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The application of nonwoven waste confinement systems in mining, water treatment and environmental solutions

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ABSTRACT
In this paper, four different solutions using nonwoven waste confinement systems produced from polyester with mass per area equal to 600 or 900g/m² are presented. The first case is part of a municipal hydraulic revitalization project in Curitiba/Brazil, where waste confinement systems were installed on site to receive the material accumulated on the bottom of a lake, responsible for it silting. On the second case, the tubes were used to replace slurry desiccation bays from mining. The new alternative increases the efficiency and the quality of the wastewater in the production process. Another case from mining is shown: a mining company that uses filter press for dewatering sludge resulting from the iron ore processing was experiencing operational difficulties because the equipment required periodic maintenance. As an alternative solution for mining tailings dewatering during maintenance periods, avoiding the shutdown of the production process, the company adopted as a solution pumping the sludge directly to the waste confinement systems that drain and stock the material. The last case was a test performed at a water treatment plant. Currently, the sludge produced during treatment is sent directly to a sewage treatment plant. Thus, to avoid network overloading, as it has been happening, solutions are being tested to choose the one with the best cost-benefit. In this context, waste confinement systems were installed to evaluate the dewatering of the sludge with and without polymers.

1. INTRODUCTION

Waste confinement system can be defined as a continuous system, in the form of a bag or tubular, that confines residue inside according to the recommendation of IGS 004:2016. It has the purpose of retaining the solid fraction present in residues such as mud or sludge, introduced into the waste confinement systems by means of dredging, thus performing the desiccation and confinement of the material.

Currently, the most found waste confinement systems on the market are made of woven or nonwoven geotextiles manufactured from polypropylene (PP) or polyester (PET) fibers. Both polymers are highly resistant and chemically stable with long lifespan.

Due to the manufacturing process and the intrinsic characteristics of the geotextile type, nonwovens have a smaller filtration opening, thus being more efficient regarding the quality of the percolated water when filtering sludge, which has a high content of fine particles. However, its tensile strength is lower when compared to a woven geotextile of the same mass per unit area.

When we look at geotextiles from the point of view of manufacturing raw materials, woven geotextiles, which are commonly made of polypropylene, are more susceptible to creep compared to nonwoven geotextiles made of polyester.

These are characteristics that should be analyzed when performing the waste confinement system sizing, considering safety factors and filling height according to the requests. An example would be the largest reduction factor that should be used when the raw material used is polypropylene relative to polyester.

This study presents four different applications of nonwoven waste confinement systems in dewatering processes. All waste confinement systems presented in this study were manufactured from nonwoven polyester (PET) geotextile, with mass per unit area of 600 and 900g/m².

2. DESCRIPTION OF WORKS

2.1 Lake clearing

In 2019, the waste confinement systems were installed in the São Lourenço Municipal Park, located in Curitiba, to receive dredging material from the waters from the bottom of the lake that was being silted (Figure 1). Thus, after dredging inside the waste confinement systems, it was possible to retain the sandy fraction responsible for siltation and to promote the dewatering of this material, allowing the percolate to be transported back to the lake. This project was part of the revitalization actions at the Belém Basin, whose waters pass through the park.

Figure 1. View of the lake in process of siltation.

The ground preparation was carried out in advance to receive the waste confinement systems. For this process, we used a geomembrane layer for waterproofing, a geotextile layer to protect the geomembrane, and gravel for leveling the ground in a layer ranging from 5 to 15 cm high, which is also responsible for the drainage of runoff water (Figure 2a).

