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ANALYSIS OF G+10 RESIDENTIAL BUILDING USING STADD PRO WITH MANUAL DESIGN

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Abstract – The planning and analysis of a G+10 residential building involve using AutoCAD for drafting, STAAD Pro for structural analysis, and manual calculations for designing columns, beams, and footings in accordance with IS-456 2000 and SP-16 codes. Given the complexity and numerous joints in multi-storied buildings, manual analysis can be cumbersome and error-prone. Hence, STAAD Pro, a modern structural analysis software, is employed to streamline and accurately perform these tasks. Multi-story structures are becoming more and more necessary due to the growing urban population and rising land costs. The proportions and arrangement required for a building to securely fulfill its intended function over its lifetime can be ascertained with the application of the structural analysis. The creative, analytical, and technical skills of structural planning and designing are combined with an understanding of building codes and regulations. By connecting with other programs like AutoCAD and MS Excel, STAAD Pro is used to efficiently provide precise results while overcoming the limits of manual design. The project entails applying different loads, implementing structural optimization using STAAD Pro, and constructing and assessing a G+10 a two-unit residential building per level. The primary goal of a structural engineer is to create a structure that is affordable, safe, and reusable. The entire structural planning and design process necessitates creativity and solid understanding.G+10 story residential building structure analysis and design using the IS Code approach. The entire structure has been analyzed, designed, and verified by hand using STAAD.PRO software. With AutoCAD, all of the drafting and detailing was completed.

Key Words :Analysis, Design, AutoCAD, STAAD.PRO, Residential building

1. INTRODUCTION

Using Auto-cad software, a G+10 residential building is planned. STAAD Pro is employed. for analysis, and manual design beams and columns ,footings are used. IS-456 2000 and SP-16 Code are consulted for the footing member. These multi-story buildings have a huge number of freely moving joints, making manual analysis very challenging and time-consuming. Hence the computer method for analysis is used using the modern analyzing Program STAAD Pro

is necessary to multi-story buildings these days because of the overpopulation of urban areas and the high cost of land. Analysis of structure is the process of figuring out an object's general shape, precise dimensions, and size such that it may safely withstand external forces and fulfill its original purpose for the duration of its useful life. Furthe rmore to creativity and computations, the entire structural planning and designing process necessitates scientific understanding of structural engineering and decision-making regarding particle aspects, such as bye-laws and design codes, supported by judgment and sample experience.

An attempt was made to plan, analyze, and design a residential building for this project. The AUTO-CAD software drafts the plan for building analysis and design, and then imports it into STAAD Pro.

The examination of a multistory G+10 two-unit residential building on each floor is the focus of the current project. After applying the dead and live loads, the design for the beams, columns, and footing is determined. With its additional features, STAAD. Pro

Programs for designing structural analysis (STAAD. Pro) is used to create the design. The structure was exposed to loads that are both vertical and horizontal. The dead load of structural elements like beams, columns, slabs, etc., and living loads make up the vertical load. According to IS 875, a building is designed for dead load, living load, and wind load because the horizontal load is made up of wind forces. The structure is designed as two-dimensional vertical frames, and trial-and-error techniques are used to determine the maximum and lowest bending moments and shear forces. according per IS456-2000 Software that is accessible at the institute is used to assist using load calculations. moments, and shear forces.

For loose soil, a deep foundation (pile) was our preference. When high rise construction calculations are done by hand, it takes longer and there's a chance that human error will happen. The applications utilized for this project are.

- AutoCAD
- STAAD.PRO

AutoCAD is a drafting program created and marketed by Autodesk Inc. that is used to design two- and three-dimensional structures. It's a drawing application for vector graphics. DWG, the default file format for AutoCAD, and to a lesser extent.STAAD.PRO

STAAD.PRO is user friendly software which is used for analyzing and designing of structures by structural engineers. STAAD.PRO provides a lot of precise and correctresults than manual techniques.STAAD.PRO software is usedfor both static and dynamic analysis

for structures such as bridges, low rise or high-rise buildings, stadiums, steel structures etc. First step in STAAD.PRO is to specify the geometry of the structures and then the properties of the members are mentioned, then the supports are generated and loadings are specified on the structure.

