ENVIRONMENTAL PROTECTION IN RIVER REGULATORY WORKS USING BIODEGRADABLE MATERIALS

PROTECȚIA MEDIULUI ÎN LUCRĂRILE DE REGULARIZARE A RÂURILOR PRIN UTILIZAREA MATERIALELOR BIODEGRADABILE

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Abstract*. The paper presents biodegradable methods and materials used to carry out river bed works. River regularization works must help to keep the environment as natural as possible. Biodegradable materials respond to bioengineering methods and concepts for ecological regulation or renaturalisation of river beds. Studies and research have shown the possibility of using biodegradable materials for the execution of shore defense works at the riverbed. The researched biodegradable materials are made of woven sheep wool fabrics and strips. They are used as a support and filter bed at the shoreline contact with the rock in the site. The material has the advantage of natural degradation in about 4-6 years after it has performed its support function. Woollen fabrics are used to make the biological cells used for river bank layout or sloping slopes.*
Key words: shore defenses, wool fabrics, biocells, renaturalisation

Rezumat. *Lucrarea prezintă metode şi materiale biodegradabile utilizate la realizarea lucrărilor din albia râurilor. Lucrările de regularizare a râurilor trebuie să contribuie la păstrarea unui mediu înconjurător cât mai natural. Materialele biodegradabile răspund metodelor şi conceptelor de bioinginerie pentru regularizări ecologice sau renaturalizarea albiilor de râu. Studiile şi cercetarea efectuată au arătat posibilitatea utilizării unor materiale biodegradabile la execuția lucrărilor de apărare de mal la albia râurilor. Materialele de tip biodegradabil cercetate sunt realizate din țesături şi fâşii presate din lână de oaie. Acestea sunt folosite ca strat suport şi filtrant la contactul apărării de mal cu roca din amplasament. Materialul are avantajul unei degradări naturale în circa 4-6 ani, după ce şi-a îndeplinit funcția de suport. Țesăturile de lână sunt folosite la realizarea celulelor biologice utilizate la amenajarea malului râurilor sau la taluzul versanților.*
Cuvinte cheie: apărări de mal, țesături de lână, biocelule, renaturalizare

INTRODUCTION

River regularization works are part of the watercourses in ensuring the stability of hydrological parameters on a determined river sector. Also, the regularization works contribute to achieving favourable environmental conditions

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on a watercourse and its riparian area. The design of shore regulation and defence works is done with hydrological parameters (flows, levels, defences, protected areas, etc.) obtained by statistical processing of data collected over long time periods. Climate changes produced over the last 30 years in Romania have substantially altered the hydrological data, a situation that forced the re-evaluation of some design rules. The European tendency to naturalize river beds which have rigid regularization works and which have negative influences on the environment has led to changes in design concepts (Avram, 2016; Luca, 2018; Bica, 2000).

Naturalization works of river beds have required the use of elastic constructions made of plastics and biodegradable materials. Elastic type works are mainly used in beds located in low cohesive rocks. Materials such as geotextiles have found applications in the structure of river defence works on rivers, but also in the construction of the slopes of various constructions in the earth (Luca *et al.,* 2016).

The purpose of the paper is to present the results of studies and researches on the behaviour of shore defence works, including geodetic and biodegradable materials, with applications on the rivers in Moldova.

MATERIAL AND METHOD

The theoretical and experimental research was carried out in the following areas:

1. Studies on the requirement for the use of biodegradable materials to carry out riverbed regularization works.
2. Studies and researches on types of biodegradable materials with applications for river bed regulating works.
3. On-site research of the behaviour of riverside regulation works made from biodegradable materials.

The research analyzed technical documentation for carrying out river regularization works on the use of biological and natural materials that can be degraded during their exploitation without affecting the aquatic or riparian environment.

The research has analyzed on the ground a series of river regularization works made with biodegradable materials in various river basins on the territory of Romania (B.H. of the Siret River, B.H. of the Olt River).

The data used in the research come from the following sources: technical expertise on the field of river regulation and river defence constructions, water basin management synthesis reports, drafting works, documentation with technical characteristics of biodegradable materials, etc.

The collection of field data was done through specialized analyzes on research fields, material sampling, photo and video surveys.

Primary data has been processed using the statistical, hydrological and hydraulic calculation programs applicable to case studies.

RESULTS AND DISCUSSIONS

Coastal defence works generally have a local character, limited to areas with economic or social objectives located near the watercourse. They must,

however, be treated in such a way as to fit into a water management plan that also protects the environment. The current state of shore defence works requires the use of biodegradable materials for more appropriate environmental protection.

Plastics are widely used to carry out shore defence work due to their high resistance to stretch, flexibility and impermeability, relatively low cost, and ease of operation. Geotextiles, which have large applications for use in a wide range of hydrotechnical construction, are detached from these. But plastics are degradable in a long time or can not be degraded. Biodegradable materials replace some of the plastics, such as geotextiles (Sion, 2019).

The most commonly used biodegradable materials are: earth, stone, wood, textiles, etc.

Stone is the most commonly used material in river regularization. The stone encompasses the works in the form of: massive rockfill, equalizing layers and filters, stone for loading elements made of branches, wicker and wood, stone for the execution of the slopes, defending and consolidating the banks, etc. The stone used is the river stone, rough stone as it results from quarries (natural blocks, stones), crushed stone, carved stone and processed in various ways (moloanes, cubes, bars, tiles et.) (Manoliu, 1973).

