A CASE STUDY OF DESIGN, INSTALLATION AND LEAKAGE DETECTION SYSTEM OF A GEOMEMBRANE LINER

M.G.A.D. LOPES*, M.C.P. BARROSO*, M.L.C. LOPES** AND J. PINHEIRO°

**Laboratório Nacional de Engenharia Civil (LNEC), Lisbon, Portugal*
***Faculdade de Engenharia da Universidade do Porto, Porto, Portugal*
°Geotelas, Lisbon, Portugal

SUMMARY: A monolandfill (ash pond) for the ashes generated in the Sines thermoelectric power plant has been con-structed, which has a geomembrane lining at its bottom to avoid impacts on the local groundwater. In order to verify the integrity of the geomembrane before the beginning of the ash disposal, a leakage detection system was installed. The paper describes the technical aspects related with the design and installation of the geomembrane liner, and presents the damage detection system used.

1. INTRODUCTION

The Sines thermoelectric power plant is located in the South of Portugal, on the Atlantic coast of the Baixo Alentejo province. The ashes produced contain hazardous components, such as heavy metals, that by leaching, may cause water resource contamination. Since the subgrade features of the constructed pond do not guarantee an efficient containment, a geomembrane lining system was also installed.

A critical aspect in the construction of the pond was the quality control of the lining system's integrity. It was necessary to ensure that any damage produced in the geomembrane would be re-paired before placing the sand cover.

2. GENERAL DESCRIPTION OF THE ASH POND

2.1 General

The ash pond will be constructed in sections and, until now, only the first cell has been finished. The excavated cell has an area of approximately 10 000 m^2, with the side slopes dipping 33^o, in agreement with the friction angle of the soil material. The ash pond is delimited by a peripheral concrete drainage ditch.

The construction of the cell started with the regularization and compaction of the bottom layer, with a final longitudinal slope of 2%. To avoid the accumulation of leachate, the bottom area was arranged into four parallel sloped longitudinal terraces, as shown in figure 1. The leachate that accumulates on the surface of the terraces will drain to one of the two leachate collection channels, as the cross slope of the terraces is also 2%.

2.2. Installation of the geomembrane

The liner system of the constructed cell incorporated two types of high density polyethylene geomembranes (HDPE), both 1mm thick. A smooth one was employed as bottom seal, and unfolded over a 20 cm compacted sand layer. The side slope seal required a textured geomembrane, to assure that no slippage would occur.

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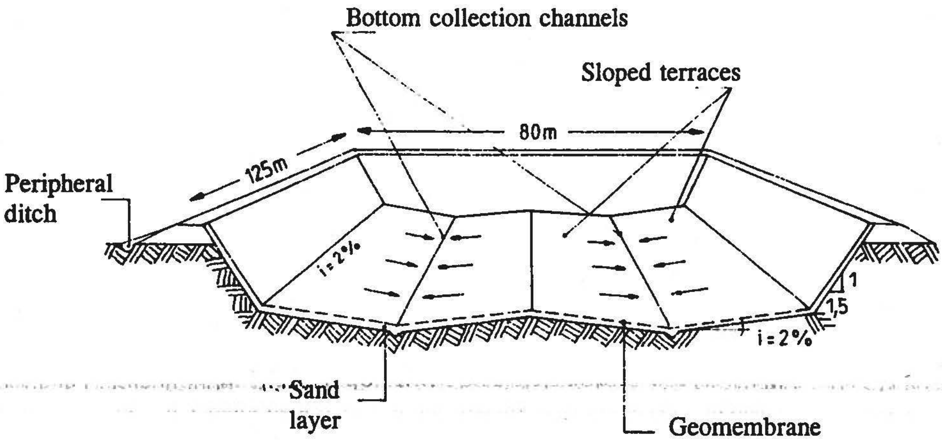


Figure 1. General view of a cell

The geomembranes were predominantly welded with a double hot wedge, except for special points where, due to any occurring defect, the use of the extrusion technique became necessary (figure 2).

