Analysis and Design of G+4 Residential Building by using Etabs

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Abstract- **Extended Three-Dimensional Analysis of Building Systems is referred to as ETABS. Skyscrapers, concrete structures, low and high rise buildings, and portal frame constructions are among the common structures that ETABS is used to study. This paper's case study primarily focuses on the structural behavior of multi-story buildings with various plan configurations, such as rectangular, C, L, and I shapes. The ETABS software is used to model a 15-story R.C.C. framed building for the purpose of analyzing ETABS issues and designing building systems. A shared database is used to link the unparalleled modeling, analytical, and design processes with ETABS's robust graphical user interface. Both STAAD and ETABS are highly powerful software programs that can handle a wide range of structural shapes, static and dynamic loads, and material properties.**

Keywords- **Etabs, Seismic loads, Deflections, wind loads, Reinforced concrete**

I. INTRODUCTION

The most comprehensive software program for building structural analysis and design is the cutting-edge and ground-breaking new ETABS.For a wide range of materials, ETABS provides unparalleled 3D object-based modeling and visualization tools, lightning-fast linear and nonlinear analytical power, sophisticated and comprehensive design capabilities, and informative graphic displays, reports, and schematic drawings that make it simple and quick for users to interpret and comprehend analysis and design results. Multi-story buildings are analyzed and designed using engineering software called ETABS.

ETABS stands for Extended Three- Dimensional (3D) Analysis of Building Systems. CAD drawings can be converted directly into ETABS models or used as templates in which ETABS objects may be overlaid. Report is generated directly in the software with complete reinforcement details. Many of the floor levels in buildings are similar which reduce modelling and design time. Fast model generation using the concept of similar stories. Different materials can be assigned to the structural elementswithin the same model such as steel, RCC, composite or any other user-defined material. CAD drawings can be converted directly into ETABS models or used as templates in which ETABS objects may be overlaid. Report is generated directly in the software with complete reinforcement details. Many of the floor levels in buildings are similar which reduce modelling and design time. Fast model generation using the concept of similar stories. Different materials can be assigned to the structural elements within the same model such as steel, RCC, composite or any other user-defined material.

ETABS (Extended Three-Dimensional Analysis of Building Systems) is a cutting-edge structural engineering software developed specifically for the analysis and design of multi-story buildings. Known for its robust capabilities and user-friendly interface, ETABS stands at the forefront of modern structural engineering tools. It integrates every aspect of the engineering design process—from modeling and analysis to design optimization and documentation—into a single streamlined platform.

ETABS provides **unparalleled 3D object-based modeling tools**, enabling engineers to construct complex building geometries with ease. The software supports a wide variety of structural materials, including reinforced concrete (RCC), steel, composite sections, and other user-defined materials. One of the most powerful features of ETABS is its ability to **handle both linear and nonlinear analyses** with remarkable speed and accuracy, ensuring reliable performance predictions even under extreme loading conditions such as seismic events.

One of the unique strengths of ETABS lies in its **multi-story modeling efficiency**. Since many floors in high-rise buildings share similar configurations, ETABS allows the replication of these "similar stories" to drastically reduce modeling time and effort. CAD drawings can be imported directly or used as templates, upon which ETABS objects may be overlaid, further streamlining the modeling process.

ETABS also excels in its **comprehensive design capabilities**, supporting international codes for concrete, steel, and composite structures. The software automatically generates detailed and code-compliant reinforcement layouts, which are accompanied by clear reports, graphical results, and schematic drawings—making interpretation of results intuitive and efficient.

II. METHODOLOGY

2.1 Overview of Plan and Structure

The generated model is the type of multi storey residential building of symmetrical plan. This model consist of ground floor and four storey. As per IS1893:2002, this area's soil type is medium stiff, comer under zoning V with the zone factor of 0.36. Following figure shows the plan of the building. This is a G+4 residential building on which each floor has 2 Flats with 2 Bedrooms, Hall and Kitchen. The house is well built and is 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 superior. Each flat has 2 toilets which makes it more advantageous.

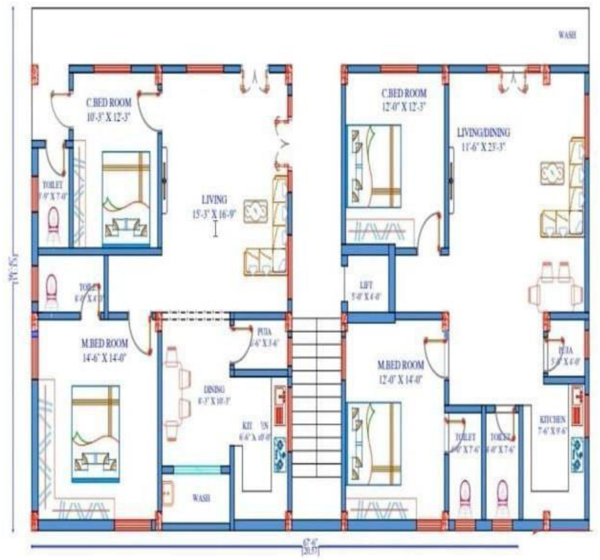


Fig1:- Plan view of the structure

2.2 Loads and Loads Combination

As per table given below, it has been seen that the building has dead load as self-weight which is automatically and already assigned in the software, Floor Finish of 1.5kN/m2 has been considered. According to IS codes IS875- part 2 live load of 2 KN/m2 has been allotted & SDL for inner and outer wall loads are 6.21 KN/m² and 12.45 KN/m² respectively.

