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Construction stages of gold mining waste storage facility, Gümüşhane Mastra Koza Mining

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ABSTRACT

Gümüşhane Koza Mastra Gold Factory waste storage facility (ADT) has been examined as an example of its construction in accordance with environmental conditions and standards. The site selection, planning, construction and inspection of waste storage facilities are carried out in accordance with legal regulations in a way that will cause the least damage to the ecological structure and living life. During the construction of Mastra ADT, slope and threshold excavations, fillings, slope surface preparation, drainage systems, soil clay fillings, laying of all coating systems, observation wells, support channel excavations and filling operations were carried out. After the completion of these studies, it is aimed to use the landfills safely and finally to bring them back to nature. In this study, the control and measurements of the construction stages of the waste storage facilities were made.

Introduction

With the rapid population growth, technological developments and industrialization, underground natural resources were needed and the extraction, processing and use of these resources is a sector that has become important for humanity [1]. This sector is gathered under the name of mining. Mining refers to the collection of techniques and operations related to the exploration, extraction and operation of reserves of all kinds of minerals, mineral ores, industrial raw materials, coal and oil, precious or semi-precious metals. Extracted mines are used in many areas of industry as a raw material, especially as fuel, according to their intended use [2]. The most extracted metals in our country are gold, silver, copper, zinc, iron, boron and lead. Especially gold is a valuable element and is accepted as the first metal benefited by humanity [3]. In this study, the construction of a waste storage facility, which will ensure that the process wastes generated during the constantly developing gold mining activities are stored in accordance with the legal regulations without causing negative effects on the environment (human, nature, vegetation, all kinds of living things, soil, water resources, groundwater) has been examined.

Material and Method

Having a total waste storage capacity of 550,000 m3, ADT has an area of 4.5 hectares [4]. The open pit converted into a waste storage facility was examined in the design, and studies were carried out in accordance with the criteria specified in the regulation for the design of ADT by examining the literature data [5]. During the construction of ADT, slope storage area and fence excavations, bonded fillings and preparation of the slope surface, drainage systems, foundation clay filling, laying of coating systems, channel arrangement are carried out. A storage area prior to the ADT excavation is given in Figure 1. After the excavation material is taken from the bottom of the storage area and a solid natural ground is found, the filling process is started. The total filling amount in the project

is 400,000 m³. The screen thickness is applied as 60 cm. A sub-drainage system is designed for the water that will accumulate under the impermeability system during periodic rises in underground and surface water levels. In this system, water is collected at the lowest possible level by means of trench and gravel filters created with perforated drainage pipes (Figure 2). A 2 mm thick rough-edged HDPE geomembrane was then used and the top drainage geocomposite system shown in Figure 3 and Figure 4 was laid.

The Anchor trench shown in Figure 5 acts as an anchor for the paved area.

Figure 1. Before the storage area

Figure 2. Images from the drainage system and landfill cover layer.

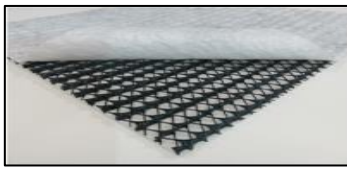


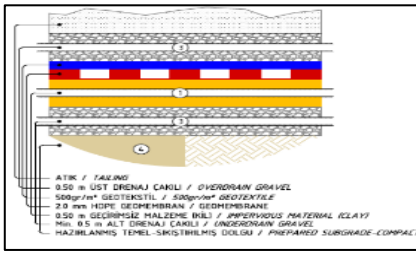
Figure 3. Geocomposite system

Figure 4. Geotextile layer

Figure 5. The anchor trenches

The containment channel was built to protect the ADT from water coming from the mountainside. The excavation of the containment channel was carried out with a slope of 0.5%. The total length of this channel, shown in Figure 6, is approximately 290 m [6]. The coating system (Geosynthetic Clay Cover, Geomembrane, Geocomposite) used on slopes and floors is as shown in Figure 7.

