HOUSE PROJECT IN UMITKOY

ARCH 332
STRUCTURAL DESIGN IN ARCHITECTURE

Instructors:
M. Halis Günel
Deniz Üçer
2013-14, Spring

GROUP 27

MELİH AKCA

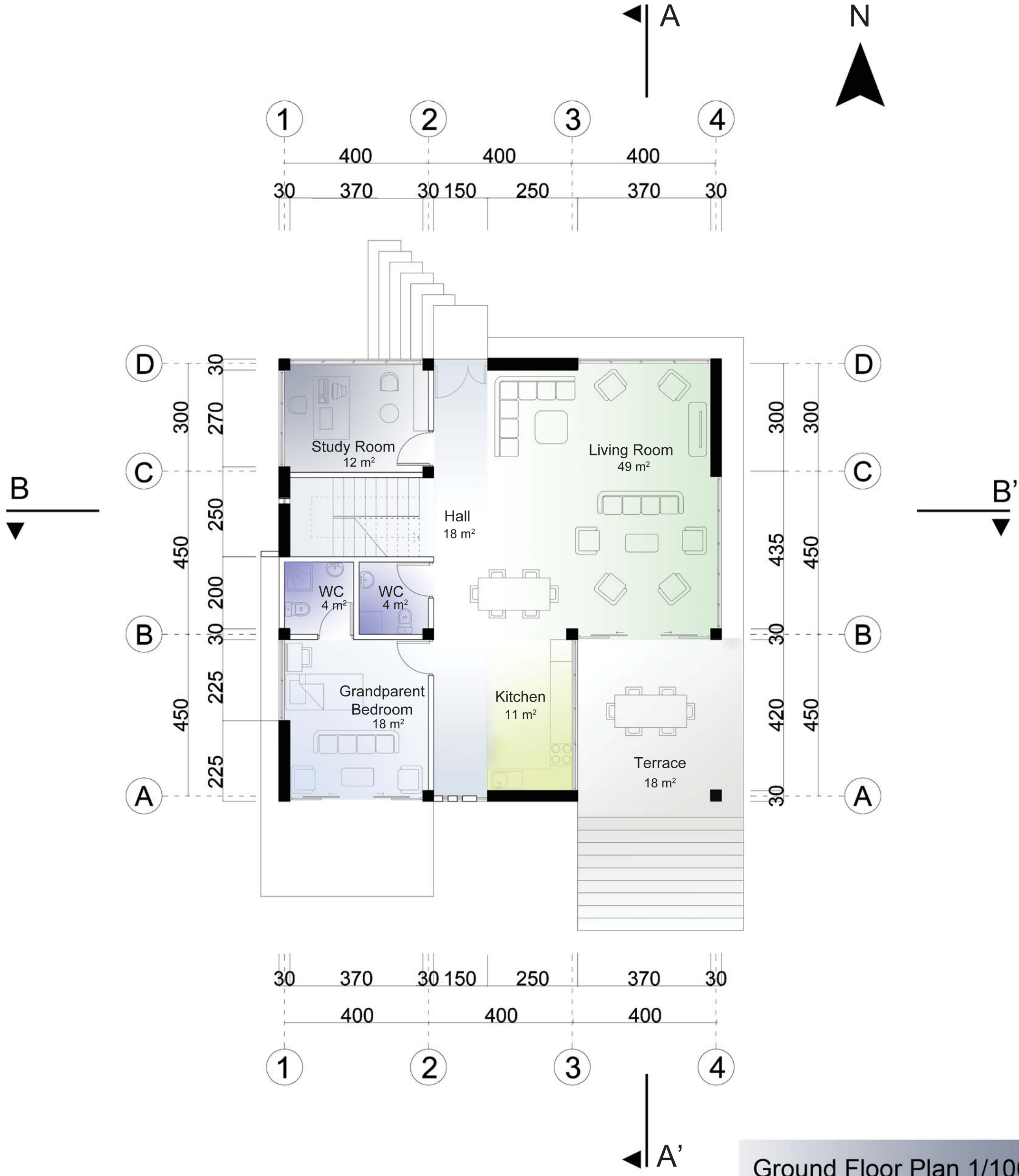
EZGİ ATÇAKAN

JÜLİDE ARZU ULUÇAY

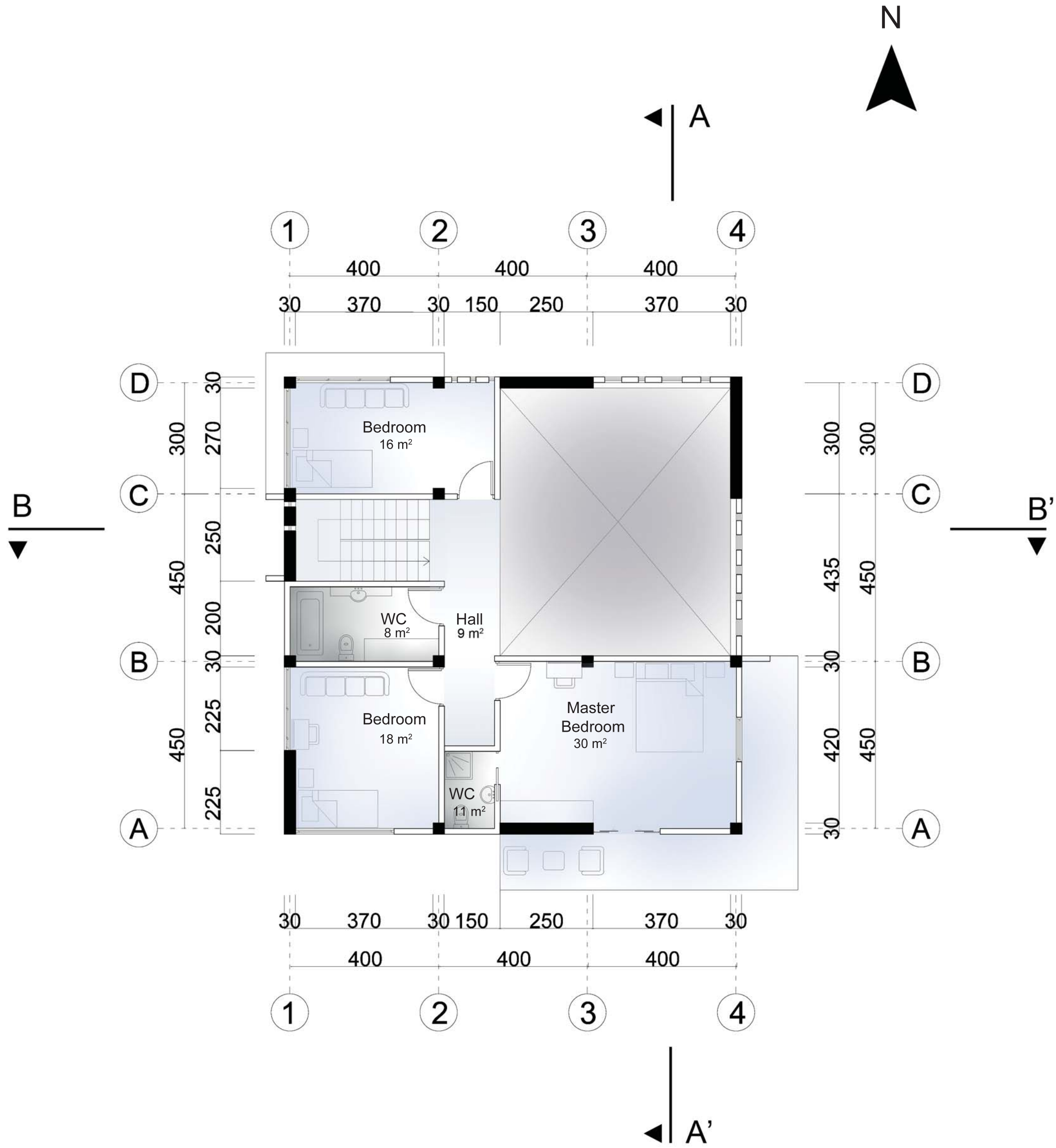
SITE PLAN 1/200

N

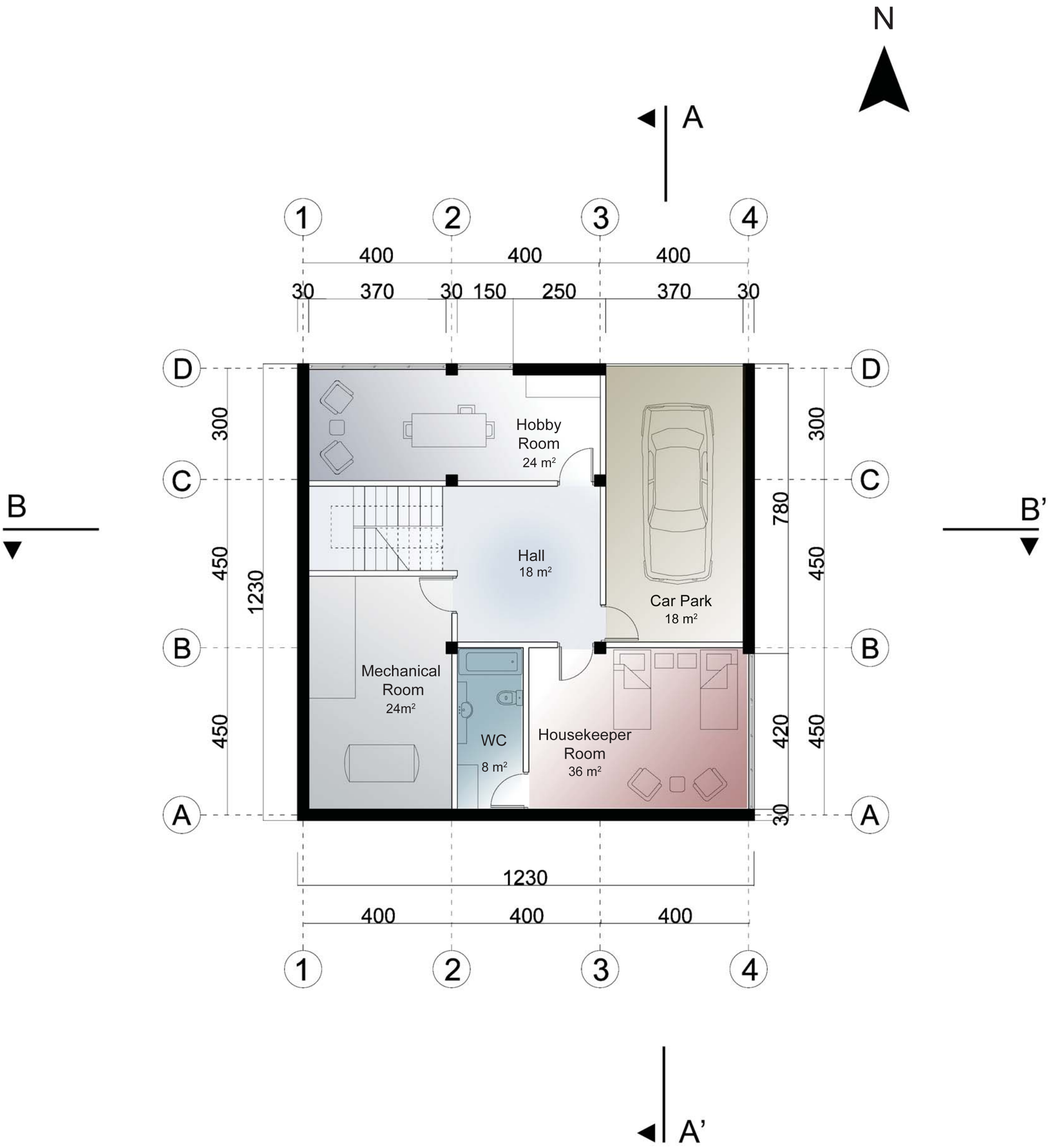
Our aim is to create a living space which connects different area at different floor.In addition, we aimed to associate house to back garden with open air terrace which is at the south part of house.
At facade, we try to emphasize shear wall in terms of color,height and form. We use horizontal and vertical continious elements as eaves and balconies.



Ground Floor Plan 1/100



First Floor Plan 1/100



Basement Floor Plan 1/100

PERSPECTIVE SECTIONS

SECTION A-A’

SECTION B-B’

