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**Elbow Repair**



**Weld-O-Let Repair**



**Eliminate welding and X-RAY**



**Bend with wrinkles**



**Cigarette wrap isolated external corrosion pitting 68% wall loss.**



**Spiral wrap long sections of external corrosion >80% wall loss. 40 foot joint repair in 1 hr, then back fill 1 hr later.**



**Many isolated external corrosion >80% reinforced. Water nor sweating lines causes any issues!**

***DOT 192.713 & 195.585 accepted PERMANENT pipeline repair  
Alternative to cutting-out pipe or welded-sleeve  
on metal-loss up to 80% and Dents, Gouges, Buckles, Wrinkles still piggable.  
Aquawrap installation repair video can be seen at  
[www.myoilpatch.com](http://www.myoilpatch.com)***



# *Pipeline defects repaired with Aqua Wrap*



**Girth Weld**



**Corrosion Pitting**



**Wrinkles on bend**



**Corrosion pitting, welding defects**



**Vertical – soil-to-air**



**Weld-O-Let**

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# Types of Composite Systems?

## Wet Layup – field impregnated



Resin mixed into cloth minutes prior to install



Each layer must be mixed with resin before applying

## Wet Layup – prepregnated



Great for odd shape repairs



Apply right out of the bag

## Rigid/Layerd/PreCured



Resin applied between each layer



Tightening it up

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# Aqua Wrap Wet Layup Installation Process

For steel substrates, it's recommend cleaning to bare metal, NACE II or SSPC-10 level. The better the cleaning and preparation, the better the wrap will bond/adhere to the pipe. For concrete surfaces, above and below the water line, all loose debris, coatings, marine growth, etc. must be removed. This can be done with high pressure water blasting or sand blasting.



**Step 1:** Sand Blast – NACE II Near White Finish.

**Step 2:** Fill all voids with 2-part load-transfer epoxy, and the entire area being wrapped.

**Step 3** spiral wrapping technique

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# Aqua Wrap Installation Process page 2 or 2



## Step 5:

Immediately after applying composite, wrap three layers of the blue plastic wrap over it tightly, and perforate it so excess water will gas out. Wait at least 1 hour to remove blue plastic.

## Step 6:

Place metal band around each end of the repair then top coat with non-permeable paint and if above ground use an acrylic paint from your local paint store.

# *What is a Composite?*

Two or more materials combined in such a way that the individual materials are easily distinguishable.

A common example of a composite is concrete. It consists of a binder (cement) and a reinforcement (gravel and rebar). Concrete is a three-phase composite.



**Composite repairs odd-shape line quickly.**

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# ***Does the DOT approve of pipeline composite repair technology?***

- **Prior to 2000, only ClockSpring's rigid composite system.**
- **Effective January 13, 2000, the DOT published:**

**Reference by Googling on: CFR 192.713 or 195.585**

*“Repaired by a method that *Reliable engineering tests and analyses show that can permanently restore the serviceability of the pipe*”.*

**ASME Post Construction Committee (PCC-2)** - does not tell the pipeline operator how to fix pipeline defects, only how composites used to make repairs are to be tested.

**ASME B31.4 & .8** – specifies composites can be used  $\leq 80\%$  corrosion spots, dents, gouges, wrinkles, etc still piggable.

# ***Composite Testing and Research***

- **ASME's Post Construction Committee (PCC-2)** established 16 composite repair engineering tests.
- Gas Research Institute (GRI)
- Southwest Research Institute (San Antonio, TX)
- Battelle Columbus Division (Columbus, Ohio)
- Kiefner & Associates, Inc.
- Stress Engineering
- Pipeline Research Council International (PRCI)
- Regulations don't specify engineering testing entity



# *Why has the energy pipeline industry started using composites to make metal wall loss & dent repairs?*

- **Alternative** to repairing a pipeline with a welded sleeve or cut-out. Used up to 80% metal wall loss, and defects still piggable.
- **In-service repair** – don't have to lower the pressure to install.
- **Faster to install** – about 1/3 of the time compared to a welded sleeve.
- **Non-conductive to CP** except carbon fiber composites.
- Wet-layup composite systems are excellent for **odd shape pipeline** sections – bends, elbows, tees, weld-o-lets.
- Often the **most economical** way to repair a pipeline.

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**Wet layup**- spiral wrapped, cures as one-solid-mass and can backfill one hour later. Requires no field mixing of resin into cloth and no cinch bars or hammers.

# Pipeline Composite Repair Materials?

- **Fibers** – E-glass, carbon, aramid  
*(Unidirectional – hoop stress or biaxial woven – hoop & axial stress)*
- **Matrix** – meaning resins: epoxy, polyester, vinyl ester, phenolic polyurethane.

