Geosynthetics Conference
Feb. 10-13, 2019 | Houston, TX USA

Applications of Leak Location Surveys in the Mining Industry

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ABSTRACT

This paper intends to present the results of Leak Location Survey applications to detect leaks in installed geomembranes for quality control of tailings dams in the Mining Industry. This research consolidates the results obtained in field inspections carried out in 22 (twenty-two) different mining industry projects in Mexico, Nevada and Michigan between 2015 and 2017. The application of the Soil Survey methodology enabled the evaluation of 298,500 m^2 of installed HDPE geomembranes and immediate repair of the identified damages. Due to its benefits in greatly improving the quality control of the waterproofing layer, it is suggested that this technique be used to minimize the environmental risks inherent to operation of tailing dams in the mining Industry.

INTRODUCTION

Since the 1970s, the use of geomembranes has become significant in the mining industry, according to Breitenbach and Smith (2006), having applications in lining solutions, evaporation ponds, tailings impoundments and heap leach pads. Such materials have been employed to minimize losses of high value metals, such as gold and copper for example, and also to reduce the leaching potential of contaminants into the soil.

In order to guarantee the functionality of the geomembranes used, their installation in conjunction with methods of material quality control is necessary and already widely used in the mining industry. However, the conventional methods employed do not allow the evaluation of 100% of the installed geomembrane, being unable to identify some types of installation damage.

Geoelectrical methods were developed in the United States in the 1980s, according to Beck et al. (2018), and have been commercially employed since 1985, but on a larger scale in the waste management industry. These methods, already established through ASTM standards, allow the ability to identify extremely small damages in 100% of the installed geomembranes, guaranteeing the integrity of the protection layer before the beginning of its use.

Results of studies developed by Thiel et al. (2005) indicated that, due to the high values associated with metals and reagents in leach solution, the use of geoelectric methods makes strict economic sense, not to mention the minimization of environmental risks for the mining industry. Despite that, the mining industry has been employing this technique in a progressive way, being the first applications in the City of Nevada in 1995, where placement of the overliner system was believed to have damaged the geomembrane. Currently, this technique has been most commonly employed in the United States, Chile, Peru and Argentina.

According to Forget et al. (2005), in 89 projects tested by using Leak Location methods during a 10-year period (2,652,000 m^2 of area), between 4 and 22 leaks per hectare were found, on average. This variation of leaks depended on the level of quality control used during the geomembrane installation. Seventy three percent of the damages occurred during the application of overlying earth material on the geomembrane, twenty-four percent occurred during the installation of the geomembrane and only two percent of the damages occurred after starting the use of the waterproofing layer. Contrary to common perception, the majority of damages did not occur due to inadequate weld procedures, so the testing regime should be expanded.

ASTM D7007 (Standard Practices for electrical methods for locating leaks in geomembranes covered with water or earthen materials) (ASTM, 2016), establishes adequate methodology to the quality control of geomembrane integrity after the placement of overlying material, the Dipole Methods: Soil Survey and Water Survey. This particular methodology uses an electrical method to inspect geomembranes covered with soil or water, for example. This method consists of applying a voltage across the plastic material to search for any electrical current leaks. Via this method it is possible to locate the damages and fix them before the deposition of waste (Laine et al, 1993). The electrical methods to locate leaks in geomembranes have been practiced worldwide for many years (Laine and Darilek, 1993). Application of these methods has been a mandatory requirement for sanitary landfills in, at least, 4 states in the United States of America such, for example, New Jersey, New York, California (GSI, 2016).

That being said, this study will present the results of three years of Electrical Leak Location application to evaluate the integrity of the waterproofing layer in tailings dams in the Mining Industry. The specific Electrical Leak Location used in this study was the Dipole Method, according to ASTM D7007, that is called herein as “Soil Survey”.

METHODOLOGY

All Soil Survey studies presented here were conducted in the states of Nevada and Michigan as well as the country of Mexico, according to the percentage distribution shown in Figure 1. As can be seen, most of the data presented originated from the Mining Industry located in Nevada (64% of the projects) and about a third of the studies were obtained in Mexico (32% of the projects). Only one project was developed in the state of Michigan (4% of the projects).

