Design and Analysis of Residential Institute Building

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Abstract - The project is about planning, designing and analyzing of an apartment building with floors of G+3. This design project is taken up with the objectives of understanding the behavior of the structure and to gain confidence in designing the structure, making use of the codal provisions. It is planned in such a way to meet all the facilities needed by the accommodator. In the residential building, all the floors are only for residential purpose and that are provided with living room, kitchen master- bed room, bath and toilets. In this project, the building is designed as a framed structure to construct houses on each floors. The load calculation for the analysis of the frame are carried out as per IS 875. The analysis of the frame is done using STAAD.PRO software. The structural elements such as slab, beam, column, footing and staircase, are designed by limit state method. Water tank and Septic tank are designed by Working Stress Method, using M25 concrete and Fe415 steel satisfying all codal provisions of IS-456: 2000 and SP-16.

Key Words: (Size 10 & Bold) Key word1, Key word2, Key word3, etc (Minimum 5 to 8 key words)...

1. INTRODUCTION

The residential building (flats) include a building which consists of separated rooms for each and every action of a man involved in his day to day life. The different types of rooms in our residential building are as follows:

- Living room
- Kitchen
- Drawing room
- Bed rooms

Attached with bathrooms and toilets

The environment of our residential building is very pleasing and gives comfort to the people living in it and it is also located in the centre of the city so that the people comfort to go in and around the city for their basic needs.

1.1 LITERATURE REVIEW:

P.P. Chandurkar et. al. (2013): Study of G+9 building:

He had presented study of G+9 building having three meters height for each storey. The whole building design had carried out according to their IS code for seismic resistant design and the building had considered fixed at base. They design for Structural elements assumed as square or rectangular in section. They analyse whole building using ETAB software in that four different models were studied with different positioning of shear walls.

Mohit Sharma et al. (2015): To study the dynamic analysis of multi-storeyed Building:

He considered a G+30 storied regular reinforced concrete framed building. Dynamic analysis of multi-storeyed building was carried out. These buildings have the plan area of 25m x 45m with a storey height 3.6m each and depth of foundation is 2.4 m. & total height of chosen building including depth of foundation is 114 m. The static and dynamic analysis has done on computer with the help of STAAD-Pro software using the parameters for the design as per the IS:1893-2002 Part-1 for the zones- 2 and 3. It was concluded that not much difference in the values of Axial Forces as obtained by static and dynamic analysis.

1.2 METHODOLOGY:

The systematic approach followed during the project considered of the following steps :

2. WORK PROCESS

2.1 BASIC DATA

i. Type of building – apartment building
ii. No of storey - G+3
iii. Type of structure – reinforced concrete frame with a one way slab and beam floor system
iv. Bearing capacity of soil- 200KN/m

Note: Others required data assume using NBC (National building code for planning and IS:456-2000 for concrete design work
2.2 PLAN OF APARTMENT BUILDING

Fig. 2: Plan

2.3 DESIGN OF BUILDING COMPONENTS

DESIGN OF SLAB

- **Lx** = 3.15 m
- **Ly** = 8.75 m
- **$f_{ck}$** = 25 N/mm²
- **$f_y$** = 415 N/mm²

**Calculation of effective depth:**
- Overall depth, **d** = 0.126 mm
- Effective cover = 20 mm
- Provide an effective depth, **d** = 130 mm
- Overall depth ‘D’ = 150 mm

**Calculation of effective span:**
- Effective span = Clear span + Effective span
  = 3.28 m
- Floor finish load = 1 kN/m
- Total load = 8.75 kN/m
- Factored load = 13.13 kN/m

**Type of slab:**
- **Ly / Lx** = 8.75 / 3.15
  = 2.78 > 2

Hence, design as One-way slab.

**Calculation of load:**
- Dead Load = 3.75 kN/m²
- Live Load = 4 kN/m²
- Floor Finishes = 1 kN/m²
- Total Load = 8.75 kN/m²

Factored Load = 8.75 x 1.5

**W_u** = 13.125 kN/m²

**Calculation of bending moment:**
- **M_u** = 17.650 kNm

**Shear force:**
- **V_u** = 21.525 kN.

**Limiting moment of reinforcement:**
- **M_u,lim** = 58.305 kNm.
- **M_u** < **M_u,lim**

Section is under reinforcement.

