Structured Geomembrane Liners in Landfill Base and Closure Systems

Clark West
Agru America Inc.

ABSTRACT: Structured or embossed HDPE and LLDPE geomembranes have been available to landfill owners and designers for over ten (10) years. As many owners and designers discover and demand the consistent high quality characteristics of this type of geomembrane due to the unique manufacturing process, the use of these materials in new landfills and mines, landfill and mine expansions and final closure designs has steadily increased. Structured liner materials are available for double lined and final cover systems and are revolutionizing the way ponds, pads and final closures are constructed. This paper will discuss the structured or embossed geomembrane concept and manufacturing process. Additionally, the paper will present comparative testing illustrating the major advantages of using this type of product in these types of applications. Both technical and economic advantages are illustrated. The cost savings include lower installation costs, less material used, and third party inspection times not to mention better performance. These new systems will be presented.

INTRODUCTION

In the liner manufacturing industry, two (2) basic processes exist for both high density polyethylene (HDPE) and linear low density polyethylene (LLDPE). One process is the calendared system the second process is a blown film method. They are available in smooth, textured and for the calendared system, structured liners. To create a textured surface on the blown film material an inert gas (nitrogen), is injected into the liner at the die under pressure to produce a textured surface. When exposed to normal pressure, it will rapidly expand and burst like a bubble creating a texturing (embossing) on the surface of the sheet. The embossed or structured texturing is created by extruding molten polyethylene between two precisely engineered rollers. On one or both rollers, an embossing exists creating a pattern of spikes on the sheet.

There are many advantages to the embossed sheet. First, the core or base thickness of the material is not affected by the process. The embossed sheet is smooth with the exception of the spikes. This is seen in the performance of the embossed material as its specifications are closer to a smooth sheet than blown film texturing. Due to the simplicity of manufacturing, there is uniformity between materials that is constant. The tensile and strain properties are not affected in the manufacturing. The material is
completely homogeneous. Finally, the integral textured profile is embedded in the sheet as well as the integral drain profile.

**The Manufacturing Method of the embossed or structured sheet includes:**

- Horizontal Flat Die Calendar Extrusion
- Precision Machined Profile Rolls
- Consistent Quality Sheet
  - Polymer
  - Thickness
  - Structure
  - Smooth Edge Textured/Structured Sheet
  - Continuous Production QC Testing

**EMBOSSED OR STRUCTURED GEOMEMBRANES**

The manufacturing process for embossed or structured Geomembrane requires two machined rollers. Therefore, it is a simple procedure to remove a single roller or set of rollers and replace them with specialized embossing rollers to create liners for a wide variety of applications. Smooth liner is best for regular use in leach pads, ponds and tailings dams. However, the embossed or structured Geomembrane is ideal for applications having low to steep slopes. The Microspike textured liner provides a greater interface on various slopes. The Grip Liner, with lower surface spikes, provides a higher interface lower surface but with a smooth upper surface if a slip plane may be needed. Drain liner containing upper surface studs and smooth under surface acts as a drainage medium replacing nets in double lined situations such as hazardous ponds or leak location systems. The Super Gripnet contains drain studs on the upper side and a spike surface on the lower for high interface. This is specifically applicable when applying to steep slopes or when the project requires a drainage medium (i.e. a landfill and/or a landfill closure). Finally, MicroDrain liner provides drainage studs on the upper surface for use on top for drainage with Microspike textured lower surface for a high interface with fabrics or Geosynthetic clay (GCL). All the drainage liners can be used in conjunction with non-woven fabrics for high transmissivity of liquids in cover situations reducing the chance of saturated soil failure scenarios.

**Transmissivity Cap Profiles:**

Laboratory Transmissivity values are dependent on the boundary layer (soil), Geotextile, normal loading and gradient. However, the Transmissivity of the drain stud profile with an overlying non-woven heat set Geotextile ranges from 1.6E-03 to 3.6E-03 m²/s.