SECTIONS

Section A-A’ 1/100

Section B-B’ 1/100

BACK GARDEN

Open Air Terrace connect House and Back Garden

FACADES

North Facade

East Facade

South Facade

West Facade

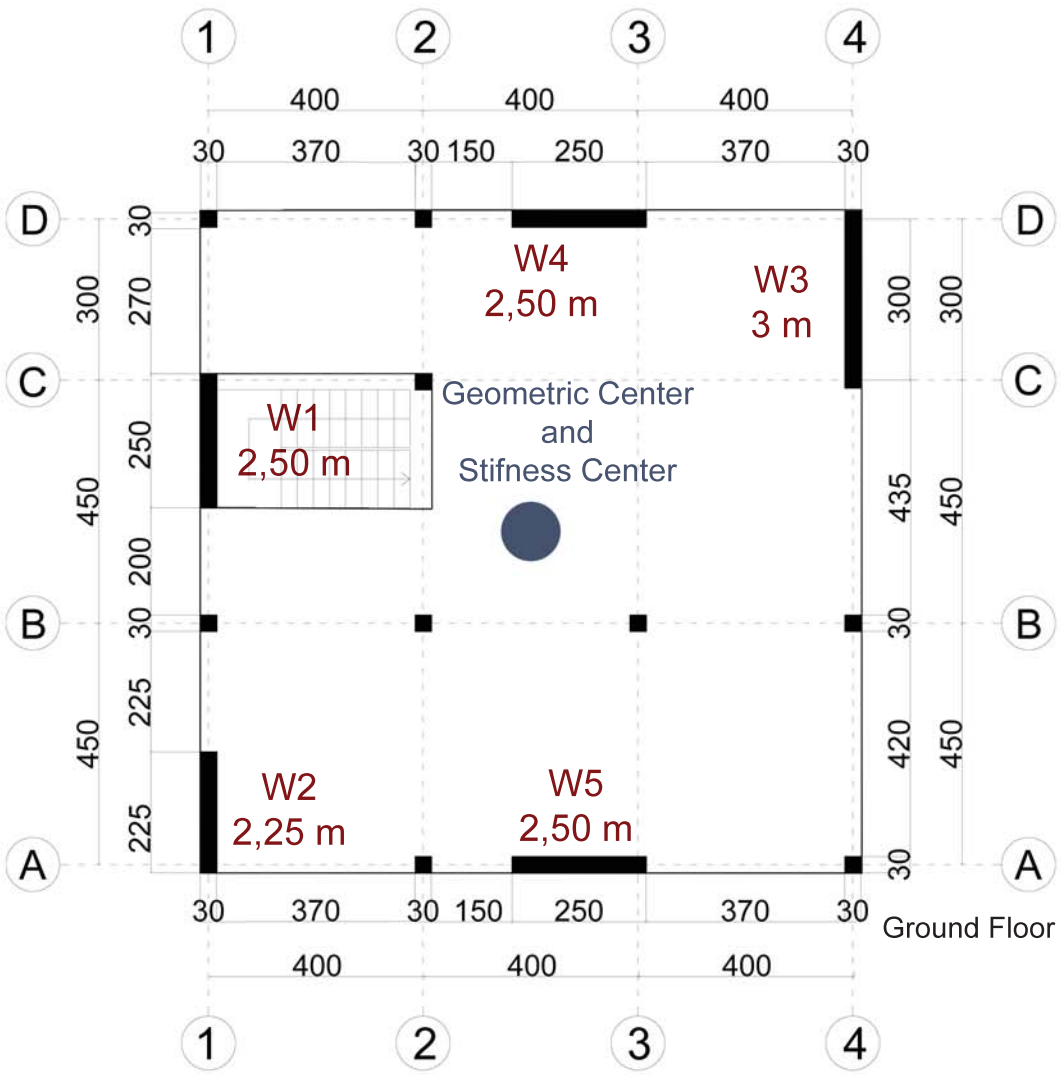
VIEWS FROM INSIDE

Living Area
and Galery Space
with Vertical
Opening

Sun shading
devices above
Staircase

Living Area with
Open Air Terrace
and Galery

SELECTION OF STRUCTURAL SYSTEM



Ground Floor

GEOMETRIC CENTER

Geometric center is at the center of the building because its symmetric

STIFNESS CENTER

$$x_{sc} = \frac{I_1 \ell_1 + I_2 \ell_2 + I_3 \ell_3}{I_1 + I_2 + I_3}$$

$$x_{sc} = \frac{(1/12x0,3x(2,5)^3x0)+(1/12x0,3x(2,25)^3x0)+(1/12x0,3x(3)^3x12)}{(1/12x0,3x(2,5)^3)+(1/12x0,3x(2,25)^3)+(1/12x0,3x(3)^3)}$$

$$= 5,998m$$

$$x_{sc} = 6m$$

$$y_{sc} = \frac{I_4 \ell_4 + I_5 \ell_5}{I_4 + I_5}$$

$$y_{sc} = \frac{(1/12x0,3x(2,5)^3x12)+(1/12x0,3x(2,5)^3x0)}{(1/12x0,3x(2,5)^3)x2}$$

$$y_{sc} = 6m$$

Stiffness center is 6;6 so stifness center and geometric center are coincided.

SHEAR WALL PERCENTAGE

Ground floor area: 144m^2

Area of shear wall on x direction:

0,3x2,50x2=1,5m^2

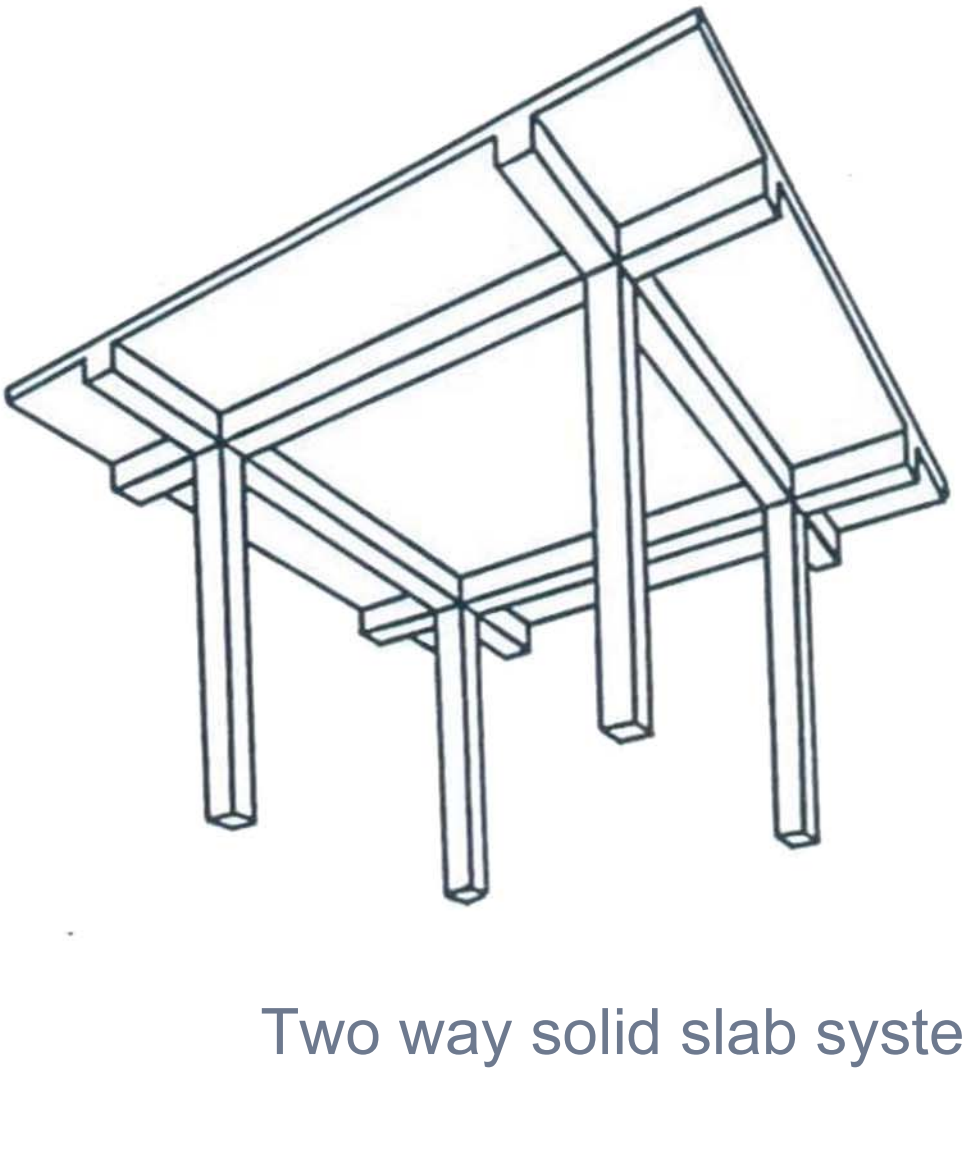
The ratio of shear wall in x direction is **1%**.

