THE LANCAIR COMPANY

Certified Aircraft

Structural Bonding Adhesive

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VP Research & Development

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Background

- Columbia 300 Program started in 1995
- Outside contour is controlled. Bond gaps take up material thickness variations.
- Allowed bond gap variation 0.0" to 0.150"
- Adhesive is based on a laminating resin developed for FAR23 application in primary structure
- Tg of more than 225F depending on post cure temperature.
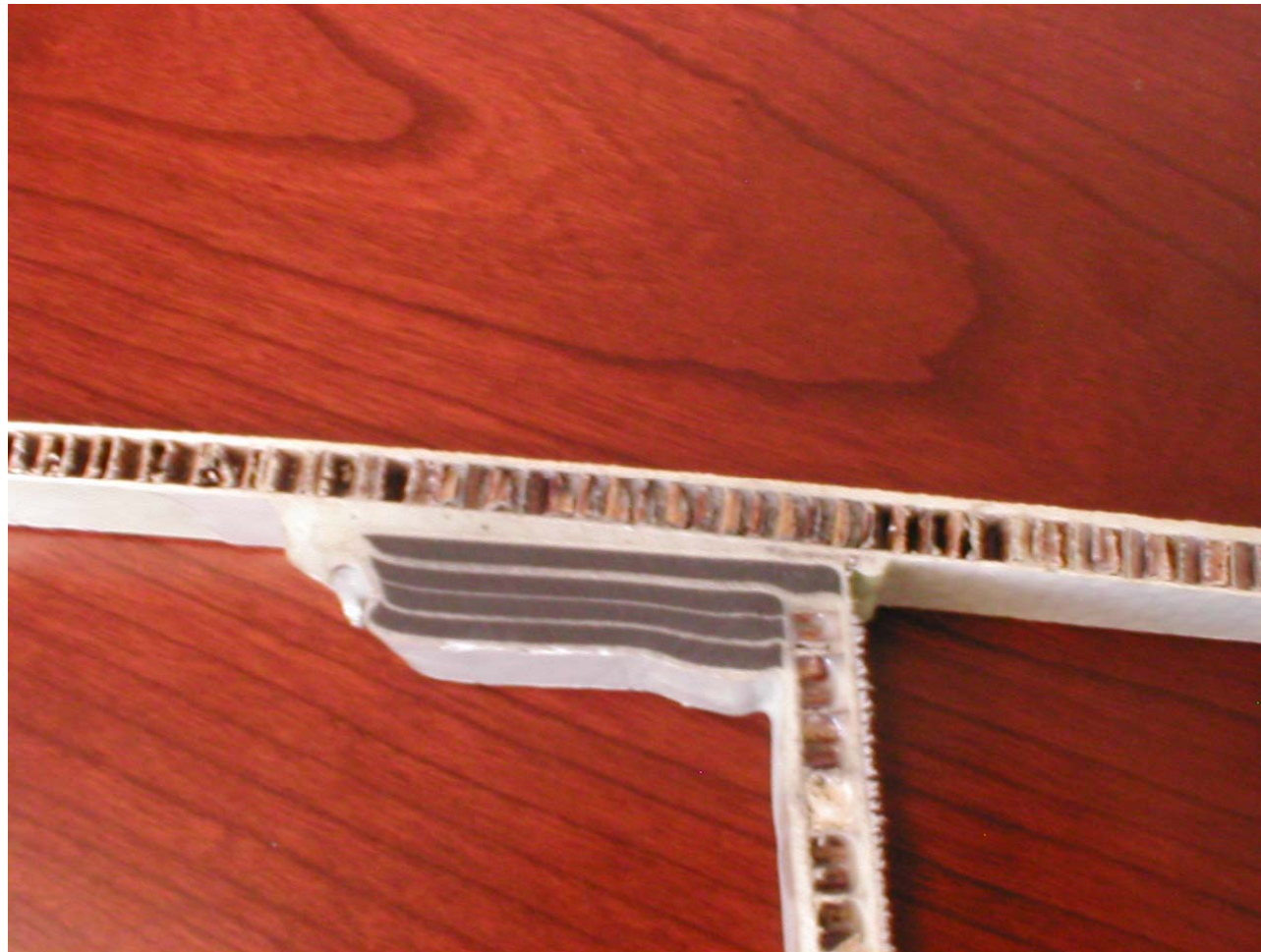- The adhesive was developed and certified under AGATE.

