ПУКНАТИНОУСТОЙЧИВОСТ НА ЕЛЕМЕНТИ ОТ ЛЕКИ БЕТОНИ

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THE CRACK RESISTANCE OF LIGHTWEIGHT CONCRETE ELEMENTS

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Abstract:
Lightweight concrete are often used to make wall and partition fences without a constructional function. The properties of the finished elements depend on the structural and mechanical characteristics of the output materials. The appearance of cracks, as well as the development of deformations, have a significant impact on the tense state of the fences.
Temperature-humidity effects are studied over the whole section of the element under consideration. Depending on the changes in the properties of the material over time, the crack resistance (durability) of lightweight concrete elements has been assessed.

Keywords:
Lightweight Concrete, Fences, Stress, Crack, Deformation.

1. INTRODUCTION

The normal maintenance of cellular concrete structures is associated with predicting their crack resistance. This is explained by the fact that the cellular concrete structures are used mainly as fencing and the development of cracks on their surface can lead to deterioration of the operational properties.

The stress state of the enclosing structures is significantly affected by the development of forced deformations due to the uneven distribution of heat and humidity along the cross-section of the structure. It is especially important to take into account the uneven distribution of heat and humidity for the construction of cellular concrete. Firstly, this is due to the fact that, due to the low thermal conductivity of cellular concrete, rapid damping of the temperature of the impacts occurs in the thickness of the structure, and as a result, significant temperature gradients appear along the thickness. Secondly, for cellular concrete structures, a high initial moisture content (20-30% by weight) is characteristic, which causes a long-lasting occurrence in these structures and the existence of a moisture gradient along the cross-section of the structure. The moisture

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content of concrete between the outer surface and the middle of the structures from gas and foam concrete can reach 10-15% of the structure.

In addition to the temperature-humidity effects on the development of forced deformations in cellular structures, carbonization has a significant effect.

2. ASSESSMENT OF THE STRESS STATE STRUCTURES

The stress state of the enclosing structures during the development of forced deformations is determined on the basis of the solution of the plane problem of the theory of elasticity using the hypothesis of plane sections. For the enclosing structures, the state of material Q (temperature, humidity and carbonation degree) varies mainly in thickness, and in the design plane the change in Q is unimportant and it can be ignored in the calculations. Stresses that arise in a structure under the action of forced deformations should be determined taking into account the influence of the rheological properties of cellular concrete.

The time variation of the material state characteristic along the thickness of the structure (coordinate z) can be expressed as:

$$Q(z,t) = T(t)A(z) \qquad (1)$$

where T and K are dimensionless functions

T depends on time ***t***

A - from the coordinates of the points of the body ***z***.

When considering the stress state of cellular concrete structures, it is necessary to focus on the regular mode of changing the characteristics of the concrete state of the structure, as characteristic of prolonged drying, the development of carbonization, changes in temperature, for which creep is most important.

With a regular mode of changing the characteristic of the material state, the function t(t), can be written in the form:

$$T(t) = 1 - e^{-\alpha t} \qquad (2)$$

where α is the experimental parameter,

t is the time in days.

The total stresses , taking creep into account, are rationally found by the expression:

$$\sigma'(t) = \sigma(t)K(t) \qquad (3)$$

where ***σ(t)*** - stress an elastic-instantaneous problem,

K(t) - stress attenuation coefficient.

With the help of the compiled program, the influence of various factors on the value of *K(t)* was analyzed and the values of this coefficient for cellular concrete structures and for actually occurring conditions were calculated (Fig. 1)

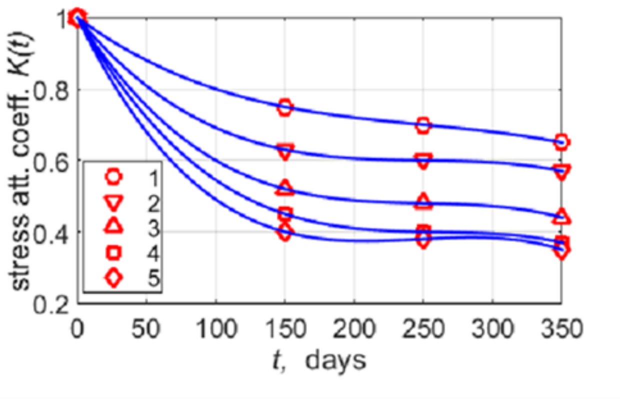


Figure 1. Dependence of stress attenuation coefficient on the creep characteristics of concrete and the duration of development of non-stationary forced deformation
1 - $\varphi_\infty = 1,0$; **2** - $\varphi_\infty = 1,5$; **3** - $\varphi_\infty = 2,0$; **4** - $\varphi_\infty = 2,5$; **5** - $\varphi_\infty = 3,0$

When assessing the stress state caused by the uneven change in humidity over the thickness of the cellular concrete structure, much attention is paid to the development of stresses by the significant nonlinearity of the dependence of the deformations of cellular concrete on its moisture content. This feature shrinkage strain of cellular concrete, which consists in the fact that when dried, the coefficient of humidity deformation after reaching a certain moisture content of the concrete increases and this increase can be very significant - 10 times or more.

