MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN
Satbayev University
Institute of Architecture and Civil Engineering named after T. Basenov
Department of "Civil Engineering and Building Materials"

Obaid Paiman

On the theme of "Energy-efficient social residential building in Almaty"

EXPLANATORT NOTE
to the diploma project

Specialty 5B072900 – Civil Engineering

Almaty 2021

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ALLOWED TO PROTECT

Head of Department
____________ Kozyukova N.V.
Master of technical science, lecturer
«_30_»___01___2021 y.

EXPLANATORY NOTE
to the diploma project

On the theme of "Energy-efficient social residential building in Almaty"

5B072900 - "Civil Engeneering"

Prepared by______________________ Paiman O.

Scientific adviser __________ Mukhanbetzhanova Zh.Sh.

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I APPROVE
Head of Department
_______________ Kozyukova N.V.
Master of technical science, lecturer
«_30_»__01__2021 y.

ASSIGNMENT
Complete a diploma project

Student: Obaid Paiman

Topic «Energy-efficient social residential building in Almaty »

Approved by the Order of the Rector of the University No. 2131-b dated November 24, 2020.

The deadline for the completed work is May 10, 2021.

Initial data for the diploma project: Construction area – Almaty

Structural schemes of the building – shear-wall system.

List of questions to be developed:

a) Architectural and analytical part: basic initial data, space-planning solutions, heat engineering calculation of enclosing structures (outer wall), lighting calculation, justification of energy efficiency measures;

b) Calculation and design part: calculation and design of a beam;

c) Organizational and technological part: development of technological maps, construction schedule and construction plan;

d) Economic part: local estimate, object estimate, summary estimate;

List of graphic material (with exact indication of required drawings):

1. General Master, plan Facade, standard floor plans, sections 1-1 and 2-2 - 4 sheets.

2. Beam specifications - 1 sheet.

3. Technical maps of concreting and formwork, calendar plan, construction site plan - 4 sheets.

11 slides of work presentation are provided.

Recommended main literature: SP RK 2.04-01-2017 "Construction climatology", SN RK 2.04-04-2013 "Construction heat engineering", SN RK 2.03-30-2017 "Construction in seismic zones"

SCHEDULE
preparation of thesis (project)

№	Part	30percentage	60percentage	90percentage	100percentage	Note
1	**Architectural and analytical**	**11.01.2021г.-14.02.2021г.**				
2	**Calculation and design**		**15.02.2021г.-23.03.2021г.**			
3	**Organizational and technological**			**24.03.2021г.-01.05.2021г.**		
4	**Economic**				**01.05.2021г.-09.05.2021г**	
5	**Pre-defense**	**10.05.2021г.-14.05.2021г.**				
6	**Anti-plagiarism, norm control**	**17.05.2021г.-31.05.2021г**				
7	**Quality control**	**26.05.2021г.-31.05.2021г.**				
8	**Defense**	**01.06.2021г.-11.06.2021г.**				

Signatures
Consultants and the normative controller for the completed diploma work (project) with an indication of the parts of work (project) related to them

Name of parts	Consultants, I.O.F. (academic degree, rank)	the date signing	Signature
Architectural and analytical	Mukhanbetzhanova Zh.Sh.		
Calculation and design	Kozyukova N.V.		
Organizational and technological	Mukhanbetzhanova Zh.Sh.		
Economic	Mukhanbetzhanova Zh.Sh.		
Norm controller	Bek.A.A		
Quality control	Tolegenova. A		

Scientific adviser ____________ Mukhanbetzhanova Zh.Sh.

The task was accepted for execution student ____________ Paiman O.

Date «30»___01___ 2021 y.

АҢДАТПА

Бұл дипломдық жобаның тақырыбы «Алматы қаласындағы энерготиімді әлеуметтік тұрғын үй». Жоба сәулет-құрылыс, дизайн және құрылыс, технология мен ұйымдастырушылық және экономикалық сияқты төрт негізгі бөлімнен тұрады.

Осы жұмысты жасау кезінде келесі бағдарламалық жасақтама қолданылды:

1 AutoCAD 2021 - құрылыс моделі мен технологиялық бөлігін жасауға арналған;

2 Autidesk Revit 2021 - ғимараттың 3D моделін жасауға арналған;

3 Etabs 2018 - ғимараттың құрылымдық бөлігін жобалауға;

4 Жобаның жалпы құнын бағалау үшін ҚР сметасы.

АННОТАЦИЯ

Тема дипломного проекта - «Энергоэффективное социальное жилое дом в городе Алматы». Проект состоит из четырех основных частей, таких как архитектурно-строительная, проектно-строительная, технологическая и организационная и экономическая.

При создании работы использовались следующие программы:

1 AutoCAD 2021 - для создания модели здания и технологической части;

2 Autidesk Revit 2021 - для создания 3D-модели здания;

3 Etabs 2018 - на проектирование конструктивной части здания;

4 Смета РК - для оценки общей стоимости проекта.

ANNOTATION

The theme of this diploma project is «Energy-efficient social residential building in Almaty city». The project consist of four main parts, such as architectural and construction, design and construction, technology and organization, and economic.

The following software programs were usesd during creating this work:

1 AutoCAD 2021- for creating building model and technological part;

2 Autidesk Revit 2021- for creating 3D-model of building;

3 Etabs 2018- for designing structural part of building;

4 Estimation RK- for estimating the overall cost of project.

CONTENT

INTRODUCTION

Construction refers to engineering transactions for the construction of buildings and structures such as residential buildings and non-residential building. A simple building can be defined as a walled space with a roof, fabric, and basic human needs. In ancient times, people lived in caves, in trees or under trees to protect themselves from wild animals, rain, sun, etc. Over time, people began to live in huts made of wooden branches.

The shelter of those old ones turned into beautiful houses. Rich people live in sophisticated homes. a building is an important indicator of a country's social progress. Each person has a desire to have comfortable houses on average, as a rule, each person spends his two-thirds of his life in houses. A civil sense of responsibility is safe. These are several reasons a person does their best and spend their hard-earned savings in their own homes. Today, house building is the main work of the country's social progress. New technologies are developed every day to build homes, cost-effectively, quickly, energy-efficiently and with the needs of the engineering and architectural community involved in the design, planning and planning of buildings.

The designer is responsible for the drafting of the building, as well as for the direction of the engineers and architects. The designer must know his job and be able to follow the instructions of the engineer and be able to draw the required building drawing, site plans, layout plans, etc. In accordance with the requirements.

The main type of urban development is multi-storey residential buildings. The operation of such houses allows us to rationally use the territory, reduce urban transport facilities, the length of engineering networks, and streets.

In the world housing construction, a large share is occupied by multi-storey residential buildings.

The use of multi-storey energy-efficient residential buildings primarily provides the goal of saving urban areas, saving energy since during the construction of multi-storey residential buildings we can significantly increase the population density. The growth of cities is "wide" and exacerbates the transport problem and increases the length of engineering networks. For the selection of types of multi-storey residential buildings in large cities, the urban planning situation is considered, as well as the conditions for the reconstruction of the central regions.

1 Architectural and construction Parts

1.1 Basic information about the construction site

The diploma project was developed for " Energy-efficient social residential building located at the address: Almaty city, "Akkent Microdistrict".

Characteristics of the building:

The level of responsibility of a residential building refers to objects of the II (normal) level of responsibility that are not technically complex, according to order No. 517 of December 20, 2016 "On amendments to the order of the Minister of National Economy of the Republic of Kazakhstan dated February 28, 2015 No. 165" On approval The rules for determining the general procedure for classifying buildings and structures as technically and (or) technologically complex objects. ”The degree of fire resistance of the building - II. The degree of durability of the building - II.

The project was developed for the following construction conditions:

humidity zone – normal [1];

climatic region - II: temperate continental climate [1];

snow region - II, the standard value of the weight of the snow cover is Sk = 1.2 kPa [2];

wind region - II, standard value of wind pressure - 0.39 kPa; wind speed – 25 m/s [2];

climatic parameters of the cold season: air temperature of the coldest day: -30 degrees celsiuse; air temperature of the coldest five-day period: -23 degrees celciuse;

Soil class – II, type of soil is sand and gravel that has medium dense [1];

the construction area is seismic zone, and the magnitude is 9 points [3]; the region hieght from sea level is 681 m;

the construction site is located in the zone of residential and administrative buildings, the relief of the site is calm.

1.2 Natural-climatic and engineering-geological conditions

The characteristic features of the climate of this territory are: an abundance of sunlight and warmth, continentality, hot long summers, relatively cold winters with alternating thaws and cold snaps, large annual and daily amplitudes of air temperature fluctuations, dry air and changes in climatic characteristics with terrain altitude [1].

The coldest month - January is characterized by negative temperatures minus 6.6 - 16.5degrees celciuse (for plains and foothills). The hottest month is August. The average temperature for the plains is 24 - 26 degrees celciuse. The absolute maximum temperature reaches 36.7 - 41.7 in the same zone.The main data on the snow cover are given in Table 2 [3].

Table 1 - Air temperature

Weather station	months												per year
	1	2	3	4	5	6	7	8	9	10	11	12	
Average monthly and average annual air temperature, degrees celciuse													
Almaty	-4.7	-3.0	3.4	11,4	16,6	21,6	23,9	22,9	17,6	9,9	2,7	-2,8	10.00
Average maximum air temperature,degrees celciuse													
Almaty	0.6	2.2	8.6	17.3	22.4	27.5	30.0	29.4	24.2	16.3	8.2	2.3	15.8
Absolute maximum air temperature, degrees celciuse													
Almaty	16.8	21.9	29.8	33.2	35.8	39.3	41.7	40.5	38.1	31.4	26.5	19.2	41.7
Average minimum air temperature, degrees celciuse													
Almaty	-8.4	-6.9	-1,1	5,9	11	15,8	18	16,8	11,5	4,6	-1,3	-6.4	5
Absolute minimum air temperature, degrees celciuse													
Almaty	-30.1	-37.7	-24.8	-10.9	-7	2	7.3	4.7	-3	-11.9	-34.1	-31.8	-37.7

Table 2 – Blanket of snow

Weather station	months									Highest values for the winter		
	9	10	11	12	1	2	3	4	5	Average.	Max.	Min.
Average monthly snow height, см												
Almaty			4	10	19	21	9			28	55	7

With distance from the mountains, the wind regime changes. The average annual wind speed is 2.3 m / s. The wind breakthrough reaches 28 m / s. The lowest average monthly wind speeds throughout the entire territory are observed in winter (December, January), and the highest - in summer.

Table 3 – Wind

Wind Weather Station	months												Per year
	1	2	3	4	5	6	7	8	9	10	11	12	
Average wind speed by months and per year, м/с													
Almaty	1,0	1,1	1.3	1.7	1.8	2.0	1.9	1.9	1.8	1.5	1.1	1,0	1.5
Maximum wind speed and wind vane breakthrough, м/с													
Almaty	12	11	20	>20	>20	18	20	18	12	15	12	12	>20

Table 4 - Repeatability of wind and calm directions, percentage

Weather station	Direction								Calm
	N	NE	E	SE	S	SW	W	NW	
Almaty	14	8	6	14	29	11	10	8	26

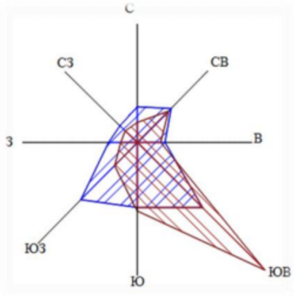

Figure 1 - Wind rose according to the weather station in Almaty

1.3 General plan

The master plan has been developed for the entire territory of the construction land plot. The plot with a total area of 3.8 hectares, allocated for construction, located in the city of Almaty, has a rectangular shape. The plot allocated for construction is free of buildings. An 8.0 meter wide driveway is provided for the territory of the facility; the pavement is made of asphalt concrete on a crushed stone base. Improvement and gardening of the site provided for by the project reduces the overall dust content and eliminates local sources of dust

Table 5 - Technical and economic indicators for the general plan

Name	Indicator
Land area	3.8 hectare
Built-up area	4939.2 $м^2$
Building factor	0.104
Landscaping area	13060.8 $м^2$
Landscaping factor	0.297
Hard surface area	20000 $м^2$
Territory utilization rate	0.745

The area around the building is landscaped and landscaped. The building has hard surfaced access roads.

1.4 Space-planning solution

The energy-efficient social residential building consists of seven buildings of twelve floors and one ground floor. The ground floor has an area of 1019.2 m^2 and each 12 floors has an area of 705.6 m^2. The height of the building from the zero mark is 36 m. The height of the typical floor is 3 m, and the height of basement is 4 m. The main staircase, elevators of the engineering equipment shaft are located in the concrete core of stiffness near to the middle in the front side of the building. Two lifts surrounded by shear walls are used in this building that each of them has respectively 630kg, and 1000kg weight. At the middle of the building there are two staircases system.

The scales for the plan and section is accepted 1:100 according to GOST 21.501. Various premises of the building are grouped according to functional characteristics, which allow organizing clear technological interconnections between them, meeting sanitary-hygienic and fire safety requirements, contributing to the convenience of operating the building, as well as increasing the comfort of living in it.

1.5 Constructive solutions of the project

The structural scheme of the building is a frame with load bearing walls, while at the level of the basement, reinforced concrete columns and walls are load-bearing (that is, it is ashear wall system). Spatial immutability is ensured by external and internal heating blocks, reinforced concrete columns and beams, and a hard floor plate made of monolithic reinforced concrete slabs.

Foundations – Raft foundation with a thickness of 900 mm . Under the foundations, perform a reinforced monolithic pad and crushed stone preparation of thicknesses 100mm. Make horizontal waterproofing of foundations from 2 layers of ruberoid on bitumen mastic. Vertical waterproofing of foundations in contact with the ground should be coated with hot bitumen 2 times.

Walls – the outer walls of the basement are monolithic reinforced concrete walls with a thickness of 400 mm, the outer walls of the first to the twelfth floor are 400 mm thick walls made of Autoclaved aerated concrete AAC blocks (Foam concrete block), internal walls with a thickness 270 mm should also be made of foam blocks on cement-sand mortar.

Partitions – partition walls with a total thickness of 175 mm to be made of Reinforced brick partition wall**.**

Slabs – monolithic reinforced concrete floor slabs with a thickness of 200 mm.

Beams – reinforced concrete with a section of 300x500;

Lintels – bar for buildings with masonry walls;

Windows - Triple Casement Vinyl Replacement Windows are selected for this buildig. It is a double-glasses window and the most energy-efficient windows and suitable for the project.

Doors - installation of molded wood composite interior doors in accordance with GOST 6629-88, PVC doors in accordance with GOST 309702002, installation of steel exterior doors in accordance with GOST 31173-2003. All the types of doors used in this building is energy-efficient and made of environmentally-friendly materials.

Blind area - The blind area is concrete along the entire perimeter of the building with a width of 1.0 m.

External finishing - from external facade plaster and, a decorative layer made of Wood Plastic Composite boards or panels.

2 Calculation and design part

2.1 Calculation of dead loads

The loads of floors and wall are presented in Table A.1 in Appendix A.

2.2 Calculation of soil pressure

Type of soil bases for foundations – sand and gravel (category II)
$\gamma = 1.73 \text{t}/m^3$
$c = 0$
$\varphi = 35°$
$h = 4\ m$
$\text{q} = 0.6\ \text{t}/m^2$
Active pressure

The intensity of the horizontal active soil pressure from its own weight γ, at a depth of h = y = 4.1 m should be determined by the formula:

$$P_\gamma = \frac{[\gamma \cdot h \cdot \lambda_г - c \cdot 2\sqrt{\lambda_г}]\text{y}}{h} \quad (1)$$

$$P_\gamma = [1.73 \cdot 4.1 \cdot 0.27 - 0 \cdot 2\sqrt{0.27}]4/4 = 1.915\ \text{t/m}^2$$

where:

$$\lambda_г = tg^2\left(45 - \frac{\varphi}{2}\right) = tg^2\left(45 - \frac{35}{2}\right) = 0.26$$

Passive pressure:
$\varphi = 35°$
$\lambda = 0.26$

$$\text{P}_\text{q} = \text{q} \cdot \lambda, \text{t/m}^2$$

$$\text{P}_\text{q} = 0.6 \cdot 0.26 = 0.15\ \text{t/m}^2$$

$$=> P = 1.915 + 0.156 = 2.93\ \text{t/m}^2$$

2.3 Determining Live loads according to EN 1991

Building category - A (residential building)
- floor – 2 кН/м^2 = 0.2 t/m^2
- staircase – 2.5 kN/m^2 = 0.2 t/m^2
- balconies – 2.5 kN/m^2 = 0.25 t/m^2
- unexploited roof – 0.5 kN/m^2 = 0.05 t/m^2

2.4 Calculating snow load

Almaty city - II snow region [1]:
μi = 0.8,
$C_e = 1$,
$C_t = 1$,
$s_k = 1.2$

$$s = \mu_i \cdot C_e \cdot C_t \cdot s_k \tag{2}$$

$$s = 0.8 \cdot 1 \cdot 1 \cdot 1.2 = 0.96\ kPa$$

where C_e −enviromental factor;
C_t −thermal coefficient;
s_k −the characteristic value of the snow load on the ground;
μ_i–snow load shape factor.

2.5 Calculation of wind load

Almaty city is located in the II wind region, $q_b = 0.39$ kPa, wind speed – 25 m/s

The dimensions of the building are 39.2 x 18 x 37 m, Almaty is the II wind region.

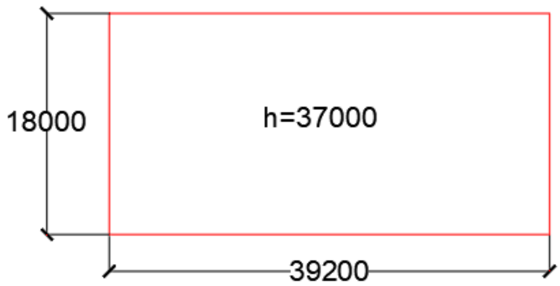

Figure 2 - Building plan

1) Calculation of wind load by OX

We divide the building in height into zones corresponding to the base height for the external pressure z_e according to the standard at $b = 18$ m ; $h = 37 < b = 39.2$ m.

The terrain category of building is IV.

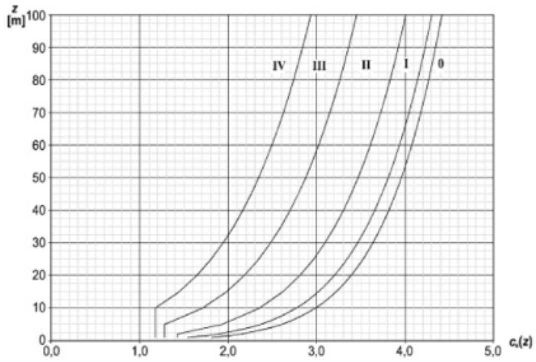

Figure 3 – exposition coefficient, c_e

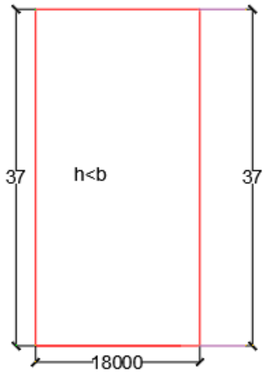

Figure 4 - Base height Z_e depending on h and b and the profile of the velocity head

Basic velocity wind pressure for wind region II, q_b = 0.39 kPa
Wind pressure w_e is equal to:

$$w_e = c_e(\text{z}) \cdot q_b \cdot c_e \tag{3}$$

At z_e = 37m; $c_e = 0.8$; z_e = 37m; $c_e(37) = 2.1$:

$$w_e = 2.1 \cdot 390 \cdot 0.8 = 655.2\ Pa = 66.8\ kg/m^2$$

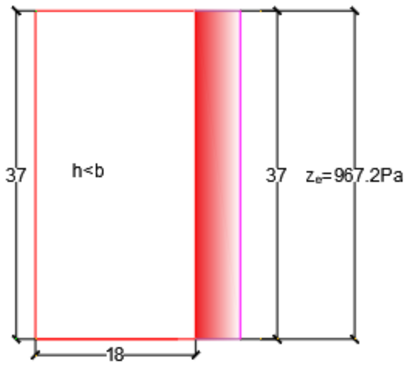

Figure 5 - Diagram of wind pressure

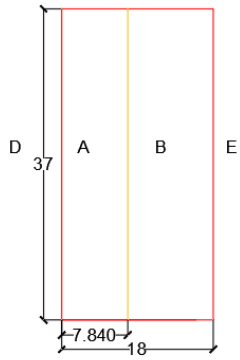

Figure 6 - Scheme of division into zones of lateral sides

External pressure on the sides:
External pressure coefficients c_{pe}.
Wind pressure w_e is equal to:

Table 6 - Values of wind pressure

A	$c_{pe} = -1.2$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-1.2) = -982.8$ Pa $= -100.2$ kg/m^2
B	$c_{pe} = -0.8$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-0.8) = -655.2$ Pa $= -66.78$ kg/m^2
D	$c_{pe} = +0.8$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (+0.8) = +655.2$ Pa $= +66.78$ kg/m^2
E	$c_{pe} = -0.5$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-0.5) = -409.5$ Pa $= -41.74$ kg/m^2

Wind loads are applied at the floor level:

At the level of the 1st floor: take into account half of the floor (1500 mm) + foundation above ground level (1000 mm). The design strip for the 1st floor is 2500 mm.

Typical floors calculated strip - 3000 mm.

At the roof level - 1500 mm.

For the windward side, two zones in the first zone from 0 to 37m include floors 1-6 floors; in the second with 7-11 + roof.

Table 7 - Pressure across the floors of the building

	first floor
D	$+66.78 \cdot 2.5 = 166.95\ kg/m$= 0.167 T/m
A	$-100.2 \cdot 2.5 = -250.5\ kg/m$= -0.250 T/m
B	$-66.78 \cdot 2.5 = -166.95\ kg/m$= -0.167 T/m
E	$-41.74\ \cdot 2.5 = -104.35\ kg/m$= -0.104 T/m
	Typical floor 2-6
D	$+66.78 \cdot 3 = 200.34\ kg/m$= 0.200 T/m
A	$-100.2 \cdot 3 = -300.6\ kg/m$= -0.300 T/m
B	$-66.78 \cdot 3 = -200.34\ kg/m$= -0.200 T/m
E	$-41.74\ \cdot 3 = -125.22\ kg/m$= -0.125 T/m

Continuaton of Table 7

	Typical floor 7-11
D	$+66.78 \cdot 3 = 200.34\ kg/m$= 0.200 T/m
A	$-100.2 \cdot 3 = -300.6\ kg/m$= -0.300 T/m
B	$-66.78 \cdot 3 = -200.34\ kg/m$= -0.200 T/m
E	$-41.74 \ \cdot 3 = -125.22\ kg/m$= -0.125 T/m
	Roof
D	$+66.78 \cdot 1.5 = +100.17\ kg/m$ =-0.100 T/m
A	$-100.2 \cdot 1.5 = -150.3\ kg/m$ =-0.150 T/m
B	$-66.78 \cdot 1.5 = -100.17\ kg/m$ =-0.100 T/m
E	$-41.74 \ \cdot 1.5 = -62.61\ kg/m$=-0.0626 T/m

2) Wind load calculation according to OY

We divide the building in height into zones corresponding to the base height for the external pressure z_e according to the standard at $h = 37$ м $> 2b = 36$ м:

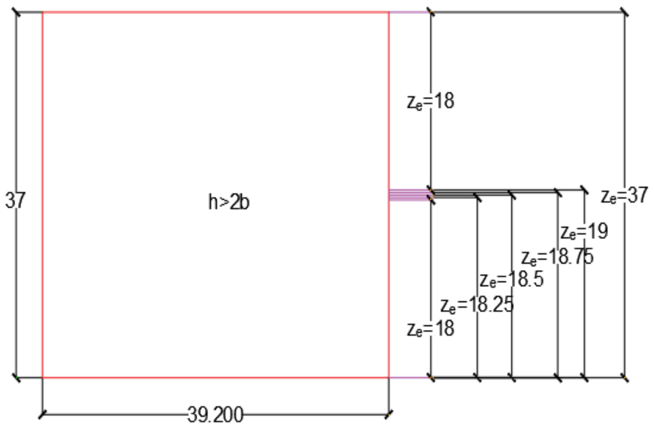

Figure 7 - base height z_e depending on h and b and the profile of the velocity head

Basic velocity wind pressure for wind region II, q_b = 0.39 kPa

Wind pressure w_e is equal to:

$$w_e = c_e(\mathrm{z}) \cdot q_b \ \cdot c_e$$

At z_e = 18m; $c_e = 0.8$; Z_e = 18m; $c_e(18) = 1.5$:

$$w_e = 1.5 \cdot 390 \cdot 0.8 = 468\ Pa = 47.7\ kg/m^2$$

At z_e = 18.25m; $c_e(18.25) = 1.525$

$$w_e = 1.525 \cdot 390 \cdot 0.8 = 475.8\ Pa = 48.5\ kg/m^2$$

At z_e = 18.5m; $c_e(18.5) = 1.55$

$$w_e = 1.55 \cdot 390 \cdot 0.8 = 483.6\ Pa = 49.3\ kg/m^2$$

At z_e = 18.75m; $c_e(18.75) = 1.575$

$$w_e = 1.575 \cdot 390 \cdot 0.8 = 491.4\ Pa = 50.1\ kg/m^2$$

At z_e = 19m; $c_e(19) = 1.6$

$$w_e = 1.6 \cdot 390 \cdot 0.8 = 499.2\ Pa = 50.9\ kg/m^2$$

At z_e = 37m; $c_e(37) = 2.2$

$$w_e = 2.2 \cdot 390 \cdot 0.8 = 686.4\ Pa = 70\ kg/m^2$$

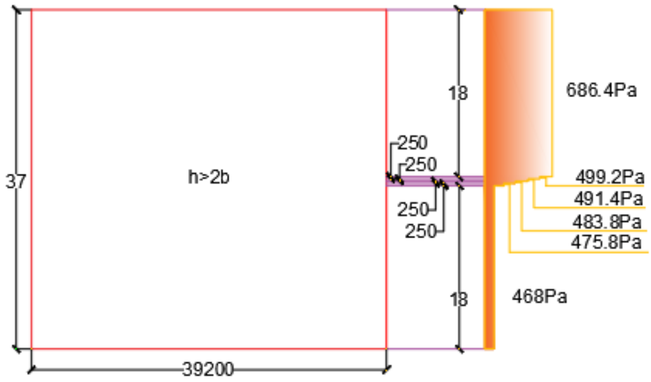

Figure 8 - Diagram of wind pressure

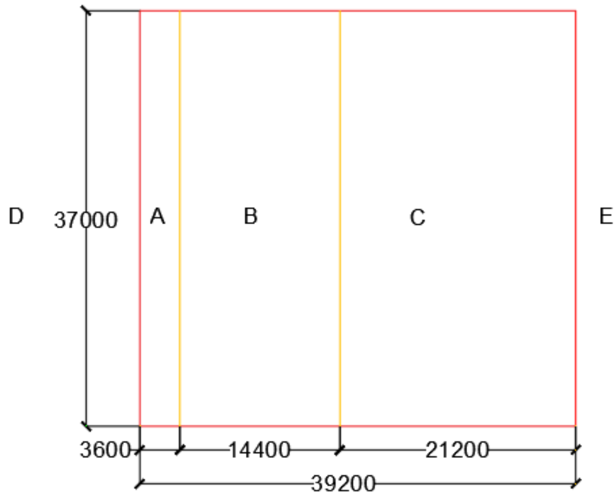

Figure 9 - Scheme of division into zones of lateral sides

Wind pressure w_e is equal to:

Table 8 - Values of wind pressure

A	$c_{pe} = -1.2$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-1.2) = -982.8\ Pa = -100.2\ kg/m^2$
B	$c_{pe} = -0.8$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-0.8) = -655.2\ Pa = -66.78\ kg/m^2$
	$c_{pe} = -0.5$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-0.5) = -409.5\ Pa = -41.74\ kg/m^2$
	$c_{pe} = +0.8$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (+0.8) = -655.2\ Pa = +66.78\ kg/m^2$
E	$c_{pe} = -0.5$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-0.5) = -409.5\ Pa = -41.74\ kg/m^2$

Wind loads are applied at the floor level:

At the level of the 1st floor: take into account half of the floor (1500 mm) + foundation above ground level (1000 mm). The design strip for the 1st floor is 2500 mm.

Typical floors calculated strip - 3000 mm.

At the roof level - 1500 mm.

For the windward side, two zones in the first zone from 0 to 37m include floors 1-6 floors; in the second with 7-11 + roof.

Table 9 - Pressure across the floors of the building

	1st floor
D	$+66.78 \cdot 2.5 = 166.95\ kg/m$= 0.167 T/m
A	$-100.2 \cdot 2.5 = -250.5\ kg/m$= -0.250 T/m
B	$-66.78 \cdot 2.5 = -166.95\ kg/m$= -0.167 T/m
C	$-41.74 \cdot 2.5 = -104.35\ kg/m$= -0.104 T/m
E	$-41.74\ \cdot 2.5 = -104.35\ kg/m$= -0.104 T/m
	Typical floor 2-6
D	$+66.78 \cdot 3 = 200.34\ kg/m$= +0.200 T/m
A	$-100.2 \cdot 3 = -300.6\ kg/m$= -0.300 T/m
B	$-66.78 \cdot 3 = -200.34\ kg/m$= -0.200 T/m
C	$-41.74 \cdot 3 = -125.22\ kg/m$= -0.125 T/m
E	$-41.74\ \cdot 3 = -125.22\ kg/m$= -0.125 T/m
	Typical floor 7-11
D	$+66.78 \cdot 3 = 200.34\ kg/m$= +0.200 T/m
A	$-100.2 \cdot 3 = -300.6\ kg/m$= -0.300 T/m
B	$-66.78 \cdot 3 = -200.34\ kg/m$= -0.200 T/m
C	$-41.74 \cdot 3 = -125.22\ kg/m$= -0.125 T/m
E	$-41.74\ \cdot 3 = -125.22\ kg/m$= -0.125 T/m
	Roof
D	$+66.78 \cdot 1.5 = +100.17\ kg/m$ =-0.100 T/m
A	$-100.2 \cdot 1.5 = -150.3\ kg/m$ =-0.150 T/m
B	$-66.78 \cdot 1.5 = -100.17\ kg/m$ =-0.100 T/m
C	$-41.74 \cdot 1.5 = -62.61\ kg/m$=-0.0626 T/m
E	$-41.74 \cdot 1.5 = -62.61\ kg/m$=-0.0626 T/m

2.6 Calculation of seismic loads

Sand and gravel soil - class II

According to the soil conditions $a_g = 0.528\ g > 0.08g$ therefore, the calculation for the determination of seismic loads along the X and Y axes is necessary.

where $a_g > 0,4g$; $a_{gv}/a_g = 0.9$:

$$a_{vg} = a_g \cdot 0.9 = 0.528g \cdot 0.9 = 0.47g > 0.25g$$

Taking into account the vertical seismic load along the Z axis is necessary.

Calculation according to horizontal:

$a_g = 0.528g,$

$q = 3$

$T_B = 0.20\ s,$

$T_c = 0.72$
With a value of the coefficient of behavior q = 3:
At 0 ≤ T ≤ 0.25:

$$S_d\ (T)_{\max} = a_g\ \left[\frac{2}{3} + \frac{T}{T_B}\left(\frac{2.5}{\mathrm{q}} - \frac{2}{3}\right)\right] = 0.528\left[\frac{2}{3} + \frac{T}{0.20}\left(\frac{2.5}{3} - \frac{2}{3}\right)\right]$$
$$= 0.528\ (0.66 + 0.83T)$$

But not less than:

$$a_g\ \cdot \frac{2.5}{\mathrm{q}} = 0.528 \cdot \frac{2.5}{3} = 0.44$$

At 0.25 ≤ T < 0. 96:

$$S_d\ (T) = a_g \cdot \frac{2.5}{\mathrm{q}} = 0.528\ \cdot \frac{2.5}{3} = 0.44$$

At T ≤ 0.96:

$$S_d\ (T)_{\max} = a_g\ \left[\frac{2.5}{\mathrm{q}}\left(\frac{T_c}{\mathrm{T}}\right)\right] = 0.528 \cdot \frac{2.5}{5}\left(\frac{0.96}{\mathrm{T}}\right) = \frac{0.25}{\mathrm{T}}$$

But not less than:

$$0.2\ a_g\ = 0.2 \cdot 0.528 = 0.105$$

The quantitative values of the ordinates of the spectra of the calculated reactions, calculated for some periods T at q = 3, are given in tables 1.

Table 10- Values of ordinates of the spectrum of calculated reactions at q = 3

T, s	0	0.25	0.50	0.96	1.20	1.50	2.0	2.50	3.0
S_d(T), in shares g	0.34	0.46	0.44	0.26	0.103	0.084	0.061	0.053	0.053

Calculation of the acceleration S_d (T) by the above formulas from NTP RK 08-01.1-2017 «Design of earthquake-resistant buildings and structures».

2.7 Thermal calculation of the outer wall

According to SPRK 2.04-01-2017 «Construction heat engineering» [p.7-10] it is necessary to determine the thickness of the insulation for the outer wall. Determine the value of the degree days of the heating period:

$$\mathrm{G_{SOP}} = \left(t_B - t_{avg}\right) \cdot z_{avg} \tag{4}$$

where, t_B= 21 degrees of Celsuise, ℃ – indoor air temperature;
t_{avg}= 1.7℃ – average temperature of the heating season;
z_{avg}= 160 days – duration of the heating period;

$$\mathrm{GSOP}\ =\ (21 - 1.7)160 = 3088℃ \cdot \mathrm{days}$$

The required resistance to heat transfer of enclosing structures that meet sanitary and hygienic and comfortable conditions is equal to:

$$R_0^{тр} = 2.45 \cdot °C/Вт$$

Table 11 - Composition of the outer wall

Material name	ϒ0, kg/m³	λ, $Вт/m^2 \cdot °C$	δ,m	$R_n = \delta/\lambda, m^2 \cdot °C/Вт$
Fiber cement siding	1650	0.76	0.149	0.196
Extruded Styrofoam(2 layers)	40	0.03	0.1	3.3
Aerated concrete	600	0.26	0.20	0.76
Polyethylene sheets	940	0.76	0.001	0.0013

The heat transfer resistance of the enclosing structure should be determined by formula 2.2:

$$R_0 = \frac{1}{\alpha_в} + \frac{\delta_1}{\delta_1} + \frac{\delta_2}{\delta_2} + \frac{\delta_3}{\delta_3} + \frac{\delta_4}{\delta_4} + \frac{1}{\alpha_н} \quad (5)$$

$$R_0 = \frac{1}{8.7} + 0.196 + 3.3 + 0.76 + 0.0013 + \frac{1}{23} = 4.4\ м^2 \cdot °C/Вт$$

$$R_0 = 4.4\ m^2 \cdot °C/Вт \geq R_0^{тр} = 2{,}45\ m^2 \cdot °C/Вт$$

The condition is met. We accept the thickness of the insulation 200 mm.

2.8 Anti-seismic measures

The threat of seismic impacts on the territory is under consideration. Seismic hazard is determined in space, in time (frequency or probability over a certain period of time) and in intensity (in points or in kinematic parameters of ground movements).

List of settlements located in the seismic zones of the Republic of Kazakhstan.

The residential building designed in the thesis is located in a seismic zone, therefore, anti-seismic measures are required. Seismicity of the work area according to SP 2.03-30-2017 is 9 points [7].

The category of soils for seismic properties is II (second). The revised seismicity value should be taken equal to 9 (nine) points.

The residential building has a length of 60 meters, since our frame is reinforced concrete, the length should not exceed 48 meters, therefore we make a sedimentary (expansion) seam.

Anti-seismic joints should be performed by erecting paired walls, paired frames, or a frame and wallThe width of the antiseismic seam between buildings or compartments should be taken not less than the total value of their calculated horizontal displacements at the corresponding level, calculated using expression (7.31). With a building height of up to 5 m, the width of the antiseismic joint, regardless of the calculation results, must be at least 30 mm. The width of the anti-seismic joint for buildings of greater height should be increased by 20 mm for every 5 m in height.

Anti-seismic joints separating the foundations (except for pile foundations) are allowed to be 10 mm wide.

In buildings located on construction sites with seismicity of 9 points or more, it is not allowed to provide the possibility of mutual displacement of adjacent compartments due to the movement of the span structures that are freely lying on the structures of adjacent compartments.

2.9 Manual calculation of beam

For the calculation, a structural element was chosen - a slab at an elevation of 34000 along the 1- A/ 1-B axis.

1) Longitudinal reinforcement calculation [5]:

Rectangular beam (30 x 50 cm)

Normal concrete class C30 / 37 (f_{ck} =30, Υ_c = 1.5, $f_{cd} = a_{cc} \cdot f_{ck} / \Upsilon_c = 1 \cdot 30 / 1.5 = 20$ MPa). Reinforcement class S450 (f_{yk} = 440 MPa, $f_v = f_{yk} / \Upsilon_s = 440 / 1.15 = 383$ MPa), $M_{ED} = 483.7\ kN.m, 184.6\ kN.m$

$$a_{Eds} = \frac{M_{eds}}{f_{cd} \cdot b \cdot d^2} \tag{6}$$

where $d = h - c_1 = 500 - 40 = 460mm$

$$a_{Eds} = \frac{184.6}{20 \cdot 10^3 \cdot 0.30 \cdot 0.46^2} = 0.145$$

Since $a_{Eds} = 0.145 \le a_{Eds,lim} = 0.372$, (see Fig. B.1. Appendix B), for the given section dimensions and concrete class, compressed reinforcement is required. Taking.

$\sigma_{sd} = f_{yd} = 434.6\ MPa, \rightarrow a_{Eds} = 0.381$, and $\omega = 0.0625$, $\zeta = \frac{z}{d} = 0.960 > z = 0.96 \cdot 460 = 441.6$, $x = 0.45\text{d} = 0.45 \cdot 460 = 207$, $\frac{c_2}{d} = \frac{40}{460} = 0.86 \sim 0.1$

$$k_d = \frac{d[cm]}{\sqrt{M_{Eds}[kN \cdot m] / b[m]}} \tag{7}$$

$$k_d = \frac{46}{\sqrt{\frac{184.6}{0.3}}} = 1.85$$

$$M_{Eds} = M_{ED} - N_{ED} \cdot z_{s1}$$

$$M_{Eds} = 184.6 - 0 = 184.6\ kN \cdot m$$

Since $k_d = 1.14$, then $k_{s1} = 2.70$ and $k_{s2} = 0.80$ [5].

$$A_{s1}[cm^2] = \rho_1 \cdot k_{s1} \frac{M_{Eds}[kN \cdot m]}{d[cm]} + \frac{N_{Ed}[kN]}{43.5}$$

$$A_{s1} = 1.01 \cdot 2.70 \frac{184.6}{46} + \frac{0}{43.5} = 10.94\ cm^2$$

where $\rho_1 = 1.01$ and $\rho_2 = 1.04$ (Table B.4)

4 rebars by diameter of 20 mm ($A_{s1} = 12.56 cm^2$).

$$A_{s2}[cm^2] = \rho_2 \cdot k_{s2} \frac{M_{Eds}[kN \cdot m]}{d[cm]}$$

$$A_{s2} = 1.04 \cdot 0.8 \cdot \frac{184.6}{46} = 4.81 cm^2$$

Compressed reinforcement is not required by design. We put it constructively.

2 rebars by diameter of 20 (A_{s2}= 6.28 cm^2).

2) Determination of transverse reinforcement

Calculation of transverse reinforcement class $S235 (f_{yk} = 235 MPa, f_{ywd} = 235 MPa)$.

Longitudinal reinforcement class $S500$ ($f_{yk} = 500 MPa, f_{yd} = 382.6 MPa, E_s = 20 \cdot 10^4$); sectional area of tensile reinforcement $A_{s1} = 12.56\ cm^2 (4\phi\ 20)$.

Required:

Determine the area and spacing of the transverse reinforcement (use the method truss analogy).

