Cytec Cycom 5320-1 T650 3k-PW Fabric Material Allowables Statistical Analysis Report

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Elizabeth Clarkson, Ph.D.

National Center for Advanced Materials Performance (NCAMP)
National Institute for Aviation Research
Wichita State University
Wichita, KS 67260-0093

Testing Facility:

National Institute for Aviation Research
Wichita State University
1845 N. Fairmount
Wichita, KS 67260-0093

Test Panel Fabrication Facility:

Gulfstream Aerospace Corporation
500 Gulfstream Road
Savannah, GA 31408

Prepared by: Elizabeth Clarkson
Digitally signed by Elizabeth Clarkson
DN: cn=Elizabeth Clarkson, o=NIAR, ou=NCAMP, email=bclarkson@niar.wichita.edu, c=US
Date: 2015.10.16 15:06:33 -05'00'
Elizabeth Clarkson, Ph.D

Reviewed by: Michelle Man
Digitally signed by Michelle Man
DN: cn=Michelle Man, o=NIAR, ou=NCAMP, email=kxman@niar.twsu.edu, c=US
Date: 2015.10.16 14:01:30 -05'00'
Michelle Man
Evelyn Lian

Approved by: Royal Lovingfoss
Digitally signed by Royal Lovingfoss
DN: cn=Royal Lovingfoss, o=NIAR, ou=NCAMP, email=rlovingfoss@niar.wichita.edu, c=US
Date: 2015.10.16 14:34:44 -05'00'
Royal Lovingfoss
Yeow Ng

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Table of Contents

List of Figures

List of Tables

1. Introduction

This report contains statistical analysis of the Cytec Cycom 5320-1 T650 3k-PW Fabric property data published in NCAMP Test Report CAM-RP-2012-017 N/C. The lamina and laminate material property data have been generated with NCAMP oversight in accordance with NSP 100 NCAMP Standard Operating Procedures; the test panels and test specimens have been inspected by NCAMP Authorized Inspection Representatives (AIR) and the testing has been witnessed by NCAMP Authorized Engineering Representatives (AER).

B-Basis values, A-estimates, and B-estimates were calculated using a variety of techniques that are detailed in section two. The qualification material was procured to NCAMP Material Specification NMS 532/6 Rev Initial Release dated July 6, 2010. The qualification test panels were cured in accordance with NCAMP Process Specification NPS 85321 Revision A dated September 23, 2010 Baseline "C" Cure Cycle. The NCAMP Test Plan NTP 5326Q1 was used for this qualification program.

The panels were fabricated at Gulfstream Aerospace Corporation, 500 Gulfstream Road, Savannah, GA 31408. The testing was performed at the National Institute for Aviation Research (NIAR) in Wichita, Kansas.

Basis numbers are labeled as 'values' when the data meets all the requirements of CMH-17 Rev G. When those requirements are not met, they will be labeled as 'estimates.' When the data does not meet all requirements, the failure to meet these requirements is reported and the specific requirement(s) the data fails to meet is identified. The method used to compute the basis value is noted for each basis value provided. When appropriate, in addition to the traditional computational methods, values computed using the modified coefficient of variation method is also provided.

The material property data acquisition process is designed to generate basic material property data with sufficient pedigree for submission to Complete Documentation sections of the Composite Materials Handbook (CMH-17 Rev G).

The NCAMP shared material property database contains material property data of common usefulness to a wide range of aerospace projects. However, the data may not fulfill all the needs of a project. Specific properties, environments, laminate architecture, and loading situations that individual projects need may require additional testing.

The use of NCAMP material and process specifications do not guarantee material or structural performance. Material users should be actively involved in evaluating material performance and quality including, but not limited to, performing regular purchaser quality control tests, performing periodic equivalency/additional testing, participating in material change management activities, conducting statistical process control, and conducting regular supplier audits.

The applicability and accuracy of NCAMP material property data, material allowables, and specifications must be evaluated on case-by-case basis by aircraft companies and certifying agencies. NCAMP assumes no liability whatsoever, expressed or implied, related to the use of the material property data, material allowables, and specifications.

Part fabricators that wish to utilize the material property data, allowables, and specifications may be able to do so by demonstrating the capability to reproduce the original material properties; a process known as equivalency. More information about this equivalency process including the test statistics and its limitations can be found in Section 6 of DOT/FAA/AR-03/19 and Section 8.4.1 of CMH-17 Rev G. The applicability of equivalency process must be evaluated on program-by-program basis by the applicant and certifying agency. The applicant and certifying agency must agree that the equivalency test plan along with the equivalency process described in Section 6 of DOT/FAA/AR-03/19 and Section 8.4.1 of CMH-17 Rev G are adequate for the given program.

Aircraft companies should not use the data published in this report without specifying NCAMP Material Specification NMS 532/6. NMS 532/6 has additional requirements that are listed in its prepreg process control document (PCD), fiber specification, fiber PCD, and other raw material specifications and PCDs which impose essential quality controls on the raw materials and raw material manufacturing equipment and processes. *Aircraft companies and certifying agencies should assume that the material property data published in this report is not applicable when the material is not procured to NCAMP Material Specification NMS 532/6. NMS 532/6* is a free, publicly available, non-proprietary aerospace industry material specification.

This report is intended for general distribution to the public, either freely or at a price that does not exceed the cost of reproduction (e.g. printing) and distribution (e.g. postage).

1.1 Symbols and Abbreviations

Test Property	Abbreviation
Warp Compression	WC
Warp Tension	WT
Fill Compression	FC
Fill Tension	FT
In-Plane Shear	IPS
Short Beam Strength	SBS
Unnotched Tension	UNT
Unnotched Compression	UNC
Laminate Short Beam Strength	SBS1
Filled Hole Tension	FHT
Filled Hole Compression	FHC
Open Hole Tension	OHT
Open Hole Compression	OHC
Single Shear Bearing	SSB
Interlaminar Tension	ILT
Curved Beam Strength	CBS
Compression After Impact	CAI

Table 1-1: Test Property Abbreviations

Test Property	Symbol
Warp Compression Strength	F_1^{cu}
Warp Compression Modulus	E_1^{c}
Warp Tension Strength	F_1^{tu}
Warp Tension Modulus	E_1^{t}
Warp Tension Poisson’s Ratio	ν_{12}^{t}
Fill Compression Strength	F_2^{cu}
Fill Compression Modulus	E_2^{c}
Fill Tension Strength	F_2^{tu}
Fill Tension Modulus	E_2^{t}
In-Plane Shear Strength at 5% strain	$F_{12}^{s5\%}$
In-Plane Shear Strength at 0.2% offset	$F_{12}^{s0.2\%}$
In-Plane Shear Peak Strength before 5% strain	F_{12}^{smax}
In-Plane Shear Modulus	G_{12}^{s}

Table 1-2: Test Property Symbols

Environmental Condition	Abbreviation	Temperature
Cold Temperature Dry	CTD	−65°F
Room Temperature Dry	RTD	70°F
Elevated Temperature Dry	ETD1	180°F
Elevated Temperature Dry	ETD2	250°F
Elevated Temperature Wet	ETW1	180°F
Elevated Temperature Wet	ETW2	250°F

Table 1-3: Environmental Conditions Abbreviations

Tests with a number immediately after the abbreviation indicate the lay-up:

1 refers to a 25/50/25 layup. This is also referred to as "Quasi-Isotropic"
2 refers to a 10/80/10 layup. This is also referred to as “Soft”
3 refers to a 40/20/40 layup. This is also referred to as “Hard”

EX: OHT1 is an open hole tension test with a 25/50/25 layup

Detailed information about the test methods and conditions used is given in NCAMP Test Report CAM-RP-2012-017 N/C.

1.2 Pooling Across Environments

When pooling across environments was allowable, the pooled co-efficient of variation was used. ASAP (**A**GATE **S**tatistical **A**nalysis **P**rogram) 2008 version 1.0 was used to determine if pooling was allowable and to compute the pooled coefficient of variation for those tests. In these cases, the modified coefficient of variation based on the pooled data was used to compute the basis values.

When pooling across environments was not advisable because the data was not eligible for pooling and engineering judgment indicated there was no justification for overriding the result, then B-Basis values were computed for each environmental condition separately using Stat-17 version 5.

1.3 Basis Value Computational Process

The general form to compute engineering basis values is: $\text{basis value} = \overline{X} - kS$ where k is a factor based on the sample size and the distribution of the sample data. There are many different methods to determine the value of k in this equation, depending on the sample size and the distribution of the data. In addition, the computational formula used for the standard deviation, S, may vary depending on the distribution of the data. The details of those different computations and when each should be used are in section 2.0.

1.4 Modified Coefficient of Variation (CV) Method

A common problem with new material qualifications is that the initial specimens produced and tested do not contain all of the variability that will be encountered when the material is being produced in larger amounts over a lengthy period of time. This can result in setting basis values that are unrealistically high. The variability as measured in the qualification program is often lower than the actual material variability because of several reasons. The materials used in the qualification programs are usually manufactured within a short period of time, typically 2-3 weeks only, which is not representative of the production material. Some raw ingredients that are used to manufacture the multi-batch qualification materials may actually be from the same production batches or manufactured within a short period of time so the qualification materials, although regarded as multiple batches, may not truly be multiple batches so they are not representative of the actual production material variability.

The modified Coefficient of Variation (CV) used in this report is in accordance with section 8.4.4 of CMH-17 Rev G. It is a method of adjusting the original basis values downward in anticipation of the expected additional variation. Composite materials are expected to have a CV of at least 6%. The modified coefficient of variation (CV) method increases the measured coefficient of variation when it is below 8% prior to computing basis values. A higher CV will result in lower or more conservative basis values and lower specification limits. The use of the modified CV method is intended for a temporary period of time when there is minimal data available. When a sufficient number of production batches (approximately 8 to 15) have been produced and tested, the as-measured CV may be used so that the basis values and specification limits may be adjusted higher.

The material allowables in this report are calculated using both the as-measured CV and modified CV, so users have the choice of using either one. When the measured CV is greater than 8%, the modified CV method does not change the basis value. NCAMP recommended values make use of the modified CV method when it is appropriate for the data.

When the data fails the Anderson-Darling K-sample test for batch to batch variability or when the data fails the normality test, the modified CV method is not appropriate and no modified CV basis value will be provided. When the ANOVA method is used, it may produce excessively conservative basis values. When appropriate, a single batch or two batch estimate may be provided in addition to the ANOVA estimate.

In some cases a transformation of the data to fit the assumption of the modified CV resulted in the transformed data passing the ADK test and thus the data can be pooled only for the modified CV method.

NCAMP recommends that if a user decides to use the basis values that are calculated from as-measured CV, the specification limits and control limits be calculated with as-measured CV also. Similarly, if a user decides to use the basis values that are calculated from modified CV, the specification limits and control limits be calculated with modified CV also. This will ensure that the link between material allowables, specification limits, and control limits is maintained.

2. Background

Statistical computations are performed with AGATE Statistical Analysis Program (ASAP) when pooling across environments is permissible according to CMH-17 Rev G guidelines. If pooling is not permissible, a single point analysis using STAT-17 is performed for each environmental condition with sufficient test results. If the data does not meet CMH-17 Rev G requirements for a single point analysis, estimates are created by a variety of methods depending on which is most appropriate for the dataset available. Specific procedures used are presented in the individual sections where the data is presented.

2.1 ASAP Statistical Formulas and Computations

This section contains the details of the specific formulas ASAP uses in its computations.

2.1.1 Basic Descriptive Statistics

The basic descriptive statistics shown are computed according to the usual formulas, which are shown below:

Mean: $$\bar{X} = \sum_{i=1}^{n} \frac{X_i}{n}$$ **Equation 1**

Std. Dev.: $$S = \sqrt{\tfrac{1}{n-1} \sum_{i=1}^{n} \left(X_i - \bar{X} \right)^2}$$ **Equation 2**

% Co. Variation: $$\frac{S}{\bar{X}} \times 100$$ **Equation 3**

Where n refers to the number of specimens in the sample and X_i refers to the individual specimen measurements.

2.1.2 Statistics for Pooled Data

Prior to computing statistics for the pooled dataset, the data is normalized to a mean of one by dividing each value by the mean of all the data for that condition. This transformation does not affect the coefficients of variation for the individual conditions.

2.1.2.1 Pooled Standard Deviation

The formula to compute a pooled standard deviation is given below:

Pooled Std. Dev.: $$S_p = \sqrt{\frac{\sum_{i=1}^{k} (n_i - 1) S_i^2}{\sum_{i=1}^{k} (n_i - 1)}}$$ **Equation 4**

Where *k* refers to the number of batches, S_i indicates the standard deviation of i^{th} sample, and n_i refers to the number of specimens in the i^{th} sample.

2.1.2.2 Pooled Coefficient of Variation

Since the mean for the normalized data is 1.0 for each condition, the pooled normalized data also has a mean of one. The coefficient of variation for the pooled normalized data is the pooled standard deviation divided by the pooled mean, as in equation 3. Since the mean for the pooled normalized data is one, the pooled coefficient of variation is equal to the pooled standard deviation of the normalized data.

$$\textbf{Pooled Coefficient of Variation} = \frac{S_p}{1} = S_p \qquad \textbf{Equation 5}$$

2.1.3 Basis Value Computations

Basis values are computed using the mean and standard deviation for that environment, as follows: The mean is always the mean for the environment, but if the data meets all requirements for pooling, S_p can be used in place of the standard deviation for the environment, S.

$$\textbf{Basis Values:} \quad \begin{aligned} A-basis &= \bar{X} - K_a S \\ B-basis &= \bar{X} - K_b S \end{aligned} \qquad \textbf{Equation 6}$$

2.1.3.1 K-factor computations

K_a and K_b are computed according to the methodology documented in section 8.3.5 of CMH-17 Rev G. The approximation formulas are given below:

$$K_a = \frac{2.3263}{\sqrt{q(f)}} + \sqrt{\frac{1}{c_A(f)\cdot n_j} + \left(\frac{b_A(f)}{2c_A(f)}\right)^2} - \frac{b_A(f)}{2c_A(f)} \qquad \textbf{Equation 7}$$

$$K_b = \frac{1.2816}{\sqrt{q(f)}} + \sqrt{\frac{1}{c_B(f)\cdot n_j} + \left(\frac{b_B(f)}{2c_B(f)}\right)^2} - \frac{b_B(f)}{2c_B(f)} \qquad \textbf{Equation 8}$$

Where

r = the number of environments being pooled together

n_j= number of data values for environment j

$$N = \sum_{j=1}^{r} n_j$$

$$f = N - r$$

$$q(f) = 1 - \frac{2.323}{\sqrt{f}} + \frac{1.064}{f} + \frac{0.9157}{f\sqrt{f}} - \frac{0.6530}{f^2} \qquad \textbf{Equation 9}$$

$$b_B(f) = \frac{1.1372}{\sqrt{f}} - \frac{0.49162}{f} + \frac{0.18612}{f\sqrt{f}}$$ **Equation 10**

$$c_B(f) = 0.36961 + \frac{0.0040342}{\sqrt{f}} - \frac{0.71750}{f} + \frac{0.19693}{f\sqrt{f}}$$ **Equation 11**

$$b_A(f) = \frac{2.0643}{\sqrt{f}} - \frac{0.95145}{f} + \frac{0.51251}{f\sqrt{f}}$$ **Equation 12**

$$c_A(f) = 0.36961 + \frac{0.0026958}{\sqrt{f}} - \frac{0.65201}{f} + \frac{0.011320}{f\sqrt{f}}$$ **Equation 13**

2.1.4 Modified Coefficient of Variation

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

Modified CV = $$CV^* = \begin{cases} .06 & if\ CV < .04 \\ \frac{CV}{2} + .04 & if\ .04 \le CV < .08 \\ CV & if\ CV \ge .08 \end{cases}$$ **Equation 14**

This is converted to percent by multiplying by 100%.

CV^* is used to compute a modified standard deviation S^*.

$$S^* = CV^* \cdot \overline{X}$$ **Equation 15**

To compute the pooled standard deviation based on the modified CV:

$$S_p^* = \sqrt{\frac{\sum_{i=1}^{k}\left((n_i - 1)\left(CV_i^* \cdot \overline{X}_i\right)^2\right)}{\sum_{i=1}^{k}(n_i - 1)}}$$ **Equation 16**

The A-basis and B-basis values under the assumption of the modified CV method are computed by replacing S with S^*

2.1.4.1 Transformation of data based on Modified CV

In order to determine if the data would pass the diagnostic tests under the assumption of the modified CV, the data must be transformed such that the batch means remain the same while the standard deviation of transformed data (all batches) matches the modified standard deviation.

To accomplish this requires a transformation in two steps:

Step 1: Apply the modified CV rules to each batch and compute the modified standard deviation $S_i^* = CV^* \cdot \bar{X}_i$ for each batch. Transform the individual data values (X_{ij}) in each batch as follows:

$$X'_{ij} = C_i\left(X_{ij} - \bar{X}_i\right) + \bar{X}_i$$ **Equation 17**

$$C_i = \frac{S_i^*}{S_i}$$ **Equation 18**

Run the Anderson-Darling k-sample test for batch equivalence (see section 2.1.6) on the transformed data. If it passes, proceed to step 2. If not, stop. The data cannot be pooled.

Step 2: Another transformation is needed as applying the modified CV to each batch leads to a larger CV for the combined data than when applying the modified CV rules to the combined data (due to the addition of between batch variation when combining data from multiple batches). In order to alter the data to match S^*, the transformed data is transformed again, this time setting using the same value of C′ for all batches.

$$X''_{ij} = C'\left(X'_{ij} - \bar{X}_i\right) + \bar{X}_i$$ **Equation 19**

$$C' = \sqrt{\frac{SSE^*}{SSE'}}$$ **Equation 20**

$$SSE^* = (n-1)\left(CV^* \cdot \bar{X}\right)^2 - \sum_{i=1}^{k} n_i\left(\bar{X}_i - \bar{X}\right)^2$$ **Equation 21**

$$SSE' = \sum_{i=1}^{k}\sum_{j=1}^{n_i}\left(X'_{ij} - \bar{X}_i\right)^2$$ **Equation 22**

Once this second transformation has been completed, the k-sample Anderson Darling test for batch equivalence can be run on the transformed data to determine if the modified co-efficient of variation will permit pooling of the data.

2.1.5 Determination of Outliers

All outliers are identified in text and graphics. If an outlier is removed from the dataset, it will be specified and the reason why will be documented in the text. Outliers are identified using the Maximum Normed Residual Test for Outliers as specified in section 8.3.3 of CMH-17 Rev G.

$$MNR = \frac{\max\limits_{all\ i}\left|X_i - \bar{X}\right|}{S}, i = 1 \ldots n$$ **Equation 23**

$$C = \frac{n-1}{\sqrt{n}}\sqrt{\frac{t^2}{n-2+t^2}}$$ **Equation 24**

where t is the $1-\frac{.05}{2n}$ quartile of a t distribution with n−2 degrees of freedom, n being the total number of data values.

If MNR > C, then the X_i associated with the MNR is considered to be an outlier. If an outlier exists, then the X_i associated with the MNR is dropped from the dataset and the MNR procedure is applied again. This process is repeated until no outliers are detected. Additional information on this procedure can be found in references 1 and 2.

2.1.6 The k-Sample Anderson Darling Test for Batch Equivalency

The k-sample Anderson-Darling test is a nonparametric statistical procedure that tests the hypothesis that the populations from which two or more groups of data were drawn are identical. The distinct values in the combined data set are ordered from smallest to largest, denoted $z_{(1)}$, $z_{(2)}$,… $z_{(L)}$, where L will be less than n if there are tied observations. These rankings are used to compute the test statistic.

The k-sample Anderson-Darling test statistic is:

$$ADK = \frac{n-1}{n^2(k-1)} \sum_{i=1}^{k} \left[\frac{1}{n_i} \sum_{j=1}^{L} h_j \frac{\left(nF_{ij} - n_i H_j\right)^2}{H_j\left(n - H_j\right) - \frac{nh_j}{4}} \right]$$

Equation 25

Where

n_i = the number of test specimens in each batch
$n = n_1+n_2+\ldots+n_k$
h_j = the number of values in the combined samples equal to $z_{(j)}$
H_j = the number of values in the combined samples less than $z_{(j)}$ plus ½ the number of values in the combined samples equal to $z_{(j)}$
F_{ij} = the number of values in the i^{th} group which are less than $z_{(j)}$ plus ½ the number of values in this group which are equal to $z_{(j)}$.

The critical value for the test statistic at 1−α level is computed:

$$ADC = 1 + \sigma_n \left[z_\alpha + \frac{0.678}{\sqrt{k-1}} - \frac{0.362}{k-1} \right]$$

Equation 26

This formula is based on the formula in reference 3 at the end of section 5, using a Taylor's expansion to estimate the critical value via the normal distribution rather than using the t distribution with k-1 degrees of freedom.

$$\sigma_n^2 = VAR(ADK) = \frac{an^3 + bn^2 + cn + d}{(n-1)(n-2)(n-3)(k-1)^2}$$

Equation 27

With

$$a = (4g-6)(k-1) + (10-6g)S$$
$$b = (2g-4)k^2 + 8Tk + (2g-14T-4)S - 8T + 4g - 6$$
$$c = (6T+2g-2)k^2 + (4T-4g+6)k + (2T-6)S + 4T$$
$$d = (2T+6)k^2 - 4Tk$$
$$S = \sum_{i=1}^{k} \frac{1}{n_i}$$
$$T = \sum_{i=1}^{n-1} \frac{1}{i}$$
$$g = \sum_{i=1}^{n-2} \sum_{j=i+1}^{n-1} \frac{1}{(n-i)j}$$

The data is considered to have failed this test (i.e. the batches are not from the same population) when the test statistic is greater than the critical value. For more information on this procedure, see reference 3.

2.1.7 The Anderson Darling Test for Normality

Normal Distribution: A two parameter (μ, σ) family of probability distributions for which the probability that an observation will fall between *a* and *b* is given by the area under the curve between a and b:

$$F(x) = \int_a^b \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} dx$$ **Equation 28**

A normal distribution with parameters (μ, σ) has population mean μ and variance σ^2.

The normal distribution is considered by comparing the cumulative normal distribution function that best fits the data with the cumulative distribution function of the data. Let

$$z_{(i)} = \frac{x_{(i)} - \overline{x}}{s}, \quad \text{for i = 1,…,n}$$ **Equation 29**

where $x_{(i)}$ is the smallest sample observation, $\overline{x}$ is the sample average, and s is the sample standard deviation.

The Anderson Darling test statistic (AD) is:

$$AD = \sum_{i=1}^{n} \frac{1-2i}{n} \left\{ \ln\left[F_0(z_{(i)})\right] + \ln\left[1 - F_0\left(z_{(n+1-i)}\right)\right] \right\} - n$$ **Equation 30**

Where F_0 is the standard normal distribution function. The observed significance level (OSL) is

$$OSL = \frac{1}{1 + e^{-0.48+0.78\ln(AD^*)+4.58AD^*}}, \quad AD^* = \left(1 + \frac{0.2}{\sqrt{n}}\right) AD$$ **Equation 31**

This OSL measures the probability of observing an Anderson-Darling statistic at least as extreme as the value calculated if, in fact, the data are a sample from a normal population. If OSL > 0.05, the data is considered sufficiently close to a normal distribution.

2.1.8 Levene's Test for Equality of Coefficient of Variation

Levene's test performs an Analysis of Variance on the absolute deviations from their sample medians. The absolute value of the deviation from the median is computed for each data value. $w_{ij} = \left| y_{ij} - \tilde{y}_i \right|$ An F-test is then performed on the transformed data values as follows:

$$F = \frac{\sum_{i=1}^{k} n_i \left(\overline{w}_i - \overline{w} \right)^2 / (k-1)}{\sum_{i=1}^{k} \sum_{j=1}^{n_i} {}_i \left(w_{ij} - \overline{w}_i \right)^2 / (n-k)}$$

Equation 32

If this computed F statistic is less than the critical value for the F-distribution having k-1 numerator and n-k denominator degrees of freedom at the 1-α level of confidence, then the data is not rejected as being too different in terms of the co-efficient of variation. ASAP provides the appropriate critical values for F at α levels of 0.10, 0.05, 0.025, and 0.01. For more information on this procedure, see references 4, and 5.

2.2 STAT-17

This section contains the details of the specific formulas STAT-17 uses in its computations.

The basic descriptive statistics, the maximum normed residual (MNR) test for outliers, and the Anderson Darling K-sample test for batch variability are the same as with ASAP – see sections 2.1.1, 2.1.3.1, and 2.1.5.

Outliers must be dispositioned before checking any other test results. The results of the Anderson Darling k-Sample (ADK) Test for batch equivalency must be checked. If the data passes the ADK test, then the appropriate distribution is determined. If it does not pass the ADK test, then the ANOVA procedure is the only approach remaining that will result in basis values that meet the requirements of CMH-17 Rev G.

2.2.1 Distribution Tests

In addition to testing for normality using the Anderson-Darling test (see 2.1.7); Stat17 also tests to see if the Weibull or Lognormal distribution is a good fit for the data.

Each distribution is considered using the Anderson-Darling test statistic which is sensitive to discrepancies in the tail regions. The Anderson-Darling test compares the cumulative distribution function for the distribution of interest with the cumulative distribution function of the data.

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-values 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.

The exact computation of k_B values is $1/\sqrt{n}$ times the 0.95th quantile of the noncentral t-distribution with noncentrality parameter $1.282\sqrt{n}$ and $n-1$ degrees of freedom. Since this in not a calculation that Excel can handle, the following approximation to the k_B values is used:

$$k_B \approx 1.282 + \exp\{0.958 - 0.520\ln(n) + 3.19/n\}$$ **Equation 33**

This approximation is accurate to within 0.2% of the tabulated values for sample sizes greater than or equal to 16.

2.2.2.2 One-sided A-basis tolerance factors, k_A, for the normal distribution

The exact computation of k_B values is $1/\sqrt{n}$ times the 0.95th quantile of the noncentral t-distribution with noncentrality parameter $2.326\sqrt{n}$ and $n - 1$ degrees of freedom (Reference 11). Since this is not a calculation that Excel can handle easily, the following approximation to the k_B values is used:

$$k_A \approx 2.326 + \exp\{1.34 - 0.522\ln(n) + 3.87/n\}$$ **Equation 34**

This approximation is accurate to within 0.2% of the tabulated values for sample sizes greater than or equal to 16.

2.2.2.3 Two-parameter Weibull Distribution

A probability distribution for which the probability that a randomly selected observation from this population lies between *a* and *b* $(0 < a < b < \infty)$ is given by

$$e^{-(a/\alpha)^{\beta}} - e^{-(b/\alpha)^{\beta}}$$ **Equation 35**

where α is called the scale parameter and β is called the shape parameter.

In order to compute a check of the fit of a data set to the Weibull distribution and compute basis values assuming Weibull, it is first necessary to obtain estimates of the population shape and scale parameters (Section 2.2.2.3.1). Calculations specific to the goodness-of-fit test for the Weibull distribution are provided in section 2.2.2.3.2.

2.2.2.3.1 Estimating Weibull Parameters

This section describes the *maximum likelihood* method for estimating the parameters of the two-parameter Weibull distribution. The maximum-likelihood estimates of the shape and scale parameters are denoted $\hat{\beta}$ and $\hat{\alpha}$. The estimates are the solution to the pair of equations:

$$\hat{\alpha}\hat{\beta}\mathrm{n} - \frac{\hat{\beta}}{\hat{\alpha}^{\hat{\beta}-1}}\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{x}_{\mathrm{i}}^{\hat{\beta}} = 0$$ **Equation 36**

$$\frac{n}{\hat{\beta}} - n\ln\hat{\alpha} + \sum_{i=1}^{n}\ln x_i - \sum_{i=1}^{n}\left[\frac{x_i}{\hat{\alpha}}\right]^{\hat{\beta}}\left(\ln x_i - \ln\hat{\alpha}\right) = 0$$ **Equation 37**

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

$$z_{(i)} = \left[x_{(i)}/\hat{\alpha}\right]^{\hat{\beta}}, \quad \text{for } i = 1, \ldots, n \qquad \textbf{Equation 38}$$

The Anderson-Darling test statistic is

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

and the observed significance level is

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

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

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

where

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

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

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

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.

$$V_B \approx 3.803+\exp\left[1.79-0.516\ln(n)+\frac{5.1}{n-1}\right] \qquad \textbf{Equation 45}$$

$$V_A \approx 6.649 + \exp\left[2.55 - 0.526\ln(n) + \frac{4.76}{n}\right]$$ **Equation 46**

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

Weibull Dist. K Factors for N<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
15	5.875	10.861

Table 2-2: Weibull Distribution Basis Value Factors

2.2.2.4 Lognormal Distribution

A probability distribution for which the probability that an observation selected at random from this population falls between a and b $\left(0 < a < b < \infty\right)$ is given by the area under the normal distribution between ln(a) and ln(b).

The lognormal distribution is a positively skewed distribution that is simply related to the normal distribution. If something is lognormally distributed, then its logarithm is normally distributed. The natural (base e) logarithm is used.

2.2.2.4.1 Goodness-of-fit test for the Lognormal distribution

In order to test the goodness-of-fit of the lognormal distribution, take the logarithm of the data and perform the Anderson-Darling test for normality from Section 2.1.7. Using the natural logarithm, replace the linked equation above with linked equation below:

$$z_{(i)} = \frac{\ln\left(x_{(i)}\right) - \bar{x}_L}{s_L}, \quad \text{for } i = 1, \ldots, n$$ **Equation 47**

where $x_{(i)}$ is the i^{th} smallest sample observation, $\bar{x}_L$ and s_L are the mean and standard deviation of the $\ln(x_i)$ values.