2. LITERATURE REVIEW

Ibrahim, et al (April 2019): Design and Analysis of Residential Building (G+4): After analyzing the G+4 storey residential buildingstructure, conducted that the structure is rate in loading likedead load, live load, wind load and seismic loads. Member dimensions are assigned by calculating the load type and its quantity applied on it. Auto CAD gives detailed informationat the structural members length, height, depth, size and numbers etc. STAAD.PRO has a capability to calculate the program contains number of parameters which are designedas per IS:456-2000. Beams were designed for flexure, shearand tension and it gives the detail number, position and spacing brief.

Mr.k prabin kuma They used static Indeterminacy methods to calculatenumbers of unknown forces. Distributing known fixed end moments, the condition of compatibility by iteration method,Kani's method was used to distribute moments at successor joints in frame and continues beam for stability of membersof building structure. They used to design software STAAD.PRO which reduced a lot of time in design, gives accuracy

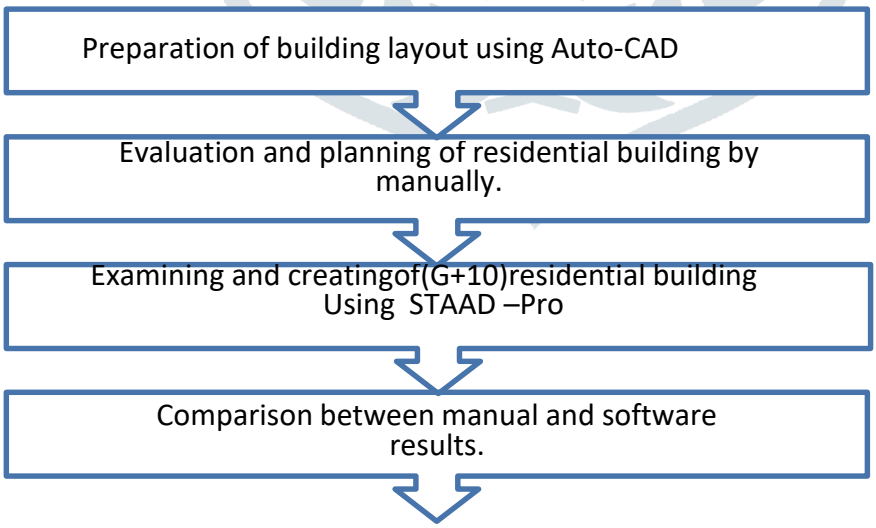
T. Naidu et.al. The analysis and design of this project are mostly based on structural framed building. Organizing, evaluating, and creating G+10 residential building structure by using Using the IS-Code technique with STAAD PRO software. For any type of building In Indiathe National Building Code governs planning (NBC). Therefore, the National Building Code of India has been appropriately followed in the planning of this residential building. With sufficient amenities, the G+10 building is framed in reinforced concrete. The limit state method is used in the design of each structural member with reference of IS: 456-2000. Different load active on the member (beam, column) are considered based on the IS CODE: 875 (Part1, Part2, Part3).

Deevi Krishna Chaitanya et.al. In response, an effort is made to use the software program staad pro to analyze and design a multi-story skyscraper. The analysis of a multi-story G+6 residential building with five flats on each floor is the focus of this project. After applying the dead and live loads, the design for the beams, columns, and footing is determined. STAAD Pro outperformed its predecessors and comparators thanks to its new features. provides the ability to share data with other popular programs like MS Excel and Auto-cad. In summary, staad pro is an extremely effective tool that saves a great deal of time and is highly accurate in designs. Thus, it can be said that the staad pro package is appropriate for use in multi-story building design**.**

3.OBJECTIVES OF THE STUDY

1)Planning and Drawing of a residential G+10 Bu ilding in Auto-Cad.
2)To develop, design and analysis model of the High rise structure in STAAD-Pro.
3)Manual Design of column and Beam, footing Member using excel sheet.

