The Effect of Surface Treatment on The Degradation of Composite Adhesives

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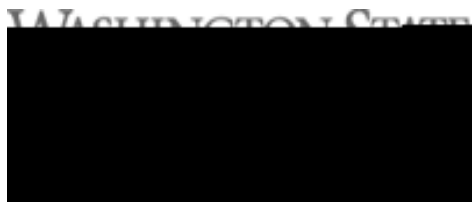
Lloyd Smith



The Effect of Surface Treatment on The Degradation of Composite Adhesives

- Motivation and Key Issues

  Adhesive bonding is required for composite structural efficiency

  Surface preparation is not standardized and affects bond integrity

  Long term durability of composite adhesive bonds is not well understood

- Objective

  Compare the effect of surface preparation on bond durability

  Investigate approaches to accelerate environmental degradation

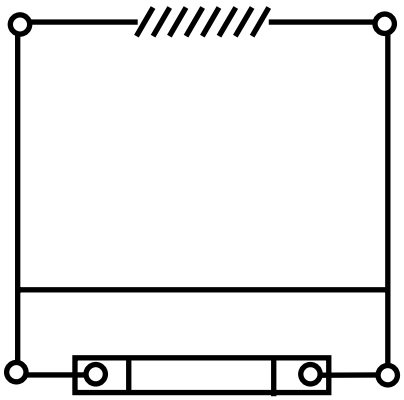
The Effect of Surface Treatment on The Degradation of Composite Adhesives

- Approach
  - Surface preparation
    - Prebond moisture
    - Peel ply
    - Abrasive techniques
  - Accelerated degradation
    - Modify wedge crack specimen
    - Combine moisture, temperature, and stress
    - Creep and fatigue of DCB
  - Material
    - BMS 8-276 form 3 prepreg (low cost)
    - 3M AF555 adhesive

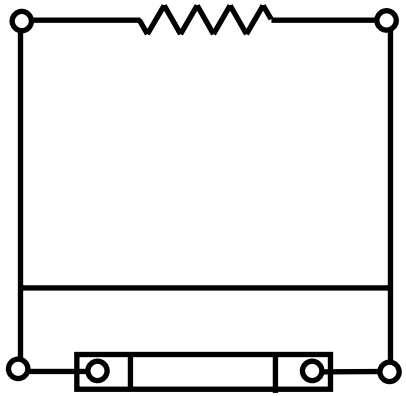
FAA Sponsored Project Information

- Principal Investigators & Researchers
  - Lloyd Smith
  - Prashanti Pothakamuri
- FAA Technical Monitor
  - Peter Shyprykevich
- Other FAA Personnel Involved
  - Curt Davies
- Industry Participation
  - Boeing: Peter VanVoast

