Installation of geosynthetics on an industrial dangerous waste landfill

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ABSTRACT: In 2008, Portugal became practically autonomous in industrial hazardous waste treatment, with the creation of recuperation, valorization and elimination centers of hazardous waste, in Chamusca town. Because of the kind of waste to be deposit in those landfils, it was necessary to apply a rigorous impermeabilization system on the bottom and slopes of the cells, made with several geosynthetic layers, each one with his specific function, and also a leakage detection system wich has the function to detect any possible damage and vanishing point.

1 INTRODUCTION

Every year in Portugal, 300000 tons of industrial hazardous waste are produced by the extractive and transform industry, construction and energy companies. The majority of this waste is composed by non halogenated solvents, oils and other aqueous solutions, industrial moods, organic and inorganic solids and cyanide solvents.

From all the annual production, a very small part of industrial dangerous waste is deposit in landfills, 16000 tons are incinerated in cement factories, mainly those can have energetic profit, and the rest of it, was since a few months ago exported to foreign countries, to be adequately treated.

Since June 2008, this situation has changed, with the creation of two centers of recuperation, valorization and elimination of hazardous waste (CIRVER), in Chamusca town. Now, it is not necessary anymore to export the major part of the industrial hazardous waste produced in Portugal, excluding hospital, radioactive and military hazardous waste whose destiny is still foreign countries.

Notwithstanding the capacity of the two CIRVER, a small part of this waste cannot be treated, due to their characteristics. For that reason it was necessary to create a landfill, impermeabilized through a system of various layers of diferent geosynthetics in bottom and slopes, associated to a leakage detection system.

2 CIRVER LANDFILL

The landfill (Figure 1) is composed of three cells, with an approximated área of 80.000 m^2, with 25.000 m^2 of bottoms and 55.000 m^2 of slopes.

Figure 1. CIRVER Landfill

The impermeabilization system of the CIRVER is identical in the bottom, slopes, and access ramp, except the last layer of geosynthetics wich change according to his function. This being the case, protection of the bottom geomembrane against aggressions from the mineral layer, protection of the slopes geomembrane during the exploration stage, and reinforcement geogrid in all the access ramps to stabilize the ground.

2.1 *Cells bottom*

Seeing that half a meter of argil was applied above the natural field, the first layer of geosynthetics was a 150 gr/m^2 geotextile, wich express function is to protect the first layer of 2.0 mm HDPE geomembrane, corresponding to the second layer (Figure 2).

Figure 2. Bottom detail

Above this first geomembrane, was applied a 200 gr/m^2 conductive geotextile, in the same manner as, respective sensors and cables net, being those covered in all the bottom area with a drainage geosynthetic composed by a HDPE net, wich function is draining any liquid that may appears between the two geomembrane layers.

Then was applied a second layer of 2.0 mm HDPE geomembrane, superiorly protected by a 290 gr/m^2 geotextile, before being finally placed a mineral layer. The impermeabilization system in the cells bottom was composed by six geosynthetics layers, in addition to the sensors network.

2.2 *Cells slopes*

On the slopes, were applied seven geosynthetics layers, being the configuration of the impermeabilization system identical to the bottom, and the first five layers on slopes equal to the first five on the bottom.

Then was first applied a 150 gr/m^2 geotextile, followed by the first 2.0 HDPE geomembrane superiorly covered by a 200 gr/m^2 conductive geotextile, cables and sensors network. Over this network was applied an HDPE net, and ultimately the second layer of 2.0 mm HDPE geomembrane.

This second geomembrane was then over protected with a drainage geosynthetic constituted by an HDPE net identical to the fourth layer, but this one attached superiorly to a 300 gr/m^2 geotextile, in order to drain liquid between the mass of waste and the HDPE geomembrane.

Finally, it was applied a 300 gr/m^2 black geotextile resistant to ultraviolet radiation, in order to protect and preserve the integrity of geosynthetics drainage that will be exposed to the sun during the time of operating the landfill (Figure 3).

Figure 3. Slopes protected by UV resistant geotextile

3 LEAKAGE DETECTION SYSTEM

Monitoring the integrity of impermeabilization system is a key aspect in the safety of an industrial dangerous waste landfill. That is the reason why has been installed a leakage detection system.

It is characterized by several factors, including the durability of various components, which are identical to the geomembrane durability and their welds, since both the coating of sensors and cables are in HDPE.

The leak detection system is located so that, even with the loss of some sensors, can operate at its full capacity, maintaining its performance. Typically, any damage is detected in geomembrane by several sensors, to in case of failure of any of them, the leakage will be detected by another sensor nearby, allowing to find any damage, even with size less than 5 mm.

The working principle of a leakage detection system is based on measuring the difference of potential. As the electric power passes with the humidity through the possible escape, it is a fundamental condition for the proper performance of the system the presence of moisture, either above or below the geomembrane, to have a good distribution of the current on the site in question. Thence the reason why it was necessary to apply a conductive geotextile, precisely to replace the humidity that supposedly should not exist between the two geomembrane layers.

The leakage detection system was applied in both the bottom and in the slopes. With the application of a conductive geotextile, the sensors were placed on top of geotextile and completely covered with a small strip of the same material in order to become fully involved by it.