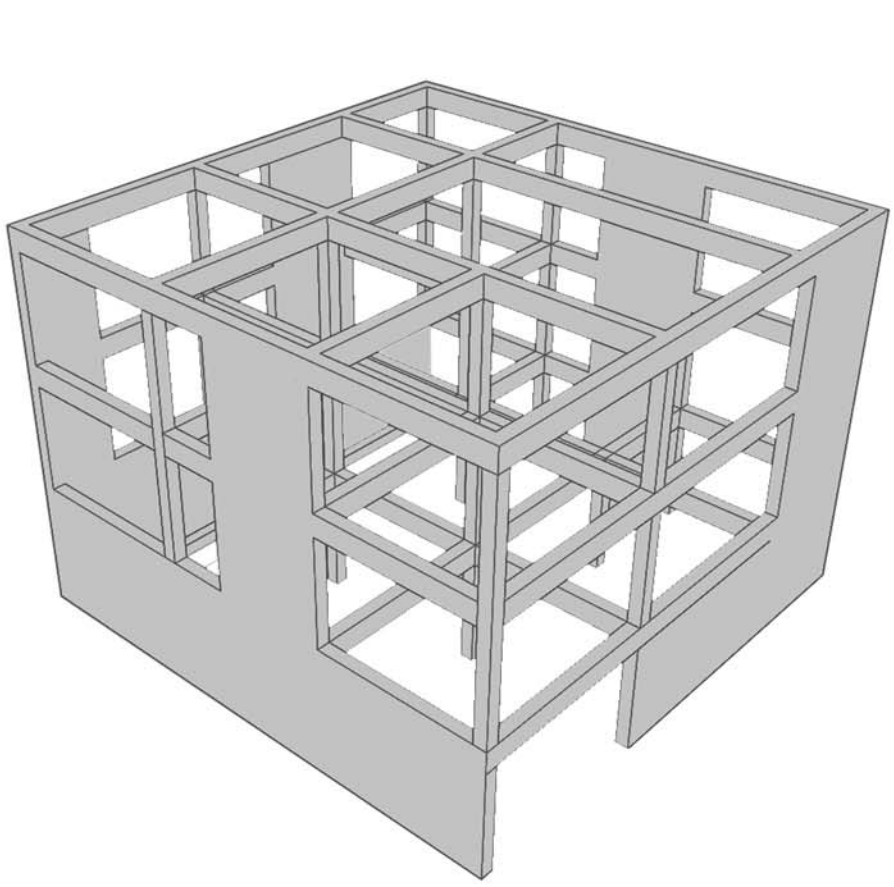
Area of shear wall on y direction:

0,3x2,50+0,3x2,25+0,3x3=2,32 m^2

The ratio of shear wall in x direction is **1,6%.**

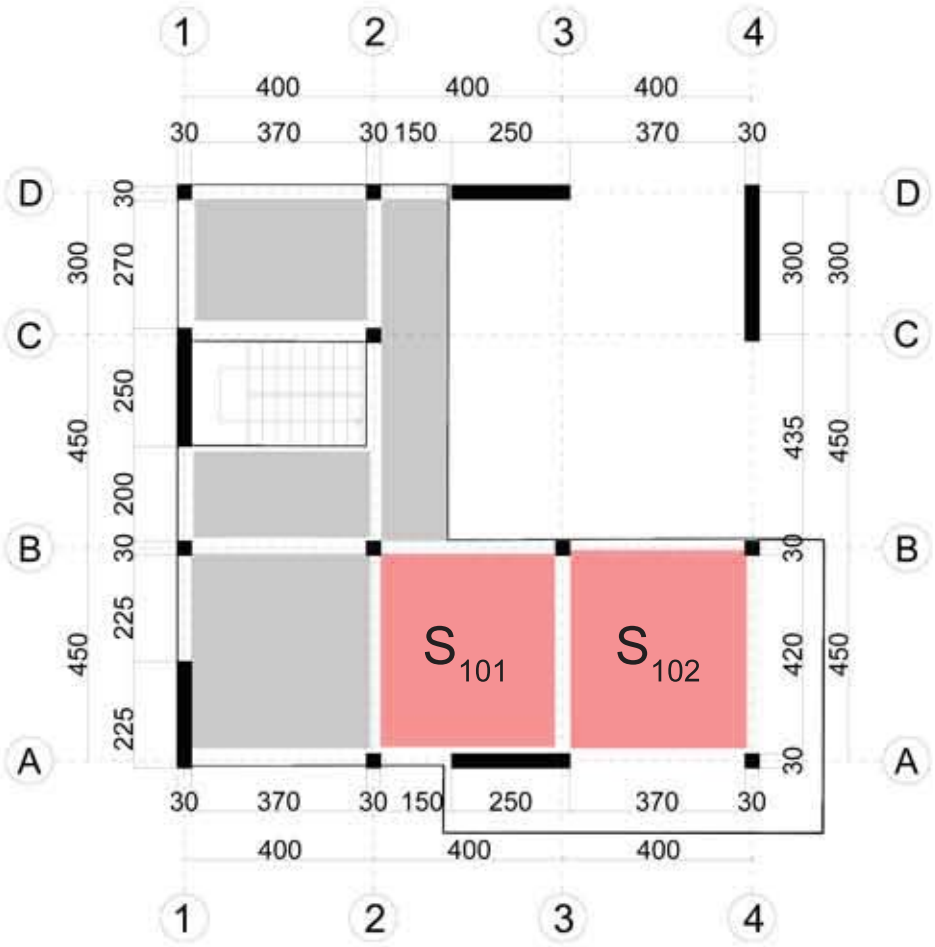
In x direction 0,75%<1% and in y direction 0,75%<1,6% so it is acceptable.