The Anderson-Darling statistic is then computed using the linked equation above and the observed significance level (OSL) is computed using the linked equation above . This OSL measures the probability of observing an Anderson-Darling statistic at least as extreme as the value calculated if in fact the data are a sample from a lognormal distribution. If OSL ≤ 0.05, one may conclude (at a five percent risk of being in error) that the population is not lognormally distributed. Otherwise, the hypothesis that the population is lognormally distributed is not rejected. For further information on these procedures, see reference 6.

2.2.2.4.2 Basis value calculations for the Lognormal distribution

If the data set is assumed to be from a population with a lognormal distribution, basis values are calculated using the equation above in section 2.1.3. However, the calculations are performed using the logarithms of the data rather than the original observations. The computed basis values are then transformed back to the original units by applying the inverse of the log transformation.

2.2.3 Non-parametric Basis Values

Non-parametric techniques do not assume any particularly underlying distribution for the population the sample comes from. It does require that the batches be similar enough to be grouped together, so the ADK test must have a positive result. While it can be used instead of assuming the normal, lognormal or Weibull distribution, it typically results in lower basis values. One of following two methods should be used, depending on the sample size.

2.2.3.1 Non-parametric Basis Values for large samples

The required sample sizes for this ranking method differ for A and B basis values. A sample size of at least 29 is needed for the B-basis value while a sample size of 299 is required for the A-basis.

To calculate a B-basis value for n > 28, the value of r is determined with the following formulas:

For B-basis values:

$$r_B = \frac{n}{10} - 1.645\sqrt{\frac{9n}{100}} + 0.23$$ **Equation 48**

For A-Basis values:

$$r_A = \frac{n}{100} - 1.645\sqrt{\frac{99n}{10,000}} + 0.29 + \frac{19.1}{n}$$ **Equation 49**

The formula for the A-basis values should be rounded to the nearest integer. This approximation is exact for most values and for a small percentage of values (less than 0.2%), the approximation errs by one rank on the conservative side.

The B-basis value is the r_B^{th} lowest observation in the data set, while the A-basis values are the r_A^{th} lowest observation in the data set. For example, in a sample of size n = 30, the lowest (r = 1) observation is the B-basis value. Further information on this procedure may be found in reference 7.

2.2.3.2 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 sample from a population for which the logarithm of the cumulative distribution function is concave, an assumption satisfied by a large class of probability distributions. There is substantial empirical evidence that suggests that composite strength data satisfies this assumption.

The Hanson-Koopmans B-basis value is:

$$B = x_{(r)} \left[\frac{x_{(1)}}{x_{(r)}} \right]^k \qquad \textbf{Equation 50}$$

The A-basis value is:

$$A = x_{(n)} \left[\frac{x_{(1)}}{x_{(n)}} \right]^k \qquad \textbf{Equation 51}$$

where $x_{(n)}$ is the largest data value, $x_{(1)}$ is the smallest, and $x_{(r)}$ is the r^{th} largest data value. The values of r and k depend on n and are listed in Table 2-3. This method is not used for the B-basis value when $x_{(r)} = x_{(1)}$.

The Hanson-Koopmans method can be used to calculate A-basis values for n less than 299. Find the value k_A corresponding to the sample size n in Table 2-4. For an A-basis value that meets all the requirements of CMH-17 Rev G, there must be at least five batches represented in the data and at least 55 data points. For a B-basis value, there must be at least three batches represented in the data and at least 18 data points.

B-Basis Hanson-Koopmans Table		
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
28	12	1.010

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

A-Basis Hanson-Koopmans Table					
n	k	n	k	n	k
2	80.00380	38	1.79301	96	1.32324
3	16.91220	39	1.77546	98	1.31553
4	9.49579	40	1.75868	100	1.30806
5	6.89049	41	1.74260	105	1.29036
6	5.57681	42	1.72718	110	1.27392
7	4.78352	43	1.71239	115	1.25859
8	4.25011	44	1.69817	120	1.24425
9	3.86502	45	1.68449	125	1.23080
10	3.57267	46	1.67132	130	1.21814
11	3.34227	47	1.65862	135	1.20620
12	3.15540	48	1.64638	140	1.19491
13	3.00033	49	1.63456	145	1.18421
14	2.86924	50	1.62313	150	1.17406
15	2.75672	52	1.60139	155	1.16440
16	2.65889	54	1.58101	160	1.15519
17	2.57290	56	1.56184	165	1.14640
18	2.49660	58	1.54377	170	1.13801
19	2.42833	60	1.52670	175	1.12997
20	2.36683	62	1.51053	180	1.12226
21	2.31106	64	1.49520	185	1.11486
22	2.26020	66	1.48063	190	1.10776
23	2.21359	68	1.46675	195	1.10092
24	2.17067	70	1.45352	200	1.09434
25	2.13100	72	1.44089	205	1.08799
26	2.09419	74	1.42881	210	1.08187
27	2.05991	76	1.41724	215	1.07595
28	2.02790	78	1.40614	220	1.07024
29	1.99791	80	1.39549	225	1.06471
30	1.96975	82	1.38525	230	1.05935
31	1.94324	84	1.37541	235	1.05417
32	1.91822	86	1.36592	240	1.04914
33	1.89457	88	1.35678	245	1.04426
34	1.87215	90	1.34796	250	1.03952
35	1.85088	92	1.33944	275	1.01773
36	1.83065	94	1.33120	299	1.00000
37	1.81139				

Table 2-4: A-Basis Hanson-Koopmans Table

2.2.4 Analysis of Variance (ANOVA) Basis Values

ANOVA is used to compute basis values when the batch to batch variability of the data does not pass the ADK test. Since ANOVA makes the assumption that the different batches have equal variances, the data is checked to make sure the assumption is valid. Levene's test for equality of variance is used (see section 2.1.8). If the dataset fails Levene's test, the basis values computed are likely to be conservative. Thus this method can still be used but the values produced will be listed as estimates.

2.2.4.1 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 $\left(n_i, \overline{x}_i, s_i^2\right)$ 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:

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

$$SST = \sum_{i=1}^{k} \sum_{j=1}^{n_i} x_{ij}^2 - n\overline{x}^2 \qquad \textbf{Equation 53}$$

The within-batch, or error, sum of squares (SSE) is computed by subtraction

$$SSE = SST - SSB \qquad \textbf{Equation 54}$$

Next, the mean sums of squares are computed:

$$MSB = \frac{SSB}{k-1} \qquad \textbf{Equation 55}$$

$$MSE = \frac{SSE}{n-k} \qquad \textbf{Equation 56}$$

Since the batches need not have equal numbers of specimens, an 'effective batch size,' is defined as

$$n' = \frac{n - \frac{1}{n}\sum_{i=1}^{k} n_i^2}{k-1} \qquad \textbf{Equation 57}$$

Using the two mean squares and the effective batch size, an estimate of the population standard deviation is computed:

$$S = \sqrt{\frac{MSB}{n'} + \left(\frac{n'-1}{n'}\right)MSE} \qquad \textbf{Equation 58}$$

Two k-factors are computed using the methodology of section 2.2.2 using a sample size of n (denoted k_0) and a sample size of k (denoted k_1). Whether this value is an A- or B-basis value depends only on whether k_0 and k_1 are computed for A or B-basis values.

Denote the ratio of mean squares by

$$u = \frac{MSB}{MSE}$$ **Equation 59**

If u is less than one, it is set equal to one. The tolerance limit factor is

$$T = \frac{k_0 - \frac{k_1}{\sqrt{n'}} + \left(k_1 - k_0\right)\sqrt{\frac{u}{u+n'-1}}}{1-\frac{1}{\sqrt{n'}}}$$ **Equation 60**

The basis value is $\bar{x} - TS$.

The ANOVA method can produce extremely conservative basis values when a small number of batches are available. Therefore, when less than five (5) batches are available and the ANOVA method is used, the basis values produced will be listed as estimates.

2.3 Single Batch and Two Batch Estimates using Modified CV

This method has not been approved for use by the CMH-17 organization. Values computed in this manner are estimates only. It is used only when fewer than three batches are available and no valid B-basis value could be computed using any other method. The estimate is made using the mean of the data and setting the coefficient of variation to 8 percent if it was less than that. A modified standard deviation (S_{adj}) was computed by multiplying the mean by 0.08 and computing the A and B-basis values using this inflated value for the standard deviation.

Estimated B-Basis = $\bar{X} - k_b S_{adj} = \bar{X} - k_b \cdot 0.08 \cdot \bar{X}$ **Equation 61**

2.4 Lamina Variability Method (LVM)

This method has not been approved for use by the CMH-17 organization. Values computed in this manner are estimates only. It is used only when the sample size is less than 16 and no valid B-basis value could be computed using any other method. The prime assumption for applying the LVM is that the intrinsic strength variability of the laminate (small) dataset is no greater than the strength variability of the lamina (large) dataset. This assumption was tested and found to be reasonable for composite materials as documented by Tomblin and Seneviratne [12].

To compute the estimate, the coefficients of variation (CVs) of laminate data are paired with lamina CV's for the same loading condition and environmental condition. For example, the 0º compression lamina CV CTD condition is used with open hole compression CTD condition. Bearing and in-plane shear laminate CV's are paired with 0º compression lamina CV's. 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 = $\bar{X}_1 - K_{(N_1,N_2)} \cdot \bar{X}_1 \cdot \max\left(CV_1, CV_2\right)$ **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 = $\bar{X}_1 - K_{(N_1,N_2)} \cdot \bar{X}_1 \cdot Max\left(8\%, CV_1, CV_2\right)$ **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

	N1													
N1+N2-2	**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	2.340	2.295	2.260	2.231	2.207	2.187	0	0	0	0
13	2.787	2.574	2.450	2.367	2.308	2.263	2.227	2.198	2.174	2.154	2.137	0	0	0
14	2.761	2.547	2.423	2.341	2.281	2.236	2.200	2.171	2.147	2.126	2.109	2.093	0	0
15	2.738	2.525	2.401	2.318	2.258	2.212	2.176	2.147	2.123	2.102	2.084	2.069	2.056	0
16	2.719	2.505	2.381	2.298	2.238	2.192	2.156	2.126	2.102	2.081	2.063	2.048	2.034	2.022
17	2.701	2.488	2.364	2.280	2.220	2.174	2.138	2.108	2.083	2.062	2.045	2.029	2.015	2.003
18	2.686	2.473	2.348	2.265	2.204	2.158	2.122	2.092	2.067	2.046	2.028	2.012	1.999	1.986
19	2.673	2.459	2.335	2.251	2.191	2.144	2.108	2.078	2.053	2.032	2.013	1.998	1.984	1.971
20	2.661	2.447	2.323	2.239	2.178	2.132	2.095	2.065	2.040	2.019	2.000	1.984	1.970	1.958
21	2.650	2.437	2.312	2.228	2.167	2.121	2.084	2.053	2.028	2.007	1.988	1.972	1.958	1.946
22	2.640	2.427	2.302	2.218	2.157	2.110	2.073	2.043	2.018	1.996	1.978	1.962	1.947	1.935
23	2.631	2.418	2.293	2.209	2.148	2.101	2.064	2.033	2.008	1.987	1.968	1.952	1.938	1.925
24	2.623	2.410	2.285	2.201	2.139	2.092	2.055	2.025	1.999	1.978	1.959	1.943	1.928	1.916
25	2.616	2.402	2.277	2.193	2.132	2.085	2.047	2.017	1.991	1.969	1.951	1.934	1.920	1.907
26	2.609	2.396	2.270	2.186	2.125	2.078	2.040	2.009	1.984	1.962	1.943	1.927	1.912	1.900
27	2.602	2.389	2.264	2.180	2.118	2.071	2.033	2.003	1.977	1.955	1.936	1.920	1.905	1.892
28	2.597	2.383	2.258	2.174	2.112	2.065	2.027	1.996	1.971	1.949	1.930	1.913	1.899	1.886
29	2.591	2.378	2.252	2.168	2.106	2.059	2.021	1.990	1.965	1.943	1.924	1.907	1.893	1.880
30	2.586	2.373	2.247	2.163	2.101	2.054	2.016	1.985	1.959	1.937	1.918	1.901	1.887	1.874
40	2.550	2.337	2.211	2.126	2.063	2.015	1.977	1.946	1.919	1.897	1.877	1.860	1.845	1.832
50	2.528	2.315	2.189	2.104	2.041	1.993	1.954	1.922	1.896	1.873	1.853	1.836	1.820	1.807
60	2.514	2.301	2.175	2.089	2.026	1.978	1.939	1.907	1.880	1.857	1.837	1.819	1.804	1.790
70	2.504	2.291	2.164	2.079	2.016	1.967	1.928	1.896	1.869	1.846	1.825	1.808	1.792	1.778
80	2.496	2.283	2.157	2.071	2.008	1.959	1.920	1.887	1.860	1.837	1.817	1.799	1.783	1.769
90	2.491	2.277	2.151	2.065	2.002	1.953	1.913	1.881	1.854	1.830	1.810	1.792	1.776	1.762
100	2.486	2.273	2.146	2.060	1.997	1.948	1.908	1.876	1.849	1.825	1.805	1.787	1.771	1.757
125	2.478	2.264	2.138	2.051	1.988	1.939	1.899	1.867	1.839	1.816	1.795	1.777	1.761	1.747
150	2.472	2.259	2.132	2.046	1.982	1.933	1.893	1.861	1.833	1.809	1.789	1.770	1.754	1.740
175	2.468	2.255	2.128	2.042	1.978	1.929	1.889	1.856	1.828	1.805	1.784	1.766	1.750	1.735
200	2.465	2.252	2.125	2.039	1.975	1.925	1.886	1.853	1.825	1.801	1.781	1.762	1.746	1.732

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

3. Summary of Results

The basis values for all tests are summarized in the following tables. The NCAMP recommended B-basis values meet all requirements of CMH-17 Rev G. However, not all test data meets those requirements. The summary tables provide a complete listing of all computed basis values and estimates of basis values. Data that does not meet the requirements of CMH-17 Rev G are shown in shaded boxes and labeled as estimates. Basis values computed with the modified coefficient of variation (CV) are presented whenever possible. Basis values and estimates computed without that modification are presented for all tests.

3.1 NCAMP Recommended B-basis Values

The following rules are used in determining what B-basis value, if any, is included in tables Table 3-1and Table 3-2 of recommended values.

1. Recommended values are NEVER estimates. Only B-basis values that meet all requirements of CMH-17 Rev G are recommended.
2. Modified CV basis values are preferred. Recommended values will be the modified CV basis value when available. The CV provided with the recommended basis value will be the one used in the computation of the basis value.
3. Only normalized basis values are given for properties that are normalized.
4. ANOVA B-basis values are not recommended since only three batches of material are available and CMH-17 Rev G recommends that no less than five batches be used when computing basis values with the ANOVA method.
5. Basis values of 90% or more of the mean value imply that the CV is unusually low and may not be conservative. Caution is recommended with B-Basis values calculated using the single point method when the B-basis value is 90% or more of the average value. Such values will be indicated.
6. If the data appear questionable (e.g. when the CTD-RTD-ETW trend of the basis values are not consistent with the CTD-RTD-ETW trend of the average values), then the B-basis values will not be recommended.

NCAMP Recommended B-basis Values for
Cytec Cycom 5320-1 T650 3k-PW fabric with 36% RC

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 F)	B-basis	94.191	95.984	88.709	NA:A	11.424	10.437	17.060
	Mean	107.279	107.485	101.592	100.115	12.538	11.504	18.882
	CV	6.747	7.736	7.764	8.852	6.320	6.000	6.000
RTD (70 F)	B-basis	108.803	91.057	105.795	84.743	9.920	7.232	12.862
	Mean	121.838	102.675	118.678	98.149	11.035	8.299	14.650
	CV	6.185	7.049	6.098	8.954	6.000	6.000	6.000
ETW2 (250 F)	B-basis	NA:A	60.037	106.643	49.201	5.465	3.322	6.057
	Mean	129.354	71.411	119.526	62.660	6.580	3.760	6.915
	CV	5.469	7.468	6.160	12.064	8.103	6.119	6.369

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 B-basis value computed using the single point method is greater than 90% of the mean value.

Table 3-1 : NCAMP Recommended B-basis values for Lamina Test Data

NCAMP Recommended B-basis Values for Cytec Cycom 5320-1 T650 3k-PW fabric with 36% RC

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

Laminate Strength Tests

Lay-up	ENV	Statistic	OHT	OHC	FHT	FHC	UNT	UNC	SSB 2% Offset	SSB Ult.	SBS1*
25/50/25	CTD (-65 F)	B-basis	35.896		41.773		73.584				
		Mean	41.167		47.455		82.950				
		CV	6.568		7.099		6.178				
	RTD (70 F)	B-basis	NA:A	43.715	43.721	71.468	79.100	74.092	96.830	118.297	8.333
		Mean	43.645	48.077	49.512	79.638	88.466	82.242	108.922	131.495	11.955
		CV	7.657	6.000	6.578	6.849	6.454	6.397	6.474	6.131	8.967
	ETW2 (250 F)	B-basis	42.946	29.998	44.705	48.582	81.730	50.235	76.455	95.468	NA:A
		Mean	48.634	34.342	50.387	56.888	91.096	58.385	88.256	108.348	6.497
		CV	6.000	6.000	6.000	6.000	6.000	6.360	7.897	6.625	6.149
10/80/10	CTD (-65 F)	B-basis	NA:A		NA:A		53.217				
		Mean	43.644		47.804		59.011				
		CV	6.115		5.205		6.000				
	RTD (70 F)	B-basis	41.555	37.947	44.589	54.025	52.219	53.686	97.899	121.832	
		Mean	45.890	42.467	49.406	60.566	58.013	60.961	108.455	135.163	
		CV	6.000	6.000	6.008	6.000	6.000	7.013	6.152	6.268	
	ETW2 (250 F)	B-basis	29.793	27.598	32.818	34.895	44.269	33.355	71.605	93.629	
		Mean	34.069	30.886	37.636	39.191	50.064	37.875	82.161	106.960	
		CV	6.000	6.002	6.046	6.000	6.000	6.430	6.244	6.000	
40/20/40	CTD (-65 F)	B-basis	NA:A		NA:A		84.972				
		Mean	46.769		53.638		95.768				
		CV	7.329		6.222		6.000				
	RTD (70 F)	B-basis	43.367	45.391	48.530	69.850	93.595	77.809	93.757	112.601	
		Mean	49.920	50.104	55.324	80.727	104.345	86.426	103.771	125.470	
		CV	7.333	6.000	7.077	6.912	6.000	6.047	6.154	6.700	
	ETW2 (250 F)	B-basis	53.033	32.844	52.116	NA:I	100.785	57.361	65.990	85.634	
		Mean	59.524	37.556	58.910	58.213	111.535	65.912	76.045	98.555	
		CV	6.000	6.000	6.000	5.809	6.000	6.878	6.348	6.000	

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 3-2 : NCAMP Recommended B-basis values for Laminate Test Data

3.2 Lamina and Laminate Summary Tables

Prepreg Material: Cytec Cycom 5320-1 T650 3k-PW
Material Specification: NMS 532/6
Process Specification: NPS 85321 Baseline Cure Cycle C

Cytec Cycom 5320-1 T650 3k-PW Fabric Lamina Properties Summary Part I

Fabric: T650 3k PW **Resin:** Cycom 5230-1

Tg(dry): 374.80 °F **Tg(wet):** 318.62 °F **Tg METHOD:** ASTM D7028

Date of fiber manufacture	Dec-10	**Date of testing**	June 2011 to May 2012
Date of resin manufacture	Aug-10	**Date of data submitta**	Nov-12
Date of prepreg manufacture	Aug to Sept 2010	**Date of analysis**	Nov to Dec 2012
Date of composite manufacture	Oct to Nov 2010		

LAMINA MECHANICAL PROPERTY B-BASIS SUMMARY
Data reported: As-measured followed by normalized values in parentheses, normalizing tply: 0.0077 in
Values shown in shaded boxes do not meet CMH17 Rev G requirements and are estimates only
These values may not be used for certification unless specifically allowed by the certifying agency

	CTD			RTD			ETW2		
	B-Basis	Modified CV B-basis	Mean	B-Basis	Modified CV B-basis	Mean	B-Basis	Modified CV B-basis	Mean
F_1^{tu} (ksi)	99.045	96.033	109.757	88.346	109.807	124.900	73.320	114.249	132.201
	(80.917)	(94.191)	(107.279)	(89.797)	(108.803)	(121.838)	(82.581)	(112.919)	(129.354)
E_1^t (Msi)			10.095			9.990			9.955
			(9.865)			(9.738)			(9.741)
ν_{12}^t			0.060			0.053			0.049
F_2^{tu} (ksi)	91.626	90.012	103.151	110.285	108.672	121.810	98.505	108.922	122.061
	(90.146)	(88.709)	(101.592)	(107.233)	(105.795)	(118.678)	(98.561)	(106.643)	(119.526)
E_2^t (Msi)			9.919			9.931			9.719
			(9.770)			(9.678)			(9.519)
F_1^{cu} (ksi)	81.426	94.224	109.965	80.350	91.563	106.167	50.012	62.933	72.629
	(95.922)	(95.984)	(107.485)	(91.000)	(91.057)	(102.675)	(53.159)	(60.037)	(71.411)
E_1^c (Msi)			9.033			9.370			8.986
			(8.815)			(9.030)			(8.840)
F_2^{cu} (ksi)	66.823	88.558	101.710	87.700	87.162	100.365	50.825	50.283	63.541
	(62.276)	NA	(100.115)	(84.894)	(84.743)	(98.149)	(49.352)	(49.201)	(62.660)
E_2^c (Msi)			8.989			8.876			8.818
			(8.868)			(8.680)			(8.732)
$F_{12}^{s0.2\%}$ (ksi)	10.574	10.437	11.504	7.647	7.232	8.299	3.155	3.322	3.760
$F_{12}^{s5\%}$ (ksi)	14.651	17.060	18.882	12.495	12.862	14.650	6.277	6.057	6.915
G_{12}^s (Msi)			0.852			0.735			0.386
SBS (ksi)	11.430	11.424	12.538	9.300	9.920	11.035	5.564	5.465	6.580

Table 3-3: Summary of Test Results for Lamina Data Part I

Prepreg Material: Cytec Cycom 5320-1 T650 3k-PW **Material Specification:** NMS 532/6 **Process Specification:** NPS 85321 Baseline Cure Cycle C	**Cytec Cycom 5320-1 T650 3k-PW Fabric Lamina Properties Summary Part II**

Fabric: T650 3k PW **Resin:** Cycom 5230-1

Tg(dry): 374.80 °F **Tg(wet):** 318.62 °F **Tg METHOD:** ASTM D7028

Date of fiber manufacture	Dec-10	**Date of testing**	June 2011 to May 2012
Date of resin manufacture	Aug-10	**Date of data submitta**	Nov-12
Date of prepreg manufacture	Aug to Sept 2010	**Date of analysis**	Nov to Dec 2012
Date of composite manufacture	Oct to Nov 2010		

LAMINA MECHANICAL PROPERTY B-BASIS SUMMARY

Data reported: As-measured followed by normalized values in parentheses, normalizing tply: 0.0077 in

Values shown in shaded boxes do not meet CMH17 Rev G requirements and are estimates only

These values may not be used for certification unless specifically allowed by the certifying agency

	ETD1			ETD2			ETW1		
	B-Basis	Modified CV B-basis	Mean	B-Basis	Modified CV B-basis	Mean	B-Basis	Modified CV B-basis	Mean
F_1^{tu} (ksi)							117.816 (118.058)	100.172 (99.813)	**128.550 (128.089)**
E_1^t (Msi)									**10.051 (9.995)**
ν_{12}^t									**0.047**
F_2^{tu} (ksi)							111.133 (110.951)	108.808 (107.547)	**123.845 (122.292)**
E_2^t (Msi)									**10.212 (10.085)**
F_1^{cu} (ksi)	94.340 (91.293)	85.895 (91.314)	**106.896 (104.394)**	66.971 (71.994)	**NA** (72.012)	**88.027 (85.318)**	76.476 (77.986)	73.036 (78.007)	**90.894 (91.087)**
E_1^c (Msi)			**9.170 (8.974)**			**9.275 (8.972)**			**9.079 (8.955)**
F_2^{cu} (ksi)	84.761 (82.340)	84.100 (82.169)	**99.075 (97.320)**	73.119 (69.235)	72.458 (69.064)	**87.433 (84.215)**	66.244 (63.676)	65.512 (63.492)	**81.669 (79.819)**
E_2^c (Msi)			**8.896 (8.724)**			**8.987 (8.712)**			**8.923 (8.715)**
$F_{12}^{s0.2\%}$ (ksi)							5.107	4.251	**5.455**
$F_{12}^{s5\%}$ (ksi)							9.028	7.407	**9.506**
G_{12}^s (Msi)									**0.560**
SBS (ksi)	8.603	8.620	**9.898**	7.997	7.526	**8.805**	7.829	7.829	**9.107**

Table 3-4: Summary of Test Results for Lamina Data Part II

Prepreg Material: Cytec Cycom 5320-1 T650 3k-PW
Material Specification: NMS 532/6
Process Specification: NPS 85321 Baseline Cure Cycle C

Cytec Cycom 5320-1 T650 3k-PW Fabric Laminate Properties Summary

Fabric: T650 3k PW **Resin:** Cycom 5230-1
Tg(dry): 374.80 °F **Tg(wet):** 318.62 °F **Tg METHOD:** ASTM D7028

PROCESSING:

Date of fiber manufacture	Dec-10	**Date of testing**	June 2011 to May 2012
Date of resin manufacture	Aug-10	**Date of data submittal**	Nov-12
Date of prepreg manufacture	Aug to Sept 2010	**Date of analysis**	Nov to Dec 2012
Date of composite manufacture	Oct to Nov 2010		

LAMINATE MECHANICAL PROPERTY B-BASIS SUMMARY

Data reported as normalized used a normalizing t_{ply} of 0.0077 in

Values shown in shaded boxes do not meet CMH17 Rev G requirements and are estimates only

These values may not be used for certification unless specifically allowed by the certifying agency

Test	Property	Layup:		Quasi Isotropic 25/50/25			"Soft" 10/80/10			"Hard" 40/20/40		
		Test Condition	Unit	B-value	Mod. CV B-value	Mean	B-value	Mod. CV B-value	Mean	B-value	Mod. CV B-value	Mean
OHT (normalized)	Strength	CTD	ksi	28.802	35.896	41.167	25.811	37.563	43.644	28.975	39.692	46.769
		RTD	ksi	23.053	36.985	43.645	36.763	41.555	45.890	32.659	43.367	49.920
		ETW1	ksi	42.701	35.915	47.319	---	---	---	---	---	---
		ETW2	ksi	41.270	42.946	48.634	28.219	29.793	34.069	49.518	53.033	59.524
OHC (normalized)	Strength	RTD	ksi	42.576	43.715	48.077	40.406	37.947	42.467	47.348	45.391	50.104
		ETW1	ksi	40.036	36.088	40.963	---	---	---	---	---	---
		ETW2	ksi	31.948	29.998	34.342	25.111	27.598	30.886	34.801	32.844	37.556
UNT (normalized)	Strength	CTD	ksi	64.223	73.584	82.950	46.067	53.217	59.011	89.896	84.972	95.768
	Modulus		msi	---	---	7.113	---	---	4.868	---	---	8.832
	Strength	RTD	ksi	66.506	79.100	88.466	49.101	52.219	58.013	98.499	93.595	104.345
	Modulus		msi	---	---	6.936	---	---	4.602	---	---	8.622
	Strength	ETW1	ksi	84.513	80.646	91.366	---	---	---	---	---	---
	Modulus		msi	---	---	7.005	---	---	---	---	---	---
	Strength	ETW2	ksi	85.654	81.730	91.096	47.781	44.269	50.064	105.689	100.785	111.535
	Modulus		msi	---	---	6.640	---	---	3.888	---	---	8.603
UNC (normalized)	Strength	RTD	ksi	75.922	74.092	82.242	55.041	53.686	60.961	79.687	77.809	86.426
	Modulus		msi	---	---	6.413	---	---	4.390	---	---	7.919
	Strength	ETW1	ksi	63.646	61.562	70.843	---	---	---	---	---	---
	Modulus		msi	---	---	6.468	---	---	---	---	---	---
	Strength	ETW2	ksi	52.065	50.235	58.385	34.198	33.355	37.875	47.566	57.361	65.912
	Modulus		msi	---	---	6.246	---	---	3.767	---	---	7.873
SBS1 (as-measured)	Strength	RTD	ksi	8.333	NA	11.955	---	---	---	---	---	---
		ETW2	ksi	4.021	5.621	6.497	---	---	---	---	---	---
FHT (normalized)	Strength	CTD	ksi	41.649	41.773	47.455	31.524	41.573	47.804	35.408	46.108	53.638
		RTD	ksi	33.807	43.721	49.512	36.234	44.589	49.406	39.240	48.530	55.324
		ETW1	ksi	51.160	47.001	53.547	---	---	---	---	---	---
		ETW2	ksi	38.050	44.705	50.387	34.595	32.818	37.636	47.869	52.116	58.910
FHC (normalized)	Strength	RTD	ksi	54.998	71.468	79.638	56.693	54.025	60.566	57.743	69.850	80.727
		ETW1	ksi	61.628	58.862	68.059	---	---	---	---	---	---
		ETW2	ksi	52.330	48.582	56.888	36.648	34.895	39.191	50.719	49.325	58.213
Single Shear Bearing (normalized)	Initial Peak Strength	RTD	ksi	89.943	NA	98.781	---	---	---	86.486	83.873	97.371
		ETW2	ksi	---	---	---	---	---	---	41.644	52.826	61.896
	2% Offset Strength	RTD	ksi	98.326	96.830	108.922	100.994	97.899	108.455	96.619	93.757	103.771
		ETW1	ksi	96.039	94.364	107.898	---	---	---	---	---	---
		ETW2	ksi	77.916	76.455	88.256	74.700	71.605	82.161	68.863	65.990	76.045
	Ultimate Strength	RTD	ksi	121.973	118.297	131.495	125.886	121.832	135.163	112.690	112.601	125.470
		ETW1	ksi	118.400	114.285	129.057	---	---	---	---	---	---
		ETW2	ksi	99.056	95.468	108.348	97.682	93.629	106.960	92.068	85.634	98.555
CAI (normalized)	Strength	RTD	ksi	---	---	33.442	---	---	---	---	---	---
ILT (as-measured)	Strength	CTD	ksi	---	---	7.440	---	---	---	---	---	---
		RTD	ksi	---	---	5.070	---	---	---	---	---	---
		ETW2	ksi	---	---	4.018	---	---	---	---	---	---
CBS (as-measured)	Strength	CTD	lb	---	---	286.249	---	---	---	---	---	---
		RTD	lb	---	---	196.160	---	---	---	---	---	---
		ETW2	lb	---	---	154.594	---	---	---	---	---	---

Table 3-5: Summary of Test Results for Laminate Data

4. Individual Test Summaries, Statistics, Basis Values and Graphs

Test data for fiber dominated properties was normalized according to nominal cured ply thickness. Both normalized and as-measured statistics were included in the tables, but only the normalized data values were graphed. Test failures, outliers and explanations regarding computational choices were noted in the accompanying text for each test.

