Organization of work on the development of measures to ensure the survivability of buildings exposed to flooding

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Abstract. Nowadays the issue of ensuring the survivability of buildings in emergency situations is relevant. Floods are one of the most frequent and serious types of natural disasters. Therefore, flood protection becomes an important task for cities, regions and countries that are exposed to the threat of flooding. Because along with human tragedies and damage to the national economy, floods cause the failure of Central supply points, on which the population is particularly dependent in an emergency. A methodological analysis of the results of flood response in the Irkutsk region in the affected areas has shown that there are number of issues related to the design construction and restoration of residential buildings in areas subject to natural emergencies. In order to solve these problems, theoretical generalizations of domestic and foreign experience are required, as well as the development of principles techniques and models of urban development placement in conjunction with technological solutions. Together, emergency response measures should have the properties of mobility, urbanization, and efficient use of the environment and resources in the implementation of investment and construction projects.

In the vast territory of the Russian Federation, natural and geographical conditions are very different. The availability of certain building materials, climate and soil that differ significantly in certain geographical areas, the variety of natural resources, minerals and associated agriculture and industry – all these factors have had a direct impact on the formation and development of various types of housing. The features of housing depend to a large extent not only on the direction of human economic activity, the historical process, the level of development of society property and class differences, but also on natural and geographical conditions [1]. The Russian Federation, due to natural and climatic factors, namely, the complexity of the terrain geographical location and features of air mass circulation, is periodically affected by natural phenomena. Depending on the strength of their manifestation, the country's economy and its population suffer significant material damage, sometimes it is associated with human casualties.

The maximum number of natural emergencies is caused by floods, which account for about 40% of the total number of emergencies. According to the Federal service for Hydrometeorology and environmental monitoring of Russia (Roshydromet) floods in the Russian Federation-prone areas a total area about 500 thousand square km; at the same time, floods can have catastrophic consequences – 150 thousand square km, which houses more than 300 cities, tens of thousands of settlements, more than 7 million hectares of agricultural land [2,3].

One of the most dangerous is flooding, caused by the breaking of a dam, dam or other hydraulic structure, or the overflow of water over the dam due to the overflow of the reservoir. Flooding of the
area located below the structure is carried out suddenly, with the arrival of the so-called break wave (displacement, skipping), the height of which can reach several meters, and the speed of movement - several tens of m/sec. This type of flooding occurred in the Irkutsk region in 2019.

In connection with the extraordinary situation on the territory of Irkutsk region as a result of flooding of settlements, deterioration of hydrometeorological conditions in the territory of the Irkutsk region and the threat of disruption of life-support systems of the population of the Irkutsk region, and economic facilities on the territory of Irkutsk region introduced a state of emergency.

In order to assess the damage and develop measures to minimize the damage consider the preliminary results of the assessment of damage from the first wave of flooding [4]:

1. The total number of flooded houses was 10,890, the number of residential premises - 17,370 with a total area of 1,122.8 thousand square meters;
2. The total number of affected socio-cultural objects is 97;
3. The total length of flooded roads of regional, inter-municipal and municipal significance is 730.8 km, the number of bridges affected is 35 bridges, of which 11 bridges were completely destroyed the remaining 24 partially.

Based on the results of surveys of housing and social facilities, it was found that the total number of residential premises requiring resettlement or major repairs was 9,867, including 7,242 premises deemed unfit for habitation, and 2,625 premises deemed to be subject to major repairs [5].

The survey showed that the remaining flooded low-rise residential buildings are losing their capital particularly wooden buildings are damaged by rot. The destruction of wooden buildings and structures is mainly due to insufficient strength of the foundations, except of pile foundations. In brick buildings, there is a gradual destruction of masonry with the loss of bricks. Metal structures and reinforced concrete reinforcement are subject to corrosion.

