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ANALYSIS AND DESIGN OF G+5 RESIDENTIAL BUILDING USING ETABS SOFTWARE:

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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 analyze & 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. To determine the maximum bending and shear forces at the design for earthquake load, an analysis using the programme ETABS was performed on the storey height of a structure located in zone V while maintaining the base dimensions. Both dynamic and static analyses have been performed for earthquake loads. A seismic load analysis has been completed. Following that, the graphs for various value displacement due to earthquake load (EQ) at all storey drifts were plotted.

1. Introduction
The innovative and forward-thinking new ETABS is an undisputed integrated programming package for the structural underpinnings analysis and planning. Unparalleled 3D article-based demonstrating and perception tools, lightning-fast linear and nonlinear logic, refined and complete plan capabilities for a wide range of materials, and sharp realistic presentations, reports, and schematic drawings are just a few of the features that ETABS offers to help clients quickly and effectively interpret and obtain examination and design results. Programming called ETABS is used to analyse and design multi-story buildings. Extended Three-Dimensional (3D) Analysis of Building Systems is known as ETABS. Computer-aided design (CAD) drawings may be directly converted into ETABS models or used as layouts on top of which ETABS articles can be layered. The fact that several floor levels in buildings are comparable reduces the amount of time needed for showing and setting up. Quick model age based on the concept of similar stories. The basic parts of a comparable model can be made from a variety of materials, including steel, RCC, composite, or other materials specified by the customer. Computer-aided design (CAD) drawings can be directly converted to ETABS models or used as formats in which ETABS objects can be superimposed.
The report is prepared simply in the software with all necessary support details. Many of the floor levels in buildings are comparable, which reduces the amount of time needed for showing and setting up. Using comparable tales as a quick model age. The basic parts of a comparable model can be made from a variety of materials, including steel, RCC, composite, or other materials specified by the customer. The design process begins with the planning of a structure, largely to satisfy the functional needs of the customer or user. An engineer would generally investigate the functional needs and the aesthetic components, while structural designers will investigate the safety, usability, durability, and cost-effectiveness of the structure for its anticipated usage during the construction.
Stability: To prevent the structure's pieces or members from buckling, sliding, or overturning when subjected to activity loads.

Strength: To successfully fend off the pressure that the heap causes in the several primary persons.
Serviceability: To ensure proper operation under service load conditions. This entails providing enough stiffness to limit deflection, break width, and vibrations to within specified cut-offs, as well as providing permeability, strength, and other properties.

2. Literature Review

The analysis of the research and comprehension of the processes are made possible by the literature review, which is a crucial component of the study. Our literature review's main goal is to provide an in-depth examination of prior studies in the field of seismic design. Using this programme will improve the analysis's accuracy. We'll put the experience in the spotlight in our review. ETAB, a software programme, was used for the analysis, while AutoCAD and REVIT were used for the drawing details. The literature review will try to establish the link between past research, work done on this topic and this study to determine its relevancy and thorough understanding. The structural components were designed manually in addition to the software design. This training helped to understand and analyze the structural problem faced by the construction industry. Calculation by software analysis gives results within the permissible limit according to IS code. Further the work is extended for a – storey building and found that the results are matching. Because the floors of a multi-story building are similar, ETABS is the ideal software to use for analysis and design. The amount of time needed for analysis and design is reduced with the use of ETABS software. It is simple to increase or decrease the building's storeys.
The IS 1893-part2:2002 and IS 456:2000 Indian Codes were followed in the design of this project. In conducting this analysis, severe seismic zones are considered, and the behaviour is evaluated using a type-medium stiff soil condition. We are proposing a strategy under zone V for our project. The zone factor is 0.36, and the seismic intensity is severe.
A literature review on performance-based design was conducted utilising a variety of pertinent books and journal articles, as well as research on the analysis and design of residential buildings using ETABS. A review of earlier studies on the subjects mentioned above is also included.

3. Codal Provisions

Indian Standard on Earthquake Engineering - Under the Bureau of Indian Standards Act of 1986, the National Standard Body of India, or BIS, is a Statutory Organisation. Making Indian Standards on various engineering topics through several Division Councils is one of the activities. Standardisation in the field of civil engineering, such as structural engineering, building materials and components, planning design, construction and maintenance of civil engineering structures, construction practises, safety in buildings, etc., is the responsibility of the Civil Engineering Division Council.
Through a network of technical committees made up of representatives from research and development organisations, consumers, industry, testing labs, government organisations, etc., these standards are developed based on the consensus principle. India is one of the nation’s most vulnerable to natural and man-made disasters, making it one of the most disaster-prone nations. A total of 85% of the territory is at risk from one or more disasters, and 57% of it, including the nation's capital, is in a hazardous seismic zone. Engineering intervention in buildings and structures to strengthen them to withstand the effect of natural hazards or to impose land use limitations so that the society's exposure to the hazard scenario is avoided or minimised are examples of disaster preventive measures. There have been several disastrous earthquakes that have occurred in the Himalayan-Naga Lushai region, Indo-Gangetic plain, Western India, and the Cutch and Kathiawar regions since these are geologically unstable areas of the nation. Strong earthquakes have also struck a significant portion of peninsular India, but these were comparatively infrequent and of far lower severity. The necessity to rationalise the design and construction of structures that are earthquake resistant while taking seismic data from these earthquake studies has long been felt. The Bureau of Indian Standards

has produced several national standards in the areas of design and construction of earthquake-resistant structures, as well as in the areas of measurement and testing related thereto, to serve this goal. Below is a description of Indian Standards for reducing earthquake risk from natural causes.

4. IS 1893(Part-1) Criteria for Earthquake Resistant Design of Structures: Part 1 General provisions and Buildings

This standard includes clauses that are universally applicable and of a generic character. Additionally, it has clauses that apply only to buildings. Apart from seismic zoning map and seismic coefficients of significant towns, map displaying epicentres, map showing tectonic characteristics, and lithological map of India are also included. It also includes general principles and design criteria, combinations, design spectrum, key aspects of buildings, and dynamic analysis.

a) Instead of five zones, the seismic zone map now only has four. Only Zones II, III, IV, and V are included in the new zoning because previously separate Zone I and Zone II have been combined. With the probabilistic Hazard Evaluation in mind, the killari region has been included to Zone III and the relevant alterations have been done. The isolated zone around Bellary has been eliminated. Parts of the eastern coast region contain hazards comparable to those in the killari region; the zone II level has been raised to zone III and connected to the zone III of the Godavari Graben region.
b) This modification employs a method that starts by figuring out the real force that the structure may receive during the likely maximum earthquake, assuming it were to stay elastic. Then, by substituting the "response reduction factor" for the earlier performance factor, the idea of response reduction caused by ductile deformation or frictional energy dissipation in the cracks is explicitly introduced into the code.
c) Changes have been made to the values of the seismic zone factors, which now represent more accurate estimates of the peak ground acceleration when considering the Maximum Considered Earthquake (MCE) and the service life of structures inside each seismic zone.
d) In areas with high seismic activity, a provision has been included to limit the use of foundations susceptible to differential settlement.

It is important to note that this standard does not aim to provide rules that would prevent any structure from being damaged by earthquakes of any size. The goal has been to make structures as resilient as possible, able to withstand shocks of moderate intensity without structural damage and shocks of severe intensity without completely collapsing.

5. Proposed provisions for beam-column joints Minimum column size Clause 1.0

The minimum column size must be at least (a) 15 times the biggest longitudinal reinforcement bar diameter of the beam passing through or anchoring into the column joint, and (b) 300 mm.

Commentary 1.0 - The following two issues may result from a narrow column: Due to the relatively narrow lever arm between the compression steel and tension steel, the moment capacity of the column section is very low (a), and the beam bars do not get enough anchoring in the column.

As a result, several seismic regulations advise that an interior column's size not be less than 20 times the diameter of the longest beam bar running parallel to Sudhir K. Jain, R.K. Ingle, and Goutam Mondal. 28 According to The Indian Concrete Journal * August 2006, the minimum column width should be 400 mm if beams employ 20 mm diameter bars. Given the practise in India, where substantially smaller column sections are now employed than what is typical in other seismic nations like the USA and New Zealand, the suggested provision for minimum column size has been maintained lower than the current international norms. The current clause no. 7.1.2 of IS 13920: 1993 states that the member's minimum dimension should not be less than 200 mm for columns. However, the shortest dimension of the column must not be less than 300 mm in frames with beams having a centre-to-centre span greater than 5 m or columns having an unsupported length greater than 4 m. It is suggested that this clause be updated to reflect clause 1.0 of this publication.

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6. **Wide Beam**

Clause 1.2.4 - Transverse reinforcement as required by clause nos. 7.4.7 and 7.4.8 of IS 13920: 1993 should be given through the joint to enable confinement for longitudinal beam reinforcement outside the column core if such confinement is necessary if the width of the beam exceeds the corresponding column size. August 2006 * A beam frame into the junction does not supply The Indian Concrete Journal 29. The width of the beam in this situation should be smaller than 3bc and bc + 1.5hc, where bc and hc are the width and depth of the column, respectively.

