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ANALYSIS & DESIGN OF R.C.C MULTISTORIED RESIDENTIAL BUILDING (C+G+5) USING ETABS

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Abstract: *The main steps of any building construction and planning is drafting, analysing and designing the building. In the present days of improving science and technology, analysing and designing of a building has been made easy by using ETABS software. ETABS software helps civil engineers to make their work easy and decreases time necessary for planning. The project going to be done is design of a multi-storey building (C+G+5) which is going to be used as a residential. The building plan has been drafted using the AutoCAD software by the requirement and available area. The super structure i.e. the building frame has been analyzed and designed using the ETABS software. In the present project C+G+5 building consider to analysis and design for gravity and lateral (wind and earth quake) loads as per Indian standards. By using the software building can be analyzed and we can check for any failures in the analysis and redesign them, so that we can prevent failures after construction. By using the output building can be constructed according to the design.*

I- INTRODUCTION

A residential building is defined as the building which provides more than half of its floor area for dwelling purposes. In other words, residential building provides sleeping accommodation with or without cooking or dining or both facilities.

A building is a man-made structure with a roof and walls standing more or less permanently in one place. Buildings come in a variety of shapes, sizes and functions, and have been adapted throughout history for a wide number of factors, from building materials available, to weather conditions, to land prices, ground conditions, specific uses and aesthetic reasons. To better understand the term building compares the list of structures. Buildings serve several needs of society – primarily as shelter from weather, security, living space, privacy, to store belongings, and to comfortably live and work. A building as a shelter represents a physical division of the human habitat (a place of comfort and safety) and the outside (a place that at times may be harsh and harmful). Ever since the first cave paintings, buildings have also become objects or canvases of artistic expression. In recent years, interest in sustainable planning and building practices has also become an intentional part of the design process of many new buildings. A slab is a flat two dimensional planar structural element having thickness small compared to its other two dimensions. It provides a working flat surface or a covering shelter in buildings. It primarily transfers the load by bending in one or two directions. Reinforced concrete slabs are used in floors, roofs and walls of buildings and as the decks of bridges. The floor system of a structure can take many forms such as in situ solid slab, ribbed slab or pre-cast units. Slabs may be supported on monolithic concrete beam, steel beams, walls or directly over the columns. Concrete slab behave primarily as flexural members and the design is similar to that of beams.

In this project, an effort made on planning, analysis and design of residential building. For analysis and design of building, the plan draft by

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AUTO-CAD software which plan import in Etabs.

1.2 CONVENTIONAL SYSTEM

The structural components in a typical multi-storey building, consists of a floor system which transfers the floor loads to a set of plane frames in one or both directions. The floor system also acts as a diaphragm to transfer lateral loads from wind or earthquakes. The frames consist of beams and columns and in some cases braces or even reinforced concrete shear walls. As the height of the building increases beyond ten stories (tall building), it becomes necessary to reduce the weight of the structure for both functionality and economy

Since concrete floors are functionally more suitable, have less vibration and more abrasion and fire resistance, the usual tendency is to make them act either with profiled steel decks and/or with steel beams to give a light weight floor system. Similarly masonry walls may be replaced with glazing and curtains or blinds to reduce the weight. The different types of floors used in steel-framed buildings are as follows:

- Concrete slabs supported by open-web joists
- One-way and two-way reinforced concrete slabs supported on steel beams
- Concrete slab and steel beam composite floors
- Profiled decking floors
- Precast concrete slab floors.
- Steel forms or decks are usually attached to the joists by welding and concrete slabs are poured on top. This is one of the lightest types of concrete floors. For structures with light loading.

1.3 OBJECTIVE

The main objective of this study is to identify various parameters to design the structure. Analysis and Design of Multi Storeyed residential Building using ETABS. The ETABS stands for extended 3D analysis for building system. This is based on the stiffness matrix and finite element based software. The analysis and design is done to satisfy all the checks as per Indian standards. Finally data base is prepared for various structural responses.

1.4 SCOPE OF WORK

The analysis is implemented for Analysis and Design of Multi Storeyed l Building using ETABS. The structure is analyzed for the loading systems as per the IS 456- 2000 codal provisions.

1.5 Types of Residential Buildings

Residential buildings are divided into following types:

Individual houses or private dwellings

1. Lodging or rooming houses
2. Dormitories
3. Apartments
4. Hotels

1. Individual houses or Private dwellings

Individual houses or private dwellings are generally owned by members of a single family only. If more than one family residing in that building then it is called as multiple family private dwelling.

2. Lodging or Rooming Houses

Lodging or rooming houses are multiple or group of buildings which come under one management. In this case, Accommodation is provided for separately for different individuals on temporary or permanent basis.

3. Dormitories

Dormitories are another type of residential buildings, in which sleeping accommodation is provided together for different individuals. School hostels, military barracks come under this category.

4. Apartments

Apartments or flats are big buildings which consists separate dwellings for different families. Apartment will resides minimum three or more families living independently of each other.

5. Hotels

Hotels are just like lodging houses and also managed by single management but they provide accommodation primarily on temporary basis. inns, motels etc come under this category.

