Planning , Analyzing and Designing of College Building by Using STAAD Pro

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ABSTRACT

Planning analysis and designing of College Building is our project which is to propose at Salem. The College building consists of a In ground floor Civil dept., laboratories, Mechanical dept., laboratories, Staff rooms for civil & mechanical staffs, Auditorium, Canteen for girls & boys. In first floor, Class rooms for civil & mechanical departments ,Dining hall, In second floor, CS dept., laboratories, IT dept., laboratories, ECE dept., laboratories, EEE dept., laboratories, Library. In third floor, Class rooms for CS&IT departments, Staff rooms for CS & IT departments. In fourth floor, Class rooms for ECE&EEE departments, Staff rooms for ECE & EEE departments. In fifth floor, Conference hall, Seminar hall. Medical room for girls & boys .Drafting method for design the plan is by Auto cad. 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 analysis is carried out by using limit state method. The plan and structural elements are designed using limit state method STAAD Pro and the reinforced detail has been obtained slabs and foundation has been designed using STAA Pro. This project helps us in exploring knowledge about planning analyzing and designing a College building.

Keywords: Planning, Analysis, Designing and Departments.

1. INTRODUCTION

Colleges touch all aspects of civilization. Great works of humankind, from the construction of the pyramids to the creation of the internet, are marvels of college. College is an evolving discipline that reinvents itself to explore and create solutions to new problems. Thus, while strategic planning is important for any organization, it is critical for an college where its role is two-fold: leadership in creating revolutionary technological advances through scientific discovery; and education of students who will have a significant positive impact on society.

2. STRUCTURAL DESIGN

2.1 Design Of Slab

fck = 25 N/mm^2
fy = 415 N/mm^2
Room size = 6.0 x 5.8m
Support = 300 mm
Thickness of slab =200mm

2.1.1 Type of Slab

ly /lx = 6/5.8 = 1.03< 2

Hence designed as two way slab

2.1.2 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 0.20 x 25
= 5 KN/m^2
Weight of floor finish =1x 1 x 0.05 x 20= 1.0 KN/m^2
Total load = 8 KN/m
Design load = 8 x 1.5 = **12 KN/m**

2.1.3 For Shorter Span, (Max Mom In Shorter Span)

M_x = 0.87 fy A_{st} d (1- fyA_{st} / fckbd)
20.60 x 10^6 = 0.87 x 415 x A_{st} x 180 (1- 415 x A_{st} / 25 x 1000 x 180)
$5.99A_{st}^2 – 64.98x10^3A_{st} + 20.60x10^6 = 0$
A_{st} min = 326.87 mm^2

2.1.4 Spacing

Assume 10 mm dia bars
- S = ast/A_{st} x b = 78.54/326.87 x 1000 = 240 mm
- 3d = 3 x 180= 540 mm
- 300 mm c/c

Provide 10 mm dia bars @ spacing 240 mm c/c distance.
Figure 1 shows the Cross section of two way slab

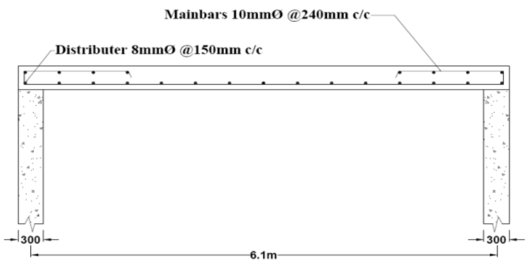


Figure 1 Cross section of Two way slab

2.2 Design of Beams

fck = 25 N/mm^2
fy = 415 N/mm^2
Clear Room size = 14.3 x 6m
Support = 300 mm
Thickness of slab D =200mm

2.2.1 Type Of Slab

ly /lx = 14.3/6
= 2.38>2

Hence designed as one way slab

2.2.2 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 0.20 x 25
= 5 KN/m^2
Weight of floor finish =1x 1 x 0.05 x 20
= 1.0 KN/m^2
Total load = 8 KN/m
Design load = 8.0 x 1.5 = 12 KN/m

2.2.3 Main Reinforcement

M_x = 0.87 fyA_{st} d (1- fyA_{st} / fckbd)
$57.28x\ 10^6$ = 0.87 x 415 x A_{st} x 180 (1- 415 x A_{st} / 25 x 1000 x 180)
$5.99A_{st}^2 – 64.98x10^3 A_{st} + 57.28x10^6 = 0$
A_{st}min = 967.85 mm^2

2.2.4 Spacing

Assume 10 mm dia bars

- S = ast/A_{st} x b = 78.54/967.85 x 1000
  = 90 mm
- 3d = 3 x 180= 540 mm
- 300 mm c/c

Provide 10 mm dia bars @ spacing 90 mm c/c distance.

