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ENGINEERING PROTECTION ECO-SYSTEMS TERRITORIES ON THE BIOSPHERE COMPATIBILITY PRINCIPLES APPLICATION

The article is devoted to the solution of the actual scientific and applied problem issue - the search for organizational and technological solutions for biosferous construction on the example of marine and river coastal areas engineering protection in Ukraine. The main causes of imperfect activities in the field of coastal areas protection are: insufficient considering natural processes laws in the coastal zone of sea, reservoirs and rivers during the formation of design decisions; work incompleteness andcoastal protection and coastal regulating structures formation incompleteness in local complexes that fully cover coastal natural systems where there is a high level of natural processes interconnections that do not ensure their project effectiveness. It was substantiated that objective of shores engineering protection ecosystems increasing objective reliability is the most rational damaging construction of the gabions.

***Key words:** technological processes; biosphere compatibility; organizational and technological solutions; construction production*

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ЗАСТОСУВАННЯ ЕКО-СИСТЕМ ІНЖЕНЕРНОГО ЗАХИСТУ ТЕРИТОРІЙ НА ПРИНЦИПАХ БІОСФЕРОСУМІСНОСТІ

Стаття присвячена розв'язанню актуального науково-прикладного проблемного питання – пошуку організаційно-технологічних рішень біосферосумісного будівництва на прикладі інженерного захисту територій морського та річкового узбережжя в Україні. Основними причинами недосконалості діяльності в галузі захисту прибережних територій є: недостатнє врахування закономірностей природних процесів у прибережній смузі моря, водосховищ та річок при формуванні складу проектних рішень; некомплексність ведення робіт та незавершеність формування берегозахисних та берегорегулюючих споруд у локальні комплекси, що повністю охоплюють берегові природні системи, в яких існує високий рівень взаємозв'язків природних процесів, що не забезпечувало їх проектну ефективність. Обгрунтовано, що метою з підвищення надійності роботи екосистем інженерного захисту берегів найбільш раціональною утрумуючою конструкцією являються габіони.

***Ключові слова:** технологічні процеси; біосферосумісність; організаційно-технологічні рішення; будівельне виробництво*

Introduction. It is well known that the construction of any object is considered as a building system – a set of construction process all stages and its participants, which has an object-oriented direction which is implemented under conditions of environment established factors influence. The analysis of international and state programs of construction biosphere compatibility allows to distinguish the main global trends in the protection of the Earth biosphere, in particular, in construction [1 – 5]:

A. Reduction of greenhouse gas emissions (emission limitation, use of renewable energy sources – solar, wind, water, energy of tides, etc.);

B. Implementation of energy-saving technologies and equipment during construction, operation and liquidation of buildings and structures (energy saving throughout building life cycle);

C. Implementation of resource-saving technologies for the implementation and mechanization of construction processes based on the principles of purposeful management of material elements properties during their processing (the so-called «nanotechnologies») and on the construction production informatization principles (logistic support of construction with the complex of building processes robotization and creating artificial structures processes);

D. Development and implementation of environmentally friendly technologies, including the construction industry, based on the latest phenomena and processes of non-waste processing of labour objects to construction products (such areas of construction and architecture as «biotechnology», «bionics»);

E. Preservation of biodiversity and natural ecosystems (atmospheric air, land and oceans, geological environment and fertile soil, flora and fauna protection).

In EU countries, the applicant (developer) who submitted a tender, which includes construction and technology solution «biosphere compatibility» requirements, receives a significant advantage, along with other competitors. In these countries, biosphere compatibility prioritizes are even the criterion of «profitability / rationality of estimated expenditures».

In our country so far there has not been practice of such preferences, as well as effective mechanisms for enhancing the motivation of construction participants to involve the principles of biosphere compatibility in the development of architectural and construction solutions. This tendency forms conflicting requirements and criteria for evaluating projects to create new products and services. In such conditions, management innovative mechanisms of construction projects and programs based on the investment-building cycle modernization and construction organization system based on the principles of biosphere compatibility acquire a special significance.

