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Problems of Designing the Organization of Hydraulic Construction and its Need for Solutions

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Abstract: this article discusses the current problems of organizing hydraulic engineering construction and their significance, as well as what and in what order needs to be built in accordance with the "Construction Organization Project" (COP) and detailed designs developed during construction. Stage (DDC) refers to the design associated with what technology to use, in what time frame and with what resources.

Keywords: hydraulic engineering construction, construction and installation works, "Construction Organization Project" (COP), detailed designs developed during the construction stage (DDC), feasibility study of investments, transport schemes, construction period, hydroelectric power station units, construction organization.

The organization of hydraulic engineering construction is a system of interconnected organizational and technological solutions, activities, and work aimed at ensuring effective and high-quality construction of the facility at a planned pace and on time. Organizational and technological decisions are decisions on the organization and technology of hydraulic engineering construction, adopted in organizational and technological documents. Organizational and technological documents are COP and DDC. COP and DDC answer the questions: what to build, in what order, using what technology, in what time frame and with what resources.

Documentation on the organization of construction and production of work includes the section "Construction Organization Project" (COP), developed at the design stage of the DDC in accordance with [1] and work projects (DDC), developed at the stage of construction of the facility on the basis of the COP and DDC.

It is prohibited to carry out construction and installation work without approved COP and DDC. In the DDC, deviations from the decisions of the PIC are not allowed without agreement with the organizations that developed and approved it [2]. When carrying out work, deviations from the DDC are not allowed without agreement with the organization that developed it and the person who approved the DDC.

COP and DDC during the construction of a facility in difficult natural and geological conditions, as well as during the construction of unique buildings and structures, must include special measures during the construction process to ensure the strength and stability of the constructed and existing buildings, structures and structures.

Requirements for the construction organization project (COP) for a hydraulic facility

In relation to hydraulic engineering construction, COP is organizational and technological documentation that defines: the order and sequence of construction of main structures and temporary facilities, the scheme for skipping construction costs, the type and design of temporary hydraulic structures, technological schemes for the construction of main structures and the execution of work, transport schemes, duration construction, timing of commissioning of individual construction stages (start-up complexes) and hydroelectric power plant units, consolidated construction calendar plan and other construction plans (schedules)5, financing plan, need for material, technical and labor resources. COP is a section of the DDC, its important part. It is developed by the design organization and approved together with the RP.

At the preliminary design stage, as part of the Investment Feasibility Study (IFS), the "Construction Organization" section is developed, which, due to the incompleteness of the development compared to the COP, should be called a section and not the COP.

The COP is one of the main sections of the RP that forms the estimated cost of construction (including chapters 1…9 of the consolidated estimate, local and site estimate calculations). In order to reduce the risk of incorrect assessment of the costs of constructing a hydropower facility, this section must be carried out in full, take into account the actual construction conditions and propose technically and economically sound ways of organizing it. The economic indicators of the construction of a hydroelectric complex, its economic efficiency, reliability and safety of operation throughout its entire life cycle largely depend on the level of design decisions adopted in the COP.

The COP approved as part of the DDC is a mandatory document for contractors and other organizations participating in the construction of the facility. Changes in individual parts of the PIC due to changes in construction conditions are subject to analysis of their impact on the further progress of construction of the facility. They must be agreed upon with the general design organization and the developer (technical customer) before implementation.

The COP is developed by the general design organization or, under an agreement with it, by a specialized design organization. Chapters (paragraphs) of the PIC related to special work, as a rule, should be developed with the participation of specialized design organizations. The cost of developing a COP is included in the cost of developing a DDC.

The starting materials for developing a COP should be:

- ➢ characteristics of the construction area: climatic conditions, the presence of a network of roads, railways and waterways, construction industry enterprises, the possibility of using local labor, etc.;
- ➢ engineering survey materials and observation data: meteorological, hydrological, hydrogeological, geological, seismological, environmental and others;
- ➢ materials on the design feasibility study of the facility at previous stages of design (scheme of territorial planning of hydropower facilities, justification of investments in the construction of the facility);
- ➢ layout of hydroelectric complex structures, space-planning and design solutions of buildings and structures, breakdown into separate stages of construction and launch complexes developed at the DDC stage;
- ➢ directive documents establishing construction deadlines for individual stages of construction and commissioning of hydroelectric power plants;
- ➢ special requirements for the construction of complex and unique facilities;
- ➢ information about the conditions for carrying out construction and installation works at reconstructed facilities;

- information about the availability of construction equipment from the contractor involved in the construction of the facility by decision of the developer (technical customer);
- other necessary information related to the specifics of the construction of the facility.

The COP must be developed for the full scope of construction provided for by the DDC. When constructing a facility in separate stages, the COP for the first stage of construction must be developed taking into account the implementation of construction for full development.

The "Construction organization" section at the design stage should be carried out in a volume sufficient to estimate the cost of work based on aggregated indicators. The COP at the DDC stage is carried out in a volume sufficient to estimate the cost of work at unit prices.

