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Toray Cetex® TC1225 (LM PAEK) T700GC 145 gsm 34% RC Unsized Fiber Unidirectional Slit Tape (0.25 inch) Material Allowables Statistical Analysis Report

NCAMP Project Number: NPN 052101

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1. Introduction

This report contains statistical analysis of the Toray Cetex® TC1225 (LM PAEK) T700GC 145 gsm 34% RC Unsized Fiber Unidirectional Slit Tape (0.25 inch) material property data published in NCAMP Test Report CAM-RP-2025-016 Rev A. The lamina and laminate material property data have been generated with NCAMP oversight through NCAMP Project Number NPN 052101 and also meet the requirements outlined in NCAMP Standard Operating Procedure NSP 100. 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 2. The qualification material was procured to NCAMP Material Specification NMS 122/2. The qualification test panels were consolidated in accordance with NCAMP Process Specification NPS 81225AFP, using “C” Consolidation Cycle. The panels were fabricated at Advanced Technologies Lab for Aerospace Systems (ATLAS) National Institute for Aviation Research (NIAR) Wichita State University located at 1845 N. Fairmount ,Wichita, KS 67260-0093 . The NCAMP Test Plan NTP 1226Q1 Rev C was used for this qualification program. 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 Vol 1. 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) Volume 1.

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 the *Statistical Methods* section of CMH-17 Vol 1. 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 the *Statistical Methods* section of CMH-17 Vol 1 are adequate for the given program.

Aircraft companies should not use the data published in this report without specifying NCAMP Material Specification NMS 122/2. NMS 122/2 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 122/2.* NMS 122/2 is a free, publicly available, non-proprietary aerospace industry material specification.

The data in 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
Longitudinal Tension	LT
Longitudinal Compression	LC
Transverse Tension	TT
Transverse Compression	TC
In-Plane Shear	IPS
Double Notch Shear	DNS
Short Beam Strength	SBS
90° Flexural	90FLEX
Unnotched Tension	UNT
Unnotched Compression	UNC
Open Hole Tension	OHT
Filled Hole Tension	FHT
Open Hole Compression	OHC
Filled Hole Compression	FHC
Single Shear Bearing	SSB
Compression After Impact	CAI

Table 1-1: Test Property Abbreviations

Test Property	Symbol
Longitudinal Compression Strength	F_1^{cu}
Longitudinal Compression Modulus	E_1^c
Longitudinal Compression Poisson's Ratio	v_{12}^c
Longitudinal Tension Strength	F_1^{tu}
Longitudinal Tension Modulus	E_1^t
Longitudinal Tension Poisson's Ratio	v_{12}^t
Transverse Compression Strength	F_2^{cu}
Transverse Compression Modulus	E_2^c
Transverse Compression Poisson's Ratio	v_{21}^c
Transverse Tension Strength	F_2^{tu}
Transverse 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 Modulus	G_{12}^s

Table 1-2: Test Property Symbols

Environmental Condition	Abbreviation	Temperature
Cold Temperature Ambient	CTA	–65 ± 5˚F
Room Temperature Ambient	RTA	70 ± 10˚F
Elevated Temperature Ambient	ETA1	275 ± 5˚F
Elevated Temperature Ambient	ETA2	400 ± 5˚F
Elevated Temperature Wet	ETW	275 ± 5˚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 50/40/10 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-2025-016 Rev A.

1.2 Pooling Across Environments

When pooling across environments was allowable, the pooled co-efficient of variation was used. CMH17 STATS (CMH17 Approved Statistical Analysis Program) 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, which are also provided by CMH17 STATS.

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.

1.4 Modified Coefficient of Variation (CV) Method

A common problem with new material qualifications is that the initial specimens produced and tested are not representative of all of the variability that will be encountered when the material is 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 the *Modified Coefficient Of Variation Approach* section of CMH-17 Vol 1. 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 CMH17 STATS. Pooling across environments will be used whenever it is permissible according to CMH-17 Vol 1 guidelines. If pooling is not permissible, the results of a single point analysis provided by CMH17 STATS is included instead. If the data does not meet CMH-17 Vol 1 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 CMH17 STATS Statistical Formulas and Computations

This section contains the details of the specific formulas CMH17 STATS 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.: $$S = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(X_i - \bar{X}\right)^2}$$ **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.: $$S_p = \sqrt{\frac{\sum_{i=1}^{k}\left(n_i - 1\right)S_i^2}{\sum_{i=1}^{k}\left(n_i - 1\right)}}$$ **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.