All individual specimen results are graphed for each test by batch and environmental condition with a line indicating the recommended basis values for each environmental condition. The data is jittered (moved slightly to the left or right) in order for all specimen values to be clearly visible. The strength values are always graphed on the vertical axis with the scale adjusted to include all data values and their corresponding basis values. The vertical axis may not include zero. The horizontal axis values will vary depending on the data and how much overlapping there was of the data within and between batches. When there was little variation, the batches were graphed from left to right. The environmental conditions were identified by the shape and color of the symbol used to plot the data. Otherwise, the environmental conditions were graphed from left to right and the batches were identified by the shape and color of the symbol.

When a dataset fails the Anderson-Darling k-sample (ADK) test for batch-to-batch variation, an ANOVA analysis is required. In order for B-basis values computed using the ANOVA method, data from five batches are required. Since this qualification dataset has only three batches, the basis values computed using ANOVA are considered estimates only. However, the basis values resulting from the ANOVA method using only three batches may be overly conservative. The ADK test is performed again after a transformation of the data according to the assumptions of the modified CV method (see section 2.1.4 for details). If the dataset still passes the ADK test at this point, modified CV basis values are provided. If the dataset does not pass the ADK test after the transformation, estimates may be computed using the modified CV method per the guidelines of CMH-17 Rev G section 8.3.10.

4.1 Warp Tension (WT)

The Warp Tension data is normalized, so both normalized and as-measured statistics are provided. The ETW1 condition had insufficient data to compute basis values, so only estimates are available for that condition. Both the normalized and the as-measured data from the RTD and ETW2 and the normalized CTD datasets failed the ADK test. Estimates of basis values were computed using the ANOVA method. The normalized CTD and RTD datasets passed the ADK tests with the use of the modified CV method. Pooling was acceptable for the normalized CTD and RTD conditions. The as measured RTD dataset and the normalized and as measured ETW2 datasets did not pass the ADK test even with the use of the modified CV method. Modified CV basis values are provided for those datasets but they are considered estimates due to the failure of the ADK test.

There was one outlier. The lowest value in batch three of the as measured data from the RTD condition was an outlier. It was an outlier only for the as measured data from batch three, not the RTD condition and not the normalized data. Statistics, estimates and basis values are given for strength data in Table 4-1 and for the modulus data in Table 4-2. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-1.

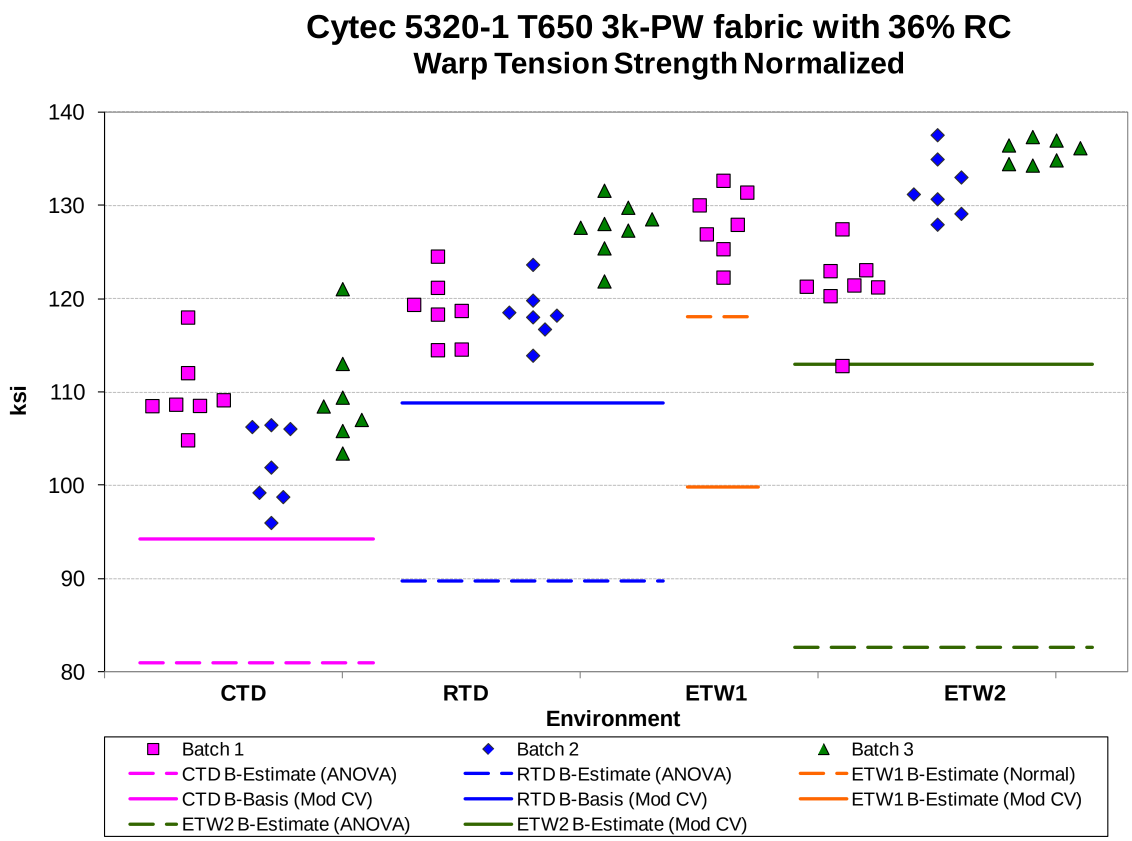

Figure 4-1: Batch plot for WT normalized strength

Warp Tension Strength Basis Values and Statistics								
	Normalized				As-measured			
Env	CTD	RTD	ETW1	ETW2	CTD	RTD	ETW1	ETW2
Mean	107.279	121.838	128.089	129.354	109.757	124.900	128.550	132.201
Stdev	5.894	5.325	3.613	7.075	5.623	6.009	3.866	8.454
CV	5.494	4.371	2.821	5.469	5.123	4.811	3.007	6.395
Mod CV	6.747	6.185	8.000	6.735	6.562	6.405	8.000	7.198
Min	95.993	113.921	122.294	112.814	99.615	114.962	121.907	114.768
Max	121.054	131.605	132.671	137.556	124.355	134.039	133.557	141.756
No. Batches	3	3	1	3	3	3	1	3
No. Spec.	21	22	7	22	21	22	7	22
Basis Values and/or Estimates								
B-basis Value					99.045			
B-Estimate	80.917	89.797	118.058	82.581		88.346	117.816	73.320
A-Estimate	62.101	66.919	111.001	49.186	91.409	62.246	110.265	31.279
Method	ANOVA	ANOVA	Normal	ANOVA	Normal	ANOVA	Normal	ANOVA
Modified CV Basis Values and/or Estimates								
B-basis Value	94.191	108.803			96.033			
B-Estimate			99.813	112.919		109.807	100.172	114.249
A-Estimate	85.206	99.806	80.455	101.186	86.258	99.032	80.745	101.434
Method	pooled	pooled	Normal	Normal	Normal	Normal	Normal	Normal

Table 4-1: Statistics and Basis values for WT Strength Data

Warp Tension Modulus Statistics								
	Normalized				As-measured			
Env	CTD	RTD	ETW1	ETW2	CTD	RTD	ETW1	ETW2
Mean	9.865	9.738	9.995	9.741	10.095	9.990	10.051	9.955
Stdev	0.158	0.104	0.073	0.139	0.131	0.110	0.048	0.101
CV	1.606	1.065	0.731	1.432	1.297	1.104	0.474	1.015
Mod CV	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
Min	9.551	9.547	9.864	9.499	9.876	9.771	10.001	9.753
Max	10.063	9.966	10.095	9.987	10.369	10.172	10.117	10.162
No. Batches	3	3	1	3	3	3	1	3
No. Spec.	21	22	9	24	21	22	9	24

Table 4-2: Statistics from WT Modulus Data

4.2 Fill Tension (FT)

The Fill Tension data is normalized, so both normalized and as-measured statistics are provided. The ETW1 condition had insufficient data to compute basis values, so only estimates are available for that condition. Both the normalized and the as-measured data from the ETW2 environmental condition failed the ADK test, but passed with the use of the modified CV method. B-estimates were computed using the ANOVA method. Pooling was acceptable for the CTD and RTD conditions. All environmental conditions could be pooled to compute modified CV basis values and estimates.

There was one outlier. The lowest value in batch one of the ETW2 normalized dataset was an outlier. It was an outlier only for batch one, not for the ETW2 condition. The same specimen was not an outlier for the as-measured dataset. It was retained for this analysis.

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

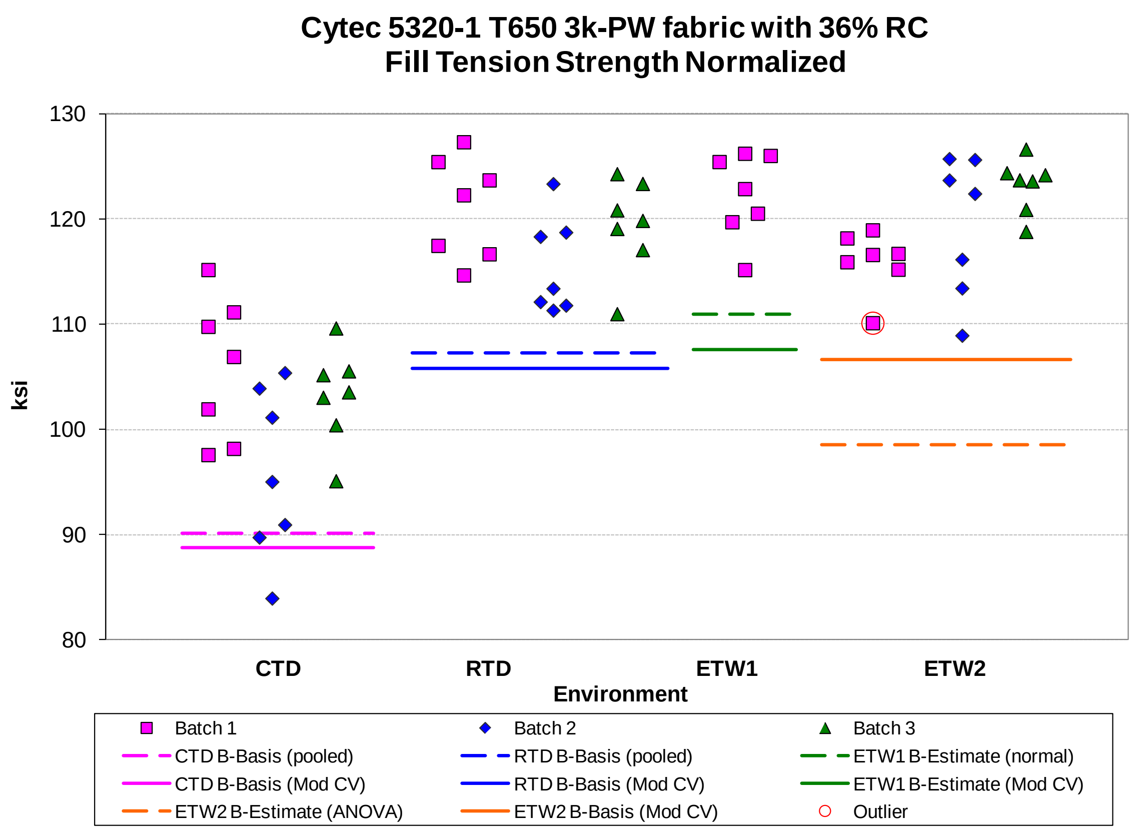

Figure 4-2: Batch Plot for FT normalized strength

Fill Tension Strength Basis Values and Statistics								
	Normalized				As-measured			
Env	CTD	RTD	ETW1	ETW2	CTD	RTD	ETW1	ETW2
Mean	101.592	118.678	122.292	119.526	103.151	121.810	123.845	122.061
Stdev	7.647	4.979	4.084	5.163	7.599	5.166	4.578	5.385
CV	7.527	4.196	3.340	4.320	7.367	4.241	3.697	4.412
Mod CV	7.764	6.098	6.000	6.160	7.683	6.121	6.000	6.206
Min	83.956	110.990	115.180	108.939	85.991	114.441	115.798	112.915
Max	115.184	127.331	126.238	126.636	116.751	130.979	128.762	130.017
No. Batches	3	3	1	3	3	3	1	3
No. Spec.	21	21	7	21	21	21	7	21
Basis Values and Estimates								
B-basis Value	90.146	107.233			91.626	110.285		
B-Estimate			110.951	98.561			111.133	98.505
A-Estimate	82.280	99.367	102.974	83.599	83.706	102.365	102.190	81.692
Method	pooled	pooled	Normal	ANOVA	pooled	pooled	Normal	ANOVA
Modified CV Basis Values and/or Estimates								
B-basis Value	88.709	105.795		106.643	90.012	108.672		108.922
B-Estimate			107.547				108.808	
A-Estimate	80.039	97.125	99.098	97.973	81.171	99.830	100.192	100.081
Method	pooled	pooled	pooled	pooled	pooled	pooled	pooled	pooled

Table 4-3: Statistics and Basis Values for FT Strength Data

Fill Tension Modulus Statistics								
	Normalized				As-measured			
Env	CTD	RTD	ETW1	ETW2	CTD	RTD	ETW1	ETW2
Mean	9.770	9.678	10.085	9.519	9.919	9.931	10.212	9.719
Stdev	0.311	0.304	0.098	0.315	0.256	0.255	0.137	0.281
CV	3.180	3.144	0.969	3.314	2.582	2.563	1.344	2.888
Mod CV	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
Min	9.288	9.187	9.969	9.070	9.553	9.463	10.001	9.318
Max	10.330	10.180	10.250	10.153	10.494	10.457	10.379	10.350
No. Batches	3	3	1	3	3	3	1	3
No. Spec.	21	22	7	21	21	22	7	21

Table 4-4: Statistics from FT Modulus Data

4.3 Warp Compression (WC)

The Warp Compression data is normalized, so both normalized and as-measured statistics are provided. The ETD1, ETD2 and ETW1 conditions had insufficient data to compute basis values, so only estimates are available for those conditions.

Both the normalized and the as-measured data from the ETW2 environmental condition and the as measured data from the CTD and RTD conditions failed the ADK test. B-estimates were computed using the ANOVA method. The as measured RTD dataset and the normalized ETW2 dataset passed with the use of the modified CV method, so modified CV B-basis values are provided for those two conditions. The as measured CTD and ETW2 datasets failed the ADK test even after the modified CV method was applied to the data. Estimates of the modified CV basis values are provided for the as-measured datasets from those two conditions, but they are considered estimates only due to the failure of the ADK test. No modified CV basis values are provided for the as measured ETD2 dataset because pooling was not available for the as measured data and the ETD2 dataset had a CV of greater than 8% which means that modified CV method would give results no different from the normal distribution estimate provided.

Pooling of the normalized data was acceptable with the ETW2 data excluded. Pooling the normalized data from all six conditions was acceptable for computing the modified CV basis values and estimates.

There were two outliers, both in the as-measured dataset only. The highest value in batch one of the as-measured CTD dataset and the lowest value in batch two of the RTD as-measured datasets were outliers for their respective batches, but not their respective conditions. Both outliers were retained for this analysis.

Statistics, basis values and estimates are given for strength data in Table 4-5 and for the modulus data in Table 4-6. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-3.

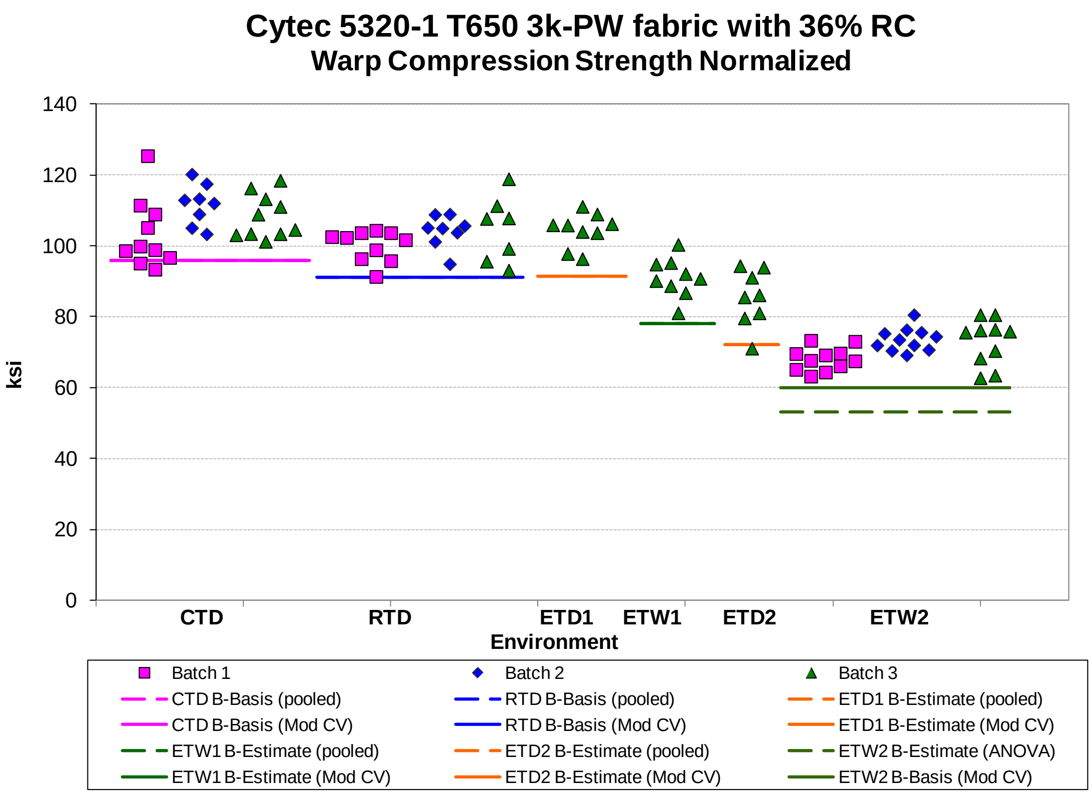

Figure 4-3: Batch plot for WC normalized strength

Warp Compression Strength Basis Values and Statistics												
	Normalized						As-measured					
Env	CTD	RTD	ETD1	ETW1	ETD2	ETW2	CTD	RTD	ETD1	ETW1	ETD2	ETW2
Mean	107.485	102.675	104.394	91.087	85.318	71.411	109.965	106.167	106.896	90.894	88.027	72.629
Stdev	8.031	6.262	4.770	5.522	7.964	4.953	8.708	7.396	5.089	5.844	8.101	5.227
CV	7.472	6.099	4.569	6.062	9.335	6.936	7.919	6.967	4.761	6.429	9.203	7.196
Mod CV	7.736	7.049	6.285	7.031	9.335	7.468	7.960	7.483	8.000	8.000	9.203	7.598
Min	93.342	91.296	96.324	81.040	71.048	62.710	95.439	92.133	98.783	80.535	73.211	63.752
Max	125.370	118.856	111.065	100.336	94.330	81.372	129.824	124.206	114.638	101.135	97.180	82.788
No. Batches	3	3	1	1	1	3	3	3	1	1	1	3
No. Spec.	28	25	9	9	8	32	28	25	9	9	8	32
Basis Values and/or Estimates												
B-basis Value	95.922	91.000										
B-Estimate			91.293	77.986	71.994	53.159	81.426	80.350	94.340	76.476	66.971	50.012
A-Estimate	87.920	83.019	83.494	70.187	64.215	40.064	60.965	61.879	85.568	66.404	52.233	33.808
Method	pooled	pooled	pooled	pooled	pooled	ANOVA	ANOVA	ANOVA	Normal	Normal	Normal	ANOVA
Modified CV Basis Values and/or Estimates												
B-basis Value	95.984	91.057				60.037		91.563				
B-Estimate			91.314	78.007	72.012		94.224		85.895	73.036	NA	62.933
A-Estimate	88.123	83.213	83.616	70.309	64.329	52.155	82.866	81.078	71.441	60.746	NA	55.897
Method	pooled	pooled	pooled	pooled	pooled	pooled	Normal	Normal	Normal	Normal	NA	Normal

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

Warp Compression Modulus Statistics												
	Normalized						As-measured					
Env	CTD	RTD	ETD1	ETW1	ETD2	ETW2	CTD	RTD	ETD1	ETW1	ETD2	ETW2
Mean	8.815	9.030	8.974	8.955	8.972	8.840	9.033	9.370	9.170	9.079	9.275	8.986
Stdev	0.237	0.120	0.091	0.142	0.130	0.189	0.251	0.179	0.082	0.139	0.181	0.180
CV	2.687	1.328	1.019	1.586	1.449	2.135	2.782	1.907	0.893	1.529	1.956	2.003
Mod CV	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
Min	8.437	8.759	8.845	8.726	8.723	8.371	8.454	8.993	9.053	8.874	8.960	8.463
Max	9.315	9.205	9.110	9.134	9.114	9.193	9.646	9.619	9.295	9.280	9.558	9.309
No. Batches	3	3	1	1	1	3	3	3	1	1	1	3
No. Spec.	21	21	7	7	7	21	21	21	7	7	7	21

Table 4-6: Statistics from WC Modulus Data

4.4 Fill Compression (FC)

The Fill Compression data is normalized, so both normalized and as-measured statistics are provided. The ETD1, ETD2 and ETW1 conditions had insufficient data to compute basis values, so only estimates are available for those conditions.

Both the normalized and the as-measured data from the CTD environmental condition failed the ADK test, but the as measured CTD dataset passed with the use of the modified CV method. B-estimates were computed using the ANOVA method. Pooling was acceptable with the CTD condition excluded. All environmental conditions could be pooled to compute modified CV basis values and estimates for the as measured data. Estimates of basis values computed with an override of the ADK test result are provided for the normalized CTD dataset.

There was one outlier. The highest value in batch three of the ETW2 dataset was an outlier for both the normalized and as measured datasets. It was an outlier only for batch three, not for the ETW2 condition. It was retained for this analysis.

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

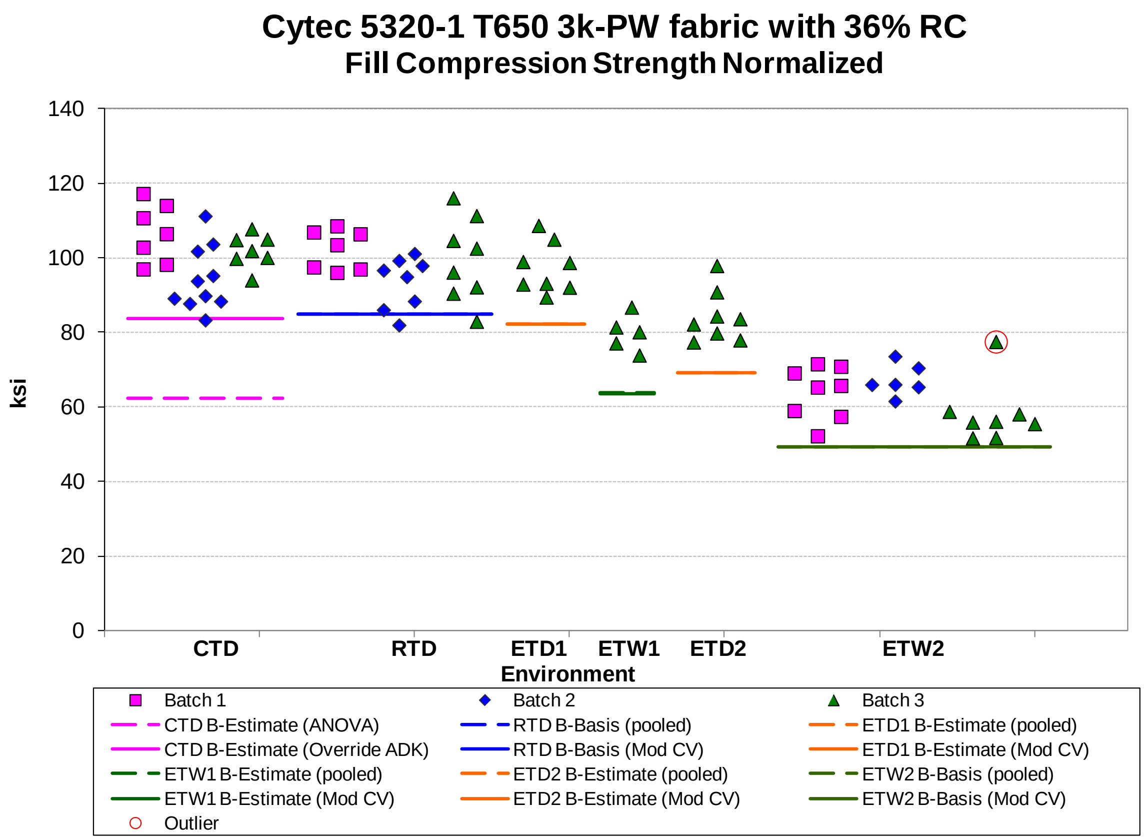

Figure 4-4: Batch Plot for FC normalized strength

Fill Compression Strength Basis Values and Statistics												
	Normalized						As-measured					
Env	CTD	RTD	ETD1	ETW1	ETD2	ETW2	CTD	RTD	ETD1	ETW1	ETD2	ETW2
Mean	100.115	98.149	97.320	79.819	84.215	62.660	101.710	100.365	99.075	81.669	87.433	63.541
Stdev	8.862	8.788	6.741	4.823	6.977	7.559	8.561	7.615	7.712	5.168	7.496	7.372
CV	8.852	8.954	6.927	6.042	8.285	12.064	8.417	7.587	7.784	6.328	8.573	11.602
Mod CV	8.852	8.954	7.463	7.021	8.285	12.064	8.417	7.794	7.892	7.164	8.573	11.602
Min	83.271	81.915	89.399	73.843	77.343	51.634	84.570	86.139	91.580	75.820	78.958	52.660
Max	117.161	116.024	108.617	86.708	97.856	77.482	116.480	117.939	110.701	89.298	101.766	79.311
No. Batches	3	3	1	1	1	3	3	3	1	1	1	3
No. Spec.	24	23	8	5	8	22	24	23	8	5	8	22
Basis Values and/or Estimates												
B-basis Value		84.894				49.352		87.700				50.825
B-Estimate	62.276		82.340	63.676	69.235		66.823		84.761	66.244	73.119	
A-Estimate	35.234	75.851	73.531	54.958	60.426	40.319	41.888	79.059	76.344	57.914	64.701	42.194
Method	ANOVA	pooled	pooled	pooled	pooled	pooled	ANOVA	pooled	pooled	pooled	pooled	pooled
Modified CV Basis Values and/or Estimates												
B-basis Value		84.743				49.201	88.558	87.162				50.283
B-Estimate			82.169	63.492	69.064				84.100	65.512	72.458	
A-Estimate		75.597	73.259	54.674	60.154	40.065	79.654	78.267	75.397	56.880	63.755	41.396
Method		pooled	pooled	pooled	pooled	pooled	pooled	pooled	pooled	pooled	pooled	pooled
Estimates of Basis Value with override of AKD test result												
B-Estimate	83.700											
A-Estimate	71.933											
Method	Normal											

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

Fill Compression Modulus Statistics												
	Normalized						As-measured					
Env	CTD	RTD	ETD1	ETW1	ETD2	ETW2	CTD	RTD	ETD1	ETW1	ETD2	ETW2
Mean	8.868	8.680	8.724	8.715	8.712	8.732	8.989	8.876	8.896	8.923	8.987	8.818
Stdev	0.476	0.306	0.103	0.257	0.050	0.383	0.410	0.263	0.145	0.334	0.120	0.358
CV	5.369	3.521	1.179	2.945	0.579	4.381	4.562	2.965	1.629	3.747	1.335	4.058
Mod CV	6.684	6.000	6.000	6.000	6.000	6.190	6.281	6.000	6.000	6.000	6.000	6.029
Min	8.083	8.203	8.497	8.239	8.644	7.938	8.365	8.521	8.726	8.359	8.830	7.977
Max	9.734	9.162	8.796	9.160	8.808	9.244	9.620	9.408	9.079	9.575	9.182	9.276
No. Batches	3	3	1	1	1	3	3	3	1	1	1	3
No. Spec.	21	21	7	8	7	21	21	21	7	8	7	21

Table 4-8: Statistics from FC Modulus Data

4.5 In-Plane Shear (IPS)

In-Plane Shear data is not normalized. The ETW1 condition has data from only one batch available, so only estimates are provided. The CTD data for the strength at 5% strain has data from only 17 specimens, which is insufficient according to the guidelines of CMH17 Rev G. Only estimates are provided for that dataset.