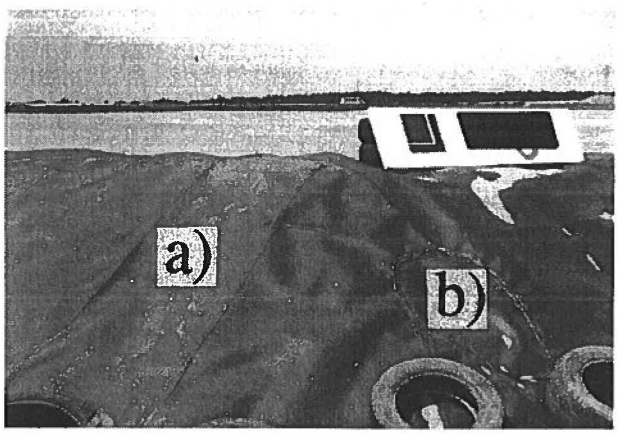


Figure 2. Geomembrane welding system: a) double hot wedge; b) extrusion

The terminal joint (geomembrane-concrete drainage ditch) was made with a high density polyethylene profile, which, on one side, was fitted into the drainage ditch and, on the other, welded to the geomembrane by extrusion. This technique offers an excellent resistance and ensures the imperviousness of the joint (figure 3).

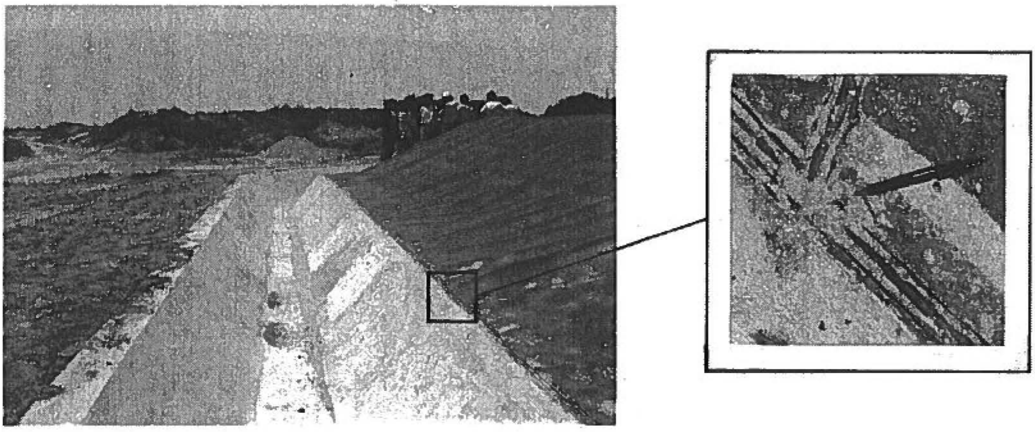


Figure 3. Geomembrane-concrete drainage ditch connection

2.3 Drainage System

The drainage system comprises the peripheral ditch, to divert the surface water runoff, and two bottom collection channels (figure 4).

Each bottom collection channel with a cross section of about 2,7m^2, has at its bottom a sand layer and a geomembrane. The drainage element is constituted by a perforated pipe, with a diameter of 300 mm, which is surrounded by gravel, the whole being wrapped up in a geotextile. The bottom collection channels convey the leachates to a location from which they are removed for treatment, the length of these channels being approximately 120m.

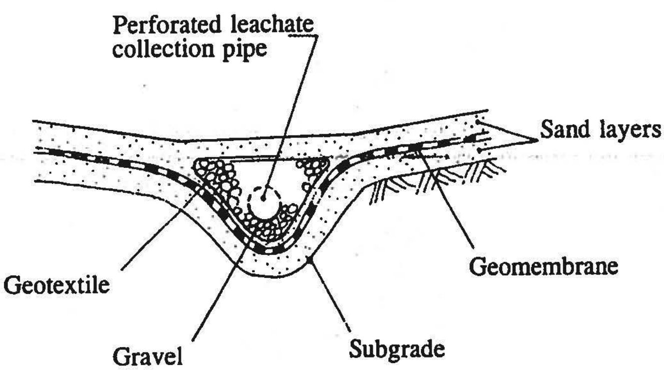


Figure 4. Bottom drainage system

3. GEOMEMBRANE QUALITY CONTROL

3.1 Quality control plan

When designing a liner, special care must be given to the geomembrane, since it is expected that they form a real barrier between the leachate and the subgrade. However, the imperviousness of the pond depends not so much on the intrinsic quality of the geomembrane, but, to a large extent, on the quality of its installation.

