MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

ODESA STATE ACADEMY OF CIVIL ENGINEERING AND ARCHITECTURE

Department of Construction Technology

Guidelines

Construction Technology

for the implementation of the course project
For the topic **«Construction technology of the zero cycle»**
for students of the educational and professional program
Construction and Civil Engineering
of the specialty 192 Construction and Civil Engineering
Educational level - Bachelor

ODESA – 2022

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ

ОДЕСЬКА ДЕРЖАВНА АКАДЕМІЯ БУДІВНИЦТВА ТА АРХІТЕКТУРИ

Кафедра Технологія будівельного виробництва

Методичні рекомендації

з навчальної дисципліни **Технологія будівельного виробництва**

до виконання курсового проекту
на тему **«Технологія будівництва нульового циклу»**
для студентів освітньо-професійної програми
Будівництво та цивільна інженерія
за спеціальністю 192 Будівництво та цивільна інженерія
Освітній рівень - перший (бакалаврський)

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The purpose of these guidelines is to assist students in the elaboration of manufacturing plans for the performance of earthworks and concrete works in the construction of the zero cycle of the building in the term papers and course projects. The guidelines provide detailed recommendations on the technology of excavation and concrete works.

Methodological guidelines are recommended for students of specialty 192 "Construction and Civil Engineering", for retrainees and professional retraining of specialists, postgraduate students and teachers.

Responsible for the issue: head of Department of Construction Technology, OSACEA, Prof., D. of Sc. **Meneyluk O.I.**

CONTENT

SECTION 1. STRUCTURE AND DESIGN OF COURSE PROJECT

The course project "Technology of construction production of the zero cycle" consists of two parts: "Earthworks during the construction of the zero cycle of the building" and "Concrete works during the construction of the zero cycle of the building".

The course project includes a calculation-explanatory note and a graphic part.

The calculation-explanatory consists of two parts, each of which has a volume of 20-25 pages, and is performed on one side of a sheet of standard A4 format. The title page of the note is drawn up in the prescribed form (Appendix K). After the title page, the content of the note, the assignment for the course project and the introduction are placed.

The introduction briefly outlines the general provisions on the composition of the set of works of the zero cycle. The main part of the note contains diagrams, tables, figures, graphs and references to the literature sources used. At the end of the explanatory note is a list of used literary sources and normative documents.

The note must be drawn up in accordance with the requirements of ДСТУ 3008:2015 [9].

The pages of the work should be numbered with Arabic numerals, following continuous numbering throughout the text.

Sections of the work should be numbered in Arabic numerals without a dot (for example, 1; 2; 3, etc.), subsections should be numbered sequentially within each section. The subsection number consists of the section number and subsection serial number separated by a dot (for example, 1.1; 1.2, etc.). Do not put a dot after the subsection number. The same principle is observed when numbering paragraphs and subparagraphs.

Illustrations (drawings, figures, diagrams, graphs) should be placed immediately after they are mentioned in the text. If they do not fit there, then they should be placed on the next page. It is not allowed to place figures, diagrams, graphics that are not referenced in the text.

The illustrations should be numbered in Arabic numerals by serial numbering within the section. The illustration number consists of the section number and the serial number of the illustration (for example, "Fig. 3.2" means: figure 2 in section 3). Tables are also placed after the text where they are referenced. The table number consists of the section number and the serial number of the table, for example, Table. 2.1 (table 1 of the section 2).

At the end of the explanatory note, the date of completion of the work and the signature of the student are put.

The calculation-explanatory note should contain the following sections:

Introduction.

1. Structural-planning solution of the building and characteristics of conditions of works.

2. Technological structure of the complex process of production of excavation and concrete works.

3. Determination of scope of work.

4. The choice of the method of production of works and a set of construction machines.

5. Calculation of labour contribution and wages.

6. Schedule for the production of works for the object.

7. Table of the need for material and technical resources.

8. Guidelines for quality control and acceptance of works.

9. Safety precautions.

10. Technical and economic performances of the manufacturing plan.

List of references.

The graphic part of the course project is carried out on two sheets of A2 format (or two sheets of A1 format), each of which shows:

1. Scope of the manufacturing plan.

2. Plan of the facility with a breakdown into sections and divisions, schemes for the movement of workers and mechanisms.

3. Schemes of development, backfilling and soil consolidation in trenches and

pits (for the first part).Schemes of concreting, reinforcement and formworks during the construction of the underground cycle of the building (for the second part).

4. Calendar schedule for the production of works.

5. Technical and economic performances according to the manufacturing plan.

The recommended diagram of layout of materials on the sheet of the graphic part is shown in Fig. 1.1 and Fig. 1.2.

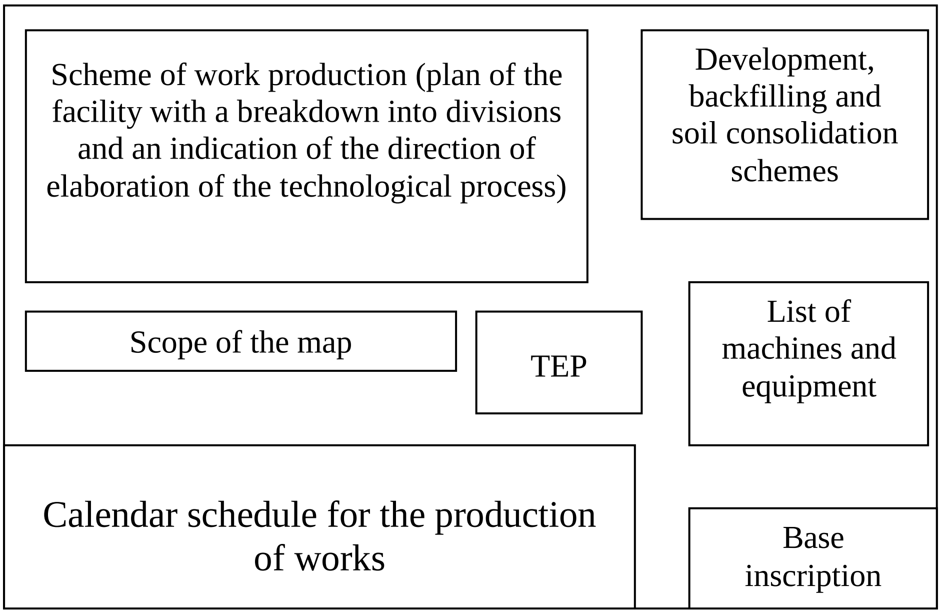


Fig. 1.1. The recommended diagram of layout of materials on the sheet of the graphic part (for the first part of course project)

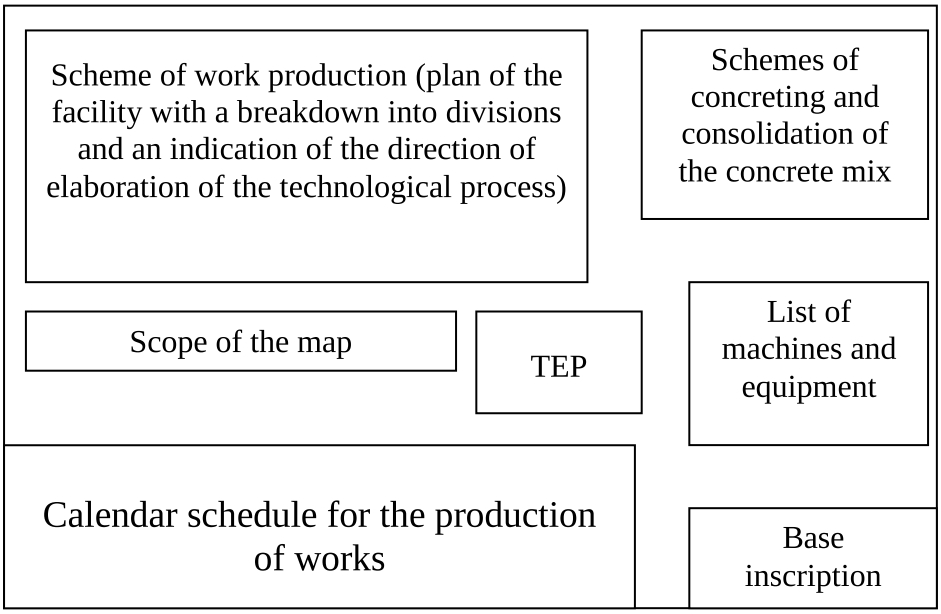


Fig. 1.2. The recommended diagram of layout of materials on the sheet of the graphic part (for the second part of course project)

SECTION 2. INSTRUCTIONS FOR THE IMPLEMENTATION OF THE SECTIONS OF THE CALCULATION-EXPLANATORY NOTE

Introduction

The introduction briefly outlines the general provisions on the composition of the complex of works of the zero cycle, the direction for improving the technology and organization of the process of earthworks, the development of integrated mechanization of in-line methods of work.

2.1. Constructive-planning concept of the building and characteristics of foundations

In this section, based on the data of the issued task and Appendixes A and C, it is necessary to give a brief description of the planning solution of the building (size and number of spans, column spacing of the middle and outer rows, spacing of the end fachwerk columns taken 6 m, size and number of expansion sections according to column 5 and 6 in Appendix A, total length and width of the building), structures of all types of monolithic reinforced concrete foundations, including foundations where expansion joints are located.

Transverse expansion joints are placed at the junction of expansion sections along the length of the building by installing paired columns with a distance between their axes in the longitudinal direction of 1 m. Under the paired columns, a common foundation of the expansion joint is placed, in which the width of all steps and the pedestal is 1 m greater than the width of the step (dimensions b, b_1, b_2) and the pedestal of ordinary foundations.

The conditional brand of the foundations of the expansion joint differs from ordinary ones by the presence of the letter "T". For example, when the brand of the ordinary foundation for the columns of the middle row is ФА-26, the brand of the foundation of the expansion joint of the same row is designated as ФА-26T.

Drawing a marking plan for foundations: for this, it is necessary to draw a grid of longitudinal and transverse axes (according to Appendix A) indicating all dimensions. On the grid, apply the contours of the foundations, their grades and the contours of the selected types of excavations (Appendix B).

It is required to note the geometric dimensions of the foundations in the table in accordance with the data in Appendix D (an example of notation in the table - see Table 2.1).

Table 2.1

Geometric dimensions of foundations

№	Brand of the foundation	Amount of foundations	Foundation height H, m	Dimensions of foundation parts, m										
				Steps					Pedestal			Recess for a column (glass)		
				a	a_1/a_2	b	b_1/b_2	H_s	a_p	b_p	H_p	a_g	b_g	H_g
1	**2**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1	ФА-1	44	1,5	1,5	-	1,5	-	0,3	0,9	0,9	1,2	0,55	0,45	0,8

After entering the data in the table, it is necessary to select the type of excavation for the foundations (a separate pit for each foundation, trenches, a continuous pit for the building) depending on the spacing of the columns, the width of the spans, the depth of the foundations and their dimensions. It is recommended for spans of more than 12 m and a column spacing of 12 m to excavate a separate pit for each foundation; with a column spacing of 6 m - trenches for a series of foundations, and with a grid of 6x6 or 6x9 m - a common foundation pit for the building.

2.2. Technological structure of the complex process of earthworks

In this section, it is necessary to briefly describe the processes that must be performed in the production of earthworks in the technological sequence. When compiling this section, it is recommended to use lecture notes and references [5, 6, 7].

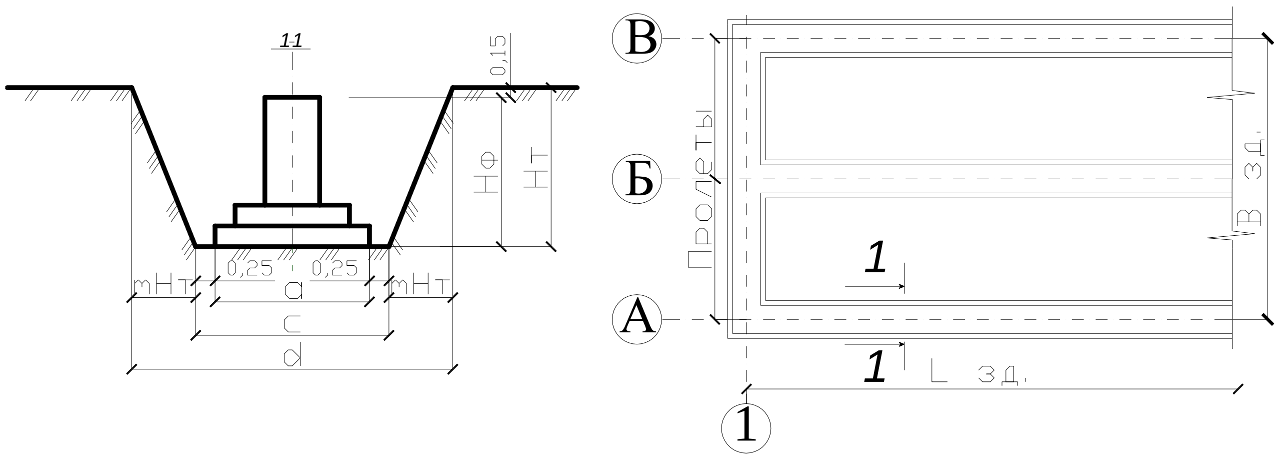
2.3. Volume determination of earthworks

Before starting works on the development of trenches and pits, it is necessary to perform work on cutting the vegetation layer. The work is carried out with a bulldozer in one or two passes along one track to a depth of 15 cm. The scope of work is determined by the area of the construction site for the future building:

$$[(B_{build.} + 1) \times (L_{build.} + 1)].$$

The calculation of the volume of earthworks when developing trenches and pits for free-standing foundations or a solid pit for a building should begin with sketching the plan elements and cross sections of trenches and pits and determining all their dimensions, as well as the geometric dimensions of the foundations.

1. **Trench volume** (V_T, m3) (Fig. 2.1) with a spacing of columns and foundations equal to 6 m with a slight slope of the terrain is determined by formula 1:



a) b)

Fig 2.1. Determination of trench volumes

a-section; b-plan.

$$V_T = \frac{c+d}{2} H_T L_T \qquad (1)$$

where: c – the width of the trench along the bottom, is taken 0,5 m more than the length of the lower foundation step a, *(c=a+0,5 m)*.

H_T – trench depth, m (is taken 0.15 m more than the height of the foundation), calculated by the formula:

$$H_T = H_f + 0,15\ m \qquad (2)$$

d – is the width of the trench along the top, (m) with the soil slope coefficient ***m*** according to Table 2.2, depending on the given type of soil and the depth of the trench, is determined by formula 3:

$$(d = 2H_T m + c) \tag{3}$$

L_T – is the trench length, m (accepted depending on the length and number of sections).

2. **The volume of the pit** (V_k, m^3) (Fig.2.2, 2.3) for a separate-standing foundation with a column spacing of 12 m or a solid pit for a building with a rectangular base and constant slopes around the entire perimeter is determined by formula 4:

$$V_K = \frac{H_K}{6}\left[ce + df + (c+d)(e+f)\right] \tag{4}$$

where: c and e – respectively, the width and length of the pit along the bottom, m.

Excavation pit plan Section A-A

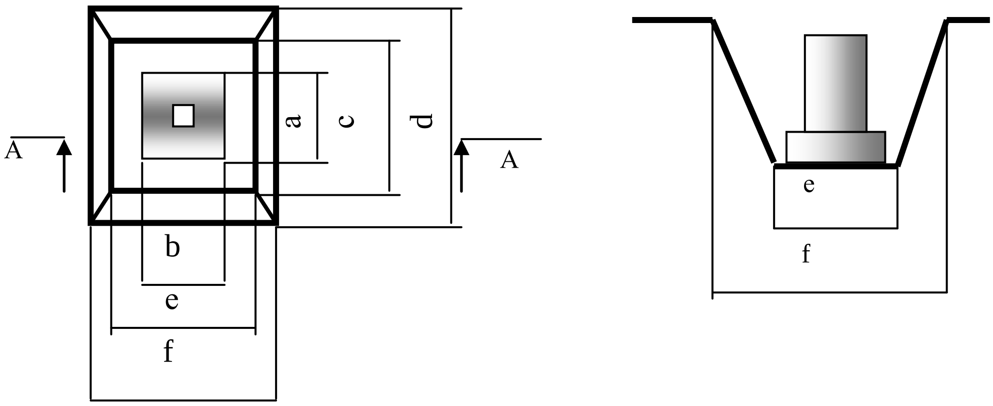
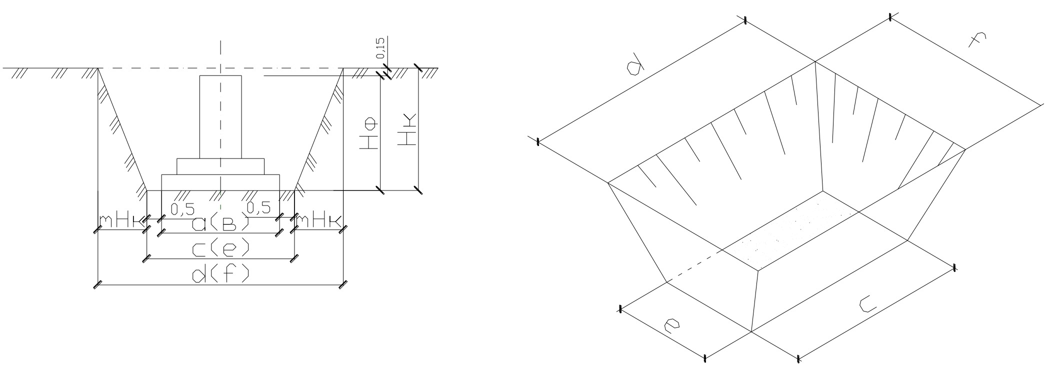


Fig. 2.2. Pit dimensions.



a b

Fig. 2.3. Determination of the volume of the pit for a separate-standing foundation.

The values ***c*** and ***e*** for separate-standing foundations are taken 1 m more than the corresponding dimensions of the lower step of the foundation:

(c=a+1m, e=b+1m).

For a solid pit (Fig. 2.4) $c = B_{build.} + a + 1$; $e = L_{build.} + b + 1$

where $B_{build.}$ – is the width of the building, m (distance between the extreme longitudinal axes);

$L_{build.}$ – is the length of the building, m (distance between the extreme transverse axes);

d and f – are the width and length of the pit along the top, respectively, m;

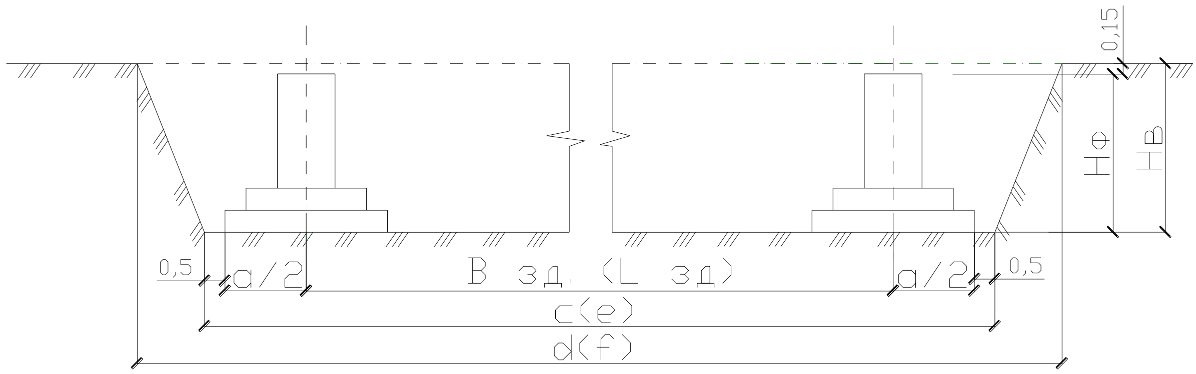


Fig. 2.4. Determining the volume of the excavation (pit) for the building.

Scheme of the transverse (longitudinal) section of the pit.

m – soil slope coefficient, taken according to Table 2.2, depending on the given type of soil and the depth of the pit.

Table 2.2

Soil slope coefficients *m*

Soils	Slope coefficients *m* depending on the excavation depth Hb, m up to:						
	1,2	1,5	1,8	2,1	2,4	2,7	3,0
Bulk	0,12	0,296	0,51	0,662	0,79	0,9	1,0
Sandy and gravelly	0,25	0,50	0,61	0,687	0,75	0,824	0,85
Sandy loam	0	0,231	0,39	0,488	0,54	0,625	0,68
Loams	0	0,035	0,17	0,287	0,38	0,445	0,50
Dry loess clays	0 0	0,017 0,026	0,08 0,12	0,141 0,203	0,19 0,27	0,222 0,325	0,25 0,37

The calculation data are summarized in Table 2.3.

Table 2.3

List for calculating the volume of excavations

№	Type: pits or trenches	Number of pits or trenches	Coef. of slope - ***m***	Foundation parameters, m			Parameters of trenches or pits, m					Soil volume, m^3 V_B	
				A	в	H_f	c	d	e	f	L_{tr}	for 1 pit or trench	Total
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
													∑=

3. The volume of soil left at the construction site for backfilling of excavations ($V_{оз}$, m^3) after the installation of foundations is calculated by formula 5:

$$V_{ОЗ} = \frac{\left[\sum(V_K + V_T) - \sum V_Ф\right]}{K_{OP}} \qquad (5)$$

where: $\sum(V_K + V_T)$ – the total volume of all pits and trenches for the foundations of the building, m^3

$\sum(V_Ф)$ – the total volume of all foundations of the building, m^3 (see table 2.4).

K_{op} – coefficient of residual loosening, taken according to the table 2.4 depending on the type of soil.

Table 2.4.

Soil loosening indicators

Soil name	Soil loosening coefficient		Volumetric mass of soil t/m^3
	$K_п$ (initial increase of soil volume after development)	$K_{о.р.}$ – (residual loosening of soils)	
Sand	1,10……1,15	1.02…..1,04	18…2,0
Sandy loam	1,12……1,17	1,03…..1,05	1,5…1,7
Light and loess-like loam	1,18……1,24	1,03…..1,06	1,5…1,8
Medium loam	1,24…….1,30	1,04…..1,08	1,7…2,0
Soft clay	1,24…….1,30	1,04…..1,07	1,7…1,9
Hard clay	1,28……1,32	1,06…..1,09	1,8…2,0

After mechanized excavation of the soil, it is necessary to clean the bottom of the pit (trench). The bottom of the trench or separated-standing pits is cleaned manually. A solid pit excavation – with a bulldozer or excavator-planner to remove the shortage of soil.

The volume of soil when cleaning the pit (trench) is determined by the formula:

$$V_з = F_{пк} \times h_з \ ,$$

where $V_з$ – Vz is the volume of soil obtained by cleaning the bottom of the pit (trench), m^3;

$F_{пк}$ – square of the base of the pit (trench), m^2 ;

$h_з$ – the depth of cleaning.

The depth of cleaning the bottom of the pit (trench) is taken according to Table 2.5.

An example of a scheme for the production of work when cutting the soil of the vegetative layer is given in Appendix J, Fig. J.1.

Table 2.5

Depth of cleaning

Excavator name	The amount of shortage soil $h_з$, cm
Single-bucket with bucket capacity, m^3:	
0,5	5
0,65–1	10
0,25–1,6	10
2–3,2	12

4. The calculation of the volume of foundations $(V_Ф, \text{m}^3)$ of all grades given in the task, as well as the foundations of expansion joints, is determined by external geometric dimensions and is given in tabular form (Table 2.6) according to formula 6:

$$V_Ф = \left(abh + a_1 b_1 h_1 + a_2 b_2 h_2 + ...a_n b_n h_n\right) \qquad (6)$$

where: $(aa_1....a_n)$ – length of foundation steps, m;

$(b\ b_1....b_n)$ – width of foundation steps, m;

$(hh_1....h_n)$ – height of foundation steps, m;

$(a_n b_n h_n)$ – length, width, height of the pedestal under-column, m.

Table 2.6

Volumes of monolithic reinforced concrete foundations

Foundation brand	The formula for calculating the volume of the foundation	The volume of one foundation. m^3	Quantity, things	Total volume of foundations, m^3
1	**2**	**3**	**4**	**5**

5. Volume of excess soil ($V_{изл}, м^3$) to be removed from the construction site by dump trucks is determined by formula 7:

$$V_{изл} = \sum(V_K + V_T)\kappa_n - V_{оз} \tag{7}$$

where: κ_n – is the coefficient of initial loosening, taken according to Table 2.4.

All calculations are summarized in Table 2.7 to compile the balance of earth masses.

Table 2.7

Earth mass balance

№	Name of works	Conventions	Counting formula	Total soil volume, m^3
1	**2**	**3**	**4**	**5**
1	Volume of excavation of soil	$\sum V_в$	$V_в=V_т+V_к+V_з$	
2	Volume of excavation of soil, taking into account the coefficient. initial loosening κ_n	$V_{вп}$	$V_{вп}=V_в\times\kappa_n$	
3	Volume of foundations	$V_ф$	*By geometric dimensions*	
4	Volume of backfill soil with coefficient residual loosening κ_{op}	$V_{оз}$	$V_{оз} = \frac{(V_{вп} - V_ф)}{\kappa_{op}}$	
5	The volume of soil to be removed	$V_{изл}$	$V_{изл}=V_{вп}-V_{оз}$	

2.4. The choice of a set of machines for the performance of earthworks

This work provides for the elaboration of technology for a part of the earthworks complex: excavation of pits and trenches, removal of excess soil outside the construction site, backfilling of the pits and trenches with consolidation.

When excavating pits and trenches, single-bucket excavators are most widely used as the leading machine. These are universal and mobile machines that allow to develop soil both with loading into vehicles and with dumping into a dump. They have interchangeable working equipment, are able to develop almost any soil and jointly work with various types of vehicles.

When selecting a leading machine, it must be taken into account that soils are divided into groups depending on the difficulty of their development (Table 2.8 [4]).

Table 2.8

Groups of soils depending on the difficulty of their development with single-bucket excavators

Soil name	Average soil density in natural state, kg/m^3	Soil group
Sand without admixtures and with an admixture of crushed stone up to 10% by volume	1600	I
Oily, soft clay	1800	II
Hard clay	2000	IV
Light and loess-like loam	1700	I
Loam with an admixture of crushed stone and construction debris	1950	III
Sandy loam without impurities	1650	IV

When selecting an excavator kit, which, in addition to the leading machine - an excavator, includes vehicles for the removal of the developed soil outside the construction site, the following recommendations should be followed.

The type of working equipment (front shovel or backhoe) is selected depending on the type of excavation being developed. Trenches and pits for free-standing foundations are developed by excavators equipped with a backhoe (Fig. 2.5) with loading of soil into vehicles and placing in a one-sided dump.

