MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
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FACULTY OF ARCHITECTURE, CIVIL ENGINEERING AND DESIGN
DEPARTMENT OF COMPUTER TECHNOLOGIES OF AIRPORT
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МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
ФАКУЛЬТЕТ АРХІТЕКТУРИ, БУДІВНИЦТВА ТА ДИЗАЙНУ
КАФЕДРА КОМП'ЮТЕРНИХ ТЕХНОЛОГІЙ БУДІВНИЦТВА ТА РЕКОНСТРУКЦІЇ АЕРОПОРТІВ

ДОПУСТИТИ ДО ЗАХИСТУ
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ДИПЛОМНА РОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ БАКАЛАВР
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Тема: Житлова будівля в м. Ізюм Харківської області

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INTRODUCTION

The war in Ukraine takes hundreds of human lives every day. In addition to destinies, railway stations, airports, apartment buildings and other infrastructure are being destroyed. The building that I received on assignment is located in the city of Izyum, Kharkiv region. The city was one of the first to experience the horrors and fears of the Russian invasion. Almost the entire city was destroyed during fierce fighting. Therefore, the relevance of my thesis should not be in question.

The apartment building that we will consider during my presentation was designed using such programs as: Archicad, AutoCAD and MONOMAKH-SAPR. The pile foundation was taken as a basis, concrete grade C25 30, reinforcement A400C, loads corresponding to DBN V.1.2-2: 2006 "Loads and influences". This 10-story, 16-apartment building will house 108 people. The house will be located in a residential area and belong to the class of responsibility SS2.

CHAPTER 1. ANALYTICAL REVIEW

1.1. Types of multi-storey residential buildings and design solutions

A multi-storey building is a building that has multiple storeys, and typically contains vertical circulation in the form of ramps, stairs and lifts.

The number of storeys is determined according to the diagram (Fig. 1.1).

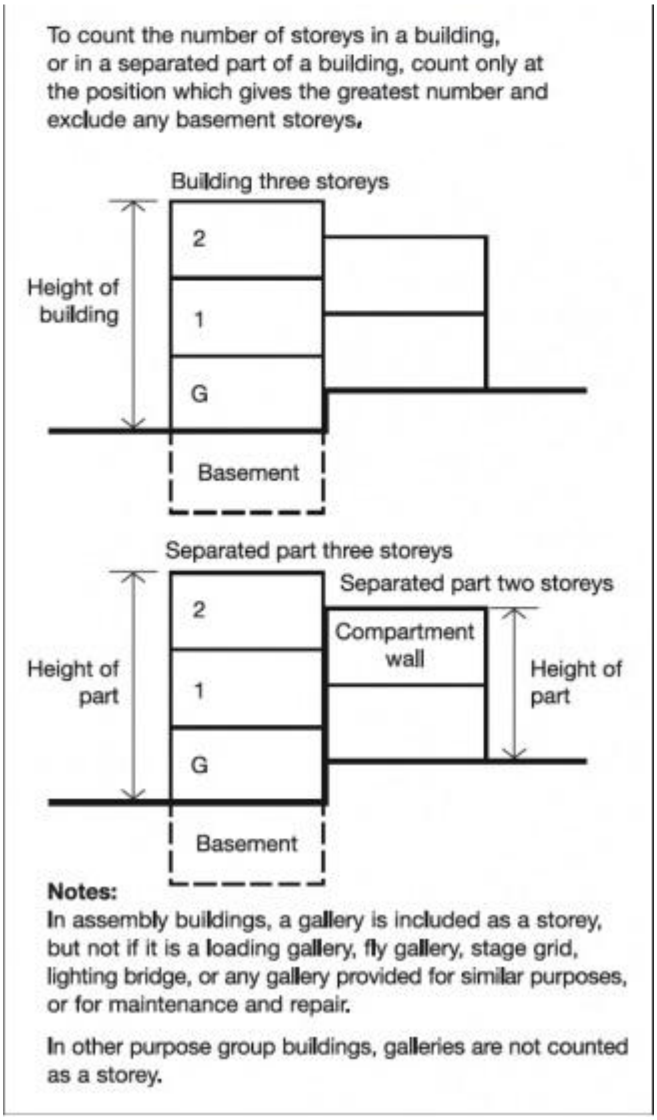

Figure 1.1 – Diagram for number of storeys determining

Depending on their height, multi-storey buildings may have particular considerations and requirements (Table 1.1) [1].

Table 1.1

Requirements for multi-storey buildings

Access and circulation	In terms of the built environment, the term ‘access’ refers to the means or ability to approach and/or enter a place, site, etc. For example, a door provides access to a building or room, a staircase provides access to an upper or lower floor. In the built environment, this generally relates to the movement of people, typically within a building. Within buildings, circulation spaces are spaces that are predominately used for circulation, such as entrances, foyers and lobbies, corridors, stairs, lifts, landings and so on.
Fire safety and evacuation	Buildings need to be designed to offer an acceptable level of fire safety and minimise the risks from heat and smoke. The primary objective is to reduce to within acceptable limits the potential for death or injury to the occupants of a building and others who may become involved, such as the fire and rescue service, as well as to protect contents and ensure that as much as possible of a building can continue to function after a fire and that it can be repaired. The risk to adjoining properties also needs to be considered, as well as possible environmental pollution.
Structural design	The structure of a building (or other built asset) – whether framed or non-framed – concerns those parts that are fundamental to its strength, stability and rigidity and which transfer the various loadings (including their self-weight) down to the foundations. This comprises loadbearingor structural primary elements. Structural design is therefore the process of creating a safe, efficient structure in which loads are conveyed safely and efficiently to the foundations and which can withstand prevailing natural forces.
Ventilation	Ventilation is necessary in buildings to remove 'stale' air and replace it with 'fresh' air.
External air movement	
Shading, views and right to light	Rights to light generally become an issue when a new development, or proposed development affects the access to light of an adjoin-

	ing property. Rights to light also apply to obstructions caused by trees, hedges and so on, but there are no rights to light for open ground.
Construction methods	
Access for maintenance and cleaning	Maintenance is the process of ensuring that buildings and other assets retain a good appearance and operate at optimum efficiency. Inadequate maintenance can result in decay, degradation and reduced performance and can affect heath and threaten the safety of users, occupants and others in the vicinity.

Classifications of multi-storeybuildings include many features (Fig. 1.2-1.3).

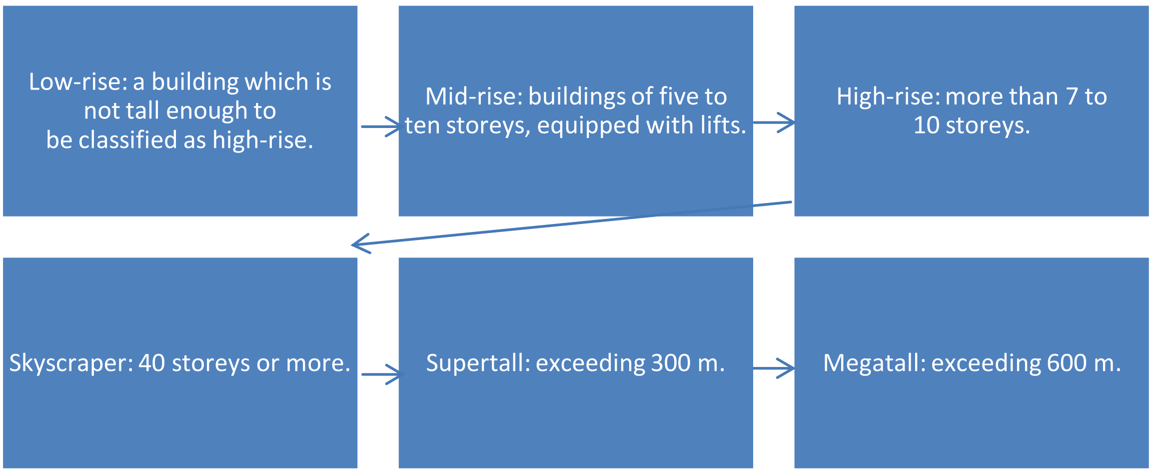

Figure 1.2. Types of multi-storeybuildings

1.2. Design solutions for modern multi-storey residential buildings

The vertical repetition of elements in multi-storey residential buildings requires a certain design discipline, which assumes, of course, with some exceptions, that all residential floors are identical (typical) and that the set of apartments on a typical floor reflects the overall ratio of apartments in the design program [1].

Due to the multiple repetition of a typical floor, its planning solution has a great impact on the value of the building. Exterior walls are expensive, and each new break in the floor plan increases its perimeter, which increases in importance as the number of floors increases. In this regard, the benefits that can be obtained from the complexity of the configuration of the floor plan must be considered in light of the increase in construction costs that they cause [31].

Not only the shape of the standard floor plan, but also its area has a great influence on the economic performance of a building. This is especially true for buildings with a reinforced concrete frame - the most common structural solution in the modern multi-storey apartment buildings [31].

In addition to these factors, one should also mention the coefficient of efficiency of using the floor area, which is a very important indicator for all multi-storey residential buildings, with the exception of gallery ones. The area of non-apartment communications usually occupies from 10 to 15% of the floor area of the floor. The lower this percentage, the more effectively the plan is solved. If the total area of non-apartment communications (common corridor, stairs, elevators, garbage chute, ventilation shafts, pipelines, etc.) is more than 15% of the entire floor area excluding balconies and loggias, the layout should be seriously revised [31].

The set of structural spatial planning and non-sowing and enclosing elements, which functions as a single system and is characterized by both architectural, structural and technological aspects of the relationship of elements, methods of their production and methods of construction, considered as an architectural and constructive technological system (ACTS). Because modern buildings are usually erected industrialized methods, from prefabricated building structures of factory production or with the use of products (formwork, etc.) or materials (concrete, etc.) of industrial production, ACTS are in fact industrialized building systems (IBS) [31].

According to the level of applied construction equipment, methods of construction of buildings, used structures and materials, there are different levels of industrial production and mechanized construction, namely: small, prefabricated, monolithic, combined and others (pneumatic, bulk, etc.) [1].

Framed structure

- Network of columns and connecting beams form the structural 'skeleton' of the building and carry loads to the foundations.

Propped structure

- Uses a cantilever slab or platform as the seating for columns. It utilises an internal core and external propped columns.

Suspended structure

- Has an internal core and horizontal floors which are supported by high-strength steel cables hung from cross beams at the top.

Cantilever structure

- Has an internal core from which beams and floors cantilever. This removes the necessity for columns.

Braced structure

- Bracing is used to give stability so that columns can be designed as pure compression members. The beams and columns that form the frame carry vertical loads, and the bracing system carries the lateral loads. Braced frames reduce lateral displacement, as well as the bending moment in columns, they are economical, easily erected and have the design flexibility to create the strength and stiffness required.

Shear wall structure

- Composed of stiff braced (or shear) panels which counter the effects of lateral and wind pressures. The pressures are transmitted to the shear walls by the floors.

Core structure

- Utilises a stiff structural core which houses lifts, stairs, and so on. Wind and lateral pressures are transmitted to the core by the floors.

Hull core structure

- Also known as ‘tube-in-tube’ and consists of a core tube inside the structure which holds services such as utilities and lifts, as well as a tube system on the exterior. The inner and outer tubes interact horizontally as the shear and flexural components of a wall-frame structure.

Figure 1.3. Structural types of multi-storey buildings

The type of skeleton are as follows [1]:

• wall (diaphragm), consisting of non-load bearing walls that work in the building as diaphragms;

• frame with non-load bearing columns, crossbars, diaphragms;

• three-dimensional block of non-load bearing spatial hollow structures;

• trunk in the presence of non-load bearing prefabricated or monolithic hollow trunk to the full height of the building used for the stair-lift unit and other purposes;

• shell with a single monolithic non-load bearing wall along the entire contour of the building.

Multi-storey buildings design various compositional schemes formed from structural spatial planning elements: single-section, multi-section, corridor, gallery, as well as combined from the main schemes - gallery-section, corridor-section. One-section houses have as a spatial planning element a section consisting of apartments grouped around the stair-lift unit, has the same type of location of apartments and bathrooms on all floors. The stair-lift unit serves th eapartments of one section. In such houses there are 3-4 apartments on the floor. Multi-section houses, consisting of rectangular sections, have anelongated shape in plan. They have ordinary and end sections; angular,cross, with shift of section-insert are also possible [1].

Corridor-type buildings have middle corridors developed along the floors, along which there are apartments with one-sided orientation of the windows. In such buildings, the exit to the stair-lift unit can be stretched by floor corridors, which makes it possible to place 6-8-10-12 apartments. Such houses must have two exits. In gallery-type houses, the entrances to the apartments are arranged from the floor open galleries, and all apartments have a two-way orientation and through ventilation. Such houses must also have two exits [1].

Table 1.2

	Number of living rooms				
	1	2	3	4	5
Area of apartments, m^2	30-40	48-58	60-70	74-85	92-98

Requirements for apartments

The height of the floors of a residential building must be the same and is accepted at least 2.8 m from the floor below the floor to the floor above the floor, and from floor to ceiling should not beless than 2.5 m. In modern apartment buildings, the floor height is mostly 3 m or 3.3 m [31].

CHAPTER 2. ARCHITECTURAL DESIGN

2.1. Structural scheme and load-bearing structures of the building

The building consists of 10 floors.

