The rationale for taking into account the organizational features of work in the winter when designing

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The rationale for taking into account the organizational features of work in the winter when designing

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Abstract. The article analyses regulatory and technical documents that regulate the organizational and technological features of building production and establish the requirements for additional resource supply when developing a design and estimate documentation, depending on various climatic conditions of the winter period. Based on the assessment of the initial conditions, as well as the complicating factors of the production of works, taken into account as part of the current standards for winter appreciation, additional resource support for the production of work in the winter is justified. Additional resource support during winter work in areas exposed to winds with a speed of more than 10 m/s, as well as temporary heating and accelerated drying (outside the heating period) to eliminate the increased humidity of structures or work surfaces in the manufacture of finishing and other special works.

1. Introduction

Weather and climatic conditions of the winter period, as well as off-season, have a significant impact on the organization of the construction process [1, 2].

The above conditions of impacts on building production include humidity effects, extreme values of snow, wind, negative temperature load, as well as special types of dynamic effects (natural disasters and natural disasters, including seismic loads caused by earthquakes).

Changes in the basic natural and climatic (meteorological) characteristics of the winter period, which, as a rule, have a pronounced alternating character (regular and random fluctuations), are one of the most important influences in the construction and repair works.

2. Methods

The rationale for an adequate and rational resource supply of work in winter is based on a systematic approach, as well as methods for quantitative and qualitative analysis of statistical data on operational production activities, taking into account organizational, technological, and regulatory technical factors.

3. Results and discussion

Implementation of construction processes in the winter period in the open air is carried out technologically under the influence of complicating natural and climatic (meteorological) conditions that significantly impede their production, which is associated with the loss of working time, a decrease in the productivity of mechanization equipment due to snowfall, poor visibility during snowstorms, and the presence of snow in the workplace, the state of the soil during earthwork.

A variety of territories of Russia with a humid and stable-humid climate (Murmansk region, the Republic of Karelia, Arkhangelsk region, Nenets Autonomous Okrug, Eastern Siberia, the Far East), coastal territories of oceans and seas, regions with frequent recurrence of storm winds (in particular, the coast of Primorsky Krai, Sakhalin, Kamchatka, Kuril Islands), significant seasonal and daily fluctuations in the temperature-humidity regime of the outdoor air, as well as high wind speeds, have a significant effect on the temperature and humidity conditions inside buildings under construction [3, 4, 5], and as a consequence on the organizational process execution interior finishing work, civil works to complete the cycle.

These factors lead to the need for planning additional resource supply, including increasing the time for performing technological operations, the time spent on construction equipment at the worksite, increasing the number of mechanization and labour resources, additional energy consumption, and in some cases causing overuse of material and technical resources, which ultimately leads to an increase in the actual costs of contracting organizations to complete the entire construction works at the construction object.

To take into account the required additional resource supply during the organization of construction and installation and repair and construction works in the winter period, a detailed consideration of organizational and technological features and the preparation of an appropriate justification as part of the design documentation being developed taking into account the requirements of current regulatory and technical conditions is necessary.

It is at the stage of development of project documentation that it is advisable to carry out a calculated justification of the necessary costs associated with the climatic features of the planned work.

Building norms and rules impose various organizational and technological requirements that establish the need for additional resource support depending on the climatic (temperature-humidity) performance of work in the winter period.

For example, the additional resource support for the production of work caused by the effect of reduced positive and negative outside temperatures is a consequence of a change in the technology of the 1. On the preparation of the base and laying concrete mixture:

- ensuring a base temperature of at least 5°C when laying concrete mixtures;
- preheating the metal to a positive temperature when concreting densely reinforced structures with large metal embedded parts.

2. For the production of concrete work (temperature and humidity aging):

- ensuring an air temperature of at least 10°C during transportation, laying and compaction of concrete mix;
- depending on the outdoor temperature, providing structures with thermal insulation or heating;
- use of anti-frosty additives.

3. On the assembly and welding of mounting joints of steel structures:

- preliminary local heating of steel (up to 120-160°C) when performing manual and mechanized
- arc welding of structures depending on the thickness of the elements to be welded, types of
- structures to be welded, steel grade and ambient temperature;
- increase in welding current during welding works by manual and mechanized method;
- the use of solutions with anti frosty additives;
- heating of welded joints controlled at low temperatures until complete removal of frozen water.

work, which includes some of the following technical requirements of SP 70.13330.2012:

Finishing work following the requirements of the technical specifications of SP 71.13330.2017 is influenced by the temperature and humidity conditions (ambient temperature and surfaces being trimmed, relative air humidity).

So, finishing works (plastering, wallpapering, installation of wood-based floor coverings) in the premises should be carried out at ambient temperatures and surfaces to be trimmed from 5°C to 30°C, relative humidity not more than 60% unless otherwise specified by the material manufacturer. The specified temperature and humidity conditions in the room must be maintained around the clock

throughout the entire period of finishing work and not less than 2 days before and 12 days after the end of work.