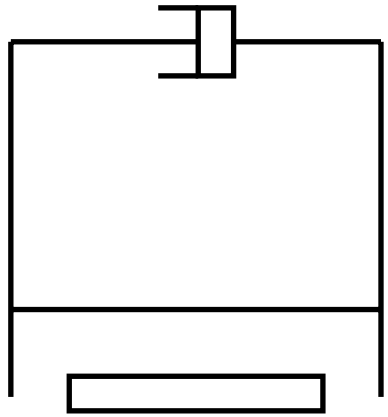
Combining Load and Environment



Threaded Rod



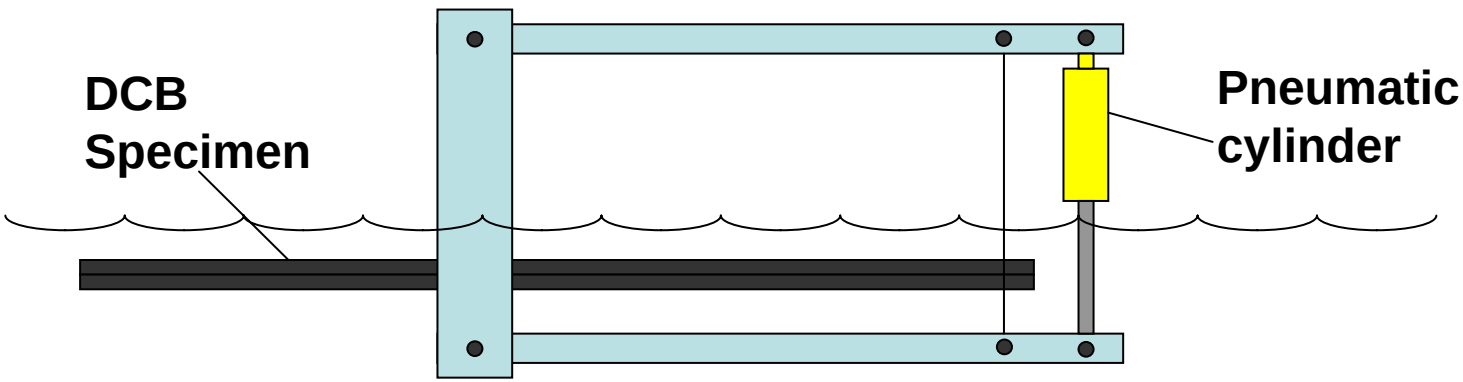
Spring



Pressure

Combining Load and Environment

- Compact Pneumatic Creep Frames

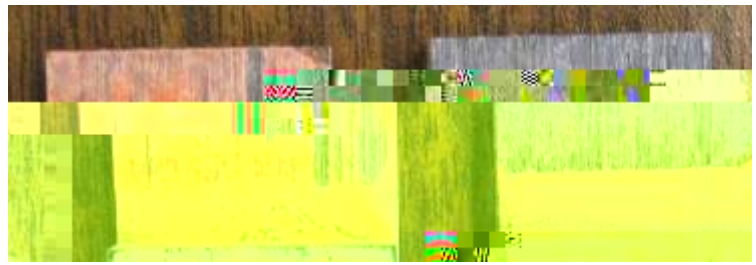


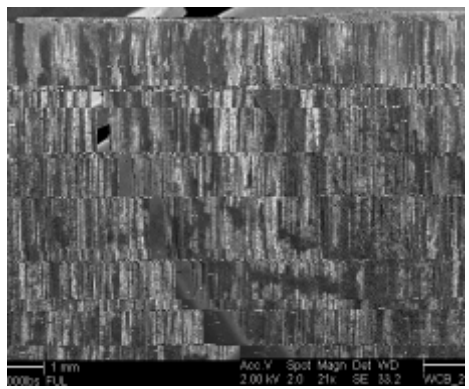
Moisture Effects

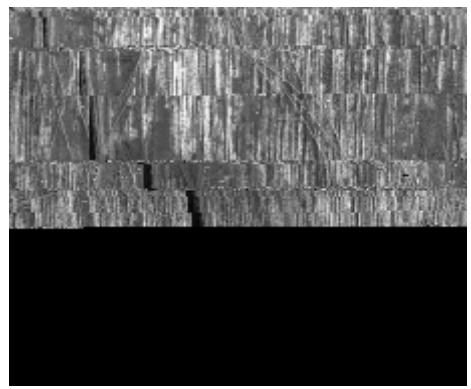
- Polyester peel ply

Moisture Effects

- Failure modes were predominantly in the adherend
- Adherend failure studies without adhesive (IPS, CILS)
- Classic and low cost material forms showed similar response