4. METHODOLOGY



4.1Building Description:

Shape of the Building	Regular (Rectangular)
No. of Stories	(G+10) Storey
Height of Stories	3.1 m (Similar)
Type of Wall	Brick Wall
Area of Building	209 m^2
Zone	II
Zone Factor	0.10

Table 1

4.2 Plan of Residential Building

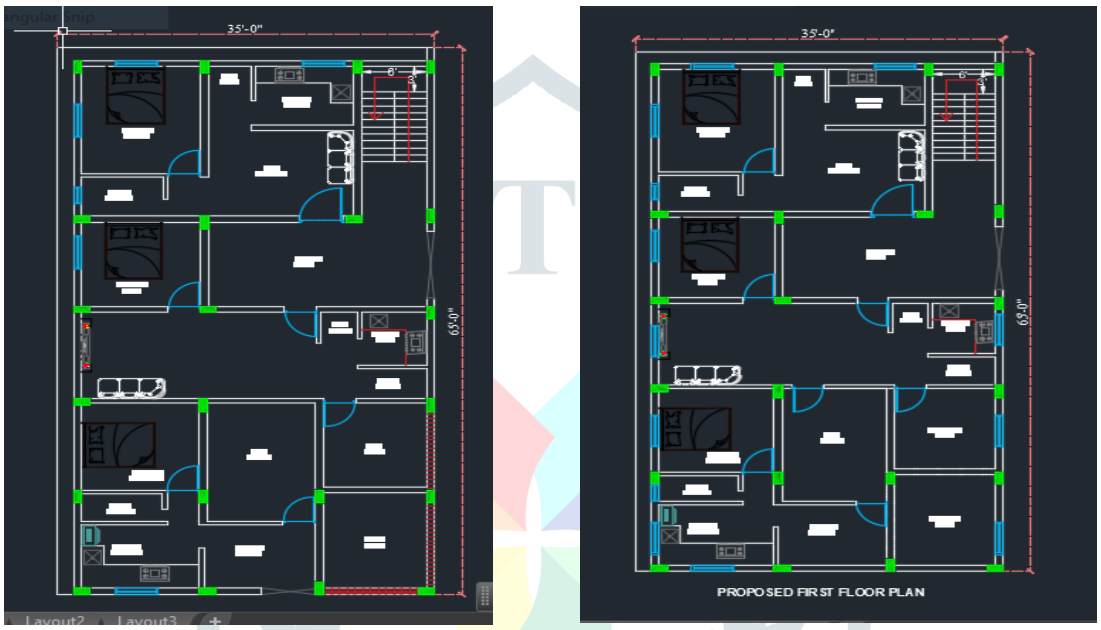


Fig.1: proposed ground & first floorplan

The two units on the 35' x 65' property are a 1 BHK and a 3 BHK, respectively. With dead load, living load, wind load, and seismic load applied, the building has ten stories.

Column	0.60 m × 0.60 m
Beam	0.40 m × 0.35 m
Slabs	0.15m thick
Live load	3kN/m^2
Floor Finish	2kN/m^2
Grade of concrete	M30
Grade of steel	Fe 500

Table 2

4.3 Loads Assigning:

A portion of the loadings were computed manually, while the remaining portion was produced via the STAAD .Pro load generator. These categories utilized for the loading cases:-

- ✓ Earthquake force
- ✓ Devoid of load
- ✓ current load
- ✓ Wind load
- ✓ **Combination of loads**
  - 1.5 (D.L + L.L)
  - 1.2 (D.L + EQx + Wx)
  - 1.2 (D.L ±EQz+Wz)

- 0.9D.L + 1.5EQ
- 0.9DL+1.5EQz
- 0.9DL+1.5Wx
- 0.9DL+1.5Wy

4.4 Analysis & interpret the result:

- Analysis of RCC framed structure
- Shear force, Bending moment and Axial force
- Design of this structure as per guidelines of IS:456- 2000(Limit state design)

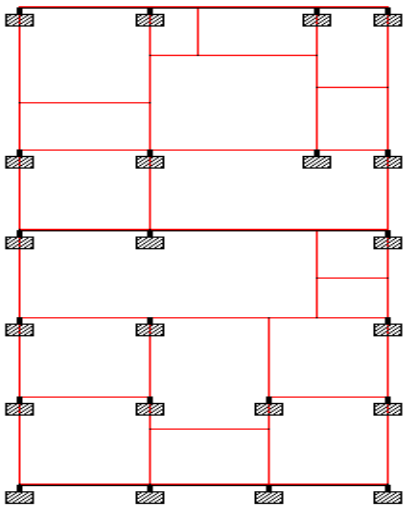
4.5 Input data:

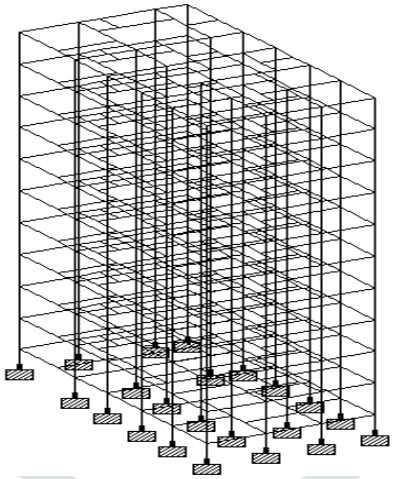
- Slab =150mm
- Beam =400mm X 350mm
- Column =600X600
- Thickness of outer wall = 230mm
- Height of parapet wall =1 m

- **Material Specification**

Grade of Concrete, M30	30 N/mm^2
Grade of Steel, Fe415	500 N/mm^2
Clear Cover of Slab, Beam	25 mm
Clear Cover of Column	40 mm

Table 3





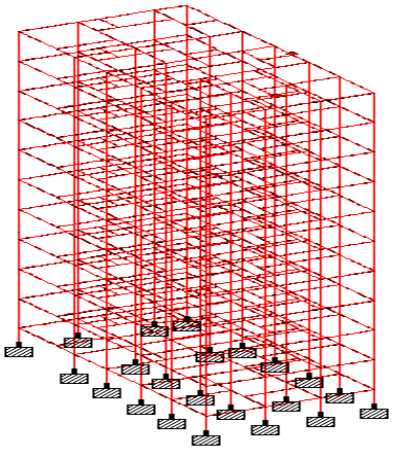


Fig.3.3:3-D View Model

5. Analysis & interpret the result:

5.1 : Interpreting the displacement

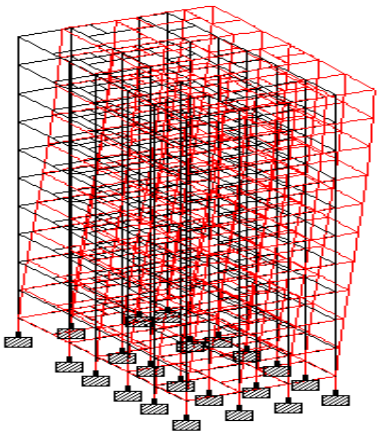


Fig.4: due to EQ in X-dirn

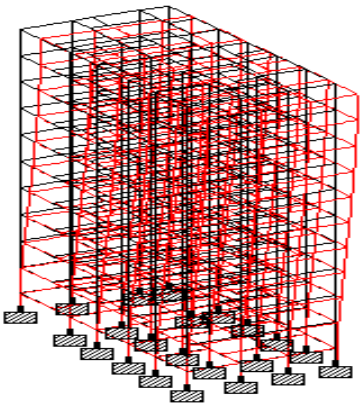


Fig.4: due to EQ in Z-dirn

5.2. Interpreting the Bending Moment

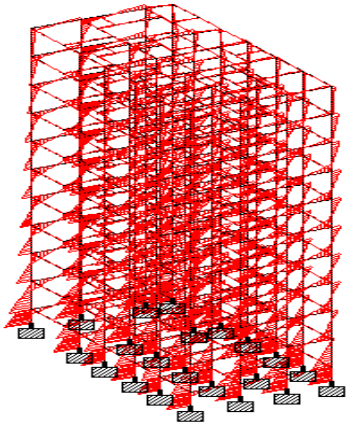


Fig.5: due to EQ in X-dirn