TABLE 1 Load values and their configuration

Types of loads	Load values	IS Code Confirmation
Dead Load	**Self-weight**	**IS875 Part-1**
Live load	**2KN/m² -all places**	**IS875 Part-1**
Floor finish	**1.5KN/m²**	**IS875 Part-1**
Super dead load	**6.21KN/m² -inner wall loads**	**IS875 Part-1**
Super dead load	**12.45KN/m² - outer wall loads**	**IS875 Part-1**

In seismic prone zones, Engineers follow latest construction techniques in the modelling or making of high-rise buildings with the help of different kinds of bracing and base isolators. Seismic zones are considered from zone II to zone V. The model in this project is from zone V. As per the location of the site, Seismic zones are marked from the particular code book. The structure has been modelled according to limit state method, Limit state method is commonly used for design method all over the world, and this structure has been examined under the below mentioned load cases & Load combination. The analysis of building has been done by the Software, the advantage of this Etabs is that it gives error-free result for RCC design as contrast to the other software

2.3 Material Type

Strength, resistance, ductility, hardness and toughness are the main and important properties judged. Materials like concrete and rebar are allotted in the software. Its strength and material properties are induced automatically as the software follows IS 456:200 which is inbuilt in the software.

All the supports to the columns are made fixed at the base which reduces the moment occurring in the structure.

TABLE 2 Dimensions of particulates

Sr. No.	PARTICULAR	DIMENSIONS
1	**Grade of concrete**	**M30**
2	**Grade of steel**	**Fe500**
3	**Thickness of slab**	**0.15 m**
4	**Zone V**	**Z. F.= 0.36**
5	**Area of building**	**190 m²**
6	**Typical storey height**	**3 m**
7	**Main Beam Elements**	**0.35 m × 0.35 m**
8	**Main Column Elements**	**0.45 m × 0.45 m**

III. RESULTS

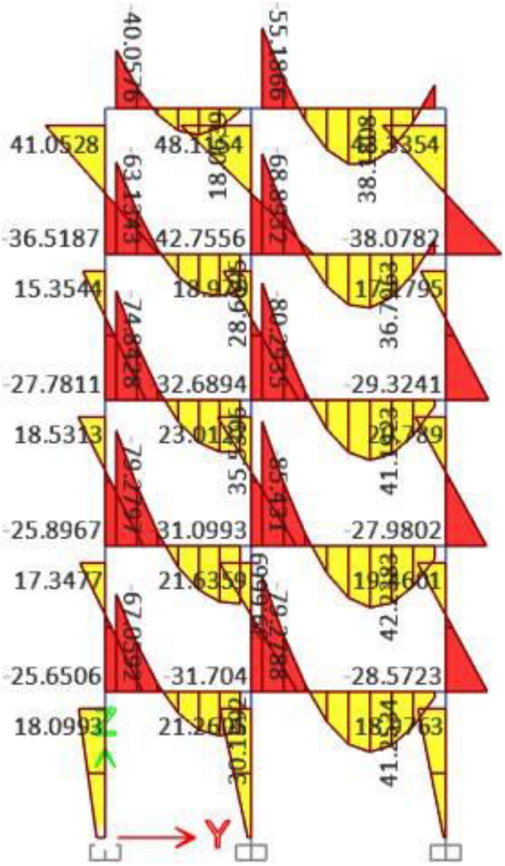


Fig 2: - Corner Beam and Column Bending Moment Diagram

Story	Beam (kN-m)	Column (kN-m)
Ground	79.2788	21.2605
1st Floor	85.4341	21.6359
2nd Floor	80.2935	23.0127
3rd Floor	68.8932	18.979
4th Floor	55.1866	48.1154

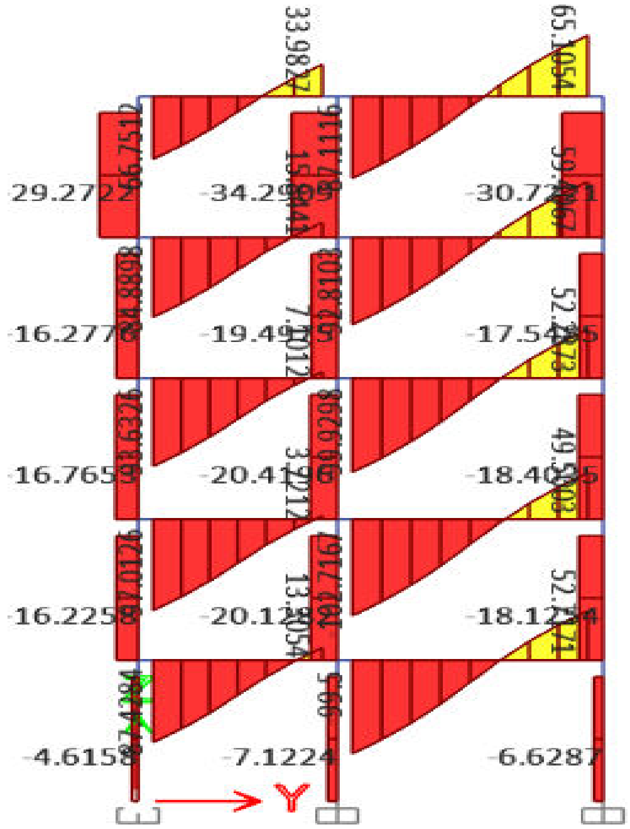


Fig 3: - Corner Beam and Column Shear Force Diagram

Story	Beam (kN)	Column (kN)
Ground	99.5	7.1224
1st Floor	102.7167	20.1282
2nd Floor	99.9298	20.4196
3rd Floor	92.8103	19.4975
4th Floor	87.116	34.2902

