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DESIGN AND ANALYSIS OF G+4 RESIDENTIAL BUILDING USING STAAD PRO

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Abstract: The subject of structural analysis deals with planning and designing the construction of ideal buildings. Basically, the design criteria for each project vary, depending on factors such built-up area, dynamic load, soil properties, and incoming load. With the advancement of science and technology today, STAD PRO and Auto Cad software have made it easier to analyze and design buildings. Computer-aided design (CAD) is used to design residential buildings, while STAD PRO is used to analyze the buildings. This process involves creating structural framing plans, obtaining structural model analyses, and designing the structures. Software Reduces Planning Time Requirement and Helps Civil Engineers Work Easier. The design of a multi-story residential building is the project that will be completed. Using Auto Cad software, the building plan was produced based on the available space and requirements. The STAD PRO software has been used for the analysis and design of the Super Structure, or the building frame. According to Indian standards, the residential building in the current project, G+5, will be analyzed designed for gravity and lateral loads, such as wind and earthquakes.

Key words: Design, Analysis, Staad pro software.

I. INTRODUCTION

GENERAL

Any construction project to starts with the layout planning of building and followed by design and analysis of the structure. this project involves the layout, planning, design and analysis of G+5 residential building located in ambaPuram, Vijayawada. For completing this project, we used drafting for AUTO CAD software and for analysis STAAD PRO V8i has been used.

OBJECTIVES

- To gain the knowledge of analysis of buildings components like columns, beams, slabs etc.
- drafting the layouts, and planning of building as per G.O. MS.NO.119 in AUTO CAD.

ROLE OF AUTO CAD

AutoCAD (Computer-Aided Design or drafting) is a widely used software application is launched in 1982 by Autodesk.

- AutoCAD is primarily used for creating detailed 2D and 3D drawings. Architects, engineers, and designers use AutoCAD to draft plans, schematics, and technical drawings. The software provides a precise and efficient platform for creating accurate representations of physical objects or structures.
- Architects use AutoCAD to create detailed architectural drawings, floor plans, elevations, and 3D models. The software allows architects to design and visualize buildings, analyses spatial relationships, and communicate their ideas effectively with clients and other stakeholders.
- AutoCAD is commonly employed in civil engineering for tasks such as designing infrastructure projects, including roads, bridges, and drainage systems. It aids in creating detailed site plans, profiles, and cross-sections, helping engineers plan and execute construction projects.

- AutoCAD is instrumental in the construction industry for creating detailed construction drawings and plans. It aids in project coordination, collaboration, and communication among architects, engineers, and construction teams

ROLE OF STAAD PRO V8i

STAAD Pro is a structural analysis & design computer program that was being developed by Research Engineers International (REL) at Yorba Linda, California in 1997. It supports all types of various steel, concrete, and timber design codes. Using STAAD Pro, civil engineers can design any type of structure, and later share the synchronized model data amongst the entire design team. It ensures on-time and budget-friendly completion of structures and designs related to steel, concrete, timber, aluminium, and cold-formed steel projects, irrelevant to the complexities.

- STAAD. Pro V8i is primarily used for structural analysis of various types of structures, including buildings, bridges, towers, and industrial structures. It employs a variety of analysis methods such as linear static, dynamic, and nonlinear analysis to assess the behavior of structures under different loading conditions
- The software allows engineers to design structural elements such as beams, columns, slabs, and foundations based on relevant design codes and standards. It provides tools for designing steel, concrete, timber, and other structural materials.
- STAAD. Pro V8i enables engineers to apply different types of loads to the structure, including dead loads, live loads, wind loads, and seismic loads. The software helps in evaluating the effects of these loads on the structure and determining the structural response.

