Environmental Containment Using Field & Factory Fabricated Geomembranes

Richelle Delia, PhD
Owens Corning
OBJECTIVE

- Opportunity to observe two unique styles of lining systems on the same site footprint
  - Primary & secondary membrane
  - Specified by lead engineer
- Product installation performance and characteristics for seepage containment geomembranes
- Variable: Location of fabrication
- System types:
  - Field-Fabricated Lining System
  - Factory-Fabricated Lining System

STUDY DESIGN

- Installation speed
- Seam testing requirements
  - Time for completion
- Seam quality in-field and factory seams
- Total cost to site owner

Qualitative Caveat: The results presented in this report are qualitative in nature and caution should be used when interpreting them given the small sample sizes.
HOLISTIC PRODUCT ANALYSIS

- Use of qualitative and quantitative methods to understand the technical performance and context for use case
- Holistic technical evaluation
- Actionable results

Tools Leveraged
- Time Studies
- Stakeholder Interviews
- Field-installations
- Prototype Mockup & Reviews
- Decision Criteria
- Selection Motivation
- Preference

Result >> Meaningful, Differentiated Innovation
**METHODOLOGY**

- Identify two or materials, technologies with similar use cases
- Complete technical analysis
- Stakeholder mapping
- Stakeholder interviews
- Identify an appropriate test-site to verify use case
- Identify tangible, quantitative metrics

---

**USE CASE**

- New product development
- Product innovation
- Market understanding

---

**STAKEHOLDER MAP**
• 7,500 square meter (78,745 sqft) storm water retention pond
• Designed to store runoff from ash landfill operations
• 3rd party owned coal-fired power plant and residual disposal landfill
Location: Northeastern
EVALUATION CRITERIA

TOTAL INSTALL COST
- Labor skill level and time required
- Site owner 3rd party expense for QA testing
- Quality Control (QC) included in install price

INSTALL QUALITY
- Wrinkles as environment changes (potential leak locations)
- Lay flat
- Seam quality

MATERIAL DURABILITY
- Puncture resistance
- Tensile strength

FITNESS FOR USE
- Specific to material being contained
- Lasts for specified time
METHODOLOGY

Pond Specification

- 1.5 mm (60 mil) Field-Fabricated Lining System
- Geosynthetic Clay Liner (GCL)
- 1 mm (40 mil) Factory-Fabricated Lining System

Installation Protocol

1. Subgrade preparation
2. Install 1.0 mm (40 mil) factory-fabricated lining system
3. Install Geosynthetic Clay Liner
4. Install identical quantity of 1.5 mm (60 mil) field-fabricated lining system

Quantitative & Qualitative

- Installation complexity
- Labor requirements
- Stakeholder interviews
FACTORY-FABRICATED LINER FABRICATION

Rolls are seamed in a controlled setting into panels
FACTORY-FABRICATED LINER INSTALLATION

Large panels are pre-welded into custom sizes, and delivered to the jobsite.

Panels are unfolded and deployed in place.

Unfolded panels are opened and pulled across coverage area.

Field seaming is needed where panels require connection.
FACTORY-FABRICATED LINER INSTALLATION

Typically delivered in rolls:
- 6.7-7.62 meters [22-25ft] wide
- 243-275 meters [800 to 900 ft] in length
- 2 tons [4,000 lbs] in weight

Typically deployed mechanically, one roll at a time

Panels are unfolded and deployed in place
SUBGRADE PREPARATION

- Ready for the installation
- Sandbags in position to ballast membrane
- 1 pipe penetration
- Installation Company: CQA Solutions
Panel diagram “shop drawing” – created by fabricator for installers use

Fabrication Company: EPI
FACTORY FABRICATED LINING SYSTEMS INSTALLATION

3000X speed, 10 sec
FIELD FABRICATED LINING SYSTEM INSTALLATION

3000X speed, 1 min
WELDING & QA/QC

**Factory-Fabricated Liner**
- Field seams completed with single-track wedge welder
- Airlanced all factory seams

**Field-Fabricated Liner**
- Field seams completed with dual-track thermal fusion welder
- Completed air channel and destructive testing
WRINKLES

