New Horizons in Earth Reinforcement – Otani, Miyata & Mukunoki (eds)
© 2008 Taylor & Francis Group, London, ISBN 978-0-415-45775-0

Special process techniques with project specified geosynthetics for sludge lagoon covers

O. Syllwasschy, O. Detert, D. Brokemper & D. Alexiew
Huesker Synthetic GmbH, Gescher, Germany

ABSTRACT: The construction of a capping system on top of a sludge lagoon is a technically hard to please task. The weak sediments and their low shear strength afford higly sophisticated and plant optimized solutions. In the past the use of plant specified fabricated geosynthetics and a detailed planned construction work results in cost and time effective solutions. Based on two topical projects the main characteristics for choosing the reinforcement, the design and the work schedule will be presented.

1 INTRODUCTION

The design of the cover respectively the liner system normally depends on the requirements of the customer or the appropriate authority and the intended use after capping. It may consist of a simple reinfocing geotextile and fill material or a multi layer combination of geotextiles, high quality soils and a qualified liner system with gas and water drainage.

The geotextile reinforcement stabilizes the soft subsoil and enables workers and construction machinery to work carefully on the sludge lagoon. The sludge maintains its geotechnical characteristics and has e.g. not to be stabilised chemically or treated in any other way.

2 TECHNICAL DESIGN

Design basis is an intensive soil investigation. There may be a higher effort compared to normal sites. Often sludge lagoons can only be walked on directly just at extreme weather (frost or drought) or with boats and pontoons.

The following data are necessary for design:

- Geotechnical parameters of sludge/fill material
- Stratification of the subsoil
- Dimensions of the sludge lagoon
- Water level
- Live load of contsruction machinery

According to the deposition history, dewatering and weather conditions the hydraulic and mechanical characteristics of the sludge may be subject to larger differences in depth and across the area.

In large lagoons with inhomogenous sludge parameters in different areas you might use reinforcement with varying and adapted design strength. In smaller lagoons or lagoons where areas with different sludge characteristics are not well known it is advisable to use the most conservative design parameters for the whole lagoon.

2.1 *Dimensioning*

At present there exists no geotechnical design analysis that correctly describes the failure mode of a typical sludge lagoon cover with geosynthetics. Nevertheless in the past analytical designs with circular or polygonal slip surfaces showed good results with sufficient factors of safety (Fig. 1).

Sometimes analysis based on wedge or slice methods (e.g. Janbu) may be advantageous compared to circle methods (e.g. Bishop, Krey) because of the better considerations of the forces of the geotextile

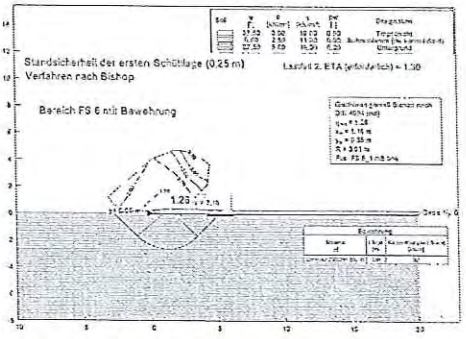


Figure 1. Typical Bishop slip circle for sludge lagoons.

A special case is the installation under water where it is useful to install prefab panels from pontoons and cover them with soil in one step.

3 CASE EXAMPLES

3.1 *Open pit mine "Grube Hoffnung"*

The "pit hope" located in the southeast of Helmstedt in the former German Democratic Republik was used as a hazardous waste landfill after formerly being used as clay mine. Geology showed a naturally clay sealed pit that has been filled with ashes and sludges from the coal refining industry (Fig. 2).

Since closure in the 1990s the pit filled with rain water up to more than 2 m above sludge level. In 2002 the responsible authority decreed to cover the landfill to avoid direct contact to the environment. The cover fill surface level should have a maximum height of 5 m including a clay barrier of 30 cm.

The sludge showed a thixotropic behaviour, incrustations on the surface and a high pH-level due to high salinity. Consolidation took place during time only by self weight, so the undrained shear strength in the water covered area was very small, just about $c_u = 0.5\,kN/m^2$ or even less.

