



Welding Guide for Coated Fabrics

800.927.8578 | info@seamancorp.com
seamancorp.com



Welding Guide for Coated Fabrics

Introduction | 1

Purpose | 1

About Seaman Corporation | 1

I The Science of Welding | 2

The Welding Triangle | 2

Defining Weld Quality | 3

Welding Parameters & Effects on Performance | 4

II Fabrication and Welding Fundamentals | 6

Best Practices | 6

Applications for Welding | 7

Concerns when Welding | 7

III Introduction to Weld Methods | 8

Hot Air | 8

Wedge | 11

RF (Radio Frequency) | 14

Extrusion | 17

Conclusion | 20

Introduction

Purpose

Coated fabrics are essential in applications ranging from architecture to industrial containment. Welding is a critical fabrication method for these materials, enabling strong, seamless bonding without adhesives or fasteners. Due to the wide range of polymer chemistries, welding parameters must be carefully matched to each material and use case. This guide examines the science behind welding, compares four primary welding methods - hot air, hot wedge, radio frequency (RF), and extrusion - and outlines best practices and precautions to ensure reliable, high-quality welds.

About Seaman Corporation

Seaman Corporation is a family-owned business founded in 1949. Headquartered in Wooster, Ohio, with additional manufacturing in Bristol, Tennessee, we employ over 450 associates companywide. As a global leader in high-performance industrial coated fabrics, we deliver advanced coated fabric solutions for single-ply roofing, geomembranes, architectural structures, and recreational applications around the world.

For over seven decades, we have remained committed to innovation, quality, and performance, ensuring protection where it matters most. Through strategic vertical integration, we control every stage of the manufacturing process to ensure unmatched product reliability and customer satisfaction. At Seaman Corporation, we continually advance the design, production, and application of industrial fabrics to exceed expectations and bring peace of mind when the stakes are high.

I. The Science of Welding

The Welding Triangle

The complicated science of welding can be distilled into three critical independent variables and one dependent variable for all techniques:

- **Pressure** is the force exerted on the materials during the energy transfer phase, ensuring contact between polymer layers.
- **Speed** is the period when the materials remain under pressure and energy input to allow proper fusion. Depending on the technique, this can be measured as cycle time (for stationary welds) or as the rate of travel in length per minute (for continuous welding).
- **Dwell** refers to the time a material is exposed to heat and pressure during the welding process. While not controlled directly, it is a factor of speed. As speed increases, dwell decreases.
- **Energy or Heat Transfer** is commonly referred to as heat when welding, but this is only the case when hot air, wedge, and extrusion welding. RF performs energy transfer by different means.

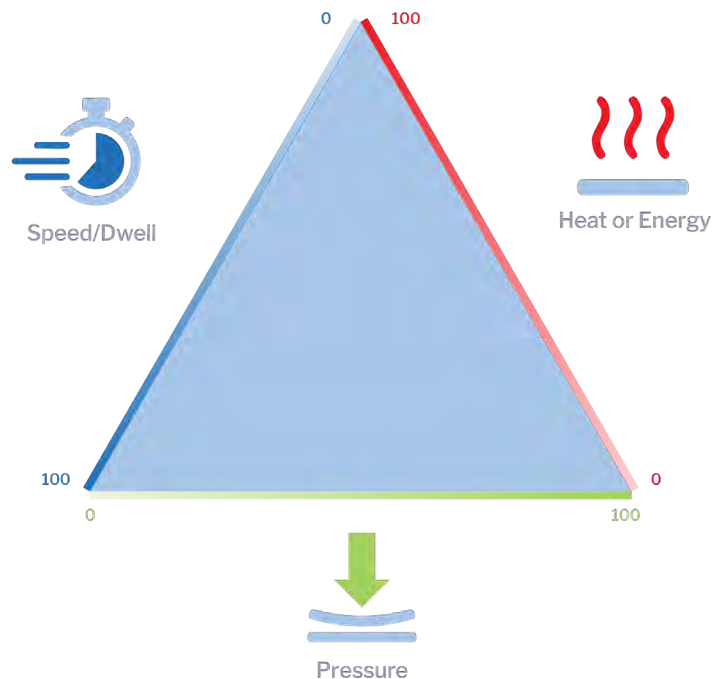


fig 1 | Welding triangles describe the relationship between pressure, speed, and heat. Due to their zero-sum relationship (pressure + dwell + heat = 100), one must carefully tune the welder to address the welding region (point where the fabrics' coatings will start to bond) and sweet spot (point that results in an optimum weld).

When trying to imagine how these variables interact, a helpful image would be that of a triangle, in which heat, pressure, and dwell parameters create a triangle, when one variable increases, another decreases [fig 1]. When looking at each variable, it becomes apparent that doing all of one single variable will not lead to a good weld. Therefore, the three variables must be used in combination to achieve an acceptable weld and will vary for different fabrics.

Defining Weld Quality

The quality of welded seams in coated fabrics is typically evaluated through destructive testing; two common methods used in the field being seam shear and peel adhesion. In seam shear testing, pulling forces are applied perpendicular to the weld [fig 2a]. A strong weld typically fails in the bulk textile material rather than at the seam itself [fig 2c], indicating that the weld is stronger than the surrounding fabric.

In peel adhesion testing, forces are applied parallel to the weld [fig 2b]. Here, failure usually occurs at the seam, where one layer of textile separates from the bulk material [fig 2d]. This test is particularly useful for evaluating the bond strength at the interface.

