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# Case study on geogrids to prevent sliding of waste in a landfill

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ABSTRACT: For a sufficient stability of a landfill on a steep slope in the Austrian mountains the reinforcement of the base lining system is necessary. To find the best economic and technical solution test fields were intalled. First results are presented.

## 1 INTRODUCTION

The landfill „Böschistobel“ is situated at the base of a steep slope in Vorarlberg, Austria. The bottom of the landfill originally was designed as a multiple-berms-slope because of the topography in this area. The horizontal base has dimensions of approximatly 30.000 m², the sloped surface area is approximatly 40.000 m².

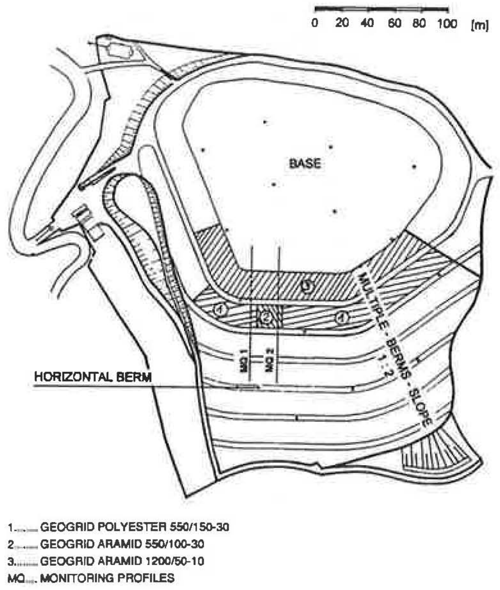

Fig. 1: Situation of the Landfill

The expected volume of the landfill will be 1.500.000 m³. The length of the slope is 160 m while the width of its base only is 90 m. The subsoil consists of slope deposits and limestone.

The composite bottom lining consists of the following (top to down):

- waste
- geotextile filter
- drainage layer
- geotextile protection layer
- geomembrane
- mineral sealing layer
- compacted subsoil

Since 1992 the Geotechnical Consulting Engineers Plankel - Pelzl & Partners has been responsible for the developement and quality control of the Böschistobel landfill. Until that time no stability analysis has been performed for the original design. Local governement regulations required a composite lining system in the slopes. This requirement had to be taken into consideration for the stability of the landfill.

## 2 STABILITY ANALYSIS

In the bottom horizontal surface area (including the slope surface area up to the first berm) a smooth geomembrane liner was applied, a textured geomembrane was applied between the 1st and 2nd berm (Fig. 2).

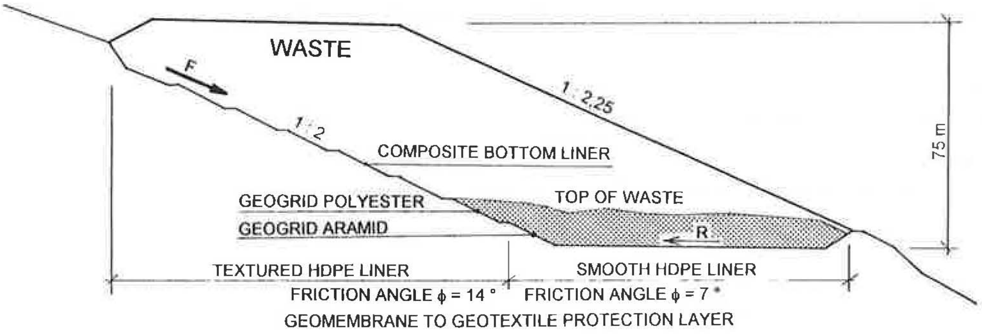

Fig. 2: Multiple-Berms-Slope-Design, Cross Section

The stability analysis indicated that a reinforcement was necessary for a sufficient factor of safety.

The calculations are based on several material parameters. The angle of friction for the interface behavior between geomembrane and geotextil protection layer was tested in laboratory tests. For calculation a friction angle of $\phi = 7$ ° resp. $\phi = 14$ ° was assumed for the smooth and textured geomembranes. The calculations showed that even with the use of textured geomembrane, an addtional reinforcement was necessary. The resulting forces in the reinforcement showed to become very high, thus only geogrids with extremely high tensile strength could meet these requirements.

For a practical and economical approach the contractor decided to set up a test field for optimizing the necessary type of reinforcement. The test field was installed in December 1995. In addition to these in-situ tests a completely redesign of the landfill layout is currently developed.

