Solvay (Formerly ACG) MTM45-1/CF0525-36%RW 3K PW AS4 Fabric Qualification Statistical Analysis Report

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List of Tables

1. Introduction

This report contains statistical analysis for Advanced Composites Group (ACG) MTM45-1/CF0525-36%RW 3K PW AS4 Fabric material properties data in ³0 7 0 -1 CF0525 Data MH Cure Cycle Values Only 2-18-10.pdf´ The lamina and laminate material property data have been generated with FAA oversight through FAA Special Project Number SP3505WI-Q and also meet the requirements outlined in NCAMP Standard Operating Procedure NSP 100.

B-Basis values along with A-estimates and B-estimates were computed using a variety of techniques that are detailed in section 2. The qualification material was procured to ACG Material Specification ACGM 1001-07 Revision Initial Release. An equivalent NCAMP Material Specification NMS 451/7 has been created. NMS 451/7 contains specification limits that are derived from the qualification dataset using guidelines in section 6 of DOT/FAA/AR-03/19 and CMH-17-1G section 8.4.1. The test panels were fabricated using ACG Process Specification ACGP 1001-02 XVLQJ ³0+´ FXUH equivalent NCAMP Process Specification NPS ZLWK ³0+´ FXUH F\FOH The panels were fabricated and mechanical testing were performed at Advanced Composites Group, 5350 S 129th E. Ave, Tulsa, OK 74134. The ACG Test Plan AI/TR/1392 Revision E was used for this qualification program.

Basis numbers are labeled as µYDOXHV¶ when the data meets all the requirements of CMH-17-1G. When those requirements are not met, the \ ZLOO EH ODEHOHG DV µHV ¹znCä²‰ ''ëó ñ

2. Background

Statistical computations are performed with AGATE Statistical Analysis Program (ASAP) when pooling across environments is permissible according to CMH-17-1G guidelines. If pooling is not permissible, a single point analysis using STAT

$$\sqrt{\quad} \qquad \text{Equation 10}$$

$$c_B(f) \quad 0.36961 \quad \frac{0.0040342}{\sqrt{f}} \quad \frac{0.71750}{f} \quad \frac{0.19693}{f\sqrt{f}} \qquad \text{Equation 11}$$

$$b_A(f) \quad \frac{2.0643}{\sqrt{f}} \quad \frac{0.95145}{f} \quad \frac{0.51251}{f\sqrt{f}} \qquad \text{Equation 12}$$

$$c_A(f) \quad 0.36961 \quad \frac{0.0026958}{\sqrt{f}} \quad \frac{0.65201}{f} \quad \frac{0.011320}{f\sqrt{f}} \qquad \text{Equation 13}$$

2.1.4 Modified Coefficient of Variation

The coefficient of variation is modified according to the following rules:

$$\text{Modified CV} = CV^* \quad \begin{cases} CV - .06 & \text{if } CV \quad .04 \\ \frac{CV}{2} \quad .04 & \text{if } .04 \quad CV \quad .08 \\ CV & \text{if } CV \quad .08 \end{cases} \qquad \text{Equation 14}$$

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An observed significance level (OSL) based on the Anderson-Darling test statistic is computed for each test. The OSL measures the probability of observing an Anderson-Darling test statistic at least as extreme as the value calculated if the distribution under consideration is in fact the underlying distribution of the data. In other words, the OSL is the probability of obtaining a value of the test statistic at least as large as that obtained if the hypothesis that the data are actually from the distribution being tested is true. If the OSL is less than or equal to 0.05, then the assumption that the data are from the distribution being tested is rejected with at most a five percent risk of being in error.

If the normal distribution has an OSL greater than 0.05, then the data is assumed to be from a population with a normal distribution. If not, then if either the Weibull or lognormal distributions has an OSL greater than 0.05, then one of those can be used. If neither of these distributions has an OSL greater than 0.05, a non-parametric approach is used.

In what follows, unless otherwise noted, the sample size is denoted by n, the sample observations by $x_1, ..., x_n$, and the sample observations ordered from least to greatest by $x_{(1)}, ..., x_{(n)}$.

2.2.2 Computing Normal Distribution Basis values

STAT17 uses a table of values for the k-factors (shown in Table 2-1) when the sample size is less than 16 and a slightly different formula than ASAP to compute approximate k-factors for the normal distribution when the sample size is 16 or larger.

Norm. Dist. k Factors for N<16		
N	B-basis	A-basis
2	20.581	37.094
3	6.157	10.553
4	4.163	7.042
5	3.408	5.741
6	3.007	5.062
7	2.756	4.642
8	2.583	4.354
9	2.454	4.143
10	2.355	3.981
11	2.276	3.852
12	2.211	3.747
13	2.156	3.659
14	2.109	3.585
15	2.069	3.520

Table 2-1: K factors for normal distribution

2.2.2.1 One-sided B-basis tolerance factors, k_B, for the normal distribution when sample size is greater than 15.

STAT17 solves these equations numerically for $\hat{\beta}$ and $\hat{\alpha}$ in order to compute basis values.

2.2.2.3.2 Goodness-of-fit test for the Weibull distribution

The two-parameter Weibull distribution is considered by comparing the cumulative Weibull distribution function that best fits the data with the cumulative distribution function of the data. Using the shape and scale parameter estimates from section 2.2.2.3.1, let

$$z_i = x_i / \hat{\alpha}, \quad \text{for } i = 1, \ldots, n \qquad \textbf{Equation 38}$$

The Anderson-Darling test statistic is

$$AD = -\sum_{i=1}^{n} \frac{1-2i}{n} \left[\ln\left(1 - \exp\left(-z_{(i)}^{\hat{\beta}}\right)\right) + z_{(n+1-i)}^{\hat{\beta}} \right] - n \qquad \textbf{Equation 39}$$

and the observed significance level is

$$OSL = 1/\left(1 + \exp[-0.10 + 1.24\ln(AD^*) + 4.48 AD^*]\right) \qquad \textbf{Equation 40}$$

where

$$AD^* = \left(1 + \frac{0.2}{\sqrt{n}}\right) AD \qquad \textbf{Equation 41}$$

This OSL measures the probability of observing an Anderson-Darling statistic at least as extreme as the value calculated if in fact the data is a sample from a two-parameter Weibull distribution. If OSL $\leq$ 0.05, one may conclude (at a five percent risk of being in error) that the population does not have a two-parameter Weibull distribution. Otherwise, the hypothesis that the population has a two-parameter Weibull distribution is not rejected. For further information on these procedures, see reference 6.

2.2.2.3.3 Basis value calculations for the Weibull distribution

For the two-parameter Weibull distribution, the B-basis value is

$$B = q\hat{\alpha}^{1/\hat{\beta}} \left(1 - \frac{V}{\sqrt{n}}\right) \qquad \textbf{Equation 42}$$

where

$$q\hat{\alpha} = 0.10536^{1/\hat{\beta}} \qquad \textbf{Equation 43}$$

To calculate the A-basis value, substitute the equation below for the equation above.

$$q\hat{\alpha} = (0.01005)^{1/\hat{\beta}} \qquad \textbf{Equation 44}$$

V is the value in Table 2-2. when the sample size is less than 16. For sample sizes of 16 or larger, a numerical approximation to the V values is given in the two equations immediately below.

$$V_B \mid 3.803 \quad \exp\ 1.79 \quad 0.516\ln(n) \quad \frac{5.1}{n \quad 1}^{a} \qquad \textbf{Equation 45}$$

$$V_A \mid 6.649 \quad \exp\ 2.55 \quad 0.526\ln(n) \quad \frac{4.76}{n}^{a} \qquad \textbf{Equation 46}$$

This approximation is accurate within 0.5% of the tabulated values for n greater than or equal to 16.

N	B-basis	A-basis
2	690.804	1284.895
3	47.318	88.011
4	19.836	36.895
5	13.145	24.45
6	10.392	19.329
7	8.937	16.623
8	8.047	14.967
9	7.449	13.855
10	6.711	12.573
11	6.477	12.093
12	6.286	11.701
13	6.127	11.375
14	5.992	11.098

2.2.4 Non-parametric Basis Values for small samples

The Hanson-Koopmans method (references 8 and 9) is used for obtaining a B-basis value for sample sizes not exceeding 28 and A-basis values for sample sizes less than 299. This procedure requires the assumption that the observations are a random s ample size

n	r	k
2	2	35.177
3	3	7.859
4	4	4.505
5	4	4.101
6	5	3.064
7	5	2.858
8	6	2.382
9	6	2.253
10	6	2.137
11	7	1.897
12	7	1.814
13	7	1.738
14	8	1.599
15	8	1.540
16	8	1.485
17	8	1.434
18	9	1.354
19	9	1.311
20	10	1.253
21	10	1.218
22	10	1.184
23	11	1.143
24	11	1.114
25	11	1.087
26	11	1.060
27	11	1.035

Table 2-3: B-Basis Hanson-Koopmans Table

2.2.5.1 Calculation of basis values using ANOVA

The following calculations address batch-to-batch variability. In other words, the only grouping is due to batches and the k-sample Anderson-Darling test (Section 2.1.6) indicates that the batch to batch variability is too large to pool the data. The method is based on the one-way analysis of variance random-effects model, and the procedure is documented in reference 10.

ANOVA separates the total variation (called the sum of squares) of the data into two sources: between batch variation and within batch variation.

First, statistics are computed for each batch, which are indicated with a subscript $n_i, \bar{x}_i, s_i^2$ while statistics that were computed with the entire dataset do not have a subscript. Individual data values are represented with a double subscript, the first number indicated the batch and the second distinguishing between the individual data values within the batch. *k* stands for the number of batches in the analysis. With these statistics, the Sum of Squares Between batches (SSB) and the Total Sum of Squares (SST) are computed:

$$SSB \quad \sum_{i=1}^{k} n_i \bar{x}_I^2 \quad n\bar{x}^2 \qquad \textbf{Equation 52}$$

$$SST \quad \sum_{i=1}^{k} \sum_{j=1}^{n_i} x_{ij}^2 \quad n\bar{x}^2$$

However, if the laminate CV is larger than the corresponding lamina CV, the larger laminate CV value is used.

The LVM B-basis value is then computed as:

LVM Estimated B-Basis = **Equation 62**

When used in conjunction with the modified CV approach, a minimum value of 8% is used for the CV.

