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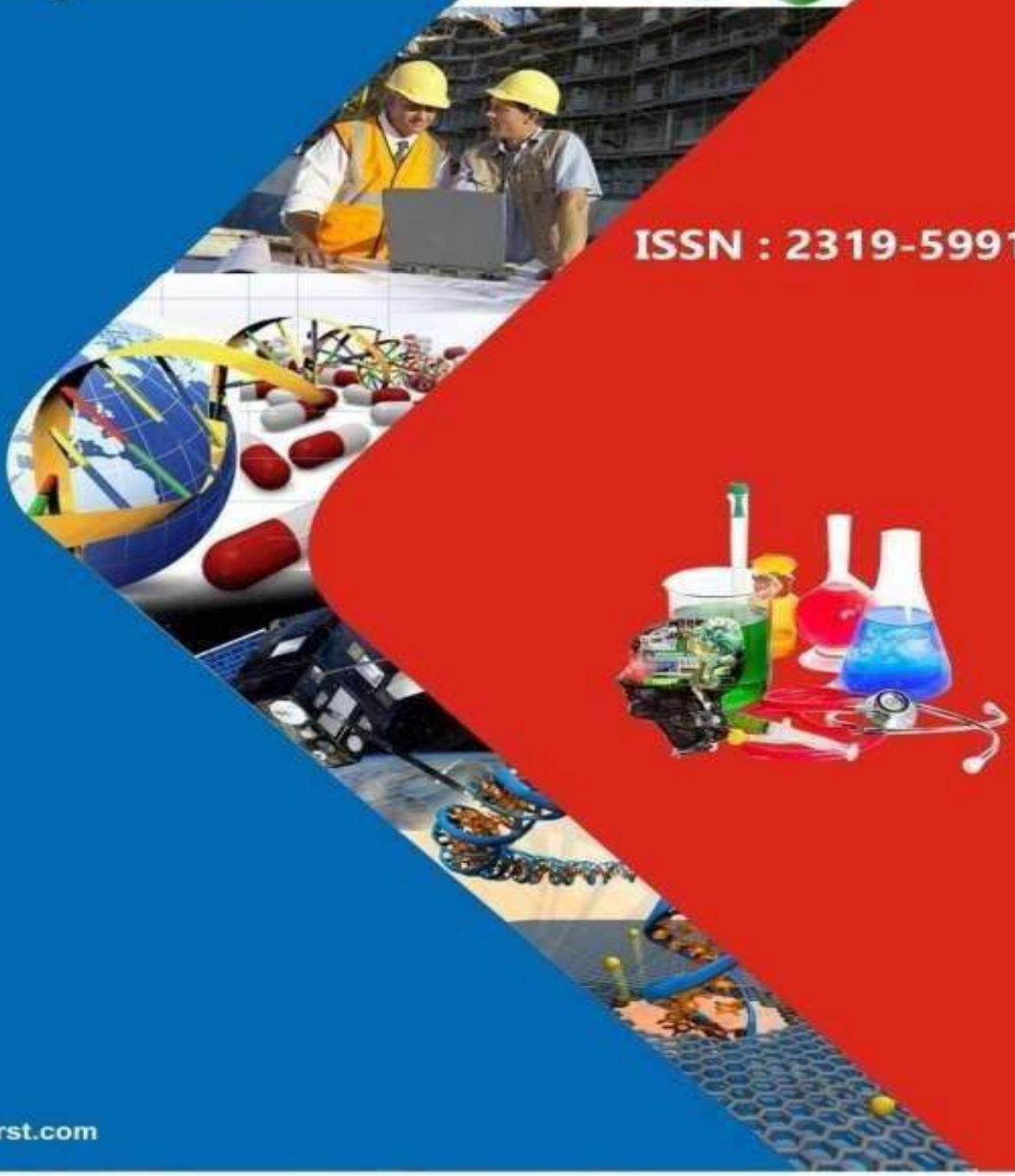

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# An existing RCC G+2 healthcare building's performance point in ETAB was determined by a non-linear static pushover analysis

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**ABSTRACT:** *Buildings must be able to safely withstand any significant ground vibrations that may occur during their construction or regular operation in order to be considered earthquake resistant. Structures that are exposed to severe ground movements are best analysed using the time-history method. On the other hand, the impact that ground movements have on structural reactions is unlike any other.This work will focus on the analysis of steel-framed buildings, specifically the pushover analysis, which is a static nonlinear process that estimates seismic structural deformations using a simplified nonlinear technique. The capacity curve or force displacement relationship of a structure or structural part may be found using this incremental static analysis. The analysis begins with a pattern of horizontal loads being given to the structure in a predefined manner. To put it another way, the structure is pushed gradually, and the total applied shear force and accompanying lateral loads are plotted at each increment until the structure reaches the collapse state. This approach involves applying certain lateral loads to a building model on a computer, such as inverted triangle or uniform loads. As the lateral load is incrementally raised, each structural component is monitored for fractures, yielding, plastic hinge creation, and eventual collapse. The weak points in the structure's seismic performance may be uncovered with substantial information using pushover analysis. This study uses pushover analysis to examine the performance point seismic response of steel-framed buildings and the influence of earthquake stresses on the frames of multi-story buildings. The current investigation involves the design of a building frame. as specified in Indian Standards (IS) 456:2000 and IS 1893:2002. The primary goal of this research is to determine the potential performance of a building when constructed in accordance with Indian Standards. Only during zone-3 earthquakes is the pushover study of a steel-framed building performed using the structural analysis program E-tabs.*

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**Keywords:** ***Pushover Analysis ; Nonlinear Static analysis ; Performance point ; Capacity curve ; Displacement ; Drift of stories ; seismic zones ; Etabs software***.

## I. INTRODUCTION

Structures endure critical inelastic distortion under a strong earthquake and dynamic qualities of the structure change with time, so examining the execution of a structure requires inelastic scientific strategies representing these dynamics. Inelastic analytical methods comprehend the real conduct of structures by recognizing disappointment modes and the potential for dynamic breakdown. Inelastic analysis methods fundamentally incorporate inelastic time history analysis and inelastic static analysis which is otherwise called pushover analysis. The inelastic time history analysis is the most exact technique to anticipate the force and deformation requests at different components of the structure. In any case, the utilization of inelastic time history analysis is constrained in of different horizontal burden designs used in customary pushover analysis, proficiency of invariant parallel burden designs in speaking to higher mode impacts and precise estimation of target uprooting at which

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seismic interest expectation of pushover technique is performed. light of the fact that dynamic reaction is exceptionally delicate to displaying and ground movement qualities. It requires appropriate demonstrating of cyclic burden disfigurement qualities considering weakening properties of exceedingly vital components. Additionally, it requires accessibility of an arrangement of delegate ground movement records that records for instabilities and contrasts in

static analysis, or pushover analysis, has been the favored strategy for seismic execution assessment because of its effortlessness. Nonlinear static analysis, or pushover analysis, has been produced in the course of recent years and has turned into the favored analysis method for configuration and seismic execution assessment purposes as the methodology is generally straightforward and considers post versatile conduct. In any case, the method includes certain approximations and improvements that some measure of variety is constantly anticipated that would exist in seismic interest forecast of pushover analysis.

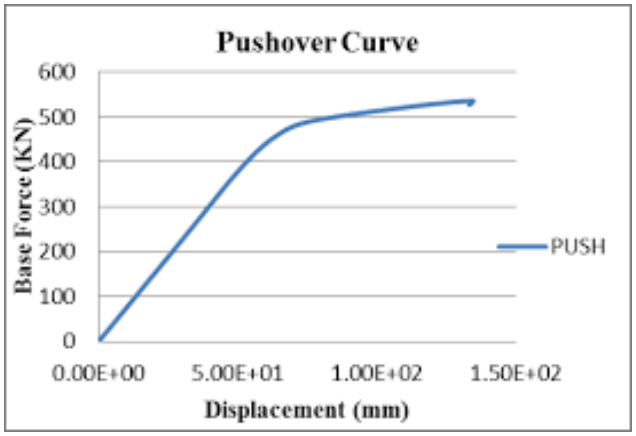


**Figure 1: Pushover Curve**

In spite of the fact that in writing, has been appeared to catch crucial auxiliary reaction attributes under seismic activity, the exactness and the unwavering quality of weakling analysis in foreseeing worldwide and neighbourhood seismic requests for the sum total of what structures have been a subject of talk and enhanced weakling systems have been proposed to conquer the specific restrictions of conventional pushover strategies. In any case, the enhanced methodology are for the most part computationally requesting and theoretically complex that utilization of such systems is unrealistic in engineering profession and codes. As conventional pushover analysis is generally utilized for configuration and seismic execution assessment purposes, its constraints, shortcomings and the exactness of its expectations in routine application ought to be recognized by considering the components influencing the pushover forecasts.

