Ministry of Education and Science of Ukraine
Dnipro University of Technology

FACULTY OF CONSTRUCTION

Department of Construction, Geotechnics and Geomechanics

EXPLANATORY NOTE
of a Bachelor's qualification work

student **Ismaiel Hamsa Ahmed Amin**

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"

Supervisors	Name	Grade system		Signature
		ranking	institutional	
qualification work	Ivanova H.P.	85	good	
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1 chapter	Ivanova H.P.	85	good	
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TASK
for a Bachelor's qualification work

student Ismaiel Hamsa Ahmed Amin **academic group** 192-17-1 IC
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Specialty 192 Building and Civil Engineering
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1	Architectural and construction chapter	31.05.2021-9.06.2021
2	Calculation and design chapter	10.06.2021-23.06.2021
3	Organizational and technological chapter	24.06.2021-4.07.2021
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Task is issued ______________________ Ass.Prof. Ivanova H.P.
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ABSTRACT

Explanatory note: 89 p., 9 figures, 11 tables, 1 annex, 19 sources.

Graphic part: 6 sheets of A1 format.

CALENDAR PLAN, COST ESTIMATE, FLOOR SLAB, FOUNDATION, SHOPPING AND ENTERTAINMENT MALL, MONOLITHIC FRAME.

The object is the project of a shopping and entertainment mall in Poltava City.

The purpose of the work is to develop drawings of the building with appropriate architectural solutions and calculations, taking into account technological and organizational solutions and economic justification.

The shopping and entertainment mall has 3-storeys aboveground part and a one-storey underground part. The building's frame is monolithic, the floors are monolithic reinforced concrete, the outer walls are made of aerated concrete.

The load-bearing structures of the building frame were calculated using the software package «Autodesk Robot Structural Analysis», the geological conditions analysis of the construction site was carried out, foundation variant and its dimensions were justified.

The scope of work is determined and technological solutions for the organization of construction production are developed, labor and safety protection measures are considered. The local cost estimate calculation was carried out, followed by the compilation of a resources list and the construction cost determination using the «AVK-5» software package.

The application area is the construction of shopping and entertainment mall, which will contribute to increasing employment and the living standards improvement. The practical significance is the rational choice of architectural forms, creating effective space-planning, structural, organizational and technological solutions. It reduces construction period and finished construction products cost.

CONTENT

INTRODUCTION

Social life forms variety of in our country predetermined the variety of types and kinds of public buildings. Some of them are mass and they are being built according to the standard design projects.

A progressive trend is represented by the cooperative buildings of enlarged objects, united into public and administrative centers, cultural, shopping centers, children's complexes, etc. In addition to the economic effect, a reduction in the nomenclature of single buildings projects is achieved, the possibility of multi-purpose use of individual rooms and the entire building is presented, and base for the interesting architecture buildings are created.

Mass residential and cultural construction is carried out mainly in an integrated manner as city-planning formations. At the same time, the network of enterprises and service institutions should be convenient, correspond to the volume and size of the population, must have standard service radiuses for citizens.

The nomenclature of public buildings and structures, their required volumes in construction are determined by regulations and are in certain ratios to the mass housing construction volume. Public buildings enlargement trend, as well as their unification into complexes-centers, was reflected in the design of various buildings of cultural and public services. Such buildings operation has proven their economic advantages (reduction of the building area, reduction of the construction costs, etc.).

1 ARCHITECTURAL AND CONSTRUCTION SECTION

1.1 Characteristics of the designed building

The construction place is Poltava city. The designed building has dimensions of 42,5 × 72,00 m in the plan, number of storeys - 3 overground floors and 1 underground floor. There is a technical floor and a top structure for elevator mechanisms. The lift shaft is made of monolithic reinforced concrete.

According to the destination the building is public.

The building class according to the durability ratio is I.

Fire resistance class of the building is I.

The foundation type is strip foundation for aerated walls and pillars foundations for columns;

Enclosing structures are aerated concrete with insulation.

Floors are made from monolithic reinforced concrete.

1.2 Climatic characteristics of the construction area

Poltava city is located in the I climatic zone. Climatic and geophysical data are taken in accordance with the design state regulations [1].

The climate is moderately continental. The average January temperature is - 6.6 ° C; July temparature- +20.5 ° C. The average annual precipitation number is 574 mm. The freezing depth does not exceed 1 m. The duration of the heating period is 177 days. Typical climate features: moderately long and warm summer; long and moderately warm autumn; snowy winter; short spring. The outside air temperature is given in the table 1.1.

Table1.1 – Outside monthly average air temperature

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
-5,6	- 4,7	0,3	9,0	13,4	18,7	20,5	14,3	7,7	1,3	4,2	- 3,4

The repeatability of the wind direction for winter and summer conditions is given in Table 1.2

Table 1.2 – The repeatability of the wind direction for winter and summer conditions, in %

Direction / Months	N	NE	E	SE	S	SW	W	NW
January	9,0	10,0	11,9	8,7	14,7	14,9	20,2	10,6
July	19,5	12,3	11,0	5,3	7,5	8,3	20,4	15,7

The average wind speed in the directions is presented in table1.3.

Table 1.3 - The average wind speed in the directions in m/sec for winter and summer conditions

Direction / Months	С	СВ	В	ЮВ	Ю	ЮЗ	З	СЗ
January	3,1	2,9	3,5	2,8	3,2	3,4	3,6	3,6
July	2,4	2,3	2,2	2,0	2,1	2,5	2,7	2,5

The prevailing wind direction in the annual wind rose is north. The wind load is - 47, snow load - 145, (DBN [2]).

1.3 General plan of the construction site

The projected building is located in Poltava. The total area of the shopping mall is 15352.8 m^2. The site is buildings free and has a good transport connection of the building under construction with the nearby infrastructure. The surface relief of the site is flat with a slight general slope to the east.

Driveways' coating is made from medium-grained asphalt concrete, sideway coating is made from small slabs. The width of the entrance and exit is 5.5 m. Building's planning marks are taken from the conditions of architectural and planning decisions document and document on the creation of optimal slopes along the passages. The parking is planned on the territory. This project was carried out in conjunction with the existing planning around. The entire territory is landscaped and greened in order to ensure normal sanitary, hygienic and aesthetic conditions.

1.4 Space-planning solution

Buildings, structures, their internal space, as well as structures, planning solutions, equipment and decoration must meet the requirements of code [3,4].

Structures, parts and equipment of buildings, decoration of walls and ceilings, floor coverings of all rooms, stairs, corridors, etc. should be designed from materials approved for use in accordance with sanitary and hygienic standards. Rooms with a constant stay of people must be ventilated, noise and temperature conditions must be observed in accordance with the requirements [5,6].

A current building has a monolithic reinforced concrete frame and monolithic floor slabs, external walls are made of aerated concrete. In addition to the main element (trading halls) the following premises are designed as part of the shopping mall:

- warehouses;
- administration offices.

The shopping mall is equipped with two cargo-passenger elevators with a lifting capacity of 400 kg.

The designed building is located in the center of a residential microdistrict. The building according to its space-planning solution fully corresponds to its purpose, it is convenient for people, operation efficient and has rational and economical designs.

1.5 Structural sollution

The shopping mall has a 3-storey aboveground part and one -storey underground part. Structurally, the building consists of a monolithic frame and a monolithic reinforced concrete floor. The main characteristics of the building:

- maximum building height h - 20.08 m;
- column span - 3, 6m and 9 m;
- underground floor height - 3.2 m;
- the height of the above-ground floors - 3.7 m;
- building length - 72 m (aboveground part);
- building width - 42.5 m (aboveground part).

1.5.1 Bases and foundations

Soil content:

- суглинок красно-бурый – более 10,0 м.
- loess loam 3.9 m - 5.4 m;
- pale yellow loess 4.5 m - 7.2 m;
- red-brown loam - more than 10.0 m.

The foundation for the construction is designed in the form of reinforced concrete foundations for columns with glass-type reinforced concrete pillars with a developed slab part, which are typical for frame buildings. Since the bearing walls are made of aerated concrete, the columnar foundation is combined with the strip foundation [7].

1.5.2 Walls and partitions

The outer walls are made of aerated concrete; mineral wool is used as insulation. Rationally designed external building structures must meet the following requirements:

- have sufficient heat-insulated properties;
- have air tightness not exceeding the established limit;
- maintain a normal humidity regime.

