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**ODESA STATE ACADEMY OF  
CIVIL ENGINEERING AND  
ARCHITECTURE**

Department Technology of Construction Production

## **Guidelines**

in the academic discipline

### **Technology of Construction Production (special course) 1**

for the implementation of the course work  
on the theme «**Technology of construction of monolithic buildings**»  
for students of the educational and professional program  
Construction and Civil Engineering  
of the specialty 192 Construction and Civil Engineering  
Educational level - the first bachelor's

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The purpose of these guidelines is to provide assistance to students in the development of technological maps for the production of form works, reinforcing works and concrete works in the process of completing course works, course and graduation projects. The guidelines provide detailed recommendations on the technology of form works, reinforcing works and concrete works.

Guidelines are recommended for students of all forms of education at the educational level Bachelor of specialty 192 "Construction and civil engineering" specialization "Industrial and civil engineering"; students of advanced training courses and retraining of specialists, graduate students and teachers.

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## CONTENT

<b>INTRODUCTION</b>	4
<b>1. COMPOSITION OF COURSE WORK</b>	5
1.1. General positions	5
1.2. The content of sections of the course work	6
<b>2. GUIDELINES FOR PERFORMING SECTIONS OF COURSE WORK</b>	7
2.1. Development of the section "Initial data and characteristics of the object"	7
2.2. Development of the section "Characteristics of structures that are being built"	7
2.3. Development of the section "Technology and organization of form works"	8
2.4. Development of the section "Technology and organization of reinforcing works"	16
2.5. Development of the section "Supply, laying and compacting the concrete mixture"	18
2.6. Development of the section "Curing and maintenance of concrete"	24
2.7. Development of the section "Bill of Quantities and Calculation of Labor Costs"	25
2.8. Development of the section "Machines, equipment and fixtures that are used"	28
2.9. Development of the section "Shift schedule of works on a typical floor"	33
2.10. Development of the section "Quality control and acceptance of works"	35
2.11. Development of the section "Measures for labor protection and safety"	46
2.12. Development of the section "Technical and economic indicators"	47
2.13. Development of the section "References"	48
<b>APPENDIXES</b>	49
<b>REFERENCES</b>	60

## INTRODUCTION

The purpose of this course work is to master the key provisions of the technology for the construction of monolithic and precast-monolithic buildings based on the requirements of the DBN, other regulatory documents, and also the development of the main elements of a project for the production of works (PPW) for concrete (reinforced concrete) works.

Regarding the complex of works on the erection of monolithic structures of buildings and structures of various types, the design process is characterized by a large combination of conditions and requirements of an organizational, technological and technical nature in the field of formwork and reinforcement works, rules for laying and compacting concrete, in-line organization of work.

The composition of a project for the production of works (PPW) for the performance of certain types of work includes:

- data on the needs for basic materials, semi-finished products, structures and products;
- technological maps for the implementation of concrete work, covering: installation of formwork, reinforcing work, work on laying and curing concrete during the installation of individual structures and large structural fragments of the building;
- a calendar schedule for the execution of work.

The development of these documents as part of the training design is largely intended to prepare the future specialist for qualified successful work in the field of design and organizational and technological preparation for the performance of concrete work on real objects.

The teacher gives the student a variant with the initial data for doing the course work from Appendix 4 of these guidelines, or gives an individual variant from another source.

## SECTION 1. COMPOSITION OF COURSE WORK

### 1.1. General positions

Course work is produced in the form of PPW elements for certain types of construction work.

The text part of the PPW is drawn up in the form of an explanatory note, where the technological documents listed in the introduction are presented as sections-chapters with the necessary calculations, justifications and technical-economic indicators.

The graphic part of the PPW is formed in the form of drawings, the composition and number of which, to the required extent, reveals and details the decisions made. Graphic elements can be included directly in the text of the explanatory note (small diagrams, assemblies and details, as explanations for the text part), and / or arranged in the form of graphic sheets with drawings, diagrams, assemblies and details, text explanations.

For performing of the course work on the design of the technology of works in the construction of the above-ground part of buildings, training tasks for monolithic housing construction are used.

The design of the text part of the PPW is made in the form of an explanatory note on numbered sheets of A4 paper. The note should contain a title page (number 1, but no printout of the number), content, introduction, and sections with technical descriptions of the work. Sections are numbered starting with the first number after the introduction. In turn, sections can contain subsections, and subsections can be further divided into independent positions of descriptions.

Figures, diagrams, graphs given in the text of the explanatory note are also numbered according to the principle of numbering tables and must contain figures with captions - the figures contained in these guidelines can be considered as design examples.

References to tables and figures in the text of the explanatory note are made as follows: (*table N.n*), (*fig. N.n*) when referring to the materials of the current

section, or (*see Table N.n*), (*see Fig. N.n*) when references to information in other sections.

The graphic part of the project (plans of a building, divisions, formwork drawings, assemblies, details and accompanying textual explanations) is drawn up in the form of drawing sheets of A1 format. References to sheets with graphic information are given as part of the explanatory note as the material is presented.

## **1.2. The content of sections of the course work**

**The explanatory note** should contain the following sections:

Introduction

1. Initial data and characteristics of the object.
2. Characteristics of structures under construction.
3. Bill of quantities of work and calculation of labor costs.
4. Technology and organization of works.
  - 4.1. Formwork works.
  - 4.2. Reinforcing works.
  - 4.3. Supply, placement and compaction of concrete mix.
  - 4.4. Concrete care and maintenance of monolithic structures.
5. Machines that were used, equipment and fixtures.
6. Shift work schedule on a typical floor.
7. Quality control and acceptance of works.
8. Measures for labor protection and safety.
9. Technical and economic indicators.

The list of references.

**The drawing sheet** should display the following:

- diagram of a layout of monolithic structures on a typical floor plan;
- section according to the scheme, work schedule;
- diagrams of work execution, units;
- technical-economic indicators;

- requirements for the quality of work performance.

## **SECTION 2. GUIDELINES FOR PERFORMING SECTIONS OF COURSE WORK**

### **2.1. Development of the section "Initial data and characteristics of the object"**

Execution of course work should begin with the study of architectural-planning and design solutions in accordance with the assignment (the construction of walls, columns, ceilings, partitions, flights of stairs, etc.). In this section, in accordance with this, the characteristics of the object are given with the necessary schemes.

### **2.2. Development of the section "Characteristics of structures that are being built"**

The load-bearing walls, columns and floor slabs of buildings in the training tasks are made of monolithic reinforced concrete. In the course of studying the architectural-planning solution of the building, blanks of formwork drawings of monolithic load-bearing reinforced concrete structures should be prepared. When designing, the work on the arrangement of the above-ground part includes the construction of:

- monolithic walls and columns of a typical building floor;
- floor slabs of a typical storey.

On the basis of the task and the completed drawings, a specification is made for monolithic and prefabricated (stair flights and landings) reinforced concrete elements (Forms 1 and 2).

## Specification of monolithic reinforced concrete elements

№ in order	Denomination of an element	Concrete class	Element dimensions, m			Volume of openings, m <sup>3</sup>	Volume of elements without openings, m <sup>3</sup>
			length	width	height		
1	2	3	4	5	6	7	8

## Specification of precast concrete elements for a typical floor

№ in order	Denomination of an element	Conventional mark	Mass of one element, t	Amount of mounted elements, pieces, per floor	Total mass of elements, t
1	2	3	4	5	6

### 2.3. Development of the section "Technology and organization of form works"

Description of formwork works in the explanatory note should include:

- information about the formwork system used (denomination, manufacturer);
- rules for acceptance and storage of formwork;
- formwork assembly-disassembly rules (the description is formed on the basis of formwork drawings with corresponding references to sheets, assemblies and parts). The brief instructions on how to dismantle the formwork are given here also;
- information about the formwork performers and the organizational form of their participation in the general cycle of concrete work;
- instructions for performing work on cleaning and lubricating the formwork;
- rules for quality control of assembly and acceptance of finished formwork;
- basic rules and safety measures in the implementation of formwork works.

The formwork used in construction must comply with the following qualities: strength, rigidity, geometric invariability of shape under the influence of loads, the

ability to provide the required quality of the concrete surface, manufacturability of assembly and disassembly.

The type of formwork is chosen taking into account the purpose of the building / structure / and type of construction, guided by educational and reference literature and the instructions of the project manager.

- In the construction of multi-storey monolithic buildings, three technological methods are most often used, differing in the design and technological features of the formwork systems used:

- erection of structural elements of buildings in a small-panel dismountable-movable formwork;

- erection of structural elements of buildings in large-panel and block movable formwork;

- the erection of structural elements of buildings in a volume-movable or formwork, extendable vertically or horizontally.

The scope of use of volumetric-movable formwork is somewhat limited compared to small- and large-panel formwork.

Additionally, there are: *unified formwork*, consisting of panels of different sizes with inventory fasteners and supporting devices, which is designed for multiple use, and stationary, *non-inventory formwork*, produced and installed on site. Non-inventory formwork is used for the installation of formwork forms of atypical structures and parts, individual fragments of structures as part of inventory formwork.

One of the most important indicators of formwork is its turnover (possibility of repeated use). The higher turnover indicator, the lower the cost of formwork per unit volume of a reinforced concrete structure.

The choice of a particular formwork system is made taking into account:

- of technological compliance of the formwork of the object structures;

- of economic efficiency of the use of one or another type of formwork systems, acceptable for the object. Here, much depends on the configuration of the structures being built.

In all types of dismountable-movable formwork systems, frame structure panels are used as primary form-building elements, the dimensions of which, as a rule, are a multiple of the module in construction - 0.3 m (300 mm). Such shields are used for formwork of vertical monolithic structures of walls and columns.

Usually, in the composition of the shields, the main ones (as a rule, shields of large size) and additional ones (3-4 types of shields of smaller modular sizes) are distinguished. Individual shields are often enlarged into formwork panels with increasing volumes both in length and in height. For the installation of formwork in the places of the corner joints of the walls, special internal corner shields are provided; on the outer side of the corners, the panels are connected using mounting connecting corners, also included in the kit. In addition, the shields of the formwork system usually include universal shields that make it possible to form the formwork of corners and columns of different sections.

The assembly of wall formwork begins with the installation of individual shields along one of the sides of the future wall. The assembly usually begins with L-shaped corner fragments that have independent stability. The stability and verticality of individual shields or enlarged wall formwork panels at the stage of initial installation and subsequent assembly of reinforcing cages is ensured by diagonal elements (braces). Adjacent edges of the shields are vertically connected and aligned using locks, overhead beams, and special crossbars. A line of formwork shields opposing each other is installed after cleaning the reinforcing cages of the walls. Horizontal anchor bolts (tie rods) are used to connect opposing formwork shields. They have two tasks: the first is to provide a given wall thickness; the second is to absorb the expansion forces from the concrete mixture at the stage of concreting the walls until the moment of setting.

The initial installation of the column formwork is carried out to ensure stability by L-shaped fragments of two universal shields and one diagonal element (brace). After installing the reinforcement, the remaining shields and one more diagonal element (brace) are added. In some cases, the entire formwork is placed after

installation or assembly of reinforcing cages that have sufficient spatial stability and rigidity.

Formwork design consists in the optimal arrangement of shields on the formwork plans of the walls and columns of a separate division or a typical floor. When designing the underground part, the arrangement of shields on the contour plans is shown for the foundation slabs, walls and columns of the underground part.

It is easier to arrange shields in the graphical editing mode on a computer: large-scale plans of shields are drawn and, further, the main shields are placed along the large-scale contour of the walls of a typical floor. When the length of the wall is not multiple of the dimensions of the main shield, selective inventory shields, bars-inserts or shields of building manufacture are used.

The placement of the main and additional shields is carried out along one lateral plane of the wall on a large-scale plan of the division or floor, indicating the places for installing the braces of the elements. The opposing shields are assigned in a mirror manner to ensure the installation of tie rods in regular formwork holes. Additionally, cross-sections of the formwork are made, where the geometry of the cross-section of the structures and the vertical dimensions of the formwork, the number of studs-ties along the height of the shields, the design of the scaffolding and formwork of the walls of the outer contour of the building, and the conditions for attaching the soles of the braces of the elements to the ceiling are specified.

Directly on the formwork plan of the walls, symbols should indicate the places for installation of the hole formers and the places for making working vertical joints, if such are necessary from the technological conditions for ensuring the continuity of concreting. The decision on the placement of working joints is obtained in the course of clarifying the technology of work on laying the concrete mixture into the formwork.

The scales of plans and units in the drawings, which use symbols, should provide a convenient perception of information.

Based on the formwork drawings, a specification is made of the main elements

of the formwork of vertical structures (see form 3). In training works, the specification of the formwork kit includes:

- inventory shields by types (basic, universal, additional, corner outer corners, corner inner corners, hinged corners);
- non-inventory shields of construction production;
- diagonal elements of all used types;
- locks by types (universal and wedge);
- suspension scaffolding brackets;
- scaffold brackets;
- plank shields of scaffolding and platforms.