## II. OBJECTIVES OF WORK

• To evaluate the seismic capacity of steel framed structures.

• To verify the seismic reserve capacity using ETABS SOFTWARE.

• It can also be useful for performance-based design of new buildings that rely on ductility or redundancies to resist earthquake forces.

• To plot Capacity Curve or Pushover Curve represents the nonlinear behaviour of the steel structure.

## III. LITERATURE REVIEW

➢ **J.Parishith V. Preetha [2017]** This review article is based on Nonlinear Static Analysis (Pushover Analysis) of RC frame buildings with shear wall **"Pushover Analysis of RC Frame Buildings with Shear Wall" Journal for Scientific Research & Development| Vol. 4, Issue 12, 2017.**—The structure in high seismic areas may be susceptible to the severe damage. The structural safety for seismic loading is one of the most important factor along with building serviceability and potential for economic loss during major earthquakes. As multi-storeyed structures are coming up in large numbers, the designers are in a necessity to provide adequate lateral strength and stability against the earthquake and wind loads. Hence in order to provide the lateral strength and stability, shear walls are introduced into the

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high-rise buildings. This review article is based on Nonlinear Static Analysis (Pushover Analysis) of RC frame buildings with shear wall and its parameters such as Lateral Displacement, Storey Shear, Storey Drift, Base shear and demand Capacity (Performance Point) are been evaluated using E-TABS and SAP software.

- **Ms. M. D. Kumbhar Prof.N.S. Vaidkar Dr. Uttam Kalwane**, The study shows that plan shape of building plays a vital role in resisting the lateral loads & also it is very simple to adopt **"Literature Review on Seismic and Wind Analysis of multi-storey RC Building with Different Plan Shapes" Journal of Science and Engineering Volume 2, Issue 4 April 2018 ISSN: 2456- 9976.**Recently there has been a considerable increase in the construction & use of multi- storey reinforced concrete buildings especially in urban areas. But as the structure extends vertically it becomes sensitive to lateral loads which are mainly in the form of seismic load & wind load. So, it is very important to protect these buildings from these loads. This paper presents an overview of research work done regarding the seismic & wind analysis of multi-storey buildings with different plan shapes. The effect of provision of shear wall, variation of seismic zone & wind speed also considered along with it. Methods used to carry out the seismic & wind analysis on of different plan shaped buildings by different researchers are studied. Effect of plan shape has been found in terms of storey drift, lateral displacement, base shear, storey shear, axial force, moments, etc. The shape having least value of parameters was considered the most stable & safe. The study shows that plan shape of building plays a vital role in resisting the lateral loads & also it is very simple to adopt.

- **Sunil Dhananjay Rathod, Swati Sham Bhokare, Aniket Arun Shivatare, Pradip Sanjay Dhiwar, Swapnil Maruti Sathe, Rajesh Navnath Shinde [2017]** These are mix type or hybrid construction called as a composite construction, which are make efficient use of constituent material which can be most effective than **"Comparative Pushover Analysis Of RCC, Steel And Composite High Rise Building Frame (G+11) By Using Etabs''. Journal Of Information, Knowledge And Research In Civil Engineering ISSN: 0975 – 6744| Nov 16 To Oct 17 | Volume 4, Issue 2.** This Project shows comparison of various aspects of building. In this project a residential of G+11 multi-story building is studied for Pushover Analysis using ETABS, assuming that material property linear, static and dynamic analysis is performed. These non- linear analysis are carried out and different parameters like displacement, storey drift, Performance point, base shear are plotted. Now it is the demand of time that every structure must be analysed and designed for lateral forces such as earthquake and wind forces. But generally it is found that the cross sectional area of RCC structural member comes out very heavy with large amount of constituent material such as steel & concrete, which takes large space in construction of multi-story building. Under such circumstances composite structure is one of the best options, which not only takes care for earthquake forces but also gives less cross sectional area of structural member and provides large space for utilization in economical way.

- **Hardik Bhensdadia', Siddharth Shah [2001]** To achieve this objective, three RC bare frame structures with G+4, G+9, G+15 stories respectively will be analysed and compared the base force and displacement of RC bare frame structure with G+4, G+9 G+15 stories in different earthquake zones bike Rajkot**. "Pushover Analysis Of RC Frame Structure With Floating Column And Soft Story In Different Earthquake Zones" International Journal Of Research In Engineering And Technology ISSN: 2319-11631 PISSN: 2321-7308** Open first

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story and Floating column are typical features in the modern multi-storey constructions in urban India. Such features are highly undesirable in buildings built in seismically active areas; this has been verified in numerous experiences of strong shaking during the past earthquakes like Bluj 2001. In this study an attempt is made to reveal the effects of floating column & soft story in different earthquake zones by seismic analysis. For this purpose Push over analysis is adopted because this analysis will yield performance level of building for design capacity (displacement) carried out up to failure, it helps determination of collapse load and ductility capacity of the structure. To achieve this objective, three RC bare frame structures with G+4, G+9, G+15 stories respectively will be analysed and compared the base force and displacement of RC bare frame structure with G+4, G+9 G+15 stories in different earthquake zones bike Rajkot. Jamnagar and Bhuj using SAP 2000 analysis package.

- **S. P. Sharma, J. P. Bhandari [2015]** The present paper gives the knowledge about the seismic behaviour of structures by using shear wall & diagrid and comparison between them. **"Literature Review on the Seismic Performance of Multi-Storey Building with Different Locations of Shear Wall and Diagrid "Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2015).**As per the previous records of earthquakes, there is an increase in the demand of use of earthquake resisting structures. So it is necessary to design and analyse the structures by considering seismic effect. The present paper gives an overview of different research works to be done regarding the study of multi-storey RC frame structure with lateral load resisting systems such as shear wall and diagrid system. The present work concerned with the comparative study of seismic analysis of multi-storied building with shear wall and bracing, analysis of multi-storey structure of different shear wall locations and heights and proper location of shear wall in the multi- storey building etc. The present paper gives the knowledge about the seismic behaviour of structures by using shear wall & diagrid and comparison between them.

- **Pamela Jennifer J , [2015]** The researchers used various countries codes to evaluate the seismic performance of the structure **"Review on Seismic Design of Multi storeyed Building using various Codes" Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 10, October 2015.** Seismic design deals with the yielding and inelastic behaviour of structural element which are detailed to exhibit such behaviour during earthquake. The structure is designed with sufficient strength to behave elastically during earthquake. Seismic design of multi storeyed RC building is to withstand the ground motion caused during the earthquake. In order to design an earthquake resistant structure an Engineer must have a well knowledge about various seismic design codes. In this paper literatures of various researches were studied. Those papers give more information about the static and dynamic analysis done on various types of structures. The use of software's in seismic analysis will reduce the time consumption and errors in analysis and design of the structure. The researchers used various countries codes to evaluate the seismic performance of the structure. The parameters such as displacement, base shear, storey drift, time period, axial and shear force bending moment were studied. From these researches, an interest arises to do seismic design of multi storyed building using various codes to understand which codal provision gives very effective design to perform good during earthquake.

- **Neha Pawar, Kuldeep Dabhekar, P.B. Patil, Isha Khedikar.** This review also focuses on the methodology to be adopted to have better seismic response of Building with Floating Column .Review on **"Effect of**

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**Floating Columns on Building subjected to seismic Forces"** In recent trends, Floating column is used to occupy more spaces for functional requirement. Floating Column is that architectural feature which gives poor response to earthquake. Hence it should be avoided in Earthquake prone zones. This review shows the responses of various studies done by Researchers. Comparison of result is done with respect to different parameters like bending moment, storey shear, displacement, time period etc. Authors have modelled various structures such as conventional Building, building with Floating Columns, building modelled with different solutions and their solution is compared. This review also focuses on the methodology to be adopted to have better seismic response of Building with Floating Column.

- **Mrugesh D. Shah,Sumant B. Patel[2001]** This paper is an approach to do nonlinear static analysis in simplify and effective manner **"NONLINEAR STATIC ANALYSIS OF R.C.C.FRAMES(Software Implementation ETABS 9.7)"**The nonlinear analysis of a structure is an iterative procedure. It depends on the final displacement, as the effective damping depends on the hysteretic energy loss due to inelastic deformations, which in turn depends on the final displacement. This makes the analysis procedure iterative. Difficulty in the solution is faced near the ultimate load, as the stiffness matrix at this point becomes negative definite due to instability of the structure becoming a mechanism.

- **Nishant Rana, Siddhant Rana [2015]** By pushover analysis, one may get an insight about the behaviour of building in non-linear zone. It is generally believed that the conventional elastic design analysis method cannot capture many important aspects that control the seismic performance of the building structure**."Non-Linear Static Analysis (Pushover Analysis) A Review" Journal of Engineering and Technical Research Volume-3, Issue-7, July 2015**,A brief review of several literatures presented shows that non-linear static analysis (pushover analysis) proves to be efficient tool for studying the behaviour of the structure in non-linear zone. Structure's failure modes due to seismic actions become more apparent by performing pushover analysis. There is future scope for further study in this area.

