COMPOSITE POLYMERS

JOINING AND REPAIR PROCEDURES FOR HETRON® AND AROPOL™ RESIN-BASED FRP EQUIPMENT

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1. INTRODUCTION

This procedure covers materials and suggested methods for the general repair of all fiberglass reinforced HETRON and AROPOL polyester resin equipment and for the butt and strap joining technique for fiberglass reinforced pipe or duct. The procedures involve relatively quick and simple processes for field or shop work. ***However, since a certain amount of know-how is required, it is recommended that properly trained personnel perform all work.*** It should be recognized that the minimum width of a joint or repair overlay and the number of plies of glass reinforcing required relate to type of construction, wall thickness and/or pressure rating of the equipment. It is extremely important to follow vendor construction specifications and material requirements. When in doubt, contact proper engineering or materials personnel or the equipment supplier.

2. SURFACE PREPARATION

Thoroughly wash down the area to be repaired or joined to remove surface contamination. Remove any damaged areas until only sound material remains. All of the surface area to be covered with fiberglass reinforcement and resin must be thoroughly sanded and roughened with a power sander. Make sure the glossy resin finish is removed. Thoroughly clean roughened areas with an approved safety solvent. Surface must be dry. Apply resin and fiberglass as soon as possible after preparation to prevent possible recontamination of the prepared area.

3. MIXING RESIN

Under no circumstances should the catalyst and promoter be mixed in the same container or poured into the resin at the same time. When mixed together these two chemicals can react explosively.

Resin used for repairing or joining should be the same type as the resin used in the original equipment. Weigh sufficient resin into a suitable container. (Avoid using more than one quart at a time.) Use this weight to determine the amount of promoter and/or catalyst. Slowly add filler such as fumed silica, if required, and mix well to a uniform consistency. If a high degree of flame retardancy is required, 3–5 percent antimony trioxide or pentoxide should be added to certain resins.[1] Measure the required amount of promoter into a clean 10 cc graduate and mix well into the resin. Measure the required amount of catalyst into a separate graduate and mix well into the resin (or promoted resin). See Table 1. More detailed information about this topic may be found in individual resin technical data sheets or in Ashland's "A Guide to Fabricating Composites with HETRON® and AROPOL™ Resins."

4. HARDENING OR CURE

Resin must be allowed to harden or cure for about 24 hours. This will vary according to weather conditions, temperatures and exact amount of promoter and/or catalyst used. An external heat source such as an infrared heat lamp will decrease hardening time and may be a necessity in cold weather. Generally, work should not be done at temperatures below 55°F unless an outside source of heat is applied. Since most polyester resins are FLAMMABLE liquids, external heat sources should be used with caution.

HETRON

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1 Consult the specific Ashland technical data sheets for HETRON or AROPOL resins to determine whether antimony trioxide should be used. Appropriate level will be 3-5 percent. Nyacol APE 3040[2] can be used with certain resins.

2 Nyacol Nano Technologies, Inc.

Care must be exercised when using an external heat source to prevent overheating which can cause cracking and/or crazing or discoloration. Acetone lightly rubbed onto the exposed resin surface will determine if the system is adequately cured. If surface softens or becomes tacky, an external heat source can be applied to fully cure the resin. If surface does not cure, entire process must be repeated from Section 2. A Barcol Hardness tester (Model GYZJ934-1)* can be used to determine if the system is cured adequately. A minimum Barcol of 35 indicates adequate cure for most resins. Consult resin data sheets for additional information.

5. JOINING PIPE OR DUCT

5.1 Preparation of Pipe or Duct (Photos 1 and 2)

Cut pipe or duct to desired length making sure that ends are squared and butt closely together. Roughen edges and prepare surfaces as described in Section 2 and photo 2. Support sections in position with jig, so that no movement occurs while making the joint or during curing.