**The slab floor formwork** is formed using lightweight formwork panels, beams and props. As panels, standard sheets of laminated plywood are often used, having dimensions of 3x1.5m and 2.4x1.2m with a sheet thickness of 18-21mm. Beams and props, their properties, are determined by the formwork system used.

Floor formwork design begins with the layout of the panels on the floor plan of a typical floor with the outlines of walls, columns and beams in the floor composition. When trying different directions for laying out panels within the contours of walls, columns, and beams, one should strive to use the maximum number of whole panels. The outer contour of the floor, free from walls, must be covered with formwork panels with a protrusion over the edge at a distance of up to 0.5-1m (!). At the same time, it should be taken into account that in the edge zones of floors without external walls, it is preferable to lay the panels with the short side parallel to the edge of the floors in order to ensure greater reliability of their fastening during the assembly of formwork and reinforcement. Non-multiple places in the plan of formwork floor panels are filled with cut-out fragments from the same panels. For the installation of cantilever protrusions of the floors beyond the contour of the external monolithic walls, the same scaffolding is used, which will then be used to install the external wall formwork shields of the next floor.

After laying out the panels, it is necessary to start laying out the beams of the upper row: at the same time, the maximum laying pitch is set, which should ensure that the plywood does not sag under the weight of the concrete mixture (usually within 0.5-0.7 m, depending on the thickness of the floor and plywood). The beams of the upper belt must necessarily be placed under the short edges of the panels - for this purpose, the layout step is reduced, the beams are doubled in the edge area. Next, the beams of the lower support belt are laid out and the formwork racks are placed. The traditional pitch of the main beams is 1.2 ... 1.5 m, the pitch of the racks is 1.5 ... 2 m. These indicators should be clarified according to the documentation for the formwork system used, where the permissible loads on the elements are usually indicated.

Particular attention is paid to the layout of the beams of the upper and lower belts in the areas of cantilever outlets of the floor formwork beyond the contour of the building. These places use:

- accelerated layout of beams;
- installation of additional racks and frames;
- anchoring the heels of the extreme racks to the lower floor;
- formation of spatially stable tours from the extreme racks;
- cohesion of beams along the length;
- obligatory fastening of the edge formwork panels to the beams with nails or self-tapping screws;
- edge fencing.

The layout of formwork panels, beams and racks is usually drawn up in the form of separate drawing plans, which indicate the main dimensions, bindings, step of the elements, give textual instructions regarding the nuances of the work that cannot be displayed graphically. The plans are supplemented with sections, on which detailing of difficult places is carried out: formwork units of beams as part of the floor; floor formwork units in the edge zones, indicating the means of additional fastening of racks, beams, edge fencing, as well as formwork units in the places

where reinforced concrete floor beams are installed. It is expedient to group the graphic materials related to the floor formwork on a separate sheet/sheets of A2-A3 formats.

On the basis of the formwork drawings, a specification is made of the main elements of the formwork of the floors (form 3 is usually given on a sheet of drawings with a formwork plan). In educational works, the specification of a set of such formwork includes:

- solid formwork panels;
- additional formwork panels with multiple turnover;
- beams of the upper belt in length;
- beams of the lower belt in length;
- racks, taking into account the needs of intermediate support of floors when supported without formwork;
- tripods for vertical fixation of racks during formwork assembly;
- inventory frames for the formation of spatial tours in the edge zones (if any are included in the system);
- shields of a side formwork of beams in the floor (if there are beams).

When using another type of formwork systems in course design, you should first understand their design features and conditions of use. The formwork solutions contained in the documentation for the use of the formwork system serve as the basis for this work. Further, on the basis of these decisions, solutions for the production of formwork work at the facility are formed. In large-block formwork, shields are folded into three-dimensional blocks with the help of unified connecting elements, the dimensions, number of which and joint designs are established in the design process. In volumetrically-movable formwork, П-shaped or L-shaped sections are connected, respectively, into tunnels or half-tunnels, tables, the number and configuration of which are also established as a result of the design of the formwork in relation to the building under consideration.

The main technical means of providing formwork work is a crane. With its help, shields of a large mass are mounted, packs of shields of small mass and other products are fed to the mounting horizon directly into the working areas, and the formwork is dismantled. It is also extremely important to have enough scaffolding and platforms to ensure work in the edge zones, at height. Such devices should ensure the simultaneous work of the brigade on at least two divisions.

The assembly of formwork using modern formwork systems for vertical structures is carried out by locksmiths. Usually, links of 2-3 working locksmiths are used. Shields weighing 100 kg or more are installed on a marked base with a crane, fixed in a vertical position with locks and braces. Work on the installation of additional fasteners, tie rods, scaffolds and fences is carried out by workers from the concrete workers team under the leadership of the foreman and link workers as soon as the reinforcing cages and formwork as a whole are ready.

Execution of formwork works when arranging one or another type of structures in the form of continuous operation of a specialized link is possible with rhythmic alternation of the performance of divisions: assembly on the first division; assembly on the second; disassembly on the first - assembly on the third, etc.

However, more often formwork is considered as part of a complex of reinforcing and formwork work, the total duration of which is determined by the amount of labor costs and the shift number of workers in a link or team. This approach is quite justified, since in the absence of formwork work, workers specializing in the assembly and disassembly of formwork are involved in reinforcing work.

Form 3

### Specification of formwork elements

№ in order	Formwork element name	Dimensions, m sketch	Weight, kg	Required quantity, pcs.
1	2	3	4	5

## **2.4. Development of the section "Technology and organization of reinforcing works"**

The working reinforcement of walls and floors in the training tasks is presented conditionally, in the form of meshes (side for walls, bottom and top for floor slabs) with a given diameter and spacing of the rods. Similarly, the reinforcement of columns, foundation slabs, beams in the composition of floors is considered.

Thus, technological methods for performing reinforcing work as part of the project involve knitting meshes of individual rods in the design position and / or installation of spatial reinforcement frames and meshes pre-assembled at the construction site of individual rods using enlarged assembly stands.

To connect reinforcement in meshes and frames, it is recommended to use overlapping rods without welding, mechanical connection using bolted couplings, mechanical connection of reinforcement using couplings and hydraulic crimping presses.

In the case of manual knitting of reinforcement meshes of walls and floors in the design position with overlapping rods and assembly of reinforcement frames of columns into spatial frames on stands with subsequent installation, the technology of reinforcement work should establish:

- specific solutions for positioning the rods in the desired spatial position during assembly (assembly order of horizontal and vertical meshes, linings, temporary supports, means of providing a protective layer of concrete);
- the magnitude of the overlaps of the connected rods, depending on the type of reinforcement, the rules for placing and knitting joints in the places of overlaps;
- rules for knitting cruciform mesh joints;
- assembly drawing of the spatial reinforcement frame of the columns (when using an enlarged frame);
- a brief description of the design of the enlarged assembly stand (when using the enlarged assembly of frames).

Carrying out reinforcing work is associated with the acceptance, storage of

reinforcement, the supply of rods to the work area by a crane, manual delivery of rods to the installation site, cleaning and cutting of rods, manufacturing of reinforcing products for temporary fastening of rods and meshes in the desired spatial position. In general terms, with the correct supply of reinforcement by a crane to the work area, manual delivery of reinforcing products is included in the time standards for the installation of reinforcing frames (delivery rods up to 4 m).

The main technical means of equipping reinforcing works is a construction crane, which ensures the supply of reinforcement to the place of assembly of frames in the design position or stands, as well as the installation of spatial frames in the design position. Bar reinforcement is supplied to the work area in packs, the mass of which is acceptable for a crane, formwork and supporting devices. Slings and storage of packs are carried out in compliance with the general rules.

The preparation of reinforcement, including the manufacture of small supporting reinforcing products, clamps, etc., is carried out at special sites equipped with machines for cleaning, cutting and bending of rods, straightening wire reinforcement. As part of such sites, a welding post is organized. The sites for preparation of reinforcement are arranged, if possible, next to sites for storage of reinforcement in order to exclude additional transport operations.

Reinforcing works are most often the most labor-intensive in the general composition of concrete work. Their implementation is almost continuously going on against the background of periodic cycles of concreting, rearrangement of formwork during the construction of a typical floor, preparation of the divisions of a foundation slab. The initial determination of the required variable number of workers to perform reinforcing work is made by dividing the total labor intensity of reinforcing, formwork and concrete laying work by the required duration of the construction of the floor in shifts. Further, the number of workers is specified when constructing a shift schedule for the construction of a typical floor, taking into account the involvement of some performers for concrete and formwork work.

The description of reinforcement work in the explanatory note is drawn up as

part of the "Technology and organization of work" section of the technological map.

The description must include:

- information about the reinforcement used (class, diameter, pitch);
- rules for acceptance and storage of reinforcing products at the construction site;
- information about the performers of reinforcing work and the organizational form of their implementation in the general cycle of concrete work;
- assembly procedure, methods of fixing the reinforcement in the desired spatial position in the form of diagrams and details on graphic sheets;
- features of the formation of joints of working rods, mesh knitting in the form of diagrams and textual explanations on graphic sheets and / or in an explanatory note;
- rules for quality control of assembly and acceptance of reinforcing frames and meshes;
- basic rules and safety measures for reinforcing work.

The volume of reinforcing work is taken depending on the type of structure as a percentage of the volume of concrete and is per 1 m<sup>3</sup> for: floors – 100-150 kg/m<sup>3</sup>; columns – 150-250 kg/m<sup>3</sup>; walls – 110-120 kg / m<sup>3</sup>.

## **2.5. Development of the section "Supply, laying and compacting the concrete mixture"**

Concrete laying naturally completes the cycle of reinforcing and formwork work, and usually includes: receiving and supplying the concrete mixture to the place of laying, laying itself, leveling and compacting the mixture in the formwork.

The processes of laying a concrete mixture are the least amenable to formal control operations, and the quality of work during laying is based on the strict adherence to generally accepted rules, which include:

- compliance with the height of the discharge of the mixture into the formwork;

- absence of an additional movement of the mixture in the formwork;
- observance of the thickness of the stacked layers to ensure high-quality compaction;
- compliance with the rules of compaction of the concrete mixture;
- observance of the geometry of the strips and layers, the pace of laying to ensure the conditions for the continuity of concreting;
- compliance with the rules for the formation of working joints;
- compliance with the rules for the restoration of concreting in the areas of working joints.

The composition of the technical methods of supplying and laying the concrete mixture in educational design implies two main options:

- mounting crane + bunkers / tubs / swivel and non-swivel + load gripping devices, a tool for laying and compacting the concrete mix;
- assembly crane + concrete pumping plants (stationary or self-propelled) + distribution plants (jibs) + tool for laying and compacting the concrete mixture.

During the construction of multi-storey monolithic / precast-monolithic / buildings, the following characteristics of divisions have developed:

- overlap - area (over the overlap) - 80 ... 200 m<sup>2</sup>; the volume of concrete is laid on the division - 30 - 60 m<sup>3</sup> (crane bucket) or 60 - 100m<sup>2</sup> (concrete pump + distributing jib);
- walls with a thickness of 200mm or less, columns with a section of 400x400mm or less - 30 - 40m<sup>3</sup> per shift;
- walls with a thickness of 300 mm or more, massive columns - 40 - 60 m<sup>3</sup> per shift.

During the laying of concrete, the characteristic links of concrete workers are used.

- 4 concrete workers when concreting walls per crane using the "crane-bucket" method;
- 4-6 concrete workers when concreting walls per one jib supplying concrete;

- 2 concrete workers when concreting columns with any method of supplying the mixture;

- 4-6 concrete workers when concreting overlaps per crane using the "crane-bucket" method;

- 6-8 concrete workers when concreting overlaps per one jib that delivers concrete.

More often, links are appointed from the composition of the complex team for the period of laying the mixture. In the absence of laying work, concrete workers return to the main team and are used for reinforcing work, installation and dismantling of formwork. Sometimes it is possible to organize the systematic daily work of specialized links of concrete workers within the framework of the first or second shift.

The fulfilment of the concreting continuity condition ensures the solidity of the structures and their fragments in the volume of the concrete laying areas. This is achieved by the fact that each portion of the concrete mix that is laid is mixed, due to compaction at its boundaries with previously laid, but not yet set concrete, forming a monolithic volume without joint.

In turn, the portions of the laid concrete mixture are formed depending on the structure being made; the layers or laying strips are ordered. Here, too, the condition of the absence of setting of previously laid concrete at the boundaries of layers and strips comes into force, which requires the correlation of their sizes with the laying performance and setting time of the concrete mixture. The ordering of the geometry of the strips is also dictated by the need for constant visual control of the boundaries of the laying zones in order not to leave uncompacted areas at the joint of the strips (a typical laying defect when laying floors).

First, you should specify the geometric dimensions of the cross sections of strips and layers:

- strip width (b, m) 2-3 m and thickness (h, m) equal to or less than the thickness of the slab when laying foundation slabs;

- strip width (b, m) 2-4 m and thickness (h, m) equal to the thickness of the slab when installing floor slabs;

- layer height (h, m) equal to the length of the working part of the vibrator (usually 0,4-0,5 m) and wall thickness (b, m) when concreting long walls.

Further, it is required to clarify the setting time of the concrete mixture after laying in the formwork,  $\tau_{CX}$ , h (usually 0.5-1 h for mixtures without additives).

