Pioneer Development of Facility Construction Territory

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Abstract. Peculiarities of pioneer development of facility construction territory in hard-to-reach and underdeveloped areas are considered. It is given the specificity and variety of work for the implementation of which it is advisable to organize a complex flow. The procedure of technological calculations and the construction of the corresponding cyclogram and schedule of pioneer development of the territory, which should be part of the facility construction schedule of the construction management plan, is disclosed. Such a schedule is the basis not only for determining the need for employees, construction equipment, materials, and structures, but also for creating schedules for employees' work and rest periods and their turnover during the pioneer development of the territory. The main goal of this work is to improve in-line construction methods using advanced organizational and technological solutions for pioneering the development of the territory for the future construction of buildings and structures. This approach allows, as a result of the application and implementation of the described principles, to form the optimal organizational and technological scheme for carrying out strip-mounting works taking into account the specifics of pioneer development and the preparatory period as a whole. In addition, the principles being implemented significantly affect the duration of work and minimize downtime of construction flows. As a result of the study, the author provides a generalized system of principles for rationalizing organizational and technological solutions for the pioneer development of construction territories, which in the future can be used as the basis of an automated apparatus for optimizing the model of building an object in pioneer territories through the use of cyclograms and advanced mathematical methods.

1. Introduction
Facility construction in hard-to-reach and underdeveloped areas is a serious problem, since in these areas, as a rule, there are no construction organizations and bases for the construction industry, social and transport infrastructure, and sources of energy resources [1, 2]. Therefore, before proceeding with the construction of the planned facilities, it is necessary to solve a set of tasks for the life support of construction units and the preparation of the material and technical base and territory of future facilities and off-site communication routes. The solution to these problems is the stage of pioneer development of the territory, which is carried out before the start of the preparatory period [3, 4].

2. Materials and Methods
2.1 Pioneer period features
Initially, organizational, economic, and engineering measures are taken to create housing and provide employees with food, medical and social services. This is preceded by targeted preparation for the pioneer development of the territory, which is carried out at the levels of design, planning, and

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construction management [5, 6]. In particular, draft programs for pioneer development of territories are being developed, the capacities of the respective construction units are being calculated, organizational and technological solutions are being developed and optimized as part of construction organization projects, the construction industry is planned to be developed, etc.

Pioneer works are very diverse, specific and individual, but the basic ones, as a rule, are:

- territory preparation, including felling of trees and shrubs, clearing of stumps, clearing, and planning of the territory, drainage of swamps, soil stabilization, etc.;
- installation of runways and helipads, mooring coastal facilities, raft craft, etc.;
- creation of storage and assembly sites for the reception and placement (assembly) of arriving construction equipment, technological equipment, structures, and materials;
- formation (assembly) of mobile complexes of residential, communal and public purposes;
- assembly of engineering facilities and units for water, heat, electricity supply;
- earthworks, including the development of trenches, laying tunnels, washing dams, etc.;
- installation of monolithic concrete and reinforced concrete structures, including the installation of sites, concrete floors, etc.;
- engineering communications laying, including trenchless laying, device of duct-free networks, etc.;
- construction of roads with crushed stone and hard surface from precast and monolithic reinforced concrete.

2.2 Organization of work
In order to carry out pioneer works, it is advisable to organize a complex flow, which combines object flows on the construction of a residential settlement, arrangement of water, heat, electricity supply; establishment of a transport network, etc. Such a flow includes 16-25 object flows, and an object flow consists of 2-8 specialized flows (Table 1).