Fibers provide the reinforcement, like rebar and gravel do for concrete. The matrix, like cement used in concrete, is what holds the fibers/reinforcement in place and allows the transfer of the load/pressure throughout the fibers/reinforcement.

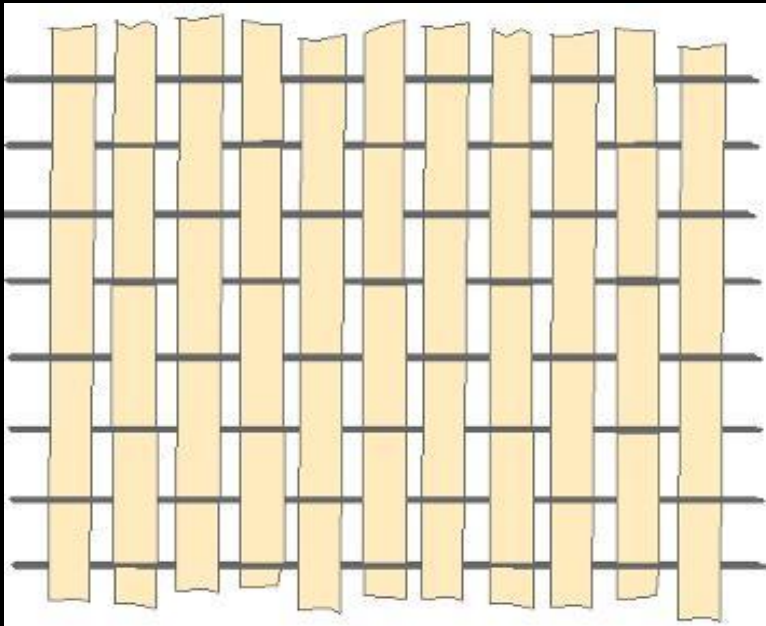


Have to mix resin into cloth in the field. You don't with wet-layup prepreg.

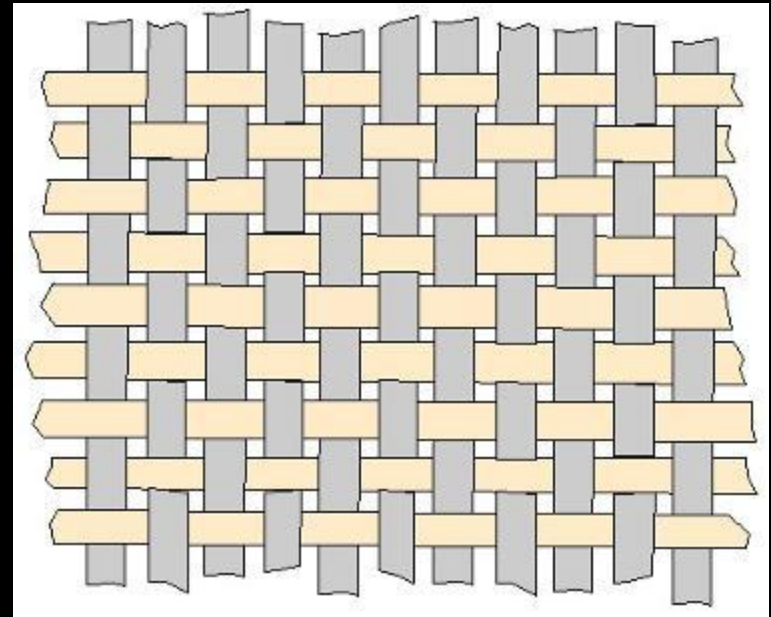


Wet-layup prepreg – apply right out of bag

# Fiber Patterns



Unidirectional – provides hoop strength only

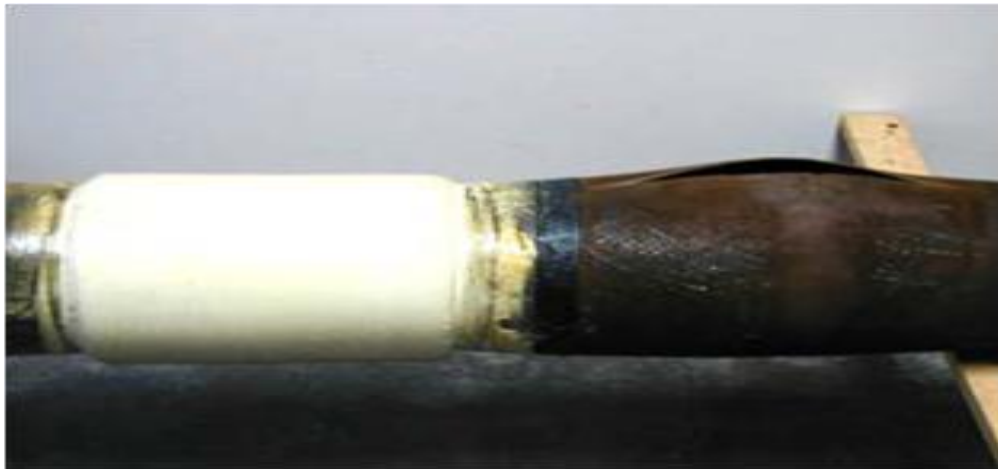


Biaxial Woven – provides hoop and axial strength, which Aqua Wrap uses.