Two way solid slab system is chosen as slab system

FIRST FLOOR SLAB



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

$$\alpha_{S101} = \frac{4+4{,}5+4{,}5}{4+4+4{,}5+4{,}5} = 0.76$$

$$\alpha_{S102} = \frac{4+4{,}5+4{,}5}{4+4+4{,}5+4{,}5} = 0{,}76$$

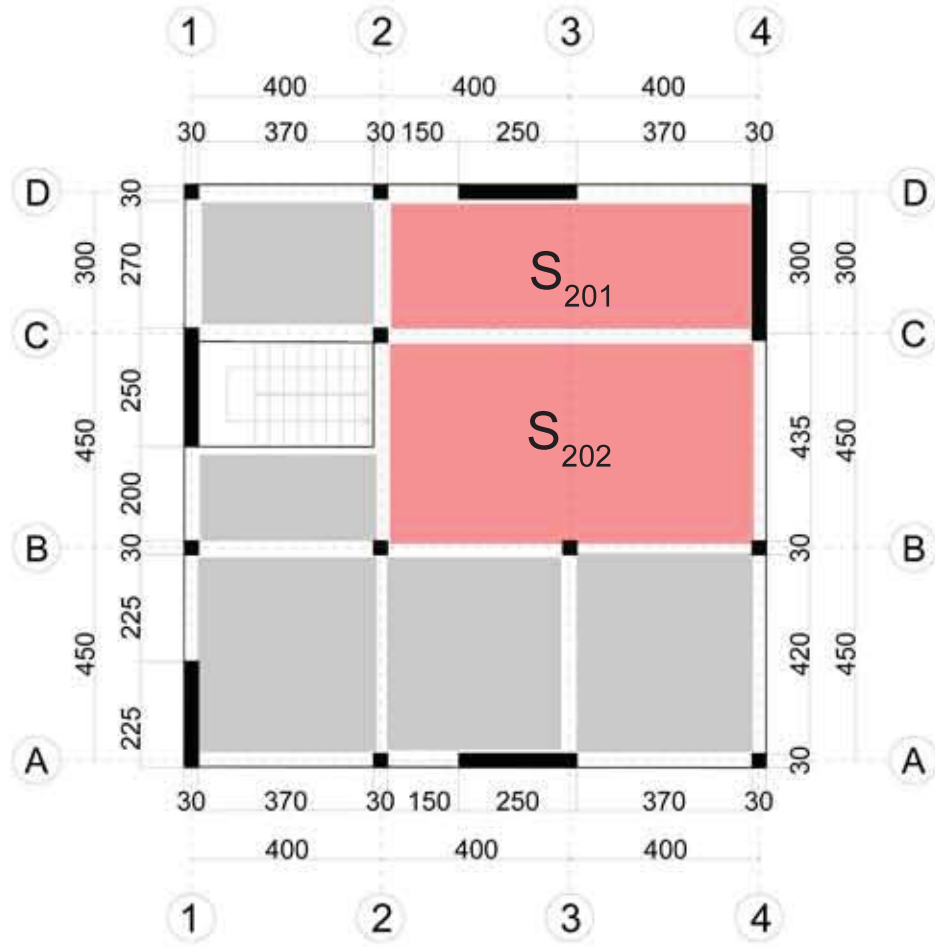
$$t \geq \frac{\ell_{short}}{15+\frac{20}{\frac{\ell_{long}}{\ell_{short}}}} \text{ x } (1-\frac{\alpha}{4})$$

$$t_{S101} = \frac{4}{15+\frac{20}{\frac{4{,}5}{4}}} \text{x} (1-\frac{0.76}{4}) = 0{,}1 \text{ m}$$

$$t_{S102} = \frac{4}{15+\frac{20}{\frac{4{,}5}{4}}} \text{x} (1-\frac{0.76}{4}) = 0{,}1 \text{ m}$$

For first floor slab most critical slabs are s_{101} and $s_{102.}$

ROOF SLAB



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

$$\alpha_{S201} = \frac{3+3+8}{3+3+8+8} = 0{,}63$$

$$\alpha_{S202} = \frac{8+8}{4{,}5+4{,}5+8+8} = 0{,}64$$

$$t \geq \frac{\ell_{short}}{15+\frac{20}{\frac{\ell_{long}}{\ell_{short}}}} \text{ x } (1-\frac{\alpha}{4})$$

$$t_{S201} = \frac{3}{15+\frac{20}{\frac{8}{3}}} \text{x} (1-\frac{0.63}{4}) = 0{,}11 \text{ m}$$

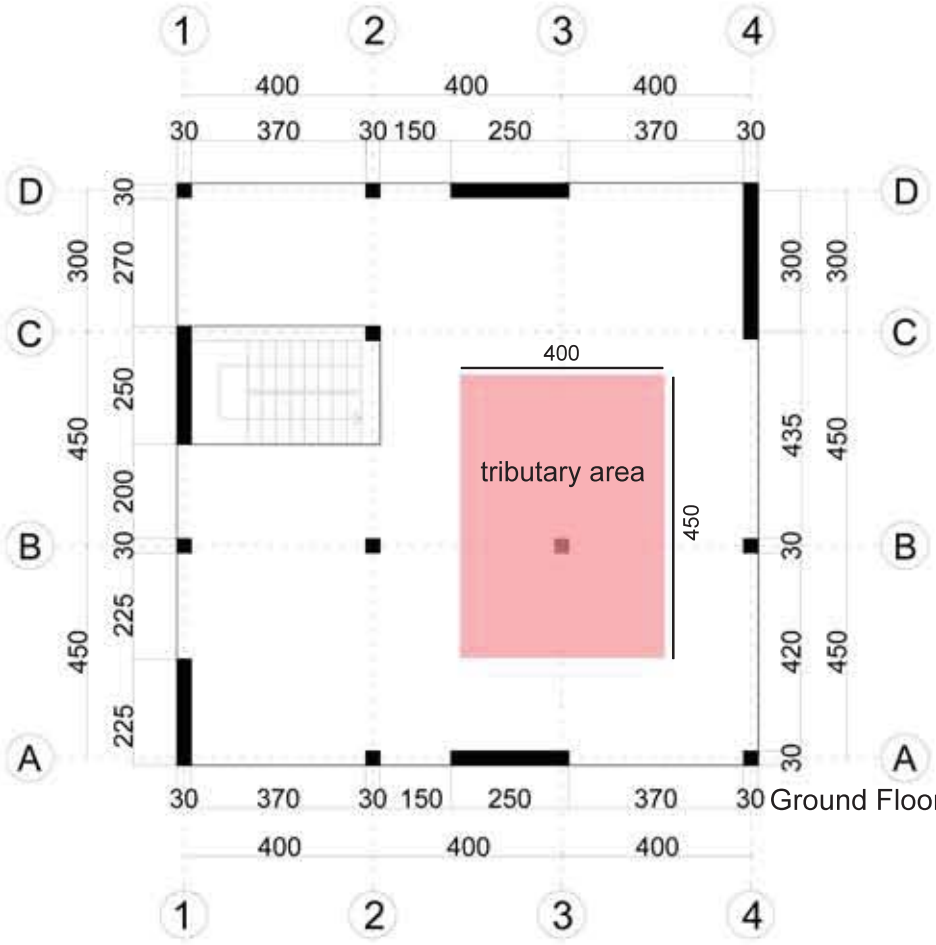
$$t_{S202} = \frac{4{,}5}{15+\frac{20}{\frac{8}{4{,}5}}} \text{x} (1-\frac{0.64}{4}) = 0{,}14 \text{ m}$$

