Long-term behavior of geodrain composites in landfill capping - results of exhumations

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ABSTRACT: Landfill cappings in Germany with geodraincomposites were exhumed after 2 up to 12 years after installation. The points of interest were polymer degradation, soil intrusion, hydraulic functions were checked as well as mechanical behavior. No chemical degradation was found, some soil was deposited in the top filter, very little in the drain core. The hydraulic performance of the design was not influenced by soil intrusions.

1 INTRODUCTION

Laboratory tests give a lot of helpful information, but the functional long-term behavior must be checked by exhumation of drains in the field, as only there all influences act simultaneously and may show synergistic effects. Therefore a program of exhumations of drain composites was started. The draincomposites were installed between 2 years and 12 years ago in different regions of Germany.

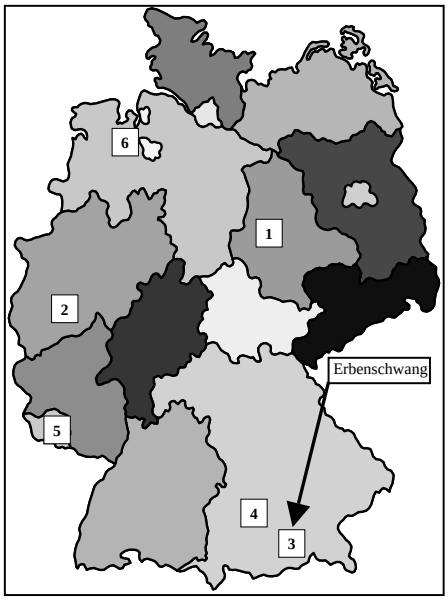

Fig.1: Exhumation sites.

2 EXHUMATION PROGRAM

To get full information on the behavior of the material on site the topsoil above and the clay liner under the drain were tested by the soil mechanics lab ICP, Karlsruhe, Germany. tBU collected precipitation data from the German Weather Service (DWD), exhumed the materials and tested hydraulic and mechanic properties of the geocomposites.

3 TYPICAL SITE

From seven places of exhumations we have selected one typical site:
Landfill Erbenschwang, (Bavaria, Germany) constructed 1987.
The cross section given below as design cross section of the landfill capping shows the location of soil and geosynthetic specimens (Fig.2).

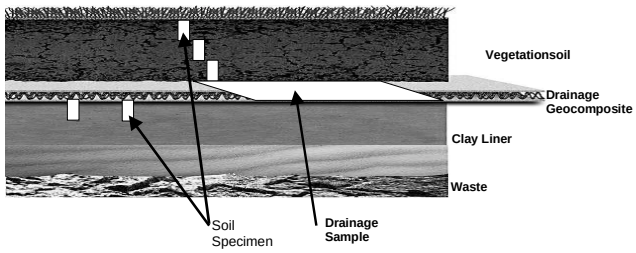

Fig. 2: cross section of the landfill capping

To show the work a typical exhumation is displayed closer.

The figures give some impression of the work.

Fig. 3: grass surface of the landfill (Bavaria)

Fig. 4: sideview of the vegetation and coarse soil

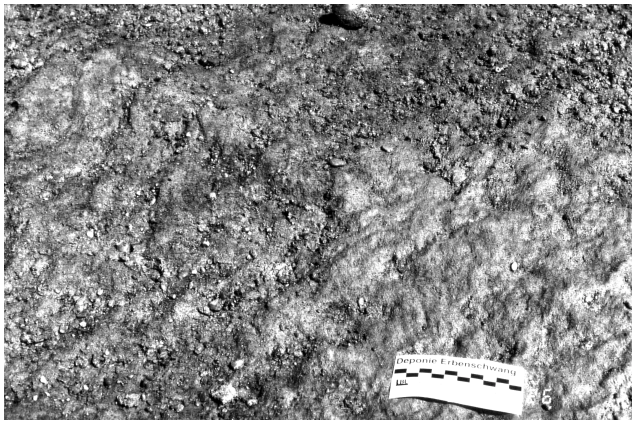

Fig. 5: upper side of drain composite after contact with topsoil.