To do this, we define the shear force that concrete can perceive by the formula:

$$V_{Rd,c} = \left\{ \left(\frac{0.18}{\gamma_c} \right) \cdot k \cdot (100 \rho_l \cdot f_{ck})^{\frac{1}{3}} \right\} \cdot b_w \cdot d, \qquad kN \qquad (8)$$

But not less than $V_{Rd,c,min} = \{0.0035 \cdot k^{\frac{3}{2}} \cdot f_{ck}^{\frac{1}{2}}\} \cdot b_w \cdot d,\ kN$

where:

$$k = 1 + \sqrt{\frac{300}{500}} \leq 2, k = 1 + \sqrt{\frac{300}{500}} = 1.77$$

$$\rho_l = \frac{A_{s1}}{b_w \cdot d} = \frac{1256}{300 \cdot 500} = 0.008 \leq 0.02$$

$$d = h - c = 500 - 40 = 460$$

$$V_{Rd,c} = \left\{ \left(\frac{0.18}{1.5} \right) \cdot 1.77 \cdot (100 \cdot 0.008 \cdot 30)^{\frac{1}{3}} \right\} \cdot 300 \cdot 500 = 162030.32 N = 162.03\ kN$$

$$V_{Rd,c,min} = \left\{ 0.0035 \cdot 1.77^{\frac{3}{2}} \cdot 30^{\frac{1}{2}} \right\} \cdot 300 \cdot 500 = 5089.7 N = 5.09 kN$$

According the Etabs calculation $V_{Ed} = 145.30$

$V_{Rd;c,min} < V_{Ed;max} < V_{Rd;c}, max$= ; 5.09 kN < 145.30 kN <162.03 kN

The step of the transverse reinforcement is determined by the formula:

$$s \leq 0.75d$$

$$s \leq 0.75 \cdot 500 = 375\ mm$$

We accept the step of the transverse reinforcement s = 375 mm.

$$A_{sw} = \frac{\mathrm{V_{Ed;max}} \cdot \mathrm{s}}{\mathrm{d_z}\ f_{sw} \cos \Upsilon} \tag{9}$$

Where take according etabs; $\mathrm{V_{Ed;max}} = 145.30$ (lateral reinforcement in a given section.

We set the angle of inclination of the cracks to the horizontal $\Upsilon = 40$

The first design section is assigned at a distance($d_z = 660\ mm$)

$$f_{sw} = 235$$

$$A_{sw} = \frac{145.3\ \cdot\ 10^3 \cdot 375}{660 \cdot\ 235 \cos 40°} = 458.5\ mm^2 = 4.58cm^2$$

We accept: $23\phi\ 10\ S235\ (A_{sw} = 4.58\ cm^2)$.

In this case, the following conditions must be met:

$$\frac{\mathrm{A_{sw}} \cdot\ \mathrm{f_{sw}}}{\mathrm{b_w} \cdot\ s} \leq 0.5\ \cdot \mathrm{v}\ \cdot\ \mathrm{f_{cd}} \tag{10}$$

Where v-coefficient, taking into account the reduction in the strength of concrete in compression under tension and equal for heavy concrete:

$$v = 0.6\left(1 - \frac{f_{ck}}{250}\right) = 0.6\left(1 - \frac{30}{250}\right) = 0.53 \geq 0.5$$

$$\frac{458.5 \cdot\ 235}{300 \cdot\ 375} \leq 0.5\ \cdot\ 0.53\ \cdot\ 20$$

$0.95 \leq 5.3$ the condition is met.

$$\mathrm{V_{Ed;max}} < \mathrm{V_{Rd;c}}, max = \frac{\mathrm{v} \cdot\ \mathrm{f_{cd}} \cdot \mathrm{b_w} \cdot \mathrm{d_z}}{\cot 40 + \tan 40} = \frac{0.53 \cdot 20 \cdot 300 \cdot 660}{\cot 40 + \tan 40} = 234746.7N = 234.7kN$$

$$\mathrm{V_{Ed;max}} = 145.3\ kN < \mathrm{V_{Rd;c}}, max = 234.7kN$$

The condition is met.

Other sections are calculated in the same way.

2.10 Calculations from Etabs

Calculation of the spatial system for static and dynamic actions with the choice of design combinations of efforts.

We create 10 load cases, thereby applying loads to the building frame:

-The dead weight of the building;

-Floors;

-Walls;
-Ground pressure;
- Long-term load;
- Short-term load;
- Snow load;
- Seismic X
- Seismic Y

Load Analysis

The 7 load cases are defined in my structure and according these load case the structure is analyzed, the load cases are illustrated in following figures.

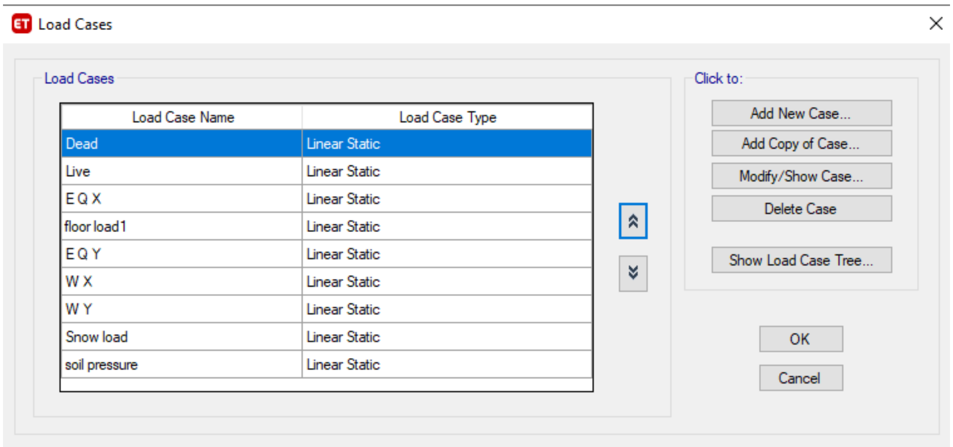

Figure 10 - Load cases

Then we proceed to the loading of our building itself that are shown in Figure A.1, Figure B.2 and Figure B.3 in Appendix B.

Combinations of action for permanent design situation (basic combination)

All coefficient and formulas are taken from SP RK EN 1990 bases for designing loading structure. We can calculate manually by the following formulas.

$$\sum_{j\geq1}\gamma_G\cdot G_K+\gamma_p\cdot \mathrm{p}+\gamma_Q\cdot Q_K+\sum_{i>1}\gamma_Q\cdot\Psi_{0.1}\cdot Q_k \qquad (11)$$

$$\sum_{j\geq1}\gamma_G\cdot G_K+\gamma_p\cdot \mathrm{p}+\gamma_Q\cdot\Psi_{0.1}\cdot Q_K+\sum_{i>1}\gamma_Q\cdot\Psi_{0.i}\cdot Q_k \qquad (12)$$

$$\sum_{j\geq1}\gamma_G\cdot G_K+\gamma_p\cdot \mathrm{p}+\gamma_Q\cdot Q_K+\sum_{i>1}\gamma_Q\cdot\Psi_{0.i}\cdot Q_k \qquad (13)$$

where $\gamma_G = 1.35$ –for permanent loads;
G_K – sum of permanent loads;;
$\gamma_Q = 1.5$ – for temporary loads ;
Q_K – sum of temporary loads;
Ψ_0, Ψ_1, Ψ_2 – in table НП.А1.1.

Combinations of actions for seismic design situations

$$\sum_{j\geq 1} G_{kj} + \text{p} + A_{Ed} + \sum_{i>1} Q_{k.i} \cdot \Psi_{2.i} \tag{14}$$

Table 12 - The values of ψ

Воздействия	ψ_0	ψ_1	ψ_2
Приложенные нагрузки в зданиях, категории (см. EN 1991-1-1):			
Категория A: бытовые, жилые зоны	0,7	0,5	0,3
Категория B: офисные площади	0,7	0,5	0,3
Категория C: зоны для собраний	0,7	0,7	0,6
Категория D: торговые площади	0,7	0,7	0,6
Категория E: складские площади	1,0	0,9	0,8
Категория F: зоны дорожного движения для транспортных средств весом ≤ 30 кН	0,7	0,7	0,6
Категория G: зоны дорожного движения для транспортных средств весом от 30 кН до 160 кН	0,7	0,5	0,3
Категория H: покрытия (крыши)[a]	0,7	0	0
Снеговые нагрузки на здания (см. EN 1991-1-3)*:			
Для районов, находящихся на высоте H > 1000 м над уровнем моря	0,7	0,5	0,2
Для районов, находящихся на высоте H ≤ 1000 м над уровнем моря	0,5	0,2	0
Ветровые нагрузки на здания (см. EN 1991-1-4)	0,6	0,2	0
Температурные воздействия (исключая пожары) на здания (см. EN 1991-1-5)	0,6	0,5	0
а) См. также 3.3.2(1) EN 1991-1-1.			

Then the combinations of design load combinations will look in accordance with Figures 8.

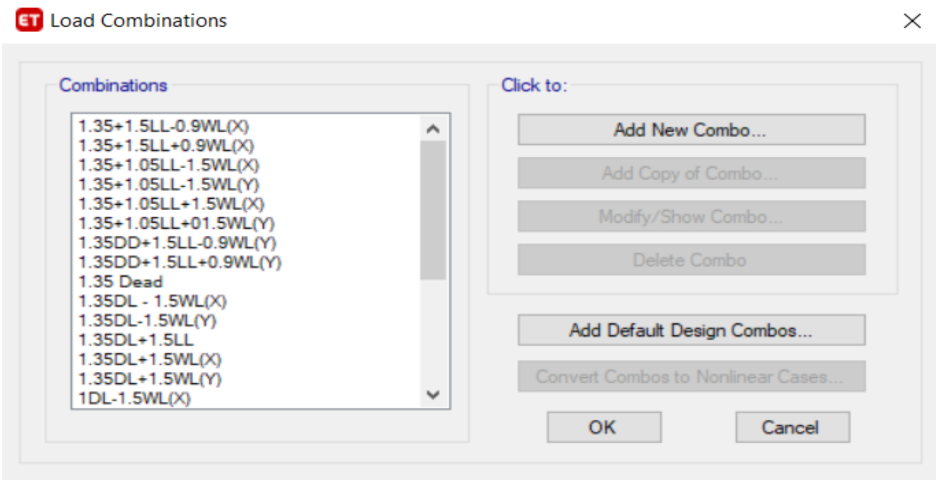

Figure 11 - Combination of actions

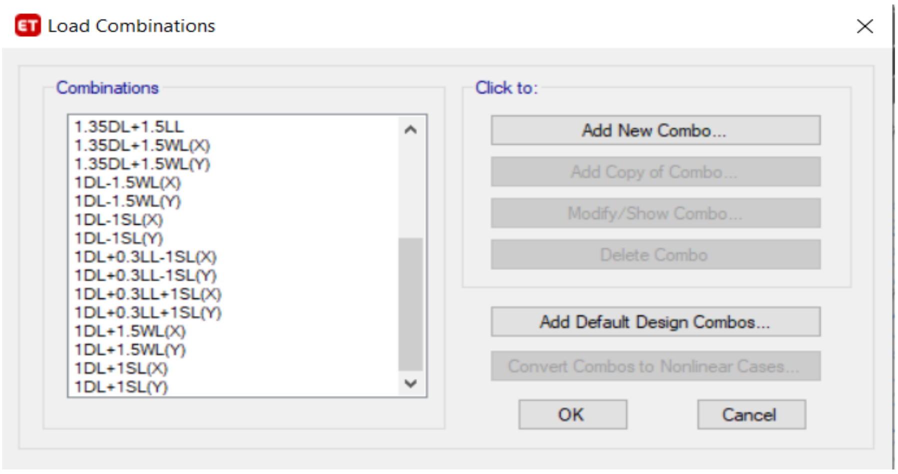

Figure 12 – Combination of actions

Ultimate strains and bases

Industrial and civil one-story and multi-storey buildings with a full frame: the same, with the device of reinforced concrete belts or monolithic floors, as well as buildings with a monolithic structure, Average $s_{(max,\ \mu)}$ = 10 cm, Respectively, according to the standard the maximum settlement of the base is $S_{(max,\ \mu)}$ = 10 cm [16].

For our design scheme, the maximum drift is 60 mm, which satisfies the condition which is shown in Figure B.4 in Appendix B,

$$s \le s_{max,\mu}$$

$$60\ mm \le 100\ mm$$

The relative difference in sediment is:

$$\mathrm{RS} = (\frac{\Delta s}{L})_u,$$

where L is the distance between the axes of the foundation blocks in the direction of horizontal loads, and in guyed supports - the distance between the axes of the compressed foundation.

According to Appendix B [1], the relative draft should not exceed 0.002.

Then, according to FigureA.5 in Appendix A, we get that the relative draft is:

$$\frac{24}{18000} = 0.00013 < 0.002$$

Conidian is met

Deflection of the slab and girder

The appearance and overall serviceability of the supporting structure may be compromised if the calculated deflection of a beam, slab or cantilever beam, near a constant combination of actions, exceeds L / 250 span. According to the standard (SN RK EN 1992-1-1 < Design of reinforced concrete structures for buildings >, according to sub-clause 7.4 Control of deflections).

The deflection of the floor slab is determined according to Figure A.5 in Appendix A

The deflection is 60 mm

According to subparagraph the deflection of the slab should not exceed a value equal to:

$$\frac{l}{250} = \frac{6800}{250} = 27.2\ mm$$

Maximum horizontal displacement from the wind

According to paragraph EN1991 10.14 of Table 22 [3], the maximum horizontal displacements from the wind are calculated by the formula:

$$\text{Maximum horizontal displacements from the wind} = \frac{h}{500}$$

where h - the height of multi-storey buildings, equal to the distance from the top of the foundation to the axis of the roof girder.

The maximum movement along the X axis is 0.5 mm.

$$0.5\ mm < \frac{37000}{500} = 74\ mm$$

The condition is met.

The maximum displacement along the Y-axis is 1.03 мм according Figure B.6 in Appendix B.

$$1.04 < \frac{37000}{500} = 74\,mm$$

The condition is met.

Checking the regularity of buildings in the plan

To begin with, let's check the building for regularity in terms of X. To do this, we use the formula according the Figure B.7 in Appendix B.

$$100 - \frac{\delta_{max} + \delta_{min}}{2 \cdot \delta_{max}} \cdot 100$$

$$100 - \frac{4.15 + 1.5}{2 \cdot 4.15} \cdot 100 = 31.9\,percent$$

According the Figure B.8 in Appendix B.

$$100 - \frac{\delta_{max} + \delta_{min}}{2 \cdot \delta_{max}} \cdot 100$$

$$100 - \frac{24.1 + 30.15}{2 \cdot 30.15} \cdot 100 = 10.03\,percent$$

According the Figure B.9 in Appendix B.

$$100 - \frac{\delta_{max} + \delta_{min}}{2 \cdot \delta_{max}} \cdot 100$$

$$100 - \frac{58.8 + 63.7}{2 \cdot 63.7} \cdot 100 = 3.8\,percent$$

According the Figure B.10 in Appendix B.

$$100 - \frac{\delta_{max} + \delta_{min}}{2 \cdot \delta_{max}} \cdot 100$$

$$100 - \frac{5.7+2.2}{2 \cdot 5.7} \cdot 100 = 30.7\,percent$$

Since not all values exceed 25%, our building is irregular in plan along the OX and OY axes.

We take all the displacement values from the ETABS software package (story response).

3 Organisational and technological Part

3.1 Earthwork

Type of soil is sand and gravel that is included in II category of soil with admixture up to 30 percent.

Initial data on soil are indicated in table 7.

Table 12 – Initial data

Name of factors	Unit of measurement	Numeric data	Note
Soil category		II	ENiR 2, edition 1 page 7-12
Average density of soil	kg/m^3	1600	ENiR 2, edition 1 page 7-12
Initial loosening factor	Percenage	10-15	ENiR 2, edition 1 page 179
Residual loosening factor	Percenage	2-5	ENiR 2, edition 1 page 179
Slope steepness factor	Percenage	0.67	Khamzin, Karasev «technology of construction procesess», page 35

Range of soil transportation: 5 km

Winter temperature of external influence: minus 10 degrees celciuse

Elevation of the base of foundation: -3 m

Determination of the scope of work

As it is known at the present time, the construction of a building and structure is not implemented without an approved estimate, therefore, customers require to know the volume of capital investments and the timing of striotel.

- Temporary fencing

Prior to the construction work necessary to perform the construction temporary fencing, fencing perimeter, m, determined by the formula:

$$P_{fen} = (20 + l_1) \cdot 2 + (20 + l_2) \cdot 2 \quad (16)$$

where l_1, l_2– length and width of the structure in plan, m.

Distance from the axis of the building in each direction is 20 m.

$$P_{fen} = (20 + 39.2) \cdot 2 + (20 + 18) \cdot 2 = 194.4 \text{ m}$$

But for the whole project the fencing will be 800 m.

- The volume of earthworks is determined when designing earthworks.

$$V_p = \frac{h}{6} \cdot \left(a \cdot b + c \cdot d + (a + c) \cdot (b + d)\right), m^3 \quad (17)$$

where a, b are the width and length of the pit along the bottom;

c, d - width and length of the pit along the top

$$V_{p1} = \frac{3}{6} \cdot \left(20.6 \cdot 41.8 + 25.7 \cdot 46.7 + (20.6 + 25.7) \cdot (41.8 + 46.7)\right) = 3080\ m^3$$

Since I have 7 identical foundation pit for the whole project:

$$V_p = 7 \cdot V_{p1} = 7 \cdot 3080 = 21560\ m^3$$

- Determine the volume of backfilling

$$V_{bf1} = \frac{V_p - V_f - V_{base}}{1 + K_{r.l}}, m^3 \qquad (18)$$

where V_f - volume of foundation elements;

V_{base} - basement volume;

$K_{r.l.}$- residual loosening factor is 0.05.

$$V_{bf1} = \frac{3080 - 635.04 - 2116.8}{1 + 0.05} = 312.53 m^3$$

Volume of backfilling for the whole project:

$$V_{bf} = 7 \cdot V_{bf1} = 2187.71 m^3$$

Basement volume:

$$V_{base} = a \cdot b \cdot h = (18 \cdot 39.2 \cdot 3) = 2116.8\ m^3$$

Volume of foundation elements:

$$V_f = 39.2 \cdot 18 \cdot 0.9 = 635.04\ m^3$$

- Determination of the volume of surplus soil

$$V_{s.s} = V_p - V_{bf}\ , m^3 \qquad (19)$$

For one building:

$$V_{s.s1} = 3080 - 312.53 = 2767.47$$

For the whole project:

$$V_{s.s} = 7 \cdot 2767.47 = 19372.29$$

- Determination of the volume of soil shortage

$$V_{short.s} = a \cdot b \cdot h_{short.s}, m^3 \qquad (20)$$

$$H_{short.s} = 0.1 \div 0.4\ m$$

$$V_{short.s} = (39.2 \cdot 18 \cdot 0.4) = 282.24\ m^3$$

For the whole project:

$$V_{short.s} = 7 \cdot 282.24 = 1975.68\ m^3$$

- Determination of the cutting area of the vegetation layer

$$S_{veg} = (10 + c + 10)\ (10 + d + 10), m^2 \qquad (21)$$

$$S_{veg} = (10 + 25.7 + 10)\ (10 + 46.7 + 10) = 3048.19\ m^2$$

For the whole project:

$$S_{veg} = 7 \cdot 3048.19 = 21337.33\ m^2$$

- The total volume of cutting of plant soil.

$$V = S \cdot h_{p.s} = 3048.19 \cdot 0.2 = 609.638 m^3$$

For the wole project:

$$V = 7 \cdot 609.638 = 4267.466\ m^3$$

- The area of soil compaction.

$$F_c = \frac{V_{bf1}}{h_c} \tag{22}$$

where h_c - thickness of the compacted layer

$$F_c = \frac{312.53}{0.2} = 1562.65\ m^2$$

For the wole project:

$$F_c = 7 \cdot 1562.65 = 10938.55\ m^2$$

- Waterproofing area of foundation slab

$$S = \frac{V_{base}}{h} \tag{23}$$

$$S = \frac{2116.8}{3} = 705.6\ m^2$$

For the whole project:

$$S = 7 \cdot 705.6 = 4939.2\ m^2$$

Table 13 - List of volumes of earthworks

№	Name of work	Unit of measurement	amount		Notes
			For one building	For the whole project	
earthwork					
1	Cutting off the vegetation layer	m^2	3048.19	21337.33	
2	Excavation by excavator				
A)	In the dump	m^3	312.53	2187.71	
B)	In vehicles	m^3	2767.47	19372.29	
3.	Development of shortage of soil	m^3	282.24	1975.68	
4.	Backfilling of soil	m^3	312.53	2187.71	
5.	Soil compaction	m^2	1562.65	10938.55	
6.	Waterproofing device	m^2	705.6	4939.2	

Selection of a set of machines for excavation work

The main factors that affect the choice of machines for implementation of earthworks are the design and dimensions of the earth structure, the group of soil, the grain size distribution of the soil and the moisture content of the soil.

Most of the volume of earthworks is carried out mechanically, using various types of machines.

Soil development is divided into 3 groups:

- earthmoving
- machines for soil compaction
- machines for auxiliary work

1) Choosing a bulldozer

Basic tractor T-130, bulldozer DZ-110, soil – course sand or gravel, cutting path length – 25.7 m, soil transportation path length – 78.4 m.

Cycle time:

$$T = t_1 + t_2 + t_3 + t_4 \qquad (24)$$

where t_1 - soil cutting time:

$$t_1 = \frac{l_1}{v_1} = 3.6 \cdot 25.7/3.2 = 28.9\text{s}$$

where 3.6 - conversion factor km/h to m/s;

l_1 - cutting path length, l_1=25.7 m;

v_1 - speed of movement of the bulldozer in 1st gear when cutting the soil;

v_1=3,2 km/h.

t_2 - soil transference time by blade:

$$t_2 = \frac{l_2}{v_2} = 3.6 \cdot 78.4/3.8 = 74.2\text{s}$$

where 3.6 - conversion factor km/h to m/s;

l_2 - length of soil transportation path, l_2=78.4 м;

v_2 - the speed of the loaded bulldozer, v_2=3.8 km/h.

t_3 - return (empty bulldozer) time :

$$t_3 = \frac{(l_1 + l_2)}{v_3} = 3.6 \cdot \frac{(25.7 + 78.4)}{5.2} = 72\ s$$

where v_3 - reverse travel speed, v_3=5.2 km/h;

t_4 - additional time spent on lifting, lowering the blade, switching speeds, turning the bulldozer, t_4=25 c.

$$T=t_1+t_2+t_3+t_4 = 21.4 + 57 + 55 +25 = 158.4\text{c}$$

$$T = 28.9 + 74.2 + 72 + 25 = 200.1\ s$$

The technical performance of the bulldozer is determined by the formula:

$$P_T = q_{pr} \cdot n \cdot \frac{k_n}{k_r} \quad (25)$$

where q_{pr} - volume of the soil dragging by blade, м;

k_n = 1.1 - coefficient of filling the geometric volume of the prism with soil;

k_r=1.25 - soil loosening coefficient.

Volume of the soil dragging by blade:

$$q_{pr} = \frac{L \cdot H^2}{2 \cdot m} = \frac{3.94 \cdot 0.815^2}{2 \cdot 0.7} = 1.87 m^3$$

where L - blade length, L = 3.94 m;

H - blade height, H=0.815 m;

m = 0.7 - coefficient depending on the ratio $\frac{H}{L}$.

Number of cycles per 1 hour of work:

$$n = \frac{3600}{T} = \frac{3600}{200.1} = 18$$

$$P_T = q_{pr} \cdot n \cdot \frac{k_n}{k_r} = 1.87 \cdot 18 \cdot \frac{1.1}{1.25} = 29.6 \frac{m^3}{h}$$

Operating performance of the bulldozer:

$$P_e = P_T \cdot k_v = 29.6 \cdot 0.8 = 23.7 \frac{m^3}{h}$$

where k_v - bulldozer utilization rate over time, k_v=0.8.

Changeable bulldozer performance:

$$P_c = 8 \cdot P_e = 8 \cdot 23.7 = 189.6 \frac{m^3}{h}$$

where 8 - the number of hours of work per shift.

2) Excavator selection

The excavation is carried out with a excavator equipped with a backhole shovel with loading soil into dump trucks and with partial filling into a dump.

We select a front shovel excavators with teeth and with a bucket volume of 1 m^3.

Table 14 – Specifications of excavator

Specification	EO-5122
Drive unit	Hydraulic
Bucket volume	1 m^3
Maximum digging depth	9.3 m
Largest cutting radius	9.9 m
Height of unloading into transport	6.6 m
Power	95 kwatt
Mass	39.5 t

3) Determining the number of dump trucks

To remove excess soil from the construction site and ensure joint work with the excavator, we choose dump trucks. The carrying capacity and the brand are assigned depending on the volume of the excavator and on the distance of the soil transportation.

Choosing a dump truck MAZ-5516

- The volume of soil in a dense body in an excavator bucket

$$V_s = \frac{V_b \cdot К_{b.f}}{К_{p.l} + 1} \quad (26)$$

$$V_s = \frac{1 \cdot 1.25}{0.25 + 1} = \frac{1.25}{1.25} = 1m^3$$

where V_b- accepted bucket volume;

$К_{b.f}$- bucket filling ratio.

for a straight shovel - from 1-1.25

$К_{p.l}$ = 0.25- primary loosening factor

Determination of the mass of soil in an excavator bucket

$$Q = V_s \cdot \rho_s = 1 \cdot 1.6 = 1.6 \text{ t}$$

where ρ_s=1.6 t/m^3- average soil density.

- Determination of the number of soil buckets loaded into the body of the dump truck

$$n = \frac{P}{Q} = \frac{20}{1.6} = 12$$

- Determination of the volume of soil in a dense body of a dump truck loaded into the body:

$$V = V_s \cdot n = 1 \cdot 12 = 12 \text{ m}^3$$

- Determination of the duration of one cycle of the dump truck

$$\text{T}_c = t_\text{l} + \frac{60 \cdot L}{V_l} + t_\text{p} + \frac{60 \cdot L}{V_P} + t_m \quad (27)$$

$$\text{T}_c = 13.8 + \frac{60 \cdot 5}{18} + 2 + \frac{60 \cdot 5}{25} + 3 = 47.4\, min$$

where L- Soil transportation distance;

t_l- soil loading time;

t_p- soil unloading time - from 1-2 min;

t_m- maneuvering time before loading and unloading - from 2-3 minutes;

V_l -the average speed of the dump truck in the loaded state.V_r=18 km/h;

V_P-from 25-30 km/h.

$$t_p = \frac{V \cdot \text{H}_{vr}^2 \cdot 60}{100} \quad (28$$

$$t_p = \frac{12 \cdot 1.92 \cdot 60}{100} = 13.8\, min$$

- Determination of the required number of dump trucks

$$N = \frac{T_c}{t_p} = \frac{47.4}{13.8} = 3.4 \approx 4$$

4) Selection of soil compactors

Since course sand or gravel is course graind soils and have little cohesiveness, therefore, considering the smallest length of the condensed strip up to 50 m we choose (DU-128) – plate compactor with a width of the compacted strip - 2.5 m.

3.2 Technological map for concreting and formwork

The composition of concrete work and formwork work in the construction of a monolithic frame includes:

- Formwork device;
- Concreting of the frame;
- Dismantling of the formwork.
- Concrete caring

Before starting the constructing of frame structure, you must:

- Deliver and place formwork panels and reinforcing bars at the storage site;
- Deliver and prepare necessary devices, inventory and tools for the work to the site;

Formwork panels and details of its fastening should be sorted by brands and standard sizes.

Reinforcing bars are delivered to the storages in the amount that ensures the work of the reinforcement during the shift.

Concrete is delivered to the construction site by concrete mixer trucks, or dump trucks adapted for the transportation of concrete.

In the places where the concrete is placed, an inventory wooden flooring is arranged.

Reinforced concrete structures in contact with the ground must be coated with hot bitumen.

Correct installation and fastening of the formwork must be accepted according to the act.

Initial data

Number of floors - 13 (including the basement)

Transportation range - 5 km

Building dimensions: l = 39.2 m, b = 18 m

Thickness of floor slabs and coverings: h = 20 cm

Bulk density of heavy concrete: 2500 kg / m^3

Floor height: typical - 3 m, basement floor - 4 m

The thickness of the shear walls are 200 mm.

Formwork installation

The installation of the formwork is carried out using a KB-403 tower crane with a boom length of 23 m, installed according to the construction plan. The installation of the formwork should be carried out according to the grips. Each floor is divided into two sections in the plan. The boom of the crane is:

$$l_{cr} = a + b + c \qquad (24)$$

where a- the distance from the crane axis to the crane rail;

b- the distance from the crane rail to the building;

c- the length of the building.

$$l_{cr} = 2 + 3 + 18 = 23$$

Columns, walls and ceilings should be concreted in the formwork. The formwork kit consists of:

- Shearwall - made of metal panels, faced with water-resistant plywood 21 mm thick, withstanding the pressure of freshly laid concrete of 60 kN / m^2; straightening locks BFD, providing in one operation the connectivity, evenness and density of the formwork panels; strands DV - 15 with a nut - gasket with a permissible load on the strand of 90 kN; leveling strand PCC with a support, ensuring the stability of the formwork structures and designed for a load of 30 kN; consoles of suspended scaffolding TRZh 120, providing safety when the load on the platform is 150 kg / m2.
- Column - metal panels TRS, lined with waterproof plywood 21 mm thick, withstanding the permissible pressure of freshly laid concrete of 100 kN /m^2, column tension bolts with permissible bolt load of 90 kN.
- Coverings - made of lattice girders GT 24 of various lengths with a bearing capacity - transverse force in struts - 14 kN, bending moment - 7 kNm, supports PER 30 with a bearing capacity of 30 kN; panels made of waterproof plywood 21 mm thick.

The formwork is delivered to the construction site in special containers by road and stored under a canopy.

The moisture content of the wood used for the deck should be no more than 18percentage, for supporting elements - no more than 22percentage. The formwork elements must fit snugly against each other during assembly. Slots in butt joints should not be more than 2 mm.

For the antidezone coating of the working surface of the formwork, water-repellent lubricants are used based on petrochemical products that do not thicken in the cold: solid oil or petrolatum-kerosene.

The formwork is disassembled in the following order:

- Remove external braces and struts;
- Remove the clamping clamps connecting the opposing walls of the formwork;
- Release the tension hooks connecting the shields with the contractions, remove the contractions and individual shields;
- The shields are torn off the concrete with stripping tools with crowbars or crank arms.

Scope of work

Calculation of the amount of work per floor:

1) Formwork

- Large-panel formwork:

$$S = L \cdot h \tag{29}$$

Floor slabs:

$$S = L \cdot B = 705.6\ m^2$$

Shear wall:

$$S = L \cdot B = 523.2\ m^2$$

Total: 1228.8 m^2

- Small-panel formwork:

Columns:

$$S = 42 \cdot 0.55 \cdot 4 \cdot 3 = 277.2\ m^2$$

Beams

$$S = 273.56\ m^2$$

Total: 550.76 m^2

Overall: 1779.56 m^2

- Support device, racks

According to norms and rules for each 4 m^2 1 rack is established.

In order to find out the number of racks you need to know the area of the building, divide the area by 4 to find out the number of racks. But racks according to ENiR are measured in meters of 100 m. To do this, multiply the number of racks by the height of the floor and divide by 100.

$$S = L \cdot b = 18 \cdot 39.2 = 705.6\ m^2 \text{ (Building area)}$$

$$n = S / 4 = 705.6/4 = 177 \text{ pcs. (Number of racks)}$$

$$L = 177 \cdot 3 = 531\ m$$

- Device of beams:

Beams are laid in the longitudinal direction every 3 meters, and in the transverse direction every 1 meter. Beam length 3 m.

In the longitudinal direction:

$$N = 39.2/3 = 14 \text{ pics.}$$

$$n_{total} = 14 \cdot 6 = 84 \text{ pics. (total)}$$

$$L = 84 \cdot 3 = 252\ m.$$

In the transverse direction:

$$n = 18/3 = 6 \text{ pics.}$$

$$n_{total} = 6 \cdot 38 = 228 \text{ pics.}$$

$$L = 228 \cdot 3 = 684\ m.$$

Table 15- Scheme of formwork for elements

Name of board	Designation	Sizes, mm	Quantity	Area of the board, m^2
Linear board	LB-1	3000×1000	74	3
Angular board	AB-1	3000×300	9	0.9
Universal board	UB-1	3000×1000	22	3
Universal board	UB-1	3000×500	32	1.5

Total				8.4

2) Concreting

Concrete mix must be transported by specialized methodes. The accepted method for transporting the concrete mixture must:

- Exclude the ingress of atmospheric precipitation and direct exposure to sunlight;
- Exclude stratification and violation of homogeneity;
- Prevent the loss of laitance or mortar.

The maximum duration of transportation of the concrete mix should be established by the construction laboratory with the condition of ensuring the preservation of the required quality of the mix on the way and at the place of its laying.

Before placing the concrete mixture, the floor (artificial), the correct installation of the formwork, reinforcement structures and embedded parts must be checked. The inner surface of the inventory formwork must be cleaned and coated with a special grease that does not impair the appearance and strength of the structures.

breaks in concreting, which require the device of working seams, is determined by the laboratory depending on the type and characteristics of the cement and the temperature of concrete hardening. Placement of the concrete mixture after The distribution of the concrete mixture in the structure to be concreted is carried out in horizontal layers of the same thickness, laid in one direction. The overlapping of the previous layer is subsequently performed before the cement sets, and the overlapping time is set by the laboratory depending on the outside air temperature, the properties of the cement used. Approximately this time is no more than 2 hours.

The duration of such breaks is carried out only after the surface of the working joint is treated with cement mortar with a thickness of 20-50 mm or with a layer of plastic concrete mixture.

The concrete mix is compacted with a deep vibrator with a flexible shaft. When compacting the concrete mixture, it is not allowed to rest the vibrators on reinforcement, embedded products, formwork fastening elements. The step of moving the vibrator should not exceed 1.5 of its radius of action. The optimal duration of vibration in one place is 20-30 s. The immersion depth of the vibrator in the concrete mixture should ensure its partial deepening into the previously laid unhardened concrete layer is showed in figure 13.

Signs of the completion of concrete compaction during the operation of vibrators are:

- stopping the settling of the concrete mixture;
- coarse aggregate coating with mortar;
- the appearance of cement laitance on the surface and in the places of contact with the formwork;
- cessation of the release of air bubbles.

After laying the top layer of the concrete mixture, it is necessary to smooth out the exposed concrete surface.

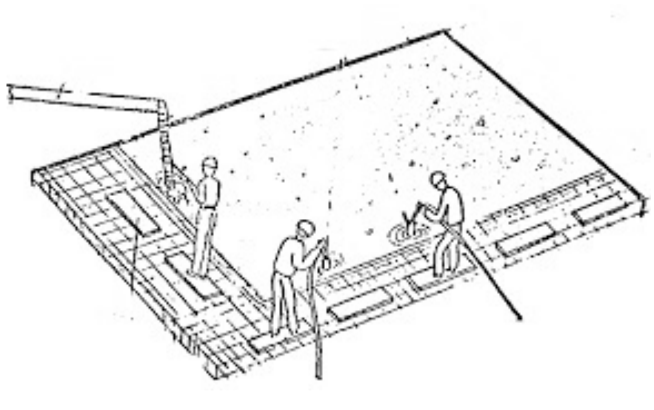

Figure.13-Concrete laying process

When caring for concrete, it is necessary to provide favorable temperature and humidity conditions for concrete hardening, protecting it from the harmful effects of wind, direct sunlight by systematic watering of moisture-consuming coatings (burlap, a layer of sand, sawdust, etc.) of concrete surfaces; the frequency of watering moisture-consuming coatings depends on climatic conditions and the need to maintain the concrete surface in a damp state;

Concreting structures must be accompanied by appropriate entries in the concrete work log.

Laying concrete mix in wall structures.

$$V_{st} = (h·a·b·ρ) = 55.08\ m^3$$

Placement of concrete mix in coatings and ceilings:

$$S = L·b·h = 39.2·18·0.15 = 105.84\ m^3$$

Paving the concrete mixture into the column:

$$S = L·b·h = 42·0.55·0.55·3 = 38.115\ m^3$$

Laying the concrete mixture in the crossbar:

$$S = L·b·h = 0.5·0.3·361.2 = 54.18\ m^3$$

- Curing of concrete

When caring for concrete, it is necessary to provide favorable temperature and humidity conditions for concrete hardening, protecting it from the harmful effects of wind, direct sunlight by systematic watering of moisture-consuming coatings (burlap, a layer of sand, sawdust, etc.) of concrete surfaces; the frequency of watering moisture-consuming coatings depends on climatic conditions and the need to maintain the concrete surface in a damp state;

$$S = a \cdot b = 705.6\ m^2$$

- Dismantling the formwork:

Large-panel formwork – 1228.8 m^2

Small-panel formwork - 550.76 m^2

Total: 1779.56 m^2

- Disassembly of racks and beams:

Support n = 177 pcs, L = 531 m

Beams L = 936 m., N = 312 pcs.

Table 16 - Statement of volumes of construction installation work

№	Name of processes	Units	1st floor volume	Number of floors	Overall volume
1	Formwork works				
	Large-panel formwork	m^2	1228.8	13	15974.4
	Small-panel formwork	m^2	550.76	13	7159.88
	support	m	531	13	6903
	Beams	m	936	13	12168
3.	Concrete works				
	Pouring	m^3	253.215	13	3291.8
	Caring	m^2	705.6	13	9172.8
4.	dismantling				
	Large-panel formwork	m^2	1228.8	13	15974.4
	Small-panel formwork	m^2	550.76	13	7159.88
	support	100 m	531	13	6903
	Beams	m	936	13	12168

- Tiering and Sizing of Structures

For the flow organization of the production of work, the object must first be divided into tiers and captures. A tier is a section of a conditionally expanded construction object vertically. 1st floor-1 tier. Capture - is a part of the object being built to which a private stream is allocated with a certain number of workers.

The number of captures can be determined by the formula [10]:

$$m = \frac{A \cdot t_{в}}{к} + n - 1 \quad (30)$$

where A- the number of shifts per day;

$t_{в}$ – the curing time of concrete until it acquires a strength equal to 15 kg/cm^2(We accept from 1-6 days);

K - Cyclic module, i.e. the duration of work on the seizure is taken equal to 1;

n- Number of simple processes (4).

$$m = \frac{2 \cdot 2}{1} + 4 - 1 = 7\ hook$$

- Calculation of the formwork turnover

This calculation shows us how many times 1 formwork is used. The quality indicator of the formwork is its turnover, i.e. possibility of repeated use.

The formwork turnover is calculated by the formula

$$Z = \frac{\sum_1^a m}{n - 1 + \frac{A \cdot t_{в}}{к}} \quad (31)$$

where Σm - The total number of captures on all levels of the structure;

A- Number of shifts per day = 2

$$\Sigma m = 7 \cdot n = 7 \cdot 13 = 91$$

$$Z = \frac{91}{4 - 1 + \frac{1 \cdot 2}{1}} = 18.2 \text{ times}$$

That is, one formwork is used 18.2 times during the construction process.
The required number of formwork kits is determined by the formula:

$$a = n + 1 + \frac{A \cdot t_{в}}{к} \tag{32}$$

$$a = 4 + 1 + \frac{1 \cdot 2}{1} = 7 \; sets$$

Selection of methods of transportation, supply, placement and consolidation of concrete mixture.

Tower crane is a boom-type slewing crane with a boom fixed in the upper part of a vertically located tower.

A tower crane is distinguished:

- Stationary
- Mobile
- Combined

1) Determination of the required lifting height of the tower crane hook:

$$H_{cr}^{tr} = H_o + H_{reserve} + H_{elem} + H_{sling} \text{ (m)} \tag{33}$$

where H_o- Mark where the element to be installed is installed (37 m)
$H_{reserve}$- Height reserve (0.5 m)
H_{elem}- Element height in mounted position (3.7 m)
H_{sling}- Height of slings (2.5 m)

$$H_{cr}^{tr} = 37 + 0.5 + 3.7 + 2.5 = 43.7 \text{ m}$$

2) Determination of the required outreach of the tower crane:

$$l_{str}^{tr} = B + \frac{a}{2} + c, \text{(m)} \tag{34}$$

Where в - Width of the building object;
a - Width of the crane runway (4.5-6 m);
c - Distance from the edge of the building to the slewing part of the crane (2 m)

$$l_{str}^{tr} = 18 + \frac{5}{2} + 2 = 23 \text{ m}$$

3) Determination of the required load moment.

$$M_{tr}^{tr} = (Q_{el} + Q_{sling}) \cdot l_{sling}^{tr} (t \cdot m) \tag{35}$$

where Q_{el}- the mass of the bucket crane (5.9 tons);

Q_{sling}- weight of slings (0.1 t);

l_{sling}^{tr}- Required boom reach.

$$M_{tr}^{tr} = (5.9 + 0.1) \cdot 23 = 138 \text{ t} \cdot \text{m}$$

4) Tower crane selection:

KB-408

Carrying capacity: 10 t

Load moment: 160 t·m

Lifting capacity at maximum outreach: 3 t

Departure range: 6 - 30 m

Lifting height freestanding crane: 57.8 m

Maximum Lifting speed: 67 m / min

5) Crane bucket:

Table 17- bucket characterisrics

Product name	Volume, l	Carrying capacity, kg	Length, mm	Width, mm	Height, mm	Weight,
BP-2	2000	6000	3600	1000	2200	880

The actual duration of the bucket is determined by the formula:

$$T = \frac{V}{P_c} \tag{36}$$

$$T = \frac{3291.8}{49.5} = 66.5 \text{ days.}$$

where V- the total required volume of concrete for the entire building;

P_c- Changeable operational efficiency of the mechanism m^3 / shift.

