ARCH 332 - STRUCTURAL DESIGN IN ARCHITECTURE II

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GROUP 5

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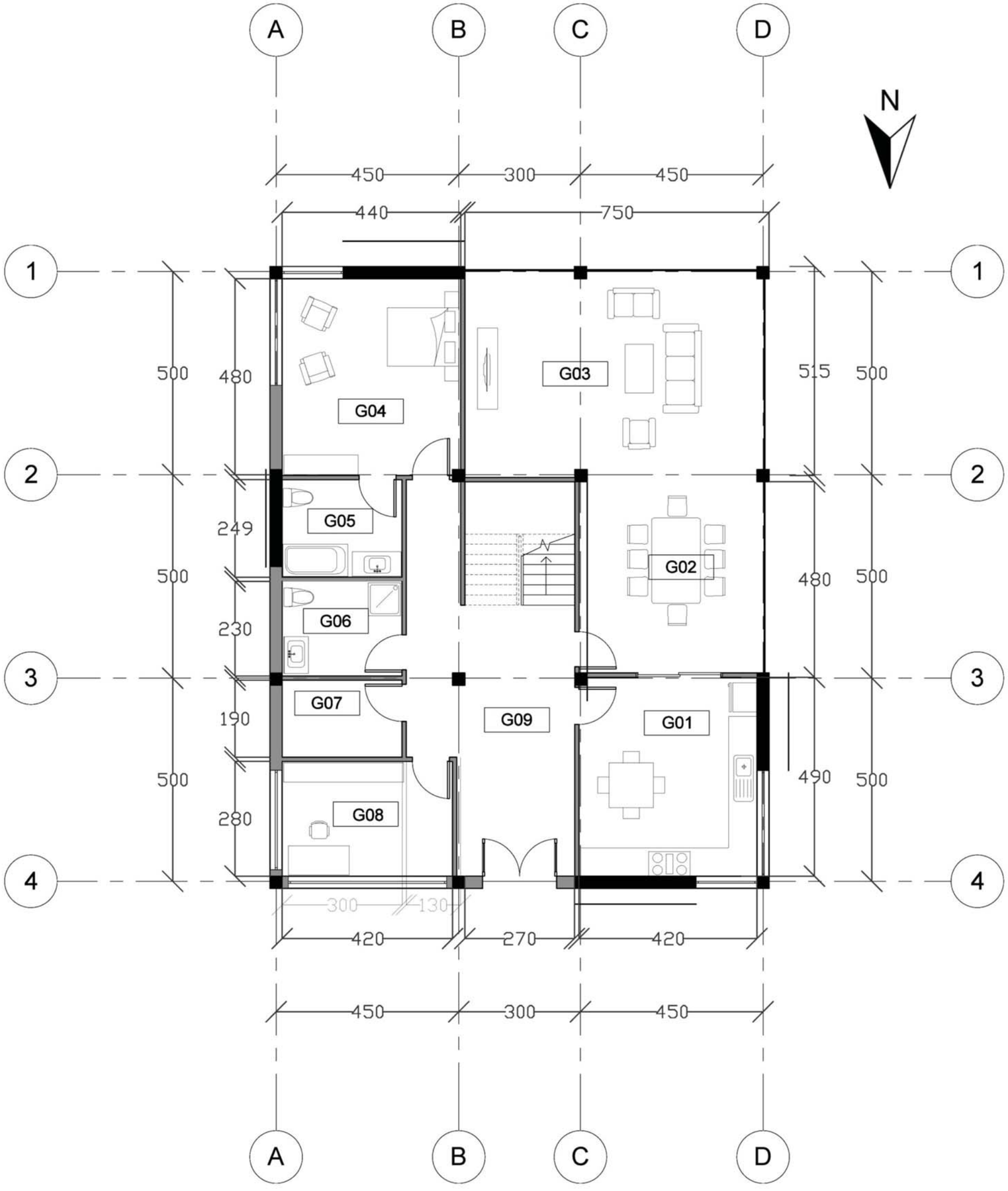
LIVING AND DINING ROOM

