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Planning , Analyzing and Designing of Staff Quaters Building By Using STAAD Pro

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Abstract

Planning analysis and designing of staff quarters Building is our project which is proposed at Salem. The staff quarters building consists of Bed room, Kitchen, Hall , Garden ,Car parking , Rest room .Drafting method for design the plan is by AutoCAD. The framed type of construction is used for the construction and the designing of structure is carried out by limit state method with the IS 456: 2000 code book. The plan and structural elements are designed using STAAD Pro and the reinforced details have been obtained slabs and foundation has been designed using STAAD Pro etc. This project helps us in exploring knowledge about planning analyzing and designing of a staff quarters building.

Keywords: Planning, Designing, Building and Staff quarters.

1. INTRODUCTION

Staff quarters are those parts of a building, traditionally in a private house, which contain the domestic offices and staff accommodation. From the late 17th century until the late 19th/early 20th century they were a common feature in many large houses. Sometimes they are an integral part of a smaller house - in the basements and attics, especially in a town house, while in larger houses they are often a purpose-built adjacent wing or block. In architectural descriptions and guide books of stately homes the servants' quarters are frequently overlooked, yet they form an important piece of social history, often as interesting as the principal part of the house itself. Before the late 17th century, servants dined, slept and worked in the main part of the house with their employers, sleeping wherever space was available. The principal reception room of a house often known as the great hall would have been completely communal regardless of hierarchy within the household.

2. SPECIFICATIONS

2.1 Foundation

Earth work excavation for foundation for all column footings will be excavated and will be in cement concrete 1:1:2 mixes, 1828mm wide and7314mm thick laid at 2743mm below ground level. The masonry footings will be in brickwork in cement mortar 1:6. The footing size is 9662x6431mm.

2.2 Basement

The basement will be in 1st class brick work in cement mortar 1:5, and 450mm thick above ground level for all walls. The basement will be filled with clean sand to a depth of 300mm. A damp proof course in cement mortar 1:3, 20 thick will be provided for all walls at basement level. The basement will be constructed by using Random Rubble masonry with cement mortar 1:5.

2.3 Sand Filling in Basement

The basement filled up with clean sand to a depth of 710mm and it should be compacted with water as per standard specifications.

2.4 Damp Proof Course

A Damp proof course using cement mortar 1:3 of 150mm thick will be Provide forallmain walls at basement level

2.5 Flooring Concrete

The flooring concrete of 1:1:2 mix with suitable thick will be provided should be finished above the sand filling and it by mosaic tiles.

2.6 Super Structure

All the walls will be in I class brick work in cement mortar 1:5, using first class bricks, and 300mm thick. The partition walls will be 100mm thick in brick work in cement mortar 1:5, using first class brick. The height of all walls will be 3000mm above floor level. All the walls including basement will be plastered smooth with cement mortar 1:4 externally and 1:6 internally for 12.5 thick. Parapet walls 230mm thick and 1m high will be provided all around.

2.7 Roofing

The roofing will be of R.C.C 1:1:2 mix, 150mm thick flat slabs over all the rooms. A weathering course in brick jelly lime concrete plastered with combination mortar 1:1:2 mix, 75mm thick will be provided over the slab.

2.8 Plastering For Super Structure

All walls will be plastered smooth surface with cement Mortar 1:5, 12 mm thick.

2.9 Sound Proofing For Ceiling & Wall

In ceiling of all rooms and walls are soundproofed with latest type soundproofing material.

2.10 Weathering Course

A Weathering course using brick jelly concrete will be provided average 75 mm thick over the slab and finished with two course of hydraulic pressed Mangalore flat tiles using cement mortar 1:5 mixed with 10% of crude Oil.

2.11 Size Of All Doors, Windows And Ventilators

MD - MAIN DOOR =1800 x 2400 mm
D_1 - DOOR =1600 x 2100 mm
D_2 - DOOR =1500 x 1800 mm
W_1 - WINDOW = 900 X 1350 mm
V - VENTILATOR =700x700mm

2.12 White Washing

One primer coat and two coats of colour wash to be done for all plastered wall surface.