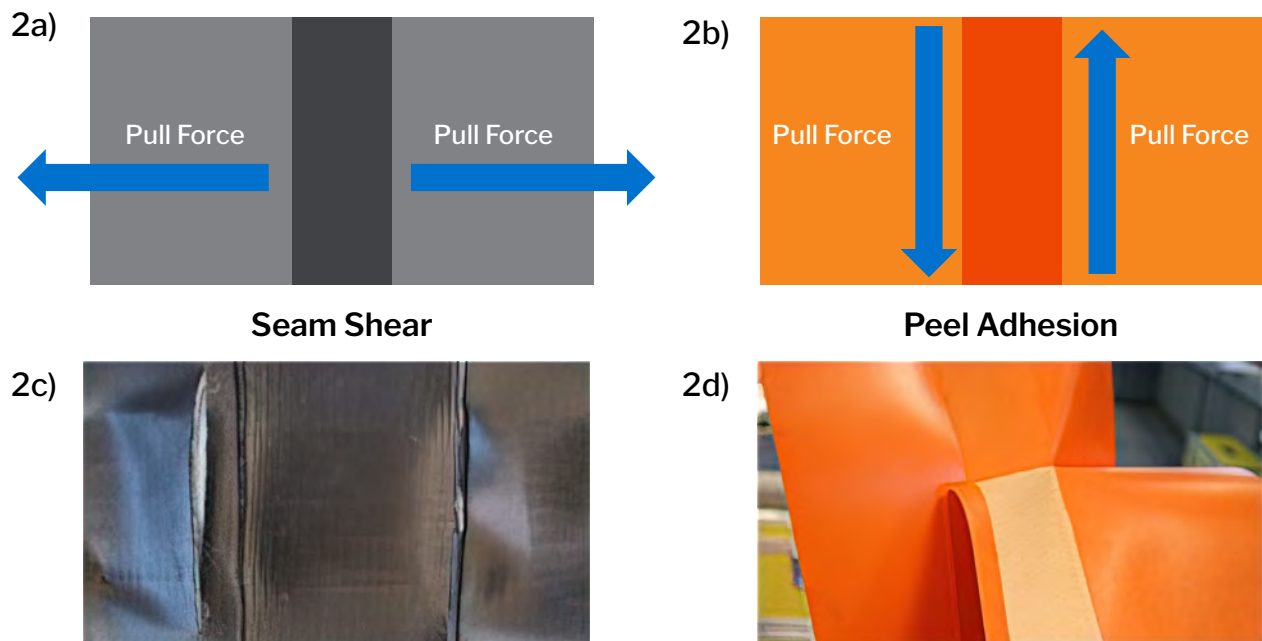


fig 2 a-d | Summary of destructive tests typically used seam shear (a) and peel adhesion (b) and the subsequent results of a “good weld” with failure of the bulk textile for seam shear (c) and failure at the weld’s textile (d)

To distinguish between “good” and “bad” welds, both visual inspection and mechanical performance should be considered. A good weld will meet or exceed the manufacturer’s specifications, while a poor weld may show signs of separation, uneven bonding, or fall short in strength tests. In cases where specifications are not provided, industry standards and guidance from organizations such as GSI (*Geosynthetic Institute*), FGI (*Fabricated Geomembrane Institute*), IAGI (*International Association of Geosynthetic Installers*), or CQA (*Construction Quality Assurance*) literature should be referenced.

To ensure traceability and accountability, it is essential to maintain thorough documentation of welding parameters, inspection procedures, and test results throughout the installation process.

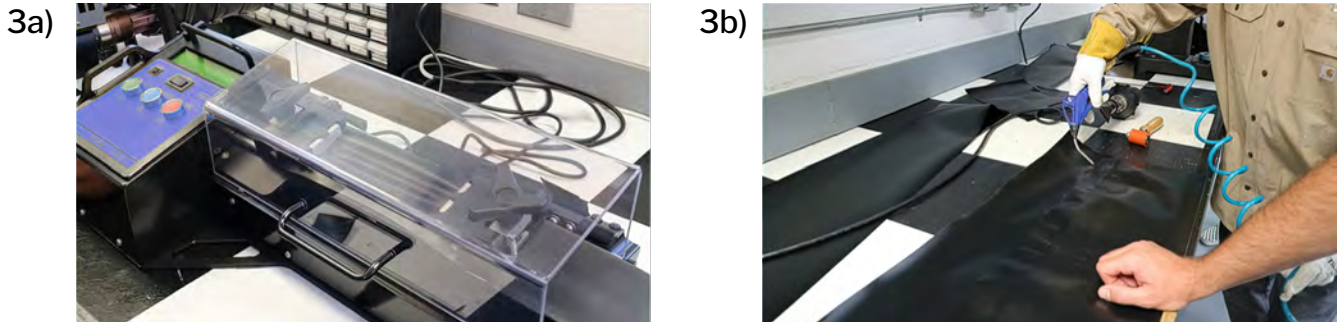


fig 3 a-b | Examples of different methods to test the quality of the weld.

Welding Parameters & Effects on Performance

Producing a high-quality weld requires careful balance of three key parameters: heat, pressure, and speed often referred to as the welding triangle. Each parameter has a “Goldilocks zone” specific to the welding method and material, where conditions are just right to form a durable, high-performing seam.



Heat

Heat must be sufficient to melt the polymer without causing degradation. Visual cues help identify heat levels:

- Too little heat: No color or gloss change or edge flow [Fig 4a].
- Optimal heat: Slight sheen and small, uniform ripples [Fig 4].
- Too much heat: Excessive sheen, large ripples, excessive melt flow [Fig 4c].

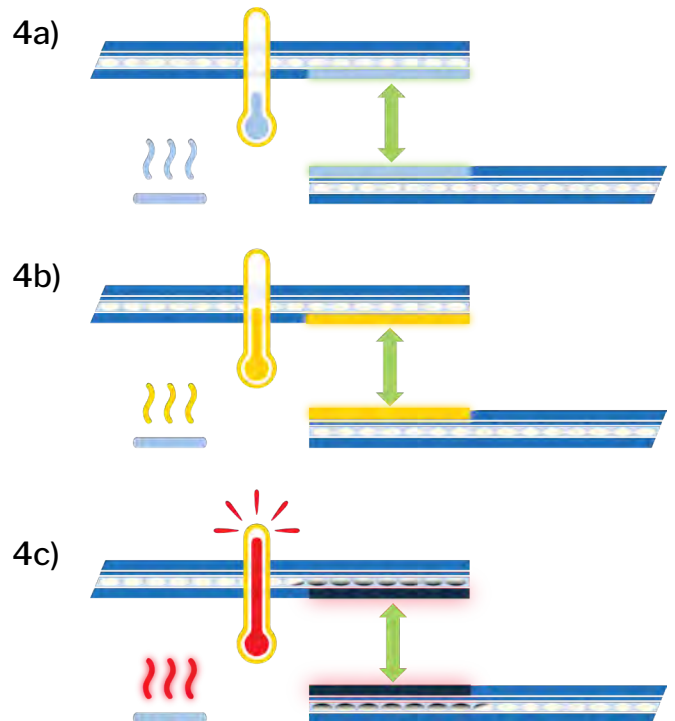
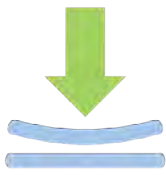


fig 4 a-c | Idealized diagram explaining the effects of how variations in heating can lead to different types of welds: a) Inadequate heating leads to no material property change, b) enough heat to begin melting polymer and deforming the coating at the seam, c) overheating leading to coating and fabric degradation at seam and deformities away from seam.

