The project consists of a house for five family members; including two children; their parents and a grandmother/grandfather; and an office used by one family member and guests in Ümitköy, Ankara. The concept of house focuses the separation of housing activities and office and the connection house in itself with a gallery. Service core is located on the west of house; including the main circulation and services.

**DESIGN CONCEPT**

On the ground floor, an office, a living area with a kitchen and a grandmother's room are located. Entrances of office and entrance of house are separated from each other. The living area faces the south to have efficient light, green areas directly and visually. By the help of gallery, two floors have connected to each other. Grandmother's room is located by thinking the least distance to the wet core and living area, and also entrance to the garden is provided for the grandmother's room. The office has own service area which connected to the main core.

On the first floor, two bedrooms and master bedroom are isolated from public areas, and they all have connection the hall that faces to the gallery and ends with a terrace. The terrace located in the north has visual contact to the road and main entrance of the house.
SECTION AA  SCALE: 1/100

SECTION BB  SCALE: 1/100
VIEW THROUGH THE LIVING SPACE

VIEW FROM THE KITCHEN
**I. Selection of Structural System**

**Reinforced Concrete Walls**

<table>
<thead>
<tr>
<th>Floor Area (m²)</th>
<th>Direction</th>
<th>Shear Wall Area (m²)</th>
<th>Percentage of Shear Walls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Floor 180m²</td>
<td>North-South</td>
<td>1.5</td>
<td>0.83</td>
</tr>
<tr>
<td></td>
<td>East-West</td>
<td>1.5</td>
<td>0.83</td>
</tr>
</tbody>
</table>

\[ L \geq 7t \]
\[ t \geq \frac{1}{15} \times \text{Storey Height} \quad (\text{Storey Height} : 300 \ cm) \]
\[ t \geq 20 \ cm \]
\[ L = 250 \ cm \quad t = 30 \ cm \]

Shear Wall Area: \( 2.5 \times 0.3 = 0.75 \times 2 = 1.5 \ m² \)

*If we take D-1 axis as (0,0) of an x-y coordinate then:*

**Stiffness Center:**
(All the shear walls are identical, their I value is identical)

\[ S_y = \frac{(Ix_5) + (Ix_0)}{1+1} = 7.5 \quad (X \text{ direction}) \]
\[ S_x = \frac{(Ix_0) + (Ix_2)}{1+1} = 6.0 \quad (Y \text{ direction}) \]

**Geometric Center:**
Plan is in a 4.00 x 5.00 grid system so geometric center would be in the center of the plan which is on \((6.0, 7.5)\) coordinates.

\[ G_x = 6.0 \quad (X \text{ direction}) \]
\[ G_y = 7.5 \quad (Y \text{ direction}) \]

- Geometric Center and Stiffness Center coincide.
II. SELECTION OF THE SLAB SYSTEM

SLAB THICKNESS

\[ t \geq \frac{t_s}{15+\frac{20}{l_t}} \times (1-\frac{\alpha}{4}) \]

\[ t_{101,109} \geq \frac{4}{15+20/1.25} \times (1-\frac{0.5}{4}) \]

\[ \geq \frac{3.5}{31} \]

\[ \geq 0.113 \text{ m} \]

\[ = 11.30 \text{ cm} \]

\[ t_{203} \geq \frac{4}{15+20/1.25} \times (1-\frac{0.325}{4}) \]

\[ \geq \frac{3.68}{31} \]

\[ \geq 0.118 \text{ m} \]

\[ = 11.85 \text{ cm} \]

**Two Way Solid Slab** is chosen.

**Slab Thickness** is chosen as \( t=12 \text{ cm} \)

DESIGN LOADS

**Dead Load:**

- Own Weight: \( 0.12 \times 2.4 = 0.3 \text{ t/m}^2 \)
- Leveling: \( 0.04 \times 2.4 = 0.1 \text{ t/m}^2 \)
- Covering: \( 0.025 \times 0.05 = 0.05 \text{ t/m}^2 \)
- Plastering: \( 0.02 \times 2.4 = 0.04 \text{ t/m}^2 \)

\[ = 0.5 \text{ t/m}^2 \]