Replaceable operational performance of a bucket for conveying concrete mixture is calculated by the formula:

$$P_c = \frac{60 \cdot V \cdot T \cdot K_B}{T_c} \frac{m^3}{\text{shift}} \tag{37}$$

$$P_c = \frac{60 \cdot 2 \cdot 8 \cdot 0.8}{15.5} = 49.5$$

where V- the volume of concrete mixture loaded into the crane with a bucket;

T - shift duration (8 hours);

K_B- The coefficient of use of the crane over time:

For a crane with an electric drive without outriggers - 0.82; for a crane with an electric drive with outriggers - 0.8; for a crane with an internal combustion engine without outriggers - 0.78; for a crane with an internal combustion engine with outriggers -0.76.

T_c- Duration of the working cycle

5) The duration of the working cycle is calculated by the formula:

$$T_c = t_r + t_s + 2t_p + t_y \text{ (minute)} \tag{38}$$

Where t_r- Time of unloading the concrete mix from the concrete truck into the buckets (0.5-1.5 min);

t_s - Time of slinging (1-1.5 minute)

t_p- Time of feeding the concrete bucket crane into the concreting block (Depends on the feed height and lifting speed, as well as on the distance and speed of horizontal movement)

t_y - Time of placing the concrete mixture into the structure (1-3 min)

$$\mathbf{T_c} = 1.5 + 3 + 2 * 4 + 3 = 15.5 \text{ minute}$$

Choice of a mechanism for conveying concrete mixture

Concrete pumps are used for general construction work related to concreting, filling with ready-mixed concrete of all types of formwork during the construction of walls, floors, foundations, and various tunnels. They are used in conjunction with equipment for the production, storage or supply of ready-mixed concrete.

Pneumatic blowers are units used for the preparation of concrete mixture and its simultaneous supply. This type of pump has a built-in compressor with an electric motor or diesel unit.

- Concrete pump:

Model (ABN 75/32)

The actual duration of the concrete pump operation is determined by the formula:

$$T = \frac{V}{P_c} \tag{39}$$

$$T = \frac{3291.8}{54.26} = 60 \text{ days}$$

where V- the total required volume of concrete for the entire building;

P_c- Changeable operational efficiency of the mechanism m^3 / shift.

$$\Pi_e = 60 * T\left(\frac{\Pi * d^2}{4}\right) * l * \vartheta * K_{ex}, \frac{m^3}{\text{shift}} \tag{40}$$

where T is the duration of work per shift 8 hours;

$\Pi = 3.14$

d - Working cylinder diameter m

l - Piston stroke length

ϑ - number of 2 piston strokes min. (Discharge rate)

K_{ex} - coefficient characterizing the ratio of the volume of concrete mixture supplied in 1 stroke to the working volume of the amplifier (0.8-0.9)

$$\Pi_e = 60 \cdot 8 \left(\frac{3.14 * 0.2^2}{4}\right) \cdot 2 \cdot 2 \cdot 0.9 = 54.26$$

- Concrete mixer truck

KaMAZ-53212

- Vibrator

IV-66

The number of concrete trucks based on the condition of uninterrupted delivery to the object:

$$N = \frac{K_r * P_e}{P_a} \tag{41}$$

where K_r- the coefficient taking into account the reserve of productivity of mechanisms to the leading machines (0.85-0.9);

P_e- operational performance of the concrete truck.

$$P_a = \frac{60 * V * T * K}{t_c} \tag{42}$$

$$P_e = \frac{k * L * n}{100} = \frac{0.72 * 800 * 18}{100} = 103.7$$

where L-the volume of the concrete mixer in litre;

n-number of batches per hour;

k-coefficient of concrete output from 0.65 to 0.72 (usually 0.67 is taken);

t_c-cycle time.

$$t_c = t_z + \frac{2 * L * 60}{v_{sr}} \tag{43}$$

where t_z- loading time of the concrete truck at the plant

$$t_c = 5 + \frac{2 * 21 * 60}{38} = 75$$

$$P_a = \frac{60 * 12 * 8 * 0.92}{75} = 69$$

Number of concrete trucks

$$N = \frac{0.9 * 103.7}{69} = 1.45 \approx 2 \text{ pcs}$$

As a result of the calculations, the most economical and profitable is the bucket crane weahers the concrete pump saves more time for this reason the concrete pump is selected for this project.

3.3 Master plan

The basic data required for the development of a building master plan are:

- Master plan of the territory with existing and under construction buildings, as well as basement communications networks;
- A calendar plan for the production of work with a schedule of labor requirements;
- Necessary construction machines and mechanisms;
- The required amount of the need for general construction structural elements, products and bulk and non-bulk resources;
- The number, list and dimensions of structures and buildings, as well as temporary warehouses at the construction site;
- Standard information on the development of building general plans.

In general, construction master plans can be dredged at various stages of the construction business.

The explanatory notes show the function of the building master plan, its purpose and for what period (for example, the installation of foundation blocks, and the installation of roofing elements or in the installation of structures in general) was developed. It is required to clarify the requirements enshrined in the base of its implementation. After that, we give the necessary calculations and give an explanatory note.

3.4 Calculation of temporary power supply

Electricity is the main source of energy used in the construction of buildings and structures. Power electricity is used to power machines and mechanisms, for electric welding and other technological needs.

Electricity is supplied to the construction from existing systems or inventory mobile power plants. Therefore, when developing theses, it is necessary to resolve the issue of power supply.

The maximum electricity consumption is set on the basis of the work schedule or network schedule.

We find the power of the outdoor lighting network by the formula:

$$W_{H.O} = K_c \cdot \sum P_{O.H} = 1 \cdot 19.2 = 19.2 \text{ kWatt}$$

where K_c- reduction coefficient of the power;

$\sum P_{O.H}$- sum of consuming power.

Indoor lighting network power:

$$W_{H.O} = 0.8 \cdot 3.2 = 2.56 \text{ kWatt}$$

Total power consumption for lighting:

$$W_{total} = 19.2 + 2.56 = 21.76 \text{ kWatt}$$

3.5 Organization of production areas, work areas and workplaces

Production areas (sites of construction and industrial enterprises with construction objects located on them, production and sanitary buildings and structures), work areas and workplaces must be prepared to ensure the safe production of work.

Preparatory activities must be completed before the start of the work. Compliance with the labor protection and safety requirements of industrial areas, buildings and structures, work areas and workplaces of newly built or reconstructed industrial facilities is determined when they are accepted for operation.

The completion of the preparatory work at the construction site must be accepted according to the act on the implementation of labor safety measures.

Production equipment, fixtures and tools used to organize the workplace must meet the labor safety requirements.

Production areas, work areas and workplaces must be provided with the necessary means of collective or individual protection of workers, primary fire extinguishing equipment, as well as communication, signaling and other technical means of ensuring safe working conditions in accordance with the requirements of the current regulatory legal acts.

Places of temporary or permanent residence of workers (sanitary facilities, resting places and passages for people), when arranging and maintaining production areas, work sites, should be located outside hazardous areas.

Hazardous areas must be marked with safety signs and inscriptions of the prescribed form.

Moving loads over ceilings, when production, residential or office premises, where people may be, fall into hazardous areas, is not allowed.

The admission to the production area of unauthorized persons, as well as drunken workers or not employed in work in this area, is prohibited.

While on the territory of a construction or production site, in production and utility rooms, at work sites and workplaces, employees, as well as representatives of other organizations, are obliged to comply with the internal labor regulations related to labor protection adopted in this organization.

Geographically separate premises, sites, work areas, workplaces must be provided with telephone or radio communications.

Workers, managers, specialists and employees must be provided with overalls, footwear and other personal protective equipment, in accordance with the Rules for providing employees with special clothing, special footwear and other personal and collective protective equipment, sanitary facilities and devices at the expense of the employer.

Calculation of required solar panels for the building

As this building should be the most energy-efficient building we need to use solar power for producing electricity.

we use 250 watt solar panel by the sizes of 1×1.6 meter (1.6 m^2) that can provide 25 percent of the building electricity. Ther number of required solar panels is determined by the formula:

$$N = \frac{P_b \cdot t}{P_p} \tag{44}$$

where P_b- building's comsumption energy that is 25 percent of the building all power consumption (24 kWatt);

t - duration of sunlight per day (4 hours);

P_p - panel power (250 Watt).

$$N = \frac{24000 \cdot 4}{250} = 384$$

Required area for this number of panels is 614.4 m^2 that will put on the roof.

4 Economic Part

4.1 Calculation of the estimated cost of construction

The estimated cost of construction is the necessary material resources, which is determined on the basis of design materials and standards in accordance with the legislation of the Republic of Kazakhstan.

The basis for construction is the estimated cost necessary to determine the indicator of investment funds for construction, to form a price for construction, serves as a guideline for customers when purchasing and concluding a contract, settlements for work performed by a contract in accordance with the current legislation of the Republic of Kazakhstan.

The cost of products at the design stage is determined according to the enlarged resource estimate norms.

This section shows the cost, that is, the required capital for the construction.

The composition of the above consists of: construction cost, including design and survey work, the price of equipment, the price of installation of equipment, etc.

Capital investment is determined by drawing up a consolidated estimate.

In the estimated summary calculation of construction, the funds are distributed according to the following divisions:

- Costs of preparatory work on the territory;
- The main elements of the object;
- Elements of service and auxiliary character.
- Elements of the energy economy.
- Objects of transport facilities and communications.
- External networks and structures of water supply, sewerage, heat supply and gas supply.
- Landscaping and gardening of the territory.
- Temporary buildings and structures.
- Costs are secondary.
- Directorates of the enterprise.
- Training of personnel.
- Exploration and design work.

The cost of construction of buildings and structures for main and additional purposes is calculated on the basis of SN RK 8.02-01-2002. The stage of calculating the cost of construction.

We find the construction cost of the estimated structures and buildings of the main and secondary nature using general estimated norms in 2019 prices.

For housing and civil construction, Chapter 3 includes the estimated cost of such objects as: utility buildings; checkpoints, greenhouses in hospital and scientific towns; waste bins, etc .; buildings and structures for cultural and domestic purposes, designed to serve workers and located within the territory allotted for the construction of enterprises; nature conservation work, work on the protection of cultural monuments, etc.

4.2 Calculation of investment costs for construction

Investment costs for construction include all costs of the customer for the project and are compiled in the form of a consolidated estimate of the cost of construction.

The consolidated estimate of the construction cost additionally includes the following cost items:

- the cost of the services of an engineer;
- training of operational personnel;
- the cost of design and survey work;
- the cost of examination of design and estimate documentation;
- costs for the implementation of architectural supervision. The cost of design and survey work is determined in accordance with the general provisions for determining the cost of design work for construction in the Republic of Kazakhstan (RDS RK 08.02-03-2002, taking into account changes from 02.7.2004)

4.3 Technical and economic indicators of the project

For the implementation of the investment project, it is planned to use borrowed funds. But at the same time, according to the legislation of the Republic of Kazakhstan, 1 percent of the total investment should be financed from its own funds.

The cost for one building will be about 210.8 million tenge.

The full estimated cost of the building (local, consolidated, facility) of the facility is attached in Appendix C.

CONCLUSION

Based on the tasks set, a graduation project was launched on the topic "Social Residential House" in Almaty.

The building is located in Akkent microdistrict srounded by tall and small buildings. After analyzing the projected building, I made several conclusions. Firstly, the main purpose of a modern social dwelling house is to provide senior citizens with living quarters for living and providing them with social, household, medical, and other types of services, and the construction of a modern social dwelling house would make life easier for many citizens of the country when living in the city of Almaty.

The advantage of a residential building is that the projected building is located in the city center and has additional service conditions. Secondly, the building is located in clay soil, which is not hazardous for construction in seismic areas. Thirdly, the construction of the sanatorium will take less than a year, which will entail additional investments for a ready-made business platform.

This project is designed for permanent residence of senior citizens in the city of Almaty. Since the possibility of developing construction in this area has great potential due to its convenient location and large investments in construction at the present time . The building has 13 stories including a basement with the height of 4 m, one meter of the basement is above the ground. In each floor there are 8 apartment for both large and small families. The height of typical floor is 3 m. It has two intrances provided with two elevators by differerent dimentions and staircases. There are 7 similar buildings in the whole project. A beautiful landscape is designed for this complex and each building has separate sufcient parking for vhicles.

This building is provided with energy-efficient materials in walls, windows, floors and roof. Solar panel power system is designed to provide 25 percent of the total electric power of the building. This building will give different view to to Almaty city, and will accommodate many families inside it.

In brief, in the near future the need for energy-efficient buildings will be increased rapidly and it is beneficial for the world future to use eco-friendly materials in construction industry.

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Appendixes

Appendix A

Table A.1- Loads on floors and walls

Applied loads	Characteristics of loads, kg/m^2
1 Unit weight:	Auto
1.1 Floor construction: For foundation:	
Concrete preparation δ=100 mm, ρ=1700 kg/m^3	$0.1 \cdot 1700 = 170$
Membrane waterproofing layer, δ=30 mm,ρ=1400 kg/m^3	$0.03 \cdot 1400 = 42$
Extruded polystyrene foam δ=40 mm,ρ=40 kg/m^3	$0.04 \cdot 40 = 1.6$
cement-sand plaster δ=50 mm, ρ=1600 kg/m^3	$0.5 \cdot 1600 = 800$
Total	1084.4 kg/m^2 =1.195 t/m^2
for typical floors:	
Vinyl flooring δ=10 mm, ρ=976 kg/m^3	$0.01 \cdot 976 = 9.76$
Reinforced cement-sand plaster δ=50 mm, ρ=1600 kg/m^3	$0.05 \cdot 1600 = 80$
Waterproofing (Membrane) δ=20 mm, ρ=1400 kg/m^3	$0.02 \cdot 1400 = 28$
Soundproofing δ=25 mm, ρ=45 kg/m^3	$0.025 \cdot 45 = 1.125$
Foamed concrete for thermal insulation δ=50 mm, ρ=1000 kg/m^3	$0.05 \cdot 1000 = 50$
Floor slab δ=200 mm, ρ=2400 kg/m^3	$0.15 \cdot 2400 = 360$
Total	528.885 kg/m^2 = 0.529 t/m^2
for flat roof:	
Floor slabs δ=200 mm, ρ=2400 kg/m^3	$0.15 \cdot 2400 = 360$
Reinforced cement-sand plaster δ=50 mm, ρ=1600 kg/m^3	$0.1 \cdot 1600 = 160$
Vapor barrier (low-Density Polyethylene sheets) δ=0.25 mm, ρ=940 kg/m^3	$0.00025 \cdot 940 = 0.235$
Thermal insulation – PIR(Polyisocyanurate) boards δ=100 mm, ρ=500 kg/m^3	$0.1 \cdot 500 = 50$
Waterproofing (Membrane) δ=20 mm, ρ=1400 kg/m^3	$0.02 \cdot 140 = 28$
Total	598.235 kg/m^2 = 0.598 t/m^2
Loads	Characteristic of loads, kg/m
1.2 Wall construction	
external self-supporting walls (wall height 3 m):	
Autoclaved aerated concrete AAC blocks (Foam concrete block) δ=200 mm, ρ=600 kg/m^3	$0.2 \cdot 3 \cdot 600 = 360$
Thermal insulation (foam board) 2 layers δ = 50 mm, ρ = 40 kg/m^3	$0.05 \cdot 2 \cdot 3 \cdot 40 = 12$
Vapor barrier (low-Density Polyethylene sheets) δ=1 mm, ρ=940 kg/m^3	$0.001 \cdot 3 \cdot 940 = 2.82$

Continuation of Appendix A

Continuation of Table A.1- Loads on floors and walls

Applied loads	Characteristics of loads, kg/m^2
Fiber cement siding δ=149 мм, ρ=1650 kg/m^3	$0.149 \cdot 3 \cdot 1650 = 737.55$
Total	1112.37 kg/m = 1.1124 T/m
Internal self-supporting walls (wall height 3m)	
Autoclaved aerated concrete AAC blocks (Foam concrete block) δ=200 mm, ρ=600 kg/m^3	$0.2 \cdot 3 \cdot 600 = 360$
Thermal insulation (foam board) δ = 54 mm, ρ = 40 kg/m^3	$0.054 \cdot 3 \cdot 40 = 6.48$
Vapor barrier (low-Density Polyethylene sheets) δ=1 mm, ρ=940 kg/m^3	$0.001 \cdot 3 \cdot 940 = 2.82$
gypsum plasterboard δ=15мм, ρ=800 kg/m^3	$0.015 \cdot 3 \cdot 800 = 36$
Total	405.3 kg/m = 0.405 T/m
external self-supporting walls (parapet height 1m):	
Autoclaved aerated concrete AAC blocks (Foam concrete block) δ=200мм,ρ=600 kg/m^3	$0.2 \cdot 1 \cdot 600 = 120$
Thermal insulation (foam board) 2 layers δ = 50 mm, ρ = 40 kg/m^3	$0.05 \cdot 2 \cdot 1 \cdot 40 = 4$
Vapor barrier (low-Density Polyethylene sheets) δ=1 mm, ρ=940 kg/m^3	$0.001 \cdot 1 \cdot 940 = 0.94$
Fiber cement siding δ=149мм, ρ=1650 kg/m^3	$0.149 \cdot 1 \cdot 1650 = 245.85$
Total	370.79 kg/m = 0.3708 T/m
Partitions (height, h = 3m)	
Reinforced brick partition wall δ=100мм, ρ=2000 kg/m^3	$0.1 \cdot 3 \cdot 2000 = 600$
Support rack profiles δ=10 мм,ρ=15 kg/m^3	$0.01 \cdot 3 \cdot 15 = 0.45$
Thermal insulation (foam board) δ=50мм, ρ=40 kg/m^3	$0.05 \cdot 3 \cdot 40 = 6$
gypsum plasterboard δ=15мм, ρ=800 kg/m^3	$0.015 \cdot 3 \cdot 800 = 36$
Итого	642.45 kg/m = 0.642 t/m
2.2 Horizontal pressure from the ground [4]:	2.071 t/m^2

Appendix B

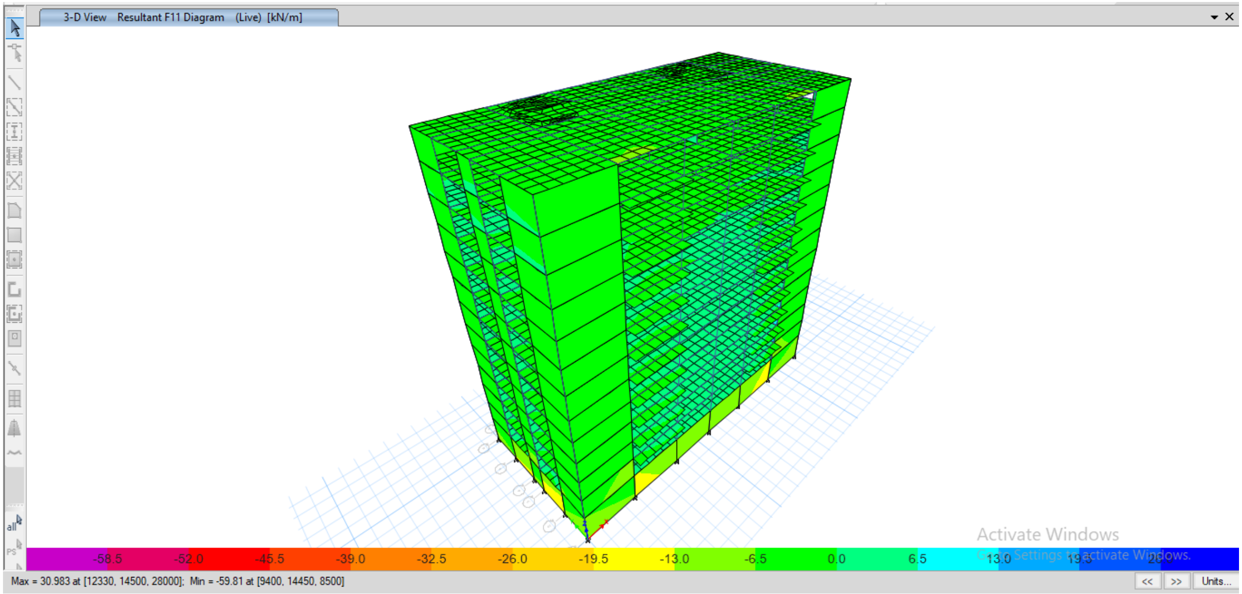


Figure B.1 – stresses on the floors due to dead load

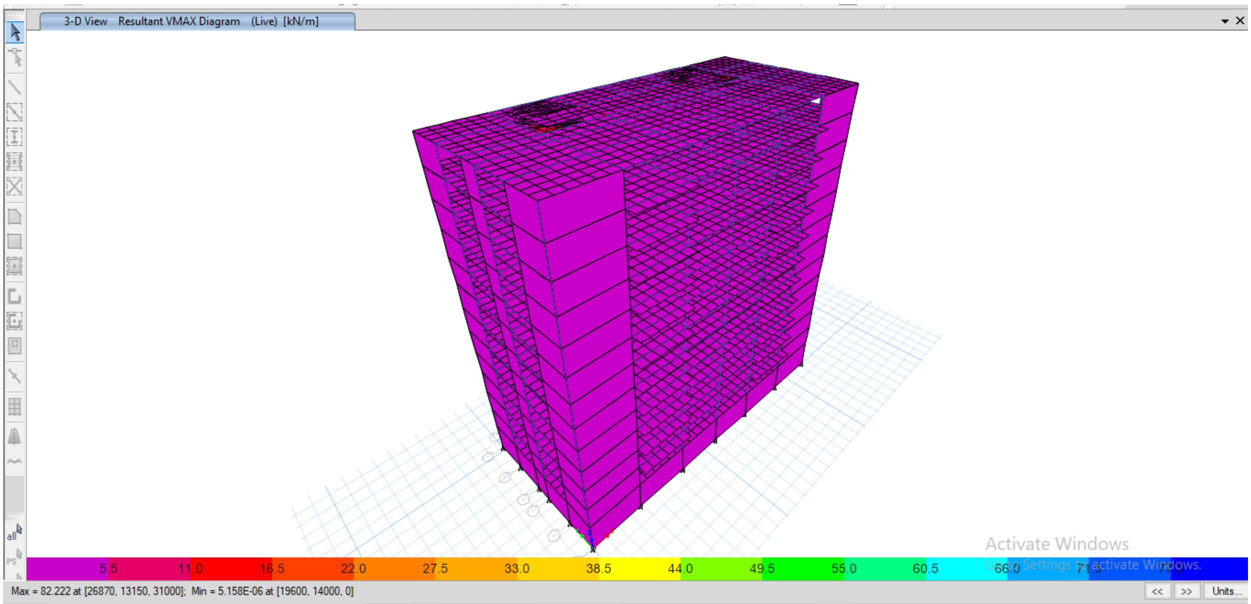


Figure B.2 - stresses on the floors due to live load

Continuation of Appendix B

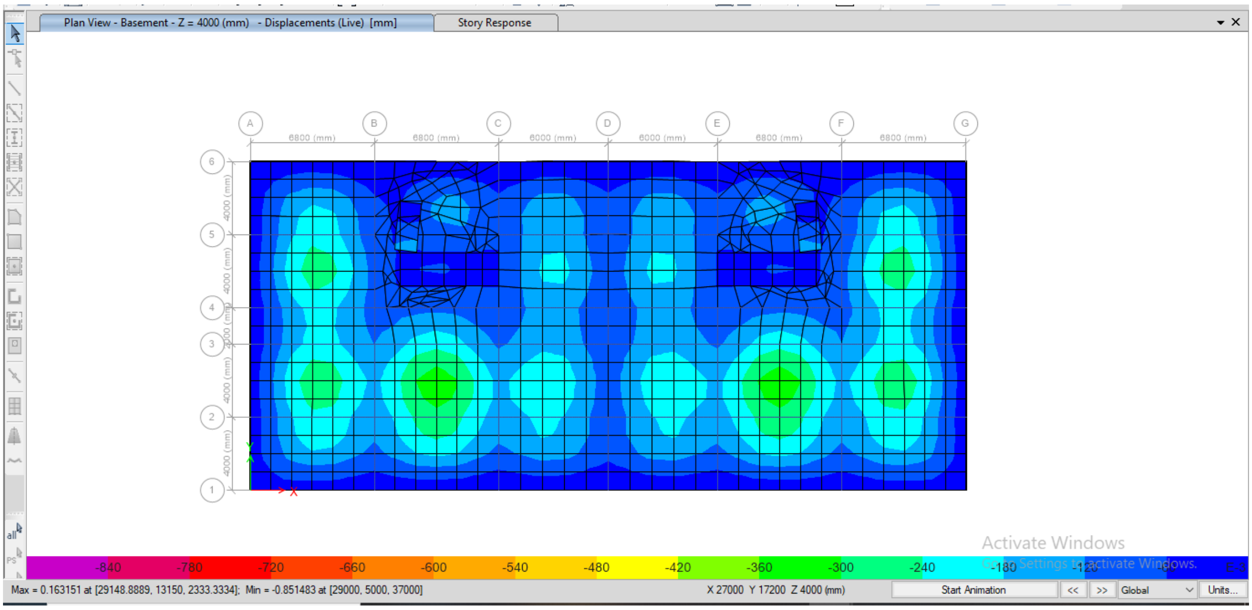


Figure B.3- Isofields of base dirift along the Z axis

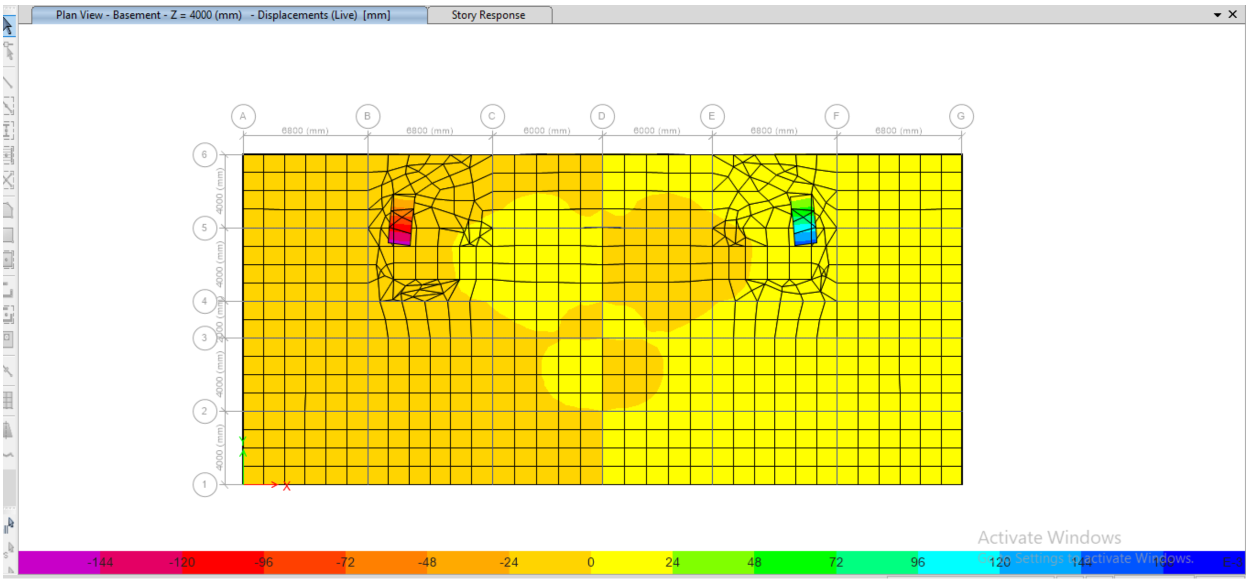


Figure B.4- Isofields of base dirift along the X and Y axis

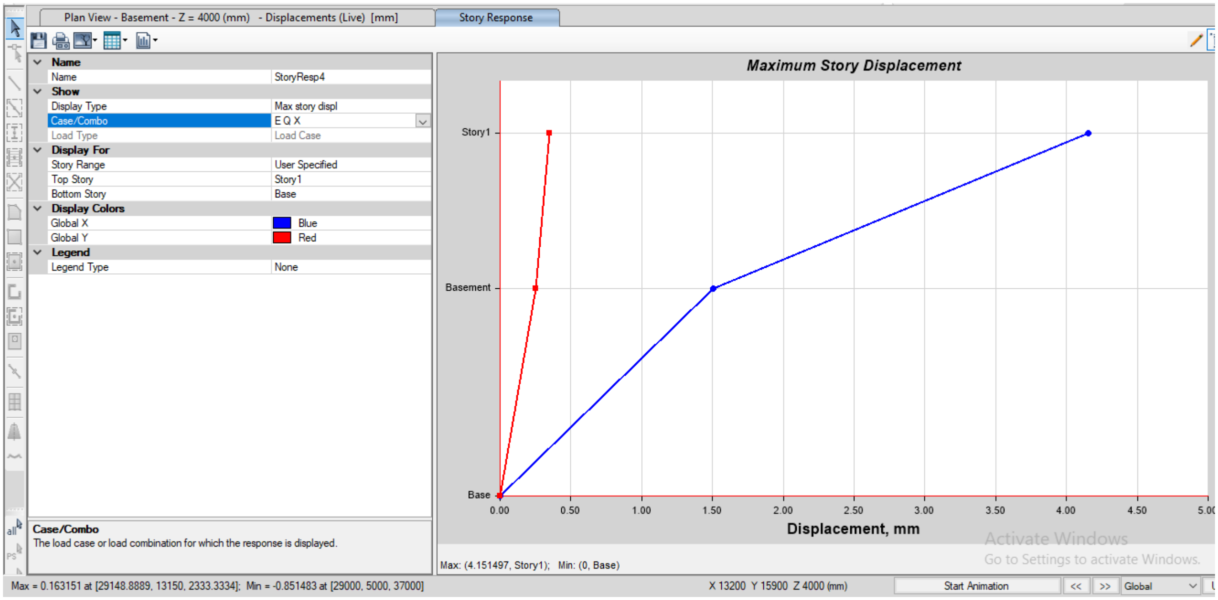
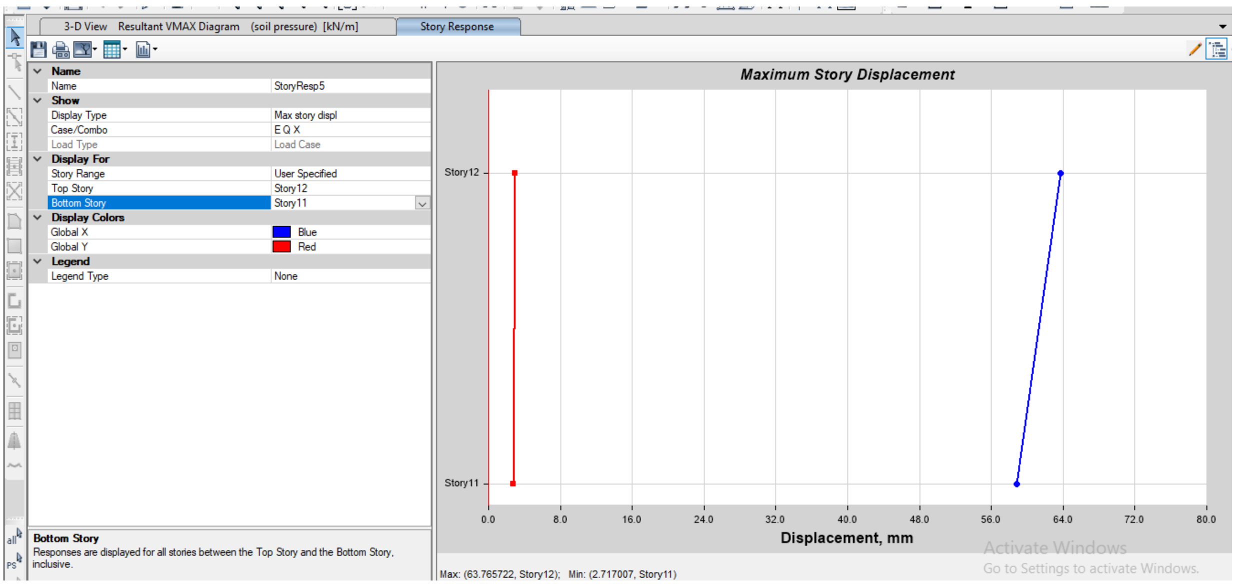


Figure B.5- Diagram of displacements of the first floor slab from seismic along X



Figures B.6- Diagram of displacements of the floor slab of the 12th floor from seismic along X

Continuation of Appendix B

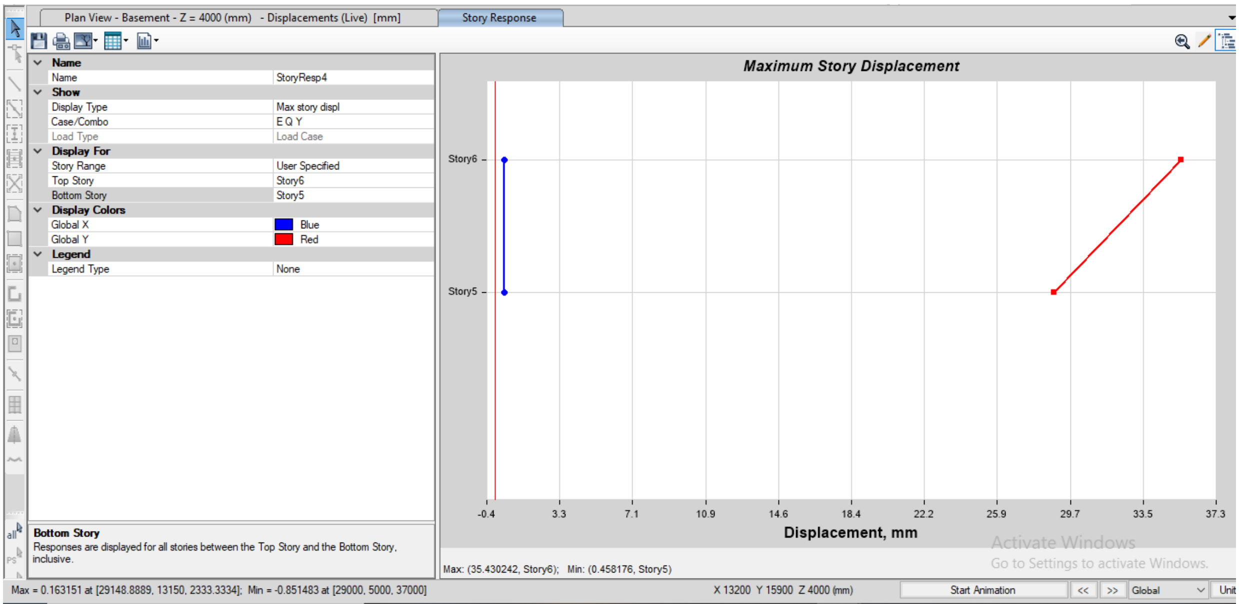


Figure B.7 - Diagram of displacements of the 6st floor slab from seismic survey along Y

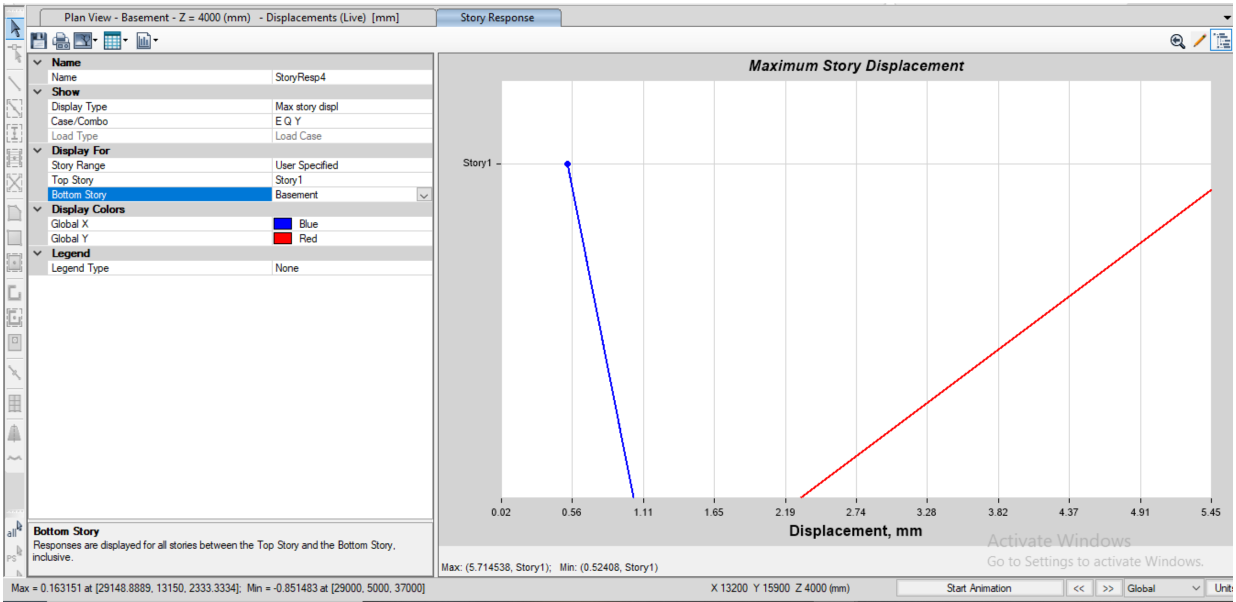


Figure B.8 - Diagram of displacements of the 1st floor slab from seismic survey along Y

Appendix C

Table B.1- Calculation of labor cost for formwork and concreting

№	Name of simple processes	volume of work		According to ENIR	Time rate man / h	Labor costs		Note
		Unite	Amount			Man hour	man days	
1	2	3	4	5	6	7	8	9
1	Installation of column formwork	m^2	277.2	Е4-1-34 Б, С-2 «а»	0,4	114.6	13.98	
2	Installation diaphragm formwork	m^2	523.2	Е4-1-34 D, Т-6, С-3 «а»	0,25	14.13	1.72	
3	Concrete supply to the formwork of columns	m^3	38.115	Е4-1-48, Т-5, С-2	18	27	3.29	
4	Placement of concrete mixture into formwork columns	m^3	38.115	Е4-1-49, Т-2, С-5	1.1	159.79	19.49	
5	Column dismantling	100 m^2	277.2	Е4-1-34 В, Т-3, С-2 «б»	0.15	42.98	5.24	
6	Immediate wrapping of the columns after dismantling with plastic wrap	m^2	2.77	Е4-1-54, С-10	0.81	2.35	0.29	
9	Concrete supply to diaphragm formwork blocks	m^3	55.08	Е4-1-48, Т-5, С-2	18	14.4	1.76	
7	Placement of concrete mixture into formwork blocks of diaphragms	m^3	55.08	Е4-1-49,В, Т-3, С-1 «d»	0.79	62.74	7.65	
8	Diaphragm dismantling	m^2	523.2	Е4-1-34 D, Т-6, С-3 «б»	0,16	9.04	1.1	

Continuation of Appendix C

Continuation of Table B.1- Calculation of labor cost for formwork and concreting

№	Name of processes	volume of work		According to ENIR	Time rate man / h	Labor costs		Note
		Unite	Amount			Man hour	man days	
9	Immediate covering of the stripped concrete surfaces of the diaphragms with peeling of the polyethylene film	100 m^2	0.57	E4-1-54, C-10	0.81	0.46	0.06	
10	Installation of formwork for slabs	m^2	105.84	E4-1-34 B, T-4, C-2 «d»	0.3	517.12	63.06	
11	Laying, distribution, compaction of concrete mix in formwork blocks of floor slabs	m^3	105.84	E4-1-49, B, T-2, C-9	0,89	1080.1	131.72	
12	Grouting of floor slab surfaces and immediate covering with plastic wrap and insulation	100 m^2	10.58	E4-1-54, C-10	0.21	3.42	0.42	
13	Dismantling of floor slabs	m^2	105.84	E4-1-34, B, T-4, C-2 «z»	0.13	214.83	26.2	
14	Immediate covering of the stripped concrete surfaces of the floor slabs with a new polyethylene film with a peg	100 m^2	10.84	E4-1-54, C-10	0.51	8.29	1	

