Site preparation in agro-industrial construction

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Abstract. The complex conditions of the execution of works on the site preparation in industrial construction are analyzed. These conditions include the influence of architectural and planning decisions of buildings and building density, the high saturation of the territory with engineering and transport communications and their numerous intersections and junctions. A complex of influencing factors is singled out, the most significant of which are selected using the construction of a multifactor model for determining the complexity of the development of the construction site. The method of determining the degree of progressiveness of the selected factors is indicated.

1. Introduction
Intrasite preparatory work consists of three interconnected stages - preliminary preparation of the construction site territory, its engineering preparation, construction of construction camps. The ratio of volumes for such stages in industrial construction is 2-5%, 75-80%, 15-25%, respectively. Territorial engineering preparation works are extremely complex and time-consuming, since they include the installation of transport communications, the re-installation of existing engineering networks, the laying of water supply, heat supply, energy supply networks and their intersections, the construction of cable, air ducts and other tunnels and canals, the construction of buildings and structures for the construction needs [3, 4, 5]. Decisions on the engineering preparation of territories provide for the determination of a large number of spatio-temporal parameters – the scope of work, their start and end, intensity, combination, continuity, etc. [1, 2]. Making engineering decisions is complicated by the influence of a number of factors reflecting the complex conditions of work.

2. Materials and Methods. Analysis of working conditions
When designing an industrial enterprise, its territory, as a rule, is divided into pre-factory, production, utility and storage areas. In the pre-factory zone there are administrative, domestic and engineering-laboratory buildings (plant management, canteens, fire stations, etc.). In the production area there are main workshops and production facilities for the industrial production.

The utility area is comprised of mechanical repair shops, water supply and electricity supply facilities, etc. The storage zone is comprised of buildings and structures for receiving, unloading and storing of raw materials and finished industrial products. Each area and interzonal space is saturated with diverse combinations of elements of the preparatory period (Table 1).
Table 1. Elements of preparatory period.

| Elements of preparatory period | Functional purpose | Design characteristics | Type of use material |
|--------------------------------|--------------------|------------------------|----------------------|
| Pipe-line                      | Water supply, drainage, heat, air and gas supply, product pipelines | Flange, socket, sleeve, with smooth ends | Cast-iron, steel, concrete, reinforced concrete, asbestos-cement, ceramic, plastic |
| Heading                        | Communication, cable, air-duct, pedestrian, over-the-road, collector | Monolithic, integrated, integrated-monolithic, made of piece materials | Reinforced concrete, concrete, brick |
| Channel                        | Heating, ventilation, cable, communication | The same | The same |
| Cable block                    | Electric cable, telephone | Integrated, integrated-monolithic, piped | Made of asbestos-cement pipes, concrete, reinforced concrete, reinforced concrete, concrete, gravel, crushed stone, soil, asphalt |
| Highway                        | Intrastate, intrainstallation, access | Integrated, integrated-monolithic, monolithic, made of bulk materials | Reinforced concrete, concrete, gravel, crushed stone, soil, asphalt |
| Site                           | On-site, assembly-picking, warehouse | Monolithic, integrated, made of made of bulk packed materials | The same |
| Foundations of elevated overpasses | Overpass | Integrated, monolithic, integrated-monolithic, pile-supported, pile-stand | Reinforced concrete, metal |
| Mobile building                | Production, storage, auxiliary, residential, public | Containerized (with running gear, without running gear), temporary structures | Wooden, metal, wood-metal, made of new materials (plastic) |

Architectural and planning decisions of buildings and structures, their number and industrial relations between them determine the size of the territory of an industrial enterprise. For example, metallurgical plants include facilities for primary production purposes - steelmaking, rolling, blast furnaces, coke ovens and other workshops, which make up about 60% of the total plant area with very high saturation of underground, elevated and transport communications. The building density of industrial enterprises is 20-45%, and in individual sections of workshops it can be 70-75%. So, the area of the complex of a 2-battery coke oven unit is 1100-1300 m long and 400-600 m wide. Up to 130 buildings, structures and installations are located on this territory.

As a rule, around the perimeter of an industrial enterprise there are ring roads with driveways and entrances to workshops along which the main sections of underground and aboveground communications are located. Branches of communications to the workshops depart from the main sections. The length of communications for the coke-chemical complex of an odd coke oven battery is about 40 thousand meters, and taking into account the multi-channel cable blocks more than 90 thousand meters. About 80% of all communications are parallel to each other and only 20% of communications are located apart.

On the territory of industrial enterprises underground and transport communications are distinguished by a significant number of mutual intersections and junctions to buildings and structures. On average, there are 300-500 junctions, 600-800 intersections between each other and up to 550 intersections with transport communications.

Sometimes there are tunnels on the territory of the enterprise, which are used not only for parallel pipelines and cables, but less often as large ducts to provide workshops and installations or as
transport routes for workers. Typically, tunnels account for up to 15-20% of all pipelines and, together with underground trestles, more than 80% of electric and telephone cables. To continue cable tunnels and overpasses, cable blocks are used when laying inter-shop electric cable and telephone networks, which can be made of reinforced concrete multi-channel panels or a set of asbestos-cement pipes with a diameter of 100-150 mm.

