Ministry of Education and Science of Ukraine
Ternopil Ivan Puluj National Technical University
(full name of higher education institution)
Faculty of Engineering of Machines, Structures and Technologies
(faculty name)
Department of Building Mechanics
(full name of department)

EXPLANATORY NOTE

for diploma project (thesis)

master of science
(educational-proficiency level)

topic: **Project of a 16-storey apartment building in Uzhgorod with a study of its behavior in seismic impacts**

Submitted by: sixth year student group IMB-62
Specialism (field of study) 192 Construction and Civil Engineering
(code and name of specialism (field of study))

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Ternopil
2019

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Educational degree master of science

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Specialism ______________________
(code and title)

APPROVED BY
Head of Department Kovalchuk Y.O.
____
____

Assignment

FOR DIPLOMA PROJECT (THESIS) FOR STUDENT

Mbaya Kazadi Christian
(surname, name, patronymic)

1. Project (thesis) theme. Project of a 16-storey apartment building in Uzhgorod with a study of its behavior in seismic impacts

Project (thesis) supervisor PhD., Assoc. Prof. Sorochak Andrii
(surname, name, patronymic, scientific degree, academic rank)

1.Approved by university order as of ____________ 201_ №____

2. Student's project (thesis) submission deadline 20.12.2019

3. Project (thesis) design basis Location of construction – Uzhgorod, normative depth of soil freezing – 0.6 m; maximum outside air temperature +39 °C; minimum outside air temperature -25 °C; normative wind pressure – 0,3 kPa; snow cover per 1 m2 of horizontal surface – 0,7 kPa

4. Contents of engineering analysis (list of issues to be developed)
Architectural and structural part, Design and calculation part, Technological and organizational part, Economical part, Labor protection, Ecology

5. List of graphic material (with exact number of required drawings, slides)
Master plan, Plan of the ground floor, Plan of typical floor, Parking plan, Facades, Section 1-1, Ceiling plan, Slab reinforcement, Column reinforcement, Plan of foundations, Construction master plan, Planned construction schedule, Technological map for stairs installation, Technological map for arrangement of flat roll roof

6. Advisors of design (thesis) chapters

Chapter	Advisor's surname, initials and position	Signature, date	
		assignment given	assignment accepted
Special part	Assoc. Prof. Sorochak A.		
Labor protection	Assoc. Prof. Kaspruk V.		
Economical part	Assoc. Prof. Melnyk L.		
Ecology	Assoc. Prof. Lyasota O.		

7. Date the assignment was given 10.09.2019

PROJECT TIME SCHEDULE

LN	Diploma project (thesis) stages	Project (thesis) stages deadlines	Notes
1	Architectural and structural part	1.10.19	
2	Design and calculation part	15.10.19	
3	Technological and organizational part	1.11.19	
4	Economical part	15.11.19	
5	Scientific research part	22.11.19	
6	Labor protection	29.11.19	
7	Ecology	10.12.19	

Student __________ (signature) Mbaya Kazadi Christian (surname and initials)

Project (thesis) supervisor __________ (signature) Sorochak Andrii (surname and initials)

Table of content

Introduction

With the development of our state, there is an outflow of population from the village to the city, as a result there is a shortage of housing..

As the state policy of Ukraine in terms of fuel and energy resources health is focused on energy saving, particular attention was paid to this problem during design. In addition, the systems of engineering equipment for buildings must meet the requirements of saving energy so that their operation can be limited by the minimum consumption of fuel and heat.

Given the economic situation of Ukraine and the lack of a family budget, it is necessary to take into account: minimize the cost of engineering equipment, reduce the cost of fencing and determine the optimum amount of living space of the house. a number of proposals have been introduced to solve the problem of energy conservation and several new engineering technologies and communications have been used.

1. Architectural and structural part

1.1. General characteristics of the site.

1.1.1 Geographical location of the site climatic conditions.

The territory for the construction of a multi-storey residential building with parking for cars in the basement is set in Uzhgorod on Lebedeva-Kumach Street.

Development area – Uzhhorod – which is located in the west of Ukraine. In the west, the region borders Poland, in the northeast with the Lviv region, in the east – with Ivano-Frankivsk, in the south the region borders with Hungary.

The geographical coordinates of the city of Uzhgorod are 48° 37 N and 26° 32 E. According to the geographical coordinates, it can be concluded that the area is located in the middle zone of the temperate zone, where the mixed forest zone passes into the forest-steppe zone.

There is no direct access to the sea. As Uzhgorod, many transport highways pass through it, which is favorable for connecting with other regions and foreign countries..

This territory has the following climatic characteristics:

- estimated winter outside air temperature (coldest 5-day): -22 °C;
- normative depth of soil freezing is 0.8-1.0 m;
- the amount of precipitation for the year – 685 mm;
- average humidity of the coldest month – 82%;
- average humidity of the warmest month – 52%;
- maximum outside air temperature + 39°C;
-minimum outside air temperature -32°C;
- normative wind speed is 0.3 kPa;
- snow cover per 1 m2 of horizontal surface - 0.7 kPa;
- prevailing winds – northwest (Fig. 1. 1.)

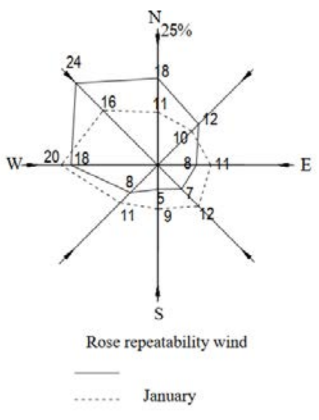

Figure 1.1 Wind rose

1.1.2 Transport links.

Transport of the Uzhgorod provides the national and economic complex of the region in freight and passenger transportation, influences the economic specialization of certain districts, increases its importance in international relations. The aggregate of all types of transport is the transport complex of Uzhgorod region.

Railway transport

Uzhgorod is connected with main railway not only with the regions and cities of Ukraine but also with foreign cities.

In order to improve the operation of the railway transport of the region, a system of automatic traffic control, autoblocking is introduced, new locomotives and cars are used. It is planned to expand container transportation.

Road transport.

Main motorway Uzhgorod-Lviv-Uzhgorod-Chop, Uzhgorod-Odessa, Uzhgorod-Chernihiv and other roads of minor importance connecting Uzhgorod with the cities of Ukraine and abroad.

Motor transport has a negative impact on the environmental situation in the city of Uzhgorod, for example, smog. A number of measures aimed at controlling and reducing emissions of flue gas into the atmosphere have been developed. Motor vehicles with diesel engines are checked for smoke.

Pipeline transportation

This type of transport is well developed in the territory of Uzhgorod region. Two gas transmission lines pass through the region.

1.1.3 Engineering-geological and hydrogeological conditions of the site.

The Uzhgorod region is located on the West-Southern slope of the Ukrainian Shield. The city of Uzhgorod is located on the Uzhgorod plateau.

According to engineering-geological surveys, the geological structure of the site consists of the following engineering-geological elements:

1. Bulk soil layer, loam with construction rubbish up to 40%, which is adhered, on separate sites with household rubbish, up to 50%, which is not adhered;
2. Loose loess, solid, highly porous sessile P≥0,58-1,85 kgf / cm^2;
3. Loam loess, low-porous, solid subsiding at P> 1,70 kgf / cm^2;

4. The loam is low porous, from tight to soft, with layers of fine sand.
Hydrological surveys have shown that groundwater is not seen at depths up to 29,00 m. The site is potentially unsinkable. Type IV.

1.2. Master plan

1.2.1. Rationale for the decision.

Local conditions had an important influence on the development of the master plan: placement of engineering communications (electricity, water supply, sewerage), a complex number of sites and a number of other factors.

This solution satisfies the functional, sanitary and hygienic requirements (see Section 2.2.3), environmental, architectural and aesthetic requirements, etc.

The layout of the plan is perpendicular to the axis of the highway, ie in such a way that the main facade is placed parallel to the axis of the highway and the red building line.

This location of the building has a logical meaning because:

- West-Southern winds, the front of which is prevailing in the Uzhgorod region, only one area of the building is open;
- the best conditions of use of natural lighting;
- the most rational use of natural relief.

A paved road is laid to the house, with sidewalks made of paving stones.

All landscaping areas are planted with a wide range of trees and shrubs. A wide selection of green spaces, rationally placed on the topography, will allow you to create a sophisticated landscape and a unique panorama of the environment when walking.

Benches for rest are arranged, where flower beds of various configurations are arranged. The retaining walls are lined with the so-called "torn stone".

1.2.2. Vertical planning (relief organization).

The plan for the organization of the terrain is shown in the letter. Works on the organization of the relief of the site are performed with the purpose of arrangement of footpaths and highways for good accessibility of people and cars. These works also include the planning of a drainage area. Remains of water are directed by artificial drainage ditches and drainage drains to the city drainage network.

All roads are arranged with a suitable slope in both perpendicular directions, which provides organized drainage of atmospheric precipitation.

1.2.3. Measures to comply with sanitary and fire protection standards of environmental protection.

In order to comply with the sanitary requirements, a so-called sanitary landscaping zone - noise protection zone and air purification from dust and smog have been set up right off the highway.

Sanitary standards in the building (thermal humidity, air aeration, etc.) are adhered to due to the latest technologies and modern engineering communications.

For the purpose of convenient fire extinguishing, a mobile road is arranged almost around the building allowing access to the building around its perimeter.

Non-smoking stairs are arranged in the building. Building designs and materials used are non-combustible and fire-resistant (concrete, reinforced concrete, drywall, brick). There is a fire alarm throughout the building.

At the end of construction, as the top layer of soil was construction debris, manure is dredged for landscaping.

The building as a whole has no harmful emissions.

1.2.4. Technical and economic indicators of the master plan.

1. The total area of the plot…..…………………………………88198, 5
2. Building area …………………………………………………9088
3. Area of landscaping ………………………………………… 39502, 9

1.3. The three-dimensional planning solution.

1.3.1. Characteristics of the functional process.

In this project, a residential house was developed to build a plot on the street. Lebedev-Kumacha. The project provides for a one-section 16-storey residential building. On the ground floor there are premises for staff, on the third, fourth and other floors are located 2x 2-room apartments, 1x 3-room apartment, 1x 4-room apartment. The comfort of staying in the home is ensured by its space-planning solution and modern equipment. There is also a car parking lot in the house. The entrance is from the street. Existing windows in the parking lot are equipped with bars. The tambour in the house ensures that no cold air enters the room when the exterior doors are opened. Each apartment has a balcony. There are two bathrooms in the apartments.

1.3.2. Description of the decision made and its justification.

The project has developed a residential building with parking in the basement. The house on three sides has rounded ledges, radius of rounding of walls R = 1800 mm. This gives the apartment building considerable architectural expressiveness. The contours of the balconies, which are equipped apartments are also rounded, which harmonizes with the contours of the house.

All rooms in apartments are isolated. The kitchen area ranges from 13,00-20,55 m^2.

By making this decision when using the building volume effectively, we maximize the impact of maximizing room space and meeting the needs of residents.

1.3.3. Technical and economic indicators of the three-dimensional planning solution.

The data is given for multi-storey residential buildings in axles 1/0-14:

1. Parking space in the basement..……………………………….……1003,89
2. Auxiliary space for parking staff………………………….........210,01
3. Ground floor space for housekeeping staff...................................344,16
4. Area of technical floors…...526,26
5. The living area of apartments is a typical floor..............................274,73
6. The total living area of the apartments...4120,95
7. Construction volume..94358

1.4. Design solutions.

1.4.1. Bearing structures. Rationale for their choice.

The design is adopted mixed with the transverse and longitudinal load-bearing walls, which will be supported by slabs.

- Foundations:

The decision was made to set up the foundations of Ø520 Boring Pumps of heavy fine-grained Group A25 grade A concrete. This is due to the fact that there are buildings nearby and no such loads will be affected by the arrangement of such piles.

– **Ceiling:**

Ceiling of the house is carried out by means of reinforced concrete hollow plates, namely PC 63.12; PC 54.12; PC 57. 12; PC 48.12; PC 48.15; PC 30.5.6, as well as monolithic sections.

In places where holes have been drilled without breaking the holes, they should be reinforced.

Slabs are joined to the walls by reinforcing steel so-called anchors that are embedded in the walls.

– **Coating:**

The coating is made of reinforced concrete, hollow slabs, which rest on the crossbar. In places where openings use monolithic areas.

– **Vertical load-bearing structures:**

The choice of vertical load-bearing structures is conditioned by the load-bearing capacity and rigidity of the building, the ability to freely plan the premises, as well as improve the aesthetic appearance of the interior. As a vertical bearing structure is used ordinary brick. The thickness of the wall is 510 mm, the attachment to the axis is 200 mm, the internal is 380 mm. In the basement there are monolithic columns with a cross section of 400×400 mm.

To ensure the rigidity of the building monolithic belts – 4 pcs.

The height of the monolithic belt is taken 0,3m. Monolithic belts are located on the markings

1 Belt – 3,000; 2 Belt – 18,000; 3 Belt – 33,000; 4 Belt – 48,000.

1.4.2. Enclosure structures.

Vertical enclosing structures

We will insulate the outer wall enclosure from the outside of the house. As a heater we will use foam-foam boards, 100 mm thick, which will be plastered with a special solution, "Cerezit", which will give the facade of the building architectural expressiveness. All partitions were made of ordinary brick, reinforced through six rows.

Euro windows with double glazing will be used to fill the window openings. These are very high quality windows with excellent heat loss performance. Their use in the home will make it more aesthetically appealing and resistant to heat loss, which in subsequent operation will lead to savings in operating costs and home heating.

The double-glazed windows in the design of the window are filled with argon, and the carrier box is made of fiberglass. As shown by the practice of the countries of the west, the windows of such materials have excellent thermal characteristics and thus durability. They have the ability to accumulate heat indoors, acting on the principle of a diode transmitting heat into the middle, but on the outside does not let out.

Doors are made with the use of valuable species of wood, such as oak, with the application of a non-traditional design to design their appearance.

All floors except bathrooms are made of oak parquet, which is laid on the prepared surface. Bathroom flooring will be made using high quality ceramic tiles made in Italy.

Horizontal enclosing structures.

Horizontal enclosing structure – roof, arranged on the slabs of the coating, insulated with mineral wool plates and covered with a plastic membrane (Fig. 1.2.)

Fig. 1.2. Membrane TPO EVERGARD
single-layer frost-resistant reinforced roofing membrane based on thermoplastic polyolefins

1.4.3. Thermal calculation of walls.

Initial conditions:

Construction area: Uzhgorod.

Name of the building: multi-storey residential building with parking in the basement.

1. Climate parameters of the construction area.

Climate parameters of the construction area are summarized in Table. 1.1.

Table 1.1 Estimated climate parameters of Uzhgorod

Ambient air temperature, °C			Humidity zone	Temperature zone
The coldest day, with confidence		The coldest five days, with confidence		
0,98	0,92	0,92		
$t_1^{0,98} = -26$	$t_1^{0,92} = -29$	$t_5^{0,92} = -22$	normal humidity	I

2. Room climate.

The parameters of the indoor climate are summarized in Table. 1.2.

Table 1.2. The calculated parameters of the microclimate of the premises

Indoor air temperature t_B, °C	Humidity of indoor air φ_B, %
18	55

Considering two options for wall insulation and choose the best one.

I option:

The design of the wall is shown in fig. 1.3. Conditions of its operation "B". The thermal performance of wall materials is summarized in Table 1.3.

The total thermal resistance for the entire wall structure is determined by the formula:

$$R_o = \frac{1}{\alpha_B} + \frac{\delta_1}{\lambda_1} + \frac{\delta_2}{\lambda_2} + \frac{\delta_3}{\lambda_3} + \frac{1}{\alpha_H};$$

where: α_B i α_H - coefficients of heat transfer and heat of perception;

δ_i i λ_i - respectively, the thickness of the layers and the thermal conductivity of the materials.

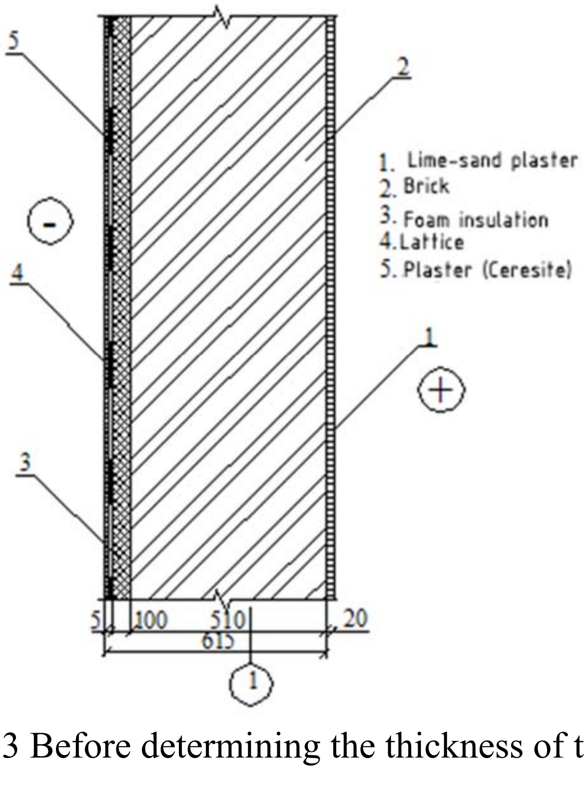

Fig. 1.3 Before determining the thickness of the insulation

Table 1.3. Calculation characteristics of materials

№ layer	Name material	Density ρ_0, kg/m^3	Thickness δ, m	Odds	
				thermal conductivity λ, W/(m·°C)	heat absorption s, W/(m^2·°C)
δ_1	Lime-sand plaster	1600	0,02	0,81	9,76
δ_2	Brick masonry made of solid clay plain brick on cement-sand mortar	1800	0,51	0,81	10,12
δ_3	PV-1 foam	100	X	0,052	0,8

In accordance with the order of the Ministry of Ukraine for Construction and Architecture under No. 117 of 27.06.96 “On the introduction of new standards for the resistance of external enclosing structures of residential and civil structures” the coefficients of resistance of the heat transfer fences should be

- Exterior walls 2, 2 m^2 ° C / W
- Roofs 2, 7 m^2 ° C / W
- Windows and balcony doors 0, 5 m^2 ° C / W

$$R_o = R_0^H = 2{,}2 м^2 {}^\circ \mathrm{C/W};$$

$$\lambda_3 = (2{,}2 - \frac{1}{23} - \frac{0{,}02}{0{,}81} - \frac{0{,}51}{0{,}81} - \frac{1}{8{,}7}) \cdot 0{,}052 = 0{,}072 м$$

We accept plates of foam 100 mm thick. Recalculate with the accepted thickness.

$$R_o = \frac{1}{23} + \frac{0{,}02}{0{,}81} + \frac{0{,}51}{0{,}81} + \frac{0{,}1}{0{,}052} + \frac{1}{8{,}7} = 2{,}74 {}^\circ \mathrm{C/W};$$

$$R_o = 2{,}74 > R_o^H = 2{,}2 м^2 {}^\circ \mathrm{C/W}.$$

The above equation indicates that this wall construction is suitable for use in the construction of an apartment building.

Option II (Fig. 1.4):

Table 1.4. Calculation characteristics of materials

№ layer	Name material	Density ρ_0, kg/m^3	Thickness δ, m	Odds thermal conductivity λ, W/(m·°C)
δ_1	Silicate brick	1800	0,51	0,87
δ_2	Silicate brick “Rockwool”		X	0,05
δ_3	Plasterboard	800	0,0125	0,21

$$\lambda_2 = (2{,}2 - \frac{1}{23} - \frac{0{,}51}{0{,}87} - \frac{0{,}0125}{0{,}21} - \frac{1}{8{,}7}) \cdot 0{,}05 = 0{,}069\text{м}$$

We accept mineral wool plates 70 mm thick. Recalculate with the accepted thickness.

$$R_o = \frac{1}{23} + \frac{0{,}0125}{0{,}21} + \frac{0{,}51}{0{,}87} + \frac{0{,}07}{0{,}05} + \frac{1}{8{,}7} = 2{,}204\ ^\circ\text{C / W};$$

$$R_o = 2{,}204 > R_o^H = 2{,}2\text{м}^2\ ^\circ\text{C / W}.$$

The above equation indicates that this wall construction is suitable for use in the construction of an apartment building.

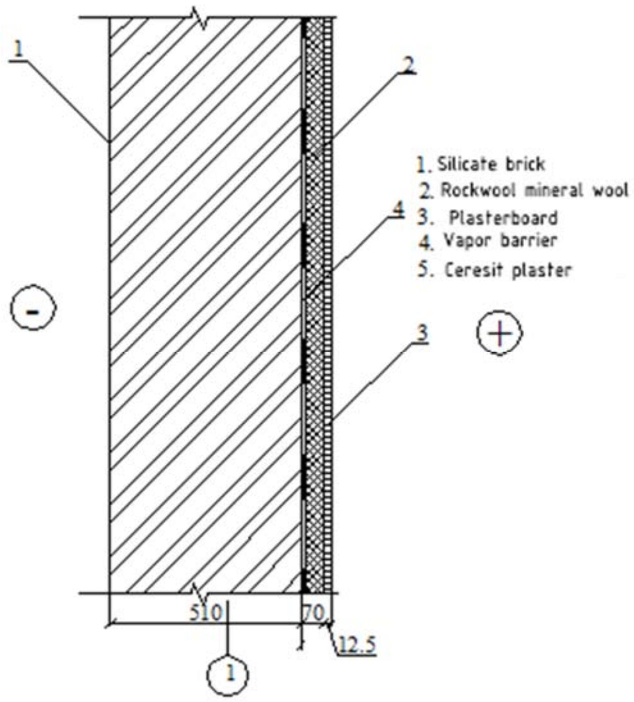

Fig. 1.4 Before determining the thickness of the insulation

1.4.4. Materials for the construction of the building, justification of their choice.

Carrier and self-supporting walls are made of ordinary brick. The exterior walls are glued with polystyrene foam boards to the PC-101 adhesive mixture.

The roofing material is a single-layer frost-resistant reinforced roofing membrane based on thermoplastic polyolefins – TPO EVERGARD.

The service life of such a roof is at least 50 years. The base of the building is lined with natural stone facing plates, using adhesive solutions. The front part of the slabs has the texture of torn stone, which gives the building a special appearance.

Parquet is used for the exterior floor covering of living rooms. For bathrooms floors, kitchens use a ceramic tile on cement-sand mortar, and a mosaic floor is used on the first floor.

The walls are plastered with a lime-sand mortar and then rubbed with a putty in color or glued with wallpaper.

1.5. Architectural and artistic decision of the building.

Of great importance for the visual perception of the building is the color, texture of the outer walls, the size and shape of the window openings.

The architectural design of the building is shaped by its silhouette, which in turn is conditioned by the projecting parts of the rooms with rounded corners.

Due to the performance of individual parts of the house will be a light shade, which will relieve the feeling of monotony of the house.

Also, the plinth, which is lined with slabs of natural stone, gives a special appearance to the building. The walls and ceiling of the first floor painted in white give the person in the room a sense of spaciousness, pompousness due to light reflections from white surfaces.

1.6. Sanitary equipment.

1.6.1. Heating.

The heating of a residential building is centralized. The so-called "warm floors" are arranged in the premises – polyamide pipes are laid in the floor, through which the premises are heated.

1.6.2. Electricity supply.

The building's power supply is centralized from the city's power line.

Emergency lighting from rechargeable batteries is provided for safe evacuation on fire.

