Seismic Analysis and Design Of G+9 Residential Building Using Etabs

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***Abstract*—As per latest predictions more than 20% of the current Indian population is going to shift to town/cities in upcoming years. But due to space constraints in the cities multi-storey apartments play a major role in the urban infra- structure development. The main objective of this current study is to seismic analysis and design of a residential building (G+9) using 'ETABS' software is used for the analysis and design purpose and 'AutoCAD' is used for detailing and preparation of drawings for this project. Planning and designing a structure is an art to achieve safety, serviceability, durability and economy. For this purpose, a site is selected in which a building of (G+9) residential building is constructed. Each floor has four flats consisting of all facilities required for a residential house like bedroom, toilet, living, dining and kitchen and store room. The present project deals with the analysis and design of the apartment building for the purpose of analysis and design the dead load and live load and seismic load are considered. Here AutoCAD is used to prepare a plan. It involves outer appearance of the plan and elevation. E-Tabs software tools is used for the analysis purpose. Using ETabs for design and analysis of any structure gives the shear-force and bending-moment and shear-force of the members of the structure like of the beams and columns due to the load acting on them even before the construction of the structure which helps in considering the design properties of the structure like grade of concrete, grade of steel, size of column, and size of beams as required for the loads acting on the structure.**

***Index Terms*—Etabs, Seismic Analysis and design of Residential building, AutoCAD for detailing and preparation of Drawings, safety, serviceability and economy.**

I. LITERATURE REVIEW

Cinitha, P. K. Umesha,Nagesh R Iyer1, N. Lakshmanan (2015)
This paper presents a typical 6-storey reinforced concrete structural frame analyzed and designed for four load cases, taking into account three revisions of IS: 1893 and IS: 456. A conceptual framework and detailed steps for performance evaluation of buildings with reinforced concrete frame are presented using the explicit force-based method described in the Indian Code of Practice. The modeling process describes issues related to capacity curve generation, damage and vulnerability index. Based on studies, a simple formula has been proposed for estimating the global damage index in the hardening and elasto-plastic regions of the capacitance spectrum.

Lin Shibin1, Xie Lili1, Gong Maosheng, and Li Ming (2010)
This paper presents a performance-based methodology for assessing building seismic vulnerability and capacity of The Vulnerability assessment methodology is based on the HAZUS methodology and the improved capacity requirement diagram method. The spectral shift (Sd) of performance points on the capacitance curve is used to estimate the damage level of the building. The relationship between Sd and peak ground acceleration (PGA) has been established and the new vulnerability function is represented in PGA. In addition, the expected value of seismic performance index (SCev) is provided to estimate the seismic performance of buildings based on the probability distribution of damage levels and the corresponding seismic performance index. The results show that the proposed vulnerability methodology can directly and quickly assess the seismic damage to large numbers of building stocks after the earthquake. SCev provides an effective index for measuring the seismic resistance of buildings, showing the relationship between the seismic resistance of buildings and the effects of earthquakes. The estimation results are compared with the damage survey of Dujiangyan City and Jiangyu in the M8.0 Wenchuan earthquake, and

show that the earthquake risk assessment and decision-making method is accepted. Describes the main reasons for the discrepancy between the estimation results and the damage report.

S. Choudhury • S. M. Singh (2013)
Here we report on a uniform design approach for RC moment resistant frame buildings. It takes into account both the design deviation and the intended performance level of the component. Rays are proportional to from the theoretical processing corresponding to the target. The proposed method was validated by designing a building with two plans, different height and different performance goals.
The proposed method was found to be sufficient to achieve a elastic RC frame building with a given performance goal of under a given hazard level.

