

Use of gabion structures as flood mitigation in hydraulic works

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Abstract

In the light of ongoing climate changes and the related increased incidence of floods of different nature confirms the need to invest in flood prevention systems and the need for the application of new, flexible technical resources available within the safety works during the floods. One of the structures, materials and technologies which in the long term prove its suitability for the whole spectrum of possible measures of flood protection are gabion structures.

1. INTRODUCTION

On the topic of floods are applicable generally known experiences and predictions expressed in the sentence: "Floods have been, they are and will be." Adverse effects of climate change only confirm these truths. (Fig.1)

In the Slovak Republic for the years 1996 - 2005 appeared floods which killed more than 50 people and damages caused by the floods reached the property of citizens, municipalities and state the amount of more than 560 mil. €.

2. GABION STRUCTURES IN RIVER SECTOR

140 years of experience the Officine Maccaferri company, linked to the scientific research of use of gabion structures on hydraulic works has reached a state that these structures are often used, demonstrating their reliability, stability, durability and ability to fit in the natural environment (Fig.2).

Gabion is a wire-stone element in the shape of a cube or cuboid, made of hexagonal double twisted wire mesh, filled with natural or quarry stone or suitable recycle. Gabion is formed by bottom and side elements, lid and diaphragms premanufactured in one element. According to the dimensions they can be divided into gabion baskets, mattresses and sack gabions.

Gravity gabion structures are built in a simple modular way, filled directly on the site with suitable aggregates in a way to ensure minimal porosity. Each of the elements must be self-supporting and dimensioned to be stable block.

Objects generally act like gravity structures. Due to this fact one of the main requirements is to reach average density of the finished structure. From gabion baskets it is possible to create almost any shape structure. If keeping in accordance with the design principles it is very durable system, where one of the best features is the ability to blend in with the surrounding natural environment.

Major advantage of these structures compared to conventional concrete or reinforced concrete structures is its drainage function, which significantly reduces the water pressures on the structure. Another advantage is that the gabion wall is able to absorb large deformations without breaking. If deformations are few centimeters, but even tens, the structure still retains its functionality compared to concrete structures, which would no longer withstands the deformation.

2.0 Classic Gabion

It is used to build retaining walls, vertical structures, dams on rivers (Fig.3, 4). Classic gabion is made of double twisted steel wire mesh with standard wire diameters 2.7 and 3.0 mm with an mesh type 8x10. Originally it was protected only with a simple coating of zinc deposition, today it is considered as the simplest treatment, as minimal standard nowadays is Galmac coating (Zn + 5% Al), which has roughly double durability. A suitable coating for hydraulic application is Galmac + organic PVC coating. The top level is a PA6 coating. An important reference in is the EN 10223-3 for double twisted steel wire meshes used in civil engineering applications. The norm provides guidance concerning the life expectancy for steel mesh, defining for polymer coated steel wire mesh a minimum assumed life of 120 years.

2.1 Gabion mattresses

Baskets whose height is significantly lower than their width and length are called mattress. Their width is typically 2.0 m, length of 3.0 to 6.0 meters, height of the baskets is 17, 23 and 30 cm. RENO mattresses are made from wire diameter of 2.2 mm and a mesh type 6x8. Depending on the required service life and the environment in which they are located, appropriate surface finish has to be selected. Heavy zinc coating, Galmac, Galmac + PVC or the best performance Galmac + PA6. RENO mattresses are manufactured with integrated double diaphragms in order reach better handling, speed of installation and stiffness of mattress. RENO mattresses are used primarily for reinforcing slopes and protecting against erosion (Fig.6). They are suitable and economical substitute for stone rip-rap (Fig.7). Mattresses are filled with stones directly on the site, where they form flexible and permeable structures.

2.2 Gabion structures in emergency works

The wire-stone gabion structures in emergency works in time of danger during floods have been used only partially. This is mainly due to the lack of information among the professionals in hydraulic sector in Slovakia, whereas abroad are those structures in such situations commonly used.

2.2.1 FLEXMAC

FLEXMAC® DT multicellular structure suitable for rapid building of anti-flood barriers and serves as ideal replacement for bagging (Fig.9,10). Units are made of double twisted hexagonal mesh type 8x10. The mesh is reinforced by vertical steel rods, lined from inside face with non-woven geotextile with a minimum weight of 250 g/m². The geotextile lining enables FlexMac to be filled with locally available materials such as sand, general fill or other materials. These can be easily placed within the structure using mechanical means or by workers. Units are supplied in bundles and wrapped in plastic for protection during freight and storage.

After temporary use, FlexMac can be folded up and efficiently stored for another emergency. It can be a temporary or permanent solution. When used as a permanent solution after the emergency has passed, it would be covered and re-vegetated in harmony with the environment. The versatility, simplicity and rapid deployment make it ideal for emergency situation.

The great advantage of FlexMac™ DT is clear when compared with traditional sand bags. In 3 hours, 30 people can construct a 10m embankment using sand bags, compared with 5 people constructing a 60m embankment using FlexMac units. To deploy and assemble a single unit requires only 2-3 people and 20-30 seconds.

3. RESUME

Aim of this article was to describe solutions made of hexagonal double twist steel wire mesh and their use in hydraulic sector. Considering the fact that majority of these solution have been on the market for over 100 years, with thousands reference structures, enormous research and development, Maccaferri decided in order to collect all old and new information to create a new book called "Use of gabion in hydraulic sector".

Manual is aimed to describe basic applications of different solution, determine material characteristics, new forms of coatings and also main design principles. The manual is a unique tool for designers, clients and all professionals in this sector.

4. REFERENCES

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