UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

RFAL
RELIABILITY AND FAILURE ANALYSIS LABORATORY

Material Strength Reliability of an E-glass Composite

UAHuntsville
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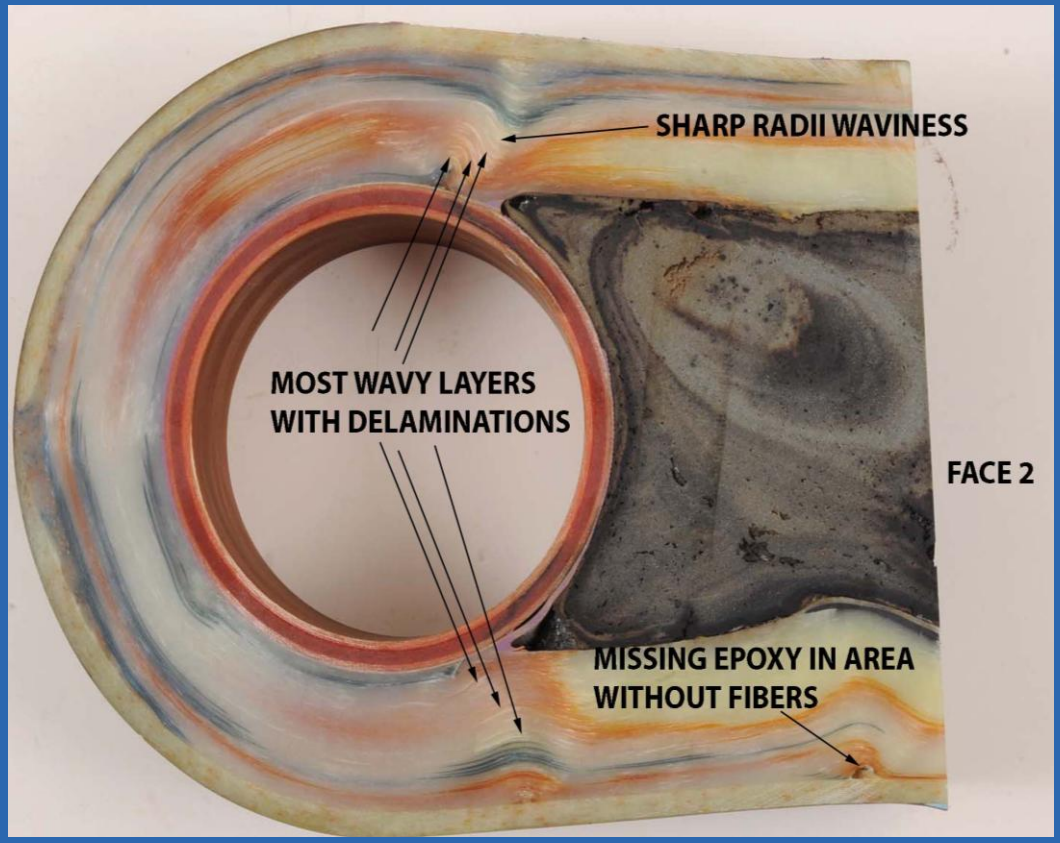
Background