1.6 Site Selection for Residential Buildings

Selection of site for any building is a very important and experts job and should be done very very carefully by an experienced engineer. The requirements of site for buildings with different occupancies are different. Following are some of the important factors which should be considered while selecting site for any residence.

1. The site should be in fully developed area or in the area which has potential of development.
2. There should be good transport facilities such as railway, bus service, for going to office, college, market, etc.
3. Civic services such as water supply, drainage sewers, electric lines, telephone lines, etc. should be very near to the selected site so as to obtain their services with no extra cost.
4. Soil at site should not be of made up type as far as possible. The buildings constructed over such soils normally undergo differential settlement and sometimes become the cause of collapse. Cracks in buildings in such conditions, are quite common
5. The selected site should be large enough; both to ensure the building abundant light and air to prevent any over dominance by the neighboring buildings.
6. The ground water table at the site should not be very high.
7. Nearness of schools, hospitals, market, etc. are considered good for residential site but these facilities do not carry any significance in the selection site for other public buildings.
8. Good foundation soil should be available at responsible depth. This aspect saves quite a bit in the cost of the building.
9. The site should command a good view of landscape such a hill, river, lake, etc.
10. Residential house site should be located away from the busy commercial roads.
11. Residential site should not be located near workshops, factories, because such locations are subjected to continuous noise.
12. Orientation of the site also has some bearing on its selection. Site should be such in our country that early morning sun and late evening sun is accepted in the building in summer and maximum sun light is available in most of winter.

II - LITERATURE REVIEW

Sreeshna K.S (2016) this paper deals with structural analysis and design of B+G+4 storied apartment building. The work was completed in three stages. The first stage was modelling and analysis of building and the second stage was to design the structural elements and the final was to detail the structural elements. In this project Etabs software is used for analysing the building. The IS:875 (Part 1) and (Part 2) were referred for dead load and live load. Design of structural elements like beam, column, slab, staircase, shear wall, retaining wall, pile foundation is done according to IS Codes.

Bandipati Anup et al., (2016) this paper deals with evaluate and plan a multi-storeyed building [G + 2 (3- dimensional frame)] adopting Etabs. The technique used in Etabs is limit state

technique. Initially they have created 2-D frames and cross checked with physical calculations. The exact result should be proved. We tested and created a G + 2 storey building [2-D Frame] instantly for all feasible load combinations. The work has been finished with some more multi-storeyed 2-Dimensional and 3- Dimensional frames beneath various load combinations

Aman et al., (2016) has discussed that the point of the structural engineer is to model a guarded structure. Then the structure is subjected to various types of loading. Mostly the loads put in on the building are considered as static. Finite part analysis that exhibit the result of dynamic load like wind result, earthquake result, etc. The work is conducted using Etabs software.

Madhurivassavai et al., (2016) he says that the most common problem country facing is the growing population. Because of the less availability of land, multi-storey building can be constructed to serve many people in limited area. Efficient modelling is performed using Etabs and AutoCAD. Manual International Journal of Pure and Applied Mathematics Special Issue 2798 calculations for more than four floor buildings are tedious and time consuming. Etabs provides us a quick, efficient and correct platform for analysing and coming up with structures.

K. Rama Raju et al., (2013) has explained that the building becomes taller, the quantity of structural material needed to withstand the oblique loads rises extremely. Tall buildings design involves conceptual design, preliminary design and lateral loads. Criteria for design are strength and serviceability. Protection ofthe structure is examined against permissible limits, roof displacements, etc.

Deevi Krishna Chaitanya, et.al (January, 2017): Analysis and Design of a (G+6) Multi-Storey Building Using Etabs.: They used static indeterminacy methods to calculate numbers of unknown forces. Distributing known fixed and moments to satisfy the condition of compatibility by Iteration method. Kani's method was used to distribute moments at successive joints in frame and continues beam for stability of members of building structure. They used the designing software Etabs. Which reduced lot of time in design, gives accuracy.

R. D. Deshpande, et.al (June, 2017): Analysis, Design and Estimation of Basement+G+2 Residential Building: They found that check for deflection was safe. They carried design and analysis of G+2 residential building by using E-Tabs software with the estimation of building by method of center line. They safely designed column using SP-16 checked with interaction formula.

Sreeshna K.S (2016) this paper deals with structural analysis and design of B+G+4 storied apartment building. The work was completed in three stages. The first stage was three dimensional models and scrutiny of building and the second stage was to design the structural elements and the final was to detail the structural elements. In this project Etabs software is used for analyzing the building. The IS:875 (Part 1) and (Part 2) were referred for dead load and live load. Design of structural elements like beam, column, slab, staircase, shear wall, retaining wall, pile foundation is done according to IS Codes.

III - LAYOUT OF C+G+5 STRUCTURE USING AUTOCAD

3.1 General

AutoCAD or Computer Aided Design is a very helpful tool in drafting and designing any structure. AutoCAD uses a Graphical User Interface for the purpose of drafting and designing any structure. The software has various inbuilt tools for complex drafting. Also AutoCAD can be used for 2D, 3D and for perspective design.

With the help of AutoCAD all the drafting for the project has been done.

