Wet Preg vs Infusion Best Practices SUN ‘n FUN 24 April 2015

Jeff Wright, Technical Director, Gougeon Brothers Inc.
Michael Bergen, Custom Technologies, LLC,

Overview

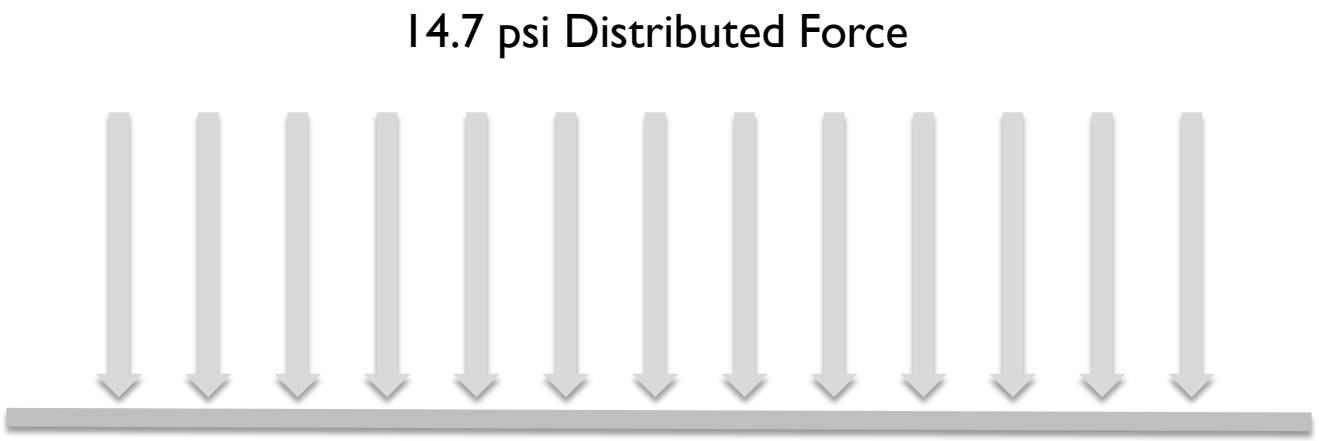
- VARTM and Wet Preg Process
- Materials
- Equipment
- When to Vacuum Bag
- Advantages
- Disadvantages
- Laminate Properties
- Laminate Design

Goal of Process

- Wet Preg or consolidating a wet laminate with a vacuum bag is intended to achieve a laminate with low void and controlled resin content with excellent adhesion of core and fabrics.

Why Vacuum Bag?

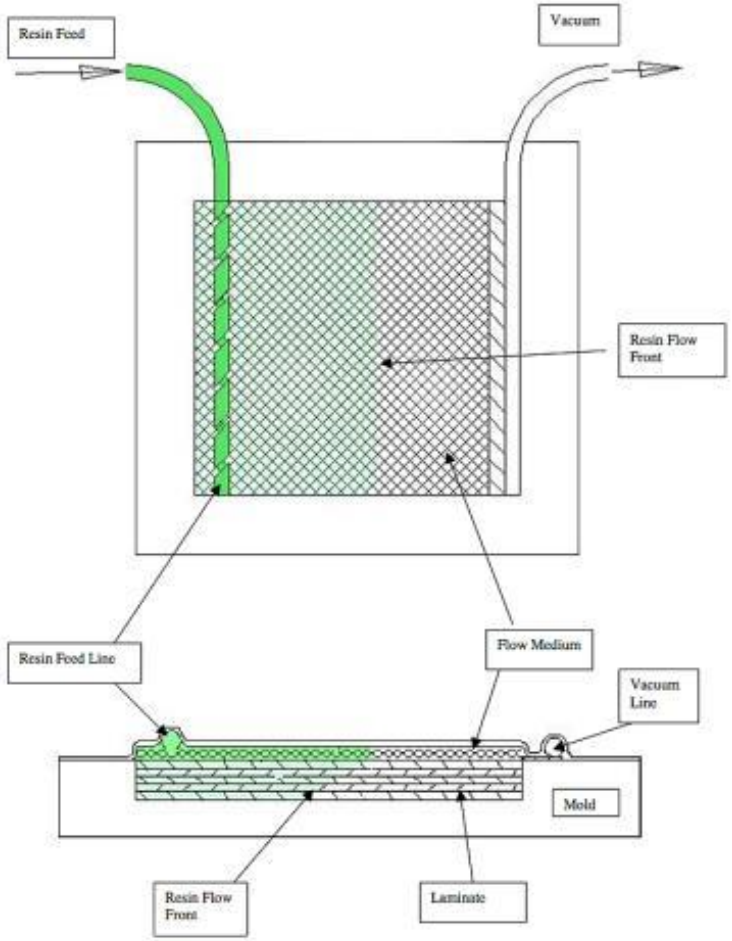
- Provides 1 atmosphere (14.7 psi) of pressure distribution
  - Equivalent of 18 stacked concrete blocks



VARTM Process Overview (no core)

- Tacky tape in place
- Vacuum Lines set in place and taped to hold temporarily
  - Spiral wrap in place and taped
  - Feed line clamped
- Resin trap in place between part & vacuum source
- Vacuum Gage in place between trap & vacuum source
- Air weave in place
- Dry laminate stack in place
- Peel ply in place
- Distribution media in place
- Vacuum bag in place
- Apply full vacuum initially
  - Check for leaks
  - Drop back in vacuum (wide & varied opinions on this)

VARTM Process Overview



Very basic layout of the process. The supporting equipment for this procedure is not shown here.

