Planning, Analyzing and Designing of Shopping Complex By Using STAAD Pro

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ABSTRACT

Planning analysis and designing of Shopping mall With Car Parking Building is our study which is propose at Salem dt. The Shopping mall consists of a Underground Floor Parking, Power saving room, Fire and safety, Security room. In Ground Floor Ladies toilet, Gents toilet, ATM, Bonquet Hall, Reception, Foot wear shop. In First Floor Market, Beauty parlour, Home appliances, Checking room, Book shop. 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 plan and structural elements such as slab, beam, column and footings are designed using limit state method in STAAD Pro and the reinforced details has been designed using the above software. This project helps us in exploring knowledge about planning, analyzing and designing a Shopping Mall Building.

Keywords: Planning, Analysis, Designing and Shopping Mall

1. INTRODUCTION

A shopping mall is, a form of grocery store, is a self-service store offering a wide variety of food and household merchandise, organized into departments. It is larger in size and has a wider selection than a traditional grocery store, also selling items typically found in a convenience store, but is smaller and more limited in the range of merchandise than a hypermarket or big-box store. The shopping complex typically comprises meat, fresh produce dairy, and baked goods departments, along with shelf space reserved for canned and packaged goods as well as for various non-food items such as household cleaners, pharmacy products and pet supplies. Most shopping mall also sell a variety of other household products that are consumed regularly, clothes, and some stores sell a much wider range of non-food products.

2. MANUAL DESIGN

2.1 Design of Simply Supported Two Way Slab

\[ f_{ck} = 25 \text{ N/mm}^2 \]

\[ f_{cy} = 415 \text{ N/mm}^2 \]

Room size = 12.8 x 10 m

Support = 300 mm

Thickness of slab = 200mm

2.1.1 Load Calculation

Consider 1m width of slab

Live load = 4 KN/m²

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

= 1 x 1 x 0.2 x 25

= 5 KN/m²

Weight of floor finish = 1 x 1 x 0.05 x 20

= 1.0 KN/m²
Total load = 10 KN/m
Design load = 6.75 x 1.5
= 15 KN/m

2.1.2 Main Reinforcement

2.1.2.1 For Shorter Span (Maximum Moment In Shorter Span)

\[
M_x = 0.87 f_y A_{st} \left( 1 - f_y A_{st} / f_{ck} \right)
\]

\[
69.95 \times 10^6 = 0.87 \times 415 \times A_{st} \times 180 \left( 1 - 415 \times A_{st} / 25 \times 1000 \times 180 \right)
\]

\[
A_{st\min} = 1211.74 \text{ mm}^2
\]

2.1.3 Spacing
Assume 20 mm dia bars

\[
S = a_{st}/A_{st} \times b = 314.15 / 1211.74 \times 1000
\]

\[
= 259.25 \text{ mm say 250 mm}
\]

\[
3d = 3 \times 180 = 540 \text{ mm}
\]

Provide 20 mm dia bars @ spacing 150 mm c/c distance.

2.1.4 Check for Deflection
Assume 12 mm dia

\[
A_{st\text{pro}} = ( a_{st} / s ) \times b = (113.09/300) \times 1000
\]

\[
= 376.96 \text{ mm}^2
\]

\%

\[
% = 100 A_{st} / A_{st\text{pro}}
\]

\[
= 100 \times 376.96 / 1000 \times 180
\]

\[
= 2.09\%
\]

\[
F_s = 0.58 \times f_y A_{s\text{req}} / A_{st\text{pro}}
\]

\[
= 0.58 \times 415 \times 1211.74 / 376.96
\]

\[
= 773.73
\]

\[
M.F = 1.50
\]

\[
d_{svi} = \text{span} / (B_v \times MF)
\]

\[
= 10180 / 32 \times 1.50 = 197.5 \text{ mm}
\]

\[
d_{req} < d_{pro}
\]

Hence Design is Safe.

Figure 1 shows the reinforcement detailing of slab.

