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Analysis And Design Of Duplex Building Using Staad Pro

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ABSTRACT :

We have done project on "SAMPADA DUPLEX " which is under the construction of Essarjee Constructions (P) Ltd.In this project we have done the analysis of designing on G+1 duplex building which is located at khajurikalan,Bhopal.It is used for residential complex in which No. of stories G+1.In the structure 5 unit of duplex structure. This project is rectangular in shape and RCC frame structure.

We have done the analysis of slabs and staircases manually and rest of the framed structure through STAAD Pro package. In the analysis we have follow the different Indian standards codes. All the loads from slabs to the beam are manually calculated and distributed in trapezoidal form. Thicknesses of slabs are calculated from the deflection criteria of IS 456:2000.

After doing all the structural analysis of our structure, we have designed the slabs and stair case manually and the beams and columns into the STAAD Pro to find out the steel used for the reinforcement. We have followed the IS 456:2000 and applied different checks. Detailing of the design has been done into the Auto CAD according to SP 34:1987.

Keywords: Structure Analysis, STAAD Pro, Duplex building, Frame Structure

1. Introduction :

Structural design is an art and science of designing, with economy and elegance, a safe, serviceable, and a durable structure. The entire process of structural planning and design requires not only imagination and conceptual thinking (which form art of designing) but also sound knowledge of science of structural engineering besides knowledge of practical aspects, such as relevant design codes and bye-laws, backed up by ample experience, institution and judgment.

Few standard problems also have been solved to show how "STAAD. Pro" can be used in different cases. These typical problems have been solved using basic concept of loading, analysis, condition as per IS code. These basic techniques may be found useful for further analysis of problems. STAAD Pro features a state-of-the-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities.

To perform an accurate analysis a structural engineer must determine such information as structural loads, geometry, support conditions, and materials properties. The results of such an analysis typically include support reactions, stresses and displacements. This information is then compared to criteria that indicate the conditions of failure. Advanced structural analysis may examine dynamic response, stability and non-linear behavior.

Often, the work is required to start soon, so the steps in design are to be arranged in such a way the foundation drawings can be taken up in hand within a reasonable period of time. Further, before starting the structural design, the following information of data is required.

1. A set of architectural drawings
2. Soil Investigation report of soil data in lieu thereof
3. Location of the place or city in order to decide on wind and seismic loadings

In this present project report there is analysis and design of Duplex building which is a ongoing project of Essarjee Constructions Pvt. Ltd. Bhopal in this we have manually calculated the different loads that are coming on the beams then by assigning the self load of beams and columns we have analyses it in the STAAD Pro and the designing of beams and columns are also done in STAAD Pro where as slabs and staircases are designed manually as per IS 456:2000. Some of the beams and columns are also checked manually then the detailing has been done into tabular form and Auto CAD drawings.

2. LITERATURE REVIEW

- V.Varalakshmi, G. Shiva Kumar and R. Sunil Sarma (2014): The design and analysis of multistoried G+5 building at Kukatpally, Hyderabad, India. The Study includes design and analysis of columns, beams, footings and slabs by using well known civil engineering software named as STAAD.PRO. Test on safe bearing capacity of soil was obtained.
- P. Jayachandran and S. Rajasekaran (2006): The design and analysis of multistoried G+4 building at Salem, tamilnadu, India. The study includes design and analysis of footings, columns, beams and slabs by using two software named as STAAD.PRO and RCC Design Suit.
- Mahesh Suresh Kumawat and L.G. Kalurkar (2014): The design and analysis of multistoried G+5 building using composite structure at earthquake zone-3. A three dimensional modeling and analysis of the structure are carried out with the help of SAP 2000 software. Equivalent Static Method of Analysis and Response spectrum analysis method are used for the analysis of both Composite and RCC structures. The results are compared and found that composite structure more economical.
- Swati D.Ambadkar, Vipul S. Bawner (2012), analyzed G +11 building by using STAAD PRO. Analysis is done for various variations such as 1) Terrain with few or no obstructions having heights below 1.5 m. 2) Terrain with obstructions having heights between 1.5 to 10 m. 3) Terrain with numerous closely spaced obstructions having the size of building structures up to 10 m in height.4) Terrain with numerous large high closely spaced obstructions. According to Internal Pressure Coefficients (*Cpi*) provided for that various variations. This analysis is done for wind speed 44 m/s, 47 m/s, 50 m/s. Results obtained from STAAD-PRO analysis are used for obtaining significant relations of moments, forces and displacement with wind speeds. Moments, forces and displacement obtained from all cases are compared with wind speeds, according to their percentage of opening provided for various variations.