2.13 Steps

The step will be in brick work in cement mortar 1:5,

Rise =150mm
Tread = 200mm

3. STRUCTURAL DESIGN

3.1 Design of Slab

fck = 25 N/mm^2
fy = 415 N/mm^2
Room size = 5 x 5 m
Support = 230 mm
Thickness of slab =150 mm

3.1.1 Type of Slab

ly /lx = 5/5 = 1>2

Hence designed as two way slab

3.1.2 Load Calculation

Consider 1m width of slab

Live load = 2 KN/m^2

Self -weight of slab = 1 x b x D x unit weight

=1 x 1 x 0.15 x 25

= 3.75 KN/m^2

Weight of floor finish =1x 1 x 0.05 x 20= 1.0 KN/m^2

Total load = 6.75 KN/m

Design load = 6.75 x 1.5 = 10.125 KN/m

3.1.3 Main Reinforcement

M_x = 0.87 fy A_{st} d (1- fyA_{st} / fckbd)

12.52×10^6 = 0.87 x 415 x A_{st} x 130 (1- 415 x A_{st} / 25 x 1000 x 130)

$5.99A_{st}^2 - 46.93 \times 10^3 A_{st} + 48 \times 10^6 = 0$

A_{st} min = 276.54 mm^2

3.1.4 Spacing

Assume 10 mm dia bars

S = ast/A_{st} x b = 78.54/1209.52 x 1000 = 290 mm

3d = 3 x 180= 390 mm

300 mm c/c

Provide 10 mm dia bars @ spacing 290 mm c/c distance.

3.1.5 Distributor Reinforcement

A_{st} min = 0.12 / 100 x B x D

= 0.12 /100 x 1000 x 150

= 180 mm^2

3.1.6 Spacing

Assume 8mm dia of distribution steel

S = ast /A_{st}min x b = (50.26/180) x 1000

= 280 mm

5d = 5 x 150 = 650 mm

450 mm

Provide 8 mm dia bars @ spacing 280 mm c/c

Figure 1 shows the Reinforcement detail of one way slab.

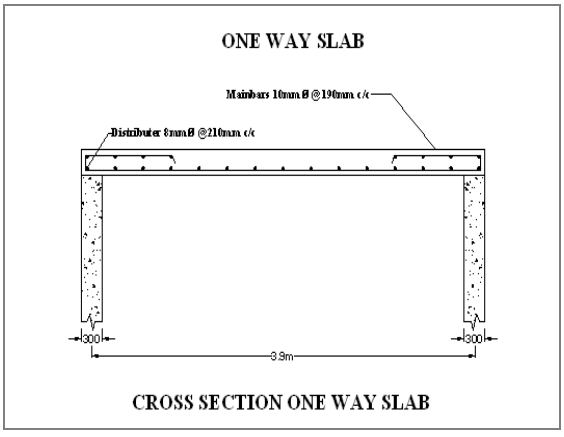

Figure 1 Reinforcement Detail of one way slab

3.2 Design of Beams

Center to center distance l_{eff} = 5.23 m

B =230mm

D =340 mm

D =300mm (assumption)
fy =415N/mm^2
fck =25N/mm^2
Q =3.45
%Ast =1.197%

3.2.1 Load Calculation

Self-weight of beam =b x D x unit Weight
=0.23x0.34x 25= 1.955 KN/m
Slab floor finish 1 = perpendicular distance x tk x unit Weight
= 2.5 x 0.05 x 20 = 2.5 KN/m
Slab self Weight1 = 2.5 x 0.15 x 25 = 9.375KN/m
Wall load =0.23 x 3 x 19 = 13.11 KN/m
Total load =27 KN/M
Factored load = 27 x 1.5 F_d= 40.5KN/m

3.2.2 Type of Section

M_{ulim} =$Q_u bd^2$=3.45 x 230 x 440^2
M_{ulim} =153.62×10^6 N.mm
M_{ulim}<Mu
Hence the section shall be designed as singly reinforced section.

