CACRC Depot Bonded Repair Investigation – Round Robin Testing

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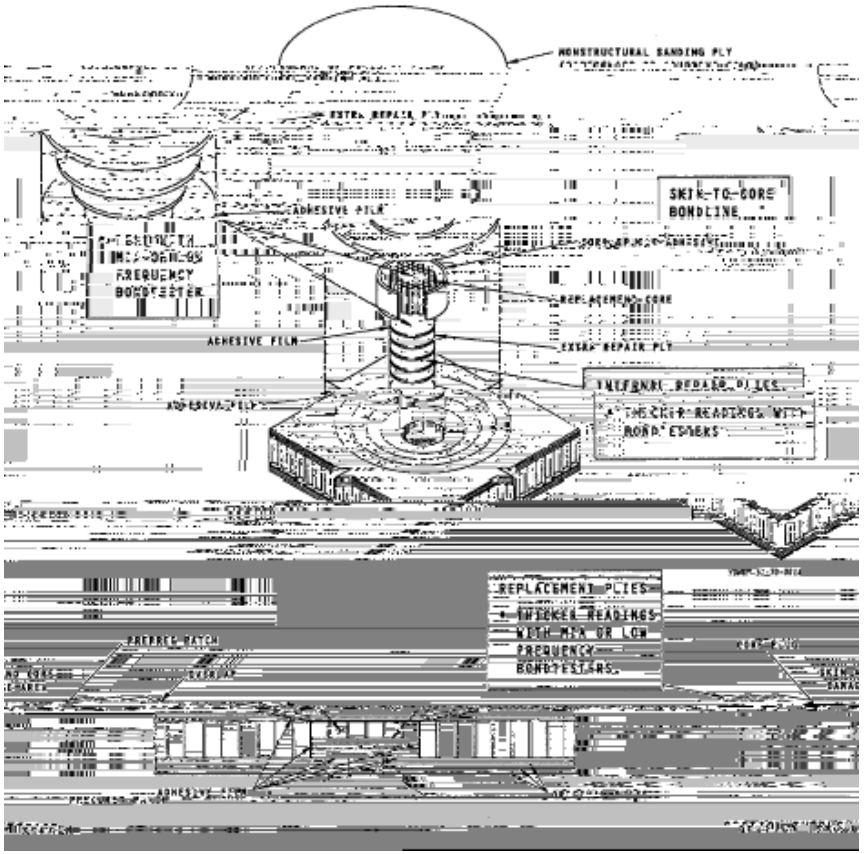
FAA Sponsored Project Information

- Principal Investigators & Researchers
  - Dr. John Tomblin, Wichita State University
  - Lamia Salah, Wichita State University
  - Mike Borgman, Spirit Aerosystems
- FAA Technical Monitor
  - Curtis Davies, Lin Pham
- Other FAA Personnel Involved
  - Larry Ilcewicz, Peter Shyprykevich
- Industry Participation
  - Mike Borgman, Spirit Aerosystems

Objective

- ü To investigate different variables on the performance of bonded repairs applied to sandwich structures
- ü To investigate the effectiveness of bonded OEM vs field repairs implemented at various OEM/ Operator depots
- ü To evaluate the static, fatigue and residual strength performance of OEM vs field repairs
- ü To evaluate the existing CACRC standards for composite repair implementation and technician training