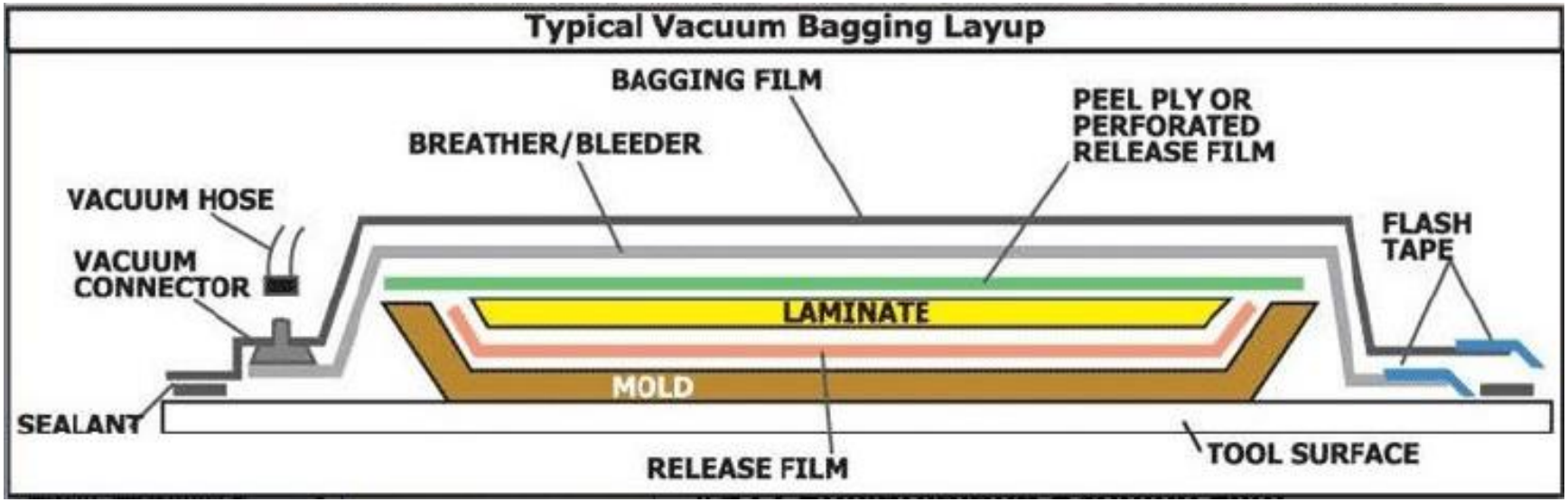
VARTM Advantages

- Less Voids
- Less VOC Exposure
- Use Polyester / VE
- No Laminating Work
- Detect Leaks vs Time
- Consistent FVF (~57%)
- Less Temp Dependent
- Suitable for Thick Stack

VARTM Disadvantages

- More Recurring Cost
- More Resin Required
- Requires Tight Bag
- More Complex Process
  - - spruces & vents
  - - complex bag
  - - greater leak risk
- Less Resin Choices
- Less Fabric Choices
- Less Additive Choices

Wet Preg-Bag Process Overview



Very basic layout of the process. The supporting equipment for this procedure is not shown here.

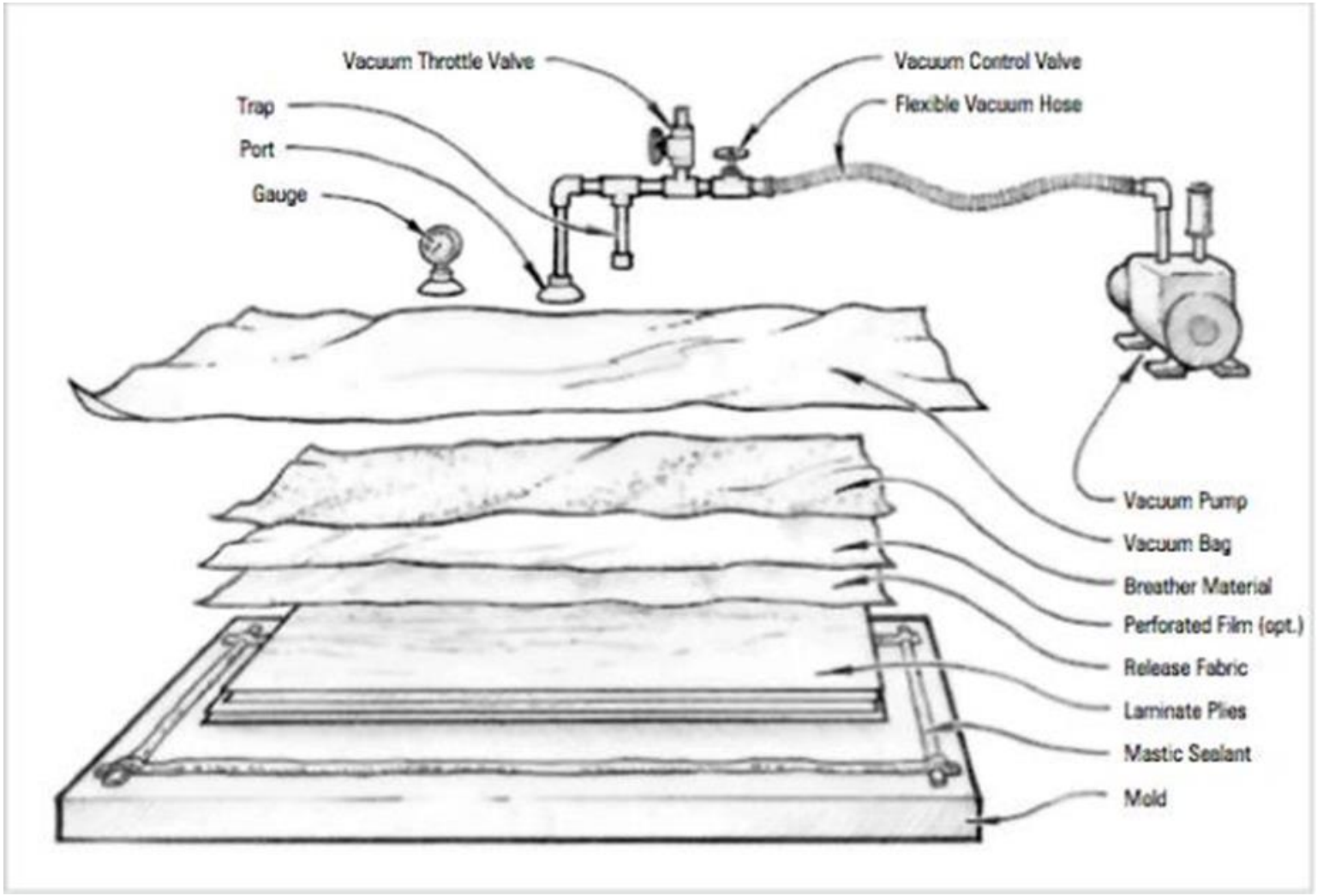
Wet Preg Pre-Process (Fabric Wet Out)

