

REPAIR AND PERFORMANCE OF CERAMIC COMPOSITE HYBRID STRUCTURE

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MOTIVATION AND OBJECTIVE

- ◆ The concept of A-Kit + B-Kit system for ground vehicles are relatively new
- ◆ A-Kit provides the minimum weight structural solution, while the B-Kit provides mission specific protection
- ◆ Repair methodologies for A+B-Kit system after damage and the performance renewal after repair are not well established
- ◆ The main objectives of this research is to develop repair methodologies for A+B systems and to determine the structural and performance renewal

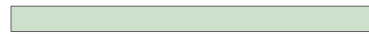
APPROACH

- ◆ Structural testing before and after damage
- ◆ Damage evaluation
- ◆ Development of repair methodologies and repair
- ◆ Structural testing after repair
- ◆ Testing

FABRICATION OF A-KIT PANEL

Fabrication of A-Kit Panels

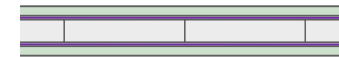
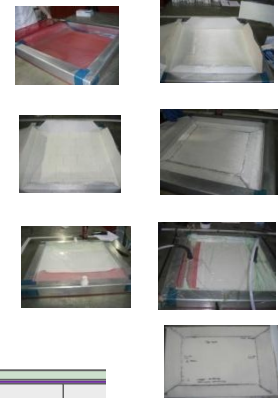
- Processing Method: VARTM
- Fabric: 100oz ZZ S-2 Glass
- Resin: CCM FCS-2
- Cure: 9 hrs @ RT
- Post Cure: 8 hrs @300F with 1hr ramp up and 1hr ramp down
- Stacking Sequence: $[0]_4$
- Panel Dimension: 24-inx24-in
- Thickness: 0.478-in
- AD: 5 psf
- Density: 2 gm/cm³
- FWF: 69%
- FVF: 50%



FABRICATION OF B-KIT PANEL

Fabrication of B-Kit Panels

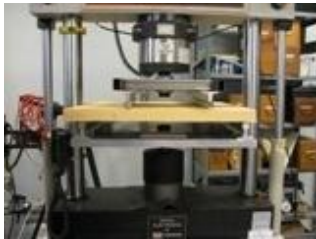
- Processing Method: VARTM
- Architecture: $[100oz]_2/Ceramic/[100oz]_2$
- Dimension: 24-in x 24-in
- Thickness: 1.33-in
- AD: ~13.5 psf



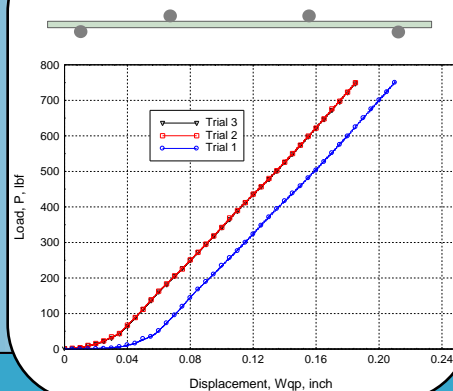
Architecture

FOUR POINTBENDING D6272-02

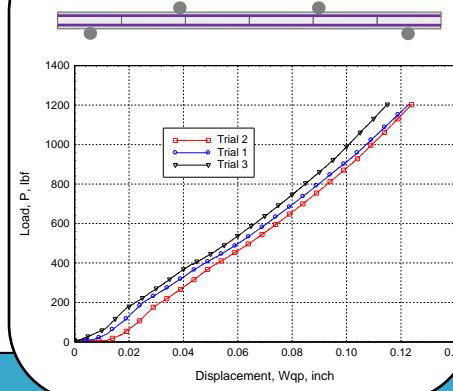
- ◆ To avoid stress concentration the loading nose and supports were made cylindrical.
- ◆ The support fixture and loading plate had holes used to adjust loading span
- ◆ The Instron 8562 was used to perform the tests



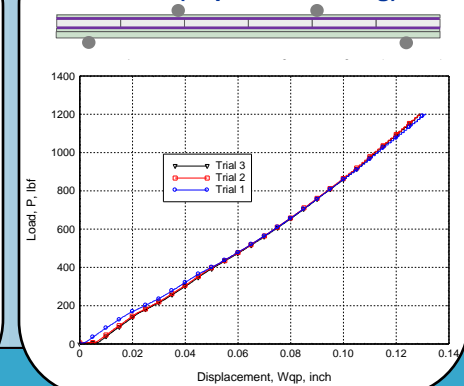
LOAD-DISPLACEMENT: A-Kit



LOAD DISPLACEMENT: B-Kit



LOAD-DISPLACEMENT: A+B Kit (Top Face Loading)

