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THEORETICAL AND PRACTICAL ASPECTS OF THE USE OF MODULAR SYSTEMS, ON THE EXAMPLE OF SEA CONTAINERS, FOR AGROECOTOURIST COMPLEXES

Abstract. *An important characteristic of buildings made of modular systems, such as containers, is the possibility of their use both individually and in various quantitative and combinatorial combinations, forming the buildings necessary for exposure and maintenance. For natural reasons, agroecotourism facilities are located far from places with developed construction infrastructure and main engineering support networks. This greatly complicates the construction of buildings and structures corresponding to the specifics of the activity. Objectively, there are no opportunities for the industrialization of construction. Extensive world experience shows the availability of such opportunities. Possible options for the layout of objects are discussed in the article.*

Keywords: *Agro-eco-tourist complexes, sea containers, container modularity, container architecture, sustainable architecture, modular systems.*

Agroecotourism is one of the most popular areas of modern recreation organization. Different countries of the world, depending on the specifics of the natural and climatic features of the territory and the peculiarities of management, organize this type of activity in different ways. The level of development of this sphere varies from country to country. In most cases, the organization takes place based on existing agricultural enterprises and nature parks. A significant problem in the organization of agroecotourism is the creation of an appropriate infrastructure for exhibiting natural and agricultural processes and serving visitors. For natural reasons, agroecotourism facilities are located far from places with developed construction infrastructure and main engineering support networks. This greatly complicates the construction of buildings and structures corresponding to the specifics of the activity. Objectively, there are no opportunities for the industrialization of construction.

The construction of buildings from modular systems, such as containers, is especially justified in difficult economic conditions, when the usual type of construction is impossible due to a shortage of material resources and time constraints. In this case, modular systems made of metal structures are an excellent alternative to expensive capital construction. An additional advantage is the speed of construction of such objects.

Introduction

Theoretical and practical aspects of the reuse of sea containers are considered from different sides. General issues of design and construction are considered by J. Shen, B. Copertaro, X. Zhang, J. Koke, P. Kaufmann and S. Krause (2020) [1], A.B. Kristiansen, B.Y. Zhao, T. Ma, and R.Z. Wang (2021) [2], F.F. Risnandar and A. Primasetra (2021) [3].

The aspect of sustainable architecture in the sphere of container application is indicated in the works of H. Islam, G. Zhang, S. Setting, M.A. Bhuiyan, (2016) [4] J.M Minguet, (2013) [5].

The prospect of using mobile modular systems made of thin-walled metal and corrugated structures in construction on the territory of the Republic of Kazakhstan is very extensive. Modular systems made of light metal structures (LMS) are widely used abroad. The use of such systems has proved to be a reliable and high-quality construction option, while economically profitable [6].

Despite a significant number of works on agroecotourism, most of them are devoted to organizational and economic aspects. At the same time, the actual issues of space-planning solutions of the exposition and buildings of the accompanying service are considered quite rarely and mainly in the aspect of using existing buildings and structures that are already in place, which in one way or another adapt to tourist needs. However, the existing nomenclature of buildings is clearly insufficient for the active development of agro-tourism potential. In addition, the exposure of agricultural production itself is assumed within the framework of the standard work of the agricultural enterprise, which is ineffective in terms of creating an attractive scenario for exposure, and a number of technological processes are generally impractical for showing to tourists. Accordingly, there is a need to form a relatively independent complex of buildings and structures focused specifically on the exhibition of agricultural activities in combination with the accompanying service of visitors. That is, the problem of accelerated, almost one-time construction of a large number of objects that has arisen at this stage of the development of the agroecotouristic service puts forward a number of peculiar tasks that have not yet received appropriate research work.

The rapid construction of a large number of typologically different objects, technologically linked into an agroecotourist complex, suggests the possibility of using end-to-end modularity. However, a large number of studies on the use of containers do not affect the field of agroecotourism. Accordingly, the use of the module proposed by the author, based on a sea container as the basis for the formation of various objects for the implementation of recreational and educational services, has the quality of novelty.

The prerequisites for the appearance of modular buildings have appeared for a long time. People needed dwellings that would be easy to transport, assemble and dismantle. Bright examples can be considered the nomad house "yurt", it was easily dismantled, quickly assembled from separate load-bearing enclosing walls and coverings [6]. In fact, we can say that our ancestors laid the foundation for modular construction (Fig.1).