A heat engineering calculation is performed in order to understand if the enclosing structures meet the listed requirements in accordance with [5]. An online software complex was used for the calculation (Figure 1.1). Partitions made of foam concrete blocks (120 and 150 mm thicknesses) are used between the rooms, providing sufficient sound insulation at the same time being fire barriers.

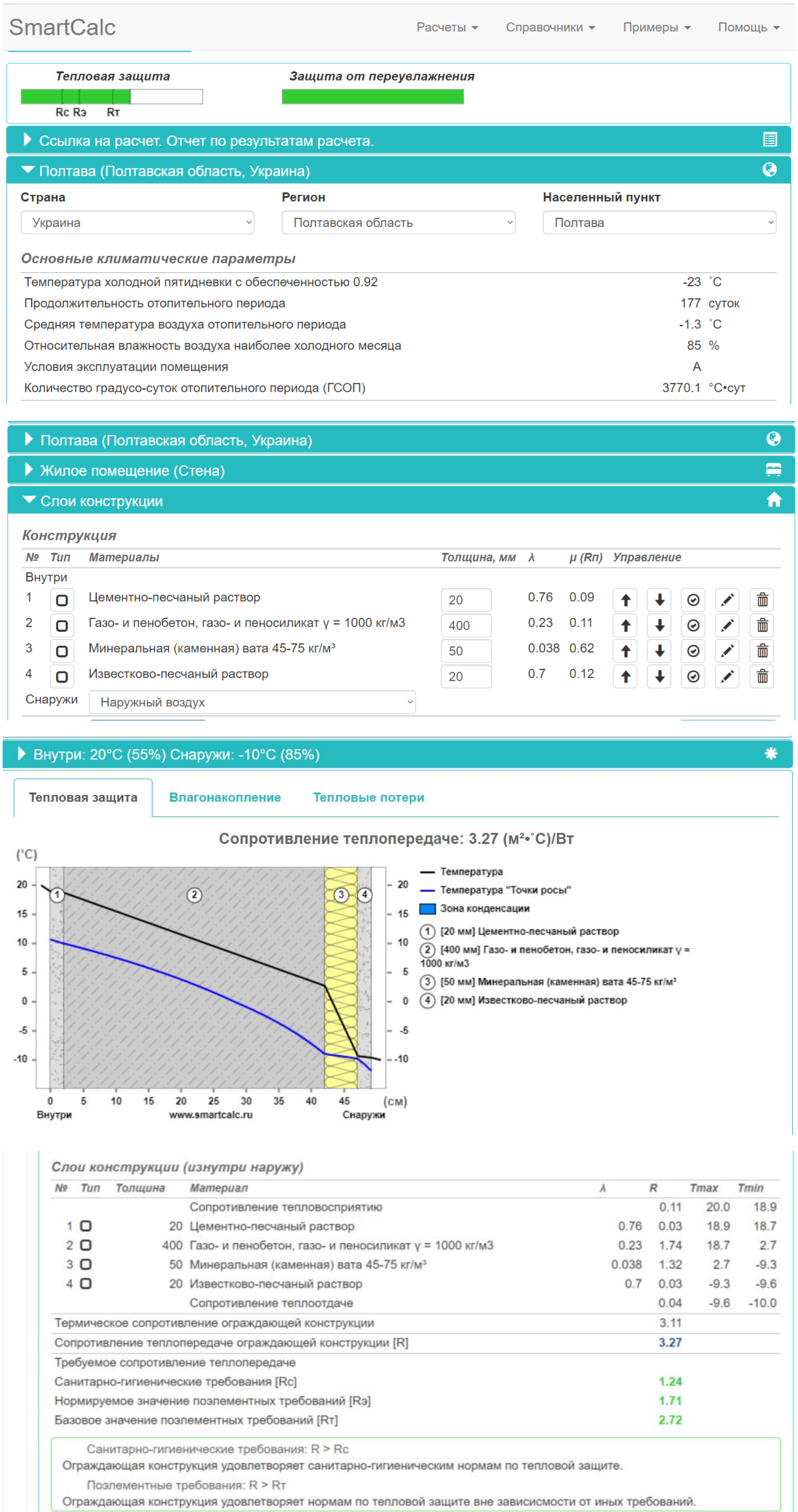

Figure 1.1 – Heat engineering calculation in SmartCalc software complex

1.5.3 Overlaps and coverings

The floors and coverings are designed with monolithic reinforced concrete with a thickness of 100 mm. The use of monolithic slabs and coatings increases the load-bearing capacity of building structures, rigidity in the longitudinal and transverse directions, as well as the speed of construction of buildings.

1.5.4 Roof

According to the design solution, the roof is designed in the form of a combined roof, which is a multi-layer structure made of layers:

- rolled material-roofing material;
- leveling screed made of cement-sand mortar, forming the foundation for the roof;
- insulation – expanded polystyrene;
- vapor barrier;
- monolithic reinforced concrete slab.

1.5.5 Windows

Windows determine the degree of comfort and its architectural and artistic solution. Windows are selected according to the standards based on the areas of the illuminated premises. According to DSTU [8] the area of windows for residential buildings should be in the range from 1/5 to 1/8 of the floor area. The window structure consists of a window box, a window sash and a window sill.

1.5.6 Doors

In the project the doors dimensions are taken according to standards. To ensure quick evacuation all doors open outward in the direction of movement to the street based on the regulations for evacuating people in case of fire. The door frames are fixed in the openings to wooden corks saturated by antiseptic, which are put into the masonry during walls construction. Door frames are arranged with thresholds for external wooden doors and on staircases, in the vestibule, and without thresholds - for internal doors. The door slabs are hung on hinges (awnings) which allow removing the wide open door slabs from the hinges for the renovation works or for the door slab replacement. Doors are equipped with handles, latches and mortise locks. Entrance lobby doors are made of two-layer extruded aluminum with corrugated surface. Door frames are made of extruded aluminum profiles with anchoring to the walls [8].

1.5.7 Floors

Floors in residential and public buildings must meet the requirements of strength, wear resistance, sufficient elasticity, noiselessness, and easy cleaning. The floor structure is considered as the soundproofing capacity of the floor plus the floor structure soundproofing. The floor covering is made from ceramic tiles. The screed is made from a mortar on expanded clay backfill, which is a soundproof layer. Mosaic floors are in the built-in rooms.

The advantages of these floors are their hygiene and noiselessness. Negative sides - high labor intensity, which also increases the construction period.

1.5.8 Exterior and interior decoration

Exterior decoration. The basement part, the outer surfaces of the floors are plastered with the addition of light colors. Window and door blocks are painted with oil paints or light-colored enamels.

Interior decoration. Internal walls are painted after the aerated concrete walls are plastered. In this case, mainly light cold colors or white are used. Decorative elements of interior decoration are used. In bathrooms floors and walls are tiled with ceramic tiles. The ceilings are painted.

1.6 Building's engineering equipment

1.6.1 Ventilation, water supply and sewerage

Since the building has I class of fire resistance, an air conditioning system is provided in each room in addition to natural ventilation; SPLIT air conditioning systems are used.

Cold water supply is designed using an internal quarter water supply collector with one input. Water is supplied through an internal main pipeline located in the basement of the building, which is isolated. Around the building there is a main fire-fighting water supply system with wells, in which fire hydrants are installed.

Sewerage is carried out in the yard with a connection into the wells of the internal quarter sewerage. Independent ways of household fecal and rain sewage are carried out from each section and each built-in room [9].

1.6.2 Power supply and installation of telephones

Power is supplied from a city substation powered by two cables (main cable and the spare cable). All switchboards are located on the ground floor.

Both internal and external telephone lines are designed for corporate communications of the shopping mall staff.

1.7 Technical and economic indicators

Buildings' economic indicators are determined by their volumetric planning and design solutions, by the type and organization of sanitary equipment. An important role is played by the room's designed height and sanitary facilities' location.

The building project is characterized by the following indicators:

- construction volume – 54421,66 m^3,
- building area – 15352,8 m^2,
- total area - 16578,76 m^2,
- useful area - 14760,49 m^2,

K1 = 0,89 is a ratio of the useful area to the total area, which characterizes the rationality of the areas use.

K2 = 3,54 is the ratio of the building volume to the total area, which characterizes the rationality of using the volume.

The building volume of the above ground part of the building is the multiplication of the horizontal section area at the first floor level above the basement (along the outer edges of the walls) on the height measured from the floor level of the first floor to the top area of the thermal insulation layer of the attic floor.