Only the ETW2 strength at 5% strain dataset passes the ADK test. The ANOVA method is used for the CTD, RTD (both 0.2% offset strength and strength at 5% strain) and ETW2 (0.2% offset strength only) to compute estimates. All these datasets pass the ADK test after the modified CV transformation is applied, so modified CV basis values and estimates are provided. Pooling across all environments was not acceptable due to the failure of Levene's test but the CTD and RTD conditions could be pooled together.

There was one outlier. The lowest value in batch one of the 0.2% offset strength dataset was an outlier for the CTD condition, but it was not an outlier for batch one.

Statistics, basis values and estimates are given for the strength data in Table 4-9 and modulus data in Table 4-10. The data, B-basis values and B-estimates are shown graphically for the 0.2% offset strength in Figure 4-5 and the strength at 5% strain in Figure 4-6.

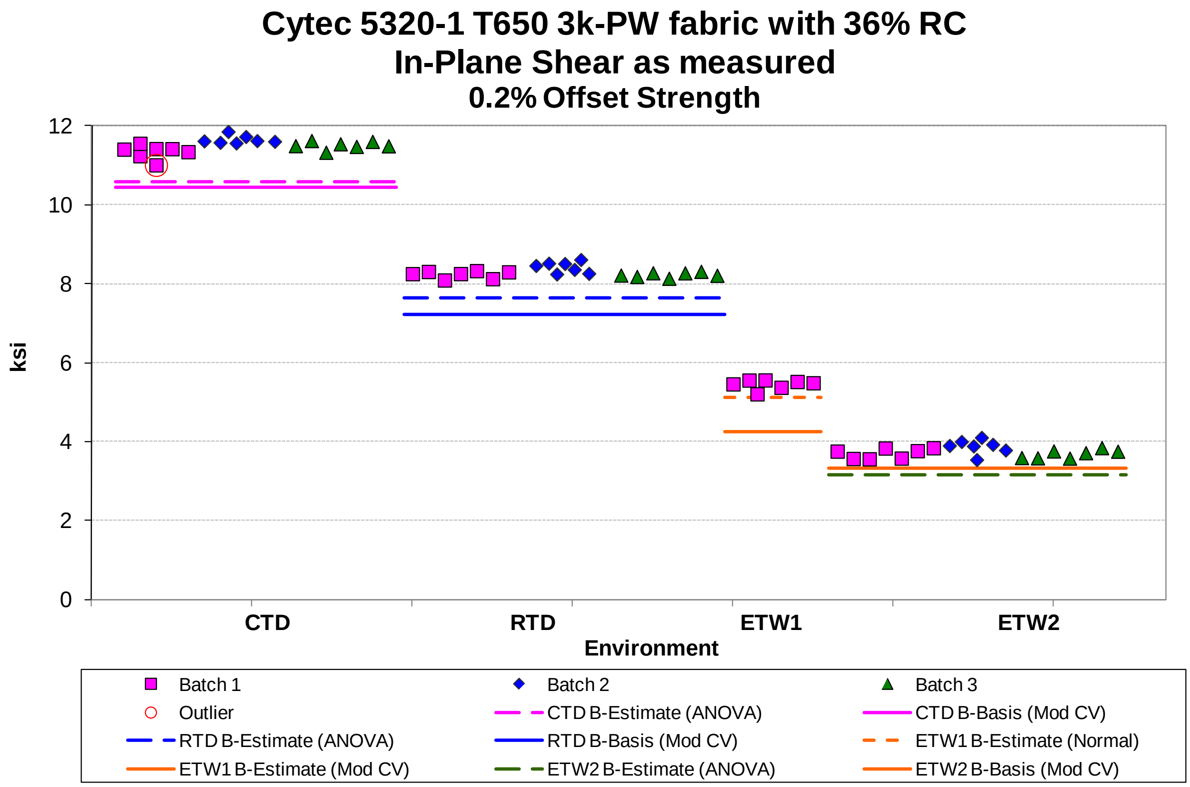

Figure 4-5: Batch plot for IPS 0.2% Offset Strength as-measured

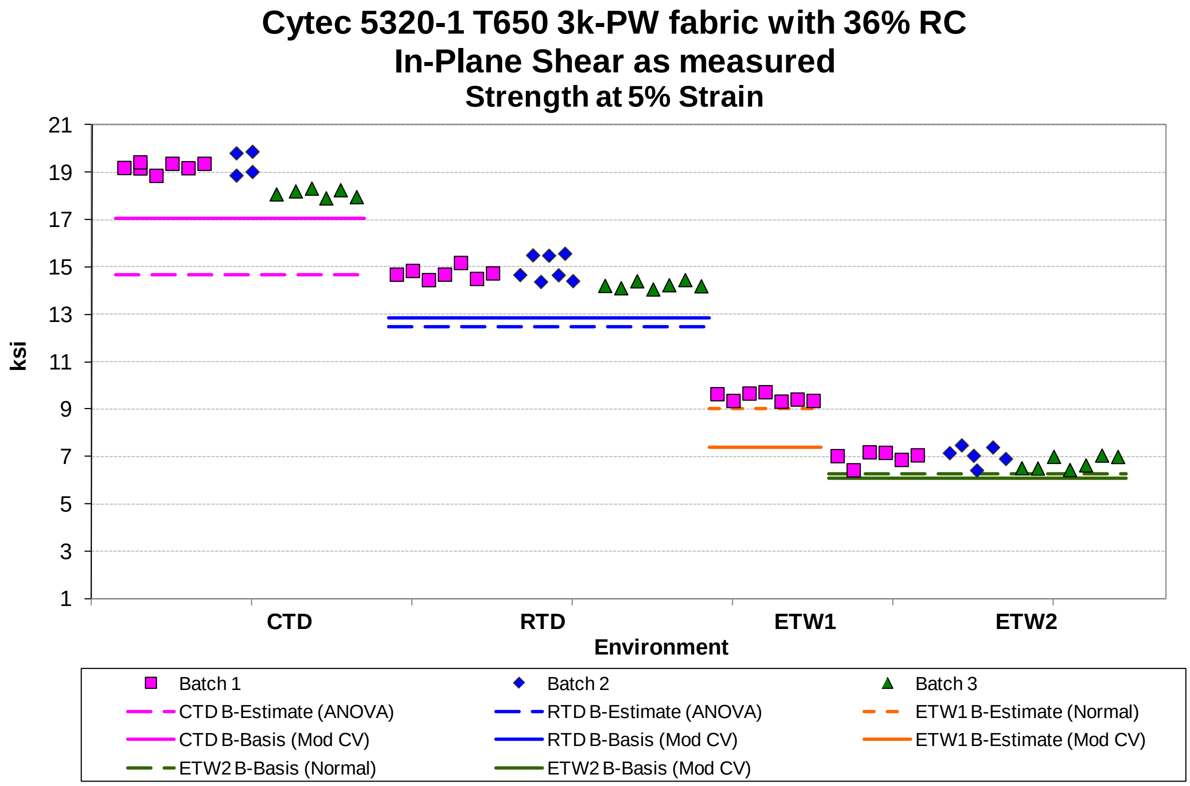

Figure 4-6: Batch plot for IPS Strength at 5% Strain as-measured

In-Plane Shear Strength Basis Values and Statistics								
	0.2% Offset Strength				5% Strain			
Env	CTD	RTD	ETW1	ETW2	CTD	RTD	ETW1	ETW2
Mean	11.504	8.299	5.455	3.760	18.882	14.650	9.506	6.915
Stdev	0.179	0.134	0.126	0.159	0.639	0.451	0.172	0.328
CV	1.559	1.612	2.302	4.238	3.382	3.081	1.809	4.737
Mod CV	6.000	6.000	8.000	6.119	6.000	6.000	8.000	6.369
Min	11.011	8.095	5.211	3.545	17.916	14.071	9.335	6.427
Max	11.856	8.614	5.563	4.108	19.882	15.577	9.733	7.487
No. Batches	3	3	1	3	3	3	1	3
No. Spec.	21	21	7	21	17	21	7	19
Basis Values and Estimates								
B-basis Value								6.277
B-Estimate	10.574	7.647	5.107	3.155	14.651	12.495	9.028	
A-Estimate	9.910	7.182	4.861	2.723	11.632	10.957	8.692	5.824
Method	ANOVA	ANOVA	Normal	ANOVA	ANOVA	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates								
B-basis Value	10.437	7.232		3.322	17.060	12.862		6.057
B-Estimate			4.251				7.407	
A-Estimate	9.703	6.498	3.427	3.009	15.832	11.626	5.971	5.448
Method	pooled	pooled	Normal	Normal	pooled	pooled	Normal	Normal

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

In-Plane Shear Modulus Statistics				
Env	CTD	RTD	ETW1	ETW2
Mean	0.852	0.735	0.560	0.386
Stdev	0.020	0.012	0.007	0.017
CV	2.387	1.664	1.336	4.359
Mod CV	6.000	6.000	6.000	6.179
Min	0.820	0.711	0.545	0.358
Max	0.881	0.759	0.569	0.422
No. Batches	3	3	1	3
No. Spec.	21	21	7	21

Table 4-10: Statistics for IPS Modulus Data

4.6 "25/50/25" Unnotched Tension 1 (UNT1)

The UNT1 data is normalized. The ETW1 condition has data from only one batch available, so only estimates are provided. The normalized CTD and RTD datasets and the as measured ETW2 dataset did not pass the ADK test. The ANOVA method is used for those three datasets. All these datasets pass the ADK test after the modified CV method is applied, so modified CV basis values and estimates are provided. The normalized dataset failed Levene's test but passed after modified CV transformation is applied so pooling was acceptable to compute the modified CV basis values.

There were two outliers. The highest values in batch one of the normalized ETW2 dataset was an outlier for the condition, but not for batch one. The lowest value in batch one of the as measured RTD dataset was an outlier for batch one but not for the RTD condition. These outliers were retained for this analysis.

Statistics, basis values and estimates are given for UNT1 strength data in Table 4-11 and for the modulus data in Table 4-12. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-7.

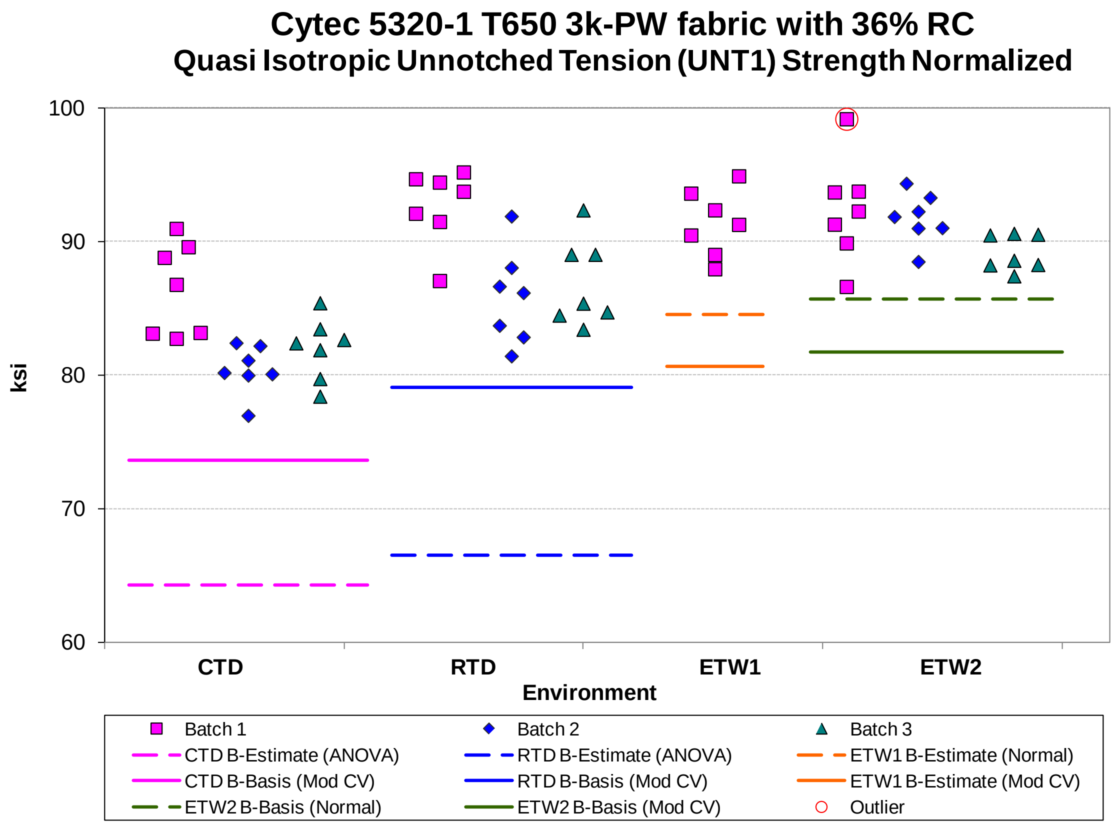

Figure 4-7: Batch Plot for UNT1 normalized strength

Unnotched Tension (UNT1) Strength Basis Values and Statistics								
	Normalized				As-measured			
Env	CTD	RTD	ETW1	ETW2	CTD	RTD	ETW1	ETW2
Mean	82.950	88.466	91.366	91.096	83.241	89.062	91.488	91.132
Stdev	3.613	4.341	2.468	2.857	3.156	4.455	2.613	3.393
CV	4.356	4.907	2.701	3.136	3.791	5.002	2.856	3.723
Modified CV	6.178	6.454	6.000	6.000	6.000	6.501	6.000	6.000
Min	76.964	81.421	87.943	86.621	77.669	82.143	88.313	85.488
Max	90.966	95.192	94.902	99.178	90.904	95.892	95.108	98.804
No. Batches	3	3	1	3	3	3	1	3
No. Spec.	21	21	7	21	21	21	7	21
Basis Values and Estimates								
B-basis Value				85.654	77.229	80.576		
B-Estimate	64.223	66.506	84.513				84.233	77.668
A-Estimate	50.856	50.829	79.693	81.775	72.943	74.526	79.129	68.059
Method	ANOVA	ANOVA	Normal	Normal	Normal	Normal	Normal	ANOVA
Modified CV Basis Values and Estimates								
B-basis Value	73.584	79.100		81.730	73.892	79.713		81.782
B-Estimate			80.646				80.787	
A-Estimate	67.281	72.797	74.504	75.427	67.600	73.421	74.655	75.490
Method	pooled	pooled	pooled	pooled	pooled	pooled	pooled	pooled

Table 4-11: Statistics and Basis Values for UNT1 Strength Data

Unnotched Tension (UNT1) Modulus Statistics								
	Normalized				As-measured			
Env	CTD	RTD	ETW1	ETW2	CTD	RTD	ETW1	ETW2
Mean	7.113	6.936	7.005	6.640	7.139	6.982	7.014	6.641
Stdev	0.143	0.186	0.108	0.119	0.105	0.173	0.109	0.092
CV	2.007	2.680	1.549	1.786	1.470	2.482	1.550	1.390
Modified CV	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
Min	6.941	6.624	6.802	6.458	6.932	6.716	6.829	6.438
Max	7.413	7.282	7.117	6.847	7.291	7.324	7.160	6.866
No. Batches	3	3	1	3	3	3	1	3
No. Spec.	21	21	7	21	21	21	7	21

Table 4-12: Statistics from UNT1 Modulus Data

4.7 "10/80/10" Unnotched Tension 2 (UNT2)

The UNT2 data is normalized. The normalized CTD and RTD datasets and the as measured CTD dataset did not pass the ADK test. The ANOVA method is used for those three datasets. All these datasets pass the ADK test after the modified CV method is applied, so modified CV basis values are provided. The as measured RTD and ETW2 dataset could be pooled to compute the basis values. Data from all three conditions tested could be pooled to compute the modified CV basis values for both the normalized and as measured datasets.

There were two outliers, both were outliers only for the normalized datasets, not the as measured datasets. The lowest value in batch three of the normalized CTD dataset was an outlier for batch three but not for the CTD condition. The highest value in batch one of the normalized RTD dataset was an outlier for batch one but not for the RTD condition. These outliers were retained for this analysis.

Statistics, basis values and estimates are given for UNT2 strength data in Table 4-13 and for the modulus data in Table 4-14. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-8.

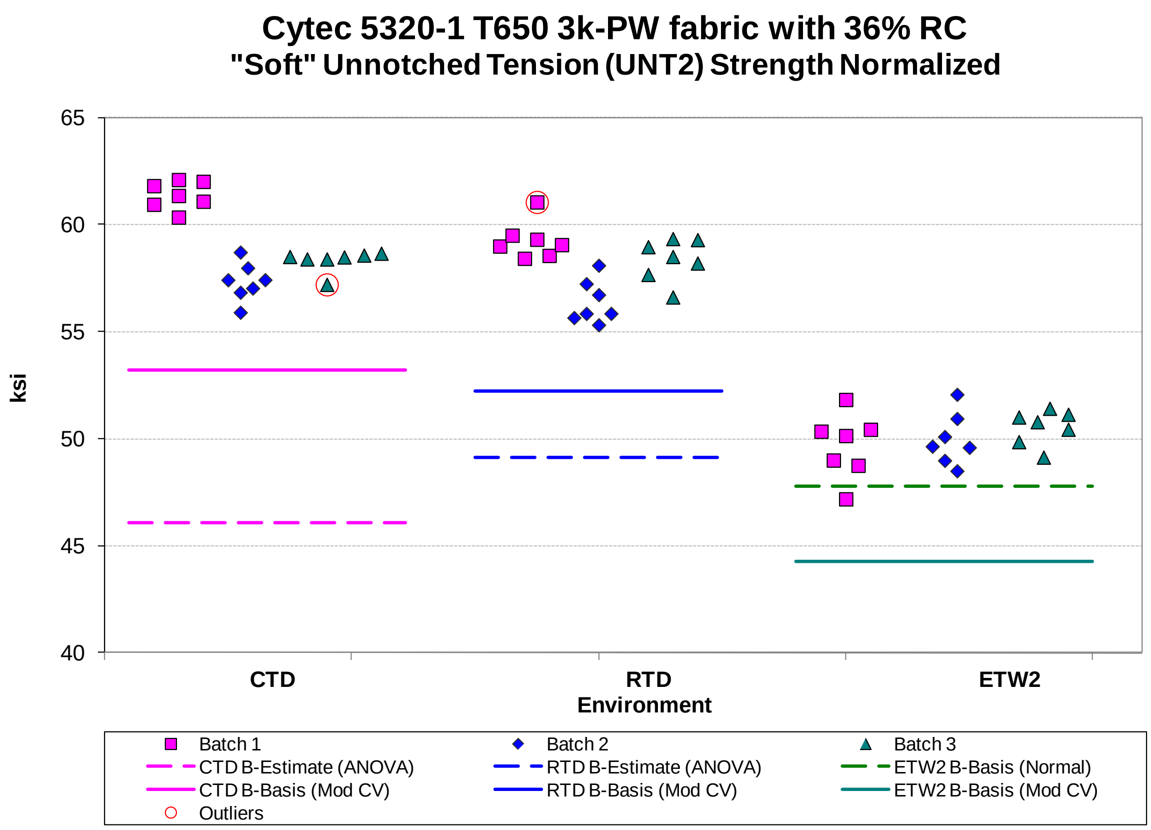

Figure 4-8: Batch Plot for UNT2 normalized strength

Unnotched Tension (UNT2) Strength Basis Values and Statistics						
	Normalized			As-measured		
Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	59.011	58.013	50.064	59.450	58.502	50.293
Stdev	1.886	1.530	1.198	1.323	1.175	1.534
CV	3.197	2.637	2.394	2.226	2.009	3.050
Modified CV	6.000	6.000	6.000	6.000	6.000	6.000
Min	55.905	55.320	47.188	57.453	56.846	46.242
Max	62.102	61.058	52.070	61.811	61.084	53.240
No. Batches	3	3	3	3	3	3
No. Spec.	21	21	21	21	21	21
Basis Values and Estimates						
B-basis Value			47.781		56.078	47.870
B-Estimate	46.067	49.101		50.901		
A-Estimate	36.825	42.738	46.153	44.797	54.413	46.204
Method	ANOVA	ANOVA	Normal	ANOVA	pooled	pooled
Modified CV Basis Values and Estimates						
B-basis Value	53.217	52.219	44.269	53.615	52.667	44.458
A-Estimate	49.305	48.307	40.358	49.676	48.728	40.519
Method	pooled	pooled	pooled	pooled	pooled	pooled

Table 4-13: Statistics and Basis Values for UNT2 Strength Data

Unnotched Tension (UNT2) Modulus Statistics						
	Normalized			As-measured		
Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	4.868	4.602	3.888	4.905	4.642	3.905
Stdev	0.089	0.118	0.106	0.065	0.113	0.101
CV	1.824	2.558	2.725	1.329	2.426	2.588
Modified CV	6.000	6.000	6.000	6.000	6.000	6.000
Min	4.696	4.259	3.734	4.810	4.362	3.785
Max	5.025	4.724	4.089	5.093	4.806	4.143
No. Batches	3	3	3	3	3	3
No. Spec.	21	21	21	21	21	21

Table 4-14: Statistics from UNT2 Modulus Data

4.8 “40/20/40” Unnotched Tension 3 (UNT3)

The UNT3 data is normalized. The as-measured CTD dataset failed the normality test, but the pooled dataset passed normality and there were no other diagnostic test failures so pooling all three conditions was acceptable for both the normalized and the as measured data. There were no outliers.

Statistics, basis values and estimates are given for UNT3 strength data in Table 4-15 and for the modulus data in Table 4-16. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-9.

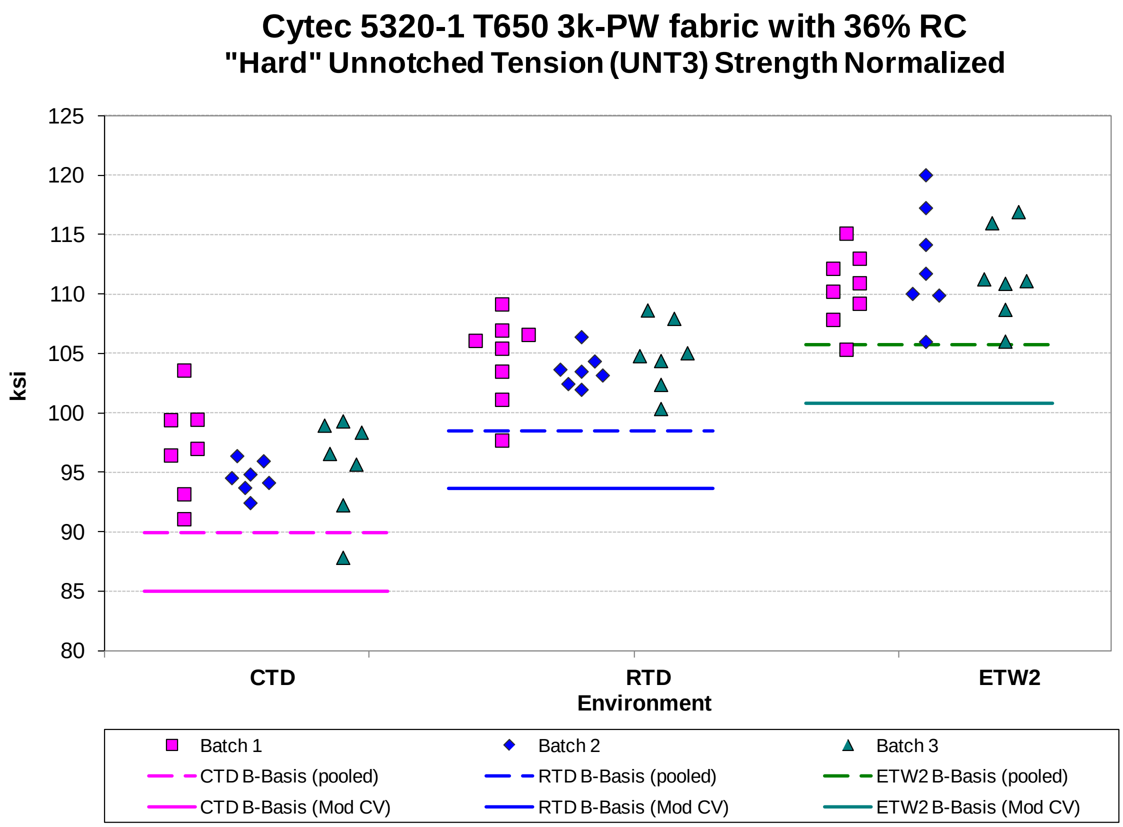

Figure 4-9: Batch Plot for UNT3 normalized strength

Unnotched Tension (UNT3) Strength Basis Values and Statistics						
	Normalized			As-measured		
Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	95.768	104.345	111.535	96.475	105.126	111.578
Stdev	3.499	2.780	3.841	3.597	2.774	4.550
CV	3.654	2.664	3.444	3.729	2.638	4.077
Modified CV	6.000	6.000	6.000	6.000	6.000	6.039
Min	87.836	97.699	105.341	87.495	98.495	104.556
Max	103.589	109.152	120.019	103.440	110.234	122.331
No. Batches	3	3	3	3	3	3
No. Spec.	21	22	22	21	22	22
Basis Values and Estimates						
B-basis Value	89.896	98.499	105.689	90.063	98.742	105.194
A-Estimate	85.938	94.536	101.726	85.741	94.414	100.866
Method	pooled	pooled	pooled	pooled	pooled	pooled
Modified CV Basis Values and Estimates						
B-basis Value	84.972	93.595	100.785	85.601	94.299	100.751
A-Estimate	77.694	86.308	93.499	78.270	86.960	93.412
Method	pooled	pooled	pooled	pooled	pooled	pooled

Table 4-15: Statistics and Basis Values for UNT3 Strength Data

Unnotched Tension (UNT3) Modulus Statistics						
	Normalized			As-measured		
Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	8.832	8.622	8.603	8.896	8.678	8.604
Stdev	0.186	0.190	0.191	0.138	0.158	0.181
CV	2.101	2.203	2.223	1.546	1.817	2.104
Modified CV	6.000	6.000	6.000	6.000	6.000	6.000
Min	8.582	8.250	8.302	8.700	8.384	8.341
Max	9.183	8.892	9.024	9.225	9.071	9.015
No. Batches	3	3	3	3	3	3
No. Spec.	21	23	22	21	23	22

Table 4-16: Statistics from UNT3 Modulus Data

4.9 "25/50/25" Unnotched Compression 1 (UNC1)

The UNC1 data is normalized. The ETW1 condition has data from only one batch available, so only estimates are provided. There were no diagnostic test failures, so pooling was acceptable for both the as measured and the normalized data.

There was one outlier. The highest value in batch one of the ETW2 data was an outlier for batch one but not for the ETW2 condition. It was an outlier in both the normalized and as measured datasets. It was retained for this analysis.

Statistics, basis values and estimates are given for UNC1 strength data in Table 4-17 and for the modulus data in Table 4-18. The normalized data and B-basis values are shown graphically in Figure 4-10.