Figure 1 – a – wooden frame of the yurt; b – metal frame of the yurt [6]

Modular systems consisting of separate light load-bearing (beams, columns) and enclosing (panels, ceilings) structures can be assembled into one-piece structures, separate buildings (3 – 5 floors). The combination of modular blocks will allow creating unified modular structures of an independent structural frame and various configurations and sizes of structures according to technological requirements.

Materials and methods

Containers used for the transportation of goods for various purposes by sea, for a large part, are a kind of "non-returnable containers". However, their dimensions, strength characteristics, high quality of waterproofing allow them to be successfully adapted for subsequent operation for various purposes.

The placement of groups of containers requires a minimally prepared horizontal platform, usually with an asphalt concrete surface. Containers are mounted on four corner supports, for example, made of reinforced concrete or steel elements. At the same time, both single-level and multi-level arrangement is practiced (taking into account the technical characteristics of loading equipment and the strength of the containers themselves - up to six levels). There is a possibility of cantilever mounting of containers (two in series as much as possible) along the long side based on a welded or bolted connection. In addition, the container itself can have a cantilever overhang up to half its length (Fig. 2).



Figure 2 – A modern house made of containers with a cantilever overhang [electronic resource: [http: www. pochtidoma.ru](http://www.pochtidoma.ru)]

For subsequent use, depending on the function, both the usual additional paint and varnish finishing of the inner surface and foam or plate insulation with subsequent sheathing are possible. At the same time, it is possible to arrange the necessary additional window and door openings (Fig. 3), located in accordance with the location of the frame racks.



Figure 3 – A modern container house with window and door openings
[electronic resource: <http://www.https://sauna-pod-klyuch.ru/>]

Separate unified modular structures supplied in the form of load-bearing racks, beams, a frame of enclosing and load-bearing panels with the necessary modular linear multiples and cross-sections are assembled into a frame of mobile structures of any shape and area with various overall dimensions and purposes (Fig. 4). The construction principle is quite simple: the main frame of unified dimensional load-bearing racks is installed and beams, panels of coverings or ceilings, after which it is sheathed with enclosing coverings such as sandwich panels or soft awning coverings.

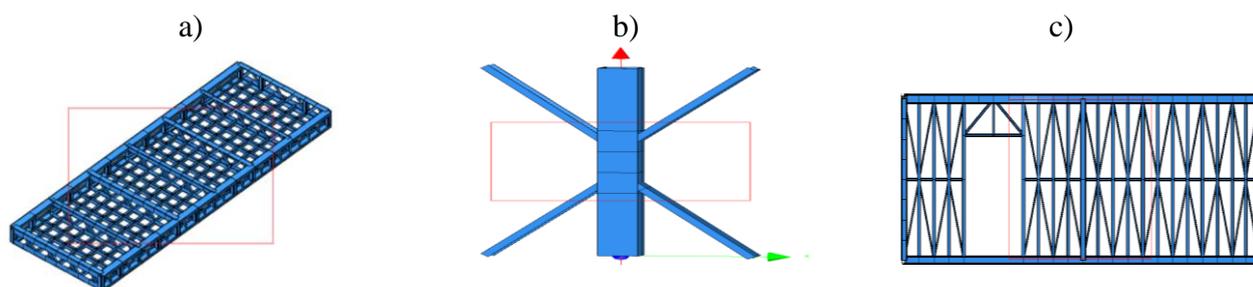


Figure 4 – Modular structures: a – overlap and coating panel;
b – column (rack); c – wall panels [authors' material]

The architectural support of the activities of agro-tourist complexes implies the presence of functionally and planning-related premises and spaces for various purposes. Based on the analysis of the modern practice of organizing this activity, it is proposed to consider the following groups of premises, which, based on the author's concept, it is advisable to form on the basis of different layouts of sea containers of several types. Visitors can not only see, but also personally participate in the processes of caring for animals and plants, collecting products, cooking and tasting various

types of it. Special attention is paid to ensuring the organization of leisure, recreation and related entertainment, as well as emergency medical care.

Argo-tourism activities can be organized both on the basis of existing or newly built agro-industrial complexes, and as independent enterprises.

