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TO ANALYZE SEISMIC DESIGN OF A RCC TWISTED BUILDING FOR ZONE-III WITH DIFFERENT ANGLE TWIST

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***ABSTRACT*:**

This paper represents the structural behaviour of RCC twisted building subjected to seismic loads with private swimming of the high rise twisted building using ETab. In a twisted tall building various rate of twist and positions of swimming pools for RCC twisted building will be analyzed. The different rate of twist 1.5, 2, 2.5, 3 & 3.5 degree per floor for twisted building are considered. The modelling and analysis will be done using ETab Results obtained will be plotted for parameters such as storey displacement, storey drift and base shear. The aim of this project is to achieve the optimum swimming pool position and angle of twist of twisted building for 1.5, 2, 2.5, 3 and 3.5 degree per floor angle of twist for different storey.

***Keywords**: Twisted Building, Swimming Pool, ETab, Seismic Analysis,*

1. INTRODUCTION

An earthquake is a natural tragedy that has claimed millions of lives throughout known and unwritten history. An earthquake is a disruptive disturbance that generates surface shaking owing to subsurface movement along a fault line or volcanic activity. The produced forces are irresponsible and only last a brief time. Humans are puzzled by its ambiguity in terms of occurrence time and nature. However, with the advancement of knowledge throughout the years, a degree of probabilistic predictability has been reached.

The ability to predict the recurrence and strength of earthquakes for a certain region has improved, but this only solves one half of the problem: knowing what's coming! The second phase is structural seismic design - to resist the storm! This component of the problem has evolved throughout the previous century, with advancements in design philosophy and methodology continually investigated, proposed, and implemented. This chapter introduces the notion of foundation isolation for earthquake-resistant structure design. The usefulness of seismic isolation is proved by modeling and analysis of multi-storey buildings, bridges, and pools.

The trend of RCC high rise structures has increased nowadays in India. Many different amenities like swimming pool, garden etc. have been provided in high story building which is very attractive from an aesthetical point of view but it is dangerous from a structural point of view.

The swimming pool is a heavy weight and the detailing is complicated, but it is not much different than other structural loads. If the pool were to break for some reason and all the water rushed out, it would destroy some interior and possibly some windows. In most cases, the extra water mass will help the building resist earthquakes by acting as a liquid mass dampener. Tall buildings carry very large gravity and lateralloads.

Twisted tall buildings of various heights, height to width aspect ratios and rates of twist are designed and their structural efficiency is investigated. Due to the unique geometric configurations of twisted forms, structural buildings are quite different from that employed for tall buildings of rectangular box forms. Twisted forms involve not only structural but also architectural and constructional challenges.

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employed for tall buildings of rectangular box forms. Twisted forms involve not only structural but also architectural and constructional challenges.

- This project investigates about the optimum twist angle and position of swimming pool of the RCC building.
- To increase value in certain buildings there are associated risks that we take like providing swimming pool.
- The amenities like swimming pool provided in high storey building are attractive from aesthetic point of view.
- This project represents the structural behaviour of RCC twisted building subjected to static load.
- In this project non-linear static method is being used.

2. PROBLEM STATEMENT

A twisted RCC building exposed to seismic loads utilizing ETab. The twist rate of RCC twisted buildings will be studied. Each level grows at its own rate. ETab will model. Base shear and storey displacement data will be shown. This project's goal is to find the best swimming pool position and angle.

Aim

"To find optimum angle of twist and position of swimming pool of RCC twisted buildings under seismic loads."

Objectives

- Comparatively Study Design and analysis of RCC twisted building with private swimming pools for G+20, G+40, by using ETab
- To study RCC twisted building for 1.5, 2, 2.5, 3, 3.5 degree per floor angle of twist for G+20,G+40,
- To study RCC twisted building for swimming pool positions on alternate floor
- To study the parameters such as storey displacement, storey drift and baseshear etc

3. RESEARCH METHODOLOGY

The Methods of Earthquake Analysis

Two broad approaches of earthquake analysis of multi – storied structures are

A. **Static Analysis –**

B. II) Equivalent Static Method – its linear static method. In this method formulas are developed to approximately represent behavior of regular structures. Base shear is calculated and distributed to various floor levels. This method is not used for irregular structures.

- **Response Spectrum Method** – It is a linear dynamic method. This method estimates peak values of response quantities. It can be used for any type of building and at all locations.
- The work consists of G+20, G+40 buildings and each building has given angle of twist and swimming pool positions. For each angle of twist there will be seven buildings considering swimming pool positions.
- For modeling and analysis of buildings ETab will be used.
- The parameters storey displacement, storey drift and base shear will be checked and their graphical representation will be made.
  - Results
  - Conclusion

Design Input Data

Material grade m50 fe500

- Beam = 0.815X0.4m
- Colum = 0.18X0.8m
- Colum = 1.3X1.3m
- Wall = 0.3m
- Wall = 0.4m
- Load pattern :-
  - Dead load
  - Live load
  - Super red load

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- 4 Earth quake: x direction
- Earth quake: Y direction
- 6)Wind load: x direction
- 7) Wind load: Y direction
- Response spectrum analysis