Mod CV LVM Estimated B-Basis = $\bar{X}_1 \quad K_{N_1,N_2} \quad \tilde{\bar{X}}_1 \quad \tilde{M}ax \ 8\%, CV_1, CV_2$ **Equation 63**

With:

$\bar{X}_1$ the mean of the laminate (small dataset)

N_1 the sample size of the laminate (small dataset)
N_2 the sample size of the lamina (large dataset)
CV_1 is the coefficient of variation of the laminate (small dataset)
CV_2 is the coefficient of variation of the lamina (large dataset)
K_{N_1,N_2} is given in Table 2-5

	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	4.508	0	0	0	0	0	0	0	0	0	0	0	0	0
4	3.827	3.607	0	0	0	0	0	0	0	0	0	0	0	0
5	3.481	3.263	3.141	0	0	0	0	0	0	0	0	0	0	0
6	3.273	3.056	2.934	2.854	0	0	0	0	0	0	0	0	0	0
7	3.134	2.918	2.796	2.715	2.658	0	0	0	0	0	0	0	0	0
8	3.035	2.820	2.697	2.616	2.558	2.515	0	0	0	0	0	0	0	0
9	2.960	2.746	2.623	2.541	2.483	2.440	2.405	0	0	0	0	0	0	0
10	2.903	2.688	2.565	2.484	2.425	2.381	2.346	2.318	0	0	0	0	0	0
11	2.856	2.643	2.519	2.437	2.378	2.334	2.299	2.270	2.247	0	0	0	0	0
12	2.819	2.605	2.481	2.399										

Table 2-5: B-Basis factors for small datasets using variability of corresponding large dataset

NCAMP Recommended B-basis Values for ACG MTM45-1/CF0525-36%RW 3K PW AS4 Fabric

All B-basis values in this table meet the standards for publication in CMH-17G Handbook
Values are for normalized data unless otherwise noted

Lamina Strength Tests

Environment	Statistic	WT	WC	FT	FC	SBS*	IPS*	
							0.2% Offset	5% Strain
CTD (-65 deg F)	B-basis	112.76	NA:A	NA:A	NA:A	NA:A	6.61	NA:I
	Mean	129.48	102.24	124.00	93.13	11.67	7.85	13.25
	CV	9.86	10.73	8.05	10.45	5.64	8.46	2.38
RTD (75 deg F)	B-basis	115.85	84.01	109.23	NA:A	9.18	5.27	8.78
	Mean	132.49	95.29	124.79	87.52	10.41	6.00	9.95
	CV	6.32	6.00	6.32	11.50	6.00	6.56	6.03
ETD (200 deg F)	B-basis				NA:A	7.61		
	Mean				74.78	8.63		
	CV				11.65	6.00		
ETW (200 deg F)	B-basis	108.00	NA:A	NA:A	41.23	5.55	2.78	NA:I
	Mean	124.88	65.98	119.65	55.59	6.30	3.32	5.52
	CV	7.34	10.65	8.82	13.41	6.00	8.44	5.36
ETW2 (250 deg F)	B-basis	111.70	NA:A	NA:A	36.07	4.32	2.32	3.91
	Mean	128.67	52.05	112.92	47.57	4.96	2.63	4.47
	CV	6.00	12.57	13.15	12.40	6.55	10.15	6.37

Notes: The modified CV B-basis value is recommended when available.
The CV provided corresponds with the B-basis value given.
NA implies that tests were run but data did not meet NCAMP recommended requirements.
"NA: A" indicates ANOVA with 3 batches, "NA: I" indicates insufficient data,
Shaded empty boxes indicate that no test data is available for that property and condition.
* Data is as measured rather than normalized
** indicates the STAT17 B-basis value is greater than 90% of the mean value.

Table 3-1 : NCAMP recommended B-basis values for lamina test data

Laminate Strength Tests

B-basis	45.32		NA:A		NA:A				
Mean	51.41		53.44		94.90				
CV	6.00		5.55		5.53				
B-basis	NA:A	37.61	NA:I	NA:I	NA:A	65.02	69.44	117.89	8.53
Mean	53.11	41.46	57.52	67.03	94.22	74.62	94.95	133.91	9.68
CV	5.18	6.00	1.28	5.75	6.30	6.52	14.50	6.46	6.00
B-basis	NA:A	25.44		NA:I	NA:I	NA:A	NA:A	NA:A	NA:A
Mean	52.53	29.29		41.32	85.84	44.11	70.98	104.36	4.70
CV	5.54	6.00		7.80	3.72	8.58	17.32	6.81	4.34
B-basis	40.40		NA:I		NA:I				
Mean	45.83		48.34		59.59				
CV	6.00		1.75		2.63				
B-basis	NA:I	NA:I	NA:I	NA:I	NA:I	NA:I	NA:I	NA:I	
Mean	43.05	37.86	44.47	46.47	60.16	49.96	82.80	118.36	
CV	1.46	1.86	0.70	3.74	1.23	3.18	6.17	4.52	
B-basis	NA:I	23.17	NA:I	28.36	NA:I	NA:I	NA:A	79.47	
Mean	34.90	26.29	36.01	33.02	48.34	31.08	62.63	91.16	
CV	1.57	6.00	1.08	7.33	3.20	4.24	16.84	6.92	
B-basis	NA:A		NA:I		NA:I				
Mean	63.85		69.55		114.35				
CV	6.93		4.30		4.20				
B-basis	NA:I	NA:I	NA:I	NA:I	NA:I	NA:I	NA:I	NA:I	
Mean	69.71	45.66	69.18	55.88	116.82	82.94	70.67	111.78	
CV	3.39	5.92	3.54	6.87	3.02	8.32	9.18	6.59	
B-basis	NA:I	27.11		34.75	NA:I	NA:I	43.65	79.06	
Mean	73.09	31.76		42.94	109.02	48.31	54.42	91.30	
CV	2.08	7.41		9.90	2.84	8.19	10.59	7.17	

Notes: The modified CV B-basis value is recommended when available.
The CV provided corresponds with the B-basis value given.
NA implb0 BT 1 0 0 1 2.25 54.08 Tm [(N)59(A)4(i)20 1 2.25 54.08 Tm [(N)5

Table 3-2 : Recommended B-basis values for laminate test data

Prepreg Material: ACG MTM45-1/CF0525-36%RW 3K PW AS4 Fabric
Material Specification: ACGM 1001-07 or NMS 451/7
Process Specification: ACGP 1001-02 or NPS 81451 "MH" Cure Cycle

Fiber: Hexcel AS4 **Resin:** MTM45-1

Tg (dry): 375.11 °F **Tg (wet):** 313.38 °F **Tg METHOD :** DMA (SACMA SRM 18R-94)

Date of fiber manufacture	Dec 2004 - Sep 2005	**Date of testing**	Nov 2005-Sep 2006
Date of resin manufacture	Sep - Oct, 2005	**Date of data submittal**	Aug-07
Date of prepreg manufacture	Sep - Oct, 2005	**Date of analysis**	Oct-09
Date of composite manufacture	Sep - Oct, 2005		

	Test Condition	Unit	B-value	Mod. CV B-value	Mean	B-value	Mod. CV B-value	Mean	B-value	Mod. CV B-value	Mean
	CTD	ksi	38.78	45.32	51.41	41.70	40.40	45.83	38.55	54.44	63.85
	RTD	ksi	34.15	46.20	53.11	39.00	36.07	43.05	63.01	58.16	69.71
	ETW	ksi	47.89	46.32	55.93	---	---	---	---	---	---
	ETW2	ksi	33.16	45.60	52.53	32.01	28.88	34.90	67.03	60.48	73.09
	RTD	ksi	33.86	37.61	41.46	34.92	31.63	37.86	40.10	38.15	45.66
	ETW	ksi	25.81	29.01	33.42	---	---	---	---	---	---
	ETW2	ksi	27.0	25.44	29.29	23.76	23.17	26.29	27.48	27.11	31.76
Strength		ksi	60.57	82.2W* nBT/F7 8.25 Tf1 0 e18(i)q0.75 474.42 628.5 12.75 reW*64/F7 8.18(i)q0.75 47 8.250.349							

Table 3-4: Summary of Test Results for Laminate Data

4. Lamina Test Results, Statistics, Basis Values and Graphs

4.1 Warp (0º) Compression Properties (WC)

The Warp Compression data is normalized, so both normalized and as-measured statistics are provided. Only the RTD data, both normalized and as measured, passed the ADK test for batch-to-batch variation. The CTD, ETW and ETW2 data did not pass the ADK, so an ANOVA analysis is required. In order for B-basis values computed using the ANOVA method, data from five batches is required. Since this dataset has only three batches, the basis values computed using ANOVA are considered estimates. The modified CV method could

4.2 Warp (0º) Tension Properties (WT)

The Warp Tension data is normalized, so both normalized and as-measured statistics are provided. The RTD and ETW2 data (both normalized and as measured) did not pass the ADK test and required the ANOVA method to compute basis values which may result in overly conservative estimates of the basis values. In order for B-basis values computed using the ANOVA method, data from five batches is required. Since this dataset has only three batches, the basis values computed using ANOVA are considered estimates. The normalized data could be pooled across all four environments to compute modified CV basis values.

The as measured RTD data did not pass the ADK test under the modified CV transformation. A B-estimate computed using the modified CV method is provided, but is considered an estimate due to the failure of the ADK test after the transformation to meet the assumptions of the modified CV method. The as measured CTD dataset had a CV greater than 8%, so modified CV basis values could not be provided.

There was one outlier. The lowest values in batch three of the as-measured ETW2 dataset was an outlier for the batch three, but not for the ETW2 condition. It was retained for this analysis.

Statistics, basis values and estimates are given for strength data in Table 4-3 and for the modulus data in Table 4-4. The normalized data, B-estimate and B-basis values are shown graphically in Figure 4-2.

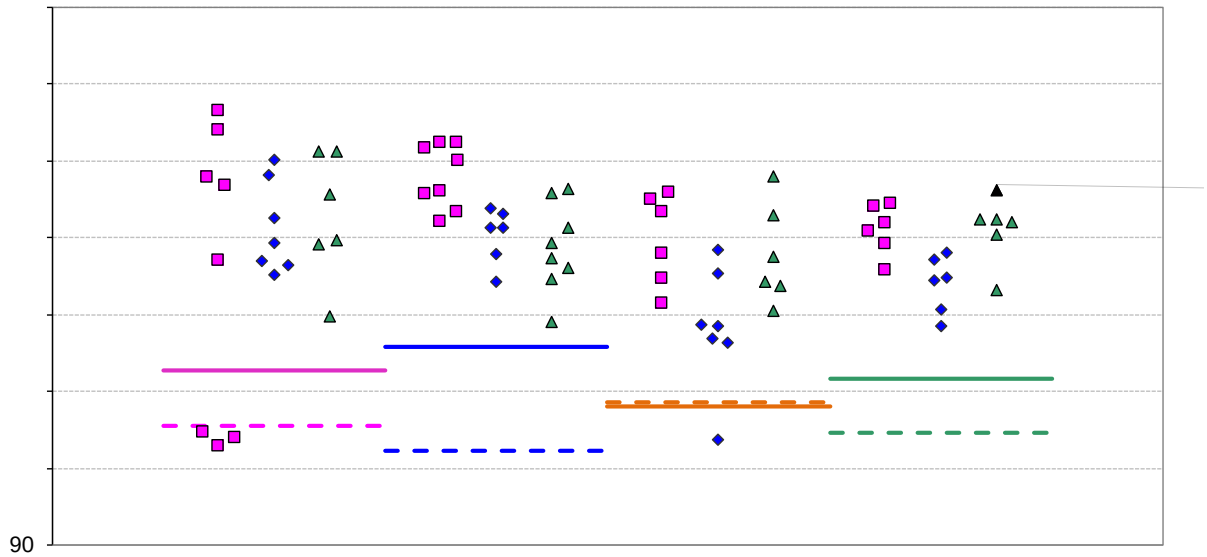

Figure 4-2: Batch Plot for WT Strength Normalized

Warp Tension (WT) Strength Basis Values and Statistics

	Normalized				As Measured			
Env	CTD	RTD	ETW	ETW2	CTD	RTD	ETW	ETW2
Mean	129.48	132.49	124.88	128.67	126.70	128.88	120.73	125.14
Stdev	12.77	6.15	8.35	4.94	12.68	6.96	8.37	4.83
CV	9.86	4.64	6.69	3.84	10.01	5.40	6.93	3.86
Mod CV	9.86	6.32	7.34	6.00	10.01	6.70	7.47	6.00
Min	102.81	118.98	103.72	118.49	100.27	114.13	99.06	115.87
Max	146.56	142.33	138.06	136.27	146.96	140.93	134.03	133.27
No. Batches	3	3	3	3	3	3	3	3
[redacted]	21	22	19	18	21	22	19	18
	Basis Values and/or Estimates							
[redacted]	105.43		108.60		102.55		104.42	
[redacted]		102.30		104.55		88.87		100.38
[redacted]	83.13	80.74	97.04	87.35	85.33	60.31	92.83	82.72
Method	Weibull	ANOVA	Normal	ANOVA	Normal	ANOVA	Normal	ANOVA
	Modified CV Basis Values and/or Estimates							
B-basis Value	112.76	115.85	108.00	111.70	NA		103.16	110.32
B-estimate						112.59		
A-estimate	101.57	104.65	96.84	100.55	NA	100.96	90.70	99.83
Method	pooled	pooled	pooled	pooled	NA	Normal	Normal	Normal

Table 4-3: Statistics and Basis values for WT Strength Data

Table 4-4: Statistics from WT Modulus Data

4.3 Fill (90º) Tension Properties (FT)

The Fill Tension data is normalized, so both normalized and as-measured statistics are provided.

