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EXPLANATORY NOTE
of a Bachelor's qualification work

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academic group 192-17-1 IC

specialty 192 Building and Civil Engineering

under educational programme Building and Civil Engineering

topic: "Construction project of shopping and entertainment mall in Poltava City"

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ABSTRACT

Explanatory note: 62 p., 18 figures, 19 tables, 2 annexes, 46 sources.

Graphic part: 4 sheets of A1 format.

7-STOREY HOTEL BUILDING, REINFORCED CONCRETE MONOLITHIC STRUCTURES, REINFORCED CONCRETE FRAME, BEAM FLOORS, BEAM-SLAB FLOORS.

The diploma project “CONSTRUCTION PROJECT OF A 7-STOREY HOTEL BUILDING IN DNIPRO CITY” can be divided into four parts:

- architectural and construction chapter;
- calculation and design chapter;
- organizational and technological chapter;
- equipment and economic chapter.

The architectural chapter of the project provides: general characteristics of the construction object, construction and climatic characteristics of the area, plan of the site, spatial plan and construction - structural solution of the building frame.

The second Chapter provides a rationale for the choice and calculation of building structures. The chapter includes the following points:

- general data;
- determination of loads and influences on load bearing structures;
- calculation of the stress - strain state of load bearing structures;
- design of reinforced concrete frame structures (columns and crossbars).

During the designing the following items were developed: formwork drawing of columns and crossbars; frame drawings of required structures reinforcement and drawings of reinforcement products.

In Chapter 3 the features of the technology of manufacturing monolithic reinforced concrete floors are considered.

The Chapter 4 economics of building construction is considered.

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INTRODUCTION

The topic of the Bachelor's thesis is “CONSTRUCTION PROJECT OF A 7-STOREY HOTEL BUILDING IN DNIPRO CITY”.

The object is located at Voznesenska Street 22 at the corner of Voznesenska Street and Mechnikova Street in the central part of Dnipro City.

The building to be designed faces Voznesenska Street with its main facade and completely fills the space between the existing buildings. It organically fits into the perimeter building of the area.

The back facade of the building faces the inner enclosed courtyard, which has a hard coating and dimensions sufficient for the fire engines reversal.

During the diploma project making in accordance with the technical task of diploma’s supervisor it was necessary to design a 7-storey part of the building.

The main efforts were focused on doing the following chapters of the project:

- architectural designing;
- reinforced concrete structures design.

Two building’s variants were considered: with slab and beam - slab floors.

During the architectural design the building’s volume - planning decision is developed.

During the doing the structural chapter of the project, working design drawings of columns and beams were developed (beam - slab floor version).

In addition, the diploma project also includes chapters "Technology and organization of construction", as well as "Economics of construction".

It should also be noted that this diploma project was developed in accordance with the current Ukrainian regulations, rules, instructions, in accordance with State and major standards.

1 ARCHITECTURAL AND CONSTRUCTION CHAPTER

1.1 General characteristics of the construction object. Climate characteristics of the area

The construction object is located in the Dnipro City, Dnipropetrovsk region, address: Voznesenska Street, 22 (fig. 1.1).

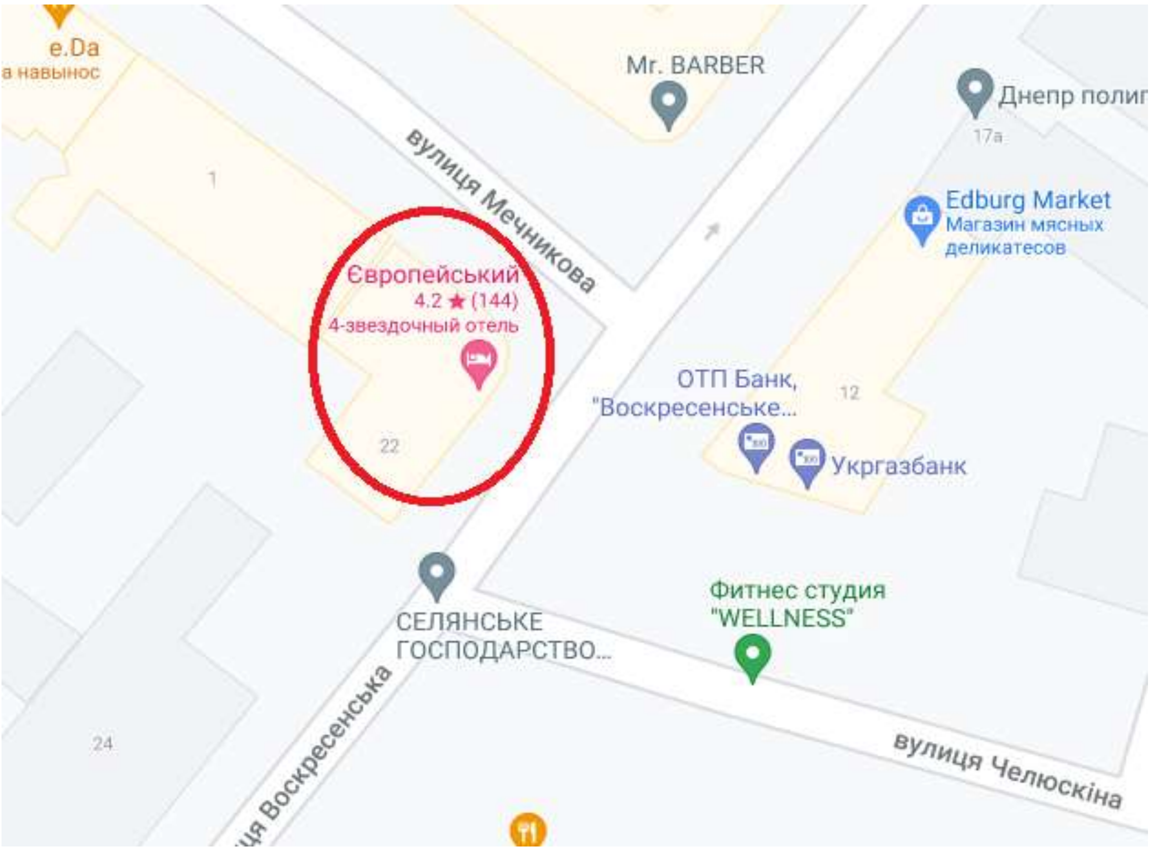


Figure 1.1 – Location of the object to be designed

The height of the building is (fig. 1.2 and 1.3):

- 22.3 m without the additional structure;
- 26.36 m taking into account the height of the additional structure.

Figure 1.2 – Building's facade

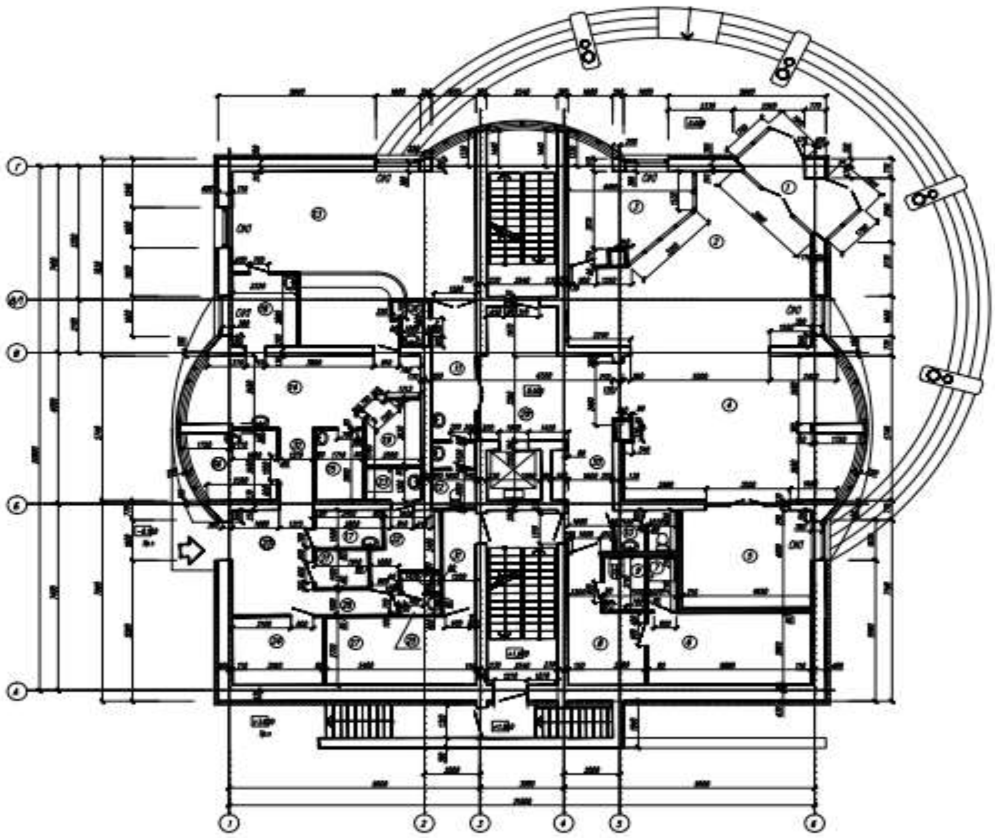


Figure 1.3 – Ground floor plan

The building has a complex shape in plan, but its main area can be inscribed in a rectangle with sides: 20,080vo21,000 m (fig. 1.4 and 1.5).

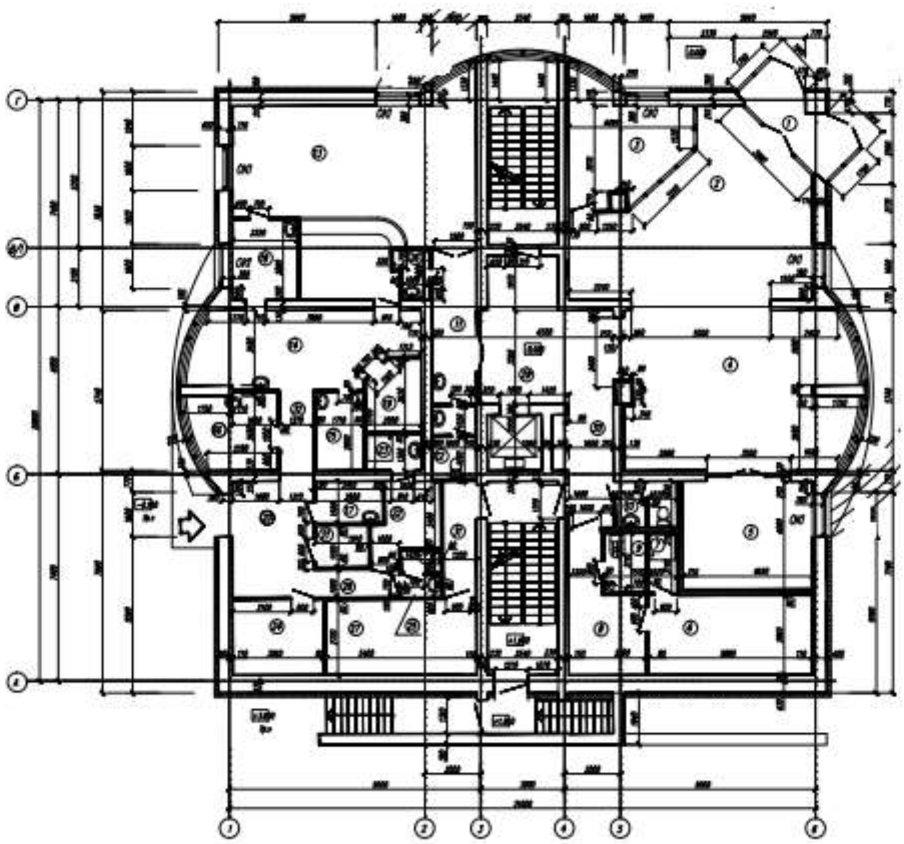


Figure 1.4 – Typical floor plan

The step of the columns is equal to:

1. Along the digital axes:

- between the axes "1" - "2" - 7,000 m;
- between the axes "2" - "3" - 2,000 m;
- between the axes "3" - "4" - 3,000 m;
- between the axes "4" - "5" - 2,000 m;
- between the axes "5" - "6" - 7,000 m.

2. Along the letter axes:

- between the axes "A" - "B" - 7,400 m;
- between the axes "B" - "G" - 6,000 m;
- between the axes "B" - "G" - 7,400 m.

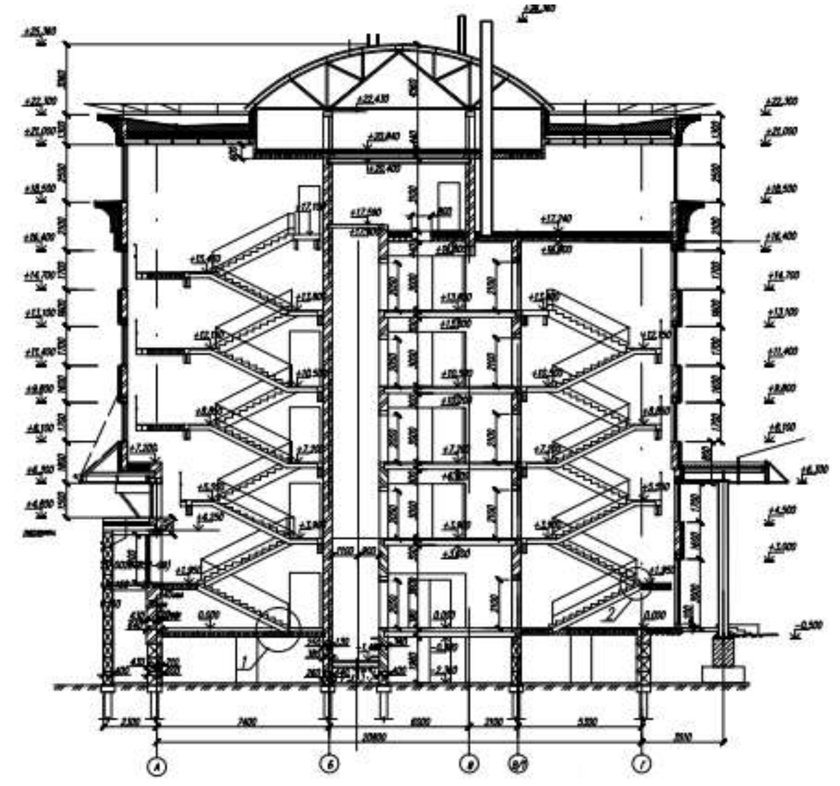


Figure 1.5 – Intersection 1-1

The floor level of the 1st floor is taken as a zero mark.