The construction volume of the underground part of the building is the multiplication of the horizontal section area of the along outer perimeter of the building at the level of the first floor (at the above basement level) on the height from the basement floor to the floor of the first floor.

The total building’s volume with basement is the sum of volumes of its underground and above-ground parts.

Building area is an area of the horizontal section of the building at the basement level, including all protruding parts and coverings.

The area of premises is measured between the surfaces of walls and partitions at floor level.

The total building area is the sum of the floors areas, measured within the inner surfaces of the outer walls. The area of staircases and various shafts is also included in the floor area.

Conclusion by section 1

In the first chapter according to the climatic characteristics of the construction area, plans, facades, sections, architectural joints were developed; the thermal engineering calculation of the enclosing structure was carried out; functional process features were also considered; external and internal decoration solutions were given; main engineering equipment was described; the general construction plan was also considered.

2 CALCULATION AND DESIGN SECTION

2.1 General ideas

The shopping mall is a structure with a monolithic reinforced concrete frame, monolithic reinforced concrete floor slabs, supported on beams along the contour.

Monolithic ribbed floor consists of a reinforced concrete slab, which is supported by a beam cage, consisting of a system of main and secondary mutually perpendicular beams. The floor slab and the beams are monolithically interconnected, which is achieved by simultaneous concreting of all floor elements in a specially made formwork [3].

For monolithic floors heavy concrete of class B20 - B25 is usually used, and for reinforcement welded frames made of A-II or A-III classes steel and ordinary wire welded mesh are used.

In this project B20 class concrete was assigned. The design resistances of such concrete for the first group limiting states will be the following:

- for axial compression R_b = 11 *MPa*,
- for axial strething R_{bt} = 0,88 *MPa*,
- concrete work conditions coefficient $m_{б1}$ = 0,85.

We will assign working reinforcement for beams in the form of welded frames made of hot-rolled steel periodic profile of the class A-III, R_s = 340 *MPa*, R_{sw} = 215 *MPa*. For transverse reinforcement class A-I R_{sw} = 170 *MPa*. We will accept the reinforcement for the slab in the form of welded meshes made of ordinary A- III class wire.

Assignment of preliminary dimensions of structures:

- cross-section dimensions of the secondary beam:

$h_{в.\,б}$=(1/12...1/20)·$l_{в.\,б}$; assign $h_{в.\,б}$ = 600/20 = 30 *cm*, b = (1/2...1/3)·$h_{в.б} \geq$ 10 *cm*; we assign the width of the secondary beam b = 20 cm.

- cross-sectional dimensions of the main beam:

$h_{г.\,б}$ = (1/8...1/15)·$l_{г.\,б}$; assign $h_{г.\,б}$ = 600/15 = 40 *cm*, *b* = (1/2...1/3)·$h_{г.б}$ ≥ 10 *cm*; we assign the width of the main beam *b* = 20 cm.

The thickness of the slab is taken equal to 10 cm, which is more then h_{min} = 60 *mm*.

2.2 Floor slab calculation

It is supposed to perform the calculation of the frame's bearing structures of the building using the «Autodesk Robot Structural Analysis» software package, where automatic accounting the elements' dead weight according to the sections' geometric characteristics and the volumetric weight of structures' materials is provided. Thus, the load is collected without taking into account the dead weight of the elements of the building's frame [2], [10]. Load collection on a monolithic floor slab is given in table 2.1.

Table 2.1 – Loads on a monolithic floor slab

Load	Normative load кN/m^2	γ_f	Design load кN/m^2
Constant: - ceramic tiles floors (δ = 0,003 m, ρ = 18 *кN/ m^3)* - cement and sand screed (δ = 0.03 *m*, ρ = 22 *кH/m^3*)	0.54 0.66	1.3 1.3	0.702 0.96
Total – constant load	1.2		1.662
Useful:	4.00	1.2	4.80
Total – useful load	4.00		4.80
Totally	5.2		6.462

Design slab's scheme is a multi-span continuous beam loaded by a uniformly distributed load (Figure 2.1).

Figure 2.1 - Design slab’s scheme

Project characteristics: SLAB

Structure type: Membrane

Coordinates of the structure’s gravity center: X = 24.000 (м)

Y = 22.413 (м)

Z = 3.462 (м)

Structure’s inertia moments: I_x = 424459205.550 (kg·m^2)

I_y = 506304762.630 (kg·m^2)

I_z = 928103706.767 (kg·m^2)

Structure’s description: number of nodes: 673,

2-d finite elements 553,

3-d finite elements: 0,

number of freedom static degrees: 3762,

loading: 4,

combinations: 1.

Variants of loadings/calculations

Loading 1 : DL1

Calculation type: Statics - Linear

Loading 2 : DL2

Calculation type: Statics - Linear

Loading 3 : DL3

Calculation type: Statics - Linear

Loading 4 : COMB1

Тип расчета: Liniar combination

Combinations

Combna-tion	Title	Calculation type	Calculation type	Loading Type	Definition
4 (C)	COMB1	Liniar combination	ПС1		1×1.00+2×1.30+3×1.20

The calculations' results are given on the figures. 2.2 – 2.8.

Figure 2.2 - Membrane force map N_x

Figure 2.3 - Membrane force map N_y

Figure 2.4 – Moments' map M_x

Figure 2.6 - Moments' map M_y

Figure 2.7 - Shear forces' map Q

Figure 2.8 – Slabs’deflections

2.3 Engineering and geological conditions of the construction site [7]

Engineering and geological intersection of the construction [11] site is given on figure 2.9.

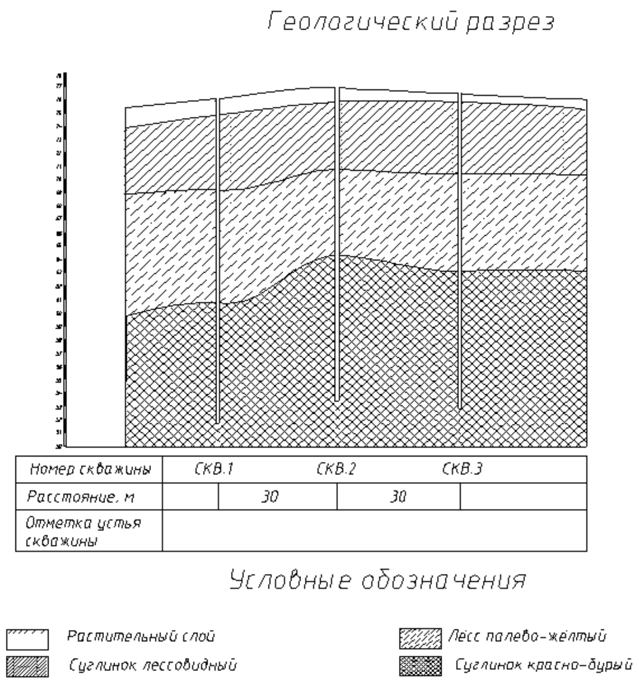

Figure 2.9 - Engineering and geological intersection of the construction site

Geological intersection consists of the following layers:

- vegetation layer - 1.8 - 2.5 *m*;
- loess-like loam - 3.9 - 5.4 *m*;
- pale yellow loess - 4.5 - 7.2 *m*;
- red-brown loam - more than 10.0 *m*.

2.4 Columnar foundation calculation

2.4.1 Determination of the foundation load.

Cargo area: 6 · 6 = 36m^2.

– load from the weight of the coating: standard load – 4,4 *kN/m*^{2},

estimated load – 5,405 *kN/m*^{2}.

Vertical reference pressure from the coating on the column:

Constant load:

- coating weight load: standard load – 4,4 *kN / m*^{2},

design load – 5,405 *kN / m*^{2}.