BEDROOM

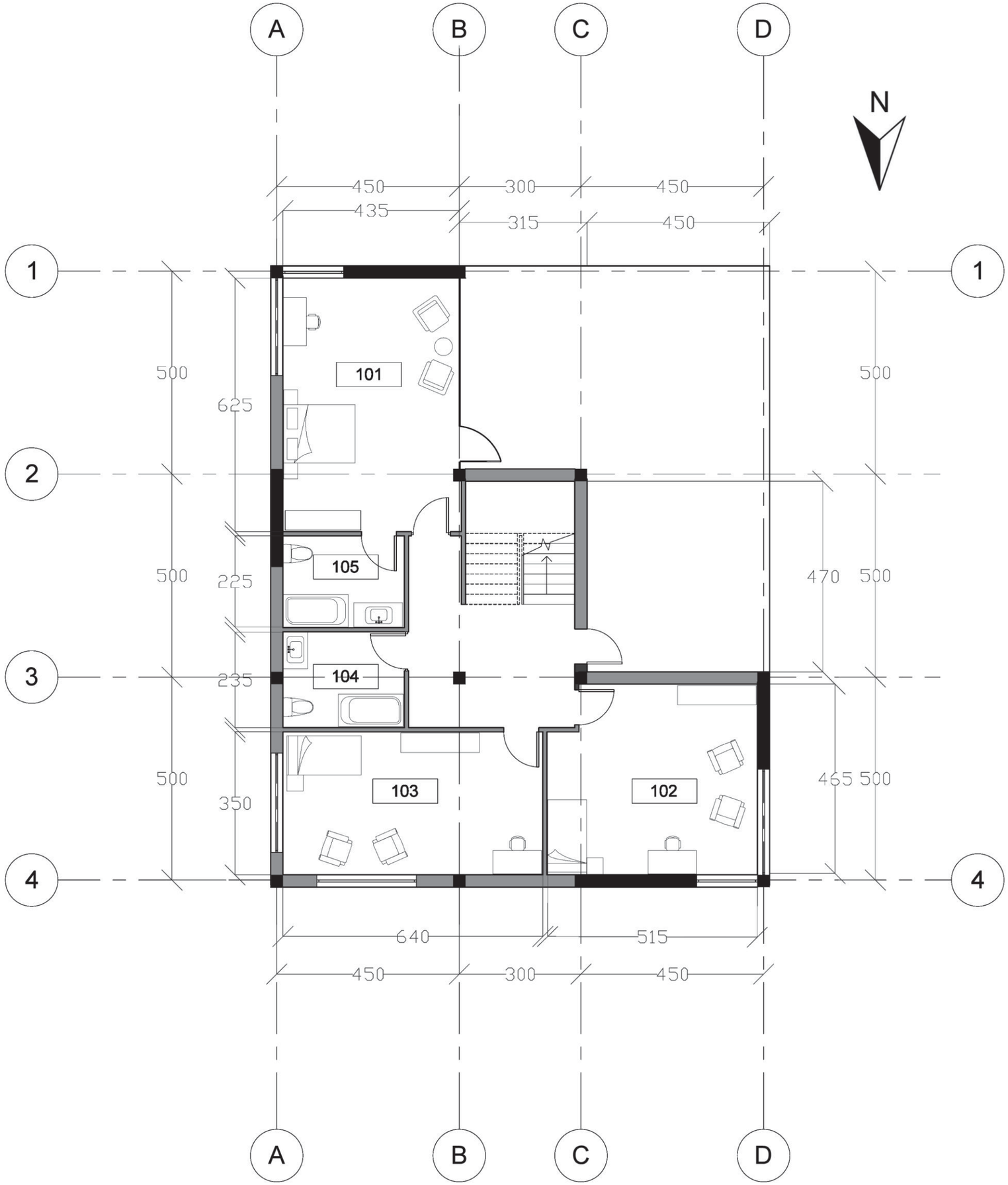
SOUTH ELEVATION

NORTH ELEVATION



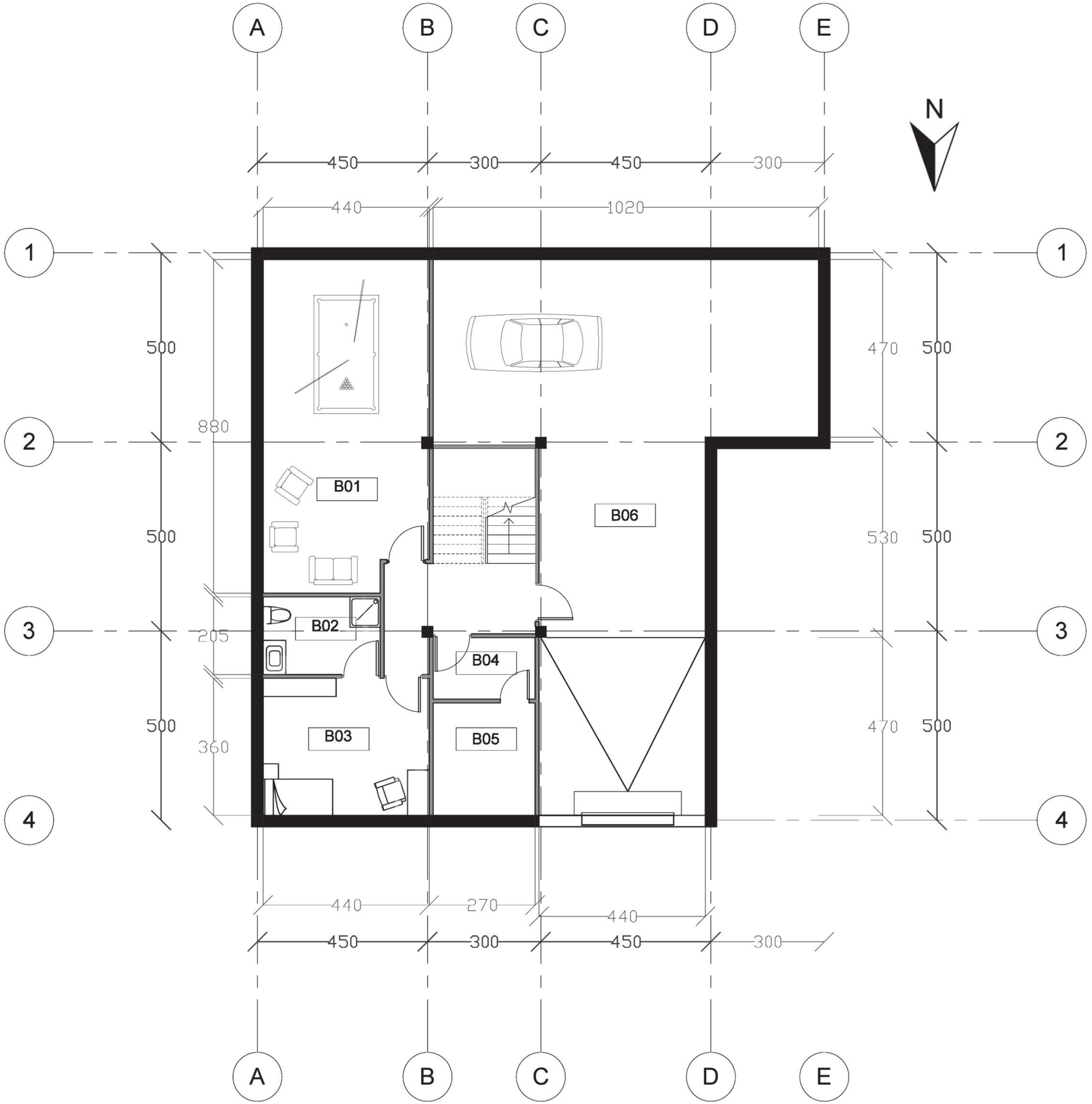
± 0.00 GROUND FLOOR PLAN

G01- Kitchen: 21 m^2
G02- Dining Room: 21 m^2
G03- Living Room: 37 m^2
G04- Grandmother Room: 28 m^2
G05- Bathroom: 7 m^2
G06- Bathroom: 7 m^2
G07- Storage: 6 m^2
G08- Study Room: 12 m^2
G09- Entrance: 33 m^2



+3.00 FIRST FLOOR PLAN

101- Master Bedroom: 27 m²
102- Bedroom 1: 23m²
103- Bedroom 1: 22 m²
104- Bathroom 2: 7 m²
105- Bathroom 2: 7 m²