Structural scheme of the building - monolithic reinforced concrete frame (frame-elm with vertical reinforced concrete diaphragms). The height of the 1st floor is 3.3 m, the height of the typical floor is 3.3 m.

Load-bearing structures are monolithic reinforced concrete:

- pylons of rectangular cross-section with dimensions of 250x1000 mm, concrete class C25/30, reinforcement A400C and A240C according to DSTU 3760:2019,

- the floor slab has a thickness of 200 mm, concrete class C25/30, reinforcement A400C and A240C according to DSTU 3760: 2019,

- monolithic walls have a thickness of 200 mm, concrete class C25 / 30, reinforcement A400C and A240C according to DSTU 3760: 2019,

- monolithic stairs, concrete class C25/30, reinforcement A400C and A240C according to DSTU 3760: 2019,

- the foundation for the building are borehole injection reinforced concrete piles with a diameter of 420 mm (concrete class C20/25, concrete grade for frost resistance F100, concrete grade for water resistance W6, reinforcement A400C and A240C according to DSTU 3760:2019), united by monolithic reinforced concrete growth 1200 mm (concrete class C20/25, concrete grade for frost resistance F200, concrete grade for water resistance W6, reinforcement A400C and A240C according to DSTU 3760: 2019).

Figure 2.1 – Entire model of the apartment building in Archicad 25

Figure 2.2 – Core of the apartment building without finishes in Archicad 25

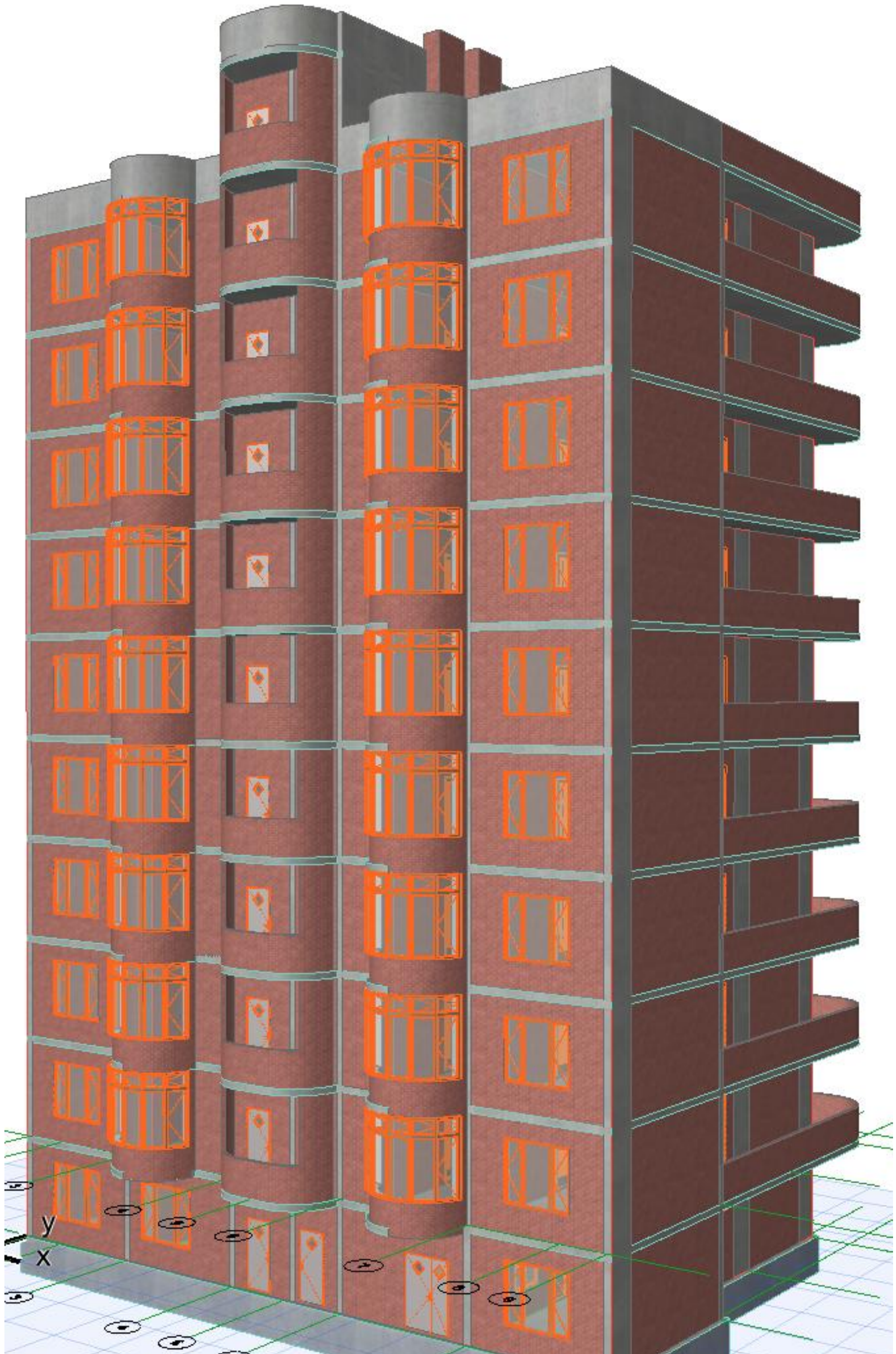

Figure 2.3 – Core of the apartment building in Archicad 25

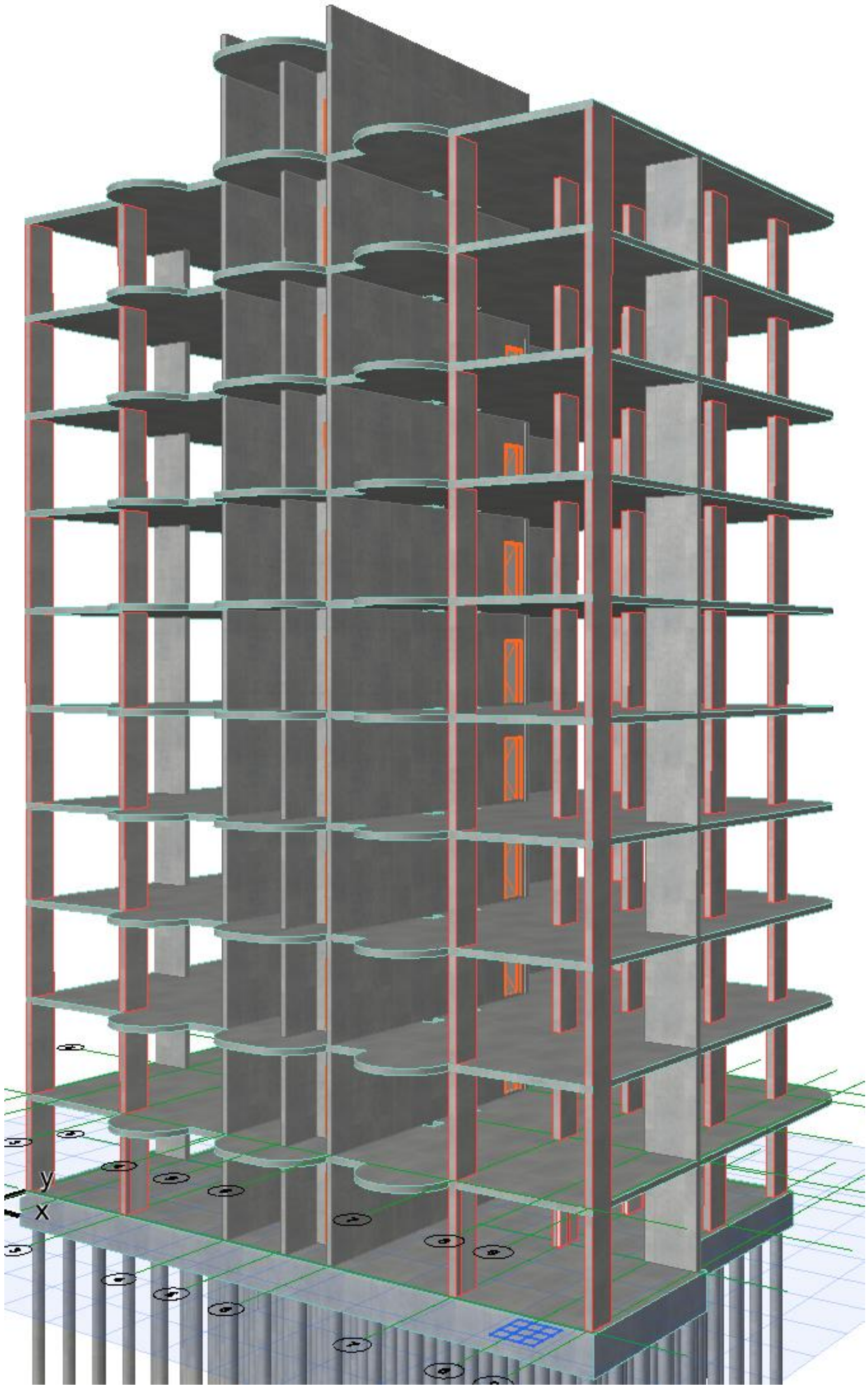

Figure 2.4 – Core of Load-Bearing, elements with piles in Archicad 25

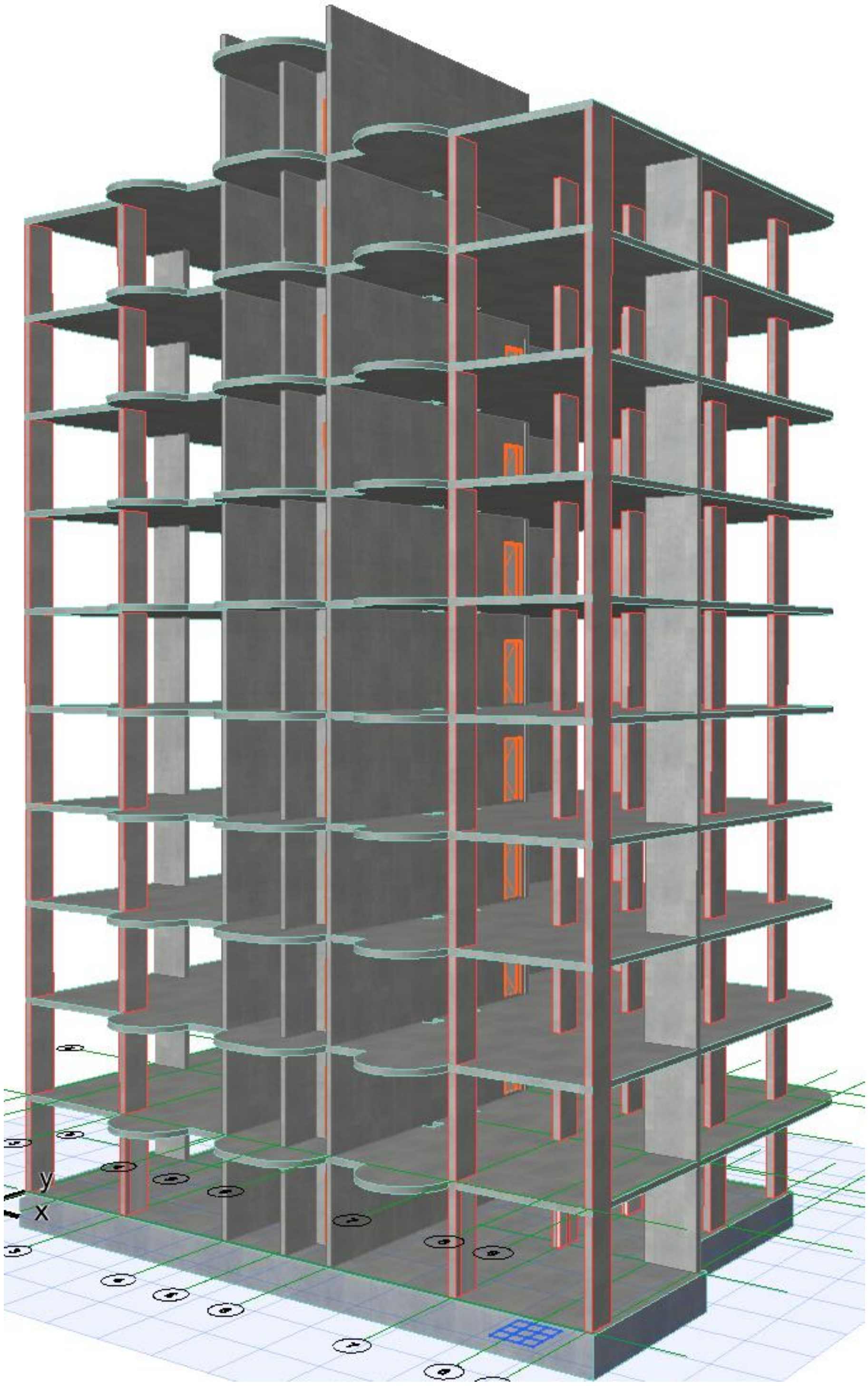

Figure 2.5 – Core of Load-Bearing elements only in Archicad 25

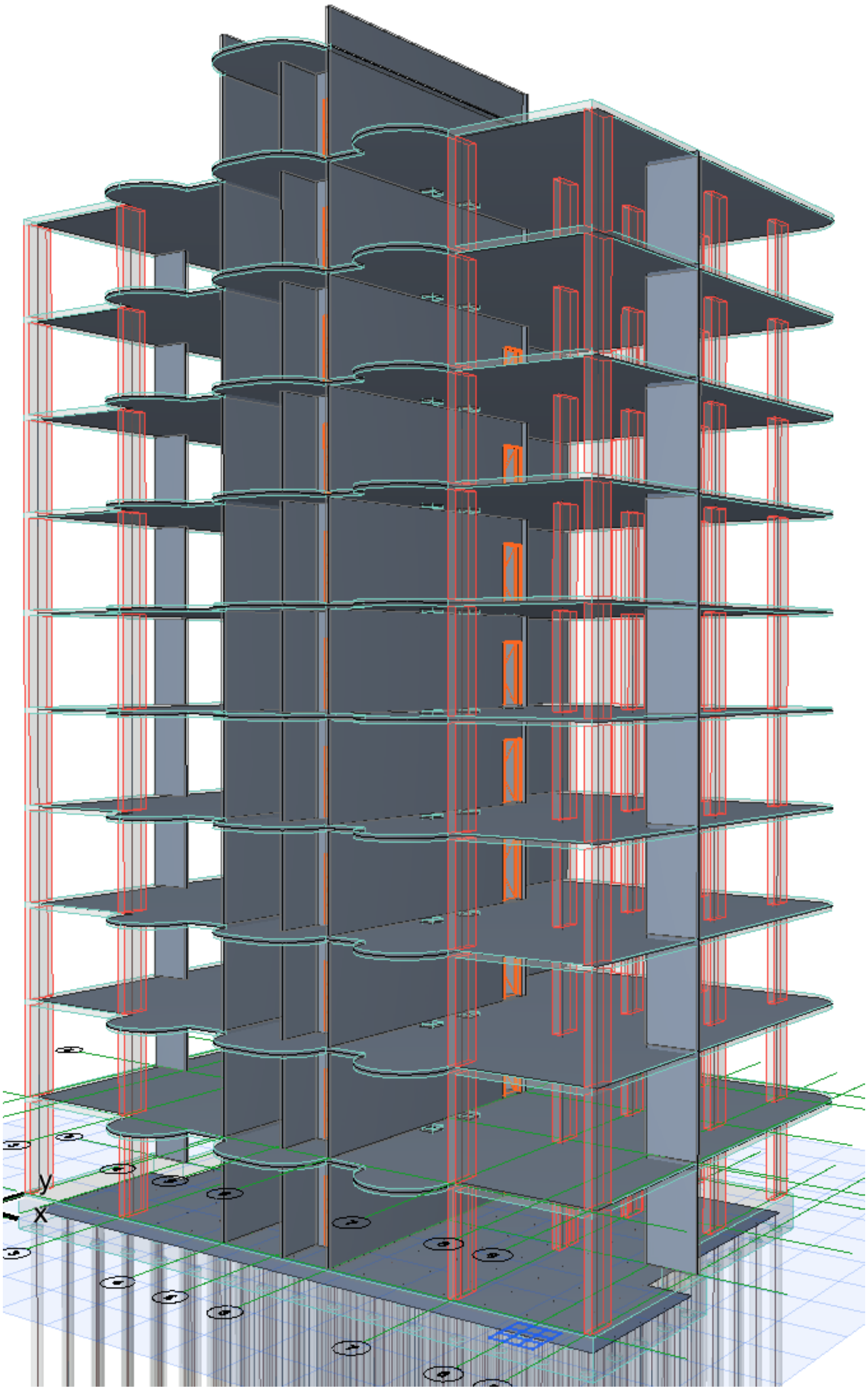

Figure 2.6 – Structural analytical model of the building with piles in Archicad 25

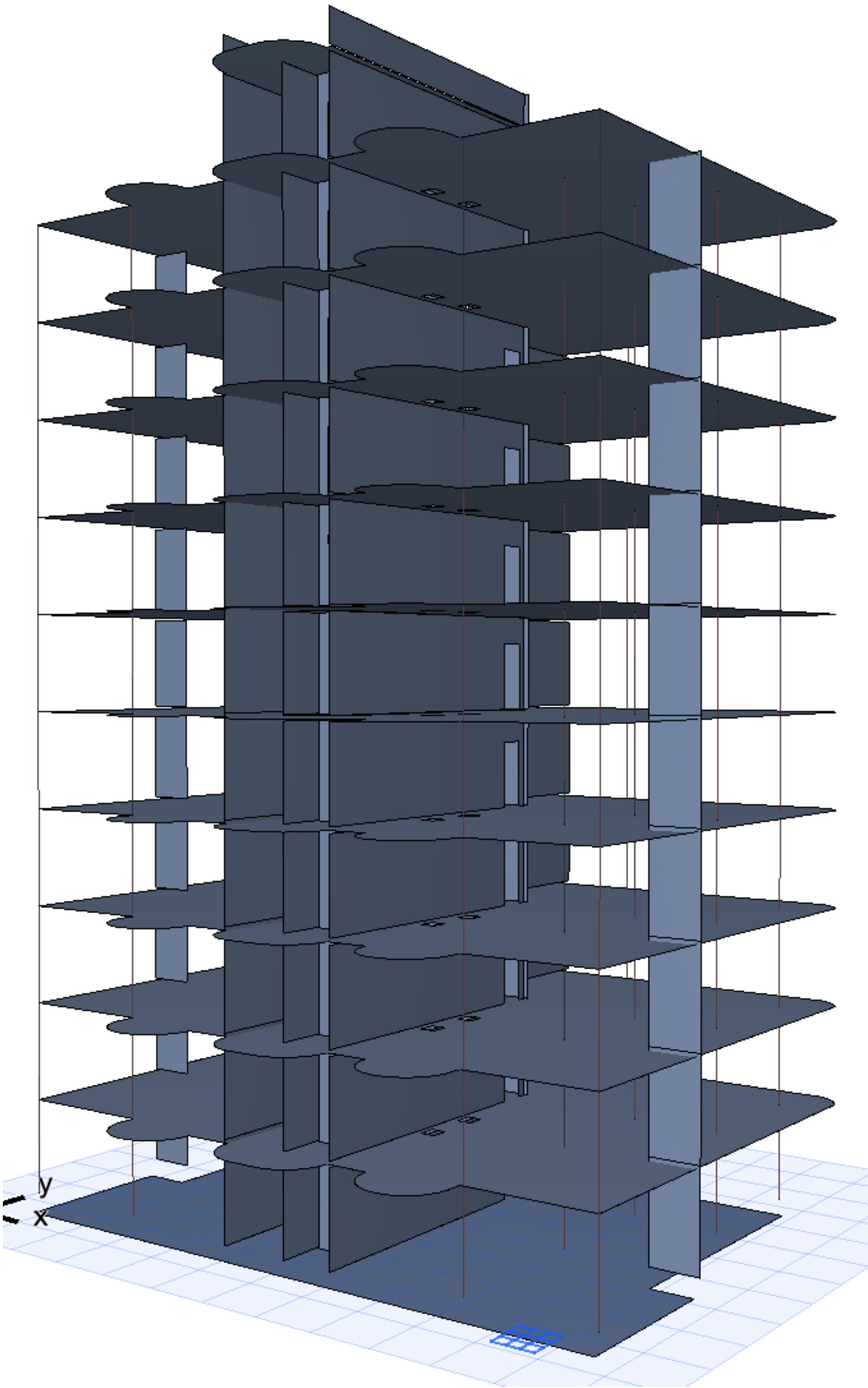

Figure 2.7 – Structural analytical model of the building in Archicad 25

2.2. Determining the class of consequences (responsibility) of a 10-storey 16-apartment residential building

We determine the estimated number of residents depending on the area of the apartment (the norm is 21 m^2 per person plus 10.5 m^2 per family).

Table 2.1

Estimated number of inhabitans

Number of rooms in the apartment	Apartment area, m^2	Number of apartments per house	Total area of apartments per house, m^2	Settlement per apartment (estimated coefficient for settlement)	Settlement at home, persons
3	132.1 (121,6+10.5)	14	1849.4	5.79	82
5	264.2 (253.7+10.5)	1	264.2	12.08	13
6	264.2 (253.7+10.5)	1	264.2	12.08	13
Total		16	2377.8		108

The number of N1 people who are permanently in the house is 108.

According to the number of persons who are permanently on the site, the residential building belongs to the class of consequences (responsibility) SS2 (DBN B.1.2-14: 2018 Table 1).

Temporary stay of people in residential buildings is not standardized and in any case should not exceed 50% of the people permanently staying in the house, ie will be 54 people. According to the number of persons who periodically stay on the site, N2 residential building belongs to the class of consequences (responsibility) SS1 (DBN B.1.2-14: 2018 Table 1).

The number of people outside the facility (for the sleeping area) is determined by the formula:

$N_3 = a \times N_1 = 1{,}5 \times 108 = 162$ (persons).

