TERM PROJECT: DREAM HOUSE
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house for a painter:

- service
- producing & exhibiting
- recreational
- bedroom
- living area
- internal vertical circulation acting as a buffer zone between public and private.
- outside vertical stairs connects two levels of outer spaces

public section

private section

shifting two sections and creating access points
\[ A_1 = 15 \times 10.2 = 153 \, m^2 \]
\[ A_2 = 6 \times 13 = 78 \, m^2 \]
\[ A = A_1 + A_2 = 153 + 78 = 231 \, m^2 \]

\[ C_{GX} = \frac{153 \times 5.2 + 78 \times 13.2}{231} = 7.83 \, cm \]

\[ C_{GY} = \frac{153 \times 7.5 + 78 \times 12.5}{231} = 9.18 \, cm \]

\[ I_{SW1} = \frac{1}{12} \times 0.25 \times (4.4)^3 = 1.77 \, m^4 \]
\[ I_{SW2} = \frac{1}{12} \times 0.25 \times (3)^3 = 0.56 \, m^4 \]
\[ I_{SW3} = \frac{1}{12} \times 0.25 \times (4.3)^3 = 1.65 \, m^4 \]
\[ I_{SW4} = \frac{1}{12} \times 0.25 \times (4.4)^3 = 1.77 \, m^4 \]
\[ I_{SW5} = \frac{1}{12} \times 0.25 \times (3)^3 = 0.56 \, m^4 \]
\[ I_{SW6} = \frac{1}{12} \times 0.25 \times (3)^3 = 0.56 \, m^4 \]

\[ X_S = \frac{\Sigma x I_x}{\Sigma I_x} \quad Y_S = \frac{\Sigma y I_y}{\Sigma I_y} \]
\[ X_S = \frac{4.6 \times 0.56 + 10.2 \times 1.77 + 16.2 \times 0.56}{0.56 + 1.77 + 0.56} = 10.27 \, cm \]
\[ Y_S = \frac{0 \times 1.77 + 15 \times 1.65 + 6 \times 0.56}{1.77 + 1.65 + 0.56} = 7.06 \, cm \]

\((X_S, Y_S) = (10.27, 7.06)\)
Shear Wall Percentage

Area of the footprint of Shear Walls on Axis

Floor Area

Total Floor Area : 231 m²

Area of Shear Walls in X direction:

0.25 × 3 + 0.25 × 3 + 0.25 × 4.4 = 1.13 > 1 ✓

Area of Shear Walls in Y direction:

0.25 × 4.4 + 0.25 × 3 + 0.25 × 4.3 = 1.27 > 1 ✓

Eccentricity

\[ e_X = \frac{|XM - XS|}{L_X} \times 100 = \frac{|7.83 - 10.27|}{16.2} \times 100 = \%15.1 > \%5 \]

\[ e_Y = \frac{|YM - YS|}{L_Y} \times 100 = \frac{|9.18 - 7.06|}{19} \times 100 = \%11.1 > \%5 \]

We should make additions and/or alterations on shear walls to superpose mass center and rigidity center.

Shear Wall Operations

• Adding shear wall on Axis 1

\[ X_S = \frac{4.6 \times 0.56 + 10.2 \times 1.77 + 16.2 \times 0.56 + 0 \times I_{SWVII}}{0.56 + 1.77 + 0.56 + I_{SWVII}} = 7.83 \]

\[ I_{SWVII} = 0.9 = \frac{1}{12} \times 0.25 \times h^3 \quad h = 3.51 \, m \]

• Shortening SWI

\[ Y_S = \frac{0 \times ISWI + 6 \times 0.56 + 15 \times 1.65}{I_{SWI} + 0.56 + 1.65} = 9.18 \]

\[ I_{SWI} = 0.86 = \frac{1}{12} \times 0.25 \times h^3 \quad h = 3.45 \, m \]
Two Way Solid Slab (S101, S102, S103, S104)

\[ t \geq 8 \text{ cm} \quad t \geq \frac{l_{sm}}{15 + \left(\frac{20}{m}\right)} \left[1 - \frac{\alpha_s}{4}\right] \]

\[ \alpha_s = \frac{\Sigma \text{length of cont. edges}}{\Sigma \text{length of all edges}} \]

For S103 → \[ \alpha_{s203} = \frac{5.6+9+9}{5.6+9+9+5.6} = 0.81 \]

For S104 → \[ \alpha_{s204} = \frac{4.6+9}{4.6+9+9+4.6} = 0.5 \]

S103 and S104 are the critical slab types, so we calculated them and we decided to take minimum slab thickness as 17 cm according to TSC(2018) and TS - 500 regulations.