3.2.3 Area of Reinforcement

Mu =0.87 fyAst (d-fyAst/fck×b)
138.47×10^6 =0.87×415×A_{st} x 400 (1-415A_{st}/25 x 230×400)
26.05 A_{st}^2-144.42 x 10^3A_{st}+138.47 x 10^6 =0
A_{st} = 1233.04 mm^2

Provide 2 legged 8 mm dia stirrups @ 250mm c/c.
Figure 2 shows the Reinforcement detail of beam.

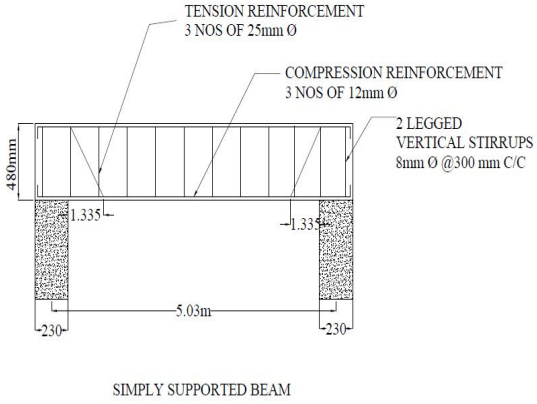

Figure 2 Reinforcement detail of beam

3.3 Design of Square Column

Size of column = 230 X 230 mm
fck = 25 N/mm^2
fy = 415 N/mm^2

3.3.1 Load Calculation

3.3.1.1 Slab

Weight of slab (1) = L x B x D x unit Weight
= 2.5 x 2.5 x 0.15 x 25 = 23.43 KN

Weight of slab ff (1) = L x B x D x unit Weight
= 2.5 x 2.5 x 0.05 x 20 = 6.25 KN
Live load (1) = 2.5 x 2.5 x 2.0 = 12.5 KN
Weight of slab (2) = L x B x D x unit Weight
= 1.5 x 2.5 x 0.15 x 25 = 14.06 KN
Weight of slab ff (2) = L x B x D x unit Weight
= 1.5 x 2.5 x 0.05 x 20 = 3.75 KN
Live load (2) = 1.5 x 2.5 x 2.0 = 7.5 KN

3.3.1.2 Beam

Beam (1) = L x B x D x unit Weight
= 2.5 x 0.23 x 0.44 x 25 = 6.33 KN
Beam (2) = 2.5 x 0.23 x 0.44 x 25 = 6.33 KN

3.3.1.3 Wall

Wall load (1) = L x B x H x unit Weight
= 3.75 x 0.23 x 3 x 19 = 49 KN
Wall load (2) = 3 x 0.23 x 3 x 19 = 39.33 KN
Wall load (2) = 2.15 x 0.23 x 3 x 19 = 28.18 KN

3.3.1.4 Column

Self weight of column = L x B x H x unit Weight
= 0.23 x 0.23 x 3 x 25 = 3.96 KN
Sum of all above loads = 210KN
No of floor consideration = 210 x 2.0 = 420 KN

3.3.1.5 Result

Size of column = 230 x 230 mm
Longitudinal reinforcement = 6nos of 12mm dia bars
Transverse reinforcement = 6mm dia at 195 mm c/c

Figure 3 shows the Reinforcement detail of R.C.C. Column.