5.2 Joining (Photos 3, 4, and 5)

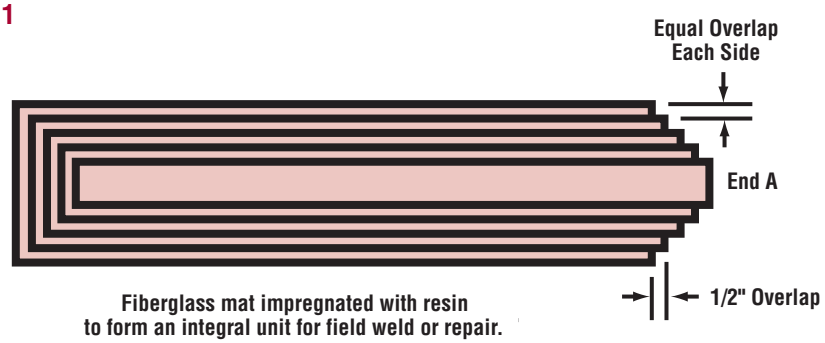
Coat all roughened edges with resin mix, completely filling the joint and slightly squeezing the sections together. It may be preferable to add fumed silica to resin for this step to produce a paste or light putty which will fill small voids 1/8-inch or less and irregularities in the joint. It is often desirable to speed-up the hardening time for this step by increasing the MEK peroxide required by 1 to 2 cc per pound. The interior surface should be relatively smooth but a light bead of resin on the interior surface is desirable.

Butted sections may be "tabbed" or "hot patched" to hold alignment until complete joint can be made. A "tab" consists of 2-3 square inches of fiberglass mat saturated with resin mix. Place prepared "tab" across joint to be made to form a "tack weld." For this step, it is often desirable to speed-up the hardening time of the resin by increasing the MEK peroxide required by 1 to 2 cc per pound (see Table 1).

5.3 Preparation of Strapping (Photos 6, 7, 8 and 9)

Prepare fiberglass reinforcements according to vendor's specifications or cut sufficient quantity according to size and ply requirements (see Figure 1). Table 2 should be used only as a guide for minimum width of joint overlays and minimum joint thickness. Joint thickness should be at least as thick as the pipe to be joined. Lay the widest section of fiberglass mat on a flat surface treated with release agent or covered with releasing film. Wet the entire surface with resin mix, using brush and/or roller. Position next ply of fiberglass offsetting about 1/2-inch on the length. Equal overlap on width is preferable but slight offset (staggered) is acceptable.

Figure 1



*Barber-Colman Instruments

Wet out the layer with resin mix. Remove as much air as possible with brush and/or roller moving toward the edges of laminate section. Care must be exercised to avoid excessive pressure which would remove excessive resin from area. Repeat with proper sequence of fiberglass until all plies have been saturated with resin and formed into one integral unit (see Figure 1).

On very thick or large diameter joints, it may be easier to saturate two or three plies of fiberglass with resin at a time. This technique helps ensure removal of trapped air and facilitates application of the strapping.

Table 1

The following is suggested as a guide. Quantities may be increased or decreased as experience dictates. Those listed will give a working time or pot life at 60°F to 70°F of 15 to 30 minutes. For every 10°F below this temperature, increase promoter and/or catalyst by 1 cc per pound.

	CC's of Promoter and/or Catalyst Required per Pound of Resin	
HETRON RESINS	**6% Cobalt Napthenate**	**9% Active Oxygen MEK Peroxide**
92FR, 99p	None	5
197-3	2	5
197P	None	5
922, 980, FR992	2*	5
942/35, 980/35, FR998/35	2*	5
970/35	2*	5**
FR990ZX	2*	5
AROPOL Resins		
7241 T-15	None	5
7334 T-15	None	5

* _ cc DMA also required
** Cumene hydroperoxide catalyst

BPO/DMA/tBPB cure system is preferable for certain environments such as hypochlorites, chlorine dioxide, etc. 1 percent BPO /.02 percent DMA/10.2 percent tBPB is suitable for 197-3 and 900 series resins.

Table 1A

ADDING WAX TO HETRON/AROPOL TOP COATS

To minimize surface tackiness and air inhibition of cure, a wax top coat resin may be required to protect the surface from contact with air.

A small amount of paraffin wax (120° - 130°F melting point), is used in the final resin surface or topcoat.

When using resin containing wax, a faster gel and cure system is recommended.

Resin containing wax should not be used during build-up of laminate because adhesion of laminate layers will suffer.

Typical Resin Wax Formulations

	1 Gallon Resin
Wax	20 grams
Styrene	180 grams

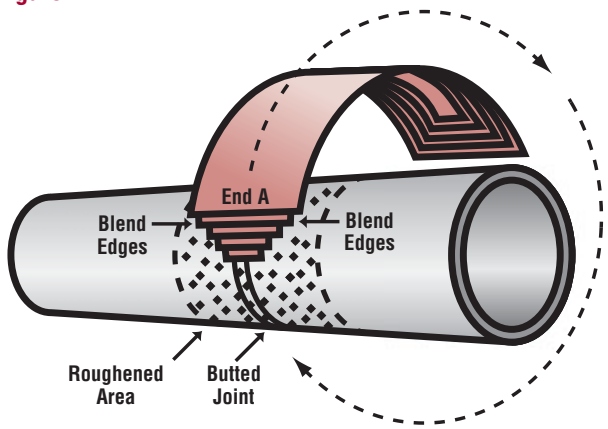
Add wax to warm styrene and mix until dissolved. Add the wax solution to one gallon of resin. Mix well.