- **Saurabh P. Hete, Sanjay K. Bhadke, Amey Khedikar [2018].** The paper gives the study of different literature investigation taken on pushover analysis **"Pushover Analysis of Existing RC Frame Structure :A State of the Art Review" Research Journal of Engineering and Technology Volume: 05 Issue: 04 | Apr-2018.**Based on the work presented in this thesis following point wise conclusions can be drawn: A detailed literature review on existing buildings conclude that the displacement demand is dependent on the geometrical configuration of frame and concentrated in the neighbourhood of the existing for existing structures. The higher modes significantly contribute to the response quantities of existing structure. Also conventional pushover analysis seems to be underestimating the response quantities in the upper floors of the irregular frames. As the shape of the triangular load pattern and first mode shape are similar for mid-rise regular buildings and close for high-rise and existing buildings, the resulting pushover curves are found to be similar for almost all the building studied here.

- **M. Sudharani, Dr. G. Nandini Devi[2015]** Pushover curves (base shear vs displacement) obtained from the analysis are used to calculate various seismic demand parameters such as over strength factor, ductility factor, response reduction factor for various structural systems in various papers. **"Seismic Demand Study on Steel Structural systems using Pushover analysis" Journal of Advanced**

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**Information Science and Technology Vol.4, No.10, October 2015**.Base shear vs. displacement curve indicates that the hollow section is far better than solid sections. When storey level get increased pushover load steps get decreased, so the capacity curve become linear for some models corresponding to its storey level. Fundamental period is directly related to the use of behaviour factor and obviously to the drift limit .the fundamental period given by the code could be obtained from the modal analysis of the frame when designed with strict drift limitation (0.005h). The provision of bracing enhances the base shear carrying capacity of frames. Bracing acts as an extra redundant in frames there by reducing inter storey drift.

- **Nukala Jitendra Babu [2010]** This paper deals with the non-linear analysis of an asymmetric building on a sloping ground subjected to live, dead and also earthquake loads in an incremental way d **"Pushover Analysis Of Unsymmetrical Framed Structures on Sloping Ground**" Linear static analysis for symmetric structures as per the design methods of IS code provisions. Linear static analysis for asymmetric structures as per the design methods of IS code provisions. Nonlinear static analysis of symmetric structures. Nonlinear static analysis of asymmetric structures on sloping ground. Pushover curves are obtained for the different cases and the maximum base shear is obtained. Conclude the comparison between the symmetric and asymmetric structures subjected to linear static and nonlinear static analysis.

- **Swarna Mekapothula, Dr R Balamurugan [2019]** this project highlights the effect of mass irregularity on different floor in buildings with pushover analysis is done by using etabs software.**"NONLINEAR STATIC ANALYSIS OF BUILDING USING ETABS".Journal of Engineering Sciences Vol 10,Issue 3, May2019**.This project is concerned with the effects of various vertical irregularities on the seismic response of a structure. From past earthquakes it is proved that many of structure are totally or partially damaged due to earthquake. So, it is necessary to determine seismic responses of such buildings. There are different techniques of seismic analysis of structure. Pushover analysis is one of the important techniques for structural seismic analysis generally the evaluated structural response is nonlinear in nature. In this project work seismic analysis of buildings with mass irregularity at different floor level are carried out. This project highlights the effect of mass irregularity on different floor in buildings with pushover analysis is done by using etabs software.

- **C.V.S. Lavanya, Emily.P.Pailey, Md. Mansha Sabreen [2017]** As this project deals with the most economical column method in this project we have design the structure in an economical way by reducing the sizes in the sections. As the load is more at the bottom when compared to the top floors, there is no need of providing large sizes at the top. Economizing the column by means of column orientation is longer span longer direction will reduce the amount of bending as a result there are of the steel is reduced. **"ANALYSIS AND DESIGN OF G+4 RESIDENTIAL BUILDING USING ETABS' 'International Journal of Civil Engineering and Technology (IJCIET) Volume 8, Issue 4, April 2017, pp. 1845– 1850 Article ID: IJCIET_08_04_210.**In this paper, from the plinth to the certain height of the building the column size may differ that is it would be more when compared to the upper columns because to reduce the failure in the structure. The diaphragm is rigid. The main beams rest on the columns to avoid local eccentricity. Comparison of analysis and design of regular and irregular configuration of multi storied building in various seismic zones using ETABS software.

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- **B. Anusha, B. Raghavendra, K. Shashipreetham, M. Sai Krishna [2020**] Using this software, we have analyzed and designed the beams, columns, slabs and staircase. The results are downloaded from the software and compared with manual calculations which are designed as per IS: 456- 2000. The structure is safe under loads **"ANALYSIS AND DESIGN OF HOSTEL BUILDING (G+4) USING ETABS".International Journal of Engineering Applied Sciences and Technology, 2020 Vol. 4, Issue 12, ISSN No. 2455- 2143**.Due to the increase in population, there is a problem in we are facing problems in constructing houses individually as large areas is required per person. So, Adaption of high rise buildings has increased. It is important for the civil engineers to analyze and design any structure before it is constructed. To get accurate values of loads, stresses and bending moments of a member, software is needed. ETABS is the software which can design complex building models. It has been used by the structural engineers because of its accuracy.

- **Sayyed Feroz Sikandar1 , Shaikh Zameeroddin, Prof. Agrawal. A. S [2019].**The design methods involves load calculations manually and analysing the whole structure by ETABS. The design methods used in ETABS are limit state design confirming to IS code of practice. Along with analysing and designing of this building, construction sites were also visited. **"Analysis and Design of Multi story Building using ETABS 2017 ".International Journal of Engineering Applied Sciences and Technology, Volume 9 Issue No. 6.**Practical knowledge is an important and essential skill required by every engineer. For obtaining this skill, an apartment building is analysed and designed, Located in Latur, Maharashtra with (G+10) storeys having a car parking facility provided at basement floor. The building has a shear wall around the lift pit. The modelling and analysis of the structure is done by using ETABS and the designing was done. Design of slab, stair case and an isolated footing are done manually. The design methods involves load calculations manually and analysing the whole structure by ETABS.

- **S Abhishek1, Manoj S,Roopa B , Bhagyashree M, Guruprasad -[2018].**This project presents multi-storeyed residential building analysed and designed with lateral loading effect of earthquake using ETABS. This project is designed as per INDIAN CODES- IS 1893-part2:2002, IS 456:2000**."Design and Analysis of Residential Building using ETABS"International Research Journal of Engineering and Technology (IRJET) e- ISSN: 2395-0056 Volume: 05 Issue: 05 | May-2018.**They should ensure that it is serviceable, habitable in healthy environment for its occupants and have longer design period. Structurally robust and aesthetically pleasing building are being constructed by combining the best properties of any construction material and at the same time meeting specific requirements like type of building and its loads, soil condition, time, flexibility and economy. In the view of above, the high rise buildings are best suited solution. This paper discusses the analysis of a commercial building (G+1) located at Hyderabad under effect of Seismic forces. Shear forces and bending moments of beams and columns are observed and concluded that larger span have more shear forces and bending moment.

- **Rinkesh R Bhandarkar , Utsav M Ratanpara, Mohammed Qureshi [2017**] The objective of this project is to check& design of the seismic response of multi- storied building using Etabs. Another object is to analysis of forces, bending moment, stress, strain &deformation or deflection for a complex structural system. To make the building earthquake resistant against seismic

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effect. To analysis story drift, displacement, shear, story stiffness model period & frequency on different floor.**" Seismic Analysis & Design of Multi story Building Using Etabs".7 IJEDR | Volume 5, Issue 2 | ISSN: 2321-9939**.This program has been thoroughly tested and used in using the program. However, all the user accepts and understands that no warranty is expressed by the developers or the distributors on the accuracy or the reliability of the program. This program is a very useful tool for the design check of concrete structures. The user must exactly understand the assumptions of the program and must independently verify the results.

- **Shubhankar Mishra, Manas Rathore [2021]** A geotechnical site investigation is method of collecting information and evaluating the conditions of the site according to which the design and construction of the foundation is made for the structure. Structural engineers are always working to find the most economical and efficient design with accuracy as well as ensuring that the final draft of the building must be serviceable for its intended usage over its design life**. "Design of Hostel Building through ETABS Software" ISSN: 2455-2631 ©May 2021 IJSDR | Volume 6 Issue 5.In this project** "Analysis and Design of hostel building (G+5) through ETABS software" is an attempt to design and analyze a hostel building using ETABS. A G+5storey building is considered for this study. The analysis is design is done as per IS 456:2000 guidelines. This project is designed as per INDIAN CODES – IS 1893 part II: 2002, IS
456:2000. Drawing and detail are done using Auto CAD.

