Rehabilitating The Artificial Ponds With Geosynthetic Clay Liners - A Case Study

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ABSTRACT

Geosynthetic Clay Liners (GCLs) offer engineers, owners and contractors safe and mostly economic solutions to everyday engineering challenges encountered particularly in hydraulic engineering applications and especially in the liquid and waste landfill barrier systems. These elements assure the durability of the structure and at the same time prevent leakage. Although still today most of the liquid containment facilities are composed of compacted clay liners and some asphalt or concrete paving, GCLs have slowly started to gain rapid acceptance in lakes, ponds and sewage lagoon projects. One of the use of this Geosynthetic product in a water containment pond at the recreation area in Homeros Valley, Bornova, Izmir is reported in this study. Some key parameters of GCLs and its comparison with similar products in the engineering field is stated. The paper ends with the field performance of GCLs using some other related case studies with an outlook on further developments.

Keywords: *Barrier Systems; GCL; Leakage; Water Containment Pond; Homeros Valley.*

1. INTRODUCTION

Using impermeable materials are higly important in some applications of hydraulic engineering. They are used in reducing the potential lekage problems and for the durability of the structure in its economical life. In water channels for instance, clay barriers are frequently used with concrete or asphalt surfacing on them. In recent years, geosyntetic clay liners are started to be used in various hydraulic structures such as water channels, water retaining pools, various retaining structures as an alternative method to the traditional ones. In this paper, an application of the use of geosynthetic clay lines in the city of Izmir at the water ponds in Bornova-Homeros valley is explained.

2. MATERIAL PROPERTIES

Geosynthetic clay liners (GCL) are water barrier nearly impermeable materials consisting of geotextiles or geomembranes with mechanically or chemically attached granular-powdered bentonite. GCL is a composite material having the properties of both geotextiles and bentonite. In areas where appropriate clay materials don't exist, it can be used as an alternative material with low cost. The main difference between the GCL's are the bentonite type (granular or powdered; sodium or calcium types), geotextile type (woven or nonwoven) , geomembrane context and their bonding technology [1].

Recently, research is going on for the GCL properties and their potential benefits. Their hydraulic properties depends on the bentonite properties within them. The only difference can be in the case of geomembrane used cases. Their hydraulic permeability values, depending on the normal stress applied, varies between $2*10^{-12}$ to $2*10^{-10}$ m/s. The durability of the GCL's are based on its chemically coherency with the environment it is being used, bentonite thickness, clogging phenomenon, and ion exchange with its environment [2].
GCL's are used with other insulation purposes not just for water retention but also in landfills. In this case, the impermeablity properties depends on the liquid-GCL chemical interaction.

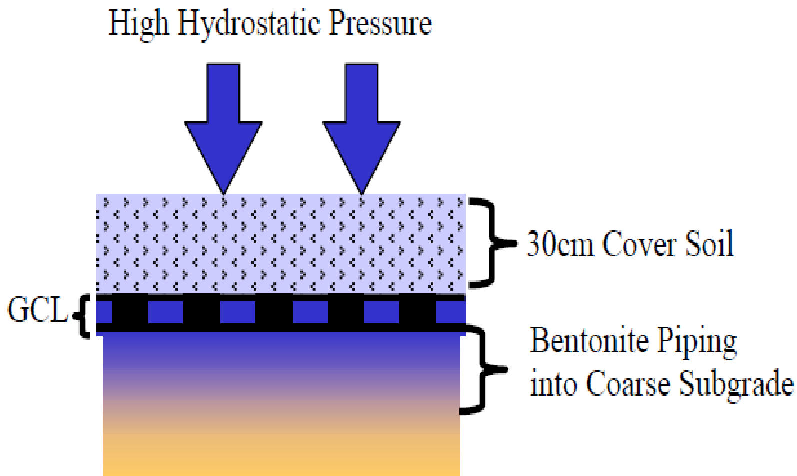

Figure 1. Hydrostatic Pressure Induced Bentonite Piping Through "Open" Geotextile

Constructing the GCL liners are simple and efficient. After levelling the ground, GCL is applied to the ground with appropriate overlapping between the GCL packages followed by appropriate filling material, to give the required normal stress for impermeability issues (Figure 1). In construction phases of the GCL, leakages of the liner can be sealed by the bentonite. Therefore, possible construction defects will be compensated easily by the material itself.
The gradation of bentonite inside the GCL is also an important factor for the permeability issues. For instance, local dense bentonite inclusions will not help the materials behaviour. To prevent these possible localizations, appropriate fill height is highly important [3].