Table 2

1/8	--	3m; v
3/16	3	4m; v
1/4	4	3m; 1wr; 2m; v
5/16	5	3m; 1wr; 3m; v
3/8	6	3m; 1wr; 2m; 1wr; 2m; v
7/16	7	3m; 1wr; 3m; 1wr; 2m; v
1/2	8	3m; 1wr; 3m; 1wr; 2m; 1m; v
9/16	9	3m; 1wr; 3m; 1wr; 2m; 1wr; 1m; v
5/8	10	4m; 1wr; 4m; 1wr; 3m; 1wr; 1m; v
11/16	11	4m; 1wr; 4m; 1wr; 4m; 1wr; 1m; v
3/4	12	4m; 1wr; 4m; 1wr; 4m; 1wr; 1m; v

m = 1_ oz chopped strand mat
wr = 24 oz woven roving
v = Type "C", 10 mil glass surfacing veil (optional)
*From surface of pipe outward

Figure 2



For use with procedure for resin wrapped joints

5.4 Application of Strapping (Photos 10-14)

Apply resin mix with brush and/or roller over all prepared areas of the joint. Take the entire strapping as prepared in Section 5.3 with the narrowest ply to the inside and place on resin coated joint. Make sure to center and position it properly (See Figure 2) over the butt seam. Wrap around the joint using an even, forward pressure to form entire joint with offset ends overlapping smoothly. The releasing film, if used, can be lifted with the strapping composite and will help to form the wrapped joint. It must be removed before the next step.

Roll out as smooth as possible blending the edges of strapping into pipe. Remove all wrinkles and entrapped air — rolling from center of joint to outside edge. Additional resin may be applied to provide a resin-rich surface. Care must be taken to prevent the strapping from sagging at the bottom of the joint during hardening.

On large diameter equipment, it may be easier to saturate only a few fiberglass plies with resin at a time and to apply strapping in two, three or four sections around the circumference to complete the wrapped joint.

After the joint has hardened, a top coat of resin mix should be applied. Wax can be added to this layer of resin as per Table 1A. If the pipe or duct will be exposed to UV radiation, approximately 0.5% of a suitable UV absorber* must be added to the resin for this final coat. Suitable UV absorbers include Cyasorb[1] UV-9, Cyasorb UV5411, Lowilite[2] 20 or Lowilite 29. Some UV absorbers will inhibit room temperature cure. Suitability of UV absorbers should be determined prior to the application.

UV additives should be predissolved in styrene monomer before being introduced into the resin.

6. REPAIR OF INTERIOR AND EXTERIOR SURFACES

The same procedures in Section 5 are generally applicable. Prepare surface as per Section 2. Apply resin mix mixed according to the directions in Section 3 with a brush. Place first, smallest, layer of fiberglass mat over area and saturate with resin using roller and/or brush. Make sure all entrained air is removed. Repeat with subsequent layers of fiberglass mat. Each layer must be larger than the underlying layer by 1/2–1-inch all around. For the last layer, use only one ply Type “C” glass veil (or synthetic veil). Cover this with a wax containing top coat. This may not be necessary for exterior repairs. Exterior repair may require UV absorber as per Section 5.4. Allow system to harden and cure.