3.2 Details of the Project:

The plot size for the project was 25x20 mts accordingly the building has been laid in the centre of the plot leaving ample space on all the

sides for landscaping and pathways for cars and for visitors parking.

The complete structure is of 600 sqyards and the numbers of floors are C+G+5 with column orientation, beam placements and slabs as per different floors.

3.3 Layout Using AutoCAD

The layout has been mostly completed using the Line command. The unit for the layout is metres with accuracy of "0.000". Below is a screen shot of the line diagram showing the centre line for beam and column layout.

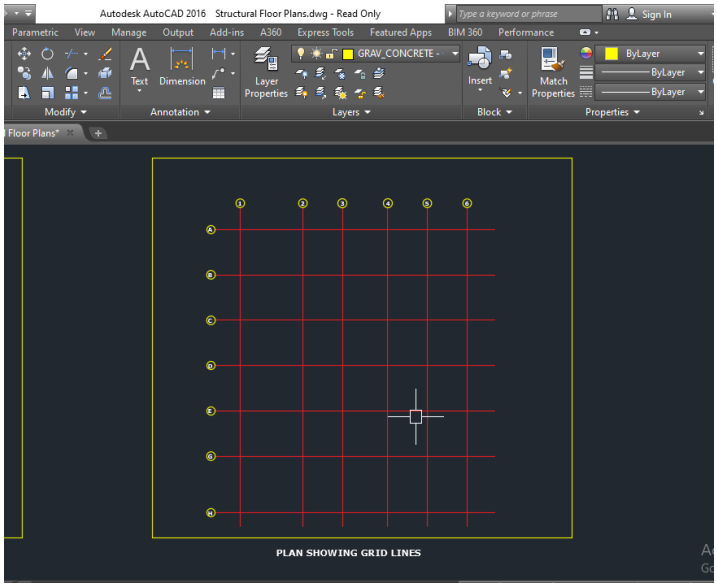

Fig 1 Shows grid lines of the building

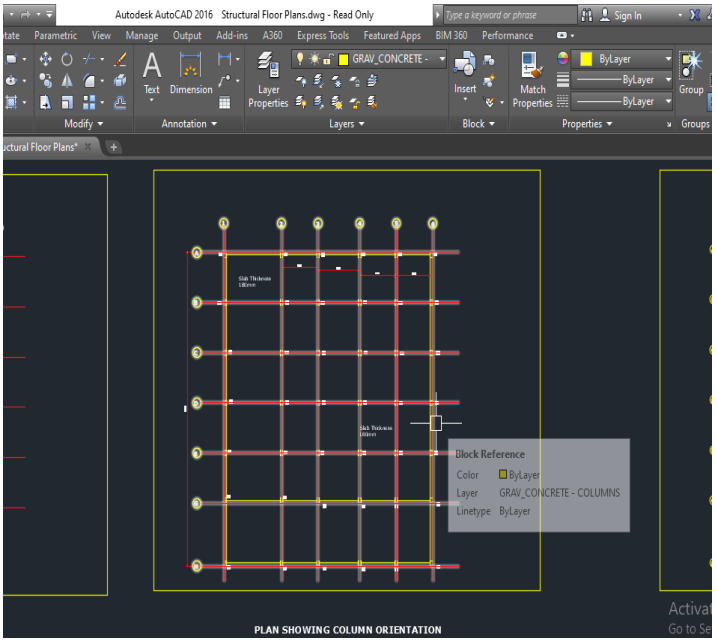

Fig 2 shows the column orientation of the building

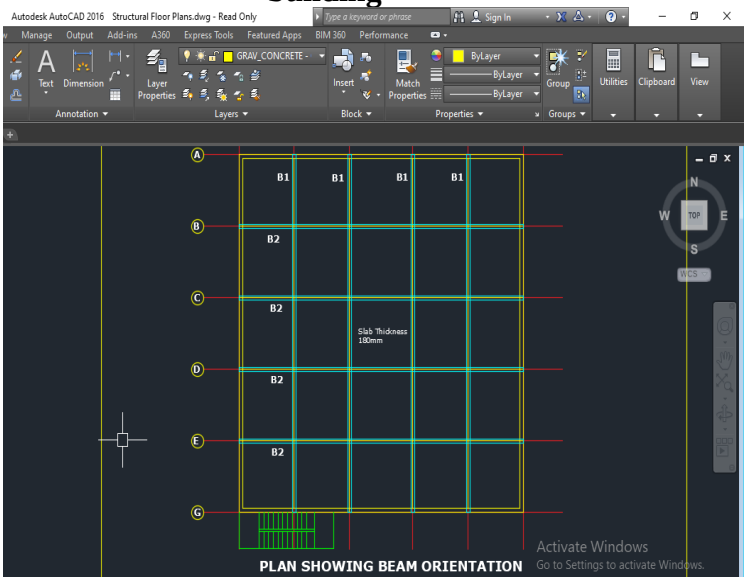

Fig 3 shows the beam orientation of the structure.