The composition and content of the COP may change taking into account the complexity and specifics of the designed objects, depending on the space-planning and design solutions, the degree of unification and typification of these solutions, the need to use special auxiliary structures, fixtures, devices and installations, the characteristics of certain types of work, as well as on the conditions of delivery of materials, structures and equipment to the construction site.

For complex objects and buildings where the following are used for the first time: a fundamentally new production technology that has no analogues; unique technological equipment; new building structures, as well as enterprises and structures, the construction of which is planned in particularly difficult geological or natural conditions, the composition of the COP, in addition to the above, includes:

- a comprehensive enlarged plan (schedule), reflecting the relationships between all construction participants, which defines: the duration of the main stages of preparation of the DDC and construction of the facility, the composition and timing of the work of the preparatory period, the order of construction of individual buildings and structures as part of the work phase (start-up complex), delivery times for technological equipment;
- instructions on the priority and timing of the necessary research work, tests and routine observations to ensure the quality and reliability of the structures, buildings and structures being erected;
- instructions on the features of constructing a geodetic alignment base and methods of geodetic control during the construction process, as well as other instrumental control of the quality and reliability of constructed structures, buildings and structures.
- When reconstructing and technically re-equipping existing waterworks, buildings and structures included in them, the COP should:
- indicate the scope of work performed without stopping the production process, and work related to the complete or partial stop of the production process;
- establish the priority and procedure for the combined execution of construction and installation work, indicating the areas and workshops in which the technological processes of the main production are changing during construction and installation work, as well as when construction work is carried out during planned technological shutdowns of the main production;
- indicate on the construction master plan: existing buildings, structures and utility networks that are not subject to reconstruction; newly erected buildings, structures and laid networks; reconstructed and dismantled buildings and structures; disassembled and repositioned utility networks; places where new networks join existing ones; passages through the territory; directions for safe passage of construction workers;
- provide in the explanatory note: a list and scope of work performed in cramped and hazardous conditions; the procedure for the operational management of reconstruction work; measures to ensure joint activities of the enterprise and the construction organization; data on

the enterprise's services for creating production conditions for builders, in-plant and in-shop lifting and transport equipment of enterprises transferred to builders for the period of reconstruction; fire and explosion safety measures; measures to ensure the stability of preserved structures during installation and dismantling work; category and volume of generated construction waste.

When constructing facilities in harsh natural conditions, the COP, in addition to the requirements, must take into account the possibility of impact on the preparation, organization and implementation of construction by the following physical, geographical and economic factors:

1. for the northern construction-climatic zone:
2. duration of seasons with low air temperatures, strong winds and snow drifts, as well as low natural illumination of the territory;
3. permafrost soils;
4. remoteness of construction projects from industrialized centers and centralized logistics supply bases;
5. dependence of the delivery of material and technical resources on navigation (seasonal) regimes on inland waterways and coastal shipping lines;
6. limited local energy sources;
7. the need to use special types of transport;
8. increased susceptibility of ecological systems to the impact of economic activities and their difficult recovery, as well as the need to eliminate waste that cannot be disposed of in production; recycling of elements contained in wastewater and atmospheric emissions, their purification, disinfection and capture;
9. the difficulty of organizing a construction site in swampy and flooded areas;
10. the need to regulate the temperature of the concrete mixture and the installations necessary for this regulation;
11. the complexity of organizing sanitary and welfare provision for workers;
12. for mountainous and high mountain areas:
13. low barometric pressure, requiring compliance with special adaptive work regimes for builders;
14. squally winds and increased lightning danger;
15. avalanches, mudflows, landslides and landslides;
16. inaccessibility of the territory (large slopes, differences in elevation);
17. for desert and semi-desert areas and areas with particularly hot climates:
18. high daytime outdoor temperatures;
19. the absence of local water supply sources in large areas and, in connection with this, the need to implement special measures for purification, desalination, transportation, cooling and storage of water;
20. the need to comply with measures to preserve the vegetation cover of weakly stable sandy soils;
21. the need to regulate the temperature of the concrete mixture and the installations required for this regulation.

When constructing facilities in areas with hazardous geological processes, in addition to the requirements, the COP must take into account the following requirements:

22. when carrying out the construction of objects erected on soils with special properties (subsidence, swelling, etc.), it is necessary to ensure the priority implementation of special measures for the organization of drainage, the installation and operation of temporary water supply systems that prevent unorganized soaking of soils, as well as for systematic monitoring of subsidence and their prevention;
23. when carrying out the construction of facilities located in areas of permafrost, decisions should be made on the order, timing and technology of performing work, taking into account the forecast of changes in temperature, permafrost-soil and hydrogeological conditions during the development of soil, construction and installation work and operation of structures.