In the first case, it is possible to permanently or temporarily add a set of premises for the organization of reception and leisure of visitors, as well as demonstrations of various types of agricultural activities to the existing production facilities and facilities for accommodation and cultural services of personnel (Fig. 5).



Figure 5 – Premises for serving visitors, engineering, technical and auxiliary personnel:
 1 – checkpoint pavilion; 2 – administrative pavilion; 3 – security pavilion; 4 – workshop pavilion (locksmith, carpentry, minor repairs); 5 – heating pavilion, drying clothes and shoes;
 6 – recreation pavilion staff on duty; 7 – pavilion of staff living quarters [authors' material]

In the second case, when the main activity is actually argo-tourism, accommodation and cultural and household services of personnel can be provided at the expense of the proposed nomenclature of container buildings (Fig. 6). The set should be supplemented with special blocks of veterinary service premises with isolation pavilions for animals, birds, amphibians, mollusks being examined or undergoing treatment, phyto-control, workshops for slaughter and division of livestock, poultry, am-

phibians, mollusks, cooled biological waste storage chambers, quality control laboratories, sites and storage tanks and manure processing, and also, other objects of the agro-industry, which for ethical and aesthetic reasons do not imply the organization of a demonstration to tourists of the process of their activities. To do this, it is possible to use the various modular offers available on the market, including container-based buildings for the appropriate purpose, including diesel, gasoline, gas and electric stations for refueling buses and visitors' cars.