IV - DESIGN PARAMETERS

4.1 Etabs Inputs statement

Concrete Grade = M25
Clear Cover = 25mm
Fc = 25 mpa
Fy main = 500mpa
Fy Section/ Stirrups = 500mpa
Density of Concrete = 23.5Kn/m^3

Loading Considerations for elements

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Consider Finishes of 75mm with 20 Kn/m^3 Density of concrete
Brick wall/Partition walls Moderate Grade = 20 Kn/m^3
Live Load = 2.0Kn/m^2 residential

4.2 Properties of elements

a). Beam Sizes

300 mm × 400 mm C to 2nd Floor
250 mm × 350 mm 3rd to 4th Floor
225 mm × 300 mm Roof Beam Size

b). Column Sizes

250 mm × 400 mm C to 2nd Floor
230 mm × 400 mm 3rd to 4th Floor
230 mm × 350 mm Secondary Columns

c). Slabs Thickness

Floors C to 1st = 200mm
Floors 2nd to 4th Slab = 150mm
Roof Slab = 125mm

d). Wall Thickness

Partition wall = 115mm
Outer Main wall = 230mm
Parapet wall = 75mm thick / Height= 1.2m

V - ANALYSIS OF STRUCTURE

5.1 Modelling of structure

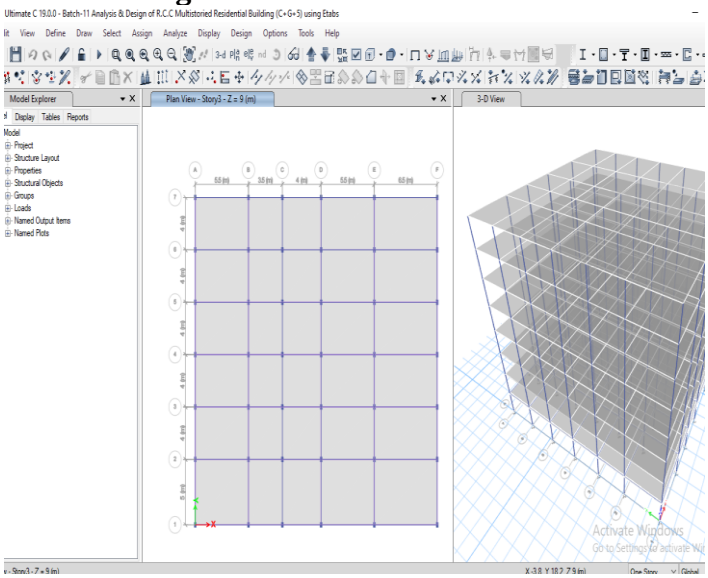


Fig 4 shows the geometry of the structure.

5.2 Member property assigning to the structural elements

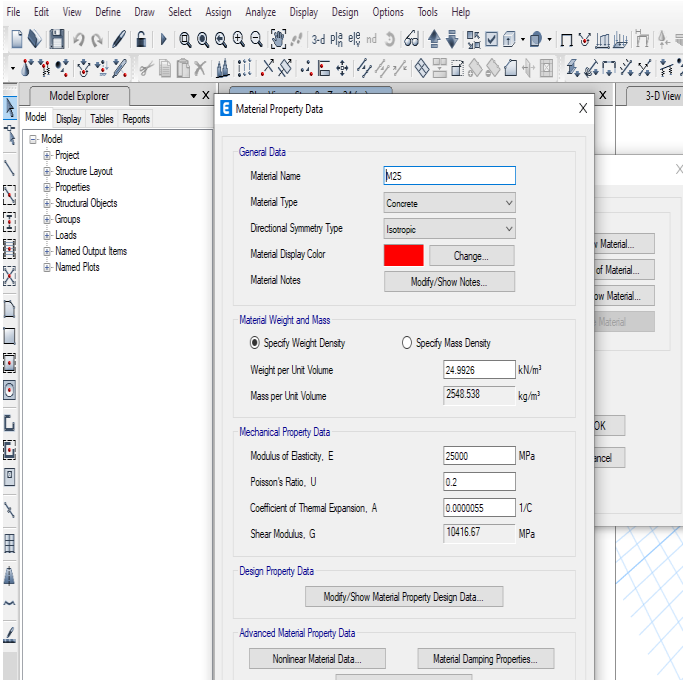


Fig 5 shows the member property of the elements.