When constructing objects in special natural conditions, the COP, in addition to the materials specified in, must contain:

for anti-landslide and anti-collapse protective structures:

- forecast of activity and intensity of landslide and landslide processes for the construction period;
- measures to ensure the stability of slopes and slopes during the construction of protective structures;
- calendar plan (schedule) of construction, drawn up taking into account the strict order and timing of all work, depending on the need to complete or temporarily stop excavation work before the onset of rainy periods of the year;
- solutions for the placement of soil and its storage, preventing the construction of dumps in the landslide zone;
- decisions on the organization of drainage, water reduction and special methods of soil consolidation;
- for anti-mudflow protective structures:
- solutions for passing, in necessary cases, floods and mudflows through unfinished structures, ensuring their safety;
- decisions on the reasonable seasonality of certain types of work, taking into account local conditions;
- indications in the construction calendar about the timing of the possible formation of a mudflow according to forecasts of survey materials;
- recommendations for placing observation points for the formation of mudflows and ensuring their stable connection with the construction control center;
- solutions for placing production facilities, residential settlements and access roads in a safe zone, as well as possible evacuation routes for people and construction equipment;
- requirements for the work schedule during the mudflow period.

In the near future, the construction of hydropower facilities is expected in the mountainous regions of the North Caucasus, Siberia and the Far East. This requires high-quality engineering surveys to identify mudflow-hazardous and potential landslide areas, and subsequently the development of anti-mudflow and anti-landslide measures in the DDC. It should be noted that methods of protection against mudflows and landslides are not sufficiently reflected in the existing technical literature.

A mudflow can destroy buildings, structures and lead to the death of people in the place where it passes, as well as block a domestic channel with the creation of backwater upstream of the river. To protect against mudflows it is necessary:

- identify mudflow-hazardous areas at the engineering survey stage;
- not to design or construct any buildings and structures in areas where mudflows pass;
- organize constant monitoring of the condition of mudflow-prone areas located near waterworks;
- create mudflow dams, traps and other protective structures.

As a negative example, we can cite the case when, during the construction of the Golovnaya Zaramagskaya hydroelectric power station, a mudflow led to the death of people and the destruction of a temporary village in the area of the hydroelectric complex.

Landslides can: destroy buildings and structures located on it or below it at elevations; block the domestic riverbed with the creation of backwater and flooding of the hydroelectric power station building located upstream; block (divide into two parts) the reservoir of a hydraulic system, creating the danger of an unpredictable breakthrough and a hydrodynamic accident; release a large amount of water over the dam with catastrophic consequences [5]. Possible measures to protect against landslides:

- identify landslide areas at the engineering survey stage;
- unload the landslide by removing the upper part of the landslide area and make the slope flatter;
- create a retaining embankment at the base of the landslide;
- secure the landslide (if possible) with prestressed anchors or bored piles to a stable part of the massif;
- bypass the landslide area using a tunnel located outside the landslide;
- organize monitoring of the condition of landslides located near waterworks;
- carry out other possible protective structures. The following examples can be given.

At the Golovnaya Zaramagskaya hydroelectric power station, a tunnel was designed and built to divert the river in the event of a landslide.

When the reservoir of the Zaramagskaya hydroelectric power station was filling, the road along the left bank began to slide and cracks formed. To eliminate landslide processes, fastening with bored piles was carried out with engagement on a stable rock mass.

When the reservoir of the Gotsatlinskaya hydroelectric power station was filling, the road along the left bank, connecting three regions of mountainous Dagestan, began to slide, and cracks appeared in several places. Traffic was stopped, a network of observation marks was created, and measures were taken to secure and stabilize landslides. Traffic was restored a month later.

A major accident occurred on October 9, 1963 at the Vajont Dam in Italy. A landslide with a volume of 240 million m3 collapsed in a reservoir with a capacity of 169 million m3. More than 50 million m3 of water spilled over the dam. A wave 90 m high washed away several settlements in 15 minutes, killing more than 2 thousand people.

During the design of the Boguchanskaya hydroelectric power station, a potentially unstable mass was discovered on the right bank at the site of the hydroelectric complex. To prevent a landslide, this massif was unloaded (its upper part was cut off), and at the base it was supported by a dumped soil prism [4].

In December 2018, a landslide collapsed in the reservoir of the Bureysky hydroelectric complex in the Khabarovsk Territory, as a result of which the reservoir was divided into two parts by a landslide. The distance from the waterworks site to the site of the collapse along the river is 120 km. The length of the dam along its crest was 740 m with a width from 180 to 500 m. The height of the dam above the reservoir level was up to 60 m. The elevation of the top of the landslide-lintel varied from elevation. 258.0 m to elevation. 311.1 m, that is, significantly higher than the NSL. The approximate volume of the collapsed rock mass, according to various estimates, was 25–34 million m3, of which 4.0–4.5 million m3 was located above the surface of the reservoir. The depth of the reservoir in the area of the landslide at the date of the event was 65 m. This created a threat of flooding of the settlement of Chekunda, located 70 km above the landslide, and the risk of flooding of engineering structures of the Baikal-Amur Mainline. 113 km up the reservoir from the landslide there was a railway and road bridge across the river.

Bureya near the village of New Urgal. In the shortest possible time, within a month and a half, a channel 240 m long, 100–150 m wide, and more than 23 m deep was made in the landslide [3].

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