International journal of basic and applied research
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.86

STOREY DRIFTS AND EARTHQUAKE LOAD (EQ) ANALYSIS OF A RESIDENTIAL BUILDING USING ETABS

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Abstract: Structural Analysis is a branch which includes in the determination of conduct of constructions to anticipate the reactions of various underlying segments because of the impact of loads. Every single construction will be exposed to possibly one or the gatherings of loads, the different sorts of loads typically considered are dead loads, live loads, wind load IS:875-1987 Part1, 2, 3, seismic load (IS:1893-2016). ETABS (Extended Three-Dimensional Analysis of Building System) is a product which is joined with all the significant forces that are static, dynamic, Linear and non-direct, and so on. This Computer programming's are additionally being utilized for the computation of forces, bending moment, stress, strain &deformation or diversion for a complex underlying framework and this software is utilized to design and plan the structures. The study of this project is to analyse & design of Reinforced Concrete building using Etabs. By this project, it has been checked that the displacement of the building seems to be within permissible limit'. The Structure has been designed as per Indian Codes & by laws provided by that area. In this paper, an analysis has been done on the storey height of a building situated in zone V, keeping the base dimensions constant, to find the maximum bending and shear forces at the design for earthquake load, using the software ETABS. For earthquake loads, both dynamic and static analysis has been done. The analysis for seismic loads has been carried out. Thereafter, the graphs for different values displacement at all the storey drifts, due to earthquake load (EQ) have been plotted. Keywords: About four key words or phrases in alphabetical order, separated by commas.

I. INTRODUCTION

A. Earthquake

A major disaster is an earthquake. We will not know the direction and intensity of the earthquake, so this will be a challenge forscience and technology. Many problems of earthquakes have been studied in the last few years. Today people live in many houses, when an earthquake hits area it will cause great damage. Therefore, earthquake analysis is important for the safety analysis of structures to prevent collapse and for structures to be designed to prevent earthquakes that may occur during the model service life. The shape of the earth is a sphere, and it has three layers crust, mantle and core. Earthquakes occur only in the crustal layer, which is divided into two parts, the lithosphere, and the asthenosphere. The lithosphere is a rigid plate that can be divided into seven large and smaller areas. The asthenosphere is rigid and the lithosphere floats on the asthenosphere, due to the movement of the convective plate on the lithosphere plate, a lot of energy is sent when two plates collide with each other. in the waves.

Waves cause the earth to fall in the form of vibrations that cause earthquakes. An earthquake is a shaking of the ground. This is a natural state. It is caused by energy discharges that create waves that travel in all directions.

B. E-Tab

ETABS is an progressed computer program utilized for dissecting and planning buildings. It offers effective devices for making 3D models, performing quick calculations for diverse sorts of materials, and producing reports and drawings. It makes a difference engineers rapidly get it and decipher investigation and plan comes about. ETABS streamlines the plan handle by permitting clients to change over CAD drawings into models or utilize them as layouts. It moreover permits for effective displaying by reusing comparative floor levels in buildings. Distinctive materials like steel, concrete, or composite can be relegated to distinctive parts of the structure.

The computer program too produces point by point documentation with bolster data. In less difficult terms, ETABS may be a supportive apparatus for engineers to dissect and plan multi-story buildings productively. ETABS (Expanded 3D Investigation of Building Frameworks) was created by a company called Computers and Structures, Inc. (CSI).

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It was established by Dr. Edmund "Ed" L. Wilson in 1975. Dr. Wilson could be a eminent auxiliary design and computer researcher who has made critical commitments to the field of auxiliary investigation and plan computer program. He played a key part within the advancement and progression of ETABS, which has ended up one of the leading computer program devices within the industry.

1) *Consequence AutoCAD Arrange:* Begin by bringing in the AutoCAD arrange into ETABS. This may be done by utilizing the "Purport" or "Open" work in ETABS, selecting the AutoCAD record, and setting it as a reference within the ETABS show.
2) *Demonstrate Setup:* Set up the show in ETABS based on the imported AutoCAD arrange. This includes making the building geometry, counting dividers, pieces, columns, pillars, and other auxiliary components. Utilize the ETABS apparatuses to draw these components precisely concurring to the measurements and format given within the AutoCAD arrange.
3) *Allot Materials:* Dole out suitable fabric properties to the auxiliary components. Indicate the sort of fabric (e.g., concrete, steel) and characterize their properties such as quality and solidness. This data can be gotten from plan details or fabric information.
4) *Apply Loads:* Apply loads to the demonstrate based on the data given within the AutoCAD arrange. This incorporates dead loads, live loads, and other pertinent loads such as wind or seismic powers. Utilize the stack application instruments in ETABS to precisely disseminate these loads on the basic components.
5) *Investigation:* Perform the auxiliary examination utilizing ETABS. The computer program will utilize numerical calculations to decide how the building reacts to the connected loads. It'll calculate the inner powers, stresses, and distortions within the structure.
6) *Design:* Based on the investigation comes about, continue with the plan prepare in ETABS. Utilize the plan capabilities of the program to check on the off chance that the basic components meet the desired plan codes and measures. ETABS will recommend fitting measurements and support for columns, pillars, chunks, and other components.
7) *Survey and Alter:* Audit the plan comes about and evaluate the basic execution. On the off chance that required, make alterations to the model in ETABS based on the plan proposals. This may include altering measurements, support, or basic setups to guarantee the specified security and productivity.
8) *Documentation:* Produce reports and drawings utilizing ETABS to report the examination and plan handle. These records will give a comprehensive outline of the basic examination, plan comes about, and any alterations made. By taking after these steps, you'll be able viably use ETABS with an AutoCAD arrange to form, analyse, and plan building structures precisely and effectively.

II. LITERATURE SURVEY

Literature review is an important part of research because it helps us understand past research and analysis in a particular field. In our case, data analysis focused on seismic design and the use of ETABS software to improve the accuracy of the analysis. We will review previous work and its relevance to our research. For our analysis we use the ETABS software package, which contains drawing data from AutoCAD and REVIT.

We compare our findings with previous studies to better understand the issue.

We create the equipment manually during the work and use the software during the design process. This helps us understand the technical issues facing the construction industry.

The analysis software provides the results on the trail according to the house rules. We spread our work across several buildings andfound that the results met our expectations. Since the floors of multi-storey buildings are similar, ETABS is suitable software for analysis and design.

