

ANALYSIS AND DESIGN OF G+ 4 RESIDENTIAL BUILDING WITH DUPLEX FLATS

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ABSTRACT:

The objective of this project is to analyze and design the G+ 4 residential building using software. The design involves analyzing the whole structure by STAAD PRO. This software features a state-of-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and Dynamic Analysis Capabilities. Moreover, the plan of the building is done by using the AUTOCAD.

The design methods used in STAAD-Pro analysis are Limit State Design conforming to Indian Standard Code of Practice. The structure is subjected to self- weight, dead load, and live load under the load case details of STAAD Pro. The supports at the base of the structure were also specified as fixed. Then STAAD Pro is used to analyse the structure and design the members. The design of the building is dependent upon the minimum requirements as prescribed in the Indian Standard Codes.

We are also going to check the deflection of various load combinations. The minimum requirements to the structural safety of building are being covered by way of laying down minimum design loads, which have to be assumed for dead loads, live load, and other external loads, the structural would be required to bear. Strict conformity to loading standards recommended in this code, it is, will ensure the structural safety of the buildings, which are being designed.

Keywords : AUTOCAD, STAAD Pro, Design parameters, Combination of loads. Bending moment and Deflections.

1.0 INTRODUCTION

The design of structural building should ensure that building can with stand with safely, operate without excessive deformation of movement. We must also verify that the design is nearly build-ed within acceptable of the materials or not. the To perform a complete analysis, a structural engineer must find the information about the loads, support support conditions and material properties after find the results of stresses and displacement. We have to design the structure should be safety and they should bear all loads and deformations caused in construction and have sufficient durability and resistance. Structure along with structural elements shall be designed by limit state design method. Design includes design for durability, construction and service life should be considered as a whole. The design of the structure depends upon the minimum requirements suggested by the Indian standard codes. The minimum requirements for safety of structures are satisfied by way of laying down minimum design loads which have to be assumed for dead loads, live loads, and others external loads, the structure would be required to bear.

Steps in structural design:

The steps involved in designing a structure are structural planning, loads computation, analysis method, design of member and detailing, etc.

The Project Objectives:

1. Drafting the layout(plan) by using AUTOCAD.
2. Analysis and design the building on STAAD PRO. V8.
3. Column Design & Beam Design.

Limit state design is used to design the building as per Indian standard considerations.

2.0 LITERATURE REVIEW

- 1. Prof. Aradhana Chavan (June 2021)** Planning, Analysis, Design and Estimation of G+4 building using STAAD PRO and AUTOCAD This project includes G +4 building with parking at ground floor and rest of the floors occupied with 2BHK flats. The response of a RCC high rise building under dead load, live load and seismic load is studied as per IS 875(Part 1): 1987and IS 875(Part 2): 1987.
- 2. Aafreen khan, shreyas shende (March 2023)** Analysis and Design of Multistorey Hospital Building (G+4).This project includes G+4 Hospital building which is having with an area of 7000 sq.ft.For this building the used softwares to plan, analysis and design is AUTOCAD, 3D SOFTWARE and STAAD PRO respectively.
- 3. Madireddy Sathyanarayana, Eda Heema Shivani (March 2019)** Design and Analysis of Duplex Building using CYPECAD Software. This project includes duplex building is analyze and design by using the software called CYPECAD. It also designed for natural forces such as earthquake and wind speed.
- 4. Jayesh, Harish, Rithik Patel (March 2023)** Analysis and Design of a Residential Building (G+4) by using STAAD PRO. A review of analysis and design of (G+4) Residential Building using STAADPRO. In accordance with IS code 456-2000.
- 5. Rashmi agashe, Marshal Bagele, Vaishnavi Deshmukh, Sharad (april 2020)** To study analysis and design of multistory building using STAAD pro and comparing with manual calculations. This project is generally based on theoretical design and analysis of structural framed building. Analysis and design of G+4 storey residential building structure by using IS code method all the drafting and detailing was done by using AUTOCAD & STAAD PRO.
- 6. Namaratha S.Patel, Vaishnavi N. Ghodake, Rucha & Yogesh (June 2022)** Design and Modelling of commercial cum Residential Building by using AUTODEST, Revit& STAADPRO. This project includes commercial cum residential building as mixed building with ground floor consisting of commercial shops and reaming are floor of building consists of 2BHK flats and it is done by using software AUTOCAD, 3D Modelling & STAAD PRO. (IScode456-2000).
- 7. IS: 875 (Part 1) – 1987 for Dead Loads, Indian Standard Code Of Practice For Design Loads (Other Than Earthquake)** For Buildings and Structures, All permanent constructions of the structure form the dead loads. The dead load comprises of the weights of walls, partitions floor finishes, false ceilings, false floors and the other permanent constructions in the buildings. The dead load loads may be calculated from the dimensions of various members and their unit weights. The unit weights of plain concrete and reinforced concrete made with sand and gravel or crushed natural stone aggregate may be taken as 24 KN/m³ and 24 KN/m³respectively
- 8. IS 456 -2000, Indian standard code of practice for plain and reinforced concrete (fourth revision),** Bureau of Indian Standards. This standard deals with the general structural use of plain and reinforced concrete. For the purpose of this standard, plain concrete structures are those where reinforcement, if provided is ignored for the determination of strength of the structures.
- 9. SP: 16 -1980, Design Aids for Reinforced Concrete to IS: 456-1978 (third revision),** Bureau of Indian Standard. This is the explanatory handbook which covers the basis/source of each clause. The objective of these design aids is to reduce design time in the use of certain clauses in the Code for the design of beams, slabs and columns in general building structures. The charts and tables included in the design aids were used in calculation of footings and slabs.