Fill Tension (FT) Strength Basis Values and Statistics

Env	CTD	RTD	ETW	ETW2	CTD	RTD	ETW	ETW2
Mean	124.00	124.79	119.65	112.92	119.62	121.50	115.00	108.75
Stdev	9.98	5.79	10.55	14.84	10.33	5.57	10.18	14.58
CV	8.05	4.64	8.82	13.15	8.63	4.58	8.85	13.40
Mod CV	8.05	6.32	8.82	13.15	8.63	6.29	8.85	13.40
Min	91.46	115.30	97.80	83.72	86.83	110.99	94.14	80.38
Max	135.86	134.16	135.04	135.19	132.85	132.43	131.02	135.48
No. Batches	3	3	3	3	3	3	3	3
No. Spec.	20	18	19	19	20	18	19	19
B-estimate	81.20	96.22	64.65	16.54	69.81	93.24	63.81	18.62
A-estimate	50.67	75.84	25.42	0.00	34.27	73.08	27.29	0.00
Method	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA
Modified CV Basis Values and/or Estimates								
B-basis Value		109.23				106.41		
A-estimate		98.22				95.73		
Method		Normal				Normal		
Basis Value Estimates with override of ADK test result								
B-estimate	104.77		99.09	83.99	100.63		95.16	80.34
A-estimate	91.10		84.51	63.47	82.44		81.10	60.19
Method	Normal		Normal	Normal	Weibull		Normal	Normal

Table 4-5: Statistics and Basis Values for FT Strength Data

Fill Tension (FT) Modulus Statistics								
	Normalized				As Measured			
Env	CTD	RTD	ETW	ETW2	CTD	RTD	ETW	ETW2
Mean	9.16	8.85	8.90	10.08	8.84	8.62	8.58	9.71
Stdev	0.45	0.14	0.31	0.31	0.41	0.26	0.30	0.35
CV	4.86	1.62	3.43	3.09	4.62	3.00	3.48	3.64
Mod CV	6.43	6.00	6.00	6.00	6.31	6.00	6.00	6.00
Min	8.29	8.59	8.47	9.28	8.04	8.22	8.11	8.84
Max	10.32	9.11	9.35	10.54	9.80	9.01	9.07	10.25
No. Batches	3	3	3	3	3	3	3	3
No. Spec.	21	18	17	17	21	18	17	17

Table 4-6: Statistics from FT Modulus Data

4.4 Fill (90º) Compression Properties (FC)

The Fill Compression data is normalized, so both normalized and as-measured statistics are provided. The CTD, RTD and ETD data (both normalized and as measured) and the as measured ETW data did not pass the ADK test, so those conditions required the ANOVA method to compute basis values which may result in overly conservative estimates of the basis values. In order for B-basis values computed using the ANOVA method, data from five batches is required. Since this dataset has only three batches, the basis values computed using ANOVA are considered estimates. The modified CV method could not be applied to any of these datasets because the coefficient of variation was above 8% in all cases. Estimates of basis values for these conditions that were computed with an override of the ADK test results are provided for the CTD, RTD and ETD data (both normalized and as measured) and the as measured ETW data.

There was one outlier. The lowest value in batch three of the CTD condition for both normalized and as measured datasets. It was an outlier for batch three, but not for the CTD condition. It was retained for this analysis.

Statistics, estimates, and basis values are given for strength data in Table 4-7 and for the modulus data in Table 4-8. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-4.

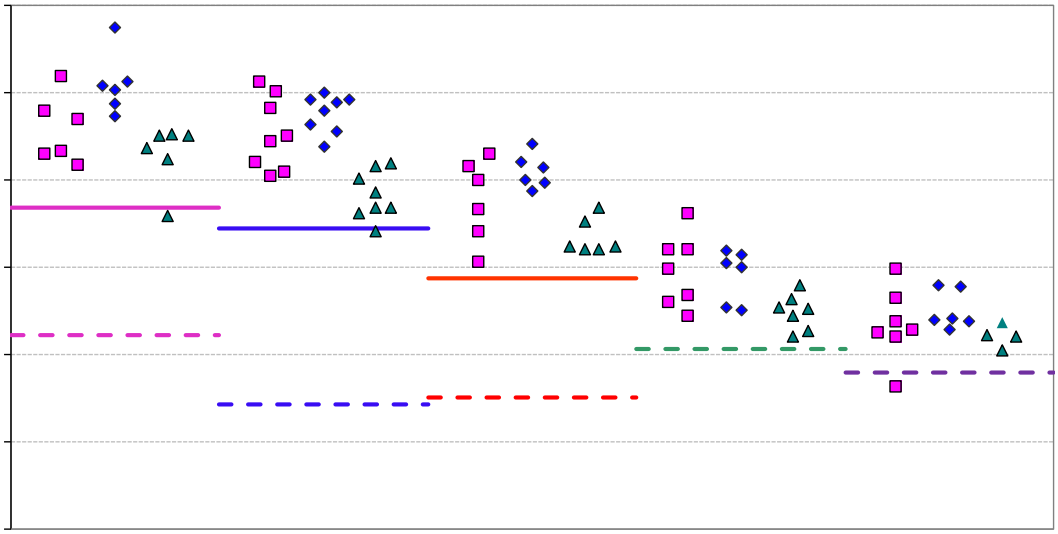

Figure 4-4: Batch Plot for FC strength normalized

Env	CTD	RTD	ETD	ETW	ETW2	CTD	RTD	ETD	ETW	ETW2
Mean	93.13	87.52	74.78	55.59	47.57	90.87	85.76	73.29	54.32	46.62
Stdev	9.74	10.06	8.71	7.46	5.90	9.78	9.52	8.15	6.85	5.48
CV	10.45	11.50	11.65	13.41	12.40	10.76	11.10	11.12	12.61	11.76
Mod CV	10.45	11.50	11.65	13.41	12.40	10.76	11.10	11.12	12.61	11.76
Min	71.99	68.45	61.09	44.35	32.52	70.12	66.67	59.75	43.02	32.63
Max	115.17	102.29	88.26	72.24	59.36	111.95	98.55	85.44	69.22	57.38
No. Batches	3	3	3	3	3	3	3	3	3	3
No. Spec.	18	24	18	20	19	18	24	18	20	19
Basis Values and/or Estimates										
B-basis Value				41.23	36.07					35.94
B-estimate	44.61	28.67	30.17			37.68	27.55	30.23	23.71	
A-estimate	10.02	0.00	0.00	31.01	27.91	0.00	0.00	0.00	1.86	28.35
Method	ANOVA	ANOVA	ANOVA	Normal	Normal	ANOVA	ANOVA	ANOVA	ANOVA	Normal
B-estimate	73.91	68.87	57.58			71.57	68.12	57.20	41.12	
A-estimate	60.31	55.50	45.41			57.92	55.47	45.82	31.74	
Method	Normal	Normal	Normal			Normal	Normal	Normal	Normal	

Table 4-7: Statistics and Basis Values for FC Strength Data

Env	CTD	RTD	ETD	ETW	ETW2	CTD	RTD

Table 4-8: Statistics from FC Modulus Data

4.5

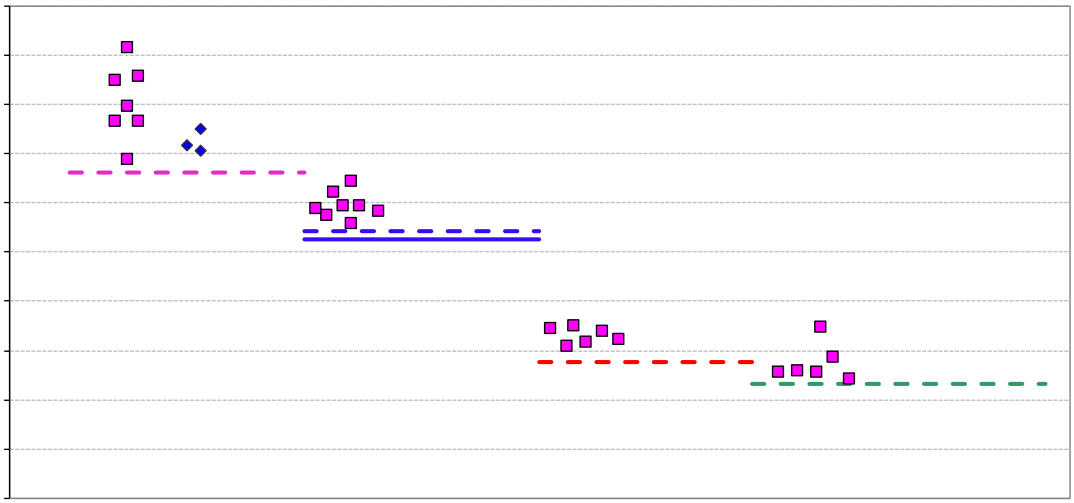

Figure 4-5: Batch Plot for IPS Strength at 0.2% Offset As-Measured

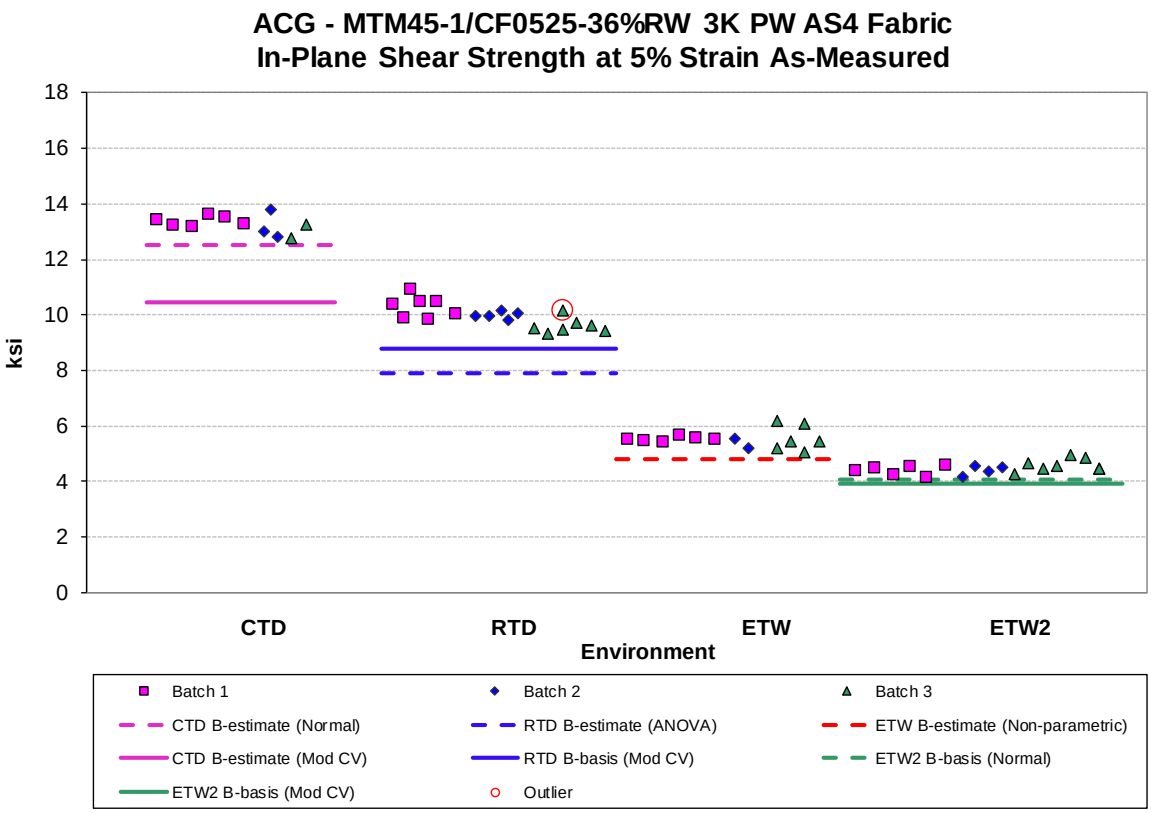

Figure 4-6: Batch Plot for IPS Strength at 5% Strain As-Measured

Env	CTD	RTD	ETW	ETW2	CTD	RTD	ETW	ETW2
Mean	13.25	9.95	5.52	4.47	7.85	6.00	3.32	2.63
Stdev	0.32	0.40	0.30	0.21	0.66	0.31	0.28	0.27
CV	2.38	4.05	5.36	4.74	8.46	5.12	8.44	10.15
Mod CV	6.00	6.03	6.68	6.37	8.46	6.56	8.44	10.15
Min	12.75	9.35	5.07	4.14	6.86	5.46	2.84	2.353450.7
Max	13.79	10.91	6.16	4.95	9.14	6.55	3.98	3.47
No. Batches	3	3						