It reduces the time required for analysis and design and allows easy replacement of building floors. Our products comply with Indian standards, especially IS 1893-part2:2002 and IS 456:2000. Our project is located in the V region with a high earthquake intensity and a response of 0.36.

For our research data, we consulted books and journals related to studies based on the design, analysis and construction of residential buildings using ETABS. We also review previous work in these areas. In short, the literature review helps us understand previous research on seismic design and the use of ETABS software. We use this software together with AutoCAD and REVIT to analyze and design various buildings.

The findings are as expected and our project follows the high seismic zone of India. The literature review includes many resources for a better understanding of the subject.

III. METHODOLOGY & MATERIALS

Block Diagram

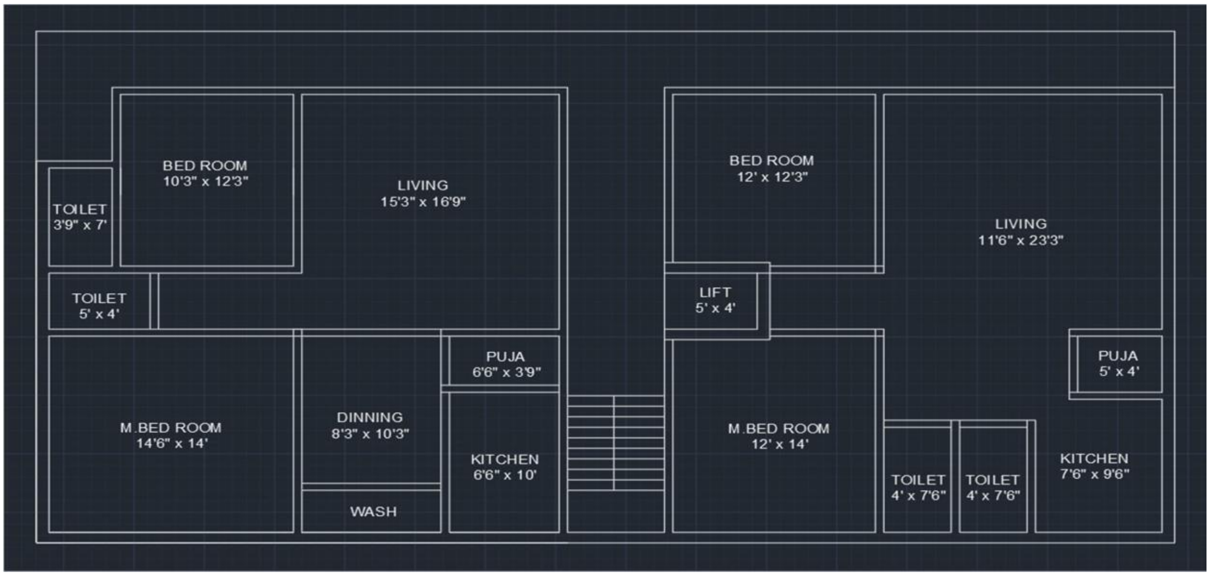

Figure (1) Plan of G+4 Reinforced Concrete building (all dimensions are in meter)

A. Structural Modelling

1) Overview

In this chapter, description of Residential building is presented. In section 4.2 four story regular reinforced concrete building is elaborated. In next section 4.3 material properties of both steel and concrete are shown. In next section 4.4 dead load , live load , earthquake load , super dead loads as well as combination of various loads are presented at the end structural elements are introduced .

2) Regular Reinforced Concrete Building

A four storied reinforced concrete building is considered. Beam length in transverse direction (x) are 4 m (3 members), 2m and 3m and beams in longitudinal direction (z) are 4m and 3m. Figure (1) shows the plan of fourth story Residential building having 5 bays in xdirection and 2 bays in x-direction. Story height of the building is taken as 3m (same for each floors). Figure (2) shows frames of the four story Reinforced Concrete Residential building. Cross section of the beam is 350x350 mm and cross section of the column is 450x 450 mm.

It provides the Structural Engineer with all of the equipment essential to create, regulate, analyse, design, and optimize constructing models. evaluation of Shear force, bending second, Displacement, Storey go with the flow, Deflection.

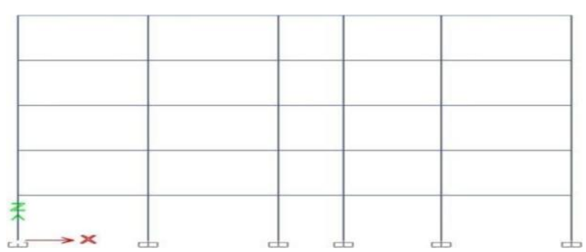

Figure (2) Frame A-A

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3) Materials

Following table shows the assumed values of steel bar and concrete taken as per IS 456:2000.

Steel Bar Properties		Concrete section Properties	
Unit Weight (γs)	76.9729 KN/m^2	Unit Weight (γc)	24.9926 KN/m^3
Modulus of elasticity	21000 Mpa	Modulus of elasticity	27386.13 Mpa
Poisson ratio (νs)	0.3	Poisson ratio (νc)	0.2
Thermal coefficient (αs)	0.0000117 Mpa	Thermal coefficient (αc)	0.0000055
Shear modulus (ςs)	80769.23 Mpa	Shear modulus (ςc)	11410.89 Mpa
Yield strength	379.5 Mpa	Damping ratio (ςc)	5%
Compressive strength(Fs)	495 Mpa	Compressive strength (Fc)	30

4) Structural Elements

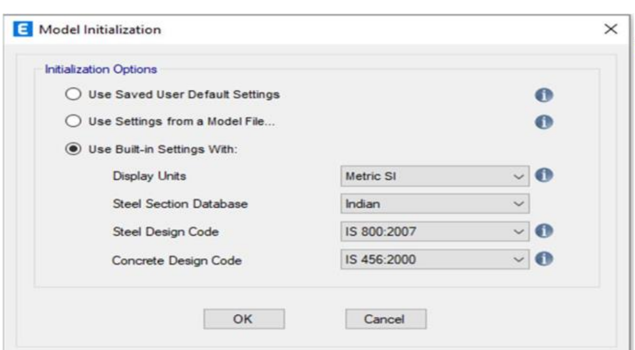
A four story symmetrical reinforced concrete residential building was analyzed for seismic loadings in ETABS software. For doing the comparative study, dimensions of beam and columns are taken as 350mm x 350mm and 450mm x 450mm respectively. Story height is taken as 3m for each stories and beam length is taken as 4m, 2m, 3m in longitudinal direction and 4m and 3m in transversedirection. These dimensions and cross sections are shown in below table.

