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G+4 Residential Building Analysis and Design using ETABS

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Abstract - This paper's research is on Etab analysis and design for reinforced concrete buildings. The building's displacement seems to be within the allowed limit, according to this study article. The width of the slab has been increased by 175 mm to accommodate the wide gap between the columns and the big slab span. The design of the structure adheres to the codes and rules of India.

***Key Words*: Etabs, Seismic loads, Deflections, wind loads, Reinforced concrete**

1. INTRODUCTION

In this modern world the construction of building has taken a long way, For this construction we require to analyze & design the structure , there has been many analysis & design software , but here we have analyzed & designed Residential building (G+4) using Etabs. ETABS stands for Extended Three Dimensional Analysis of Building Systems. In this research paper Etabs has been used to analyze & design of Reinforced concrete building (G+4).This structure has been constructed in Bangalore, Karnataka.

The building has been analyzed & designed by as per Indian Standard conformation codes & after analysis & design, here an attempt has been made to understand the behavior of the building.

The building has been analyzed & designed using Limit state method. The structure has been checked for wind load & Seismic loads (lateral loads also).

1.1 Overview of Plan & Structure

This is a G+4 residential building in which each floor consists of 2 Bedroom, hall and a kitchen. The house is well lit and spacious. The main door is headed towards East. The Master-Bedroom with attached toilet is in the south-west, kitchen is in the South-East which is most preferable. The basement is provided with a small garden and abundance of parking space for 2 and 4 wheelers.

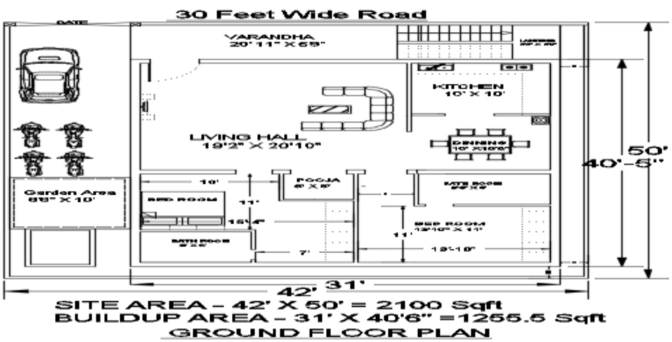

Fig 1- Plan of the building

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2. Loads & Load Combination

Table -1: showing loads as per Indian standards

Types of Loads	*Location/ Load Values*	*IS codes Conformation*
Dead Load	Self-weight (1)	IS 875 Part-1
Live Load	2kN/m^2 for all places except balcony 3kN/m^2	IS 875 Part-2
Super Dead Load	1 kN/m^2 floor finish	IS 875 Part-1
Super Dead Load	3000 liters for water tank	IS 875 Part-1
Seismic Load X	Zone II	IS 1893-2002
Seismic Load Y	Zone II	IS 1893-2002
Wind Load X	Bangalore	IS 875:2015, Part-3
Wind Load Y	Bangalore	IS 875:2015,Part-3

As per table, it has been clear that the building has been designed to sustain self-weight (1) which has been normally automatically assigned by software, floor finish of 1kN/m^2 has been considered. As per IS codes 875- part 2 live load of 2 kN/m^2 has been assigned & 3kN/m^2 live load has been assigned for balcony areas. On the top of the building 3000litres of water tank has been placed and their load has been considered on the structure. As the location of the structure is in Bangalore, wind load has been considered 33m/s as per IS 875 part 3 annex A, Structure Class B and terrain category 2 has been considered for calculating the wind pressure which structure has to withstand. Windward & Wind leeward has been also applied on the structure. For Seismic load Zone II has been considered for analysis of the structure.

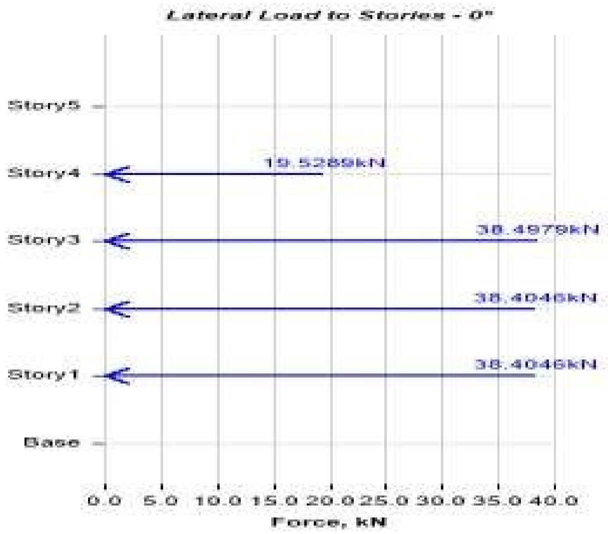

Fig -2: Wind load on building (0degree)

