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ANALYSIS AND DESIGN OF G+4 COMMERCIAL BUILDING BY USING ETABS

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ABSTRACT

Structural Analysis is a branch which involves in the determination of behavior of structures in order to predict the responses of different structural csomponents due to the effect of loads. Each and every structure will be subjected to either one or the groups of loads, the various kinds of loads normally considered are dead load, live load, wind load IS:875-1987 Part1, 2, 3, earthquake load(IS:1893-2016). ETABS (**Extended Three Dimensional Analysis of Building System**) is a software which is incorporated with all the major analysis engines that are static, dynamic, Linear and non-linear, etc. This Computer software's are also being used for the calculation of forces, bending moment, stress, strain &deformation or deflection for a complex structural system & this Software is used to analyze and design the buildings.

Keywords: Etabs, Static Analysis, Dynamic Analysis, Non-linear Analysis, Linear Analysis.

1. INTRODUCTION

The term building in Civil Engineering is used to mean a structure having various components like foundation, walls, columns, floors, roofs, doors, windows, ventilators, stairs lifts, various types of surface finishes etc. Structural analysis and design are used to produce a structure capable of resisting all applied loads without failure during its intended life. Prior to the analysis and design of any structure, necessary information regarding supporting soil has to be collected by means of geotechnical investigation. A geotechnical site investigation is a process of collecting information and evaluating the conditions of the site for the purpose of designing and constructing the foundation for a structure.

Structural engineers are facing the challenges of striving for most efficient and economical design with accuracy in solution while ensuring that the final design of a building and the building must be serviceable for its intended function over its design life time. Nowadays various software packages are available in the market for analyzing and designing practically all types of structures viz. RISA, STAADPRO, ETABS, STRUDL, MIDAS, SAP and RAM etc.

LOADS ON THE STRUCTURE

A.DEAD LOAD: (IS:875-1987) PART-1

The dead load comprises of the weight of the walls, partition floors finishes, false ceiling, false floors and the other permanent constructions in the building. The dead loads may be calculated from the dimensions of various members and their unit weight. The unit weight of plain concrete and reinforced concrete made with sand and gravel or crushed natural stone aggregate may be taken as 24KN/m and 25KN/m respectively.

IMPOSED LOADS: (IS:875-1987) PART-2

The Imposed load is produced by the intended use or occupancy of a building including the

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weight of movable partitions, distribution and concentrated loads, the load due to impact and vibration and dust loads. Imposed loads do not include loads due to the wind, seismic activity, snow and loads imposed due to temperature changes to which the structure will be subjected to creep and shrinkage of the structure, the differential settlements to which the structure may undergo.

WIND LOAD: (IS:875-2015) PART-3

Wind is air in motion relative to the surface of the earth. The primary cause of wind is traced to the earth's rotation and differences in terrestrial radiation. The radiation effects are primarily responsible for convention either upward or downwards. The wind generally blows horizontal to the ground at high wind speeds. Since vertical components of atmospheric motion are relatively small, the term 'wind' denotes almost exclusively the horizontal wind, vertical winds are always identified as such. The wind speeds are assessed with the aid of anemometers or anemograph which are installed at meteorological observations at heights generally varying from 10 to 30 meters above ground.

METHODOLOGY

Analysis and Design in Etabs:

The procedure carried out for Modeling and analyzing the structure involves the following flow chart.