4. DESIGN & MODELLING

Response spectrum analysis:-

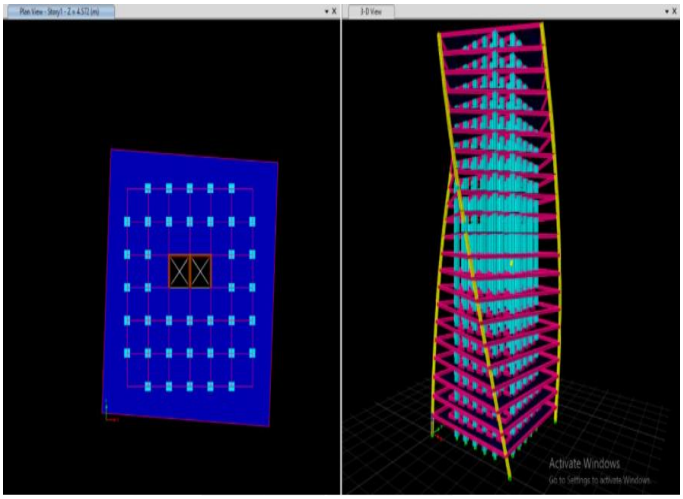

Figure1.1: 2 Degree Model design

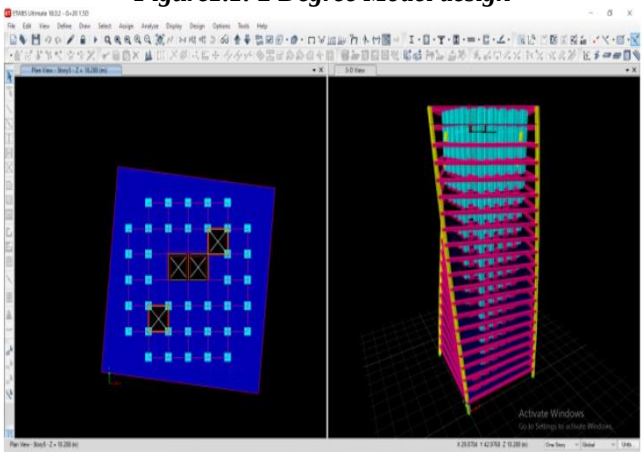

Figure1.2: 1.5 Degree Model design

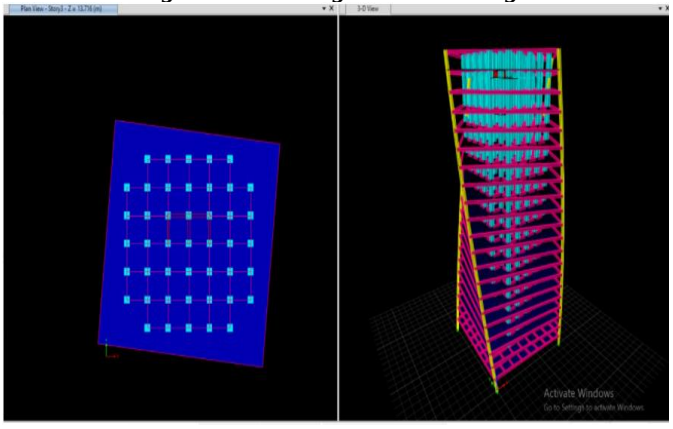

Figure1.3: 2.5 Degree Model design

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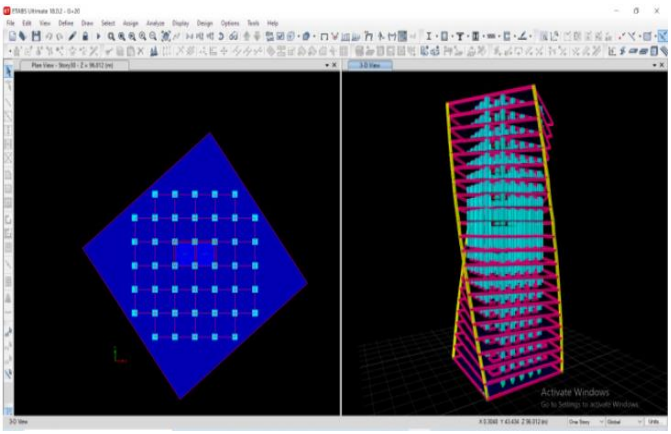

Figure1.4: 3 Degree Model design

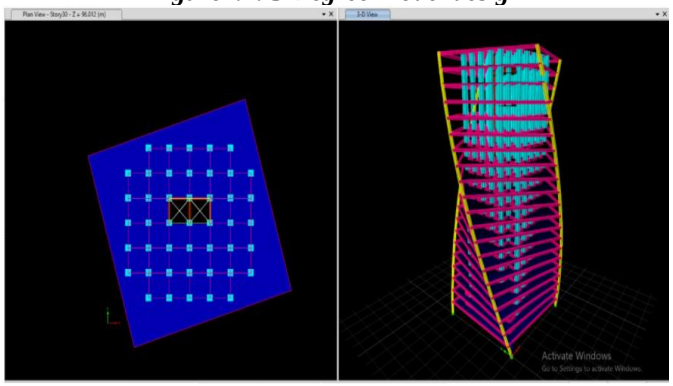

Figure1.5: 3.5 Degree Model design

5. RESULT & DISCUSSION

Storey Displacement

Table1.1: Maximum Storey Displacement

MAXIMUM STORY DISPLACEMENT					
STORY	1.5 D	2.0 D	2.5 D	3.0 D	3.5 D
BASE	0	0	0	0	0
STOREY 1	0.007826	0.010871	0.010439	0.010373	0.010111
STOREY 2	0.021913	0.029927	0.02895	0.028899	0.028305
STOREY 3	0.038784	0.052384	0.050964	0.051082	0.050196
STOREY 4	0.057276	0.076441	0.074616	0.075017	0.073881
STOREY 5	0.077074	0.102076	0.09995	0.100644	0.099255
STOREY 6	0.097442	0.12832	0.126012	0.126925	0.125194
STOREY 7	0.118302	0.155319	0.152852	0.153915	0.151748
STOREY 8	0.139103	0.182189	0.179501	0.180689	0.177994
STOREY 9	0.159909	0.209147	0.206493	0.207321	0.203906
STOREY 10	0.180328	0.23561	0.232928	0.233213	0.228803
STOREY 11	0.200431	0.261755	0.260082	0.258464	0.252742
STOREY 12	0.219785	0.287126	0.283779	0.282577	0.275253
STOREY 13	0.23839	0.311937	0.309597	0.305578	0.296358
STOREY 14	0.256441	0.335806	0.332839	0.327187	0.315739
STOREY 15	0.273905	0.358799	0.353382	0.347439	0.333484
STOREY 16	0.290434	0.380697	0.376096	0.36607	0.349361
STOREY 17	0.306007	0.4015	0.393854	0.383069	0.363463
STOREY 18	0.320482	0.420995	0.413982	0.398302	0.375634
STOREY 19	0.333793	0.439096	0.428531	0.411737	0.385969
STOREY 20	0.345764	0.455488	0.443305	0.423135	0.394155
STOREY 21	0.356105	0.469355	0.455509	0.431967	0.400068

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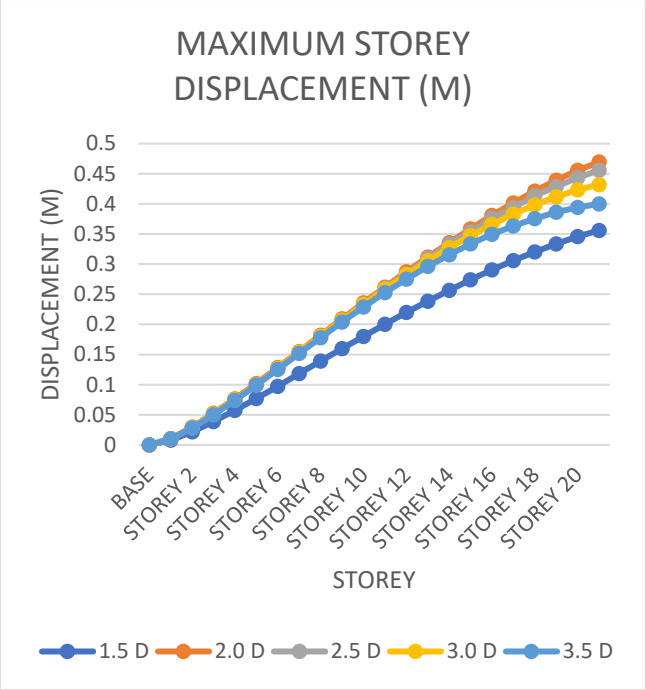

Graph1.1: Maximum Storey Displacement

Storey Stiffness

Table1.2: Storey Stiffness

MAXIMUM STORY STIFFNESS					
STORY	1.5 D	2.0 D	2.5 D	3.0 D	3.5 D
BASE	0	0	0	0	0
STOREY 1	8983249	5834606	5951474	5624788	5411247
STOREY 2	13677186	9192840	9268659	8421170	8062520
STOREY 3	4200058	2738482	2771621	2612386	2489538
STOREY 4	11272205	7523149	7558529	7025351	6682081
STOREY 5	3720041	2395097	2418585	2304928	2190744
STOREY 6	10557219	6752164	6791559	6412949	6098333
STOREY 7	3529642	2188658	2218778	2133050	2030457
STOREY 8	10139622	6340067	6349939	6020319	5688625
STOREY 9	3408276	2072753	2066994	2026377	1930434
STOREY 10	9830047	6105459	6055533	5748765	5463091
STOREY 11	3310616	1996202	2017826	1940511	1875497
STOREY 12	9655483	5977616	5998779	5726804	5458274
STOREY 13	3271079	1940678	1953992	1911379	1855916
STOREY 14	9454883	5883059	5791902	5715927	5526493
STOREY 15	3122760	1889671	1872090	1868699	1838983
STOREY 16	9300014	5679889	5509233	5603154	5480627
STOREY 17	2964887	1773377	1754852	1776520	1771011
STOREY 18	8595911	5086785	4936588	5183900	5129346
STOREY 19	2536232	1477177	1466834	1512942	1532359
STOREY 20	6298010	3478627	3466862	3799235	3935475
STOREY 21	1192626	672168.3	770685.7	793757.2	877197.4

