

# PERFORMANCE OF THE GEOSYNTHETICS USED AS A COAST PROTECTION IN COLAN, PIURA

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## 1. RESUMEN:

Con el pasar de los años, las aplicaciones de los Geosintéticos han ido diversificándose como respuesta ante las diferentes necesidades en las que métodos convencionales o uso de materiales tradicionales ya no resultan ser rentables. Por ejemplo, en el campo de la ingeniería civil, específicamente en el área de protección costera, se ha visto introducido del uso de material Geosintético a través de las Geobolsas como posible alternativa en algunos puntos de la costa norte del Perú, centrándonos en este artículo específicamente en las Geobolsas utilizadas en la protección del centro turístico Costa Bonita ubicado en la playa La Esmeralda que baña al distrito de Colán, provincia de Paita, departamento de Piura. Haremos uso de este caso para evaluar su desempeño frente a diversos factores desde su colocación hasta su término de vida útil.

## ABSTRACT:

Over the years, the applications of Geosynthetics have been diversifying in response to the different needs in which conventional methods or use of traditional materials are no longer profitable. For example, in the field of civil engineering, specifically in the area of coastal protection, the use of Geosynthetic material through Geobags has been introduced as a possible alternative in some parts of the north coast of Peru, focusing on this article specifically in the Geobags used in the protection of the Costa Bonita resort located on the La Esmeralda beach that bathes the district of Colán, province of Paita, department of Piura. We will use this case to evaluate its performance against various factors from its placement to its end of life.

## 2. INTRODUCTION:

Although it is true, the diversity of construction materials allows a wide range of solutions to various situations, there are alternatives that generate a better response. To do this, these materials are tested in order to meet the standards necessary to fulfill their function and define which ones best adapt their characteristics to these solicitation responses; However, this does not always define the reality for which they will be destined since Mother Nature, as a global agent in every field of engineering, is unpredictable, and the best thing to do is try to get as close as possible to cover all the necessary aspects.

Thus, through this article, we will focus on studying the behavior and performance of the Geobags placed in the Costa Bonita resort of Colán and its surroundings, given various factors that could test their versatility, whether their standards as a Geosynthetic material as well as those outside its solicitations.



Figure 1. Geobags used in the coastal defense of the Costa Bonita resort.



Figure 2. View of the Costa Bonita-Colan resort.

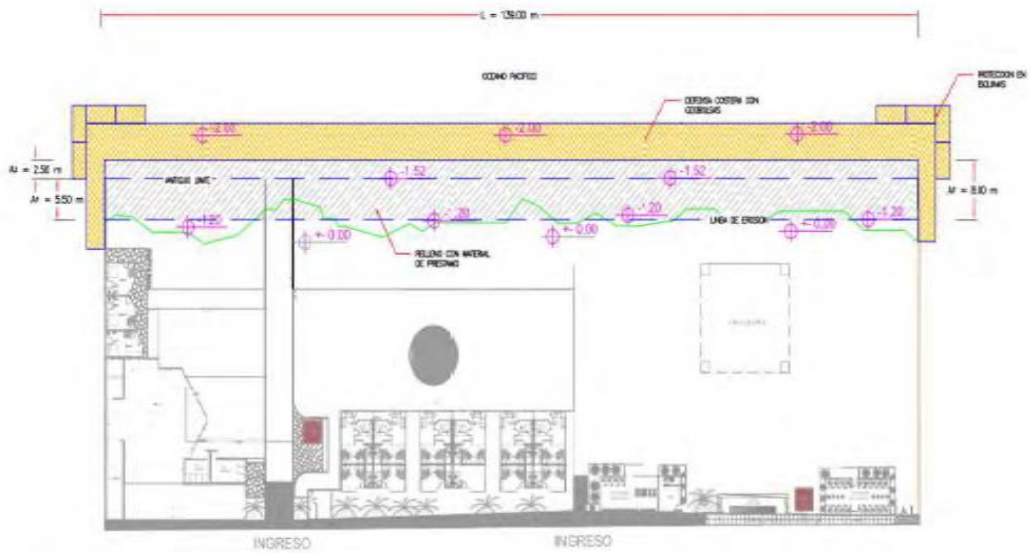


Figure 3. Plan view of the coastal defense with geotextiles.