Reference SAE ARP5089

Previous Research

ü Objective

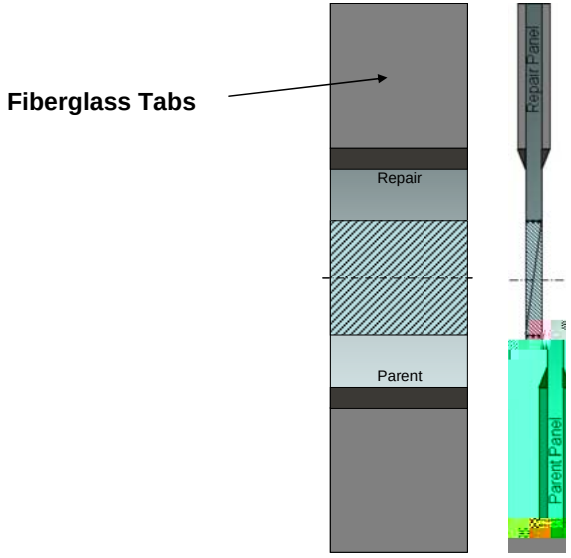
Previous Research

OEM Prepreg Repair Method

- Repair material:
- T300/934 3K-70-PW prepreg with FM 377S adhesive
- 0.25” overlap
- No extra ply
- 350°F cure

- Picture Frame shear elements were sent to 4 different airline depots for repair
- All depots were provided shear elements to repair using the OEM and the CACRC repair procedure
- All shear elements were mechanically tested to failure

Previous Research- Repair after Contaminant Exposure



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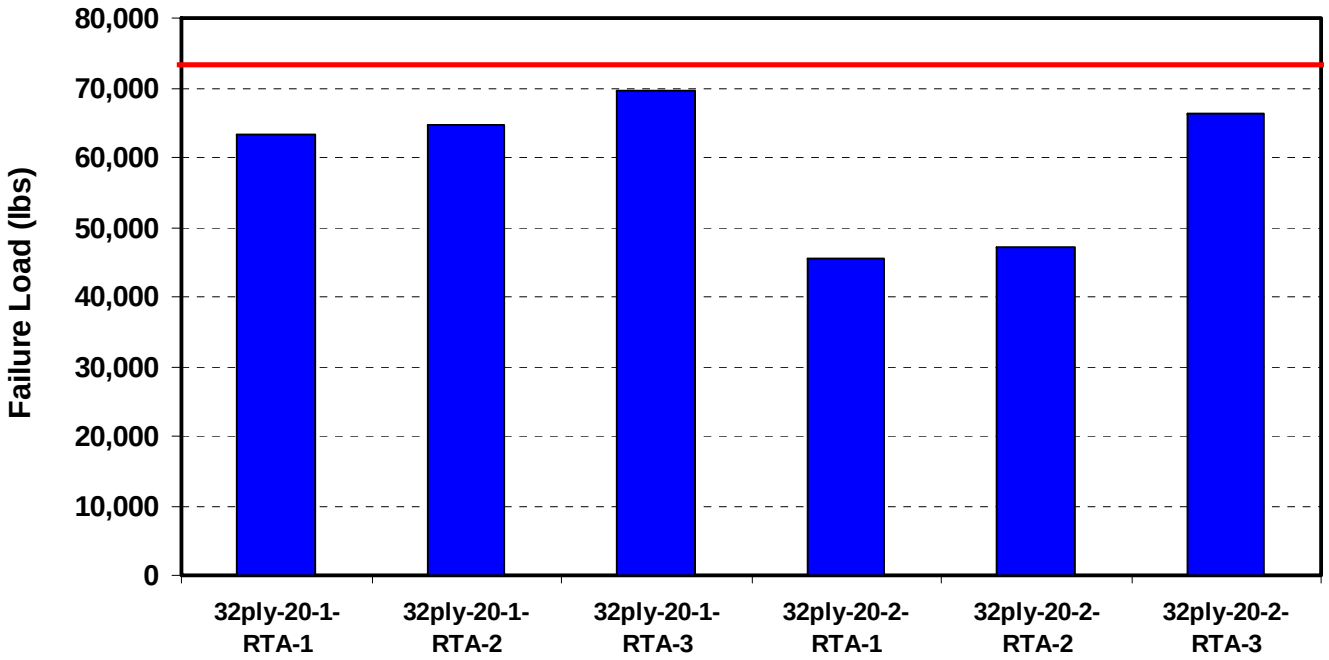
Repair after Contaminant Exposure

