



Field Service Issues

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Field Service Issues

- Cosmetics
- Weathering
- Cracking
- Water Resistance



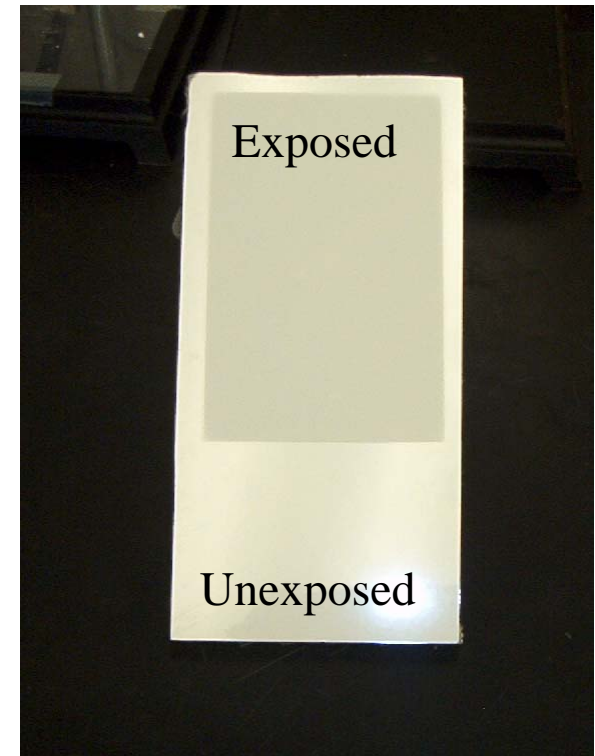
Weathering

- Weathering
 - The effect of sunlight, temperature, water, wind, and pollutants on the surface appearance of FRP parts.
- Weathering Issues
 - Chalking
 - Fading
 - Yellowing
 - Fiber Bloom –non-gel coated FRP parts
- Chalking, fading and yellowing are cosmetic issues and do not affect strength.



Chalking and Fading

- Chalking
 - Breakdown of a part's top surface into an extremely fine powder.
 - Limited to surface
- Fading
 - Uniform, unrecoverable change in color
 - Less brightness/intensity
 - Washed-out appearance

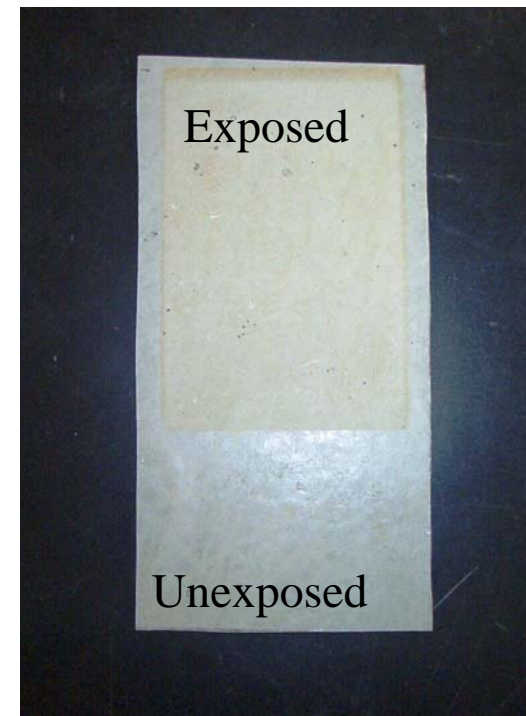


White Gel Coated Panel
with *Chalking*



Yellowing

- Part surface exhibits a yellow cast.
- Uniform or Non-uniform
- Non-Uniform
 - Application issue
 - Non-uniform exposure



Gray FRP part with yellowing.



Fiber Bloom

- Non-gel coated parts
- Outer resin rich layer worn away
- Fibers protruding through the surface



Weathering

- Some change to the surface of an FRP part is expected with exposure
- Changes may occur in a few months make take years
 - Exposure level
 - FRP surface (gel coated vs. non-gel coated)
 - For gel coated parts
 - Type of gel coat
 - Grade of gel coat
 - Color of gel coat
 - Application



Weathering Evaluation

- Accelerated Methods
 - QUV-A, QUV-B, EMMAQUA, Xenon
 - All give results faster than real exposure, but may not correlate
- Real Time Methods
 - South Florida
 - Correlates with real exposure, but time consuming
- Weathering performance based on color and gloss changes.



