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STUDY OF FATIGUE OF CONCRETE ON LIMESTONE SAND

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Reinforced concrete structures made from local materials are subjected to repeated loads during operation, which requires an assessment of their fatigue strength and deformability of such concrete.

Key words: strength, deformability, fatigue, calcareous sand, concrete.

Formulation of the problem. Reinforced concrete structures made of local materials are subjected to the operation of the operation of repeatedly repeated load, which requires an assessment of their fatigue strength and deformability of such concrete..

Analysis of recent research and publications. Work that would consider the effect of cyclic loads on reinforced concrete structures made on limestone sand is not enough. The main regulatory document defining the general requirements for concrete and reinforced concrete structures [3] does not contain recommendations for calculating the fatigue strength of structures made of concrete on limestone sand.

Therefore, when calculating constructional structures made of concrete in limestone sand, it is necessary to take into account the fatigue strength and deformability of such concrete.

Formulating the goals of the article. The study of fatigue and deformability of the properties of concrete on limestone sand with axial compression was carried out in the laboratory of reinforced concrete structures ODABA. Concrete prisms measuring 150x150x600 mm and 150 mm cubes were tested at the age of one year. In the manufacture of concrete experimental specimens, limestone sand derived from stone waste materials in the Odessa region of limestone shells with a fraction of 0.5 mm was used. The strength of the initial rock is 0.8-1.5 MPa. As a large aggregate, granite gravel fraction 5 ÷ 20 mm was used.

The samples were heat treated according to the regime: shuttering after concrete for 3-4 hours, raising the temperature - 3 hours, isothermal warming at t = 75-85 ℃ -1.5 hours.

The prismatic strength of concrete on limestone sand is 17 MPa, the initial modulus of elasticity is 18 MPa.

Main part. Most building constructions, including creep beams, cover panels and overlays, which are installed by various vibration machines, are subject to multi-cyclic loads. Such designs, which are designed for the action of static loads, test the effect of cyclic loads, which requires their tiredness [1].

There are not enough quartz sand in the southern regions of Ukraine, which is used for the manufacture of reinforced concrete structures [2].

Therefore, the use of limestone waste is of particular relevance. Limestone sand, which is obtained by crushing and scattering of stone waste, according to its mechanical characteristics, is suitable for the manufacture of concrete and structures.

It is necessary to get results of researches of concrete on limestone sand.

The tests were carried out on a hydraulic press with a pulsator at a load frequency of 455 cycles per minute.

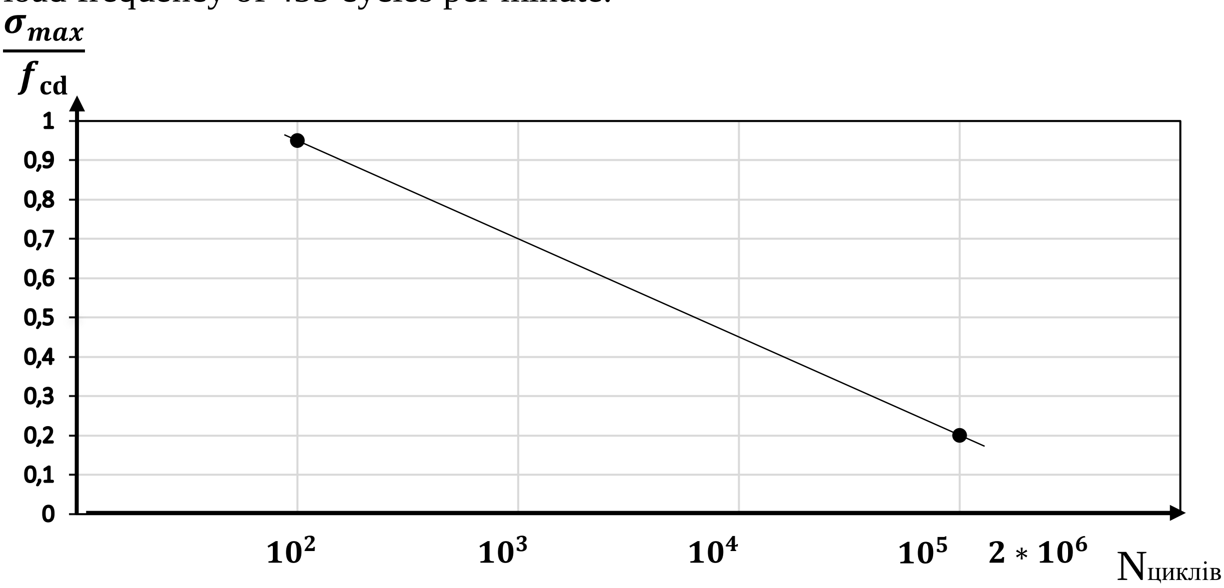

Fig.1 Dependence of the relative boundary of the durability of concrete on the number of cycles, at ρ=0,33

At the first stage, stress is set, which exceeds the limit of the endurance of the sample material, that is, $\sigma = 0{,}9 f$cd, where $f$cd - estimated resistance of concrete on limestone sand. At the same time, the sample was destroyed for a small number of cycles N1. The load on the next prisms has been gradually reduced (0,8; 0,7; 0,52; 0,46) $f$cd. Each of the less loaded samples, withstood a large number of cycles before fracture. According to the results of the tests, the relationship between the relative stresses of the repeated load and the number of cycles was established (Fig. 1).