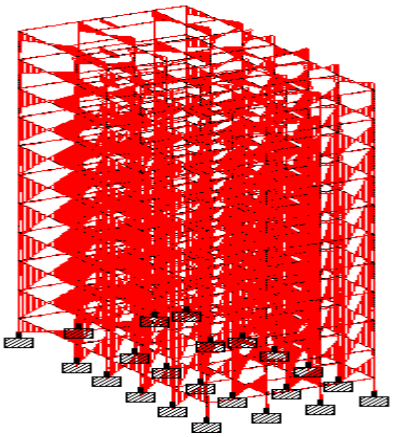


Fig.5: due to EQ in Z-dirn

5.3 Interpreting the Axial Force

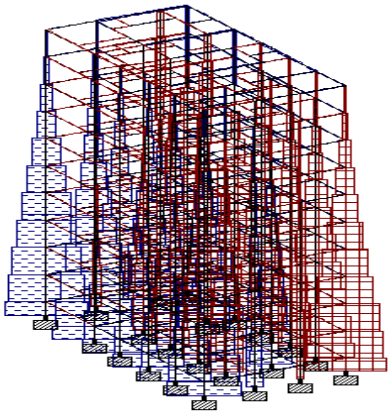


Fig.6: due to EQ in X-dirn

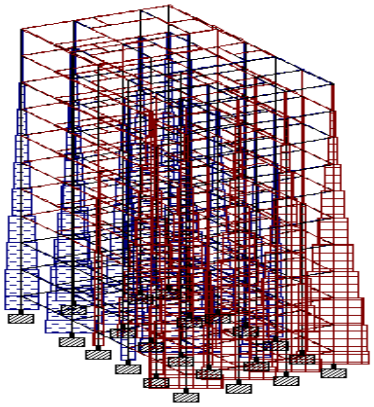


Fig.6: due to EQ in Z-di

5.4 Interpreting the Shear Force

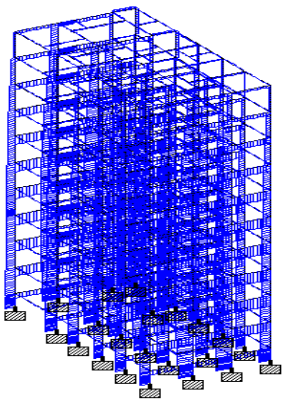


Fig.7: due to EQ in X-dir[n]

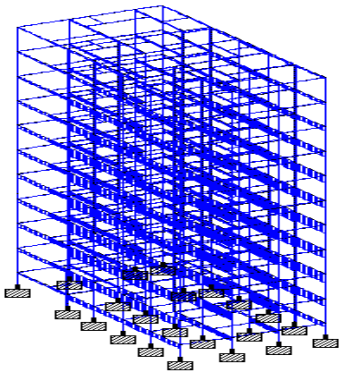


Fig.7: due to EQ in Z-dirn

6 . Design of the structure:

- The beam's design
- The Column's Style
- Design of Foundation

Material Specification

Grade of Concrete, M30	30 N/mm^2
Grade of Steel, Fe415	500 N/mm^2
Clear Cover of Slab, Beam	25 mm
Clear Cover of Column	40 mm

Table 4

Beam design

6.1 Beam design 181 (corner beam)

Results from software:

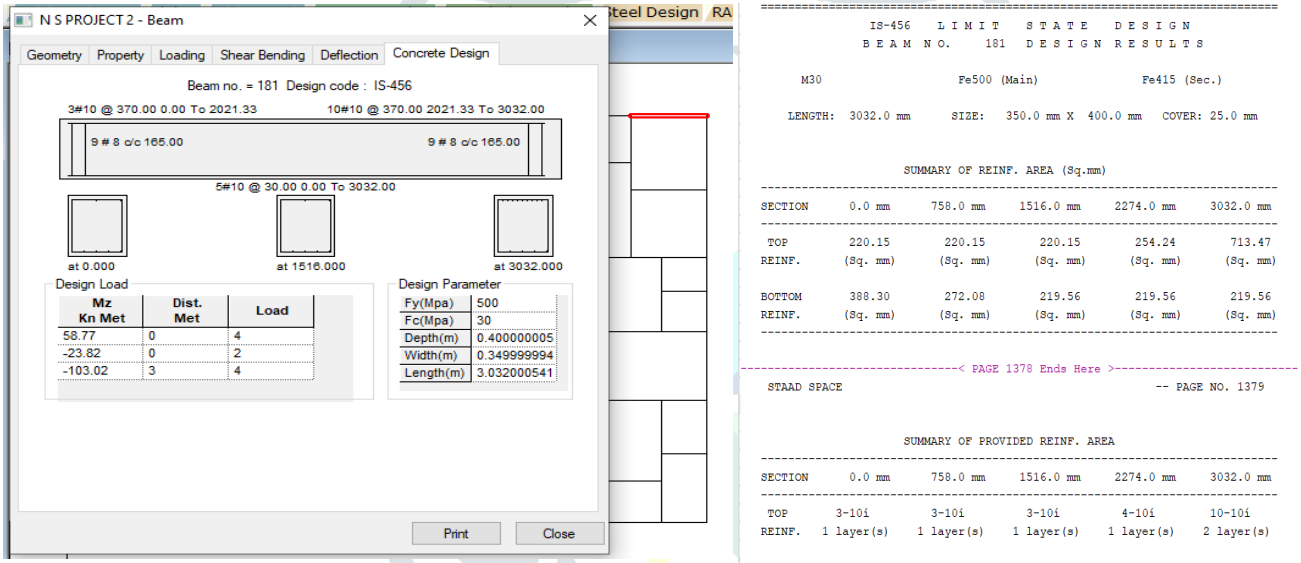
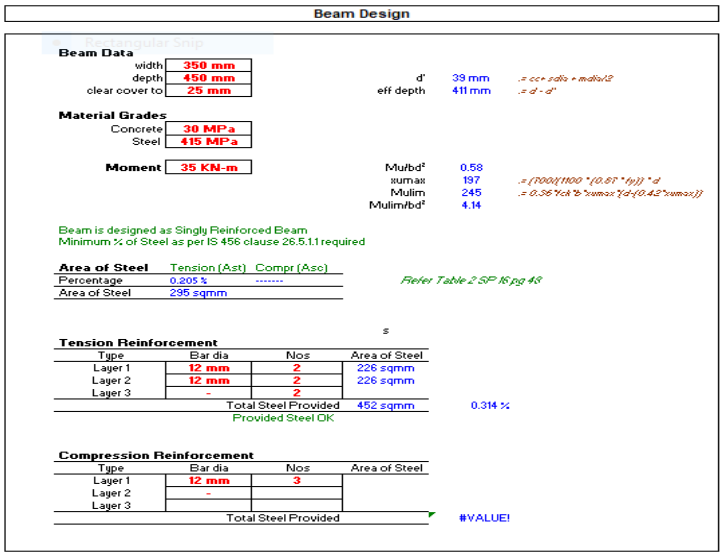


Fig .8 (Detailing of beam)

Manual Design



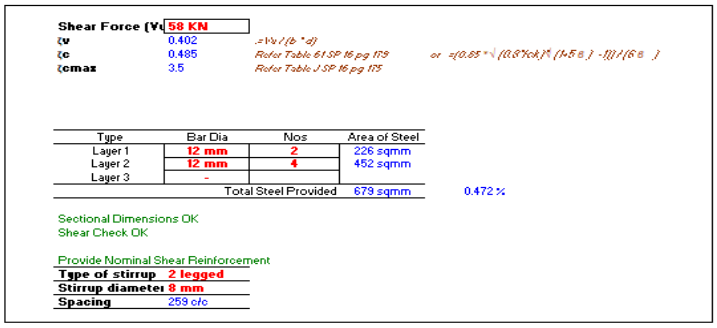


Fig .9

The computation of Fig. 6.1 above, when done manually and using software analysis, yields nearly identical results. The beam is designed as a beam with one side (reinforcement) with 3-12 mm bars in the upper (compression) and 4- 12 mm bars at the bottom for reinforcement.