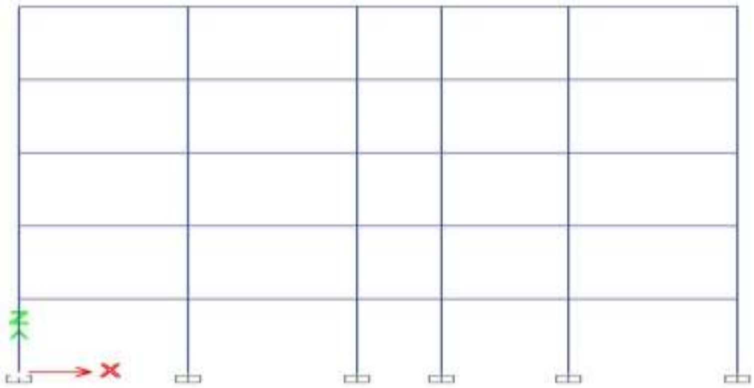
Commentary 1.2.4 - This clause refers to the wide beam, that is, the width of the beam exceeds the corresponding column dimension. In that case, the beam reinforcement not confined by the column reinforcement should be provided lateral support either by a girder framing into the same joint or by transverse reinforcement. The limit of maximum width of wide beam is specified to ensure the formation of beam plastic hinge.

7. **Structure Modelling**

This chapter provides a description of a residential structure. Section 4.2 contains a four-story regular Buildings made of reinforced concrete are ornate. 4.3 Material Properties of Both Steel is the part after that. and tangible are displayed. Dead load, live load, seismic load, and super dead load are discussed in section 4.4.

Regular Reinforced Concrete Building - Considered is a reinforced concrete structure with five stories. Beam lengths are 4m (3 members), 2m, and 3m in the transverse direction (x) and 4m and 3m in the longitudinal direction (z). A five-story residential structure with five bays in the (x) direction and two bays in the (y) direction is seen in Figure (a). The building's story height is assumed to be 3 metres (the same for each level). The five-storey reinforced concrete residential building's frame is seen in figure (b). The column's cross section is 450x450mm, while the beam's cross section is 350x350mm.

Figure-1, Plan Of G+5 Residential Reinforced Concrete Building (all direction in meter)



also, by transverse reinforcement. To ensure the construction of a plastic beam hinge, the maximum width of broad beams is limited.

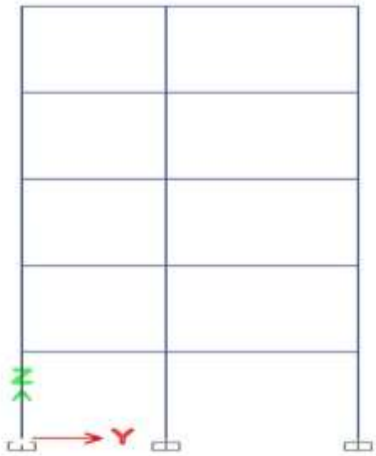


Figure-3, Frame 1-1

8. General Data

Framework = G + 4
(For each floor) Floor Height = 3m
Concrete grade (for each structural component) = M30 (IS 456-2000).
Fe500 is the minimum acceptable steel grade (under IS 800-2007).
350 x 350 mm for the beam size
Size of column: 450 × 450 mm
For each inner and outer wall, the wall loads are assumed to be 6.21 KN/m2 and 12.45 KN/m2, respectively. 3.75 KN/m2 of slab load is selected for study. All the beams in an RC building are subjected to a floor finish load of 1.5 KN/m2 and are analyzed in accordance with IS 875 (part 1). According to IS 875 (part2), a live load of 2 KN/m2 is offered. The building's gravity loads are displayed in the table below.

Table-1 Types of Loads and Their Values

Types of loads	Load values	IS Code confirmation
Dead load	Self-weight	IS 875 Part-1
Live load	2 KN/m2 -all places	IS 875 Part-2
Floor finish	1.5 KN/m2	IS 875 Part-1
Super dead load	6.21 KN/m2 -inner wall loads	IS 875 Part-1
Super dead load	12.45 KN/m2 outer wall loads	IS 875 Part-1

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The building is then assessed for live load, seismic load in accordance with IS-1893:2002, and dead load, which consists of the self-weight of the beams, columns, slabs, and floors. The many types of loads exerted on the structure are depicted in the figures below.