Table-Beam and column length and their Cross Section.

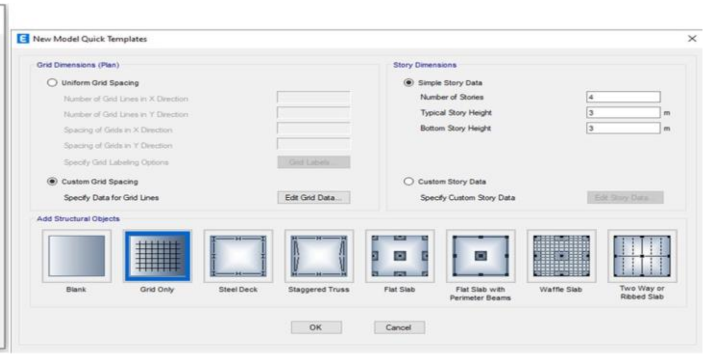
Structural Elements	Cross section (mm x mm)	Length (m)
Beam in longitudinal Direction (x)	350 x 350	4m (three no.) 3m
Beam in Transverse Direction(z)	350 x 350	4m 3m
Columns	450 x 450	4m

B. Methods

1) Analysis in ETABS



ETABS 19 application



select Grid and Story inputs

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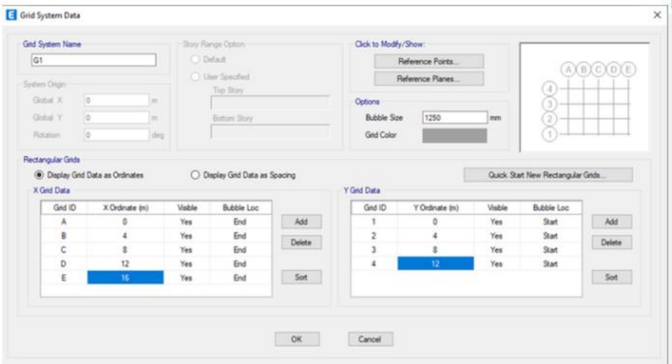
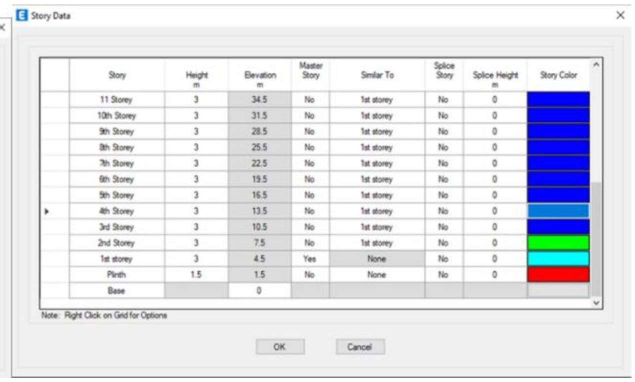
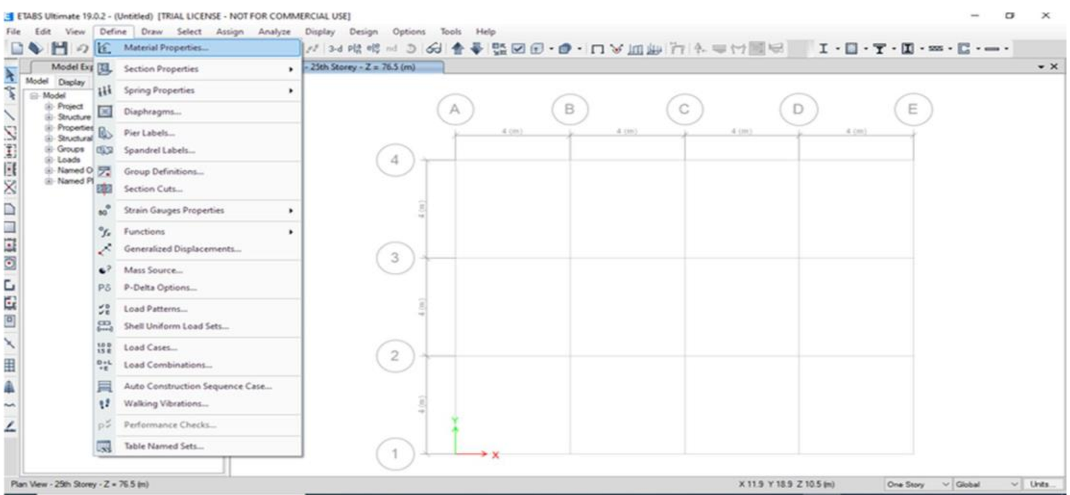