The last required indicator is the laying productivity, V, m<sup>3</sup>/h. Usually this value is determined by the productivity of the link of concrete workers.

After that, the maximum length of the strip or laying layer is determined according to the concreting continuity condition:

$$L = (V * \tau_{CX}) / (h \times b), \text{ m} \quad (2.1)$$

In the event of interruptions during the concreting of structures, the boundaries of the laying sections form working joints. The position of such joints in structures of various types is subject to certain rules and is indicated on the formwork plans. Usually this should be done in relation to long walls and floors of a large area, where the construction joints include specially installed reinforcing meshes. The restoration of concreting in the zones of working joints is subject to certain rules, which must be given in the technological documentation.

The main technical means for mounting prefabricated structures and large formwork elements, supplying materials, etc. are:

- assembly crane;
- load-handling devices;
- fixtures for alignment and temporary fixing of mounted elements;
- devices that ensure the safety of working at heights.

Depending on the purpose, stationary (at an object with large volumes of concrete work), trailed and self-propelled concrete pumping units with a concrete pipeline or a distribution jib are used. The distribution jib is carried out by its own (concrete pump truck) or remote (autonomous) on masts, tables, telescopic racks.

Concrete pumps can pump concrete mixtures of plastic (cone draft 5-8 cm) and

cast (cone draft 12-15 cm) consistency. The optimal value of the water-cement ratio is considered to be 0.5-0.6. The largest size of crushed stone / gravel / ranges from 20-60 mm and depends on the diameter of the concrete pipeline.

The choice of concrete pumping plants is made according to the reference literature (Appendix 1). In doing so, the following requirements must be taken into account:

- the concrete pump must ensure the supply of the concrete mixture to the entire height of the building;
- the productivity of the concrete pump should be used to the maximum.

It is expedient to use truck-mounted concrete pumps in those cases when the radius of action of the distribution jib allows one or more parking areas to cover the entire area of the division that is being concreted. At the same time, free passage of concrete mixer trucks to the concrete pump should be ensured.

Distribution jibs and mechanical manipulators can be used as specialized equipment for the distribution of concrete mix, complete with concrete pumps. Distribution jibs are installed at the facility in the area of the division, which is being concreted, and connect, to the concrete pump by the main pipeline. The stability of the distribution jibs is ensured by attaching them to the load-bearing structural elements or to the formwork, as well as using a counterweight or ballast. Mechanical manipulators are used, if necessary, repeated rearrangements of specialized equipment for the distribution of the concrete mix.

When supplying a concrete mixture to a structure using a crane, bunkers (buckets) are used as containers. Bunkers according to the device and the principle of operation can be divided into rotary and non-rotary. The characteristics of distribution jibs and bunkers produced by industry should be found in the reference literature on construction.

The height of the free discharge of the concrete mixture into the formwork is limited: for floors – up to 1 m, for walls – up to 4,5 m, for columns – up to 5 m, for unreinforced structures – up to 6 m. With a greater height of free discharge, the

concrete mixture is laid using aircraft or trunks.

To obtain high-quality concrete with specified physical and mechanical properties, the laid concrete mixture is compacted. Depending on the adopted compaction technology (bayonet, tamping, vibration, rolling, vacuuming), the choice of technical means is carried out. For monolithic structures of a multi-storey building (walls, floors, columns), vibration methods and various types of vibrators are most often used, listed in Table 2.1 (technical characteristics of deep vibrators are given in Appendix 2); for thin-walled structures (thickness up to 250 mm), the concrete mixture can be compacted using vibrating screeds.

Table 2.1.

Types of vibrators for concrete compaction

Types of vibrator	Scope of use	Depth of impact, cm	Productivity, m <sup>3</sup> /hour	Vibration duration
rammer vibrator	foundations, underlying layers	<20	1-10	15-30 seconds
deep vibrator	foundations, massifs, columns, beams, walls, coverings	<50	3-30	10-35 seconds
external vibrator	columns, walls	<30	1-2	1-5 minutes
surface vibrator	floors, coatings, roads	<30	5-40	0,6-1,4 minutes

The maximum possible thickness of structures for compaction with vibrating screeds: with single reinforcement - 250 mm, with double reinforcement - 120 mm. When the thickness of flat structures is greater than that indicated above, the concrete mixture is first compacted with deep vibrators, and then treated with surface vibrators and vibrating screeds.

Concrete laying works are carried out in specially designated divisions and areas, as well as in separate structures, where the formwork and reinforcement are assembled earlier and accepted according to the acts.

The divisions are structural fragments, simultaneously concreted during one or two working shifts. The appointment of divisions usually takes into account:

- of the established pace of construction of the building;
- of the provision of further stability and geometric invariability of the fragments of the structures under construction;
- of the geometry of the working areas of the mechanisms for supplying the mixture used;
- of constructive and technological requirements for compliance with the conditions for the continuity of concreting and the placement of working joints.

The divisions, if possible, should be equal in terms of labor input (deviations in the labor input of erecting different divisions should not exceed 25%). The boundaries of the divisions must be determined in the places that are planned for the construction of working and temperature joints; in cases where the boundaries of the divisions violate the integrity of the structure, they should be arranged in places where the lines of minimum internal stresses pass. Additionally, when assigning grips, one should take into account the possibility of workers accessing the work area in the presence of formwork. The boundaries of the divisions must be applied to the formwork plans, floor plans, foundation slabs.

## **2.6. Development of the section "Curing and maintenance of concrete"**

Instructions for curing and caring for concrete are given in the explanatory note based on ДБН В.2.6-98:2009 "Concrete and reinforced concrete structures".

In order for freshly laid concrete to gain the necessary strength at the appointed time, it must be properly looked after in the first days of hardening. In the initial period of hardening, concrete must be protected from atmospheric precipitation or moisture loss, and in the future, temperature and humidity conditions must be maintained with the creation of conditions that ensure its strength. Conditions for curing concrete should provide:

- protection from the sun, wind, rapid drying;
- prevention of significant temperature-shrinkage deformations and the occurrence of cracks;

- prevention of shocks, shocks and other impacts, including mechanical damage.

Favourable temperature-humidity conditions are created by systematic watering. To do this, the exposed surfaces of freshly laid concrete are covered with a moisture coating (tarpaulin or burlap), and in the absence of these materials, the concrete surface is closed 3-4 hours after it is laid with a layer of sand or sawdust and watered. Depending on climatic conditions, the frequency of watering should be such that the surface of the concrete during the maintenance period is always wet.

The movement of people on the concreted structures and the installation of the formwork of the upper structures are allowed after the concrete reaches a strength of at least 1.5 MPa. More details on the strength of concrete as a percentage of the strength during stripping for different classes of concrete are given in Appendix 3.

## **2.7. Development of the section "Bill of Quantities and Calculation of Labour Costs"**

Fulfilment of course work should begin with the study of architectural-planning and design solutions in accordance with the assignment (the construction of walls, columns, ceilings, partitions, flights of stairs, etc.).

The list of scopes of work (form 4) is filled in in the sequence corresponding to the composition of the structures under consideration and the designed technology for fulfilment work.

Form 4

The list of scopes of work

No in order	Name of processes	Unit of measurement of volume	Number of works per floor	Note
1	2	3	4	5

At this stage, certain technological ideas about the nature of the work produced

are already required. For example, for concrete work you need to know:

- How is the reinforcement installed? (frames, meshes or individual rods);
- How are rod connections made? (knitting, welding, mechanical connections);
- What type of formwork will be used? (large panel for crane installation, small panel for manual assembly, tunnel, etc.);
- What method will be used for supply the concrete mix into the formwork? ("Crane - bucket", concrete pump and distribution jib, laying from vehicles, etc.).

At the stage of formation of a list of scopes of work for the installation of walls and partitions, it is necessary to set the conditions and methods for supplying materials and transporting them on the floors (by crane or lift to remote platforms; transportation on the floor by a stretcher or using wheelbarrows, average distance of manual transportation), which platforms and scaffolds to use.

When compiling Form 4, it is also required to determine a number of related characteristics, for example, the mass of reinforcement for walls, floors and other structural elements of the building. Notes on Form 4 may include volume formulas, references to structural locations, and other notes explaining the work or a way to determine its volume of transportation on the floors.

When compiling Form 5, it will also be necessary to determine a number of related characteristics, for example, the mass of reinforcement for walls, floors and other structural elements of the building. Notes on Form 5 can include formulas for calculating volume, references to the location of structures, and other comments explaining the work or how to determine its volume.

Calculation of labour costs (Form 5), which can be used when issuing work orders for workers, is compiled in accordance with the requirements of ДБН А.3.1-5:2016 "Organization of construction production".

Column 1 indicates the numbers of the paragraph, table, columns and positions of the norm adopted according to the relevant norms: ДСТУ БД.2.2-6:2016. (Collection 6) – "Concrete and reinforced concrete monolithic structures."

## Calculation of labor costs

Justification of the norm	Name of works	Unit of measurement	Scope of work	Norm of time per unit of measurement, man-hour $\frac{\text{workers}}{\text{machinists}}$	Labor costs for the entire scope of work (labor intensity), man-days $\frac{\text{workers}}{\text{machinists}}$	Price per unit of measure, UAH $\frac{\text{workers}}{\text{machinists}}$	The cost of labor for the entire scope of work, UAH. $\frac{\text{workers}}{\text{machinists}}$
1	2	3	4	5	6	7	8
Total:					$\Sigma$		$\Sigma$

Column 2 contains a list of works corresponding to those accepted in the technological map with binding to the positions provided for in the collection of norms.

In column 3, the units of measurement corresponding to the norms are put down, in column 4 - the common scopes of each type of work calculated earlier.

According to the selected group in ДСТУ, column 5 indicates the time rate per unit of measurement for the main workers (numerator) and machinists (denominator) per man-hour. Column 7 indicates the price per unit of measurement according to ABK-5.

Column 6 records the calculated total labor costs for workers and machinists man-days. Total labor costs are defined as the product of the scope of work and the norm of time, divided by the duration of the work shift (8.2 hours).

In column 8, the cost of labor costs for the entire scope of work is recorded, equal to the product of the scope of work (column 4) and the price (column 7).

At the end of the calculation, the totals for columns 6 and 8 are put down.

## 2.8. Development of the section "Machines, equipment and fixtures that are used"

When choosing methods for performing concrete work, the parametric selection of distribution devices for supplying the concrete mixture is mainly carried out: stationary or mobile jibs distributing concrete. Using the reference characteristics of such devices in terms of the distance and height of the mixture supply (Fig. 2.1), the rules for their installation relative to the boundaries of the structures being erected, the edges of the pits determine and optimize the installation locations of such devices on the scale plans of the site, directly on the divisions and work areas.

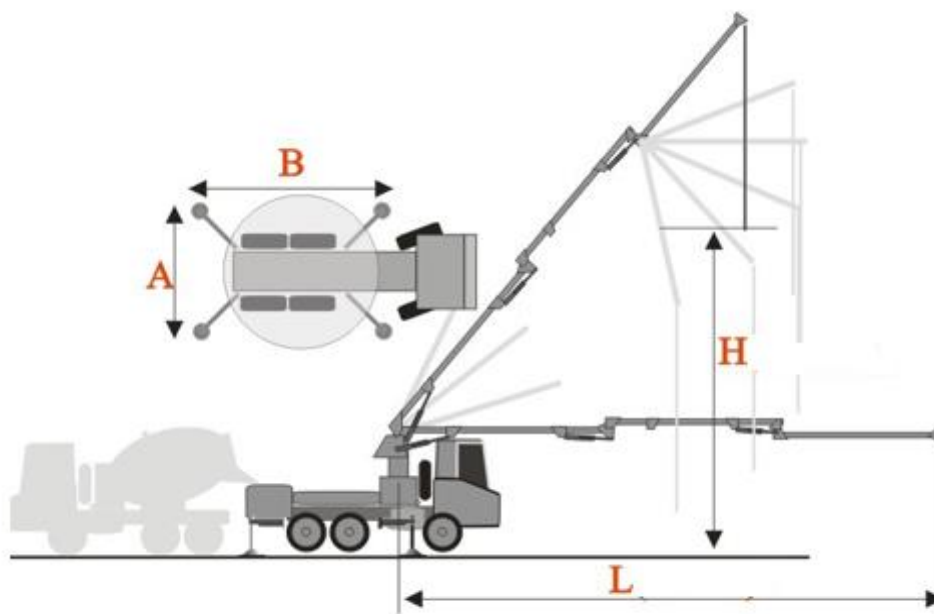


Fig. 2.1. The main technical parameters of the jibs distributing concrete used in technological design.

When erecting precast-monolithic and monolithic high-rise buildings, it is recommended to use tower cranes. Depending on the size of the building, rail-mounted cranes (for linearly extended multi-section buildings) or attachment cranes (for single-section buildings) can be used. When designing work on the construction of the underground part, self-propelled crawler or pneumatic wheel

jib cranes can be used. On fig. 2.2 shows diagrams for the construction of the above-ground part of buildings using various methods of installing cranes. In the case of a one-sided installation (diagram in Fig. 2.2a), the tower crane coverage area covers the entire width of the building, which requires the use of more powerful cranes; when using two cranes located on opposite sides of the building under construction (diagram in Fig. 2.2b), the coverage area of each of the cranes must cover at least half the width of the building. When erecting high-rise, "point" buildings, such diagrams are often used, which are shown in Fig. 2.2c.