South Florida Exposure



Weathering

- Application
 - Dust, dirt or build-up on molds
 - Build-up polystyrene or wax
 - Additions to gel coat
 - Calibration (catalyst to resin/gel coat ratio)
 - Gel coat thickness



Weathering

- Minimizing effects
 - Wash regularly
 - Wax parts 1-2 times per year
 - Cover surface when not in use
- For parts that have weathered
 - Wash
 - Wax
 - Sanding and buffing



Cracking

- Structural Cracking
 - Crack extends into laminate
 - Caused by unanticipated stress applied to part
 - Occurs in relatively small fraction of FRP parts
 - Affects structural integrity of part
- Exterior Coating (Cosmetic) Cracking
 - Crack in exterior coating (gel coat) only. Does not extend into the laminate.
 - Caused by stress induced movement of the laminate.
 - Occurs in relatively small fraction of FRP parts
 - Does not affect structural integrity of part
 - Can lead to significant rework or warranty costs



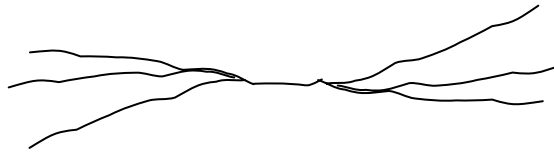


Types of Exterior Coating Cracking

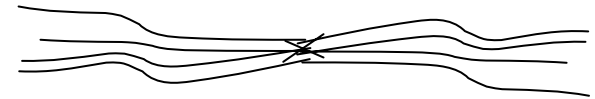
- Linear Cracking – caused by flexural stress



Parallel Stress



Divergent Stress Field



Convergent Stress Field

Linear cracks



Note: Source
is too thick gel
coat

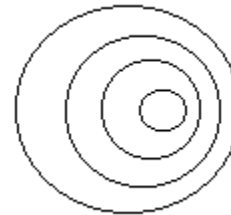


Types of Exterior Coating Cracking

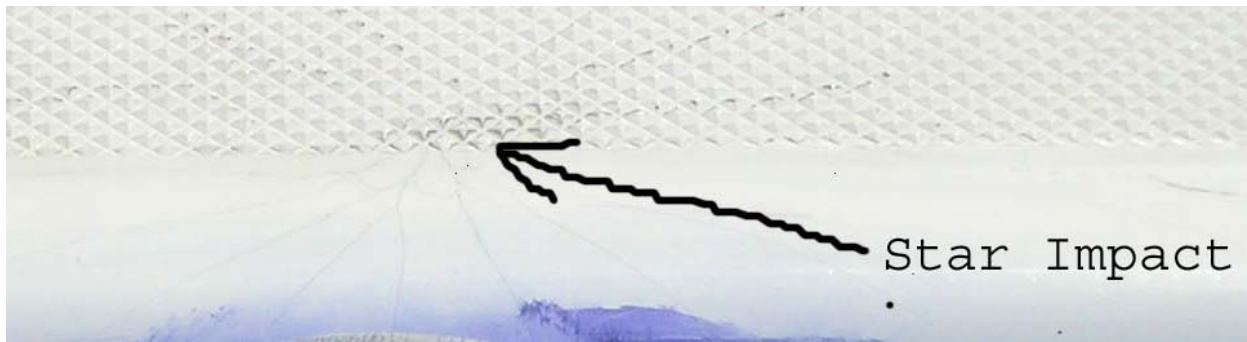
- Radial Cracking – caused by impact



Reverse Impact

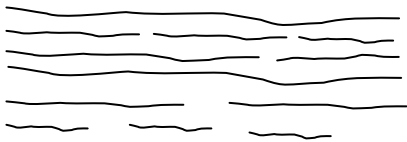


Frontal Impact



Types of Exterior Coating Cracking

- Thermal Fatigue Cracking – repeated expansion and contraction



Linear



Isotropic

- Stress Risers – cutout or fastener concentrates strain into a localized area





Test Methods for Evaluating Exterior Coating Cracking

- Film elongation
- Flexure to first audible

} **Linear Cracking**

- Reverse Impact

} **Radial Cracking**

- Thermal Shock

} **Thermal Fatigue Cracking**



Sources of Exterior Coating Cracking

- Coating Thickness
 - A thick, un-reinforced layer is prone to cracking.
- Part Design
 - Must account for all loading scenarios in part's life cycle (fabrication, transportation and in-service)
 - Part complexity increases difficulty of coating and lamination application as well as de-mold
- Under-Cure of Coating or Laminate
 - Under-cured coatings and resins are susceptible to cracking.
 - Thin coating application
 - Incorrect initiator level
 - Low ambient temps
 - Early de-mold