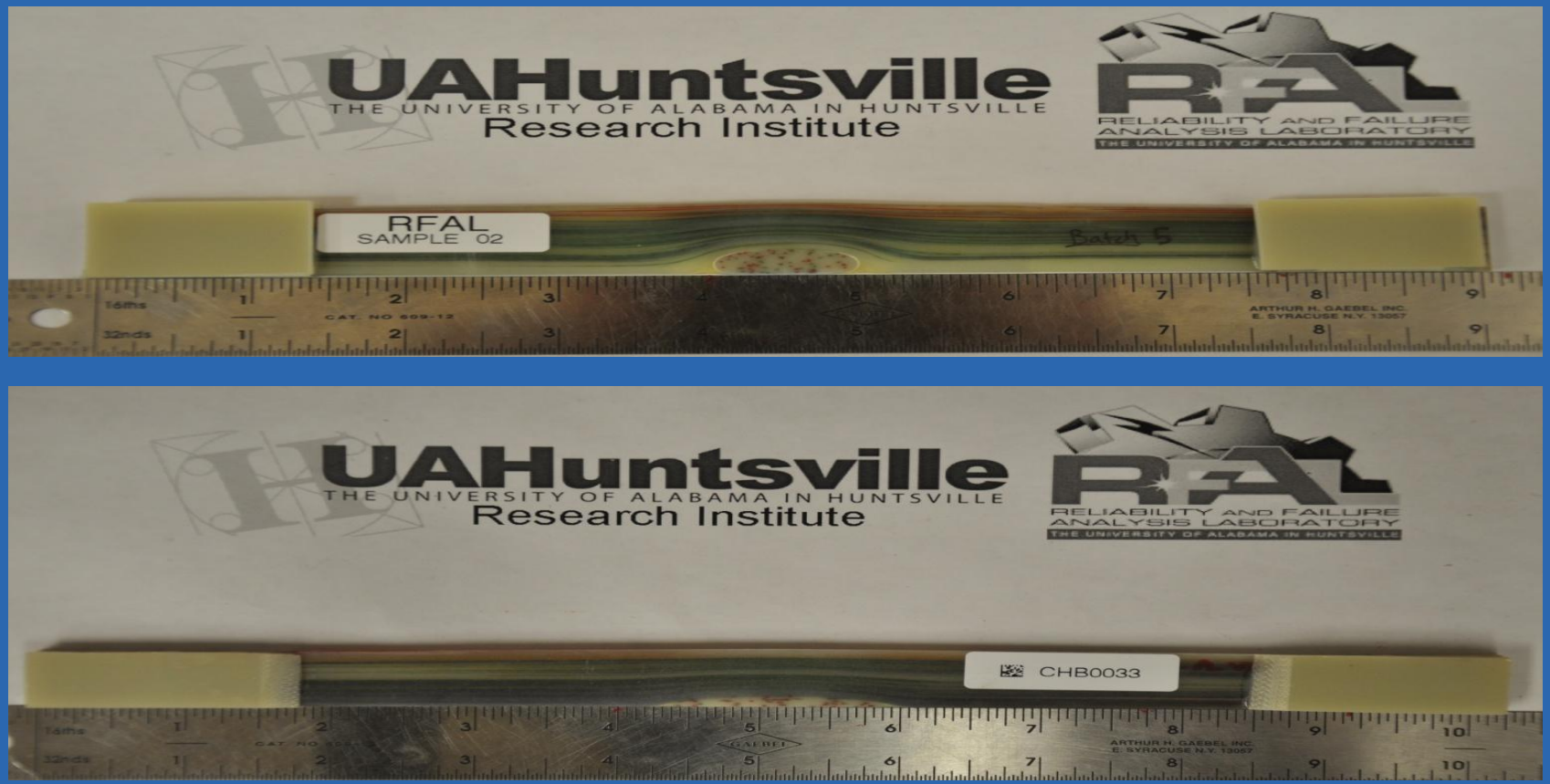
- Composite materials are now widely used for structural applications.
- Quality processing of these materials can be very complex.
- Important for Reliability community to understand composites and their properties.