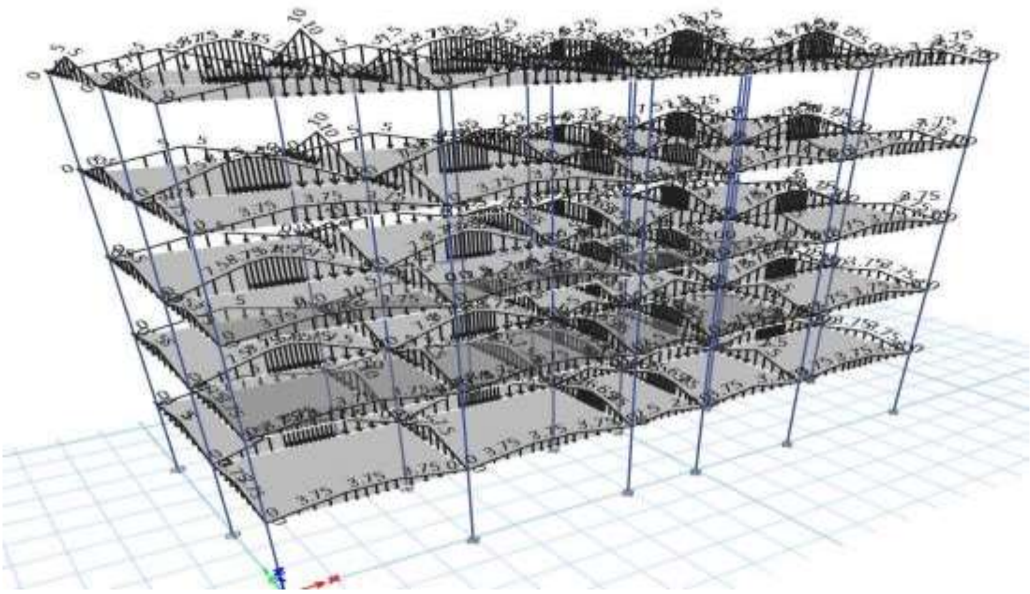

Figure-4, Live Loads acting on the structure

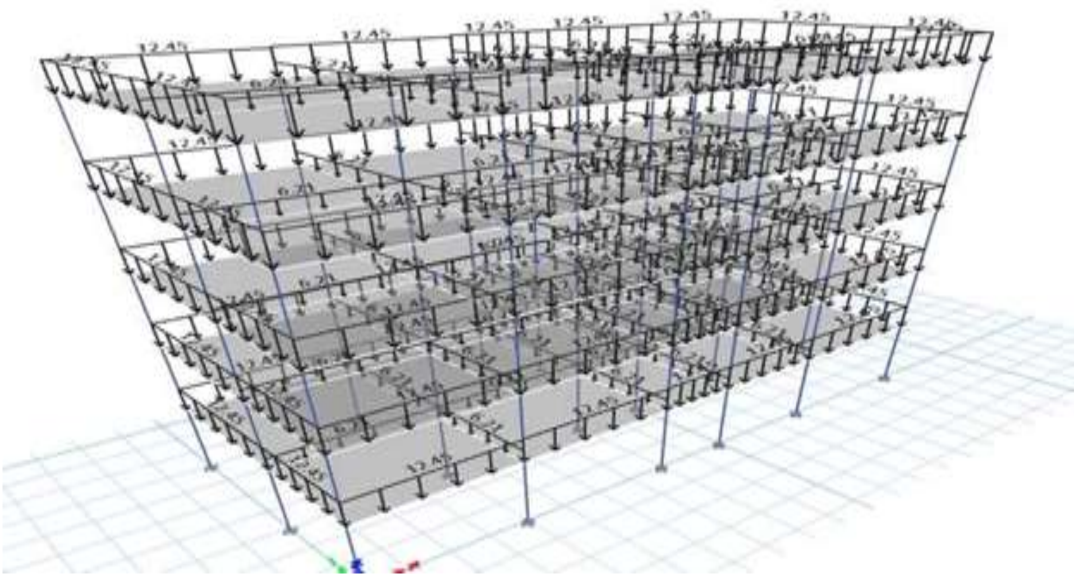

Figure-5 Wall loads acting on the structure

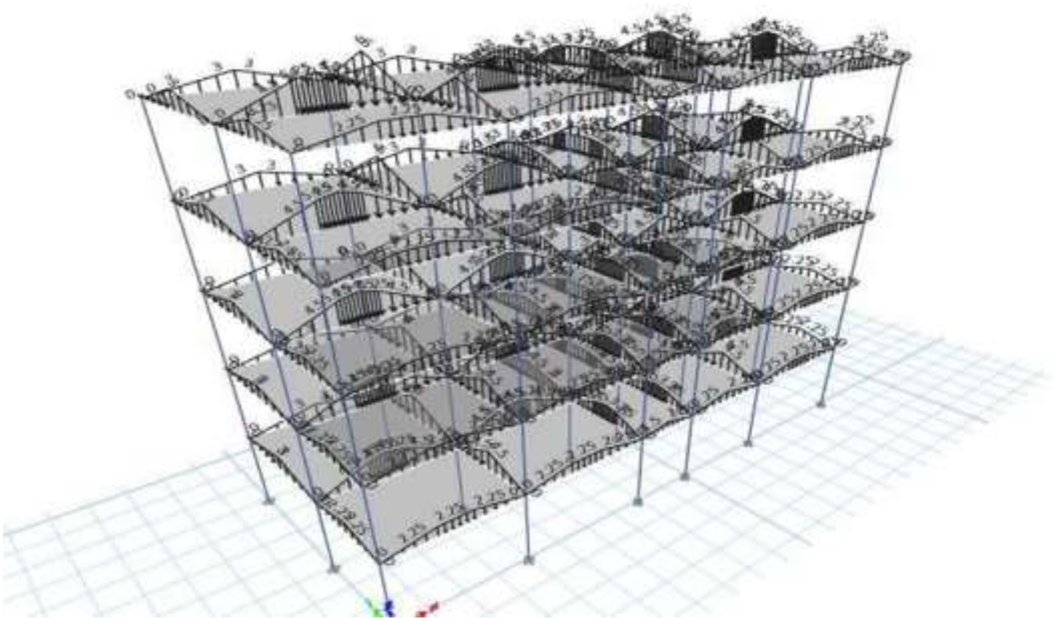

Figure-6 Floor load acting on the structure

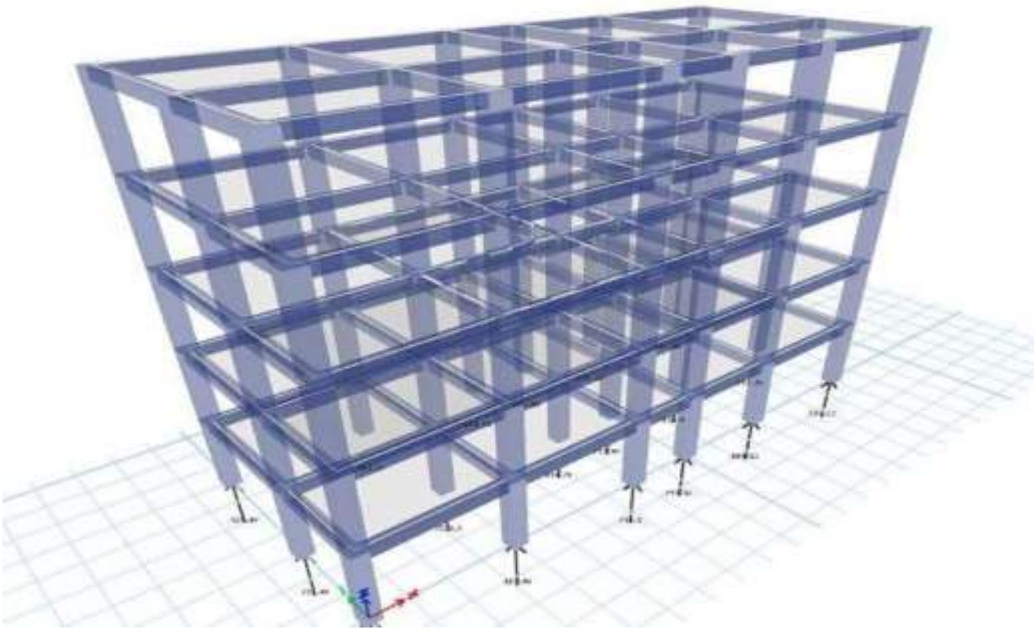

Figure-7 3D View of the structure

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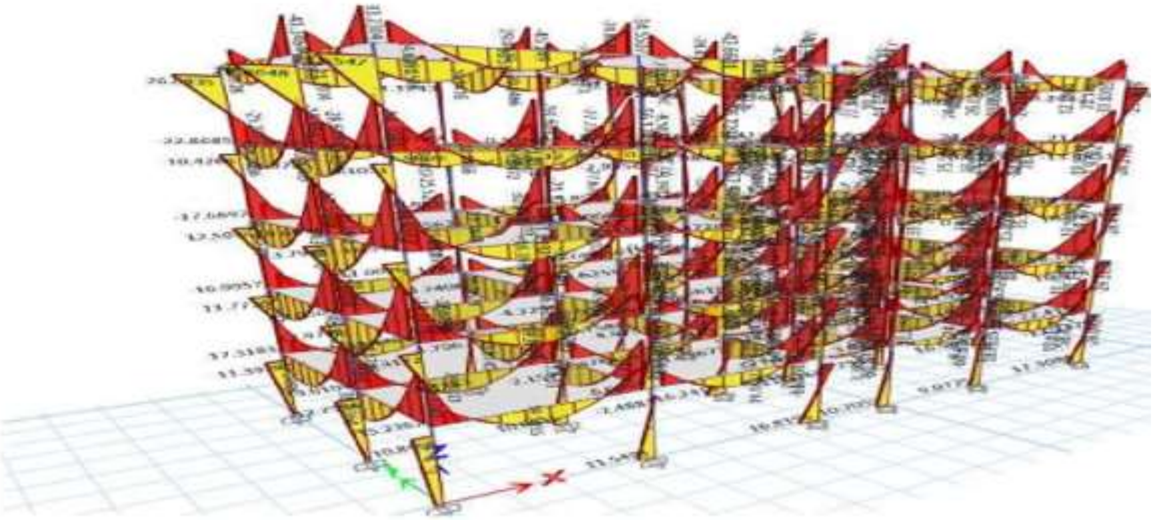
9. Properties of Material-

Following table shows the properties of material



Steel Bar Properties		Concrete section Properties	
Unit Weight (γs)	76.9729 KN/m³	Unit Weight (γc)	24.9926 KN/m³
Modulus of elasticity	21000 Mpa	Modulus of elasticity	27386.13 Mpa
Poisson ratio (vs)	0.3	Poisson ratio (vc)	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

Table-2 Properties of steel bar and concrete as per IS-456

Yield strength	**379.5 Mpa**	**Damping ratio (ςc)**	**5%**
Compressive strength (Fs)	495 Mpa	Compressive strength (Fc)	30

10. Structural Element

Using ETABS software, the seismic loadings of a residential structure with four stories of symmetrical reinforced concrete were examined. The dimensions of the beam and columns are 350 mm x 350 mm and 450 mm x 450 mm, respectively, for the comparative analysis. For each story, the story height is assumed to be 3 meters, and the beam length is assumed to be 4 meters in the longitudinal direction and 4 meters in the transverse direction. The table below displays these measurements and cross sections. Table 3 shows the length and cross section of beams and columns.

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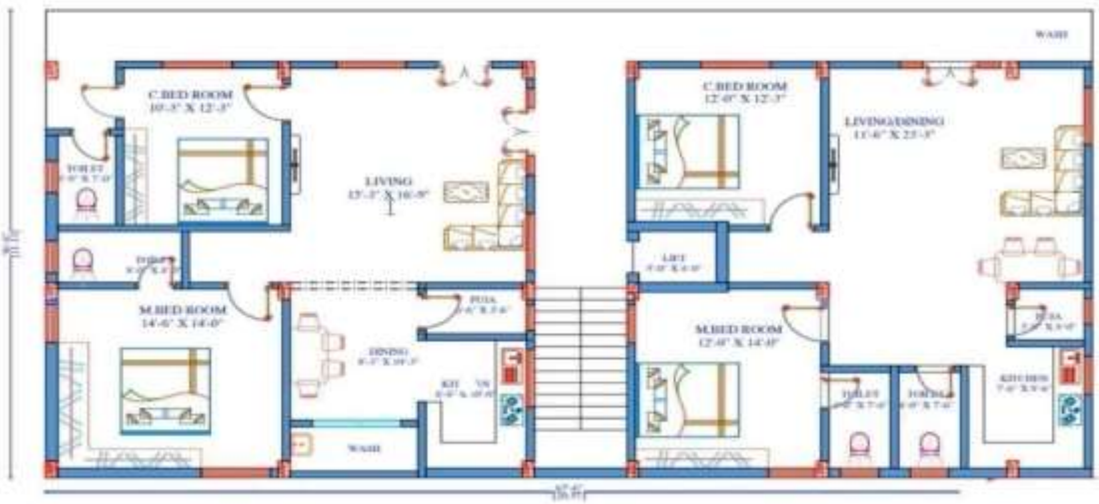
Table-3 Beam and Column length and their cross section

Structural Elements	Cross section (mm x mm)	Length (m)
Beam in longitudinal Direction (x)	350 x 350	4m (three numbers) 2m 3m
Beam in Transverse Direction(z)	350 x 350	4m 3m
Columns	450 x 450	4m

11. Methodology

Importing floor plan using AutoCAD.