1.2. General characteristics of the district and construction site

1. The construction object is located in the climatic south-eastern region.

2. The number of degrees - days of the heating period is 3000.

3. The outside environment temperature of the construction object is given in a table presented on fig.1.6.

Область, місто	Середня місячна температура повітря / середня добова амплітуда температури												Середня за рік	Температура повітря, °C						Період із середньою добовою температурою повітря					
														холодного періоду				теплого періоду		<8 °C		<10 °C		>21 °C	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		найхолодніша доба забезпеченістю		найхолодніша п'ятиденка забезпеченістю		найжаркіша доба забезпеченістю 0,95	найжаркіша п'ятиденка забезпеченістю 0,99	тривалість, діб	середня температура, °C	тривалість, діб	середня температура, °C	тривалість, діб	середня температура, t °C
														0,98	0,92	0,98	0,92								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Дніпропетровська область Дніпропетровськ	-4,7 6,0	-3,8 5,9	1,1 7,0	9,6 9,9	16,0 11,0	19,6 10,8	21,6 10,6	20,7 11,2	15,4 10,7	8,6 8,8	2,2 5,6	-2,5 5,0	8,7	-29	-27	-26	-24	30	26	172	-0,2	188	0,6	57	21,6

Figure 1.6 – The outside environment temperature of the construction object

4. The precipitation amount of the construction site area is given in a table presented on fig. 1.7.

Область, місто	Середня по місяцях кількість опадів, мм / наявність снігового покриву, дні												Кількість опадів за рік, мм
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Дніпропетровська область													
Дніпропетровськ	43/20	43/18	43/8	41/–	46/–	66/–	54/–	47/–	38/–	35/–	47/3	47/15	550

Figure 1.7 – The precipitation amount of the construction site area

4. Snow area - IV.

4.1. Characteristic value of snow load: s0 = 1.4 kPa

5. Wind area - III (area type "III")

5.1. The value of wind load: w0 = 0.5 kPa

6. Designed seismicity is 5 points according to cards A and B of the USSR-2004 and 6 points on map C of the USSR-2004 (DBN B.1.1-12 2006).

1.3. Volume-planning and structural solutions

1.3.1. Volume-planning solution

The designed 7-storey building of the tower-type hotel consists of one section.

Building has the following structure:

At the level -2,360 ...- 0,380 m there is a basement, where technical equipment and technical rooms are located.

At 0.000 ... 3,600 m there is a ground floor, where administrative premises and 20 spots cafe are located.

At 3,900 ... 16,800 m there are four floors with hotel rooms, administrative and office premises.

The top floor is technical floor (it is located at 17,590-20,400 m).

The list of the premises is given in table 1.1.

Table 1.1 – The list of the premises

Number of rooms	**Name**	**Square, m2.**
Mark 0.000 m		
1	Entrance vestibule	8.00
2	Lobby	44.60
3	Security room	15.50
4	Registration office	46.40
5	Premises for administration	18.90
6	Staff room	16.40
7	Shower room	10.65
8	Linen storage room	10.55
9	Inventory storage room	3.60
10	Office bathroom	3.60
Cafe for 20 seats		
11	Tambour	8.75
12	Bathroom for visitors	4.15
13	Hall for 20 seats	48.8
14	Room for cooking hot food	20.75
15	Room for cooking cold snacks	4.80
16	Room for serving dishes	8.20
17	Vegetable room	3.72
18	Room of washing tableware	6.60
19	Room of washing kitchen dishes	4.80
20	Loading room	12.30
21	Room for storage of dry products	2.75
22	Wardrobe	5.90
23	Shower cabin	2.55

24	Office of the Head of production	8.80
25	Bathroom for staff	2.40
26	Pantry for storage of cleaning equipment	2.00
27	Utility room	14.30
28	Corridor	2.00
29	Hall	22.00
30	Corridor	7.05
31	Corridor	5.10
32	Corridor	4.00
Plans of typical floors at 3,900, 7,200, 10,500 and 13,800 m		
1	First category room (single)	23.45
2	Living room	15.95
3	Bathroom	4.25
4	Hallway	3.25
5	Double room	33.40
6	Living room	27.70
7	Bathroom	4.75
8	Living room	2.95
9	First category room (single)	29.45
10	Living room	15.00
11	Bathroom	4.25
12	Hallway	3.20
The first category single room (storage)		
13	Living room	15.60
14	Bathroom	5.10
15	Hallway	4.30

The first category single room for low mobility groups (storage)		
16	Living room	15.60
17	Bathroom	5.10
17	Bathroom	5.50
18	Hallway	4.70
Studio Double Room		
19	Living room	22.00
20	Bathroom	6.00
21	Hallway	3.60
Number fund		
22	Hall	66.40

Technological outputs are provided for roof maintenance.

Ventilation of apartments and corridors is performed due to natural ventilation, as well as through the exhaust ventilation blocks located in bathrooms and kitchens.

There is a warm attic on the mansard floors.

The connection between the floors is made using a stair - elevator hall, consisting of stairwells and an elevator car.

1.3.2. Architectural-structural solution

The building to be designed is frame type, made of monolithic reinforced concrete and self-supporting three-layer (insulation, brick and plaster) walls.

The spatial rigidity of the building is provided by the joint work of hard horizontal disks (slab floors or beam - slab floors) and slab foundation, as well as monolithic reinforced concrete columns.

1. Monolithic slab reinforced concrete foundation under the entire structure has a thickness of 0.8 m.

2. The columns have the following heights:

- 2.36 meters in the basement, solid columns with a cross section of 40x40 cm;

- 3.90 meters on the ground floor, solid columns with a cross section of 40x40 cm;

- 3.3 meters on each of the four residential floors, solid columns with a cross section of 40x40cm;

- 2.0 * meters on the technical floor, solid columns with a cross section of 40x40 cm.

3. Reinforced concrete monolithic beams with a cross section of 40x40 m (in the case of a building with a beam - slab floor slabs only).

4. Floor slabs. Monolithic slabs has a thickness of 180 mm (in a variant of the building with beam - plate floors) or 220 mm (in a variant of the building with slab floors).

5. External walls are self-bearing, designed from silicate brick, external insulation of aerated concrete and internal plaster.

The walls are insulated with aerated concrete on the outside, and they are plastered with a 20 mm thickness layer of cement - sand plaster inside.

Outside, the layer of aerated concrete layer is glued with a fiberglass mesh and plastered .

Interior walls and partitions are designed using brick, silicate brick, ceramic bricks or plasterboard.

Stairs.

Reinforced concrete two-parts staircases, which consists of two parts, two stair beams, a jumper and a staircase slab are assigned in the project.

Steel handrails are welded to the embedded parts on the side of the staircase part.

Roof, drainage.

The roof is designed using a two-layer roll made of Uniflex polymer material.

The roof has a 2% slope so an internal drain for precipitation is designed.

roof Exit is designed through the stairwell.

Windows, doors.

Double-glazed windows are single-chamber, plastic.

Doors are partly metal, partly wooden, partly made of MDF, and sometimes - plastic.

1.4. Heat and technical calculation of walls

Calculation procedure:

1. For external enclosing structures of heated buildings and structures it is obligatory fulfill the condition:

$$R_{\sum np} \geq Rq_{\min}$$

$$\Delta t_{np} \leq \Delta t_{cr}$$

$$\tau_{в} \min \rangle\, t_{\min}$$

where $R_{\sum np}$ - reduced heat transfer resistance of nontransparent enclosing structure or nontransparent part of enclosing structure, $m^2 \cdot K / W$;

$Rq_{\min}$ - the minimum allowable value of the heat transfer resistance of the opaque enclosing structure or the nontransparent part of the enclosing structure, the minimum value of the heat transfer resistance of the translucent enclosing structure, $m^2 \cdot K / W$;

Δt_{np} - temperature difference between the temperature of the indoor air and the reduced temperature of the inner surface of the enclosing structure, °C.

Δt_{cr} - permissible difference between the temperature of the indoor air and the reduced temperature of the inner surface of the enclosing structure according to sanitary and hygienic requirements, °C.

$\tau_{в}$ min - the minimum value of the inner surface temperature in conductive inclusions areas in the enclosing structures,°C.

$t_{\min}$ - the minimum allowable value of the inner surface temperature at the designed values of indoor and outdoor air temperatures, °C.

The minimum allowable value of heat transfer resistance of enclosing structures of public buildings for the II temperature zone $Rq_{\min}$ = 2.5 m2 × K / W.

2. The reduced heat transfer resistance of the enclosing structure should be calculated according to the formula:

$$R_{\sum np} = \frac{1}{\alpha_b} + \sum_{i-1}^{n} R_i + \frac{1}{\alpha_3} = \sum_{i=1}^{n} \frac{\delta_i}{\lambda_{ip}} + \frac{1}{\alpha_3} + \frac{1}{\alpha_b}, \text{ where}$$

3. For this object, according to the map of temperature zones, Dnipro is located in the II zone, the humidity regime is normal (operating conditions B) according to table. 1 ДБН В.2.6-31: 2006 "Thermal insulation of buildings" [6] define:

- α_b, and α_3 - heat transfer coefficient of the inner and outer surfaces of the enclosing structure, W / (m^2 · K), which are accepted in accordance with ДБН В.2.6.-31: 2006 "Thermal insulation of buildings" (Annex E) and are equal to:

α_b = 8.7

α_3 = 23

δ_i – layer's thickness;

λ_{ip} - designed coefficient of material's thermal conductivity;

R_i - thermal resistance of the structure's i-th layer.

4. Section the outer protective structure (wall) consists of enclosing layers with the following properties:

1 layer (cement - sand plaster):

- thickness δ = 0.02 m;

- specific weight γ1 = 1800 kg / m2;

- conductive heat transfer coefficient λ1 = 1,200 W / m * sec.

2nd layer (self-bearing wall on cement-sand mortar of silicate solid brick):

- thickness δ = 0, 250 m;

- specific weight γ2 = 1900 kg / m3;
- conductive heat transfer coefficient λ2 = 0.98 W / m * s.

3rd layer (aerated concrete, its thickness should be determined during the thermal calculation):

- thickness δ =? - must be determined;
- specific weight γ_3 = 600 kg / m^3;
- conductive heat transfer coefficient λ_2 = 0.09 W / m * sec.

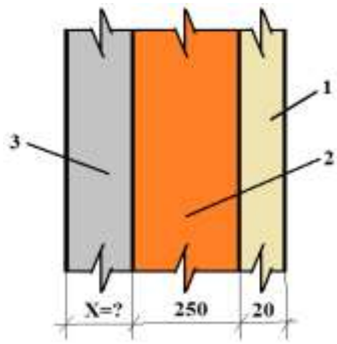


Figure 1.8 – Designed scheme of the outer wall.

Notes: 1 - cement - sand plaster layer $\delta = 20$ mm; 2 - self-bearing wall on cement - sand mortar based on a silicate monolithic brick $\delta = 250$ mm; 3 - foamed plastic layer, its thickness should be determined during the thermal calculation

Next, we determine the thickness of the insulating layer of the aerated concrete wall structure:

$$Rq_{\min} - R_{\sum np} = 2,5 - \frac{1}{8,7} - \frac{0,02}{1,200} - \frac{0,250}{0,980} - \frac{x}{0,090} - \frac{1}{23} = 0,$$

where x = 0,186 m.

Estimated wall thickness 0.02 + 0.25 + 0.186 = 0.456 m = 456 mm.

Given that the standard thickness of aerated concrete is 50, 100, 200 and 400 mm, the total wall thickness is 470 mm.

1.5. Chapter 1 conclusions

1. The main elements of a multi-purpose building which perceive the load are:

- monolithic reinforced concrete foundation;
- monolithic reinforced concrete columns;
- monolithic reinforced concrete crossbars;
- monolithic reinforced concrete floor slabs.

2. The frame rigidity of the 7-storey (taking into account the basement and technical floors) building is provided by a spatial frame with rigid nodes between monolithic columns (crossbars in the version of the building in the beam - slab version), floor slabs, and rigid connection of monolithic columns with monolithic slab foundation.

3. Building's horizontal elements (in the case of slab floors) are reinforced concrete slabs of monolithic concrete.

4. The horizontal elements of the building (in the version with beam - slab floors) are reinforced concrete crossbars and reinforced concrete slabs of monolithic concrete.

5. Vertical elements of the building are reinforced concrete columns and diaphragms made of monolithic concrete.

6. The frame model is determined by:

- technological and architectural requirements;
- building's operating conditions;
- climatic conditions;
- types and materials of enclosing and load-bearing structures.