**Live Load:**

\[ q \approx 0.2 \text{ t/m}^2 \]

**Total Load:**

\[ (P_d) = 1.4 \times \text{Dead Load} + 1.6 \times \text{Live Load} \]

\[ = 1.4 \times 0.5 + 1.6 \times 0.2 \]

\[ = 1 \text{ t/m}^2 \]
### III. COLUMN DIMENSION

#### TRIBUTARY AREA

<table>
<thead>
<tr>
<th>Tributary Area</th>
<th>a x b = 4 x 5 = 20 m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall Load</td>
<td>0.45 t/m²</td>
</tr>
</tbody>
</table>

**First Floor Wall Load**

\[
W_1 h_1 x 0.45 + W_2 h_2 x 0.45 + W_3 h_3 x 0.45 + W_4 h_4 x 0.45 + W_5 h_5 x 0.45 + 2 x (W_6 h_6 x 0.45) x 1.4 = (2.35 x 2.60 x 0.45 + 0.75 x 2.60 x 0.45 + 1.4 x 2.60 x 0.45 + 1.85 x 2.60 x 0.45 + 1.95 x 2.60 x 0.45 + 2 x (0.90 x 0.50 x 0.45)) x 1.4 = 14.17 \text{ t}
\]

**Second Floor Wall Load**

First Floor Wall Load

**COLUMN DIMENSION**

\[
N_d = \sum \text{Slab Load} + \sum \text{Wall Load}
\]

\[
N_d = 88.34 \text{ t}
\]

**Min Area**

\[
\min A_c = \frac{N_d}{0.75 f_{cd}}
\]

\[
\min A_c = \frac{88340}{0.75 x 130 \text{ kg/cm}^2} = 907 \text{ cm}^2
\]

COLUMN DIMENSIONS: 35 X 35 cm
Load: \( P_d \times \frac{L_{\text{short}}}{3} \times \left( 1.5 - \frac{0.5}{L_{\text{long}}/L_{\text{short}}} \right) \)

**A-B Interval**

3-4 Interval:

\[ w = 1 \times \frac{4}{3} (1.5 - \frac{0.5}{3}) \]

\[ w = 1.57 \text{ t/m} \]

wall load = \( (2.60 \times 0.45) \times 1.4 \)

\( = (1.2 \times 1.4) \)

\( = 1.64 \text{ t/m} \)

\( q = \text{wall load} + \text{slab load} \)

\( q = 1.64 + 1.57 = 3.21 \text{ t/m} \)

**B-C Interval**

2-3 and 3-4 Interval:

\[ w = 1 \times \frac{4}{3} (1.5 - \frac{0.5}{3}) \]

\[ w = 1.57 \text{ t/m} \]

wall load = \( (2.60 \times 0.45) \times 1.4 \)

\( = (1.2 \times 1.4) \)

\( = 1.64 \text{ t/m} \)

\( q = 2w + \text{wall load} \)

\( q = 3.14 + 1.64 = 4.78 \text{ t/m} \)

**C-D Interval**

2-3 and 3-4 Interval:

\[ w = 1 \times \frac{4}{3} (1.5 - \frac{0.5}{3}) \]

\[ w = 1.57 \text{ t/m} \]

wall load = \( (2.60 \times 0.45) \times 1.4 \)

\( = (1.2 \times 1.4) \)

\( = 1.64 \text{ t/m} \)

\( q = 2w + \text{wall load} \)

\( q = 3.14 + 1.64 = 4.78 \text{ t/m} \)