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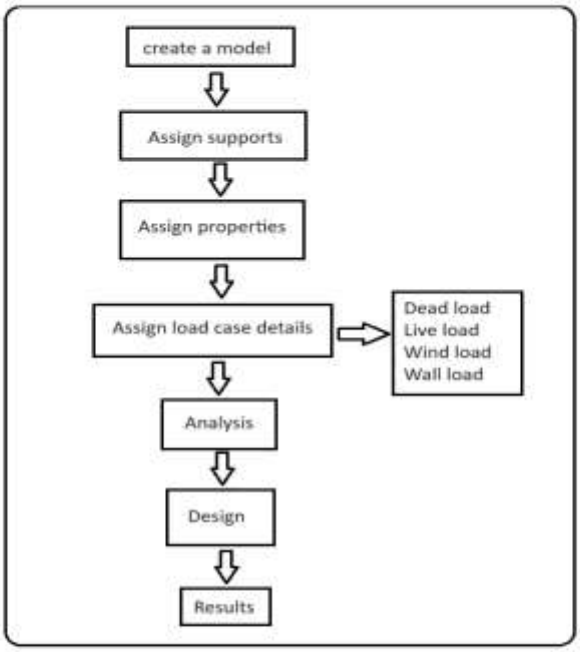
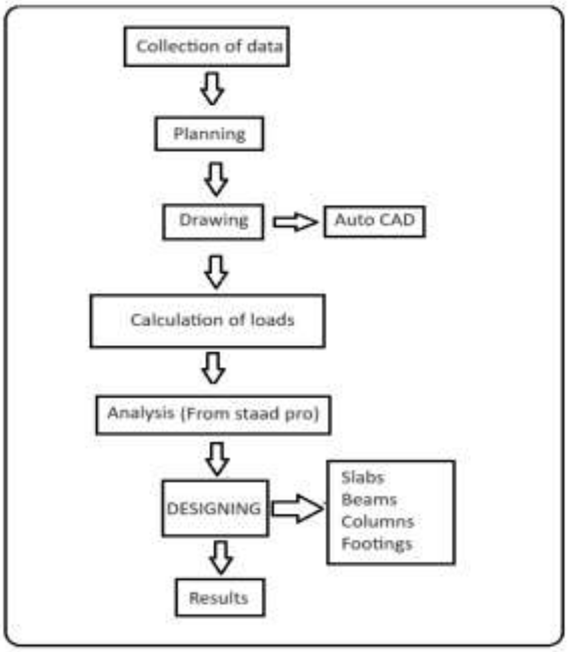
II. METHODOLOGY

The methodology is adopted to completion of following project as given below;

STAAD pro methods: -



Manual methods: -



Orientation of Building Loads:

Vertical loads	Horizontal Loads	Longitudinal Loads
Dead Load	Wind Load	Tractive Forces
Live Load	Earth Quake Load	Braking Forces
Impact Load	Seismic	Some special cases like design of Gantry Girders

Characteristic Load:

Defined as the value of that load which has 95% probability of not being exceeded during the service span of the structure

However, this requires a large amount of statistical data, since such data are not available, code recommends to take the Working loads (or) Service loads based on past experience, judgment and are taken as per IS: 875 & IS: 1893 Codes.

Design Loads:

The variation of load due to unforeseen increase in Loads, Constructional inaccuracies, type of Limit State etc., are taken into account to define Design Load.

The Design Load is given by;

Design load = Y, * Characteristic Load

(Where, - partial safety factor)

Partial Safety Factor (8,) for loads According to IS: 456-2000

Load Combinations	Limit State of Collapse			Limit State of Serviceability		
	DL	LL	WL	DL	LL	WL
DL+ LL	1.5	1.5	-	1.0	1.0	-
DL+WL	0.9(or) 1.5	-	1.5	1.0	-	1.0
DL+LL+WL	1.2	1.2	1.2	1.0	0.8	0.8

III. LAYOUT OF S+G+4 RESIDENTIAL BUILDING

DETAILS OF RESIDENTIAL BUILDING:

Number of stories: S+G+4

Number of staircases: 1

Number of lifts: 1

Type of construction: RCC framed structure

Type of wall: brick wall

Stilt floor height: 2.75m

Ground floor height:3.0m

Floor to floor height:3.0m

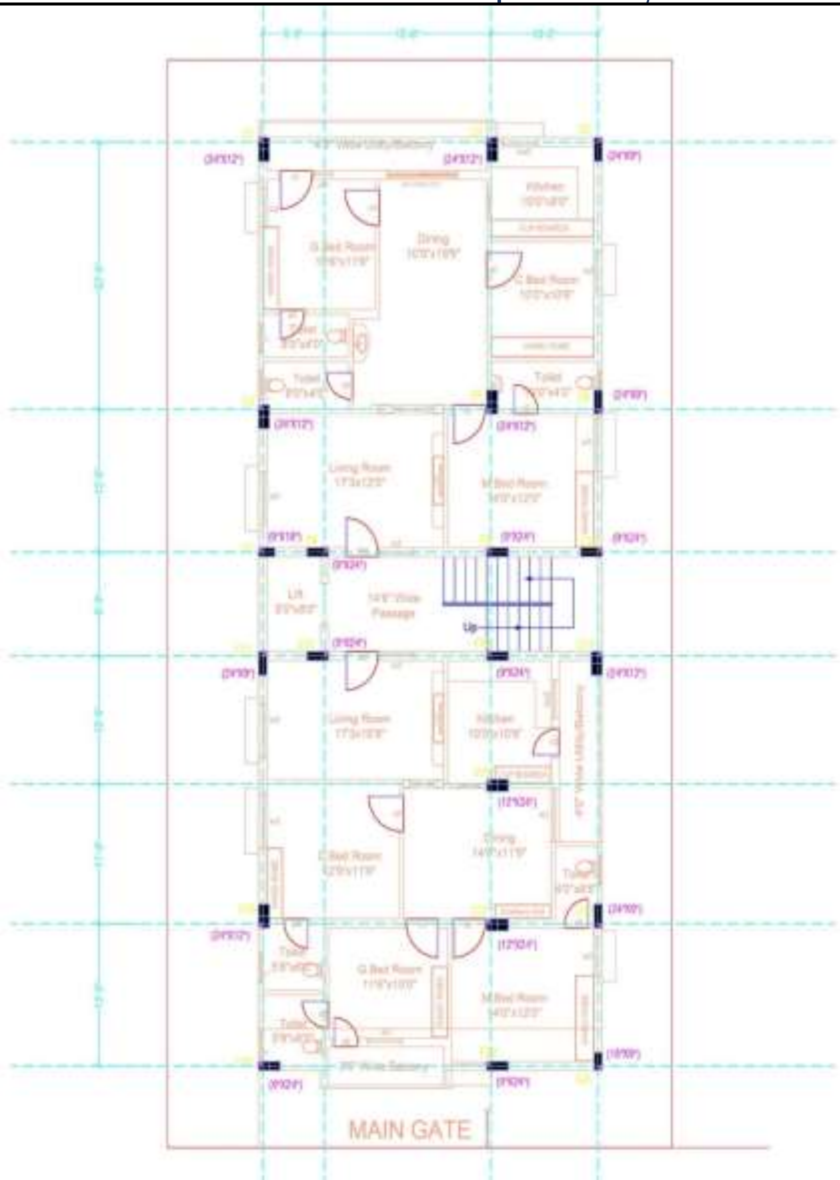
Wall: 230mm thick masonry wall for external and 115mm thickness internal walls

MATERIAL:

Grade of concrete: M20

Grade of steel: HYSD Bars Fe415 grade

Bearing capacity of soil:392KN/M.



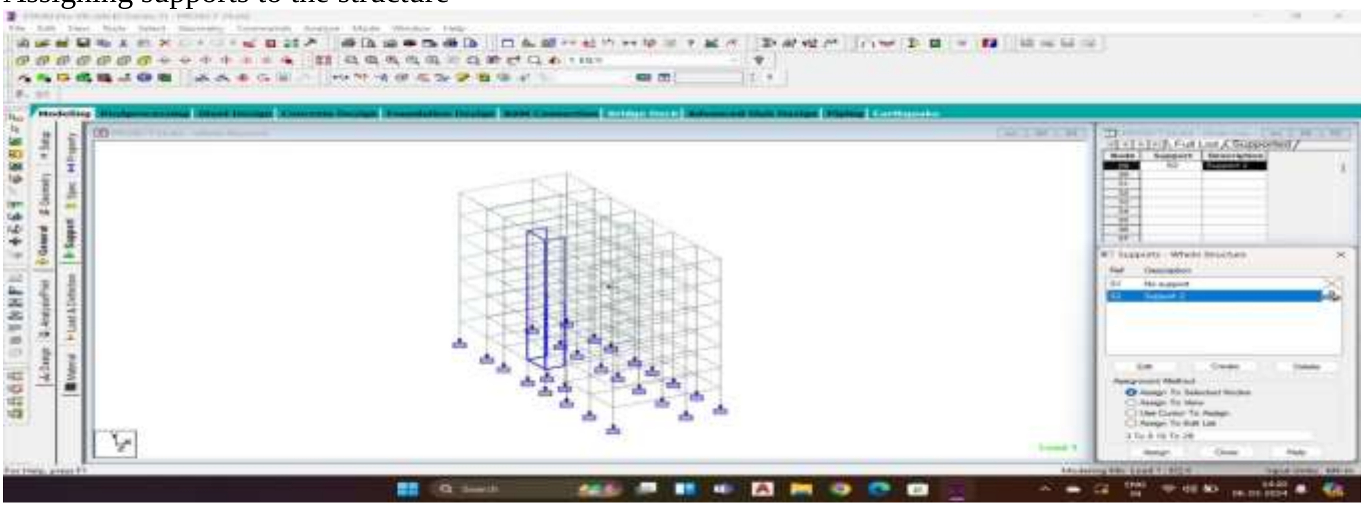
IV. ANALYSIS OF RESIDENTIAL BUILDING USING STAAD PRO SOFTWARE

