Czech Technical University in Prague

Faculty of Civil Engineering Thákurova 7, 166 29 Praha 6

TECHNICAL REPORT
PART CONCRETE

Diploma Project

RESIDENTIAL APARTMENT BUILDING

Name: Bc.Yosufi Mohammad Fayez

Supervisor: doc.Ing. František Kulhánek, CSc.

Consultant: Ing. Josef Novák, Ph.D.

Academic year:2019/2020

Signature:

Apartment Building Multifunctional

Identification data:

- **Project name:** Residential apartment building (Multifunctional)
- **Location:** Prague Pod Harfou
- **Function of the building:** Apartment building, Administrative, Shopping,Garage.
- **Stage :** Building permits.
- **Investor** : Private.
- **supplier:** will be selected by tender.

2. General description of achitectural and engineering design of the building:

a) Purpose of this object:

- This Apartment building is located in an urban area Pod Harfou Prague 09 Czech Republic the total area of the building is 667 m^2 this building is consists of 7 floors including of the basement,the basement is provided for car parking, ventilation and boiler rooms for the whole residence of the building and on the ground floor there is stores and storage's, staircase , elevators, roof is not accessible to public except repair and maintain reason there s also 4 Apartments

Apartments type:

- Basement:boiler room, ventilation room 1x staircase ,1x corridors,1x elevator the rest of the area is provided for motor and car parking.
- Ground floor:1x staircase, 1x elevator 8x corridors,1x toilets,1x shopping, 1x technical room and also there is 24x storage's.
- 2nd floor:10x offices 1x men toilet,1x women toilet,1x disable toilet,1x cleaning room1x corridor,1x staircase,1x elevator and 1x balcony in one sides of the building.
- On the 3th to the last floors which is 4x apartment, each apartment consists of 1x bed room,1x bath with toilet,1x corridor,1x kitchen with dinning room except apartment A-J as they have one single bed room.
- there is opening in order to have accessibility to the roof for service or emergency case.
- Generally Surrounding the building with dimension of 1,5m there is stone pavements and the other area of the building will be after the rough landscaping grassed and planted with low and medium greenery.
  Generally in order to prevent the transformation of noise to the structure, Sound which transmission caused by footsteps on staircases can be an unpleasant experience and design , insufficient impact sound insulation can cause discomfort to my design. the acoustic solution is done by HTT Halfen system (impact sound insulation) The solutions can be doned by 3 steps.

➢ A: flight to the landing connection is doned by HALFEN HTT impact sound insulation unit with the lenght of l = 1200 mm with its fire grading F90/F120 – impact sound pressure level L = 12 dB.

➢ B: the connection between landing and main bearing structure which support the landing is implemented by HBB-T Halfen bi-trapez box bearing at the bottom.

➢ C: HTPL joint sheets insulation to be attached on the side wall, following the stairway, using the integrated self-adhesive tape. The joints must be cleaned and carried out without lack the width shal be 50 mm it is adhesive tape.

4. Evaluation of structural solutions:

Due to structural solution for main bearing elements and their satisfactory together with architects plan there are several solution for basement which is a wall system and it more suits to our projects to determine a wall system ans slab without beam and several other solution for further floors but from all alternatives the structural slutions of variant A,C is determined for our design.

4.1 Evaluation of structural solution in basement:

In the basement one of the best key function to solve the structural solution is that the two-way monolithic concrete solid slab with depth h = 200 mm supported by columns 300x300mm and reinforced concrete walls in all external parts of the building in the both directions by the way slab without beam is used here in order to prevent reduction of the basement height. Also slab of the staircase is assumed as a one-way slab which is supported in concrete walls. the judgments of the geometry of structural elements is given later.

This solution can reduce both depth and reinforcement of the slab, but has the inconvenience of beams, which may hinder matching the internal walls sequence, especially for dwellings. For a safe preliminary evaluation of the quantity of materials the slab “voids” due to stairs and lifts assumed as not present. The resulting extra volume of concrete takes into accounts deformations of form works and any loss of concrete during casting (pump filling, etc.).

4.2. Evaluation of structural solution in ground:

In the ground floor one of the key function to solve the structural solution is that the tow-way concrete solid slab with depth h = 200 mm supported by (300 x 300) mm columns and reinforced concrete walls wit the thickness of 300mm in all external parts of the building in the both directions,so main bearing elements are horizontally concrete slab,shell and vertically reinforced walls,columns. The system is a combine solution.

Also slab of the staircase is assumed as a one-way slab which is supported in concrete walls. the judgments of the geometry of structural elements is given later.as e can see that in the ground floor(floor above)of it is provided for the offices with very light weight of the partitions walls, therefore two way way monolithic concrete slab or slab without beam is one the convenient way to solve the bearing structures.

Shell is supported vertically by two columns and horizontally with tow beams.

Obviously this solution can make ease the reduction height on one sides which is provided for stores.

Also in order to prevent lateral loads the building is provided by several shear walls in both sides and concrete core.

4.3 Evaluation of structural solution 2nd floors(Office):

In the 2th floors which is provided to be a offices with the balcony,the key function to have a solution for the structure is that the two - way monolithic concrete solid slab with depth h = 200 mm supported by (300 x 300) mm columns and reinforced concrete walls on both sides with the thickness of t = 300mm the system is mainly a combined system, the two external parts of the building in the one directions is provided concrete walls and in the other sides is masonry porotherm bricks 300mm which is a dry fix system,Also slab of the staircase is assumed as a one-way slab which is supported in concrete walls. the judgments of the geometry of structural elements is given later. This solution can make ease the detailing connection of the thermal insulation's and has high economic benefits in compare to other solutions.

This is mention-able that the building is supported by two reinforced concrete walls with the thickness of 300mm from basement to the final finished structures in order to prevent lateral loads,the concrete core of sufficient to prevent lateral load as well as the two other walls.

4.4 Evaluation of structural solution from 3th to the seven floors(Apartments):

Obviously from 3th floors to the seven floors which is provided to be apartments with the balcony and one of the key function to have a solution for the structure is that the two - way monolithic concrete solid slab with depth h = 200 mm supported by reinforced concrete walls with the thickness of 300mm on two sides and and 300 mm masonry bricks on one sides and concrete columns 300x300mm, the system is mainly a combined system, the two external parts of the building in the both directions is provided concrete walls and in the other sides is masonry Porotherm bricks 300mm which is a dry fix system,Also slab of the staircase is assumed as a one-way slab which is supported in concrete walls. the judgments of the geometry of structural elements is given later. This solution can make ease the detailing connection of the thermal insulation's and has high economic benefits in compare to other solutions.

The highest benefits in this solution is that supporting of each flat with two reinforced concrete walls can make a perfect fixed joint and basically it can prevent sound transmissions, deformation and etc….

This is mention-able that the building is supported by two reinforced concrete walls with the thickness of 300mm from basement to the final finished structures in order to prevent lateral loads,the concrete core of sufficient to prevent lateral load as well as the two other walls.

5. Evaluation of loads:

Structure is designed according to eurocodes therefore permanent,variable,and snow loads are take in to consideration during the design evaluations within respect to safety factors.

6. Loads bearing elements:

As the structure is a combine system of bearing elements there are walls columns beams are as a main bearing element.

7. Horizontal elements:

Horizontal bearing elements are monolithic one way / two way reinforced concrete slab and beams firstly the concrete slab is transferring the load to to the columns then vertically transferred to the foundations.

8. Vertical elements:

In this structure the main bearing elements are walls and columns so both of this element transferring the load from roof to the foundation of the structures.

9. Stiffening elements:

So, in order to prevent the displacement of the building due to lateral loads, therefore there are walls on both sides of the building with concrete core which is located in elevator shaft so this elements with their corporations can present as a main stiffening element.

10. Vertical communications:

One-way staircase and elevator are as a main communication in the buildings both of them initiate from the basement till the 5th floors, there is one opening in last floor in order to have accessibly to the roof.

11. Foundation:

Basically the general vertical load of the building is distributed vertically by two courses of the shallow foundations into subsoil.

1) By reinforced concrete wall from whole round of the building including of concrete core, in subsoil bearing capacity shall be provided with strip footing.

2) By reinforce concrete columns which positioned mainly inside of the building, in subsoil bearing capacity shall be provided with pad footing.

Generally this strip foundation is a continues reinforced concrete strip on which the load bearing walls with the thickness of 300 mm are built centrally.

This represents a level base for the walls and its dimensions must be sufficient to allocate the load imparted to the foundation to subsoil area capable of supporting the building weight without excessive compaction,so due to the fact that the use of concrete as it is easy to place, spread and level in the foundation trench. Due to its ability to harden concrete creates a basis for walls and develops proper compressive strength to support the foundations' load therefore The basic purpose of this foundation is to spread the load over a larger area so that the soil is able to withstand the stress, and safe bearing pressure is not exceeded.This represents a level base for the walls and its dimensions must be sufficient to allocate the load imparted to the foundation to subsoil area capable of supporting the building weight without excessive compaction, so due to the fact that the use of concrete as it is easy to place, spread and level in the foundation trench. due to its ability to harden concrete creates a basis for walls and develops proper compressive strength to support the foundations load, therefore the basic purpose of this foundation is to spread the load over a larger area so that the soil has capability to withstand the stress, and safe bearing pressure is not exceeded.

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Preliminary Design(Design dimensions of all elements)

Apartment Building Multifunction

Name: Bc.Yosufi Mohammad Fayez

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Contents:

General description of the building:

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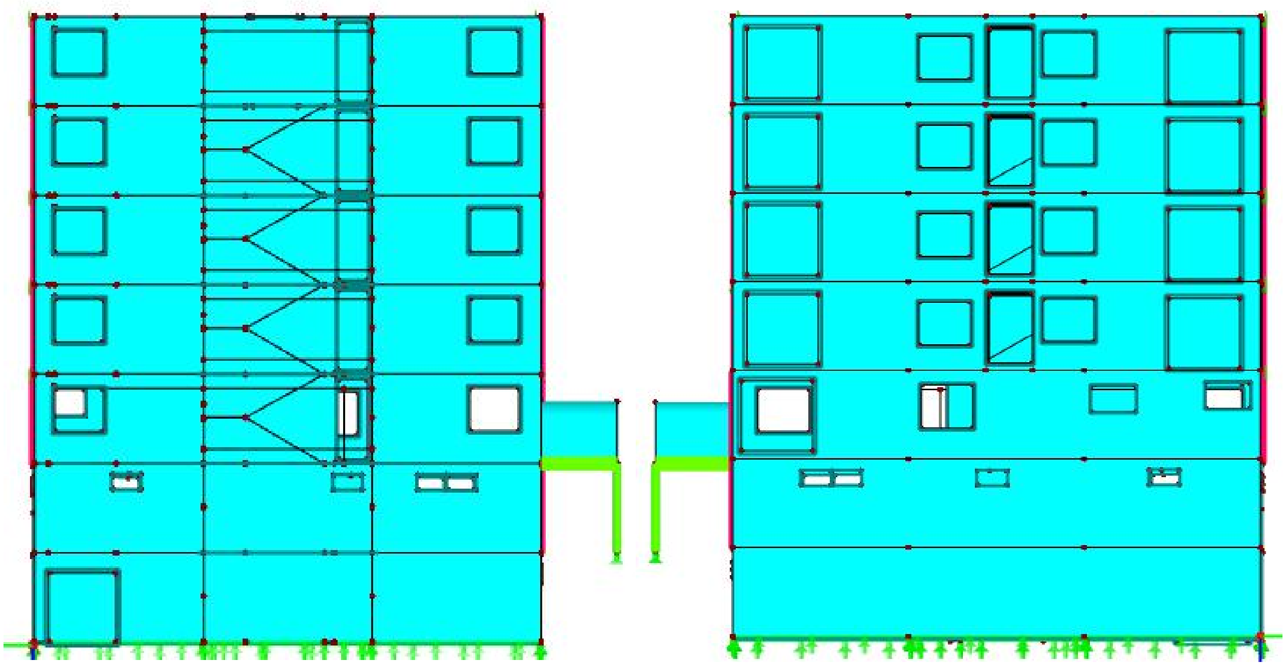

