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CONTENT

INTRODUCTION

Reconstruction of residential buildings is one of the important ways to solve the housing problem. It allows to prolong the life cycle of obsolete buildings, eliminate communal settlements, significantly improve the quality of housing, modernize by the engineering equipment, improve the architectural expressiveness of buildings, operational reliability and durability, increase energy efficiency.

Every year there is a growing need for reconstruction and restoration of the country's housing stock, as the moral deterioration of buildings is accompanied by physical wear and tear of engineering systems and structural elements, which accelerates the overall aging process.

The minimum required volume of reconstruction of residential buildings is more than 70 million square meters. m of total area. Of these, about 6% of residential buildings - pre-revolutionary buildings, 27% - built in the prewar and postwar years, more than 65% of residential buildings - the first generation of industrial housing construction.

Reconstruction is associated with the restoration of operational performance and strengthening of load-bearing elements of buildings. These works require individual approaches, which differ from the design solutions in new construction process.

Usually the reconstruction of residential buildings is carried out in conditions of increased limitation, which does not allow the use of optimal complexes of construction machines and mechanisms. This circumstance requires the development of new methods of production of works, technical and organizational solutions, the involvement of special machines and the use of new technologies. The severity of this problem increases with the production of reconstruction work without resettlement.

Increasing the density of buildings is one of the important tasks of housing reconstruction. Increasing the number of storeys allows to some extent to solve this problem. The most cost-effective and rational is to increase the density of buildings through low-rise superstructure and extension of buildings, the annexe of multi-storey inserts between reconstructed buildings and the construction of detached buildings, the creation of infrastructure objects, more productive use of underground space.

Comprehensive reconstruction of the quarter building allows to create comfortable living conditions that meet the modern requirements of the urban environment.

To reduce the overall duration and cost of work, industrial technologies are involved. Thanks to these technologies, the efficiency of reconstruction and reduction of social tensions increase.

The problem of building reconstruction is considered from the standpoint of the principle of integrity, which involves a comprehensive consideration of internal and external factors affecting the building during its operation, and a systematic approach, which means making decisions on choosing the most efficient technologies and methods of building reconstruction. The building is considered as a complex system consisting of structures, elements of landscaping, engineering equipment, is under the influence of temporary factors of internal action from operation and the external environment.

The approaches to the practical assessment of the reliability of buildings taking into account the degree of wear of structural elements and methods of their regeneration are planned. Physical and mathematical models of reliability give quantitative and qualitative assessmentof the condition of buildings before and after reconstruction. The obtained techniques allow to predict the condition of buildings and their reliability using time parameters.

Adaptation of developments of technological and organizational reliability of construction, manufacturability of constructive and organizational decisions allowed to use a number of the advanced technologies providing complex reconstruction on quarter building.

It is established that the principles of optimization of technological and organizational solutions can be adapted to the conditions of reconstruction work, carried out, as a rule, on limited sites of urban development.

The most rational solution when carrying out reconstruction in small or medium-sized cities is the concept used, which is based on the principle of low-rise superstructure. This circumstance is associated with minimizing the cost of strengthening structures and maximizing the preservation of existing utilities.

CHAPTER 1
ANALYTICAL REVIEW

1.1 Analysis of housing stock

Reform in the field of housing and communal services is characterized by a gradual change in the relationship between its main actors, namely the authorities, the population - users of housing and communal services, and enterprises - providers of these services. In Soviet times, the main actors in the field of housing and communal services were the state authorities.

Previously, new construction, maintenance and repair were funded by the state. However, today the situation has changed significantly - there is an institution of homeowners (98% of housing is privately owned), as well as business structures operating in the market of construction and operation of housing. However, the issue of determining at the state level the mechanism for financing repair work, which is necessary to keep the housing stock in a satisfactory condition, remains acute. The housing stock of Ukraine is divided into three groups:

1) private housing stock. These include residential houses, privatized apartments (houses) that are privately owned and designed to meet the housing needs of owners and members of their families. The law allows privatized housing to be rented to others.

2) state housing stock consists of buildings owned by state enterprises, institutions and organizations on the right of full economic management or operational management. The state housing stock includes residential buildings that have been put into operation and living quarters in other buildings intended for permanent residence of citizens [1];

3) communal housing stock is a fund owned by territorial communities of villages, settlements, cities, districts in cities.

Today, according to the State Statistics Service, as of 01.01.2015, 97.5% are private housing, 2.3% – communal and 0.2% – state-owned housing.

According to the research of the analytical center of the Association of Ukrainian Cities, today there are 25.5 thousand houses built according to the projects of the first mass series of brick, block and large-panel buildings with a total area of 72 million m^2, i.e. 23% of the city's housing needs to be restored.

Many regions of Ukraine operate over 50 years of age. Thus, in Zaporizhia, Cherkasy, Mykolaiv, Kharkiv, oblasts about 30% are residential buildings built in the 1950s and earlier. 18 - 20% of such housing is in the Autonomous Republic of Crimea, Dnipropetrovsk, Zakarpattia, Ivano-Frankivsk regions. In the city of Kyiv, this share is 13.5% [2].

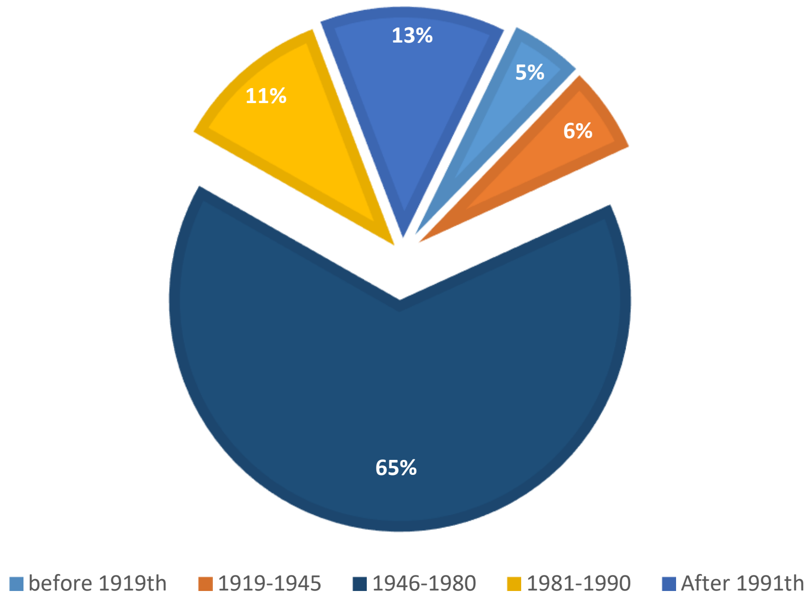

Fig. 1.1. The structure of the housing stock of Ukraine by years of construction

As can be seen from Fig. 1.1, most of Ukraine's housing stock was built in the 1950s, so more than 60% of homes need major repairs. One-fifth of the heating networks are in a state of emergency. More than a third of boilers that provide heat to apartment buildings are energy-intensive and obsolete, municipal infrastructure is worn out more than by 60%.

In the course of long-term operation under the influence of physical and mechanical and chemical factors constructive elements and the engineering equipment constantly wear out; their operational qualities decrease, various malfunctions appear. All this leads to accidents and loss of their original cost. Physical wear is a criterion for assessing the technical condition of the house as a whole and its structural elements and engineering equipment.

By physical wear and tear of buildings, structures and engineering equipment we mean the loss of technical and operational indicators due to human activity, the action of natural, climatic and technological factors. The amount of physical wear characterizes the degree of deterioration of technical and operational performance of the building compared to the original and is expressed by the ratio of the cost of objectively necessary repair work to their replacement cost.

The amount of physical wear of technical equipment, individual structures or their parts is determined according to the tables of the "Rules for assessing the physical wear of residential buildings" [3] by comparing the signs of physical wear with those found during the survey. The growth curve of physical wear of a residential building can be represented graphically in the form of a graph (Fig. 1.2).

Thus, it is safe to say that after 50 years, the physical deterioration of the house begins to increase rapidly, especially in houses whose quality of operation does not meet standards, i.e. it can be stated that current and major repairs are either not carried out or are carried out late and improper way.

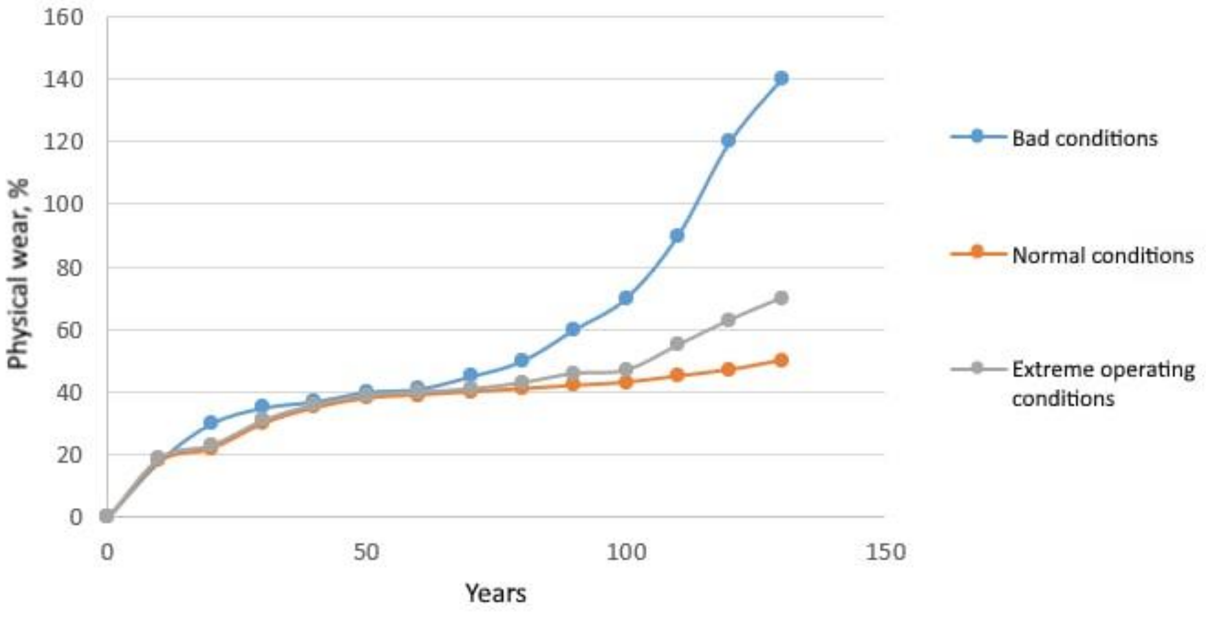

Fig. 1.2. Dependence of physical wear on the age of the house and the quality of its operation

According to state statistics, the housing stock of Ukraine as of January 1,2021 is 9.16 million houses with a total area of 1,014 million m^2, in particular: housing stock of apartment buildings – 510 thousand houses with a total area of 464 million m^2, housing stock of individual buildings – 8,54 million houses with a total area of 560 million m^2 [4]. It should also be noted that 23,913 thousand people lives in individual estates, and 21,719 thousand people – in apartment buildings.

The existing housing stock needs to be repaired and reconstructed. Due to the lack of funding for maintenance, most of the housing stock of Ukraine is in unsatisfactory technical condition, there is a tendency of premature aging of the housing stock. The category of dilapidated and emergency residential buildings includes 55.2 thousand houses with a total area of 4.84 million m^2, in which 167.4 thousand inhabitants live permanently. The housing stock of the houses of the first mass construction, characterized by the worst operational characteristics, is about 72 million m^2. In fact, every fourth city dweller lives in dwellings that are in poor condition and have exhausted their operational resources. Characteristics of the technical condition of the housing stock by regions of Ukraine are given in table 1.1.

According to state statistics as of January 1,2021, 46.9 thousand houses (0.5% of the total number of residential buildings in the country) with a total area of 3.9 million m^2, in which 95.5 thousand inhabitants live, are classified as dilapidated. The emergency category includes 13.2 thousand houses (0.1% of residential buildings in the country), with a total area of 1.2 million square meters, with a population of 23.1 thousand. The increase in the deterioration of the housing stock is due to the significant service life of most residential buildings. Also, one of the reasons for the deterioration of the technical condition of the housing stock is the lack of regular maintenance and overhaul due to lack of funding. The dependence of the increase in physical wear and tear of residential buildings on timely repairs is shown in Fig. 1.3.

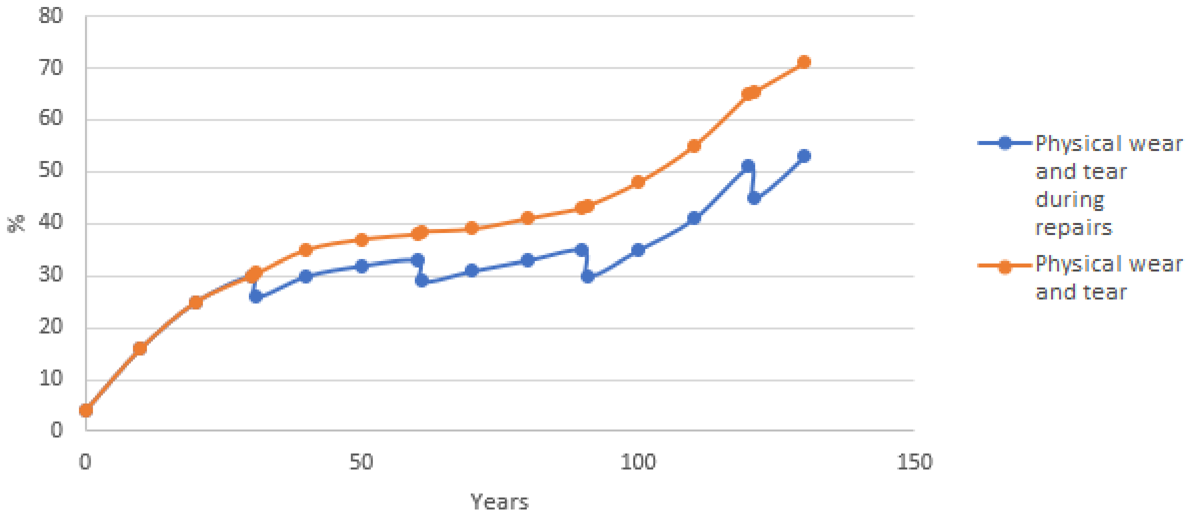

Fig. 1.3. The curve of increase of physical wear and curve of increase of physical wear at timely carrying out of repairs

Analyzing the data illustrated in Figure 3, we can say that the timely overhaul leads to a slowdown in the growth of physical wear and tear, which prolongs its effective use. The urgency of reconstruction work, and especially modernization, is evidenced by the fact that almost 40% of housing in Ukraine is still not equipped with sewerage, heating, hot and cold water, gas, etc. Due to a lack of funding and a lack of skilled workers, housing offices have not been able to cope with their direct responsibilities for a long time, making the already neglected housing stock even worse. The solution to this problem has become possible with the introduction of alternative forms of management and maintenance of housing, such as management companies or associations of co-owners of apartment buildings.

Table 1.1

Characteristics of the technical condition of the housing stock by regions of Ukraine as of 01.01.2021

Region	Number of residential buildings in total, thousand units	Total area of living quarters, thousand m^2	Ветхі та аварійні будинки	
			Total area of dilapidated housing stock, thousand m^2	Total area of emergency housing stock, thousand m^2
Crimea	338,7519	40580,083	203	40,6
Vinnytsia region	562,193	44348,905	265,8	88,6

Volyn region	236,29	22637,413	113	22,6
Dnipro region	608,945	79073,616	237,3	79,1
Donetsk region	851,598	101949,805	235,2	100,8
Zhytomyr region	382,212	33585,344	235,2	33,6
Transcarpathian region	319,992	29354,088	58,8	0
Zaporizhzhia region	350,241	41075,096	82,2	41,1
Ivano-Frankivsk region	353,712	34064,806	102,3	34,1
Kyiv region	547,732	57034,391	285	57
Kirovohrad region	310,754	24728,920	123,5	0
Luhansk region	515,476	55321,557	2212	55,3
Lviv region	466,113	55847,080	111,6	55,8
Mykolaiv region	261,111	25965,756	52	26
Odesa region	481,104	53411,176	427,2	106,8
Poltava region	422,103	36810,639	184	36,8
Rivne region	262,159	24902,841	149,4	24,9
Sumy region	325,566	27939,408	223,2	27,9
Ternopil region	285,283	25911,466	77,7	51,8
Kharkiv region	495,912	64891,166	518,4	64,8
Kherson region	285,07	25524,872	76,5	25,5
Khmelnytsky region	381,133	33861,596	169	33,8
Cherkasy region	428,101	34244,397	239,4	68,4
Chernivtsi region	252,146	21213,691	106	42,4
Chernihiv region	393,911	29982,766	119,6	29,9
Kyiv	35,654	61598,372	369,6	61,598

1.2 Reasons for reconstruction

Today, Ukraine is undergoing a radical restructuring of its economy and economic activity, of which social and cultural transformations are an integral part. Under such conditions, the problem of urban reconstruction acquires national and national importance. Reconstruction and repair of buildings and structures is becoming one of the significant parts of the municipal economy.

In the field of reconstruction, complex social, economic, historical-cultural, architectural-aesthetic, engineering-technical, sanitary-hygienic, town-planning and other problems are closely intertwined, which determines the complexity of urban renewal processes.

To a large extent, the effectiveness of solving the problem of reconstruction of the modern city depends on the successful resolution of issues related to the reconstruction of mass construction areas of the 60-70s, built of typical 5-storey large-panel and brick buildings built according to the rules of the time. that do not meet modern requirements and standards (see Fig.1.4 and Fig.1.5).

In the complex of research of problems of reconstruction of modern cities not only of Ukraine, but also practically of all countries of Eastern Europe, the questions of reconstruction of areas of 5-storeyed building of mass housing construction play an important role.

More than 70 million m^2, i.e. 23% of the housing stock in the cities of Ukraine is the total area of housing in the five-storey version. Approximately one in four city dwellers lives in an apartment building that was built at the time and needs to increase comfort level today.