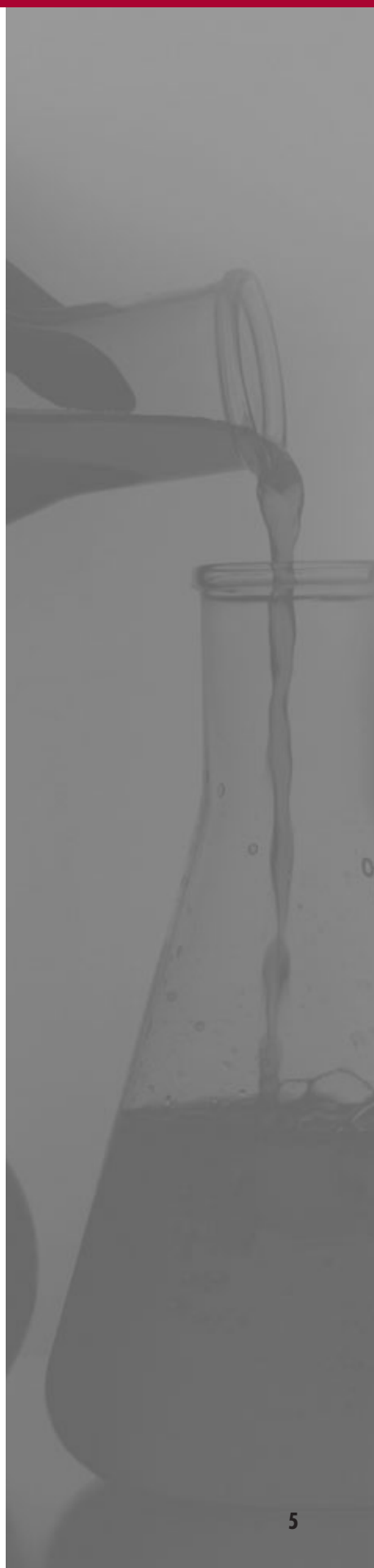
7. REPAIR OF HOLES, LEAKS, CRACKS, ETC.

The damaged area can be drained or plugged and then repaired with a new section or by “patch” technique. The surface must be prepared as described in Section 2. For pipe and other equipment of similar diameter, the procedures outlined in Section 5 are directly applicable, i.e., the wrap or strap technique is used, either to join-in the new section or to “patch” the damaged area.

For larger diameters and larger damaged area, it may be necessary to apply a temporary backing of sheet metal or cardboard with a release agent before proceeding with repair according to Section 6 and, in general, Section 5.

1 Cytec Industries

2 Great Lakes Chemical Corporation



8. INSTALLATION OF NOZZLES

Follow specifications and recommendations of the equipment supplier. Follow general procedures outlined in Sections 5, 6 and 7. A generous filler of resin putty according to Section 5.2 (at least 1/8-inch radius) must be applied to all portions of pipe neck on both sides of wall and allowed to harden. Interior surface must be finished with at least one layer of Type "C" glass of synthetic surfacing veil with a wax containing top coat.

9. CLEAN-UP

All equipment should be cleaned immediately after use with a safety solvent. Solvent can be used to clean work areas or resin spills.

10. GENERAL INFORMATION

Serrated aluminum rollers are far superior to common mohair or paint rollers. Rapid dabbing with a stiff bristled brush can be used to remove entrapped air. For maximum shelf life, store resin, promoter, catalyst, etc., separately at 75° or cooler according to the supplied instructions. All materials and work performed should be at 65°–85°F. No joints should be made in rain, snow or in excessively high humidity. Fiberglass reinforcement must be clean and dry.

11. SAFETY INFORMATION

Resins contain ingredients which could be harmful if mishandled. Contact with skin and eyes should be avoided and inhalation exposure minimized. Necessary protective equipment and clothing should be worn.

Ashland maintains Material Safety Data Sheets (MSDS) on all of its products. MSDSs contain health and safety information for your development of appropriate product handling procedures to protect your employees and customers. The MSDSs should be read and understood by all of your supervisory personnel and employees before using the products in your facilities.

12. TROUBLESHOOTING

POOR BOND – Check for surface cleanliness, contamination and preparation. Glass reinforcement must be dry. Resin, catalyst, promoter and other additives must be fresh and must not have been contaminated with any foreign materials such as wax.

AIR BUBBLES OR BLISTERING – Check for improper rolling or too "hot" a cure system.

WHITE BLUSH - White cast or appearance after curing. Glass reinforcement may have contained moisture or the joint or repair was made in a very humid environment. Surface resin may not have been properly cured because of high humidity.

POOR GLASS WET-OUT – Check for improper rolling. Resin may have been too thick or too thin (drainage).

TACKY OR WET RESIN – Check for proper concentrations of catalyst and promoter. Check cure temperature. Check to see that wax was added to final laminate layer.

CRACKING AND CRAZING – Check for proper concentrations of catalyst and promoter. Check work area temperature and thickness of lay-up.

HOT SPOTS AND SPOTTY CURE – Check mixing procedures.