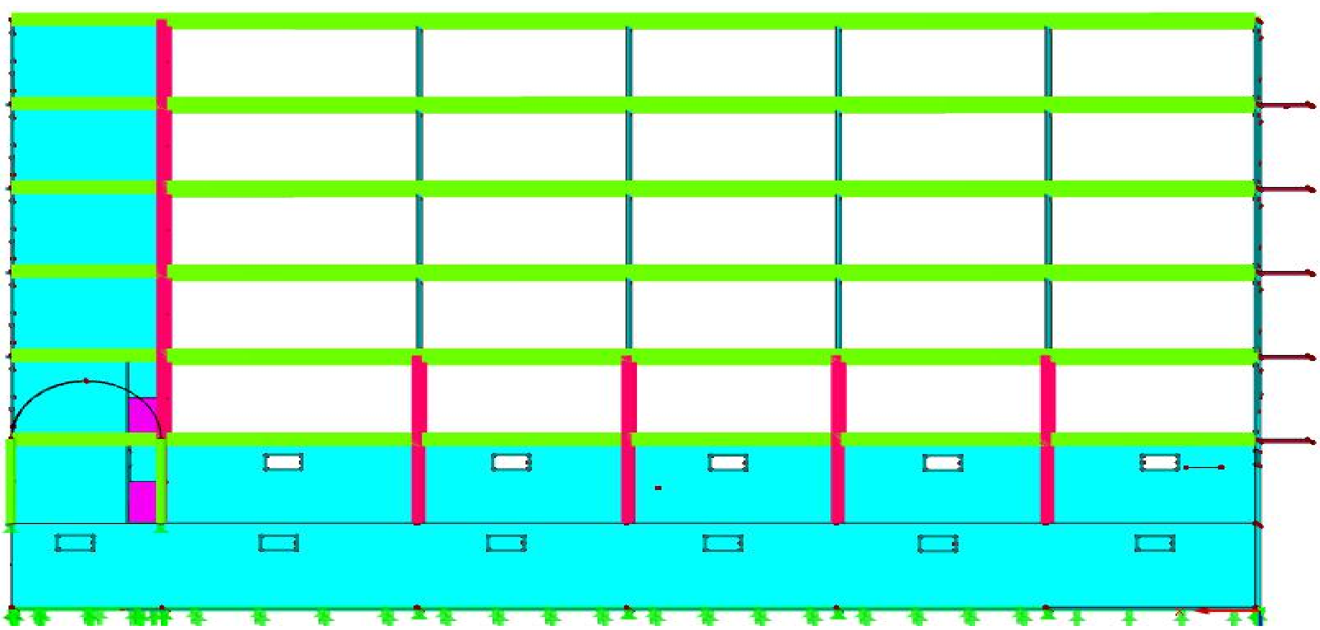

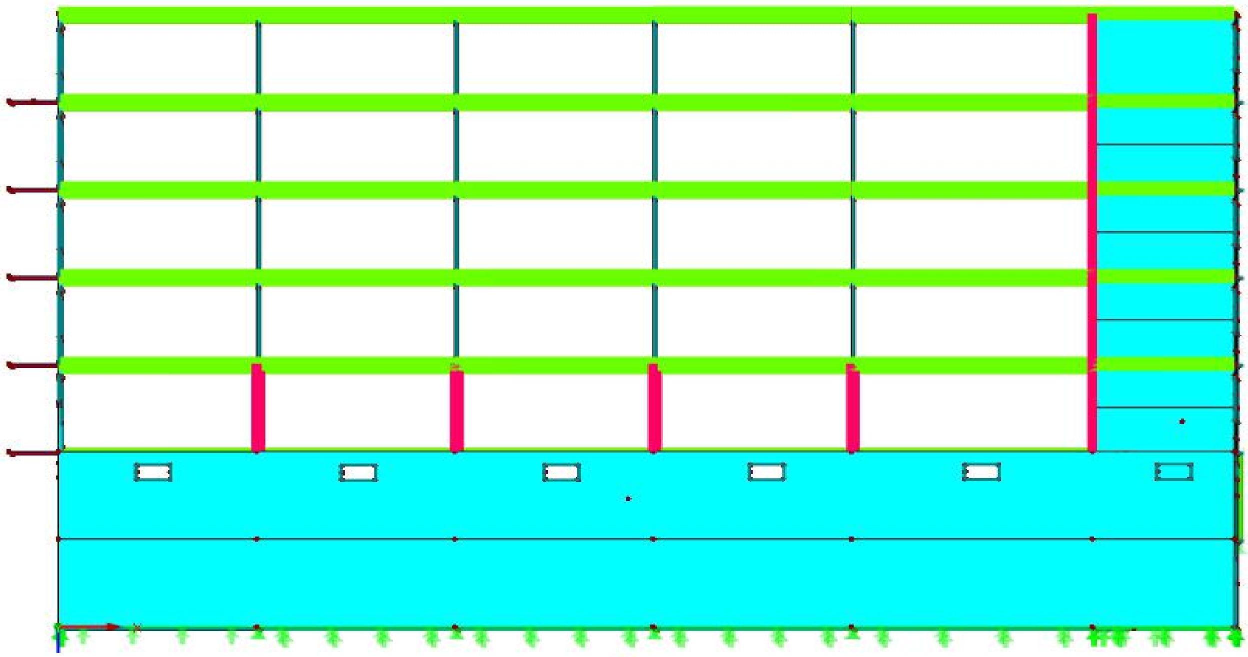

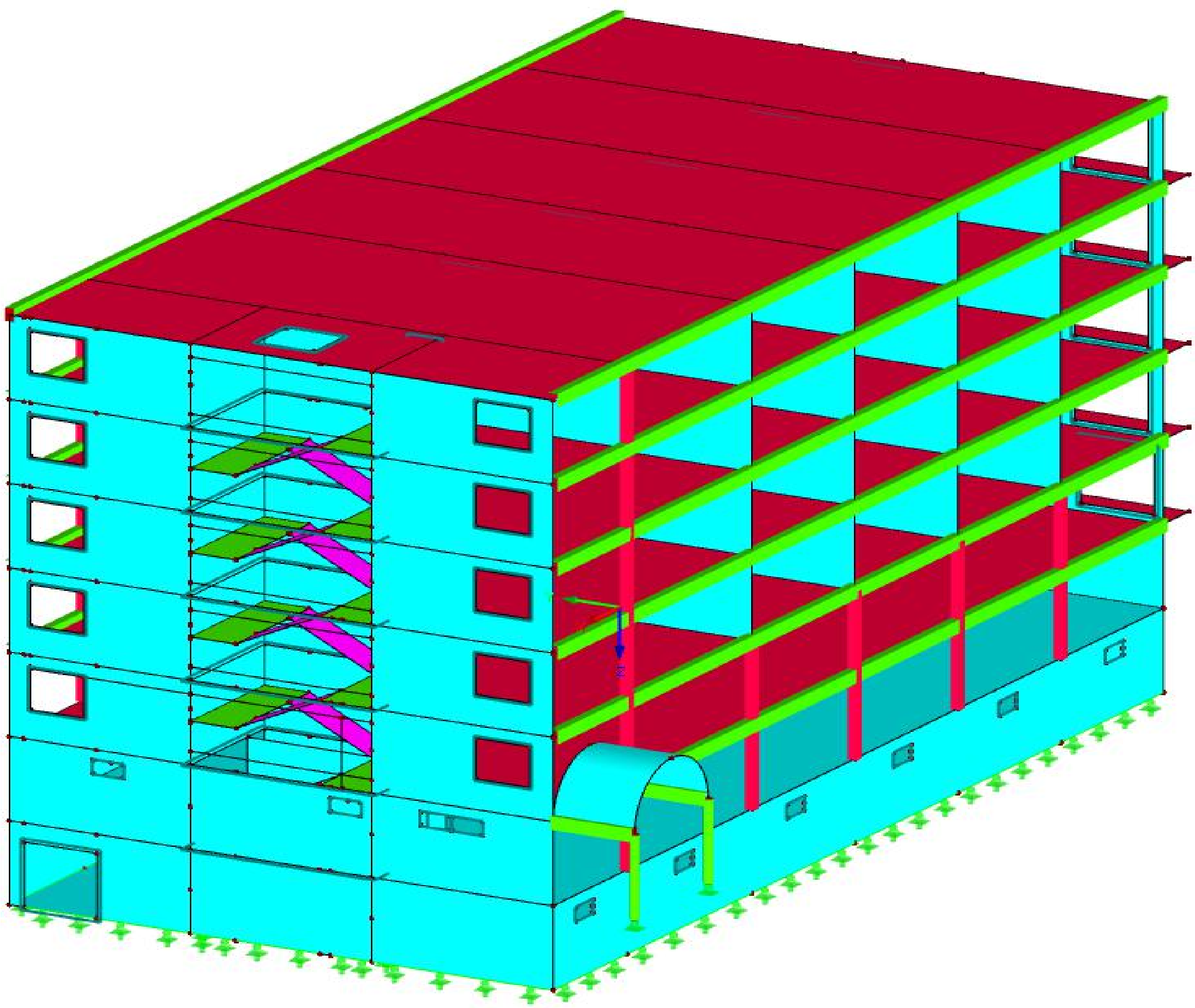

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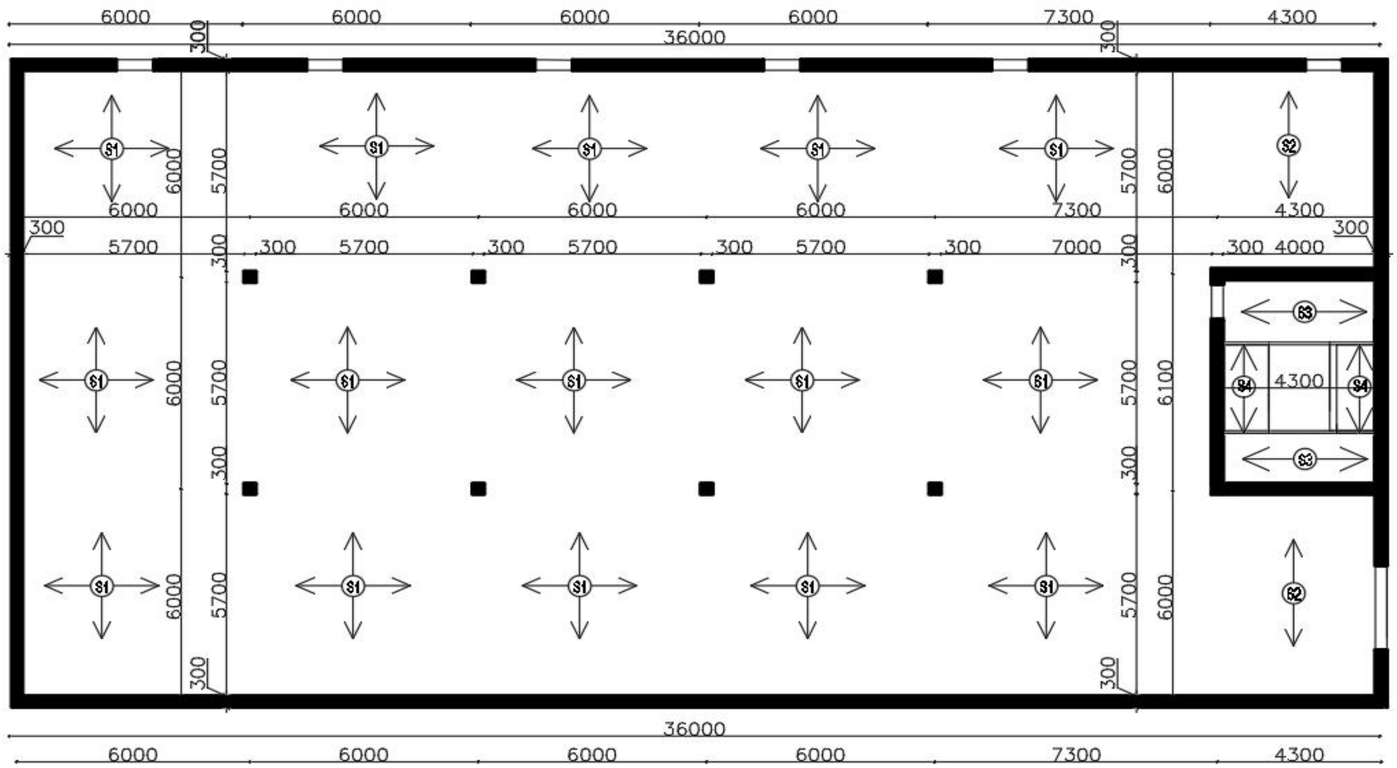
BASEMENT : - 6,420 M, - 3,320M



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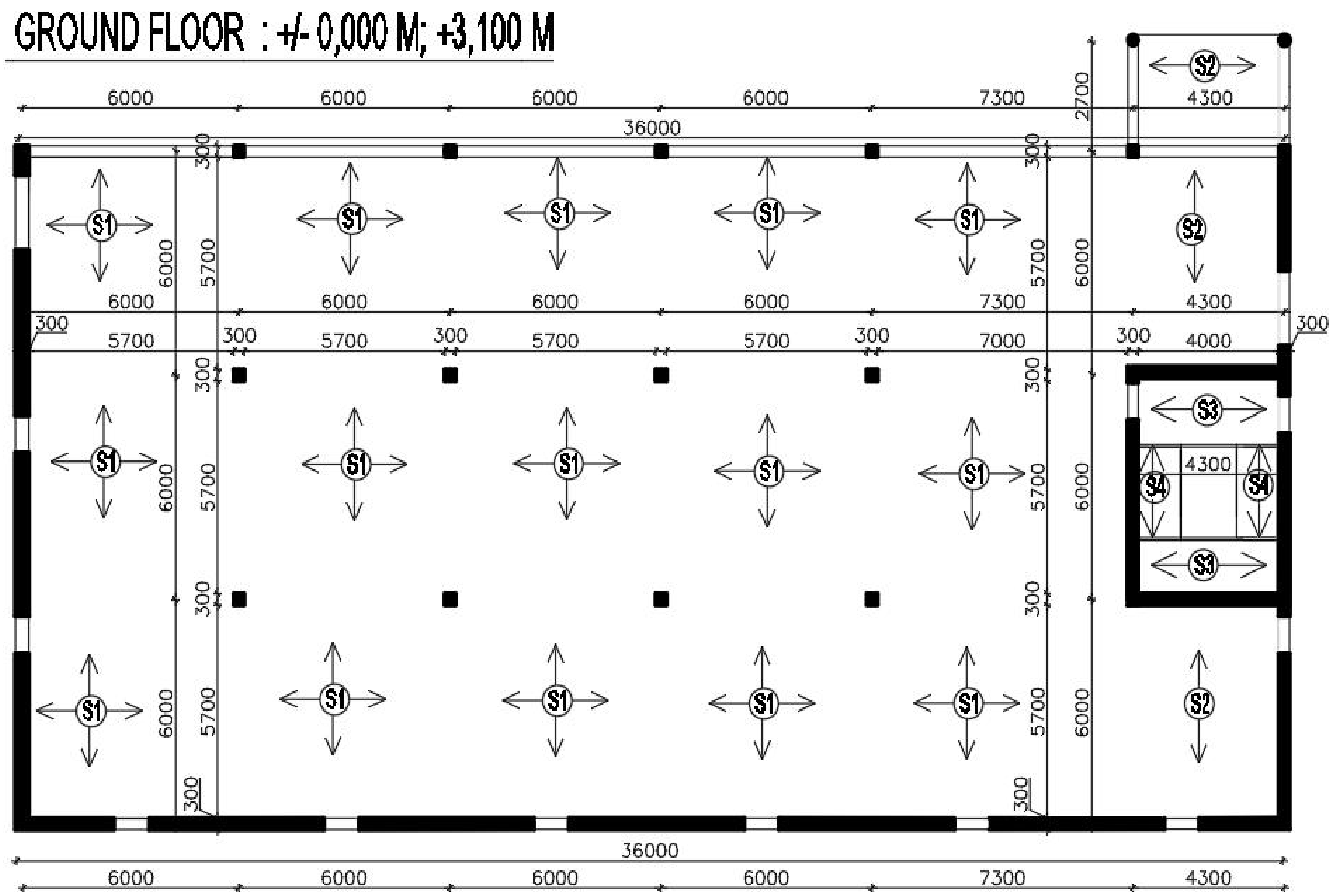

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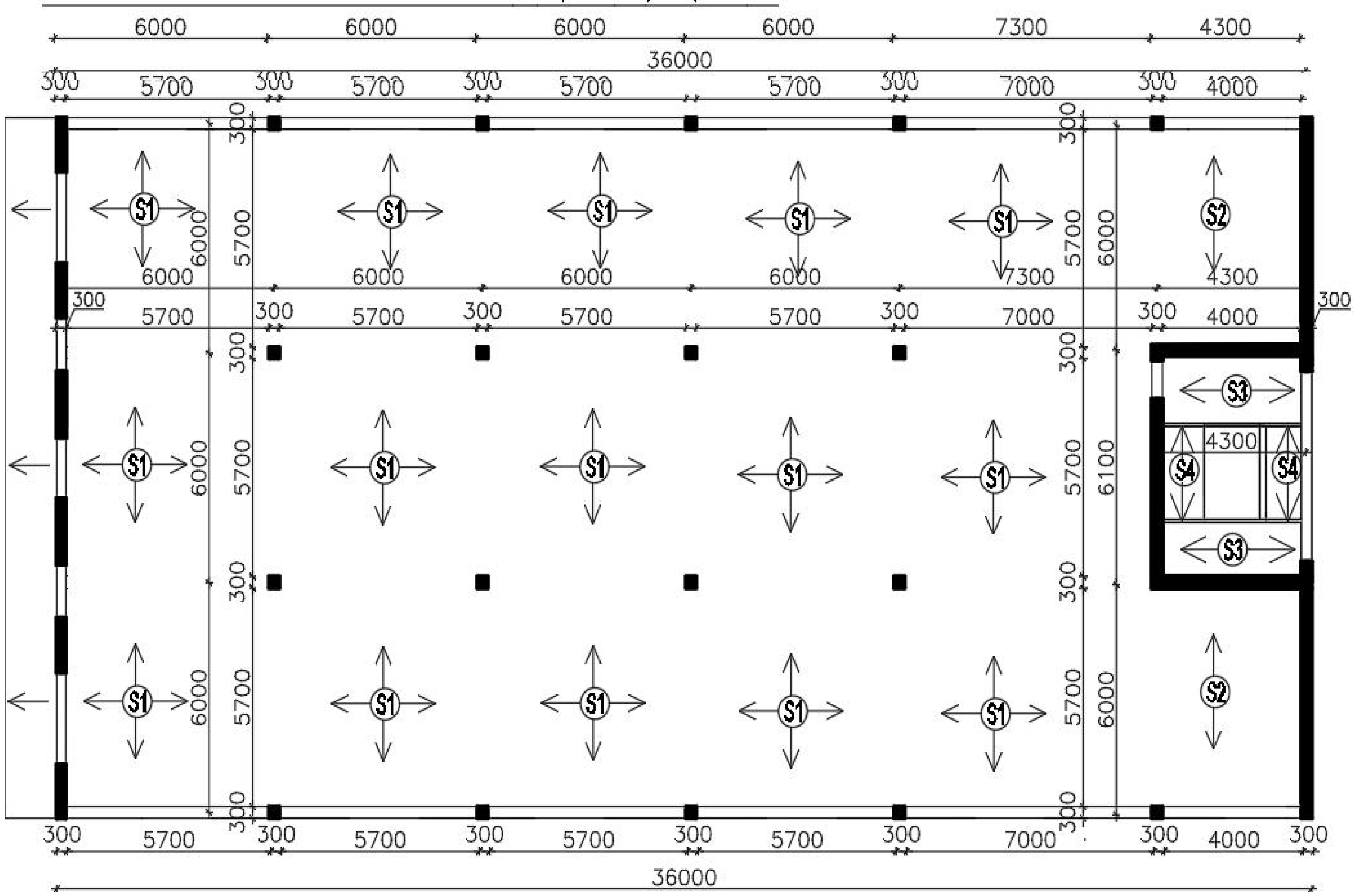
This is mention-able that the building is supported by two reinforced concrete walls with the thickness of 300mm from basement to the final finished structures in order to prevent lateral loads,the concrete core of sufficient to prevent lateral load as well as the two other walls.