Table 1. Structure of the complex flow in the pioneer development of the territory (fragment)

| Flow no. | Object flow                        | Specialized and private streams                                                                 |
|---------|------------------------------------|---------------------------------------------------------------------------------------------------|
| 1       | Territory preparation               | Felling of trees of a forest, uprooting of stumps, cutting and uprooting of bushes and small forests, uprooting and removal of oversized stones, backfilling of holes after uprooting of stumps |
| 2       | Territory ground leveling          | Development, movement and laying of soil                                                          |
| 3       | Helipad installation               | Arrangement of a working area with a side and end safety strip, artificial runway                  |
| 4       | Construction of residential villages | Installation of concrete (gravel) foundation, installation (blocking) of containers, laying of external engineering networks |
| 5       | Arrangement of roads and driveways  | Installation of hod, curb, sand blanket, hand-pitched stone subbase, laying of plates (monolithic coating) |
| 6       | Installation of external power supply networks | Trench development, bed preparation, cable laying, trench filling                                 |
| 7       | Arrangement of drains              | Development of trenches and pits, pipe laying and testing, installation of wells, backfilling of trenches |
| 8       | Installation of external water supply networks | Development of trenches and pits, pipe laying, installation of fittings, network testing, installation of wells and chambers, backfilling of trenches |

When organizing an integrated flow for pioneer development of the territory, the following conditions should be taken into account:
all object flows should be developed in a strictly defined technological sequence, determined depending on the influence of natural and climatic factors and the degree of development of the area;
object and specialized flows should be maximally combined in time, avoiding unreasonable breaks between them;
time and rate of implementation of object flows should ensure timely opening of the fronts of related work.
Technological calculations and construction of complex flow cyclogram should be carried out in the following sequence:
determination of the duration of the deployment period of all object flows as part of a complex flow;
development of an integrated flow design scheme with an indication of the amount of work for each object flow;
establishing the duration of object flows and their main parameters (intensity, time of inclusion in the complex flow);
construction of progress schedule for each object flow;
construction of the cyclogram of the integrated flow for the pioneer development of the territory (Figure 1).

The intensity of the finished product complex flow can be defined as

$$J_k = \frac{V_p}{T}$$  \hspace{1cm} (1)

where $J_k$ - intensity of output of the finished product by a complex flow;

$V_p$ - total volume of work performed in the integrated workflow, expressed in appropriate units of the finished product;

$T$ - duration of the finished product in a complex flow, days.

In case of pioneer development of the territory with finished products, the results of the work of object flows can be considered conditionally, and their meters are units of the volume of work, for example, for preparing a territory - m², excavation - m³, laying utility networks - m, etc. Therefore, the intensity of the complex flow can be defined as the sum of the intensities of the object flows, but expressed in the unit of measure of the finished product of the complex flow (m², rub.).
As experience has shown, the period of deployment of the complex flow of pioneer development of the territory in hard-to-reach and underdeveloped areas is at least 200-250 working days. Consequently, the output period of the finished product of the complex flow will be

\[ T = T^H - t \] (2)

where \( T^H \) - estimated (directive) duration of the pioneer period, days;
\( t \) - duration of the deployment of the complex flow, days

The intensity of object flows is determined from the condition that all object flows, except the first, are performed at a uniform pace and must be completed by the beginning of the reception of labor resources, construction equipment, technological equipment, structures and materials, i.e.

\[ J^o_i = W^p_i \cdot f^k \] (3)

where \( J^o_i \) - intensity of the \( i \)-th object flow;
\( W^p_i \) - production volume of the \( i \)-th object flow per unit volume of final production of complex flow, defined as
\[ W_i^p = \frac{W_o}{V_k} \] (4)

where \( W_o \) - production volume of the object flow;
\( V_k \) - production volume of the complex flow.

The intensity of the first object flow for the preparation of the territory is calculated separately since it opens the working area for the remaining object flows.

3. Results and discussions

Based on the indicators of the intensity of object flows and their volumes of work, a schedule for pioneer development of the territory is being developed, which may be part of the schedule for the construction of facilities in the construction organization project. According to this schedule, it is traditionally possible to determine the need for employees by time periods, construction equipment, structures and materials.