Immediately from the diagram it follows that for concrete on limestone, a linear dependence between $\frac{\sigma_{max}}{f_{\text{cd}}}$ and lg N within the study (from N=$1 * 10^3$ to N=$2 * 10^6$ cycles). With increasing number of cycles there was a decrease in the fatigue strength of concrete. It is established that the boundary of endurance of concrete on limestone sand with coefficient of asymmetry of a cycle $\rho = 0{,}33$ is $0{,}5f_{\text{cd}}$.

Based on dependency analysis $\sigma = f(\varepsilon)$, Based on experimental data, after the application of statistical and multi-cyclic loading, a change in the deformative properties of concrete has been established. Figure 2 shows a graph $\sigma = f(\varepsilon)$, obtained during the study of prisms from concrete on granite crushed stone and limestone sand (Fig. 2). The graph shows the change in relative longitudinal deformations in the process of pulsation.

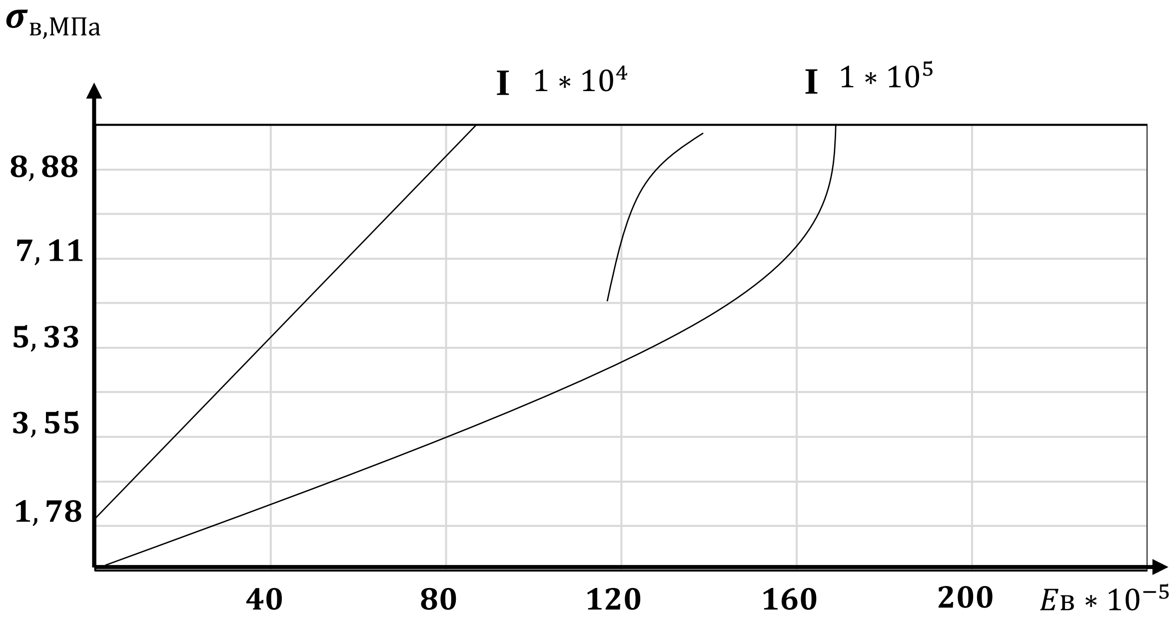

Fig.2 Diagram of compression of concrete on limestone sand under the influence of multi-cyclic loading at $\rho = 0{,}33$

In the study of endurance of concrete from limestone sand it was established that under the action of a cyclic load that exceeds the limit of endurance, the dependence of "stress - deformation" after the corresponding number of cycles is aligned, and with a further increase in the number of cycles N curvature in the direction of the axis of deformation. During the study, the full deformation of the concrete increases. As the number of cycles increases, the magnitude of the deformation of the vibroconversion (residual deformation) increases, with this increase appreciably in the initial load period and has no tendency to stabilize with subsequent repetition of the load. The value of strain on the base N= $2 * 10^6$ cycles, with coefficient of asymmetry of the cycle $\rho = 0{,}33$ is from 84,5% to 167% values of deformations of concrete obtained at the first statistical load.