- **Sayyed A.Ahad , Hashmi S Afzal , Pathan Tabrej , Shaikh Ammar , Shaikh Vikhar , Shivaji Bidve [2017].**The design methods involves load calculations manually and analysing the whole structure by ETABS.

The design methods used in ETABS are limit state design confirming to IS code of practice. Along with analysing and designing of this building, construction sites were also visited. **'Analysis and Design Of Multi story Apartment Building Using ETABS' 'International Journal Of Engineering And Computer Science''ISSN:2319-7242 Volume 6 Issue 5 May 2017, Page No. 21269-21285**.To get exposure to engineering experience and knowledge, which are required in the industry and not taught in the lecture rooms. To apply the engineering knowledge taught in the lecture rooms in real industrial situations. To share the experience gained from the "industrial training" in the discussion held in the lecture rooms. To get a feel of the work environment.

## IV. SUMMARY OF LITERATURE REVIEW:

- The literature review conducted as part of the study shows that there are numerous studies found on Pushover analysis.
- The following conclusions are drawn from the previous studies :

- Pushover analysis is a static analysis used to investigate how far into the inelastic range a building can go before it is on the verge of a total or a partial collapse.
- A model for the building is assembled on a computer, with all load-resisting elements together with their force– deformation relationships both before and after yielding and with dead loads plus average live loads.
- Then a small set of horizontal forces is applied so as to simulate the effects of ground motions, and deformations are calculated.
- Pushover analysis was carried out for the base-fixed superstructure to examine the yield displacements and succeeding inelastic behavior.

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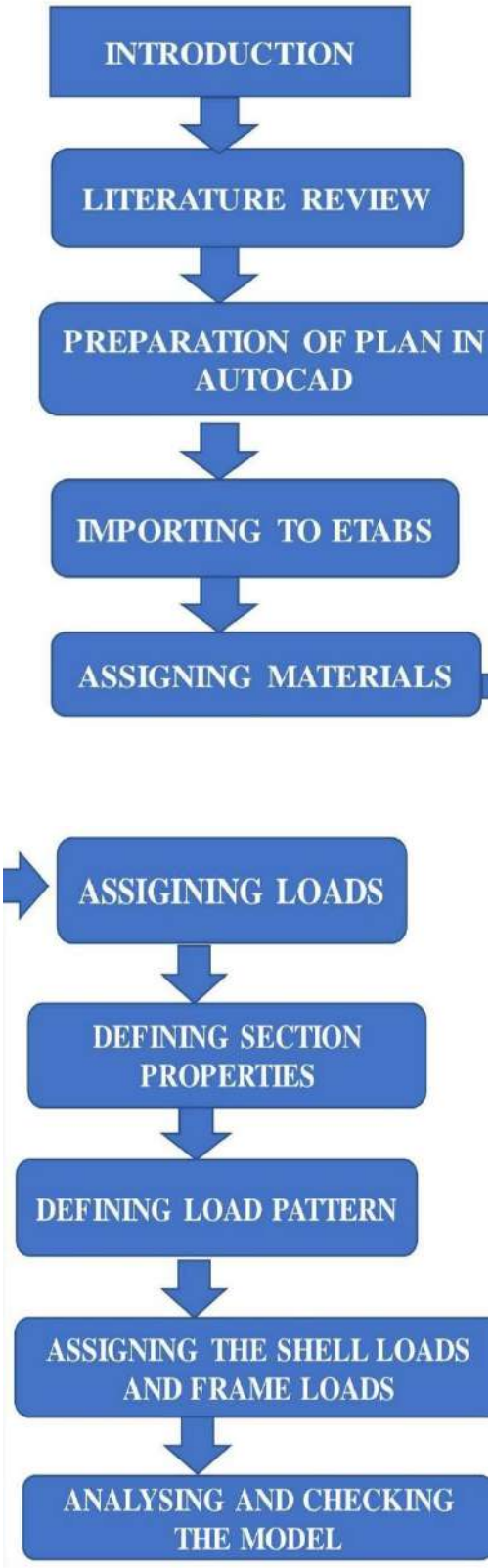
- The results were used to capture the overall damage with respect to the story drift.
- conventional pushover analysis with a mass-proportional lateral load pattern is performed to investigate not only considered subassemblies, but also the influence of TRM strengthening on their response.
- The obtained pushover curves and experienced lateral displacement of the strengthened in-plane model for both shell and solid elements are presented.
- In addition to the capacity, the damage initiation point is also highlighted no marked difference was detected between this point in the strengthened model with that of the plain one. This is probably due to a very local damage that occurs at this point.
- As conventional pushover analysis is generally utilized for configuration and seismic execution assessment purposes, its constraints, shortcomings and the exactness of its expectations in routine application ought to be recognized by considering the components influencing the pushover forecasts.
- The inelastic time history analysis is the most exact technique to anticipate the force and deformation requests at different components of the structure.
- The seismic response of RC building frame in terms of performance point and the effect of earthquake forces on multi story building frame with the help of pushover analysis is carried out in this paper.
- The design methods involves load calculations manually and analysing the whole structure by ETABS. The design methods used in ETABS are limit state design confirming to IS code of practice.
- The results are downloaded from the software and compared with manual calculations which are designed as per IS: 456- 2000.

## V. METHODOLOGY



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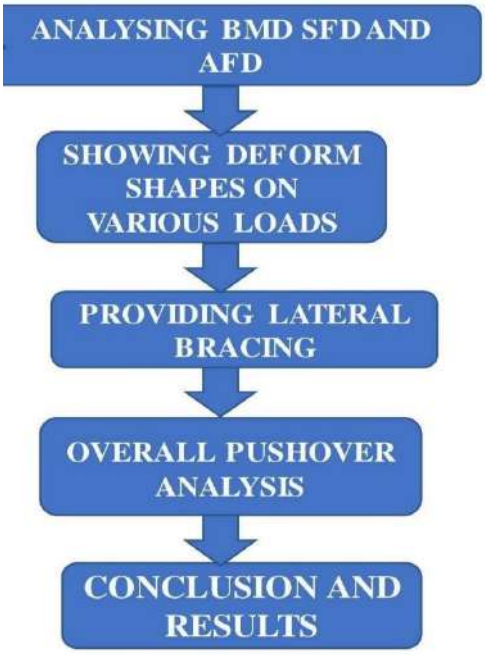


- ✓ **INTRODUCTION:** The objective and scope of the project are determined and knowledge about ETABS and p delta effect has been gained.
- ✓ **LITERATURE REVIEW:** Literature reviews of various authors are collected and their results were studied.
- ✓ **PREPARATION OF PLAN IN AUTOCAD:** building plan is drawn in AUTOCAD.
- ✓ **IMPORTING TO ETABS:** The plan drawn in AUTOCAD is imported in ETABS with proper grid spacing's.
- ✓ **DEFINING AND ASSIGNING MATERIALS:** The material specifications are assigned and beams and columns are placed.
- ✓ **ASSIGNING LOADS AS PER IS CODES:** After the building is designed various loads are assigned as per IS CODE specifications.
- ✓ **SECTION PROPERTIES:** Property modifiers may be used as a scale factor to modify the stiffness of section properties for frame, shell, and tendon objects. Property modifiers may be assigned either to object sections or to the objects themselves.
- ✓ **SHELL LOADS AND FRAME LOADS:** a three or four-node area object used to model membrane and plate- bending behaviour. Shell objects are useful for simulating floor, wall, and bridge deck systems; 3D curved surfaces; and components within structural members, such the web and flanges of a W-Section.
- ✓ **ANALYSE THE BUILDING MODEL:** Run the analyses after applying loads.
- ✓ **BMD,SFD,AFD:** Shear and bending moment diagrams are analytical tools used in conjunction with structural analysis to help perform structural design by determining the value of shear force and bending moment at a given point of a structural element such as a beam.
- ✓ **SHOWING DEFORM SHAPES ON VARIOUS LOADS:** A deformed plot shows the shape of your model according to the values of a nodal variable such as displacement.
- ✓ **OVERALL PUSHOVER ANALYSIS:** to evaluate the seismic capacity of existing structures and appears in several recent guidelines for retrofit seismic design.