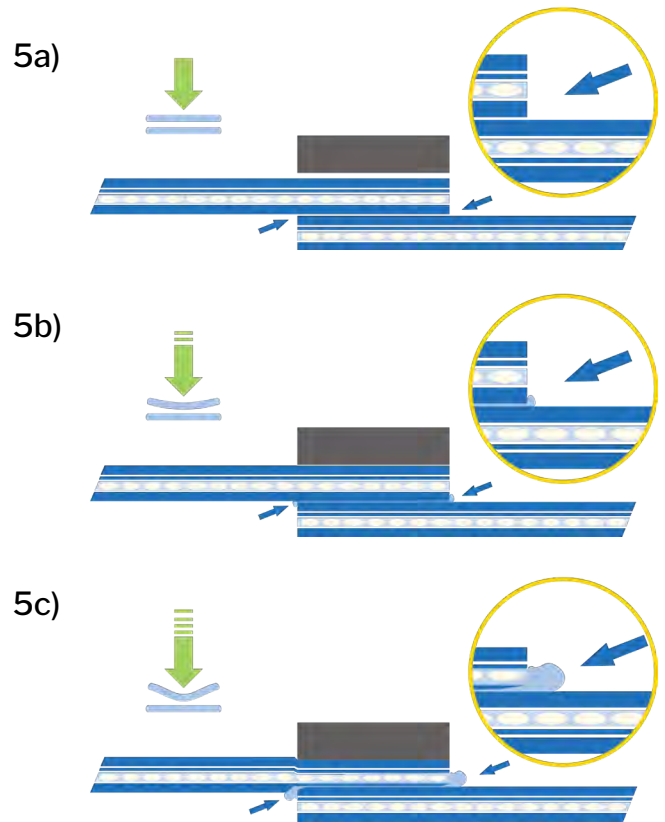


Pressure

Like heat, pressure influences polymer flow at the seam:

- Too little pressure: Panels stick but lack material intermingling; no material flow [Fig 5a].
- Optimal pressure: Controlled flow and intermingling of polymers; meets performance specs [Fig5b].
- Too much pressure: Excessive material flow displaces polymer, weakening the seam [Fig 5c].

fig 5 a-c | Idealized diagram explaining the effects how variations in pressure can lead to different types of welds: a) Inadequate pressure leads to coatings intermingling without material flow at seams, b) adequate pressure leads to coatings intermingling with melt flow at the seams, c) too much pressure leads to textile contact and severe flow of polymer from composite.



Speed

Welding speed affects dwell, or exposure time to heat and pressure:

- Too slow: Over-welding, risking material degradation.
- Too fast: Under-welding, leading to weak seams. Operators often prioritize speed for productivity, but must remain vigilant for signs of under-welding and adjust accordingly

II. Fabrication and Welding Fundamentals

Just as a chain is only as strong as its weakest link, a coated fabric is only as durable as the method that bonds its panels. Welding is the preferred method for fabricating coated fabrics due to its ability to create durable, leak-proof seams. Unlike adhesives or stitching, welding forms a direct physical bond between panels, allowing the chemical and weather-resistant properties of the base material to extend seamlessly across the joint. Welding provides a cost-effective, quality option for bonding fabric panels.

The tradeoff to welding is that its success is highly dependent on technique. Poor welds can compromise the structure, leaving the underlying material susceptible to damage. To achieve high-quality, reliable welds, it is essential to select the appropriate welding method for the material and application, follow established best practices, and proactively address potential issues.

Best Practices

i. Avoiding Common Defects

To ensure reliable seams and maintain weld integrity, watch for these common issues and their cause:

Burn-through:	
Problem 	Degrading coating and fabric, leading to poorer performance
Cause 	Excessive heat or slow welding speed
Solution: 	Lower temperature and/or increase speed (Verify on test weld)

Cold Welds:	
Problem 	Weak bonding of panels, leading to poorer performance
Cause 	Insufficient heat and/or pressure
Solution: 	Increase heat and/or pressure (Verify on test weld)

Misalignment:	
Problem 	Insufficient overlap of panels, leading to poorer performance
Cause 	Improper overlap or tension when welding
Solution: 	Properly set up and monitor during welding

Surface Contamination:	
Problem 	Weak bonds due to interference by dirt, dust, oils, grease, or moisture
Cause 	Welding surface is dirty
Solution 	Clean welding surface and welding equipment of any dirt, oils, grease, moisture or burnt material

ii. Safety

Maintaining a safe welding environment is essential to protect both personnel while assuring work quality. Operators should:

- Wear appropriate personal protective equipment (PPE)
- Ensure proper ventilation to avoid inhalation of fumes
- Follow equipment operating and safe handling procedures

Additionally, clear safety protocols help prevent accidents and reduce risks associated with high temperatures, electrical equipment, and potentially hazardous fumes.

iii. Equipment Maintenance

Consistent, high-quality welds depend on regular maintenance of welding equipment. Machines should be routinely inspected, cleaned, and calibrated according to manufacturer specifications. When found, worn components must be replaced promptly to prevent inconsistent welds and avoid equipment damage. This preventative maintenance not only minimizes mechanical failures and extends equipment life but also ensures stable welding parameters and ensures long-lasting installation.

Applications for Welding

As stated above, welding is a robust and versatile technique for bonding across a wide range of industries. Given the diversity of material chemistries and system requirements, operators must understand the specific needs of each application to ensure durable, long-lasting welds.

Selecting the appropriate welding method depends on the equipment, the demands of the final product, and the intended use. Broadly speaking, hot air and wedge welding are commonly used in geomembrane and roofing applications due to their efficiency and adaptability. Radio frequency (RF) welding is preferred in architectural fabric fabrication for its precision, consistency, and time efficiencies during factory fabrication. Extrusion welding is primarily used in geomembrane installations where added structural protection is required.

Concerns When Welding

While welding has the potential to offer many benefits, attention to detail is essential to avoid quality issues and ensure safe, reliable performance. The following are five potential concerns when welding.