**EXAMPLE**
Photo from different installation project

FACTORY-FABRICATED

FIELD-FABRICATED
• Field-fabricated liner displays expansion with ambient temperature rise.
• This can create challenges in welding, and prevent intimate contact with the ground, thereby potentially compromising performance.
FACTORY-FABRICATED LINER WRINKLES

**EXAMPLE**
Photo from different installation project
## Stakeholder Perspectives

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Factory-Fabricated</th>
<th>Field-Fabricated</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engineer</strong></td>
<td>3 Seams</td>
<td>191 seams</td>
</tr>
<tr>
<td><strong>Specifier</strong></td>
<td>Less Documentation</td>
<td></td>
</tr>
<tr>
<td><strong>Site Owner</strong></td>
<td>Fewer Welds</td>
<td></td>
</tr>
<tr>
<td><strong>Installation Company Owner</strong></td>
<td>Puncture resistance and tensile strength higher</td>
<td>Lower puncture resistance and tensile strength</td>
</tr>
<tr>
<td></td>
<td>Fewer wrinkles</td>
<td>More wrinkles (in similar conditions)</td>
</tr>
<tr>
<td></td>
<td>Less time to install (half day)</td>
<td>More time to install (two days)</td>
</tr>
<tr>
<td></td>
<td>Pre-fabricated panels/corners</td>
<td>Field Seams</td>
</tr>
<tr>
<td></td>
<td>Fewer seams</td>
<td>More seams</td>
</tr>
<tr>
<td></td>
<td>4 panels</td>
<td>95 panels</td>
</tr>
<tr>
<td></td>
<td>Less destructive testing needed</td>
<td>More time spent for destruct testing</td>
</tr>
<tr>
<td><strong>Installation Day of Manager</strong></td>
<td></td>
<td>Have to cut product in field to seam length needed</td>
</tr>
<tr>
<td></td>
<td>Fewer QAs needed</td>
<td>More QAs over more days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Need to abrade surface</td>
</tr>
<tr>
<td>STAKEHOLDER</td>
<td>FACTORY-FABRICATED</td>
<td>FIELD-FABRICATED</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>INSTALLER</td>
<td>Quick to install</td>
<td>More panels needed</td>
</tr>
<tr>
<td></td>
<td>Wider panels/covers more</td>
<td>More destructs</td>
</tr>
<tr>
<td></td>
<td>Fewer destructs</td>
<td>11-12 crew members</td>
</tr>
<tr>
<td>CREW SIZE</td>
<td>20-25 crew members</td>
<td>More, lower skilled labor ($10-13/hr)</td>
</tr>
<tr>
<td>WELDING</td>
<td>Wedge weld</td>
<td>Hot air weld</td>
</tr>
<tr>
<td></td>
<td>Increased time finding weld setting on first experience with product</td>
<td>Installers accustomed to welding material, fast</td>
</tr>
<tr>
<td></td>
<td>Scrim could cause welding to be more difficult</td>
<td>Requires grinding before extrusion welds</td>
</tr>
<tr>
<td></td>
<td>Trial Weld</td>
<td>Trial Weld</td>
</tr>
<tr>
<td></td>
<td>Airlance prefabricated seams</td>
<td>Air channel test field seams</td>
</tr>
<tr>
<td></td>
<td>40 mm thick</td>
<td>60 mm thick</td>
</tr>
</tbody>
</table>

Estimated total for Factory-fabricated: 
5 hours 37 mins*  

Estimated total for Field-Fabricated: 
16+ hours*  

* Time associated with adverse weather conditions removed
COMPLETED INSTALLATION

Completed installation time 6 hours
Panels were welded together using a DemTech VM 20 single-track wedge welder. Average temperature setting was between 700° F and 750° F, with speed setting at approximately 14 ft/min.
“If it’s in big sections … it’s going to be much better because **you have a lot less welds** [with Factory-Fabricated Geomembrane] than you will with the normal 15 or 20 foot wide rolls.” – Site Owner

