Formation of architectural objects for extreme habitat conditions in the context of innovative paradigms

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Abstract. Article is devoted to an actual problem of defining features of architectural objects and their construction for extreme habitat conditions in the context of innovative paradigms. The purpose of article is to consider approaches to dealing with the creation of the artificial habitat environment for extreme conditions, uses to ensure the safety of the existence of technological innovation of the future. It has been established that depending on natural conditions distinguish areas of very extreme conditions, requiring the need to protect the person from the surrounding aggressive environment. A leading approach to the study of the problem based on the search for new, including innovative solutions, home and life-support systems, making full use of technical innovation and creative development of advanced technologies. As a result of research defined the features of construction for each extreme region, and also identify specific requirements for the design of artificial environment. Materials can be useful to the theory and practice of forming the space habitat not only for extreme, but for normal conditions as opens completely new possibilities in architecture and construction.

1. Introduction

A distinctive feature of our times is the growing dynamism of society associated with the accelerated development of scientific and technological progress, the expansion of the geography of activity of people, increased population mobility, migration, etc. This entails changes in all spheres of human activity. When creating architectural objects and their construction in extreme conditions this poses a challenge for modern architecture completely new security concerns population.

The solution to the problem of creating an artificial habitat environment in extreme conditions has always attracted the attention of scientists, philosophers, engineers, architects, doctors, environmentalists, sociologists, psychologists and other specialists, hence the complexity study of the problem. The solutions of this problems has attracted many professionals involved in the formation of spatial environment in extreme conditions and proposes concrete solutions and developments performed in the framework of this concept.

Of special interest are problems formation of space habitats in the cold aggressive environment, considered in the works by Galeev S.A. [3], Saprykina N.A. and Saprykin I.A. [2], as well as in regions of hot desert in research by Esaulov G.V. [4], are notes the urgency and the need to develop techniques of creating architectural objects to reduce aggressive influence factors of natural environment on the human body.

The establishment of underground space habitats in studies Rogozhnikova M.A. [6] and Saprykina N.A. [5] is notes the desirability of its application in various fields - from Space Mountain abandoned mines and before the creation of the in-depth underground homes. In conditions of high mountains and seismic areas in the work of Saprykina N.A. [7] in the context of environmental approaches to creating residential environment suggested buildings and structures with the Organization of systems of autonomous power supply.

Formation of habitats during construction environment on water and underwater in research Kizilova S A [8] noted the usefulness of alternative architecture principles, and in the organization of
the artificial habitable environment in cosmos in research Gogolkina O.V. [12] and Saprykina N.A. [13] notes the need to develop innovative new approaches to design and construction. In addition, the formation environment of habitation under extreme conditions in the study Saprykina N.A. [15] notes the relevance of the development of innovative energy technologies based on information design.

Stringent requirements when designing architectural in extreme environment of habitats require to the architect to think comprehensively and require extensive research in connection with exceptional complexity and relevance of this issue.

The relevance of the issue. The solution to the problem of creating an artificial habitat environment for extreme conditions as an integrated ecological system will provide an opportunity to increase the level of compliance of architectural sites to the needs of society, reduce material costs their construction and increase the comfort and safety of their stay in areas with aggressive environment. In this regard, it is important to note also the need to review traditional tools architecture and use of other fields of science and technology, made possible thanks to recent developments in the field of electronic technology.

The purpose of this article is to review approaches to dealing with the creation of the artificial habitat environment for extreme conditions, uses to ensure the safety of the existence of technological innovation of the future. It is warranted to identify ways and methods for creating an artificial habitat Environment that practically are not used in modern architecture and construction practice.

2. Materials and method of research
The complex technological and economic requirements for creating such architectural objects cause the search for new approaches and use such analytical methods of research as: integrated design object as a system, a method of structural analysis and the informational methods. The main and common characteristics of extreme areas are: remoteness and isolation from developed areas, their inaccessibility, complex and adverse and impossible without the appropriate technical equipment conditions the existence of the people. This also includes the temporariness of human habitation and the autonomy of the existence of settlements, a specific demographic composition of the population, etc.

Depending on natural conditions distinguishes areas of very extreme conditions, requiring the need to protect the person from the surrounding aggressive environment: cold (North, Arctic, and Antarctica), hot (desert), sharply continental (highlands). Depending on the extreme factors and conditions of construction environment include the creation of architectural sites in the northern regions, on the water, underwater and underground, construction in seismic and other hazardous areas with aggressive environment. In connection with the expansion of the range of those areas it influences both on Earth and beyond. If we consider the particular construction separately for each extreme, you can highlight a number of specific requirements to design out there to artificial environment.

