On Aspects of Using Gabion Structures for Urban Space Design

Ilya Katkov¹, Anna Shabanova¹, Veronika Karpova¹
¹Academy of Architecture and Civil Engineering of Samara State Technical University.
194 Molodogvardeyskaya Str., Samara Russia
anna-v-schabanowa@yandex.ru

Abstract. This article deals with analysis of positive and negative aspects of using gabion structures in urban space. The impact of gabion structures on safety of the recreational feature, i.e. the pond Krugly near the shopping center "Pyramida" in the city of Samara has been assessed by applying two indicators – water quality and safety of recreants. Recommendations on the choice of technical solutions for the improvement of recreational areas near residential buildings have been given.

1. Introduction
The modern urban environment is characterized by high-density development and, as a rule, a lack of comfortable recreational features. The development of new territories and their improvement is impossible without engineering structures meant to design the surrounding space. A special example of these are gabion structures, the main purpose of which is to protect soils from erosion.

Gabions have already been widely used for erecting retaining walls, [1], bank protection, [2], as well as for constructing noise screens, [3].

2. Object and methods of research
The use of gabion structures allows not only developing new areas of the urban territory but also making them more comfortable and safe for people including those with limited mobility. Therefore, gabions have become widely used when improving recreational features, including water bodies.

The Federal Targeted Program "Development of water sector of the Russian Federation in 2012-2020" specifies as one of the purposes "preservation and restoration of water features to the state that provides environmentally favorable conditions of life for population". In this regard, the study of various aspects, including environmental, of using gabion structures for the urban environment design is of vital importance.

Nowadays, there are already exemplary records of improving water features in urban conditions, where gabion structures are used, which give an impressive ecological and visual effect, [4]. At the same time, there is evidence that the use of the bank protection made of stone gabions based on a steel mesh of galvanized wire results in acidification of water, death of many aquatic organisms and excessive development of blue-green algae, [5].

In this paper the authors assessed two safety aspects of gabion structures used in the bank protection of urban water bodies – environmental (water quality) and social (safety of recreants) according to the results of a survey of the pond Krugly near the shopping center "Pyramida" in Samara. The pond is located in a small park (figure 1) and is used for recreational purposes, [6].
In 2013, within the framework of the City Targeted Program, the bank protection was carried out using gabion structures (figure 2). Almost all higher aquatic vegetation, previously covering up to 25% of the ponds water-surface area was destroyed.
To assess the impact of the conducted works on the safety of the recreational feature, the analysis of water samples taken from the pond Krugly was carried out. The state of the surrounding area and gabion structures was assessed visually.

3. Results and discussions

The results of our survey (table 1.) allow assessing the impact of gabion structures on water quality.

Table 1. The change in the water quality of the pond Krugly after carrying out the bank protection with the help of gabion structures

| Indicator                | Water testing results prior to the construction of gabions, mg/l [7] | Water testing results after the construction of gabions, mg/l [6] |
|--------------------------|---------------------------------------------------------------------|------------------------------------------------------------------|
| BOD5                     | 1,0                                                                 | 5,8                                                              |
| Nitrate nitrogen         | 1,82                                                                | 3,12                                                             |
| Ammonium nitrogen        | 0,16                                                                | 0,16                                                             |
| Permanganate index       | 10,64                                                               | 6,6                                                              |
| Total Ferrum             | 0,147                                                               | 0,4                                                              |
| Copper compounds         | 0,0014                                                              | 0,0084                                                           |

The lowering of permanganate index, which occurred precisely due to relocation of the surface runoff into the subsurface one should be considered the only positive effect of gabions creation. Particular attention must be paid to the simultaneous growth of three indicators, signaling about deterioration of organic oxidation processes in the pond water: nitrate nitrogen, ammonium nitrogen and BOD5. In a natural reservoir oxidation processes are particularly intense in the rhizosphere of higher aquatic vegetation.

It is obvious that the reason of decreasing intensity of oxidation of organic detergent-type pollutants is the destruction of water-torch brushwood that fulfills the function of natural bio plateau, when preparing for the gabion structures construction (figure 3).
The increase in copper grade to eight MAC is of particular concern. The reason for this is also the destruction of higher aquatic vegetation, which in natural conditions plays the role of heavy metals’ phytosorbent, reducing their content in water. Thus, the comparison of the water quality in the pond before and after the bank protection works with the help of gabions showed its significant deterioration.

4. Conclusions
Gabion structures have become popular in the urban areas improvement due to the fact that a wide range of problems are solved with their help, they are easy to erect, and are relatively of low cost in comparison with concrete structures of the same function. The urban space design, meeting safety requirements, should be based on the results of existing facilities’ surveys.

This especially applies to city water features as they function as recreation centers. With this in mind, there is a need to assess the recreants’ health risks. Details of gabion structures (wire mesh, which is sometimes subjected to destruction) carry the risk of injury for visitors of the water feature, especially for children. Because of this, in reservoirs located in residential areas, it is worth considering safer options for bank protection, for example, geosynthetic grids with grass sowing.

References
[1] R. A. Gerasimov, L. A. Nemchikova, Installation of a low-mass retaining wall on the basis of gabions, Proceedings of the Novosibirsk state University of Architecture and Civil Engineering (Sibstrin), vol. 21, № 2 (68), pp. 60-67, 2018.
[2] E. I. Kaluzhskaya, M. A. Bosov, Method of erecting flexible bio-positive structures, Bulletin of Transbaikal State University, vol. 24, № 1, pp. 4-9, 2018.
[3] Gabions as noise-proof walls, World Railways, №. 6, pp. 74-75, 2014.
[4] V. I. Smetanin, V. A. Vlasov, Methods of improving the state of water bodies in urban areas, Privolzhsky Scientific Journal, № 1 (9), pp. 148-152, 2009.

[5] I. G. Boykova, V. V. Volshanik, N. B. Karpova, V. G. Pechnikov and E. I. Pupyrev, Operation, reconstruction and protection of water bodies in the city, Moscow: Publishing House ASV, 256 p., 2008.

[6] A. V. Shabanova, Contemporary state of ponds in the city of Samara. Shopping center "Pyramida", Ecology of Russia: on the way to innovation, № 10, pp. 139-145, 2014.

[7] A. E. Vasin, Yu. L. Gerasimov, I. V. Dyuzhaeva, Yu. V. Sachkova, E. S. Selezneva, Invertebrates in the pond ecosystem on Amineva street (the city of Samara) in 2010, Bulletin of SamGU, № 3/2 (94), pp. 34-40, 2012.