- Dry fabric is saturated with laminating resin
- Do not over saturate!
- Controlling resin content
  - Impregnator often used
  - Hand Wet with pre measured amounts
    - Cut fabrics and weigh
    - Weigh resin amount

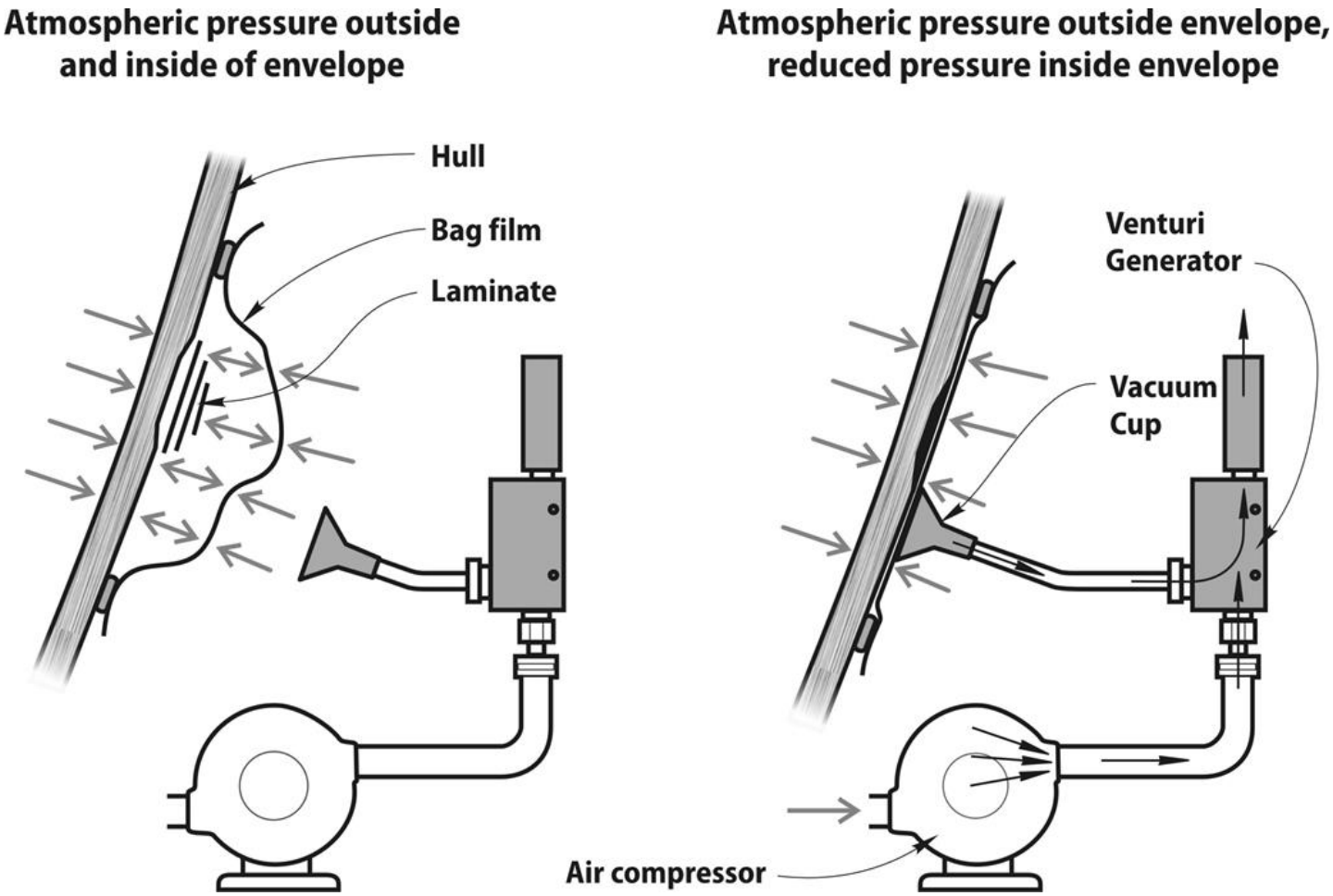
Wet Preg Process (Place Material in mold)

- Roll out laminate
  - Vacuum bag will not fix large voids
  - Vacuum Bag is only intended for additional compaction
- Pre coat core materials

Wet Preg Process (Apply Vacuum Bag Materials)