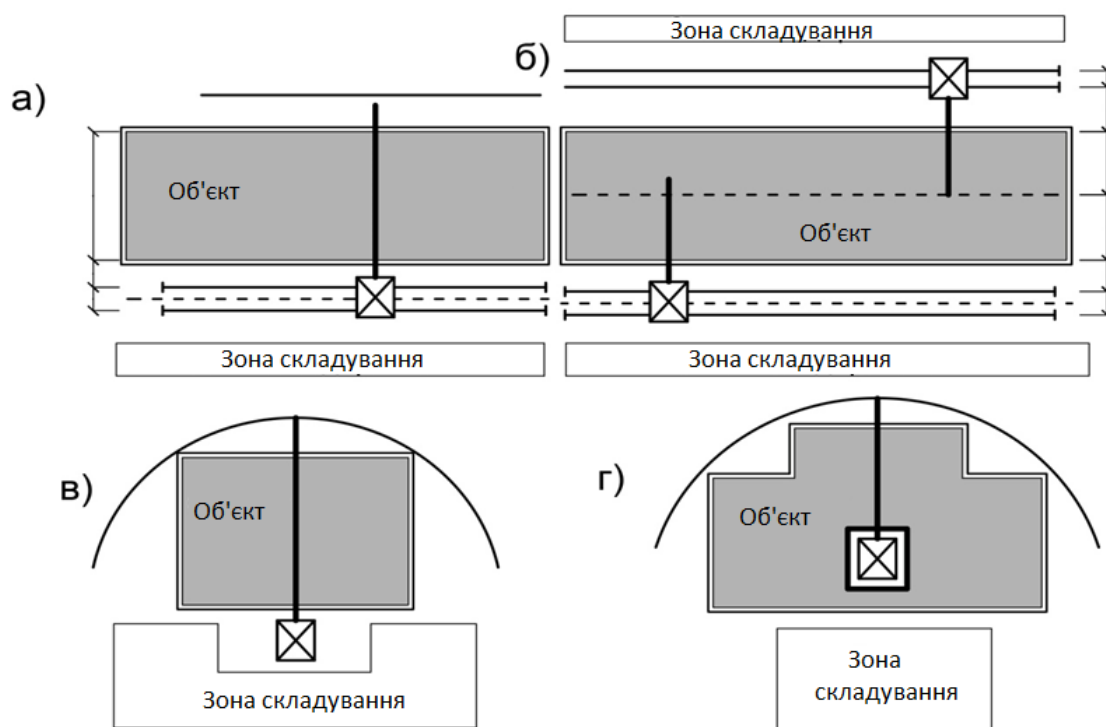


Fig. 2.2. Crane installation diagrams: a) one-way; b) double-sided; c) the attachment crane is located on the outside of the building; d) the attachment crane is located in the core of the building stiffness.

The choice of cranes in the construction of monolithic and precast-monolithic buildings is carried out in two stages. At the first stage, the necessary technical parameters of cranes are determined: lifting capacity, jib reach, hook lifting height (Fig. 2.3). This work is best done using tabular form 6.

## Crane lifting characteristics

№ in order	Name of the lifted load	Required load capacity $P_{KP}$ , t	Required hook height, $H_{KP}$ , m	Required hook reach, $L$ , m	Crane hook reach range, m
1	2	3	4	5	6

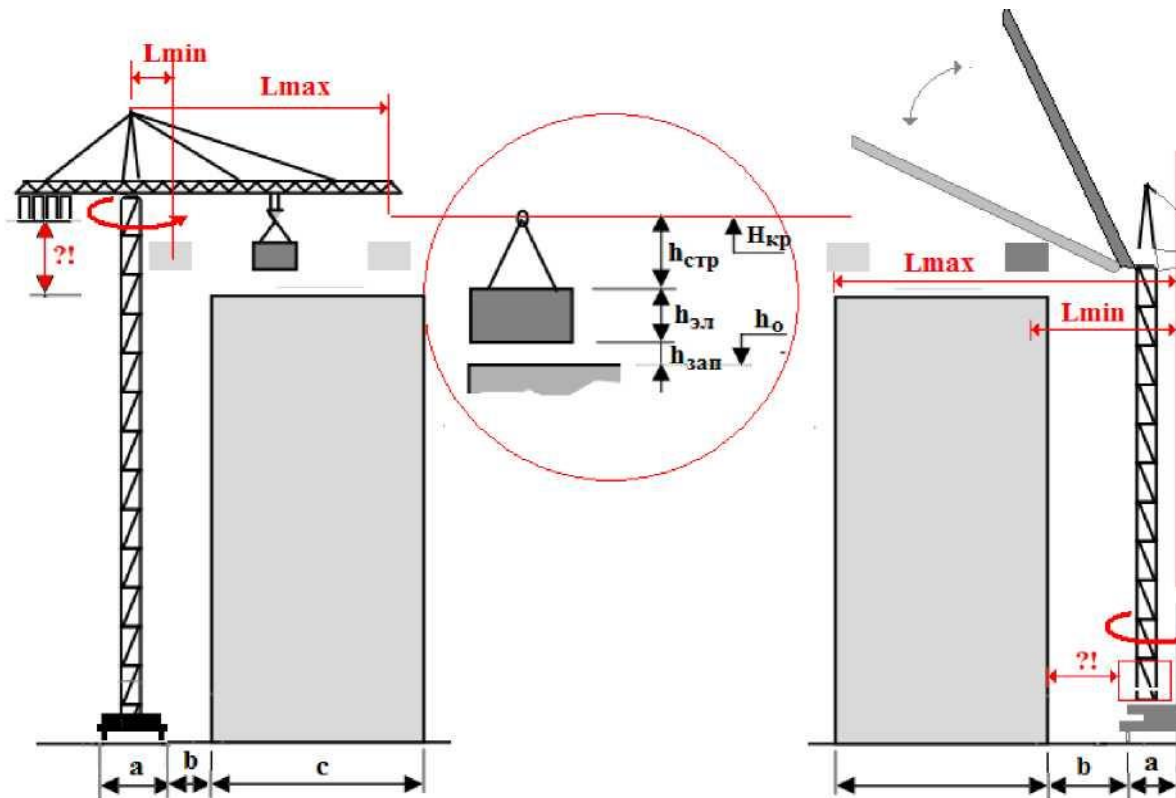


Fig.2.3. Diagram for determining the parameters of tower cranes.

The lifting height of the tower crane hook is determined by the formula:

$$H_{KP} = h_0 + h_3 + h_{еп} + h_{кр} \quad (2.2)$$

where:

$H_{KP}$ - is the distance from the level of the crane parking (top of the rail head of the crane track) to the geometric centre of the hook link, m

$h_0$ - is the level of the upper mounting horizon, m;

$h_{3ан}$  - is the headroom when lifting a load over a high obstacle, it is taken equal to 0,5 m;

$h_{еп}$  - is the highest of the heights of the lifted loads (concrete hopper, formwork panel or block, reinforcement cage, prefabricated assembly element), m;

$h_{\text{crp}}$ - is the calculated height of the sling.

Crane jib reach  $L$ , m, is determined by the formula

$$L = a / 2 + b + c \quad (2.3)$$

where:

a- crane runway width, m;

b- distance from the crane rail nearest to the building to the nearest protruding part of the building, m;

c- the distance to the most distant part of the building (most often, the width of the building), m. The calculated value of this indicator can be influenced by technological factors. For example, in the case of using movable volumetric formwork or “tables” of formwork for floors when working with one crane,  $2m +$  half the length of the formwork block must be added to the width of the building.

Since at this stage of the calculation the model of the crane that will be accepted for work is unknown, the value of "a" can be taken equal to the width of the crane runway of any of the cranes of the required lifting capacity, and then clarified after selecting a particular crane. The value of "a" also depends on the design of a particular crane, so at this stage of the calculation can be taken:

– for cranes with a slewing tower and a counterweight located above the building - 2 m;

– for cranes with a slewing tower and a counterweight located at a level - equal to the radius of the slewing part minus 0.5 "a", and plus 1 meter - to ensure the required width of the crane working area.

The required lifting capacity of the crane is equal to the sum of the mass of the lifted load and the mass of the lifting device:

$$P_{\text{кр}} = Q_{\text{BAH}} + q, \text{ T} \quad (2.4)$$

where:

$Q_{\text{BAH}}$  – the mass of the lifted load (panel or formwork block, reinforcing cage, prefabricated assembly element), t;

$q$ - the mass of the rigging device, t.

For the bunker with concrete mixture:

$$Q_{\text{баш}} = V_{\text{беш}} \cdot W_{\text{беш}} + q_{\text{б}} \quad (2.5)$$

where:

$V_{\text{беш}}$  - nominal capacity of the bunker,  $\text{m}^3$ ;

$W_{\text{беш}}$  - the volumetric mass of concrete is taken equal to  $2400 \text{ kg/m}^3$  for heavy concrete,  $1800 \text{ kg/m}^3$  for expanded clay concrete;

$q_{\text{б}}$  - own mass of the bunker, kg.

It should also be taken into account that, as a rule, carriage cranes should be used to dismantle the large-panel slab formwork and the movable-volumetric formwork. When using adjustable distributing jibs or a mechanical distributor for supplying concrete mix, the need to lift and reposition them by a crane should be taken into account, that is, the lifting capacity of the crane must be greater than the mass of the distributing installation.

Further, according to the reference literature, several options for cranes are selected, the operating parameters of which are equal to or slightly more than necessary. When choosing a crane of any type, a combination of the maximum values of  $P_{\text{кр}}$ ,  $H_{\text{кр}}$  and  $L$  is usually set as indicators of one lift, which ensures the operation of the crane with all elements in the entire working area. However, sometimes individual lifts (usually associated with the rearrangement of equipment) may have selective characteristics in terms of height and hook reach, which requires a special check of the crane for the possibility of their implementation. In this case, for a separate lift, one should enter the value of the range of working outreaches of the crane hook ( $L_{\text{min}} - L_{\text{max}}$ ) and determine the possibility of its implementation relative to the individual position of the crane relative to the building under construction.

In the construction of multi-storey buildings, universal rope slings are widely used, equipped with pull hooks for lifting prefabricated elements, formwork blocks and panels by mounting loops. The standard provides for the following types of rope slings: 1CK (1SR) - single branch; 2CK (2SR) - two-branch; 3CK (3SR) - three-

branch; 4CK (4SR) - four-branch (version 1 and 2), CKII (SRL) - two-loop (version 1 and 2); CKK (SRR) - ring (versions 1 and 2). For the installation of tunnel formwork elements, special "Duck Nose" traverses are used.

Along with unified general-purpose slings, special slings are used, designed for a specific range of products and slinging schemes. To lift floor slabs with six suspension points, balancing slings with blocks are used, which provide uniform tension of the branches of the slings.

Traverses are used to lift long structures when the use of conventional slings is impossible.

Data on the accepted load gripping devices are entered in Form 7.

Form 7

#### List of requirements for lifting devices and mounting equipment

№	Sketch	Device weight, t	Carrying capacity, t	Fixture height, m	Required quantity, pcs.	Assignment
1	2	3	4	5	6	7

### 2.9. Development of the section "Shift schedule of works on a typical floor"

The work schedule is drawn up according to Form 8 in accordance with the indicators below.

Form 8

#### Work Schedule

Name of works	Unit of measurement	Scope of work	Labor intensity (labor costs) for the entire scope of work, man-days	The composition of the link (team), machines and mechanisms	Working days (shifts, hours)
1	2	3	4	5	6

Column 1 - "Name of work" lists in the technological sequence of execution all the main, auxiliary and related work processes and operations included in the

complex process for which the technological map has been drawn up.

Columns 1, 2, 3 and 4 are taken from the calculation.

Column 5 - "The composition of the link (team) in the shift, machines, mechanisms" provides the quantitative, professional and qualified composition of the construction units to perform each work process and operation. It is selected depending on the labor intensity, volume and timing of the work. If the work is carried out with the help of mechanisms, then this column indicates the name, type, brand, number of accepted construction machines and mechanized devices. At the same time, it is necessary to strive to maintain a constant composition of complex and specialized teams for the entire duration of the work. When choosing machines and devices, it is necessary to provide options for replacing them if necessary.

In column No. 6, the number of days required to complete this work is calculated as the multiplication of labour intensity by the number of workers performing the work and the number of shifts.

If you want to reduce the number of working days, you can organize another shift (increase from two to three) for processes that use construction mechanisms. For processes performed manually or with the help of a mechanized tool, an increase in the number of workers is planned. Moreover, this increase should be a multiple of the composition of the link according to the norm.

After that, a work schedule is drawn up. In this case, a line is drawn in each line corresponding to the number of days in column No. 6 and the selected scale.

