


Figure-24: Shear force along Transverse direction for Model 2

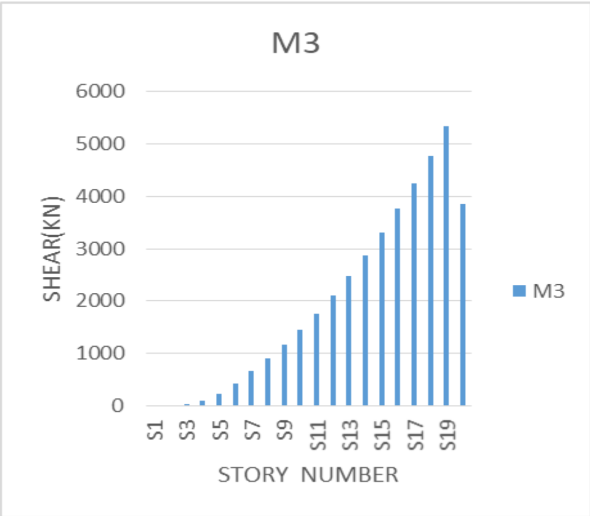


Figure-25: Shear force along longitudinal direction for Model 3

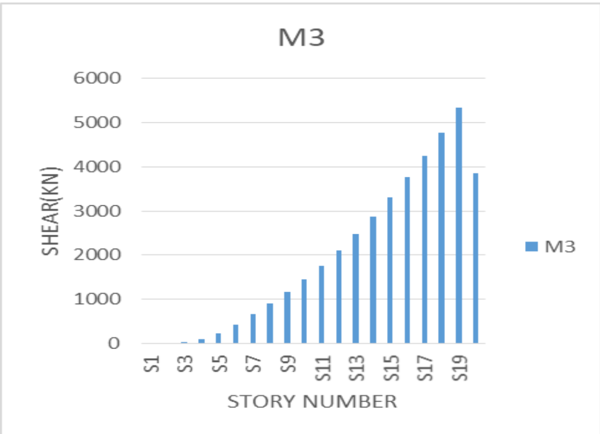


Figure-26: Shear force along Transverse direction for Model 3

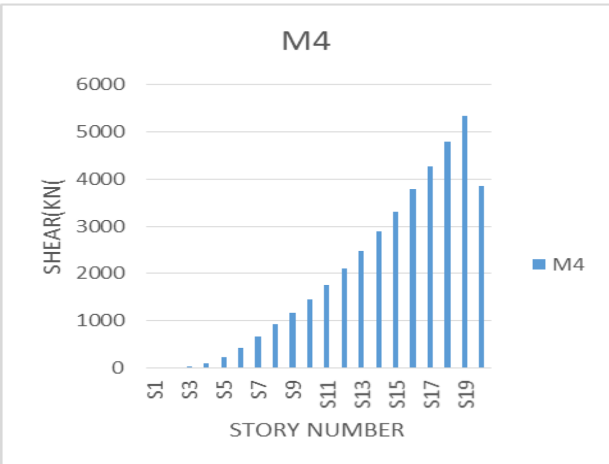


Figure-27: Shear force along longitudinal direction for Model 4

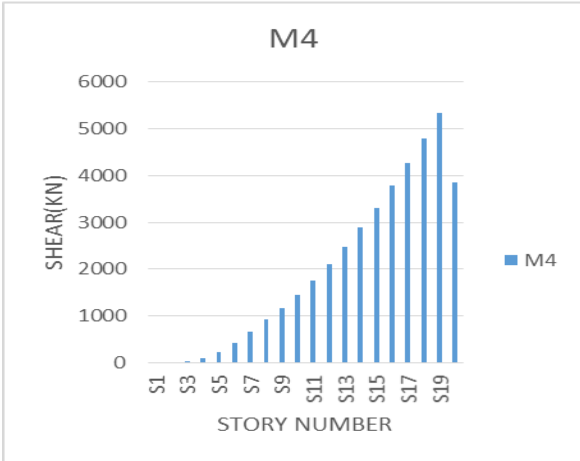


Figure-28: Shear force along Transverse direction for Model 4

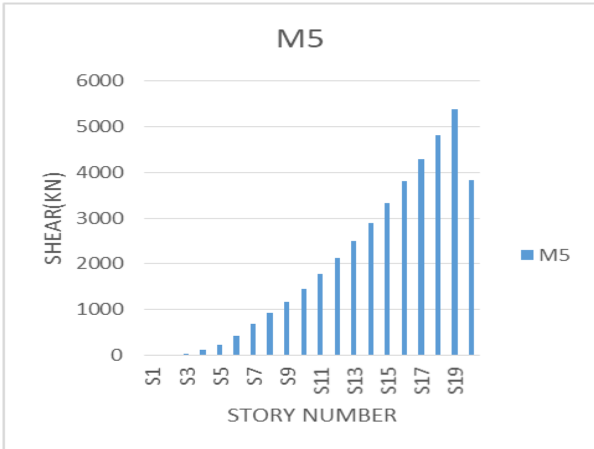


Figure-29: Shear force along Longitudinal direction for Model 5

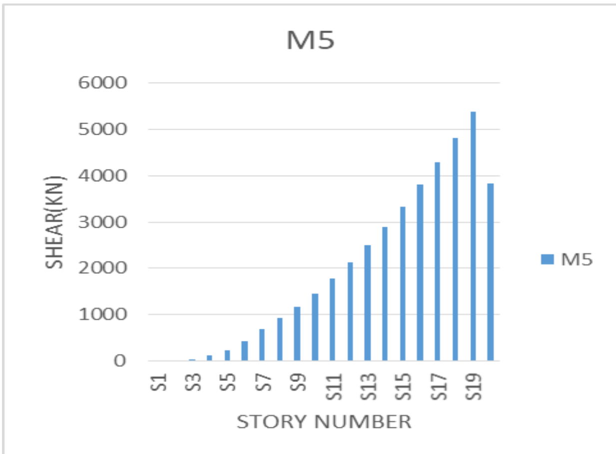


Figure-30: Shear force along Transverse direction for Model 5

3.3.Lateral Displacements

The displacements at every floor level are tabulated in tabulated for E.S. Method and R.S.Method. For better explanation the displacement along Lgtd and Trvs directions are plotted in graphs can be seen in figures-5.1 to 5.8 the lateral displacements are maximum for top stories and gradually reduced for bottom stories as mention in below tables.

a) Lateral Displacement for Models on Plain Ground

Table 11: Lateral Displacements (mm) along Lgtd and Trvs direction for model-1

storey number	ES METHOD		RS METHOD	
	Uy	Uy	Ux	Uy