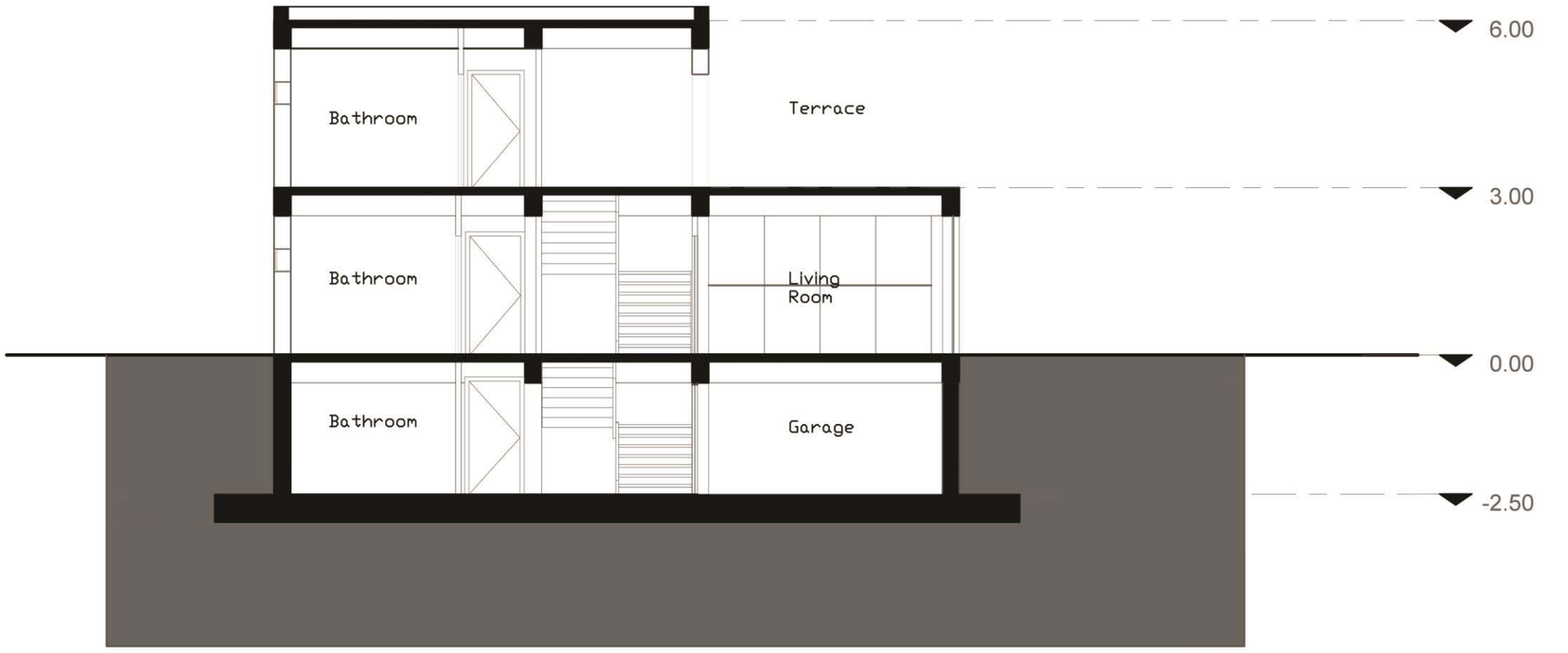


- 3.00 BASEMENT FLOOR PLAN

B01- Hobby Room: 38 m^2
B02- Bathroom: 6 m^2
B03- Housekeeper Room: 16m^2
B04- Storage : 5m^2
B05- Hvac : 8m^2
B06- Garage: 93 m^2