Equipment Calibration:	Incorrect temperature, speed, or pressure can produce weak welds and damage the fabric or discolor the coatings. Regularly calibrating and maintaining machines at the start of every shift or post maintenance is crucial.
Material Compatibility:	Not all fabrics are weldable. Use manufacturer guidelines to ensure compatibility.
Surface Cleanliness:	Dust, grease, or moisture can inhibit or prevent bonding. Always ensure surfaces are clean and dry before welding.
Environmental Conditions:	Humidity, temperatures or precipitation influences weld quality. Only weld in desirable conditions.
Inspection:	Always perform visual and mechanical seam inspections. Skipping checks can lead to premature failures.

III. Introduction to Weld Methods

While understanding science is critical to appreciating a good weld, one's equipment is arguably more paramount. This section will explore methods of welding, how they work, the required equipment, suitable applications, and general guidelines for process settings. Understanding these fundamentals is essential for selecting the right technique based on material type, performance requirements, and end-use conditions.

Hot Air Welding

How It Works

Hot air welding uses convection heating to bond two panels. A controlled stream of heated air is directed between two overlapping panels, melting the surface coatings. Once the polymers reach their melting point, the panels are immediately pressed together using a roller, forming a fused seam as the material cools. This process creates a durable, waterproof seam, making it ideal for applications requiring flexibility and environmental resistance.

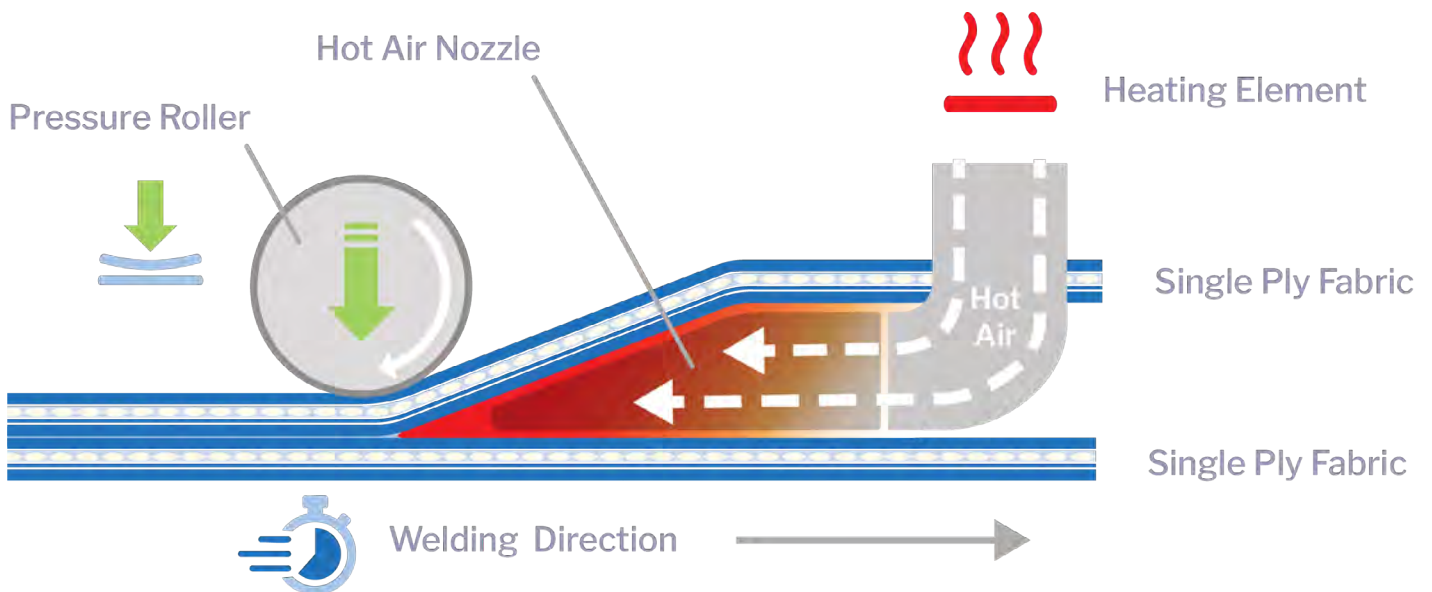


fig 6 | Lateral view of how hot air welding works and how the three key parameters come into play.

Equipment

Hot air welders are available in various configurations to meet the needs of different fabrication tasks. The two most used styles are handheld and self-propelled welders. Handheld welders are ideal for detailing, repairs, and short weld lengths where precision and maneuverability are required [Fig 7a]. Self-propelled welders are designed for longer, continuous welds in less complex areas, offering consistent speed and pressure control [Fig 7b].

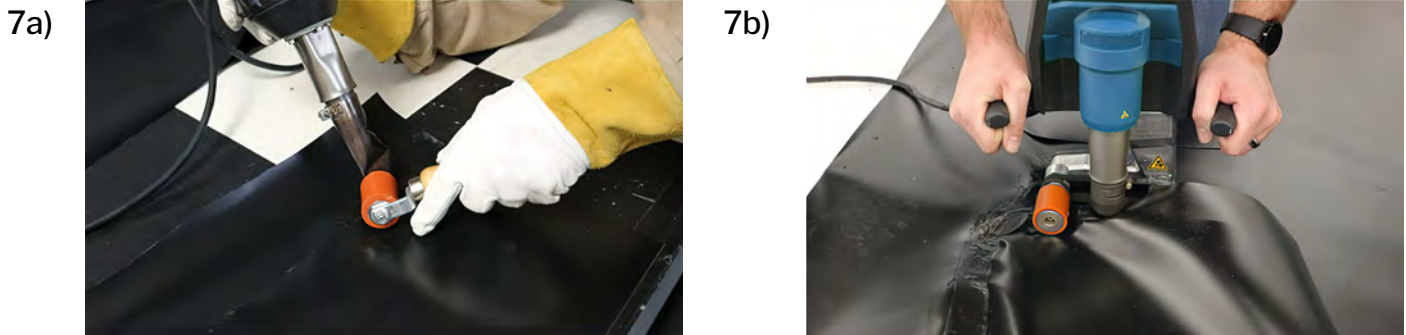


fig 7 | Popular styles of welders: a) handheld and b) self-propelled.

Modern hot air welding machines often feature advanced controls for temperature, speed, and pressure, along with data logging capabilities to record the settings used during each weld. These enhancements improve process repeatability and quality assurance.