Rotary and linear electric cable wells are made of cast concrete, and linear sections of cable blocks are enclosed in thin-walled concrete or reinforced concrete clips.

The designs of tunnels, channels and blocks installed on the territory of an industrial enterprise, as a rule, are low-tech due to the heterogeneity of the elements and the low degree of their factory readiness. The labor intensity of monolithic sections, including turning angles, ventilation shafts and installation openings is about 3 times higher in comparison with prefabricated structures.

3. Results and discussions

If it is impossible to use permanent communications or if there are no project routes of the same designation, it is necessary to develop options for using other communications in places of energy consumption. In addition, temporary jumpers are provided in the spacing between the used communication sections. Fecal, drainage and industrial sewage (both gravity and pressure), pressure pipelines of drinking, industrial, reverse and rain water, systems of heat and air can be interchangeable. It should be noted that the options of used pipelines, roads and railways may not have the optimal length, since the routing schemes are designed. As a rule, the length of access roads, of water supply, heat, energy and sewage can increase [6, 8]. However, the additional costs in such cases are small compared with the construction of temporary communications [7, 9].

A significant amount of preparatory work is occupied by the construction of temporary roads. In some cases, the area of use of permanent roads is 75-80%. As a rule, asphalt road pavements can be asphalt-concrete on a gravel base, monolithic concrete and reinforced concrete on sand and gravel base, prefabricated reinforced concrete slabs on a sand base. For all these structures, side stones are not installed, storm drains are arranged, and seams between the plates are poured with bitumen or bitumen rubber mastic. The destruction at this arrangement of roads is not more than 15 - 20%.

Distinctive features of the site preparation are the rather high laboriousness of performance of general construction and special construction works, as well as their complex coordination in time and space both among themselves and with the construction of buildings and structures.

Long-term practice of site preparation shows that the complexity of on-site works depends on the influence of a variety of factors that were evaluated as a result of an expert survey (Table 2).

Since the “noise level” was in the range of 15-20%, therefore, the main factors influencing on the complexity of the construction site development are K2, K4, K6, K7, K9. As a result of the construction, the multivariate regression model has the following form:

\[ Q = 29.12 - 0.565K_2 - 0.106K_4 - 0.305K_6 - 0.116K_7 - 0.102K_9, \]

where Q is the complexity of the construction site development.

Table 2. Characteristic of factors of the construction site development.

| Factor                                           | Factor code | Factor value (when ranking by factor K3), % |
|--------------------------------------------------|-------------|---------------------------------------------|
| Technological effectiveness of utilities construction methods | K1          | 19                                          |
| Advance construction of utilities under the transport paths of the construction site | K2          | 54                                          |
| Timely production and technological equipment with materials and products | K3          | 0                                           |
| Combined laying of various utilities located outside the construction zones of objects | K4          | 71                                          |
The choice of rational sets of construction machines and mechanisms

Combined laying of various utilities and the construction of underground parts of buildings and structures

Replacing the functions of temporary utilities and transport communications with permanent ones

Soil readiness for excavation at low temperatures

Advance combined laying of utilities under assembly and storage sites

| Factor Description                                      | K<sub>i</sub> | Value |
|--------------------------------------------------------|--------------|-------|
| Combined laying of various utilities and the construction of underground parts of buildings and structures | K<sub>5</sub> | 8.2   |
| Replacing the functions of temporary utilities and transport communications with permanent ones | K<sub>6</sub> | 62    |
| Soil readiness for excavation at low temperatures | K<sub>7</sub> | 38    |
| Advance combined laying of utilities under assembly and storage sites | K<sub>8</sub> | 13    |
| Soil readiness for excavation at low temperatures | K<sub>9</sub> | 64    |

The degree of progressiveness of each of the factors left can be measured through appropriate indicators of the reduction in the complexity of work. For example, the indicator of substitution of temporary utilities and transport communications functions with constants can be determined as follows:

\[ P_7 = \frac{\sum_{i=1}^{n} g_{ij}}{\sum_{j=1}^{m} b_{ij}}, \]

where \( P_7 \) is dimensionless coefficient of progressiveness of factor K<sub>7</sub>;

\( g_{ij} \) is the complexity of the construction of permanent utilities and transport communications on the i-th site of the construction site, \( i = 1, n \);

\( b_{ij} \) is the complexity of the construction of permanent utilities and transport communications on the j-th site of the construction site, \( j = 1, m \).

4. Discussions and conclusions

The multivariance of decisions on the site preparation is determined by the great variety of combinations of elements of the preparatory period, which include pipelines, tunnels, channels, cable blocks, roads, railways, installation sites, foundations of overpasses, underground parts of buildings and structures.

It is advisable to carry out the selection of decisions in stages - development and analysis of a combined plan for the preparatory period, dismemberment of the construction site into homogeneous areas, determination of the technological sequence of work.

The most rational is the following technological sequence of preparatory on-site works – vertical layout of the territory; the construction of household towns of builders; communications’ laying under the road; laying of engineering networks to meet the needs of construction in energy resources; the construction of foundations of elevated overpasses located along roads; the construction of roads used for construction needs; laying of permanent communications passing in recesses combined with parts of buildings and structures; laying of permanent communications under the assembly storage sites; arrangement of installation and storage sites; preparatory works on sites outside the assembly zones for the construction of buildings and structures.

References

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