SEISMIC ANALYSIS AND DESIGN OF RCC TWISTED BUILDING USING ETab

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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,

I. 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 lateral loads.

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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- 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.

II. 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.

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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, 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
- ✓ 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

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

IV. DESIGN & MODELLING

Response spectrum analysis:-

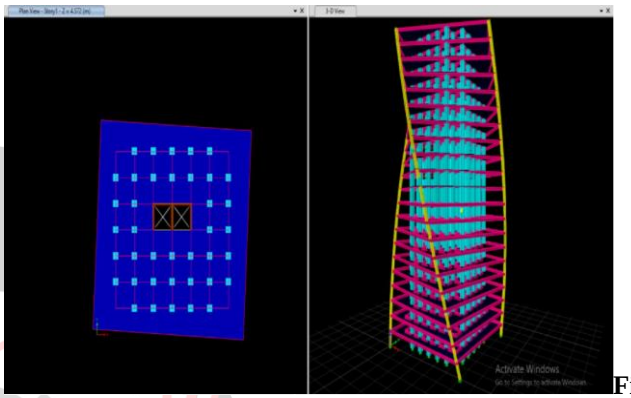

Figure1.1: 2 Degree Model design

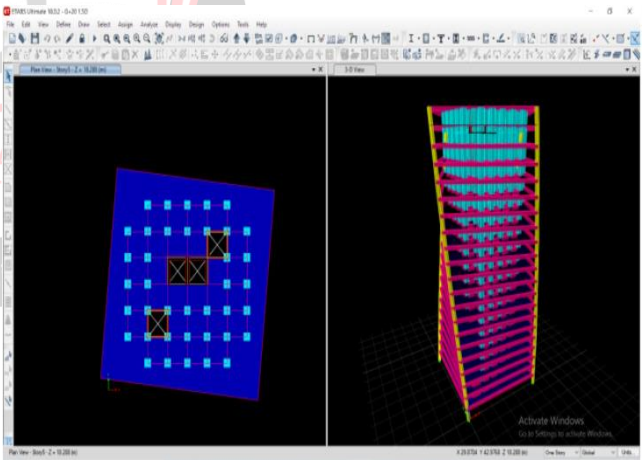

Figure1.2: 1.5 Degree Model design

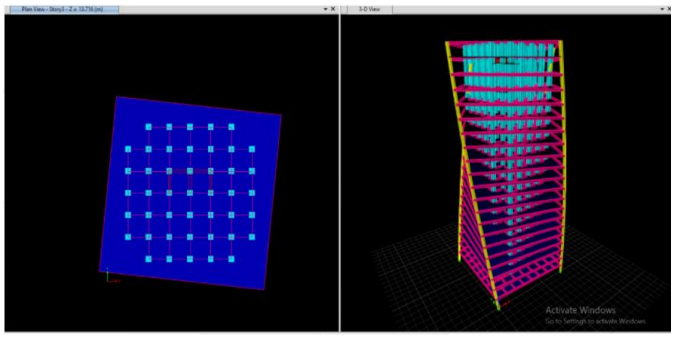

Figure1.3: 2.5 Degree Model design

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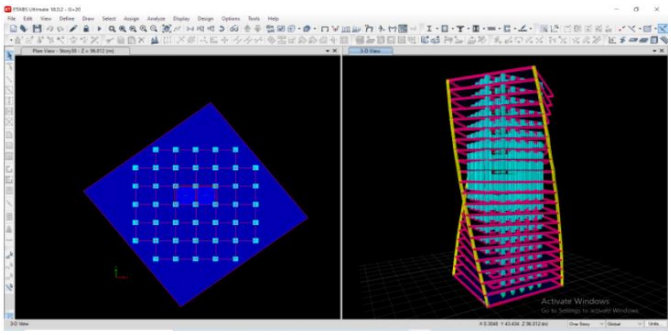


Figure1.4: 3 Degree Model design

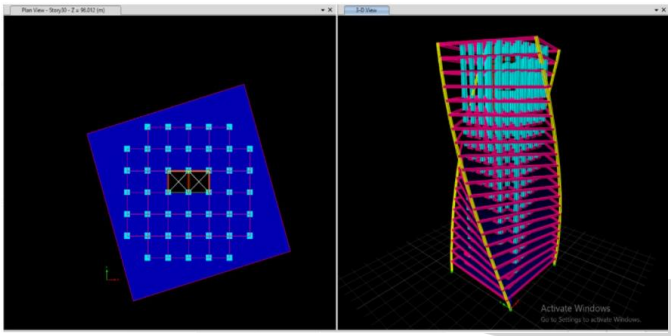
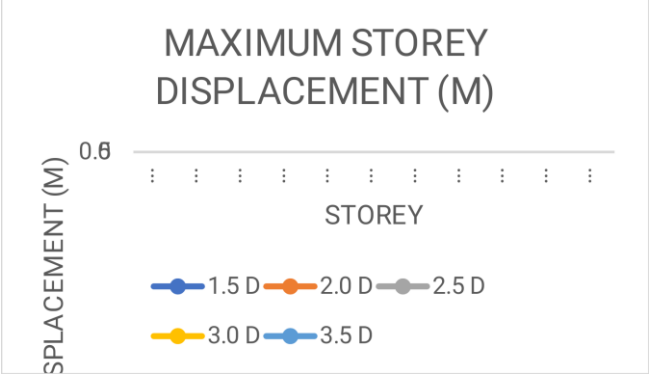