2.4.1. Calculation of drilling variables of the leading earth-moving machine

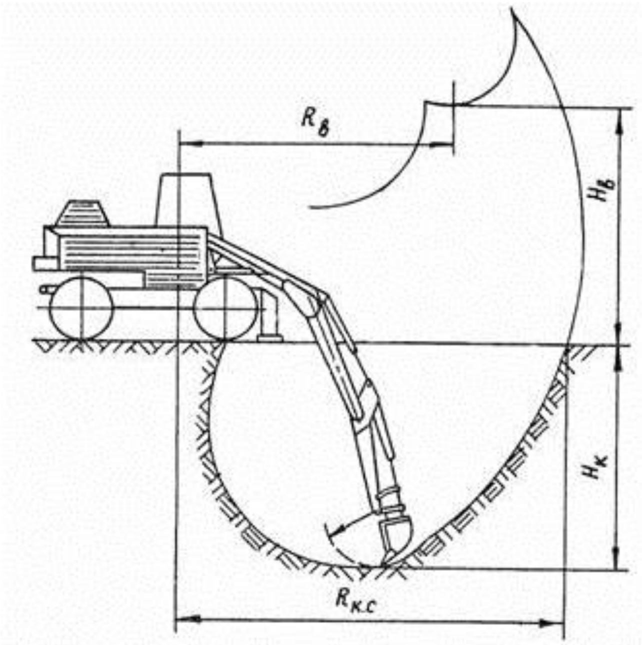


Fig. 2.5. Scheme of operation of an excavator with backhoe equipment

$R_{к,с}$ - maximum digging radius at parking level; $H_к$ - maximum digging depth; $H_в$ - maximum unloading height; $R_в$ - unloading radius at the maximum unloading height

The development is carried out below the level of the excavator parking. The pit for the entire building, or part of it, is developed by single-bucket excavators equipped with a front shovel, backhoe and dragline. Soil excavation with excavators with the front shovel (Fig. 2.6) is carried out above the parking level with soil loading onto vehicles and less often with dumping into a dump.

The bucket capacity of the selected excavator depends on the total volume of the developed soil and can be selected according to Table 2.9.

According to the selected bucket capacity, using table E.1 of Appendix E, an excavator is selected, in which the maximum digging depth should be greater than the depth of the pit (trenches). At the same time, the depth of the pit (trench) must be not less than the size that ensures the full filling of the bucket of the appropriate capacity for one excavating (Table 2.10).

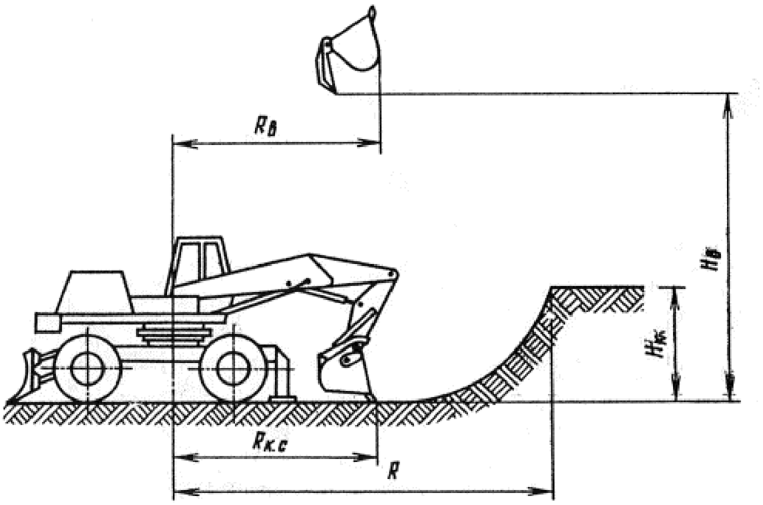


Fig. 2.6. Scheme of operation of an excavator with front shovel equipment

$R_{к.с}$ - smallest digging radius at parking level; R - digging radius at estimated bottomhole height; $R_в$ - unloading radius at the highest unloading height; $H_к$ - estimated bottomhole height; $H_в$ - maximum unloading height

Table 2.9

Approximate capacity of the excavator bucket depending on the volume of excavated soil

Scope of works, m^3	up to 500	500-1500	1500-5000	5000-11000	11000-15000	Более 1500
Recommended bucket capacity, m^3	0,15-0,25	0,25-0,40	0,5-0,65	0,65-0,80	0,80-1,0	1,0-1,5

Table 2.10

The smallest depth of the excavation being developed, ensuring the complete filling of the excavator bucket

Working equipment of the excavator	Group of soil	Excavator bucket capacity, m^3					
		0,25	0,5	0,8	1,0	1,5	2,0
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Backhoe	I , II, Ш	1,2 1,8	1,5 2,0	1,8 2,0	2,2 3,0	- -	- -
Front shovel	I , II, Ш, IV	1,5 2,5 3,0	1,5 2,5 3,5	2,5 4,5 5,5	3,0 4,5 6,0	3,0 4,5 6,0	2,5 4,0 6,0

After choosing the brand of the excavator according to Appendix E, its characteristics are entered in Table 2.11.

Table 2.11

Technical characteristics of the selected excavator

Name of indicator	Unit of measurements	Value
Bucket capacity q	m^3	
Groups of developed soil		
Digging depth $H_к$	m	
Digging radius $R_к^н$	m	
Distance from boom axis to rotation axis $r_ш$	m	
Height of an axis of the tailpiece of boom $h_ш$	m	
Distance from the axis of rotation to the support l_0	m	
Distance from support to slope (minimum) l_n	m	
The minimum step size of the excavator L_n	m	

Working radius of digging of an excavator depends on the accepted technology of excavation (frontal or side penetration).

Operation at maximum boom outreach leads to rapid wear of the machine, so the optimal value is taken, which is 90%.

$$R^р_к = 0{,}9R_к,$$

where 0,9 – coefficient of use of the technical characteristics of the excavator.

The maximum digging radius along the bottom y $R^н_{max}$, m, is calculated from the following dependencies (see Fig. 2.7):

$$f = \sqrt{h_m{}^2 + (R^р{}_к - r_ш)^2}$$

$$R^н_{max} = \sqrt{h_m^2 + (R^р_к - r_ш)^2 - (H_к + h_m)^2} + r_ш \quad (8)$$

Minimum digging radius on the bottom $R^н_{min}$:

$$R^н_{min} = l_n + l_0 + H \cdot m \quad (9)$$

Maximum top digging radius:

$$R^в_{max} = R^н_{max} - H \cdot m$$

Movement step, m:

$$L_n = R^н_{max} - R^н_{min}$$

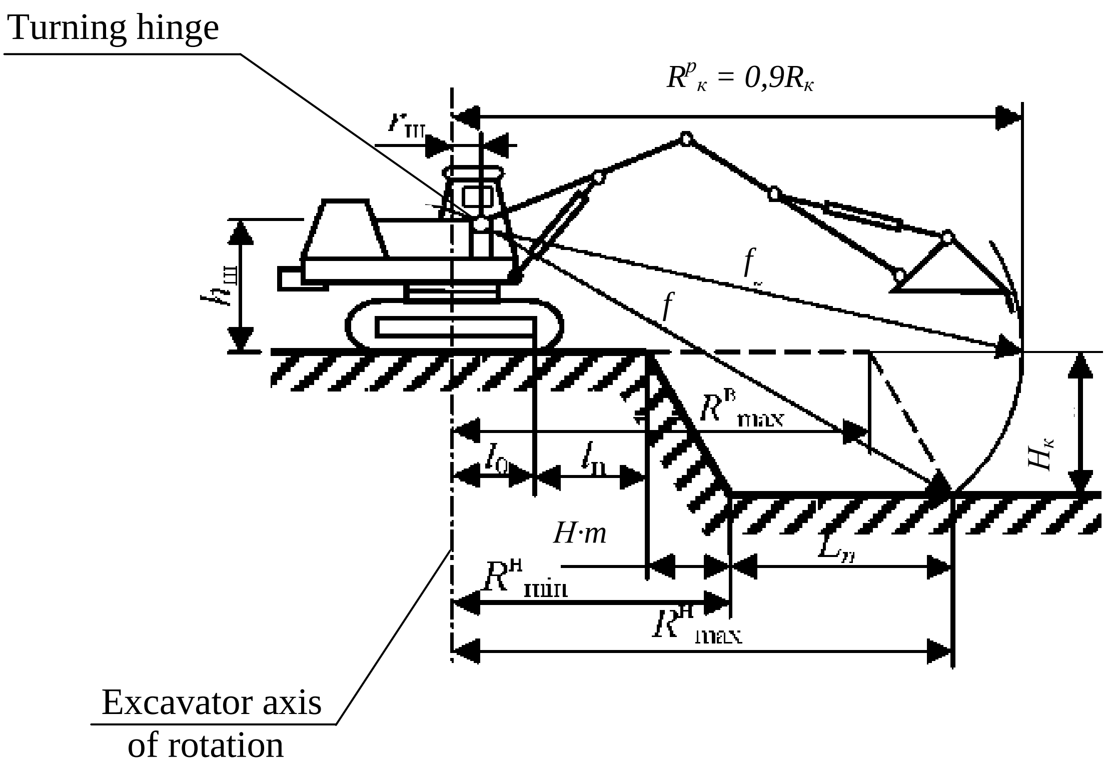


Fig. 2.7. Determining the parameters of the excavator

Checking the correctness of the choice of an excavator according to the depth $H_к$ of the pit with the bucket capacity q is carried out according to the formula [15]:

$$H_к \geq 3\sqrt[3]{q}$$

If this condition is not met, it is necessary to choose an excavator of a different brand.

The type of bucket is chosen according to the category of soil: for soils of categories I and II - with a continuous cutting edge; for III and IV - with bucket teeth.

Examples of soil development schemes are given in Appendix J, fig. J.3-J.7

2.4.2. The choice of the type and number of vehicles for the removal of soil

For soil transportation distances over 500 m, dump trucks are used.

The selection of dump trucks for the removal of excess soil from pits and trenches is to determine their brand, load capacity, body capacity and quantity in the kit.

As a first approximation, we select the type of vehicle according to the capacity of the dump truck body (3-6 excavator buckets).

The calculation of the number of vehicles is determined from the condition of the uninterrupted operation of the excavator. The calculation is performed in the following sequence.

1. Determination of the number of buckets loaded into one dump truck:

$$n = \frac{V_{куз}}{gk_p \cdot k_{зап}} \tag{10}$$

where: n – is the number of buckets loaded into one dump truck;

$V_{куз}$ – the volume of the dump truck body in m^3 (see Appendix F, Table F.1.);

g – is the capacity of the excavator bucket in m^3 (see Appendix E, Table E.1.);

κ_n – coefficient of initial soil loosening (see Table 2.4);

$k_{зап}$ – the coefficient of filling the bucket with soil in a dense state is taken:

Soil group	$k_{зап}$
I	0,87
II	0,83
III	0,80
IV	0,75

The mass of the soil immersed in the body of the dump truck must not exceed the load capacity of the dump truck.

$$P_{груз} \geq \gamma Q,$$

$P_{груз}$ – load capacity of a dump truck, t (see Appendix F, Table F.1.);

γ – is the volumetric mass of soil, t/m^3 (Table 2.4)

Q – volume of soil loaded into a dump truck, m^3, equal to

$$Q = ngk_{зап}$$

Underload of a dump truck is allowed no more than 10%, overload – no more than 5%.

The number of units of equipment N for transporting soil, determined from the condition of ensuring the uninterrupted operation of the excavator, is determined by the formula:

$$N_{тр} = \frac{(t_н + 2\frac{L}{V_{ср}} + t_{р.м})}{t_н} \qquad (11)$$

where L – is the distance to the dump, km; determined by the task;

$2\frac{L}{V_{ср}}$, min, – duration of a truck run, min, at an average speed $V_{ср}$, km/h, both ways, taking into account possible breaks during the trip;

$t_н$ – duration of loading a truck, min:

$t_н = n/ц;$

n – the number of buckets with soil, pieces, necessary for loading into a vehicle;

$$n = \frac{P_{авт}}{qa}$$

где $P_{авт}$ – carrying capacity of the car, kg;

q – excavator bucket capacity, m^3;

a – is the density of the soil in its natural state, kg/m;

$ц$ – the total number of working cycles of the excavator per minute, $ц$ = 1/ excavator cycle time per minute (Table E.2, Appendix E);

$t_{р.м}$ – time of maneuvering and unloading of the dump truck; determined depending on the brand of the mechanism (Table F.1, Appendix F), min.

When excavating pits, an excavator loads part of the soil into dump trucks, and dumps part of it into a dump for backfilling.

Therefore, the number of dump trucks obtained by calculating according to formula 11 must be reduced, because development with dumping into a dump is faster than when loading into vehicles. The value Δ, by which the number of cars decreases, is determined by the formula:

$$\Delta = \frac{V_{оз}\frac{t_{оз}}{t_{изл}}}{V_{изл} + V_{оз}\frac{t_{оз}}{t_{изл}}}, \qquad (12)$$

where: $V_{оз}$ – is the volume of soil (in a dense state) dumped into a dump (Table 2.7), in m^3;

$V_{изл}$ – is the volume of soil (in a dense state) exported outside the construction site (Table 2.7), in m ^{3};

$t_{оз}$ – time for the development of 100 m^3 of soil by an excavator with dumping into a dump in hours, determined by the time standards of Appendix I;

$t_{изл}$ – time for the development of 100 m^3 of soil by an excavator with loading into a dump truck in hours, determined by the time standards from Appendix I.

Thus, the accepted number of dump trucks, in which the excavator will be able to develop the soil with loading onto vehicles with simultaneous dumping into a dump, can be determined by the formula:

$$N = N_{тр}(1 - \Delta).$$

Based on the results of the calculation, a soil removal schedule is drawn up

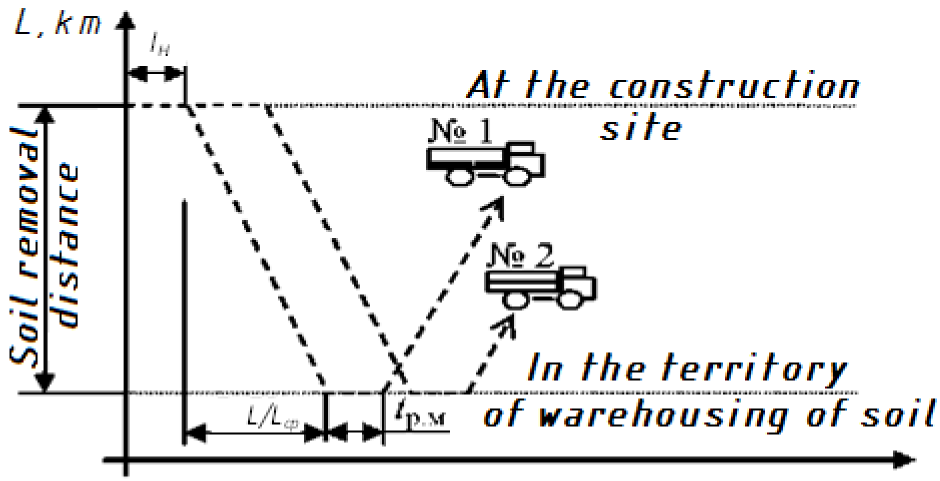


Fig. 2.8. Soil removal schedule

2.4.3. The choice of mechanization for backfilling and consolidation of ground

The backfilling of the excavations is carried out using a bulldozer with soil previously developed by an excavator.

At the same time, the thickness of the backfilled layer for sand should be no more than 70 cm, for sandy loam and loam – 60 cm, for clay – 50 cm.

Simultaneously with backfilling, the soil is consolidated in layers in the recesses using rollers and (or) manual pneumatic rammers (Fig. 2.9).

Backfilling of the recesses of pits or trenches is carried out after the concrete reaches the required strength and the formwork of the structures is dismantled. Bulldozers are used to move soil located at the edges of pits or along the sides of trenches. Technical characteristics of bulldozers are given in Appendix G.

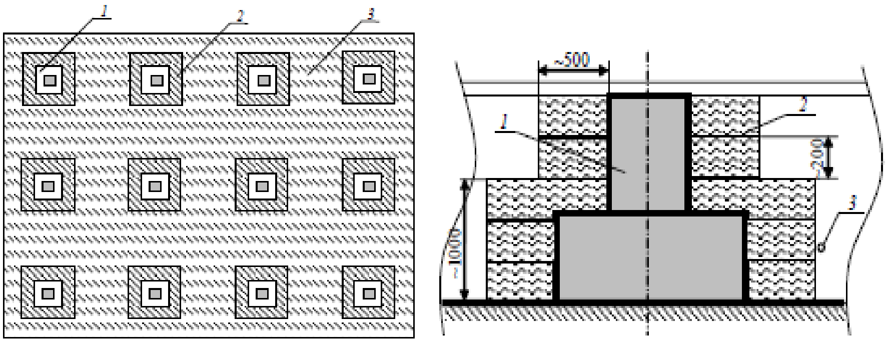


Fig.2.9. Plan - scheme of soil consolidation:

1 – foundation; 2 – soil consolidation zone with manual rammers; 3 – zone of soil consolidation by mechanical rammers

Soil leveling around the foundations at a distance of at least 0,8 m is carried out manually in layers of 0,1 .... 0,2 m thick, and consolidation is carried out by self-propelled electric rammers ИЕ-4504, ИЕ-4505 and ИЕ-4502, rammers by vibrating electric ТВЕ -1 or pneumatic rammers for several penetrations in strips that overlap with subsequent penetrations. The thickness of the dumped layer should be no more than 40 cm, the number of passes should be at least 4.

In excavations with a width of 0,8 ... 1,4 m, the soil is leveled with layers of a given thickness using a micro-bulldozer, which is lowered to the bottom of the pit with a crane. In the backfilling process, when the excavation width reaches more than 1,4 m, a small-sized bulldozer based on the T-54B tractor can be used, and in the upper part — a large-sized bulldozer working for backfilling the soil.

Layer-by-layer consolidation in cramped conditions can be carried out in strips using small-sized self-propelled rollers ДУ-10А or ДУ-54 with vibratory drums.

The soil is consolidated, starting from the areas near the building structures, and then moving towards the edge of the slope, while each subsequent pass of the tamping machine should overlap the track of the previous one by 10–20 cm. Technical characteristics of soil consolidation machines are given in Appendix H.

An example of a scheme for backfilling and soil consolidation in the recesses of the pit is given in Appendix J, Fig. J.2.

After completing the selection of all the necessary mechanisms for earthworks, it is necessary to complete a list of machines and mechanisms in the form (Table 2.12).

Table 2.12

List of machines and mechanisms in the production of earthworks

Name of works	Characteristics of working conditions	Scope of work	Name and brand of machines	Technical characteristics
1	**2**	**3**	**4**	**5**
Soil development	Нв, Soil group	Vв	Excavator - front shovel (backhoe)	Digging depth Digging radius Bucket capacity
Backfilling	Нв, Soil group	Vо.з.	Bulldozer	Blade length Blade height
Soil consolidation	Нв, Нс – height of consolidated soil layer	Vо.з.	1) Manually 2) By mechanized way	Consolidation depth Consolidation width Engine power Bearing plate (rammer) dimensions
Removal of excess soil		Vизл.	Dump truck	Body capacity, carrying capacity

2.5. Calculation of labour contribution and wages

Calculation of labour contribution (Table 2.13), which can be used when issuing job orders to workers, is compiled in accordance with the requirements of ДБН А.3.1-5-96 «Organization of construction production» [1] and the Manual for the elaboration of POC and PPW to ДБН А.3.1-5-96 [2].

Table 2.13

Calculation of labour contribution

Justification of the norm	Works	Unit of measurement	Scope of works	Norm of time per unit of measure man-hour $\frac{\text{workers}}{\text{machinists}}$	Labour contribution for the entire scope of works (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 works, UAH $\frac{\text{workers}}{\text{machinists}}$
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Total:					∑		∑

Column 1 indicates the paragraph numbers, tables, columns and positions of the norm adopted according to the relevant regulatory documents ДБН [3, 4].

In ДБН [3, 4] there are no norms for some types of work. In this case, paragraphs should be used in relation to the types of work as close as possible in terms of the composition of work operations or updated versions of programs for a personal computer (PC), АВК-3 (Автоматизований випуск кошторисів), «Тендер-контракт», «Зодчий» , etc.

In addition to the norm of time, the average category of works is indicated. In this case, it is necessary to determine the composition of the team of workers. It is indicated in column 9. So, for example, if the average category is 3.6, then the team can consist of 1 worker of the 5th category, 1 - 4th and 1 worker of the 2nd category ((5+4+2)/ 3 = 3,6).

Column 2 contains a list of works that correspond to those adopted in the manufacturing plan with a link to the positions provided for by the collection of norms.

In column 3, the units of measurement corresponding to the norms are put down, in column 4 - the total volumes of each type of works calculated earlier.

In accordance with the selected paragraph of the ЕНиР, ДБН or АВК 3 paragraph, column 5 indicates the time norm per unit of measurement for the main workers (numerator) and machinists (denominator) in man-hours. Column 7 indicates the price per unit of measurement.

In column 6 enter the calculated total labour contribution for workers and drivers in man-days. The total labour contribution are determined as the multiplication of the amount of work (column 4) by the norm of time (column 5), and divided by the duration of the work shift (8,2 hours).

In column 8 enter the cost of labour contribution for the entire amount of work equal to the multiplication of the amount of work (column 4) and prices (column 7).

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

To compile the calculation, it is recommended to use the norms given in the Appendix I.

2.6. Work schedule

The work execution schedule is drawn up in the form given in Table 2.14 in accordance with the indicators below.

Table 2.14

Work Schedule

Name of works	Unit of measurement	Scope of works	Labor intensity (labour contribution) for the entire scope of works, man-days	The composition of the brigade (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 manufacturing plan has been drawn up.

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

Column 5 – «The composition of the brigade (team) in the shift, machines, mechanisms» lists the quantitative, professional and qualified composition of construction units for the implementation of each work process and operation. It is selected depending on the labour 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 installations. 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 installations, it is necessary to provide for options for replacing them if necessary.

Column 6 calculates the number of days required to complete this work. It is calculated as the quotient of dividing column 4 by column 5.

In that case, if as a result of the calculation you get too many days and the work should be done faster, then proceed as follows:

1. If the work is performed by mechanisms, then their execution can be scheduled in 2 or 3 shifts, or the number of mechanisms can be increased. The latter can only be done if the conditions of the construction site allow it, while ensuring compliance of the safety and labor protection regulations.

2. If the work is done manually or with the help of a mechanized tool and there is a need to speed it up, then 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. For example, it was: 5th category - 1 person, 4th - 2 people, 2nd - 1 person. Then you can plan 5 categories - 2 people, 4th - 4 people, 2nd - 2 people. Or 5th category - 3 people, 4th - 6 people, 2nd - 3 people. etc.

After that, the work schedule itself is drawn up. In this case, a line is drawn in each line corresponding to the number of days in column 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 manufacturing plan has been drawn up, must be a multiple of the duration of the work shift for single-shift work or a working day for two- and three-shift work.

When drawing up the calendar 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 production line methods of work.

In the event that the duration of work on one division or tier is significantly less than one day, then it is necessary to perform an hourly schedule for 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 schedule, you can use modern PC project management programs. There are two versions of them at the TSP department. These are "Sure Track Project Manager Rus" and "Microsoft Project 98". The American company Primavera Systems, Inc has developed a number of similar programs. These are Primavera Project Planner Professional (P4), Time Line 6.5, Open Plan Professional, etc. These programs allow you to make a linear schedule of work production very quickly. At the same time, it can be shown on it in the same way as on the network model: time margins, the relationship between works, the «critical track». The same programs make it possible to draw up, if necessary, 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 presence of indicators characteristic of the network model, combined with the ability to quickly adjust, make such graphs indispensable and very useful in the implementation of construction projects.

2.7. Material and equipment

The kit of necessary machines and mechanisms for earthworks is assigned taking into account specific conditions and technical solutions. It is compiled in the form given in table 2.15.

Table 2.15

The need for machines, equipment, tools, inventory and fixtures

Machines, equipment, tools, inventory and fixtures	Type	Brand	Amount	Technical characteristic
Machines see table 2.11				
optical level	Bosch GOL	26 D Professiona	1 per division	СКО — 1,6 mm per 1 km double stroke.
theodolite	2Т - 30 П		1 per division	Magnification of the telescope — 20X; Angle of view -2^0; The smallest sighting distance — 1,2 m
template of steepness of slopes			1 per division	
densitometer		ГРПТ-2, ППГР-1	1 per division	
moisture meter		ПННВ-1, ПГР-1	1 per division	
metal tape measure			1 per division	
rule			1 per division	
rectangular digging shovel pointed digging shovel		ЛКП-1 ЛКО-1	3 per division	

2.8. Quality requirements and acceptance of works

The processes of erection of earthen structures are subjected to systematic control, including in the general case: the position of excavations and embankments in space (planned and high-rise); geometric dimensions of earthen structures; properties of soils that lie at the base of structures; properties of soils used for the construction of bulk structures; quality of soil placement in embankments and backfilling (characteristics of placed and consolidated soils).

Constant quality control is carried out by line engineering and technical workers. For this, daily operational control is organized, which is carried out by the manufacturers of works and foremen with the involvement of representatives of the geodetic service and the construction (soil) laboratory.

When controlling the position in space and the size of structures, the following is checked: the location on the plan of earth structures and their dimensions; elevation marks of the edges and the bottom of the recesses; elevation marks of top of embankments, taking into account the margin for settlement; elevation marks of planned surfaces; slopes of excavations and embankments. This control is carried out using geodetic instruments (goniometers, theodolites and levels), as well as the simplest tools and devices - tape measures, meters, building levels, plumb lines, templates, slopes, rails 2 and 3 m long with measuring wedges to establish the size of the gaps under them , sets of sights and landmarks. The data obtained by measurements should not exceed the geometric dimensions of the deviations allowed by regulatory documents.

The results of quality control of work are presented in tabular form (Table 2.16) in accordance with the requirements of ДБН [1].

Table 2.16

Scheme of operational quality control of earthworks

Operations subject to control		Operations quality control			
maker of works	master	compound	ways	terms	attracted services

In the course of earthworks, general work logs should be kept and certificates of examination of hidden works should be drawn up. These documents are presented at the time of delivery and acceptance of work performed.

Examples of operational quality control schemes are presented below in sections 2.8.1 – 2.8.4.

2.8.1. The scheme of in- process quality control of excavation digging (trenches) for structures

Technical requirements

СНиП 3.02.01-87 s.p. 1.11, 3.1-3.11, 3.29, Table 4

The dimensions of the excavations along the bottom in natural conditions should not be less than those established by the project.

The minimum width of excavations (Fig. 2.10) must be at least the width of the structure + 0,2 m on each side, if necessary, the movement of people in the recess – at least 0,6 m.

Deviations from the design longitudinal slope of the bottom of trenches, excavations with slopes should not exceed ± 0.0005.

Excavations should be developed, as a rule, up to the design mark, while maintaining the natural composition of the foundation soils.

Deviations of the marks of the bottom of the recesses in the places of foundations and placing structures:

- in the final development should not exceed ± 5 cm;
- in rough development should not exceed the data given in Table. 2.16.

