

The Effect of Surface Treatment on The Degradation of Composite Adhesives

Lloyd Smith

Prashanti Pothakamuri

Outline

- **Year 1**
 - **The effect of adherent moisture content prior to bonding on adhesion**
 - **Peel Ply study**
 - **Modified Wedge Crack**
- **Year 2**
 - **Double Cantilever Beam**

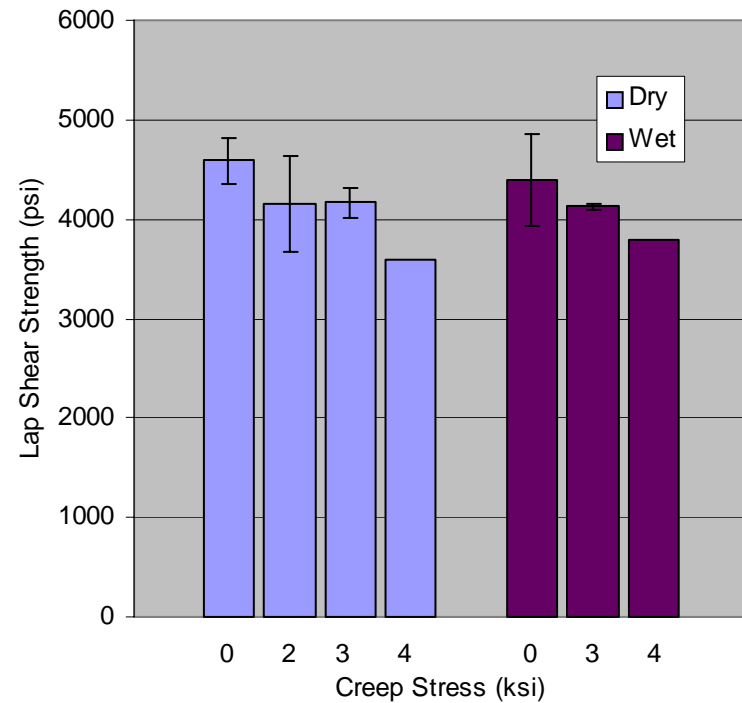
Adherend Moisture Effects

- Pre-cured adherents soaked to 1% moisture content prior to bonding uncured skin
- 140F, H₂O, 1k hrs



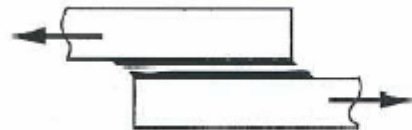



<u>Coupon</u>	<u>Process</u>	<u>Creep Stress (ksi)</u>			
		<u>0</u>	<u>2</u>	<u>3</u>	<u>4</u>
WLS	Dry	3	3	3	3
WLS	Wet	3	0	3	3

Adherend Moisture Effects

- **Status**
 - Exposure completed 6/8/05
 - 2 wet coupons and 2 dry coupons at 4 ksi failed during exposure