1.6.3. Water supply and drainage.

Water supply and drainage of the building is centralized. Water supply to the building is provided by the energy-saving pipes of Ecoflex Thermo (insulated pipes for use as external and internal hot water systems.)

Drainage is carried out by multi-layered Nepso pipes.

1.6.4. Ventilation.

The ventilation of the premises is carried out through a ventilation system equipped with recuperators (appliances that recycle the heat of the outgoing air and heat the fresh inlet air with this heat not only to refresh the air, but also to maintain a stable thermal regime of the room.

1.7. Occupational health and safety measures.

The issue of occupational safety while performing construction works is solved in the project of construction organization.

The organization of the construction site, sections of work and workplaces must ensure the safety of workers at all stages of the work.

All construction works are carried out in strict compliance with the requirements of SNIP III-4-80.

The dwelling house does not have a harmful effect on the environment, and as a result of functioning is not the production of material goods, but is intended to perform a residential function.

There are no harmful emissions into the air, and the drainage of household wastewater is carried out in the city sewer network.

The facility is provided with all exits and entrances in case of fire. And also all fire-fighting measures are taken according to the normative documents.

Lighting of premises and courtyard is carried out according to all requirements and standards stipulated by regulatory documents.

All materials intended to be used in the construction are in compliance with environmental standards and therefore do not pose a threat to the environment.

Differences of floors and heights of stairways are observed in accordance with established rules of safety rules. The height of the steps and ledges is selected with maximum convenience for the people who will use them.

2. Design and calculation part

2.1 Calculation and construction of precast concrete slab with round hollows

2.1.1 Plate materials

The multi-hollow overlapping panel is made according to the current-aggressive technology with electrothermal reinforcement of the reinforcement onto the stops and heat treatment. According to [2] concrete heavy class C20/32 (prism strength standard $f_{ctk}=f_p=$ 15 MPa; estimated f_{cd}=11,5 MPa; coefficient of working conditions for concrete γ_{bn}=0,9; regulatory tensile resistance $f_{sk}=f_{sk,sef}$ =1,4 MPa; calculated f_{bt}= 0,9 MPa; the initial modulus of concrete elasticity E_b= $24\cdot10^2$ MPa).

Longitudinally prestressed A400C steel reinforcement [3] (design resistance f_{etd}=365 MPa, modulus of elasticity E_s=$20\cdot10^4$ MPa); cross fittings and welded nets of steel grade BP-1 (at d = 4 mm: f_s=365 MPa, f_{sw}=265 MPa; at d= 5 mm: f_s=360 MPa, f_{yed}=260 MPa; modulus of elasticity E_s=$17\cdot10^4$ MPa); welded frames of longitudinal installation and cross-section armature of class A240C (f_s=225 MPa, f_{yed}=175 MPa).

2.1.2 Determination of loads

Table 2.1 - Collection of loads per 1 m^2 of ceiling

№	Name load	Normative load, Pas	Reliability factor, γ_f	Estimated load, Pas
1	Parquet floor; t = 0,02 m ρ=800 kg / m ^{3}	160	1,1	176
	Cement-concrete layer t = 0,065 м ρ=1600 kg / m^3	1040	1,2	1249
	Foam Concrete Soundproofing Plate t = 0,06 m ρ=500 kg / m^3	300	1,2	360
	RC plate t = 0,11 m ρ=2500 kg / m^3	2750	1,1	3025
	Partitions *	500	1,1	550
	Permanent	4750	-	5360
2	Temporary	3000	1,2	3600
	short-lived	2100	1,2	2520
	long lasting	900	1,2	1080
	Total	7750		8960

* Since the actual placement of temporary partitions is unknown, the load from them is assumed to be uniformly distributed over the ceiling with intensity 500 N / m^2.

Load per 1 m of the length of the panel, taking into account the reliability coefficient by purpose γ_n =0,95.

- settlement constant:

p = 5360·1,2·0,95 = 6110,4 N / m = 6,11 kN / m;

- settlement complete:

q = 8960·1,2·0,95 = 10214 N / m = 10,2 kN / m;

- regulatory constant:

$p_п$ = 4750·1,2·0,95= 5415 N / m = 5,42 kN / m;

- regulatory full:

$q_п$ = 7750·1,2·0,95= 8835 N / m = 8,84 kN / m;

- regulatory permanent and long-term:

p= 5650·1,2·0,95= 6441 N / m = 6,44 kN / m;

- regulatory short-term:

p = 2100·1,2·0,95= 2394 N / m = 2,39 kN / m.

2.1.3 The calculation of the plate by the boundary states of the first group

Setting the estimated dimensions of the slab and determining the effort from external loads.

We determine the estimated span of the floor slab:

$l_0 = 5700 - 0,5(250 + 250) = 4500 мм.$

The cross-section of the multi-hollow plate (Fig. 2.1) is replaced by the equivalent I-section (Fig. 2.2).

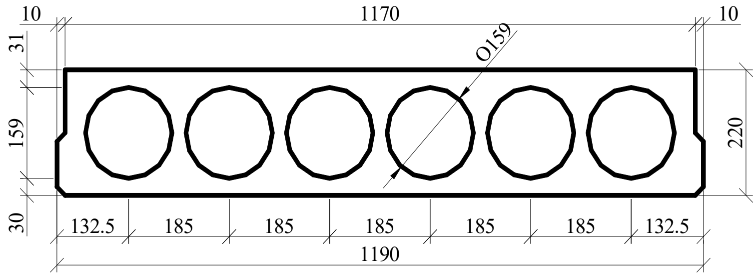

Figure 2.1 - Cross-section of the plate

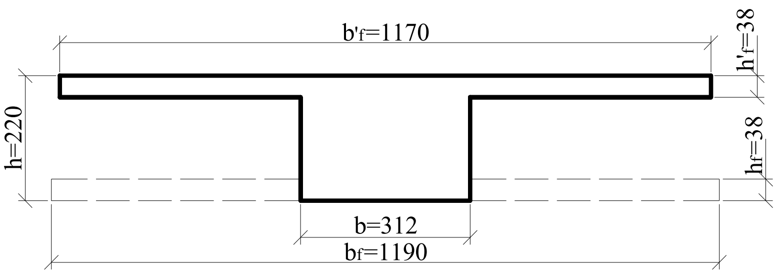

Figure 2.2 - Design section of the slab

The height of the section of the plate is accepted

$h \approx l_o / 25 = 545 / 25 = 21{,}8 \approx 22$ cm;

working height $h_o = h - a = 22 - 3 = 19$ cm.

The remaining sizes of the calculated section (Fig.2.3):

We replace the area of circular voids with rectangles of the same area and the same moment of inertia. We calculate:

$h_1 = 0{,}9d = 0{,}9 \cdot 15{,}9 = 14{,}3$ cm;

- thickness of the top and bottom shelves $h_f^{/} = h_f = (22 - 14{,}3) \cdot 0{,}5 = 3{,}8$ cm;
- width of the top and bottom shelves, respectively, $b_f^{/} = 117$see, $b_f = 119$ cm;
- width of ribs $b = 117 - 6 \cdot 14{,}3 = 31{,}2$ cm.

We determine the efforts in the slab under the influence of external loads:

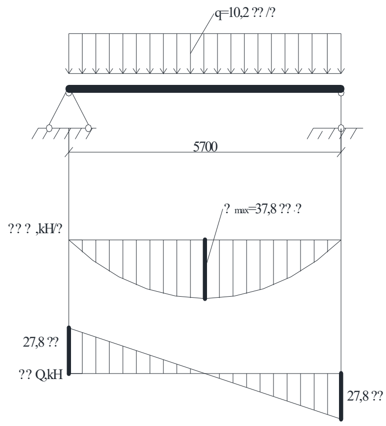

Figure 2.3 - Calculation scheme

Bending moment from design load:

$M = (q \cdot l_0{}^2) /8=(10,2\cdot 5,45^2)/8 = 37,87$ kNm;

The transverse force from the design load:

$Q = (q \cdot l_0) /2=(10,2 \cdot 5,45)/2 = 27,8$ kN;

Bending moment from full regulatory load:

$M = (8,84 \cdot 5,45^2)/ 8 = 32,82$ kNm;

Transverse force from full regulatory load:

$Q = (8,84 \cdot 5,45)/ 2 = 24,09$ kN;

Efforts from the effect of the regulatory load of constant and long-lasting:

$M = (6,44 \cdot 5,45^2)/ 8 = 23,91$ kNm;

$Q = (6,44 \cdot 5,45)/ 2 = 17,55$ kN;

Efforts from the effect of regulatory load of the short-term:

$M =(2,39 \cdot 5,45^2)/ 8 = 8,87$ kNm.

2.1.4 Calculation of the strength of the normal section

The entire width of the shelf is entered in the calculations $b_f^{/} = 117$ cm since:

$(b_f^{/} – b) / 2 = (117 – 31,2) / 2 = 42,9$ cm $< 1 / 6 \cdot l_o = 1 / 6 \cdot 545 = 90,83$ cm.

The position of the boundary of the compressed zone of concrete is determined by dependence:

$M \le \gamma_{b2} \cdot f_{bt} \cdot b_f{}^{/} \cdot h_f{}^{/} \cdot (h_o – 0,5 \cdot h_f{}^{/})$;

$37{,}84 \cdot 10^5 < 0{,}9 \cdot 11{,}5 \cdot 117 \cdot 3{,}8 \cdot (19 - 0{,}5 \cdot 3{,}8) \cdot 100 = 78{,}69 \cdot 10^5$ H· cm.

The boundary of the compressed zone of concrete passes in the shelf, the calculation is conducted as a rectangular section with dimensions $b_f' \times h$.

Calculate α_m by the formula:

$$\alpha_m = \frac{M}{\gamma_{br} \cdot fbt \cdot b_f^{/} \cdot h_o^{\ 2}} = \frac{37{,}84 \cdot 10^5}{0{,}9 \cdot 11{,}5 \cdot 117 \cdot 19^2 \cdot 100} = 0{,}087.$$

For the table we find value $\xi = 0{,}092$, ή= 0,954.

The characteristic of the compressed zone is determined by the formula for α=0,85 for heavy concrete:

$\omega = \alpha - 0{,}008 \cdot \gamma_{b2} \cdot f_{bt} = 0{,}85 - 0{,}008 \cdot 0{,}9 \cdot 11{,}5 = 0{,}767.$

The boundary height of the compressed zone is determined by the formula (25) [3]:

$$\xi_r = \frac{\omega}{1 + \sigma_{sr} / \sigma_{sc,u} \cdot (1 - \omega / 1{,}1)} = \frac{0{,}767}{1 + 365 / 500 \cdot (1 - 0{,}767 / 1{,}1)} = 0{,}653,$$

where $\sigma_{sf} = F_s = 365$ MPa; $\sigma_{sc,и} = 500$ MPa at $\gamma_{b2}=0{,}9<1{,}0$. $\xi=0{,}092<\xi_f=0{,}653$.

The cross-sectional area of the stretched reinforcement:

$A_s = M / F_s \cdot ή \cdot h_o = 37{,}84 \cdot 10^5 / 365 \cdot 0{,}954 \cdot 19 \cdot 100 = 7{,}46\ cm^2$.

We accept 6 Ø 14 A400C with $A_s=9{,}23\ cm^2$.

2.1.5 Calculation of the strength of sections inclined to the longitudinal axis

We check the condition of the need to install transverse fittings for the multi-hollow panel, $Q_{max}=27{,}8$ kN.

We calculate the projection from an inclined section by the formula:

$$c = \frac{\varphi_{b2} \cdot (1 + \varphi_f + \varphi_n) \cdot R_{bt} \cdot bh_0^2}{Q_b} = \frac{B_b}{Q_b},$$

where $\varphi_{b2} = 2$ – for heavy concrete; φ_f – coefficient taking into account the effect of the overhangs of the compressed shelves; in a very hollow plate at seven edges;

$$\varphi_f = 7 \cdot 0{,}75 \cdot \frac{3 \cdot h_f'^2}{b \cdot h_0} = 7 \cdot 0{,}75 \cdot \frac{3 \cdot 3{,}8^2}{31{,}2 \cdot 19} = 0{,}385 < 0{,}5;$$

$\varphi_n = 0$, due to lack of compression force;

$$B_b = \varphi_{b2} \cdot (1 + \varphi_f + \varphi_n) \cdot R_{bt} \cdot \gamma_{b2} \cdot bh_0^2 = 2 \cdot (1 + 0{,}385) \cdot 0{,}9 \cdot 0{,}9 \cdot 31{,}2 \cdot 19^2 \cdot 100 =$$
$$= 25{,}27 \cdot 10^5\, H \cdot см.$$

In the calculated inclined section $Q_b = Q_{sw} = Q/2$, so:

$$c = \frac{B_b}{0{,}5Q} = \frac{25{,}27 \cdot 10^5}{0{,}5 \cdot 27800} = 182 см > 2h_0 = 2 \cdot 19 = 38 см.$$

We accept c=38 cm, then:

$$Q_b = \frac{B_b}{c} = \frac{25{,}27 \cdot 10^5}{38} = 0{,}665 \cdot 10^5\, N = 66{,}5 kN > Q = 27{,}8 kN$$

Therefore, the transverse armature is not required for the calculation:

$$q_{sw} = \frac{R_{sw} \cdot A_{sw}}{s} = \frac{175 \cdot 0{,}85}{10} 100 = 1487{,}5 kH / см$$

Transverse fittings are installed according to design requirements, positioning it in increments:

s ≤ h/2=22/2=11 cm, and s ≤ 15 cm.

Assign the cross bars Ø6 A240C after 10 cm near the supports on sections of length 1/4 span. In the middle 1/2 part of the panel to connect the longitudinal rods of the frame for structural reasons we put the transverse rods after 0.5 m. Three frames are provided $A_{sw} = 3 \cdot 0{,}283 = 0{,}85$ cm^2.

2.1.6 Calculation of the plate by the boundary states of the second group

For structures used indoors, to fracture toughness of which Category 3 requirements are required, crack opening widths are limited: short-term [α_{cfc1}]= 0,4 mm, long lasting [α_{cfc2}] = 0,3 mm.

The calculation is based on load with load factor of reliability γ_f = 1,0.

The width of the crack opening is determined by the formula:

$$\alpha_{cfc} = \varphi_1 \cdot \eta \cdot \delta \cdot \lambda \cdot \sigma_s / E_s \cdot d.$$

The strees in the longitudinal working armature is determined by the formula:

$$\sigma_s = \frac{M}{A_s \cdot Z} \ .$$

We accept the shoulder of the inner pair of forces:

$Z \approx h_o - 0{,}5 \cdot h_f^{/} = 19 - 0{,}5 \cdot 3{,}8 = 17{,}1$ cm.

Reinforcement tension from the action of constant and long-term regulatory loads (bending moment M_{nl} = 23,91 kN· m.

$$\sigma_s = \frac{2391000}{9{,}23 \cdot 17{,}1 \cdot (100)} = 151{,}49 \text{ MPa;}$$

The tension in the reinforcement from the action of full regulatory load, from which the bending moment M_n = 32,82 kN· m,

$$\sigma_s = \frac{3282000}{9{,}23 \cdot 17{,}1 \cdot (100)} = 207{,}94 \text{ MPa.}$$

The reinforcement factor is accepted without taking into account the compressed concrete zone:

$$\mu = \frac{A_s}{b \cdot (h - h_f^{/})} = \frac{9{,}23}{31{,}2 \cdot (22 - 3{,}8)} = 0{,}016 \, .$$

The coefficient φl is assumed to be equal:

- for short-term loads and short-term effects of constant and long loads φl = 1,0;
- for long-term continuous and long-term loads for heavy concrete structures of natural moisture:

$$\varphi_l = 1{,}6 - 15\mu = 1{,}6 - 15 \cdot 0{,}016 = 1{,}36 \, .$$

Coefficient η = 1,0 - for core reinforcement of periodic profile.

The coefficient δ is determined by the formula:

$$\delta = \frac{\alpha}{\varphi_d \cdot (1 + 2 \cdot \alpha \cdot \mu)} ,$$

where $\alpha = E_s / E_b = 20 \cdot 10^4 / 24 \cdot 10^3 = 8{,}75$;

φ_d =1,3 – coefficient determined by linear interpolation.

Calculate:

$$\delta = \frac{8{,}75}{1{,}3 \cdot (1 + 2 \cdot 8{,}75 \cdot 0{,}016)} = 5{,}26.$$

The coefficient λ is determined by the formula:

$$\lambda = 2 \cdot (1 - \frac{1}{e^{\omega}}) \le 1{,}45,$$

where the coefficient ω is determined by the formula:

$$\omega = \frac{5 + 0{,}6 \cdot \frac{\sigma_s}{f_{bt,ser}}}{\delta}.$$

For short-term loads and long-term continuous and long-term loads:

$$\omega = \frac{5 + 0{,}6 \cdot \frac{207{,}94}{15}}{5{,}26} = 2{,}53;$$

For long-term continuous and long-term loads:

$$\omega = \frac{5 + 0{,}6 \cdot \frac{151{,}49}{15}}{5{,}26} = 2{,}1.$$

We calculate the coefficient λ: for short-term loading action:

$$\lambda = 2 \cdot (1 - \frac{1}{e^{2{,}53}}) = 1{,}84;$$

For long load action:

$$\lambda = 2 \cdot (1 - \frac{1}{e^{2{,}1}}) = 1{,}76.$$

Determine the width of the crack opening:

$$a_{crc1} = 1{,}0 \cdot 1{,}0 \cdot 5{,}26 \cdot 1{,}84 \cdot \frac{207{,}94}{21 \cdot 10^4} \cdot 14 = 0{,}134(мм) \lhd [a_{crc1}] = 0{,}4мм:$$

$$a_{crc2} = 1{,}36 \cdot 1{,}0 \cdot 5{,}26 \cdot 1{,}76 \cdot \frac{151{,}49}{21 \cdot 10^4} \cdot 14 = 0{,}127(мм) < [a_{crc2}] = 0{,}3мм.$$

The condition is fulfilled.

2.1.7 Calculation of the slab for the opening of the cracks inclined to the longitudinal axis

The width of inclination of inclined cracks should be determined at two levels: at the level of the transverse reinforcement and at the level of the longitudinal stretched reinforcement.

The marginal width of the opening of inclined cracks is similar to the border width of the opening of normal cracks [a_{cfc1}] ≤ 0,4 mm, [a_{cfc2}] ≤ 0,3 mm.

1. Calculation of the slab for the opening of cracks inclined to the longitudinal axis at the level of the transverse reinforcement.

The calculation is based on the formula:

$$a_{crc} = \varphi_l \cdot \eta \cdot \delta \cdot \lambda \cdot \frac{\sigma_{s\omega}}{E_s} \cdot d_\omega,$$

where φ_l – coefficient assumed equal to:

- with short-term load action φl = 1,0,
- for long-term action φl = 1,5;
- η = 1,3 – for rod fittings smooth.

The coefficient δ is determined by the formula:

$$\delta = \frac{\alpha}{\varphi_d (1 + 2\alpha\mu_{s\omega})},$$

where $\alpha = \frac{E_{s\omega}}{E_b} = \frac{21 \cdot 10^4}{24 \cdot 10^3} = 8{,}75;$

$\varphi_d = 1{,}0;$

$$\mu_{s\omega} = \frac{A_{s\omega}}{b \cdot s} = \frac{0{,}85}{31{,}2 \cdot 10} = 0{,}0027$$

We define:

$$\delta = \frac{8{,}75}{1{,}0(1 + 2 \cdot 8{,}75 \cdot 0{,}0027)} = 8{,}36.$$

The coefficient λ is determined by the formula:

$$\lambda = 2 \cdot (1 - \frac{1}{e^\omega}) \le 1{,}45,$$

in which the coefficient ω is determined by the formula:

$$\omega = \frac{5 + 0,6\dfrac{\sigma_{s\omega}}{R_{b,ser}}}{\delta} \le \frac{0,5(h_o - a^{/})}{d_{\omega} \cdot s},$$

where d_{ω} – diameter of clamps.

The tension in the clamps is determined by the formula:

$$\sigma_{s\omega} = \frac{Q - Q_{b1}}{\varphi_{s\omega} \cdot A_{s\omega} \cdot h_o} \cdot s \le R_{s,ser},$$

here:

- Q=$Q_{п}$=24,09 kN – from the short-lived effect of the entire regulatory load;
- Q=$Q_{п}$=17,55 kN – from prolonged action of constant and long-term loading;

Q_{b1} is determined by the formula:

$$\varphi_{b3}(1 + \varphi_n)R_{bt,ser} \cdot b \cdot h_o \le Q_{b1} \le 2,5R_{bt,ser} \cdot b \cdot h_o;$$

Calculate: $Q_{b1,\max} = 2,5R_{bt,ser} \cdot b \cdot h_o = 2,5 \cdot 1,4 \cdot 31,2 \cdot 19 \cdot (10^{-1}) = 207,48$ kN;

$$Q_{b1,\min} = \phi_{b3}(1 + \phi_n) \cdot R_{bt,ser} \cdot b \cdot h_o = 0,6 \cdot (1 + 0) \cdot 1,4 \cdot 31,2 \cdot 19 \cdot (10^{-1}) = 49,8 \text{ kN}.$$

We accept $Q_{b1} = Q_{b1,min}$ = 49,8 kN.

Coefficient $\varphi_{s\omega}$ is determined by the formula:

$$\varphi_{s\omega} = 0,45 + 50\mu_{s\omega} = 0,45 + 50 \cdot 0,0027 = 0,585 < 0,8.$$

We calculate the voltage $\sigma_{s\omega}$:

- from the short-term effect of all regulatory load

$$\sigma_{s\omega} = \frac{(24,09 - 49,8) \cdot (10)}{0,585 \cdot 0,85 \cdot 19} \cdot 10 < 0,$$

that is, inclined cracks at the transverse reinforcement level do not appear;

- from long-acting constant and long-term loading: since Q = 17,55 kN < $Q_{b,min}$ = 49,8 kN, it means that $\sigma_{s\omega} < 0$, that is, inclined cracks and no load appears from this load.

If that happens in one or both cases of external load action $\sigma_{s\omega} > 0$, то a_{cfc} is determined by the formula above, for which all the necessary constituent parameters have already been determined.

2. Calculation of the slab for the opening of cracks inclined to the longitudinal axis at the level of the longitudinal stretched reinforcement

In this case, the calculation of acfc is based on the formula given earlier, in which the stress in the tensile armature σs is determined by the formula:

$$\sigma_s = \frac{M - 0{,}5 \cdot C_o \cdot (Q - Q_{b1})}{A_s \cdot Z_s}.$$

Here: Q i Q_{b1} defined in the previous section;

we accept accordingly:

- for short-term external loading Q = 24,09 kN

$Q_{b1} = Q_{b1,max}$ = 207,48 kN;

- for long duration Q = 17,55 kN and $Q_{b1} = Q_{b1,max}$ =207,48 kN;

The length of the projection of a dangerous inclined crack on the longitudinal axis of the element is determined by the formula:

$$h_o \le C_o = \sqrt{\frac{\varphi_{b2}(1+\varphi_n+\varphi_f)R_{bt} \cdot b \cdot h_o^2}{q_{s\omega}}} \le 2h_o;$$

Calculate:

$$C_o = \sqrt{\frac{2 \cdot (1+0+0{,}385) \cdot 0{,}9 \cdot 31{,}2 \cdot 19^2 \cdot (100)}{1487{,}5}} = 43{,}45(см) > 2h_o = 2 \cdot 19 = 38(см),$$

we accept $C_o = 2\ h_o$ = 38 cm.

