Study on Performance And Assessment of RCC Building With Various Load Resisting System Using Different Type of Soil

Sunny Gorivale[1], Prof. V.P Bhusare[2]
[1]Dept of Civil Engineering
[2]*AssistantProfessor*, Dept of Civil Engineering
[1, 2] Savitribai Phule Pune University, Pune

Abstract*- The high rise buildings are most commonly being made up of Reinforced concrete. The structural behavior of multi-Storey building such as Regular RCC building, Braced building and Mivan building in accordance with the seismic provisions suggested in IS: 1893-2016 to analyze the performance of existing buildings if exposed to seismic loads. In this modelling of G+40 stores RCC framed building is studied for earthquake load using ETABS2016. Assuming that material property is dynamic analysis is performed. These analyses are carried out by considering at seismic zones III and for zone the behavior is assessed by taking three different types of soils namely soft, Medium and Hard soil. Post analysis of the structure Storey Displacement , time period and Storeyforces results are also computed and compared for all the cases.*

Hence the aim of present study is to Analysis of Regular RCC building, Braced building and mivan building and compare seismic performance of G+40 Storey structures situated in earthquake zones III & using soft, medium and hard soil. All frames are designed under same gravity loading. Response spectrum method of analysis used for seismic analysis. ETABS software is used and the results are compared.

Keywords- ETABS, Earthquake loading, high-rise, Storey Drift, response spectrum, mivan, Braced

I. INTRODUCTION

General Introduction

There is rising awareness today that the speed of construction desires to be set superior importance particularly for huge housing projects. This is often crucial for the earlier business of kit investments.

There is a requirement to scale back the housing cost to attain the national objective of making an outsized standard. Luckily, certain progressive technologies providing quicker construction are already available within the country. For e.g. autoclaved blocks, Prefabrication, tunnel formwork, and aluminum formwork (MIVAN Technology) of construction etc.

It's now well-known that the Mivan Technology reduces the price of construction from above analysis, hence the technology is beneficial to the development company and builder. However, what about the top user i.e. the those that are visiting occupy the homes built by mivan technology. In India the occupants of homes built by mivan technology must have experience of living in an exceedingly house constructed by conventional technology as mivan technology has recently came in India. Supported this fact, during this project we've got taken a survey of individuals who are occupied in houses built by mivan technology. By adopting Mivan technology within the project not only it gives the higher quality of construction and but also increases the speed of construction and reduces the value since a number of the development activities are completely eliminated et al are reduced to an extent.

Fig- 1 Showing the Mivan technology used for the building

Braced RCC Building:-

As building heights were increased and subjected to higher wind loads, new types ofbracing systems were needed to reinforce the structure which in simple terms had toperform as a very tall cantilever. Where moment resisting beam to column connections were insufficient, K and X bracing was added. This was typically located internally, near the core, in order to make it as unobtrusive as possible; i.e. having no impact on the design of the façade or the flow of traffic in the building. As requirements for mechanical systems increased, these were often relegated to designated floors at intervals over the height of the building. Truss structures were used at these floors as a stabilization method.

Shear Wall Frame Structure

Reinforcedconcretestructuralframesareoneofthemostp opularstructuralsystems.In this system RCC frame is braced with concrete shear wall. The main reason to brace a shear wall with RCC frame is to counter the effects of lateral loads acting on a structure due to earthquake, wind etc. The most convenient place to locate shear wall is an external blank wall on edges or on two parallel edges so that stiffness of structure is maintained in best possible way. It should be spaced symmetrically so that center of gravity (C.G.) of structure remains at center and there is not much eccentricity on application of lateral loads like seismic, wind etc. So, its placement needs special skills and experience because if not placed at proper location it would lead to adverse behavior.