3. CASE STUDY AND METHOD OF CONSTRUCTION

Water reservoirs in Homeros valley is constructed for typical flood barriers and also for recreation purposes. The proposed application is in the upper part of the valley. Different construction methods are used in the area for water retention. Firstly, the proposed pool area is filled and compacted with a locally avaible clay soil, and its behaviour is observed in the following months. After some time, it is not accepted as the appropriate material, and therefore concrete lining is applied in some possible leaking parts. In the folllowing year, the performance of the reservoir is not found acceptable, the pools can not sustain water because of the excesive leakage problem. Therefore, a more technologically advanced material is chosed for the application. The proposed design methodology is first leveling the ground and applying the GCL on top of the previously constructed concrete-clay soil, and then filling the area with 25-35 cm height clay layer.

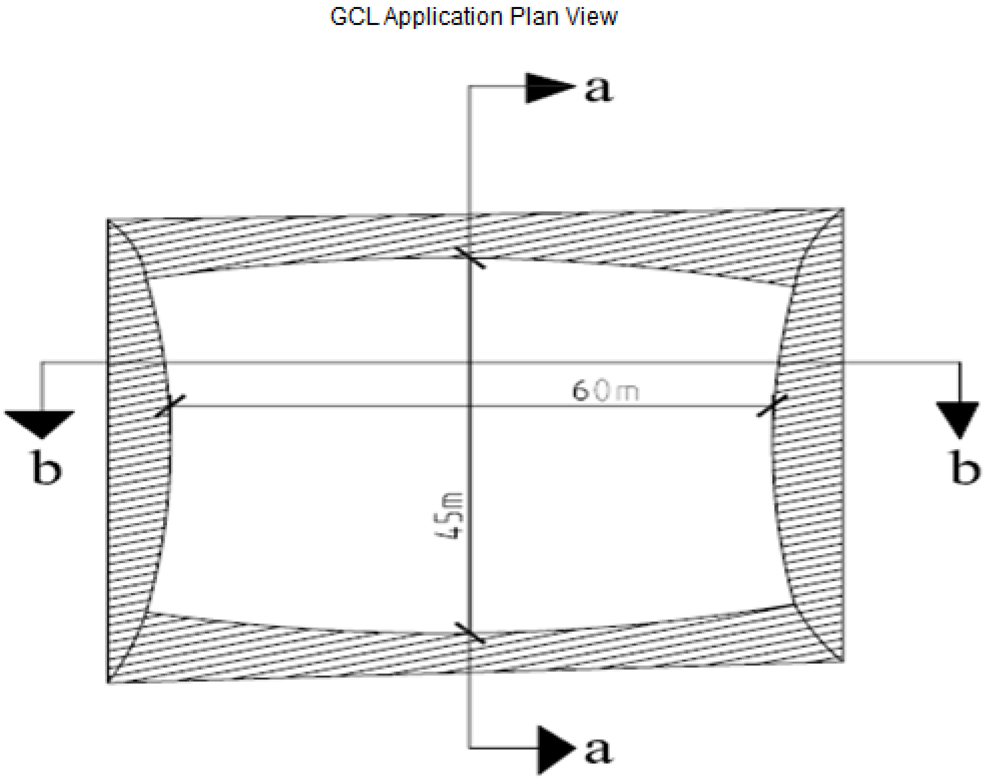

Figure 2. Plan View Of The Construction Site

GCL sheets shall be anchored to the appropriate anchor trenches around the area. These trenches are excavated according to the water-inlet and water outlet levels. Figure 3 shows the typical view of these trenches. After, leveling the ground and excavating the anchor trenches, GCL sheets are directly applied to the ground. These sheets are placed with at least 20 cm overlaps, which is an important issue. (Figure 4)

Figure 3. Trenches In The Upper Part Of The Site

Figure 4. View of the site and Construction of GCL

Downstream part of the pond is especially important, where double layers of geosyhthetic clay liners and more overlappings are used. The stability of anchored areas are especially important, where more focused construction is needed (Figure 4,5).