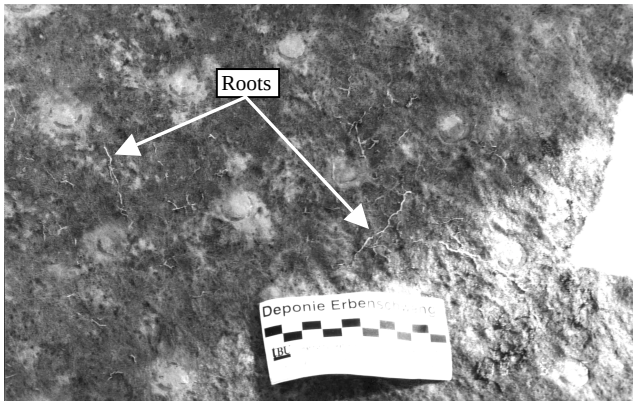

Fig. 6: lower contact side to clay liner (small roots visible).

4 LABORATORY MEASUREMENTS, ADDITIONAL INFORMATION

We exhumed this material short time after very heavy rainfall in that region (Fig. 7)

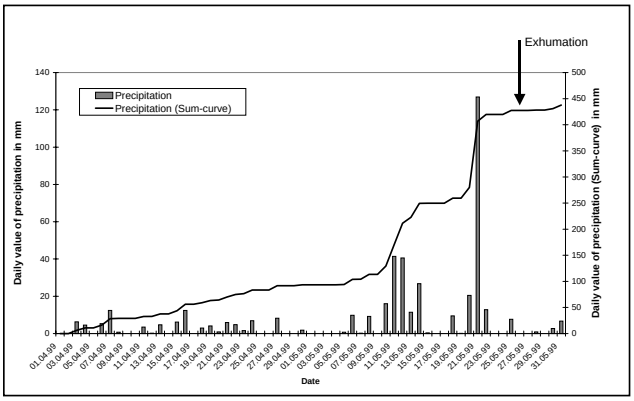

Fig. 7: Daily rain events and precipitation sum curve

and expected a waterfilled drain. We found some humidity in the nonwoven filter, but no signs of extreme flow. The drain composite was washed to find soil intrusion. The result is shown in Fig. 8, which shows some soil in the upper filter, no soil in the core, sometimes some clay from the underlaying clay liner in the bottom geotextile.

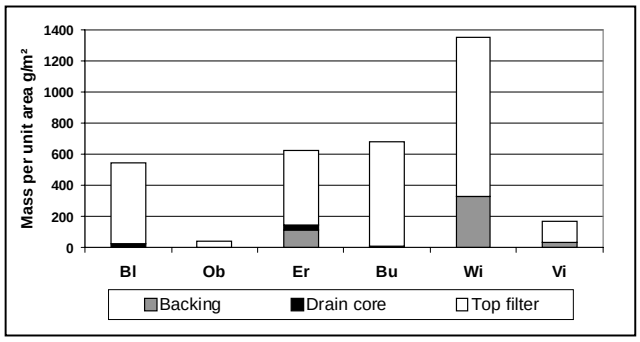

Fig. 8: Soil embedment in the elements of geocomposites.

Additionally the exhumed specimen with soil were tested on permittivity and transmissivity. After removing the soil the hydraulic properties, compressive creep and internal shear were tested. The results are given in the following table 1.

Test		with soil intrusion	without soil intrusion
mua geodrain	g/m²	**1585**	**958**
top filter		**664**	**181**
draincore		**628**	**595**
bottom filter		**290**	**179**
$k_{v(10°C)}$ top filter at 20 kPa	m/s	**7,4E-04**	**1,3E-03**
$\Psi_{(10°C)}$ top filter at 20 kPa	1/s	**6,9E-01**	**1,2E+00**
$k_{h(20°C)}$ at 20 kPa	m/s	**3,1E-02**	**-**
$q_{(20°C)}$ at 20 kPa, i = 1	m²/s	**2,1E-04**	**-**
Compressive creep at 20 kPa/1000h thickness	mm	**-**	**5,68**
Internal shear test			
internal angle of friction	deg	**-**	**32,5**
cohesion	kPa	**-**	**22,8**