**Reinforcement:**
- **M_u** = 0.87 $f_y A_{st}$ [1 - ($f_y A_{st} / f_{ck}$ $b$ $d$)]
- 58.305 x 10⁶ = 0.87 x 415 x **A_{st}** x 130 [1 - 276 x 10⁻⁴**A_{st}**] = 1548 mm²

Using 12 mm dia bars,
- **a_{st}** = $\pi/4$ x 12²
  = 200.96 mm²
- Spacing = $(a_{st} / A_{st}) x 1000$ = 150 mm

**Spacing limit:**
- i) 3d = 3 x 130 = 390 mm
- ii) 300 mm

Adopt a spacing of 150 mm & alternate bars are at bent up @ supports.

**Distribution Reinforcement:**
- **A_{st}** = 0.12 % b D
  = (0.12 x 1000 x 150) / 100
  = 180 mm²

Using 10 mm dia bars,
- **a_{st}** = $\pi/4$ x 10²
  = 78.54 mm²
- Spacing = $(a_{st} / A_{st}) x 1000$ = 436 mm

**Spacing Limit:**
- i) 5d = 5x130 = 650 mm
- ii) 450 mm

Provide 10 mm dia bars at 300 mm spacing.

**Check for shear stress:**

Considering the shorter span and unit widen of slab
- **$\tau_v$** = **V_u** / **b** **d**
  = (21.525 x 10³) / (1000 x 130)
\( P_t = 100 \times A_{st \text{ (pro)}} / b \cdot d \)
\( = (100 \times 1548) / (1000 \times 130) \)
\( = 1.19 \)

(Refer table 19 of IS: 456 : 2000)
\( \tau_c = 0.685 \text{ N/ mm}^2 \)
\( K \times \tau_c = 1.3 \times 0.685 \)
\( = 0.89 \text{ N/ mm}^2 \)

Hence, the shear stresses are within safe permissible limits.

**DESIGN OF TWO WAY SLAB :**

- \( l_x = 3.2 \text{m} \)
- \( l_y = 3.3 \text{m} \)
- \( f_{ck} = 25 \text{N/mm}^2 \)
- \( f_y = 415 \text{N/mm}^2 \)

**Type Of Slab:**
\( L_y / L_x = 3.3 / 3.2 \)
\( 1.03 < 2 \)

Hence, design as two-way slab.

**Depth Of Slab:**
Span/overall depth = 35x0.8
\( = 3.2 \times 10^3 / 35 \times 0.8 \)
\( = 120 \text{mm} \)
\( d = 120 - (16 / 2) - 20 \)
\( = 92 \text{mm (or) 100mm} \)

**Effective Span:**
Effective span = (clear span + eff depth)
\( = (3.2 \times 10^3) + 100 \)
\( = 3300 \text{mm} \)
\( = 3.3 \text{m} \)
\( c/c \text{ of support} = 3430 \text{mm} \)

**Load Calculation:**
Self wt of slab = (1 \times 0.12 \times 25)
\( = 3 \text{kN/m}^2 \)
Live load = 2kN/m²
Floor finish load = 1 kN/m²
Total load = 6kN/m²
Design load \( W_u = 9 \text{kN/m}^2 \)

**Ultimate Design Moments And Shear Force:**
Refer table 27 of IS456-2000,
\( \alpha_x = 0.062 \)
\( \alpha_y = 0.062 \)
\( M_{ux} = \alpha_x W_u l_x^2 \)
\( = 5.71 \text{kNm} \)
\( M_{uy} = \alpha_y W_u l_y^2 \)
\( = 6.08 \text{kNm} \)
\( V_{ux} = 0.5 W_u \)
\( = 14.85 \text{kN} \)

**Check Of Depth:**
\( M_{max} = 0.138 f_{ck} b d^2 \)
\( = 0.138 \times 25 \times 1000 \times 100 \)
\( = 1.38 \text{kNm} \)
\( 6.08 \times 10^6 = 6.08 \times 25 \times 1000 \times 100 \)
\( d = 41.98 \text{mm} < 100 \text{mm} \)

Hence safe.