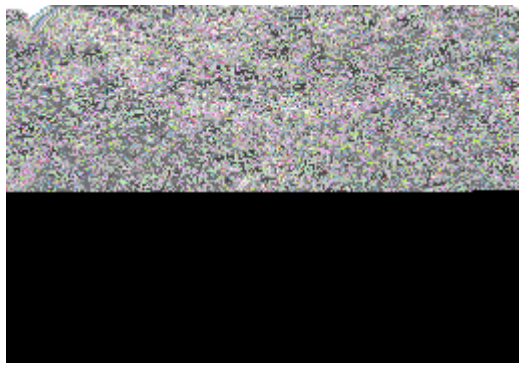
Peel Ply

- TWSL failure modes

- Similar results observed with Creep-Rupture, DCB and Wedge Crack

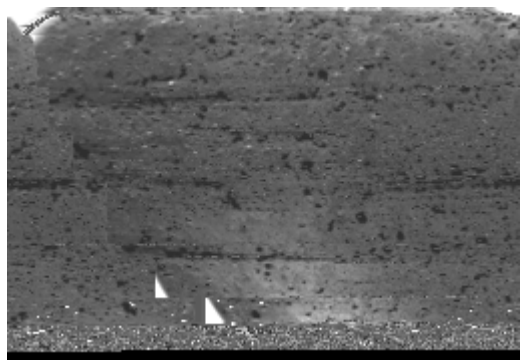
Surface Abrasion

Polyester peel ply



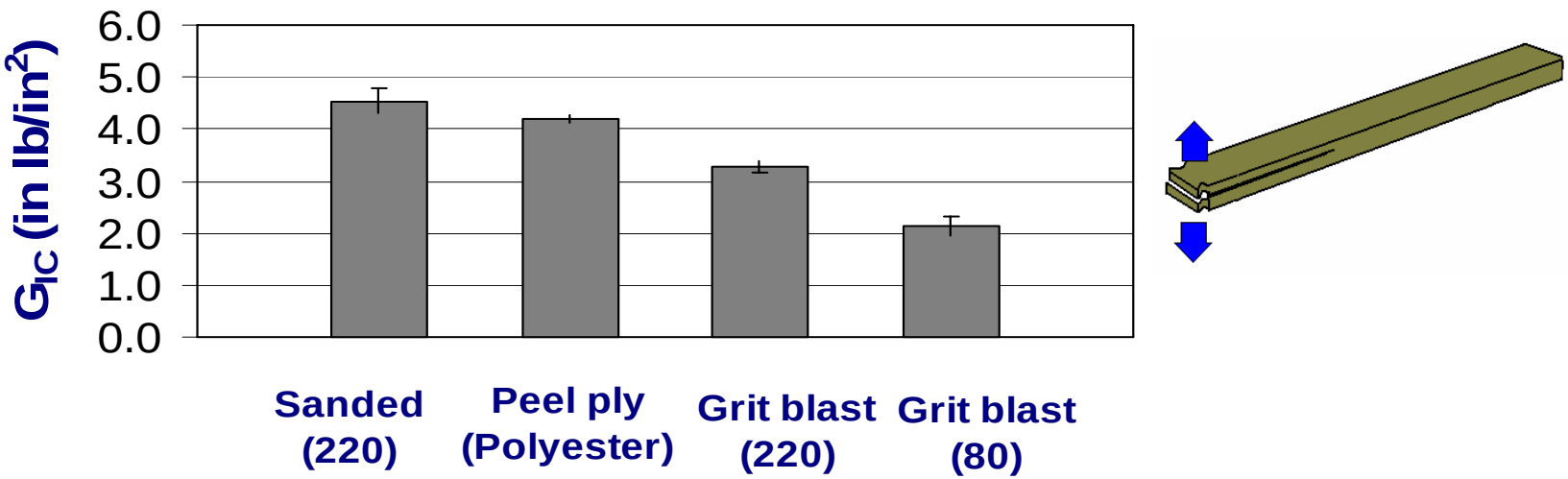
Grit blast 80