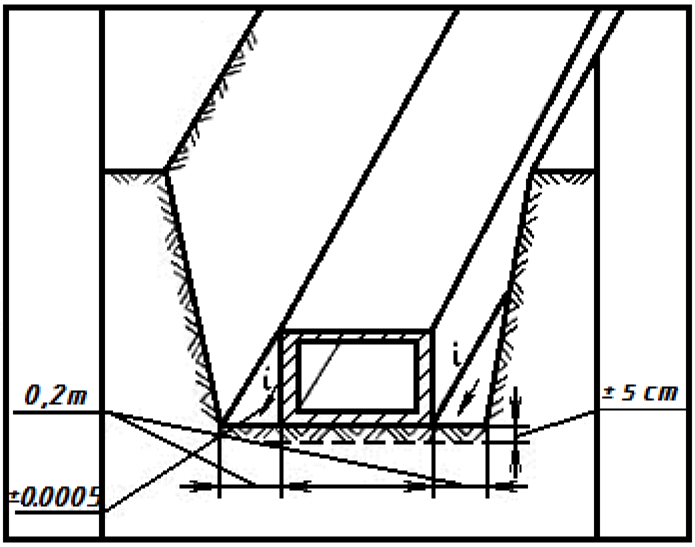


Fig. 2.10. Deviations in the development of excavations for structures

Table 2.16

Deviations of the elevation marks of the bottom of the recesses (excavations)

Deviations of the elevation marks of the bottom of the recesses from the design ones during rough development		
Type of mechanism for the soil excavation	Limit deviations, cm	Number of measurements
1) with single-bucket excavators equipped with buckets with teeth:		
a) with a mechanical drive by type of equipment:		
dragline;	+25	20
front shovel;	+10	15
backhoe	+15	10
б) with hydraulic drive;	+10	10
2) with single-bucket excavators equipped with leveling buckets, cleaning equipment and other special equipment for leveling works by excavators-planners;	+5	5
3) with bulldozers;	+10	15
4) with trench excavators;	+10	10
5) with scrapers	+10	10

Table 2.17

Composition of operations and controls

Composition of operations and controls			
Stages of works	Controlled Operations	Control (method, scope)	Documentation
Preparatory works	Check: – execution of the vertical leveling of the surface of the construction site (if necessary); – the alignment of the center axes and the reliability of their fastening; – performance of surface water and groundwater drainage works with the help of temporary or permanent devices (if necessary).	Visual Measuring Visual	General work log
Mechanized soil development, cleaning the bottom of the pit (trench)	To control: - deviations of elevation marks of the recesses bottom relative to the design ones; – the type and characteristics of the opened soil of natural bases for foundations and earth structures; - deviations of the bottom elevation marks of the excavations during the final development (revision) from the design ones; – deviations from the design slope of the bottom of trenches and other excavations with slopes; - the dimensions of the recesses along the bottom; - the steepness of the slopes.	Measuring, measurement points are set randomly; to the received area 10÷20 measurements Technical inspection of the entire surface of the base. Measuring, in the corners and center of the pit, at the intersections of the axes of buildings, in places where elevations change; at least 10 measurements per received area Measuring, in places of turns, junctions, location of wells, but not less than 50 m. Measuring Same	General work log
Acceptance of performed works	To check: – accordance of the geometric dimensions of the pit (trench) with the design dimensions; – the value of the mark and slopes of the bottom of the pit (trench); – the steepness of the slopes of the pit (trench); – the quality of ground of the base (if necessary).	Visual Same Same Technical inspection of the entire surface of the base	Certificate of inspection of hidden works
Control and measuring tool: level, theodolite, tape measure, template of slope steepness.			
Operational control is carried out by: master (foreman), geodesist - in the process of work. Acceptance control is carried out by: employees of the quality service, master (foreman), geodesist, representatives of the customer.			

Instructions for the production of works

СНиП 3.02.01-87 s.p. 3.6-3.8, 3.11

Excavations in soils, except for boulders, rocks, should be developed, as a rule, up to the design level mark while maintaining the natural layer of the base soils, it is allowed to develop excavations in two stages: rough - with deviations given in Table 1, and final (immediately before the construction of the structure).

Finalization of shortfalls to the design mark should be carried out with the preservation of the natural composition of the foundation soils.

Replenishment of soil excavation excesses in the places of foundations and structures placing should be carried out with local soil with consolidation to the density of the soil of the natural composition of the base or low-compressibility soil (deformation modulus of at least 20 MPa). In subsiding soils of type II, the use of draining soil is not allowed.

2.8.2. Scheme of in- process quality control of excavation of pit by digging machine

Technical requirements

СНиП 3.02.01-87 s.p. 1.11, 3.1, 3.2, 3.6, Table 4

The dimensions of the pits along the bottom in their natural form must be at least those established by the project.

The minimum width of the pits must be at least the width of the structure + 0,2 m on each side, if necessary, the movement of people along the bottom of the pit - not less than 0,6 m.

- The pits should be developed, as a rule, up to the design mark with the preservation of the natural composition of the foundation soils.
- Deviations of the marks of the bottom of the pits in the places of foundations and placing structures:
- in the final development should not exceed ± 5 cm;
- during rough development (Fig. 2.11) should not exceed the data given in table 3.

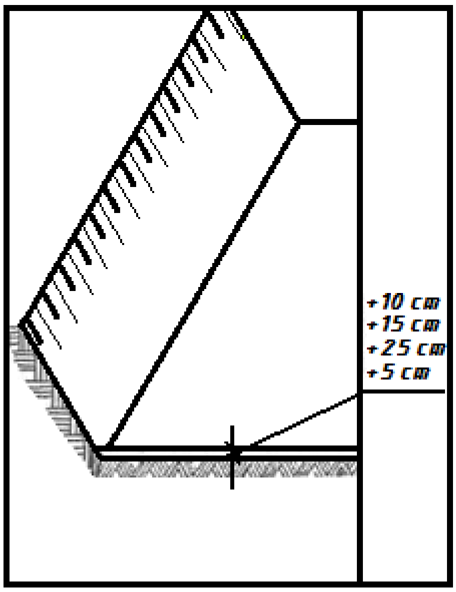


Fig. 2.11. Deviation of pit bottom marks
during rough development

Table 2.18

Type of mechanism for excavation

Type of mechanism for the soil excavation	Limit deviations, cm	Number of measurements
1) with single-bucket excavators equipped with buckets with teeth:		
a) with a mechanical drive by type of equipment:		
dragline;	+25	20
front shovel;	+ 10	15
backhoe	+ 15	10
б) with hydraulic drive;	+ 10	10
2) with single-bucket excavators equipped with leveling buckets, cleaning equipment and other special equipment for leveling works by excavators-planners.	+5	5

Table 2.19

Composition of operations and controls

Stages of works	Controlled Operations	Control (method, scope)	Documentation
Preparatory works	Check: – execution of the vertical leveling of the surface of the construction site (if necessary); – the alignment of the center axes of the structure and the boundaries of the pit.	Visual Measuring	General work log
Mechanized soil development	To control: - deviations of elevation marks of the recesses bottom relative to the design ones; – type and characteristics of the opened ground of natural bases; – the dimensions of the pit in the plan; – the steepness of the slopes.	Measuring, measurement points are set randomly; to the received area 10÷20 measurements Technical inspection of the entire surface of the base. Measuring Same	General work log
Acceptance of performed works	Проверить: – geometric dimensions of the pit; – elevation marks and slopes of the bottom of the pit; – the steepness of the slopes of the pit; – the quality of ground of the base (if necessary).	Measuring Same Same Technical inspection of the entire surface of the base	Certificate of inspection of hidden works
Control and measuring tool: level, tape measure, theodolite, template.			
Operational control is carried out by: master (foreman), geodesist - in the process of work. Acceptance control is carried out by: employees of the quality service, master (foreman), representatives of the technical supervision of the customer.			

For works on the construction of bases for structures, an act of examination of hidden works should be drawn up.

Not allowed:

– erosion, softening, loosening or freezing of the top layer of the base soil with a thickness of more than 3 cm.

2.8.3. Scheme of in- process quality control of the backfill

Technical requirements

СНиП 3.02.01-87 s.p. 4.15, 4.26

The presence of frozen clods in the outer recesses near the buildings and upper zones of trenches with placed communications should not be more than 20% of the total volume.

The size of solid inclusions, including frozen clods, should not exceed 2/3 of the thickness of the consolidated layer, but not more than 30 cm, as shown in Fig. 2.12.

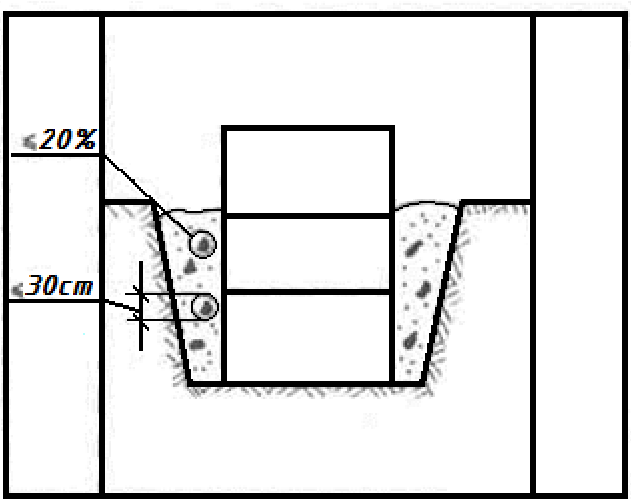


Fig. 2.12. The presence of frozen clods in the outer recesses near the buildings and the upper zones of the trenches.

The granulometric composition of the soil must correspond to the project (deviations are allowed in no more than 20% of the determinations).

The average density of dry backfill soil in the tested area should not be lower than the design one (deviations are allowed in density values lower than the design ones by 0.06 g/cm^3 in individual determinations, but not more than in 20% of determinations).

Table 2.20

Composition of operations and controls

Stages of works	Controlled Operations	Control (method, scope)	Documentation
Preparatory works	Check: – examination of previously performed earthworks; – the cleanliness of the base and the freezing of the soil (in winter); – the presence in the project of data on the types and characteristics of ground for backfilling, instructions for experimental consolidation.	Visual Same Same	General work log, certificate of inspection of hidden works
Backfilling of recesses of excavation	Control: – the granulometric composition of the soil intended for backfilling (if necessary); – the presence of wood, fibrous materials, rotting or easily compressible construction debris in the soil; – the presence of frozen clods in backfills; – the size of solid inclusions, including frozen clods; – the presence of snow and ice in backfills and their foundations; – the temperature of the soil, poured and consolidated at a negative air temperature; – the average density of the dry backfill soil in the area being checked.	Measuring and registration according to the instructions of the project Visual, every shift Visual Same Same Measuring, periodic Same	General work log
Acceptance of performed works	Check: – compliance of the physical and mechanical characteristics of the poured and consolidated soil with the requirements of the project	Laboratory control	Certificate of acceptance of performed works
Control and measuring tool: level; densitometer ГРПТ-2, ППГР-1; moisture meter ПННВ-1, ПГР-1			
Input and operational control is carried out by: master (foreman). Acceptance control is carried out by: employees of the quality service, master (foreman), representatives of the technical supervision of the customer.			

Not allowed:

- the presence of wood, rotting or easily compressible construction debris in the soil;

– presence of snow and ice in backfills and their foundations;

- the presence of frozen clods for recesses inside the building.

Instructions for the production of works

СНиП 3.02.01-87 s.p. 4.9-4.11, 4.15

Backfilling of trenches with placed pipelines should be carried out in two stages:

– at the first stage, the lower zone is backfilled with an unfrozen ground that does not contain solid inclusions larger than 1/10 of the diameter of asbestos-cement, plastic, ceramic, reinforced concrete pipes, to a height of 0,5 m above the top of the pipe, and for other pipes - soil without inclusions larger than 1/4 of their diameter to a height of 0,2 m above the top of the pipe with tamping of recesses and its layer-by-layer consolidation to the design density on both sides of the pipe;

– at the second stage, the upper zone of the trench is backfilled with soil that does not contain solid inclusions with a size larger than the pipe diameter.

Backfilling of trenches with impassable channels should be carried out in two stages:

– the lower zone to a height of 0,2 m above the top of the channel is covered with non-frozen soil that does not contain solid inclusions larger than 1/4 of the channel height, but not more than 20 cm, with its layer-by-layer consolidation to the design density on both sides of the channel;

– the upper zone is filled with soil that does not contain solid inclusions larger than 1/2 of the channel height.

Backfilling of trenches to which only the own weight of a ground is transferred may be carried out without consolidation of the soil, but with filling along the track of the trench of the windrow, the dimensions of which should be determined taking into account the subsequent natural settlement of the soil.

Backfilling of narrow recesses, if it is impossible to consolidate the ground with the available means, should be carried out with low-compressibility soils (sand, gravel) with watering.

2.8.4. Scheme of in- process quality control of vertical land levelling

Technical requirements

СНиП 3.02.01-87 p. 3.29

Allowed deviations (Fig. 2.13.)**:**

– marks of the planned surface from the design ones, except for irrigated lands, should not exceed:

– in non-rocky soils – ±5 cm;

– in rocky soils – from +10 to -20 cm.

– the slope of the planned surface from the design one, except for irrigated lands, is ±0.001.

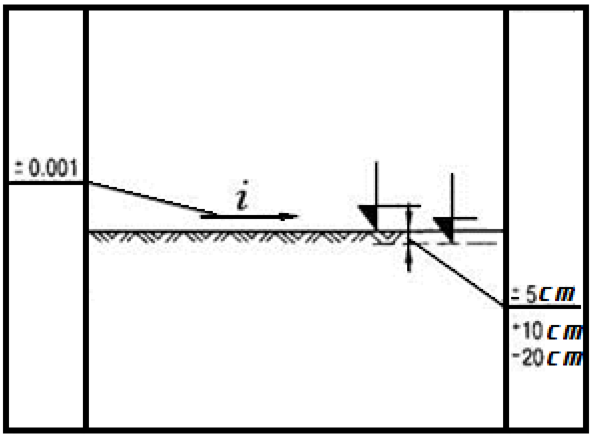


Fig. 2.13. Permissible deviations of the vertical layout of the surface

Not allowed:

– formation of closed lowerings on a leveled surface.

Table 2.21

Composition of operations and controls

Stages of works	Controlled Operations	Control (method, scope)	Documentation
Preparatory works	Check: – availability of geodetic marking signs, geodetic marking scheme; – cutting off the fertile soil layer; – performance of work on the removal of surface and groundwater from the territory of the planned surface (if necessary).	Visual Technical inspection Same	General work log
Implementation of planning	Control: - the magnitude of the slopes; - the magnitude of elevation marks of the surface.	Measuring Same	General work log
Acceptance of performed works	Check: - compliance of the actual elevation marks of the planned surface with the design ones; - compliance of the actual slopes of the planned surface with the design ones; – degree of ground consolidation (if necessary); - the absence of waterlogged areas and local subsidence of the soil.	Measuring, on a grid of 50 x 50 m Visual or measuring, on a grid of 50 x 50 m Laboratory Visual	Certificate of acceptance of work performed, executive geodetic scheme
Control and measuring tool: metal tape measure, leveling board, level.			
Entrance and operational control is carried out by: master (foreman), geodesist - in the process of work. Acceptance control is carried out by: employees of the quality service, master (foreman)), geodesist, representatives of the customer.			

2.9. Occupational safety

Safety instructions must be specific and correspond to the materials and conditions of the work production at the site. Below are some of them.

Earthworks are carried out in compliance with the requirements of ДБН А.3.2-2-2009 ССБП. «Охорона праці і промислова безпека в будівництві. Основні положення» [11], ДБН В.1.1-7-2002. «Пожежна безпека об'єктів будівництва» [12]. The operating instructions for the machines and equipment used must be followed. All vehicles must be in good condition.

Prior to the start of earthworks, the exact location of existing underground utilities is determined with the installation of special signs. The development of soil near them can be carried out only after obtaining a written permission from the organization operating the cable networks. The development of the soil near the electric cables is carried out without the use of impact tools and under the supervision of the manufacturer or foreman, as well as a representative of the organization responsible for the operation of these communications. If underground utilities are found that are not specified in the project, excavation work must be stopped until their purpose is clarified. Work is also stopped if harmful gases are found in the excavation. Soil development should be carried out with slopes, the steepness of which is taken according to ДБН Д.2.4-1-2000. Сборник 1. «Земляные работы» [3] and ДБН Д.2.2-1-99. Сборник1. «Земляные работы» [4].

When working at night, the work site must be illuminated, and earth-moving, transport machines must have individual lighting. During the break, the excavator bucket is lowered into the ground. The parking lot and the ways of movement of machines should be outside the prism of cave-in of the excavation of soil.

2.10. Technical and economic performances

Technical and economic performances are compiled according to the calculation of labour contribution and the work schedule. The technical and economic performances include:

- standard labour contribution of workers (man-hours) - based on the calculation results;

- standard costs of machine time (machine-hour) - based on the calculation results;

- wages of workers (UAH) - on the basis of the calculation;

- wages of machine operators (UAH) - based on the calculation results;

- duration of work - according to the schedule;

- production of one worker per shift, B_p

$$B_p = V/\sum T,$$

where: V– is the volume of earth masses, m^3;

$\sum T$ – total labor intensity in accordance with the final line of column 6 of the calculation (numerator), or column 4 of the graph;

- labour contribution per 1 m^3 of developed soil, T_e

$$T_e = \sum T/S,$$

- the cost of machine time per 1m^3 of developed soil, $t_{маш}$

$$t_{маш} = \sum T_{маш}/S,$$

where: $\sum T_{маш}$ – machine time costs in accordance with the final line of column 6 of the calculation (denominator);

- the cost of labour contribution 1m^3 of developed soil C_e

$$C_e = C/S,$$

where: C – is the total cost of labour contribution.

Technical and economic performances are summarized in Table 2.22.

Table 2.22

Technical and economic performances

№	Name of indicator	Unit of measure	Quantity
1	**2**	**3**	**4**
1.	Earthwork duration.	days	
2.	Labor intensity of the work for the entire volume.	man-days	
3.	Labor intensity of development of 1 m^3 of soil	man-days/ m^3	
4.	Production of one worker per day.	m^3/day	
5.	The cost of developing 1 m^3 of soil.	monetary units/ m^3	
6.	Total cost of work	monetary units	

SECTION 3. STRUCTURE AND COMPOSITION OF THE MANUFACTURING PLAN FOR THE PRODUCTION OF CONCRETE WORKS DURING THE CONSTRUCTION OF THE ZERO CYCLE OF THE BUILDING

Manufacturing plans are the main part of organizational and technological documentation. They regulate the means of technological support, the rules for the implementation of technological processes in the construction and reconstruction of buildings and structures.

The manufacturing plan should consist of the following sections:

1. Scope of the map.
2. Organization and technology of work performance.
3. Requirements for the quality and acceptance of work.
4. Calculation of labour contribution, machine time and wages.
5. Schedule of works on the object.
6. Table of the need for material and technical resources.
7. Safety precautions.
8. Technical and economic performances of the manufacturing plan.

3.1. Application area

In this section, it is necessary to indicate the binding of technology and organization of work to specific materials and conditions for the production of work at the construction site in accordance with the task (task variants see in Appendix A).

3.2. Organization and technology of work performance

In this section of the manufacturing plan, specific instructions for the organization and technology of concrete work, in accordance with the task (materials, building, etc.) should be developed.

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* This section of the guidelines is based on [9], taking into account the requirements of [1] and recommendations [2, 18].

Below is general information, from which it is necessary to choose what is suitable for the relevant conditions, necessarily in an indicative (prescriptive) form.

The production of work must be planned in divisions, with the organization of work according to the line method. The size of the division is selected depending on the size and configuration of the building.

Concrete work is carried out in flows. The composition of the processes included in the flows is taken depending on the design and technological solution. In this case, the flows must be coordinated in time, taking into account the timing of technological breaks. Schemes of technological operations of concreting are given in the Appendix L.

3.3. Requirements for the quality and acceptance of works. Operational control schemes

Quality control of work should be carried out in accordance with the operational quality control schemes given in Table. 3.1-3.3 and Appendix M.

During the production of concrete work, logs should be kept and certificates of examination of hidden work should be drawn up. These documents are presented upon delivery of the object.

Table 3.1

Scheme of operational quality control of formworks

Controlled Operations	Requirements	Methods and means of control	Who controls and when	Who is in control
1	**2**	**3**	**4**	**5**

Table 3.2

Scheme of operational quality control of reinforcing

Controlled Operations	Requirements	Methods and means of control	Who controls and when	Who is in control
1	**2**	**3**	**4**	**5**

Table 3.3

Scheme of operational quality control of concrete works

Controlled Operations	Requirements	Methods and means of control	Who controls and when	Who is in control
1	**2**	**3**	**4**	**5**

3.4. Calculation of labour contribution and wages

Calculation of labour contribution (Table 3.4), which can be used when issuing work orders-jobs to workers, is compiled in accordance with the requirements of ДБН А.3.1-5-2016 «Organization of construction production» [1] and the Manual for the elaboration of POC and PPW to ДБН А.3.1-5-2016 [2].

Column 1 indicates the numbers of the paragraph, table, columns and positions of the norm adopted according to the corresponding collection of ЕНиР or ДБН.

Many new types of work are missing from the ДБН and ЕНиР. In this case, paragraphs should be used in relation to the types of work that are as close as possible in terms of the composition of work operations or updated versions of programs for a personal computer: АВК-5, «Тендер-контракт», «АС-4», etc.

In addition to the norm of time, is indicated the average category of work. In this case, it is necessary to determine the composition of the team of workers. It is indicated in column 9. So, for example, if the average category is 3,6, then the team can consist of 1 worker of the 5th category, 1 worker of the 4th and 1 worker of the 2nd category ((5 + 4 + 2) / 3 = 3,6).

Table 3.4.

Calculation of labour contribution

Justification of the norm	Name of the work	Unit of measurement	Scope of works	Norm of time per unit of measure man-hour / machine-hour	Labour contribution for the entire scope of works (labor intensity), man-hour / machine-hour	Price per unit of measure, UAH	The cost of labor for the entire scope of works, UAH	The composition of the team according to the norm
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Total:					∑		∑	

Column 2 contains a list of works corresponding to those adopted in the manufacturing plan with a link to the positions provided for by the collection of norms. In column 3, the units of measurement corresponding to the norms are put down, in column 4 – the total volumes of each type of work calculated earlier.

In accordance with the selected paragraph of the ENiR or DBN paragraph, column 5 indicates the time rate per unit of measurement for workers in man-hours and for machinists in the machine-hours. Column 7 indicates the price per unit of measurement.

If the time norm is not given for the mechanized process, it is calculated by dividing the time norm for workers by the quantitative composition of the team.

The calculated total labour contribution are entered in column 6, for workers in man-days, for machinists – in machine-shifts. Total labour contribution are determined as the result of multiplying the amount of work (column 4) by the time rate (column 5) divided by the duration of the work shift (8,2 hours).

The cost of labour contribution for the entire scope of work, equal to the result of multiplying the scope of work (column 4) by the rate (column 7), is entered in column 8.

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

To compile the calculation, it is recommended to use the norms given in Appendix N.

3.5. Work schedule

The work schedule is drawn up in the form given in Table. 3.5, in accordance with the indicators below.

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 manufacturing plan has been drawn up.

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

Table 3.5.

Work Schedule

Name of works	Unit of measurement	Scope of works	Labor intensity (labour contribution) for the entire scope of works, man-days / machine-shifts	The composition of the brigade (team) in the shift, machines, mechanisms	Number of working days, shifts, hours	Work schedule						
						working days, shifts, hours						
1	**2**	**3**	**4**	**5**	**6**	**7**						
						1	2	3	4	5	6	7

Column 5 - “The composition of the brigade (team) in the shift, machines, mechanisms” provides the quantitative, professional and qualified composition of construction units for the implementation of 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 installations. 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 installations, it is necessary to provide for options for replacing them if necessary.

Column 6 calculates the number of days required to complete this work. It is calculated as the quotient of dividing column 4 by column 5.

In the event that the calculation results in too many days and the work should be done faster, then proceed as follows:

1. If the work is performed by mechanisms, then you can schedule their execution in 2 or 3 shifts, or increase the number of mechanisms. The latter can only be done if the conditions of the construction site allow it, in order to ensure that the safety and labor protection regulations are complied with.

2. If the work is done manually or with the help of a mechanized tool and there is a need to speed it up, then it is planned to increase the number of workers. Moreover, this increase should be a multiple of the composition of the team

according to the norm. For example, it was: 5th category – 1 person, 4th – 2 people, 2nd – 1 person. Then it can be planned: 5th category – 2 people, 4th – 4 people, 2nd – 2 people; or 5th category – 3 people, 4th – 6 people, 2nd – 3 people, etc.

After that, the work schedule itself is drawn up (column 7). In this case, a line is drawn in each row corresponding to the number of days in column 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 manufacturing plan has been drawn up, must be a multiple of the duration of the work shift for single-shift work or a working day for two- and three-shift work.

When drawing up the calendar 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 line methods of work.

If the duration of work on one division or tier is significantly less than one day, then it is necessary to perform an hourly schedule for 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 schedule, you can use modern PC project management programs. There are two versions at the TCP department. These are «SureTrak Project Manager Rus» and «Microsoft Project». The American company Primavera Systems, Inc. has developed a number of similar programs. These are **«**Primavera Project Planner Professional (P4**)**», «Time Line 6.5», « Open Plan Professional», etc.

These programs allow you to quickly draw up a linear schedule for the production of work. At the same time, it, like the network model, can show: time margins, the interconnection of works, the “critical track”. The same programs make it possible to draw up, if necessary, schedules for financing work, handling of materials, machines and mechanisms, etc. These programs also 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 presence of indicators characteristic of the network model, combined with the ability to quickly adjust, make such graphs indispensable and very useful in the implementation of construction projects.

3.6. Material and technical resources

The set of necessary machines and mechanisms for the production of concrete works is assigned taking into account specific conditions and technical solutions. It is compiled in the form given in Table. 3.6. Accounting for materials, products, structures and semi-finished products is summarized in the form given in Table 3.7 and Appendix H.

Table 3.6.

List of machines and mechanisms for placing concrete mix

№	Name of works	The nature of conditions of the works	Scope of works	Name and brand of machines	Technical characteristics
1	**2**	**3**	**4**	**5**	**6**
1	Delivery of concrete mix	Transportation distance, L (km)	Vб	Concrete truck, Dump truck, etc.	Body capacity
2	Concreting	Aggregate size, slump	Vб	Concrete pump, crane, skip (bucket)	Productivity
3	Consolidation of concrete mix		Vб	Vibrator	Length of the working part, radius of doing

3.7. Safety

Safety instructions must be specific and appropriate to the materials and conditions of production of works at the site. Below are some of them.

Concrete work is carried out in compliance with ДБН А.3.2-2-2009 «Industrial safety in construction», «Rules for the design and safe operation of load-lifting cranes», «Fire safety rules for the production of construction and installation works» [11]. Need to use the operating instructions for the machines and equipment applied. All vehicles must be in good condition.

Table 3.7

List of materials, products and semi-finished products

№	Material name	Unit of measurement	Quantity (material consumption for the entire volume)
1	**2**	**3**	**4**
1	Concrete class		
2	Reinforcing mesh		
3	Frames		
4	Formwork panels		

3.8. Technical and economic performances

Technical and economic performances are compiled according to the calculation of labour contribution and the work schedule. The Technical and economic performances include:

- standard labour contribution of workers (man-hours) - based on the calculation results;

- standard costs of machine time (machine-hour) - based on the calculation results;

- wages of workers (UAH) - based on the calculation results;

- wages of machine operators (UAH) - based on the calculation results;

- duration of work - according to the schedule;

- production of one worker per shift, B_p

$$B_p = V/\sum T,$$

where: V– is the volume of concrete works, m^3

$\sum T$ – the total labor intensity in accordance with the final line of column 6 of the calculation (numerator), or column 4 of the graph;

- labour contribution per $1m^3$ of placed concrete, T_e

$$T_e = \sum T/V,$$

- the cost of machine time per 1m3 of placed concrete, $t_{маш}$

$$t_{маш} = \sum T_{маш}/V,$$

where: $\sum T_{маш}$ – machine time costs in accordance with the final line of column 6 of the calculation (denominator);

- cost of labour contribution 1m^3 of placed concrete C_e

$$C_e = C/V,$$

where: C – is the total labour contribution.