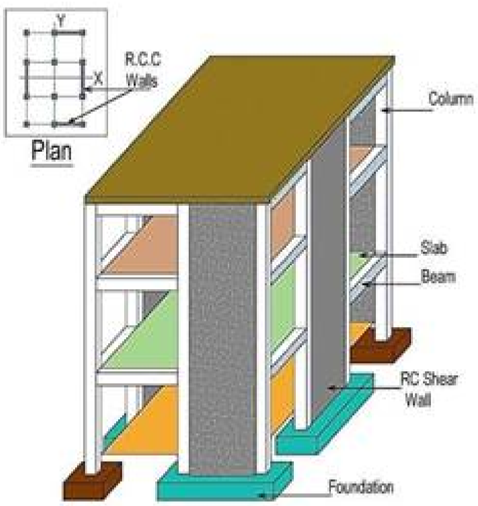


Fig 1.2 Typical shear wall frame structure

RESEARCHMETHODOLOGY

Response spectrum method

This method is applicable for those structures where modes apart from the elemental one affect significantly the response of the structure. during this method the response of multi degree of freedom system is expressed because the superposition of modal response, each modal response being determined from the spectral analysis of single degree of freedom system, which is then combined to match the entire response. Modal analysis of the response history of structure to specified ground motion; however, the strategy is sometimes utilized in conjunction with a response spectrum.

Seismic Weight

The seismic weight of the whole building is the sum of the seismic weights of all the floors. The seismic weight of each floor is its full dead load plus the appropriate amount of imposed load, the latter being that part of the imposed loads that may reasonably be expected to be attached to the structure at the time of earthquake shaking. It includes the weight of permanent and movable partitions, permanent equipment, a part of the live load, etc. While computing the seismic weight of each floor, the weight of columns and walls in any Storey should be equally distributed to the floors above and below the Storey. Any weight supported in between stories should be distributed to the floors above and below in inverse proportion to its distance from the floors.

As per IS 1893(Part I):2016, the percentage of imposed load as given in Table 5 should be used. For calculating the design seismic forces of the structure, the imposed load on the roof need not be considered.

PROBLEMFORMULATION

Multi-storied ferroconcrete, moment resisting space frame are analyzed using professional software ETABS 2016. Model G+40 of building frame with three bays in horizontal and three bays in lateral direction is analyzed by Response Spectrum Method. The plan dimensions of buildings are shown in table below. The plan view of building, elevation of various frames is shown in figures below.

Table No I: Detail Features of Building

Type of structure	Frame structure
Moment-Resisting frame	SMRF
No of Stories	G+40
Height of each Storey	3m
Height of ground Storey	1.2m
Thickness of slab	150mm
Thickness of outer wall	230mm
Thickness of inner wall	150mm
Grade of reinforcing steel	Fe 415
Density of concrete	25 kN/m3
Density of Brick wall	20 kN/m3
Grade of concrete in slab	M35
Grade of concrete in beam	M35
Grade of concrete in column	M35
Grade of concrete in footing	M35
Seismic Analysis	Dynamic

A. G+40 StoreyBuildingFloor Plan:

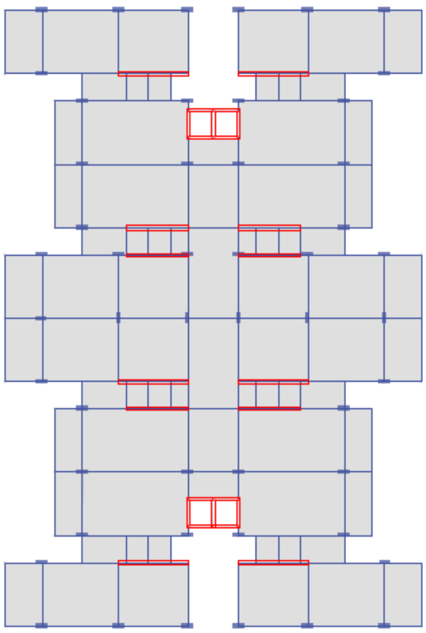


Fig.G+40StoreyBuildingPlan

B. G+40 Storey BuildingModel:

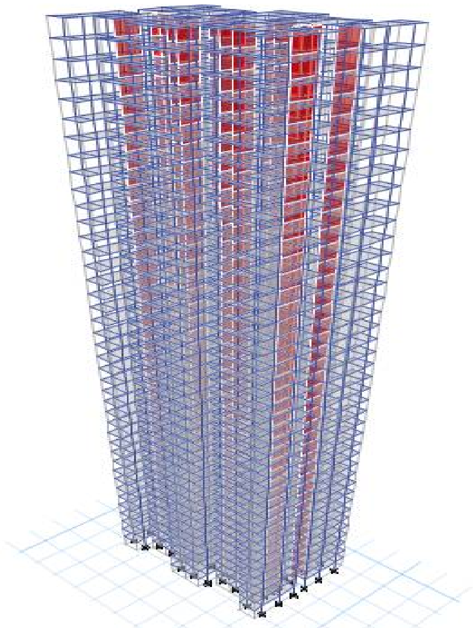


Fig.G+40Storey Building Model

IV. RESULTS

4.1 Storey displacement

Table 4.1 Regular RCC building model Storey displacement with Soft soil at zone III.

