

# The System of Indicators for Assessing a Mobile Construction Company

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## ABSTRACT

Mobility is the most important property of the building system, and almost all construction companies and their formations have the appropriate mobility. In conditions of market relations, construction companies, due to high competition, are continuously increasing the scope of work outside their permanent location. In addition, in recent years, hard-to-reach regions of the Far North, Siberia and the Far East have been actively developed. For this, mobile forms of labor organization are increasingly used - rotational and expeditionary ones, which allow the autonomous development of territories and the construction of various objects on them away from the primary production structures, stationary enterprises and bases of the construction industry and social infrastructure. In this regard, it becomes necessary to assess the sufficiency of mobile elements in a construction company, the possibility of their quick delivery to the construction areas, bringing them to the required concentration and ensuring the reliability of work. Therefore, the whole set of mobile construction processes is presented in the form of a system consisting of three interconnected subsystems - the formation of the structure and capacity of the construction company, the movement and concentration of resources of construction formations, the implementation of production processes, and the creation of finished construction products. For each of the subsystems, based on the description of their procedures, the corresponding estimated indicators, methods of their calculation and comparative analysis are proposed.

**Keywords:** *mobility of a construction company, mobile elements, fixed assets, concentration of resources, assessment of the degree of mobility, degree of mobility; organizational and technological solutions, management*

## 1. INTRODUCTION

In the years of market relations, the mobility of construction companies and their units increases significantly. This is facilitated not only by the development of new hard-to-reach areas, but also, above all, by the search and implementation of the scope of construction and installation work due to high competition outside the permanent deployment of the construction company. As a result, construction companies transfer their structural units to mobile forms of labor organization - rotational and expeditionary ones, purchase high-performance mobile equipment, transport means of mechanization and technological equipment, mobile factories of the construction industry and a base for assembling materials and structures [7, 9].

Nowadays, in the overwhelming majority of construction companies, mobile elements for organizing work make up a significant part of fixed assets. This indicator, together with a set of measures for the organization of labor, is an objective and quite sufficient characteristic of the level of mobility of a construction company before the start of work. At the same time, when developing new territories and erecting buildings and structures on them, such a characteristic will clearly not be enough [5].

## 2. MATERIALS AND METHODS

The functioning of the mobile system can be expressed in the form of three interconnected subsystems - the formation of the structure and capacity of the construction company, the movement and concentration of resources of construction formations, the implementation of production processes, and the creation of finished construction products.

Each of these subsystems differs in its area of action, tasks, functions and methods of their implementation, which ultimately characterizes mobility as an objective property of the construction system.

## 3. RESULTS

In the first subsystem, the construction company is first transferred to the mobile status - the "Regulations on the rotational method of organizing work" is developed and approved, an order on the procedure for transferring employees to the rotational method is put into effect, additional agreements to labor contracts are concluded.

The expediency of developing the "Regulations on the rotational method of organizing work" is dictated by the need to combine in one document the fundamental provisions on the working conditions of the rotational method - organization of work (formation of shift personnel, delivery of workers to the shift and back), organization of shift camps (housing and communal and sanitary services for workers), work and rest regime (summary recording of working hours, duration of work shift and inter-shift rest), remuneration, benefits and compensations (procedure for remuneration, bonuses for employees, accounting for overtime work, allowances to the tariff rate, accounting for regional coefficients) and other sections that take into account the specifics of the construction company [1, 13].

Next, a program of pioneer development is formed, which includes a list of sites accepted for pioneer development during the planned and subsequent year, indicating the start and end dates of pioneer work on these sites and with the allocation of the amount of work performed under the general contract and by own forces. On the basis of data on the distribution of the scope of work by performer, general contractors determine subcontractors for construction sites and facilities, and draw up protocols for agreeing the scope of work with them. At the same time, the agreed delivery schedules for the required resources are transferred to the construction and special departments. The distribution of the scope of work at the pioneer facilities is carried out taking into account the requirements of their rhythmic development, based on the conditions of the most complete and even load of the production capacity of mobile formations [11].

At the stage of agreeing on the scope of pioneering work, the production capacity of the subdivisions involved for their implementation is determined by an aggregated calculation based on data on the number of employees and output. At the same time, issues are being resolved and new pioneer units are being formed.

On the basis of the specified data, work production schedules for all divisions and consolidated schedules are developed. Consolidated schedules for the production of work are optimized based on the conditions of uniform and continuous use of labor and technical resources due to:

- determination of the order of work execution at the facilities;
- combining the performance of work in time;
- changes in the intensity of resource consumption.

The second subsystem is characterized by the processes of movement and concentration of construction production resources in the territory of pioneering development. Delivery of workers to facilities is carried out, as a rule, centrally on the basis of employee turnover schedules depending on the form of work organization and the approved cycle of work and rest regimes, including the duration of the shift (expedition), travel time from the place of permanent residence to the construction site and back, and the duration of the necessary rest. Travel time includes the number of days it takes to get workers to work and back. Delivery of workers to the place and back can be carried out by road and rail transport, civil aviation and river fleet.