a) Slab Properties

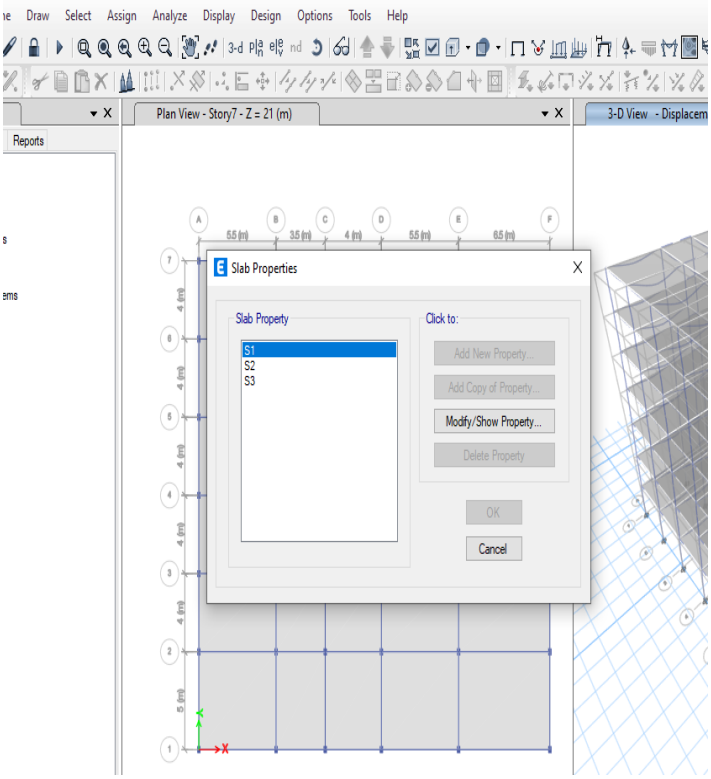


Fig 6 shows the slab member property

b). Beams and columns Property

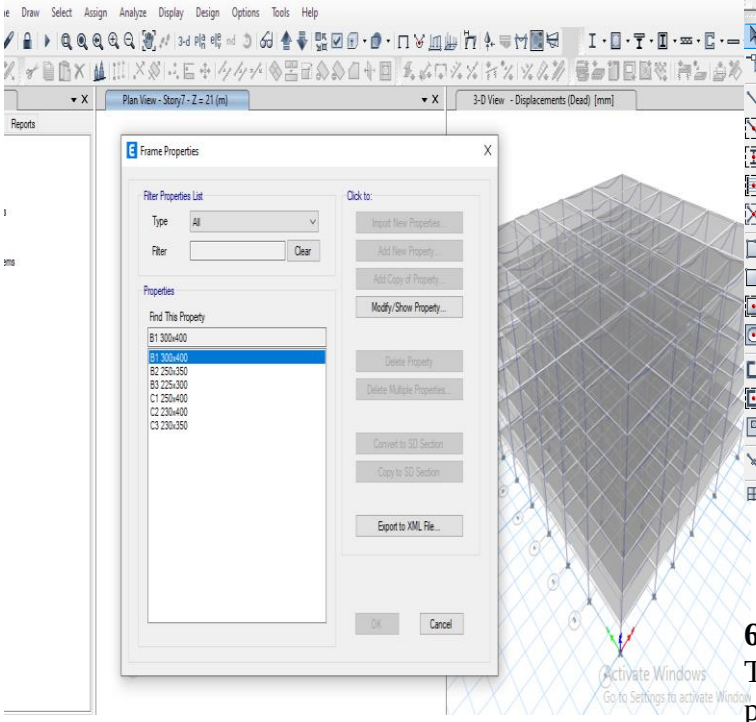


Fig 7 shows the Beam member property

5.3 Assigning of Loads (Load Cases)

- Dead Load
- Live Load
- Floor Finishes
- Brick Wall Load
- Inner Partition Wall Loads
- Roof Loads