II. INTRODUCTION

ETABS the name itself stands for Extended three-dimensional analysis of building system. ETABS is mainly used for design and analysis of structure of the building. ETABS contains features like modelling, designing, and analysis of a structure. ETABS not only handle the analysis and design of simple structure and can give accurate results but also it can handle the complex and largest building structural models. An apartment building is actually a single storey house and it's a part of a multi storey building. Due to growing population and less availability of land this multi storey buildings are constructed which serve many people in a limited area, more over the deforestation is avoided and its sense of development is an important indicator of social progress of the country. Nowadays the house building is a major work of the social progress of the country, daily new technique is developed for the construction of house economically, quickly and fulfilling the requirements of the community. Engineers do the planning, designing, planning layout etc. ETABS is engineering software which is used to analysis and design multi-storey building. CAD drawings can be converted directly into ETABS models or used as templates in which ETABS objects may be overlaid. Report is generated directly in the software with complete reinforcement details. Many of the floor levels in buildings are similar which reduce modelling and design time. Fast model generation using the concept of similar stories. Different materials can be assigned to the structural elements within the same model such as steel, RCC, composite or any other user- defined material. The term building in Civil Engineering is used to mean a structure having various components like foundation, walls, columns, floors, roofs, doors, windows, ventilators, stairs lifts, various types of surface finishes etc. Structural analysis and design are used to produce a structure capable of resisting all applied loads without failure during its intended life. Prior to the analysis and design of any structure, necessary information regarding supporting soil has to be collected by means of geotechnical investigation. A geotechnical site investigation is the process of collecting information and evaluating the conditions of the site for the purpose of designing and constructing the foundation for a structure. Structural engineers are facing the challenges of striving for most efficient and 3building must be serviceable for its intended function over its design life time. Buildings are the structures with different structural members that should withstand different types of loads acting on them, so the engineers are facing problems in producing the most accurate and economical design of the building for the loads action on them. Now-a-days software's are taking part in producing the most efficient and economical building design and analysis for the loads acting on the building even before the construction of the building ETABS is the abbreviation of "Extended 3D Analysis of Building System, so Etabs helps in analyzing the loads acting on the building even before the construction.

Once the loads are obtained, the component takes the load first i.e. the slabs can be designed. Designing of slabs depends upon whether it is a one-way or a two-way slab, the end condition and the loading. From the slabs, the loads are transferred to the beam. The loads coming from the slabs onto the beam may be trapezoidal or triangular. Depending on this, the beam may be designed. Thereafter, the loads (mainly shear) from the beams are taken by the columns. For designing columns, it is necessary to know the moments they are subjected to for this purpose, frame analysis is done by Kanis method. After this the designing of column is taken up depending on end conditions, moments, eccentricity and if it is a short

or slender column. Finally, the footings are designed based on the loading from the column and also the soil bearing capacity value for that` particular area. Most importantly, the sections must be checked for all the components with regard to strength and serviceability. The term building in Civil Engineering is used to mean a structure having various components like foundation, walls, columns, floors, roofs, doors, windows, ventilators, stairs lifts, various types of surface finishes etc. Structural analysis and design are used to produce a structure capable of resisting all applied loads without failure during its intended life. Prior to the analysis and design of any structure, necessary information regarding supporting soil has to be collected by means of geotechnical investigation. A geotechnical site investigation is the process of collecting information and evaluating the conditions of the site for the purpose of designing and constructing the foundation.

Aim of the study:

The main aim of this study is the analysis and design of G+9 residential building by using ETABS.

Objectives:

The objective is to analysis of forces, stress, strain, deflection and bending moment for a G+9 structural system
The objective is to design and analyses the G+9 residential building by using ETABS software
To prepare the 3D model of the structure by using the E-TABS Software for detailed analysis and design.
To get the knowledge on parameters of structural elements like beams, columns, slabs in the design.
To design structural components like beam, slab, column and footing manually.

To understand the basic principles of structures by using Indian Standard Codes.

To identify the stability and workability of structure against various supernatural events

To check the stability of beam and column for the designed load conditions

To analysis for Shear & Bending moment, and Analyzing with all the Indian Standard Codes for buildings. The objective of structural design is to design the structure for strength, stability as well as workability. The design of structure must be satisfying basically three design requirements.
Stability Prevent the structure by overturning, sliding or buckling, or any of the parts under the action of load.
Strength to resist the stress induced in various parts of structure.

Serviceability so that structure gives satisfactory results under service load condition- which gives idea that provide adequate strength and stiffness, reinforcement to resist deflection and vibration within desirable limit.