Before remediation could start nearly 65,000 m^3 of wastewater had to be pumped and treated on site before feeding the next receiving water course.

3.1.1 *Design*

The geotextile part of design and engineering, done by HPC Harress Pickel Consult, Merseburg, consisted of a 250 g/m^2 non-woven and a PP-geogrid of short term tensile strength of $P_{ult} = 60\,kN/m$ respectively 80 kN/m. In the northern stiffer part as single layer and in the southern weaker part as double crosswise geogrid reinforcement (Fig. 3). Additionally the southern part was divided by dams made from dumped concrete debris into four smaller lagoons (Fig. 8).

Figure 2. Open pit mine "Grube Hoffnung".

3.1.2 *Construction*

After profiling steep slopes down to an inclination of 1v:3h the installation of the non-woven and the geogrid started in the stiffer northern part, anchoring them in embankments at the side of the lagoon (Figs. 4, 5). In this part the non-woven could be placed by hand and the help of cross beams.

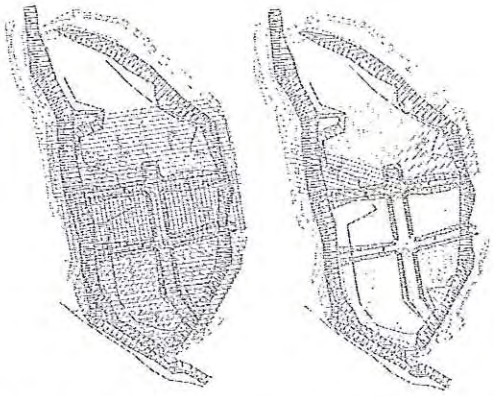


Figure 3. Laying pattern of crosswise geogrid reinforcement.

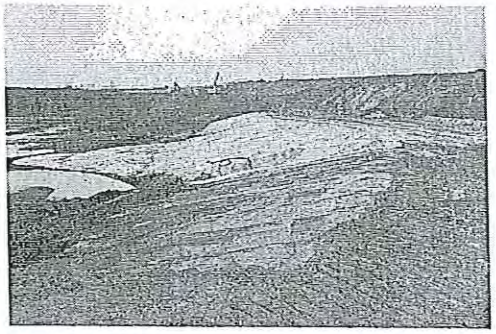


Figure 4. Profiling the slopes to 1v:3h.

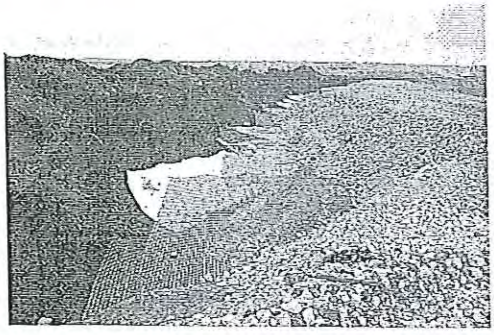


Figure 5. Anchoring of geogrids in the embankments.

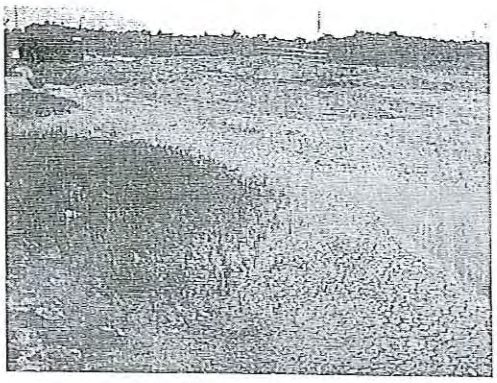


Figure 10. Southeastern Part (Photo EN-PRO-TEC).