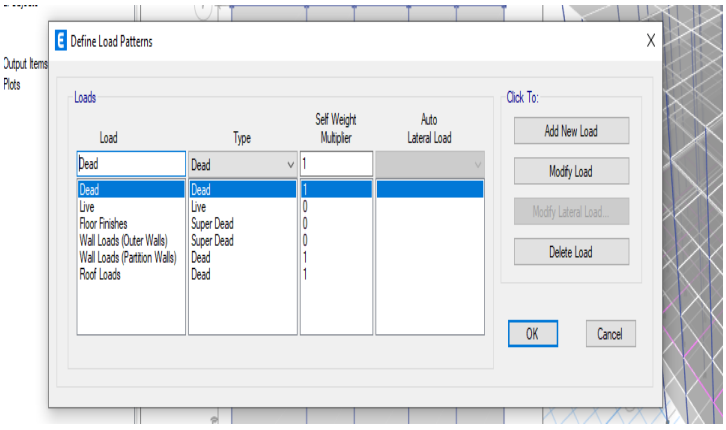


Fig 8 load patterns for the structure

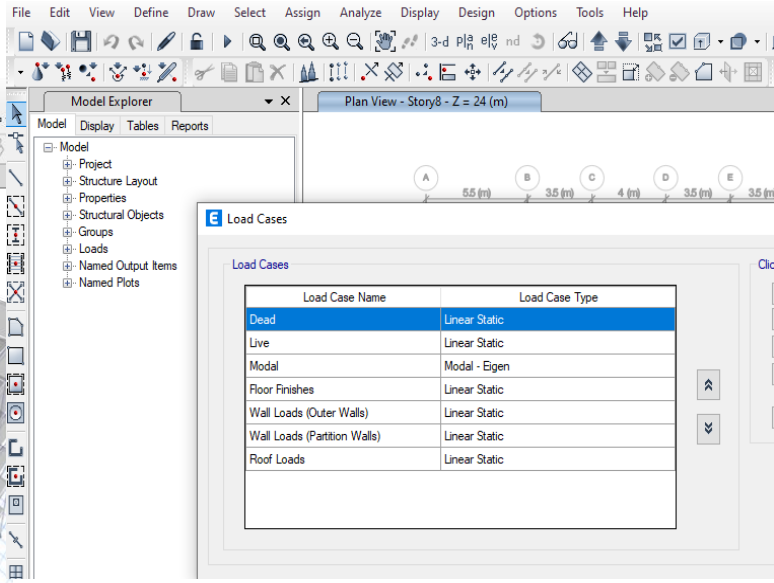
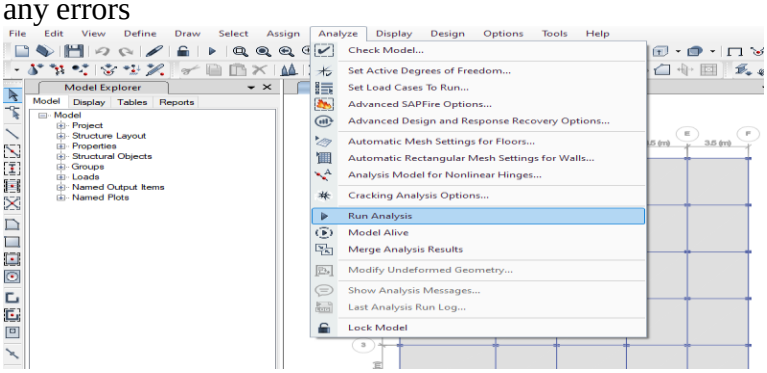


Fig 9 load cases for the structure

VI - ETABS RESULTS

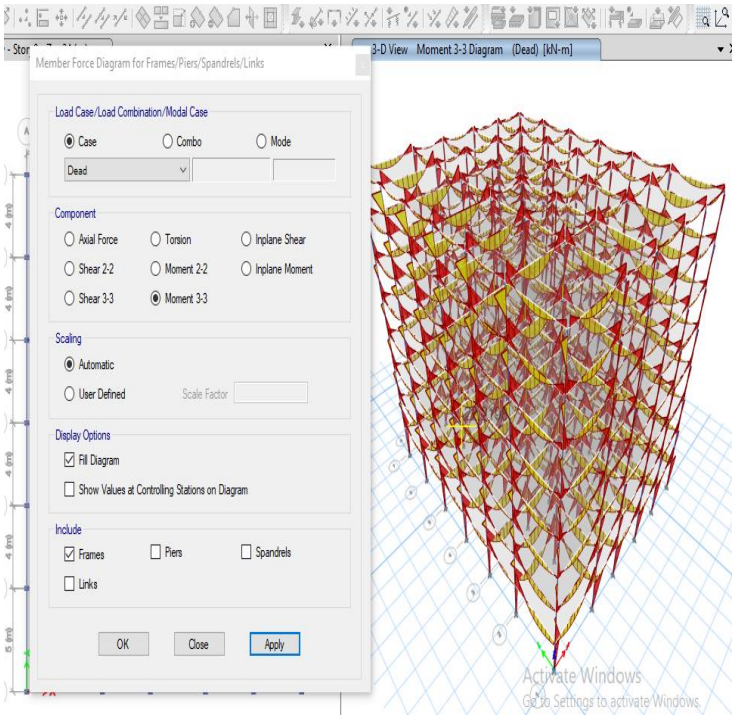
6.0 Etabs result output.

The analysis done from considering all the above parameters state that the structure is safe without any errors