Vertical bearing pressure from the coating to the column:

$$P_1 = q_{расч}^{пост} B \cdot \frac{L}{2}\gamma_n + \frac{G_{m.k}}{2}\gamma_f \cdot \gamma_n = 6,229 \cdot 6 \cdot \frac{6}{2} \cdot 0,95 + \frac{91}{2} \cdot 1,1 \cdot 0,95 = 154,07 kN$$

$$q_{расч}^{пост} = \frac{5,405}{0,707} = 6,229\, kN,$$

- floor weight: $q_{расч2}^{пост} = 8 \cdot 1,1 = 8,8 kN/m^2$,

$$P_2 = q_{расч}^{пост} \cdot B \cdot \frac{L}{2} \cdot \gamma_n = 8,8 \cdot 6 \cdot \frac{6}{2} \cdot 0,95 = 150,48 kN ,$$

- column dead weight load: *в* = 0,4*m;* *h*=0,4m*;* *H*=3,2 *m.*

$$P_3 = в \cdot h \cdot H \cdot \rho_{бет} \cdot \gamma_f \cdot \gamma_n = 0,4 \cdot 0,4 \cdot 3,2 \cdot 25 \cdot 1,1 \cdot 0,95 = 13,376 kN$$

Total constant load: $P_{пост}$= 154 ,07+150,48+13,376=317,926 *kN*

Temporary load:

- useful: q_3=4·1,3=5,2 *kN* , *P*=5,2·36=187,2 *kN*.
- snow load:

$$P_{сн.вр} = S_0 \cdot \mu \cdot \gamma_f \cdot \frac{L}{2} \cdot B \cdot \gamma_n = 1,11 \cdot 1 \cdot \frac{6}{2} \cdot 6 \cdot 0,95 = 18,981 kN,$$

where S_0=1,11 for Poltava [1]/

$P_{вр}$=187,2+18,981=206,181 *kN*.

Total loading on foundation: $P=P_{пост}+P_{вр}$=317,926+206,181=524,107 *kN*.

2.4.2 Definition of the foundation's basic dimensions

Determination of the estimated foundation's bottom depth:

$$d_{fn} = k_n \cdot d_f = 0,4 \cdot 0,9 = 0,36m,$$

where k_n=0,4 - coefficient of thermal building effect of the (for buildings with a basement and average daily temperature 20˚C, [1];

$d_f = 0.9m$ - standard depth of soil freezing.

Determine the foundation's depth value d_w depending on the design soil freezing $d_w < d_f$ +2 no less than d_f .

Taking into account the technological features of the designed building, the depth of the foundation is *d* = 7,1 m, basement mark - 6,0025, basement floor thickness 0,3 м.

Предварительно определим размеры подошвы фундамента из учёта воздействия нормальной силы: The dimensions of the foundation’s bottom are preliminarily determined taking into account the normal force effect:

$$A = \frac{N}{(R_o - \beta\gamma_M d)} = \frac{524{,}107}{300 - 20 \cdot 7{,}1} = 4{,}852 m^2$$

where γ_M – foundation material’s unit weight;

β – coefficient which takes into account the smallest soil unit weight in comparison with the foundation material’s unit weight

The foundation is monolithic and centrally loaded, then: $l = b = 2{,}4$ *m* and

$$A = b \cdot l = 2{,}4 \cdot 2{,}4 = 5{,}76 m^2$$

Determine the designed soil resistance [7]:

$$R_{np} = \frac{\gamma_{c1} \cdot \gamma_{c2}}{k}(M_g \cdot d_1 \cdot \gamma'_{II} + (M_g - 1) \cdot d_b \cdot \gamma'_{II} + M_c \cdot c_{II} + M_\gamma \cdot k_z \cdot b \cdot \gamma_{II}),$$

$$R_{np} = \frac{1{,}25 \cdot 1{,}1}{1}(0{,}38 \cdot 1 \cdot 2{,}4 \cdot 17{,}86 + 2{,}72 \cdot 7{,}1 \cdot 15{,}94 + 5{,}24 \cdot 23{,}05) = 613{,}01 \text{ } kPa$$

where $\gamma_{c1} = 1{,}25$, $\gamma_{c2} = 1{,}1$ – working conditions coefficients;

$k = 1$– coefficient for soil strength characteristics (c and φ), determined by direct tests;

$M_q = 2{,}72$, $M_c = 5{,}28$, $M_\gamma = 0{,}38$ – coefficients at $\varphi_{II} = 24^o$;

d_1 – foundation bottom depth;

γ'_{II} = (0,5 ·1,6+0,7·1,59)/1,2 = 1,594 t/m^3 = 15,94 kN/m^3- the average designed values of the unit weights of soils lying above the foundation bottom;

d_b- basement depth;

c_{II} = 23,05 *kPa* - the designed value of unit adhesion of the soil layed under the foundation bottom;

k_z =1 –coefficient of foundation area impact, for the foundation $b < 10$ *m*.

γ_{II} –the average designed unit weight value of the soils lying below the foundation bottom, which is determined according to the formula:

$$\gamma_{II} = \frac{4,9 \cdot 1,6 + 7,2 \cdot 1,59 + 10,4 \cdot 2,01}{4,9 + 7,2 + 10,4} = 17,86 \ kN/m^3.$$

We calculate the foundation weight:

$$N_f = V_f \cdot \rho_{бет} = (2,4 \cdot 2,4 \cdot 0,45 + 1,8 \cdot 1,8 \cdot 0,3) \cdot 25 = 89,1 \ kN,$$

where V_f – foundation volume;

$\rho_{бет}$ – concrete density.

Determine the soil weight on the foundation edge (the unit weight of the backfill soil is 16 kN/m^3):

$$N_g = (2,4 \cdot 0,45 \cdot 0,3 \cdot 2 + 1,8 \cdot 0,3 \cdot 0,3 \cdot 2) \cdot 16 = 15,552 \ kN$$

Determine the average pressure on soil at the foundation bottom:

$$P_{cp} = (R_0 + N_f + N_g)/A = (524,107 + 89,1 + 15,552)/5,76 = 109,16 \ kN$$

$$P_{cp} \le R_0, \quad 109,16 \le 613,01.$$

2.4.3 Foundation calculation of the deformations

The settlement of the centrally loaded foundation is determined using the method of layer-by-layer summation. We find the vertical stresses diagram values from the action of the soil weight according to the formula: $\sigma_{zq,i} = \sum_{i=1}^{n} \gamma_c \cdot h_i$ and additional formula $0,2 \cdot \sigma_{zq,i}$.

At bulk layer 1 bottom: $\sigma_{zg,1}$ =2 ·16,1=32,2 kN/m^2.

At foundation bottom layer:

$$\sigma_{zg,0} = \sigma_{zg,1} + \gamma_2 \cdot d_f = 1,3 \cdot 16,1 + 14,1 \cdot 7,1 = 100,11\ kN/m^2,$$

$$0,2 \cdot \sigma_{zg,0} = 0,2 \cdot 100,11 = 20,84\ kN/m^2.$$

At bottom layer 2:

$$\sigma_{zg,3} = 100,11 + 14,1 \cdot 1 = 114,21\ kN/m^2,\ 0,2 \cdot \sigma_{zg,3} = 0,2 \cdot 114,21 = 22,84\ kN/m^2.$$

At bottom layer 3:

$$\sigma_{zg,4} = 114,21 + 14,55 \cdot 6,45 = 208,06\ kN/m^2,\ 0,2 \cdot \sigma_{zg,4} = 0,2 \cdot 208,06 = 41,61\ kN/m^2.$$

Determine the additional pressure on the base

$$P_0 = P - \sigma_{zg\,0} = 109,16\ \text{kN/m}^2 - 100,11\ \text{kN/m}^3 = 9,05\ kN/m^2,$$

where $\sigma_{zg} = \gamma_c \cdot d$.

Assign the elementary layer thickness: $z = 0,4 \cdot 1,2 = 0,48\ m$.

The additional pressure ordinates are calculated according to the formula:

$$\sigma_{zpi} = \alpha \cdot P_0,$$

where α - coefficient taken depending on the foundation bottom shape and the ratio between the rectangular foundation sides and the relative depth, which is equal to $\xi = 2 \cdot z / b$.

Soil settlement ends in a layer where the following condition is tru: a $\sigma_{zp} \leq 0,2\sigma_{zq}$ at E > 5 MPa. This condition is realized at a 3.76 m depth from the surface, excluding bulk soils:

$$S=0,8 \cdot 0,36 /5,6\cdot(0,0562 + 0,054 + 0,045 + 0,034 + 0,0252 + 0,0189) +$$
$$+0,8\cdot0,36/5,7\cdot(0,0167 + 0,0144 + 0,093) = 0,012 + 0,0063 = 0,0183 = 1,83\ cm$$

Foundations' settlements S =1,83 *cm*

The pressure on the roof of the underlying layer's unconsolidated soil is less than the initial subsidence pressure P_{sl} .