Figure1.5: 3.5 Degree Model design

V. RESULT & DISCUSSION

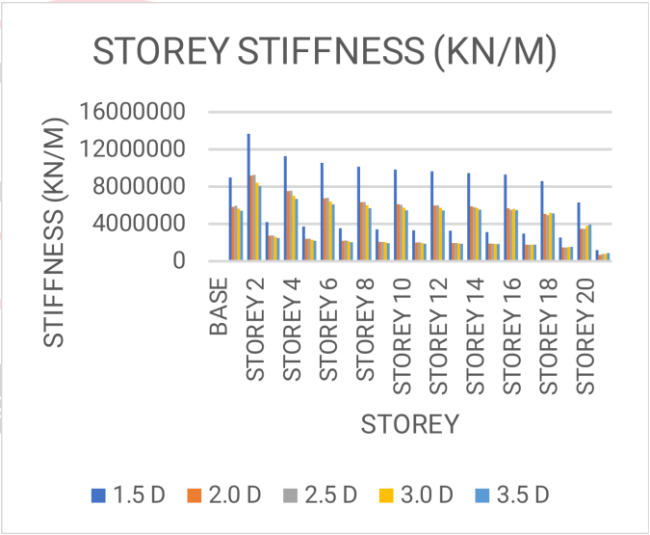
Storey Displacement

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



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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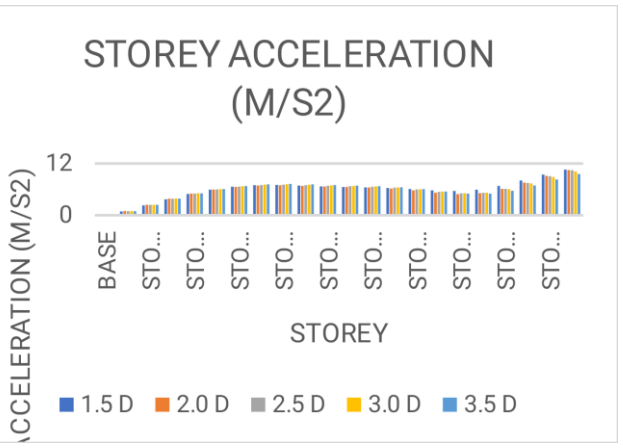
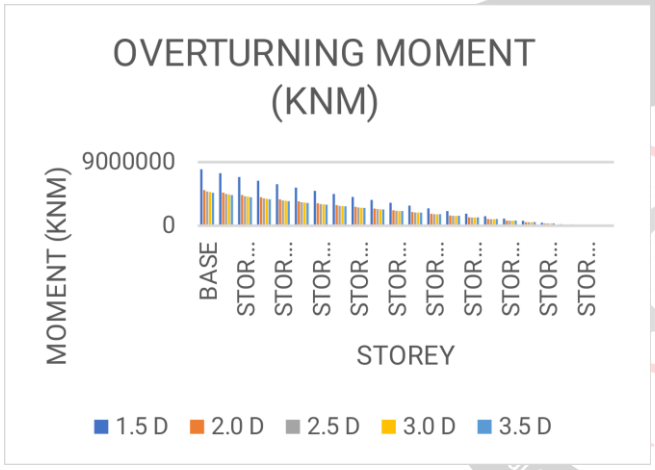
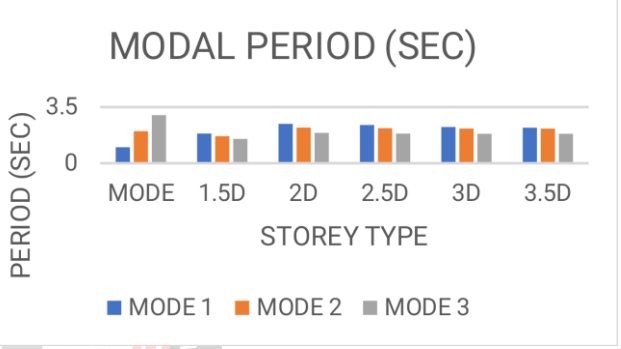
MAXIMUM OVERTURNING MOMENT					
STORY	1.5 D	2.0 D	2.5 D	3.0 D	3.5 D
BASE	7992972	5039763	4843236	4767568	4664354
STOREY 1	7435627	4687095	4505976	4435982	4341697
STOREY 2	6895133	4350527	4183723	4119615	4034637
STOREY 3	6374621	4032478	3878758	3820733	3745451
STOREY 4	5875781	3733361	3591651	3539840	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



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





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

VI. CONCLUSION

- 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

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