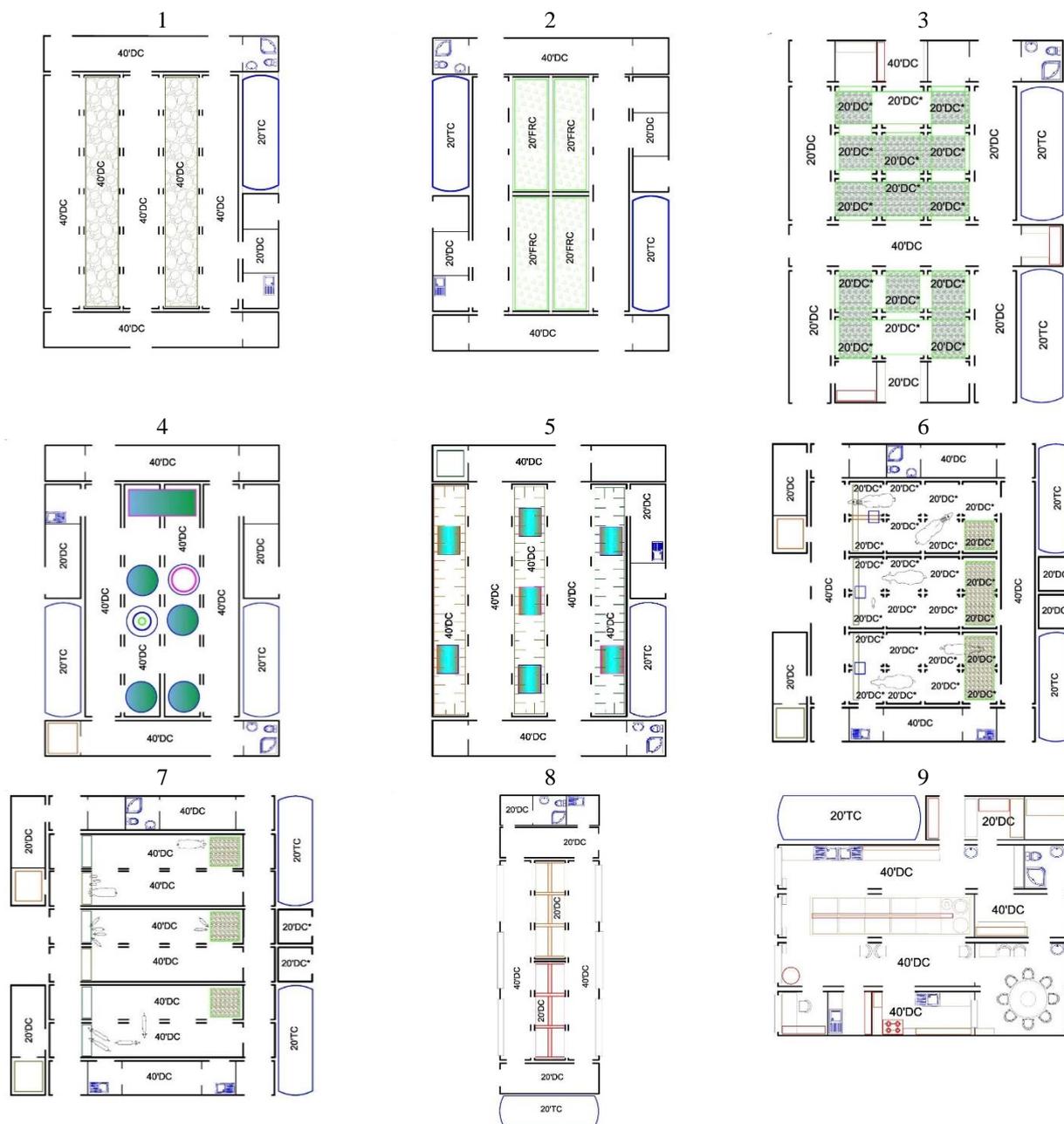


Figure 6 – Premises for demonstration of cultivation of vegetables, fruits, flowers, snails, mushrooms, edible insects, animals: 1 – mushroom / snail breeding demonstration pavilion; 2 – flower / vegetable / berry breeding demonstration pavilion; 3 – fruit and nut breeding demonstration pavilion; 4 – fish / crayfish breeding demonstration pavilion; 5 – turtle / frog keeping demonstration pavilion; 6 – horse / pony / donkey / cow keeping demonstration pavilion camels; 7 – pavilion for the demonstration of pigs / sheep / goats; 8 – pavilion for the demonstration of rabbits / nutria; 9 – pavilion for demonstration of breeding edible insects [material of the authors]

However, the largest volume of services and activities requires various degrees of modernization of sea containers with the installation of window and door openings corresponding to the technological processes of interior decoration, wiring of pipelines and cables of engineering support systems, as well as the layout of block containers in various spatial combinations. At the same time, combinatorics, unlike singly located containers, requires the installation of a common pitched, quick-mounted roof with a minimum slope for waterproofing the seams between containers and organizing the drainage of atmospheric precipitation with subsequent use for irrigation. Between the block thermal and vapor barrier is carried out directly at the joints.

In the conditions of organizing an entertainment and educational program of agroecotourism, ensuring its attractiveness, the need to create a sufficient level of comfort for visitors and staff of agroecotourist enterprises, such layouts are unacceptable. A high level of comfort of stay and the maximum possible provision of an educational and entertainment component is an essential part of the economic success of these enterprises.

Accordingly, the layout of these residential and industrial premises should be somewhat different, taking into account the demonstration component. Layouts that meet these requirements, showing a basic layout that ensures the actual organization of the visitor service process. Depending on the specific conditions of accommodation, the thematic orientation of the agro-tourist complex (crop, poultry, livestock, fish farming, mixed, complex), seasonality (seasonal, year-round), its capacity, the availability of various capacities of engineering support systems, the proposed planning solutions can be adjusted and supplemented with block containers of aggregate, transformer, boiler houses, pumping stations, warehouses, tanks.

Results and discussion

The advantage of a modular system of light steel structures with relatively traditional construction methods:

- savings in the consumption of materials and funds associated with the scale of use;
- quick erection of buildings and structures;
- introduction of promising light energy-efficient building materials found in the world;
- high level of quality control of structures produced at the plant;
- providing excellent heat and sound insulation of enclosing structures;
- adaptability for future extensions, ease of installation and dismantling;
- reliability and stability of buildings and structures.

The formation of a complex of buildings and structures for agroecotourism activities as a component of the sustainable development system of the region involves the achievement of a number of parameters throughout the life cycle of the enterprise – creation, operation, liquidation. The proposed modular system based on previously used sea containers for their intended purpose solves the bulk of the tasks of this problem.

The first position is associated with a technologically high level of production of the base element, since mass production immediately gives a positive economic effect relative to the piece, especially when it is centralized. The main thing here is the flow of production with uniformity of processes at each stage, ensuring high quality, rather tightly controlled and verified at each stage. An important component of this position is the very fact of reuse of the product that was originally used as a container, since the return of this container is quite problematic from the point of view of both filling the volume with goods in demand in the base loading region and the logistics of actually delivering empty containers.