III. MATERIALS AND METHODOLOGY

Materials:

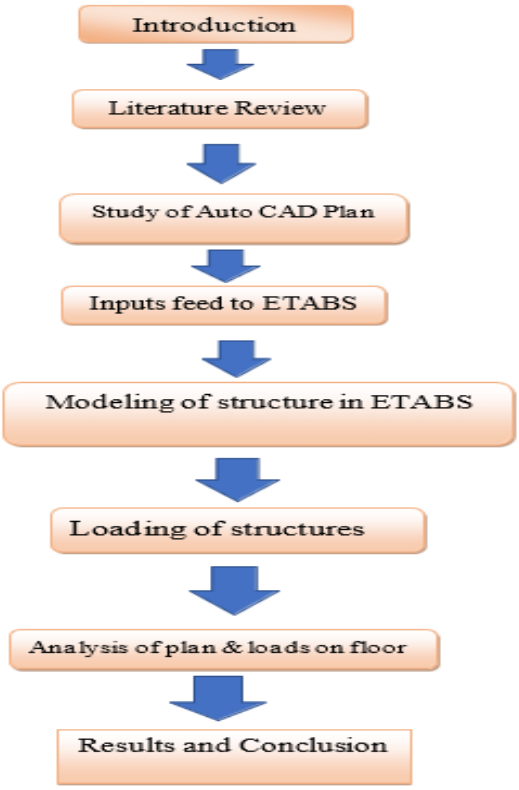
Material Property Grade of concrete (for all structural elements): M30 Unit weight of concrete: 25kN/m3
Grade of concrete: M30 Grade of steel: HYSD Fe 415
Beam Size: 350 X 380
Column Size: 450 X 500

Description of Loads All moving loads come under live loads:

Live load (on floors): 2kN/m2, (IS 875:1987 – Part - 2)
Live load (on roof): 1kN/m2, (IS 875:1987 – Part -2)

Floor finishes are the super imposed dead loads.

Floor Finishes (on floors): 1.5kN/m2
Floor Finishes (on roof): 2kN/m2



LOADS ON BUILDING

Loads acting on building are generated either by force or nature or are manmade. The natural forces are due to temperature, air, earth quake, gravitational force etc. Manmade forces are generated by movement of people, impact loads etc. The loads considered in the design includes Dead Load, Live Load, Wind Load, Seismic Load etc.

Dead Load

All permanent Constructions of the structure form the Dead Loads. Dead Loads shall be calculated on the basis of unit weights which shall be established taking into account the materials specified for construction from IS 875 (Part 1) 1987.

Sl.no	Load on building Components	Load taken (Kn/m)
1.	Beam	3.325Kn/m
2.	Column	5Kn/m
3.	Slab	3.75Kn/m

Live Load

The imposed loads to be assumed in the design of building shall be the greatest loads that probably will be produced by the intended use or occupancy, but shall not be less than the minimum loads specified in IS 875 (Part 2) 1987. Floor loads shall be investigated for UDL and corresponding concentrated load. Imposed loads do not include loads due to wind, earthquake, snow etc.

From IS code 875 (Part 2) for a residential building live load should be 2KN/m^2

Wind Load

Wind is air in motion relative to the surface of the earth. The primary cause of wind is traced to earth's rotation, and difference in terrestrial radiation. The radiation effects are primarily responsible for convection, either upwards or downwards. The wind generally blows horizontal to ground at high wind speeds. Since vertical components of atmospheric motion are relatively small the term wind denotes almost exclusively the horizontal wind; vertical winds are always identified as such.

Wind Load applied in X – Direction = 0.8

Wind load applied in Y – Direction = 0.86

3.4 PROCEDURE PROCEDURE IN ETABS:

Structure having grade of concrete for beam, column is M30 and for slab it is M30 with unit weight of concrete being 25kN/m3. Column size for the structure is 0.45mx0.50m, while the beam size is 0.35mx0.38m. The structure models having each storey height of 3m. Firstly a

plan has been drawn in Auto-Cad and its centre-line diagram has been imported to Etabs then its design, modelling, analysis has been done in Etabs.