![Reinforcement detailing of slab](image_url)

2.2 Design of Simply Supported Beam

2.2.1 Available Data

Center to center distance \(l_{eff} = 12.3 \text{ m}\)

\[
B = 300 \text{ mm},
\]

\[
d = 560 \text{ mm}
\]

\[
D = 600 \text{ mm (assumption)}
\]

\[
F_y = 415 \text{ N/mm}^2
\]

\[
f_{ck} = 25 \text{ N/mm}^2
\]
Q = 3.45
\%A_{st} = 1.197%

2.2.2 Load Calculation

Self weight of beam = b x D x unit Weight
= 0.3 x 0.6 x 25 = 4.5 KN/m
Slab floor finish = perpendicular distance x tk x unit Weight
= 4.8x 0.05 x 20 = 6 KN/m
Slab self Weight = 4.8x 0.15 x 25 = 18 KN/m
Wall load = 0.3x 3.5 x 19 = 19.95 KN/m
Total load = 48.45 KN/M
Factored load = 45.6 x 1.5 F_d = 72.67 KN/m

2.2.3 Reinforcement

\[ A_{st1} = \frac{M_{ulim}}{(0.87 \times f_y \times (d - 0.42 \times u_{Maximum}))} \]
\[ A_{st1} = \frac{324.57 \times 10^6}{(0.87 \times 415 \times (600 - 0.42 \times 0.48 \times 600))} \]
\[ A_{st1} = 1876.60 \text{ mm}^2 \]
\[ A_{st2} = \frac{M_{UA}}{(0.87 \times f_y \times (d - d'))} \]
\[ A_{st2} = \frac{62.31 \times 10^6}{(0.87 \times 415 \times (600 - 40))} \]
\[ A_{st2} = 308.17 \text{ mm}^2 \]

Total Ast = Ast_1 + Ast_2
\[ A_{st} = 2184.77 \text{ mm}^2 \]

Provide 20 mm dia bars
\[ a_{st} = 314.16 \text{ mm}^2 \]
NOS = Ast/ast = 2184.77 / 314.16 = 7 nos
Ast = 7 \times \pi \times 20^2 / 4 = 2199.11 \text{ mm}^2

Provide 7 nos of 20 mm dia bars as tension reinforcement

2.2.4 Check for Stiffness

\[ \%A_{st} = \frac{100 \times A_{st}}{b \times d} = \frac{100 \times 2199.11}{(30 \times 600)} \]
\[ \% A_{st} = 1.22 \]
\[ F_s = 0.58F_y (A_{streq}/A_{stpro}) \]
\[ F_s = 0.58 \times 415 \times (2184.77 / 2199.11) = 240 \text{ Curve MF} = 0.8 \]
\[ d_{av} = \frac{\text{span} \times (B_Y \times MF)}{d} = \frac{12300 \times 0.8}{32} = 480 \text{ mm} \]

Hence design is safe.

Figure 2 shows the Reinforcement details of the beam.

2.3 Design of Square Column
2.3.1 Available Data

Size of column = 500 x 500 mm

\[ f_{ak} = 25 \text{ N/mm}^2 \]

\[ f_y = 415 \text{ N/mm}^2 \]

2.3.2 Load Calculation

2.3.2.1 Slab

Weight of slab (1) = L x B x D x unit Weight
= 6 x 4.65 x 0.2 x 25 = 139.5 KN

Weight of slab (2) = L x B x D x unit Weight
= 6 x 4.7 x 0.2 x 25 = 141 KN

Weight of slab ff (1) = L x B x D x unit Weight
= 6 x 4.65 x 0.05 x 20 = 27.9KN

Weight of slab ff (2) = L x B x D x unit Weight
= 6 x 4.7 x 0.05 x 20 = 28.2 KN

Live load (1) = 6 x 4.65 x 4 =111.6 KN

Live load (2) = 6 x 4.7 x 4 =112.8 KN

2.3.2.2 Beam

Beam (1) = L x B x D x unit Weight
= 6 x 0.3 x 0.6 x 25 = 27 KN

Beam (2) = 4.7 x 0.3 x 0.6 x 25 = 24.15 KN

Beam (3) = 4.65 x 0.3 x 0.60 x 25 = 20.92 KN

2.3.2.3 Wall

Wall load (1) = L x B x H x unit Weight
= 4.65 x 0.3 x 3.5 x 19 = 93.7 KN

Wall load (2) = 4.7 x 0.3 x 3.5 x 19 = 92.7 KN

2.3.2.4 Column

Self weight of column = L x B x H x unit Weight
= 0.5 x 0.5 x 3.5 x 25 =21.87 KN

Sum of all above loads = 841.34 KN

No of floor consideration = 833.47 x2 = 1682.68 KN say 1670

2.4 Transverse Reinforcement

2.4.1 Minimum Diameter

Not less than 6mm

2.4.2 Pitch

LLD = 500 mm

16 x 16 =260mm

Provide 6 mm dia laterals at 260mm c/c

2.4.3 Result

Size of column = 500x 500 mm

Longitudinal reinforcement = 6 nos of 16mm dia bars

Transverse reinforcement = 6mm dia at 260 mm c/c

Figure 4 shows the Reinforcement detail of R.C.C. square Column.
2.5 Design of Isolated Rectangular Footing