2 CALCULATION AND DESIGN CHAPTER

2.1. General data. Determination of loads on the frame

In this chapter the collecting loads materials are given. They have the same value for monolithic reinforced concrete buildings with different structures of floors.

Loads on the building include:

- load from the weight of structures;
- load from the weight of the building’s roof rolled coating;
- snow load;
- wind load;
- load from the weight of equipment and people;

Loads on the building frame were collected in accordance with the requirements of ДБН В.1.2-2: 2006. In this case:

- the own weight of the load-bearing elements of the frame was determined automatically using the Monomakh software;
- load from the weight of the coating according to the design task is equal to 0.06 t / m^2 = 60 kg / m2;
- snow load for IV snow area is equal to 0.137 t / m^2 = 1.40 kPa;
- wind loads for III wind region ("III" area type) is equal to: w0 = 0.5 kPa;
- load from the weight of equipment and people is equal to 500 kg / m2.
- the calculated seismicity according to cards A and B of the USSR-2004 and 6 points according to the map C of the USSR-2004 (ДБН В.1.1-12 2006) is equal to 5 points.

Snow load on the building’s roof was determined according to point 8 of ДБН В.1.2-2: 2006 for III wind district. For this purpose we used the electronic engineer's manual software (ESPRI). Calculation results and initial data are given below in Annex D in Table D1 and in fig. 2.1 in chapter 2.

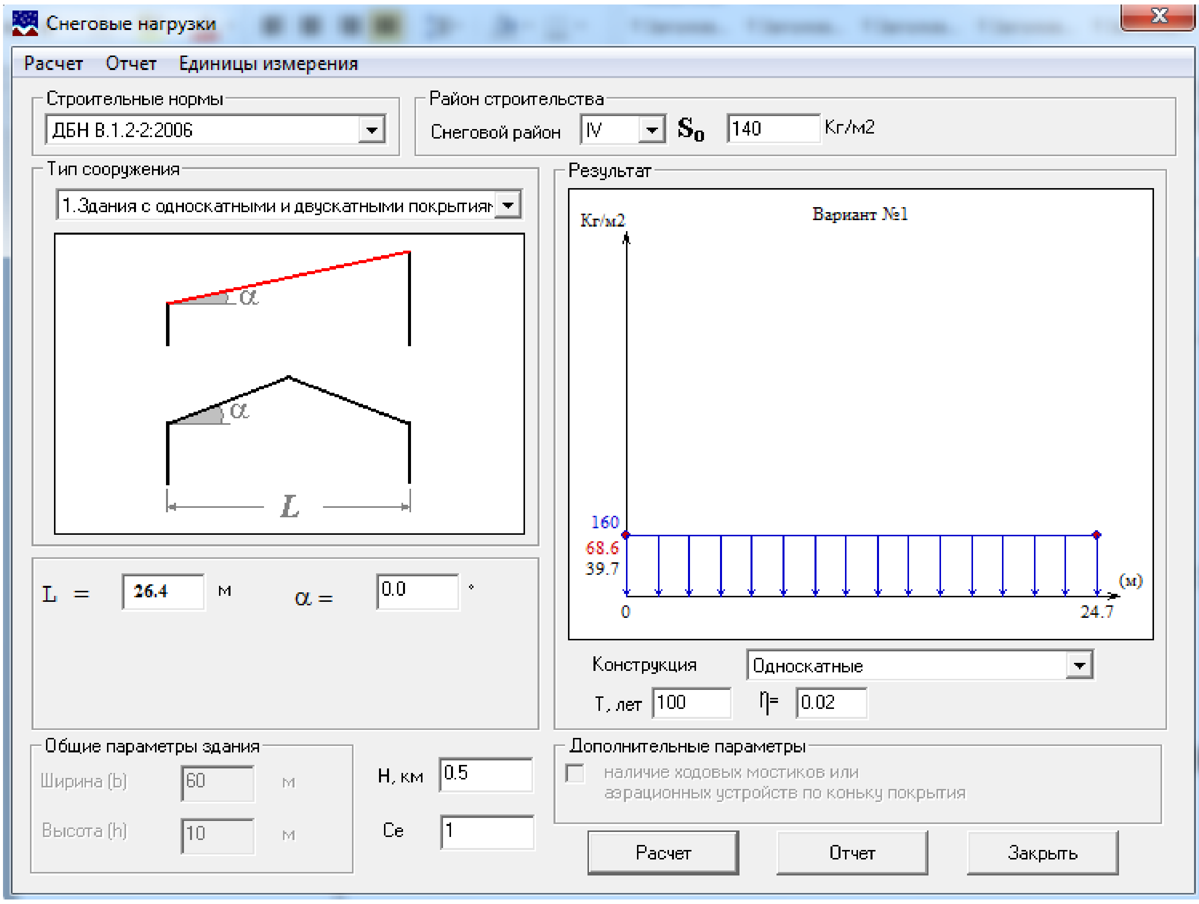


Figure 2.1 –ESPRI dialogue window. Initial data for determination of the snow load

The wind load on the building's roof was determined according to point 9 of DBN B.1.2-2: 2006 for the III wind district, the type of area - III. For this purpose, we used the electronic engineer's manual (ESPRI).

The initial data for the calculation are given in the dialog window of the ESPRI software in fig. 2.2.

Wind loads data in axes 1-12 are given in Annex D in tables D2 (windward side) and D3 (leeward side).

Wind loads data on from the A-E axes are given in Annex D in tables D4 (windward side) and D5 (leeward side).

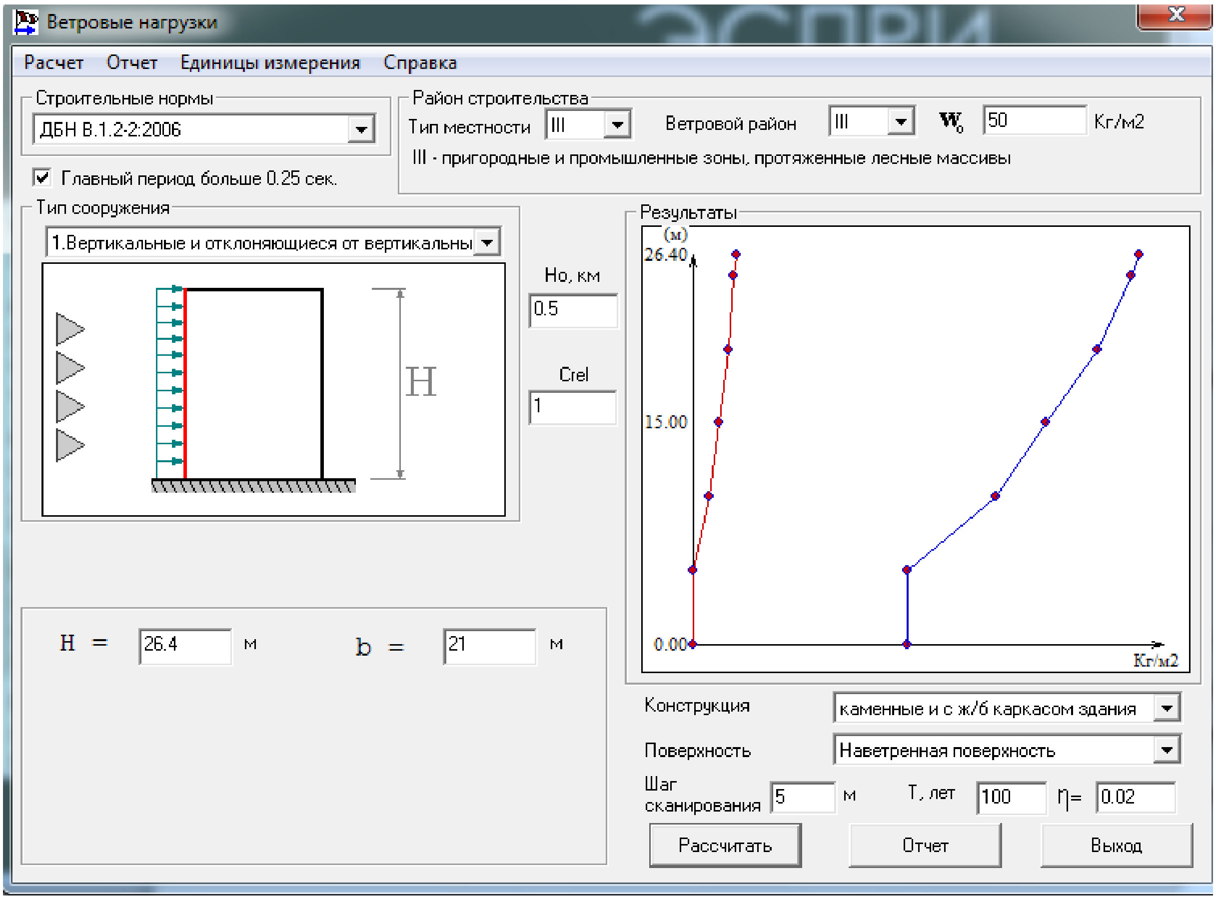


Figure 2.2 – ESPRI dialogue window. Initial data for the determinating a wind load

Accepted data for the calculation of the stress - strain state of the building are given in table 2.1.

Table 2.1 – Loading taken for the building calculation

№	Load	Coefficient of reliability	Load title	Load value
1	1	1.1	Own weight of structures	Does not require recalculation
2	2	1.4	Weight of equipment and people	500 kg / m2 = 0.500 t / m2
3	3	1.2	Snow load	Given in table D1
4	4	0.9	Wind loads in axes 1-22	Given in tables D2 and D3
5	5	0.9	Wind loads in the axes AE	Given in tables D4 and D5

Note: Coefficients of reliability are accepted according to the requirements of project technical task document

2.2. Reinforced concrete structures. Static calculation of the building framework in spatial position

In total, two variants of the building were considered (with slab and beam - slab floors).

In all cases a separate calculation method was used, which means that firstly the stress-strain state of the building was established.

In the first case the following parameters of load-bearing structures were assigned:

- the columns' section is 600x600 mm;
- floor slab thickness is 220 mm.

In the second case, the following parameters of the load-bearing structures were adopted:

- the section is full 400x400 mm;
- thickness of a floor slab is 180 mm.
- section of crossbars included in floor slab is 400x400 mm.

The calculation of the stress - strain state, designing elements and making of drawings of the working building project were performed using the "Monomakh" software.

We used two node elements and 2d- elements for modeling building's elements.

Crossbars and columns were modeled using two-node elements, and foundation slabs and floor slabs were modeled using 2-d elements.

A three-dimensional model of the building (in slab floors version, fig. 2.3) was made using the "Компоновка" software.

Building's three-dimensional model (variant with beam - plate floor slabs) is given in fig. 2.4.

At this stage the following steps were performed:

- making the grid of columns;

- material and geometry of columns were assigned and their installation in the model were performed;

- material and geometry of foundation slab were assigned and their installation in the model were performed;

- material and geometry of floor slabs were assigned and their installation in the model were performed;

- loads application taking into account their combinations (Table 2.1).

After modeling the building the following operations were performed:

- calculation of the whole building;

- finite element calculation;

- export of finite element calculation results to the design software.

Then, using the software package "Column" calculating and designing monolithic reinforced concrete columns was performed.

The following operations were performed:

- reinforcement frame type was assigned;

- assignment of the protective concrete layer thickness;

- calculation;

- generation of material plots and their analysis;

- generation of working project drawings;

- editing parameters of working project drawings on the screen and for the print.