Figure 6. Containment channel



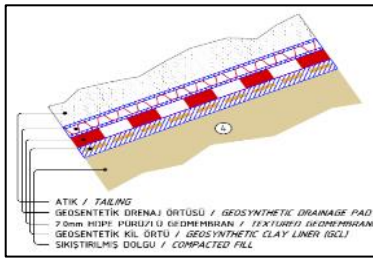


Figure 7. Applied coating materials

Results

In order to ensure floor sealing, the compression value in the technical specification should be 85% in the filling works performed in ADT. Analysis values of 3903.05 grams of filling material are given in Table 1.

Table 1. Sample filling material sieve analysis results

Sieve no (inch)	Openness(mm)	Remain(gr)	Remain (%)	Total Remain(gr)	Total Remain (%)	Total pass (%)
No: 4"	100	155,02	3,97	155,02	3,97	96,03
No: 3"	75,0	444,22	11,38	599,24	15,35	84,65
No: 2.5"	63.5	217,10	5,56	816,34	20,92	79,08
No: 2"	5.0	403,14	10,33	1219,48	31,24	68,76
No: 1 1/2"	38,1	439,76	11,27	1659,24	42,51	57,49
No: 1"	25,40	328,12	8,41	1987,36	50,92	49,08
No:(3/4)"	19,05	209,69	5,37	2197.05	56.29	43,71
No: (3/8)"	9,53	296.14	7,59	2493,19	63,88	36,12
No:4	4,76	226.06	5,79	2719,25	69,67	30,33
No: 10	2.00	256.23	6.56	2975,48	76,23	23,77
No: 40	0,425	293,64	7,52	3269,12	83.76	16,24
No: 140	0,106	477.84	12,24	3746,96	96.00	4,00
No: 200	0,075	42,16	1,08	3789,12	97.08	2,92

The permeability value of the permeable filling material is required to be $1*10^{-4}$ m/s and above. Table 2. shows the permeability laboratory results of sample 1 filling material.

Table 2. Permeability laboratory results of sample 1 filling material

	First value	Last value	Water temp. (°C)	time t (s)	DH (cm)	kt (cm/s)	$m_t\ 10^{-6}$ Nsm	k_{20} $k_1(m_t/m_{20})$	
								cm/s	**m/s**
1	29.00	33.00	20	10	248	$1.68*10^{-02}$	60.0000	$1.00*10^{10}$	$1.00*10^{-02}$
2	33.00	37.00	20	10	251	$1.83*10^{-02}$	60.0000	$1.09*10^{10}$	$1.09*10^{-02}$
3	41.00	45.00	20	10	255	$2.15*10^{-02}$	60.0000	$1.29*10^{10}$	$1.29*10^{-02}$
						$1.89*10^{-02}$	Average	$1.13*10^{10}$	$1.13*10^{-02}$

After all the experiments, the geomembrane thickness used in the project was measured as 2 mm, and its suitability for use was examined, and vacuum and air tests were carried out to measure the durability of the coating materials.

Discussion

During the construction and operation of the mine sites, it is implemented by the regulations to take measures in a way that will cause the least damage to the environment.

It has been observed that all required field and laboratory tests have been carried out in order to prevent any leakage or leakage from the area where the process wastewater is stored in the examined Mastra 3rd ADT.

Conclusion

It has been determined that the values found as a result of all controls are in accordance with the standards. The compression ratio of the filling material used in the project is desired to be 85%, and results above this value were obtained in the compression test results. It is stated in the results that the permeability value obtained in the results of the basic clay analysis is $3.5*10^{-10}$ m/sec. According to the regulation, the permeability of the clayey material to be used on the base should be 9 to 10 m/s at the most. The values obtained in the coating systems used in ADT, the values obtained in the tensile and shear tests, were tested up to 1129 kN in the 543 kN minimum shear test. The minimum limit values of the European Institute of Geosynthetics should be 530-701 kN. With the restructuring of ADT, it is considered as a great ecological benefit as it will ensure that a virgin land is not used and will eliminate many environmental risk sources such as groundwater pollution, air pollution caused by various climatic factors, pollution of surface water resources and agriculture.

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Author contributions:

Volkan Emre Demir: Data curation, Writing-Original draft preparation. **Beyhan Kocadağistan:** Visualization, Investigation, Writing-Reviewing and Editing.

Conflicts of interest:

The authors declare no conflicts of interest.

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