2.2.5 Check For Deflection

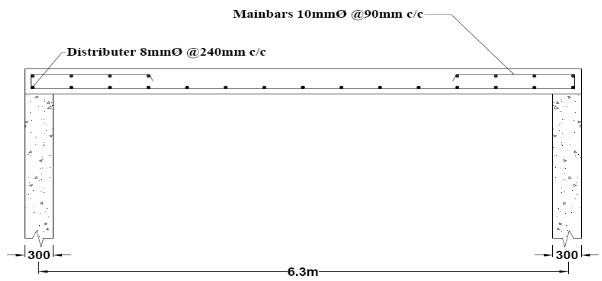
Assume 10mm dia

Ast_{pro} = (ast/s) x b=(78.54/90) x 1000
= 872.67mm^2
% of steel = 100A_{st}/bd
= 100 x 872.67 /1000 x 180
= 0.48 %
Fs = 0.58 x $fyAst_{req}/Ast_{pro}$
= 0.58 x 415 x **967.85**/872.67
= 290
M.F = 1.15 (by using 290 curve in graph)
davi = span/(B_V x MF)
= 6180/32 x 1.15 = 160mm

dreq< d pro

Hence design is safe

Figure 3 shows the cross section of one way slab.



CROSS SECTION ONE WAY SLAB

Figure 3 Cross section of one way slab

2.3 Simply Supported Roof Beam

2.3.1 Available Data

Center to center distance l_{eff} = 6.30m
B = 300mm
D = 600mm
D = 560mm (assumption)
Fy = 415N/mm^2
Fck = 25N/mm^2
Q = 3.45
%Ast = 1.197%

2.3.2 Load Calculation

Self weight of beam = b x D x unit Weight
=0.30x 0.34x 25=2.55 KN/m
Slab floor finish 1 = perpendicular distance x thickness x unit weight
=2.9 x 0.05 x 20=2.9 KN/m
Slab self Weight1 =2.9 x 0.20 x 25=14.5KN/m
Wall load =0.30 x 4.5 x 19=25.65 KN/m
Total load =46 KN/M
Factored load =46 x 1.5
F_d =69KN/m

2.3.3 Size of Beam

Equating Mu =Mulim
M_u = $Q_u bd^2$ (b=2/3d)
D = $(3 \text{ x Mu}/2 \text{ x Qu})^{1/3}$
= $(3 \text{ x } 342.32 \text{ x } 10^6/(2 \text{ x } 3.45))^{1/3}$
D = 530 mm
D = 530mm<560 mm Hence safe
D =600mm
Adopt greater value for further design

2.3.4 Area Of Reinforcement

Mu = 0.87 fyAst (d-fyAst/fck×b)
342.32×10^6 = 0.87×415×Astx560(1-415Ast/25 x 300×560)
$19.97AST^2-202.18X10^3AST+342.320X10^6= 0$
Ast = $2149.52mm^2$

2.3.5 Check For Stiffness

%Ast @ mid span = 2280.84x100 / 300x560
= 1.35%
Stress in tension reinforcement ,
Fs = 0.58 Fy(Astreq/Astpro)
MF = 0.95 (From pg no 1.52)
D = 6300/32x0.95
= 280mm<560mm
Hence it is safe

Figure 4 shows the Simply supported roof beam.

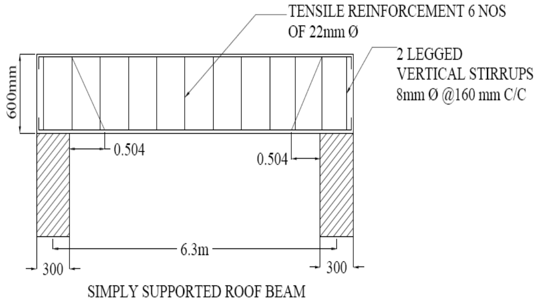


Figure 4 Simply supported Roof Beam

2.4 Design of Square Column

2.4.1 Available Data

Size of column = 450 X 450mm
fck = 25 N/mm^2
fy = 415 N/mm^2

2.4.2 Load Calculation

2.4.2.1 Slab

Weight of slab1 = L x B x D x unit Weight
=3.0 x 2.9 x 0.20 x 25 = 43.5 KN
Weight of slab ff 1 = L x B x D x unit Weight
= 3.0 x 2.9 x 0.05 x 20 = 8.7 KN
Live load 1 = 3.0 x 2.9 x 2.0 = 17.4 KN