Figure 4. Plant location Commercial premises Costa Bonita, Colán Sur.



Figure 5. Old structure and erosion line boundary.

### 3. DESIGN AND CONSTRUCTION PROCESS:

To better understand the behavior of geobags, it is necessary to take into account some important aspects such as the design and construction technique used in these elements.

Two components stand out in the design: the design of the hydraulic force and the internal design of the geostructure. The first one is related to the dimensioning of the elements that will be used in the defense project system for which empirical formulas are used that relate basic parameters, such as the Pilarczyk formula, by the hydraulics engineer. With the second, reference is made to the capacity that the geotextile element must have before, during and after its placement using some data known as the height of the waves, the period of peak wave, water tank, etc.

Taking into account the requirements of the project together with the design procedure, it opens the way to a geometric design. In general and as it was in this case, an external entity proposes the use of one of its solutions. For the Costa Bonita, it was suggested the use of a system of rectangular prismatic geobags with a capacity of  $12.5 \text{ m}^3$  which would be filled with sandy material of the place with a percentage of fines less than 15%.

Table 1. Geometry of geobag design.

SHAPE	DIMENSIONS (m)			WEIGHT (tons)
	L	W	H	
Rectangular prismatic	5	2.45	1	22

Once the dimensions have been chosen, the geostructure profile is assigned. For the case applied in the defense of the Costa Bonita, it was applied as follows: two geobags in the first level, one in the second level and one in the third level. Likewise, the placement of a non-woven geotextile protection mantle to prevent the washing of fines from the protection slope.

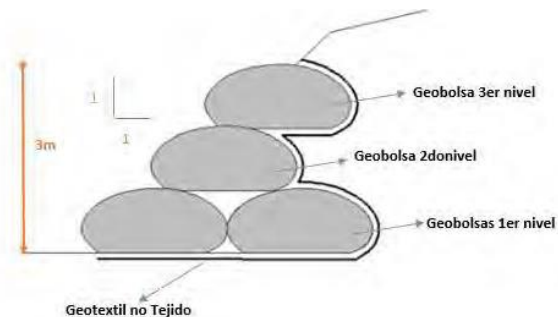


Figure 3. Profile outline of the geobag structure.

If we talk about the construction process, it consists of the placement and in-situ filling of the geotextile elements (Geobags) according to their design and layout, forming a flexible coating. The use of heavy machinery for the processes of excavation and filling of geobags (excavator and backhoe); as well as the provision of plans for the installation of the defense that covers the requirements of the project and recommendations of the manufacturer.

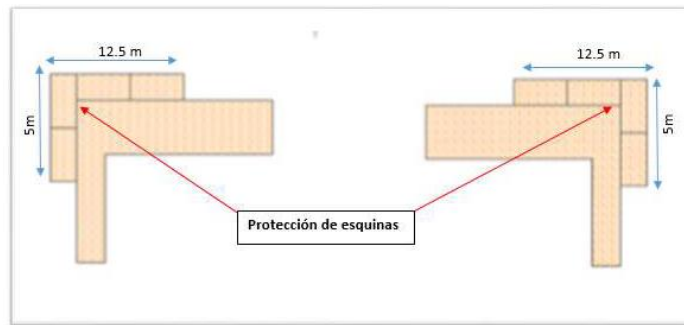


Figure 6. Corner protection of the premises (Plant View)

#### 4. GEOBAGS IN COLAN:

It should be noted that the use of Geobags in Costa Bonita and in some other nearby points, derives from the change in the traditional use of concrete or castling coastal defenses since they have previously been applied to offer not so pleasant results for users who searched for Geobags a more dynamic alternative due to their behavior. It is necessary to point out that after its placement, this system has been exposed to a Coastal Child, which was not foreseen in its solicitations.

To analyze their performance, a series of visits were made to the mentioned place to observe their status and behavior. As a result, a series of factors that were involved in the decreasing service of the system and in the user's willingness to take the initiative to replace it with a different one could be deduced:

##### 4.1. Anthropogenic Factor:

Many times, the hand of man is the most degenerative factor in terms of quality of duration of a structure; Moreover, when the ignorance or ignorance of the purpose for which they have been elaborated is reflected in acts of vandalism that cause the early death of the elements. Geobags in Colan were no exception; on the contrary, the rupture of some of them was due in principle to small holes originated by sharp elements that with the passage of time and by the action of strong currents, external elements such as rocks and material detached from surrounding constructions and even by the same thrust of the filling material of the Geobags, these ended up deteriorating preventing them from fulfilling their function for a longer time.