3. DESCRIPTION

The structure is consisting of 5 duplex. Each duplex (7mX13m) size and G+1.It is use for residential purpose. The grade of concrete use M20 and grade of steel Fy415.

Statement of project

- Utility of building : residential complex
- No of stories : G+1
- Shape of the building : Rectangular
- No of staircases : 5
- No. of Apartment : 5
- Type of construction : R.C.C framed structure
- Types of walls : brick wall

Geometric details:

- First to floor height : 3m.
- Height of plinth level : 0.6m
- Depth of foundation : 2 m
- Area of each Apartment : 104 sq m

Materials:

- Concrete grade : M20
- All steel grades : Fe415 grade
- Type of steel bars : HYSD
- Bearing capacity of soil : 150 kN/m^2
- Poisson's ratio : 0.17

Density

- Plain concrete : 24.0 kN/m^3
- Reinforced concrete : 25.0 kN/m^3
- Flooring material : 20.0 kN/m^3
- Brick masonry : 19.0 kN/m^3

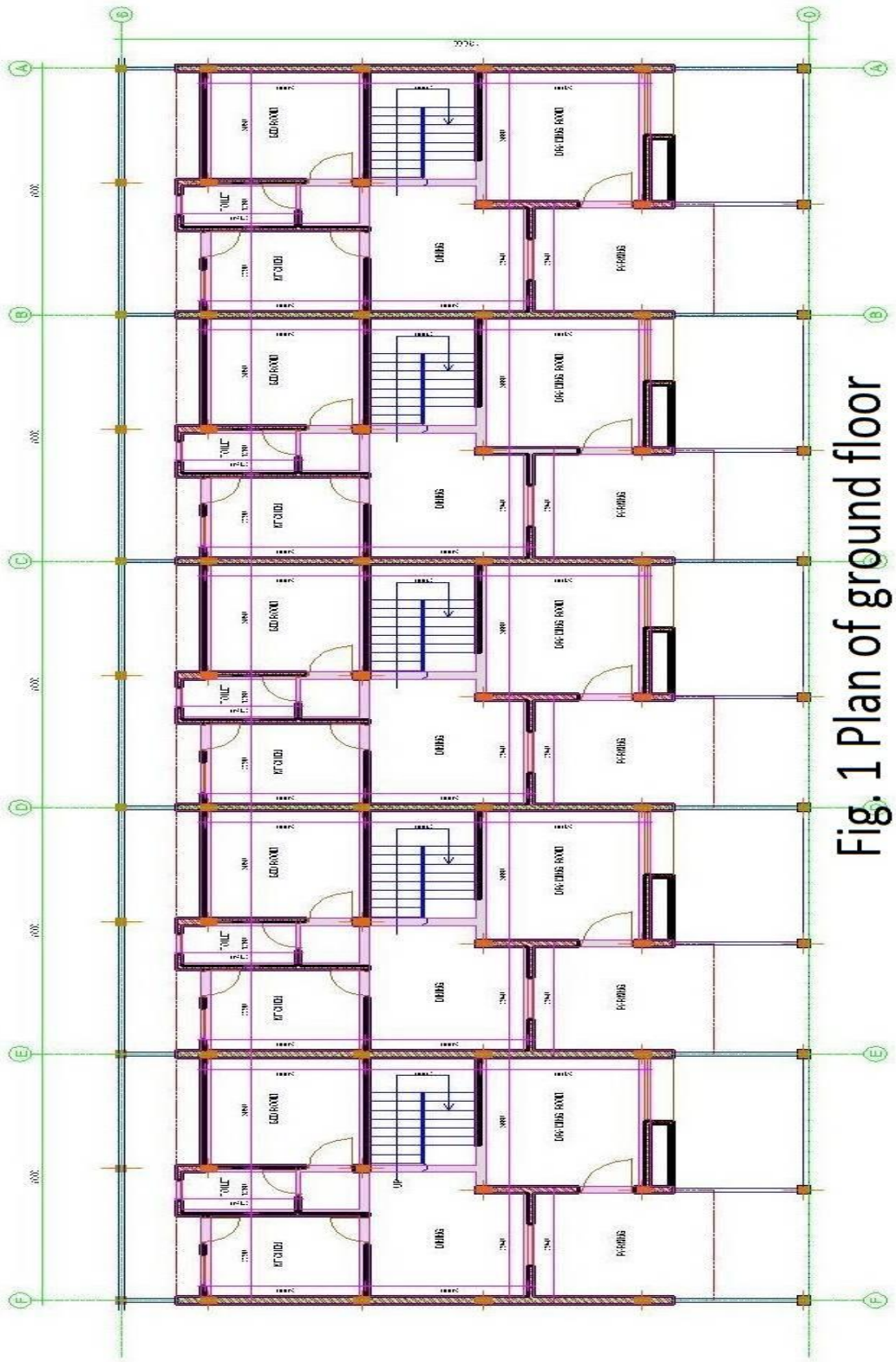


Fig. 1 Plan of ground floor

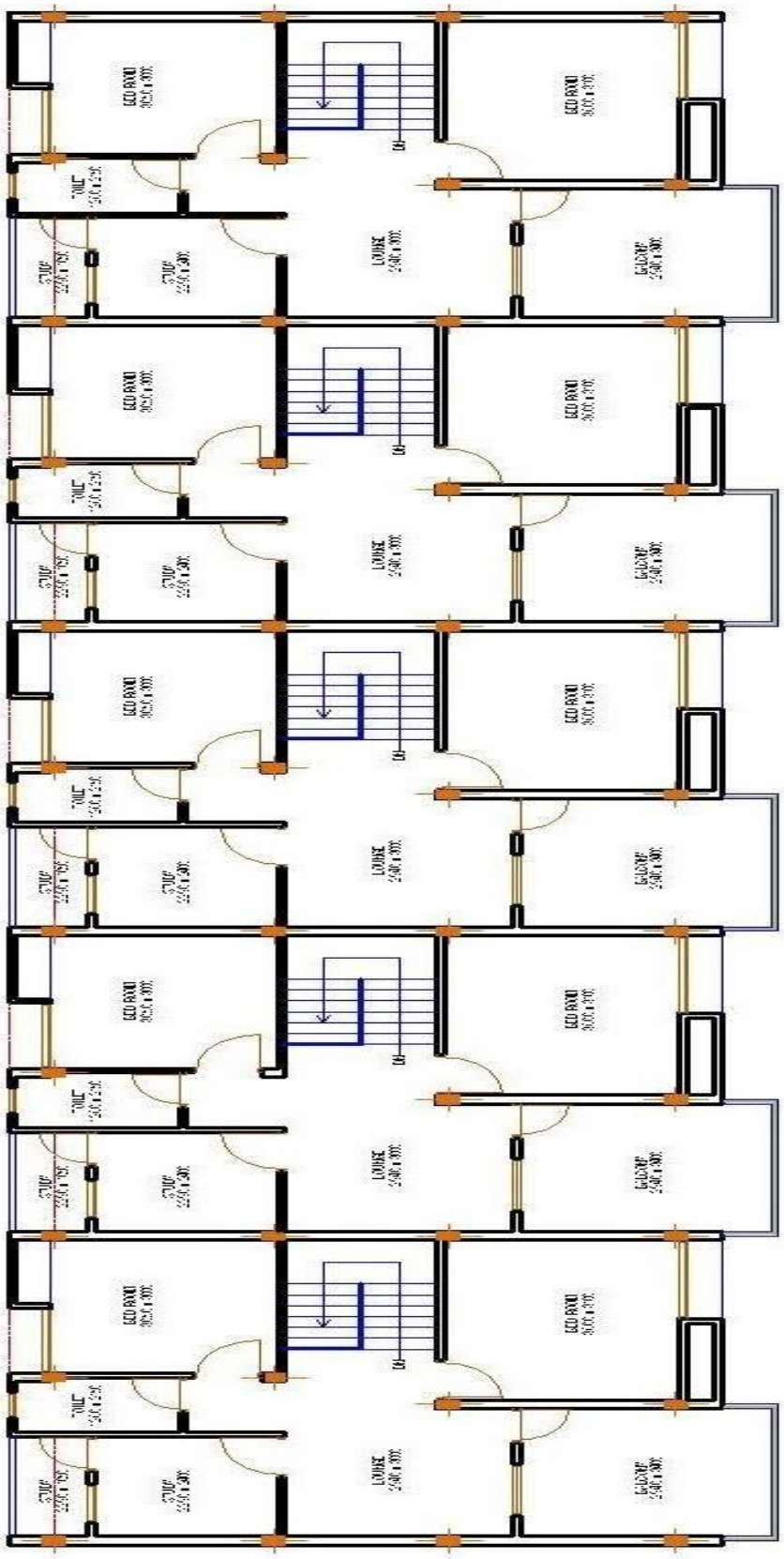


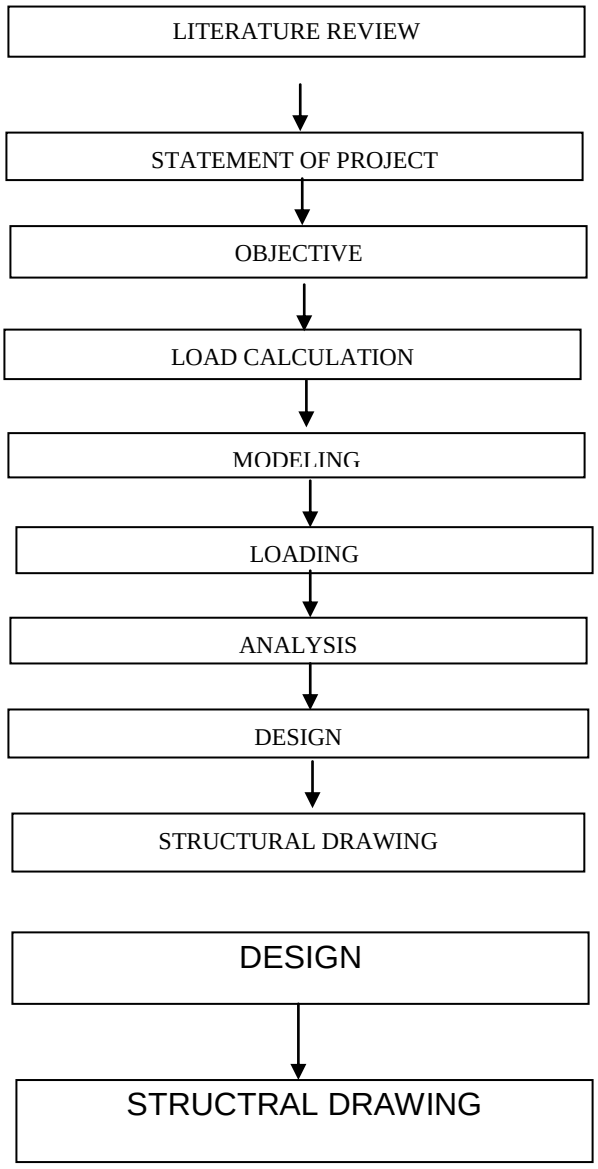
Fig.2 Plan of 1st floor

4. OBJECTIVES

This project aims for relearning of concept of structural design with the help of computer aids. Briefly we have gone through following points through out of the project work.