Prepare the beam- column plan with the centerline

⇩

Enter grid spacing in Etabs i.e. centerline spacing of beams

⇩

Enter concrete, Rebar properties & Beam-column sizes

⇩

Model the structure in seconds using Etabs quick drawing tools

⇩

Apply DL+LL+ SIDL +EQ+WL Using IS codes as per site conditions

⇩

Form load combinations & assign support conditions

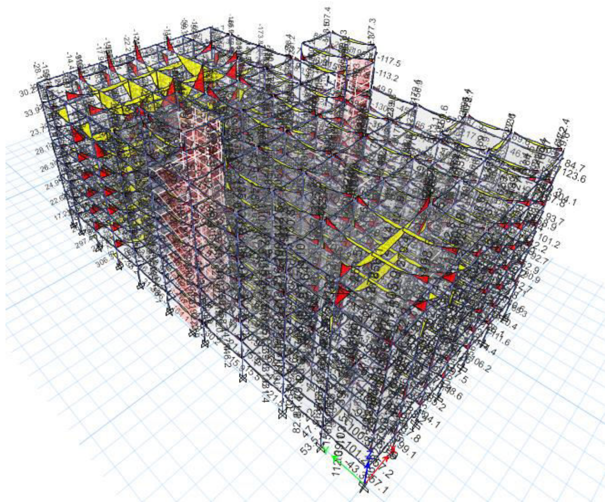
⇩

Analyze the structure & apply load + deflection checks

⇩

Design the Structure & apply design checks

MOMENT DIAGRAM FOR FRAMES OF WHOLE STRUCTURE



ETABS 2016 Concrete Frame Design IS 456:2000 Beam Section Design (Envelope)

Beam Element Details

Level	Element	Unique Name	Section ID	Length (mm)	LLRF
5F(roof)	B111	400	CB 450X1200	5930	1

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)	h (mm)
450	1200	450	0	40	**40**	1200

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Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)	E_c (MPa)	f_{ck} (MPa)
27386.13	30	1	500	500	27386.13	30

Design Code Parameters

γ_C	γ_S
1.5	1.15

Flexural Reinforcement for Major Axis Moment, M_{u3}

	End-I Rebar Area mm²	End-I Rebar %	Middle Rebar Area mm²	Middle Rebar %	End-J Rebar Area mm²	End-J Rebar %
Top (+2 Axis)	0	0	918	0.17	2181	0.4
Bot (-2 Axis)	1989	0.37	1305	0.24	0	0

Flexural Design Moment, M_{u3}

	End-I Design M_u kN-m	End-I Station Loc mm	Middle Design M_u kN-m	Middle Station Loc mm	End-J Design M_u kN-m	End-J Station Loc mm
Top (+2 Axis)	0	1186	-309.9	3953.3	-1103.4	5480
Combo	UDCon50		UDCon49		UDCon41	
Bot (-2 Axis)	994.4	0	671.4	1581.3	0	5480
Combo	UDCon2		UDCon42		UDCon50	

Shear Reinforcement for Major Shear, V_{u2}

End-I Rebar A_{sv} /s mm²/m	Middle Rebar A_{sv} /s mm²/m	End-J Rebar A_{sv} /s mm²/m
498.8	821.05	806.94

Design Shear Force for Major Shear, V_{u2}

End-I Design V_u kN	End-I Station Loc mm	Middle Design V_u kN	Middle Station Loc mm	End-J Design V_u kN	End-J Station Loc Mm
121.2299	1186	0.4	3953.3	457.3866	4348.7
UDCon50		UDCon2		UDCon2	

Torsion Reinforcement

Shear Rebar A_{svt} /s mm²/m
821.05

Shear Design

Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	V_c + V_s kN
Top	Leg 1	575	UDCon42	117.5281	106.1	-103.2259	33.8195	131.7595
Top	Leg 2	575	UDCon42	228.6369	131.1	-90.5879	67.5114	263.3914
Top	Leg 3	575	UDCon41	108.8204	-82.8	85.2328	33.6464	131.5864
Top	Leg 4	575	UDCon38	835.0487	615	-359.2297	135.5983	505.7783
Top	Leg 5	575	UDCon42	1270.7438	1090.4	-694.2774	311.2792	1201.0392
Top	Leg 6	575	UDCon37	483.6245	-144.7	97.4201	128.61	498.79
Top	Leg 7	575	UDCon37	589.6295	-440.7	237.148	130.718	500.898
Bottom	Leg 1	851.02	UDCon42	248.9706	-197.7	-181.3873	36.4334	181.3873
Bottom	Leg 2	634.18	UDCon42	440.0072	-285.1	-287.7561	71.7147	287.7561