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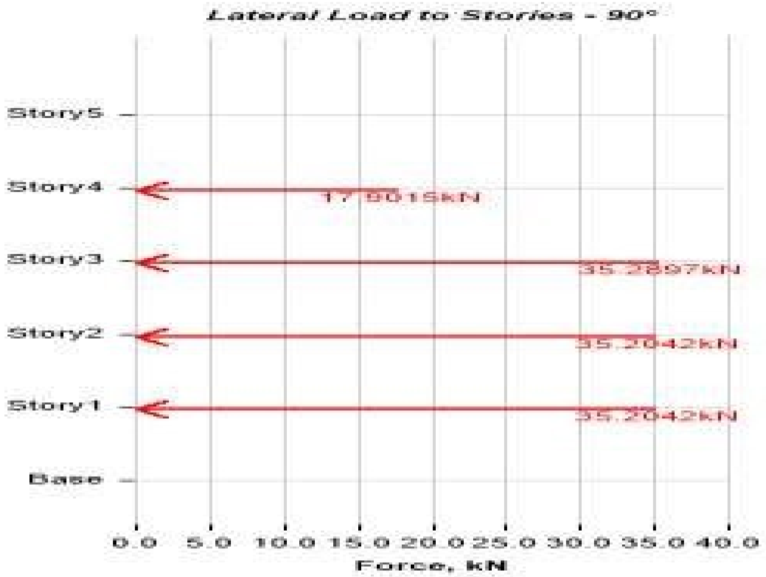

Fig -3: Wind load on building (90degree)

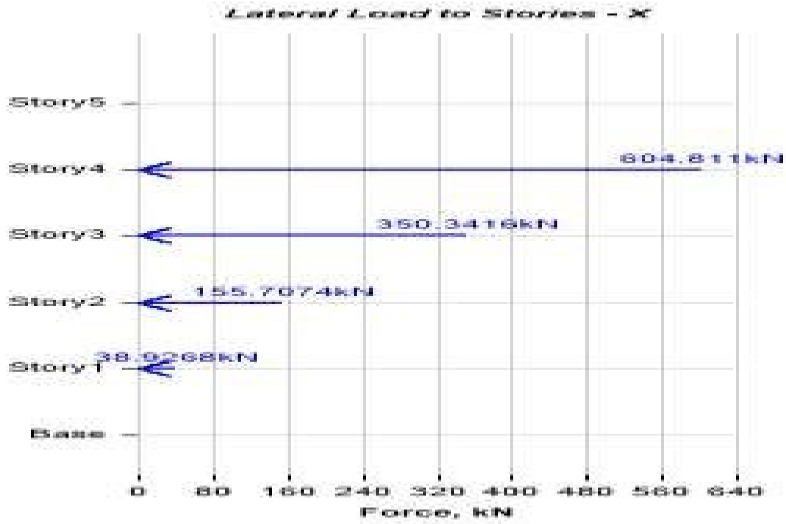

Fig -4: Seismic load on building (X direction)

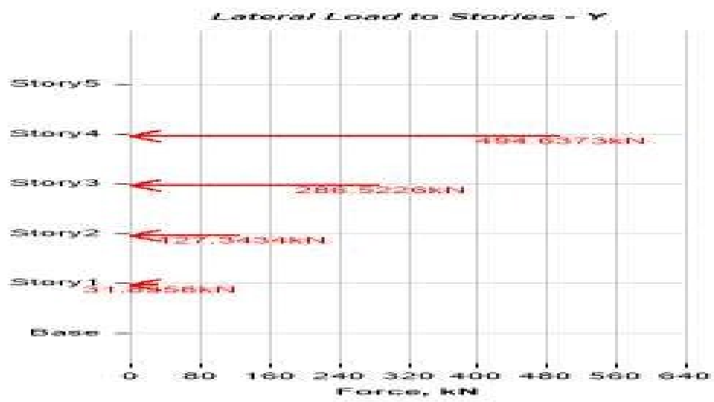

Fig -5: Seismic load on building (Y direction)

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From the above fig it has been clearly shown that the seismic effect will be more on the as building height increases.
In seismic prone areas they follow modern construction techniques in the construction of high rise buildings by using different kinds of base isolators and by providing bracing. Seismic zones are from zone II to zone V. According to the location of the construction, Seismic zones are decided from the respective code book

The structure has been designed as per limit state method, Limit state method is mostly used design method across the world, and this structure has been checked under above listed load cases & Load combination. The analysis of building has been done by Software itself, the best part of this Etabs is that it gives precise result for reinforced concrete design compared to the other software.