Applications

Hot air welding is highly valued for its versatility and equipment customizability, making it suitable across a broad range of industries and fabrication designs. One of its key strengths lies in the availability of both automated and handheld configurations, each serving distinct roles in the field.

Automated hot air welders are preferred for long field laps due to their ability to deliver consistent, high-quality welds over extended lengths. These machines maintain uniform heat, pressure, and speed, reducing operator fatigue and significantly boosting productivity.

Hot air welder's compact design and customizable nozzles allow operators to weld within complex geometries and confined spaces, which is especially critical in roofing, architectural, and geomembrane installations. When precision and mobility are required, such as in patching or fabricating deployable items, handheld hot air welders are the tool of choice.

Recommended Initial Welding Settings and Best Practices

When beginning to weld, it is important to remember that ideal welding conditions are variable and will likely differ from the previous welding conditions. This is primarily due to environmental conditions, but can differ slightly by operator and handling. When first setting up an automated hot air welder, a nominal temperature to start with (based on internal testing) is 900°F at a speed of 10 feet (3 meters) per minute for KEE roofing or EIA coated fabrics. Thinner materials such as architectural fabrics consisting of PVC start at 12 feet (4 meters) per minute.

After one performs a test weld, they should check the weld for proper melt flow and symmetry on each side. Once completely cooled (not partially, or lukewarm), pull the panels apart in looking for complete coating removal from the fabric. If a field tensiometer is available pull a weld sample in the shear direction to ensure the failure does not occur in the welded area. If the weld resembles a bad weld, adjust temperature or speed to correct. Operating a hand welder is a slower process as a result the heat of the hand welder should start around 570°F. If able, do some test welds before welding a patch and adjust as needed.

Hot Air Welding

PROS

- Versatile equipment designs make hot air welding adaptable to many job types
- A variety of tips allow precise heat application, making it easier to work with complex shapes or tight areas
- The handheld hot air welder is typically used in applications requiring detailing, field repair, etc.

CONS

- Can be slower than other welding methods
- Performance is more sensitive to environmental conditions due to the open-air nature of the process

Wedge Welding

How It Works

Unlike hot air welding, which uses convection to indirectly melt the material, wedge welding applies direct contact heat. In this method, two overlapping sheets are passed over a heated metal wedge [Fig 8], which directly melts the polymer surfaces. Immediately after heating, the materials are pressed together under controlled pressure, forming a uniform, continuous seam as they cool.

This direct heating approach allows for precise control and is especially effective for long, straight welds in applications such as geomembranes and roofing systems.

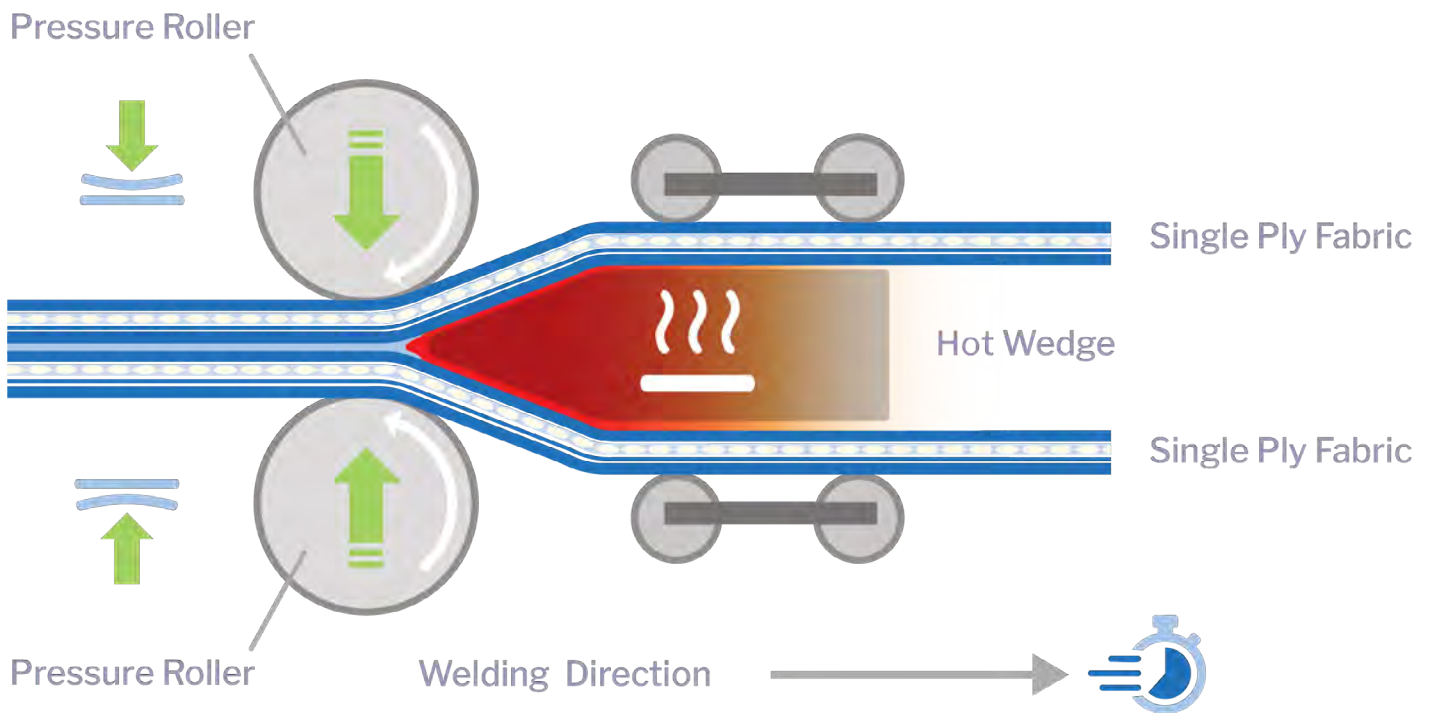


fig 8 | Lateral view of what is occurring during wedge welding.

Equipment

Wedge welding is widely adopted, particularly in the fabrication of geomembranes. These machines offer precise control over the key welding parameters, including temperature (°F), pressure (psi), and speed (feet per minute), making them ideal for producing consistent, high-quality seams.

Advanced wedge welding systems often include data logging capabilities, allowing operators to record weld parameters in real time. This feature is especially important for international projects, where traceable quality documentation is required to meet regulatory and performance standards.



fig 9 | This is an example of a wedge welder.

