Combination method of the intrasite preliminary works with the works of main period

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Abstract. The intrasite works volume to be executed prior to the main construction and installation works is specified herein. The part of these works – utility systems installation in combined earth cuts and plots development out of the installation zones of civil engineering – is proposed to be executed in combining with the main period construction works. In this regard there is the solutions development method, containing the determination of structure and volume of the intrasite preliminary works being executed prior to the main construction period and in combining with this period. The dependence of specified parameters from the territory built-up density is shown herein. The obtained calculated indices of works volume may be used for the facility design and works execution, and may serve as a basis for the relevant regulations development (the fragment of such regulations is given in this Article). The specified method efficiency is characterized by the significant reduction of the earth works volume and construction machinery capacity increase.

1. Introduction

The intrasite works on construction site organization and on development of normal working and living conditions for construction organizations are executed during the preliminary construction period of the establishments, buildings and facilities [1- 5]. Such works package includes the geodesic location surveys, buildings breakdown (demolition), territories clearing and planning, utilities laying and removal, temporary roads and storage platforms organization, erection of the facilities for construction use [4, 6-12]. The intrasite preliminary works are executed prior to the main construction and installation works. Their completion is certified by the Certificate made by the Contractor (the Customer) and the general contracting construction organization featuring the subcontractors executing the works during the preliminary period [9 - 16]. However, as construction practice shows, it is appropriate to execute the significant volume of the intrasite preliminary works in combining with the facility main erection works. Such approach allows both lowering the preliminary period duration and above all significantly reducing the volumes of series of works and their cost [17- 20].

2. Practical application

In the industrial construction, long distances between the underground utilities, buildings and facilities foundations provide for their separate erection even in cases of their parallel location at small distances from buildings and facilities. Hence the numerous intersections of earth cuts slopes occur, the volume of earth works increases, especially of those being executed manually, the works execution is significantly complicated. In order to avoid any accidents, the management of enterprises to be
reconstructed may, for example, severely restrict the construction organizations in use of machinery and equipment. Therewith specifically the utilities joint points to foundations as well as their intersections points tend to be accidental because of sagging. Pipelines of different functional purpose with tunnels, channels, cable blocks, above-ground racks foundations as well as their intersections and branches may be placed in the combined earth cuts. The combined trench for 2-5 pipelines may be excavated in one digging using the back shovel excavator. Therewith the earth cuts with vertical walls require for the preliminary earth compacting on the surface, and regular moving earth piles by the bulldozer from the trench edge. Hence earth works volume reduces for 20-40%, and the excavator and bulldozer capacity increases for 15-18% due to diggings number reduction, decrease of free running and earth excavation large volumes at the bounded areas. Besides the combined earth cuts, the areas with utilities out of the installation zones of the buildings and facilities construction may be developed together with the main construction works period as they does not hold in the intrasite preliminary works execution.

3. Results

Thus the intrasite works volume includes the following:
- works to be fully executed prior to the main construction and installation works commencement \((V_1)\);
- work, which may be executed at the same time as the buildings and facilities utilities and foundations in the combined earth cuts \((V_2)\);
- works being executed at areas out of the installation zones of the buildings and facilities construction, which may be executed during the main period \((V_3)\).

General volume of the intrasite preliminary works \((V)\) can be calculated using the following formula

\[
V = V_1 + V_2 + V_3
\]  

(1)

As the works range covers the whole territory of construction site, then the works volume will directly depend on this territory built-up density, i.e.

\[
P = \frac{F_1}{F_2}
\]  

(2)

where \(F_1, F_2\) – built-up area and with account of fencing as applicable.

However, the intrasite preliminary works volume may be expressed through the volume being executed prior to the main period commencement \((V^D)\) and through the volume being executed in combining with it \((V^C)\) by the following formula

\[
V(P) = V^D(P) + V^C(P)
\]  

(3)

As was noted above, value \(V^D(P)\) will be in volume \(V_1\), and value \(V^C(P)\) – in volume \(V_2\). However, at the built-up density tending to zero \((P \to 0)\) the areas plot out of the installation zones of the buildings and facilities construction will tend to a maximum value, and in case of the built-up density tending to one \((P \to 1)\) such plot tends to zero. Thus, in case of the built-up density coefficient change from 0 to 1 the “transformation” of volume \(V_3\) to volumes \(V_1\) and \(V_2\) occurs. Considering that for each facility all components of the intrasite preliminary works volume will be expressed by its own, but constant values, then the regularity of works volume change \(V_3\) may be expressed as

\[
V_3(p) = V^D_3(P) + V^C_3(P)
\]  

(4)

where \(V^D_3(P)\) – volume of the intrasite preliminary works being executed at areas out of the installation zones prior to the main works commencement;

\(V^C_3(P)\) – volume of the intrasite preliminary works being executed at areas out of the installation zones in combining with the main works.

The whole variety of organizational and process solutions for the intrasite preliminary works execution можно свести к определению of the intrasite works structure and volume being executed:

Prior to the main period commencement
Combining with the main works

\[ V^C(P) = V_2 + V_3^C(P) \]  

(6)

To define the functions \( V_3^D(P) \) and \( V_3^C(P) \) selected was for more than 50 facilities presenting the various industrial construction branches and covering the whole range of intrasite preliminary works.

4. Consideration

Statistic modeling results have allowed obtaining the following empiric functions of the preliminary works execution

Prior to the main period commencement

\[ V^D = \begin{cases} 
0.54 \cdot P + 0.48 \cdot P^{0.447} & \text{if } P \leq 0.71 \\
(1 - 0.29 \cdot P) & \text{if } P > 0.71 
\end{cases} \]  

(7)

Combining with the main works

\[ V^C = \begin{cases} 
1 - 0.54P - 0.48 \cdot P^{0.447} & \text{if } P \leq 0.71 \\
0.29P & \text{if } P > 0.71 
\end{cases} \]  

(8)

5. Conclusion

Calculated indices of the volume of intrasite preliminary works being executed prior to the commencement of the facility construction main period and combining with the main construction and installation works may be used directly in the design (project documentation, Section “Construction organization project”), works execution (works execution plans, process charts), operational planning and construction management. Furthermore, the proposed procedures of determination of the intrasite works allocation volumes may serve as the basis for the relevant regulations development (Table 1).

| Facility name | Facility characteristics | Built-up density, % | Volume of preliminary works, % | Calculated indices, % |
|---------------|-------------------------|--------------------|-------------------------------|------------------------|
|               |                         | Prior to the main period commencement | Combining with construction and installation works (CIW) |
| Consumer goods industry | The capacity is equal to 5 mln items of knitted outwear per year | 55 | 8 | 5.32 | 2.68 |
| Fish industry | The capacity is equal to 20 tonnes of finished products per day, with the refrigeration warehouse with a capacity of 25 th. tonnes | 58 | 16 | 10.36 | 5.64 |
| Dairy-and-meat industry | Milk processing capacity of 35 tonnes with 25 tonnes of whole-milk products output per day | 44 | 10 | 5.7 | 4.3 |

Table 1. Calculated indices of the preliminary works execution (fragment)
Meat-packing plant: The capacity is equal to 50 tonnes of meat per shift, with the refrigeration warehouse with a capacity of 2000 tonnes.

| Measuring Unit | Capacity 1 | Capacity 2 | Capacity 3 |
|----------------|------------|------------|------------|
|                | 42         | 12         | 6.63       |
|                |            |            | 5.37       |

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