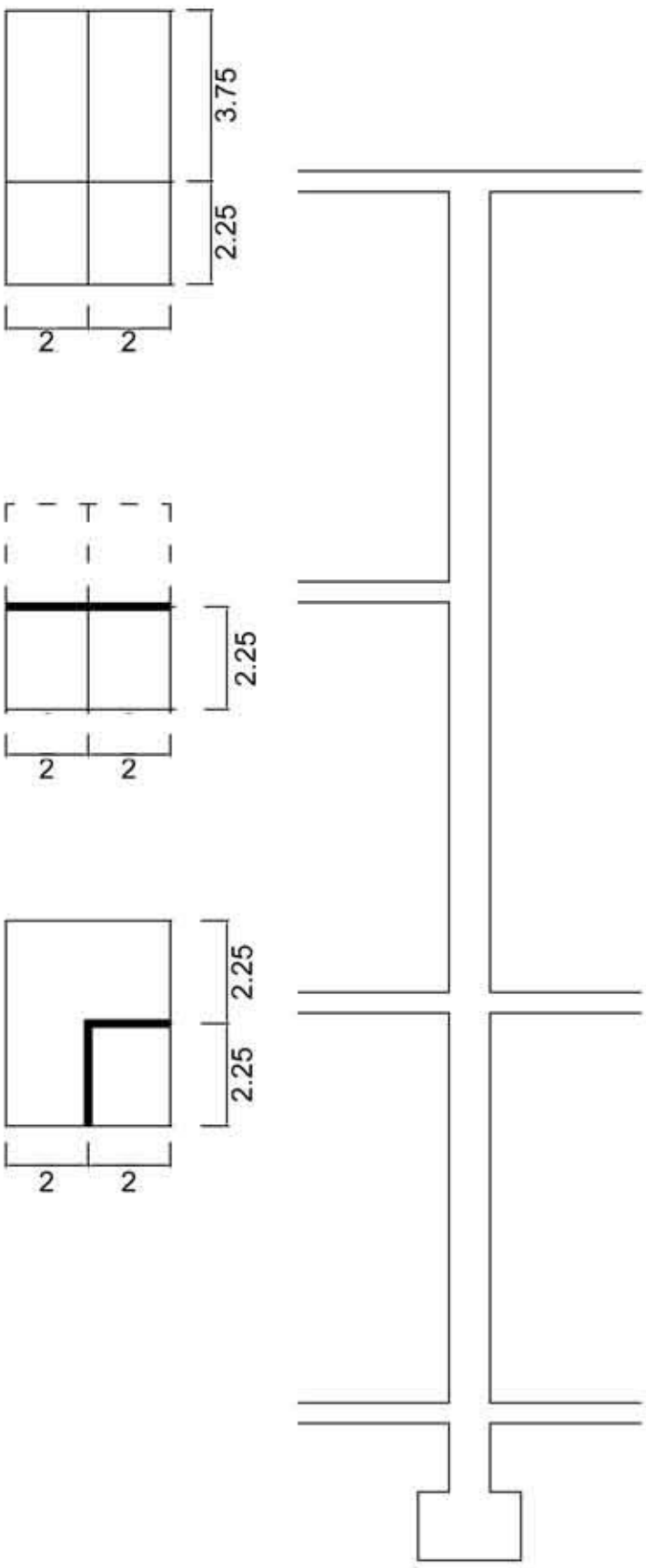
For first floor slab most critical slabs are s_{201} and $s_{202.}$

Since the most critical slab is s_{202} at roof slab and its thickness is 14 cm. Slob thickness should be more than critical slab thikness.

SLAB THICKNESS = 15 cm

COLUMN DIMENSION





Beam depth= $\frac{\text{Longest span}}{12,5} = \frac{800}{12,5} = 64$ cm

Assume beam depth is 65 cm and wall height is 2,35m.

Design Loads for slab:

Dead Load:

own weight:0,15x2,4=0,36 t/m²
levelling:0,004x2,4=0,096 t/m²
covering:0,025x2=0,05 t/m²
plastering:0,02x2=0,04 t/m²

