ON THE SERVICE LIFE ASSESSMENT OF REINFORCED CONCRETE ELEMENTS OF BRIDGE SPANS.

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Annotatsiya. *Maqolada avtomobil yo‘llari va ko‘priklarning xalq xo‘jaligidagi o‘rni, tabiiy sharoiti, avtomobil va temir yo‘l transportining unumdorligi, samaradorligi va xavfsizligini hisobga olgan holda, barcha yo‘l elementlarining parametrlarini texnik-iqtisodiy asoslash tamoyillari, ularning qurilishdan keyingi umrboqiyligini hisobga olingan.*
Kalit so’zlar. *ko'priklar, yo'l o'tkazgichlar, ko'prik konstruktsiyalari, nuqsonlar va shikastlanishlar, yoriqlar, rekonstruksiya, ekspluatatsiya ishonchliligi, umrboqiylik.*
Аннотация. *В статье учтены роль автомобильных дорог и мостов в народном хозяйстве, их природные условия, производительность, экономичность и безопасность автомобильного и железнодорожного транспорта, принципы технико-экономического обоснования параметров всех элементов дорог, их долговечность после строительство.*
Ключевые слова: *мосты, эстакады, мостовые конструкции, дефекты и повреждения, трещины, реконструкция, эксплуатационная надежность, долговечность.*
Abstract. *The article takes into account the role of roads and bridges in the national economy, their natural conditions, productivity, efficiency and safety of road and rail transport, the principles of feasibility study of the parameters of all road elements, their durability after construction.*
Keywords: *bridges, overpasses, bridge structures, defects and damage, cracks, reconstruction, operational reliability, durability.*

Introduction. The Republic pays special attention to the development of the construction of transport infrastructure both within and outside the Republic. From the first days of independence, President Sh. M. Mirziyaev identified as one of his priorities the design and construction of the most convenient and shortest roads and bridges with high capacity, which would ensure Uzbekistan’s access to the world market. Currently, new projects are being implemented in the Republic of Uzbekistan to ensure the development of transport and communication infrastructure. Over the past years, such large-scale work has been carried out as the construction of main roads, the establishment of transport links with foreign countries, the introduction of modern equipment and technologies into the road sector, the training of specialists that meet the requirements of today and the improvement of their qualifications.

Considering the role of highways and bridges in the national economy, natural conditions, productivity, efficiency and safety of road and rail transportation, the principles of feasibility study of the parameters of all road elements, as well as the choice of road direction and their construction, are of great importance [1].

These features of their work must be taken into account by designers, builders, and maintenance workers who are obliged to ensure normal year-round service of the road for a long time [2]. With the current increase in traffic flow, bridge structures must develop accordingly. Naturally, the designs of bridge abutments and intermediate supports had to meet the growing requirements for span structures.

