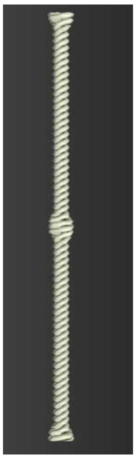

Fig. 1. Model fiberglass reinforcement

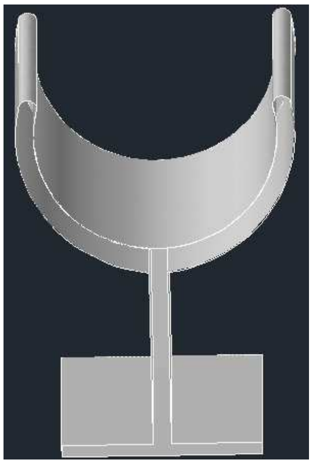

Fig. 2. Model anchoring compound

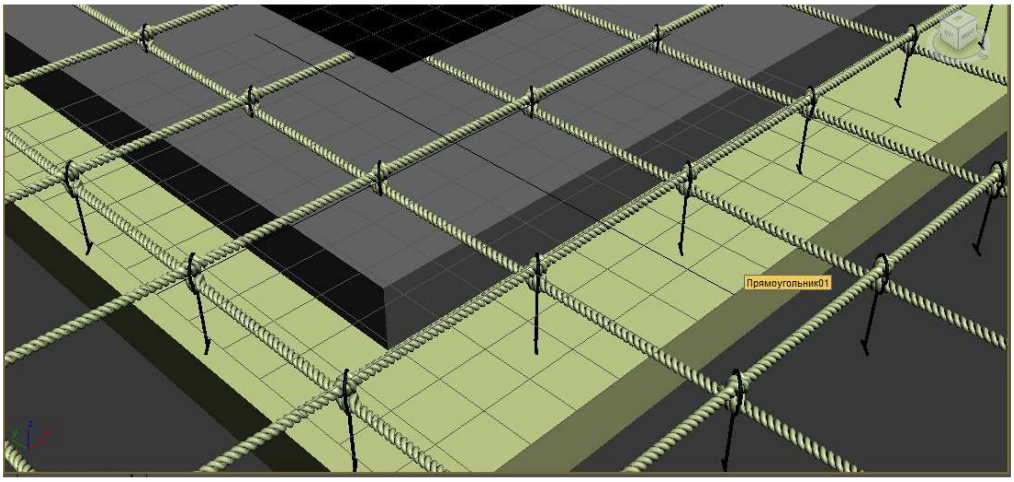

Fig. 3. Model reinforcing cage

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UDC 624.072

ON THE EFFECT OF LONGITUDINAL DEFORMATION ON THE PARAMETERS OF THE STRESS-STRAIN STATE OF THE HINGELESS ARCH

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The article studies the effect of longitudinal strains for two circuits of hingeless arch loading on parameters of its stress-strain state (SSS), depending on the two parameters of the arch design scheme, that characterize the degree of flatness of arch axis outlines and the extent of arch body massiveness. A significant dependence of the parameters of the stress-strain state (SSS) on the arch design scheme is established. Obtaining the numerical values of the analyzed variables is carried out in the MathCAD program.

Widely used in civil and industrial construction are statically indeterminate arch designs. Determination of internal forces in them is usually performed by force method. Included in the canonical equation coefficients and free terms are the displacements determined according to the formula of Maxwell-Mohr, and their value depends on the bending, longitudinal and shear structure deformations. It is believed that while applying calculation method of forces to most rod structures it is enough to consider only the bending deformation. But when estimating the arches, as shown by the research of professor Bernstein S.A. [1], Rabinovich I.A. [2] Kiselyov V.A. [3], this is not enough, and requires consideration of the longitudinal strain. However, the accomplished studies were associated with the calculation of two-hinged arches and were carried out for private numerical schemes of loading.

The influence of longitudinal strain on the parameters of the stress-strain state of the hingeless arch is studied in general view (fig. 1).

