

# Sandfilled Geosynthetics for the Protection of Landfill Liners

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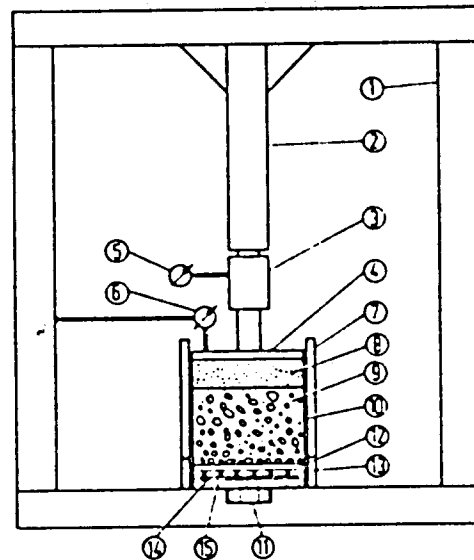
**ABSTRACT:** Landfill design regulations in Germany require a proven protection of the geomembrane by an effective protection system. Systems are tested in a standardized test. Systems, which match the requirements, contain polymeric and mineral components. One system, made of a spacer fabric, filled with sand, is shown in development, test results, production and application.

## 1 INTRODUCTION

As the 2.5 mm HDPE base lining geomembrane (according to German landfill regulations) shall have a high durability, mechanical stress must be limited. From the design the liner is free of tensile stresses, longtime settlement may lead to deformations. These deformations may not exceed 3 % linear strain (according to guidelines of Bundesanstalt für Materialforschung und -prüfung -BAM-). During construction and landfill operation local deformations by drainage material must not exceed 0.25 % (value given by BAM). This local deformation limit requires intensive protection.

### 1.1 Standard test for protection layers in landfills

Between some material-testing institutions a round robin test was made, which showed a realistic behaviour of the lining and protection system. Test device is given in figure 1 from (Arbeitskreis "Geotechnik der Deponien und Altlasten").



- |                           |                               |
|---------------------------|-------------------------------|
| 1 testing rig             | 9 drainage material           |
| 2 compression rod         | 10 vertical slippage film     |
| 3 hydraulic jack          | 11 pressure measurement       |
| 4 compression plate       | 12 geotextil protection layer |
| 5 load cell               | 13 polymer liner              |
| 6 deformation measurement | 14 soft metal sheet           |
| 7 test container          | 15 elastomeric pad            |
| 8 sand compensation layer |                               |

Figure 1

The applied load is 1000 kPa (i.e. 60 m waste height), temperature 40 °C, duration 1000 h. To accelerate the tests load may be increased by 50 %. The soft metal sheet (60 % Pb 90 % Zu) beyond the polymer liner is the deformation memory, where deformations can be measured after unloading.

## 2 PROTECTION EFFICIENCY OF POLYMERIC OR MINERAL LAYERS

Figure 2 gives some deformed metal sheets under non-woven protection layers (mass per unit area and load are given).

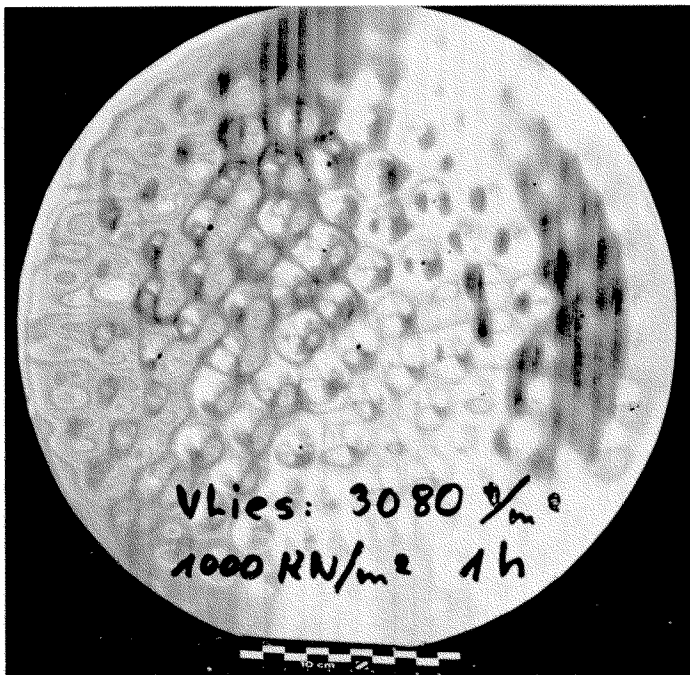
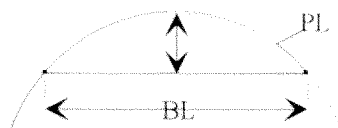


Figure 2

Up to 3000 g/m<sup>2</sup> needle punched non-wovens were tested and showed decreasing deformations with increasing mass per unit area, but the local deformation stayed greater than 0.25 %. Local deformation is calculated as peripheral length of a buckle related to base length

$$\varepsilon = \frac{PL - BL}{BL} \cdot 100$$



Parallel to the tests with different mass per unit area of non-wovens, the efficiency of mineral layers of different kind, grain size and layer thickness placed between thin PP-tape fabric was tested. Layers of common riversand (quartzitic, rounded, continuously graded between 0 and 4 mm) showed no deformation at a thickness of 15 mm (variation 10, 15, 20, 25 mm) sand loaded by 22 mm glass spheres with up to 1500 kPa. As there is no creep in the minerals, the duration of tests can be reduced. One state guideline requires a protection system of 1200 g/m<sup>2</sup> non-woven plus 15 cm of crushed stone graded between 0 und 8 mm.