The amount of the slump is S_{sl} = 4,95 *cm*. It is necessary to fulfill the condition, according to [7], [10]:

$$S + S_{sl} < S_u = 12,0\ cm,\ \ 1,83 +4,95 = 6,78\ \text{cm} < S_u = 12,0\ cm,$$

the condition is realized.

Conclusion by section 2

The calculation of the building frame load-bearing structures was carried out using the "Autodesk Robot Structural Analysis" software package, the loads were collected in the current chapter. The selection of the main structural elements has been done.

The analysis of the construction site's geological conditions was carried out, the foundation design was justified and its dimensions were determined. The necessary checks were performed in accordance with the relevant regulatory documents' requirements after all calculations.

3 ORGANIZATIONAL AND TECHNOLOGICAL SECTION

3.1 Organization of construction

The organization of construction is an interconnected system of construction preparation, planning a general order of priority and deadlines for work, the supply of all types of resources (material, human), management and ensuring construction efficiency and quality. The task of the organization is ensuring construction in the optimal time with high quality of construction and minimal labor, material and monetary resources.

The project of works production (PWP) is developed according to working drawings and serves to determine the most effective methods of construction and erecting works (CEW), which help to reduce the cost, duration and labor costs. It is prohibited to do construction work without a PWP. The approved PWP must be delivered to the construction site 2 months before the work is carried out at least. The purpose of the PWP project documentation is the basis for the annual and operational planning of the organization of the CEW for the main objects.

At designing the main construction plan the following factors are taken into account: the terrain is flat, temporary communications connection for the construction needs is made to the urban city central systems.

3.2 Determination of the construction period works scope

The volume of construction and erecting works is calculated according to [12]. We specify the physical scope of work according to the working drawings of the previous chapters.

The calculations results of the construction and erecting works volume (CEW) are summarized in Table 3.1.

Table 3.1-Statement of works volume

№	Name of the works	Units of measurement	Volume
1	Cutting the top soil layer	ha	0,6
2	Soil development into the dump using «dragline» excavator	m^3	32648,4
3	Soil development using an excavator with loading on motor transport	m^3	27751,59
4	Manual soil development	m^3	689,76
6	Soil backfilling using bulldozer	m^3	4896,81
7	Compaction of the filled-in soil with rammers	m^3	413,62
8	Installation of strip foundations for walls	m^3	49,248
9	Installation of columnar foundations for columns	m^3	46,23
10	Laying foundation beams	pieces	42
11	Concreting the lower columns (for 1-2 floors)	m^3	70,656
12	Concreting columns (on the 3rd floors)	m^3	31,376
13	Concreting columns (on the 4th-5th floor)	m^3	73,408
14	Installing staircases	pieces	40
15	Concreting the floor (for 3-5 floors)	m^3	612
16	Installation of ribbed floor slabs (the 3rd-5th floors)	pieces	54
17	Installation of ribbed floor slabs (for 1-2 floors)	pieces	144
18	Concreting the floor (for 1-2 floors)	m^3	408
19	Concreting beams	m^3	829,8
20	Installation of stairwells	pieces	32
21	Aerated concrete masonry of external walls	m^3	21448,898
22	Foam concrete masonry of internal walls	m^3	54,612
23	Installing ready-made window blocks	pieces	105
24	Installation of stained glass windows	m^2	347,8
25	Installation of ready-made door blocks	pieces	48
26	Floors waterproofing	m^2	15352,8
27	Heat and sound insulation of floors	m^2	15352,8
28	Installation of cement screeds on floors	m^2	15352,8
29	Installation of asphalt concrete pavement	m^2	2630,4
30	Floor coverings made of ceramic tiles	m^2	7676,4
31	Installation of linoleum floor coverings	m^2	3070,56
32	Mosaic tile floor coverings	m^2	4605,84
33	Vapor barrier of the coating	m^2	1584
34	Roof construction	m^2	1584
35	Trusses installation	pieces	5
36	Improved plastering	m^2	4177,2
37	Easy walls painting using oil paint	m^2	1044,33
38	Simple ceilings painting	m^2	15352,8
39	Silicate facades painting	m^2	4766,44
40	Perimeter pavement	m^2	234

The delivery of materials to the construction site is carried out depending on the cargo to be transported, the conditions and transportation distances.

We accept the following types of vehicles:

- for foundation beams-MAZ-200
- for aerated concrete-MAZ-504
- trusses -MAZ-504
- for stairwells -ZIL-120N.

3.3 Temporary buildings and structures

Temporary buildings and structures are designed in the following sequence:

-the designed number of workers, engineering and technical workers, other staff and junior maintenance personnel (JMP) is established;

- required areas and number of buildings and structures is determined;
- lists of titular and non-titular temporary buildings and structures are compiled.

The designed number of workers is taken based on workers' movement schedule, according to which N_{max}=52 *people* (including 37 men, 25 women).

Table 3.2 - Employees categories ratio

Public construction	Workers	Engineering and technical workers	Employees	JMP	Total
%	85	8	5	2	100
people	52	5	3	2	62

$$N_{общ} = (N_{раб} + N_{итр} + N_{сл} + N_{моп}) \times k = (52+5+3+2) \times 1{,}05 = 65 \textit{ people}$$

3.3.1. Determinating nomenclature, area and number of temporary buildings and structures

The need of space for temporary buildings and structures is presented in Table 3.3.

Table 3.3 - The need of space for temporary buildings and structures

№	Building (construction)	Designed quantity	Norm of the area for 1 pers., m²	Designed area	Dimensions, m	Useful area	The code of a typical project	Building type	Number of auxiliary buildings and structures
1	2	3	4	5	6	7	8	9	10
Administrative:									
1	Site engineer’s office		4		9×2,7×2,6	22	420-01-3	П	
2	The master's office		4		6,0×2,7×2,6	14,45	40-04-38	К	
3	Telephone and radio node		7		9,0×2,7×2,6	22	420-01-12	П	
4	Red corner	65	0,75	48,75	6,0×2,7×2,6	14,45	420-04-44	К	4
Storage facilities:									
5	The warehouse is unheated				12×9,0×3,92	70,4	420-09-16	С	
6	Storeroom				6,0×6,9×2,68	37,4	420-04-31	К	
7	Fence roof				18,0×12,0×4,8	-	420-06-34	С	
Sanitary and household:									
8	Dressing room: - female - male	25 37	0,6 0,5	15 18,5	6,0×2,7×2,6	14,45	420-04-21	К	4
9	Rooms for heating workers	52	0,1	5,2	6,0×2,7×2,6	14,45	420-04-9	К	1
10	Shower room	52	0,82	42,6	9,0×2,7×2,6	22	420-01-6	П	2
11	A room for drying clothes	52	0,2	10,4	9,0×2,7×2,6	22	420-01-13	П	2
12	Toilet: - female - male	25 37	0,14 0,07	3,5 2,59	6,0×2,7×2,6	14,45	420-04-23	К	2
13	Medical center	62			7,9×2,7×2,6	19,8	ВМ	К	1
14	Buffet	62	0,67	42,78	9,0×2,7×2,6	22	420-01-6	П	2

3.3.2 Organization of storage facilities at the construction site

The size of storages on the construction site is assumed, taking into account the following factors:

- a one-time maximum material resources stock intended for keeping in warehouses;

- material resources type and their quantity according to the storage standards per one square meter of the storage area;

- type of storage room;

- the type of vehicles and the number of transport units which arrive at the storage for unloading at the same time;

- a mechanization method of loading and unloading operations.

The need for storage space is presented in Table 3.4.