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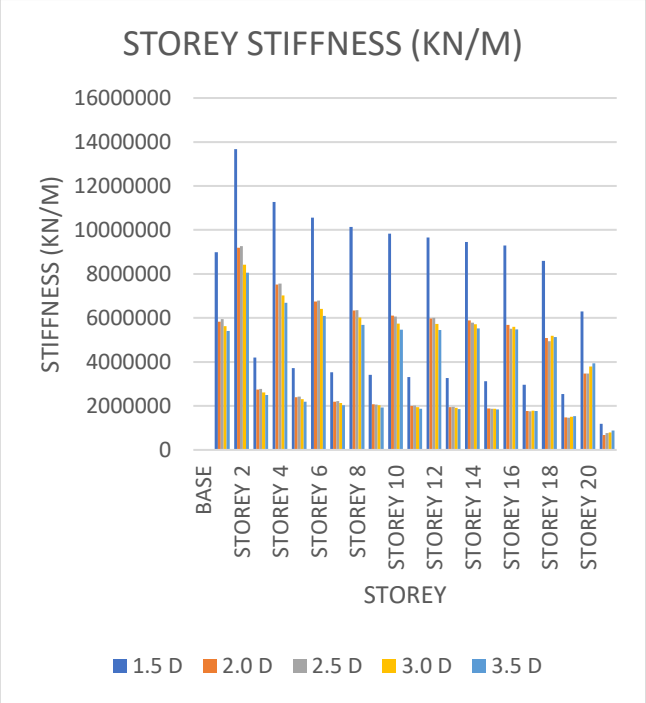

Graph1.2: Storey Stiffness

Table1.3: Maximum Overturning Moment

MAXIMUM OVERTURNING MOMENT					
STORY	1.5 D	2.0 D	2.5 D	3.0 D	3.5 D
BASE	7992972	5039763	4843236	4767568	4664354
STOREY 1	7435627	4687095	4505976	4435982	4341697
STOREY 2	6895133	4350527	4183723	4119615	4034637
STOREY 3	6374621	4032478	3878758	3820733	3745451
STOREY 4	5875781	3733361	3591651	3539840	3474630
STOREY 5	5398183	3451657	3321095	3275540	3220682
STOREY 6	4940119	3184284	3064331	3024946	2980595
STOREY 7	4498840	2927579	2817974	2784565	2750612
STOREY 8	4071657	2677666	2578442	2550692	2526897
STOREY 9	3655903	2431338	2362985	2320197	2305982
STOREY 10	3249881	2186034	2108305	2090588	2085318
STOREY 11	2851942	1940011	1873594	1860094	1862830
STOREY 12	2462034	1692707	1637947	1628102	1637893
STOREY 13	2079790	1444181	1401303	1394517	1410167
STOREY 14	1707519	1196794	1165716	1161407	1181639
STOREY 15	1348158	953289.2	933529	931151.5	954492.7
STOREY 16	1009940	720176.1	710627.1	709652.1	734349.9
STOREY 17	700400.9	503422.3	502382.4	502322.6	526574.4
STOREY 18	432851.6	313656	318494.9	318922	340431.9
STOREY 19	217695.6	159003.4	166592	167019.8	183761.7
STOREY 20	70171.61	51918.8	62009.42	58253.51	67593.2
STOREY 21	0	0	2.18E-05	1.04E-05	6.43E-06

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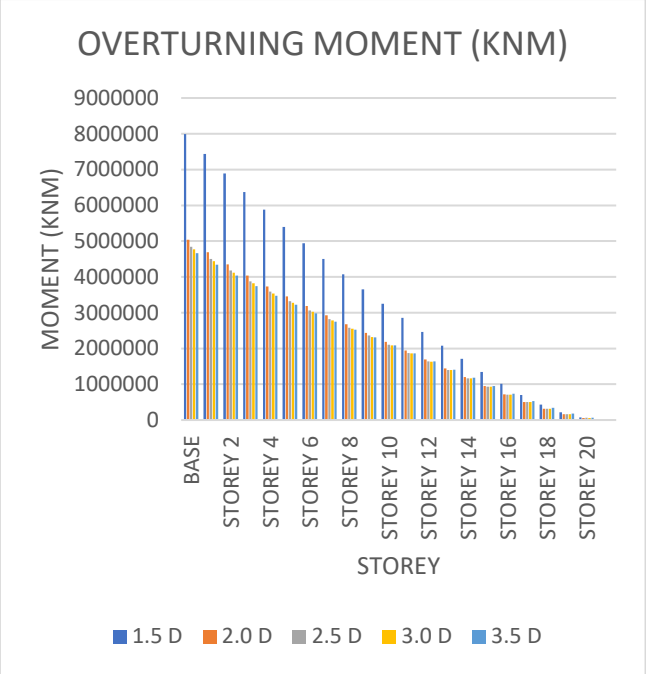

Graph1.3: Maximum Overturning Moment

Table1.4: Maximum Storey Acceleration

MAXIMUM STORY ACCELERATION (M/SEC2)					
STORY	1.5 D	2.0 D	2.5 D	3.0 D	3.5 D
BASE	0	0	0	0	0
STOREY 1	0.878	0.966	0.954	0.954	0.944
STOREY 2	2.282	2.431	2.41	2.425	2.411
STOREY 3	3.693	3.845	3.834	3.868	3.854
STOREY 4	4.938	5.032	5.034	5.093	5.085
STOREY 5	5.938	5.961	5.987	6.066	6.073
STOREY 6	6.627	6.585	6.642	6.742	6.769
STOREY 7	6.979	6.898	6.995	7.104	7.157
STOREY 8	7.036	6.95	7.086	7.194	7.269
STOREY 9	6.887	6.821	6.973	7.078	7.168
STOREY 10	6.693	6.668	6.838	6.921	7.009
STOREY 11	6.55	6.55	6.752	6.79	6.866
STOREY 12	6.463	6.437	6.616	6.676	6.735
STOREY 13	6.324	6.189	6.409	6.439	6.488
STOREY 14	6.08	5.772	6.001	6.035	6.066
STOREY 15	5.774	5.23	5.428	5.491	5.488
STOREY 16	5.638	4.899	5.087	5.111	5.026
STOREY 17	5.931	5.134	5.215	5.222	5.006
STOREY 18	6.79	6.107	6.123	6.043	5.685
STOREY 19	8.063	7.573	7.497	7.382	6.91
STOREY 20	9.43	9.147	9.056	8.865	8.301
STOREY 21	10.591	10.489	10.46	10.173	9.57