According to the number of persons outside the facility, the residential building belongs to the class of consequences (responsibility) SS2 (DBN B.1.2-14: 2018 Table 1).

1. The house is not located in the protected area of cultural heritage sites and is not a cultural heritage site.
2. We assume that the construction of the house is provided in the usual engineering and geological conditions, in the absence of such complicating conditions as seismic, subsidence, etc. The house is not subject to increased environmental hazards.
3. We assume that the failure of the house does not affect the closure of transport, communications, energy.

Conclusion. According to all the calculations of the characteristics of possible consequences in accordance with table 1 10-storey 16-apartment apartment building belongs to the class of consequences (responsibility) SS2.

2.3. Thermal calculation of external enclosing structures (multilayer) and determination of thermal resistance (R).

Table 2.2

Materials characteristics

№	Material	Layer Thickness, mm	Thermal Conductivity, W/(m*K)
1	Plaster – Lime Sand	10	0.70
2	Insulation – Mineral Hard	150	0.038
3	Brick	250	0.81
4	Plaster - Gypsum	10	0.19

Determine thermal resistance of multilayer wall [11]:

$$R_{\Sigma} = \frac{1}{\alpha_B} + \frac{\delta_1}{\lambda_{1\,p}} + \frac{\delta_2}{\lambda_{2\,p}} + \frac{\delta_3}{\lambda_{3\,p}} + \frac{\delta_4}{\lambda_{4\,p}} + \frac{1}{\alpha_3} \geq R_{q\,min}$$

where $R_{q\,min}$ – permissible minimum thermal resistance,

δ– layer thickness, m

λ– thermal conductivity, W/(m*K).

Kharkiv region is the first temperature region [11].

$R_{q\,min}$of the external walls equals 3.3 m^2 K/W

α_B = 8,7 Wt/(m^2*K)

α_3 = 23 Wt/(m^2*K)

$$R_{\Sigma} = \frac{1}{8.7} + \frac{0.01}{0.70} + \frac{0.15}{0.038} + \frac{0.25}{0.81} + \frac{0.01}{0.19} + \frac{1}{23} = 4.48 \geq R_{q\,min}$$

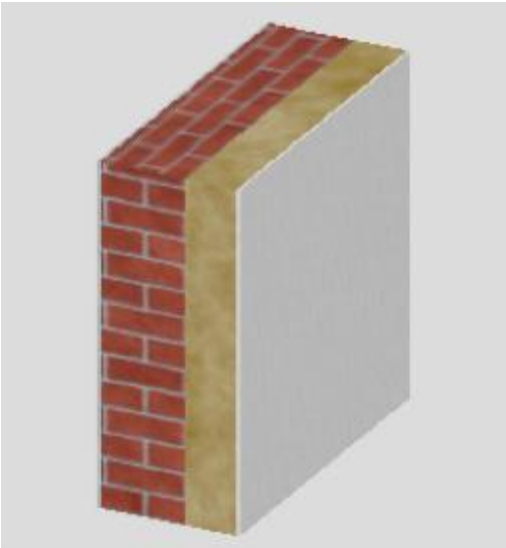

Figure 2.8 – External non-load bearing wall structural layers

CHAPTER 3. STRUCTURAL DESIGN

3.1. Loads and Impacts

Loads and impacts for building structures are accepted according to DBN B.1.2-2: 2006, taking into account the requirements of DBN B.1.1-2: 2016, DBN B.1.2-14, constant loads from the own weight of load-bearing frame structures are accepted according to the design documentation.

Table 3.1 shows the types of loads that are taken into account.

Table 3.1

Loads that are applied to a three-dimensional computer model

№ of load	Name and type of load	The magnitude of a load (characteristic value)	Load reliability factor	The magnitude of a load (estimated value)
1	2	3	4	5
Constant loads				
1	Dead weight of columns, pylons, walls, monolithic floors Dead weight of external wall	Taken into account when calculating the computer model automatically	1.1 1.1	
2	Dead weight of partitions	Variable to 2.05 kPa	1.0	To 2.05 kPa
3	Dead weight of the floor	Variable to 1.8 kPa	1.3	To 2.34 kPa
4	Dead weight of a roof	Taken into account when calculating the computer model automatically	1.1	
Temporary loads				
5	Short-term on - overlap - lobbies, stairs - load along the balcony of 0.8 m	 1,5 kPa 3.0 kPa 4.0 kPa	 1.3 1.2 1.2	 1.95 kPa 3.6 kPa 4.8 kPa
6	Snow load, kPa	1.46	1.14	Taking into account the height and configuration
7	Wind load, kPa	0.43	1.14	

Table 3.2 shows the main and special combinations of loads, consisting of permanent and temporary loads that caused the greatest effort and displacement in the building structures.