- Carrying out a complete analysis and design of the main structural elements of a duplex building including beams, columns, slabs, staircase, and foundation.
- Detailing as per the result
- Reduce the time in design work.
- Improve the accuracy.
- Structure designed should satisfy limit state of stability.
- It should satisfy the limit state of serviceability.
- It should satisfy the criteria of ultimate strength.
- Getting familiar with structural soft wares (STAAD Pro, STAAD Foundation, AutoCAD)
- Getting real life experience with engineering practices

5. METHOLODOGY



6. Results and Discussion

The analysis and design was done according to standard specifications to the possible extend. For analyzing the beams and the columns, we had assuming the width of the beam on the architectural considerations and some theoretical knowledge. The depth of the beams was decided according to the Clause 23.2.1 of IS 456:2000.Leaving some section, all the sections were passed and the failed section had been reconsidered.

We have transferred the slab load to the beams as member load as we don't want slab stiffness to play a part in the analysis. if we include slabs, there will be stiffness contribution from the slabs and the beam results will not be conservative.

Also if plates were added in the slabs and staircases then we have to mash the plate and at the same time beams were also mashed. In that case STAAD will design each beam bit by bit and then we have to join them together.

After the analysis and designing various results like maximum bending moment, maximum shear force, maximum axial force, maximum joint displacement and maximum section displacement are evaluated and effective and critical floor is determine among the structure considering combined factored dead and live load.

Some of the column design result of STAAD Pro had been improved as STAAD Pro designed it by taking the minimum diameter of the bar so that the no of bars has been increased and spacing between them decreased to less than 50 mm.

Table.1 Footing details

Footing No.	Foundation Geometry			Footing Reinforcement		Pedestal Reinforcement	
	Length	Width	Thickness	Bottom Reinforcement(Mz)	Bottom Reinforcement(Mx)	Main Steel	Trans Steel
F1	1.50 m	1.5 m	0.250 m	Ø10 @ 255 mm c/c	Ø10 @ 255 mm c/c	4 - Ø10	Ø6 @ 160 mm
F2	1.75 m	1.75m	0.250 m	Ø10 @ 205 mm c/c	Ø10 @ 230 mm c/c	8 - Ø10	Ø6 @ 160 mm
F3	2.0 m	2.0 m	0.250 m	Ø10 @ 145 mm c/c	Ø10 @ 170 mm c/c	8 - Ø10	Ø6 @ 160 mm
F4	2.25 m	2.25 m	0.300 m	Ø10 @ 130 mm c/c	Ø10 @ 150 mm c/c	8 - Ø10	Ø6 @ 160 mm
F5	2.5 m	2.25 m	0.30	Ø10 @ 100 mm c/c	Ø10 @ 115 mm c/c	8 - Ø10	Ø6 @ 160 mm

Table.2 Column details

Colum No.	Size (mm)	Main reinforcement	Tie reinforcement
C1	200X200	4 – 12mm ϕ	8 mm ϕ rectangular ties @ 190 mm c/c
C2	200X300	4 – 12mm ϕ	
C3	200X300	4 – 16mm ϕ	8 mm ϕ rectangular ties @ 200 mm c/c
C4	200X300	8- 16mm ϕ	8 mm ϕ rectangular ties @ 200 mm c/c
C5	200X300	8– 12mm ϕ	8 mm ϕ rectangular ties @ 190 mm c/c

