House Project in Ümitköy

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**Geometric Center**

Since the slab is simply rectangular, the geometric center is located on midpoints of the lengths on X and Y axis. The origin is depicted on the figure.

\[
G_x = \frac{-12}{2} = 6 \\
G_y = \frac{15}{2} = 7.5
\]

**Stiffness Center**

Dimensions of shear walls on X axis (namely W5,W4) = 0.3m x 3.2 m

\[
XR = \frac{\left(\frac{1}{12} \times 0.3 \times (3.2)^3 \times 0\right) + \left[\frac{1}{12} \times 0.3 \times (3.2)^3 \times 12\right]}{2 \times \left[\frac{1}{12} \times 0.3 \times (3.2)^3\right]} = 6
\]

Dimensions of shear walls on Y axis (namely W1,W2,W3,W4) = 0.3m x 2.1 m

\[
XR = \frac{\left[\frac{1}{12} \times 0.3 \times (2.1)^3 \times 15\right] + \left[\frac{1}{12} \times 0.3 \times (2.1)^3 \times 9\right] + \left[\frac{1}{12} \times 0.3 \times (2.1)^3 \times 6\right] + \left[\frac{1}{12} \times 0.3 \times (2.1)^3 \times 0\right]}{4 \times \left[\frac{1}{12} \times 0.3 \times (2.1)^2\right]} = 7.5
\]

**Shear Wall Percentage**

Area of the Footprint of Shear Walls on x Axis

\[
\text{Floor Area}
\]

Total Floor Area : 180 m²

Area of shear walls on Y direction : 0.3 x 2.1 x 4 = 2.52 m²

The ratio of shear wall area on Y direction to floor area : \(\frac{2.52}{180} = 0.014 \quad \rightarrow \% 1.4\)

Area of shear walls on X direction : 0.3 x 3.2 x 2 = 1.92 m²

The ratio of shear wall area on X direction to floor area : \(\frac{1.92}{180} = 0.0106 \quad \rightarrow \% 1\)
Flat Plate is selected as the structural system. According to the standards, the minimum thickness should be greater than h = 200mm. According to the rules, we choose 20 cm as slab thickness.

The dimensions of columns in the span direction should not be less than 1/20 of the span length in that direction nor less than 300mm.
**Wall Load**

Tributary Area: 4.5 x 4 = 18 m²

**+.00 Floor Tributary Area**

Total Wall Length: 5.5 m

**+.3.00 Floor Tributary Area**

Total Wall Length: 5.78 m

*In order to be on the safe side, door loads are taken as wall loads.*

Wall Load = Wall Length x Wall Height x Distributed Wall Load (0.45 t/m²) x Dead Load Factor

Slab Load = Total Design Load x Tributary Area

Assume Slab depth is 20 cm and wall height is 280 cm

- Slab Load: 1.3 t/m² x 18 m² = 23.4 t = 23400 kg
- Wall Load: 5.78 m x 2.8 m x 0.45 t/m² x 1.4 = 10.196 t = 10196 kg
- Slab Load: 1.3 t/m² x 18 m² = 23.4 t = 23400 kg
- Wall Load: 5.5 m x 2.8 m x 0.45 t/m² x 1.4 = 9.702 t = 9702 kg
- Slab Load: 1.3 t/m² x 18 m² = 23.4 t = 23400 kg

Total Load: 23400 + 10196 + 23400 + 9702 + 23400 = 90098 kg

**Design Loads (Live Load and Dead Load)**

Dead Load for Flat Slab:

- Own Weight: 0.2 x 2.4 = 0.48 t/m²
- Leveling: 0.04 x 2.4 = 0.096 t/m²
- Covering: 0.025 x 2 = 0.05 t/m²
- Plastering: 0.02 x 2 = 0.04 t/m²

Total Dead Load = 0.668 t/m² ~ 0.7 t/m²

Live Load:

- We can consider 200 kg/m²

Total Load = (1.4 x DL) + (1.6 x LL)
= (1.4 x 0.7) + (1.6 x 0.2)
= 1.3 t/m²

According to Standards:

\[ A_c \geq \frac{N_d}{0.75 x f_{cd}} \]

\[ A_c \approx 750 \text{mm}^2 \]

According to TS-500 column dimensions:

Then: 1200 cm² > 924 cm²

\[ \square \]
The area depicted in the figure chosen for the two cycle method since the columns and the shear walls in that axis have the greatest distance to the other walls and shear walls. We will make the calculation according to the first floor in that area because wall load on the first floor is greater than ground floor. (Live load and the slab load is the same.)

