Characteristics of geosynthetics used in the waterponds in Spain

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ABSTRACT: We have determined the characteristics of various geosynthetics used in waterproofing systems in the last year in Spain. We have been carried out the tests to calculate the mass per unit area, tensile strength, elongation in the load maximum static punching CBR and dynamic puncture resistance (cone drop). It also exhibits the behavior of polyester drainage geocomposite used in alkaline medium. The land where the pond was located was formed by volcanic rock and has therefore been necessary to prepare the subgrade properly and applied a layer of porous concrete to act as a waterproofing system support. A few months after finishing this work identified a pathology investigation once it was found that due to the reaction caused in polyester drainage geocomposite was hydrolyzed by contact with the basic medium of concrete. The results obtained for the demostration of this problem and proposed solution to resolve it.

1 INTRODUCTION

In the year 1977 was held in Paris the International Symposium on the use of textiles in Geotechnics, there was where Mr. J.P. Giroud begin to use the name of Geotextiles to designate these materials. Subsequently, the International Geosynthetics Society (IGS) held successive international conferences on the topic in Las Vegas, Vienna, Singapore, Atlanta, Nice and Yokohama (Leiro, 2006). Nationally, the relevant chapters celebrate, in turn, local events several times a year and the past celebrations took place in Santa Cruz de Tenerife, Valencia and Seville (Blancoe, 2008; Leiro, 2008, Abad, 2009).

Geotextiles, in almost all of the ponds built in Spain, are situated between the substrate and the synthetic polymer geosynthetic barrier, (Leiro et al. 2002; Aguiar and Blanco, 1995) but sometimes, its placement can occur between two polymeric geosynthetic barriers of the same nature as is required by the designer that´s the case of Los Cabezos in Villena (Alicante) or in cases of re-lining to avoid possible incompatibilities between the geomembranes, as a possible migration of plasticizers from a poly (vinyl chloride) geomembrane plasticized and another of different raw material. In the case of dams, it is common to use polymeric geosynthetic barriers whit a geotextile facing on one side wich be in contact with the concrete, this is the case of the waterproofing of Portuguese dams Coviao do Ferro and Pracana (Liberal et al., 2003).

The use of geosynthetics as drainaige is today a common use. It´s basic purpose is the collection of water and drive it avoiding erosion and minimazing pore pressure. Apart from its role in the stability of the work, is important to identify and measure possible leaks (Ferrer et al., 2005, Santamaría et al. 2008).

Although actually these materials can be made of polyamides and even of different composites fibers, in our country, are usually made from polypropylene, polyethylene and polyester (Leiro and Blancoe, 1990). The first two products are polyolefins that have lost their link polymerization "phi" and only in its structure contain connections "sigma", while the polyester is a polycondensate that its polymerization reaction does not lose the structure "ester" of the monomer starting. As a result of this type of structure of the macromolecule, polypropylene and polyethylene have a high chemical inertness and will only attack in homolytic or radical reactions that may be caused by exposure to UV radiation from the sun (Carneiro, 2005) by what must remain adequately protected work. Instead polyester, react perfectly in heterolithic or ionic reactions, such as its hydrolysis in the presence of highly acidic pH or basic, the reaction of an ester with a base is the formation of soaps called saponification (Navarro et. al, 1989). Given the support and environment to be installed where it will choose the appropriate geotextile and therefore makes use of them in the facing of dams and even on roller compacted concrete (Scuero, 2004; Scuero and Vaschetti, 2008).

This paper aims to present the experimental results obtained in the laboratory with a series of geosynthetics were used in the waterproofing of ponds in recent years in Spain and, basically, determine the pathology observed in one of them employed as drainage geocomposite.

2 EXPERIMENTAL

Ponds that are considered in the study all the geosynthetics used in waterproofing are Acanabre, Alfondons, Alisarejos, Bediesta, Bonales, Capdepera, Covachas, El Toscar, Es Mercadal, Inca, loins, Treasure Mountain, Couples, Peguera, break, Robles, Torrealta-2 and Zacillo. The polymeric geosynthetic barriers used on the geotextile are high density polyethylene (HDPE) with the exception of the small dam Acanabre and Bediesta, where we used poly (vinyl chloride) plasticized (PVC-P) and drinking water pond belonging to the Commonwealth of Taibilla Cannals that use was made of rubber terpolymer ethylene-propylene-diene monomer (EPDM).

2.1 *Tests in the geotextiles*

In this case, geotextiles were used for the protective function of polymer geosynthetic barrier, therefore, and as the essential characteristics and the respective rules for this function tests performed, as reflected in the relevant harmonized standard, were as follows:

- Mass per unit area UNE-EN ISO 9864
- Tensile strength BS EN ISO 10,319
- Elongation UNE-EN ISO 10,319
- Puncture (CBR) UNE-EN ISO 12236
- Drilling dynamic BS EN ISO13433

After carrying out the tests, we can compare the values of the results obtained with the values declared by the manufacturer in the documentation accompanying the CE marking for the protection function in this application (Sans, 2008).

