

Geomembrane Welding: Split Wedge vs. Solid Wedge

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A common question in the geomembrane industry is whether a split wedge or a solid wedge is the better choice, and why. This article examines the key differences between split-wedge (dual-track) and solid-wedge systems for geomembrane welding.

The answer is not always straightforward. The appropriate wedge configuration depends on factors including the geomembrane polymer, whether the material is reinforced or unreinforced, material thickness, project specifications, quality-control and quality-assurance requirements, and whether welding is performed in the field or in a controlled factory environment.

Thermal wedge welding is one of the most widely used methods for joining thermoplastic geomembranes in both factory and field applications. A heated metal wedge passes between overlapping sheets, transferring heat to the mating surfaces. Pressure rollers then bring the heated surfaces into intimate contact, allowing polymer-chain interdiffusion to produce a strong, uniform fusion seam. When properly controlled, the seam can achieve tensile performance comparable to the parent geomembrane.

Copper-alloy wedges provide excellent thermal conductivity and are normally recommended for welding polyolefin geomembranes, including HDPE, LLDPE and PP, helping to maintain consistent weld temperatures and efficient production rates. Stainless-steel wedges have lower thermal conductivity versus copper wedges and are commonly used for PVC and PVC/EIA geomembranes because of their superior resistance to corrosion from acidic by-products generated when chlorine base materials are heated during welding.

Split and solid wedges are typically about 2 in. (50 mm) wide, although wider solid wedges, including 3 in. (76 mm) versions, are used with some reinforced materials to encapsulate exposed edges and reduce the potential for wicking. Figures 1 and 2 show an illustration of a 2-inch copper-alloy split wedge and a 2-in. stainless-steel alloy solid wedge, respectively.

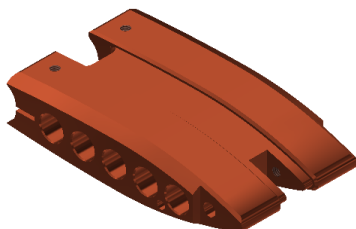


Figure 2. Copper Split Wedge



Figure 1 Stainless Steel Solid Wedge

Three Critical Welding Variables

Regardless of wedge type, seam quality depends on the interaction of three key welding parameters:

- **Temperature:** Sufficient heat must be transferred to the mating surfaces to achieve fusion without thermally degrading the polymer. Machine temperature settings vary with material, thickness, wedge design, travel speed, sheet temperature, and ambient conditions; settings in the approximate range of 320°C to 460°C (608°F to 860°F) are commonly encountered on standard wedge welders.
- **Pressure:** Geomembrane wedge welders use silicone/rubber or steel nip rollers to apply consolidation pressure. Depending on the machine, pressure may be adjusted by a spring-loaded mechanism, pressure lever, or screw/cam arrangement. Adequate and repeatable pressure is required to bring the heated surfaces together and maintain intimate contact during fusion.
- **Welding Speed:** Travel speed controls the time available for heat transfer and must be balanced with temperature and pressure. Excessive speed can result in insufficient heating and an under-fused seam, while overly slow travel can overheat or thermally degrade the material. Incorrect combinations of these parameters can also produce misleading surface appearances. For example, excessive heat and pressure combined with low travel speed may soften the surface and force molten material from the weld zone, while fusion at the interface remains inadequate, a condition often referred to as a "cold weld." For this reason, temperature, speed, and pressure should be evaluated together rather than as independent settings. Material type and thickness, sheet temperature, welding equipment, and ambient conditions must also be considered when establishing welding parameters.

Split Wedge (Dual-Track) Welders

A split-wedge welder creates two parallel weld tracks separated by a continuous internal air channel. This configuration is widely used for critical containment applications because the channel enables non-destructive air-pressure evaluation of long production seams. Split-wedge welding is commonly used with unreinforced thermoplastic geomembranes including HDPE, LLDPE and PVC and may also be used with suitable reinforced materials. Figure 3 shows a 2-in. stainless-steel split wedge.