Table 1: Results of laboratory tests (mua = mass per unit area)

5 SCANNING ELECTRON MICROSCOPE (SEM) IMPRESSIONS

As there was very little soil in the geotextiles, we found only some deposits of grains in the filters. The Fig. 9 and Fig. 10 show nonwoven knit bonded filters (Malivlies) with granular embedments

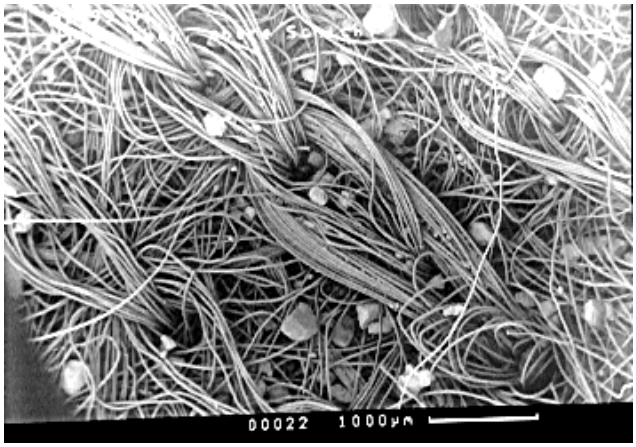

Fig. 9: granular intrusions in the nonwoven filter

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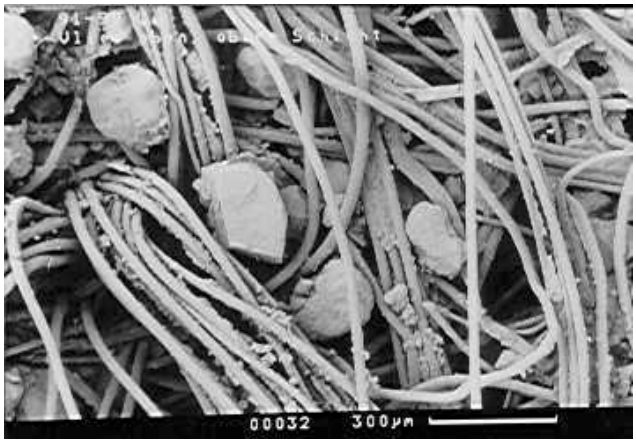

Fig. 10: grains and fine soil particles in the nonwoven filter

and Fig. 11,12,13 very curious attachments of fine particles on a fibre. The fine soil particles seem to have grown in concentric layers; the pearl chain structure may be caused by drying shrinkage.