Approximately accepted $Z_s \approx h_o - 0{,}5\ h'_f$ = 19 – 0,5 · 3,8 = 17,1 cm.

Determine the magnitude of the bending moment at a distance $C_o = 2 \cdot h_o$ = 38 cm from the support:

- with a short duration of the entire load:

$$M = M_n = \frac{(g_n + v_n) \cdot l_o}{2} \cdot C_o - \frac{(g + v_n) \cdot C_0^2}{2} =$$

$$= \frac{8{,}84 \cdot 5{,}45}{2} \cdot 0{,}38 - \frac{8{,}84 \cdot 0{,}38^2}{2} = 8{,}52(кН \cdot м);$$

- with long-term continuous and long-term loading:

$$M = M_n = \frac{6{,}44 \cdot 5{,}45}{2} \cdot 0{,}38 - \frac{6{,}44 \cdot 0{,}38^2}{2} = 6{,}41\,\text{kN·m}.$$

Adjust the transverse force acting on the distance accordingly C_o = 38 cm from the support:

- short-lived $Q = Q_n$ = 24,09 – 8,84 ·0,38 = 20,73 kN;

- long lasting $Q = Q_n$ = 17,55 – 6,44 · 0,38 = 15,1 kN.

We define σ_s :

- from the short duration of the entire load:

$$\sigma_s = \frac{8{,}52 \cdot 10^5 - 0{,}5 \cdot 38 \cdot (20{,}73 - 207{,}48) \cdot 10^3}{9{,}23 \cdot 17{,}1 \cdot 10^2} = 278{,}79 \text{ MPa};$$

- from prolonged action of constant and long-term loading:

$$\sigma_s = \frac{6{,}41 \cdot 10^5 - 0{,}5 \cdot 38 \cdot (15{,}1 - 207{,}48) \cdot 10^3}{9{,}23 \cdot 17{,}1 \cdot 10^2} = 272{,}2 \text{ MPa}.$$

Calculate a_{cfc}:

- from the short duration of the entire load:

$a_{cfc\ 1}$=1,0·1,0·5,26·1,84· $(278{,}79/21\cdot 10^4)$·14 = 0,18mm < [a_{cfc1}]= 0,4 mm. The condition is fulfilled;

- from prolonged action of constant and long-term loading:

$a_{cfc\ 2}$ =1,36·1,0·5,26· 1,76·$(272{,}2/21\cdot 10^4)$·14 = 0,23mm<[a_{cfc2}] = 0,3 mm. The condition is also fulfilled.

2.1.8 Calculation of deflection of the plate

The deflection in the middle of the span of the plate is determined by the formula:

$$f = s \cdot l_o^2 \cdot (1 / f),$$

where s – a factor that depends on the element's design scheme. For a freely supported beam at evenly distributed load s =5 / 48.

Boundary deflection for flat ceiling elements at l < 6 m is [f]=l/200=570/200=2,85 cm.

Full curvature 1 / f in mid-span of the slab is determined by the formula:

$$1 / f = (1 / f)_1 - (1 / f)_2 + (1 / f)_3,$$

where $(1 / f)_1$ - curvature from short-term action of the whole load;

$(1/f)_2$ – curvature from short-term action of constant and long-term loading;

$(1/f)_3$ – кlong-lasting, constant and long-acting curvature.

Curvatures $(1 / f)_1$, $(1 / f)_2$, $(1 / f)_3$ are determined by the formula:

$$1 / f = \frac{M \cdot \psi_s}{Z \cdot A_s \cdot E_s \cdot (h_o - x)},$$

With $(1 / f)_1$ i $(1 / f)_2$ is determined at ψs, which corresponds to the short-term load action, a $(1 / f)_3$ - at ψs, which corresponds to a long load action.

The coefficient ψs, taking into account the work of stretched concrete in the areas between the cracks, is determined by the formula:

$\psi_s = 1,25 - \varphi_{ls} \cdot \varphi_m \leq 1,0$,

here φls coefficient, taking into account the duration of the external load, is taken on the table 36 [2]:

$\varphi_{ls1} = \varphi_{ls2} = 1,1$; $\varphi_{ls3} = 0,8$.

The coefficient φm is determined by the formula:

$$\varphi_m = \frac{R_{bt,ser} \cdot W_{pl}}{M_r} \leq 1.0,$$

here M_f – the normative value of the bending moment from the corresponding load, namely: $M_{f1} = 32,82$ kN· m, $M_{f2} = M_{f3} = 23,91$ kN· m.

The elastic-plastic moment of resistance of the cross-section relative to the lower face is determined by the formula $W_{p1} = \gamma \cdot W_{fed}$,

where $\gamma = 1,5$ – for a cross section with a shelf in the compressed concrete zone.

The moment of resistance of the given cross-section along the lower zone $W_{fed} = I_{fed}/Y_o$.

To calculate I_{fed} i Y_o determine the area of the given section.

At $\alpha = E_s / E_b = 21 \cdot 10^4 / 24 \cdot 10^3 = 8,75$.

$A_{fed} = A + \alpha \cdot A_s = b_f^{/} h_f^{/} + b \cdot (h - h_f^{/}) + \alpha \cdot A_s = 117 \cdot 3,8 + 31,2 \cdot (22 - 3,8) + 8,75 \cdot 9,23 = 1093,2$ cm^2.

Static moment of the given section relative to the lower face:

$S_{fed} = b_f^{/} \cdot h_f^{/} \cdot (h - 0,5 \cdot h_f^{/}) + b \cdot (h - h_f^{/}) \cdot 0,5 \cdot (h - h_f^{/}) + \alpha \cdot A_s \cdot a =$

$= 117 \cdot 3,8 \cdot (22 - 0,5 \cdot 3,8) + 31,2 \cdot (22 - 3,8) \cdot 0,5 \cdot (22 - 3,8) + 8,75 \cdot 9,23 \cdot 3 = 14346$ cm^3.

The distance from the bottom face to the center of gravity of the cross section:

$Y_o = S_{fed} / A_{fed} = 14346 / 1093,2 = 13,12$ cm.

The moment of inertia of the given cross section with respect to its center of gravity:

$I_{fed} = b_f^{/} \cdot (h_f^{/})^3 / 12 + b_f^{/} \cdot h_f^{/} \cdot (h - 0,5 \cdot h_f^{/} - y_o)^2 + b \cdot (h - h_f^{/})^3 / 12 +$

$+ b \cdot (h - h_f^{/}) \cdot (h - 0,5 \cdot h_f^{/} - y_o)^2 + \alpha \cdot A_s \cdot (y_o - a)^2 = 117 \cdot 3,8^3 / 12 + 117 \cdot 3,8 \times$

$\times (22 - 0,5 \cdot 3,8 - 13,12)^2 + 31,2 \cdot (22 - 3,8)^3 / 12 + 31,2 \cdot (22 - 3,8) \cdot (22 - 0,5 \times$

$\times 3,8 - 13,12)^2 + 8,75 \cdot 9,23 \cdot (13,12 - 3)^2 = 73807$ cm^4.

Calculate:

$W_{fed} = 73807 / 13,12 = 5626$ cm^3;

$W_{p1} = 1,5 \cdot 5626 = 8439$ cm^3;

$\varphi_{m1} = 1,4 \cdot (100) \cdot 8439 / 32,82 \cdot 10^5 = 0,36$;

$\varphi_{m2} = \varphi_{m3} = 1,4 \cdot (100) \cdot 8439 / 23,91 \cdot 10^5 = 0,5$;

$\psi_{s1} = 1,25 - 1,1 \cdot 0,2 = 1,03 > 1,0$, we accept $\psi_{s1} = 1,0$;

$\psi_{s2} = 1,25 - 1,1 \cdot 0,5 = 0,7$;

$\psi_{s3} = 1,25 - 0,8 \cdot 0,5 = 0,85$.

To simplify further calculation, without significant error and its effect on the accuracy of the results, we approximate the height of the compressed zone of concrete equal to the thickness of the shelf, ie $x = h_f^{/} = 3,8$ cm,

then $z = h_o - 0,5 \cdot h'_f = 19 - 0,5 \cdot 3,8 = 17,1$ cm.

Calculate:

$(l/f)_1 = (32,82 \cdot 10^5 \cdot 1,0) / (17,1 \cdot 9,23 \cdot 21 \cdot 10^6 \cdot (19 - 3,8)) = 6,51 \cdot 10^{-5}$ (1/cm);

$(l/f)_2 = (23,91 \cdot 10^5 \cdot 0,7) / (17,1 \cdot 9,23 \cdot 21 \cdot 10^6 \cdot (19 - 3,8)) = 3,32 \cdot 10^{-5}$ (1/cm);

$(l/f)_3 = (23,91 \cdot 10^5 \cdot 0,85) / (17,1 \cdot 9,23 \cdot 21 \cdot 10^6 \cdot (19 - 3,8)) = 4,03 \cdot 10^{-5}$ (1/cm);

$(l/f) = (6,51 - 3,32 + 4,03) \cdot 10^{-5} = 7,22 \cdot 10^{-5}$ (1/cm).

The final deflection of the slab inside its span:

$f = 5 / 48 \cdot 545^2 \cdot 7,22 \cdot 10^{-5} = 2,23$ see $< [f] = 2,85$ cm,

that is, the stiffness of the plate is sufficient.

2.1.9 Checking the panel for installation loads

The panel has four mounting hinges of A240C grade steel, which are located 70 cm from the ends of the panel (Fig. 2.4.). Taking into account the dynamic coefficients kd = 1,4 the calculated load from the panel's own weight:

$$1\, q = k_d \gamma_f gb = 1{,}4 \cdot 1{,}1 \cdot 2750 \cdot 1{,}19 = 5050\, H/м,$$

where g=h_{fed}·ρ=0,11·25000=2750 N / m^2– own weight of the panel; b – structural weight of the panel; ρ – density of concrete.

The design scheme of the panel is shown in Fig. 2.4. Negative bending moment of the console part of the panel

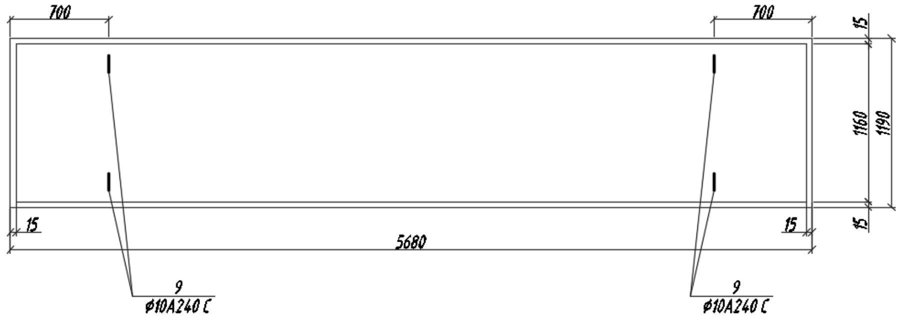

Figure 2.4 - Floor panel layout for installation loads

$$M = \frac{ql_1^2}{2} = \frac{5050 \cdot 0{,}7}{2} = 1240 H/м.$$

This moment is perceived longitudinally by the fittings of the frames. Assuming that z_1=0,9h_0, the required cross-sectional area of the specified reinforcement is:

$$A_s = \frac{M}{z_1 R_s} = \frac{124000}{0{,}9 \cdot 19 \cdot 225 \cdot 100} = 0{,}32 см^2,$$

Much less than the accepted structural reinforcement 3Ø10 A400C, A_s=2,36 cm^2.

When lifting the panel, its weight can be transferred to two loops, then the effort on one loop is:

$$N = \frac{ql_0}{2} = \frac{5050 \cdot 5{,}45}{2} = 13761{,}25 H.$$

The cross-sectional area of the loop reinforcement:

$$A_s = \frac{N}{R_s} = \frac{13761{,}25}{210 \cdot 100} = 0{,}655 см^2;$$

We accept structural rods with a diameter 10 mm; A_s=0,785 cm^2.

2.2 Column calculation

2.2.1 Design data

Calculate the parking column. The section is designated square with dimensions $b_c=h_c=0{,}4$ m.

Condition $b_c \geq b_{mb}=0{,}3$ m – the condition is fulfilled.

The geometric height of the column is $l_0=3{,}2+0{,}05=3{,}25$ m.

According to the recommendations of norms (clause 2.5, 2.19 [1]) we assign concrete of class C20/25.

$f_{вn}=18{,}5$ MPa; $f_{вt,n}=1{,}6$ MPa; $f_{в}=14{,}5$ MPa; $f_{вt}=1{,}05$ MPa; $E_b = 30\cdot10^3$ MPa.

Reinforcement columns A400C:

$f_{sn}=390$ MPa; $f_s=365$ MPa;

2.2.2 Load on the column

We determine the magnitude of the longitudinal force acting on the element from the total calculated loads and constant and long. To do this, we first calculate the required values:

$A_f = l_{sb} \cdot l_{mb} = 3 \cdot 6{,}35 = 19{,}05 м^2$;

Load from over-parking coverage:

$G_s = 8{,}215 \cdot 19{,}05 \cdot 1{,}1 \cdot 0{,}95 = 163{,}54 kH$

Load from crossbars. Number of crossbars – 2.

$G_p = 18{,}8 \cdot 3 \cdot 0{,}95 = 53{,}58 kH$

Snow load is determined by [4].

Kyiv belongs to the second snow district.

$S_0=0{,}7$ kPa; $\mu=1$, since $\alpha<25°$;

$S^n = S_o \cdot \mu = 0{,}7 \cdot 1 = 0{,}7 кПа$; $\gamma_f=1{,}4$;

$S = 1{,}4 \cdot 0{,}7 \cdot 0{,}95 = 0{,}93 кПа$.

Full load on a column of snow:

$G_{сн} = 19{,}05 \cdot 0{,}93 = 17{,}72 kH$.

Load from the column's own weight:

$G_k^n = 0,4 \cdot 0,4 \cdot 25 \cdot 3,2 = 12,8 kH$;

$G_k = 1,3 \cdot G_k^n = 12,8 \cdot 1,3 \cdot 0,95 = 15,81 kH$.

The total load acting on the column:

$N = 163,54 + 53,58 + 3,0 \cdot 19,05 + 17,72 + 15,81 = 307,8 kH$;

$N_l = 163,54 + 53,58 + 0,3 \cdot 3,0 \cdot 19,05 + 0 + 15,81 = 250,08 kH$.

2.2.3 Calculation of the strength of the sections of the column

The estimated length of the column l_0=0,7·3,25=2,275 m.

Relation $l_0 / b_c = 2,275 / 0,3 = 7,58 \prec 20$, so the calculation is conducted as a centrally compressed element.

We assign a coefficient in advance $\varphi = 0,9$, then the required cross-sectional area of the fitting is:

$$A_{s,tot} = \frac{N/\varphi - R_b A}{R_{sc}} = \frac{307,8/0,9 - 1,45 \cdot 0,9 \cdot 1600}{36,5} = -47,84 см^2,$$

where $A = b_c h_c = 40 \cdot 40 = 1600 см^2$.

We accept the area of the reinforcement based on the minimum reinforcement

$\mu_{\min} = 0,05$.

$A_s = A \cdot \mu_{\min} = 1600 \cdot 0,005 = 8 см^2$.

We accept working fittings in the column 4Ø16 A400C with A_s=8,04 cm^2.

We check the load-bearing capacity of the column to calculate the coefficients:

$$\alpha = \frac{36,5 \cdot 8,04}{1,45 \cdot 0,9 \cdot 1600} = 0,14.$$

By value $\frac{N_l}{N} = \frac{250,08}{307,8} = 0,81$, and $\frac{l_0}{b_c} = \frac{3,25}{0,4} = 8,13$ we define $\varphi_b = 0,909$, and $\varphi_{sb} = 0,909$.

$$\varphi = 0,909 + 2(0,909 - 0,909)0,14 = 0,909 = \varphi_{sb} = 0,909.$$

We accept in the calculation $\varphi = \varphi_{sb} = 0,909$.

The carrying capacity of the element:

$N_u = 0{,}909(1{,}45 \cdot 0{,}9 \cdot 1600 + 36{,}5 \cdot 8{,}04) = 2164{,}7 \kappa H \succ N = 307{,}8 \kappa H$ - the bearing capacity of the column is provided.

Transverse fittings are made of steel A240C, with a diameter of 8 mm and in increments S=500 mm.

2.3 Assessment of engineering and geological conditions of constructional site

Geomorphologically, the site is located on the Uzhgorod Plateau.

Based on the results of surveys in 2001, Sich LLC was investigated geological conditions of the site.

According to engineering-geological surveys, the geological structure of the site consists of 4 engineering-geological elements.

The geological structure of the site is represented by an engineering-geological section (Fig. 2.5.)

Hydrological surveys have shown that groundwater is not noticed at depths up to 29,00 m, but at a depth of 26,0-27,0 m, soils are soft.

According to the soil conditions the site belongs to the II type of subsidence.

Based on the conducted field and laboratory studies, 4 IGEs were installed. According to the investigations in the adjacent territories and the results of the investigations, no signs of the presence of karst-suffusion processes were detected.

In the drilled wells it is supposed to soak up the settling soil, for its compaction. The compaction in this way soils can be considered as settling soils of type I.

These are the main indicators of soil physicomechanical definitions recommended for the calculation of the natural basis.

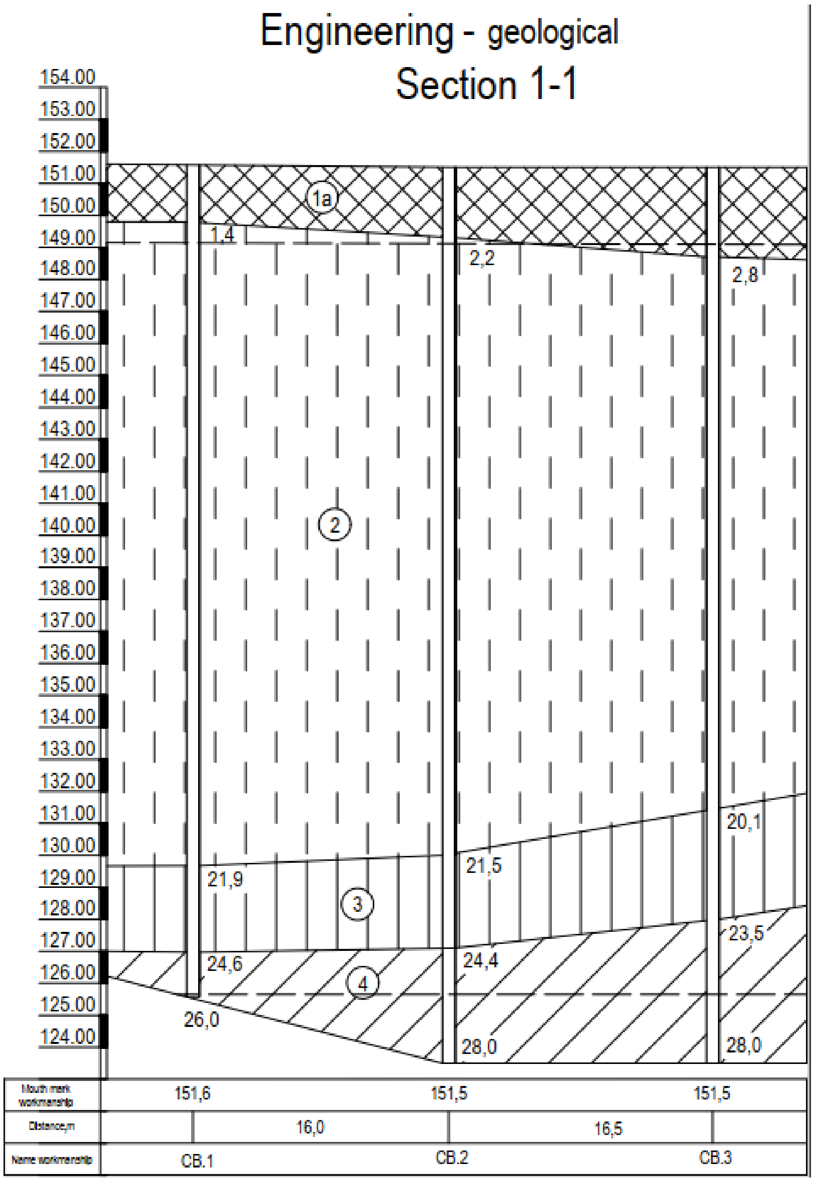

Fig.2.5. Engineering-geological section 1-1

2.4. Determination of loads on foundations.

a) Axis foundation 14

Determine the width of the tape foundation.

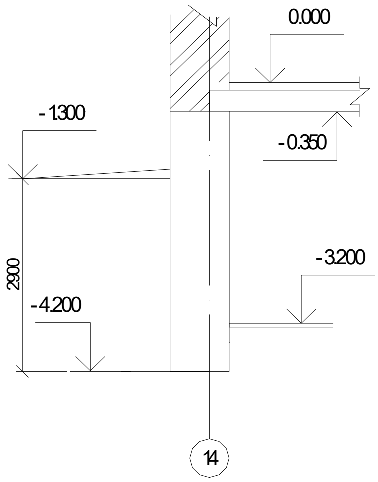

Figure 2.6. Before determining the width of the sole of the belt the foundation.

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Depth of foundation laying d = 2.9 m. There is a basement whose depth is from the soil surface d_b=1,9 m. Under the sole of the foundation lies a loamy forest, highly porous, sloping with a fluidity index I_L=-0,28, porosity coefficient e=0,811.

Table 2.1 Summary geotechnical table of normative and calculation values of soil properties

Number of geological engineering element	Description of geological engineering elements	Normative values										Initial subsidence pressure	Estimated values at confidence probabilities						Classification of soils according to table 1 SNIP IV-10
		Natural humidity	Number of plasticity	The limit of rolling	Fluidity index	Porosity ratio	Degree of humidity	Volumetric weight of natural humidity	Volume of skeleton	The deformation module	The angle of internal friction		Specific weight		Pitome clutch		The angle of internal friction		
													0,85	0,95	0,85	0,95	0,85	0,95	
		ω	I_p	ω_p	I_L	e	S_p	γ	γ	E	φ	$P_{пр}$	γ	γ	C	C	φ	φ	
		Parts of unit						g/cm³	g/cm³	MPa	º	MPa	g/cm³	g/cm³	MPa	MPa	º	º	
1a	Bulk soil-layer, loam with budseeit to 40% of the condensed, on separate sites with household seeit to 50%, not matured (embankment)							1,58	Walk through the foundations										24 б
2	Loam loess, solid, highly porous, subsiding at P≥0,058-0,185MPa, carbonized	0,13 / 0,29	0,05	0,15	-0,28	0,811	0,46 / >1,0	1,69 / 1,92	1,49	10 / 7	23 / 20	>0,058	1,69 / 1,92	1,66 / 1,90	0,0104 / 0,008	0,008 / 0,006	23 / 20	20 / 18	34 a
3	Loam loess, low porous, solid, subsiding at P>0,17MPa, carbonized	0,15 / 0,27	0,10	0,16	-0,08 / >1,0	0,738	0,54 / >1,0	1,77 / 1,96	1,54	16 / 11,5	23 / 21	>0,17	1,77 / 1,96	1,74 / 1,94	0,023 / 0,021	0,021 / 0,020	23 / 21	21 / 19	33 a
4	The loam is low porous, from tight to soft, with layers of fine sand	0,22 / 0,25	0,13	0,16	0,25 / 1,00	0,698	0,84 / 0,97	1,93 / 1,99	1,59	18,6 / 15	22 / 21	—	1,93 / 1,99	1,90 / 1,97	0,028 / 0,026	0,026 / 0,024	22 / 21	20 / 18	33 a

Table 2.2 Design features and weight of 1 m^2 designs.