Table.3 Beam details

Beam No	Size (mm)	Top reinforcement			Bottom reinforcement			Shear reinforcement		
		Left (mm)	Mid (mm)	Right (mm)	Left (mm)	Mid (mm)	Right (mm)	Left (mm)	Mid (mm)	Right (mm)
B1	200X300	2-12 ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
B2	200X300	5-12 ϕ	4-12ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
B3	200X300	3-12 ϕ	2-12ϕ	4-12ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
84	200X300	5-12 ϕ	3-12ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
B5	200X300	5-12 ϕ	2-12ϕ	6-12ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
B6	200X300	4-12 ϕ	2-12ϕ	5-12ϕ	2-12ϕ	2-12ϕ	6-12ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
B7	200X300	4-12 ϕ	2-12ϕ	5-12ϕ	2-12ϕ	3-12ϕ	2-12ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100

B8	200X400	5-12 ϕ	3-12ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
B9	200X300	3-12 ϕ	2-12ϕ	5-12ϕ	2-16ϕ	2-16ϕ	2-16ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
B10	200X400	2-12 ϕ	2-12ϕ	6-12ϕ	6-12ϕ	2-12ϕ	2-12ϕ	2L-8 ϕ@125	2L-8 ϕ@100	2L-8 ϕ@125
B11	200X400	3-12 ϕ	2-12ϕ	2-12ϕ	2-16ϕ	3-16ϕ	3-16ϕ	2L-8 ϕ@125	2L-8 ϕ@125	2L-8 ϕ@125
B12	200X300	4-12 ϕ	2-12ϕ	4-12ϕ	2-12ϕ	3-12ϕ	2-12ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
B13	200X300	2-12 ϕ	2-12ϕ	2-12ϕ	2-16ϕ	2-16ϕ	2-16ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
B14	200X300	2-16 ϕ	2-16ϕ	2-16ϕ	2-12ϕ	3-12ϕ	2-12ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
B15	200X300	2-16ϕ	2-16ϕ	2-16ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
B116	200X400	2-12 ϕ	2-12ϕ	5-12ϕ	5-12ϕ	2-12ϕ	2-12ϕ	2L-8 ϕ@125	2L-8 ϕ@100	2L-8 ϕ@125
B117	200X300	3-12 ϕ	2-12ϕ	2-12ϕ	2-12ϕ	4-12ϕ	4-12ϕ	2L-8 ϕ@125	2L-8 ϕ@125	2L-8 ϕ@125
B18	200X300	2-16 ϕ	2-16ϕ	2-16ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
B19	200X400	2-12 ϕ	2-12ϕ	2-12ϕ	2-12ϕ	3-12ϕ	3-12ϕ	2L-8 ϕ@125	2L-8 ϕ@125	2L-8 ϕ@125
B20	200X300	2-16 ϕ	2-16ϕ	2-16ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2L-8 ϕ@100	2L-8 ϕ@100	2L-8 ϕ@100
B21	200X400	2-12 ϕ	2-12ϕ	3-12ϕ	3-12ϕ	2-12ϕ	2-12ϕ	2L-8 ϕ@125	2L-8 ϕ@125	2L-8 ϕ@125
B22	200X400	2-12 ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2-12ϕ	2L-8 ϕ@125	2L-8 ϕ@125	2L-8 ϕ@125

Table.3 Slab details

Slab No.	Thickness	Reinforcement in shorter span ()	Reinforcement in longer span ()	Remark
S1	100	8mm dia bar @230mm C/C	8mm dia bar @230mm C/C	Two way slab
S2	100	8mm dia bar @230mm C/C	8mm dia bar @230mm C/C	One way slab
S3	110	8mm dia bar @230mm C/C	8mm dia bar @230mm C/C	Two way slab

7. Conclusions

- Designing using Software's like STAAD Pro reduces lot of time in design work.
- Details of each and every member can be obtained using STAAD Pro.
- All the List of failed beams can be obtained and also Better Section is given by the software.
- Accuracy is improved by using software.
- Shear force and Bending moment give the every beam and column.
- In STAAD Pro design of slab and staircase as a plate element, It is design manually

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