S20	74.056	69.237	54.688	53.683
S19	72.633	68.268	53.748	53.041
S18	70.895	66.921	52.616	52.159
S17	68.74	65.103	51.227	50.976
S16	66.13	62.806	49.553	49.483
S15	63.067	60.056	47.588	47.687
S14	59.577	56.895	45.333	45.604
S13	55.695	53.371	42.796	43.244
S12	51.467	49.531	39.988	40.622
S11	46.942	45.424	36.921	37.751
S10	42.169	41.092	33.613	34.644
S9	37.201	36.578	30.083	31.315
S8	32.093	31.922	26.356	27.778
S7	26.907	27.163	22.46	24.046
S6	21.717	22.344	18.437	20.135
S5	16.616	17.519	14.352	16.072
S4	11.735	12.764	10.309	11.917
S3	7.261	8.217	6.482	7.796
S2	3.481	4.139	3.153	3.981
S1	0.841	1.059	0.771	1.028

Table 12: Lateral Displacements (mm) along Lgtd and Trvs direction for model-2

storey number	ES METHOD		RS METHOD	
	Uy	Uy	Ux	Uy
S20	5.634	8.762	5.187	7.602
S19	5.552	8.647	5.128	7.525
S18	5.47	8.531	5.069	7.447
S17	5.388	8.415	5.01	7.369
S16	5.306	8.299	4.951	7.292
S15	5.224	8.183	4.892	7.214
S14	5.142	8.067	4.833	7.136
S13	5.059	7.951	4.774	7.058
S12	4.977	7.835	4.715	6.98
S11	4.895	7.718	4.656	6.903
S10	4.812	7.602	4.597	6.825
S9	4.73	7.486	4.538	6.747
S8	4.648	7.37	4.478	6.669
S7	4.566	7.254	4.419	6.591
S6	4.484	7.138	4.36	6.513
S5	4.401	7.022	4.301	6.435
S4	4.319	6.906	4.241	6.357
S3	4.238	6.791	4.182	6.279
S2	4.156	6.675	4.123	6.201
S1	1.781	2.847	1.773	2.653