3.0 METHODOLOGY:

The plan of the residential building is regular. It has a story height of (H) 3.0m where all stories were same height. The Residential building consists of four stories, five stories including the ground floor each floor consists of four duplex flats. The residential building length is 24m and width is 35m so the area is 2737m. The building consists of rectangular columns with cross section (0.30 x 0.45) m, rectangular beams with cross-section (0.30 x 0.50) m and slab thickness of 150mm. A model of G+4 storey is developed, analysis & design using STAAD-Pro software. Building plan size is 35 X 24 m. The building is situated in perzadiguda in zone 2.

WORKING WITH STAAD PRO.

The GUI (or user) communicates with the STAAD analysis engine through the extension of .std input file. That input file is a text file consisting of a series of commands which are executed sequentially. The commands contain either instructions or data pertaining to analysis and/or design. The STAAD input file can be created through a text editor or the GUI Modeling facility. In general, any text editor may be utilized to edit/create the STD input file. The GUI Modeling facility creates the input file through an interactive menu-driven graphics oriented procedure

Following specifications are given to the structure:

Flow chart

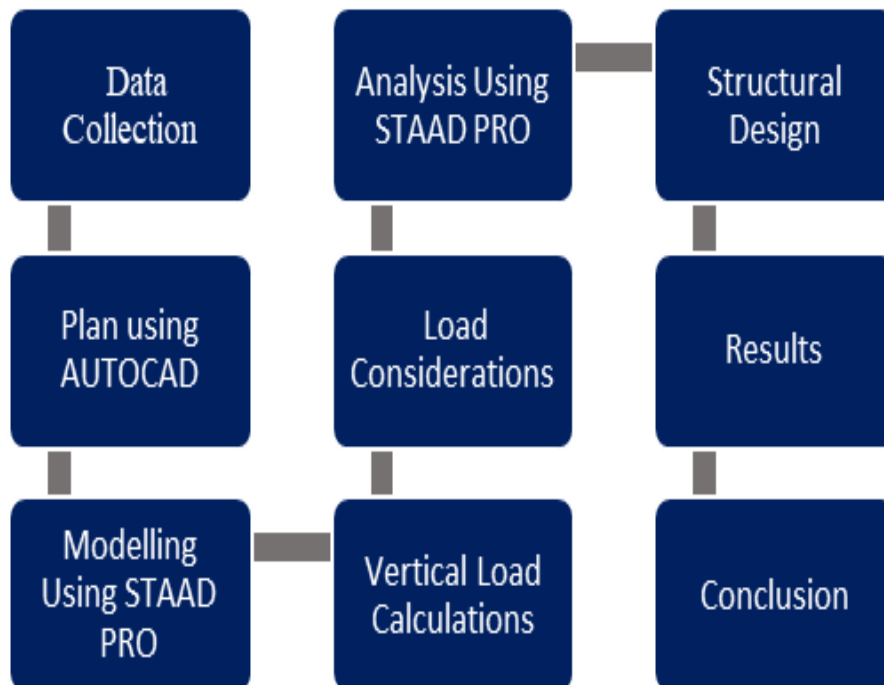


Figure 1: Process of stilt Residential

Following Specifications are given to the Structure:

Table 1: Building Specifications

Columns	0.30m X 0.45m
Beams	0.30m X 0.50m
Slabs	0.15m
Parapet Wall	0.1m
Dead load	-1 KN/m ²
Live Load	2 KN/m ²
Grade of concrete	M30
Grade of steel	415 N/m ²
No. of floors	4
Height of floor to floor	3m
Height of ground storey	3m
Total height of building	15m

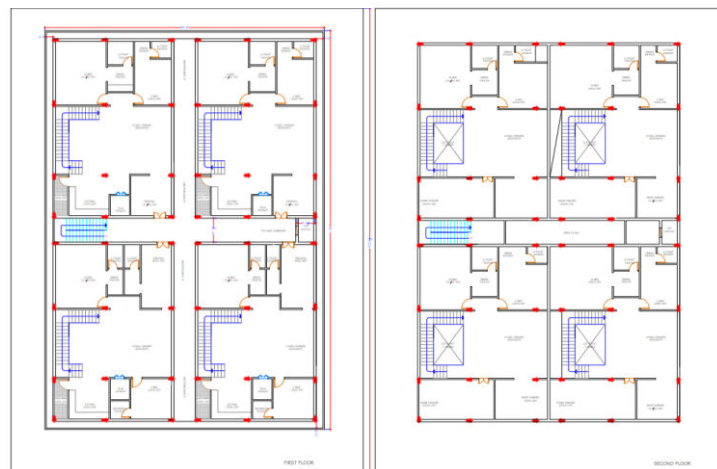


Figure 2: Plan of Stilt Residential Building

Generation of the structure:

The structure is generated from the input file in the STAAD Pro. The figure below shows the GUI generation method.

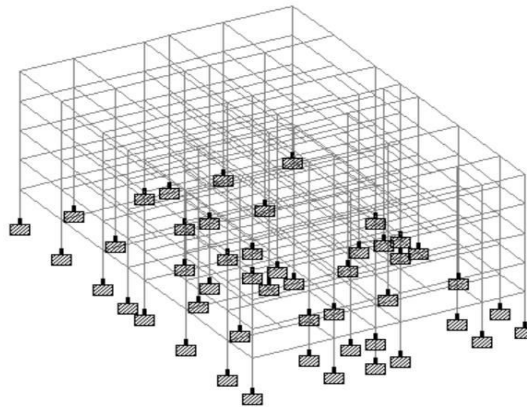


Figure 3: Generation of the Structure in Staad pro.

