Geomembrane Fabrication and Installation

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in conjunction with

Geosynthetic Materials Association

FGI
Overview

• Quick Overview
• Geomembranes
• Fabrication
• Installation
• QC Testing
• Finished Containment System
• Summary and Questions
Factory v. Field Seaming

Clean & Controlled

Dirty & Uncontrolled
Fabricated Materials

Capable of being:
- seamed, tested, and rolled or folded in a factory
- transported, unfolded, and deployed with ease at site
- field seam and tested
Advantages

Fabricated vs. Field Assembled
## Typical Panel Sizes

<table>
<thead>
<tr>
<th>Geomembrane and Thickness</th>
<th>Weight per Area (lbs/ft²)</th>
<th>Panel Area (ft²)</th>
<th>Panel Dimensions (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 mil LLDPE</td>
<td>0.195</td>
<td>30,770</td>
<td>150 ft*205 ft</td>
</tr>
<tr>
<td>30 mil PVC</td>
<td>0.189</td>
<td>31,745</td>
<td>150 ft*210 ft</td>
</tr>
<tr>
<td>30 mil Ethylene Interpolymer Alloy (EIA)</td>
<td>0.22</td>
<td>27,270</td>
<td>150 ft*180 ft</td>
</tr>
<tr>
<td>36 mil Reinforced Polypropylene</td>
<td>0.165</td>
<td>36,360</td>
<td>180 ft*200 ft</td>
</tr>
</tbody>
</table>
## 2012 FGI Market Survey

<table>
<thead>
<tr>
<th>Manufacturer's Survey</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unsupported Geomembranes (category total)</strong></td>
<td>532,755,889 square feet</td>
</tr>
<tr>
<td><strong>Supported Geomembranes (category total)</strong></td>
<td>1,767,517,996 square feet</td>
</tr>
<tr>
<td></td>
<td>2,300,273,885 square feet</td>
</tr>
</tbody>
</table>
Fabrication

- Incoming materials
- Panel layout and design
- Welding
- QC and Testing
- Packaging
- Installation
- Testing
- Verification
Geomembrane Fabrication

- Eliminate 80% of field seams
- Are welded in a climate controlled environment
- Are made to size to fit the job
- Reduce field time and speed installations
Geomembranes

- CSPE – Chlorosulphonated Polyethylene
- EIA - Ethylene Interpolymer Alloy
- EPDM - Ethylene Propylene Diene (EPDM)
- EVOH - Ethylene Vinyl Alcohol
- fPP – Flexible polypropylene
- fPP-R – Reinforced flexible polypropylene
- HDPE – High density polyethylene
- LLDPE – Linear low density polyethylene
- Polyurethane – Polyurethane
- PVC – Polyvinyl chloride
- WCP – Woven coated polyethylene
- Scrim/reinforcement – Reinforcing fabric
Fabricated Geomembranes

- IAGI
- Lightweight Reinforced Geomembranes < 25 mil
- Heavyweight Reinforced Geomembranes > 25 mil
- Unsupported Compounded Geomembranes
  - many varieties – PVC, Thermoset Polyolefin (TPO), Ethylene Interpolymer Alloy (EIA)
Fabrication

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Incoming Materials

• Incoming materials are inspected
• Manufacturer’s test reports are reviewed
  • Mill test reports – actual tests
  • Mill Certificates – a certification
Manufacturer Certifications

- Manufactures certify to product specifications
Panel Layout and Design

- Panels are sized to fit the project
- Can be rectangular panels or shaped
Complex Panel Layout and Design
Complex Panel Layout and Design
Welding and Seaming

• A variety of welding and seaming methods
  • Hot wedge
  • Hot air
  • Dielectric or RF welding (PVC and PUR only)
  • Single welders and multi welders
  • Solvents
  • Adhesives
Welding and Seaming
Automated Solvent Seaming
Automated Solvent & RF Seaming
Automated Thermal Seaming
Complex Welding and Seaming
QC and Testing

