Flexible Geomembrane Institute

"Reinforced Vs Unreinforced Geomembranes"

Written By Brian Fraser and Pat Elliott (FGI Members) - March 2026

This FGI article examines some of the key differences between reinforced and unreinforced geomembranes. Both geomembrane types are widely used throughout the containment industry and produced using various geomembrane polymers and thicknesses. They do however differ significantly in some of their mechanical and performance properties including tensile and tear strengths, tensile elongation, dimensional stability, and thermal expansion and contraction. Often, both a reinforced and unreinforced geomembrane of the same polymer type can be a suitable option for the same containment project.

Reinforced Geomembranes

Reinforced geomembranes also sometimes referred to as "supported," contain an internal fabric or scrim that enhances tensile strength, improves dimensional stability, and reduces thermal expansion and contraction. The scrim is most commonly manufactured from high-tenacity polyester (PET) yarn, which provides excellent tensile strength, low creep elongation (resistance to long-term stretching), and superior dimensional stability. High density polyethylene (HDPE) scrims are also used, particularly in the lighter weight grades of reinforced woven coated polyethylene (R-WCPE) geomembranes.

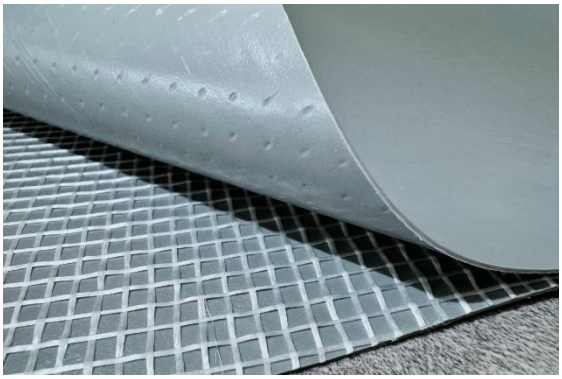

Figure 1. Photo of polyester fabric scrim geomembrane

A polyester scrim provides the geomembrane with dimensional stability under temperature fluctuations and high tensile strength. By limiting polymer movement above and below the scrim, the scrim minimizes thermal expansion and contraction, thereby reducing the potential for wrinkles in the geomembrane. To create an impervious geomembrane barrier, a polymer coating or film lamination is applied to both sides of the scrim (see Figure 1). These impermeable coatings provide the geomembrane with its low hydraulic conductivity, vapor transmission, chemical resistance, UV stability, and durability. Reinforced geomembranes are available in thicknesses typically ranging

from 30 to 60 mil (0.75 mm to 1.5 mm) and in roll stock widths from 90" to 144" (2.3 m to 3.66 m). Most standard reinforced geomembranes have good flexibility properties and can be factory fabricated into larger custom size and shaped panels. Both factory and field welding is commonly performed using thermal wedge and hot air welding methods.

Standard Reinforced Geomembranes

Typical reinforced geomembranes are listed below in alphabetical order by polymer type:

- **Chlorosulphonated Polyethylene (R-CSPE)**
- **Linear Low Density Polyethylene (R-LLDPE)**
- **Polyvinyl Chloride + EIA (Ethylene Interpolymer Alloy) (R-EIA)**
- **Polypropylene (R-PP)**
- **String Reinforced Polyethylene (R-SRP)**
- **Woven Coated Polyethylene (R-WCPE)**
- **Polyurethane (R-PU)**

Figure 2. Installation of R-WCPE Soil Remediation Cover

Common Applications

Reinforced geomembranes are widely used in most geosynthetic industry sectors including municipal water, wastewater treatment, municipal waste, mining, oil & gas, and agriculture. Their increased tensile strength makes them particularly suitable for high-stress applications including long and steep slopes, high vertical walls, and floating cover weighted trough systems. Common markets and applications include:

- **Municipal Water** – Geomembranes for bottom liner systems, floating covers, and baffle curtains for ponds, reservoirs, and underground treatment basin and clearwells.
- **Municipal Waste** – Landfill bottom liner and final cover systems and both interim and daily waste covers
- **Mining** – Geomembranes are used for mine waste covers, tailing storage areas, process water ponds
- **Oil & Gas** – Geomembranes for produced water and wastewater ponds, above ground storage tanks (AST's) (see Figure 4), secondary containment for tank farms, fuel storage, and spill control

- **Agriculture** - Anaerobic digesters cover systems, irrigation canal liners, and wastewater lagoons
- **Brownfields** – Environmental soil remediation bottom liner and cover systems as shown in Figure 2.