The second position is solved in the field of transportation and installation of individual elements, which is technologically and logistically quite well developed in world practice and requires minimal effort in preparing the construction site, which determines the optimally low level of impact on the landscape. It is practically possible not to disturb the vegetation layer by arranging only angular metal or reinforced concrete prefabricated monolithic foundations. It is possible to use rubble concrete supports made of local materials. In the case of a rocky base, it is enough to simply align the zones of corner supports at the same level.

The third position of saving energy costs is that the main work on the adaptation of containers can be carried out in factory conditions, bringing them to the place of use ready "turnkey". If the work is carried out on site, then the bulk of it is carried out inside in an essentially closed room, which protects workers from most adverse natural and climatic factors. Together, this simplifies the achievement of high quality of work performed, reduces the time of their implementation, since, among other things, it implies multi-shift, almost round-the-clock production.

The fourth position is related to the use in the adaptation of containers of materials of high factory readiness with technologically proven packaging, warehousing, transportation and application (steel profiled sheet and metal profiles for a pitched roof over a block of containers; drywall, fiberboard and chipboard with guides made of bent thin-walled steel profiles, metal-plastic and plastic window and door blocks, plate insulation and foam insulators of seams and joints for interior decoration).

The fifth position is the possibility of using for engineering energy and water supply the work of the complex, product processing and waste disposal, which do not provide for a demonstration component, massively offered on the market block-modular container aggregate, boiler houses, pumping, tank, slaughtering shops and poultry and other elements of full factory readiness.

The sixth position is determined by the possibility of active use of wind and solar energy. At the same time, modular block-container differentiated or integrated wind and solar generators of factory manufacture are massively offered on the market. The solar panels can also be located as tightly as possible on the roofs of all pavilions of the agro-tourist complex and part of the adjacent territory.

The seventh position is the system for collecting, cleaning and using rain and meltwater. This water is suitable for use in tanks for breeding, for example, frogs and turtles, as well as in irrigation and hydroponics systems for crop production. An interesting possibility is the creation of "green" roofs with a flower-lawn surface.

The eighth position is the organization of a circulating water supply system in a water supply and sewerage complex, when water from sinks, baths, showers, toilets is collected, cleaned and sent to the flush system in toilets. It is significant that this water can also be used for watering both cultivated and naturally growing plants.

The ninth position makes it possible to improve the indicators by differentiating the collection of food and technological waste, household garbage, used containers and packaging. For example, food waste and waste from the pre-sale preparation of snails, frogs, a number of crop products are used for the preparation of feed and fertilizers.

The tenth position is related to the possibility of converting manure, plant processing products and parts of household wastewater into biofuels. The corresponding units in the modular-container version are also widely distributed.

Another important position of the agroecotourist complex is the promotion of respect for the environment and the use of renewable energy sources.

The object of agroecotourism is a pre-existing, existing, reconstructed or newly created resource that has been transformed into a popular product by organizational, financial, transport, logistics and information and entertainment events. The specificity of agroecotourism, consisting in a purposeful trip to the object of exposure and a relatively long stay with it, implies the presence of an extensive and thematically diverse program of additional services in the field of recreation and educational pastime. Agroecotourist complexes are formed both on the basis of the resources of traditional land use available in a given area, and by organizing new, historically uncharacteristic methods of land use for this area. The organization models of agroecotourist enterprises are based on various relationships with existing or absent agricultural enterprises in the area. Intra-model differences are fixed on the structure and relationships of the components of the agroecotourist enterprise: agroecoexposition, tourist and administrative-service complexes. The arrangement of fully functioning agroecotourist complexes requires a significant number of buildings for various purposes, the function of which is unlikely to be compensated within the framework of an existing agricultural enterprise. In these conditions, the problem arises of determining the necessary nomenclature of buildings and structures and their corresponding space-planning solutions.

The use of a modular system based on the reuse of sea cargo containers is seen as a promising opportunity to solve a complex of buildings for an agroecotourist enterprise. This is based on their spatial variability, functional adaptability, low labor costs for foundations, installation, and dismantling, which is important for minimizing the impact on the territory of the exposition development, confirmed by extensive world experience. In practice, some processes of agricultural production, consumer services and accommodation with varying degrees of convenience are organized in a modular container system. However, tourist orientation requires the creation of much more convenient spaces for exhibiting production and a different level of comfort of accommodation and organization of visitors' stay.