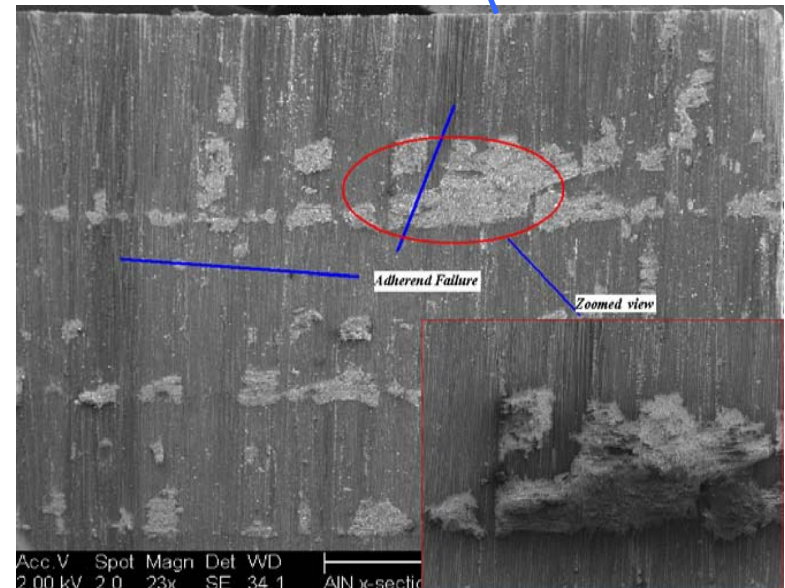
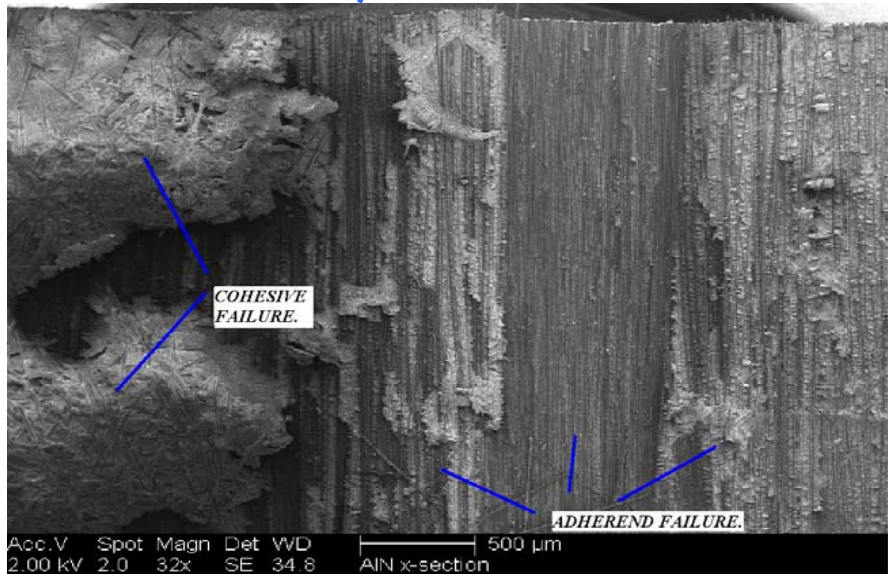
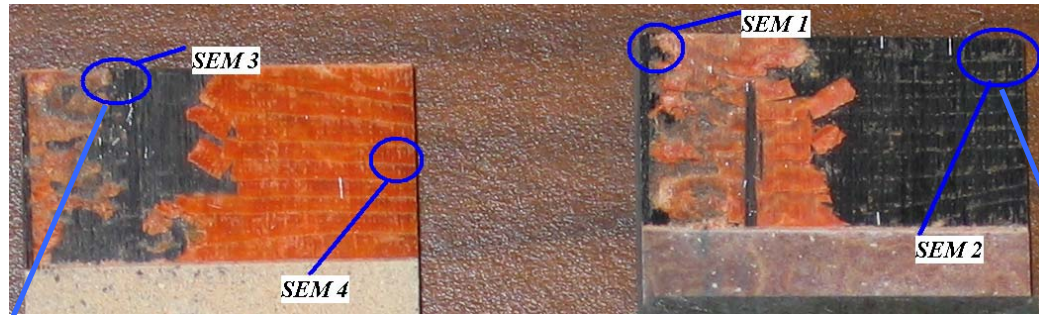
Adherend Moisture Effects