Appendex D

OBJECT ESTIMATE

Estimated Cost	**210000**	Thous.Tenge
Normative Labor Intensity	**13.213**	Thous.pers.h
Estimated Wages	**5495.41**	Thous.Tenge

Compiled in prices for 01.1. 2001 y

№ n/n	No. of estimates and calculations	Name of works and costs	Estimated Cost, Thous. Tenge				Normative Labor Intensity	Estimated Wages
			construction and installation works	equipment, furniture and inventory	other costs	Total		
1	2	3	4	5	6	7	8	9
1	1	Energy-efficient social residential complex in Almaty	210000	--	--	210000	38.082	2738.023
2		**Total**	210000	--	--	**210000**	38.082	2738.023
3		Temporary buildings and structures	2310	--	--	2310	38.082	2738.023
4		Return of materials from temporary buildings and structures	346.5	--	--	346.5	38.082	2738.023
5		**Total**	2310	--	--	**2310**	38.082	2738.023
6		**Total**	212310	--	--	**212310**	38.082	2738.023
7		Additional costs in the production of work in the winter	2547.72	--	--	2547.72	38.082	2738.023
8		Seniority costs			2123.1	2123.1	38.082	2738.023
9		Additional vacation costs			849.24	849.24	38.082	2738.023
10		**Total**	**2547.72**		**2972.34**	**5520.06**	38.082	2738.023
11		**Total**	214857.72		2972.34	217830.06	38.082	2738.023
12		Including refundable amounts	346.5		--	346.5	38.082	2738.023
13		**Total according to the estimated calculation in the base prices of 2001.**	214857.72		2972.34	217830.06	38.082	2738.023
14		Total estimated at current prices in 2021.	734813.4024		10165.4028	744978.8052	38.082	2738.023
15		Including refundable amounts in current prices	1185.03			1185.03	38.082	2738.023
16		Taxes, fees, mandatory payments,			14899.5761	14899.5761	38.082	2738.023
17		Estimated cost at current price level	734813.4024		25064.9789	759878.3813	38.082	2738.023
18		НДС (12%)			91185.40576	91185.40576	38.082	2738.023
19		Construction cost	734813.4024		116250.3847	851063.7871	38.082	2738.023

Figure D.1- Object estimation

Continuation of Appendix D

Estimated calculation of the cost of construction in the amount of 19r 7c — 851063.787 Thous.Teng
including refundable amounts: 15r 7c — **1185.03** Thous.Teng
value added tax 18r7c — 91185.4058 Thous.Teng

ESTIMATE CALCULATION OF THE COST OF CONSTRUCTION

Compiled in prices for 01.1. 2001 y

№ п/п	No. of estimates and calculations	Name of works and costs	Estimated cost, Thous.Tenge			Total, Thous. Tenge
			construction and installation works	equipment, furniture and inventory	other costs	
1	2	3	4	5	6	7
1	1	Energy-efficient social residential complex in Almaty	151687.49	--	--	151687.49
2		**Total=1 row**	151687.49	--	--	**210000**
3		Temporary buildings and structures 1,1%*2 row 7column	2310	--	--	2310
4		Return of materials from temporary buildings and structures 15%*3r7c	346.5	--	--	346.5
5		**Total=3 row**	2310	--	--	**2310**
6		**Total 2r+5r**	212310	--	--	**212310**
7		Additional costs in the production of work in the	2547.72	--	--	2547.72
8		Seniority costs 1%*6r7c			2123.1	2123.1
9		Additional vacation costs 0,4%*6r7c			849.24	849.24
10		**Total 7r+8r+9r**	**2547.72**		**2972.34**	**5520.06**
11		**Total 6r+10r**	214857.72		2972.34	217830.06
12		Including refundable amounts=4r	346.5		--	346.5
13		**Total according to the estimated calculation in the base prices of 2001.=11r**	214857.72		2972.34	217830.06
14		Total estimated at current prices in 2021. 13r*3,42	734813.402		10165.4028	744978.81
15		Including refundable amounts in current prices 12r7c*3,42	1185.03			1185.03
16		Taxes, fees, mandatory payments,2%*14r7c			14899.5761	14899.576
17		Estimated cost at current price level 14r+16r	734813.402		25064.9789	759878.38
18		НДС (12%)*17r7c			91185.4058	91185.406
19		Construction cost17r+18r	734813.402		116250.385	851063.79

Figure D.2- Estimate calculation of the cost of construction

Continuation of Appendix D

OBJECT ESTIMATE

Estimated Cost	**210000**	Thous.Tenge
Normative Labor Intensity	**13.213**	Thous.pers.h
Estimated Wages	**5495.41**	Thous.Tenge

Compiled in prices for 01.1. 2001 y

№ п/п	No. of estimates and calculations	Name of works and costs	Estimated Cost, Thous. Tenge				Normative Labor Intensity	Estimated Wages
			construction and installation works	equipment, furniture and inventory	other costs	Total		
1	2	3	4	5	6	7	8	9
1	1	Energy-efficient social residential complex	151687	--	--	210000	38.082	2736.023
2		**Total**	151687	--	--	**210000**	38.082	2736.023
3		Temporary buildings and structures	2310	--	--	2310	38.082	2736.023
4		Return of materials from temporary buildings and structures	346.5	--	--	346.5	38.082	2736.023
5		**Total**	2310	--	--	**2310**	38.082	2736.023
6		**Total**	153997	--	--	**153997**	38.082	2736.023
7		Additional costs in the production of work in the winter	1847.964	--	--	1847.964	38.082	2736.023
8		Seniority costs			1539.97	1539.97	38.082	2736.023
9		Additional vacation costs			615.988	615.988	38.082	2736.023
10		**Total**	**1847.964**		**2155.958**	**4003.922**	38.082	2736.023
11		**Total**	155844.964		2155.958	158000.922	38.082	2736.023
12		Including refundable amounts	346.5		--	346.5	38.082	2736.023
13		**Total according to the estimated calculation in the base prices of 2001.**	155844.964		2155.958	158000.922	38.082	2736.023
14		Total estimated at current prices in 2021.	532989.7769		7373.37636	540363.1532	38.082	2736.023
15		Including refundable amounts in current prices	1185.03			1185.03	38.082	2736.023
16		Taxes, fees, mandatory payments,			10807.26306	10807.26306	38.082	2736.023
17		Estimated cost at current price level	532989.7769		18180.63942	551170.4163	38.082	2736.023
18		НДС (12%)			66140.44996	66140.44996	38.082	2736.023
19		Construction cost	532989.7769		84321.08938	617310.8663	38.082	2736.023

Figure D.3- Object estimate

АҢДАТПА

Бұл дипломдық жобаның тақырыбы «Алматы қаласындағы энерготиімді әлеуметтік тұрғын үй». Жоба сәулет-құрылыс, дизайн және құрылыс, технология мен ұйымдастырушылық және экономикалық сияқты төрт негізгі бөлімнен тұрады.

Осы жұмысты жасау кезінде келесі бағдарламалық жасақтама қолданылды:

1 AutoCAD 2021 - құрылыс моделі мен технологиялық бөлігін жасауға арналған;

2 Autidesk Revit 2021 - ғимараттың 3D моделін жасауға арналған;

3 Etabs 2018 - ғимараттың құрылымдық бөлігін жобалауға;

4 Жобаның жалпы құнын бағалау үшін ҚР сметасы.

АННОТАЦИЯ

Тема дипломного проекта - «Энергоэффективное социальное жилое дом в городе Алматы». Проект состоит из четырех основных частей, таких как архитектурно-строительная, проектно-строительная, технологическая и организационная и экономическая.

При создании работы использовались следующие программы:

1 AutoCAD 2021 - для создания модели здания и технологической части;

2 Autidesk Revit 2021 - для создания 3D-модели здания;

3 Etabs 2018 - на проектирование конструктивной части здания;

4 Смета РК - для оценки общей стоимости проекта.

ANNOTATION

The theme of this diploma project is «Energy-efficient social residential building in Almaty city». The project consist of four main parts, such as architectural and construction, design and construction, technology and organization, and economic.

The following software programs were usesd during creating this work:

1 AutoCAD 2021- for creating building model and technological part;

2 Autidesk Revit 2021- for creating 3D-model of building;

3 Etabs 2018- for designing structural part of building;

4 Estimation RK- for estimating the overall cost of project.

CONTENT

INTRODUCTION

Construction refers to engineering transactions for the construction of buildings and structures such as residential buildings and non-residential building. A simple building can be defined as a walled space with a roof, fabric, and basic human needs. In ancient times, people lived in caves, in trees or under trees to protect themselves from wild animals, rain, sun, etc. Over time, people began to live in huts made of wooden branches.

The shelter of those old ones turned into beautiful houses. Rich people live in sophisticated homes. a building is an important indicator of a country's social progress. Each person has a desire to have comfortable houses on average, as a rule, each person spends his two-thirds of his life in houses. A civil sense of responsibility is safe. These are several reasons a person does their best and spend their hard-earned savings in their own homes. Today, house building is the main work of the country's social progress. New technologies are developed every day to build homes, cost-effectively, quickly, energy-efficiently and with the needs of the engineering and architectural community involved in the design, planning and planning of buildings.

The designer is responsible for the drafting of the building, as well as for the direction of the engineers and architects. The designer must know his job and be able to follow the instructions of the engineer and be able to draw the required building drawing, site plans, layout plans, etc. In accordance with the requirements.

The main type of urban development is multi-storey residential buildings. The operation of such houses allows us to rationally use the territory, reduce urban transport facilities, the length of engineering networks, and streets.

In the world housing construction, a large share is occupied by multi-storey residential buildings.

The use of multi-storey energy-efficient residential buildings primarily provides the goal of saving urban areas, saving energy since during the construction of multi-storey residential buildings we can significantly increase the population density. The growth of cities is "wide" and exacerbates the transport problem and increases the length of engineering networks. For the selection of types of multi-storey residential buildings in large cities, the urban planning situation is considered, as well as the conditions for the reconstruction of the central regions.

1 Architectural and construction Parts

1.1 Basic information about the construction site

The diploma project was developed for " Energy-efficient social residential building located at the address: Almaty city, "Akkent Microdistrict".

Characteristics of the building:

The level of responsibility of a residential building refers to objects of the II (normal) level of responsibility that are not technically complex, according to order No. 517 of December 20, 2016 "On amendments to the order of the Minister of National Economy of the Republic of Kazakhstan dated February 28, 2015 No. 165" On approval The rules for determining the general procedure for classifying buildings and structures as technically and (or) technologically complex objects. ”The degree of fire resistance of the building - II. The degree of durability of the building - II.

The project was developed for the following construction conditions:

humidity zone – normal [1];

climatic region - II: temperate continental climate [1];

snow region - II, the standard value of the weight of the snow cover is Sk = 1.2 kPa [2];

wind region - II, standard value of wind pressure - 0.39 kPa; wind speed – 25 m/s [2];

climatic parameters of the cold season: air temperature of the coldest day: -30 degrees celsiuse; air temperature of the coldest five-day period: -23 degrees celciuse;

Soil class – II, type of soil is sand and gravel that has medium dense [1];

the construction area is seismic zone, and the magnitude is 9 points [3]; the region hieght from sea level is 681 m;

the construction site is located in the zone of residential and administrative buildings, the relief of the site is calm.

1.2 Natural-climatic and engineering-geological conditions

The characteristic features of the climate of this territory are: an abundance of sunlight and warmth, continentality, hot long summers, relatively cold winters with alternating thaws and cold snaps, large annual and daily amplitudes of air temperature fluctuations, dry air and changes in climatic characteristics with terrain altitude[1].

The coldest month - January is characterized by negative temperatures minus 6.6-16.5degrees celciuse (for plains and foothills). The hottest month is August. The average temperature for the plains is +24 - +26 degrees celciuse. The absolute maximum temperature reaches + 36.7_ + 41.7 in the same zone.The main data on the snow cover are given in Table 2 [3].

Table 1 - Air temperature

Weather station	months												per year
	1	2	3	4	5	6	7	8	9	10	11	12	
Average monthly and average annual air temperature, degrees celciuse													
Almaty	-4.7	-3.0	3.4	11,4	16,6	21,6	23,9	22,9	17,6	9,9	2,7	-2,8	10.00
Average maximum air temperature,degrees celciuse													
Almaty	0.6	2.2	8.6	17.3	22.4	27.5	30.0	29.4	24.2	16.3	8.2	2.3	15.8
Absolute maximum air temperature, degrees celciuse													
Almaty	16.8	21.9	29.8	33.2	35.8	39.3	41.7	40.5	38.1	31.4	26.5	19.2	41.7
Average minimum air temperature, degrees celciuse													
Almaty	-8.4	-6.9	-1,1	5,9	11	15,8	18	16,8	11,5	4,6	-1,3	-6.4	5
Absolute minimum air temperature, degrees celciuse													
Almaty	-30.1	-37.7	-24.8	-10.9	-7	2	7.3	4.7	-3	-11.9	-34.1	-31.8	-37.7

Table 2 – Blanket of snow

Weather station	months								Highest values for the winter		
	9	10	11	12	1	2	3	4	5	Average.	Max.	Min.
Average monthly snow height, см												
Almaty			4	10	19	21	9			28	55	7

With distance from the mountains, the wind regime changes. The average annual wind speed is 2.3 m / s. The wind breakthrough reaches 28 m / s. The lowest average monthly wind speeds throughout the entire territory are observed in winter (December, January), and the highest - in summer.

Table 3 - Wind

Wind Weather Station	months												Per year
	1	2	3	4	5	6	7	8	9	10	11	12	
Average wind speed by months and per year, м/с													
Almaty	1,0	1,1	1.3	1.7	1.8	2.0	1.9	1.9	1.8	1.5	1.1	1,0	1.5
Maximum wind speed and wind vane breakthrough, м/с													
Almaty	12	11	20	>20	>20	18	20	18	12	15	12	12	>20

Table 4 - Repeatability of wind and calm directions, percentage

Weather station	Direction								Calm
	N	NE	E	SE	S	SW	W	NW	
Almaty	14	8	6	14	29	11	10	8	26

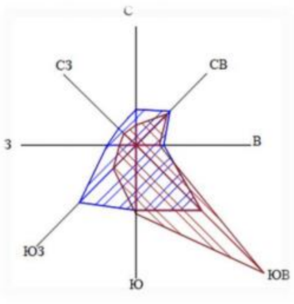


Figure 1 - Wind rose according to the weather station in Almaty

1.3 General plan

The master plan has been developed for the entire territory of the construction land plot. The plot with a total area of 3.8 hectares, allocated for construction, located in the city of Almaty, has a rectangular shape. The plot allocated for construction is free of buildings. An 8.0 meter wide driveway is provided for the territory of the facility; the pavement is made of asphalt concrete on a crushed stone base. Improvement and gardening of the site provided for by the project reduces the overall dust content and eliminates local sources of dust

Table 5 - Technical and economic indicators for the general plan

Name	Indicator
Land area	3.8 hectare
Built-up area	4939.2 $м^2$
Building factor	0.104
Landscaping area	13060.8 $м^2$
Landscaping factor	0.297
Hard surface area	20000 $м^2$
Territory utilization rate	0.745

The area around the building is landscaped and landscaped. The building has hard surfaced access roads.

1.4 Space-planning solution

The energy-efficient social residential building consists of seven buildings of twelve floors and one ground floor. The ground floor has an area of 1019.2 m^2 and each 12 floors has an area of 705.6 m^2. The height of the building from the zero mark is 36 m. The height of the typical floor is 3 m, and the height of basement is 4 m. The main staircase, elevators of the engineering equipment shaft are located in the concrete core of stiffness near to the middle in the front side of the building. Two lifts surrounded by shear walls are used in this building that each of them has respectively

630kg, and 1000kg weight. At the middle of the building there are two staircases system.

The scales for the plan and section is accepted 1:100 according to GOST 21.501. Various premises of the building are grouped according to functional characteristics, which allow organizing clear technological interconnections between them, meeting sanitary-hygienic and fire safety requirements, contributing to the convenience of operating the building, as well as increasing the comfort of living in it.

1.5 Constructive solutions of the project

The structural scheme of the building is a frame with load bearing walls, while at the level of the basement, reinforced concrete columns and walls are load-bearing (that is, it is ashear wall system). Spatial immutability is ensured by external and internal heating blocks, reinforced concrete columns and beams, and a hard floor plate made of monolithic reinforced concrete slabs.

Foundations – Raft foundation with a thickness of 900 mm . Under the foundations, perform a reinforced monolithic pad and crushed stone preparation of thicknesses 100mm. Make horizontal waterproofing of foundations from 2 layers of ruberoid on bitumen mastic. Vertical waterproofing of foundations in contact with the ground should be coated with hot bitumen 2 times.

Walls – the outer walls of the basement are monolithic reinforced concrete walls with a thickness of 400 mm, the outer walls of the first to the twelfth floor are 400 mm thick walls made of Autoclaved aerated concrete AAC blocks (Foam concrete block), internal walls with a thickness 270 mm should also be made of foam blocks on cement-sand mortar.

Partitions – partition walls with a total thickness of 175 mm to be made of Reinforced brick partition wall**.**

Slabs – monolithic reinforced concrete floor slabs with a thickness of 200 mm.

Beams – reinforced concrete with a section of 300x500;

Lintels – bar for buildings with masonry walls;

Windows - Triple Casement Vinyl Replacement Windows are selected for this buildig. It is a double-glasses window and the most energy-efficient windows and suitable for the project.

Doors - installation of molded wood composite interior doors in accordance with GOST 6629-88, PVC doors in accordance with GOST 309702002, installation of steel exterior doors in accordance with GOST 31173-2003. All the types of doors used in this building is energy-efficient and made of environmentally-friendly materials.

Blind area - The blind area is concrete along the entire perimeter of the building with a width of 1.0 m.

External finishing - from external facade plaster and, a decorative layer made of Wood Plastic Composite boards or panels.

2 Calculation and design part

2.1 Calculation of dead loads

The loads of floors and wall are presented in Table A.1 in Appendix A.

2.2 Calculation of soil pressure

Type of soil bases for foundations – sand and gravel (category II)
$\gamma = 1.73 \text{t}/m^3$
$c = 0$
$\varphi = 35°$
$h = 4\ m$
$\text{q} = 0.6\ \text{t}/m^2$
Active pressure

The intensity of the horizontal active soil pressure from its own weight γ, at a depth of h = y = 4.1 m should be determined by the formula:

$$P_\gamma = \frac{[\gamma \cdot h \cdot \lambda_г - c \cdot 2\sqrt{\lambda_г}]\text{y}}{h} \tag{1}$$

$$P_\gamma = [1.73 \cdot 4.1 \cdot 0.27 - 0 \cdot 2\sqrt{0.27}]4/4 = 1.915\ \text{t/m}^2$$

where:

$$\lambda_г = tg^2\left(45 - \frac{\varphi}{2}\right) = tg^2\left(45 - \frac{35}{2}\right) = 0.26$$

Passive pressure:
$\varphi = 35°$
$\lambda = 0.26$

$$\text{P}_\text{q} = \text{q} \cdot \lambda, \text{t/m}^2$$

$$\text{P}_\text{q} = 0.6 \cdot 0.26 = 0.15\ \text{t/m}^2$$

$$=> P = 1.915 + 0.156 = 2.93\ \text{t/m}^2$$

2.3 Determining Live loads according to EN 1991

Building category - A (residential building)
- floor – 2 кН/м^2 = 0.2 t/m^2
- staircase – 2.5 kN/m^2 = 0.2 t/m^2
- balconies – 2.5 kN/m^2 = 0.25 t/m^2
- unexploited roof – 0.5 kN/m^2 = 0.05 t/m^2

2.4 Calculating snow load

Almaty city - II snow region [1]:
μi = 0.8,
$C_e = 1$,
$C_t = 1$,
$s_k = 1.2$

$$s = \mu_i \cdot C_e \cdot C_t \cdot s_k \tag{2}$$

$$s = 0.8 \cdot 1 \cdot 1 \cdot 1.2 = 0.96\ kPa$$

where C_e −enviromental factor;
C_t −thermal coefficient;
s_k −the characteristic value of the snow load on the ground;
μ_i –snow load shape factor.

2.5 Calculation of wind load

Almaty city is located in the II wind region, $q_b = 0.39$ kPa, wind speed – 25 m/s

The dimensions of the building are 39.2 x 18 x 37 m, Almaty is the II wind region.

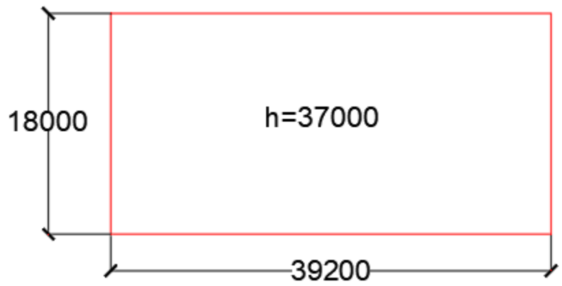


Figure 2 - Building plan

Calculation of wind load by OX

We divide the building in height into zones corresponding to the base height for the external pressure z_e according to the standard at $b = 18$ m ; $h = 37 < b = 39.2$ m.

The terrain category of building is IV.

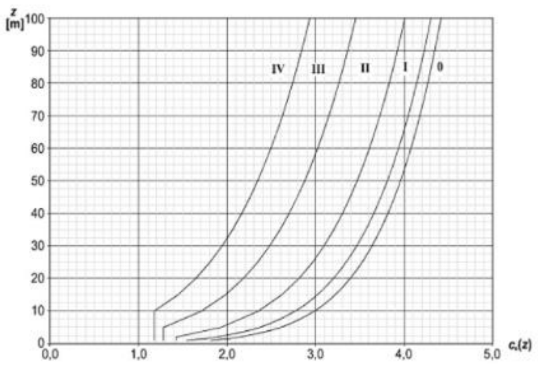


Figure 3 – exposition coefficient, c_e

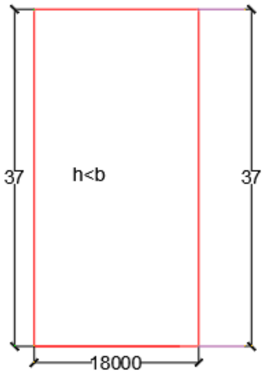


Figure 4 - Base height Z_e depending on h and b and the profile of the velocity head

Basic velocity wind pressure for wind region II, q_b = 0.39 kPa
Wind pressure w_e is equal to:

$$w_e = c_e(\mathrm{z}) \cdot q_b \cdot c_e \tag{3}$$

At z_e = 37m; $c_e = 0.8$; z_e = 37m; $c_e(37) = 2.1$:

$$w_e = 2.1 \cdot 390 \cdot 0.8 = 655.2\ Pa = 66.8\ kg/m^2$$

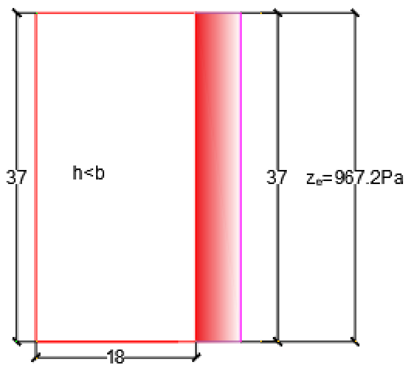


Figure 5 - Diagram of wind pressure

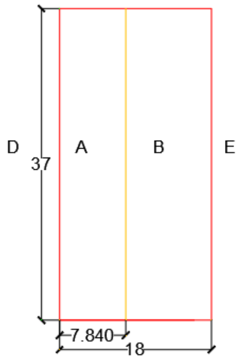


Figure 6 - Scheme of division into zones of lateral sides

External pressure on the sides:
External pressure coefficients c_{pe}.
Wind pressure w_e is equal to:

Table 6 - Values of wind pressure

A	$c_{pe} = -1.2$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-1.2) = -982.8$ Pa $= -100.2$ kg/m^2
B	$c_{pe} = -0.8$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-0.8) = -655.2$ Pa $= -66.78$ kg/m^2
D	$c_{pe} = +0.8$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (+0.8) = +655.2$ Pa $= +66.78$ kg/m^2
E	$c_{pe} = -0.5$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-0.5) = -409.5$ Pa $= -41.74$ kg/m^2

Wind loads are applied at the floor level:

At the level of the 1st floor: take into account half of the floor (1500 mm) + foundation above ground level (1000 mm). The design strip for the 1st floor is 2500 mm.

Typical floors calculated strip - 3000 mm.

At the roof level - 1500 mm.

For the windward side, two zones in the first zone from 0 to 37m include floors 1-6 floors; in the second with 7-11 + roof.

Table 7 - Pressure across the floors of the building

	first floor
D	$+66.78 \cdot 2.5 = 166.95\ kg/m$= 0.167 T/m
A	$-100.2 \cdot 2.5 = -250.5\ kg/m$= -0.250 T/m
B	$-66.78 \cdot 2.5 = -166.95\ kg/m$= -0.167 T/m
E	$-41.74 \cdot 2.5 = -104.35\ kg/m$= -0.104 T/m
	Typical floor 2-6
D	$+66.78 \cdot 3 = 200.34\ kg/m$= 0.200 T/m
A	$-100.2 \cdot 3 = -300.6\ kg/m$= -0.300 T/m
B	$-66.78 \cdot 3 = -200.34\ kg/m$= -0.200 T/m
E	$-41.74 \cdot 3 = -125.22\ kg/m$= -0.125 T/m

Contiuaton of Table 7

	Typical floor 7-11
D	$+66.78 \cdot 3 = 200.34\ kg/m$= 0.200 T/m
A	$-100.2 \cdot 3 = -300.6\ kg/m$= -0.300 T/m
B	$-66.78 \cdot 3 = -200.34\ kg/m$= -0.200 T/m
E	$-41.74\ \cdot 3 = -125.22\ kg/m$= -0.125 T/m
	Roof
D	$+66.78 \cdot 1.5 = +100.17\ kg/m$ =-0.100 T/m
A	$-100.2 \cdot 1.5 = -150.3\ kg/m$ =-0.150 T/m
B	$-66.78 \cdot 1.5 = -100.17\ kg/m$ =-0.100 T/m
E	$-41.74\ \cdot 1.5 = -62.61\ kg/m$=-0.0626 T/m

Wind load calculation according to OY

We divide the building in height into zones corresponding to the base height for the external pressure z_e according to the standard at $h = 37$ м $> 2b = 36$ м:

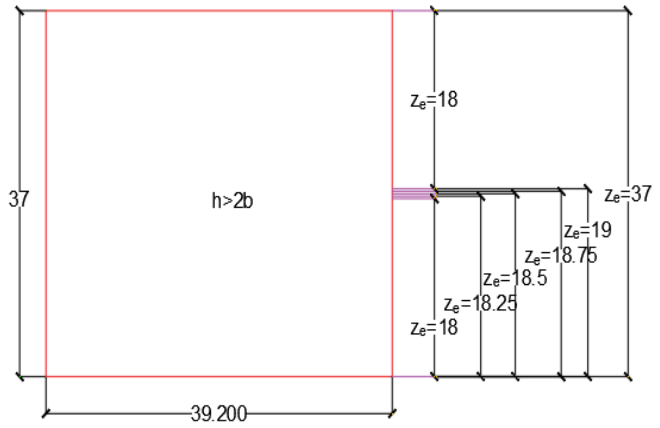


Figure 7 - base height z_e depending on h and b and the profile of the velocity head

Basic velocity wind pressure for wind region II, q_b = 0.39 kPa

Wind pressure w_e is equal to:

$$w_e = c_e(\text{z}) \cdot q_b\ \cdot c_e$$

At z_e = 18m; $c_e = 0.8$; Z_e = 18m; $c_e(18) = 1.5$:

$$w_e = 1.5 \cdot 390 \cdot 0.8 = 468\ Pa = 47.7\ kg/m^2$$

At z_e = 18.25m; $c_e(18.25) = 1.525$

$$w_e = 1.525 \cdot 390 \cdot 0.8 = 475.8\ Pa = 48.5\ kg/m^2$$

At z_e = 18.5m; $c_e(18.5) = 1.55$

$$w_e = 1.55 \cdot 390 \cdot 0.8 = 483.6\ Pa = 49.3\ kg/m^2$$

At z_e = 18.75m; $c_e(18.75) = 1.575$

$$w_e = 1.575 \cdot 390 \cdot 0.8 = 491.4\ Pa = 50.1\ kg/m^2$$

At z_e = 19m; $c_e(19) = 1.6$

$$w_e = 1.6 \cdot 390 \cdot 0.8 = 499.2\ Pa = 50.9\ kg/m^2$$

At z_e = 37m; $c_e(37) = 2.2$

$$w_e = 2.2 \cdot 390 \cdot 0.8 = 686.4\ Pa = 70\ kg/m^2$$

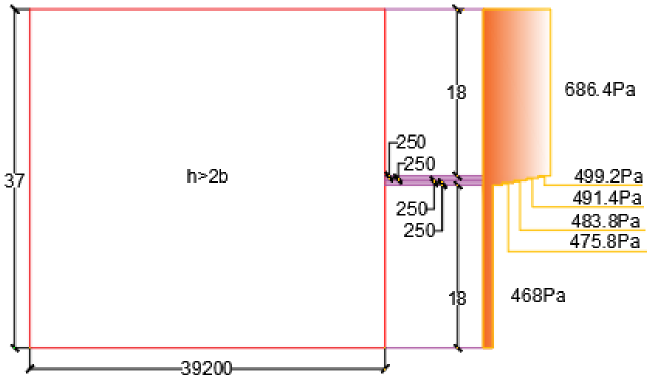


Figure 8 - Diagram of wind pressure

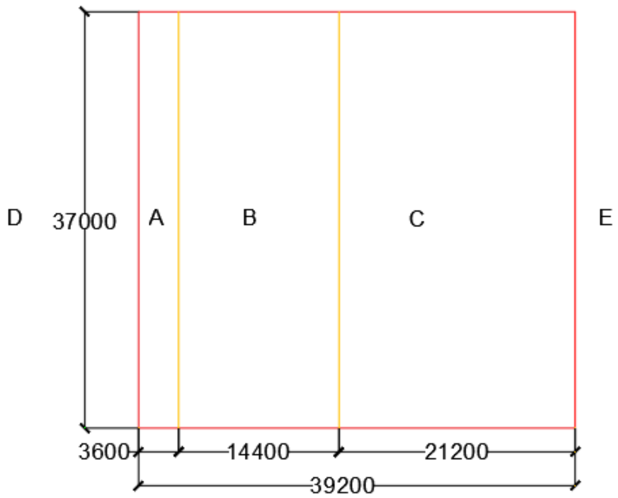


Figure 9 - Scheme of division into zones of lateral sides

Wind pressure w_e is equal to:

Table 8 - Values of wind pressure

A	$c_{pe} = -1.2$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-1.2) = -982.8\ Pa = -100.2\ kg/m^2$
B	$c_{pe} = -0.8$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-0.8) = -655.2\ Pa = -66.78\ kg/m^2$
	$c_{pe} = -0.5$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-0.5) = -409.5\ Pa = -41.74\ kg/m^2$
	$c_{pe} = +0.8$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (+0.8) = -655.2\ Pa = +66.78\ kg/m^2$
E	$c_{pe} = -0.5$	$c_e(37) = 2.1$	$w_e = 2.1 \cdot 390 \cdot (-0.5) = -409.5\ Pa = -41.74\ kg/m^2$

Wind loads are applied at the floor level:

At the level of the 1st floor: take into account half of the floor (1500 mm) + foundation above ground level (1000 mm). The design strip for the 1st floor is 2500 mm.

Typical floors calculated strip - 3000 mm.

At the roof level - 1500 mm.

For the windward side, two zones in the first zone from 0 to 37m include floors 1-6 floors; in the second with 7-11 + roof.

Table 9 - Pressure across the floors of the building

	1st floor
D	$+66.78 \cdot 2.5 = 166.95\ kg/m$= 0.167 T/m
A	$-100.2 \cdot 2.5 = -250.5\ kg/m$= -0.250 T/m
B	$-66.78 \cdot 2.5 = -166.95\ kg/m$= -0.167 T/m
C	$-41.74 \cdot 2.5 = -104.35\ kg/m$= -0.104 T/m
E	$-41.74\ \cdot 2.5 = -104.35\ kg/m$= -0.104 T/m
	Typical floor 2-6
D	$+66.78 \cdot 3 = 200.34\ kg/m$= +0.200 T/m
A	$-100.2 \cdot 3 = -300.6\ kg/m$= -0.300 T/m
B	$-66.78 \cdot 3 = -200.34\ kg/m$= -0.200 T/m
C	$-41.74 \cdot 3 = -125.22\ kg/m$= -0.125 T/m
E	$-41.74\ \cdot 3 = -125.22\ kg/m$= -0.125 T/m
	Typical floor 7-11
D	$+66.78 \cdot 3 = 200.34\ kg/m$= +0.200 T/m
A	$-100.2 \cdot 3 = -300.6\ kg/m$= -0.300 T/m
B	$-66.78 \cdot 3 = -200.34\ kg/m$= -0.200 T/m
C	$-41.74 \cdot 3 = -125.22\ kg/m$= -0.125 T/m
E	$-41.74\ \cdot 3 = -125.22\ kg/m$= -0.125 T/m
	Roof
D	$+66.78 \cdot 1.5 = +100.17\ kg/m$ =-0.100 T/m
A	$-100.2 \cdot 1.5 = -150.3\ kg/m$ =-0.150 T/m
B	$-66.78 \cdot 1.5 = -100.17\ kg/m$ =-0.100 T/m
C	$-41.74 \cdot 1.5 = -62.61\ kg/m$=-0.0626 T/m
E	$-41.74 \cdot 1.5 = -62.61\ kg/m$=-0.0626 T/m

2.6 Calculation of seismic loads

Sand and gravel soil - class II

According to the soil conditions $a_g = 0.528\ g > 0.08g$ therefore, the calculation for the determination of seismic loads along the X and Y axes is necessary.

where $a_g > 0{,}4g$; $a_{gv}/a_g = 0.9$:

$$a_{vg} = a_g \cdot 0.9 = 0.528g \cdot 0.9 = 0.47g > 0.25g$$

Taking into account the vertical seismic load along the Z axis is necessary.

Calculation according to horizontal:

$a_g = 0.528g,$

$q = 3$

$T_B = 0.20\ s,$

$T_c = 0.72$

With a value of the coefficient of behavior q = 3:

At 0 ≤ T ≤ 0.25:

$$S_d\ (T)_{\max} = a_g\ \left[\frac{2}{3}+\frac{T}{T_B}\left(\frac{2.5}{\mathrm{q}}-\frac{2}{3}\right)\right] = 0.528\left[\frac{2}{3}+\frac{T}{0.20}\left(\frac{2.5}{3}-\frac{2}{3}\right)\right]$$
$$= 0.528\ (0.66 + 0.83T)$$

But not less than:

$$a_g\ \cdot \frac{2.5}{\mathrm{q}} = 0.528 \cdot \frac{2.5}{3} = 0.44$$

At 0.25 ≤ T < 0. 96:

$$S_d\ (T) = a_g \cdot \frac{2.5}{\mathrm{q}} = 0.528\ \cdot \frac{2.5}{3} = 0.44$$

At T ≤ 0.96:

$$S_d\ (T)_{\max} = a_g\ \left[\frac{2.5}{\mathrm{q}}\left(\frac{T_c}{\mathrm{T}}\right)\right] = 0.528 \cdot \frac{2.5}{5}\left(\frac{0.96}{\mathrm{T}}\right) = \frac{0.25}{\mathrm{T}}$$

But not less than:

$$0.2\ a_g\ = 0.2 \cdot 0.528 = 0.105$$

The quantitative values of the ordinates of the spectra of the calculated reactions, calculated for some periods T at q = 3, are given in tables 1.

Table 10- Values of ordinates of the spectrum of calculated reactions at q = 3

T, s	0	0.25	0.50	0.96	1.20	1.50	2.0	2.50	3.0
S_d(T), in shares g	0.34	0.46	0.44	0.26	0.103	0.084	0.061	0.053	0.053

Calculation of the acceleration S_d (T) by the above formulas from NTP RK 08-01.1-2017 «Design of earthquake-resistant buildings and structures».

2.7 Thermal calculation of the outer wall

According to SPRK 2.04-01-2017 «Construction heat engineering» [p.7-10] it is necessary to determine the thickness of the insulation for the outer wall. Determine the value of the degree days of the heating period:

$$\mathrm{G_{SOP}} = \left(t_B - t_{avg}\right) \cdot z_{avg} \tag{4}$$

where, $t_в$= 21 degrees of Celsuise, ℃ – indoor air temperature;

t_{avg}= 1.7℃ – average temperature of the heating season;

z_{avg}= 160 days – duration of the heating period;

$$\mathrm{GSOP}\ =\ (21 - 1.7)160 = 3088^{\circ}\mathrm{C} \cdot \mathrm{days}$$

The required resistance to heat transfer of enclosing structures that meet sanitary and hygienic and comfortable conditions is equal to:

$$\mathrm{R}_0^{\text{тр}} = 2.45 \cdot {}^{\circ}\mathrm{C}/\text{Вт}$$

Table 11 - Composition of the outer wall

Material name	Υ_0, kg/m^3	λ, Вт/$m^2\cdot$°C	δ,m	$R_n = \delta/\lambda, m^2 \cdot$°C/Вт
Fiber cement siding	1650	0.76	0.149	0.196
Extruded Styrofoam(2 layers)	40	0.03	0.1	3.3
Aerated concrete	600	0.26	0.20	0.76
Polyethylene sheets	940	0.76	0.001	0.0013

The heat transfer resistance of the enclosing structure should be determined by formula 2.2:

$$R_0 = \frac{1}{\alpha_в} + \frac{\delta_1}{\delta_1} + \frac{\delta_2}{\delta_2} + \frac{\delta_3}{\delta_3} + \frac{\delta_4}{\delta_4} + \frac{1}{\alpha_н} \quad (5)$$

$$R_0 = \frac{1}{8.7} + 0.196 + 3.3 + 0.76 + 0.0013 + \frac{1}{23} = 4.4\ м^2 \cdot °C/Вт$$

$$R_0 = 4.4\ m^2 \cdot °C/Вт \geq R_0^{тр} = 2{,}45\ m^2 \cdot °C/Вт$$

The condition is met. We accept the thickness of the insulation 200 mm.

2.8 Anti-seismic measures

The threat of seismic impacts on the territory is under consideration. Seismic hazard is determined in space, in time (frequency or probability over a certain period of time) and in intensity (in points or in kinematic parameters of ground movements).

List of settlements located in the seismic zones of the Republic of Kazakhstan.

The residential building designed in the thesis is located in a seismic zone, therefore, anti-seismic measures are required. Seismicity of the work area according to SP 2.03-30-2017 is 9 points [7].

The category of soils for seismic properties is II (second). The revised seismicity value should be taken equal to 9 (nine) points.

The residential building has a length of 60 meters, since our frame is reinforced concrete, the length should not exceed 48 meters, therefore we make a sedimentary (expansion) seam.

Anti-seismic joints should be performed by erecting paired walls, paired frames, or a frame and wallThe width of the antiseismic seam between buildings or compartments should be taken not less than the total value of their calculated horizontal displacements at the corresponding level, calculated using expression (7.31). With a building height of up to 5 m, the width of the antiseismic joint, regardless of the calculation results, must be at least 30 mm. The width of the anti-seismic joint for buildings of greater height should be increased by 20 mm for every 5 m in height.

Anti-seismic joints separating the foundations (except for pile foundations) are allowed to be 10 mm wide.

In buildings located on construction sites with seismicity of 9 points or more, it is not allowed to provide the possibility of mutual displacement of adjacent compartments due to the movement of the span structures that are freely lying on the structures of adjacent compartments.

2.9 Manual calculation of beam

For the calculation, a structural element was chosen - a slab at an elevation of +34000 along the 1- A/ 1-B axis.

1) Determination of the cross-sectional area of reinforcement [5].

Longitudinal reinforcement calculation:

Rectangular beam (30 x 50 cm)

Normal concrete class C30 / 37 (f_{ck} =30, Υ_c = 1.5, $f_{cd} = a_{cc} \cdot f_{ck} / \Upsilon_c = 1 \cdot 30 / 1.5 = 20$ MPa). Reinforcement class S450 (f_{yk} = 440 MPa, $f_v = f_{yk} / \Upsilon_s = 440 / 1.15 = 383$ MPa), $M_{ED} = 483.7\ kN.m, 184.6\ kN.m$

$$a_{Eds} = \frac{M_{eds}}{f_{cd} \cdot b \cdot d^2} \tag{6}$$

where $d = h - c_1 = 500 - 40 = 460mm$

$$a_{Eds} = \frac{184.6}{20 \cdot 10^3 \cdot 0.30 \cdot 0.46^2} = 0.145$$

Since $a_{Eds} = 0.145 \leq a_{Eds,lim} = 0.372$, (see Fig. B.1. Appendix B), for the given section dimensions and concrete class, compressed reinforcement is required. Taking.