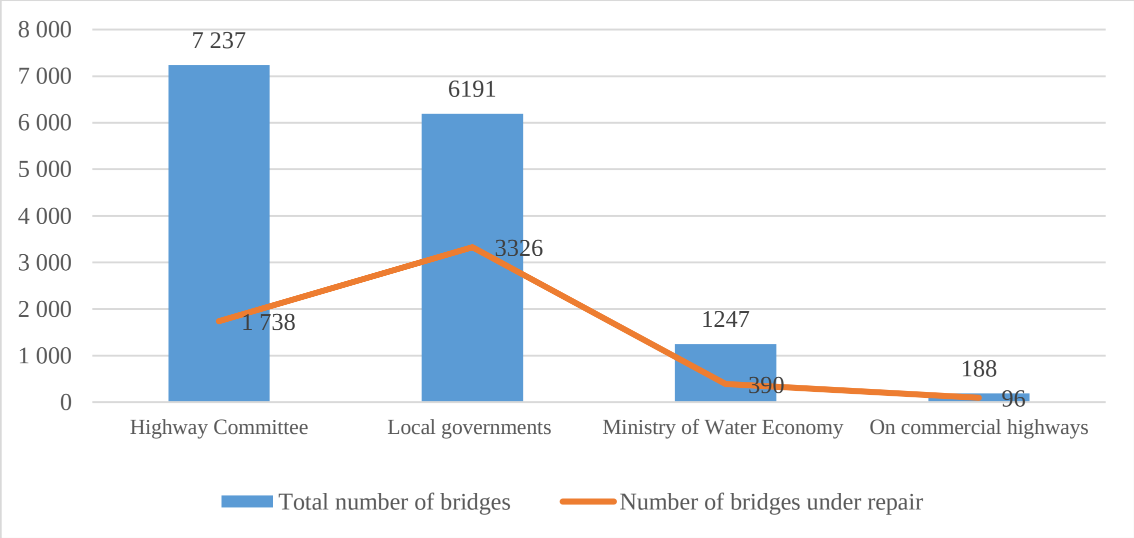

Figure 1. Total number of bridges in use in the republic

Methods. Tasks technical diagnostics of any structures and structures is the development of methods and tools intended for qualitative and quantitative assessment of indicators characterizing the structural and operational properties and condition of functioning objects, their elements and materials, as well as drawing up recommendations for their further operation in accordance with technical requirements (Fig. 1.).

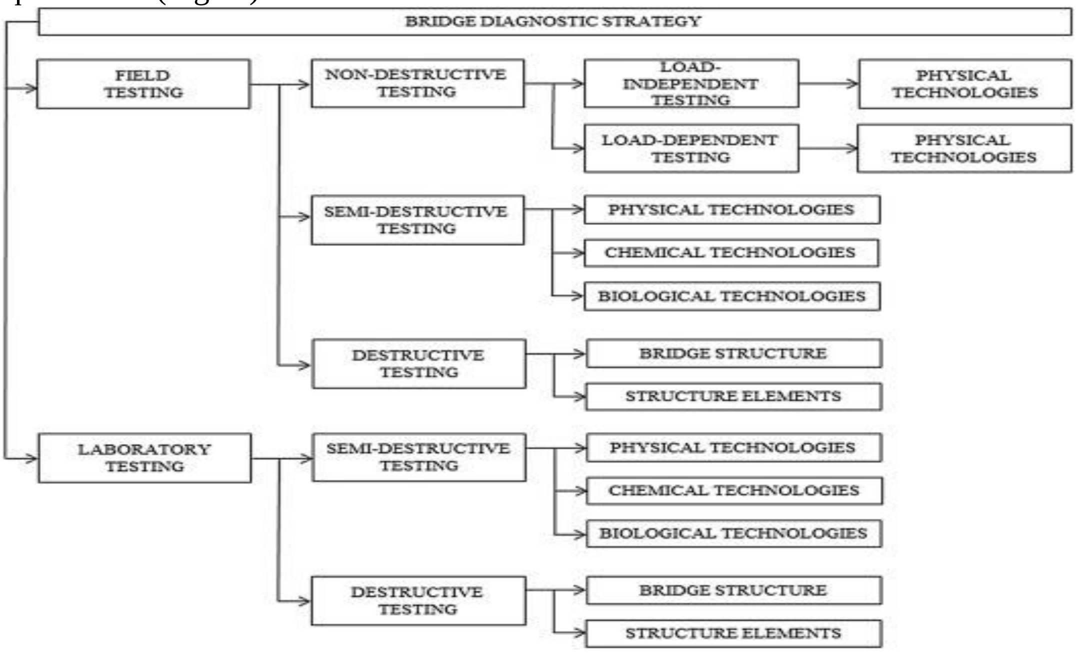

Figure 1. Technical diagnostics of bridge structures

Technical diagnostics of load-bearing structures of transport structures has the main goal - to determine the actual technical condition of the structures, their ability to withstand the design loads operating in a given period and ensure normal operation of the building. The objectives of the survey may include searching for the best options for strengthening and rehabilitation of structures, adaptability of the building to new loads and operating conditions during its proposed reconstruction. If the survey is carried out after an accident, its causes, feasibility and the possibility of restoring the building or its individual parts are analyzed. [3]