Applications

Wedge welding, like hot air welding, is versatile and can be used across a wide range of applications. However, it is most employed during the initial fabrication of membranes, rather than for patchwork or detailing. The type of membrane being welded influences the fabrication location, wedge composition, and welder settings.

Fabrication Location

- **Field Fabrication:** Used for stiffer materials (e.g., HDPE) that cannot be folded or rerolled after welding. These are welded on-site.
- **Factory Fabrication:** Used for flexible materials that can be repackaged and transported post-welding.
- Regardless of location, wedge welders perform best on flat, stable surfaces with clean, dry panels, ensuring optimal seam integrity.

Wedge Composition and Material Compatibility

Selecting the correct wedge material is essential for equipment longevity and weld quality:

- **Copper Wedges:** Recommended for polypropylene (PP), polyethylene (PE), and urethane (PU) due to their thermal conductivity and compatibility.
- **Stainless Steel Wedges:** Required for ethylene interpolymer alloy (EIA) and polyvinyl chloride (PVC) materials. These materials contain chlorine, which can corrode copper; stainless steel resists this degradation, extending the life of the wedge.
- Understanding both the flexibility of the fabric and the chemical composition of the membrane ensures proper equipment selection and reliable weld performance.

Recommended Settings

Wedge welding performance is highly dependent on initial settings and material characteristics. A common starting point for wedge welders is a temperature of 700°F and a speed of 13 feet per minute. These baseline settings provide a good foundation, but adjustments are often necessary based on visual inspection and weld performance.

Initial adjustments typically focus on welding speed, as it directly affects dwell time and melt behavior. Operators should monitor visual cues such as melt flow, seam symmetry, and surface texture to guide fine-tuning. Thinner membranes, such as woven PE, PP, and flexible PVC, can generally be welded at higher speeds due to their lower thermal mass and faster heat response. Thicker materials, including HDPE, PU, and EIA, require slower speeds to ensure adequate heat penetration and seam integrity. Understanding the thermal and mechanical behavior of each material is essential for optimizing weld quality and minimizing rework or failure in the field.

Wedge Welding

PROS

- Typically, the go-to method for initial production welds
- Offers excellent consistency and speed in controlled environments
- Weld data can be logged for quality control

CONS

- Less suited for complex repairs
- More sensitive to surface flatness and environmental variables in field conditions

Equipment

RF equipment has continued to improve since its inception in the 1940s. From one size fits all, to change position and frequency on demand, this technique has become more versatile and easier to utilize effectively. RF welders are comprised of a press with a diode.

RF uses the anode and cathode to pass radio frequencies through the material which heats the polymer.

This frequency is controlled by the volts supplied to the equipment and the amps used to perform the weld. Other than varying the power supply and energy used, the amount of time the material is subjected to the frequency, the pressure at which the material is held, and the cooling time can also be set. Other than the large press, the equipment typically comes with interchangeable plates, allowing the operator to change the length and width of the welds depending on the end application.

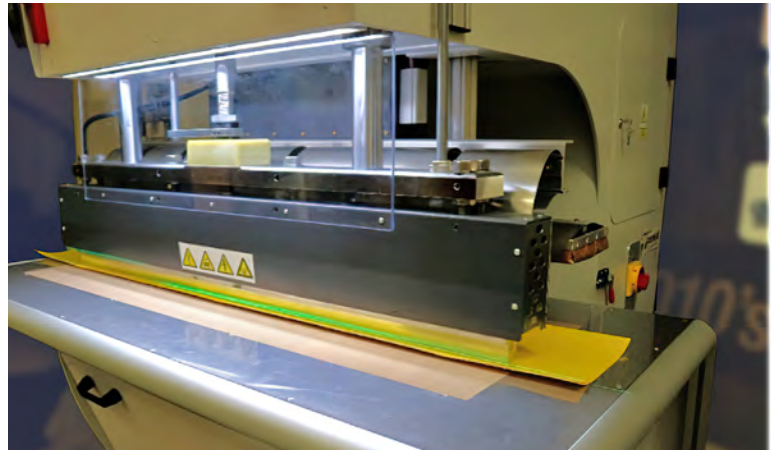


fig 11 | This is an example of an RF welder.

Applications

Due to the large size and stationary nature of the equipment, RF welding is restricted to controlled environments where space and infrastructure can accommodate the press-based system.

RF welding is especially prevalent with fabricating architectural fabrics, where precision and repeatability are critical. Panels of various geometries are manufactured in the factory according to detailed blueprints. Once completed, these panels are shipped to the installation site. There they are assembled using either additional welds (typically hot air or wedge welding) or mechanical fasteners, depending on the engineering specifications and structural requirements.

This workflow allows for high-quality, pre-engineered components to be fabricated under controlled conditions, ensuring consistency and reducing on-site labor complexity.



fig 12 | An example of a control panel for an RF welder.

Recommended Settings

Due to the wide variety of RF welding equipment models and suppliers over the years, it is difficult to provide a universal starting point for settings. However, based on experience at Seaman Corporation, a current range of 1.5 to 2.3 amps with a 1,000-volt supply when using a 4-foot die has proven effective for welding EIA and flexible PVC materials. If weld quality

is poor, adjustments should focus on dwell time, cooling time, and pressure. Weld time is the dwell time; this can improve polymer flow and bonding. Pressure is the force on the seam to ensure the two faces are fused together. Cooling time the allowed time weld to solidify before releasing pressure. While newer RF welding systems may offer additional adjustment options such as programmable cycles, real-time monitoring, and automated feedback, these features enhance stability and control but are not strictly necessary for producing a good weld.

RF Welding

PROS

- Most consistent weld quality
- Precise and repeatable control
- No open heat source
- Excellent for complex shapes

CONS

- Limited to polar materials (PVC, TPU, EIA)
- Slowest of the methods
- Requires custom tooling
- Potential for electromagnetic interference

Extrusion Welding

How It Works

Extrusion welding involves two simultaneous processes that work together to form a strong, continuous bond between membrane panels. In one process, hot air is directed over the weld area to preheat the membrane surfaces, ensuring proper adhesion and minimizing thermal shock when the molten polymer is applied. In the second process, a weld rod, made from the same polymer as the membrane, is fed into a small extruder. Inside the extruder barrel, the rod is heated and subjected to shear forces, transforming it into a molten state. The molten polymer is then extruded through a die or end plate, shaping it into a bead that is deposited between the two panels' surfaces. As the molten material accumulates, it creates a buffer layer that causes the extruder to “float” slightly above the surface. The operator guides the extruder along the seam at a controlled rate, maintaining a consistent layer of molten polymer. This forms a sealing bead that bonds the edges of the two membrane panels together.

