

GEOLOGGER – A new type of monitoring system for the total area monitoring of seals on landfill sites

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ABSTRACT: The discussion about security of landfill sites in the past was a question of confidence in the sealing systems. The modern combination sealing system is the result of extensive scientific experiments. Nevertheless, the behaviour of landfill site seals under real life conditions is very little known. Facing the enormous environmental consequences of undetected leakages an intelligent and continuous monitoring of landfill seals has to be required.

1. Reasons and requirements for the monitoring of landfill seals

Monitoring improve the safety of the sealing system, especially in the critical phases during the construction and during the depositing of the first layer of waste. During these phases they can be uncovered and repaired at reasonable costs. The components of the sealing systems can be tested under objectiv operational conditions. Domestic water regulations exclude any danger to the ground water, therefore it is expected that in the close future monitoring systems will be mandatory for landfill sites. The environmental liability regulations provide for a change the burden of proof. A monitoring system enable the operator of the landfill site to demonstrate that the site sealing system is not the cause of the problem. All these reasons increase the acceptance of the site and reduce fears in the local population.

The life span of a monitoring system must be at least as long as that of the seals, in sites well over 100 years. It should base on a clear, unambiguous measuring principle and should not negatively influence the construction or functioning of the seal. The system must be able to continue in operation if one of the individual components fails. Direct monitoring of the seal is fundamentally preferable in that it detects problems with the seal before pollution arises. Monitoring systems must possess the possibility to regularly test their own functions to prevent false alarms and to make shure that a failure in the seal will never keep undetected.

2. The GEOLOGGER leak detection and location system

GEOLOGGER is a measuring system for continual monitoring, detection and location of leaks in the geomembrane seals in waste disposal sites. GEOLOGGER uses the differences in conductivity between the electrodes, the mineral seals, the geomembrane, as well as the protection and drainage layers, to detect and locate any damage to the seal. One set of special electrodes are laid under the sealing membrane in parallel lines with a separation of circa 5m between each one and a second set are laid at right angles to this above the membrane. The electrodes are electrically coupled with their environment over their entire length. When a voltage is put across the two electrodes the arrangement works like two plate. electrodes separated by an insulating sheet -in this case the geomembrane (GM). Diagram 1 shows a schematic of the system.

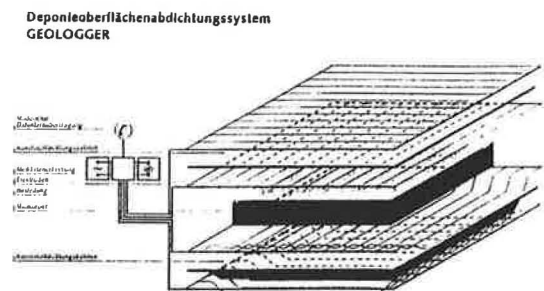


Diagram 1: GEOLOGGER schematic

When the GM is intact the value of the current in this circuit is governed by conductivity of the earth in the area around the edge of the GM. If the GM is damaged the resistance measured between the nearest electrodes in that area goes down to nearly zero. The location of the electrodes is known and so the cross-over points for each combination of upper and lower electrodes can be calculated.

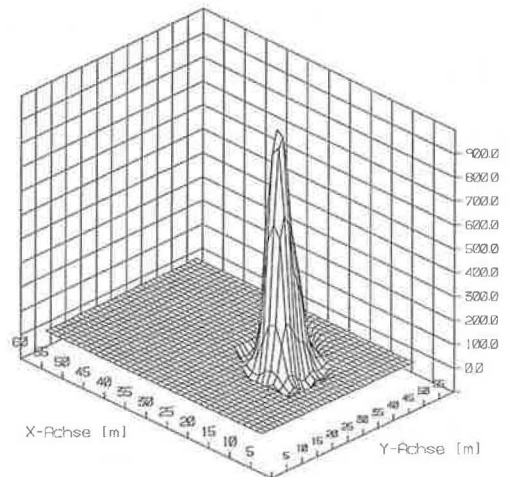
GEOLOGGER works with special corrosion resistant electrodes that are based on non-metallic conductors in the form of flat bands. In the case of settlement they are stretchable more than 25%. The electrodes are connected to the monitoring equipment by HDPE insulated flat bus connectors. To ensure that the measuring equipment can be practically installed under construction site conditions GEOLOGGER uses a special connection technique.

The measuring system consists of a signal source, a computer controlled switching and data recording system based on PROGEO Software. The following measuring algorithms can be automatically carried out at any chosen time: comparative-, absolute-, parallel resistance-, through resistance-, electrode connection- and signal voltage measurement. GEOLOGGER is fitted with a modem for sending the data or an alarm signal to authorized telephone connections.

GEOLOGGER is installed during the laying of the geomembrane and checked in situ. The lower electrodes are pressed into the mineral sealing layer with a special device in order to avoid the displacing when laying the GM. To ensure perfect functioning and a long service life of the system there is a strict quality control on all phases of the production process right from the manufacturing of individual components to installing the functioning system.

3. Experiences under real life conditions

As part of the development process a 1 m² scale model in the laboratory and then a 100 m² trial area were build and tested, followed by test areas in Essen, Lemförde (2.500m²), Boeldershoek (3.000m² (NL)) and de Vlagheide (5.000m² (NL)). No corrosion or significantly electrically or mechanically changes of the electrodes, the connectors or the bus connectors, and no adversely affection of the seals by the build in monitoring sytem could be proved. At the test area Lemförde the function of GEOLOGGER was demonstrated to official representants from the government department for materials research, the Bavarian water department, the environmental protection department and the Bavarian administration. An independant representant made a small 8mm



PROGEO Testfeld Lemförde

Differenzmessung vor/nach Leakage Hr. Klopper
Messdaten nach math. Auswertung

Diagram 2: location after mathematical analysis

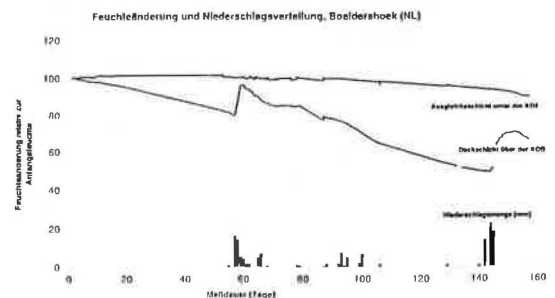


Diagram 3: moisture variation and fall events in relation to the time of observation

leakage. The results of the mathematical analysis give a distribution of values as shown in diagram 2.

Another interesting result is the significant correlation between the fall events and the moisture in the cover layer measured by the upper electrodes in the test area Boeldershoek (NL). The changing moisture content is detected by a varied value of through resistance. The parallel resistance measuring between neighbouring electrodes can be used as well. The coherences are shown in diagram 3.

The upper layer of the test area was divided into 3 sections, each with a different proportion between sandy ground and compost. The increasing moisture content effected sinking resistances with significant differences between the sections. Summarized it can be established, that GEOLOGGER is very good suited for leak detection and -localization, not only in the landfill site context. Especially the results of the moisture variation monitoring set up a rather big range of new applications.