Table 13: Lateral Displacements (mm) along Lgtd and Trvs direction for model-3

storey number	ES METHOD		RS METHOD	
	Uy	Uy	Ux	Uy
S20	3.578	5.423	3.212	3.212
S19	3.51	5.317	3.163	3.163
S18	3.441	5.211	3.114	3.114
S17	3.372	5.105	3.065	3.065
S16	3.302	4.999	3.016	3.016
S15	3.233	4.893	2.967	2.967
S14	3.164	4.787	2.918	2.918
S13	3.095	4.681	2.869	2.869
S12	3.025	4.575	2.82	2.82
S11	2.956	4.468	2.77	2.77
S10	2.886	4.362	2.721	2.721
S9	2.817	4.256	2.672	2.672
S8	2.748	4.15	2.622	2.622
S7	2.678	4.044	2.573	2.573
S6	2.609	3.938	2.524	2.524
S5	2.54	3.832	2.475	2.475
S4	2.471	3.726	2.425	2.425
S3	2.402	3.621	2.376	2.376
S2	2.334	3.516	2.327	2.327
S1	1.04	1.568	1.024	1.024

Table 14: Lateral Displacements (mm) along Lgtd and Trvs direction for model-4

storey number	ES METHOD		RS METHOD	
	Uy	Uy	Ux	Uy
S20	3.186	4.731	2.827	4.176
S19	3.116	4.623	2.777	4.099
S18	3.047	4.516	2.727	4.022
S17	2.977	4.408	2.676	3.944

S16	2.907	4.3	2.626	3.867
S15	2.837	4.193	2.576	3.789
S14	2.767	4.085	2.525	3.712
S13	2.697	3.977	2.475	3.634
S12	2.627	3.869	2.424	3.556
S11	2.556	3.761	2.374	3.479
S10	2.486	3.653	2.323	3.401
S9	2.416	3.545	2.272	3.323
S8	2.346	3.437	2.222	3.245
S7	2.276	3.329	2.171	3.167
S6	2.206	3.221	2.121	3.09
S5	2.136	3.114	2.07	3.012
S4	2.066	3.007	2.019	2.935
S3	1.997	2.9	1.969	2.857
S2	1.927	2.793	1.919	2.78
S1	0.9	1.282	0.902	1.284

Table 15: Lateral Displacements (mm) along Lgtd and Trvs direction for model-5

storey number	ES METHOD		RS METHOD	
	Uy	Uy	Ux	Uy
S20	2.618	3.675	2.264	3.147
S19	2.543	3.564	2.208	3.063
S18	2.468	3.452	2.152	2.98
S17	2.392	3.34	2.096	2.896
S16	2.317	3.228	2.039	2.812
S15	2.241	3.116	1.983	2.728
S14	2.165	3.004	1.926	2.644
S13	2.089	2.891	1.869	2.56
S12	2.013	2.779	1.813	2.476
S11	1.937	2.666	1.756	2.392
S10	1.861	2.554	1.699	2.307
S9	1.785	2.441	1.642	2.223
S8	1.709	2.329	1.585	2.138
S7	1.634	2.217	1.528	2.054
S6	1.558	2.106	1.471	1.97
S5	1.483	1.994	1.414	1.886
S4	1.408	1.884	1.358	1.803
S3	1.333	1.774	1.302	1.719
S2	1.26	1.665	1.246	1.637
S1	0.588	0.783	0.571	0.756

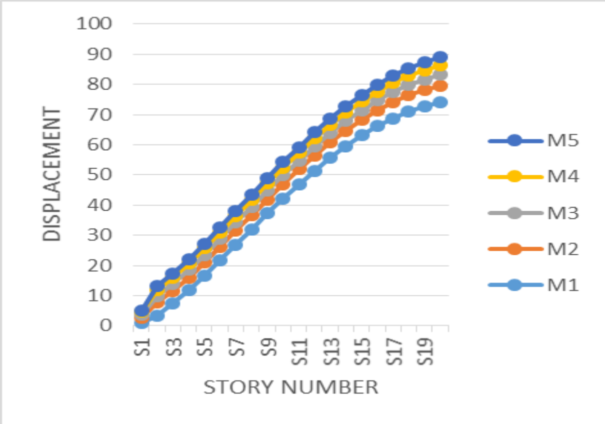


Figure-31: Displacements of Models on plain ground along Longitudinal direction (Analysis cases: Equivalent Static Method)