Moreover, all vehicles must be specially equipped for the transport of people.

The concentration of workers at construction sites can be carried out by brigade or by links. With concentration by brigade, as a rule, a complete change of the worked brigade with a new brigade is carried out. In the case of using turnover by links, the work of each link is carried out according to a flexible schedule [7].

The change and delivery of workers associated with the maintenance and operation of rotational camps and industrial and warehouse complexes to the place of work and back is carried out according to an individual schedule, which should ensure the continuity of maintenance of construction production, accounting and safety of material values.

Logistical support of works and activities of pioneering development of new construction sites is carried out on the basis of production and technological completion of development objects with the supply of building structures, products, materials and equipment with technological kits in accordance with the schedule of construction and installation works.

When planning and organizing complete deliveries, it is recommended to use a unified regulatory and technological documentation (URTD), which is included in the work production project. To increase the efficiency of supplying the facilities under construction with the necessary material and technical resources, it is advisable to introduce payments for the supplied technological kits in accordance with the schedule of construction and installation works. Supplies of material and technical resources are directly planned for the rotational brigade.

As a regulatory framework for determining the need for material and technical resources, working drawings of objects, data from the stages of engineering surveys, work projects and technological schemes, regional rates of consumption of materials in capital construction are used.

The third subsystem includes the implementation of production processes and the creation of finished construction products. The construction of facilities in hard-to-reach and underdeveloped areas consists of three periods - pioneer development of the territory, preparatory and main periods.

Pioneering development includes preliminary preparation of territories for future construction and a set of measures for the receiving and deployment of construction and assemblage units and their material and technical base [6, 7]. The scope of work on the preliminary preparation of territories includes a part of the work related to the preparatory period for the construction of facilities in developed areas - the creation of a geodetic grid base, drainage of swamps, uprooting of stumps and bushes, etc. In the zone of permafrost soils, special work related to soil stabilization is also carried out.

The complex of measures for the preparation of life support consists of organizational, economic, engineering and technical measures.

The first envisage actions to provide workers with housing, fuel, water, food, energy, medical services, reliably

operating both inside and inter-district transport and communications.

The engineering and technical life support measures include: the creation of receiving areas - "targets" for dropping urgent cargo from aircraft; helipads and runways, berthing and mooring coastal devices and structures, assembly of offshore floating craft, storage and assembly sites for receiving people, machines and mechanisms, equipment, materials, structures from base centers, as well as assembly of mobile residential complexes, objects of utility and public services, engineering facilities, heat, water, and power supply units.

For specialized mobile units, the basic nomenclature is such types of work as deforestation, clearing and planning of the territory, drainage of swamps, artificial consolidation of soils, road construction, embedding of dams, construction of water, energy and heat supply lines, receiving and placement of labor and material and technical resources, etc.

The preparatory period includes off-site and on-site work [2, 3, 10].

Offsite preparatory work includes the construction of external access roads to the construction site and supply bases, railways and automobile roads, berths, power transmission and communication lines, water supply networks with fences. The existing practice of the production of off-site preparatory work in industrial, housing and civil and other types of construction is based on solutions that ensure the possibility of their implementation in the main volume before the start of construction of facilities, buildings and structures. These solutions include the definition of spatial and temporal parameters: the scope of work, their beginning and end, intensity, alignment, continuity, etc.

It is expedient to consider the on-site preparatory work in the form of three interconnected formations (groups): preliminary preparation of the territory, engineering preparation of the construction site, construction of mobile (inventory) complexes (construction camp).

To carry out the work of the preparatory and main periods of construction, an operational dispatch control service is created [4, 8, 12, 14]. In their work, dispatching personnel use:

- weekly and daily schedules of work and schedules for the provision of construction materials, structures and other material resources, mechanization and vehicles;
- consolidated statements of supplies of building materials and transportation schemes;
- regulatory, organizational and technological documentation;
- minutes of supervisory meetings;
- the dispatcher's log containing a list of incoming orders and messages with dates, times, from whom they were received and to whom they are intended, as well as the date, time and mark on the implementation of the measures taken by the dispatcher;
- network and linear construction schedules;
- situational plan of the construction area;
- construction master plan of the object under construction;

- information and reference materials on topics related to this construction object;

- provisions on actions in case of fires, accidents and other emergencies.

The degree of mobility of a construction company is determined based on the recommendations [5] as the ratio of the cost of mobile elements of fixed assets to the total cost of assets:

$$K = \frac{f}{F} \quad (1)$$

where  $f$  – the cost of mobile elements of fixed assets of a construction company;

$F$  – the cost of fixed assets of a construction company.