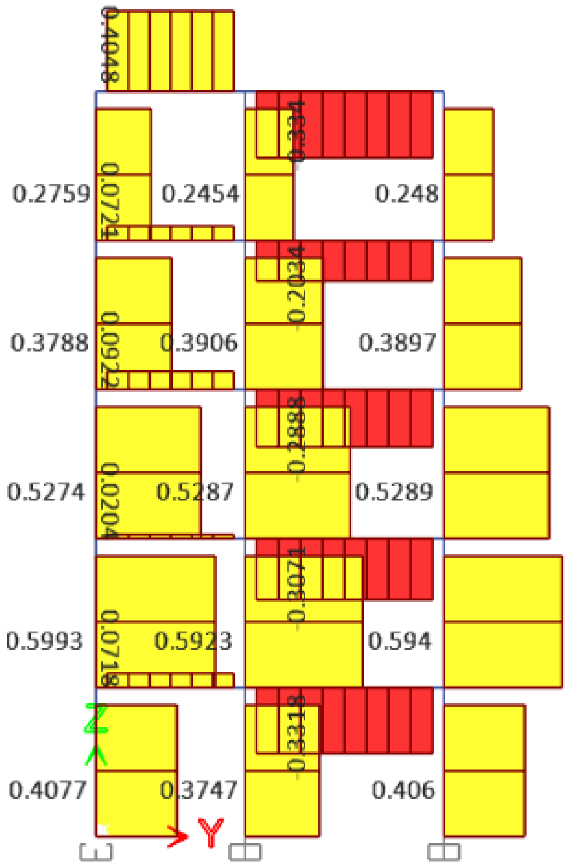


Fig 4: - Corner Beam and Column Torsion Diagram

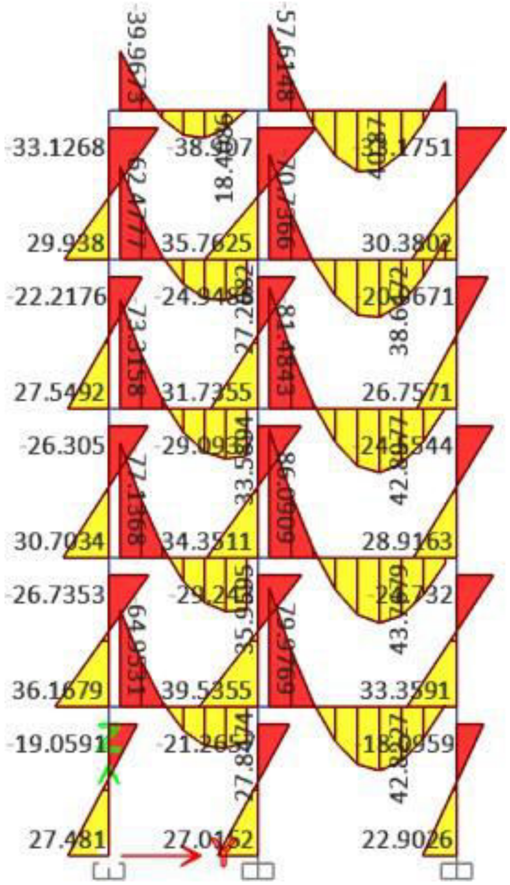


Fig 5: - Centre Beam and Column Bending Moment

Story	Beam (kN-m)	Column (kN-m)
Ground	0.3318	0.4077
1st Floor	0.3071	0.594
2nd Floor	0.2883	0.5289
3rd Floor	0.2034	0.3906
4th Floor	0.334	0.2759

Story	Beam (kN-m)	Column (kN-m)
Ground	79.9769	27.481
1st Floor	86.0909	39.5355
2nd Floor	81.4843	34.3511
3rd Floor	70.7366	31.7355
4th Floor	57.6148	35.7625