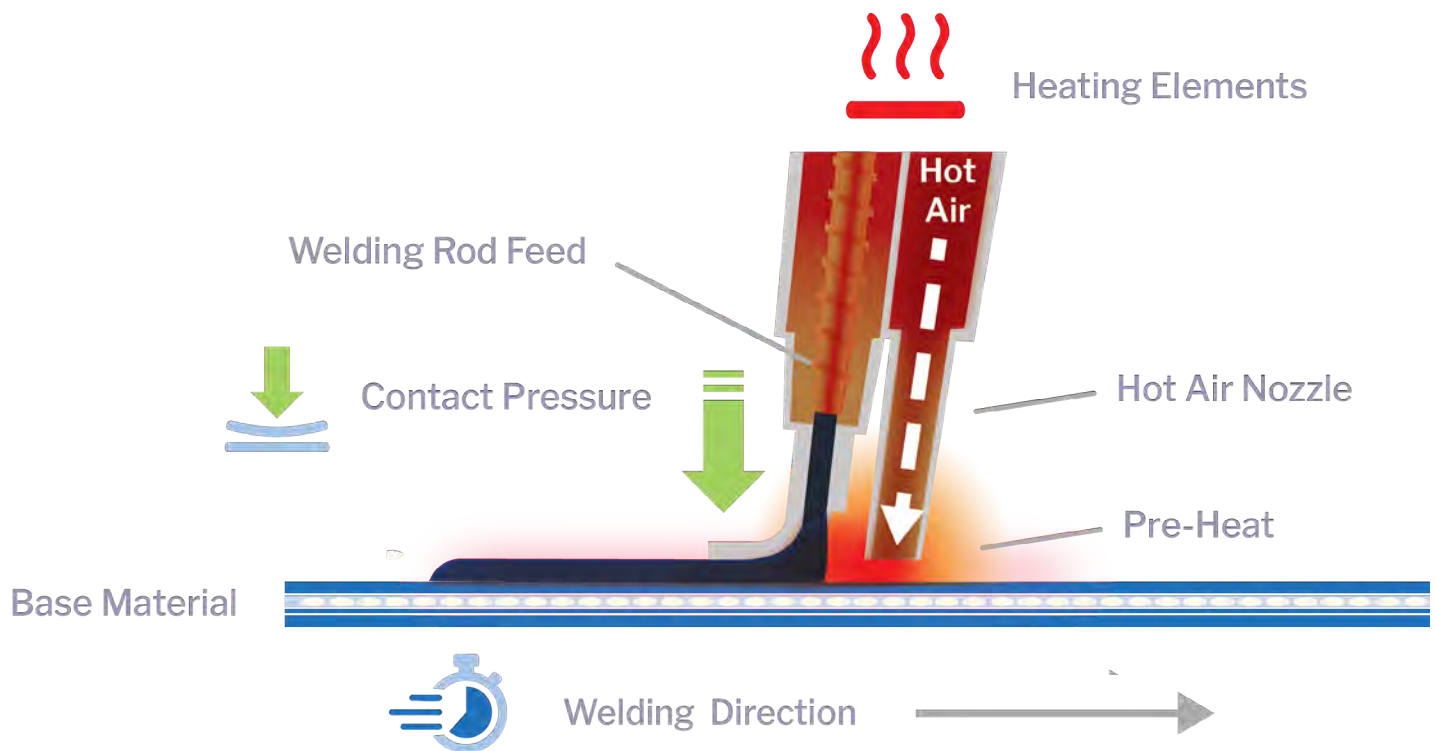


fig 13 | Lateral view of extrusion welding.

Equipment

To perform extrusion welding, a spool of weld rod, a spool holder, and an extrusion welder are needed. During the process, the weld rod is pulled from the holder, sent through the extrusion welder, and laid down in varying flat extrudates. The extrusion welder itself is comprised of a small single screw extruder, typically coupled with a hot air welder. All extrusion welders look very similar but may contain different process controls.

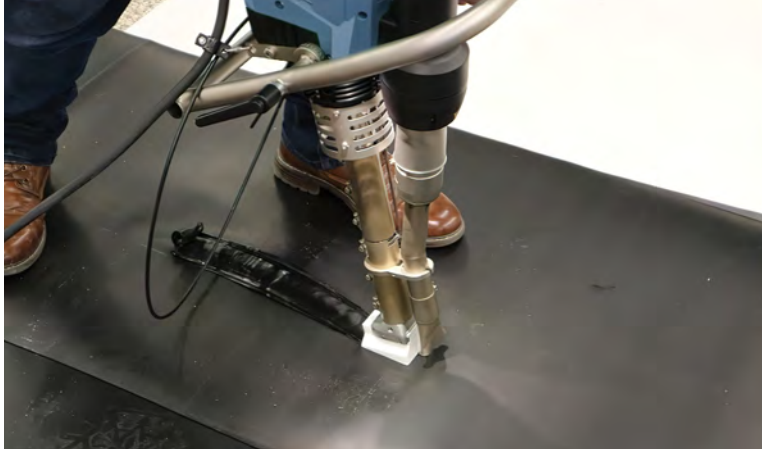


fig 14 | This is an example of extrusion welding.

Application

Unlike the other methods discussed above, extrusion welding purpose is not the primary bonding but a secondary bond to provide additional protection. The additional protection improves long-term durability and environmental resistance, especially in containment systems exposed to aggressive chemicals or moisture. For these reasons extrusion welding is typically used in geomembrane installations, where it serves to seal gaps, reinforce seams, and enhance containment integrity.

Recommended Settings

To ensure proper adhesion and long-term seam performance, it is critical to use compatible materials during extrusion welding. Weld rods must match the composition of the membrane; using unmatched polymers such as combining HDPE with PVC or EIA can result in poor bonding and damage to the liner. According to at least one company in the industry, HDPE weld rods typically require extrusion temperatures around 450°F, while EIA and PVC rods should be processed between 375°F and 410°F.