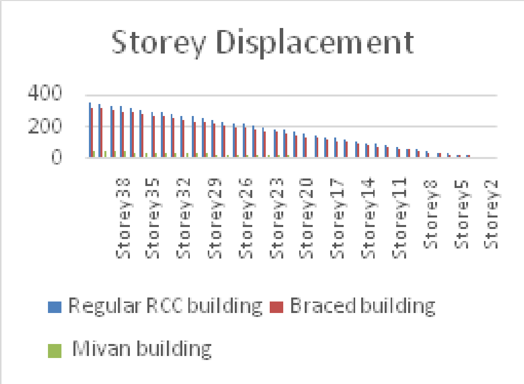
Storey	Load Case/Combo	Displace-ment mm
Storey40	0.9DL+1.5WL+X	345.555
Storey39	0.9DL+1.5WL+X	336.868
Storey38	0.9DL+1.5WL+X	328.504
Storey37	0.9DL+1.5WL+X	320.172
Storey36	0.9DL+1.5WL+X	311.696
Storey35	0.9DL+1.5WL+X	303.103
Storey34	0.9DL+1.5WL+X	294.395
Storey33	0.9DL+1.5WL+X	285.568
Storey32	0.9DL+1.5WL+X	276.62
Storey31	0.9DL+1.5WL+X	267.551
Storey30	0.9DL+1.5WL+X	258.371
Storey29	0.9DL+1.5WL+X	249.08
Storey28	0.9DL+1.5WL+X	239.684
Storey27	0.9DL+1.5WL+X	230.191
Storey26	0.9DL+1.5WL+X	220.61
Storey25	0.9DL+1.5WL+X	210.952
Storey24	0.9DL+1.5WL+X	201.226
Storey23	0.9DL+1.5WL+X	191.444
Storey22	0.9DL+1.5WL+X	181.621
Storey21	0.9DL+1.5WL+X	171.769
Storey20	0.9DL+1.5WL+X	161.902
Storey19	0.9DL+1.5WL+X	152.038
Storey18	0.9DL+1.5WL+X	142.191
Storey17	0.9DL+1.5WL+X	132.38
Storey16	0.9DL+1.5WL+X	122.625
Storey15	0.9DL+1.5WL+X	112.944
Storey14	0.9DL+1.5WL+X	103.361
Storey13	0.9DL+1.5WL+X	93.898
Storey12	0.9DL+1.5WL+X	84.581
Storey11	0.9DL+1.5WL+X	75.439
Storey10	0.9DL+1.5WL+X	66.502
Storey9	0.9DL+1.5WL+X	57.805
Storey8	0.9DL+1.5WL+X	49.39
Storey7	0.9DL+1.5WL+X	41.302
Storey6	0.9DL+1.5WL+X	33.6
Storey5	0.9DL+1.5WL+X	26.354
Storey4	0.9DL+1.5WL+X	19.652
Storey3	0.9DL+1.5WL+X	13.609
Storey2	0.9DL+1.5WL+X	8.38
Storey1	0.9DL+1.5WL+X	4.179

Table 4.2 Braced building model Storey displacement with Soft soil at zone III.