The work schedule indicates the sequence of work processes and operations, their duration and mutual coordination along the scope of work and in time. The duration of the complex construction process, for which the technological map has been drawn up, must be a multiple of the duration of the work shift when working in one shift or a working day when working in two and three shifts.

When compiling the calendar plan (schedule), it is necessary to take into account the breakdown of the entire scope of work into divisions, technological tiers, etc., as well as the requirements of regulatory documents on the need to organize in-

line work methods.

If the duration of work on one division or tier is significantly less than one day, then it is necessary to make an hourly schedule on a typical division. Then calculate the amount of time to complete all the work on the building as a whole and indicate it in a note.

To draw up a calendar plan, you can use modern project management software for PC. There are two Russified versions at the TCP department. These are "SureTrak Project Manager Rus" and "Microsoft Project 98". The American company Primavera Systems, Inc has developed a number of other programs that allow you to quickly draw up a linear schedule for the execution of work. At the same time, it can be shown on it in the same way as on the network model: time reserves, interconnection between works, the "critical path". If necessary, these same programs make it possible to draw up schedules for financing work, submission of materials, mechanisms, etc. And most importantly, they allow you to conduct operational planning in the process of work and instantly make any adjustments.

The visual linear form of the graph and the availability of indicators that are typical for the network model, combined with the ability to quickly adjust, make such graphs indispensable and very useful in the implementation of construction projects.

## **2.10. Development of the section "Quality control and acceptance of works"**

Quality control of work should be carried out in accordance with the operational quality control scheme (Form 10).

When carrying out formwork work, the relevant journals and acts must be conducted. These documents are presented upon commissioning of the facility.

During the installation of the formwork, continuous monitoring is carried out to ensure that the project exactly complies with the requirements of the ДБН В.2.6-98:2009 "Concrete and reinforced concrete structures".

### Formwork works.

The deflection of the assembled formwork (Fig. 2.4):

- for vertical surfaces is  $1/400$  of the span;
- for floors is  $1/500$  of the span.

Minimum strength of concrete of unloaded monolithic structures when dismantling of formworks of surfaces:

- vertical from the condition of maintaining the shape is  $0,2 - 0,3$  MPa;
- horizontal and inclined ones with a span:  
of up to 6 m - 70% of the project strength;  
with more than 6 m - 80% of the project strength.

For the device of the formwork of prefabricated monolithic structures, an act is drawn up for closing hidden works with the preparation of an executive geodetic scheme, which indicates the deviations of the formwork from the project position.

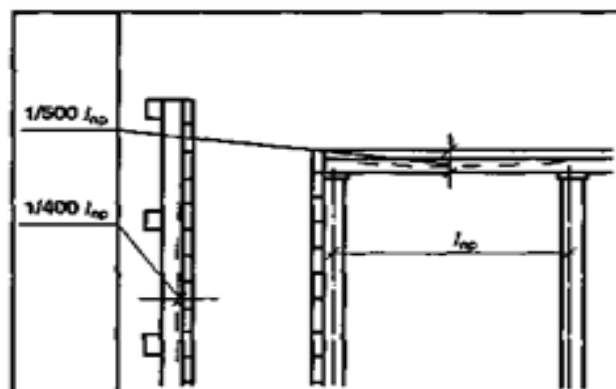


Fig.2.4. Deviation of mounted formwork.

Table 2.2

## Composition of operations and controls for formwork works

Stages of works	Controlled Operations	Control (method, scope)	Documentation
Preparatory Works	<p>Need to check:</p> <ul style="list-style-type: none"> <li>- availability of a formwork quality document;</li> <li>- availability of PPW for the installation and acceptance of formwork;</li> <li>- quality of preparation and elevation mark of the base;</li> <li>- presence and condition of fasteners</li> </ul>	<p>Visual</p> <p>The same</p> <p>Visual, measuring</p> <p>Visual</p>	Passport (certificate), general work log (concrete work log)
Formwork assembly	<p>Need to control:</p> <ul style="list-style-type: none"> <li>- observance of the procedure for assembling formwork shields;</li> <li>- density of connection of formwork shields</li> <li>- compliance with the geometric dimensions and design slopes of the formwork planes;</li> <li>- reliability of fastening of formwork shields.</li> </ul>	<p>Technical inspection</p> <p>Visual, for all elements</p> <p>The same</p> <p>Technical inspection</p>	General work log (concrete work log)
Formwork acceptance	<p>Need to check:</p> <ul style="list-style-type: none"> <li>- correspondence of geometric dimensions</li> <li>- the position of the formwork relative to the center axes;</li> <li>- correct installation and reliability of fastening of the system as a whole.</li> </ul>	<p>Visual, for all elements</p> <p>measuring</p> <p>Technical inspection</p>	General work log (concrete work log)
Control-measuring tool: tape measure, construction slope, level, theodolite, metal ruler.			
<p>Operational control is carried out by: a master (foreman), a geodesist - in the process of performing work.</p> <p>Acceptance control is carried out by: employees of the quality service, the master (foreman), representatives of the technical supervision of the customer.</p>			

The numerical values of deviations in the accuracy of installation and manufacture of inventory formwork are given in Table 2.3.

Table 2.3

Inventory formwork size intervals, mm	Accuracy deviation value, mm	
	manufacturing	installation
50 - 80	± 0,37	± 0,85
80 - 120	± 0,44	± 1,10
120 - 180	± 0,50	± 1,25
180 - 250	± 0,58	± 1,45
230 - 315	± 0,65	± 1,60
315 - 400	± 0,70	± 1,80
400 - 500	± 0,78	± 2,00
500 - 630	± 0,88	± 2,20
630 - 800	± 1,00	± 2,50
800 - 1000	± 1,15	± 2,80
1000 - 1250	± 1,30	± 3,30
1250 - 1600	± 1,55	± 3,80
1600 - 2000	± 1,85	± 4,60
2000 - 2500	± 2,20	± 5,50

Differences of surfaces, including butt ones, for structures ready for painting without putty should not exceed 2 mm.

Installation and acceptance of the formwork, dismantling of the formwork of monolithic structures, cleaning and lubrication are carried out according to the project of production of works.

Permissible deviations:

- for the installation marks of the floor formwork - 10 mm;
- for formwork hinge backlash – 1 mm.

Differences of surfaces at the joints of the formwork parts should not exceed for:

- designed for painting - 2 mm;
- designed for wallpapering - 1 mm.

The deflection of the assembled slab formwork is 1/500 of the span.

The minimum strength of concrete when dismantling the formwork of loaded structures, including from higher concrete, is determined by the PPW and agreed with the design organization.

For the installation of the formwork of prefabricated monolithic structures, an inspection report of hidden work is drawn up with a tool check of marks and axes.

Table 2.4

Composition of operations and controls

Stages of work	Controlled Operations	Control (method, scope)	Documentation
Preparatory work	<p>it is necessary check:</p> <ul style="list-style-type: none"> <li>- the availability of a quality document for the formwork;</li> <li>- the availability of PPW for the installation and acceptance of formwork;</li> <li>- the presence and condition of fasteners, scaffolding means.</li> </ul>	<p>Visual</p> <p>The same</p> <p>- // -</p>	<p>Passport (certificate), general work log</p>
Formwork assembly	<p>needs to be controlled:</p> <ul style="list-style-type: none"> <li>- compliance with the order of assembly of formwork panels, scaffolding, embedded elements;</li> <li>- the density of pairing of formwork panels with each other;</li> <li>- compliance with the geometric dimensions and design slopes of the formwork planes;</li> <li>- the reliability of the fastening of the shields.</li> </ul>	<p>Technical inspection</p> <p>Measuring, all elements</p> <p>The same</p> <p>Technical inspection</p>	<p>General work log</p>
Formwork acceptance	<p>need to check:</p> <ul style="list-style-type: none"> <li>- the conformity of the geometrical dimensions of the formwork with the design ones;</li> <li>- the position of the formwork along the laying axes in the plan and vertically, including the designation of the design marks of the top of the concreted structure;</li> <li>- the correct installation and reliability of the entire system as a whole.</li> </ul>	<p>Measuring</p> <p>Measuring</p> <p>Technical inspection</p>	<p>General work log (concrete work log)</p>
Control and measuring tool: rail-slope, building level, metal ruler, level, theodolite.			
Operational control is carried out by: a master (foreman), a geodesist - in the process of performing work.			
Acceptance control is carried out by: employees of the quality service, the master (foreman), representatives of the technical supervision of the customer.			

The numerical values of deviations in the accuracy of installation and production of inventory formwork are given in Table 2.5.

Table 2.5

Inventory formwork size intervals, mm	Accuracy deviation value, mm	
	manufacturing	installation
50 - 80	± 0,37	± 0,85
80 - 120	± 0,44	± 1,10
120 - 180	± 0,50	± 1,25
180 - 250	± 0,58	± 1,45
230 - 315	± 0,65	± 1,60
315 - 400	± 0,70	± 1,80
400 - 500	± 0,78	± 2,00
500 - 630	± 0,88	± 2,20
630 - 800	± 1,00	± 2,50
800 - 1000	± 1,15	± 2,80
1000 - 1250	± 1,30	± 3,30
1250 - 1600	± 1,55	± 3,80
1600 - 2000	± 1,85	± 4,60
2000 - 2500	± 2,20	± 5,50

The accuracy of the installation of inventory formwork for unique and special buildings should be determined by the project. For all inventory formwork must be recorded in the “Formwork turnover log”. According to the technical conditions (TC) of the formwork manufacturer, the number of formwork rotations between major repairs and the total number of rotations before formwork disposal should be determined. All this data is logged.

Installation and acceptance of formwork, removal of formwork of monolithic structures, cleaning and lubrication are done according to the project of production of work.

### **Reinforcement works**

Permissible deviations:

- 1) in the distance between separately installed working rods for:
  - columns and beams - 10 mm;
  - slabs and walls of foundations - 20 mm;

- massive structures - 30 mm.

2) in the distance between the rows of reinforcement for:

- slabs and beams up to 1 m thick - 10 mm;

- structures with a thickness of more than 1 m - 20 mm.

3) when reinforcing structures with individual rods installed overlapping without welding, the length of the allowance is determined by the project.

4) when reinforcing the structure with welded meshes and frames, it is allowed to install them without welding by making an allowance for the length specified in the project, but not less than 250 mm.

5) of the total length of welds at the junction of overlapping rods or at each half of the junction with overlays:

- for class A-I rods:

- with double-sided welds – 3 mm,

- and with one-sided welds – 6 mm;

- for rods of class A-II and A-IV:

- with double-sided welds – 4 mm,

- and with one-sided welds – 8 mm.

6) from the design of the thickness of the protective layer of concrete - according to table 2.6.

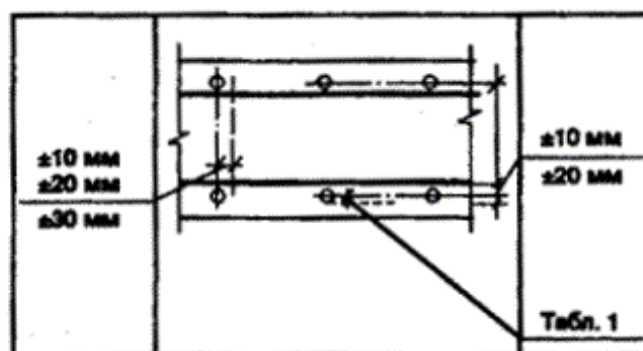


Fig.2.5. Deviation of mounted meshes and frames.

The manufacture of spatial large-sized reinforcing products should be carried out in assembly jigs.

Non-welding connection of the rods should be carried out:

- butt joints - with an overlap or crimp sleeves and screw couplings to ensure the equal strength of the joint;

- cruciform joints - by arc tacks or by tying with annealed wire. It is allowed to use special connecting elements (plastic and wire clamps).

Table 2.6

The value of boundary deviations for reinforcement work

Technical characteristics	Boundary deviations, mm
The thickness of the protective layer is up to 15 mm and the cross-sectional dimensions of the structure, mm: up to 100; from 101 to 200	+4 +5
The thickness of the protective layer is from 16 to 20 mm and the cross-sectional dimensions of the structure, mm: up to 100; from 101 to 200; from 201 to 300; over 300	+4; -3 +8; -3 +10; -3 +15; -5
The thickness of the protective layer is over 20 mm and the cross-sectional dimensions of the structure, mm: up to 100; from 101 to 200; from 201 to 300; over 300	+4; -5 +8; -5 +10; -5 +15; -5

The installation of reinforcing structures is carried out mainly of large-sized blocks or unified prefabricated meshes, ensuring the fixation of the protective layer.

Installation of pedestrian, transport or mounting devices on reinforcing structures should be carried out according to the project for the production of works in agreement with the design organization.

The edges of the flat elements of embedded parts should not have burrs, blockages and roughness exceeding 2 mm.

On the elements of reinforcing products and embedded parts, there should be no peeling of rust and scale, as well as traces of oil, bitumen and other contaminants.

The composition of operations and controls are presented in Table 2.7.

