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ANALYSIS AND DESIGN OF (G+5) COMMERCIAL BUILDING USING ETABS

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ABSTRACT

Structural analysis is a field that studies how structures behave or forecasts how various structural elements will react to loads. Every single structure will be exposed to one or more sets of loads, as well as different types of loads. Dead load, live load, earthquake load, and wind load are typically considered.

The software ETABS (Extended Three-Dimensional Analysis of Building System) is specifically designed for building analysis and design. It is integrated with all of the main analysis engines, including static, dynamic, linear, and non-linear.

Our project is titled "Analysis and Design of Commercial Buildings Using ETABS Software".

This study considers a multi-story skyscraper. Analysis is performed using the static approach, and design is done in accordance with IS 456:2000 requirements. Additionally, an attempt was made to design the structural elements manually. AutoCAD is used to create drawings. Revit Architecture is used to create three-dimensional models.

Key Words: Auto Cad, ETABS, Revit, bending moment, Shear force, IS codes**,**

1. INTRODUCTION

Commercial buildings are those that serve a commercial purpose. Commercial structures include office buildings, retail shops, and warehouses, among others. Commercial property, which also includes multi-family structures like apartment buildings, is a little different from this. This is because commercial buildings are the sites of business, whereas commercial property generates revenue for its owners without necessarily being the site of commerce. In some situations, multi-use buildings with a variety of spaces—such as residences and a retail area—can nevertheless be classified as commercial.

INTRODUCTION TO ETABS

ETABS is an analysis and design-based program that is extremely valuable for structural engineers. When high-rise structures are developed using ETABS, the most cost-effective design is obtained. It is the most widely used structural engineer's software program for model production, analysis, and multilateral design. It features an intuitive user-friendly GUI, visualization tools, sophisticated analysis and design capabilities, and seamless connection with a variety of other modeling and design software applications.

2. LITERATURE REVIEW

Chandrasekhar and Rajasekhar (2015):

The multi-story skyscraper was analyzed and designed using ETABS software. For this study, a G+5 story building subjected to the lateral loading effects of earthquakes and wind was taken into consideration. ETABS was used for analysis.

They have also taken into account the likelihood that a fire would spread and the significance of using fireproof materials that meet the highest performance and dependability standards. They recommended that ETABS software, which is highly inventive and simple for high-rise buildings, be used extensively to cut down on the amount of time needed for design.

Balaji and Salvarsan M.E (2016):

ETABS was used to analyze and design a multi-story structure in both static and dynamic loading conditions. In this work, ETABS was used to study the earthquake loads of a G+13- story residential building.

They conducted both static and dynamic analyses, assuming that material properties were linear. Severe seismic zones were taken into account when doing the non-linear analysis, and type II soil conditions were used to evaluate the behavior. Plotting and analysis were done on various outcomes, such as displacements and base shear.

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3. METHODOLOGY

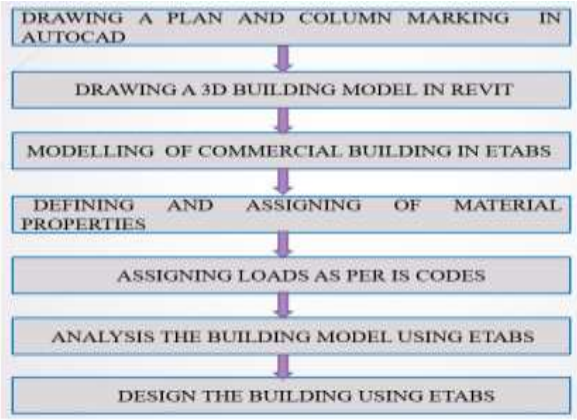


FIG 3.1: Methodology Flowchart

SOFTWARE USED

The following software are used for the design of G 4 Domestic structure in this design.

1. AUTOCAD Software.
2. ETABS Software.
3. Revit Architecture.

4. PLAN OF THE BUILDING

The material is used for construction is reinforced concrete with M-30 grade concrete and Fe- 415 grade of steel. Type of the project = Structural Analysis Design of Commercial Building.

Building Type = Commercial Building-shopping mall

Location = Hyderabad, Telangana.