The calculation took into account the responsibility class SS2 and the category of responsibility of structures, according to DBN B.1.2-14, by applying the appropriate reliability coefficients (1.1 for calculation with the first group of limit states and 0.975 for calculation for the second group of limit states). The magnitude of the seismic is 6 points.

Typical wind load for the 2st wind district is 430 Pa. Terrain type – 2.

Typical snow load for the 5th snow district is 1460 Pa.

Table 3.2

Estimated load combinations

Loads	Load combinations							
Constant	+	+	+	+	+	+	+	+
Temporary	+	+	+	+	+	+	+	+
Snow	+							
Wind X			+	(-)				
Wind Y					+	(-)		
Seismic X							+(-)	
Seismic Y								+(-)

3.2. Finite Element Modelling in MONOMAKH-SAPR

MONOMAKH-SAPR software is intended for analysis and design of monolithic reinforced concrete structures and structures with brick walls. It is possible to perform analysis of the whole structure or its separate parts and generate working drawings and reinforcement patterns for structural elements [3, 26, 28-30].

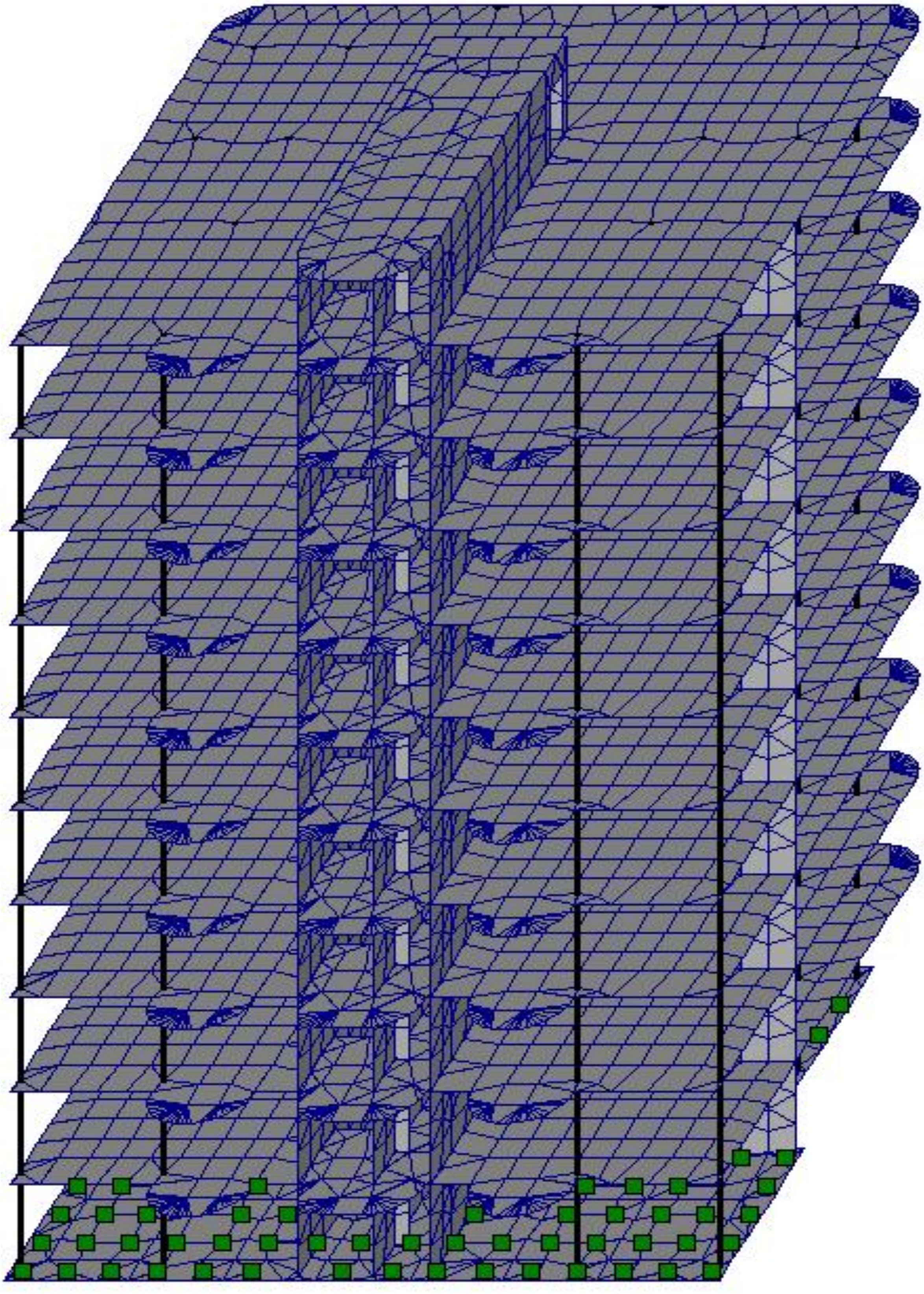

Figure 3.1 – Results of MCE calculations

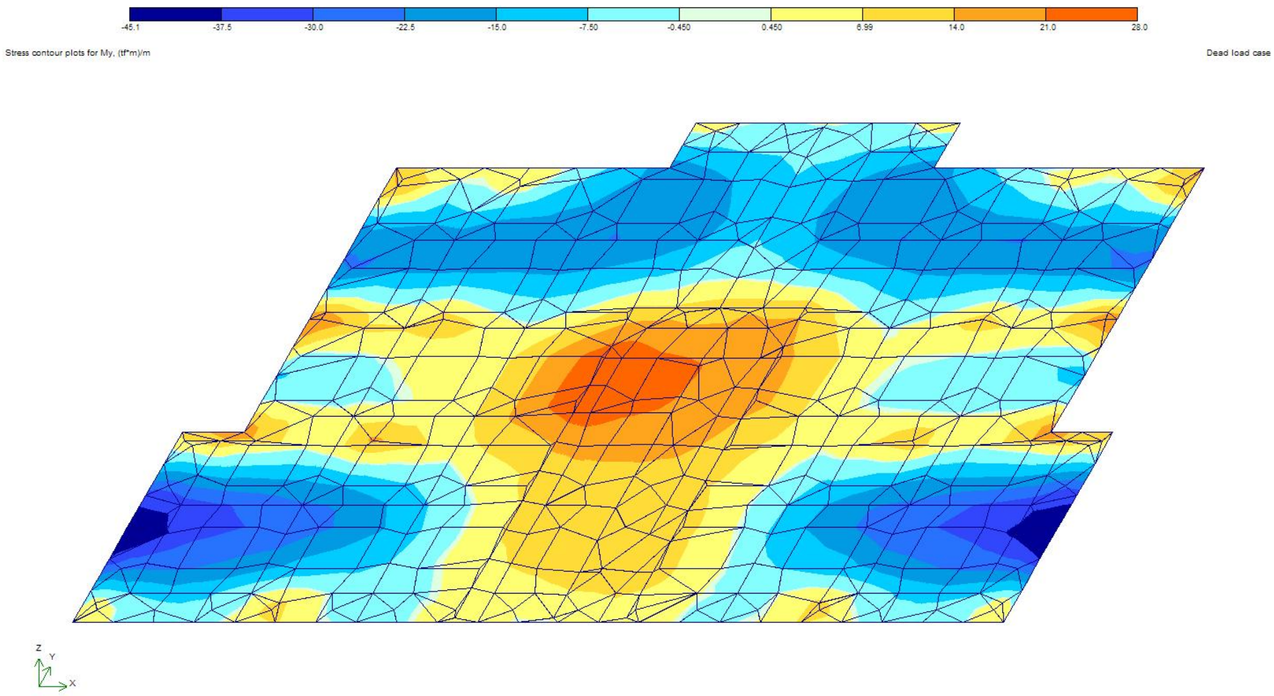

Figure 3.2 – Isopoly of stresses and forces of foundations on M_y

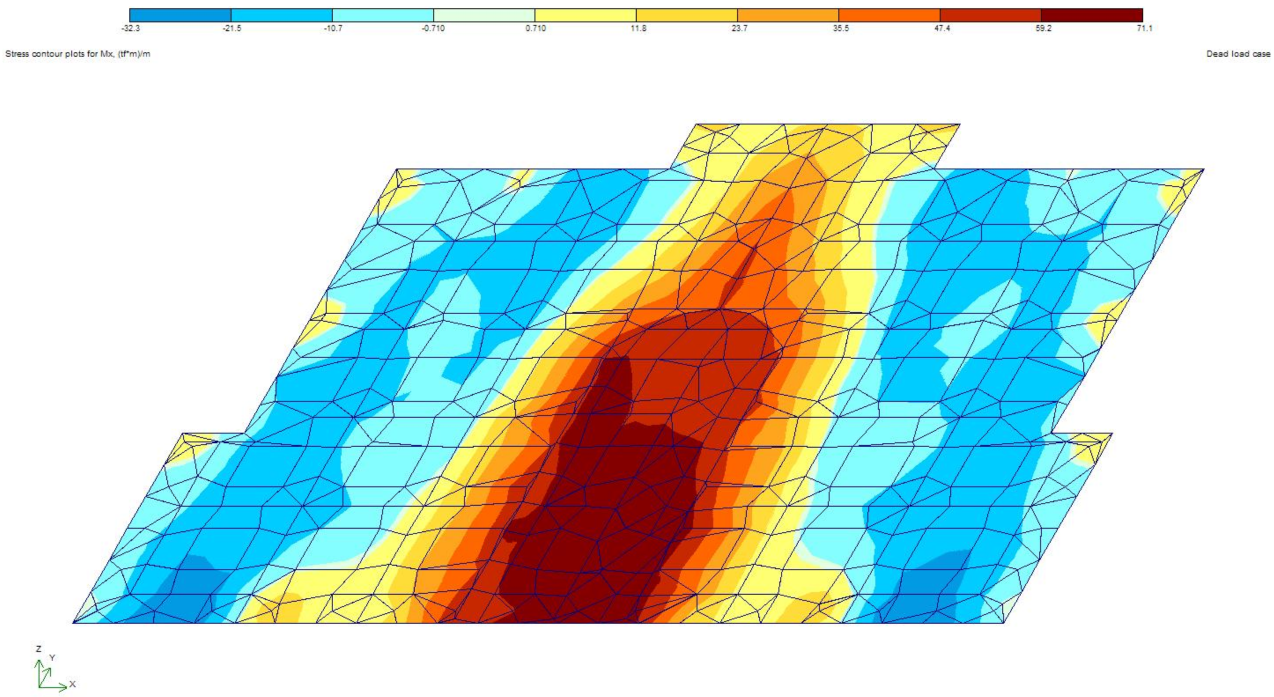

Figure 3.3 – Isopoly of stresses and forces of foundation on M_x

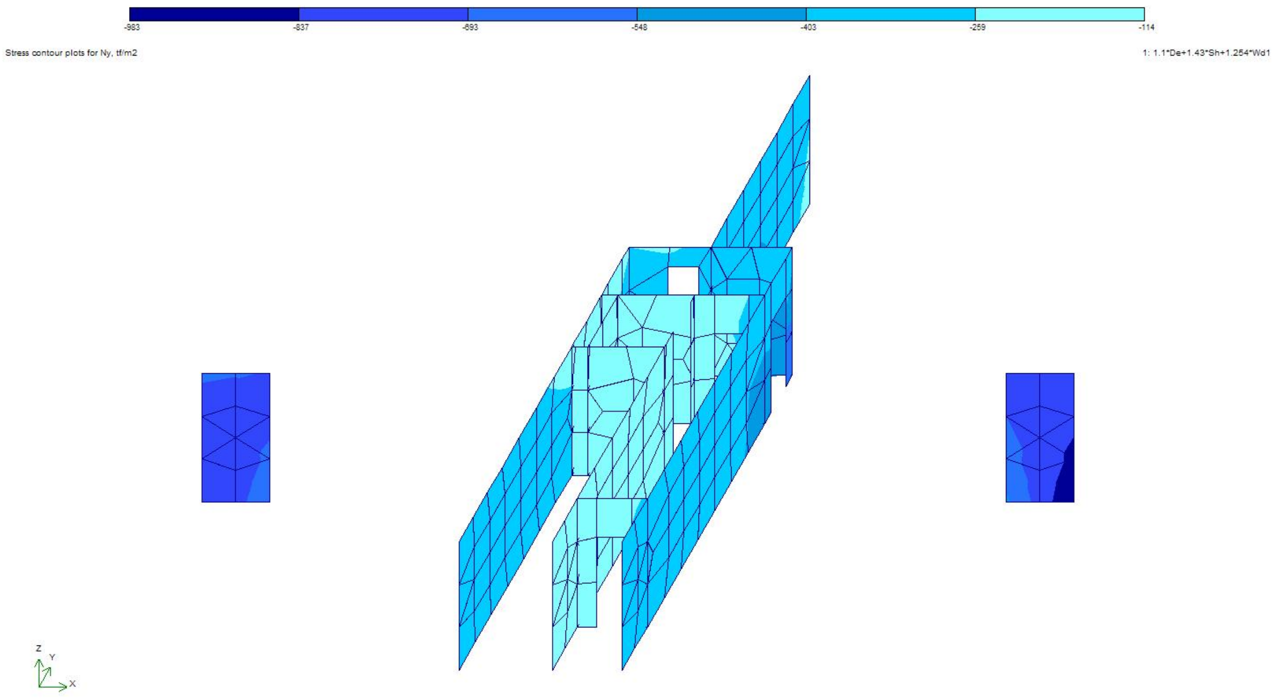

Figure 3.4 – Isopoly of stresses and forces of walls on N_y

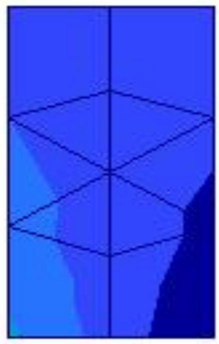

Figure 3.5 – The wall with the largest value of the interior effort N_y under the 1st type of load