The schedule for pioneer development of the territory is, of course, not the only document and is supported by a number of other tasks to be solved, including:

- highlighting the features of the pioneer work in difficult conditions;
- justification of the organizational and technological scheme that determines the sequence of development of the territory;
- determination of the technological sequence of work in certain areas;
- statement of requirements for the methods and forms of organization and performance of works;
- justification of decisions on the storage of equipment, structures, and materials and their enlargement;
- formation of proposals for the organization of geodetic control and ensuring the quality of work performed;
- justification of decisions on environmental protection and land site restoration.

Important documents for the effective pioneer development of territories include the schedule of working and resting hours of employees, the schedule for employee rotation, as well as documentation on the organization of a mobile residential complex (rotation shift camp).

Work and rest regimes of employees are formed taking into account the characteristics of the territory being developed, the characteristics of the production processes being carried out, biomedical and legislative restrictions, the climatic conditions of work, the degree of acclimatization of the employee. Common work schedules, for example, on a rotational basis, are “symmetric” and “asymmetric” schedules. In the first case, the employee works for 15 days and rests for 15 days, and in the second case, two months of work are replaced by a month of rest. It should be noted that according to the results of domestic and foreign studies, reduction factors for rotation shift employees at 9, 10, 11, and 12-hour work shifts have been developed, which serve as an appropriate guide when drawing up schedules of work and employees’ rest.

Rotation (expeditions) of employees is usually carried out by brigades and less often by team units. Management and engineering personnel, as well as employees of auxiliary and operational services, are replaced according to individual schedules, depending on the current situation and the need for continuous work at the facilities.

Delivery of employees to the place of work and back is carried out exclusively centrally and is fully paid by the construction organization.
The working time of rotation shift (expedition) employees is recorded by the sheet, one of the samples of which is given in Figure 2.

| No. | PerNo | Full name | Days of month |
|-----|-------|-----------|---------------|
|     |       |           | 1 2 3 4 5 6 7 8 9 1 0 1 2 3 4 5 6 7 8 9 10 11 12 | 3 1 Total |

Approved:

Head of the organization

______________________________
(signature)

SHEET

of recording the calendar days of the expedition and on the way when working with the expeditionary rotation shift method in the Far North and in areas equivalent to them

__________ ____________
(name of organization) (facility name)

for ________ month ________ year

Superintendent engineer (master)

______________________________
(signature)

Legend: 10 - number of hours actually worked during the working day;
D - days on the road;
W - weekends and holidays;
P - days of periodic rest;
O - “off” rotation period;
Db - days of disability.

Figure 2. Approximate sheet of recording the calendar days of the expedition and on the way when working with the expeditionary rotation shift method in the Far North and the areas equivalent to them

Rotation shift camps are created, and if available, settlements are used as housing for temporary residence of employees. Rotation shift camps usually consist of mobile (inventory) buildings of collapsible and container types of residential and public purposes. In such camps, employees are provided with food, medical, sanitary-hygienic, and trade services.

4. Conclusions

The initial stage in the construction of facilities in hard-to-reach and underdeveloped areas is the pioneer development of the territory of future facilities, which consists in the implementation of life support measures, acceptance and deployment of building and installation formations and their material and technical base, and preparation of the territory for construction.

Pioneer work should be carried out in the form of a complex flow, including a set of object flows for the construction of a residential village, the creation of engineering infrastructure, and the preparation of the entire construction area. Such a flow may include from 16 to 25 object flows.

It is advisable to take the intensity and the period of production of finished products as the main parameters of the complex flow for pioneer development of the territory. In this case, the intensity of the complex flow is defined as the sum of the intensities of the object flows expressed in the unit of measurement of the finished product of the complex flow.
According to the indicators of the complex flow, an appropriate schedule is being developed for pioneer development of the territory, which may be an integral part of the schedule for the construction of construction projects. Such a schedule serves as the basis for drawing up the need for employees, construction equipment, materials and structures.

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