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# CALCULATION OF DEFORMATION CHANGES OF CENTRALLY COMPRESSED REINFORCED CONCRETE COLUMNS IN DRY HOT CLIMATIC CONDITIONS

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***Abstract.*** *This article is devoted to theoretical and experimental study of the deformative characteristics of high-center-compressed reinforced concrete elements in a dry roast climate. Based on the conducted studies, it was established: in conditions of dry roast climate, the physicomechanical and deformation properties of concrete changed from the temperature and humidity of the air, which should be taken into account in the calculations.*

***Keywords:*** *crack resistance, thermocouple, solar radiation, temperature and shrinkage deformations, working conditions, strength, long-term loading, permanent mode, elastic-compressed reinforced concrete element, elastic-plastic state, shrinkage, width of crack disclosure, the strength and deformation properties of honeycomb stacked reinforced concrete columns in dry roast climate conditions*

Fluctuations in air temperature and humidity during the day and season of the year (summer and winter) adversely affect the formation of the concrete structure. Intensive dehydration of concrete at elevated temperature and low relative humidity of the environment leads to a decrease in its strength and modulus of elasticity. A large daily temperature difference causes an uneven distribution of temperature stresses over the sections of concrete. [3,4]

Design and construction of reinforced concrete structures for a dry hot climate without taking into account deformations, forces caused by changes in high temperature and low humidity leads to early cracking in concrete, their excessive opening, as well as to large deformations of the structure.

One of the most important factors in improving the reliability and durability of structures of buildings and structures, especially for the Republic of Uzbekistan, is the further improvement of methods for their calculation, taking into account real operating conditions.

In this regard, an urgent task is to conduct experimental and theoretical studies of the crack resistance of eccentrically compressed reinforced concrete elements made of heavy concrete under the influence of force factors and adverse effects of dry hot climate conditions.

To study the work of eccentrically compressed reinforced concrete elements, experimental columns of rectangular section with dimensions of 16x30 cm and a height of 100 cm were made, which had consoles. All columns had symmetrical reinforcement with 4 rods with a diameter of 14 mm, class A-III.

To measure the deformations of the tensile reinforcement, metal pins with a diameter of 12 ... 14 mm on a base of 250 mm were welded to it.

To measure concrete deformations in the compressed and tensile zones, pins 6 mm in diameter and 50 ... 60 mm high were installed on both sides of the column on a base of 250 mm along the height of the section. The distance between two pins was measured with a portable indicator. In order to study the temperature distribution in concrete over the cross section of the columns in a dry hot climate, chromel-copel thermocouples were placed in the columns.

Simultaneously, 10x10x10 cm cubes and 10x10x40 cm prisms were made.

The samples were concreted in a horizontal position in metal molds. Samples were made in July, when there were average daily fluctuations in air temperatures up to 20 and relative humidity up to 20% [5]

During this period, the air temperature reached 36 , and the relative humidity decreased to 17%. All columns after concreting for 7 days were in the formwork under wet sawdust, and then they were stripped. Samples of columns were made in three series. Samples of the first series were exposed to direct solar radiation to determine the change in temperature across the section of the element. Samples of the first series were at the test site in an unloaded state to determine the temperature-shrinkage deformations of the columns. To determine the effect of direct solar radiation, one part of the experimental columns was installed at the test site. Some samples of the second series were protected from direct solar radiation. These samples were in the conditions of the shop.

Another part of the samples was exposed to direct solar radiation in the open air. The columns of the second series were tested with a short-term load with different eccentricities of its application at the age of 40-50 days. Series III columns were loaded with a long-term load of 0.8 NCRC and 0.5Np, which were exposed to the air for 1 year, and then were destroyed by a short-term load in order to determine how direct solar radiation affects the strength and fracture toughness of the columns. [75]

According to the results of short-term tests with e= 0.5Y=7.5 cm and e= Y=15 cm, it was found that with the formation of cracks in the tension zone, the intensity of the increase in the deformation of the tension reinforcement, as well as the compressed concrete, increases. Dry hot climate conditions also affect the relative deformation of the reinforcement. In columns under load 0.8 NCRC and 0.5Np and under the influence of solar radiation were 13 ... 40% more than in columns located in the workshop.

Air temperature and humidity also affect the change in the deformation of the extreme fiber of the compressed concrete zone. [2]

Relative deformations of the extreme compressed fiber of concrete in columns under the influence of solar radiation (at a load of 0.5 Nr) increased by 35 ... 60% compared with concrete deformations at a short-term load at the age of 40 days. In a dry hot climate, with an increase in eccentricity, the deformability of concrete and reinforcement increases.