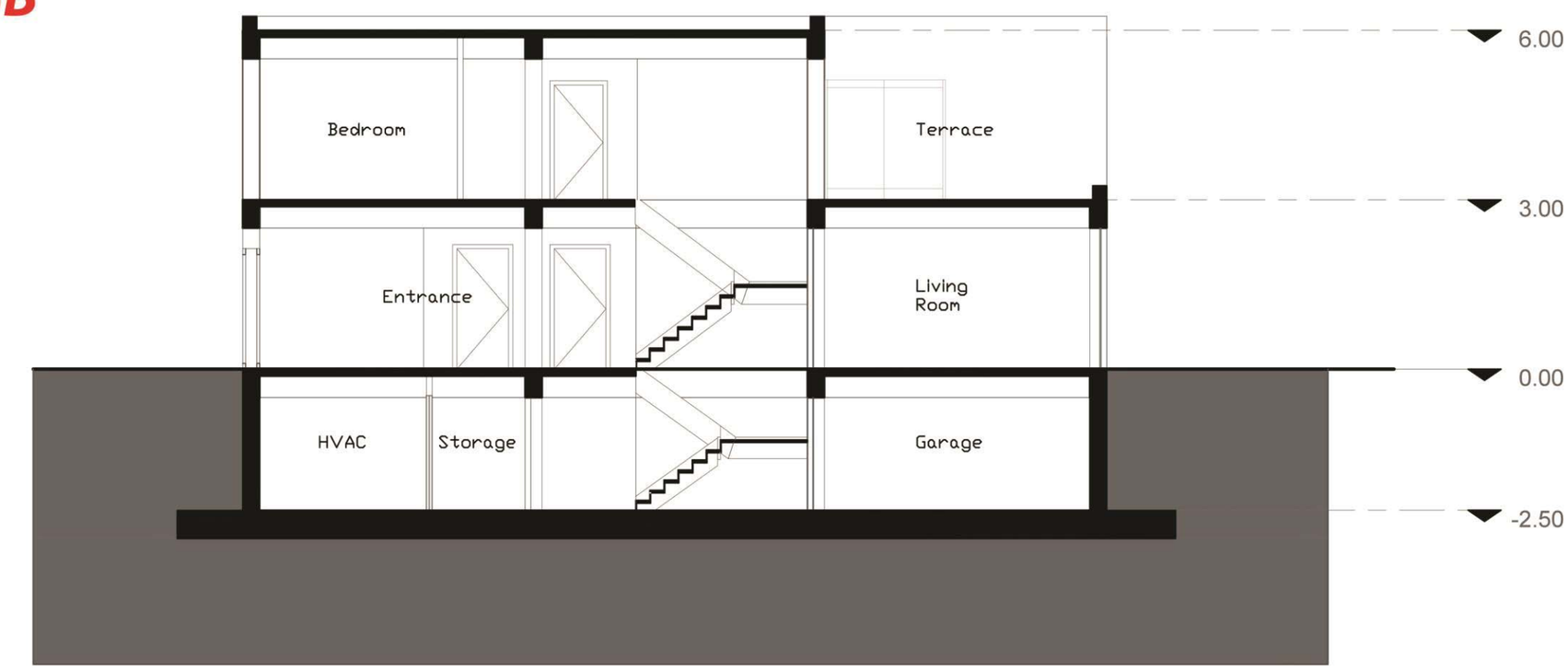
SECTION AA

scale : 1/100

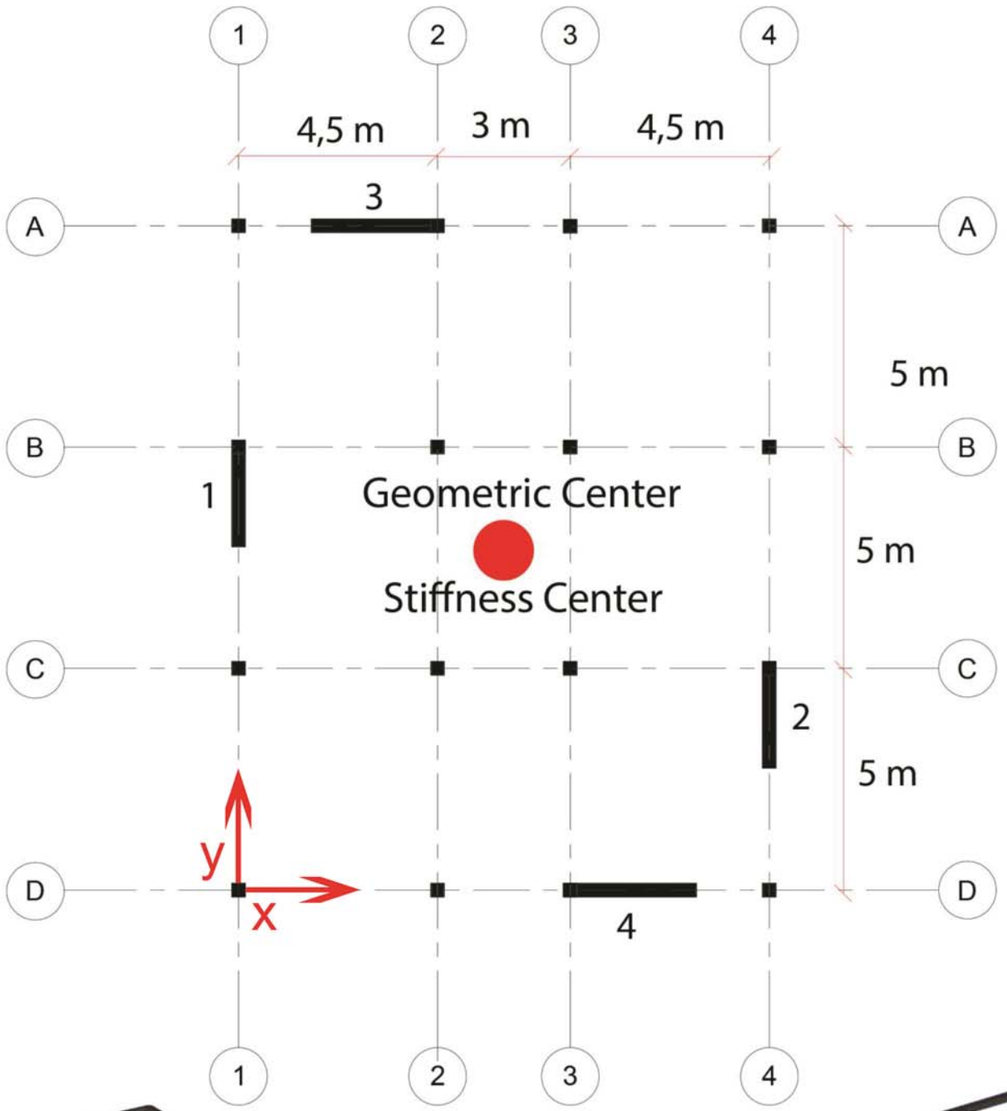


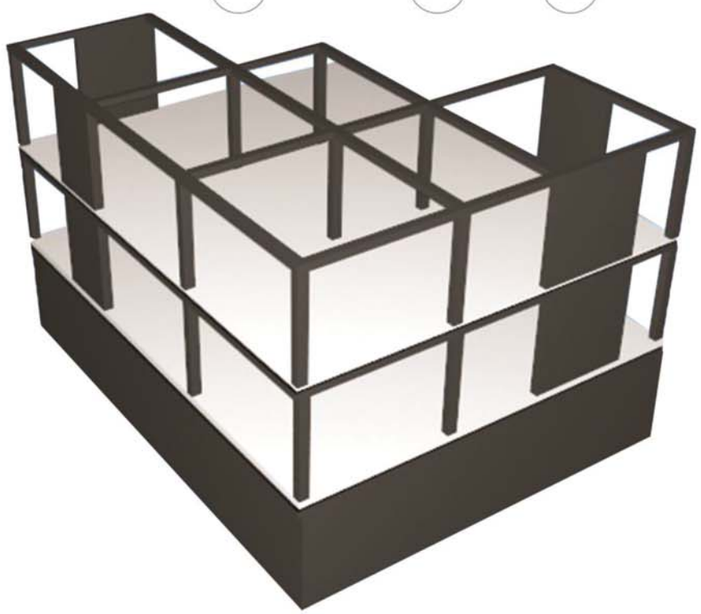
SECTION BB

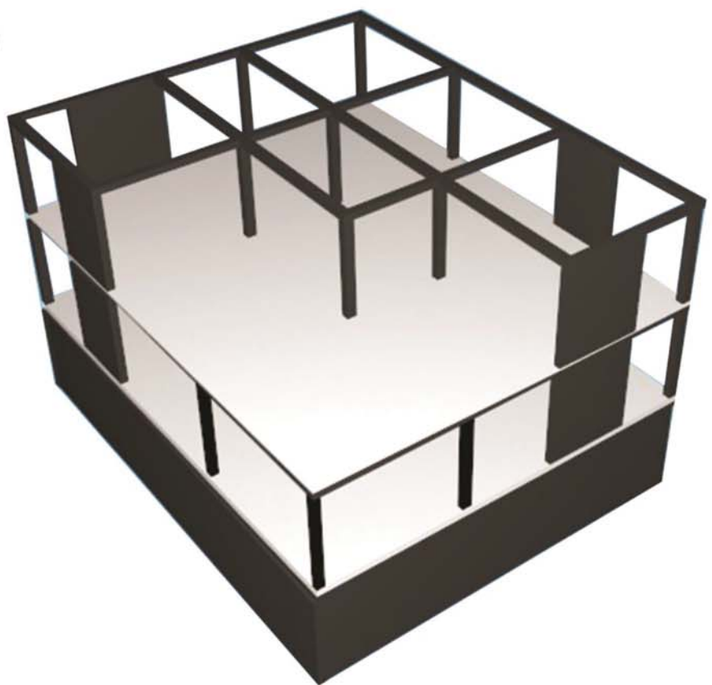
scale : 1/100



STRUCTURAL SYSTEM:







GEOMETRIC CENTER

Since, it is pure geometry i.e. the form is symmetric, geometric center is at the center of the building .

STIFFNESS CENTER

The dimensions of shear walls on y axis are 0.3x2.4 (namely 1,2) According to y-axis:

$$\frac{[(1/12) \times (0,3) \times (2,4)^3 \times 0] + [(1/12) \times (0,3) \times (2,4)^3 \times 12]}{[(1/12) \times (0,3) \times (2,4)^3] \times 2} = 6$$

The dimensions of shear wall on x-axis are 0,3x3 (namely 3,4) According to x-axis:

$$\frac{[(1/12) \times (0,3) \times (3)^3 \times 15] + [(1/12) \times (0,3) \times (3)^3 \times 0]}{[(1/12) \times (0,3) \times (3)^3] \times 2} = 7,5$$

Coordinates of the Stiffness Center is **6;7,5** so it's coincides with Geometric Center

Shear Wall Percentage

Total Floor Area: 180 m²

Area of Shear Walls on y direction:

0.3x2,4x2 = 1.44 m²

The Ratio of shear wall area in y direction to floor area

1,44/180 = 0,008 ⟶ 0,8 %

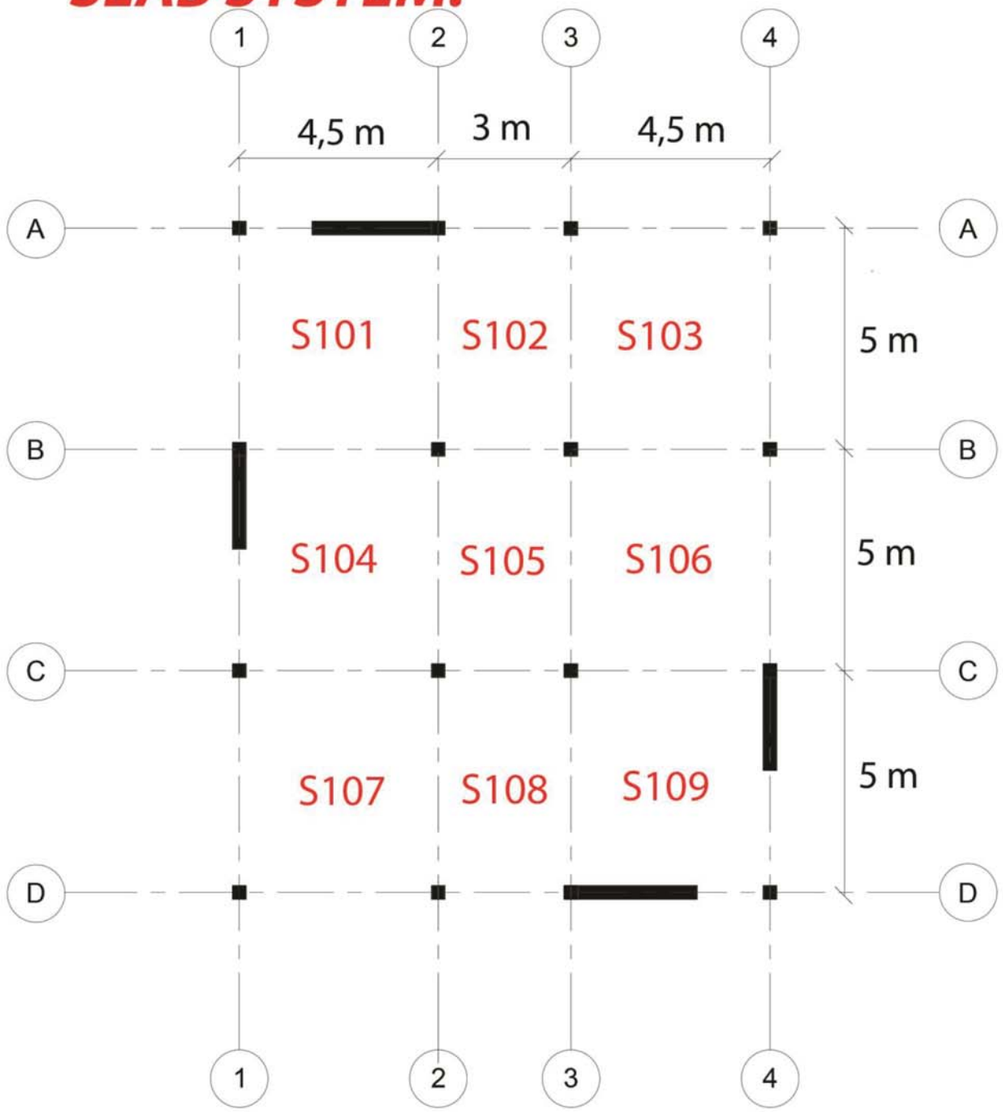
Area of Shear Walls on x direction:

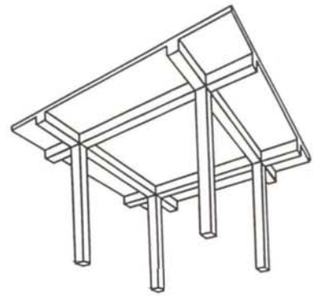
0.3x3x2 = 1.8 m²

The Ratio of shear wall area in x direction to floor area

1,8/180 = 0,01 ⟶ 1 %

SLAB SYSTEM:





Two way solid slab is selected.

formula: $t \geq \frac{l_{short}}{15+\frac{20}{\frac{l_l}{l}}} \times \left(1 - \frac{\alpha}{4}\right)$

$$\alpha = \frac{\text{length of continuous edges}}{\text{total length of all edges}}$$

$$\alpha_{S101} = \frac{4,5+5+3}{4,5+5+4,5+5} = 0,66$$

$$\alpha_{S102} = \frac{5+3+5}{3+5+3+5} = 0,81$$

$$\alpha_{S103} = \frac{4,5+5}{4,5+5+4,5+5} = 0,5$$

$$\alpha_{S104} = \frac{4,5+5+4,5+2,4}{4,5+5+4,5+5} = 0,87$$

$$\alpha_{S105} = \frac{3+5+3+5}{3+5+3+5} = 1$$

$$\alpha_{S106} = \frac{4,5+5+4,5}{4,5+5+4,5+5} = 0,73$$

$$\alpha_{S107} = \frac{4,5+5}{4,5+5+4,5+5} = 0,5$$

$$\alpha_{S108} = \frac{5+3+5}{3+5+3+5} = 0,81$$

$$\alpha_{S109} = \frac{4,5+5+3+2,4}{4,5+5+4,5+5} = 0,78$$

$$t_{101} = \frac{4,5}{15+\frac{20}{\frac{5}{4,5}}} \times \left(1 - \frac{0,73}{4}\right) = 11,14 \text{ cm}$$

$$t_{106} = \frac{4,5}{15+\frac{20}{\frac{5}{4,5}}} \times \left(1 - \frac{0,73}{4}\right) = 11,14 \text{ cm}$$

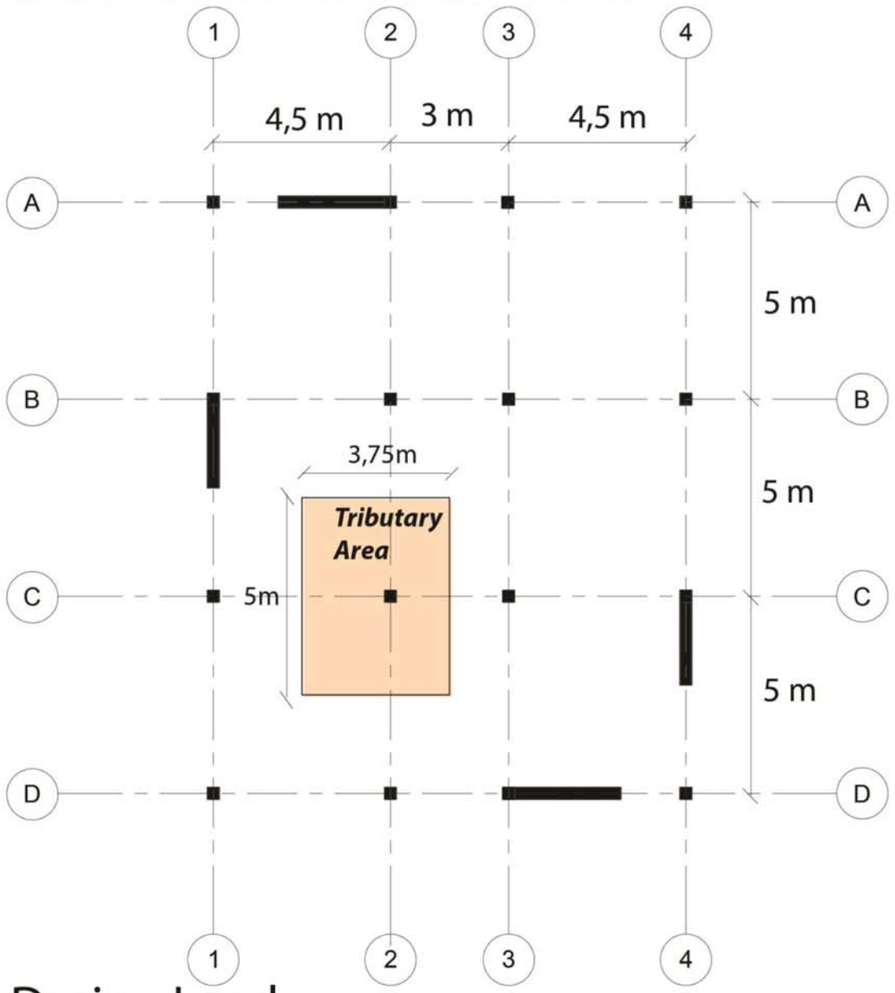
$$t_{103} = \frac{4,5}{15+\frac{20}{\frac{5}{4,5}}} \times \left(1 - \frac{0,5}{4}\right) = 11,93 \text{ cm}$$

$$t_{107} = \frac{4,5}{15+\frac{20}{\frac{5}{4,5}}} \times \left(1 - \frac{0,5}{4}\right) = 11,93 \text{ cm}$$