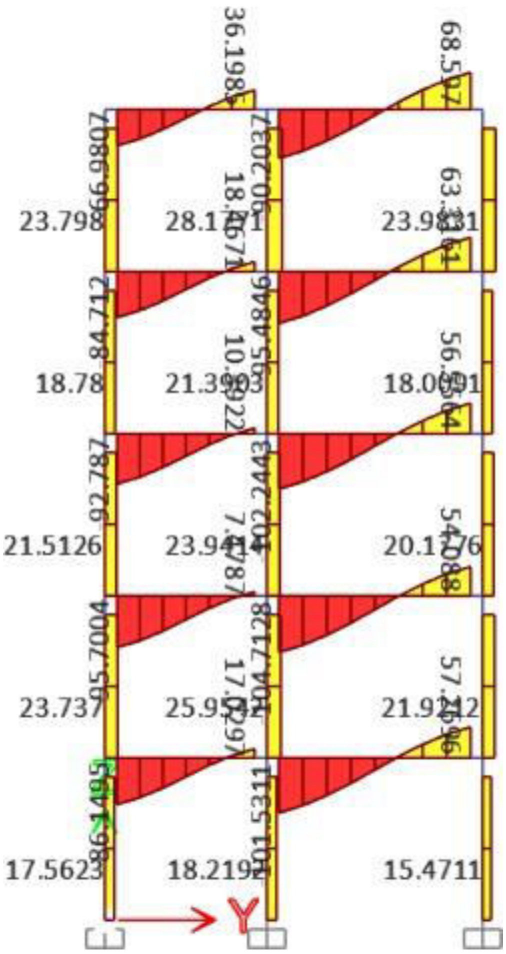


Fig 6: - Centre Beam and Column Shear Force Diagram

Story	Beam (kN)	Column (kN)
Ground	101.5311	18.2192
1st Floor	104.7128	25.954
2nd Floor	102.2423	23.94
3rd Floor	95.4846	21.3903
4th Floor	90.2037	28.1771

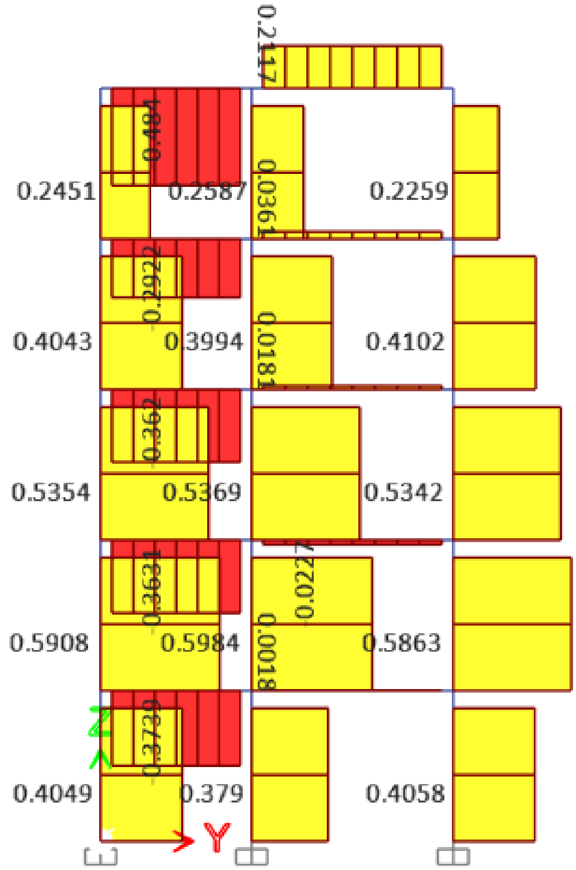


Fig 7: - Centre Beam and Column Torsion Diagram

Story	Beam (kN-m)	Column (kN-m)
Ground	0.3739	0.4058
1st Floor	0.3631	0.5908
2nd Floor	0.362	0.5369
3rd Floor	0.2922	0.4102
4th Floor	0.2587	0.2587

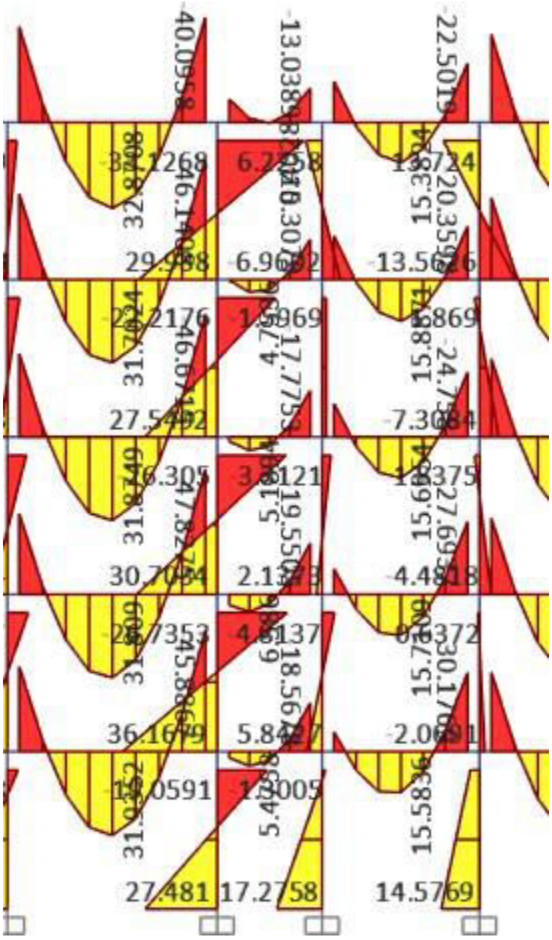


Fig 8: - Front Beam and Column Bending Moment

Story	Beam (kN-m)	Column (kN-m)
Ground	79.9769	27.481
1st Floor	86.0909	36.1679
2nd Floor	46.6715	30.7034
3rd Floor	47.8275	27.5492
4th Floor	45.886	29.938