Introduction

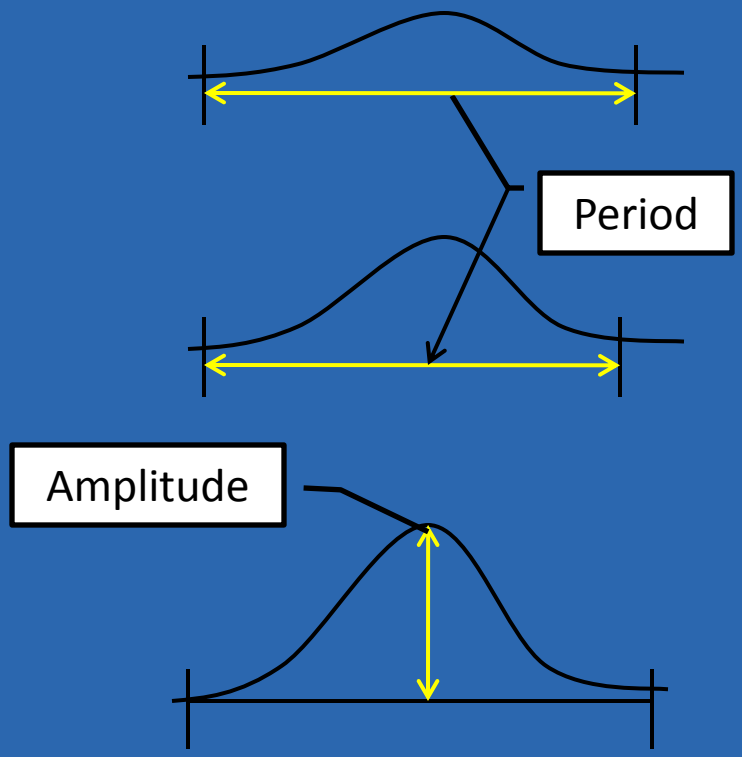


- Presented a problem with processing defects in the form of complex fiber waviness.
- Developed a process to represent the waviness.
- Define waviness effect on the static properties in tension.

Representative Coupons



Amplitude/Period^2 Ratio



- Measurement of period was defined as the point at which the fiber becomes linear.
- Measurement of amplitude was defined as the height of the inserted defect from the base of the coupon.

Scoring

FOM	CAT
0 < FOM < 0.125	1
0.125 < FOM < 0.25	1.5
0.25 < FOM < 0.85	2
0.85 < FOM < 1.75	2.5
1.75 < FOM < 3.1	3
3.1 < FOM < 4.8	3.5
4.8 < FOM < 6.8	4
6.8 < FOM < 9.3	4.5
FOM > 9.3	5

- The severity of wrinkles were described by the following equation.

$$FOM = \frac{Amplitude}{Period^2}(\%involvement)100$$

- This equation assigns a numerical value to equate to a category score.