Table 4-9: Statistics and Basis Values for IPS Strength Data

In-Plane Shear (IPS) Modulus As-Measured Statistics				
Env	CTD	RTD	ETW	ETW2
Mean	0.63	0.54	0.37	0.31
Stdev	0.03	0.04	0.03	0.03
CV	5.41	7.52	9.23	10.61
Mod CV	6.71	7.76	9.23	10.61
Min	0.56	0.47	0.31	0.25
Max	0.71	0.60	0.44	0.38
No. Batches	3	3	3	3
No. Spec.	23	24	20	21

Table 4-10: Statistics from IPS Modulus Data

4.6 Lamina Short Beam Strength (SBS)

The Short Beam Strength data is not normalized. Pooling across the environments was not acceptable due to the data failed the Levene's test for equality of variance. The CTD, RTD and ETW conditions did not pass the ADK test. This means those datasets required the ANOVA method to compute basis values which may result in overly conservative basis values. In order for B-basis values computed using the ANOVA method, data from five batches is required. Since this dataset has only three batches, the basis values computed using ANOVA are considered estimates. The RTD and ETW conditions data did pass the normality test, and passed the ADK test under the modified CV transformation, so the modified CV values are provided. B-estimates computed using the modified CV method are provided for the CTD condition, but they are considered estimates due to the failure of the ADK test after the transformation to meet the assumptions of the modified CV method.

There were two outliers, both in the ETW2 condition. The highest value in batch two and the lowest value in batch three, both were outliers only for their respective batches, but not for the ETW2 condition. Both outliers were retained for this analysis.

Statistics, basis values and estimates are given for SBS strength data in Table 4-11. The as measured data, B-estimates and B-basis values are shown graphically in Figure 4-7.

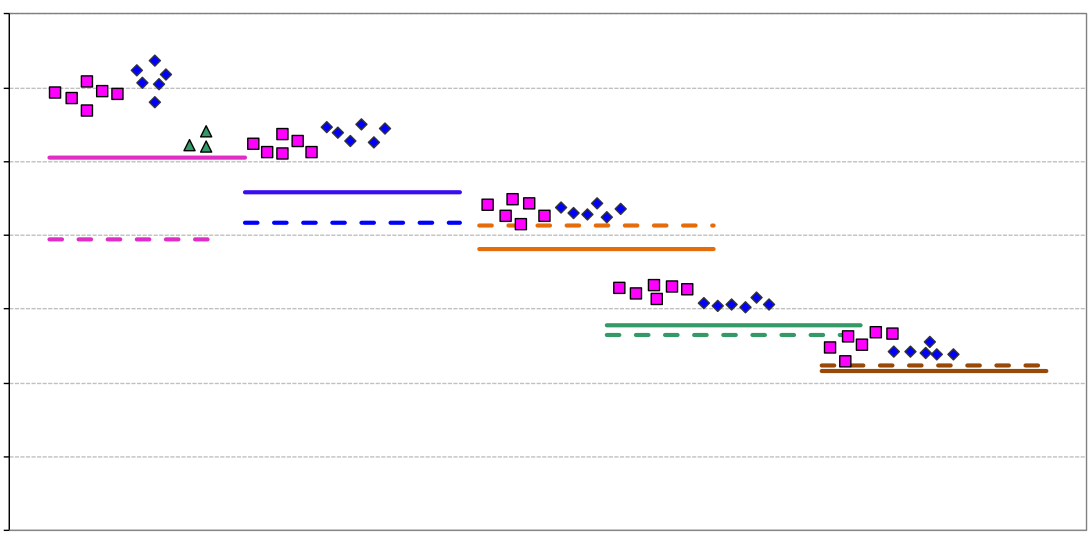

Figure 4-7: Batch Plot for SBS

Env	CTD	RTD	ETD	ETW	ETW2
Mean	11.67	10.41	8.63	6.30	

Table 4-11: Statistics and Basis Values for SBS Data

5. Laminate Test Results, Statistics, Basis Values and Graph

Many of the laminate tests were performed with one batch only. In those cases, there was insufficient data to produce basis values meeting the requirements of CMH-17-1G, so only estimates are provided. When possible, estimates were prepared in the following ways and multiple estimates are provided.

1. Using the ASAP program to pool across the available environments. The modified CV values from this program are provided.
2. The Lamina Variability method detailed in section 2.4. LVM Mod CV values are not available for laminate test properties that use the CV from the following lamina tests and conditions due to their CV ¶ being greater than 8%.
    a. WC CTD
    b. WC ETW
    c. WC ETW2
    d. WT CTD
    e. FC all conditions
    f. FT CTD
    g. FT ETW
    h. FT ETW2

Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	94.90	94.22	85.84	90.67	90.47	80.98
Stdev	5.25	5.94	3.19	4.86	5.37	3.66
CV	5.53	6.30	3.72	5.36	5.93	4.52
Modified CV	6.77	7.15	8.00	6.68	6.97	8.00
Min	86.08	86.69	80.45	83.06	82.57	75.33
Max	101.69	106.70	89.61	96.72	102.88	85.70

0.0010376 4 6 250.5 reW*5 T/F7 8.275 T 1 60 1 17

Table 5-1: Statistics and Basis Values for UNT1 Strength Data

Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	6.53	6.29	6.45	6.24	6.03	6.09
Stdev	0.60	0.39	0.15	0.59	0.36	0.14
CV	9.13	6.13	2.27	9.41	5.94	2.32
Modified 21(v)]TJ ETBT1 0 0 1 105.18 70.085.18 70dif33.32						

Table 5-2: Statistics from UNT1 Modulus Data

Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	59.59	60.16	48.34	57.42	57.95	46.35
Stdev	1.57	0.74	1.55	1.93	0.67	1.33
CV	2.63	1.23	3.20	3.36	1.15	2.87
Modified CV	8.00	8.00	8.00	8.00	8.00	8.00
Min	57.69	59.42	46.38	55.19	57.18	44.77
Max	61.90	61.37	50.76	59.93	58.88	48.74
No. Batches	1	1	1	1	1	1
No. Spec.	6	6	6	6	6	6
B-estimate	47.06	54.23	44.33	45.17	51.31	42.49
A-estimate	NA	NA	NA	NA	NA	NA
Method	LVM	LVM	LVM	LVM	LVM	LVM
B-estimate	NA	49.93	40.00	NA		

Table 5-3: Statistics and Basis Values for UNT2 Strength Data

"Soft" Unnotched Tension (UNT2) Modulus Statistics						
	Normalized			As Measured		
Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	4.46	4.12	3.96	4.30	3.97	3.80
Stdev	0.11	0.10	0.20	0.13	0.09	0.21
CV	2.41	2.38	4.95	3.06	2.33	5.40
Modified CV	6.00	6.00	6.47	6.00	6.00	6.70
Min	4.33	4.01	3.74	4.12	3.88	3.53
Max	4.63	4.23	4.25	4.48	4.07	4.10
No. Batches	1	1	1	1	1	1
No. Spec.	6	5	6	6	5	6

Table 5-4: Statistics from UNT2 Modulus Data

"Hard" Unnotched Tension (UNT3) Strength Basis Values and Statistics						
	Normalized					
Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	114.35	116.82	109.02	119.01	122.09	113.02
Stdev	4.80	3.53	3.10	4.62	3.58	3.35
CV	4.20	3.02	2.84	3.88	2.93	2.97
Modified CV	8.00	8.00	8.00	8.00	8.00	8.00
Min	106.54	109.94	105.58	111.33	114.68	109.04
Max	119.93	122.12	112.56	124.66	126.50	117.38
No. Batches	1	1	1	1	1	1
No. Spec.	6	8	6	6	8	6
	Basis Values and/or Estimates					
B-estimate	90.31	105.84	99.98	93.62	108.73	103.60
A-estimate	NA	NA	NA	NA	NA	NA
Method	LVM	LVM	LVM	LVM	LVM	LVM
	Modified CV Basis Values and/or Estimates					
B-estimate	NA	97.88	90.20	NA	102.29	93.52
A-estimate	NA	NA	NA	NA	NA	NA
Method	NA	LVM	LVM	NA	LVM	LVM

Table 5-5: Statistics and Basis Values for UNT3 Strength Data

"Hard" Unnotched Tension (UNT3) Modulus Statistics						
	Normalized			As Measured		
Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	7.94	7.69	8.65	8.27	8.02	8.95
Stdev	0.45	0.06	0.30	0.47	0.07	0.34
CV	5.70	0.82	3.43	5.71	0.91	3.75
Modified CV	6.85	6.00	6.00	6.86	6.00	6.00
Min	7.47	7.58	8.38	7.71	7.92	8.65
Max	8.63	7.75	9.02	8.97	8.10	9.33
No. Batches	1	1	1	1	1	1
No. Spec.	6	6	5	6	6	5

Table 5-6: Statistics from UNT3 Modulus Data

Quasi Isotropic Unnotched Compression (UNC1) Modulus Statistics						
	Normalized			As Measured		
Env	RTD	ETW	ETW2	RTD	ETW	ETW2
Mean	5.66	6.59	6.52	5.50	6.44	6.40
Stdev	0.30	0.34	0.49	0.31	0.34	0.46
CV	5.24	5.17	7.49	5.63	5.32	7.16
Modified CV	6.62	6.59	7.75	6.81	6.66	7.58
Min	5.03	6.07	5.68	4.84	5.94	5.62
Max	6.50	6.94	6.87	6.29	6.82	6.73
No. Batches	3	1	2	3	1	2
No. Spec.	18	6	7	18	6	7

Table 5-8: Statistics from UNC1

5.2.2 [3]6RIW´ 8QQRWFKHG &RPSUHVVLRQ 3URSHUWLHV 81&

The UNC2 data is normalized. This property had data from only one batch available. There was insufficient data to meet the requirements of CMH-17-1G, so only estimates are provided. B-estimates were prepared using the laminate variability method (LVM) detailed in section 2.4. Modified CV values are not available for the ETW2 condition due to the large CV of the warp compression lamina data for the ETW2 condition which was used to compute the LVM B-estimate.