Design: Uses a split/dual heated wedge to form two distinct parallel weld tracks separated by a small, unbonded central air channel.

Testing Capability: Allows non-destructive air-channel pressure testing. The ends of the channel are sealed and the channel is pressurized in accordance with the applicable test procedure to evaluate the continuity and integrity of the dual-track seam.

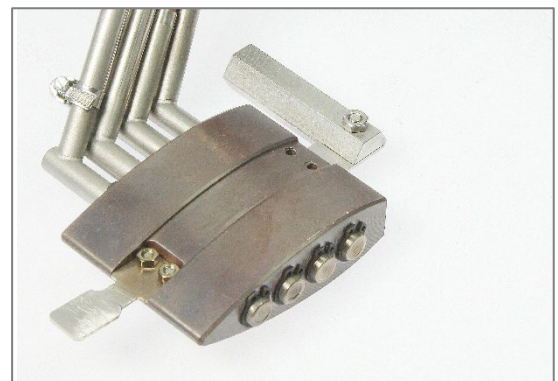


Figure 3. Leister stainless steel split wedge

Best Used For: Commonly used for unreinforced smooth or textured geomembranes, including HDPE, LLDPE and PVC, where project specifications require air-channel testing of production seams. Suitability ultimately depends on the material and project requirements.

Advantages

- Allows non-destructive air channel pressure testing.
- Provides continuous verification of seam integrity.
- Quickly identifies leaks or discontinuities.
- Commonly specified for projects with stringent construction quality assurance (CQA).
- Enables rapid non-destructive evaluation of long seam lengths; however, air-channel pressure testing evaluates seam continuity and leak integrity and does not replace destructive peel and shear testing where such testing is required by the project specification.
- Widely accepted for more critical environmental containment applications.

Solid Wedge (Single Track) Welders

A solid-wedge welder produces a single continuous fusion seam across the overlap, maximizing the bonded width. This configuration is commonly used for reinforced geomembranes because a continuous bond can encapsulate exposed reinforcement at the sheet edge and reduce potential pathways for capillary wicking or leakage. Solid-wedge welding may also be appropriate for certain thin unreinforced geomembranes where forming and maintaining a stable air channel is difficult. Solid wedges are widely used in controlled factory-fabrication operations; however, many modern fabrication facilities can also produce split-wedge seams and perform air-channel pressure testing when required by the material system or project specification.

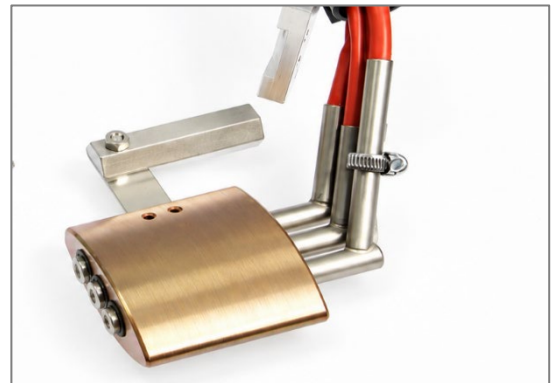


Figure 4. Leister copper solid wedge

Design: Uses a single solid heated wedge to fuse the overlapped sheets into one continuous bond. The finished weld width depends on the wedge and machine configuration and is commonly about 25 mm (1 in.) or greater.

Testing Capability: A solid-wedge seam has no internal air channel and therefore cannot be evaluated by pressurized air-channel testing. Seam integrity is instead assessed using the destructive and/or alternative non-destructive methods specified for the material and project, which may include peel/shear testing, vacuum-box testing, air-lance testing, electrical leak-location methods, or mechanical point-stress testing where applicable.