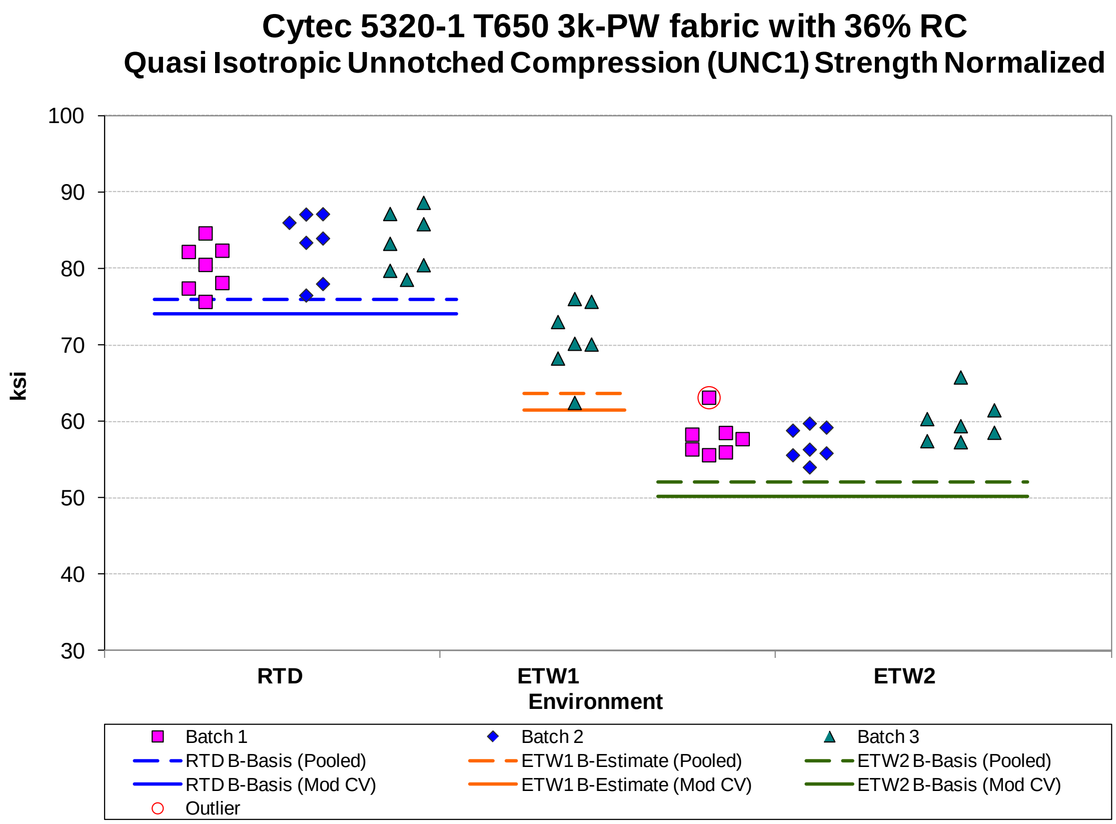

Figure 4-10: Batch plot for UNC1 normalized strength

Unnotched Compression (UNC1) Strength Basis Values and Statistics						
	Normalized			As-measured		
Env	RTD	ETW1	ETW2	RTD	ETW1	ETW2
Mean	82.242	70.843	58.385	82.818	70.952	58.500
Stdev	3.942	4.710	2.756	4.214	4.532	2.525
CV	4.793	6.649	4.720	5.089	6.388	4.317
Modified CV	6.397	7.325	6.360	6.544	7.194	6.159
Min	75.686	62.481	54.039	75.410	62.838	55.307
Max	88.649	76.061	65.806	90.165	75.523	65.250
No. Batches	3	1	3	3	1	3
No. Spec.	21	7	21	21	7	21
Basis Values						
B-basis Value	75.922		52.065	76.444		52.126
B-Estimate		63.646			63.694	
A-Estimate	71.604	59.460	47.747	72.089	59.472	47.771
Method	pooled	pooled	pooled	pooled	pooled	pooled
Modified CV						
B-basis Value	74.092		50.235	74.616		50.299
B-Estimate		61.562			61.613	
A-Estimate	68.524	56.164	44.667	69.013	56.180	44.695
Method	pooled	pooled	pooled	pooled	pooled	pooled

Table 4-17: Statistics and Basis Values for UNC1 Strength Data

Unnotched Compression (UNC1) Modulus Statistics						
	Normalized			As-measured		
Env	RTD	ETW1	ETW2	RTD	ETW1	ETW2
Mean	6.413	6.468	6.246	6.455	6.481	6.264
Stdev	0.174	0.095	0.209	0.125	0.076	0.163
CV	2.719	1.469	3.352	1.931	1.174	2.595
Modified CV	6.000	6.000	6.000	6.000	6.000	6.000
Min	6.103	6.336	5.861	6.160	6.407	6.014
Max	6.610	6.582	6.581	6.661	6.596	6.562
No. Batches	3	1	3	3	1	3
No. Spec.	21	7	21	21	7	21

Table 4-18: Statistics from UNC1 Modulus Data

4.10 "10/80/10" Unnotched Compression 2 (UNC2)

The UNC2 data is normalized. The data failed Levene's test for equal variance but pooling the two conditions, RTD and ETW2, was acceptable with the equal C.V. method.

There was one outlier. The lowest value in batch two of the normalized ETW2 dataset was an outlier for batch two. It was not an outlier for the ETW2 condition or for the as measured dataset. It was retained for this analysis.

Statistics, basis values and estimates are given for UNC2 strength data in Table 4-19 and for the modulus data in Table 4-20. The normalized data and B-basis values are shown graphically in Figure 4-11.

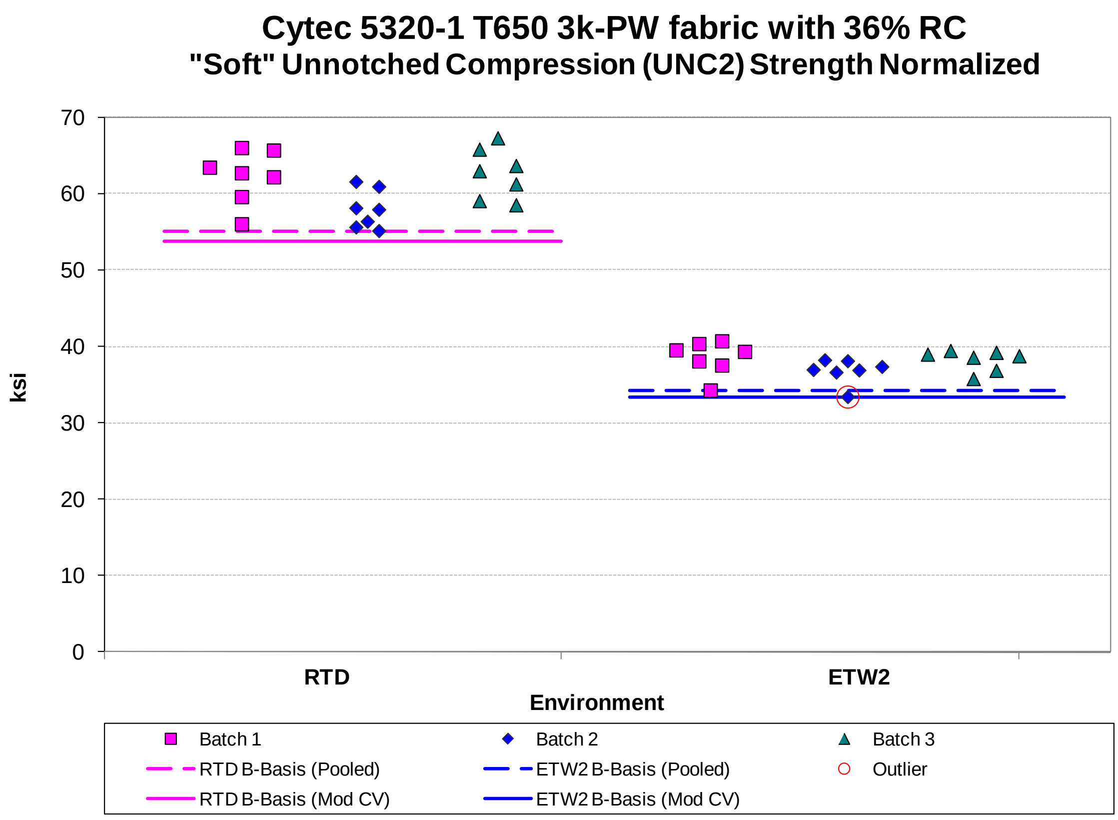

Figure 4-11: Batch plot for UNC2 normalized strength

Unnotched Compression (UNC2) Strength Basis Values and Statistics				
	Normalized		As-measured	
Env	RTD	ETW2	RTD	ETW2
Mean	60.961	37.875	62.373	38.573
Stdev	3.673	1.841	3.285	1.649
CV	6.026	4.861	5.267	4.274
Modified CV	7.013	6.430	6.634	6.137
Min	55.161	33.441	57.475	34.762
Max	67.294	40.729	69.048	40.683
No. Batches	3	3	3	3
No. Spec.	21	21	21	21
Basis Values and Estimates				
B-basis Value	55.041	34.198	57.067	35.292
A-Estimate	50.973	31.670	53.420	33.036
Method	pooled	pooled	pooled	pooled
Modified CV Basis Values and Estimates				
B-basis Value	53.686	33.355	55.304	34.201
A-Estimate	48.686	30.249	50.445	31.196
Method	pooled	pooled	pooled	pooled

Table 4-19: Statistics and Basis Values for UNC2 Strength Data

Unnotched Compression (UNC2) Modulus Statistics				
	Normalized		As-measured	
Env	RTD	ETW2	RTD	ETW2
Mean	4.390	3.767	4.494	3.844
Stdev	0.079	0.203	0.071	0.185
CV	1.797	5.383	1.580	4.812
Modified CV	6.000	6.692	6.000	6.406
Min	4.275	3.056	4.382	3.157
Max	4.538	4.065	4.653	4.079
No. Batches	3	3	3	3
No. Spec.	21	20	21	20

Table 4-20: Statistics from UNC2 Modulus Data

4.11 "40/20/40" Unnotched Compression 3 (UNC3)

The UNC3 data is normalized. The ETW2 dataset, both normalized and as measured, failed the ADK test but passed after modified CV method was applied to the data. Pooling was acceptable to compute the modified CV basis values.

The RTD dataset, both normalized and as measured, failed all distribution tests. There were two outliers in the UNC3 RTD dataset. Both were outliers for both the normalized and as measured datasets. The highest value in batch one of the RTD data was an outlier for both the batch and the condition. After it was removed, the RTD datasets, both normalized and as measured, passed the normality test. This outlier was removed for this analysis. Although no specific cause has been identified for the extreme high strength value, because it is a high value it is permissible to remove this outlier simply because it is an outlier.

The lowest value in batch three of the RTD dataset was an outlier for batch three only in the initial analysis, but was an outlier for the RTD condition after the high outlier in batch one was removed from the dataset. This outlier was retained for this analysis.

Statistics, basis values and estimates are given for UNC3 strength data in Table 4-21 and for the modulus data in Table 4-22. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-12.

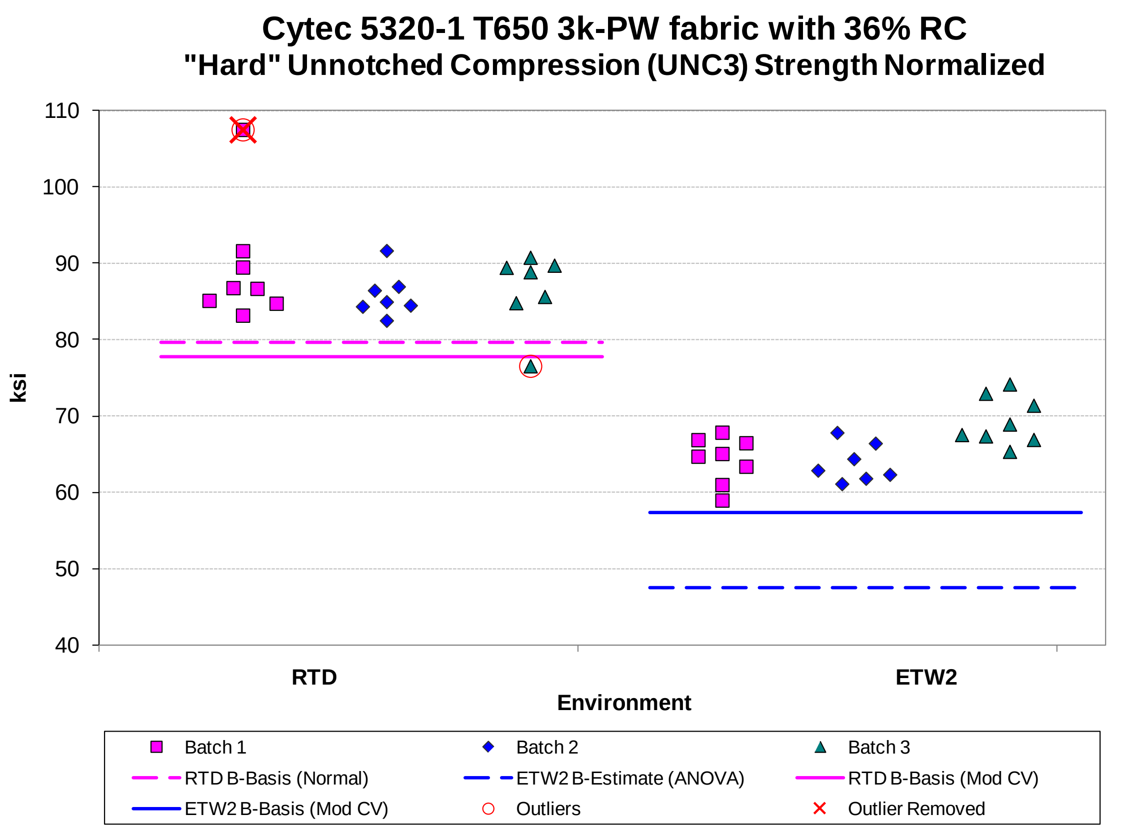

Figure 4-12: Batch plot for UNC3 normalized strength

Unnotched Compression (UNC3) Strength Basis Values and Statistics				
	Normalized		As-measured	
Env	RTD	ETW2	RTD	ETW2
Mean	86.426	65.912	89.237	67.662
Stdev	3.538	3.794	3.352	3.963
CV	4.093	5.756	3.756	5.857
Modified CV	6.047	6.878	6.000	6.929
Min	76.559	58.980	79.663	60.568
Max	91.661	74.176	94.912	77.027
No. Batches	3	3	3	3
No. Spec.	21	23	21	23
Basis Values and Estimates				
B-basis Value	79.687		82.852	
B-Estimate		47.566		49.175
A-Estimate	74.883	34.463	78.300	35.970
Method	Normal	ANOVA	Normal	ANOVA
Modified CV Basis Values and Estimates				
B-basis Value	77.809	57.361	80.371	58.864
A-Estimate	71.900	51.438	74.291	52.769
Method	pooled	pooled	pooled	pooled

Table 4-21: Statistics and Basis Values for UNC3 Strength Data

Unnotched Compression (UNC3) Modulus Statistics				
	Normalized		As-measured	
Env	RTD	ETW2	RTD	ETW2
Mean	7.919	7.873	8.174	8.068
Stdev	0.152	0.289	0.125	0.274
CV	1.921	3.669	1.528	3.399
Modified CV	6.000	6.000	6.000	6.000
Min	7.563	7.521	7.921	7.652
Max	8.134	8.660	8.362	8.857
No. Batches	3	3	3	3
No. Spec.	21	21	21	21

Table 4-22: Statistics from UNC3 Modulus Data

4.12 Lamina Short-Beam Strength (SBS)

The Short Beam Strength data is not normalized. The data from the RTD environmental condition failed the ADK test, but passed with the use of the modified CV method. B-estimates were computed using the ANOVA method. The ETD1, ETW1 and ETD2 environmental conditions had data from only one batch available, which is insufficient to produce B-Basis values. Estimates based on the single batch are provided. Pooling all conditions was acceptable when using the modified CV method.

There was one outlier. The lowest value in batch three of the RTD dataset was an outlier. It was an outlier only for batch three, not for the RTD condition. It was retained for this analysis.

Statistics, basis values and estimates are given for SBS strength data in Table 4-23. The data, B-estimates and B-basis values are shown graphically in Figure 4-13.

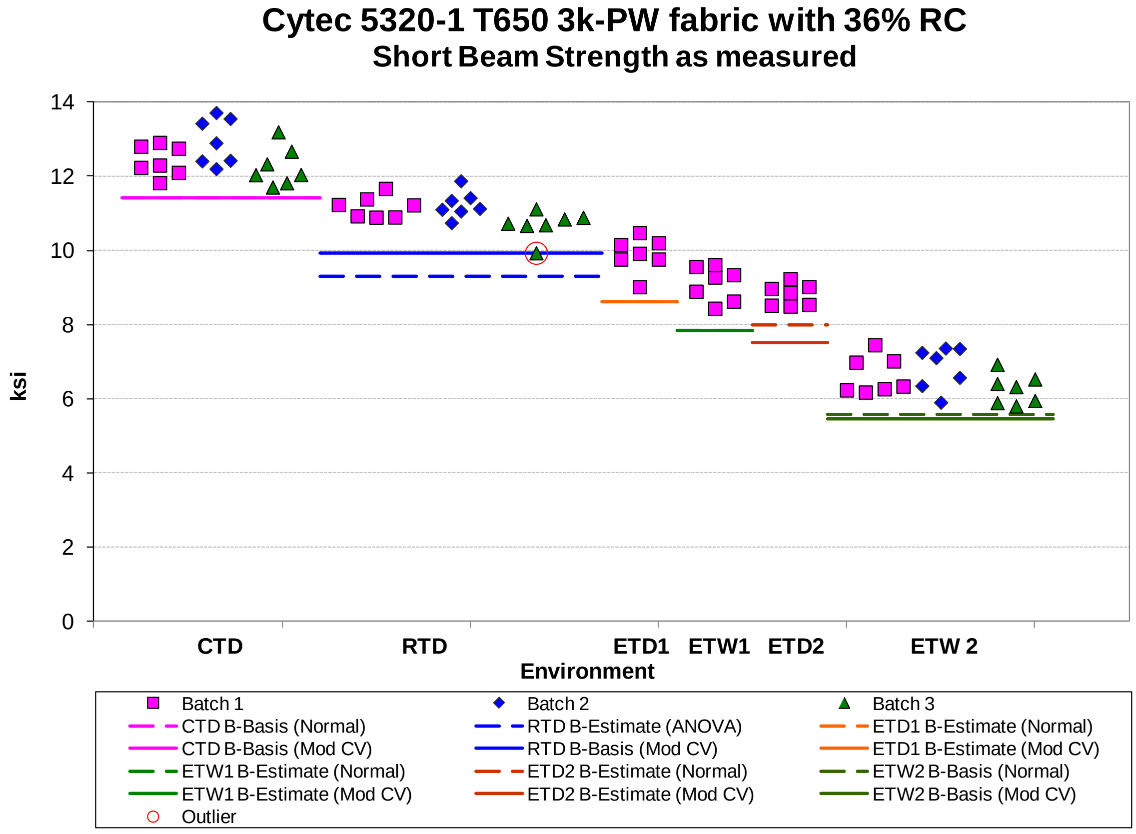

Figure 4-13: Batch plot for SBS as-measured

Short Beam Strength (SBS) Basis Values and Statistics						
Env	CTD	RTD	ETD1	ETW1	ETD2	ETW2
Mean	12.538	11.035	9.898	9.107	8.805	6.580
Stdev	0.582	0.407	0.467	0.460	0.291	0.533
CV	4.640	3.691	4.714	5.055	3.304	8.103
Mod CV	6.320	6.000	6.357	6.527	6.000	8.103
Min	11.703	9.931	9.017	8.436	8.494	5.804
Max	13.712	11.871	10.476	9.613	9.233	7.452
No. Batches	3	3	1	1	1	3
No. Spec.	21	21	7	7	7	21
Basis Values and Estimates						
B-basis Value	11.430					5.564
B-Estimate		9.300	8.603	7.829	7.997	
A-Estimate	10.640	8.061	7.691	6.930	7.429	4.840
Method	Normal	ANOVA	Normal	Normal	Normal	Normal
Modified CV Basis Values and Estimates						
B-basis Value	11.424	9.920				5.465
B-Estimate			8.620	7.829	7.526	
A-Estimate	10.679	9.176	7.892	7.101	6.799	4.721
Method	pooled	pooled	pooled	pooled	pooled	pooled

Table 4-23: Statistics and Basis Values for SBS Data

4.13 Laminate Short-Beam Strength (SBS1)

The Laminate Short Beam Strength data is not normalized. The data from the RTD environmental condition failed the normality, Weibull and log-normal tests so only the non-parametric approach could be used to compute basis values. Since it failed normality even after the modified CV transform was applied to the data, modified CV basis values are not provided for the RTD condition.

The data from the ETW2 condition does not pass the ADK test even after the modified CV method is applied. Estimates were computed using the ANOVA method. Modified CV basis values are labeled as estimates due to the failure of the ADK test after the modified CV transformation.

There was one outlier. The lowest value in batch two of the RTD dataset was an outlier. It was an outlier only for the RTD condition, not for batch two. It was retained for this analysis.

Statistics, basis values and estimates are given for SBS1 strength data in Table 4-24. The data, B-estimates and B-basis values are shown graphically in Figure 4-14.

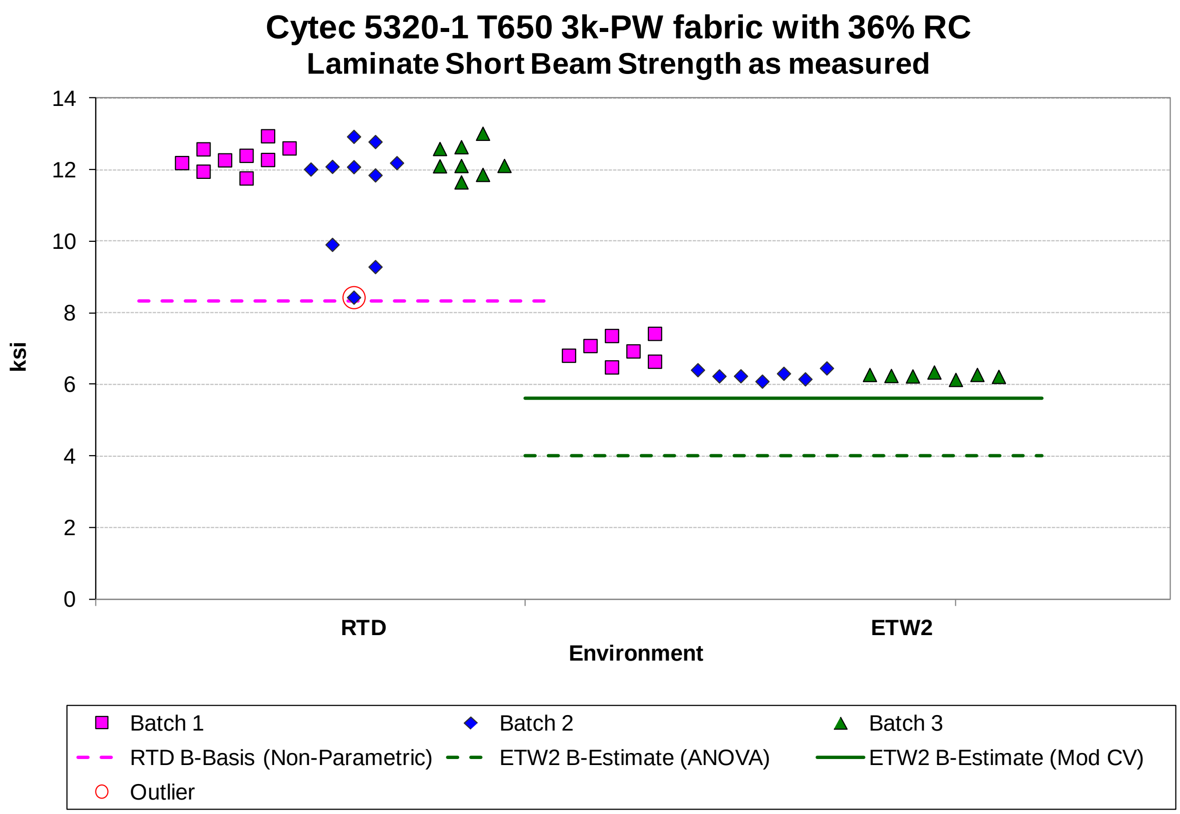

Figure 4-14: Batch plot for SBS1 strength as-measured

Laminate Short Beam Strength (SBS1) Basis Values and Statistics		
Env	RTD	ETW2
Mean	11.955	6.497
Stdev	1.072	0.399
CV	8.967	6.149
Modified CV	8.967	7.075
Min	8.439	6.092
Max	13.019	7.427
No. Batches	3	3
No. Spec.	27	21
Basis Value Estimates		
B-basis Value	8.333	
B-Estimate		4.021
A-Estimate	5.330	2.254
Method	Non-Parametric	ANOVA
Modified CV Basis Values and		
B-Estimate	NA	5.621
A-Estimate	NA	4.997
Method	NA	Normal

Table 4-24: Statistics and Basis Values for SBS1 Strength Data

4.14 "25/50/25" Open-Hole Tension 1 (OHT1)

The OHT1 data is normalized, so both normalized and as-measured statistics are provided. The ETW1 condition had insufficient data to compute basis values, so only estimates are available for that condition. Both the normalized and as measured CTD and RTD datasets and the normalized ETW2 dataset did not pass the ADK test. The ANOVA method is used for those datasets. The CTD and ETW2 datasets passed the ADK test after the modified CV method is applied, so modified CV basis values are provided. The RTD datasets, both normalized and as measured, did not pass the ADK test even after applying the modified CV method. Estimates of modified CV basis values are provided for the RTD dataset, but they are considered estimates due to the failure of the ADK test. Pooling was not acceptable to compute the modified CV basis values.

There was one outlier. The highest value in batch one of the ETW2 dataset was an outlier. It was an outlier for the condition, but not for batch one in the as measured dataset, but an outlier for both the batch and the condition for the normalized dataset. This outlier was retained for this analysis.

Statistics, basis values and estimates are given for OHT1 strength data in Table 4-25. The normalized data, B-basis values and B-estimates are shown graphically in Figure 4-15.

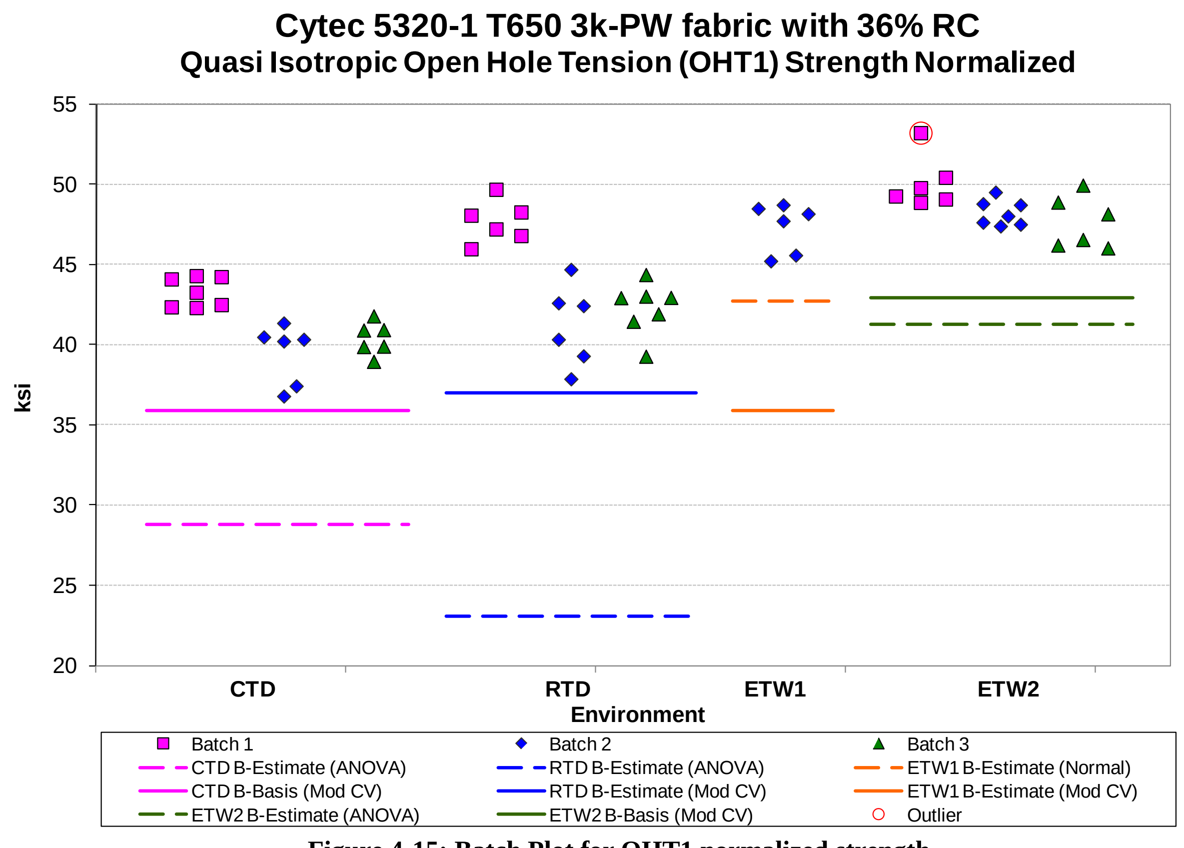

Figure 4-15: Batch Plot for OHT1 normalized strength

Open Hole Tension (OHT1) Strength Basis Values and Statistics								
	Normalized				As-measured			
Env	CTD	RTD	ETW1	ETW2	CTD	RTD	ETW1	ETW2
Mean	41.167	43.645	47.319	48.634	41.255	43.798	48.067	48.558
Stdev	2.114	3.342	1.525	1.669	1.918	2.960	1.805	1.611
CV	5.136	7.657	3.222	3.432	4.650	6.759	3.755	3.318
Modified CV	6.568	7.829	8.000	6.000	6.325	7.379	8.000	6.000
Min	36.801	37.877	45.226	46.035	37.143	38.550	45.790	45.719
Max	44.305	49.687	48.721	53.216	44.781	49.162	49.958	53.001
No. Batches	3	3	1	3	3	3	1	3
No. Spec.	19	19	6	19	19	19	6	19
Basis Values and Estimates								
B-basis Value								45.418
B-Estimate	28.802	23.053	42.701	41.270	31.430	26.381	42.599	
A-Estimate	19.977	8.355	39.417	36.019	24.420	13.951	38.712	43.188
Method	ANOVA	ANOVA	Normal	ANOVA	ANOVA	ANOVA	Normal	Normal
Modified CV Basis Values and/or Estimates								
B-basis Value	35.896			42.946	36.169			42.879
B-Estimate		36.985	35.915			37.499	36.483	
A-Estimate	32.160	32.263	28.112	38.914	32.563	33.032	28.557	38.853
Method	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Table 4-25: Statistics and Basis Values for OHT1 Strength Data

4.15 "10/80/10" Open-Hole Tension 2 (OHT2)

The OHT2 data is normalized, so both normalized and as-measured statistics are provided. Both the normalized and as measured datasets for all three conditions did not pass the ADK test. The ANOVA method is used to provide estimates for all datasets. The RTD and ETW2 datasets passed the ADK test after the modified CV method is applied, so modified CV basis values are provided. Pooling those two conditions was acceptable to compute the modified CV basis values. The CTD datasets, both normalized and as measured, did not pass the ADK test even after applying the modified CV method. Estimates of modified CV basis values are provided for the CTD dataset, but they are considered estimates due to the failure of the ADK test.

There were two outliers, both for the normalized data only. The highest values in batch one of the RTD dataset and in batch three of the ETW2 dataset were outliers for their respective batches, but not for their respective conditions. Both outliers were retained for this analysis.

Statistics, basis values and estimates are given for OHT2 strength data in Table 4-26. The normalized data and B-basis values are shown graphically in Figure 4-16.