The implemented quality control plan foresaw several steps. It began with a visual inspection of the cell bottom layer, made before putting the geomembrane in place. The main goal was to check the existence of roots, angular stones, or any other object that may cause holes in the geomembrane.

A second visual inspection was made after the installation of the geomembrane in order to assure that no damage has occurred during the transportation or due to the installation procedure.

The joints correspond to the zones where a potential leachate leakage has the highest probability to occur. Because of that, a strict control was made along this zones. A non destructive air pressure test was used for the hot wedge welded joints. Where the air pressure test was not applicable (extrusion joints), a vacuum chamber test evaluated if any leak was present.

Independently of the methodology adopted, every defect found was numbered, registered its location, and the kind of problem described. Later on, still before beginning with the ash disposal, all identified defects were repaired, and new tests made.

To prove the quality of the weldings, on site destructive peel tests were done too. In these tests the overlapped edge of the bottom sheet is pulled from the top sheet, in order to verify if separation occurs.

No matter how careful manufacture and quality control of the geomembranes are, the possibility of damage during the shipment and/or installation is always possible. Such damage can result in the leakage of dangerous substances, and contamination of groundwater resources. Thus, with the purpose of detecting any damage occurred, not only in the installation phase, but during the first five years of the pond operation, an electrical monitoring and control system was further placed at the pond bottom.

3.2 - Leakage detection system

The electrical detection system consists in a network of sensors (figure 5), placed under the geomembrane. All sensors are connected with the central unit (figure 6), via cables, which are also installed under the geomembrane. An electrical source is applied above the liner, and the sensors measure the electrical field generated by this source (figure 7). An interpretative software analyses the data from the central unit, producing an equipotential diagram, any abnormality showing up as peaks on a contour line display.

In the present case, the sensors were distributed according to a 10 x 10 m^2 grid, the co--ordinate system having its origin at the central unit.

After completion of the installation of the geomembrane and the protective layer (20 cm sand), an electrical current was applied. The sensors beneath the geomembrane measured the potential coming from the source. The current density of the field depends on the integrity of the geomembrane. The measured data were treated by the software, and a three-dimensional map was draw (figure 8). The analysis of the results gave a precise information on the position of the damages present in geomembrane.