2.1. The organization of space habitats in the cold aggressive environment - architecture in high latitudes
During the planning and construction of inhabited places in the conditions of the North of the main town-planning challenge is to protect the person from the adverse effects of the external conditions of the bioclimatic improvement environment, as well as the operating conditions of the residential settlements. Specifics are climatic conditions in these areas, weak industrial base construction and lack of reliable vehicles require a special approach to the design and construction of residential homes and buildings cultural and community purpose.

Specific extreme natural and climatic conditions of a large part of the construction areas with increased duration of the winter period, and a number of other regional factors hamper the development of agriculture and many industries industry. The remoteness of the areas from cities and other human settlements entails a lack or shortage of local workforce and the need to provide shelter
and various types of social services. The absence in most cases of local building materials necessitate transportation here designs and elements of buildings or transport them by air.

All of this necessitates the use, particularly in the early stages of development, the mobile settlements with smaller lifetimes, that with the brevity of their lifetime reduces construction costs. Residents of mobile settlements a number of specifics because of settlements object (building power lines, oil and gas pipelines, roads, railways, etc.) to move from one place to another, and as a result of conduct relatively long period under unfavorable conditions [1]. Here, effectively making transformable spatial structures that you can use to quickly create objects for different purposes. When establishing such settlements, it is advisable to use the principles of transformation and mobility. The prefabricated modular buildings and complexes have not only high performance characteristics. They survive as low temperatures in Northern and southern high temperature thermal insulation thanks to modern environmentally friendly materials [2].

The harshness of the climate and low temperature necessitated insulation interior space from the surrounding building environment, as well as place the highest demands on thermal insulation of buildings. The presence of permafrost, accompanied by thawing in violation of topsoil, leads to the loss of bearing capacity building, which requires the use of pile foundations. If there is not enough sunlight for short day construction of the façade should ensure maximum transmission of sunlight during the winter and protection from overheating in the summer.

Addressing issues of design and construction of these types of settlements fairly considered in detail in the literature. Therefore, we can mention some basic design requirements in the conditions of the North. These include: the formation of a compact planning structure of residential objects, to effectively use its territory and reduce communication; introduction of construction planning techniques regulating microclimate and reduce aggressive impact factors of natural environment on the human body. Incorporation of these requirements is particularly important to develop sound development proposals with extreme northern conditions, so as to determine to what extent and how buildings and structures should isolate a person from natural environment [3].

2.2. The formation of architectural objects in the hot aggressive environment habitats

In extreme hot desert regions there are some similar requirements as for the northern regions. There is a general problem of protection from extreme environmental conditions of environment. Despite unfavorable natural conditions (excessive solar radiation, dust, the mobility of the sands etc.), there is a deeper exploration of the industrial potential of deserts where there are deposits of valuable mineral fossil. This in turn raises the issue of organization of production and residential complexes. In the same way as in northern areas, there is a shortage of local building materials, as well as materials with low thermal conductivity and temperature resistance [4].

One of the main challenges when designing of buildings and structures in hot desert is the reduced heat load on them. For this purpose, it is necessary to take into account the close connection orientation, insolation and ventilation buildings, as well as the height and density of building. An important requirement is the arrangement of the buildings into a single closed space with internal green and water yards, with the device in the walls of small light apertures [5]. In addition, it is necessary to use different devices to protect against sunlight and hot winds, to capture favorable air currents and its cooling. Here can be used by the dynamic alternative architecture techniques: from the use of the simplest transformable Sun shields and devices before the introduction of the solar- wind and bioenergy.

2.3. The features create underground space habitats

Experience in designing and creating an artificial habitat environment in extreme conditions would be useful in the creation of underground construction projects. In the conditions of city building they include engineering and transport facilities, trading enterprises and public nutrition, entertainment, administrative and sporting facilities. In addition, objects of utilities and communications, warehouse objects, industrial objects, objects of engineering equipment, etc.
However, ways to of underground urban development applies not only to address urban challenges. Great value they acquire to use mountain abandoned mines, where it is possible to have objects in the most various applications: warehouses, cold storage, garages, some industrial companies, archives of securities documents, depositories, mushroom plantation, greenhouses, museums, churches, resorts, etc. [6].

The emergence of problems of underground construction in cities due to such factors as lack of town of vacant land, the need for a loosening of the historical building, speed and continuous motion public, special and individual transport, preservation of historical and architectural ensembles, development systems of cultural and community welfare and public services, etc.

To resolve conflicts related to particular cultural or historical value of the plot, as well as for energy savings and conservation ecology construction sites, due to a slight disruption of natural environment and visual compositions, there is the trend of creating in-depth underground dwellings. In this regard, one of the most interesting destinations in modern architecture is the use of natural materials, borrowed directly from the clay (for example, earthen architecture) [7].

