Technical Considerations on the Management of Coastal Areas Rehabilitation Projects

Georgiana Grigoras¹, Ionuț Cristian Mihalache¹, and Eduard Edelhauser^{2,}*

¹ Management and Industrial Engineering Department, University of Petroșani, Petroșani, 332006 Romania

² Head of the Management and Industrial Engineering Department, University of Petroșani, Petroșani, 332006 Romania

Abstract. Coastal erosion contributes to the loss of particularly valuable land, which can damage coastal ecosystems and cause economic and social damage to the area where they occur. Coastal erosion is a natural process that affects shores around the world. The article presents aspects of coastal erosion in Romania as well as some solutions proposed to reduce this phenomenon. Submerged structures are exposed to erosion therefore a close monitoring is necessary. A malfunction will result in the damage of the structure as well as endangering marine wildlife. The proposed solutions are meant to protect the coastal area against erosion, protecting the shore, adjacent land and ecosystems. These solutions will also protect the economic infrastructure and social objectives endangered by marine erosion. A monitoring program will be implemented for a medium and long term, supporting the maintenance operations.

1 Introduction

Project management in construction is one of the most complex activities based on the fact that a large number of factors are involved, factors that may undergo unforeseen changes and may lead to failures of these projects. The field of project management is a vast field in which each process has its own particularity, and as a result of the evolutions that take place, in which everything is done under the pressure of time, it becomes increasingly obvious the importance of the role that management plays in a project. Each project in the field of constructions is unique, in terms of the objective that will be achieved. In this paper the authors analysed the management of a project in the field of Black Sea shoreline, which is a difficult project, and needs knowledge of key elements, hotspots, and also risks that are involved for each stage from tender to commissioning that can make the difference between success and failure.

The management of this type of project is very important due to the following factors: in Romania in the last period of time no projects of this type have been carried out; personnel involved in all stages of this project must be competent and experienced, and due to the peculiarities of the constructions, they are more difficult to find; the equipment with

* Corresponding author: eduardedelhauser@upet.ro

which the works will be carried out is not available to all those who work in the field of construction; the place of activities is a more special one, being about the Black Sea coast and sometimes even in the open sea. All these factors, but also the lack of information make necessary the existence of documentation to help to achieve a successful management of these construction projects.

2 Theoretical Framework. Specific Constructions the Rehabilitation of Coastal Areas

In the south eastern part of Romania, in the area bordering the Black Sea, coastal erosion is a result of the action of several factors, such as waves, wind, storms, rains and human activities. Research conducted in the coastal area of the Black Sea has highlighted the phenomenon of erosion of beaches and cliffs, which have led to collapses and landslides that endanger human lives and the stability of buildings located at the top of the cliffs. Also, in the coastal area of the Black Sea on the territory of Romania, coastal erosion represents a real risk for the environment, the phenomenon manifesting itself on different levels of intensity along the approximately 240 km of the coast, measured from North to South, from the Chilia arm (Musura gorge) and up to Vama Veche (border with the Republic of Bulgaria). According to the numerous analyses performed, it was concluded that coastal erosion reaches in some areas the rate of approx. 2 m / year.

The summary coastal protection works carried out in the last decades didn't had the expected effects. Therefore, it is necessary to speed up their implementation, according to the new concepts of coastal protection. Some hydrotechnical works carried out in the area have had a negative effect on the coastal area due to the fact that they have created sea currents that have favoured land erosion and sand transport. As a result, European funds were accessed for the rehabilitation of the Black Sea coast. A first stage was carried out, related to the period until 2020, and then another period will take place starting with 2021. In addition to the activities of protecting the sea shore, a sanding will be carried out.

3 Methodology. Case study of the Objectives and Activities Specific to Coastal Rehabilitation Projects in the Northern Part of the Black Sea Coast

3.1 Global Geographical Situation

For the beginning, the authors involved in the projects identified the activities that must be carried out for the rehabilitation of the second dam, which are part of a project for the protection and rehabilitation of the Black Sea coast. On the distance between Periboina and Edighiol, which is a coastal cordon, the sediments are brought by the Danube and there is a large amount of shell fragments.

The orientation of the shoreline is northeast - southeast - southwest from the Portita dam to Midia, leads to a stronger exposure of storms and winds from the north, which leads to an active supply of sediment on the coast in the south.