Table 2.7

## Composition of operations and controls

Stages of work	Controlled Operations	Control (method, scope)	Documentation
Preparatory work	to check: <ul style="list-style-type: none"> <li>- availability of a quality document;</li> <li>- quality of reinforcing products;</li> <li>- quality of preparation and marking of the carrier base;</li> <li>- correctness of installation and fixing of the formwork.</li> </ul>	Visual  Visual, measuring, The same  Technical inspection	Passport (certificate), general work log
Installation of reinforcing products	to control: <ul style="list-style-type: none"> <li>- the order of assembly of elements of the reinforcing cage;</li> <li>- accuracy of installation of reinforcing products in plan and height, reliability of their fixation;</li> <li>- the size of the protective layer of concrete.</li> </ul>	Technical inspection of all elements The same  - // -	General work log
Acceptance of work performed	to check: <ul style="list-style-type: none"> <li>- compliance of the position of the installed reinforcing products with the design one;</li> <li>- the size of the protective layer of concrete;</li> <li>- reliability of fixing reinforcing products in the formwork;</li> <li>- the quality of the welding (binding) of the frame nodes.</li> </ul>	Visual, measuring  measuring  Technical inspection of all elements The same	Act of inspection of hidden works
Control and measuring tool: plumb line, metal tape measure, metal ruler.			
Operational control is carried out by: a master (foreman).			
Acceptance control is carried out by: employees of the quality service, master (foreman), representatives of the technical supervision of the customer.			

## Laying concrete mixes.

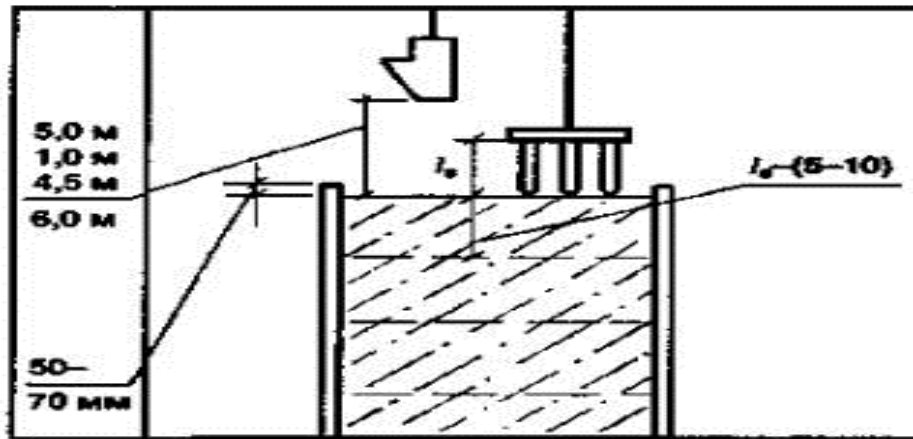


Fig. 2.6. Scheme of dropping concrete mix.

Permissible deviations:

Height of free dropping of the concrete mixture into the formwork of the structure, m, not more than: for columns – 5,0 m; for floors – 1,0 m; for walls – 4,5 m; for non-reinforced structures – 6,0 m.

The top level of the laid concrete mixture should be 50 – 70 mm below the top of the formwork panels.

The thickness of laying layers of the concrete mixture:

- when compacting the mixture with heavy hanging vertically located vibrators is 5–10 cm less than the length of the working part of the vibrator;

- when compacting the mixture with hanging vibrators located at an angle to the vertical (up to  $30^\circ$ ) is not more than the vertical projection of the length of the working part of the vibrator;

- when compacting the mixture with manual deep vibrators is not more than 1,25 of the length of the working part of the vibrator;

- when compacting the mixture with surface vibrators in structures:

unreinforced - 70 cm;

with single reinforcement - 25 cm;

with double reinforcement - 12 cm.

The composition of operations and methods of control are presented in Table 2.8.

Table 2.8

Composition of operations and methods of control

Stages of work	Controlled Operations	Control (method, scope)	Documentation
Preparatory work	to check:		General log of work, act of acceptance of previously completed work, passports (certificates)
	- availability of acts on previously performed hidden works;	Visual	
	- correctness of installation and reliability of fixing the formwork;	Technical inspection	
	- readiness of all mechanisms and devices;	Visual	
	- the cleanliness of the base or previously laid concrete layer and the inner surface of the formwork;	The same	
	- the presence of lubricant on the inner surface of the formwork;	- // -	
	- condition of reinforcement and embedded parts;	Technical inspection, measuring	
	- callout of the design mark of the top of concreting.	Measuring	
Concrete laying, concrete hardening, formwork dismantling	to control:		General work log, concrete work log
	- the quality of the concrete mixture;	Laboratory	
	- formwork condition;	Technical inspection	
	- the height of the dropping of the concrete mixture, the correctness of the performance of the working joints;	Measuring, 2 times per shift	
	- temperature-humidity conditions of concrete hardening;	Measuring	
	- the actual strength of concrete and the timing of formwork dismantling	Measuring	
Acceptance of work performed	to check:		General work log, geodetic scheme
	- the actual strength of the concrete;	Laboratory	
	- surface quality of structures, dimensions	Visual, measuring	
Control-measuring tool: construction slope, tape measure, metal ruler, level.			
Operational control is carried out by: master (foreman), engineer of the laboratory post - in the process of performing work.			
Acceptance control is carried out by: employees of the quality service, master (foreman), representatives of the technical supervision of the customer.			

Before concreting, horizontal and inclined concrete surfaces of working joints must be cleaned of debris, dirt, oils, snow, ice, cement membrane.

Before laying the concrete mixture, the cleaned surfaces must be rinsed with water and dried with a jet of air.

Concrete mixtures should be laid in concrete structures in horizontal layers of the same thickness without breaks, with consistent direction of laying in one direction in all layers.

Laying of the next layer of concrete mixture is allowed before the beginning of setting of the concrete of the previous layer. The duration of the break between the laying of adjacent layers of concrete mix without the formation of a working joint is established by the construction laboratory.

When compacting the concrete mixture, it is not allowed to rest the vibrator on reinforcement and embedded products, formwork fasteners.

The surface of the working joints, arranged when laying the concrete mixture intermittently, should be perpendicular to the axis of the concreted columns and beams, the surface of the slabs and walls. The restoration of concreting is allowed to be carried out when the concrete reaches a strength of at least 1,5 MPa.

Form 9

#### Scheme of operational quality control of formwork works

Controlled Operations	Requirements	Methods and means of control	Who controls and when	Who gets involved to control
1	2	3	4	5

### **2.11. Development of the section "Measures for labor protection and safety"**

Instructions on labor protection and safety precautions for all types of work on the construction of a typical floor are given in an explanatory note based on ДБН А.3.3-2-2009 «Система стандартів безпеки праці. Промислова безпека у будівництві» - («System of labor safety standards. Industrial safety in

construction»).

## 2.12. Development of the section "Technical and economic indicators"

Technical and economic characteristics are compiled according to the calculation of labor costs and the work schedule. The technical and economic indicators include:

- labor costs of workers (man-hour) – based on the calculation results;
- labor costs of workers (man-hours) on mechanization means (machinists) based on the calculation results;

- wages of workers (UAH) – on the basis of the calculation;
- wages of machinists (UAH) – based on the calculation results;
- duration of work – according to the schedule;
- production of one worker per shift,  $B_p$

$$B_p = V / \Sigma T, (2.6)$$

where:  $V$  is the total amount of work, structures on a given structure (the unit of measure  $m^3$  is the volume of laid concrete, the volume of external walls, masonry of internal walls, etc., sometimes it is more convenient to use the unit  $m^2$  – the area of a typical floor, walls, etc. ).

$\Sigma T$  – total labor intensity in accordance with the final;

- labor costs per unit of product measurement,  $T_i$ :

$$T_i = \Sigma T / V, (2.7)$$

- the cost of machine time per unit of measurement of products,  $t_{\text{Mаш}}$

$$t_{\text{Mаш}} = \Sigma T_{\text{Mаш}} / V, (2.8)$$

where:  $\Sigma T_{\text{Mаш}}$  – the cost of machine time relative to the final;

- the cost of labor costs per unit of product measurement  $C_e$ :

$$C_e = C / V, (2.9)$$

where:  $C$  – total cost of labor cost.

Technical-economic characteristics are summarized in the table Form 10.

## Technical-economic characteristics

№ in order	Indicator name	Unit of measurement	Number
1	2	3	4
1	Duration of works	days	
2	The laboriousness of works for the entire volume, T	man-days	
3	Labor costs per unit of product measurement, $T_i$	man-days / $m^3$	
4	Production of one worker per shift, $B_p$ .	$m^3$ / man-days	
5	The cost of labor costs per unit of measurement of products, $C_e$	monetary unit / $m^3$	
6	Total cost of work, C	monetary unit	

**2.13. Development of the section "References"**

All sources of information used during the work on the project (textbooks, guidelines, Internet sites, etc.) should be listed here.

## APPENDIXES

### Appendix 1

#### Technical indicators of concrete pumps

Parameters	Models												
	АБН-21	АБН-32	АБН-37	АБН-42	АБН-47	БН-20Е	БН-20Д	БН-45	БН-70Д	3-296	3-252	СБ-95А	АБН-60
Productivity, m <sup>3</sup> /hour	75	90	125	140	160	20	20	45	70	10	20	25	60
Mobility of the concrete mixture (sedimentation of a standard cone), cm	6 - 12								4 - 12				
Concrete pipeline diameter (internal), mm	125								150	203	120	100	
Loading height, mm	1450					1400							
The largest aggregate size, mm	50					40	40	50	60	40	60	40	30
Mass of technological equipment, t	9,5	15,0	17,0	21,7	28,1	2,2	3,0	4,5	5,0	2,65	7,9	11,3	11,3
The volume of the loading funnel, m <sup>3</sup>	0,7		0,6			0,45	0,45	0,6	0,7				

Technical characteristics of deep vibrators

Name	EIK-130	IB-75	IB-113	IB-117A	IB-116A	IB-116A-1.6
Scope of application	Compaction of concrete mixtures with the sedimentation of a cone (OK) = 2..8 cm of reinforced structures				Compaction of concrete mixtures with the sedimentation of a cone (OK) = 1..8 cm of lightly reinforced structures	
Vibrator tip diameter, mm	51	28	38	51	76	
Vibrator tip length, mm	410				430	
Synchronous frequency of oscillation, Hz	285	330		285	210	
Rotor speed, rpm	3000	2850			2800	
Electric motor power rated/consumed, kW	1,0 / 1,3	0,75 / 1,0			1,0 / 1,4	1,2 / 1,6
Voltage, V	220	42				
Current strength, A	6,5	20	24			
Electric motor dimensions LxHxW, mm	350x180x280	350x180x270				
Flexible shaft length, m	3					
Mass of the working set, kg	30	22	29	31	35	38

Concrete strength curing time (in days,  $t_r$ ) as a percentage (%) of the design strength ( $R_{np}$ ) when dismantling the formwork

Concrete class and cement grade	$t^{\circ}\text{C}$ of concrete	Value (in days) at the strength of concrete when dismantling the formwork as a percentage (%) of the design strength			
		15-20%	70%	80%	100%
Concrete class B15 ... B22,5 of Portland cement grade 400	5	2	22	28	more than 28
	10	1,5	13	20	more than 28
	20	1	6	10	28
	30	0,5	4	6	14
Concrete class B15 of Portland cement grade 300	5	3	28	more than 28	more than 28
	10	2	19	28	more than 28
	20	1	9	14	25
	30	0,5	6	10	14
Concrete class B15 ... B22,5 on Portland slag cement grade 400	5	3	28	more than 28	more than 28
	10	2	21	28	more than 28
	20	1,5	9	14	28
	30	0,5	7	9	14

Note:

1. For dismantling the formwork of the side shields of foundations, beams, crossbars, columns – 15-20%.
2. For dismantling the formwork of slabs with a span of up to 3 m of load-bearing structures with a span of up to 6 m with an actual load on the elements of less than 70% of the normative – 70%.
3. For dismantling the formwork of structures with a span of more than 6 m – 80%.

For dismantling the formwork of structures with a span at an actual load of more than 70% of the standard load and for prestressed structures – 100.