2.4.2.2 Beam

Beam (1) = L x B x D x unit Weight
= 2.9 x 0.3 x 0.6 x 25 = 13.05 KN
Beam (2) = 3.0 x 0.3 x 0.6 x 25 = 13.5 KN

2.4.2.3 Wall

Wall load (1) = L x B x H x unit Weight
= 2.9 x 0.3 x 4.5 x 19 = 74.38 KN
Wall load (2) = 3.0 x 0.3 x 4.5 x 1= 76.95 KN

2.4.2.4 Column

Self weight of column = L x B x H x unit Weight
= 0.45 x 0.45 x 4.5 x 25=22.78 KN
Sum of all above loads = 263.72 KN
No of floor consideration = 270 x 5= 1350 KN
Say W = 1350 KN

2.4.2.5 Transverse Reinforcement

2.4.2.6 Minimum Diameter

1/4 x dia = 1/4 x 22 = 5.5mm
Not less than 6mm

2.4.2.7 Pitch

LLD = 450 mm
16 x 22 = 352 mm
300mm
Provide 6mm dia laterals at 300mm c/c

2.4.2.8 Result

Size of column = 450 x 450 mm
Longitudinal reinforcement = 6nos of 22mm dia bars
Transverse reinforcement = 6mm dia at 300 mm c/c
Figure 5 shows the Reinforcement of R.C.C square column

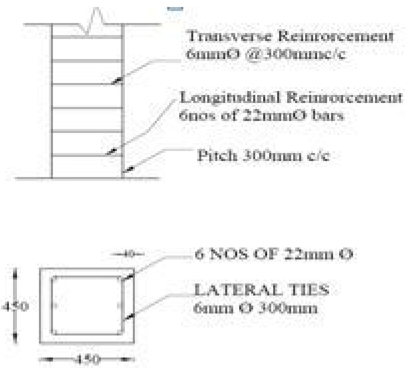


Figure 5 Reinforcement of R.C.C square column

2.5 Design Of Simply Supported Plinth Beam

2.5.1 Available Data

Center to center distance l_{eff}=6.30m
B =300mm,
D =400mm
D =360mm (assumption)
Fy =415N/mm^2
Fck =25N/mm^2
Q =3.45
%Ast =1.197%

2.5.2 Load Calculation

Self weight of beam =b x D x unit Weight
=0.3x 0.4x 25=3.0 KN/m
Wall load =0.3 x 4.5 x 19=25.65 KN/m
Total load =28.65 KN/M
Factored load =28.65 x 1.5
F_d = 43KN/m

2.5.3 Reinforcement

Ast_1 =M_{ulim}/(0.87 x fy x (d-0.42 X_{umax}))
=134.13 x 10^6/ (0.87 x 415 x (360-0.42 x 0.48 x 360)
Ast_1 =1292.51mm^2
Ast_1 =M_{UA}/(0.87 X fy x (d-d'))
=79.2 x 10^6/(0.87 x415 x (360-40))
Ast_2 =685.50mm^2
TOTAL Ast =Ast_1+Ast_2
Ast =1978mm^2
Provide 22mm dia bars
Ast =380.14mm^2
NOS =Ast/ast=1978/380.14=6nos
Ast =6 x π x 22^2/4=2280.78mm^2
Provide 6nos of 22mm dia bars as tension reinforcement.

2.5.4 Check for Stiffness

% Ast = 100Ast/bd = 100 x 2280.78 /(300 x 360)
% Ast = 2.11
Fs = 0.58Fy (Ast_{req}/Ast_{pro})
= 0.58x415x (1978/2280.78)
= 240 Curve MF = 0.8
d_{avi} = span/(B_V x MF)

d = 6300/32x0.8 = 250 mm< 360 mm.

Hence design is safe.

Figure 6 shows the simply supported Plinth beam.