However, in calculations this nonlinearity is not taken into account, but a constant coefficient of shrinkage is used, which depends on the range of humidity change. For cellular concrete, two moisture coefficients, δ_1 and δ_2, are used -

δ_1 for the wetness range Wp <W <Wb, and δ_2 for - Wb≤W <Wf, where:

Wp - primary

Wb – boundary

Wf – finaly

Accepting the nonlinear relationship between shrinkage deformations and humidity complicates the determination of the stresses. Therefore, for practice, can use an approximate methods of finding pre-emption.

Stress Ơ (t) in the process of changing the humidity of the structures is determined with the coefficient of humidity deformations $\delta = \delta_1$. If W < Wb, the σ_1 (t_1) arising in the construction during the humidity change is also determined simultaneously for which the uniform moisture distribution equal to Wb is taken as the initial one. The obtained values of stresses are multiplied by the coefficient of stress attenuation in concrete, corresponding to the duration of the proceeding processes t and t_1. The computed σ (t) and σ_1 (t_1) are summable.

3. EXPERIMENTS AND RESULTS

On the basis of these assumptions, the stress state of cellular concrete structures was nalysed during the development of the forced deformation process. As experimental samples, cellular concrete blocks (thickness 28 cm) and panels (24 cm thick) were used, which dry freely under the conditions of the warehouse of finished products. The physical and mechanical characteristics of the concrete are:

BLOCKS - ρ_{ob} = 890 kg/m^3 R_{cb} = 56 MPa E_b = 36,5 GPa -

PANELS - ρ_{op} = 835 kg/m^3 R_{cp} = 42 MPa E_p = 27 GPa –

The average weight moisture of concrete of test products after the end of autoclave treatment was in the range of 20 - 24%. The distribution of concrete moisture over the thickness of the structure and its variation over time was determined by th Samples were taken from the surface layer 1 cm thick and every 2 to 4 cm along the thickness of the structure. In parallel with moisture measurements, measurements were made with the aid of special deformation devices of both surface layers and layers at various depths from the surface of the structure. The deformations were measured in the plane of the structure along two perpendicular directions, indicated by the indicators.

Measurements of the deformations of the layers of structures at different depths from the surface showed that the cross-section of the structure remains flat when using an uneven drying, and thus the use of hypotheses and flat sections in determining the stress state of a structure is fully justified.e sampling method.

The coefficient of moisture shrinkage was determined on 10x10x10 cm prisms, which were prepared together with experimental structures. The average values obtained for the moisture shrinkage coefficients are: δ_b.= 3,1x10^5, δ_p.= 2,3x10^5. In both cases Wb = 11,5%. Analysis of the curves for the development of deformations of full-scale structures, shown in Fig. 2, gives grounds to state that this type of deformation is caused by a change in the value of the moisture strain coefficient when the concrete moisture content changes. Comparison of moisture measurement data of structures and their deformations demonstrates that an increase in the deformation rate marked on 130-140 days is associated with a decrease in the moisture content of the surface layers of structures up to W <Wlim. This circumstance confirms the conclusion that it is necessary to take into account the nonlinearity in the relationship between shrinkage and humidity when determining the stress state of large-sized cellular concrete structures.