Storey	Load Case/Combo	Displacement mm
Storey40	0.9DL+1.5WL+X	315.94
Storey39	0.9DL+1.5WL+X	307.705
Storey38	0.9DL+1.5WL+X	299.485
Storey37	0.9DL+1.5WL+X	291.233
Storey36	0.9DL+1.5WL+X	282.915
Storey35	0.9DL+1.5WL+X	274.519
Storey34	0.9DL+1.5WL+X	266.04
Storey33	0.9DL+1.5WL+X	257.478
Storey32	0.9DL+1.5WL+X	248.833
Storey31	0.9DL+1.5WL+X	240.108
Storey30	0.9DL+1.5WL+X	231.304
Storey29	0.9DL+1.5WL+X	222.43
Storey28	0.9DL+1.5WL+X	213.496
Storey27	0.9DL+1.5WL+X	204.507
Storey26	0.9DL+1.5WL+X	195.471
Storey25	0.9DL+1.5WL+X	186.398
Storey24	0.9DL+1.5WL+X	177.298
Storey23	0.9DL+1.5WL+X	168.185
Storey22	0.9DL+1.5WL+X	159.069
Storey21	0.9DL+1.5WL+X	149.965
Storey20	0.9DL+1.5WL+X	140.887
Storey19	0.9DL+1.5WL+X	131.85
Storey18	0.9DL+1.5WL+X	122.872
Storey17	0.9DL+1.5WL+X	113.969
Storey16	0.9DL+1.5WL+X	105.16
Storey15	0.9DL+1.5WL+X	96.466
Storey14	0.9DL+1.5WL+X	87.907
Storey13	0.9DL+1.5WL+X	79.507
Storey12	0.9DL+1.5WL+X	71.289
Storey11	0.9DL+1.5WL+X	63.281
Storey10	0.9DL+1.5WL+X	55.51
Storey9	0.9DL+1.5WL+X	48.007
Storey8	0.9DL+1.5WL+X	40.808
Storey7	0.9DL+1.5WL+X	33.952
Storey6	0.9DL+1.5WL+X	27.484
Storey5	0.9DL+1.5WL+X	21.458
Storey4	0.9DL+1.5WL+X	15.942
Storey3	0.9DL+1.5WL+X	11.018
Storey2	0.9DL+1.5WL+X	6.792
Storey1	0.9DL+1.5WL+X	3.367

Table 4.3 Mivan building model Storey displacement with Soft soil at zone III

Storey	Load Case/Combo	Displacement mm
Storey40	0.9DL+1.5WL+X	47.241
Storey39	0.9DL+1.5WL+X	45.751
Storey38	0.9DL+1.5WL+X	44.271
Storey37	0.9DL+1.5WL+X	42.797
Storey36	0.9DL+1.5WL+X	41.327
Storey35	0.9DL+1.5WL+X	39.865
Storey34	0.9DL+1.5WL+X	38.41
Storey33	0.9DL+1.5WL+X	36.951
Storey32	0.9DL+1.5WL+X	35.489
Storey31	0.9DL+1.5WL+X	34.026
Storey30	0.9DL+1.5WL+X	32.564
Storey29	0.9DL+1.5WL+X	31.103
Storey28	0.9DL+1.5WL+X	29.647
Storey27	0.9DL+1.5WL+X	28.195
Storey26	0.9DL+1.5WL+X	26.757
Storey25	0.9DL+1.5WL+X	25.327
Storey24	0.9DL+1.5WL+X	23.908
Storey23	0.9DL+1.5WL+X	22.502
Storey22	0.9DL+1.5WL+X	21.112
Storey21	0.9DL+1.5WL+X	19.74
Storey20	0.9DL+1.5WL+X	18.387
Storey19	0.9DL+1.5WL+X	17.057
Storey18	0.9DL+1.5WL+X	15.751
Storey17	0.9DL+1.5WL+X	14.472
Storey16	0.9DL+1.5WL+X	13.224
Storey15	0.9DL+1.5WL+X	12.01
Storey14	0.9DL+1.5WL+X	10.832
Storey13	0.9DL+1.5WL+X	9.7
Storey12	0.9DL+1.5WL+X	8.612
Storey11	0.9DL+1.5WL+X	7.57
Storey10	0.9DL+1.5WL+X	6.578
Storey9	0.9DL+1.5WL+X	5.641
Storey8	0.9DL+1.5WL+X	4.761
Storey7	0.9DL+1.5WL+X	3.943
Storey6	0.9DL+1.5WL+X	3.191
Storey5	0.9DL+1.5WL+X	2.51
Storey4	0.9DL+1.5WL+X	1.905
Storey3	0.9DL+1.5WL+X	1.381
Storey2	0.9DL+1.5WL+X	0.944
Storey1	0.9DL+1.5WL+X	0.593



Graph: 4.1 Storey Displacement V/s. Different type of building in Soft soil.