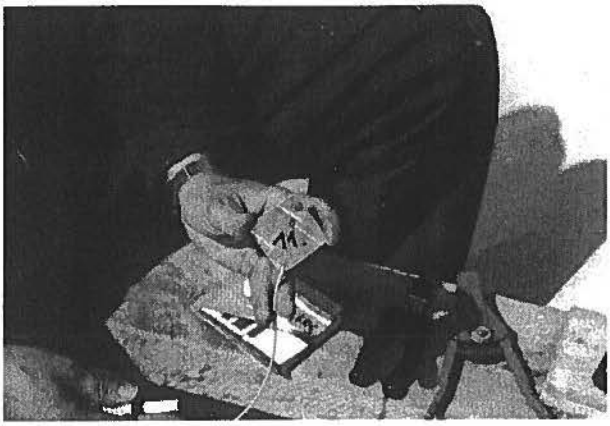


Figure 5. Sensor

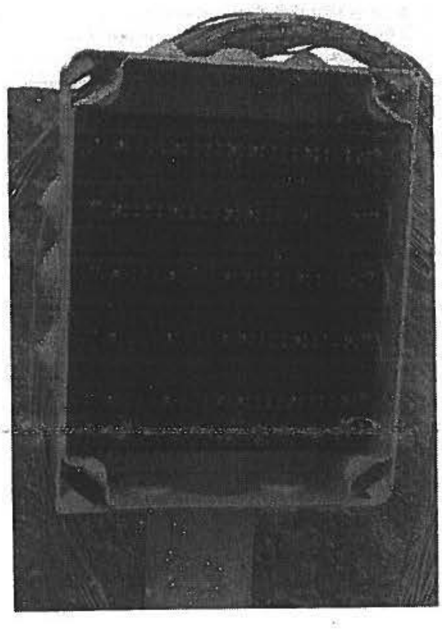


Figure 6. Central unit

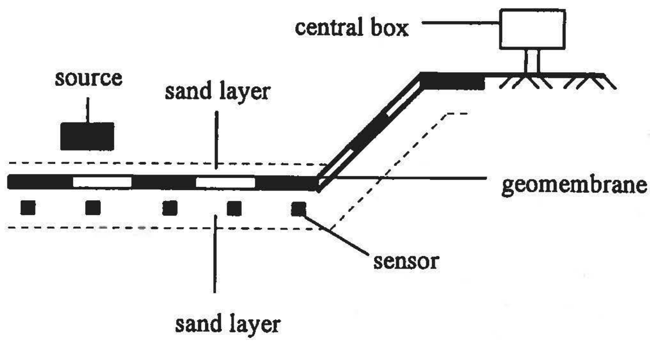
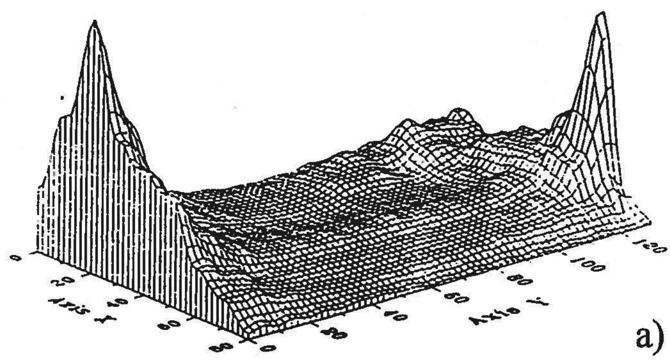


Figure 7. Damage detection system



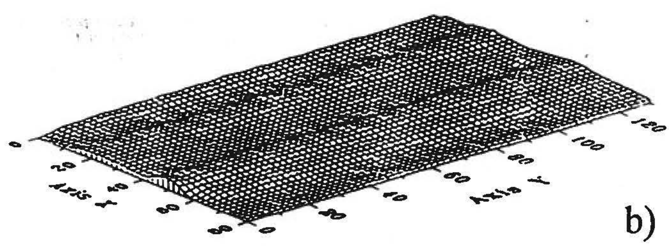


Figure 8. Three-dimensional current density diagram: a) before repair; b) after repair

As show in figure 8a, two very strong anomalies located respectively, at the points x=17 m, y=1,3 m, and x=56 m, y= 128 m showed up. These anomalies screen smaller ones, as the one show as example in figure 9, that may be hidden by their big effect.

After completion of the repairs, the site was resurveyed, to insure that there were no more damaged areas. This procedure was followed until the total integrity of the geomembrane was confirmed (figure 8b).

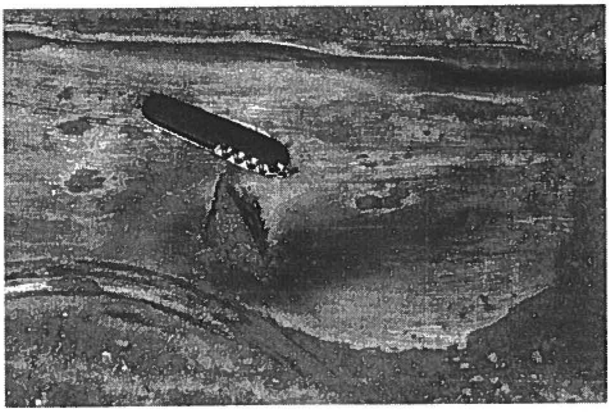


Figure 9. Example of geomembrane damage

4. FINAL REMARKS

The conditions under which this ash pond was constructed lead, to the following remarks:

- A system which is able to localise possible defects in the geomembranes is very important, because it allows the repair of any possible damage before the beginning of the refuse disposal.
- Although the worst phase, in what concerns the possibility of a geomembrane damage, is during its installation and in the beginning of the disposal, a monitoring system covering a long term is recommended, in order to guarantee that the groundwater resources are still protected.

5. BIBLIOGRAPHY

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