Most of the areas investigated, that is, 82% of the projects have a double layer of HDPE geomembrane to protect the soil. Only 18% of the evaluated projects had only one layer of geomembrane. The thickness of the geomembranes installed in the studied projects varied between 1.5 and 2 mm.

This paper evaluated the results of application of Soil Survey method for the primary and/or secondary geomembrane layer, which was covered by earth material (such as sand, clay or similar), and with a leak barrier layer that could have contact with the tailing material. The total area surveyed, including all the projects, was approximately 300 hectares.

The electrical leak location method consists of applying a voltage across the geomembrane liner. This voltage produced a relatively uniform potential voltage distribution when no leaks are present. If the geomembrane has a leak, current flowing through it produces an anomaly in the measured electrical field. Thereby the leaks can be detected and located. These anomalies in the electrical field are detected by making systematic measurements over the geomembrane area. Figure 1 is a diagram illustrating the method.

During the inspection, a power supply connected to two electrodes is used (source and return electrodes). The source electrode is placed in the soil on the geomembrane and the return electrode is placed in the soil under the geomembrane in the leak location zone. The power source will generate an electrical field in the covering soil. If the liner has a leak, electrical current will flow through the leak to the return electrode, causing a localized abnormality in the potential gradient. That principle is shown on Figure 1.

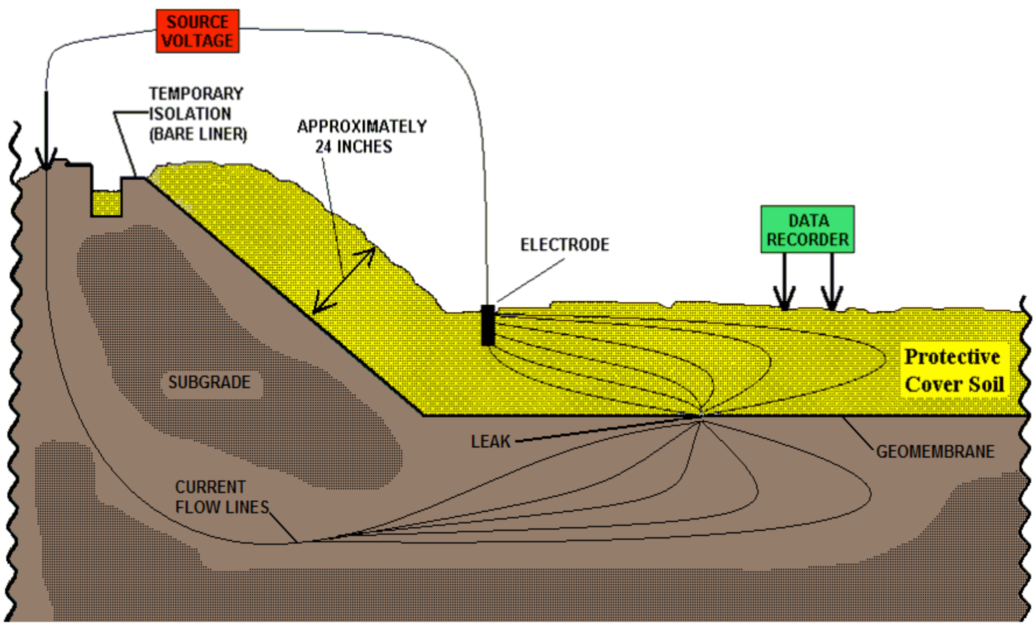

Figure 1. Diagram illustrating Soil Survey methodology (from Leak Location Service, Inc.).

Soil Survey measurements are made using a pre-defined grid, which determines the measurement points on the inspected area. The grid used was 3 by 3 meters and measurements were done every 1.5 meters. The data was collected using a portable data logger, presented in Figure 2, and downloaded using software responsible for processing the information enabling data analysis for the damage locations.

Figure 2: Technicians collecting field measurements.