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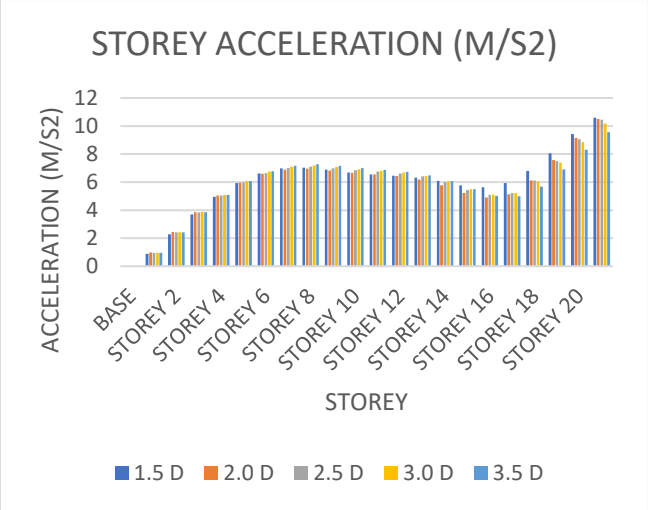
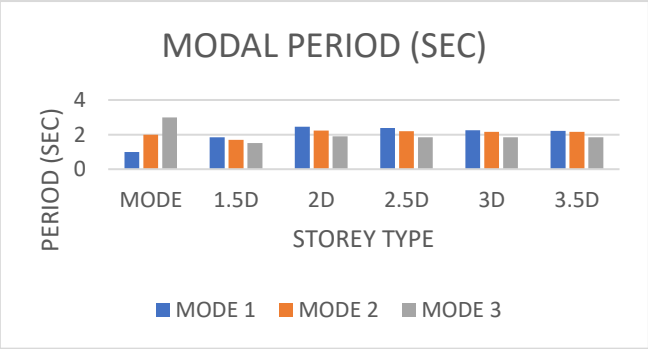


Graph1.4: Maximum Storey Acceleration

Table1.5: Modal periods

MODAL PERIODS (SEC)					
MODE	1.5D	2D	2.5D	3D	3.5D
1	1.853	2.457	2.387	2.26	2.216
2	1.687	2.224	2.188	2.165	2.161
3	1.519	1.894	1.851	1.837	1.838



Graph1.5: Modal periods

Design and Modelling for G+ 40 Storey's

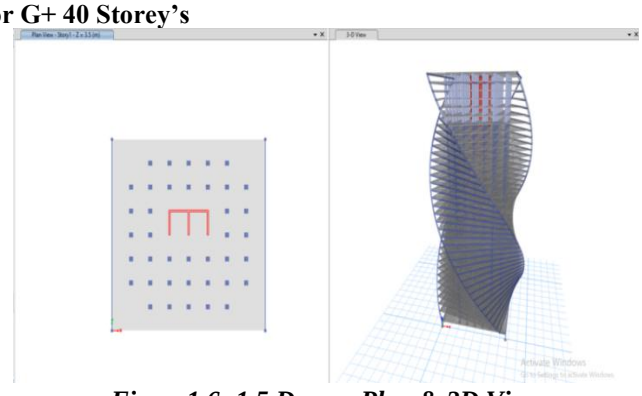


Figure1.6: 1.5 Degree Plan & 3D View

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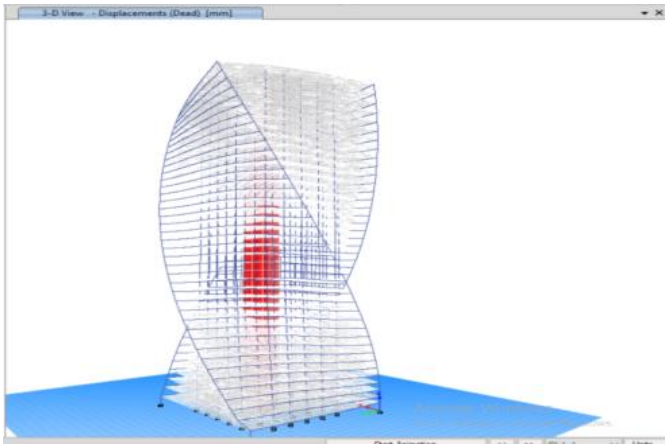

Figure1.7: 2 Degree Model design

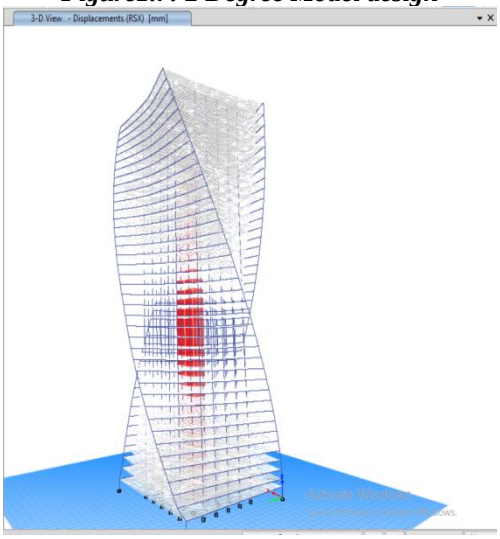

Figure1.8: 2.5 Degree Displacement due to dead load

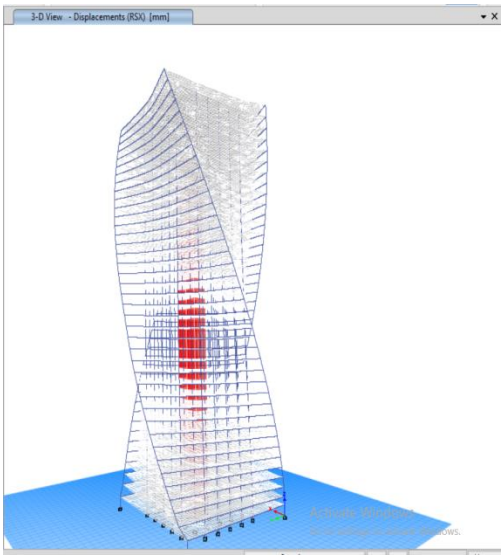

Figure1.9: 3 Degree Displacement due to earthquake load X direction

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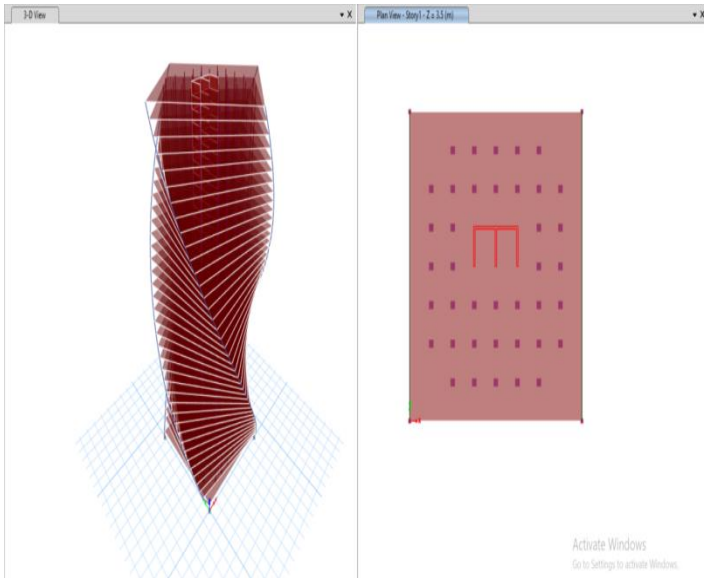