$\sigma_{sd} = f_{yd} = 434.6\ MPa, \rightarrow a_{Eds} = 0.381,$ and $\omega = 0.0625, \quad \zeta = \frac{z}{d} = 0.960 > z = 0.96 \cdot 460 = 441.6$, $x = 0.45\text{d} = 0.45 \cdot 460 = 207, \quad \frac{c_2}{d} = \frac{40}{460} = 0.86{\sim}0.1$

$$k_d = \frac{d[cm]}{\sqrt{M_{Eds}[kN \cdot m] / b[m]}} \tag{7}$$

$$k_d = \frac{46}{\sqrt{\frac{184.6}{0.3}}} = 1.85$$

$$M_{Eds} = M_{ED} - N_{ED} \cdot z_{s1}$$

$$M_{Eds} = 184.6 - 0 = 184.6\ kN \cdot m$$

Since $\text{k}_\text{d} = 1.14$, then $\text{k}_{\text{s1}} = 2.70$ and $\text{k}_{\text{s2}} = 0.80$ [5].

$$A_{s1}[cm^2] = \rho_1 \cdot k_{s1} \frac{M_{Eds}[kN \cdot m]}{d[cm]} + \frac{N_{Ed}[kN]}{43.5}$$

$$A_{s1} = 1.01 \cdot 2.70 \frac{184.6}{46} + \frac{0}{43.5} = 10.94\ cm^2$$

where $\rho_1 = 1.01$ and $\rho_2 = 1.04$ (Table B.4)

4Ø 20 ($A_{s1} = 12.56 cm^2$)

$$A_{s2}[cm^2] = \rho_2 \cdot k_{s2} \frac{M_{Eds}[kN \cdot m]}{d[cm]}$$

$$A_{s2} = 1.04 \cdot 0.8 \cdot \frac{184.6}{46} = 4.81 cm^2$$

Compressed reinforcement is not required by design. We put it constructively.

2Ø20 (A_{s2}= 6.28cm^2)

1. Determination of transverse reinforcement

Calculation of transverse reinforcement class $S235(f_{yk} = 235MPa, f_{ywd} = 235MPa)$.

Longitudinal reinforcement class $S500$ ($f_{yk} = 500MPa, f_{yd} = 382.6MPa$, $E_s = 20 \cdot 10^4$); sectional area of tensile reinforcement $A_{s1} = 12.56\ cm^2(4\phi\ 20)$.

Required:

Determine the area and spacing of the transverse reinforcement (use the method truss analogy).

To do this, we define the shear force that concrete can perceive by the formula:

$$V_{Rd,c} = \left\{\left(\frac{0.18}{\gamma_c}\right) \cdot k \cdot (100\rho_l \cdot f_{ck})^{\frac{1}{3}}\right\} \cdot b_w \cdot d, \qquad kN \qquad (8)$$

But not less than $V_{Rd,c,min} = \{0.0035 \cdot k^{\frac{3}{2}} \cdot f_{ck}^{\frac{1}{2}}\} \cdot b_w \cdot d,\ kN$

where:

$$k = 1 + \sqrt{\frac{300}{500}} \leq 2, k = 1 + \sqrt{\frac{300}{500}} = 1.77$$

$$\rho_l = \frac{A_{s1}}{b_w \cdot d} = \frac{1256}{300 \cdot 500} = 0.008 \leq 0.02$$

$$d = h - c = 500 - 40 = 460$$

$$V_{Rd,c} = \left\{\left(\frac{0.18}{1.5}\right) \cdot 1.77 \cdot (100 \cdot 0.008 \cdot 30)^{\frac{1}{3}}\right\} \cdot 300 \cdot 500 = 162030.32N = 162.03\ kN$$

$$V_{Rd,c,min} = \left\{0.0035 \cdot 1.77^{\frac{3}{2}} \cdot 30^{\frac{1}{2}}\right\} \cdot 300 \cdot 500 = 5089.7N = 5.09kN$$

According the Etabs calculation $V_{Ed} = 145.30$

$V_{Rd;c,min} < V_{Ed;max} < V_{Rd;c}, max$= ; 5.09 kN < 145.30 kN <162.03 kN

The step of the transverse reinforcement is determined by the formula:

$$s \leq 0.75d$$

$$s \leq 0.75 \cdot 500 = 375\ mm$$

We accept the step of the transverse reinforcement s = 375mm

$$A_{sw} = \frac{\mathrm{V_{Ed;max}} \cdot \mathrm{s}}{\mathrm{d_z}\ f_{sw} \cos \Upsilon} \tag{9}$$

Where take according etabs; $\mathrm{V_{Ed;max}} = 145.30$ (lateral reinforcement in a given section.

We set the angle of inclination of the cracks to the horizontal $\Upsilon = 40$

The first design section is assigned at a distance($d_z = 660\ mm$)

$$f_{sw} = 235$$

$$A_{sw} = \frac{145.3\ \cdot\ 10^3 \cdot 375}{660 \cdot\ 235 \cos 40°} = 458.5\ mm^2 = 4.58cm^2$$

We accept: $23\phi\ 10\ S235\ (A_{sw} = 4.58\ cm^2)$.

In this case, the following conditions must be met:

$$\frac{\mathrm{A_{sw}} \cdot\ \mathrm{f_{sw}}}{\mathrm{b_w} \cdot\ s} \leq 0.5\ \cdot \mathrm{v}\ \cdot\ \mathrm{f_{cd}} \tag{10}$$

Where v-coefficient, taking into account the reduction in the strength of concrete in compression under tension and equal for heavy concrete:

$$v = 0.6\left(1 - \frac{f_{ck}}{250}\right) = 0.6\left(1 - \frac{30}{250}\right) = 0.53 \geq 0.5$$

$$\frac{458.5 \cdot\ \ 235}{300 \cdot\ 375} \leq 0.5\ \cdot\ 0.53\ \cdot\ 20$$

$0.95 \leq 5.3$ the condition is met.

$$\mathrm{V_{Ed;max}} < \mathrm{V_{Rd;c}}, max = \frac{\mathrm{v} \cdot\ \mathrm{f_{cd}} \cdot \mathrm{b_w} \cdot \mathrm{d_z}}{\cot 40 + \tan 40} = \frac{0.53 \cdot 20 \cdot 300 \cdot 660}{\cot 40 + \tan 40} = 234746.7N$$
$$= 234.7kN$$

$$\mathrm{V_{Ed;max}} = 145.3\ kN < \mathrm{V_{Rd;c}}, max = 234.7kN$$

The condition is met.

Other sections are calculated in the same way.

2.10 Calculations from Etabs

Calculation of the spatial system for static and dynamic actions with the choice of design combinations of efforts.

We create 10 load cases, thereby applying loads to the building frame:

-The dead weight of the building;

-Floors;

-Walls;

-Ground pressure;

- Long-term load;
- Short-term load;
- Snow load;
- Seismic X
- Seismic Y

Load Analysis

The 7 load cases are defined in my structure and according these load case the structure is analyzed, the load cases are illustrated in following figures.

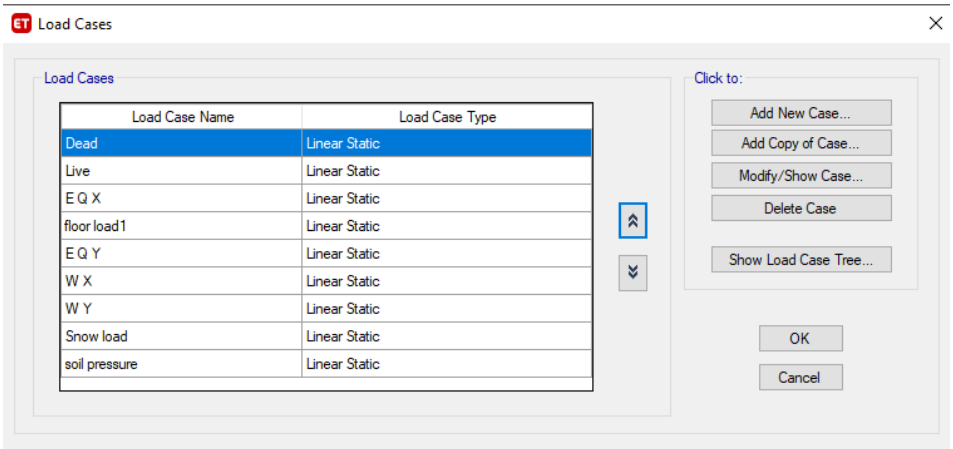


Figure 10 - Load cases

Then we proceed to the loading of our building itself that are shown in Figure A.1, Figure B.2 and Figure B.3 in Appendix B.

Combinations of action for permanent design situation (basic combination)

All coefficient and formulas are taken from SP RK EN 1990 bases for designing loading structure. We can calculate manually by the following formulas.

$$\sum_{j\geq 1}\gamma_G\cdot G_K+\gamma_p\cdot \mathrm{p}+\gamma_Q\cdot Q_K+\sum_{i>1}\gamma_Q\cdot \Psi_{0.1}\cdot Q_k \quad (11)$$

$$\sum_{j\geq 1}\gamma_G\cdot G_K+\gamma_p\cdot \mathrm{p}+\gamma_Q\cdot \Psi_{0.1}\cdot Q_K+\sum_{i>1}\gamma_Q\cdot \Psi_{0.i}\cdot Q_k \quad (12)$$

$$\sum_{j\geq 1}\gamma_G\cdot G_K+\gamma_p\cdot \mathrm{p}+\gamma_Q\cdot Q_K+\sum_{i>1}\gamma_Q\cdot \Psi_{0.i}\cdot Q_k \quad (13)$$

where $\gamma_G = 1.35$ –for permanent loads;

G_K – sum of permanent loads;;

$\gamma_Q = 1.5$ – for temporary loads ;

Q_K – sum of temporary loads;

Ψ_0, Ψ_1, Ψ_2 – in table НП.A1.1.

Combinations of actions for seismic design situations

$$\sum_{j\geq 1}G_{kj}+\mathrm{p}+A_{Ed}+\sum_{i>1}Q_{k.i}\cdot \Psi_{2.i} \quad (14)$$

Table 12 - The values of ψ

Воздействия	ψ_0	ψ_1	ψ_2
Приложенные нагрузки в зданиях, категории (см. EN 1991-1-1):			
Категория A: бытовые, жилые зоны	0,7	0,5	0,3
Категория B: офисные площади	0,7	0,5	0,3
Категория C: зоны для собраний	0,7	0,7	0,6
Категория D: торговые площади	0,7	0,7	0,6
Категория E: складские площади	1,0	0,9	0,8
Категория F: зоны дорожного движения для транспортных средств весом ≤ 30 кН	0,7	0,7	0,6
Категория G: зоны дорожного движения для транспортных средств весом от 30 кН до 160 кН	0,7	0,5	0,3
Категория H: покрытия (крыши)[a]	0,7	0	0
Снеговые нагрузки на здания (см. EN 1991-1-3)*:			
Для районов, находящихся на высоте H > 1000 м над уровнем моря	0,7	0,5	0,2
Для районов, находящихся на высоте H ≤ 1000 м над уровнем моря	0,5	0,2	0
Ветровые нагрузки на здания (см. EN 1991-1-4)	0,6	0,2	0
Температурные воздействия (исключая пожары) на здания (см. EN 1991-1-5)	0,6	0,5	0
а) См. также 3.3.2(1) EN 1991-1-1.			

Then the combinations of design load combinations will look in accordance with Figures 8.

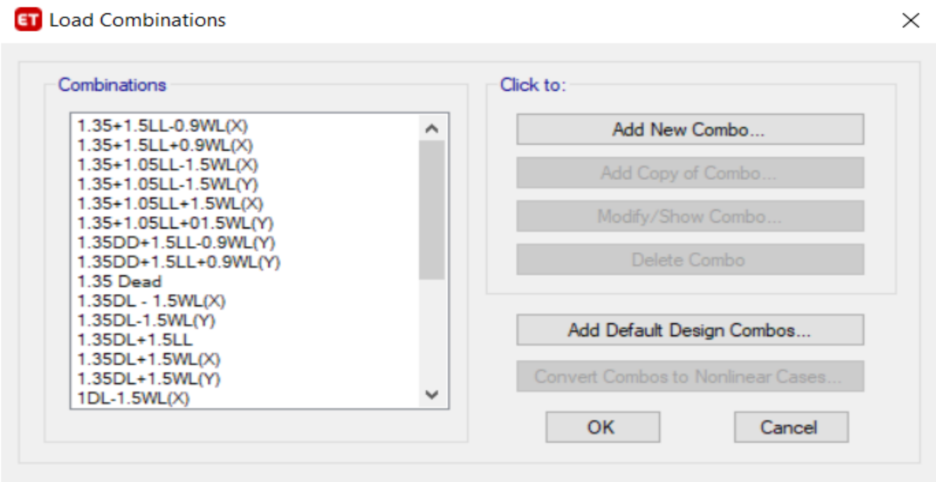


Figure 11 - Combination of actions

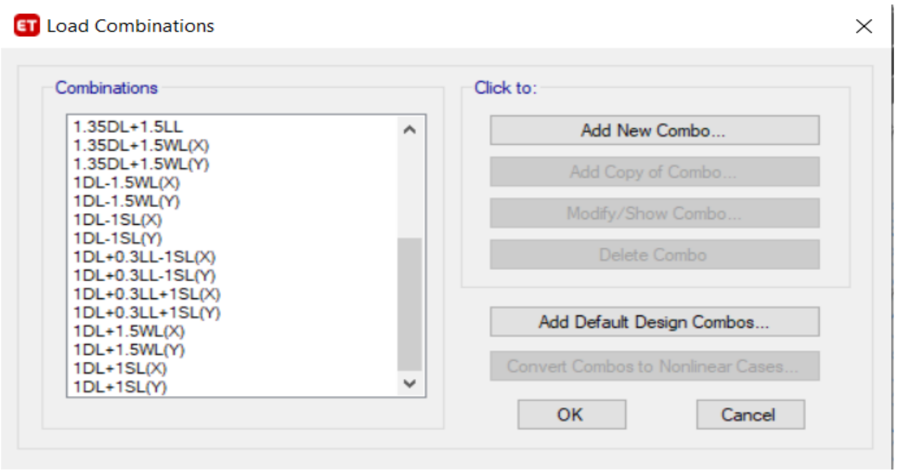


Figure 12 – Combination of actions

Ultimate strains and bases

Industrial and civil one-story and multi-storey buildings with a full frame: the same, with the device of reinforced concrete belts or monolithic floors, as well as buildings with a monolithic structure, Average s_ (max, μ) = 10 cm, Respectively, according to the standard the maximum settlement of the base is $S_{(max,\ \mu)}$ = 10 cm [1].

For our design scheme, the maximum drift is 60 mm, which satisfies the condition which is shown in Figure B.4 in Appendix B,

$$s \leq s_{max,\mu}$$

$$60\ mm \leq 100\ mm$$

The relative difference in sediment is:

$$\text{RS} = (\frac{\Delta s}{L})_u,$$

where L is the distance between the axes of the foundation blocks in the direction of horizontal loads, and in guyed supports - the distance between the axes of the compressed foundation.

According to Appendix B [1], the relative draft should not exceed 0.002.

Then, according to FigureA.5 in Appendix A, we get that the relative draft is:

$$\frac{24}{18000} = 0.00013 < 0.002$$

Conidian is met

Deflection of the slab and girder

The appearance and overall serviceability of the supporting structure may be compromised if the calculated deflection of a beam, slab or cantilever beam, near a constant combination of actions, exceeds L / 250 span. According to the standard (sn pk en 1992-1-1 + np <Design of reinforced concrete structures for buildings>, according to sub-clause 7.4 Control of deflections).

a) For plat

The deflection of the floor slab is determined according to Figure A.5 in Appendix A

The deflection is 60 mm

According to subparagraph the deflection of the slab should not exceed a value equal to:

$$\frac{l}{250} = \frac{6800}{250} = 27.2\ mm$$

Maximum horizontal displacement from the wind

According to paragraph EN1991 10.14 of Table 22 [3], the maximum horizontal displacements from the wind are calculated by the formula:

$$\text{Maximum horizontal displacements from the wind} = \frac{h}{500}$$

where h - is the height of multi-storey buildings, equal to the distance from the top of the foundation to the axis of the roof girder.

The maximum movement along the X axis is 0.5 mm.

$$0.5\ mm < \frac{37000}{500} = 74\ mm$$

The condition is met.

The maximum displacement along the Y-axis is 1.03 мм according Figure B.6 in Appendix B.

$$1.04 < \frac{37000}{500} = 74\,mm$$

The condition is met.

Checking the regularity of buildings in the plan

To begin with, let's check the building for regularity in terms of X. To do this, we use the formula according the Figure B.7 in Appendix B.

$$100 - \frac{\delta_{max} + \delta_{min}}{2 \cdot \delta_{max}} \cdot 100$$

$$100 - \frac{4.15 + 1.5}{2 \cdot 4.15} \cdot 100 = 31.9\,percent$$

According the Figure B.8 in Appendix B.

$$100 - \frac{\delta_{max} + \delta_{min}}{2 \cdot \delta_{max}} \cdot 100$$

$$100 - \frac{24.1 + 30.15}{2 \cdot 30.15} \cdot 100 = 10.03\,percent$$

According the Figure B.9 in Appendix B.

$$100 - \frac{\delta_{max} + \delta_{min}}{2 \cdot \delta_{max}} \cdot 100$$

$$100 - \frac{58.8 + 63.7}{2 \cdot 63.7} \cdot 100 = 3.8\,percent$$

According the Figure B.10 in Appendix B.

$$100 - \frac{\delta_{max} + \delta_{min}}{2 \cdot \delta_{max}} \cdot 100$$

$$100 - \frac{5.7+2.2}{2 \cdot 5.7} \cdot 100 = 30.7\,percent$$

Since not all values exceed 25%, our building is irregular in plan along the OX and OY axes.

We take all the displacement values from the ETABS software package (story response)

3 Organisational and technological Part

3.1 Earthwork

Type of soil is sand and gravel that is included in II category of soil with admixture up to 30 percent.

Initial data on soil are indicated in table 7.

Table 12 – Initial data

Name of factors	Unit of measurement	Numeric data	Note
Soil category		II	ENiR 2, edition 1 page 7-12
Average density of soil	kg/m^3	1600	ENiR 2, edition 1 page 7-12
Initial loosening factor	Percenage	10-15	ENiR 2, edition 1 page 179
Residual loosening factor	Percenage	2-5	ENiR 2, edition 1 page 179
Slope steepness factor	Percenage	0.67	Khamzin, Karasev «technology of construction procesess», page 35

Range of soil transportation: 5 km

Winter temperature of external influence: -10 degrees celciuse

Elevation of the base of foundation: -3m

Determination of the scope of work

As it is known at the present time, the construction of a building and structure is not implemented without an approved estimate, therefore, customers require to know the volume of capital investments and the timing of striotel, then for the construction of each building or structure it is necessary to calculate the volume of work.

-temporary fencing

Prior to the construction work necessary to perform the construction temporary fencing, fencing perimeter, m, determined by the formula:

$$P_{fen} = (20 + l_1) \cdot 2 + (20 + l_2) \cdot 2 \quad (16)$$

where l_1, l_2– length and width of the structure in plan, m.

Distance from the axis of the building in each direction is 20 m.

$$P_{fen} = (20 + 39.2) \cdot 2 + (20 + 18) \cdot 2 = 194.4 \text{ m}$$

But for the whole project the fencing will be 800 m.

- The volume of earthworks is determined when designing earthworks.

$$V_p = \frac{h}{6} \cdot \left(a \cdot b + c \cdot d + (a + c) \cdot (b + d)\right), m^3 \quad (17)$$

where a, b are the width and length of the pit along the bottom;
c, d - width and length of the pit along the top

$$V_{p1} = \frac{3}{6} \cdot \left(20.6 \cdot 41.8 + 25.7 \cdot 46.7 + (20.6 + 25.7) \cdot (41.8 + 46.7)\right) = 3080 m^3$$

Since I have 7 identical foundation pit for the whole project:

$$V_p = 7 \cdot V_{p1} = 7 \cdot 3080 = 21560 m^3$$

- Determine the volume of backfilling

$$V_{bf1} = \frac{V_p - V_f - V_{base}}{1 + К_{r.l}}, m^3 \quad (18)$$

$$V_{bf1} = \frac{3080 - 635.04 - 2116.8}{1 + 0,05} = 312.53 m^3$$

Volume of backfilling for the whole project:

$$V_{bf} = 7 \cdot V_{bf1} = 2187.71 m^3$$

V_{base} – basement volume

$$V_{base} = a \cdot b \cdot h = (18 \cdot 39.2 \cdot 3) = 2116.8 \text{ m}^3$$

V_f- volume of foundation elements

$$V_f = 39.2 \cdot 18 \cdot 0.9 = 635.04 m^3$$

$К_{r.l.}$- residual loosening factor

- Determination of the volume of surplus soil

$$V_{s.s} = V_p - V_{bf}, m^3 \quad (19)$$

For one building:

$$V_{s.s1} = 3080 - 312.53 = 2767.47$$

For the whole project:

$$V_{s.s} = 7 \cdot 2767.47 = 19372.29$$

- Determination of the volume of soil shortage

$$V_{short.s} = a \cdot b \cdot h_{short.s}, \text{ m}^3 \quad (20)$$

$$H_{short.s} = 0.1 \div 0.4 \text{ m}$$

$$V_{short.s} = (39.2 \cdot 18 \cdot 0.4) = 282.24 m^3$$

For the whole project:

$$V_{short.s} = 7 \cdot 282.24 = 1975.68 m^3$$

- Determination of the cutting area of the vegetation layer

$$S_{veg} = (10 + c + 10)(10 + d + 10), m^2 \quad (21)$$

$$S_{veg} = (10 + 25.7 + 10)\,(10 + 46.7 + 10) = 3048.19\ m^2$$

For the whole project:

$$S_{veg} = 7 \cdot 3048.19 = 21337.33\ m^2$$

- The total volume of cutting of plant soil.

$$V = S \cdot h_{p.s} = 3048.19 \cdot 0.2 = 609.638 m^3$$

For the wole project:

$$V = 7 \cdot 609.638 = 4267.466\ m^3$$

- The area of soil compaction.

$$F_c = \frac{V_{bf1}}{h_c} \tag{22}$$

where h_c - thickness of the compacted layer

$$F_c = \frac{312.53}{0.2} = 1562.65\ m^2$$

For the wole project:

$$F_c = 7 \cdot 1562.65 = 10938.55\ m^2$$

- Waterproofing area of foundation slab

$$S = \frac{V_{base}}{h} \tag{23}$$

$$S = \frac{2116.8}{3} = 705.6\ m^2$$

For the whole project:

$$S = 7 \cdot 705.6 = 4939.2\ m^2$$

Table 13 - List of volumes of earthworks

№	Name of work	Unit of measurement	amount		Notes
			For one building	For the whole project	
earthwork					
1	Cutting off the vegetation layer	m^2	3048.19	21337.33	
2	Excavation by excavator				
A)	In the dump	m^3	312.53	2187.71	
B)	In vehicles	m^3	2767.47	19372.29	
3.	Development of shortage of soil	m^3	282.24	1975.68	
4.	Backfilling of soil	m^3	312.53	2187.71	
5.	Soil compaction	m^2	1562.65	10938.55	
6.	Waterproofing device	m^2	705.6	4939.2	

Selection of a set of machines for excavation work

The main factors that affect the choice of machines for implementation of earthworks are the design and dimensions of the earth structure, the group of soil, the grain size distribution of the soil and the moisture content of the soil.

Most of the volume of earthworks is carried out mechanically, using various types of machines.

Soil development is divided into 3 groups:

- earthmoving
- machines for soil compaction
- machines for auxiliary work

1) Choosing a bulldozer

Basic tractor T-130, bulldozer DZ-110, soil – course sand or gravel, cutting path length – 25.7 m, soil transportation path length – 78.4 m.

Cycle time:

$$T = t_1 + t_2 + t_3 + t_4 \qquad (24)$$

where t_1 - soil cutting time:

$$t_1 = \frac{l_1}{v_1} = 3.6 \cdot 25.7/3.2 = 28.9s$$

where 3.6 - conversion factor km/h to m/s;

l_1 - cutting path length, l_1=25.7 m;

v_1 - speed of movement of the bulldozer in 1st gear when cutting the soil;

v_1=3,2 km/h.

t_2 - soil transference time by blade:

$$t_2 = \frac{l_2}{v_2} = 3.6 \cdot 78.4/3.8 = 74.2s$$

where 3.6 - conversion factor km/h to m/s;

l_2 - length of soil transportation path, l_2=78.4 м;

v_2 - the speed of the loaded bulldozer, v_2=3.8 km/h.

t_3 - return (empty bulldozer) time :

$$t_3 = \frac{(l_1 + l_2)}{v_3} = 3.6 \cdot \frac{(25.7 + 78.4)}{5.2} = 72\ s$$

where v_3 - reverse travel speed, v_3=5.2 km/h;

t_4 - additional time spent on lifting, lowering the blade, switching speeds, turning the bulldozer, t_4=25 c.

$$T=t_1+t_2+t_3+t_4 = 21.4 + 57 + 55 +25 = 158.4c$$

$$T = 28.9 + 74.2 + 72 + 25 = 200.1\ s$$

The technical performance of the bulldozer is determined by the formula:

$$P_T = q_{pr} \cdot n \cdot k_n / k_r \qquad (25)$$

where q_{pr} - volume of the soil dragging by blade, м;

$$q_{pr} = \frac{L \cdot H^2}{2 \cdot m} = \frac{3.94 \cdot 0.815^2}{2 \cdot 0.7} = 1.87 m^3$$

where L - blade length, L = 3.94 m;

H - blade height, H=0.815 m;

m = 0.7 - coefficient depending on the ratio H/L;

n - number of cycles per 1 hour of work:

$$n = 3600/T = 3600/200.1 = 18$$

where k_n=1.1 - coefficient of filling the geometric volume of the prism with soil, k_r=1.25 - soil loosening coefficient,

$$P_T = q_{pr} \cdot n \cdot \frac{k_n}{k_r} = 1.87 \cdot 18 \cdot \frac{1.1}{1.25} = 29.6 \ m^3/h$$

Operating performance of the bulldozer:

$$P_e = P_T \cdot k_v = 29.6 \cdot 0.8 = 23.7 \ m^3/h$$

where $k_в$ - bulldozer utilization rate over time, k_v=0.8.

Changeable bulldozer performance:

$$P_c = 8 \cdot P_e = 8 \cdot 23.7 = 189.6 \ m^3/h$$

where 8 - the number of hours of work per shift.

2) Excavator selection

The excavation is carried out with a excavator equipped with a backhole shovel with loading soil into dump trucks and with partial filling into a dump.

We select a front shovel excavators with teeth and with a bucket volume of 1 m^3.

Table 14 – Specifications of excavator

	EO-5122
1.Drive unit	Hydraulic
2. Bucket volume	1 m^3
3. Maximum digging depth	9,3 m
4. Largest cutting radius	9,9 m
5. Height of unloading into transport	6,6 m
6. Power	95 kwatt
7. Mass	39,5 t
H_{vr1}	1,64
H_{vr2}	2,2
$C_{m.s.}$	42.64 y.e.
$C_{i.r.}$	37.34 thous. y.e.

3) Determining the number of dump trucks

To remove excess soil from the construction site and ensure joint work with the excavator, we choose dump trucks. The carrying capacity and the brand are assigned depending on the volume of the excavator and on the distance of the soil transportation.

Choosing a dump truck MAZ-5516

- The volume of soil in a dense body in an excavator bucket

$$V_s = \frac{V_b \cdot K_{b.f}}{K_{p.l} + 1} \quad (26)$$

$$V_s = \frac{1 \cdot 1.25}{0.25 + 1} = \frac{1.25}{1.25} = 1m^3$$

where V_b- accepted bucket volume;

$K_{b.f}$- bucket filling ratio.

for a straight shovel - from 1-1.25

$K_{p.l}$ = 0.25- primary loosening factor

Determination of the mass of soil in an excavator bucket

$$Q = V_s \cdot \rho_s = 1 \cdot 1.6 = 1.6 \text{ t}$$

where ρ_s=1.6 t/m^3- average soil density.

- Determination of the number of soil buckets loaded into the body of the dump truck

$$n = \frac{P}{Q} = \frac{20}{1.6} = 12$$

- Determination of the volume of soil in a dense body of a dump truck loaded into the body:

$$V = V_s \cdot n = 1 \cdot 12 = 12 \text{ m}^3$$

- Determination of the duration of one cycle of the dump truck

$$T_c = t_l + \frac{60 \cdot L}{V_l} + t_p + \frac{60 \cdot L}{V_P} + t_m \quad (27)$$

$$T_c = 13.8 + \frac{60 \cdot 5}{18} + 2 + \frac{60 \cdot 5}{25} + 3 = 47.4\, min$$

where L- Soil transportation distance;

t_l- soil loading time;

t_p- soil unloading time - from 1-2 min;

t_m- maneuvering time before loading and unloading - from 2-3 minutes;

V_l -the average speed of the dump truck in the loaded state.V_r=18 km/h;

V_P-from 25-30 km/h.

$$t_p = \frac{V \cdot H_{vr}^2 \cdot 60}{100} \quad (28)$$

$$t_p = \frac{12 \cdot 1.92 \cdot 60}{100} = 13.8\, min$$

- Determination of the required number of dump trucks

$$N = \frac{T_c}{t_p} = \frac{47.4}{13.8} = 3.4 \approx 4$$

4) Selection of soil compactors

Since course sand or gravel is course graind soils and have little cohesiveness, therefore, considering the smallest length of the condensed strip up to 50 m we choose (DU-128) – plate compactor with a width of the compacted strip - 2.5 m.

3.2 Technological map for concreting and formwork

The composition of concrete work and formwork work in the construction of a monolithic frame includes:

- Formwork device;
- Concreting of the frame;
- Dismantling of the formwork.
- Concrete caring

Before starting the constructing of frame structure, you must:

- Deliver and place formwork panels and reinforcing bars at the storage site;
- Deliver and prepare necessary devices, inventory and tools for the work to the site;

Formwork panels and details of its fastening should be sorted by brands and standard sizes.

Reinforcing bars are delivered to the storages in the amount that ensures the work of the reinforcement during the shift.

Concrete is delivered to the construction site by concrete mixer trucks, or dump trucks adapted for the transportation of concrete.

In the places where the concrete is placed, an inventory wooden flooring is arranged.

Reinforced concrete structures in contact with the ground must be coated with hot bitumen.

Correct installation and fastening of the formwork must be accepted according to the act.

Initial data

Number of floors - 13 (including the basement)

Transportation range - 5 km

Building dimensions: l = 39.2 m, b = 18 m

Thickness of floor slabs and coverings: h = 20 cm

Bulk density of heavy concrete: 2500 kg / m^3

Floor height: typical - 3 m, basement floor - 4 m

The thickness of the shear walls are 200 mm.

Formwork installation

The installation of the formwork is carried out using a KB-403 tower crane with a boom length of 23 m, installed according to the construction plan. The installation of the formwork should be carried out according to the grips. Each floor is divided into two sections in the plan. The boom of the crane is:

$$l_{cr} = a + b + c \tag{24}$$

where a- the distance from the crane axis to the crane rail;

b- the distance from the crane rail to the building;

c- the length of the building.

$$l_{cr} = 2 + 3 + 18 = 23$$

Columns, walls and ceilings should be concreted in the formwork. The formwork kit consists of:

- Shearwall - made of metal panels, faced with water-resistant plywood 21 mm thick, withstanding the pressure of freshly laid concrete of 60 kN / m^2; straightening locks BFD, providing in one operation the connectivity, evenness and density of the formwork panels; strands DV - 15 with a nut - gasket with a permissible load on the strand of 90 kN; leveling strand PCC with a support, ensuring the stability of the formwork structures and designed for a load of 30 kN; consoles of suspended scaffolding TRZh 120, providing safety when the load on the platform is 150 kg / m2.

- Column - metal panels TRS, lined with waterproof plywood 21 mm thick, withstanding the permissible pressure of freshly laid concrete of 100 kN /m^2, column tension bolts with permissible bolt load of 90 kN.

- Coverings - made of lattice girders GT 24 of various lengths with a bearing capacity - transverse force in struts - 14 kN, bending moment - 7 kNm, supports PER 30 with a bearing capacity of 30 kN; panels made of waterproof plywood 21 mm thick.

The formwork is delivered to the construction site in special containers by road and stored under a canopy.

The moisture content of the wood used for the deck should be no more than 18percentage, for supporting elements - no more than 22percentage. The formwork elements must fit snugly against each other during assembly. Slots in butt joints should not be more than 2 mm.

For the antidezone coating of the working surface of the formwork, water-repellent lubricants are used based on petrochemical products that do not thicken in the cold: solid oil or petrolatum-kerosene.

The formwork is disassembled in the following order:

- Remove external braces and struts;
- Remove the clamping clamps connecting the opposing walls of the formwork;
- Release the tension hooks connecting the shields with the contractions, remove the contractions and individual shields;
- The shields are torn off the concrete with stripping tools with crowbars or crank arms.

Scope of work

Calculation of the amount of work per floor:

1) Formwork

- Large-panel formwork:

$$S = L \cdot h \tag{29}$$

Floor slabs:

$$S=L \cdot B = 705.6\ m^2$$

Shear wall:

$$S = L \cdot B = 523.2\ m^2$$

Total: 1228.8 m^2

- Small-panel formwork:

Columns:

$$S=42 \cdot 0.55 \cdot 4 \cdot 3 = 277.2\ m^2$$

Beams

$$S = 273.56\ m^2$$

Total: 550.76 m^2

Overall: 1779.56 m^2

- Support device, racks**:**

According to norms and rules for each 4 m^2 1 rack is established.

In order to find out the number of racks you need to know the area of the building, divide the area by 4 to find out the number of racks. But racks according to ENiR are measured in meters of 100 m. To do this, multiply the number of racks by the height of the floor and divide by 100.

$$S = L \cdot b = 18 \cdot 39.2 = 705.6\ m^2 \text{ (Building area)}$$

$$n = S / 4 = 705.6/4 = 177 \text{ pcs. (Number of racks)}$$

$$L= 177 \cdot 3 = 531\ m$$

- Device of beams:

Beams are laid in the longitudinal direction every 3 meters, and in the transverse direction every 1 meter. Beam length 3 m.

In the longitudinal direction:

$$N = 39.2/3 = 14 \text{ pics.}$$

$$n_{total} = 14 \cdot 6 = 84 \text{ pics. (total)}$$

$$L= 84 \cdot 3=252\ m.$$

In the transverse direction:

$$n=18/3=6 \text{ pics.}$$

$$n_{total} = 6 \cdot 38=228 \text{ pics.}$$

$$L= 228 \cdot 3 = 684\ m.$$

Table 15- Scheme of formwork for elements

Name of board	Designation	Sizes, mm	Quantity	Area of the board, m^2
Linear board	LB-1	3000×1000	74	3
Angular board	AB-1	3000×300	9	0.9
Universal board	UB-1	3000×1000	22	3
Universal board	UB-1	3000×500	32	1.5
Total				8.4

2) Concreting

Concrete mix must be transported by specialized methodes. The accepted method for transporting the concrete mixture must:

- Exclude the ingress of atmospheric precipitation and direct exposure to sunlight;

- Exclude stratification and violation of homogeneity;

- Prevent the loss of laitance or mortar.

The maximum duration of transportation of the concrete mix should be established by the construction laboratory with the condition of ensuring the preservation of the required quality of the mix on the way and at the place of its laying.

Before placing the concrete mixture, the floor (artificial), the correct installation of the formwork, reinforcement structures and embedded parts must be checked. The inner surface of the inventory formwork must be cleaned and coated with a special grease that does not impair the appearance and strength of the structures.

breaks in concreting, which require the device of working seams, is determined by the laboratory depending on the type and characteristics of the cement and the temperature of concrete hardening. Placement of the concrete mixture after The distribution of the concrete mixture in the structure to be concreted is carried out in horizontal layers of the same thickness, laid in one direction. The overlapping of the previous layer is subsequently performed before the cement sets, and the overlapping time is set by the laboratory depending on the outside air temperature, the properties of the cement used. Approximately this time is no more than 2 hours.

The duration of such breaks is carried out only after the surface of the working joint is treated with cement mortar with a thickness of 20-50 mm or with a layer of plastic concrete mixture.

The concrete mix is compacted with a deep vibrator with a flexible shaft. When compacting the concrete mixture, it is not allowed to rest the vibrators on reinforcement, embedded products, formwork fastening elements. The step of moving the vibrator should not exceed 1.5 of its radius of action. The optimal duration of vibration in one place is 20-30 s. The immersion depth of the vibrator in the concrete mixture should ensure its partial deepening into the previously laid unhardened concrete layer is showed in figure 13.

Signs of the completion of concrete compaction during the operation of vibrators are:

- stopping the settling of the concrete mixture;

- coarse aggregate coating with mortar;

- the appearance of cement laitance on the surface and in the places of contact with the formwork;

- cessation of the release of air bubbles.

After laying the top layer of the concrete mixture, it is necessary to smooth out the exposed concrete surface.

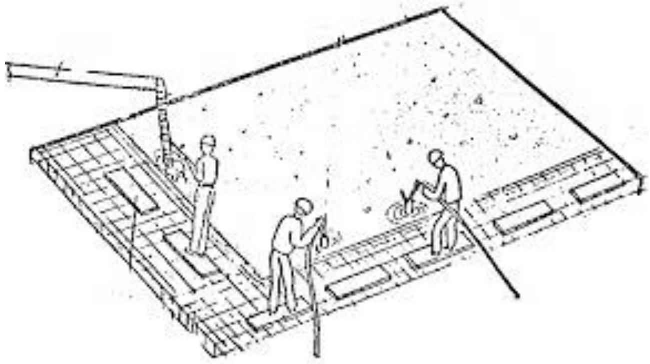


Figure.13-Concrete laying process

When caring for concrete, it is necessary to provide favorable temperature and humidity conditions for concrete hardening, protecting it from the harmful effects of wind, direct sunlight by systematic watering of moisture-consuming coatings (burlap, a layer of sand, sawdust, etc.) of concrete surfaces; the frequency of watering moisture-consuming coatings depends on climatic conditions and the need to maintain the concrete surface in a damp state;

Concreting structures must be accompanied by appropriate entries in the concrete work log.

Laying concrete mix in wall structures.

$$V_{st} = (h \cdot a \cdot b \cdot \rho) = 55.08\ m^3$$

Placement of concrete mix in coatings and ceilings:

$$S = L \cdot b \cdot h = 39.2 \cdot 18 \cdot 0.15 = 105.84\ m^3$$

Paving the concrete mixture into the column:

$$S = L \cdot b \cdot h = 42 \cdot 0.55 \cdot 0.55 \cdot 3 = 38.115\ m^3$$

Laying the concrete mixture in the crossbar:

$$S = L \cdot b \cdot h = 0.5 \cdot 0.3 \cdot 361.2 = 54.18\ m^3$$

- Curing of concrete

When caring for concrete, it is necessary to provide favorable temperature and humidity conditions for concrete hardening, protecting it from the harmful effects of wind, direct sunlight by systematic watering of moisture-consuming coatings (burlap, a layer of sand, sawdust, etc.) of concrete surfaces; the frequency of watering moisture-consuming coatings depends on climatic conditions and the need to maintain the concrete surface in a damp state;

$$S = a \cdot b = 705.6\ m^2$$

- Dismantling the formwork:

Large-panel formwork – 1228.8 m^2

Small-panel formwork - 550.76 m^2

Total: 1779.56 m^2

- Disassembly of racks and beams:

Support n = 177 pcs, L = 531 m

Beams L = 936 m., N = 312 pcs.

Table 16 - Statement of volumes of construction installation work

№	Name of processes	Units	1st floor volume	Number of floors	Overall volume
1	Formwork works				
	Large-panel formwork	m^2	1228.8	13	15974.4
	Small-panel formwork	m^2	550.76	13	7159.88
	support	m	531	13	6903
	Beams	m	936	13	12168
3.	Concrete works				
	Pouring	m^3	253.215	13	3291.8
	Caring	m^2	705.6	13	9172.8
4.	dismantling				
	Large-panel formwork	m^2	1228.8	13	15974.4
	Small-panel formwork	m^2	550.76	13	7159.88
	support	100 m	531	13	6903
	Beams	m	936	13	12168

- Tiering and Sizing of Structures

For the flow organization of the production of work, the object must first be divided into tiers and captures. A tier is a section of a conditionally expanded construction object vertically. 1st floor-1 tier. Capture - is a part of the object being built to which a private stream is allocated with a certain number of workers.