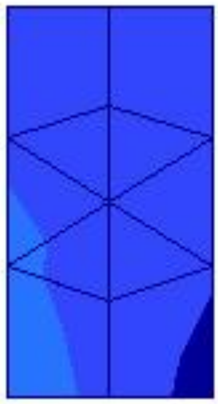

Figure 3.6 – The wall with the largest value of the interior effort N_y under the 2nd type of load

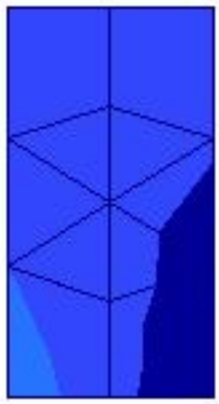

Figure 3.7 – The wall with the largest value of the interior effort N_y under the 3rd type of load

Figure 3.8 – The wall with the largest value of the interior effort N_y under the 4th type of load

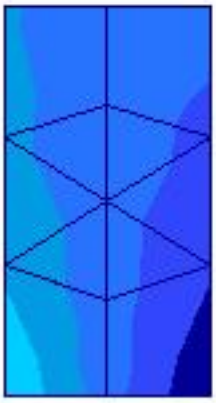

Figure 3.9 – The wall with the largest value of the interior effort N_y under the 5th type of load

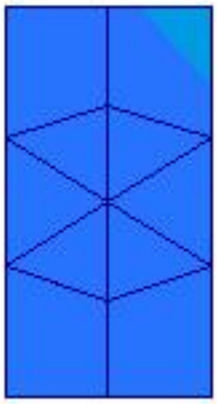

Figure 3.10 – The wall with the largest value of the interior effort N_y under the 6th type of load

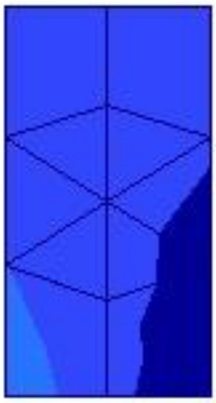

Figure 3.11 – The wall with the largest value of the interior effort N_y under the 7th type of load

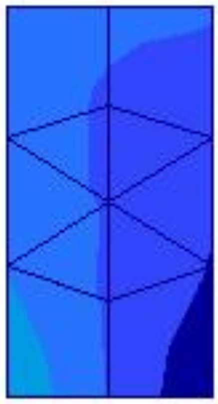

Figure 3.12 – The wall with the largest value of the interior effort N_y under the 8th type of load

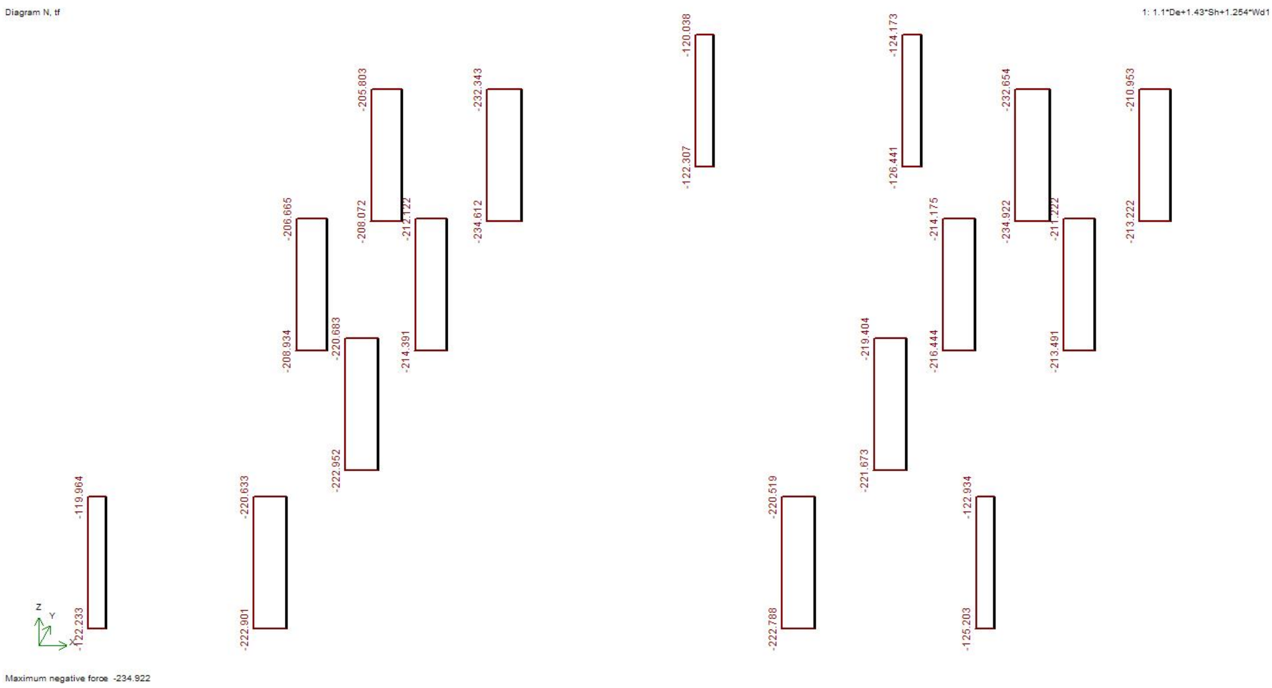

Figure 3.13 – Plots of effort of Columns on N

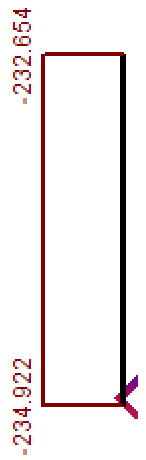

Figure 3.14– Column with the largest internal value efforts N under the 1st type of load

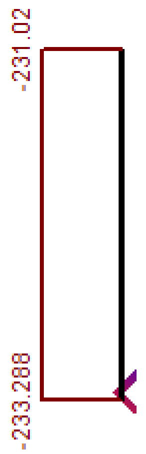

Figure 3.15– Column with the largest internal value efforts N under the 2nd type of load

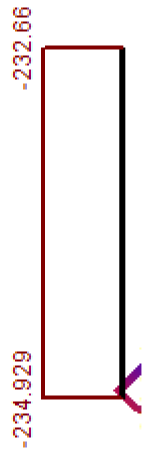

Figure 3.16– Column with the largest internal value efforts N under the 3rd type of load

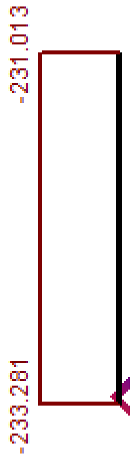

Figure 3.17– Column with the largest internal value efforts N under the 4th type of load

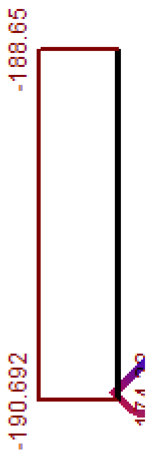

Figure 3.18– Column with the largest internal value efforts N under the 5th type of load

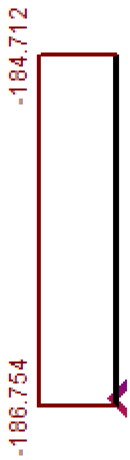

Figure 3.19– Column with the largest internal value efforts N under the 6th type of load

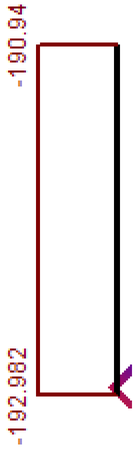

Figure 3.20– Column with the largest internal value efforts N under the 7th type of load

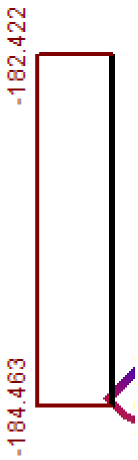

Figure 3.21– Column with the largest internal value efforts N under the 8th type of load

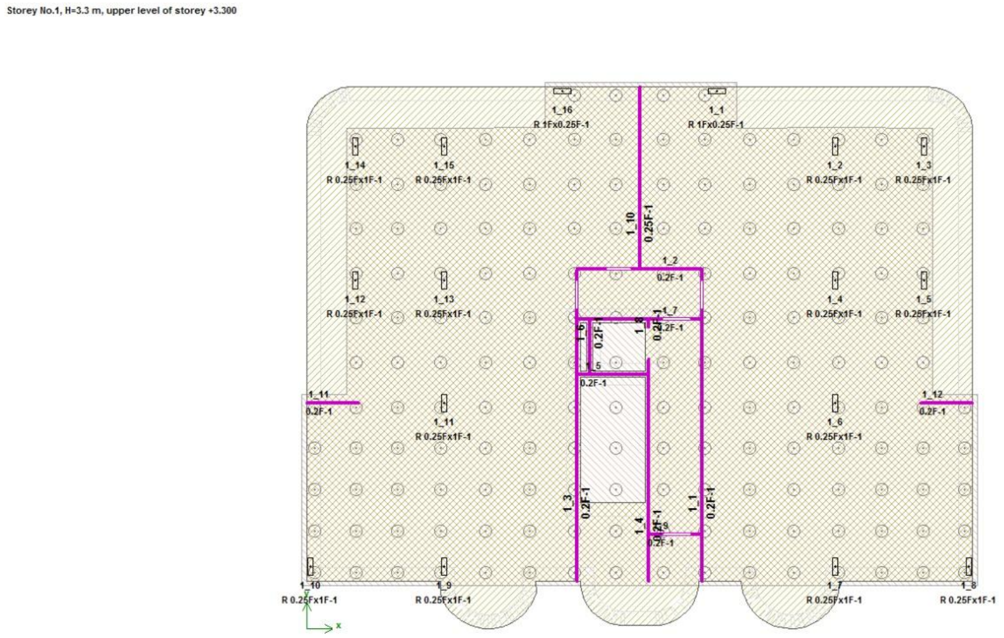

Figure 3.22 – General view with numbers of Column and Walls.

Wall with the largest internal value efforts N is 1_12.

Column with the largest internal value efforts N is 1_2.

CHAPTER 4.TECHNOLOGY OF CONSTRUCTION

4.1.Construction of objects with the help of bored-injection piles

Bored-injection piles are used in the construction of objects located in a densely built-up area: the historical center of the city, its residential areas, etc. They are an effective replacement for driven piles, during which powerful dynamic impacts on the ground are formed, which leads to the destruction of the integrity of nearby buildings. The use of bored piles completely solves the problem of the destructive impact on buildings located in the immediate vicinity of the construction site [8,9,14,18,23].

4.1.1. The essence of the technology of bored-injection piles

For bored piles, wells from 420 to 820 mm in diameter are drilled in the ground. Upon reaching the required depth, they are filled with a cement-sand or water-cement mortar, which is fed inside under strong pressure through a hollow auger. Due to the supply of the mixture under pressure, it can be supplied both in vertically and horizontally drilled wells. Further, a reinforced frame is immersed into the well with a still uncured concrete solution (Figure 4.1) [23].

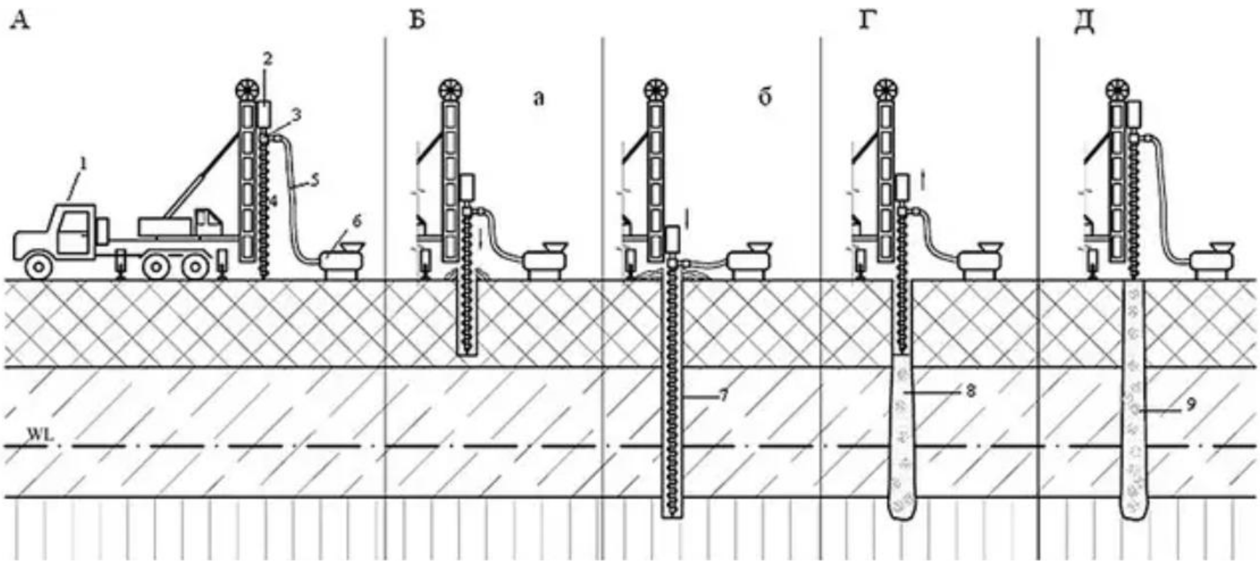

Figure 4.1 – Technology of bored-injection piles

4.1.2.The procedure for driving bored injection piles

As the concrete mortar hardens, the well turns into a monolithic reinforced concrete structure, which later becomes the basis of the future foundation of the building or a fastening element of the walls [23].