2.5.1 Available Data
Size of column = 500 x 500 mm  
Safe bearing capacity = 150 KN/m²  
fₚk = 25 N/mm²  
f_y = 415 N/mm²

2.5.2 Size of Footing
Axial load of footing = 150KN  
Assume the self Weight of footing as 10% of the column load  
W₁ = 10/100 x 1670  
= 167 KN  
Total load on soil = 1670 + 167 = 1837KN  
Area of footing required = total load / sbc  
= 1837 / 150  
= 12.25 m²

Since it is a square column  
B x L = 12.25 m²  
B x (B) = 12.25 m²  
B² = 12.24  
B = 3.5  
L = 3.5 m  
Area of footing = 3.5 x 3.5 = 12.25 m²

2.5.3 Check for Shear

2.5.3.1 Transverse Shear
V₀ = f₀ x length x (3.25 - 0.5)  
= 224.94 x 3.5 x 2.75  
= 2165.05 KN  
τᵥ = V₀/bd = 2165.05 x 10³ / 3500 x 500  
τᵥ = 1.2 N/mm²  
% A₀ = 100A₀/bd = 100 x 4704 / (3500 x 500)  
= 0.28 %  
τ_c = 0.34 N/mm²  
Kτ_c = 1 x 0.34 = 0.34 N/mm²  
τᵥ > Kτ_c Not Safe in shear
2.5.4 Check for SBC of Soil

Column load = 1670 KN
Weight of footing = 3.5 x 3.5 x 1.12 x 25 = 343 KN
Total load on soil = 2013 KN
Pressure on soil = 2013 / (3.5 x 3.5) = 164.33 KN/m²

164.33 KN/m² < 200 KN/m²
Hence safe.

Figure 5 shows the Reinforcement detailing of footing.

2.6 Design of Staircase

Vertical height = 4 m = 4000 mm
Rise = 150 mm
Tread = 250 mm

2.6.1 Size of Staircase

Number of rise = 4000/150 = 26 nos
Number of flight = 2 nos
Rise per flight = 13 nos
Number of tread = 13-1 = 12 nos
Landing of going = 12 x 250 = 3000 mm
Weight of landing = (4000-3000)/2 = 500 mm

2.6.2 Load Calculation

Assume waist slab thickness = 150 mm
Self weight of waist slab = 1 x 0.15 x 0.25 x 25 = 3.75 KN/m
Plain area = W₁ x ((R² + T²)/T²)^(1/2)
= 3.75 x ((0.15² + 0.25²)/0.25²)^(1/2)
= 4.37 KN/m
Weight of step per m² = 0.5 x 0.15 x 0.25 x 25 = 0.46 KN/m
Load of step per meter length = 0.46 x 1000/2 = 1.84 KN/m
Assume floor finish = 0.8 KN/m
Live load = 4.5 KN/m

Figure 6 shows the Reinforcement detailing of stair case.
Figure 6 Reinforcement detailing of Stair case

3. STAAD REPORT

Figure 7 shows the whole structure.

Figure 7 Whole Structure

Figure 8 shows the 3D Rendering view.

Figure 8 3D Rendered view

Figure 9 shows the plate in normal fill.
Figure 9 Plate in normal fill

Figure 10 shows the Plate in normal line.

Figure 10 Plate in normal line

Figure 11 shows the concrete design diagram.

Figure 11 Concrete design diagram

Figure 12 shows the Concrete design in column.
Figure 12 Concrete design in column

TOTAL VOLUME OF CONCRETE = 3599.5 CU.METER

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TOTAL = 1563205

Figure 13 shows the blue print of the building.

Figure 13 Blue Print

4. CONCLUSION

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

References


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