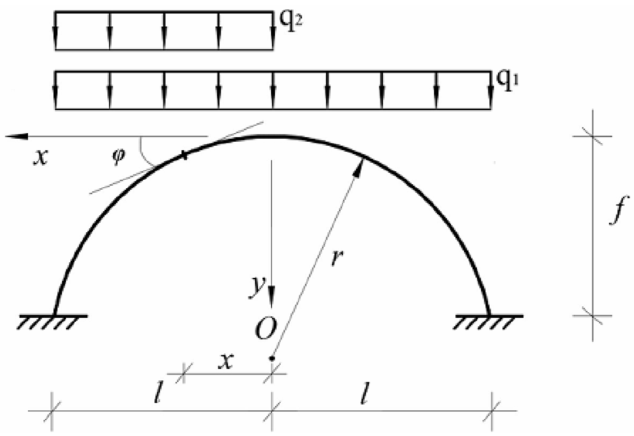

Fig. 1. Hingeless arch

The outline of the circular arch with a constant symmetrical cross-section along the length of the span is considered. The following parameters of arch geometry are introduced:

$$\alpha = \frac{f}{l},\ \lambda = \frac{l}{r}\ r = \sqrt{\frac{I_z}{A}}.$$

The first parameter characterizes the degree of flatness of arch axis outlines. The second parameter characterizes the arch body massiveness. Given the introduced parameters the law of arch axis outlines has the form

$$\gamma = \frac{1}{\alpha\beta}\left(1 - \sqrt{1 - \beta^2\xi^2}\right),$$

where $\gamma = \frac{y}{f}$, $\xi = \frac{x}{l}$ – section dimensionless coordinates.

Two schemes of arch loading by uniformly distributed load are considered, along the entire length of the span and half of the span. The calculation of the arch is carried out by force method using three variants of the basic system: three-hinged arch, curve beam with a beam supporting scheme and curve beam with cantilevered supporting scheme. Canonical equations of the force method for the three options are presented as:

$$\delta_{11}X_1 + \delta_{12}X_2 + \delta_{13}X_3 + \Delta_{1P} = 0,$$

$$\delta_{21}X_1 + \delta_{22}X_2 + \delta_{23}X_3 + \Delta_{2P} = 0,$$

$$\delta_{31}X_1 + \delta_{32}X_2 + \delta_{33}X_3 + \Delta_{3P} = 0.$$

To be able to study the effect of longitudinal strain on the parameters of the arch stress strain state (SSS), when determining the coefficients and free terms of the canonical equations, Maxwell-Mohr formula is written in the form:

$$\delta_{ij}(\alpha,\lambda) = I_{ij}^{M}\left(1+\frac{I_{ij}^{N}}{I_{ij}^{M}}\right),\ \Delta_{iP}(\alpha,\lambda) = I_{iP}^{M}\left(1+\frac{I_{iP}^{N}}{I_{iP}^{M}}\right),\ (i,j=1,2,3),$$

where I_{ij}^{M}, I_{iP}^{M} – integrals that take into account the effect of bending deformations; I_{ij}^{N}, I_{iP}^{N} – integrals, that take into account the effect of longitudinal deformation. Then the expressions given in brackets quantitatively characterize the impact of longitudinal strain on the coefficients and free terms, depending on the two parameters of the arch geometry.

This allows to further assess the impact of the behavior of these parameters on the relative change of the bending moments and longitudinal forces due to the account of longitudinal strain

$$\Delta M(\xi,\alpha,\lambda) = \frac{M(\xi,\alpha,\lambda) - M_M(\xi,\alpha,\lambda)}{M(\xi,\alpha,\lambda)},$$

$$\Delta N(\xi,\alpha,\lambda) = \frac{N(\xi,\alpha,\lambda) - N_M(\xi,\alpha,\lambda)}{N(\xi,\alpha,\lambda)},$$

where M, N – dimensionless bending moments and arch longitudinal forces, determined with account of bending and longitudinal strains; M_M, N_M – dimensionless bending moments and arch longitudinal forces determined with account of only bending deformations.

Figure 2 shows dependence graphs in the values of bending moments and longitudinal forces for the first version of the main system with arch loading along the length of the entire span:

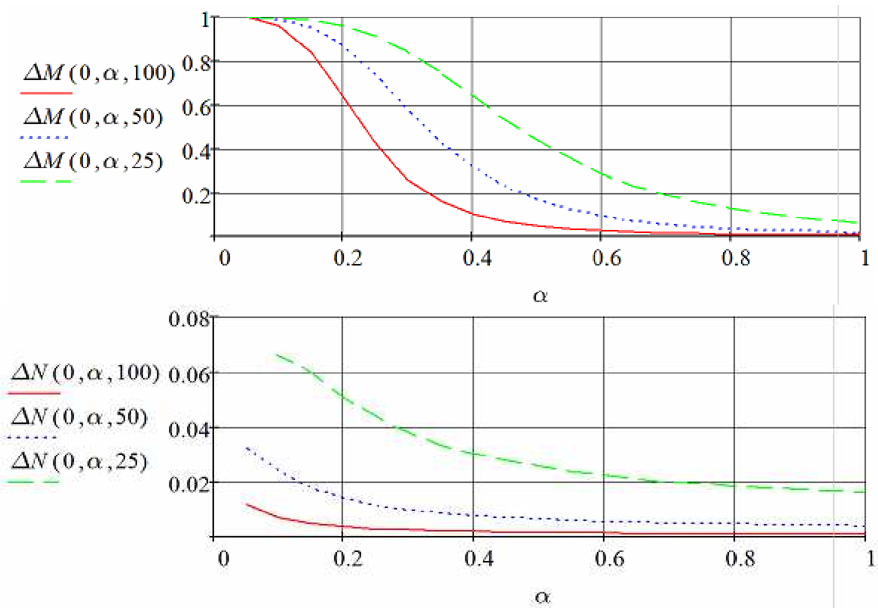

Fig. 2. Dependence of value changes of the bending moments and longitudinal forces from the parameters of the arch

Graphs are built in MathCAD program. Similar diagrams are constructed for the second load circuit, as well as for other embodiments of the basic system.

The analysis of the graphs leads to the following conclusions:

1. Accounting of the effects of longitudinal strain in determining the parameters of the stress-strain state (SSS) depends essentially on the parameters α and λ. Where α characterizes the degree of arches flatness. λ describes the arch body massiveness.

2. Accounting of the effects longitudinal strain in determining the parameters of the stress-strain state (SSS) depends on the choice of the basic variant of forces method.

3. Accounting of the effects longitudinal strain in determining the parameters of the stress-strain state (SSS) is practically independent of the type of load.

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UDC 691.33:659.475.4

THE COMPOSITE BINDER FOR SELF-COMPACTING CONCRETE

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Application of self-compacting concrete (SCC) is one of the prior directions in *modern construction. Despite the reduction of energy consumption in the production of reinforced concrete structures, high physical and mechanical properties, the SCC is more expensive material compared to conventional vibration compaction concrete. One of the solutions of this problem is the use of secondary products industry as raw material components of the SCC. The effect of water treatment of sludge of thermal Electrical Station on the kinetics of a set of strength of the cement stone, together with the introduction of its hyperplasticizer was studied. The possibility of using water treatment of sludge as dispersed filler was shown, the optimum filler content and hyperplasticizer was defined.*

The use of self-compacting concrete (SCC) in modern construction is one of the most significant achievements of construction technology in recent years. Self-compacting concrete is a concrete, whose properties are determined by vibration-free sealing of concrete, able to spread, completely fill the cavity of the formwork and compacted under its own weight [1].

Depending on the method of providing resistance to delamination and water separation there are two basic types of self-compacting concrete: fine divided type; stabilizing type.

In the first type of self-compacting concrete mixtures high extendable grains coarse and fine aggregate is achieved by introduction in composition of concrete thin concrete inert or active filler, comparable on dispersion with a binder.

Chemical analysis of the majority of fillers allows to conclude that the basic compound included in them composition are calcium carbonate $CaCO3$ and magnesium carbonate basic $3MgCO \square MgOH \square 2H2O$.

Many researchers established that carbonate-containing additives are not inert fillers, and can have a significant influence on the processes of formation of structure of cement stone, performing not only the function of thickeners and activating the binder hydration process, and contributing to an increase in the degree of crystallinity formed hydrate [2, 3, 4, 5, 6].

Analysis of the results of numerous studies on the use of cement compositions containing SCC fine carbonate fillers shows:

– there are different points of view on efficiency, optimal dispersive capacity and aggregate consumption, in each case these indicators are determined experimentally;

– the most commonly used fillers are metakaolin and silica fume, they are expensive mineral additions, which leads to increased cost of SCC in comparison with a similar concrete type;

Accordingly, many researchers give the priority to active carbonate containing fillers, manufactured by using local raw materials or secondary products of various industries.

By considering a group of technologeneous products of similar composition in Belarus it was revealed that the greatest interest represent a sludge chemical water treatment (SCHWT) thermal power plants, stored in large quantities in the tailings pond or industrial landfills. The problem of sludge disposal in Belarus is not completely solved [7].

Application of SCHWT as a part of self-compacting concrete allows to utilize waste and thereby improve the ecological situation in the republic.

In the number of papers the results of research related to the use water treatment sludge of thermal Electrical Station are shown.

Vishniakova J.V. determined that in the cement matrix filled with sludge water treatment of thermal Electrical Station internal defects are localized – microcracks, and their number and size decrease, stress concentrations are reduced [8].

In studies [9] it is shown that the use of waste water treatment with a moisture content of 40% leads to retardation of setting of the cement for 4 hours, and to decrease of strength of cement stone by 25%.