Type of Slab = Two-way slab

Total Built-up Area = 1050 sq.-m. (assumed 42m x 25m)

Method of Analysis = Static Analysis (Linear)

Material Properties of the structure:

Beam Sizes = 300mm x 500mm

Column Size = 300mm x 500mm

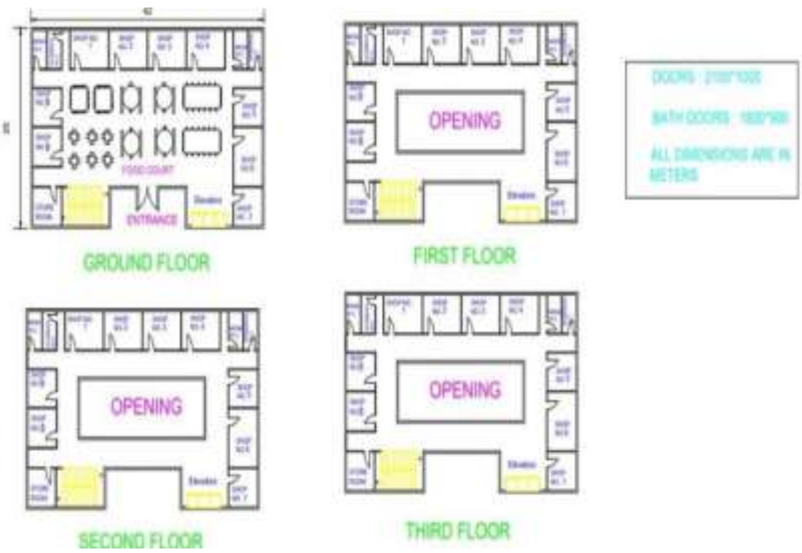
Slab Thickness = 200 mm

Number of stories = G+3

Height = 15m Live Load = 5 kN/m² and 1.5 kN/m² (as per IS 875 part II2015)

Dead Load = Self -weight of members (as per IS 875 part I-2015)

Seismic Load = Calculated as per IS 1893(part I) – 2016



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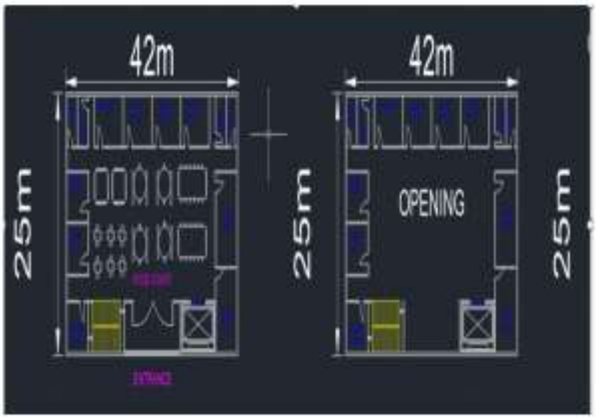

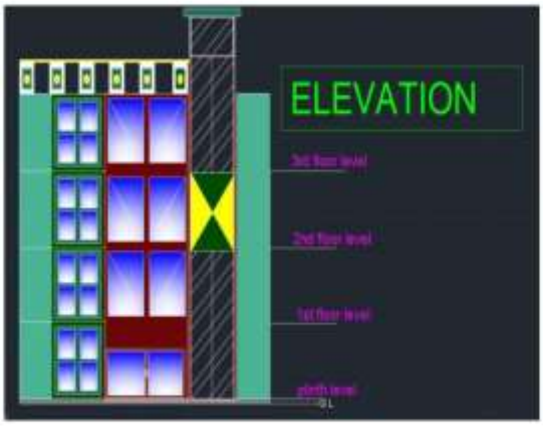

FIG 4.2 Plan View For Gf **,**1ST**,** 2nd,3rd, 4th And 5th Floor **FIG 4.4:** Elevation View