№	Type of loads	Calculation formula	Regulatory load kN / m^2 N_n=N_{II}	Load reliability factor, γ_f	Estimated load kN / m^2 N_I
	Roof				
1	Plastic membrane ρ =0,14 кN / m^2		0,14	1,3	0,182
2	Cement screed, ρ = 22 кN / m^3, t = 20 mm	22 x0,02	0,44	1,3	0,572
3	Insulation t = 80 mm, ρ =4 kN/m^3	0,08x4	0,32	1,2	0,384
4	Steam insulation (polyethylene film) t=0,002 mm, ρ = 6 kN/m^3	0,002x6	0,012	1,3	0,0156
5	The round-hollow plate ρ =2,5 kN / m^2		2,5	1,1	2,75
	Together		3,016	1,24	3,9036
	Attic ceiling				
1	Cement screed t = 20 mm, ρ =22 kN/m^3	0,02x22	0,44	1,3	0,57
2	Cellular concrete t = 100 mm, ρ =5 kN / m^3	0,1x5	0,5	1,3	0,65
3	Steam insulation ρ =0,05 kN / m^2		0,05	1,3	0,06
4	The round-hollow plate ρ =2,5 kN / m^3		2,5	1,1	2,75
	Together		3,54	1,25	4,03
	Ceiling of other floors				
1	Parquet *t = 20* mm, *ρ =5* kN/m^3	0,020x5	0,10	1,3	0,13
2	Glue-soluble mix for gluing of a parquet t=10 mm		0,010	1,2	0,012
3	Slag concrete *t =50* mm, *ρ =10* kN / m^3	0,05x10	0,5	1,3	0,65
4	The round-hollow plate ρ =2,5 kN / m^3		2,5	1,1	2,75
	Together		3,110	1,22	3,542
	Basement ceiling				
1	Parquet t = 20 mm, ρ =5 kN/m^3	0,020x5	0,10	1,3	0,13
2	Glue-soluble mix for gluing of a parquet t=10 mm		0,010	1,2	0,012
3	Cement-sand screed t = 20 mm, ρ =20 kN / m^3	0,020x20	0,4	1,3	0,52

4	Expanded claydite t=30 mm, ρ =5 kN / m^3	0,030x5	0,15	1,3	0,195
5	Foam insulation t = 50 mm, ρ =1 kN / m^3	0,05x1	0,05	1,2	0,06
6	Steam insulation (1 layer of roofing material) ρ =0,05 kN / m^2		0,05	1,3	0,065
7	The round-hollow plate ρ =2,5 kN / m^3		2,5	1,1	2,75
Together			3,26	1,24	3,73
	Over-parking coverage				
1	Concrete slabs t = 50 mm, ρ =24 kN/m^3	0,05x24	1,2	1,3	1,56
2	Quartz sand t=30 mm, ρ=21,5 kN/m^3	0,030x21,5	0,645	1,3	0,84
3	Hot roofing mastic ρ =0,15 kN / m^2		0,15	1,3	0,195
4	Cement-sand screed reinforced t = 30 mm, ρ =24 kN/m^3	0,030x24	0,72	1,3	0,936
5	Expanded clay t = 150 mm, ρ =5 kN / m^3	0,15x5	0,75	1,3	0,975
6	Waterproofing layer ρ =0,25 kN / m^2		0,25	1,3	0,325
7	Monolithic concrete slabt = 80 mm, ρ =25 kN / m^3	0,080x25	2,0	1,3	2,6
8	Plate cover ρ =2,5 kN / m^2		2,5	1,1	2,75
Together			8,215	1,275	10,181

Table 2.3 Load on the base of the column along the axis 14 (A=1,375).

№	Type of load	The formula for determining the load	Regulatory load and design for deformation calculation $N_n=N_{II}$, kN	Reliability factor for load γ_f	Design load for load capacity calculation $N_I=N_n*\gamma_f$, kN
1	2	3	4	5	6
	A. Steel loads:				
1	Weight of over-parking coverage	8,215*1,375	11,3	1,275	14,41
2	The weight of the basement wall	1*3,2*18*0,55	31,68	1,1	34,85
Together with steady loads			42,98	-	49,26
	B. Temporary loads:				
1	Snow for calculations - by the carrying capacity	0,7*1,375*0,9	-	1,4	1,21
Total time loads			-	-	1,21
Together			42,98	-	50,47

At 1m length of the foundation: n_{II}=42,98/1=42,98 кN / m,
n_I=50,47/1=50,47 кN / m.

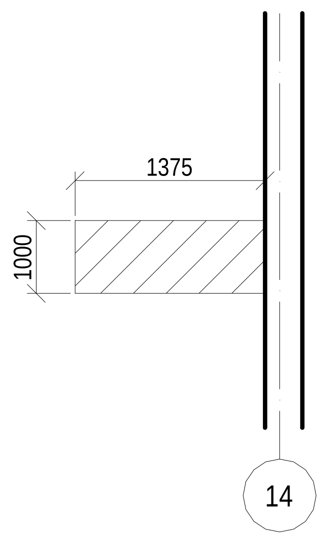

Fig.2.5. The loading area on the axis 14

The loads are collected in tabular form (Table 2.3).
The loading area affected by the load (Figure 2.3): $A = 1 \cdot 1{,}375 = 1{,}375 м^2$

N_{II}=42,98 кN / m.

We find value F_0=200 кPa.

Determine in the first approximation the width of the sole of the foundation

$$b = \frac{N_{II}}{R_0 - \overline{\gamma} d} = \frac{42{,}98}{200 - 20 \cdot 2{,}9} = 0{,}3 \text{ m.}$$

We refine the value of F by accepting b=0,3 m.

$$R = \frac{\gamma_{c1} \cdot \gamma_{c2}}{k}\left[M_{\gamma} \cdot k_z \cdot b \cdot \gamma_{II} + M_q \cdot d_n \cdot \gamma_{II} + (M_q - 1)d_b \cdot \gamma_{II}^{/} + M_c \cdot C_{II}\right]$$

$\gamma_{c1} = 1{,}25;\ \gamma_{c2} = 1{,}0;$

$M_{\gamma} = 0{,}51;\ M_q = 3{,}06;\ M_c = 5{,}66;$

$k = 1;\ k_z = 1;$

$\gamma_{II} = 16{,}9\ \kappa H/\text{м}^3;\ \gamma_{II}^{/} = 16{,}9\ \kappa H/\text{м}^3;$

$C_{II} = 10{,}4\kappa\Pi a.$

d_1= d- d_b=2,9-1,9=1,0 m.

$$R = \frac{1{,}25 \cdot 1}{1}\left[0{,}51 \cdot 1 \cdot 0{,}3 \cdot 16{,}9 + 3{,}06 \cdot 1{,}0 \cdot 16{,}9 + (3{,}06 - 1)1{,}9 \cdot 16{,}9 + 5{,}66 \cdot 10{,}4\right] =$$
$$= 224{,}14\kappa\Pi a.$$

4. Clarify the value b:

$$b = \frac{N_{II}}{(R - \gamma \cdot d)} = \frac{42{,}98}{224{,}14 - 20 \cdot 2{,}9} = 0{,}26\text{м}.$$

Since the wall we have a thickness of 615 mm, we assume the thickness of the block = 0,6 m.

b) Axis foundation 10

The loads are collected in tabular form (Table 2.4).

Load area affected by loading (Fig. 2.6): $A = 1 \cdot 2{,}6 = 2{,}6\text{м}^2$

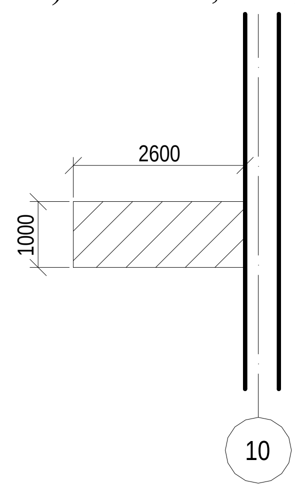

Fig.2.6.The cargo area on the axis 10

Table 2.4 Load on the base of the column along the axis 10 (A=2,6).

№	Type of load	Definition formula load	Regulatory load and design for deformation calculation $N_n=N_{II}$, kN	Reliability factor for load γ_f	Design load for load capacity calculation $N_I=N_n*\gamma_f$, kN
1	2	3	4	5	6
	A. Steel loads:				
1	Weight of roof (roof)	3,016*2,6	7,84	1,24	9,72
2	Attic floor weight	3,54*2,6	9,204	1,25	11,51
3	Weight of ceiling 16 floors	3,110*2,6*16	129,38	1,22	157,84
4	Weight of the basement floor	3,26*2,6	8,476	1,24	10,51
5	The weight of the basement wall	1*3,2*18*0,55	31,68	1,1	34,85
6	Weight of the wall 1-17 th	1*3*18*0,55*17	504,9	1,1	555,39
	floor	1*3,18*18*0,55	31,48	1,1	34,63
7	Weight of the parapet and the wall above the attic		22,1	1,1	24,31
	ceiling	0,5*2,6*17			
8	The weight of the interior partitions on 17 floors				
Together with steady loads			745,06	-	838,76
	B. Temporary loads:				
1	Snow for calculations				
	- by the carrying capacity	0,7*2,6*0,9	-	1,4	2,29
	On the attic floor	0,7*2,6*0,9	1,638	1,3	2,13
2	The load on the overlapping				
3	living quarters for calculations				
	- by deformation	17*0,3*2,6*0,95	12,6	-	-
	- by the carrying capacity	17*1,5*2,6*0,9	-	1,3	77,57
Total time loads			14,238	-	81,99
Together			759,3	-	920,75

At 1m length of the foundation: N_{II}=759,3/1=759,3 кN / m,

N_I=920,75/1=920,75 кN / m.

Determination of the bearing capacity of the hanging drill pile.

Length of pile is 23.5 m, diameter is 500 mm. The pile is arranged in the forest sieving soil of type II, but having soaked it we will compact it and we will have forest soil of soil type I, which is not taken into account in the calculations.

The lower end of the pile rests on loam low-porous, with layers of fine sand.

$$F_d = \gamma_c(\gamma_{CR} \cdot R \cdot A + u\sum\gamma_{cf} \cdot f_i \cdot h_i),$$

where γ_c=1,0; γ_{CF}=1,0

d – pile diameter or its extension, m; d = 0,5m;
h – depth of laying, m, the far end of the pile or its extension, h=23,5 m;
A– the area of resistance of the pile ,

$$A = \frac{\pi d^2}{4} = \frac{3{,}14 \cdot 0{,}5^2}{4} = 0{,}196 м^2;$$

u– perimeter of the pile u=πd=3,14·0,5=1,57 m; γ_{cf}=0,8
F– for clay soils is determined from table 7 DBN B.2.1-10-2009.
For loam with I_L=0,25 at depth 23,5 m F=1995 kPa;
f_i– is determined from table 2 SNiP.02.02-85
for loam з I_L=0,25
at a depth of 20.08 m – f1 = 68.6 kPa;
at a depth of 21.57 m – f1 = 70.14 kPa;
at a depth of 22.78 m – f1 = 72.56 kPa;

$$F_d = \gamma_c(\gamma_{CR} \cdot R \cdot A + u\sum\gamma_{cf} \cdot f_i \cdot h_i) = 1{,}0(1 \cdot 1995 \cdot 0{,}196 + 1{,}57 \cdot (0{,}8 \cdot 68{,}6 \cdot 2{,}0 +$$
$$+ 0{,}8 \cdot 70{,}14 \cdot 0{,}968 + 0{,}8 \cdot 72{,}56 \cdot 1{,}45)) = 780{,}76 kH.$$

Bearing capacity of the pile F_d=780,76 kN. Permissible load
P= F_d/γ_k=780,76/1,4=557,69 kN.

Determining the distance between the piles in the foundation.

The load on the foundation wall of a multi-storey building N_I=920,75 kN/m. Permissible load on the pile P=557,69 kN.

$$a = \frac{P}{N_I} = \frac{557{,}69}{920{,}75} = 0{,}61 м.$$

Piles are placed in two rows at a distance of not more than 1.2 m

c) Axis C foundation

The loads are collected in tabular form (Table 2.6).

Load area affected by load (Figure 2.7): $A = 3 \cdot 6{,}35 = 19{,}05 м^2$

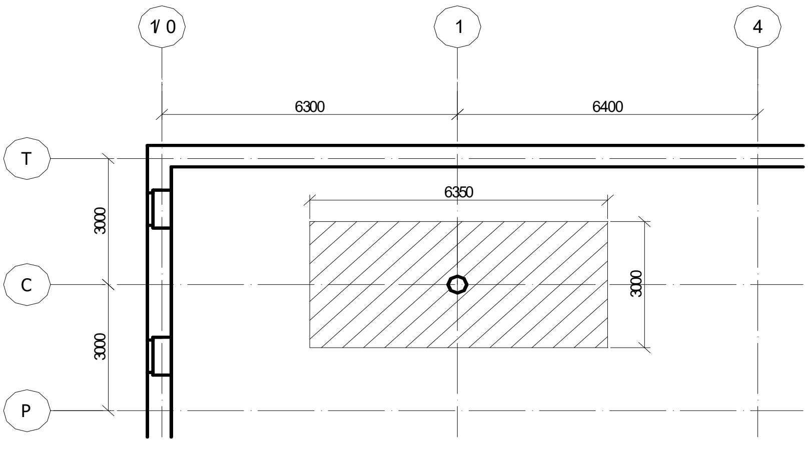

Fig.2.7.The cargo area along the axis C.

Table 2.6 Load on the base of the column along the C axis (A_k = 19,05).

№	Type of load	The formula for determining the load	Regulatory load and design for deformation calculation $N_n=N_{II}$, kN	Reliability factor for load γ_f	Design load for load capacity calculation $N_I=N_n*\gamma_f$, kN
1	2	3	4	5	6
	A. Steel loads:				
1	Weight of over-parking coverage	8,215*19,05	156,5	1,275	199,53
2	Weight columns	0,4*0,4(3,2+0,2)*25	13,6	1,1	14,96
3	Weight 2 bolts	18,8*2	37,6	1,1	41,36
Together with steady loads			207,7	-	255,85
	B. Temporary loads:				
1	Snow for calculations - by the carrying capacity	0,7*19,05*0,9	-	1,4	18,67
Total time loads			-	-	18,67
Together			207,7	-	274,52

At 1m length of the foundation: N_{II}=207,7/1=207,7 кN / m,
N_I=274,52/1=274,52 кN / m.

Determination of the bearing capacity of the hanging drill pile.

Length of pile is 23.5 m, diameter is 500 mm. The pile is arranged in the forest sieving soil of type II, but having soaked it we will compact it and we will have forest soil of soil type I, which is not taken into account in the calculations.

The lower end of the pile rests on loam low-porous, with layers of fine sand.

$$F_d = \gamma_c(\gamma_{CR} \cdot R \cdot A + u\sum \gamma_{cf} \cdot f_i \cdot h_i),$$

where γ_c=1,0; γ_{CF}=1,0

d – pile diameter or its extension, m; d = 0,5 m;

h – depth of laying, m, the far end of the pile or its extension, h=23,5 m;

A– the area of resistance of the pile,

$$A = \frac{\pi d^2}{4} = \frac{3{,}14 \cdot 0{,}5^2}{4} = 0{,}196 м^2;$$

u– perimeter of the pile u=πd=3,14·0,5=1,57 m; γ_{cf}=0,8

F–for clay soils is determined from table 7 DBN B.2.1-10-2009

.For loam with IL = 0.25 at a depth of 23.5 m F = 1995 kPa;

fi – determined from table 2 SNiP.02.02-85

for loam with IL = 0.25

at a depth of 20.08m – f1 = 68.6 kPa;

at a depth of 21.57m – f1 = 70.14 kPa;

at a depth of 22.78m – f1 = 72.56 kPa;

Bearing capacity of the pile F_d=780,76 kN. Permissible load
$P = F_d/\gamma_k$=780,76/1,4=557,69 kN.

Determining the distance between the piles in the foundation.

The load on the foundation wall of a multi-storey building N_I=274,52 кN/m. Permissible load on the pile P=557,69 kN.

$n = \frac{N_I}{P} = \frac{274,52}{557,69} = 0,49$ piece.

We accept 1 pile.

2.5 Conclusions

Therefore, in the design section is designed precast concrete slab with round hollows of heavy concrete. Thickness of slabs 220 mm, concrete class C20/32. The reinforcement was selected according to the active loads, the strength plates and the fracture toughness were calculated, the crack opening width was calculated.

The load-bearing capacity of the column according to its loads is investigated.

Thus, in the second section the engineering-geological conditions of the construction site by drilling of wells are studied in more detail, and the physical and mechanical characteristics of the soil of the building site are obtained. Types of soils in subsidence are determined.

The pile type foundation was designed along with the pillars. The decision to adopt a pile foundation in this project was made due to the poor bearing capacity of the soil base. Piles of pillars work as follows: they transfer the load to the solid foundation soil with their lower end, that is, the lateral surface of the pile is practically not involved.

3. Technological and organizational part

3.1. Description of the main technological processes

During the preparatory period (18 working days) the following works are performed at the site:

- the site is exempted from existing plantings (uprooting all obstructive shrubs and trees);
- breaks the geodetic grid with the arrangement of temporary and permanent benchmarks;
- imported to the site and installed temporary buildings;
- necessary communications are made.

After completion of all these works, it is the turn of installation.

Earthworks

Earthworks begin by cutting the vegetation layer of soil 30 cm thick throughout the entire construction site. The bulldozer does this work in two shifts of soil to be folded into temporary cavaliers.

To reduce soil loss, the bulldozer blade is equipped with side openings. Soil cutting is carried out with a wedge-shaped cut, a trench method of work. The bulldozer repeatedly passes on one and the same trail, producing a trench to 0.6 m of the wall which prevents soil from scattering. Between the trenches there are jumper widths of 0.4 - 0.5 m, then they are cut in the same method.

Soil development is a leading process and is performed by a backhoe excavator. The soil is being developed by a excavator in a cobblestone.

The soil compaction is performed after backfilling and filling the soil with floor tampers.

Arragement of the foundation

Under the walls of the blocks (parking) arrange the tape foundation of concrete blocks, and under the building foundations designed drilling piles.

Before the beginning of the foundation, the bottom of the pit is cleaned and planned, and then sand preparation is arranged. After completion of preparatory work, the device begins to pile injection piles.

The blocks are laid on top of the grill on a cement - sand mortar. Laying of the base blocks is performed with the lining both along the wall (not less than 240 mm) and in the places of contact of longitudinal and transverse walls (not less than 300 mm).

The necessary bandaging of the blocks is ensured by the use of monolithic sections.

Erection of brick walls

Walls are streamlined by dividing the entire volume into six slots. At the same time as the laying of the walls, a team of installers arrange the scaffolding, and the installers of the KB-504.2 crane feed pallets with bricks to the place of masonry.

Check the quality of masonry during the erection of the walls of the foreman and master.

Ceiling arrangement and cover

After the basement walls are erected, the basement floor slabs are mounted. Plates are supplied to the place of insertion by the KB-504.2 crane. After that anchor the boards, bend the mounting loops and fix the seams. Then the masonry erects the walls, and then install the floor slabs in the same sequence.

Work on installation of slabs of overlapping and covering should be carried out by the current method. Monolithic areas of overlapping and covering should be carried out in such sequence:

- formwork;
- attach reinforcement grids;
- concreting;
- compact concrete mix;
- concrete care;
- remove formwork.

Floor arrangement

There are three types of floors in the project: parquet, ceramic and mosaic - concrete (in corridors and technical rooms).

Work to begin with the arrangement of concrete preparations, and then screeds.

The floors are arranged by two crews: the first - flooring, the second - concrete.

Having arranged the parquet floor in the basement, the team of parquet workers goes to the ground floor, and in their place come the concrete workers and arrange the mosaic floor. Then repeat the path of the first brigade.

3.2 Land improvement

After dismantling all the scaffolding and sending the equipment, work begins on the improvement of the territory.

To the exposed places return a vegetative layer, arrange lawns.

Asphalt a network of tracks and rotundas, concrete stairs. Trees and other plantings are planted. All work is carried out in accordance with the master plan.

3.3 Labor protection during execution of works

When performing construction works it is necessary to be guided by the requirements of DBN A.3.2-2-2009 "Safety in construction".

All hoisting gear must be tested and issued with a test act. Posters and warning signs should be posted on all hazardous areas of the site.

Installation of structures must be carried out by workers with the necessary qualifications and who have received appropriate safety and fire safety training. Altitude works are allowed specially trained workers not less than the third category and work experience of at least one year.

Before lifting the crane, make sure the sling is secure. Cargo slinging can only be done by a slinging machine who has the tolerance. It is forbidden to be in the area of operation of the crane to outsiders. Installation workers should be provided with overalls, helmets and safety belts that attach to structures when working at height.

During installation, installers should be on special mobile platforms equipped with handrails, which exclude the possibility of falling from a height.

Moving structures should be raised above the projecting structures by 0.5 - 1.0 m.

Persons responsible for the operation of hoisting machines and mechanisms inspect the sleepers at least every 6 months, grab a month, slings every 10 days.

There should be a single alarm system at the construction site and linking slingers to the crane.

When constructing structures, it is necessary to follow the step rules:

- to store materials in the places specified in the project;
- for materials that are stored in stacks, use gaskets to prevent the structure from collapsing.

When unloading the machine or vice versa, the driver must exit the machine to prevent accidents.

Transport of large loads is carried out by special vehicles. The loads shall be secured in such a way as to prevent them from rolling or falling. When transporting combustible materials such as paint, bitumen must be taken to prevent overheating and burning.

Earthworks are allowed to be carried out only after approval of the project of execution of works.

In the case of underground structures unforeseen by the project, work is stopped until further instructions are received.

In the immediate vicinity of the electrical cable, the soil gas pipeline must be developed manually using shovels. For descent of workers to a pit use step-ladders in width of 0,5 m.

When laying masonry, it is forbidden to lay the wall standing on it. On the scaffolding between the wall, the stacked materials and the inventory, there should be a passage of at least 60 cm.

3.4 Methods of work execution in winter

Earthworks

Soil to be developed in winter is prevented from freezing by lowering to a depth of 20 cm with the help of excavators or diesel hammer C–254.

With small volumes for blowing, it is recommended to take jackhammers.

When backfilling, ice and snow are collected, frozen ground tubers break.

Stone work

The main method for masonry in the winter is the freezing method: the masonry is carried out outdoors not heated by a snow-cleaned brick in a heated solution, which will allow compression of the solution in the seams of the masonry. At air temperature t = -4°C to -20°C, the grade of mortar for winter masonry increases by one degree compared to the mark set for summer masonry.

Concrete work

At minimum daily air temperature, the concrete mix should be prepared in heated water. Heating of the aggregate comes when the heat introduced into the concrete with hot water is not enough.

The mixing of the concrete mixture increases by 50% compared to the summer time. The concrete mix is applied to the base, which is frozen and free of snow and ice.