Figure1.10: Plan & 3D View of 3.5 Degree

Analysis For G+40 Storey Building

Table1.6: Story Displacement

STOREY	1.5D	2D	2.5D	3D	3.5D
Story40	162.125	154.212	162.125	156.815	150.672
Story39	155.443	153.082	159.443	154.082	148.138
Story38	154.632	152.016	156.632	151.2	145.529
Story37	153.532	151.962	153.732	148.196	142.762
Story36	151.737	149.153	150.737	145.052	139.84
Story35	146.65	148.032	147.65	141.779	136.758
Story35	143.408	148.159	144.408	138.36	133.502
Story34	142.454	145.361	141.464	134.798	130.073
Story33	137.486	141.56	138.496	131.458	126.484
Story32	133.301	139.205	135.405	128.286	122.753
Story31	130.186	134.986	132.186	124.98	118.888
Story30	129.735	129.835	128.835	121.536	115.34
Story29	124.323	125.343	125.343	117.947	111.951
Story28	121.759	121.709	121.709	114.208	108.433
Story27	117.928	119.21	117.928	111.813	104.783
Story26	113.998	111.238	113.998	106.43	101.004
Story25	109.918	108.391	109.918	102.372	97.099
Story24	105.68	108.433	105.68	98.406	93.069
Story23	101.288	104.783	101.288	94.294	88.919
Story22	96.744	101.004	96.744	90.11	84.648
Story21	92.046	97.099	92.046	85.834	80.266
Story20	87.211	93.069	87.211	81.465	76.137
Story19	82.236	88.919	82.236	76.996	71.991
Story18	77.132	84.648	77.132	72.415	67.788
Story17	71.908	80.266	71.908	67.726	63.514
Story16	66.566	76.137	66.566	62.932	59.171
Story15	61.132	71.991	61.132	58.03	54.751
Story14	57.65	55.89	57.65	55.89	52.748
Story13	55.633	53.038	55.633	53.038	50.239
Story12	49.097	47.966	50.087	47.966	45.644
Story11	43.548	42.841	44.528	42.841	40.961

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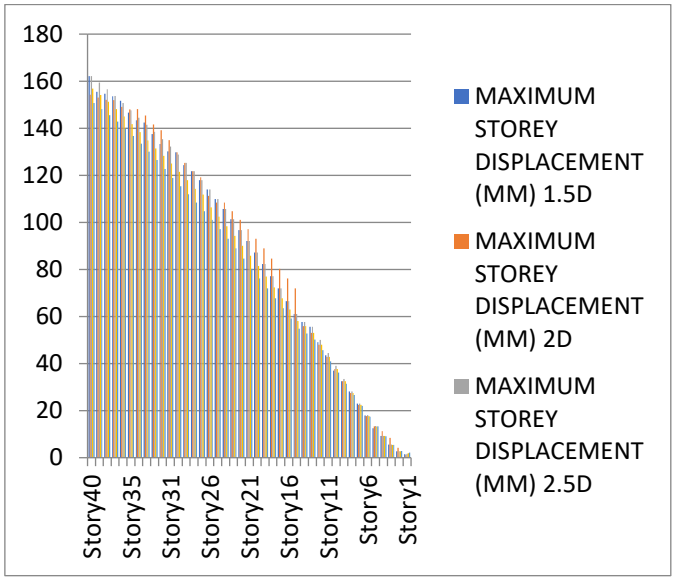
Story10	36.991	37.685	38.991	37.685	36.219
Story9	32.521	32.54	33.521	32.54	31.443
Story8	28.143	27.456	28.163	27.456	26.684
Story7	22.94	22.493	22.98	22.493	21.975
Story6	17.999	17.725	18.042	17.725	17.389
Story5	12.44	13.258	13.44	13.245	13.369
Story4	9.277	11.298	9.287	9.176	9.087
Story3	5.562	8.358	5.572	5.474	5.421
Story2	2.655	4.201	2.755	2.739	2.793
Story1	1.518	1.016	1.618	1.92	2.127
Base	0	0	0	0	0



Graph1.6: Story Displacement

Table1.7: Maximum Storey Drift

Storey	**1.5D**	**2D**	**2.5D**	**3 D**	**3.5D**
Story40	0	0	0	0	0
Story39	2960.486	2964.2352	2956.843	2964.235	2980.679
Story38	207733.6	8736.0167	8799.023	8826.017	8877.878
Story37	227549	17152.6848	16991.27	17052.69	17157.26
Story36	248115.3	27140.9891	27017.82	27130.97	27303.7
Story35	269364	38593.5354	38409.54	38593.54	38847.88
Story35	78379.15	51045.0447	50770.13	51045.04	51392.44
Story34	92542.66	64184.5023	63798.9	64184.5	64634.36
Story33	107138.1	77819.5962	77305.65	77819.6	78379.15
Story32	122249.1	91868.646	91212.71	91868.65	92542.66
Story31	137994	106347.7819	105542	106347.8	107138.1
Story30	154488.1	121344.1364	120388.1	121344.1	122249.1
Story29	171814.2	136979.808	135881.5	136979.8	137994
Story28	190006.2	153374.3878	152150	153374.4	154488.1
Story27	209048	170614.7724	169287.8	170614.8	171814.2
Story26	228886.3	188738.6541	187338.2	188738.7	190006.2
Story25	249449.9	207733.5844	206292.4	207733.6	209048
Story24	270669.3	227548.9928	226101.7	227549	228886.3
Story23	292492.3	248115.3348	246697.4	248115.3	249449.9
Story22	314890.9	269364.0109	268010.4	269364	270669.3

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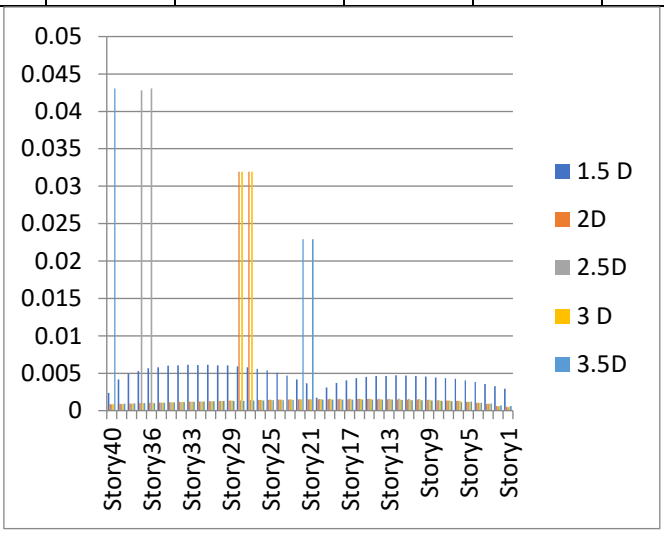
Story21	337859.7	291242.4224	289987	291242.4	292492.3
Story20	349872.2	313721.0722	312596	313721.1	314890.9
Story19	361407.3	336792.0671	335827.2	336792.1	337859.7
Story18	385544.2	345216.8	346278.3	345216.8	349872.2
Story17	410270.9	360460.7198	359683	360460.7	361407.3
Story16	435570.4	384733.6549	384166.6	384733.7	385544.2
Story15	461406.9	409607.4104	409270.5	409607.4	410270.9
Story14	487730.2	435061.0444	434969.3	435061	435570.4
Story13	514444.1	461054.8351	461218.6	461054.8	461406.9
Story12	541730.1	487535.1953	487960	487535.2	487730.2
Story11	569357.7	514444.089	515131.1	514444.1	514485.4
Story10	597312.8	541730.0656	542676	541730.1	541624
Story9	625601.7	569357.701	570555.6	569357.7	569113.4
Story8	654245.7	597312.7686	598752.6	597312.8	596941.8
Story7	683270.5	625601.7335	627270.8	625601.7	625118.2
Story6	712695.7	654245.697	656129.6	654245.7	653665.6
Story5	742525.4	683270.4905	685353.6	683270.5	682611.6
Story4	772744	722685.6484	714961.9	712695.7	711976.5
Story3	741764.7	754225.3869	743964	742525.4	741764.7
Story2	771959.9	782843.9955	775329.6	772744	771959.9
Story1	802527.1	813327.5282	806040.8	803317.5	802527.1
Base	834486.6	834102.1422	837049.9	834202.1	833428.9