Technical and economic performances are summarized in Table 3.8.

Table 3.8

Technical and economic performances

№	Name of indicator	Unit of measurement	Quantity
1	**2**	**3**	**4**
1.	The duration of concrete, reinforcement and formworks.	days	
2.	Labor intensity of works for the entire volume.	man-days	
3.	Labor intensity of placing 1 m^3 of concrete.	man-days/m^3	
4.	Production of one worker per day.	m^3/day	
5.	The cost of placing 1m^3 of concrete.	UAH / m^3	
6.	Total cost of works.	UAH	

4. PRODUCTION OF CONCRETE WORKS

In this section, it is necessary to briefly list the name of the processes that must be performed during the production of concrete work in the technological sequence. When compiling this section, it is recommended to use lecture notes and references [16, 20, 22].

The technological process of erecting monolithic reinforced concrete foundations consists of performing interrelated works on the formwork setting with its subsequent dismantling, installation of reinforcement, reinforcing meshes and frames, placing the concrete mix and caring for the concrete during its hardening. In this case, the main leading process is the handling and placement of the concrete mix. All other types of work preceding the concreting of structures (formwork setting, placing of reinforcement, and delivery of concrete mix) are designed in such a way as to ensure the design rate of concreting in accordance with the productivity of concrete- placing mechanization equipment.

4.1. Technology of formworks

The type of formwork is determined by the features of the structure to be concreted and the methods of work. The optimal type of formwork is selected by a technical and economic comparison of options. Given the limited volume of the course project, it is allowed to reasonably choose the type of formwork according to design features from among the rational ones for concreting free-standing foundations:

A. Collapsible small-panel formwork. It consists of a set of elements weighing no more than 50 kg and an area of about 1 m^2, which allows workers to assemble and disassemble it manually (Fig. 4.1).

B. Metal unified formwork (ЦНИИОМТП), including panels 1000 ... 1800 mm long and 300 ... 600 mm wide, couplers, sliding crossbars, telescopic - racks, etc. When constructing formwork for stepped foundations, load-bearing beams with a mass of 180-320 kg are used, which requires the use of a crane. Mounting and dismantling of the formwork can be carried out of previously enlarged blocks (block-permutable variant).

C. Steel block forms, representing a spatial frame detachable or one-piece structure, mounted and dismantled by a crane (Fig. 4.2). Their use is effective when concreting more than 50 foundations of the same type.

When choosing a formwork, one should use the recommendations [11]; according to the existing dimensions of the foundations, calculate the amount of formworks. An example of the specification of formwork elements is given in Appendix Q, Table Q.1.

Calculations summarize in table. 4.1.

Table 4.1

Determining the scope of formworks

№	Foundation brand	Square of 1 shield, m^2	Number of shields per 1 foundation	Number of foundations	The total square of shields, with the square of one shield, m^2		
					Up to 1	Up to 2	Over 2
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**

a) b)

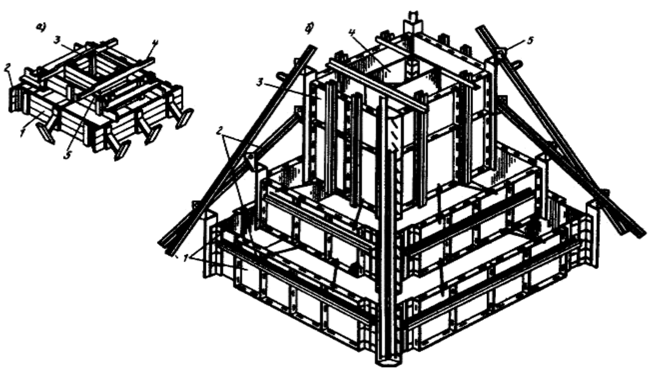


Fig. 4.1. Panel formwork for stepped glass-type foundations for columns:

a - of shields on jointed slats: 1 - embedded shield; 2- patch shield; 3- formwork - emptyformer; 4- support bar; 5- strand (twisting); b - of inventory shields: 1- corner formwork boards; 2- grapples; 3- upper step formwork; 4- glass former; 5- checkboxes.

4.2. Technology of reinforcing

Monolithic reinforced concrete foundations of socket type are reinforced as follows. Reinforcing meshes are placed in the steps of the foundations. The base of column (column pedestal) is reinforced with a frame. According to the source data (Appendix A and D) calculate the volume of reinforcing. Data summarize in Table. 4.2.

Reinforcement of the foundations of the expansion joint is conditionally accepted: 2 frames with a total mass of 1,6 times more and the number of meshes is 1,5 times more than that of ordinary foundations.

For example, when reinforcing an ordinary foundation for columns of medium rows of the ФА-26 brand with four meshes weighing 18 kg each and one frame weighing 58 kg. Reinforcement of the foundation of the expansion joint of the same series of brand ФА-26т: 4 × 1,5 = 6 reinforcing meshes weighing 18 kg each and two frames weighing (58 × 1,6): 2 = 46,4 kg.

Table 4.2

Consumption of concrete and reinforcement during the construction of foundations

<table>
<tr><td rowspan="3">Found. brand</td><td rowspan="3">Number of found.</td><td colspan="3">Volume, m^3</td><td colspan="2">Concrete consumption, m^3</td><td colspan="7">Reinforcement consumption</td></tr>
<tr><td rowspan="2">recess in found. for column</td><td rowspan="2">one found.</td><td rowspan="2">Total</td><td rowspan="2">For 1 found.</td><td rowspan="2">Total</td><td colspan="2">meshes of steps</td><td colspan="2">A frame of the column base (pedestal) of the foundation</td><td colspan="3">Total meshes and frames, pcs. (from units of mass to, kg)</td></tr>
<tr><td>mass, kg</td><td>Quant.</td><td>mass, kg</td><td>Quant.</td><td>20</td><td>50</td><td>100</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td></tr>
</table>

4.3. Technology of concrete works

With centralized preparation, the concrete mix is delivered to the place of placing mainly by concrete trucks and concrete mixer trucks.

The concrete mix delivered to the facility by road transport is delivered to the place of placing by one of the following methods: self-propelled jib cranes in buckets; vibration chutes; belt conveyors (transporters); concrete pumps (pipeline method); self-propelled concrete placers, etc.

Currently, the most common methods of handling concrete mix to the structure are crane handling of concrete mix and handling of the mix by concrete pumps.

When choosing methods for handling concrete mix, one should proceed from the following recommendations:

Crane handling of concrete in buckets (Fig. 4.2) is used when concreting most monolithic structures of the above and below ground parts of one-story and multi-story buildings using cranes to install heavy reinforcing frames and meshes, formwork forms and loading and unloading works. It is expedient to use this method of concrete mix handling at an average work intensity of 30 ... 35 m^3 per shift.

The concrete mix delivered by road transport is unloaded into rotary buckets with a capacity of 0,5 ... 2,0 m^3 (Appendix P, Table 4), installed on plank boards in the area of the crane. The number of buckets is chosen so that their capacity is a multiple of the capacity of the concrete truck body.

Concrete pumps are used when handling concrete mix to all types of structures, with a concreting intensity of at least 40 m^3 per shift, as well as in cramped conditions and in places inaccessible to other means of mechanization. Distance of concrete handling up to 400 m horizontally and up to 50 m vertically. Concrete pumps with a capacity of 40 m^3/h and more are used for concreting massive low-reinforced foundations with a total volume of concrete up to 10 thousand m^3.

Concrete pumps are pumped concrete mixes of plastic (SK=5...8 cm) and cast consistency (SK=12...20 cm) with the largest aggregate size within 20...60 mm.

The normative shift productivity of concrete pumps ($П_б$) is calculated by formula 1:

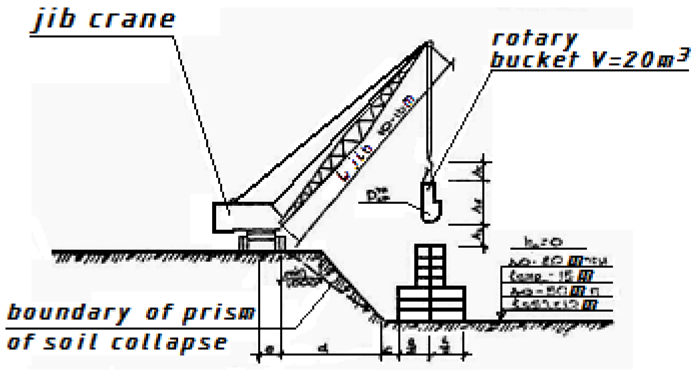
$$П_б = \frac{100 * t_{CM}}{H_{BP}} \ (m^3/cm) \qquad (1)$$

where: t_{CM} – is the duration of the work shift, h;

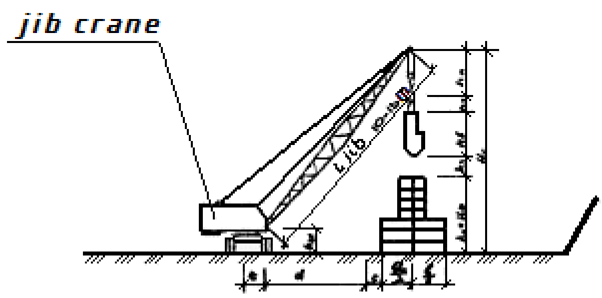
H_{BP} – is the norm of machine time (machine hours) for the handling of 100 m^3 of concrete mix into the structure by a concrete pump according to ЕНиР 4-1-36, Table 7.

Technical characteristics of concrete pumps are given in Appendix P, Table P.3.

Concreting scheme – see Appendix L, Fig. L.2.



a) Scheme of concreting when placing a crane on the edge of the pit (trench)



b) Scheme of concreting when placing a crane at the bottom of the pit

Fig. 4.2. Schemes of concreting with a crane.

The calculation of the volume of foundations (V_{Φ}, m^3) of all grades given in the assignment, as well as the foundations of expansion joints, is determined by external geometric dimensions and is given in tabular form (Table 4.3.) According to formula 2:

$$V_{\Phi} = (abh + a_1b_1h_1 + a_2b_2h_2 + \dots a_nb_nh_n) \qquad (2)$$

where: $(aa_1 \dots a_n)$ – foundation steps length, m;

$(b\, b_1 ... b_n)$ – foundation steps width, m;

$(h h_1 ... h_n)$ – foundation steps height, m;

Table 4.3

Volumes of monolithic reinforced concrete foundations

Foundation brand	The formula for calculating the volume of the foundation	The volume of one foundation, m^3	Quantity, PCS.	The total volume of foundations with the volume of each, m^3			
				up to $3m^3$	up to $5m^3$	up to $10m^3$	≥ $10m^3$
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**

Vibration chute. A relatively simple method is considered to be the method of placing a concrete mix into a structure using a vibratory feeder and vibration chutes (Fig. 4.3). In this way, it is advisable to concrete structures located below ground level (in trenches and pits).

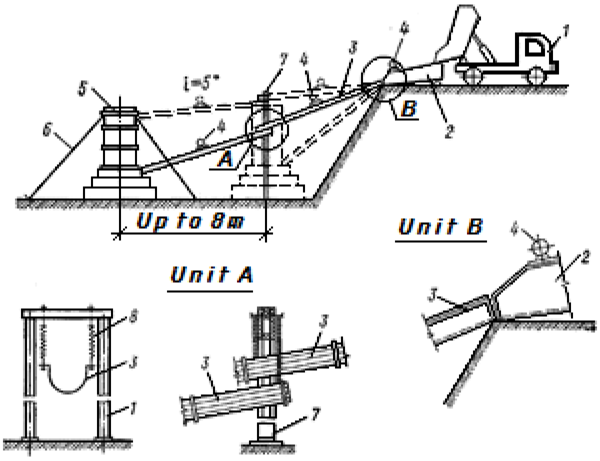


Fig. 4.3. Concrete handling through vibrating chutes:

1 – concrete truck; 2 – vibrating feeder; 3 – vibration chute (tray); 4 – vibrator; 5 – formwork; 6 – guyline; 7 – rack; 8 – spring suspension.

From the vehicle that delivered the concrete mix, it is unloaded into a vibrating feeder, which is a welded box, triangular in plan, equipped with a vibrator. The vibratory feeder is installed so that its bottom is inclined by 5–10° towards the concreted structure. The output opening of the vibrating feeder is equipped with a sector gate.

Vibrating chutes 4 and 6 m long are attached to the exit opening. The chutes are attached to inventory racks on spring suspensions. The angle of inclination of the vibration chutes to the horizon is 5–30°. With the help of vibration chutes, mixes with a sedimentation of a cone from 4 to 12 cm are placed.

Rigid mixes move poorly along vibrating chutes: cast mixes can be transported along vibration chutes with small slopes (5–10°). With large slopes, the concrete mix splashes out through the sides of the vibrating chutes. The rate of placing with the help of vibration chutes depends on the angle of their inclination and the sedimentation of a cone of the concrete mix. It ranges from 10 to 30 m^3/h.

4.4. Formation of a set of machines for the production of concrete works

The choice of the optimal variant of mechanization of work on the handling and placing of the concrete mix is carried out in two stages. At the first stage, depending on the volume of structures to be concreted, their location in the plan, the distance of handling of the concrete mix, the rate of concreting and the properties of the concrete mix, two or three technically possible options are determined.

With centralized preparation of the concrete mix, its delivery to the place of placing is carried out mainly by concrete trucks and concrete mixer trucks (Fig. 4.4).

Concrete truck

Concrete mixer truck

Fig. 4.4. Mechanisms for transporting concrete mix.

Concrete trucks are the most advanced mode of transport for transporting concrete mix. They have a special tipping body with a deep streamlined shape, mounted on a truck chassis. This shape of the body prevents the mix from splashing and the leakage of cement milk during movement. At the moment of overturning, the bottom takes up a vertical position, due to which the concrete mix is completely unloaded without the use of manual labor.

Concrete mixer trucks represent a group of special machines designed for transporting dry and ready-mixed concrete in a mixing drum. The range of transportation of dry mix and components is not technologically limited. Mixing them with water begins on the way in such a way that the mix is ready by the time it is delivered to the facility. When transporting ready-mixed concrete, the permissible distance is limited to 45 ... 100 km, depending on the mobility of the concrete mix.

Technical characteristics of vehicles are given in Appendix P of Table 1, and the possible maximum distances for transporting the concrete mix, depending on its mobility and type of road surface in Table 4.4.

Table 4.4

Maximum distances for transporting concrete mix at air temperature +20..+30°C, km

Type of road surface	Transportation speed, km/h	Mobility of concrete mix, cm	Transportation distance, km		
			Concrete mixer trucks in mode		Concrete truck
			A	B	
1	**2**	**3**	**4**	**5**	**6**
Rigid (asphalt, asbestos concrete, etc.)	30	1…3 4…6 7…9 10…16	not limited	up to 100 up to 80 up to 60 up to 45	up to 45 up to 30 up to 20 up to 15
Soft (ground, improved)	15	1…3 4….6 7….9 10…16	application is not recommended		up to 12 up to 8 up to 6 up to 4

Note: Mode A provides for turning on the drum 10...20 minutes before unloading. Mode B – periodic inclusion of the drum during transportation.

When choosing a self-propelled jib crane for concrete handling, installation of reinforcement and formwork, the required operating parameters of the crane are determined:

1. Load capacity P_{KP}^{TP}, t – is calculated by formula 3:

$$P_{KP}^{TP} = (P + P_T)n_H \qquad (3)$$

where:

P – maximum weight of the lifted load (concrete mix, formwork or reinforcement), t;

P_T – weight of the bucket without concrete, t; (Appendix P, Table 4);

$n_н$ – coefficient taking into account the mass of load-grappling devices and the deviation of the mass of the lifted loads from their nominal value ($n_н$ =1,08...1,10).

2. Hook lifting height H_{KP}^{TP}, m (Fig. 4.2 a, b) is calculated by formula 4:

$$H_{KP}^{TP} = h_o + h_з + h_б + h_c \qquad (4)$$

where:

h_o – height to which it is necessary to lift the load, m;

$h_з$ – reserve of height under the lower surface of the lifted load above the highest obstacle, m ($h_з$ is assumed to be at least 0,5 m);

$h_б$ – maximum height of the lifted load, m (concrete bucket, reinforcing frame, formwork element or block form);

h_c – calculated height of slings, m (h_c = 2...3 m).

3. Minimum hook reach required L_{KP}^{TP}, m.

a) when concreting structures of the underground part from the edge of the pit (Fig. 4.2 a) is determined by the formula 5:

$$L_{KP}^{TP} = \frac{в}{2} + c + d + e \qquad (5)$$

where:

в – foundation width, m;

c – distance from the structure to be concreted to the base of the slope, m (c = 0,3...0,5 m);

d – minimum horizontal distance from the base of the excavation slope to the nearest crane support (Table 4.5.);

e – the distance from the crane support to its axis is taken:

- for caterpillar and truck cranes – 2 m,

- for pneumatic wheel cranes – 2,5 m.

Table 4.5

Minimum horizontal distances from the base of the excavation slope to the nearest crane support «d», m

Soil	Distance value d, m at excavation depth up to, m				
	1	2	3	4	5
Sandy	1,5	3,0	4,0	5,0	6,0
Sandy loam	1,25	2,4	3,6	4,4	5,3
Loamy	1,0	2,0	3,25	4,0	4,75
Clay	1,0	1,5	1,75	3,0	3,50

b) when concreting the structure of the underground part from the bottom of the pit (Fig. 4.2 b), the minimum required hook reach is calculated by formula 6:

$$L_{KP}^{TP} = \frac{(H_C - h_ш)(A + K)}{(H_C - h_Ф)} + l_Ш; \qquad (6)$$

$$H_c = h_ф + h_з + h_б + h_C + h_П;$$

where:

H_c – distance from the crane parking level to the boom, m;

$h_ш$ – distance from the crane parking level to the hinge of the attached boom, m (assumed 1,5 m);

A – distance from the crane of the size of the structure being erected to the place of delivery of the load, m;

$l_ш$ – distance from the hinge of attachment of the crane boom to the axis of rotation of the crane, m (assumed 1,5 m);

$h_ф$ – concrete foundation height, m ($h_ф = H_ф$);

$h_и$ – pulley block height in the extended state, m ($h_и$=*2...2,5m*).

According to the required operating parameters found ($P_{KP}^{TP}, H_{KP}^{TP}, L_{KP}^{TP}$), using the data of Appendix P, Table. P.2, as well as reference literature, select jib cranes whose technical characteristics (lifting capacity, hook height and hook reach) would not be less than required.

Normative shift productivity of jib cranes ($П_к$) is determined by formula 7:

$$П_K = \frac{t_{CM}}{H_{BP}}; (m^3/cm) \qquad (7)$$

where:

$t_{см}$ – duration of the work shift, h ($t_{см}$ =8,2h);

$Н_{вр}$ – norm of machine time of a jib crane, for the handling of 1 ton of concrete mix according to ЕНиР, collection 24 §24-13,

$γ_б$ – average density of concrete mix, t/m^3 ($γ_б$ = 2,4 t/m^3).

Appendix A

Table A.1

Variants of assignments for earthworks during the construction of monolithic reinforced concrete foundations of frame buildings

№ of the variant	Planning decision of the building					Brands of foundations for columns (conditional)			Concrete class, B	Sedimentation of a standard cone, cm	Maximum aggregate size, mm	Speed of mixing of concrete mix, s	Distance from the concrete plant, km	Type of road coating	Soil on site
	Span, m	Number of spans	Column spacing, m	Section length, m	Number of sections	Outer rows	Middle rows	End half-timbered (end fachwerk)							
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1	12	6	6	60	2	ФА-2	ФА-6	ФА-2	15	12	40	45	10	H	Sand
2	12	5	6	72	2	ФА-9	ФА-13	ФА-9	12,5	6	60	60	3	S	Sandy loam
3	12	4	6	60	3	ФА-3	ФА-7	ФА-3	12,5	10	80	90	5	S	Loam
4	18	4	6	72	2	ФА-10	ФА-14	ФА-10	15	8	40	60	15	H	Clay
5	18	3	12	72	3	ФА-12	ФА-16	ФА-12	15	12	30	45	10	H	Loam
6	18	5	12	60	3	ФА-17	ФА-21	ФА-17	12,5	7	70	120	4	S	Sandy loam
7	18	4	6	72	3	ФА-27	ФА-31	ФА-9	15	5	40	60	2	S	Clay
8	24	4	6	60	2	ФА-39	ФА-41	ФА-14	15	8	20	45	6	H	Sand
9	24	3	12	72	2	ФБ-14	ФБ-17	ФБ-6	12,5	10	60	90	20	H	Loam
10	24	4	12	60	3	ФА-42	ФА-44	ФА-18	12,5	8	70	150	8	S	Clay
11	24	3	12	72	3	ФБ-16	ФБ-18	ФБ-6	15	13	50	60	12	S	Sand
12	18	4	12	60	3	ФБ-12	ФБ-14	ФА-17	15	6	40	45	25	H	Clay
13	18	4	12	72	2	ФБ-26	ФБ-29	ФБ-2	15	5	50	60	35	H	Sand
14	24	3	12	72	3	ФБ-32	ФБ-33	ФБ-3	15	10	80	180	40	H	Clay
15	18	4	12	60	3	ФВ-1	ФВ-3	ФВ-9	15	12	40	45	4	S	Sandy loam
16	18	3	12	72	2	ФВ-2	ФВ-5	ФБ-27	12,5	5	60	90	12	H	Loam
17	24	4	12	72	2	ФВ-7	ФВ-10	ФБ-23	12,5	10	30	45	35	H	Clay
18	24	3	12	60	3	ФВ-8	ФВ-11	ФБ-22	12,5	5	70	150	20	H	Sandy loam
19	24	5	12	60	2	ФВ-12	ФВ-15	ФБ-19	15	14	60	120	6	S	Sand

Continuation of table A.1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
20	18	5	12	60	2	ФВ-18	ФВ-19	ФБ-20	15	6	40	60	10	H	Clay
21	18	4	6	60	3	ФА-25	ФА-29	ФА-15	15	8	50	90	8	H	Sandy loam
22	18	3	6	72	2	ФА-34	ФА-36	ФА-22	15	10	80	240	20	H	Loam
23	24	4	6	60	2	ФБ-24	ФБ-30	ФА-11	12,5	8	60	90	7	H	Clay
24	18	5	12	60	2	ФБ-7	ФБ-13	ФБ-3	12,5	12	40	45	16	H	Sand
25	18	4	12	72	2	ФБ-28	ФБ-31	ФБ-8	12,5	8	50	60	5	S	Sandy loam
26	24	5	12	60	2	ФВ-4	ФВ-13	ФА-28	15	6	70	150	40	H	Loam
27	24	3	12	60	3	ФА-20	ФА-34	ФА-8	15	4	50	60	15	H	Loam
28	24	4	12	72	2	ФА-40	ФА-45	ФА-26	12,5	10	80	240	12	H	Sandy loam
29	9	8	6	60	3	ФА-1	ФА-5	-	12,5	4	40	45	4	S	Sand
30	12	6	6	72	2	ФА-15	ФА-23	-	15	12	70	120	45	H	Clay
31	9	7	6	60	3	ФБ-1	ФБ-8	-	15	10	60	90	2	S	Loam
32	9	4	6	72	3	ФБ-4	ФБ-11	-	15	10	30	45	15	H	Sand
33	9	6	6	60	2	ФБ-9	ФБ-15	-	12,5	8	40	60	30	H	Clay
34	9	8	6	72	2	ФА-4	ФА-24	-	12,5	13	25	45	3	S	Loam
35	12	5	6	72	2	ФА-19	ФА-32	ФА-3	12,5	8	60	90	25	H	Sandy loam
36	12	6	6	60	3	ФА-23	ФА-35	ФА-7	15	7	40	45	4	S	Clay
37	24	3	12	72	3	ФБ-10	ФБ-21	ФА-11	12,5	14	80	180	8	H	Sand
38	30	3	12	60	3	ФВ-17	ФВ-20	ФА-5	12,5	6	60	90	5	S	Loam
39	30	4	12	60	3	ФВ-9	ФВ-16	ФА-5	15	10	30	45	10	S	Sandy loam
40	30	3	12	60	3	ФВ-6	ФВ-14	ФА-16	15	8	30	45	10	H	Clay

Note:

1. The main dimensions of the foundations of the respective grades are given in Appendix D.
2. The foundations are taken with a top elevation mark of 0,15 m.
3. The step of the columns of the end fachwerk is taken 6 m.
4. In the places where the sections are joined, paired columns of an expansion joint are installed, under which a common foundation is installed. Its overall dimensions are determined by adding 1 m to the width (size b) of the corresponding foundations of the middle and outer rows.