**Reinforcement Calculations:**
\( M_u = 0.87 f_y A_{st \text{ d}} [1 - (f_y A_{st} / f_{ck} b \cdot d)] \)
\( A_{st} = 173.38 \text{mm}^2 \)

Adopt 10mm dia bar,
\( A_{st} = \pi/4 \times 10^2 = 78.55 \text{mm}^2 \)
Spacing limit, As per IS 456-200
1.3d = 3 \times 100 = 300 \text{mm}
2.300mm
\( A_{st \text{ min}} = 0.12\% b d = 144 \text{mm}^2 \)
No.of bars = \( A_{st} / A_{st} \)
\( = 2.2 \)
Spacing of main reinforcement,
\( S = 1000 \times A_{st} / A_{st} \)
\( = 452.76 \text{mm (or) 450mm} \)
Provide 10mm dia @ 250mm c/c

**Distribution Reinforcement:**
Spacing of distribution rod,
\( S = 1000 \times A_{st} / A_{st} \)
\( = 50.265 / 144 \times 1000 = 349 \text{mm} \)
So provide 8mm dia @ 300mm c/c.

**Check For Shear Stress:**
\( \tau_v = V_u / b \cdot d \)
\( = (14.85 \times 10^3) / (1000 \times 100) \)
\( = 0.165 \text{ N/ mm}^2 \)
\[ \text{Self weight} = 0.23 \times 0.55 \times 25 = 3.162 \text{ KN/m} \]

\[ \text{Live load} = 8.75 \text{ kN/m} \]

\[ \text{Total load, } W = 11.912 \text{ kN/m} \]

\[ \text{Factored load, } W_u = 1.5 \times \text{total load} = 1.5 \times 11.912 = 17.868 \text{ kN/m} \]

**Ultimate Design Moment & Shear Force:**

\[ B.M = \frac{W L^2}{8} = 171 \text{ kNm} \]

\[ V_u = \frac{W L}{2} = 78.17 \text{ kN} \]

**Check For Effective Depth Required:**

\[ D = \left( \frac{M_{ulimit}}{0.138 f_{ck} b} \right)^{0.5} \]

\[ M_{ulimit} = 0.138 f_{ab} d^2 = 198.97 \times 10^6 \text{ Nmm} \]

\[ M_u < M_{ulimit} \]

the beam is designed as under reinforced section.

**Main Reinforcement:**

**Calculation of Ast:**

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

\[ A_{st} = 979.04 \text{ mm}^2 \]

Use 16 mm dia bars as a main reinforcement

Number of bars = 949.04 / 201.06 = 5 no's

Hence provide 5 no's of 16 mm dia bars as a main reinforcement

**Distribution Reinforcement Bars:**

From IS 456:2000, clause 26.5.2.1

\[ A_{st,min} = 0.12\% \text{ of } b D \]

\[ A_{st,min} = (0.12 / 100) \times 230 \times 550 = 151.8 \text{ mm}^2 \]

Use 12 mm dia bar as a distribution reinforcement

Number of bars = 151.8 / 113.09 = 1.34 = 2 no's

Hence provide 2 no's of 12 mm dia bars as a distribution reinforcement.
Check For Shear:
Normal shear stress, \( \tau_v = \frac{V_u}{b d} \)
\[ = \frac{(78.17 \times 10^3)}{(230 \times 500)} \]
\[ = 0.68 \text{ N/mm}^2 \]

**Pt**
\[ = 100 \times A_{st \text{(pro)}} / b d \]
\[ = \frac{(100 \times 979.04)}{(230 \times 500)} \]
\[ = 0.85 \]

(Refer table 19 of IS: 456 : 2000)
\( \tau_c = 0.598 \text{ N/mm}^2 \)

Hence shear reinforcement as provided in vertical stirrups.

Design For Shear Reinforcement:
From IS 456:2000, clause 40.4
Shear carrying capacity of steel
\( V_u = V_u - (\tau_c b d) \)
\[ = 9.4 \text{ kN} \]

Use 10 mm dia bars of 2 legged vertical stirrups.

Spacing:
Least as follows,
i) \( V_{us} = (0.87 f_{y} A_{sv} d) / S_v \)
\[ A_{sv} = 2 \times \pi / 4 \times 10^2 \]
\[ = 157.08 \text{ mm}^2 \]
\( V_{us} = (0.87 \times 415 \times 157.08 \times 500) / (9.4 \times 10^3) \)
\[ = 3016.69 \text{ mm} \]

ii) 0.75d = 0.75 \times 500 = 375 mm

iii) 300mm
Hence provide 10 mm dia bars 2 legged vertical stirrups @ 300 mm c/c distance as a shear reinforcement.