In panel low-rise residential buildings with enclosing structures made of two-layer panels made of non-autoclaved reinforced concrete, the foam concrete insulation is peeled off, and a layer of light concrete is destroyed in solid wall panels. The durability of concrete and reinforced concrete elements, Foundation blocks, pile heads and grillage are reduced under the influence of water, which leads to a decrease in the capital of buildings. If there is insufficient concrete density in the protective layer of reinforced concrete elements, rebar steel intensely corrodes. Especially intensively corrode embedded parts and welds of external wall panels. Low-quality manufacturing of large-size structures, as well as damage during their heat and humidity treatment, contributes to the reduction of durability and capital during flooding.

As a result, a set of measures to protect residential buildings, structures, utilities, etc. in flood-prone areas, as well as in flood-prone areas, should include forecasting, planning and implementation of work before the onset of flooding, as well as during its passage and after the end of a natural disaster.

After a natural disaster, it is advisable to analyze, summarize and develop recommendations for ensuring the safety of living in multistorey residential buildings that have been flooded by flood waters. To develop recommendations, it is necessary to have these conclusions on visual inspection of residential multistorey and low-rise buildings and technical solutions to ensure the safety of living in residential multi-apartment and low-rise buildings that have been flooded by flood waters.

Based on this, the methodology for developing recommendations includes the following activities:

1. Analyze the submitted technical documentation based on the results of a survey of the technical condition of residential apartment buildings that have fallen into the flood zone, perform their classification according to the degree of danger to the life and health of residents, taking into account natural and climatic conditions and the likelihood of progressive deformations and damage;
2. Prepare the final report on the results of the analysis of the submitted deliverables, develop recommendations and technical solutions to ensure safe living in residential homes exposed to flood waters and having signs of a decrease in bearing capacity and stability of structural elements [6,7];
3. Taking into account typical failures of load-bearing and enclosing structures of buildings, develop recommendations of a compensating nature in order to ensure their operability for the subsequent period of operation, taking into account natural and climatic conditions and the consequences of flooding;
4. carry out a selective (at least 5 representative buildings) assessment of the technical condition of buildings by means of their microdynamic survey using contactless laser equipment with computer processing of the results.

At the municipal level, to organize the above activities, it is advisable to organize a separate service, the main activity is the provision of public services, execution of works and execution of the state functions to ensure the implementation of statutory powers of public authorities of the Irkutsk region in the part of realization of measures on construction, reconstruction, capital repair of capital construction objects, which are lost or damaged as a result of an emergency situation.

In the event of an emergency caused by flooding of residential buildings, there was a problem in the regulatory and legal protection of the population, the economy and the national heritage of the country as a whole from natural emergencies [8]. In many respects, this problem is caused by the complete absence or imperfection of legislative and regulatory documents that should clearly fix the legal status, content, timing of drafting and mechanisms for implementing support measures. On this basis, at the level of the government of the Russian Federation, special attention should be paid to the relations regulated by legislation in the field of architectural activity, in particular, the placement and construction of low-rise residential buildings on territories subject to natural emergencies.

Considering the high probability of emergency situations on the territory of the Russian Federation, the formation of housing in special natural conditions must be carried out in accordance with the approved urban planning documentation, namely, the settlement scheme. The type of settlement is determined by the peculiarities of the structure of the economic base and size of settlements and its shape is determined by density of the network of settlements, their relative placement within a particular area, as well as the level of development of different kinds of functional relations between them. It should be remembered that the implementation of a new model of economic and social development of the country is possible only if favorable conditions are created for the reproduction of its main resource – human potential, which in turn is directly related to the reconstruction of the settlement system and a cardinal improvement in the quality of the urban environment.

It follows that the solution of problems of effective housing formation in special natural conditions is possible only on the basis of joint work of all levels of government, scientists, architects, designers, engineers, economists, technologists, designers, ecologists and other interested specialists. When designing and constructing residential buildings, it is necessary to consider not only the current regulatory and methodological framework of the Russian Federation, but also the world's promising trends in optimizing both spatial planning and design solutions.

According to the results of surveys conducted in July 2019, by August 1, 2019, it was found that about 47% of families who lost their homes wanted to stay in their localities. Considering the survey data, the government of the Irkutsk region decided to build new housing. The Ministry is taking measures to organize integrated development of territories in the city of Tulun and the city of Nizhneudinsk. 3 territories for complex development have been identified.