In this case, at each moment of time, the value of  $f$  will be:

$$f_{\mu} = \sum_{i=1}^n f_{i\mu}^{(1)} + f_{\mu}^{(2)} + f_{\mu}^{(3)} \quad (2)$$

where  $f_{i\mu}^{(1)}$  – the cost of mobile elements used at the  $i$ -th object in the  $\mu$ -th period of time;

$f_{\mu}^{(2)}$  – the cost of mobile elements being repaired in the  $\mu$ -th period of time;

$f_{\mu}^{(3)}$  – the cost of free (unused) mobile elements in the  $\mu$ -th period of time.

To assess the degree of mobility of workers, the following expression can be used:

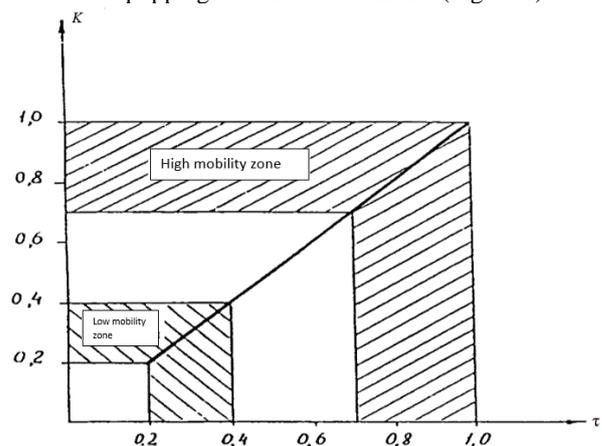
$$\tau = \frac{q}{p} \quad (3)$$

where  $\tau$  – the degree of mobility of workers in a construction company;

$q$  – the number of construction brigades transferred to mobile forms of labor organization;

$p$  – total number of construction brigades.

Indicators  $K$  and  $\tau$  are interconnected and with a change in the value of one of the indicators, the value of the other changes proportionally. The validity of this provision is confirmed by the practice of construction companies: the creation of a mobile formation is carried out with its simultaneous equipping with mobile elements (Figure 1).



**Figure 1.** Relationship between indicators of the degree of mobility  $\tau$  and  $K$

The degree of mobility of the formation (brigade, area) can be estimated as

$$K_{i\mu} = \frac{f_{i\mu}^{(1)}}{F_{i\mu}} \quad (4)$$

where  $F_{i\mu}$  – the cost of fixed assets of a construction organization at the  $i$ -th object in the  $\mu$ -th period of time.

To assess the level of concentration of resources of mobile formations in the development of territories and the construction of facilities, it is recommended to use the average intensity of work on the facility as a reference indicator, which is defined as

$$\bar{J}_i = \frac{C_i}{T_i} \quad (5)$$

where  $\bar{J}_i$  – the average intensity of work at the  $i$ -th object;

$C_i, T_i$  – the estimated cost and duration (standard, estimated) of the  $i$ -th object, respectively.

The actual scope of work performed by mobile formations at the  $i$ -th object in the  $\mu$ -th period of time will be

$$J_{i\mu} = \frac{V_{i\mu}}{t_\mu} \quad (6)$$

where  $V_{i\mu}$  – the actual scope of work performed at the  $i$ -th object in the  $\mu$ -th period of time;

$t_\mu$  – duration of the  $\mu$ -th time period.

Then the main condition determining the degree of concentration of resources on the  $i$ -th object will be equal to

#### 4. CONCLUSIONS

Thus, at each stage of design, planning and production of work with the use of rotational and expeditionary modes of work, it is possible to assess the degree of mobility of construction units and their readiness for reliable operation. For this purpose, a set for determining the estimated indicators and methods for their comparison is proposed.

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$$J_{i\mu} = \bar{J}_i \quad (7)$$

If this condition is not met, then the following cases are possible

$$a) J_{i\mu} > \bar{J}_i \quad (8)$$

In this case, the actual intensity of work production is higher than the average intensity and, therefore, due to the reduction of resources, the position can be leveled in the next ( $\mu+1$ ) period of time, and then the actual intensity of work production will be

$$J_{i,\mu+1} = \frac{V_{i,\mu+1}}{t_{\mu+1}} - \left( \frac{V_{i\mu}}{t_\mu} - \frac{C_i}{T_i} \right) \quad (9)$$

$$b) J_{i\mu} < \bar{J}_i$$

Here, the shortage of resources does not allow achieving the average intensity of work on the object. Therefore, the resource concentration indicator should be increased to ensure the following actual intensity of work

$$J_{i,\mu+1} = \frac{V_{i,\mu+1}}{t_{\mu+1}} + \left( \frac{C_i}{T_i} - \frac{V_{i\mu}}{t_\mu} \right) \quad (10)$$

But in this case, the obtained expressions [9, 10] are identical and after some transformations will have the following form

$$J_{i,\mu+1} = \frac{V_{i,\mu+1} \cdot t_\mu - V_{i\mu} \cdot t_{\mu+1} + \bar{J}_i \cdot t_{\mu+1} \cdot t_\mu}{t_{\mu+1} \cdot t_\mu} \quad (11)$$

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