No cracks appeared in unloaded columns exposed to solar radiation for 12 months. Under short-term loading of these columns, cracks were formed at a load of 52.9 ... 53.6 kN.

This moment of cracking was less than for columns in constant mode by an average of 19%.

In columns subjected to long-term loading under load

N=0.8 NCRC for 12 months under solar radiation and constant mode, no cracks appeared. Under their short-term loading, the moment of crack formation was 55.6 kN, which is 6% less than for unloaded columns aged 12 months. Comparing the moments of crack formation, we can state that for those exposed to solar radiation, this figure is 22% less than in columns that are in a constant mode. Under the influence of long-term load

0.8 NCRC, the first cracks appeared on the heated surface after 56 days from the start of observation (with the onset of temperature in July) in the column exposed to solar radiation, and after 71 days cracks appeared in the column exposed to solar radiation by a compressed face. [5]

As follows from the analysis, that the influence of a dry hot climate significantly affects the moment of crack formation. This is due to the appearance of self-stresses in concrete, caused by both shrinkage deformations and uneven heating of concrete along the height of the element section, as well as a decrease in concrete tensile strength. [4]

When determining shrinkage stresses in a column, the scale factor is taken into account; in addition, in columns, in addition to shrinkage deformations, tensile stresses arise in concrete due to the difference in the expansion coefficient of reinforcement and thermal deformation of concrete. This causes additional tensile strains in the concrete, which contribute to early cracking. [4]

The theoretical moment of crack formation, taking into account the climatic impact of a dry hot climate, can be determined by the formula: [3]

$$M_{схс} = (R_{bt,ser} \cdot \gamma_{tt} - \delta_{cs}) \cdot W_{pl} \qquad (1)$$

Here $R_{bt,ser}$ - design tensile strength of concrete in the calculation for the 2nd group of limit states;

$W_{pl}$ – moment of resistance of the reduced section for the extreme stretched fiber, taking into account the inelastic deformations of the stretched concrete:

$\gamma_{tt}$ - tensile stress factor for concrete.

The values of $R_{bt}$, ser and $E_b$ for concrete were taken according to experimental data, taking into account the coefficients and βb, depending on the storage conditions and hardening of concrete.

In the course of observing the development of cracks in columns under a load of 0.8 NCRC and 0.5Np, it was found that at a load of 0.8 NCRC with e= 0.5Y and e= Y, the crack opening width increases over time and after a year the opening width was 0.15 and 0.17 mm respectively for the columns under the influence of solar radiation on the stretched zone 0.14 and 0.15 mm on the compressed zone. For columns in constant mode, the crack width is 0.13 and 0.14 mm, which is 9% lower. This is due, apparently, to a more intensive development and increased values of concrete shrinkage deformations in columns exposed to solar radiation.

At a load of 0.5 NCRC, the nature of crack opening is similar to the nature of crack opening at a load of 0.8 NCRC. The maximum crack opening width at e= 0.5Y and e= Y was 0.22 and 0.22 mm, respectively, for columns exposed to solar radiation in the tensile zone and 0.2 and 0.21 mm in the compressed zone. Compared with the theoretical values, the crack opening width will be larger, which confirms the effect of shrinkage on the crack resistance of an eccentrically compressed reinforced concrete element and the need to take into account the effect of a dry hot climate in their calculation.

In this regard, it is recommended to calculate the crack opening width of reinforced concrete elements located in a dry hot climate using the formula:

$$a_{crc} = \delta \cdot \eta \cdot 20 \cdot (3.5 - 100\mu)\sqrt[3]{d}\left[\frac{\varphi_l \cdot \delta_s}{E_s} + \varepsilon_{sp} + \varepsilon_{cs1}\right] \qquad (2)$$

Here $\delta$ - take equal to 1.0 for eccentrically compressed elements

$\varphi_l$ – take equal when taking into account short-term loads and short-term effects of permanent and long-term loads (first stage of work) - 1.0; when taking into account the long-term action of constant and long-term loads (second stage of work), for structures made of heavy concrete of natural moisture

$$\varphi_l = 1,6 - 15\mu \qquad (3)$$

coefficient η is taken equal to:

with bar reinforcement of a periodic profile - 1.0 and smooth - 1.3.

The stress δs in the bars of the extreme row of reinforcement for eccentrically compressed elements is determined by the formula:

$$\delta_s = \frac{N(l_s - Z)}{A_s \cdot Z} \quad (4)$$

counting z= where z is the distance between the centers S and S1.

The coefficient of reinforcement of the section is taken equal to the ratio of the cross-sectional area of \u200b\u200bthe reinforcement S to the cross-sectional area of concrete (at a working height h0, but not more than 0.02);

d - rod reinforcement diameter, mm.

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