## 3 MONITORING SYSTEM

Two monitoring profiles were installed on site. Sensors for temperature, strain and pressure are used.

Strains are measured by extensometers (Type SOLEXPERTS) which are directly fixed to the geogrids. The measuring basis is 1000 mm and the measuring range reaches 100 mm. The sensitivity is 0,01 mm.

Pressures are monitored by pneumatic pressure cells (Type GLÖTZL) in tangential and normal direction. The senitivity is 0,05 bar.

Fig. 3 shows the layout of a monitoring cross section.

Monitoring cross section 1 is situated on ARAMID geogrids. The second section is on POLYESTER geogrids.

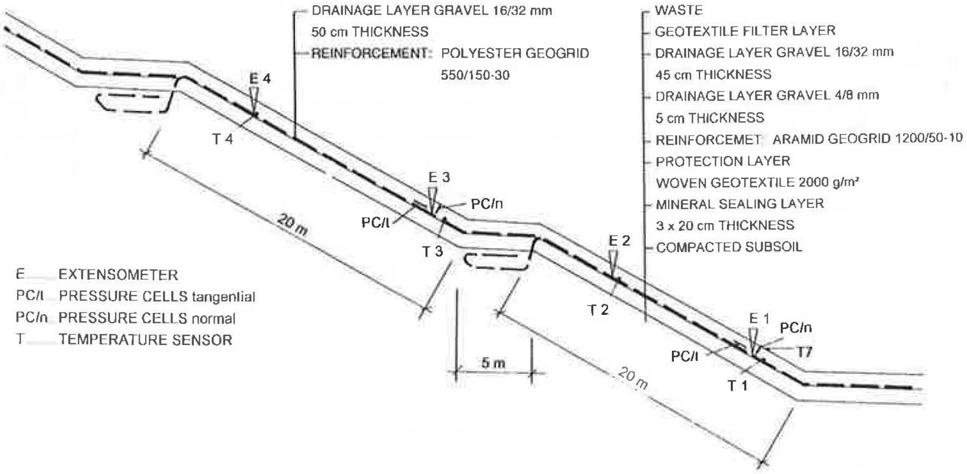

Fig. 3: Monitoring Profile 1

## 4 GEOGRID

Three different types of geogrids were installed in the testfield:

Type A: Geogrid Aramid 1200/50-10
woven type of material
Type B: Geogrid Aramid 550/100-30
woven type of material
Type C: Geogrid Polyester 500/150-30
warp knitting technology

Peak tensile strength longitudinal direction in kN/m/ lateral direction in kN/m – mesh opening size in mm

The stress-strain-behaviour of the three geogrid types are shown in Fig. 4. The aramid products are charac-terized by high strength at low strains and they show a linear stress-strain-behaviour. The ultimate tensile strength is achived at the rupture strain of 3.5 %. Polyester products show the ultimate tensile strength at the rupture strain of 10 % and have a non linear stress-strain-behaviour.

## 5 TEST RESULTS

Figure 5 shows the developement of landfilling. The beginning of filling up was in January 1996. Within one month 7.5 m of waste covered the test area 1. During weather conditions with outside temperatures of - 10 °C to - 5 °C the temperature within the waste-body climbes in two months up to 37 °C.

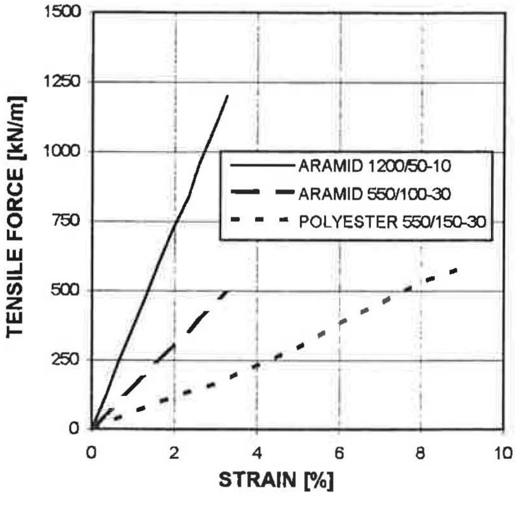

Fig. 4: Stress-Strain-Behaviour of the Geogrid

The tensile force in the reinforcement rises imediately after filling up the waste. Obviously the intaction between filter layer and geogrid is perfect. The high stiffness of the grid (Aramid 1200/50-10) results in high stresses at low strains (Fig. 6). That the pressure cells do not show the current load of approx. 10 m waste over burden can be explained with the way of refilling of waste.