General:

The layout is drawn by an AUTO CAD and imported to STAAD PRO software using DXF file format. And translation repeat tool is used to create the floors according to the plan.

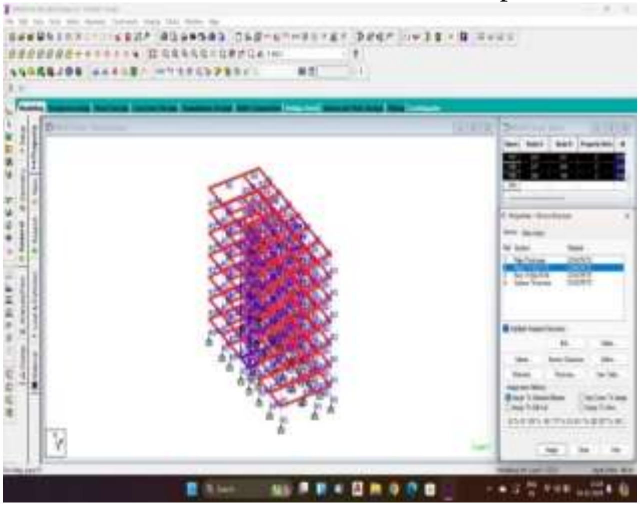
Model creating:

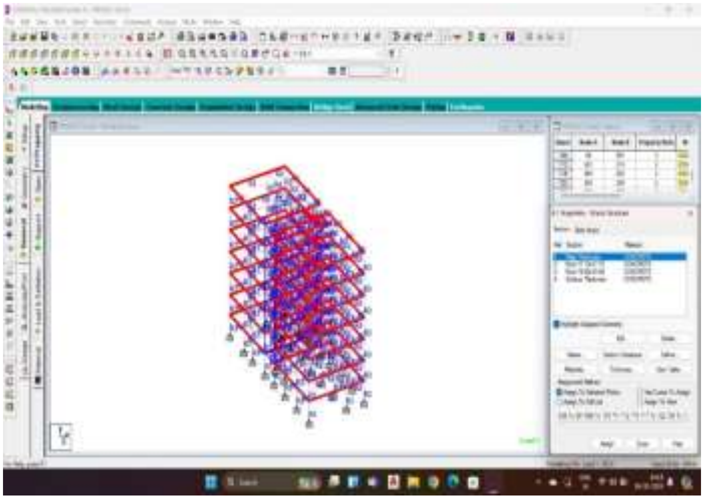
Assigning supports to the structure



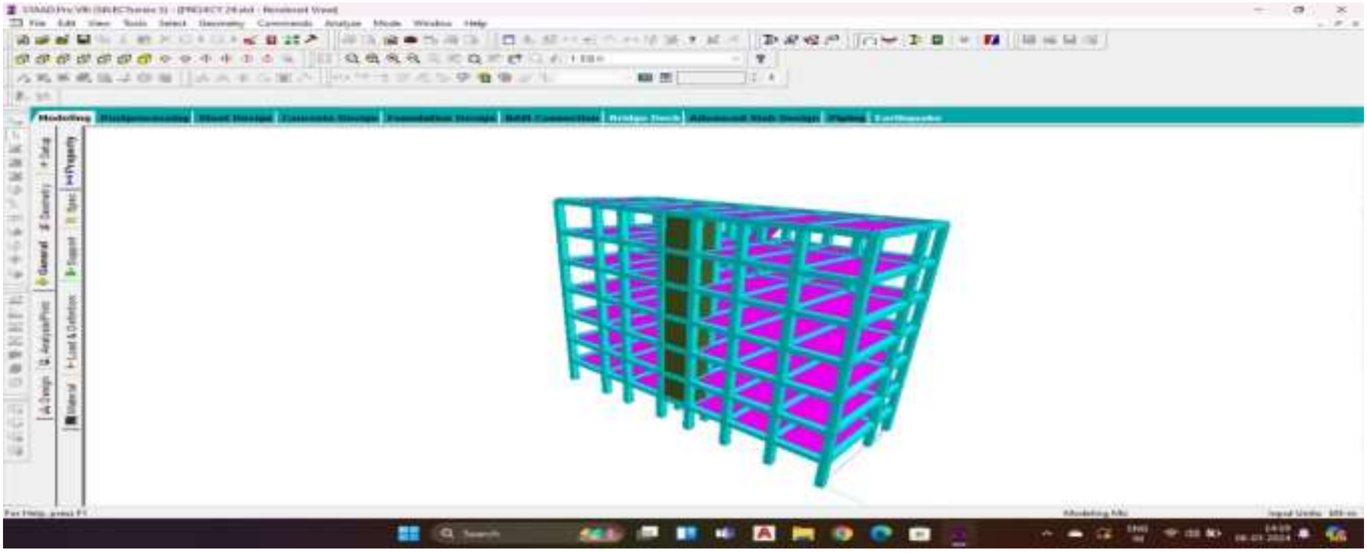
PROPERTIES:

- Assigning properties to the structure
- Beam size 0.45mx0.45m
- Column size 0.50mx0.50m
- Plate thickness 0.2m
- Surface thickness is also same as plate thickness





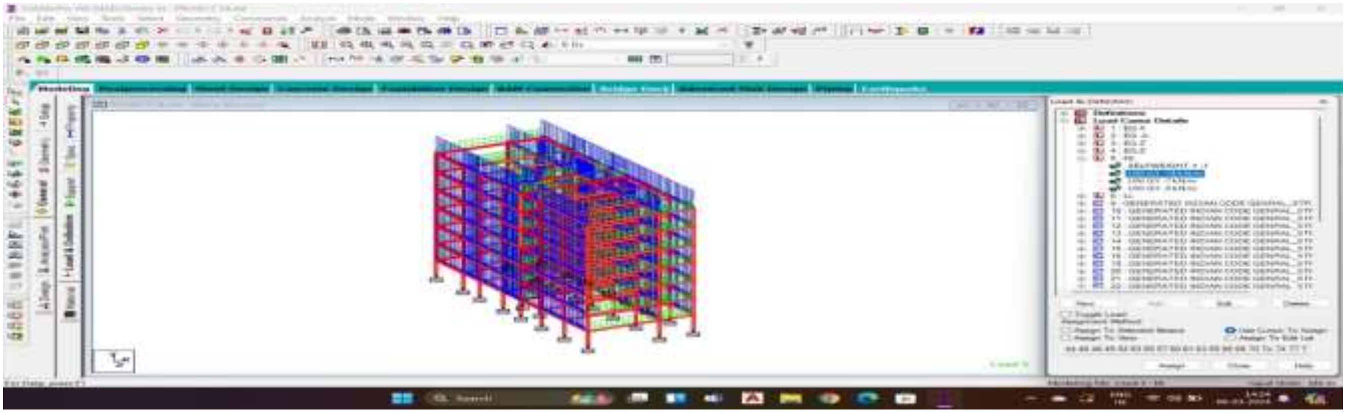
3D RENDERING VIEW:



LOADING:

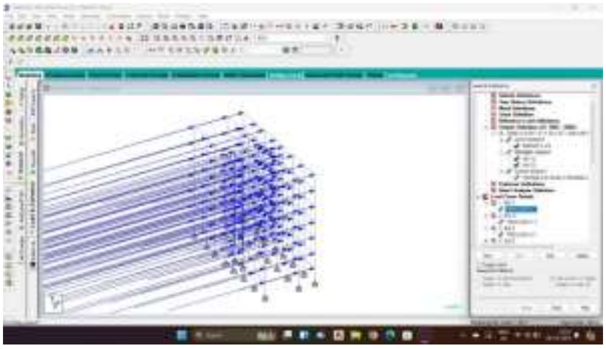
The loading will be considered in the structure

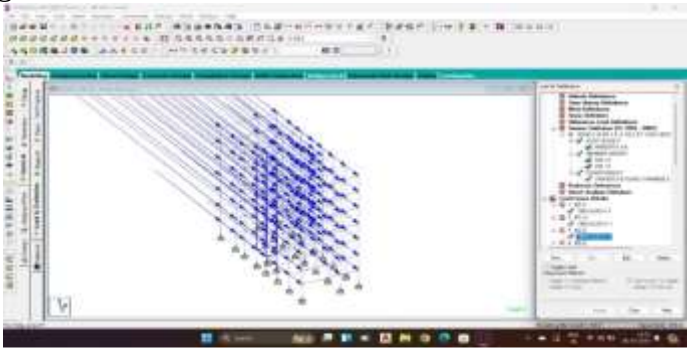
- Self-weight
- Dead load
- Live load
- Seismic load
- Load combinations