TYPICAL FLOOR PLANS OFFICES : + 3,100 M; +6,200 M



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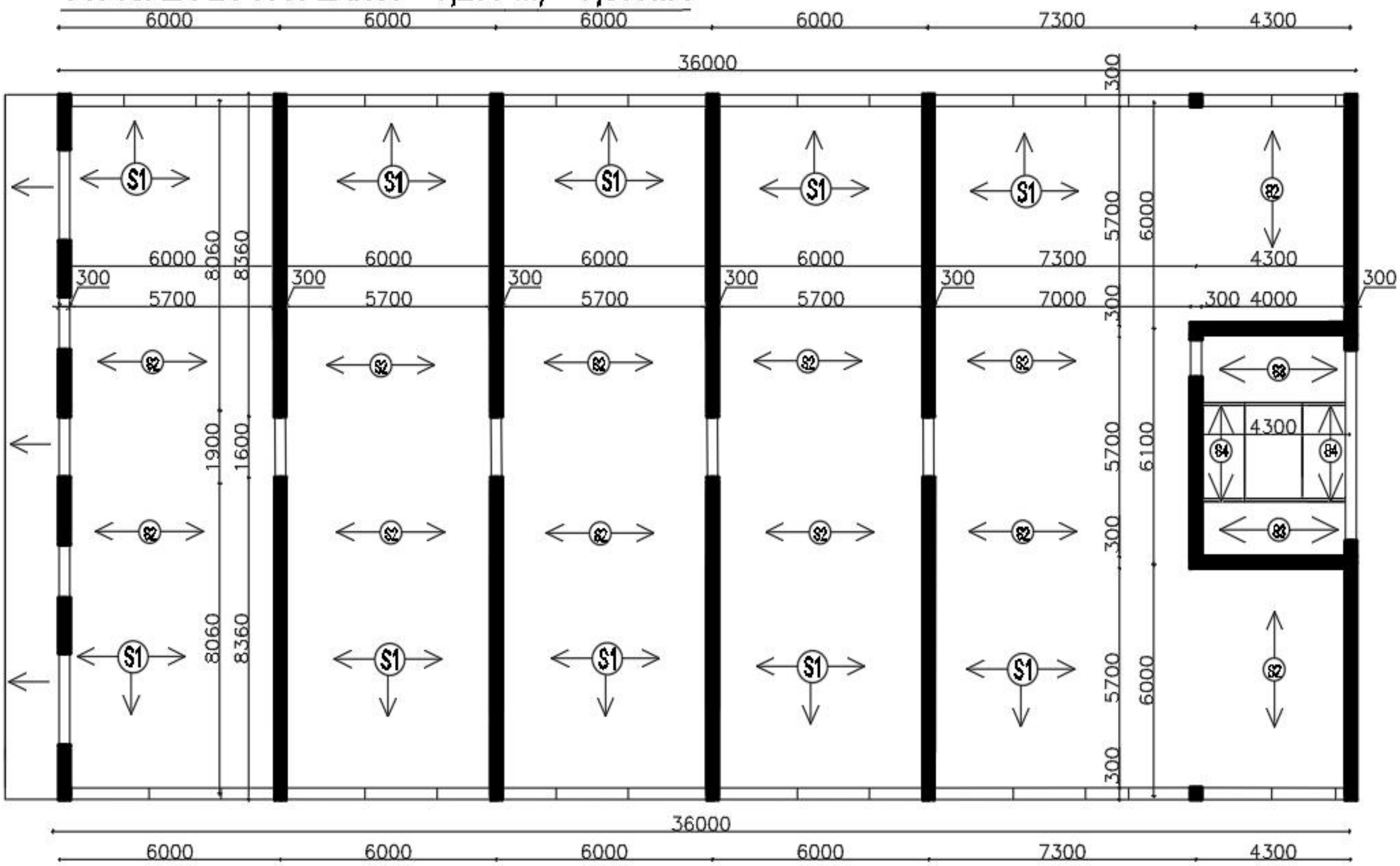
TYPICAL FLOOR PLANS: + 6,200 M; + 9,300M .



Preliminary Design (Design dimensions of all elements)

Apartment House Multifunction

Fundamental Requirements:

Used documents, standards

ČSN EN 1990 Eurocode: Basis of structural design

ČSN EN 1991-1-1 Eurocode 1: Actions on structures: General actions - Densities, self-weight and imposed loads.

ČSN EN 1991-1-3 Eurocode 1: Actions on structures: General actions - Snow loads

ČSN EN 1991-1-4 Eurocode 1: Actions on structures: General actions - Wind

ČSN EN 1992-1-1 Eurocode 2: Design of concrete structures: General rules and rules for buildings

ČSN EN 1993-1-1 Eurocode 3: Design of steel structures: General rules and rules for buildings

ČSN EN 1996-1-1 Eurocode 6: Design of masonry structures: General rules for reinforced and unreinforced masonry structures.

Source: http://eurocodes.jrc.ec.europa.eu/showpage.php?id=13

1: basic materials of concrete and steel.

Concrete:

Strength class of the concrete C40/50[Mpa]

Characteristic cylinder strength. $f_{ck} = 40$ [MPa]

Cube Characteristic cube strength. $f_{ck} = 50$ [MPa]

Target mean cylinder strength. $f_{cm} = 48$ [MPa]

Mean axial tensile strength. $f_{ctm} = 3.5$ [MPa]

Mean secant modulus of elasticity. $E_{cm} = 35$ [GPa]
Concrete density. $\rho = 2500$ [kg/m^3]
Partial safety factor for concrete. 1.5 [-]

Steel:

Steel grade B500 S B

The Class is B

Characteristic yield strength $\mathbf{f_{yk}} = 500$ [Mpa]

Characteristic strain at maximum force $\boldsymbol{\varepsilon_{uk}} = 5$ [%]

Density $\boldsymbol{\rho} = 7850$ [kg/m^3]

Modulus of elasticity **E** = 210 000 MPa [N/mm^2]

Partial safety factor for steel 1.15 [-]

Things to remember is that all of this data which is marked above is achieved from sample test of the materials (concrete & steel) to be judged for the durability of the structure.

Design cover for main reinforcement:

we need to take into account in the design of the cover reinforcement secure transmission of forces in cohesion protection of steel against influence of the environment (thermal insulation, corrosion) . according to Eurocode EN 206-1 for my building I need to take into considerations the influence of the environment as follows.

XC1- for internal slabs and foundations C25/30

XC2 - for reinforced walls.

Xc1 – dry or permanently wet concrete inside the building with low air humidity.

XC2- wet rarely dry concrete suffer subject the long-term water like many foundations.

$$\boldsymbol{C_{nom} = c_{min} + \Delta c_{dev}}$$

$$C_{min} = \max\,(Cmin,_b\,;\,C_{min,dur}\,;10\,mm\,)$$

$\boldsymbol{\Delta c_{dev}}$ = 10 mm (technology allowance)

$C_{min,b}$ = 10 mm (cover depth necessary for good mechanical bond between steel and concrete, equal to diameter of steel bars)

The value $C_{min,dur}$ depends on the "structural class", which has to be determined first. So in my case the structure service life is designed for 50 years therefore the initiation of the structure class is nominated as s4.

The minimum cover with regard to the durability for reinforcement steel according EN 10080.

Table: 1.4.2 determination of Cmin,dur which is function of structure class and exposure class.

Environmental Requirement for $c_{min,dur}$ (mm)							
Structural Class	Exposure Class according to Table 4.1						
	X0	XC1	XC2 / XC3	XC4	XD1 / XS1	XD2 / XS2	XD3 / XS3
S1	10	10	10	15	20	25	30
S2	10	10	15	20	25	30	35
S3	10	10	20	25	30	35	40
S4	10	15	25	30	35	40	45
S5	15	20	30	35	40	45	50
S6	20	25	35	40	45	50	55

$$\boldsymbol{C_{nom} = c_{min} + \Delta c_{dev}}$$

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$$C_{min} = \max\,(10\,;\,15\,;10\,mm\,)$$

$$C_{min} = 15\ \ [mm\,]$$

$$\mathrm{C} = c_{min} + \Delta c_{dev}$$

$$C_{slab} = 10 + 15 = 25 \text{ [mm]}$$

$$C_{wall} = 10 + 25 = 35 \text{ [mm]}$$

Slab depth design:

The slab depth is evaluated from the extreme area of the most loaded parts of the building which is nominated as a tributary area. The load is collecting by 2 - way monolithic reinforced slab then transferred to the beams then to the walls and finally by the wall transferred to the foundation part of the building.

Empirical estimation:

Basement slab: $hs = (\frac{Lx + Ly}{75}) = (\frac{7300 + 6000}{75}) = [177.33 \; Approx. = 200 \; mm]$

Effective depth: $d = hs - c - \phi = 200 - 25 - 16/2 = [167 \; mm]$

Deflection control: $\lambda = \frac{L}{d} \leq \lambda \lim = Kc1 * Kc2 * Kc3 * \lambda d, tab$

Outer span in basement:

L – Length of the shorter span 4300 [mm] in x - direction.

d – Effective width of cross section

K_{c1} – effect of shape 1.0

K_{c2} - effect of span 1.0 `

K_{c3}- effect of reinforcement 1.2

$\lambda_{d,tab}$ depend of the table we will consider 0.5% reinforcement ratio for the inner span.

$\lambda_{d,tab}$ for outer span of the continuous beam/slab

	Concrete class						
ρ	12/15	16/20	20/25	25/30	30/37	40/50	50/60
0,5 %	19,0	20,5	22,1	24,1	26	33,5	41,5
1,5 %	15,9	16,4	16,9	17,6	18	19,5	20,8

$$\lambda = \frac{L}{d} \leq \lambda \lim = Kc1 * Kc2 * Kc3 * \lambda d, tab$$

$$\lambda = \frac{l}{d} = \frac{4300}{167} = 25.75$$

$$\lambda \lim = Kc1 * Kc2 * Kc3 * \lambda d, tab = 1 * 1 * 1.2 * 33.5 = 40.2$$

$$\lambda \leq \lambda \lim \rightarrow 25.75 \leq 40.2$$

General conditions and relationships:

$\lambda \leq \lambda \lim$

We can see that after the evaluation the final depth of the concrete slab in basement and all typical floors is 200[mm] so in this case I will use the design further calculation within take into consideration the slab thickness to be 200 [mm] one of the reason which I have same slab heights is that this element have large span dimensions in each typical floors.

Inner span in basement:

L – Length of the longer span 6000 [mm] in x - y - directions.

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1,5 %	18,3	18,9	19,5	20,3	21	22,5	24

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Empirical estimation:

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NOTE:

the principal is the same as basement because there is same bearing element in each directions and the structures has same construction solution in case load bearing elements.

Empirical estimation:

Typical floor slab: $hs = (\frac{Lx + Ly}{75}) = (\frac{7300 + 6000}{75}) = [177.33\ Approx. = 200\ mm]$

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ρ	12/15	16/20	20/25	25/30	30/37	40/50	50/60
0,5 %	19,0	20,5	22,1	24,1	26	33,5	41,5
1,5 %	15,9	16,4	16,9	17,6	18	19,5	20,8

$$\lambda = \frac{L}{d} \leq \lambda \lim = Kc1 * Kc2 * Kc3 * \lambda d, tab$$

$$\lambda = \frac{l}{d} = \frac{4300}{167} = 25.75$$

$$\lambda \lim = Kc1 * Kc2 * Kc3 * \lambda d, tab = 1*1*1.2*33.5 = 40.2$$

$$\lambda \leq \lambda \lim \rightarrow 25.75 \leq 40.2$$

General conditions and relationships:

$\lambda \leq \lambda \lim$
We can see that after the evaluation the final depth of the concrete slab in basement and all typical floors is 200[mm] so in this case I will use the design further calculation within take into consideration the slab thickness to be 200 [mm] one of the reason which I have same slab heights is that this element have large span dimensions in each typical floors.

Inner span in basement:

L – Length of the longer span 6000 [mm] in x - y - directions.

d – Effective width of cross section

Kc_1 – effect of shape 1.0

K_{c2} - effect of span 1.0 `

K_{c3}- effect of reinforcement 1.2
$\lambda_{d,tab}$ depend of the table we will consider 0.5% reinforcement ratio for the inner span.

$\lambda_{d,tab}$ for inner span of the continuous beam/slab

	Concrete class						
ρ	12/15	16/20	20/25	25/30	30/37	40/50	50/60
0,5 %	21,9	23,7	25,5	27,8	30,8	38,6	48
1,5 %	18,3	18,9	19,5	20,3	21	22,5	24

$$\lambda = \frac{L}{d} \leq \lambda \lim = Kc\,1 * Kc\,2 * Kc\,3 * \lambda d\,, tab$$

$$\lambda \lim = Kc1 * Kc2 * Kc3 * \lambda d\,, tab = 1*1*1.2*33.5 = 40.2$$

$$\lambda = \frac{l}{d} = \frac{1600}{167} = 9.58$$

$$\lambda \leq \lambda \lim \rightarrow 9.58 \leq 40.2$$

Beam depth design:

$$hB = \left(\frac{L}{12} - \frac{L}{15}\right) = \left(\frac{6000}{12} - \frac{6000}{15}\right) = (500 - 400)[mm]$$

$$hB = 500mm$$

$$bB = \left(\frac{1}{2} - \frac{1}{3}\right)hB = \left(\frac{500}{2} - \frac{500}{3}\right) = (250 - 166.67)mm$$

$$bB = 300mm$$

so, in this case I will use the design further calculation within take into consideration the beam height to be $h_{B,final} = 500\ mm$,bB = 300 mm

Evaluation of the loads in the structure:

Generally, actions for use in design shall be obtained from parts of EN 1991 as following:

EN1991-1.1 Densities, self-weight and imposed loads.

EN1991-1.3 Snow loads

EN1991-1.4 Wind loads

This is mention-able that with respect limited dimensions of the building, thermal actions were not considered, nor were impact and explosion action.

the partial safety factors have to be taken into consideration as the suggested values in EC2.

In this case for all loads consider are design values for the self-weight of the structures (dead loads) we consider partial safety factor of γ = 1.35 [-] and for variable loads γ = 1.50

Evaluations of the load slab on the grade:

Load on the basement slab:

	No #	kind of layer	thickness [mm]	Density [KN/m³]	Characterstic value [KN/m²]	Safety factor	Design value [KN/m²]
permanent load	1	Anti- sliding paint	0		0	1.35	0
	2	Another permanent load	10		0.01	1.35	0.0135
	3	RC slab	100	25	2.5	1.35	3.375
	4	plain concrete levelling	50	24	1.2	1.35	1.62
	Permanent load from typical slab gd				3.71	1.35	5.0085

Table 6.8 – Imposed loads on garages and vehicle traffic areas is determined by 2 categories category **F** traffic and parking areas for light vehicles ≤ 30kN gross vehicle weight and ≤ 8 seats but also not including of driver)

	No#	kind of layer	thickness [mm]	Density [KN/m³]	Characteristic value [KN/m²]	Safety factor	Design value [KN/m²]
variable loads	1	category F			2	1.50	3
	2	movable partition <3kn/m			1.2	1.50	1.8
	Total variable load on typical floor slab qd				3.2	1.5	**4.8**

The total value of characteristic load:

$Fk = (Gk + Qk) = (3.71 + 3.2) = 6.91 KN / m^2$ will be applied in software for further calculations.

The total value of design load:

$$Fd = (Gd + Qd) = (5.0085 + 7.8) = 9.80 KN / m^2$$

Permanent load in one tributary area of the ground Floor.

Category A: Areas for domestic and residential activities.

	No#	kind of layer s	thickness [mm]	Density [KN/m³]	Characteristic value [KN/m²]	Safety factor	Design value [KN/m²]
permanent load	1	Epoxy layer	-	-	0	0	0
	2	Leveling concrete	60	24	1.44	1.35	1.944

	3	PE layer	-	-	0		0
	4	acoustic insulation	100	0.3	0.03	1.35	0.0405
	5	reinforce concrete slab	200	25	5	1.35	6.75
	Permanent load from typical slab gd				6.47	1.35	8.74

Usually in case of the areas in residential, commercial, administration and social building shall be divided into some specific categories according to their specific uses in table 6.1 categories of use.
Variable loads in one tributary area of the typical floor.D - D1 Areas in general retail shops.

variable loads	No#	kind of layer	thickness [mm]	Density [KN/m³]	Characteristic value [KN/m²]	Safety factor	Design value [KN/m²]
	1	category A domestic areas			4	1.50	6
	2	movable partition <3kn/m			1.2	1.50	1.8
	Total variable load on typical floor slab qd				5.2	1.50	**7.8**

The total value of characteristic load:

$Fk = (Gk + Qk) = (6.47 + 5.2) = 11.67 KN / m^2$ will be applied in software for further calculations.

The total value of design load:

$$Fd = (Gd + Qd) = (8.74 + 7.8) = 16.54 KN / m^2$$

Permanent load in one tributary area of the typical Floor(offices).

Category B:Office areas.C2: Areas with fixed seats,

permanent load	No#	kind of layer s	thickness [mm]	Density [KN/m³]	Characteristic value [KN/m²]	Safety factor	Design value [KN/m²]
	1	PVC plank	10		0.022	1.35	0.0297
	2	Leveling concrete	60	24	1.44	1.35	1.944
	3	PE layer	-	-	0		0
	4	acoustic insulation	50	0.3	0.015	1.35	0.0203
	5	reinforce concrete slab	200	25	5	1.35	6.75
	Permanent load from typical slab gd				6.477	1.35	8.75

Usually in case of the areas in residential, commercial, administration and social building shall be divided into some specific categories according to their specific uses in table 6.1 categories of use.
Variable loads in one tributary area of the typical floor.

variable loads	No#	kind of layer	thickness [mm]	Density [KN/m³]	Characteristic value [KN/m²]	Safety factor	Design value [KN/m²]
	1	Category B Office areas			3	1.50	4.5
	2	movable partition <3kn/m			1.2	1.50	1.8

	Total variable load on typical floor slab qd				4.2	1.50	6.3

The total value of characteristic load:

$Fk = (Gk + Qk) = (6.477 + 4.2) = 10.677 KN / m^2$ will be applied in software for further calculations.

The total value of design load: $Fd = (Gd + Qd) = (8.75 + 6.3) = 15.05 KN / m^2$

Permanent load in one tributary area of the typical Floors apartments:

Category A: Areas for domestic and residential activities.

	No#	kind of layer s	thickness [mm]	Density [KN/m³]	Characteristic value [KN/m²]	Safety factor	Design value [KN/m²]
permanent load	1	PVC plank	10		0.022	1.35	0.0297
	2	Leveling concrete	60	24	1.44	1.35	1.944
	3	PE layer	-	-	0		0
	4	acoustic insulation	50	0.3	0.015	1.35	0.0203
	5	reinforce concrete slab	200	25	5	1.35	6.75
	Permanent load from typical slab gd				6.477	1.35	8.75

	No#	kind of layer	thickness [mm]	Density [KN/m³]	Characteristic value [KN/m²]	Safety factor	Design value [KN/m²]
variable loads	1	category A domestic areas			2	1.50	3
	2	movable partition <3kn/m			1.2	1.50	1.8
	Total variable load on typical floor slab qd				3.2	1.50	4.8

The total value of characteristic load:

$Fk = (Gk + Qk) = (6.477 + 3.2) = 9.677 KN / m^2$ will be applied in software for further calculations.