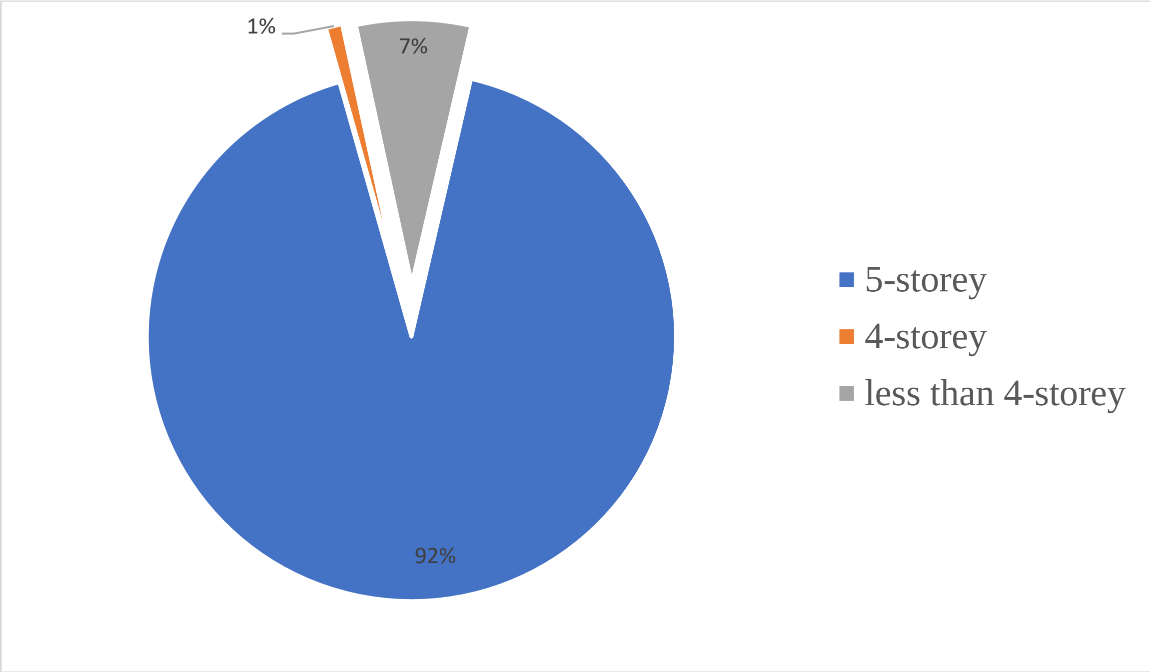

Fig.1.4. Diagram of the number of storeys of the first mass buildings

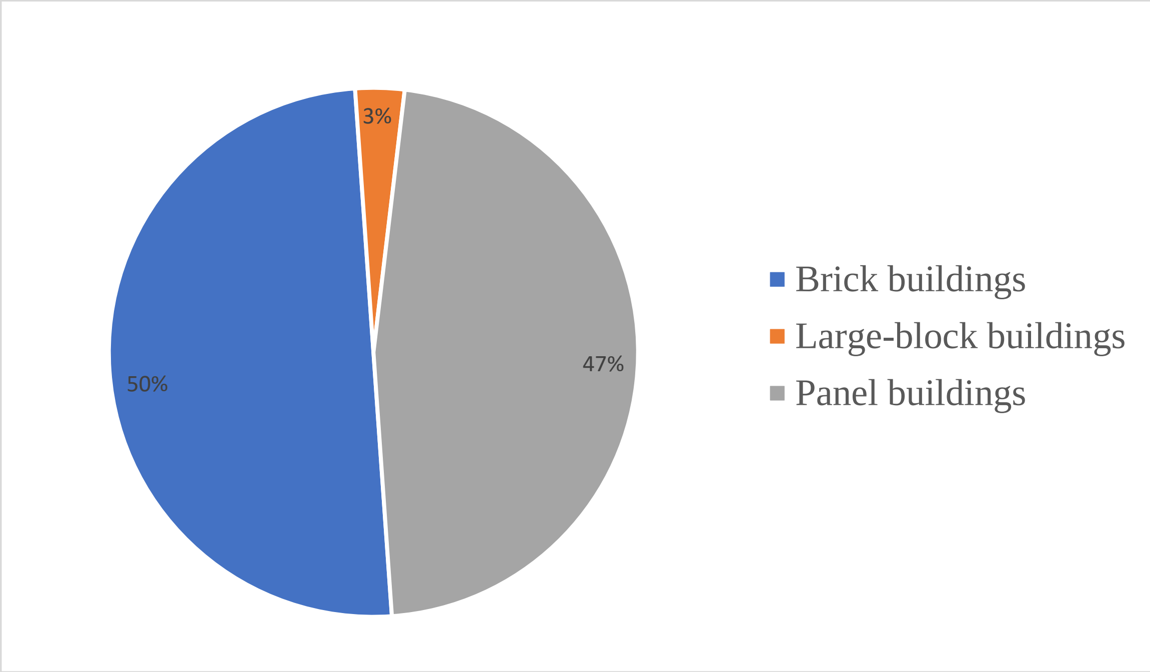

Fig.1.5. Diagram of the construction of the outer walls of the houses of the first mass construction

In the post-war period, due to the urgent need for a sharp increase in the volume of housing construction, the creative research of architects and builders was aimed at the widespread introduction of industrial housing construction technologies, characterized by rigid typing and unification of not only structural elements, planning schemes and space-spatial solutions, but also town planning practices.

In Ukraine at that time, intensive construction was carried out not only in Kyiv, but also in such major cities as Kharkiv, Donetsk, Dnipropetrovsk, Luhansk and others. Today, the total number of houses built on the projects of the first mass series is about 25 thousand units. Of these, the houses of the 464th series account for 20.54%.

Such houses are obsolete, but despite this, the period of physical depreciation for them has not yet expired. In large cities today are almost completely used vacant land for development, which also indicates the feasibility of their reconstruction. Therefore, an important reserve for obtaining additional housing without attracting significant costs for the development of new territories and new construction is the reconstruction of the existing 5-storey buildings of areas of mass housing construction through a set of reconstruction works. In addition, the urban significance of the territories of 5-storey buildings of areas of mass housing construction is highly appreciated. An example of this is the residential area DVRZ or "Vidradny" in Kyiv, which is located in close proximity to the city center, in relation to peripheral modern residential areas has convenient connections with subway stations, the existing service network and a developed system of green areas. In this area, as a result of reconstruction of 5-storey buildings, by improving their planning and design solutions, improving construction techniques, taking into account the improvement of sanitary and hygienic and consumer quality of housing, these benefits will create housing conditions that corresponds to modern requirements.

Increased demands on the quality of the living environment and the need for a variety of types of apartments puts forward the transition to market relations and the emergence of different forms of ownership.

Attracting significant investments that can be realized as a result of reconstruction will help resolve the contradictions between the existing requirements for the comfort of housing and the conditions that have actually developed in areas of mass housing construction. It is urgent to develop a qualitatively new approach to the problems of reconstruction, development of design solutions for the reconstruction of 5-storey buildings, including buildings of series 1-464. Modernization of the planning decision of 1-464 series buildings should be based not on "improved" standard projects, but on design decisions in relation not only to the technical condition of a particular building, but also its place in the spatial planning structure of the district as a whole. Only with such an approach to reconstruction it is possible to justify options for planning apartments that would take into account the specific urban situation, sanitary and hygienic conditions of the environment and the needs of the population.

The development of new methodological approaches is made urgent by the lack of sufficient regulatory and methodological support for the design of reconstruction of serial buildings of 5-storey buildings of areas of mass housing construction, taking into account modern requirements for housing comfort.

It is necessary to take into account the emergence of various forms of ownership and the removal of restrictions on the area of apartments of private owners. As a result of reconstruction there is a possibility of receiving various types of apartments: commercial (bought in private property) and social (given by the state on the basis of rent).

Regardless of the need to improve the consumer quality of the first type of apartment by increasing the size and variety of planning decisions, sanitary and hygienic conditions for all types of apartments must meet regulatory requirements.

1.3 Reconstruction problems

It should be noted that in recent years, the number of accidents during the reconstruction has increased significantly. This applies not only to unique or large-scale, but also ordinary small buildings. There are several reasons for this. This may be due to negligence of workers or poor quality of materials, but the main reason is the small number of regulatory and methodological support, and the lack of a single and "adequate" method of calculating the stress-strain state of the structure where the design scheme is changing due to installation or dismantling buildings during reconstruction [5]. In order to reduce the risk of an emergency situation, in the process of reconstruction, it is necessary to accurately investigate and predict the stress-strain state of the structure.

1.4 Subject of research

On the example of the project of a 5-storey dormitory building with built-in non-residential premises designed to accommodate offices and two apartments (Lugansk, Kotelnikova Street, 1).

The structural scheme of the building is made with a mixed frame: longitudinal and transverse frames of brick columns and rigidly hammered into them prefabricated reinforced concrete beams and load-bearing longitudinal and transverse walls on which the prefabricated reinforced concrete beams rest. The ceilings of the 1st floor and the basement are made of prefabricated reinforced concrete inserts with a rack at the bottom of the prefabricated reinforced concrete beams. The floor of 2-5 floors is made of prefabricated reinforced concrete beams, on which are laid load-bearing wooden beams. During the reconstruction of the building, the floors of 1-5 floors were replaced with monolithic reinforced concrete floors. There is also an opening (dismantling of the wall element) for the entire height of the building.

Fig. 1.6 shows the general view of the dormitory building before and after the reconstruction

a)

b)

Fig. 1.6. General view of the dormitory building a) before reconstruction b) after reconstruction

CHAPTER 2
ARCHITECTURAL DESIGN

2.1. General data

2.1.1. Urban development conditions

Reconstruction of a dormitory building with built-in non-residential quarters for an office and two apartments. Luhansk, street Kotelnikova, 1

The land plot under reconstruction is located in the built-up area, in the central part of the city of Luhansk (see Fig.2.1).

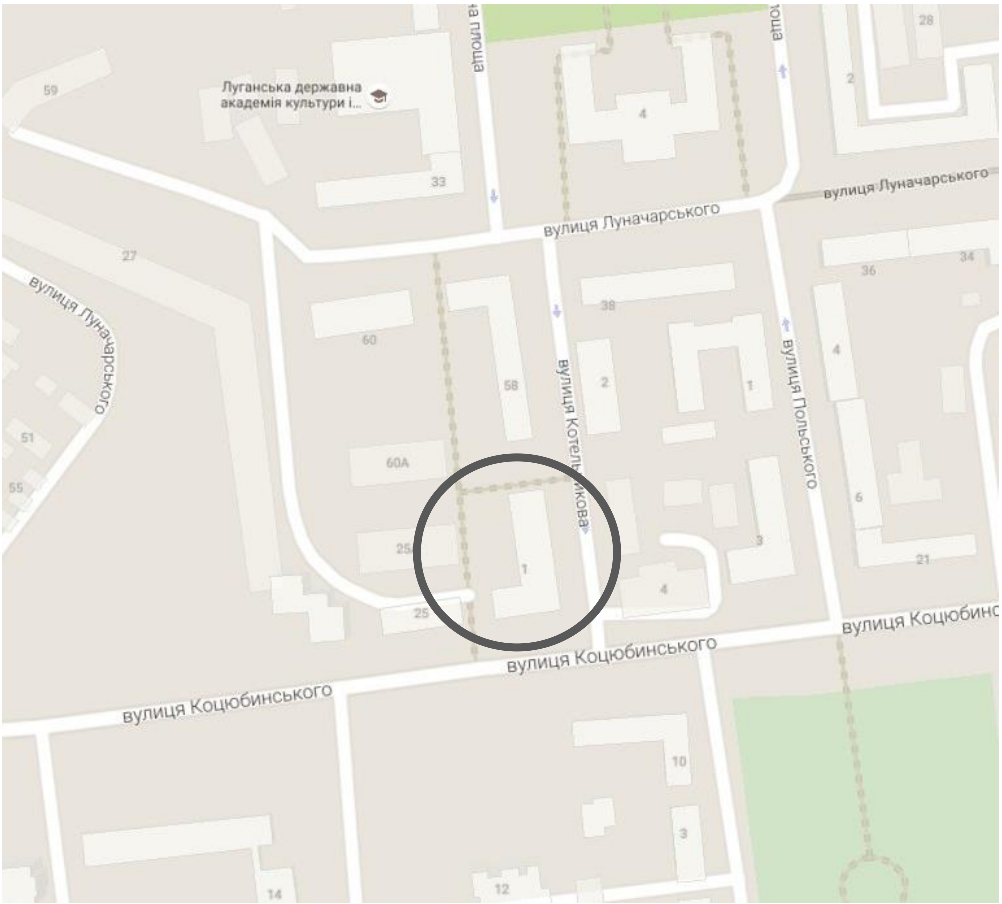

Fig 2.1. Situatory plan.

The relief of the sloping area is equal to the general slope in the north-western direction. The absolute mark of the surface varies from 78.0 to 81.0. The site is equipped with access roads that provide transportation of construction materials on the site. Travel to the construction site for road transport is carried out from the street.

Kotelnikov. Sedimentary soils are an unfavorable physical and geological factor within the site.

2.1.2. Master plan

The land plot where the building will be reconstructed is located in the central part of Luhansk directly on Kotelnikova Street 1.

The general plan of the land plot of the administrative building of LLC "LEO" is developed according to: town-planning requirements, DBN 360-92 *, DBN B.2.3-5-2001 and tasks for designing. The project provides for the following measures for the organization and improvement of land.

The outer part of the plot:

- arrangement of a parking lot for temporary storage of visitors' cars for 10 cars, with a rectangular (90 °) arrangement of cars, in the "pocket" of the carriageway of Kotsyubinsky street. Arrangement of lawns along the main facade. Parameters of parking places – 5.0x2.5 m. Material of covering of territories of parking – asphalt concrete. Pavement material - concrete tiles. Preserved trees in the parking lot should be protected with a lawn of stumps 1.0x1.5 m.

Courtyard of the plot:

- arrangement of fencing of the yard in the sash of the facades and along the branch line with gates for pedestrians and gates for entry and exit of cars. The main entrance-exit to the territory of the yard is planned at the intersection of the inner quarter passages going from the Kotelnikov street and from the Lunacharskogo street. A security post is located at the entrance. The emergency entrance-exit is planned on the axis of the existing driveway to the residential building №47. It is planned to arrange a turning area on this driveway.
- on the territory of the yard is organized a one-way road with a width of 3.5 m and areas for economic purposes, including a site for garbage collection. Material of covering the territory of the yard – asphalt concrete. Sanitary gaps

from the windows of residential and public buildings to utility sites are sustained.

The master plan is made on a topographic survey at a scale of 1:500 and is shown in Fig. 2.2. Materials of technological, construction and plumbing parts of the project were used during its development.

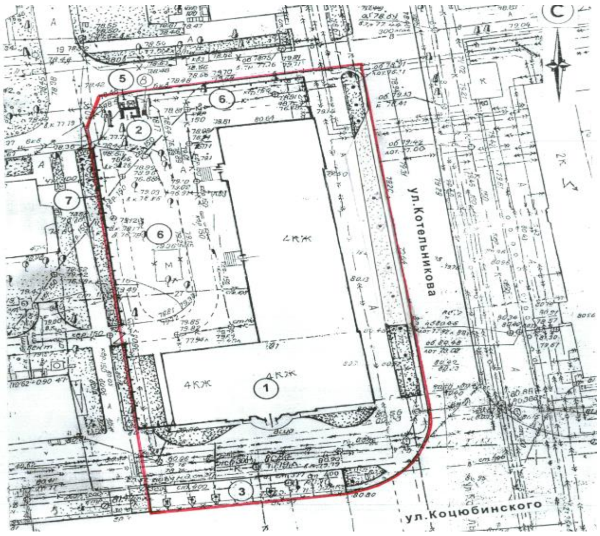

Fig 2.2. Master plan

2.2. Natural circumstances

The construction area of Luhansk, according to DSTU-N B B.1.1-27:2010 [6] belongs to zone II and has the following climatic characteristics:

• average annual temperature +8,6 ° C;

• average January temperature -5 ° C;

• average temperature in July + 22 ° C;

• the outdoor air temperature of the cold five-day period 0,98 -29,0 ° C;

• the duration of the period with an average daily temperature of less than 0 °C 188 days;

• depth of freezing of the soil 1,2m.

2.3. Volume-planning solutions of the building

The planning and constructive decision of the building is subject to new requirements of comfort on thermal conductivity of external walls.

Structural scheme of a building with an incomplete frame, with external and internal load-bearing walls.

Fig 2.3. Photo of the reconstructed building

The dormitory building (see Fig. 2.3), which is subject to reconstruction, with built-in non-residential premises is designed to house offices and two apartments. In axes 15-17 on the second and third floors the location of two service apartments is designed. From the first to the fifth floor there are offices.

The building was commissioned in the early 50th of last century. The building is L-shaped in plan and consists of 2 parts (axes 1-4, A-M the building is 5-storey, axes 5-17, A-I – 4-storey), structurally related. In axes 4-5 the temperature seam is executed. Paving is made along the perimeter of the building. The structural scheme of the building is made with a mixed frame: longitudinal and transverse frames from brick columns and rigidly hammered in them prefabricated reinforced concrete beams located on axes 2, 3 and in axes 2-3, on axes D, F and in axes D-F and load-bearing longitudinal and transverse walls on which prefabricated reinforced concrete beams rest. Thus, the spatial stability of the building in the longitudinal and transverse directions is provided by rigid frames.

In the axes 3 t 8, A t Q is located in the basement (former bomb shelter). Basements, located in the axes 8-12 and 12-17, which isn’t connected by passages. Basement walls are made of rubble stone sandstone.

Exterior and interior walls are made of solid and silicate brick.

Basement overlap is monolithic reinforced concrete. The overlap of the 1st floor is made of prefabricated reinforced concrete inserts with a rack at the bottom with dimensions of 500 x 900 mm reinforced concrete beams. The overlap of 5 floors is made of prefabricated reinforced concrete beams, on which are laid load-bearing wooden beams.

The roof is tent. in the 4-storey part of the building – 3-pitched, in the 5-storey part – 4-pitched.

The roof is made of roofing steel on a wooden frame.

The entrance and access to the residential part of the house is provided from the Kotsyubynskoho street.

The entrance and access to the office space of the house is provided from the Kotsyubynskoho street.

Smokeless stairwell type H-1 [7].

2.3.1. Architectural measures of fire protection

To ensure fire safety are provided:

- installation of fire shields, sandbox and water tank under the canopy during the reconstruction of the building;
- installation of protective shut-off devices is provided on the lines supplying socket groups;
- water consumption for the purposes of external firefighting is 20 l/p;
- insulator used for wall insulation (expanded polystyrene) is separated by a layer of non-combustible fibrous material (basalt fiber) with a width of at least 200 mm in height of the level of overlaps;
- suspended ceiling frame is made of nonflammable materials;
- safety signs are installed in all non-residential premises and inscriptions are made in accordance with the classification of fire zones;
- wiring is performed by cables with copper cores with wires connecting by means of electrical junction boxes;
- inscriptions, plates and the like are provided with an indication of the location of the nearest telephone and the method of calling the fire brigade.

The water well in which the fire hydrant is designed is installed at the point of connection to the existing water supply networks.

For the needs of external firefighting, existing fire hydrants can be used, located at 2 and 7 Kotelnikova Street in the wells of the existing city water supply network with a diameter of 100 mm at a distance of less than 150 m from the building. Fire hydrants must be tested by the public utility company "Miskvodokanal" (it is necessary to provide a hydrant test report). Locations of fire hydrants are indicated by indicators illuminated in the dark.

According to DBN B.1.1.7-2016 [7], the reconstructed building has a degree of fire resistance III.

Service apartments located on the second and third floors of the reconstructed building, isolated from public premises (no common entrances and stairwells).

Opening windows with an area of more than 1.2 square meters are provided in the outer walls of stairwells.