Basis Values:

$$A - basis = \overline{X} - K_a S$$
$$B - basis = \overline{X} - K_b S \qquad \textbf{Equation 6}$$

2.1.3.1 K-factor computations

K_a and K_b are computed according to the methodology documented in the *Statistical Methods* section of the CMH-17 Vol 1 Handbook. 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

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

$f = N - r$

$$q(f) = 1 - \frac{2.323}{\sqrt{f}} + \frac{1.064}{f} + \frac{0.9157}{f\sqrt{f}} - \frac{0.6530}{f^2}$$ **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:

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

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

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.

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

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

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

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

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 as described in the *Maximum Normed Residual* section of the CMH-17 Vol 1 Handbook.

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

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

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 $z_{(1)}, z_{(2)},\ldots z_{(L)}$, 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:

$$ADK = \frac{n-1}{n^2(k-1)}\sum_{i=1}^{k}\left[\frac{1}{n_i}\sum_{j=1}^{L} h_j \frac{\left(nF_{ij}-n_iH_j\right)^2}{H_j\left(n-H_j\right)-\frac{nh_j}{4}}\right] \quad \textbf{Equation 25}$$

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:

$$ADC = 1+\sigma_n\left[z_\alpha + \frac{0.678}{\sqrt{k-1}} - \frac{0.362}{k-1}\right] \quad \textbf{Equation 26}$$

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.

$$\sigma_n^2 = VAR(ADK) = \frac{an^3+bn^2+cn+d}{(n-1)(n-2)(n-3)(k-1)^2} \quad \textbf{Equation 27}$$

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

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

$$OSL = \frac{1}{1 + e^{-0.48 + 0.78\ln(AD^*) + 4.58AD^*}}, \quad AD^* = \left(1 + \frac{4}{n} - \frac{25}{n^2}\right)AD$$ **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. CMH-17 STATS 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.

2.1.9 Distribution Tests

In addition to testing for normality using the Anderson-Darling test (see 2.1.7), CMH17 STATS 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 $x_{(1)}, ..., x_{(n)}$.

2.1.9.1 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 non-centrality parameter $1.282\sqrt{n}$ and n − 1 degrees of freedom. Since this is 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.

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

The exact computation of k_A values is $1/\sqrt{n}$ times the 0.95th quantile of the noncentral t-distribution with non-centrality 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_A 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.

2.1.9.3 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

$$e^{-\left(a/\alpha\right)^{\beta}} - e^{-\left(b/\alpha\right)^{\beta}}$$ **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 2.1.9.3.1). Calculations specific to the goodness-of-fit test for the Weibull distribution are provided in section 2.1.9.3.2.

2.1.9.3.1 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**

CMH17 STATS solves these equations numerically for $\hat{\beta}$ and $\hat{\alpha}$ in order to compute basis values.

2.1.9.3.2 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 2.1.9.3.1, let

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

The Anderson-Darling test statistic is

$$\mathrm{AD}=\sum_{\mathrm{i}=1}^{\mathrm{n}}\frac{1-2\mathrm{i}}{\mathrm{n}}\left[\ln\left[1-\exp(-\mathrm{z}_{(\mathrm{i})})\right]-\mathrm{z}_{(\mathrm{n}+1-\mathrm{i})}\right]-\mathrm{n}$$ **Equation 39**

and the observed significance level is

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

where

$$AD^{*}=\left(1+\frac{0.2}{\sqrt{n}}\right)AD$$ **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.

2.1.9.3.3 Basis value calculations for the Weibull distribution

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

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

where

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

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

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

V is the value in Table 2-1 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.

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

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

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 2-1: Weibull Distribution Basis Value Factors

2.1.9.4 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.

2.1.9.4.1 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 Equation 29 above with Equation 47 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 Equation 30 above and the observed significance level (OSL) is computed using Equation 31 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 $\leq$ 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.

2.1.9.4.2 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.

2.1.10 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.

2.1.10.1 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:

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

For A-Basis values:

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

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 value is 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.

2.1.10.2 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 2-2. 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 2-3. For an A-basis value that meets all the requirements of CMH-17 Vol 1, 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 2-2: 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 2-3: A-Basis Hanson-Koopmans Table

2.1.11 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.