Station Location	ID	Rebar mm²/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	V_c + V_s kN
Bottom	Leg 3	575	UDCon41	317.0337	132.7	118.9026	37.7868	135.7268
Bottom	Leg 4	575	UDCon38	380.3847	-469.5	-389.4355	126.557	496.737
Bottom	Leg 5	575	UDCon42	1625.659	-283.4	-721.5646	318.337	1208.097
Bottom	Leg 6	575	UDCon38	731.885	-104	-171.5573	133.5469	503.7269
Bottom	Leg 7	575	UDCon37	552.9722	175.8	234.0586	129.989	500.169

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	0	UDCon47	48.624	-2.2	0.52	7
Top–Right	Leg 1	230	UDCon47	188.4143	81.8	7.52	7
Top–Left	Leg 2	0	UDCon31	247.1168	-14.1	1.17	7
Top–Right	Leg 2	0	UDCon31	336.7105	44.1	2.07	7
Top–Left	Leg 3	230	UDCon39	108.8204	-82.8	7.01	7
Top–Right	Leg 3	0	UDCon39	108.3257	19.6	2.27	7
Top–Left	Leg 4	0	UDCon27	812.3283	-139	2.31	7
Top–Right	Leg 4	0	UDCon27	1170.0813	254.3	3.62	7
Top–Left	Leg 5	0	UDCon27	2233.8058	-168	1.96	7
Top–Right	Leg 5	0	UDCon27	2301.2828	33.3	1.9	7
Top–Left	Leg 6	0	UDCon3	573.6776	-4.2	1.14	7
Top–Right	Leg 6	0	UDCon3	716.566	2.7	1.41	7
Top–Left	Leg 7	0	UDCon39	1243.3634	-66.7	2.77	7
Top–Right	Leg 7	0	UDCon39	972.551	224.6	3.07	7
Bottom–Left	Leg 1	230	UDCon2	249.0573	-133.3	11.82	7
Bottom–Right	Leg 1	0	UDCon2	80.3879	29.6	2.81	7
Bottom–Left	Leg 2	0	UDCon36	589.7562	-139.8	4.79	7
Botto	Leg	0	UDC	440.0	57.8	2.7	7

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Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
m–Right	2		on36	812			
Bottom–Left	Leg 3	230	UDCon40	194.231	-82.1	7.58	7
Bottom–Right	Leg 3	230	UDCon40	317.0337	132.7	12.28	7
Bottom–Left	Leg 4	0	UDCon2	601.5408	-275.8	2.62	7
Bottom–Right	Leg 4	0	UDCon2	620.5626	79.3	1.63	7
Bottom–Left	Leg 5	0	UDCon2	2384.8649	-81.7	2.01	7
Bottom–Right	Leg 5	0	UDCon2	2063.1083	92.5	1.76	7
Bottom–Left	Leg 6	0	UDCon2	977.9789	-86.5	2.36	7
Bottom–Right	Leg 6	0	UDCon2	482.1799	5	0.97	7
Bottom–Left	Leg 7	0	UDCon31	783.8332	-23	1.65	7
Bottom–Right	Leg 7	0	UDCon31	855.9671	18.5	1.77	7

CONCLUSION

1) The structural design is based on the ETABS and the theory of LIMIT STATE METHOD which provide adequate strength, serviceability, and durability besides the economy.
2) The preparation of the project has provided an excellent opportunity to emerge ourselves in planning &designing of G+4 commercial building.
3) This project has given an opportunity to recollect and coordinate the various methods of designing and engineering principles which we have learned in our lower classes.
4) The displacement, shear force, bending moment variation has been shown by ETABS.
5) If any beam and column fail, the dimensions of beam and column should be changed and reinforcement detailing can be produced.
6) By this project we are able to identify, formulate, and solve complex engineering problems by applying principles of engineering.