## Appendix 4

### Assignment for the design of technology for the construction of a multi-storey monolithic residential building

Variant \_\_\_\_\_

Student \_\_\_\_\_ Faculty (Institute) \_\_\_\_\_

Course \_\_\_\_\_ Group \_\_\_\_\_ Teacher \_\_\_\_\_

Date of receipt of the task \_\_\_\_\_ Project defense date \_\_\_\_\_

#### Variants of initial data for design

Variant	Scheme number	Number of stories	Height of a storey, m	Basement storey height, m	Soil, elevation mark of surface, m	Thickness of monolithic reinforced concrete walls, mm	Monolithic floor slab thickness, mm	Basement wall thickness, mm	Column section (A x B), mm	Section of monolithic beams (H <sub>b</sub> x B <sub>b</sub> ), mm	Foundation thickness, mm	Used concrete class	Diameter / spacing of working reinforcement of wall, mm	Diameter / spacing of reinforcement meshes of floor slab, mm	Diameter / spacing of reinforcement meshes of f. slabs, mm	Concrete temperature after laying (winter)	Construction rate of a typical storey, days	Formwork manufacturer
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	14	3	2,8	clay, -0,7	200	200	300	500 x 400	500 x 250	700	B20	18 / 250	18 / 250	20 / 250	+15	14	Peri
2	2	16	2,8	2,7	sandy loam, -1,0	220	200	320	600 x 400	550 x 250	800	B30	16 / 200	14 / 200	22 / 250	+14	12	Dalli
3	3	12	3,2	3,0	sandy loam, -0,8	180	180	280	400 x 400	450 x 250	600	B22,5	16 / 250	16 / 200	18 / 200	+12	8	Крамос
4	4	18	3,1	3,0	clay, -0,9	250	200	350	600 x 500	600 x 250	900	B25	20 / 250	16 / 250	22 / 200	+10	9	Doka
5	5	17	3,3	3,1	loam clay, -0,6	220	180	320	500 x 500	550 x 300	850	B25	18 / 250	16 / 250	22 / 250	+9	10	Крамос
6	2	15	2,9	2,6	sandy loam, -0,8	200	160	300	500 x 500	500 x 300	750	B20	18 / 200	18 / 250	20 / 200	+11	11	Thyssen

Table continuation

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
7	3	10	3,0	2,7	sandy loam, -0,7	180	160	250	400 x 400	400 x 200	500	B30	14 / 200	14 / 200	18 / 250	+16	13	Meva
8	4	19	3,1	3,0	sandy, -1,2	250	180	350	600 x 500	600 x 300	950	B22,5	18 / 250	16 / 200	22 / 200	+14	9	Pilosio
9	5	11	3,3	2,9	sandy, -1,1	180	160	250	400 x 400	450 x 200	550	B25	20 / 250	16 / 200	22 / 200	+14	9	Dalli
10	1	13	2,8	2,6	clay, -0,6	200	180	280	500 x 400	450 x 300	650	B20	16 / 200	18 / 250	18 / 200	+12	12	Doka
11	3	14	3,0	2,8	clay, -0,7	200	200	300	500 x 400	500 x 250	700	B20	18 / 250	18 / 250	20 / 250	+15	14	Doka
12	4	16	2,8	2,7	clay loam, -1,0	220	200	320	600 x 400	550 x 250	800	B30	16 / 200	14 / 200	22 / 250	+14	12	Peri
13	5	12	3,2	3,0	sandy loam, -0,8	180	180	280	400 x 400	450 x 250	600	B22,5	16 / 250	16 / 200	18 / 200	+12	8	Dalli
14	2	18	3,1	3,3	clay, -0,9	250	200	350	600 x 500	600 x 250	900	B25	20 / 250	16 / 250	22 / 200	+10	9	Крамос
15	1	17	3,3	3,1	clay loam, -0,6	220	180	320	500 x 500	550 x 300	850	B25	18 / 250	16 / 250	22 / 250	+9	10	Doka
16	3	15	2,9	2,6	sandy loam, -0,8	200	160	300	500 x 500	500 x 300	750	B20	18 / 200	18 / 250	20 / 200	+11	11	Крамос
17	2	10	3,0	2,7	sandy loam, -0,7	180	160	250	400 x 400	400 x 200	600	B30	14 / 200	14 / 200	18 / 250	+16	13	Thyssen

Table continuation

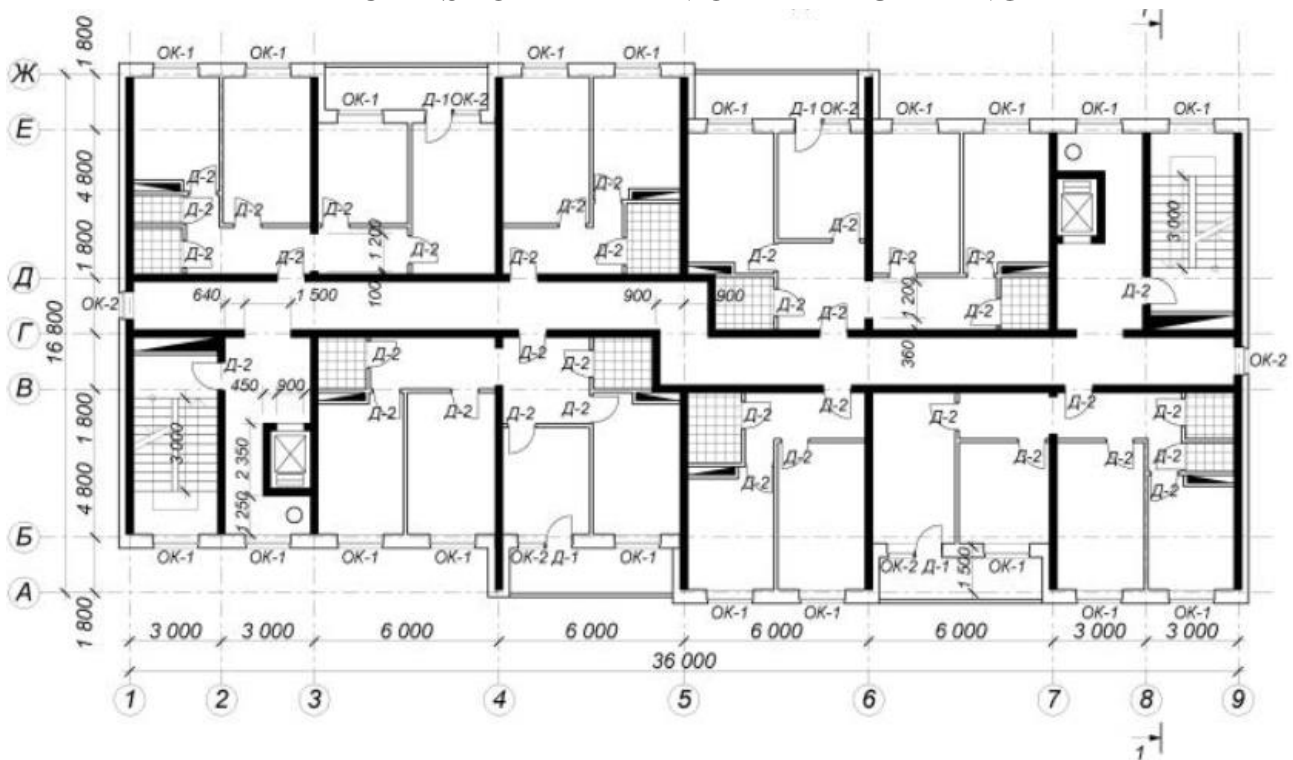
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
18	1	15	2,9	2,6	sandy loam, -0,8	200	160	300	500 x 500	500 x 300	750	B20	18 / 200	18 / 250	20 / 200	+15	12	Крамоч
19	5	14	3,2	2,8	clay, -0,9	180	180	280	500 x 400	400 x 250	600	B25	16 / 200	14 / 200	22 / 250	+14	12	Thyssen
20	4	12	3,0	2,7	clay loam, -0,8	200	180	300	400 x 400	500 x 250	700	B20	18 / 250	18 / 250	20 / 250	+12	10	Dalli
21	3	15	2,8	2,7	clay, -0,6	200	180	280	500 x 400	400 x 250	650	B22,5	16 / 200	18 / 250	18 / 200	+12	11	Peri
22	5	12	3,0	2,8	clay loam, -1,0	220	200	300	600 x 400	550 x 250	700	B25	16 / 200	14 / 200	20 / 200	+10	11	Doka
23	1	14	3,2	3,0	sandy loam, -0,8	180	180	280	400 x 400	450 x 250	600	B22,5	18 / 250	18 / 200	20 / 200	+14	10	Pilosio
24	3	16	3,3	3,1	loam clay, -0,6	220	180	300	500 x 400	500 x 300	750	B20	18 / 250	16 / 250	20 / 250	+11	10	Thyssen
25	2	12	3,2	2,8	sandy, -1,1	200	160	250	450 x 400	400 x 200	600	B25	20 / 250	18 / 200	20 / 200	+12	9	Meva
26	4	14	3,0	2,9	loam clay, -1,0	180	160	260	500 x 400	400 x 250	650	B30	16 / 200	16 / 200	18 / 250	+15	12	Pilosio
27	3	15	3,2	3,1	sandy, -0,9	250	200	350	500 x 500	400 x 250	800	B22,5	18 / 250	16 / 200	22 / 200	+14	10	Dalli
28	1	12	3,3	2,8	clay, -0,8	200	180	300	450 x 400	400 x 250	700	B25	16 / 200	14 / 200	20 / 250	+12	12	Doka

Table continuation

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
29	2	16	3,0	3,0	sandy, -1,2	250	200	250	500 x 500	550 x 250	800	B25	18 / 250	16 / 200	22 / 200	+14	10	Thyssen
30	5	14	2,8	2,8	loam clay, -0,9	220	200	280	500 x 400	450 x 300	900	B30	18 / 250	18 / 250	20 / 200	+10	11	Peri