Grid system data dialogue box

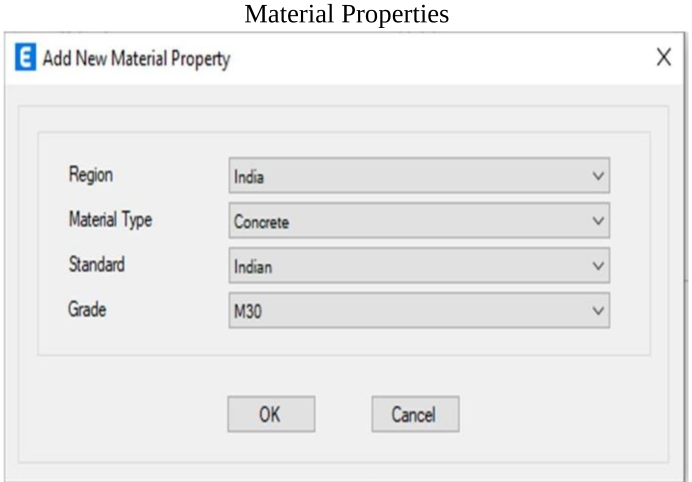


story data dialogue box

2) Applying Properties to Materials



Material Properties



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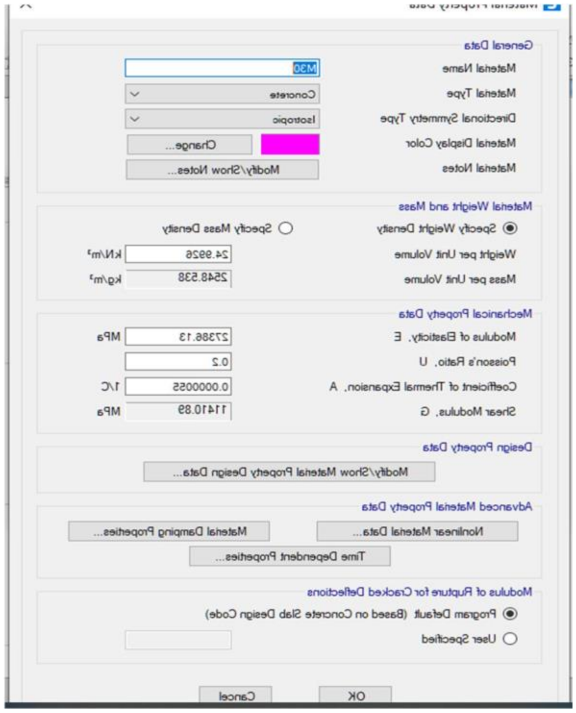

Material properties: Summary

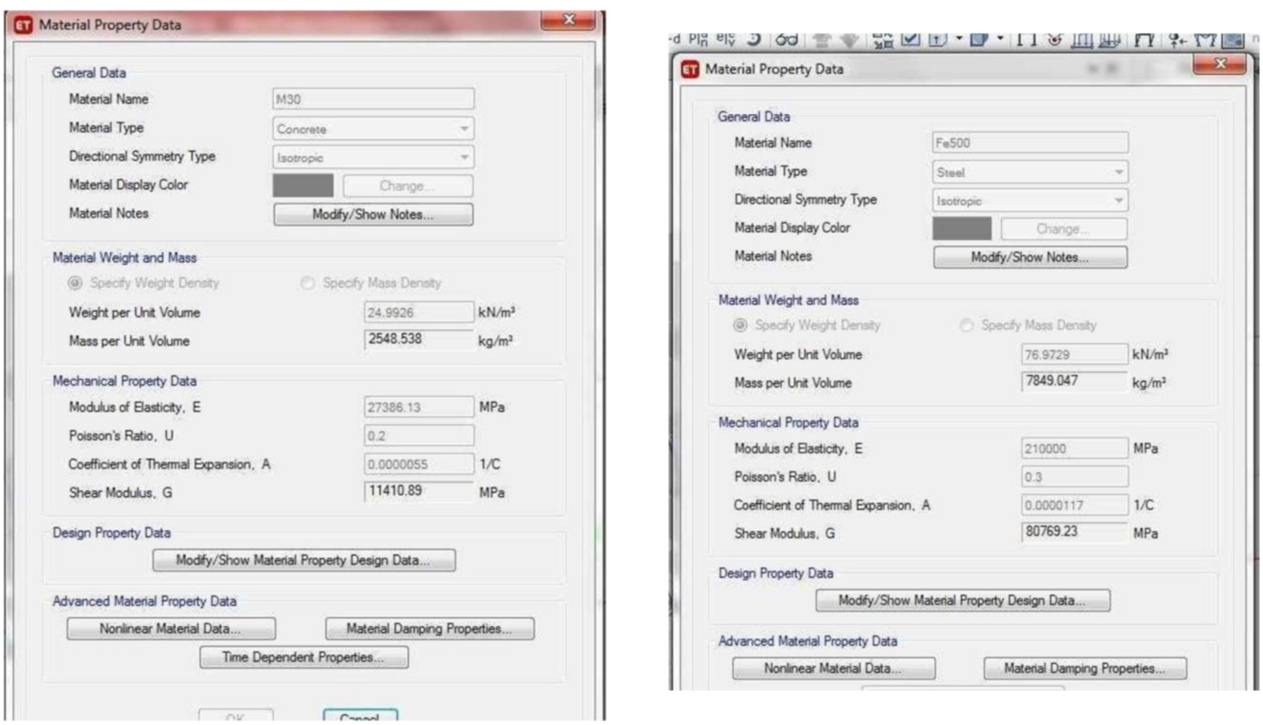

Figure Summary of Material Properties Frame Sections: Summary

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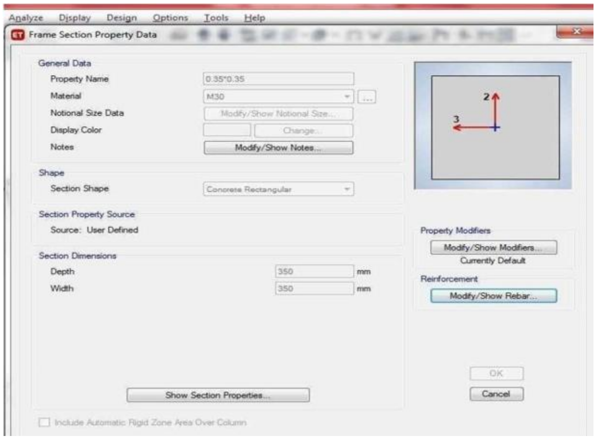
M30 Grade concrete
350mm X 350mm

Fe500 Steel
450 mm x 450 mm



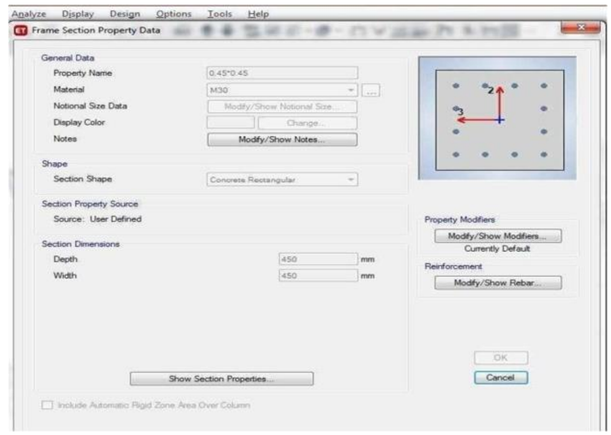
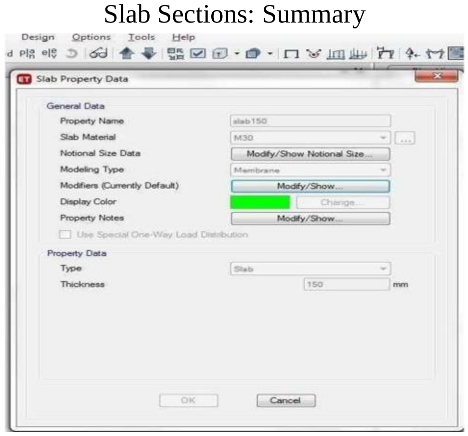
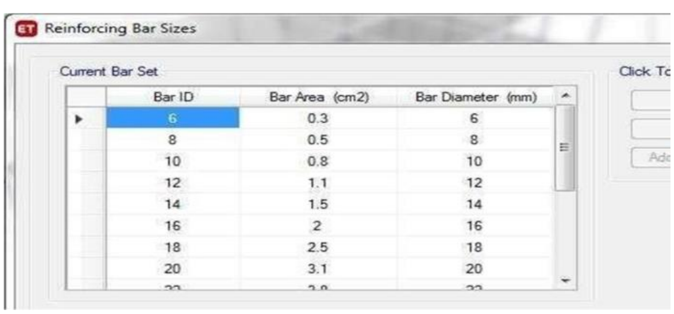