2.2.1. - Results

Data from tests conducted on samples of widely varying values geotextiles originated as a result of the various origins of macromolecular materials. The mass per unit area varies between 198 on breaking up to 644 g/m2 Bediesta. The tensile strength is between 11 kN / m in Inca and 35 kN / m in Acanabre. The elongation ranges between 31% and 109% of Bediesta Bonales and Treasure Mountain. Dynamic perforation (cone drop) has a range of values ranging from a diameter of 9 mm cone Acanabre, Capdepera Alfondons and 20 mm in Mountain Treasury. Finally, the static punching (CBR) has a puncture resistance ranging from 2.2 kN to 5.8 kN Inca Acanabre.

2.2 *Testing conducted in drainage geocomposite*

Over time not observed any pathology in geotextiles, but in drainage geocomposite because after a few months by a geotechnical problem, had to be made up on the sill waterproof system detected a serious deterioration in the same, therefore proceeded to a detailed study of their behavior. Here we refer to this geosynthetic.

Given the situation presented in work samples were taken in three areas of the reservoir will call N, S and E, as well as three rolls of original drainage geocomposite collected in a work zone, the reference will be 1, 2 and 3. The drainage geocomposite used, it is a drainage geocomposite, which consists of two nonwoven geotextiles and Geomats, which serves as geonet.

To try to reproduce in the laboratory, hypothetically, he could occur on site, there were a series of accelerated tests to verify the behavior of drainage geocomposite in a basic medium, such as occurred in the concrete in contact with water due to leaching. Thus, it proceeded with the trial based drainage geocomposite es at the UNE-EN 14 030 "Geotextiles and related products. Selective test method for determining the resistance to acid and alkaline liquids. To do this, he prepared a solution of calcium hydroxide saturated with approximately 2.5 g / l, in which the specimens were immersed for three days. The container with the specimens was introduced in an oven at 60 º C with constant stirring.

In order to study independently the behavior of the materials that formed the original drainage geocomposite, separated the two nonwoven geotextiles and Geomats.

Table 1 . Experimental Results

SAM-PLE	SENTID	Tensile strength, (KN/m)		Residual strength after subjected to $Ca(OH)_2$ (%)
		With out $Ca(OH)_2$	Subjected to $Ca(OH)_2$	
Geomat original. Roll 1	A	0.86	(*)	
	B	0.91	(*)	
Geomat original. Roll 2	A	0.72	0.27	37.5
	B		(*)	
Geomat original. Roll 3	A	0.68	(*)	
	B	1.29	0.14	10.9
Geomat N	A	0.62	(*)	
	B	0.80	(*)	
Geomat S	A	0.52	(*)	
	B	0.79	(*)	
Geomat E	A	0.48	0.25	52.0
	B	0.48	0.42	88.0
Geo-textile original. Roll 1	A	5.30	5.13	
	B	5.92	5.72	
Geo-textile original. Roll 2	A	4.45	4.55	
	B	5.78	6.12	

(*) The specimens could not be tested in tension after being subjected to attack with the dissolution of calcium hydroxide due to its deterioration.

In the original rolls (1 and 3) were separated from non-woven geotextiles Geomats and eight specimens were produced, four in the longitudinal and transverse four. In Reel 2 specimens were prepared only the Geomats, as in samples taken from the slopes of the reservoir. The experimental results achieved are presented in Table 1.

Geotextiles tested were not attacked by the basic solution of calcium hydroxide, as evidenced by the results of its tensile strength, where the values obtained before and after alkaline treatment are practically the same.

The original drainage geocomposite geomats from the rolls substantially deteriorated so much so that in only two cases it was possible to conduct the tensile test, but showed degradation. In the Geomats from the roll 2, the specimens were left with the basic treatment for a period of time greater, namely, three cycles for a three successive days. At the end of this time, probes the Geomats denoted a high degree of deterioration, which from carrying out the tensile test.

The specimens taken from the slopes of the reservoir is subjected, as stated before the same test as the original materials. The degree of degradation experienced prevented the tensile test on the samples referenced as N and S. The spoilage observed in these materials is superior to that achieved by the samples of the original scrolls.

3 CONCLUSIONS

1 .- With regard to the geotextiles tested, except those from ponds and Mountain Alfondons Treasury, came without proper identification and without the relevant certificates for the CE, so it was not possible to contrast the values obtained declared by the manufacturer in the above licenses. The Treasury from Mountain meets all the requirements.

2.-As for geosynthetic drainage include the following:

- Of the specimens made of polyester Geomats subject to attack by the dissolution of calcium hydroxide, has only been able to determine the tensile strength in some cases because they have suffered a significant deterioration from carrying out such evidence. In which it has been performing the test after three days under the attack of calcium hydroxide, have suffered a significant decline in its tensile strength.
- The values obtained in the non-woven geotextiles for initial conditions and subject to attack after calcium hydroxide, are substantially the same, so we can deduce that it has not affected the calcium hydroxide attack. This is because its raw material is polypropylene, which remains unchanged in a basic medium.
- Results obtained in the laboratory on the drainage geocomposite geomats show a significant decline in their properties by subjecting the attack of a saturated solution of calcium hydroxide at 60 ° C, which can be explained by the hydrolysis of polyester polymer with which it was manufactured. This confirms what happened at work due to hydrolysis caused by contact with the alkaline solution produced in the leaching of the concrete.
- There are three possible solutions for the repair and after seeing the advantages and disadvantages of each one of them is chosen only of removing drainage geocomposite and replaced by another type polyolefin compatible with concrete. This option was the quickest, cheapest and technically adequate. The reservoir is now fully operational.

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