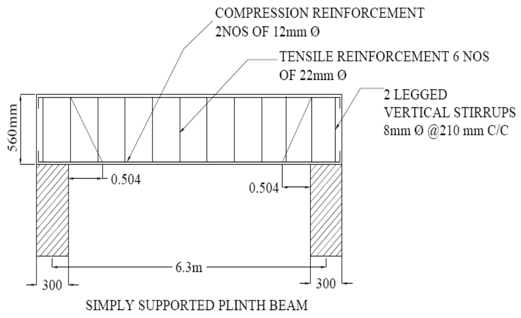


Figure 6 Simply supported Plinth beam

2.6 Design of Isolated Square Footing

2.6.1 Available Data

Size of column =450 x 450mm

Safe bearing capacity =200 KN/m^2

fck = 30 N/mm^2

fy = 415 N/mm^2

2.6.2 Size of Footing

Axial load of footing = 1350 KN

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

W1 =10/100 x 1350

= 135 KN

Total load on soil =1350+135=1485 KN

Area of footing required = total load /SBC

= 1485/200

= 7.425m^2

Since it is a square column

B x L =7.425 m^2

B X (B) =7.425 m^2

B^2 =7.425

$= \sqrt{7.425}$ = 2.8

B = 1.8 & L

= 2.8m

Area of footing =2.8x 2.8 =7.84 m^2

2.6.3 Tension Reinforcement

M_U = 0.87 fyA_{st} d (1- fyA_{st} / fckbd)

2397.76x 10^6 = 0.87 x 415 x A_{st} x 920 (1- 415 x A_{st} / 30 x 2800 x 920)

1.78A_{st}^2 – 332.16 x $10^3$$A_{st}$ + 2397.76 x 10^6 = 0

Ast_L = 7521.88 mm^2

Ast_{min} = 0.12/100 x (b x D)

= (0.12/100) x 2800 x 970

Ast_{min} = 3259.20 mm^2

Ast =π x 22^2/4=380.14mm^2

NOS = Ast_L / ast = 3529.20/380.14 = 10nos

Provide 10 nos of 22mm dia bars in long direction at uniform spacing

Ast = 10x π x 22^2/4 = 3801.32mm^2

2.6.4 Check for SBC of Soil

Column load =1350 KN
Weight of footing =2.8 x 2.8 x 0.97 x 25=190.12 KN
Total load on soil =1550 KN
Pressure on soil =1550 / (2.8x 2.8)=197.70 KN/m^2

197.70 KN/m^2< 200KN/m^2

Hence safe.

Figure 7 shows the Reinforcement of the Square footing.

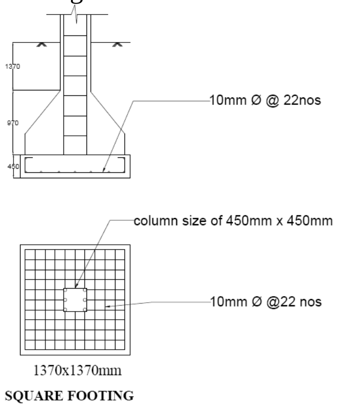


Figure 7 Reinforcement of the Square footing

2.6.5 Staad Report

Figure 8 shows the 3D structure of the building.

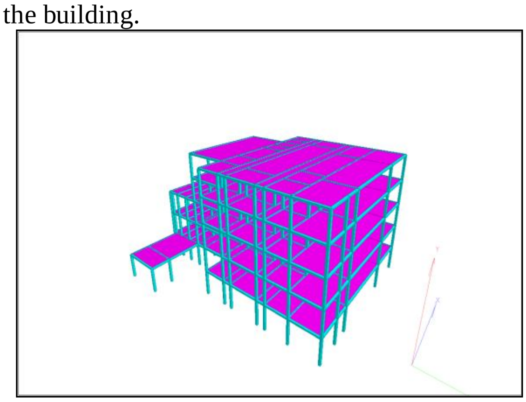


Figure 8 3D Structure

Figure 9 shows the Beam 35 bending moment.

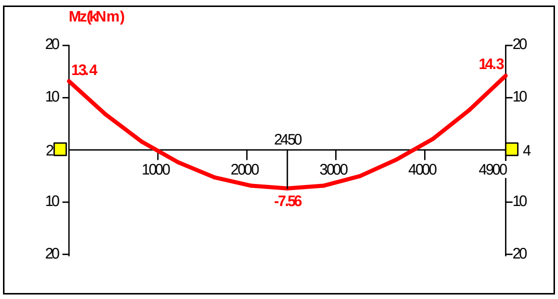


Figure 9 Beam 35 Bending Moment

Figure 10 shows the slab stress normal fill.