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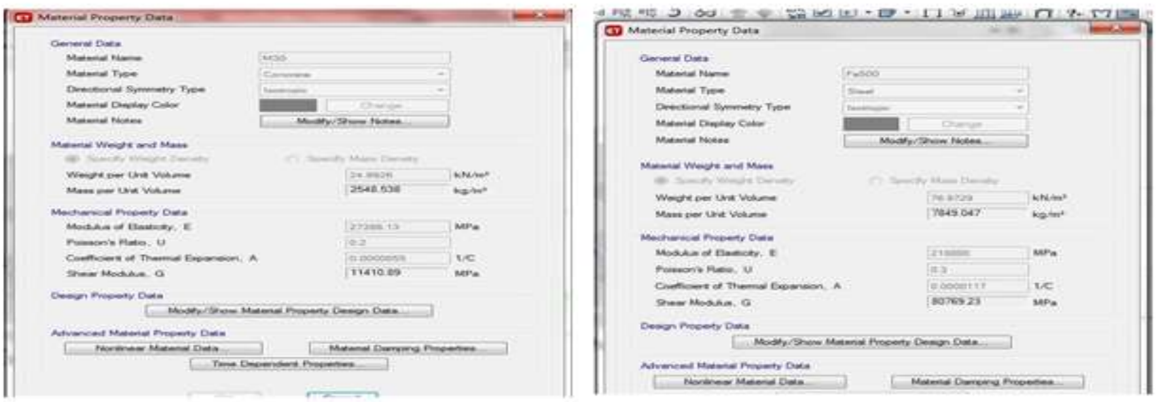
Analysis in ETABS
Material properties: Summary



Figure(10) Summary of Material Properties

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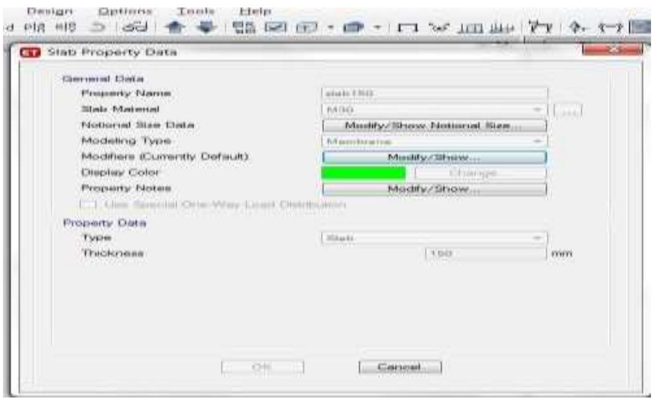
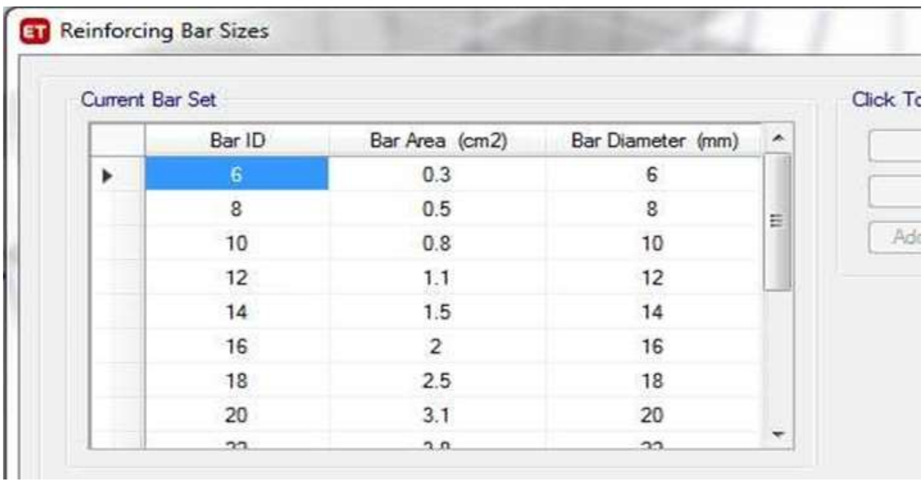
Figure(11) Summary of Frame Sections

12. Slab Section Summary




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
[illegible]	[illegible]	[illegible]

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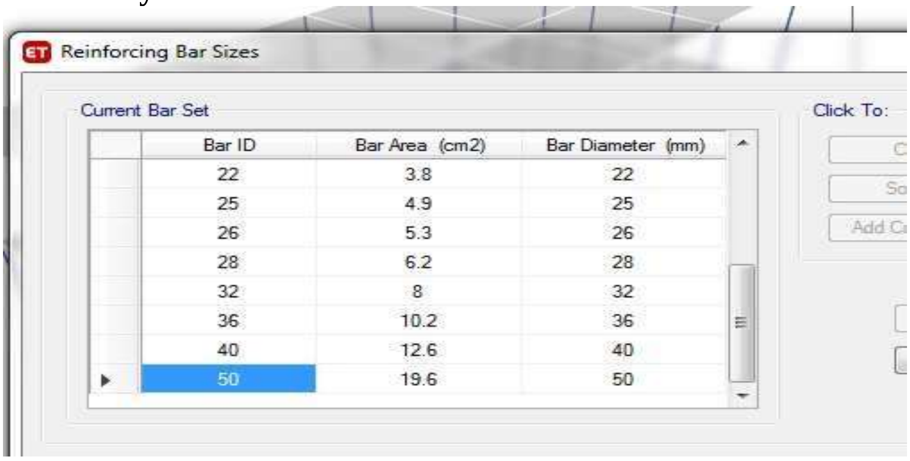
13. Reinforced Bar Summary



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

14. Framing Of Model

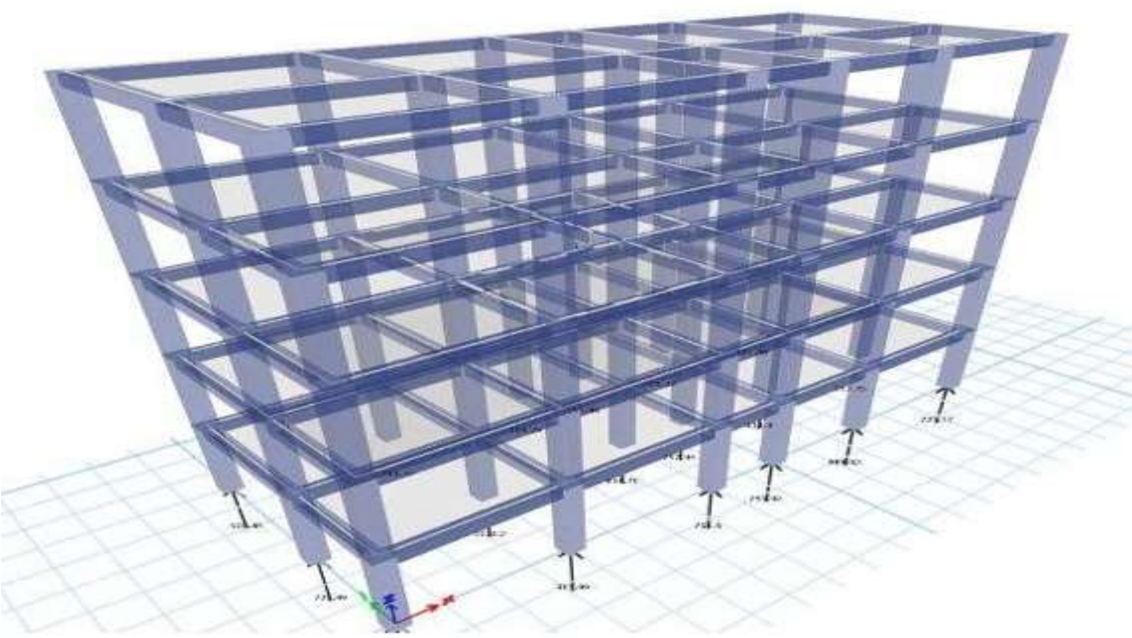


Figure (14) Base Loads acting on the Structure

Load Patterns:

Table 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	

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15. Load Calculations

Dead Load- To begin with, cross sectional dimensions are assumed in order to calculate the dead load using the structure's known weights. IS 875:1987 (Part 1) specifies values for the unit weights of the materials and the unit weight of the entire construction. As a result, the accompanying figure depicts the dead loads allocated to the ground floor.

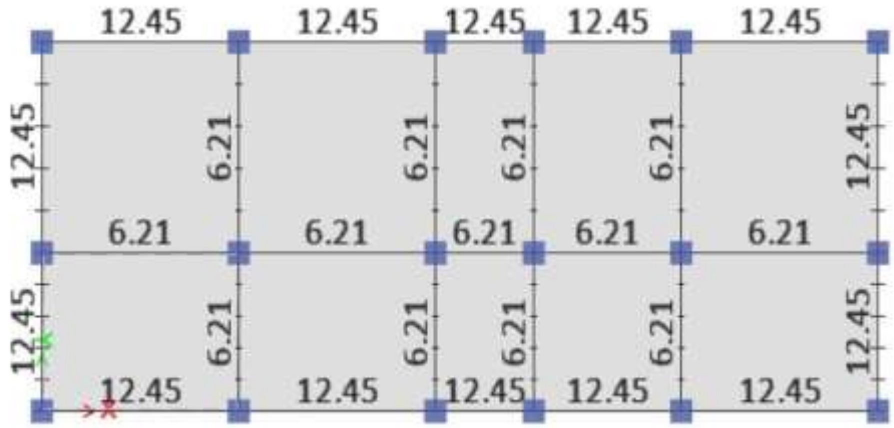
Concrete weighs 30 Kn/m3 per unit.

Here is an example calculation:

Wall Load-

a) Outer wall load (9-inch wall) (wall thickness: 9 inches = 0.23 meters) = wall thickness times floor height times brick density = 0.23 x 3 x 18 = 12.45 KN/m2.

b) Inner wall load (4.5 Inch wall) (Wall thickness = 4.5 Inch = 0.115m) = Wall thickness x Floors' Height x Bricks' Density = 0.115 x 3 x 18 = 6.25 KN/m2.