One Way Solid Slab (S105)

\[ t \geq 8 \text{ cm} \quad t \geq \frac{l_s}{25} \quad \text{since} \quad \frac{l_l}{l_s} = \frac{13}{6} > 2 \]

For S105 → \[ t \geq \frac{600}{25} = 24 \text{ cm} \]
**Tributary Area**

\[ A_1 = 4.5 \times 5.1 = 28 \, m^2 \]

\[ A_2 = 2.5 \times 5.1 = 12.75 \, m^2 \]

**Design Loads**

**Dead Load on Solid Slab**

- Own weight: \( 0.17 \times 2.4 = 0.408 \, t/m^2 \)
- Leveling: \( 0.04 \times 2.4 = 0.09 \, t/m^2 \)
- Covering: \( 0.025 \times 2.0 = 0.05 \, t/m^2 \)
- Plastering: \( 0.020 \times 2.0 = 0.04 \, t/m^2 \)

**Total Dead Load**

\[ 0.408 + 0.09 + 0.05 + 0.04 = 0.588 \, t/m^2 \]

**Live Load on Solid Slab**

\[ 0.2 \, t/m^2 \] for residential buildings

**Total Load**

\[ 1.4 \times 0.588 + 1.6 \times 0.2 = 1.14 \, t/m^2 \]

**Slab Load on Column**

\[ 1.14 \times 40.75 = 46.45 \, t \]

**Wall Loads**

- Wall Load: \( 0.15 \, t/m^2 \)
- Tributary Area: \( 5.5 \times 5.1 = 28.05 \, m^2 \)
- Wall Load on Column: \( 28.05 \times 0.15 \times 1.4 = 5.89 \, t \) (Beam own weight is not included)

**Total Load on Column**

\[ N_d = 46.45 \, t + 5.89 \, t = 52.64 \, t \]

\[ A_C \geq \frac{N_d}{0.40f_{ck}} \quad A_C \geq \frac{52640}{0.40 \times 200} \quad A_c \geq 658 \, cm^2 \]

However, according to TC-500 minimum column dimension can be \( 30 \times 30 \, cm \), so we take column dimensions as \( 30 \times 30 \, cm \).
Beam on Axis D

\[ P_d = 1.14 \ t \quad P = P_d \times \frac{l_s}{3} \quad P = P_d \times \frac{1}{3} \times \left[ 1.5 - \frac{0.5}{l_s^2} \right] \]

\[ P_1 = P_3 = 1.14 \times \frac{4.6}{3} = 1.75 \ t/m \quad P_1 + P_3 = 3.5 \ t/m \]

\[ P_2 = P_4 = 1.14 \times \frac{5.6}{3} = 2.13 \ t/m \quad P_2 + P_4 = 4.26 \ t/m \]

\[ \begin{align*}
I_{\text{column}} & = 30 \ \frac{1}{12} \times 0.3 \times (0.3)^2 = 0.00068 \ m^4 \\
I_{\text{beam}} & = 51 \ \frac{1}{12} \times 0.3 \times (0.51)^2 = 0.0033 \ m^4
\end{align*} \]

→ Since the beam depth should be at least 3 times the slab thickness, assumed beam depth is taken as 51 cm

\[ r_{12} = \frac{0.0033}{4.6} + 2 \times \frac{0.00068}{3} = 0.61 \]

\[ r_{21} = \frac{0.0033}{4.6} + 2 \times \frac{0.00068}{3} \times \frac{0.0033}{5.6} = 0.41 \]

\[ r_{23} = \frac{0.0033}{4.6} + 2 \times \frac{0.00068}{3} \times \frac{0.0033}{5.6} = 0.33 \]

\[ r_{32} = 0 \]
According to TC-500, beam depth should be at least 3 times of slab thickness, so beam depth is selected as 51 cm.
Beam on Axis 2

\[ P_d = 1.14 \, t \]

\[ P = P_d \times \left( \frac{1}{3} \times \left[ 1.5 - \frac{0.5}{(\frac{1}{P_d})^2} \right] \right) \]

\[ P_1 = 1.14 \times \frac{4.6}{3} \times \left[ 1.5 - \frac{0.5}{(\frac{9}{4.6})^2} \right] = 2.39 \, t \]

\[ P_2 = 1.14 \times \frac{5.6}{3} \times \left[ 1.5 - \frac{0.5}{(\frac{9}{5.6})^2} \right] = 2.78 \, t \]

\[ P_3 = 1.14 \times \frac{4.6}{3} \times \left[ 1.5 - \frac{0.5}{(\frac{6}{4.6})^2} \right] = 2.11 \, t \]

\[ P_4 = 1.14 \times \frac{5.6}{3} \times \left[ 1.5 - \frac{0.5}{(\frac{6}{5.6})^2} \right] = 2.27 \, t \]

\[ P_1 + P_2 = 5.17 \, t/m \]

\[ P_3 + P_4 = 4.38 \, t/m \]

\[ I_{\text{column}} = 0.00068 \quad I_{\text{beam}} = 0.0033 \]
According to TC-500, beam depth should be at least 3 times of slab thickness, so beam depth is selected as 51 cm.

\[ h = d + 5 \text{ (clear cover)} = 42.64 \text{ cm} \]