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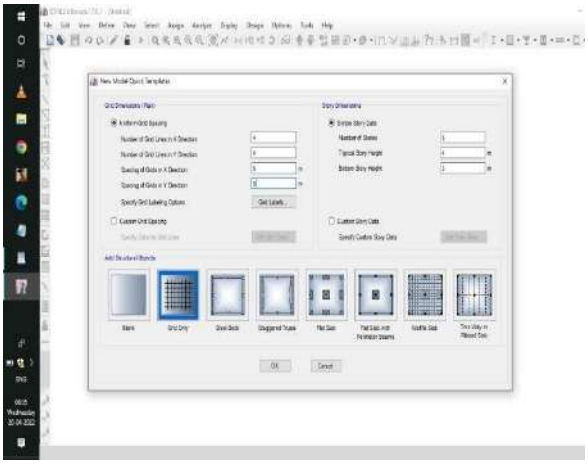
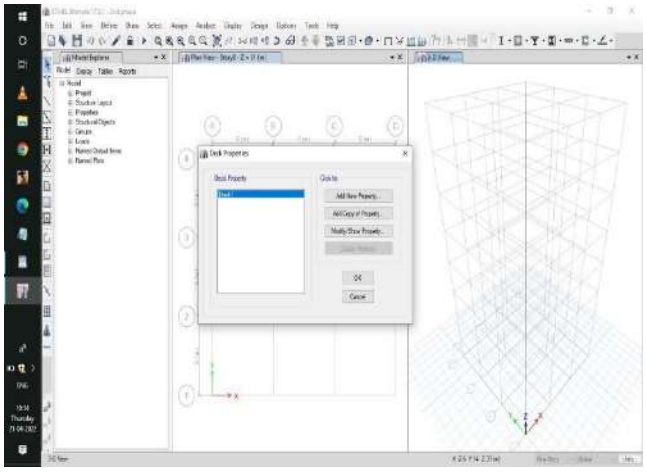
## CHAPTER 4

## ASSIGNING MATERIALS

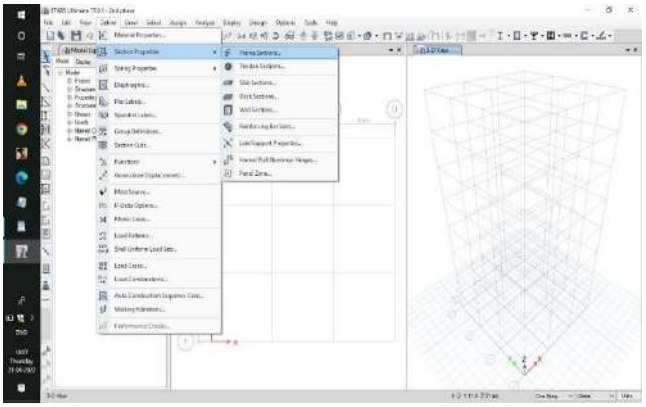
Steel Frames regular structure with stilt 8 have been considered in the study Fundamental period of vibration of the frame with fixed support and Fe345 and IS 800- 2007. model analysis has been evaluated in this building frame is designed as per Indian standards.In order to understand the effect of pushover analysis of existing Steel frame structure base model using ETABS 2017. Pushover analysis of the models are performed using ETABS 2017.

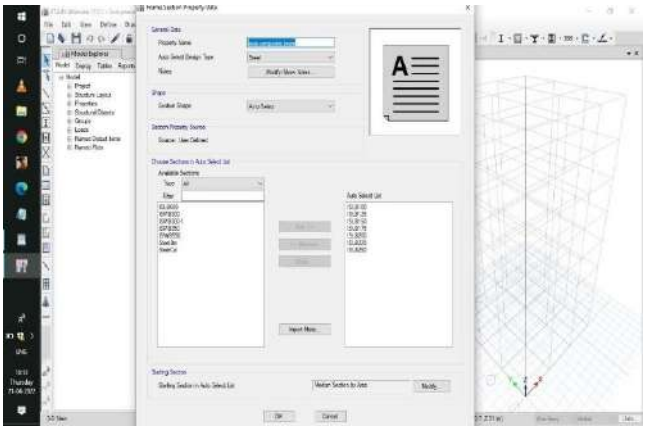


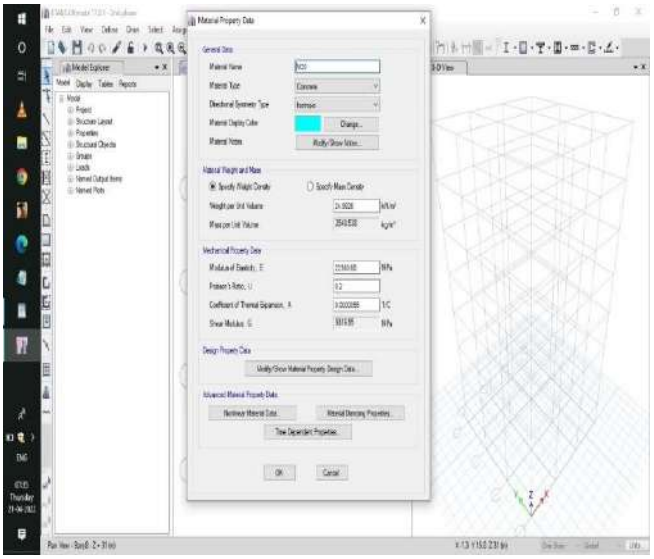


### 4.2 MATERIAL PROPERTIES

ISMB 300 FOR COLUMN







ISMB 350 FOR BEAM FE345

GRADE OF STEEL HYSD500

### 4.3 SIZE OF STRUCTURAL ELEMENT

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COLUMN ISMB- 300

BEAM ISMB- 350

SLAB THICKNESS- 150MM

BEAM MAIN ISMB- 350

SLAB -4000Psi

DECK SLAB -Fe345

DECK STAIRS – SOLID SLAB 4000Psi.

## ASSIGNING LOADS

**Table 4.1 - Load Patterns**

| Name | Type | Self Weight Multiplier | Auto Load |
|---|---|---|---|
| Dead | Dead | 1 | |
| Live | Live | 0 | |
| sdl | Superimposed Dead | 0 | |
| sesmic x | Seismic | 0 | IS1893 2002 |
| sesmic y | Seismic | 0 | IS1893 2002 |
| wind x | Wind | 0 | Indian IS875:1987 |
| wind y | Wind | 0 | Indian IS875:1987 |
| general | Other | 0 | |

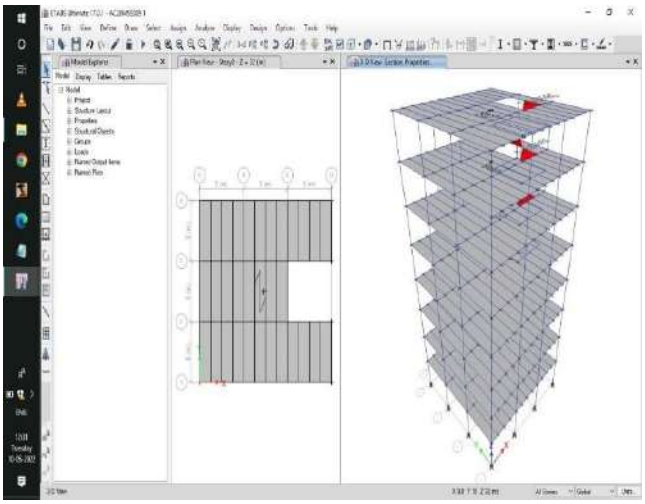
## ASSIGN FRAMES

Mesh Wall at locations where you expect loading to vary via Edit > Edit Shells > Divide Shells.

**Concentrated loads** – Apply concentrated moments and/or joint loads by selecting the joint and going to Assign > Joint Loads > Force.

**Line loads** – For linear distributed loading, define a frame object with negligible structural properties, then draw these frames where line loads are to be applied. Select the frame objects and go to Assign > Frame loads > Distributed, then scale their magnitude according to tributary allocation.

**Area loads** – Similarly, apply shell loads by selecting the wall and going to Assign > Shell loads > Uniform or Non-Uniform loads.