Analysis Supports: The base supports of the structure are assigned as fixed

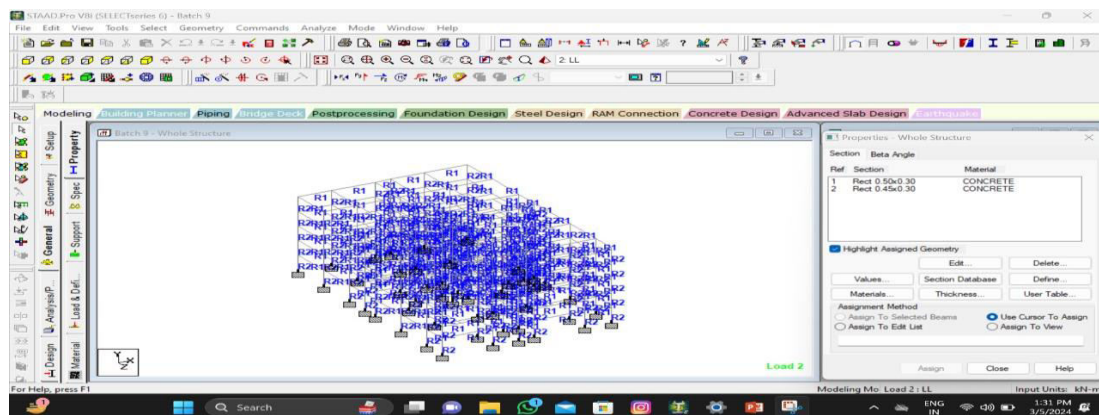


Figure 3 : Supports

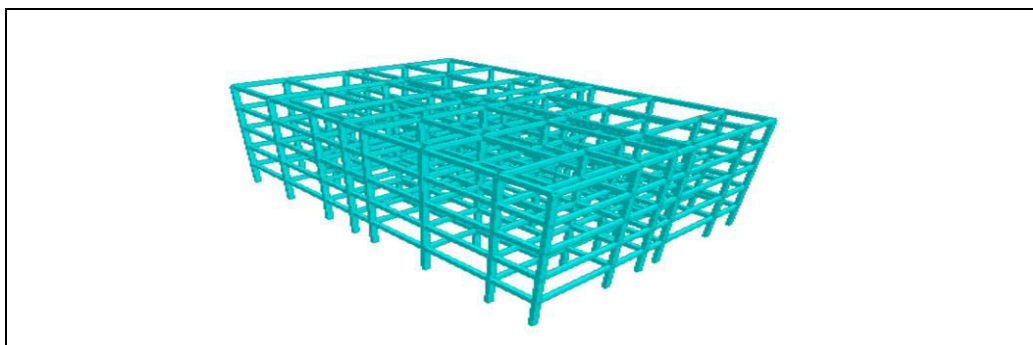


Figure 4: 3D modelling

Loading:

Loads in a structure can be specified as joint load, member load, temperature load and fixed-end member load. STAAD can also generate the self-weight of the structure and use it as uniformly distributed member loads in analysis. Any fraction of this self weight can also be applied in any desired direction.

The loading cases were consider acting on the building:

- Dead load
- Live load

Dead Load

[IS 875(Part 1):1987 This is a Code of practice for design loads (other than earthquake) for buildings and structures Part 1.

The dead load comprises of the weights of walls, partitions floor finishes, false ceilings, false floors and the other permanent constructions in the buildings.

- Dead load calculation

1) Self-weight= 1KN

2) Member load (ML)= wall thickness X (Floor Height-Beam Depth) X unit weight on masonry.

Self- weight: The self-weight of the structure can be generated by STAAD-Pro itself with the self-weight command in the load case column.

Live Load

[IS 875(Part 2) 1987] This is a Code of practice for design loads (other than earthquake) for buildings and structures: Part 2