Due to the large number of structures and the limited volume of the master's thesis and according to the task of diploma supervisor I designed:

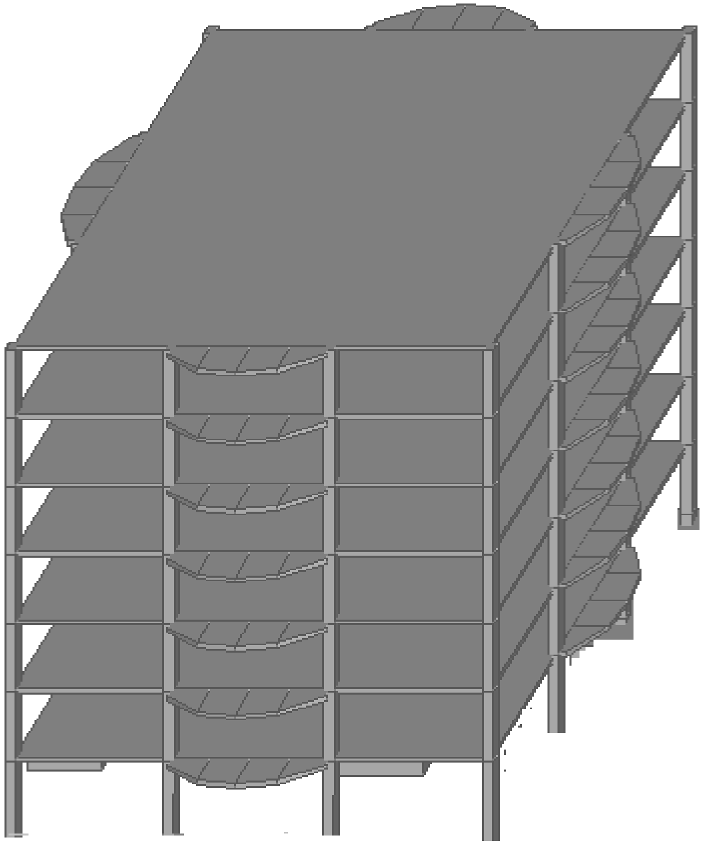
- columns K2-3 and K3-9 located on the 2nd and 3rd floors, respectively, in the building in the version with slab floors;

- columns K2-3 and K3-9 located on the 2nd and 3rd floors, respectively, for the building in the version with beam - slab floors;

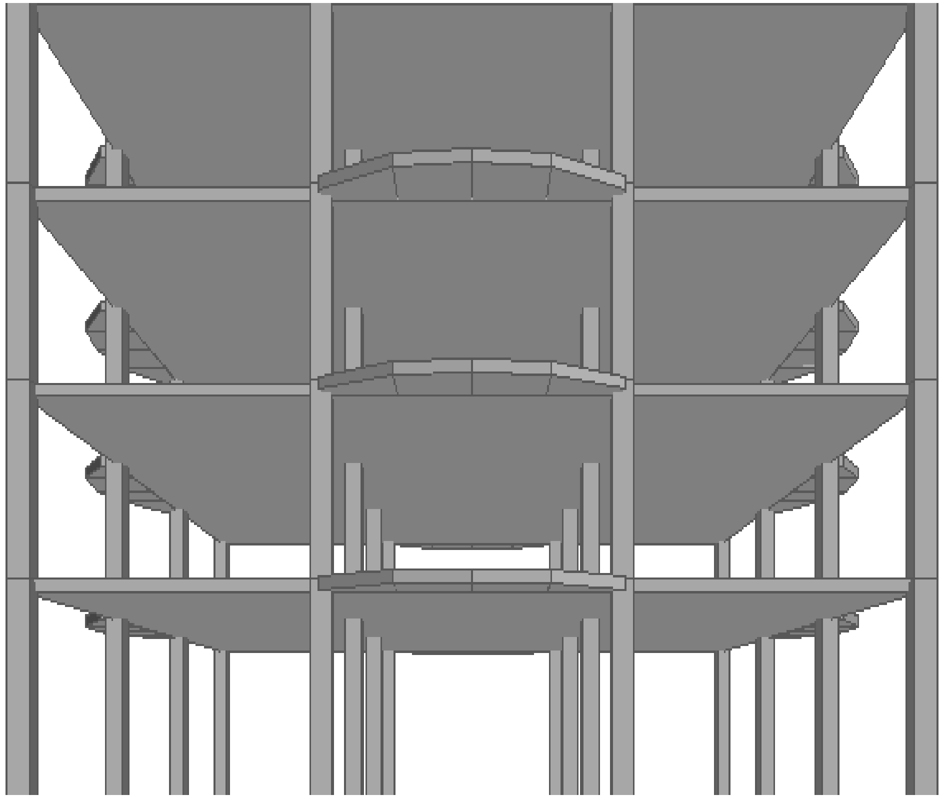
- beams B2-3, B3-3, B4-3 and B5-3 for the building in the version with beam - slab floors.

Drawings of the working design of columns K2-3 and K3-9 for the variant of the building with slab floors are shown in fig. 2.5 and E1 in Annex E, respectively.

Working project drawings of columns K2-3 and K3-9 for the variant of the building with beam - slab floors are shown in fig. 2.6 and E2 in Annex E, respectively.

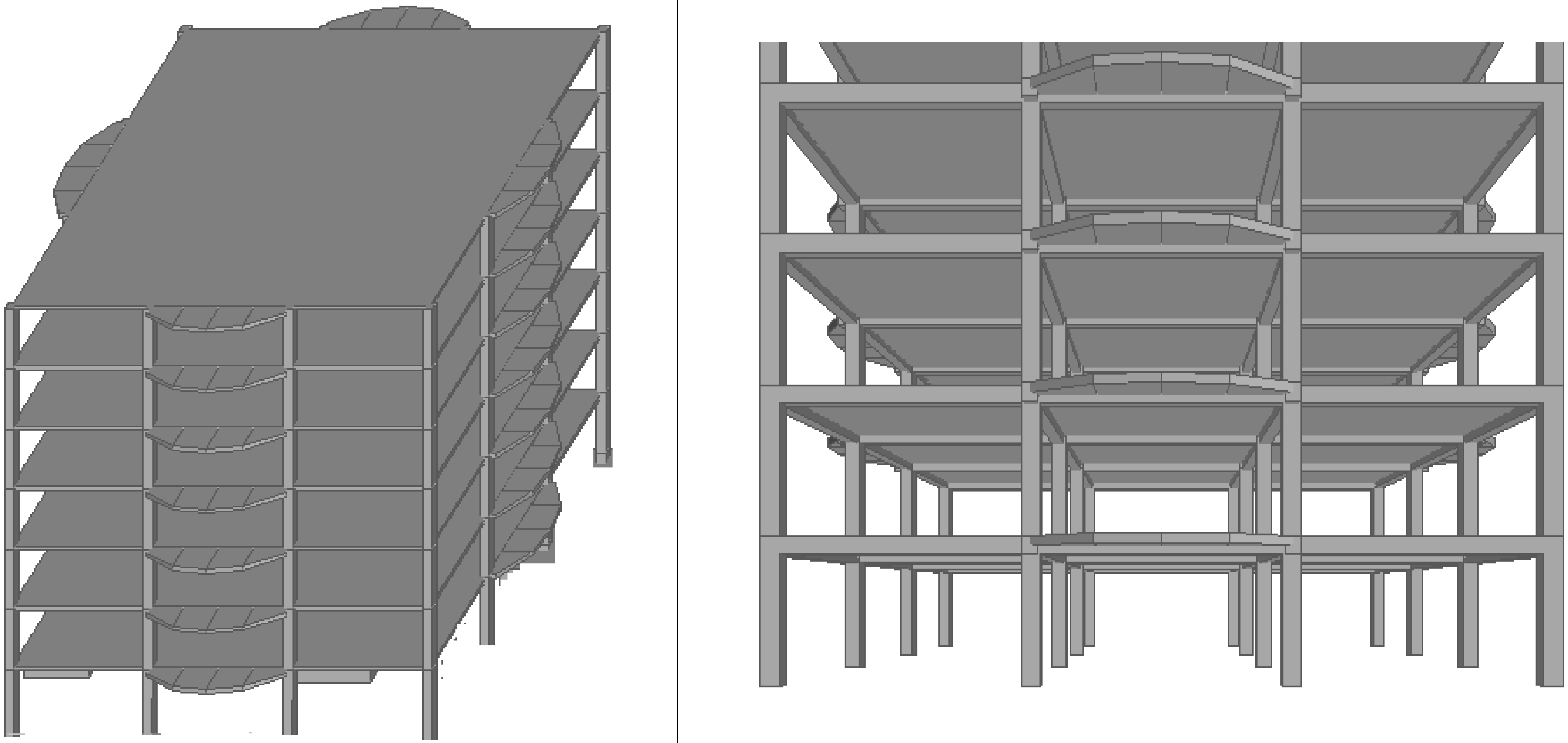


Axonometry



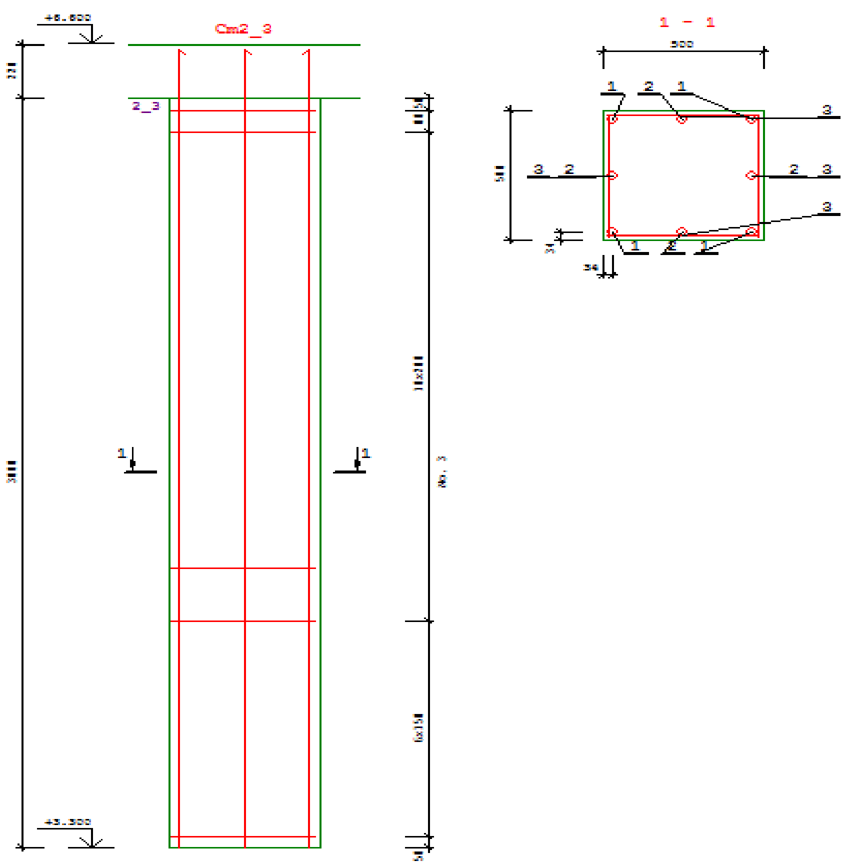
Prospect

Figure 2.3 – Building's model with slab floors. Note: foundations are simply shown



Axonometry	Prospect

Figure 2.4 – Model of a building with beams-slab floors. Note: foundations are simply shown



Specification of column Cm2_3

No.	Description	Name	Q-ty	Mass of unit, kg	Notes
		Components			
1		ø25 AIII l=3250	4	15.8	
2		ø16 AIII l=3250	4	5.2	
3		ø8 AI l=450	72	0.2	
		Materials			
		Class of concrete B20			0.8 m3

Class of reinforcement AIII AI according to GOST 5781-82

List of steel consumption, kg

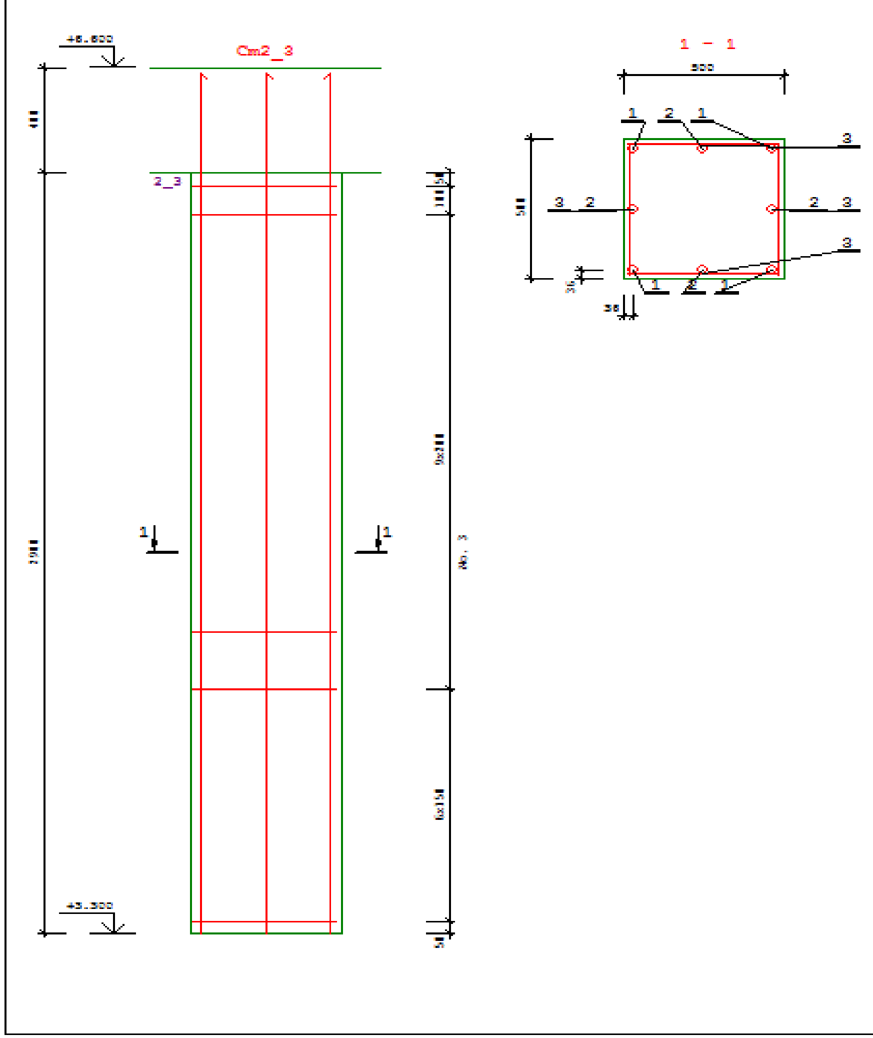
Element mark	Reinforcement bars					
	Class of reinforcement					In all
	AI		AIII			
	GOST 5781-82		GOST 5781-82			
	ø8	Altogether	ø16	ø25	Altogether	
Cm2_3	14	14	21	63	84	98

Modif.	Number	Sheet	Doc. No.	Orig.	Date

Stage	Sheet	Of sheets
R	1	1

Cm2_3

Figure 2.5 – Variant of a building with a slab floor. Column K2-3. Working project drawings



Specification of column Cm2_3

No.	Description	Name	Q-ty	Mass of unit, kg	Notes
		Components			
1		ø32 AIII l=3280	4	20.7	
2		ø16 AIII l=3280	4	5.2	
3		ø8 AI l=480	68	0.2	
		Materials			
		Class of concrete B20			0.8 m3

Class of reinforcement AIII AI according to GOST 5781-82

List of steel consumption, kg

Element mark	Reinforcement bars					
	Class of reinforcement					In all
	AI		AIII			
	GOST 5781-82		GOST 5781-82			
	ø8	Altogether	ø16	ø32	Altogether	
Cm2_3	13	13	21	83	104	117

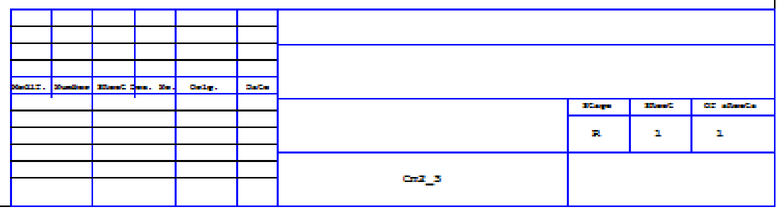


Figure 2.6 – Variant of a building with a beam - slab floor. Column K2-3. Working project drawings

After that, using the software package "Beam" calculation and design of structures of monolithic reinforced concrete columns was performed.