Results. In real operating conditions, bridges are simultaneously exposed to several influences. As a result, the intensity of damage accumulation increases, which can accelerate the failure of the structure. The influence of several factors can be taken into account by introducing a multifactorial measure of accumulated damage *D*. It is selected based on physical concepts of the operation of the structure under loads and environmental influences and is taken equal to zero for the initial state and one at the moment of failure during operation [4]:

$$D = \frac{\Delta(x_1, x_2, \ldots x_t; \sigma; t) - \Delta_0}{\Delta_k - \Delta_0}, \qquad (5)$$

here: $\Delta(x_1, x_2, \ldots x_t; \sigma; t)$ - current values of the damage measure over time t depending on stresses and variable factors of the loaded mode and operating conditions $x_1, x_2, \ldots, x_t$; Δ_k is the final value of the measure of accumulated damage at the moment of failure; Δ_0 is the value of the measure of accumulated damage in the initial period of operation ($t = 0$).

At time $t = 0$, the initial conditions are met : $\Delta(x_1, x_2, \ldots x_t; \sigma; 0) = \Delta_0$, $D = 0$. Failure occurs when the service life of the structure is equal to the service life: $\Delta(x_1, x_2, \ldots x_t; \sigma; T) = \Delta_0$, $D = 1$, where *T is* the service life of the structure.

to choose a universal measure of damage that could reflect the full impact of all changes in a material such as concrete. But, as experience shows, most external influences reduce the strength of concrete, which affects the durability and reliability of the structure. [5]

The value of residual strength, which depends on the combined action of repeated load and environment, duration of load application, chemical aggression in concrete, etc., can be obtained on the basis of active experiments, allowing one to obtain the necessary multifactor correlations. Damage measure D is a slowly changing function of the interactions of damaging factors. Increment of the damage measure in the time interval Δt:

$$\Delta D(\sigma_j) = v_j \Delta t, \ (6)$$

where v_j - rate of increase in damage measure over time t in the stress range $\sigma - \Delta\sigma/2 < \sigma_j < \sigma + \Delta\sigma/2$.

Variables $x_1, x_2, \ldots, x_i$, defining the measure of damage D according to formula (5), depend on time:

$$x_1 = \varphi_1(t), x_2 = \varphi_2(t) \ldots, x_i = \varphi_i(t). \ (7)$$

Damage measure speed $v_j = dD_j / dt$ is a complex function of many variables $x_1, x_2, \ldots, x_i$, each of which in turn is a function of an independent variable time t according to expression (7):

$$v_j = \sum_{i=1}^{i} D'_{xi}(x_1, x_2, \ldots, x_i, \sigma_j, t)\varphi'_i(t), \ (8)$$

where D'_{xi} *is* the derivative of the measure of accumulated damage with respect to the variable x_i; $\varphi'(t)$ - derivative with respect to time t of the dependence of the factor $x_i = \varphi_i(t)$.

Mathematically, this means that the measure of accumulated damage is a non-linear function, and the rate of accumulated damage depends *on D*. In equation (5) we replace the values $x_1, x_2, \ldots$, x_i to their values according to expression (7):

$$D = \frac{\Delta[\varphi_1(t), \varphi_2(t), \ldots, \varphi_i(t)] - \Delta_0}{\Delta_K - \Delta_0}, \qquad (9)$$

From equation (9) we express $t = f(D_i, \sigma_i)$ and substitute the values *of* t into equality (7):

$$x_1 = \varphi_1(D, \sigma_j), x_2 = \varphi_2(D, \sigma_j) \ldots, x_i = \varphi_i(D, \sigma_j).$$