2.1.11.1 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 methods described in the *Calculation Of Statistically-Based Material Properties* section of the CMH-17 Vol 1 Handbook 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.

2.2 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 = $\overline{X} - k_b S_{adj} = \overline{X} - k_b \cdot 0.08 \cdot \overline{X}$ **Equation 61**

2.3 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 = $\overline{X}_1 - K_{(N_1,N_2)} \cdot \overline{X}_1 \cdot \max\left(CV_1, CV_2\right)$ **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 = $\overline{X}_1 - K_{(N_1,N_2)} \cdot \overline{X}_1 \cdot Max\left(8\%, CV_1, CV_2\right)$ **Equation 63**

With:

$\overline{X}_1$ 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 2-4

		N1													
		2	3	4	5	6	7	8	9	10	11	12	13	14	15
N1+N2-2	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 2-4: B-Basis Factors for Small Datasets Using Variability of Corresponding Large Dataset

2.4 0º Lamina Strength Derivation

Lamina strength values in the 0º direction were not obtained directly for any conditions during compression tests. They are derived from the cross-ply lamina test results using a back out formula. Unless stated otherwise, the 0° lamina strength values were derived using the following formula:

$F_{0^\circ}^{u} = F_{0^\circ/90^\circ}^{u} \cdot BF$ where BF is the backout factor.

$F_{0^\circ/90^\circ}^{u}$ =UNC0 or UNT0 strength values

$$BF = \frac{E_1\left[V_0 E_2 + \left(1-V_0\right)E_1\right] - \left(\nu_{12}E_2\right)^2}{\left[V_0 E_1 + \left(1-V_0\right)E_2\right]\left[V_0 E_2 + \left(1-V_0\right)E_1\right] - \left(\nu_{12}E_2\right)^2} \qquad \textbf{Equation 64}$$

V_0=fraction of 0º plies in the cross-ply laminate (½ for UNC0)
E_1 = Average across of batches of modulus for LC and LT as appropriate
E_2 = Average across of batches of modulus for TC and TT as appropriate
ν_{12} = major Poisson's ratio of 0º plies from an average of all batches

This formula can also be found in section 2.4.2, equation 2.4.2.1(b) of CMH-17 Vol 1.

In computing these strength values, the values for each environment are computed separately. The compression values are computed using only compression data, the tension values are computed using only tension data. Both normalized and as-measured computations are done using the as-measured and normalized strength values from the UNC0 and UNT0 strength values.

2.4.1 0º Lamina Strength Derivation (Alternate Formula)

In some cases, the previous formula cannot be used. For example, if there were no ETD tests run for transverse tension and compression, the value for E_2 would not be available. In that case, this alternative formula is used to compute the strength values for longitudinal tension and compression. It is similar to, but not quite the same as the formula detailed above. It requires the UNC0 and UNT0 strength and modulus data in addition to the LC and LT modulus data.

The 0° lamina strength values for the LC ETD condition were derived using the formula:

$$F_{0^\circ}^{cu} = F_{0^\circ/90^\circ}^{cu} \frac{E_1^c}{E_{0^\circ/90^\circ}^c}, \quad F_{0^\circ}^{tu} = F_{0^\circ/90^\circ}^{tu} \frac{E_1^t}{E_{0^\circ/90^\circ}^t} \qquad \textbf{Equation 65}$$

with

$F_{0^\circ}^{cu}, F_{0^\circ}^{tu}$ the derived mean lamina strength value for compression and tension respectively

$F_{0^\circ/90^\circ}^{cu}, \quad F_{0^\circ/90^\circ}^{tu}$ are the mean strength values for UNC0 and UNT0 respectively

$E_1^c, \quad E_1^t$ are the modulus values for LC and LT respectively

$E_{0^\circ/90^\circ}^c, \quad E_{0^\circ/90^\circ}^t$ are the modulus values for UNC0 and UNT0 respectively

This formula can also be found in section 2.4.2, equation 2.4.2.1(d) of CMH-17 Vol 1.