Best Used For: Factory and field welding of flexible geomembranes including reinforced and certain very thin, unreinforced geomembranes (<0.75 mm / 30 mil) when reliable air-lance testing is impractical. In certain reinforced materials, exposed scrim or fabric reinforcement can create leakage paths within a split-wedge air channel, causing pressure loss that does not necessarily indicate

defective weld tracks. In these cases, solid-wedge welding with alternative verification methods may be more appropriate. Solid wedges are sometimes used on longer tie-in seams where the older material cannot be properly cleaned up and trimmed enough for a proper extrusion fillet weld. In this application, solid-wedge welding can often produce a higher-quality seam while reducing the physical demands on liner installation technicians.

Advantages

- Simple and efficient welding process.
- Provides a full weld width.
- Well suited for reinforced geomembranes and thinner gauge flexible geomembranes.
- Ideal for controlled factory fabrication environments.
- Can produce highly consistent seams when the welding parameters, material preparation, equipment condition, and operating procedures are properly controlled.
- Provides excellent seam performance where air-channel testing is impractical.
- Allows direct visual examination of the full continuous weld surface and edges as part of routine workmanship inspection, supplemented by the specified destructive and non-destructive test methods.
- Well suited to documented factory quality-control programs using controlled procedures, calibrated equipment, and routine seam testing.

Considerations

Although air-channel pressure testing is not available for a solid-wedge seam, factory fabrication can provide controlled environmental conditions, documented welding procedures, equipment monitoring, and routine destructive and non-destructive testing. These controls can support highly repeatable seam quality. Experienced fabrication plants normally use either solid or split wedges according to the geomembrane construction and project specification.

Quality Assurance Considerations

Quality-assurance requirements should be established for the geomembrane system and project, regardless of whether a split or solid wedge is used. The principal difference is not that one weld type is inherently stronger or subject to a lower quality standard; rather, the available verification methods differ. When correctly produced in the same compatible material, both configurations can develop high-performance fusion seams. A split wedge provides an internal air channel for continuous pressure evaluation, whereas a solid wedge requires other specified destructive and/or non-destructive verification methods.

For many containment applications, including landfills, mining facilities, and other critical containment projects, specifications require non-destructive air-channel testing of field seams. In these cases, a split-wedge seam is commonly specified because its dual-track geometry creates a continuous air channel that enables this test method.

Factory fabricated panels are normally produced under controlled manufacturing procedures and conditions using calibrated equipment and routine quality-control testing. Depending on the material construction and project requirements, fabricators may use either solid- or split-wedge welding. Solid-wedge welding is often preferred when an air channel is impractical or when non-destructive air-channel testing is not required.

Most importantly, long-term seam performance depends on correct welding procedures, qualified technicians, surface preparation, appropriate and controlled temperature-speed-pressure settings, equipment condition and calibration, and a robust quality-control/quality-assurance program rather than on wedge configuration alone. Table 1 provides a summary comparison of each wedge.

Table 1 - Comparison at a Glance

Feature	Split Wedge	Solid Wedge
Weld Design	Dual-track seam with internal air channel	Single continuous fusion seam
Air-Channel Pressure Testing	Yes	No
Non-Destructive Verification	Air-channel pressure testing; other methods as specified	Alternative NDT methods as specified, e.g., vacuum box, air lance, electrical leak location, or mechanical point-stress methods where applicable
Welded Surface Area	Two weld tracks separated by an air channel	Continuous bonded full wedge width
Quality Verification	Air-channel testing plus destructive peel/shear testing as specified	Destructive peel/shear testing plus applicable alternative NDT methods
Typical Materials	Commonly HDPE, LLDPE and other suitable geomembranes; some reinforced materials	Commonly reinforced – RPE, WCPE, RPP, R-LLDPE and thinner unreinforced flexible geomembranes (PVC, LLDPE, PP) where a continuous seam is advantageous
Common Applications	Field containment seams requiring air-channel testing	Factory-fabricated panels, reinforced materials, and applications where air-channel testing is impractical

Summary

Split- and solid-wedge welding are proven methods for producing high-performance geomembrane seams; neither is inherently stronger than the other because of its geometry. The appropriate method depends on the geomembrane construction, application, welding environment, project specifications, and required CQA/CQC verification methods.