# *Which Composite is the strongest?*

Most composites used in the energy pipeline market place have undergone 3<sup>rd</sup>-party engineering fatigue testing to prove they can last anywhere from 20-50 years as a permanent pipeline field repair. Ask the composite manufacturer for their testing results; such as, ASME Post Construction Committee (PCC-2).



**50% defect wrapped with wet-layup prepreg and burst tested to failure. Good section of pipe failed and wet-layup did not.**

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# *What types of energy pipeline defects can be repaired with composites?*

- External Corrosion –  $\leq 80\%$  wall loss on any shape of pipeline.
- Internal Corrosion – not recommended for pressures above 300psi.
- Dents or Gouges – as long as the pipeline is still piggable.



# *Soil-to-air composite repairs*



**Aqua Wrap Soil to air interface corrosion repaired quickly 2"x10' roll.**

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# Wet-layup Pipeline Repair Photos



**Elbow repaired with composite in less than one hour**



**Soil to air interface repair in one hour , 2"x10'**



**Wet-layup ready to apply right out of the bag, requires no field-mixing of cloth with epoxy resin minutes prior to install.**



**44' linear 10" pipe with 77% external corrosion repaired with wet-layup, in one hour, to reinforce hoop strength. No pressure reduction & backfilled one hour later.**

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Dehy  
44.5"OD  
wrapped  
with wet-  
layup  
repair

# *How many layers do I need to apply?*

- Most composite manufacturers have a spread-sheet calculator that uses Barlow's formula,  $R_{stren}$  and factors in the mechanical strength that each layer of their composite system provides, per their 3<sup>rd</sup>-party engineering testing results.
- Make sure their calculator factors in the degradation of their composite wrap's materials. They might only need 4 layers today to contain your actual MOP, but 20 years from now that same material might only have 70% of its strength remaining.
- Most composite manufacturers have performed 3<sup>rd</sup> party testing to determine the degradation of their composite wrap's materials.



# *How far past the defect must you wrap?*

- ASME Post Construction Committee-2  
formula:

Length of the defect plus

2 X 2.5 X SQRT of (OD X Wall Thickness )

2

# *Are Composites Pig Detectable?*

- Composite wraps are identifiable by a pig when placing a metal band around the end of each side of the composite wrap.



**Place metal bands around each end of the repair so it will be smart-pig detectable.**

# *What lengths and widths are available for each composite systems?*

**Wet Layup – prepregnated** Supplied in 2“,3” 4“, 5”, 6” , 8”,10“, 12” wide X 10’, 20’, 25’, 30’, 50’, 60’, 90’, 120’ long rolls and installed continuously and can be circumferentially or spiral wrapped.

**Wet Layup – field impregnated** Typically supplied in 12” wide  
One roll of cloth for each layer must be wetted with resin and installed separately and only circumferentially wrapped.

**Rigid/Layerd/Full Cure -** Typically supplied in 12” wide  
Have to apply resin between each layer and only circumferentially wrapped.



# ***Cost comparison of composite systems used to repair pipelines:***

**Wet Layup –** Least expensive  
**prepregnated**

**Wet Layup –** More expensive  
**field impregnated**

**Rigid/Layerd/Full Cure -** Most expensive

# ***Factors to consider when choosing a composite:***

- **Engineering testing** - 3<sup>rd</sup>-party engineering testing? DOT requires that composites have “Reliable Engineering Testing” before being used on a regulated line.
- **DOT regs and ASME Codes** – read and understand them, don’t rely on composite manufacturers.
- **Type of defect** – wet-layup will conform to both straight and odd shaped pipelines, and the rigid/layer/pre-cured systems are typically limited to straight pipelines.
- **Life of repair** – how long do you need the repair to last? 25 year? 50 Years?
- **Length of repair** – how many linear/axial inches or feet do you need repaired? Wet layup pre-pregated systems come in many different widths so you only buy near the exact amount of material needed. Field impregnated and rigid/layer/pre-cured systems only come in 12” wide and often rigid systems require 8 layers when only 4 are needed.
- **Costs** – wet-layup systems are cheaper than rigid systems, especially pre-pregated.
- **Carbon wraps** – don’t apply directly against the steel pipeline, because it’s more positive than steel and will thus cause corrosion. Insulate with a two-part non-permeable epoxy or a layer of fiberglass wrap before applying onto pipeline.