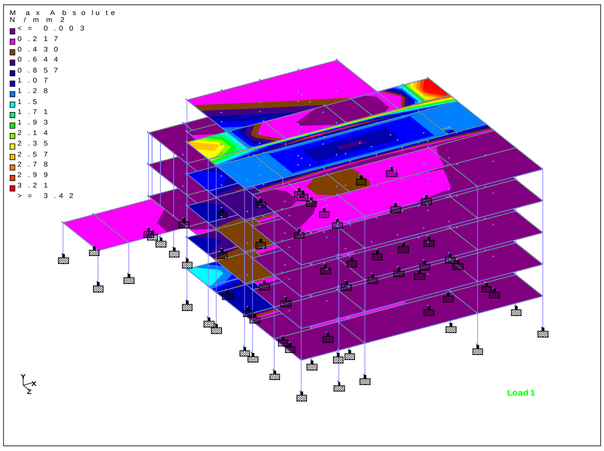


Figure 10 Slab Stress Normal Fill

Figure 11 shows the Slab stress normal line.

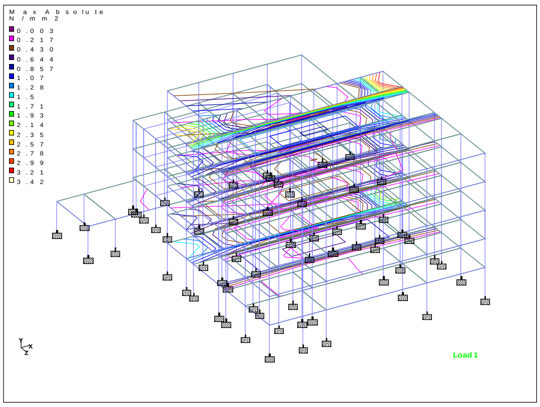


Figure 11 Slab Stress Normal Line

Figure 12 shows the column reinforcement design.

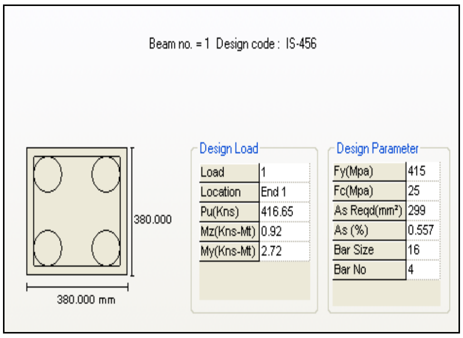


Figure 12 Column Reinforcement Design

Figure 13 shows the shear bending.

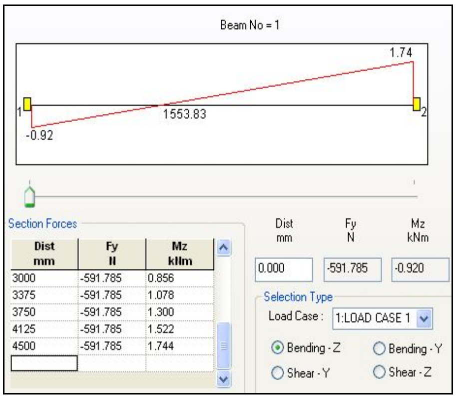


Figure 13 Shear bending

2.6.6 Concrete Take off (For Beams And Columns Designed Above)

Total volume of concrete = 368.15 cu.meter

BAR DIA (in mm)	WEIGHT (in New)
8	83762.62
16	229851.88
20	25889.59
25	15814.41

TOTAL= 355318.50

Figure 14 shows the Blue Print of the building.

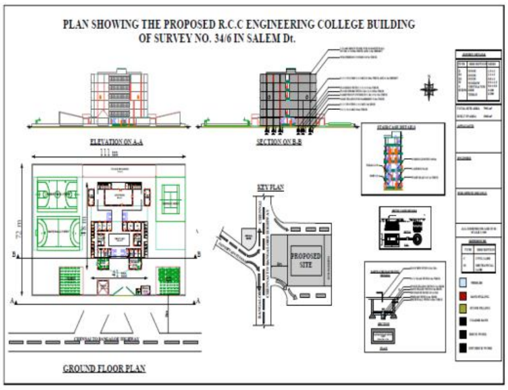


Figure 14 Blue Print

3. CONCLUSION

Through our study concluded that application of software in civil industry plays important role in our study. In our study college building designed by adopting limit state method for analysis and design of our structure. Time taken for doing this project is very less due to the application of the software. It bring extra accuracy in dimension and analysis part through study. Hence, concluded that application of software in Civil Engineering filed is quite good and comprehensive for further study of structural parameter.

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