4.2 Modal Time Period Results

Table 4.4 Regular RCC building modal time period with soft soil at zone III

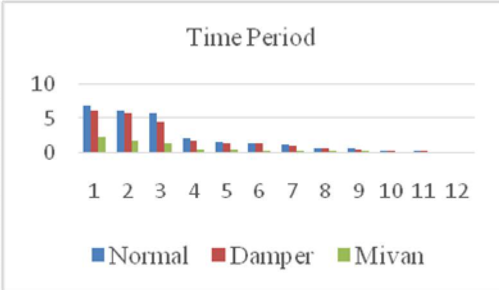
TABLE: Modal Periods and Frequencies			
Case	Mode	Period	Frequency
		sec	cyc/sec
IS 1893 2016	1	6.836	0.146
IS 1893 2016	2	6.258	0.16
IS 1893 2016	3	5.723	0.175
IS 1893 2016	4	2.172	0.46
IS 1893 2016	5	1.7	0.588
IS 1893 2016	6	1.506	0.664
IS 1893 2016	7	1.187	0.842
IS 1893 2016	8	0.748	1.338
IS 1893 2016	9	0.615	1.625
IS 1893 2016	10	0.412	2.428
IS 1893 2016	11	0.404	2.476
IS 1893 2016	12	0.154	6.497

Table 4.5Braced building modal time period with soft soil at zone III

TABLE: Modal Periods and Frequencies			
Case	Mode	Period	Frequency
		sec	cyc/sec
IS 1893 2016	1	6.105	0.164
IS 1893 2016	2	5.885	0.17
IS 1893 2016	3	4.613	0.217
IS 1893 2016	4	1.87	0.535
IS 1893 2016	5	1.493	0.67
IS 1893 2016	6	1.359	0.736
IS 1893 2016	7	1.016	0.984
IS 1893 2016	8	0.684	1.463
IS 1893 2016	9	0.532	1.881
IS 1893 2016	10	0.402	2.488
IS 1893 2016	11	0.35	2.854
IS 1893 2016	12	0.149	6.725

Table 4.6 Mivan building modal time period with soft soil at zone III

TABLE: Modal Periods and Frequencies			
Case	Mode	Period	Frequency
		sec	Cycle/sec
IS 1893 2016	1	2.235	0.448
IS 1893 2016	2	1.683	0.594
IS 1893 2016	3	1.273	0.786
IS 1893 2016	4	0.468	2.139
IS 1893 2016	5	0.433	2.309
IS 1893 2016	6	0.228	4.395
IS 1893 2016	7	0.198	5.044
IS 1893 2016	8	0.197	5.083
IS 1893 2016	9	0.166	6.023
IS 1893 2016	10	0.117	8.531
IS 1893 2016	11	0.089	11.182
IS 1893 2016	12	0.065	15.449



Graph 4.2 Modal time period v/s. Different type of building in soft soil

4.3 Building Storey Force Results

Table 4.7Regular RCC building Storey force with soft soil at zone III

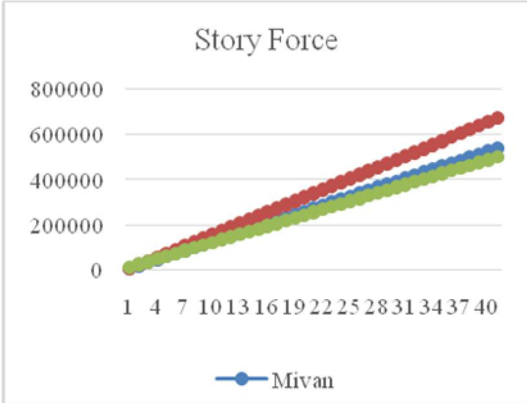
Storey 18	1.2(DL+LL+EQ+X)	298674.87	-2930.25	7218932.8
Storey 17	1.2(DL+LL+EQ+X)	311958.52	-2975.84	7539960.3
Storey 16	1.2(DL+LL+EQ+X)	325242.16	-3016.506	7860987.9
Storey 15	1.2(DL+LL+EQ+X)	338525.81	-3052.528	8182015.5
Storey 14	1.2(DL+LL+EQ+X)	351809.46	-3084.188	8503043.1
Storey 13	1.2(DL+LL+EQ+X)	365093.11	-3111.767	8824070.6
Storey 12	1.2(DL+LL+EQ+X)	378376.75	-3135.547	9145098.2
Storey 11	1.2(DL+LL+EQ+X)	391660.4	-3155.809	9466125.8
Storey 10	1.2(DL+LL+EQ+X)	404944.05	-3172.835	9787153.4
Storey 9	1.2(DL+LL+EQ+X)	418227.69	-3186.906	10108181
Storey 8	1.2(DL+LL+EQ+X)	431511.34	-3198.304	10429209
Storey 7	1.2(DL+LL+EQ+X)	444794.99	-3207.309	10750236
Storey 6	1.2(DL+LL+EQ+X)	458078.63	-3214.204	11071264
Storey 5	1.2(DL+LL+EQ+X)	471362.28	-3219.27	11392291
Storey 4	1.2(DL+LL+EQ+X)	484645.93	-3222.788	11713319
Storey 3	1.2(DL+LL+EQ+X)	497929.57	-3225.039	12034346
Storey 2	1.2(DL+LL+EQ+X)	511218.71	-3226.306	12355443
Storey 1	1.2(DL+LL+EQ+X)	524507.84	-3226.868	12676540
Ground storey	1.2(DL+LL+EQ+X)	537796.97	-3227.009	12997636