When carrying out wallpaper work in rooms until the wallpaper is completely dried, it is necessary to maintain a constant humidity regime, the air temperature during drying of glued wallpaper should not exceed 23°C, maintaining the above temperature and humidity conditions until the object is commissioned.

When installing floors in the construction of which products and materials are based on wood or its waste, synthetic resins and fibers, xylolithic coatings, and in the subsequent period until the facility is commissioned, the relative humidity in the room should not exceed 60%.

To determine the additional costs associated with the complication of the production of work in the winter, as well as labour and material resources, the corresponding standards of collections of norms of additional costs are used in the production of construction and installation (GSN 81-05-02-2007) and repair and construction works (GSNr 81-05-02-2001).

The standards for the types of construction given in these collections are annual average and are used year-round when calculating for completed construction and repair works, regardless of the actual time of the year during which the construction is carried out.

According to the general provisions of the GSN 81-05-02-2007, the norms of the collection take into account additional costs when performing construction and installation works, due to the influence of negative air temperatures, as well as wind speeds up to 10 m/s inclusive.

To compensate for the additional costs associated with the organizational and technological features of work in areas subject to winds more than 10 m/s, according to the general provisions of GSN 81-05-02-2007, surcharges may be made in the form of coefficients for the number of windy days in the winter.

In this regard, in the project documentation, preparation of the justification is necessary, which is the basis for the possibility of taking into account the additional costs when performing work in the winter, associated with the influence of winds, at a speed of more than 10 m/s.

The rationale for the selection of the coefficient to the standards of GSN 81-05-02-2007 with the number of windy days of the winter period is carried out using;

• code of rules SP 131.13330.2018. 'SNiP 23-01-99* Construction climatology' (control of the duration of the winter period);

• data from the technical report of engineering and hydrometeorological surveys presented as part of the design documentation for the construction object (determining the duration of the winter period, as well as the number of windy days of the winter period at a speed of more than 10 m/s);

• samples of the observation array of the All-Russian Research Institute of Hydrometeorological Information - the World Data Center (VNIIGMI-WDC) of the Federal Service for Hydrometeorology and Environmental Monitoring.

Surcharges in the form of coefficients are determined depending on the number of windy days in the winter (from 10 to 30% and over 30%) and are calculated by the ratio of the total number of windy days with a maximum wind speed of more than 10 m / s to the total number of observation days.

For construction projects located in areas with a humid and stable-humid climate, additional justification of the costs caused by the organizational and technological features of the production of interior finishing work in conditions of high humidity is required.

To eliminate high humidity in the premises of the building, the following drying methods can be used technologically:

- ventilation of the premises — the organization of natural or forced air exchange in the room;
- drying by infrared heaters — heating and drying the surface under the influence of thermal radiation by infrared rays;
- room warming — an increase in air temperature, causing evaporation of moisture; • condensation drainage — drying coatings by collecting and condensing water vapour of moist air.

Of the above methods of eliminating high humidity by heating indoor air in rooms and forced air exchange is the most expensive, given the constant increase in the cost of electricity consumption.

Also, indoor air exchange involves not only removal but also the supply of outdoor air, which will require additional energy to drain it in areas with high humidity. Performing natural air exchange by airing rooms in areas with humid and persistently humid climates will not lead to the desired results.

The method of eliminating high humidity using radiant energy (heat) from electric or infrared incandescent lamps has its nuances. The amount of radiant energy (heat) transmitted by infrared heaters can be many times greater than the amount of heat that the material receives as a result of conventional air drying. However, despite the high thermal power of the radiant flux, the duration of drying with infrared rays in many cases is close to the duration of air drying. This is explained by the need for interruptions in drying sessions, as well as a lag in the movement of moisture from the thickness of the material to its surface compared to the rate of evaporation of moisture from the surface under the influence of infrared rays.

The heating of the premises, together with the use of condensation drainage, has a high rate of specific moisture removal (absorption of moisture from the air), the compactness of the mobile drying systems used, and relatively low energy consumption [6]. In addition to the above, this method allows you to smoothly control the relative humidity and prevent uneven drying, swelling, warping and cracking of finishing materials.

According to the technical part, the norms of the GSN collection 81-05-02-2007 do not take into account the costs of temporary heating of buildings finished in the draft (outside the specified heating period) to eliminate the increased humidity of structures or machined surfaces in the manufacture of finishing and other special works carried out following technical requirements. The standard refers to buildings with erected walls, a topcoat, and filling all openings.

Costs associated with additional measures for temporary heating of the building outside the heating period, as well as for accelerated drying, to eliminate the increased humidity of structures or machined surfaces in the manufacture of finishing and other special work carried out following the requirements of technical conditions, are accounted for in the order provided for in section III GSN 81-05-02-2007, taking into account the required period of temporary heating based on the calculation made by the design organization.

