Manual analysis of VILLA and Comparison of result with STADD-PRO analysis

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ABSTRACT

Structural designing is the primary aspect of civil engineering. The foremost basic in Structural designing is the design of simple basic components and members of building like beams, columns and footings in order to design them it is important to first obtain the plan of a particular building. There by depending on the suitability plan layout of beams and columns are fixed.

Once the loads are obtained the component takes the load first is slab so first slab is designed. designing of slabs depends upon whether it is a one way or a two way slab the end conditions and loading. From the slab the load gets transferred to beam. The loads coming from the slabs onto the beam may be trapezoidal or triangular. Depending on this the beam may be designed. There after loads (mainly shear) from the beams are taken by the columns. For designing columns it is necessary to know the moments they are subjected to. For this purpose frame analysis is done by Kane’s method. After this the designing of columns is taken up depending on end conditions moments, eccentricity. Finally footings are designed based on the loading from the column and also soil bearing capacity value for that particular area.

Keywords: Analysis sequence, Structural Analysis, Numerical Computation, Design System.

1. INTRODUCTION

In its modern form, a gated community is a form of residential community or housing estate containing strictly-controlled entrances for pedestrians, bicycles, and automobiles, and often characterized by a closed perimeter of walls and fences. Gated communities usually consist of small residential streets and include various shared amenities. For smaller communities this may be only a park or other common area. For larger communities, it may be possible for residents to stay within the community for most day-to-day activities. Gated communities are a type of common interest development, but are distinct from intentional communities.

In addition to a heightened sense of security, most gated communities provide a park or playground, community centre, swimming pool and private storage for homeowners. Larger, more prestigious communities may also include schools for young children, tennis
courts, fitness centers, golf courses and marinas. Homeowner’s association fees pay for the building and maintenance of common areas in a gated community.

2. SCOPE OF THE STUDY

At the end of the study we will have complete knowledge of designing of structural members according to IS 456-2000 which help us to design any structural member in future.

3. DESIGN OF SLAB

3.1 Two adjacent edges discontinuous

Data:

Dimension of slab          = 5.18m × 4.4 m          fck = 20 N/m²
Support width                 = 230 mm                             fy   = 415 N/m²
Live load                        = 3 KN/m²
Floor finish                     = 1.5 KN/m²

Aspect ratio:

\[ \frac{L_y}{L_x} \]

For values of \[ \frac{L_y}{L_x} \] & edge condition from table: 26 of IS: 456

\[ \frac{L_y}{L_x} = \frac{5.14}{4.48} = 1.17 < 2 \]

So it is a two way continuous slab

Effective stiffness depth required for:
Minimum depth = \( \frac{\text{span}}{26} \) (for continuous slab)

\[ d = \frac{4400}{26} = 170 \text{ mm} \]

Assume effective cover = 20 mm, Using 10 mm diameter bars

Effective depth = \( d = 170 \text{ mm} \)

Overall depth = \( D = 170 + 20 + (10/2) \)

\[ = 195 \text{ mm} \]

\[ d = 170 \text{ mm} \]

\[ D = 195 \text{ mm} \]

Effective span:

As per IS 456:

Effective span = c/c of supports (or) clear span + effective depth (whichever is less)

- (Clear span + effective depth) = (4.4 + 0.17) = 4.57 m
- (Centre to centre of support) = (4.4 + 0.23) = 4.63 m

Hence \( L = 4.57 \text{ m} \)

Loading on the slab:

Self-weight of slab = (0.195 \times 25) = 4.875 \text{ KN/m}^2

Floor finish = 1.5 \text{ KN/m}^2

Live load = 3 \text{ KN/m}^2

Total service load = \( w = 9.375 \text{ KN/m}^2 \)

Ultimate load = \( w_u = 1.5 \times 9.375 = 14.06 \text{ KN/m}^2 \)

Wall load = 17 \times 0.23 \times 0.1 = 0.391 \text{ KN/m}^2

Design load = 14.45 \text{ KN/m}^2

Bending moment coefficients:

Short span:

1. Negative moment at continuous edge (-\(\alpha x\)) = 0.057
2. Positive moment at mid span (+\(\alpha x\)) = 0.043

Long span:

1. Negative moment at continuous edge (-\(\alpha y\)) = 0.047
2. Positive moment at mid span (+\(\alpha y\)) = 0.035

Bending moment:

- B.M along span (+ve) = 0.043 \times 14.45 \times 4.572
  \[ \text{Mux} = 12.97 \text{ KN.m} \]
- B.M along span (-ve) = 0.057 \times 14.45 \times 4.572
  \[ \text{Mux} = 17.20 \text{ KN.m} \]
- B.M along span (+ve) = 0.035 \times 14.45 \times 4.572
  \[ \text{Muy} = 10.56 \text{ KN.m} \]
Check for effective depth:

\[ M_{\text{max}} = 0.138 f_{ck} b d^2 \]

\[ d^2 = \frac{17.20 \times 10^6}{0.138 \times 20 \times 10^3} \]

\[ d = 78.94 \text{ mm} < 170 \text{ mm} \]

CALCULATION OF REINFORCEMENT

3.4.2 For short span at mid span

\[ M_s = 0.87 f_y A_{st} d \left(1 - \frac{f_y A_{st}}{b d f_{cd}}\right) \]

\[ A_{st} = 206.00 \text{ mm}^2 \]

Number of bars = 3

Assuming 10 mm dia bars, spacing = \( \left(\frac{\text{Ast of one bar}}{\text{total Ast}}\right) \times 1000 \)

= 333.33 mm

Check for spacing:

For minimum reinforcement consideration,

1.333.33 mm

2.3 \( d = 3 \times 170 = 510 \text{ mm} \)

3.300 mm

Therefore, provide 3.10 mm diameter bars at 300 mm c/c spacing

3.4.3 For short span at continuous edge

\[ M_s = 0.87 f_y A_{st} d \left(1 - \frac{f_y A_{st}}{b d f_{cd}}\right) \]

\[ A_{st} = 275.65 \text{ mm}^2 \]

Number of bars = 4

Assuming 10 mm dia bars, spacing = \( \left(\frac{\text{Ast of one bar}}{\text{total Ast}}\right) \times 1000 \)

= 250 mm

Check for spacing:

For minimum reinforcement consideration,

1.250 mm

2.3 \( d = 3 \times 170 = 510 \text{ mm} \)

3.300 mm

Therefore, provide 4-10 mm diameter bars at 250 mm c/c spacing
C/S OF TWO WAY SLAB ALONG SHOTER SPAN

Fig 4

CALCULATION OF END MOMENTS IN FRAME "ABC"

Fig 8

ANALYSIS OF FRAME "ABC"

Fig 7
8.3 DESIGN OF BEAM

Dimension:

Shear force \( = 107 \text{ kN} \)

Moment \( M_s = 92.75 \text{ kN.m} \)

Beam size \( = 0.23 \times 0.4 \text{m} \)

Limiting moment of resistance

\[
M_{u, \text{limit}} = 0.138 f_yd^2
\]

\[
M_{u, \text{limit}} = [0.138 \times 20 \times 225 \times 400^2] \times 10^4
\]

\[
= 101.54 \text{ kN.m}
\]

Since \( M_s < M_{u, \text{limit}} \), section in under reinforced

Effective Span:

Centre to centre distance \( = 4.63 \text{m} \)

Clear span + d \( = 4.57 \text{m} \)

Therefore take \( L = 4.57 \text{m} \)

Calculation of loads:

Dead load on beam \( = 0.23 \times 0.425 \times 25 \text{ kN/m} \)

Imposed load on beam \( = 60.92 \text{ kN/m} \)

Total load \( = 63.34 \text{ kN/m} \)

Factored load \( = 95.04 \text{ kN/m} \)

\[ (Bending \ moment) = \frac{95.04 \times 4.57^2}{8} = 248.11 \text{ kN.m} \]

Since B.M > M.R.