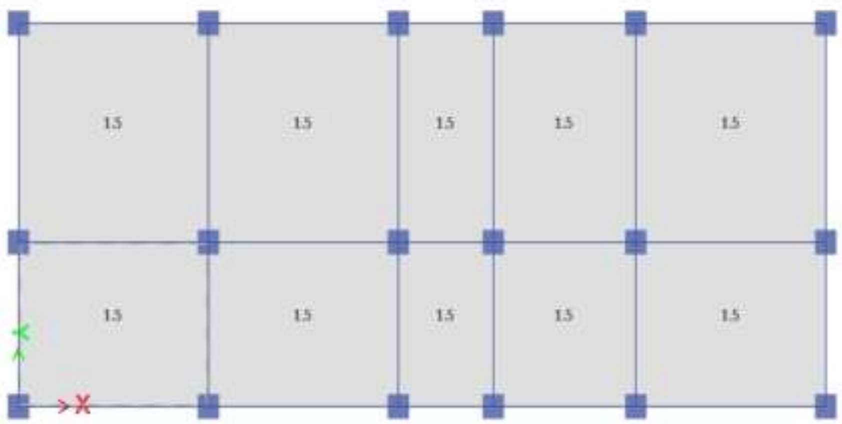


(Wall loads on structure)

Dead Load-

Floor finish = 1.5 KN/m^2 (as per IS 875 part 1)

Total floor load = 1.5 KN/m^2



(Dead load on the structure)

Live Loads- All loads on the structure that are not dead loads are referred to as "live loads," also known as "imposed loads." IS 875:1987 (part 2) specifies the standard loading values. The following graphic displays the assigned live loads for the ground level under consideration.

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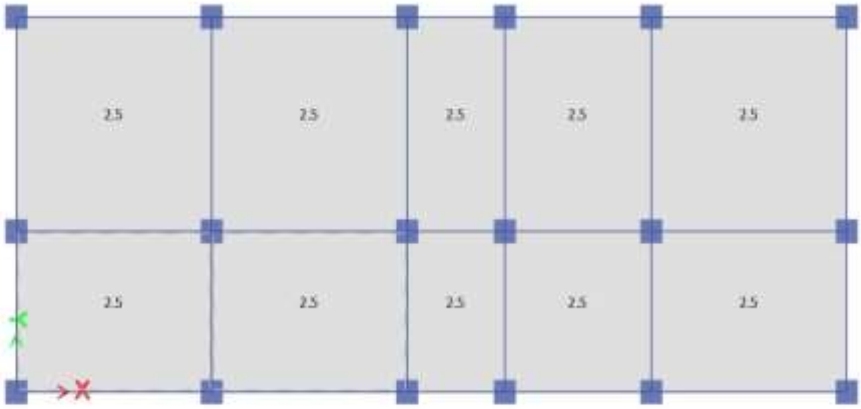

(Live loads on the structure)

Earthquake Loads- Waves are created by earthquakes, and the speed at which they travel depends on the size and intensity of the earthquake. The effect of an earthquake on a structure relies on several factors, including the stiffness of the soil medium, the structure's stiffness, its height, and its location. IS 1893:2002, Part 1 prescribes the seismic forces.

Zone 5 includes the construction zone. And according to IS 1893:2002 (part 1), the seismic base shear calculation was performed. The following phrase must be used to compute the base shear or total design lateral force, as well as any principal direction.

Vb= Ah x W

Ah x W = VB

VB = Design base shear where

depending on the basic time and kind of soil, Ah = Design horizontal seismic coefficient Building seismic weight, expressed as W

The horizontal seismic design coefficient.

Ah= ZISa/ RSa

Where Z is the zone factor, which accounts for the maximum seismic risk and the structural service life in a zone. According to Table 6 of IS 1893 (Part 1):2002, the factor Z in the denominator is used to reduce the maximum considered earthquake zone factor to factor for design basic earthquake (DBE), I = importance factor, depending on the functional use of structures, characterised by hazardous failure consequences, post-earthquake functional needs, historical significance, or economic importance.

R = response reduction factor, depending on how well the structure withstands seismic damage, which is shown by ductile or brittle deformations. The ratio (I/R) must not, however, be more than 1.0. The values for buildings are provided in IS 1893 (part 1):2002 table 7.

Sa/Sg, which stands for average response acceleration coefficient, is calculated using the vibrations' estimated fundamental natural periods in both directions.

The IS 1893:2002 (part I) earthquake load calculation standard is used. The building is in seismic zone 5.

Response Reduction Factor, R = 5, Seismic Zone Coefficient, Z = 0.36

Factor of importance, I = 1

II Site Type

16. Auto Seismic Loading IS 1893:2002 Auto Seismic Load Calculation:

In this computation, the ETABS programme calculates the automatically produced lateral seismic loads for the load pattern Eqx in accordance with IS1893 2002.

Eccentricity and Direction Direction = X

User-Specified User Period T = 0.850 sec is the calculation method for the structural period.
coefficients and factors
Response Reduction Factor, R = 5 Seismic Zone Factor, Z = 0.36 Importance Factor, I = 1
Spectral Acceleration Coefficient for Seismic Response, SA/g = 2.5/T SA/g = 2.5

17. Calculated Base Shear:

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y	0.532	4698.0654	422.8259

Loads

Table 6:- Applied story forces

Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
Story5	15	0	176.3618
Story4	12	0	131.4475
Story3	9	0	73.9392
Story2	6	0	32.8619
Story1	3	0	8.2155
Base	0	0	0

(Applied story forces)

18. Load Combinations-

To preserve the serviceability and safety of all sorts of forces that would constantly act on all structures, it would have been very expensive to design the structures.

To guarantee at least 95% of the time, the notion of characteristic loads has been adopted. The characteristic loads are to be determined based on the average/mean load of some automated combinations of all the loads listed above. The combination of the loads to be considered in the design of the buildings is specified in IS 456:2000, IS 875:1987 (Part-5), and IS 1893(part-I):2002. Below is a list of the various combinations that were used: Table 7: Combinations of loads.

Name	Type	Is Auto	Load Name	SF	Notes
DCon1	Linear Add	Yes	Dead	1.5	Dead [Strength]
DCon1			floorload	1.5	
DCon1			floor load	1.5	
DCon1			wall loads	1.5	
DCon2	Linear Add	Yes	Dead	1.5	Dead + Live [Strength]
DCon2			Live	1.5	
DCon2			floorload	1.5	
DCon2			floor load	1.5	
DCon2			wall loads	1.5	
DCon3	Linear Add	Yes	Dead	1.2	Dead + Live + Static Earthquake [Strength]
DCon3			Live	1.2	
DCon3			floorload	1.2	
DCon3			floor load	1.2	
DCon3			wall loads	1.2	
DCon3			EQ X	1.2	
DCon4	Linear Add	Yes	Dead	1.2	Dead + Live - Static Earthquake [Strength]
DCon4			Live	1.2	
DCon4			floorload	1.2	
DCon4			floor load	1.2	
DCon4			wall loads	1.2	
DCon4			EQ X	-1.2	
DCon5	Linear Add	Yes	Dead	1.2	Dead + Live + Static Earthquake [Strength]

Name	Type	Is Auto	Load Name	SF	Notes
DCon5			Live	1.2	
DCon5			floorload	1.2	
DCon5			floor load	1.2	
DCon5			wall loads	1.2	
DCon5			EQ Y	1.2	
DCon6	Linear Add	Yes	Dead	1.2	Dead + Live - Static Earthquake [Strength]
DCon6			Live	1.2	
DCon6			floorload	1.2	
DCon6			floor load	1.2	
DCon6			wall loads	1.2	
DCon6			EQ Y	-1.2	
DCon7	Linear Add	Yes	Dead	1.5	Dead + Static Earthquake [Strength]
DCon7			floorload	1.5	
DCon7			floor load	1.5	
DCon7			wall loads	1.5	
DCon7			EQ X	1.5	
DCon8	Linear Add	Yes	Dead	1.5	Dead - Static Earthquake [Strength]
DCon8			floorload	1.5	
DCon8			floor load	1.5	
DCon8			wall loads	1.5	
DCon8			EQ X	-1.5	
DCon9	Linear Add	Yes	Dead	1.5	Dead + Static Earthquake [Strength]
DCon9			floorload	1.5	
DCon9			floor load	1.5	
DCon9			wall loads	1.5	
DCon9			EQ Y	1.5	
DCon10	Linear Add	Yes	Dead	1.5	Dead - Static Earthquake [Strength]
DCon10			floorload	1.5	
DCon10			floor load	1.5	
DCon10			wall loads	1.5	
DCon10			EQ Y	-1.5	
DCon11	Linear Add	Yes	Dead	0.9	Dead (min) + Static Earthquake [Strength]
DCon11			floorload	0.9	
DCon11			floor load	0.9	
DCon11			wall loads	0.9	
DCon11			EQ X	1.5	
DCon12	Linear Add	Yes	Dead	0.9	Dead (min) - Static Earthquake [Strength]
DCon12			floorload	0.9	
DCon12			floor load	0.9	
DCon12			wall loads	0.9	
DCon12			EQ X	-1.5	
DCon13	Linear Add	Yes	Dead	0.9	Dead (min) + Static Earthquake [Strength]
DCon13			floorload	0.9	
DCon13			floor load	0.9	
DCon13			wall loads	0.9	
DCon13			EQ Y	1.5	
DCon14	Linear Add	Yes	Dead	0.9	Dead (min) - Static Earthquake [Strength]
DCon14			floorload	0.9	
DCon14			floor load	0.9	
DCon14			wall loads	0.9	
DCon14			EQ Y	-1.5	