The calculation of primary means of fire extinguishing is made and the ordered specification for purchase of fire extinguishers and fire doors is executed.

Fire extinguishers OU-3 should be installed in the following rooms: in the switchboard and ventilation chambers (premises №№17, 602, 603); in offices with a computer for 2 pcs. (№№128, 147, 168); in offices with a computer for 2 pcs. (№№121, 137, 169).

An internal fire-fighting network equipped with fire hydrants has been designed. Fire hydrants are installed in the socle, 1st, 2nd, 3rd, 4th, 5th floor in special lockers at a height of 1.35 m above floor level. It is also necessary to install two fire extinguishers OP-9 in special lockers for fire hydrants.

Also to install shockproof doors (with a fire resistance limit of at least 30 minutes for ventilation rooms), exits from the attic and the front doors to the apartments.

To install a shockproof door with a fire resistance limit of at least 45 minutes for switchboard premises.

At least two evacuation exits from each floor have been designed.

Exit from the basement does not connect with the stairwells of public and residential parts of the building. There are 7 opening windows in the basement with size 0.9x1,2 m with brackets in the pit for evacuation.

Fire breaks to existing buildings, structures, utilities are observed.

The internal fire-fighting water supply system with a water consumption of 2.5 l/s is designed.

Building structures with a standardized limit of fire resistance are used.

Wooden elements of attic coverings (rafters, latticework) are processed by means of fire protection which provides group I of fire protection efficiency according to GOST 16363-98 [8]. Fire-retardant work must be carried out by an organization licensed to carry out this type of work.

Cabinets for fire hydrants placed on the evacuation routes and the walls protruding beyond the plane do not reduce the normalized width of the evacuation route.

The entrance to the fire truck facility is designed on the appropriate roads with the following characteristics:

- distance from the nearest edge of the road to the building – 8-10 m;
- road width for fire truck – 3.5m;
- bearing capacity of the road surface – 28 tons per axle;
- radius of curvature – 12м;
- the slope is NOT more than 10% on the road and 1% on the site for the installation of mechanical ladders.

2.4. Architectural and constructive decisions

2.4.1. Overall dimensions

Spatial planning decisions of the building are made on the basis of the design task and in accordance with the requirements of sanitary and fire regulations.

Degree of fire resistance of the house – III. Production category – F.

The building consists of two 5- and 4-storey blocks separated by a temperature seam, with three stairwells (two for the administrative part of the building and one for residential apartments of official appointment), with L-similar form in plan, the size in the axes 58.01x29.40 m and the height of a typical floor – 3.3 m, the fifth – 3.4 m, basement – 3.3 m.

2.4.2. Constructive solutions

The building has an incomplete frame, external and internal load-bearing walls.

2.4.3. Load-bearing walls of the building

Basement walls made of rubble sandstone 800 mm thick on M50 cement mortar. The walls of the 1st floor are of red clay solid brick M75 on cement-lime mortar M50 thickness - 640mm. External walls 510 mm thick of the other floors from a silicate brick of the 100 brand on a cement-lime solution of the 25-50 brand. In some areas of the outer walls in the partitions of the masonry of the inner verst is made of slag concrete stones. The total area is 2474.2 m2, with thermal resistance

Ract=5,7 m^2 °C/W;

Internal load-bearing walls from a red corpulent clay brick of the M75 brand on cement-lime mortar of the M50 brand.

Thermal calculation of external walls

The calculation is carried out in accordance with DBN B.2.6-31:2016 [9].

Estimated winter outdoor temperature; К; For the Lugansk city is -22˚С

The building is built in the humidity zone №2 (normal), the mode of the room (living room) - normal. Operating conditions of protective structures "B".

Table 2.1

Thermal characteristics of load-bearing wall materials

Material	Thickness F, mm	λ, *W/(m·K)*	R ,*m^2· K/ W*
Silicate brick	510	0,871	0,59
Insulation	30	0,055	0,55
Internal plaster	20	0,814	0,02

We perform a calculation to determine the coefficient of heat transfer resistance:

Ro exterall=0,133+0,59+0,55+0,02+0,05=1,343

Finding the required heat transfer resistance of enclosing structures:

where n – coefficient, which is taken depending on the location of the enclosing structure in relation to the outside air temperature;

n=1 for exterior walls and non-attic floors;

n=0,9 for attic floors;

t – estimated indoor air temperature, K;

t – estimated winter outdoor temperature; K;

Δt – normative temperature difference between the temperature of the indoor air and the temperature of the inner surface of the enclosing structure; Δt = 7 – for external walls, Δt =5 – for coverings and overlappings;

λ – heat transfer coefficient to the inner surface of enclosing structures; for walls, floors and smooth ceilings = 0,133W/m^2· K.

We compare the obtained values:

R =1,343m^2•K/W > Rcr=0,817 m^2•K/W

The actual value of thermal resistance is greater than necessary. The condition is met. The wall is suitable for economic indicators.

2.4.4. Internal partition walls

Depending on the planning decisions, the internal partition walls are made of aerated concrete blocks 100 mm thick (in the interior partitions), 200 mm (in the interior partitions), 300 mm (in the corridors).

The walls are combined with inclusion of monolithic reinforced concrete pylons on constructive decisions except the above-stated walls.

Partitions of underground floors are made of brick, 120 mm thick.

2.4.5. Wall finishing

In bathrooms and kitchens on all height of the room plastering, putty, a first coat and painting by acrylic structures is provided. Paint color chosen by the responsible designer. In living rooms pasting by wall-paper on in advance prepared surface is provided.

2.4.6. Overlap

Overlapping is monolithic beamless. Reinforcement with class A-III fittings (diameter 12 mm). For reinforcement, knitted nets are used, combined into spatial frames. Concrete for overlapping – class B25.

2.4.7. Stairways

The design of ladders is combined-monolithic (platforms – monolithic reinforced concrete, marches - type-setting reinforced concrete stroke of factory production).

2.4.8. Floors

Depending on the purpose of the premises, the floors can be made of concrete, wood, linoleum, and in the bathrooms – of ceramic tiles. The floor is laid on cement-sand screed 20 mm thick, and foam concrete insulation 50 mm thick, in all rooms of the building, except bathrooms.

The floors of the bathrooms are made of ceramic tiles, which are laid on cement-sand contraction 30 mm thick, the third layer is foam concrete 50 mm thick. Arranging a waterproofing from a polyethylene film is between a layer of foam concrete and a plate of overlapping.

2.4.9. Ceilings

Depending on the purpose of the room, the project provides for the following ceilings:

- in apartments – putty, primer, painting with acrylic compositions;
- in office premises – putty, primer, painting with water-dispersed compositions;

2.4.10. Exterior finishing

2.4.10.1. Finishing of facades

Finishing the facades of the building involves painting with weather-resistant paints on light gray plaster. Window blocks are metalplastic with filling of apertures with double-glazed windows. The base of the building is veneered with brown ceramic tile.

Interior decoration involves, mainly, a suspended ceiling type "Armstrong", walls - plaster, painting with silicate paints, wallpapering.

2.4.10.2. Exterior windows and doors

All external apartment doors are made of the metal profiles plasticized in factory conditions. These doors and windows are equipped with the necessary neoprene gaskets. All deaf front doors and vestibules are provided with a layer of insulation.

Glazing of windows is performed by double-glazed windows.

2.4.10.3. Interior doors and partitions

Depending on the place of installation and purpose of the project, metal, metalplastic and wooden interior doors, as well as brick or aerated concrete partitions are provided.

2.4.10.4. Waterproofing

The project provides for three types of waterproofing:

1) Waterproofing type 1 is provided for waterproofing of walls on perimeter, plates on the ground and plates of the area of object.
2) Waterproofing type 2 is used on floors in bathrooms, kitchens, technical rooms and in the parking garage.
3) Waterproofing type 3 is intended for waterproofing flat roofs and terraces.

2.4.10.5. Construction heat engineering

The roof of the residential building is insulated with TECHNOROOF mineral wool boards, thickness 150 mm (γ = 140 kg/m^3, λ = 0,040 W/m°C). Ract = 3.95 m^2°C/W, which is not less than necessary R0 = 3,75 m^2°C/W.

Overlapping area at the +3.600, which is the outer enclosing structure (above the parking lot), insulated with extruded expanded polystyrene (γ = 35 kg/m^3, λ = 0,029 W/m°C) thickness 100 mm. Heat transfer resistance Ract = 4,0 m^2°C/W, what is more than necessary R0 = 3,75 m^2°C/W.

Windows and balcony doors are metal-plastic blocks with triple glazing (with an outer layer of double-glazed windows). Actual heat transfer resistance

Ract = 0,576 m^2°C/W > R0 = 0,5 m^2°C/W.

Entrance doors to the house are metal with a combination lock insulated. Actual heat transfer resistance

Ract = 0,50 m^2°C/W > R0 = 0,44 m^2°C/W.

Entrance doors to the apartment are metal fire insulated. Actual heat transfer resistance

Ract = 0,30 m^2°C/W > R0 = 0,25 m^2°C/W.

Entrance doors of offices are metalplastic with triple glazing (with an external layer from double-glazed windows). Actual heat transfer resistance

Ract = 0,576 m^2°C/W > R0 = 0,5 m^2°C/W.

Warming of walls of the stairwells adjacent to apartments to execute expanded polystyrene t = 50 mm and plastering with cement-sandy solution on a grid t = 10 mm.

CHAPTER 3
CONSTRUCTIVE PART

3.1 Initial data for design

The building consists of two 5- and 4-storey blocks, separated by a temperature seam, with three stairwells (two for the administrative part of the building and one for residential premises for official purposes), with L-shaped form in the plan, the sizes in axes 58,01x29, 40 m and height of a typical floor – 3,3 m, the fifth floor – 3,4 m, basement – 3,3 m.

Foundations for external and internal walls are made of rubble sandstone with a strength of at least 40.0 MPa on lime-cement mortar brand M50.

Brick columns are made of red clay solid brick brand M75 on cement-lime mortar brand M50, different cross-section in plan. They have an axial reference in the plan.

The monolithic beamless overlapping is projected. Reinforcement is carried out with reinforcement class A400C (diameter 12 mm). Knitted nets combined into spatial frameworks are provided for reinforcement. Concrete class of floor slabs is C20/25.

The external and internal walls of the building are load-bearing. Basement walls made of rubble sandstone 800 mm thick on M50 cement mortar. The walls of the 1st floor are made of red clay solid brick M75 on cement-lime mortar M50 thickness – 640 mm. On the outside, the 1st floor walls have a protective plaster layer. The external walls of the next floors are 510 mm thick and made of M100 silicate brick on M25-50 cement-lime mortar. On separate sites of external walls in piers a laying of an internal wall is made of slag concrete stones.

The internal walls are made of red solid clay bricks of the M75 brand on a cement-lime mortar of the M50 brand.

Construction area – Luhansk:

- snow load on the 4th district [10] So = 1.4 kPa;

- wind load in 2nd district [10] Wo = 0,5 kPa;
- regulatory value of the load on the overlap P = 2,0 kPa;
- soil conditions of the III category;
- seismicity of the construction site – 5 points [11];
- average temperature of the coldest five weeks: -25° C.
- estimated winter temperature of the coldest day: -29° C.
- maximum depth of soil freezing – 1m.
- There is no aggressive influence of technological processes on building structures. Groundwater at a depth of 15 m isn't detected.

3.2. Calculation of the reconstructed building

To create the design scheme of the building, it was necessary to create an architectural plan of a typical floor with geometric dimensions in the AutoCAD program. Then create five new layers (WALLS, WALL_DOORS, SLABS, SLAB_OPENING, COLUMNS), and specify each layer according to the design element. Export the resulting drawing to the LAYOUT(КОМПОНОВКА) program.

In the LAYOUT(КОМПОНОВКА) program we set the following parameters: characteristics of materials for each type of structures, characteristics of the soil base, add foundations, adjust the size of the elements and set the load:

- Evenly distributed loads:
  - Constant loads from own weight of plates of overlapping and a roof;
  - Long-term snow load is determined by the formula:

$$Sp = (0.4\ So - \overline{S}) \cdot C \tag{4.1}$$

where S = 160 Pa = 0,016 t/m²; So – characteristic value of snow load, which is determined by DBN B.1.2-2:2006[10] Fig. 8.1; C = 1;

  - Short-term snow load is calculated by the formula:

$$S_m = \gamma_{fm} \cdot S_0 \cdot C \tag{4.2}$$

where γ_{fm}= 1

- Temporary loads (depending on the purpose of the building, climatic and seismic areas).

- Linear loads – loads from partitions and other structures that are not marked on the design diagram.
- Seismic load determined according to DBN B.1.1-12:2014 [11].
- Wind load determined in accordance with 9.1 DBN B.1.2-2:2006 [10].

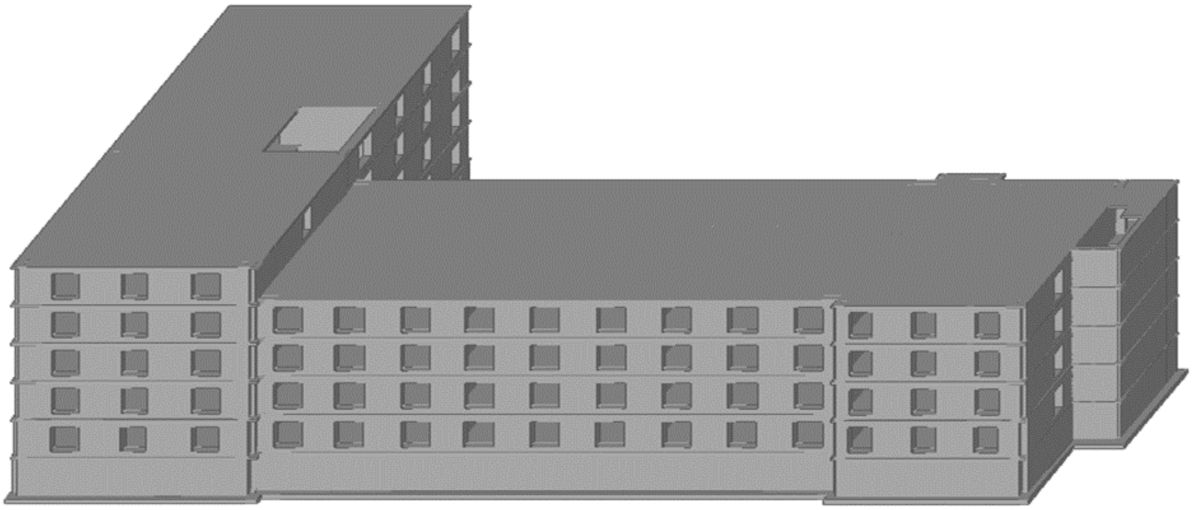

Fig. 3.1. 3-D model of the reconstructed building

Table 3.1

Collecting loads for paving slabs on marks 19,200;16,000m.

Type of load	Regulatory load, Pa	Coefficient of reliability on loading γ_f	Estimated load, Pa
Constant from weight:			
Concrete preparation of the brand C8/10 $\delta = 40$ mm	800	1.1	880
Waterproofing (3 layers of bituminous mastic) $\delta = 15$ mm	180	1.1	198
Concrete screed C8/10 $\delta = 60$ mm	1200	1.1	1320
Protective layer "Panbeksil" $\delta = 20$ mm	360	1.1	396
Reinforced concrete floor slabs C20/25 $\delta = 250$mm	6250	1.1	6875
Total:	8790		9669
Temporary:			
long-term	1500	1.2	1800
short-term	1000	1.2	1200
snowy	1600	1.2	1920
Total:	4100		4920
Full:	12890		14589

Table 3.2

Collecting loads for floor slabs (1-4 floors)

Type of load	Regulatory load, Pa	Coefficient of reliability on loading γ_f	Estimated load, Pa
Constant from weight:			
Concrete preparation of the brand C8/10 $\delta = 40$ mm	800	1.1	880
Waterproofing (3 layers of bituminous mastic) $\delta = 15$ mm	180	1.1	198
Concrete screed C8/10 $\delta = 60$ мм	1200	1.1	1320
Protective layer "Panbeksil" $\delta = 20$ mm	360	1.1	396
Reinforced concrete floor slabs C20/25 $\delta = 250$mm	6250	1.1	6875
Total:	8790		9669
Temporary:			
long-term	6000	1.2	7200
short-term	4000	1.2	4800
Total:	10000		12000

To calculate the foundation structures (strip and columnar foundation) a model of the soil base will be created and attached to the model of the building created in the program LAYOUT (КОМПОНОВКА).

Next, the calculation of the entire building and the calculation of the finite element method was performed.