=0,54 t/m²

Live Load=0,2 t/m²

Total Load=(1,4x0,54)+(1,6x0,2)=1,08 t/m²

slab load: (3,75+2,25)x(2+2)x1,08=25,92 t

wall load: (2,35)x(2+2)x0,45x1,4=5,92 t

slab load: (2+2)x(2,25)x1,08=9,72

wall load: (2,25+2)x(2,35)x0,45x1,4=6,29

slab load: (2+2)x(2,25+2,25)x1,08=19,44

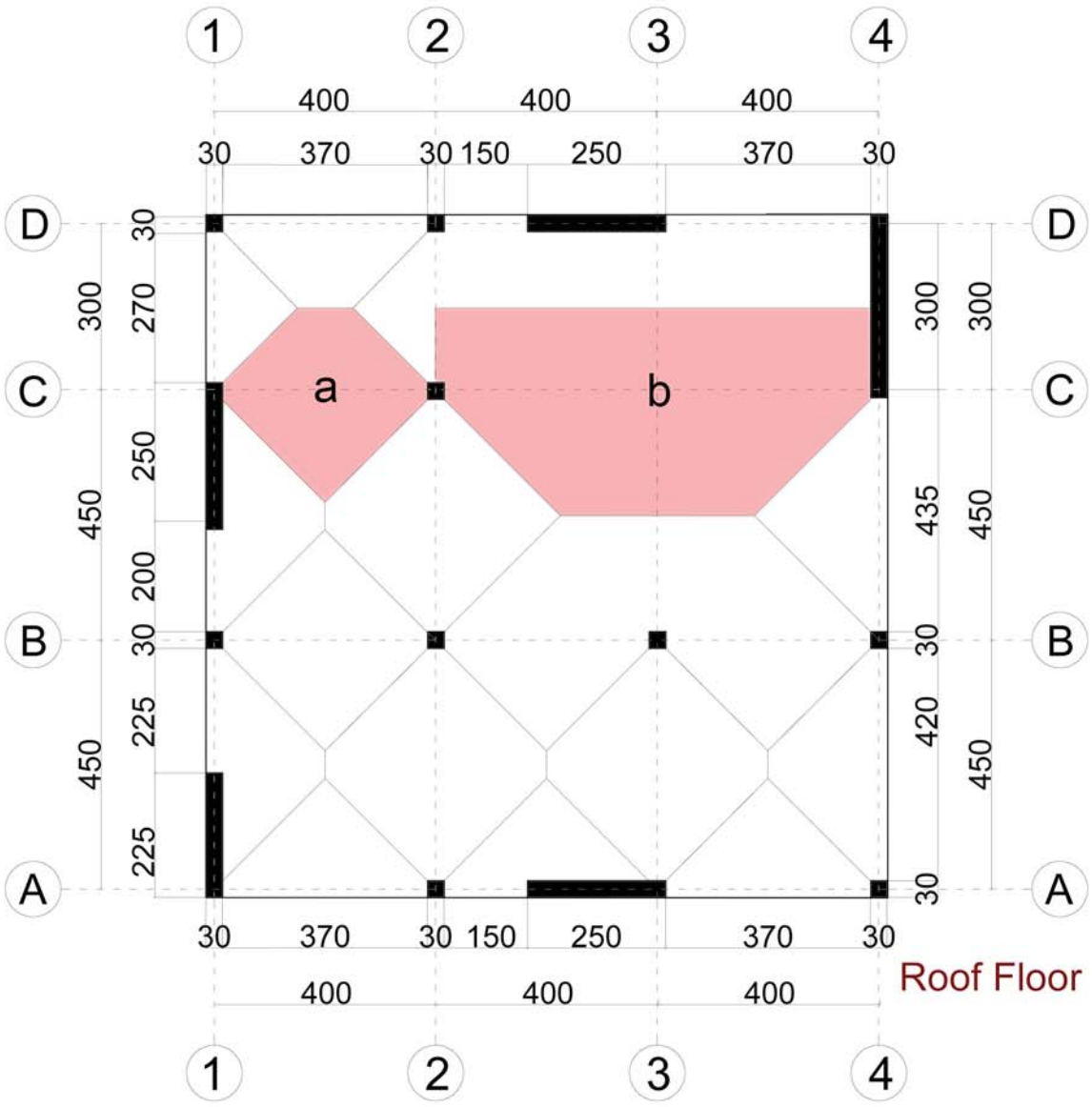
total load: 67,29 t = 67290 kg

Then; $A_c \geq \frac{N_d}{0,75 x f_{cd}}$

$= \frac{67290}{0,75x130} = 690,15$ cm²

Since min $A_c < 750$ cm²

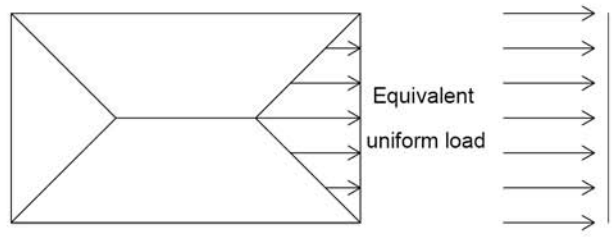
Column dimentions are 30cmx30cm according to TS-500



After calculating several beams, we realize that the most critical beam is roof beam which passes through the gallery

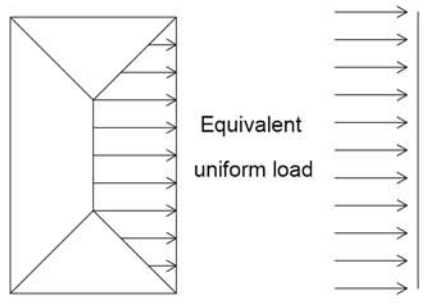
For Short Span

$$P_d x \frac{\ell_{short}}{3}$$



For Long Span

$$P_d x \frac{\ell_{short}}{3} x \left(1{,}5 - \frac{0{,}5}{\frac{(\ell_{long})^2}{(\ell_{short})^2}}\right)$$



P_d=(1,4xDL)+(1,6xLL)

P_d=(1,4x0,54)+(1,6x0,2)

=1,08 t/m²

Load Region a :

$$w_{12} = 1{,}08 \times \frac{3}{3} \times \left(1{,}5 - \frac{0{,}5}{\frac{(4)^2}{(3)^2}}\right) + 1{,}08 \times \frac{4}{3} = 2{,}75 \text{ t/m}$$

Load Region b :

$$w_{24} = \frac{1{,}08 \times 8 \times 3}{2 \times 8} + 1{,}08 \times \frac{4{,}5}{3} \times \left(1{,}5 - \frac{0{,}5}{\frac{(8)^2}{(4{,}5)^2}}\right) = 3{,}79 \text{ t/m}$$

I_{column}=1/12x0,3x(0,3)³=0,000675 m⁴

I_{shear}=1/12x2,5x(0,3)³=0,0056 m⁴

I_{shear2}=1/12x3x(0,3)³=0,0067 m⁴

I_{beam}=1/12x0,3x(0,65)³=0,0068 m⁴

$$\textbf{FEM} = \frac{W \times l^2}{12}$$

$$\textbf{mid-span moment} = \frac{W \times l^2}{24}$$

$$r_{12} = \frac{0{,}0068/4}{(0{,}0068/4)+(0{,}0056/3)} = 0{,}477$$

$$r_{21} = \frac{0{,}0068/4}{(0{,}0068/4)+(0{,}0068/8)+(0{,}000675/3)} = 0{,}612$$

$$r_{24} = \frac{0{,}0068/8}{(0{,}0068/4)+(0{,}0068/8)+(0{,}000675/3)} = 0{,}306$$

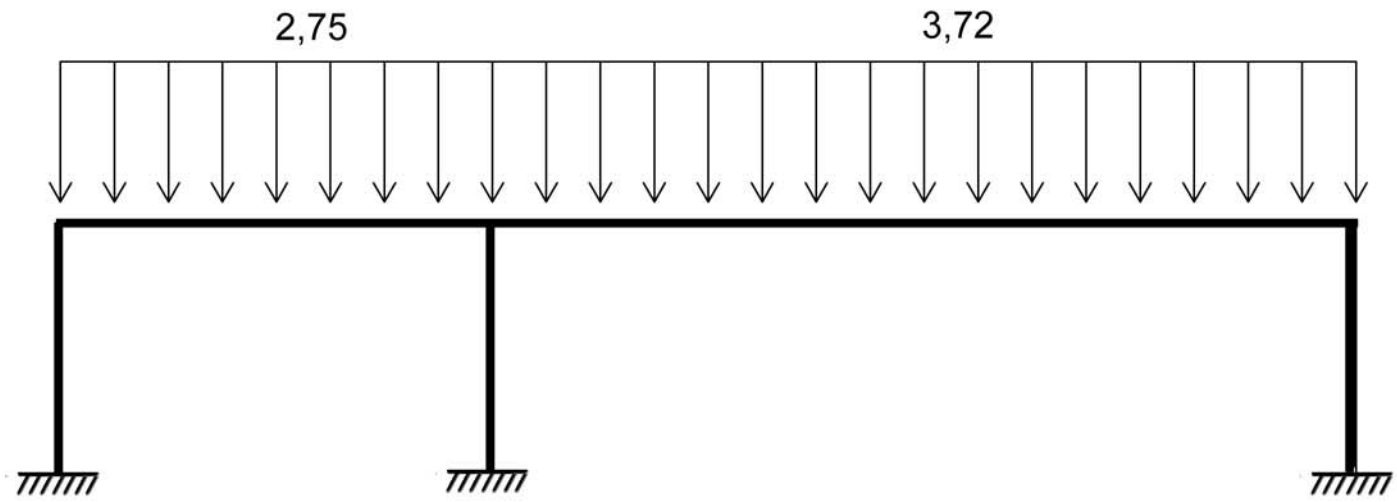
$$r_{42} = \frac{0{,}0068/8}{(0{,}0068/8)+(0{,}0067/3)} = 0{,}276$$