Since the most critical slab thickness t103 and t107 =11,93 cm

Slab Thickness : **12 cm**

COLUMN DIMENSIONS:



Design Loads:

Dead Load:

Own Weight: 0,12 x 2,4 = 0,288 t/m²
Levelling: 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

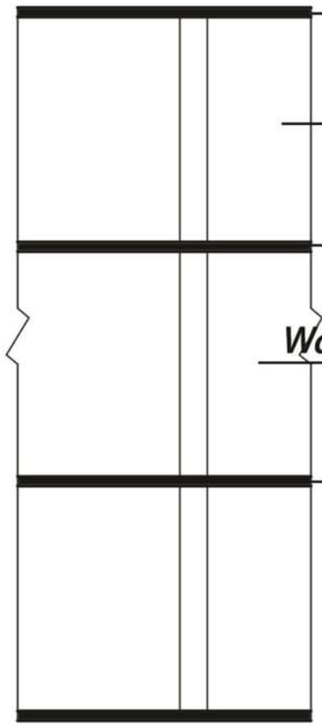
0,288 + 0,096 + 0,05 + 0,04 = 0,474 t/m² ≅ 0,5 t/m²

Live Load: 0,2 t/m²

TOTAL LOAD: (1,4 x 0,5) + (1,6 x 0,2) = 1,02 t/m²

Tributary Area

Assume Beam Depth is 50 cm so Wall Height: 2,5 m



Slab Load: (3,75m x 5m) x 1,02 t/m² = 19,125 t = 19125 kg

Wall Load: (8,4m x 2,5m) x 0,45 t/m² = 9,45 t = 9450 kg

Slab Load: (3,75m x 5m) x 1,02 t/m² = 19,125 t = 19125 kg

Wall Load: (10,53m x 2,5m) x 0,45 t/m² = 11,846 t = 11846 kg

Slab Load: (3,75m x 5m) x 1,02 t/m² = 19,125 t = 19125 kg

Note : To be on the safe side, door openings are ignored.

TOTAL LOAD =19125 + 9450 + 19125 + 11846 + 19125 = 78671 kg

$$\text{then; } Ac \geq \frac{Nd}{0{,}75 \times fcd}$$

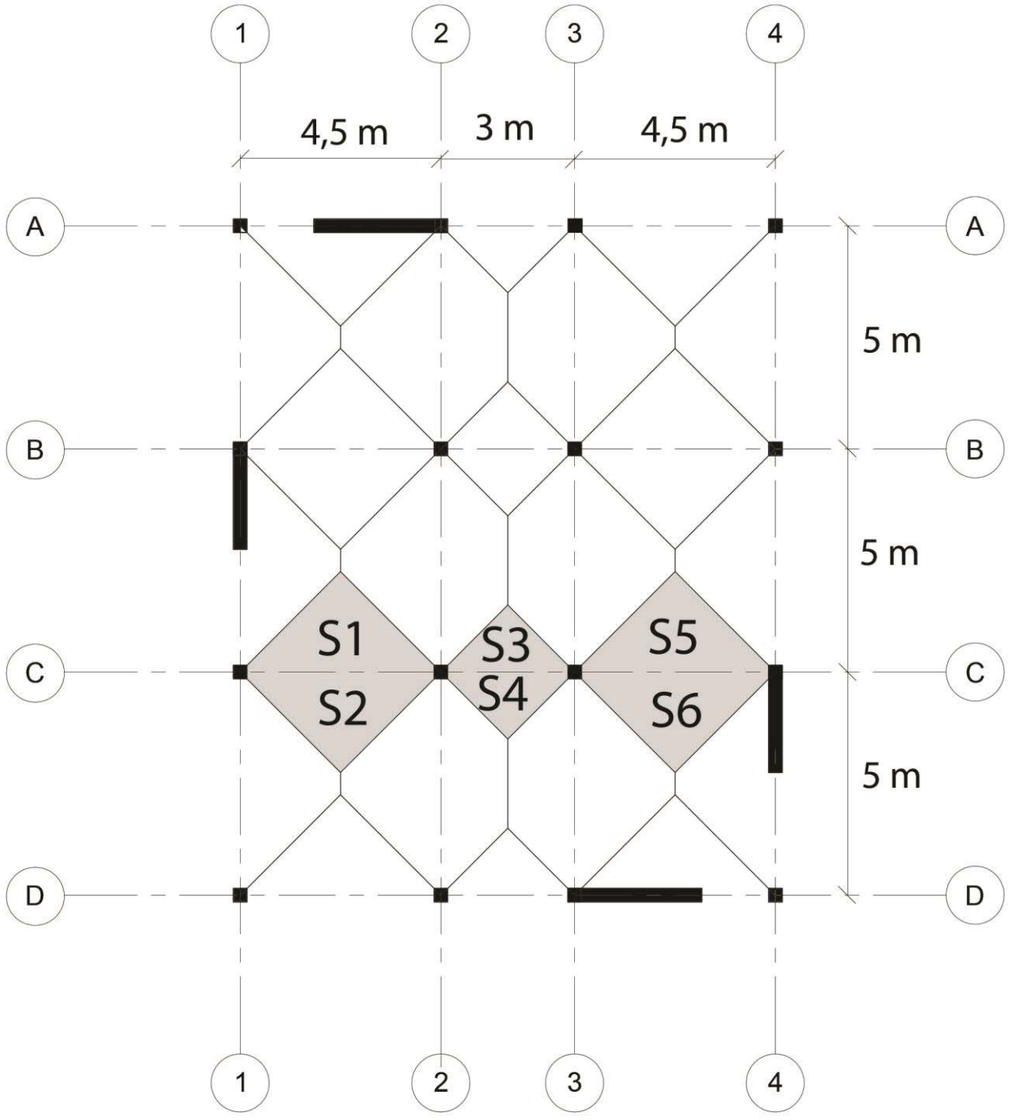
$$\frac{78671}{0{,}75 \times 130}$$

then; Ac ≥ 806,88 cm²

30 x 30 = 900 > 806,88

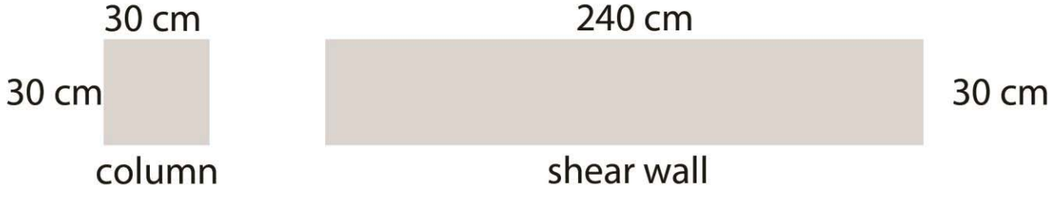
30 x 30

BEAM ANALYSIS



$I_{column} = 1/12 \times 0,3 \times (0,3)^3 = 0,000675\ m^4$

$I_{shear\ wall} = 1/12 \times 2,4 \times (0,3)^3 = 0,0054\ m^4$



For Short Span

$$W = Pd \times \frac{l_{short}}{3}$$

$Pd = (1,4 \times DL) + (1,6 \times LL)$

$Pd = (1,4 \times 0,5) + (1,6 \times 0,2) = 1,02\ t/m^2$

Load on region a (S1 & S2) :