Figure- Summary of Frame Sections

Slab Sections: Summary



Slab 150
Figure- Summary of Slab Sections

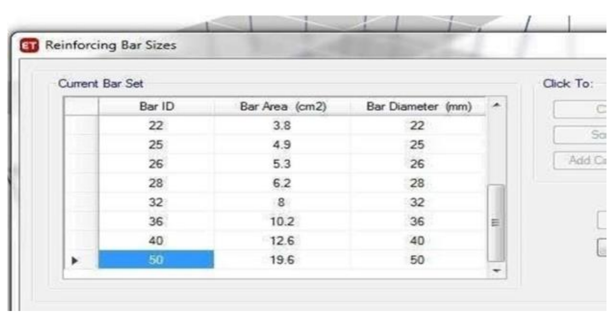


Reinforcing Bar Sizes

Current Bar Set

Bar ID	Bar Area (cm2)	Bar Diameter (mm)
6	0.3	6
8	0.5	8
10	0.8	10
12	1.1	12
14	1.5	14
16	2	16
18	2.5	18
20	3.1	20

Reinforcing Bar Sizes: Summary



Reinforcing Bar Sizes

Current Bar Set

Bar ID	Bar Area (cm2)	Bar Diameter (mm)
22	3.8	22
25	4.9	25
26	5.3	26
28	6.2	28
32	8	32
36	10.2	36
40	12.6	40
50	19.6	50

Summary of Reinforcing Bar Sizes

3) Framing of Model

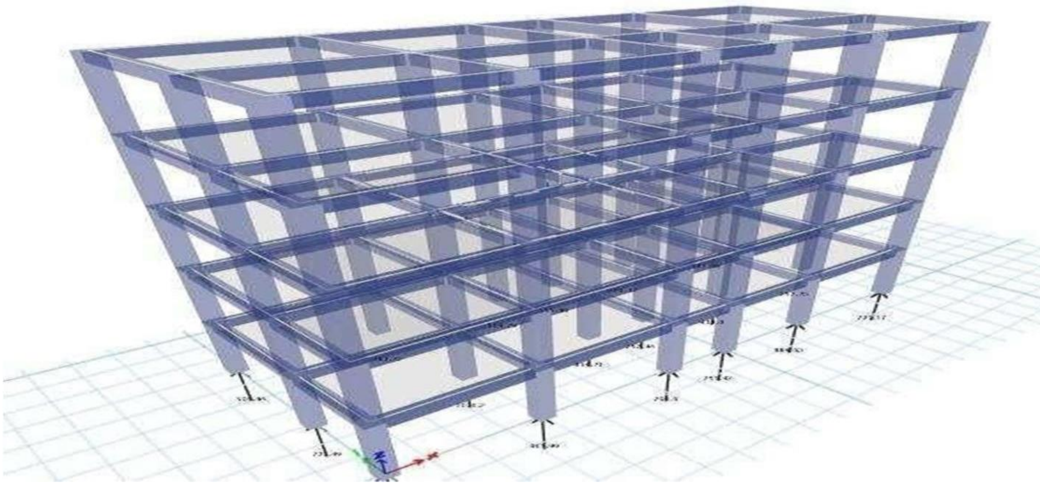


Figure-Base Loads acting on the Structure

4) Load Patterns

Name	Is Auto Load	Type	Self Weight Multiplier	Auto Load
~LLRF	Yes	Other	0	
Dead	No	Dead	1	
EQ X	No	Seismic	0	IS1893 2002
EQ Y	No	Seismic	0	IS1893 2002
floorload	No	Super Dead	0	
Live	No	Live	0	
wall loads	No	Super Dead	0	

Table 4:- Load Pattern

C. Load Calculation

Cross sectional dimensions are assumed initially to estimate the dead load from the known weights of the structure. Values of the unit weights of the materials and unit weight of the overall structure are specified in IS 875:1987 (Part 1). So the dead loads assigned on the ground floor is shown in the following figure. Unit weight of Concrete = 30 Kg/m3.

Here sample calculation is done:

Wall load

1) Outer wall load (9 Inch wall) (Wall thickness)

= 9 inch

= 0.23m)

= Wall thickness x height of floors x density of Bricks

=0.23 x 3 x 18 = 12.45 KN/m2

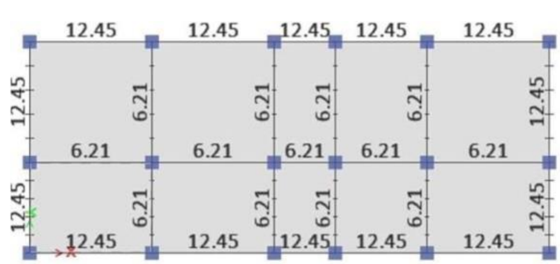


Figure-Wall Loads on Structure

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2) Inner wall load (4.5 Inch wall) (Wall thickness)
= 4.5 inch
= 0.115m)
= Wall thickness x height of floors x density of Bricks
= 0.115 x 3 x 18
= 6.25 KN/m2

Dead load
Floor finish = 1.5 KN/m2 (as per IS 875 part 1)
Total floor load = 1.5 KN/m2

IV. OBSERVATIONS

A. Shear force table

Table :- Comparison of Shear Forces acting at Corner, Centre and Front Beams and Columns