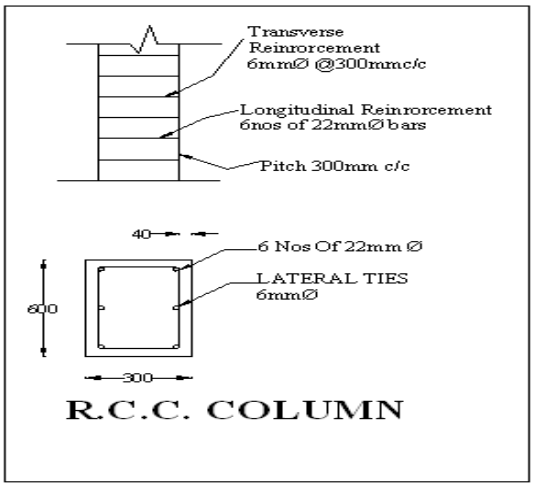

Figure 3 Reinforcement detail of R.C.C. Column

3.4 Design of Footing

Size of column = 230 x 230 mm
Safe bearing capacity = 50 KN/m^2
fck = 30 N/mm^2
fy = 415 N/mm^2

Axial load of footing = 420 KN

Assume the self Weight of footing as10%of the column load

W1 =10/100 x 420 = 42 KN

Total load on soil =420+42 =470 KN

Area of footing required = total load /sbc

= 470 / 150

= 3.13 m^2

Since it is a Square column

3.4.1 Tension Reinforcement

M_{UL} = 0.87 fy A_{st} d (1- fyA_{st} / fckbd)

496.75 x 10^6 = 0.87 x 415 x A_{st} x 520 (1- 415 x A_{st} / 30 x 1800 x 520)

2.17A_{st}^2 – 187.74 x $10^3 A_{st}$ + 496.75x 10^6 = 0

= 2758.20 mm^2

Provide 16 nos of 10 mm dia bars in long direction at uniform spacing

Figure 4 shows the reinforcement details of footing.

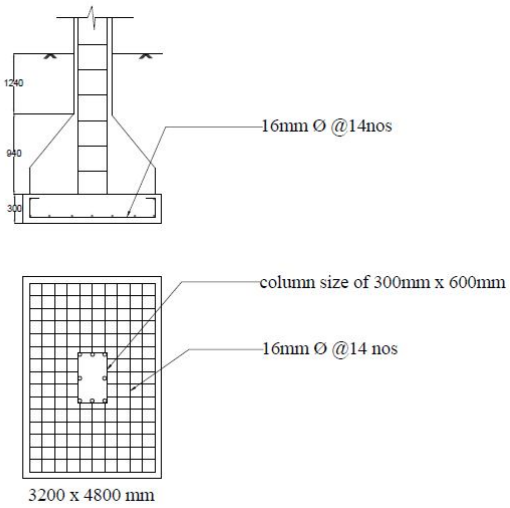

Figure 4 Reinforcement detail of footing

4. STAAD REPORT

Figure 5 shows the whole structure of the building.

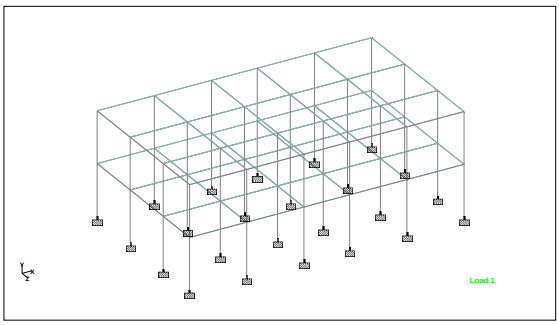

Figure 5 Whole Structure

Figure 6 shows the 3D Rendering view.

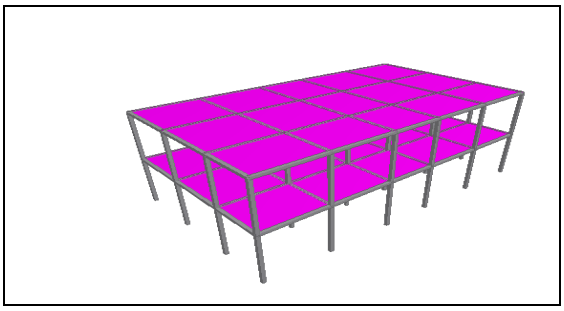

Figure 6 3D Rendered view

Figure 7 shows the Bending moment diagram.