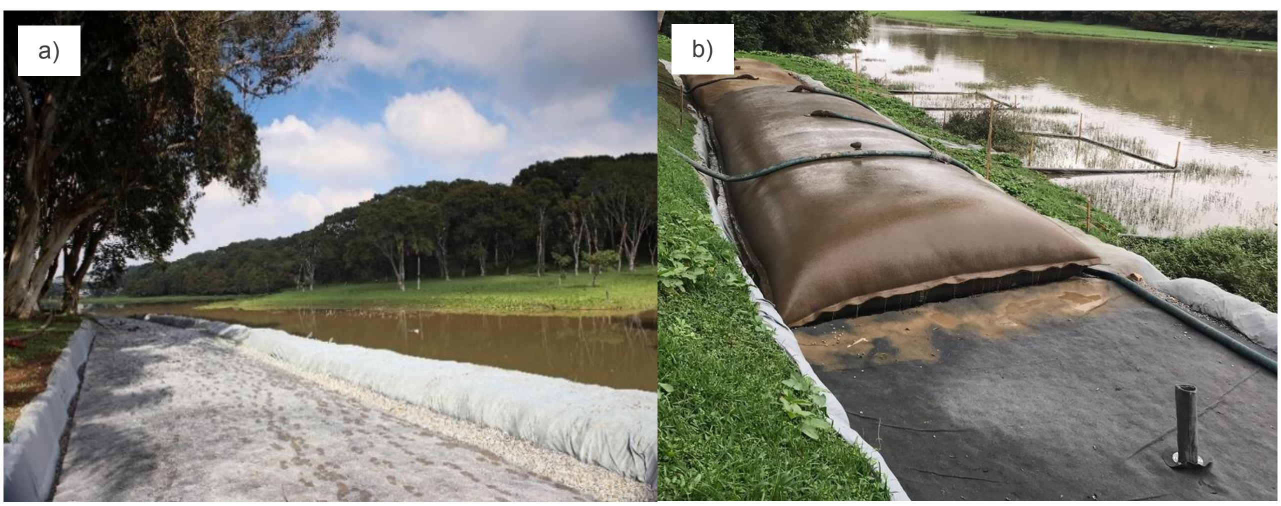

Figure 2. a. Location previously prepared to receive the waste confinement systems. b. Waste confinement systems in an alternating system.

Prior to the beginning of the waste confinement systems filling, cone tests were performed. Due to the composition of the highly sandy dredged material, it was found that dewatering occurred very quickly, thus not requiring the addition of flocculant polymer. On the prepared site, the waste confinement systems were installed, which had dimensions of 4.8m wide and 15m long, and 5.8m wide and 30m long (Table 1). Both types of waste confinement systems had 3 filling ports each. Filling occurred in an alternating process (Figure 2b): as one remained dewatering, the other received dredging load from the lake.

Table 1. Technical characteristics of the waste confinement systems

Length	Width	Composition	Mass per unit area
15m	4,8m	100% polyester	900 g/m²
30m	5,8m	100% polyester	900 g/m²

2.2 Waste confinement systems to replace the filter press in mining tailings

This case presents the insertion of waste confinement systems in the production process of a mining company that uses a filter press for dehydration of sludge from iron ore beneficiation in the Pau Branco mine. The equipment (filter press), however, needs periodic maintenance. As an alternative solution for dewatering the tailings in its maintenance periods, and to prevent the production process from stopping, the company adopted, as a solution, the pumping of mud directly into the waste confinement systems, which performs the desiccation of the material (Figure 3).

Waste confinement systems of 4.8m wide and 50m long were dimensioned (Table 2) in order to meet the demand, respecting the technical specifications of the product.

The sizing was performed based on the volume that would be stored, on the strength of the geotextile, and on the safety factors that would guarantee the good performance of the waste confinement systems.

Figure 3. Waste confinement systems is desiccation process.

Table 2. Technical characteristics of the waste confinement systems.

Length	Width	Composition	Mass per unit area
50m	4,8m	100% polyester	600 g/m²

2.3 Waste confinement systems to replace mining tailings desiccation bays.

A company with a plant located in Sabará, Minas Gerais, used decantation bays to dehydrate the mud from the mining process. The generated mud was guided directly to the bays to desiccate (Figure 4) and, subsequently, the dry tailings received proper destination.