The following operations were performed: - reinforcement frame type was assigned; - assignment of the protective concrete layer thickness; - calculation; - generation of material plots and their analysis; - generation of working project drawings; - editing parameters of working project drawings on the screen and for the print.

The theoretical plots of longitudinal and transverse reinforcement of the beam B2-3 are shown in fig. 2.7 and 2.8 respectively. Working project drawings for the beam B2-3 is shown in fig. 2.9. Working project drawings for beams B3-3, B4-3 and B5-3 are given in Annex E, respectively, in fig. E3, E4 and E5.

According to the task of the diploma supervisor these beams were reinforced with the following frames:

- beam B2-3 using welded frame;
- beam B3-3 using knitted frame without bends;
- beam B4-3 using welded frame;
- beam B5-3 using knitted frame without bends.

Chapter 2 conclusions

The materials presented in the second chapter allowed us to make the following conclusions:

1. Collecting loads on the load-bearing building’s structures of the hotel building has been performed. The following loads are considered: - own weight of structures; - the own weight of the building material; - weight of snow cover; - wind pressure; - weight of the equipment and the weight of people.

On this basis a table of load combinations is built.

2. Two variants of construction are considered: with slab and beam - slab floors.

3. According to the design task, the following elements of the load-bearing structures of the frame are designed: - columns (4 pieces); - beams (4 pieces).

4. Working project drawings are developed for all specified structures.

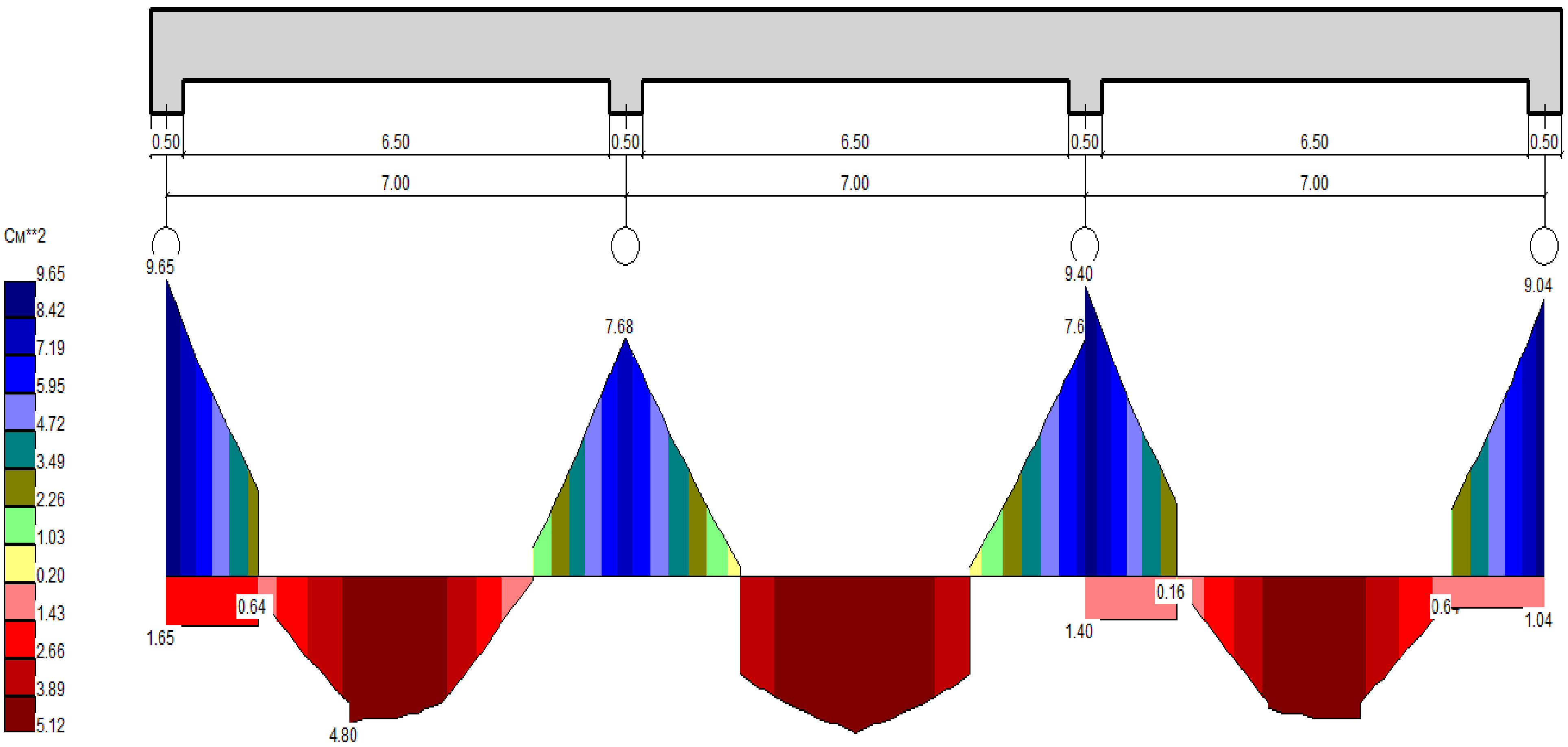


Figure 2.7 – Variant of a building with a beam - slab floor. Beam B2-3. Theoretical diagram of long reinforcement

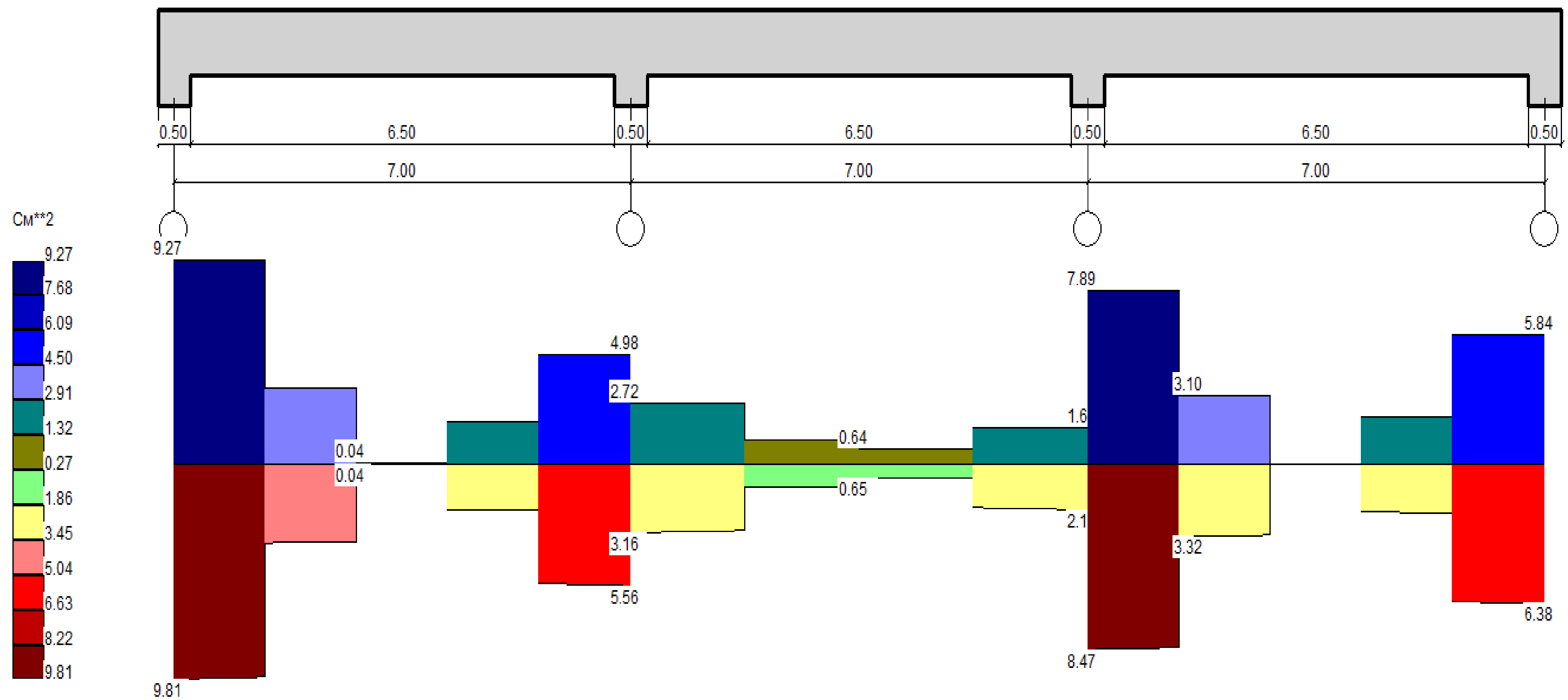
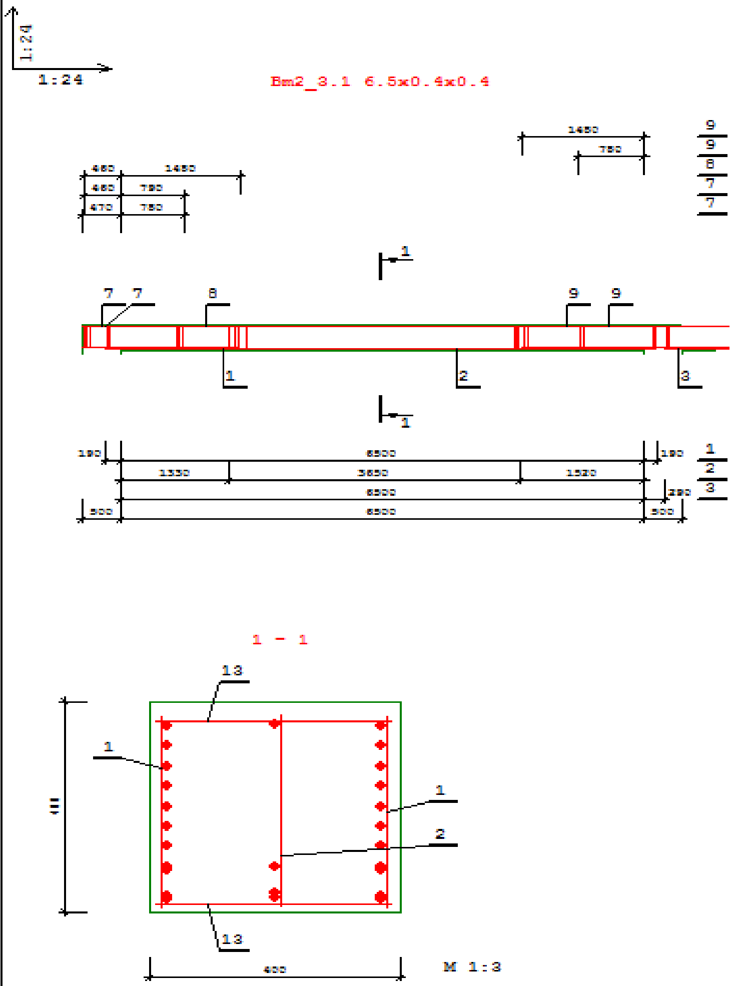


Figure 2.8 – Variant of a building with a beam - slab floor. Beam B2-3. Theoretical diagram of transverse reinforcement



Specification of beam Bm2_3.1

No.	Label	Name	Quant.	Weight item, kg	Remarks
		Built-up units			
		Plane framework			
1		FB1	2		
2		FB2	1		
3		FB3	2		
7		FB7	2		
8		FB8	2		
9		FB9	4		
		Components			
13		∅6 AI l=350	426	0.1	
		Materials			
		Concrete grade B20			1.0 m3

Reinforcement type AI AIII according to GOST 5781-82

List of steel consumption, kg

Mark of element	Reinforcement							
	Reinforcement type							In all
	AI				AIII			
	GOST 5781-82				GOST 5781-82			
	∅6	∅10	∅12	Total	∅8	∅10	Total	
Bm2_3	105	17	23	145	95	96	191	336

Stage	Sheet	Sheets
R	1	1

Bm2_3

Figure 2.9 – Variant of a building with a beam - slab floor. Beam B2-3. Working project drawings

3 ORGANIZATIONAL AND TECHNOLOGICAL CHAPTER

This chapter contains a fragment of the developed technological instructions card, which shows the organization of formwork, reinforcement and concrete work at providing concrete floors.