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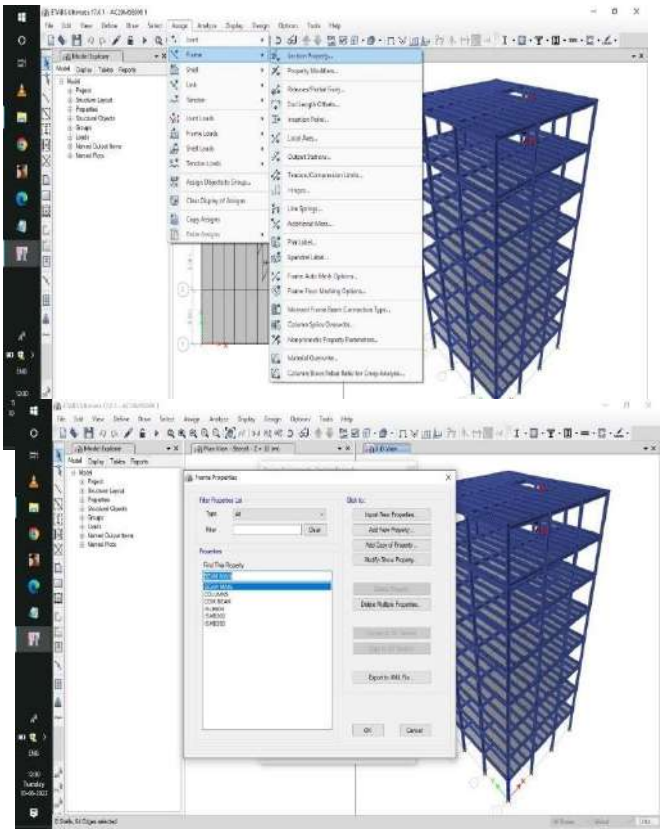

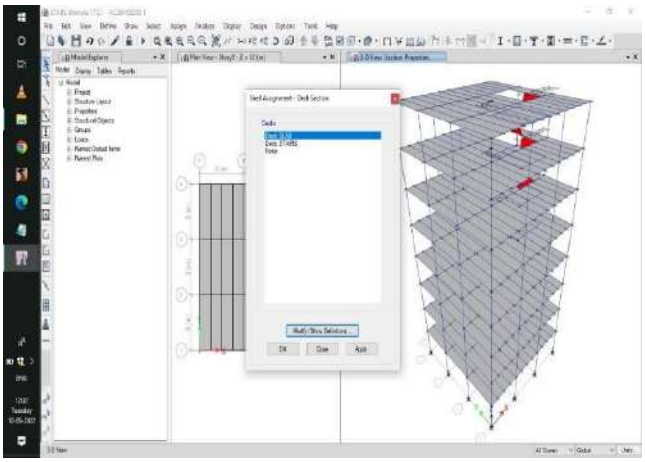

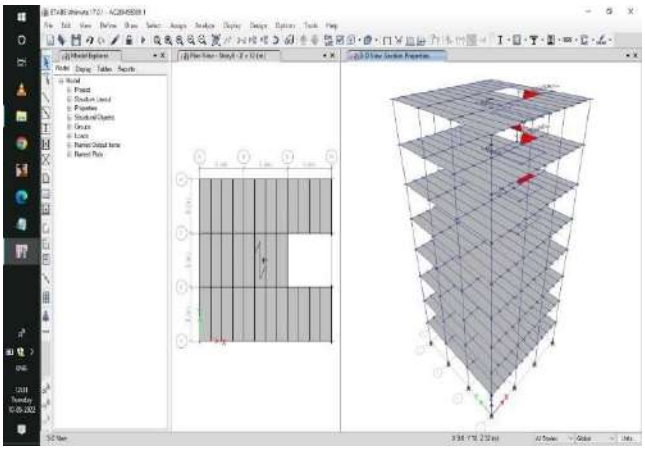

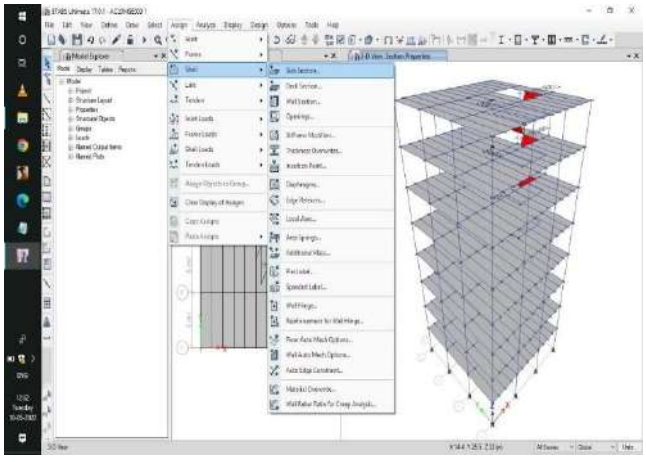

## CHAPTER 6

### DEFINING SECTION PROPERTIES

**The process for importing frame section properties from shape libraries is shown through the sequence of screenshots which follow:**

Select frame properties.

Expand frame properties menu.

Import frame section property.

Import section property file

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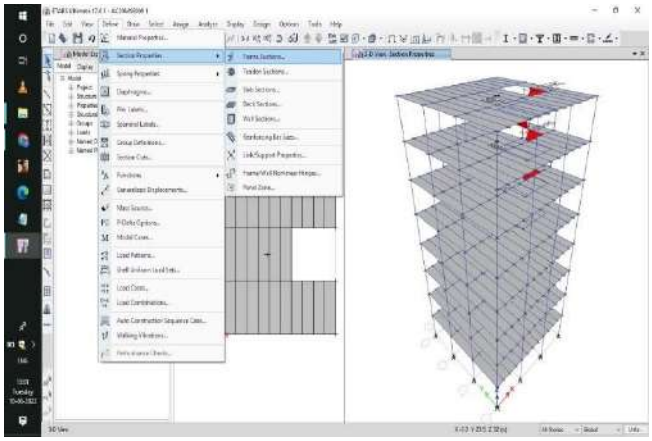

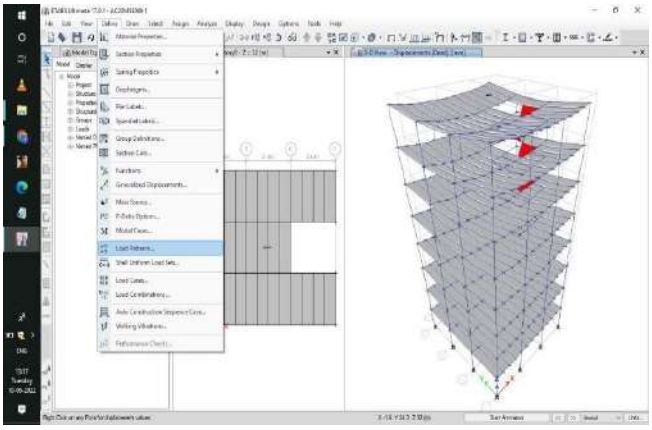

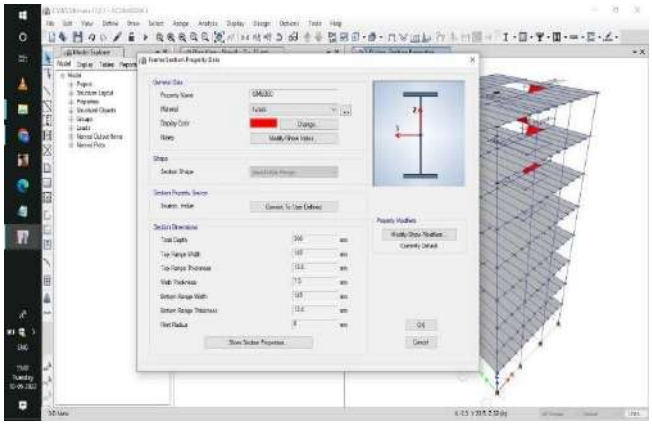

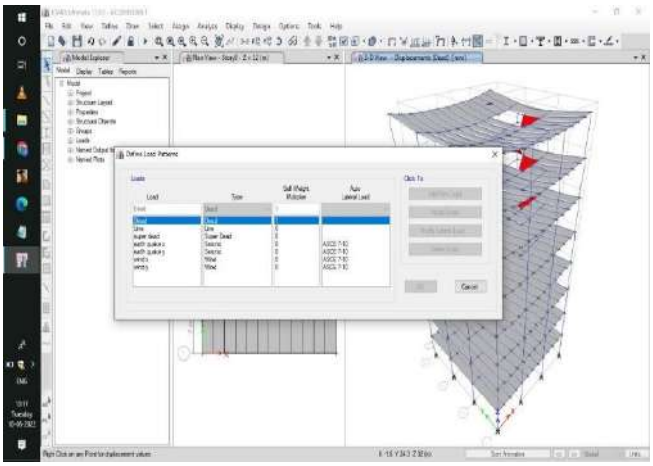

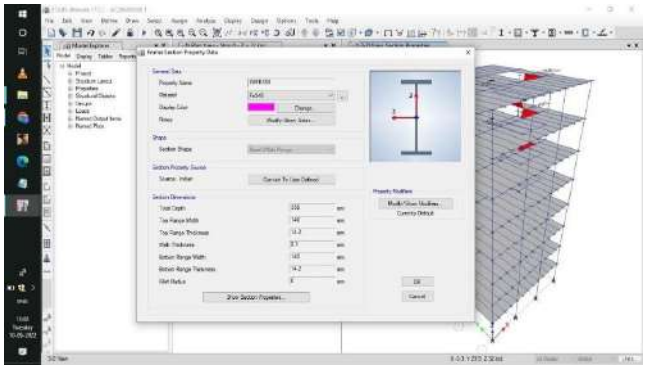

## CHAPTER 7

**Each load pattern is assigned a design type (DEAD, WIND, QUAKE, etc.) which classifies the load and initiates the associated computational process. Users may define an unlimited number of load patterns. Load patterns are then applied through load cases to generate analysis results.**

## CHAPTER 8

## ASSIGNING THE SHELL LOADS AND FRAME LOADS.

In ETABS non-uniform loads can be assigned to shell elements via **Assign > Shell Loads > uniform**. This option allows the user to assign non-uniform loads in any direction based on global coordinates.