Appendix B

The example of a marking plan for foundations

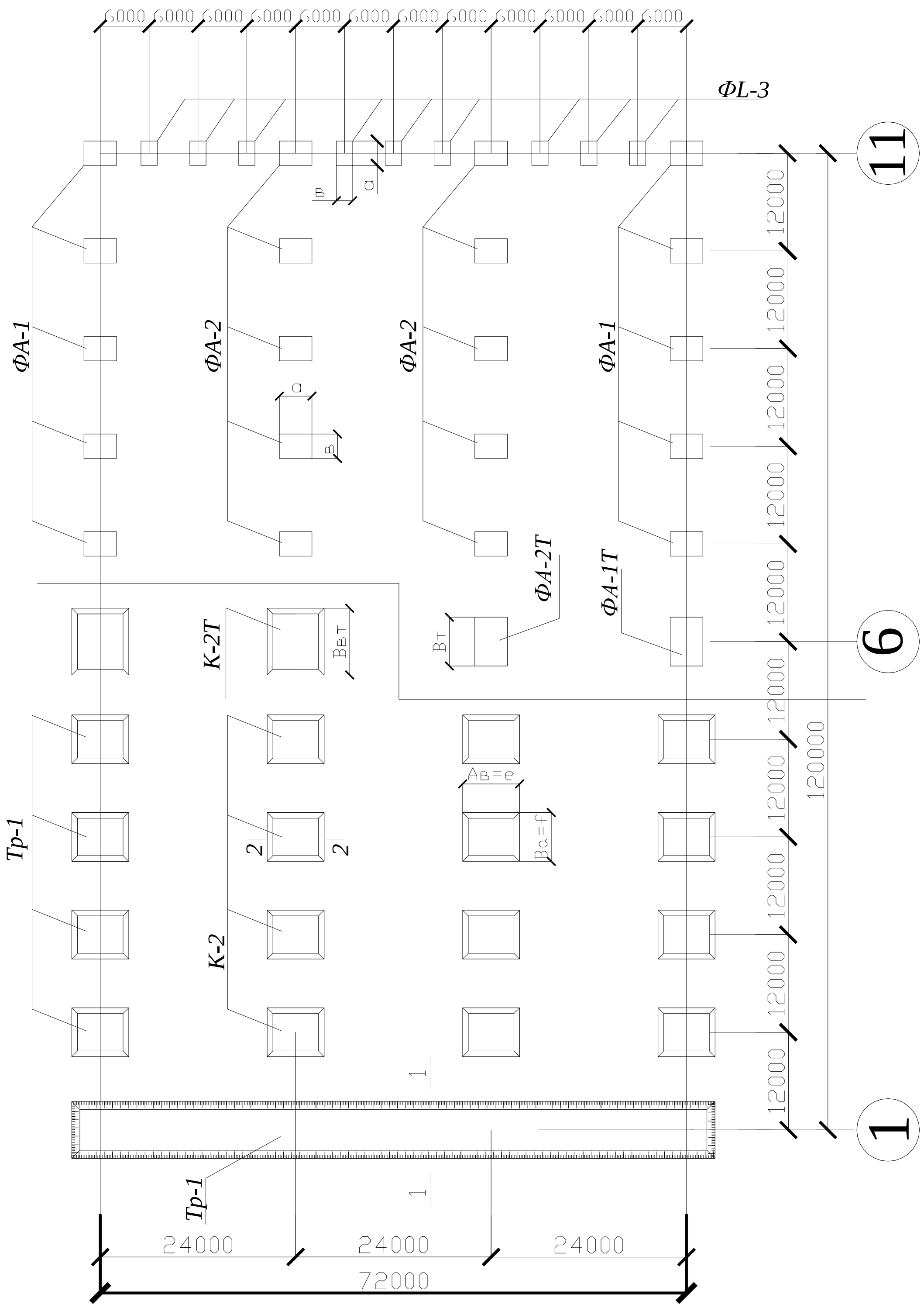
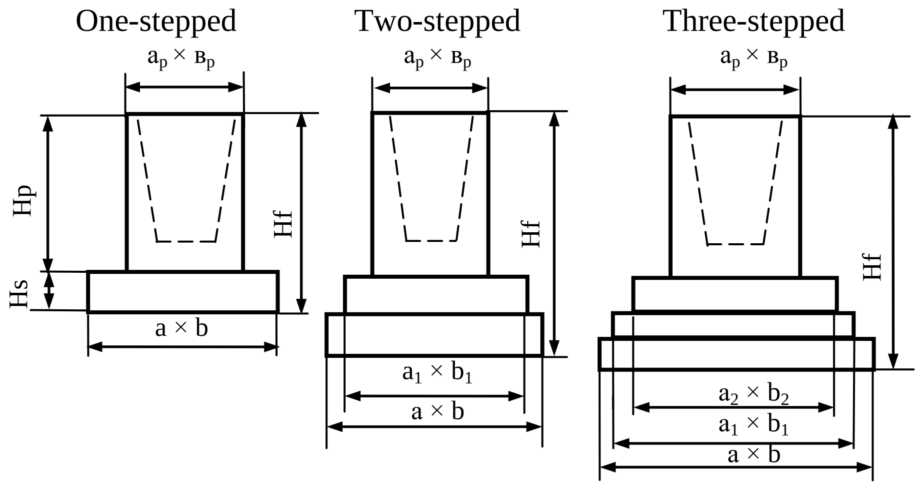


Fig. B.1. Foundation marking plan.

Appendix C

Sketches of monolithic reinforced concrete foundations



One-stepped:

V_{sp}=0,16 m^3
ФА-1 - ФА-8
Hs=300 mm;
ФА-9 - ФА-16
Hs=450 mm.
V_{sp}=0,31 m^3
ФБ-1 - ФБ-11
Hs=450 mm.

Two-stepped:

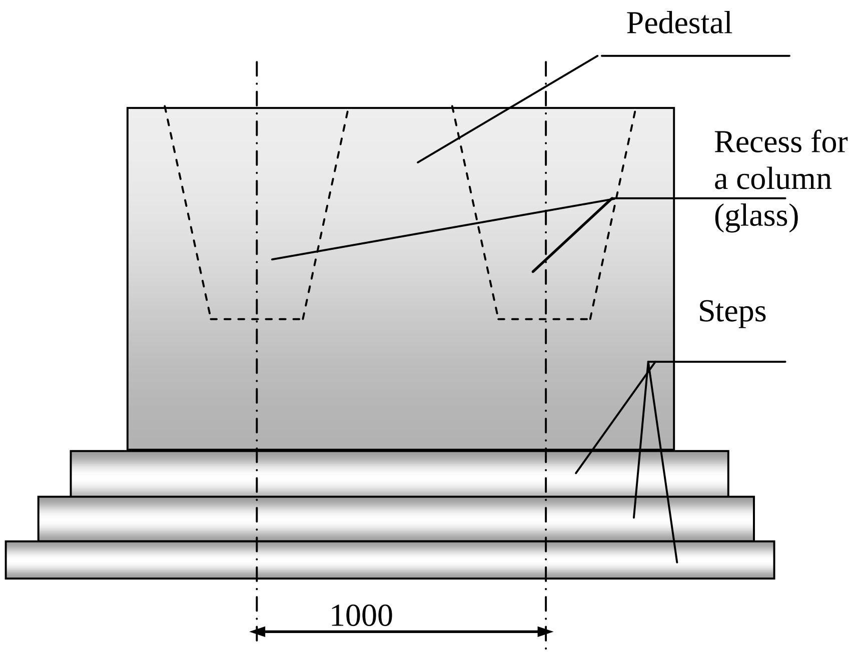
V_{sp}=0,22 m^3
ФА-17 - ФА-36
Hs=300 mm;
V_{sp}=0,34 m^3
ФБ-12 – ФБ-24
Hs=300 mm.
V_{sp}=0,44 m^3
ФВ-1 – ФВ-15
Hs=300 mm.

Three-stepped:

V_{sp}=0,25 m^3
ФА-37 - ФА-45
Hs=300 mm;
ФА-44 - ФА-45
Hs(upper)=450 mm.
V_{sp}=0,36 m^3
ФБ-25 – ФБ-33
Hs=300 mm.
V_{sp}=0,52 m^3
ФВ-16 – ФВ-20
Hs=300 mm.

Expansion joint foundation block

The dimensions of the foundation blocks of expansion joints should be taken: b+1 m, respectively b_1 and b_2 +1 meter.



Appendix D

Table D.1

Dimensions of monolithic reinforced concrete foundations

<table>
<tr><th rowspan="3">Foundation brand</th><th rowspan="3">Concrete consumption, m^3</th><th colspan="5">Foundation dimensions, mm</th><th colspan="2">Reinforcing mesh of a sole</th><th rowspan="3">Reinforcing cage weight, kg</th></tr>
<tr><th rowspan="2">Height, Hf</th><th rowspan="2">Step length, a</th><th rowspan="2">Step length, a_1 (a_2)</th><th rowspan="2">Step width, b</th><th rowspan="2">Step width, b_1 (b_2)</th><th rowspan="2">number</th><th rowspan="2">mesh weight, kg</th></tr>
<tr></tr>
<tr><td>**1**</td><td>**2**</td><td>**3**</td><td>**4**</td><td>**5**</td><td>**6**</td><td>**7**</td><td>**8**</td><td>**9**</td><td>**10**</td></tr>
<tr><td>ФА-1</td><td>1,4</td><td>1500</td><td rowspan="4">1500</td><td rowspan="4">-</td><td rowspan="4">1500</td><td rowspan="4">-</td><td>2</td><td>9</td><td>38</td></tr>
<tr><td>ФА-2</td><td>1,7</td><td>1800</td><td>2</td><td>12</td><td>36</td></tr>
<tr><td>ФА-3</td><td>2,2</td><td>2400</td><td>2</td><td>21</td><td>42</td></tr>
<tr><td>ФА-4</td><td>2,7</td><td>3000</td><td>2</td><td>27</td><td>43</td></tr>
<tr><td>ФА-5</td><td>1,6</td><td>1500</td><td rowspan="4">1800</td><td rowspan="4">-</td><td rowspan="4">1500</td><td rowspan="4">-</td><td>2</td><td>15</td><td>36</td></tr>
<tr><td>ФА-6</td><td>1,8</td><td>1800</td><td>2</td><td>20</td><td>40</td></tr>
<tr><td>ФА-7</td><td>2,3</td><td>2400</td><td>2</td><td>25</td><td>45</td></tr>
<tr><td>ФА-8</td><td>2,8</td><td>3000</td><td>2</td><td>30</td><td>49</td></tr>
<tr><td>ФА-9</td><td>1,8</td><td>1500</td><td rowspan="4">1800</td><td rowspan="4">-</td><td rowspan="4">1500</td><td rowspan="4">-</td><td>2</td><td>12</td><td>41</td></tr>
<tr><td>ФА-10</td><td>2,1</td><td>1800</td><td>2</td><td>21</td><td>36</td></tr>
<tr><td>ФА-11</td><td>2,6</td><td>2400</td><td>2</td><td>27</td><td>47</td></tr>
<tr><td>ФА-12</td><td>3,1</td><td>3000</td><td>2</td><td>25</td><td>50</td></tr>
<tr><td>ФА-13</td><td>2,1</td><td>1500</td><td rowspan="4">2100</td><td rowspan="4">-</td><td rowspan="4">1500</td><td rowspan="4">-</td><td>2</td><td>29</td><td>40</td></tr>
<tr><td>ФА-14</td><td>2,3</td><td>1800</td><td>2</td><td>23</td><td>41</td></tr>
<tr><td>ФА-15</td><td>2,8</td><td>2400</td><td>2</td><td>31</td><td>42</td></tr>
<tr><td>ФА-16</td><td>3,3</td><td>3000</td><td>2</td><td>29</td><td>43</td></tr>
<tr><td>ФА-17</td><td>2,4</td><td>1500</td><td rowspan="9">2400</td><td rowspan="11">1800</td><td rowspan="5">1500</td><td rowspan="5">1500</td><td>2</td><td>14</td><td>45</td></tr>
<tr><td>ФА-18</td><td>2,6</td><td>1800</td><td>2</td><td>26</td><td>52</td></tr>
<tr><td>ФА-19</td><td>3,1</td><td>2400</td><td>2</td><td>33</td><td>39</td></tr>
<tr><td>ФА-20</td><td>3,6</td><td>3000</td><td>2</td><td>42</td><td>58</td></tr>
<tr><td>ФА-21</td><td>2,8</td><td>1500</td><td>4</td><td>8</td><td>60</td></tr>
<tr><td>ФА-22</td><td>3,0</td><td>1800</td><td rowspan="8">1800</td><td rowspan="8">1800</td><td>4</td><td>9</td><td>62</td></tr>
<tr><td>ФА-23</td><td>3,5</td><td>2400</td><td>4</td><td>10</td><td>64</td></tr>
<tr><td>ФА-24</td><td>4,0</td><td>3000</td><td>4</td><td>11</td><td>66</td></tr>
<tr><td>ФА-25</td><td>3,7</td><td>2400</td><td>4</td><td>19</td><td>70</td></tr>
<tr><td>ФА-26</td><td>4,2</td><td>3000</td><td rowspan="2">2700</td><td>4</td><td>18</td><td>53</td></tr>
<tr><td>ФА-27</td><td>3,3</td><td>1500</td><td>4</td><td>17</td><td>80</td></tr>
<tr><td>ФА-28</td><td>3,5</td><td>1800</td><td rowspan="8">3000</td><td rowspan="8">2100</td><td>4</td><td>12</td><td>75</td></tr>
<tr><td>ФА-29</td><td>4,0</td><td>2400</td><td>4</td><td>21</td><td>67</td></tr>
<tr><td>ФА-30</td><td>4,5</td><td>3000</td><td rowspan="6">2100</td><td rowspan="6">1500</td><td>4</td><td>28</td><td>72</td></tr>
<tr><td>ФА-31</td><td>3,4</td><td>1500</td><td>2</td><td>23</td><td>48</td></tr>
<tr><td>ФА-32</td><td>4,1</td><td>2400</td><td>2</td><td>30</td><td>56</td></tr>
<tr><td>ФА-33</td><td>4,6</td><td>3000</td><td>2</td><td>47</td><td>62</td></tr>
<tr><td>ФА-34</td><td>3,9</td><td>1800</td><td>4</td><td>26</td><td>60</td></tr>
<tr><td>ФА-35</td><td>4,3</td><td>2400</td><td>4</td><td>38</td><td>64</td></tr>
<tr><td>ФА-36</td><td>5,5</td><td>1800</td><td>3300</td><td>2100</td><td>2400</td><td>1500</td><td>4</td><td>42</td><td>70</td></tr>
</table>

Continuation of the table D.1

1	2	3	4	5	6	7	8	9	10
ФА-37	5,5	2400	3300	2400 (1500)	2400	1800 (1800)	4	39 41	44
ФА-38	6,0	2400	3600	2700 (1800)			4	50	49
ФА-39	5,9	1800			2700	2100 (1500)	4	62	50
ФА-40	6,9	3000					4	70	54
ФА-41	6,7	1800	4200	3000 (2100)			4	93	60
ФА-42	7,1	1800			3000		4	87	66
ФА-43	7,6	2400					4	76	70
ФА-44	8,6	1800	4800	3600 (2400)			4	11	72
ФА-45	9,6	3000					4	37	69
ФБ-1	2,6	1500	2100	-	1500	-	2	8	45
ФБ-2	3,0	1800					2	12	50
ФБ-3	3,9	2400					2	14	56
ФБ-4	4,7	3000					2	14	61
ФБ-5	2,8	1500	2400	-	1500	-	2	26	62
ФБ-6	3,2	1800					2	33	72
ФБ-7	4,1	2400					2	42	79
ФБ-8	3,1	1500	2400	-	1800	-	4	11	86
ФБ-9	3,5	1800					4	12	80
ФБ-10	4,4	2400					4	15	77
ФБ-11	5,3	3000					4	18	82
ФБ-12	3,5	1500	2700	2100	1800	1800	4	15	60
ФБ-13	4,8	2400	3000	2400			4	18	62
ФБ-14	3,9	1500					4	15	64
ФБ-15	4,3	1800			2100	2100	4	20	66
ФБ-16	5,1	2400					4	25	58
ФБ-17	4,3	1500			2400	1800	4	30	68
ФБ-18	5,6	2400					4	40	70
ФБ-19	4,4	1500	3300				4	33	71
ФБ-20	4,8	1800	3600	2700			4	42	76
ФБ-21	5,7	2400			2700	2100	4	51	80
ФБ-22	5,9	2400					4	47	83
ФБ-23	5,4	1800					4	40	79
ФБ-24	6,9	2400					4	46	66
ФБ-25	5,3	1500	3300	2700 (1800)	2400	1800 (1800)	4	49	70
ФБ-26	5,7	1800					4	51	65
ФБ-27	6,6	2400	3600				4	61	75
ФБ-28	5,5	1500					4	62	79
ФБ-29	6,0	1800			2700	2100 (2100)	4	75	81
ФБ-30	7,6	2400					4	79	90
ФБ-31	7,5	1500	4200	3300 (2400)			4	93	91
ФБ-32	10,4	2400					4	91	86
ФБ-33	10,6	2400	4800	3600 (2700)	3000 (3300)	2400 (1800)	4	99	96

Continuation of the table D.1

1	2	3	4	5	6	7	8	9	10
ФВ-1	4,0	1500	3000	2400	1800	1800	4	21	58
ФВ-2	5,6	2400					4	28	70
ФВ-3	4,5	1500			2100	2100	4	26	80
ФВ-4	5,0	1800					4	30	75
ФВ-5	6,1	2400					4	47	67
ФВ-6	7,2	3000			2400	1800	4	50	72
ФВ-7	5,1	1800					4	42	84
ФВ-8	3,2	2400					4	48	80
ФВ-9	4,9	1500					4	54	76
ФВ-10	5,5	1800	3300	2700			4	61	67
ФВ-11	6,6	2400					4	66	81
ФВ-12	5,2	1500					4	67	71
ФВ-13	5,7	1800	3600				4	70	64
ФВ-14	7,9	3000			2700	2100	4	69	59
ФВ-15	5,7	1500					4	75	66
ФВ-16	5,8	1500	3600	2700 (2100)	2400	1800 (1800)	4	81	71
ФВ-17	6,3	1800		3300 (2400)	2700	2100 (1800)	4	86	84
ФВ-18	8,1	1800					4	95	70
ФВ-19	8,6	1800					4	93	89
ФВ-20	9,5	1800	4800	3600 (2700)		2400 (1800)	4	101	85

Table D.2

Dimensions of pedestals and recesses for columns (glasses)

Foundation brand	Dimensions of pedestals, mm	Dimensions of recesses for columns (glasses), mm		
		a_g	b_g	H_g
1	**2**	**3**	**4**	**5**
ФА-1 – ФА-45	900x900	550	450	800
ФБ-1 – ФБ-33	1200x1200	700	600	900
ФВ-1 – ФВ-20	1500x1200	900	600	900

Note:

The width of the foundation blocks of expansion joints is taken: b +1 m, respectively b_1 and b_2 +1 meter.

The number of recesses for columns (glasses) in the foundation blocks of the expansion joint is 2.

Appendix E

Table E.1

Characteristics of single-bucket excavators [15]

Excavator brand	Bucket capacity q, m^3	Soil group	Digging depth H, m	Digging radius $R_л$ m	$r_ш$, m	h_m, m	l_0, m	l_n, m	L_n, m
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ЭО-2621	0,25	1-3	4,15	5,3	0	1,3	1,22	1	1,1
ЭО-3122	0,4	1-4	5,2	8,2	0,36	1,71	2,25	1,1	1,3
ЭО-3122	0,5	1-4	4,7	7,6	0,36	1,71	1,42	1	1,3
ЭО-3122	0,5	1-3	5,2	8,2	0,36	1,71	2,25	1,1	1,3
ЭО-3122	0,63	1-3	4,8	7,8	0,36	1,71	1,42	1	1,4
ЭО-3122	0,8	1-2	4,8	7,8	0,36	1,71	1,42	1,1	1,4
ЭО-3221	0,4	1-4	5,8	8,8	0,45	1,7	2,5	1,15	1,3
ЭО-3221	0,4	1-2	8,4	11,6	0,45	1,7	2,5	1,12	1,3
ЭО-3221	0,63	1-4	4,8	7,9	0,45	1,7	2,15	1,15	1,3
ЭО-3221	0,8	1-2	4,8	7,2	0,45	1,7	2,5	1,15	1,4
ЭО-3322Д	0,5	1-4	4,3	7,5	0,45	1,7	1,4	1	1,3
ЭО-3322Д	0,2	1-4	4,3	7,5	0,45	1,7	1,4	1	1,3
ЭО-3322В	0,4	1-4	5	8,2	0,45	1,7	1,4	1	1,3
ЭО-3323	0,5	1-4	5,4	8,5	0,45	1,7	1,4	1	1,3
ЭО-3323	0,63	1-4	4,5	7,7	0,45	1,7	1,4	1	1,3
ЭО-3323	0,8	1-2	4,5	7,7	0,45	1,7	1,4	1	1,3
ЭО-4321А	0,5	1-4	6,7	10,6	0,52	2,05	1,45	1	1,3
ЭО-4321А	0,63	1-4	6	9,2	0,52	2,05	1,45	1	1,4
ЭО-4321А	1	1-3	5,6	8,9	0,52	2,05	1,45	1	1,55
ЭО-4321А	0,8	1-4	5,5	8,7	0,52	2,05	1,45	1	1,4
ЭО-4321А	1	1-2	4,6	7,3	0,52	2,05	1,45	1	1,55

Continuation of the table E.1

1	2	3	4	5	6	7	8	9	10
ЭО-4321 Б ЭО-4124	0,65	1-4	5,7	9,1	0,52	2,05	1,45	1	1,40
МТП-71	1,25	1-2	5,5	8,9	0,52	2,20	2,5	1,15	1,75
МТП-71	1	1-3	5,5	8,9	0,52	2,20	2,5	1,15	1,55
МТП-72	1,25	1-2	5,3	8,8	0,52	2,20	2,5	1,15	1,75
МТП-72	1	1-4	5,3	8,8	0,52	2,20	2,5	1,15	1,55
МТП-72	0,75	1-4	4,8	8,6	0,52	2,20	2,5	1,15	1,4
ЭО-5123	1,25 1,6	1-3 1-3	6,2	9,7	0,645	2,00	1,56	1,15	1,75 2,0
ЭО-5123	2	1-2	6,9	9,4	0,64	2,00	1,56	1,15	2,0
ЭО-5123	1,12	1-4	7,7	11,2	0,64	2,00	1,56	1,15	1,75
ЭО-6122А	1,6	1-4	7,2	11,5	0,77	2,43	1,8	1,15	2,0
ЭО-6122А	2,5	1-3	7,2	11,5	0,77	2,43	1,8	1,15	2,0
Уо1уо EC240B	0.96	1-4	6,5	10,3	0,20	1,60	2,35	1,40	1,50
EC360B	1,4	1-4	7,5	11,2	0,20	1,40	2,12	1,40	2,0
EC460B	1,8	1-4	8,3	12,1	0,40	1,50	2,68	1,50	2,0
Komatsu PC300-7	1,2	1-3	7,4	11,1	0,30	1,80	2,30	1,40	2,0
Komatsu PC 130-8	0,8	1-4	7,5	11,2	0,40	1,70	2,10	1,50	2,0
Mara1826	0,85	1-4	6,8	10,3	0,30	1,70	1,91	1,40	1,5
Mara1834	1,05	1-4	7,7	11,3	0,4	1,80	2,05	1,50	1,5

Table E.2

The duration of the working cycle of single-bucket excavators with equipment "backhoe" [15]

Excavator brand	Time, min
Э-302Б, Э-302БС	15
Э-303Б	15
Э-304В	15
Э-652Б, Э-652БС	20
Э-10011Д, ЭО-5111АС	23
Э-1251Б, Э-1252Б, Э-1252БС	25
ЭО-2621А	15
ЭО-3322; ЭО-3322А	16,5; 16
Э-5015А	16
ЭО-4321	16
ЭО-4123	16
ЭО-4121	18

Appendix F

Table F.1

Technical characteristics of dump trucks [15]

Brand	Carrying capacity, t	Overall dimensions			Body capacity, m^3	Turning radius, m	Loading height, m	Unloading duration with maneuvering $t_{р.м}$, min
		length, m	width, m	height, m				
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
ГАЗ-93А	2,55	5,24	2,10	2,13	1,65	8,10	1,58	0,8
ЗИЛ-555	5,25	5,55	2,40	2,32	3,10	7,80	2,00	1,2
ЗИЛ ММЗ-554М	5,7	7,70	2,50	2,40	6,0	8,00	2,15	2,0
МАЗ-5549	8,0	5,78	2,60	3,30	5,10	8,60	2,46	2,0
МАЗ-503Б	7,00	5,92	2,60	2,55	5,00	7,00	2,15	1,8
КамАЗ-55102	7,00	8,01	2,32	2,63	7,90	8,50	2,90	1,8
КамАЗ-5511	13,00	7,63	2,50	2,70	6,60	7,50	2,10	1,8
КРаЗ-256Б	12,00	8,10	2,64	2,83	6,50	11,20	2,64	1,8

Appendix G

Table G.1

Specifications of bulldozers

Brand: new	Brand: old	Basic Tractor	Power, kWt	Weight, t	Dump: length x height, m	Development depth, m	Dimensions: length× width× height, m	Productivity, m/h	The cost of a machine-shift, UAH
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ДЗ-4	Д-159Б	ДТ-54А	40		2,8x0,8	0,15	4,3x2,8x2,3	200	3,85
ДЗ-71	Д-740	Т-50АП	37	3,1	2,0x0,6	0,2	5,0x2,2x2,4	200	-
ДЗ-37	Д-579	МТЗ-52	41	3,8	2,0x0,7	0,15	6,2x2,3x3,3	200	3,85
ДЗ-29	Д-535	Т-74	55	6,6	2,6x0,8	0,3	4,8x2,5x2,5	280	4,31
ДЗ-42	Д-606	ДТ-75	59	7,3	2,6x0,8	0,3	4,8x2,6x2,7	300	4,61
ДЗ-128	-	ДТ-75	59	7,3	2,6x1,0	0,3	4,8x2,6x2,7	300	-
ДЗ-8	Д-271А	Т-100М	79	13,6	3,2x1,2	1,0	5,3x3,2x3,1	510	6,32
ДЗ-17	Д-492А	Т-100	79	14,0	3,9x1,0	0,5	5,5x3,2x3,1	570	5,82
ДЗ-18	Д-493А	Т-100М	79	13,6	3,9x1,0	0,5	5,5x3,2x3,1	570	5,82
ДЗ-19	Д-494а	Т-100М	79	13,6	3,0x1,3	0,4	5,1x3,2x3,1	570	6,60
-	Д-259	Т-100	79	14,0	4,2x1,1	0,5	5,5x3,2x3,1	570	6,60
ДЗ-53	Д-686	Т-100М	79	14,1	3,2x1,2	1,0	5,5x3,2x3,1	570	6,52
ДЗ-54С	Д-687	Т-100	79	13,7	3,2x1,2	0,4	5,5x3,2x3,1	570	7,26
ДЗ-9	Д-275А	Т-180	132	18,9	3,4x1,4	1,0	6,7x3,4x2,5	900	9,01
ДЗ-24А	Д-521	Т-180	132	18,2	3,4x1,1	1,0	7,0x4,4x2,8	900	37,73
ДЗ-25	Д-522	Т-180	132	17,9	4,4x1,2	0,5	7,0x4,4x2,8	960	42,56
ДЗ-35А	Д-575А	Т-180	132	17,1	3,6x1,3	0,5	6,6x3,9x2,8	960	37,85
-	Д-290	Т-180	132	18,5	4,6x1,3	0,5	8,2x3,4x2,8	1020	36,57
ДЗ-48	Д-661	К-702	155	18,2	3,6x1,2	0,6	7,5x3,6x3,5	1050	-
-	Д-384А	ДЭТ-250	221	31,8	4,5x1,4	0,3	6,9x4,5x3,2	1400	52,68
-	Д-385	ДЭТ-250	221	33,5	4,5x1,4	0,5	8,7x4,2x3,1	1400	52,96
ДЗ-34С	Д-572С	ДЭТ-250	221	31,4	4,5x1,6	0,4	6,9x3,8x3,2	1400	53,79