2.1 *Load* Combination

Table -2: load combinations as per Indian standards

Limit State of Strength
1. Dead Load (1.5)+Live Load (1.5)+Super DeadLoad(1.5)
2. Dead Load(1.5)+Wind Load X (1.5) +Super DeadLoad(1.5)
3. Dead Load(1.5)+Wind Load Y (1.5) +Super DeadLoad(1.5)
4. Dead Load(1.5)+Seismic load X (1.5) +Super DeadLoad(1.5)
5. Dead Load(1.5)+Seismic load Y (1.5) +Super DeadLoad(1.5)
6. Dead Load(1.2)+ Live load (1.2) + Wind load X(1.2)+SDL(1.2)
7. Dead Load(1.2)+ Live load (1.2) + Wind load Y(1.2) +SDL(1.2)
8. Dead Load(0.9)+Wind Load X (1.5)
9. Dead Load(0.9)+Wind Load Y (1.5)
Limit State of Serviceability
1. Dead Load (1)+Live Load (1)+Super Dead Load(1)
2. Dead Load(1)+Wind Load X(1) +Super DeadLoad(1)
3. Dead Load(1)+Wind Load Y (1) +Super DeadLoad(1)
4. Dead Load(1)+Seismic load X (1) +Super DeadLoad(1)
5. Dead Load(1)+Seismic load Y (1) +Super DeadLoad(1)
6. Dead Load(1)+ Live load (0.8) + Wind load X (0.8) +SDL(1)
7. Dead Load(1)+ Live load (0.8) + Wind load Y (0.8) +SDL(1)

3. Material Property

Mechanical characteristics are also used to assist with material classification and identification. Strength, ductility, hardness, impact resistance and fracture toughness are the most common properties regarded. Most structural materials are anisotropic, meaning that the characteristics of their products differ with orientation. The universal building materials which are used for

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construction in real world are also defined in ETABS. Materials like concrete and rebar are defined. Its strength and material properties are generated automatically as it follows I.S456:2000

Table -3: Showing material property

Material Type	Grade of Material	Fu / Compressive Strength	Fy/yield Strength
Concrete	M30	30 N/mm^2	
Concrete	M25	25 N/mm^2	
Rebar	HYSD 500	545 N/mm^2	500 N/mm^2
Rebar	HYSD 550	585 N/mm^2	550 N/mm^2

Table-5: Structural components and specification

Material list	Grade	Size
Beam	M25	400X400
Beam	M25	400X500
Beam	M25	400X600
Column	M30	400X600
Slab	M25	175 mm thick
Rebar	HYSD550	25 mm dia
Rebar	HYSD550	32 mm dia
Rebar	HYSD500	8 mm dia

Fig-6: showing beam layout of the structure

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4. Base reaction summary

Description	L/C	FX ,kN	FY,kN	FZ,kN	MX,KNm	MY,kNm	MZ, kNm
Max Fx	DCon20 Min	1688.6906	0	35131.871	1047.1	-1821.2	-109.1
MinFx	DL+EQ1.5 1	-1688.690	0	1728	1036.8	-256.2	99.12
Max Fy	DCon22 Min	0	1381.07	35131.871	1909.1	-1996.21	711.2
Min Fy	DCon21 Max	0	-1381.07	35131.871	2184.4	-1996.21	-713.7
Max Fz	DCon2	0	0	36859.871	21504.4	-2085.2	0
Min Fz	Wind Load Y 1	-134.836	0	0	0	-926.46	809.0157
Max Mx	DCon21 Max	0	-1381.070	35131.871	2184.41	-1996.1	-713.7
Min Mx	Wind Load Y 1	-134.836	0	0	0	-926.46	809.0157
Max My	Wind Load X 2	0	-123.5996	0	-849.2636	0	679.79
Min My	DCon19 Max	-1688.690	0	35131.871	-2046.81	-2165.2	-1098
MaxMz	DL+EQ1.5 2	-1688.690	0	1728	2046.83	2568.21	1098.4
Min Mz	DL+EQ1.5 1	-1688.690	0	1728	-1036.8	-2562.1	-996.2