According to the provisions of the current norms, the following requirements are put forward for concreting and reinforcement of bored injectionpiles [23]:

- for reinforcing the piles, spatial frames are used, the longitudinal belts of which are spaced at a uniform distance from each other. The minimum number of longitudinal rods is 6 pieces, rods with diameters over 18 mm are used (reinforcement class A400C);
- the diameter of the frame used is always 14 cm smaller than the diameter of the well developed for the pile. This prevents the risk of the framework jamming in the cavity;
- the maximum length of one section of the frame is 11.7 meters; if it is necessary to reinforce a large well, individual frames are welded together directly at the construction site;
- increased requirements for rigidity are imposed on the reinforcement cages of bore-injection supports. The connection of structural elements is carried out by welding, the reinforcement is additionally reinforced with metal rings, which are located on the outer side of the frame in increments of 2 meters. Rings with a width of 6 to 9 cm are used. Metal thickness is from 7 to 9 mm;
- it is obligatory to have a protective layer of concrete around the reinforcement with a thickness of more than 7 cm. The uniform position of the frame in the well is achieved by installing clamps on steel stiffening rings;
- concrete grades C20/25 and higher, are used for concreting the pile. The normative content of cement in the mixture is 350 kg / cubic meter. The volume of aggregate in the composition is from 25%, fine-grained crushed stone is used as an aggregate, with a particle size of 10 to 20 mm;

- the consistency of the concrete used to fill the well should ensure the mobility of the mixture and its free passage through the cavity of the screw string. Specific water separation of concrete is within 2%. To obtain the plasticity of the mixture, a plasticizing component is added to the concrete composition - LST (lignosulfonate, concentration up to 0.2% of the total mass), which increases the hardening time of the composition, which is especially important when installing piles in the hot season;
- the overspending of the mixture, associated with the need to fill the well until the concrete, clean from sludge, starts to flow out of the cavity, is 25% of the planned volume of the bored-injection pile.

4.1.3. The process of installation of a reinforcement cage in a well

Also, certain requirements are put forward for the process of installation of piles [23]:

- with continuous operation, it is allowed to drill adjacent wells at a distance exceeding 3 diameters of an already formed support. If the distance is less than required, it is possible to develop a well only after 24 hours after concreting the previous pile;
- it is imperative to maintain a constant pressure of concrete supply when filling the well, with a decrease in pressure, it is necessary to reduce the speed of extraction of the screw string;
- the concreting process occurs with continuous reciprocating movements of the auger;
- the filling of the well stops at the moment when the concrete mixture, clean from sludge and contaminants, begins to come out of the cavity. After that, the territory is cleaned from contaminated concrete, a conductor is mounted at the wellhead and the ground part of the support is concreted;

- upon completion of concreting, the MBU drives away from the well and the soil developed during the development of the cavity is removed from the site by an excavator;
- reinforcement of the support occurs immediately upon completion of filling the well with concrete and cleaning the mouth of the cavity. The maximum pause between concreting and reinforcement should not exceed 20 minutes.

4.1.4. The use of bored piles

This technology is used [23]:

- During construction in conditions of dense building of large cities;
- To strengthen the walls of the pit in conditions of high flowability of the soil;
- To give stability and prevent accidental deformation of the load-bearing structures of old reconstructed buildings;
- To add additional structures to the building. In this case, bored piles are used to give additional stability to the retaining walls.


Figure 4.2 - Drilling wells for bored injection piles

Reconstruction of the foundation with bored injection piles begins with drilling of the concrete body of the foundation. A hole with a diameter similar to the size of a pile is created in it, after which a tubular inventory conductor made of steel is installed in the cavity, and a well is developed in the soil to the required depth. Important.the rotation of the drill string occurs inside the conductor, which prevents possible damage to the auger when it comes into contact with concrete. After drilling the well, the drill string is removed from it and the cavity is concreted using an injector connected to a concrete pump. Filling is carried out until the solution clean from the sludge starts to come out of the well [23].

Upon completion of concreting, a reinforcing cage is immersed in the cavity, consisting of sections 3-4 meters long, interconnected by welding. In the process of hardening, concrete seizes with the body of the reconstructed foundation and forms a monolithic structure with it, which, due to bored piles, transfers the load from the building to the deep layers of the soil [8,9,23].

Mobile drilling rigs (MBU) are involved in the creation of bored injection piles. This is a self-propelled vehicle equipped on a wheeled or tracked transport base. In foundation construction, wheeled MCUs are most common, due to their greater mobility and ability to get to target objects on their own. The MBU drilling equipment is located on a working platform mounted on a transport chassis with the help of articulated joints. Depending on the type of platform, the machines are classified into fixed and rotary. For the development of each subsequent well, an MDR with a fixed platform needs to change its position on the site, while the presence of a rotary platform allows the machine to drill several wells at once along the perimeter of the current location [23].

4.2. Technology and organization of work on the construction of walls

The peculiarity of concreting the walls depends on the architectural and planning and design solutions, a set of machines and mechanisms used to perform technological processes, as well as the type of formwork [23].

Design of formwork works is carried out in accordance with the requirements ДСТУ Б В.2.8-41:2011"Formwork for the construction of monolithic concrete and reinforced concrete structures. As elements for the formation of slots in the formwork for the construction of load-bearing walls and elevator shaft can be used channel [8,9,14,18,23].

Installed in the design position, such elements are fixed with struts in the longitudinal and transverse directions to give them rigidity and prevent them from distorting the shape when laying the concrete mixture [23].

When using collapsible formwork, the walls are concreted in sections. If the length of the wall is more than 20 mp, it is divided into separate sections of 7… 10 m, and on the boundaries of the sections install distribution formwork.The formwork of the walls is installed in a sequence determined by its design. In the course of performance of works it is necessary to provide stability of separate elements and a timbering as a whole [23].

When erecting walls, formwork boards are installed in two stages. First, mount the reinforcing frame, then the formwork on one side to the full height of the floor, and at the last stage - the formwork on the other side. In the top part fix a working flooring with a protective protection.At acceptance of a timbering control the geometrical sizes, convergence of axes, verticality and horizontality of the corresponding elements of a timbering, correctness of arrangement of mortgage details, density of joints and seams. For perception of pressure of concrete mix the timbering is equipped with special inventory screeds, and sometimes additional inserts [8,9,23].

Dismantling of wall formwork is performed sequentially: dismantling (from top to bottom) struts and beacon risers, working fasteners and contractions, formwork boards.When the height of the walls is up to 3 m, the concrete mixture is fed directly into the formwork at several points along the length of the site by buckets or concrete pumps. For concreting, use a concrete mixture with a mobility of 6… 8 cm. Concrete is laid in horizontal layers 0.3 - 0.4 m thick with mandatory compaction of the mixture with deep vibrators. Vibrators must not touch either the reinforcement or the formwork during the compaction of the concrete mix. Transmission through these elements of vibrations can cause the destruction of previously laid layers of concrete. At height of walls over 3 m for giving of concrete mix in a timbering use link "trunks" [23].

In the process of concreting, the condition of the reinforcement is monitored and its displacement from the design condition is prevented. Renewal of concreting on the next highest height is allowed only after the installation of the working seam and gaining strength of concrete not less than 1.5 Mpa [23].

4.3. Technology and organization of work on the construction of columns

The most massive structures erected from monolithic reinforced concrete are columns with a cross section of 0.4x0.4 m… 0.8x0.8 m. For columns with dense reinforcement use a concrete mixture with a cone draft (OK) 6… 8 cm and aggregate size up to 20 mm , with weak reinforcement is concreted with a mixture of OK = 4… 6 cm and aggregate size up to 40 mm [8,9,14,18,23].

Columns up to 5 m high are concreted continuously at full height in layers 0.3… 0.4 m thick. The concrete mixture is loaded from above with a bucket or a flexible "trunk" of the concrete pipe manipulator and compacted with deep vibrators. To reduce the complexity of work and improve the quality of the formwork arrange special windows, through which the supply of concrete mixture and its compaction.In some cases (for supply of concrete mix) the second tier of a timbering of columns is carried out with removable boards which establish only after completion of concreting of the first tier [8,9,14,18,23].

4.4. Technology and organization of work on the construction of floor slabs

Monolithic flooring is arranged after the construction of walls, columns below the floor and gaining the necessary initial strength.Depending on the design solutions for the floor of the house, appoint the technology of their construction. When designing a complex process, it is advisable to use the flow method of work, which is based on the uniform continuous operation of all parts of the process and is accompanied by uniform participation of labor and the use of building materials [23].

To organize the flow of work, the house in the plan is conditionally divided into grips in compliance with the requirements as shown in Figure 4.3.

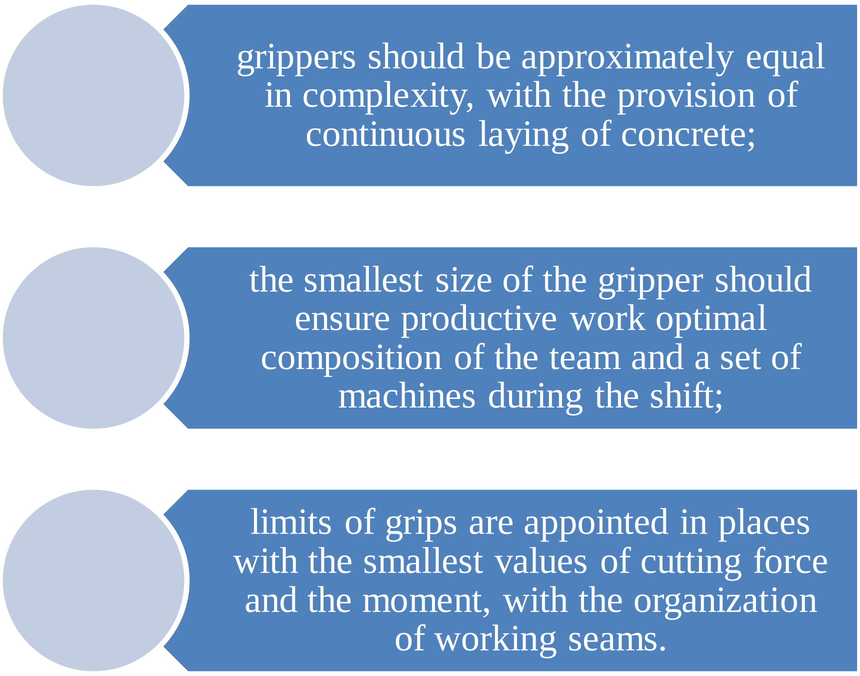

Figure 4.3 – Grips

In beamless floor slabs, the working seam is assigned within 0.25L, where L is the run between the main vertical structures (with the diaphragm of the walls and columns) [23].

In beam slabs, when concreting in the direction of the main beams or girders, the working seams are arranged with in two middle quarters of the girders and slabs. When concreting parallel to secondar beams – with in one third of the beams and slabs. The surface of the working seam must be perpendicular to the surface of the floor slab [8,9,14,18,23].

Between specialized processes of laying concrete mix and dismantling of a timbering organize a technological break (ttp) during which care of concrete is carried out. During this period, the concrete must reach a certain stripping strength (Table 4.1) [8,9,14,18,23].

Table 4.1

Stripping strength of concrete

№	Constructions	Minimum strength of concrete in percent from design to actual loads	
		Less than 70% of the estimated	More than 70% of the estimated
1.	Horizontal and inclined and runs up to 6m	70	100
2.	The same over 6m	80	100

To prevent the harmful effects of loads on the concrete, the movement of people, or the installation of scaffolding is allowed only after it reaches a strength of not less than 1.5 MPa.The system consisting of wooden beams, fork heads, telescopic racks and coatings in the form of boards or sheets of waterproof plywood has become widespread at the present stage of construction of monolithic floors [23].

In order to reduce the number of formwork boards for the construction of floor slabs during the dismantling of the formwork, the supporting struts are replaced by support ones, which support the concrete structure through wooden spacers [23].

The step between the racks is assigned depending on the strength of the concrete [8,9,14,18,23]:

1.2 -1.5 m with a concrete strength of 35-40% of R28;

1.6 - 2.0 m at a strength of 45 -50% of R28;

2.1 - 2.5 m at a strength of 55 - 60% of R28;

2.6 - 3.0 m at a strength of 65 - 80% of R28.