## 3 DEVELOPMENT OF MINERAL FILLED PROTECTION SYSTEMS

As mineral layers with thickness of about 3 cm cannot be placed with mechanized tools and without risk of damage or perforation of the liner the development of mineral protection systems grew in 3 branches:

- 1) small elements of spacer fabric filled in place [Mineral landfill liner protection mat (MDDS®), Gebrüder Friedrich]
- 2) large elements of spacer fabric filled in place [Incomat®, Huesker Synthetic]
- 3) large elements of 3-dimensional mats filled in place [Depomat®, Naue Fasertechnik]

No	sizes m	thickness mm	fill material	mass per unit area kg/m <sup>2</sup>
1)	1.0 x 1.5	2 x 15	sand 0/2	2 x 25
2)	2.0 x 5.0*	50 - 150*	sand 0/8*	70 - 200
3)	2,0 x 30*	30	sand 0,5/1,5	>48

\* customer-specific

Table 1

## 4 REQUIREMENTS BY PROVING AUTHORITIES

### 4.1 Resistance of geotextile envelope against chemical attack

The HDPE-tape spacer fabric, made by Amoco, Gronau, D, is coated with a thin LDPE-film to prevent fine particles from getting lost. The uncoated fabric has to prove its resistance against a collection of high concentration liquids (table 2). A deviation of 25 % of the reference values (strength end deformation) is accepted.

40 Vol.-% Trimethylpentan 30 Vol.-% Methylbenzol (Toluol) 20 Vol.-% Dimethylbenzol (Xylol) 10 Vol.-% Methylnaphthalin
35 Vol.-% Fuel oil 35 Vol.-% Paraffine oil 30 Vol.-% Lubricating oil
40 Vol.-% Solution of Dimethylamine
30 Vol.-% Methanol 30 Vol.-% Propanol-(2), (Isopropanol) 40 Vol.-% Ethandiol-(1,2), (Glykol)
30 Vol.-% Trichlorethylen 30 Vol.-% Tetrachlorethylen 40 Vol.-% Methylenchlorid
50 Vol.-% Ethane acid 50 Vol.-% Propane acid
50 Vol.-% Sulfuric acid 50 Vol.-% Nitric acid

Table 2

### 4.2 Hydraulic stability of sandfilling

For the improbable ease that the geotextile envelope may be degraded, the sand filling should stay at the initial placement.

### 4.3 Quality assurance of production

To guarantee a product of specified quality for each entity, a quality control system for all production steps

is required. The geotextile envelope is surveyed on strength and deformation by the accredited Labor für Baustoffe, Fachhochschule Münster, D.

The sandfilled element is surveyed on dimensions and sand mass per unit area by the same independent body. Each element is checked after production before delivery.

### 4.4 Safe joints

Handling 1.5 m<sup>2</sup> elements with a mass of 37 kg is easy with handling support by little hoists. Each joint between elements could be a weak point in the protection area. Therefore the MDDS-mats are placed in two layers with a clear overlapping part of the mat. Woven lines help aligning the elements. The deformation of the liner beyond joints of the protection layer are in the same order as overlapping non-wovens create.

## 5 DEVELOPMENTS BY GEBRÜDER FRIEDRICH/AMOCO

The MDDS-mat developed by the two firms is a LDPE-coated HDPE-tape fabric with a nominal space of 13 mm, woven in rolls of 2000 m fabric. The rolls are transported to the filling plant near Berlin, where the elements are cut, sewn on the bottom to form a bag, filled and sewn on top. Specific property is a high friction value. The MDDS-elements were applied in a industrial waste fill at Salzgitter. Tests show values given in table 2.

Materials	Angle of friction
MDDS/flat HDPE liner	18 °
MDDS/structured liner	23 °
MDDS/MDDS	20 °
Gravel 16/32/MDDS	27 °

shear angles with other materials

Table 2

They are a proven method for keeping the landfill liner free of damage during installation and these mineral filled geosynthetics may also be advantageously used, where the plastic deformation capacity of polymers is not required; i.e. protection of roof sealings.

## 6 COST EFFICIENCY

The efficiency of mineral filled geosynthetics as protection layer is the same as those of the guideline with 1200 g/m<sup>2</sup> + 15 cm sand. Cost for material and placing are lower, possibility of damage or penetration of the liner during construction seems very much lower. The difference volume of 0.13 m<sup>3</sup>/m<sup>2</sup> is a big advantage of the MDDS-system.

## 7 REFERENCES

- Deutsche Gesellschaft für Erd- und Grundbau e.V.  
(1991) Empfehlungen des Arbeitskreises "Geotechnik der Deponien und Altlasten", *Bautechnik* Heft 9/91
- TA Siedlungsabfall: *Dritte Allgemeine Verwaltungsvorschrift zum Abfallgesetz*, Bundesanzeiger-Verlag (1993)
- Müller-Rochholz, J. (1992) Schutzlagen - Mechanische Einwirkungen, Dauerhaftigkeit, Karl Joachim Thomé-Kozmiensky, "*Abdichtung von Deponien und Altlasten*", EF-Verlag für Energie und Umwelttechnik GmbH, Berlin, ISBN 3-924511-53-5
- Richtlinie über Deponiebasisabdichtungen aus Dichtungsbahnen (1985), Landesamt für Wasser und Abfall NRW, Postfach 5227, 4000 Düsseldorf 1