Scheme № 1

TYPICAL STOREY PLAN OF THE BUILDING



Dimensions of elevator cabins

Cargo-passenger elevator - carrying capacity 500 kg – 1200 x 2200 mm

Passenger elevator - carrying capacity 320 kg – 1200 x 1000 mm

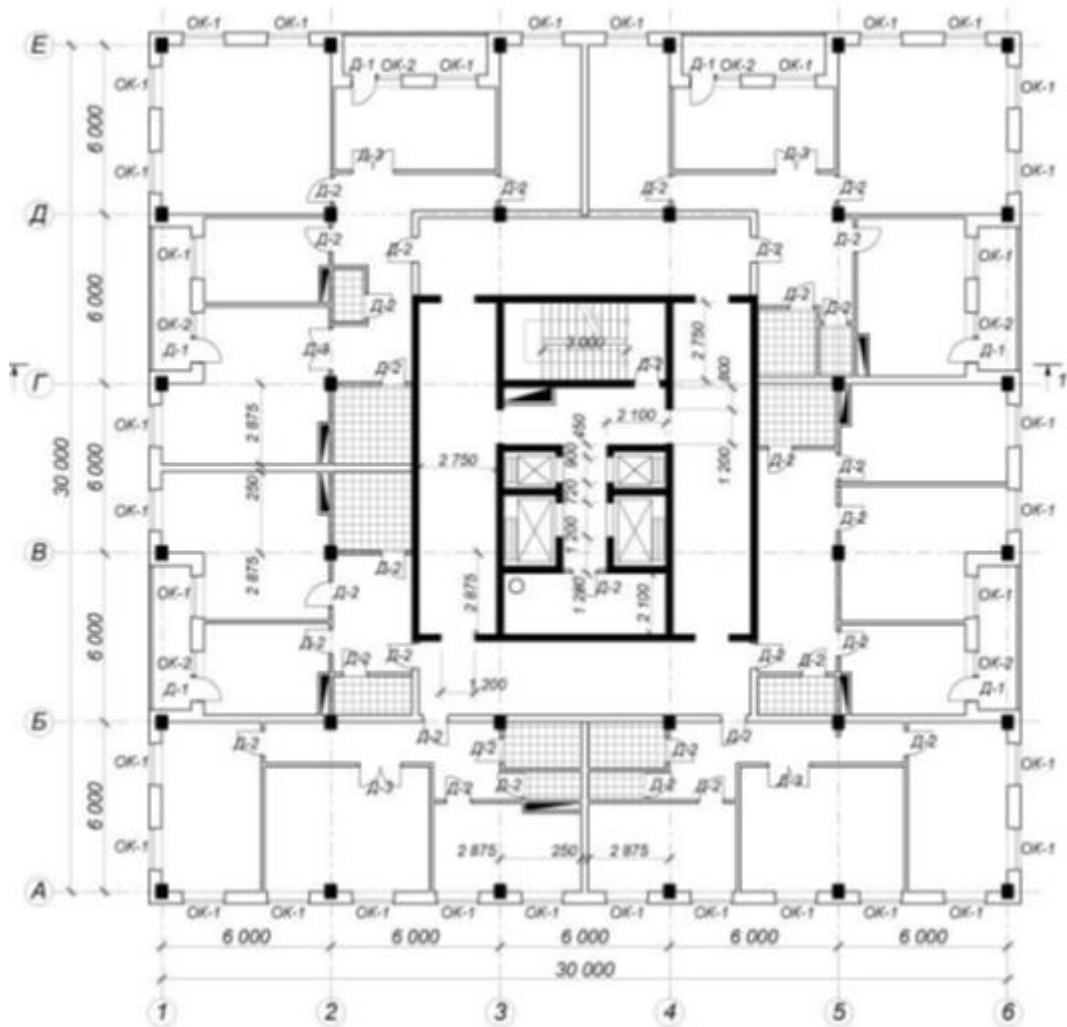
Window and door marking

OK - 1	OK - 2	Д - 1	Д - 2
15 - 15	15 - 9	21 - 9C	21 - 9Г
18 - 15	18 - 9	24 - 9C	24 - 9Г

Г- blind door, C- glazed door

## Scheme № 2

### TYPICAL STOREY PLAN OF THE BUILDING



#### Dimensions of elevator cabins

Cargo-passenger elevator - carrying capacity 500 kg – 1200 x 2200 mm

Passenger elevator - carrying capacity 320 kg – 1200 x 1000 mm

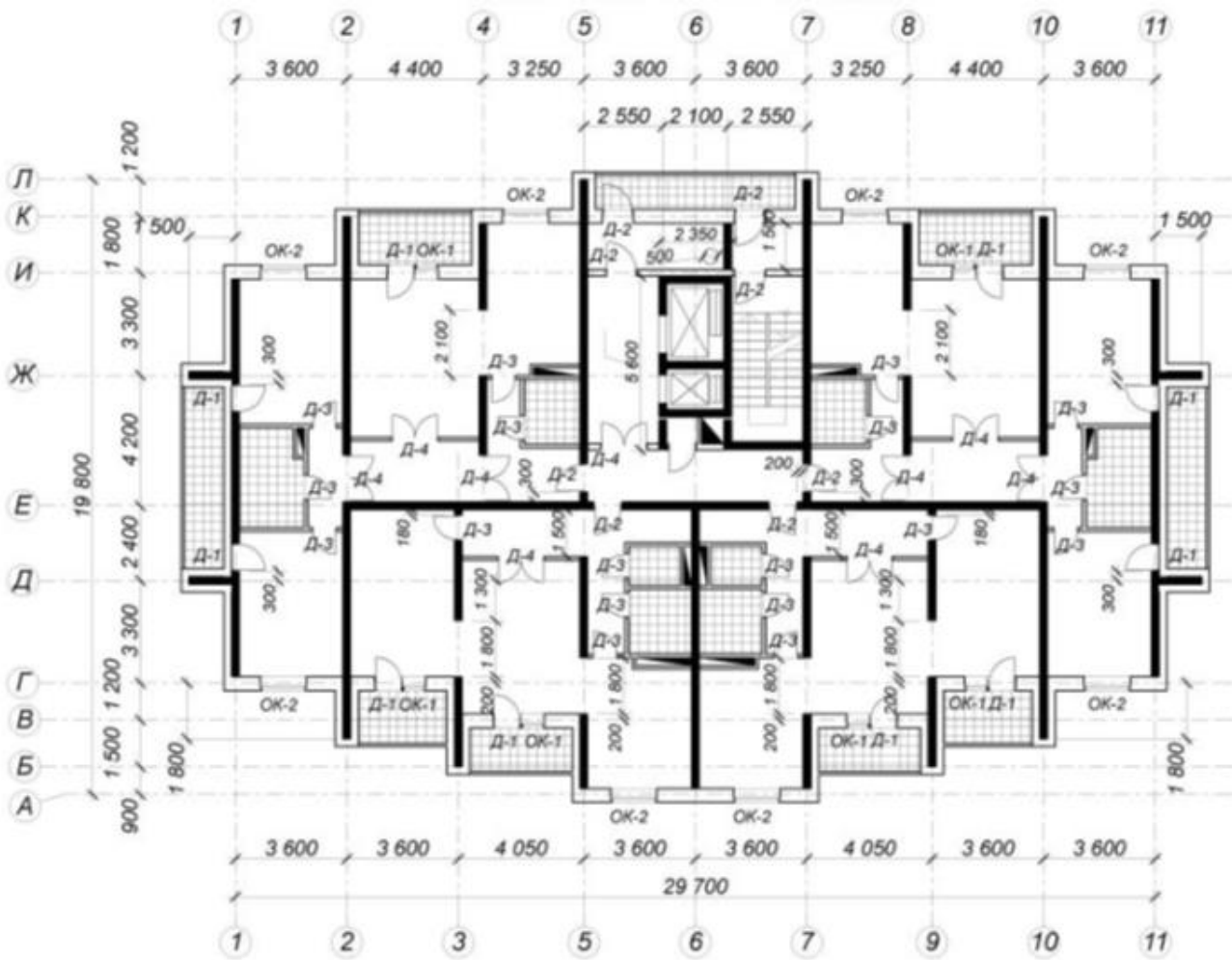
#### Window and door marking

OK - 1	OK - 2	Д - 1	Д - 2	Д - 3
15 - 15	15 - 9	21 - 9C	21 - 9Г	21 - 15C
18 - 15	18 - 9	24 - 9C	24 - 9Г	24 - 15C

Г- blind door, C- glazed door

### Scheme № 3

#### TYPICAL STOREY PLAN OF THE BUILDING



#### Dimensions of elevator cabins

Cargo-passenger elevator - carrying capacity 500 kg – 1200 x 2200 mm

Passenger elevator - carrying capacity 320 kg – 1200 x 1000 mm

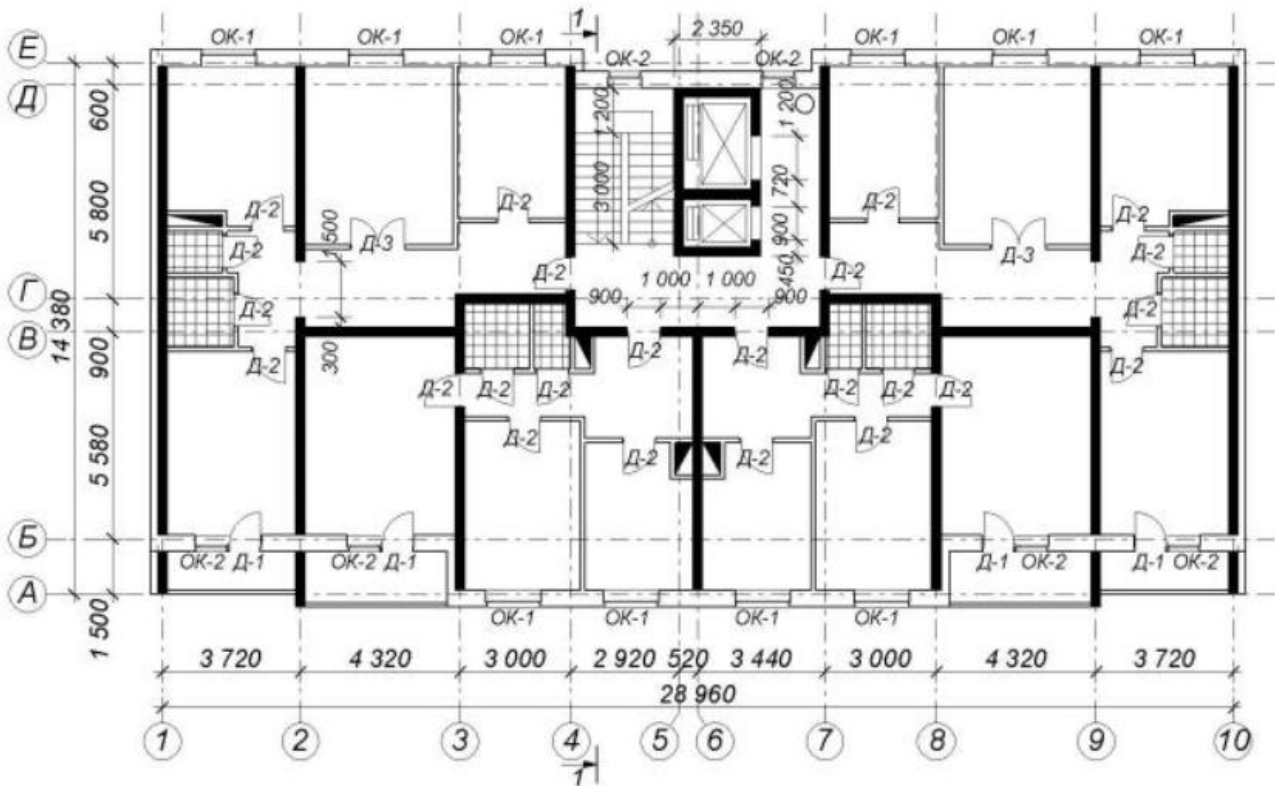
#### Window and door marking

ОК-1	ОК-2	Д-1	Д-2	Д-3	Д-4
15 - 15	15 - 7,5	21 - 9С	21 - 9Г	21 - 8Г	21 - 15С
18 - 15	18 - 7,5	24 - 9С	24 - 9Г	24 - 8Г	24 - 15С

Г- blind door, С- glazed door

## Scheme № 4

### TYPICAL STOREY PLAN OF THE BUILDING



#### Dimensions of elevator cabins

Cargo-passenger elevator - carrying capacity 500 kg – 1200 x 2200 mm

Passenger elevator - carrying capacity 320 kg – 1200 x 1000 mm

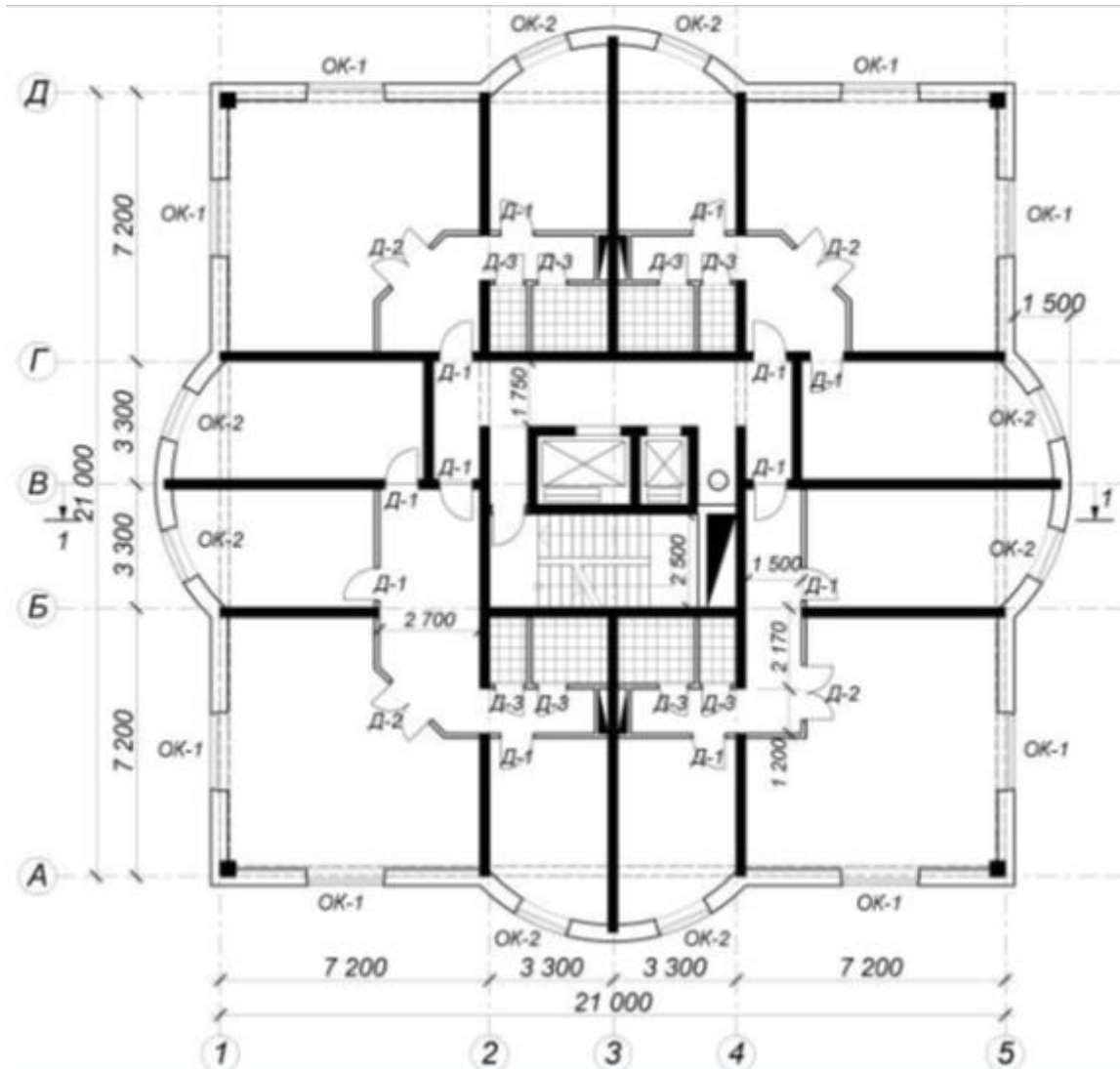
#### Window and door marking

OK - 1	OK - 2	Д - 1	Д - 2	Д - 3
15 - 15	15 - 9	21 - 9C	21 - 9Г	21 - 15C
18 - 15	18 - 9	24 - 9C	24 - 9Г	24 - 15C

Г- blind door, C- glazed door

Scheme № 5

TYPICAL STOREY PLAN OF THE BUILDING



Dimensions of elevator cabins

Cargo-passenger elevator - carrying capacity 500 kg – 1200 x 2200 mm

Passenger elevator - carrying capacity 320 kg – 1200 x 1000 mm

Window and door marking

ОК-1	ОК-2	Д-1	Д-2	Д-3
15 - 21	15 - 15	21 - 9С	21 - 9Г	21 - 8Г
18 - 21	18 - 15	24 - 9С	24 - 9Г	24 - 8Г

Г- blind door, С- glazed door

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