DISCUSSION AND RESULTS

Figure 3 shows the density of leaks in the different projects. As can be seen, ten of the twenty-two projects (or 45% of total inspected areas) had density of leaks ranging from 0 to 5 leaks per hectare (10,000 m^2). From this, four projects had zero leaks in the inspection. One inspected area presented a density of 7 leaks/hectare. The other 45% of the projects presented densities ranging from 11 to 30 leaks, with half of this group identified as having 11 to 20 damages and the other half with 21 to 30 damages. Just one inspected area contained more than 31 leaks/hectare.

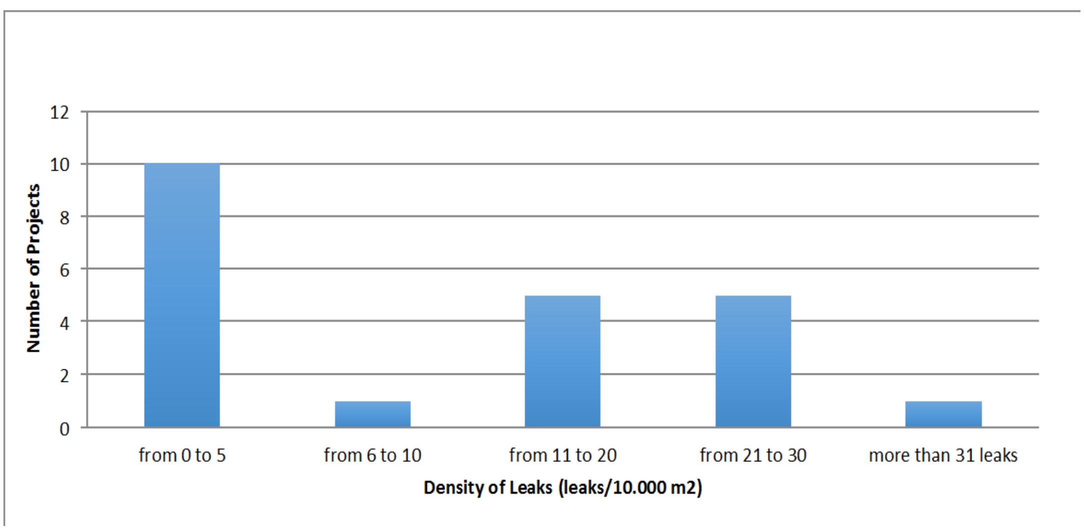

Figure 3: Density of leaks that were found in the twenty-two inspected areas.

Considering 95.5% of the studied projects, it is possible to observe that the average density was decreasing year by year since 2015, according to Figure 4. This other 4.5% represents just one project, evaluated in 2017, which had 41 leaks/10,000m^2. This project presented an unusual result of density of leaks.

Additionally, considering 100% of the projects, it is possible to observe the same reduction in the density of leaks from Figure 4. The difference is that the observed reduction between 2016 and 2017 will be lower when compared to Figure 4.