Where project specifications require non-destructive air-channel evaluation, split-wedge welding provides a practical means of testing long seam lengths in the field. For reinforced or thinner flexible geomembranes, and for factory-fabricated panels where an air channel may be impractical, solid-wedge welding can provide an efficient continuous fusion seam. Many geomembrane fabrication facilities today provide both wedge configuration options. Solid wedges are also used in the field on longer tie-in seams where the older existing material cannot be properly cleaned up enough for a proper extrusion fillet weld.

Ultimately, successful geomembrane welding depends on qualified and skilled technicians, validated welding procedures, appropriate control of temperature, speed and pressure, calibrated and well-maintained equipment, and a robust quality-control and quality-assurance program, regardless of the wedge type used. Figures 5, 6 and 7, from left to right, show examples of geomembrane wedge welders supplied by Leister, Demtech and DMS Welding. These machines are available with both split and solid wedges.



Figure 5. Leister GEOSTAR G7 LQS



Figure 6. Demtech Pro-Wedge with Auto Gauge



Figure 7. DMS Equipment Badass 300

References and Guidelines

- **ASTM D4437/D4437M:** Standard Practice for Nondestructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
- **ASTM D5820-23:** Standard Practice for Pressurized Air Channel Evaluation of Dual-Seamed Geomembranes.
- **ASTM D7177/D7177M-21:** Standard Specification for Air Channel Evaluation of Polyvinyl Chloride (PVC) Dual Track Seamed Geomembranes.
- **FGI 10-2024, Factory Fabrication Guideline:** Guidance for a minimum quality-control (QC) system for factory fabrication, testing, packaging, handling, and shipping of flexible geomembrane panels: <https://www.thefgi.org/protected/fgi-guidelines>
- **FGI - Flexible Geomembrane Terminology:** <https://www.thefgi.org/protected/geomembrane-guide>
- **FGI – Online Geomembrane Welding Basic Training Courses, Part 1, 2, 3, 4:** <https://www.thefgi.org/resources/cqa-certification>
- **GRI-GM19:** Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes. See the Geosynthetic Institute specifications page: <https://geosynthetic-institute.org/specs.htm>
- **GRI-GM30:** Test Methods, Test Properties and Testing Frequency for Reinforced Composite Polyethylene (RCPE) Geomembranes. See the Geosynthetic Institute specifications page: <https://geosynthetic-institute.org/specs.htm>
- **IAGI Installation Guidelines:** Guidance for installation of HDPE, LLDPE, PVC and reinforced geomembranes: <https://www.iagi.org/installation-guidelines>
- **IAGI Certified Welding Technician Program (CWT):** <https://www.iagi.org/about-cwt>

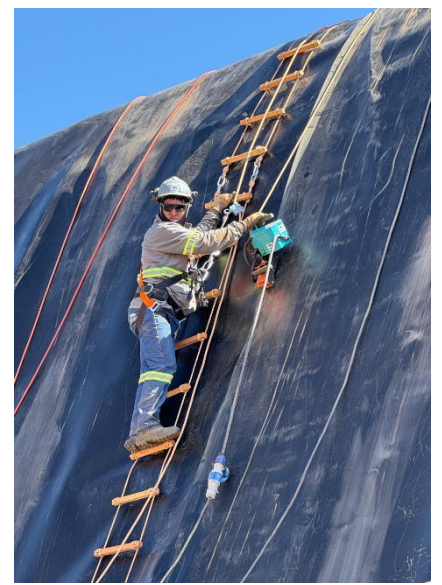


Figure 8, 9, 10. Manufactures Wedge Welders (Left to Right) – Leister, Demtech, DMS Welding Solutions