Wing Skin Bonding

Wing Skin Bonding
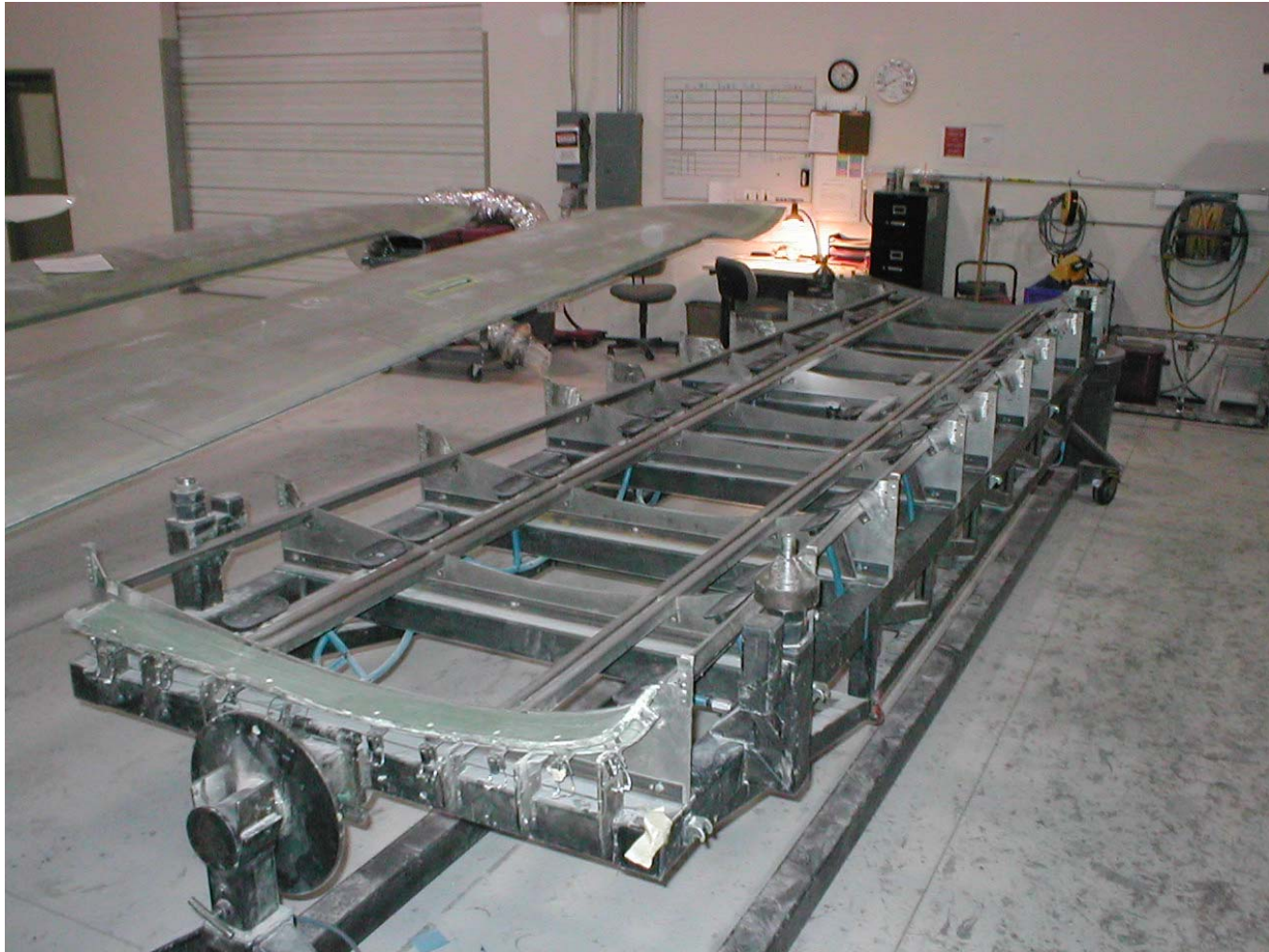
Lancair Bonding Paste

Handling Characteristics

- Substrate surface has to be primed
- Added filler in the adhesive allows vertical bondlines from 0.0 < .150"
- Pot life > 4hours
- Post cure at 200F to achieve Tg of 225F
- Handle cure required if parts are manipulated prior to post cure.

Test Matrix
Chemical and Physical Properties

Material	No	Test	Method	No. Tests
Resin and Hardener	1	Pot Life, Nominally Mixed	ASTM D2471	3x3
	2	Thermal Profile, Nominally Mixed	ASTM D3418 (DSC) or SACMA SRM 18 (DMA)	3x1
	3	Constituent Identification, Resin	ASTM E682 (HPLC)	3x1
	4	Constituent Identification, Resin	ASTM E168 (FTIR)	3x1
	5	Constituent Identification, Hardener	ASTM E682 (HPLC)	3x1
	6	Constituent Identification, Hardener	ASTM E168 (FTIR)	3x1
With Fillers	7	Rex Durometer Type A Hardness Tester, Mixed w. Fillers	ASTM D2583	3x1