The total value of design load:

$$Fd = (Gd + Qd) = (8.75 + 4.8) = 13.55 KN / m^2 * 4 = 52.88 KN / m^2$$

Permanent load in one tributary area of the roof structures:

	No#	kind of layer	thickness [mm]	Density [KN/m^3]	Characteristic value [KN/m^2]	γ	Design value [KN/m^2]
permanent load	1	washed river gravel	50	15	0.0225	1.35	0.030
	2	Bitumen water proofing	8		0.0305	1.35	0.04
	3	XPS insulation	150	0.3	0.045	1.35	0.06
	4	vapor barrier asphalt pn.	3.5	-	-	-	-
	5	reinforced concrete slab	200	25	5	1.35	6.75
	6	plaster	5	0	0.005	1.35	0.006
	Total load from the roof				5.10	1.35	6.88

Categories of loaded area (of a roof) generally there are 3 categories according to table 6.9:

Category H – Accessible for normal maintenance and repair only.

Imposed load on the roof:

	No#	kind of layer	thickness [mm]	Density [KN/m^3]	Characteristic value [KN/m^2]	Safety factor	Design value [KN/m^2]
variable loads	1	category F			1	1.50	1.50
	2	Snow load			0.75	1.50	1.125
	Total variable load on typical floor slab qd				2.75	1.50	**2.625**

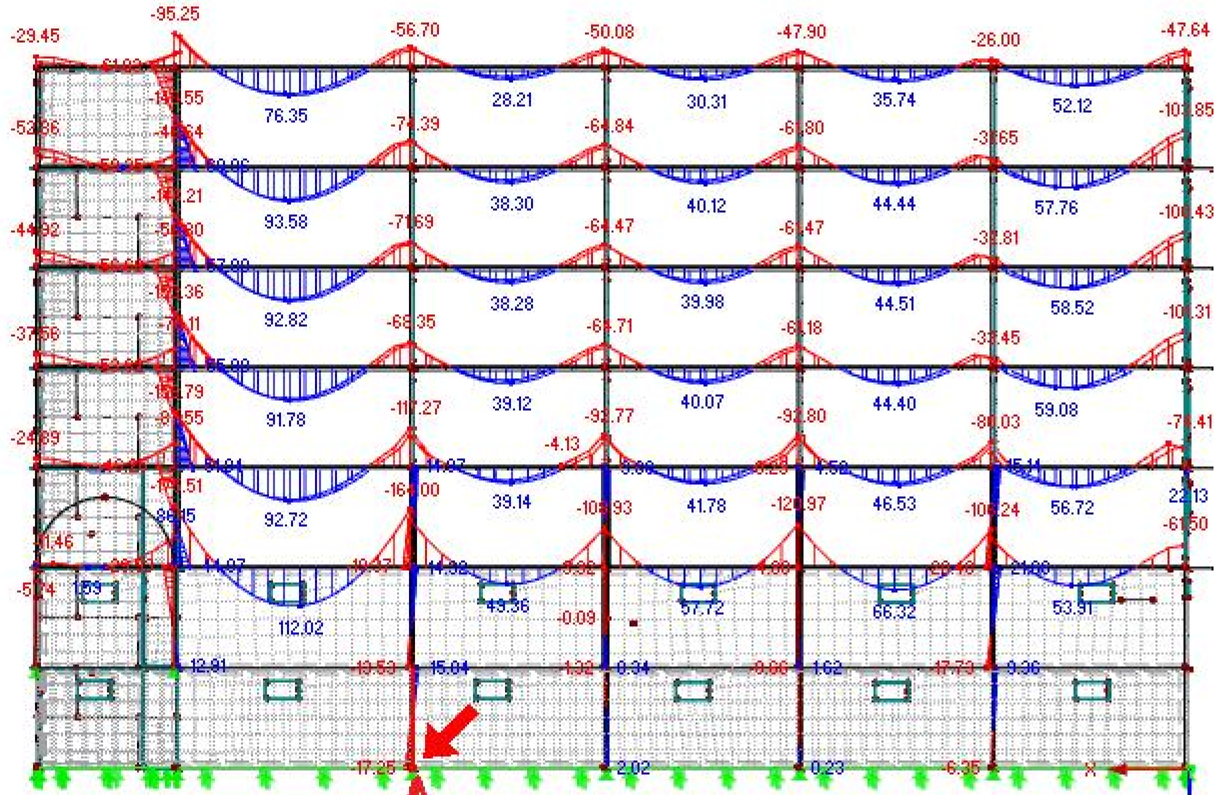
The total value of characteristic load:

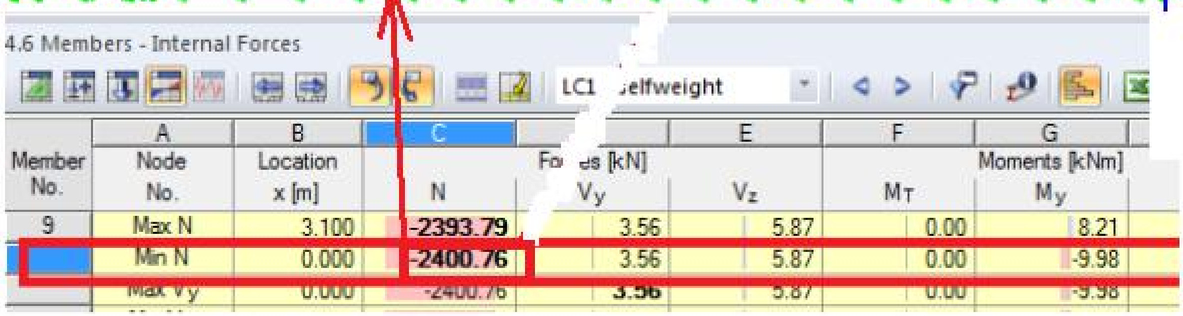
$Fk = (Gk + Qk) = (5.10 + 2.75) = 7.85 KN / m^2$ will be applied in software for further calculations.

The total value of design load:

$$Fd = (Gd + Qd) = (6.88 + 2.625) = 9.505 KN / m^2$$

Internal forces:





4.6 Members - Internal Forces

LC1 Selfweight

	A	B	C	D	E	F	G
Member No.	Node No.	Location x [m]	Forces [kN] N	V_y	V_z	Moments [kNm] M_T	M_y
9	Max N	3.100	-2393.79	3.56	5.87	0.00	8.21
	Min N	0.000	-2400.76	3.56	5.87	0.00	-9.98
	Max Vy	0.000	-2400.76	3.56	5.87	0.00	-9.98

Load bearing walls (vertical Resistance):

Preliminary design dimension and judgment of the resistance check of internal load bearing walls (tributary width) in structures, basically This load bearing wall shall transfer the total loads from slabs and beams of a tributary width vertically to the foundation of the structures, Basically the Load which carried by this wall to the foundation of the structure is $NEd = 2400.76 KN/m$

Calculate design load in the Bottom parts of the wall (NEd).

$$N_{Ed} \leq N_{Rd}$$

$NEd \leq NRd = 0.8Ac * Fcd + As * Fyd$

$$Ac = \frac{NEd}{(0.8 * Fcd + 0.02 * Fyd)} = \frac{2400.76 * 1000}{(0.8 * 20 + 0.02 * 400)} = 100032 mm^2 \longrightarrow$$ *but we know that Ac is = B*L therefore,*

$B * L = 48675 mm^2 \rightarrow B = \frac{100032 mm^2}{1000 mm} = 100.032 mm \rightarrow$ but we know that the minimum thickness of the load bearing wall is 200mm therefore we can confirms that

$A_c = 200 * 1000 = 200000\ mm^2$

$N_{Ed} \leq N_{Rd} = 0.8 * 200000 * 20 + 0.02 * 200000 * 400 = 4800000\ N = 4800\ KN$

$NEd = 2400.76 KN \leq NRd = 4800 KN$ so the justification is confirmed by safe side.

The judgment says that this estimation has implemented safely and rightly while the resistance is much higher than the applied load so means that we are in safe sides, but this judgment was only to those walls which subjected to the vertical load only.

$$N_{Ed} \leq N_{Rd}$$

$NEd \leq NRd = 0.8 Ac * Fcd + As * Fyd$

$$Ac = \frac{NEd}{(0.8 * Fcd + 0.02 * Fyd)} = \frac{2400.76 * 1000}{(0.8 * 20 + 0.02 * 400)} = 100.32 m^2 \longrightarrow$$

$Min.area, Ac = 0.063 \mathrm{m}^2$

$\rightarrow Column = 300 X 300 mm$

Justification of the condition have be done by further calculation via RFEM software.

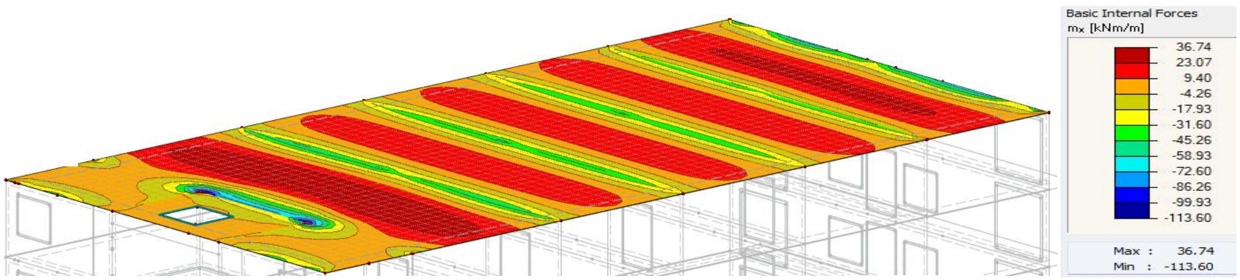
General determinations of all basic internal forces:

Basic internal forces in roof structures:

Basic internal force on roof structures is confirmed by Combination of C06 surface dead load and variable load excluded of snow load according to category I sk = 0.75 KN/m^2 for Prague Czech Republic.

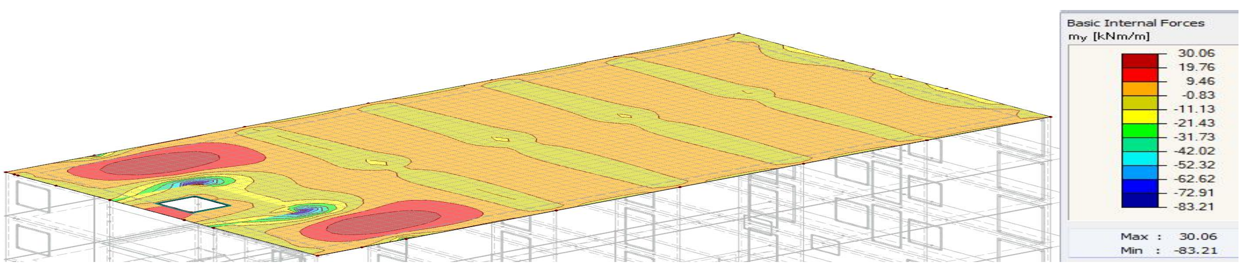
Moment mx:

Coordinates x-y is assumed, max support moment is in support axis of B - 6, and C - 6, & max span moment is in each midspan moment which is supported by two parallel reinforced concrete walls; therefore, design justifications will focus on this part as an extreme one.



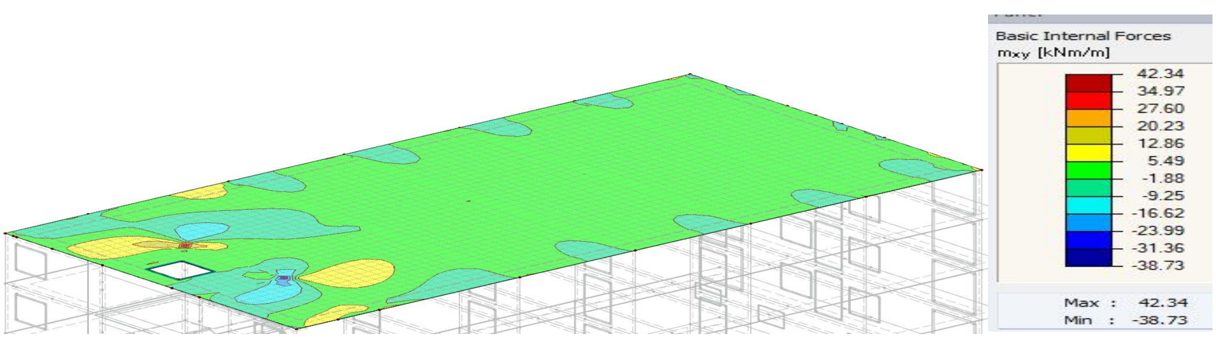
Moment my:

max support moment is in two edges of concrete core & max span moment is in two spans to the y- direction's midspan moment, therefore design justifications will focus on this part as an extreme one.



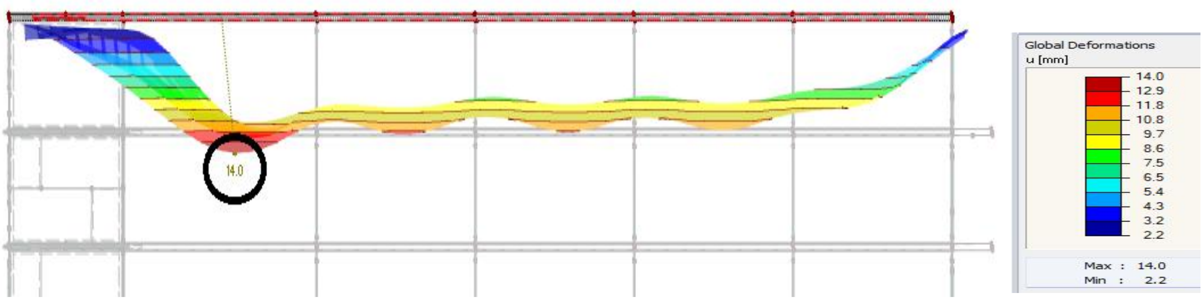
Moment mxy:

Coordinates x-y is assumed, Now as we see that the max moments are in each edges of concrete core, max support moment is in support axis of B - 6, while max span moment is in support C - 6, therefore design justifications will focus on this part as an extreme one.



Global deformations:

Basically, we see that the maximum global deformation is in our max span in range of 14mm.



Loading moment:

$m\phi = mx*cos2\phi + my*sin2\phi + 2mxy*sin\phi cos\phi$

Condition for Loading Moment:

$(-)m'_{Rd\Phi} < m_{\Phi} < m_{Rd\Phi}$

mx = -113.6

my = -83.21

mxy = 38.73

Design moments:

Lower surface					
$m_{Rdx} = m_x + \lvert m_{xy} \rvert$		kNm/m	$m_{Rdy} = m_y + \lvert m_{xy} \rvert$		kNm/m
$m_{Rdx} =$	-74.87	kNm/m	$m_{Rdy} =$	-44.48	kNm/m
Upper surface					
$m'_{Rdx} = -m_x + \lvert m_{xy} \rvert$		kNm/m	$m'_{Rdy} = -m_y + \lvert m_{xy} \rvert$		kNm/m
$m'_{Rdx} =$	152.33	kNm/m	$m'_{Rdy} =$	121.94	kNm/m

Upper surface:

A'sx,req. = m'edx/(0.9*d'x*fyd)				Steel: B500B			Concrete: C30/37		
Asx,req. = 2403.011				fyd = 500/1.15			fcd = 30/1.5		
A'sx,prov.≥ A'sx,req.				fyd =	434.782609	N/mm2	fcd =	20	N/mm^2
A'sx,prov. =n* π * (ϕ/2)^2				z'x = d'x - 0.4*x					
A'sx,prov.	2789.734	mm^2		z'x=	131.676801	mm			
A'sx,prov.≥ A'sx,req.		Okay		x'_x= A'sx,prov.*fyd/(0.8*b*fcd)				b = 1000 mm	
				x'_x =	75.8079966	mm			
n = A'sx,req./(π*(ϕ/2)^2)									
n =	30.59609			h_s = 200 mm			c = 25 mm		
n = 33 Bars		12 Bars ϕ10		d'x = h - c - ϕ/2 - ϕstr			ϕ = 10 mm		
		12 Bars ϕ14		d'x =	162	mm	ϕstr = 8 mm		
A'sy,req. = m'edy/(0.9*d'y*fyd)									
A'sy,req. =	3480								
A'sy,prov.≥ A'sy,req.				z'y = d'y - 0.4x					
A'sy,prov. =n* π * (ϕ/2)^2				z'y=	121.021739	mm			
A'sy,prov.	3770	mm^2							
				x'_y = A'sy,prov.*fyd/(0.8*b*fcd)				b = 1000 mm	
A'sy,prov.≥ A'sy,req.		Okay		x'_y =	102.445652	mm			
n = A'sy,req./(π*(ϕ/2)^2)				h_s = 200 mm			c = 25 mm		
n =	30.76996			d'y = h - c - ϕ/2 - ϕstr			ϕ = 12 mm		
n = 30 Bars		12 Bars ϕ12		d'y =	162	mm	ϕstr = 8 mm		
		12 Bars ϕ16							