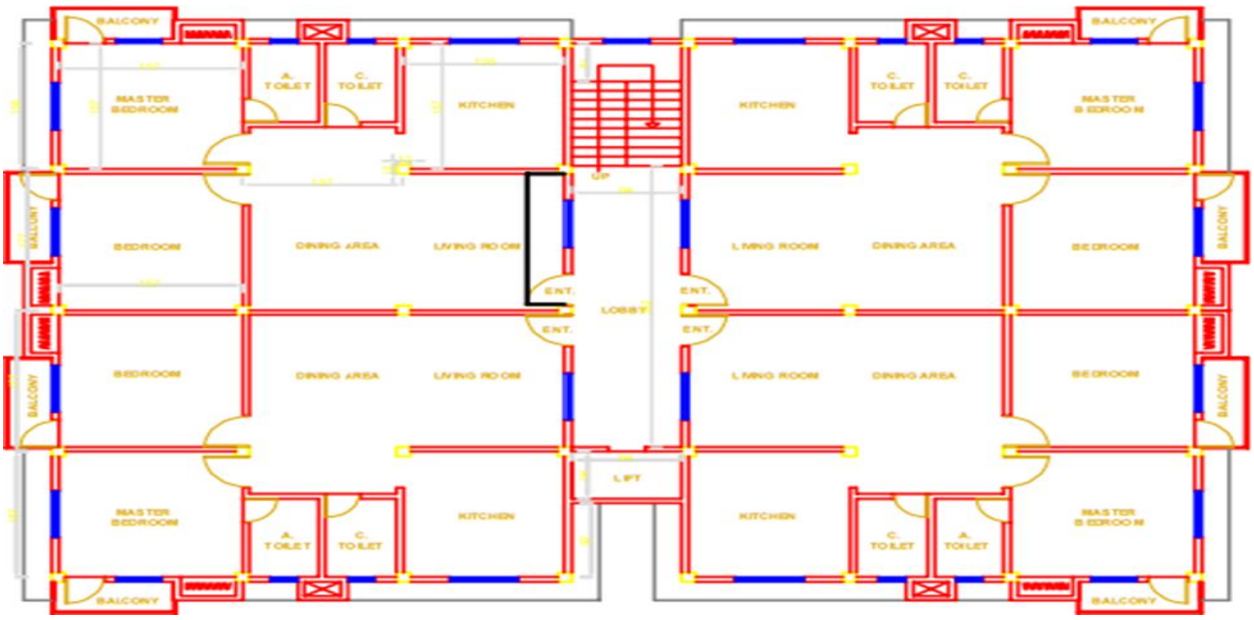


Figure1 Plan of Residential building

IV. RESULT AND DISCUSSION

All the defined beams, columns and slabs are assigned to the grid as per the plans and the drawings. Support restrains and loads as mentioned above are assigned to the respective members and the model is checked initially for any errors in assigning

Go to quick draw beams shortcut < in property select beam < then in working plane select all stories < then drag the cursor and select the plan view and the beams are drawn