Unreinforced Geomembranes

Unreinforced geomembranes also known as “standard” geomembranes do not have an internal fabric or scrim and are manufactured as monolithic, homogeneous single-ply geomembranes. Typical unreinforced geomembranes include HDPE, LLDPE, and PVC. HDPE and LLDPE provide excellent chemical resistance and UV stability and can be used in longer term exposed applications. PVC geomembranes also provide very good overall chemical resistance as well as excellent flexibility, tensile elongation, and welding properties (see Figure 3). For longer term projects, unreinforced PVC geomembranes should be backfilled with a selected soil covering to prevent UV exposure. Both PVC and LLDPE materials provide very good multiaxial tensile test properties, which is important when working with poorly compacted subgrade conditions. PVC and LLDPE geomembranes can also be factory fabricated into large custom panels (see Figure 6). While HDPE is noted for its good overall chemical resistance and UV stability, it has lower yield tensile elongation properties and is not suitable for applications that require flexibility, elongation, or multiaxial tension properties. Based on its lower yield elongation properties, HDPE is also not suitable for factory fabrication and all welding needs to be performed on site using thermal fusion hot wedge and extrusion welding.

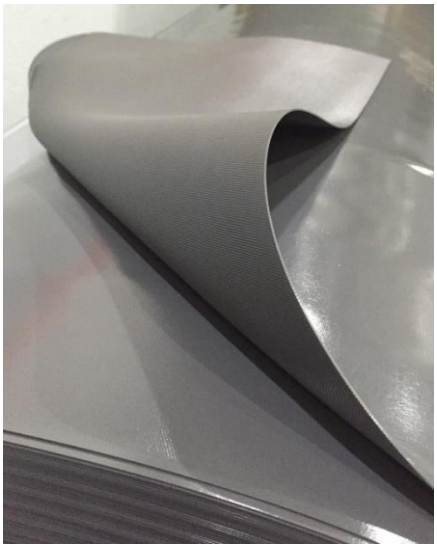

Figure 3. PVC 40 mil Geomembrane

HDPE and LLDPE are typically produced in thicknesses of 30, 40, 60, and 80 mil (0.75, 1.00, 1.5, 2.0 mm) and are available in black or white colors. A white surface color reflects UV irradiance which reduces geomembrane surface temperatures. This helps to reduce the amount of geomembrane thermal expansion and contraction, which results in wrinkles. HDPE and LLDPE are commonly produced in wider roll widths typically 23 ft (7.0 m). Standard grade PVC is normally produced in thicknesses of 20, 30, 40, and 60 mil (0.5, 0.75, 1.0, 1.5 mm) in roll widths ranging from 90” to 110” (2.3 m – 2.8 m).

Standard Unreinforced Geomembranes

Typical unreinforced geomembranes are listed below in alphabetical order by polymer type:

- **High Density Polyethylene (HDPE)**
- **Linear Low Density Polyethylene (LLDPE)**
- **Poly Vinyl Chloride (PVC)**

Fig. 4. LLDPE 40 mil installed in above ground storage tank (AST) for produce water

Applications for Unreinforced Geomembranes

Unreinforced or standard geomembranes are widely used as impermeable barriers in the main geomembrane markets. Their excellent chemical resistance, UV stability and barrier properties make them ideal for the containment of liquids and gases including water, slurries, chemicals, methane and more stringent hazardous waste. Unreinforced geomembrane markets and applications include:

- **Municipal Waste** – Geomembranes for landfill bottom liner and final cover systems and leachate ponds
- **Mining** – Geomembranes for tailing ponds, heap leach pads, and process water
- **Oil & Gas** – Geomembranes for brine ponds, mud pits, above ground storage tanks (AST's), Secondary Containment for tank farms, fuel storage, and spill control
- **Agriculture** - Anaerobic digesters, irrigation canals and reservoirs
- **Municipal Water** – Geomembranes for ponds, reservoirs, and treatment basins (see Figure 7)
- **Brownfields** – Soil remediation bottom liner and cover systems (see Figure 5)
- **Decorative Ponds** – Golf course ponds, landscape ponds, recreational parks (see Fig. 8)

Summary

Reinforced and unreinforced geomembranes offer distinct combinations of strength, durability, flexibility, and long-term performance that make them valuable across a broad range of containment applications. Because containment needs vary significantly from project to project, design engineers should carefully evaluate material properties and site-specific conditions to ensure proper geomembrane selection. No single geomembrane type is suitable for every application. Staying current on available geomembrane technologies and their appropriate uses

is essential for engineers and owners seeking optimal system performance. For additional information on geomembranes, geosynthetics, and FGI member resources, please visit the FGI website at www.thefgi.org.

Figure 5. Deployment of fabricated reinforced LLDPE (R-LLDPE) panels for produced water pond

Figure 6. Deployment of fabricated 40 mil LLDPE panels for above ground storage tank.

Figure 7. Installed weighted tensioned trough 45 mil R-CSPE floating cover for potable water.

Figure 8. Factory fabricated PVC geomembrane panels being installed for a golf course pond

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