There were no outliers.

Statistics and A- and B-estimates are given for strength data in Table 5-9 and for the modulus data in Table 5-10. The normalized data and the B-estimates are shown graphically in Figure 5-5.

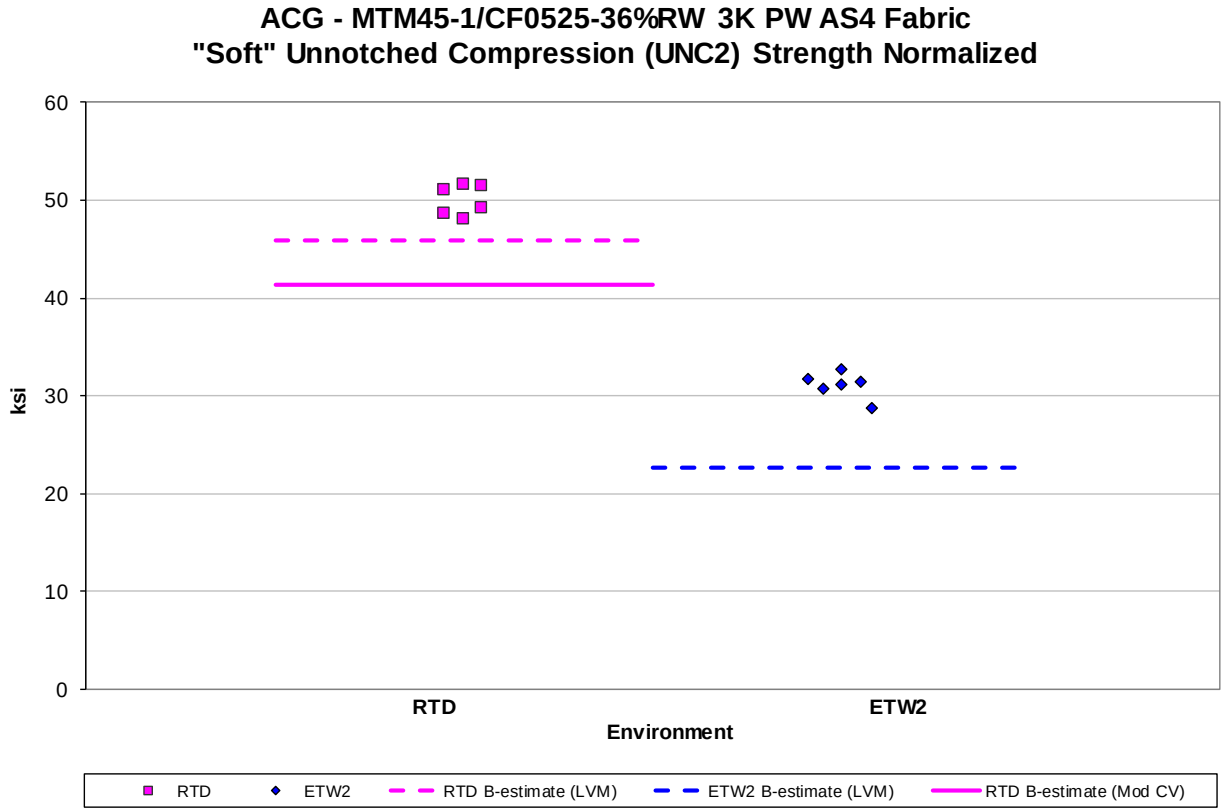

Figure 5-5: Batch Plot for UNC2 Strength Normalized

"Soft" Unnotched Compression (UNC2) Strength Basis Values and Statistics				
	Normalized		As Measured	
Env	RTD	ETW2	RTD	ETW2
Mean	49.96	31.08	49.55	29.96
Stdev	1.59	1.32	1.73	1.34
CV	3.18	4.24	3.49	4.48
Modified CV	8.00	8.00	8.00	8.00
Min	48.01	28.75	47.41	27.99
Max	51.62	32.68	51.68	32.07
No. Batches	1	1	1	1
No. Spec.	6	6	6	6
Basis Values and/or Estimates				
B-estimate	45.89	22.72	44.84	21.81
A-estimate	NA	NA	NA	NA
Method	LVM	LVM	LVM	LVM
Modified CV Basis Values and/or Estimates				
B-estimate	41.34	NA	41.00	NA
A-estimate	NA	NA	NA	NA
Method	LVM	NA	LVM	NA

Table 5-9: Statistics and Basis Values for UNC2 Strength Data

"Soft" Unnotched Compression (UNC2) Modulus Statistics				
	Normalized		As Measured	
Env	RTD	ETW2	RTD	ETW2
Mean	3.95	5.09	3.92	4.89
Stdev	0.32	0.74	0.30	0.67
CV	8.16	14.56	7.54	13.71
Modified CV	8.16	14.56	7.77	13.71
Min	3.61	3.77	3.63	3.70
Max	4.50	5.52	4.42	5.26
No. Batches	1	1	1	1
No. Spec.	6	5	6	5

Table 5-10: Statistics from UNC2 Modulus Data

Env

Table 5-11: Statistics and Basis Values for UNC3 Strength Data

Env	RTD	ETW2	RTD	ETW2
Mean	7.89		7.63	
Stdev	0.29		0.28	
CV	3.64		3.61	
Modified CV	6.00		6.00	
Min	7.45		7.18	
Max	8.21		7.98	
No. Batches	1		1	
No. Spec.	6		6	

No modulus values were available for compression tests at the ETW2

Table 5-12: Statistics from UNC3 Modulus Data

5.3 Open Hole Tension Properties

5.3.1 Quasi Isotropic Open Hole Tension Properties (OHT1)

The OHT1 data is normalized. None of the conditions tested with multiple batches passed the Anderson-Darling k-sample test for batch-to-batch variation, so an ANOVA analysis is required. In order for B-basis values computed using the ANOVA method, data from five batches is required. Since this dataset has only three batches, the basis values computed using ANOVA are considered estimates and may be overly conservative. The data from the CTD condition, both normalized and as measured passed the ADK test under the modified CV transformation. The normalized CTD dataset failed the normality test, but passed the normality test after the transformation to meet the assumptions of the modified CV method. So modified CV basis values are provided for that dataset.

The RTD and ETW2 datasets, both normalized and as measured, did not pass the ADK test under the modified CV transformation. B-estimates computed using the modified CV method are provided, but they are considered estimates due to the failure of the ADK test after the transformation to meet the assumptions of the modified CV method.

The ETW condition had data from only one batch available, so there was insufficient data to meet the requirements of CMH-17-1G. B-estimates were prepared using the laminate variability method (LVM) which is detailed in section 2.4.

There were no outliers.

Statistics, estimates and basis values are given for strength data in Table 5-13. The normalized data, B-estimates and B-basis values are shown graphically in Figure 5-7

Figure 5-7: Batch Plot for OHT1 Strength Normalized

Quasi Isotropic Open Hole Tension (OHT1) Strength Basis Values and Statistics								
	Normalized				As Measured			
Env	CTD	RTD	ETW	ETW2	CTD	RTD	ETW	ETW2
Mean	51.41	53.11	55.93	52.53	49.60	51.56	53.92	50.69
Stdev	1.97	2.75	1.15	2.91	1.93	2.77	1.12	3.00
CV	3.84	5.18	2.05	5.54	3.90	5.37	2.07	5.93
Modified CV	6.00	6.59	8.00	6.77	6.00	6.68	8.00	6.96
Min	47.03	48.87	54.57	47.71	45.03	47.30	52.70	45.82
Max	53.62	57.02	57.55	56.45	51.78	55.87	55.67	55.27
No. Batches	3	3	1	3	3	3	1	3
No. Spec.	18	18	6	19	18	18	6	19
Basis Values and/or Estimates								
B-estimate	38.78	34.15	47.89	33.16	37.97	33.52	45.89	30.79
A-estimate	29.76	20.61	NA	19.32	29.67	20.64	NA	16.57
Method	ANOVA	ANOVA	LVM	ANOVA	ANOVA	ANOVA	LVM	ANOVA
Modified CV Basis Values and/or Estimates								
B-basis Value	45.32				43.73			
B-estimate		46.20	46.32	45.60		44.76	44.66	43.81
A-estimate	41.01	41.32	NA	40.69	39.57	39.95	NA	38.93
Method	Normal	Normal	LVM	Normal	Normal	Normal	LVM	Normal

Table 5-13: Statistics and Basis Values for OHT1 Strength Data

5.3.2 [illegible] Open Hole Tension Properties (OHT2)

The OHT2 data is normalized. The normalized data for the CTD condition did not pass the Anderson-Darling k-sample test for batch-to-batch variation. This means that dataset required the ANOVA method to compute basis values which may result in overly conservative basis values.

Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	45.83	43.05	34.90	44.07	41.80	22.22
Stdev	0.99	0.63	0.55	0.97	0.68	0.33
CV	2.17	1.46	1.57	2.20	1.63	1.50

Table 5-14: Statistics and Basis Values for OTH2 Strength Data

Table 5-15: Statistics and Basis Values for OHT3 Strength Data

5.4 Open Hole Compression

5.4.1 Quasi Isotropic Open Hole Compression 1 (OHC1)

The OHC1 data is normalized. Both the normalized and the as measured data for the RTD condition did not pass the Anderson-Darling k-sample test for batch-to-batch variation. This means those datasets required the ANOVA method to compute basis values which may result in overly conservative basis values. However, the RTD data did pass the normality test, and passed the ADK test under the modified CV transformation, so the pooled modified CV values are provided. Pooling was acceptable for the modified CV basis values.

The ETW conditions had data from only one batch available, so there was insufficient data to meet the requirements of CMH-17-1G. B-estimates were prepared using the laminate variability method (LVM) which is detailed in section 2.4. The ETW data was included in the pooled dataset for the modified CV basis values.

There was one outlier. The highest value in batch one of the as measured RTD data. It was an outlier only for batch one, but not for the RTD condition. It was retained for this analysis.

Statistics, estimates and basis values are given for OHC1 strength data in Table 5-16. The normalized data, B-estimates and B-basis values are shown graphically in Figure 5-10.