**FEM Calculations:**

\[ FEM_{AB} = FEM_{BA} = \frac{q l^2}{12} = \frac{3.21 x (5)^2}{12} = 6.68 \text{ tm} \]

\[ \text{Midspan} = \frac{q l^2}{24} = \frac{3.21 x (5)^2}{24} = 3.34 \text{ tm} \]

\[ FEM_{BC} = FEM_{CB} = \frac{q l^2}{12} = \frac{4.78 x (5)^2}{12} = 9.96 \text{ tm} \]

\[ \text{Midspan} = \frac{q l^2}{24} = \frac{4.78 x (5)^2}{24} = 4.98 \text{ tm} \]

\[ FEM_{CD} = FEM_{DC} = \frac{q l^2}{12} = \frac{4.78 x (5)^2}{12} = 9.96 \text{ tm} \]

\[ \text{Midspan} = \frac{q l^2}{24} = \frac{4.78 x (5)^2}{24} = 4.98 \text{ tm} \]
Beam (approximate)

\[ h = \frac{L}{12} = \frac{5}{12} = 0.42 \text{ m} \]
\[ I_{beam} = \frac{bh^3}{12} = \frac{0.3x(0.42)^3}{12} = 0.0018 \text{ m}^4 \]

Column

\[ I_{cd} = \frac{0.35x(0.35)^3}{12} = 0.00125 \text{ m}^4 \]

\[ r_{AB} = 0.00105_{(1/L)^3} = \frac{6.6x10^{-4}}{3.6x10^{-4} + 8.3x10^{-4}} = 0.30 \]
\[ r_{BA} = 0.0079_{(1/L)^3} = \frac{7.2x10^{-4}}{7.2x10^{-4} + 8.3x10^{-4}} = 0.23 \]
\[ r_{BC} = 0.0070_{(1/L)^3} = \frac{3.6x10^{-4}}{3.6x10^{-4} + 8.3x10^{-4}} = 0.23 \]
\[ r_{CB} = 0.0070_{(1/L)^3} = \frac{3.6x10^{-4}}{3.6x10^{-4} + 8.3x10^{-4}} = 0.23 \]
\[ r_{CD} = 0.0079_{(1/L)^3} = \frac{6.6x10^{-4}}{6.6x10^{-4} + 8.3x10^{-4}} = 0.23 \]
\[ r_{DC} = 0.00105_{(1/L)^3} = \frac{3.6x10^{-4}}{3.6x10^{-4} + 8.3x10^{-4}} = 0.30 \]

TWO-CYCLE METHOD:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEM</td>
<td>0.30</td>
<td>0.23</td>
<td>0.23</td>
<td>0.30</td>
</tr>
<tr>
<td>Cycle 1</td>
<td>-0.37</td>
<td>-0.37</td>
<td>-0.37</td>
<td>-0.37</td>
</tr>
<tr>
<td>Cycle 2</td>
<td>0.31</td>
<td>0.52</td>
<td>0.52</td>
<td>0.31</td>
</tr>
<tr>
<td>(\Sigma_1)</td>
<td>0.89</td>
<td>-0.52</td>
<td>-0.52</td>
<td>0.89</td>
</tr>
<tr>
<td>(\Sigma_2)</td>
<td>4.42</td>
<td>-8.20</td>
<td>-8.20</td>
<td>4.42</td>
</tr>
</tbody>
</table>

BEAM DEPTH:

\[ K_0 = \frac{b_wf^2}{M} \]
\[ b_w = 30 \text{ cm} \]
\[ M = 1120 \text{ t.m} \]
\[ = 1120000 \text{ kg.cm} \]
\[ K_0 = 0.025 \text{ cm}^2/\text{kg} \]
\[ 0.025 = \frac{30x d^2}{1120000} \]
\[ d^2 = 933.33 \text{ cm}^2 \]
\[ d = 30.55 \text{ cm} \]
\[ h = d + 4 \]
\[ = 30.55 + 4 \approx 34.5 \text{ cm} \]
\[ h \geq 3t \]

Beam Depth = 36 cm