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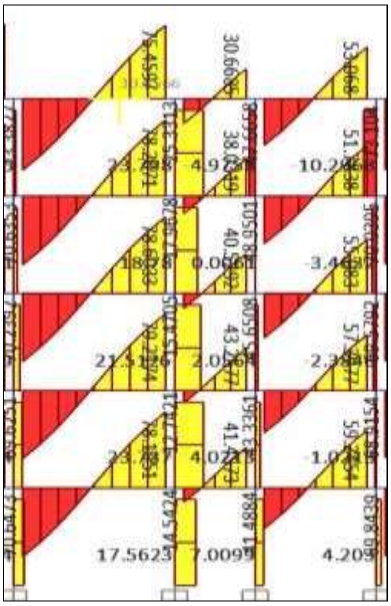
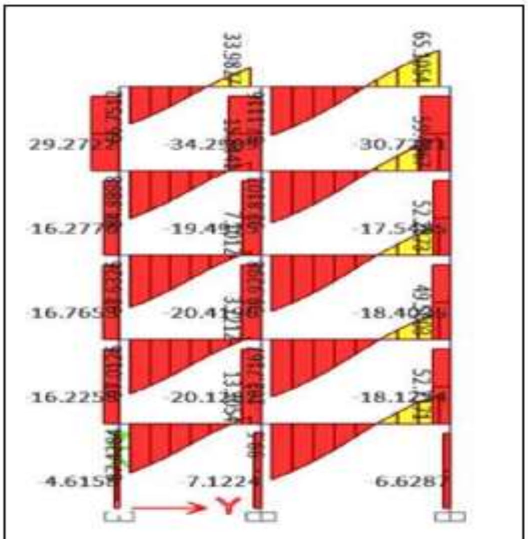
19. **Observation, Data Collection, Interpretation & Calculation:**

For shear force table is given below

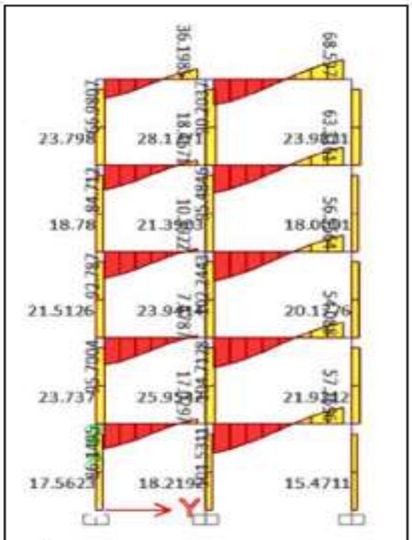
			Beam (KN)					**Column (KN)**		
	Ground	First	Second	Third	Fourth	Ground	First	Second	Third	Fourth
Corner	99.5	102.71	99.93	92.810	87.11	7.122	20.12	20.41	19.49	34.29
Centre	101.53	104.71	102.24	95.485	90.203	18.219	25.954	23.94	21.39	28.177
Front	70.647	69.625	70.239	70.633	73.382	17.56	23.737	21.512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



(Shear force at front beams and columns)



Shear Force at Corner Beams and Columns



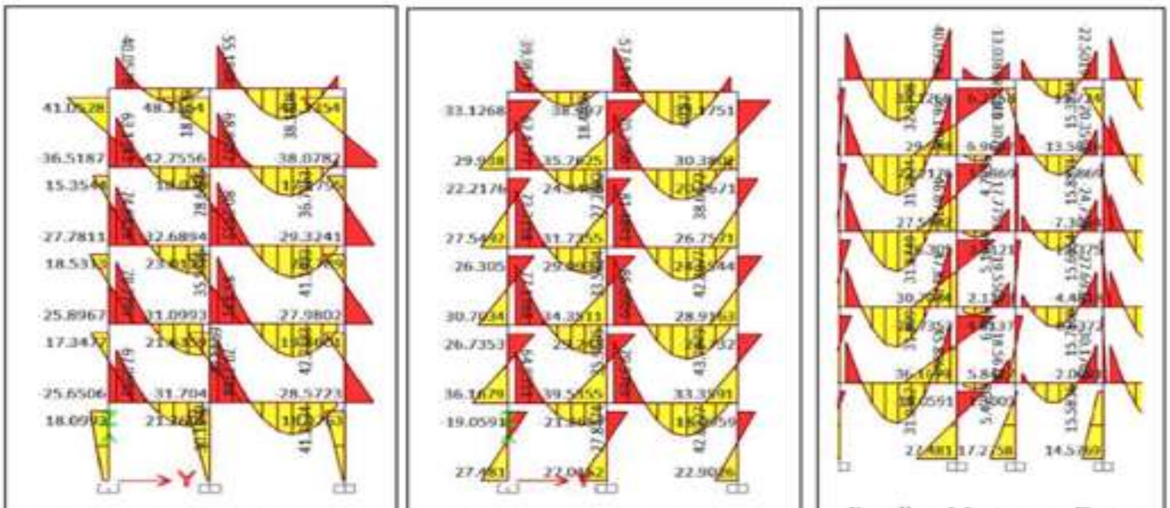
Shear Force at Centre Beams and Columns

20. Bending Moment Table:

b) Bending moment table

Table 9:- 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



Bending Moment at Corner Beams and Columns

Bending Moment at Centre Beams and Columns

Bending Moment at Front Beams and Columns

Figure(19) Comparison of Bending Moments acting at Corner, Centre and Front Beams and Columns

c) Torsional force table

Table 10:- Comparison of Torsional Forces acting at Corner, Centre and Front Beams and Columns

	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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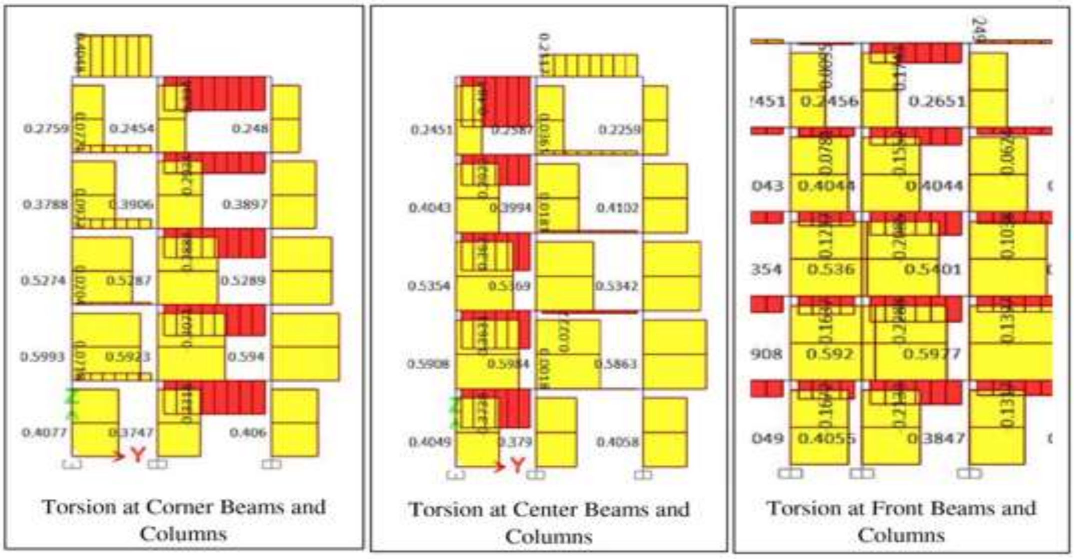
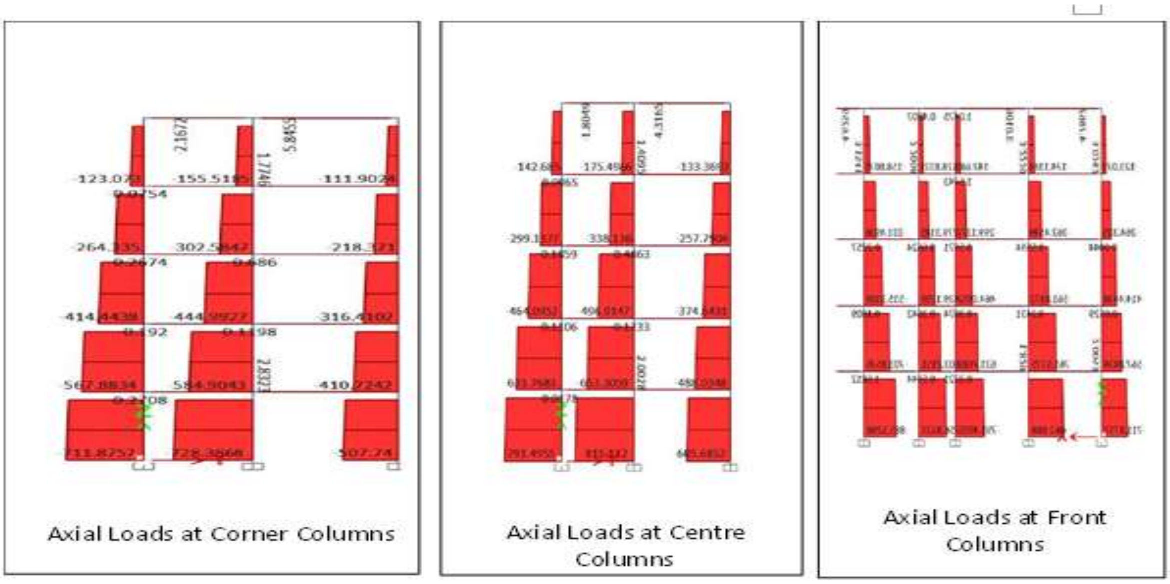


Figure(20) Comparison of Torsional Forces acting at Corner, Centre and Front Beams and Columns

d) Axial Load on column

Table 11: - Comparison of Axial Loads acting at Corner, Centre, and Front Columns

	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



(Comparison of axial loads acting at corner, centre, and front column)

21. Calculation And Interpretation:

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5.2 Calculations & Interpretation

Table 12: - Percentage difference in axial load on different positions of columns a) 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		

b) 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		

c) 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 13: - Percentage difference in bending moment on different positions beams a) 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		

b) 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		

c) 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		

22. Result And Discussion

In the ETABS 2018 Software, the structure was analysed as a typical moment opposing construction. By beginning with the specifics/specifications of the plan, the joint coordinate command is used to create the coordinates and to designate the joints of the structure. The connectedness between joints is shown by the member incidence command. By using beam elements, the columns and beams are presented. Each member's member attributes must be identified. Maximum design loads, moments, and shear on each member were determined by the analysis. We design the primary structure using these numbers, and further construction is completed. After studying the structure, we also obtain the results that are shown above.