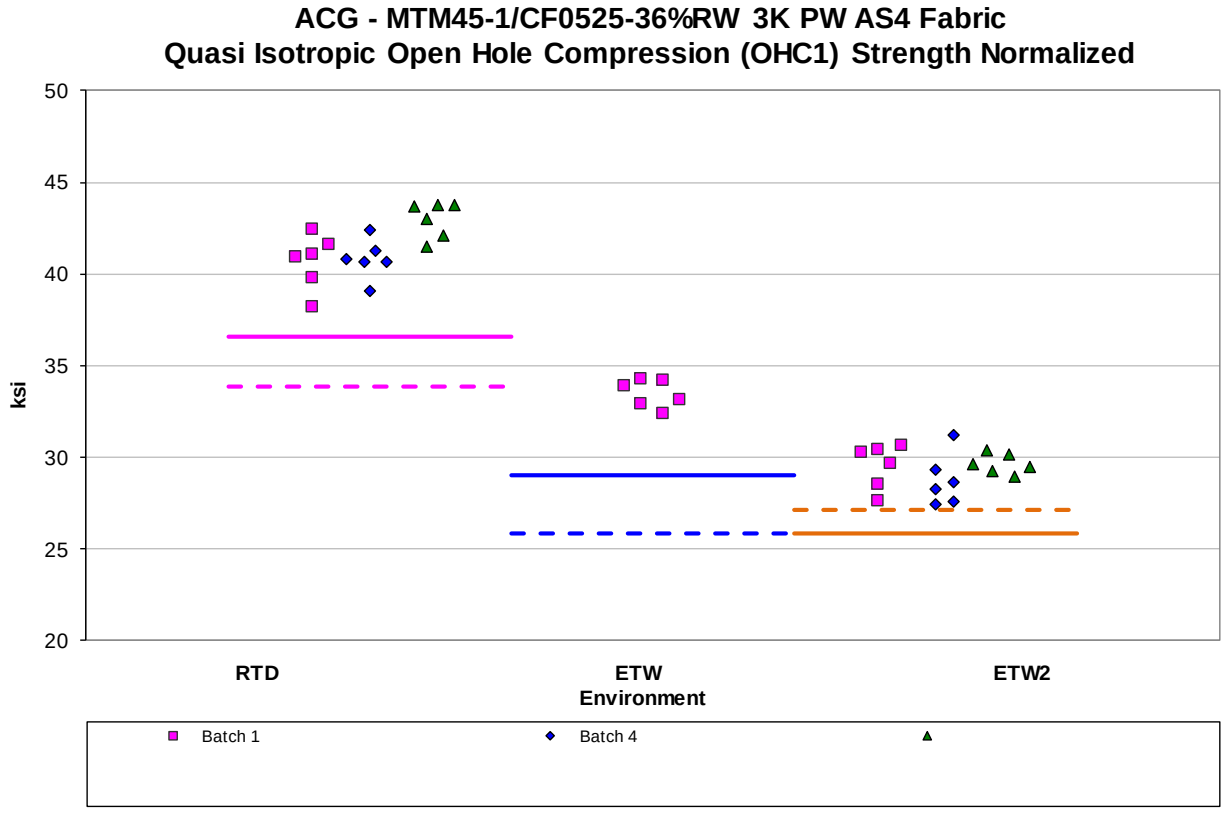

Figure 5-10: Batch Plot for OHC1 Strength Normalized

Quasi Isotropic Open Hole Compression (OHC1) Strength Basis Values and Statistics						
	Normalized			As Measured		
Env	RTD	ETW	ETW2	RTD	ETW	ETW2
Mean	41.46	33.42	29.29	40.30	31.81	28.16
Stdev	1.56	0.77	1.11	1.59	0.81	1.25
CV	3.76	2.31	3.80	3.94	2.54	4.43
Modified CV	6.00	6.00	6.00	6.00	6.00	6.22
Min	38.15	32.33	27.43	37.42	30.59	26.08
Max	43.73	34.25	31.20	43.13	32.95	30.13
No. Batches	3	1	3	3	1	3
No. Spec.	18	6	18	18	6	18
Basis Values and/or Estimates						
B-basis Value			27.09			25.70
B-estimate	33.86	25.81		31.65	24.37	
A-estimate	28.44	NA	25.53	25.49	NA	23.95
Method	ANOVA	LVM	Normal	ANOVA	LVM	Normal
Modified CV Basis Values and/or Estimates						
B-basis Value	37.61		25.44	36.54		24.41
B-estimate		29.01			27.50	
A-estimate	35.01	26.49	22.84	34.00	25.04	21.87
Method	pooled	pooled	pooled	pooled	pooled	pooled

Table 5-17: Statistics and Basis Values for OHC2 Strength Data

Env	RTD	ETW2	RTD	ETW2
Mean	45.66	31.76	44.76	30.81
Stdev	2.70	2.17	2.56	2.12
CV	5.92	6.83	5.72	6.87
Modified CV	8.00	7.41	8.00	7.44
Min	42.05	27.16	41.35	26.27
Max	51.24	34.78	50.18	33.72
No. Batches	1	3	1	3
No. Spec.	8	18	8	18

Table 5-18: Statistics and Basis Values for OHC3 Strength Data

5.5 Filled Hole Tension

5.5.1 Quasi Isotropic Filled Hole Tension (FHT1)

The FHT1 data is normalized. The data for the CTD condition, both normalized and as measured, did not pass the Anderson-Darling k-sample test for batch-to-batch variation. This means the ANOVA method to compute basis values is required. In order for B-basis values computed using the ANOVA method, data from five batches is required. Since this dataset has only three batches, the basis values computed using ANOVA are considered estimate and may result in overly conservative basis values. The CTD data did not pass the ADK test under the modified CV transformation, so B-estimates computed using the modified CV method are provided, but they are considered estimates due to the failure of the ADK test after the transformation to meet the assumptions of the modified CV method.

The RTD condition had data from only one batch available, so there was insufficient data to meet the requirements of CMH-17-1G. B-estimates were prepared using the laminate variability method (LVM) which is detailed in section 2.4.

There were no outliers.

Statistics and A- and B-estimates are given for FHT1 strength data in

Quasi Isotropic Filled-Hole Tension (FHT1) Strength Basis Values and Statistics				
	Normalized		As Measured	
Env	CTD	RTD	CTD	RTD
Mean	53.44	57.52	51.11	55.05
Stdev	2.96	0.74	2.92	0.81
CV	5.55	1.28	5.72	1.47
Modified CV	6.77	8.00	6.86	8.00
Min	48.06	56.79	46.02	53.98
Max	59.27	58.61	56.45	56.30
No. Batches	3	1	3	1
No. Spec.	18	6	18	6
Basis Values and/or Estimates				
B-estimate	36.09	51.85	33.37	48.73
A-estimate	23.70	NA	20.72	NA
Method	ANOVA	LVM	ANOVA	LVM
Modified CV Basis Values and/or Estimates				
B-estimate	46.30	47.74	44.19	45.69
A-estimate	41.24	NA	39.29	NA
Method	Normal	LVM	Normal	LVM

Table 5-19: Statistics and Basis Values for FHT1 Strength Data

"Soft" Filled Hole Tension (FHT2) Strength Basis Values and Statistics						
	Normalized			As Measured		
Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	48.34	44.47	36.01	46.48	42.97	34.79
Stdev	0.85	0.31	0.39	0.86	0.24	0.41
CV	1.75	0.70	1.08	1.84	0.55	1.19
Modified CV	8.00	8.00	8.00	8.00	8.00	8.00
Min	47.18	44.07	35.45	45.01	42.61	34.08
Max	49.30	44.84	36.44	47.35	43.26	35.32
No. Batches	1	1	1	1	1	1
No. Spec.	6	6	6	6	6	6
Basis Values and/or Estimates						
B-estimate	38.18	40.09	33.03	36.57	38.04	31.89
A-estimate	NA	NA	NA	NA	NA	NA
Method	LVM	LVM	LVM	LVM	LVM	LVM
Modified CV Basis Values and/or Estimates						
B-estimate	NA	36.91	29.80	NA	35.67	28.79
A-estimate	NA	NA	NA	NA	NA	NA
Method	LVM	LVM	LVM	LVM	LVM	LVM

Table 5-20: Statistics and Basis Values for FHT2 Strength Data

5.5.3 3+DUG´)LOOHG +RO H 7HQVLRQ)+7

The FHT3 data is normalized. This property had data from only one batch available. There was insufficient data to meet the requirements of CMH-17-1G, so only estimates are provided. B-estimates were prepared using the laminate variability method (LVM) detailed in section 2.4. Modified CV values are not provided for the CTD data due to large CV of the warp tension lamina data for the CTD condition which was used to compute the LVM B-estimate.

There were no outliers.

Statistics and B-estimates are given for FHT3 strength data in Table 5-21. The normalized data and B-estimates are shown graphically in Figure 5-15.

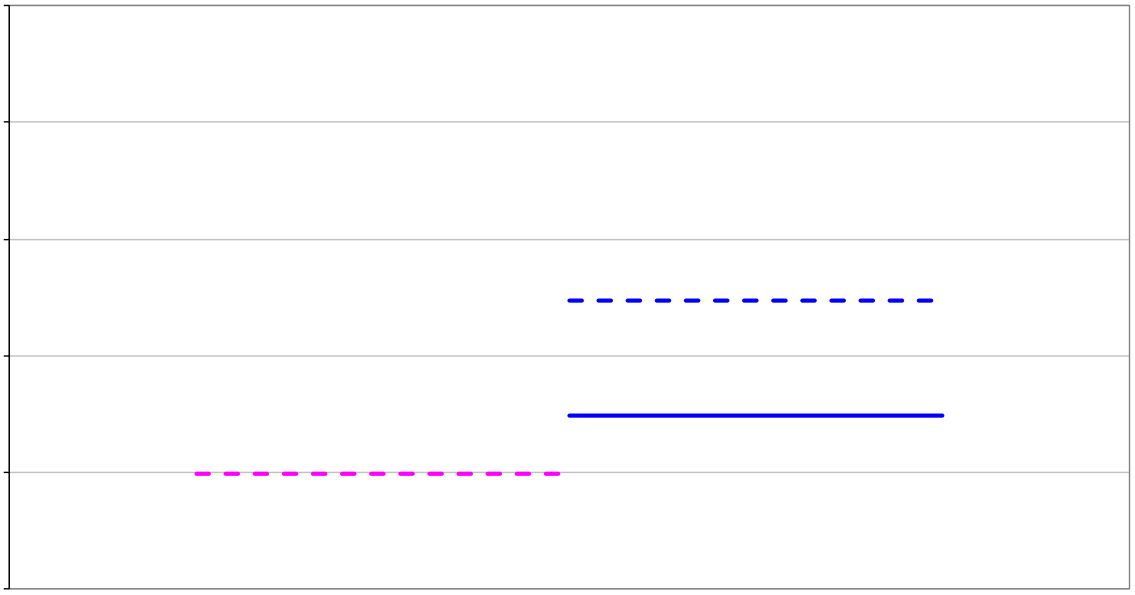

Figure 5-15: Batch Plot for FHT3 Strength Normalized

Env	CTD	RTD	CTD	RTD
Mean	69.55	69.18	67.25	67.20
Stdev	2.99	2.45	2.86	2.69
CV	4.30	3.54	4.25	4.00
Modified CV	8.00	8.00	8.00	8.00
Min	65.28	66.42	63.36	64.20
Max	72.75	72.29	70.49	70.33
No. Batches	1	1	1	1
No. Spec.	6	6	6	6
B-estimate	54.93	62.36	52.90	59.49