$$S1 = 1,02 \times \frac{4,5}{3} = 1,53\ t/m$$

$$S1 = 1,02 \times \frac{4,5}{3} = 1,53\ t/m$$

Wall Load: $1,4 \times 0,45 \times 2,5 = 1,57\ t/m$

$S1 + S2 + Wall\ Load = 1.53 + 1.53 + 1,57 =$ **4,63 t/m**

Load on region b (S3 & S4) :

$$S3 = 1,02 \times \frac{3}{3} = 1,02\ t/m$$

$$S4 = 1,02 \times \frac{3}{3} = 1,02\ t/m$$

Wall Load: $1,4 \times 0,45 \times 2,5 = 1,57\ t/m$

$S3 + S4 + Wall\ Load = 2,04 + 1,57 =$ **3,61 t/m**

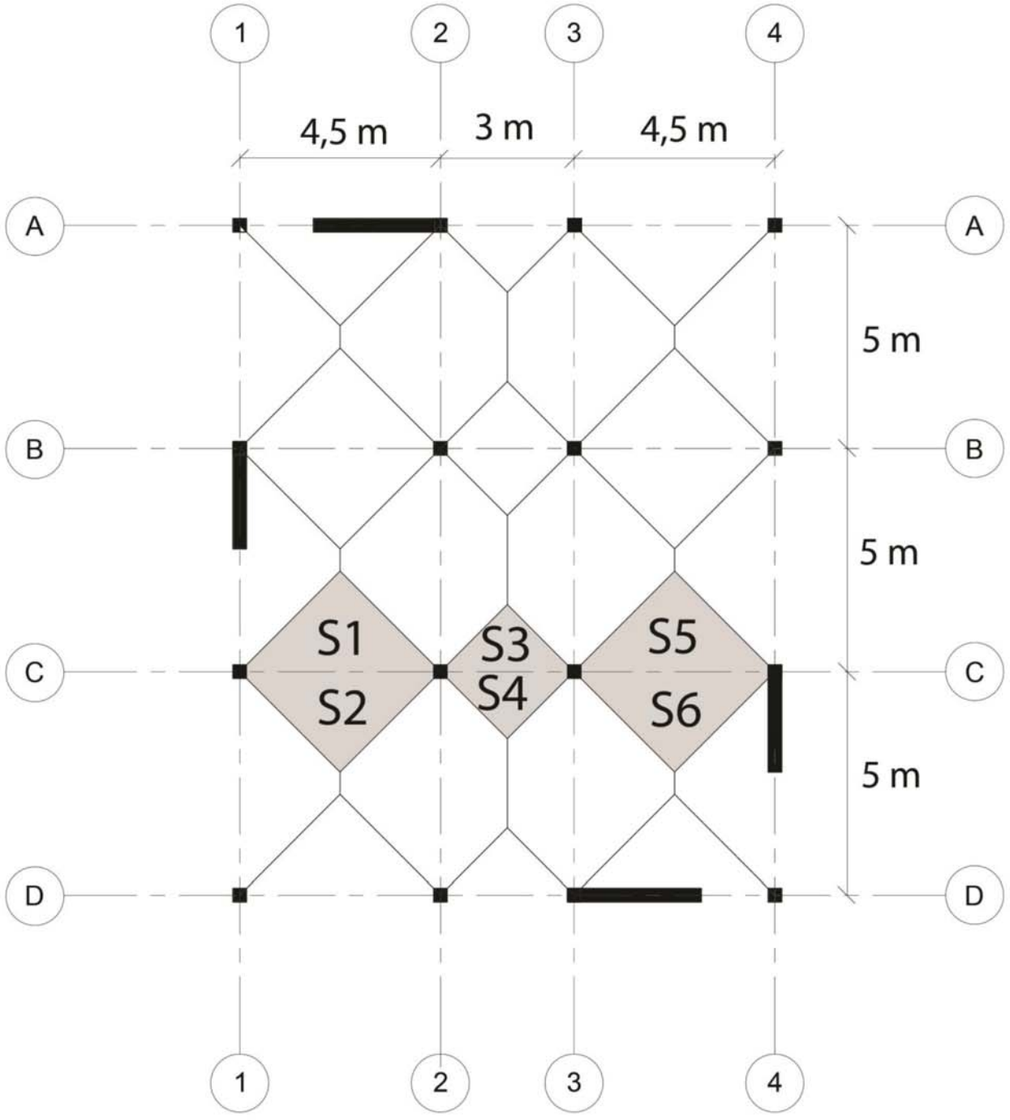
Load on region c (S5 & S6):

$$S5 = 1,02 \times \frac{4,5}{3} = 1,53\ t/m$$

$$S6 = 1,02 \times \frac{4,5}{3} = 1,53\ t/m$$

Wall Load: $1,4 \times 0,45 \times 2,5 = 1,57\ t/m$

$S5 + S6 + Wall\ Load = 1.53 + 1.53 + 1,57 =$ **4,63 t/m**



$$r_{1-2} = \frac{0{,}003125 / 4{,}5}{(0{,}003125 / 4{,}5) + 2 \times (0{,}000675 / 3)} = \mathbf{0{,}606}$$

$$r_{2-1} = \frac{0{,}003125 / 4{,}5}{2 \times (0{,}000675 / 3) + (0{,}003125 / 4{,}5) + (0{,}003125 / 3)} = \mathbf{0{,}317}$$

$$r_{2-3} = \frac{0{,}003125 / 3}{2 \times (0{,}000675 / 3) + (0{,}003125 / 4{,}5) + (0{,}003125 / 3)} = \mathbf{0{,}476}$$

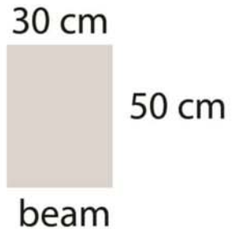
$$r_{3-2} = \frac{0{,}003125 / 3}{2 \times (0{,}000675 / 3) + (0{,}003125 / 3) + (0{,}003125 / 4{,}5)} = \mathbf{0{,}476}$$

$$r_{3-4} = \frac{0{,}003125 / 4{,}5}{2 \times (0{,}000675 / 3) + (0{,}003125 / 3) + (0{,}003125 / 4{,}5)} = \mathbf{0{,}317}$$

$$r_{4-3} = \frac{0{,}003125 / 4{,}5}{2 \times (0{,}0054 / 3) + (0{,}003125 / 4{,}5)} = \mathbf{0{,}161}$$