In the process of erecting a building as the strength of concrete is increased, the pitch between the racks is increased to 3000 mm. The final dismantling of the struts is allowed to be performed only when the concrete reaches the design stripping strength [23].

Arrange the racks in the sequence as shown in Figure 4.4.

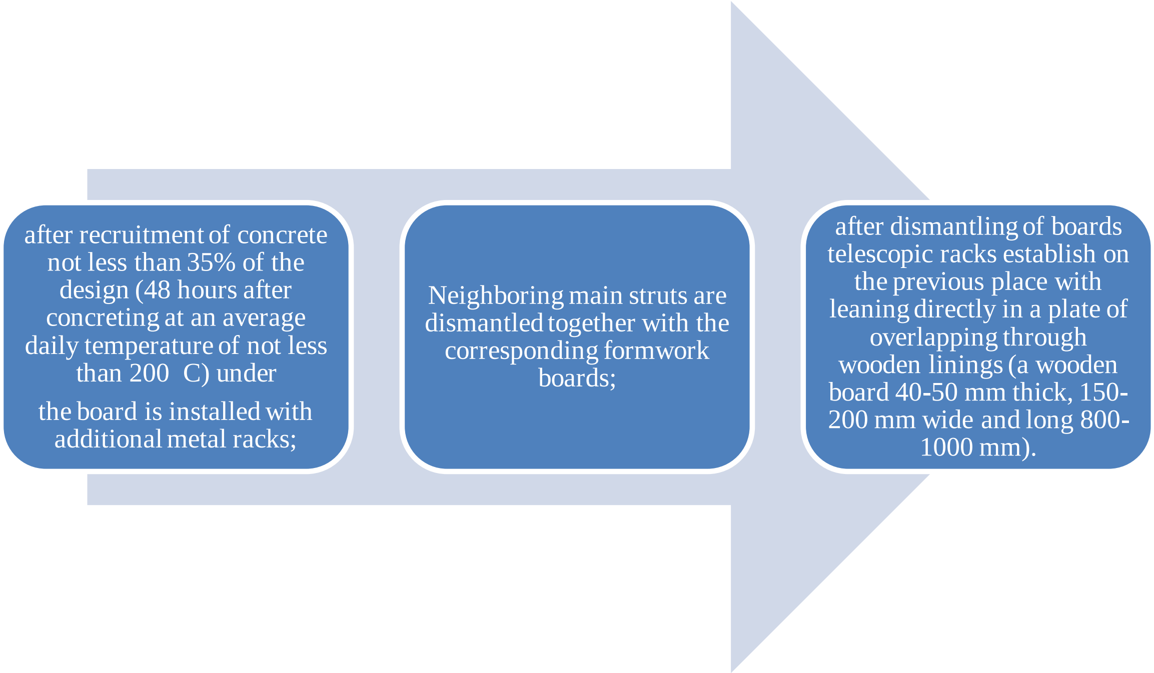

Figure 4.4. – Racks

To dismantle the side elements of the formwork, which do not carry the load from the mass of structures, the required strength should be 0.2… 0.4 Mpa [23].

Conclusions

1. In this bachelor thesis, we examined what types of the apartment buildings are, what engineering solutions were created for them.
2. The second and third sections of the thesis gave us an understanding of how the house is, what decisions are made in it and how it will be created. In the end, we refreshed and maybe someone got new knowledge on the topic of bored piles.
3. Finite element modelling of apartment building is performed by using MONOMAKH-SAPR. Reinforced concrete pylon, mat foundation and slab are designed. Construction procedure of monolithic reinforced elements is developed.

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APPENDENCIES

APPENDEX A. FINITE ELEMENT ANALYSIS RESULTS

Результаты МКЭ расчета

Км 1_2 (1_2)	N	Mx	My	Qx	Qy	T	Сечение
Постоянная	162.89	12.12	-0.679	-0.503	4.29	0	1_2.1
	160.82	-2.02	0.982	-0.503	4.29	0	1_2.2
Кр. временная	38.41	4.06	0.887	0.434	1.62	0	1_2.1
	38.41	-1.29	-0.544	0.434	1.62	0	1_2.2
Ветровая 1	0.652	-1.02	-0.258	-0.133	-0.339	0	1_2.1
	0.652	0.102	0.183	-0.133	-0.339	0	1_2.2
Ветровая 2	0.657	-0.861	-0.083	-0.044	-0.290	0	1_2.1
	0.657	0.097	0.061	-0.044	-0.290	0	1_2.2
Сейсмическая 1	1.79	-1.82	-0.848	-0.435	-0.572	0	1_2.1
	1.79	0.106	0.587	-0.435	-0.572	0	1_2.2
Сейсмическая 2	3.87	-3.42	-0.331	-0.175	-1.15	0	1_2.1
	3.87	0.380	0.247	-0.175	-1.15	0	1_2.2

Км 1_2 (2_2)	N	Mx	My	Qx	Qy	T	Сечение
Постоянная	145.66	-1.77	-1.29	-0.752	-0.501	0	2_2.1
	143.59	-0.114	1.19	-0.752	-0.501	0	2_2.2
Кр. временная	34.06	0.339	0.233	0.161	0.359	0	2_2.1
	34.06	-0.844	-0.297	0.161	0.359	0	2_2.2
Ветровая 1	0.621	-0.045	-0.178	-0.107	-0.029	0	2_2.1
	0.621	0.051	0.174	-0.107	-0.029	0	2_2.2
Ветровая 2	0.595	-0.028	-0.036	-0.022	-0.029	0	2_2.1
	0.595	0.067	0.038	-0.022	-0.029	0	2_2.2
Сейсмическая 1	1.70	-0.272	-0.684	-0.406	-0.198	0	2_2.1
	1.70	0.425	0.654	-0.406	-0.198	0	2_2.2
Сейсмическая 2	3.53	-0.183	-0.145	-0.091	-0.125	0	2_2.1
	3.53	0.265	0.155	-0.091	-0.125	0	2_2.2

Км 1_2 (3_2)	N	Mx	My	Qx	Qy	T	Сечение
Постоянная	128.93	-0.160	-1.17	-0.754	-0.088	0	3_2.1
	126.86	0.129	1.32	-0.754	-0.088	0	3_2.2
Кр. временная	29.84	0.775	0.361	0.221	0.486	0	3_2.1
	29.84	-0.829	-0.367	0.221	0.486	0	3_2.2
Ветровая 1	0.580	-0.097	-0.206	-0.123	-0.049	0	3_2.1
	0.580	0.066	0.199	-0.123	-0.049	0	3_2.2
Ветровая 2	0.535	-0.051	-0.046	-0.027	-0.029	0	3_2.1
	0.535	0.045	0.045	-0.027	-0.029	0	3_2.2
Сейсмическая 1	1.59	-0.333	-0.764	-0.454	-0.146	0	3_2.1
	1.59	-0.498	0.736	-0.454	-0.146	0	3_2.2
Сейсмическая 2	3.19	-0.237	-0.185	-0.111	-0.122	0	3_2.1
	3.19	0.185	0.181	-0.111	-0.122	0	3_2.2

Коэффициенты

Надежности по ответственности 1.1

	надж.	длит.	прод.	расчетных сочетаний 1-е	2-е	3-е
Постоянная	1	1	1	1	1	0.9
Кр. временная	1.3	0.35	1	1	0.9	0.5
Ветровая	1.14	0	0	1	0.9	0
Сейсмическая	1	0	0	0	0	1

Снижающий для кр. врем. нагрузки

Км 1_2 (1_2)	Км 1_2 (2_2)	Км 1_2 (3_2)
1	1	1

Учитывать в расчете:
- автоматически сформированные РСН
- РСН, сформированныедля случаев а, б

Учитывать при автоматическом формировании РСН:
- знакопеременность ветровой и сейсмической нагрузки

Расчетные сочетания нагрузок
Сокращенный список

Первая группа пред. состояний. Случай б (все нагрузки)

Км 1_2	(1_2)	N	Mx	My	Qx	Qy	T	Сечение
Гр. 1	1	234	19.1	0.522	0.0664	7.03	0	1_2.1
		198	15.4	-0.302	-0.337	5.53	0	длит. часть
								Sнс, Sлс, Nc | 1.1ПО+1.43КР
	2	180	12.1	-1.07	-0.721	4.29	0	1_2.1
		179	13.3	-0.747	-0.554	4.71	0	длит. часть
								Tx | 1.1ПО+1.254В1
	3	228	19.7	0.687	0.155	7.18	0	1_2.1
		196	15.2	-0.347	-0.358	5.44	0	длит. часть
								Ty, Sнлс | 1.1ПО+1.287КР-1.1286В1
Гр. 2	1	184	18.7	0.327	0.00439	6.66	0	1_2.1
		171	13	-0.45	-0.39	4.65	0	длит. часть
								Sнс, Ty | 0.99ПО+0.715КР-1.1С2
	2	189	-2.81	1.23	-0.666	4.77	0	1_2.2
		169	-2.32	0.836	-0.39	4.65	0	длит. часть
								Sлс | 0.99ПО+0.715КР+1.1С1
	3	193	11.1	-0.402	-0.381	4.14	0	1_2.1
		171	13	-0.45	-0.39	4.65	0	длит. часть
								Nc | 0.99ПО+0.715КР+1.1С2
	4	163	9.99	-1.6	-0.976	3.61	0	1_2.1
		161	12	-0.672	-0.498	4.24	0	длит. часть
								Tx | 0.99ПО+1.1С1
	5	187	16.9	0.895	0.29	6.03	0	1_2.1
		171	13	-0.45	-0.39	4.65	0	длит. часть
								Sнлс | 0.99ПО+0.715КР-1.1С1

		Первая группа пред. состояний. Случай а (продолжит.)						
Гр. 3	1	234	19.1	0.522	0.0664	7.03	0	1_2.1
		198	15.4	-0.302	-0.337	5.53	0	длит. часть
								Sнс, Sлс, Nс, Ty, Sнлс | 1.1П0+1.43КР
	2	179	13.3	-0.747	-0.554	4.71	0	1_2.1
		179	13.3	-0.747	-0.554	4.71	0	длит. часть
								Tx | 1.1П0
Км 1_2	(2_2)	N	Mx	My	Qx	Qy	T	Сечение
		Первая группа пред. состояний. Случай б (все нагрузки)						
Гр. 1	1	209	-1.46	-1.09	-0.598	-0.0379	0	2_2.1
		177	-1.77	-1.3	-0.747	-0.371	0	длит. часть
								Sнс, Nс | 1.1П0+1.43КР
	2	205	-1.56	-1.32	-0.741	-0.122	0	2_2.1
		176	-1.79	-1.32	-0.755	-0.389	0	длит. часть
								Sлс, Sнлс | 1.1П0+1.287КР+1.1286В1
	3	161	-2	-1.64	-0.961	-0.587	0	2_2.1
		160	-1.94	-1.42	-0.827	-0.551	0	длит. часть
								Tx, Ty | 1.1П0+1.254В1
Гр. 2	1	172	-1.71	-1.27	-0.73	-0.377	0	2_2.1
		153	-1.66	-1.22	-0.704	-0.406	0	длит. часть
								Sнс, Nс | 0.99П0+0.715КР+1.1С2
	2	170	-1.8	-1.86	-1.08	-0.457	0	2_2.1
		153	-1.66	-1.22	-0.704	-0.406	0	длит. часть
								Sлс, Sнлс | 0.99П0+0.715КР+1.1С1
	3	146	-2.05	-2.03	-1.19	-0.713	0	2_2.1
		144	-1.75	-1.28	-0.745	-0.496	0	длит. часть
								Tx, Ty | 0.99П0+1.1С1
		Первая группа пред. состояний. Случай а (продолжит.)						
Гр. 3	1	209	-1.46	-1.09	-0.598	-0.0379	0	2_2.1
		177	-1.77	-1.3	-0.747	-0.371	0	длит. часть
								Sнс, Sлс, Nс, Sнлс | 1.1П0+1.43КР
	2	160	-1.94	-1.42	-0.827	-0.551	0	2_2.1
		160	-1.94	-1.42	-0.827	-0.551	0	длит. часть
								Tx, Ty | 1.1П0
Км 1_2	(3_2)	N	Mx	My	Qx	Qy	T	Сечение
		Первая группа пред. состояний. Случай б (все нагрузки)						
Гр. 1	1	184	0.932	-0.765	-0.514	0.599	0	3_2.1
		157	0.212	-1.1	-0.719	0.147	0	длит. часть
								Sнс, Nс, Ty | 1.1П0+1.43КР
	2	179	-0.85	1.21	-0.684	0.473	0	3_2.2
		153	-0.231	1.29	-0.73	0.122	0	длит. часть
								Sлс, Sнлс | 1.1П0+1.287КР+1.1286В1
	3	143	-0.298	-1.54	-0.983	-0.159	0	3_2.1
		142	-0.176	-1.28	-0.829	-0.0965	0	длит. часть
								Tx | 1.1П0+1.254В1