The latest sources of research and publications analysis. Recently, there were attempts where was a new concept – the biospheric compatibility of construction. Authors of scientific and technical developments and real projects, namely O. A. Tugay [5], D. A. Kramer [6], D. B. Odly [7], T. Yu. Bystrov [8], O. V. Demidova [9], V. V. Savyovsky [10], I. P. Boyko [11] and others under biosphere compatibility mean local elimination of the consequences of previous contaminations with the simultaneous objects purpose change – reconstruction or industrial and civil purpose, urban development existing objects deep modernization.

Selection of previously unsettled parts of the general problem. In contrast to the approach to eliminate the consequences of previous contaminants with the simultaneous change in the purpose of the objects, in this study, biosphere compatibility of construction principles application is considered as a purposeful improvement of construction production, eliminating the causes of its negative impact on the environment in the projects of coastal areas engineering protection and is based on the use of environmental engineering protection systems with the use of natural materials and the consideration of natural processes in the coastal zone during design decisions formation.

The purpose of the article is to develop an innovative platform for the application of eco-systems for engineering protection of marine and river coastal areas (as the interaction of protection structures against the effect of geodynamic processes with a soil massif) on the principles of biosphere compatibility.

The achievement of this goal requires the search for an organizational and technological solution based on the use of environmental systems of engineering protection with the use of natural materials, deepened underwater structures that extinguish wave energy, protect the coastal zone and the environment.

Main material presentation. Geodynamics is a field of Earth sciences that examines geological processes in terms of operating forces. In order to describe the occurring processes, the continuous medium approach is very important for understanding a wide range of geological problems, since it allows us to apply well-developed physical and mathematical methods of the elastic deformations theory, the flow of ideal and viscous fluid, heat and mass transfer, etc.

From the standpoint of building eco-systems biosphere compatibility of territories engineering protection, the focus of such projects should be given globally.

As the main man-made unit, a finished construction object is adopted where the ultimate set of factors is determined as having significant impact on the ecosystem.

Solving these issues, modern theoretical developments on coastal processes regulation, simulation of coast strained-deformed state, energy efficient engineering protection use, etc. are of great importance.

Outbound processes can be predicted. It requires careful engineering, geological and hydrological research. The following conditions must be considered for the forecast of landslides: slope presence and a sufficient mass of rocks, which has a tangential direction to the surface.

Today, several methods for predicting landslides exist:

– long-term (for years);

– short-term (for months, weeks);

– urgent (for hours).

For long-term forecasting, the rhyth method is used, which is based on rainfall and other meteorological elements.

Short-term and urgent forecasts are based on geodynamic measurements use and predictive model of the shear process construction using regression analysis based on their basis, while considering slope stability which is determined by retaining forces and displacement forces ratio.

The methods of forecasting landslide phenomena include:

a) settlement (engineering calculations under simplified schemes);

b) simulation (numerical modeling with variable parameters);

c) the method of analogies (or comparative-geological) - comparison of slope main characteristics (geological structure, rock strength, height, steepness, etc.) with similar characteristics of other slopes which known stability.

d) the historical-geological method - comparison of slope actual conditions with its earlier conditions.

e) the earth masses balance consideration method- for prediction of rotation and extrusion repeated displacement.

e) the influence of factors consideration method- processes that change the size of the coefficient of slope stability.

g) observing the precursors of landslide processes method (landslides) – the growth of deformations, the origin or sources disappearance, sound phenomena, etc.

Most of the potential landslides can be prevented if timely measures are taken at the initial stage of their development.

Thus, an increase in the water cut in the Dnipro River in the upper peaks of each reservoirs has led to sharp and significant rise of the erosion corresponding local bases. A new coastline with a total length of about 3.5 thousand km was formed. A third of the new waterfall perimeter in the reservoirs is actively destroyed by denudation, especially abrasive and erosion processes, and needs protection [12].