7.DESIGN OF COLUMNS

7.1 Column design No 101

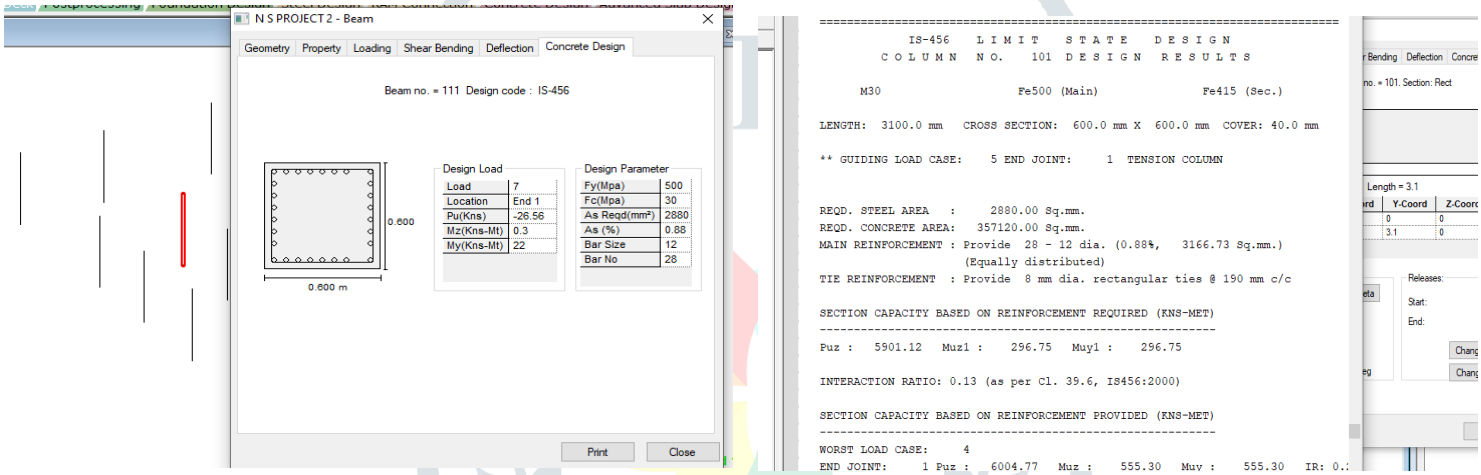
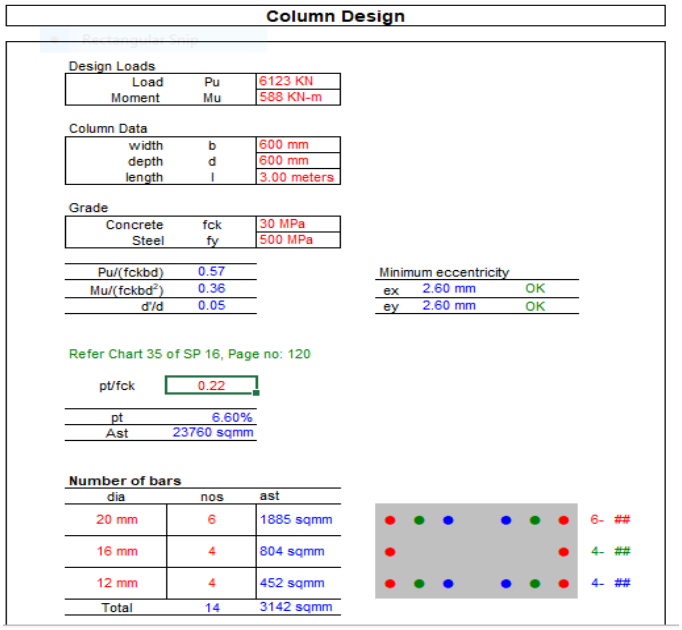


Fig .10 (Column design)

Manual Design



Increase the bar diameter or The total number of bars provided

fy	d'/d	Chart No.	Page No
250	0.05	Chart 27	112
	0.1	Chart 28	113
	0.15	Chart 29	114
	0.2	Chart 30	115
415	0.05	Chart 31	116
	0.1	Chart 32	117
	0.15	Chart 33	118
	0.2	Chart 34	119
500	0.05	Chart 35	120
	0.1	Chart 36	121
	0.15	Chart 37	122
	0.2	Chart 38	123

	250	Chart 27
	415	Chart 31
	500	Chart 35

Chart No.	Page No
Chart 35	120

Fig.11

Output:

Owing to the extensive and comprehensive description of the staad output for every single column, we have included a column design result below that details the loads, moments, amount of steel needed, adopted section, and other information. .And C1,C2,C3,C4,C5,C6,C7,C8,C9 C11,C17,C19, are columns are designed as same .& it contain 6 bars of 20mm &4bars of 16mm &4 bars of 12mm.By using S16-1930 code book.