This technological instructions card keeps the following procedure:

3.1. Formworks

They include:

- transportation of formwork to the installation area;
- marking of the basis under a step of the main racks;
- installation of the main racks;
- installation of racks connections;
- installation of longitudinal beams;
- installation of crossbeams;
- treatment of plywood ends with anti-adhesive oil;
- installation and fastening of a plywood deck;
- installation of intermediate racks in the span between the main;
- installation of the formwork of the side surfaces of the floor slab;
- deck treatment using anti-adhesive oil.

Table 3.1 – The location plan of the main and secondary racks, as well as main and secondary beams

Slab thickness, mm	The distance between the second-row beams C, mm		The distance between the main beams A, mm		Permissible distance between the racks - B when the distance between the main beams - A, mm				
	at the thickness of plywood, t = 18 mm	at the thickness of plywood, t = 21 mm	at plywood thickness t = 18 mm	at plywood thickness t = 21 mm	when the distance between the main beams A = 1500 mm	when the distance between the main beams A = 1750 mm	when the distance between the main beams A = 2000 mm	when the distance between the main beams A = 2250 mm	when the distance between the main beams A = 2500 mm
160	625	625	2440	2350	1960	1820	1700	1600	1520
180	500	625	2440	2270	1860	1720	1610	1520	1440
200	500	625	2360	2270	1770	1640	1530	1440	1370
220	500	625	2290	2200	1690	1560	1460	1380	1290
240	500	500	2270	2140	1620	1500	1400	1320	1180
280	500	500	2200	2050	1510	1400	1310	1120	990
300	500	500	1980	2020	1460	1360	1280	980	910
260	500	500	2230	2090	1560	1440	1350	1220	1100

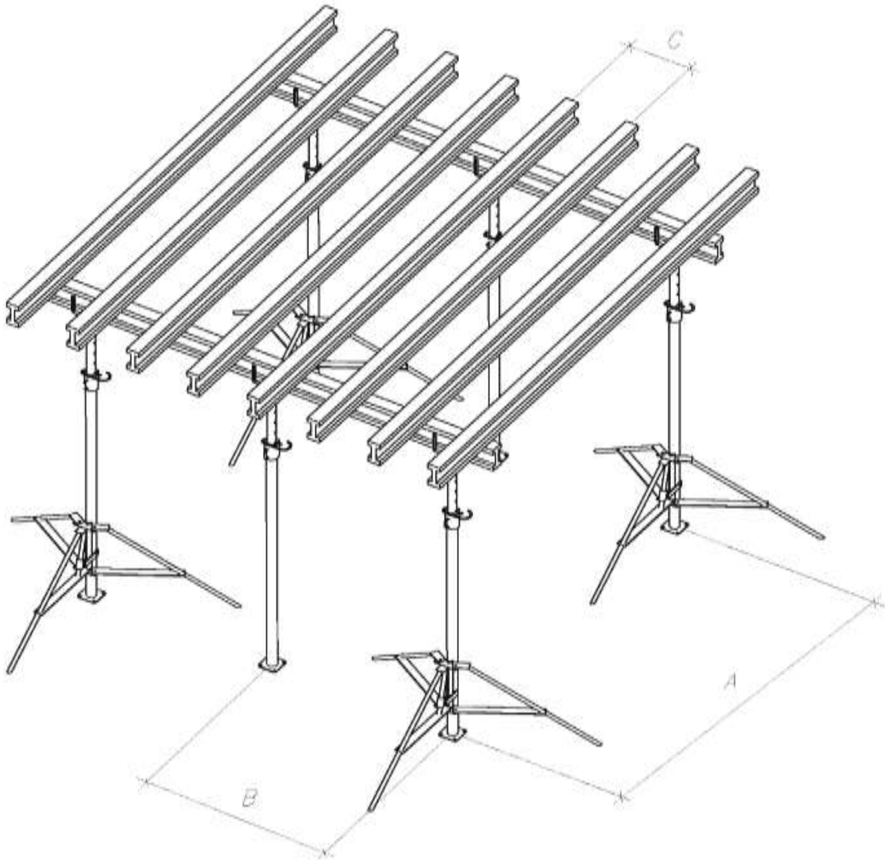


Figure 3.1 – The location scheme of the main and secondary racks, main beams, secondary beams

The step between main and secondary racks, main beams, secondary beams should be determined in accordance with table 3.1. and Figure 3.1.

3.2. Reinforcement works

According to the technology, there are reinforcement works in winter and summer conditions.

In summer conditions the procedure for performing reinforcement works includes:

- transportation of reinforcing products, clamps, embedded parts, slotters, thermocouples, PVC – tubes to the putting area;

- making a base from the reinforcing rods of the lower grid;

- installation of separate reinforcing rods the bottom grid using wire joints binding;

- installation of remote gaskets (retainers of the protective layer);

- installation of rods of strengthening of the lower grid, in openings in a plate and places of emergence of the greatest efforts;

- installation of a cut-off for the working seam;

- installation of a basis from directing reinforcing cores of the top grid;

- installation of separate reinforcing rods the top grid using wire joints binding;

- installation of embedded parts, slotters, thermal inserts, channels for wiring;

- installation of rods of strengthening of the top grid, at openings in a plate and places of occurrence of the greatest efforts;

- installation of a technological seam by fixing a wire mesh between the top and bottom reinforced bars;

- installation of limiters for the formation of the top and bottom protective layer in the top and bottom technological seam surface.

In winter conditions, the procedure for performing reinforcement works includes:

- transportation of reinforcement products, clamps, embedded parts, slotters, thermocouples, PVC – tubes to the area;

- installation of the base of the bottom grid guide reinforcement rods;

- installation of the bottom grid of individual reinforcing rods with wire joints;

- installation of remote gaskets - retainers of the protective layer;

- installation of reinforcing bars of the lower grid near the holes in the slab and places of significant stresses in the structure;

- installation of cut-off structures for the working seam;

- laying of concrete heating wires with their fixing to the bottom using a knitting wire;

- installation of supporting structures and frameworks fixing them to the bottom grid using a knitting wire.

The reinforcement works procedure in winter conditions includes:

- cleaning the formwork surface from snow and ice;
- installation of base using directing top grid reinforcing bars;
- installation of the upper grid of individual reinforcing bars with wire joints;
- installation of inbuilt elements, slotters, thermal inserts and channels for wiring;
- installation of top grid strengthening rods, openings in a slab and greatest stresses places;
- making a technological seam by fixing a wire mesh between the top and bottom reinforcement bars;
- installation of boards - limiters for making upper and lower protective layer in the upper and lower surface of the technological seam.
- covering the reinforced floor (to avoid the snow penetration in a structure).

3.3. Concrete works

They include:

- receiving concrete mixture in the bunker;
- supply of concrete mixture in a concreting zone;
- laying the concrete mixture with consolidation using a deep vibrator;
- leveling a concrete mixture according to marks;
- smoothing a concrete mixture;
- cleaning the receiving bunker, tools and equipment from concrete.

Concrete care has differences in winter and summer.

In summer conditions it is necessary to cover the open surfaces of the slab with p / e membrane.

In winter it is necessary to perform:

- heating wires connection to power cables, voltage supply from the transformer;
- temperature measurements in concrete.

3.4. Formwork deinstallation

Distinction of formwork distinction during summer and winter conditions.

In summer, you should perform:

- deinstallation and storage of intermediate racks;
- lowering a coating on the main racks;
- overturning crossbeams "sideways";
- deinstallation and storage of plywood boards;
- deinstallation and storage of cross beams;
- deinstallation and storage of longitudinal beams;
- deinstallation and storage of the main racks and tripods;
- transportation of formwork elements;
- cleaning formwork elements from concrete.

In winter conditions the deinstallation form works includes:

- transformer disconnection, deinstallation of power cables;
- removal of concrete insulating coatings, their cleaning, folding and storage on pallets for further transportation to the new working zone;
- deinstallation and storage of intermediate racks;
- lowering of a coating on the main racks;
- overturning the cross beams "sideways";
- deinstallation and storage of plywood boards;
- deinstallation and storage of cross beams;
- deinstallation and storage of longitudinal beams;
- deinstallation and storage of the main racks and tripods;
- transportation of formwork elements;
- cleaning of formwork elements from concrete;
- installation of changing bearing racks.

3.5. Working team's professional staff members

The work is carried out by a chain method of a complex team of 6 people, taking into account the combination of the following professions:

- carpenter - concrete worker of 4 category – 2 persons;
- carpenter - concrete worker of the 3rd category – 2 persons;
- carpenter - concrete worker of 2 category – 2 persons.

In this case all workers must have the skills of laying reinforcement products and tying joints.

In addition, at least two members of one construction zone team must be certified slingers.

In the absence of the above mentioned specialties and qualifications of workers, workers training and certification must be hold before the start of work.

Chapter 3 conclusions

1. In accordance with the works' task a fragment of the technological instructions card on reinforced concrete monolithic floor was prepared.

2. It is established that in this case the work should be performed using a chain method of a 6 people complex team, taking into account the combination of the following professions:

- carpenter - concrete worker of 4 category – 2 persons;
- carpenter - concrete worker of the 3rd category – 2 persons;
- carpenter - concrete worker of 2 category – 2 persons.

4 EQUIPMENT AND ECONOMIC CHAPTER

In accordance with the task, we calculated the cost of materials needed to manufacture the building’s frame in the following variants:

1. Monolithic reinforced concrete foundation, monolithic reinforced concrete columns and slab floors.

2. Monolithic reinforced concrete foundation, monolithic reinforced concrete columns and beam - slab floors.

Data on the selecting dimensions of these structures are given in chapter 2 and Annex E.

At calculating the value we used market prices from the following
sources:

1. Concrete 1400 - hryvnias per m^3.

2. Reinforcement bars - 12,500 hryvnias per ton.

3. Formwork 72 hryvnias per square meter.

First, the load-bearing structures cost of the building in the slab floors version was determined (tables 4.1 - 4.12).

The total volumes of materials required for the manufacturing a frame are given in table 4.13.

Next, the cost of the load - bearing structures of the building in the variant of beam - slab floor slabs was determined (tables 4.14 - 4.25).

The total volumes of materials required for the manufacturing a frame are given in table 4.26.

Next, the difference in the cost of materials required for the manufacture of building’s frames in the variants with slab and beam - slab floors was calculated. The following data was found:

1. The difference Δ between the cost required for the manufacture of the building’s frame with slabs (Vpl) and beam - slab (Vbpl) is equal to:

$$\Delta = Vbpl - Vpl = 4945796-4312669 = 633127 \text{ hryvnias.}$$

Table 4.1 – Variant of a building with a slab floor. Basement. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	159.62	13.20	0.00	105.26	278.08
Concrete, price	351160	29040	0	231570	611769
Reinforcement bars, kg	4879	2272	0	5589	12741
Reinforcement bars, price	79046	36812	0	90549	206408
Formwork, m^2	196.40	105.60	0.00	478.45	780.45
Formwork, price	58920	31680	0	143535	234135
Total price	489126	97532	0	465654	1052312

Table 4.2 – Variant of a building with a slab floor. First floor. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	0.00	13.20	0.00	105.26	118.46
Concrete, price	0	29040	0	231570	260610
Reinforcement bars, kg	0	1893	0	5589	7483
Reinforcement bars, price	0	30672	0	90549	121221
Formwork, m^2	0.00	105.60	0.00	478.45	584.05
Formwork, price	0	31680	0	143535	175215
Total price	0	91392	0	465654	557046

Table 4.3 – Variant of a building with a slab floor. Second floor. Volume of concrete, weight of reinforcement and formwork area

and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	0.00	13.20	0.00	105.26	118.46
Concrete, price	0	29040	0	231570	260610
Reinforcement bars, kg	0	1325	0	5589	6914
Reinforcement bars, price	0	21457	0	90549	112006
Formwork, m^2	0.00	105.60	0.00	478.45	584.05
Formwork, price	0	31680	0	143535	175215
Total price	0	82177	0	465654	547831

Table 4.4 – Variant of a building with a slab floor. Third floor. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, cubic meters	0.00	13.20	0.00	105.26	118.46
Concrete, price	0	29040	0	231570	260610
Fittings, kg	0	867	0	5589	6456
Fittings, price	0	14040	0	90549	104589
Formwork, m2.	0.00	105.60	0.00	478.45	584.05
Formwork, price	0	31680	0	143535	175215
In total, the price	0	74760	0	465654	540414

Table 4.5 – Variant of a building with a slab floor. The fourth floor. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	0.00	13.20	0.00	105.26	118.46
Concrete, price	0	29040	0	231570	260610
Reinforcement bars, kg	0	653	0	5589	6243
Reinforcement bars, price	0	10581	0	90549	101130
Formwork, m^2	0.00	105.60	0.00	478.45	584.05
Formwork, price	0	31680	0	143535	175215
Total price	0	71301	0	465654	536955

Table 4.6 – Variant of a building with a slab floor. Fifth floor. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	0.00	13.20	0.00	105.26	118.46
Concrete, price	0	29040	0	231570	260610
Reinforcement bars, kg	0	653	0	5589	6243
Reinforcement bars, price	0	10581	0	90549	101130
Formwork, m^2	0.00	105.60	0.00	478.45	584.05
Formwork, price	0	31680	0	143535	175215
Total price	0	71301	0	465654	536955

Table 4.7 – Variant of a building with a slab floor. Sixth floor. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	0.00	13.20	0.00	105.26	118.46
Concrete, price	0	29040	0	231570	260610
Reinforcement bars, kg	0	912	0	5589	6502
Reinforcement bars, price	0	14782	0	90549	105331
Formwork, m^2	0.00	105.60	0.00	478.45	584.05
Formwork, price	0	31680	0	143535	175215
Total price	0	75502	0	465654	541155