For hundreds of years, this experience was used by the peoples of Africa, Asia, South America and other regions of southern latitudes due to the fact that the clay is a natural and universal battery heat and provides a balanced internal microclimate due to the good ventilation qualities. In addition, clay is a material that allows fast enough to erect buildings of this kind. All this made contemporary architects interested in the possibilities of earthen construction.

Thus, the main positive qualities using earthen construction are its cheapness, environmental friendliness and brief terms of erection of the object. Underground and earthy construction with certain advantages, is gaining increasing recognition, and modern the level of technology promotes to its broad development. The experience of such construction gives examples of its versatile use in various fields of human activity that has great prospects.

2.4. The peculiarities of formation of high mountains habitats environment and seismic areas

Under extreme conditions of high mountains and seismic areas there is a need for construction engineering objects here, as well as residential and public buildings. Development in these mining enterprises, agricultural production, research and other objects puts the problem of adapting buildings and structures to the specifics of their operation in such conditions for comfortable and stay safe people [8].

In these areas, features of the construction are defined by meteorological and geophysical conditions. The ways to confront the earthquakes, snow avalanches, to occasional minor rockslides and the others in practice and research quite known. They are taken into account when drafting the construction techniques, choosing designs and create architectural and planning solutions construction sites [9]. It is obvious that the production objects in such areas it is advisable to carry out expeditionary or the urgent-methods. Application of highly mobile buildings and structures, with using of systems of autonomous power supply is indispensable for the permanent residence of the population in these areas in case of natural disasters.

2.5. The peculiarities of formation of habitats environment during the construction on water and under water

Due to the fact that almost all the listed scope extreme on Earth comparatively widely understood, it is advisable to pay particular attention to the organization of the space in the most aggressive areas - on the water and under the water. Use of riches of the oceans to expand territory on land, as well as the development of the economic potential of the oceans as a source of food, mineral and organic resources attracted the attention of construction in this environment. Experience of the ocean opens new frontiers and gives the precedents of organization an artificial habitat precedent in aggressive environment.

When construction on the water poses a number of problems with regard to the need to overcome the immense water spaces (construction of super bridges), due to the scarcity of land (floating cities
and airfields), and mining (underwater drilling oil wells). Known is projects of construction of super huge bridges (architect I. Friedman) and floating cities (P. Maymon). In connection with the shortage of space on the islands, this problem tries to solve the Japanese architects and specialists (K. Tange, K. Kikutake, V. Jonas, W. Katavolos, etc.). Such artificial islands already exist, for example, in the form of enormous platforms, with which drilling of undersea oil wells (in Russia in the construction of the town of oil rocks). The entire water complex includes residential, public and industrial premises, as well as a stand-alone subsidiary of electro-energy devices [9].

Artificial islands projects-airfields located at some distance from the coast, developed in the United States, England, and Japan that can solve the problem of coastal towns, where there are no plots for the construction of airfields. This also solves the problem of harmful noise exposure created powerful and ultra-fast planes in addition; this solves the problem of obstacles related to terrain that prevented the aircrafts during takeoff and landing. Of course, in economic and technical relations such island airfields still disadvantageous, but environmental benefits obvious.

As in any extreme area, this is a problem for creation of comfortable living and working conditions of people forced on duty sometime is in conditions of exclusion and isolation from the rest of the world. It is clear that here will find widespread use of alternative architecture principles. When this is solved a number of economic and environmental challenges: organization of autonomous energy supply using natural renewable energy sources. It is possible that the design and construction of artificial islands-recreation centers will lead to the emergence of a new original direction in architecture because mastering the coastal shelf allows you to embark on a new stage of organization artificial human habitat environment [9].

No less attention attracts and underwater construction. Here, as in space exploration, is a choice between automatic or human. Because the current level of science and technology does not solve all the problems just by using machines, creating a comfortable and reliable artificial human habitat is one of the important tasks. This is due to the additional costs in connection with the operation of the underwater research facilities and the adaptation of the human body.

It is obvious that the main difficulty in the organization of underwater sites are the civil and erection works. Therefore, all underwater homes mostly created on the land, and then descend into the water, fully ready to operate as mobile. In addition to using the principles of mobility when you create small confined spaces of houses underwater, it is also important to use the principles of transformation of inhabited space in connection with the necessity of its multifunctional use [9].