The number of captures can be determined by the formula [10]:

$$m = \frac{A \cdot t_{в}}{к} + n - 1 \quad (30)$$

where A- the number of shifts per day;

$t_{в} -$ the curing time of concrete until it acquires a strength equal to 15 kg/cm^2(We accept from 1-6 days);

K - Cyclic module, i.e. the duration of work on the seizure is taken equal to 1;

n- Number of simple processes (4).

$$m = \frac{2 \cdot 2}{1} + 4 - 1 = 7\ hook$$

- Calculation of the formwork turnover

This calculation shows us how many times 1 formwork is used. The quality indicator of the formwork is its turnover, i.e. possibility of repeated use.

The formwork turnover is calculated by the formula

$$Z = \frac{\sum_1^a m}{n - 1 + \frac{A \cdot t_{в}}{к}} \quad (31)$$

where Σm - The total number of captures on all levels of the structure;

A- Number of shifts per day = 2

$$\Sigma m = 7 \cdot n = 7 \cdot 13 = 91$$

$$Z = \frac{91}{4 - 1 + \frac{1 \cdot 2}{1}} = 18.2 \text{ times}$$

That is, one formwork is used 18.2 times during the construction process.

The required number of formwork kits is determined by the formula:

$$a = n + 1 + \frac{A \cdot t_{в}}{к} \quad (32)$$

$$a = 4 + 1 + \frac{1 \cdot 2}{1} = 7 \ sets$$

Selection of methods of transportation, supply, placement and consolidation of concrete mixture.

Tower crane is a boom-type slewing crane with a boom fixed in the upper part of a vertically located tower.

A tower crane is distinguished:

- Stationary
- Mobile
- Combined

1) Determination of the required lifting height of the tower crane hook:

$$H_{cr}^{tr} = H_o + H_{reserve} + H_{elem} + H_{sling} \text{ (m)} \quad (33)$$

where H_o- Mark where the element to be installed is installed (37 m)

$H_{reserve}$- Height reserve (0.5 m)

H_{elem}- Element height in mounted position (3.7 m)

H_{sling}- Height of slings (2.5 m)

$$H_{cr}^{tr} = 37 + 0.5 + 3.7 + 2.5 = 43.7 \text{ m}$$

2) Determination of the required outreach of the tower crane:

$$l_{str}^{tr} = B + \frac{a}{2} + c, \text{(m)} \quad (34)$$

Where в - Width of the building object;

a - Width of the crane runway (4.5-6 m);

c - Distance from the edge of the building to the slewing part of the crane (2 m)

$$l_{str}^{tr} = 18 + \frac{5}{2} + 2 = 23 \text{ m}$$

3) Determination of the required load moment.

$$M_{tr}^{tr} = \left(Q_{el} + Q_{sling}\right) \cdot l_{sling}^{tr} (t \cdot m) \quad (35)$$

where Q_{el}- the mass of the bucket crane (5.9 tons);

Q_{sling}- weight of slings (0.1 t);

l_{sling}^{tr}- Required boom reach.

$$M_{tr}^{tr} = (5.9 + 0.1) \cdot 23 = 138 \text{ t} \cdot \text{m}$$

4) Tower crane selection:
KB-408
Carrying capacity: 10 t
Load moment: 160 t·m
Lifting capacity at maximum outreach: 3 t
Departure range: 6 - 30 m
Lifting height freestanding crane: 57.8 m
Maximum Lifting speed: 67 m / min
5) Crane bucket:

Table 17- bucket characterisrics

Product name	Volume, l	Carrying capacity, kg	Length, mm	Width, mm	Height, mm	Weight,
BP-2	2000	6000	3600	1000	2200	880

The actual duration of the bucket is determined by the formula:

$$T = \frac{V}{P_c} \tag{36}$$

$$T = \frac{3291.8}{49.5} = 66.5 \text{ days.}$$

where V- the total required volume of concrete for the entire building;
P_c- Changeable operational efficiency of the mechanism m^3 / shift.

Replaceable operational performance of a bucket for conveying concrete mixture is calculated by the formula:

$$P_c = \frac{60 \cdot V \cdot T \cdot K_B}{T_c} \frac{m^3}{\text{shift}} \tag{37}$$

$$P_c = \frac{60 \cdot 2 \cdot 8 \cdot 0.8}{15.5} = 49.5$$

where V- the volume of concrete mixture loaded into the crane with a bucket;
T - shift duration (8 hours);
K_B- The coefficient of use of the crane over time:

For a crane with an electric drive without outriggers - 0.82; for a crane with an electric drive with outriggers - 0.8; for a crane with an internal combustion engine without outriggers - 0.78; for a crane with an internal combustion engine with outriggers -0.76.

T_c- Duration of the working cycle

5) The duration of the working cycle is calculated by the formula:

$$T_c = t_r + t_s + 2t_p + t_y \text{ (minute)} \qquad (38)$$

Where t_r- Time of unloading the concrete mix from the concrete truck into the buckets (0.5-1.5 min);

t_s - Time of slinging (1-1.5 min)

t_p- Time of feeding the concrete bucket crane into the concreting block (Depends on the feed height and lifting speed, as well as on the distance and speed of horizontal movement)

t_y - Time of placing the concrete mixture into the structure (1-3 min)

$$\mathbf{T_c} = 1.5 + 3 + 2 \cdot 4 + 3 = 15.5 \text{ minute}$$

Choice of a mechanism for conveying concrete mixture

Concrete pumps are used for general construction work related to concreting, filling with ready-mixed concrete of all types of formwork during the construction of walls, floors, foundations, and various tunnels. They are used in conjunction with equipment for the production, storage or supply of ready-mixed concrete.

Pneumatic blowers are units used for the preparation of concrete mixture and its simultaneous supply. This type of pump has a built-in compressor with an electric motor or diesel unit.

- Concrete pump:

Model (ABN 75/32)

The actual duration of the concrete pump operation is determined by the formula:

$$T = \frac{V}{P_c} \qquad (39)$$

$$T = \frac{3291.8}{54.26} = 60 \text{ days}$$

where V- the total required volume of concrete for the entire building;

P_c- Changeable operational efficiency of the mechanism m^3 / shift

$$\Pi_e = 60 \cdot T\left(\frac{\Pi \cdot d^2}{4}\right) \cdot l \cdot \vartheta \cdot K_{ex}, \frac{m^3}{\text{shift}} \qquad (40)$$

where T is the duration of work per shift 8 hours;

Π = 3.14

d - Working cylinder diameter m

l - Piston stroke length

ϑ - number of 2 piston strokes min. (Discharge rate)

K_{ex} - coefficient characterizing the ratio of the volume of concrete mixture supplied in 1 stroke to the working volume of the amplifier (0.8-0.9)

$$\Pi_e = 60{\cdot}8\left(\frac{3.14{\cdot}0.2^2}{4}\right){\cdot}2{\cdot}2{\cdot}0.9 = 54.26$$

- Concrete mixer truck

KaMAZ-53212

- Vibrator

IV-66

The number of concrete trucks based on the condition of uninterrupted delivery to the object:

$$N = \frac{K_r{\cdot}P_e}{P_a} \quad (41)$$

where K_r- the coefficient taking into account the reserve of productivity of mechanisms to the leading machines (0.85-0.9);

P_e- operational performance of the concrete truck.

$$P_a = \frac{60{\cdot}V{\cdot}T{\cdot}K}{t_c} \quad (42)$$

$$P_e = \frac{k{\cdot}L{\cdot}n}{100} = \frac{0.72{\cdot}800{\cdot}18}{100} = 103.7$$

where L-the volume of the concrete mixer in litre;

n-number of batches per hour;

k-coefficient of concrete output from 0.65 to 0.72 (usually 0.67 is taken);

t_c-cycle time.

$$t_c = t_z + \frac{2{\cdot}L{\cdot}60}{v_{sr}} \quad (43)$$

where t_z- loading time of the concrete truck at the plant

$$t_c = 5 + \frac{2{\cdot}21{\cdot}60}{38} = 75$$

$$P_a = \frac{60{\cdot}12{\cdot}8{\cdot}0.92}{75} = 69$$

Number of concrete trucks

$$N = \frac{0.9 \cdot 103.7}{69} = 1.45 \approx 2 \text{ pcs.}$$

Conclusion: As a result of the calculations, the most economical and profitable is the bucket crane weahers the concrete pump saves more time for this reason the concrete pump is selected for this project.

3.3 Master plan

The basic data required for the development of a building master plan are:

Master plan of the territory with existing and under construction buildings, as well as basement communications networks;

A calendar plan for the production of work with a schedule of labor requirements;

Necessary construction machines and mechanisms;

The required amount of the need for general construction structural elements, products and bulk and non-bulk resources;

The number, list and dimensions of structures and buildings, as well as temporary warehouses at the construction site;

Standard information on the development of building general plans. In general, construction master plans can be dredged at various stages of the construction business.

The explanatory notes show the function of the building master plan, its purpose and for what period (for example, the installation of foundation blocks, and the installation of roofing elements or in the installation of structures in general) was developed. It is required to clarify the requirements enshrined in the base of its implementation. After that, we give the necessary calculations and give an explanatory note.

3.4 Calculation of temporary power supply

Electricity is the main source of energy used in the construction of buildings and structures. Power electricity is used to power machines and mechanisms, for electric welding and other technological needs.

Electricity is supplied to the construction from existing systems or inventory mobile power plants. Therefore, when developing theses, it is necessary to resolve the issue of power supply.

The maximum electricity consumption is set on the basis of the work schedule or network schedule.

We find the power of the outdoor lighting network by the formula:

$$W_{H.O} = K_c \cdot \sum P_{O.H} = 1 \cdot 19.2 = 19.2 \text{ kWatt}$$

where K_c- reduction coefficient of the power;

$\sum P_{O.H}$- sum of consuming power.

Indoor lighting network power:

$$W_{H.O} = 0.8 \cdot 3.2 = 2.56 \text{ kWatt}$$

Total power consumption for lighting:

$$W_{total} = 19.2 + 2.56 = 21.76 \text{ kWatt}$$

3.5 Organization of production areas, work areas and workplaces

Production areas (sites of construction and industrial enterprises with construction objects located on them, production and sanitary buildings and structures), work areas and workplaces must be prepared to ensure the safe production of work.

Preparatory activities must be completed before the start of the work. Compliance with the labor protection and safety requirements of industrial areas, buildings and structures, work areas and workplaces of newly built or reconstructed industrial facilities is determined when they are accepted for operation.

The completion of the preparatory work at the construction site must be accepted according to the act on the implementation of labor safety measures.

Production equipment, fixtures and tools used to organize the workplace must meet the labor safety requirements.

Production areas, work areas and workplaces must be provided with the necessary means of collective or individual protection of workers, primary fire extinguishing equipment, as well as communication, signaling and other technical means of ensuring safe working conditions in accordance with the requirements of the current regulatory legal acts.

Places of temporary or permanent residence of workers (sanitary facilities, resting places and passages for people), when arranging and maintaining production areas, work sites, should be located outside hazardous areas.

Hazardous areas must be marked with safety signs and inscriptions of the prescribed form.

Moving loads over ceilings, when production, residential or office premises, where people may be, fall into hazardous areas, is not allowed.

The admission to the production area of unauthorized persons, as well as drunken workers or not employed in work in this area, is prohibited.

While on the territory of a construction or production site, in production and utility rooms, at work sites and workplaces, employees, as well as representatives of other organizations, are obliged to comply with the internal labor regulations related to labor protection adopted in this organization.

Geographically separate premises, sites, work areas, workplaces must be provided with telephone or radio communications.

Workers, managers, specialists and employees must be provided with overalls, footwear and other personal protective equipment, in accordance with the Rules for providing employees with special clothing, special footwear and other personal and collective protective equipment, sanitary facilities and devices at the expense of the employer.

Calculation of required solar panels for the building

As this building should be the most energy-efficient building we need to use solar power for producing electricity.

we use 250 watt solar panel by the sizes of 1×1.6 meter (1.6 m^2) that can provide 25 percent of the building electricity. Ther number of required solar panels is determined by the formula:

$$N = \frac{P_b \cdot t}{P_p} \tag{44}$$

where P_b- building's comsumption energy that is 25 percent of the building all power consumption (24 kWatt);

t- duration of sunlight per day (4 hours);

P_p- panel power (250 Watt).

$$N = \frac{24000 \cdot 4}{250} = 384$$

required area for this number of panels is 614.4 m^2 that will put on the roof.

4 Economic Part

4.1 Calculation of the estimated cost of construction

The estimated cost of construction is the necessary material resources, which is determined on the basis of design materials and standards in accordance with the legislation of the Republic of Kazakhstan.

The basis for construction is the estimated cost necessary to determine the indicator of investment funds for construction, to form a price for construction, serves as a guideline for customers when purchasing and concluding a contract, settlements for work performed by a contract in accordance with the current legislation of the Republic of Kazakhstan.

The cost of products at the design stage is determined according to the enlarged resource estimate norms.

This section shows the cost, that is, the required capital for the construction.

The composition of the above consists of: construction cost, including design and survey work, the price of equipment, the price of installation of equipment, etc.

Capital investment is determined by drawing up a consolidated estimate.

In the estimated summary calculation of construction, the funds are distributed according to the following divisions:

- Costs of preparatory work on the territory;
- The main elements of the object;
- Elements of service and auxiliary character.
- Elements of the energy economy.
- Objects of transport facilities and communications.
- External networks and structures of water supply, sewerage, heat supply and gas supply.
- Landscaping and gardening of the territory.
- Temporary buildings and structures.
- Costs are secondary.
- Directorates of the enterprise.
- Training of personnel.
- Exploration and design work.

The cost of construction of buildings and structures for main and additional purposes is calculated on the basis of SN RK 8.02-01-2002. The stage of calculating the cost of construction.

We find the construction cost of the estimated structures and buildings of the main and secondary nature using general estimated norms in 2019 prices.

For housing and civil construction, Chapter 3 includes the estimated cost of such objects as: utility buildings; checkpoints, greenhouses in hospital and scientific towns; waste bins, etc .; buildings and structures for cultural and domestic purposes, designed to serve workers and located within the territory allotted for the construction of enterprises; nature conservation work, work on the protection of cultural monuments, etc.

4.2 Calculation of investment costs for construction

Investment costs for construction include all costs of the customer for the project and are compiled in the form of a consolidated estimate of the cost of construction.

The consolidated estimate of the construction cost additionally includes the following cost items:

- the cost of the services of an engineer;
- training of operational personnel;
- the cost of design and survey work;
- the cost of examination of design and estimate documentation;
- costs for the implementation of architectural supervision. The cost of design and survey work is determined in accordance with the general provisions for determining the cost of design work for construction in the Republic of Kazakhstan (RDS RK 08.02-03-2002, taking into account changes from 02.7.2004)

4.3 Technical and economic indicators of the project

For the implementation of the investment project, it is planned to use borrowed funds. But at the same time, according to the legislation of the Republic of Kazakhstan, 1 percent of the total investment should be financed from its own funds.

The cost for one building will be about 210.8 million tenge.

The full estimated cost of the building (local, consolidated, facility) of the facility is attached in Appendix C.

CONCLUSION

Based on the tasks set, a graduation project was launched on the topic "Social Residential House" in Almaty.

The building is located in Akkent microdistrict srounded by tall and small buildings. After analyzing the projected building, I made several conclusions. Firstly, the main purpose of a modern social dwelling house is to provide senior citizens with living quarters for living and providing them with social, household, medical, and other types of services, and the construction of a modern social dwelling house would make life easier for many citizens of the country when living in the city of Almaty.

The advantage of a residential building is that the projected building is located in the city center and has additional service conditions. Secondly, the building is located in clay soil, which is not hazardous for construction in seismic areas. Thirdly, the construction of the sanatorium will take less than a year, which will entail additional investments for a ready-made business platform.

This project is designed for permanent residence of senior citizens in the city of Almaty. Since the possibility of developing construction in this area has great potential due to its convenient location and large investments in construction at the present time . The building has 13 stories including a basement with the height of 4 m, one meter of the basement is above the ground. In each floor there are 8 apartment for both large and small families. The height of typical floor is 3 m. It has two intrances provided with two elevators by differerent dimentions and staircases. There are 7 similar buildings in the whole project. A beautiful landscape is designed for this complex and each building has separate sufcient parking for vhicles.

This building is provided with energy-efficient materials in walls, windows, floors and roof. Solar panel power system is designed to provide 25 percent of the total electric power of the building. This building will give different view to to Almaty city, and will accommodate many families inside it.

In brief, in the near future the need for energy-efficient buildings will be increased rapidly and it is beneficial for the world future to use eco-friendly materials in construction industry.

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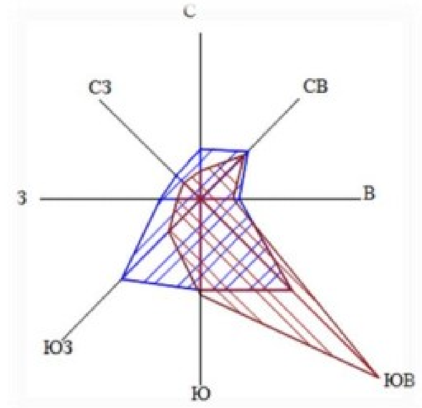
General plan

Wind rose



Explanation of building

Position	Name of area
1	Main building
2	Parking
3	Guard
4	Play zone
4	Park

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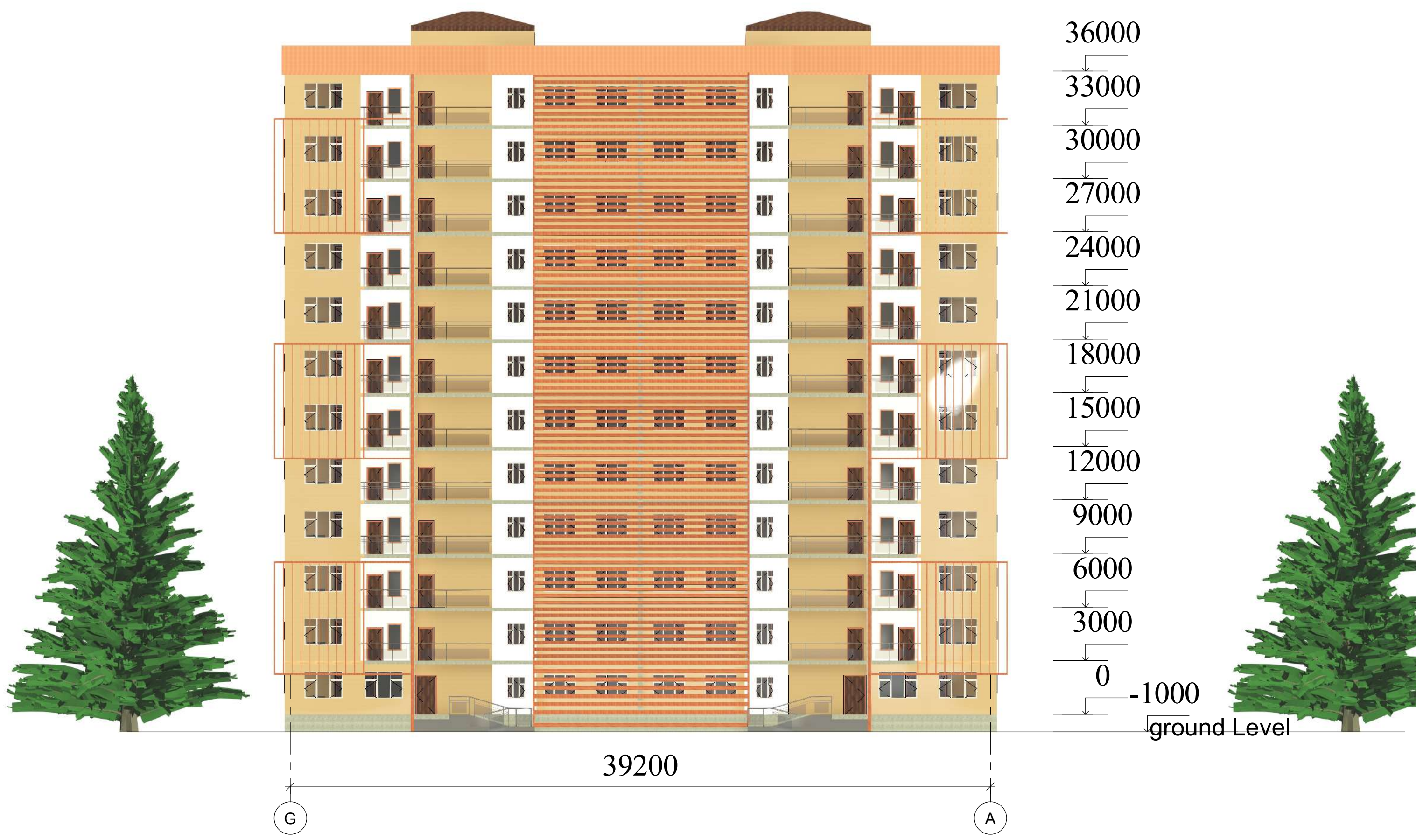
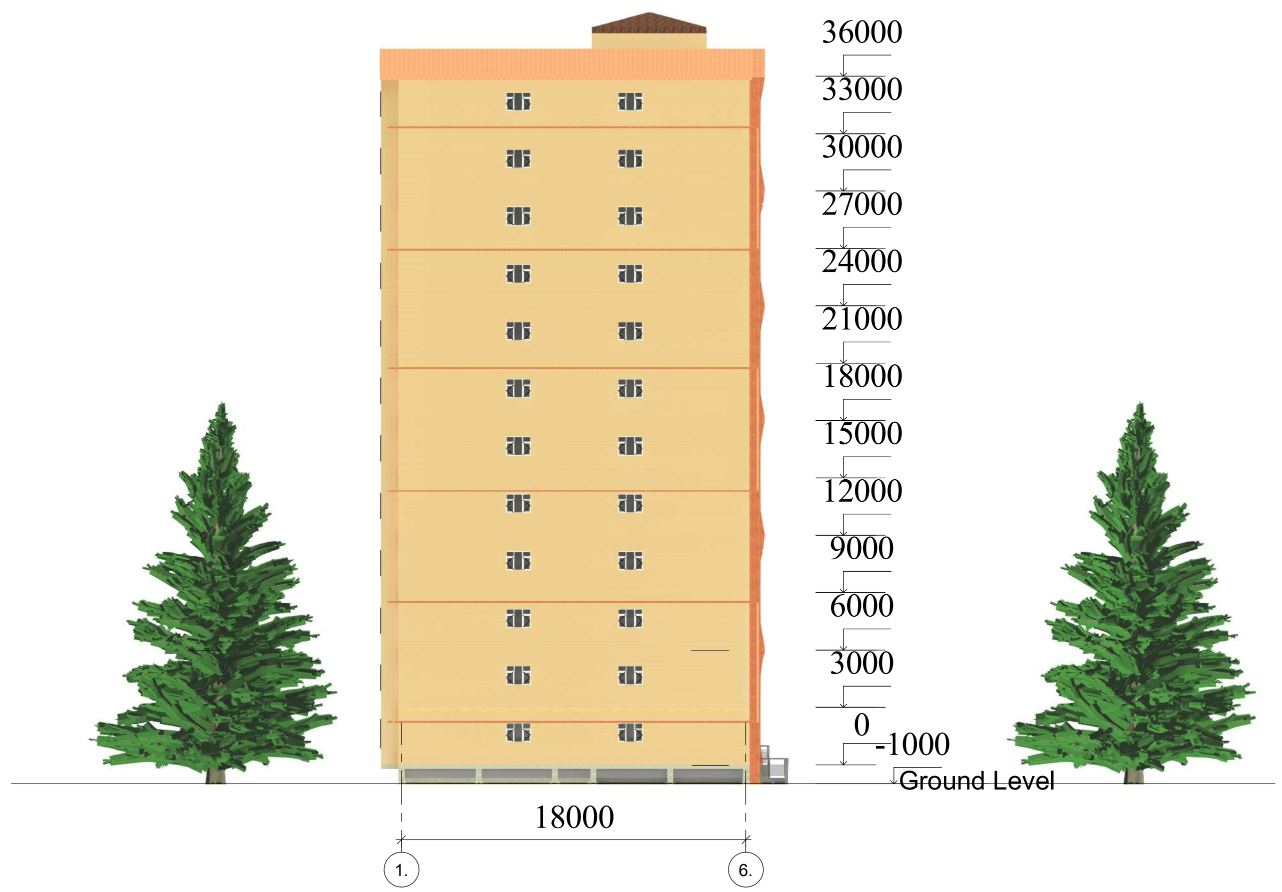
						Energy-effecient social residential Building in Almaty			
Ch	Sheet	List	Doc.No	Sign	Date				
Head of Dep		Kozukova N.V.				Architectural and analytical part	Stage	List	Lists
Supervisor		Mukhanbetzhanova Zh.Sh.					DP	1	9
Consultant		Kozukova N.V.							
N. controller		Bek A.A.				General Plan	Civil Engineering and Building Materials Department		
Created by		Paiman O.							

Front view



Side View



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Consultant		Mukhanbetzhanova Zh.Sh.			
N. controller		Bek A.A.			
Created by		Paiman O.			

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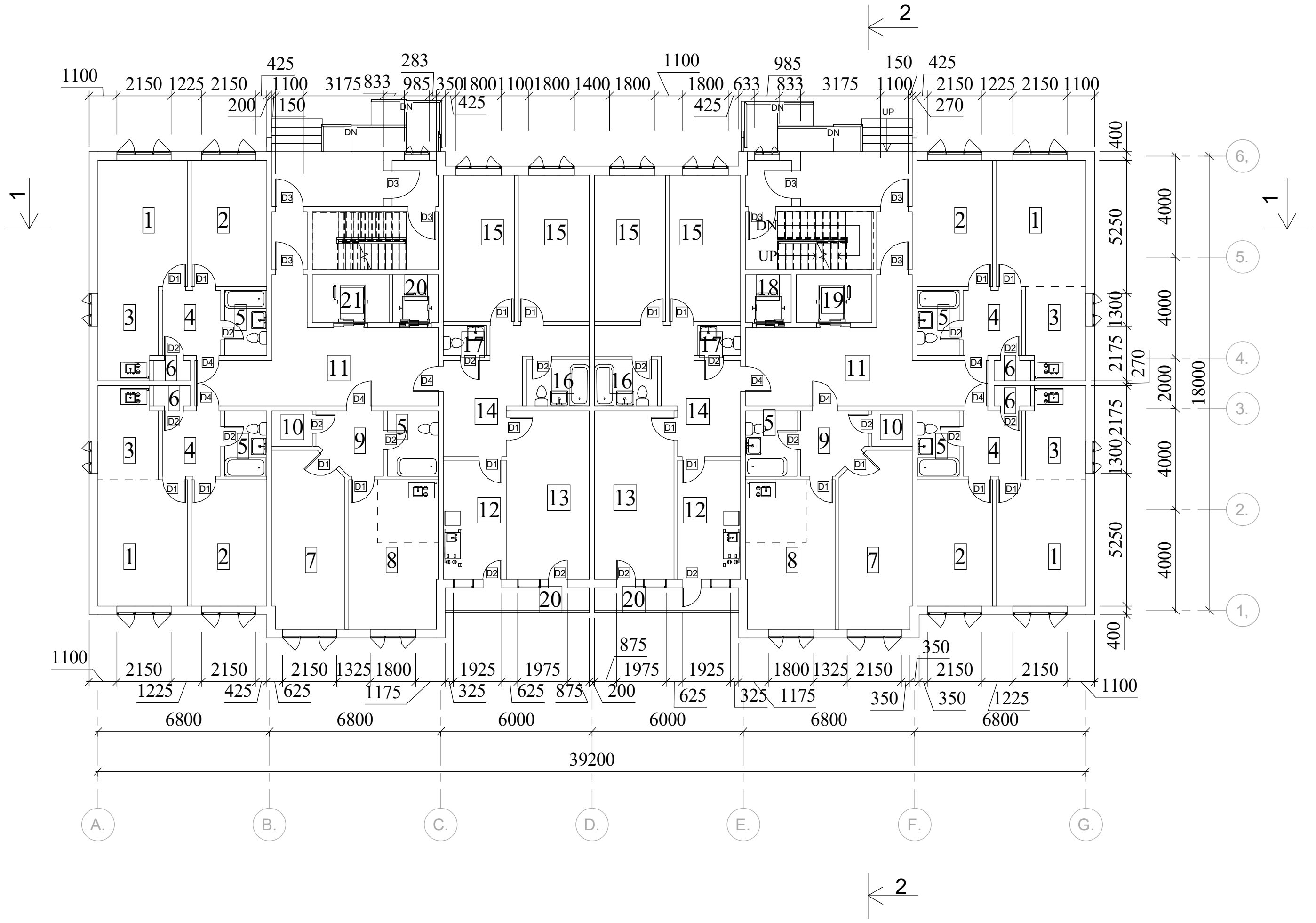
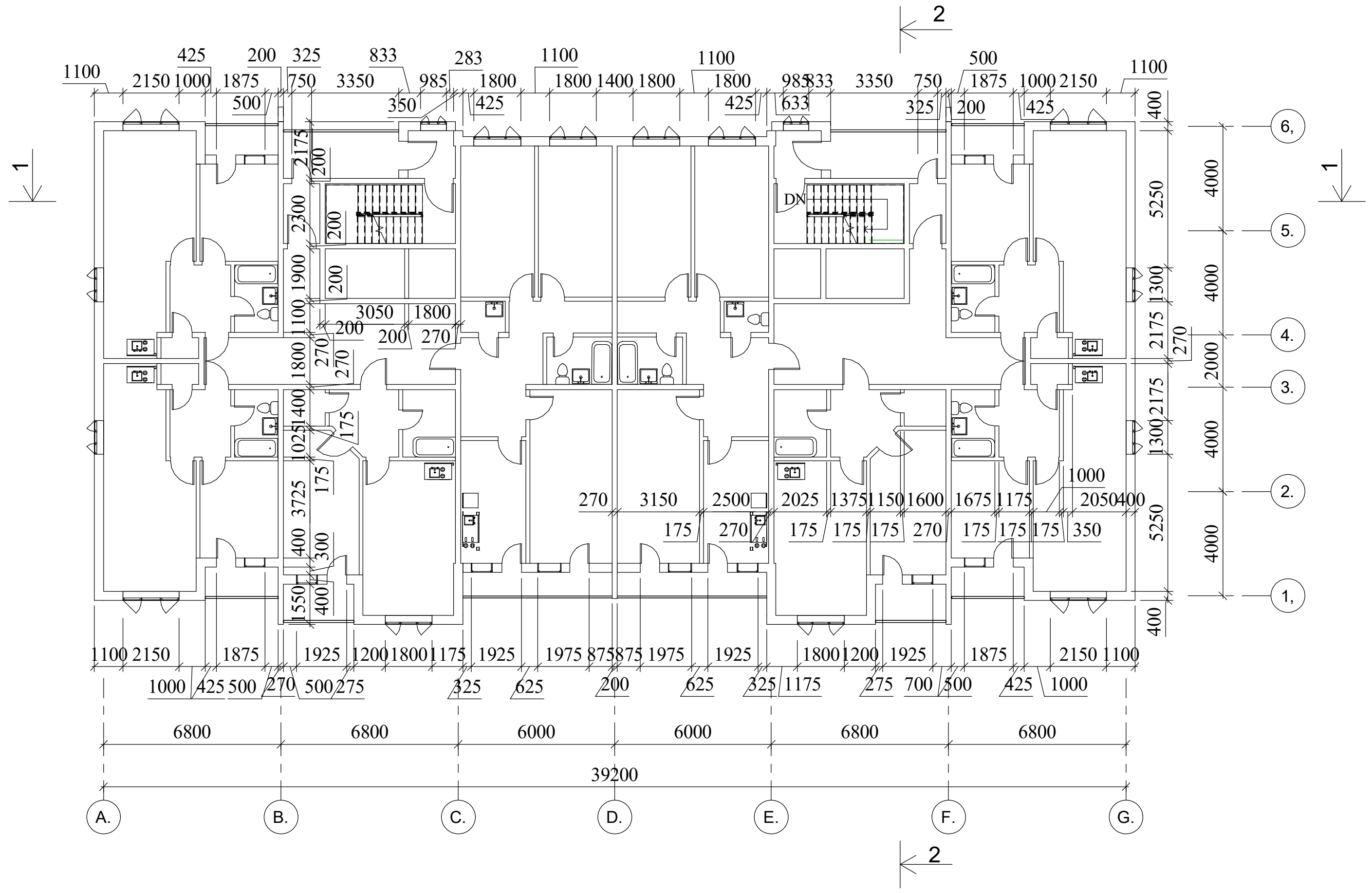
Architectural and analytical part	Stage	List	Lists
	DP	2	9
Elevations	Civil Engineering and Building Materials Department		

First Floor Plan



Typical Floor Plan



Explanation on rooms

No	Rooms	Area, m^2
1	Living room	17.75
2	Bedroom	15.002
3	Kitchen	8.46
4	Corridor	5.99
5	Bathroom	4.31
6	Utility room	1.16
7	Guest room	20
8	Dining room	14.9
9	Corridor	6.05
10	Utility room	2.24
11	Corridor	32.1
12	Kitchen	11.75
13	Guest room	20.95
14	Corridor	10.67
15	Bedroom	16.39
16	Bathroom	4.56
17	Bathroom	2.05
18	Elevator	3.42
19	Elevator	5.7
20	Balcony	5.72

Explanation on doors

No	Doors	Size, bxh, m
1	D1	0.9x2.130
2	D2	0.76x2.1
3	D3	1.1x2.1
4	D4	1x2.1

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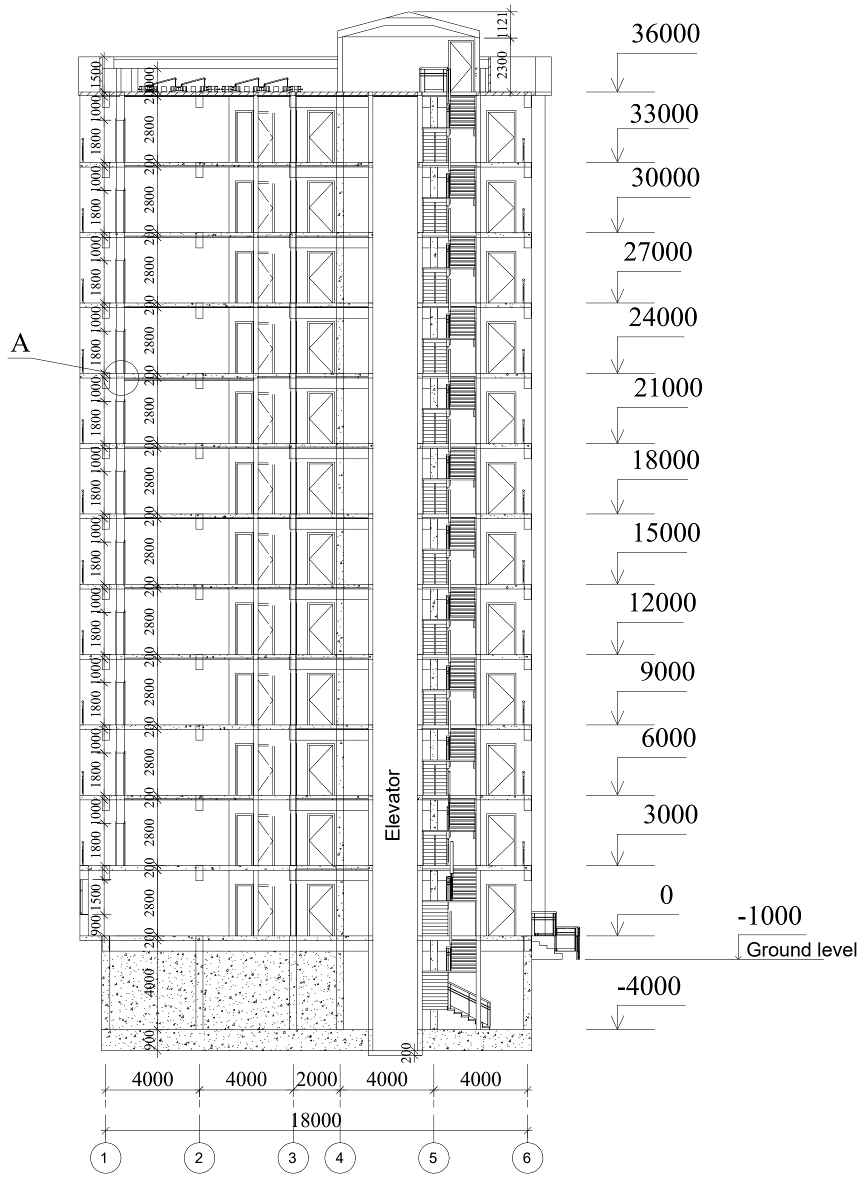
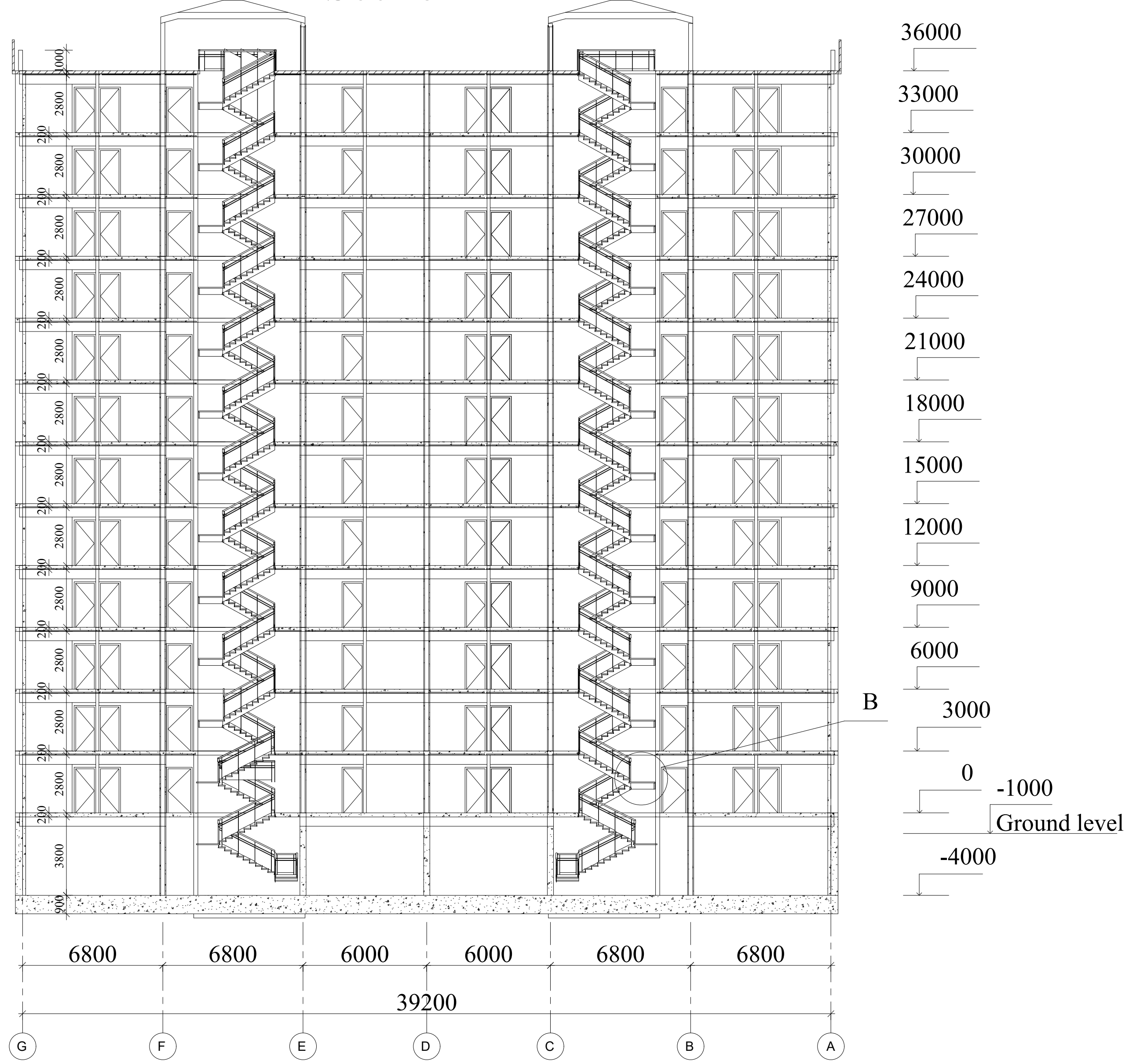
Supervisor	Mukhanbetzhanova Zh.Sh.						DP	3	9
Consultant	Mukhanbetzhanova Z.S.					Floor Plans	Civil Engineering and Building Materials Department		
N. controller	Bek A.A.								
Created by	Paiman O.								

