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Technological Methods for Improving the Water Resistance of Concrete in a Dry Hot Climate

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ABSTRACT*:* The article is devoted to the method of making concrete in the dry hot climate of Uzbekistan; in the study of this problem, methods and tools of construction technology are used. Technologies for the manufacture of concrete, as well as concrete and reinforced concrete products and structures were developed by many Uzbek and foreign scientists. The article analyzes the characteristic features of construction technology, taking into account the influence of different local resources.

KEY WORDS*:* construction, concrete, dry hot climate, waterproofing bridge, reinforced concrete.

I.INTRODUCTION

The foundations of modern technology for the manufacture of concrete, as well as concrete and reinforced concrete products and structures were developed by many Uzbek and foreign scientists. However, their works are mainly devoted to the issues of concrete technology under so-called "normal" conditions (ambient temperature 15-20 °C and relative humidity over 50 %) or in winter concreting conditions. At the same time, almost a quarter of reinforced concrete products are produced in areas with a dry hot climate, which significantly affects the technology of concrete production, causing intense evaporation of moisture from the concrete mixture and changing the nature of the physicochemical processes occurring during concrete hardening. When concreting structures in the summer, the temperature difference between the outer and inner layers of concrete reaches 50-60 °C, which causes a thermally stressed state and surface cracking. Lack of proper maintenance of concrete contributes to rapid dewatering and loss of strength. If the impact of a dry, hot climate is underestimated, the quality and durability of structures are significantly reduced.

The climatic conditions of Central Asia differ from the Central European ones in the length of the hot dry season, the presence of a vast zone of deserts and semi-deserts, where there is no large aggregate, and the small aggregate does not completely meet the requirements of standards, as well as high seismicity. These factors make significant adjustments to the theory and practice of production of concrete and reinforced concrete.

The territory of Uzbekistan is located between 35 and 450 north latitude, its climate is moderately warm and sharply continental. Large amounts of solar heat result in high temperature levels, very hot, dry, long summers and short, erratic winters. The value of solar radiation in the summer months ranges from 600-800 cal / cm^2 per day, and the number of days with an average air temperature of more than + 250 ^{0}C in a number of regions exceeds 140 (Tashkent-142, Termez-166, Bukhara-169, while in Moscow - only 46). Most of the precipitation falls during the cold season. During the summer months, the average amount of precipitation in Tashkent is 17. Relative humidity in summer is on average 30-50 %. In the daytime it drops to 10-15 %, and at night it rises to 50-70 %.

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Summer drought is accompanied by intense heat; the average July temperature in Tashkent is -26.9; Termez 30.7 ^{0}C. The average maximum outside air temperatures are 29.5-39.8, and the absolute maximum reaches 42-50 °C. In the warm half of the year over the semi-desert and desert areas of Uzbekistan, an area of slightly reduced pressure is created, which causes the formation of a hot dry wind, the average speed of which in July is 1.2-2.4 m / s. The winds blowing from the valley are relatively strong. Sometimes in the foothills there is a gusty and warm wind-blower (6,37). The terrain has a great influence on the climate of Uzbekistan; as you climb the mountains, the temperature drops by about 1 °C for every 200 m.

Since the weather conditions are predetermined by the long-term climatic indicators of the area, it is advisable to take them into account differentially when determining the concrete technology. In this regard, the territory of the Central Asian republics from the point of view of the identity of conditions for the production of concrete works can be divided into four natural and climatic zones:

1. Mountainous, covering the Pamir and Tien Shan regions and characterized by a cool climate with cool summers and severe winters.
2. The zone of foothill oases, including the Fergana Valley, Tashkent and Samarkand regions of Uzbekistan.
3. A desert zone with cold winters, covering the western part of Uzbekistan.
4. A desert zone with warm winters, located in the south-west of Uzbekistan.

High air temperatures and intense solar radiation, combined with winds, cause rapid evaporation of moisture from the concrete mixture during its manufacture, transportation and laying, which significantly affects the nature of the physicochemical and mechanical processes occurring during concrete hardening. In this regard, it is necessary to distinguish between the concepts of dry hot climate and dry hot weather.