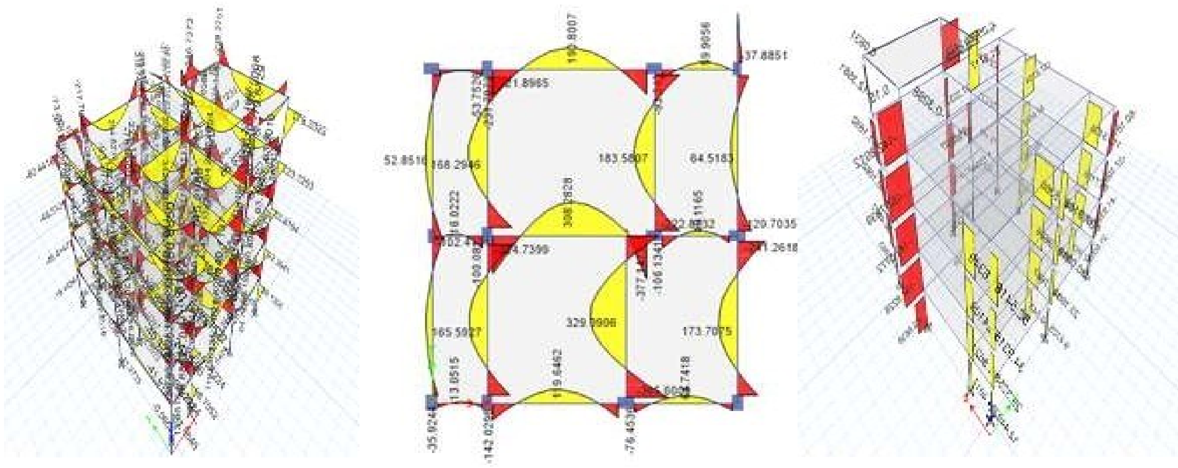

Fig-7: Maximum Bending Moment Diagram and shear force diagram (Isometric & Plan View)

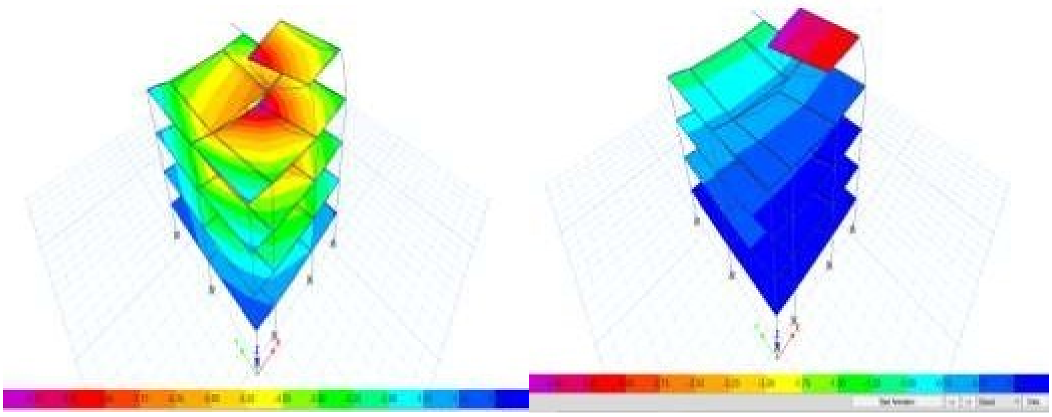

Fig -8: Maximum lateral and vertical deflections

Result

Table-5 shows the base reaction summary these reaction has been generated from the software. The generated column reaction will be taken for the design of foundation of the structure as per soil condition. From table-5 it has been briefly explained that the moments has been on higher side so foundation should be designed properly or else use SAFE software of CSI.

It has been evident that from fig-2 top of the structure has higher wind intensity forces compared to the said as the height of the building increases wind load also increases on to From Figure-8 the horizontal and vertical deflections are 3.50mm and 9.10mm respectively which seems to be allowed as the permissible limit 20mm.

It is evident that slab thickness is higher as expected because of large span & spacing.

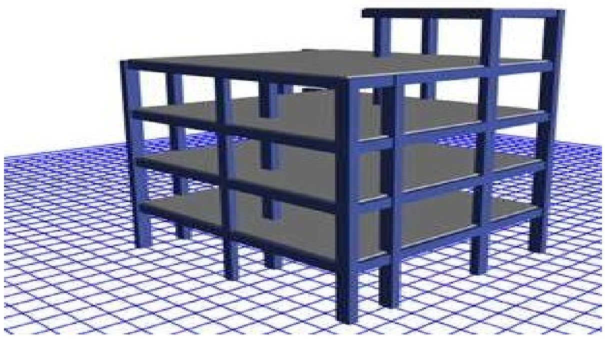

Fig-9- Rendered View of the Structure

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