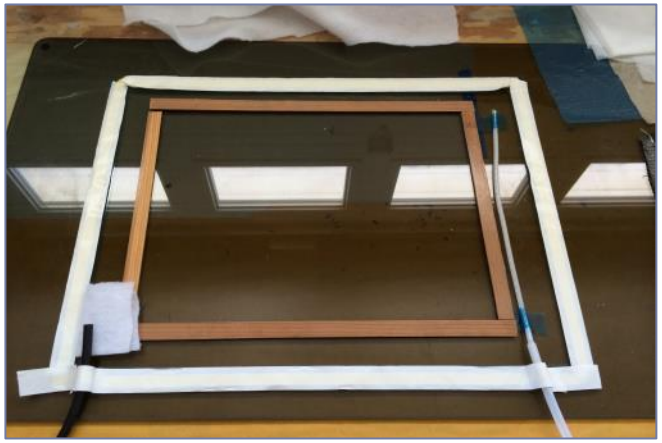
Wet Preg Process (Pull Vacuum)

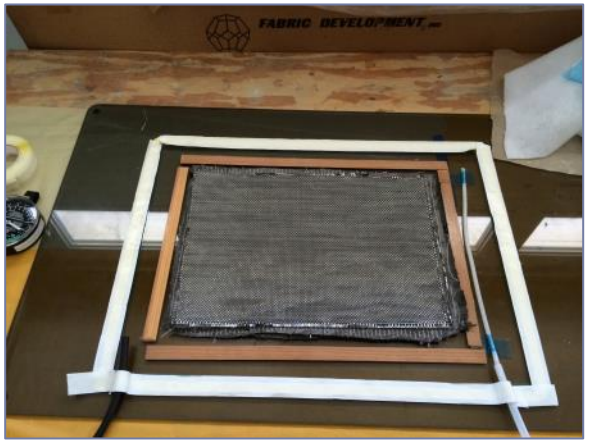


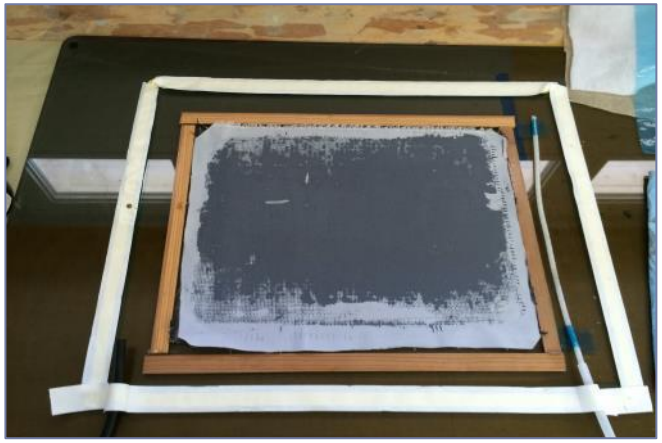
Wet Preg Bagging Steps (no core)

- Tacky Tape
- Vacuum Lines set in place and taped to hold temporarily
  - Spiral wrap in place
- Vacuum Gage in place opposite of vacuum source
- Wet Preg or Down-hand Laminate placed
- Peel Ply in place
- P-3 (or similar) in place
- Air-weave bleeder ply in place
- Vacuum Bag in place after paper is removed from tacky tape
- Apply vacuum
- Check for leaks (will be immediately obvious)
- 13" Hg until onset of gelation then full vacuum. The biggest risk is sucking the laminate dry until resin gels

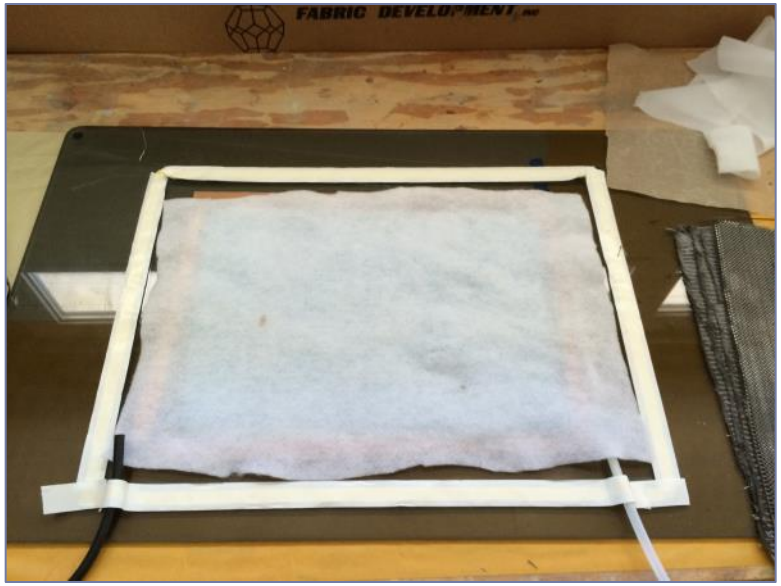
Sample Part

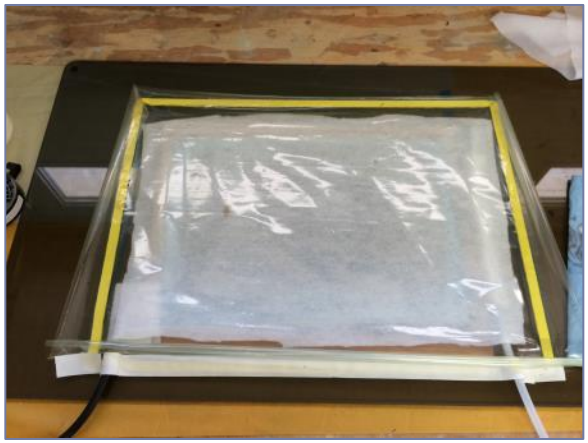


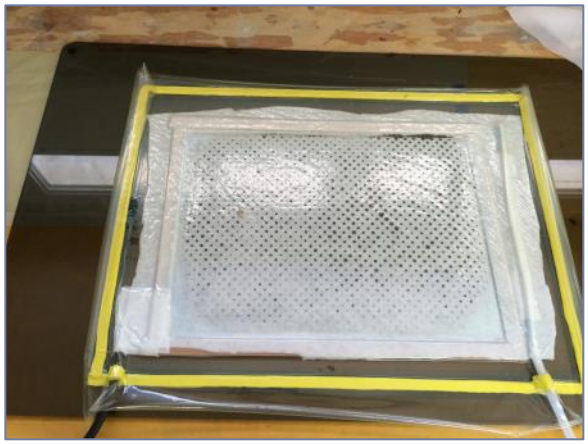




Sample Part Cont.