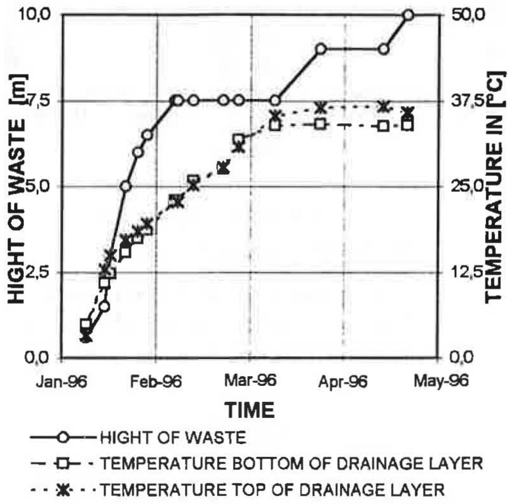

Fig. 5: Hight of Waste, Temperature in the Lining System

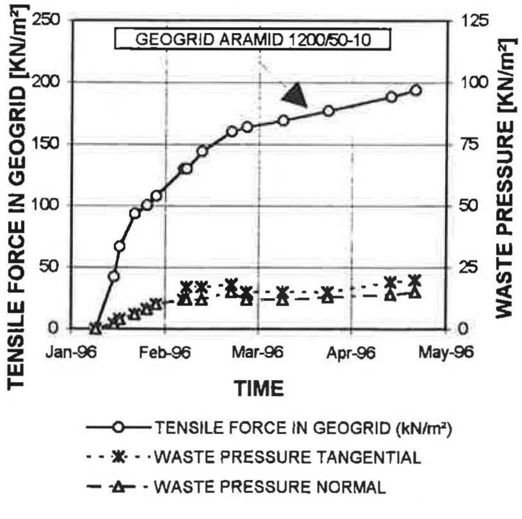

Fig. 6: Tensile Force in ARAMID Geogrid, Pressure Normal and Tangential to Lining System

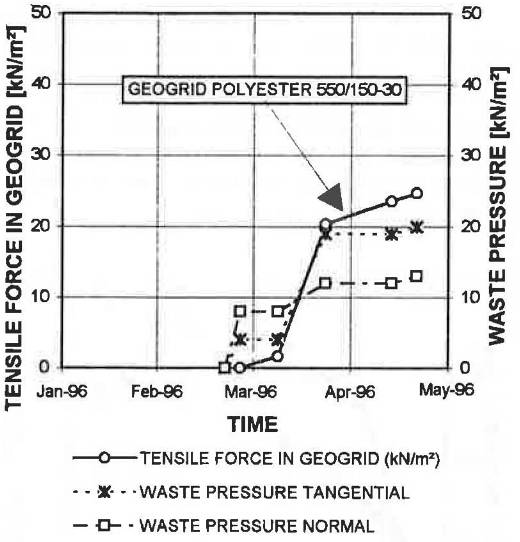

Fig. 7: Tensile Force in POLYESTER Geogrid, Pressure Normal and Tangential to Lining System

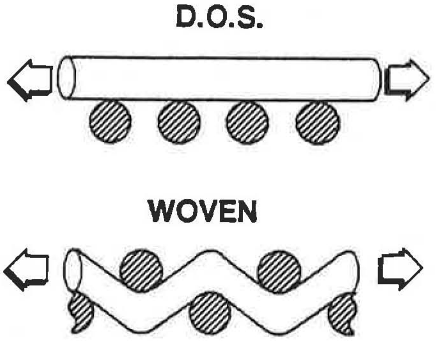

Fig. 8: Arrangement of fibres in a D.O.S and woven structures

In Fig. 7 we can see results from strain and pressures measurements of the approximatly 2 m covered testfield. In this section the waste was installed as usually in layers and a typical developement of pressure and tangential and normal forces could be monitored. Even smalest displacements caused interation between filter layer and the polyesters geogrid. Due to the D.O.S (Directional . Orientated . Structure) structure of the product the straight and plane arrangement of fibres in the structue ensures, that the full potential of strength can be utilised as the load is placed on the product (Fig. 8).