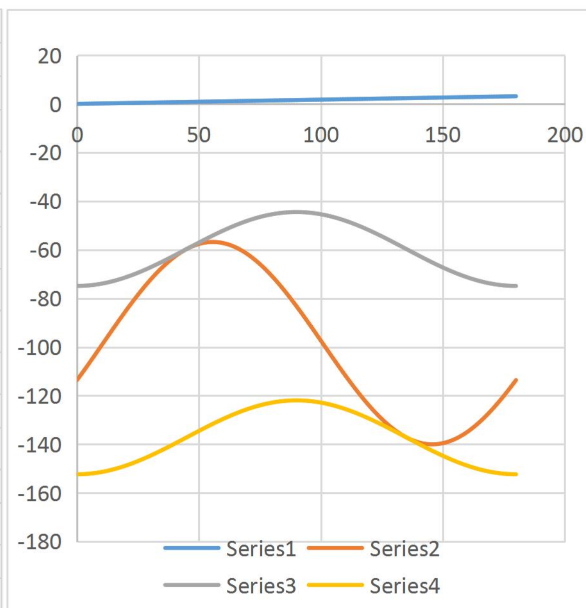
Resistance moment:

Lower surface							
$m_{Rdx} = A_{sx} * f_{yd} * z_x$			$m_{Rdy} = A_{sy} * f_{yd} * z_y$				$m_{Rd\Phi} = m_{Rdx} * \cos\Phi^2 + m_{Rdy} * \sin\Phi^2$
m_{Rdx} =	77.14	kNm	m_{Rdy} =	132.4428034	kNm		
Upper surface							
$m'_{Rdx} = A'_{sx} * f_{yd} * z'_x$			$m'_{Rdy} = A'_{sy} * f_{yd} * z'_y$				$m'_{Rd\Phi} = m'_{Rdx} * \cos\Phi^2 + m'_{Rdy} * \sin\Phi^2$
m'_{Rdx} =	159.7144722	kNm	m'_{Rdy} =	198.3704159	kNm		

Lower surface:

Asx,req. = medx/(0.9*dx*fyd)					Steel: B500B			Concrete: C30/37		
Asx,req. =	-902.5209644				fyd = 500/1.15			fcd = 30/1.5		
Asx,prov.≥ Asx,req.					fyd =	434.7826087	N/mm2	fcd =	20	N/mm^2
Asx,prov. =n* π * (ϕ/2)^2					z_x = dx-0.4*x					
Asx,prov. =	697.4335691	mm^2			z_x =	204.4192003	mm			
Asx,prov.≥ Asx,req.		Fail			x_x = As,prov.*fyd/(0.8*b*fcd)				b = 1000 mm	
					x_x =	18.95199916	mm			
n = Asx,req./(π*(ϕ/2)^2)										
n =	11.49125382				h_s = 250 mm			c = 25 mm		
n = 9 Bars		3 Bars ϕ10			d_x = h - c - ϕ/2 - ϕstr			ϕ = 10 mm		
		3 Bars ϕ14			d_x =	212	mm	ϕstr = 8 mm		
Asy,req. = medy/(0.9*dy*fyd)										
Asy,req. =	-538.7256451									
Asy,prov.≥ Asy,req.					zy = dy - 0.4*x					
Asy,prov. =n* π * (ϕ/2)^2					zy=	193.9261269	mm			
Asy,prov. =	1570.796327	mm^2								
					x_y = As,prov.*fyd/(0.8*b*fcd)				b = 1000 mm	
Asy,prov.≥ Asx,req.		Okay			x_y =	42.68468279	mm			
n = Asx,req./(π*(ϕ/2)^2)					h_s = 250 mm			c = 25 mm		
n =	4.763380521				d_y = h - c - ϕ/2 - ϕstr			ϕ = 12 mm		
n = 12 Bars		5 Bars ϕ12			d_y =	211	mm	ϕstr = 8 mm		
		5 Bars ϕ16								

Reliability Conditions:			
$(-)(m_{Rdx} - m_x) * (m_{Rdy} - m_y) + m^2_{xy} \leq 0$			
-39633.603	< 0	TRUE	
$(-)(m'_{Rdx} + m_x) * (m'_{Rdy} + m_y) + m^2_{xy} \leq 0$			
-3810.5489	< 0	TRUE	
$m_x \leq m_{Rdx}$	True		
$m_y \leq m_{Rdy}$	True		
$m_x \geq -m'_{Rdx}$	True		
$m_y \geq -m'_{Rdy}$	True		

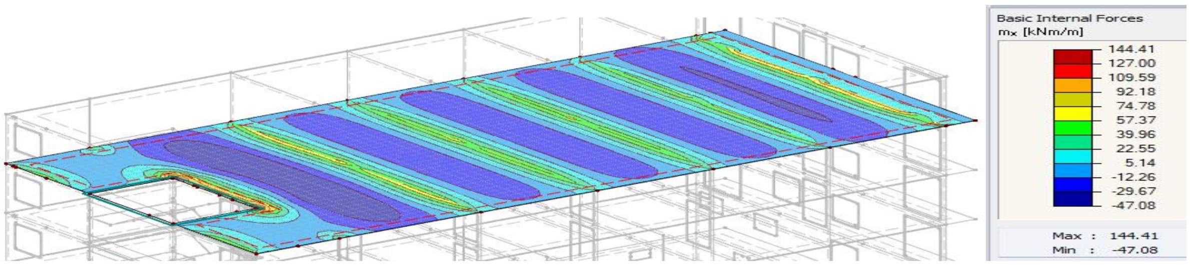


Basic internal forces in typical floors (apartments) 3- 6:

Moment mx:

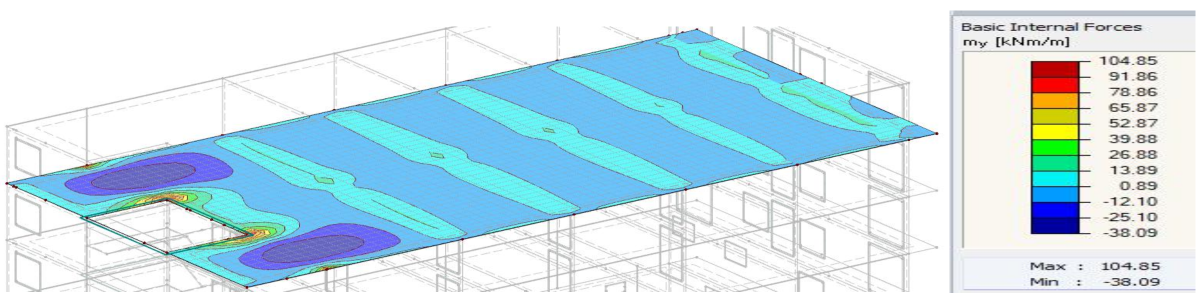
Basic internal force on typical floor (apartment's) structures is confirmed by Combination of C03 surface dead load and variable load.

Coordinates x-y is assumed, Now as we see that the max support moment is in two edges of concrete core max support moment is in support axis of B - 6, and C - 6, & max span moment is in each midspan moment which is supported by two parallel reinforced concrete walls; therefore, design justifications will focus on this part as an extreme one.



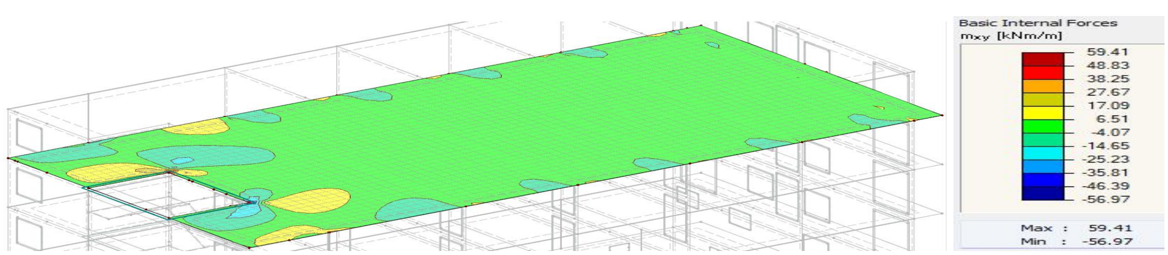
Moment my:

Coordinates x-y is assumed, max support moment is in two edges of concrete core max support moment is in support axis of B - 6, and C - 6, & max span moment is in two spans to the y- direction's midspan moment, therefore design justifications will focus on this part as an extreme one.



Moment mxy:

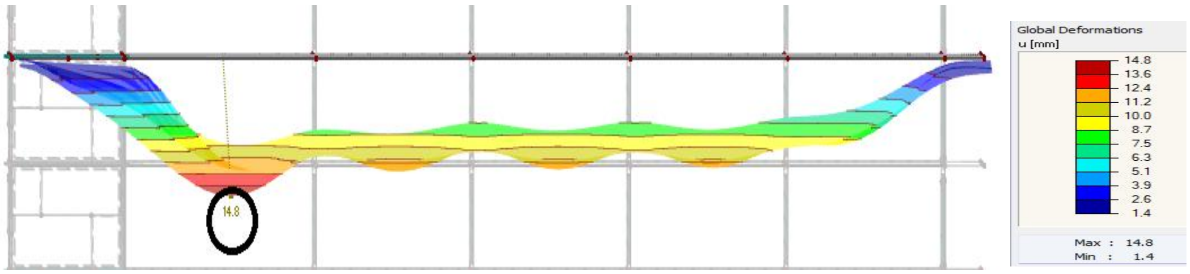
Coordinates x-y is assumed, Now as we see that the max moments are in each edges of concrete core, max support moment is in support axis of B - 6, while max span moment is in support C - 6, therefore design justifications will focus on this part as an extreme one.



These four apartments have same functionality therefore load distributions of one typical floor is equivalent to each one of them therefore design evaluation will take int account of one typical floor.

Global deformations:

Basically, we see that the maximum global deformation is in our max span in range of 14.8mm.



Loading moment:

$m\phi = mx*\cos2\phi + my*\sin2\phi + 2mxy*\sin\phi\cos\phi$

Condition for Loading Moment:

$(-)m'_{Rd\Phi} < m_{\Phi} < m_{Rd\Phi}$

mx = -47.08

my = -38.09

mxy = 56.97

Design moments:

$m_{Rdx} = m_x + \lvert m_{xy} \rvert$		kNm/m		$m_{Rdy} = m_y + \lvert m_{xy} \rvert$		kNm/m
$m_{Rdx} =$	9.89	kNm/m		$m_{Rdy} =$	18.88	kNm/m
Upper surface						
$m'_{Rdx} = -m_x + \lvert m_{xy} \rvert$		kNm/m		$m'_{Rdy} = -m_y + \lvert m_{xy} \rvert$		kNm/m
$m'_{Rdx} =$	104.05	kNm/m		$m'_{Rdy} =$	95.06	kNm/m

Upper surface:

A'sx,req. = m'edx/(0.9*d'x*fyd)					Steel: B500B			Concrete: C30/37		
Asx,req. =	1641.392318				fyd = 500/1.15			fcd = 30/1.5		
A'sx,prov.≥ A'sx,req.					fyd =	434.782609	N/mm2	fcd =	20	N/mm^2
A'sx,prov. =n* π * (ϕ/2)^2					z'x = d'x - 0.4*x					
A'sx,prov.	2789.734276	mm^2			z'x=	131.676801	mm			
A'sx,prov.≥ A'sx,req.		Okay			x'$_x$ = A'sx,prov.*fyd/(0.8*b*fcd)				b = 1000 mm	
					x'$_x$ =	75.8079966	mm			
n = A'sx,req./(π*(ϕ/2)^2)										
n =	20.89885608				h$_s$ = 200 mm			c = 25 mm		
n = 33 Bars		12 Bars ϕ10			d'x = h - c - ϕ/2 - ϕstr			ϕ = 10 mm		
		12 Bars ϕ14			d'x =	162	mm	ϕstr = 8 mm		
A'sy,req. = m'edy/(0.9*d'y*fyd)										
A'sy,req. =	3480									
A'sy,prov.≥ A'sy,req.					z'y = d'y - 0.4x					
A'sy,prov. =n* π * (ϕ/2)^2					z'y=	121.021739	mm			
A'sy,prov.	3770	mm^2								
					x'$_y$ = A'sy,prov.*fyd/(0.8*b*fcd)				b = 1000 mm	
A'sy,prov.≥ A'sy,req.		Okay			x'$_y$ =	102.445652	mm			
n = A'sy,req./(π*(ϕ/2)^2)					h$_s$ = 200 mm			c = 25 mm		
n =	30.76995566				d'y = h - c - ϕ/2 - ϕstr			ϕ = 12 mm		
n = 30 Bars		12 Bars ϕ12			d'y =	162	mm	ϕstr = 8 mm		
		12 Bars ϕ16								

Lower surface:

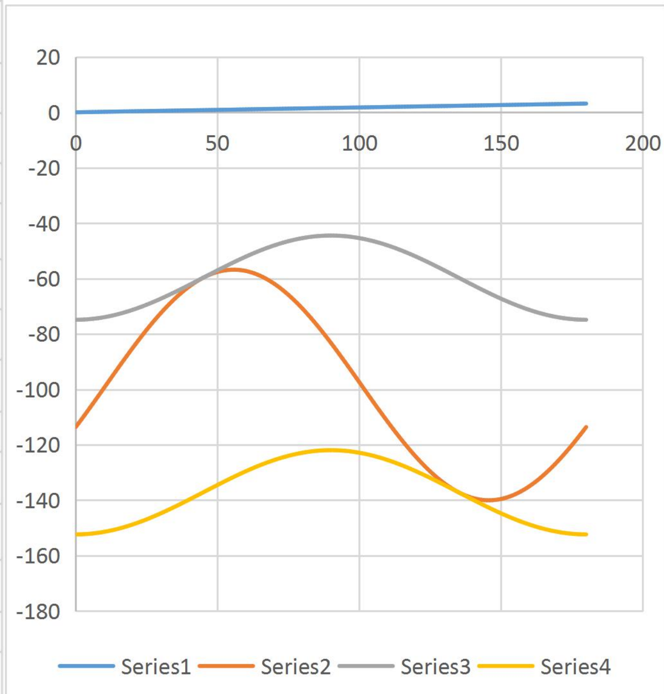
Asx,req. = medx/(0.9*dx*fyd)					Steel: B500B			Concrete: C30/37		
Asx,req. =	119.2190776				fyd = 500/1.15			fcd = 30/1.5		
Asx,prov.≥ Asx,req.					fyd =	434.7826087	N/mm2	fcd =	20	N/mm^2
Asx,prov. =n* π * (ϕ/2)^2					z$_x$ = dx-0.4*x					
Asx,prov. =	697.4335691	mm^2			z$_x$ =	204.4192003	mm			
Asx,prov.≥ Asx,req.		Okay			x$_x$ = As,prov.*fyd/(0.8*b*fcd)				b = 1000 mm	
					x$_x$ =	18.95199916	mm			
n = Asx,req./(π*(ϕ/2)^2)										
n =	-1.51794444				h$_s$ = 250 mm			c = 25 mm		
n = 9 Bars		3 Bars ϕ10			d$_x$ = h - c - ϕ/2 - ϕstr			ϕ = 10 mm		
		3 Bars ϕ14			d$_x$ =	212	mm	ϕstr = 8 mm		
Asy,req. = medy/(0.9*dy*fyd)										
Asy,req. =	228.6677199									
Asy,prov.≥ Asy,req.					zy = dy - 0.4*x					
Asy,prov. =n* π * (ϕ/2)^2					zy=	193.9261269	mm			
Asy,prov. =	1570.796327	mm^2								
					x$_y$ = As,prov.*fyd/(0.8*b*fcd)				b = 1000 mm	
Asy,prov.≥ Asx,req.		Okay			x$_y$ =	42.68468279	mm			
n = Asx,req./(π*(ϕ/2)^2)					h$_s$ = 250 mm			c = 25 mm		
n =	-2.021866552				d$_y$ = h - c - ϕ/2 - ϕstr			ϕ = 12 mm		
n = 12 Bars		5 Bars ϕ12			d$_y$ =	211	mm	ϕstr = 8 mm		
		5 Bars ϕ16								

Resistance moment:

Lower surface				
$m_{Rdx} = A_{sx} * f_{yd} * z_x$		$m_{Rdy} = A_{sy} * f_{yd} * z_y$		$m_{Rd\Phi} = m_{Rdx} * \cos\Phi^2 + m_{Rdy} * \sin\Phi^2$
m_{Rdx} = 77.14	kNm	m_{Rdy} = 132.4428	kNm	
Upper surface				
$m'_{Rdx} = A'_{sx} * f_{yd} * z'_x$		$m'_{Rdy} = A'_{sy} * f_{yd} * z'_y$		$m'_{Rd\Phi} = m'_{Rdx} * \cos\Phi^2 + m'_{Rdy} * \sin\Phi^2$
m'_{Rdx} = 281.0073	kNm	m'_{Rdy} = 278.6878	kNm	

Reliability Conditions:

$(-)(m_{Rdx} - m_x) * (m_{Rdy} - m_y) + m^2_{xy} \leq 0$		
-39633.603	< 0	TRUE
$(-)(m'_{Rdx} + m_x) * (m'_{Rdy} + m_y) + m^2_{xy} \leq 0$		
-31224.393	< 0	TRUE
$m_x \leq m_{Rdx}$	True	
$m_y \leq m_{Rdy}$	True	
$m_x \geq -m'_{Rdx}$	True	
$m_y \geq -m'_{Rdy}$	True	

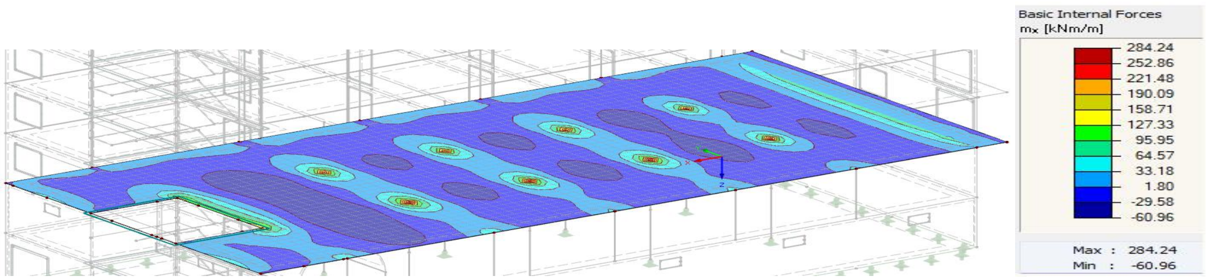


General principle of surface designing of the reinforcement and calculation for administrative part and shopping area will be same procedures as mentioned above calculations therefore I will take into account for further design only roof structures and typical apartments.