In a dry hot climate, especially in the manufacture of products in open workshops and on landfills without heat treatment, shrinkage phenomena due to contracting and drying of cement paste proceed most intensively. There is a decrease in the volume of concrete, accompanied by the formation of a significant number of pores in it and an increase in internal stresses, which reduce the bearing capacity of the structure. When selecting the composition of concrete, serious attention should be paid to the possibility of forming a dense skeletal part by correctly determining the proportion of coarse (gravel or crushed stone) and fine (sand) aggregate. With a properly selected ratio of sand to cement, these stresses are partially perceived by a rigid skeleton, which reduces destructive processes. The lower the proportion of sand, the lower the water demand of the concrete mix. Aggregates used in concrete must meet the requirements of the relevant GOSTs.

For the production of concrete and reinforced concrete products, subject to heat and moisture treatment at atmospheric pressure and temperatures up to 100 °C, Portland cement, slag Portland cement, pozollan Portland cement and their varieties, as well as other types of binders that meet special technical conditions and ensure the desired properties are used as binders concrete.

In Uzbekistan, complete additives are used as plasticizing additives, consisting of two or more substances. Experimental works of Uzbek scientists have shown that CaCI2, NaCI, FeCI3 additives in combination with NaNO are very effective in the construction of buildings from monolithic concrete. Complex additives are recommended to be introduced in the amounts indicated in Table 1.

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Table 1.

Complex supplements

Type of construction	**Maximum permissible dosage of additives,% of the mass of cement**		
	$CaCI_2$+NaNO	**NaCI+NaNO**	**$FeCI_3$+NaNO**
Unreinforced	2,0+2,0	3,0+3,0	2,0+2,0
Lightly reinforced	1,5+1,5	2,0+2,0	1,0+1,0
Densely reinforced	1,0+1,0	1,5+1,5	1,0+1,0

To speed up concrete work, as well as to improve the quality of the surface layer of concrete (when concreting floors, road surfaces, hydraulic structures, etc.), the laid concrete is evacuated. Concrete surface treatment by vacuum treatment creates the most favorable conditions for concrete hardening, as it prevents the evaporation of mixing water. However, it should be borne in mind that cements with low water loss lend themselves to evacuation worse than cements with low water retention capacity. Therefore, vacuum treatment of concrete made on cements with water-retaining additives is allowed only after preliminary verification and empirically establishing the optimal vacuum regime.

Concrete maintenance is a laborious and complex technological operation, the costs of which depend on local conditions (availability of water, appropriate materials, etc.), as well as on the type and composition of concrete, the type of binder used and other factors and significantly affect the cost of 1m3 of monolithic concrete. On very hot days (daytime temperature 42-45 °C), it is advisable to carry out concreting work at the end of the afternoon and at night, which will significantly improve the conditions for placing concrete. It is recommended to finish concrete surfaces immediately after the completion of concrete compaction. To protect the concrete surface from rapid drying and cracking, it is recommended to keep them under the coating for another 2-3 days after completing the subsequent maintenance without additional moisture.

The concrete surface can be coated with special film-forming compounds (mainly in light colors), if this is permissible for aesthetic and sanitary-hygienic reasons. The application of such compositions is especially advisable when concreting extended structures with a large open surface module (road surfaces, airfields, canal lining, etc.), as well as when performing work in arid areas. Film waterproofing compensates for unfavorable climatic influences on concrete, and in some cases increases the strength characteristics by 15- 20 % compared to concrete hardened under normal conditions.

The most rational method of caring for concrete in arid desert areas is the use of ready-made polymer films, predominantly of light colors. The surfaces of the structures must be covered immediately after finishing. It is recommended that:

- weld separate pieces of polymer films into larger panels and cover surfaces with them throughout the entire area;
- fix the edges of the panels with boards, sprinkle with sand or soil;
- to ensure a tight fit of panels to the surface of the smoothed concrete without folds and wrinkles;
- protect the film from mechanical damage;
- after completing the maintenance of concrete, remove the film in the evening.

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The timing of concrete curing under polymer films is assigned by construction laboratories for specific climatic conditions.

Thus, for the conditions of Uzbekistan, it is most effective to use preliminary heating of products until they reach a stripping strength equal to 30-40 % of the design strength, followed by aging under a film coating. This allows, due to the use of environmental heat at the second stage, to dramatically increase the productivity of construction enterprises and thereby reduce the cost of production.

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