Settlements and economic objects located along the reservoirs coastline, after filling each of them fall into negative processes and phenomena activation zones. These zones belong to territories with a special use mode. In the legal and technical literature they were called «zones of prohibition or restriction of new capital construction», «zones of buildings removal and population mandatory relocation». Use of such territories is possible only on the condition of liquidation or limitation of adverse processes in the reservoirs coastal zone or their planned management. Particularly relevant these issues are within the settlements [13, p. 26].

Coastal zones of reservoirs within the cities protect from water harmful effects (flooding, destruction of coastal land). The most important (and, consequently, the most expensive) shore-based structures are vertical sloping and stepped quays type strengthening , walls berthing and retaining, dams with collapsed drainage, etc.

Protected buildings are included in the complex of measures for the rational use and shores protection, which are united by the term «measures for the engineering protection of shores and coastal areas from harmful effects of water reservoirs». The realization of this complex of measures in the territories of settlements and economic objects refers to «engineering training of the territory». It minimizes manifestations of the coastal process (transit flows of water and streams of sediment, standing waves, erosion of the bottom at the shallows and accumulation of sediment), or contributes to the transformation of the abrasive or erosional shore into an analogue of the denudation shore in rocky rocks.

Outside the boundaries of settlements and economic objects, coastal measures in reservoirs are limited, as a rule, administrative and organizational (regulation of coastal areas use) and agro-forestry (foraging and afforestation of coastal areas, biological attachment of slopes and landslides). Engineering protection of shores and coastal areas in this case is carried out only in special cases (protection of valuable forest and land, natural monuments, recreational facilities, etc.).

Such problems current level consideration involves computer simulation of interaction processes in the system «foundation – design of engineering protection» sea coast and river banks of [14 – 18]. Significant progress recently achieved in hydrodynamics, is associated primarily with the development of mathematical modeling methods. Modern mathematical modeling of each physical process involves solving several tasks:

1) mathematical model of a particular physical process formulation (or group of processes);

2) formulation of the algorithm for solving this problem;

3) display of numerical algorithm on the architecture of the computer system used for calculations.

All these tasks are closely linked. Before exploring mathematical methods of any natural processes, it is necessary to highlight those basic principles and decisive moments that allow to describe course quantitative and qualitative terms satisfactory and simply and to create a model. The actual structure of the soil base is much more complicated than the simple objects that are available for research by the methods of modern theory. Hydrodynamic

phenomena are described by equations based on the laws of mass conservation and number of motion, state equations and the thermodynamics laws. All these equations are approximate.

Solving a series of tasks for random processes of any kind is difficult. When considering geodynamic processes with time-varying probable state changes, one can specify a particular method of research – a direct dynamic method. This method is oriented to the study of orthogonal functional bases in the space of functions with limited energy, which corresponds to the physics of the results obtained on the one hand and contributes to the emergence of a special expression that describes the geological phenomena in the finite period of time. The nature of the resulting relations is the following: matrix representations of linear operators are used as media of process information. In these cases, it is possible to involve numerical simulation procedures that allow implementation at the level of modern computer programs. Of particular interest is the number of circumstances that are associated with the weakening of the models time dependencies which in the field of operator representations are reduced to parametric relations. In this way, it is not only possible to solve tasks from a larger class, but also it is possible to accumulate information, which is especially important for geological applications.

The direct dynamic method allows directly, by linear equation, to write the explicit expression of their solution in a closed form, using the symbolic matrix, which has obvious theoretical and practical significance for solving the problems of analysis, identification and synthesis. All tasks solved by simulation methods in the case of linear non-stationary systems are solved by this method without simplifying the system mathematical description. The form of algorithms does not depend on the type of the functions basic system, which provides the universality method. As for type of the basic system it depends only on the numerical expressions of the systems characteristics of the systems. The advantage of direct dynamic method is its correctness.

Mathematical methods can be applied to experimental and empirical material in geology in different ways. For hydrogeology, their main application is to identify and forecast the processes of water exchange. Proper water exchange estimates considering the maximum number of factors affecting these processes, based on a well-developed theory, will clarify the role of groundwater, for example, in erosion processes on the coast of the seas and rivers.