Wet Preg Materials

- Resin
  - Can be done with any hand laminating system
  - High performance resins favored
  - Medium to high viscosity
    - Balance between wet out and drain out
    - Infusion resin are not a good choice (low viscosity/expensive)

Wet Preg Materials

- Fabrics
  - All fabrics can be used
  - Flow is not issue
  - Be aware of drain out (vertical or inclined surfaces)

Wet Preg Materials

- Cores
  - All cores can be used (including honeycomb)
  - No flow channels required

Wet Preg Materials

- Vacuum Bag
  - Don't use plastic film from local retail sources, purchase good quality film
  - Vacuum leaks are frustrating to chase and poor quality film will be too porous
  - Handle the bag carefully as little pin holes caused by inadvertent damage (folding, wrinkling, scissors, blades, pointing things on table) are tough to locate once in place
- Tacky Tape
  - Recommend either **Schnee-Morehead or General Sealants**

Equipment

- Vacuum Pump
  - More is better. Purchase a pump that is a little more than needed
  - Some pumps do not draw a full 28" Hg so make sure to study the SPECs (Note: can't achieve full vacuum at higher altitudes)
- Venturi Blocks
  - PRO: reasonable price
  - CON: work well but need a lot of compressor & compressor runs constantly (due to throttle technique to maintain 12" until gelation)
- Vacuum Gage & Hose
  - Low priced gage can be purchased at the local auto parts retailer or Sears
  - Polypro tubing may be purchased at local home improvement center

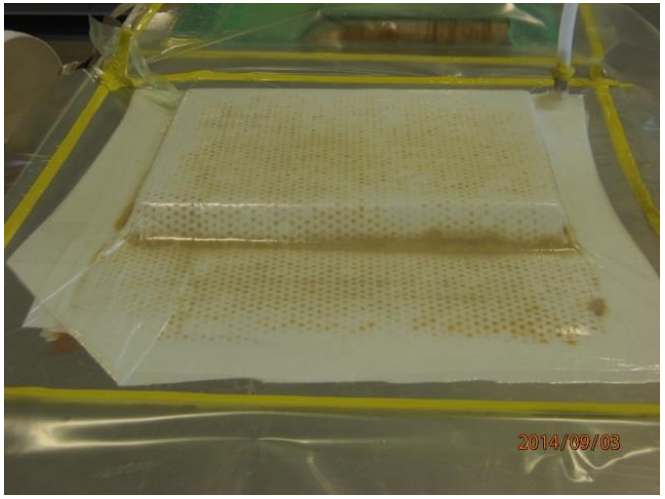
Process Materials

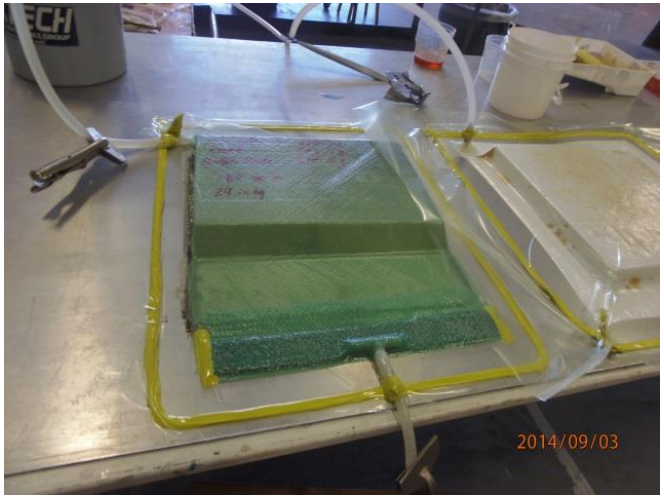
- Air Weave (wet bagging)
- P3 Perforated Film (wet bagging)
- Peel Ply (both processes)
  - Use heat scoured polyester, medium weave (AIRTECH Release Ply-F is ideal)
- Nylon Tubing & Fittings (both processes)
- Teflon Tape
- Flashbreaker Tape or good masking tape (both processes)

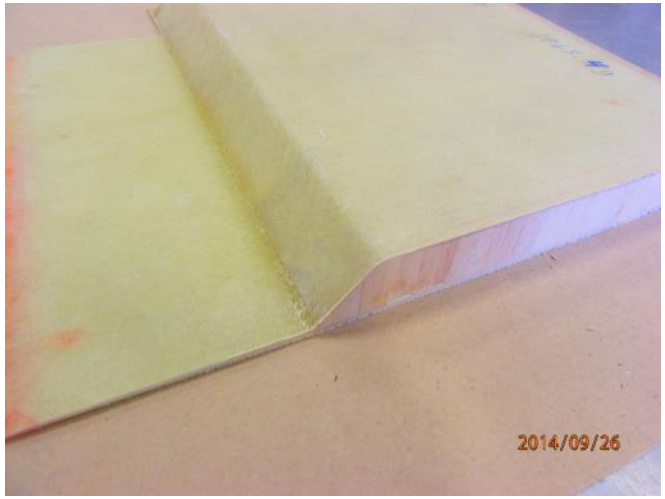
When to use Wet Preg Process

- Repairs
- Porous Core
- Honycomb Core
- Unable to pull 29” vacuum
- Core Bedding only

Laminate Test







Laminate Properties

Cored Laminate: 6 layers 12 oz. biaxial glass, 1.5" AL600 Balsa, 6 layers 12 oz. biaxial glass
Solid Laminate: 12 layers biaxial glass

- ***INFUSED PANEL:***
- Resin weight 26% : Fiber weight 74%
- Thickness: 0.158 inches
- Vacuum Pressure: 29" hg
- Flow media was applied on both skins
- Epoxy in core: .075 (fluid ounces) per (square inch).