Sanding 220

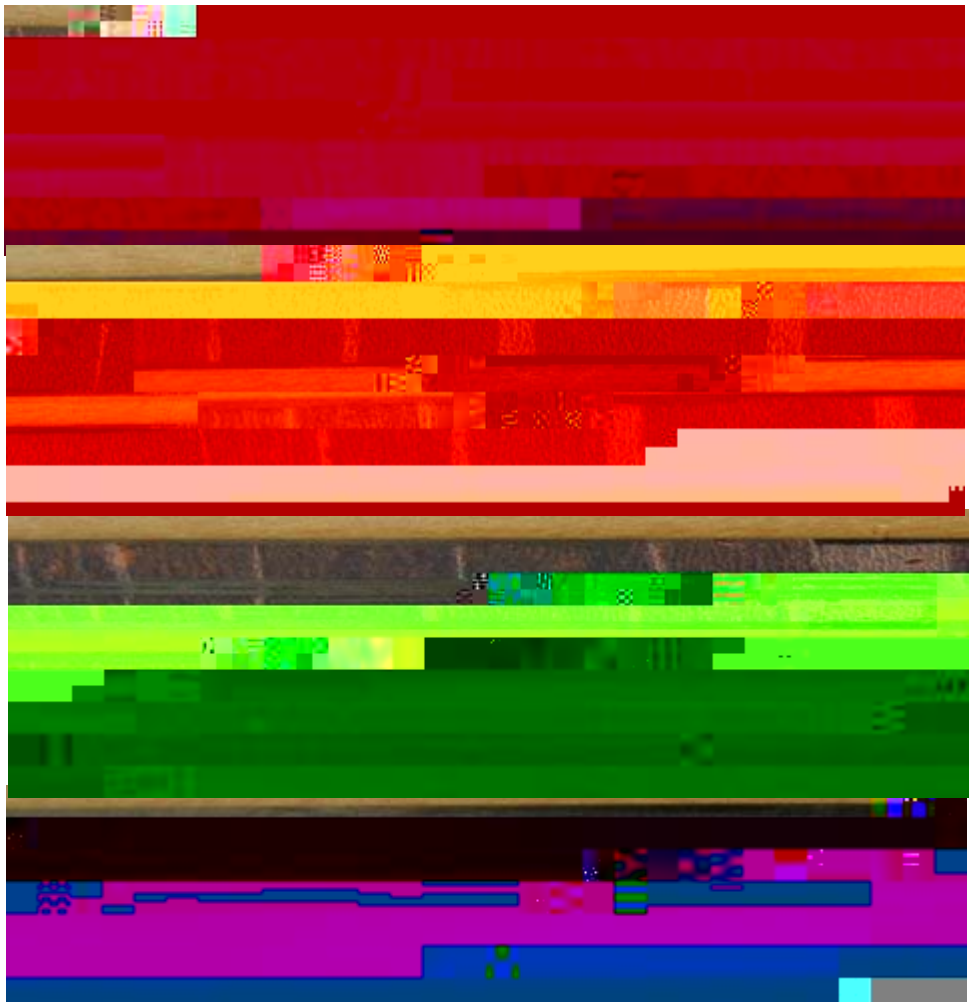


Grit blast 220

Surface Abrasion



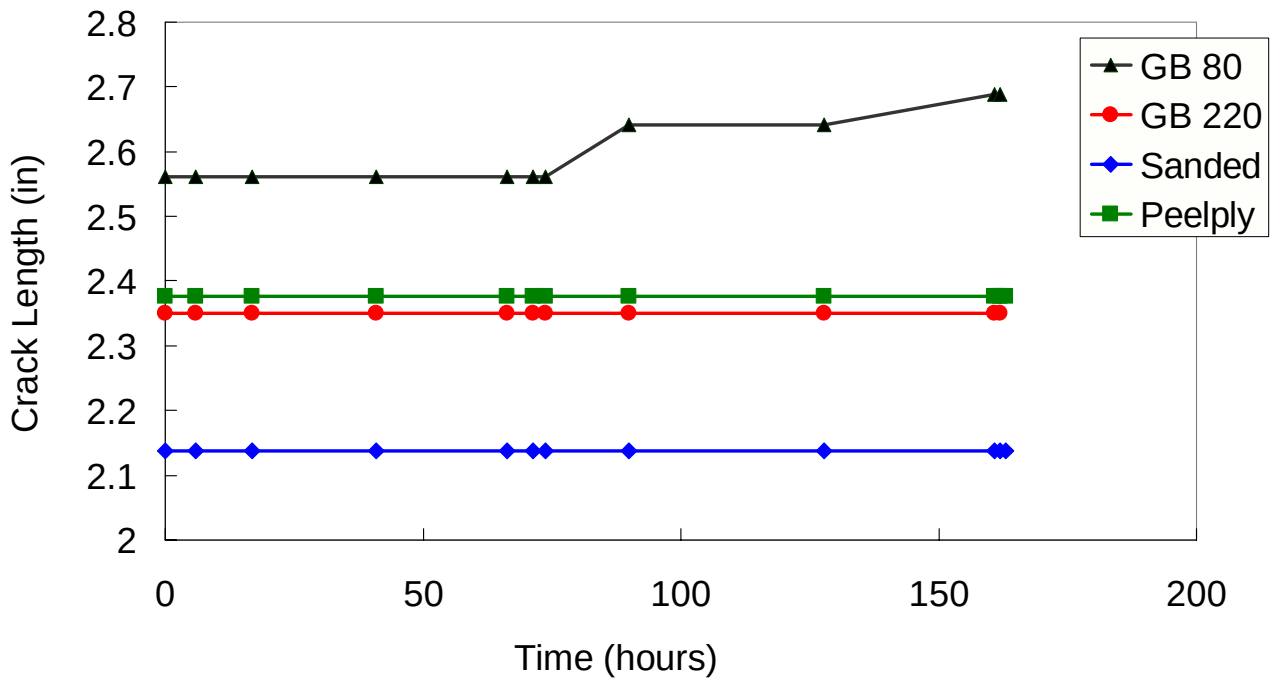
Surface Abrasion



Sanded
99% cohesive, 1 % adherend
Polyester
90% cohesive, 10% adherend
GB 220
70% cohesive, 30% adherend
GB 80
100% adherend