- Failure mode: **Shear** **Peel**
 - Adherend  
 - Cohesive  
 - Adhesive  

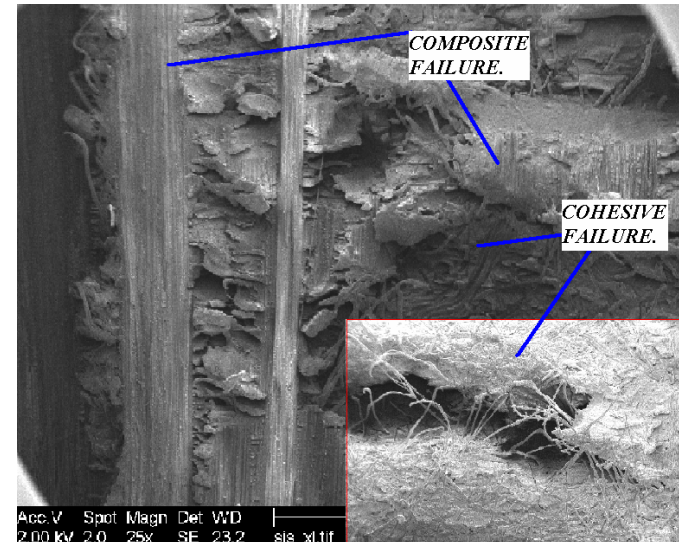
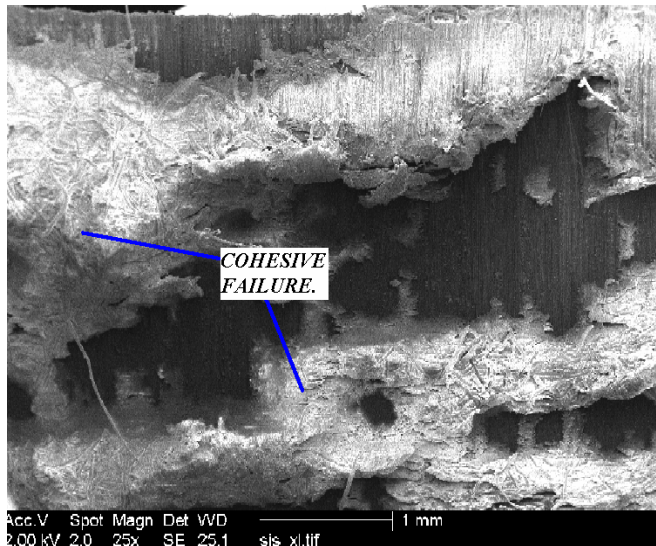
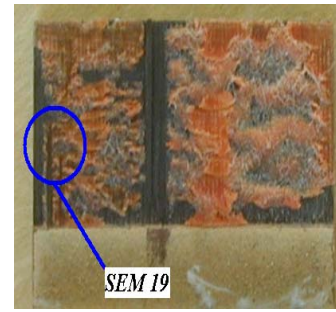
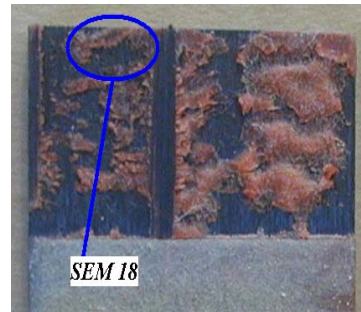
Adherend Moisture Effects

Type of Load	Dry Failure Mode	Wet Failure Mode
0 ksi	90% adherend 10% cohesive	95% adherend 5% cohesive
2 ksi	97% adherend 3 % cohesive	n/a
3 ksi	95% adherend 5 % cohesive	95% adherend 5 % cohesive
4 ksi	60% adherend 40% cohesive	98% adherend 2 % cohesive
4 ksi Creep rupture	98% adherend 2 % cohesive	99.5% adherend 0.5% cohesive