Table 4.8Braced building Storey force with soft soil at zone III

Storey 18	1.2(DL+LL+EQ+X)	373934.6476	-0.000002827	9037698.258
Storey 17	1.2(DL+LL+EQ+X)	390564.9043	-0.000002854	9439592.832
Storey 16	1.2(DL+LL+EQ+X)	407195.161	-0.000002882	9841487.406
Storey 15	1.2(DL+LL+EQ+X)	423825.4178	-0.000002931	10243382
Storey 14	1.2(DL+LL+EQ+X)	440455.6741	-0.00000295	10645277
Storey 13	1.2(DL+LL+EQ+X)	457085.9306	-0.000002984	11047171
Storey 12	1.2(DL+LL+EQ+X)	473716.1896	-0.000003004	11449066
Storey 11	1.2(DL+LL+EQ+X)	490346.445	-0.000003027	11850960
Storey 10	1.2(DL+LL+EQ+X)	506976.7024	-0.000003021	12252855
Storey 9	1.2(DL+LL+EQ+X)	523606.9601	-0.000003043	12654749
Storey 8	1.2(DL+LL+EQ+X)	540237.2185	-0.000003051	13056644
Storey 7	1.2(DL+LL+EQ+X)	556867.4749	-0.00000306	13458539
Storey 6	1.2(DL+LL+EQ+X)	573497.7314	-0.000003063	13860433
Storey 5	1.2(DL+LL+EQ+X)	590127.9886	-0.000003077	14262328
Storey 4	1.2(DL+LL+EQ+X)	606758.2457	-0.000003077	14664222
Storey 3	1.2(DL+LL+EQ+X)	623388.503	-0.000003081	15066117
Storey 2	1.2(DL+LL+EQ+X)	640025.6168	-0.000003082	15468098
Storey 1	1.2(DL+LL+EQ+X)	656662.7311	-0.00000308	15870079
Groud storey	1.2(DL+LL+EQ+X)	673302.7783	-0.000003081	16272130