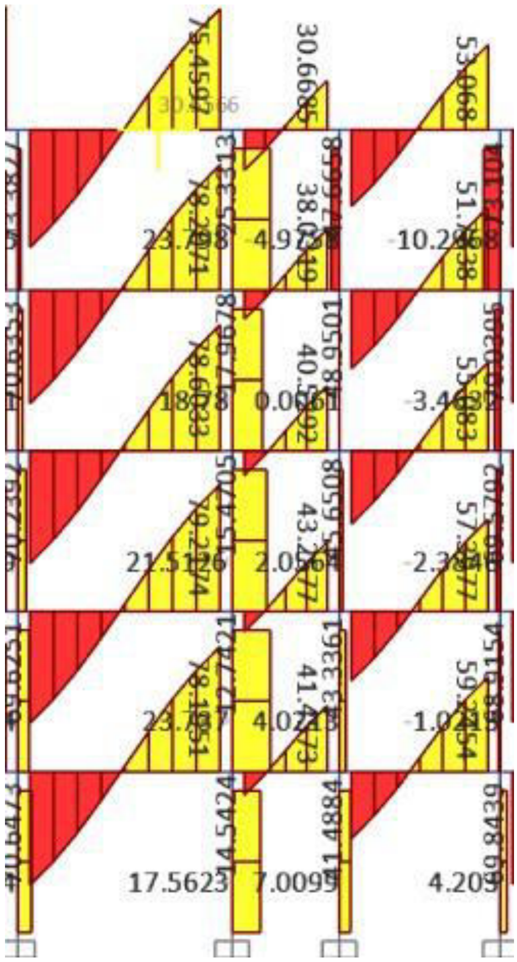


Fig 9: - Front Beam and Column Shear Force Diagram

Story	Beam (kN)	Column (kN)
Ground	70.6473	17.5623
1st Floor	69.6251	23.737
2nd Floor	70.2392	21.5126
3rd Floor	70.6335	18.78
4th Floor	73.3827	23.798

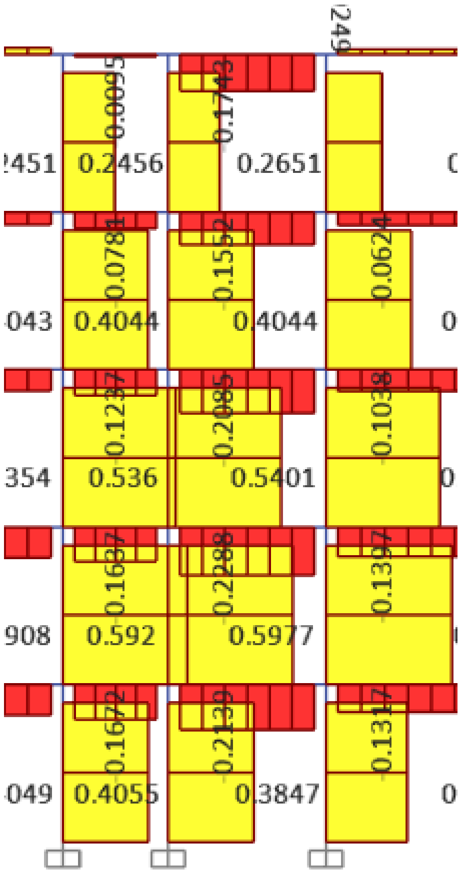
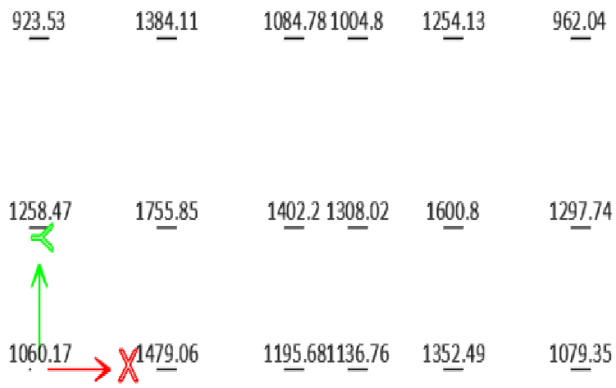


Fig 10: - Front Beam and Column Torsion Diagram

Story	Beam (kN-m)	Column (kN-m)
Ground	0.1672	0.4055
1st Floor	0.1637	0.5977
2nd Floor	0.2085	0.5401
3rd Floor	0.1552	0.4044
4th Floor	0.1743	0.2651

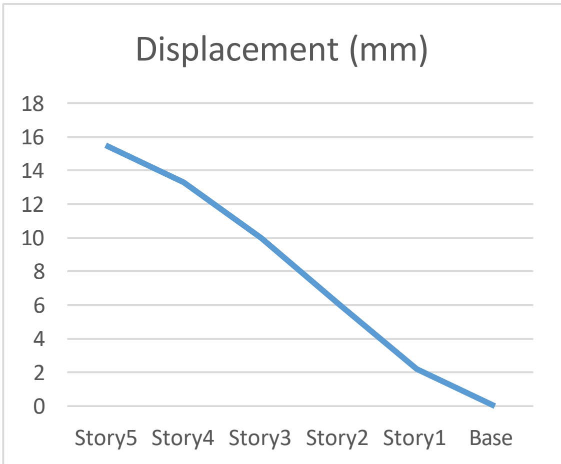
Story	Displacement (mm)
Story5	15.503
Story4	13.28
Story3	9.993
Story2	6.049
Story1	2.185
Base	0