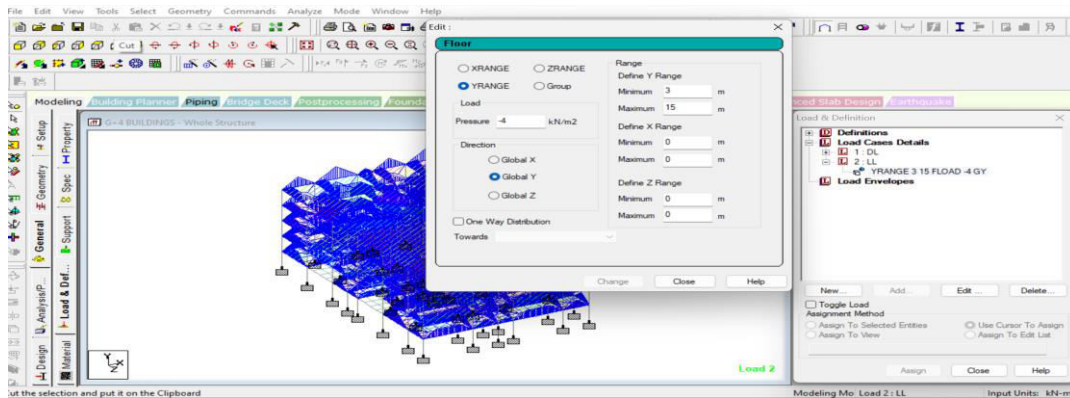


Figure 5: Floor load

Floor Load: Floor load is calculated based on the load on the slabs. Floor load: $25 \times 0.125 = 3.125 \text{KN/m}$.