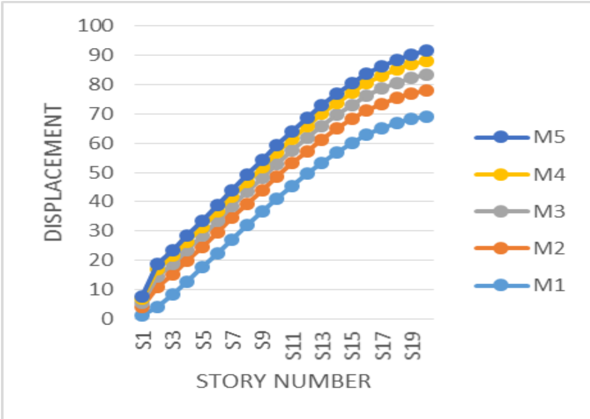


Figure-32: Displacements of Models on plain ground along Transverse direction (Analysis cases: Equivalent Static Method)

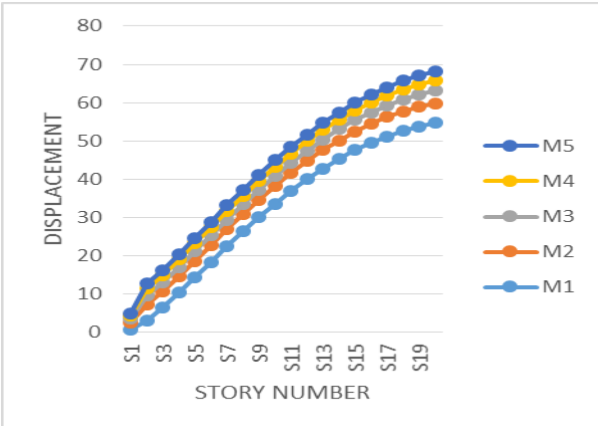


Figure-33: Displacements of Models on plain ground along Longitudinal direction (Analysis cases: Response Spectrum Method)

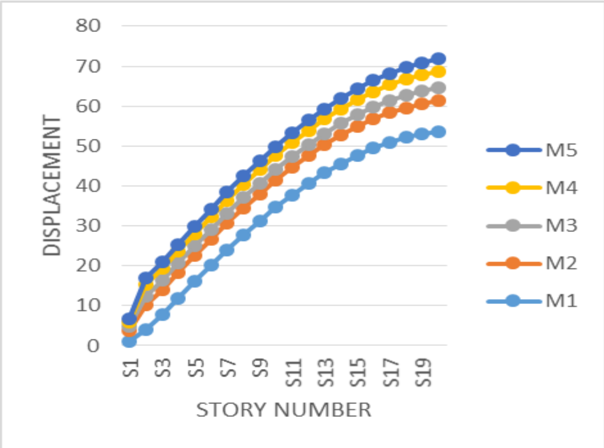


Figure-34: Displacements of Models on plain ground along Transverse direction (Analysis cases: Response Spectrum Method)

b) Lateral Displacement For Models On elevated Ground

Table 16: Lateral Displacements (mm) along Lgtd and Trvs direction for model-1

storey number	ES METHOD		RS METHOD	
	Uy	Uy	Ux	Uy
S20	56.067	57.215	46.632	54.846
S19	54.412	56.178	45.267	53.853
S18	52.381	54.718	43.622	52.497
S17	49.853	52.733	41.61	50.695
S16	46.789	50.213	39.204	48.437
S15	43.196	47.187	36.407	45.742
S14	39.114	43.702	33.238	42.633
S13	34.603	39.812	29.721	39.136
S12	29.744	35.572	25.89	35.272
S11	24.635	31.04	21.793	31.065
S10	19.402	26.273	17.507	26.544
S9	14.211	21.343	13.161	21.756
S8	9.298	16.347	8.97	16.789
S7	5.002	11.455	5.296	11.831
S6	2.036	7.123	2.716	7.425
S5	0.512	3.769	1.294	4.013
S4	0.015	1.651	0.556	1.853
S3	0.077	0.526	0.191	0.676
S2	0.033	0.092	0.045	0.2
S1	0.005	0.004	0.008	0.045