The results of the calculation of the finite element method:

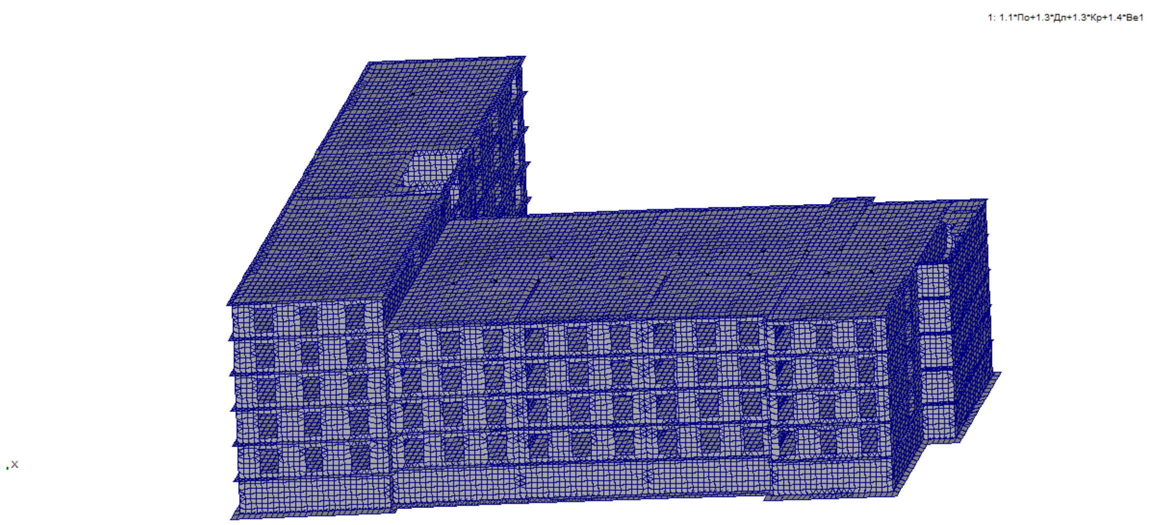

Fig. 3.2. Deformed diagrams of building sections

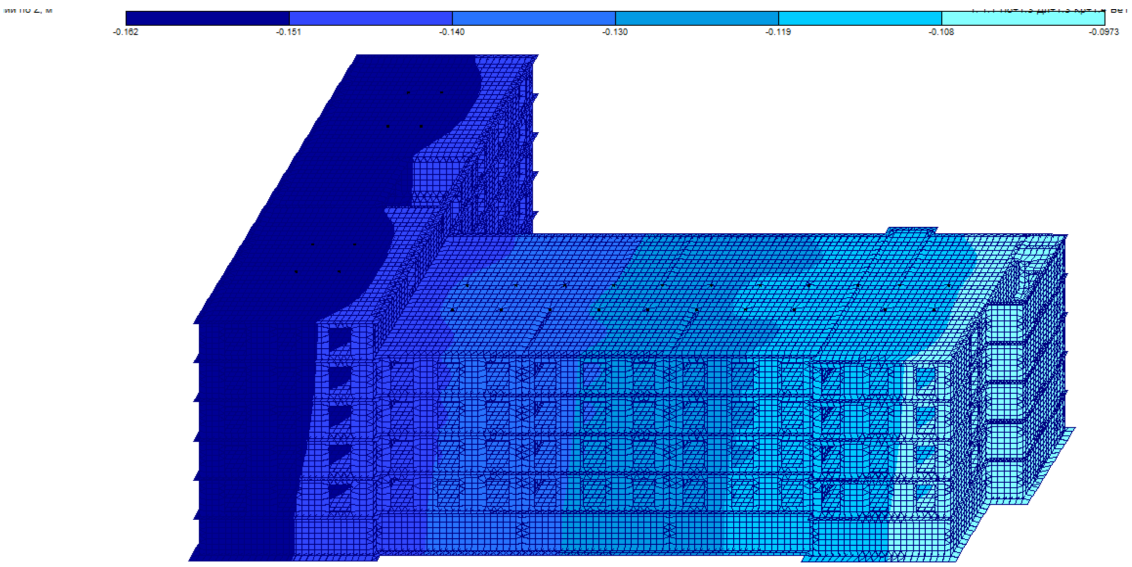

Fig. 3.3. Moving sections of the building along the axis Z

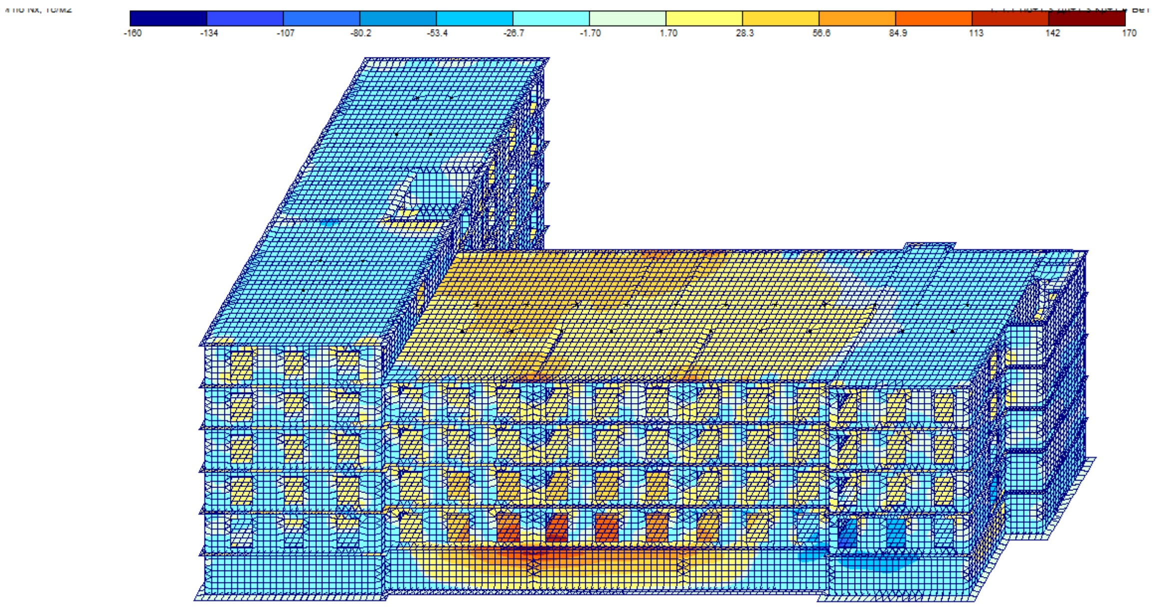

Fig. 3.4. Stress isofields Ny

After the calculations, we can export the data for each structural element in the design programs MONOMACH-SAPR and LIRA-SAPR for more detailed calculation and reinforcement.

3.3. Calculation and design of a monolithic floor slab

Calculation, design and reinforcement of the floor slab is performed in the software package LIRA-SAPR 2021.

For greater accuracy of reinforcement, the plate is calculated together with the entire structure, so we take into account the work of the entire structure.

An important point in the formation of the design scheme of the plate is the purpose of the finite elements. For floor and floor slabs we will use universal shells of a finite element – №41, №42 та №44.

After calculating the constructive model of the house, select the plate we need and view the results.

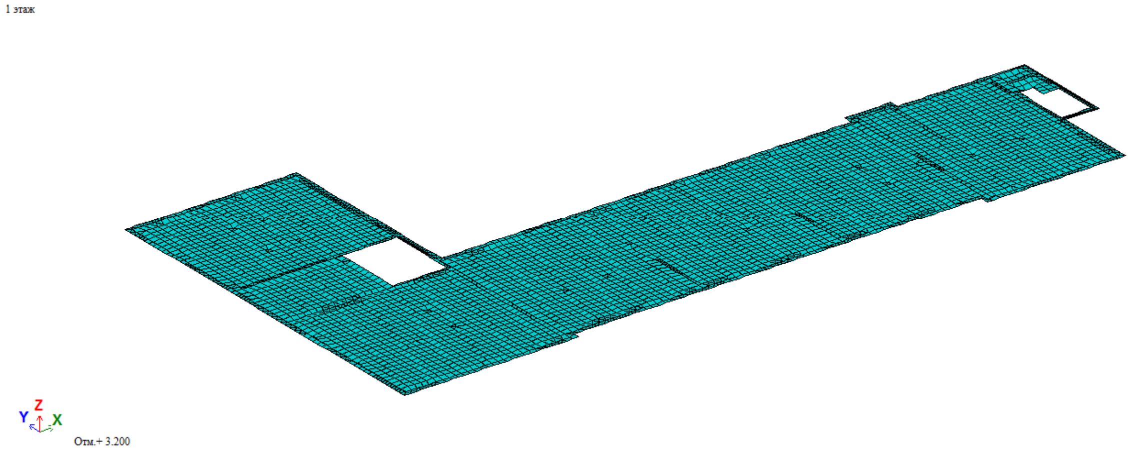

Fig. 3.5. Finite element diagram of the plate at the mark +3,200 m

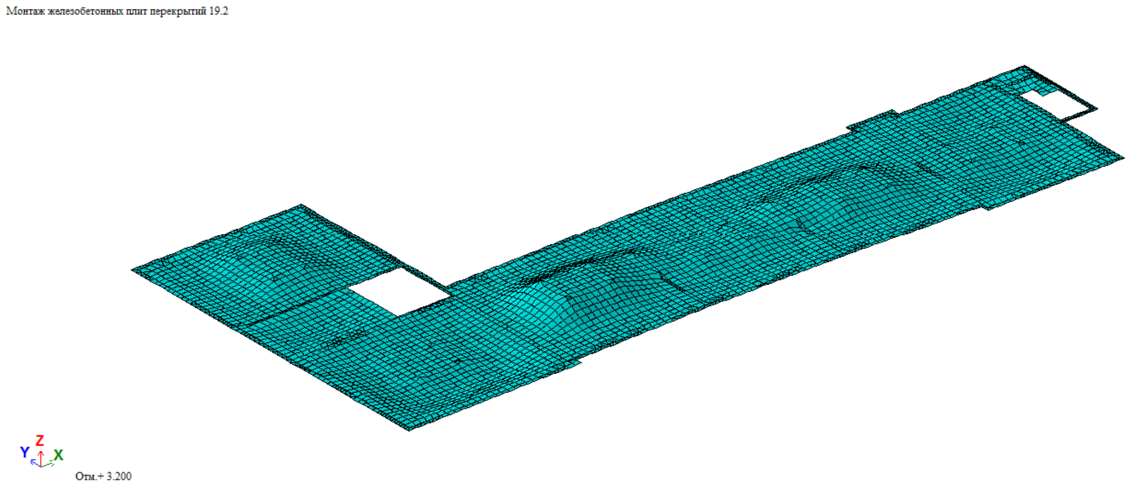

Fig. 3.6. Deformed finite element scheme of the plate

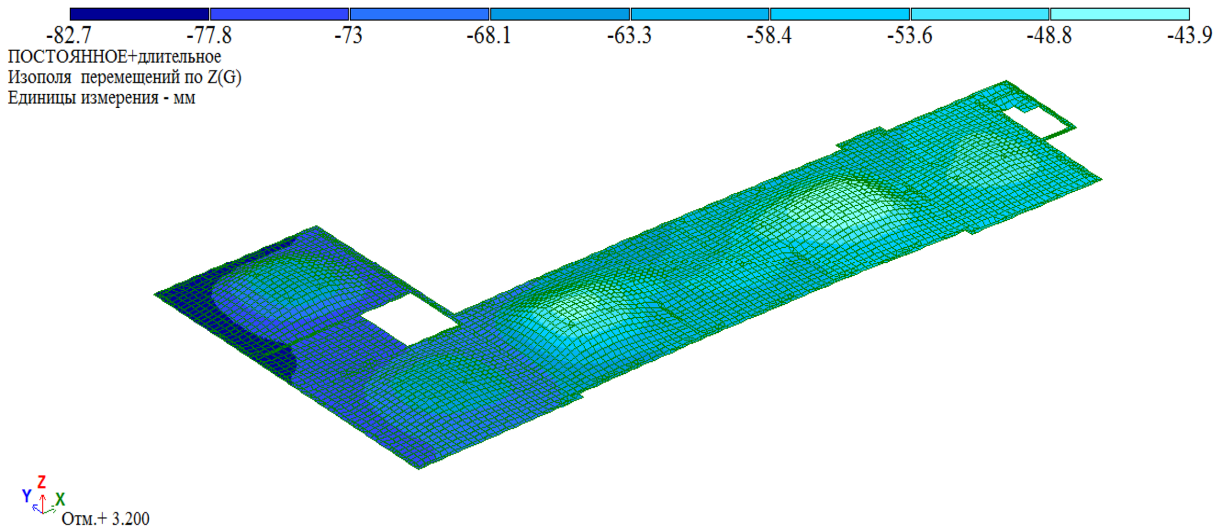

Fig. 3.7. Isopoly of displacements along the Z axis of the wooden board, before reconstruction

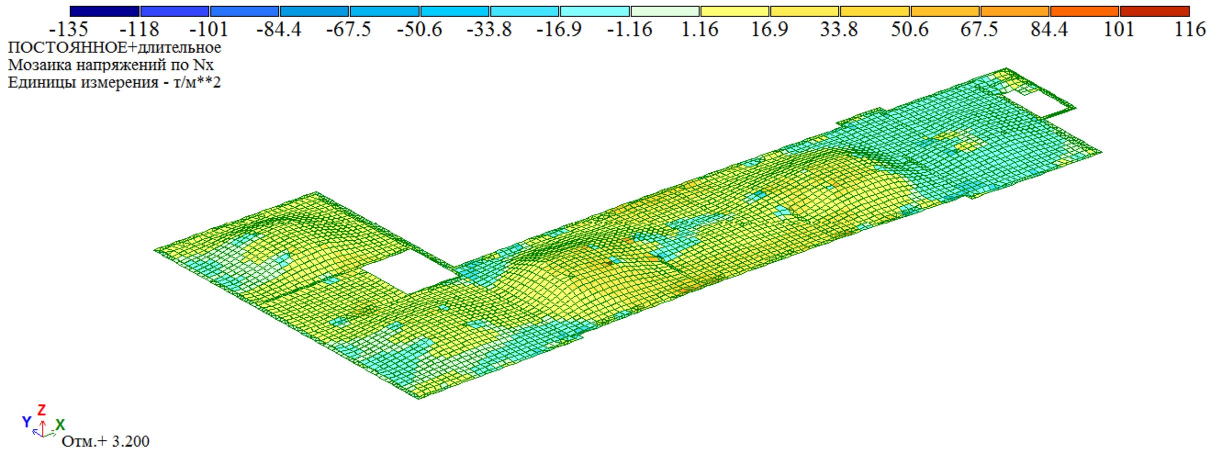

Fig. 3.8. Mosaic of stresses Nx of a wooden slab before reconstruction.

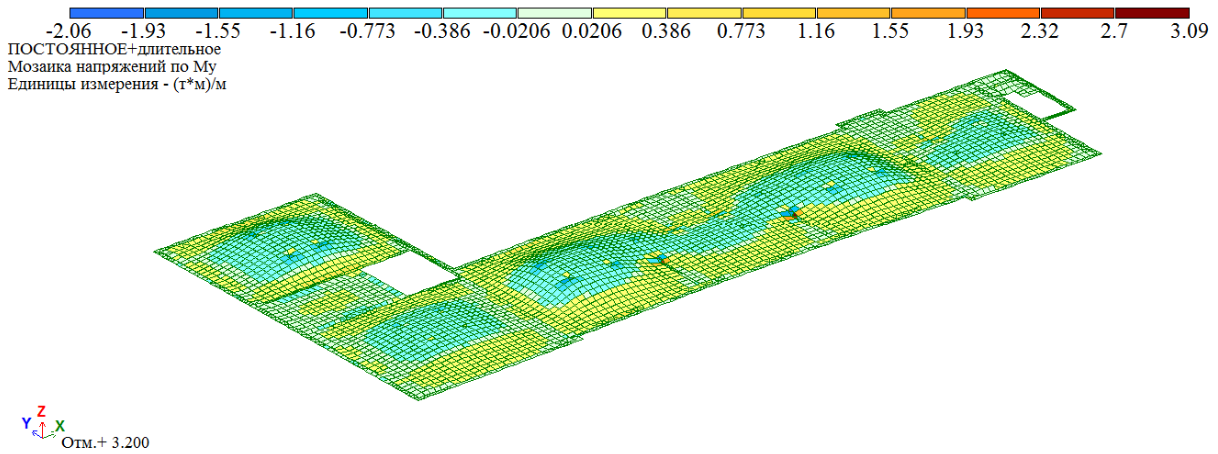

Fig. 3.9. Mosaic of stresses My of a wooden slab before reconstruction.

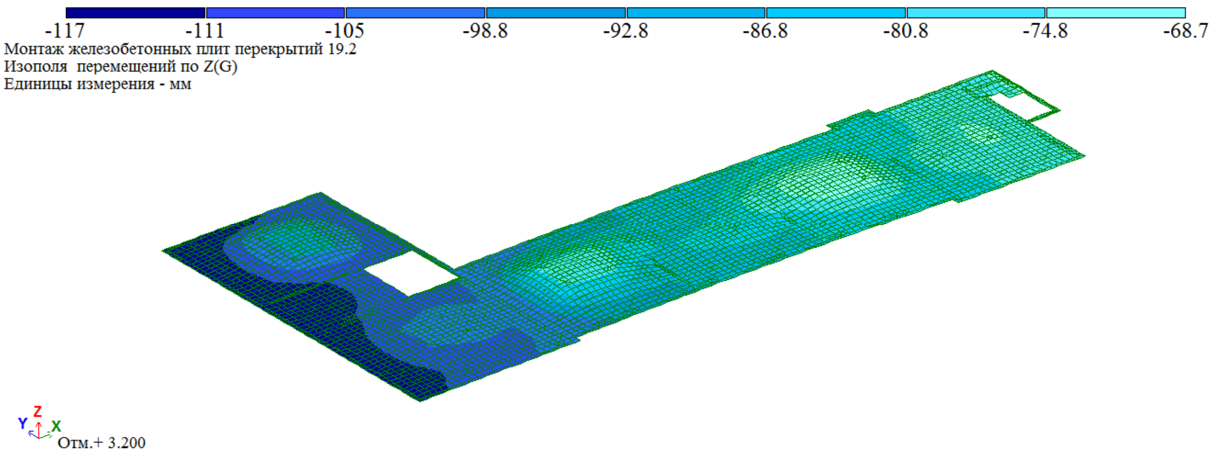

Fig. 3.10. Isopoly displacements along the Z axis of the reinforced concrete slab, after reconstruction.

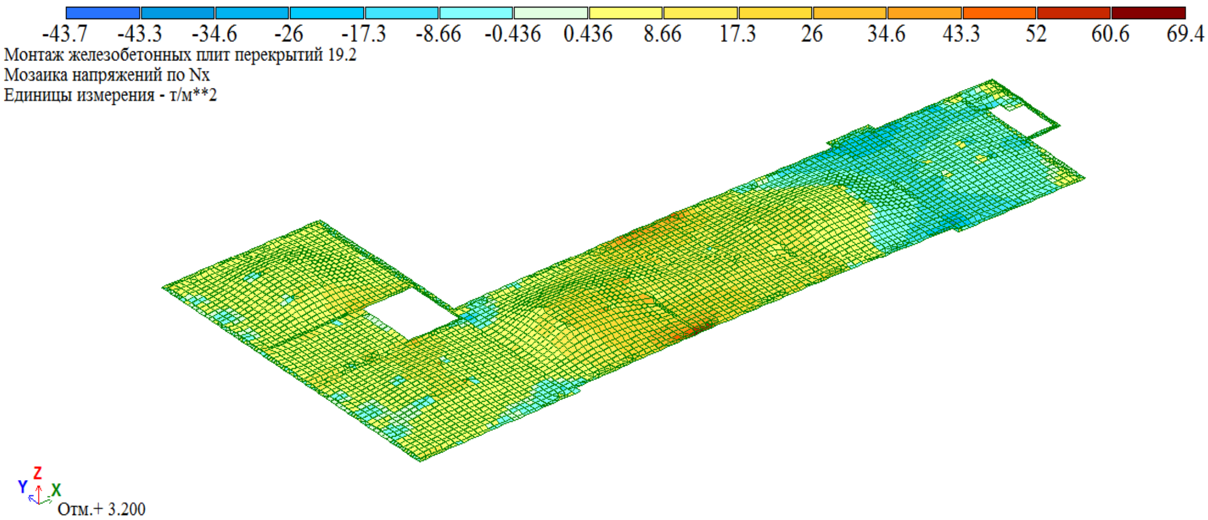

Fig. 3.11. Mosaic of stresses Nx of reinforced concrete slab, after reconstruction.