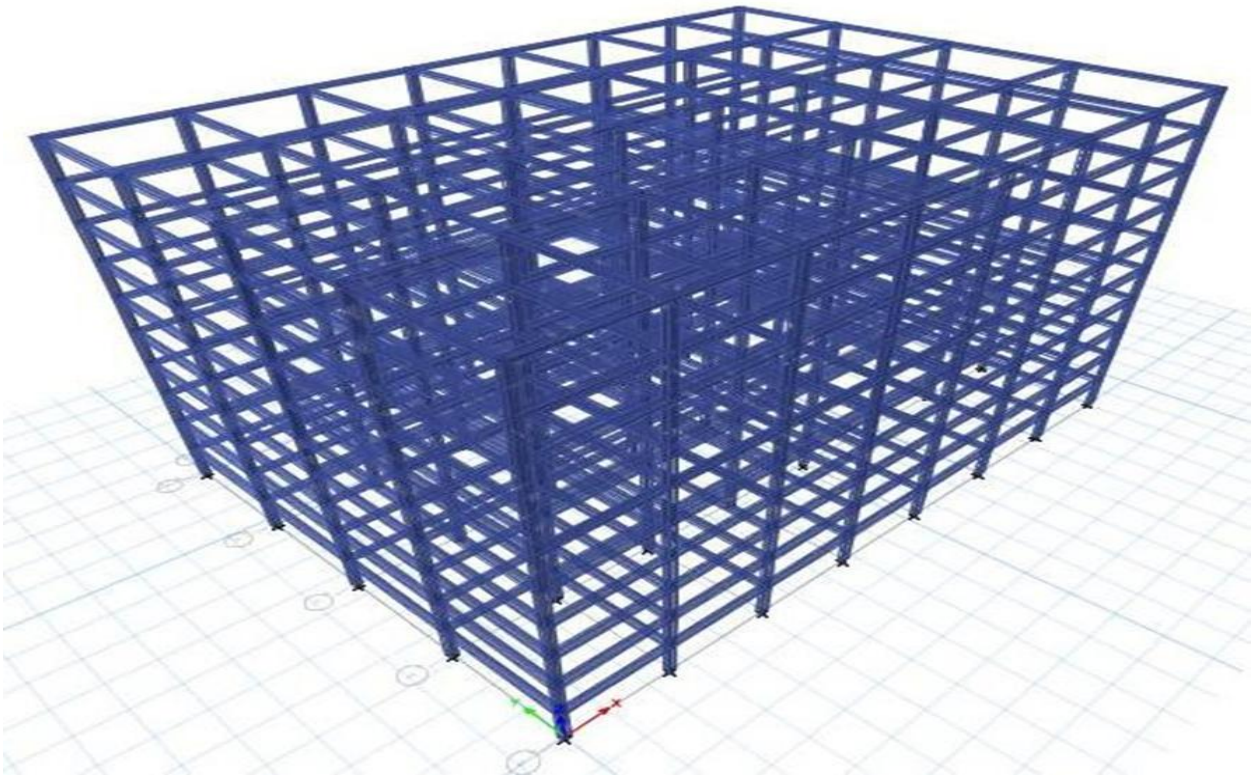


Figure 2 beams drawn

Go to quick draw columns shortcut < in property select column < then in working plane select all stories < then drag the cursor and select the plan view and the columns are drawn

