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The benefit of geotextile tube for mining application

Oreo Chao, ACE Geosynthetics, Taichung, Taiwan
Zoe Lin, ACE Geosynthetics, Taichung, Taiwan
Jimmy Yeh, ACE Geosynthetics, Taichung, Taiwan
Lili Yang, ACE Geosynthetics, Taichung, Taiwan

ABSTRACT
The case is located in a mining zone of Chile, where the main processing mineral is copper ore. The traditional treatment method requires excavating a plurality of reservoirs to store the mine water. The ore is carried out by means of natural exposure and requires water source for beneficiation operations. Therefore, it consumes great deal of time and also needs large space to handle big amount of copper ore. The lack of local water resources and insufficient storage capacity have seriously affected the mining environment and treatment efficiency. The separated water is pumped into the reservoir for further treatment and subsequent recycling. After filling the geotextile tube (ACETube®) with copper sludge, the tube is placed for one month for gravity dewatering and exposure. The water content of the sludge can be promptly reduced to below 20%, which is beneficial to the subsequent mineral refining. This project used geotextile tubes to treat copper sludge for 4 to 5 months and it successfully reduced the amount of time required for processing the tailing compared to traditional methods. Since the drained clean water can be recycled in a short period of time, the demand for new tailings dams is minimized, hence the cost of water recycling can be effectively decreased. Besides, the minerals contained in the tailing are of high economic values and can be effectively retrieved from geotextile tube dewatering solution, turning waste mine water into commercial commodity.

1. BACKGROUND

Copper is one of the most widely used metals in industrial applications. Copper is rinsed with a large amount of water during the beneficiation process. However, fine-grain tailings that are difficult to settle and separate will be stored using lagoons, requiring a large area of tailings pond to handle the high cost of construction.
The case is located in a copper mine in Chile. In order to avoid the shortage of storage capacity and lack of water resources, the owner proposed to use the dewatering geotextile tube to carry out the emptying operation in the tailings pond and recycle the filtrate after the subsequent dewatering. In addition, the owner can hope to extract valuable metals from the dehydrated mud cake for recycling and resale. Therefore, the case also uses geotextile tube to effectively retain the characteristics of the fine solids in the sludge.

2. DESIGN CONCEPT

2.1 Pending Tailing Ponds Problem

The tailings pond in this case area is shown in Figure 1. The tailings sludge to to carry out the treatment with conditions of around 80% water content rate, specific gravity of 3.0, and total of approx. 40,000m3 copper slurry volume.
Because of the large-scale mining and reprocessing of the mining area, the capacity of the tailings pond of the mining area has been insufficient, and no new land was available to build new tailings dam. Besides, the mine is located in a remote mountainous area, and water resources are not easy to reach. Therefore, the owner hopes to recover the water in the tailings dam and use it in the mining area after treatment. In addition, due to the tailings mud contains high amounts of valuable metals, the owner hopes to have a high-efficiency method to obtain the solids in the tailings mud for the extraction and recovery of precious metals and increase the effective capacity of the mine.

Figure 1. Mine Copper Tailing Pond

2.2 Geotextile Tube Features and Functions

High-strength fibers are woven into geotextiles, the woven geotextiles are sewn into tubular bags, called geotextile tubes. Considering the characteristics of sludge, the material used in this case is a specially designed polypropylene (PP) high-strength, high-permeability, low AOS woven fabric. The material is highly resistant to UV and it is characterized by high acid and alkali resistance as well. Thanks to additional feature of high strength and low specific gravity, the volume and weight of geotextile tube are lightweight and facilitate transportation and construction operations. The geotextile tube is connected to the pipeline at the construction site to be filled with dredged sediment or varied sludge dewatering treatment. Consequently, for sludge treatment projects, the efficiency of tube dewatering becomes of great help. On the other hand, the sludge can be additionally treated with a suitable polymer agglutinating substance to cause flocculation, which can concentrate the fine particles in the sludge into larger-sized flocs; the sludge after flocculation is filled into the geotextile tube, the extra filling pressure and the weight of the sludge itself will promote the dewatering and solidification of the tailings sludge. The system operation is shown in Figure 2.