Appendix H

Table H.1

Specifications of soil consolidation machines

Brand		Machine characte-ristic	Basic Tractor	Power, kWt	Weight t	Depth of a consolida-ted layer, m	Width of a consolidated layer, m	Dimensions: length × width × height
new	old							
Tamping machines on the base of a bulldozer								
ДУ-12В	Д-471В	Hinged	Т-100М	79	6,5	1,2	2,5	5,0x2,5x 3,0
ДУ-12В	Д-471В	Hinged	Т-130	118	6,5	1,2	2,5	5,0x2,5x 3,0
ЦНИИС РМЗ	II	Self-propelled	Т-110М	79	18,8	1,2	2,8	7,7x3,2x 3,1
Vibrating plates								
	Д-604*			4,4	0,125	0,57	0,66	1,5x1,0x 1,0
-	Д-605*	-	-	4,4	0,125	0,83	1,0	1,5x1,0x 1,0
-	Д-639*	-	-	7,4	0,25	0,5	1,2	2,8x1,5x 1,5
-	Ц-368Б*	-	-	16,9	2,2	1,8	1,4	2,8x1,7x 1,5
С8Б-20*	-	-	-	2,6	0,23	0,3	0,35	1,6x0,4x 0,9
В8Б-31,5*	-	-	-	5,2	1,2	0,75	0,75	2,9x1,4x 1,4
8УР-12,5*	-	-	-	2,6	0,15	0,4	0,55	1,4x0,8x 0,9
8УР-25*	-	-		4,4	0,27	0,4	0,75	1,5x1,0x 1,0
УР-31,5/1*	-	-	-	5,2	0,5	0,6	1,0	2,4x1,1x 1,1
В8Б-63*	-	-	-	11	1,4	1,0	0,9	2,9x1,6x 1,5
8УР-63/1*	-	-	-	11	0,7	0,6	2,0	2,5x1,3x 1,4

Continuation of the appendix H

Table H.2

Vibration-proof pneumatic rammers

The name of indicators	ПТ-6	ПТ-9	ПТ-4503
Impact energy, J	4,0	20	25
Impact frequency, Hz (not less than)	14	10	12
Compressed air pressure, MPa (kg/cm^2)	0,63 (6)	0,63 (6)	0,63 (6)
Specific air consumption, m^3/min, no more	0,78	0,90	1,1
Rammer shoe diameter, mm	40	60	70
Piston stroke, mm	100	120	120
Weight without shoe, kg	6,0	9,0	10,5
Hose inner diameter, mm	14	16	16
Overall dimensions, mm, length x width x height	950x55x55	1070x65x65	1185x80x80

Table H.3

Electrical vibration rammers

Technical characteristics	
Electric rammer ИЭ-4502	
Thickness of the consolidated soil layer, m:	
Non-cohesive	0,45
Cohesive	0,3
Productivity on soils, m^3/h	
Non-cohesive	27
Cohesive	18
Impact frequency, s^{-1}	9,3
Voltage, V	220
Current frequency, Hz	50
Range of fluctuations of a rammer shoe, m	0,03
Power consumption, W	1600
Rammer shoe area, m^2	0,109
Working mode	continuous
Overall dimensions, mm	970x475x1050
Weight, kg	81,5
Electric vibration rammer ТВЭ-1	
Maximum plate weight, kg	45
Driving force, kN	2,5 ... 5,1
Dimensions of the supporting part of the plate, mm (length x width x height)	300 x 200 x 12
Vibration frequency, Hz	50
Overall dimensions	
- length, mm	400
- width, mm	330
- height	550
Productivity for 1 pass, m^2/h	up to 300
Travel speed, m/min	20
Specific pressure, kN/m^2	42 ... 84
Electromechanical vibrator, type	ИВ-99Б
Engine's type	Asynchronous three-phase
Installed power, kW	0,25
Rated power, kW	0,5
Voltage, V	42; 220; 380 (by order)

Appendix I

Table I.1

Norms and prices for earthworks

№ in order	Rationale for АВК-3	Description of works	Units of a measurement	Time norm man-hour (workers / machinists)	Price, UAH (workers / machinists)	The composition of the team
1	2	3	4	5	6	7
1		**Cutting the vegetation layer**				Machinist 6 category-1 Machinist 's assistant 5th category -1
	ПР1-4001	1 soil group	1000 m^2	00,00 1,64	00,00 10,28	
	ПР1-4002	2 soil group	1000 m^2	00,00 3,56	00,00 22,34	
2		**Development of soil into a dump by excavators with a bucket with a capacity of:**				Machinist 6 category-1 Machinist 's assistant 5th category -1
		1,5-3 m^3:				
	Е1-11-1	soil group 1	1000 m^3	7,16 31,48	40,38 221,94	
	Е1-11-2	soil group 2	1000 m^3	8,79 38,58	49,58 272,00	
	Е1-11-3	soil group 3	1000 m^3	10,74 47,20	60,57 332,79	
	Е1-11-4	soil group 4	1000 m^3	14,72 64,67	83,02 455,94	
	Е1-11-5	soil group 5	1000 m^3	19,55 85,69	110,26 604,12	
	Е1-11-6	soil group 6	1000 m^3	22,61 99,16	127,52 699,11	
		1,0 m^3				
	ПР1-1001	soil group 1	100 m^3	1,06 6,54	4,22 37,49	
	ПР1-1002	soil group 2	100 m^3	1,26 7,73	4,91 44,28	
	ПР1-1003	soil group 3	100 m^3	1,53 9,36	6,08 53,65	
	ПР1-1004	soil group 4	100 m^3	2,06 12,63	8,19 72,40	
	ПР1-1005	soil group 5	100 m^3	2,68 16,41	10,66 94,05	
	ПР1-1006	soil group 6	100 m^3	3,23 19,82	12,85 113,60	
		0,65-0,8 m^3:				
	ПР1-10071	soil group 1	100 m^3	1,53 5,01	6,08 29,18	
	ПР1-1008	soil group 2	100 m^3	1,81 5,95	7,20 34,63	

Continuation of the table I.1

1	2	3	4	5	6	7
	ПР1-1009	soil group 3	100 m^3	2,42 / 7,99	9,62 / 46,50	Machinist 6 category-1 Machinist 's assistant 5th category -1
	ПР1-1010	soil group 4	100 m^3	3,19 / 10,51	12,69 / 61,18	
	ПР1-1011	soil group 5	100 m^3	4,07 / 13,35	16,19 / 77,70	
	ПР1-1012	soil group 6	100 m^3	4,94 / 16,17	19,65 / 94,14	
		0,5 m^3:				
	ПР1-1013	soil group 1	100 m^3	2,07 / 6,62	8,23 / 39,15	
	ПР1-1014	soil group 2	100 m^3	2,69 / 8,60	10,70 / 50,90	
	ПР1-1015	soil group 3	100 m^3	3,31 / 10,58	13,16 / 62,64	
	ПР1-1016	soil group 4	100 m^3	4,45 / 14,23	17,70 / 84,22	
	ПР1-1017	soil group 5	100 m^3	6,00 / 19,18	23,86 / 113,54	
	ПР1-1018	soil group 6	100 m^3	7,04 / 22,49	28,00 / 133,11	
		0,3-0,4 m^3:				
	ПР1-1019	soil group 1	100 m^3	2,75 / 7,89	10,94 / 39,77	
	ПР1-1020	soil group 2	100 m^3	3,28 / 9,40	13,04 / 47,35	
	ПР1-1021	soil group 3	100 m^3	4,38 / 12,57	17,42 / 63,31	
	ПР1-1022	soil group 4	100 m^3	5,27 / 15,14	20,96 / 76,28	
		0,25 m^3:				
	ПР1-1023	soil group 1	100 m^3	3,03 / 8,55	12,05 / 43,69	
	ПР1-1024	soil group 2	100 m^3	3,90 / 11,01	15,51 / 56,24	
	ПР1-1025	soil group 3	100 m^3	5,38 / 15,21	21,40 / 77,69	
3		**Soil development by excavators with loading into vehicles with a bucket with a capacity of: 1,25-1,6 m^3**				Machinist 6 category-1 Machinist 's assistant 5th category -1
	E1-16-7	soil group 1	1000 m^3	7,12 / 52,86	35,39 / 389,38	
	E1-16-8	soil group 2	1000 m^3	8,84 / 65,55	43,93 / 482,81	
	E1-16-9	soil group 3	1000 m^3	10,47 / 77,66	52,04 / 572,08	

Continuation of the table I.1

1	2	3	4	5	6	7
	E1-16-10	soil group 4	1000 m^3	14,57 / 108,02	72,41 / 795,67	
	E1-16-11	soil group 5	1000 m^3	17,34 / 128,65	86,18 / 947,59	
	E1-16-12	soil group 6	1000 m^3	19,89 / 148,67	98,85 / 1095,12	
		1,0 m^3				
	ПР1-1026	soil group 1	100 m^3	1,25 / 8,83	4,97 / 57,25	
	ПР1-1027	soil group 2	100 m^3	1,48 / 10,43	5,89 / 60,50	
	ПР1-1028	soil group 3	100 m^3	1,86 / 13,19	7,40 / 76,55	
	ПР1-1029	soil group 4	100 m^3	2,41 / 17,10	9,58 / 99,26	
	ПР1-1030	soil group 5	100 m^3	3,13 / 22,00	12,45 / 127,62	
	ПР1-1031	soil group 6	100 m^3	3,78 / 26,61	15,03 / 154,39	
		0,65-0,8 m^3				
	ПР1-1032	soil group 1	100 m^3	1,79 / 8,51	7,12 / 50,77	Machinist 6 category-1 Machinist 's assistant 5th category -1
	ПР1-1033	soil group 2	100 m^3	2,12 / 9,11	8,43 / 54,03	
	ПР1-1034	soil group 3	100 m^3	2,85 / 12,00	11,33 / 71,07	
	ПР1-1035	soil group 4	100 m^3	3,75 / 15,86	14,91 / 93,94	
	ПР1-1036	soil group 5	100 m^3	4,76 / 19,25	18,93 / 113,69	
	ПР1-1037	soil group 6	100 m^3	5,77 / 24,24	22,95 / 143,55	
		0,5 m^3				
	ПР1-1038	soil group 1	100 m^3	2,23 / 9,45	8,87 / 56,79	
	ПР1-1039	soil group 2	100 m^3	2,73 / 11,53	10,86 / 69,25	
	ПР1-1040	soil group 3	100 m^3	3,33 / 14,10	13,24 / 84,70	
	ПР1-1041	soil group 4	100 m^3	4,34 / 18,34	17,26 / 110,15	
	ПР1-1042	soil group 5	100 m^3	5,76 / 24,16	22,91 / 144,99	
	ПР1-1043	soil group 6	100 m^3	6,68 / 28,29	26,57 / 169,93	

Continuation of the table I.1

1	2	3	4	5	6	7
		0,3-0,4 m³:				
	ПР1-1044	soil group 1	100 m^3	3,01 11,73	11,97 60,00	Machinist 6 category-1 Machinist 's assistant 5th category -1
	ПР1-1045	soil group 2	100 m^3	3,80 14,88	15,11 76,12	
	ПР1-1046	soil group 3	100 m^3	5,12 19,72	20,36 100,84	
	ПР1-1047	soil group 4	100 m^3	5,72 22,20	22,75 113,55	
		0,25 m³:				
	ПР1-1048	soil group 1	100 m^3	4,60 16,46	18,29 84,84	
	ПР1-1049	soil group 2	100 m^3	5,92 21,25	23,54 109,53	
	ПР1-1050	soil group 3	100 m^3	8,18 29,09	32,53 149,91	
4		**Cleaning the bottom of the pit (trench) manually**	100 m^3			Digger 2 category - 1
	E1-164-1	soil group 1		200,60 00,00	970,90 00,00	
	E1-164-2	soil group 2		261,80 00,00	1267,11 00,00	
	E1-164-3	soil group 3		421,60 00,00	2048,98 00,00	
	E1-164-4	soil group 4		605,20 00,00	2941,27 00,00	
5		**Backfilling trenches and pits with bulldozers**				Machinist 5 category-1
	E1-27-1	soil group 1	1000 m^3	00,00 15,16	00,00 102,46	
	E-27-2	soil group 2	1000 m^3	00,00 17,67	00,00 119,46	
	E1-27-3	soil group 3	1000 m^3	00,00 20,65	00,00 139,61	
6		**Soil consolidation:** **with pneumatic rammers**				Machinist 6 category-1
	E1-134-1	soil group 1-2	100 m^3	18,36 5,52	99,51 33,06	
	E1-134-2	soil group 3-4	100 m^3	21,93 6,60	118,86 39,53	

Continuation of the table I.1

1	2	3	4	5	6	7
		with trailed rollers with layer thickness:				
	E1-130-1	25 cm	1000 m^3	00,00 36,42	00,00 288,43	
	E1-130-2	30 cm	1000 m^3	00,00 32,55	00,00 257,75	
	E1-130-3	40 cm	1000 m^3	00,00 24,70	00,00 195,50	
	E1-130-4	45 cm	1000 m^3	00,00 20,76	00,00 164,26	
	E1-130-5	50 cm	1000 m^3	00,00 16,84	00,00 133,15	
	E1-130-6	60 cm	1000 m^3	00,00 8,99	00,00 70,91	
		with trailed padfoot rollers with layer thickness:				
	E1-131-1	10 cm	1000 m^3	00,00 69,35	00,00 546,76	
	E1-131-2	15 cm	1000 m^3	00,00 59,31	00,00 467,62	Machinist 6 category-1
	E1-131-3	20 cm	1000 m^3	00,00 49,34	00,00 389,01	
		with self-propelled vibratory rollers with layer thickness:				
	E1-132-1	25 cm	1000 m^3	00,00 29,65	00,00 228,38	
	E1-132-2	30 cm	1000 m^3	00,00 27,02	00,00 208,22	
	E1-132-3	35 cm	1000 m^3	00,00 24,35	00,00 187,75	
	E1-132-4	40 cm	1000 m^3	00,00 21,67	00,00 167,18	
	E1-132-5	50 cm	1000 m^3	00,00 16,32	00,00 126,13	
	E1-132-6	60 cm	1000 m^3	00,00 10,99	00,00 85,19	

Appendix J

Examples of earthworks production schemes

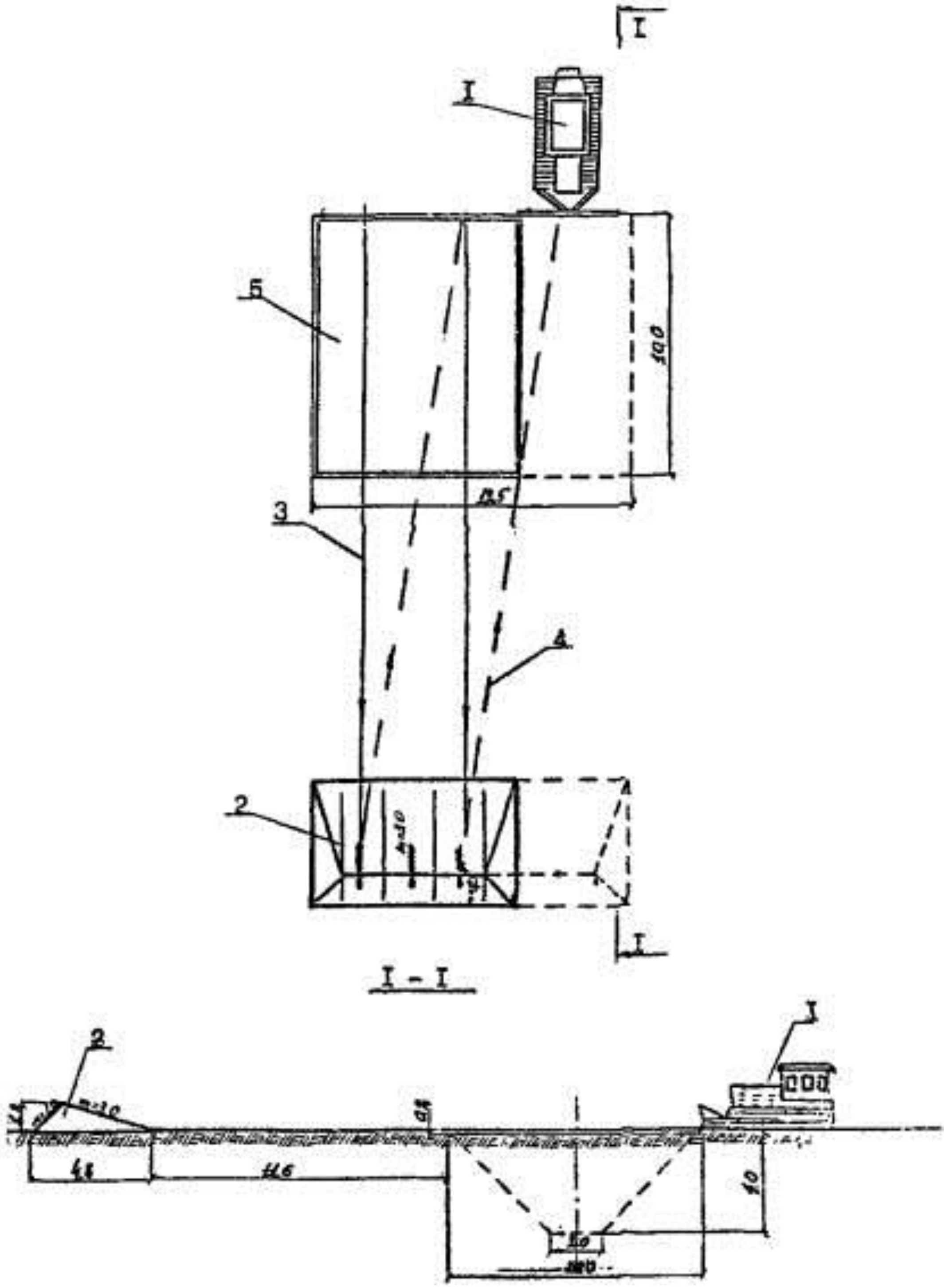


Fig. J.1. Scheme of the production of works when cutting the soil of the vegetative layer: 1 - bulldozer; 2 - cavalier of vegetable soil; 3 - working strokes of the bulldozer; 4 - idle strokes of the bulldozer; 5 - surface of the pit

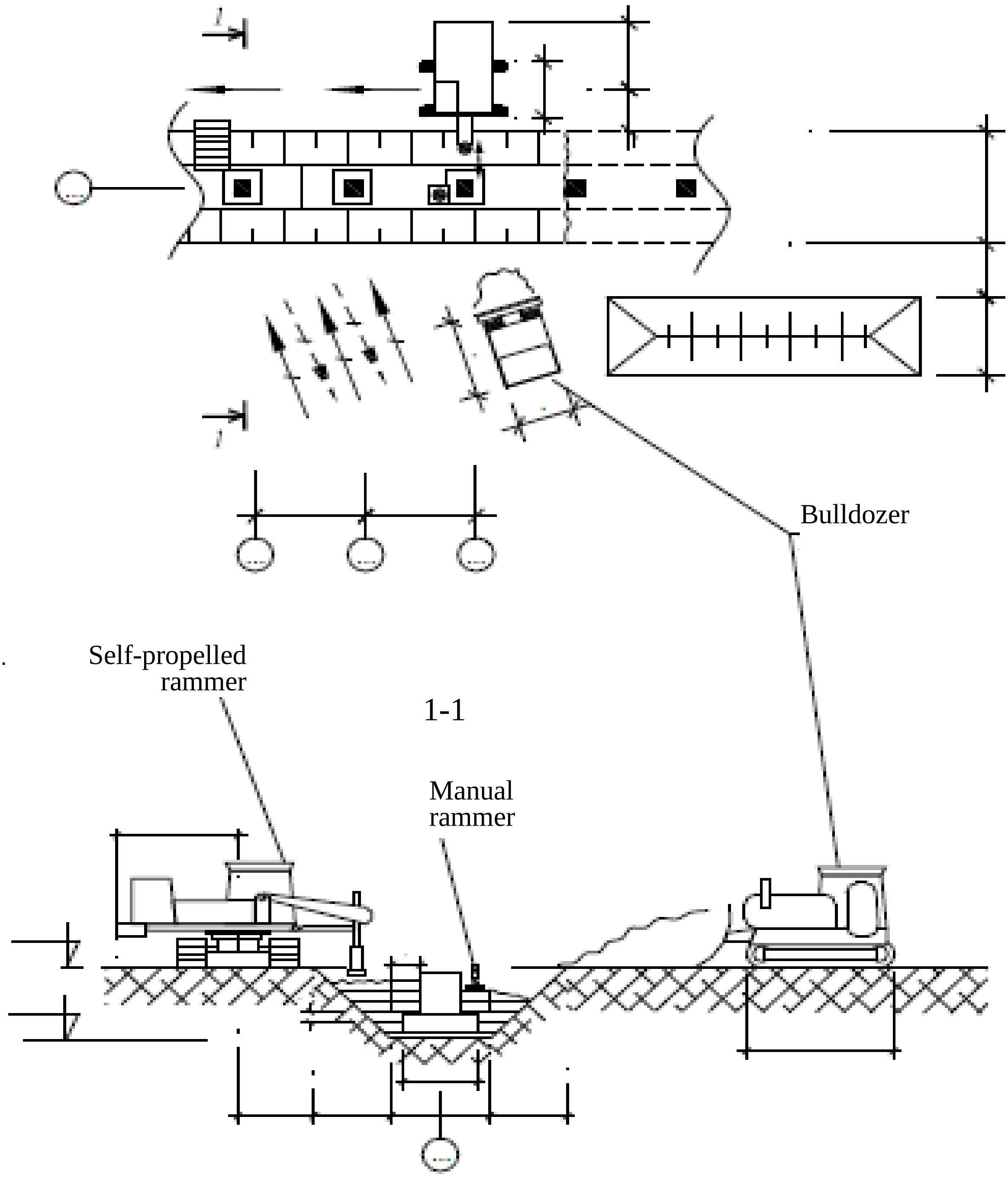


Fig. J.2. Scheme of backfilling and soil consolidation in the recesses of the pit

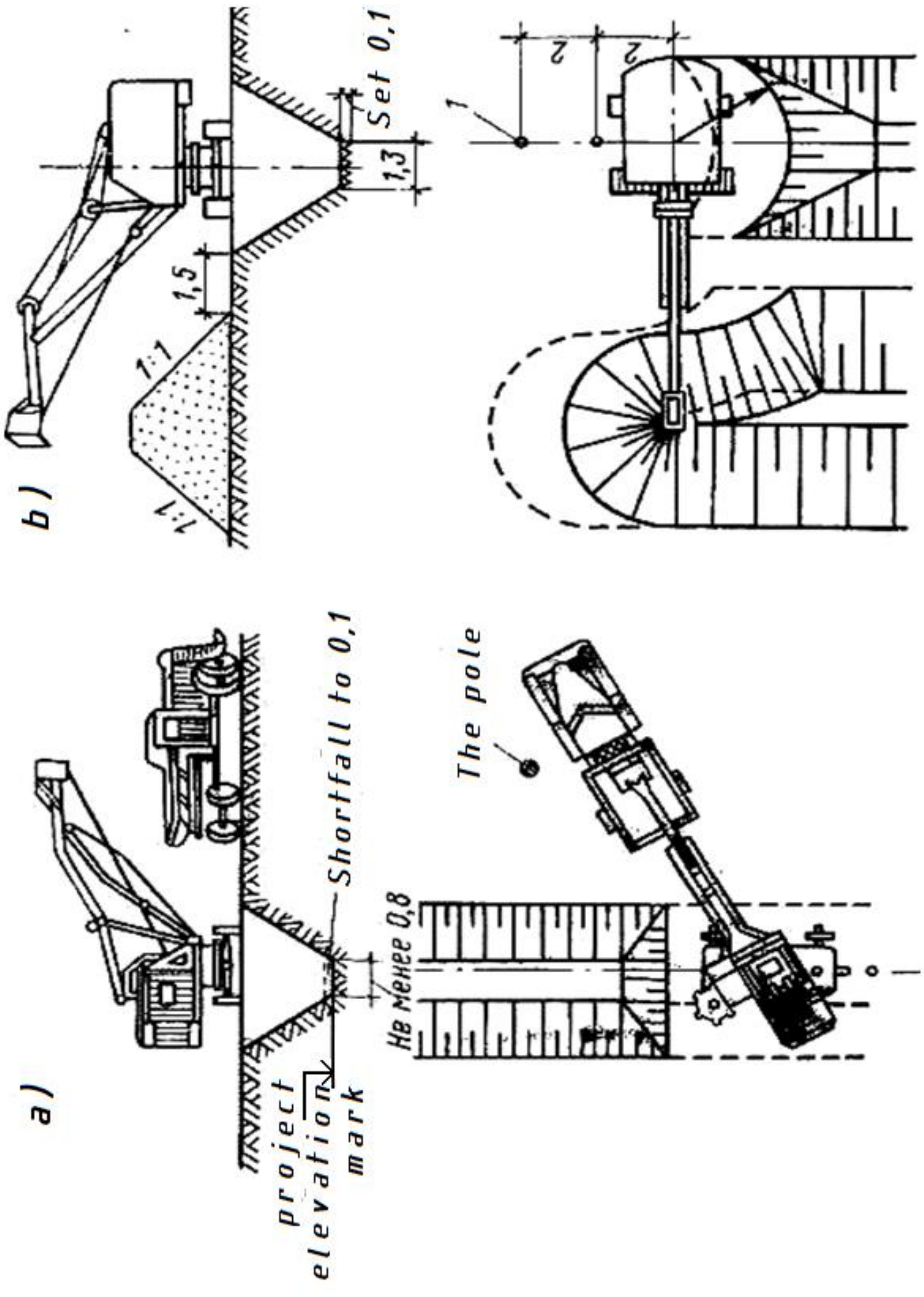


Fig. J.3. Schemes of trenching stroke with an excavator equipped with a backhoe: a- frontal stroke; b- side stroke

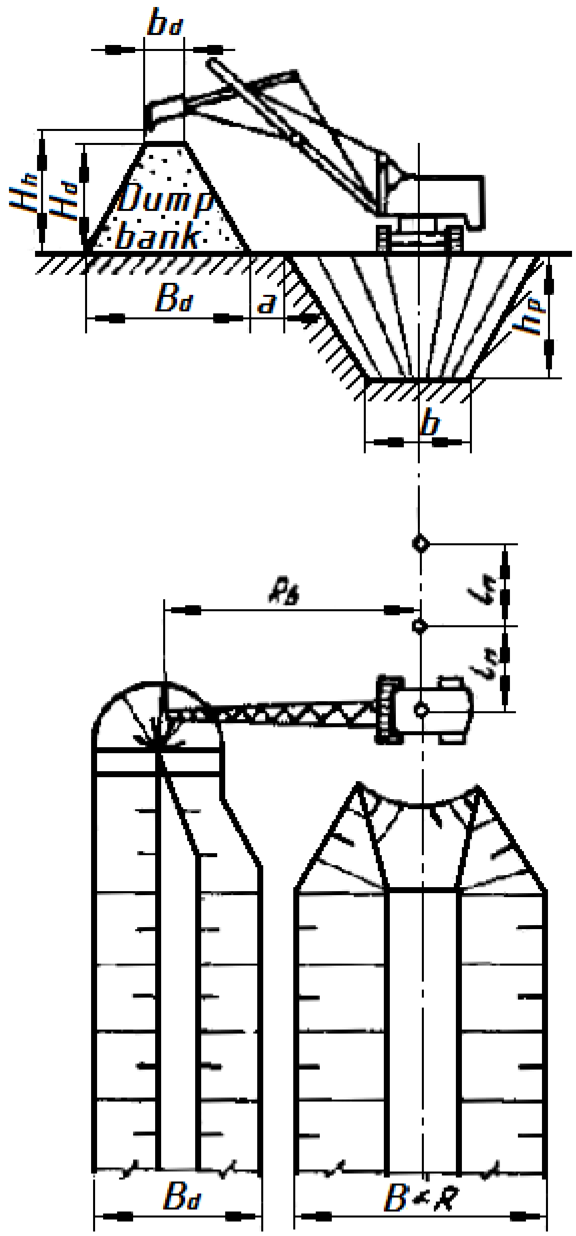


Fig. J.4. Scheme of a digging face when developing trenches with an excavator equipped with a backhoe