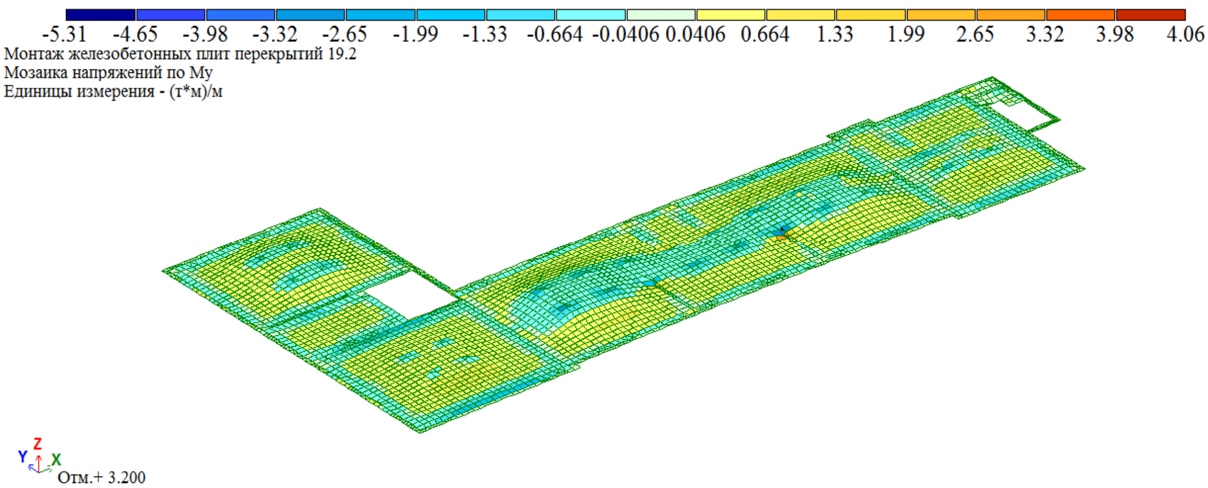

Fig. 3.12. Mosaic of stresses My of reinforced concrete slab, after reconstruction.

For reinforcement of the structure we will use the design subsystem LIRA-SAPR 2021: ARM-SAPR. To do this, you must specify the following material parameters:

- Element type - shell;
- Type of concrete – C20/25;
- Reinforcement type - longitudinal A400C; transverse A240C.

The calculation will be performed according to the results of design combinations of loads (DCL).

After the calculation we get the following results.

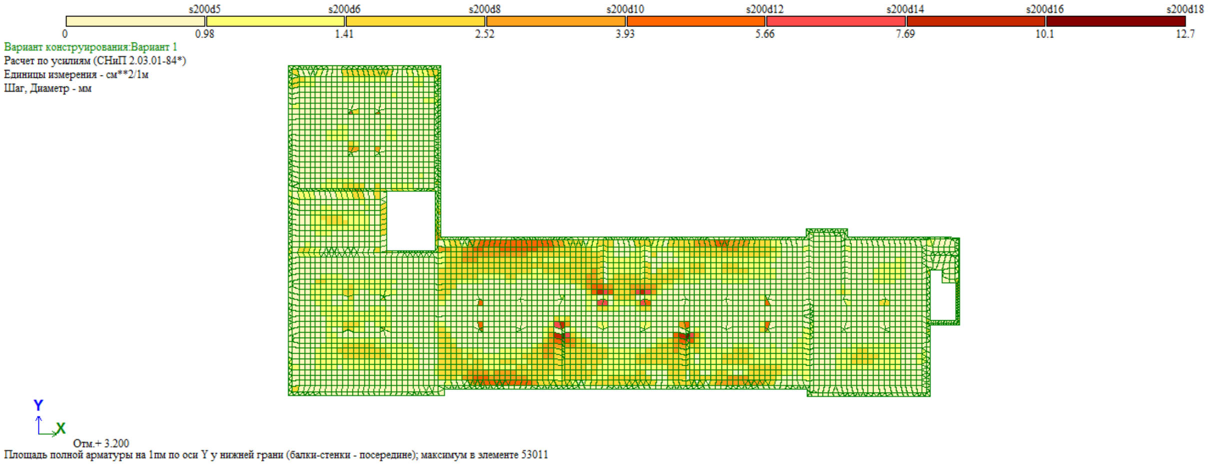

Fig. 3.13. Bottom reinforcement along the axis X

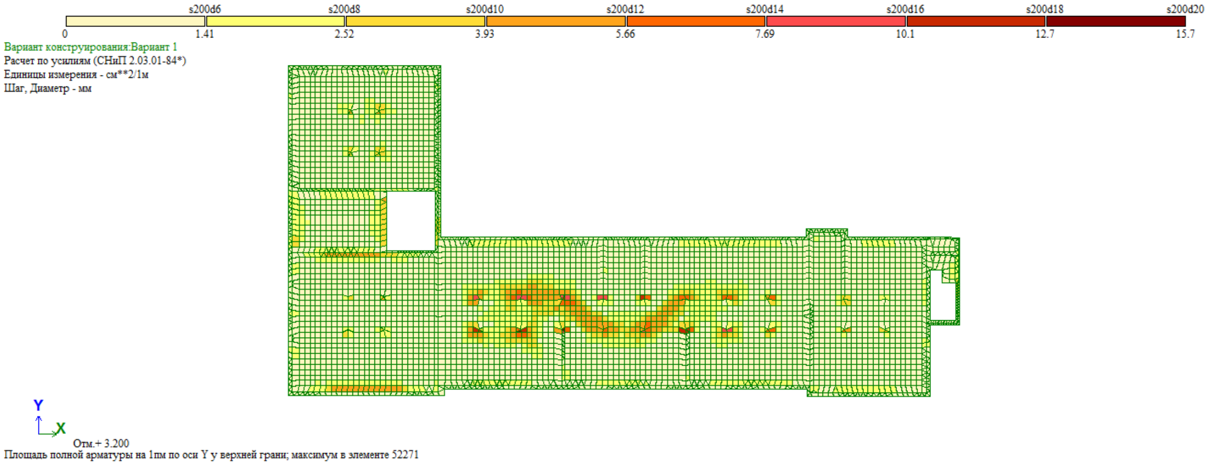

Fig. 3.14. The top reinforcement along the axis X

3.4 Calculation of reinforced concrete wall

With the help of the program LIRA-SAPR 2021 the process of dismantling the wall element was modeled. In these figures we can investigate how the effort in the walls has changed when the wooden floor was, and after the installation of all reinforced concrete slabs.

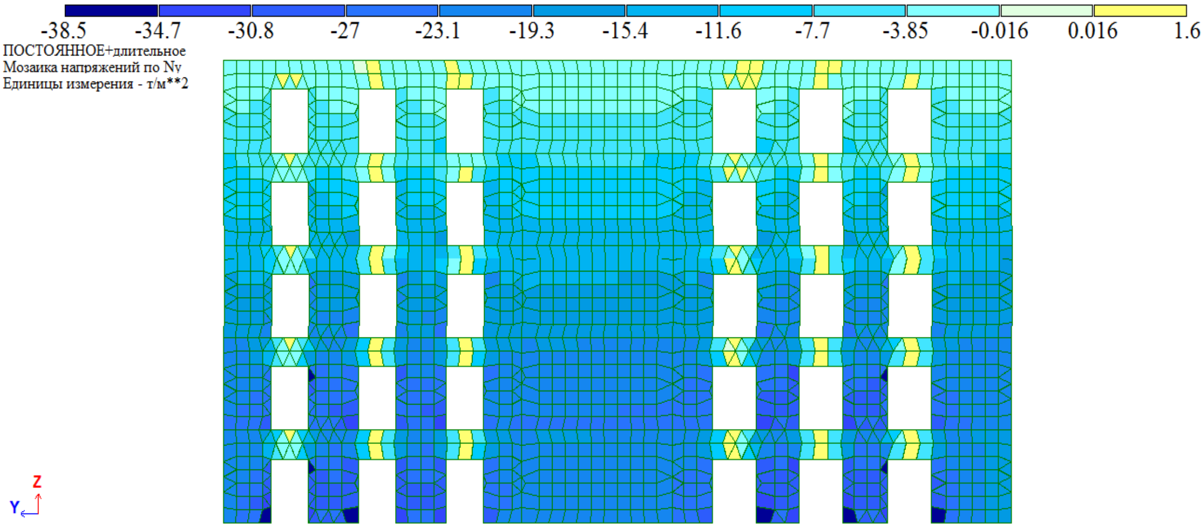

Fig. 3.15. Effort Ny in a fragment of a wall with wood overlap.

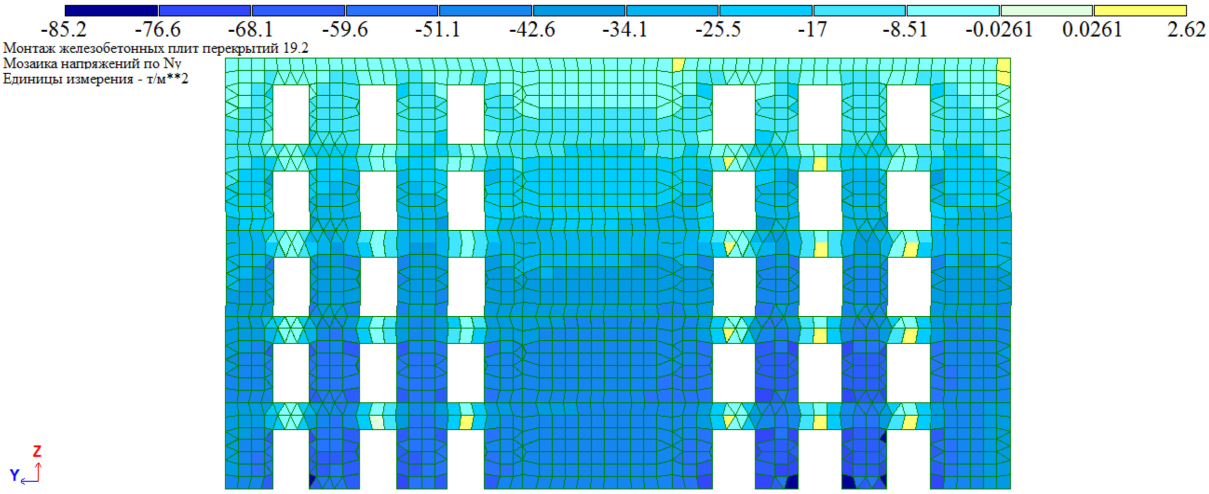

Fig. 3.16. Effort Ny in a fragment of the wall with a reinforced concrete overlap.

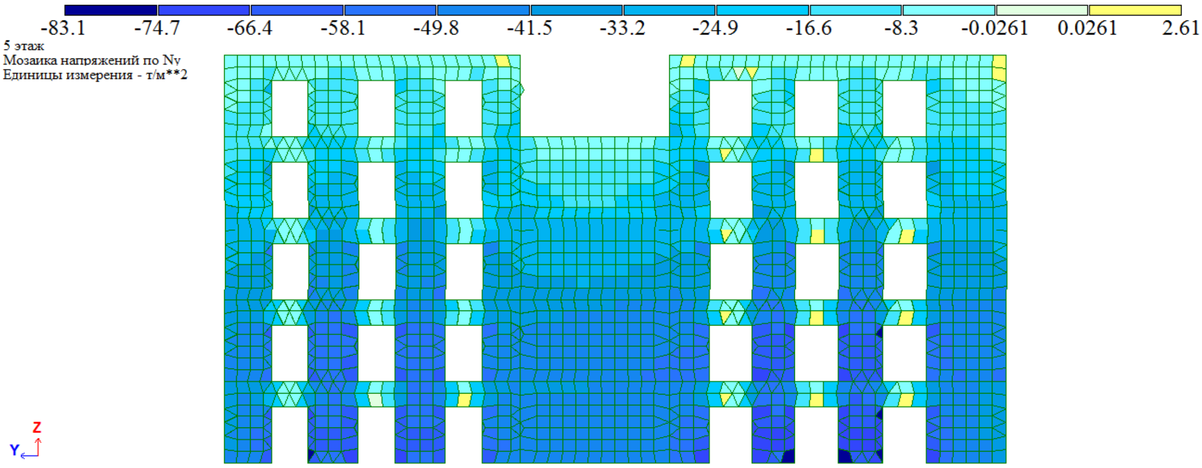

Fig. 3.17. Effort Ny in a fragment of the wall, after dismantling the wall element on the 5th floor

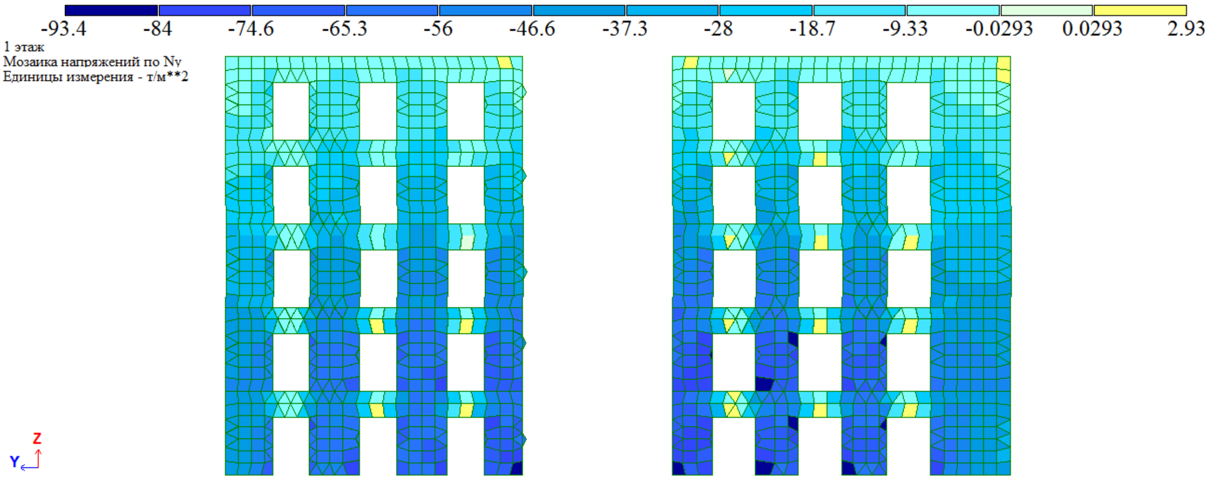

Fig. 3.18. Effort Ny in a fragment of the wall, after dismantling the wall element on all floors

After analyzing the change in effort, a variant of reinforcing the wall with a reinforced concrete collar was proposed. Reinforced concrete collar is made of concrete from C8/10 to C12/15 with reinforcement with vertical rods up to 12 mm in diameter and welded collars up to 10 mm in diameter. The distance between the collars should not exceed 15 cm. The thickness of the collar is determined by calculation and taken from 6 to 10 cm.

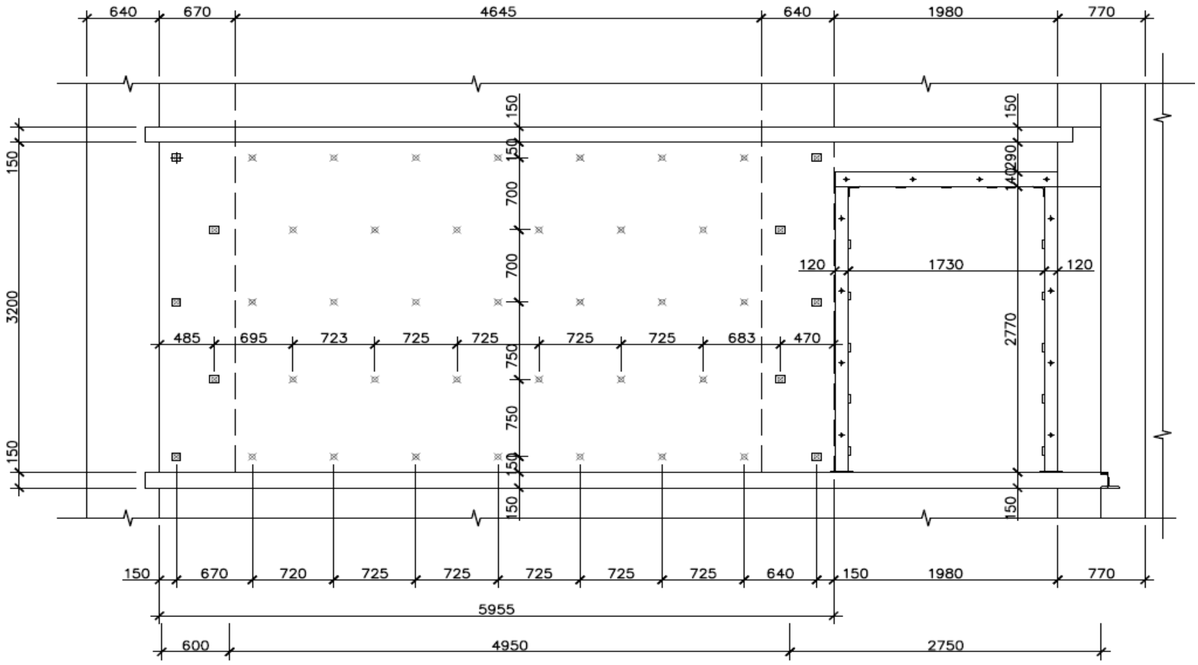

Fig. 3.19. The scheme of installation of through anchors.

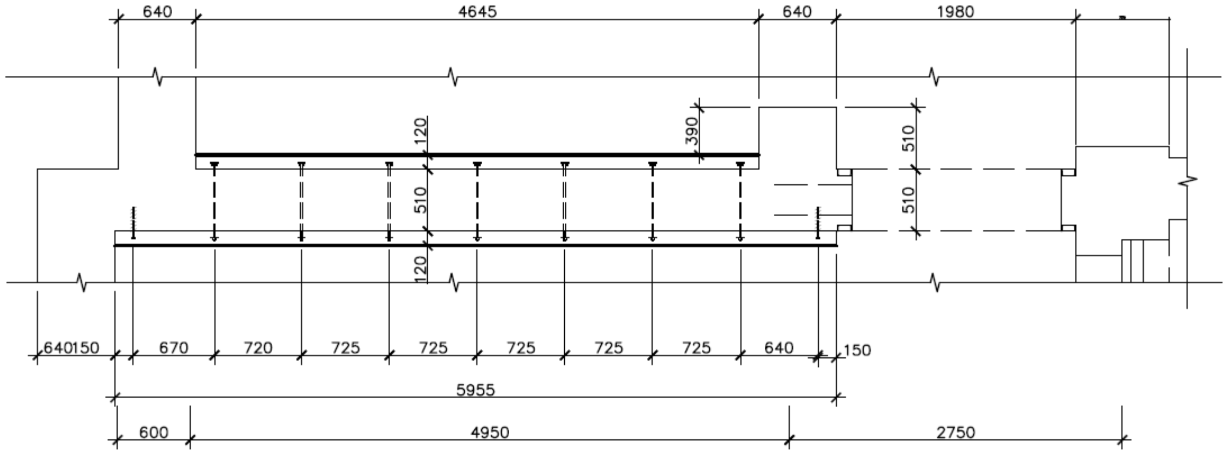

Fig. 3.20. The scheme of arrangement of a reinforced concrene shell at the level of the first floor

CHAPTER 4
FUNDAMENTALS AND FOUNDATIONS

4.1 Engineering and geological conditions

The survay area is located in the central part of Luhansk.

The geological structure and hydrogeological conditions of the site are illustrated by engineering-geological section. The category of complexity of engineering and geological conditions is the second.