	Beam (KN)					Column (KN)				
	Ground	First	Second	Third	Fourth	Ground	First	Second	Third	Fourth
Corner	99.5	102.71	99.93	92.810	87.11	7.122	20.12	20.41	19.49	34.29
Centre	101.53	104.71	102.24	95.485	90.203	18.219	25.954	23.94	21.39	28.177
Front	70.647	69.625	70.239	70.633	73.382	17.56	23.737	21.512	18.78	21.798

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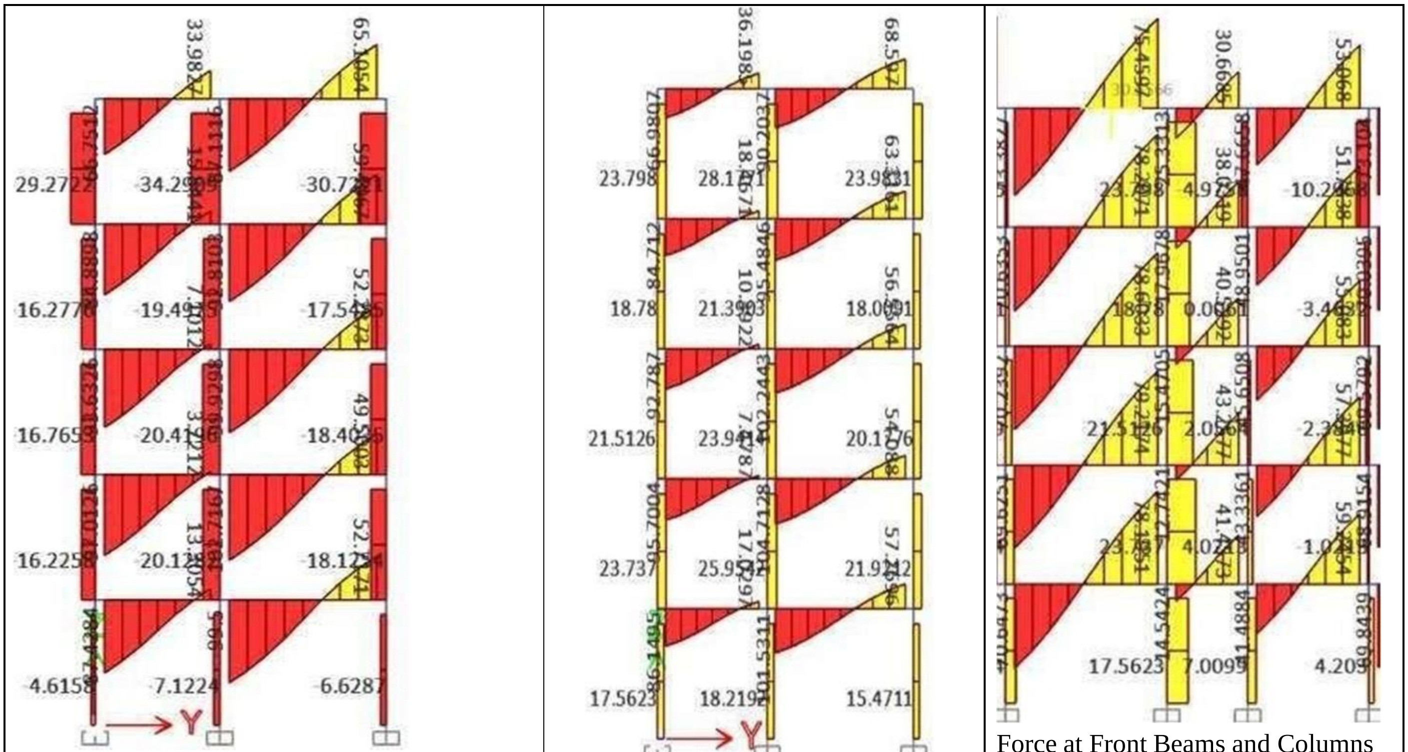

Shear Force at Corner Beams and Columns

Force at Centre Beams and Columns

Force at Front Beams and Columns

Figure-Comparison of Shear Forces acting at Corner, Centre and Front Beams and Columns

Index in Cosmos
May 2024, Volume 14, ISSUE 2
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B. Bending Moment Table

Table :- Comparison of Bending Moments acting at Corner, Centre and Front Beams and Columns

	Beam KN-m					Column KN-m				
	Ground	First	Second	Third	Fourth	Ground	First	Second	Third	Fourth
Corner	79.278	85.434	80.293	68.293	55.186	21.260	21.635	23.012	18.979	48.1154
Centre	79.976	86.090	81.484	70.7366	57.6148	27.481	39.535	34.511	31.7355	35.762
Front	79.976	86.090	46.675	47.827	45.886	27.481	36.176	30.703	27.54	29.938