Base Reactions



Displacement Graph

Intensity	Reaction (kN)
Maximum	1755.85
Minimum	923.53
At center columns	1402.2

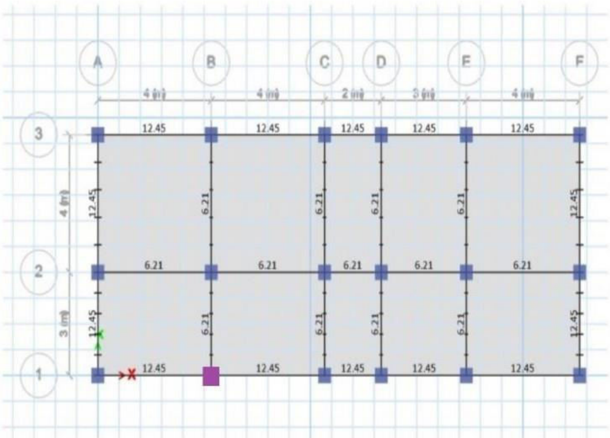


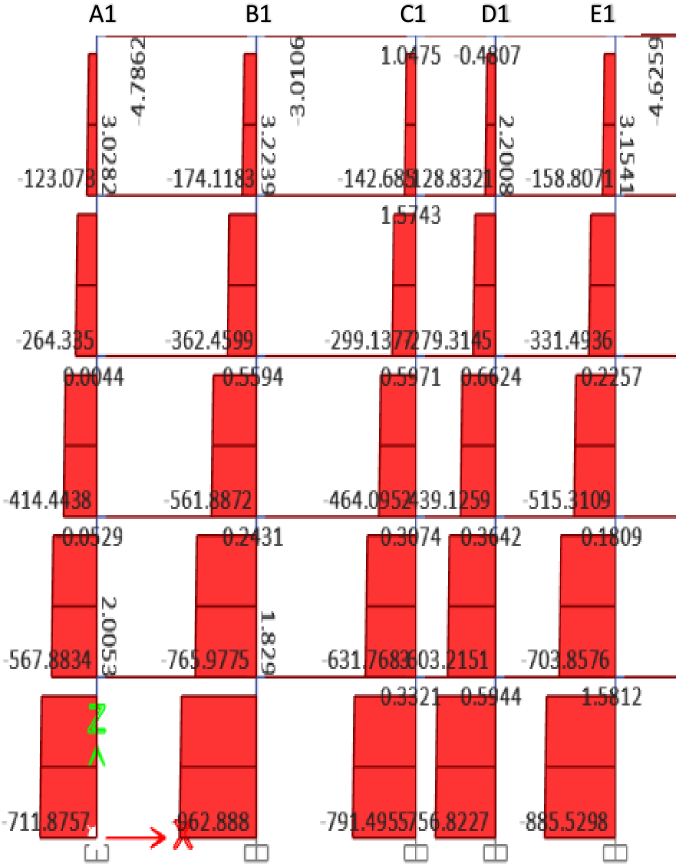
IV. CONCLUSION

From the results we concluded about the variations / percentage increase in each floor of particular beams and columns.

A. Axial Load

1. **Axial Load on Front column B1**

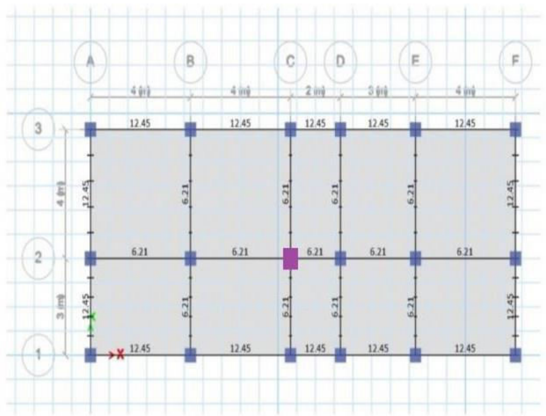




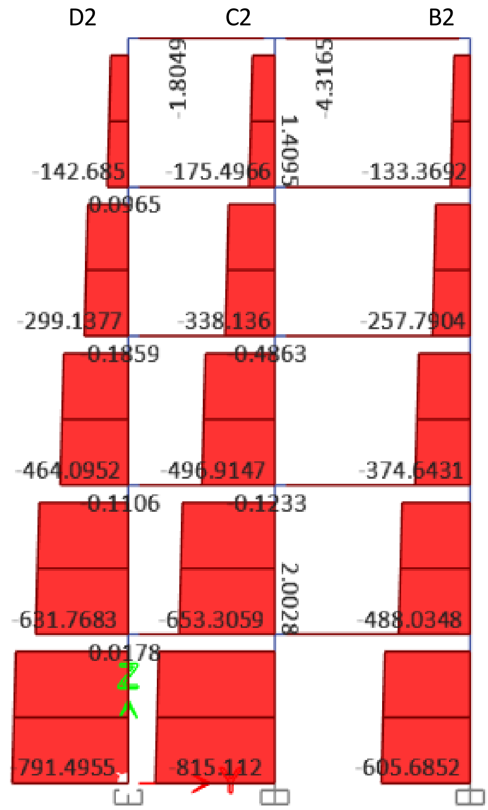
Storey	Axial load on Column B1 (KN-m)
Ground Floor	962.88
1st Floor	765.97
2nd Floor	561.88
3rd Floor	362.459
4th Floor	174.118

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. **Axial Load on Centre Column C2**