A sufficiently promising way of fixing slopes in our time is the use of gabion structures (Fig. 1), which can be in the form of: box-shaped (1, 2, 3) or cylindrical structures (G), so-called «Reno» mattresses.

Gabions are a double torsion metal grid construction, which is filled with any stone material, and its weight and characteristics are in accordance with the static and functional requirements of the structure. Usually, as filler, large rubble, pebble, or quarry stone are used. The size of the filler should be larger than the mesh of the cell so that it does not fall out of the gabion. At the same time, large stones are placed along the edges, and the middle is filled with smaller ones. The space between the rocks is covered with soil, which acts as connecting material.

Suspended walls of gabions can be massive outline (gravitational walls) and fine lines (semi-gravitational walls). They may be low: <1,5 high:> 1,5, where H – visible wall height, m; – effective width. The face of such walls can be arranged: step (vertical or angled to vertical) or smooth (vertical or inclined).

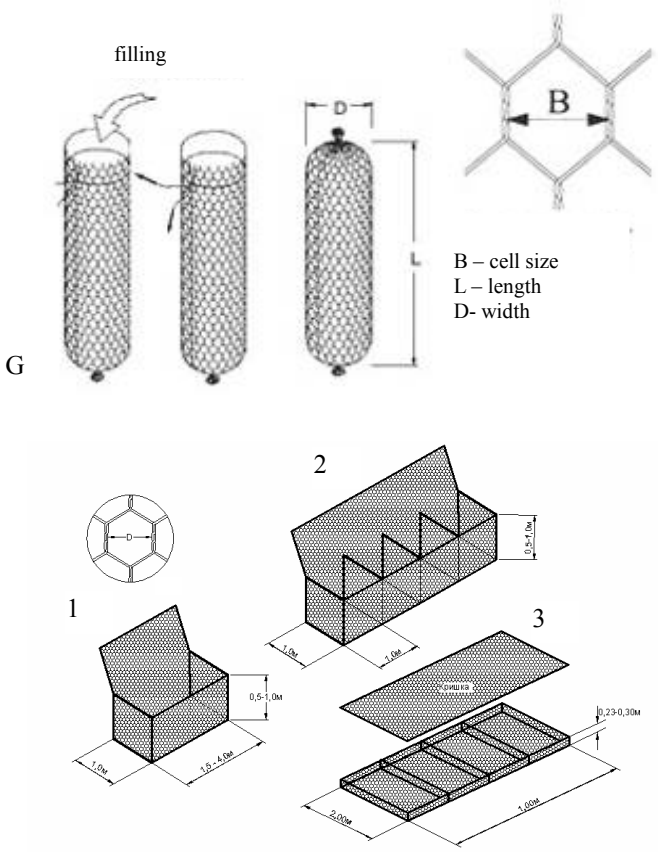

Figure 1 – Structures of slopes engineering protection artificial eco-systems

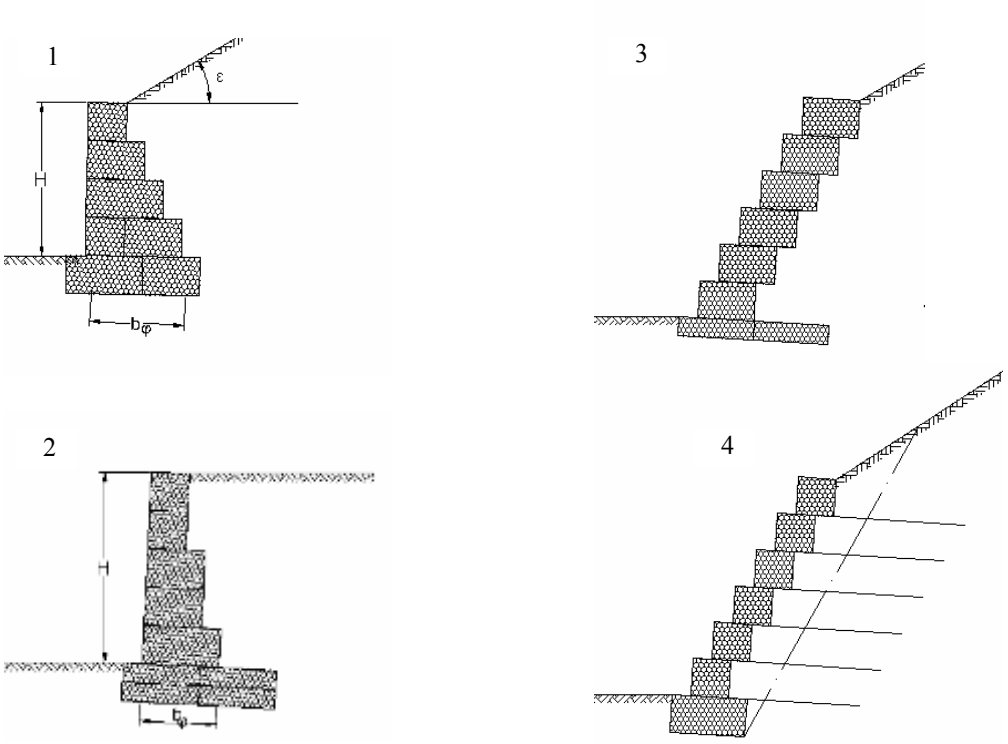

Figure 2 – Artificial systems of slopes and coasts engineering protection schemes:
1) gravitational wall; 2) half-gravity wall; 3) step; 4) thin wall with anchoring

Gabions are mainly used for erection of retaining walls, motor and railroads embankments strengthening, river and sea coast protection, landscape works, stabilization of soil erosion and conservation of soil. Due to very good hydraulic characteristics, they are used for coastal reinforcement of rivers, in the construction of spillway dams. PVC-coated gabions are used to protect the seaside coast. By the time, gabion structures are merged with the environment and become part of the natural landscape. They acquire the maximum strength and stability due to natural processes, since over time there is accumulation of soil particles between the stones, which contributes to the formation of vegetation on the surface of the gabions. The most rapid growth of plants becomes in the presence of horizontal terraces between each tier of gabions. Due to the porous structure of gabions, a high permeability of gabion structures for water and air is achieved.