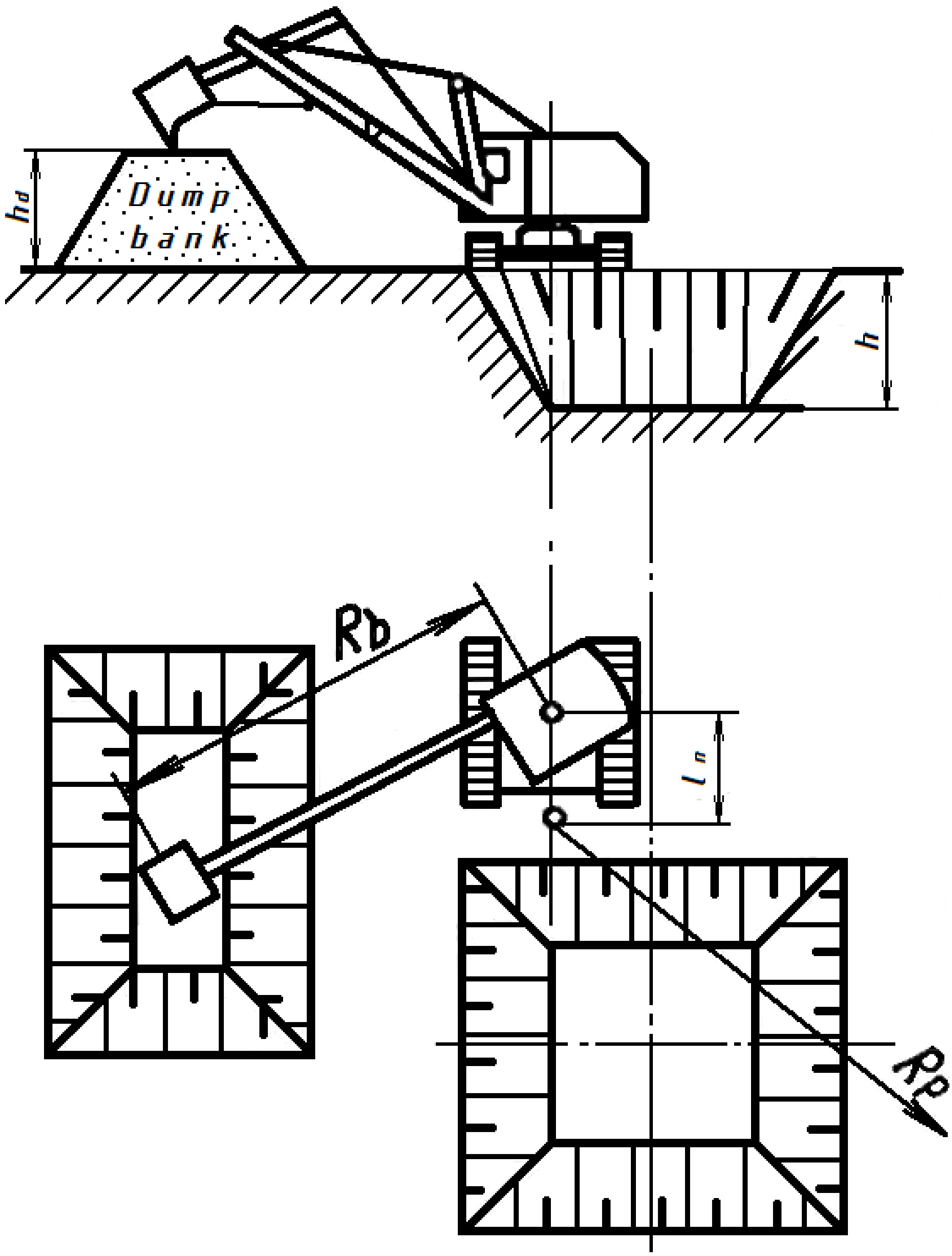


Fig. J.5. Development of pits for free-standing foundations with an excavator equipped with a backhoe

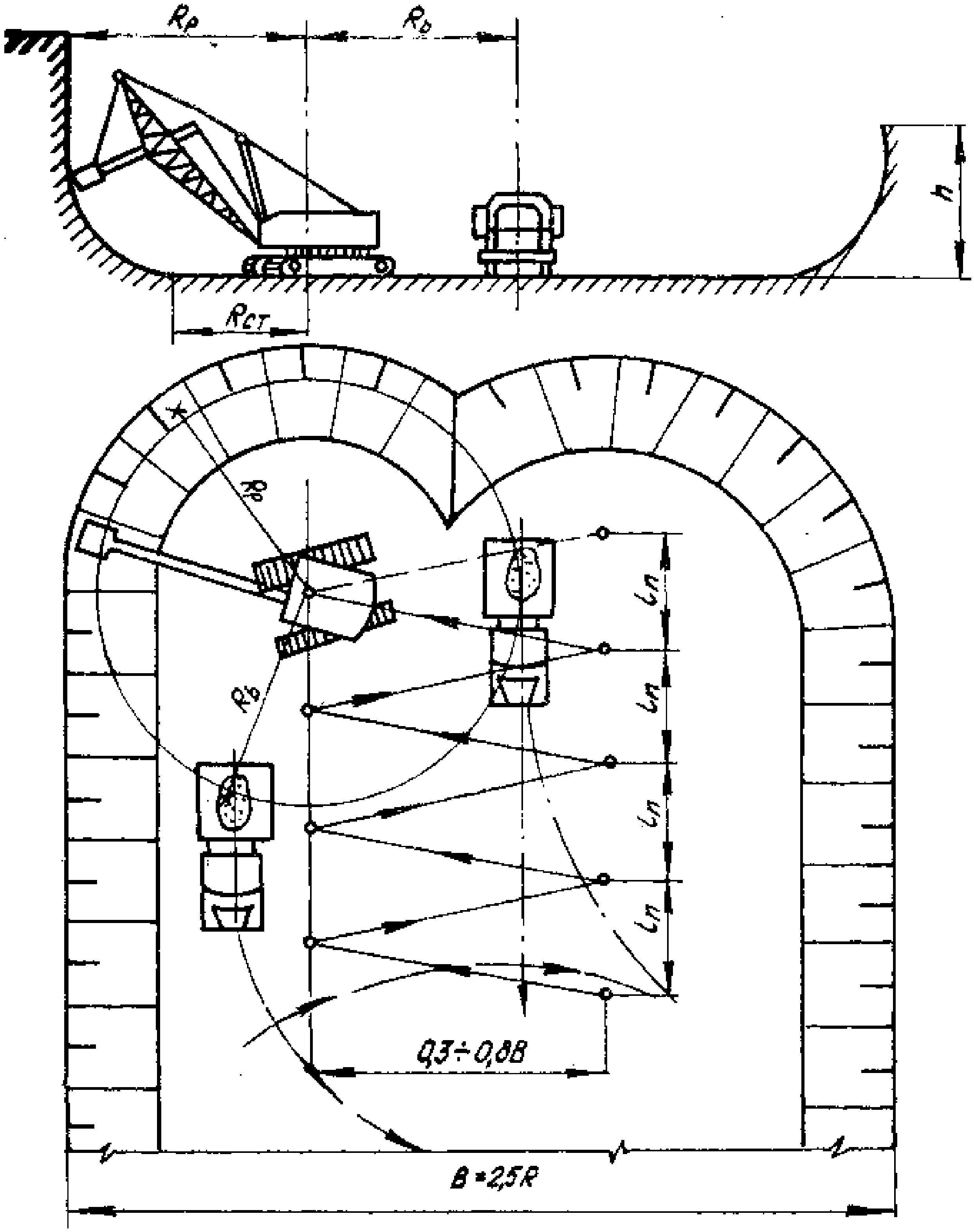


Fig. J.6. Scheme of the face when developing a pit with a frontal stroke by an excavator equipped with a front shovel

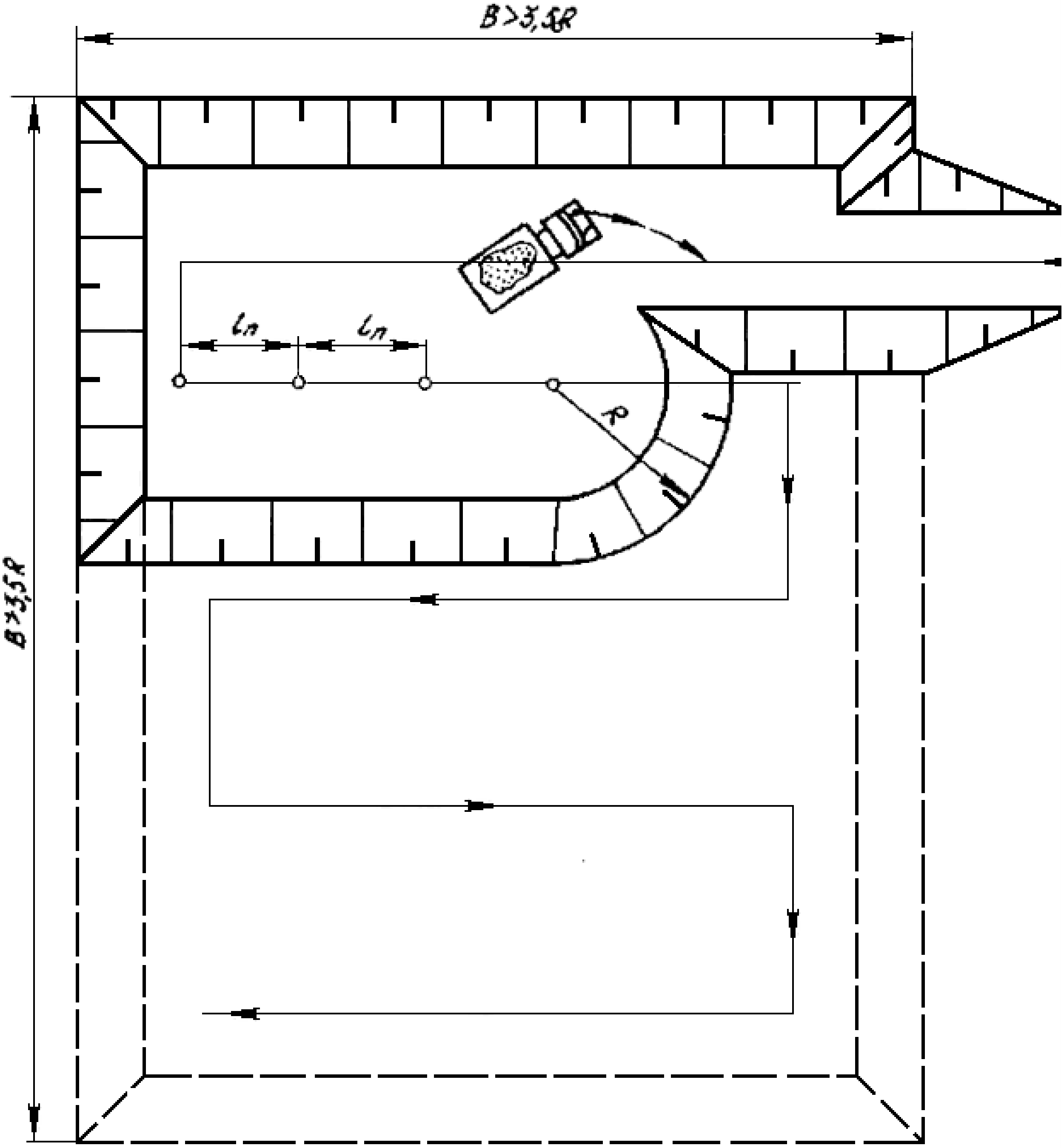
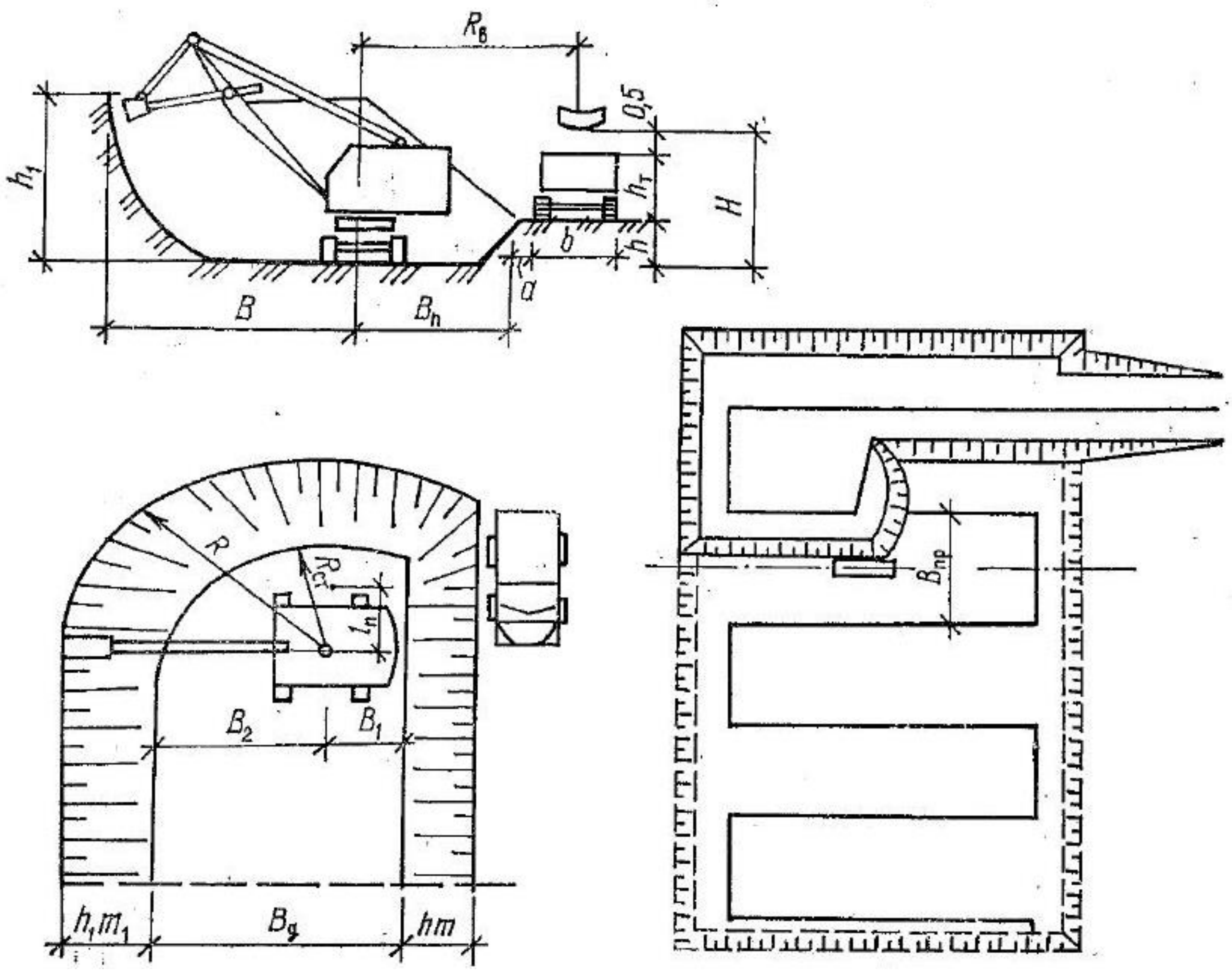


Fig J.7. Scheme of development of a pit by side stroke with an excavator equipped with a front shovel



a b

Fig. J.8. Scheme of development of a pit by side strokes with the location of vehicles above the bottom of the digging face:

a - cross section and plan of the face; b - plan of the pit

Appendix K

Title page sample

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

ODESSA STATE ACADEMY
CIVIL ENGINEERING AND ARCHITECTURE

DEPARTMENT OF CONSTRUCTION TECHNOLOGY

EXPLANATORY NOTE

to course project

in the discipline "Construction technology"

for the topic: **"Construction technology of the zero cycle"**

COMPLETED:

Student of the group _________________

SUPERVISOR:______________________

WORKLOAD:

Note pages_____

The graphical part____

Odesa - 20__

Appendix L

Scheme of concrete work production

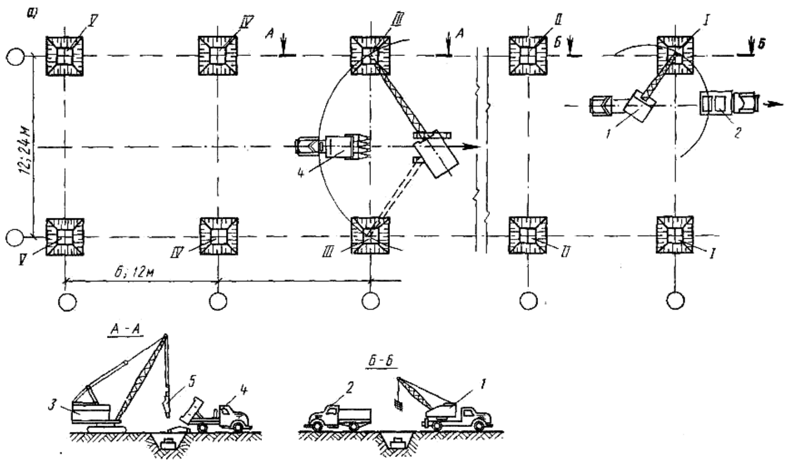


Fig. L.1. Scheme of the technological process for the installation of monolithic reinforced concrete foundations using cranes

a — process sequence; б — crane movement scheme; I — installation of the reinforcement; II— the formwork installation; Ш — placing concrete mix; IV — hardening and maintenance of concrete; V — demounting of a formwork; 1 — truck crane; 2 — automobile; 3 — self-propelled jib crane; 4 — dump truck; 5 — bucket.

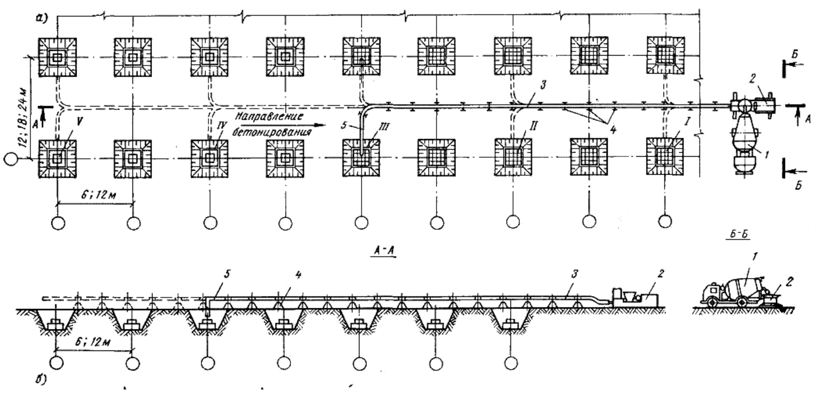
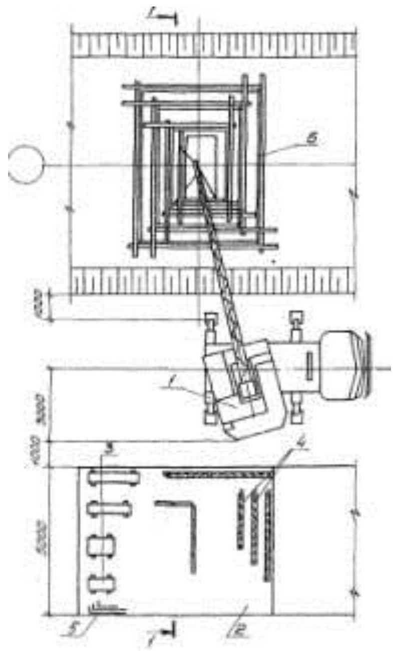


Fig. L.2. Scheme of the technological process for the installation of monolithic reinforced concrete foundations with concrete pumps

a - the sequence of the process; б - scheme of pipeline relocation; I - installation of fittings; II - formwork setting; III - placing the mix; IV - concrete curing and maintenance; V - formwork dismantling; 1 - truck mixer; 2 - concrete pump; 3 - pipeline; 4 - inventory rack; 5 - flexible hose.

Scheme of production

of the formworks



Section 1-1

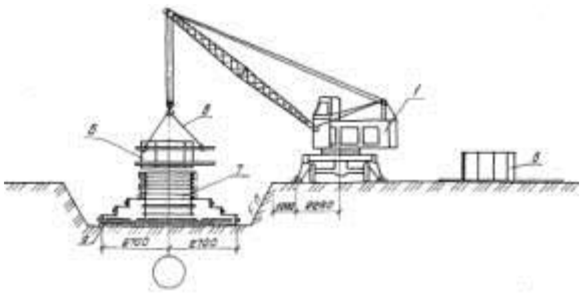


Fig. L.3. Scheme of the technological process of mounting panel formwork

Appendix M

Scheme of operational quality control of the installation of monolithic concrete and reinforced concrete foundations

Table M.1

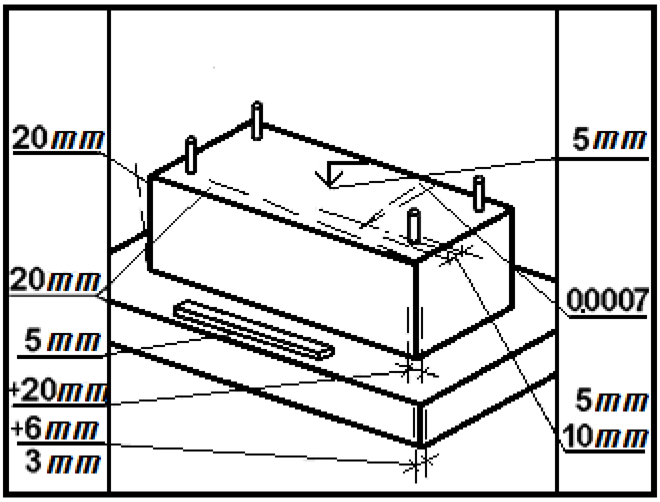
Composition of operations and controls

Stages of works	Controlled Operations	Control (method, scope)	Documentation
Preparatory works	It is necessary to check: - correct installation and reliability of fixing the formwork, supporting scaffolding, fastenings; - the preparedness of all mechanisms and devices that ensure the production of concrete work; - compliance of the base elevation mark with the requirements of the project; - the cleanliness of the base or previously placed concrete layer and the inner surface of the formwork; - the condition of the reinforcement and embedded parts (the presence of rust, oil, etc.), the compliance of the position of the installed reinforcement with the design one; - the design elevation mark of the top of concreting on the inner surface of the formwork.	Technical inspection Visual Measuring Visual Technical inspection, measuring Measuring	General work log, certificate of inspection of hidden works

Concrete placing, concrete hardening, formwork dismantling	to control: - the quality of the concrete mix; - formwork condition; - the height of the dropping of the concrete mix, the thickness of the placed layers, the step of rearranging the deep vibrators, the depth of their immersion, the duration of the vibration, the correct execution of the working joints; - temperature-humidity conditions of concrete hardening; - the actual strength of concrete and the timing of formwork dismantling.	 Laboratory Technical inspection Measuring, 2 times per shift Measuring The same	General work log
Acceptance of work performed	To check: - the actual strength of the concrete; - surface quality of structures; - quality of materials and products used in a structure; - its geometric dimensions, conformity of the structure to the working drawings.	 Laboratory Visual The same Measuring, each structural element	General work log, act of acceptance of performed works
Control and measuring tools: construction plumb line, theodolite, tape measure, metal ruler, level, 2-meter rail.			
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.			

Technical requirements

СНиП 3.03.01-87 p. 2.112, 2.113, table 11



Permissible deviations:

- planes from the vertical or design slope to the entire height of the foundations 20 mm;

- elevation marks of surfaces and embedded products serving as supports for precast concrete columns and other prefabricated elements 5 mm;

- horizontal planes for the entire length of the verified section 20mm;

- the slope of the supporting surfaces of foundations when supporting steel columns without gravy 0,0007;

- local unevenness of the concrete surface when checking with a two-meter rail, except for supporting surfaces of 5 mm;

- element lengths 20 mm;

- cross-section of elements +6 mm, 3 mm;

- location of anchor bolts:

- on the plan inside the contour of the support 5 mm;

- on the plan outside the contour of the support 10 mm;

- along the height of the contour of a support +20 mm;

- difference in height marks at the junction of two adjacent surfaces 3 mm.

Acceptance of structures should be formalized in accordance with the established procedure by an act of survey of hidden works or an act of acceptance of critical structures.

Requirements for the quality of the materials used

ДСТУ Б В.2.7-96-2000 Construction Materials. Concrete mixes. Technical specifications. ДСТУ Б В.2.7-32-95 Construction Materials. Sand dense natural for construction materials, products, designs and works. Technical specifications.

Each batch of concrete mix, which is sent to the consumer, must have a quality document, which must indicate:

- manufacturer, date and time of dispatch of the concrete mix;
- type of concrete mix and its symbol;
- the number of the composition of the concrete mix, the class of concrete in terms of compressive strength;
- mark on average density (for lightweight concrete);
- type and amount of additives;
- the largest aggregate size, concrete mix workability;
- number of the accompanying document;
- manufacturer's warranty;
- other indicators if necessary.

The methods used for transporting the concrete mix should exclude the possibility of atmospheric precipitation entering the mix, violation of uniformity, loss of cement mortar, and also ensure the protection of the mix from the harmful effects of wind and sunlight during transit.

The maximum duration of transportation of mixes is 90 minutes. The stratified mix must be mixed on site.

When incoming control of the concrete mix at the construction site, it is necessary:

- to check the availability of the passport for the concrete mix and the data required in it;
- by external inspection, make sure that there are no signs of stratification of the concrete mix, that the concrete mix contains the required fractions of large aggregate;
- if there are doubts about the quality of the concrete mix, require a control check in accordance with ГОСТ 10181-2002.

Transportation and handling of concrete mixes should be carried out by specialized means that ensure the preservation of the specified properties of the concrete mix. It is forbidden to add water at the place of placing the concrete mix to compensate for its mobility.

Instructions for production of works

СНиП 3.03.01-87 p. 2.8–2.16, 2.109, 2.110

Before concreting the base, the horizontal and inclined concrete surfaces of the working joints must be cleaned of debris, dirt, oils, snow and ice, cement film, etc. Immediately before placing the concrete mix, the cleaned surfaces must be washed with water and dried with a jet of air.

All structures and their elements closed in the course of subsequent production of works (prepared structure bases, reinforcement, embedded products, etc., as well as the correct installation and fixing of the formwork and its supporting elements) must be accepted according to the act.

The height of the free throwing of the concrete mix into the formwork of weakly reinforced structures is not more than 4,5 m.

Concrete mixes must be placed in the concreted structures in horizontal layers of the same thickness without gaps, with consistent direction of placing in one direction in all layers.

The thickness of the placed layers of the concrete mix:

- when consolidation of the mix with heavy suspended vertically located vibrators, it is 5-10 cm less than the length of the working part of the vibrator;

- when consolidation of the mix with manual deep vibrators - no more than 1,25 of the length of the working part of the vibrator.