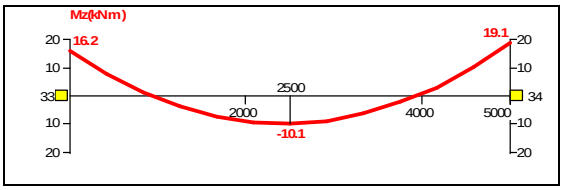

Figure 7 Bending Moment diagram

Figure 8 shows the shear force diagram.

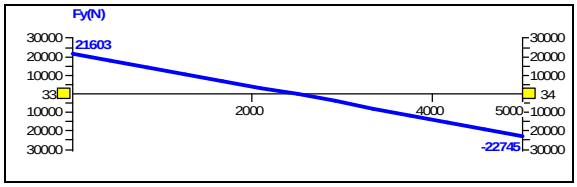

Figure 8 Shear Force Diagram

Figure 9 shows the Maximum bending moment at Critical Beam.

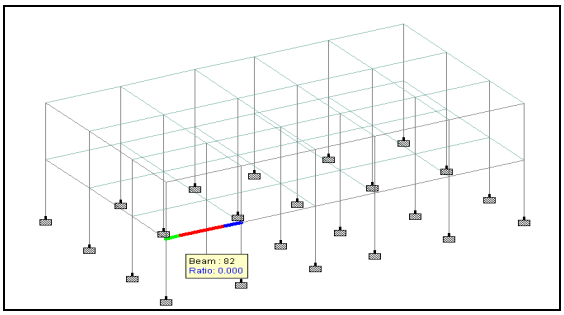

Figure 9 Maximum Bending moment at Critical Beam

4.1 B E A M N O. 297 D E S I G N

M25 Fe415 (Main) Fe415 (Sec.)

LENGTH: 5000.0 mm SIZE: 230.0 mm X 230.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	1250.0 mm	2500.0 mm	3750.0 mm	5000.0 mm
TOP REINF.	253.20 (Sq. mm)	0.00 (Sq. mm)	0.00 (Sq. mm)	0.00 (Sq. mm)	303.70 (Sq. mm)

BOTTOM 0.00 92.80 151.21 92.80 0.00
REINF. (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION 0.0 mm 1250.0 mm 2500.0 mm 3750.0 mm 5000.0 mm

TOP 2-16í 2-16í2-16í2-16í2-16í
REINF. 1 layer(s) 1 layer(s) 1 layer(s) 1 layer(s) 1 layer(s)

BOTTOM 2-16í 2-16í2-16í2-16í2-16í
REINF. 1 layer(s) 1 layer(s) 1 layer(s) 1 layer(s) 1 layer(s)

SHEAR 2 legged 8í 2 legged 8í 2 legged 8í 2 legged 8í 2 legged 8í
REINF. @ 80 mm c/c @ 80 mm c/c @ 80 mm c/c @ 80 mm c/c @ 80 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM

SHEAR DESIGN RESULTS AT 310.0 mm AWAY FROM START SUPPORT
VY = 18.85 MX = 0.08 LD= 1

Figure 10 shows the Reinforcement details for beam.

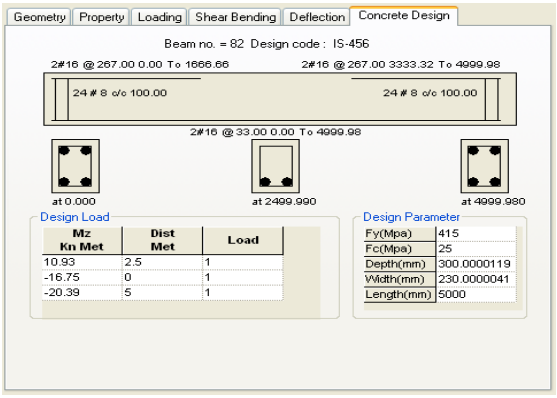

Figure 10 Reinforcement Details for Beam

Figure 11 shows the Maximum Bending moment at critical column.