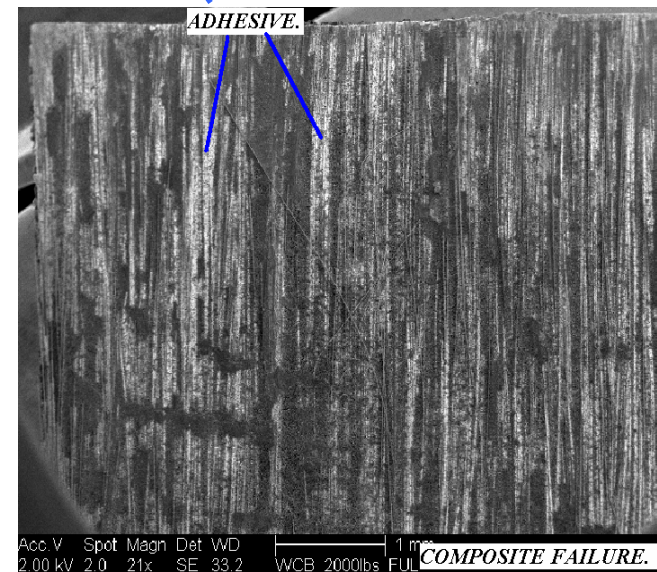
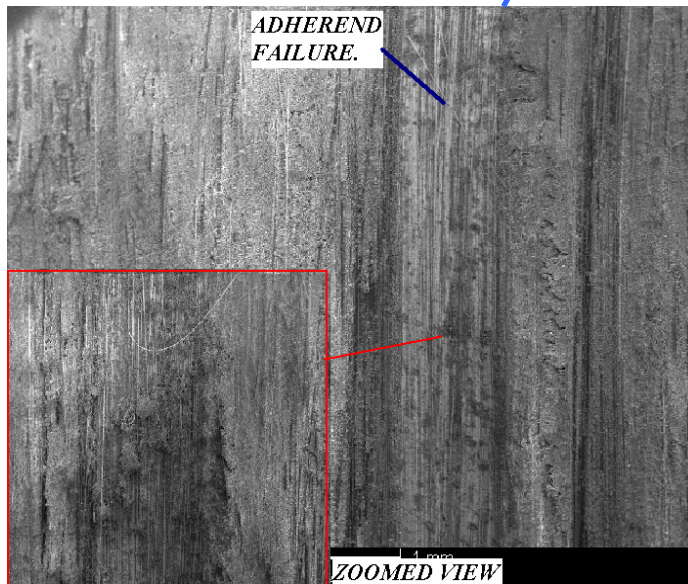
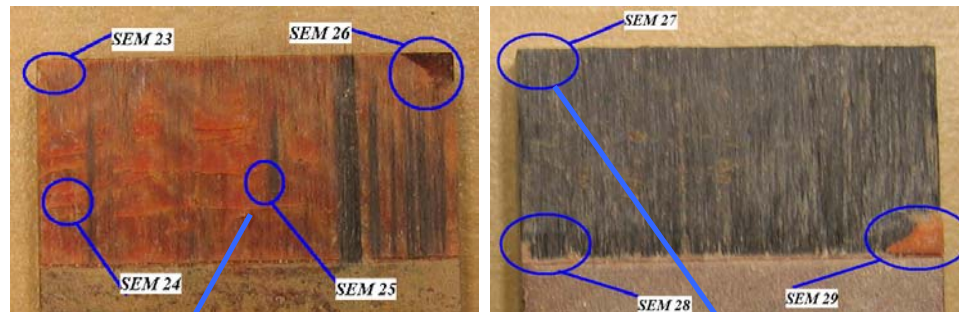
Adherend Moisture Effects (0 ksi, dry)



Adherend Moisture Effects (4k ksi, dry)



Adherend Moisture Effects (4 ksi rupture, wet)



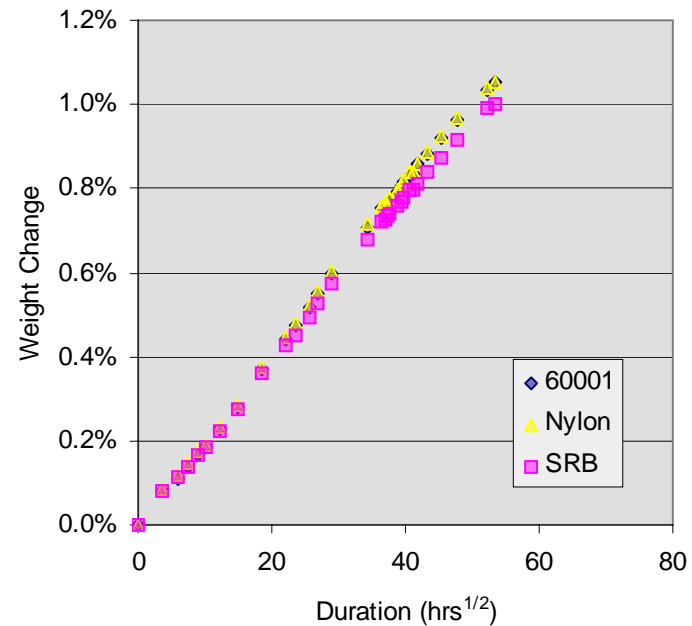
Peel Ply Study

- Measure fracture toughness and shear strength as a function of surface preparation and exposure duration
- 140F, H₂O, 60% UTS (~3 ksi)
- Saturate coupons before applying load

<u>Coupon/peel ply</u>	<u>0 hrs</u>	<u>2k hrs</u>	<u>4k hrs</u>
DCB/60001	5	5	5
DCB/Nylon	5	5	5
DCB/SRB	5	5	5
WLS/60001	5	5	5
WLS/Nylon	5	5	5
WLS/SRB	5	5	5