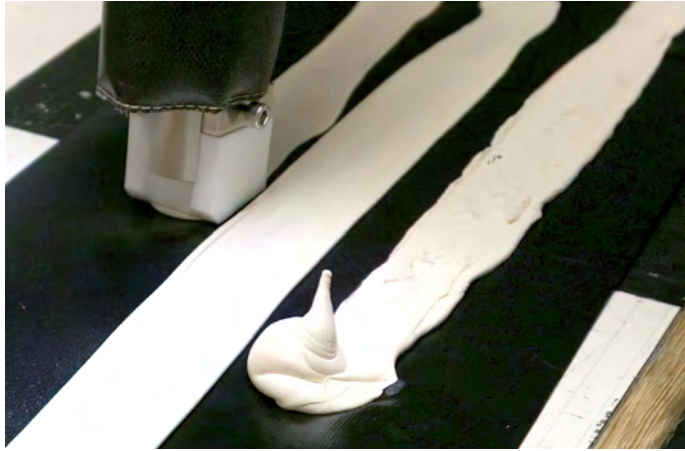


fig 15 | The extrusion weld on the left is smooth and glossy, while the weld on the right is bumpy letting you know the settings are not correct.

Operating outside these temperature ranges can compromise weld quality: underheating HDPE leads to weak adhesion, while overheating EIA or PVC causes polymer degradation.

Accurate identification of both the weld rod and membrane is essential before welding begins. Additionally, EIA and PVC rods must not be left inside a non-operating extrusion welder, as this can degrade the polymer, resulting in poor weld appearance and premature

equipment wear. Adhering to these guidelines helps maintain weld integrity and extends the life of both the liner and the welding equipment.

Extrusion Welding

PROS

- Provides additional sealing and coverage over primary welds
- Fills gaps, creating a smooth edge and enhanced water barrier
- Helps prevent reinforcement degradation from wicking or capillary actions

CONS

- The equipment is heavy and less portable
- Requires an external power source and welding rod feed
- Weld rod must be purged before setting the tool down to prevent equipment damage when using EIA or PVC rods

Conclusion

Welding coated fabrics successfully requires a thorough understanding of the material's composition, the capabilities of the welding equipment, and the influence of environmental conditions. When these factors are properly controlled, the resulting welded seams offer excellent strength, durability, and long-term performance across a wide range of applications. Maintaining detailed documentation of welding parameters, inspections, and test results is essential for traceability and quality assurance. For further assistance or technical support, please contact us or your equipment provider.

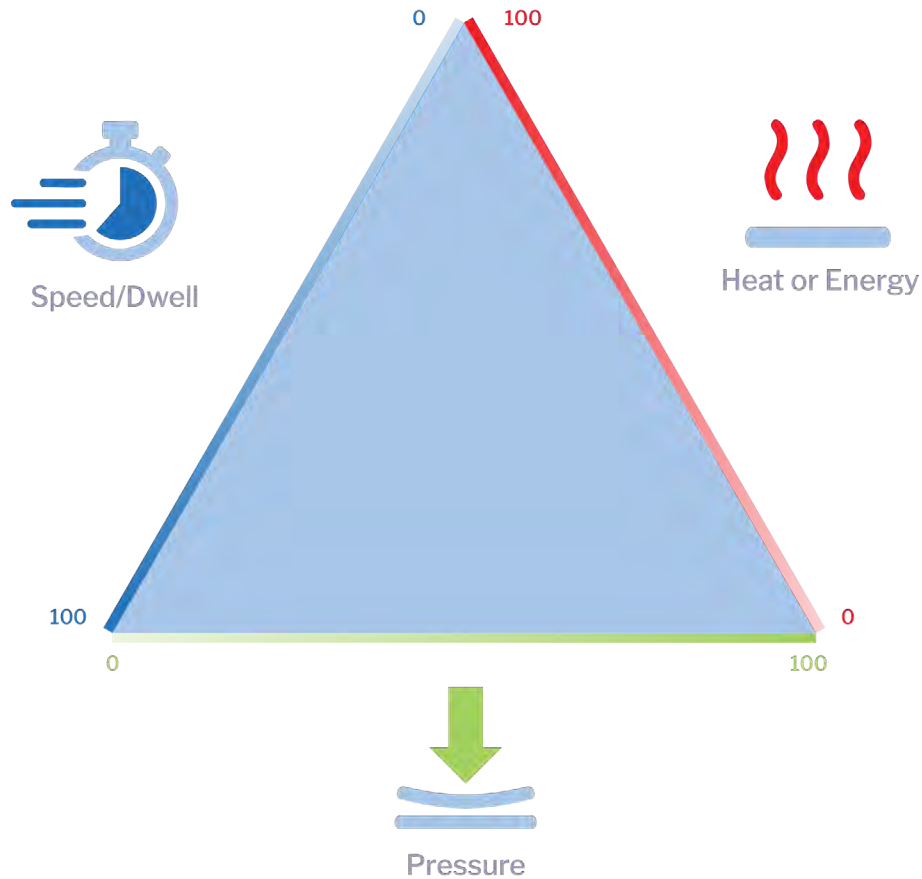


Seaman Corporation

1000 Venture Blvd
Wooster, OH 44691

Toll Free | [1.800.525.8527](tel:18005258527)

www.SeamanCorp.com



This guide is provided for informational purposes only and is not to be relied upon as a professional opinion, training tool, warranty, or guarantee of performance whatsoever. Welding should be performed only by qualified and trained professionals. This guide is not intended to serve as a substitute for professional training, OSHA compliance, or manufacturer instructions. Seaman Corporation makes no representations or warranties regarding the accuracy, completeness, or safety of the welding methods or other information contained in this guide. Users assume all risks associated with welding activities, including but not limited to fire hazards, personal injury, and property damage. It is the responsibility of the contractor to ensure compliance with all applicable laws, regulations, and safety standards. Seaman Corporation disclaims any liability for injuries, damages, or losses resulting from the use of this guide. Always consult OSHA guidelines, local building codes, and product-specific instructions before performing any welding work.

Building Together for a Stronger Future

Coated fabrics, or membranes, are essential in applications ranging from architecture to industrial containment.

Welding is a critical fabrication method for these materials.

This guide examines the science behind welding coated fabrics, compares four primary welding methods and outlines best practices and precautions to ensure reliable, high-quality welds.

Presented by your partners at Seaman Corporation, manufacturer of high-quality coated fabrics.

Learn more about us at
seamancorp.com
or contact us at
info@seamancorp.com
800.927.8578



Seaman Corporation

1000 Venture Blvd | Wooster, OH 44691