Table 4.9 Mivan building Storey force with soft soil at zone III

TABLE: Storey Forces				
Storey	Load Case/Combo	P	VX	MX
		kN	kN	kN-m
Storey40	1.2(DL+LL+EQ+X)	9071.2148	-217.7521	218378.8957
Storey39	1.2(DL+LL+EQ+X)	21312.4633	-584.2878	513237.3827
Storey38	1.2(DL+LL+EQ+X)	33553.7174	-932.7261	808095.9533
Storey37	1.2(DL+LL+EQ+X)	45791.3615	-1263.4153	1102901.001
Storey36	1.2(DL+LL+EQ+X)	58029.0064	-1576.9288	1397706.059
Storey35	1.2(DL+LL+EQ+X)	70266.6511	-1873.7246	1692511.114
Storey34	1.2(DL+LL+EQ+X)	82504.2959	-2154.2609	1987316.169
Storey33	1.2(DL+LL+EQ+X)	94741.9404	-2418.9955	2282121.222
Storey32	1.2(DL+LL+EQ+X)	106979.5849	-2668.3864	2576926.274
Storey31	1.2(DL+LL+EQ+X)	119217.2289	-2902.8918	2871731.32
Storey30	1.2(DL+LL+EQ+X)	131454.8732	-3122.9696	3166536.369
Storey29	1.2(DL+LL+EQ+X)	143692.5176	-3329.0778	3461341.421
Storey28	1.2(DL+LL+EQ+X)	155930.162	-3521.6745	3756146.472
Storey27	1.2(DL+LL+EQ+X)	168167.8073	-3701.2177	4050951.535
Storey26	1.2(DL+LL+EQ+X)	180405.4519	-3868.1653	4345756.588
Storey25	1.2(DL+LL+EQ+X)	192643.0959	-4022.9755	4640561.634
Storey24	1.2(DL+LL+EQ+X)	204880.7402	-4166.1062	4935366.683
Storey23	1.2(DL+LL+EQ+X)	217118.3845	-4298.0155	5230171.733
Storey22	1.2(DL+LL+EQ+X)	229356.0291	-4419.1614	5524976.786
Storey21	1.2(DL+LL+EQ+X)	241593.6727	-4530.0018	5819781.828
Storey20	1.2(DL+LL+EQ+X)	253831.3176	-4630.9948	6114586.885
Storey19	1.2(DL+LL+EQ+X)	266068.962	-4722.5985	6409391.936
Storey18	1.2(DL+LL+EQ+X)	278306.6064	-4805.2708	6704196.988
Storey17	1.2(DL+LL+EQ+X)	290544.2505	-4879.4697	6999002.034
Storey16	1.2(DL+LL+EQ+X)	302781.895	-4945.6534	7293807.086
Storey15	1.2(DL+LL+EQ+X)	315019.539	-5004.2797	7588612.132
Storey14	1.2(DL+LL+EQ+X)	327257.1836	-5055.8068	7883417.186
Storey13	1.2(DL+LL+EQ+X)	339494.828	-5100.6926	8178222.235
Storey12	1.2(DL+LL+EQ+X)	351732.4722	-5139.3951	8473027.284
Storey11	1.2(DL+LL+EQ+X)	363970.1164	-5172.3724	8767832.332
Storey10	1.2(DL+LL+EQ+X)	376207.7608	-5200.0825	9062637.383
Storey9	1.2(DL+LL+EQ+X)	388445.4049	-5222.9834	9357442.429
Storey8	1.2(DL+LL+EQ+X)	400683.0491	-5241.5332	9652247.478
Storey7	1.2(DL+LL+EQ+X)	412920.6935	-5256.1898	9947052.528
Storey6	1.2(DL+LL+EQ+X)	425158.3377	-5267.4112	10241858
Storey5	1.2(DL+LL+EQ+X)	437395.982	-5275.6555	10536663
Storey4	1.2(DL+LL+EQ+X)	449633.626	-5281.3808	10831468
Storey3	1.2(DL+LL+EQ+X)	461871.2702	-5285.0449	11126273
Storey 2	1.2(DL+LL+EQ+X)	474111.3748	-5287.1063	11421099
Storey 1	1.2(DL+LL+EQ+X)	486351.4794	-5288.0224	11715925
Ground storey	1.2(DL+LL+EQ+X)	498591.5841	-5288.2515	12010752



Graph 4.3Storey Force Vs. Different Type of Building in soft Soil

V. CONCLUSION

In the present study, comparative analysis of RCC building with Regular RCC building, Mivan wall building and braced building it has been carried out for different number of storey. The buildings are analyses for earthquake zone III with soft soil, medium soil and hard soil. Comparison has been made on different structural parameters viz. base shear, time period and storey force etc.

Based on the analysis results following conclusions have been drawn.

1. Analysis of building i. e Regular RCC, Braced and Mivan building with soft soil condition with zone III. The Max. Storey Displacement, Mivan building structure Storey Displacement is decreased to 86% as compare toRegular RCC and Braced Building .
2. Comparing Regular RCC building, Braced RCC building and mivan building with soft soil condition the modal time period is maximum in normal and Braced RCC building as compare to mivan building. The modal time period increase 2.690 times as compare Normal and Braced RCC building, but quite shows good performance in time periods.
3. Analysis of Regular RCC, Damper and Mivan building in zone III with soft soil , the Storey Forces of Braced Building is 20-25% more than Regular RCC Building and the Storey Forces of Regular RCC Building is 11-13% more than Mivan Building.
4. Analysis of Regular RCC, Damper and Mivan building in zone III with soft soil but overall performance of Mivan building is better than Normal and Braced RCC building.

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