The high requirements for the creation of underwater inhabited objects other than purely technical, include a large architectural complex mental tasks. In small confined spaces underwater homes apart from the principles of mobility are important principles for the transformation of inhabited space in connection with the necessity of its multifunctional use. In addition to all necessary amenities they provide a favorable psychological atmosphere, which in turn determines the efficiency of manufacturing operations.

Because underwater and space environment aggressive to humans, then here is the most acute problem of creating volumetric-spatial solutions industrial-residential complexes with the sustenance of a closed system (when using natural renewable energy sources). So much so that studies in this area to develop recommendations for the use of scientific and technological achievements in development and advance their use.

2.6. The creating artificial habitable environment in the cosmos - weightlessness architecture

Extreme conditions in cosmos affect the Organization and creation of artificial habitat Environment depending on the distance from ground: orbital objects in near-Earth space and interplanetary objects, as well as run in outer space. Here the specific factors are determining environment for her specific requirements and evaluation criteria. This is primarily due to weightlessness as a factor that explains of our view of the usual environment and creates certain difficulties for human existence in space [10].

Zero gravity defines the specific conditions of existence and requires modifying the properties of the construction materials used. This allows you to use the construction techniques that cannot be
applied in the face of the Earth. So, expanding transformable structures, previously soaked in special structures under the influence of vacuum and solar radiation provide great advantages over conventional methods of construction. Unlimited opportunities arise in connection with the creation of space composite materials competing with conventional materials. Architecture of weightlessness is an area of unlimited possibilities in shaping of form. But since the construction of space objects on a variety of technical reasons will be done on Earth and transported in a compact form, there is a need to create transformable kinematic structures. Transformation of structural systems requires not only at the stage of transportation, but also at the stage of exploitation. Organization of the normal flow of functional processes in closed, confined space would require its multipurpose use, which is possible only through transformation [11].

In the face of the problem of the touch hunger in an enclosed space can be solved through the use of controlled dynamic light-color forms, sound and heat of the climate, for example, simulating natural rhythms [12]. Thus, when create a programmed environment in extreme conditions can be applied the principles of kinematic formation. Development and production of these designs requires new approaches to design and construction organization that promotes their application on the Earth conditions.

2.7. Innovative energy technologies in the formation environment of habitation under extreme conditions
The problem of energy saving, resource saving and money spent in the construction and operation of buildings requires the development of architectural and construction techniques to enhance their energy efficiency through the use of alternative modes renewable sources of energy and new clean technologies. In many countries, this trend is reflected in the architecture of its further development in the so-called "autonomous house", which is an example of self-organization of life of people. Therefore, the establishment of autonomous small power plants based on renewable energy and supplying local consumers, has obvious advantages. Providing power and heat supply systems here is a huge social problem.

Implementation of environmental principles in the notion of electronic offline home based on progressive science and construction equipment holds great promise for use in the architecture of future scientific and technological developments, generating new ideas. This enables you to unleash the potential of architecture and best meet the needs of society [13]. Therefore, the establishment of autonomous small power plants based on renewable energy and supplying local consumers, has obvious advantages. Providing power and heat supply systems here is a huge social problem.

Using the principles of information technologies can provide successful urban development outside the direct spatial dependence on infrastructure, i.e. do without creating major highways and power grids. This will be possible when using alternative energy sources and eco-technology, satellite communications and the Internet. In this case, typology of architecture restocked with new kinds of architectural objects [14].

In resettlement system extreme areas, a new element of infrastructure represents are information-dispatching and technological centers. In regard they are new architectural element of the infrastructure of the future architectural complexes and managerial and technological centers. They do not require a lot of maintenance personnel and can be located at significant distances from each other, that it is important for extreme conditions [15].

Within this issue of great importance also and is conducting research and experimental work to create architecture planning and volumetric-spatial solutions industrial-residential complexes non-waste technology conditions for permanent and temporary residence. Such complexes needed for industry construction, agriculture (vegetable, livestock and poultry), science, recreation and tourism (recreational complexes and protection of environment), etc.

3. Results and discussion
Innovative approaches to formation of architectural objects of extreme habitats identified in this review in the context of the following fields marked.

3.1. The organization of space habitats in the cold aggressive environment. The main design requirements in the North are: forming a compact planning structure of residential education, to effectively use its territory and reduce of communications; introduction of construction planning techniques regulating microclimate and reduce aggressive impact factors of natural environment on the human body. When establishing such settlements to use the principles of transformation and mobility.

3.2. The formation of architectural objects in the hot aggressive environment habitats. An important requirement is the arrangement of the buildings into a single closed space with internal green and water yards, with the device in the walls of small light apertures, as well as the use of various devices to protect against sunlight and hot winds, to capture favorable air currents and it’s cooling.