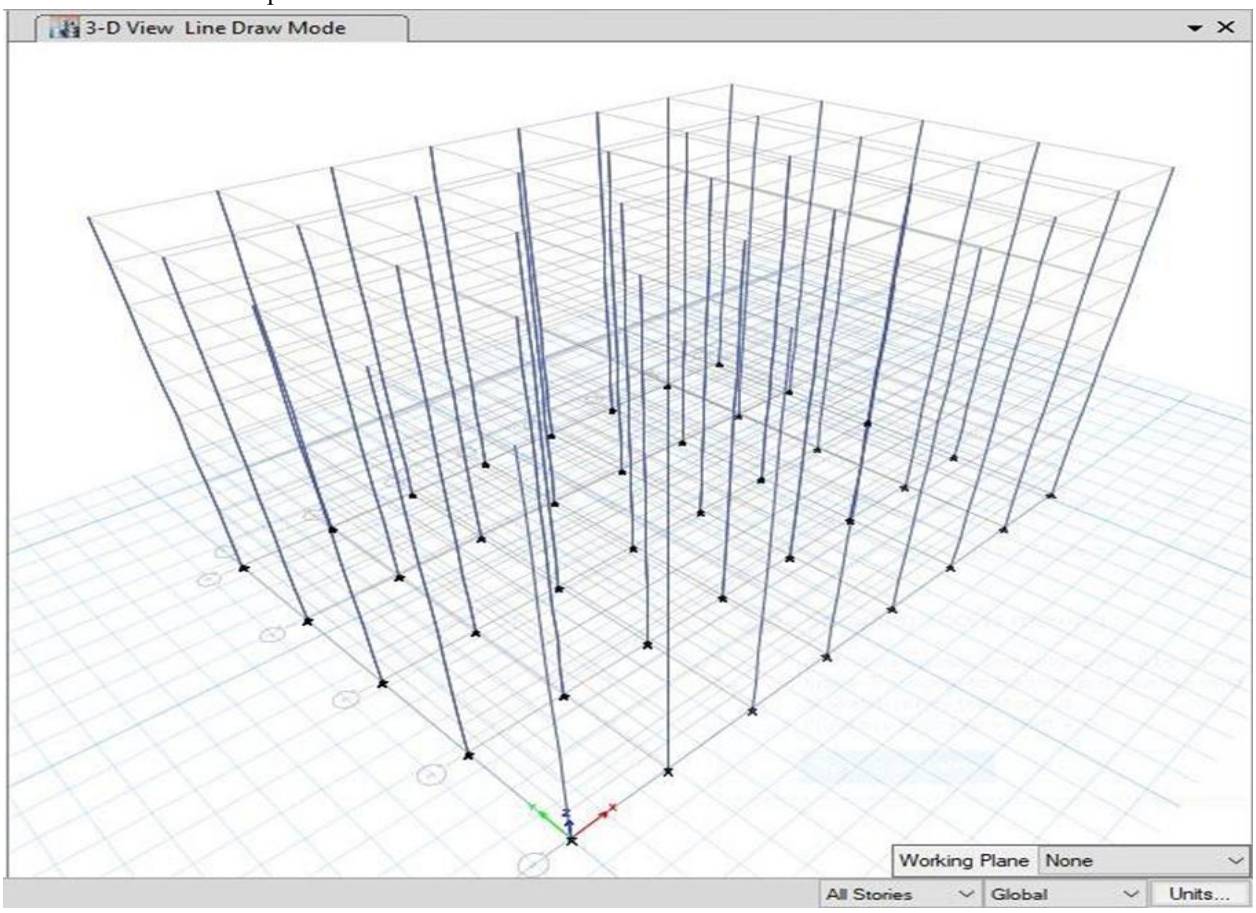


Figure 3 columns drawn

Go to quick draw slab shortcut < in property select slab < then in working plane select all stories < then drag the cursor in the plan and select the plan view and the slabs are drawn < then select one story < then in 3d view select base slab and delete.

RESULT

This chapter provides analysis results.

Structure Results

Table - Base Reactions

Load Case/Combo	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	X m	Y m	Z m
Dead	0	0	205956.4149	5475611	-4633636	0	0	0	0
Live	0	0	67482	1789696	-1518211	0	0	0	0
wx	-3956.0574	366.3016	-3335.8558	-95817.2458	79683.1726	122381.3698	0	0	0
wy	0	3296.7145	0	-51742.2496	0	74176.0772	0	0	0
sx	-6285.1297	0	0	0	-145949	167135.6936	0	0	0
sy	0	-6285.1297	0	145949.4804	0	-141404	0	0	0
1.5(DL+LL)	0	0	410157.6224	10897960	-9227771	0	0	0	0
1.5(WL+SL)	-15361.7808	549.4524	-5003.7837	-143726	-99399.4618	434275.595	0	0	0
DCon1	0	0	308934.6224	8213416	-6950454	0	0	0	0