- ***VACUUM BAGGED PANEL:***
- Resin weight 26% : Fiber weight 74%
- Thickness: 0.158 inches
- Epoxy mixed to wet fabric: 45% fiber weight
- Perforated film: P3 intervals, tiny holes approximately every 8 mm.
- Breather: 4 layers 4 oz.
- Vacuum Pressure: 20" hg
- Epoxy in core: .031 (fluid ounces) per (square inch).

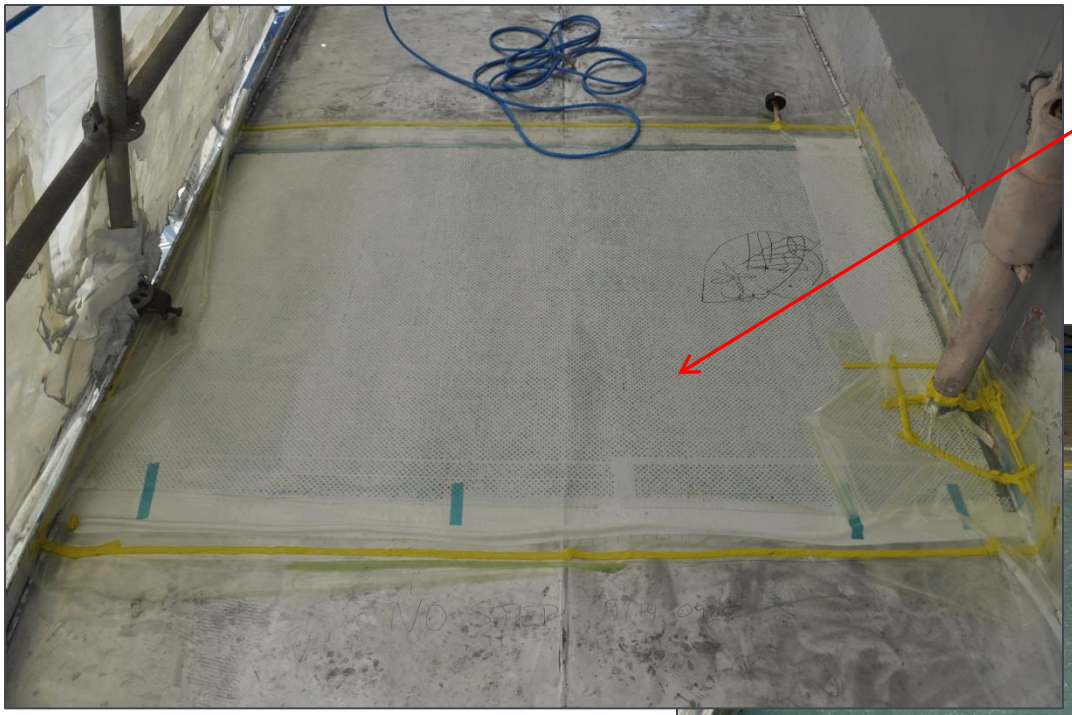
Wet Preg Advantages

- Lower Vacuum levels than infusion
- Lower cost resin selection
- Larger choice of resins, cores and fabrics
- More control over resin content
- Lower overall recurring costs
- Lower aptitude(?) level
- No need for distribution media (aka shade cloth for VARTM)
- Potentially lighter part of same pedigree (less resin into core)
- Ability to adjust FVF
- Ability to consolidate thick laminates
- Filled resins can be used (i.e. ATH)

Wet Preg Disadvantages

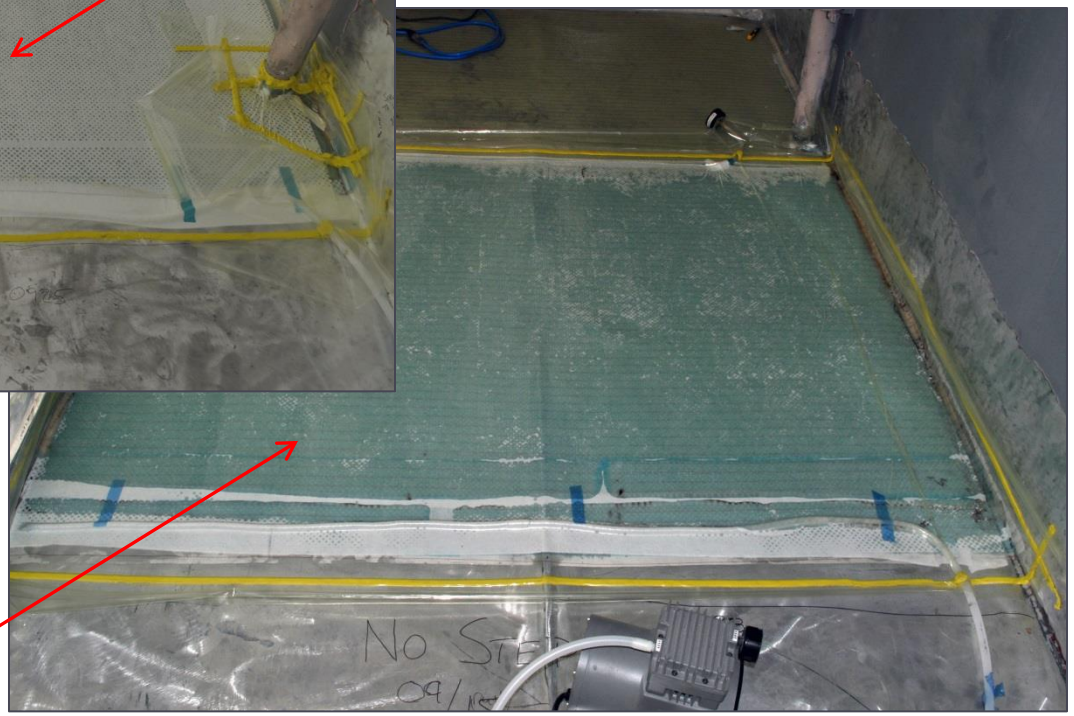
- Required to handle wet fabrics
  - Significant exposure to workers
  - Mixing and dispensing of resin
  - Potential resin run out
- Greater level of effort if impregnator is used (clean up)
- FVF may vary
- Gel time resin creates timing issues
- Thick laminate may require multiple steps
- Risk of higher void content
  - Especially at both surfaces
- Ambient temperature issues
  - Premature gelation
  - Lower consolidation