The corner radiates shear power, for instance, acting at the first floor at 102.7 KN, and the corner sections shear power, for instance, operating at the fourth story at 34.29 KN.

The main floor, for instance, has the most shear force operating in the centre shafts at 104.71 KN, whereas the fourth floor, for instance, has the highest shear force acting in the focus sections at 28.17 KN.

At the fourth floor, for instance, 73.38 KN, the shear force acting on the fringe radiates is at its highest, and the fourth floor is also where the shear force acting on the fringe segments is at, for instance 23.79 KN.

The maximum twisting second radiates after a corner are at the first floor, for example 85.43 KN-m, while the maximum corner sections are at the fourth floor, for instance 48.12 KNm.

For example, the twisting second following focus segments is largest from the start floor at 86.09 KN-m, and that following focus radiates is greatest from the start floor at 39.53 KNm.

For instance, the twisting second following fringe radiates is largest from the outset floor at 86.09 KN-m, and the twisting second following fringe segments is greatest at 36.16 KN-m.

The corner segments' torsional power is largest from the first story, for example 0.594 KN, while the torsional power after corner radiates is maximum at the fourth floor, for example 0.334 KN.

The torsional power radiating from the focus is highest at the ground floor, for example 0.374 KN, and at the first floor, for example 0.5908 KN, for the intermediate parts.

The second floor, for example, has the highest torsional power after the fringe radiates (0.21 KN), and the highest torsional power after the fringe portions.

Utilising ETABS, the research and configuration tasks can be completed in the allotted time. The project provides the assurance needed to accomplish high-rise or multi-story building projects. We can accommodate different part sizes at various design members by observing the effects of plan data. When the design is examined using ETABS Software, the supplied story of the residential building is found to be secure.

23. Applications of ETABS Software

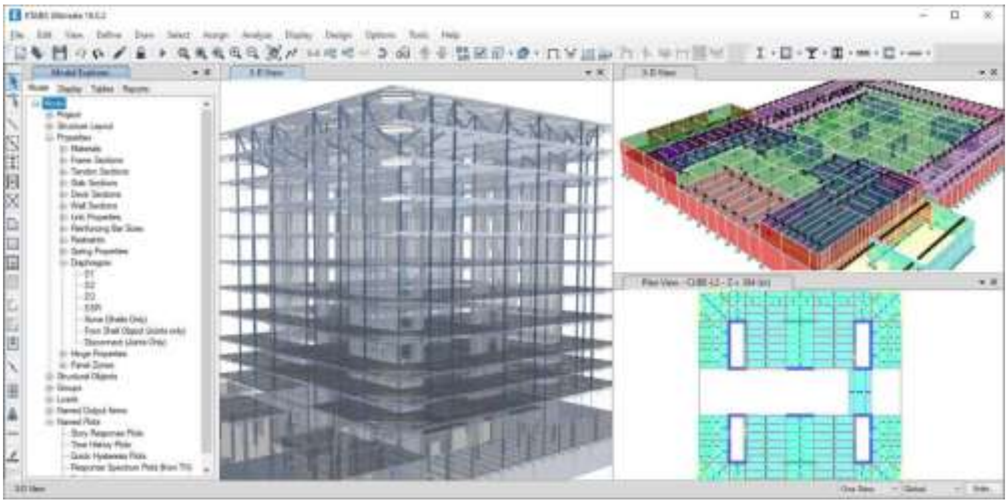
Only structural engineers and architects are skilled users of this programme. It is a programme for three-dimensional analysis and planning.

Building analysis and design software has been the industry standard for nearly thirty years thanks to ETABS. Following the same procedure today, ETABS has developed into a programme for strategically evolved structure analysis and design.

A graphical user interface built on aesthetic articles served as the basis. The desired, novel, and distinct longing computations for plan research and analysis govern the plan. Reproducing norms of integration, creativity, and professional progress with capacities for both drafting and output delivery.

You can implement a tonne of things with ETABS programming, such as moment-resisting frames and braced frames. It can also examine any type of support roof structure, a structure with reduced beam size, or a structure with side plates. Additionally, you can design rigid floor structures or flexible floors, unorganised material layouts, incline sections, and parking structure structures.

Aside from those, the programme can create basic concrete structures, intermediate-level floor frameworks, multiple tower structures, and various-level diaphragm structures. With this programme, it is simpler to examine the high-level composite floor framework or steel joist floor outlining strategy. Modelling, analysis, design, and reporting tasks are all performed using a single user interface provided by ETABS. The number of model windows, model control perspectives, and information views is unrestricted.



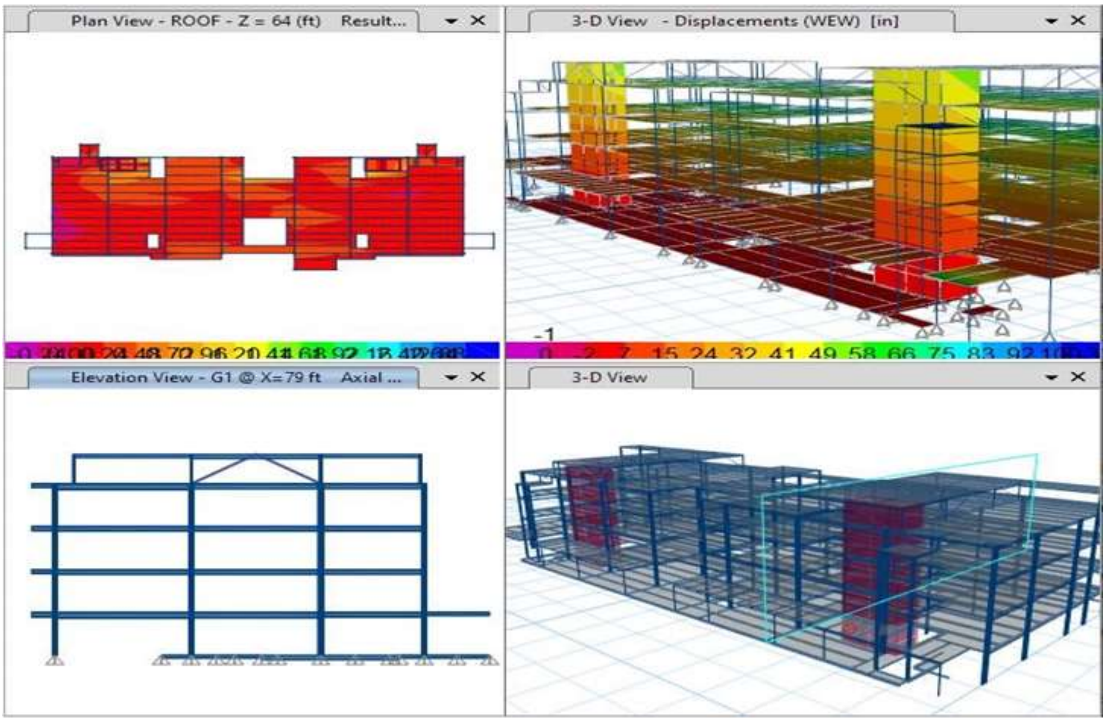
(Direct Graphics in ETABS)

Additional DirectX Graphics

Flythroughs and rapid revolutions/rotations are taken into consideration while navigating models in DirectX illustrations with attached speed up designs.

Many perspectives

On a single screen, users can view moment diagrams, load tasks, deflected shapes, plan output, and reports.