**Interface Sheer – Cap Loading:**

Soil / Grip Liner Surface (degrees):
Soil / Drain Liner Surface w/Geotextile:

- Sand 30P 30LD

Closure System for Landfill Sites Using an Impermeable Synthetic Grass Cover System

As a response to numerous failures and poor post landfill closure performance, new approaches are sought by engineers. Engineers seek to establish a more stable and environmentally sound solution in closed landfill waste rock piles and leach pads further reducing the generation of Acid Rock Drainage. One of the latest approaches showing great promise is an exposed Geosynthetics cover system. The system incorporates a textured geomembrane, in combination with a synthetic turf and a highly transmissive drainage layer above the membrane. The drainage component, locking infill ballast and internal friction angles, allows for installation of the cover on very steep slopes previously needing dramatic slope angle reduction. The system provides rapid installation and superior environmental characteristics. The design also provides resistance to hurricane force winds and intense rain events. The system eliminates the need for borrow, reduces earthwork costs, fuel consumption and on-going maintenance as required by a vegetative closure, (i.e. re-seeding, soil replacement, fertilizing and irrigation). Site-specific comparisons at disposal units in various geographic regions have shown a significant savings for closure construction and post closure care while improving operational compliance.

MineSite Test Pad

A test pad to define suitability for use of structured liners under cover material was initiated by a Landfill Closure Division in Nevada to confirm suitability of DrainLiner™ or similar liners for use on future landfill closures.

Steve Boyce, the design engineer, (then of Knight Piesold’s office in Elko, Nevada), proposed testing the material to be used for one of the to be closed landfills. Four pieces 13.16 m² each of Agru America Drain Liner material, two 2mm and two 1.5mm were delivered to the landfill site. One piece each of 1.5mm and 2mm DrainLiner® was placed with 10oz non woven heat burnished fabric (HB down) on top. The cover soil comprising of 0.304-0.46 minus sub-grade with limited fines, much coarser than intended for the landfill, was placed over the top of the liner. Using a Caterpillar D9...
Bulldozer, the soil, placed to 0.941 mtr, was tracked over many times. Then, a fully loaded landfill water truck/scrap er made ten passes over sub grade.

Once the test was complete, the liner was exposed and inspected for damages. However, the material was completely void of any damage. Testing continued as the cover soil was reduced to 0.6 mtr and the water truck completed an additional ten passes. This would provide evidence of the 0.6 depth being sufficient. Next, a Track Hoe was brought to the site to carefully remove the overburden. The fabric, when exposed, was peeled back with the help of the Track Hoe to expose the liner.

There appeared to be very little superficial damage to the liner and no penetrations of the liner. This was confirmed when the material was taken back to the engineers lab and tested with a vacuum box.

It had been proposed to use a 2mm liner with a geocomposite covering the liner for a drainage medium. This testing provided enough information to allow the engineer to use Agru America 1,5 mm Drain Liner and 10 oz fabric saving the client considerable costs in material and installation.

**Case History – Gilt Edge Mine – Superfund Site – Ruby Waste Rock Dump Cap**

- 80 mil Super Gripnet LLDPE
- 65 Acre Cap System for prevention of ARD
- Valley Fill - 1800 ft long slope with 9 - 25 ft wide benches (40 ft vertical), perimeter ditches, subsurface and surface drainage
- Short Construction Season (high elevation)
- High water flow rate and high interface shear resistance required for geomembrane system

**Cover System Layers**

- 75 mm (6 in): Topsoil Vegetation Layer
- 1.0 m (36 in): Processed Soil/Rock Layer
- 0.5 m (18 in): Processed Cover Drain Layer

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• 335 g/sm (10 oz/sy) NW Heatset Geotextile
• 2.0 mm (80 mil) LLDPE Structured GM
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0.3 m (12 in): Processed Base Layer

**Interface Characteristics**

- Processed Base vs. Bottom Spike Texture
  - 32 deg Peak and 32 deg LD
- Processed Cover Soil vs. Top Drain Structure with Heat Set Geotextile
  - 37 deg Peak and 37 deg LD
• Water Flow Rate under 550 psf – 2.6 gpm/ft² (10 oz/sy NW Heat Set Geotextile)

Structured Geomembranes – Waste Cell Advantages

**Bottom Lining System**
- Increased Cell Capacity
- Increased Cell Stability
- Reduction in Layers (Integral Drain Layer)

**Cell Closure System**
- Increased Slope Stability
- Composite (Integral) Drain System
- Ease of Installation on Slope

**STRUCTURED GEOMEMBRANES - SUMMARY**

- Cost Effective Solution for Slope Stability and Drainage
- Consistent Quality Texture or Structure
- Reduction in CQA costs

**CONCLUSION**

Structured Flat Die extrusion methods provide a large variety of materials to give engineers and designers a wider range of materials that can more closely fit the requirements of the project they are designing for creating a greater factor of safety which is a benefit to all.