We express the rate of damage accumulation through D *by* substituting $x_i = \varphi_i(D_i, \sigma_i)$ into expression (8):

$$v_j = \sum_{i=1}^{i} D'_{xi}[\varphi_i(D, \sigma_j)]\varphi'_i(t), \qquad (10)$$

We replace the increment in equality (6) with a differential, taking into account the probabilistic nature of the stress distribution and relation (10), we write:

$$dD = \int_{\sigma_0}^{\infty} [\sum_{i=t}^{1} D'_{xi}(D, \sigma)\varphi'_i(t) p(\sigma; t)] d\sigma dt \qquad \text{(eleven)}$$

where: σ_0 – voltage value below which damage does not occur; $p(\sigma; t)$ - stress distribution density at time t.

Integrating expression (11) over the variable D ranging from $D_0 = 0$ to $D_k^{/} = 1$, by variable t within the limits of $t_0 = 0$ and $t_k = 1$, we obtain the condition under which the structure fails:

$$\int_{Du}^{1} \frac{dD}{\int_{0}^{E^{\cdot}} \int_{\sigma_0}^{\infty} [\sum_{i=t}^{1} D_{xi}^{/}(D,\sigma)\varphi_i^{/}(t)\, p(\sigma;t)] d\sigma dt} = 1, \quad (12)$$

where *T is* the service life of the structure. Condition (12) is *the basic equation for calculating service life.* It establishes the relationship between the service life of the structure, the value of stresses, their probabilistic distribution, and the intensity of exposure to damaging environmental factors. From the solution of the basic equation the service life of the structure is found[6].

A significant difference between service life calculations and traditional calculations of the bearing capacity of a structure is the introduction into the calculation of the rate of rewarding processes and changes in the internal properties of the structure. In a generalized form, the algorithm for calculating the service life of load-bearing structures is:

$$T = \nabla \frac{D(R,\sigma,P_R,a_{агр})}{\sigma,P_\sigma,\alpha_{агр}}, \qquad (13)$$

Where ∇ - an operator that converts the mathematical dependencies of the structural strength reserve and the rate of damage accumulation into service life; $D(R, \sigma, P_R, a_{\text{agr}})$ - a mathematical representation of the strength reserve of a structure, depending on its strength R, effective stresses σ, probabilistic properties of strength P_R, the degree of resistance of the aggressive environment a_{agr}; $h(\sigma, P_\sigma,$ *and* $_{\text{agr}})$ - the rate of damage accumulation, depending on stresses, probabilistic properties of the load P_σ, indicators of the aggressiveness of environmental influences[7].

The operator in the simplest case is a division operation, however, if we take into account the history of loaded structures together with the aggressive influence of the environment, then it is necessary to solve the basic equation (12) to determine the service life, which in its structure corresponds to expression (13) [8]. For the residual service life, the initial measure of accumulated damage at the time of technical diagnosis is not equal to zero, and then the basic equation for calculating the residual service life (12) takes the following form:

$$\int_{Du}^{1} \frac{dD}{\int_{0}^{E^{\cdot}} \int_{\sigma_0}^{\infty} [\sum_{i=t}^{1} D_{xi}^{/}(D,\sigma)\varphi_i^{/}(t)\, p(\sigma;t)] d\sigma dt} = 1, \qquad (14)$$

where D_{and} is a measure of accumulated damage after t_{and} years of operation; T' *is* the service life at which the structure fails, taking into account its actual technical condition at time t_{and}.

Conclusion. All initial data for determining the residual service life according to the formula $T_{\text{rest}} = T' - t_{\text{and}}$ are accepted in accordance with the operating conditions after the moment of monitoring the technical condition: stress from the load σ, variable factors $_i$ *that* determine the operating conditions during the remaining period of operation from the moment t_{and} until the structure fails T The quantitative value of the measure of accumulated damage D_{and} is determined on the basis of instrumental measurements of the characteristics of the stressed deformed state, the study of loading modes and operating conditions of structures.

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