- Even after fully drying the repair joint, the original repair joint capability may not be restored
- WA-0 specimens are specimens that were conditioned at 145°F 85%RH until moisture equilibrium then dried back to 0% moisture



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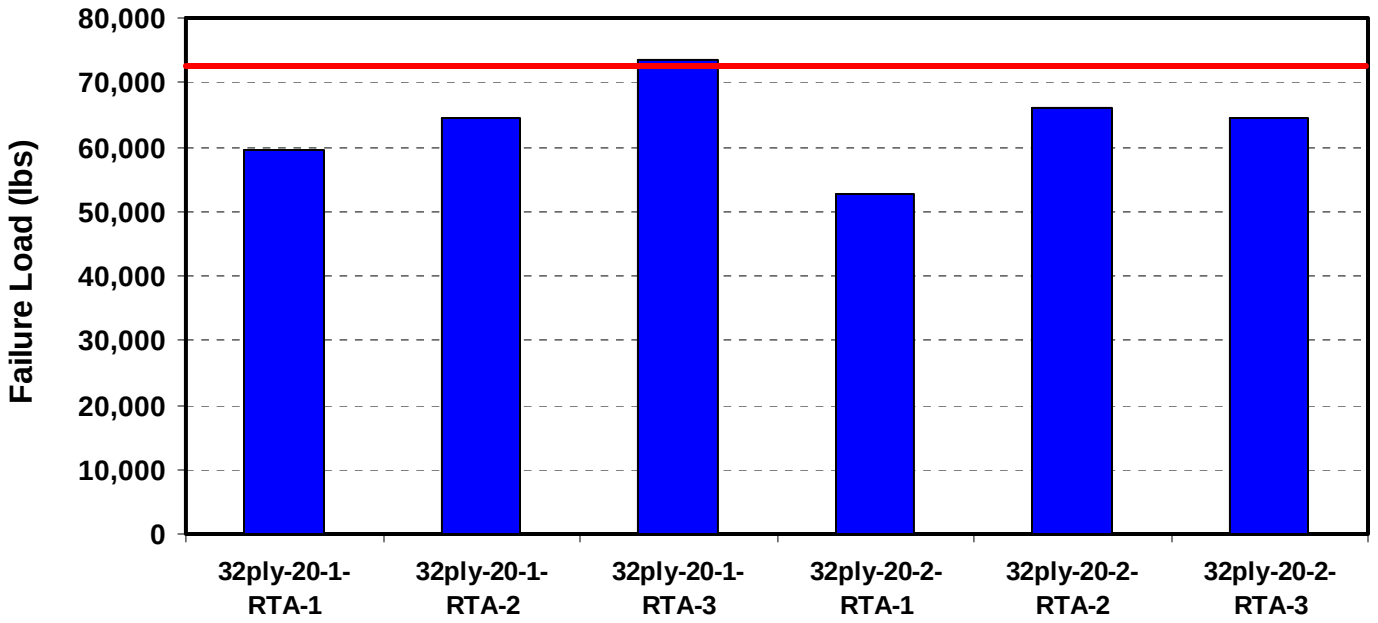
Repair after Contaminant Exposure

- WA-75 specimens are specimens that were conditioned at 145°F 85%RH until moisture equilibrium then dried back to 75% saturation

Ultimate Strength of WA-75 specimens tested at RTA



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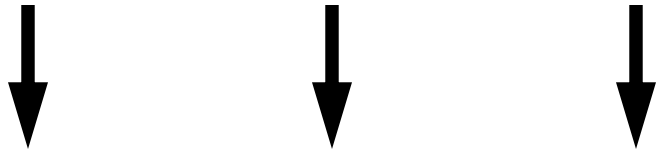
Repair after Contaminant Exposure

