INTERNATIONAL MULTIDISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
SJIF 2019: 5.222 2020: 5.552 2021: 5.637 2022:5.479 2023:6.563 2024: 7,805
eISSN :2394-6334 https://www.ijmrd.in/index.php/imjrd Volume 12, issue 06 (2025)

UDC 691

THE INFLUENCE OF A DRY, HOT CLIMATE ON THE RHEOLOGICAL PROPERTIES OF CONCRETE MIXTURES BASED ON LOW-WATER-CONSUMPTION CEMENTS

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Annotation: The influence of extreme climatic conditions (high temperatures and low humidity) on mobility, persistence, setting speed and evaporation of moisture in concrete mixtures is investigated. Patterns of changes in rheological parameters in hot climates have been established. Recommendations on the adaptation of mixtures for hot regions are given.

Keywords: concrete mix, rheological properties, dry climate, hot climate, mobility, preservation.

Аннотация: Исследуется влияние экстремальных климатических условий (высоких температур и низкой влажности) на подвижность, сохраняемость, скорость схватывания и испарение влаги в бетонных смесях. Установлены закономерности изменения реологических параметров в условиях жаркого климата. Даны рекомендации по адаптации смесей для жарких регионов.
Ключевые слова: бетонная смесь, реотехнологические свойства, сухой климат, жаркий климат, подвижность, сохраняемость.

The dry, hot climate is typical for many regions of Central Asia and the Middle East. The main climatic features are high air temperature (over 35-40 °C) and low relative humidity (<30%). Under such conditions, the rate of evaporation of moisture from the concrete mixture increases sharply, which leads to a deterioration in its technological properties, a decrease in the strength and durability of structures.

Cements of low water consumption (LW) have the ability to form concrete with less mixing water, which improves the water-cement ratio and allows for high strength. However, in a dry climate, the efficiency of the central heating system can also be reduced due to premature evaporation of moisture and accelerated setting.

The purpose of this study is to analyze the influence of climatic factors on the rheotechnological characteristics of CNG-based concrete mixtures and to develop recommendations for improving their resistance to external climatic influences.

Research methodology. Assume the following initial conditions:

Air temperature: +40 °C;

Relative humidity: 20 %;

Cement: PC 500-D0 with low water consumption;

In/Out: 0.35;

Additive: superplasticizer 1% by weight of cement;

Initial mobility: 22 cm (according to the draft of the cone);

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Weight of one batch: 20 kg

1. Mobility of the concrete mix (cone sediment) = 22 cm.

According to experience, at a temperature of +40 °C and 20% humidity, mobility decreases by ~30% in the first 30 minutes due to moisture evaporation and the onset of hydration.

Mobility along the cone sediment

Table 1

Time	**Expected mobility (cone draft), cm**
0 min	22
30 min	15,4 (−30%)
60 min	10,5 (−52%)
90 min	6,6 (−70%)

We consider the retention coefficient as the ratio of mobility to the initial one:

$R_r = \frac{S_t}{S_0}$

Время	**St (см)**	R_r
30 мин	15,4	0,70
60 мин	10,5	0,48
90 мин	6,6	0,30

The beginning and end of setting (according to the Vic device). Standard value (GOST 310.3–76 for PC):

Start: no earlier than 45 minutes

End: no later than 600 min

At a temperature of +40 °C, hydration accelerates:

Setting time: $t_h = t_{n0} - \Delta t_{climate} \approx 90\text{-}25 = 65$ min

End of grasping: tk = 180-40 = 140 min

The loss of water due to evaporation (by weight) is determined by the following formula (SNiP 3.03.01-87):

$\Delta W = E \cdot A \cdot t$

Here:

E — evaporation rate (g/m2·h): at +40 °C and 20% humidity ≈ 250 g/m2·h

A — open area: 0.1 m2 (for the tray)

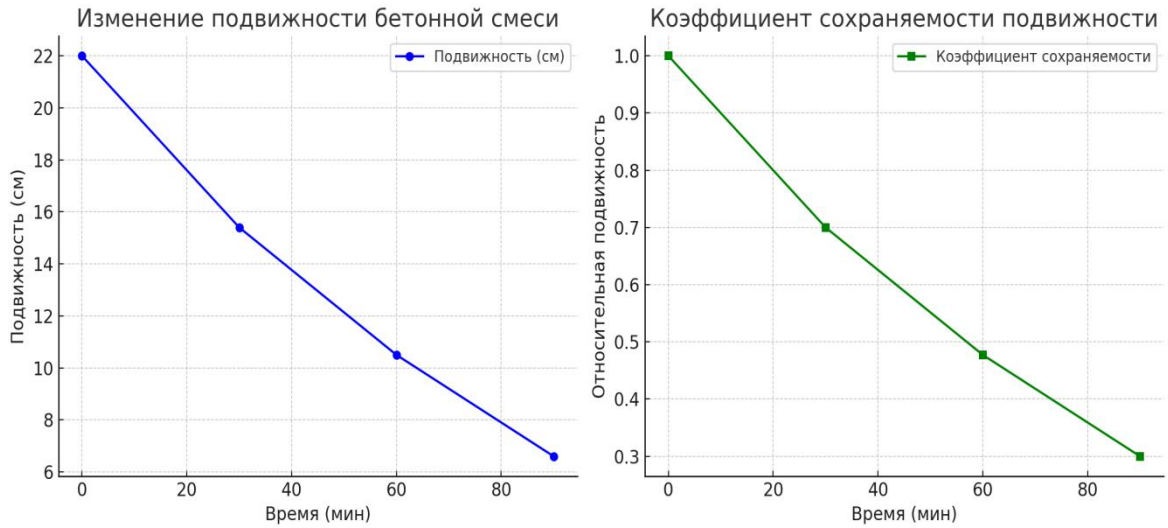
t — time, hour

In 1 hour:

$\Delta W = 250 * 0{,}1 * 1 = 25$ g water

For a mixture weighing 20 kg with a moisture content of 7% (1400 g of water):

$\frac{25}{14\,00} * 100\% = 1{,}79\%$ (that is, almost 2% of water is lost in one hour.).



Conclusion. In a dry, hot climate, concrete mixtures based on cements with low water consumption are subject to rapid evaporation of moisture and accelerated setting, which requires adjustments to the composition and concreting technology. The use of modern chemical additives, technological techniques and protective measures makes it possible to effectively adapt such mixtures to extreme climatic conditions and ensure high quality and durability of concrete.

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