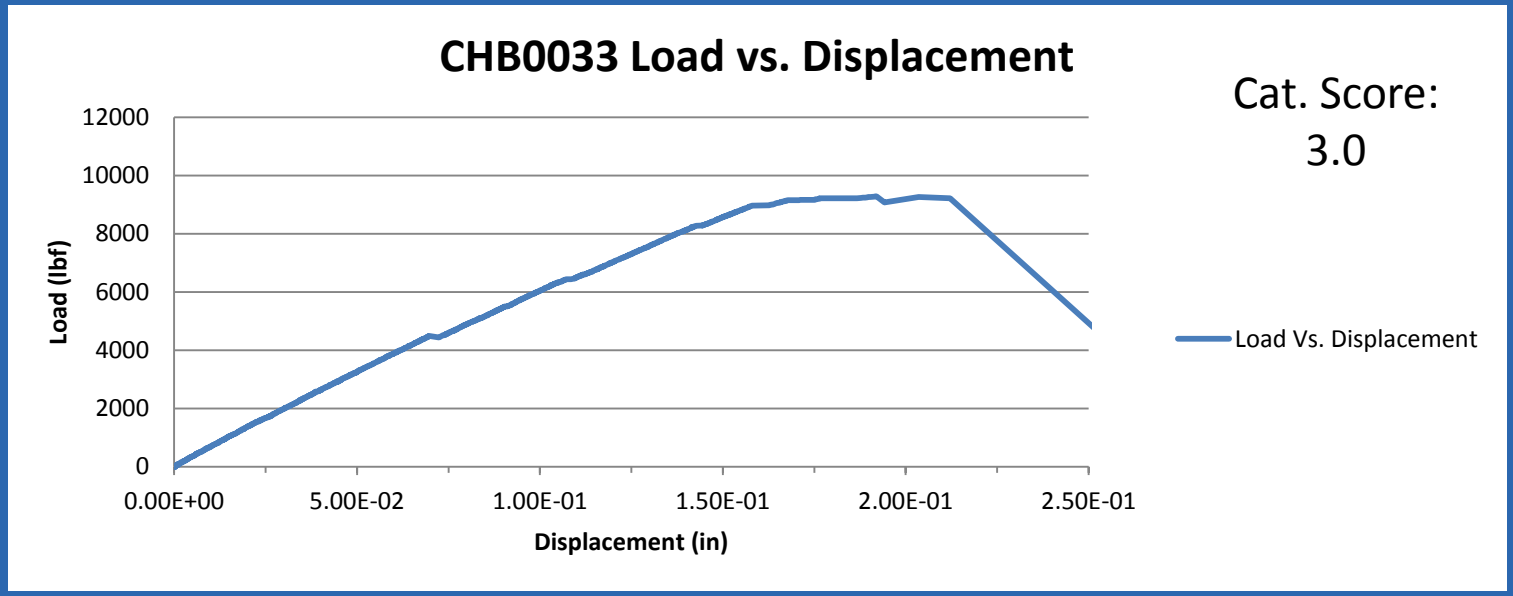
Experimental Design

- Experimental design incorporated 5 types of wrinkle defects with varying amplitude/period in addition to a control group.
- Defect types were categorized based on a normalized Amplitude/Period^2 ratio.
- Static tensile tests were performed.

Coupon Type
1 (Control)
2.5
3
3.5
4.0
4.5

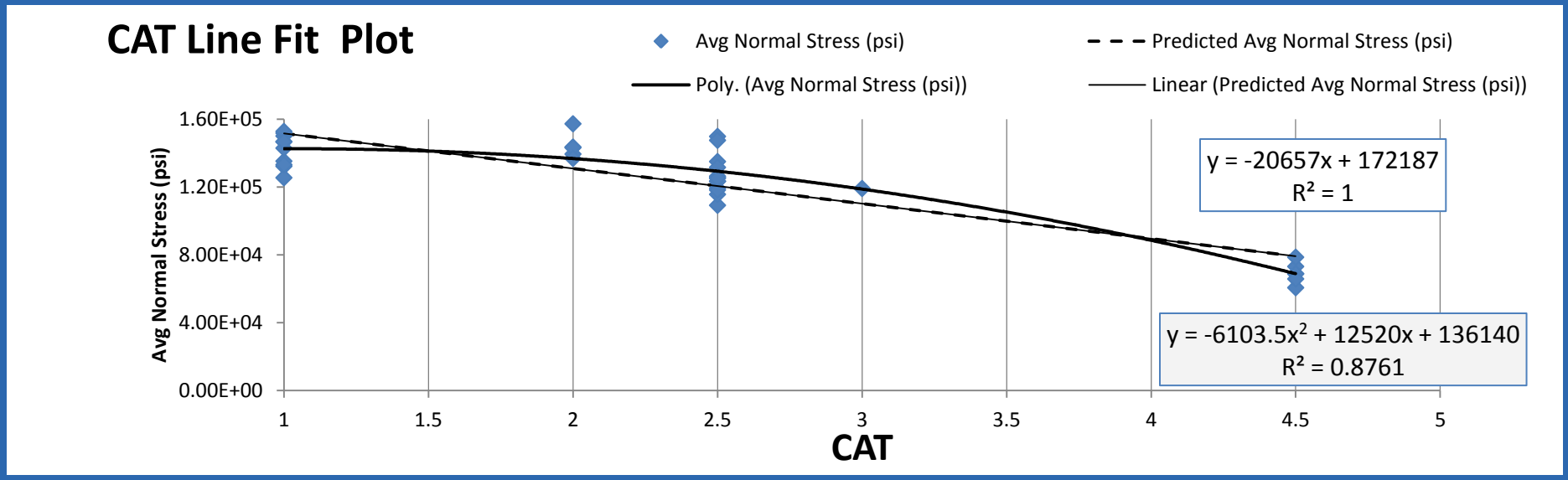
Test

- Samples were taken to ultimate load and data was recorded for material properties of the control/defect samples in tension.