DCon2	0	0	410157.6224	10897960	-9227771	0	0	0	0
DCon3	-4747.2689	439.5619	324123.0709	8603387	-7286597	146857.6438	0	0	0
DCon4	4747.2689	-439.5619	332129.1249	8833348	-7477836	-146858	0	0	0
DCon5	0	3956.0574	328126.0979	8656277	-7382217	89011.2926	0	0	0
DCon6	0	-3956.0574	328126.0979	8780458	-7382217	-89011.2926	0	0	0
DCon7	-5934.0862	549.4524	303930.8387	8069690	-6830930	183572.0547	0	0	0
DCon8	5934.0862	-549.4524	313938.4061	8357142	-7069979	-183572	0	0	0
DCon9	0	4945.0718	308934.6224	8135803	-6950454	111264.1158	0	0	0
DCon10	0	-4945.0718	308934.6224	8291029	-6950454	-111264	0	0	0
DCon11	-5934.0862	549.4524	180356.9897	4784324	-4050748	183572.0547	0	0	0
DCon12	5934.0862	-549.4524	190364.5572	5071775	-4289797	-183572	0	0	0
DCon13	0	4945.0718	185360.7734	4850436	-4170273	111264.1158	0	0	0
DCon14	0	-4945.0718	185360.7734	5005663	-4170273	-111264	0	0	0
DCon15	-7542.1557	0	328126.0979	8718368	-7557356	200562.8323	0	0	0
DCon16	7542.1557	0	328126.0979	8718368	-7207077	-200563	0	0	0
DCon17	0	-7542.1557	328126.0979	8893507	-7382217	-169685	0	0	0
DCon18	0	7542.1557	328126.0979	8543228	-7382217	169684.8271	0	0	0
DCon19	-9427.6946	0	308934.6224	8213416	-7169379	250703.5403	0	0	0
DCon20	9427.6946	0	308934.6224	8213416	-6731530	-250704	0	0	0
DCon21	0	-9427.6946	308934.6224	8432340	-6950454	-212106	0	0	0
DCon22	0	9427.6946	308934.6224	7994492	-6950454	212106.0338	0	0	0
DCon23	-9427.6946	0	185360.7734	4928050	-4389197	250703.5403	0	0	0
DCon24	9427.6946	0	185360.7734	4928050	-3951348	-250704	0	0	0
DCon25	0	-9427.6946	185360.7734	5146974	-4170273	-212106	0	0	0
DCon26	0	9427.6946	185360.7734	4709125	-4170273	212106.0338	0	0	0

Table - Story Forces

Story	Load Case/Combo	Location	P kN	VX kN	VY kN	T kN-m	MX kN-m	MY kN-m
Story10	Dead	Top	13787.8895	0	0	0	372982.8152	-310228
Story10	Dead	Bottom	20595.6415	0	0	0	547561.0597	-463364
Story10	Live	Top	6480	0	0	0	174960	-145800
Story10	Live	Bottom	6748.2	0	0	0	178969.59	-151821
Story10	Wx	Top	-379.4947	-227.6968	21.083	7043.8437	-10246.3574	16128.5256
Story10	Wx	Bottom	-379.4947	-227.6968	21.083	7043.8437	-10309.6066	15445.4351
Story10	Wy	Top	0	0	189.7474	4269.3156	0	0
Story10	Wy	Bottom	0	0	189.7474	4269.3156	-569.2421	0
Story10	Sx	Top	0	-1379.1672	0	36869.0802	0	0
Story10	Sx	Bottom	0	-1379.1672	0	36869.0802	0	-4137.5016
Story10	Sy	Top	0	0	-1379.1672	-31029.5349	0	0
Story10	Sy	Bottom	0	0	-1379.1672	-31029.5349	4137.5016	0
Story10	1.5(DL+LL)	Top	30401.8343	0	0	0	821914.2228	-684041
Story10	1.5(DL+LL)	Bottom	41015.7622	0	0	0	1089796	-922777
Story10	1.5(WL+SL)	Top	-569.2421	-2410.296	31.6246	65869.3858	-15369.5362	24192.7884
Story10	1.5(WL+SL)	Bottom	-569.2421	-2410.296	31.6246	65869.3858	-15464.4098	16961.9003

V. CONCLUSION

From the above study seismic analysis and design of G+9 storey Residential building situated in Hyderabad using ETABS 2015, the following concluding remarks can be made: -

ETABS is user friendly and powerful FEM (Finite Element Method) computer structural program which allow user to do quick 2D and 3D modeling of RCC structural frames with 3D graphical interface.

3D model of residential building which is made in ETABS, gravity load analysis has been performed and all the necessary

reactive forces and deformation diagrams have been generated, all the classical method of analysis.

Design of beams (Continuous beams and simply supported beams) and column as per for practical execution have been generated in the form of AutoCAD drawings.

Loads are taken as dead load live load wind load and seismic load or earthquake load.

Shear wall is taken sustain the building as it is multistorey high-rise building.

All the designs of continuous slabs have been taken from ETABS for each base joint where footing is expected.

For the designs of footings all the base reactions have been taken from ETABS for each base joint where footings are expected.

All the footings have been designed manually as per IS 456:2000 Codal provision.

For reinforcement in the structure we are using as per IS 800:2007.

All the structural elements are adequate in design conforming both limit state of collapse and limit state of serviceability.

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