Table 17: Lateral Displacements (mm) along Lgtd and Trvs direction for model-2

storey number	ES METHOD		RS METHOD	
	Uy	Uy	Ux	Uy
S20	1.864	4.347	1.805	4.448
S19	1.815	4.274	1.764	4.388
S18	1.766	4.201	1.723	4.328
S17	1.717	4.128	1.682	4.268
S16	1.668	4.055	1.641	4.208
S15	1.618	3.982	1.6	4.147
S14	1.569	3.909	1.559	4.087
S13	1.52	3.836	1.518	4.027
S12	1.471	3.763	1.477	3.967
S11	1.421	3.689	1.435	3.906
S10	1.372	3.616	1.394	3.846
S9	1.323	3.543	1.353	3.786
S8	1.273	3.47	1.312	3.725
S7	1.224	3.396	1.27	3.665
S6	1.175	3.297	1.229	3.604
S5	1.125	3.21	1.187	3.544
S4	1.075	3.11	1.145	3.483
S3	1.025	3.024	1.103	3.423
S2	0.973	2.925	1.058	3.363
S1	0.313	1.235	0.343	1.433

Table 18: Lateral Displacements (mm) along Lgtd and Trvs direction for model-3

Storey number	ES METHOD		RS METHOD	
	Uy	Uy	Ux	Uy
S20	1.505	2.938	1.455	3.067
S19	1.465	2.878	1.422	3.018
S18	1.425	2.819	1.389	2.969
S17	1.385	2.759	1.356	2.92
S16	1.345	2.699	1.322	2.871
S15	1.305	2.639	1.289	2.822
S14	1.265	2.579	1.255	2.773
S13	1.224	2.519	1.222	2.723
S12	1.184	2.459	1.188	2.674
S11	1.144	2.399	1.154	2.625
S10	1.104	2.339	1.121	2.575
S9	1.063	2.279	1.087	2.526
S8	1.023	2.219	1.053	2.476
S7	0.983	2.159	1.02	2.427
S6	0.943	2.099	0.986	2.377
S5	0.902	2.039	0.952	2.327
S4	0.861	1.979	0.918	2.278
S3	0.82	1.919	0.883	2.228
S2	0.777	1.859	0.845	2.178
S1	0.442	0.844	0.479	0.984

Table 19: Lateral Displacements (mm) along Lgtd and Trvs direction for model-4

storey number	ES METHOD		RS METHOD	
	Uy	Uy	Ux	Uy
S20	1.464	2.657	1.406	3.075
S19	1.422	2.596	1.371	3.019
S18	1.38	2.534	1.336	2.963
S17	1.338	2.472	1.301	2.907
S16	1.295	2.41	1.266	2.851
S15	1.253	2.348	1.23	2.795
S14	1.21	2.286	1.195	2.739
S13	1.168	2.224	1.16	2.682
S12	1.126	2.162	1.124	2.626
S11	1.083	2.099	1.089	2.569
S10	1.041	2.037	1.054	2.513
S9	0.998	1.975	1.018	2.456
S8	0.956	1.913	0.983	2.4
S7	0.913	1.851	0.947	2.344
S6	0.871	1.789	0.912	2.287
S5	0.828	1.727	0.876	2.231
S4	0.785	1.665	0.84	2.174
S3	0.742	1.604	0.804	2.118
S2	0.697	1.542	0.765	2.061
S1	0.405	0.697	0.437	0.918

Table 20: Lateral Displacements (mm) along Lgtd and Trvs direction for model-5

storey number	ES METHOD		RS METHOD	
	Uy	Uy	Ux	Uy
S20	0.961	1.51	0.912	1.498
S19	0.931	1.465	0.886	1.462
S18	0.9	1.42	0.861	1.425
S17	0.87	1.375	0.835	1.387
S16	0.839	1.33	0.809	1.35
S15	0.808	1.285	0.783	1.313
S14	0.777	1.239	0.757	1.275
S13	0.746	1.194	0.731	1.238
S12	0.715	1.148	0.705	1.2
S11	0.683	1.103	0.679	1.162
S10	0.652	1.057	0.653	1.125
S9	0.621	1.012	0.627	1.087
S8	0.59	0.967	0.601	1.049
S7	0.56	0.921	0.575	1.012
S6	0.529	0.876	0.549	0.973
S5	0.497	0.83	0.522	0.934
S4	0.466	0.783	0.496	0.895
S3	0.435	0.737	0.469	0.855
S2	0.406	0.688	0.443	0.812
S1	0.244	0.321	0.261	0.371