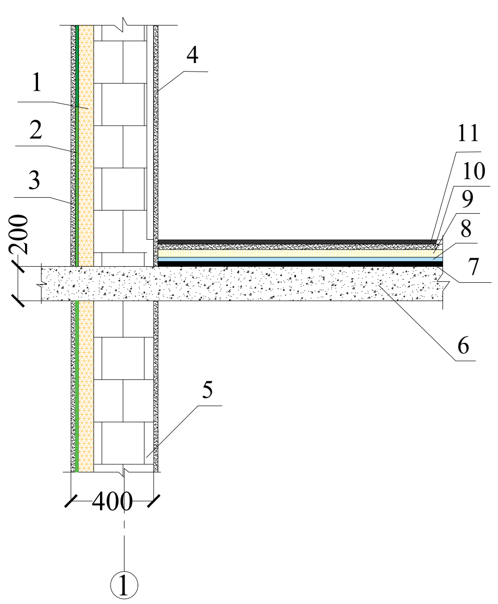
Section 2-2



Section 1-1



A



1- Thermal insulation (foam board), 100mm

2- Vapor barrier (Polyethylene sheets), 1mm

3- Fiber cement siding, 139mm

4- Fiber cement siding,10mm

5- Auto claved aerated concrete AAC blocks, 200mm

6- Reinforced concrete slab

7-Water proofing(Membrane), 20mm

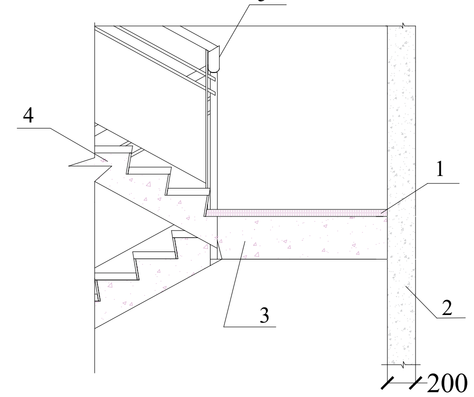
8- Sound proofing, 25mm

9- Thermal insulation (Foamed concrete), 50mm

10- Reinforced cement-sand plaster, 50mm

11- Vinyl flooring, 10mm

B



1- Tile with cement mortar

2- Reinforced concrete shear wall

3- Reinforced concrete plate, 150mm

4- Stairs

5- Railing

Ch	Sheet	List	Doc.No	Sign	Date				
						KazNITU-5B072900-Civil Engeneering-02.08.02-2021-DP			
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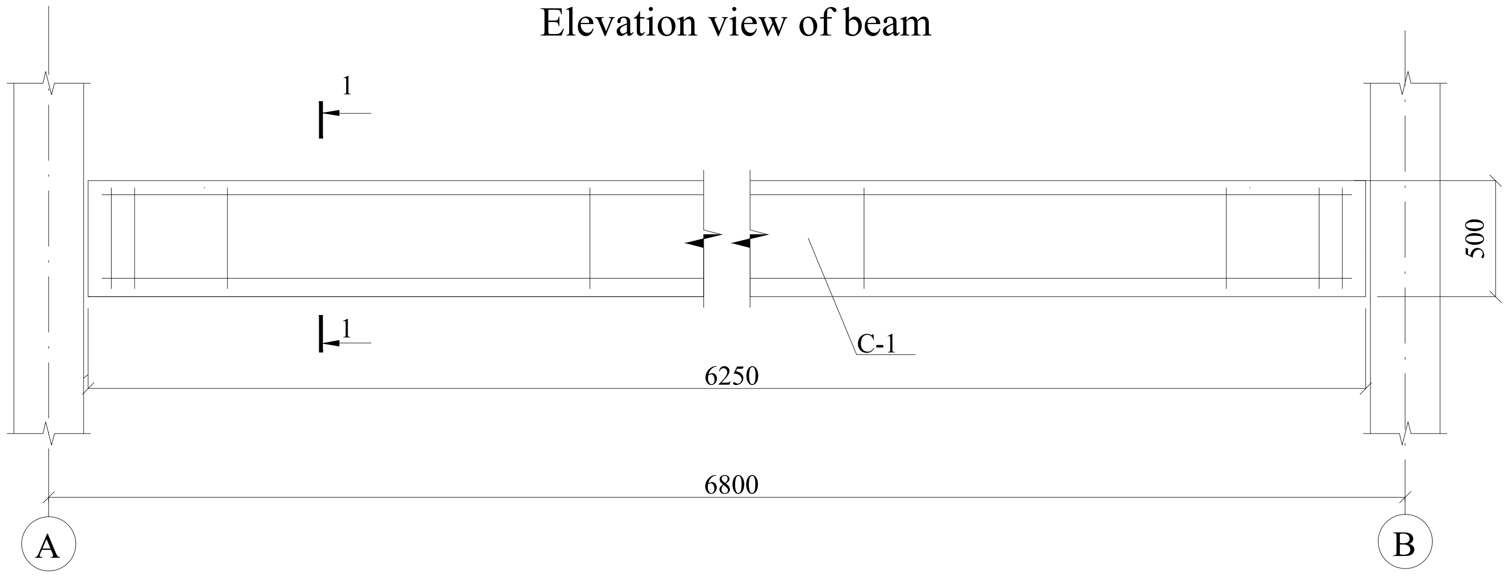
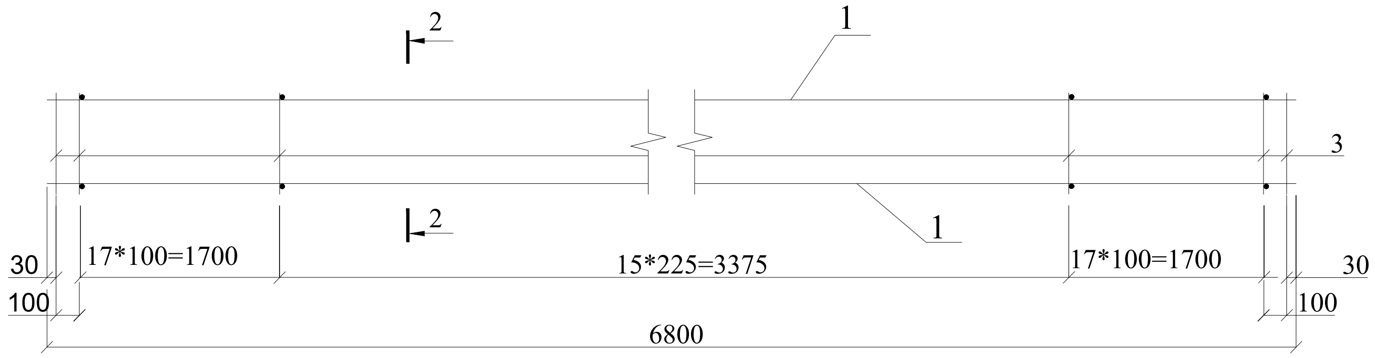
Supervisor	Mukhanbetzhanova Zh.Sh.						DP	4	9
Consultant	Kozukova N.V.					Sections	Civil Engineering and Building Materials Department		
N. controller	Bek A.A.								
Created by	Paiman O.								

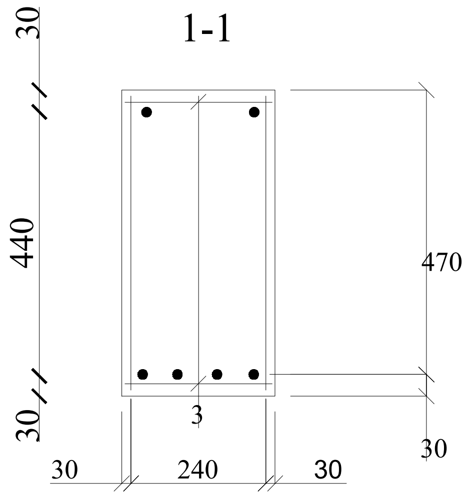
Elevation view of beam



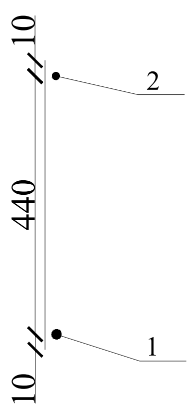
Frame C-1



1-1



2-2



Reinforcement specification

Position	Design C	Diameter, steel grade	Length, mm	Num.	Mass, Kg-1m	Note
1	EU 2-2004	Ø20S500	6800	4	2.47	
2	EU 2-2004	Ø20S500	6800	2	2.47	
3	EU 2-2004	Ø10S275	1620	49	0.617	
		Material				
		C30/37				37

Steel consumption

Frame	Reinforcement products		
	Reinforcement class		
	S500	S275	Total
	EU 2-2004		
	Ø20	Ø10	
C-1	100.776	48.98	149.75

						KazNITU-5B072900-Civil Engeneering-02.08.02-2021-DP
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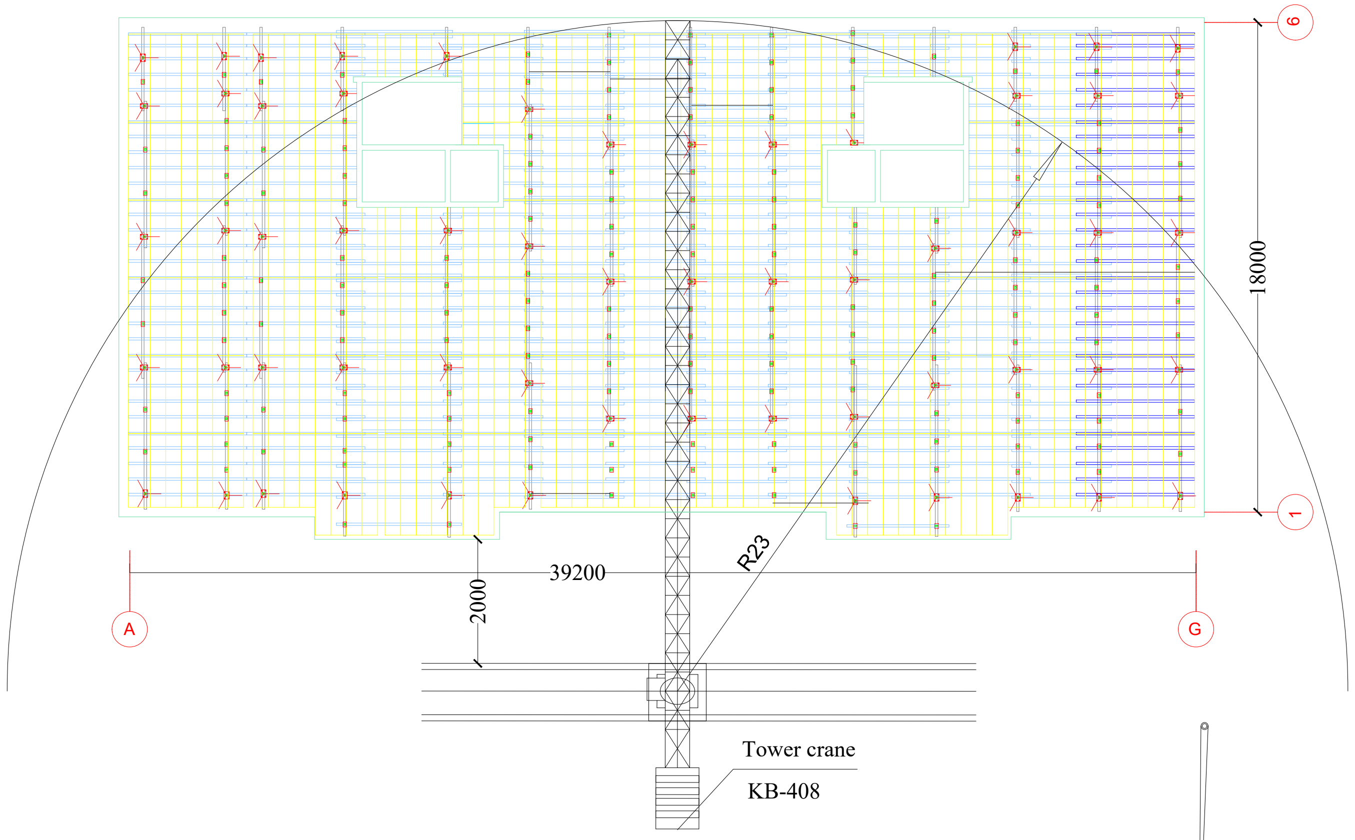
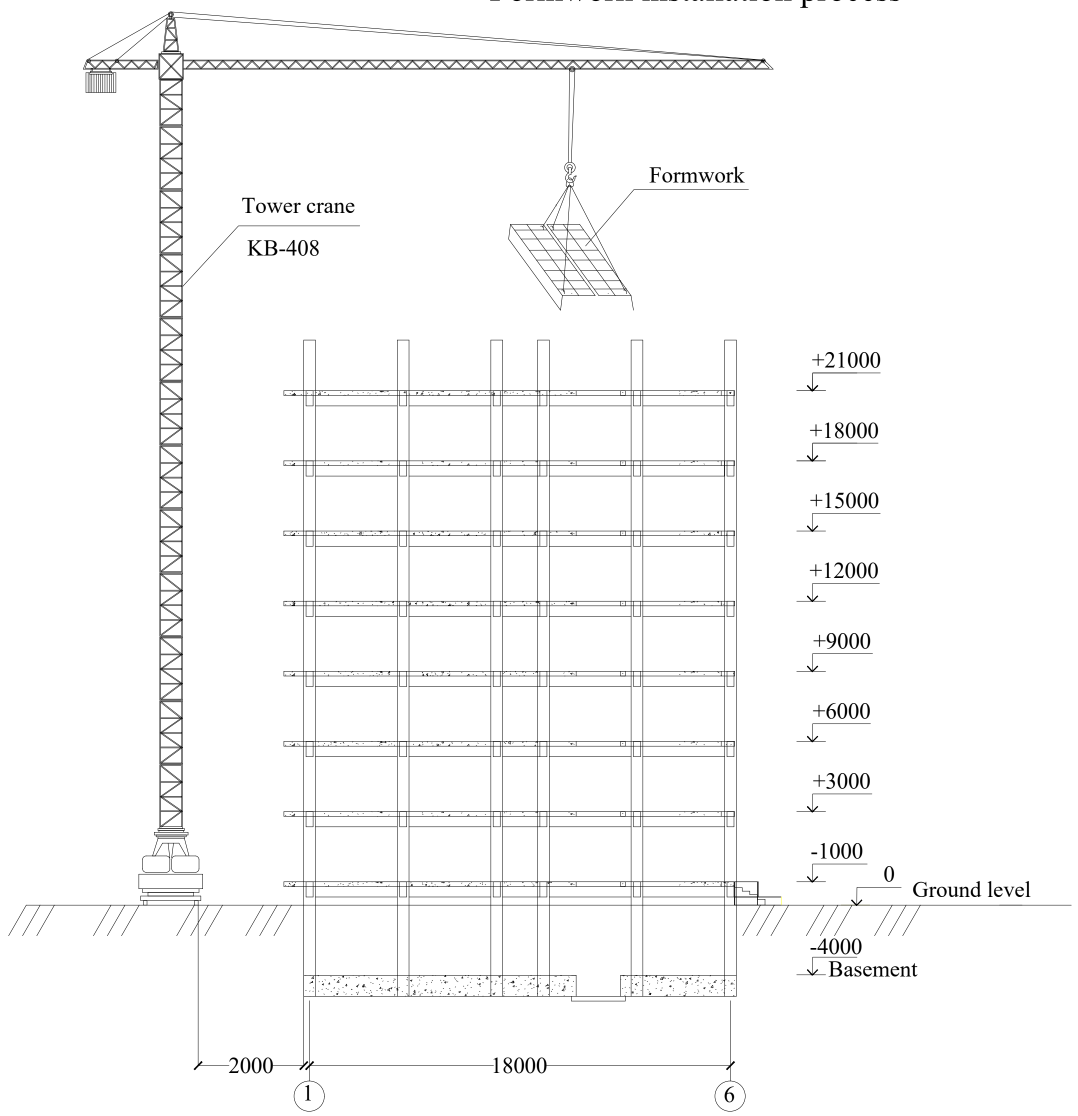
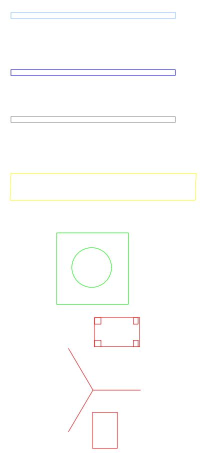
Head of Dep	Kozukova N.V.					Design and calculation part — Stage: DP; List: 5; Lists: 9
Supervisor	Mukhanbetzhanova Zh.Sh.					
Consultant	Kozukova N.V.					
N. controller	Bek A.A.					Calculation of beam — Civil Engineering and Building Materials Department
Created by	Paiman O.					

Formwork scheme for typical floor

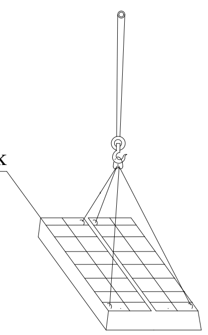


Formwork installation process



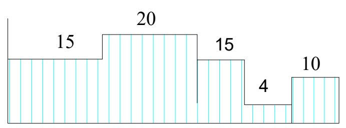


	H18 - 300cm	209
	H18 - 320cm	19
	H18 - 300cm	84
	Plywood 24mm 300x50cm	474
	Telescopic stand	177
	shearlegs	130
	fork	105
	Unvilka	231



Schedule for the performing of formwork per floor

Name of works	Volume of work		Labor intensity man.hour	Number of worker per shift	Duration		Days						
	Unite	Amount			Hour	Sh	1	2	3	4	5	6	7
Formwork installation	m^2	705.6	517.12	15	14	2	15						
Installation of fittings slabs	t	10	134	12	6	2			20				
Floor concreting	m^3	105.8	50.57	15	4	1					15		
Curing concrete	m^3	105.8	42.67	4	21	1						4	
Dismantling	m^2	705.6	214.83	10	7	2							10



SAFETY REQUIREMENTS

1. In construction and mounting work it is necessary to deal with the requirements of "Safety in construction", "Fire safety rules "," Rules for the construction and safe operation of cranes. "
The safety of work must be ensured: by choosing the appropriate rational technological equipment;The safety of work must be ensured: by choosing the appropriate rational technological equipment; preparation and organization of workplaces for the production of work; the use of protective equipment for workers; holding medical examination of persons admitted to work; timely training and verification of the knowledge of working personnel and engineers on safety precautions during construction and installation works.
2. When working at a height of more than 1.5 m, all workers must use safety harnesses with carabineers.
3. Dismantling of the formwork is allowed after the concrete has gained stripping strength and with the permission of the work manufacturer.
4. Dismentaling of the formwork from the concrete should be carried out using jacks. The concrete surface in the process of tearing off must not get damaged. The use of cranes to lift the shuttering boards is prohibited.

LIST OF REQUIRED MACHINES AND EQUIPMENT

Machines name	Brand	Amount	Note
Tower crane	KB-408	1	Formwork and reinforcement work
Concrete mixer truck	KaMAZ-53212	1	Concrete supply
Concrete pump	ABN 75/32	1	Concrete supply and placement
Pneumatic rammer	I-157	1	Concrete compaction
Vibrator	IV-66	2	Concrete compaction
Formwork		-	Forming structures

Ch	Sheet	List	Doc.No	Sign	Date
Head of Dep	Kozukova N.V.				
Supervisor	Mukhanbetzhanova Zh.Sh.				
Consultant	Kozukova N.V.				
N. controller	Bek A.A.				
Created by	Paiman O.				

KazNITU-5B072900-Civil Engeneering-02.08.02-2021-DP

Energy-Effecient Social Residential Building in Almaty

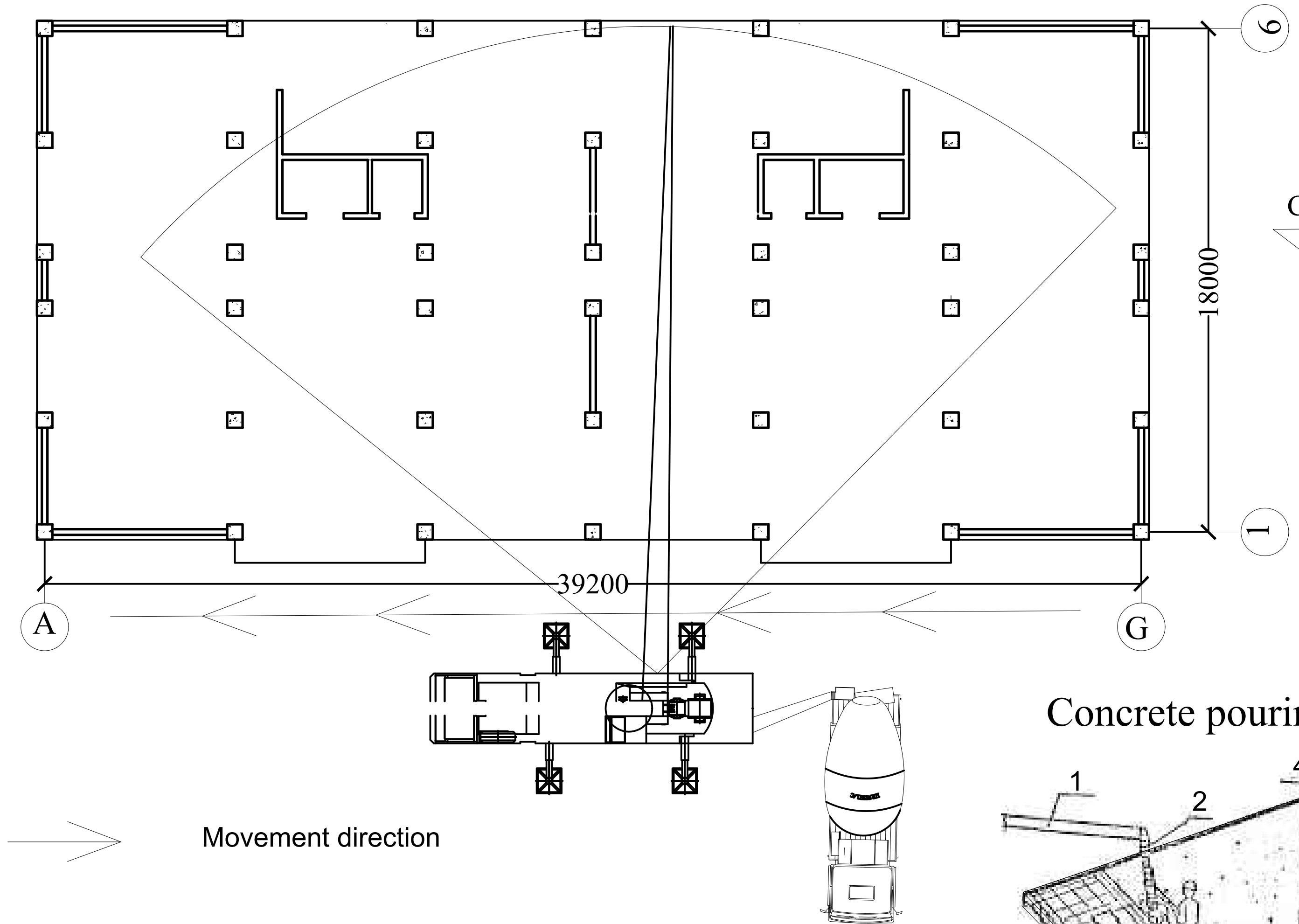
Organisational and technological part

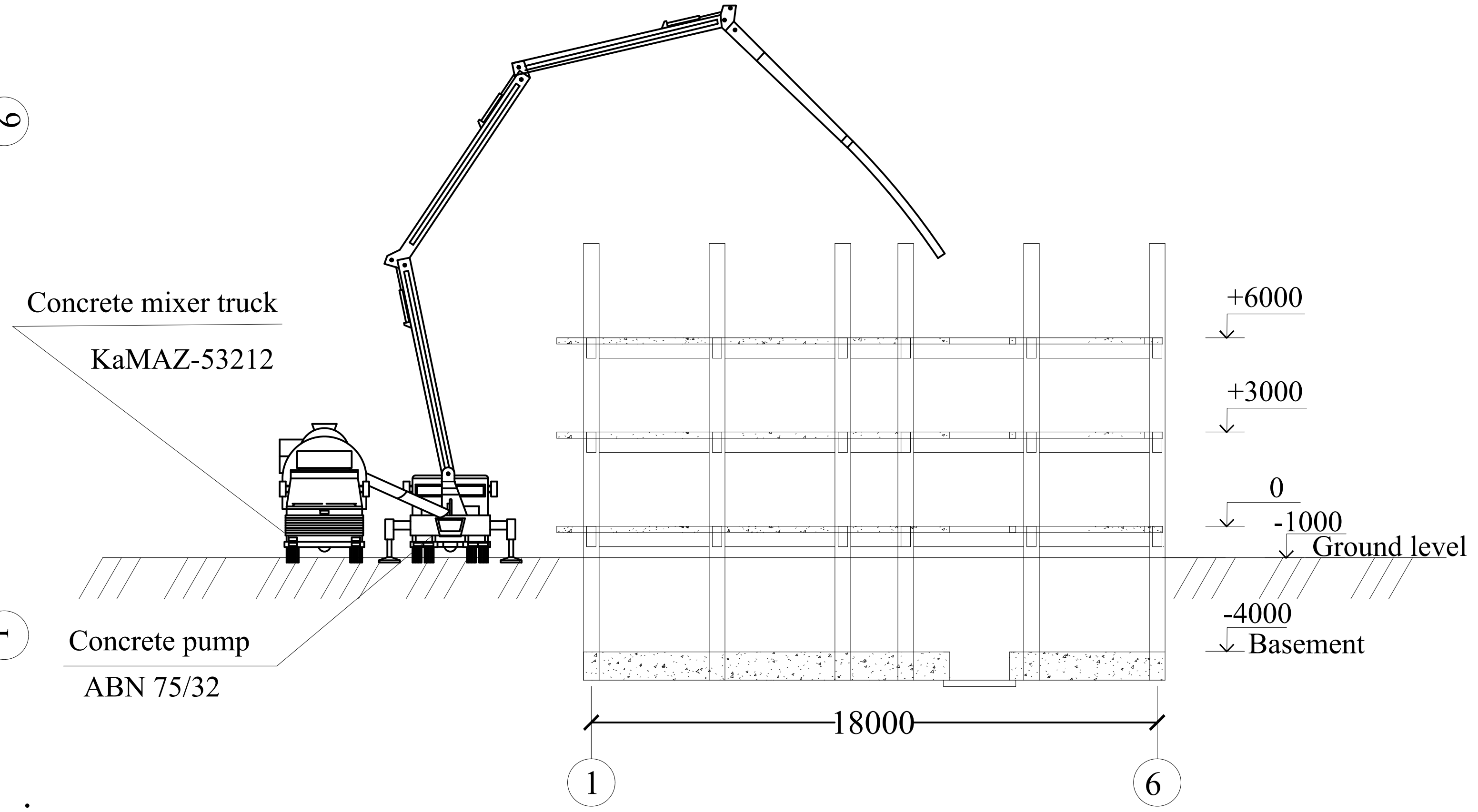
Stage	List	Lists
DP	6	9

Technical map for formwork

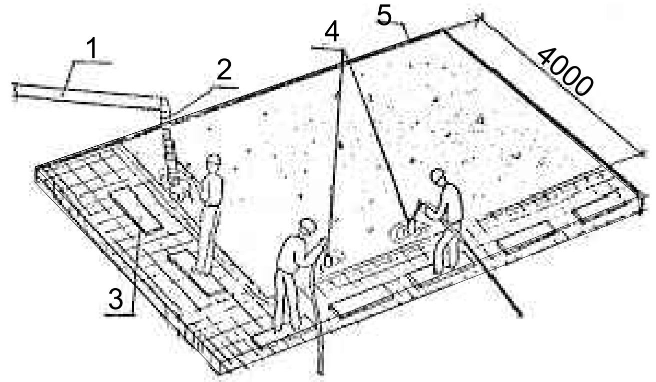
Civil Engineering and Building Materials Department

Scheme of concreting for typical floor





Concrete pouring process



1. Concrete pump
2. pouring concrete
3. Temporary board for standing
4. Vibrating
5. Formwork

General information on concreting

Concrete mix must be transported by specialized methodes. The accepted method for transporting the concrete mixture must:

-Exclude the ingress of atmospheric precipitation and direct exposure to sunlight;

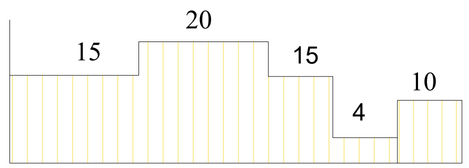
-Exclude stratification and violation of homogeneity;

-Prevent the loss of laitance or mortar.

The maximum duration of transportation of the concrete mix should be established by the construction laboratory with the condition of ensuring the preservation of the required quality of the mix on the way and at the place of its laying. Before placing the concrete mixture, the floor (artificial), the correct installation of the formwork, reinforcement structures and embedded parts must be checked. The inner surface of the inventory formwork must be cleaned and coated with a special grease that does not impair the appearance and strength of the structures. Breaks in concreting, which require the device of working seams, is determined by the laboratory depending on the type and characteristics of the cement and the temperature of concrete hardening. Placement of the concrete mixture after The distribution of the concrete mixture in the structure to be concreted is carried out in horizontal layers of the same thickness, laid in one direction. The overlapping of the previous layer is subsequently performed before the cement sets, and the overlapping time is set by the laboratory depending on the outside air temperature, the properties of the cement used. Approximately this time is no more than 2 hours. The duration of such breaks is carried out only after the surface of the working joint is treated with cement mortar with a thickness of 20-50 mm or with a layer of plastic concrete mixture. The concrete mix is compacted with a deep vibrator with a flexible shaft. When compacting the concrete mixture, it is not allowed to rest the vibrators on reinforcement, embedded products, formwork fastening elements. The step of moving the vibrator should not exceed 1.5 of its radius of action. The optimal duration of vibration in one place is 20-30 s.

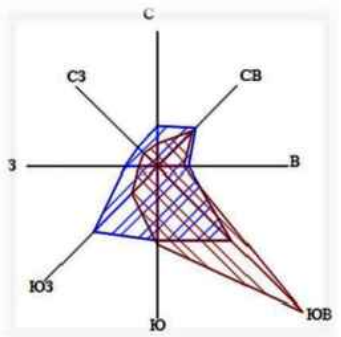
Schedule for the production of concrete work per floor

No	Name of works	Volume of work		Labor intensity man.hour	Number of worker per shift	Duration		Days						
		Unite	Amount			Hour	Sh	1	2	3	4	5	6	7
1	Formwork installation	m^2	705.6	517.12	15	14	2	15						
2	Installation of fittings slabs	t	10	134	12	6	2			20				
3	Floor concreting	m^3	105.8	50.57	15	4	1					15		
4	Curing concrete	m^3	105.8	42,67	4	21	1						4	
5	Dismantling	m^2	705.6	214.83	10	7	2							10

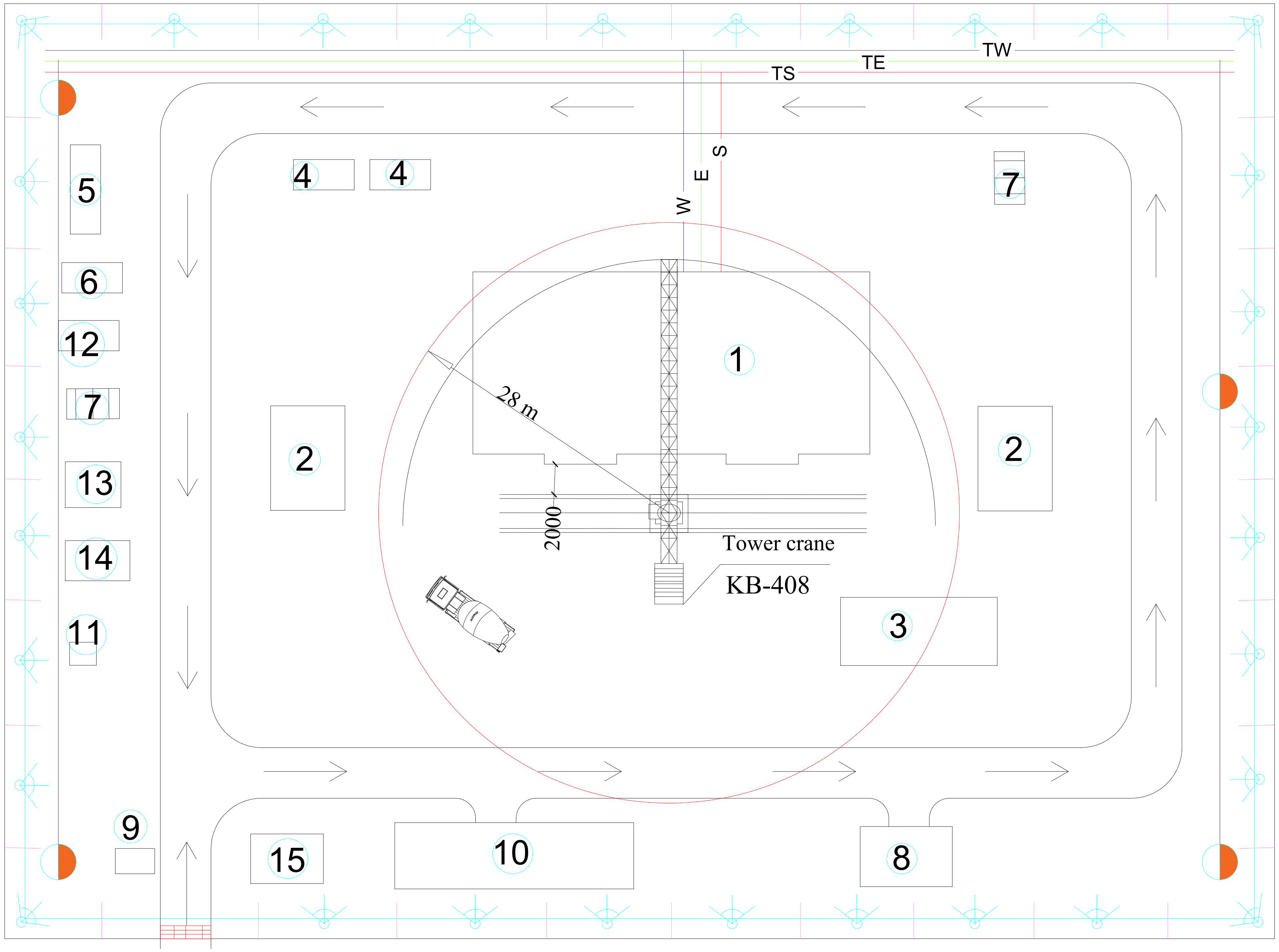


Ch	Sheet	List	Doc.No	Sign	Date	KazNITU-5B072900-Civil Engeneering-02.08.02-2021-DP		
						Energy-Effecient Social Residential Building in Almaty		
Head of Dep	Kozukova N.V.					Organisational and technological part	Stage	List	Lists
Supervisor	Mukhanbetzhanova Zh.Sh.						DP	7	9
Consultant	Mukhanbetzhanova Zh.Sh.								
N. controller	Bek A.A.					Concreting	Civil Engineering and Building Materials Department		
Created by	Paiman O.								

Wind rose



General master plan



Explanation of the site

Pos.	Name of building	Size	Quantity
	Permanent		
1	Building under construction	39.2x18	1
	Temporary		
2	Closed warehouse	8x6	2
3	Open warehouse	12x6	1
4	Office and control room	3x4	2
5	Dining room	8x3	1
6	Room for foreman	5x3	1
7	Toilet	3x1	2
8	Trash can	5x3	1
9	Check point	3x3	1
10	Parking	15x6	1
11	Transformer substation	4x3	1
12	Restroom	5x3	1
13	Workshop	3x5	1
14	Shower	8x3	1
15	Car wash	2x3	1

External lighting of the site

Fire hydrant

Gate

TS Temporary sewage

TE Temporary power line

TW Temporary Water supply

S Permanent sewage

E Permanent power line

W Permanent water supply

Direction of movement

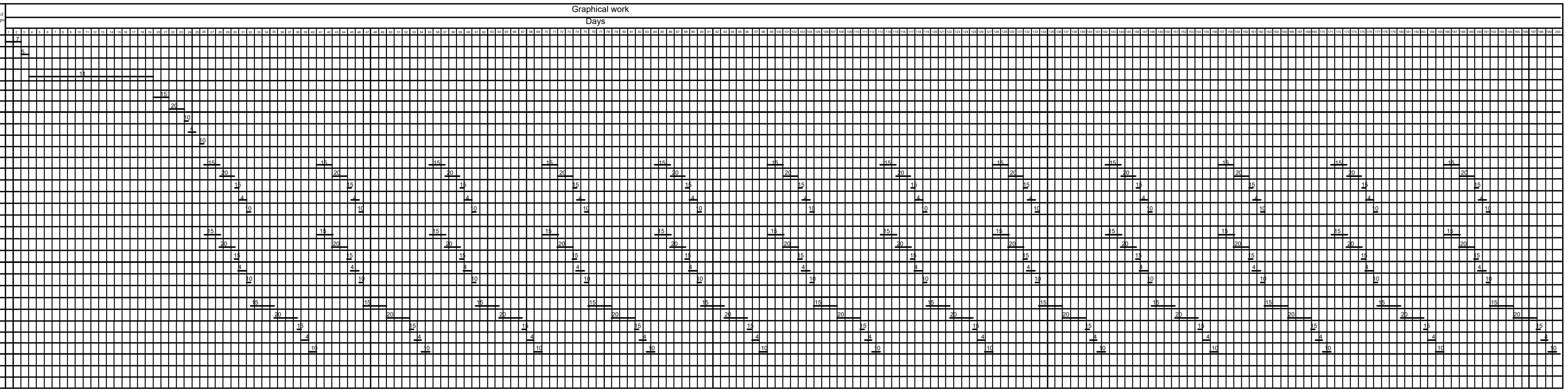
Direction of movement

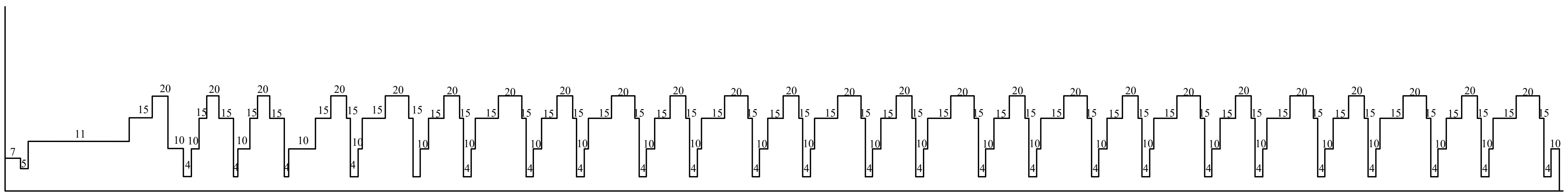
Red zone of crane

						KazNITU-5B072900-Civil Engeneering-02.08.02-2021-DP			
Ch	Sheet	List	Doc.No	Sign	Date	Energy-Effecient Social Residential Building in Almaty			
Head of Dep		Kozukova N.V.				Organizational and Technological Part	Stage	List	Lists
Supervisor		Mukhanbetzhanova Zh.Sh.					DP	8	9
Consultant		Kozukova N.V.				General master plan	Civil Engineering and Building Materials Department		
N. controller		Bek A.A.							
Created by		Paiman O.							