Table 3.4 - The need for storage space

Name of materials, structures, elements	Units of measurement	Number of materials	Q сут.	Reserve rate n, days	Accepted stock, Q скл.	The norm of storage q	Useful area, S пол.	Area use factor, k	Designed storage area	Accepted area
1	2	3	4	5	6	7	8	9	10	11
Aerated concrete	m^3	2144,9	34,08	10	340,8	2	170,4	0,7	243,4	244
Foundation beams	m^3	32,76	0,87	10	8,7	0,3	29	0,7	41,43	42
Stairwells	m^2	38,4	0,95	10	9,5	0,6	15,83	0,7	22,61	23
Staircases	m^2	19,6	0,48	10	4,8	0,6	8	0,7	11,43	12
Foam concrete	m^3	54,612	19,52	10	195,2	2	97,6	0,7	139,4	140
Window blocks	m^2	140	20,02	10	200,2	45	4,45	0,5	8,9	9
Door blocks	m^2	216	30,89	10	308,9	44	7,02	0,5	14,04	14
Roofing material	m^2	7286,4	347,3	10	3473,2	200	17,37	0,7	24,81	25
Ceramic tile	m^2	7676,4	365,9	10	3659,1	79	46,32	0,5	92,64	93
Crossbars	m^2	95,4	10,49	10	104,94	0,7	149,9	0,7	214,1	214
Linoleum	m^2	3070,6	439,1	10	4390,9	90	48,79	0,5	97,58	98

3.4 Temporary water supply of the construction site

The total maximum water consumption per 1 hour for production and household needs is calculated by summing up the water costs for an individual consumer:

$$Q_{общ} = Q_{вр} + Q_{хоз} + Q_{душ},\ m^3/\ hour.$$

Water consumption for production needs:

$$Q_{пр} = \Sigma V_{сут} \cdot q_1 \cdot k_1 / 1000 \cdot t,\ m^3/hour,$$

where $Q_{пр}$ - maximum consumption for construction processes per 1 hour;

$V_{сут}$ - volume of a certain type of CEW per 24 hours or working transport units number per shift;

q_1 – the norm of the desired water flow rate for the corresponding measurer;

k_1 – the coefficient of hourly unevenness of water consumption depending on the consumer type;

t – the number of working shift hours of the.

Water consumption for household needs:

$$Q_{хоз} = N \cdot q_2 \cdot k_2 / 1000 \cdot t\ ,\ м^3/час = 62 \cdot 25 \cdot 2/1000 \cdot 8 = 0{,}387\ m^3/hour,$$

where $Q_{хоз}$ - maximum consumption for household needs per 1 hour;

N – the number of workers in the most numerous shift;

q_2 - the rate of the required water consumption per one worker per shift;

k_2 - the coefficient of water consumption irregularity per 1 hour for this type of needs.

Water consumption for shower facilities:

$$Q_{душ} = N \cdot q_3 \cdot k_3 / 1000 \cdot t_1,\ м^3/час = 0{,}3 \cdot 62 \cdot 40 \cdot 1.0/1000 \cdot 0.75 = 0{,}992\ m^3/hour,$$

where $Q_{душ}$ - maximum consumption for shower facilities per 1 hour;

N - the number of employees taking a shower (30% of N_{max});

q_3 - the rate of water consumption per worker taking a shower;

k_3 - the coefficient of water consumption irregularity per 1 hour;

t_1 – the duration of shower facilities work (t = 0.75 hours).

Water consumption for external fire extinguishing:

$$Q_{пож} = 10 \cdot 3600/1000 = 36\ m^3/hour$$

$$Q_{общ1} = Q_{вр} + Q_{хоз} + Q_{душ} = 432{,}18+0{,}387+0{,}992 = 433{,}56\ m^3/\ hour$$

$$Q_{общ} = Q_{пож} + 0{,}5 \cdot Q_{общ1} = 36+0{,}5\cdot 433{,}56 = 252{,}78\ m^3/\ hour$$

Pipe's diameter:

$$D = \sqrt{\frac{4 \cdot Q_{расч}}{П \cdot V \cdot 3600}} = \sqrt{\frac{4 \cdot 252{,}87}{3.14 \cdot 1.5 \cdot 3600}} = 0.244 м$$

we accept D = 250 mm [13].

The water calculation for production needs is given in Table 3.5.

Table 3.5-Calculation of water for production needs

Stage	№	Types of processes (works) which require water	Units of measurement	$V_{сут}$	q_1	k_1	$Q_{пр}$, m^3/ hour
1	2	3	4	5	6	7	8
1	1 2 3	Excavator operation Refueling the excavator Moistening the soil during compaction	vehicle hours vehicle m^3	170,12 4 431,62	10 100 150	1,5 1,5 1,25	0,319 0.075 12,14
2	4 5	Watering concrete and form-work Roofing works	m^3 m^2	1171,9 158400	400 11	1,5 1,5	87,89 326,7
3	6	Plastering works	m^2	33,92	8	1,5	0,051
4	7	Painting works	m^2	26706	1	1,5	5,01

3.5 Temporary provision of the construction site with electricity

For the organization of temporary power supply of the construction site it is necessary to:

- determine the electricity consumers on the site;
- set the required transformer power;
- select the energy production source;
- design the power grid.

Calculation of the required electric transformer power:

$$P = 1.1\left(\sum \frac{P_{пр} \cdot k_1}{\cos\varphi} + \sum \frac{Pm \cdot k_2}{\cos\varphi} + \sum P_{в.о.} \cdot k_3 + \sum P_{н.о.} \cdot k_4\right),$$

where P – required transformer power, *kWt*;

1,1 - a coefficient which takes into account the network voltage losses;

$P_{пр}$ - the necessary power for production needs (the power capacity of construction vehicles and facilities), *kWt*;

$P_{в.о.}$ - required power for indoor premises lighting, *kWt*;

P_{m} - the necessary capacity for technological needs, *kWt*;

$P_{н.о.}$ - required power for outdoor lighting, *kWt*.

k_1 - k_4 – demand coefficients which depend on the number of consumers.

The calculation of the electricity demand is given in Table 3.6.

Table 3.6- Electricity demand calculation

№	Consumers	Units of measurement	Quantity	The norm per unit of power, kWt	Demand coefficient	Power coeffi-cient
1	2	3	4	5	6	7
	Production and technological consumers:					
1	Welding machine STE-24	pieces		59,2	0,3	0,5
2	Machine for feeding bitumen mastics to the roof SO-100A	pieces		54	0,35	0,4
3	Mobile compressor SO-57A	pieces		60	0,1	0,4
4	Paint unit SO-74A	pieces		5,25	0,1	0,4
				0,27	0,1	0,4
5	Electric lighting:					
	Internal:					
	- administrative premises	100 m^2		0,15	0,8	1
	- household premises			0,12	0,8	1
	- storages			0,7	0,35	1
6	Outdoor:					
	- working lighting	100 m^2		0,25	1	1
	- internal roads	1 km		3	1	1

We accept a transformer substation КТП СКБ.

3.6 Technological instructions card of monolithic building frame production

The technological instructions card is applicable for the designed diploma project, as well as for similar structures buildings.

3.6.1 Determination of the required installation cranes' parameters

Crane's installation parameters include [14]:

- installation weight $Q_м$;
- hook lifting height $H^{тр}_{кр}$;
- hook overhang $l_к$.

The installation mass is defined as the sum of the installing element and the installation equipment tools:

$$Q_м = Q + \Sigma q/$$

Required lifting height of the hook:

$$H^{тр}_{кр} = h_o + h_з + h_n + h_e = 26{,}105 + 1 + 3{,}1 + 3 = 33{,}205\ m,$$

where $h_з = 1\ m$ – the accepted height of the element to be installed;

h_e – height of the gripping device;

h_o – height from the level of the installation crane to the support;

$h_n = 3{,}1\ m$ – height of the polyspast;

$h_e = 3\ m$ – the maximum element's height.

Since the building has a wide underground part, the tower crane is located outside the underground part at 1.2 m distance from the underground structures. Based on these conditions the required radius of crane operation is equal to:

$$l_к = 1{,}2 + 0{,}8 + 23{,}4 + 10{,}3 + 3{,}75 = 39{,}45\ m.$$

We accept a truck crane KATO KA-900 (maximum load capacity of 90 tons) for the production of works.

3.6.2 Organization and technology of process execution

The aboveground part of the building is divided into 2 work zones during its construction.

For monolithic structures the crane was selected taking into account the height of the building. The crane was selected according to the technical characteristics (load capacity, radius of crane operation and crane tower height).

The concrete mixture is delivered using concrete mixers and transported to the place of laying by a concrete pump SB-126 with a maximum height of concreting of 65m. Installation of reinforcement and formwork is carried out by a truck crane KATO KA-900

Before the aboveground structures concrete works the following works must be performed:

1) organization of the construction site in accordance with the main construction plan at the stage of the building’s aboveground part construction;

2) preparation of acceptance certificates for hidden works;

3) technical inspection of the lifting mechanism and inspection of lifting devices;

4) preparation and inspection of the necessary equipment and devices;

5) temporary lighting of workplaces;

6) ensuring uninterrupted concrete delivery to the construction site.