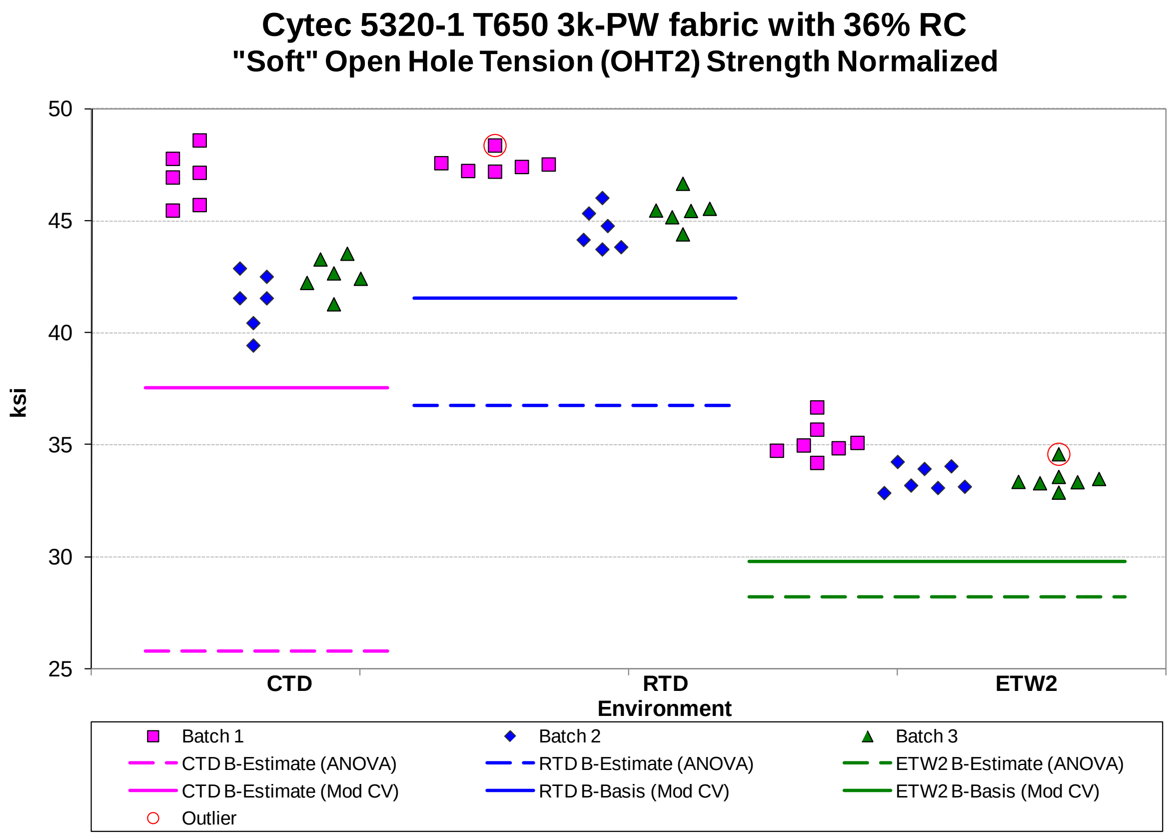

Figure 4-16: Batch Plot for OHT2 normalized strength

Open Hole Tension (OHT2) Strength Basis Values and Statistics						
	Normalized			As-measured		
Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	43.644	45.890	34.069	43.892	46.210	34.152
Stdev	2.669	1.431	1.011	2.488	1.044	0.827
CV	6.115	3.118	2.969	5.668	2.258	2.423
Modified CV	7.057	6.000	6.000	6.834	6.000	6.000
Min	39.450	43.739	32.865	40.159	44.199	32.812
Max	48.605	48.378	36.688	48.432	47.728	36.029
No. Batches	3	3	3	3	3	3
No. Spec.	18	18	21	18	18	21
Basis Values and Estimates						
B-Estimate	25.811	36.763	28.219	27.766	41.444	30.103
A-Estimate	13.082	30.248	24.043	16.256	38.046	27.212
Method	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA
Modified CV Basis Values and Estimates						
B-basis Value		41.555	29.793		41.853	29.853
B-Estimate	37.563			37.970		
A-Estimate	33.262	38.619	26.844	33.782	38.901	26.888
Method	Normal	pooled	pooled	Normal	pooled	pooled

Table 4-26: Statistics and Basis Values for OHT2 Strength Data

4.16 "40/20/40" Open-Hole Tension 3 (OHT3)

The OHT3 data is normalized, so both normalized and as-measured statistics are provided. Both the normalized and as-measured CTD and RTD datasets and the normalized ETW2 dataset did not pass the ADK test. The ANOVA method is used for those datasets. The as-measured CTD and RTD datasets and the normalized RTD and ETW2 datasets passed the ADK test after the modified CV method is applied, so modified CV basis values are provided. The normalized CTD dataset did not pass the ADK test even after applying the modified CV method. Estimates of modified CV basis values are provided for the CTD dataset, but they are considered estimates due to the failure of the ADK test. Pooling was acceptable for the normalized RTD and ETW2 datasets and all three conditions of the as-measured data to compute the modified CV basis values.

There were no outliers. Statistics, basis values and estimates are given for OHT3 strength data in Table 4-27. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-17.

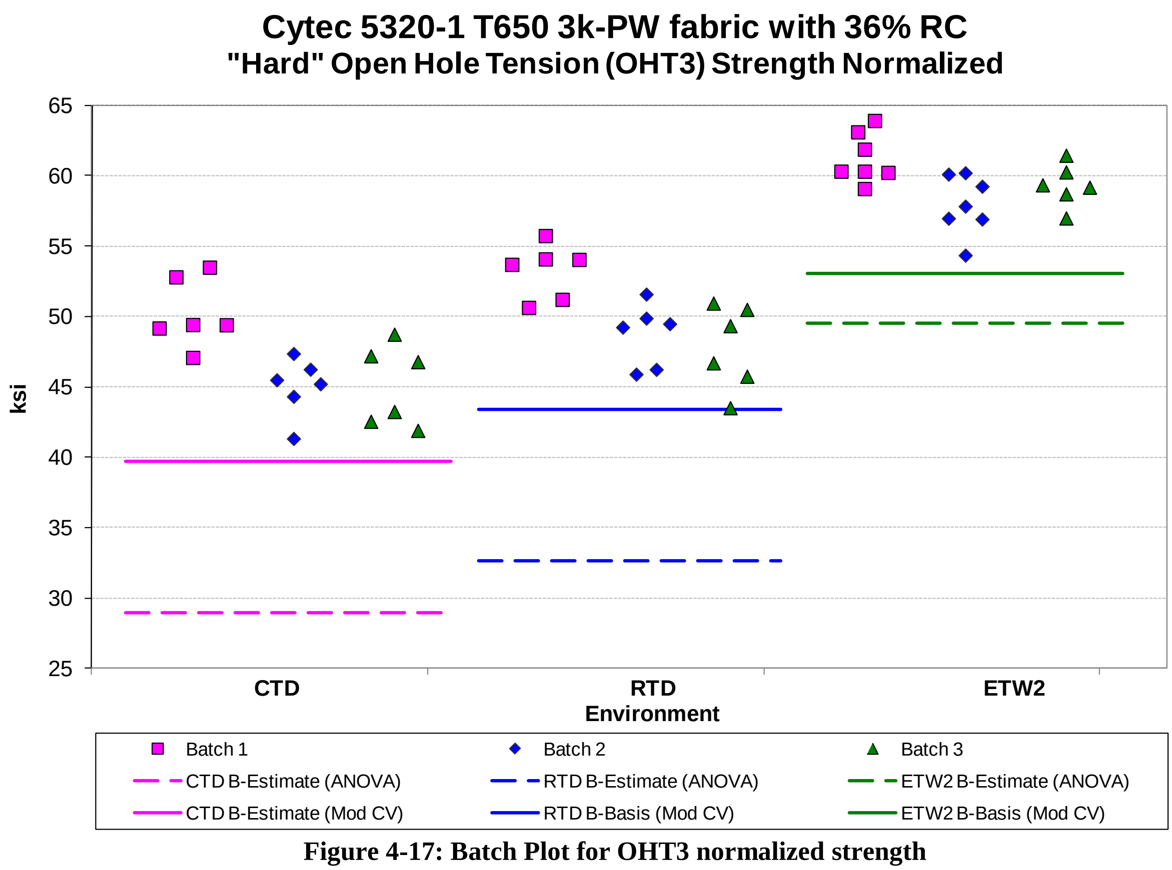

Figure 4-17: Batch Plot for OHT3 normalized strength

Open Hole Tension (OHT3) Strength Basis Values and Statistics						
	Normalized			As-measured		
Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	46.769	49.920	59.524	46.882	50.115	59.588
Stdev	3.428	3.328	2.235	3.335	3.231	2.094
CV	7.329	6.667	3.755	7.113	6.448	3.515
Modified CV	7.665	7.333	6.000	7.556	7.224	6.000
Min	41.332	43.519	54.356	41.050	42.979	55.338
Max	53.498	55.745	63.919	53.367	56.305	63.607
No. Batches	3	3	3	3	3	3
No. Spec.	18	18	20	18	18	20
Basis Value Estimates						
B-basis Value						55.555
B-Estimate	28.975	32.659	49.518	31.873	34.214	
A-Estimate	16.284	20.347	42.380	21.174	22.876	52.685
Method	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA	Normal
Modified CV Basis Values and Estimates						
B-basis Value		43.367	53.033	40.557	43.791	53.327
B-Estimate	39.692					
A-Estimate	34.686	38.923	48.575	36.346	39.579	49.104
Method	Normal	pooled	pooled	pooled	pooled	pooled

Table 4-27: Statistics and Basis Values for OHT3 Strength Data

4.17 "25/50/25" Filled-Hole Tension 1 (FHT1)

The FHT1 data is normalized. The ETW1 condition has data from only one batch available, so only estimates are provided. The RTD condition has data from only 15 specimens available. This is insufficient for single point (RTD condition only) computations for basis values but acceptable for basis value computations when pooled across multiple conditions. The RTD and ETW2 datasets, both normalized and as measured, did not pass the ADK test. The ANOVA method is used for those datasets. All these datasets pass the ADK test after the modified CV method is applied, so modified CV basis values are provided. Pooling was acceptable to compute the modified CV basis values.

There were no outliers. Statistics, basis values and estimates are given for FHT1 strength data in Table 4-28. The normalized data and B-basis values are shown graphically in Figure 4-18.

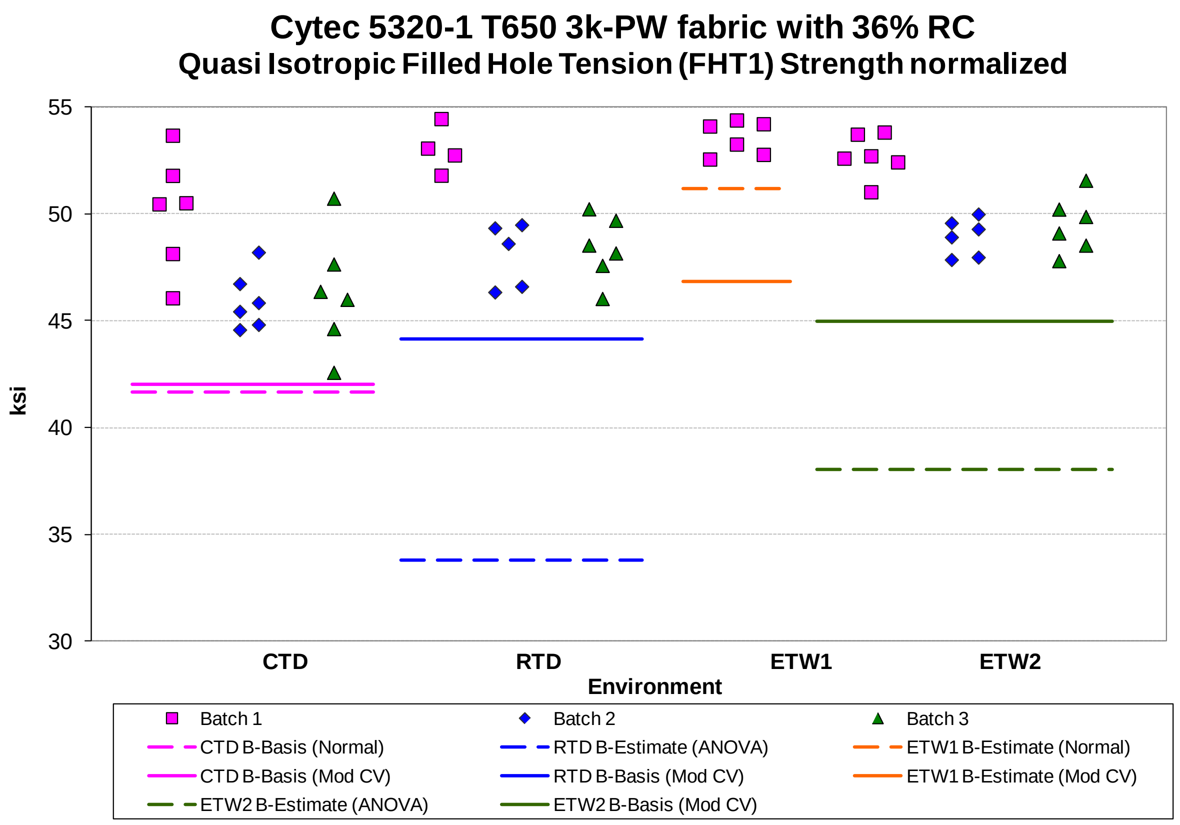

Figure 4-18: Batch plot for FHT1 normalized strength

Filled Hole Tension (FHT1) Strength Basis Values and Statistics								
	Normalized				As-measured			
Env	CTD	RTD	ETW1	ETW2	CTD	RTD	ETW1	ETW2
Mean	47.455	49.512	53.547	50.387	47.564	49.768	53.203	50.483
Stdev	2.941	2.553	0.788	1.995	2.660	2.217	0.775	1.820
CV	6.197	5.157	1.471	3.959	5.592	4.455	1.457	3.606
Modified CV	7.099	6.578	6.000	6.000	6.796	6.227	6.000	6.000
Min	42.581	46.034	52.557	47.804	42.807	46.071	52.535	47.798
Max	53.671	54.448	54.384	53.819	53.254	53.650	54.418	54.046
No. Batches	3	3	1	3	3	3	1	3
No. Spec.	18	15	6	18	18	15	6	18
Basis Values and Estimates								
B-basis Value	41.649				42.313			
B-Estimate		33.807	51.160	38.050		36.684	50.855	40.345
A-Estimate	37.534	22.608	49.463	29.246	38.591	27.358	49.185	33.112
Method	Normal	ANOVA	Normal	ANOVA	Normal	ANOVA	Normal	ANOVA
Modified CV Basis Values and Estimates								
B-basis Value	41.773	43.721		44.705	42.036	44.134		44.956
B-Estimate			47.001				46.835	
A-Estimate	37.986	39.953	43.322	40.918	38.352	40.469	43.255	41.272
Method	pooled	pooled	pooled	pooled	pooled	pooled	pooled	pooled

Table 4-28: Statistics and Basis Values for FHT1 Strength Data

4.18 “10/80/10” Filled-Hole Tension 2 (FHT2)

The FHT2 data is normalized. The as measured ETW2 dataset did not pass any of the distribution tests, so the non-parametric method was used to compute basis values. The CTD and RTD datasets, both normalized and as measured, did not pass the ADK test. The ANOVA method was used to compute estimates for those datasets. Only the normalized CTD dataset did not pass the ADK test after the modified CV method was applied, so modified CV basis values are not provided for that dataset. Estimates are provided instead. They are labeled as estimates due to the failure of the ADK test after the modified CV method.

Pooling the RTD and ETW2 dataset was acceptable to compute the modified CV basis values for the normalized data. All three conditions could be pooled for the as measured data to compute the modified CV basis values.

There were no outliers. Statistics, basis values and estimates are given for FHT2 strength data in Table 4-29. The normalized data and the B-basis values are shown graphically in Figure 4-19.

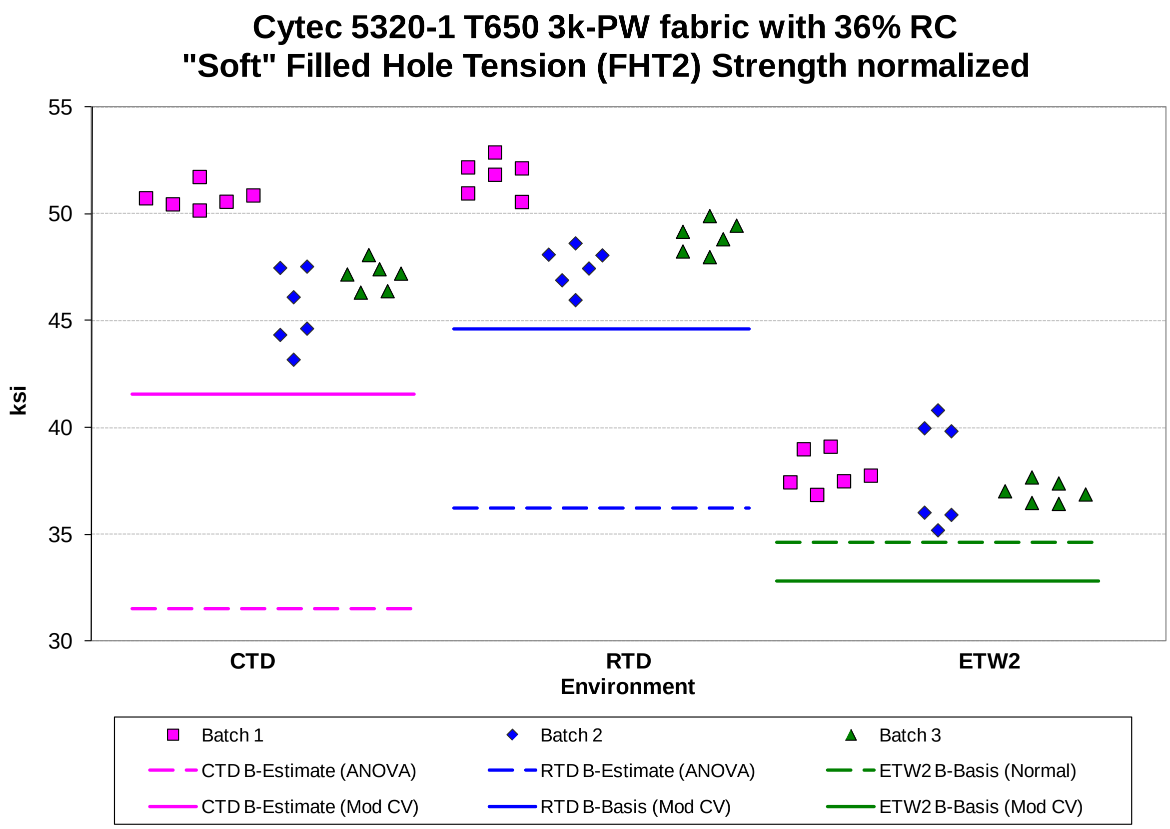

Figure 4-19: Batch plot for FHT2 normalized strength

Filled Hole Tension (FHT2) Strength Basis Values and Statistics						
	Normalized			As-measured		
Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	47.804	49.406	37.636	48.108	49.611	37.699
Stdev	2.488	1.984	1.540	2.368	1.593	1.671
CV	5.205	4.015	4.092	4.922	3.211	4.433
Modified CV	6.602	6.008	6.046	6.461	6.000	6.216
Min	43.187	45.976	35.208	44.153	46.367	35.683
Max	51.735	52.883	40.819	51.871	52.877	41.566
No. Batches	3	3	3	3	3	3
No. Spec.	18	18	18	18	18	18
Basis Values and Estimates						
B-basis Value			34.595			35.158
B-Estimate	31.524	36.234		33.407	40.465	
A-Estimate	19.904	26.832	32.441	22.915	33.939	28.397
Method	ANOVA	ANOVA	Normal	ANOVA	ANOVA	Non-Parametric
Modified CV Basis Values and Estimates						
B-basis Value		44.589	32.818	43.098	44.602	32.689
B-Estimate	41.573					
A-Estimate	37.165	41.312	29.542	39.756	41.260	29.347
Method	Normal	pooled	pooled	pooled	pooled	pooled

Table 4-29: Statistics and Basis Values for FHT2 Strength Data

4.19 "40/20/40" Filled-Hole Tension 3 (FHT3)

The FHT3 data is normalized. The as measured CTD and ETW2 datasets and the normalized datasets for all three conditions tested did not pass the ADK test. The ANOVA method was used to compute basis estimates for those datasets. With the exception of the normalized CTD dataset, these datasets passed the ADK test after the modified CV method was applied, so modified CV basis values are provided. Data from all three conditions tested could be pooled to compute the modified CV basis values for the as measured datasets. The RTD and ETW2 conditions could be pooled to compute the modified CV basis values for the normalized datasets. Estimates of modified CV basis values are provided for the normalized CTD dataset. They are labeled as estimates due to the failure of the ADK test after the modified CV method was used.

There were no outliers. Statistics, basis values and estimates are given for FHT3 strength data in Table 4-30. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-20.

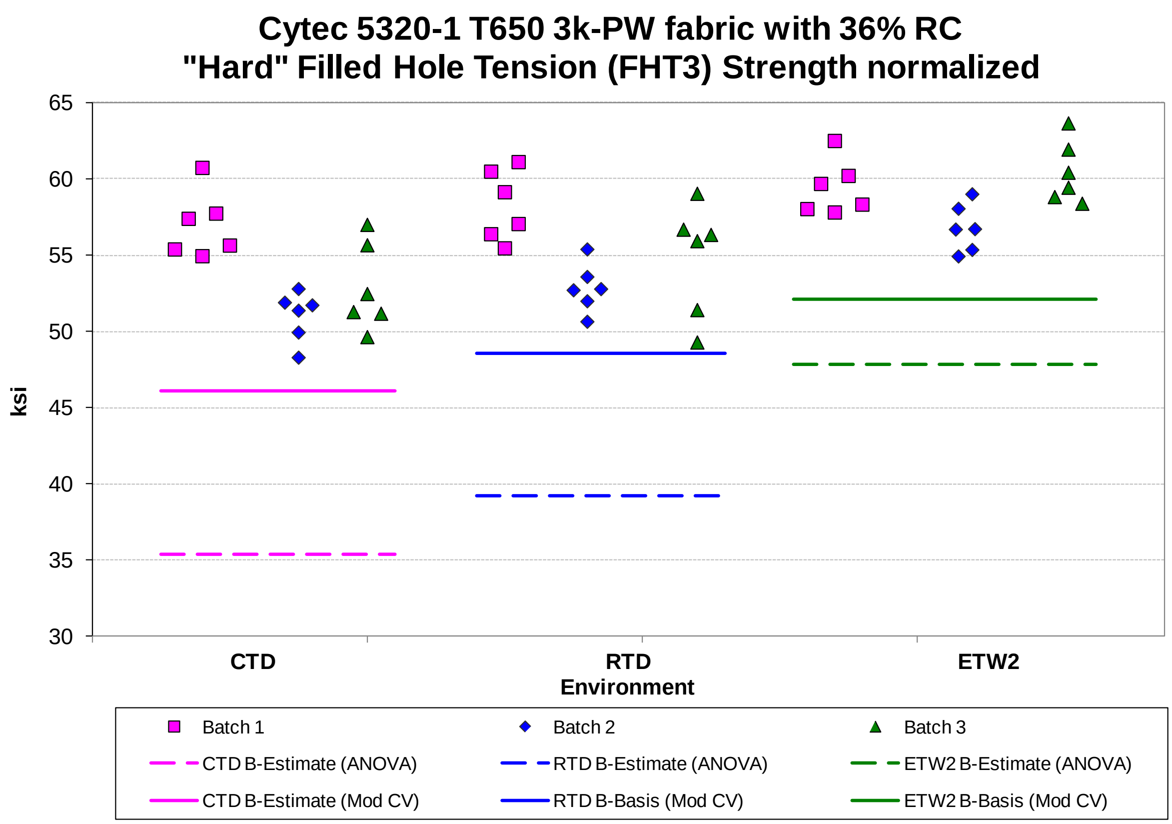

Figure 4-20: Batch plot for FHT3 normalized strength

Filled Hole Tension (FHT3) Strength Basis Values and Statistics						
	Normalized			As-measured		
Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	53.638	55.324	58.910	54.032	55.808	59.244
Stdev	3.337	3.405	2.313	3.144	3.120	2.210
CV	6.222	6.154	3.926	5.819	5.590	3.730
Modified CV	7.111	7.077	6.000	6.910	6.795	6.000
Min	48.313	49.307	54.951	49.013	50.154	55.568
Max	60.759	61.138	63.675	59.861	60.354	64.231
No. Batches	3	3	3	3	3	3
No. Spec.	18	18	18	18	18	18
Basis Values and Estimates						
B-basis Value					49.649	
B-Estimate	35.408	39.240	47.869	38.200		48.679
A-Estimate	22.404	27.773	39.998	26.909	45.284	41.146
Method	ANOVA	ANOVA	ANOVA	ANOVA	Normal	ANOVA
Modified CV Basis Values and Estimates						
B-basis Value		48.530	52.116	47.489	49.265	52.702
B-Estimate	46.108					
A-Estimate	40.781	43.909	47.494	43.125	44.901	48.338
Method	Normal	pooled	pooled	pooled	pooled	pooled

Table 4-30: Statistics and Basis Values for FHT3 Strength Data

4.20 "25/50/25" Open-Hole Compression 1 (OHC1)

The OHC1 data is normalized. The ETW1 condition has data from only one batch available, so only estimates are provided. The normalized RTD dataset did not pass the ADK test. The ANOVA method was used to compute basis values estimates for that dataset. It passed the ADK test after the modified CV method was applied, so modified CV basis values are provided. Data from all three conditions tested could be pooled to compute the as measured basis values and the modified CV basis values for both the normalized and as measured datasets.

There were no outliers. Statistics, B-basis values and estimates are given for OHC1 strength data in Table 4-31. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-21.

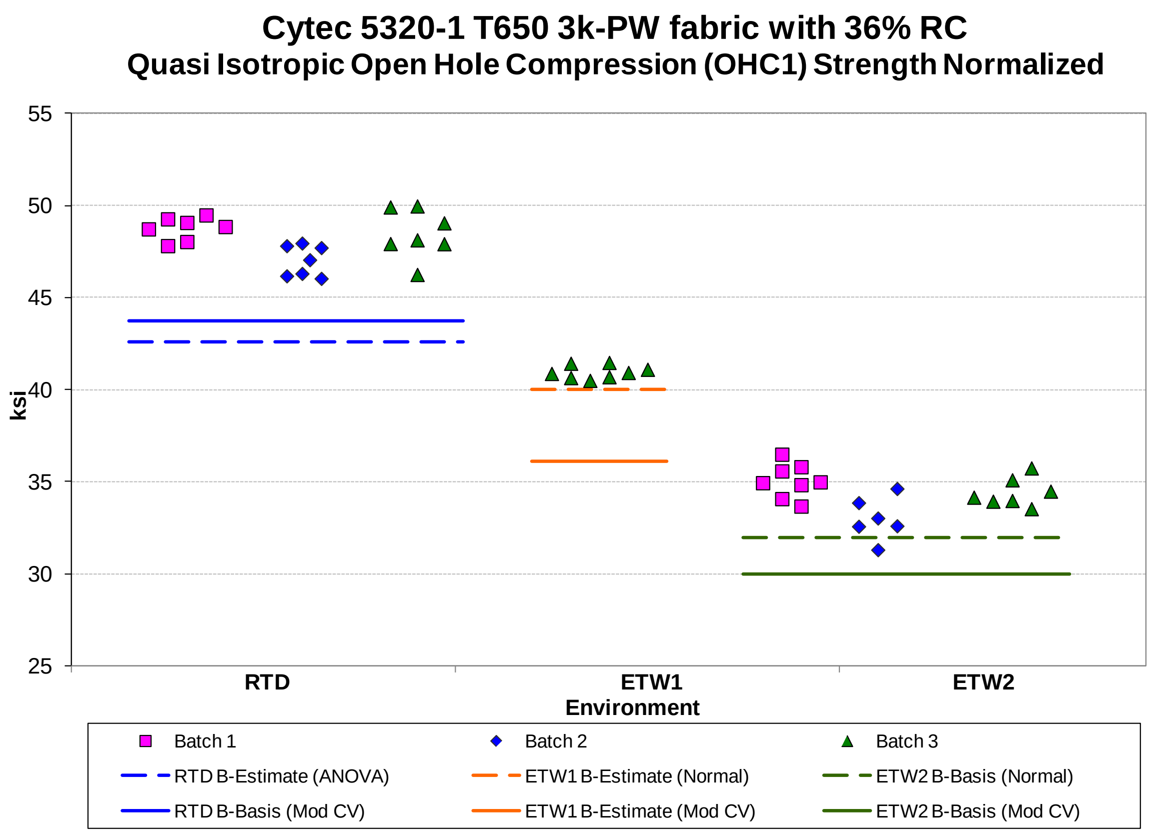

Figure 4-21: Batch plot for OHC1 normalized strength

Open Hole Compression (OHC1) Strength Basis Values and Statistics						
	Normalized			As-measured		
Env	RTD	ETW1	ETW2	RTD	ETW1	ETW2
Mean	48.077	40.963	34.342	48.267	41.400	34.440
Stdev	1.204	0.357	1.269	0.928	0.651	1.202
CV	2.504	0.870	3.696	1.923	1.574	3.491
Modified CV	6.000	6.000	6.000	6.000	6.000	6.000
Min	46.044	40.506	31.311	46.524	40.558	31.741
Max	49.978	41.479	36.496	49.913	42.510	36.606
No. Batches	3	1	3	3	1	3
No. Spec.	21	8	22	21	8	22
Basis Values and Estimates						
B-basis Value			31.948	46.469		32.650
B-Estimate	42.576	40.036			39.391	
A-Estimate	38.649	39.387	30.238	45.243	38.198	31.422
Method	ANOVA	Normal	Normal	pooled	pooled	pooled
Modified CV Basis Values and Estimates						
B-basis Value	43.715		29.998	43.884		30.075
B-Estimate		36.088			36.502	
A-Estimate	40.740	33.191	27.019	40.896	33.593	27.083
Method	pooled	pooled	pooled	pooled	pooled	pooled

Table 4-31: Statistics and Basis Values for OHC1 Strength Data

4.21 "10/80/10" Open-Hole Compression 2 (OHC2)

The OHC2 data is normalized. The normalized ETW2 dataset did not pass the ADK test. The ANOVA method was used to compute basis estimates for that dataset. It passed the ADK test after the modified CV method was applied, so modified CV basis values are provided. Both the normalized and as-measured RTD and ETW2 conditions did not pass Levene's test for pooling using the assumption of equal standard deviations, but did pass Levene's test for pooling under the assumption of equal coefficients of variation. Pooled basis values presented here are based on the equal C.V. method. Pooling was acceptable for the as measured data and for the modified CV method for both normalized and as measured.