Housing construction is provided under 3 mechanisms:

1. Three-way contracts (payment is made at the expense of certificates for the purchase (construction) of residential premises).

2. Formation of the state housing Fund at the expense of the Federal budget for citizens who refused or did not receive a certificate.

3. Formation of a specialized housing Fund at the expense of the regional budget, with subsequent compensation of costs from the Federal budget.

For the complex development of land plots from the regional budget of 2019, the customer Service of the Irkutsk region has mastered 621,192. 3 thousand rubles (49% of the plan) [9]. These funds are used to prepare urban planning documentation for land plots, design and construction of residential premises engineering and transport infrastructure facilities.

According to the results of 2019, the transfer of funds for major repairs of residential premises was carried out on 1,721 certificates (65.6% of the total volume of residential premises subject to major repairs) for a total of 327,433,2 thousand rubles. According to 1,126 certificates, the first part of the
social payment was transferred in the amount of 50% in the amount of 173,276. 1 thousand rubles. 337.7 thousand rubles were transferred to advance work on 4 residential premises where major repairs were carried out within the framework of trilateral agreements. According to 491 certificates (18.7% of the total volume of residential premises subject to major repairs), payment was made in full for 153,819.4 thousand rubles [10,11]. Major repairs in residential premises have been completed.

A comprehensive analysis of the current situation in the Irkutsk region allowed us to determine the main elements of the formation of low-rise and multistorey housing in areas subject to natural emergencies (Picture 1).

The types of activities in the territories subject to emergency situations of natural character

**Urban development actions**
1. Engineering protection of coastal territories from flooding
2. Measures to lower the water table
3. Measures for drainage of wetlands
4. Construction of residential buildings on high places

**Architectural and planning actions**
1. Designing the height of the basement of a residential building at least 1.5 m from the level of the planned ground level
2. Design of the floor level of a residential building at least 2 m from the level of the planned landmark
3. Creating attic rooms in the attic space

**Engineering and constructive actions**
1. Ensuring the necessary rigidity and stability of residential buildings
2. Increasing the rigidity of the coupling structures
3. Consideration of the possibility of hinge joints that do not violate the operational reliability of buildings

**Constructive and technological actions**
1. Consideration of the possibility of using steel reinforcement in the construction of monolithic concrete foundations
2. The use of major materials in the construction of walling
3. Effective strengthening of a roof overlappings
4. Development of measures to ensure the necessary rigidity and stability of residential buildings
5. Increasing the rigidity of the interface of building structures
6. the device of hinge joints that do not violate the operational reliability of buildings

**Picture 1.** List of activities in territories subject to natural emergencies

Initially, on the territory of the Irkutsk region, traditional technologies of building houses were used to quickly ensure housing construction. However, it is advisable to use alternative technologies, for example, the development of an original creative idea that can serve as a scientific and practical basis for solving the topic of architecture of residential buildings located on territories subject to natural
emergencies. There is the experience of Western countries, where such a type of house as an amphibious house is common. This is a system that rises when flooding occurs and remains on the surface. The Foundation used in it is hollow and filled with foam, due to which, such a structure is almost impossible to flood: fixed to the front and back on special piles, it is able to painlessly transfer the increase in water level to 5.5 m. At the same time, residents are not left without light, gas and other benefits of civilization, which are supplied using flexible PVC-pipes, and easily float along with the house [12, 13]. The second type of buildings, floating houses, unlike amphibian houses, will never touch the ground, and will be in the river all year round. Scientists are constantly developing a way to integrate their technology with existing buildings, which is the best solution.

This approach to the practice of housing construction in areas subject to natural emergencies shows that under the influence of scientific and technological progress, changes occur in building structures and materials, engineering equipment and operating systems in the field of individual residential buildings [14, 15]. These trends give rise to new housing typologies that require the adaptation of old residential buildings to new conditions, especially to extreme natural conditions, in the event of which special attention should be paid to the creation of flexible structures of residential buildings and housing complexes.

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