The thickness of soils to a depth of 15.0 m has been studied in terms of physical and mechanical properties and nomenclature in accordance with DSTU B B.2.1-5-96 [12] is divided into 6 engineering-geological elements. At their allocation it is established that change of characteristics of soils irregular in plan and depth.

As a result of the analysis of spatial variability of indicators of properties of soils and check of possibility of unity of initially set layers seven engineering and geological elements are allocated.

The first layer (IGE-1) – bulk soil is heterogeneous in composition and depth. The second layer (IGE-2) – covered with soil and plant layer. The third layer (IGE - 3) – yellow-brown loam, solid consistency with the inclusion of layers of carbonates, macroporous, loess-like, subsidence, with the inclusion of marl gravel up to 20% in the sole. The fourth layer (IGE-4) – sands are yellow-brown, greenish-gray of medium size, medium density with layers of fine sands, little moisture, in the sole of the layer with the inclusion of marl gravel up to 20%. The fifth layer (IGE-5) – finely dispersed weathering product of light gray marl of solid consistency. Sixth layer (IGE-6) – gravelly soils: gravel, layers of marl light gray, gray with fine aggregate up to 15%, with the inclusion of blocks of marl on the sole. Lies below the mark 76.00 - 78.00 m, layer thickness from 5 to 7 m. Groundwater to a depth of 15 m is not detected.

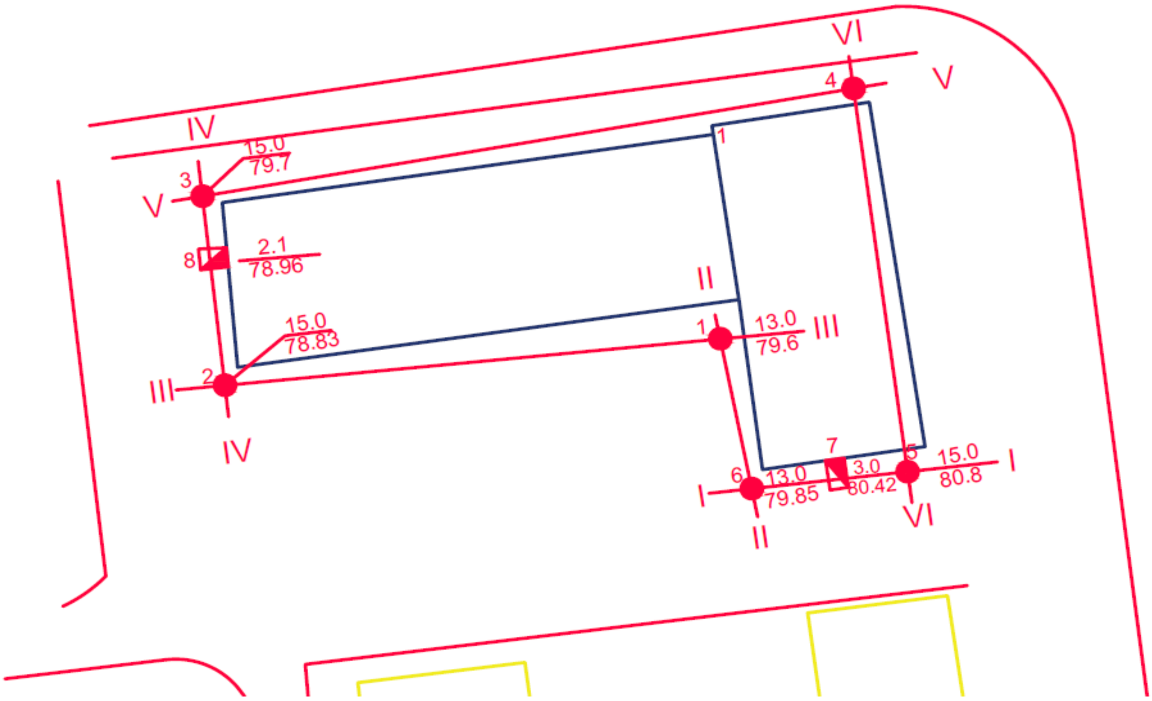

Fig.4.1. Location survey plan

4.2 Composition and physico-mechanical properties of soils

As a result of the analysis of spatial change of indicators of properties of soils and check of possibility of association of initially set layers the following engineering and geological elements are allocated.

IGE I. Bulk soil - asphalt, black soil, gravel, loam. The soil is not homogeneous in composition and structure. Specific gravity of soil Y=17.64 kN/m³; modulus of deformation of the soil in a given station R0 =100 KPa;

IGE II. Soil-vegetative layer – loamy black soil, solid. Soil specific gravity Y=18.42 kN/m³; soil deformation modulus in a given station R0 =50 KPa;

IGE III. Yellow-brown loams with the inclusion of carbonates, solid in water-saturated state, refractory. According to preliminary estimates, prone to subsidence. Specific gravity of soil Y=18.21 kN/m³; modulus of soil deformation in the natural state 16.47 MPa; modulus of soil deformation in a given state 3.76 MPa;

IGE IV. Yellow-brown sand, medium size, including pebbles, gravel up to 11%. The soil is not homogeneous in composition and structure. Specific gravity of soil Y=16.17 kN/m³; modulus of soil deformation in a given state 28.0 MPa;

IGE V. Crushed stone, layers of gray marl, with fine-dispersed pigment up to 20%, with the inclusion of blocks. Specific gravity of the soil Y=16.56 kN/m³; modulus of soil deformation in a given state 20.0 MPa;

IGE VI. Rocky soil of reduced strength, cracked. Specific gravity of the soil Y=16.37 kN/m³;

During the geological survey, excavation was carried out.

Requirements for the development of the bore pit:

- it is necessary that the depth of the pit reaches the soil base on which the foundation rests. Deepening of the pit below the base of the foundation is possible only if the foundation is in good condition and is a fairly monolithic structure; but not more than 5-10 cm. If you carry out excessive excavation of the soil from under the foundation, it can cause damage to it or the structure itself;
- the size of the pit is actually determined by the size of the base of the foundation in the plan, as well as its shape and soil characteristics. That is, the excavation of the "ground" should be performed from the wall or column on the area of the foundation (in accessible places) by small measures (up to 10-40 cm) depth directly to the edge of the foundation, and then lead its opening to the sole (along the wall), that is, we learn the geometric dimensions: length, width and thickness. The deepening of the pit stops if it begins to flood. In this case,we need to wait and agree with the engineer-performer a quick inspection;
- after carrying out inspections the pit needs to be filled up. For this purpose manual ramming or pouring of soil is carried out. After the pit is filled in, it is necessary to allow the soil to settle and compact, then carry out work on the restoration of structures. If the pit was made outside, it is recommended to wait until the soil is washed away by precipitation.

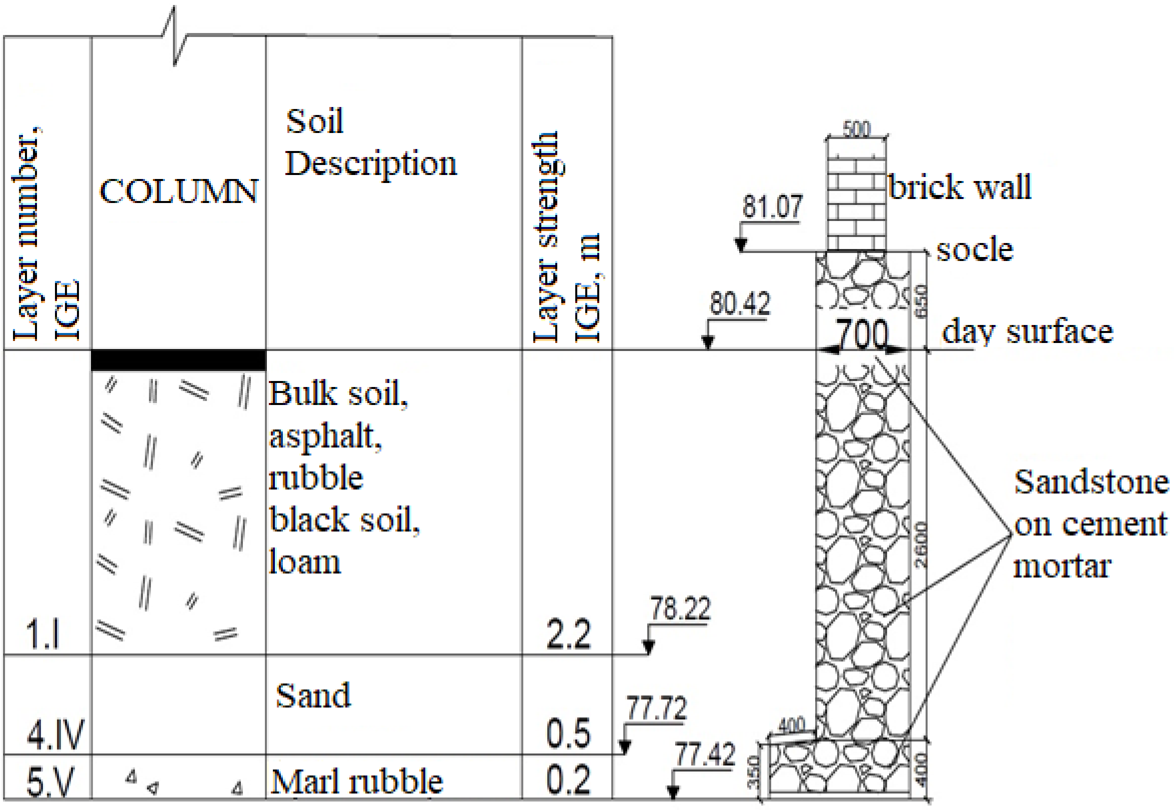

Fig. 4.2. Drawing an open foundation with a pit №7

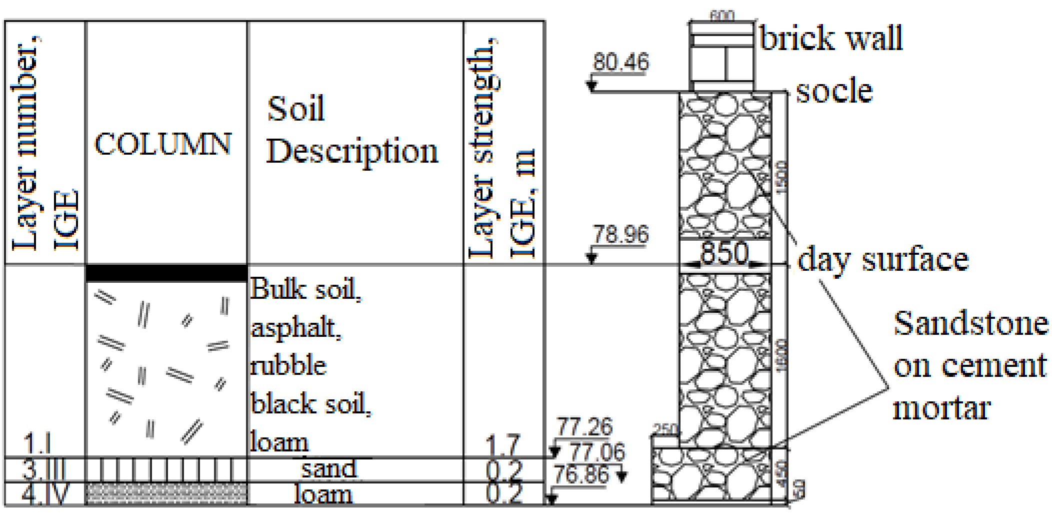

Fig. 4.3. Drawing an open foundation with a pit №8

4.3. Calculation of the foundation slab

The calculation of the building was performed using PC LIRA-SAPR 2021 using the finite element method.

According to engineering and geological surveys with the help of the subsystem "Soil" soil modeling is carried out.

The foundations for the external and internal walls are made of rubble sandstone with a strength of not less than 40.0 MPa on lime-cement mortar brand M50.

Brick columns are made of red solid clay brick brand M75 on cement-lime mortar brand M50, different cross-section in plan. The plan has an axial reference. Foundations of strip type.

To determine the stiffness coefficient in the i-th section of the foundation using the formula

$$k_i = \frac{P_g}{S_i}, \text{ where}$$

P_g - average pressure on the sole of the foundation;

S_i - sludge at the i-th point from the pressure determined by the relevant regulations, taking into account the geological structure of the vertical, passing through the i-th section.

A spatial model of the soil base in the Soil program is formed according to the given engineering and geological conditions of the construction site.

As a result of static calculation of a plate in the program "LAYOUT" ("КОМПОНОВКА") internal efforts and other parameters of elements of the settlement scheme are defined..

Since the reconstruction is carried out, it is necessary to investigate how the initial internal efforts and other parameters change with the final (after all the works).

The results of the calculation are presented in the figures 4.4.-4.11.

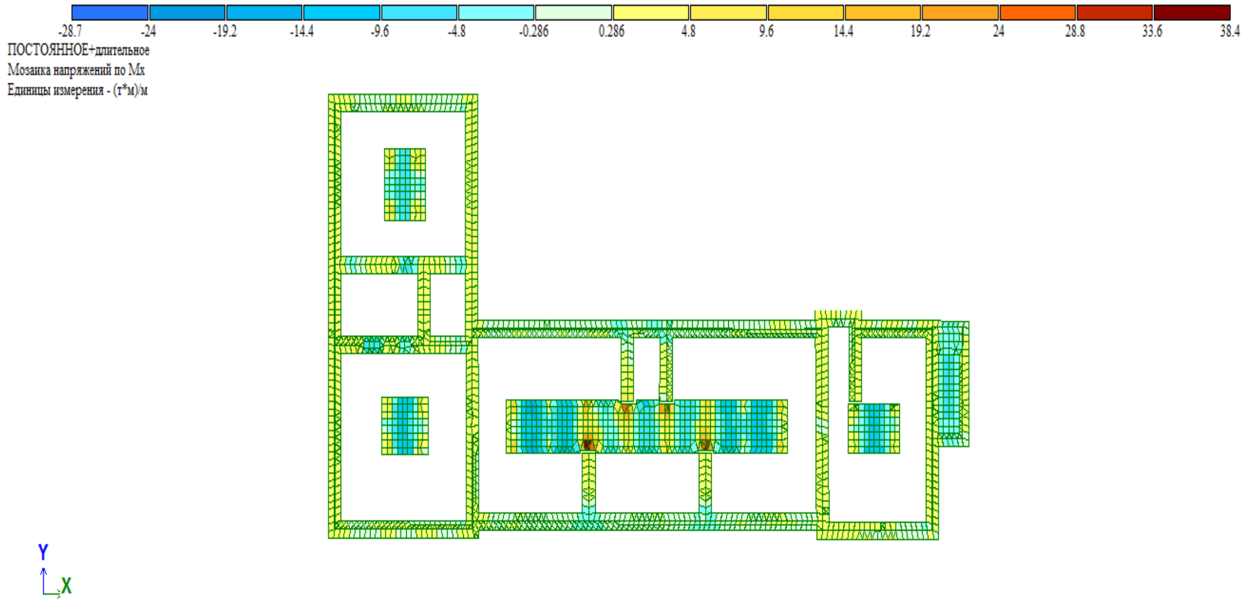

Fig. 4.4. Isopoly of internal efforts in the foundation before the reconstruction Mx

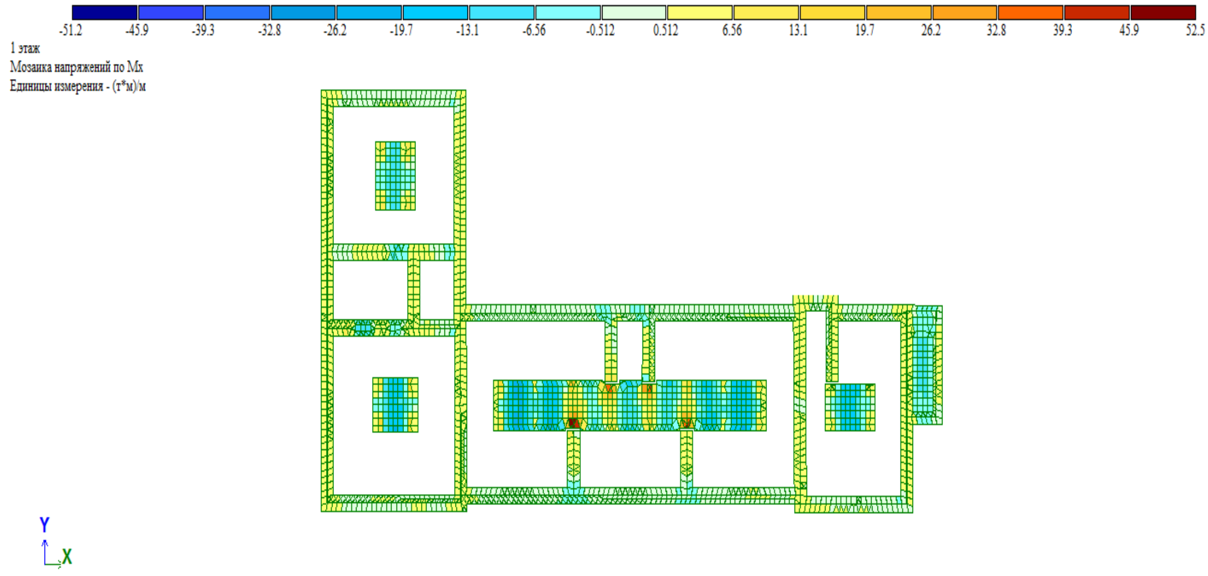

Fig. 4.5. Isopoly of internal efforts in the foundation after the reconstruction Mx

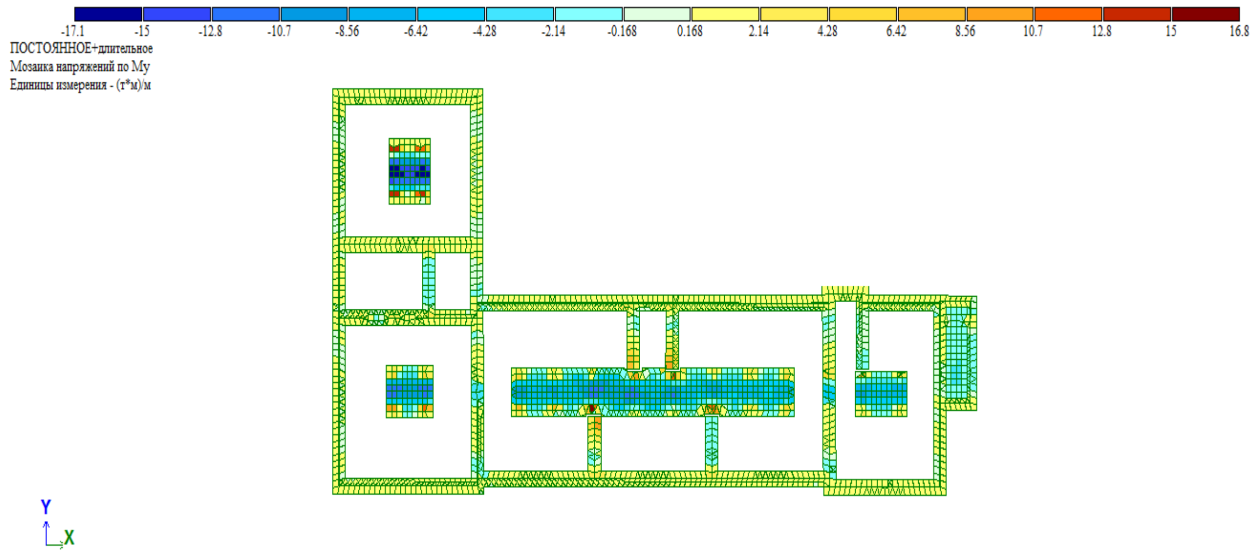

Fig. 4.6. Isopoly of internal efforts in the foundation before the reconstruction My