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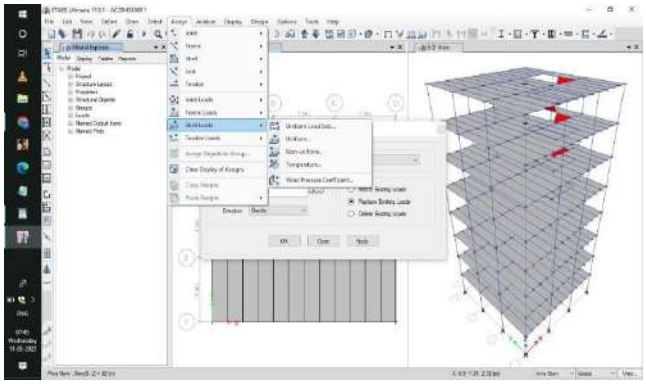
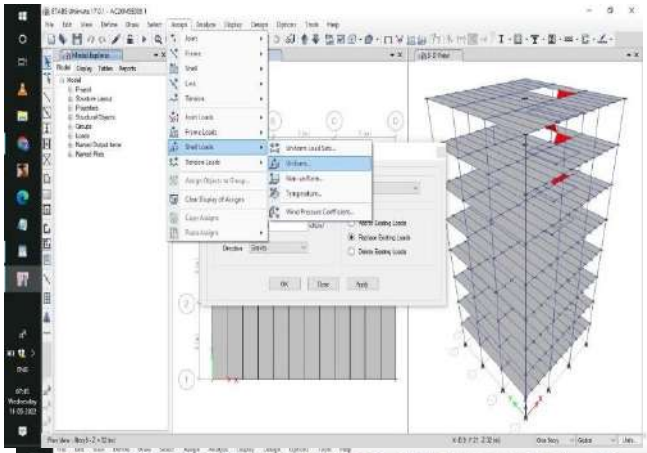
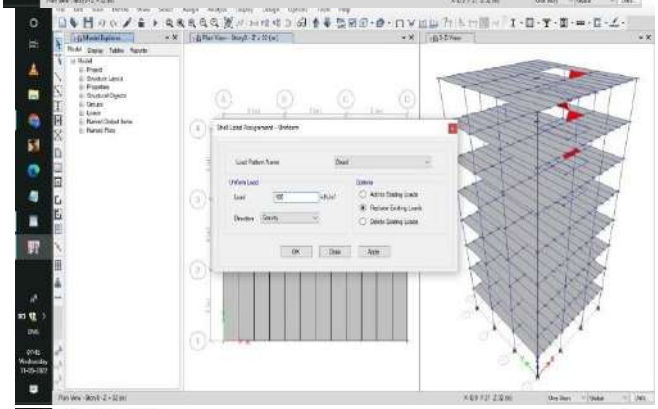
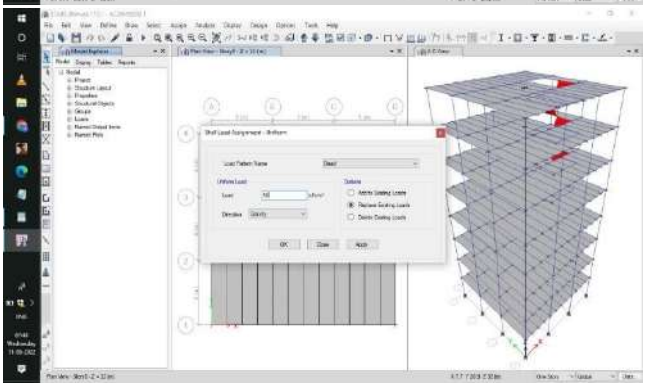






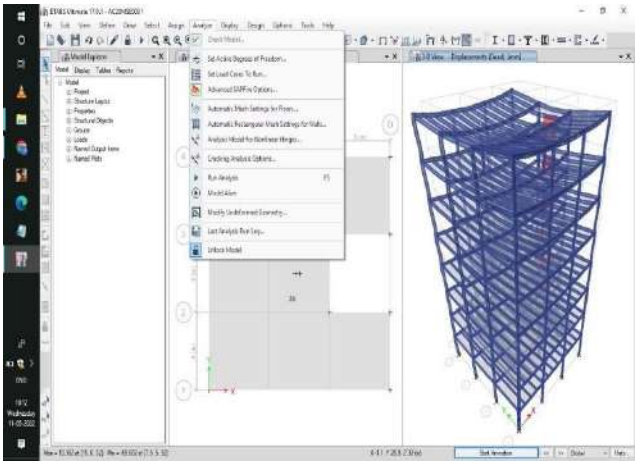


## CHAPTER 9

## ANALYSING AND CHECKING THE MODEL

There are two options to design the columns in ETABS. We can either use the “Reinforcement to be Checked” and “Reinforcement to be Designed” option. Reinforcement to be checked option is used when the designer inputs the number of rebars and the program will check if the inputted rebar is sufficient enough to carry such load. On the other hand, when using “Reinforcement to be Designed”, the program will generate the area of rebar needed in that column for the designer to interpret into how many numbers of rebar required.

Of the two options in column design, this article will guide on how to do it using the “Checked” option.



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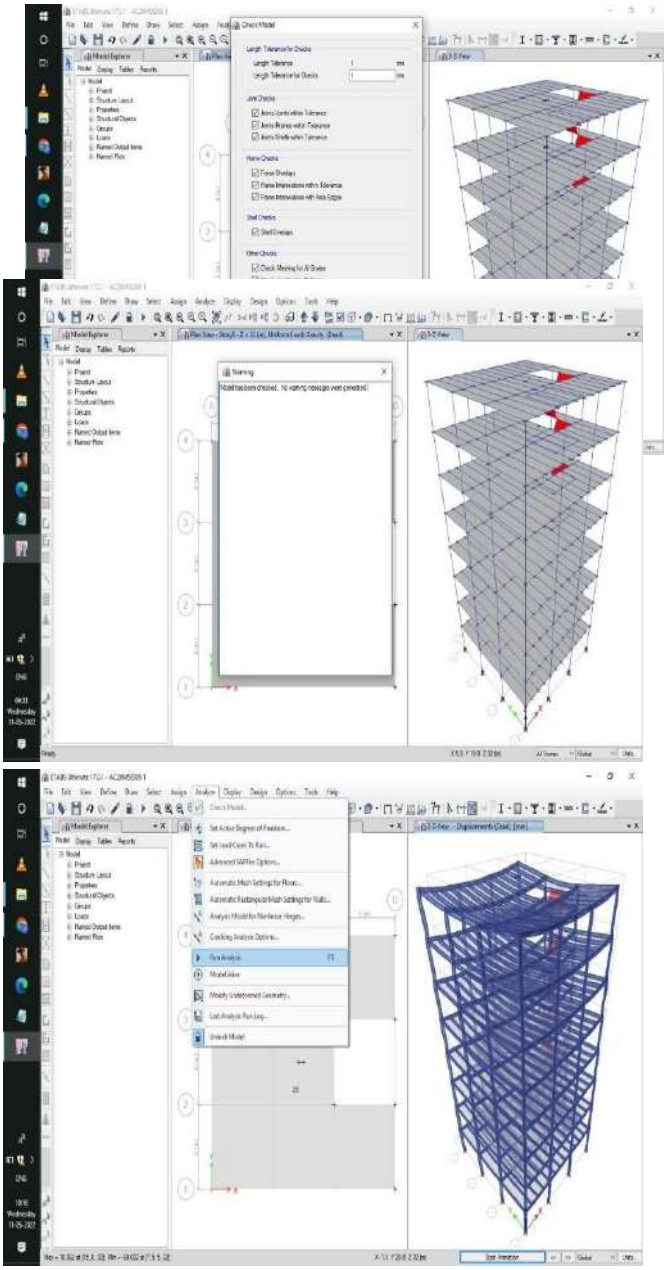