Table 5-21: Statistics and Basis Values for FHT3 Strength Data

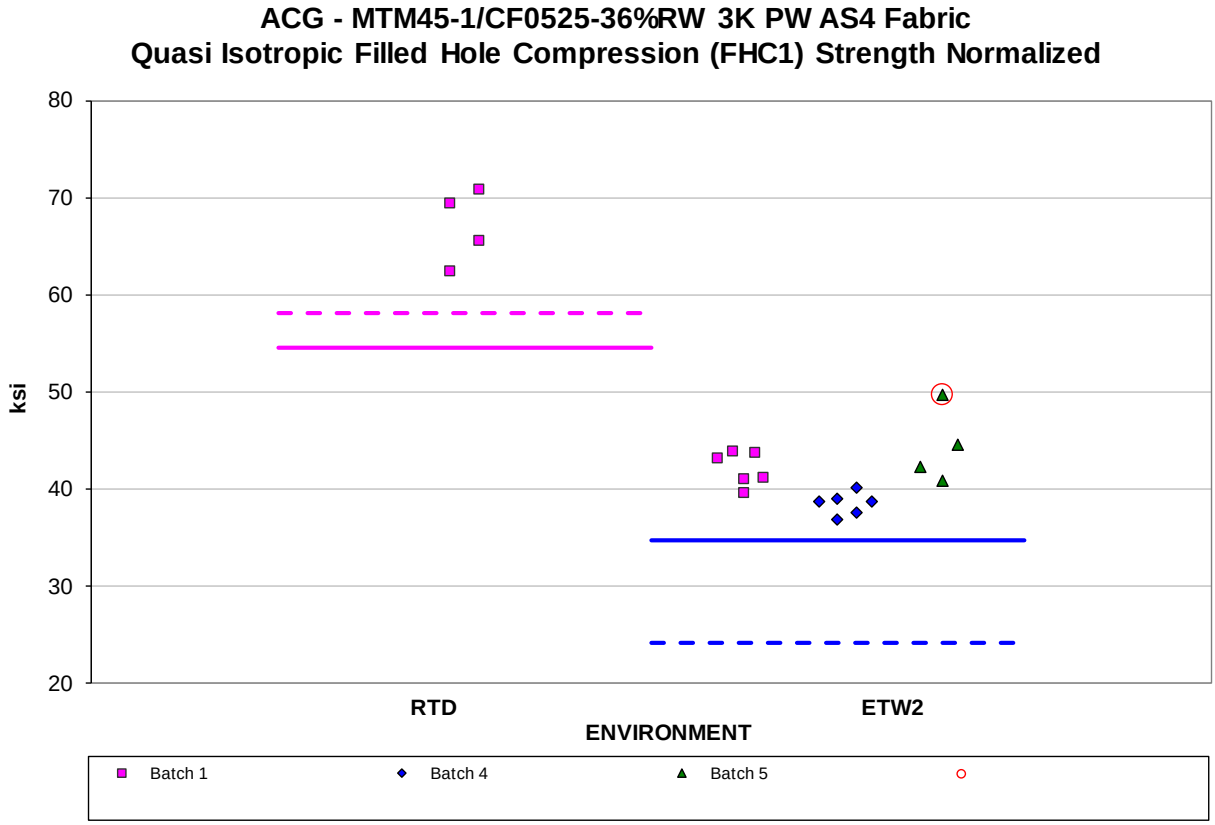

Figure 5-16: Batch Plot for FHC1 Strength Normalized

Table 5-22

5.6.2 ³6RIW´)LOOHG +RO(FHC2) RPSUHVVLRQ

The FHC2 data is normalized. The RTD condition had data from only one batch available, so there was insufficient data to meet the requirements of CMH-17-1G. B-estimates were prepared using the laminate variability method (LVM) which is detailed in section 2.4.

There was one outlier. The highest value in batch one of the RTD condition for both the normalized and as measured datasets. It was an outlier only for batch one, not for the RTD condition. It was retained for this analysis.

Statistics, estimates and basis values are given for FHC2 strength data in Table 5-23. The normalized data, B-estimates and B-basis values are shown graphically in Figure 5-17.

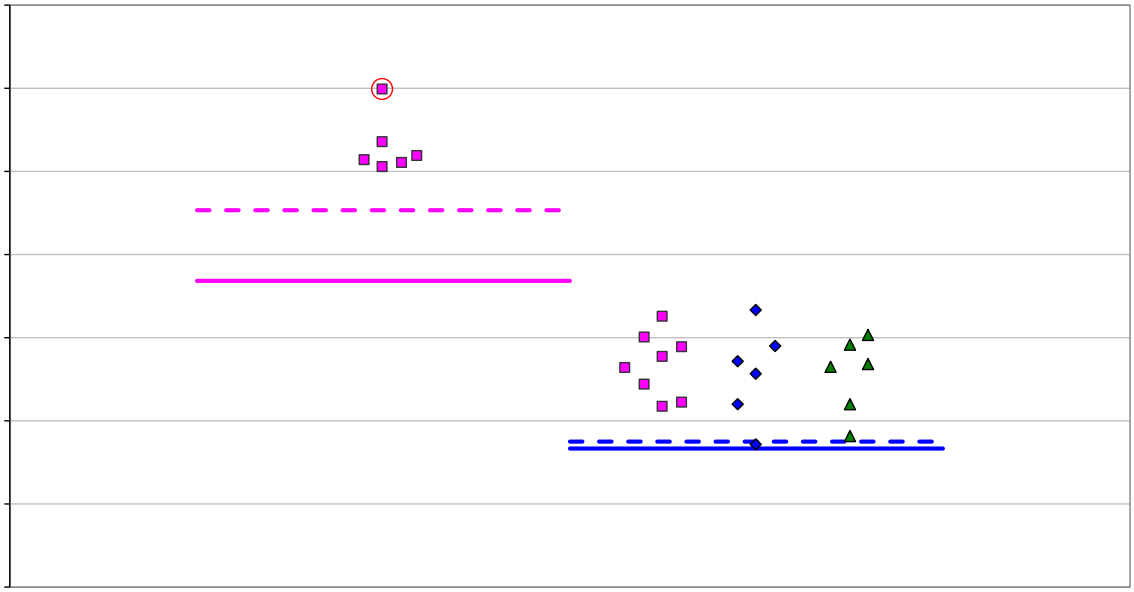

Figure 5-17: Batch Plot for FHC2 Strength Normalized

"Soft" Filled-Hole Compression (FHC2) Strength Basis Values and Statistics				
	Normalized		As Measured	
Env	RTD	ETW2	RTD	ETW2
Mean	46.47	33.02	44.83	31.71
Stdev	1.74	2.20	1.71	2.07
CV	3.74	6.65	3.82	6.53
Modified CV	8.00	7.33	8.00	7.27
Min	45.20	28.60	43.64	27.86
Max	49.86	36.63	48.18	35.51
No. Batches	1	3	1	3
No. Spec.	6	20	6	20
Basis Values and/or Estimates				
B-basis Value		28.79		27.72
B-estimate	42.68		40.57	
A-estimate	NA	25.78	NA	24.88
Method	LVM	Normal	LVM	Normal
Modified CV Basis Values and/or Estimates				
B-basis Value		28.36		27.27
B-estimate	38.45		37.09	
A-estimate	NA	25.05	NA	24.12
Method	LVM	Normal	LVM	Normal

Table 5-

5.6.3 “Hard” Filled Hole Compression (FHC3)

The FHC3 data is normalized. The ETW2 condition had only four specimens from batch four and those were from only one cure cycle, which is insufficient to compute B-basis values and only B-estimates are provided. Modified CV values are not provided for the ETW2 condition due to the large CV of ETW2 data for this test.

The RTD condition had data from only one batch available, so there was insufficient data to meet the requirements of CMH-17-1G. B-estimates were prepared using the laminate variability method (LVM) which is detailed in section 2.4.

There were no outliers.

Statistics and A- and B-estimates are given for FHC3 strength data in Table 5-24. The normalized data and B-estimates are shown graphically in Figure 5-18.

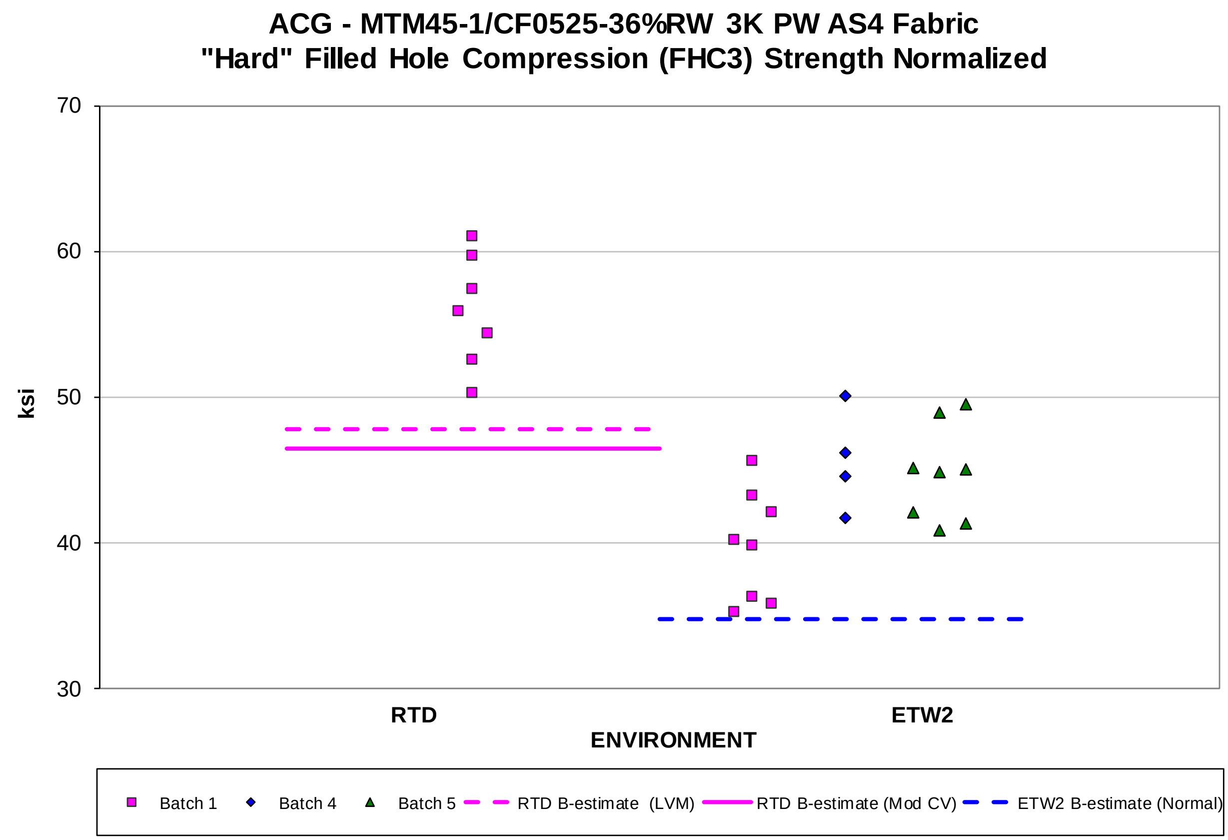

Figure 5-18: Batch Plot for FHC3 Strength Normalized

"Hard" Filled-Hole Compression (FHC3) Strength Basis Values and Statistics				
	Normalized		As Measured	
Env	RTD	ETW2	RTD	ETW2
Mean	55.88	42.94	58.33	42.63
Stdev	3.84	4.25	3.90	3.62
CV	6.87	9.90	6.68	8.48
Modified CV	8.00	9.90	8.00	8.48
Min	50.25	35.27	52.51	36.74
Max	61.06	50.07	63.92	48.83
No. Batches	1	3	1	3
No. Spec.	7	20	7	20
Basis Values and/or Estimates				
B-estimate	47.82	34.75	50.15	35.66
A-estimate	NA	28.92	NA	30.71
Method	LVM	Normal	LVM	Normal
Modified CV Basis Values and/or Estimates				
B-estimate	46.49	NA	48.53	NA
A-estimate	NA	NA	NA	NA
Method	LVM	NA	LVM	NA

Table 5-24: Statistics and Basis Values for FHC3 Strength Data

5.7 Laminate Short Beam Strength (SBS1) Data

The Laminate Short Beam Strength data is not normalized. The ETW data had insufficient data to meet the requirements of CMH-17-1G

Env	RTD	ETW	ETW2
Mean	9.68	6.43	4.70
Stdev	0.15	0.24	0.20
CV	1.53	3.74	4.34
Modified CV	6.00	8.00	6.17
Min	9.39	6.22	4.37
Max	9.89	6.84	5.04
No. Batches	3	1	3
No. Spec.	18	6	18
B-basis Value	9.39		
B-estimate		4.93	3.33
A-estimate	9.18	NA	2.36
Method	Normal	LVM	ANOVA
Modified CV	3.CVsm 0 V0( )6(V(.)6l 0)]TETBT1 0 0 1 1		
B-basis Value	8.53		
B-estimate		NA	4.12
A-estimate	7.72	NA	3.72
Method	Normal	NA	Normal

Table 5-25: Statistics and Basis Values for SBS1 Data

5.8 Pin Bearing

5.8.1 Quasi Isotropic Pin Bearing (PB1)

The PB1 data is normalized. The ETW2 data did not pass the Anderson-Darling k-sample test for batch-to-batch variation for both the 2% offset and ultimate strength, both normalized and as measured, so an ANOVA analysis is required. In order for B-basis values computed using the ANOVA method, data from five batches is required. Since this dataset has only three batches, the basis values computed using ANOVA are considered estimates and may be overly conservative.