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                                                                Tx | 1.1ПО+1.254В1
Гр. 2   1       149     -1.01   1.86    -1.09   0.1     0       3_2.2
                133     -0.0795 1.22    -0.691  0.0348  0       длит. часть
                                                                Sнс, Sлс, Sнлс | 0.99ПО+0.715КР+1.1С1
        2       152     0.135   -1.1    -0.71   0.127   0       3_2.1
                135     0.0353  -1.06   -0.691  0.0348  0       длит. часть
                                                                Nc | 0.99ПО+0.715КР+1.1С2
        3       129     -0.525  -1.99   -1.25   -0.247  0       3_2.1
                128     -0.159  -1.15   -0.747  -0.0869 0       длит. часть
                                                                Tx | 0.99ПО+1.1С1
        4       147     0.762   -0.055  -0.0889 0.421   0       3_2.1
                135     0.0353  -1.06   -0.691  0.0348  0       длит. часть
                                                                Ty | 0.99ПО+0.715КР-1.1С1
                Первая группа пред. состояний.  Случай а (продолжит.)
Гр. 3   1       184     0.932   -0.765  -0.514  0.599   0       3_2.1
                157     0.212   -1.1    -0.719  0.147   0       длит. часть
                                                                Sнс, Nc, Ty | 1.1ПО+1.43КР
        2       182     -1.04   0.931   -0.514  0.599   0       3_2.2
                154     -0.273  1.27    -0.719  0.147   0       длит. часть
                                                                Sлс, Sнлс | 1.1ПО+1.43КР
        3       142     -0.176  -1.28   -0.829  -0.0965 0       3_2.1
                142     -0.176  -1.28   -0.829  -0.0965 0       длит. часть
                                                                Tx | 1.1ПО
Номера колонн, определивших РСН:
        1_2
---------------------------------------------------------------------------
                Расчетное армирование
---------------------------------------------------------------------------
                Км 1_2  (1_2)           Км 1_2  (2_2)           Км 1_2  (3_2)
Продольная арматура
 полная         12.568          12.568          12.568
 по прочности   12.568          12.568          12.568
 % армирования  0.50272         0.50272         0.50272
Поперечная арматура
 на 1 м длины   0.169935                0.0231318               0.0253436
Ширина раскрытия трещин
 непродолжит.   0               0               0
 продолжит.     0               0               0
---------------------------------------------------------------------------
                Расстановка продольной арматуры
---------------------------------------------------------------------------
Армирование симметричное.  Выпуски в верхнюю колонну
                Км 1_2  (1_2)           Км 1_2  (2_2)           Км 1_2  (3_2)
                к-во    диам.           к-во    диам.           к-во    диам.
угловые         4       16              4       16              4       16
боковые         4       16              4       16              4       16
Всего           8d16            8d16            8d16
 площадь арм.   16.085          16.085          16.085
 % армирования  0.643398                0.643398                0.643398
---------------------------------------------------------------------------
                Анкеровка продольной арматуры
---------------------------------------------------------------------------
```

```
---------------------------------------------------------------------------
Диаметр стержня Длина анкеровки Длина нахлестки
16              390             470
---------------------------------------------------------------------------
                Расстановка поперечной арматуры
---------------------------------------------------------------------------
                Км 1_2  (1_2)           Км 1_2  (2_2)           Км 1_2  (3_2)

Зона анкеровки
                к-во    диам.           к-во    диам.           к-во    диам.
                4       6               4       6               4       6
шаг             150                     150                     150
привязка 1-го   50                      50                      50
зона раскладки  450                     450                     450
привязка посл.  500                     500                     500

Основная зона
                к-во    диам.           к-во    диам.           к-во    диам.
                12      6               12      6               12      6
шаг             200                     200                     200
привязка 1-го   700                     700                     700
зона раскладки  2200                    2200                    2200
привязка посл.  2900                    2900                    2900

Доборный
                к-во    диам.           к-во    диам.           к-во    диам.
                1       6               1       6               1       6
шаг             150                     150                     150
привязка        3050                    3050                    3050

расст. до верха 50                      50                      50
Площадь арматуры на 1 м длины
                2.82743         2.82743         2.82743
Режимы установки шпилек
 нет
---------------------------------------------------------------------------
                Замечания
---------------------------------------------------------------------------
нет
---------------------------------------------------------------------------
```

Контур Плити(Товщинаплити 20.00 см)								
Точка	X(см)	Y(см)	Точка	X(см)	Y(см)	Точка	X(см)	Y(см)
1	0.00	160.73	2	1.16	760.73	3	0.00	1660.73
4	0.00	1673.23	5	1.20	1693.08	6	2.99	1703.91
7	6.87	1718.31	8	16.15	1741.19	9	29.79	1763.24
10	44.60	1780.10	11	58.48	1792.16	12	73.24	1802.14

Контур Плити(Товщинаплити 20.00 см)								
Точка	X(см)	Y(см)	Точка	X(см)	Y(см)	Точка	X(см)	Y(см)
13	87.85	1809.78	14	104.47	1816.16	15	118.68	1819.93
16	128.97	1821.72	17	140.70	1822.96	18	1122.50	1823.23
19	2095.00	1823.23	20	2107.77	1822.69	21	2119.67	1821.19
22	2130.77	1818.89	23	2141.02	1815.99	24	2151.22	1812.29
25	2162.82	1806.99	26	2173.17	1801.24	27	2183.92	1794.04
28	2196.52	1783.64	29	2210.92	1768.44	30	2221.77	1753.49
31	2230.72	1737.34	32	2236.97	1721.64	33	2241.02	1707.49
34	2244.02	1690.29	35	2245.00	1673.23	36	2245.00	760.73
37	2245.00	160.73	38	1795.50	160.73	39	1793.73	121.20
40	1787.80	103.83	41	1780.57	88.41	42	1757.59	55.80
43	1741.84	40.45	44	1727.47	29.35	45	1711.69	19.80
46	1700.99	14.58	47	1680.32	7.16	48	1665.96	3.55
49	1648.26	0.76	50	1632.50	0.00	51	1609.03	1.75
52	1590.94	5.29	53	1577.04	9.48	54	1564.01	14.58
55	1548.86	22.48	56	1536.82	30.09	57	1526.47	38.05
58	1507.56	55.94	59	1488.86	81.13	60	1481.24	95.08
61	1475.25	109.24	62	1471.27	121.20	63	1462.93	160.57
64	1332.50	160.73	65	1322.50	160.73	66	1320.89	141.12
67	1313.28	109.23	68	1300.23	81.62	69	1283.96	59.99
70	1259.67	39.36	71	1248.31	30.62	72	1224.21	19.73
73	1205.94	14.36	74	1190.25	11.82	75	1178.50	10.67
76	1072.50	10.73	77	1056.99	11.35	78	1040.43	14.24
79	1025.31	18.28	80	1009.13	24.54	81	996.33	31.27
82	977.16	44.91	83	962.35	58.82	84	947.67	77.55
85	936.61	97.01	86	931.90	108.30	87	927.65	121.60
88	923.29	144.52	89	922.50	160.73	90	912.50	160.73
91	772.50	160.73	92	773.73	121.20	93	767.26	102.64
94	757.25	82.61	95	749.92	71.39	96	737.59	55.80
97	726.60	44.83	98	704.92	27.82	99	693.29	20.79
100	680.99	14.58	101	659.38	6.76	102	640.55	2.59
103	625.22	0.56	104	612.50	0.00	105	594.01	1.05
106	582.76	2.74	107	570.27	5.54	108	552.85	11.13

Контур Плити(Товщинаплити 20.00 см)								
Точка	X(см)	Y(см)	Точка	X(см)	Y(см)	Точка	X(см)	Y(см)
109	532.35	20.51	110	521.25	27.02	111	504.29	39.62
112	487.41	55.80	113	473.52	73.79	114	463.14	91.12
115	458.22	101.73	116	452.50	116.50	117	452.50	160.73

ОТВОРИ						
№ отвору	№ точки	X(см)	Y(см)	№ точки	X(см)	Y(см)
1	1	965.00	1030.73	2	1142.50	1030.73
	3	1152.50	1014.73	4	1152.50	908.06
	5	1142.50	865.73	6	965.00	865.73
2	1	965.00	1030.73	2	1142.50	1030.73
	3	1152.50	1014.73	4	1152.50	908.06
	5	1142.50	865.73	6	965.00	865.73
3	1	965.00	1030.73	2	1142.50	1030.73
	3	1152.50	1014.73	4	1152.50	908.06
	5	1142.50	865.73	6	965.00	865.73

Колони											
№ кол.	X ,см	Y ,см	Тип перерізу	b(d) ,см	h(d1) ,см	b1 ,см	h1 ,см	b2 ,см	h2 ,см	b3 ,см	h3 ,см
1	1382.50	1810.73	прямокутник	100.0	25.0						
2	1782.50	1623.23	прямокутник	25.0	100.0						
3	2082.50	1623.23	прямокутник	25.0	100.0						
4	1782.50	1173.23	прямокутник	25.0	100.0						
5	2082.50	1173.23	прямокутник	25.0	100.0						
6	1782.50	760.73	прямокутник	25.0	100.0						

Колони											
№ кол.	X ,см	Y ,см	Тип перерізу	b(d) ,см	h(d1) ,см	b1 ,см	h1 ,см	b2 ,см	h2 ,см	b3 ,см	h3 ,см
7	1782.50	210.73	прямокутник	25.0	100.0						
8	2232.50	210.73	прямокутник	25.0	100.0						
9	462.50	210.73	прямокутник	25.0	100.0						
10	12.50	210.73	прямокутник	25.0	100.0						
11	462.50	760.73	прямокутник	25.0	100.0						
12	162.50	1173.23	прямокутник	25.0	100.0						
13	462.50	1173.23	прямокутник	25.0	100.0						
14	162.50	1623.23	прямокутник	25.0	100.0						
15	462.50	1623.23	прямокутник	25.0	100.0						
16	862.50	1810.73	прямокутник	100.0	25.0						

Стіни					
№	Товщина (см)	X1 (см)	Y1 (см)	X2 (см)	Y2 (см)
1	20.0	1332.50	160.73	1332.50	1211.23
2	20.0	1332.50	1211.23	912.50	1210.77
3	20.0	912.50	160.73	912.50	1210.77
4	20.0	1152.50	160.73	1152.50	908.06
5	20.0	912.50	855.73	1152.50	855.73
6	20.0	955.00	1040.73	955.00	855.73
7	20.0	1332.50	1040.73	912.50	1040.73
8	20.0	1152.50	1014.73	1152.50	1040.73
9	20.0	1152.50	315.73	1332.50	315.73
10	25.0	1122.50	1211.00	1122.50	1823.23
11	20.0	1.16	760.73	175.00	760.73
12	20.0	2070.00	760.73	2245.00	760.73

Характеристики матеріалів

Характеристики матеріалів	
Клас бетону Вид бетону Розрахунковийопір бетону на стиск Модуль пружності бетону	C25/30 - важкий 1170 2.75e+006
Класпоздовжньоїарматури (вздовж X) Розрахунковийопірпоздовжньоїарматури на розтяг Модуль пружностіарматури	A400C 37500 2e+007
Класпоздовжньоїарматури (вздовж Y) Розрахунковийопірпоздовжньоїарматури на розтяг Модуль пружностіарматури	A400C 37500 2e+007
Класпоперечноїарматури Розрахунковийопірпоперечноїарматури на розтяг Модуль пружностіарматури	A240C 18000 2.1e+007
Об'ємна вага	2.5
Жорсткістьпружноїосновигрунту на стиск: Жорсткістьпружньоїосновигрунту на зсув: Відстаньдоцентрів ваги арматури:	0 0
віднижньоїграні відверхньоїграні	3 3

Навантаження										
Тип	Вид	Величина	X1	Y1	X2	Y2	X3	Y3	X4	Y4
Пост.	P-розп.	0.44								
Коротк.	P-розп.	0.15								
Коротк.	P-розп.П.	0.30	1152.50	315.73	1332.50	315.73	1332.50	1040.73	1152.50	1040.73
Коротк.	P-розп.П.	0.30	912.50	1040.73	1332.50	1040.73	1332.50	1211.23	912.50	1210.77
Коротк.	P-розп.П.	0.30	912.50	160.73	1152.50	160.73	1142.50	425.73	922.50	425.73
Коротк.	P-розп.П.	0.40	0.00	788.73	134.51	788.73	134.50	1685.23	803.00	1686.00
			802.94	1823.05	140.70	1822.96	87.85	1809.78	58.48	1792.16
			44.60	1780.10	16.15	1741.19	6.87	1718.31	1.20	1693.08

Навантаження										
Тип	Вид	Величина	X1	Y1	X2	Y2	X3	Y3	X4	Y4
Коротк.	Р-розп.П.	0.40	2245.00	788.73	2110.49	788.73	2110.50	1685.23	1442.00	1686.00
			1442.06	1823.05	2104.30	1822.96	2157.15	1809.78	2186.52	1792.16
			2200.40	1780.10	2228.85	1741.19	2238.13	1718.31	2243.80	1693.08

Коефіцієнтисполучення					
	Постійне	Довготривале	Короткочас.	Сейсміка	Вітер
Надійності	1.00	1.20	1.30	1.00	1.14
Тривалості	1.00	1.00	0.35	0.00	0.00
I осн. сполучення	1.00	1.00	1.00	0.00	1.00
II осн. сполучення	1.00	0.95	0.90	0.00	0.90
III особ.сполучення	0.90	0.80	0.50	1.00	0.00

APPENDEX B. DRAWINGS