The concrete mixture is produced at the central concrete plant and delivered to the construction site in accordance with the weekly-daily schedule.

Concrete transportation is carried out by concrete mixers, concrete carts or modernized dump trucks.

Reception and delivery of concrete to the place of laying is carried out by a concrete pump SB-123 with maximum height of concreting of 65m. Concreting is performed by a complex concreters’ team consisting of 29 people in 2 shifts.

Works begin with the metal formwork installation for columns, after the binding and installation of reinforcement frames into columns begins. In parallel, it is begun to install scaffolding systems from inventory pillars under the shield formwork of the beamsfree floor. After their installation, the floor's shield formwork is installed, and the reinforcement grids are laid in the floor. Installation of reinforcement and formwork is carried out by a truck crane КАТО КА-900.

Concreting of the building's load-bearing structures (columns) begins after checking the reinforcement arrangement compliance with the project. Floor concreting begins after a technological break of 1.5-2 hours, associated with the shrinkage of the laid concrete in the bearing structures. The process of working zone concreting is done in two shifts with an average concrete laying of 88 m^3 per shift.

In the concreting process additives are used in concrete to accelerate the hardening of the concrete mixture (calcium chloride) and to increase plasticity (C-3 superplasticizer type). The laid concrete mixture is compacted using surface vibrators and deep vibrators.

After concreting and compacting all the structures of the storey, a technical break is provided in order concrete will be able to gain 70% of the design strength. According to the" Design of reinforced concrete works " by Kuznetsov Yu. P. [15], we assign the technological break duration equal to 4 days for concrete B25 and the average outdoor temperature of 25 ° C.

During the technological break, the concrete must be cared of using sprinkling its surface with matting and periodic watering with water from a water engine twice a day at least.

After the concrete has set the required strength, the floor formwork and columns are de-installed. The accordance of the structures to the project is checked.

According to the regulations during the reinforced concrete works, it is necessary to control the certain operations:

1. Formwork arriving at the construction site must be inspected and instrumentally tested. In the future, periodic formwork control is carried out after 20 times at least during its operation. The assembled and prepared formwork must be accepted according to the act;

2. De-installation of the formworkmust be done only following the master’s permission;

3. Reinforcement grids are putting down over the place of their laying not lower than 80 cm, and only after reinforcement workers direct them to the design position;

4. The columns’ reinforcement cages are putting down over the place of their installation not lower than 30 cm, and after reinforcement workers direct them to the design position.

5. Concrete’s quality control is realized as the accordance between its physical and mechanical parameters and project requirements. It is carried out at the stage of its production and concrete finished state stage. Its mobility is checked at production and laying stages.

3.7 Labor protection

When developing instructions on labor protection, the following requirements are used: NPAOP 0.00–4.12.05. Standard procedure regulation for conducting training and testing labor protection issues knowledge [16].

3.7.1 Electrical safety in construction

Various equipment used in renovation and construction work requires strict following safety rules. Violation of these requirements leads to electric shock, fires from short circuits.

There are three types of possible electric shock to a person:

- single-pole - when a person's hand, head or any body’s part accidentally touches any electicity carrying part. Single-pole collision injuries is 85 % of the total number of electric injuries;

- two-pole, - when a person accidentally touches two wires;

- the step voltage appears when a person approaches to a damaged wire which has fallen on the ground and it is under voltage or when a person approaches the place of an electric cable put in the ground with a broken insulation.

Under electric influence it is not always possible to leave it. Quite often, this leads to a fatal outcome. Incorrect actions and methods of providing first before medical help can only worsen the condition of the victim. Methods of interrupting a closed electrical circuit include:

- the passive action method, or falling;
- the active action method, or hanging on the wire.

Help to the victim is following:

1. Turning off the blade switch, removing the plug from the socket.
2. If victim’s clothes are wet, then dry non-conductive objects (a rubber hose, a rope, a scarf) should be thrown over him.
3. Without touching the body and hair of the victim, it is necessary to drag him to the side.
4. A person can be pushed away from the wire with a palm wrapped in a dry cloth or other insulating material. This method is also applicable if the victim is wearing wet clothes.
5. In the absence of a switch or any switching devices and when it is not possible to use other methods, you should quickly cut the wires with a tool with a dry insulated handle. During cutting, you should turn away, because due to a short circuit the molten metal splashes from wires and cutting tools can be got into the face, and a flash can cause a temporary blindness.
6. The wire is moved out of the hands of the victim using a dry rail, a board or other non conducting objects.
7. In order to save the victim the following case can be used: another bare, previously grounded wire can be thrown over the bare wires. The electricity flow will thus be turned into the ground and the voltage will drop to a safe value, when the victim will be able to unclench his fingers and leave the wire.

8. If a person is struck by an electric shock, accompanied by loss of consciousness, you should to help the victim immediately beginning to perform artificial respiration.

Artificial respiration is performed without stopping until the victim regains consciousness. If possible, the victim should be given oxygen and done an indirect heart massage. After he regains consciousness, you should immediately call a doctor.

In order to avoid injuries during renovation and construction work, it is necessary to ground the metal parts of electric tools and equipment.

It is not allowed to solder the grounding circuit with the grounded parts of the facilities, in these cases electric welding should be used. Artificial electrical earthing facilities are made in the form of metal pipes driven into the ground and connected together by a strip, or in the form of metal tapes laid underground at a depth of 80 cm.

The insulation of electrical wires and electrical equipment must be in good condition, because this ensures the safety of people.

Portable electric lighting in the open air is carried out with a voltage of up to 15 V, at laying basement walls indoors - up to 40 V. The light bulb should be enclosed in a protective grid with a light reflector and in an insulated cartridge in a specially insulated holder with a handle and a hook.

The ends of a low-voltage lamp’s wires must have a plug.

To ensure the safety of people it is important to provide the correct installation of electrical facilities.

3.7.2 Industrial sanitation in construction

The labor protection basic requirements including industrial sanitation, should be taken into account in the work production project. The project contains specific questions on sanitary and hygienic, and living conditions service of workers

Sanitary and living conditions provision is carried out by equipping the complex of living conditions premises and devices on the construction sites: dressing rooms, restrooms, washrooms, showers; rooms for drying, repairing and dedusting workwear; for women's personal hygiene; rooms for heating, relax time, eating, local heating installations; solar radiation and precipitation shelters; places for smoking.

The list of sanitary and living conditions facilities and the requirements for them are regulated by [17].

If there is a working shift of less than 15 people on the construction site, it is allowed to have an incomplete complex of sanitary and living conditions devices. They must include a field trailer, a washbasin, a toilet, a summer-type shower and special tanks for drinking water. In the warm season washbasins are arranged in the open air with the tent installation. The number of taps in the washbasins is determined as one tap for fifteen people, and for shower — one shower for five people. The water consumption rates for one procedure are as follows: for a shower it is 50 liters, for a washbasin it is for 4 liters, and for ascending shower it is 20 liters. Fountains connected to tanks are arranged in order to provide workers with drinking water.

Drinking water tanks are made with easily cleaned and disinfected materials with tightly closed lids. The tanks are locked and installed at a height of 1 m from the floor at least.

The quality of drinking water should be checked by the district sanitary and epidemiological station of the Ministry of Health. If the drinking water cannot be used in its raw form, it is necessary to provide workers with boiled water with a temperature not higher than 20° and not lower than 8° [18].

3.7.3 Fire safety in construction

In order to prevent fires it is important to ensure fire safety at the construction works stage [4].

Structural elements of buildings must be fire resistant, meet the relevant standards and have certificates.

Construction and finishing materials are tested for the parameters of flammability, fire resistancy, flame propagation, smoke formation and toxicity.

Combustible materials must be certified with the certificates demonstration at handing over a construction object. Obligatory equipment is used to ensure fire safety in buildings. A set consisting of a fire crane and a fire extinguisher is placed in mounted or built-in fire boxes. The fire box should be in any residential, public or industrial building.

The structure of the building should allow the evacuation of people and provide access for firefighters. Fire hoses are designed to supply fire extinguishing agents under pressure. The building for fire protection must be equipped with enough quantity of internal fire water taps, every tap is equipped with a sleeve. The electrical equipment of the buildings must comply with the rules of fire safety and have fire protection and an emergency shutdown system, while the fire detection system wires must be working for a sufficient time for the people's evacuation.