LOW BARCOL HARNESS LEVELS – Check concentration of catalyst and promoter. Make sure resin, catalyst and promoter are fresh. Check cure temperature.

For additional guidance in this area, please consult- A Guide to Fabricating Composites with HETRON® and AROPOL™ Resins.

Contact your materials supplier, equipment fabricator, or Ashland's HETRON Resin Technical Service Laboratory at 1.800.327.8720 (or 1.614.790.4399) or at hetron@Ashland.com for assistance if there is any indication that procedures are not producing satisfactory results. Visit us online at www.hetron.com.

13. EQUIPMENT REQUIRED

Resin • promoters • catalyst • solvent • fiberglass mat • woven roving • surfacing veil or mat • fumed silica • styrene • wax • UV absorber • release agents and films • hack saws • saber saws • cut-off wheels or similar equipment • disc sanders • files • abrasive paper • work bench and pipe stands and/or jibs • scissors • stiff bristled brushes • serrated aluminum rollers • unwaxed paper measuring cups or tubs • mixing sticks (tongue depressors).

14. MATERIAL SUPPLIERS

Your local Ashland Distribution rep can often provide complete joining and repair kits. They also can supply a complete line of Ashland HETRON or AROPOL thermosetting resins.

The following chart lists different HETRON and AROPOL resins and their performance characteristics.

For additional advice on resin selection for specific FRP composite applications, consult Ashland's **Resin Selection Guide**, available from your local distributor or your Ashland sales representative.

For product or technical information, telephone our HETRON Technical Service Group at **1.800.327.8720** or e-mail at hetron@Ashland.com.

RESIN SERIES	CHARACTERISTICS[1] (Consult Technical Data Sheets for each resin's flame spread[2] capabilities)
Chlorendic Polyester	
HETRON 92FR	Flame retardant. Has met Class 1 flame spread without antimony. Good corrosion resistance to vapors.
HETRON 197	Highly corrosion resistant and heat resistant. Class II flame spread can be achieved.
Bisphenol A Fumerate Polyester	
HETRON 700	Broadest corrosion resistance to both acids and bases.
Furan	
HETRON 800	Excellent resistance to both organic solvents and aqueous systems. Not recommended for strong oxidizers.
Epoxy Vinyl Ester	
HETRON 922	Corrosion resistant to both strong acids and bases. Inherent toughness and high tensile elongation provide fabrication advantages and resistance to both impact and thermal shock damage.
HETRON 980	Superior corrosion resistance compared to HETRON 922 resin. Improved thermal properties.
HETRON FR992SB	Flame retardant version of HETRON 922 epoxy vinyl ester resin. Class 1 or 2 flame spread can be achieved.
High Performance Epoxy Vinyl Ester	
HETRON 942/35	High performance epoxy vinyl ester resin with improved resistance to hydrocarbon solvents and superior thermal properties.
HETRON 970/35	First generation premium epoxy vinyl ester. Improved solvent resistance vs. many styrenated[3] epoxy vinyl esters.
HETRON 980/35	High performance epoxy vinyl ester resin formulated to provide maximum heat and corrosion resistance to strong acids and oxidizing chemicals. Superior toughness.
HETRON FR998/35	Combines ASTM E-84 Class 1 capability with improved corrosion and heat resistance
Isophthalic Polyester	
HETRON99P	Flame retardant providing moderate corrosion resistance. Has met Class 1 with the addition of 3% antimony.
AROPOL 7241 Series	Good corrosion resistance at moderate temperatures, including hydrocarbon solvent resistance.
AROPOL 7334 Series	Resilient. Moderate heat and corrosion resistance.
Fire Retardant Resins	
HETRON 620T	Flame retardant. Class 1 without antimony can be achieved. <35% styrene.
MODAR Series	Non-halogenated flame retardant product capable of Class 1 flame spread and less than 200 smoke.
HETRON 92FR	Flame retardant. Has met Class 1 flame spread without antimony. Good corrosion resistance to vapors.

[1] Data sheets which describe these resins in more detail are available from your Ashland sales or technical service representative.

[2] Class I=0 to 25 flame spread; Class II=>25 to 75 flame spread. Class III=>75 flame spread per the ASTM E84 tunnel test.

Welding Procedures

1. Firmly support pipe sections. Square the ends to be welded using saber saw.
2. Rough the outside surfaces with sander approximately 1" farther in from the ends than the finished weld surface. Where the inside welds are possible, interior surfaces should be sanded prior to assembly.