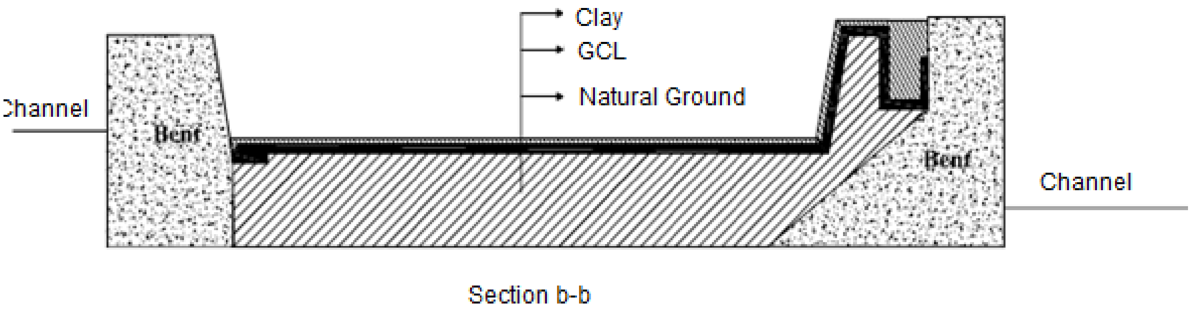

Figure 5. Section b-b Of The Site

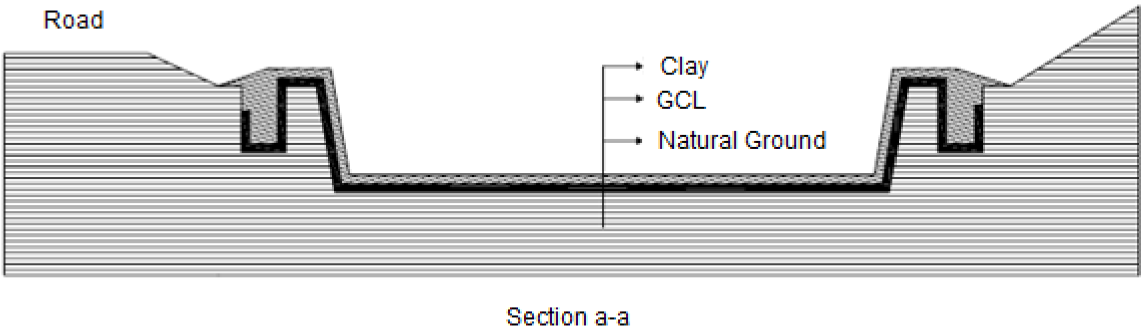

Figure 6. Section a-a Of The Site

Filling the GCL layer with appropriate heigh clay is crucial for the bentonite to expand under pressure and close the gaps with chemical interaction properties. Low plastic clay is used for this project because of its low permeability and well-compactible properties. This fill layer is an important integrated part of the project. (Figure 7,8).

Figure 7. Filling The GCL Layer With A Backhoe

Figure 8. The Final View Of The Site After Construction

4. CONCLUSION

This paper points out an application of a highly integrated and technologically advanced material with an example. As opposed to traditional impermeable liners, some of the important points in GCL can be stated as following:

- The impermeability of the GCL is nearly 50 times that of the standart clay liners .
- Construction defects and changes of the environmental conditions during its economical life can be compensated by GCL upto %20 deformability values, while for other techniques, this condition does not hold [4].
- Sodium-bentonite, with its high expansibility, fills the defected parts and reinforce the material [5].
- The use of GCL is especially highlighted when there are not qualified clay soils around for the appropriate filling procedures. Its great advantage lies in its economical aspect.
- Enough surcharge is crucial for the economical service life of the site. Therefore, appropriate control of the GCL construction and application is important [6].

In this study, technologically advanced and economical alternative of a construction method is highlighted with a given case study and some literature technical documentations. The long-term durability of GCL sites and other theoretical issues are recorded and can be found elsewhere in literature [7,8]. These alternative design methods and problems makes the engineer to think and apply new and radical design methods, therefore innovative design methods can emerge.

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