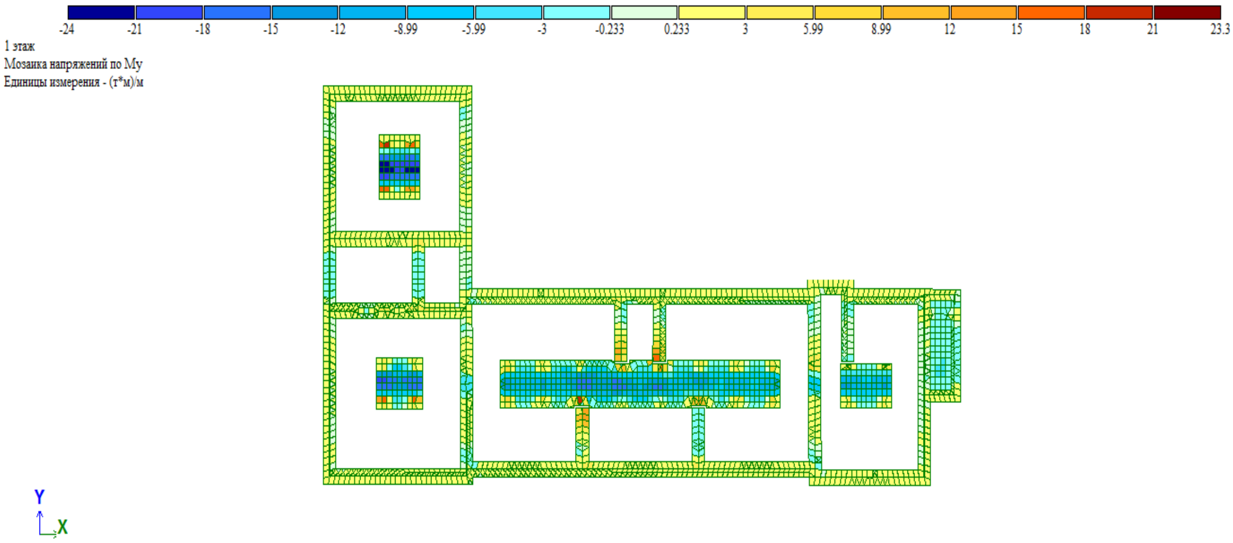

Fig. 4.7. Isopoly of internal efforts in the foundation after the reconstruction My

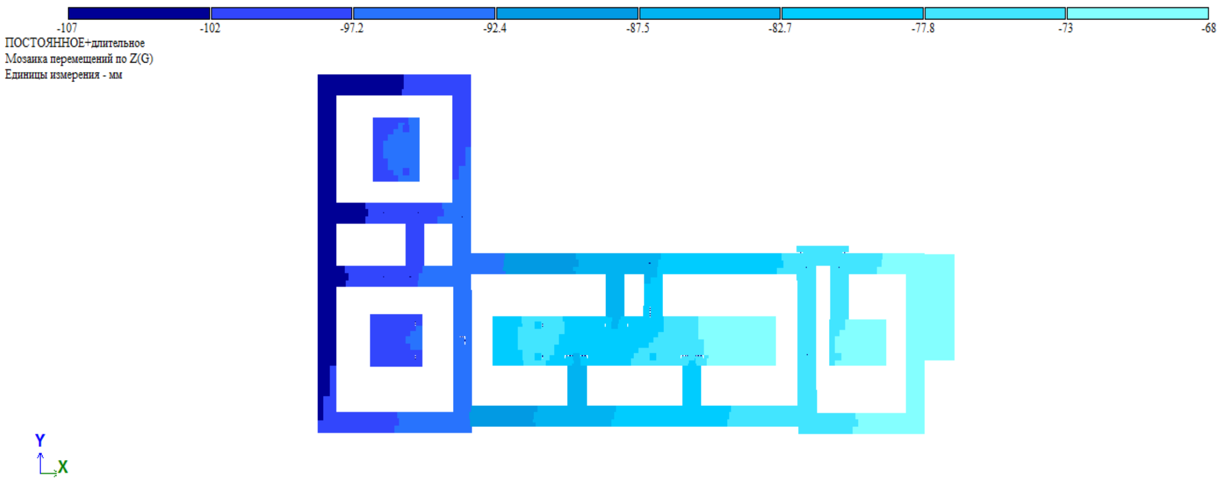

Fig. 4.8. Mosaic of movements along the Z axis in the foundation before the reconstruction

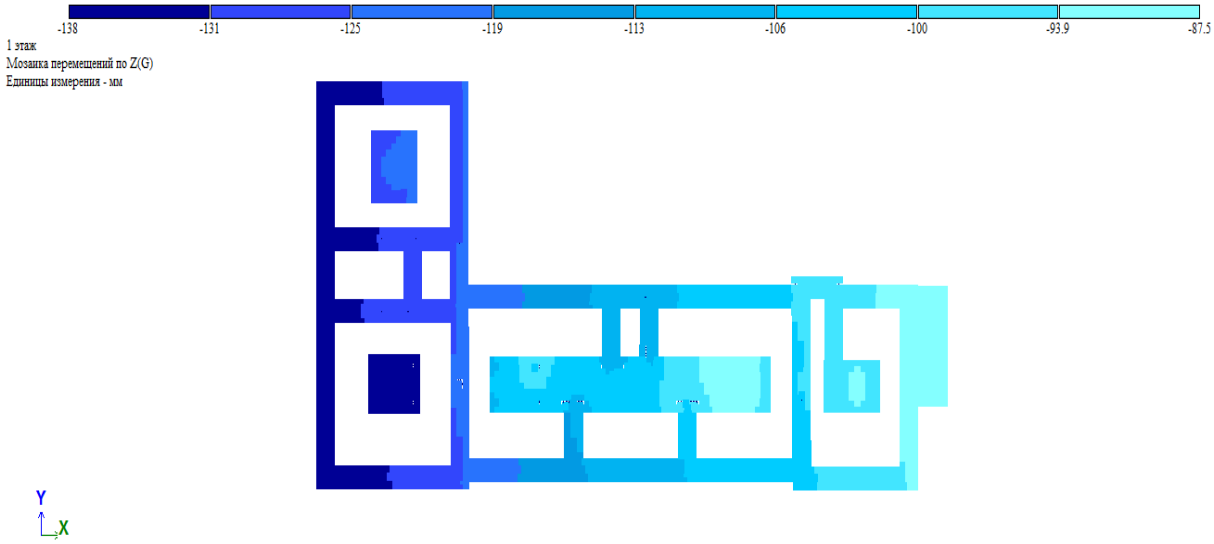

Fig. 4.9. Mosaic of movements along the Z axis in the foundation after the reconstruction

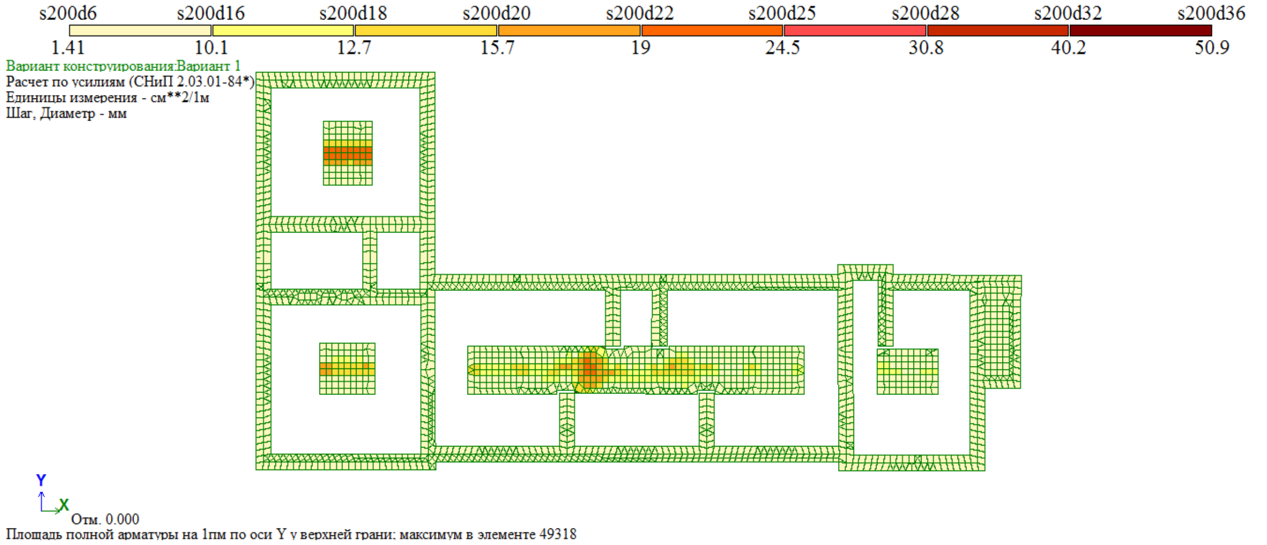

Fig. 4.10. The scheme of the top reinforcement in the base plate

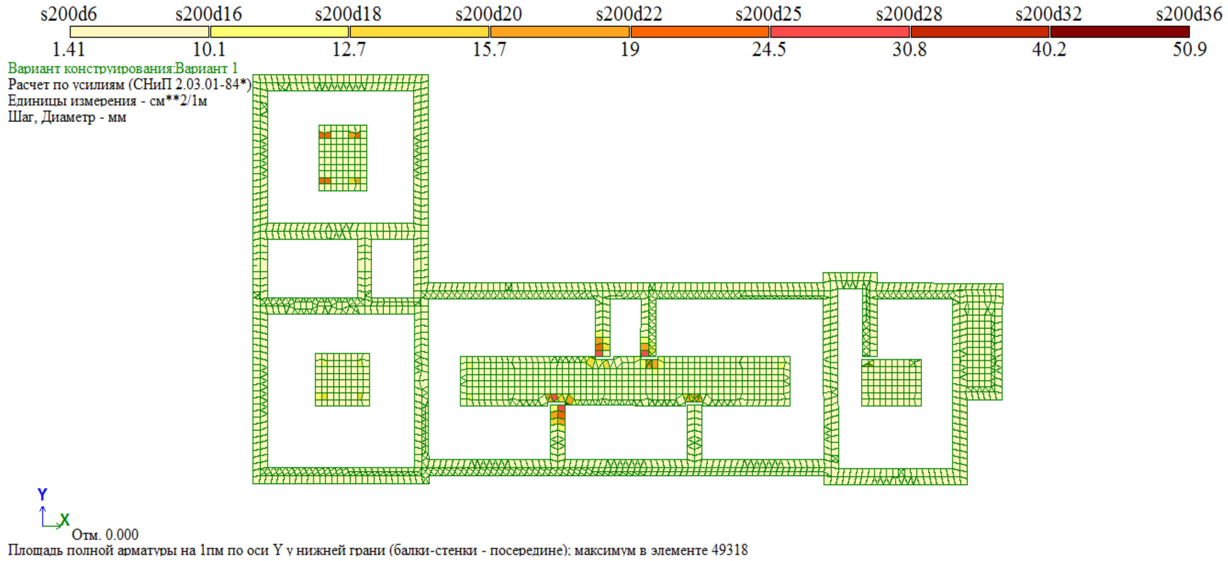

Fig. 4.11. Scheme of lower reinforcement in the foundation slab

4.4. Gathering loads on the foundation

To determine the loads, we calculate the payload and the own weight of structures per 1 m². The load from the allocated cargo areas at the level of each overlap is transferred to individual columns, and from the columns – to the foundation.

When designing at boundary conditions, efficiency and reliability, load-bearing capacity and normal operation are provided by design coefficients that allow to take into account the features of physical and mechanical properties of soil bases, the specifics of loads, responsibilities and features of structural schemes of buildings and structures.

The load on the base may be determined without taking into account its redistribution on the foundation structure when calculating the average values of deformations of the base.

Table 4.1.

Gathering loads on the foundation

Load	Regulatory load, kg/m^2	Coefficient of reliability	Estimated load, kg/m ^{2}
Load gathering per 1 m^2 of overlap of the first floor			
Constant load: 1) Monolithic reinforced concrete floor, thick 120 mm, 2500 kg/m^3	0.12*2500=300	1,1	300*1,1=330
2)Sound insulation, thickness 50 mm, 25 kg/m^3	50*25/1000=1,25	1,3	1,25*1,3=1,6
3) Cement-sand screed, thickness 20 mm, 1800kg/m^3	20*1800/1000=36	1,3	36*1,3=46,8
4) Ceramic tile, thick 4 mm, 1800 kg/m^3	4*1800/1000=7,2	1,3	7,2*1,3=9,4
Total:	344,45		387,8
Temporary load for the premises 150 kg/m^2	150	1,3	150*1,3=195
Load gathering per 1 m^2 of overlap of the second floor			
Constant load: 1) Monolithic reinforced concrete overlap, thickness 120 mm, 2500 kg/m^3	0.12*2500=300	1,1	330*1,1=330
2) Cement-sand screed, thickness 20 mm, 1800 kg/m^3	20*1800/1000=36	1,3	36*1,3=46,8

3) Linoleum, thickness 2 mm, 1800 kg/m^3	2*1800/1000=3,6	1,3	3,6*1,3=4,7
Total:	339,6		381,5
Temporary load for the premises 150 kg/m^2	150	1,3	150*1,3=195
Load gathering per 1 m^2 of overlap of the third floor			
Constant load: 1)) Monolithic reinforced concrete overlap, thickness 120 mm, 2500 kg/m^3	0.12*2500=300	1,1	330*1,1=330
2) Cement-sand screed, thickness 20mm, 1800 kg/m^3	20*1800/1000=36	1,3	36*1,3=46,8
3) Linoleum, thickness 2 mm, 1800 kg/m^3	2*1800/1000=3,6	1,3	3,6*1,3=4,7
Total:	339,6		381,5
Temporary load for the premises 150 kg/m^2	150	1,3	150*1,3=195
Load gathering per 1 m^2 of overlap of the fourth floor			
Constant load: 1)) Monolithic reinforced concrete overlap, thickness 120 mm, 2500 kg/m^3	0.12*2500=300	1,1	330*1,1=330
2) Cement-sand screed, thickness 20 mm, 1800 kg/m^3	20*1800/1000=36	1,3	36*1,3=46,8
3) Linoleum, thickness 2 mm, 1800 kg/m^3	2*1800/1000=3,6	1,3	3,6*1,3=4,7
Total:	339,6		381,5
Temporary load for the premises 150 kg/m^2	150	1,3	150*1,3=195
Load gathering per 1 m^2 of overlap of the fifth floor			
Constant load: 1)) Monolithic reinforced concrete overlap, thickness 120мм, 2500 kg/m^3	0.12*2500=300	1,1	330*1,1=330
2) Cement-sand screed, thickness 20 mm, 1800 kg/m^3	20*1800/1000=36	1,3	36*1,3=46,8
3) Linoleum, thickness 2 mm, 1800 kg/m^3	2*1800/1000=3,6	1,3	3,6*1,3=4,7
Total:	339,6		381,5
Temporary load for the premises 150 kg/m^2	150	1,3	150*1,3=195
Load gathering per 1 m^2 of covering			
Constant load: 1) Lattice of pine board,	40*600/1000=24	1,1	24*1,1=26,4

thickness 40 mm, 600 kg/m^3			
2) Metal tile 5 kg/m^2	5	1,1	5*1,1=5,5
3) Waterproofing 1,3 kg/m^2	1,3	1,1	1,3*1,1=1,4
4) Rafter cleat, cross section 60x120 mm, sling stroke – 1.1 m, pine – 600 kg/m^3	6*12*600/(1*11000)=3,9	1,1	3,9*1,1=4,3
Total:	34,2		37,6
Temporary load: Snow load 140 kg/m^2	140	1,25	140*1,25=175
Load from 1 m^2 of exterior walls			
Constant load: 1) A brick wall on a heavy mortar, thickness 510 mm, 1800 kg/m^3	510*1800/1000=918	1,1	918*1,1=1009,8
2) Insulation, thickness 60 mm, 55 kg/m^3	60*55/1000=3,3	1,1	3,3*1,1=3,6
3) Exterior and interior plaster walls of cement-lime mortar, thickness 30 mm, 1900 kg/m^3	2*30*1900/1000=114	1,1	102*1,1=125,4
Total:	1035,3		1138,8
Load from 1 m^2 of internal walls			
Constant load: 1) A brick wall on a heavy mortar, thickness 510 mm, 1800 kg/m^3	510*1800/1000=918	1,1	918*1,1=1009,8
3) Exterior and interior plaster walls of cement-lime mortar, thickness 30 mm, 1900 kg/m^3	2*30*1900/1000=114	1,1	114*1,1=125,4
Total:	1032		1135,2
Load gathering on the foundation			
Constant load: 1) From the weight of the wall height 19,2 m	1035,3*19,2=19877.76		1138,8*19,2= 21864,96
2) From the overlap above the 1st floor (Span in its pure form 4.7-0.51-0.255=3.935m)	344,45*3,935/2=677,7		387,8*3,935/2= 763
3) From the overlap above the 2nd floor (Span in its pure form 4.7-0.51-0.255=3.935m)	339,6*3,935/2=666,5		381,5*3,935/2= 750,6
4) From the overlap above the 3rd floor (Span in its pure form 4.7-0.51-0.255=3.935m)	339,6*3,935/2=666,5		381,5*3,935/2= 750,6

5) From the overlap above the 4th floor (Span in its pure form 4.7-0.51-0.255=3.935m)	339,6*3,935/2=666,5		381,5*3,935/2= 750,6
6) From the overlap above the 5th floor (Span in its pure form 4.7-0.51-0.255=3.935m)	339,6*3,935/2=666,5		381,5*3,935/2= 750,6
7) From a design of a covering (length of a slope of a rafter is 5.8 m)	34,2*5,8/2=99,2		37,6*5,8/2=109
Total:	23320.66		25820.36
Temporary load: 1) On the overlap over the 5th floor	150*3,935/2=295,13		195*3,935/2= 383,66
2) On the overlap over the 5nd floor	70*3,935/2=137,73		91*3,935/2= 179,04
3) On the overlap over the 3rd floor	70*3,935/2=137,73		91*3,935/2= 179,04
4) On the overlap over the 4th floor	70*3,935/2=137,73		91*3,935/2= 179,04
5) On the overlap over the 5th floor	70*3,935/2=137,73		91*3,935/2= 179,04
6) Snow load	140*5,8/2=406		175*5,8/2=507,5
Total:	1252.05		1607.32

5.4.1 Strengthening the foundation structure

Width b of existing foundation 120 cm, calculated soil resistance R=2.3 kg/cm^2, traverse stroke 1.3 m. After reinforcement, the foundation must withstand the load F = 320 kN/m. d = 25 cm. Since the strip foundation is calculated by the length of the foundation area l=100 cm. The required width of the base of the foundation is equal to:

$$b_1=F/l\cdot R=32000/100\cdot 2.3=139.1=140 \text{ cm.}$$

The width of the concreting strips d of the foundation on each side:

$$d=0.5(b_1-b)=0.5(140-120)=10 \text{ cm.}$$

Load received by the foundation from the reactive soil pressure $s_{soil}=R_{soil}$=2.3 kg/cm^2 on width d =10 cm and length l = 120 cm equal:

$$F_d=s\cdot d\cdot l=2.3\cdot 10\cdot 120=2760\text{kg}=27{,}6\text{kN.}$$

This load will be perceived by each console of a traverse and to cause in it the bending moment:

$$M_d = F_d \cdot l_1 = 2760 \cdot 85.5 = 23{,}598 kNm.$$

The cross section of the traverse is taken from two channels. The required moment of resistance W_{tr} equal:

$$W_{tr} = M_d / R = 235980/2350 = 100 cm^3$$

where R – calculated steel resistance ВСт3пс, accepted for DBN B.2.6-198:2014 [13]. The traverse is accepted from two channels № 12:

$$2W_x = 2 \cdot 50{,}6 = 101{,}2 > 100 cm^3$$

The new strips of the foundation with a width of d works as indivisible reinforced concrete beams. They perceive the pressure on the ground and rest on top of the traverses.