3.5 Determining the complexity and timing of construction

3.5.1. Determination of the volume of general construction works

Table 3.1 Work volume statement

№ p / p	Name of works	Un. mea.	Amount
1	2	3	4
1	Site planning	m^2	3682,24
2	Cut the vegetable layer	m^2	3682,24
3	Excavation of soil in a pit	m^3	6134,06
4	Soil completion in the pit	m^2 m^3	2051,65 205,17
5	Backfill of sinus ground	m^2	86,416
6	The arrangement of rubble preparation under	piece	1219
7	foundations	m^3	950,53
8	Installation of wall blocks	m^3	330,34
9	Buroinjection pile arrangement	m^2	423,8
10	Vertical waterproofing of two layers of bitumen	m^2	1069,8
1	2	3	4
11	Arrangement of monolithic columns in the parking lot	m^3	5,63
12	Installation of floor slabs above the parking lot	piece	138
13	Backfill of sinus ground	m^3	1189,29
14	Compaction of soil with rammers	m^3	1189,29
15	Arrangement of the underlying concrete layer	m^2	1066,86
16	Brick laying of exterior walls	m^3	2792,51
17	Brick laying of interior walls	m^3	2857,0
18	Brick laying of partitions	m^2	1632
19	Installation of monolithic belts t = 300mm	m^3	80,2
20	(4 belts)	piece	34
21	Installation of stairs	piece	34
22	Installation of stairs marches	piece	1282
23	Installation of floor slabs and coverings	m^3	172,7
24	Concreting of monolithic sections of overlapping and covering	m^2	1328,1
25	Filling of window openings	m^2	1357,1
26	Filling of doorways	m^2	580,68
27	Steam insulation	m^2	580,68
28	Mineral wool cover insulation	m^2	580,68
29	Installation of cement-sand screed	m^2	580,68
30	Membrane roof arrangement	m^2	546,3
31	Insulation of the over-parking floor	m^2	9034,55
32	Arrangement of cinder layer on the floor	m^2	1233,42

33	Arranging the concrete floor in the basement	m^2	9034,55
34	Leveling the ceiling surface	m^2	9034,55
35	Water-emulsion painting of a ceiling	m^2	25992,7
36	Plaster of interior walls	m^2	24804,7
37	Water-emulsion painting of walls	m^2	24804,7
38	Improved painting of walls with oil paints	m^2	9034,55
39	Limestone ceiling painting	m^2	2248,49
40	Ceramic floor arrangement	m^2	1434,2
41	Mosaic floor arrangement	m^2	5362,14
42	Arrangement of a parquet floor	m^2	5362,14
43	Parquet floor lacquer for 2 times	m^2	1188
44	Facing the inner walls with ceramic tiles	m^2	178,3
45	Paving device	m^2	195,05
46	Facing the plinth	m^2	6529,73
47	Preparation of the facade surface	m^2	6529,73
48	Insulation by foam boards	m^2	6529,73
49	Waterproofing	m^2	6529,73
50	Priming of surfaces	m^2	6529,73

3.5.2 Defining the complexity of the work

Table 3.2 Statement of the complexity of the work

№	Rationale for DBN	Name of works	Units vm.	No.	The complexity	
					Norm of unit	For the whole volume
1	2	3	4	5	6	7
1	1-30-2	Site planning	1000 m^2	3,682	3,12	1,44
2	1-21-6	Cut the vegetable layer	1000 m^2	3,682	20,6	9,48
3	1-13-5	Excavation of soil in a pit	1000 m^3	6,134	84,66	64,91
4	1-13-5	Soil completion in the pit	1000 m^3	0,205	84,66	2,17
5	11-2-4	The arrangement of the crushed stone preparation under the foundation t = 100 mm	100 m^2	0,864	5,12	0,55
6	7-1-3	Installation of wall blocks	100 piece	12,19	87,97	134,04
7	5-29-2	Borehole injection piles Ø500	m^3	950,53	2,98	354,07
8	6-19-1	Arrange the gadget	100 m^3	3,30	1196,25	493,45
9	8-4-3	Horizontal waterproofing of two layers of roofing material	100 m^2	4,238	31,76	16,82
10	8-4-7	Vertical waterproofing of two layers of bitumen	100 m^2	10,698	33,5	44,80
11	6-15-1	Arrangement of monolithic columns in the parking lot	100 m^3	0,563	833,75	58,68
12	7-45-6	Installation of floor slabs above the parking lot	100 piece	1,38	332,05	57,28
13	1-27-2	Backfill of sinus ground	1000 m^3	1,189	137,0	20,36
14	1-134-1	Compaction of soil with rammers	100 m^3	1,189	18,36	2,73

15	11-2-9	Arrangement of the underlying concrete layer	100 m^2	10,669	5,78	7,71
16	8-19-3	Brick laying of exterior walls t = 510 mm	m^3	2792,51	7,17	2502,80
17	8-19-3	Brick laying of internal walls t = 510 mm	m^3	2857	6,92	2471,30
18	8-7-3	Brick laying of partitions with reinforcement t = 65 mm	100 m^2	16,32	225,94	460,92
19	6-19-1	Installation of monolithic belts t = 300mm (4 belts)	100 m^3	0,802	1196,25	119,92
20	7-47-2	Installation of stairs	100 piece	0,34	343,65	14,61
21	7-47-4	Installation of stairs marches	100 piece	0,34	319,0	13,56
22	7-45-6	Installation of floor slabs and coverings	100 piece	12,82	332,05	532,11
23	6-22-3	Concreting of monolithic sections of overlapping and covering	100 m^3	1,727	932,35	201,27
24	10-18-1	Filling of window openings	100 m^2	13,281	252,8	419,68
25	10-26-1	Filling of doorways	100 m^2	13,571	142,1	241,05
26	12-20-1	Steam insulation	100 m^2	5,807	24,49	17,78

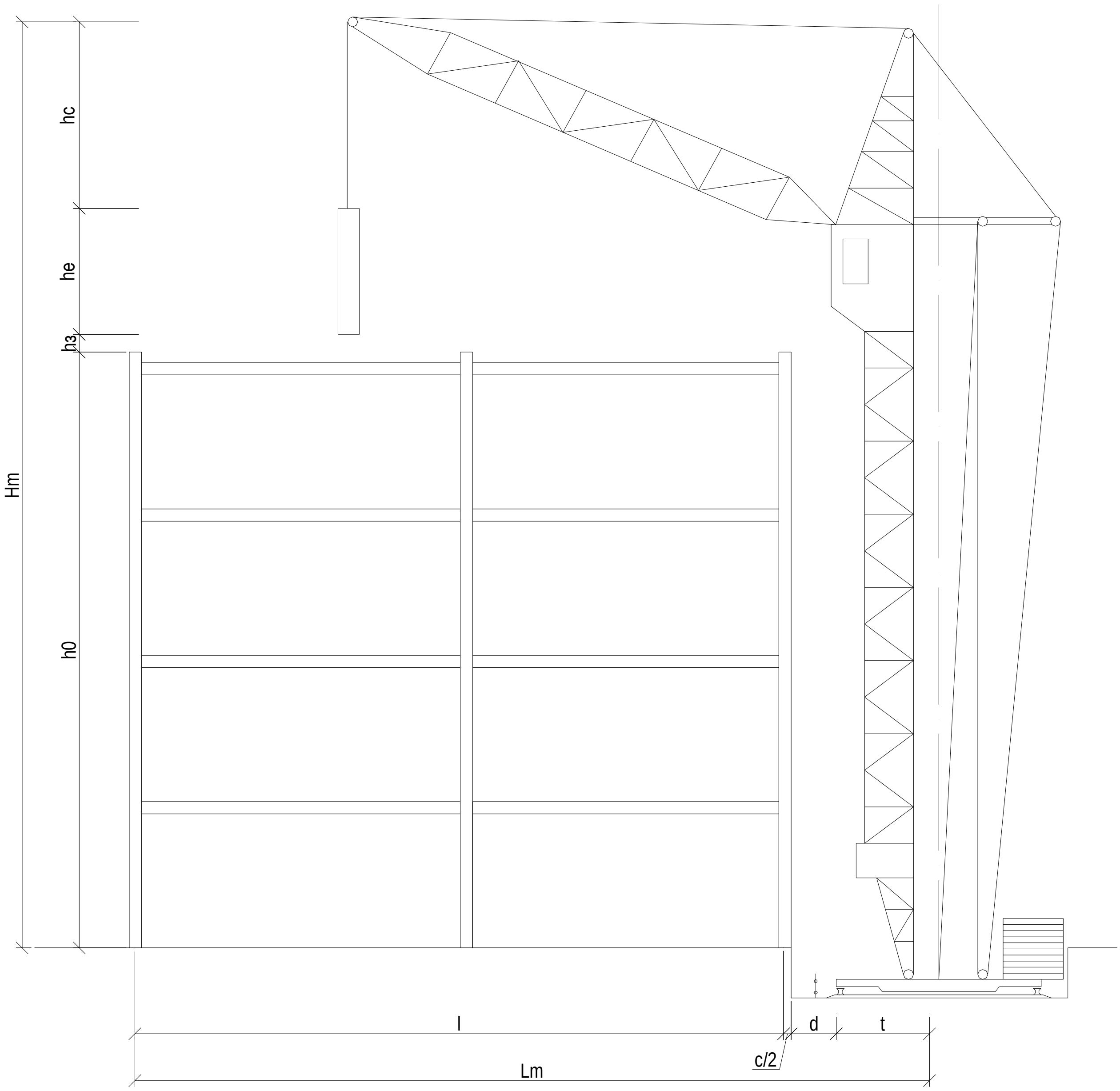

Fig. 3.1 Scheme for determining the parameters of the tower crane.

3.6. Technological map for the installation of stairs and platforms

3.6.1. Scope

The technological map is designed for the installation of step marches and platforms for the step cage of a 15-storey building with parking in the basement.

The work is performed in two shifts.

3.6.2. Technology and organization of the construction process.

Prior to the installation of stairs and marches is necessary:

–To finish the brickwork of the walls of the staircase to the bottom mark of the platform;

–Prepare tools, implements, fixtures necessary for stairways and marches;

–To mark the place of laying of the stairways horizontally and to mark the distances between the sites vertically;

- check the size of stairs and platforms.

Ladder marches and platforms are in stock in the range of the crane, taking into account the sequence of installation.

Complete sets of prefabricated products are continuously renewed as the building is assembled from the warehouse.

When stacking stairs and platforms in a horizontal position, the bottom row is stacked on wooden substrates on a pre-aligned horizontal base.

In all tiers on the height of the stack pads with sections of 8 × 7 cm are arranged vertically in the same plane.

Lifting and moving elements of stairs and platforms during loading and unloading is performed smoothly, without jerks, rocking with the use of extensions. The slinging of stairs and platforms is carried out by mounting loops with a six-lane sling.

When installing reinforced concrete marches and platforms, the crane is first raised to a height of 0.2-0.3 m above the ground and held for some time on the weight to check the reliability of the sling and the correct position of the lifting element and then the lift continues. At horizontal moving construction rises not less than 0,5m above the obstacles, encountered along the way.

The element is lowered to the installation site no more than 30 cm above the design position, after which the installers direct it to the installation site.

Installation of stairs and platforms must be carried out in the course of the brickwork of the staircase.

The procedure of installation of precast concrete structures of the staircase is as follows:

- establish the first base platform, check it and fix it, then mount the second platform and conclude a ladder march, etc.

Particular attention is paid to the installation of the first platform, as errors in the installation site will cause defects in the installation of all elements of the stairwell.

The level of the platforms is checked by leveling at the level of overlap of each floor.

The following rules must be observed when installing sites:

- the bed on which the platform is installed should be no more than 12 mm thick. The seams are sewn with a solution.

Installation of precast concrete platforms and marches is performed by the mounting link:

Installer of the 4th year — 1

Installer of the 3rd year — 1

Rigger of the 3rd year — 1

During installation, the following operations are performed:

–Preparation of tools;

–Subject of solution;

- Reception and installation of a ladder march and platform;

- reconnaissance of the ladder march and platform;

- breakdown;

– hemp and seam fill.

First, the installers with the help of steel roulette design the place of installation of the staircase with the marking on the wall. The site is installed by the installers and placed in place according to the markings. One installer checks the position of the site with a pattern that has the shape of a stairway.

The second adjusts the scrap position of the site and concludes in the design position. The joints are earned by the solution.

The installation of the stairway begins with the cleaning of the surface of the staircase to support the march and the bedding solution.

The ladder march for 4 loops and lift the crane. The installers take the march at a height of 0.2-0.3 m and orient the yogh to the place of laying. In this case, one installer is on the upper platform and the other on the intermediate one. march to design position.After completion of the reconciliation checks the horizontal of the stairs.

When performing the work it is necessary to observe the safety rules, paying special attention to the following:

–All workers engaged in installation work must be trained and instructed on the safety of working methods in accordance with the safety instructions for the installation of steel and reinforced concrete structures.

- The decks and steps above 1 m above ground level or overlapping should be enclosed by railings of at least 1 m in height

- it is forbidden for people to stay on floors and stairwells below those on which construction and assembly work is performed (at one grip), as well as in the area of movement of elements and structures by cranes;

–The installer working at height must be given overalls and a tested safety belt, which he must always wear while working at a height of more than 1.5 m from the ground;

–To protect danger zones on the way of the crane movement and at workplaces;

–Parameters of passageways and passageways must be installed in the territory of the assembly sites, zones and passages that are dangerous for passage and passage should be identified, as well as signs and signals visible both day and night, which indicate danger or traffic prohibition..

- gripping devices must be manufactured in full accordance with the "Rules of arrangement and safe operation of hoisting cranes", as well as the State standards.

Table 3.4 Calculation of labor costs and wages

№	Rationale norms DBN	Name of works	One. measurement	Amount works	Average discharge works	Norm time on units of measurement l-year.	Costs work on the whole volume l-days	Price on one vm. UAH	Cost for the whole amount of work, UAH
1	2	3	4	5	6	7	8	9	10
1	7-47-4	Installation of stairs	100piece	0,34	3,5	319	13,56	740-08	251,63
2	7-47-2	Installation of stairs	100piece	0,34	3,7	343,65	14,61	817-88	278,08
3	8-6-7	Brick laying of the walls of the staircase in 1.5 bricks	m^3	416,34	2,7	6,92	360,13	17-73	7381,71
							∑388,3		∑7911,42

3.6.3. Technical and economic indicators

Technical and economic indicators

№ p/p	Name of indicators	Un. mea.	Amount
1	The volume of work	m^3	93,5
2	Duration of work	days	156
3	The complexity of the work	l-days	388,3
4	The specific complexity of the work	m^3/ l-days	4,15
5	Output in natural indicators per worker	m^3/ l-days	0,24
6	The crew's work for the change	m^3	0,72

3.6.4. Logistics resources

Basic designs, materials

№	Name	Brand	Unit of measurement	Number
1	Stairway	LM30.11	piece	34
2	Staircase	LP22.13.2	piece	34
3	Cement mortar	M -100	m^3	0,85

Machines, equipment, tools

№ p/p	Name	Type	Brand	Amount	Tech-chara-stic
1	Mounting crane	tower	KB-504.2	1	-
2	The sling is a six-ton universal load-lifting capacity 2,5t with a sling length of 4,0m.	-	CINIOMTP 054-1000	1	-
3	Ladder platform for slinging of marches and platforms	-	NIOMT	2	-
4	0.27 m^3 solution box	-	Drawing No. 1107 of the Mosobloggrest Building Trust	2	-
5	Bucket for solution	-	-	1	-
6	Lighting installation (mast)	-	Orgenergo Institute	1	-
7	Spotlight	CCD-35	-	12	500W
8	Mounting belt with carbines, clamps	-	GOST 718-51	2	-
9	The meter is steel	-	GOST 7253-54	1	-
10	The roulette is steel	PC-20	GOST 7202-61	1	-
11	The brush is metallic	-	-	2	-
12	Scrap steel assembly	LM-4	GOST 1405-65	2	-
13	Trowel mason	KB	GOST 9533-60	4	-
14	The hammer is a steel hammer	MKI	GOST 11042-64	4	-
15	Building level	IC1-300	GOST 9416-67	1	-
16	The shovel is owl	PR	GOST 3620-87	2	-
17	The shovel is bayonet	PKO-1	GOST 3620-61	1	-
18	Hemp rope Ø15,9mm for drawing	-	-	40 m.r.	-
19	Helmet to protect the head from damage	-	GOST 9819-61	3	-
20	Projector inventory portable support	-	-	1	-

Schedule of works

№ p/p	Name	Units. measure-ment	Time standard per unit l-h.	Time standard per unit l-h.	The complexity of the entire volume of work l-dn	The composit. of the team	The number of chan.	Working days												
								4	8	12	16	20	24	30	34	38	42	46	50	54
1	Installation of stairs	100pie.	0,34	319	13,56	mounter	2													
2	Installation of stairs	100pie.	0,34	343,65	14,61	mounter	2							54 20						
3	Brick laying of staircase walls in 2 bricks	m^3	416,34	6,92	360,13	rigger	2													

3.7. Technological map for arrangement of flat roll roof, device of linoleum floors

3.7.1 Field of application

The technological map is designed for the roofing device made of rolled roofing material "Elabit". "Elabite" is a rolled material consisting of a non-corrosive base (fiberglass, fiberglass or polyester), on which a bituminous binder is applied on both sides. The lower side of the material is covered by a flammable polymer film, the upper side is polymeric or coarse-grained.

3.7.2 Organization and technology of construction process

Roofing arrangements must be completed prior to the start of the installation and accepted:

- all construction and installation work on insulated areas, installation and fixing to the steel profiled decks of gutter funnels, expansion joints, anchor bolts, antiseptic wooden bars for fixing insulating layers and protective aprons;

- layers of steam and thermal insulation, screeds and then a check was made of the slopes and evenness of the base under the roof on all surfaces, including the eaves of the roofs and the places of adjoining protruding above the roof structural elements.

If all the requirements of the project for the quality of the base are met, the surface of the screed can be primed. The base is dry after priming and is ready for the roof to be installed.

The thermal insulation soaked during installation must be removed and replaced with a dry one.

During the period of work organization, a special condition is that the insulation work must be carried out in dry weather, to prevent the insulation material from getting wet. The quality of the thermal insulation must be specified in the hidden works acts.

In the new coating, the roofing carpet is made of two layers of surfaced roll material, and coarse-grained materials are applied to the top layer.

Bonding "Elabit" is carried out by heating the deposited layer with burners that run on liquefied propane-butane gas or liquid fuel.

The device of the roof carpet within the working engagements starts with the reduced areas: eaves, areas of the location of the gutter funnels and grooves.

When sticking insulation layers, allow the adjacent adjacent webs to be 100 mm.

Technological techniques for stickers of surfaced roll material may be different. The work can be performed in the following order: on the prepared basis roll out 5-7 rolls, try on one roll in relation to another and provide the necessary leave. Then the ends of all the rolls are glued to one side and the webs of the roll material are rolled back into the rolls. Rolls, unfolding, are glued to the base with the help of a manual gas or liquid burner.

One should pay particular attention to the synchronization of the melt layer of the mastic and the roll. The speed of movement is determined by the time required to start the melting of the mastic layer of the adhesive roll, which is evaluated visually at the beginning of the formation of the melt roller mastic.

3.7.3 Safety recommendations

When working with gas-flame equipment, it is recommended to wear safety goggles.

During interruptions, the flame of the burner must be extinguished and its valves tightly closed.

Roofing materials, equipment, fuel should be lifted using hoisting mechanisms in special containers or tightly packed into packages.

If gas leaks from cylinders are detected, work should be stopped immediately. Repair of cylinders or other equipment in the workplace of gas flame works is not allowed.

The roofer's workplace must be provided with the following fire fighting and medical supplies:

- powder fire extinguishers per one roof section of at least two pieces;
- a sand box with a capacity of 0.05 cubic meters;
- blades - 2 pieces;
- asbestos canvas - 1 sq. m;
- first aid kit with a set of medicines.

In the event of a workplace fire it is necessary to extinguish it with the use of fire extinguishers, dry sand, covering the fires with asbestos or tarpaulin cloth.

Roofing works at the same time as other construction and erection works on roofs related to the use of open flames (welding, etc.) are not allowed.

The equipment used for heating the surfaced roll roofing material is not allowed to be used with faults that can lead to fire, as well as with switched off measuring instruments and technological automation, providing control of the set modes of temperature, pressure and other regulated safety conditions.

It is forbidden to use the heating equipment:

- heat frozen piping, valves, gearboxes and other parts gas installations with open flames or hot objects;
- use sleeves longer than 30 m;
- twist, refract, or clamp gas piping sleeves;
- use clothing and gloves with traces of oils, fats, gasoline, gas and other flammable liquids;
- allow students, as well as employees who do not have a qualification and safety certificate to work independently.

It is allowed to store no more than the variable needs of consumables on the roof of the roofing works.

The stock of materials must be at least 5 m from the boundary of the work area.

If there is a fire or burning signs (smoke, burning odor, fever, etc.):

- notify the fire department immediately;
- take measures to evacuate people, extinguish fires and ensure the preservation of property.

After completion of the work, it is necessary to inspect the sites and bring them into fire condition. The facility must identify the person responsible for the preservation and readiness for primary fire extinguishing agents.

3.7.4 Calculation of labor costs and wages

Rationale	The name of the components of the process	Units	Volume of works	Norm of time. per unit. measurement man. - hour	Costs labor for the whole volume of work, man.-days	Costs labor for the whole volume of work, man.-days	Cost costs for all volume of work UAH
DSTU B D.2.2-12:2012	Arrangement of vapor barrier pasting in one layer...	100m²	58,07	59,28	24,49	58,07	3442
DSTU B D.2.2-12:2012	Warming of coverages by flags from a foam plastic polistirol'nogo on a bitumastic in one layer	100m²	58,07	227,50	29,39	58,07	13211
DSTU B D.2.2-12:2012	Arranging of the leveler gatherings cement-sandy in thick 15 mm	100 m²	58,07	765,20	38,39	58,07	44435
DSTU B D.2.2-12:2012	Arranging of roofs of flat is from naplavlyuvanikh materials in two layers	100 m²	58,07	137,93	21,8	58,07	8010
DSTU B D.2.2-12:2012	Arranging of gully craters	pie.	12	142,3	22,8	58,07	8610
DSTU B D.2.2-12:2012	Protection of roof	100 t	1,41	111,6	16,14	58,07	7550
	All				153,01		85258

3.7.5 Technical and economic indicators

Labor costs - 153.01 man-days.

The output per worker per shift is 7.25 m2.

Cost of works - 85258 UAH.

3.7.6 Schedule of works

The name of the process	Units	Volume of works	Costs labor, man-days mach-chan.	Duration of execution, days	Composition of brigade	Working days 1 2 3 4 5 6 7 8 9 10
Laying vapor barrier in one layer	100 m²	58,07	24,49	4	4 gr (2)	4 gr (2)
Heat insulation of foam boards of polystyrene on bituminous mastic in 1 layer	100 m²	58,07	29,39	1	4 gr (2)	4 gr (2)
Adjustment of leveling couplers cement-sand 15 mm thick	100 m²	58,07	38,39	1	4 dr (2)	4 gr (2)
Arrangement of flat roofs from weldable materials in two layers	100 m²	58,07	21,8	2	4 gr (2)	4 gr (2)
Arranging of gully craters	pie.	12	22,8	1	4 gr (2)	4 gr (2)
Protection of roof	100 m	1,41	16,14	1	4 gr (2)	4 gr (2)
Work of faucet						

3.7.7 Statement of need for materials and semi-finished products

Name	Un.mea.	Amount
Primer for foundation preparation	kg.	1230
Elabit-K, Elabit-P roll materials	m^2	1370
Cement-sand mortar	m^3	18
Steel building enclosure	kg.	330

3.7.8 Equipment, devices, inventory

Name	Type,Brand	Un.mea.	Amount	Technical cha-stic
Mobile crane	KC-4571	Pie.	1	Q=5t,L=22m
Propane-butane cylinder	-	Pie.	2	-
Gas	GG-2C	Pie.	2	-
Skating rink	-	Pie.	2	-
Attachment	C-108	Pie.	4	-
Trolley with capacity	-	Pie.	1	-
The container is rolled	-	Pie.	1	on 4 rolls
Carver	-	Pie.	2	-
Roulette	-	Pie.	2	10m
Folding meter	-	Pie.	4	-
Rubber hose	-	Pie.	4	Length 1.5m
Rubber hose	-	Pie.	4	Length 15m
Brush	KMA-2	Pie.	4	-
Bucket	-	Pie.	4	10l
Norm set	-	Pie.	4	-

Rubber boots	-	Kit	10	-
Tank for mastic	-	Pie.	4	Volume of 15 l
Cabinet brigade	-	Pie.	1	-
the roofing brush	-	Pie.	4	-
Thermometer	-	Pie.	4	Until 300 deg.