SEISMIC LOAD:

STAAD pro follows the following procedure to generate the seismic loads





LOAD COMBINATIONS:

All the load cases are tested by taking load factors and analyzing the different load combination as per IS 456 and analyzing the building for all load cases

LOAD FACTORS AS PER IS 456-2000

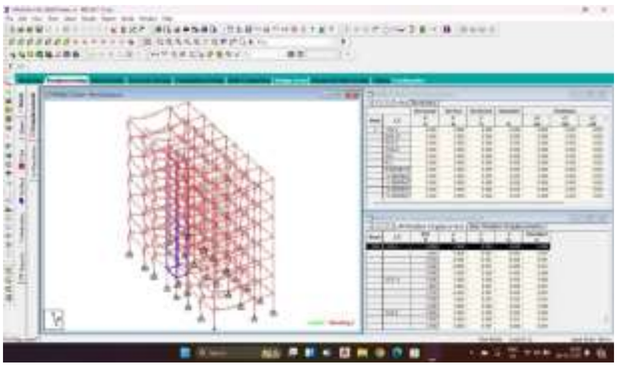
Live load	Dead load	Seismic load
1.5	1.5	0
1.2	1.2	1.2
0.9	0.9	0.9

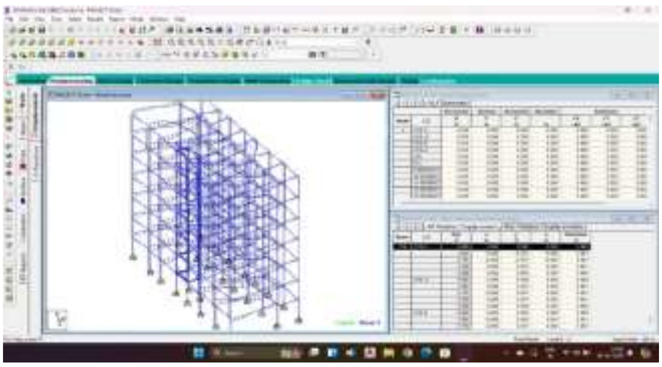
LOAD COMBINATIONS:

All the load cases are tested by taking load factors and analysing the different load combination as per IS 456 and analysing the building for all load cases

LOAD FACTORS AS PER IS 456-2000

Live load	Dead load	Seismic load
1.5	1.5	0
1.2	1.2	1.2
0.9	0.9	0.9





V. STRUCTURAL DESIGN

SLAB:

Slab is a structural element usually made up of reinforced concrete. They help in transferring the loads further to beams.

Slab design:

Size: 5m x 3.5m

Live load; 3KN/m2

Floor finish load; 1KN/m2

Adopt effective depth =125mm

Overall depth=150mm

Calculation of steel (main reinforcement)

Along shorter span direction:

Mu=0.87xfyxAstxdx(1-fyxAst/bxdxfck)
10.968x106=0.87x415xAstx125x(1-415xAst/1000x125x30)
Ast=250mm2
Using 8mm diameter bars
Spacing of bars as per clause 26.3.3
S=ast/Astx1000(50.265/250) x1000=200mm
Spacing should not be more than 3d and 300mm

- 3x125=375mm
- 300mm

Provide 8mm bars @200mmc/c
Along longer span direction:
My=0.87xfyxAstxdx(1-fyxAst/bxdxfck)
d=125-8=117mm
7.179x106=0.87x415xAstx117x(1-415xAst/1000x117x30)
Ast=173.51mm2
Using 8mm diameter bars
Spacing of bars as per clause 26.3.3
S=ast/Astx1000(50.265/173.51) x1000=290mm
Spacing should not be more than 3d and 300mm