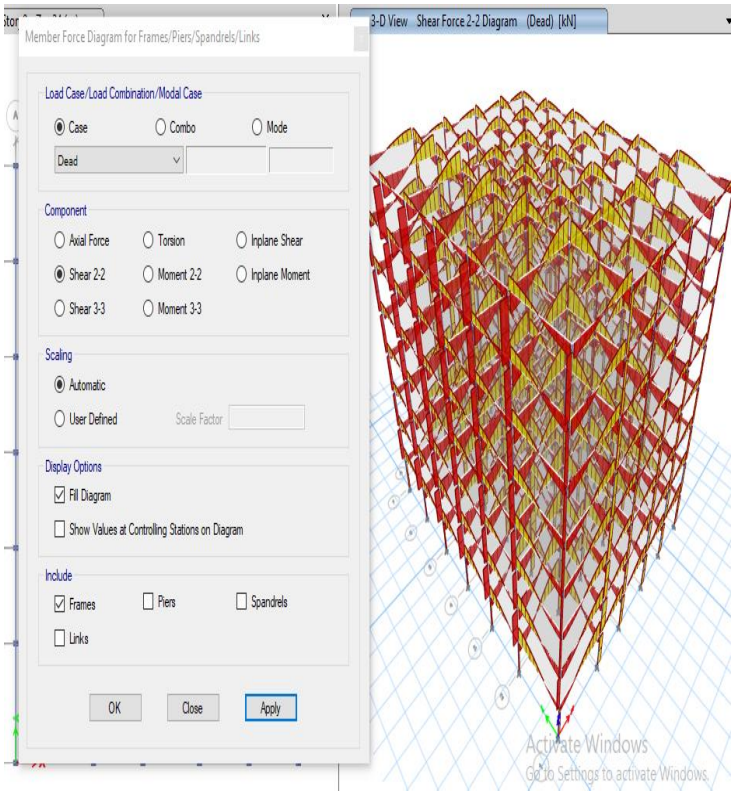


6.1 Design Moment , axial and Shear Results

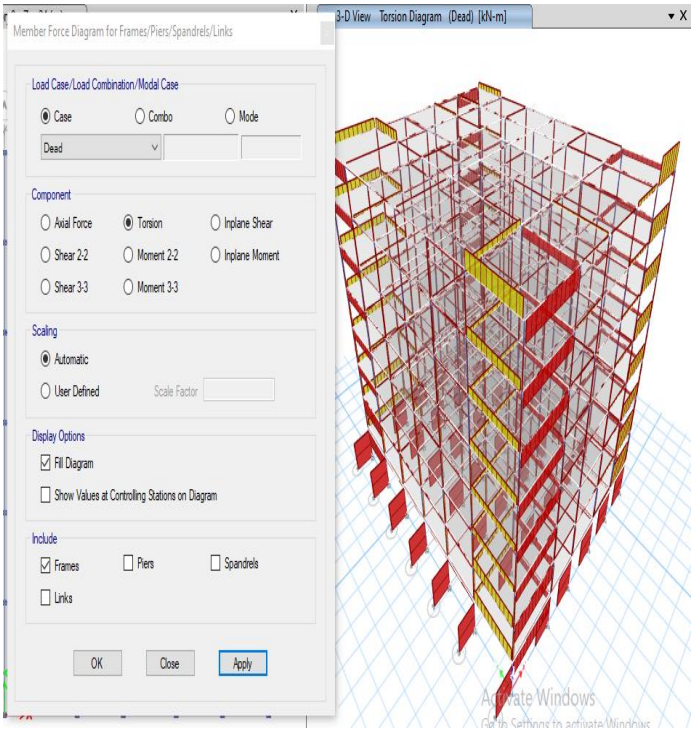
6.2 Bending Moment Results



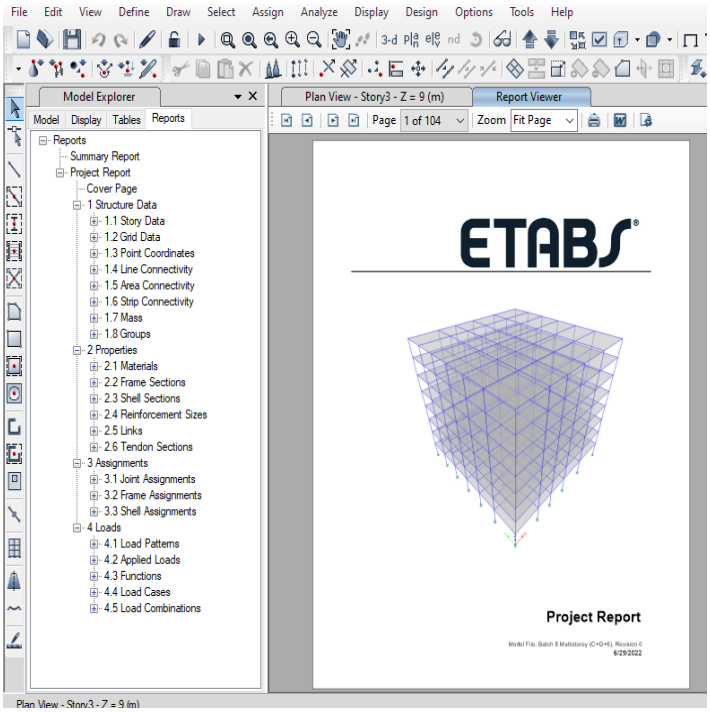
6.3 Shear Force Results



6.4 Torsion Force Results



6.5 Reinforcement Design Outputs



1 STRUCTURE DATA

This chapter provides model geometry information, including items such as story levels, point coordinates, and element connectivity.

Story Data

Table 1 Story Definitions

Tower	Name	Height m	Master Story	Similar To	Splice Story	Color
T1	Story7	3	No	None	No	Red
T1	Story6	3	No	None	No	Magenta
T1	Story5	3	No	None	No	Yellow
T1	Story4	3	No	None	No	Gray8Dark
T1	Story3	3	No	None	No	Blue
T1	Story2	3	No	None	No	Green
T1	Story1	3	No	None	No	Cyan

Table 2.1 - Material Properties - General

Material	Type	SymType	Grade	Color	Notes
4000Psi	Concrete	Isotropic	f'c 4000 psi	Gray8Dark	
A416Gr270	Tendon	Uniaxial	Grade 270	Green	
A615Gr60	Rebar	Uniaxial	Grade 60	Blue	
A992Fy50	Steel	Isotropic	Grade 50	Yellow	
HYSD500	Rebar	Uniaxial	HYSD Grade 500	Gray8Dark	
M25	Concrete	Isotropic	M25	Yellow	