Previous Research – Lessons Learned

Adhesively **B**onded **R**epairs are **P**rocess **D**ependent

- ü Repair Technician Training: technician training directly affects the quality (structural integrity of a bonded repair). Only properly/ recently trained technicians should perform bonded repairs
- ü Cure Cycle Deviation: an improper cure cycle will yield a deficient repair
- ü Contaminated Repair Surface: pre-bond moisture, contaminated repair surface will yield a substandard bonded repair

Bonded **R**epair **Q**uality **A**ssurance



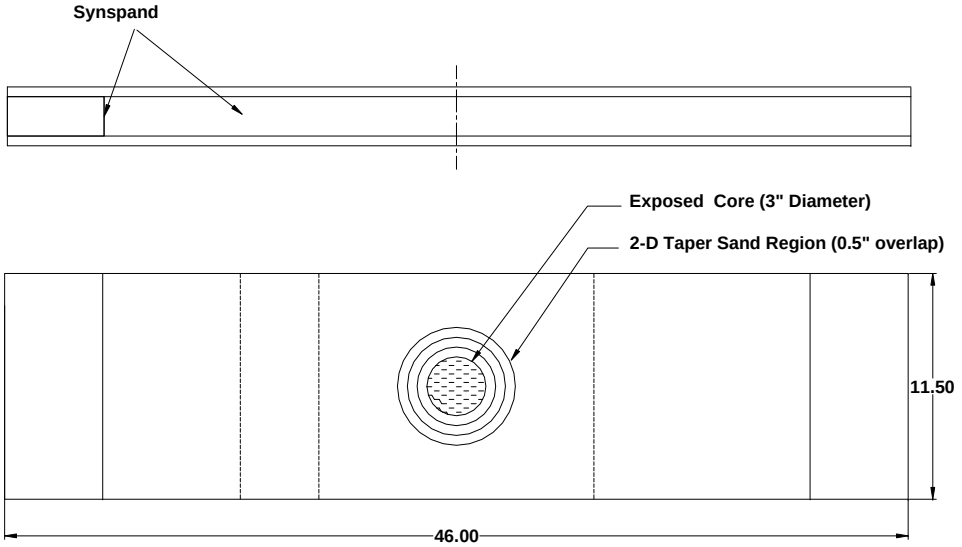
Control of incoming material

Process Control

NDI

Proposed Research – Sandwich Coupon Configuration

- Large beams, 12” x 48” with the repair tested in compression
- 3-ply facesheets, 1/8” core cell size, 2” thick



- Parent Material: T300/ 934 with FM 377S adhesive
- Repair Materials: OEM repair using parent system (350°F cure)
  Field repair 1 using Hexcel M20 PW (250°F cure) - Prepreg
  Field repair 2 using Epocast 52A/B - Wet lay-up

Sandwich Test Matrix

- ü A 2.5” hole diameter will be used to simulate damage on all coupons
- ü Detailed test matrix is outlined in figure 1 below
- ü Airline depots: Northwest/ Delta, United (4 Depots)

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Figure 1 : CACRC Round Robin Test Matrix

Repair Station	Coupon Configuration	Repair Type	Number of test Replicates Loading Mode		
			Compression Static RTA	Compression Static ETW	Compression RS ETW
OEM	Pristine/ Undamaged	N/A	6	6	6
OEM	2.5" hole	None		3	3
OEM	2.5" hole	2D-OEM		3	3
Field Station 1	2.5" hole	2D-R1		3	3
Field Station 1	2.5" hole	2D-R2		3	3
Field Station 2	2.5" hole	2D-R1		3	3
Field Station 2	2.5" hole	2D-R2		3	3
Field Station 3	2.5" hole	2D-R1		3	3
Field Station 3	2.5" hole	2D-R2		3	3
Field Station 4	2.5" hole	2D-R1		3	3
Field Station 4	2.5" hole	2D-R2		3	3
Total			6	36	36

Status/ Benefits to Aviation

- ü NIAR will provide detailed Repair procedures to be reviewed by OEM (Airbus and Boeing)
- ü Approved repair procedures will be supplied along with coupons to OEM/ field stations

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