As an alternative way to dehydrate the mud, a pilot test with the waste confinement systems was initially performed, obtaining excellent results. The initial test was performed with mini-bag, following the recommendations of ASTM D7880/D7880M-13, in which the dewatering flow and the percolated water quality were evaluated.
The results obtained were highly satisfactory; therefore, the waste confinement systems became effectively part of the mining waste treatment process. The infrastructure of the site was adjusted in order to receive the waste confinement systems, to wait for the dewatering to form the cake, and to keep them in operation (Figure 5). The characteristics of the waste confinement systems used are presented in Table 3.

Figure 4. Directly dredged waste bay.

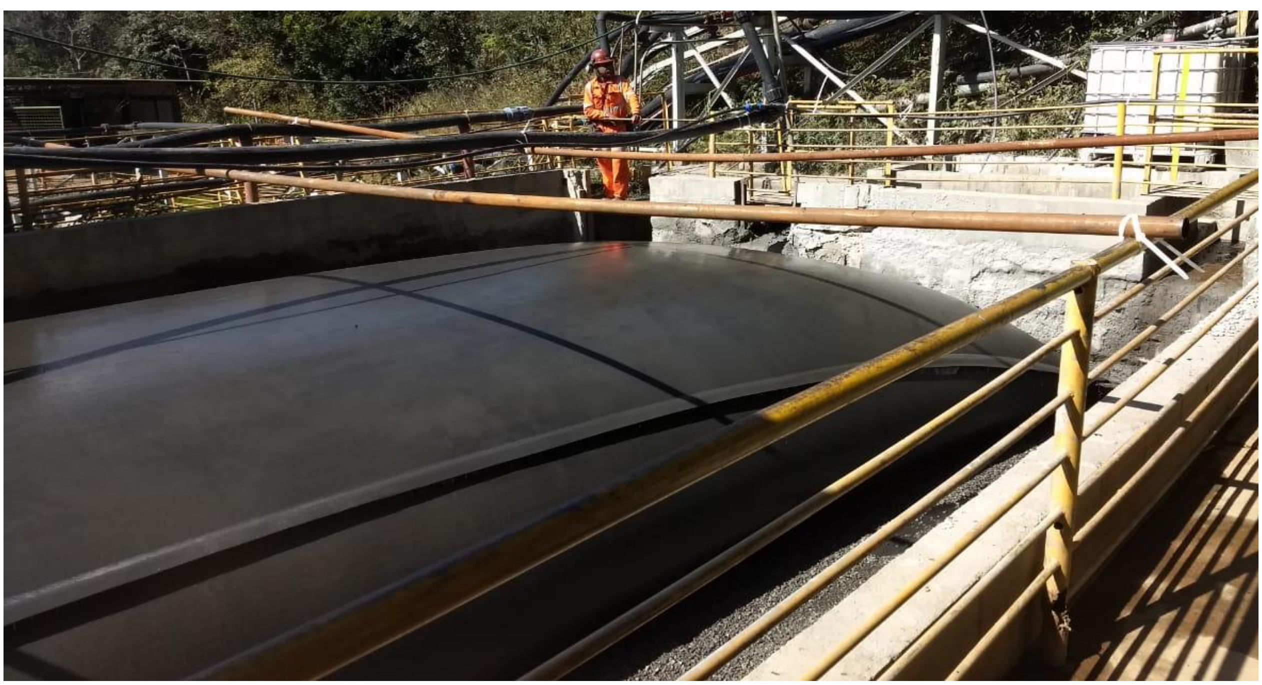

Figure 5. Waste confinement systems implanted in the place where the bays used to work.

Table 3. Technical characteristics of the waste confinement systems

Length	Width	Composition	Mass per unit area
25m	4,8m	100% polyester	900g/m²

2.4 Waste confinement systems to replace centrifuge in water treatment plant.

In 2019, a study using waste confinement systems for sludge dewatering from a Water Treatment Plant was carried out in Nova Odessa - SP. The objective was to prove the efficiency of using waste confinement systems to replace centrifuges, commonly used equipments in the water treatment process. The project foresaw that the waste confinement systems would be filled with sludge from the washing of decanter tanks (Figure 6), which occurs weekly at the aforementioned WTP.