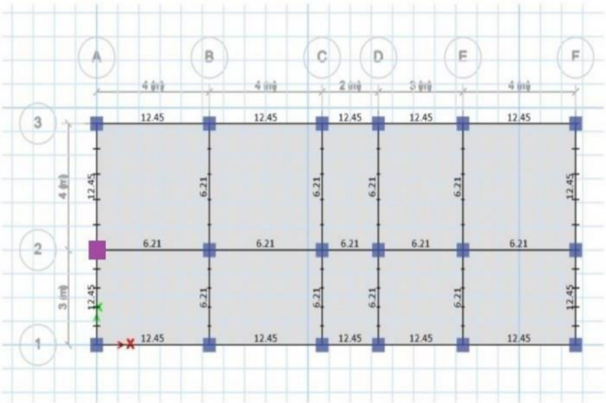


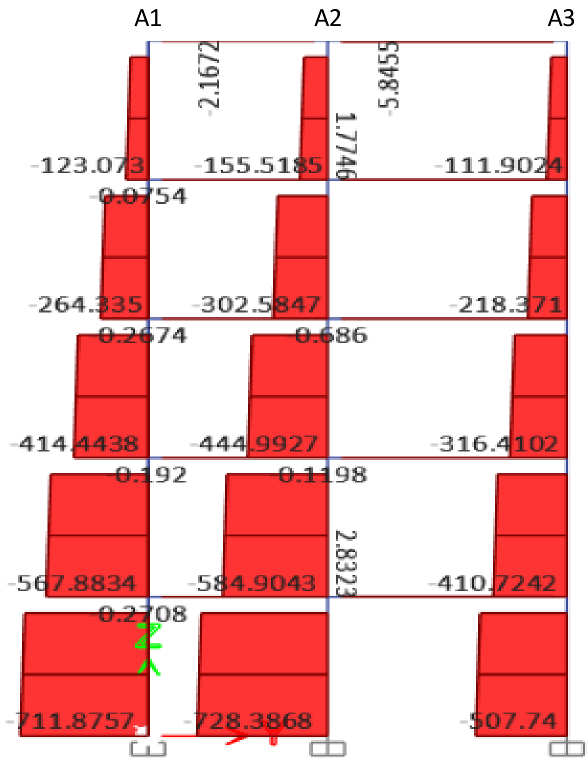
Storey	Axial load on column (KN-m)
Ground floor	815.112
1st Floor	653.305
2nd Floor	496.914
3rd Floor	338.136
4th Floor	175.496



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. Axial Load on Corner Column A2



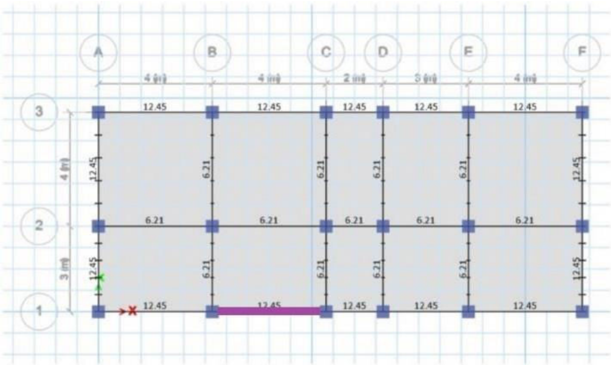


Storey	Axial load on column (KN-m)
Ground Floor	728.3868
1st Floor	584.904
2nd Floor	444.99
3rd Floor	302.58
4th Floor	155.518

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		

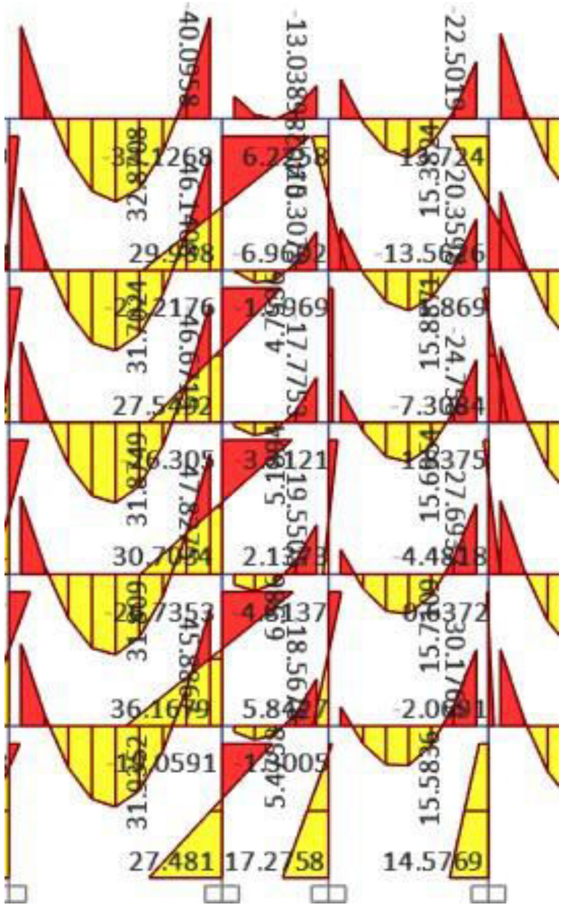
B. Bending Moment

1. Bending Moment on Front Beam B1C1



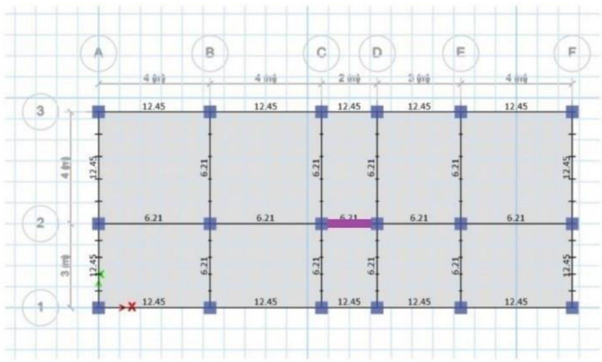
Story	Beam (kN-m)
Ground	79.9769
1st Floor	86.0909
2nd Floor	46.6715
3rd Floor	47.8275
4th Floor	45.886