Test Matrix
Bonded Strength Properties

| Substrate Material	Test No.	Bond Thickness	Environmental Condition		
			CD	RTD	HW
Glass Cloth/Epoxy Prepreg Substrate	1	.020"	3x6	3x6	3x6
	2	.060"	3x6	3x6	3x6
	3	.150"	3x6	3x6	3x6
Carbon Cloth/Epoxy Prepreg Substrate	3	.150"	3x6	3x6	3x6
Glass Cloth/Epoxy Wet Layup Substrate	3	.150"	3x6	3x6	3x6

Test Matrix: Creep Properties

- Test duration: 1000h

- Applied Stress: 500 psi

- Pass-Fail Criteria: <3.5% Avg. , <5% Max.

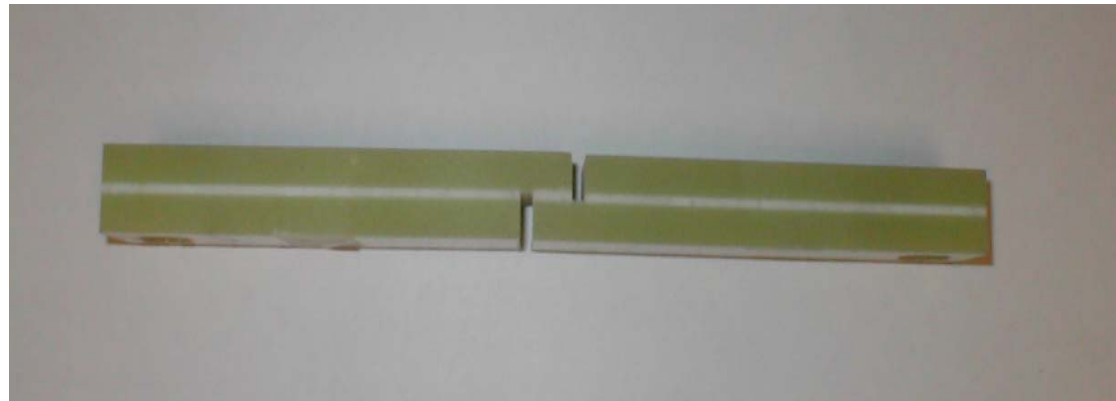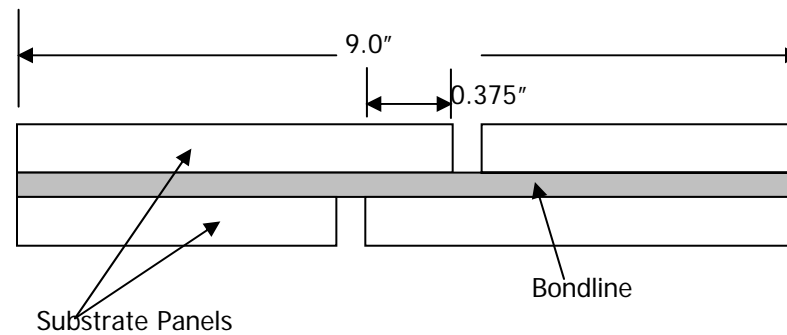| Material	No.	Bond Thickness	Test Condition		
			CD	RTD	HD
Glass Prepreg Substrate with Filled Epoxy Adhesive	1	0.100"	---	---	1x3