Ambient Conditions Matter



Hot Deck During Day:

Note the low bleed in the P3 as 1st several plies are gelled



Cooler Deck at Night:

Bleed through P3 is higher so 1st plies haven't gelled

290 SQ FT Finished Product

USS Chosen Pilot House Foredeck

VARTM Built Boat

Mako under construction at Hodgdon Yachts

26 meter Mako MK V.1

Wet Preg Built Boat Examples

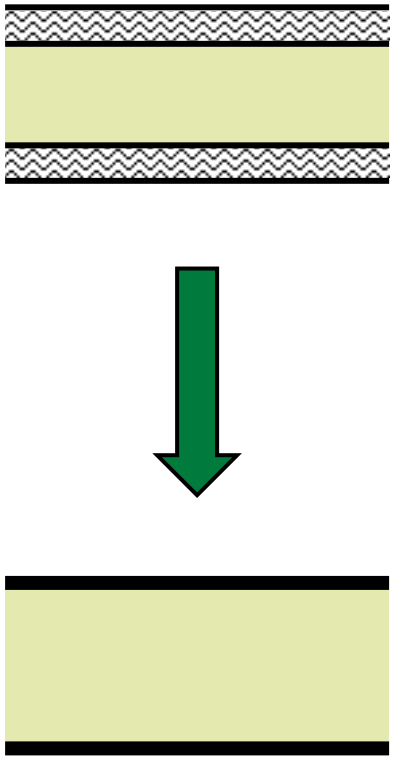
Mystic Powerboats 15.2 meter
244 mph

Credit: John Cosker

42 meter Adler II
50 mph

Credit: Captain Michael Auer

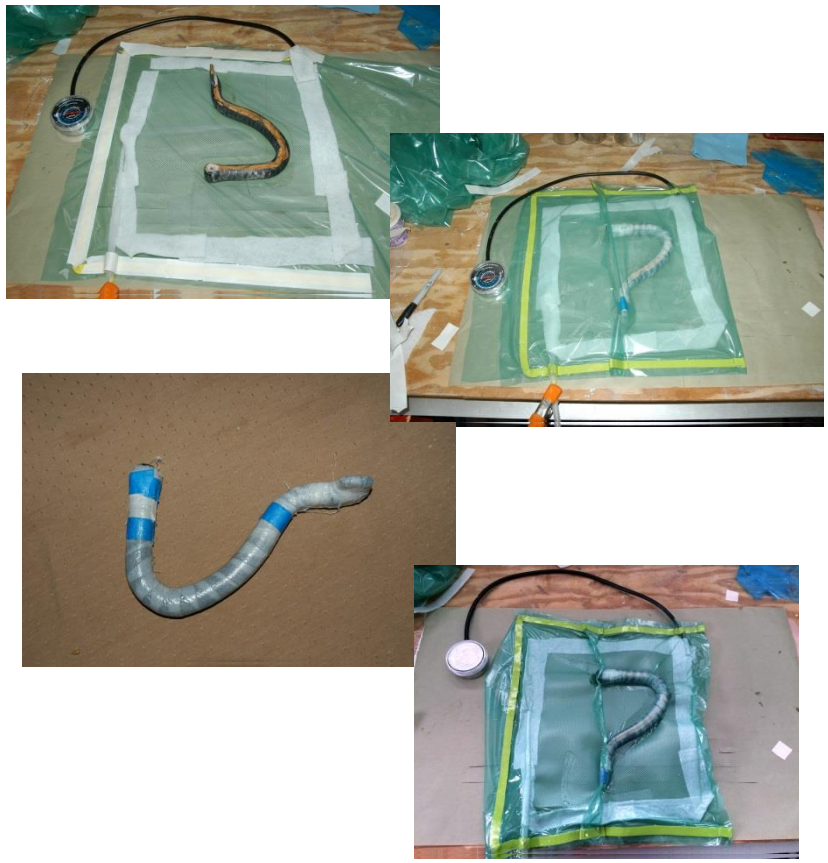
Re-engineering Laminate



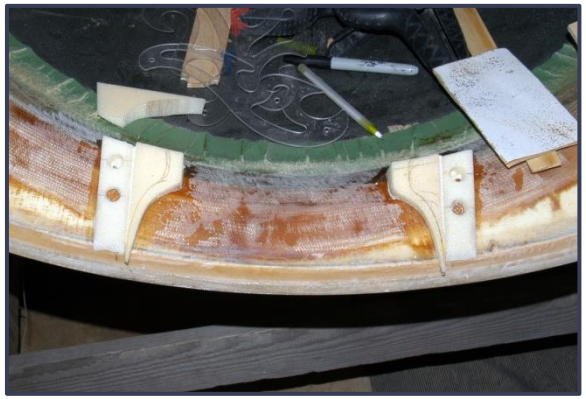
- Resin use ↓
- Mat use ↓
- Skin thickness ↓
- Core thickness ↑
- Interlaminar strength ↑
- Laminate strength ↑
- Structural fiber use ↑

Uses?