B1 C1 D1 E1

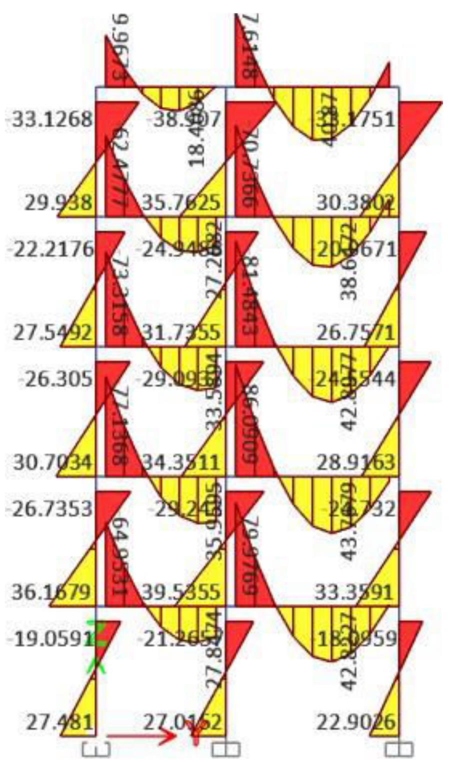


Floor	Bending Moment	Difference	Percentage Increase
Ground	79.9769		
		6.114	7.6447%
First Floor	86.0909		
		-39.4194	45.7881%
Second Floor	46.6715		
		1.156	2.4768%
Third Floor	47.8275		
		-1.9415	4.0593%
Fourth Floor	45.886		

2. Bending Moment on Centre Beam C2D2

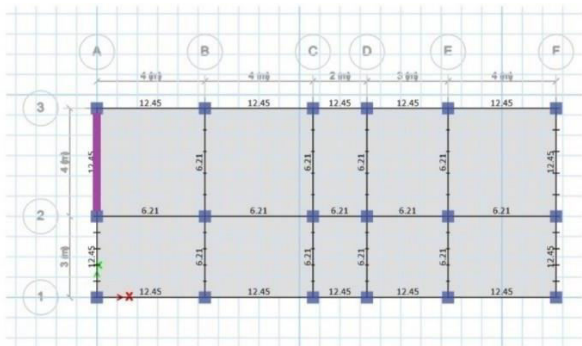


Story	Beam (kN)
Ground	101.5311
1st Floor	104.7128
2nd Floor	102.2423
3rd Floor	95.4846
4th Floor	90.2037



3. Bending Moment on Corner Beam A23

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		



Story	Beam (kN-m)
Ground	79.2788
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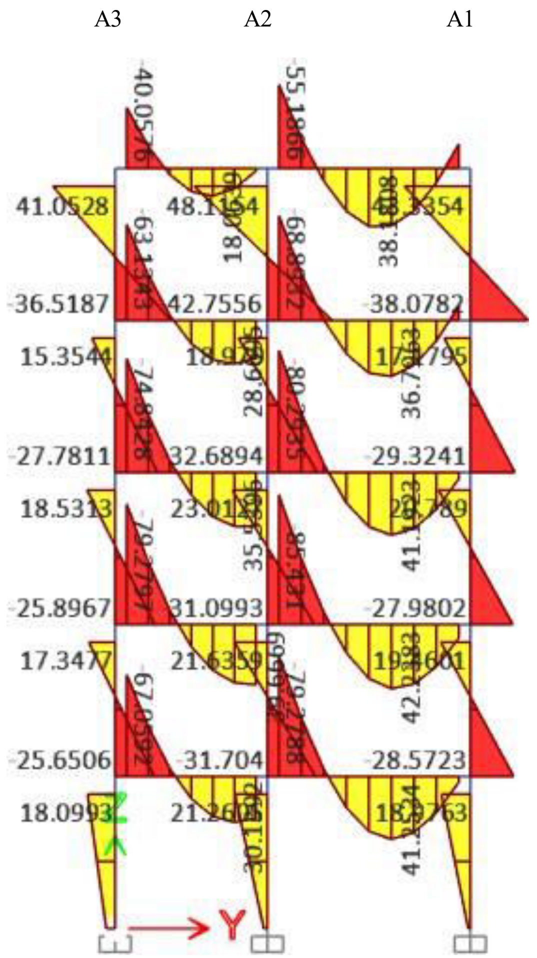

Floor	Bending Moment	Difference	Percentage Increase
Ground	79.2788		
		6.1553	7.76415
First Floor	85.4341		
		-5.1406	6.01705
Second Floor	80.2935		
		-11.4003	14.1982%
Third Floor	68.8932		
		-13.7066	19.8954%
Fourth Floor	55.1866		

After concluding the above tables, it can be said that the variation does not exceed **10%** and hence the analysis is safe.

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