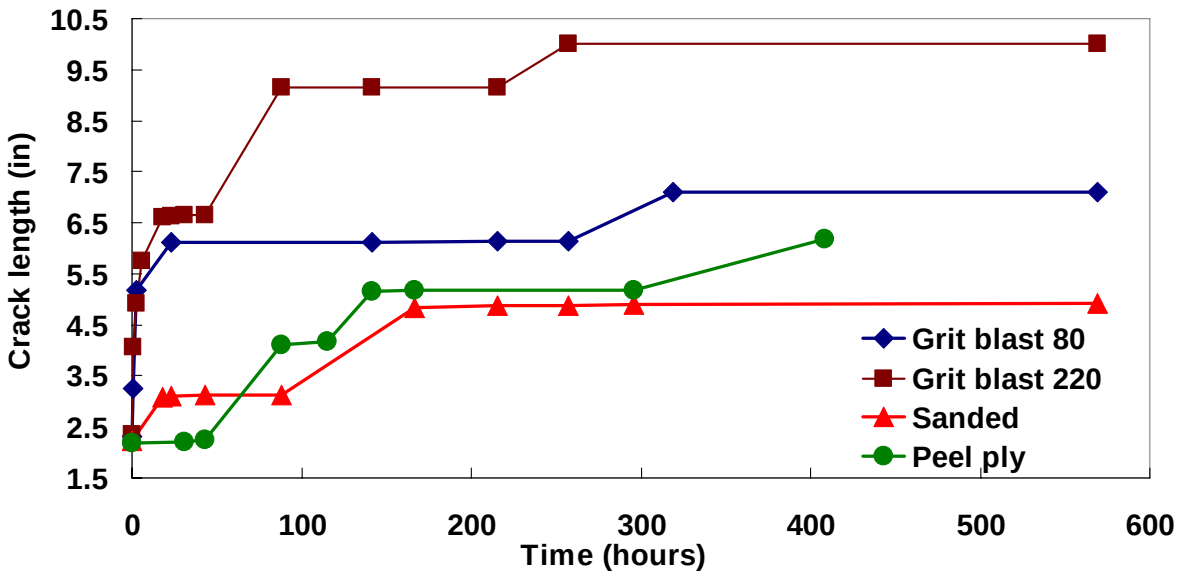
Surface Abrasion

- Creep load of 90% baseline crack initiation load
- Minimal crack growth observed



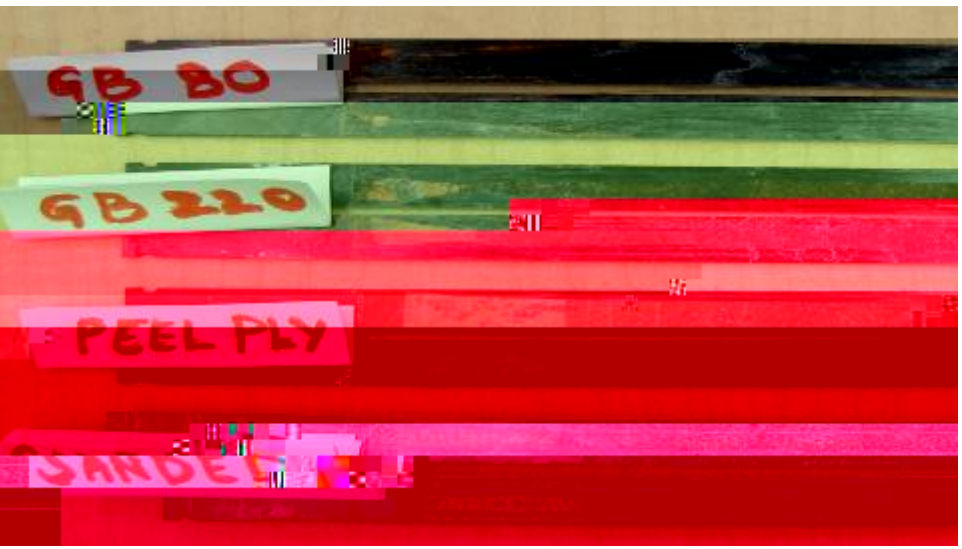
Surface Abrasion

- Same load applied to all DCB specimens
  - 9.5 lbs
- Slopes of GB 80 and 220 are higher



Surface Abrasion

- Failure modes similar to baseline results



- GB 80 - 100% adherend
- GB 220 - 60% cohesive 40% adherend
- Peel ply - 50% adherend 50% cohesive
- Sanded – 20% adherend 80% cohesive

Summary

- Integrity of composite bonds using AF555 is relatively insensitive to prebond moisture content
- Moisture tends to encourage interlaminar failure of BMS 8-276 form 3 laminates
  - May be due to toughening system
- Peel ply can produce surfaces acceptable for direction adhesion
  - Peel ply should be matched with prepreg

Summary

- Surface abrasion did not significantly improve bond integrity
  - Slight improvement with sanding
  - Decrease with grit blasting
- Components of service exposure should not be studied individually in the laboratory
- Stress accelerated adhesive degradation
  - Residual shear strength
  - Creep rupture
  - Strain energy release rate

Summary

- Load control appears to accelerate degradation more than displacement control
  - Repeated loading accelerated degradation further