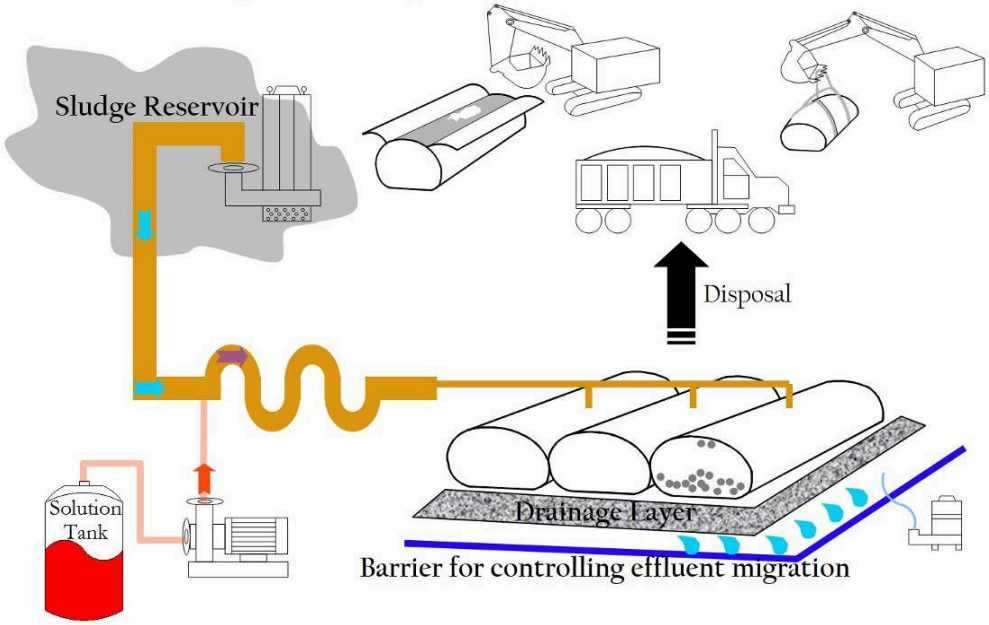


Figure 2. Geotextile tube system operation

2.3 Specification Setting

In this case, the site restrictions, dewatering efficiency, and filling rate are considered. The size of the geotextile tube is 17.2m in circumference and 24 to 30 m in length. The geotextile tube needs to withstand high pumping pressure during construction, so the most important specification setting is the tensile strength of the geotextile. In order to know the geotextile tensile strength, the project was analyzed by GeoCoPS software, according to the characteristics of the mentioned sludge and the size of the geotextile tube. The analysis results are shown in Figure 3. Based on the tensile strength resulted from GeoCoPS analysis, the designer selects different geotextiles for cone test to confirm the best fabric that has at the same time, both dewatering and filtering effects. Based on the tensile strength resulted from GeoCoPS analysis, the designer selects different geotextiles for cone test to confirm the best fabric that has at the same time, both dewatering and filtering effects. The final selection of geotextile is shown in Table 1. The characteristics of the selected geotextile are high water permeability and high filtration under appropriate AOS, which is favored by the designer.

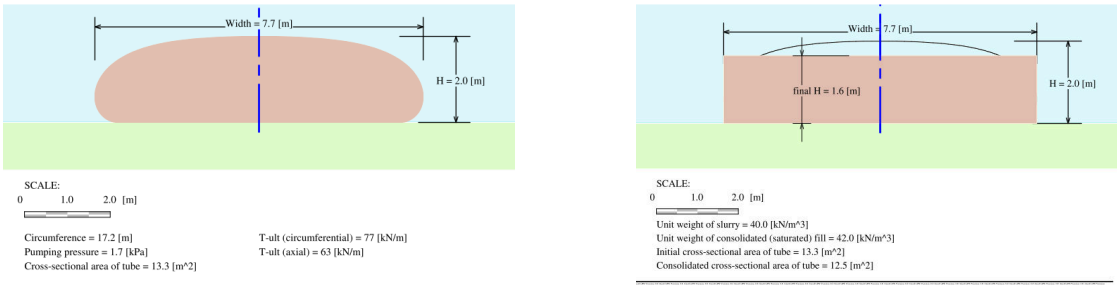


Figure 3. Analysis result

Table 1. Geotextile specification

Characteristics	Unit	Value	Test standard
Nominal Tensile Strength _MD	kN/m	70	ASTM D4595
Nominal Tensile Strength _CD	kN/m	105	ASTM D4595
Static Puncture Resistance (CBR)	N	9000	ASTM D6241
Permittivity (50mm head)	1/s	0.6	ASTM D4491
Apparent Opening Size (O_{95})	mm	0.425	ASTM D4751

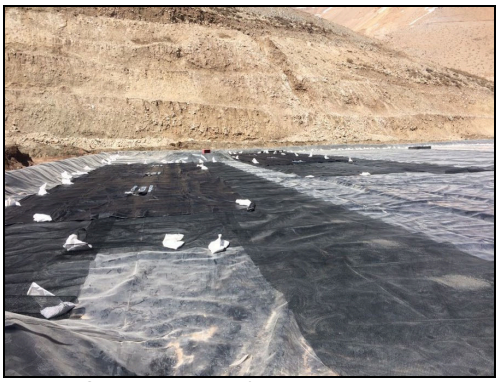
Note: MD machine direction, CD cross direction (also mean circumference direction of geotextile tube)

2.4 Site and Stack Configuration

In order to prevent the filtered liquid from infiltrating into the ground, the geomembrane is first laid on the bottom of the construction site as a barrier, and the ditches are dug around the site to collect the filtrate, and then the pump is used to extract the filtrate. It will be recycled to the mining area.
Taking into account that the hinterland of the mining area is limited, and the sludge dewatering efficiency can be increased at the same time, it is necessary to stack three layers of geotextile tubes. According the field size of the jobsite, the lengths of the geotextile tubes are 24m, 27.5m and 30m from the top to the bottom of the stack respectively. After the mud cake in the tube reaches the target moisture content, the stacked geotextile tubes are removed, and the number of three-layer geotextile tube is then re-laid. This step is repeated until the expected tailings dam is absolutely drained; Therefore, the total number of geotextile tube is about 100 units.