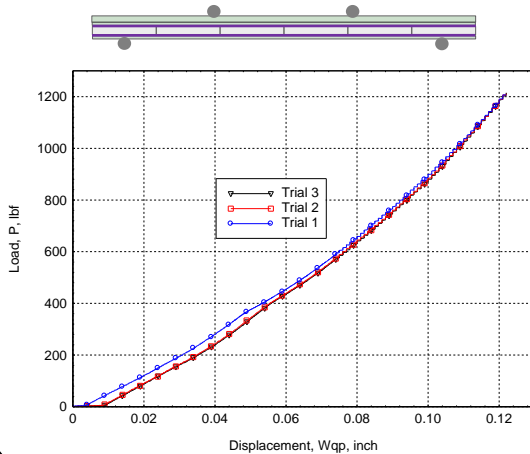


REPAIR AND PERFORMANCE OF COMPOSITES

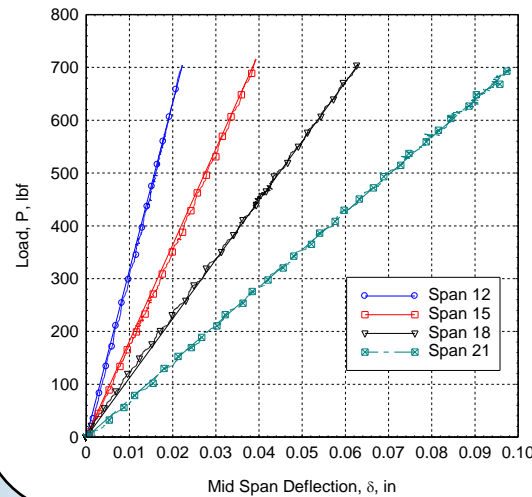
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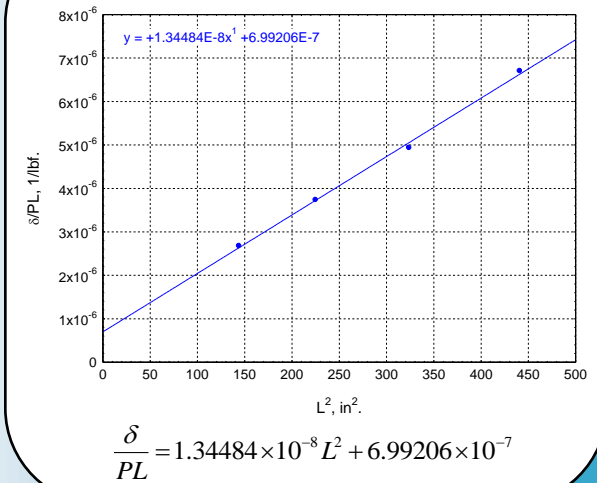
LOAD-DISPLACEMENT: A+B Kit (Bottom Face Loading)



ANALYSIS: A-Kit



ANALYSIS: A-Kit



EQUATIONS

$$\delta = \frac{0.23rL^2}{d}$$

δ = mid span deflection(in), r = strain (in/in)
 L = support span (in), d = depth of A-Kit (in)

$$\frac{\delta}{PL} = \frac{1}{48EI} L^2 + \frac{1}{4GA}$$

P = Applied Load (lbf),
 EI = flexural rigidity (psi-in⁴)
 GA = Shear rigidity (psi-in²)

CALCULATIONS

$$\frac{1}{48EI} = 1.34484 \times 10^{-8}$$

$$EI = 1,549,131 \text{ psi-in}^4$$

$$\frac{1}{4GA} = 6.99206 \times 10^{-7}$$

$$GA = 357,548 \text{ psi-in}^2$$

$$E = 6.2 \text{ Msi}$$

$$G = 0.0298 \text{ Msi}$$

CONCLUSIONS

- ◆ A four-point bend test fixture has been fabricated to tests 2-ft x 2-ft composite panels at four different support spans, i.e., 12in, 15in, 18in, & 21in.
- ◆ A-Kit, B-Kit, and A+B Integral panels have been tested under four point bend loading.
- ◆ Some non-linearity in load-deflection is observed, and a compliance calibration of the test fixture is necessary.
- ◆ Allen's test method is used to determine the bending stiffness and shear rigidity of A-Kit panel.

FUTURE WORKS

- ◆ Four Point Bending at all four spans for the B and A+B integral panels
- ◆ Develop and implement repair methodologies
- ◆ Structural testing after repair
- ◆ Testing
- ◆ Damage Evaluation after repair

ACKNOWLEDGEMENTS

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