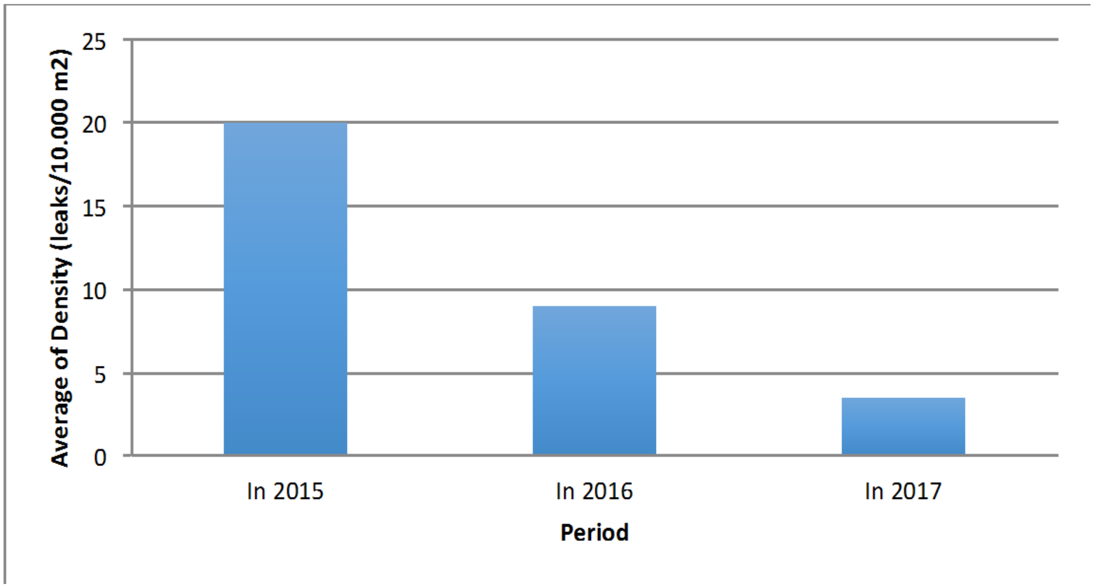

Figure 4. Average density of leaks within the period of this study.

Figures 5 and 6 show pictures of typical damages found by Leak Location Soil Surveys. Figure 6 shows a rock puncture damage like the one found in the Mexico project with a density of more than 31 leaks/hectare. Figure 5 shows a cut damage, like the one found in another Mexico Project in 2017.

Figure 5. Cut damage.

Figure 6. Rock Puncture damage.

CONCLUSION

As seen throughout this article, Geomembrane Construction Quality Control using Leak Location Soil Surveys proved to be efficient in identifying geomembrane leaks and damages caused by the geomembrane installation and covering. The use of this method could help reduce pronounced economic and environmental consequences associated to leaching of metals to the soil. It means that if that size of leak was found and repaired, the installer will save significant amounts of money because it will avoid having to remediate and clean up the damage caused by such a leak in the future.

Therefore, all the results found in this study attest that the mining industries aforementioned could have repaired about 220 leaks in a total of 300 hectares of inspected area.

Besides that, the reduction of damages in the geomembrane, due to incorrect procedures, could have been diminished with time.

Thus, the results of the Leak Location Soil Survey show that geomembrane leaks are a real threat to liner installations in the mining industry. Consequently, this testing technique should be adopted in other projects in the mining industry as an additional tool in the quality control program for geomembrane installations.

This technique, already practiced in Nevada, Mexico and Michigan, represents an improvement for geomembrane installation quality control and should be replicated not only in other States in the U.S., but all over the world as well.

REFERENCES

ASTM D 7007. Standard Practice for Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earth Materials, *American Society for Testing and Materials*, West Conshohocken, Pennsylvania, USA.

ASTM International D 6747. Standard Guide for Selection of Techniques for Electrical Leak Location of Leaks in Geomembranes, *American Society for Testing and Materials*, West Conshohocken, Pennsylvania, USA.

Beck A., Smith M. and Colmanetti J. (2018). *Métodos Geoelétricos Empregados na Minimização de Perdas de Solução em Pilhas de Lixiviação de Minério*, https://www.researchgate.net/publication/238100562.

Breitenbach A. and Smith M., (2006). Overview of geomembrane history in the mining Industry. *Proceedings 8th International Conference on Geosynthetics*. Yokohama, Japan.

Forget B, Rollin L., Jacquelin T. (2005). Lessons Learned from 10 Years of Leak Detection Surveys on Geomembranes. Proceedings Sardinia, Sardinia.

Koerner, R.M., Koerner, J.M. and Koerner, G.R. (2016). *Status of the Electrical Leak Location Survey (ELLS) Method Among State Environmental Protection Agencies in the USA*. Folsom, Pennsylvania, USA.

Laine, D. and Darilek, G. (1993). Locating Leaks in Geomembrane Liners of Landfills Covered with a Protective Soil, *Geosynthetics' 93*. Vancouver, Canada: 1403-1412.

Thiel R., Darilek, G. and Laine, D. (2003). Cutting Holes for testing vs. testing for holes. *GFR Magazine*. June/July: 20-23.

Thiel R., Beck A. and Smith M. (2005). The Value of Geoelectric Leak Detection Services For The Mining Industry. *Geo-Frontier Congress 2005.* Austin, Texas, USA: 24-26.