**FGI Webinar: Best Practices for Geomembrane Penetration and Attachment Details**

**Presented by:**

Ron Frobel, P.E. (Owner/Principal, RK Frobel and Associates)
Patrick Elliott (Director of Installation Services, Colorado Lining; President, FGI)
Matthew Kemnitz (President, Leak Location Services, Inc.)

Host:
Dr. Timothy D. Stark (Professor, University of Illinois; Technical Director, Flexible Geomembrane Institute)

Date: April 11, 2024

---

## Introduction & Background

This webinar addressed the critical yet often overlooked aspect of geomembrane system design: penetration and attachment details. The presenters emphasized that while projects may invest heavily in the primary liner, inadequate attention to connection points can jeopardize the entire system's integrity. The session provided a comprehensive overview of design requirements, practical installation techniques, and quality assurance testing for various attachment scenarios. The focus was on designing these details with the same rigor as the main liner system, covering applications for both exposed and buried geomembranes in reservoirs, landfills, and containment facilities.

---

## Top of Slope & Perimeter Attachments

Anchor trench configurations for slope terminations are the primary method.

Trench dimensions: 12–36 inches wide/deep; minimum 18-inch run-out from slope edge (36-inch preferred in sandy soils).

Three main methods:

- Standard shovel-type trench
- V-trench for canals (excavated with motor grader)
- Mechanical batten bar systems with anchor bolts for concrete curbs

Specialized connection for floating covers: loop reinforced liner through fixture with rope hem, secured with high-torque half-inch anchor bolts.

Recommendation: import quality soil for backfill and compact to 95% Standard Proctor for stability.

---

**Mechanical Structure Terminations**
Batten bar and anchor bolt system is standard for concrete structures.

Anchor bolts: 3/8"–1/2" diameter, stainless steel or aluminum, set 3.5–4.5 inches deep.

Installation steps:

- Apply butyl tape to seal batten bar base to concrete
- Place EPDM or neoprene gasket on top
- Torque nuts to 15–25 ft-lbs; re-torque after 24 hours

Design preferences:

- Liner straight onto horizontal concrete shelf to avoid stress
- Maintain 4-inch clearance above grade for installer access
- Spacing: 6 inches on center underwater, 12 inches above-water
- Prefabricated strips with elongated bolt holes simplify field alignment
- Protective cap strip recommended in high-traffic/public areas

---

**Embed Strips & Extrusion Welding**
Pre-manufactured polymer strips (HDPE, PVC, PP) cast into concrete, liner extrusion-welded to strip.

Lower structural integrity than mechanical fastening; not recommended for high-stress applications.

Challenges: proper strip placement and continuity during concrete pouring; coordination with concrete contractor.

Ideal for non-critical, exposed applications or attaching pipe boot skirts with minimal stress.

---

**Horizontal & Vertical Pipe Penetrations**
Robust boot and skirt assemblies seal geomembrane to pipes.

Prefabricated boots (HDPE/reinforced) preferred for quality control.

Large pipes: banding system (e.g., Band-It®) preferred over screw clamps (suitable only for ≤6 inches, non-critical above-water).

Design considerations:

- Extend pipe sufficiently for installer access
- Use dual bands/clamps with sealant (e.g., Sicaflex-1A)
- Concrete collar isolates pipe from movement
- Prefabricated corners for square columns avoid difficult field welds

---

**Site Implementation & Installer Perspectives**
Deep reservoirs (87-foot slopes): anchor trenches require imported, well-compacted soil, 3-foot run-out, perimeter curb.

Mechanical attachments for floating covers must withstand extreme wind uplift.

Prefabricated boots allow quality welding in controlled environment; install with care:

- Leave sleeve partially open for gasket/clamp placement
- Use stainless steel bands (not hose clamps)
- Seal the end

Flat attachments preferred over wrapping columns.
Anti-bridging bars prevent liner deformation.
Regular maintenance: screw clamps can loosen; exposed details vulnerable to damage.

---

**Electrical Leak Location Testing (E-Location)**
Standards: ASTM D6747 (spark, water puddle, or dipole methods).

Isolation: ensure all current passes through potential leaks, not shunt paths.

Pipe boots: conductive liner or embedded wire enables spark testing.
Metal bands/clamps can cause false signals; note or temporarily cover.

Pre-test checklist:

- Inspect trenches
- Verify bolt torque
- Check damage
- Ensure all seals intact

Detailed drawings and QA/QC protocols available on Flexible Geomembrane Institute website.

---

**Conclusions & Recommendations**

- Penetration/attachment details require design effort equal to main liner system.
- Anchor trenches: sized for pull-out strength and soil conditions.
- Mechanical batten bar systems: robust, proper torque/sealing required.
- Embed strips: suitable for low-stress applications.
- Prefabricated pipe boots with banding: preferred over field-fabricated solutions.
- Isolation critical for electrical leak testing.
- Regular inspection/maintenance ensures long-term performance.
- Collaboration between designers, installers, and testers essential for constructability and integrity.

---

**Additional Information**
A full recording of the webinar and presentation slides were made available on the Flexible Geomembrane Institute website.

Next webinar: *Remote Sensing for Cover Integrity and Methane Emissions* (May 9, 2024).

Speakers addressed attendee questions; a follow-up podcast was provided for remaining questions.

Detailed design drawings and QA/QC resources accessible via Flexible Geomembrane Institute online resources.