Graph1.7: Maximum Story Drift

Table1.8: Maximum Overturning Moment

Storey	1.5D	2 D	2.5D	3 D	3.5D
Story40	287158.08	297256.36	306284.099	297256.36	348691.845
Story39	560721.497	560821.567	578621.886	560821.567	671650.784
Story38	747921.316	758819.366	781298.481	758819.366	929913.983
Story37	888356.067	898465.078	923379.235	898465.078	1131652.505
Story36	979123.862	989222.945	1014361.716	989222.945	1280992.007
Story35	1079111.621	1044931.368	1068137.273	1044931.368	1385371.433
Story34	1104453.558	1079111.621	1099869.984	1079111.621	1452667.107
Story33	1130033.346	1104453.558	1121233.793	1104453.558	1494472.066
Story32	1161037.127	1130033.346	1141906.956	1130033.346	1524389.027
Story31	1198247.724	1161037.127	1167748.353	1161037.127	1551034.301
Story30	1239115.005	1198247.724	1199175.294	1198247.724	1578846.675
Story29	1281393.026	1239115.005	1233924.156	1239115.005	1589231.242

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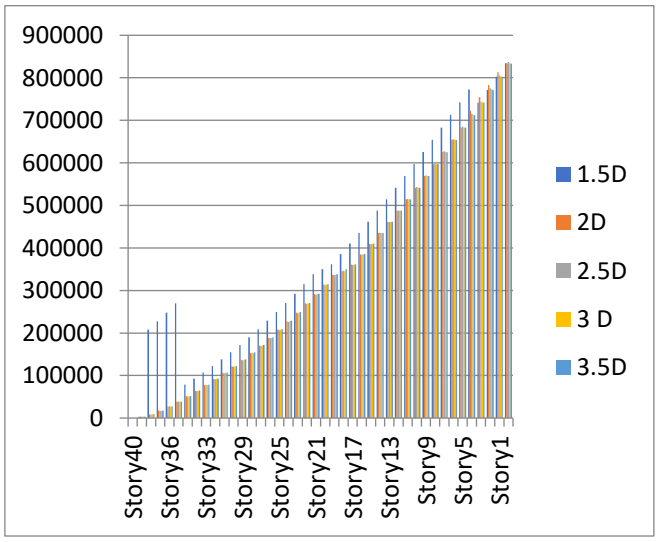
Story28	1319428.848	1281393.026	1268177.622	1281393.026	1614544.45
Story27	1349169.257	1319428.848	1297588.953	1319428.848	1657695.595
Story26	1371685.252	1349169.257	1320981.642	1349169.257	1716674.364
Story25	1490041.254	1371685.252	1337871.129	1371685.252	1783329.638
Story24	1519519.535	1392055.439	1348903.463	1392055.439	1855514.744
Story23	1550386.024	1408123.873	1356446.027	1408123.873	1929824.119
Story22	1580923.599	1423241.97	1363745.147	1423241.97	2001801.857
Story21	1611729.281	1441525.052	1374402.53	1441525.052	2070544.725
Story20	1642748.988	1463941.45	1389251.333	1463941.45	2134306.071
Story19	1674811.262	1490041.254	1407588.936	1490041.254	2191713.209
Story18	1712326.598	1519519.535	1430082.08	1519519.535	2244583.484
Story17	1759957.185	1550386.024	1454848.394	1550386.024	2295294.048
Story16	1131652.505	1580923.599	1478902.631	1580923.599	2346203.322
Story15	1280992.007	1611729.281	1503631.21	1611729.281	2402162.127
Story14	1385371.433	1642748.988	1530087.086	1642748.988	2465653.332
Story13	1452667.107	1674811.262	1559309.121	1674811.262	2544076.723
Story12	1494472.066	1712326.598	1593853.773	1712326.598	2641581.695
Story11	1524389.027	1759957.185	1638200.864	1759957.185	2760971.254
Story10	1551034.301	1823267.35	1699291.53	1823267.35	2906892.473
Story9	1578846.675	1910839.325	1783102.248	1910839.325	3086398.385
Story8	1589231.242	2028376.923	1896184.231	2028376.923	3300603.981
Story7	1614544.45	2188360.874	2051195.722	2188360.874	3559725.82
Story6	1783102.248	2409810.572	2265177.447	2409810.572	3889068.083
Story5	1896184.231	2724800.428	2568951.444	2724800.428	4351884.545
Story4	2051195.722	3203725.52	3044506.349	3203725.52	4993396.758
Story3	2265177.447	4076478.869	3878765.166	4076478.869	6122139.692
Story2	2568951.444	6170216.916	5820617.937	6170216.916	8574127.417
Story1	3044506.349	8403431.29	9180404.26	8403431.29	8091486.113
Base	0	0	0	0	0



Graph1.9: Maximum Overturning Moment

Table1.10: Maximum Story Stiffness

STOREY	1.5 D	2D	2.5D	3 D	.5D
Story40	0.002378	0.000857	0.000842	0.000867	0.043048
Story39	0.004171	0.000899	0.000889	0.000912	0.000923
Story38	0.004922	0.000956	0.000922	0.000956	0.000959

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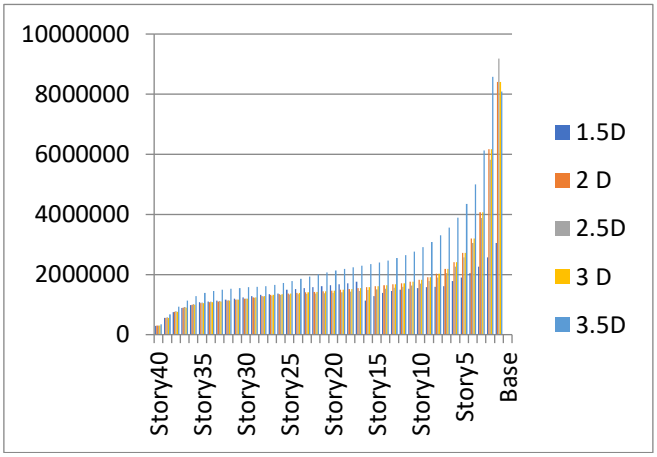
Story37	0.005282	0.001002	0.042793	0.001002	0.000989
Story36	0.005646	0.001043	0.043067	0.001043	0.001018
Story35	0.005807	0.001087	0.001028	0.001087	0.001046
Story35	0.006017	0.001128	0.001078	0.001128	0.001099
Story34	0.006044	0.001166	0.001121	0.001166	0.001146
Story33	0.006141	0.0012	0.001171	0.0012	0.001187
Story32	0.006111	0.001231	0.001218	0.001231	0.001223
Story31	0.006144	0.001258	0.001259	0.001258	0.001254
Story30	0.006059	0.001292	0.001302	0.001292	0.001283
Story29	0.006046	0.001331	0.001339	0.001331	0.0013
Story28	0.005913	0.031947	0.001376	0.031947	0.001317
Story27	0.005809	0.031947	0.001409	0.031947	0.001329
Story26	0.005599	0.001416	0.001436	0.001416	0.00135
Story25	0.005385	0.001443	0.001462	0.001443	0.00138
Story24	0.005051	0.001463	0.001484	0.001463	0.001404
Story23	0.004679	0.001484	0.001502	0.001484	0.001425
Story22	0.004179	0.001495	0.001517	0.001495	0.022923
Story21	0.003654	0.001501	0.001535	0.001501	0.022923
Story20	0.001712	0.001503	0.00156	0.001503	0.001467
Story19	0.003082	0.0015	0.001581	0.0015	0.001472
Story18	0.003694	0.001519	0.001597	0.001519	0.001471
Story17	0.004054	0.001533	0.001607	0.001533	0.001458
Story16	0.004351	0.001538	0.001609	0.001538	0.001454
Story15	0.004494	0.001537	0.001602	0.001537	0.001463
Story14	0.00463	0.001524	0.001607	0.001524	0.001463
Story13	0.004653	0.001503	0.001607	0.001503	0.001452
Story12	0.004704	0.001488	0.001597	0.001488	0.00143
Story11	0.00467	0.001481	0.001574	0.001481	0.001393
Story10	0.004659	0.00146	0.001539	0.00146	0.001367
Story9	0.00454	0.001423	0.001486	0.001423	0.00135
Story8	0.004425	0.001365	0.001414	0.001365	0.001313
Story7	0.004345	0.001324	0.001365	0.001324	0.001245
Story6	0.004255	0.001282	0.001317	0.001282	0.001149
Story5	0.004057	0.001163	0.001188	0.001163	0.001225
Story4	0.003847	0.001059	0.001062	0.001059	0.001048
Story3	0.003575	0.000918	0.000898	0.000918	0.000946
Story2	0.003274	0.000626	0.000589	0.000626	0.000715
Story1	0.002909	0.000549	0.000462	0.000549	0.000608
Base	0	0	0	0	0