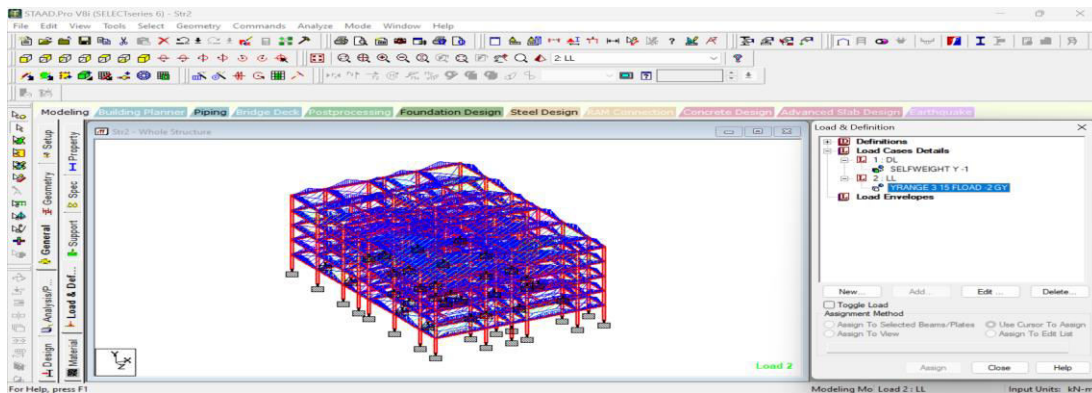


Figure 6: Loads

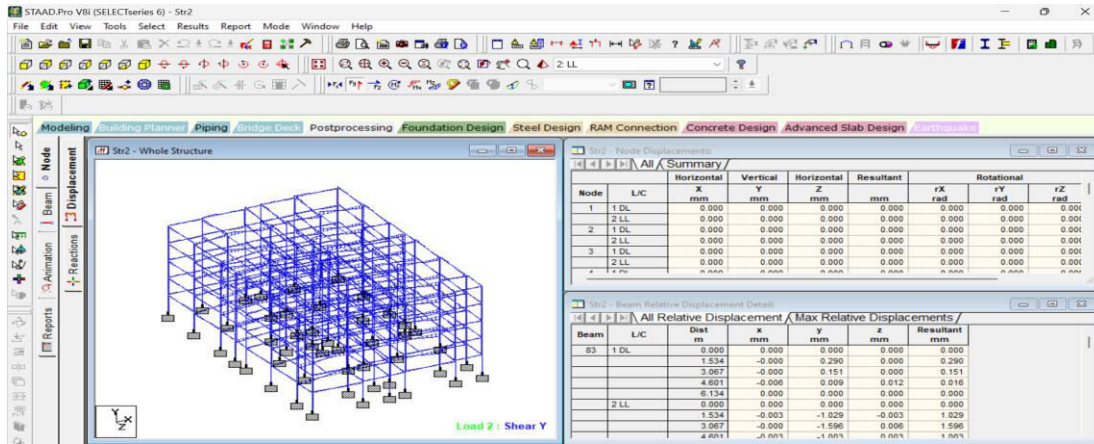


Figure 7: Shear Force

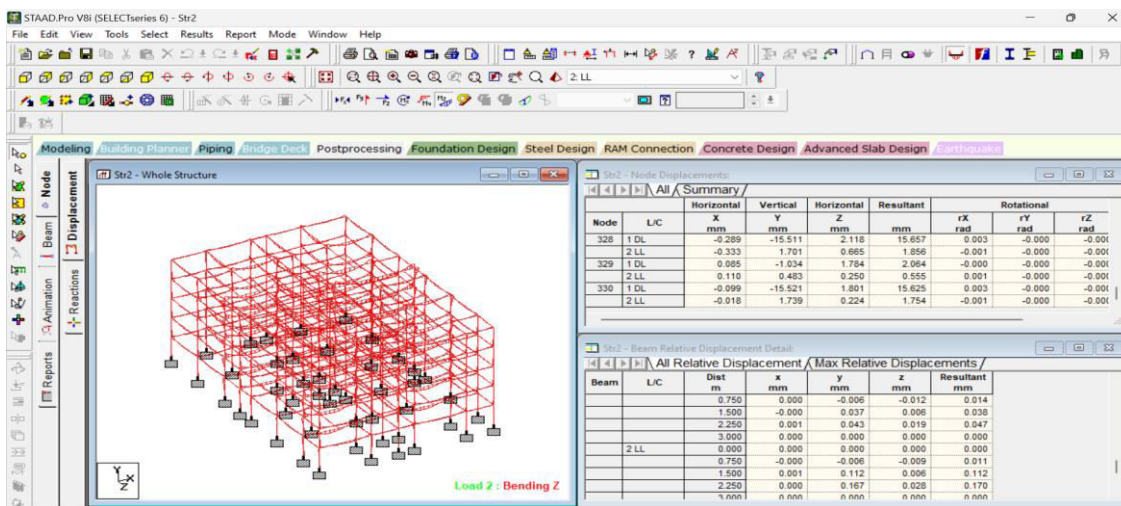


Figure 8: Bending Moment

Design of RCC Elements:

Table 2: Design of Beams (Mu value varies for each beam)

B	300mm
D	500mm
Cover	50mm
Fy	415 N/mm ²
Fck	30 N/mm ²
Mu	20.64 KN-m

COLUMN DESIGN:

Columns are designed for axial forces and biaxial moments at the ends. All active load cases are tested to calculate reinforcement. The loading which yield maximum reinforcement is called the critical load. Column design is done for square section. Square columns are designed with reinforcement distributed on each side equally for the sections under biaxial moments and with reinforcement distributed equally in two faces for sections under uniaxial moment. All major criteria for selecting longitudinal and transverse reinforcement as stipulated by IS: 456 have been taken care of in the column design of STAAD.

Table 2: Design of Columns (Pu, My, Mz value varies for each beam)

B	300 mm
D	450 mm
Cover	50 mm
Fy	415 Mpa
Fck	30 Mpa
Pu	0.09 KN
Mz	13.87 KN-m
My	1.17 KN-m

4.0 RESULTS:

Section		Axial	Shear		Torsion	Bending	
		Max Fx kN	Max Fy kN	Max Fz kN	Max Mx kNm	Max My kNm	Max Mz kNm
Rect 0	Max +ve	17.977	30.914	2.354	4.324	5.573	67.876
	Max -ve	-9.020	-30.283	-2.350	-4.168	-5.665	-28.893
Rect 0	Max +ve	329.407	18.646	11.827	0.597	19.761	25.965
	Max -ve	0.000	-15.832	-7.249	-0.435	-55.869	-32.978

Figure 7: Maximum Forces (Axial, Shear, Torsion & Bending)