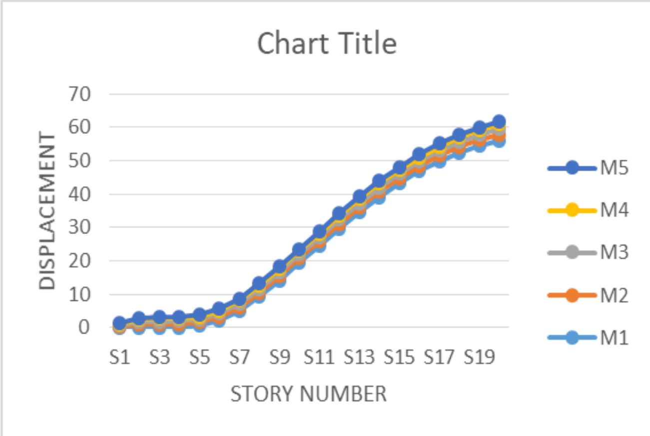


Figure-35: Displacements of Models on Curve slope ground along longitudinal direction (Analysis cases: Equivalent Static Method)

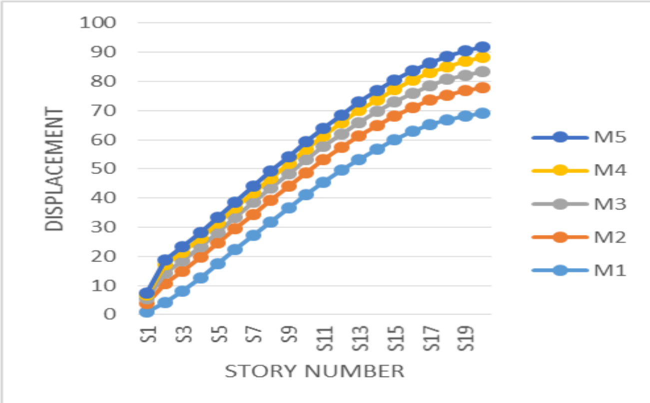


Figure-36: Displacements of Models on Curve slope ground along Transverse direction (Analysis cases: Equivalent Static Method)

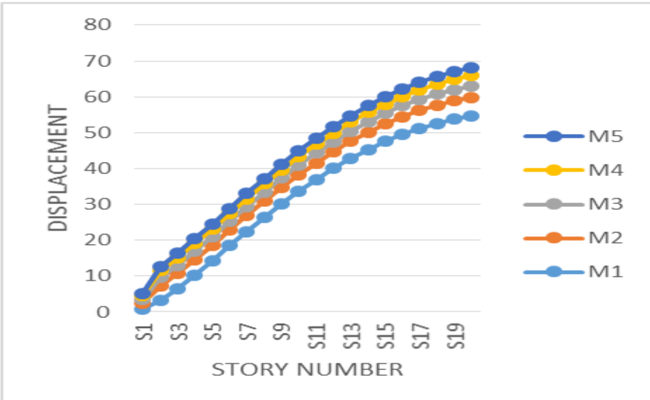


Figure-37: Displacements of Models on Curve slope ground along longitudinal direction (Analysis cases: Response Spectrum Method)

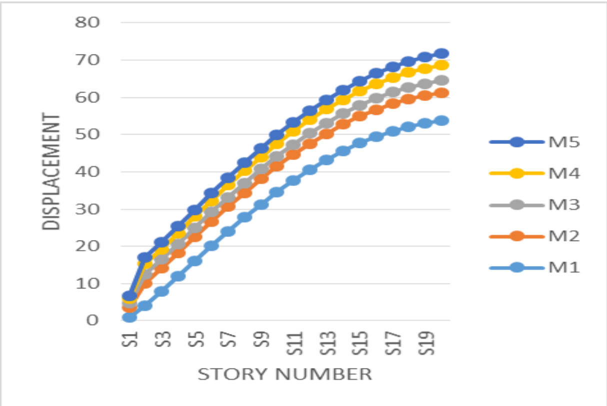


Figure-38: Displacements of Models on Curve slope ground along Transverse direction (Analysis cases: Response Spectrum Method)

CONCLUSSION

1. As the infills, concert shear and concert core walls are provides which leads to reduces in fundamental natural periods.
2. Storey displacement are found within the specified limit.
3. The maximum displacement notice in model 1
4. The minimum displacement noticed in model 5
5. The masonry infill walls increases the behaviour of structure during earthquake.
6. The influence of masonry infills may reduce the displacement of structure.
7. The strength of structure can be increases by avoiding soft stories.
8. The presence of central concrete shear wall and concrete shear wall at corners and concrete shear walls on outer side also reduces the seismic effect on structure

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