3.7.9. Scheme of operational quality control of the performance of roofing

Name of operations subject to control		Quality control of operations		
Foreman's	Master's	Complement	Methods	Time
Preparation of the basis	—	Surface evenness, absence of thermal insulation layer violations. Compliance with design bias. Laying places to mines, parapets, walls	Visually, the rail, slope and other measuring	Before the start of the device screed and carpet
Installation of cement-sand screed	—	Evenness of surface, absence of caverns, influxes of thermal insulation. compliance with the design bias. Laying of adjacent places, smoothness of transition of a surface	Visually, level	Before the start of the coupler
Laying of heat-insulating plates	—	Thickness of layers of observance of deviations, tight fit of products to the isolated surface with each other	Using measuring tools	In the process of work
Arrangement of drains. creating a bias cover	—	Compliance of longitudinal and transverse biases with design	Visually, level	Before the start of the coupler
Sticker roll rug	—	Thoroughness of the roof carpet sticker (layer by layer). Overlapping of seams (overlay) of a young adhesive of additional layers of a carpet at the places of adjoining	Visually	Top of the roll carpet sticker

3.7.10. Safety measures when performing roofing works

Additional safety requirements are imposed on roofers engaged in construction work. Roofers are allowed to undergo medical examinations, special training courses, and have passed exams and are certified to be at least 18 years of age and over 60 years of age. The facility must be equipped with a first aid kit and medication.

Workplaces should, where necessary, have enclosures, protective and safety devices. All workers engaged in roofing work must be provided with overalls, work footwear of the required sizes and personal protective equipment in accordance with the nature of the work being performed..

All workers must be instructed on fire safety measures. Workplaces that are hazardous to the fire situation are equipped with the primary means of extinguishing fire: sand boxes, fire shields with tools and equipment. For smoking cigarettes we take special places equipped with barrels filled with water.

To prevent splashing of the binder, boilers and transfer tanks and bitumen feeds must be no more than 3/4 of their capacity.

When preparing the bitumen primer, heated to 70 ° C, the bi-tum is poured into a solvent vessel and stirred with a wooden stirrer. Daily reserves of fuel and raw materials should be no closer than 4 m from the boiler. The transfer and transportation of mastic in open containers is prohibited. Along the perimeter of the building it is planned to establish an area that is dangerous for people to move around, to enclose or mark it with clearly visible warning signs and inscriptions. The width of the zone

7,8 0,3 = 2,4 m at building height up to 7,8 m.

3.8. Definition of the term of construction

The duration of the construction period is governed by the rules of construction duration and construction time (DSTU B A.3.1-22: 2013).

For the construction of a 15-storey residential building with underground parking, the construction period is 443 days.

The most responsible and important in the calendar plan is the production schedule. When drawing up the plan, it is necessary to take into account the directive term of construction technological duration of work execution, maximum time combination of certain types of work, execution of works by large construction machines, in two shifts, uniform distribution of workers, observance of labor and safety rules.

The duration of the work on the graph is indicated by a vector line. Above it is indicated the number of workers. The duration of work for mechanized work is determined by the number of machine changes, for others, based on the number of workers in the team (unit) that perform the process. The number of workers is determined in accordance with the accepted complexity. Not allowed large changes in the number of workers, as the schedule of their movement will be with a big difference.

It is necessary to strive for a constant number of workers at the facility. Changes in their number are allowed. The schedule should be drawn up so that after the end of the work on one job the workers go to another.

Columns 1-5 of the schedule are filled in on the basis of complexity and machine changes. Accepted complexity is determined by multiplying the number of workers by the length of time worked in days and by the number of shifts.

The required machines are accepted in accordance with previously selected methods of work. Box 9 is determined by the number of machine changes received, which is obtained by multiplying the duration of work in days by the number of changes.

The duration of the execution of certain types of work involving construction machines, which is determined by dividing the number of machine changes by the number of changes. The number of changes for all major machines is accepted at least two.

The number of workers per shift is determined by the ratio of labor input to the duration of the process. Box 13 records the composition of the crew.

Small and homogeneous works can be performed by a team of one specialty, for example - manual tillage, a device of sand preparation for foundations, a device of waterproofing of foundation blocks, preparation for paving, improvement of the territory.

In the process of developing the calendar plan, it is necessary to provide for the equal use of workers. For this purpose, as the plan is drawn up under it, a schedule of changes in the number of workers is crossed out. For each day, the number of workers is summed up and postponed, taking into account that the technological sequence of work and the rules of labor protection are not violated.

3.8.1. Calendar of construction

The calendar schedule is made in compliance with the basic rules of its construction, taking into account the use of complex mechanization, technological sequence, terms of execution of their work accuracy and the maximum possible alignment.

The grid schedule has 50 events and is calculated based on the determinant card. The volume and labor input data were used to compile the determinant card.

All works of the underground part are designed for 2 grips.

Ground part - the erection of the frame is performed on the floors and the grip is taken 3 floors.

The roof is covered with a plastic membrane, divided into two clamps

Finishing works are carried out from the bottom to the bottom and for the capture it is accepted:

1 grip - 18-16 floors

2 engagements - 15-13 floors

3 clutches - 12-10 floors

4 clutches - 9-7 floors

5 grasp - 6-4 floors

6 grips - 3-1 floors

In parallel with the finishing works, the interior is externally equipped.

3.8.2 Determinator of the work and resources of the calendar schedule

Table 3.5 Determination card for grid jobs and resources

№	Circle of work	Characteristics of works		Amount of work		The complexity, people days	Performer		Number of changes to day	The main mechanisms	
		The name of the works	Term, days	Unit measurement	Q-ty		Brigade, profession	No. people in the shift		Name	No.
1	2	3	4	5	6	7	8	9	10	11	12
1	1-30-2	Site planning	18	1000 m^2		1,44	Workers	10	1	Bulldozer	1
2	1-21-6	Cut the vegetable layer	2	1000 m^2	3,682	9,48	5gr-1; 4gr-4; 3gr-5	2	2	Bulldozer	2
3	1-13-5	Excavation of soil in a pit	4	1000 m^3	3,682	64,91	Machinist 6gr-1	4	2	Excavator	2
4	1-13-5	Soil completion in the pit	4	1000 m^3	6,134	2,17	Machinist 6gr-1	4	2	Excavator	2
5	11-2-4	The arrangement of the crushed stone preparation under the foundation t = 100 mm	2	100 m^2	0,205	0,55	Remember machines. 4gr-1	6	2	Concrete pump	1
6	7-1-3	Installation of wall blocks	14	100 piece	0,864	134,04	- // -	6	2	Concrete pump	1
7	5-29-2	Borehole injection piles Ø500	14	m^3	12,19	354,07	Machinist 3gr-1	8	2	Concrete pump	1
8	6-19-1	Arrange the gadget	14	100 m^3	950,53	493,45	Concrete mixer 5gr-1; 4gr-2;	8	2	Concrete pump	1
9	8-4-3	Horizontal waterproofing of two layers of roofing material	7	100 m^2	3,30	16,82	3gr-2	4	2	KB-504.2	1
10	8-4-7	Vertical waterproofing of two layers of bitumen	7	100 m^2	4,238	44,80	- // -	4	2	KB-504.2	1
11	6-15-1	Arrangement of monolithic columns in the	7	100 m^3	10,698	58,68	Machinist 3p-	8	1	-	-

		parking lot					1				
12	7-45-6	Installation of floor slabs above the parking lot	7	100 piece	0,563	57,28	Concrete ixer 5gr-1; 4gr-2;	8	1	-	-
13	1-27-2	Backfill of sinus ground	2	1000 m^3	1,38	20,36	3gr-4	20	2	KB-504.2	1
14	1-134-1	Compaction of soil with rammers	2	100 m^3	1,189	2,73	5gr-1;4gr-1;3gr-2;2gr-1	20	2	-//-	-//-
15	11-2-9	Arrangement of the underlying concrete layer	4	100 m^2	1,189	7,71	-//-	20	2	-//-	-//-
16	8-19-3	Brick laying of exterior walls t = 510 mm	26	m^3	10,669	2502,80	-//-	20	2	-//-	-//-
17	8-19-3	Brick laying of internal walls t = 510 mm	26	m^3	2792,51	2471,30	-//-	20	2	-//-	-//-
18	8-7-3	Brick laying of partitions with reinforcement t = 65 mm	26	100 m^2	2857	460,92	-//-	20	2	-//-	-//-
19	6-19-1	Installation of monolithic belts t = 300mm (4 belts)	26	100 m^3	16,32	119,92	Joiner 4gr-1; 3gr-1	2	2	-	-
20	7-47-2	Installation of stairs	26	100 piece	0,802	14,61	-//-	2	2	-	-
21	7-47-4	Installation of stairs marches	26	100 piece	0,34	13,56	-//-	2	2	-	-
22	7-45-6	Installation of floor slabs and coverings	26	100 piece	0,34	532,11	8	9	10	11	12
23	6-22-3	Concreting of monolithic sections of overlapping and covering	4	100 m^3	12,82	201,27	-//-	2	2	-	-
24	10-18-1	Filling of window openings	26	100 m^2	1,727	419,68	-//-	2	2	-	-
25	10-26-1	Filling of doorways	26	100 m^2	13,281	241,05	-//-	2	2	-	-
26	12-20-1	Steam insulation	4	100 m^2	13,571	17,78	Insulators	4	1	-	-
27	12-18-1	Mineral wool cover insulation	4	100 m^2	5,807	21,33	5gr-1; 4gr-1; 3gr-2	4	1	-	-
28	12-22-1	Installation of cement-sand screed	3	100 m^2	5,807	27,87	- // -	5	1	-	-
29	12-1-6	Membrane roof arrangement	18	100 m^2	5,807	15,82	Roofers	5	1	-	-
30	12-18-1	Insulation of the over-parking floor	9	100 m^2	5,807	20,07	5gr-1; 4gr-2; 3gr-2	20	2	-	-

31	12-18-1	Arrangement of cinder layer on the floor	34	100 m^2	5,463	331,91	-//-	20	2	-	-
32	11-15-1	Arranging the concrete floor in the basement	9	100 m^2	90,345	87,94	-//-	20	2	-	-
33	15-64-2	Leveling the ceiling surface	16	100 m^2	12,334	838,51	-//-	20	2	-	-
34	11-27-3	Ceramic floor arrangement	22	100 m^2	90,345	470,72	-//-	20	2	-	-
35	11-17-3	Mosaic floor arrangement	18	100 m^2	22,485	518,36	-//-	20	2	-	-
36	11-34-3	Arrangement of a parquet floor	30	100 m^2	14,342	1088,98	Concrete mixers 5gr-1; 4gr-1; 3gr-4	6	1	-	-
37	15-151-2	Water-emulsion painting of a ceiling	13	100 m^2	53,621	188,15	-//-	6	1	-	-
38	15-61-1	Plaster of interior walls	41	100 m^2	90,346	3484,69	-//-	6	1	-	-
39	15-151-2	Water-emulsion painting of walls	10	100 m^2	259,93	516,56	-//-	6	1	-	-
40	15-152-1	Lime wall painting	10	100 m^2	248,05	470,67	-//-	6	1	-	-
41	15-152-1	Limestone ceiling painting	8	100 m^2	248,05	171,43	-//-	6	1	-	-
42	15-171-2	Parquet floor lacquer for 2 times	15	100 m^2	90,346	123,86	Workers 5gr-1; 4gr-3; 3gr-5	9	2	-	-
43	11-27-2	Facing the inner walls with ceramic tiles	8	100 m^2	53,62	248,71	-//-	9	2	-	-
44	11-19-3	Paving device	5	100 m^2	11,88	7,32	-//-	9	2	-	-
45	15-5	Facing the plinth	2	100 m^2	1,783	181,08	-//-	9	2	-	-
46	15-69-2	Preparation of the facade surface	10	100 m^2	1,951	395,94	-//-	9	2	-	-
47	26-12-	Insulation by foam boards	6	100 m^2	65,297	77,05	-//-	9	2	-	-

	1										
48	8-4-5	Waterproofing	6	100 m^2	65,297	603,51	Painters 6gr-1; 5rg-1; 4gr-2; 3gr-2 6	6	2	-	-
49	15-185-1	Priming of surfaces	6	100 m^2	65,297	642,52	-//-	6	2	-	-
50	15-155-2	Painting of facades	20	100 m^2	65,297	251,80	-//-	6	2	-	-
					∑	18946,27				-	-
		Plumbing works	18	3%	123,72	568,39	Plumbing fixtures	6	2	-	-
		Electrical work	18	2%	123,72	378,93	5gr-1; 4gr-3; 3gr-5	6	2	-	-
		Land improvement	18	1%	-	568,39	Electricians	6	1	-	-
		Delivery of the object		0,5%		94,73	-//-	6			
		Unforeseen work	48	10%	-	1894,63		10	1	-	-
					∑	22640,8					

3.8.3 Technical and economic indicators of the calendar schedule

Total duration of construction $T_{кр} \leq T_{норм}$ 443<450 days.

Reconciliation rate of construction processes over time $K_{сум} = \frac{\sum_{1}^{n} t_{m-n}}{T_{кр}} = \frac{1196}{443} = 2{,}7$

$T_{кр}$ – duration of critical path in days;

T – duration of work in days according to the calendar schedule.

Indicator of uneven movement of labor resources

$$K_{нер} = \frac{N_{\max}}{N_{сер}} = \frac{76}{51} = 1{,}5$$

$N_{\max}$ – maximum number of workers per day;
$N_{сер}$ – average number of workers.

$$N_{сер} = \frac{\sum Q}{T_{кр}} = \frac{22640{,}8}{443} = 51$$

$\sum Q$ – the total complexity that is required to build an object or structure, man-days.
Variability indicator

$$K_{зм} = \frac{N}{\sum_{1}^{n} t_{m-n}} = \frac{2153}{1196} = 1{,}8$$

N – the total number of changes worked out over the period of the property's construction.

$\sum_{1}^{n} t_{m-n}$ – the total number of days worked over the period of the construction of the object.

3.8.4. Consideration of requirements of safety at design calendar plan.

A work schedule is a basic design document that establishes a technological link between individual construction processes and the mobility of workers over time to ensure the creation of a finished object.

When linking the sequence of construction works for the construction of a tractor repair shop, the features of technology of complex processes, design and planning decisions, regulatory terms of construction, safety conditions when performing separate works and when combining several works, the conditions of industrial sanitation are taken into account

Installation of structures is carried out only after installation, testing and technical inspection of the installation crane.

At the site (occupation), where the installation work is carried out, we prohibit the execution of other works and finding extra people.

During the erection of the building, it is forbidden to perform work related to finding people in one section (occupation, section), over which the movement, installation and temporary fixing of elements of prefabricated structures or equipment is carried out.

When erecting an auto repair shop, simultaneous execution of work combined vertically, is allowed with the written order of the chief engineer and we plan to perform them at different bites, if there is a danger when performing the work below.

The procedure for carrying out the work in the calendar is planned in such a way that provides stability of the constructions that are being mounted and the reinforcement of concrete joints, which allows the installation of the following structural elements of the building.

Thus, following the conditions and safety measures, it is planned to combine the works on the roof arrangement with the works on the arrangement of concrete preparation for the floor, arrangement of partitions, installation of doors and gates, masonry of framing, plastering of frames and partitions, finishing works as outside building.

Over time, these works are combined, but they are designed to be performed on different parts of the building.

When performing roofing work using hot bitumen with several links, the distance between them is accepted not less than 10 m.

Finishing works are planned in the warm season and, if necessary, after the start of central heating.

Specific works: sanitary and electrotechnical included in the nomenclature of works in order to create safe and safe working conditions at the facility and to create conditions for normal sanitary and hygienic servicing of workers.

3.9. Construction master plan

Construction master plan is one of the important parts of the project of organization of construction and production of works. Based on the developed plan, the amount of priority preparatory for the construction of buildings and structures is determined, the execution of which stipulates the terms of construction of the building.

The plan shows the location of temporary structures of the crane.

The radii of rounding of roads have been adopted such that the necessary standard sizes of construction products can be transported. On the site there is a water supply system with fire hydrants, fountains, water intakes, water supply to shower rooms, dining room.

The temporary power supply system provides full power for the construction site at night, and connects all units and mechanisms. The space for the transformer substation and switchboards is enclosed to prevent unauthorized persons from entering their territory and electrocution.

The construction site on all sides is closed by a temporary fence.

3.9.1. Calculation of warehouses and sites

The calculation of warehouse areas is performed in tabular form (Table 3.6).

In order to calculate the area of warehouses, it is necessary to make a preliminary selection of basic building materials with production rates of materials in accordance with DBN.

Table 3.6 Selection of building materials

№	Normative source for DBN	Name of works	Scope of work		Cost of materials	
			Unit of measurement	Number of units	Per unit	On the whole volume
					people-year	people-days
1	5	2	3	4	6	7
1	8-19-3	Laying of exterior walls. Brick, mortar	m^3	2792,51	394piece 0,24 m^3	1100249piece 670,2 m^3
2	8-19-3	Laying of internal walls. Brick, mortar	m^3	2857	394piece 0,24 m^3	1125658piece 685,68 m^3
3	8-7-3	Laying of brick partitions. Brick, mortar	100 m^2	16,32	2700piece 0,77 m^3	44064piece 12,57 m^3
4	7-45-6	Installation of overlapping panels Overlapping plates. Solution	100piece	12,82	– 4,1 m^3	1282piece 52,56 m^3
5	7-47-4	Installation of stairs. Cement mortar.	100piece	0,34	– 0,16 m^3	34piece 0,054 m^3
6	7-47-2	Installation of stairs. Solution.	100piece	0,34 –	– 0,16 m^3	34piece 0,054 m^3
7	10-18-1	Window blocks	100 m^2	13,28	–	1328 m^2
8	10-26-1	Door blocks	100 m^2	13,57	–	1357 m^2
9	12-1-6	Covering with a plastic membrane. Plastic membrane	100 m^2	5,807	-	580,7 m^2
10	12-18-1	Heat insulation boards with minvat. Heater	100 m^2	11,27	1,03 m^3	11,61 m^3
11	12-20-1	Steam insulation from the film. Film	100 m^2	5,807	110 m^2	638,8 m^2
12	11-27-3	Ceramic floor. Ceramic tile. Solution	100 m^2	22,485	102 m^2 1,32 m^3	2293,5 m^2 29,68 m^3
13	11-34-3	Parquet floor. Parquet. Parquet varnish	100 m^2	53,621	102 m^2 30kg	5469,34 m^2 1608,63 kg
14	15-61-1	Plastering of walls, ceilings. Putty	100 m^2	350,28	79,4kg	27812,2 kg
15	15-152-1	Painting of walls, ceilings. Lime	100 m^2	338,4	15,1kg	5110kg
16	11-27-1	Facing of walls by a tile. Tile. Solution	100 m^2	11,88	102 m^2 1,5 m^3	1212 m^2 17,82 m^3

3.9.2. Calculation of warehouse areas for construction

Table 3.7 Statement of calculation of warehouses

№	Name of materials of structures and details	Units of measurement	Number of materials	Estimated period	The biggest daily expenses	Accepted stock in warehouses	Stock in natural display.	Maternal preservation rate. per 1m3 area composition	Usable floor area of m2	Coefficient of use. area	The estimated area of the warehouse	Type of warehouse	Type of structures
1	Brick	t.piece	2269,97	156	20,8	10	208	0,7	297,14	0,7	424,5	open	–
2	Plates of overlapping	m^3	1282,0	156	11,75	5	58,75	1,0	58,75	0,7	83,93	open	–
3	Ladder marches	m^3	26,5	156	0,24	5	1,2	1,0	1,2	0,7	1,71	open	–
4	Stairs	m^3	14,96	156	0,14	5	0,7	1,0	0,7	0,7	1,0	open	–
5	Window blocks	m^2	1328	156	12,17	5	60,85	45	1,35	0,7	1,93	mad	–
6	Door blocks	m^2	1357	156	12,44	5	62,2	41	1,52	0,7	2,17	mad	–
7	Plastic membrane	m^2	580,7	8	103,8	5	519	500	1,04	0,7	1,49	closed	Coll
8	Heater	m^3	11,61	8	2,08	5	10,4	2,0	5,2	0,7	7,43	mad	–
9	Film	m^2	638,8	8	114,19	5	570,95	200	2,85	0,7	4,07	closed	Coll
10	Ceramic tile	m^2	2293,5	108	30,37	10	303,7	80	3,8	0,7	5,43	-//-	-//-
11	Parquet	m^2	5469,34	108	72,42	10	724,2	354	2,05	0,7	2,93	-//-	-//-
12	Putty	t	27,81	108	0,37	10	3,7	0,8	4,63	0,7	6,61	-//-	-//-
13	Lime	t	5,11	108	0,068	10	0,68	2,6	0,26	0,7	0,37	-//-	-//-

Open warehouses - 511.14 m^2; Closed warehouses - 20,9 m^2; Mounted - 11,53 m

3.9.3. Calculation of administrative and residential buildings

Table 3.8 Estimated number of employees

Number of employees in the most downloaded shift R	Main production workers R_1	ITP R_2	Employees R_3	ILO and security R_4	Estimated number of workers $R_{роз}$
$R = R_{\max}$ 41 worker	$R_1 = 0{,}1R$ 4,1=4,0 worker	$R_2 = 0{,}12 \cdot (R_1 + R)$ R_2=0,12(4+41)= =6 worker	$R_3 = 0{,}02 \cdot (R_1 + R_2)$ R_3 =0,02(4+6)= =1 worker	$R_4 = 0{,}1 \cdot \begin{pmatrix} R + R_1 + \\ + R_2 + R_3 \end{pmatrix}$ R_4=0,1(41+4+6+1)= =5 worker	$R_{розр} = (R + R_1 + +R_2 + R_3)$ $R_{розр}$ =41+4+6+1+5= =57 worker

Table 3.9 Calculation of temporary buildings and structures

№	The name of the temporary houses	$R_{розр}$	Norm for one worker	Calc. Square, m^2	Type of the accepted house	Dimensions	Number of houses	Accepted area, m^2
1.	Checkpoint	–	–	9	Cont.	3x3	1	9
2.	Prorobskaya	10	4	40	Cont.	3x3	5	45
3.	Dressing rooms	76	0,6	45,6	Cont.	3x4	4	48
4.	Showers	41	41:8x3	15,4	Cont.	3x3	2	18
5.	Washbasins	57	57:7x1,5	12,2	Cont.	3x5	1	15
6.	Toilet	57	57:15x3	11,4	Cont.	3x2	2	12
7,	For drying clothes	41	0,25	10,25	Cont.	3x4	1	12
8,	Approx. for eating	57	1,0	57	Cont.	3x5	4	60
								Σ219 m^2

3.9.4 Calculation of temporary water supply object of construction

It is recommended that the design of temporary water supply is carried out in the following order:

-definition of water consumers;

- determination of water demand of consumers
- definition of estimated water costs for construction;
- establishment of water quality requirements;
- choice of sources of water supply;
- design of water supply systems and choice of network scheme;
- calculation of pipe diameter.