There were no outliers. Statistics, basis values and estimates are given for OHC2 strength data in Table 4-32. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-22.

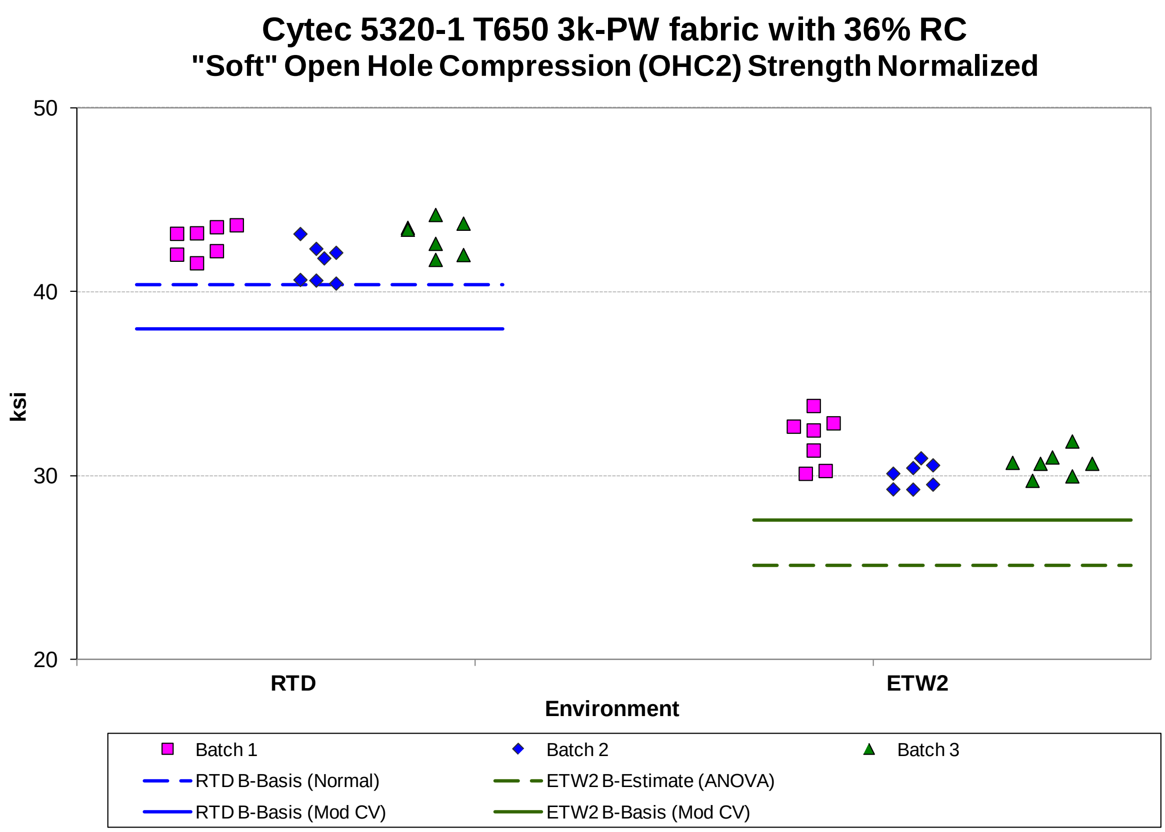

Figure 4-22: Batch plot for OHC2 normalized strength

Open Hole Compression (OHC2) Strength Basis Values and Statistics				
	Normalized		As-measured	
Env	RTD	ETW2	RTD	ETW2
Mean	42.467	30.886	42.707	31.007
Stdev	1.082	1.237	1.044	1.171
CV	2.548	4.005	2.444	3.778
Modified CV	6.000	6.002	6.000	6.000
Min	40.466	29.271	40.376	29.221
Max	44.195	33.814	44.114	34.128
No. Batches	3	3	3	3
No. Spec.	21	21	21	21
Basis Values and Estimates				
B-basis Value	40.406		40.297	29.257
B-Estimate		25.111		
A-Estimate	38.937	20.988	38.640	28.055
Method	Normal	ANOVA	pooled	pooled
Modified CV Basis Values and Estimates				
B-basis Value	37.947	27.598	38.162	27.707
A-Estimate	34.840	25.339	35.038	25.439
Method	pooled	pooled	pooled	pooled

Table 4-32: Statistics and Basis Values for OHC2 Strength Data

4.22 “40/20/40” Open-Hole Compression 3 (OHC3)

The OHC3 data is normalized. There were no diagnostic test failures or outliers. Pooling the two conditions was acceptable. Statistics, basis values and estimates are given for OHC3 strength data in Table 4-33. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-23.

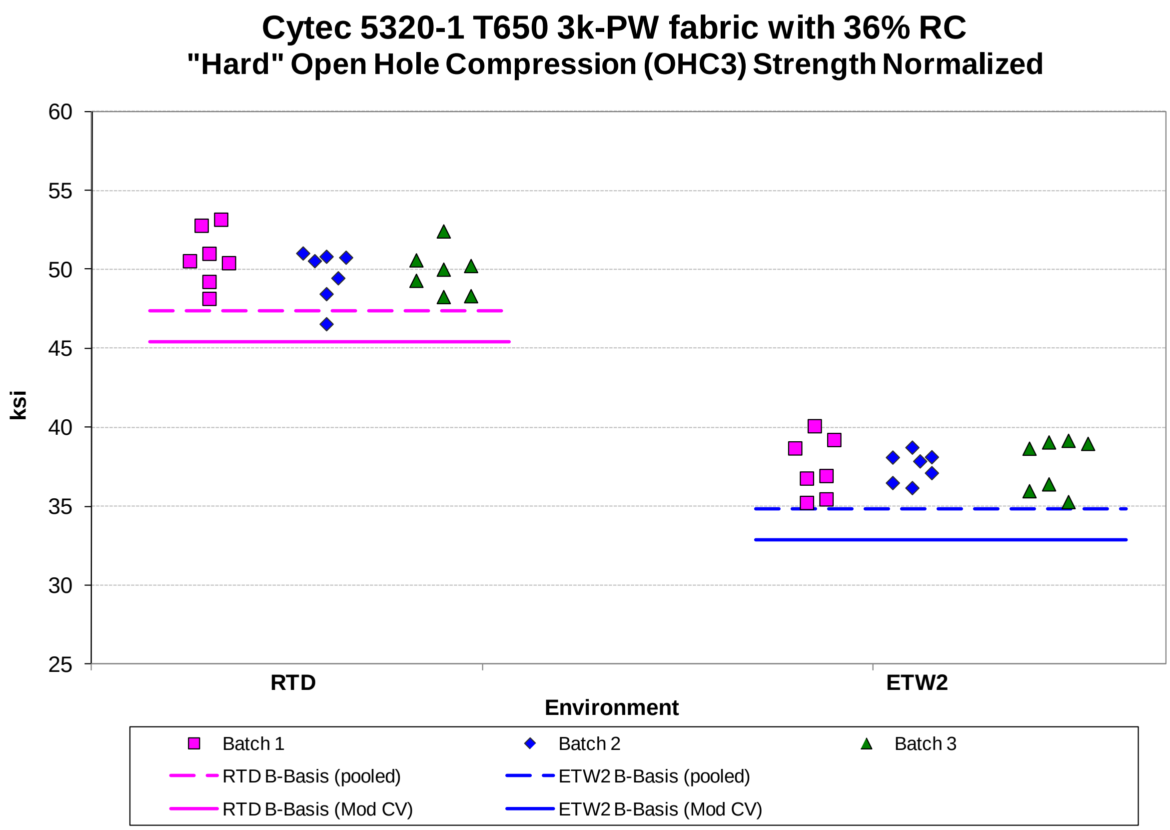

Figure 4-23: Batch plot for OHC3 normalized strength

Open Hole Compression (OHC3) Strength Basis Values and Statistics				
	Normalized		As-measured	
Env	RTD	ETW2	RTD	ETW2
Mean	50.104	37.556	50.236	37.660
Stdev	1.625	1.478	1.515	1.536
CV	3.244	3.935	3.016	4.078
Modified CV	6.000	6.000	6.000	6.039
Min	46.555	35.239	47.339	35.004
Max	53.172	40.096	52.874	39.863
No. Batches	3	3	3	3
No. Spec.	21	21	21	21
Basis Values and Estimates				
B-basis Value	47.348	34.801	47.530	34.954
A-Estimate	45.455	32.907	45.670	33.095
Method	pooled	pooled	pooled	pooled
Modified CV Basis Values and Estimates				
B-basis Value	45.391	32.844	45.500	32.924
A-Estimate	42.153	29.605	42.245	29.669
Method	pooled	pooled	pooled	pooled

Table 4-33: Statistics and Basis Values for OHC3 Strength Data

4.23 "25/50/25" Filled-Hole Compression 1 (FHC1)

The FHC1 data is normalized. The ETW1 condition has data from only one batch available, so only estimates are provided. The ETW2 condition has data from only 16 specimens available. This is insufficient for single point (ETW2 condition only) computations for basis values but acceptable for basis value computations when pooled across multiple conditions. The as measured and normalized RTD datasets did not pass the ADK test. The ANOVA method was used to compute basis estimates for those datasets. Both of these datasets passed the ADK test after the modified CV method was applied, so modified CV basis values are provided. When all environments are transformed, they pass Levene's test. Data from all three conditions tested could be pooled to compute the modified CV basis values for both the normalized and as measured datasets.

There were no outliers. Statistics, basis values and estimates are given for FHC1 strength data in Table 4-34. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-24.

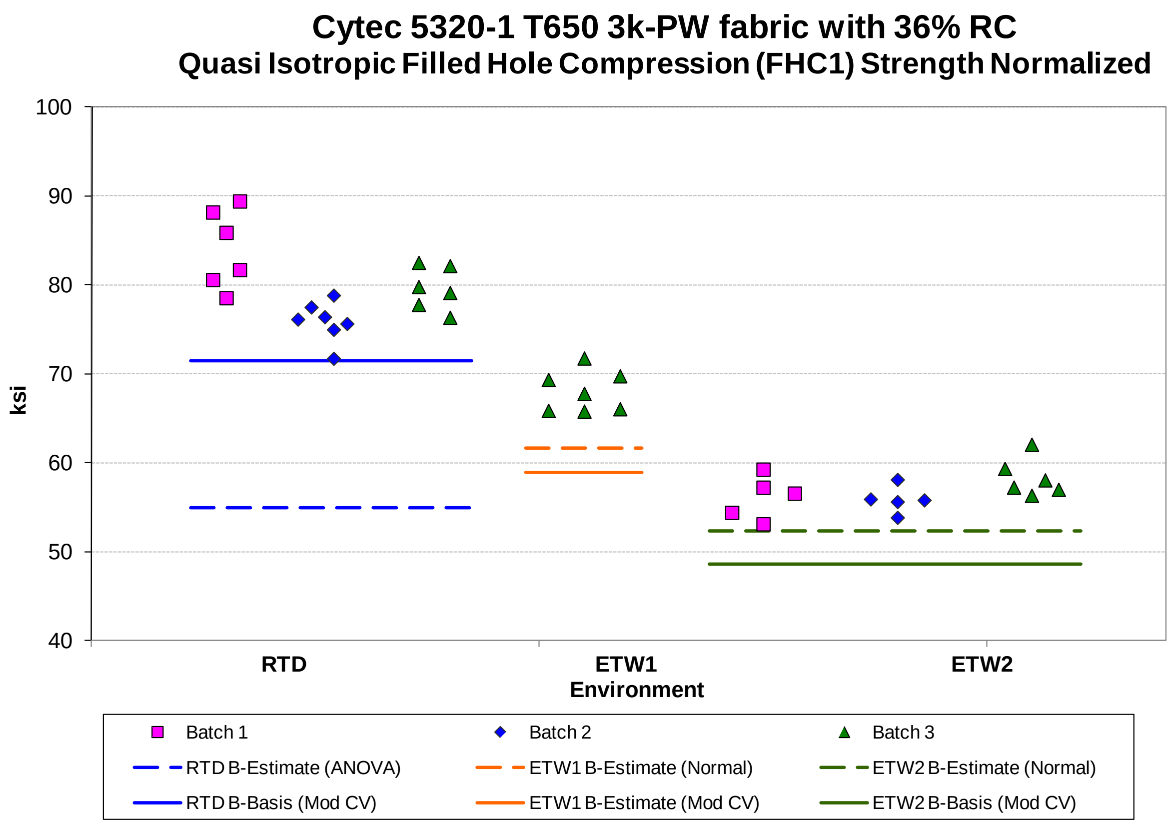

Figure 4-24: Batch plot for FHC1 normalized strength

Filled Hole Compression (FHC1) Strength Basis Values and Statistics						
	Normalized			As-measured		
Env	RTD	ETW1	ETW2	RTD	ETW1	ETW2
Mean	79.638	68.059	56.888	79.882	68.273	56.950
Stdev	4.537	2.316	2.241	4.062	2.058	2.210
CV	5.697	3.403	3.939	5.084	3.014	3.880
Modified CV	6.849	6.000	6.000	6.542	6.000	6.000
Min	71.731	65.800	53.139	72.939	65.545	53.150
Max	89.402	71.764	62.082	89.016	71.110	62.109
No. Batches	3	1	3	3	1	3
No. Spec.	19	7	16	19	7	16
Basis Values and Estimates						
B-basis Value						
B-Estimate	54.998	61.628	52.330	58.422	62.559	52.454
A-Estimate	37.416	57.104	49.113	43.111	58.540	49.282
Method	ANOVA	Normal	Normal	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates						
B-basis Value	71.468		48.582	71.930		48.867
B-Estimate		58.862			59.323	
A-Estimate	65.908	53.469	43.051	66.519	54.074	43.484
Method	pooled	pooled	pooled	pooled	pooled	pooled

Table 4-34: Statistics and Basis Values for FHC1 Strength Data

4.24 “10/80/10” Filled-Hole Compression 2 (FHC2)

The FHC2 data is normalized. The pooled dataset did not pass Levene's test for pooling using the assumption of equal standard deviations, but it did pass Levene's test for pooling under the assumption of equal coefficients of variation. Pooled basis values presented here are based on the equal C.V. method.

There was one outlier. It was the lowest value in batch one of the ETW2 dataset. It was an outlier only for batch one in the as measured dataset, but it was an outlier for both batch one and the ETW2 condition for the normalized dataset. It was retained for this analysis.

Statistics, basis values and estimates are given for FHC2 strength data in Table 4-35. The normalized data and the B-basis values are shown graphically in Figure 4-25.

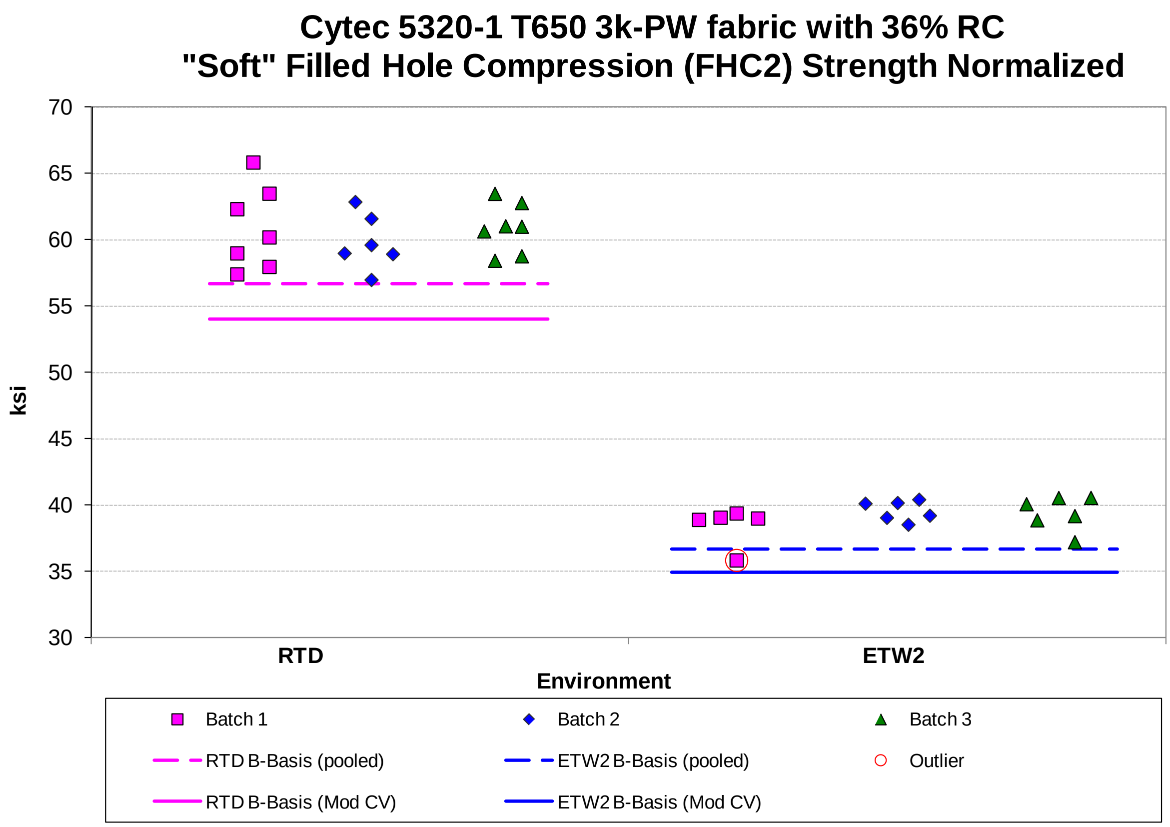

Figure 4-25: Batch plot for FHC2 normalized strength

Filled Hole Compression (FHC2) Strength Basis Values and Statistics				
	Normalized		As-measured	
Env	RTD	ETW2	RTD	ETW2
Mean	60.566	39.191	60.729	39.312
Stdev	2.357	1.216	2.186	1.268
CV	3.891	3.102	3.599	3.227
Modified CV	6.000	6.000	6.000	6.000
Min	56.986	35.850	58.035	36.013
Max	65.838	40.562	65.175	40.587
No. Batches	3	3	3	3
No. Spec.	20	17	20	17
Basis Values and Estimates				
B-basis Value	56.693	36.648	56.975	36.845
A-Estimate	54.029	34.933	54.393	35.182
Method	pooled	pooled	pooled	pooled
Modified CV Basis Values and Estimates				
B-basis Value	54.025	34.895	54.170	35.002
A-Estimate	49.525	31.998	49.658	32.096
Method	pooled	pooled	pooled	pooled

Table 4-35: Statistics and Basis Values for FHC2 Strength Data

4.25 “40/20/40” Filled-Hole Compression 3 (FHC3)

The FHC3 data is normalized. The ETW2 condition has data from only 12 specimens available. This is insufficient for CMH17 Rev G computations for basis values. The as measured and normalized RTD datasets did not pass the ADK test. The ANOVA method was used to compute basis estimates for those datasets. Both of these datasets passed the ADK test after the modified CV method was applied, so modified CV basis values are provided.

There were no outliers. Statistics, basis values and estimates are given for FHC3 strength data in Table 4-36. The normalized data, B-estimates and the B-basis values are shown graphically in Figure 4-26.

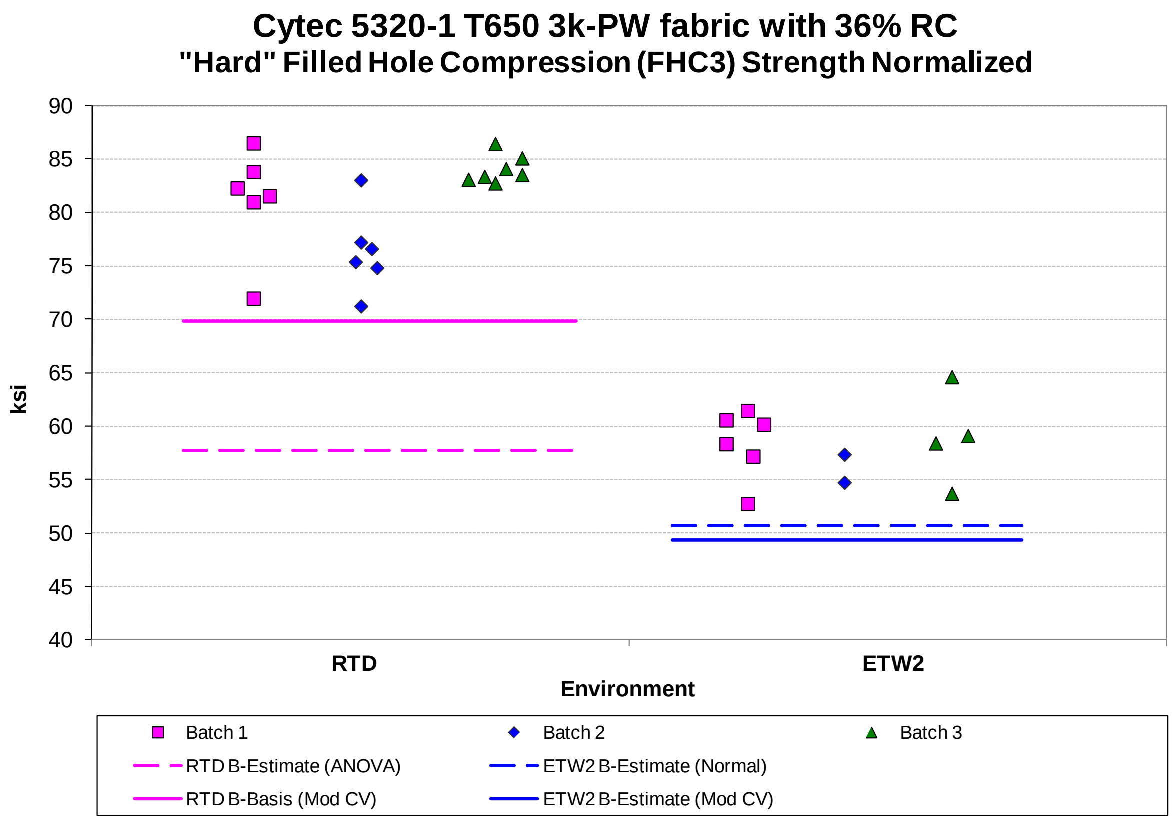

Figure 4-26: Batch plot for FHC3 normalized strength

Filled Hole Compression (FHC3) Strength Basis Values and Statistics				
	Normalized		As-measured	
Env	RTD	ETW2	RTD	ETW2
Mean	80.727	58.213	81.322	58.669
Stdev	4.702	3.382	4.622	3.393
CV	5.825	5.809	5.684	5.783
Modified CV	6.912	6.905	6.842	6.891
Min	71.245	52.765	71.680	53.081
Max	86.497	64.625	87.325	65.397
No. Batches	3	3	3	3
No. Spec.	19	12	19	12
Basis Values and Estimates				
B-Estimate	57.743	50.719	60.231	51.151
A-Estimate	41.348	45.474	45.190	45.888
Method	ANOVA	Normal	ANOVA	Normal
Modified CV Basis Values and Estimates				
B-basis Value	69.850		70.477	
B-Estimate		49.325		49.729
A-Estimate	62.139	43.147	62.788	43.514
Method	Normal	Normal	Normal	Normal

Table 4-36: Statistics and Basis Values for FHC3 Strength Data

4.26 “25/50/25” Single-Shear Bearing 1 (SSB1)

The SSB1 data is normalized. The ETW1 condition has data from only eight specimens available and the initial peak strength dataset has only 16 specimens available from the RTD condition. This is insufficient for CMH17 Rev G computations for basis values, so only estimates are provided for those datasets.

The as measured datasets for the RTD condition (initial peak strength, 2% offset strength and ultimate strength) did not pass the ADK test. The ANOVA method was used to compute basis estimates for those datasets. All of these datasets passed the ADK test after the modified CV method was applied, so modified CV basis values are provided. When all environments were transformed, they passed Levene's test, so pooling was acceptable to compute the modified CV basis values.

The normalized initial peak strength dataset failed the normality test, even after the modified CV transformation was applied, so modified CV basis values are not provided.

There were four outliers. The highest value in batch two of the as measured ultimate strength dataset for the ETW2 condition was an outlier for that condition, but not for batch two and not for the normalized dataset. The lowest value in batch one of the normalized ultimate strength dataset for the RTD condition was an outlier for batch one but not the RTD condition and not for the as measured dataset. The lowest value in batch one of the initial peak normalized strength dataset for RTD condition is an outlier for both batch one and the RTD condition but not for the as measured dataset. The highest value in batch three of the initial peak normalized strength dataset for RTD condition is an outlier for batch three but not for the RTD condition and not for the as measured dataset. All four outliers were retained for this analysis.

Statistics, basis values and estimates are given for the SSB1 normalized strength data in Table 4-37 and the SSB1 as measured strength data in Table 4-38. The normalized data, B-estimates and B-basis values are shown graphically for initial peak strength and 2% offset strength in Figure 4-27 and for ultimate strength in Figure 4-28.