3. INSTALLATION PROCESS

Figure 4. shows the installation process of the geotextile tube for this project.
The work implement time is divided into three sections: filling, exposure and completion. More details are described below:

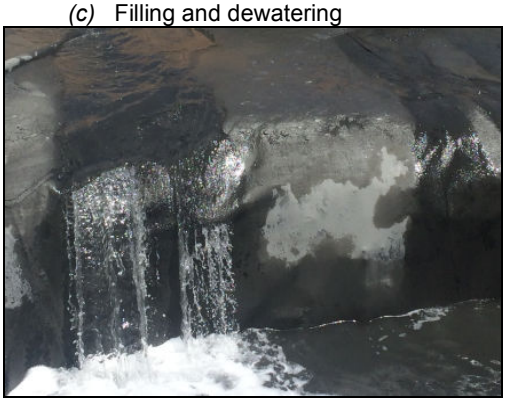


(a) Lay Geomembrane & geotextile tube

(b) Fill the geotextile tube with tailing slurry

(c) Filling and dewatering

(d) Stacking geotextile tube



(e)Filtrate collecting and reusing

(f) Copper re-extracting from sludge cake

Figure 4. Installation Process

3.1 Filling

Initial filling (as part a and b of Figure 4) is basically one day, subsequent re-filling operations are carried out for about two days, and the filling height is not stopped until the height of the geotextile tube can not be lowered in a short period of time. The number of repeated fillings is about six times.

3.2 Exposure

After filling (as part c, d and e of Figure 4), the geotextile tube continues to dewater for a period of time. At the same time, the mud cake inside the tube is compacted and solidified due to moisture discharge; the moisture content of the geotextile tube is measured after/about 30 days. When the water content is reduced to 60%, the dewatering exposure is determined to be complete.

3.3 Finish

The geotextile tube is directly cut open after exposure to the sun, and the mud cake is transported to the heavy metal extraction field (as part f of Figure 4). The case was completed from the site layout to the dewatering of all tailings sludge, and the treatment took a total of 5 months.

4. CONCLUSION

4.1 Performance of Geotextile Tube

4.1.1 Solve Land Using Limit

The customized design of geotextile tube sizes, improve the available area of mining field, effectively empty the mine dam sludge, increase the storage capacity of the tailings dam, plus stack ability (show as Figure 5). Moreover, it reduces the pressure on demand for working space.

Figure 5. Stack Geotextile tube

4.1.2 Working Efficiency

The geotextile tube used in this case has excellent water permeability, such as Figure 6, which can accelerate the dehydration time. Instead of the estimated one-year treatment time, the application of geotextile tube has successfully shorten it to five month. Thanks to the dewatering system with geotextile tubes, the tailings pond is quickly and effectively emptied and the owners are very happy about it.

Figure 6. Excellent permeability geotextile tube

4.1.3 Environmental Protection

With the excellent water permeability of geotextile tube and the proper polymer, the moisture in the tube can be quickly discharged, and it can be recycled shortly and in large quantities for mining operations.

4.2 Additional Value

4.2.1 Time Benefit

It takes several years to use the tailings pond to directly precipitate and expose the sludge for concentration. The project's jobsite has a limited working area, and the geotextile tube requires only five months of dewatering treatment, which has successfully reduced the time required for tailings dehydration.

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4.2.2 Cost

(a) Direct cost: The use of geotextile tube replaces the maintenance costs of the original mechanical dewatering of the mine and greatly reduces the cost of electricity; this method reaches the best balance between time and cost.

(b) Indirect cost: The geotextile tube dewatering method is used to remove sludge quickly and at low cost, by eliminating the cost and time required for the mine to build additional tailings. The recycling of the filtrate also indirectly eliminates the cost of accessing the water resources in the mining area.

4.2.3 Profit

A large amount of sludge solids are retained, and the mud cake is rich in precious metals, which can be extracted and resold for profit, so that the waste becomes a valuable commodity and it is a direct benefit.

4.2.4 Environment Protection

The use of the geotextile tube method can recover the filtrate and the mud cake with high efficiency. This result can avoid the pollution of the mine adjacent to the environment and avoid the damage of the heavy metal in the mud cake to the earth. In conclusion, the environmental protection effect is well achieved.

REFERENCE

Dov, L. and Ora, L. (1996). GeoCoPS : Supplemental Notes.