Name	Material	Shape	Color							3Pos m3
B1 300x400	M25	Concrete Rectangular	Cyan							6000
B2 250x350	M25	Concrete Rectangular	Magenta							3645.8
B3 225x300	M25	Concrete Rectangular	Gray8Dark	675	6318	4804.6	28476.6	506.25	562.5	562.5 1.5 2531.3
C1 250x400	M25	Concrete Rectangular	Green							4166.7
C2 230x400	M25	Concrete Rectangular	Red	920	103995.4	40556.7	122666.7	766.7	766.7	3526.7
C3 230x350	M25	Concrete Rectangular	Yellow	805	84095	35487.1	82177.1	670.8	670.8	3085.8

Area Load Assignments - Uniform (continued)

Story	Label	UniqueName	Load Pattern	Direction	Load kN/m2
Story5	F8	128	Floor Finishes	Gravity	1.5
Story5	F9	129	Floor Finishes	Gravity	1.5
Story5	F10	130	Floor Finishes	Gravity	1.5
Story5	F11	131	Floor Finishes	Gravity	1.5
Story5	F12	132	Floor Finishes	Gravity	1.5
Story5	F13	133	Floor Finishes	Gravity	1.5
Story5	F14	134	Floor Finishes	Gravity	1.5
Story5	F15	135	Floor Finishes	Gravity	1.5
Story5	F16	136	Floor Finishes	Gravity	1.5
Story5	F17	137	Floor Finishes	Gravity	1.5
Story5	F18	138	Floor Finishes	Gravity	1.5
Story5	F19	139	Floor Finishes	Gravity	1.5
Story5	F20	140	Floor Finishes	Gravity	1.5
Story5	F21	141	Floor Finishes	Gravity	1.5
Story5	F22	142	Floor Finishes	Gravity	1.5
Story5	F23	143	Floor Finishes	Gravity	1.5
Story5	F24	144	Floor Finishes	Gravity	1.5
Story5	F25	145	Floor Finishes	Gravity	1.5
Story5	F26	146	Floor Finishes	Gravity	1.5
Story5	F27	147	Floor Finishes	Gravity	1.5
Story5	F28	148	Floor Finishes	Gravity	1.5
Story5	F29	149	Floor Finishes	Gravity	1.5
Story5	F30	150	Floor Finishes	Gravity	1.5
Story4	F1	151	Floor Finishes	Gravity	1.5
Story4	F2	152	Floor Finishes	Gravity	1.5
Story4	F3	153	Floor Finishes	Gravity	1.5
Story4	F4	154	Floor Finishes	Gravity	1.5
Story4	F5	155	Floor Finishes	Gravity	1.5
Story4	F6	156	Floor Finishes	Gravity	1.5
Story4	F7	157	Floor Finishes	Gravity	1.5
Story4	F8	158	Floor Finishes	Gravity	1.5
Story4	F9	159	Floor Finishes	Gravity	1.5
Story4	F10	160	Floor Finishes	Gravity	1.5
Story4	F11	161	Floor Finishes	Gravity	1.5
Story4	F12	162	Floor Finishes	Gravity	1.5
Story4	F13	163	Floor Finishes	Gravity	1.5
Story4	F14	164	Floor Finishes	Gravity	1.5
Story4	F15	165	Floor Finishes	Gravity	1.5
Story4	F16	166	Floor Finishes	Gravity	1.5
Story4	F17	167	Floor Finishes	Gravity	1.5
Story4	F18	168	Floor Finishes	Gravity	1.5
Story4	F19	169	Floor Finishes	Gravity	1.5
Story4	F20	170	Floor Finishes	Gravity	1.5
Story4	F21	171	Floor Finishes	Gravity	1.5
Story4	F22	172	Floor Finishes	Gravity	1.5

Analysis Results

This chapter provides analysis results.

Structure Results

Table Base Reactions

Output Case	Case Type	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	X m
Dead	LinStatic	-336	-336	23546.7236	299016.3587	-295682.2471	8	0
Live	LinStatic	0	0	10937.5	136718.75	-136718.75	0	0
Floor Finishes	LinStatic	0	0	6562.5	82031.25	-82031.25	0	0
Partition Wall Loads	LinStatic	0	0	9345.7	123982.6	-117816.65	0	0
External Wall	LinStatic	0	0	17197.6	216524	-212483.6	0	0

Type	FX kN	FY kN	FZ kN	MX kN-m	MY kN-m	MZ kN-m	X m	Y m	Z m
atic	0	0	0	0	0	0	0	0	0
natio	-504	-504	84978.7854	1082331.3131	-1062021	12	0	0	0
natio	-504	-504	101385.0354	1287409.4381	-1267099	12	0	0	0

VII - CONCLUSION

Building plan was develop and draft in Auto-CAD with required dimension. During designing C+G+5 storeys residential building structure is capable to sustain all loads acting on building. The design of slab, beam, column, is done with IS 456-2000 as limit state method in addition to that IS code 875 were also used for other loading parameters. Etabs has the ability to calculate the Reinforcement needed for any concrete section. The design output gives the complete detailing of reinforcement quantity of the complete structure as output and as per result; structure is safe without any errors as per output given by Etabs.

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