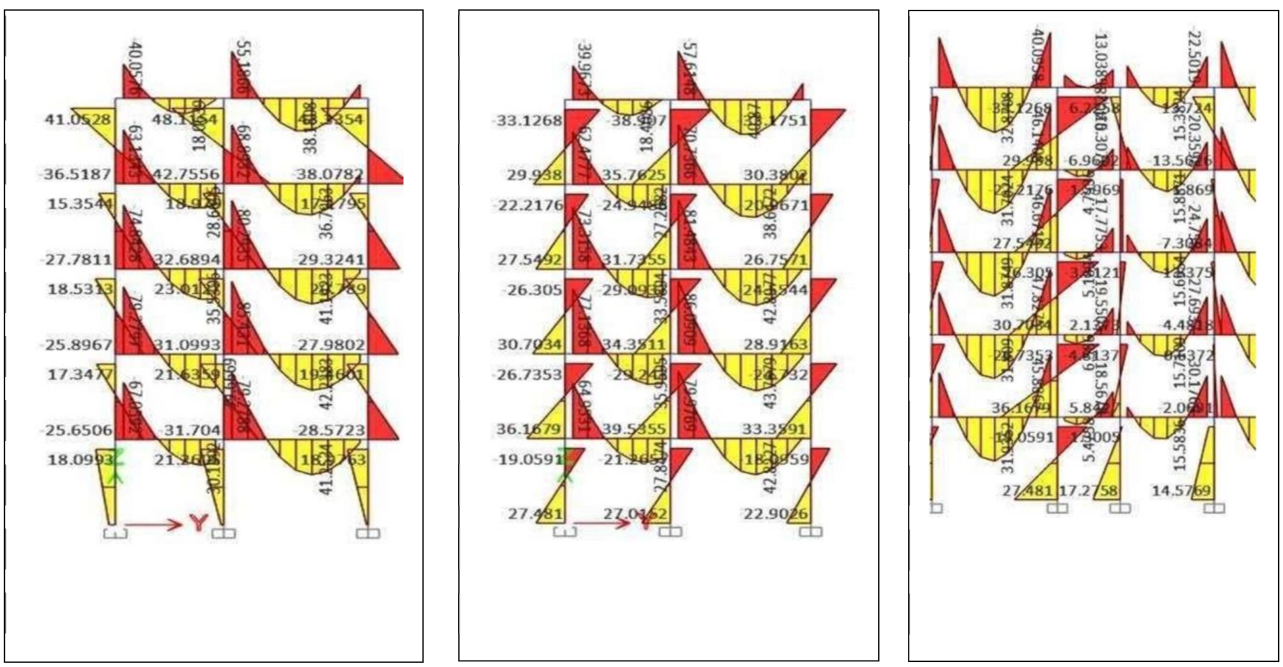

Figure- Comparison of Bending Moments acting at Corner, Centre and Front Beams and Columns

C. Torsional Force Table

Table:- Comparison of Torsional Forces acting at Corner, Centre and Front Beams andColumns

Index in Cosmos
May 2024, Volume 14, ISSUE 2
UGC Approved Journal

	Beams (KN)					Columns (KN)				
	Ground	First	Second	Third	Fourth	Ground	First	Second	Third	Fourth
Corner	0.3318	0.3071	0.2883	0.334	0.4077	0.4077	0.594	0.5289	0.390	0.279
Centre	0.3739	0.3631	0.362	0.2922	0.2587	0.4058	0.5908	0.5369	0.441102	0.2587
Front	0.1672	0.1637	0.2085	0.1552	0.1743	0.4055	0.5977	0.5401	0.4044	0.2651

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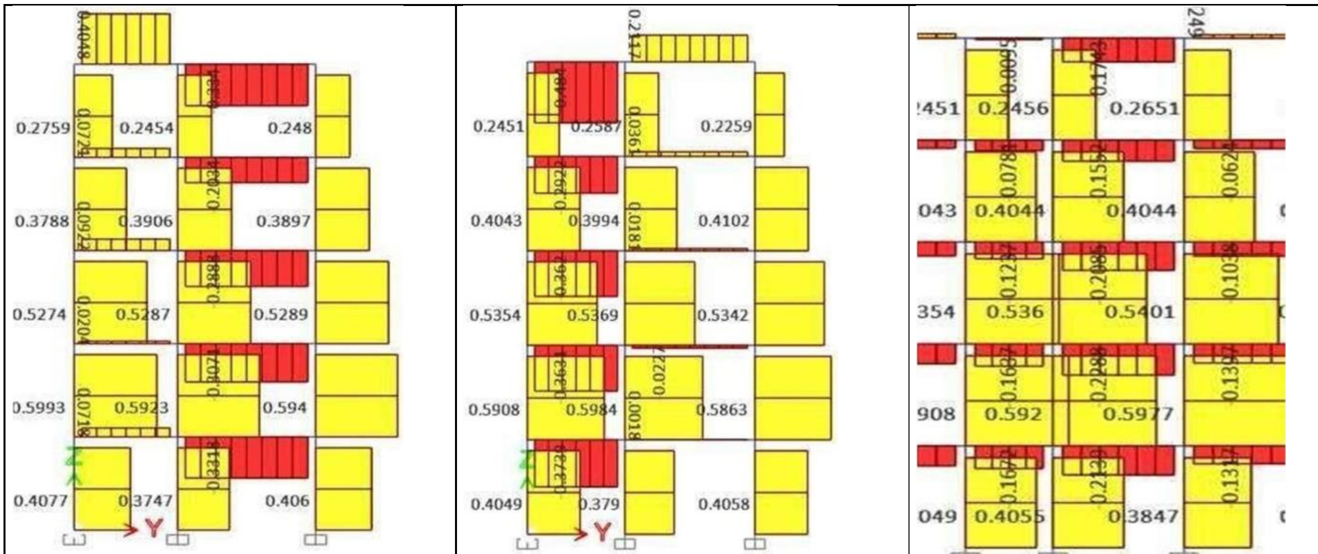

Torsion at Corner Beams and Columns

Center Beams and Columns

Front Beams and Columns

Figure- Comparison of Torsional Forces acting at Corner, Centre and Front Beams and Columns

D. Axial Load on Column

Table:- Comparison of Axial Loads acting at Corner, Centre and Front Columns

	Columns KN-m				
	Ground	First	Second	Third	Fourth
Corner	728.3868	584.90	444.99	302.58	155.518
Centre	815.112	653.305	496.914	338.136	175.496
Front	962.88	765.97	561.88	362.459	174.118

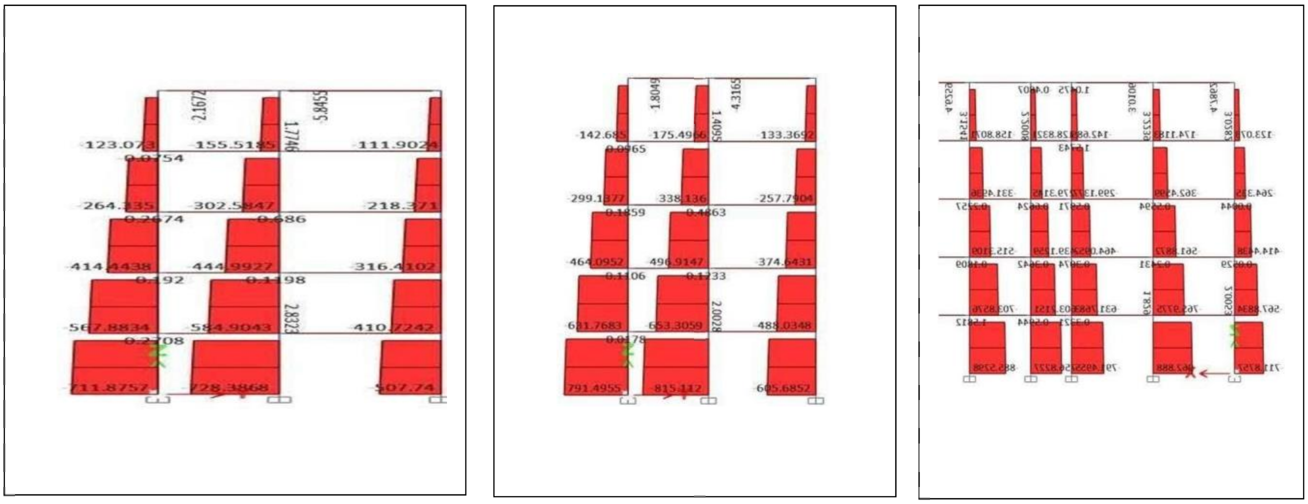

Figure- Comparison of Axial Loads acting at Corner, Centre and Front Columns

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E. *Calculations & Interpretation*