Shear Strength Properties

Lap Shear Strength
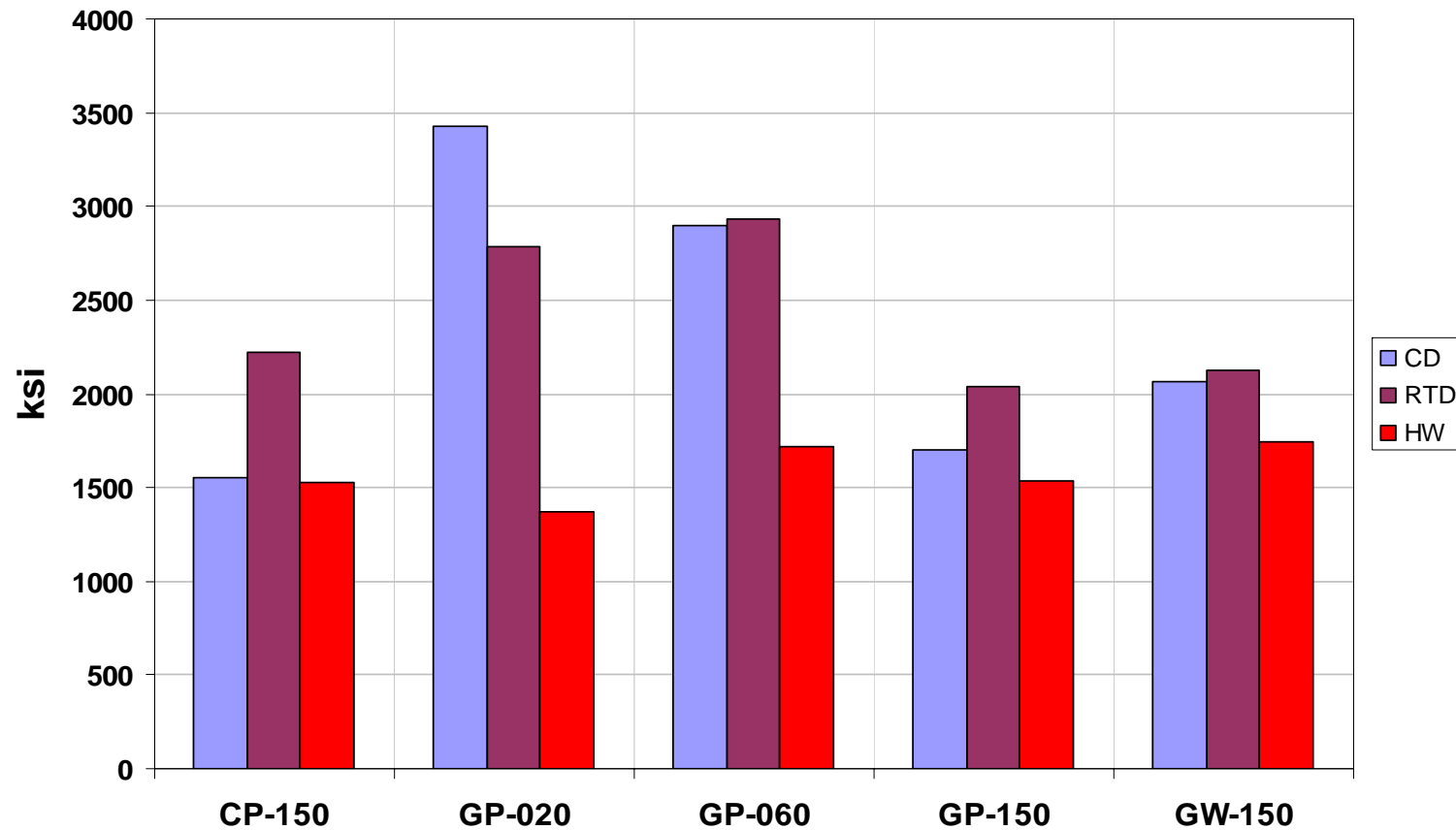
Test Panel Fabrication

- Specimen geometry to MIL-HNDBK-17-E but using composite substrate

9.0″

0.375″

Substrate Panels

Bondline

Quality Assurance

- Supplier QA
  - **FTIR or HPLC of Resin and Hardener**
  - **No Strength Properties are required, because the resin is mixed with filler in-house.**

- Receiving Inspection
  - **Pot Life, ASTM D2471**
  - **Thermal Profile via DSC or DMA**
  - **Lap Shear Strength**

- Process Verification
  - **Glass transition temperature Tg via DSC or DMA**
  - **Tg is representative of the amount of cure and final part strength.**

IMQ Requirements :New Adhesive

- All initial Adhesive Certification Tests
- Tg requirement of allows two options:
  - Tg > Max Operating temperature(175F) + 50°F margin.
  - **OR**
  - Strength at 225 F should be more than 67% of strength at 175 F
- Representative Full Scale Test.

Bonded Assembly Inspection

- Bond gap control
  - Bond rods control minimum gap
  - Dry fit to check for maximum bond gap
- NDI for voids
  - Visual Inspection for squeeze-out
  - Tap testing
  - Ultra Sound using Sonic Bondmaster

Sonic Bondmaster

Surface Preparation and Manufacturing Considerations

- As important as the adhesive qualities

- Peelply-only not sufficient

- Bead blasting for best results

- Solvent wipe required

Alternative Surface Preparation Evaluation Tests

- A version of traveling wedge test was used to evaluate various surface treatments and surface preparation methods.

- Wedge driven in to specimen vertically at 0.05 in/min and the failure modes analyzed.

- Failure Modes :
  - Cohesive
  - Adhesive

- Preliminary Conclusions
  - Bead blasting was found to remove most of the clear tape, and Teflon tape effects and was repeatable.
  - Hand sanding was found to be less reliable

Bead Blast Booth

Summary

- Lancair's structural adhesive is customized to the manufacturing process
- The limiting factor is the prepreg resin adhesion to the fiber.
- A room temperature curing adhesive would be most desirable. But could not be found.
- Structural certification by test or very conservative analysis due to lack of precise analytical means.
- Tg and toughness are conflicting requirements