3.3. The features create underground space habitats. The emergence of underground construction is evident in various spheres:
   • To use the mountain abandoned mines, where it is possible to have objects in the most various purposes (warehouses, refrigerators, parking garages, some industrial companies, archives and documents, securities depositories, mushroom plantation, greenhouses, museums, churches, resorts, etc.). The text should be set to single line spacing.
   • In the cities due to the disadvantage of free territories the necessity of disintegration of the historical building, the development of high-speed and continuous traffic, preserving historical and architectural ensembles, etc.
   • To create the in-depth underground dwellings using natural materials, borrowed directly from the Earth, which is inexpensive, environmentally friendly and concise terms of erection of the object.

3.4. The peculiarities of formation of high mountains habitats environment and seismic areas. Construction works are determined by meteorological and geophysical conditions. In the face of disasters such as earthquakes, avalanches, rock falls, etc. require the use of highly mobile buildings and structures, with the organization of systems of autonomous energy supply. It is indispensable when the permanent residence of the population in these areas in case of natural disasters.

3.5. The peculiarities of formation of habitats environment during the construction on water and under water:
   • Organization of artificial water habitats environment linked to the expansion of the territories on land and development of the economic potential of the oceans. Here will find widespread use of alternative architecture principles - organization of autonomous energy supply using natural renewable energy sources, because it solved a number of economic and environmental objectives.
   • Creating a comfortable and reliable artificial human habitat environment under of water supply-residential complexes associated with autonomous closed life support system. The high requirements for the creation of underwater inhabited objects in addition to purely technical include large complex architectural and psychological tasks.

3.6. The creating artificial habitable environment in the cosmos - weightlessness architecture. Weightlessness is determines the specific conditions and requires the use of the properties of the building materials and techniques that are impossible to implement in the face of the Earth. There is a need to create transformable kinematic structures, which requires new approaches to design and construction.
3.7. Innovative energy technologies in the formation environment of habitation under extreme conditions. Developing progressive direction in the architecture, applying new technologies when creating architectural objects in extreme conditions, associated with the new attitude to environmental values, environment and save energy conservation. This will be possible when using alternative sources of energy and environmental technology, satellite communications and the Internet.

4. Conclusion.
Construction in the extreme conditions requires the use of innovative methods and approaches in architectural and technological formation of objects. As a result of the research in this article describes new approaches to creating artificially environment of habitat for extreme conditions which uses to ensure the safety of the existence the technological innovation of the future. In this regard, identified approaches and techniques for creating an artificial environment in such conditions:

- The establishment of the compact planning structure of inhabited space for effective use of the territory and reduce of communication, as well as for the regulation of microclimates and reduce aggressive impact of factors of natural environment on the body for human in cold conditions.
- The creating of the space habitats with the use of various devices for protect against sunlight and the hot winds, for capture favourable air currents and its cooling for architectural objects in hot aggressive environment.
- The establishment of underground space habitats in various spheres: to use the mountain abandoned mines, establishing systems of high-speed and continuous traffic of transport, creating the in-depth underground dwellings using natural materials.
- The using of highly mobile buildings and structures, with the organization of systems of autonomous energy supply in conditions of high mountains habitats environment and seismic areas, as well as in the event of disasters.
- The using of the principles of alternative architecture with uses natural renewable sources of energy to create a comfortable and reliable artificial environment human habitation on the water and under the water.
- The creating of the transformable kinematic structures, manufacturing of which requires the new approaches to design and construction, in the artificial habitable Wednesday under space conditions.
- The creating of the space in extreme conditions of habitats like integrated ecological system using innovative energy technologies.

The main objective of the considered problem is to create a programmed environment in extreme conditions Arctic, desert, underground, underwater, Alpine, space and other habitats. Here is created an unusual environment and erased the line between technology and architecture. This extends the creative possibilities and generates a new direction in architecture - technology architecture. The problem of creating an artificial habitat environment in extreme conditions will require adjustments to the existing method of design, since it cannot be solved purely by architectural means. The term "architecture" in this case, loses his usual concept. It means not only the building but also the totality of phenomena occurring around the person.

The practical significance. Development of principles of designing and creating project proposals for the organization of pre-fabricated settlements in areas with extreme natural conditions is of great importance in different fields of human activity. Experience in creating such objects will be useful when organizing seasonal recreation and tourism, festivals and other events and shows, as well as socio-political and religious events.

Research in this area will develop recommendations on the application of scientific and technological achievements in the development of extreme areas and for normal conditions, as well as on long-term use of the achievements, the emergence of which are very probably. Here the technological architecture becomes a customer who requires certain new technical achievements and even scientific discoveries.
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