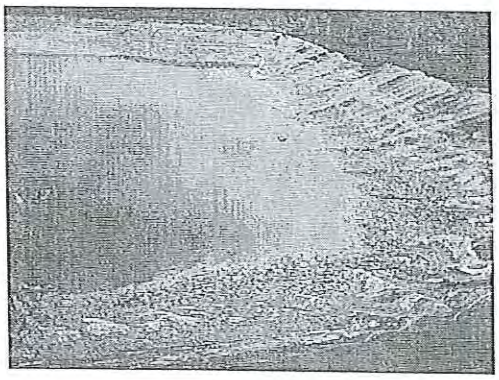


Figure 11. Northern Part (Photo EN-PRO-TEC).

walk on, but at least 60 cm below surface the SPT showed values between N = 0.5 to 3, or even less.

The geotechnical data base of the mud was rather small and no time for additional investigation, so the design based on the SPT results and the review of the designer from EN-PRO-TEC, Nordhorn.

Due to the rather small size of the lagoon a panel design was chosen (Fig. 12). The required seam strength of the panel and the high pH-value pH = 10.6 required to use a biaxial PVA-geogrid combined with a 300 g/m^2 PP-non-woven. The use of a PP-geogrid was not taken into account due to the worse seam strength. The higher price of the PVA material in contrast to PP was more than compensated by the highly reduced amount of work as with single layer installation.

In accordance with the designing engineer the panel had to be anchored in- and outside of the lagoon. The inner anchot trench was designed to withstand pullout forces of the panel, whereas the outer anchor trench guarantees that no sludge can squeeze out between reinforcement and the basic FML at the edge. This solution was very well appreciated by the responsible authority that forbade any pollution of the surrounding moreland (Fig. 13).

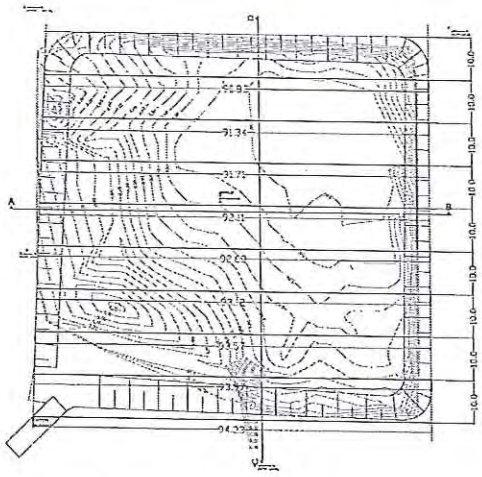


Figure 12. Plan view of lagoon and panel.

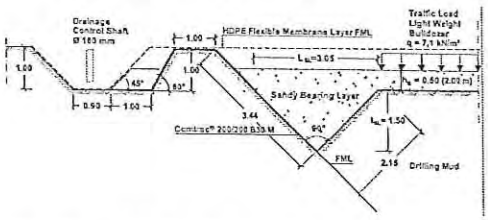


Figure 13. Detail of anchor trenches.