Buildings and structures are equipped with automatic fire extinguishing systems, which must be controlled and have a constant volume of fire extinguishing substances. For extinguishing local fires fire extinguishers are used, which are mandatory firefighting equipment. They differ according to the type of extinguishing agent, the method acting and volume.

The building's fire alarm system must have external detectors in the form of light and sound sufficient signals.

Buildings' ventilation must have an appropriate supply and exhaust system (natural or mechanical) to remove smoke. The building planning should not allow the fire to spread beyond the fire source.

3.7.4 Safety in emergency situations

One of the main methods of protection is timely and rapid removal of people from the danger zone, i.e. evacuation. The type of evacuation is determined by the type, nature and conditions of emergency. Planned and emergency evacuations differ in time. Emergency evacuation is caused by rapid processes of negative factors accumulation in the emergency zone or high levels of these factors initially.

Among the measures to protect the enterprise staff, which are developed by the object commission, working shift evacuation actions are indicated, both in case of a danger and in case of an emergency. The following measures and time parameters for evacuation are planned based on the predicted accidents possibility, catastrophes or natural disasters that may cause human victims, cause people health damage, destroy their living conditions:

- the evacuation type is determined (planned or emergency);
- the calculation of staff number necessary for the evacuation is carried out;
- production accident-free lockdown measures are being established;
- plans of evacuees' movement from the emergency zone to temporary accommodation points are assignes etc.

The evacuation organization is different for the enterprise staff and for the population in the city, village. Taking into account the analysis and assessment of the situation, the head of the emergency commission can make one of the decisions:

- orginize an evacuation inside the object;
- take the staff out of the object.

Conclusion by section 3

In the organizational and technological chapter organizational measures are considered and the procedure for carrying out construction and installation works is described.

The volume of construction and installation works, the required labor capacity of workers and vehicles, the work duration are defined and crane choice is justified also.

The calculation of storages premises and temporary buildings was carried out for the correct storage services organization. The calculation of the water and electricity supply of the construction site was also performed.

A technological instructions card was done for a building's monolithic frame production. Analyzing the construction processes for the current building and guided by the requirements [16], appropriate measures of labor protection and fire safety were determined.

4 EQUIPMENT AND ECONOMIC SECTION

4.1 General information

A cost estimate is a document which represents the calculation of the construction object cost. It may include the cost of only works, works and materials, or works, materials and necessary inventory.

The cost estimate can have two types:

- commercial cost estimates, which are made at negotiated prices;
- cost estimate made according to one of the regulatory bases.

Types of cost estimate documentation:

- local cost estimate or cost estimated calculation;
- object cost estimate;
- summary construction cost estimate (repair);
- costs summary (if necessary).

A local cost estimate is a document which forms a detailed calculation of the work volume, as well as the amount of costs that were spent on the construction (reconstruction). Local cost estimates are made for a specific construction object. Depending on the estimate type purpose its parts may also be changed. As a rule, the following types of parts are used:

- for construction works (roof, foundations and basement of the building, fences, -walls, frame, etc.);
- for special construction works (insulation, brickwork, protective coverings, etc.);
- on sanitary and technical works inside the premises (heating, sewerage, ventilation, air conditioning, etc.);
- on the installation of the necessary equipment.

The cost displayed in this type of document includes 3 types of costs: direct (which go to pay for employees, purchase of products, materials, maintenance of operating machines), overhead costs and estimated profit (are given based on the results of calculated direct costs).

Object cost estimate is the estimate which is made for the object as a whole. Estimates based on project documentation, and the estimated calculation is in its absence.

Object cost estimates determine data from local estimates as a whole for a building or structure. In the object cost estimate each line is the result of a local estimate. The costs from the local estimates are distributed in the object one for the following types of work:

- construction works;
- installation work;j
- equipment, furniture, inventory;
- other expenses.

Summary estimate calculation is a document that determines the estimated cost of construction. It combines all the costs of construction as a whole. It is compiled based on object estimates, calculated for its result and the contract price of construction is formed on the basis of it. It consists of 12 chapters.

Costs summary is compiled if the construction of buildings and structures for various purposes. Namely industrial and residential-civil one is carried out on the object. The cost summary is compiled on the basis of summary estimates. Their costs are distributed according to the type of work in the same place, separately for industrial and civil-housing.

The estimated documentation is compiled in accordance with DSTU [19] with the application of:

- resource element estimated standards for construction work;
- resource estimated standards for the operation of construction vehicles.

4.2 Measures for reducing the construction duration.

Reducing the construction duration allows to reduce costs, which practically do not depend on the volume of work performed on the object. The shorter the duration of construction, more conditional fixed costs will be saved.

Saving of conditional fixed costs allows the construction organization to get additional profit if the construction duration reduction is achieved not due to the development and application of a more economical design solution of the building, but due to the organization and construction technology improvement.

4.3 Calculation of the economic effect

The economic effect of reducing the construction time is determined by the following formula:

$$E_{ф} = Ф \times Є_{н} \times (T_{н} - T_{п}),$$

where $Ф$ – total contract price;

$Є_{н}$ – expected efficiency of construction for a given object (0,15);

$T_{н}$ = 390 days (1,068 years) – the standard duration of construction;

$T_{п}$ = 102 days – the project duration of construction.

$$T_{н} - T_{п} = 390 – 102 = 288 \text{ days (0.78 years).}$$

To reduce the construction duration the working hours for concrete masonry work of the external walls were changed. Namely, a second shift was introduced, which significantly affects the object commissioning time and the contract price.

$$E_{ф} = 135903{,}59408 \times 0{,}15 \times (1{,}08-0{,}3) = 16512{,}2866 \text{ thousands of UAH.}$$

The estimated documentation is given in Annex A.

4.4 Technical and economic indicators of the project

№	Indicator name	Calculation formula	Value
1	The total area of the building, m^2	$S_{building}$	16578,76
2	Building volume, m^3	$V_{building}$	54421,66
3	Useful area of the building, m^2	S_{useful}	14760,49
3	Total labor costs for construction and installation works, man-days.	Q_{ciw}	32553,99
4	Labor costs per unit of volume, man-days /m^3	$Q_{ciw}/V_{building}$	0,6
5	Labor costs per unit of area, man-days /m^2	$Q_{ciw}/S_{building}$	1,96
6	Contract price, thousands of UAH	$C_{contract\ price}$	135903,594
7	Total estimated cost, thousands of UAH	C_{ciw}	91605,2231
8	Total estimated cost for 1 m^3, thousands of UAH /m^3	$C_{ciw}/V_{building}$	2497
9	Total estimated cost for 1 m^2, thousands of UAH /m^2	C_{ciw}/S_{useful}	9207
10	Average output per worker, UAH / man-days	C_{ciw}/Q	2587
11	Duration of construction, days /months	T	102/3,34

Conclusion by section 4

In the economic chapter the types of design and estimate documentation are considered, construction reducing measures are given, the economic effect is calculated, which amounted to 16512,2 thousand UAH because of reducing the construction time.

Also in this chapter estimated calculations for construction and installation works are compiled and technical and economic indicators of the construction are determined.

GENERAL CONCLUSIONS

In the first chapter according to the climatic characteristics of the construction area, plans, facades, sections, architectural joints were developed; the thermal engineering calculation of the enclosing structure was carried out; functional process features were also considered; external and internal architectural solutions were given; main engineering equipment was described; the general construction plan was also considered.

In the second chapter the calculation of the load-bearing structures of the building frame was carried out using the "Autodesk Robot Structural Analysis" software package, collecting loads and selecting the main structural elements were performed.

After analyzing the geological conditions of the construction site the choice of the foundation was justified and its dimensions were determined. The necessary checks have been carried out in accordance with the requirements of the relevant regulations.

In the third chapter (organizational and technological chapter) organizational measures are considered, and the procedure for carrying out construction and installation works is described, their scope is determined. The necessary labor intensity of workers and machines and the duration of work are also determined; installation crane variant is justified. For the correct storage economy organization, the distribution of storages premises and temporary buildings was carried out. The calculation of the construction site's water and electricity supply was also performed. A technological instructions' card for building monolithic frame erecting has been compiled. Appropriate measures for labor protection and fire safety are provided.

In the fourth (economic) chapter the cost estimate types documentation are considered, the economic effect is calculated, which amounted to 16512,2 thousand UAH by reducing the construction time. Also, in this chapter estimated calculations for construction and installation works are made and technical and economic construction indicators are determined.

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ANNEX A