Table 4.8 – A variant of a building with a beam - slab floor. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	159.62	92.40	0.00	736.81	988.83
Concrete, price	351160	203280	0	1620990	2175430
Reinforcement bars, kg	4879	8576	0	39126	52581
Reinforcement bars, price	79046	138925	0	633844	851815
Formwork, m^2	196.40	739.20	0.00	3349.15	4284.75
Formwork, price	58920	221760	0	1004744	1285424
Total price	489126	563965	0	3259578	**4312669**

Table 4.9 – A variant of a building with a beam - slab floor. Basement. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	167.55	13.20	27.52	87.62	295.89
Concrete, price	368610	29040	60544	192762	650956
Reinforcement bars, kg	4997	2362	2079	3664	13102
Reinforcement bars, price	80955	38268	33684	59349	212256
Formwork, m^2	203.68	105.60	206.40	478.45	994.13
Formwork, price	61104	31680	61920	143535	298239
Total price	510669	98988	156148	395646	1161451

Table 4.10 – A variant of a building with a beam - slab floor. First floor. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	0.00	13.20	27.52	87.62	128.34
Concrete, price	0	29040	60544	192762	282346
Reinforcement bars, kg	0	1986	2044	3664	7694
Reinforcement bars, price	0	32178	33112	59349	124639
Formwork, m^2	0.00	105.60	206.40	478.45	790.45
Formwork, price	0	31680	61920	143535	237135
Total price	0	92898	155576	395646	644120

Table 4.11 – A variant of a building with a beam - slab floor. Second floor. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	0.00	13.20	27.52	87.62	128.34
Concrete, price	0	29040	60544	192762	282346
Reinforcement bars, kg	0	1410	2080	3664	7154
Reinforcement bars, price	0	22841	33703	59349	115893
Formwork, m^2	0.00	105.60	206.40	478.45	790.45
Formwork, price	0	31680	61920	143535	237135
Total price	0	83561	156167	395646	635374

Table 4.12 – A variant of a building with a beam - slab floor. Third floor. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	0.00	13.20	27.52	87.62	128.34
Concrete, price	0	29040	60544	192762	282346
Reinforcement bars, kg	0	906	2122	3664	6691
Reinforcement bars, price	0	14681	34370	59349	108400
Formwork, m^2	0.00	105.60	206.40	478.45	790.45
Formwork, price	0	31680	61920	143535	237135
Total price	0	75401	156834	395646	627881

Table 4.13 – A variant of a building with a beam - slab floor. The fourth floor. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	0.00	13.20	27.52	87.62	128.34
Concrete, price	0	29040	60544	192762	282346
Reinforcement bars, kg	0	653	2139	3664	6455
Reinforcement bars, price	0	10581	34644	59349	104574
Formwork, m^2	0.00	105.60	206.40	478.45	790.45
Formwork, price	0	31680	61920	143535	237135
Total price	0	71301	157108	395646	624055

Table 4.14 – A variant of a building with a beam - slab floor. Fifth floor. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	0.00	13.20	27.52	87.62	128.34
Concrete, price	0	29040	60544	192762	282346
Reinforcement bars, kg	0	653	2221	3664	6537
Reinforcement bars, price	0	10581	35975	59349	105905
Formwork, m^2	0.00	105.60	206.40	478.45	790.45
Formwork, price	0	31680	61920	143535	237135
Total price	0	71301	158439	395646	625386

Table 4.15 – A variant of a building with a beam - slab floor. Sixth floor. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	0.00	13.20	27.52	87.62	128.34
Concrete, price	0	29040	60544	192762	282346
Reinforcement bars, kg	0	1010	1996	3664	6670
Reinforcement bars, price	0	16359	32339	59349	108047
Formwork, m^2	0.00	105.60	206.40	478.45	790.45
Formwork, price	0	31680	61920	143535	237135
Total price	0	77079	154803	395646	627528

Table 4.16 – A variant of a building with a beam - slab floor. Volume of concrete, weight of reinforcement and formwork area and their price

Materials	Foundations	Columns	Beams	Slabs	Total
Concrete, m^3	167.55	92.40	192.64	613.33	1065.92
Concrete, price	368610	203280	423808	1349333	2345031
Reinforcement bars, kg	4997	8981	14681	25645	54303
Reinforcement bars, price	80955	145488	237827	415446	879716
Formwork, m^2	203.68	739.20	1444.80	3349.15	5736.83
Formwork, price	61104	221760	433441	1004744	1721049
Total price	510669	570528	1095075	2769523	**4945796**

2. The relative difference δ between the cost required for the manufacturing a building's frame with slabs (Vpl) and beam - slab (Vbpl) is equal to:

δ = (Vpbl - Vpl) / Vpl * 100% = **(4945796-4312669) / 4312669** * 100 =14.7%.

Chapter 4 conclusions

The materials presented in this chapter allowed us to draw the following conclusions.

1. The cost required for the manufacturing load-bearing structures in the case of a building with beam - slab floors on 633127 hryvnias more than the cost of the frame with slab floors.

2. The relative cost required for the manufacturing load-bearing structures in the case of a building with beam - slab floors is 14.7%. more than the cost of the slab floors frame.

GENERAL CONCLUSIONS

The fulfilled thesis work allowed us to draw the following conclusions:

1. A reinforced concrete frame made of monolithic reinforced concrete is a main element of the spatial framework of a 7-storey building which receives the load.

2. This framework is formed by columns and floor slabs.

3. The load collecting on the load-bearing structures of the building for manufacturing reinforcement structures is made. On this basis a table of load combinations is built.

4. Two variants of building are considered: with slab and beam - slab floors.

5. A fragment of technological instructions card organization of the reinforced concrete monolithic floors has been developed.

6.At doing economic part of the project the following positions were established:

6.1. The cost required for the manufacturing load-bearing structures in the case of a building with beam - slab floors on 633127 hryvnias more than the cost of the frame with slab floors.

6.2. The relative cost required for the manufacturing load-bearing structures in the case of a building with beam - slab floors is 14.7%. more than the cost of the slab floors frame.

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ANNEX D

Table D1 – Snow load on the roof of the house

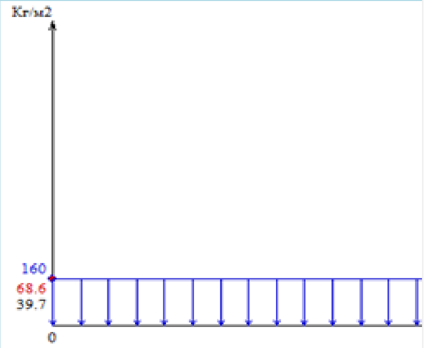
Епюра	Прив'я-зка, (м)	Експлуата-ційна нава-нтаження, (Кг/кв.м)	Максима-льне нава-нтаження, (Кг/кв.м)	Квазіпос-тійні нава-нтаження, (Кг/кв.м)
	**0**	**68.6**	**160**	**39.7**

Table D2 – Wind load from axes 1-12. Windward

Binding, (m)	**Operating load, (kg / m^2)**	**Maximum load, (kg / m^2)**	**Binding, (m)**	**Operating load, (kg / m^2)**	**Maximum load, (kg / m^2)**
0.00	7.18	38.99	5.00	7.18	38.99
10.00	9.58	51.98	15.00	10.97	59.57
20.00	12.37	67.15	25.00	13.27	72.02
26.40	13.52	73.38			

Table D3 – Wind load from axes 1-12. Leeward

Binding, (m)	Operating load, (kg / m²)	Maximum load, (kg / m²)	Binding, (m)	Operating load, (kg / m²)	Maximum load, (kg / m²)
0.00	-5.38	-29.23	5.00	-5.38	-29.23
10.00	-7.17	-38.98	15.00	-8.22	-44.66
20.00	-9.27	-50.35	25.00	-9.94	-54.00
26.40	-10.13	-55.03			

Table D4 – Wind load from the axes AE. Windward

Binding, (m)	Operating load, (kg / m²)	Maximum load, (kg / m²)	Binding, (m)	Operating load, (kg / m²)	Maximum load, (kg / m²)
0.00	7.18	38.99	5.00	7.18	38.99
10.00	9.58	51.98	15.00	10.97	59.57
20.00	12.37	67.15	25.00	13.27	72.02
26.40	13.52	73.38			

Table D5 – Wind load from the axes AE. Leeward

Binding, (m)	Operating load, (kg / m²)	Maximum load, (kg / m²)	Binding, (m)	Operating load, (kg /m²)	Maximum load, (kg / m²)
0.00	-5.38	-29.23	5.00	-5.38	-29.23
10.00	-7.17	-38.98	15.00	-8.22	-44.66
20.00	-9.27	-50.35	25.00	-9.94	-54.00
26.40	-10.13	-55.03			

ANNEX E

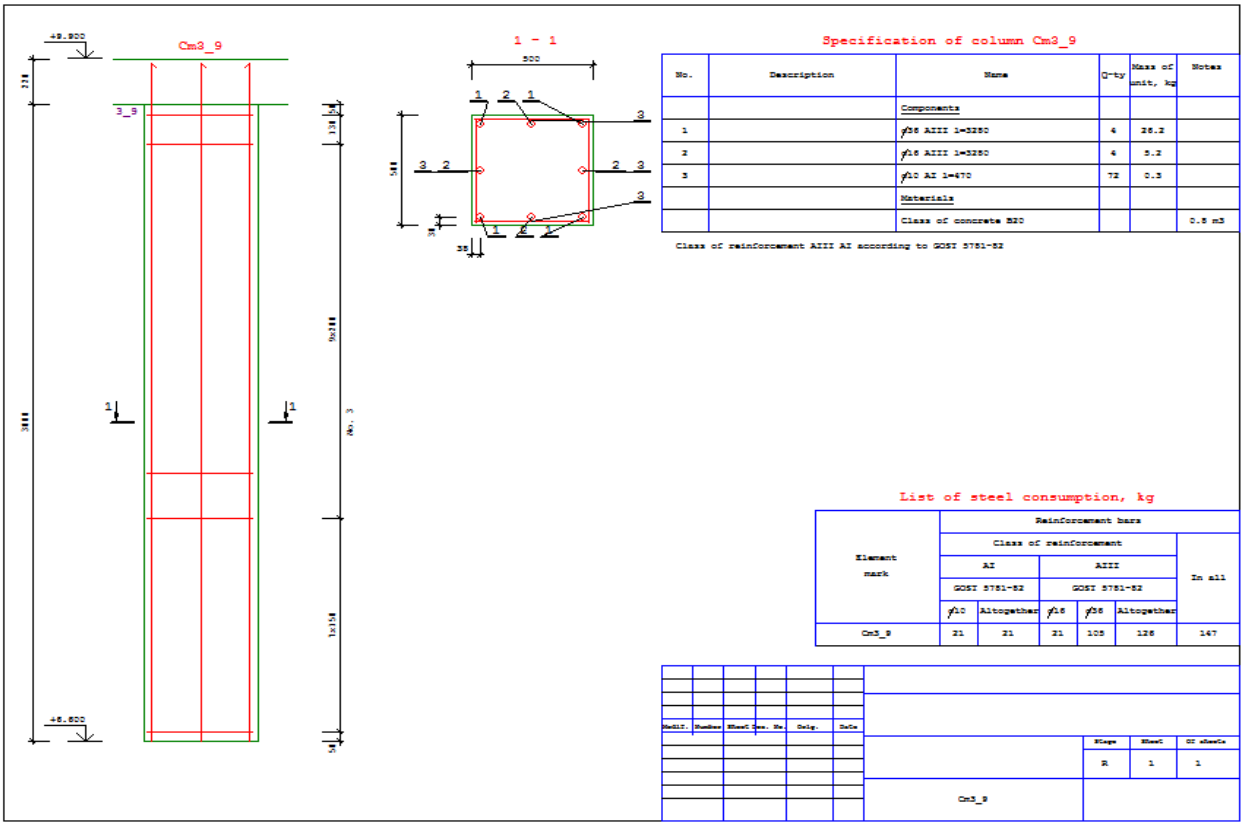


Figure E1 – Variant of a building with slab floors. Column K3-9. Working project drawings