(Multiple Views Of the plan)

Data management and swift navigation

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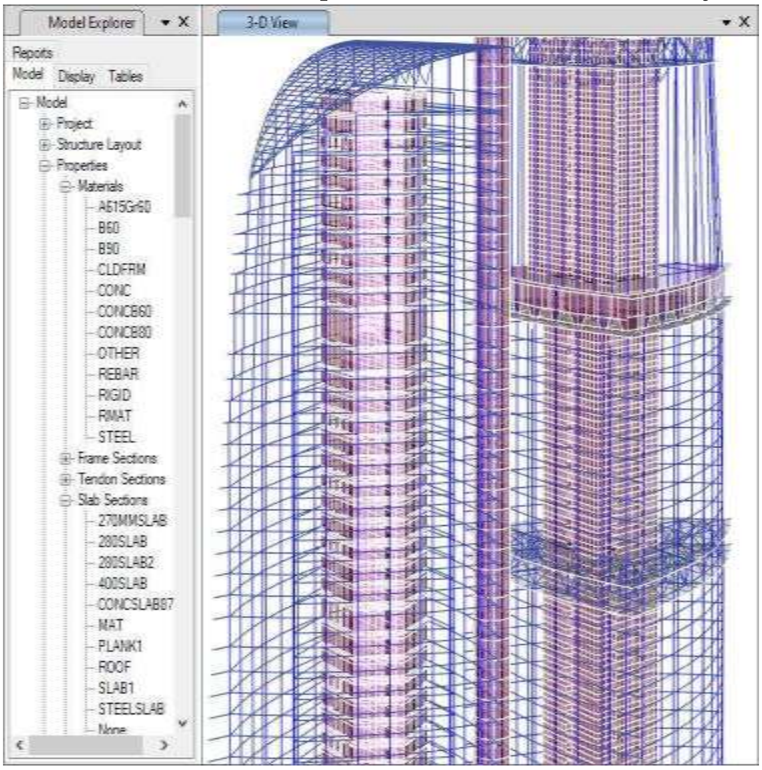
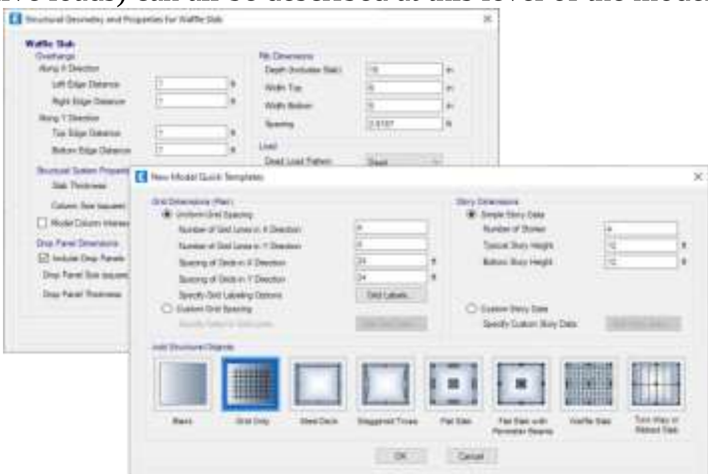
Our ability to manage the data in your model is enhanced by the ETABS model explorer. Properties may be categorised, copied, changed, and dropped directly into task models by dragging them there. In the model explorer, user-characterized presentations can be efficiently set up for quick navigation.



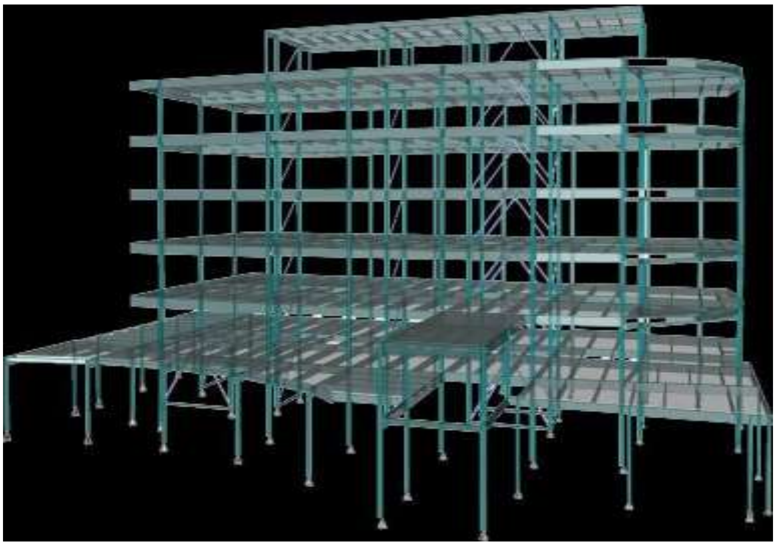
Modelling

ETABS offers a variety of formats for quickly starting a new model. The number of storeys, the default structural framework sections, the default slab and drop plan sections, and uniform loads (particularly dead and live loads) can all be described at this level of the model format.



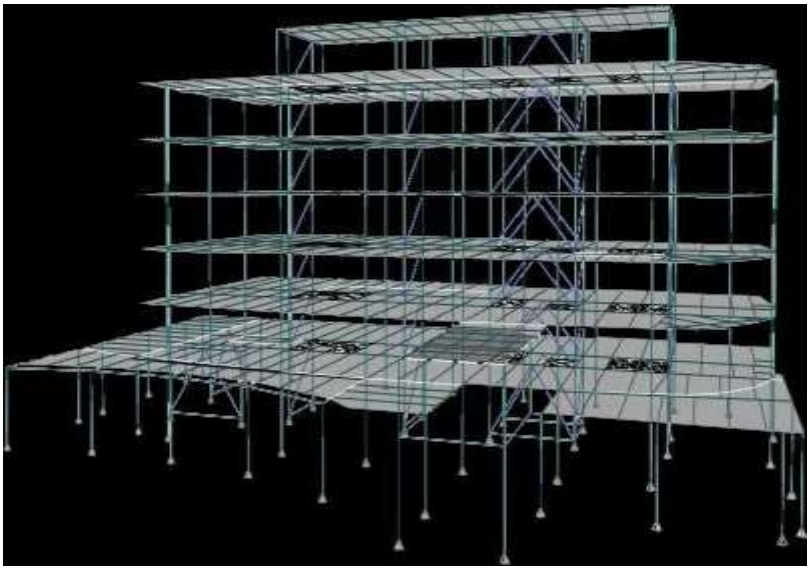
Physical Model

Objects that address the physical structural components make up the physical model. Insertion pressures, member orientations, object convergences, and other mathematical characteristics captured by the object model are precisely displayed using physical model viewpoints.



Research Model

The restricted component model of the design, which is made up of the connection of the joints, frames, and shells as well as the meshing, is displayed from the views of the analytical models. The analytical model is automatically generated from the model and its tasks and parameters at the time the analysis is done.



24. The following effects of ETABS software are felt in the building, designing, and modelling sectors:

1. It is a substance used in building structures. It looks at seismic execution, surveys it, and assesses the load capacity of building structures.
2. With the aid of this programme, the analytical model may be seen and managed with extreme accuracy. At each grid line, plans and elevation views are automatically produced.
3. Concrete moment frames and concrete shear walls are analysed using ETABS programming. For the static and dynamic analysis of multi-story frame and shear wall structures, it has received enormous recognition.

4. It boosts the effectiveness of underlying structural engineering professionals and is the most widely used civil designing tool in the structural sector. Additionally, it prevents the waste of time and money on generally beneficial projects.
5.The input, output, and numerical solution methods used by ETABS are specifically designed to benefit from the remarkable physical and mathematical characteristics associated with building-type

structures. This analysis and design tool expedites the preparation of the data, interpretation of the output, and execution.

25. Future Aims of the Work

Multi-story building analysis and plan developing are taken into consideration by ETABS, a significant programming tool. A 3D showing programme for structure analysis and plan designing is called ETABS. One may do both steel structures and RC structures with this programme.

ETABS provides users with Graphic information and change for easy and quick model generation for a construction, which is highly important for the engineers to immediately known whether the materials used are appropriate or not. As the software provides a complete interpretation of the structure, any new developments in the software will be especially helpful to engineers since they will no longer need to spend as much time and effort on the associated paperwork.

Any type of complicated design may be properly created as a 3D model using plan views and elevations. This programme allows for complete tower and skyscraper structural design, reducing the amount of paper effort that was previously required. Additionally, there is a need to create more specialised software, such as ETABS, and models to test the structural suitability of various complex designs more accurately.

This programme will enable civil engineers to look through a thing in new dimensions before it is really built. It will provide an idea of how the structure will respond to different sorts of loads and stresses placed on or applied to a specific area of the entire structure. Engineers will save time and money by not having to get inaccurate paper-based information or calculations; instead, software like ETABS will perform the calculations quickly and effectively.

To get experience and professional status in the structural area, which will allow them to be a better engineer and be helpful for the benefit of the engineers, future structural engineers need to master software like ETABS at their early stage of learning about civil engineering.

A popular piece of software for analysing and creating structures, notably buildings, is ETABS. Numerous potential career opportunities and advantages may result from studying ETABS software, including:

Employment in the field of structural engineering: ETABS is one of the most often used software packages. You can acquire the abilities and information required to pursue a career in this sector by studying ETABS software.

Higher pay: Employers may be willing to pay you more if you have expertise with ETABS software. The earnings are relatively high in this industry due to the need for qualified specialists.

Design complicated structures: ETABS is capable of modelling and designing a variety of structures, such as skyscrapers, bridges, dams, stadiums, and more. You may learn how to design these intricate structures using ETABS software, and you can participate in the most cutting-edge projects in the market.

Efficiency gain: The software's architecture simplifies the design process and cuts down on the amount of time needed to develop a building. You may greatly increase your production and efficiency by utilising ETABS.

Opportunities to work overseas: Since ETABS is used all over the world, learning this programme may present you with the chance to work abroad and acquire a range of professional expertise.

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