DESIGN OF COLUMN
Length = 3 m
Grade = M25
Steel = Fe415

Assume column size = 300 mm x 230 mm

Load calculation:
load from beam B1 = \( (3.15 \times 15.713) / 2 \)
\[ = 24.75 \text{ kN} \]

load from beam B2 = \( (8.75 \times 17.868) / 2 \)
\[ = 78.17 \text{ kN} \]

Self weight of column = 3 \times 0.3 \times 0.23 \times 25
\[ = 5.175 \text{ kN} \]

Total load, \( W \) = 108.095 kN

Factored load, \( W_u \) = 108.09 \times 1.5
\[ = 162.1425 \text{ kN} \]

Size Of Column:
Assume 1 % of steel reinforcement
\( A_{sc} = 1\% A_g = 0.01 A_g \)
\( A_c = A_g - 0.01 A_g = 0.99 A_g \)

From IS 456:2000, clause 39.3
\( P_u = (0.45 f_{ck} A_c) + (0.67 f_y A_{sc}) \)
\[ = 13.92 A_g \]

\( A_g = 11648.17 \text{ mm}^2 \)

\( A_g = b \times d \)
\[ d = 50.64 \text{ mm say 50 mm} \]

Check For Slenderness:
From IS 456 : 2000, column 25.12
Effective length of column = 0.85 x L
\[ = 0.85 \times 3000 \]
\[ = 2550 \text{ mm} \]

Assume least lateral dimension of column,
\( B = 230 \text{ mm} \)

Slenderness ratio = (Effective Length / LL Dimension)
Where, LL Dimension = Least Lateral Dimension
\[ = (2550 / 230) \]
\[ = 11.09 < 12 \]

Therefore column is short column

To Find \( A_{sc} \):
\( A_{sc} = 0.01 A_g \)
\[ = 0.01(230 \times 300) = 690 \text{ mm}^2 \]

Use 12 mm diameter bars,
Spacing = \( (a_{st} / A_{st}) \times 1000 = 150 \text{ mm} \)
Number of bars = \( (690) / (\pi / 4 \times 12^2) \)
\[ = 6.1 \]

Hence provide 6 numbers of 12 mm dia bars @ 150 mm c/c
Clear Cover:
From IS 456:2000, clause 26.4.1, greater of as follows,
Diameter of longitudinal reinforcement= 12 mm
Clear cover = 40 mm

Transverse Reinforcement:
From IS 456:2000, clause 26.5.3.2(c)
a) Maximum diameter of reinforcement
Greater of as follows,
1) 1/4 x diameter of largest longitudinal reinforcement= 1/4 x 12 = 3 mm
2) 6 mm (Say 8 mm) Diameter of transverse reinforcement= 8 mm

b) Pitch
Least of as follows,
1) b = 230 mm
2) 16 x dia of smallest longitudinal reinforcement= 16 x 12 = 192 mm
3) 300 mm
Hence provide 8 mm diameter bar @ spacing of 200 mm c/c
distance of transverse reinforcement.

DESIGN OF FOOTING:
Load from column= 2000 kN
Size of column = 300 mm x 230 mm
SBC = 200 kN/m²

\[ f_{ck} = 25 \text{ N/mm}^2 \]
\[ f_y = 415 \text{ N/mm}^2 \]

SIZE OF FOOTING:
Assume self-weight of footing as 10% of column load
Self-weight of footing = 200 kN
Total load on soil = 2200 kN
Factored load = 2200 x 1.5 = 3300 kN

SBC of soil = 200 kN/m²
Area of footing required = 3300 / 250 x 1.5 = 8.8 m²
Assume Side ratio= 1.3

\[ L \times B = 1.3 B \text{ m}^2 \]
\[ 1.3B \times B = 8.8 \text{ m}^2 \]
\[ B = 3 \text{ m} \]
\[ L = 4 \text{ m} \]

We take length and width as 3 x 4 m for each footing
Check = 3300 / (3 x 4) kN/m² = 275 kN/m²
Hence the footing is adequate since the soil pressure developed at the base is less than the bearing capacity of soil.