Beam	L/C	Dist m	x mm	y mm	z mm	Resultant mm
83	1 DL	0.000	0.000	0.000	0.000	0.000
		1.534	-0.000	0.290	0.000	0.290
	3.067	-0.000	0.151	0.000	0.151	
	4.601	-0.006	0.009	0.012	0.016	
	6.134	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	
2 LL		1.534	-0.002	-0.514	-0.003	0.514
		3.067	-0.003	-0.798	-0.006	0.798
	4.601	0.001	-0.502	0.003	0.502	
	6.134	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	
84	1 DL	0.000	0.000	0.000	0.000	0.000
		0.921	-0.001	-0.028	0.000	0.028
	1.841	-0.002	-0.054	0.000	0.054	
	2.762	-0.002	-0.044	0.000	0.045	
	3.683	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	
2 LL		0.921	-0.000	-0.041	0.000	0.041
		1.841	-0.000	-0.074	0.000	0.074
	2.762	-0.000	-0.055	0.000	0.055	
	3.683	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	
85	1 DL	0.000	0.000	0.000	0.000	0.000
		0.921	-0.000	-0.028	0.000	0.028
	1.841	-0.000	-0.054	0.000	0.054	
	2.762	-0.000	-0.044	0.000	0.044	
	3.683	0.000	0.000	0.000	0.000	
	0.000	0.000	0.000	0.000	0.000	

Figure 8: Max displacement

Corner Stress									
Beam	L/C	Dist m	Corner 1 N/mm2	Corner 2 N/mm2	Corner 3 N/mm2	Corner 4 N/mm2	Max Comp N/mm2	Max Tens N/mm2	
83	1 DL	0.000	-2.580	-2.539	2.614	2.573	2.614	-2.580	
		1.534	-0.923	-0.902	0.957	0.936	0.957	-0.923	
		3.067	0.070	0.071	-0.036	-0.037	0.071	-0.037	
		4.601	0.397	0.378	-0.363	-0.344	0.397	-0.363	
		6.134	0.060	0.021	-0.026	0.013	0.060	-0.026	
		0.000	-1.401	-1.394	1.364	1.357	1.364	-1.401	
2 LL		1.534	0.619	0.622	-0.656	-0.659	0.622	-0.659	
		3.067	1.494	1.493	-1.530	-1.530	1.494	-1.530	
		4.601	0.564	0.560	-0.601	-0.597	0.564	-0.601	
		6.134	-1.511	-1.518	1.474	1.482	1.482	-1.518	
		0.000	-0.438	-0.441	0.432	0.435	0.435	-0.441	
		0.921	0.028	0.026	-0.033	-0.032	0.028	-0.033	
84	1 DL	1.841	0.254	0.254	-0.259	-0.259	0.254	-0.259	
		2.762	0.240	0.241	-0.245	-0.246	0.241	-0.246	
		3.683	-0.014	-0.011	0.009	0.006	0.009	-0.014	
		0.000	-0.493	-0.466	0.486	0.459	0.486	-0.493	
		0.921	0.063	0.077	-0.070	-0.083	0.077	-0.083	
		1.841	0.369	0.369	-0.376	-0.376	0.369	-0.376	
2 LL		2.762	0.259	0.246	-0.266	-0.253	0.259	-0.266	
		3.683	-0.100	-0.127	0.094	0.120	0.120	-0.127	
		0.000	-0.444	-0.434	0.438	0.428	0.438	-0.444	
		0.921	0.025	0.030	-0.030	-0.035	0.030	-0.035	
		1.841	0.254	0.253	-0.259	-0.259	0.254	-0.259	
		2.762	0.243	0.237	-0.248	-0.242	0.243	-0.248	
85	1 DL	0.000	-0.444	-0.434	0.438	0.428	0.438	-0.444	
		0.921	0.025	0.030	-0.030	-0.035	0.030	-0.035	
		1.841	0.254	0.253	-0.259	-0.259	0.254	-0.259	
		2.762	0.243	0.237	-0.248	-0.242	0.243	-0.248	
		3.683	-0.100	-0.127	0.094	0.120	0.120	-0.127	
		0.000	-0.444	-0.434	0.438	0.428	0.438	-0.444	