It is, therefore, necessary to have a criterion of the disposition of these elements in terms of their protection; since, trying to make the population aware of the importance of these elements not only for the Tourist Center and its surroundings but also for themselves, is a somewhat complicated task. Initially, those who come to visit the place may be aware in the first instance of the purpose of the Geosynthetic material placed on the edge; However, under the influence of alcohol and other substances, this no longer prevails in the minds of young people who attend the resort much less in those who spend late at night to perform acts of vandalism.



Figure 7. Geobag with apparent cuts.

4.2. *Filling material:*

The importance of a good “constructive” or manufacturing and implementation process is printed on good service and useful life of various elements; However, this is often overlooked when the urgency and urgency of its placement are given higher priority for its use. In the case of the Goebolsas, a good selection of filling material is essential prior to its placement and, although it is true, use is made of filling material itself, it is not always free of impurities or objects that could damage Geosynthetic material such as glass, metal elements, logs, etc. They are thrown on the beach either by the tide of surrounding areas or by the residents themselves.

Despite this, users decided on their own to ignore this clarification, thus also reducing the possibility that the Geobag system has optimal durability and an effective quality of service since, these elements housed inside the Geobags by it shock of the tide to the protection system and the gravity action itself makes them want to go outside, producing holes that eventually end in the collapse of several Geosynthetic elements.



Figure 8. Geobags covered by sea sediments.

4.3. *Maintenance:*

The existence of elements that could generate damage, from the inside of the Geobags, were already mentioned if they were not removed from the filling material. Also, reference should be made to the damage they could cause when they impact the waves against the Geosynthetic material protection system. In addition to this, the accumulation of sediments from the seashore in the free spaces of the system as well as in the surroundings and on it, make the system a mound that gradually loses stability because the Geobags do not have enough space to rearrange itself to the action of the tide and the exit of the sediment in the inferior part and little by little they are sinking.



Figure 9. Logs and stones brought by the sea current.

#### 4.4. Niño Costero Phenomenon:

This phenomenon occurred at the beginning of 2017 was decisive to evaluate the behavior of the coastal defense system since it is part of the unpredictable factors of nature that are outside the design solicitations; that is, when the Geobolous ones were placed, it was not considered that they would have to be there to withstand the rising tide and the incessant rains that, as the sea level increased, were washing the seating floor of the Geobags and in some cases displacing them since, to this type of phenomena it is not at all right to link an exact period of occurrence or to predict their appearance with accuracy, so it was not foreseen within the solicitations linked to the design.

The action of this phenomenon increased the speed of marine currents and water level, which directly affected the system; therefore, it happened that the other factors previously mentioned (not counting the anthropogenic factor) were proportionally increased in the scale of damage. In other words, if before the possibility of damage by external objects only applied to the lines of Geosynthetic material reached by the water level and dependent on the speed with which they impacted; Due to the rising tide and the increase in the water level, the impact was even greater, reaching not only the Geobags placed at the bottom but also those that were above the average level and we no longer talk about elements such as small stones or small pieces of wood or glass, but of larger elements dragged by the strong current of nearby areas such as concrete blocks with reinforcing steel projections, larger stones, fence trunks placed by the locals, etc.

Not to mention the number of sediments that were catapulting and burying at the same time the defense system and the speed with which the base floor was being washed by the strong current.



Figure 10. Effects produced by the phenomenon.

#### 5. PERFORMANCE:

Despite the performance of all these previously affected factors and those already implicit in the useful life of Geobags (such as UV rays, etc.), it develops its function as a coastal defense system in a favorable manner. This does not mean that they have not been seen; on the contrary, it was natural to observe the results of the blows and other direct aggressions to the system, but as it has been said, they are "natural" responses to such a convergence of factors and that the set of Geosynthetic material would be expected in due course to show weakness.

It is for this reason that people who initially made use of the protection of Geobags to defend the tourist center considered the idea of replacing with a defense of rock and sand to believe that the Geosynthetic system does not provide security or complied With its function correctly.