5. 3D MODEL IN REVIT

FIG 5.1: FRONT VIEW **FIG 5.2:** INSIDE VIEW -2

6. LOAD CALCULATIONS

6.1 DEAD LOAD AND LIVE LOAD CALCULATIONS

1.Dead Load External wall = 0.3x3x20 = 18kn/m

Internal wall = 0.15x3x20 = 9kn/m

Load on slab = Self wt of slab=0.2x25 = 5kn/m^2

2. Live load = 1.5kn/m^2

Floor finishing = 1kn/m^2

Unit wt of RCC = 25KN/M^3

Self wt of slab = 5kn/m^2

6.2 CALCULATION OF DESIGN WIND SPEED OF ALL STORY'S:

Story-1,2, 3,and 4

Design wind Speed (Vz)

Vz=Vb x K1 x K2 x K3 x K4 m/s Vb=44m/s

6.3 SEISMIC ZONE CALCULATION DESIGN

Calculation of Horizontal Seismic Coefficient:

For 4-story Building Along X=direction Base dimension along x – direction=42m

Height of Building H=16.5m Translational time period Ta=0.075 X h $^{0.75}$(Clause7.6.2MRFbuilding)

h = 16.5 Ta = 0.075×h $^{0.75}$ Ta = 0.775sec of Sa/gV aluefor0.77secis2.5

Horizontal Seismic Coefficient Ah=[(2/3 x z/2) x (Sa/g)]/(R/I)

Z=0.10 R=5, I=1.0 Sa/G=2.5 Ah=0.025

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7. ANALYSIS, DESIGN & MODELING USING ETABS-20