The necessity to apply a conductive geotextile becomes from the fact that the system include two layers of geomembrane, and the main objective is to detect any damage on the second layer. That is the reason why the geotextile is applied between the two layers of HDPE geomembrane. In this case, since the landfill is divided into three large cells, several boxes (Figure 4) were installed to control, more specifically 7 units in the way of access around the site, cell 1 served by two checkboxes, cell 2 served by 1 checkbox, and cell 3 as well the largest of all, is linked to four checkboxes.

Figure 4. Leakage detection system checkbox

3.1 *Common operation mode*

Under the second layer of geomembrane where any leakage might occur, was placed a network of sensors, with each one connected to a control checkbox.

To generate a homogeneous electric field, a source of electricity is generated upper to the geomembrane, being induced by the control box. The sensors network then detect any leakage in the impermeabilization system, through a passage of current between the top side and the low side of the geomembrane (conductive geotextile).

If there is a hole in the geomembrane, the electrical load will increase from top to bottom, showing the two neighboring sensors, a large increase in the difference of potential, wich will pinpoint the fault in the geomembrane after the measurement of various differences of potential levels.

With this method of leakage detection, it is possible to locate holes with a diameter less than 5 mm, and with a precision corresponding to a value from 5% to 15% of spacing between two sensors, wich varies from 0,5m to 1,0m.

It is important to note that the leakage detection have an automatic alarm system, visible on the control panel (Figure 5) by any person, but it is not possible to locate immediately the fault in the geomembrane, appearing only one indicator light for alarm, that warns of a possible leakage. To locate the leak in the cell, it is necessary to use special software with a layout of the place in question, where all the sensors are deployed. Through analysis of the sensors network, the software will provide us with 2D and 3D, the exact location of the hole.

Figure 5. Control panel of the automatic alarm system

3.2 *Case study*

A case study of a leak detected in cell 1 is now demonstrated, with the leakage detection system described above.

Here, we can verify on 2D (Figure 6) and 3D (Figure 7), the detection of a difference in electrical potential recorded by the system through sensors, which clearly shows the presence of some kind of damage in the geomembrane.

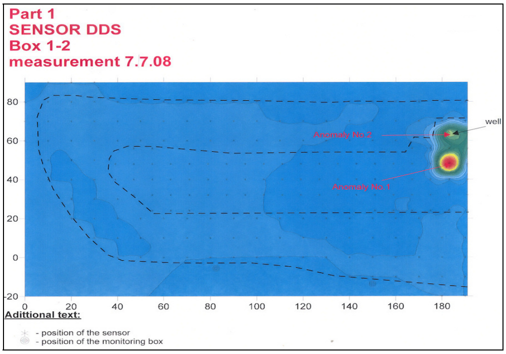

Figure 6. Anomaly location in 2D

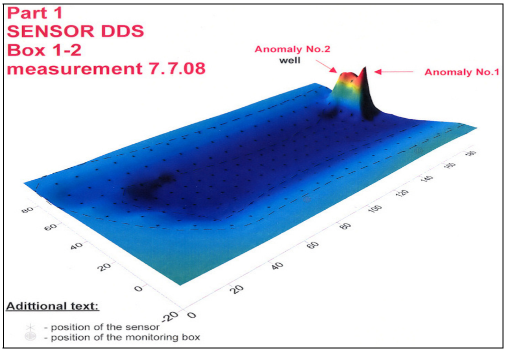

Figure 7. Anomaly location in 3D

Later, during the cleaning of the indicated place, the damage was identify, a rip in geomembrane with about 20 cm diameter, caused by the wheels of a truck, probably during the operation of placing the final mineral layer (Figure 8).

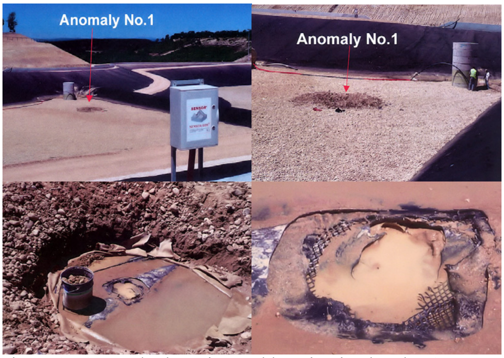

Figure 8. Anomaly detection and location in alveolus 1

After the exact location of the anomaly, the mineral, geosynthetic drainage and geomembrane protection layers were removed, and the repair was made using a HDPE patch and extrusion welding (Figure 9).


Figure 9. Damage repair

4 CONCLUSION

It is easy to find in the market, geosynthetics with several technical features necessary for any function of impermeabilization, sealing, or geotechnical solutions (drainage, reinforcement, etc.) that is required of waste landfills.

After this project in the area of hazardous industrial waste, the techniques currently used in the implementation and installation of geosynthetics in landfill waste are shown, always highlighting the most important rule of quality control of materials and installation, to get the system reliable and safe for the environment and minimize the impact generated by production of waste.

It is also evident, and after the monitoring of these works, the extreme need for awareness of industry, construction and energy, in the chapter of hazardous waste production, in order to minimize its impact on the environment through the possible reduction, reuse and recycling of waste that is produced in Portugal, as well as authorities, planners and contractors for technical and economic advantages of the installation of geosynthetics in all areas of engineering.

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