**Calculation of Wall Loads (First Floor)**

For two cycle graphics, axis 1-2 will be taken as 2.9 m instead of 4.15 m but, to be on the safe side, whole wall load on the 1-2 axis was taken (in 4.15 distance).

<table>
<thead>
<tr>
<th>Between the axis</th>
<th>Load</th>
<th>Total Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>13.125 x 2.8 x 0.45 x 1.4 = 23,153 t</td>
<td>23,153 + 29,25 = 52,403 t</td>
</tr>
<tr>
<td>2-3</td>
<td>8.15 x 2.8 x 0.45 x 1.4 = 10,849 t</td>
<td>10,849 + 17,55 = 28,399 t</td>
</tr>
<tr>
<td>3-4</td>
<td>7.25 x 2.8 x 0.45 x 1.4 = 12,789 t</td>
<td>12,789 + 16,56 = 29,349 t</td>
</tr>
</tbody>
</table>

**Calculation of Slab Loads (First Floor)**

<table>
<thead>
<tr>
<th>Between the axis</th>
<th>Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>1.3 x 4.5 x 5 = 29.25 t</td>
</tr>
<tr>
<td>2-3</td>
<td>1.3 x 4.5 x 3 = 17.55 t</td>
</tr>
<tr>
<td>3-4</td>
<td>1.3 x [(4.5 x 4 - 3.9 x 1.35)] / 2 = 16.56 t</td>
</tr>
</tbody>
</table>

**Calculation of the Distributed Loads (First Floor)**

<table>
<thead>
<tr>
<th>Between the axis</th>
<th>Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>52.403 / 3.1 = 16.904 t</td>
</tr>
<tr>
<td>2-3</td>
<td>28.399 / 3 = 9.466 t</td>
</tr>
<tr>
<td>3-4</td>
<td>29.349 / 4 = 7.337 t</td>
</tr>
</tbody>
</table>
Design of Beams

Two Cycle Method

**Calculation of I Values**

- **(Flat slab)**: \( I_{12} = I_{23} = I_{34} = \frac{1}{12} \times 4.5 \times (0.2)^2 = 0.003 \text{ m}^4 \)
- **(Columns)**: \( I_1 = I_3 = \frac{1}{12} \times 0.3 \times (0.4)^2 = 0.0016 \text{ m}^4 \)
- **(Shear Wall)**: \( I_4 = \frac{1}{12} \times 3.2 \times (0.3)^2 = 0.0072 \text{ m}^4 \)

**Calculation of r Values**

- \( r_{12} = \frac{I_{12}}{L_{12}} + 2 \times \left( \frac{I_1}{L_1} \right) = \frac{0.003}{3.1} + 2 \times \left( \frac{0.003}{3} \right) = 0.475 \quad r_{21} = 0 \)
- \( r_{32} = \frac{I_{32}}{L_{32}} + \frac{I_{34}}{L_{34}} + [2 \times \left( \frac{I_3}{L_3} \right)] = \frac{0.003}{3} + \frac{0.003}{4} + 2 \times \left( \frac{0.0016}{3} \right) = 0.355 \quad r_{23} = 0 \)
- \( r_{43} = \frac{I_{43}}{L_{43}} + \frac{I_{43}}{L_{43}} + [2 \times \left( \frac{I_4}{L_4} \right)] = \frac{0.003}{3} + \frac{0.003}{4} + 2 \times \left( \frac{0.0072}{3} \right) = 0.266 \)

**Slab Depth**

\[ K_0 = \frac{bw \times d^3}{2} \]

\[ K_0 = \frac{450 \times 0.025}{1675200} = 9.647 \]

Since 20 cm ≥ 9.647 cm, our flat is SAFE.