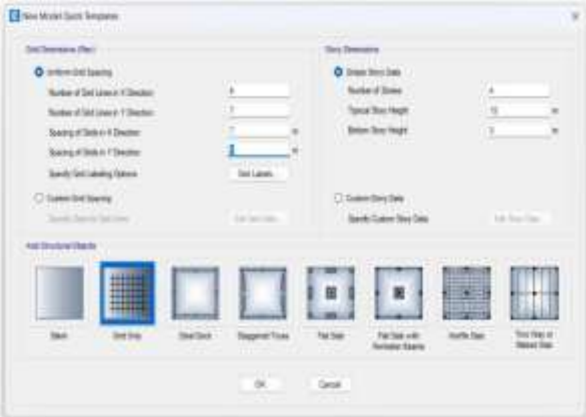


Fig 7.1 Grid Spacing

Fig 7.2 Frame Property

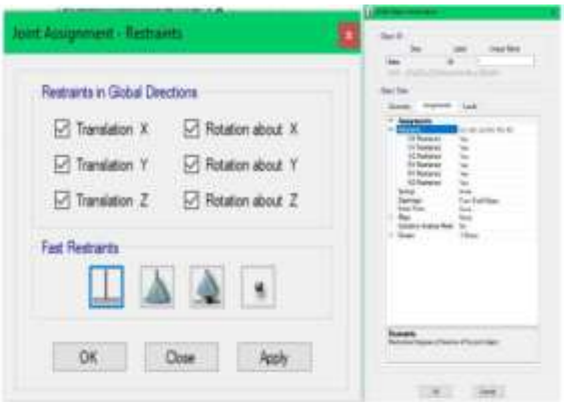


Fig 7.3 Support Selection

Fig 7.4 Load Selection

7.2 Results

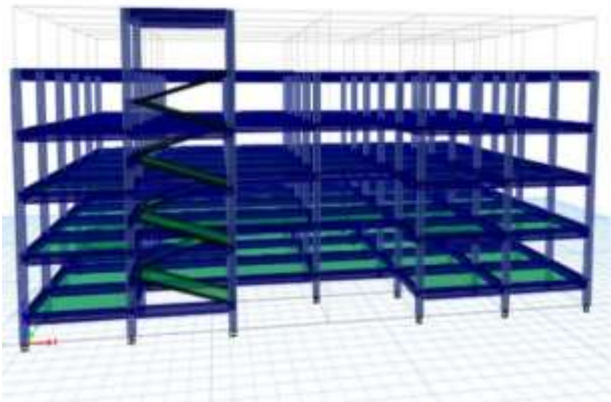


Fig: 7.4 ASSIGNED PROPERTIES

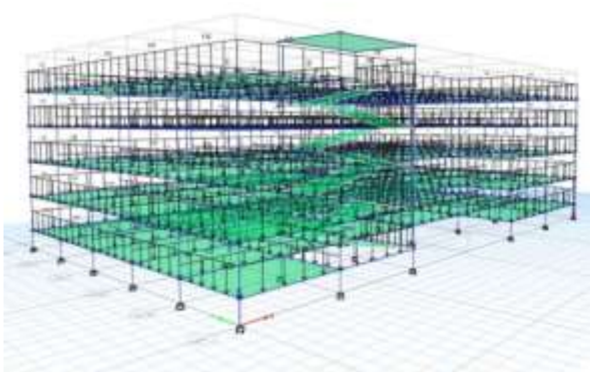


Fig: 7.5 ASSIGING LOADS

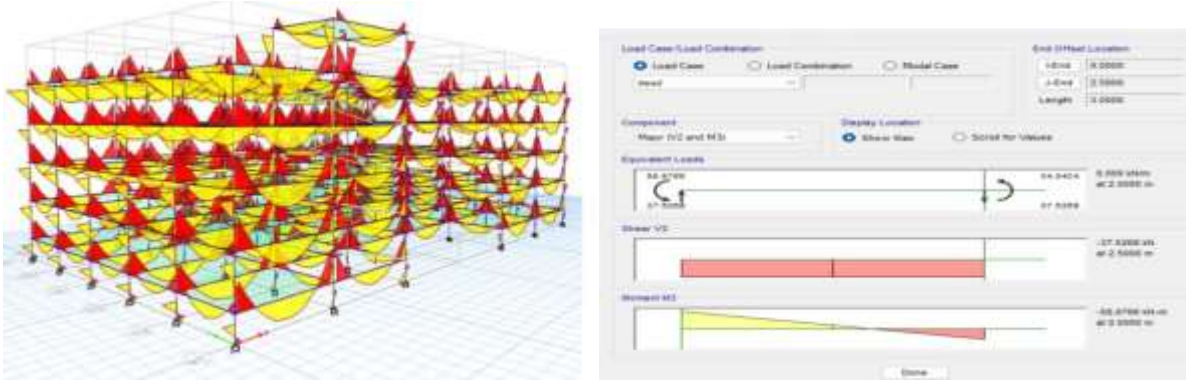
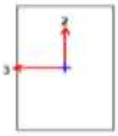


Fig:7.6 SHEAR FORCE AND BENDING MOMENT DIAGRAMS

7.3 COLUMNS RESULT REPORT:

ETABS Concrete Frame Design

IS 456:2000 + IS 13920:2016 Beam Section Design (Summary)



Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
Story4	C3	4362	b-300*500	DConS2	0	3000	0.825	Ductile Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
300	500	300	0	50	50

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	415	415

Design Code Parameters

γ_C	γ_S
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
-111.0761	0.1589	70.8671	646.0789

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
-111.0761	0.2492	0	-111.3253

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	-111.3253		743	0	743	428
Bottom (-2 Axis)		0	371	0	0	371

Shear V_e kN	Shear V_s kN	Shear V_c kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
70.8671	100.0714	54	103.046	332.53

Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
0.1589	70.8671	220	420	0

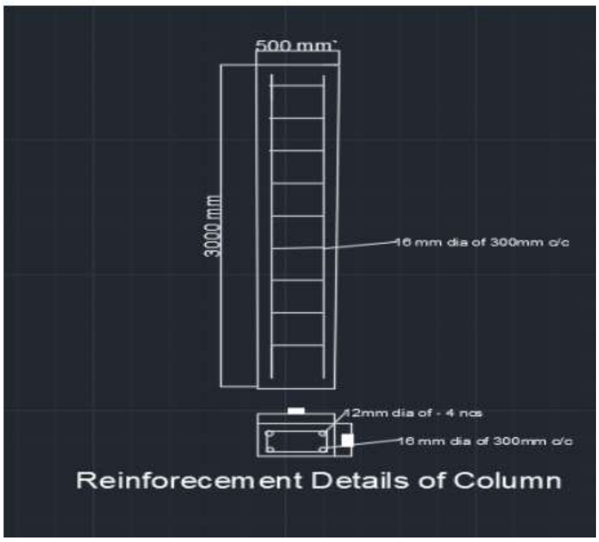


Fig: 7.7 REINFORCEMENT DETAILS FOR COLUMN

7.4 BEAM RESULT REPORT

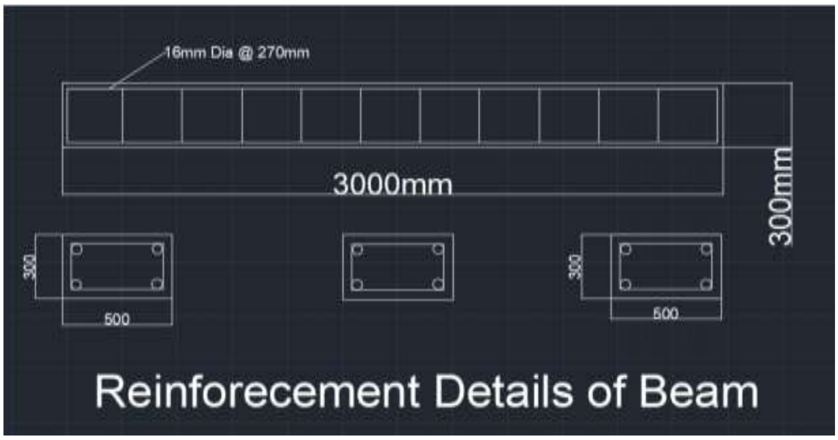
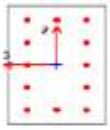


Fig 7.7 REINFORCEMENT DETAILES FOR BEAM

ETABS 2016 Concrete Frame Design

IS 456:2000 Column Section Design



Column Element Details Type: Ductile Frame (Summary)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
TOF	C30	115	COLUMN 300 X 500	UDCon23	2500	3000	0.6

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
300	500	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	415	415

Axial Force and Biaxial Moment Design For P_u , M_{u2} , M_{u3}

Design P_u kN	Design M_{u2} kN-m	Design M_{u3} kN-m	Minimum M_2 kN-m	Minimum M_3 kN-m	Rebar Area mm²	Rebar % %
1199.9203	1.775	-25.9983	23.9984	25.9983	1200	0.8

Axial Force and Biaxial Moment Factors

	K Factor Unitless	Length mm	Initial Moment kN-m	Additional Moment kN-m	Minimum Moment kN-m
Major Bend(M3)	0.771768	2500	-1.035	0	25.9983
Minor Bend(M2)	1	2500	0.71	0	23.9984

Shear Design for V_{u2} , V_{u3}

	Shear V_u kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
Major, V_{u2}	1.7746	101.9186	52.8002	70.1831	332.53
Minor, V_{u3}	1.252	96.1587	48.0004	63.0489	554.22

Joint Shear Check/Design

	Joint Shear Force kN	Shear V_{Top} kN	Shear $V_{u,Tot}$ kN	Shear V_c kN	Joint Area cm²	Shear Ratio Unitless
Major Shear, V_{u2}	N/A	N/A	N/A	N/A	N/A	N/A
Minor Shear, V_{u3}	N/A	N/A	N/A	N/A	N/A	N/A

(1.1) Beam/Column Capacity Ratio

Major Ratio	Minor Ratio
N/A	N/A

Additional Moment Reduction Factor k (IS 39.7.1.1)

A_g cm²	A_{sc} cm²	P_{uz} kN	P_b kN	P_u kN	k Unitless
1500	14.3	2469.4913	944.9647	1199.9203	0.832764

Additional Moment (IS 39.7.1) (Part 1 of 2)

	Consider M_a	Length Factor	Section Depth (mm)	KL/Depth Ratio	KL/Depth Limit	KL/Depth Exceeded
Major Bending (M_3)	Yes	0.833	500	3.859	12	No
Minor Bending (M_2)	Yes	0.833	300	8.333	12	No

8. CONCLUSION

1. The primary focus of this project is the analysis and design of a multi-story commercial structure utilizing ETABS, accounting for all potential load combinations in accordance with IS Code. overcoming the design obstacles are explained conceptually.

2. Using ETABS software, the building's axial force, shear force, and bending moment were examined.

3. We have examined the 3D modelling and design of RCC commercial buildings using the Revit and ETABS software.

4. In addition, rectification in ETABS is as easy as changing the values at the location of the fault, with the results generated in the output.

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