Graph1.10: Maximum Story Stiffness

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STOEY	1.5D	2D	2.5D	3 D	3.5D
Story40	689.41	589.39	586.31	642.51	574.39
Story39	509.78	567.7	521.9	567.7	521.9
Story38	429.78	476.19	461.33	486.19	461.33
Story37	378.67	368.94	350.8	402.45	395.27
Story36	379.07	325.09	277.09	321.51	327.91
Story35	379.37	389.79	221.56	250.9	265.93
Story35	373.84	265.38	207.39	21.16	220.27
Story34	359.08	321.51	213.72	215.77	214.1
Story33	338.73	250.9	218.98	216.52	226.54
Story32	318.53	21.16	250.93	215.19	270.57
Story31	305.87	215.77	299.35	255.83	321.44
Story30	307.3	216.52	344.29	299.93	368.6
Story29	324.75	215.19	381.1	337.7	405.41
Story28	373.75	255.83	406.85	364.68	428.4
Story27	337.49	299.93	419.81	378.67	435.73
Story26	303.27	418.29	419.52	379.07	427.48
Story25	277.76	461.33	406.82	379.37	405.55
Story24	284.31	395.27	384.21	373.84	373.75
Story23	305.31	327.91	356.18	359.08	337.49
Story22	337.7	265.93	329.46	338.73	303.27
Story21	375.34	220.27	312.09	318.53	277.76
Story20	411.97	214.1	310.58	305.87	284.31
Story19	442.34	226.54	326.24	307.3	305.31
Story18	463.05	270.57	354.33	324.75	337.7
Story17	472.34	321.44	387.55	354.4	375.34
Story16	469.72	368.6	419.29	389.36	411.97
Story15	460.25	405.41	444.77	422.99	442.34
Story14	455.41	277.09	461.13	450.28	463.05
Story13	430.26	221.56	466.88	467.91	472.34
Story12	395.12	207.39	461.69	474.48	469.72
Story11	351.66	213.72	445.87	469.39	460.25
Story10	301.08	218.98	435.25	453.11	455.41
Story9	246.87	250.93	420.08	426.5	430.26
Story8	445.87	299.35	385.26	390.56	395.12
Story7	435.25	344.29	342.54	346.64	351.66
Story6	420.08	381.1	293.4	296.29	301.08
Story5	385.26	219.65	239.63	241.39	246.87
Story4	342.54	182.24	183.32	184.12	187.14
Story3	293.4	125.12	126.52	126.63	128.18
Story2	69.21	70.98	71.73	71.54	71.61
Story1	24.69	25.49	25.69	28.46	33.1
Base	0	0	0	0	0

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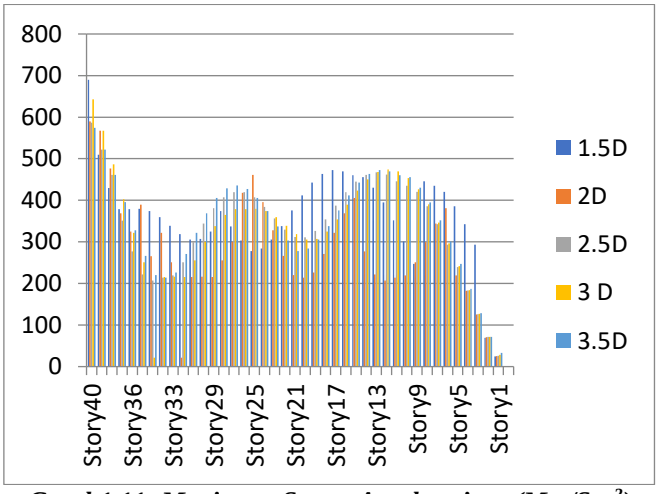

Graph1.11: Maximum Storey Accelerations (Mm/Sec^2)

Base Shear

MODEL 2 D		
EQX		
	TIME PERIOD (SEC)	BASE SHEAR (KN)
	4.435	10875
EQY		
	TIME PERIOD (SEC)	BASE SHEAR (KN)
	5.179	10875

MODEL 2.5D		
EQX		
	TIME PERIOD (SEC)	BASE SHEAR (KN)
	5.435	11975
EQY		
	TIME PERIOD (SEC)	BASE SHEAR (KN)

MODEL 1.5 D		
EQX		
	TIME PERIOD (SEC)	BASE SHEAR (KN)
	3.285	9776
EQY		
	TIME PERIOD (SEC)	BASE SHEAR (KN)
	4.279	9776

MODEL 3 D		
EQX		
	TIME PERIOD (SEC)	BASE SHEAR (KN)
	5.178	11982.5956
EQY		

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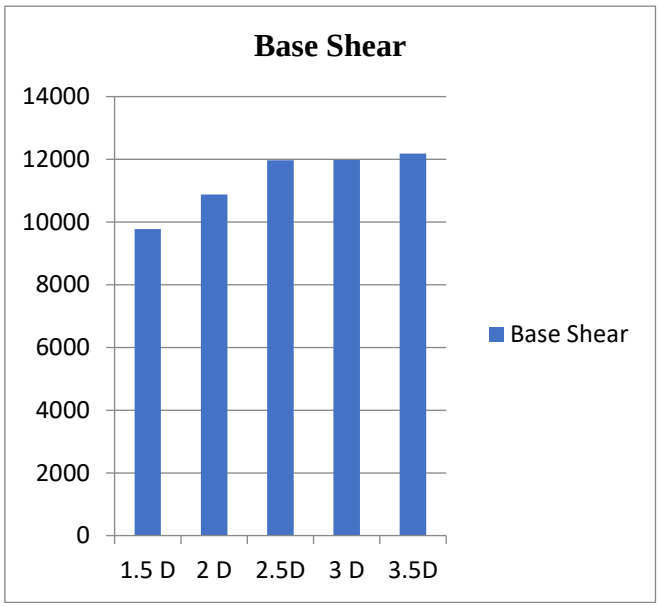
	TIME PERIOD (SEC)	BASE SHEAR (KN)
	6.033	11982.5956

MODEL 3.5D		
EQX		
	TIME PERIOD (SEC)	BASE SHEAR (KN)
	5.058	12189.3381
EQY		
	TIME PERIOD (SEC)	BASE SHEAR (KN)
	5.907	12189.3381

Table1.12: Base Shear

Twist	Base Shear
1.5 D	9776
2 D	10875
2.5D	11975
3 D	11982.59
3.5D	12189.33



Graph1.12: Base Shear

6. CONCLUSION

When the rotation of the structure is increases then the base shear is also increase the total 3.5D structure base is higher than the remaining the structure. The base shear is 5% to 15% increases as compare to the other structure. The maximum storey acceleration of the structure is 1.5D is increased by 14 %, 14.05%, 8%, and 16% as compared to the 2D , 2.5D , 3D and 3.5D when we decreases the twisted angle then the acceleration is increases. The Storey Stiffness 2.5D is increases by 6-7% around but 1.5D is decreasing by 66% around means when we increases the twist angle of floor then the Stiffness also increases.