- Small parts are possible:
  - Hinge arms
  - Oil tanks
  - Cowl blisters
  - Local mounting points
    - seat belts
    - threaded inserts
  - Accessories cradles
- Bonding pressure

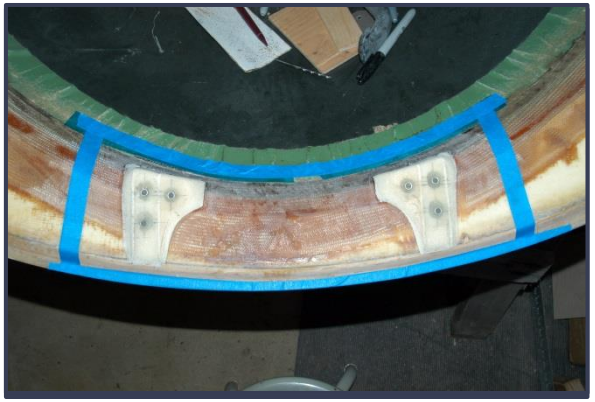


Conforming over Complex Shapes



Shape Foam Cores

Pot In Threaded Inserts & Tape Off Tacky Tape Locations



Vacuum Laminate

Finished Pads

Quick & Simple Oven

- Made of insulating board purchased from home improvement store
- Tape together with Al foil tape
- Use heat gun as source for the heat and air circulation
- Use simple digital temperature controller
- Can build up to very large sizes if one can deliver enough heat

Quick & Simple Oven Cont.

No No's

- Rags (read bond breaker)
  - Cloth rags are not used no matter how often they are washed or washed with
  - Preferred are the Scott Blue Shop or the Multi-Ply, Reinforced Nylon Fiber Utility Towel
- Fabric Handling – not handle with bare hands
- Shop heating – I do not recommend kerosene heat as it puts contaminants in the air and so on the surface of your work
- Diluents in resin – some have used alcohols to thin out epoxy resin – DON'T! Keep your resins at temperatures in the 80's or 90's. Use a heat box if you have to (wooden box with light bulb & thermostat).
- Open Fabric storage – keep your fabric in a bag to be free of dust and moisture: preserves sizing
- Open Resin storage – epoxies last a long time when stored cool & dry
- Solvent wiping / cleaning – many like to clean with acetone or MEK; these are potential bond breakers. I recommend isopropyl alcohol as it does not have any recycled adds due to the medical requirements. Try to get 92%.
- Additives (fumed silica aka cabosil, micro-balloons, flox) – cabosil at less than 2% for thixing and balloons or flox as required. Cabosil has no strength. Additives are introduced after resin & hardener is thoroughly mixed

Sources List

- Vacuum techniques manual (.pdf): http://www.westsystem.com/ss/how-to-publications-2
  - Scroll down until you see the vacuum techniques manual
- Vacuum pumps: Combined Fluid Products Co., Cathy, 847.540.0054 (combinedfluidproducts.com) or the WWW
- Processing Supplies:
  - Northern Composites: nfgsales.com
  - Freeman Supply: freemansupply.com
  - Coast-line International: coastlinedistributors.com
  - AIRTECH: airtechonline.com, Gregg Brown, gbrown@airtechintl.com
  - Resins: ProSet Epoxies, Jeff Wright, jcw@prosetepoxy.com, 888.377.6738 (prosetepoxy.com)
- Mold Release: Zyvax, mstevens@chemtrend.com, 800.746.4773 (zyvax.com)

Sources List Cont.

- Reinforced Nylon Fiber Utility Towel: Grangers Part# 5LG 76 1000/PK or Item # 5LG97 150/PK
- Teflon Tape: CS Hyde Company, 1" wide Skived PTFE Part# 15-2A-1, 2" wide Skived PTFE Part# 15-2A-2 (cshyde.com)
- Airtech Flashbreaker Tape – Airtech (airtechonline.com), Coast-Line International (coast-lineintl.com) or Freeman Supply (**freemansupply**.com)
- Vacuum Bag Tape – General Sealants (generalsealants.com). Yellow AT-200Y is preferred.
- Scissors: Kretzer Finny 74525 10.0" - Extra Heavy Duty, Industrial Scissors (on the web ~$40) or John A. Eberly, Inc. Textile and Sewing Scissors and Shears Professional Cutlery Industrial Tools and Supplies, Box 8047 Syracuse NY 13217, 800-532-3759

Sources List Cont.

- Wheel Cutters: Olfa Rotary Cutter sold at many fabric stores
- Fiberglass Rollers: E S Manufacturing, St Petersburg, FL (esmfg.com)
- Tongue Depressors: non-sterile – any local medical supply
- Epoxy Tooling Gel: ProSet M1019/224 or PTM&W PT 1105A & B
- Ultracal 30: Freeman Supply, (freemansupply.com)
- Carbon and glass fabric & sleeving: Soller Composites, LLC, 55 Industrial Park Drive, (Unit #3) Franklin, NH 03235 (sollercomposites.com)
- Duratec Base Primer (high build primer for plugs & molds): Express Composites, 451 Taft St NE # 15, Minneapolis, MN 55413 (www.expresscomposites.com)

Questions?

- Join me at the Composites Workshop for a hands-on demonstration
  - Easy processing demonstration
- My Email:
  - dmbergen@customtechllc.com