The justification of the additional costs of temporary heating and accelerated drying (outside the heating period) to eliminate the increased humidity of structures or machined surfaces in the manufacture of finishing and other special works that take into account the specific conditions of the work and the necessary drying time is carried out using:

- code of rules SP 71.13330.2017 (to justify the fulfillment of the requirements for finishing work);
- data on the schedule for the duration of the finishing work in the construction organization project of the PIC (to determine the duration of the finishing work);
- data from the technical report of engineering and hydrometeorological surveys presented as part of the design documentation for the construction project (to comply with the temperature and humidity conditions under which it is expected that finishing work will be performed);
- • an array of observations of VNIIGMI-WDC on climatic conditions (to identify specific conditions of the temperature and humidity conditions under which finishing work is supposed to be carried out);
- 'i-d-diagrams of moist air named after Professor Ramzin L.K', further — i-d-diagram (for determining the moisture content of air);
- electricity tariffs approved by the regional authority (to justify the cost of electric energy).

Following the work schedule, the construction organization project determines the estimated period of finishing work at the facility.

According to the rules of section III of the GSN 81-05-02-2007, the costs of temporary heating are determined depending on the temperature zone of the location of the object, the building volume of the building (it's actually heated parts based on the design data) and the duration of heating, by summing the costs of heat and electrical energy, as well as the cost of operating a temporary heating system.

Taking into account the requirements of SP 71.13330.2017 to maintain the temperature and humidity conditions of the premises, in addition to temporary heating of the building, additional organizational and technological features for eliminating high humidity during finishing work on

structures or machined surfaces (outside the heating period) are measures for accelerated drying using air dryers.

According to paragraph 7 of Section III of the GSN 81-05-02-2007, costs using temporary local devices (installations) to accelerate the drying of buildings should be determined additionally on the basis of an appropriate calculation taking into account the specific temperature and humidity conditions of the building and the duration of drying (in within 15 days).

The desired values of temperature and humidity conditions are determined according to the technical report of engineering and hydrometeorological surveys, as well as a representative sample of the observation array of the VNIIGMI-WDC construction area for 25 years, and include the following data:

- about the average monthly outdoor temperature, ºC;
- about relative humidity, %;
- on the average value of the outdoor temperature during the period of finishing work;
- about the average value of relative humidity during the period of finishing work.

Based on the available data (a report of engineering and hydrometeorological surveys and a representative sample of the VNIIGMI-WDC monitoring array) on the values of temperature and humidity conditions during the period of finishing work, compared with the requirement of SP 71.13330.2017, a decision is made to take measures to remove excess moisture.

To accelerate drying and eliminate the increased humidity of structures or machined surfaces in the manufacture of finishing and other special works, mobile air dryers are used.

The order of selection of air dryers is to determine the productivity of the equipment (g/hour, l/hour) by condensation of moisture from the air at the appropriate air temperature, taking into account the frequency of air exchange.

To establish the moisture content in the air under the considered conditions (air temperature t ºC, relative humidity φ%), an id-chart is used according to which, based on the given temperature and humidity conditions, the moisture content d1 is determined in the following units of ‘g moisture/kg air’.

To fulfill the requirements of SP 71.13330.2017 to achieve the criterion of heat and humidity conditions for the production of finishing and other special works, based on the i-d diagram, a calculation is made of the air drying in the room to achieve the required relative humidity to the value $\varphi = 60\%$ at $t = const$.

As a result of the physical process of moisture condensation in the dehumidifier, the moisture content d1 (g / kg dry air) is reduced based on the assumed (reported) heat and humidity conditions of the work (taken from the report of engineering and hydrometeorological surveys and a representative sample of the VNIIGMI observation array) - MCD), to a value of d2 corresponding to the required relative humidity $\varphi = 60\%$ according to SP 71.13330.2017.

To determine the performance of the air dryer, the amount of equipment, as well as the required electrical power consumption, the volume of the premises is calculated based on the design documentation.

The calculation of the additional costs of electric energy is carried out taking into account the round-the-clock (within 15 days) operation of the air dehumidifiers, as well as the tariff of electric energy approved by the regional authority.

During decoration work, the total amount of electric energy consumed by air dryers to maintain the temperature and humidity conditions in the room around the clock for 15 days is determined as the product of the consumed power of the air dryer kW, the number of air dryers, the number of hours in a day, the number of days.

Additional costs for the payment of electric energy to eliminate the increased humidity of structures or machined surfaces in the manufacture of finishing and other special works (outside the heating period) are determined by a separate calculation and are included in the design and estimate documentation of the construction site.

4. Conclusions

The organizational and technological features of the organization of construction and installation and repair and construction work in the winter period are considered to take into account the required additional resource supply for construction production, due to a change in the technology of work execution caused by exposure to lower positive and negative outside temperatures and a change in the temperature and humidity of the environment.

A study of the costs associated with the climatic features of the planned work execution confirms the need for their detailed calculation justification at the stage of development of design documentation, taking into account the requirements of current regulatory and technical conditions.

The practical significance of the study is the justification of the necessary additional resource support in the conditions of the organization of work in the winter during the design, to ensure the quality of construction and installation work and accounting for planned costs.

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