The calculated moment in these beams is equal to:

$$M = q \cdot l^2/12 = 23 \cdot 120^2/12 = 27600 kgcm = 276.0 kNm$$

$$\text{де } q = s \cdot d = 2.3 \cdot 10 = 23 kg/cm.$$

We set height of the foundation of 50 cm and a protective layer of concrete to working fittings of 70 mm, Fittings d = 12 mm A400C. We have a working cross-sectional height of the beams h_o= 50-7-0.5 =42.5 см. Section of fittings of class A400C is necessary at R_s= 3750 kg/cm^2 (by DBN B.2.6-98:2009 [14]): $A_s = M/0.8\, h_o \cdot R_s$= 106893/0.8 · 42.5 · 3750 = 0.84 cm^2. For constructive reasons where d =150 mm we accept two frameworks with the top and bottom armature from d =10 mm A400C, transverse reinforcement rods with d = 8 A240C with a stroke 250 mm.

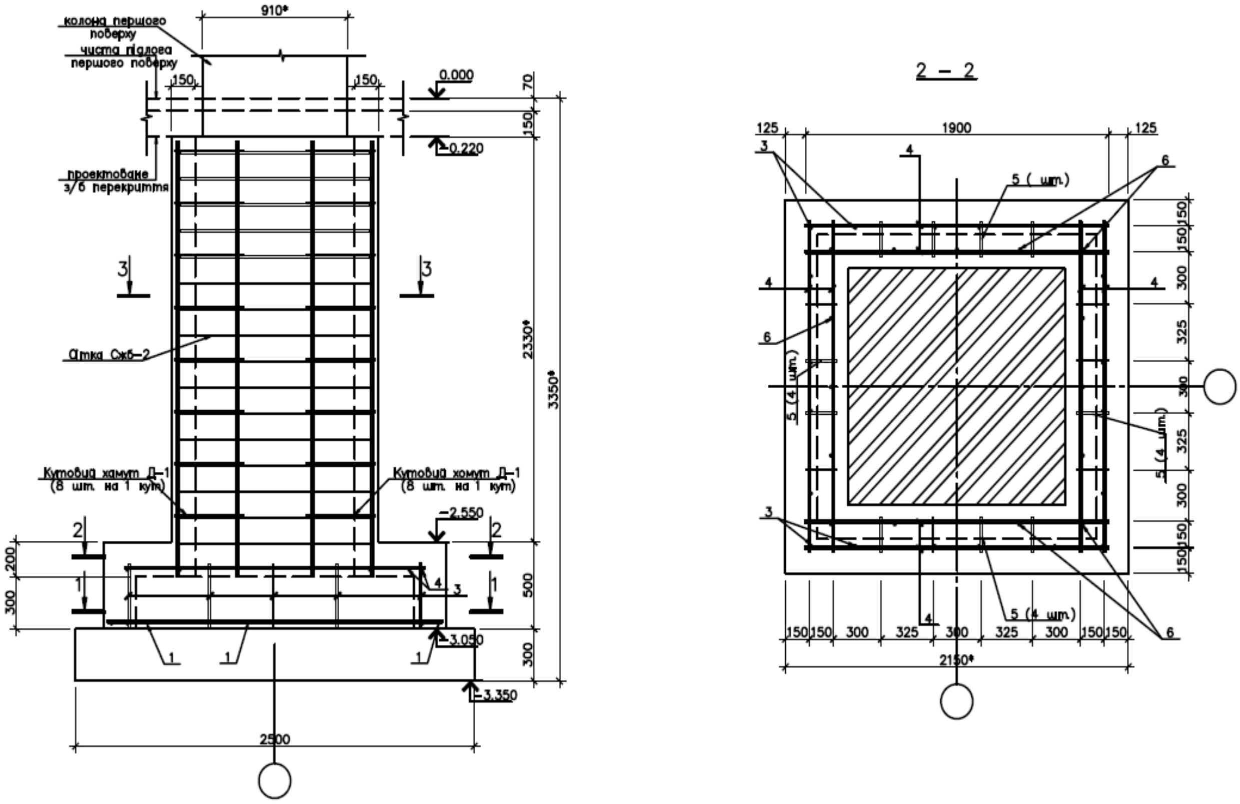

Fig. 4.12. Reinforced concrete foundation clamp

CHAPTER 5
TECHNOLOGY OF CONSTRUCTION PRODUCTION

5.1. Preparing the house for the overlap change

During the inspection of the house revealed that the wooden floor of the dormitory was outdated and damaged, so it was decided to replace it with a beamless concrete floor. Therefore, this technological map was developed to replace the floor.

The position of the house is favorable for the replacement of the floor. There is enough space on all sides of the renovated house, and there are entrances on both sides. On one side of the building is the central Kotsyubynskoho street, which facilitates the transportation of materials and construction equipment. Due to the sufficient space on the construction site, small areas are possible for storing materials and carrying out certain types of works.

Changing the floor begins with dismantling the wooden floor. The next step is to mount the scaffolding that stands on the basement floor. Scaffolding is attached to existing walls. It is arranged on wheels so that it can be easily moved. The holes in the walls left after the dismantling of the wooden floor are thoroughly cleaned. Holes that are not used when installing a new floor are laid with brickwork. Holes used in the installation of reinforced concrete floors expand to a height of 30 cm. All holes are blown with compressed air. In all holes preparation from a cement-sandy solution which regulates the future horizontality of longitudinal armature.

5.2. Decking works

For the manufacture of reinforced concrete slabs of certain sizes and configurations, it is necessary to lay the reinforcement and concrete mixture in a pre-prepared form, which is called formwork.

The formwork at height is supported in the design position by scaffolding. Formwork and lining should be hard, rigid and unchanging, easy to manufacture, easy to assemble and disassemble. The side of the formwork adjacent to the concrete should be smooth, the joints of boards should not miss cement milk during concreting.

Formwork elements are made taking into account their multiple use, to reduce the cost of concrete and reinforced concrete structures.

The cost of formwork is 20-30% of the total cost of concrete and reinforced concrete structures.

The formwork is installed by construction fitters. They determine the location of the formwork relative to the axes, then straighten to the design position, checking the size of the vertical gap between adjacent boards. The formwork is arranged at 3 cm below the fittings.

Wooden and plywood formwork and elements of wooden scaffolding that support it should be rationally manufactured in the formwork shops of woodworking plants. With a small amount of work and in the absence of central workshops, wooden formwork can be made in on-site formwork workshops.

For proper assembly and disassembly of the formwork it’s marked.

Construction fitters who assemble the formwork work according to the marking or installation drawing, which consists of a plan of the structure with the applied elements of the reinforced concrete structure and the marks assigned to them. The formwork is assembled using templates, conductors and other devices that ensure the accuracy of work with minimal labor costs.

In the presence of the crane of sufficient loading capacity the timbering should be collected in the enlarged blocks and to establish by these cranes.

Installed and prepared for concreting load-bearing elements of the floor and formwork shall be inspected in accordance with the requirements of regulatory documents:

- the bearing basis supporting a timbering, a wall design and a timbering is checked up;
- rigidity and immutability of the whole system;
- the density of the formwork panels and joints of the formwork elements together;

- the condition of installation of reinforcement, flooring, formwork, scaffolding and fastening should be continuously monitoring during concreting.

Prior to the start of work on the installation of a monolithic floor, its prepared basis must be adopted by the act of the commission with the participation of the customer and the contractor, and if necessary, a representative of the design institute or organization. An act of covert work must be drawn up on a prepared basis.

The increase in strength of concrete is monitored by the laboratory by testing a series of samples, and conclusions are drawn regarding the curing time. Taking into account the strength of concrete, the timing of stripping of concrete and reinforced concrete structures is assigned.

Before dismantling, open concrete surfaces are inspected and pounded. When stripping, it is necessary to keep the formwork from damage to reduce the cost of its repair.

The process of stripping begins with the removal of the side elements of the formwork, as they do not carry the load of its own weight of the structure. Under favorable conditions, the side formwork is removed for 3-5 days after laying the concrete mixture.

The load-bearing formwork of reinforced concrete structures is removed in about 10-12 days, depending on the outside air temperature, brand and type of cement, the size and nature of the loads. These terms are determined in relation to the type of structures, based on the required strength of concrete before stripping.

Formwork dismantling works are performed by construction fitters of the 3rd and 4th categories.

Concreting is performed by concrete workers of the 4th and 3rd category. They take the concrete mixture, level it and seal it.

5.3 Reinforcement works

In reinforced concrete reinforcement is steel rods of different cross-sections and shapes that absorb tensile forces arising in reinforced concrete elements from the own weight of the structure and external loads. Usually the fittings has constant cross section.

The fittings used in reinforced concrete designs and constructions are divided into working, distributive, assembly, collars.

Working reinforcement receives tensile forces that occur in reinforced concrete structures from its own weight and external loads.

Distribution reinforcement is usually located perpendicular to the working one, and serves to hold the working reinforcement rods in a certain position and distributes the load between them.

In cases where the working rods perceive not only tensile but also compressive forces, in such structures as beams, crossbars, arrange double reinforcement.

The clamps connect the reinforcement into a single frame and protect the concrete from the appearance of oblique cracks near the supports.

Mounting reinforcement does not receive any effort, serves to assemble the reinforcement frame and provides the exact position of the working reinforcement and clamps during concreting.

To prevent the reinforcement from slipping in the concrete, the rods, which are prone to stretching, are bent at the ends in the form of hooks.

The use of reinforcement of periodic profile due to the increased adhesion to the concrete mixture allows you to abandon the hooks, which saves steel.

Reinforcing rods at the points of intersection are mainly combined by welding and only in cases where a small amount of work is carried out - can be connected with soft wire.

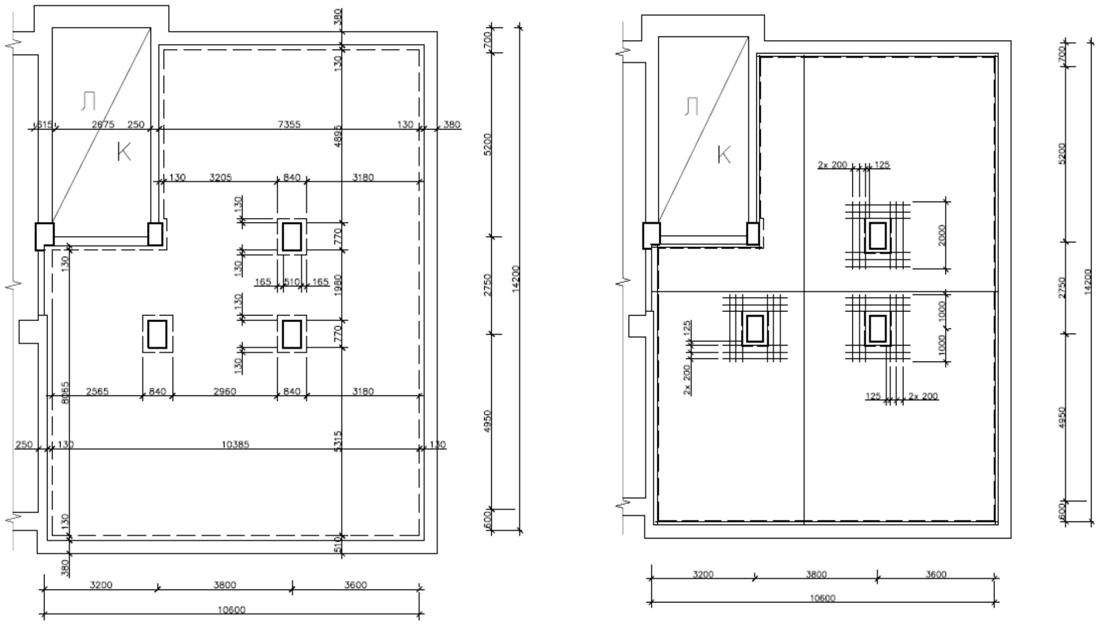

Fig. 5.1. Top and lower reinforcement of the plate part.

Reinforcing mesh is used for reinforcement of slabs. In it the rods connected in places of intersections by welding or knitting intersect. They are made in the form of separate cloths (flat grids) of the necessary size and in the form of rolls of big length from which pieces of the necessary sizes are cut off.

The object receives blanks in the form of straight rods. In the warehouse of the armature-welding enterprise rods are prepared for transportation. Rods are tied in bundles weighing 60 kg or more. Each batch of products is marked with a label indicating the name of the structure, the number of the drawing and product, weight, quantity and other data. Reinforcement kits are transported to sites by truck. Products that exceed the length of the body by more than 1.5 m, transported by truck with a semi-trailer. Vehicles with fittings approach the crane hook or the on-site warehouse, where it is recommended to keep the stock of fittings for three shifts.

Installation of reinforcement begins after checking the formwork for stability, strength, stability and compliance with its design position.

To fix the position of the working reinforcement or the thickness of the protective layer of concrete use shaped stands made of plastic or metal.

5.4 Concreting

5.4.1 General concreting provisions

After the formwork is installed, the mixture is laid. Transportation of ready concrete mix is carried out by concrete trucks. Lifting and delivery of the mixture to the place of laying is carried out using a concrete pump CP-1. The maximum allowable height of their free fall when dispensed to the vehicles should not exceed 2 m for heavy mixtures, 1.5 m for light mixtures.

The concrete mix submitted to the laying place must have:

- the required ease of installation with deviations of mobility not more than 30% and rigidity not more than 20%;
- temperature within 5-35°C;
- the required porosity with deviations of not more than + 10% of the specified value;
- the average density in the compacted state, not exceeding 5%;
- the appropriate water holding capacity of the mixture, which was installed in the laboratory.

Laying of concrete mix is carried out continuously. The time of the forced break during laying should not exceed the time of the beginning of setting of cement.

Concrete compaction is carried out with the help of vibrating devices. When using deep vibrators for compaction of concrete mixtures in the products take into account the effective range of vibrators. The vibration zones of the mixture from each immersion of the vibrators usually overlap each other by 1/5. The vibrators are immersed in a vertical position to the full depth of the layer of the mixture to be laid, penetrating into the layer (if any), which lies below.

Compaction of the mixture with surface vibrators is done in continuous strips, preventing untreated areas.

Compaction of concrete mixtures is considered sufficient if there is a cessation of sedimentation and release of air bubbles on the surface, as well as immersion of a large aggregate.

During the laying and compaction of the concrete mixture, the condition of the formwork scaffolding is carefully monitored. If deformations or displacements of the formwork are detected, concreting is stopped and measures are taken to eliminate defects. At the end of the shift, mechanisms, equipment and devices are cleaned of concrete inflows. Concrete is cared for, in other words it is watered. After a technological break (5 days) we lay expanded clay and compact it. The formwork removes and rearranges to a new place of concreting.

5.4.2 Materials for concrete mixes

Compositions of concrete and mortar mixtures are selected by the enterprise where the mixtures are manufactured. This provides mixtures and concretes with specified properties.

Selection and adjustment of mixtures should be done before the start of production, when changing the design characteristics of concrete or mortar, type or supplier of starting materials and process parameters, as well as according to operational control of production.

Employees of the laboratory of the manufacturer must check the batches of each batch of concrete mixtures of different compositions, adjust the composition and give permission for the use of the batch of mixture at the first preparation. The batch is the amount of concrete or mortar mixture of the same composition, prepared during one shift from the original materials of the same quality, the same equipment.

For preparation of high-quality concrete it's recommended to use Portland cement grades M350, M400, M500.

Gravel, crushed stone and their combinations, from erupted metamorphic and sedimentary rocks, from blast furnace slag, as well as from indirectly extracted rocks and wastes of concentrators in the form of fractions: 5-10; 10-20; 20-40 i 40-70 mm should be used for preparation of heavy concrete as a large aggregate.

It is not allowed to use crushed stone from sedimentary rocks with an admixture of amorphous silica or marl, atmospheric agents that are destroyed by alkalis, which are part of the fine aggregate.

It is not allowed to use a natural gravel-sand mixture without scattering it on gravel and sand, as well as gravel containing grains of shale, which has the ability to break down during water saturation and freezing.

The largest grain size of the aggregate in the concrete mixture should be less than 1/3 – the smallest thickness of the product and 3/4 – the distance between the reinforcing rods.

The grade of crushed stone for strength must be at least 700. The strength of the aggregate must exceed the design grade of concrete by 1.5 times for concretes of class up to C18/22,5 (M300) and by 2 times – for concretes of a class above C18/22,5.

Natural sand with a modulus of 1.5 to 3.25 should be used as a fine aggregate for light and heavy concrete.

Chemical additives and complexes based on them are introduced into the concrete in order to improve the technological properties of concrete mixtures, optimize density, increase frost resistance, accelerate the hardening of concrete or mortar, water resistance and other technical properties.

Chemical additives that have a solid structure are dissolved, brought to the required concentration and fed into the tanks of the concrete mixing plant.

Depending on the ambient temperature, features of technology of preparation and laying of mixes heating of initial materials is possible. The allowable temperature of the starting materials when loading in the mixer should be:

- dense aggregates – within 5-40°C;
- porous fillers, water and solutions of additives – within 5-70°C;
- cement – within 5-60°C.

Deviations and tolerances that characterize the accuracy of construction and installation work are assigned by the project of works execution depending on the specified accuracy class (determined by functional, technological design and economic requirements) and are determined by regulations.

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