8. Foundation design:

8.1 Foundation design number F1:

DESIGN OF SQUARE FOOTING					
A) INPUT DATA					
SBC OF SOIL	180	KN/m2	Fck	30	N/mm2
WIDTH OF COLUMN , B	600	MM	Fy	500	N/mm2
DEPTH OF COLUMN , D	600	MM	CLEAR COVER	50	MM
SERVICE LOAD	2762	KN	DIA. OF STEEL	16	MM
FOOTING WIDTH 10% OF P	276.2	KN	GROSS LOAD ,P	3038.2	KN
B) FOOTING SIZE					
AREA OF FOOTING, Arequired	16.9	m2	PROVIDE, Area	18.49	mm2
length of footing required, Lreq	4.11	m	PROVIDE, Lf	4.3	m
Width of footing req, Breq	4.11	m	PROVIDE, Bf	4.3	m
UPWARD SOIL PRESSURE	164.315846	KN/m2	Upward soil pressure < SBC,Hence OK		
C) DEPTH REQUIRED FOR FLEXURE					
BENDING MOMENT ,M	1209.10	KNm	Factor moment,Mu	1813.6	KNm
Effective depth of footing,drequired	319.18	mm	d(provided)	650	mm
Overall depth,D provided	700	mm	overall depth,D (pro.	700	mm
D) DESIGN FOR REINFORCEMENT					
Area of steel ,Ast	6683.91	mm2	Area of steel ,Astmi	3612	mm2
% of steel, Pt	0.239	%	Satisfies min. R/C i.e 0.12%,HENCE SAFE		
NO.OF BAR'S	33	NO's	Spacing, Sv	129.37	mmc/c
			Spacing, Sv provide	175	mmc/c
E) CHECK FOR ONE WAY SHEAR					
Shear Force, V	847.869767	KN	Ultimate shear ,Vu	1271.8	KN
Nominal shear stress,Tv	0.455	N/mm2	Tc,	0.4584	
			Safe in one-way shear		
F) CHECK FOR TWO WAY SHEAR (PUNCHING SHEAR)					
Net shear force, F	2781.45649	KN	Fu	4172.2	KN
Tv	1.284	N/mm2	KsTc	1.37	N/mm2
			Safe in Two-way shear		
G) DETAILING					

SIZE OF FOOTING L*B*D (mm)			PROVIDED REINFORCEMENT (mm)				
Length	Width	Depth	Along length		Along width		No.of bar
4300	4300	700	T	175	T	175	33
			16	mm c/c	16	mm c/c	No's

Fig.12

The soil bearing capability is 180 kN/m2, and the square footing has a service load of 2762 kN. The footing is 4.3 meters in both length and breadth, for a total area of 18.49 meters square. The bars are spaced 175 mm center to center, with 33 reinforcement bars measuring 16 diameter of mm on each side.& the foundation's depth of 650mm

The quantity and spacing of bars have been estimated using structural computations in order to verify that the footing can carry the service load and meet the standards for soil bearing capacity. To give the footing the required strength, 33 bars totaling 16 mm in diameter on both sides have been chosen, spaced 175 mm center to center. Additionally, F9,F18,F12

9 CONCLUSIONS

On the following work carried out, we conclude that: -

1. This project has provided us with the chance to compile and organize the different technical and design techniques that we have learned.
2. In accordance with IS: 456-2000, analysis and design were completed using STAAD.PRO software and successfully confirmed by hand.
3. The results of calculations made manually and through software analysis are nearly identical..
4. As storey height rises, displacement increases.
5. 5061 KN is the maximum axial force in the Y direction.
6. STAAD PRO is a flexible software that can determine the lateral deflection caused by an earthquake load and determine the amount of reinforcing required for any concrete section. Numerous parameters in the program are created in accordance with IS: 456(2000) and IS 1893:2002.

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