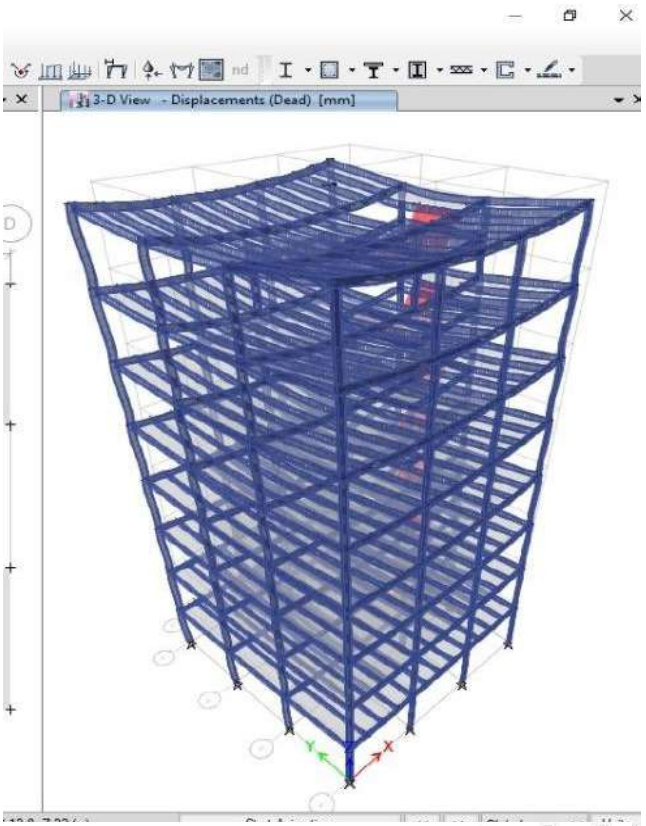


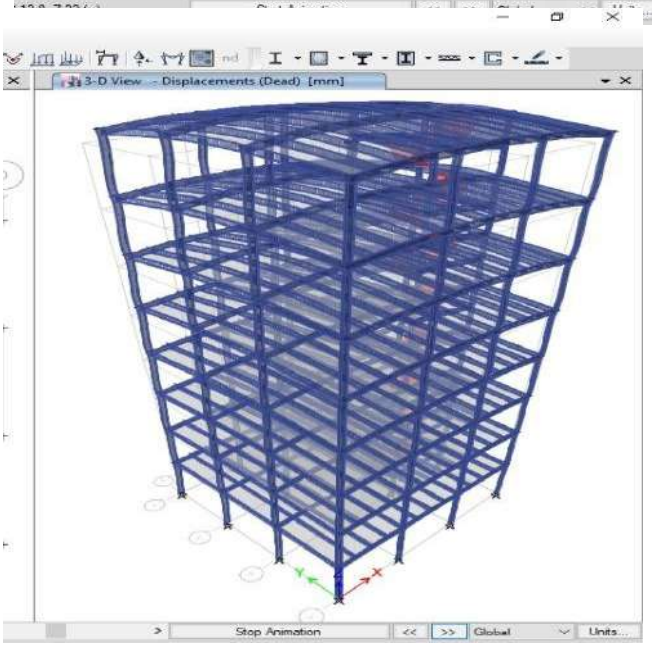


**3D VIEW**

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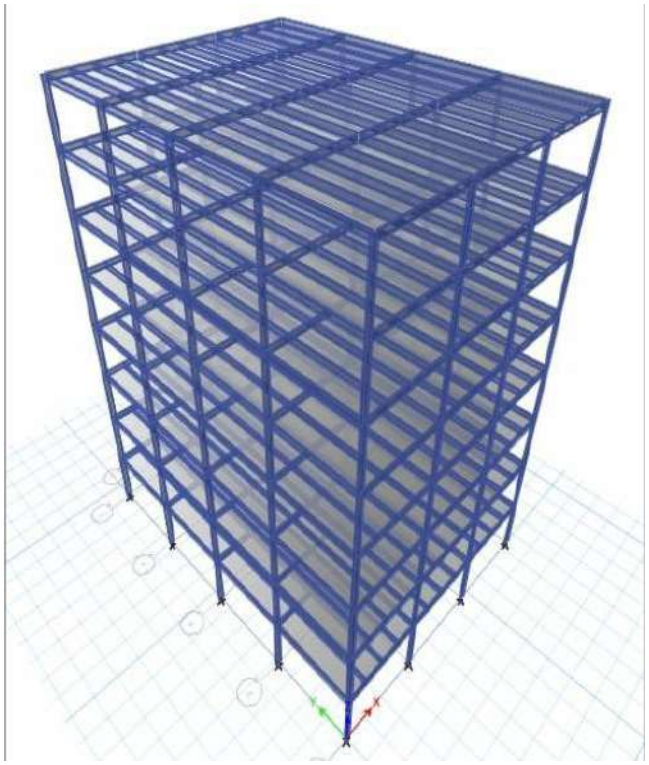
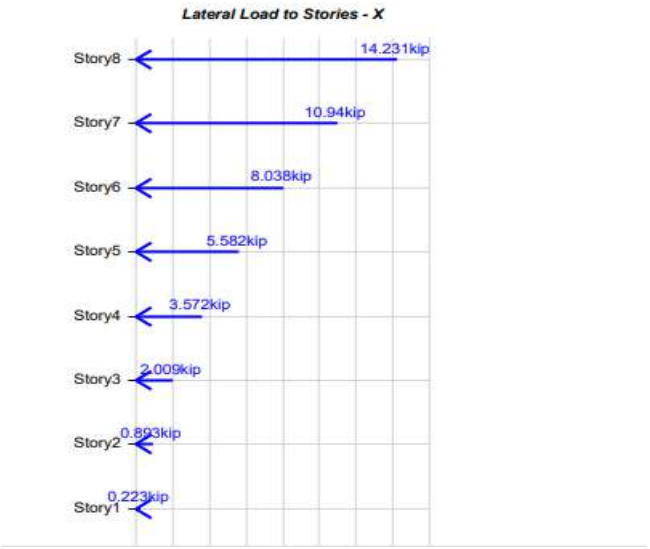


Loads




**CHAPTER 10**

**OVERALL REPORTS**

**BASE SHEAR AND SEISMIC WEIGHT OF THE BUILDING**

| Story | Elevation ft | X-Dir kip | Y-Dir kip |
|---|---|---|---|
| Story8 | 96 | 0 | 14.231 |
| Story7 | 84 | 0 | 10.94 |
| Story6 | 72 | 0 | 8.038 |
| Story5 | 60 | 0 | 5.582 |
| Story4 | 48 | 0 | 3.572 |
| Story3 | 36 | 0 | 2.009 |
| Story2 | 24 | 0 | 0.893 |
| Story1 | 12 | 0 | 0.223 |
| Base | 0 | 0 | 0 |

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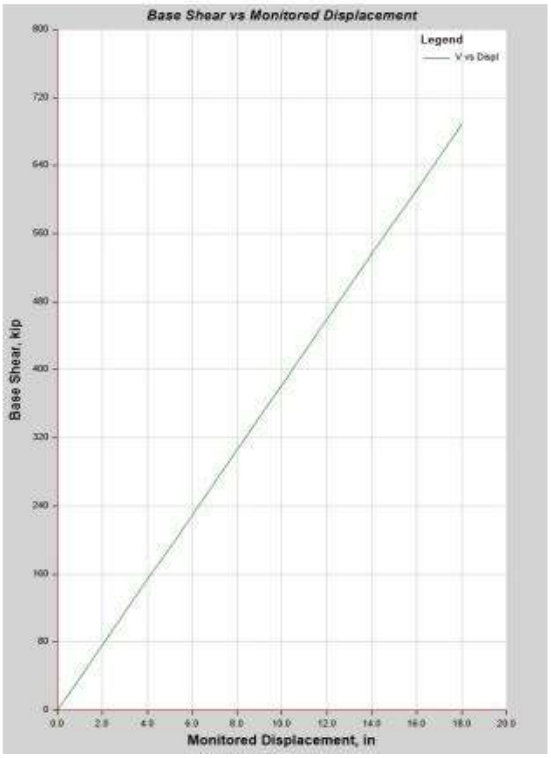
Loads




## PUSHOVER CURVE




| Story | Elevation ft | X-Dir kip | Y-Dir kip |
|---|---|---|---|
| Story8 | 96 | 14.231 | 0 |
| Story7 | 84 | 10.94 | 0 |
| Story6 | 72 | 8.038 | 0 |
| Story5 | 60 | 5.582 | 0 |
| Story4 | 48 | 3.572 | 0 |
| Story3 | 36 | 2.009 | 0 |
| Story2 | 24 | 0.893 | 0 |
| Story1 | 12 | 0.223 | 0 |
| Base | 0 | 0 | 0 |

Table 5.7 - Modal Load Participation Ratios

| Case | Item Type | Item | Static % | Dynamic % |
|---|---|---|---|---|
| Modal | Acceleration | UX | 99.95 | 97.8 |
| Modal | Acceleration | UY | 100 | 100 |
| Modal | Acceleration | UZ | 0 | 0 |

Table 5.8 - Modal Direction Factors

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## CHAPTER 11 RESULTS AND DISCUSSIONS.

- Software used for nonlinear static analysis is ETABS 2016 having features of performing performance based analysis by going through some simple steps.
- The push over curve are mainly explained using standard pushover curve in which categorization stress points are done.

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