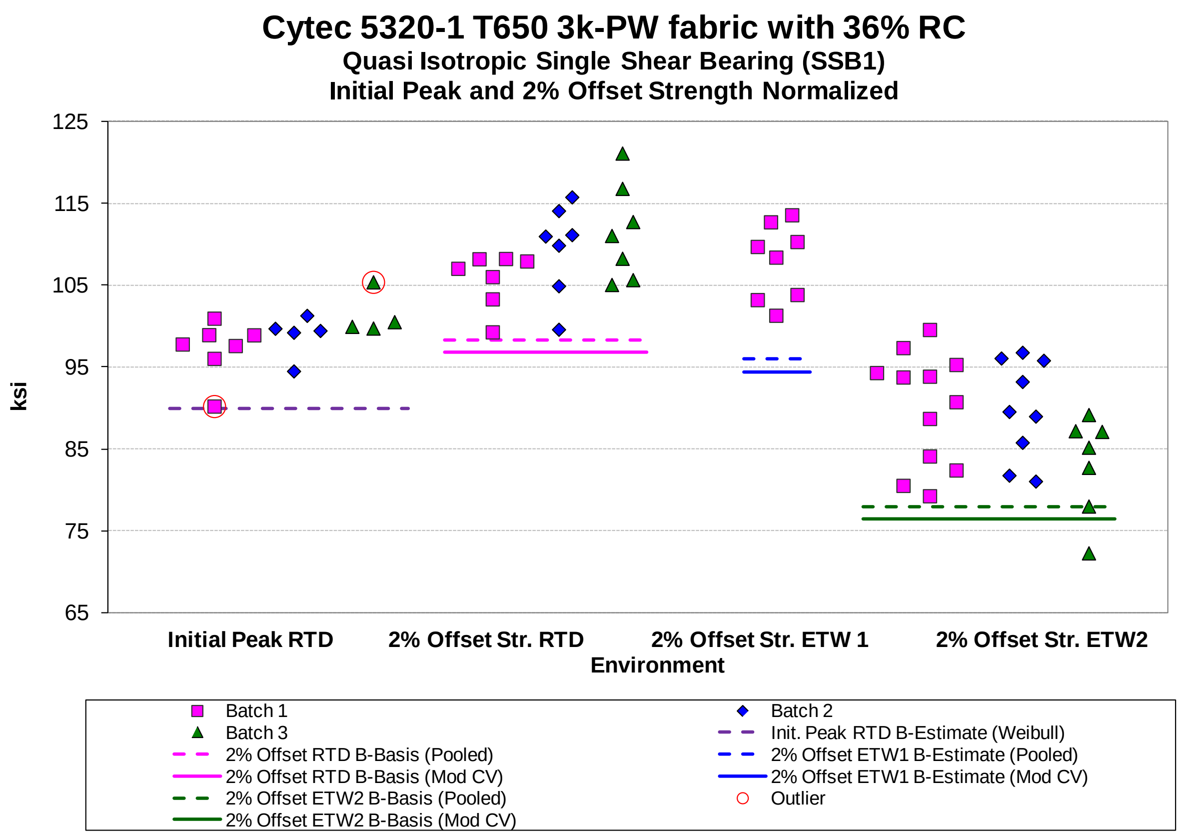

Figure 4-27: Batch plot for SSB1 Initial Peak and 2% Offset Strength normalized

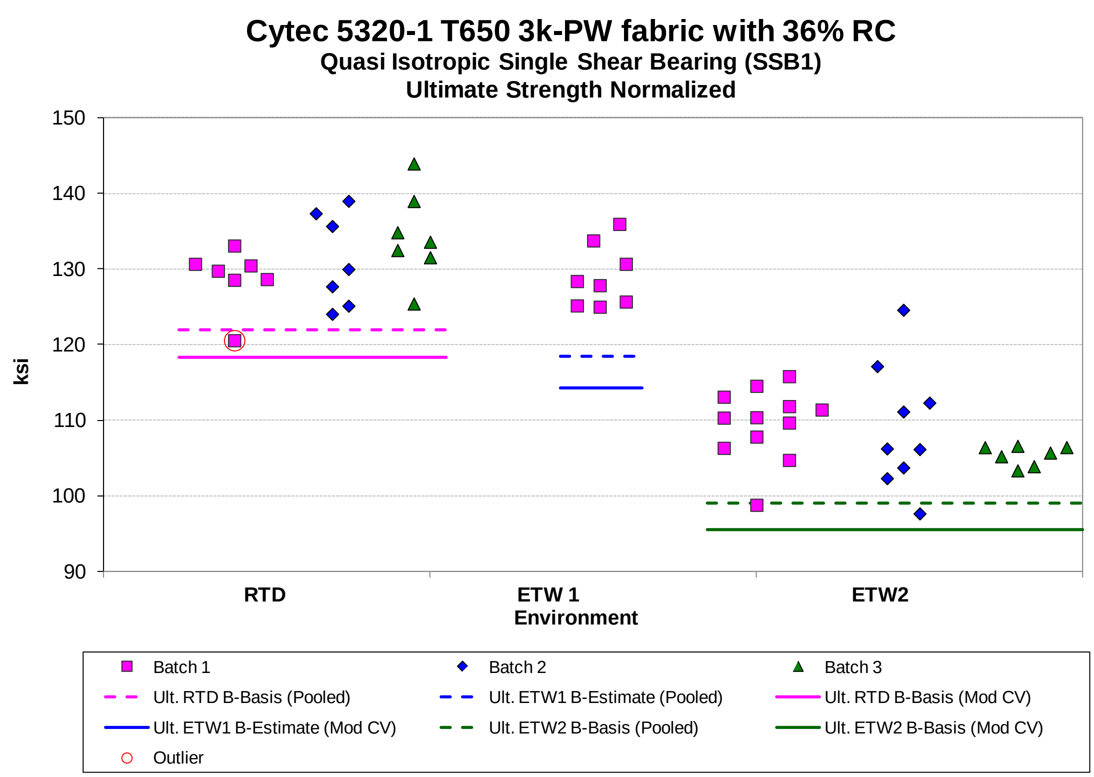

Figure 4-28: Batch plot for SSB1 Ultimate Strength normalized

Single Shear Bearing (SSB1) Strength Basis Values and Statistics							
Normalized							
Property	Initial Peak Strength	2% Offset Strength			Ultimate Strength		
Env	RTD	RTD	ETW1	ETW2	RTD	ETW1	ETW2
Mean	98.781	108.922	107.898	88.256	131.495	129.057	108.348
Stdev	3.296	5.389	4.576	6.879	5.606	4.092	5.688
CV	3.337	4.948	4.241	7.794	4.263	3.171	5.250
Modified CV	6.000	6.474	6.121	7.897	6.131	6.000	6.625
Min	90.233	99.295	101.322	72.309	120.566	124.996	97.664
Max	105.402	121.128	113.588	99.584	143.939	135.950	124.590
No. Batches	3	3	1	3	3	1	3
No. Spec.	16	21	8	28	21	8	28
Basis Values and Estimates							
B-basis Value		98.326		77.916	121.973		99.056
B-Estimate	89.943		96.039			118.400	
A-Estimate	81.045	91.137	89.030	70.673	115.513	112.101	92.547
Method	Weibull	pooled	pooled	pooled	pooled	pooled	pooled
Modified CV Basis Values and Estimates							
B-basis Value	NA	96.830		76.455	118.297		95.468
B-Estimate			94.364			114.285	
A-Estimate	NA	88.626	86.366	68.190	109.342	105.555	86.446
Method	NA	pooled	pooled	pooled	pooled	pooled	pooled

Table 4-37: Statistics and Basis Values for SSB1 Strength Data normalized

Single Shear Bearing (SSB1) Strength Basis Values and Statistics							
As-measured							
Property	Initial Peak Strength	2% Offset Strength			Ultimate Strength		
Env	RTD	RTD	ETW1	ETW2	RTD	ETW1	ETW2
Mean	99.056	109.613	106.749	88.279	132.316	127.693	108.370
Stdev	4.163	6.331	4.156	7.001	6.605	3.861	5.863
CV	4.203	5.776	3.893	7.931	4.991	3.024	5.410
Modified CV	6.101	6.888	6.000	7.965	6.496	6.000	6.705
Min	88.839	97.761	100.994	71.592	118.027	124.223	98.645
Max	106.555	122.453	111.714	99.584	144.899	134.657	127.948
No. Batches	3	3	1	3	3	1	3
No. Spec.	16	21	8	28	21	8	28
Basis Values and Estimates							
B-basis Value				75.688		117.658	97.825
B-Estimate	77.764	81.753	95.948		104.529		
A-Estimate	62.589	61.868	88.388	66.603	84.697	110.634	90.217
Method	ANOVA	ANOVA	Normal	Normal	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates							
B-basis Value		97.176		76.143	118.694		95.076
B-Estimate	86.766		92.829			112.446	
A-Estimate	78.118	88.738	84.603	67.641	109.452	103.436	85.764
Method	Normal	pooled	pooled	pooled	pooled	pooled	pooled

Table 4-38: Statistics and Basis Values for SSB1 Strength Data as measured

4.27 "10/80/10" Single-Shear Bearing 2 (SSB2)

The SSB2 data is normalized. The only diagnostic test failure was the as measured RTD dataset for 2% offset strength which did not pass the ADK test. The ANOVA method was used to compute basis estimates for that dataset. However, it passed the ADK test after the modified CV method was applied, so modified CV basis values are provided. Pooling was appropriate for the normalized datasets, both 2% offset strength and ultimate strength dataset, but not the as measured datasets due to a failure of the ADK test for the as measured 2% offset strength and a failure of Levene's test for the as measured ultimate strength. Pooling was acceptable for all of the modified CV basis value computations.

There were no outliers. Statistics, basis values and estimates are given for the SSB2 strength data in Table 4-39. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-29.

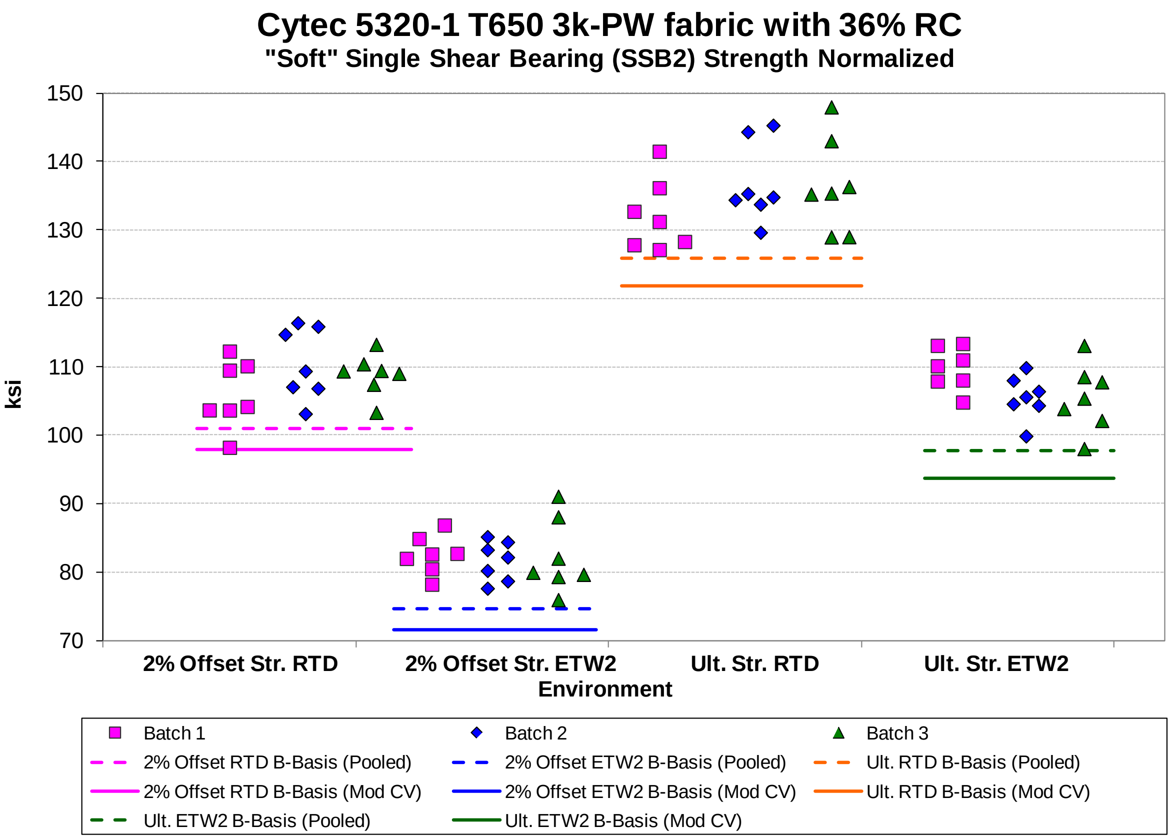

Figure 4-29: Batch plot for SSB2 normalized strength

Single Shear Bearing (SSB2) Strength Basis Values and Statistics								
	Normalized				As-measured			
Property	2% Offset Strength		Ultimate Strength		2% Offset Strength		Ultimate Strength	
Env	RTD	ETW2	RTD	ETW2	RTD	ETW2	RTD	ETW2
Mean	108.455	82.161	135.163	106.960	109.791	82.609	136.829	107.503
Stdev	4.667	3.687	6.132	4.136	5.420	4.137	7.035	3.716
CV	4.304	4.488	4.537	3.867	4.936	5.008	5.142	3.457
Modified CV	6.152	6.244	6.268	6.000	6.468	6.504	6.571	6.000
Min	98.223	75.961	127.122	98.042	98.244	75.585	126.342	97.989
Max	116.429	91.069	147.978	113.397	119.690	93.342	150.221	112.650
No. Batches	3	3	3	3	3	3	3	3
No. Spec.	21	21	21	21	21	21	21	21
Basis Values and Estimates								
B-basis Value	100.994	74.700	125.886	97.682		74.728	123.426	100.425
B-Estimate					86.621			
A-Estimate	95.867	69.573	119.510	91.306	70.083	69.109	113.871	95.378
Method	pooled	pooled	pooled	pooled	ANOVA	Normal	Normal	Normal
Modified CV Basis Values and Estimates								
B-basis Value	97.899	71.605	121.832	93.629	98.623	71.440	122.950	93.625
A-Estimate	90.644	64.350	112.670	84.467	90.947	63.764	113.412	84.087
Method	pooled	pooled	pooled	pooled	pooled	pooled	pooled	pooled

Table 4-39: Statistics and Basis Values for SSB2 Strength Data

4.28 "40/20/40" Single-Shear Bearing 3 (SSB3)

The SSB3 data is normalized. The initial peak strength dataset has data from only 15 specimens available from the RTD condition and only 14 specimens from the ETW2 condition. This is insufficient for CMH17 Rev G computations for basis values so only estimates are provided for the initial peak datasets.

There was insufficient data for the initial peak strength datasets to be pooled. The ultimate strength datasets, both as measured and normalized, did not pass Levene's test for equality of variance, so the data from the two conditions (RTD and ETW2) could not be pooled together. However, the 2% offset strength datasets, both as measured and normalized, and the ultimate strength dataset after the modified CV method was applied passed all tests for pooling environmental conditions.

There was one outlier. The highest value in batch two of the ETW2 condition for 2% offset strength was an outlier for batch two, not the ETW2 condition for both the as measured and normalized dataset. It was retained for this analysis.

Statistics, basis values and estimates are given for the SSB3 normalized strength data in Table 4-40 and the as measured strength data in Table 4-41. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-30.

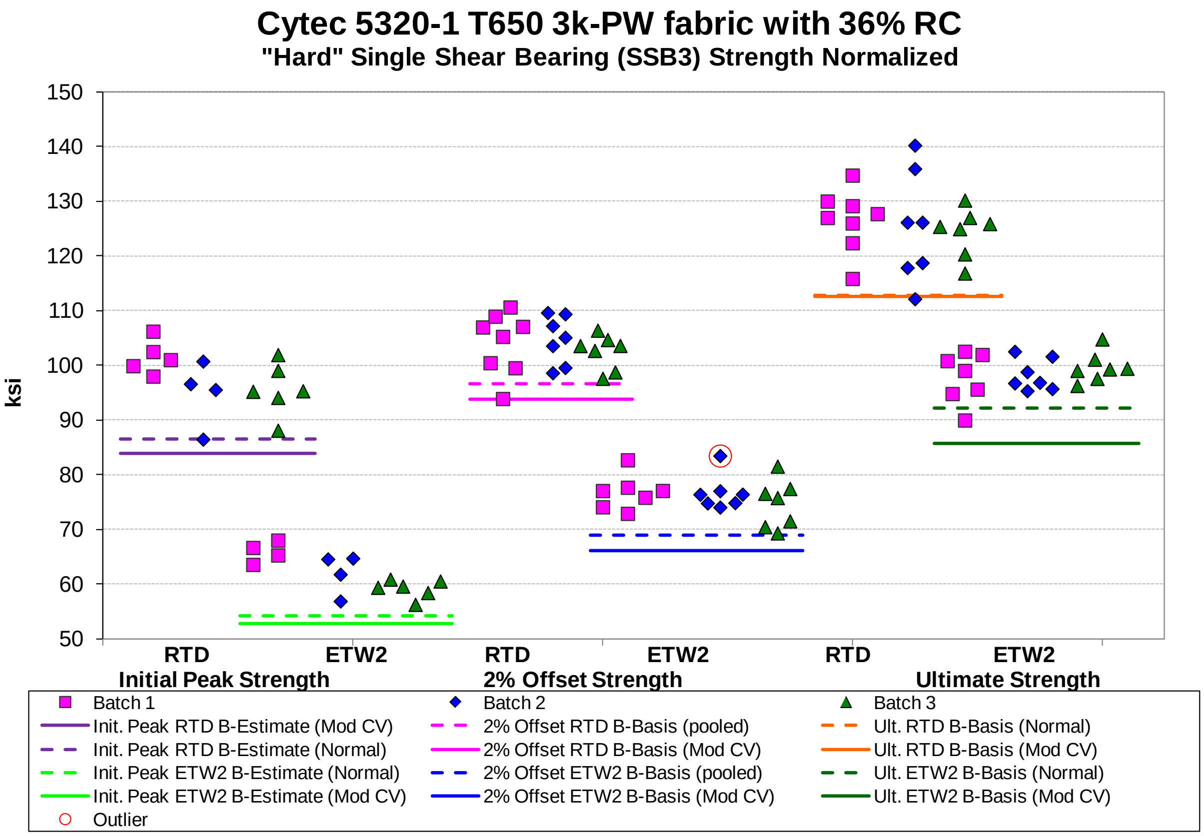

Figure 4-30: Batch plot for SSB3 normalized strength

Single Shear Bearing (SSB3) Strength Basis Values and Statistics						
	Normalized					
Property	Initial Peak Strength		2% Offset Strength		Ultimate Strength	
Env	RTD	ETW2	RTD	ETW2	RTD	ETW2
Mean	97.371	61.896	103.771	76.045	125.470	98.555
Stdev	5.257	3.647	4.470	3.570	6.777	3.406
CV	5.399	5.891	4.308	4.695	5.401	3.456
Modified CV	6.700	6.946	6.154	6.348	6.700	6.000
Min	86.469	56.264	93.892	69.330	112.129	89.961
Max	106.196	68.010	110.616	83.462	140.211	104.779
No. Batches	3	3	3	3	3	3
No. Spec.	15	14	22	21	22	21
Basis Values and Estimates						
B-basis Value			96.619	68.863	112.690	92.068
B-Estimate	86.486	41.644				
A-Estimate	78.821	27.220	91.682	63.934	103.562	87.442
Method	Normal	ANOVA	pooled	pooled	Normal	Normal
Modified CV Basis Values and Estimates						
B-basis Value			93.757	65.990	112.601	85.634
B-Estimate	83.873	52.826				
A-Estimate	74.403	46.482	86.845	59.087	103.719	76.765
Method	Normal	Normal	pooled	pooled	pooled	pooled

Table 4-40: Statistics and Basis Values for SSB3 Strength Data normalized

Single Shear Bearing (SSB3) Strength Basis Values and Statistics						
	As Measured					
Property	Initial Peak Strength		2% Offset Strength		Ultimate Strength	
Env	RTD	ETW2	RTD	ETW2	RTD	ETW2
Mean	98.599	62.297	104.982	76.642	126.946	99.326
Stdev	5.167	3.467	5.195	3.846	7.790	3.771
CV	5.240	5.566	4.949	5.018	6.136	3.796
Modified CV	6.620	6.783	6.474	6.509	7.068	6.000
Min	88.735	56.942	93.337	69.210	113.393	89.506
Max	108.293	67.282	113.421	84.514	144.464	106.091
No. Batches	3	3	3	3	3	3
No. Spec.	15	14	22	21	22	21
Basis Values and Estimates						
B-basis Value			96.893	68.520	112.255	92.143
B-Estimate	87.901	54.974				
A-Estimate	80.368	49.829	91.311	62.946	101.761	87.022
Method	Normal	Normal	pooled	pooled	Normal	Normal
Modified CV Basis Values and Estimates						
B-basis Value			94.430	66.048	113.451	85.777
B-Estimate	85.093	53.383				
A-Estimate	75.617	47.147	87.148	58.775	104.138	76.476
Method	Normal	Normal	pooled	pooled	pooled	pooled

Table 4-41: Statistics and Basis Values for SSB3 Strength Data as measured

4.29 Compression After Impact 1 (CAI1)

The CAI1 data is normalized, so both normalized and as measured statistics are provided. Basis values are not computed for this property. Testing is done only for the RTD condition. Summary statistics are presented in Table 4-42 and the data are displayed graphically in Figure 4-31. There were no outliers. Only one batch of material was tested. The highest value was identified as an outlier. It was identified as an outlier for both the normalized and the as measured datasets.

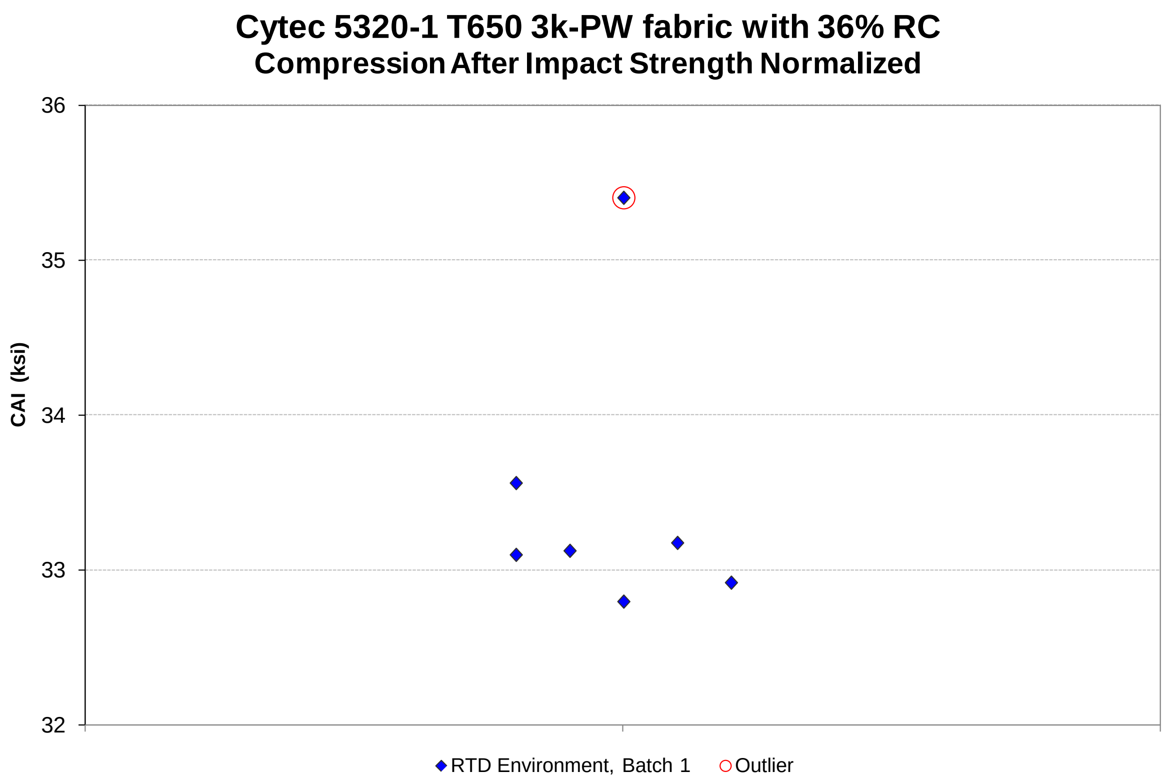

Figure 4-31: Plot for Compression After Impact normalized strength

Compression After Impact (CAI1) Strength Statistics		
	Normalized	As-measured
Env	RTD	RTD
Mean	33.442	33.301
Stdev	0.898	0.889
CV	2.684	2.669
Modified CV	6.000	6.000
Min	32.800	32.605
Max	35.405	35.252
No. Batches	1	1
No. Spec.	7	7

Table 4-42: Statistics for Compression After Impact Strength Data

4.30 Interlaminar Tension Strength (ILT) and Curved Beam Strength (CBS)

The ILT and CBS data is not normalized. Basis values are not computed for these properties. However the summary statistics are presented in Table 4-43 and the data are displayed graphically in Figure 4-32. There were no outliers. Only one batch of material was tested.

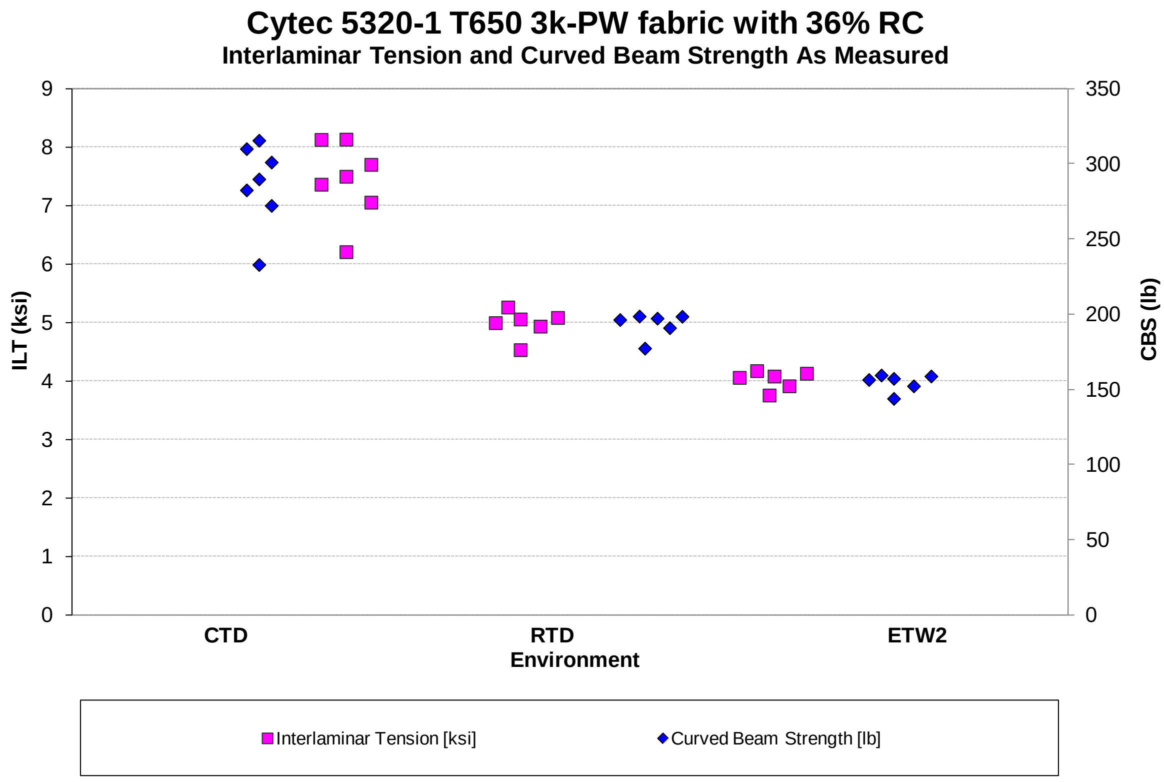

Figure 4-32: Plot for Interlaminar Tension and Curved Beam Strength as-measured

Interlaminar Tension (ILT) and Curved Beam Strength (CBS) Statistics as-measured						
	ILT			Curved Beam Strength		
Env	CTD	RTD	ETW2	CTD	RTD	ETW2
Mean	7.440	5.070	4.018	286.249	196.160	154.594
Stdev	0.670	0.333	0.156	28.017	11.093	5.856
CV	9.008	6.569	3.878	9.788	5.655	3.788
Modified CV	9.008	7.284	6.000	9.788	6.828	6.000
Min	6.208	4.531	3.756	232.859	177.240	143.817
Max	8.132	5.631	4.173	315.503	214.607	159.361
No. Batches	1	1	1	1	1	1
No. Spec.	7	7	6	7	7	6

Table 4-43: Statistics for ILT and CBS Strength Data

5. Outliers

Outliers were identified according to the standards documented in section 2.1.5, which are in accordance with the guidelines developed in section 8.3.3 of CMH-17 Rev G. An outlier may be an outlier in the normalized data, the as-measured data, or both. A specimen may be an outlier for the batch only (before pooling the three batches within a condition together) or for the condition (after pooling the three batches within a condition together) or both.

Approximately 5 out of 100 specimens will be identified as outliers due to the expected random variation of the data. This test is used only to identify specimens to be investigated for a cause of the extreme observation. Outliers that have an identifiable cause are removed from the dataset as they inject bias into the computation of statistics and basis values. Specimens that are outliers for the condition and in both the normalized and as-measured data are typically more extreme and more likely to have a specific cause and be removed from the dataset than other outliers. Specimens that are outliers only for the batch, but not the condition and specimens that are identified as outliers only for the normalized data or the as-measured data but not both, are typical of normal random variation.

All outliers identified were investigated to determine if a cause could be found. Outliers with causes were removed from the dataset and the remaining specimens were analyzed for this report. Information about specimens that were removed from the dataset along with the cause for removal is documented in the material property data report, NCAMP Test Report CAM-RP-2012-017 N/C.

Outliers for which no causes could be identified are listed in Table 5-1. With the exception of the specimen CUHYA114A for the UNC3 test, these outliers were included in the analysis for their respective test properties.

Test	Condition	Batch	Specimen Number	Normalized Strength	Strength As-measured	High/ Low	Batch Outlier	Condition Outlier
FT	ETW2	1	CUHUA21HF	110.133	Not an Outlier	L	Yes	No
WT	RTD	3	CUHJC213A	Not an Outlier	124.012	L	Yes	No
SBS	RTD	3	CUHQC212A	NA	9.931	L	Yes	No
SBS1	RTD	2	CUHqB274A	NA	8.439	L	No	Yes
IPS - 0.2% Offset	CTD	1	CUHNA115B	NA	11.011	L	No	Yes
UNT1	RTD	1	CUHAA114A	Not an Outlier	85.911	L	Yes	No
UNT1	ETW2	1	CUHAA21GF	99.178	Not an Outlier	H	No	Yes
UNT2	CTD	3	CUHBC11AB	57.207	Not an Outlier	L	Yes	No
UNT2	RTD	1	CUHBA112A	61.058	Not an Outlier	H	Yes	No
OHT1	ETW2	1	CUHDA21BF	53.216	53.001	H	No - as meas Yes - norm	Yes
OHT2	RTD	1	CUHEA113A	48.378	Not an Outlier	H	Yes	No
OHT2	ETW2	3	CUHEC11AF	34.598	Not an Outlier	H	Yes	No
FHC2	ETW2	1	CUH8A216F	35.850	36.0133	L	Yes	No - as meas Yes - norm
UNC1	ETW2	1	CUHWA11CF	63.158	62.814	H	Yes	No
UNC2	ETW2	2	CUHXB219F	33.441	Not an Outlier	L	Yes	No
UNC3	RTD	1	CUHYA114A**	107.515	108.235	H	Yes	Yes
UNC3	RTD	3	CUHYC111A	76.559	79.663	L	Yes	Yes
WC	CTD	1	CUHLA118B	Not an Outlier	129.824	H	Yes	No
WC	RTD	2	CUHLB211A	Not an Outlier	97.150	L	Yes	No
FC	ETW2	3	CUHZC21HF	77.482	79.311	H	Yes	No
CAI	RTD	1	CUHKA114A	35.405	35.252	H	Yes	NA
SSB1 - Ultimate Strength	ETW2	2	CUH1B118F	Not an Outlier	127.948	H	No	Yes
SSB1 - Ultimate Strength	RTD	1	CUH1A111A	120.566	Not an Outlier	L	Yes	No
SSB1 - Initial Peak Strength	RTD	1	CUH1A211A	90.233	Not an Outlier	L	Yes	Yes
SSB1 - Initial Peak Strength	RTD	3	CUH1C114A	105.402	Not an Outlier	H	Yes	No
SSB3 - 2% Offset Strength	ETW2	2	CUH3B11AF	83.462	84.514	H	Yes	No

** This specimen was removed from the analysis

Table 5-1: List of Outliers

6. References

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