When consolidation of the concrete mix, it is not allowed to support the vibrators on the reinforcement and embedded products, rods and other elements of the formwork fastening. The depth of immersion of the deep vibrator in the concrete mix should ensure its deepening into the previously placed layer by 5-10 cm.

Placing of the next layer of concrete mix is allowed before the beginning of setting of the concrete of the previous layer. The duration of the break between the placing of adjacent layers of concrete mix without the formation of a working joint is established by the construction laboratory. The top level of the placed concrete mix should be 50-70 mm below the top of the formwork panels.

Measures for the care of concrete control over their implementation and the timing of the dismantling of the formwork should be established by the PPW.

The minimum strength of concrete when dismantling the formwork of unloaded structures is 0,2-0,3 MPa.

Appendix N

Table N.1

Time and wages norms for concrete works

№ in order	Rationale for АВК-5	Description of works	Units of measuring	Time norm man-hour / machine-hour	Price, UAH	The consist of the team
1	2	3	4	5	6	7
Formworks						
1	ЕД 6-50-1	Installation of wooden formwork of panels up to 1 m^2 up to 2 m^2 over 2 m^2	m^2	0,65 0,52 0,43	35,87 27,81 17,45	Carpenter 4th c. - 1 2nd c.- 1
2	ЕД 6-54-1	Installation (wood) of metal formwork up to 2 m^2 over 2 m^2	m^2	0,38 0,44	31,90 28,4	Construction locksmith 4th c. - 1 3rd c.- 1
3	Е 4-1-32	Cutting holes in the formwork: - for the descender gutters - for lowering the vibrator	1 hole	0,65 0,47	12,3 9,13	Carpenter 3rd c. - 1 2nd c. - 1
4	Е 4-1-32	Installation of a gutter for lowering concrete up to 50 kg up to 100 kg	1 gutter	0,65 1,05	12,3 19,6	Carpenter 3rd c. - 1 2nd c. - 1
5	Е 4-1-32	Removing the gutter up to 50 kg up to 100 kg	1 gutter	0,28 0,41	6,8 9,5	Carpenter 3rd c. - 1 2nd c. - 1
6	Е 4-1-32	Installation of funnels for handling concrete mix	1 funnel	0,32	5,95	Carpenter 3rd c. - 1
7	Е 4-1-32	Removing funnels	1 funnel	0,16	3,2	Carpenter 3rd c. - 1
8	Е 4-1-32	Placing planks in expansion joints	1m^2 joint area	0,56	10,2	Carpenter 4th c. - 1

Continuation of the table N.1

1	2	3		4	5	6	7
9	E 4-1-32	Removing planks		$1m^2$ joint area	3,1	21,1	Carpenter 3rd c. - 1
10	E 4-1-32	Sealing gaps in the formwork with tow		100 m of sealing	5,4	24,5	Carpenter 3rd c. - 1
11	E 4-1-27	Dismantling of wooden formwork of panels up to 1 m^2 up to 2 m^2 over 2 m^2		m^2	 0,155 0,13 0,1	 30,8 23, 1 12,4	Carpenter 3rd c. - 1 2nd c. - 1
12	E4-1-29	Removing the metal formwork block up to 2 m^2 over 2 m^2		m^2	 0,22 0,18	 26,90 23,2	Construction locksmith 4th c. - 1 3rd c.- 1
Reinforcing							
13	ЕД6-61-12 ЕД6-61-13 ЕД6-61-14	Installing meshes or wireframes manually up to 20 kg up to 50 kg up to 100 kg		1 mesh or frame	 0,17 0,25 0,37	 15,44 12,17 11,17	Reinforcing worker 3rd c.- 1 2nd c. - 2
Concrete works							
Preparation of concrete mix							
14	E4-1-35	Concrete mixer capacity up to	Mixing time, sec	$1m^3$			Concrete mixer operator 4th c. - 1 3rd c.- 1
		100 m^3	45 60 90 120		0,39 0,46 0,61 0,76		
		150 m^3	45 60 90 120 150;		0,27 0,32 0,42 0,52 0,62		
		250 m^3	45 60 90 120 150 180 240		0,175 0,2 0,26 0,32 0,38 0,44 0,56		

Continuation of the table N.1

1	2	3		4	5	6	7
		Concrete mixer capacity up to 425 m^3	Mixing time, sec 45 60 90 120 150 180 240	1m^3	0,115 0,13 0,165 0,2 0,23 0,27 0,34		Concrete mixer operator 4th c. - 1 3rd c. - 1
15		Delivery of concrete mix		1m^3	10,1/18,7	44,1/66,4	
16	E4-1-36	Installation of a concrete pipeline with a diameter: 150 mm 180 mm		1m	0,31 0,42	16,7 14,5	Concrete pumping machine operator 4th c. - 1 locksmith 4th c. - 1 3rd c. - 3
17	E4-1-36	Dismantling of a concrete pipeline with a diameter 150 mm 180 mm		1m	0,13 0,18	13,7 10,9	Concrete pumping machine operator 4th c. - 1 Locksmith 4th c. - 1 3rd c. - 2
18	E4-1-36	Acceptance of concrete mix into the intermediate hopper		1 m^3	0,115	22,4	Concrete worker 2nd c. - 1
19	ЕД6-66-1	Handling of concrete mix to the place of placing, depending on the productivity of the concrete pump: 10 m^3/h 20 m^3/h		100 m^3	28/14 18,9/6,3	76,9/178,4 67,9/147,3	Concrete pumping machine operator 4th c. - 1 Locksmith 4th c. - 1 Concrete worker 2nd c. - 1

Continuation of the table N 1

1	2	3	4	5	6	7
20	4-1-36	Concrete pipeline cleaning	100 m	6,5	17,8	Concrete pumping machine operator 4th c. - 1 Locksmith 4th c. - 1 Concrete worker 2nd c. - 1
21	4-1-36	Detachment and connection of concrete conduit links during layer-by-layer concreting	100 m	20	53,1	Locksmith 4th c. -1 Concrete worker 2nd c. - 2
22	ЕД6-65-1	Handling of concrete mix by crane in buckets up to 3 m^3 5 m^3 10 m^3	1 m^3	0,44 0,36 0,28	75,1 62,3 58,4	Concrete worker 4th c. -1 2nd c. -1
23	ЕД6-67-1	Handling of concrete mix from dump trucks	1 m^3	0,33	53,51	Concrete worker 3rd c. -1, 2nd c. -1
24	4-1-41	Consolidation of the concrete mix with a vibrator up to 1 m^3 3 m^3 5 m^3 10 m^3	1 m^3	1,65 1,15 0,86 0,64	37,8 33,2 28,9 26,1	Concrete worker 4th c. -1 2nd c. -1
Concrete care work						
25	Е 4-1-42	Sprinkling concrete surface with water	100 m^2	0,15	31,4	Concrete worker 2nd c. -1
26	Е 4-1-42	Covering the concrete surface with insulation: - gunny, mats - sawdust	100 m^2	0,2 0,28	45,5 49,1	Concrete worker 2nd c. -1
27	Е 4-1-42	Removal of insulation from the concrete surface: - gunny, mats - sawdust	100 m^2	0,23 0,32	22,7 24,1	Concrete worker 2nd c. -1

Appendix O

Material and technical resources

Table O.1

The need for machines, equipment, tools, inventory and fixtures

Name	Brand, technical characteristics, ГОСТ, № of the drawing	Amount, things	Purpose
1	**2**	**3**	**4**
Machineries and equipment			
Automobile crane	СМК-10, Crane boom length - 16 m; Load capacity - 10 t	1	Handling of reinforcement, formwork, concrete mix
Concrete pump truck	СБ-126А, Distribution boom feed range 18 m; productivity technical - 60 m^3/h	1	Concrete mix handling
Concrete paver	СБ-131, Productivity - 20 m^3/h	1	Same
Concrete mixer truck	СБ-159, СБ-921А	1	Transportation of concrete mix
Welding transformer	ТД-500	1	Welding works
Compressor	СБ-45Б	1	Compressed air handling
Electrified tools			
Drill universal	ИЭ-1035	1	Hole drilling
Paint sprayer	СО-71Б	1	Lubrication of shields
Electrode holder	ГОСТ 14651-78*Е	1	Welding works
Deep vibrator	ИВ-67	2	Concrete mix consolidation
Manual construction-assembly tool			
Assembly crow-bar	ЛМ-24 ГОСТ 1405-83	1	Element trueing
Locksmith chisel	ГОСТ 7211-86Е	1	Cleaning of welding spots
Locksmith hammer	ГОСТ 2310-77*Е	1	Same
Construction steel hammer	МКУ-2, ГОСТ 11042-83	1	Tapping concrete
Trowel КБ	ГОСТ 9533-81	1	Leveling the mortar
Blacksmith's blunt-nosed sledgehammer	ГОСТ 11402-75	1	Bending reinforcing bars
Mortar shovel	ГОСТ 3620-76	2	Handling of mortar
Metal scraper	Р.Ч. 568-75 ЦНИИОМТП	2	Formwork cleaning
Metal brush	ТУ 494-01-04-76	1	Reinforcement cleaning
Paint roller	ГОСТ 10831-80	1	Formwork panel lubrication

Continuation of the table N 1

1	2	3	4
Wrenches	ГОСТ 2339-80	1 kit	Formworks
Tool kit for manual arc welding	ТУ 36 1162-81	1 kit	Welding works
Shears for cutting reinforcement	ГОСТ 7210-75*Е	1	Reinforcing
Combination pliers	ГОСТ 5547-86*Е	1	Same
End wire-cutters	ГОСТ 7282-75*Е	1	Same
File flat blunt-nosed	ГОСТ 1465-80*	1	Same
Measuring and control-measuring instruments			
Tape-measure	ГОСТ 7502-80*	1	Control-measuring works
Folding metal meter	ТУ 12-156-76	1	Same
Construction steel plumb line	ОТ-600	1	Same
Construction level	УС2-300	1	Same
Appliances			
Sling six-branch universal	ГОСТ 25573-82*	1	Sling of structures
Rotary hopper	БП-1,0, capacity -1,0m^3, ГОСТ 21807-76*	2	Concrete mix handling
Pressure paint tank	СО-126А	1	Formwork panel lubrication
Device for knitting reinforcing bars	The trust «Orgtekhstroy Glavmospromstroy»	1	Assembly of enlargement cages
Clamp for temporary fastening of reinforcing mesh	Р.Ч. Bureau of Introduction ЦНШОМТП	1	Reinforcing
Clamp for temporary fastening of reinforcing cages	The trust Mosorgpromstroy	1	Same
Jig for assembly of reinforcing cages	Giproorgselstroy	1	Same
Twister	ТУ 67-399-82	1	Same
Individual protection means			
Protective eyeglasses	ГОСТ 12.4.013-85Е	2	Welding works
Protective shield for electric welder	ГОСТ 12.4.035-78*	1	Same
Safety belt	ГОСТ 12.4.089-80	For all team	Technique of safety
Construction helmet	ГОСТ 12.4.087-84	Same	Same
Rubber gloves	ГОСТ 20010-74*	2	Concrete works
Rubber boots	ГОСТ 5375-79*	2	Same

Table O.2

The need for materials and semi-finished products

Name of material, semi-finished product, structure (brand, ГОСТ)	Source data				Need for material	
	Units of measuring	Scope of works		Accepted material consumption rate		
		Φ-1	Φ-2		Φ-1	Φ-2
Small-panel metal formwork	m^2	20,5	19,1	-	20,5	19,1
Reinforcement meshes	t	0,198	0,65	-	0,198	0,654
Concrete mix	m^3	9,1	14,7	1,01	9,2	14,8
Electrodes E-42	kg	-	-	-	1,0	3,3
Emulsion for lubricating formwork panels	1 m^2 of a forming formwork	20,5	19,1	0,20-[x)] 0,35 0,45-0,55	4,1- 7,2 9,2-11,3	3,8- 6,7 8,6-10,5

[x)] In the numerator - the consumption when applied by pneumatic spray,

in the denominator - the consumption when applied manually with a brush or roller.

Appendix P

Performance characteristics of concrete pumps, cranes and vibrators

Table P.1

Technical indicators of vehicles for the transport of concrete mix

Indicators	Unit of measurement	Dump truck brands				Concrete truck brands			Concrete mixer truck brands		
		ГАЗ-53Б	ЗИЛ-555	МАЗ-503Б	КрАЗ-256	СБ-113Б	АБ-32	СБ-124	АБС-6	СБ-92В-4	СБ-159Б-2
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Load capacity	t	3,5	4,5	7	11	3,8	7,0	7,0	-	-	-
Body capacity (drum)	m^3	2,4	3,1	5,5	6,5	2,8	5,0	7,5	10,12	8,0	8,0
The volume of transported concrete mix	m^3	1,5	2,0	3,2	4,5	1,6	3,2	4,0	6	4,5	5
Base machine chassis model	-	-	-	-	-	КамАЗ 5511	МАЗ-503А	ЗИЛ-130Д	КрАЗ-65101	ЗИЛ-1233Д	Урал-55571

Appendix P (continuation)

Table P.2

Technical indicators of construction cranes

Crane brand	Hook lifting height, Нк (m)	Ratio P_{max}/L_{min}, (t/m)	Ratio P_{min}/L_{max}, (t/m)
1	**2**	**3**	**4**
КС-2561Д	8 12	6,3/3,3 3,6/4,1	1,9/7,1 0,9/10
КС-3561А	10 18	10/3,8 3,0/6,8	1,9/10 0,4/17,5
КС-4561 (К-162)	10 18 22	16/4 8,2/5 5,5/6	2,8/10 1,2/13 1,1/14
КС-4361А (К-161)	10 15 20	16/4 8/5 5,8/6,5	2,2/10 2/13,5 1,2/16
КС-5363 (К-255А)	15 20	25/4 16/6	4/13,8 2/18
КС-5363 (К-255А)	25 30	11,9/6,5 8/7,5	1/22 0,6/25
МКП-25А	19,1 19,1 fly jib – 5m 22,1 22,1 fly jib – 5m 27,1 27,1	17,5/3,4 5/8,4 17/3,2 5/9,3 13,8/4 5/8	3,5/15,8 2,4/20 2,8/17,1 1,9/22,5 2,6/15,5 1,9/21
МКГ-16М	10 18 26	16/4 9/5,5 4,6/8	4/10 1,5/16 0,4/20
МКГ-25	12,5 17,5 fly jib – 5m 22,5 22,5 fly jib – 5m 27,5 27,5	25/4 21/4,2 21/4,5 5/5,2 12,5/5,1 5/5,8	4/12 3,5/16 2,8/18 2,3/19 2,4/18,5 2,0/19
МКГ-40	15,8 15,8 fly jib - 6m 20,8 20,8 fly jib – 6m 25,8	40/5 8/10,3 28/6,4 7/11,5 7/12	8/14 6,5/20 4/18 3,8/24,5 2,7/29

Note: The values (maximum lifting capacity at minimum outreach of a crane boom and minimum lifting capacity at maximum outreach of a crane boom) for pneumatic and truck cranes are given when they operate on the carried out supports.

Appendix P (continuation)

Table P.3

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	С-296	С-252	СБ-95А	АБН-60
Productivity, m^3/hour	75	90	125	140	160	20	20	45	70	10	20	25	60
Mobility of concrete mix (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	---
The volume of the loading funnel, m^3	0.7		0,6			0,45	0,45	0,6	0,7				
Overall dimensions, mm	10x 2,5x 3,8	10,3 x 2.5x 3,9	12 x 2,5 x 3,9 5	13,3 x 2,5x 3,95	12,4 x 2.5x 3,96	5,3x 1,9x 2,05	5,3x 1,9x 2,05	2,04 x5,3 9x2, 32	6,2 x2, 3x 1,9 3	2,46 x 1,35 x 1,7	-- - -- - -- -	0,8x 1,875 2,6	--- --- ---

Note:

СБ-95А concrete pump – with oil-hydraulic drive and articulated boom, АБН-60 concrete pump truck – with distribution boom L=17 m;

АБН brand concrete pumps – with hydraulic drive;

Concrete pump БН-20Е – with an electro-hydraulic drive from a 380 V network;

Concrete pumps БН-20Д, БН-45 and БН-70Д – with hydromechanical drive;

Concrete pumps С-296, С-252 and С-284А – with a mechanical drive;

The distance of transportation of concrete pumps when calculating the one-time costs and labor intensity of relocation is assumed to be 10 km.

Appendix P (continuation)

Table P.4

Technical characteristics of swivel buckets

Indicators	Swivel bucket brands						
	БПВ-0,5	БПВ-0,8	БПВ-1,0	БПВ-1,2	БПВ-1,6	БПВ-2,0	БПВ-3,0
Capacity, m^3	0,5	0,8	1,0	1,2	1,6	2,0	3,0
Overall dimensions, mm:							
length	3045	2820	3384	3000	3867	3874	4000
width	958	1150	1410	1700	1524	2748	2550
height	1085	900	1010	1060	1004	920	1950
Bucket weight, kg	325	370	495	700	635	920	1630
The same with concrete mix, kg	1525	2290	2890	3580	4475	5720	8830

Table P.5

Technical characteristics of deep vibrators

<table>
<tr><th>Denomination</th><th>ЕПК-130</th><th>ИВ-75</th><th>ИВ-113</th><th>ИВ-117А</th><th>ИВ-116А</th><th>ИВ-116А-1.6</th></tr>
<tr><td>Application field</td><td colspan="4">Consolidation of concrete mixes with SK=2..8 cm reinforced structures</td><td colspan="2">Consolidation of concrete mixes with SK=1..8 cm lightly reinforced structures</td></tr>
<tr><td>Vibrator tip diameter, mm</td><td>51</td><td>28</td><td>38</td><td>51</td><td colspan="2">76</td></tr>
<tr><td>Vibrator tip length, mm</td><td colspan="4">410</td><td colspan="2">430</td></tr>
<tr><td>Synchronous oscillation frequency, Hz</td><td>285</td><td colspan="2">330</td><td>285</td><td colspan="2">210</td></tr>
<tr><td>Rotation frequency of rotor, rev./min</td><td>3000</td><td colspan="3">2850</td><td colspan="2">2800</td></tr>
<tr><td>Electric motor power nominal / consumed, kW</td><td>1,0/1,3</td><td colspan="3">0,75/1,0</td><td>1,0/1,4</td><td>1,2/1,6</td></tr>
<tr><td>Voltage, V</td><td>220</td><td colspan="5">42</td></tr>
<tr><td>Current strength, A</td><td>6,5</td><td colspan="3">20</td><td colspan="2">24</td></tr>
<tr><td>Electric motor dimensions LxHxW, mm</td><td>350x180x280</td><td colspan="5">350x180x270</td></tr>
<tr><td>Flexible shaft length, m</td><td colspan="6">3</td></tr>
<tr><td>Mass of the working kit, kg</td><td>30</td><td>21,8</td><td>28,6</td><td>30,5</td><td>35</td><td>38,5</td></tr>
</table>

Table P.6

Set time, in days (tт), of the dismantling-formwork strength of concrete, in % of the design (Rpr)

Concrete class and cement grade	^0C of concrete	Value in days at dismantling-formwork strength of concrete in % of the design			
		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	28
	30	0,5	6	10	24
Concrete class B15 ... B22.5 of 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 panels 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 standard – 70%.

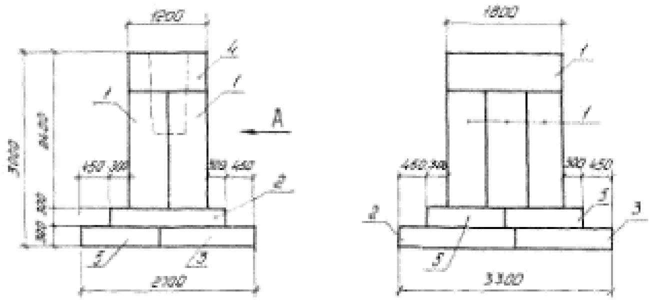
3. For dismantling the formwork of structures with a span of more than 6 m – 80%.

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

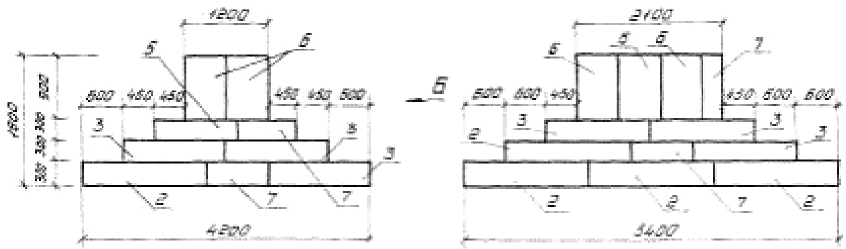
Appendix Q

Scheme of unfolding formwork panels

Φ-1



Φ-2



Connection of two panels between themselves

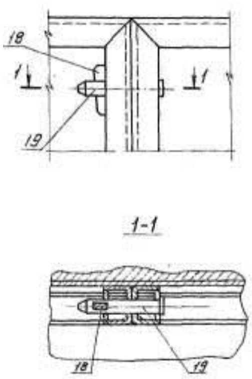


Table Q.1

Specification of formwork elements

Pos.	Name	Brand	Quantity for one foundation, pcs.		Square of shields, m^2			Weight, kg		
					One shield	for foundation		Units	for foundation	
			Ф-1	Ф-2		Ф-1	Ф-2		Ф-1	Ф-2
1	Shield	ЩМ 1,8´0,6	12	-	1,08	12,96	-	46,2	554,4	-
2	Shield	ЩМ 1,8´0,3	4	10	0,54	2,16	5,40	29,6	118,4	296,0
3	Shield	ЩМ 1,5´0,3	4	12	0,45	1,80	5,40	24,6	98,4	295,2
4	Shield	ЩМ 1,3´0,6	3	-	0,72	1,44	-	32,2	84,4	-
5	Shield	ЩМ 1,5´0,3	6	2	0,36	2,16	0,72	20,0	120,0	40,0
6	Shield	ЩМ 0,9´0,6	-	10	0,54	-	5,40	24,9	-	249,0
7	Shield	ЩМ 0,9´0,3	-	8	0,27	-	2,16	15,3	-	122,4
8	Brace	Сх-3,6	4	4	-	-	-	25,2	104,8	104,8
9	Brace	Сх-3,0	4	10	-	-	-	22,2	88,8	222,0
10	Brace	Сх-2,4	6	10	-	-	-	18,2	109,2	182,0
11	Brace	Сх-1,8	6	4	-	-	-	14,3	85,8	57,2
12	Brace	Сх-1,2	-	2	-	-	-	10,5	-	21,0
13	Mounting angle	УМ 1,2´0,3	8	-	-	-	-	2,8	22,4	-
14	Mounting angle	УМ 0,6´0,3	-	4	-	-	-	1,5	-	6,0
15	Mounting angle	УМ 0,3´0,3	8	16	-	-	-	0,8	6,4	12,8
16	Tension hook		82	102	-	-	-	0,21	17,2	21,4
17	Wedge	Z=125 mm	82	102	-	-	-	0,25	20,5	25,5
18	Wedge	Z=80 mm	34	34	-	-	-	0,06	2,0	2,0
19	Pin	Z=123 mm	34	34	-	-	-	0,95	32,3	32,3
20	Bracing wire	-	20 m	30 m	-	-	-	0,4	8,0	12,0
21	Bracing wire lock	-	12	12	-	-	-	0,64	7,7	7,7
22	Socket-type recess	-	1	1	-	-	-	81,0	81,0	81,0
23	Corbel with flooring	-	1	1	-	-	-	96,5	96,5	96,5
Total by items1-23		-	-	-	-	20,5	19,1	-	1638,2	1886,8

Note: positions of the specification are shown in the Fig. Q.1.

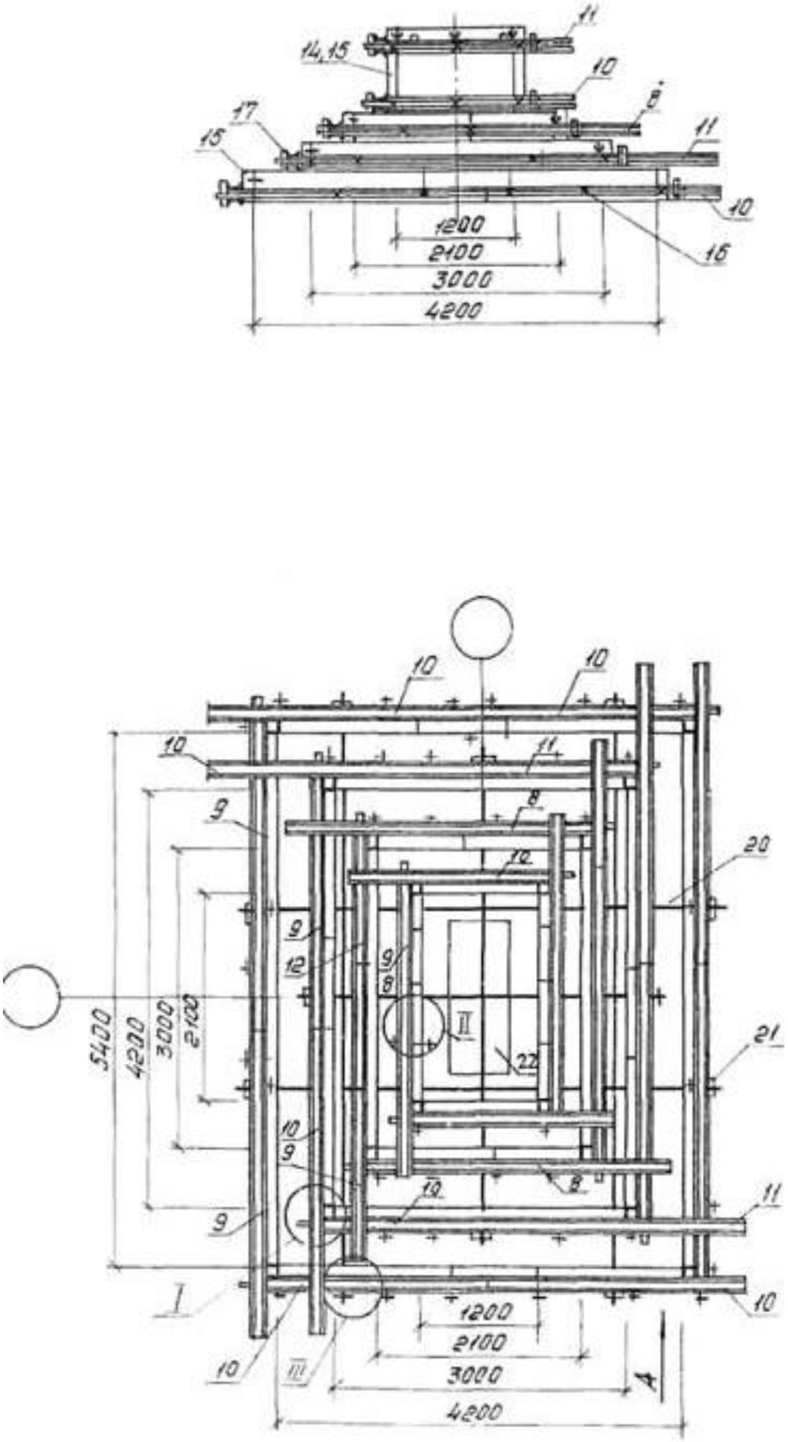


Fig. Q.1. Scheme of installation of panel formwork

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