3. Coat roughened end edges of pipe with small amount of catalyzed resin. Any large voids may be filled with a silica filled resin putty.
4. Support components in joint position as rigidly as possible so that no movement occurs while making the joint. Fill joint with resin.

5. A “Hot Patch” technique may help prevent movement of pipe during the weld-cure period. Wet 2" squares of mat with a small amount of resin using three times normal amount of catalyst. Apply “Hot Patches” at intervals around joint. Curing or hardening in a matter of minutes, they secure pipe sections in proper alignment. Mix resin and catalyst for “Hot Patches” in a small paper cup and discard immediately after use to avoid contaminating welding resin.

6. Lay out fiberglass mat strips on the work table. Length of each strip should be two inches longer than circumference of pipe. Strips longer than 36" may be cut in half to simplify application. Mix prescribed amount of catalyst with required amount of resin in a separate clean container. Prepare only the amount of resin which can be used immediately (about 1 qt. per 6 sq. ft. of mat). Resin will harden in about 20-30 minutes.

7. After mixing in the catalyst thoroughly, pour the resin onto the widest mat first. Spread it over the entire mat strip, working it into the mat fibers manually. (Neoprene gloves are recommended.)

8. Place the next widest strip onto the first with one end of the second strip starting approximately 1" in from the end of the first. Doing this with each successive strip results in a feathered edge (see Figure 1) to product a smooth weld strip joint. Add more resin and work into the second strip.

9. Add other strips in the same manner. In wetting each strip, it is best to be a little "lean" on resin at this stage rather than over-wetting. More resin may be added later, if necessary. After laying the final strip, compress the strips together with glove-protected hand to remove large air bubbles and to make sure all layers are wetted with the resin.

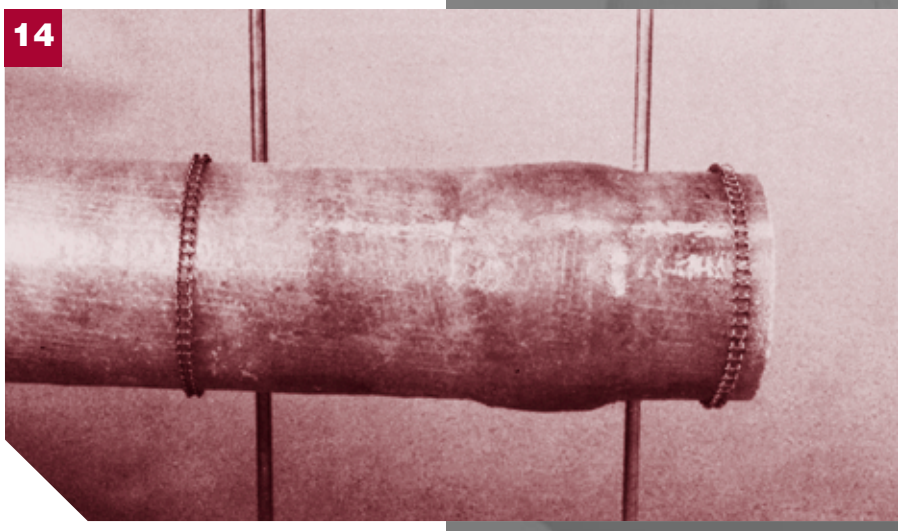
10. Pick up the completed weld strip by one end and center it carefully on the pipe joint. Apply the tapered end first with the narrowest strip on the pipe weld.

11. Be sure the weld is centered, with care taken to avoid wrinkles on the under or back side of the weld. Continue applying the strip around the joint until the free end overlaps the beginning. Lightly press out the air bubbles with gloved hands (See Figure 2).

12. Finish the application of the weld with the roller. Any remaining air bubbles will appear as light spots. These should be rolled to the edge of the weld where they will be released and disappear. If weld is not a straight butt joint, a little extra rolling and hand work to shape mat strips to structure configuration will eliminate bumps and ridges.

13. At this stage, resin may be added where necessary if any mat appears to not be thoroughly wetted. It is better to have too little resin on the weld strip, when initially applied, than too much. Over wetting makes it difficult to keep the weld strips in place. Also, coat the remaining sanded surface areas with resin.

14. Allow the completed weld to completely cure thoroughly tack free. Do not move or disturb weld until it is thoroughly cured. If temperature is below 55°F, keep weld area warm with heat lamps. For exterior installations, protect the weld from the weather.



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