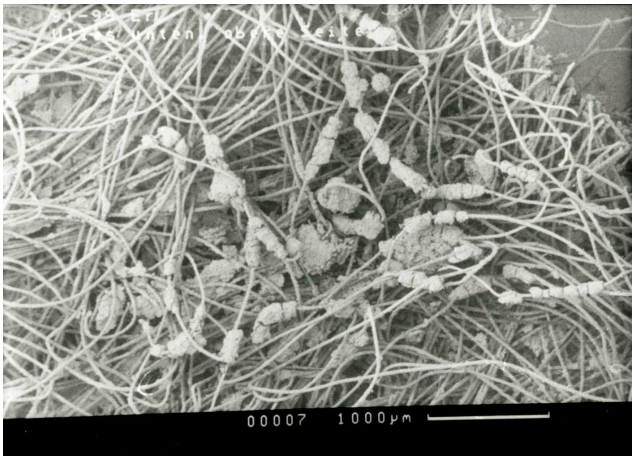

Fig. 11: soil attachements to fibres

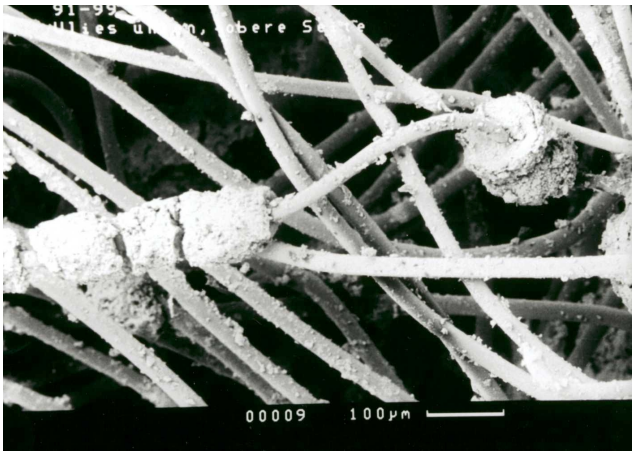

Fig. 12: closeup to particle attachements

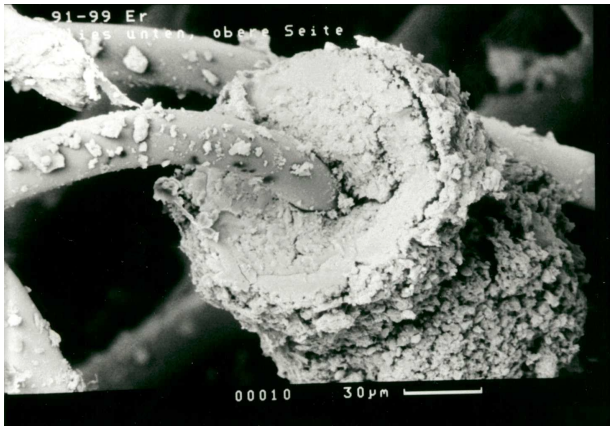

Fig. 13: concentric layers of fine soilparticles

Roots were found macroscopically only between nonwoven joints (Fig. 14); some very fine could be discovered in the drain core (Fig. 15).

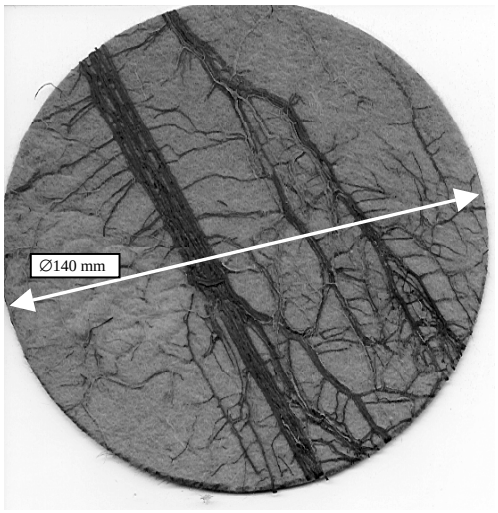

Fig. 14: roots in a double layer of nonwoven (joint)

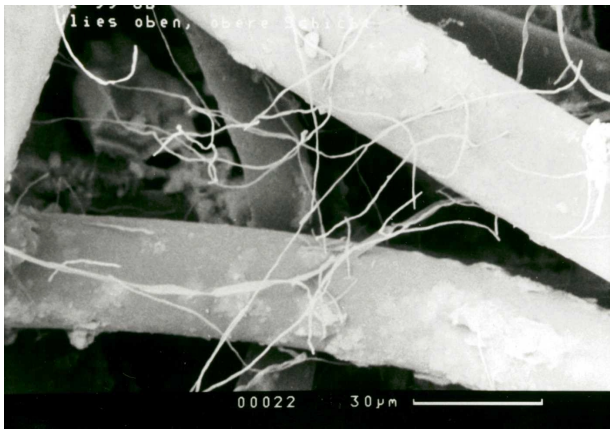

Fig. 15: very fine root fragments in the topfilter

6 CONCLUSION

The exhumation of random wire draincomposites after up to 12 years of service showed:

- no measurable polymer degradation (mechanical properties, DSC)
- roots only in areas of permanent humidity (contact zone to clay liner, dubbing areas of nonwoven, very thin in the drain core bottom)
- hydraulic properties of the filters with embedded soil is nearly halved
- draincore volume is not affected by soil and roots
- high rainfall events lead to smaller drain flow than design values estimate
- all systems worked well independent of time of service.