“It makes it a little more foolproof. The less seams …, the less holes, the less […]walking on it. **Ease of installation makes a big difference.**”
– Installation Company Owner

“[Factory-fabricated] Covers a lot more. With **one** [Factory-Fabricated] panel, it’d probably take you about 6/7 panels with [Field Fabricated system].” – Installer

“If the material is cheaper, performs well, installs quicker, then there is no reason not to make that change.”
– Engineer

“…when you talk about the reduction of QA time, it is very serious… **[Factory-Fabricated Geomembrane] is a big reduction in third-party cost.**”
– Installation Day of Manager
### SUMMARY

<table>
<thead>
<tr>
<th>Field-Fabricated</th>
<th>Factory-Fabricated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smaller, consistent width panels</td>
<td>Larger, customizable size panels</td>
</tr>
<tr>
<td>95 panels deployed</td>
<td>4 panels deployed</td>
</tr>
<tr>
<td>191 field seams</td>
<td>3 field seams</td>
</tr>
<tr>
<td>All Field seams</td>
<td>Factory-fabricated + field seams</td>
</tr>
<tr>
<td>Total Field Seam Length: 5387 LF</td>
<td>Total Field Seam Length: 418 LF</td>
</tr>
<tr>
<td>Length Extrusion Weld Repairs: 2145 LF</td>
<td>Length Extrusion Weld Repairs: 108 LF</td>
</tr>
<tr>
<td># Extrusion Weld Repairs: 253</td>
<td># Extrusion Weld Repairs: 12</td>
</tr>
<tr>
<td>Smaller rolls</td>
<td>Higher puncture resistance</td>
</tr>
<tr>
<td>Installer familiarity</td>
<td>Higher tensile performance</td>
</tr>
<tr>
<td>Proven field performance</td>
<td>More, low skilled labor</td>
</tr>
<tr>
<td>Fewer, high skilled labor</td>
<td>Approx. 1/3 time required to install</td>
</tr>
<tr>
<td></td>
<td>Less time, risk of subgrade exposed to elements</td>
</tr>
</tbody>
</table>

Proper material selection & due diligence considers holistic evaluation of material properties in addition to cost to site owner, test method requirements and labor costs.
Questions?

Thank You For Attending!

Richelle Delia
Owens Corning
Richelle.Delia@owenscorning.com
Richelle Delia, Ph.D.
Product Researcher
Owens Corning
Richelle.Delia@owenscorning.com

Timothy D. Stark Ph.D., P.E.
Professor of Civil & Environmental Engineering
University of Illinois at Urbana-Champaign
Technical Director
Fabricated Geomembrane Institute
tstark@Illinois.edu

Jennifer Miller, M.S.
Coordinator
Fabricated Geomembrane Institute
University of Illinois at Urbana-Champaign
fabricatedgeomembrane@gmail.com
Next FGI Webinar

Understanding Leak Location Surveys for Owners & Inspectors

Tuesday, April 28, 2020 at Noon CDT
Free to Industry Professionals
1.0 PDH

Presenter:
Matthew Kemnitz
President, Leak Location Services Inc.
Check out the FGI’s Website

- Online PDH Program
- New!! Podcasts
- Latest Specifications and Guidelines
- Installation Detail Drawings (PDF and DWG)
- Technical Papers and Journal Articles
- Webinar Library (available to view and download)
- ASTM Field and Laboratory Test Method Videos
- Pond Leakage Calculator
- Panel Weight Calculator
- Photo Gallery
- Member Directory
- Material and Equipment Guides
- Industry Events Calendar
- Women in Geosynthetics

www.fabricatedgeomembrane.com