Basic internal forces in typical floors (administrative):

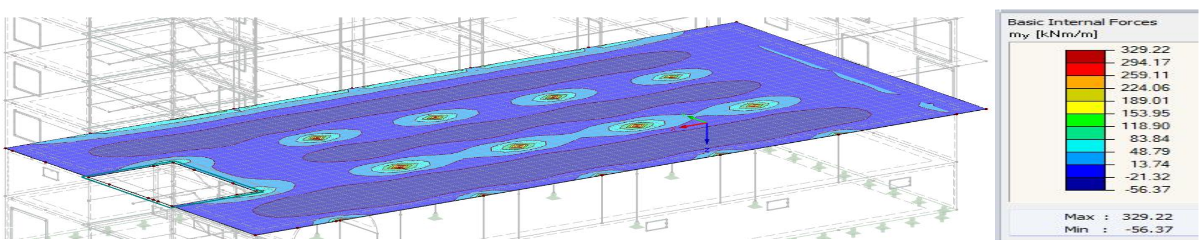
Moment mx:

Basic internal force on typical floor (administrative) structures is confirmed by Combination of C02 surface dead load and variable load according to category B: office area.



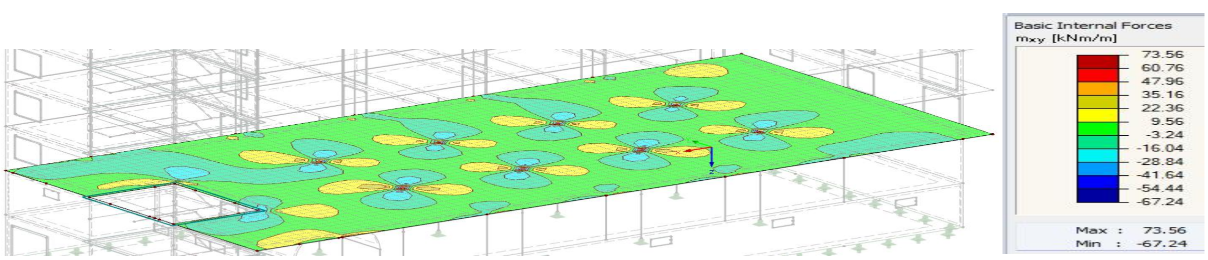
Moment my:

Basic internal force on typical floor (administrative) structures is confirmed by Combination of C02 surface dead load and variable load according to category B: office area.

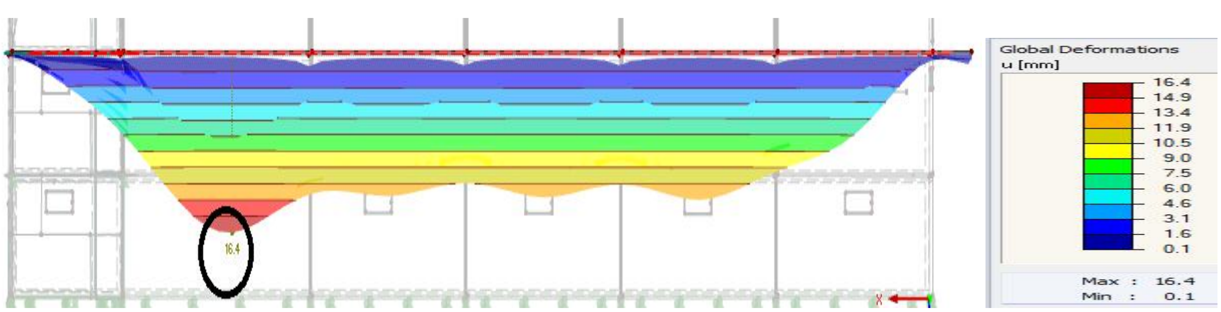


Moment mxy:

Basic internal force on typical floor (administrative) structures is confirmed by Combination of C02 surface dead load and variable load according to category B: office area.



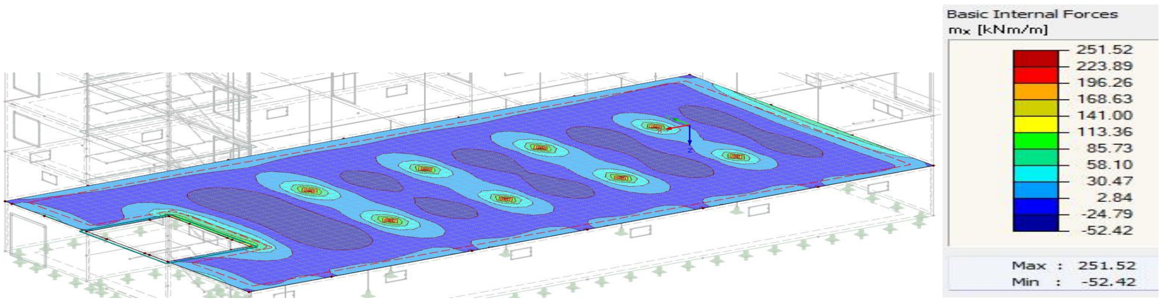
Global deformations: u→16.4mm



Basic internal forces in typical floors (shopping area

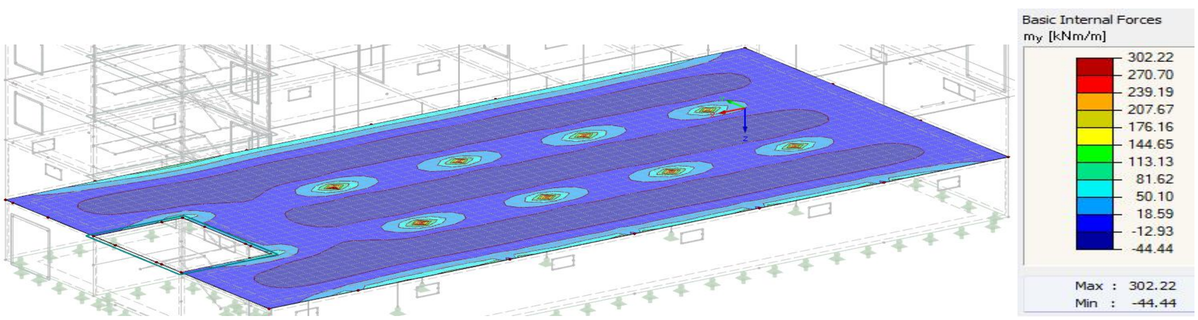
Moment mx:

Basic internal force on typical floor (shopping area) structures is confirmed by Combination of C01 surface dead load and variable load.



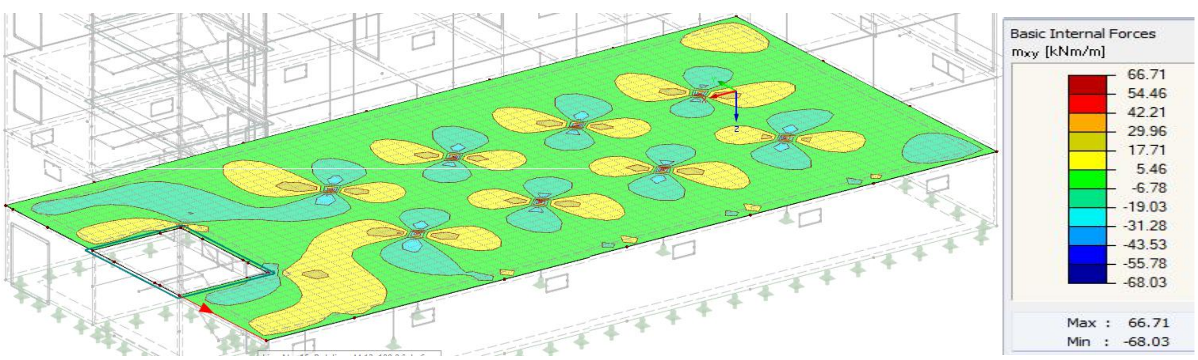
Moment my:

Basic internal force on typical floor (shopping area) structures is confirmed by Combination of C01 surface dead load and variable load.

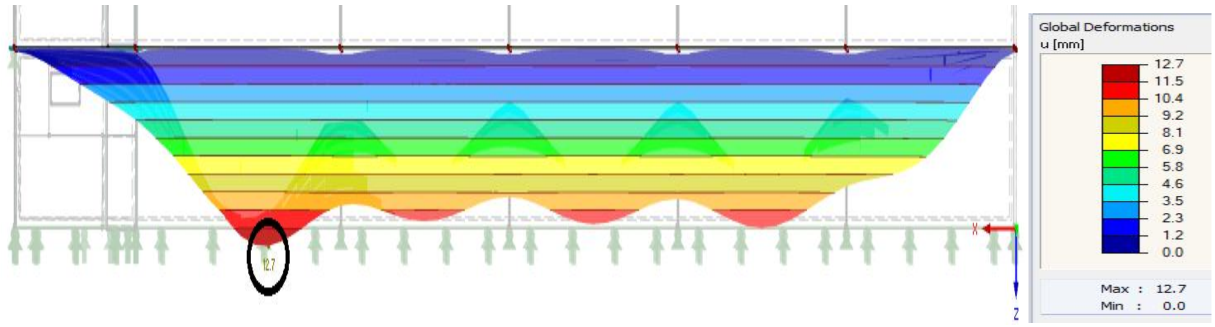


Moment mxy:

Basic internal force on typical floor (shopping area) structures is confirmed by Combination of C01 surface dead load and variable load.



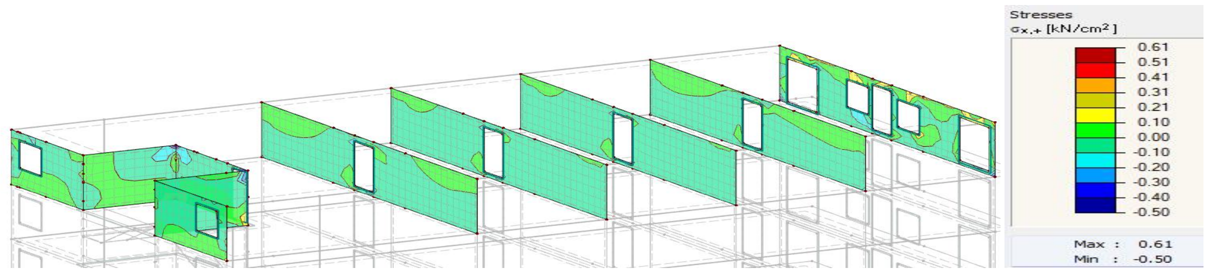
Global deformations: u→12.7mm



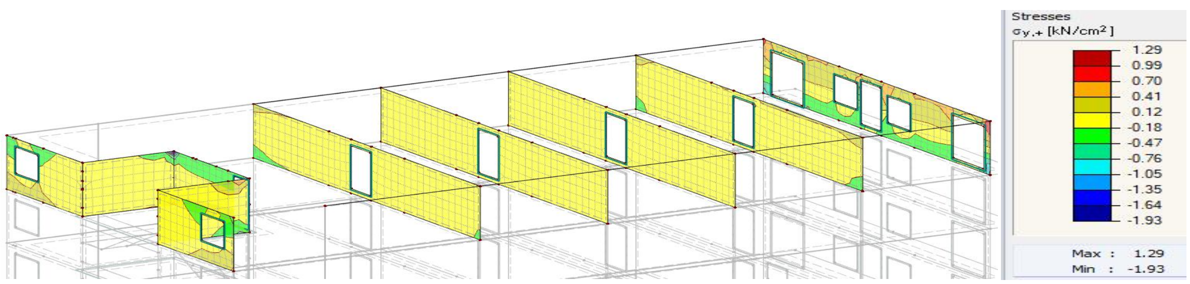
Basic internal stresses:

Roof structures:

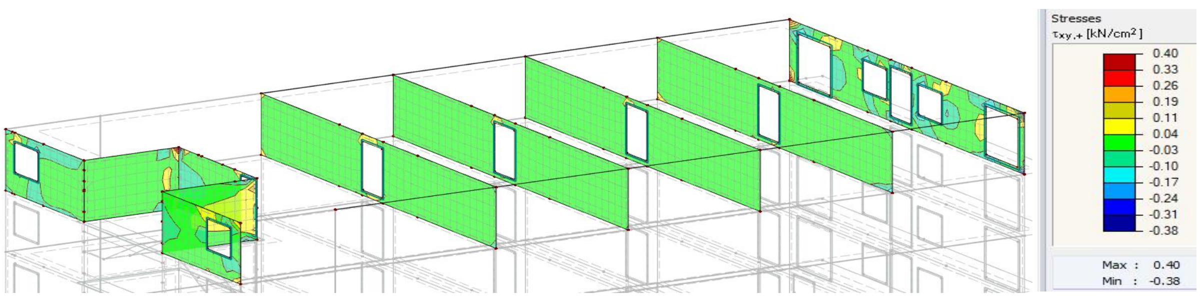
Stress Ϭx:



Stress Ϭy:



Stress Ϭxy:



Loading moment:

σϕ = σx·cos2ϕ + σy·sin2ϕ + 2·τ xysinϕcosϕ

Condition for Loading Moment:

(-)fcdϕ≤ σϕ ≤ftd ϕ

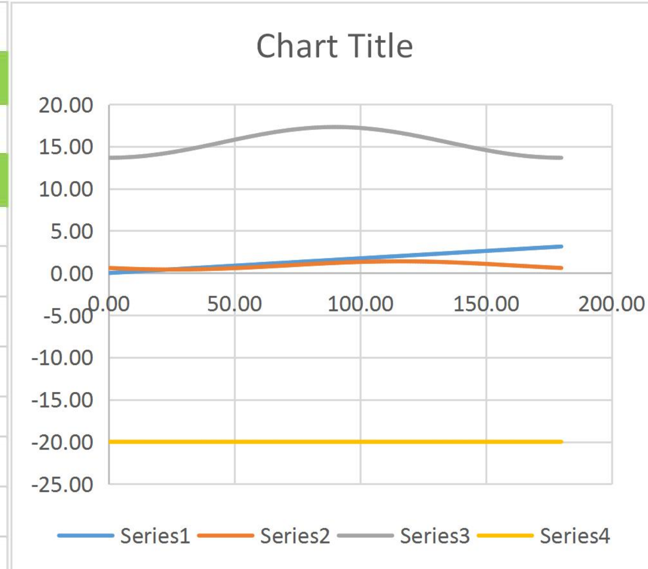
σx =	0.60
σy =	1.20
τxy =	-0.38

Design stresses		
f_{tdx} =	$\sigma_x + \lvert\tau_{xy}\rvert$	
f_{tdx} =	0.98	
f_{tdy} =	$\sigma_y + \lvert\tau_{xy}\rvert$	
f_{tdy} =	1.58	
fcdϕ = f cd x= f cdy= fcd		
fcdϕ	20.00	
ftdϕ = ft d x·cos2ϕ + ftdy·sin2ϕ		
σϕ = σx·cos2ϕ + σy·sin2ϕ + 2·τ xysinϕcosϕ		
Steel:	B500B	
	fyd=500/1.15	
	fyd =	434.78
ftdx = as· f yd / (t*1)		
Asx,req. =	1352.40	
n=As,req * 4 /(π*ϕ2)		
nx =	4.30	
nx =	60.00	ϕ 20 mm 4 sides each 15
Asx,prov. = n*π*ϕ²/4		
Asx,prov.	18849.56	
Asx, prov. > Asx, req.	True	