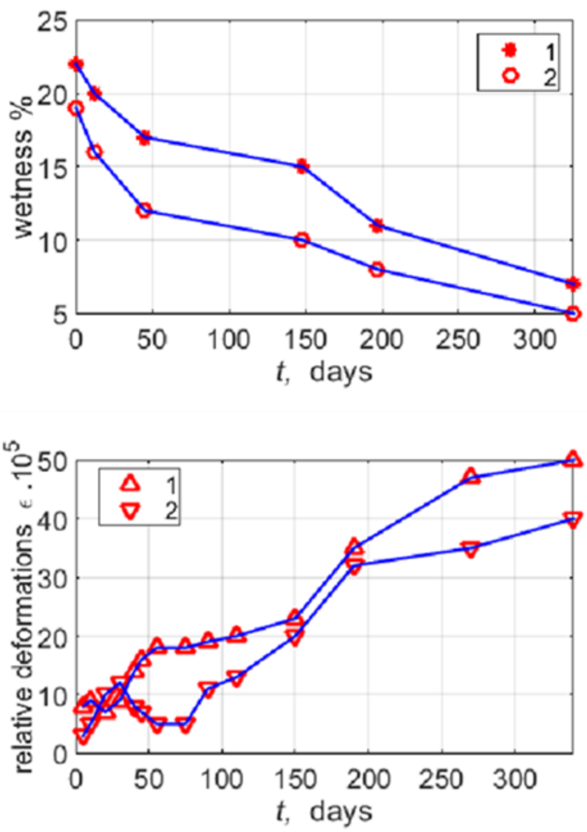
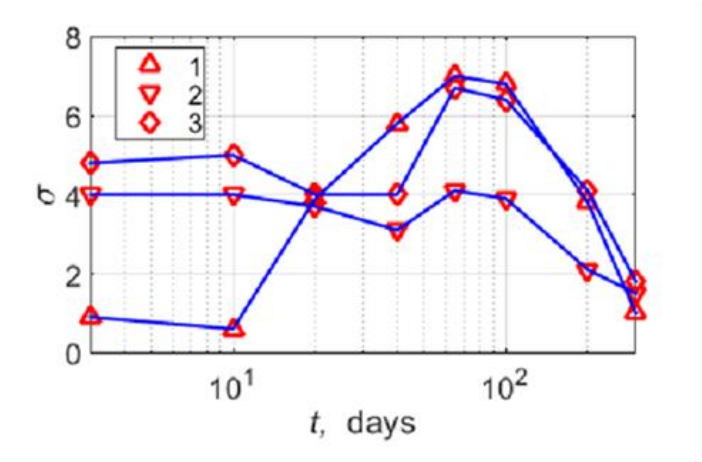


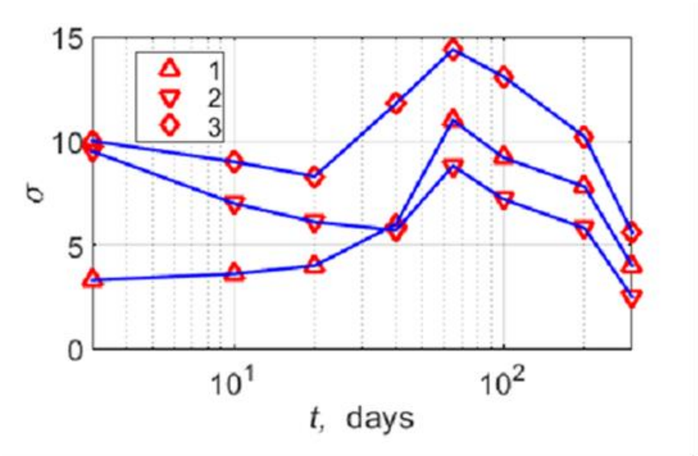
Figure 2. Dependence of deformations on moisture changes – **1** – block, **2** - panel

On the basis of the obtained data on the distribution of moisture in concrete structures, the change in their stress state during the drying process was determined.

Figure 3 shows the development of tensile stresses in the surface layers of experimental structures, since it is the stresses that determine the crack resistance of enclosing structures for evaluation. The data obtained by calculation for the elastic stage at $\delta = \delta av$ were compared and taking into account the effect of creep at constant and changing values of the moisture strain coefficient. This comparison shows that the consideration of creep and non-elongation in the dependence of shrinkage deformation on humidity makes it possible to more accurately determine the stress state of cellular concrete structures and, consequently, to correctly estimate their fracture toughness.



a)



b)

Figure 3. Variation of tensile stresses in the surface layers: a) block, b) panel,
1- elastic stage at $\delta = \delta_{av}$; 2 and 3 - with considering the influence of creep at $\delta = \delta_{av}$

The experiment showed that the tensile strength of concrete R_t does not characterize the fracture toughness of the surface layers of the structure. Based on their analogy with the stressed state of the bent element as a criterion for assessing the fracture toughness of enclosing cellular concrete structures, it is possible to suggest the value R_b- the bending strength of concrete.

4. CONCLUSION

In conclusion, the durability of the enclosing structures of cellular concrete is determined mainly by the appearance and development of cracks that arise and crumble during working. Cracks are the beginning of the destruction processes in concrete structure and create conditions for the intensive development of corrosion in the reinforcement. Therefore, it is necessary to determine the actual crack resistance of cellular concrete in structures, taking into account the rheological properties and the development of forced deformations in this concrete.

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