Figure 6. Decanter tank to be washed.

Prior to filling the waste confinement systems, cone tests were performed to verify the need to add polymer to the sludge, identifying the optimal point of dewatering efficiency. To do so, different polymers were tested (Figure 7), determining, finally, that the one already used by WTP would bring higher discharge efficiency.

The entire test was performed with two geotextile mass per unit area: 600 and 900g/m², and in duplicate.

Figure 7. Cone in process of dewatering with polymer.

After laboratory testing, full-scale testing was initiated (Figure 8). A metal structure with PVC geomembrane was designed to accommodate the waste confinement system and to allow percolate capture and measurement by means of a flowmeter.

Figure 8. a. b. Waste confinement system ready for filling and accommodated within a metal structure with a geomembrane. c. d. Waste confinement system during a filling process.

The characteristics of the waste confinement systems used are presented on Table 4.

Table 4. Technical characteristics of the waste confinement systems.

Length	Width	Composition	Mass per unit area
10m	4,8m	100% polyester	600 g/m²

The sludge pumped into the waste confinement system had around 3 to 4% of content of solids. The evolution of content of solids was monitored weekly for approximately 100 days, when it was possible to determine approximately 20% of content of solids in the center and 25% at the edges. At the end of the test, the waste confinement system was destined to the landfill.

3. CONSIDERATIONS

This paper presented the application of waste confinement systems in four cases of different works, highlighting the application of waste confinement systems as a viable and efficient substitution to various equipment and methods of tailings desiccation.

In all cases, the solution proved to be highly efficient, achieving low turbidity percolation (Figure 11), evolution of ideal content of solids within the monitored period, and confinement of solid fraction as forecasted. In addition, it proved to be an easy-to-use and cost-effective alternative compared to conventional solutions.

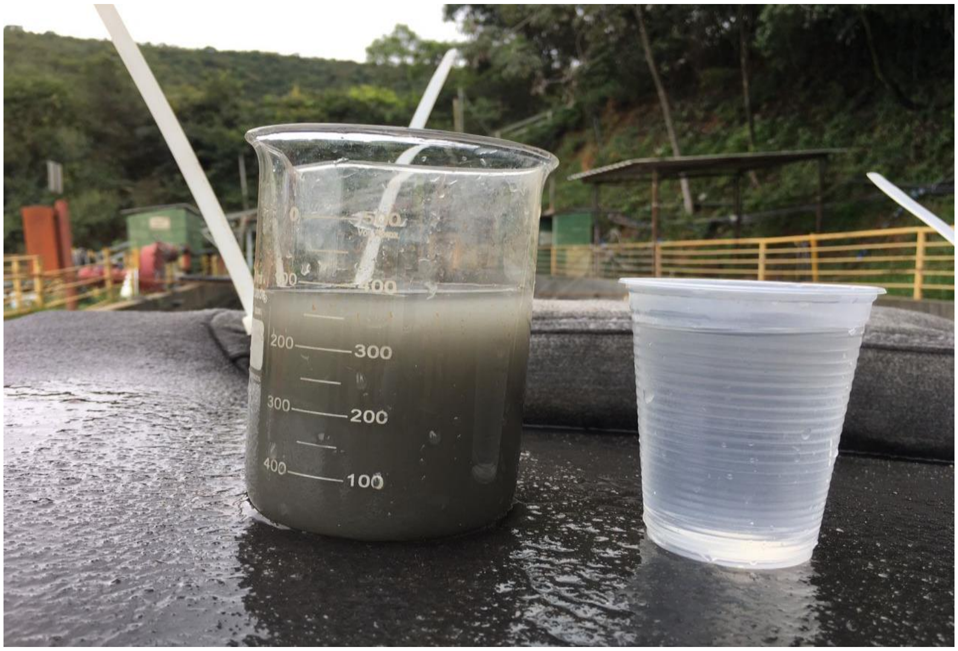

Figure 11. On the left, dredged water. On the right, obtained percolate.

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