The initial design data for water supply are:

- nomenclature and volumes of work;
- terms of work;
- the number of workers employed at the construction site;
- data on sources of water supply.

The estimated seconds of water consumption are determined by the formulas for each consumer separately.

For production purposes, the secondary costs of water are equal:

$$Q_b = \frac{V \cdot q_1 \cdot k_1}{n \cdot 3600},$$

where Q_b- maximum secondary water consumption for production purposes, l;

V - the amount of construction work, or the amount of production that is produced per shift at a construction site;

q_1 - the amount of construction work, or the amount of production that is produced per shift at a construction site;

K_1 - coefficient of uneven water consumption;

n - number of hours per shift.

For economic and drinking needs, secondary water costs are equal:

$$Q_Г = \frac{P_{роз}}{3600} \times (\frac{q_3 \cdot k_3}{n} + q_4 \cdot k_4),$$

where Q_m- maximum secondary water consumption for drinking-water needs at the construction site, l;

$R_{роз}$- maximum number of construction workers per shift;

q3 – norm of water consumption per person per shift in l;

q4 - rate of water flow for receiving one shower in l;

k3 – coefficient of unevenness of water consumption for sanitary needs;

k4 – coefficient, which takes into account the ratio of workers who use the shower to the largest number of workers per shift, is assumed equal to 0.3… 0.4.

n is the number of hours per shift.

For extinguishing a fire at a construction site, the secondary water costs are taken according to the norms, which are adopted depending on the area of the construction site, for the area of the site up to 30 ha – 10 l / s.

The calculation data should be summarized in a table of water needs at the construction site.

Table 3.10 Water needs on the construction site

№	Consumers of water	The amount of work per shift		Water costs, l	
		Unit measurement	Quantitative indicator	Norm of unit measurement, l	Common water consumption in liters
1	2	3	4	5	6
Production needs					
1	Plaster works	m^2	162,16	8,0	0,072
2	Painting works	m^2	343,56	1,0	0,019
					∑0,091 l/s
Economic and drinking needs					
	Drinking costs:	people	57	15	0,08
	working				
	and other needs				
	Used. shower	people	34	30	0,035
					∑0,115 l/s
Fire-fighting needs					
	Area up to 30 hectares				10/s

Estimated second costs are the largest.

$Q_{1роз}=Q_В+Q_Г=0,091+0,115=0,206$ l/s

$Q_{2роз}=Q_П+1/2(Q_В+Q_Г)=10+1/2(0,091+0,115)=10,103$ l/s

Calculation of pipe diameter

The calculation of the diameter of the pipes of the water supply network must be performed during the periods of its hardest work, that is, it should provide of water consumers in terms of maximum water intake and for the duration of the fire extinguishing. The pipe diameter is calculated according to the formula:

$$D=\sqrt{\frac{4Q_p 1000}{\pi V}}=\sqrt{\frac{4\cdot 10{,}103\cdot 1000}{3{,}14\cdot 1{,}5}}=92{,}63\textit{мм}\,.$$

where V – the speed of movement of water through the pipes *V=1,2 – 2 m/s* (for temporary water supply).

We accept asbestos-cement pipes with *Ø100 mm* with fire hydrant 100 mm.

3.9.5 Temporary calculation electrical supply of the construction object

The required amount of electricity is determined by the power of the power devices, the external and internal lighting and the production needs.

For the calculation of the production schedule, the maximum energy requirements are determined, and then the electricity costs for individual consumers located on a separate site.

Table 3.11 Electricity costs

№ з/п	Consumers of water	Unit measurement	Quantitative indicator	Rate per unit or installed power, kW	Common electricity costs
1	2	3	4	5	6
			Power electricity		
1	KB-504.2 tower crane	piece	1	50,0	50
2	Electric welding machine	piece	1	20,0	20
					∑70
			Internal electric lighting		
	Office, control room, domestic premises	m^2			
	Showers and toilets	m^2	219	0,015	3,285
	Canopies	m^2	11,53	0,015	0,173
	Closed warehouses	m^2	20,9	0,003	0,31
					∑3,77
			Exterior lighting		
	The territory of the site	100 m^2	71,16	0,015	1,07
	Open warehouses	100 m^2	5,11	0,05	0,26
	The main roads and driveways		0,19	5,0	0,95
	Stone pit	100 m^2	4,25	0,08	0,34
	Emergency lighting	km	0,1	3,5	0,35
					∑2,97

The approximate cost of electricity at the construction site for technological needs and electrical lighting, for the operation of electric motors, construction machines, mechanisms and units is determined by technical characteristics or standards.

The estimated power of the transformer substation will be equal:

$$P = 1{,}1(\frac{70 \cdot 0{,}6}{0{,}75} + 0 + 3.77 \cdot 0{,}8 + 2.97 \cdot 1.0) = 68.18 кВт.$$

We accept the transformer TM 100/6 with power of 100 kW.

3.9.6. Technical and economic indicators on the plan

1. Area of construction area $F_б = 7511.67 м^2$
2. The area is occupied by permanent structures $F_п = 1654 м^2$
3. The area is occupied by temporary structures $F_т = 219 м^2$
4. The length of temporary roads is 222 m
5. Length of mains (permanent and temporary) 450 m
6. Length of water supply networks (permanent and temporary) 250 m
7. The length of the fence is 347 m
8. Building factor

$$K_1 = \frac{K_T}{F_б} = \frac{222}{7512} = 0{,}0296$$

Area utilization factor

$$K_2 = \frac{K_T + F_c + F_{T.K} + F_{I.K}}{F_б} = \frac{25 + 22.5 + 888 + 1654 + 219}{7512} = 0{,}374$$

where F_T - area occupied by temporary structures;

F_c - area of warehouses;

$F_{T.K}$ - the area occupied by transport communications;

$F_{I.K}$ - an area occupied by engineering communications;

$F_б$ - the area of the construction site

3.10. Occupational health and safety

All construction work must be carried out in accordance with the requirements of SNIP 4.3. section 4-80.

It is forbidden to carry out works, to store building materials, to arrange parking of cars in the protection zone of the operating transmission lines without coordination with their operating organization.

Along the perimeter of the constructions, establish and mark the danger zone for people, whose width should be at least 7 m.

The operation of the excavator within the radius of the excavator plus 5 m is prohibited.

The installation area, the danger area for locating people while moving, and securing structures must be clearly visible with warning signs or alarms.

Bridges and handrails with handrails should be installed in places when passing through trenches and, if necessary, working conditions.

Soil development in the vicinity of communications is permitted only with the help of shovels and with the written permission of the organization responsible for their operation.

Scaffolding, scaffolding and other facilities for the height of the construction and installation work must be inventory and made on typical projects.

Metal scaffolding should be secured. Placement of temporary roads, cranes, mechanisms, storage facilities, sanitary facilities is shown in the construction plan.

3.10.1 Firefighting measures

All construction work must be carried out in accordance with the requirements of DBN A.3.1-5-2016.

Prior to commencement of construction works, the construction site should be provided with electricity and water, a fire hydrant within 100 m of the fire area should be installed and connected.

On the site of the construction site install a fire shield with a full set of equipment to it and a box with sand.

Approaches to fire extinguishers should be free.

To alert the fire to connect and connect a special alarm with a siren.

The site's construction site must be connected to public roads prior to construction.

The cultivation of campfire in the construction site is prohibited.

Workplace lighting during off-hours (excluding regular lighting) must be switched off and electrical wiring provided for all phases.

All construction work must be carried out in compliance with the rules of fire safety in the production of construction works.

3.10.2 Environmental protection measures for the period of construction.

Provide the following environmental protection measures during the construction period:

- trees, shrubs placed on the site of the site and in the adjacent demolition areas should be preserved without damage;
- the vegetation layer of soil is stored separately and used for land improvement;
- collection of household waste into a metal box, which is installed on the concrete site;
- organize the removal of construction debris by dump trucks at the nearest landfill;
- after finishing work to disassemble the temporary toilet, to fill the pit.

Provide landscaping with trees, shrubs and lawns.

4. Economic part

Estimated documentation is prepared using:

1) Rules for determining the cost of construction [26];

2) Consolidation of the direct cost estimates of the cost of 1 buildings, structures, objects, dwellings in current prices for labor and material and technical resources, according to the average data of the State Building of Ukraine as of 2019-2020.

In the summary estimate, after summarizing Chapters 1-12, the following are determined: estimated profit, administrative expenses, funds to cover the risk, funds to cover the costs associated with inflationary processes, taxes and fees, return amounts.

1. Generation costs are determined according to the calculation;

2. Average indicator of limit of funds for erection and dismantling of titular temporary buildings and structures [26] supplement 6 -2,25%;

3. Cost index for the risk coverage of all construction participants [26] Annex 14 Table 2;

4. The average annual construction inflation index, K-1.0515 (calculation). Costs related to inflation-related costs, calculated taking into account the beginning of 2019 and the completion of construction in 2019;

5. The average indicator of the size of the estimated profit, [26] supplement 13 - 6.20 UAH. people. year;

6. Administrative costs 0, 90 n. people. year;

7. The municipal tax rate is 10%.

To complete the economic part of the diploma - determine the estimated cost of construction, perform calculations for general construction work, object estimates and summary estimates of construction. The calculations are performed according to the consolidated standards and rules for determining the cost of construction [26].

After completing all the calculations in the estimate documentation for the construction of a fifteen-storey building with underground parking in Uzhgorod, we can conclude that this project is economically feasible. All calculations were made in accordance with [26] "Rules for determining the cost of construction".

Total consolidated estimate - UAH 27 215,942 thousand.

Including:

- - Estimated cost – 19 550,151 UAH.
- - Estimated labor costs for the object – 18, 256 563 thousand people-hours
- - Estimated salary on the object – 4 115,363 thousand UAH.

According to the resource elementary estimates (RECN) the level of salary for construction works as of October 20, 2019 is from 8527,52 UAH. at an average discharge of 3.8.

5. Labor protection

5.1. Safety and fire safety at the construction site.

The organization of the construction site, sections of work and workplaces must ensure the safety of workers at all stages of the work.

The construction site is centrally located so it must be fenced off to prevent unauthorized access. Enclosures adjacent to places of mass passage of people must be fitted with a solid protective visor. The design of the fence must meet the requirements of GOST 23407-78: the design of the fence should be collapsible with unified elements, connections and mounting details, the height of the protective panels with the visor is 2.0 m, in sparse panels fence distance in the gap the details of filling the panels of the panels should be within 80-100 mm, the protective visor is installed on the top of the enclosure with the rise to the horizon at an angle of 200 towards the sidewalk, the panels of the visor should provide the sidewalk and in walk in his region (the part of the traffic) 50-100 mm.

Areas of potentially hazardous industrial factors must have signal enclosures that meet the requirements of GOST 23407-78: the height of the racks of the signal enclosure should be 0.8 m, the distance between the racks should not exceed 6.0 m.

There are 1 entrances and 1 exits to the construction site, temporary roads with a width of 6.0 m allow road transport with access to all warehouses and junctions.

When entering a construction site, a traffic pattern must be installed, and road signs on the roadsides and road signs that clearly regulate the traffic order of the vehicle in accordance with the traffic rules.

The speed of motor transport near the production sites should not exceed 10 km / h on straight sections and 5 km / h on turns.

At the construction site, all hazardous areas (erection zone, crane area) are enclosed.

Installation work is allowed for regular people who have undergone a medical examination and are allowed to work at altitude.

The slinging of goods is carried out according to the technical card, the distribution of cargoes and reinforced concrete elements is carried out after fixing them.

The scaffolding must have a level working flooring with a gap between the boards of not more than 5 mm, and when placing the flooring at a height of 1.3 m or more -

fencing and side elements. The connection of decking boards is only allowed along their length, where the ends of the contacting elements should be placed on the support and overlap it at least 0.2 m in each direction. The scaffolding should be attached to the wall of the house under construction. In the absence of specific instructions in the manufacturer's instructions, the mounting of the scaffolding to the walls of the building must be made at least through one tier for the extreme points, through two spans for the upper tier and one mounting for every 50 m2 of the projection of the scaffolding surface on the facade of the building.

The premises in which dusty materials are to be handled, as well as workplaces near the machinery for crushing, grinding and sieving these materials, shall be provided with ventilation systems (ventilation).

Workplaces where adhesives, mastics, paints and other materials emitting explosive or hazardous substances are used or prepared, are not allowed to operate using open flames or sparks.

On the territory of construction in the locations of temporary buildings, warehouses, workshops installed fire shields / stands / and water barrels.

To prevent the spread of fire it is necessary to ensure the construction of sufficient fire extinguishing agents, to observe the rules of storage, placement and limitation of the amount of combustible substances and materials, as well as to comply with other requirements of GOST 12.1.004-76.

Violators of the rules of fire safety, if violations had grave consequences, are held criminally liable under the Criminal Code, punished by correctional work for a term up to 2 years, and if there were also human victims, imprisonment up to 8 years.

The main causes of fires during construction work:

- defects in building structures, structures, layout of premises, arrangement of communications;
- defects in equipment, malfunction of technological processes and improper performance of works;

- malfunction of the power supply and exhaust systems in the internal combustion engines, the absence of spark extinguishers on the exhaust pipes of the engines;
- violations of the rules of use of open flames, especially near the places of use or storage of hot or flammable substances;
- lack or failure of grounding of tanks with liquid oil products;
- malfunction or absence on some objects of the system of blister protection.

Posts with fire-fighting facilities should be organized at the construction site, as well as particularly hazardous fire-fighting areas should be identified. Within these zones, oil paints, oils, resins, oils, fuel and lubricants should not be stored, these materials should be stored in separate storage rooms. under the canopy. The storage of oxygen cylinders and cylinders with other combustible gases in one room is prohibited. All open-fire work is permitted only with the permission of the person responsible for fire safety at the construction site.

Fire safety is a condition of an object that eliminates the possibility of fire, and in case of its occurrence eliminates the effect on people of dangerous factors of fire and provides protection of material values.

Fire safety is ensured by creating a system of fire prevention measures and active fire protection.

Fire prevention is a set of organizational measures and technical means aimed at preventing the possible occurrence of a fire or reducing its effects,

An active fire protection system is a set of organizational measures and technical means for combating fires and preventing people from causing dangerous fires, as well as limiting material damage from it.

To prevent fires in construction organizations develop organizational, technical, regime, fire-evacuation, tactical, preventive, construction and other measures of modes of operation of machinery and equipment, which completely eliminates the possibility of sparks and flames. I at work, contact heated equipment parts with combustible materials.

Organizational activities include the right choice of technology; prevention of blockage of premises and construction sites; training employees in fire safety rules; special placement of materials in warehouses and equipment in garages and repair shops.

Technical measures include proper selection and installation of electrical equipment, lightning protection systems and earthing arrangements, spark arresters and the like.

Measures of a regime nature are the prohibition of smoking, the ignition of the fire, the proper storage of oiled cloths, the constant control over the storage of materials that can ignite and so on.

Tactical and preventive measures include the rapid operation of fire crews, the provision of facilities with primary fire extinguishers, as well as the maintenance of the plumbing system, etc.

Construction measures are used in the design and construction of structures, the creation of fire-prevention structures of buildings, as well as in the design of machines and equipment.

5.2. Safety measures.

5.2.1 Safety at drilling operations

Proper organization of drilling works has two main goals:

1) mount the rig according to safety requirements; 2) to carry out installation and dismantling of the drilling rig as soon as possible.

Safety at drilling operations depends largely on the design of the rig. The drilling rig consisted of a ground structure and drilling power equipment, the design of the rig should ensure the rational organization of technological processes for drilling wells, high productivity and safety of the drill crew.

The drilling rig must be provided with low-mechanical means, as well as mechanisms and devices that increase safety. Manometers and other measuring instruments shall be installed so that their markings are clearly visible to the operating personnel. Drilling rigs 14 m high and above should be fastened with stretches of steel kainites, whose diameter is determined by calculation.

If workers are required to climb a drill rig or mast under operating conditions, they must be fitted with ladder-ladders, ladder ladders or tunnel ladders. Stepladders shall have an elevation angle of more than 60 °, a width of not less than 0.7 m, step steps no greater than 0.3 m, a side sheathing height of 0.15 m and double-sided handrails 1 m high.

Drilling rigs must have work platforms with a shelter for the drilling worker from adverse weather conditions. The platforms should have a width of not less than 0.7 m and a railing height of 1 ... 1.25 m. .

When moving self-propelled drilling rigs, the worker is allowed to be more breathable in the driver's cab. When moving under the power line, everyone except the driver must leave the installation and the speed should not exceed 5 km / h. It is forbidden to work on the drilling rig below the transmission line in the security zone of the LEI of the work, it is allowed to perform only after instructing the workers and issuing a dress-tolerance.

The drilling rig must be inspected prior to the start of the change by the driller, periodically, at least once in a decade by the driller 1 once every 2 months by a technician and mechanic..

Equipment, machinery and equipment used in drilling rigs must have passports, and rope hoists must be certified. Passports must be filled regularly by a mechanic. Equipment, rigs, looms and pumps should be operated at load and pressure not exceeding the passport, measuring instruments (gauges), mass indicators, etc.) must have the seal or stamp of the repairing organization.

Use rigid tow rods or steel ropes when moving installations. People not directly involved in the drilling rig work should be brought to a dangerous distance equal to one and a half height of the rig. The distance from the tower to the tractor carrying it must be not less than the height of the tower plus 5 m. The tower should be moved during the day. It is forbidden to move them at night, in heavy fog, during icing, and in the wind over 5 points.

Self-propelled drilling rigs mounted on the vehicle are moved with the mast lowered and the mast fixed.

Safety rules for drilling operations provide for periodic testing of drilling rigs and masts during their operation. The order of testing and culling of towers is set by industry standard.

Drilling rigs and masts are subject to testing after the depreciation period of operation, modernization or major repairs, after loading, which has led to the failure of metal structures and accidents. A commission is appointed for the test. Before commencing, his commission inspects the drill rig and checks the integrity of the metalwork and screw connections. If found unsuitable structural elements before the test, replace them with quality.

Well drilling is carried out either by the drill master himself or by an experienced driller in his presence. Drilling equipment maintenance in the drilling process is essential to create safe working conditions. Before starting the drive engines of the drilling rig, check the presence and serviceability of the enclosure, the absence of extraneous objects on them.

After that, a warning signal is given and the switch is on. During the work it is forbidden to repair, clean, lubricate mechanisms, remove parts, fences, drive belts, guide rope hoists, etc. with their hands.

After completion of drilling operations, it is necessary to carry out liquidation works in accordance with the "Rules for the elimination of tamponage of drilling wells for various purposes, backfilling of mining work and the dumping of those wells in to prevent pollution and depletion of groundwater", eliminate pollution from fuel and lubricants and remediation.

5.2.2 Safety measures for waterproofing works

Construction structures and pipelines are destroyed by the action of water and various aggressive environments. Different types of waterproofing are used to protect them. Factors such as humidity, aggressiveness of the medium, hydrostatic pressure, temperature and mechanical action are taken into account. Waterproofing works are performed with various hot bitumen, adhesives, epoxy mastics, roll materials, plastics, varnishes, resins and the like.

All these materials can release gaseous substances and create an explosive and fire-hazardous environment, as well as harmful effects on the human body.

The main causes of injury during waterproofing work: the presence of a large amount of manual work, poor organization of workplaces, insufficient training of insulators, performance of work at height, carrying out these works without individual means of protection, etc.

Before application of waterproofing materials of a structure it is necessary to prepare accordingly, to clear of dust and dirt, to dry and to substantiate. The preparation of surfaces for insulation is performed with the help of pneumatic and electric shock instruments, sandblasters and mechanical wire brushes. After drying the primer layer, apply a permanent insulating layer.

Concrete structures from the action of aggressive water protect synthetic resins, varnishes, enamels. Hot asphalt waterproofing is used to protect them from pressure water, cement-plaster waterproofing is used from pressureless water.

When applying a primer, loading bitumen into the boiler and other robots where mastic may be sprayed, work in safety glasses and respirators, and in the places of mastic preparation there must be a set of fire extinguishers (two fire extinguishers, a shovel, a box of dryers. sand and technical felt).

It is allowed to make bituminous mastic only on a specially designated site. The latter is chosen in flat terrain with convenient access at least 50 m from wooden buildings and warehouses, 30 m from power lines, 15 m from the trenches and ditches. Bituminous melting installations should be placed less than 5 m apart.

The grass should be thoroughly cleaned on the base of 5 m from the bitumen smelter.

It is necessary to put insulating materials under a canopy at a distance not closer than 25 m from the place of preparation of mastic, and the reserves of these materials and fuel in the volume of regular loading - not closer than 5 m from the boiler.

Bitumen boilers should be well fixed and have non-flammable, tightly sealed lids with handles. No more than 3/4 of their capacity will be allowed to fill the boilers.

The pulverized fillers are poured into the boilers in a dry form and in small doses. Wet bitumen may not be lowered into the boiler, as the water leaked into the heated bitumen may cause greasy steam and ejection of bitumen mastic. The filler should be filled with a layer of bitumen on the surface of the bitumen and stirred for 15-20 minutes, until the filler is completely dry.

To prevent coking and to accelerate the heating, the bitumen should be stirred constantly in the boiler with a wooden stirrer blade with a handle of at least 1.6 m in length. ..6 kg. After the first portion of bitumen is melted, the boiler should be refilled by lowering small pieces of bitumen along its walls. A moderate flame must be maintained in the furnace so that the bitumen in the boiler does not heat above 200 ° C to prevent it from igniting.

In the event of a leak in the boiler, the work should be stopped by extinguishing the fire in the furnace, and then the boiler must be cleaned and repaired. Cleaning of the boiler is allowed after cooling to 50 ° C.

If bituminous mastic has erupted in the boiler, it is necessary to close it tightly with a lid and stop the fuel supply to the furnace. It is forbidden to flood bituminous mastic with water or with snow.

Mixing of bitumen with gasoline or diesel fuel in the preparation of bituminous mastic is carried out at least 50 m from the place of cooking of the bitumen. The bitumen temperature should not exceed 70 ° C. Only shovels can mix the bitumen with gasoline or diesel. When mixed, heated bitumen is poured into gasoline (but not vice versa).

The bituminous mastic is transported to the site of use in conical tanks with tight lids. The tank is filled with bituminous mastic no more than 3/4 of the volume. Pour the mastic into the tank with the help of long-handled pots. They deliver the tanks to the workplace in a mechanized way with the help of trolleys.

Hot mastic is served in a trench, securing a rope with a carbine to the tank. It is only possible to accept the tank after it has been securely installed at the bottom of the trench.

Elastic half-glasses are used for eye protection. Workwear are cleaned of dust after every change and washed with hot water every week. The fulfillment of these conditions made it possible to reduce occupational diseases and industrial injuries on waterproofing works.

5.2.3. Safety measures when performing welding work.

When performing welding work in the same room with other works, measures must be taken to eliminate the possibility of the influence of dangerous and harmful production factors on employees..

When performing welding at different levels vertically, protection of personnel working at the lower levels, from accidental fall of objects, electrode clogs, metal splashes, etc., must be ensured.

Areas with a dangerous production factor should be fenced in accordance with the requirements of DSTU 23407-78 and DSTU 12.2.062-81.