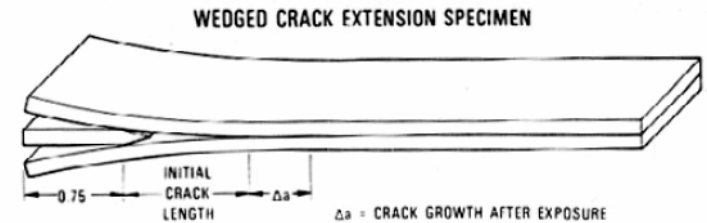
Peel Ply Study

- **Saturation has taken longer than anticipated**
 - **Goal: 1k hrs**
 - **Current: > 3k hrs**



Modified Wedge Crack

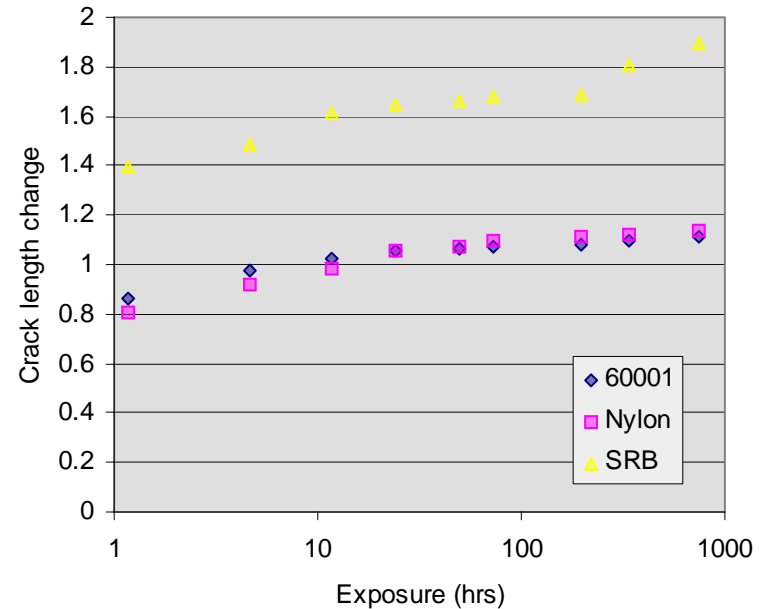
- Compare crack growth
- 140F, H₂O, wedge



<u>Coupon/peel ply</u>	<u>Uni</u>	<u>Compliant</u>
WC/60001	5	5
WC/Nylon	5	5
WC/SRB	5	5

Modified Wedge Crack

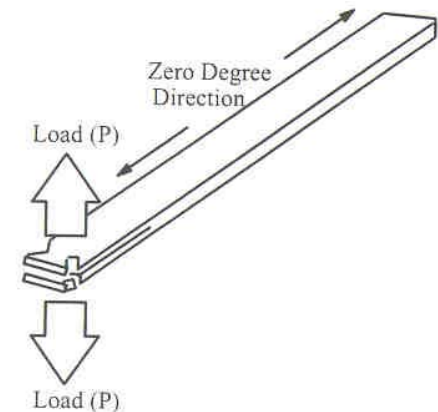
- Crack growth rates are comparable
- Rate of SRB is slightly higher
- All SRB coupons failed by 750 hours
- Rate of SRB would be higher if longer coupons were used
- Compliant coupons waiting on Peel Ply Study fracture toughness



Double Cantilever Beam (yr 2)

	140 F water immersion			-65 F in air		No exposure	Total coupons
	Constant load	No load	Fluctuating load	Constant load	No load		
Un-sanded	10	5	10	10	5	5	45
Sanded	10	5	10	10	5	5	45
Grit blast 1	10	5	10	10	5	5	45
Grit blast 2	10	5	10	10	5	5	45

1. Saturate all coupons at 140F in immersed water before exposure (will likely require over 3 months)
2. use standard 1/2 x 13 inch Boeing DCB specimens
3. Coupons to be processed using 60001 peel ply, cured and machined by Boeing.
4. Sanding shall be done with 180 grit sand paper until peel ply texture is removed. Sanded surface will be solvent cleaned prior to bonding.
5. Grit blast parameters will be determined from SEM surface examination. Grit blast 1 will be the control, removing only the peel ply texture. Grit blast 2 will be severe, partially removing the substrate.
4. 140 F exposure conducted at WSU, -65 F exposure conducted at Boeing
5. Applied load should produce ~90% Gic
6. Measure crack growth daily for 100 hours, weekly for up to 4000 hours
7. Measure Gic at conclusion of test.



Double Cantilever Beam (yr 2)