Calendar schedule

№ п/п	Name of works	Scope of work		labor costs man/day	Required machines		Prod.works per day	Number of shift	number of workers per shift
		unite	Amount		Name	Number of machine per shift			
1	temporary fence	1 m	194.4	16.5			4	2	2
2	cutting off the vegetation layer	1000 m^2	3.04812		Bulldozer DZ-110	3	1.5	2	1
3	excavation	100 m^3	30.80						
4	excavation of soil into vehicles	100 m^3	27.67		EO-5122	150	15	3	4
6	device of monolithic structures. (foundation)								
7	formwork device	1 m^2	102.96	95.4			8	3	4
8	reinforcement work	t	95.7	39.1			2	3	4
9	concrete placement	1 m^3	609.64	21.7	ABN 75/32		1	3	4
10	concrete care	100 m^2	7.056	0.972			0,5	1	2
11	dismantling	1m^2	102.96	23,8			4	3	2
12	device of monolithic structures. (column)								
13	formwork device	1 m^2	277.2	106.1			8	3	4
14	reinforcement work	t	5.98	46.8			6	3	2
15	concrete placement	1 m^3	37.35	143.8			12	3	4
16	concrete care	100 m^2	2.77	0.04			0,5	1	2
17	dismantling	1m^2	277.2	39.8			6,5	3	2
18	device of monolithic structures. (wall)								
19	formwork device	1 m^2	523.2	289.9			12	3	8
20	reinforcement work	t	11.19	99.1			4	3	8
21	concrete placement	1 m^3	46.57	239.1			10	3	8
22	concrete care	100 m^2	4.87	0.46			0,5	1	2
23	dismantling	1m^2	523.2	173.9			7	3	8
24	device of monolithic structures. (floor and beam)								
25	formwork device	1 m^2	1003.8	433.6			18	3	4
26	reinforcement work	t	4.25	99.1			4	3	4
27	concrete placement	1 m^3	154.74	83.9			3	3	4
28	concrete care	100 m^2	705.6	8.3			2	2	2
29	Dismantling	1m^2	1003.8	177.4			12	2	2
30	foundation waterproofing	100 m^2	7.06	6,05			1,5	2	2
31	backfilling	100 m^3	3.13		Bulldozer DZ-110	4.4	2	2	1
32	soil compaction	100 m^2	15.63		Hamm HD 90	0.6	0,5	1	1





Statement of the needs of machines and mechanisms

Name	Mark	Note
1. Bulldozer	DZ-110	Cutting vegetable backfill
2. Excavator with back shovel	EO-5122	Soil development in dump and transport funds
3. Self-propelled roller	DU-128	Soil compaction
4. Dump truck	MAZ-5516	Removal of soil
5. Concrete pump	ABN 75/32	Concrete supply
6. Tower crane	KB-408	Delivery of goods

$$K_{нер} = \frac{n_{max}}{n_{cp}} = \frac{20}{25.5} = 0.78 \leqslant 1.5$$

$$n_{cp} = \frac{Q}{П} = \frac{5100.5}{200} = 25.5$$

Technical and economic indicators

№	Name	Unite	Number
1	Labor costs	man-day	5100.5
2	Duration	day	200

						KazNITU-5B072900-Civil Engeneering-02.08.02-2021-DP
						Energy-Effecient Social Residential Building in Almaty
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Head of Dep	Kozukova N.V.					Organizational and technological Part — Stage: DP; List: 9; Lists: 9
Supervisor	Mukhanbetzhanova Zh.Sh.					
Consultant	Kozukova N.V.					
N. controller	Bek A.A.					Calendar Schedule — Civil Engineering and Building Materials Department
Created by	Paiman O.					

Appendixes

Appendix A

Table A.1- Loads on floors and walls

Applied loads	Characteristics of loads, kg/m^2
1 Unit weight:	Auto
1.1 Floor construction: For foundation:	
Concrete preparation δ=100 mm, ρ=1700 kg/m^3	$0.1 \cdot 1700 = 170$
Membrane waterproofing layer, δ=30 mm,ρ=1400 kg/m^3	$0.03 \cdot 1400 = 42$
Extruded polystyrene foam δ=40 mm,ρ=40 kg/m^3	$0.04 \cdot 40 = 1.6$
cement-sand plaster δ=50 mm, ρ=1600 kg/m^3	$0.5 \cdot 1600 = 800$
Total	1084.4 kg/m^2 =1.195 t/m^2
for typical floors:	
Vinyl flooring δ=10 mm, ρ=976 kg/m^3	$0.01 \cdot 976 = 9.76$
Reinforced cement-sand plaster δ=50 mm, ρ=1600 kg/m^3	$0.05 \cdot 1600 = 80$
Waterproofing (Membrane) δ=20 mm, ρ=1400 kg/m^3	$0.02 \cdot 1400 = 28$
Soundproofing δ=25 mm, ρ=45 kg/m^3	$0.025 \cdot 45 = 1.125$
Foamed concrete for thermal insulation δ=50 mm, ρ=1000 kg/m^3	$0.05 \cdot 1000 = 50$
Floor slab δ=200 mm, ρ=2400 kg/m^3	$0.15 \cdot 2400 = 360$
Total	528.885 kg/m^2 = 0.529 t/m^2
for flat roof:	
Floor slabs δ=200 mm, ρ=2400 kg/m^3	$0.15 \cdot 2400 = 360$
Reinforced cement-sand plaster δ=50 mm, ρ=1600 kg/m^3	$0.1 \cdot 1600 = 160$
Vapor barrier (low-Density Polyethylene sheets) δ=0.25 mm, ρ=940 kg/m^3	$0.00025 \cdot 940 = 0.235$
Thermal insulation – PIR(Polyisocyanurate) boards δ=100 mm, ρ=500 kg/m^3	$0.1 \cdot 500 = 50$
Waterproofing (Membrane) δ=20 mm, ρ=1400 kg/m^3	$0.02 \cdot 140 = 28$
Total	598.235 kg/m^2 = 0.598 t/m^2
Loads	Characteristic of loads, kg/m
1.2 Wall construction	
external self-supporting walls (wall height 3 m):	
Autoclaved aerated concrete AAC blocks (Foam concrete block) δ=200 mm, ρ=600 kg/m^3	$0.2 \cdot 3 \cdot 600 = 360$
Thermal insulation (foam board) 2 layers δ = 50 mm, ρ = 40 kg/m^3	$0.05 \cdot 2 \cdot 3 \cdot 40 = 12$
Vapor barrier (low-Density Polyethylene sheets) δ=1 mm, ρ=940 kg/m^3	$0.001 \cdot 3 \cdot 940 = 2.82$

Continuation of Appendix A

Continuation of Table A.1- Loads on floors and walls

Applied loads	Characteristics of loads, kg/m^2
Fiber cement siding δ=149 мм, ρ=1650 kg/m^3	$0.149 \cdot 3 \cdot 1650 = 737.55$
Total	1112.37 kg/m = 1.1124 T/m
Internal self-supporting walls (wall height 3m)	
Autoclaved aerated concrete AAC blocks (Foam concrete block) δ=200 mm, ρ=600 kg/m^3	$0.2 \cdot 3 \cdot 600 = 360$
Thermal insulation (foam board) δ = 54 mm, ρ = 40 kg/m^3	$0.054 \cdot 3 \cdot 40 = 6.48$
Vapor barrier (low-Density Polyethylene sheets) δ=1 mm, ρ=940 kg/m^3	$0.001 \cdot 3 \cdot 940 = 2.82$
gypsum plasterboard δ=15мм, ρ=800 kg/m^3	$0.015 \cdot 3 \cdot 800 = 36$
Total	405.3 kg/m = 0.405 T/m
external self-supporting walls (parapet height 1m):	
Autoclaved aerated concrete AAC blocks (Foam concrete block) δ=200мм,ρ=600 kg/m^3	$0.2 \cdot 1 \cdot 600 = 120$
Thermal insulation (foam board) 2 layers δ = 50 mm, ρ = 40 kg/m^3	$0.05 \cdot 2 \cdot 1 \cdot 40 = 4$
Vapor barrier (low-Density Polyethylene sheets) δ=1 mm, ρ=940 kg/m^3	$0.001 \cdot 1 \cdot 940 = 0.94$
Fiber cement siding δ=149мм, ρ=1650 kg/m^3	$0.149 \cdot 1 \cdot 1650 = 245.85$
Total	370.79 kg/m = 0.3708 T/m
Partitions (height, h = 3m)	
Reinforced brick partition wall δ=100мм, ρ=2000 kg/m^3	$0.1 \cdot 3 \cdot 2000 = 600$
Support rack profiles δ=10 мм,ρ=15 kg/m^3	$0.01 \cdot 3 \cdot 15 = 0.45$
Thermal insulation (foam board) δ=50мм, ρ=40 kg/m^3	$0.05 \cdot 3 \cdot 40 = 6$
gypsum plasterboard δ=15мм, ρ=800 kg/m^3	$0.015 \cdot 3 \cdot 800 = 36$
Итого	642.45 kg/m = 0.642 t/m
2.2 Horizontal pressure from the ground [4]:	2.071 t/m^2

Appendix B

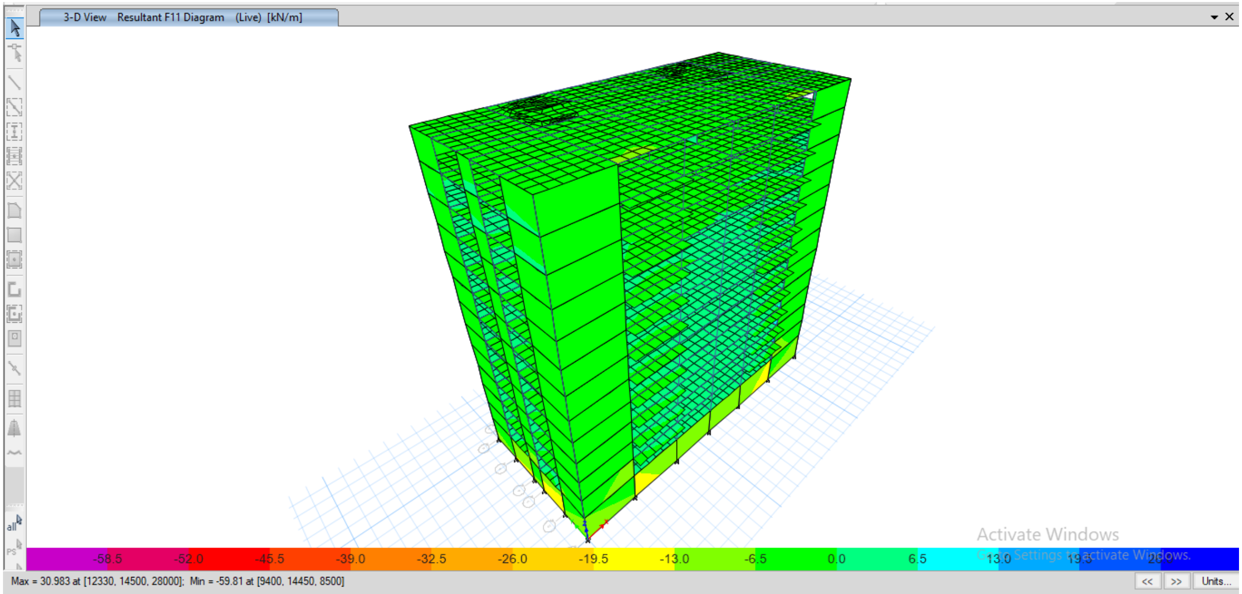


Figure B.1 – stresses on the floors due to dead load

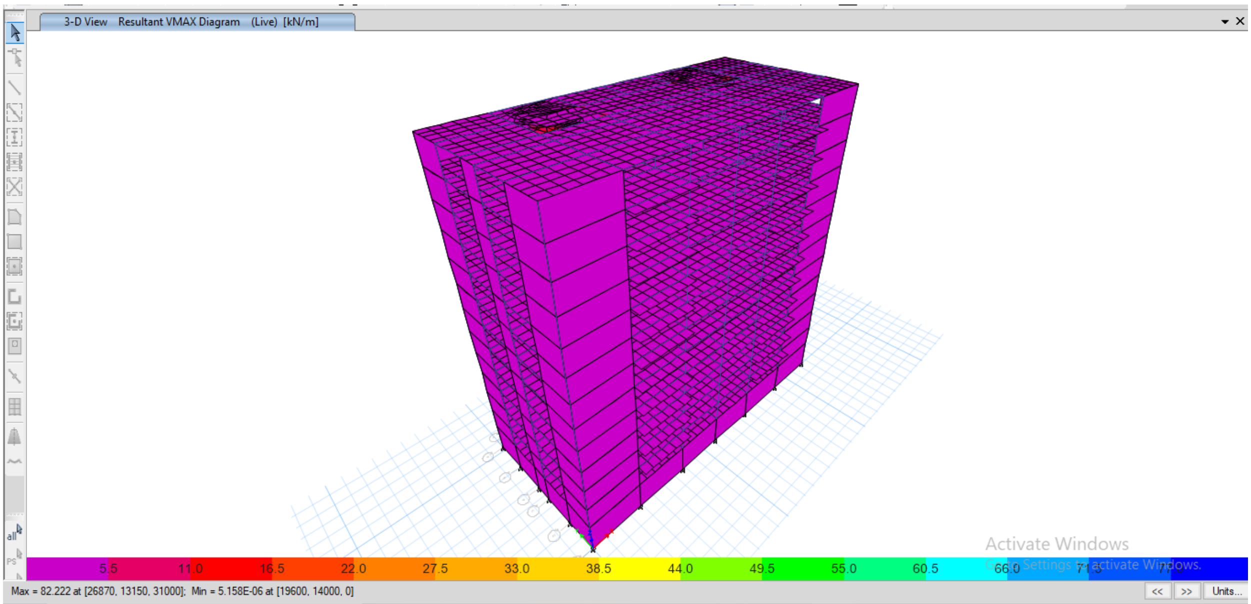


Figure B.2 - stresses on the floors due to live load

Continuation of Appendix B

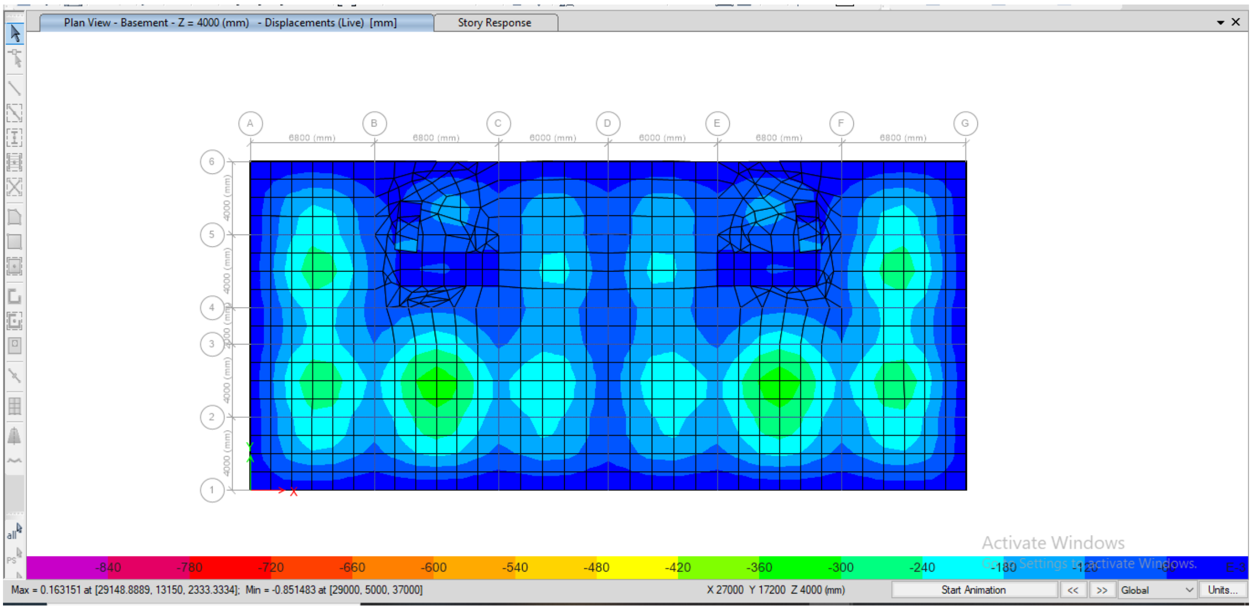


Figure B.3- Isofields of base dirift along the Z axis

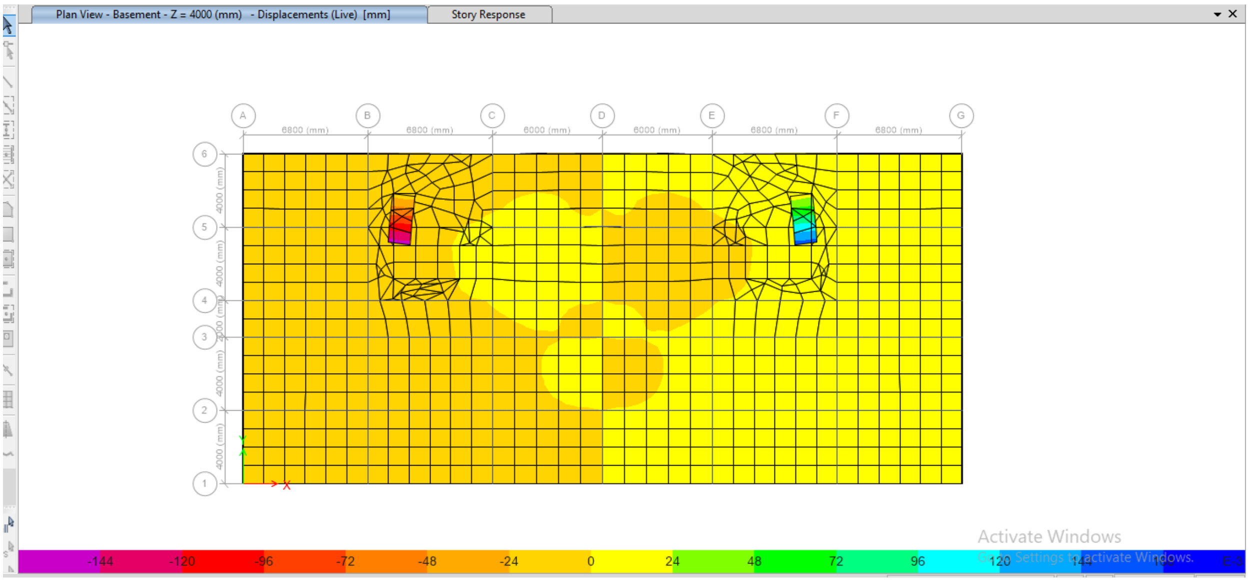


Figure B.4- Isofields of base dirift along the X and Y axis

Continuation of Appendix B

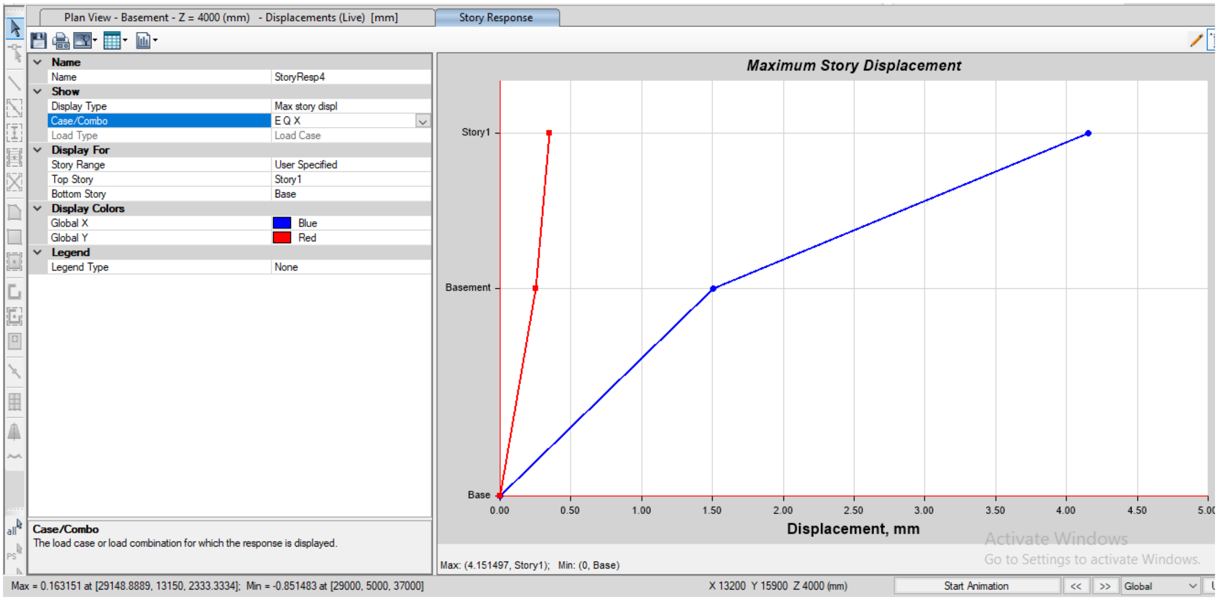
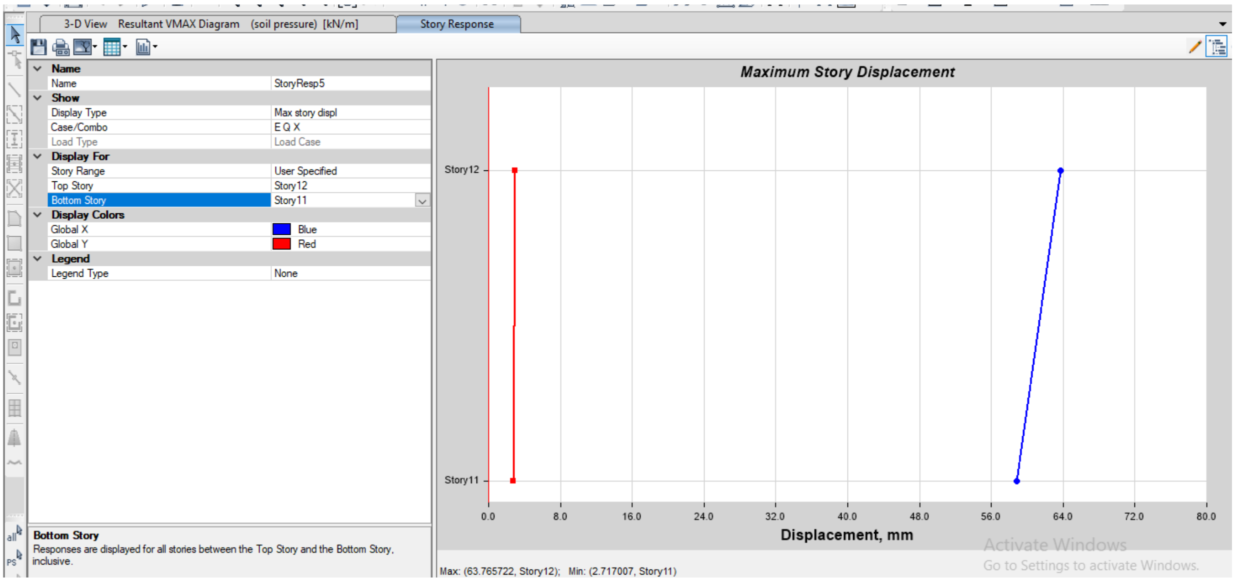


Figure B.5- Diagram of displacements of the first floor slab from seismic along X



Figures B.6- Diagram of displacements of the floor slab of the 12th floor from seismic along X

Continuation of Appendix B

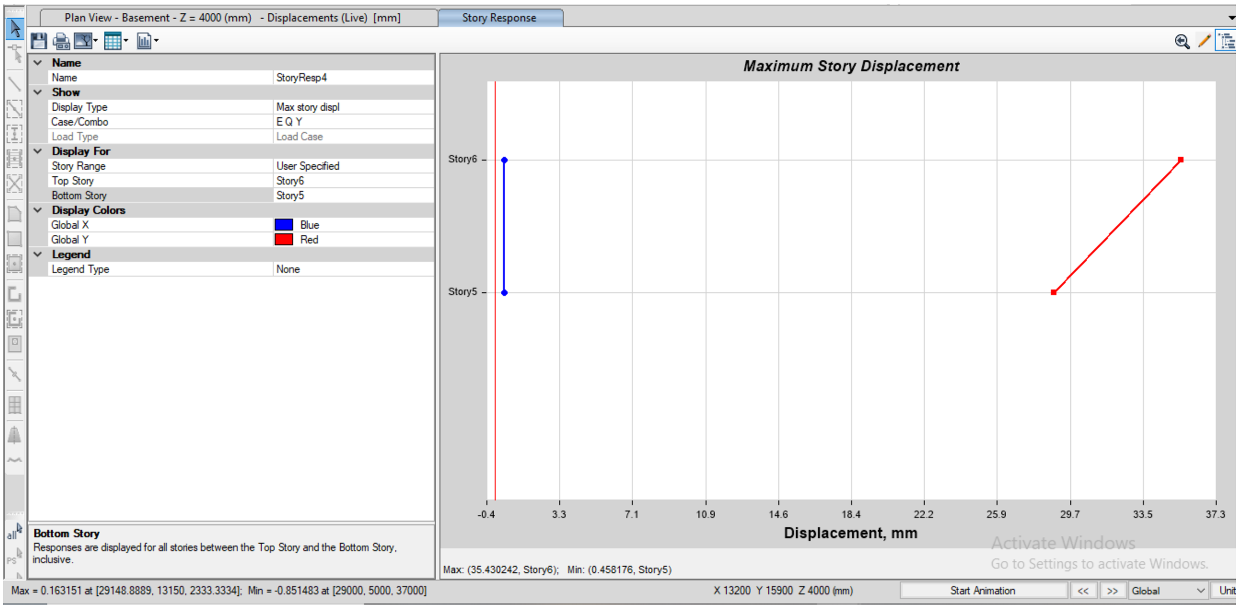


Figure B.7 - Diagram of displacements of the 6st floor slab from seismic survey along Y

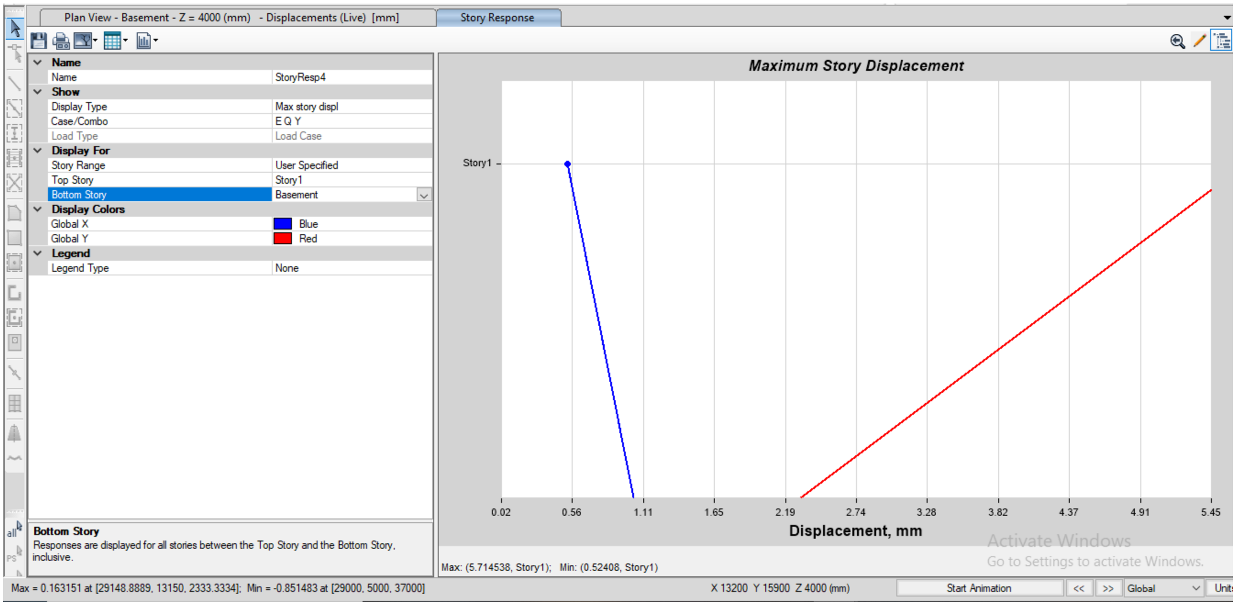


Figure B.8 - Diagram of displacements of the 1st floor slab from seismic survey along Y

Appendix C

Table B.1- Calculation of labor cost for formwork and concreting

№	Name of simple processes	volume of work		According to ENIR	Time rate man / h	Labor costs		Note
		Unite	Amount			Man hour	man days	
1	2	3	4	5	6	7	8	9
1	Installation of column formwork	m^2	277.2	E4-1-34 Б, C-2 «а»	0,4	114.6	13.98	
2	Installation diaphragm formwork	m^2	523.2	E4-1-34 D, T-6, C-3 «а»	0,25	14.13	1.72	
3	Concrete supply to the formwork of columns	m^3	38.115	E4-1-48, T-5, C-2	18	27	3.29	
4	Placement of concrete mixture into formwork columns	m^3	38.115	E4-1-49, T-2, C-5	1.1	159.79	19.49	
5	Column dismantling	100 m^2	277.2	E4-1-34 B, T-3, C-2 «б»	0.15	42.98	5.24	
6	Immediate wrapping of the columns after dismantling with plastic wrap	m^2	2.77	E4-1-54, C-10	0.81	2.35	0.29	
9	Concrete supply to diaphragm formwork blocks	m^3	55.08	E4-1-48, T-5, C-2	18	14.4	1.76	
7	Placement of concrete mixture into formwork blocks of diaphragms	m^3	55.08	E4-1-49,B, T-3, C-1 «d»	0.79	62.74	7.65	
8	Diaphragm dismantling	m^2	523.2	E4-1-34 D, T-6, C-3 «б»	0,16	9.04	1.1	

Continuation of Appendix C

Continuation of Table B.1- Calculation of labor cost for formwork and concreting

№	Name of processes	volume of work		According to ENIR	Time rate man / h	Labor costs		Note
		Unite	Amount			Man hour	man days	
9	Immediate covering of the stripped concrete surfaces of the diaphragms with peeling of the polyethylene film	100 m^2	0.57	E4-1-54, C-10	0.81	0.46	0.06	
10	Installation of formwork for slabs	m^2	105.84	E4-1-34 B, T-4, C-2 «d»	0.3	517.12	63.06	
11	Laying, distribution, compaction of concrete mix in formwork blocks of floor slabs	m^3	105.84	E4-1-49, B, T-2, C-9	0,89	1080.1	131.72	
12	Grouting of floor slab surfaces and immediate covering with plastic wrap and insulation	100 m^2	10.58	E4-1-54, C-10	0.21	3.42	0.42	
13	Dismantling of floor slabs	m^2	105.84	E4-1-34, B, T-4, C-2 «z»	0.13	214.83	26.2	
14	Immediate covering of the stripped concrete surfaces of the floor slabs with a new polyethylene film with a peg	100 m^2	10.84	E4-1-54, C-10	0.51	8.29	1	

Appendex D

OBJECT ESTIMATE

Estimated Cost	**210000**	Thous.Tenge
Normative Labor Intensity	**13.213**	Thous.pers.h
Estimated Wages	**5495.41**	Thous.Tenge

Compiled in prices for 01.1. 2001 y

№ n/n	No. of estimates and calculations	Name of works and costs	Estimated Cost, Thous. Tenge				Normative Labor Intensity	Estimated Wages
			construction and installation works	equipment, furniture and inventory	other costs	Total		
1	2	3	4	5	6	7	8	9
1	1	Energy-efficient social residential complex in Almaty	210000	--	--	210000	38.082	2736.023
2		**Total**	210000	--	--	**210000**	38.082	2736.023
3		Temporary buildings and structures	2310	--	--	2310	38.082	2736.023
4		Return of materials from temporary buildings and structures	346.5	--	--	346.5	38.082	2736.023
5		**Total**	2310	--	--	**2310**	38.082	2736.023
6		**Total**	212310	--	--	**212310**	38.082	2736.023
7		Additional costs in the production of work in the winter	2547.72	--	--	2547.72	38.082	2736.023
8		Seniority costs			2123.1	2123.1	38.082	2736.023
9		Additional vacation costs			849.24	849.24	38.082	2736.023
10		**Total**	**2547.72**		**2972.34**	**5520.06**	38.082	2736.023
11		**Total**	214857.72		2972.34	217830.06	38.082	2736.023
12		Including refundable amounts	346.5		--	346.5	38.082	2736.023
13		**Total according to the estimated calculation in the base prices of 2001.**	214857.72		2972.34	217830.06	38.082	2736.023
14		Total estimated at current prices in 2021.	734813.4024		10165.4028	744978.8052	38.082	2736.023
15		Including refundable amounts in current prices	1185.03			1185.03	38.082	2736.023
16		Taxes, fees, mandatory payments,			14899.5761	14899.5761	38.082	2736.023
17		Estimated cost at current price level	734813.4024		25064.9789	759878.3813	38.082	2736.023
18		НДС (12%)			91185.40576	91185.40576	38.082	2736.023
19		Construction cost	734813.4024		116250.3847	851063.7871	38.082	2736.023

Figure D.1- Object estimation

Continuation of Appendix D

Estimated calculation of the cost of construction in the amount of 19r 7c — 851063.787 Thous.Teng

including refundable amounts: 15r 7c — 1185.03 Thous.Teng

value added tax 18r7c — 91185.4058 Thous.Teng

ESTIMATE CALCULATION OF THE COST OF CONSTRUCTION

Compiled in prices for 01.1. 2001 y

№ п/п	No. of estimates and calculations	Name of works and costs	Estimated cost, Thous.Tenge			Total,Thous. Tenge
			construction and installation works	equipment, furniture and inventory	other costs	
1	2	3	4	5	6	7
1	1	Energy-efficient social residential complex in Almaty	151687.49	--	--	151687.49
2		**Total=1 row**	151687.49	--	--	**210000**
3		Temporary buildings and structures 1,1%*2 row 7column	2310	--	--	2310
4		Return of materials from temporary buildings and structures 15%*3r7c	346.5	--	--	346.5
5		**Total=3 row**	2310	--	--	**2310**
6		**Total 2r+5r**	212310	--	--	**212310**
7		Additional costs in the production of work in the	2547.72	--	--	2547.72
8		Seniority costs 1%*6r7c			2123.1	2123.1
9		Additional vacation costs 0,4%*6r7c			849.24	849.24
10		**Total 7r+8r+9r**	**2547.72**		**2972.34**	**5520.06**
11		**Total 6r+10r**	214857.72		2972.34	217830.06
12		Including refundable amounts=4r	346.5		--	346.5
13		**Total according to the estimated calculation in the base prices of 2001.=11r**	214857.72		2972.34	217830.06
14		Total estimated at current prices in 2021. 13r*3,42	734813.402		10165.4028	744978.81
15		Including refundable amounts in current prices 12r7c*3,42	1185.03			1185.03
16		Taxes, fees, mandatory payments,2%*14r7c			14899.5761	14899.576
17		Estimated cost at current price level 14r+16r	734813.402		25064.9789	759878.38
18		НДС (12%)*17r7c			91185.4058	91185.406
19		Construction cost17r+18r	734813.402		116250.385	851063.79

Figure D.2- Estimate calculation of the cost of construction

Continuation of Appendix D

OBJECT ESTIMATE

Estimated Cost	**210000**	Thous.Tenge
Normative Labor Intensity	**13.213**	Thous.pers.h
Estimated Wages	**5495.41**	Thous.Tenge

Compiled in prices for 01.1. 2001 y

№ п/п	No. of estimates and calculations	Name of works and costs	Estimated Cost, Thous. Tenge				Normative Labor Intensity	Estimated Wages
			construction and installation works	equipment, furniture and inventory	other costs	Total		
1	2	3	4	5	6	7	8	9
1	1	Energy-efficient social residential complex	151687	--	--	210000	38.082	2736.023
2		**Total**	151687	--	--	**210000**	38.082	2736.023
3		Temporary buildings and structures	2310	--	--	2310	38.082	2736.023
4		Return of materials from temporary buildings and structures	346.5	--	--	346.5	38.082	2736.023
5		**Total**	2310	--	--	**2310**	38.082	2736.023
6		**Total**	153997	--	--	**153997**	38.082	2736.023
7		Additional costs in the production of work in the winter	1847.964	--	--	1847.964	38.082	2736.023
8		Seniority costs			1539.97	1539.97	38.082	2736.023
9		Additional vacation costs			615.988	615.988	38.082	2736.023
10		**Total**	**1847.964**		**2155.958**	**4003.922**	38.082	2736.023
11		**Total**	155844.964		2155.958	158000.922	38.082	2736.023
12		Including refundable amounts	346.5		--	346.5	38.082	2736.023
13		**Total according to the estimated calculation in the base prices of 2001.**	155844.964		2155.958	158000.922	38.082	2736.023
14		Total estimated at current prices in 2021.	532989.7769		7373.37636	540363.1532	38.082	2736.023
15		Including refundable amounts in current prices	1185.03			1185.03	38.082	2736.023
16		Taxes, fees, mandatory payments,			10807.26306	10807.26306	38.082	2736.023
17		Estimated cost at current price level	532989.7769		18180.63942	551170.4163	38.082	2736.023
18		НДС (12%)			66140.44996	66140.44996	38.082	2736.023
19		Construction cost	532989.7769		84321.08938	617310.8663	38.082	2736.023

Figure D.3- Object estimate

МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РЕСПУБЛИКИ КАЗАХСТАН
СӘТБАЕВ УНИВЕРСИТЕТІ

RESPONSE

OF THE SUPERVISOR
for the graduation project

Paiman Obaid
5B072900-Civil Engineering

Topic: «Energy efficient social residential building in Almaty»

The student Paiman Obaid showed good preparation and professional literacy during the training.

Paiman Obaid completed his thesis in full and completed the literacy for further work in this specialty.

All sections are made at a good level and fully meet the requirements for the thesis. An analytical review of the selected design of the residential complex was carried out, the seismicity of the city of Almaty was taken into account. The architectural-planning and structural sections were developed in accordance with the issued task. The technical and economic review and construction production technology have been developed at a good level.

The thesis is completed at a good level and meets the requirements for bachelor's theses. Paiman Obaid deserves a high score of 90 points..

Supervisor
Master of technical sciences, lecturer

______________________Mukhanbetzhanova Zh.Sh.

«30» may 2021 yr.

Протокол анализа Отчета подобия Научным руководителем

Заявляю, что я ознакомился(-ась) с Полным отчетом подобия, который был сгенерирован Системой выявления и предотвращения плагиата в отношении работы:

Автор: Пайман Обаид

Название: Energy efficient social residential building in Almaty

Координатор:Надежда Козюкова

Коэффициент подобия 1:1.8

Коэффициент подобия 2:0.3

Замена букв:109

Интервалы:0

Микропробелы:2

Белые знаки: 0

После анализа Отчета подобия констатирую следующее:

- ☐ обнаруженные в работе заимствования являются добросовестными и не обладают признаками плагиата. В связи с чем, признаю работу самостоятельной и допускаю ее к защите;
- ☐ обнаруженные в работе заимствования не обладают признаками плагиата, но их чрезмерное количество вызывает сомнения в отношении ценности работы по существу и отсутствием самостоятельности ее автора. В связи с чем, работа должна быть вновь отредактирована с целью ограничения заимствований;
- ☐ обнаруженные в работе заимствования являются недобросовестными и обладают признаками плагиата, или в ней содержатся преднамеренные искажения текста, указывающие на попытки сокрытия недобросовестных заимствований. В связи с чем, не допускаю работу к защите.

Обоснование:

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Дата *Подпись Научного руководителя*

Протокол анализа Отчета подобия

заведующего кафедрой / начальника структурного подразделения

Заведующий кафедрой / начальник структурного подразделения заявляет, что ознакомился(-ась) с Полным отчетом подобия, который был сгенерирован Системой выявления и предотвращения плагиата в отношении работы:

Автор: Пайман Обаид

Название: Energy efficient social residential building in Almaty

Координатор: Надежда Козюкова

Коэффициент подобия 1:1.8

Коэффициент подобия 2:0.3

Замена букв:109

Интервалы:0

Микропробелы:2

Белые знаки:0

После анализа отчета подобия заведующий кафедрой / начальник структурного подразделения констатирует следующее:

☐ обнаруженные в работе заимствования являются добросовестными и не обладают признаками плагиата. В связи с чем, работа признается самостоятельной и допускается к защите;
☐ обнаруженные в работе заимствования не обладают признаками плагиата, но их чрезмерное количество вызывает сомнения в отношении ценности работы по существу и отсутствием самостоятельности ее автора. В связи с чем, работа должна быть вновь отредактирована с целью ограничения заимствований;
☐ обнаруженные в работе заимствования являются недобросовестными и обладают признаками плагиата, или в ней содержатся преднамеренные искажения текста, указывающие на попытки сокрытия недобросовестных заимствований. В связи с чем, работа не допускается к защите.

Обоснование:

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Дата *Подпись заведующего кафедрой /*

начальника структурного подразделения

Окончательное решение в отношении допуска к защите, включая обоснование:

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Дата *Подпись заведующего кафедрой /*

начальника структурного подразделения