BENDING MOMENT DUE TO PRESSURE:
Bending moment for shorter side
\[ M_u = P_a x l x^2 / 2 \]
\[ = 261.855 \text{ kNm} \]
\[ M_u = P_a x l x^2 / 2 \]
\[ = 470.59 \text{ kNm} \]

DEPTH OF FOOTING:
i) From moment consideration
\[ M_u (\text{limit}) = 0.138 \times f_{ck} \times b \times d \]
\[ = 369.33 \text{ mm} \]

\[ \tau_c = 0.36 \text{ N/mm}^2 \]
\[ P_t = 0.25\% \]
\[ \tau_c = \frac{V_{ul}}{bd} \]
assume shear strength as 0.36 N/mm²
for M25 grade concrete
\[ 0.36 = 275 (1.85 - d)/d \]
\[ d = 800 \text{ mm} \]
Take \( D = 800+6+40 = 846 \text{ mm} \)

To Find Area Of Steel
Longer span:
\[ M_a = 0.87 \times f_y \times A_{st} \times d [1 - f_y \times A_{st}/f_{ck} \times b \times d] \]
\[ A_{st} = 1688.36 \text{ mm}^2 \]

Shorter span:
\[ M_a = 0.87 \times f_y \times A_{st} \times d [1 - f_y \times A_{st}/f_{ck} \times b \times d] \]
\[ A_{st} = 924.29 \text{ mm}^2 \]
Use 16 mm dia bars,
Spacing (longer span) = 150 mm
Use 10 mm dia bars,
Spacing (shorter span) = 200 mm
\( r/f \) in central bar with of 3 m = \( \frac{2}{B+1} \)
\( A_s = \frac{(78.54/200) \times 10^3}{392.5} \)
\( \approx 392.5 \)
\( (2/1.3+1) \times 392.5 \)
\( = 341.30 \text{ mm}^2 \)
\( A_{s,\text{min}} = 0.12 \% bd \)
\( = 0.12/100 \times 1000 \times 800 \)
\( = 960 \text{ mm}^2 \)
provide 12 mm dia bars
spacing = 113/960 x 1000
\( = 117.70 \text{ mm c/c} \)
Provide 12 mm dia @ 100mm c/c

**CHECK FOR SHEAR STRESS:**
Punching shear stress across the section
\( V_z = P_u \times (A-a) \)
\( = 183.33 \times (3.00 \times 2.00 - 0.885 \times 0.665) \)
\( = 992.1 \text{ kN} \)
\( \tau_s = V_z / b d \)
\( = 0.56 \text{ N/mm}^2 \)
\( \tau_s < K_S \times \tau_C \)
\( \tau_C = 0.25 (f_{ck})^{0.5} = 1.1 \text{ N/mm}^2 \)
\( k_S = 1 \)
\( \tau_C = 1.1 \text{ N/mm}^2 \)
Hence safe.

**DESIGN OF SUNSHADE:**

**Specification:**
Projection of sunshade = 600 mm
Assume uniform thickness = 50 mm

**Load Calculation:**
Consider on meter length of sunshade
Total self-weight of sunshade = 1 x 0.6 x 0.05 x 0.5 x 25000
\( = 750 \text{ kN} \)
Total imposed load = 1 x 0.6 x 0.75
\( = 450 \text{ kN} \)
Total load = 1200 kN
Therefore design load = 1800 kN

**Bending Moment:**
\( W_u = 1800 \times 0.6 / 2 \)
\( = 540 \text{ kNm} \)

**Depth Required:**
Effective depth required, \( d = \sqrt{\frac{W_u}{Q_u x b}} \)
\( = 13.98 \text{ mm} \)
Eff depth available = 32 mm
32 mm >13.98mm
Hence ok
\( A_{st} = 482 \text{ mm}^2 \)
Minimum area of steel provided = 60 mm²
Assume 6mm dia bars
Maximum permitted spacing = 3 x d
\( = 3 \times 32 \)
\( = 90 \text{ mm} \)
Provide 6mm dia Fe415 bars @ 90mm c/c

**Distribution Bars :**
0.12% of steel = 60 mm²
\( = 36 \text{ mm}^2 \)
Assume 6mm dia bars
Maximum permitted spacing = 180 mm
Provide 4 no.s of 6mm dia bars