Under the action of a cyclic load there is a decrease in the initial modulus of elasticity of limestone concrete. On average, reducing the initial module is from 50% to 60%.

The most intense reduction of this value from 20% to 30% took place in the first $10^4 - 10^5$ full load cycles. When comparing the initial modules of elasticity of concrete $E_в$ on limestone, which are given on (Fig. 3), it can be concluded that the degree of decline $E_в$ depends on the prismatic strength of the concrete. The lower the prism strength of the concrete, the more intense the decrease in the value $E_в$.

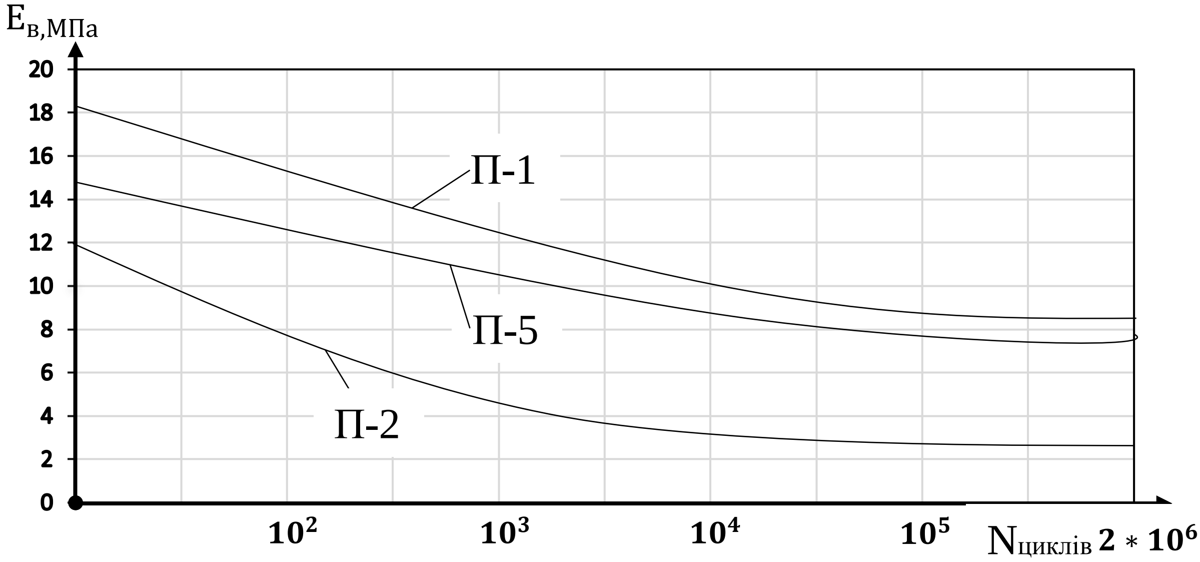

Fig. 3 Dependence of the initial modulus of elasticity of concrete on limestone sand on the number of cycles at =0,33

Experimentally set the value of the transition factor $k_b = \frac{E_{b,N}}{E_{b,I}}$ from the modulus of elasticity of concrete on limestone sand at repeated loading $E_{b,N}$ to the original static module $E_{b,I}$. For concrete prisms on limestone sand value has been obtained k_b at a load that is 10% of the destructive. It ranges from 0.75 to 0.63. At 50% of the load from the devastating, the value of this coefficient is an average of 0.67 to 0.52.

Conclusions. Relative boundary of endurance on the base N=$2 * 10^6$ concrete cycles on granite gravel and lime sand is $0{,}5f_{\mathrm{cd}}$. At a cyclic load there is a decrease in the initial modulus of elasticity of concrete on limestone sand by 50-60%. The value of strain on the base N=$2 * 10^6$ cycles ranges from 85.4 to 167% of the values of concrete obtained with static loading.

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ИССЛЕДОВАНИЕ УСТАЛОСТИ БЕТОНА НА ИЗВЕСТКОВОМ ПЕСКЕ

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Железобетонные конструкции, изготовленные из местных материалов, подвергаются в процессе эксплуатации воздействию многократно повторяющейся нагрузки, что требует оценки их усталостной прочности и деформативности такого бетона.

Ключевые слова: прочность, деформативность, усталость, известковый песок, бетон.

ДОСЛІДЖЕННЯ ВТОМИ БЕТОНУ НА ВАПНЯНОМУ ПІСКУ

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Досліджено втоми міцності і деформативності бетонів на вапняному піску, що дає можливість застосовувати залізобетонні конструкції, виготовлені з місцевих матеріалів, які піддаються впливу циклічних навантажень.

Ключові слова: міцність, деформативність, втома, вапняний пісок, бетон.