Resisting stresses			
ftd x = ρx· f yd			
ftd x =	13.66		
ftdy = ρy· f yd			
ftdy =	17.30		
$f_{td\Phi}$ = ftdx*cosΦ^2 + ftdy*sinΦ^2			
σcd = 2·|τ xy| ≤ v*f cd		True	
σcd =	0.76	v·f cd =	15.84
v = 0.6*(1 − ⍰ ⍰ ⍰/ 250)			
v =	0.53		
v≥0,5	True		

			concrete C30/37		
t =	600.00		fcd = 30/1.5		
ϕ =	20.00		fcd =	20.00	
		ftdy = as· f yd / (t*1)			
		As,req. =	2180.40		
		n=As,req * 4 /(π*ϕ2)			
		ny =	6.94		
		ny =	76.00	ϕ 20 mı	4 lines each 19
		Asy,prov. = n*π*ϕ²/4			
		Asy,prov.	23876.10		
		Asy, prov. > Asy, req.	True		

Reability conditions		
-(ftd x - σx)·(ftdy - σy) + τ 2 xy ≤ 0		True
-(ftd x + σx)·(ftdy + σy) + τ 2 xy ≤ 0		True
σx ≤ ftd x	True	
σy ≤ ftdy	True	
σx ≥ -fcd	True	
σy ≥ -fcd	True	



ULS Check
I- $f_{tdx,Res.} > f_{tdx,Des.}$
II - $\zeta < \zeta_{bal}$
III- $\rho_{min} \le \rho \le \rho_{max}$
IV- $\varepsilon_s \le \varepsilon_{su}$

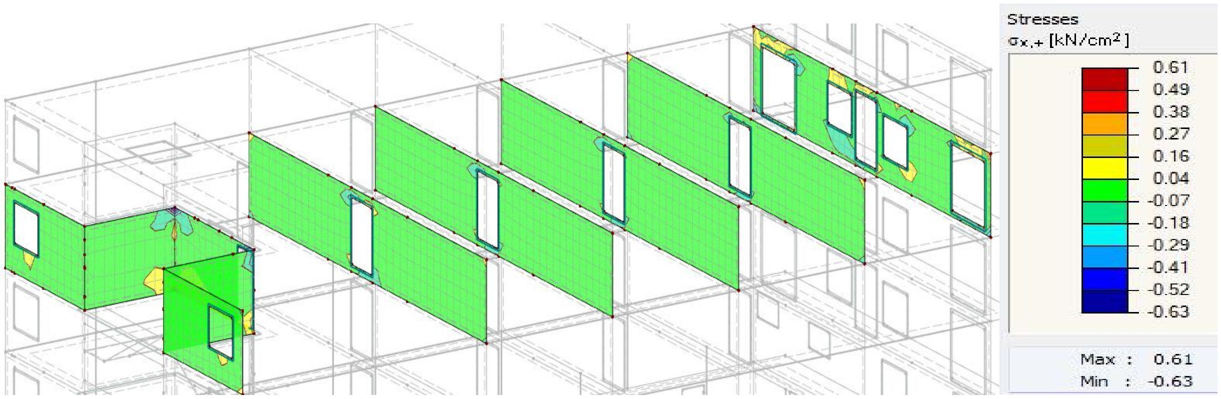
	III- $\rho_{min} \le \rho \le \rho_{max}$				
	0.0015 ≤	As, prov. / ≤ 0.04			
		≤		≤	
X	0.0015	True	0.0314	True	≤ 0.04
Y	0.0015	True	0.0398	True	≤ 0.04

General principle of stress designing of the reinforcement and calculation for administrative part and shopping area will be same procedures as mentioned above calculations therefore I will take into account for further design only roof structures and typical apartments.

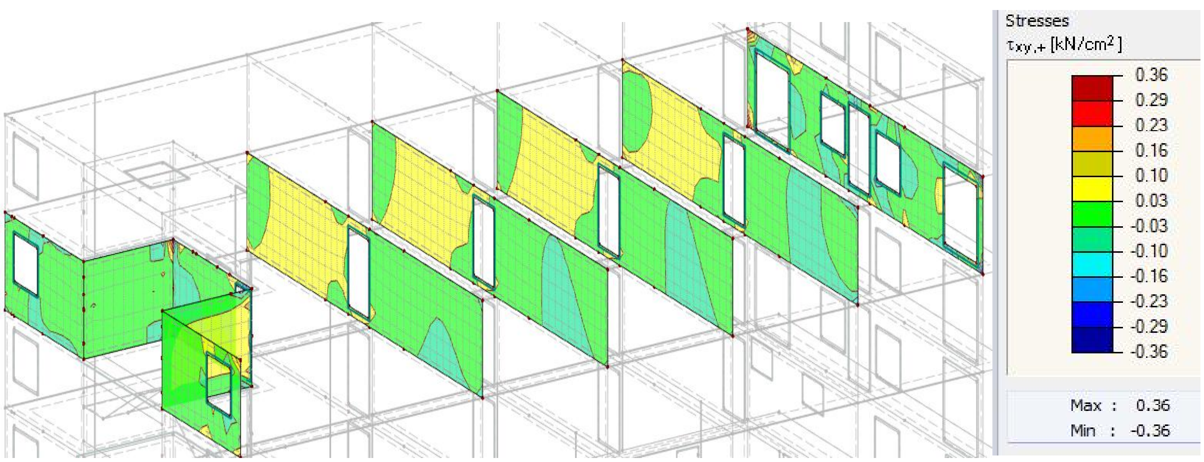
Basic internal stresses:

Typical apartments:

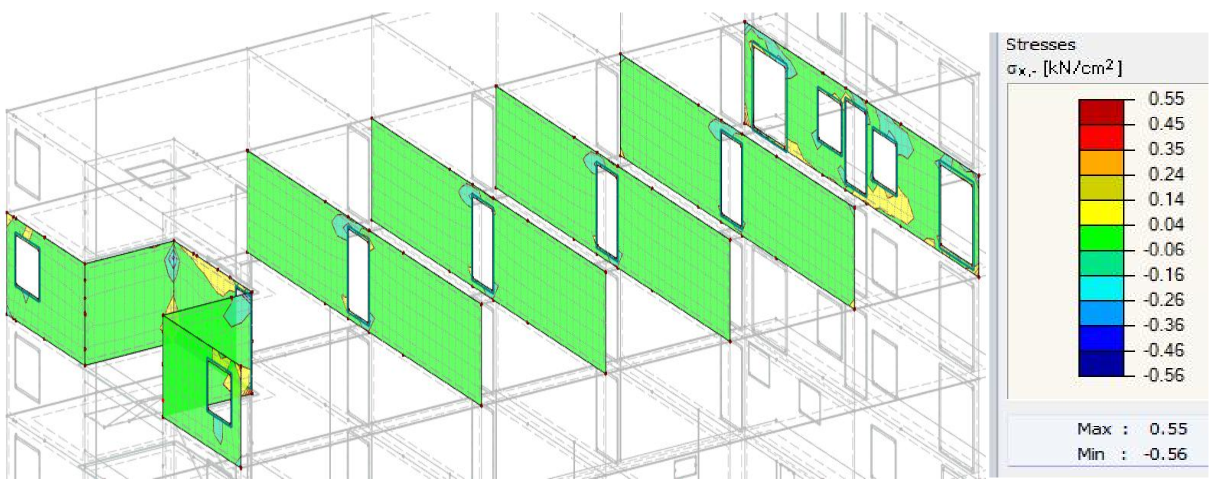
Stress Ϭx:



Stress Ϭy:



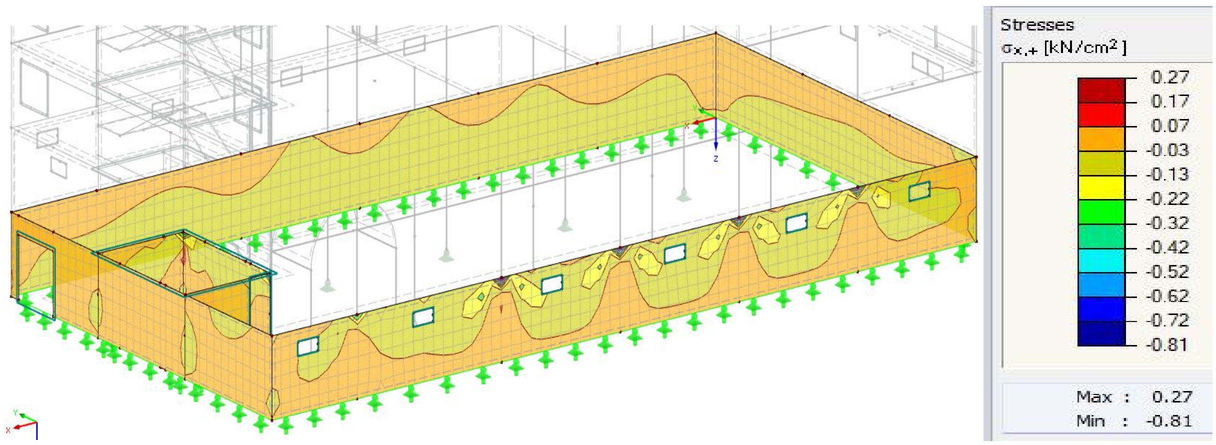
Stress Ϭxy:



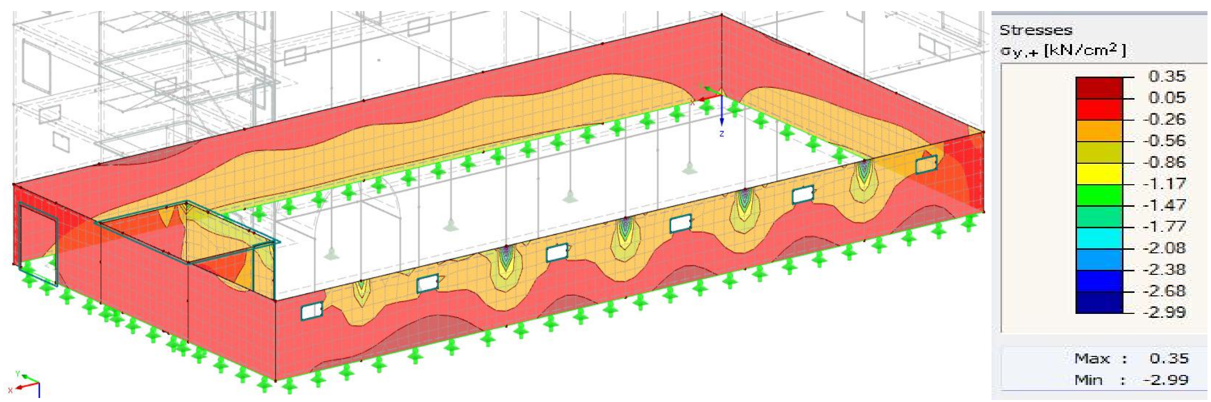
Basic internal stresses:

Basement walls:

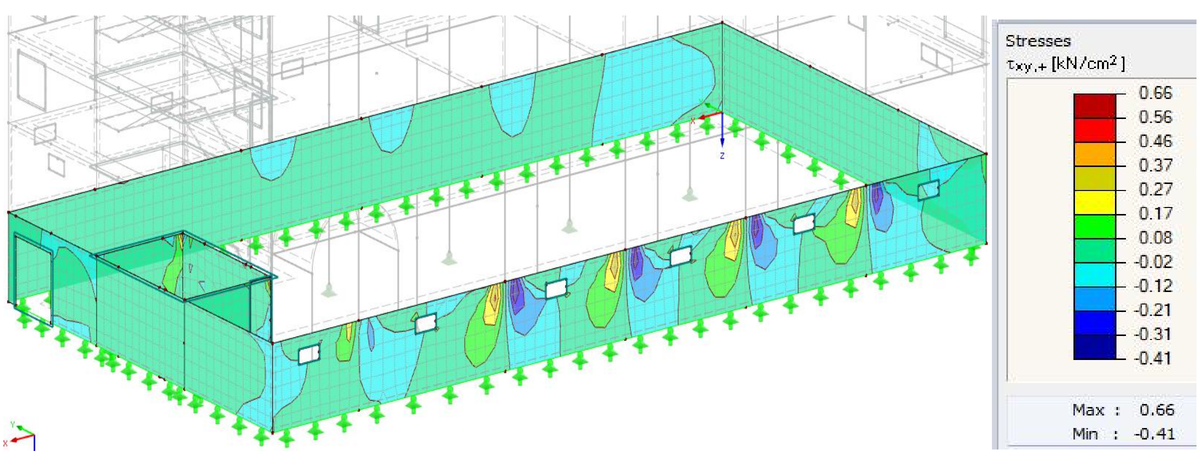
Stress Ϭx:



Stress Ϭy:



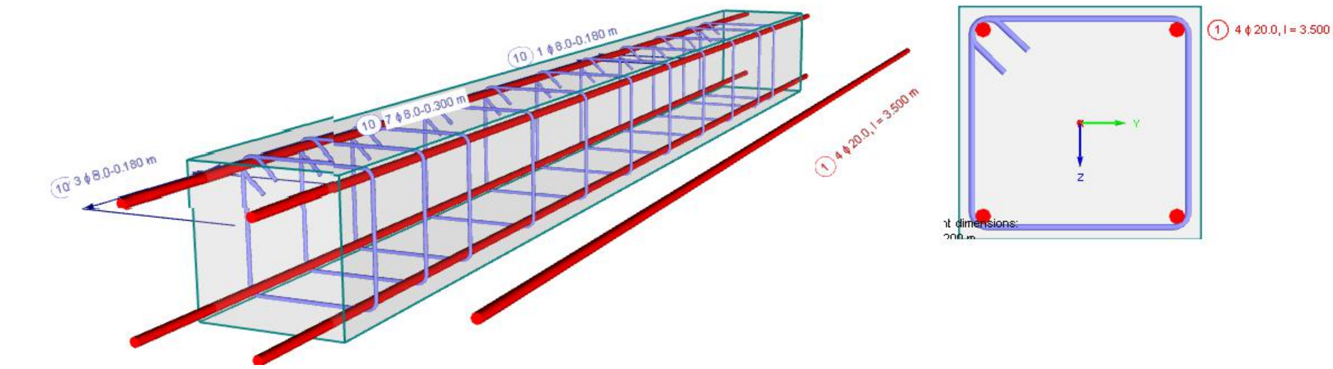
Stress Ϭxy:



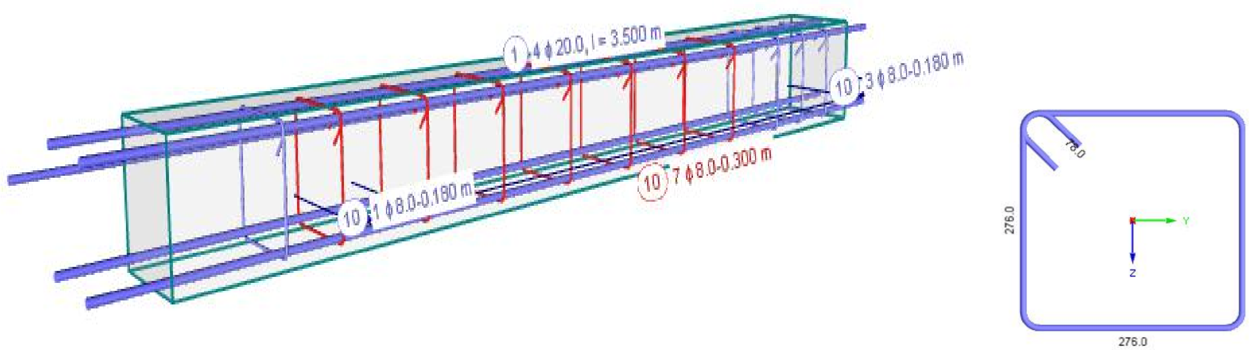
Design of members:→for column:

with respect to assumption of coordinates x-y designing for vertical member column 8 in axis of B-5 and horizontal member 72 shall be considered.

Longitudinal reinforcement.



Shear reinforcement for column:



Total amount of re-bars for vertical resistance of member 8.

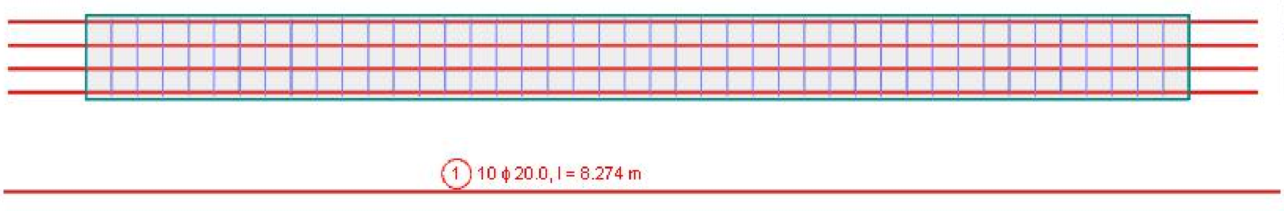
Item No.	A Reinforcement Type	B d_s [mm]	C Surface Type	D Number of Bars	E Length [m]	F Anchorage Type Start	G Anchorage Type End	H Bending Diameter [mm]	I Weight [kg]
	Material No. 4 - Reinforcing Steel B 500 S (A)								
1	Longitudinal	20.0	Ribbed	40	3.500	Straight	Straight		345.26
2	Longitudinal	20.0	Ribbed	4	3.836	Straight	Straight		37.84
3	Longitudinal	20.0	Ribbed	8	3.676	Straight	Straight		72.52
4	Longitudinal	20.0	Ribbed	4	4.211	Straight	Straight		41.54
5	Longitudinal	20.0	Ribbed	8	3.809	Straight	Straight		75.16
6	Longitudinal	20.0	Ribbed	8	3.757	Straight	Straight		74.13
7	Longitudinal	20.0	Ribbed	8	4.026	Straight	Straight		79.43
8	Longitudinal	20.0	Ribbed	8	4.066	Straight	Straight		80.21
10	Shear	8.0	Ribbed	197	1.228	Hook	Hook		95.46
Sum				285					901.54

Vertical member resistance for Column 8 with four longitudinal re bars is confirmed.