Sources of Exterior Coating Cracking

- Laminate Fiber Contents
 - Low, high or inconsistent glass contents can lead to cracking.
- Assembly
 - Flexing of parts for fitting and joining, drilling fastener holes or installing fasteners
- Thermal stresses
- Unintended usage



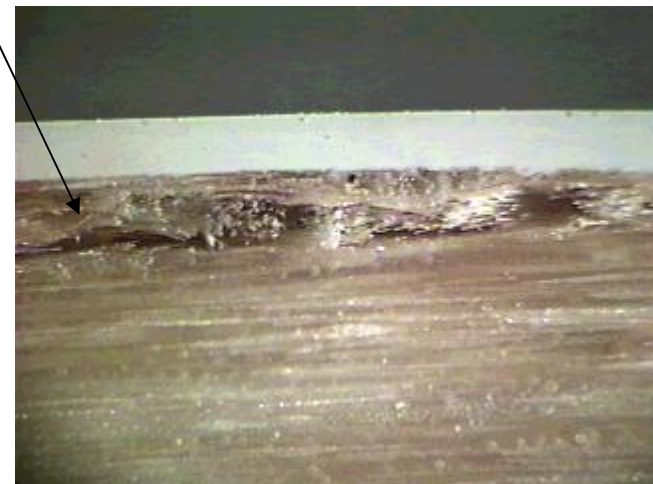
Water Resistance

- The effect of water exposure on the FRP parts
 - Primarily a concern for Marine and sanitary applications
- Water Resistance Issues
 - Blisters
 - Color change - blushing
 - Print – fiber shape showing in surface
 - Cracks
 - Loss of gloss



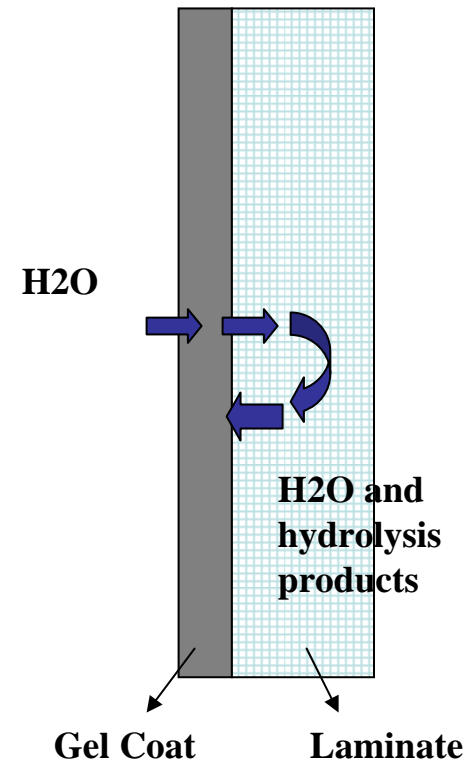
Blisters

- Voids in the laminate
 - As part is heated, air in void expands
 - Pressure from the air expansion can cause a blister
- Entrapped liquids
 - Expand with heat
 - Catalyst
 - Water
 - Solvents
 - Oil
 - Uncatalyzed resin



Blisters

- Osmosis
 - Movement of solution components through a membrane
 - Membrane – gel coat
 - Solution - water
 - Water penetrates gel coat
 - Saturates the gel coat and laminate
 - Water hydrolyzes the laminating resin
 - Solution of water and hydrolysis products can't move through the membrane
 - Resulting pressure can result in blisters





Water Resistance

- The water resistance of an FRP part is determined by the total part construction
- Gel coat – Type, grade, color
 - Blistering, color change, cracking, print, loss of gloss
- Barrier Coat - Type
 - Blistering, print
- Skin Laminate – Resin type, quality
 - Blistering, print



		STANDARD GEL COAT			
	THICK SECTION				
	THIN SECTION				
		NO BARRIER	VE SKIN with FIBER	VE BARRIER	BARRIER + SKIN
Hours @ 100 C		46	52	92	92
Blister Rating (Thick)		0.5	0.5	0.1	0.2
Blister Rating (Thin)		2.0	1.2	0.0	0.0



Water Resistance Evaluation

- Water Boil Test
- Surface of FRP part exposed to boiling water
- Typical duration – 100 hours
- Panels visually rated for blisters, color change, print, cracks, loss of gloss





Summary

- Discussed three field issues seen with FRP parts
 - Weathering
 - Cracking
 - Water resistance
- Causes
- Minimization
- *Questions?*