• Guideline for frequency of testing
• ASTM D7982
  • Tests are done on each machine/operator
    • At the beginning of welding
    • Every 4 hours
    • After each shift change
  • Test welds are done with mach/operator combo
• Fabricators will also test individual liners
  • See fabricator’s literature
Factory Weld Testing

- Destructive
  - In lab
  - On shop floor
Factory Seam Testing
Unreinforced Materials
Factory Seam Testing
Reinforced Materials
Factory Weld Testing

- Non destructive
- Climate controlled
- ASTM D4437
Packaging

• Panels are accordion folded then:
  • Folded again, or
  • Rolled

• Panel size are usually limited by weight
  • Lighter materials can cover a larger area

• Wrapped in a protective wrapper
• Placed on a pallet for shipment
Factory Panel Packaging
Factory Panel Packaging

Accordion Folded Panels

Rolled Panels
Factory Panel Packaging

- 9,000 lb single piece panel
Installation

• This section covers geomembrane installation
  • Site Preparation
  • Handling Storage and Deployment
  • Welding
  • QC and Testing
  • Documentation
Site Preparation

• Subgrade Guideline for Fabricated Geomembranes
  • Subgrade smooth flat and unyielding
  • Drainage provided if base is below water table
  • No standing water
  • Free of rocks (size depends on material type)
Unacceptable Subgrade Conditions
Site Preparation – Subgrade

Grade must be smooth
Subgrade Preparation

Subgrade Preparation prior to panel deployment
Site Preparation - Underlayment

- Geotextiles can be used to cushion geomembranes
- Geo-composites can be used for rougher subgrades and high ground water applications.
Geotextile Installation

• Used as cushion for membrane materials
• Installed both under & over in many applications
• Usually nonwoven

Non-Woven Geotextile installed over geomembrane as protective layer
Handling Storage and Deployment

• ASTM D7865
  • Panel Identification
  • Unrolling/Unfolding directions
  • Rolling/Folding/Packaging/Pallets/Slings
  • Transportation
  • Deployment
Material Deployment

• One-piece liner for under tank
Material Deployment
Deploying Fabricated Panels - Machinery
Material Deployment

- Two acre pond requires only four PVC panels
- Deployed in ½ day
Material Deployment

- Only 2 field seams
- up to 80% less field seams
Field Welding

- Hot Air Welding
Field Welding
Hot Wedge Welders
Pipe Penetrations

90° Pipe Boots

Pipe Boot fabricated to slope angle
QC and Testing

• Destructive Seam Testing
  • ASTM D6214 for solvent welded materials
  • ASTM D6392 for unsupported materials
  • ASTM D7272 for tape seamed materials
  • ASTM D7749 for supported materials (grab test)
QC and Testing

• Non-destructive Seam Testing
  • ASTM D4437 Seam integrity
    • Air Lance
    • Point Stress
• Vacuum Chamber testing
  • ASTM D4437, D5641
• Air Channel Testing
  • ASTM D4437, D5820, D7177 (PVC)
• Spark Testing
  • ASTM D4437, D6365, D7240
Air Lance Seam Testing

- ASTM D4437
- 3/16” diameter nozzle
- 50 PSI
- < 2” from seam
Air Lance Seam Testing

Locate small voids or unbonded areas
Air Channel Seam Testing
PVC & fPP Air Channel Seam Testing

Aneurysm
Field QC and Testing

• Electrical Leak Location Methods
  • ASTM D 6747, D7002, D7007, and D7703
Summary

• Fabrication
  • Controlled environment
  • 80% less field seams
  • Many geomembranes installed in a single piece (tank liners)

• Installation
  • Subgrade preparation is key
  • Field seam types depend on material type
  • Destructive and non-destructive testing available
  • Optional Leak location methods
Questions
Contact Information

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**Upcoming Industry Webinar:**
Episode 1: Overview of Electrical Leak Location (ELL) 
Methods and Their Application  
*Presented by Abigail Gilson, M.S., P.E.*  
**Date:** Tuesday, November 21, 2017 @ 1:00 – 2:00pm EST  
**IGS-NA:** www.igs-na.org