The proposed forty-eight combinations of containers of various sizes and purposes with the appropriate layout allow us to solve the entire complex of tasks of spa-

tial and technological organization of the work of an agroecotourist enterprise. Part of the processes of agricultural production for technical and technological or moral and ethical reasons is inappropriate for inclusion in the exposition. Therefore, it is advisable to use the available nomenclature of standard container modules for their organization. The set of modular pavilions and their relative positions are adjusted depending on the specific landscape context, the availability and development of the basic agricultural enterprise, the thematic focus and seasonality of the agroecotourist complex, the projected mass of visits.

Conclusion

The relevance of the topic is due to the prospects for the development of the construction of structures from modular systems in the territories of the Republic of Kazakhstan. Fact that modular systems, using the example of containers, can solve the problems of the construction of agro-tourism complexes in the territories of the Republic of Kazakhstan, focusing on the international experience of countries such as: Great Britain, China, USA, Canada, where the construction of buildings from modular systems metalwork is gaining momentum.

This research topic also has prospects for expansion and deepening. Therefore, the definition of a set of modular buildings for various mono- and poly-thematically specialized complexes seems promising. Based on the calculations of prospective occupancy, it is advisable to determine the appropriate number of buildings for various purposes both in the field of visitor accommodation and staff services and in the field of exhibited processes, taking into account the convenience of demonstrating agricultural production from the standpoint of the number of tourists served at the same time. The problem of determining the time frame of the complexes is interesting, implying the possibility of their transformation or relocation to another territory, which is due to the basic mobility of the modular container system.

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АГРОЭКОТУРИСТІК КЕШЕНДЕРГЕ АРНАЛҒАН ТЕҢІЗ КОНТЕЙНЕР- ЛЕРІ МЫСАЛЫНДА МОДУЛЬДІК ЖҮЙЕЛЕРДІ ПАЙДАЛАНУДЫҢ ТЕОРИЯЛЫҚ ЖӘНЕ ПРАКТИКАЛЫҚ АСПЕКТІЛЕРІ

Андатпа. *Контейнерлер сияқты модульдік жүйелерден жасалған ғимараттардың маңызды сипаттамасы оларды жеке де, әртүрлі сандық және комбинаторлық комбинацияларда да пайдалану мүмкіндігі, көрмеге және қызмет көрсетуге қажетті ғимараттарды қалыптастырады. Табиғи себептерге байланысты агроэкотуризм объектілері құрылыс инфрақұрылымы дамыған жерлерден алыс орналасқан. Бұл сәйкес ғимараттар мен құрылыстарды салуды айтарлықтай қиындатады. Әлемдік ауқымды тәжірибе мұндай мүмкіндіктердің бар екенін көрсетеді. Нысандарды жоспарлаудың мүмкін нұсқалары мақалада талқыланады.*

Түйін сөздер: *агроэкотуристік кешендер, теңіз контейнерлер, модульдік контейнерлер, контейнерлік сәулет, тұрақты сәулет, модульдік жүйелер.*

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ТЕОРЕТИЧЕСКИЕ И ПРАКТИЧЕСКИЕ АСПЕКТЫ ИСПОЛЬЗОВАНИЯ МОДУЛЬНЫХ СИСТЕМ, НА ПРИМЕРЕ МОРСКИХ КОНТЕЙНЕРОВ, ДЛЯ АГРОЭКОТУРИСТСКИХ КОМПЛЕКСОВ

Аннотация. *Важной характеристикой зданий из модульных систем, таких как, контейнеры является возможность их использования как в индивидуальном порядке, так и в различных количественных и комбинаторных сочетаниях, формируя необходимые для экспонирования и обслуживания постройки. По естественным причинам объекты агроэкотуризма находятся вдали от мест с развитой строительной инфраструктурой. Это в значительной степени затрудняет возведение соответствующих зданий и сооружений. Обширный мировой опыт показывает наличие таких возможностей. Возможные варианты планировки объектов рассмотрены в статье.*

Ключевые слова: *агроэкотуристские комплексы, морские контейнеры, модульность контейнеров, контейнерная архитектура, устойчивая архитектура, модульные системы.*