Assume the beam depth is 50 cm

$$I_{beam} = 1/12 \times 0{,}3 \times (0{,}5)^3 = 0{,}003125 \text{ m}^4$$

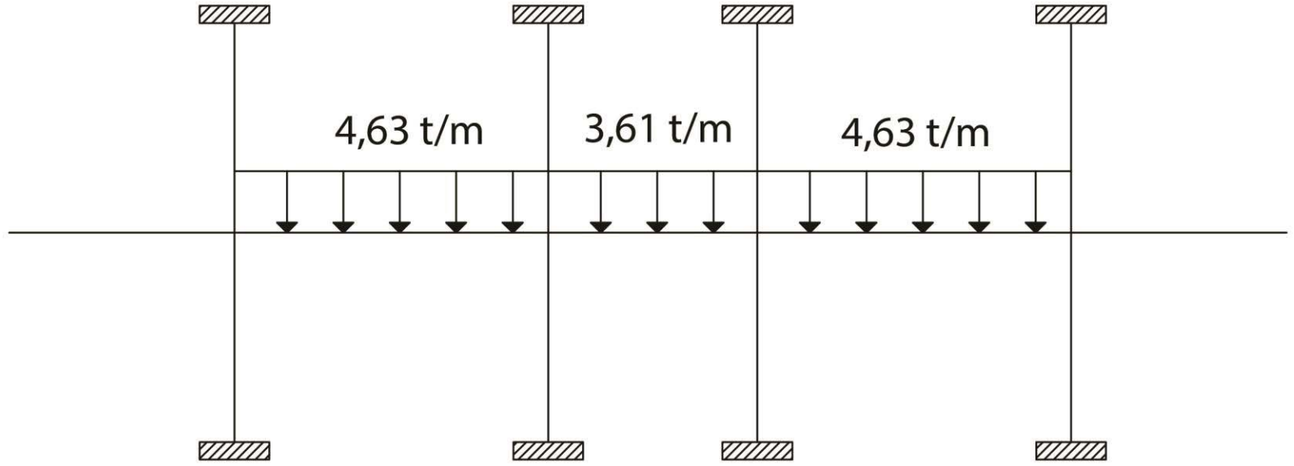


$$r = \frac{I/l}{\sum I/l}$$

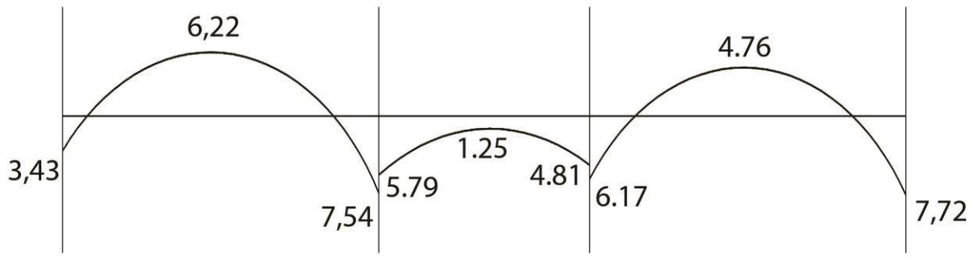
$$\mathbf{FEM} = \frac{W \times l^2}{12} \qquad \mathbf{FEM}_{1-2} = \frac{4{,}63 \times (4{,}5)^2}{12} = 7{,}81 \text{ tm}$$

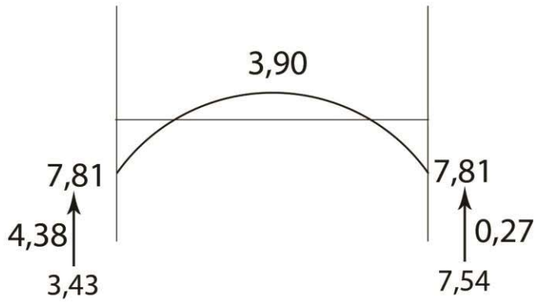
$$\mathbf{FEM}_{2-3} = \frac{3{,}61 \times 3^2}{12} = 2{,}70 \text{ tm} \qquad \mathbf{FEM}_{3-4} = \frac{4{,}63 \times (4{,}5)^2}{12} = 7{,}81 \text{ tm}$$

TWO CYCLE METHOD



	0,6		0,3	0,5	0,5	0,3		0,1
FEM	7,81		-7,81	2,70	-2,70	7,81		-7,81
	0,76		-2,34	-1,27	1,27	0,39		-0,76
$\sum_1$	8,57		-10,15	1,43	-1,43	8,20		-8,57
	-5,14		2,61	4,36	-3,38	-2,03		0,85
$\sum_2$	3,43		- 7,54	5,79	- 4,81	6,17		- 7,72



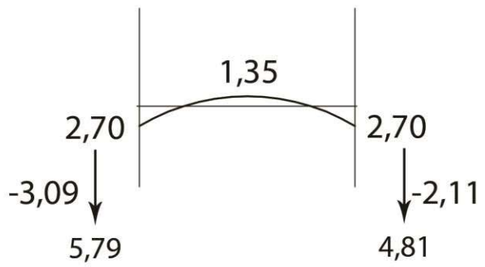


First Span:

$$\frac{4{,}38 + 0{,}27}{2} = 2{,}32$$

Mid - Span Moment

$$\frac{4{,}63 \times 4{,}5^2}{24} + 2{,}32 = 6{,}22 \text{ tm}$$

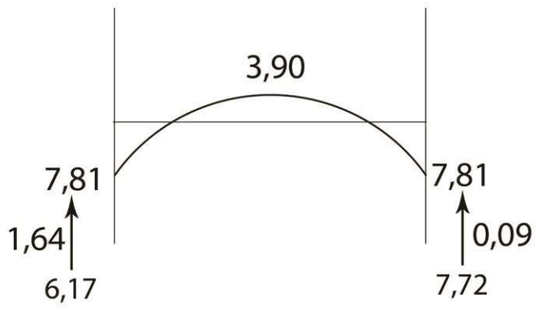


Second Span:

$$\frac{-3{,}09 - 2{,}11}{2} = -2{,}6$$

Mid - Span Moment

$$\frac{3{,}61 \times 3^2}{24} - 2{,}6 = -1{,}25 \text{ tm}$$



Third Span:

$$\frac{1{,}64 + 0{,}09}{2} = 0{,}86$$

Mid - Span Moment

$$\frac{4{,}63 \times 4{,}5^2}{24} + 0{,}86 = 4{,}76 \text{ tm}$$

Beam Depth:

$$K = \frac{bw \times d^2}{M} \qquad 0{,}025 = \frac{30 \times d^2}{772000} \longrightarrow d = 25{,}36$$

$$h \geq d + 5 = 30{,}36$$

$$h \geq 3t = 3x12 = 36 \longrightarrow \text{Beam Depth : 40 cm}$$