Design of members:→for beam:

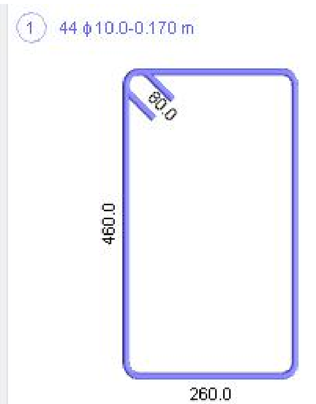
Longitudinal reinforcement.

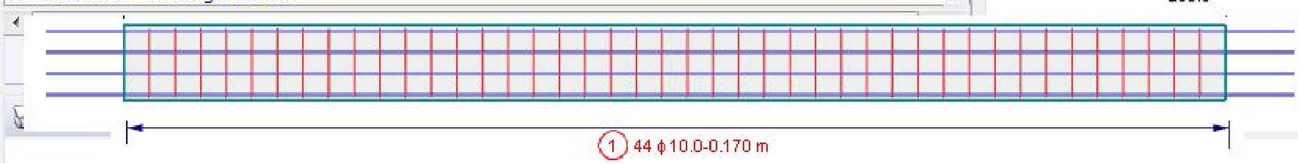
Member No. 72 - Rectangle 300/500									
1	All round	10	20.0	31.42	8.274	-0.516	7.757	☑	204.04
Member No. 73 - Rectangle 300/500									
1	All round	4	20.0	12.57	6.517	-0.317	6.200	☑	64.28



Shear reinforcement for beam:

A	B	C	D	E	F	G	H	I	J	K
Section	Item No.	No. of Stirrups	d_s [mm]	Length [m]	x-Location [m] from	to	Spacing s_{li} [m]	Number of Sections	Weight [kg]	Notes
Member No. 67 - Rectangle 300/500										
67	1	31	10.0	6.000	0.000	6.000	0.200	2	31.69	115)
Member No. 68 - Rectangle 300/500										
68	1	12	10.0	2.150	0.000	2.150	0.195	2	12.27	115)
Member No. 69 - Rectangle 300/500										
69	1	12	10.0	2.150	0.000	2.150	0.195	2	12.27	115)
Member No. 70 - Rectangle 300/500										
70	1	38	10.0	7.300	0.000	7.300	0.197	2	38.84	115)
Member No. 71 - Rectangle 300/500										
71	1	31	10.0	6.000	0.000	6.000	0.200	2	31.69	115)
Member No. 72 - Rectangle 300/500										
72	1	44	10.0	7.300	0.000	7.300	0.170	2	44.97	
Member No. 73 - Rectangle 300/500										





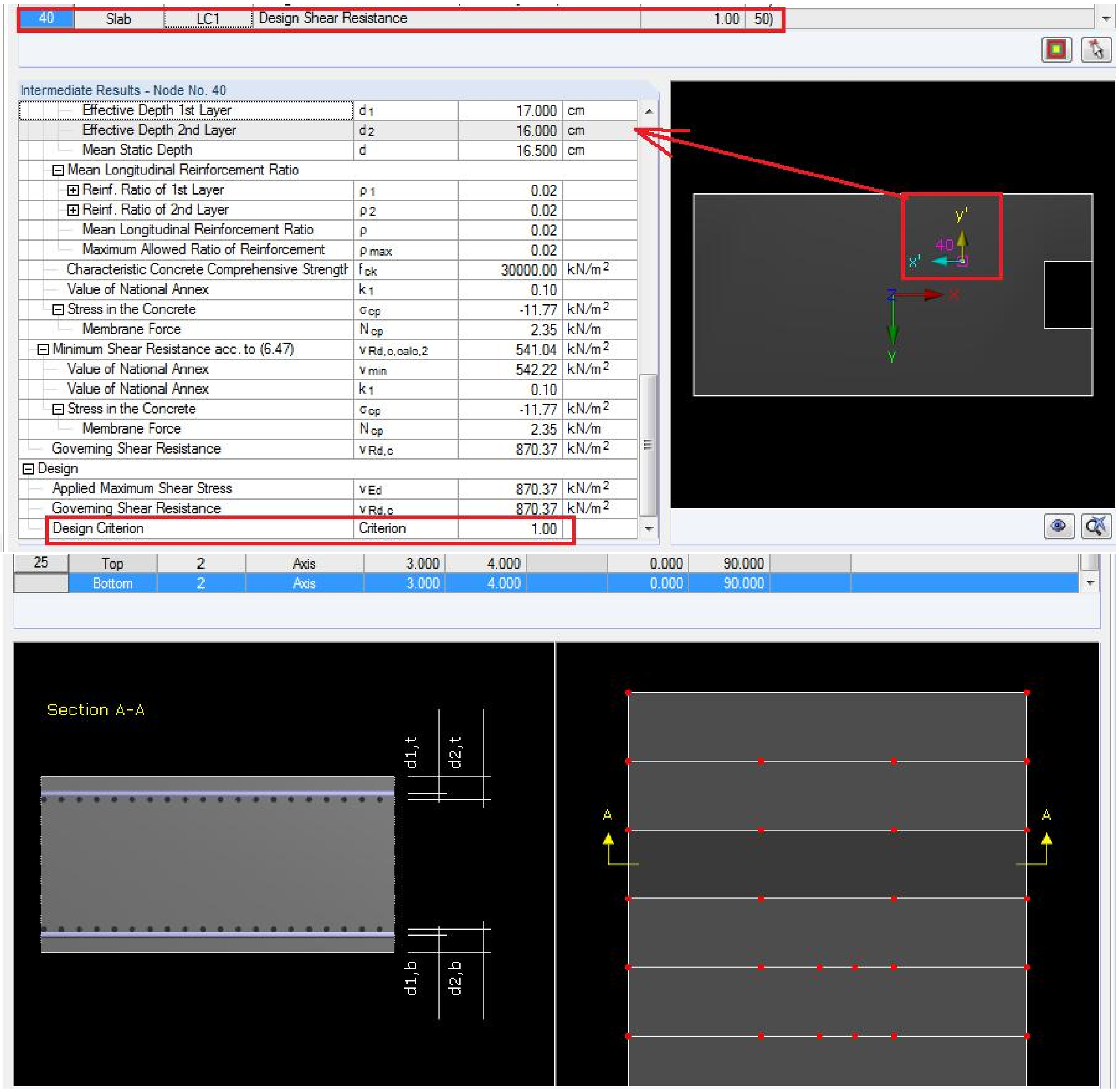
Total amount of re-bars for horizontal resistance of member 72.

A	B	C	D	E	F	G	H	I	J
Item No.	Reinforcement Type	d_s [mm]	Surface	No. of Bars	Length [m]	Anchorage Type Start	End	Bending Diameter [m]	Weight [kg]
68	Longitudinal	20.0	Ribbed	4	6.496	Straight	Straight		64.08
69	Longitudinal	20.0	Ribbed	4	6.571	Straight	Straight		64.82
70	Longitudinal	20.0	Ribbed	4	8.220	Straight	Straight		81.09
71	Longitudinal	20.0	Ribbed	4	4.842	Straight	Straight		47.76
72	Longitudinal	20.0	Ribbed	4	6.762	Straight	Straight		66.70
73	Longitudinal	20.0	Ribbed	4	6.785	Straight	Straight		66.93
74	Longitudinal	20.0	Ribbed	6	8.143	Straight	Straight		120.49
75	Longitudinal	20.0	Ribbed	4	4.830	Straight	Straight		47.64
76	Stirrup	10.0	Ribbed	40	1.003	Hook	Hook	0.040	24.74
77	Stirrup	10.0	Ribbed	2090	1.658	Hook	Hook	0.040	2140.28

Horizontal member resistance for beam number 72 with four longitudinal re bars is confirmed.

Punching:→for column:

with respect to assumption of coordinates x-y designing for vertical member column 8 in axis of B-5 shall be considered.



40	Slab	LC1	Design Shear Resistance	1.00	50)

Intermediate Results - Node No. 40

Effective Depth 1st Layer	d_1	17.000	cm
Effective Depth 2nd Layer	d_2	16.000	cm
Mean Static Depth	d	16.500	cm
Mean Longitudinal Reinforcement Ratio			
Reinf. Ratio of 1st Layer	ρ_1	0.02	
Reinf. Ratio of 2nd Layer	ρ_2	0.02	
Mean Longitudinal Reinforcement Ratio	ρ	0.02	
Maximum Allowed Ratio of Reinforcement	ρ_{max}	0.02	
Characteristic Concrete Comprehensive Strength	f_{ck}	30000.00	kN/m2
Value of National Annex	k_1	0.10	
Stress in the Concrete	σ_{cp}	-11.77	kN/m2
Membrane Force	N_{cp}	2.35	kN/m
Minimum Shear Resistance acc. to (6.47)	$v_{Rd,c,calc,2}$	541.04	kN/m2
Value of National Annex	v_{min}	542.22	kN/m2
Value of National Annex	k_1	0.10	
Stress in the Concrete	σ_{cp}	-11.77	kN/m2
Membrane Force	N_{cp}	2.35	kN/m
Governing Shear Resistance	$v_{Rd,c}$	870.37	kN/m2
Design			
Applied Maximum Shear Stress	v_{Ed}	870.37	kN/m2
Governing Shear Resistance	$v_{Rd,c}$	870.37	kN/m2
Design Criterion	Criterion	1.00	

25	Top	2	Axis	3.000	4.000	0.000	90.000
	Bottom	2	Axis	3.000	4.000	0.000	90.000

Earth pressure acting on basement walls (Horizontal Resistance):

Extreme parts of the Lateral earth pressure on basement wall is generally from back fill soil with maximum height of 2,65 m. the resultant force due to the earth pressure in our basement wall shall be calculated as follow.

$$F_{EP} = \frac{1}{2} * K * \gamma * h_{BS}2$$

where

F_{EP} – Resultant force acting on the basement wall

h_{BS} – height of backfill soil

γ – specific weight of backfill soil

K – coefficient of earth pressure at rest

Coefficient of earth pressure at rest can be calculated as follows:

K = μ / (1 - μ) μ is the poisons ratios for different kinds of back fill soil in my case I have a sandy clay which is wet μ = 0.37

$$K = \frac{\mu}{(1-\mu)} = \frac{0{,}37}{(1-0{,}37)} = 0{,}587$$

Specific weight of back fill soil can be calculated as follows:

$$\gamma = \rho * A_G$$

where:

ρ – density of soil $= 20\ KN/\mathrm{m3}$

A_G – Acceleration of gravity $A_G = 9.81\ \mathrm{m/s2}$

in my case I have a sandy clay which is wet and the density can be considered $20\ KN/\mathrm{m3}$

$$\gamma = \rho * A_G = \frac{9{,}81m}{s^2} * \frac{2000Kg}{m^3} = 19620\frac{N}{m^3} = 19{,}62\ \frac{KN}{m^3}$$

position of the acting force in earth pressure area can be calculated as follow:

$d_{bp} = \frac{h_{BS}}{3} = \frac{2,87}{3} = 0,97m$

where

$d_{bp} -$ distance from the bottom parts of the basement wall.

$$F_{EP} = \frac{1}{2} * 0,587 * 19,62 \ \frac{KN}{m^3} \ * 2,87m^2 \ = 47,44 \ KN/m$$

this is the final resultant force which acts in extreme part of the basement wall and of course that this force is much smaller than applied vertical force therefore the vertical designed reinforcement bar can be able (after judgment of further calculation) to resists this force and does not have any influence of changing the geometry of the reinforced wall.

Design the geometry of the staircase:

- Height of the floor h_{foolr} =3320 mm
- Depth of the main slab h_s = 200 mm
- Depth of floor structure h_f = 120 mm

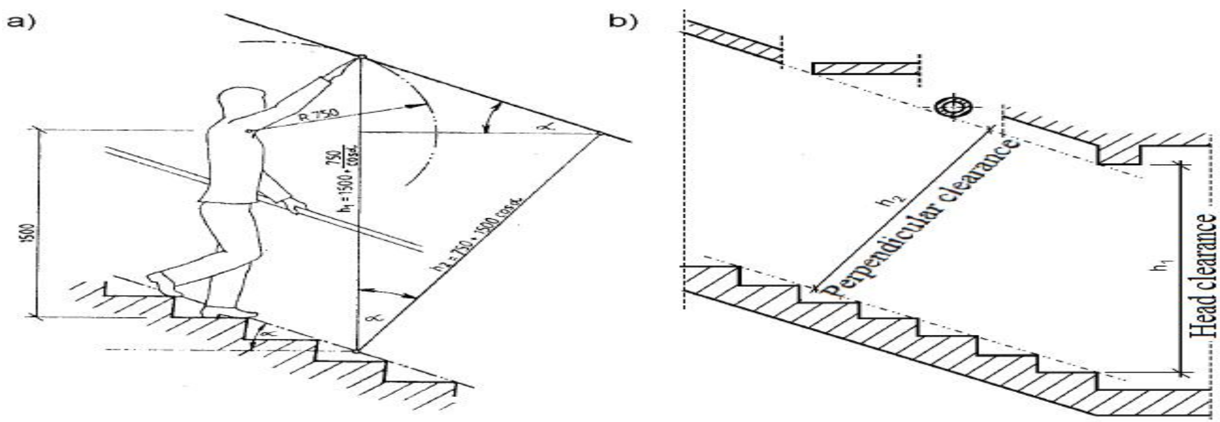
Dimensions of the staircase:

- Ideal height of one step is 170 mm
- 3320 / 170 = 19.529=> 20 steps (2 flights each of them with 10 steps)
- Height of one step *h* = 3320/ 20 = 166 => 170 mm
- Width of one step *b* = 630 – 2*h* => 630 – 2 x 170 = 290 mm
- **DESIGN: Staircase with 170 / 290 mm steps, 2 flights, 10 steps in each flight**
- Width of the flight – 1200 mm
- Width of the gap between the flights – 100 mm
- Width of the landing – 1500 mm , 1700mm
- Total Width of the flight and gap between is 1200*2+100 = 2500 mm
- Length of flight is 9 x 290 = 2610 mm
- Slope of the staircase is α= arc tan (h/b) => arc tan (160 / 310) = 30.38°

Preliminary check of the depth of the slab.

- The staircase is considered as one-way slab with the span of 2320 mm. The slab will be simply supported => the depth should be at least 2320/25 = 92.8 mm.
- The depth and flooring of landings is the same as the depth of the main slab – 200 mm.
- The depth of flights can be obtained from the details of flight-landing connections in my case, the depth is 140 mm.
  200 mm > 92.8 mm and 140 mm > 92.8 mm => **OK**
- **Perpendicular and head clearance of the staircase**
- Head clearance of the staircase should be more than 1500+750/cosα = 1500+750/cos (27.30°) = 2532 mm > and more than 2100 mm.
- Head clearance of our staircase is $h_1 = h_k – h_s – h_f – h$ = 3100 – 200 – 130 –160 = 2600 mm => **OK.**

- Perpendicular clearance of the staircase should be more than 750+1500*cosα = 750+1500*cos (27.30°) = 2085 mm and more than 1900 mm Perpendicular clearance of our staircase is $h_2 = h_1$*cosα = 2600*cos (30.38°) = 2310 mm > 2085 mm => **OK.**



Load calculation of the staircase: (in ground floor)

- Evaluations of the load which based on the landing of the staircase:

	No#	kind of layer	thickness [mm]	Density [KN/m³]	Characteristic value [KN/m²]	γ	Design value [KN/m²]
landing load	1	PVC plank + others	40		0.022	1.35	0.0297
	2	plain concrete leveling	60	24	1.44	1.35	1.944
	3	PE layer	-	-	0		0
	4	Reinforced slab	200	25	5	1.35	5.75
	1	live load			2	1.5	3
	Permanent and variable load from typical slab gd+				8.462		10.73

Load in landing: $Fd = 10.73 KN / m^2$

	No#	kind of layer	thickness [mm]	Density [KN/m³]	Characteristic value [KN/m²]	γ	Design value [KN/m²]
flight loads	1	Reinforced slab	200/cos (27.30°)	25	5.625	1.35	7.60
	2	PVC plank	0.5*160+310/310		0.813	1.35	1.10
	3	steps	160/2	25	2.025	1.35	2.74
	4	live load			2	1.5	3
	Total variable load on typical floor slab qd				10.463		**14.44**

Load in Flights: $Fd = 14.44 KN / m^2$