The overturning moment effect of the all structure all near about the same the only 1-2% slightly increases 2.5D structure. Means no effect of floor rotation on the moment. It was increases when increases the storey height.

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The maximum storey displacement of the structure 2.5D is increase 6% as compared to other type of structure all around displace nearly same means when we twisted the floor displacement is decreases.

When we increase the rotation of the floor then the modal time period is also decreases

The maximum storey acceleration of the structure is 1.5D is increased by 2 %, 1.5%, 3%, and 1.8% as compared to the 2D , 2.5D , 3D and 3.5D when we decreases the twisted angle then the acceleration is increases.
storey stiffness is for 1.5D Is increasing by 43 %, 35%, 33.5% and 26.4% as compare to the 2D, 2.5D, 3D and 3.5D model.

The overturning moment is for 1.5D is increasing by 41 %, 33.4%, 31.5% and 24.4% as compare to the 2D, 2.5D, 3D and 3.5D model.

The maximum storey displacement of the structure 2.0D is increase 6% as compared to other type of structure but only 10% 1.5D type of structure .the displacement is varying for floor to floor.

When the rotation of the structure is increases then the base shear is also increase the total 3.5D structure base is higher than the remaining the structure. The base shear is 4% to 12% increases as compare to the other structure.
When we increase the rotation of the floor then the modal time period is also decreases

REFERENCES

1. Numerical and Experimental Investigation of Rectangular Liquid-Containing Structures under Seismic Excitation, Iman Bahreini Toussi, MDPI, 22 December 2020
2. Performance of An Rcc Frame Building Subjected to Hydrodynamic Force at Each Floor Level - A Case Study by Chokshi Shreya H., Dalal S.P. (2015), International Journal of Research in Engineering and Technology (IJRET), Volume 04 Issue 06 June 2015
3. Structural Engineering of Complex-Shaped Tall Buildings-Moon K. S, R International Conference, Hong Kong, 21st March 2019
4. Analysis And Design Of Twisted Building By Using Staad.Pro V8i- E.Srinivasulu, K. S. Subrahmanyam, L. Manikanta, Ch. Satish, Divya Anusha Naid, Journal of Emerging Technologies and Innovative Research (JETIR), April 2019, Volume 6, Issue
5. Turning Torso by Santiago Calatrava, Journal of Emerging Technologies and Innovative Research (JETIR), April 2019, Volume 6, Issue 4-
6. Comparative Study on the Structural Behavior of RCC and Steel Twisted Building by Sanjay R, Dr. B. Shivakumaraswamy, International Research Journal of Engineering and Technology (IRJET), Volume 06 Issue 09, Sep 2019
7. Analysis of Sloshing Impact on Overhead Liquid Storage Structures P. Muthu, Vijay & Amar Prakash, International Journal of Research in Engineering & Technology, Aug 2018
8. Numerical Analysis of the Dynamic Responses of Multistorey Structures Equipped with Tuned Liquid Dampers Considering Fluid-Structure Interactions Bui Pham Duc Tuong, the Open Construction and Building Technology Journal, October 02, 2019
9. A Review on Seismic Behaviour of Intze Pool with Varying Different Seismic Zones & Different Soil Condition Arvind Kumar, Rajeev Banerjee, JETIR 2018
10. Joaquín G. Ruiz-Pinilla a, Antoni Cladera “Joint strengthening by external bars on RC beam-column joints” Published by Elsevier Ltd. 8 October 2022

DOI: 10.46121/pspc.53.2.21

11. Wissam Nadir, Ammar Yasir Ali, Majid M.A. Kadhim “Structural behavior of hybrid reinforced concrete beam-column joints under cyclic load: State of the art review”, Published by Elsevier Ltd. 20 September 2021
12. Seismic Behavior Experimental Study on the Joint of Circular Tubed Steel-Reinforced Concrete Columns Yan Dai, Shaofeng Nie, Tianhua Zhou, and Research Article 29 September 2021
13. Khaleel Mohammed, M Jameel, Zainah Ibrahim and Chee Ghuan Tan Performance of a Ductile Hybrid Post-Tensioned Beam-to-Column Connection for RCC Concrete Frames under Seismic Loads: A Review Science Direct 16 August 2021
14. Hilal Meydanli Atalay and Sevket Ozden “Cyclic Behavior of Beam-Column Connections in RCC Structures” Science Direct 11 February 2021
15. Arthi S and Jaya KP, “Seismic performance of RCC shear wall-slab connection under cyclic loading: experimental test vs. numerical analysis” Council of Scientific and Industrial Research, July2020
16. Azim Mohd Radzi, Roszilah Hamid “A Review of RCC Concrete Beam-to-Column Connections Subjected to Severe Fire Conditions Noor” Research Article 30 November 2020
17. Baoxi Song, Dongsheng Du 1, Weiwei Li “Analytical Investigation of the Differences between Cast-In-Situ and RCC Beam-Column Connections under Seismic Actions” ScienceDirect 22 November 2020
18. Zhiwu Yu, Xiaoyong Lv, Yujie Yu “Seismic Performance of RCC Concrete Columns with Improved U-type Reinforcement Ferrule Connections” International Journal of Concrete Structures and Materials, Springer 2019
19. Structural Performance of PC Double Connection under Gravity and Seismic Loading, International Journal of Concrete Structures and Materials, 2020
20. Gemechu Abdissa “Finite Element Analysis of Reinforced Concrete Interior Beam Column Connection Subjected to Lateral Loading” American Journal of Civil Engineering, 23 April2020
21. T. Subramani, R. sathiyaraj, et.al “Design and Analysis of prefabricated structure using E-Tab” (IJETTCS) March 2018
22. P. Karthigai Priya, Minamata “A Review of RCC Concrete” (IRJET) Jan 2018
23. Akash Lanke, Dr. D. Venkateswarlu, “Design, cost & time analysis of RCC & RCC building” (IRJET) June 2016
24. Hari Prasad M “Comparative Study between RCC and Cast In-Situ Structure under Combination of Dynamic Loads and Connections between RCC Elements, IJSRD 2016
25. Kyoung Sun Moon (2010) “Structural Engineering for complex shaped tall buildings” ASCE (2011), AEI 2011.
26. Kyoung Sun Moon (2014) “Structural Design and construction of complex shaped tall buildings” IACSIT International Journal of Engineering and Technology, Vol. 7, No.1, February 2015.
27. Kyoung Sun Moon (2010) “Studies on various structural system design options and their performances” The Structural Design of tall and special building, Struct. Design Tall Spec, Build, (2012), in Wiley Online Library.
28. Kyoung Sun Moon (2011) “Diagrid Structures for Complex Shaped Tall buildings” Procedia Engineering 14 (2011) 1343-1350.

DOI: 10.46121/pspc.53.2.21

29. Karel Vollers Free D Geometries (2011) “High Rise Building with Twisted Facades” CTBUH 2005 7th world congress, New York.
30. Chokshi Shreya H., Dalal S.P., “Performance of an RCC Frame Building Subjected to Hydrodynamic Force at Each Floor Level - A Case Study”, IJRET: International Journal of Research in Engineering and Technology, ISSN: 2319-1163, Volume: 04, Issue: 06 June-2015.

DOI: 10.46121/pspc.53.2.21