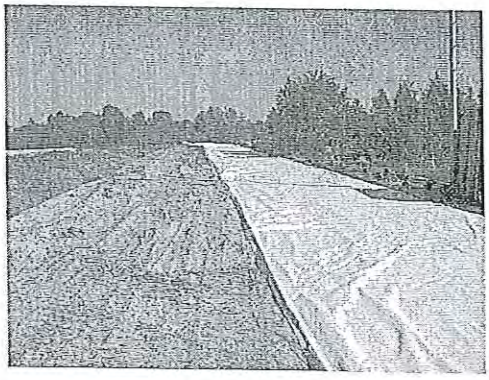


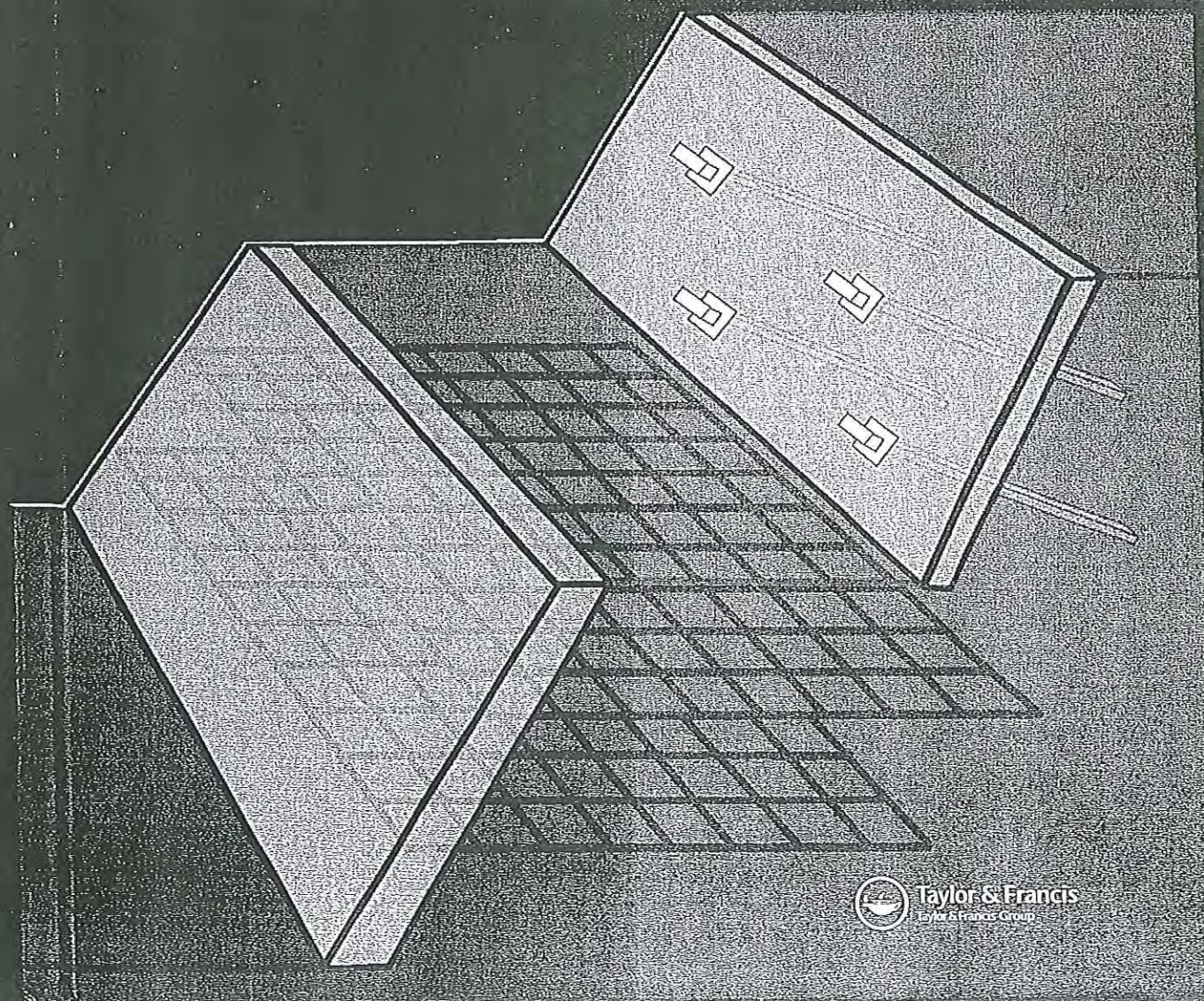
Figure 14. Preparation of the panel on site.

The panel was produced in three steps. At first the non-woven was sewed on the geogrid creating the combined product type Comtrac®.

In the second step two adjacent sheets were seamed together in plant in accordance to the installation plan. These sheets (width = 10 m, weight = 850 kg) were coiled in the right direction so they could be unwound correctly on site, the plant seam on the right hand side, the left hand side near to the lagoon ready for the seam to be done using hand sewing machines

NEW HORIZONS in EARTH REINFORCEMENT

Edited by
JUN OTANI, YOSHIHISA MIYATA & TOSHIFUMI MUKUNOKI



Taylor & Francis
Taylor & Francis Group