Wood is used in the form of raw (round, semi-round wood) and engraved. Woodworks are executed for driven pile, pairs and stakes, wall panels, joining elements etc. Wood is also used in the form of rods, branches, trees, pines, pines, logs, beams, longlines, wale, timber, etc., which are introduced in the river blocks. The branches and threads are used to make fascinations, hedges, and slings used in shore defence (Luca, 2011).

a b

Fig. 1 Biological works in shore defence on Breţcu River, place. Tg. Secuiesc: a - braids/ wattle; b - details on the location of biological protection (Luca, 2011)

An example of biological woodworks has been made by sectors of the Breţcu and Ojdula Rivers, in the area of Tg. Secuiesc, Covasna County. The paper (Luca, 2011) presents the field research on the behaviour of these works. Protective work of the bedside slope at the two biological rivers consists of shafts, waders of willow rods, swamps. The canes and wicker canopies were

placed at the base of the slope. Propagation of floods a year after execution led to the partial degradation of these protection works.

The completed biological defence system takes some time to get into operation and carry out the designed tasks. The high frequency of floods and the low resistance of the bedrock caused a differentiated behaviour on the segments (fig. 1).

At international level, works of biodegradable materials, especially wood, are being carried out constantly in the settlements, in the planning of rivers. These works are required by law to create a natural environment as well as to protect the environment.

a b

Fig. 2 Adjustment works made of wood on rivers: a - the Isar River in the centre of Munich, Germany; b - the Kwaczy River, northern Poland (Sion, 2019).

Biodegradable materials in the form of textile fabrics are planar structures of vegetable materials (eg. jute, coconut) or animal (eg. wool). The fabrics are in the form of fabrics, fusils, pressed bands, etc. The functions performed by them in the shore defence works are;

- separation, when used as a layer of separation between physical properties;
- filtering when it prevents the migration of rock particles, but allows the penetration of water without pressure;
- protection against degradation of slopes or slopes to erosive water, etc.

Biodegradable geotextiles are made of degradable fibers based on natural wool, with or without a jute mesh used to increase mechanical strength. Geotextiles should be placed on smooth surfaces in such a way as to reduce creases or creases from the material. For protection and defence of the slopes, geotextile is attached to the vegetation, in order to avoid soil erosion and slipping through the effects of precipitation and wind. Geotextile is a support for vegetation anchorage, preserves soil moisture even at high temperatures, and by decomposition over time it contributes to feeding the soil with nutrients, thus reintegrating into the natural cycle.

The weaving or nonwoven wool products work together in the structure of the construction elements used to regulate rivers and rocks defence works with rock from the foundation layer, as well as with the building components (Sion, 2019). The textile materials are flexible, which allows for very good molding on the mounting surface (the case of the slopes) (fig.3).

a b

Fig. 3 Biodegradable geotextiles: a - material layout and leaching on the slope; b - tiling of a woollen cloth geotextile (Sion, 2019).

The biodegradable fabric layer made of a woollen fabric used as a support for the location of regularization works and shore defence works has the following characteristics: raw material: natural wool fibbers; standard dimensions: width - 2.0 m, length 25 - 50 m, thickness - 3.0 mm; mechanical parameters: weight - 0.25 kg/m^2, traction resistance - 4 daN/5 cm; MD / CMD prolongation - 125%; water absorption capacity: 140%.

Woollen fabric is a geotextile that degrades biologically in about 2 to 3 years from natural wool fibber without reinforcement of various fibbers. Above the woollen fabric placed on the channel slopes or the bank of the river are placed grass seeds over which is filled a vegetal soil filling. By using this composite it is avoided the formation of sliding plans on the slope and the conditions for the realization of the vegetation layer protection are ensured.

River bank or sloping slope can be protected with biodegradable pre-sown mattresses. They prevent erosion by absorbing the energy resulting from the impact of precipitation, by insulating water and allowing water to pass through material into the rock site. This process cancels both erosion forces. Erosion protection mattresses are made up of coconut or straw trapped together with a lightweight reinforcement mesh of polymers. The polymer grid can be replaced with a jute mesh.The protective mattress is strong and flexible, with a thick texture that creates a barrier to wind and precipitation, which provides total soil and seed protection, contributing to long-term growth and development. The natural components of the mattress degrade biologically without harming the environment. The grid of polymers remains intact for longer and ensures the reinforcement of the grass roots (Sion, 2019).

The use of geotextile from natural or animal fibbers has several advantages:

- the result of the degradation of plant-derived fibbers (eg cotton, jute, hemp, etc.) is carbonated hydrates, which become a natural fertilizer introduced into the soil and helps to grow plants;

- wool geotextile takes over the energy resulting from rainfall and allows water to flow through the material into the soil beneath the wool fabric, helping to reduce the surface erosion phenomenon;

a b

Fig. 4 Mixed riverside protections: a - grilled and sown geo-bags; b - geocells filled with grass roots.

- ensures the development of vegetation on the slope and contributes to the creation of a natural environment;

- geotextiles of vegetal and animal fibers provide protection of the slopes by fixing the vegetation on them, avoiding the erosion of the slope by the action of water and wind.

CONCLUSIONS

1. Ensuring optimal environment protection in the watercourse area requires the use of biodegradable materials for the execution of the regularization works.

2. The biodegradable material most commonly used in the execution of river regularization works is wood but which is limited to use due to low mechanical strengths and rapid degradation over time.

3. Studies and research have shown the use of woollen fabrics and wafers as a supporting layer for the location of river bed settling work on riverbed sites.

4. Biodegradable materials have the advantage of destruction after a period of operation, and degraded components are returned to the soil as nutrients.

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