$$FEM_{1\text{-}2} = \frac{2{,}75 \times 4^2}{12} = 3{,}67 \text{ tm}$$

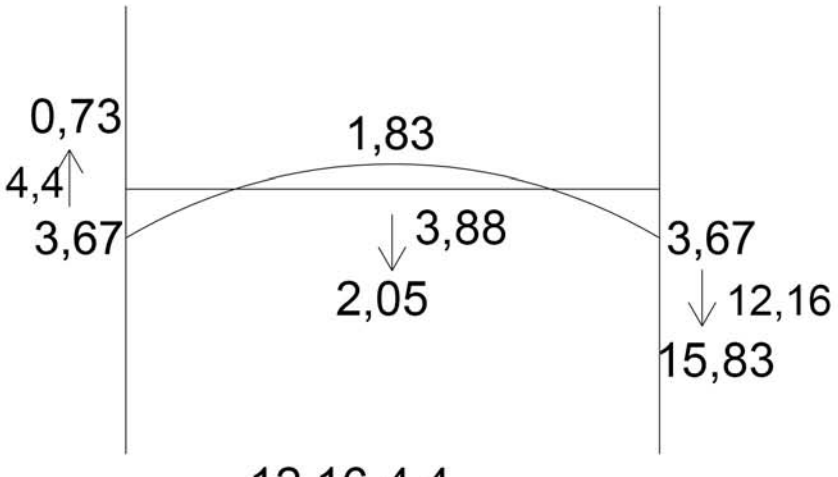
$$\text{mid-span moment}_{1\text{-}2} = \frac{2{,}75 \times 4^2}{24} = 1{,}83$$

$$FEM_{2\text{-}4} = \frac{3{,}79 \times 8^2}{12} = 20{,}21 \text{ tm}$$

$$\text{mid-span moment}_{2\text{-}4} = \frac{3{,}79 \times 8^2}{24} = 10{,}10 \text{ tm}$$

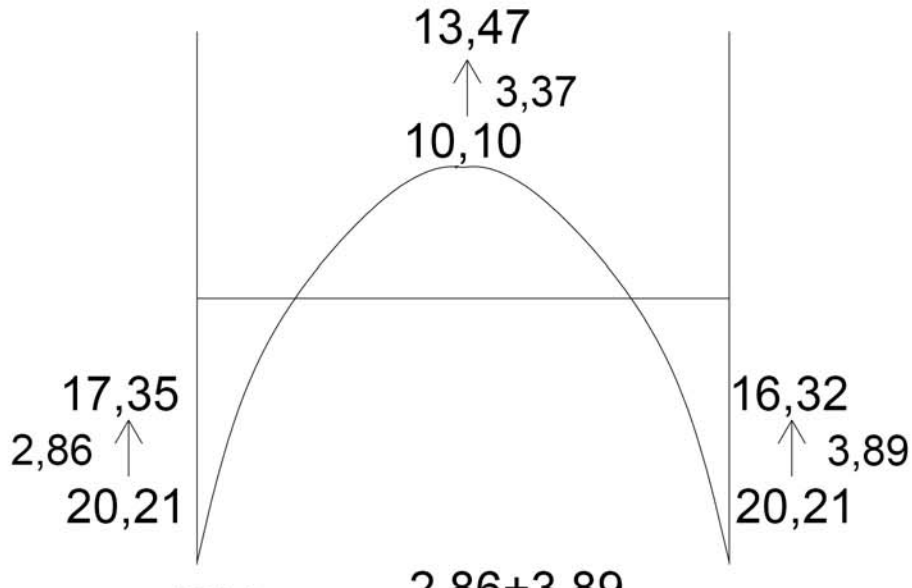


r	0,477	0,612	0,306	0,276
FEM	3,67	-3,67	20,21	-20,21
	-5,06	-0,87	2,78	-2,53
$\sum_1$	-1,39	-4,54	22,99	-22,54
	0,66	-11,29	-5,64	6,22
$\sum_2$	-0,73	-15,83	17,35	-16,32



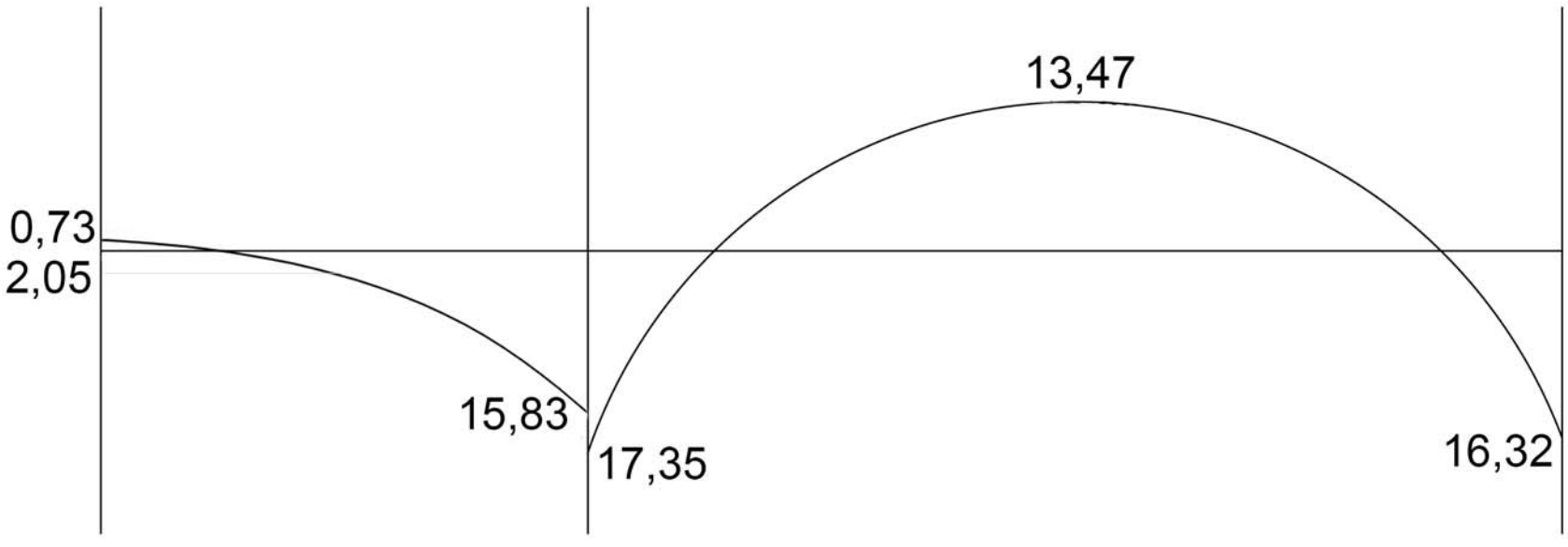
Mid span: $\frac{12,16-4,4}{2}$ =3,88

1,83-3,88= **-0,34**



Mid span: $\frac{2,86+3,89}{2}$ =3,37

10,10+3,37= **13,47**



$K=\frac{bwxd^2}{M}$ =====> $0,025=\frac{30xd^2}{1735000}$ =====> d=38,02

h>d+5 = 42,68 and h>3t and t=15 =====> h>45

Beam Depth = 50 cm