We go for doubly reinforced beam

Moment of resistance of auxiliary section:

\[
M_s = M_{u, \text{limit}} - M_{aux}
\]

\[
M_{aux} = 155.36
\]

Area of compression steel corresponding to \( M_{aux} \)

\[
M_{aux} = f_{sc} A_{sc} \times (d - d')
\]

\[ A_{sc} = 1257.4 \]

Assume \( d' = 50 \text{mm} \)

\[
\frac{d'}{d} = 0.125
\]

\[ f_{sc} = 353 \]

Assuming 20mm diameter, No of bars = 4

Therefore provide 4 bars with an area of 1256 \( \text{mm}^2 \)

The stress in compression steel \( (f_{sc}) \) can be calculated based on the grade of steel and ratio of

\[
\frac{d'}{d} \text{ as follows}
\]
6.3 COLUMN DESIGN

Data:

- Column size: 350mm × 400mm
- Axial load: 250kN
- Unsupported length: 4570mm
- Concrete mix: M20
- Characteristic strength of reinforcement: 415 N/mm²

Slenderness ratio:

\[
\frac{(L/D)}{D} = \frac{(0.65 \times 4570 / 400)}{400} = 7.42 < 12 \text{(in x-direction)}
\]

\[
\frac{(L/D)}{D} = \frac{(0.65 \times 4570 / 350)}{350} = 8.48 < 12 \text{(in y-direction)}
\]

Therefore column is short column.

Minimum eccentricity:

IS 456-2000 clause 25.4

\[
\varepsilon_{\text{min}} = 22.47 > 20 \text{mm}
\]

Also 0.05 D = 0.05 × 400 = 20 < \varepsilon_{\text{min}} \text{ (in x-direction)}

\[
\varepsilon_{\text{min}} = 20.8 > 20 \text{mm}
\]

Also 0.05 D = 0.05 × 400 = 20 < \varepsilon_{\text{mp}} \text{ (in y-direction)}

Uniaxial short column should be designed

\[
D = 400 + \frac{16}{2} + 40 = 448
\]

\[
\frac{d'}{D} = 0.1 \text{ (in x-direction)}
\]
Factored ultimate load:
\[ P_u = 375 \text{KN} \]

Moments due to beams:
\[ M_{UX} = 33.19 \text{KN.m} \]
\[ M_{UV} = 70.70 \text{KN.m} \]

Reinforcement calculation:

Reinforcement on two sides
Reinforcement is distributed equally on two sides.

Uni–axial moment’s capacity about x – x axis:
\[ d/\bar{d} = 45/0.448 = 0.1 \]
Chart for \( d/\bar{d} \) = 0.1 will be used.

\[
\begin{align*}
\frac{P_u}{f_{cu}b\bar{d}} &= 0.10 \\
\frac{M_{Ux}}{f_{cu}b\bar{d}^2} &= 0.18
\end{align*}
\]

Referring to chart 20

\[
\frac{P}{f_{cu}} = 0.11
\]

3% of \( f_{uel} \) = 2.2%

\[ P_x = 0.4f_{uel}A_x + 0.67f_{uel}A_{re} \]
Area of main reinforcement
\[ A_{re} = 3000 \text{mm}^2 \]

Using 20mm dia,

Number of bars = 6

Design of Lateral ties:
Dia of tie should not be less than 1/4 th dia of largest longitudinal steel or 6mm, whichever is greater.
\[ 26/4 = 6.5 \text{ or } 6 \text{mm} \]

Use 8mm dia for lateral ties

Spacing of lateral ties:
\[ 16x \text{ dia} = 16 \times 26 = 416 \text{mm} \]
\[ D = 448 \text{mm} \]
\[ 300 \text{mm} \]

Use minimum of all the above, i.e. 300mm c/c spacing.
4. CONCLUSIONS

The aim of this project is to portray analysis of different members of a residential villa which is made of RCC. This was made using latest software’s & manual analysis & building codes.

The 3D analytical models & Kanni’s method is done in Auto-cad Software with manual analysed values which helped to develop a design with accurate values & optimized to arrive a cost efficient design.
5. REFERENCES