Restoration of the territory eco-systems natural state, in particular the sea coast, on the principles of biosferous-compatible construction will ensure the ecological security of the regions, preservation of water resources and will have the corresponding social significance as they will become recreational zones. In order to achieve this goal, it is necessary, first of all, to conduct a series of studies to determine the impact of sea abrasion on the stability of the composite area, especially in Odesa and Odesa region, where shifts and landslides are widespread, mainly forest soils, which, due to moisture, on the one hand and the actions of the sea, on the other hand, predetermine the deformation processes of the soil massif, which indicates this issue study lack, and also points to the need to use preventive measures to ensure the territory stability.

Conclusions. To preserve the coastline it is necessary to develop engineering protection ecological systems program of natural and artificial seas, reservoirs and rivers coasts. Gabions should be classified as rational retaining constructions of slopes (coastline). Using gabions as shore protectors, in combination with biological fixation (the formation of vegetation on the surface of gabions) meets the requirements of reproduction and conservation of natural ecosystems and does not violate the aesthetic value of coastal landscapes. Under such conditions, engineering systems of coast protection, created on the principles of biosferous construction, act not only as the abiotic factors of water and adjacent coastal ecosystems, they themselves are also formed in the form of a biotic factor - coastal biocenosis.

In order to improve the reliability of shores and rivers ecosystems protection, further research should be aimed at obtaining information on the stress-strain state of the earth mass under the influence of geodynamic processes and technological influences, which can be accomplished by such systems numerically simulating with the use of powerful computers and modern calculation- software complexes (for example, ASND VESNA).

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