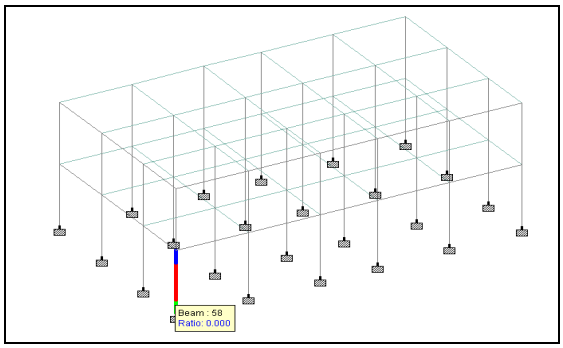

Figure 11 Maximum Bending moment at Critical Column

4.2 C O L U M N No. 398 D E S I G N R E S U L T S

M25 Fe415 (Main) Fe415 (Sec.)
LENGTH: 5000.0 mm CROSS SECTION: 230.0 mm X 300.0 mm COVER: 40.0 mm

** GUIDING LOAD CASE: 1 BRACED LONG COLUMN
REQD. STEEL AREA : 248.42 Sq.mm.
REQD. CONCRETE AREA: 68751.59 Sq.mm.
MAIN REINFORCEMENT : Provide 4 - 16 dia. (1.17%, 804.25 Sq.mm.)
(Equally distributed)
TIE REINFORCEMENT : Provide 8 mm dia. rectangular ties @ 230 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)

Puz : 850.78 Muz1 : 28.01 Muy1 : 20.83

INTERACTION RATIO: 1.00 (as per Cl. 39.6, IS456:2000)

Figure 12 shows the Reinforcement details for column.

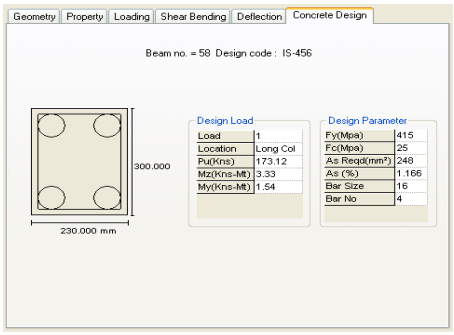

Figure 12 Reinforcement Details for Column

4.2 Concrete Take off

(FOR BEAMS AND COLUMNS DESIGNED ABOVE)

TOTAL VOLUME OF CONCRETE = 41.40 CU.METER

BAR DIA (in mm)	WEIGHT (in New)
8	14703.13
16	38398.60
20	2902.56
25	1511.89
TOTAL	57516.18

5. DRAWING

Figure 13 shows the blue print of the building.

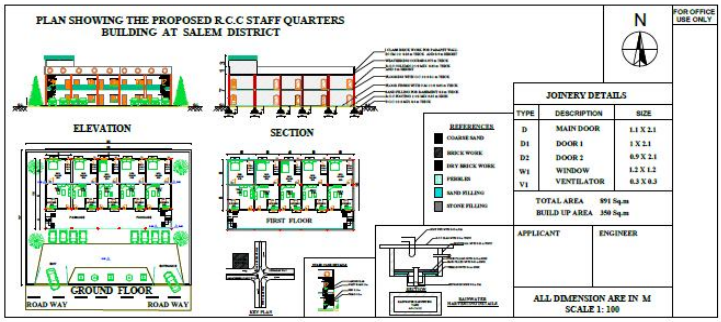

Figure 13 Blue print

6. CONCLUSION

Our study concluded that application of software in Civil industry plays important role in our study. Staff quarters are essential and very important for the staffs working nearby industry .The structure is designed as a framed structure for the purpose of extending floors time taken for doing this project is very less due to the application of the software and this software is quite good and comprehensive for further study of structural parameter.

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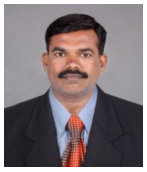

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