Fig. 1. Positioning of construction works (Edighiol and Periboina dams located in the northern part of the Black Sea coast)

The inlets from Periboina and Edighiol controlled the exchange of water and sediments with the Razelm - Sinoe lagoon system. They can be artificially controlled by dams but as they are currently operated, they have no direct impact on coastal dynamics. The entire barrier beach from the south of Periteasca to Periboina and the southern extremity of the Sinoe Lagoon (Edighiol) migrated to the shore through significant overflow processes. Thus, the shoreline faces, therefore, a rapid retreat, and in this context the dams represent a coastal system with the specification that the Edighiol dam has an opening of over 80 m.

Fig. 2. Edighiol dam

At Edighiol, figure 2, the water from Lake Sinoe is discharged into the sea through a channel of about 35 m, the shores being connected by a bridge consisting of 8 openings with a width of 4.7 m each. In the southern part there is a metal bridge, which once opened, allows small boats to enter the lake. The maximum flow that can be transited through the evacuation channel is $80 \text{ m}^3 / \text{s}$.

Fig. 3. Periboina dam

3.2 Technical Situation

The structure of the Periboina dam (figure 3) has an opening of over 400 m, being made up of a large number of individual dams, each with a width of about 2 m. The maximum flow that can be evacuated through the dams is about $220 \text{ m}^3 / \text{s}$. The dams are made up of dams with small openings that allow the transit of water from the lake to the sea, but do not allow the passage of fish. On the other hand, it is possible to completely close the lake to the Black Sea. This may be necessary in order to maintain a specific water level in the lake (in the type of dry periods), and on the other hand this is necessary to prevent the entry of sea water into the lake. Also, the dams can be handled with a crane that can be moved by rail.

In general, both works of coastal structure present elements with advanced state of degradation, having areas in which: concrete slabs show cracks and dislocated portions; the unsorted stone core is washed under concrete slabs (figure 4); displaced stabile pods; algae have developed and the protective mantle of stone blocks fell apart; the concrete pillars show cracks and detachments of material (figure 5) and the equipment that serves the dams is rusty and partially non-functional (figure 6).

Fig. 4. Concrete slabs show cracks and dislocated portions and the unsorted stone while the core is washed under concrete slabs

Fig. 5. Displaced stable pods and stable pods on which algae developed, while the protective mantle from stone blocks, fell apart and the concrete pillars show cracks and detachments of material

Fig. 6. The equipment that serves the dams is rusty and partially non-functional

It is known that the geology of the land is as follows: in the surface with a variable thickness between 0.50 m and 1.50 m there is a layer of topsoil or fill, up to a depth of 2.30 m followed by a layer of sand with plant debris and fragments of shells, which has a medium thickness, follow up to a depth of at least 10 m a layer of fine sand. Within the sand layer there are small intercalations of dusty clay. The sands within this layer have values of the friction angle between 30 - 38 degrees. The degree of compaction increases with the depth being between 40 and 60. The works are located on sandy soils, whose granulometry differs both in depth and as the spreading surface. According to studies, these soils do not show liquidity.

4 Proposed Solutions and Discussions

4.1 Proposed Improvements and Technical Solutions

Based on the analysis of the existing situation and based on the worldwide literature review [4-6] and also the Romanian specific literature [3, 10], the authors consider useful to make the following improvements:

- removal of existing coastal structures;
- execution of new coastal structures connected to the shore;
- replacement of dams and related equipment for handling dams;
- rehabilitation of concrete dam structures;
- shore protection.

In general, the coastal structures are represented by

- protection structures connected to the shore,
- shore defences,
- defences of electricity poles,
- rehabilitation of concrete structures,
- replacement of equipment related to the dam system.

The proposed improvements are:

- Proposed Improvement 1: Therefore, the foundation of the structures is proposed to be properly sized to eliminate local erosion due to the strong action of waves and reflected or broken waves or currents, so that a possible deformation of the foundation has minimal effects on other parts of the structure.
- Proposed Improvement 2: Another proposal is that the core of the structure will be protected by means of the respective armour layer a filter layer if this is necessary according to the list of design standards, principles and normative.
- Proposed Improvement 3: A proposal for the execution of the core, the materials from the existing coastal structures will be reused, and it will be completed with the same type of materials. The structures will thus have an adequate robust berm to limit the damage caused by the energy of dissipation of waves, currents and erosion, to an acceptable level.
- Proposed Improvement 4: Finally, it is proposed that the response of the structure to the hydraulic load be verified by physical hydraulic tests or by numerical modelling. The mantle of the stone structure will be designed based on "Rock Structures" and "Concrete Armor Units Specifications".