It is a fact that without the deserved care and with the actions of agents not provided for, the coastal defense of Geobolsas will be reduced in quality of life and service, but this is something that does not depend directly on its faculty as a material and is alien to its design requirements. How to make users understand that the dejection of the elements placed on the coast does not imply that their performance is not as expected, that it is a natural thing that the elements are not immune to certain factors and therefore are not eternal.

It is easy for those who are often related to material issues; However, for those who only seek a quick response without prior consultation and who believe that the larger the structure, the better results they will have, the less feasible.

Such is the case of the Costa Bonita that after the “death” of the Geobags (and with some still in current state for the service) it is decided to use them as a filling of a new defense system based on rocks and sand with the Haste of time to open the tourist center. If a better option had been selected, I would have chosen to replace Geobags that were in very bad conditions and reinforcing the stability of the whole system since, in the long term, the defense of sand and rock, in case of eventualities such as that of the Niño Costero Phenomenon would have even more series repercussions not only in the resort but also in the surroundings. In addition, when you travel along the shore of the tourist center you can divide the impact that the provisional system that you have created is generating in the nearby areas; then, when gaining land of the sea, it looks for the lateral ones to balance its natural state so that the water level is getting closer and closer to the houses and this has the normal swell and needless to say before an eventuality like that of the Niño Costero Phenomenon.

## 6. CONCLUSIONS:

- The use of Geosynthetic material as an alternative in coastal defense systems demonstrates the versatility of materials in the engineering field. Such is the case of Geobags that demonstrate that the use of new solutions can be at the level and even exceed those traditionally used giving good results not only in terms of service but also, in time and money.
- Nature is unpredictable but not decisive, which generates new solicitations and considerations regarding materials available in the market. In addition to this, the new conservative trends of the environment make the creation of new materials dynamic and that options that meet the standards are sought.
- We cannot doubt the performance of Geosynthetic materials, as is the case of Geobags in Colán; well, in the event of significant scale eventualities such as the Niño Costero Phenomenon, they fulfilled their function within the limit offered. Even some of them are still in perfect condition along the shore implying that it is a matter of taking certain criteria to improve their behavior.
- We must be aware that the materials are not eternal and that it is typical of its passing nature, fulfilling its function, and even more, by adding factors other than those already requested, the wear and tear of its durability. This does not take away the fact of its reliability at the time of use, but the measures and / or considerations to be taken into account for better performance.
- It is important to raise awareness among users with all the required information both, during and after disposing of the Geosynthetic materials and generating bonds of trust between company-user with constant communication. In this way, those who choose to use alternatives such as Geosynthetics will not only be satisfied with the product but also with the agents involved in its entirety.
- It is worth mentioning that in future projects of use of this type of materials or any other alternative that is unknown to the population; even more if they are large-scale projects, add the chain of ties to the competent State. Many times it fails to believe that it is only a matter of offering and not providing support and / or information in this regard, which closes some future doors to innovative solutions.

7. ANNEXES:



Figure 11 and 12. Provisional sand and rock barrier next to the Geobags.



Figure 13. New coastal defense.



Figure 14. Sand and stone barrier wash produced by the tide.





Figure 15. The sea tries to recover land by entering the surrounding areas.



Figure 16. Geobags in areas near the resort.

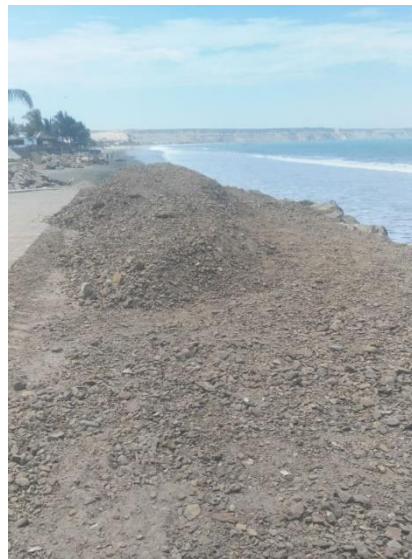


Figure 17 and 18. Current state of coastal defense.

#### 8. REFERENCES:

Ramirez, A. (2017). Procedimiento constructivo utilizando la tecnología de geotextiles para protección costera en Colán-Piura. Piura, Perú. Universidad de Piura.

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