The ETW2 datasets, both normalized and as measured, failed the normality test but passed it after the transformation to meet the assumptions of the modified CV method. However, the ETW2 data for ultimate strength, both normalized and as measured, did not pass the ADK test under the modified CV transformation. B-estimates computed using the modified CV method are

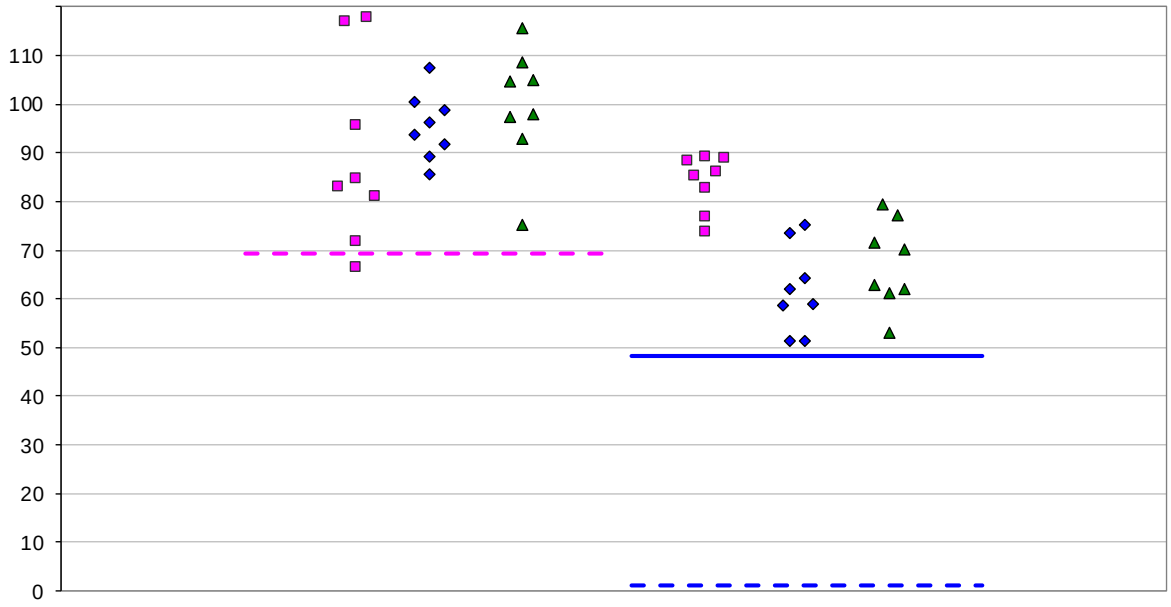

Figure 5-20: Batch Plot for PB1 2% Offset Strength Normalized

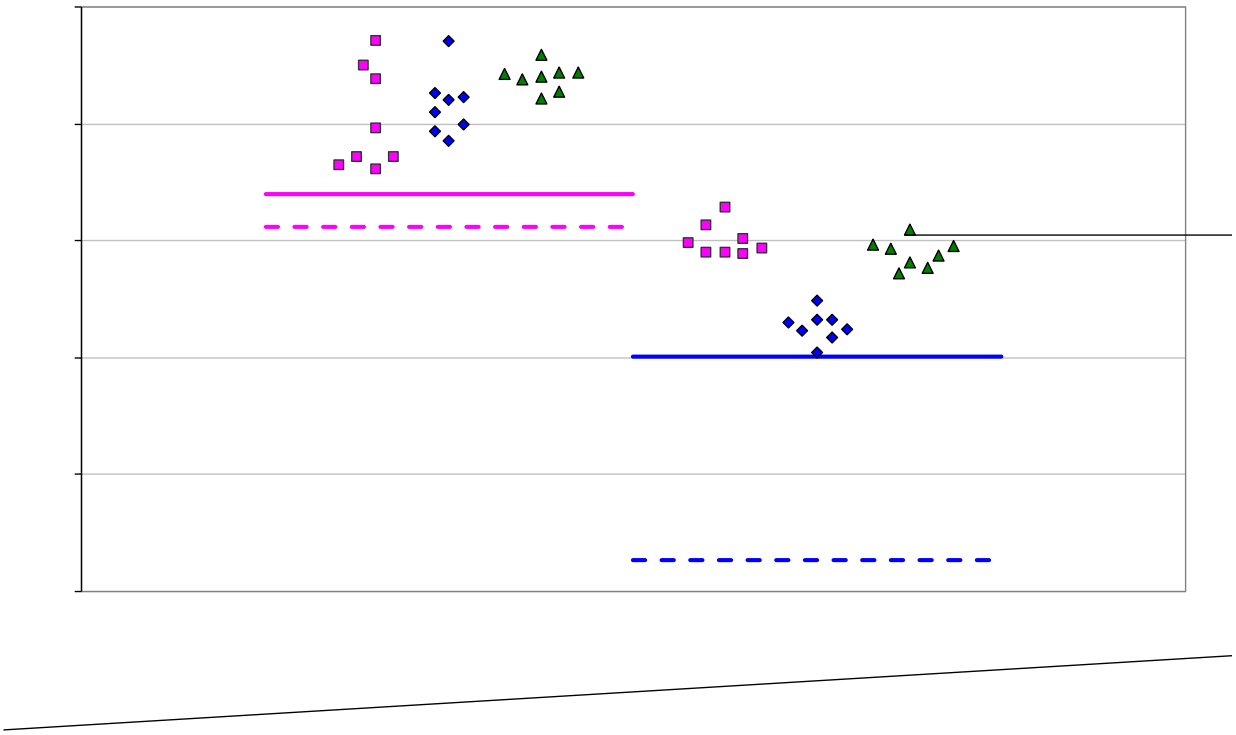

Figure 5-21: Batch Plot for PB1 Ultimate Strength Normalized

5.8.2 3 6 R I W ´ 3 L Q % H D U L Q J 3 %

The PB2 data is normalized. The ETW2 condition data did not pass the Anderson-Darling k-sample test for batch-to-batch variation for the 2% offset, so an ANOVA analysis is required. In order for B-basis values computed using the ANOVA method data from five batches is required. Since this dataset has only three batches, the basis values computed using ANOVA are considered estimates and may be overly conservative. They did not pass the ADK test under the modified CV transformation, so B-estimates computed using the modified CV method are provided, but they are considered estimates due to the failure of the ADK test after the transformation to meet the assumptions of the modified CV method. However, modified CV basis values are not provided for the 2% offset strength for ETW2 condition due to the large CV of both the as measured and normalized data. Instead, estimates of basis values that were computed with an override of the ADK test results are provided.

The RTD condition had data from only one batch available, so there was insufficient data to meet the requirements of CMH-17-1G.84 Tm0 g0 G[(NC)-5(P)] TJETQq0.00000912 0 612 792 reW* n423o[(n

Jae

5.10 Compression After Impact Strength

The CAI data is normalized, so both normalized and as-measured statistics are provided. Basis values are not computed for this property. Only one batch of material was tested. Testing was done only for the RTD condition. There were no outliers. However the summary statistics are presented in Table 5-30 and the data are displayed graphically in Figure 5-27.

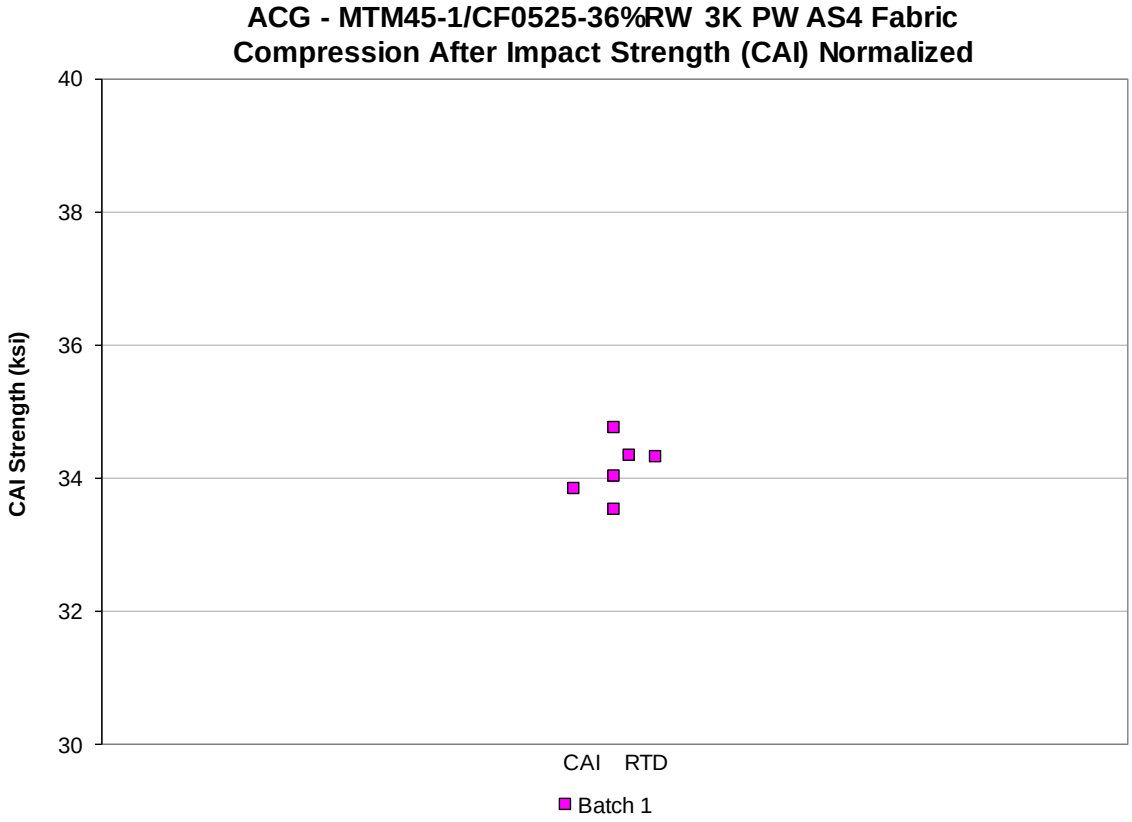

Figure 5-27: Plot for normalized Compression After Impact (CAI) Strength Data

Compression After Impact Strength (ksi) Statistics		
	Normalized	As Measured
Env	RTD	RTD
Mean	34.44	32.63
Stdev	0.70	1.48
CV	2.03	4.54
Modified CV	6.00	6.27
Min	33.52	31.33
Max	35.76	34.98
No. Batches	1	1
No. Spec.	8	8

Table 5-30: Statistics for CAI Data

7. References

1. Snedecor, G.W. and Cochran, W.G., *Statistical Methods*, 7th ed., The Iowa State University Press, 1980, pp. 252-253.
2. Stefansky, W., "Rejecting Outliers in Factorial Designs," *Technometrics*, Vol. 14, 1972, pp. 469-479.
3. 6 F K R O]) : D Q G 6 W H S K H Q V 0 ' D U O L Q J 7 H V W V R I) L W ´ Sample Anderson-Darling Tests of Fit," *Journal of the American Statistical Association*, Vol. 82, 1987, pp. 918-924.
4. Lehmann, E.L., *Testing Statistical Hypotheses*, John Wiley & Sons, 1959, pp. 274-275.
5.