**Check For Shear :**
Nominal shear stress = \( V_u / b d \)
\( = 0.06 \text{ N/mm}^2 \)
\( \tau_C = 0.28 \text{ N/mm}^2 \)
Hence the slab is safe against shear

**Development Length :**
\( L_d = (6 \times 0.87 \times 415) / (4 \times 1.2 \times 1.6) \)
\( = 280 \text{ mm} \)
Result:
Thickness of sunshade = 60 mm
Main R/F: 8mm dia Fe415 bars @ 200mm c/c
Distribution R/F: 8mm dia Fe415 bars @ 200mm

DESIGN OF STAIRCASE

Data:
Thread = 300 mm
Rise = 150 mm
Width of landing beam = 1.32 m
Imposed load = 5 kN/m²
Floor finish load = 1 kN/m²
fck = 25 N/mm²
fy = 145 N/mm²

Dimensions:
Height of each flight = 3.00 / 2 = 1.5 m
Number of risers required = 1.5 / 0.15 = 10 NoS
Number of treads in each flight = 9 NoS
Space occupied by treads = 9 x 0.3 = 2.7 m
Bearing of landing slab = 230 mm
Thickness of waist slab D = 200 mm
Effective span = 4.43 m

Load Calculation:
W = Ws (R² + T²)¹/₂ / T
= 5.59 kN/m²
Dead load on one step = 0.75 kN/m²
Total load = 12.34 kN/m²

Bending Moment & Shear Force:
Maximum bending moment at centre of span
M = 0.125 W₀ L²
= 45.40 kNm

Check For Depth Of Waist Slab:
Mₜₙ = 0.138 x fck x b x d²
= 120 mm
Hence safe

Main Reinforcement:
Mₙ = 0.87 x fy x A₀ x d [1 - fₙ x A₀ / fck x b x d]
A₀ = 936.47 mm²

Provide 12mm dia bars
Spacing = A₀ / a₀
Provide 12mm dia bars at 150mm c/c spacing

Distribution Reinforcement:
= 0.12% bD
= 0.12 / 100 x 1000 x 200
= 240mm²
Provide 10mm dia bars
Spacing = 373.9 = 370mm
Provide 10mm dia bars at 300mm c/c spacing

2.4 STAAD.Pro OUTPUT ANALYSIS

in our project we consider G+3 apartment building for planning, design and analysis, the each floor contain 4 no’s of 2BHK flat.

STAAD.Pro RESULT
STAAD.Pro V8i SELECTseries4
Version 20.07.09.31
Proprietary Program of
Bentley Systems, Inc.
Date = OCT 19, 2016
Time = 12:11:52

TOTAL REACTION
FORCE-X = 0.00
FORCE-Y = 75387.87
FORCE-Z = 0.00

BEAM.232
LENGTH : 3980.0 mm
SIZE : 230.0 mm X 500.0 mm
COVER : 30.0 mm
SECTION 0.0 mm 995.0 mm 1990.0 mm 2985.0 mm 3980.0 mm
TOP 218.58 0.00 0.00 218.58 218.58
BOTTOM 218.58 218.58 218.58 218.58 0.00

COLUMN.291
LENGTH: 3000.0 mm
CROSS SECTION: 230.0 mm x 300.0 mm
COVER : 40.0 mm
LOAD CASE : 2 (Z) / (Y)
STEEL AREA: 1269.60 Sq.mm.
REQU. CONCRETE AREA: 67730.41 Sq.mm.

MAIN REINFORCEMENT : Provide 12 - 12 dia. (equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. rectangular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED

TOTAL VOLUME OF CONCRETE = 144.4 CU.METER

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Fig -1: 3D VIEW

3. CONCLUSION

In this project, we have successfully made an attempt of Planning, Analyzing and Designing an Apartment building. The design has been made accordingly satisfy all practical needs. The structural members are designed manually and analyzed by using STAAD.PRO software. The two way slab, singly reinforced beams, columns, isolated footings and dog legged staircase are designed for M25 grade concrete and Fe415 steel by Limit State Method and Water tank and septic tank by Working Stress method using IS-456: 2000 and SP-16. By choosing this project, we had an opportunity to learn about the requirements of planning and designing of a residential building. During this design project, we learned various methodologies and necessary design concepts used in the today's construction world.

REFERENCES