Results

- Test results were plotted graphically and compared to a theoretical strength calculation.
- Results did not seem to fit a linear regression, but more closely fit a polynomial due to the R^2 value.



Conclusions

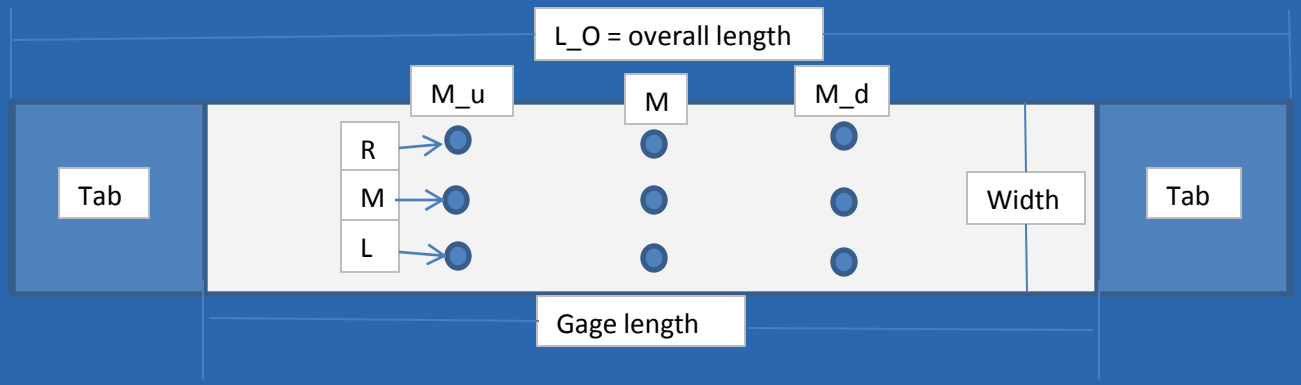
- Testing performed allowed RFAL to see a trend of material strength degradation as the Amplitude/Period^2 ratio increased.
- Ongoing work is focusing on the static shear properties of the material.
- Future work will involve fatigue testing.
- Full characterization of the composites' material properties.

Questions?

For Questions or comments
please visit us at
http://rfal.uah.edu
and reply via the contact us page

Measurements

- Dimensional measurements were collected after the materials were processed and machined.



- Statistical methods were performed to qualify process variability of the samples created.

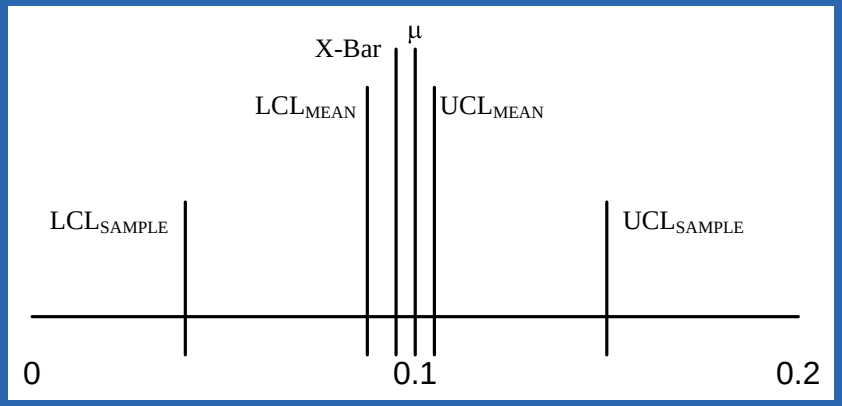
Sample Qualification

Statistical Significance of Sample Mean to Sample Goal of (0.1”)

Confidence Limits - Mean	
LCL_{MEAN} =	0.086
UCL_{MEAN} =	0.104
Test of Hypotheses - Means	
T_{TEST} =	-1.157
T_{CRIT} =	2.032
p-Value =	0.255
Confidence Limits - Sample	
LCL_{SAMPLE} =	0.041
UCL_{SAMPLE} =	0.149

Illustration of Upper and Lower 95% Confidence Limits

- The cross sectional area falls within the range for the dimensional goal of the sample.



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