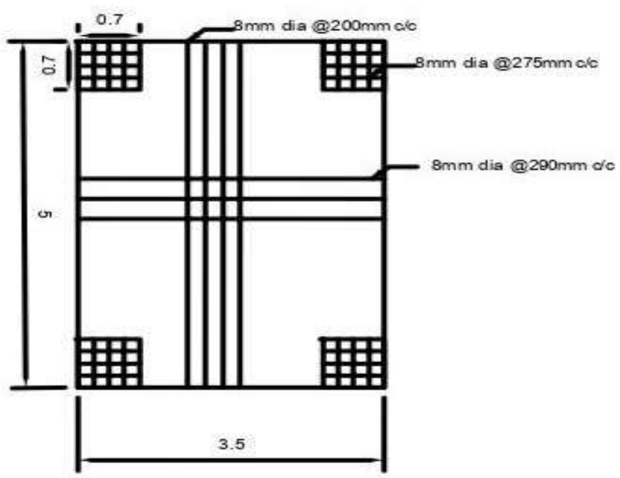
- 3x125=375mm
- 300mm

Provide 8mm bars @290mmc/c
Reinforcement in edge strip:
Ast=0.12% of gross area=0.12/100 x1000x150=180mm2
Using 8mm diameter bars
Spacing of bars as per clause 26.3.3
S=ast/Astx1000=(50.265/180)x1000=275mm
Spacing should not be more than 5d and 450mm

- 5x125=625mm
- 450mm

Provide 8mm bars @275mmc/c

Torsional Reinforcement:
Area of torsional steel (3/4) Ast
=3/4 x 250=187.5mm2

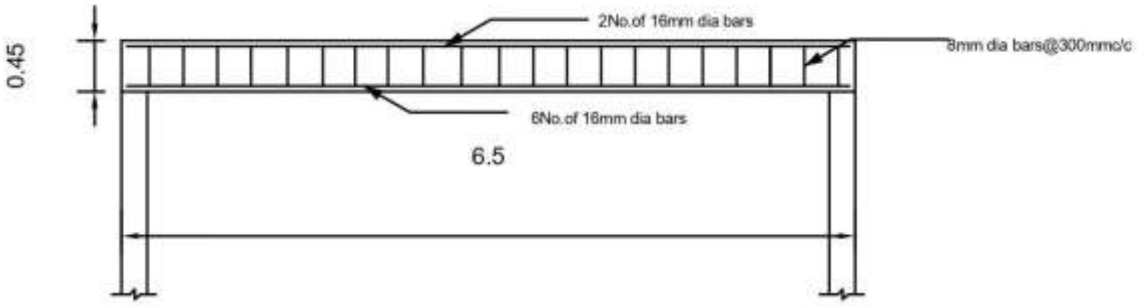


DESIGN OF BEAM:

Bam size =450mmx450mm
Length of beam =6.5m
Total load = 23KN/m
Factored load = 34.5KN/m
Calculation of bending moment and shear force:
bending moment =Wul2/8=34.5x6.52/8=182.20KN-M
shear force=WuL/2=34.5x6.5/2=112.125KN
Mu limit = 0.36x Xu max /d x (1-0.42 Xu max/d) x bd2fck
=0.36x0.48x(1-0.42x0.48) x450x4002x30
=373.24KN-m
Mu<Mu limit (singly reinforced beams)
Tension reinforcement:
Mu=0.87xfyxAstxdx(1-fyxAst/bxdxfck)
182.2x106=0.87x415xAstx400x(1-415xAst/450xx400x30)
Ast=1415.60mm2
Provide 8no of 16mm Dia bars
Ast provide=1608.49mm2
Nominal shear stress:
τv=Vu/bd
=117.125x103/450x400
= 0.623N/mm2
τc max =3.5N/mm2
τv< τc max hence it is safe
100Ast/bd=0.89
By using table number 19 of IS 456-2000 we get τc value
τc=0.629N/mm2
τv > τc (shear reinforcement has to design)
balance shear
Vus=Vu- τc bd
=112.125x103-0.62x450x400
=525KN
Two legged 8mm stirrups has been placed
Sv=0.87xFyxAsvxd/Vus
=0.87x415x50.265x400/525
=13827.3mm
Maximum allowed spacing 0.75dand 300mm

- 0.75x400=300mm
- 300mm

Hence provide two legged 8mm stirrups @300mmc/c
Check for deflection:
For simply supported beams l/d ratio=20
Modification factor steel=0.89
Fs=0.58xFyxAst required /Ast provided
=0.58x415x1415.60/1608.49
=211.83N/mm2
Maximum permitted limit = 0.89x20=17.8
l/d provided=6500/400=16.25<17.8
hence deflection is safe



DESIGN OF COLUMN:

Size of column =500x500mm
Length =3m
Factored load =3855.85KN

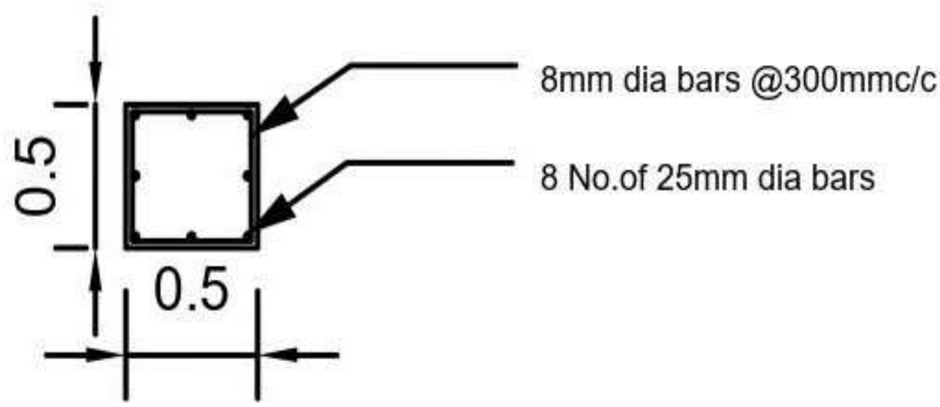
Slenderness ratio:
Slenderness ratio=l/d=3000/500=6<12
Hence it is short column
Verification of eccentricity:
emin=L/500+d/30
=3000/500+500/30
=22.66>20
It should not less than 0.05times of lateral dimension
0.05xd=0.05x500=25>emin
As per clause 39.3 of IS 456-2000

Calculation of longitudinal reinforcement:
Pu=0.4xFckxAc+0.67xFyxAsc
Ag=Ac+ Asc
Ac= Ag- Asc
3.855.85x103=0.45x30x (500x500- Asc) +0.67x415x Asc
Asc=3079.37mm2
Provide 8 No. of 25mm diameter bars
The area of reinforcement is more than minimum steel requirement
Of 0.8% of gross area
=0.8/100 x500x500
=2000mm2

Calculation of pitch and diameter:

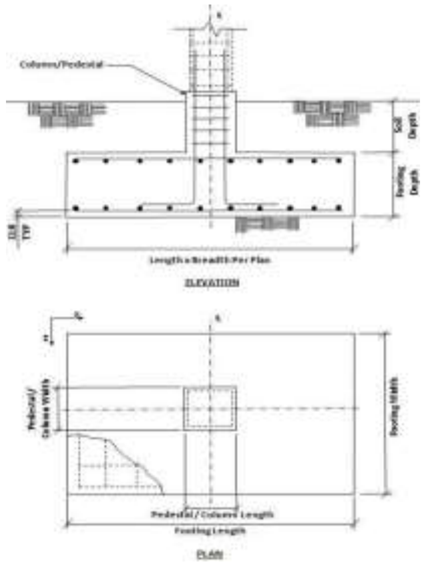
- **Pitch**
  Least lateral dimension=500mm
  Sixteen times of diameter=16x25=400mm
  300mm
- **Diameter**
  One-fourth times of diameter= ¼ x25=6.25mm
  8mm

Provide 8mm Dia bars@ 300mmc/c



FOOTING:

Foundations are structural elements that transfer loads from the building or individual column to the earth If these loads are to be properly transmitted, foundations must be designed to prevent excessive settlement or rotation, to minimize differential settlement and to provide adequate safety against sliding and overturning.



VI. CONCLUSIONS

From the all observations, i here conclude that

- deigning using software like STAAD pro reduces time of designing compare to manual design
- detailing of each component member will be obtained by Staad Pro
- in case of any failures occurs it gives the errors and its simply rectified by changing the properties
- accuracy is improved by software
- it gives the concrete designing by each member as per IS 456

We can conclude that there is difference between the theoretical and practical work done. As the scope of understanding will be much more when practical work is done. We get more knowledge in such a situation, where we have great experience doing the practical work**.**

VII. REFERENCES

REFERENCES:

- design of reinforced concrete structures -N. SUBRAMANIAN
- reinforced concrete structures-Dr.I.C. SYAL

CODES:

- IS 456-2000Code of Practice for Plain & Reinforced Concrete
- IS 875 PART-1 Code of practice for DEAD LOADS
- IS 875 PART-II Code of practice for LIVE LOADS
- IS 1893-2002 code of practice for SEISMIC LOADS