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Operational Reliability of Prefabricated Reinforced Concrete Slabs of Non-Rolled Roofs of Residential Buildings

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Abstract: *This article presents the results of experimental and theoretical studies on the evaluation of the operational reliability of elements of roll-free roofs of residential buildings built in Tashkent. To study this issue, comprehensive tests were carried out related to the study of the influence of operating conditions on the properties of concrete and the work of precast reinforced concrete slabs.*

Keywords: *operational reliability, concrete, roofing slab, roll-free crush, reliability, climate, result.*

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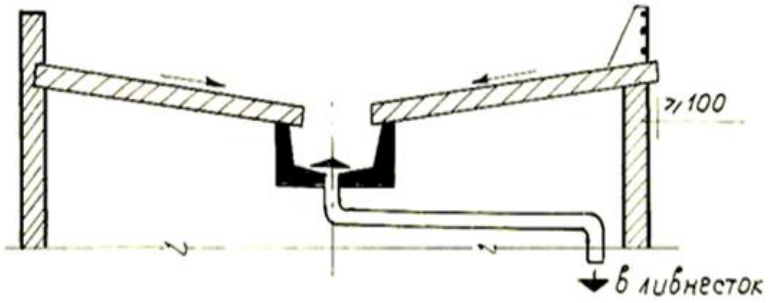
Introduction. At the end of the eighties of the last century, residential large-panel 9-storey houses with a roll-free roof were built in the city of Tashkent, in which ribbed slabs of a folded shape with a shelf in the compressed zone of the structure and prestressed trough-shaped drainage trays were used as reinforced concrete roofing slabs [1] for water drainage (see fig.).

a)



b)

Rice. a) General view of a nine-story residential building with a rolled roof;

b) Structural scheme of the roof with internal organized drainage.

1. prefabricated reinforced concrete roofing slab;
2. Prefabricated reinforced concrete gutter;
3. Outer wall of the attic.

According to the operating conditions, the concretes of these structures are tested, in addition to the external load, the effect of changes in climatic temperature, air humidity, solar radiation, precipitation, moisture and drying, freezing and thawing. From the degree of negative influence of these parameters individually, as well as in combination, their stress-strain state largely depends. In turn, the degree of influence of these factors largely depends on the formed initial structure of concrete, the features of the manufacturing technology and climatic conditions (the season of manufacture and loading of the structure) by the time the structure is closed and their changes during operation [2].

Main part. In connection with the above, of practical and scientific interest is the study of the influence of environmental parameters characteristic of the climatic conditions of the dry hot climate of the city of Tashkent, on the strength and deformation of roof concrete and the operation of roof structures. Without taking these issues into account, significant errors can be made in the calculations of reinforced concrete roof structures. To solve the tasks set, experimental studies were carried out in natural conditions.

Experimental studies to study changes in the strength and deformation of concrete of classes B25 and B30 were carried out on non-standard samples of cubes and prisms that underwent heat and moisture treatment according to the regime used in the manufacture of roof structures in the factory. The prototypes were tested a year after they were manufactured during this period they were affected by changes in the parameters of the external environment, as well as atmospheric precipitation.

The results obtained on the effect of a dry hot climate on the main characteristics of concrete in comparison with the data obtained for normal conditions are presented in the table.

No.	Feature names	Values of statistical distribution parameters		
		η	σ	ν,%
1.	Cubic strength, R	0,85	0,102	12,0
2.	Initial modulus of elasticity,Ev	0,95	0,093	9,8
3.	Inelastic ultimate strains in compression, Sv	0,86	0,123	14,3
4.	Tensile strength at splitting, R*btp*	0,92	0,148	16,1
5.	Flexural tensile strength, R*btu*	0,87	0,111	12,8

6.	R*btp* / R ratio	0,07	0,001	14,3
7.	R*btu* / R ratio	0,185	0,018	9,7

Notes. η is the average value of the ratio of the corresponding characteristics of concrete for natural and normal conditions; σ is the standard deviation of the mean value of this ratio; v - coefficient of variation.