Also, based on the analysis of the existing situation and based on the worldwide literature review [6, 7, 9] and also the Romanian specific literature [1, 2, 8], the authors consider useful to make the following technical solution proposal:

- Technical Solution 1: The replacement of the equipment related to the Edighiol and Periboina dam system and respectively the acquisition of a crane type equipment for handle these dams, at both dams the existing communication channel between sea and lake will be cleared.
- Technical Solution 2: At Edighiol dam it will be removed the existing coastal structure in the northern part of the evacuation channel, and it will continue with an execution of a new coastal structure with a length of about 85 m.
- Technical Solution 3: At Peiboina dam the shore protection will be restored in the missing section in the northern area of the dam system, similar to the existing one.
- Technical Solution 4: The armour layer will be made of stone (layer thickness 0.8 m) with a slope of 1: 1.5. Under this layer, a smaller category stone layer (layer thickness 0.5 m) laid on geotextile will be applied.

- Technical Solution 5: At the foot of the shore defence, the stone layer will be extended by approx. 5 m in order to combat erosion at the base of this structure.
- Technical Solution 6: The concrete structure will be rehabilitated, including the replacement of the degraded concrete piles and the restoration of the defence at their base. In order to conserve biodiversity, the construction of artificial reefs and the introduction of biostructures and repopulation with marine species are planned.

4.2 Considerations Regarding the Management of Coastal Rehabilitation Projects

The project manager must identify problems that can appear in the good development of the project and this is essential for the progress of the project. Based on the authors experience in the field of project management and the current analysed situation of the coastal area rehabilitation project some consideration can be made [11, 12].

4.2.1 Objectives

Thus, from the first design phase, it is necessary for the staff involved to be able to carry out the activities necessary for a correct design, as close as possible to reality. Due to the fact that we do not have specialists in the country with similar experience, fact required in the specifications by the beneficiary of such a work, certainly application requirement will be submitted abroad to send offers for project implementation. Thus, it appears the obligation of the project manager to carefully check the participants.

4.2.2 Constrains

After establishing the winner of the design and construction of the objectives, another important step is the knowledge by the designer of the field conditions. Due to the fact that the constructions are in the area of the Black Sea coast, the tests that must be performed for a good design are weather dependent. Thus, geotechnical drilling cannot be carried out, which are necessary to identify the foundation land, at sea if the weather does not allow it. Also, for the same reason, divers cannot be used to ascertain the stages in which the existing works are, which are covered by the sea.

4.2.3 Schedule of Works

The project manager must request from the designer a schedule of the works to be performed in the field, in order to estimate the possibility of their performance, based on the weather forecasts. After performing the field works, the next step is to check the times when the design is done. It should remember that in some areas of the sea shore between May 1 and September 15 cannot be performed construction works. In this case, the project manager will impose a fragmentation of the execution of the works and the analysis of some solutions so that there are no "dead" times. It is also possible to make supplies with materials, or some construction works that do not affect the tourism on the coast. By requesting a schedule of works, the project manager can identify the roads that the project can travel in order to avoid delays and price changes, respectively.

In the field of constructions and in particular in coastal areas rehabilitation projects, represented in this case of the projects from the northern part of the Black Sea Coast, the project management has a decisive role due to the fact that each project is unique and the

factors involved in its achievements varied depending from the staff (designers, project verifiers, builders, site managers technical execution managers), to the necessary materials for the actual work, respectively the construction materials suppliers. The complexity requires a very rigorous management so that there are no "dead times" or work breaks. For example, in the dam case, part of the rehabilitation work is the repair of the dam support pillars foundation. These foundations are in the water, and the project manager must first of all have a Gantt plan for carrying out the work in stages, a plan that he will overlap on the weather forecast. For construction works that take place on the seashore, where their completion depends on the weather, the project manager must consider all options, including postponement of deadlines due to unfavorable weather.

5 Conclusions

Marine structures, due to the fact that they are almost entirely in contact with water, are more subject to erosion. For this reason, tracking the behaviour over time of the effects of corrosion, but also their rehabilitation is the main factor for their proper functioning. Moreover, improper functioning not only affects the construction itself but can also affect marine biodiversity. The solutions proposed in this paper by the authors have the role of achieving a protection of the coastal area against erosion, a rehabilitation and protection of the shoreline, adjacent lands but also of land and marine ecosystems. Also, based on the experience of the authors, the authors consider that the proposed solutions will protect the economic infrastructure and social objectives endangered by marine erosion processes. Finally, the authors propose the implementation of an integrated program for monitoring the coastal area in the medium and long term, to support maintenance operations.

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