Workplaces above 1.3 m from the level or ground of continuous overlap shall be equipped with enclosures in accordance with DSTU 12.4.059-89 not less than 1.1 m high, consisting of a handrail, one intermediate element and a sideboard not less than 0.15 m

When producing welding work at a height of more than 5 m, scaffolds (platforms) of non-combustible materials must be arranged in accordance with the requirements of DSTU 12.2.012-75.

In the absence of scaffolds (electric platforms), electric welders should use safety belts and fire-resistant carburetor bumps. Workers should use special tool bags and collect electrode plugs.

The preservation of the starting welding materials and finished products must be carried out in warehouses which are equipped and maintained in accordance with the requirements of building, sanitary and fire-fighting rules and regulations approved in due course.

When preserving welded workpieces, welding materials and finished products, there should be no obstruction to natural light, ventilation, passage, passage, use of fire equipment and means of protection of workers.

The degreasing of the surfaces of welded products should be done with solutions approved for use by sanitary and fire control bodies.

Spent materials (clogs of electrodes, scabbard, process specimens, degreasing waste, etc.) should be collected in metal containers and, as accumulated, removed from the sites to sites for collection and disposal in the territory of the enterprise.

Persons who have been trained, instructed and tested for safety requirements with an electrical safety qualification group of not less than II and relevant certificates are allowed to perform welding.

Welding work at height 1 is allowed for workers who have undergone a special medical examination, who have experience of climbing work for at least one year and the level of the welder is not lower than III.

Workers in the welding professions must be provided with personal protective equipment in accordance with the standard industry standards approved in the prescribed manner, and in accordance with the nature and conditions of the work.

Protection of the face and eyes is provided with shields in accordance with GOST 12.4.035-78 and glasses in accordance with GOST 12.4.013-85 (with filters - for GOST 12.4.080-79).

Personal protective equipment according to GOST 12.4.051-87 should be used for the protection of hearing organs.

To protect the head from mechanical influences and electric shock, protective helmets in accordance with GOST 12.4.128-83 should be used.

5.2.4. Safety measures when performing stone work.

When applying for cranes, ceramic stones and other small blocks to the workplace, pallets, containers and gripping devices must be used to prevent the load from falling when lifted.

When laying the walls of buildings to a height of 0.7 m from the working deck and the distance from the level behind the wall being erected, to the surface of the earth (overlap) more than 1.3 m, it is necessary to apply mass protection (fencing or safety belts).

Temporary fixings of the eaves elements may be removed after reaching the strength specified in the design.

Loss of resistance by a person can be related to the effect of personal factors (illness or physical and neuro-psychic overload), as well as to the effect on the human factors of the external environment (movement of crane materials, structures, etc.). The collapse of the scaffolding is usually associated with an overload or violation of the installation or operating rules, in addition, very often the reason for the injury is the use of various occasional supports, ladders, boxes, etc. for the bedding.

5.2.5. Safety measures during installation work.

In the production of installation (dismantling) works in the conditions of the operating enterprise, the operated power grids and other existing engineering systems in the area of work must, as a rule, be disconnected, shortened, and the equipment and pipelines shall be exempt from explosive, combustible and harmful substances.

Methods of slinging of structural elements and equipment must ensure that they are fed to the installation site in a position close to the design

Cleaning of the components to be assembled from the dirt should be done before lifting them.

Movement-mounted elements shall be kept free from rocking and rotation by flexible distractions.

It is forbidden to stay on the structural elements during their lifting or moving.

During the breaks, it is not allowed to leave raised elements of structures and equipment in the hanging position.

It is not allowed to install installers on installed structures and their elements.

The elements installed in the design position must be secured in such a way as to ensure their stability and geometric stability,

It is forbidden to place people under the elements that are mounted before mounting them in the design position and fixing. If necessary, working under the equipment (structures) to be mounted and also on the equipment (structures), special measures must be taken to ensure the safety of workers.

Painting and anticorrosive protection of structures and equipment in cases when they are carried out at the construction site, should be done, as a rule, before their rise to the design mark.

During the installation of structures of buildings or structures, installers should be on previously installed and securely fixed scaffolds, which are used for the safe execution of works at a height of 1 m above ground level.

Buildings usually use inventory scaffolding, scaffolding, cradles that have passports of the manufacturing companies. Non-stocking tools are used in exceptional cases with the permission of the chief engineer of the construction and assembly organization, if the height of the non-stock scaffolding is more than 4 m, they are built according to the approved design.

Scaffolding is used to perform construction work within one floor. They are installed in the middle of the building and transferred by crane from one floor to another.

Analysis of accidents while working on scaffolding shows that accidents occur mainly due to loss of stability of scaffolding, which is caused by various reasons:

- incorrect and insufficient fastening of scaffolds to walls, uneven support of racks on the ground;

- overloading due to the accumulation of materials and construction details on scaffolding that exceeds the allowable values;
- dynamic influence on the elements of structures, scaffolding and loss of strength of their individual elements.

The structure of the scaffolding must be designed for durability and the individual elements for durability. Calculations of load-bearing elements (supports, decks, runs, etc., etc.) are performed, taking into account the mass of workers, (the mass of materials, containers, transport means, etc.).

To ensure the stability of the scaffolds in the transverse direction, they must be securely fastened to the wall with anchors.

All boards should be nailed to the inside.

The dismantling of the scaffolding is carried out in the reverse sequence of its installation, when all materials, tools and vehicles are removed from the decks, the scaffolding elements are lowered by means of cranes.

To protect people who are on scaffolding, a lightning rod is provided for direct lightning strikes.

There are a number of works in construction where fencing is impossible (at the edge of overlapping, cornice, etc.), in these cases only rope protection and mounting belts are used.

5.2.6. Safety Measures in performing concrete and reinforced concrete works.

Concrete works include the manufacture and installation of formwork, the preparation of concrete mix, its transportation and laying, care of concrete, mechanical treatment of concrete structures, quality control of work, disassembly of formwork after curing concrete and the like.

The materials used to make the concrete mix, in the processing, transportation and other operations, form a significant amount of dust, which adversely affects the respiratory tract of the person and causes diseases of the skin of the face and hands. The production of the concrete mix is accompanied by considerable noise, vibration, which adversely affect the hearing organs and the nervous system of the service personnel. This can cause work-related morbidity or cause injury.

To prevent falls from a height, workplaces are enclosed with inventory devices and scaffolding. The use of chemical additives, as well as highly active concrete mixtures, makes it necessary to protect the person from touching the concrete mixture. For this purpose it is necessary to use personal protective equipment: rubber gloves, protective overalls and work shoes, safety goggles.

Prior to laying concrete, it is necessary to draw up an act on the reliability of formwork, supporting scaffolding and decking. Before starting work, check the equipment and tools necessary for the work.

Placing on the formwork of equipment and materials not foreseen by the project of production of works, as well as staying of people directly on the floor, participating in the work, is not allowed.

The concrete mix container shall be checked before work, paying attention to the locks' serviceability in order to prevent the mixture from being unloaded. When placing concrete from the tank, the distance between the lower end of the tank and the previously embedded concrete or the surface to which the concrete is placed must be no more than 1 m, if the distance is not foreseen by the work production project.

When compacting the concrete mixer with electric vibrators, it is not allowed to move the vibrator for the current-carrying hoses, and during the break in the work and during the transition from one place to another the electric vibrators must be switched off.

Prior to the commencement of the concrete mix with the concrete pump, the whole system of the concrete mixer is tested under a pressure that is 1.5 times higher than the working one, and 300 ... 350 l of cement mortar of plastic mix (composition 1: 2) are passed through the pump for lubrication of the concrete pump and relief. movement of concrete mixture. The place of laying of the concrete mix is connected by signaling to the engineer of the concrete pump.

In order to avoid any congestion in the concrete mixer, the concrete mix cannot be left there without moving for more than 20 minutes, for safe transportation of the concrete mix the size of the filler (gravel, gravel) should be no more than 1/3 of the diameter of the concrete mixer. If the throat of the concrete pump is clogged with the concrete mixture, the engine must be stopped and the plug must be punctured. The concrete pump system is periodically washed with pressurized water or compressed air. Workers at the outlet of the concrete plant must be at least 40 m away when cleaning.

When laying the concrete mixture into the formwork, the technological modes of supplying the concrete mixture must be adhered to to prevent the formwork from collapsing. Therefore, when designing the formwork take into account the weight of the formwork itself, the weight of the reinforcement and the concrete mixture, and also take into account the dynamic loads that can occur when the formwork of the concrete mixture, as well as when it is compacted by vibrators.

The main types of injuries during the formwork works: electric shock during installation of metal and wood-metal formwork with hoisting mechanisms near the power lines; falling from a height; falling of non-secured formwork boards; irritating effect on the skin of chemical workers and others.

Working conditions when performing formwork work form requirements for the use of technological means of safety. Depending on the destination, they can be divided as follows:

- Means of protection against falling from a height (enclosures, safety ropes and safety belts);
- Means of protection against falling of objects from height (protective helmets);
- bridging tools and other technological equipment that promotes safety;
- Chemicals to prevent chemicals from entering the skin when lubricating formwork elements (goggles, rubber gloves, etc.).

Before laying the concrete mixture, the master must check the correct installation and reliability of the formwork, supporting scaffolding, working decks and enclosed fittings.

Formwork at a height of more than 5 m is installed from special scaffolding. In windy weather the mounting of the formwork at altitude should be carried out with the utmost care. Formwork boards have a large "sail" and are subjected to strong wind gusts, which is a source of industrial hazards.

When laying the concrete mixture at a height of more than 1.5 m, work floors or concrete workplaces are surrounded by railings.

When assembling formwork elements in several tiers, each subsequent tier should only be installed after fixing the lower one.

If the installation of the second tier formwork on the lower tier the enclosures must be maintained and light inventory portable ladder ladders must be used to move to the second tier. The formwork is disassembled only upon reaching the design of the specified strength in the sequence stipulated by the specifications..

The formwork can only be disassembled with the permission of the master and under his supervision. When disassembling formwork, make sure that there is no accidental fall of formwork elements or supporting scaffolding. The dismantled formwork is stacked on the ground, sorted into stacks.

At small volumes of concrete works and absence in the area of construction of high-performance concrete units the production of the mixture directly at the construction site with the use of concrete mixers with the volume of mixing drum 100 ... 500 l is allowed.

The fitting and processing of fittings must be carried out in specially designated and properly equipped locations.

The preparation and processing of the fittings must be carried out in specially designated for this and appropriately arranged sites.

When performing work on the procurement of reinforcement is necessary:

- to fence places intended for unwinding of bays (hanks) and repair of fittings;
- when cutting machine tools of rods into segments with length less than 0.3 m, use devices that prevent their flight;
- to assemble the prepared fittings in specially designated for this place;

- close the shields of the end parts of the bars of the reinforcement in places of common passageways that are less than 1 m wide.

5.3. Industrial sanitation.

For domestic servicing, a small town with inventory cars and collapsible houses, with showers and bathrooms is arranged.

A meal room is provided to ensure proper nutrition.

At night, the construction site is illuminated in accordance with GOST 12.1.046-85.

Toxic substances are stored away from household premises.

Drinking water is supplied by temporary water supply and complies with GOST 2873-83 "Drinking water".

Workers are provided with overalls and personal protective equipment.

The calculation of temporary rooms is given in the calculation of the plan.

5.4. Protective grounding.

Perform the calculation of protective grounding for the grounding of a concrete mixer with a voltage of U = 380V in a three-phase grid with isolated neutral with the following data:

Loam soil with specific electrical resistance $\rho = 400 Ом \cdot м$;

as steel earthing pipes with a diameter were adopted $d = 0{,}08 м$ and

length $l = 2{,}5 м$, located vertically and together with a 40x4 mm steel strip.

find the resistance of a single vertical grounding conductor R_b, Ом, by the formula:

$$R_b = \frac{\rho_{розр.}}{2\pi \cdot l}\left(\ln\frac{2l}{d} + \frac{1}{2}\cdot\frac{4t+l}{4t-l} \right)$$

We accept $\psi = 1{,}7$. Then $\rho_{розр.} = 400 \cdot 1{,}7 = 680 \; Ом \cdot м$.

$$R_b = \frac{680}{2\pi \cdot 2{,}5}\left(\ln\frac{2\cdot 2{,}5}{0{,}08} + \frac{1}{2}\ln\cdot\frac{4\cdot 2{,}05+2{,}5}{4\cdot 2{,}05-2{,}5} \right) = 192 \; Ом.$$

We determine the resistance of the steel strip that connects the grounding rods,

$$R_{II} = \left(\frac{\rho_{розр.}}{2\pi \cdot l}\right)\ln\left(\frac{l^2}{d \cdot t}\right) \ Ом.$$

Find the calculated resistance of the soil $\rho_{розр.}$ when using a 50m horizontal electrode strip.

$\rho_{розр.} = \rho \cdot \psi^{/} = 400 \cdot 5{,}9 = 2360 Ом \cdot м$. At a strip length of 50 m $\psi^{/} = 5{,}9$

$$\eta_b \ ma \ \eta_r \ R_{II} = \left(\frac{2360}{2\pi \cdot 50}\right)\ln\left(\frac{50}{0{,}04 \cdot 0{,}8}\right) = 84 Ом.$$

Determine the approximate number of n single rod grounders by the formula:

$$n = \frac{R_b}{r_3 \cdot \eta_b} = \frac{192}{4 \cdot 1} = 48 \ шт.$$

We accept the placement of vertical grounding on the contour with the distance between adjacent grounding equal.

For the table. 3.2 and 3.3 [11] we find the true values of the coefficient of use $\eta_b \ ma \ \eta_r$. Value $\eta_b = 0{,}66 ma \ \eta_r = 0{,}39$.

Find the required number of vertical grounding conductors $n = \frac{R_b}{r_3 \cdot \eta_b} = \frac{192}{4 \cdot 0{,}66} \approx 73 \ шт.$

Determine the total design resistance of the grounding device R, taking into account the connection strip

$$R = \frac{R_b \cdot R_r}{R_b \cdot \eta_r + R_r \cdot \eta_b \cdot n} = \frac{192 \cdot 84}{192 \cdot 0{,}39 + 84 \cdot 0{,}66 \cdot 73} \approx 3{,}91 \ Ом.$$

The calculation is done correctly since $R \le [r_3]$ 3,91<4.

6. Ecology

6.1 The effect of the projected object on the environmental components.

During the construction and operation of the projected object, the following environmental components may be affected:

- soil and plant complex;
- the ground layer of the atmosphere.

Changes in the components of the environment may result from this action.

Actions on the soil and plant complex are manifested in the form of disturbances of the surface of the earth in the strip of alienation around the object of construction. In this case, the following forms of violations are possible: compaction or loosening of soil, trench recesses, roads of temporary roads, grubbing and transplanting of trees. The source of action on environmental components may be construction machinery and equipment.

When performing construction works, soil, groundwater contamination with construction and household waste, debris, fuel and lubricants may be contaminated.

Operation of the projected object is connected with the formation of household and industrial wastewater.

6.2 Measures to reduce the negative impact of the projected object on the environment

During the construction and operation of the facility, atmospheric air pollution occurs as a result of road transport emissions of CO, NOx, SO2, CnHm, soot.

Calculation of emissions of harmful substances from automobile engines when working at a construction site.

Automobile engines work in the construction of buildings and structures on different types of fuel: gasoline (4 brands) and diesel fuel. The list of basic machines and mechanisms at the construction site is given in Table 6.1

Table 6.1 - Basic Machines and Mechanisms

№	Name of machines	Type of fuel	Fuel 100 km	Number of hours worked
1.	Cars dump trucks, cargo. up to 10 t	AI	28	2748
2.	Cranes on track, cargo. 16 t	AI	31	1366
3.	Bulldozer, 96 kW power	DP	30	44,7
4.	Excavators are one-bucket. tracked, 0.65 m3 bucket volume	DP	26	681,8
5.	Irrigation machines, 6 thousand liters	AI	36	41,6
6.	Farm trucks, cargo. 30 t	DP	30	98,2

Calculations of annual emissions of pollutants by motor vehicles required for state or municipal emissions accounting in order to remove payments for environmental pollution and to develop measures to reduce them.

The methodology of calculation of emissions of harmful substances by motor transport is based on the average specific emission by construction mechanisms and cars of separate groups (freight, special, buses, cars, etc.). The emission of harmful substances is corrected depending on the technical condition of the cars, their average age, the influence of natural and climatic conditions.

It is difficult to determine the mileage in km for partially idling cars (truck cranes, excavators, bulldozers, etc.). In this case, the calculation of the maximum one-off emissions, as well as the calculation of the second and annual emissions is made by the formulas:

$$M_j = C_{jxx} \bullet Acn \bullet a_B / t,$$

$$C_{jxx} = 1.3 \bullet Q \bullet p \bullet P_{xx},$$

where A_{cn} is the number of cars in the j-th group, pc;

a_B - average car release coefficient, $a_B = 1$;

Q is the amount of fuel burned, l / km;

p - fuel density, kg / dm^3 (for gasoline p = 0.75 kg / dm^3; for diesel fuel p = 0.826 kg/dm^3);

t - time of the car at the construction site; t = 2 min;

P_{xx} is a dimensionless factor characterizing the ratio of the mass of emitted pollutants to the mass of fuel burned (Table 6.2).

1.3 - coefficient for taking into account the average speed of movement and idling.

Annual emissions are calculated using the formula

$$M_{y.j} = C_j \bullet A_{cn} \bullet AB \bullet T \bullet 10^{-6}$$

where T is the total running time of the car engine per year, hours.

Table 6.2 - Coefficient P^{xx}

Type of fuel	The P value for				
	C	$C_n N_m$	NO_X	SO_2	soot
The P value for	2,62	1,01	0,27	0,01	-
Diesel fuel	0,27	0,06	0,03	0,03	0,23

The results of the calculation of the seconds and annual emissions of pollutants during the operation of diesel and gasoline powered construction machinery are given in Table 6.3.

The calculations are made only for emissions of construction machinery and vehicles operating at the construction site.

Table 6.3 - Calculation of emissions of harmful substances during the operation of construction machinery and vehicles

Name of machines	Number of cars .	Type of fuel	Fuel rate, kg / h	Working hours	Mass emission of substances									
					C		$C_n N_m$		NO_x		CO_2		soot	
					g/s	t/y	g/s	t/y	g/s	t/y	g/s	t/y	g/s	t/y
Dumpers, with a load capacity of up to 10 t	2	AI	28	2748	0,705	13,96	0,27	5,38	0,073	1,44	0,003	0,053	-	-
Crawler cranes, up to 16t	2	AI	31	1366	0,78	7,7	0,3	2,96	0,081	0,79	0,003	0,03	-	-
Bulldozer, 96 kW power	1	DP	30	44,7	0,087	0,000014	0,065	0,000106	0,0097	0,0000156	0,0097	0,000016	0,074	0,00027
Excavators	2	D	26	681,8	0,076	0,37	0,016	0,081	0,019	0,095	0,019	0,095	0,064	0,31
Irrigation machines, 6 thousand liters .	1	AI	36	41,6	0,85	0,128	0,33	0,049	0,088	0,0132	0,003	0,000489	-	-
Farm trucks with a load capacity of 30 t.	1	DP	30	98,42	0,087	0,000307	0,019	0,000068	0,009	0,000034	0,009	0,000034	0,074	0,00262
Accepted for calculation: AI DP					 3,635 0,337		 1,403 0,12		 1,117 0,0467		 0,0144 0,0467		 0,286	 0,3849
Total						23,31		8,898		3,397		0,1919	0,286	0,3849

7. Scientific research part

7.1 Seismic forces

Seismic forces are irregular in nature and unpredictable hence the static and dynamic investigation of the structures have turned into essential worry of structural Engineer. The main reason for the failure of the building is due to the plan irregularity of the RC multistory building. So, as it's fundamental to detect the seismic response of the structure in high seismic zones to decrease the seismic harms in structures.

The main objective of the present study is to obtain the seismic response of the structure (i.e. displacement, overturning moment ,story drift ,story shear) for building. During the design of structures for construction in seismic region it is necessary to follow the basic requirements developed to reduce the risk of collapses during the earthquakes and to insure the earthquake resistance of buildings. These requirements are based on years of experience analyzing the consequences of catastrophic earthquakes and improvement of anti-seismic measures given in design norms of different countries (Construction in seismic regions of Ukraine, 2006; Seismic Building Design Code, 2011; Eurocode 8, 2004).

7.2 Principles of damage tolerance policy

1. At rare destructive earthquakes it is necessary to insure the safety of people`s lives, valuable equipment and infrastructure which is necessary to eliminate the consequences of earthquakes. The facility can have a limit state close to collapse. This principle is called as Principle of facility safety.

2. At strong earthquakes and earthquakes of moderate intensity the structures can have significant damages and residual deformations. The load-bearing structures should have capability to be stable during the further earthquake (aftershock) without violation of stability. It is the Principle of allowed damages.

3. At weak repetitive earthquakes and limited destructions the approved anti-seismic measures should insure the normal facility operation. It is the Principle of no damages.

At design for earthquake resistance in addition to basic principles it is necessary to do the following actions:

• to consider the secondary factors such as fire, displacements or soil liquefaction and others

• to assess the response spectra in places where the equipment which is important for facility operation is installed

• to develop the measures on population safety including the fire protection, air-conditioning, water supply and other systems

• to develop the measures on facility protection against progressive collapse caused by failure of responsible structures, terrorist intervention and other dangerous events

The dependency between structure reduction coefficient R μ , ductility coefficient μ and period of natural vibrations T n is as follows:

$$R_\mu = \begin{cases} 1, \quad T_n < T_a \\ \sqrt{2\mu - 1}, T_a < T_n < T_b \\ \mu, \quad T_b > T_n \end{cases}$$

where T_a , T_b and T_n are borders of zones which correspond to the dynamic system response to accelerations, velocity and displacements at earthquake.

Dependences were used to build up the graphs of dynamic response factors and inelastic response spectra which help to determine the seismic loading on buildings and facilities and their nonlinear displacements on the basis of spectral method given in DBN B.1.1-12:2006 and taking into account the spectral dynamic response factors for soils of the first, second and third categories.

The methodology to calculate the seismic response (non-linear displacements) of buildings is built on the basis of load-bearing capacity spectrum (BCS).

Usage of software to form design multimass three-dimensional model of the building on the basis of design or actual data in accordance with the results of structures surveys during the assessment of earthquake resistance of the existing building with damages caused by earthquakes. Diagrams of concrete and reinforcement state and cracks in load-bearing structures of superstructure and foundation are considered.

General conclusions

The territory for the construction of a multi-storey residential building with parking for cars in the basement is set in Uzhgorod on Lebedeva-Kumach Street. The master plan and measures to landscaping were described. The architectural part of the project was developed, the basic decisions were substantiated by the corresponding calculations. For the designed sixteen-storey apartment building brick walls and combined prefabricated and monolithic ceilings has been chosen. Plans for the ground and typical floors and foundations were designed.

Detailed calculation of the individual structures used in the project – foundation, monolithic column and ceiling slab – was performed. Calculation and design was made using standard approaches described in building codes and methodical guidelines for designing taking into account the features of the designed building.

Technological maps for the process of stairs and platforms installation and for the arrangement of flat roll roof were developed. The required materials and workforce were determined. The necessary construction equipment and machines were selected.

Existing approaches to multi-stored building behavior evaluation in seismic impacts were analyzed. Usage of finite element method was proposed for the further evaluation and corresponding simulation model was created. Deformations of designed sixteen-stored apartment building from vibration under normative seismic impact were determined using proposed model.

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