According to this table, the tensile strength of concrete during splitting and bending is more sensitive to the negative effects of natural conditions in a dry hot climate. The analysis of the data obtained also confirms that steamed concrete, which hardens in natural conditions in a dry hot climate, experiences destructive processes to a lesser extent than natural hardening concrete due to early structure formation without climate action. Direct experimental confirmation of this was obtained by analyzing the parametric levels of micro-cracking in concrete under load. By analyzing experimental data to assess the lower limit of micro-cracking $R°_{cr}/ R_b$ and the conditional upper limit of cracking for the concretes under consideration, the following expressions are proposed:

$R°_{cr}/ R_b = 0.35 \log R_b - 0.59$ (1)

$R°_{cr}/ R_b = 0.35 \lg R_b - 0.28$ (2)

In expressions (1) and (2), the values of the prism strength of concrete are taken without a unit of measurement. According to the experimental data, the characteristics of the crack resistance of concrete in natural conditions are on average reduced by 8-15% compared with similar characteristics obtained for laboratory conditions. Moreover, the greater the strength of concrete, the less this decrease.

Studies of the influence of temperature and humidity climatic conditions on deformations (deflections) of prefabricated reinforced concrete slabs of non-rolled roofs were carried out in natural operating conditions in the attic of a 9-storey residential building.

According to the data of experimental studies, the nature of the change in the temperature of the concrete of the shelf and the longitudinal rib of precast concrete slabs are closely related to changes in the temperature of the ambient air. The results of the research showed that at an ambient temperature of +44, the temperature of the concrete of the slab flange can reach 84, while in the longitudinal rib it was 75. In this state, no thermal cracks have been observed in the slab elements at the moment.

These experiments also established that complete deformations of reinforced concrete slabs are of a periodic nature due to temperature changes both during the day and seasonally throughout the year. In this case, the maximum deformation during the day corresponds to 16:00, and the minimum values approximately to 4:00 in the morning. The maximum values of deformation during the year correspond to the summer period, and the minimum values, to the winter.

By analyzing the data obtained, it was found that the season of manufacture (loading) has a significant impact on the magnitude of temperature and humidity deformations of precast concrete slabs of non-rolled roofs. Deflections of flight-made slabs are on average 20-25% higher than deflections of similar winter-made slabs obtained after an annual observation, which is associated with changes in the strength of concrete and its initial modulus of elasticity, as well as the influence of climatic temperature. Under the influence of the temperature difference of the concrete across the cross section of the longitudinal rib, a temperature difference is obtained and a temperature bend is formed. In this regard, the full deflection (curvature) of a plate without cracks in the tension zone is defined as the sum of the curvature from short-term and permanent and long-term temporary loads, minus the curvature from thermal deformation. At the same time, the best agreement between the

calculated values of the total deflection of the slabs and the experimental ones is ensured by introducing the following adjustments to the regulatory documents [3]:

- the design temperature of the roof concrete is assumed to be 75;
- the influence of the season of manufacture (loading) is estimated by the coefficients 1.0 (for summer) and 0.75 (for winter);
- coefficient taking into account the influence of short-term creep is taken equal to 0.85;
- coefficient taking into account the effect of long-term creep of concrete in the compressed zone, when there are no cracks in the tension zone, is taken equal to 2.5;
- The coefficient of linear thermal expansion of concrete is taken when heated to 100 equal to degree -1.

Conclusion. The stress-strain state of reinforced concrete roof slabs largely depends on changes in the strength and deformation characteristics of concrete and their behavior under the influence of environmental factors characteristic of a dry hot climate.

The level of compressive stresses in the concrete of the flange and the longitudinal rib of the slab does not exceed the established lower limits of micro destruction and is within 0.3 and 0.35, respectively, of the design concrete resistance established by the design standards [3].

A certain increase in the deformability of roofing slabs after long-term operation (more than 30 years) has been established due to a decrease in the initial modulus of elasticity and an increase in the creep of concrete in a dry hot climate [4].

The calculation of the full deflection of reinforced concrete roof slabs should be carried out taking into account the climatic operating conditions on the characteristics of concrete and the operation of roof structures.

The implementation of the above conclusions in the form of a conclusion will generally ensure. Operational reliability of prefabricated reinforced concrete roof slabs, taking into account the load and adverse environmental conditions provided for by the design standards.

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