Figure 9: overall stresses

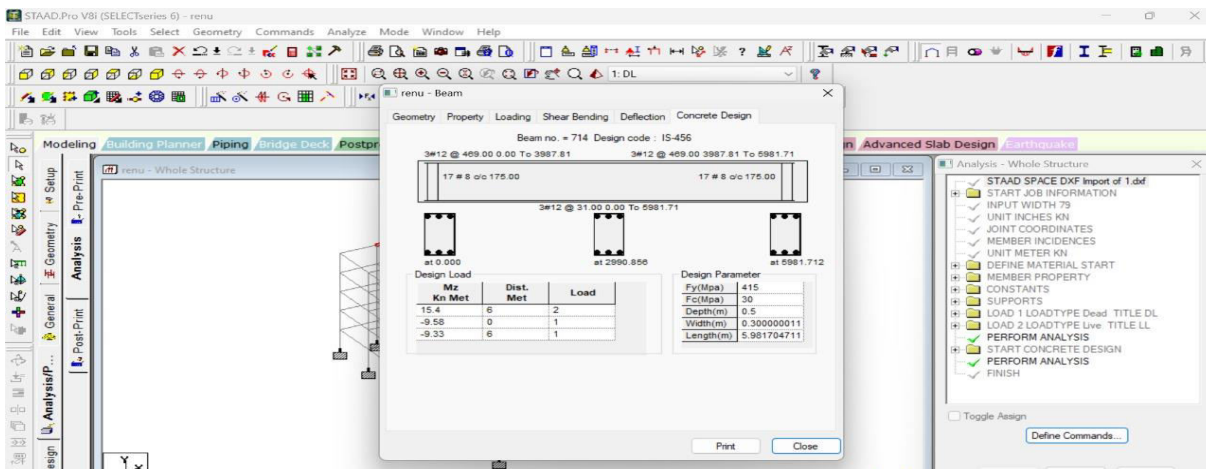


Figure 10 : Reinforcement Details of Beam

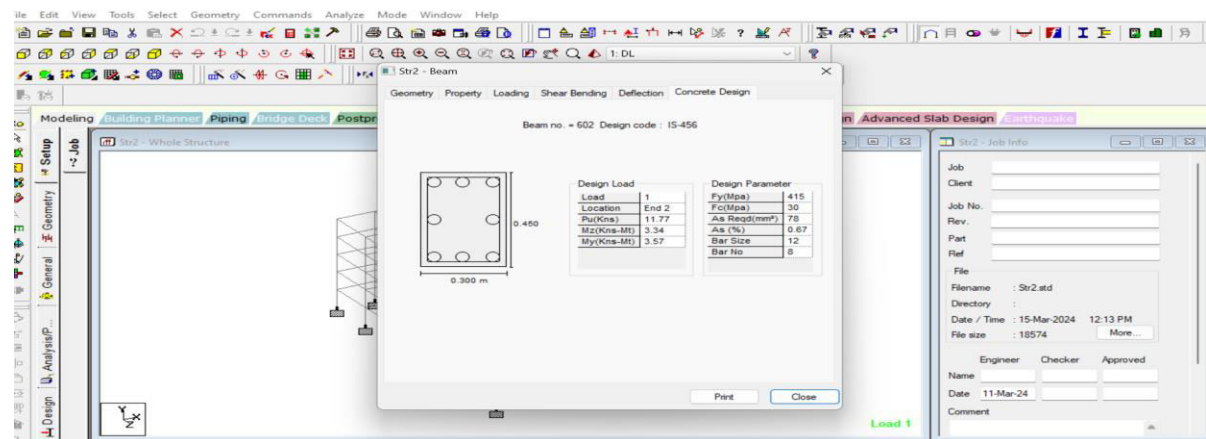


Figure 11: Reinforcement details of column

CONCLUSION:

- This project is mainly concentrated with the analysis and design of G+ 4 Residential Building with Duplex Flats with all possible cases of the loading's using STAAD .Pro Meeting the design challenges.
- We also check the deflection of various members under the given loading,
- Structural analysis, design of steel elements and reinforcement in concrete columns with the aid of STAAD pro developed by Bentley is done as per codal requirements.
- Building is safe about Shear force and Bending Moment.
- Further in case of rectification it is simple to change the values at the place where error occurred and the obtained results are generated in the output.
- STAAD.Pro V8i is an advanced software which provides us a quick, efficient, easy to use and accurate platform for analyzing and designing the structures.
- During the course of project, we have gained the knowledge on designing of beams and columns.
- This project also clears after application of loads the shear force and bending moment of the building is safe.

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