Table:- Percentage difference in axial load on different positions of columns

1) *Front Column*

Floor	Axial load (KN/m²)	Difference	Percentage increase
Ground floor	962.88		
		-196.91	20.45%
First floor	765.97		
		-204.09	26.64%
Second floor	561.88		
		-199.421	35.49%
Third floor	362.459		
		-188.341	51.96%
Fourth floor	174.118		

2) *Centre Column*

Floor	Axial load (KN/m²)	Difference	Percentage increase
Ground floor	815.112		
		-161.807	19.85%
First floor	653.305		
		-156.391	23.93%
Second floor	496.914		
		-158.778	31.95%
Third floor	338.136		
		-162.64	48.098%
Fourth floor	175.496		

3) *Corner Column*

Floor	Axial load (KN/m²)	Difference	Percentage increase
Ground floor	728.386		
		-143.482	19.698%
First floor	584.904		
		-139.914	23.921%
Second floor	444.99		
		-142.41	32.002%
Third floor	302.58		
		-147.062	48.602%
Fourth floor	155.518		

Table:- Percentage difference in bending moment on different positions beams

1) *Front Beam*

Floor	Bending Moment	Difference	Percentage Increase
Ground	101.5311		
		3.1817	3.1337%
First Floor	104.7128		
		-2.4705	2.359%
Second Floor	102.2423		
		-6.7577	6.609%
Third Floor	95.4846		
		-5.2809	5.530%
Fourth Floor	90.2037		

2) *Centre Beam*

Floor	Bending Moment	Difference	Percentage Increase
Ground	79.9769		
		6.114	7.6447%
First Floor	86.0909		
		-39.4194	45.7881%
Second Floor	46.6715		
		1.156	2.4768%
Third Floor	47.8275		
		-1.9415	4.0593%
Fourth Floor	45.886		

3) *Corner Beam*

Floor	Bending Moment	Difference	Percentage Increase
Ground	79.2788		
		6.1553	7.76415
First Floor	85.4341		
		-5.1406	6.01705
Second Floor	80.2935		
		-11.4003	14.1982%
Third Floor	68.8932		
		-13.7066	19.8954%
Fourth Floor	55.1866		

After calculating the percentage difference from the above tables, We can interpret that the variation does not exceed **10%** and hence the analysis is safe.

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V. RESULT AND DISCUSSION

1) Samples were analysed in ETABS 20 software based on the time endurance model. The coordinate command is used to create coordinates and specify origins/properties and nodal points of the structure. The member join command is used to specify the connection between the joints. Lines and beams, see the use of beams. Ownership must be determined for each property owner. The maximum design loads, duration and cut of each element obtained by analysis. Based on these products, we build the main model and complete further development. We also included the results after examining the samples. The shear force of acting at the corner is the highest from the first set, for example is 102.7 KN, while the shear force at the corner is in the fourth layer, for example 34. to make 29 KN. The shear force applied to the central shaft is greatest at the main floor, ie 104.71 KN, while the actual force is at the fourth floor, ie 28.17 KN. The shear force acting on the electric edge is highest at the fourth floor, such as 73. 38 KN, the edge is on the fourth floor, for example 23.79 KN. The secondary voltage of the angle is maximum from the starting system, for example is 85.43 KN-m, while the angle of the angle is the maximum of four layers, for example 48.12, KN-m.
2) The second jump for the focus beam is the largest from the start set, for example is 86.09 KN-m, while the second warp of the focus segment is the largest from the start set, for example 39.53 KN-m. The electric edge has the largest warp second from the starting layer, namely 86.09 KN-m, while the edge section has the second largest warp, namely 36, from the starting layer. 16 dates. The torsional force radiating along the corner is the largest of the four layers, such as 0.334KN, and the torsional force of the corner is the largest from the first layer, such as 0.594KN. The torsional force propagating through the focal point is the largest in the substrate, such as 0.
3) While it is 374 KN, the force in the middle part is the highest from the first layer, ie 0.5908 KN. The torsional force radiating along the edge is greatest at the second layer, ie 0.21KN, while the torsional force at the remaining edge is greatest at the first layer, ie 0. 597KN.Using ETABS, you can complete the search and installation job in the specified time. This project provides real knowledge in the completion of the construction of tall buildings or multi-storey buildings. Paying attention to the results of the preparation of the data, we can accept the placement of the various elements of the design in various dimensions. A particular store in a residential building was found to be safe during design analysis using ETABS software.

VI. FUTURE SCOPE OF WORK

1) ETABS is an important programming tool that takes high rise building analysis and design planning into account. ETABS is 3D image programming for all types of analyse is and design planning. With this study, steel and reinforced concrete structures can be made. ETABS provides users with graphic information and transformations for efficient and fast creation of designs; this helps a lot for engineers to directly understand whether the building materials are suitable or not. Since t he software provides a comprehensive description of the structure, new developments from the software will l be more beneficial for engineers as they will save time and effort on working papers.
2) Create 3D models, including the use of perspective and elevation plans, to effectively 3D model any hybrid design Models of towers and skyscrapers will be completely created in this software, and a lot of information will usually be stored that needs to be done before this software is created. Many software requirements such h as ETABS and models must also be developed to accurately check the suitability of various designs. This software will take civil engineers to the next level in understanding things before they are built. It will give an idea about how the structure can meet the various loads and loads demanded / given to certain parts of the whole structure. When software like ETABS does the calculations efficiently and effectively, it will save engineers the time and cost needed to get a lot of error data/accounts.
3) Future structural engineers should learn software such as ETABS in the early stages of civil engineering to gai n knowledge and skills in the field of construction; this will help them become good engineers and will be ben official for successful engineers.

International journal of basic and applied research
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)
Cosmos Impact Factor-5.86

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