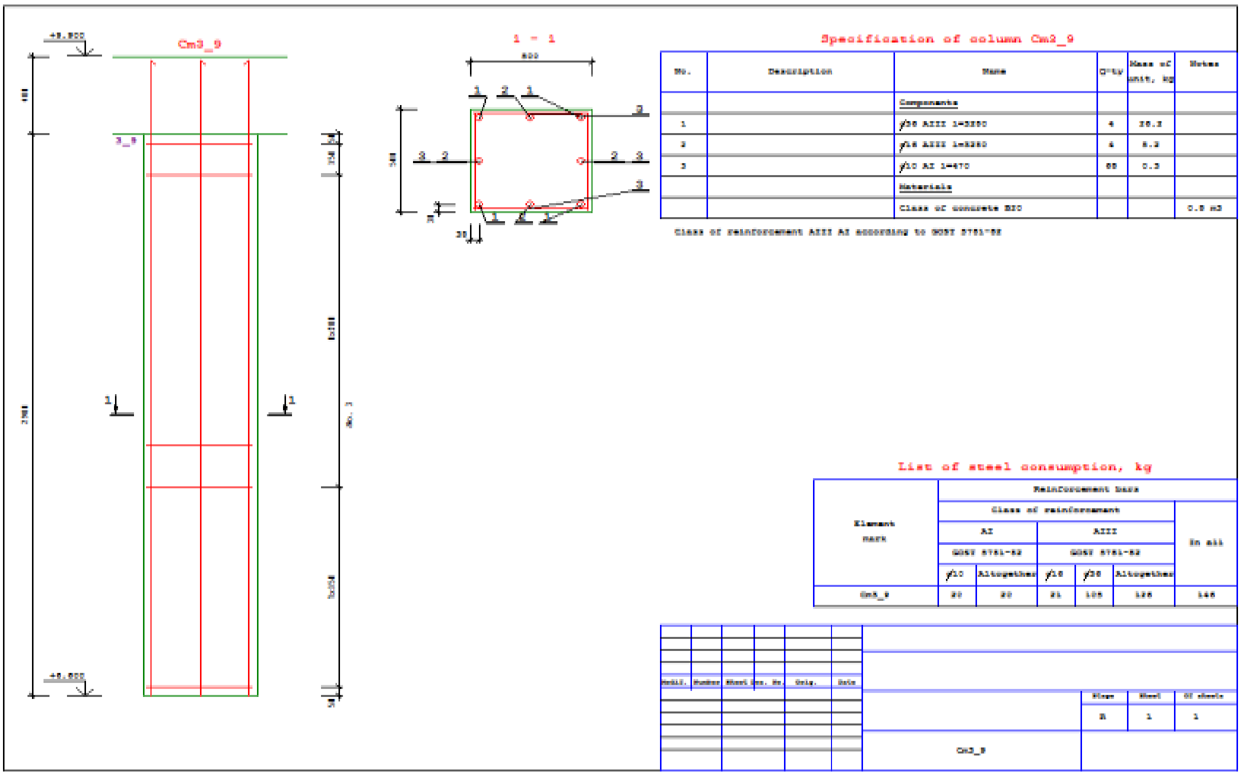
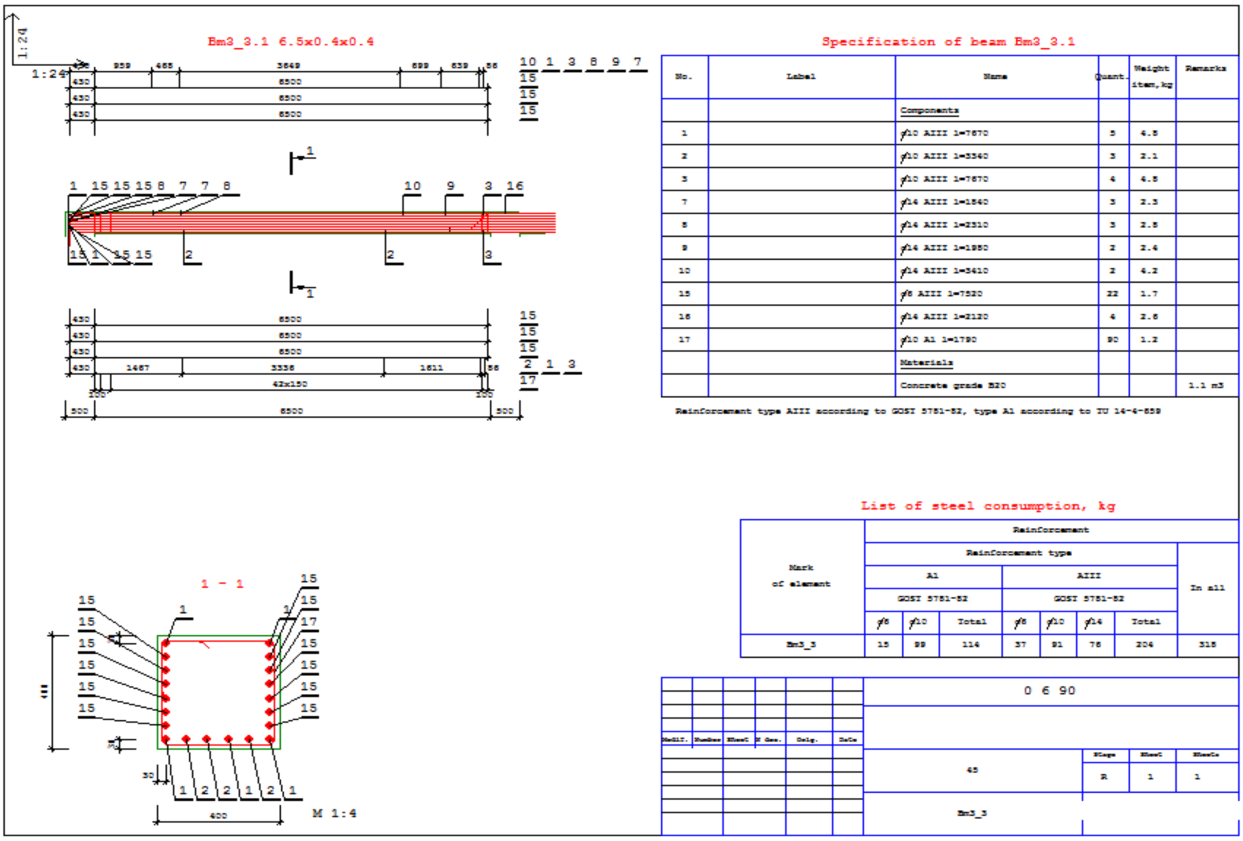


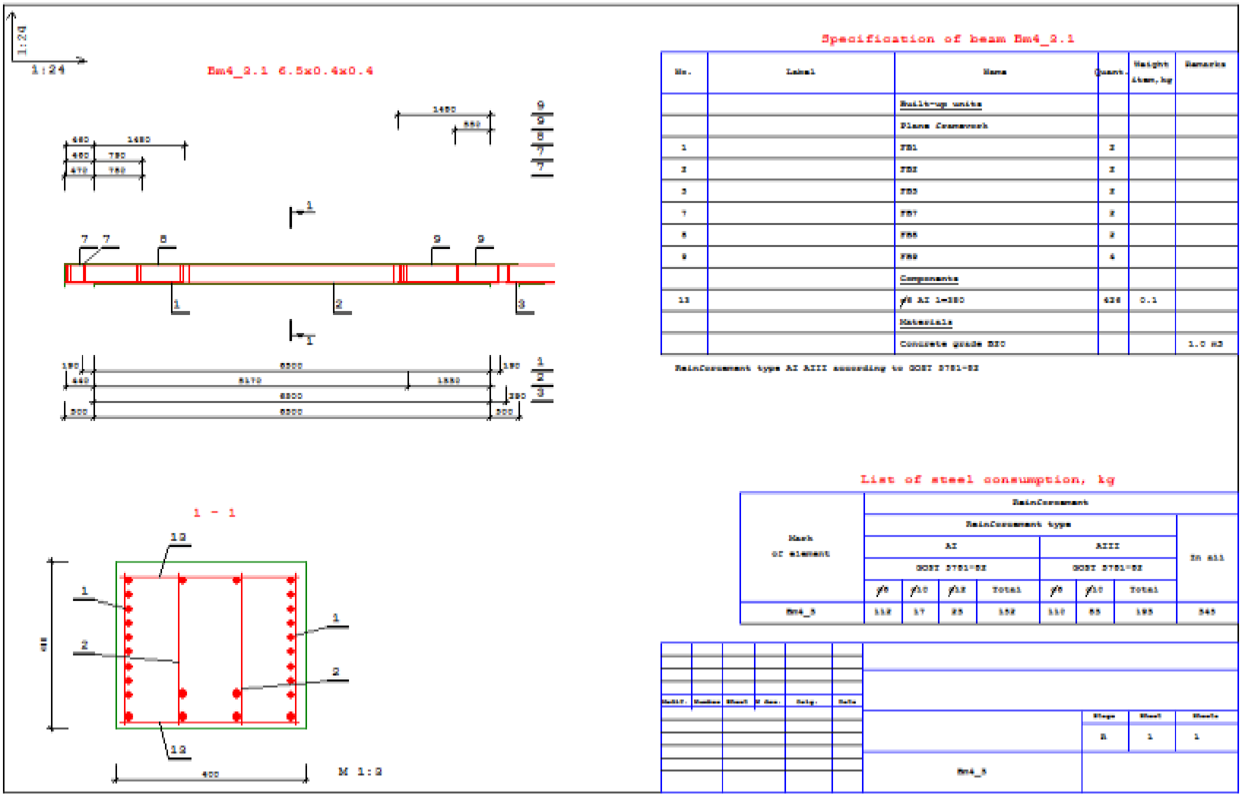
Figure E2 – Variant of a building with slab floors. Column K3-9. Working project drawings



No.	Label	Name	Quant.	Weight item, kg	Remarks
		Components			
1		⌀10 AIII l=7670	5	4.8	
2		⌀10 AIII l=3340	3	2.1	
3		⌀10 AIII l=7670	4	4.8	
7		⌀14 AIII l=1540	3	2.3	
8		⌀14 AIII l=2310	3	2.8	
9		⌀14 AIII l=1950	2	2.4	
10		⌀14 AIII l=3410	2	4.2	
15		⌀8 AIII l=7520	22	1.7	
16		⌀14 AIII l=2120	4	2.6	
17		⌀10 A1 l=1790	90	1.2	
		Materials			
		Concrete grade B20			1.1 m3

Mark of element	Reinforcement: A1, GOST 5781-82, ⌀8	⌀10	Total	AIII, GOST 5781-82, ⌀8	⌀10	⌀14	Total	In all
Bm3_3	15	99	114	37	91	76	204	318

Figure E3 – Variant of a building with a beam - slab floor. Beam B3-3. Working project drawings



No.	Label	Name	Quant.	Weight item, kg	Remarks
		Built-up units			
		Plane framework			
1		FR1	2		
2		FR2	2		
3		FR3	2		
7		FR7	2		
8		FR8	2		
9		FR9	4		
		Components			
13		⌀8 AI l=380	424	0.1	
		Materials			
		Concrete grade B20			1.0 m3

Mark of element	Reinforcement: AI, GOST 5781-82, ⌀8	⌀10	⌀12	Total	AIII, GOST 5781-82, ⌀8	⌀10	Total	In all
Bm4_3	112	17	23	152	112	63	193	345

Figure E4 – Variant of a building with a beam - slab floor. Beam B4-3. Working project drawings

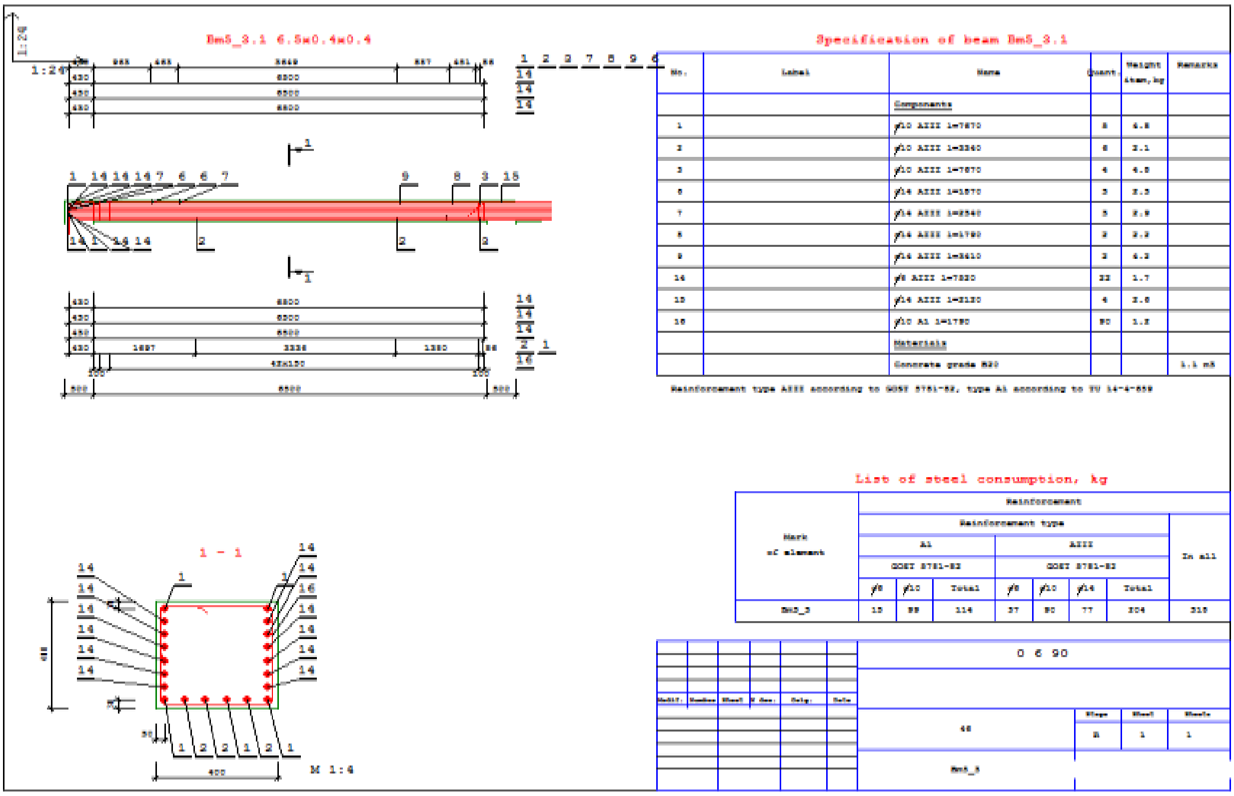


Figure E5 – Variant of a building with a beam - slab floor. Beam B5-3. Working project drawings