2.5 Specification Limits

Specification limits are calculated based in the qualification dataset only. In order to compute specification limits we make the following assumptions: a) The qualification dataset represents the population[1] b) In the future we might draw a new sample of size n=5 c) In the future we might run an acceptance test for the new sample statistics (this is a hypothesis testing approach; testing the hypothesis that the sample statistics equal the population parameters with $\alpha = 1\%$). Then, the specification limits are computed as the limits required by the statistics of the future sample to pass the acceptance test. The statistics to be tested are be the modulus mean, the strength mean or the strength minimum individual of the qualification dataset. In the case of modulus mean, a two-tails

[1] This is a different assumption than the one required for computing allowables. While computing allowables, we assume that all the future material properties values are the population and the qualification dataset is the sample.

interval is used. In case of strength mean and strength minimum individual, a one-tail left interval is used.

Therefore, in order to compute the specification limits we need to compute the intervals around the mean and minimum individual values from the qualification dataset for some specific material property, according to the following formulas. First, assume the following:

$x = \text{Some Material Strength Property}$
$\overline{x} = \text{Mean of x}$
$S = \text{Standard Deviation of x}$

Then we define:

$\mathrm{W_{mean}} = \mathrm{W_{mean}}$= Specification limit for the mean
$\mathrm{W_{min\,indiv}} = \mathrm{W_{min\,indiv}}$ = Specification limit for the minimum individual

We compute these as the following:

$\mathrm{W_{mean}} = \overline{x} - \mathrm{k_n^{mean}}.\mathrm{S}$ **Equation 64**
$\mathrm{W_{min\,indiv}} = \overline{x} - \mathrm{k_n^{min\,indiv}}.\mathrm{S}$ **Equation 65**

Where the tolerance factor k^{mean} is found in table 8.5.17 in CMH-17 Vol 1 for n=5 and α =0.01 and tolerance factor $k^{min\ indiv}$ is found in table 8.5.18 in CMH-17 Vol 1 for n=5 and α =0.01

For modulus properties we define:

$\mathrm{W_{lower}}$ = Lower specification limit for the mean of modulus property
$\mathrm{W_{upper}}$ = Upper specification limit for the mean of modulus property

We compute these as the following:

$\mathrm{W_{lower}} = \overline{x} - \mathrm{k.S}$ **Equation 66**
$\mathrm{W_{upper}} = \overline{x} + \mathrm{k.S}$ **Equation 67**

Where the tolerance factor k is determined by the following equations:

$k = t_c.\sqrt{(\frac{1}{N} + \frac{1}{n})}$ **Equation 68**

and

$t_c = t.INV(\alpha, N)$ **Equation 69**

Where t.INV is the inverse of the cumulative Student’s t-distribution, N=sample size of the qualification dataset, n=5 and α =0.01.

2.5.1.1 Specification Limits for Program

The tables below have the qualification dataset statistics and specification limits. Table 2-5 is for strength properties and Table 2-6 is for modulus properties.

Test Property	Test Condition	Mean [ksi]	CV (%)	Mod CV (%)	k_mean	k_min indiv	As-is		Mod CV		Notes
							W_mean [ksi]	W_min indiv [ksi]	W_mean [ksi]	W_min indiv [ksi]	
0° Tension (LT): Normalized Strength from LT specimens	RTD (70°F)	393.9	6.808	7.404	1.143	3.072	363.3	311.5	360.6	304.3	Qualification Data Only
0°/90° Compression (UNC0) Normalized Strength	RTD (70°F)	113.5	4.178	6.089	1.143	3.072	108.1	98.98	105.7	92.31	Qualification Data Only
90° FLEX Normalized Strength	RTD (70°F)	21.92	13.809	13.809	1.143	3.072	18.47	12.63	18.47	12.63	Qualification Data Only

Table 2-5: Specification Limits and Qualification Data for Strength Properties

Test Property	Test Condition	Mean [Msi]	CV (%)	Mod CV (%)	t_statistic	As-is		Mod CV		Notes
						Lower Limit [Msi]	Upper Limit [Msi]	Lower Limit [Msi]	Upper Limit [Msi]	
0° Tension (LT) Normalized Modulus	RTD (70°F)	19.38	2.257	6.000	2.878	18.74	20.01	17.73	21.02	Qualification Data Only
0°/90° Compression (UNC0) Normalized Modulus	RTD (70°F)	9.430	3.484	6.000	2.861	8.960	9.900	8.636	10.22	Qualification Data Only

Table 2-6: Specification Limits and Qualification Data for Modulus Properties

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 Vol 1. 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 Vol 1 is 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 Table 3-1 and Table 3-2 of recommended values.

1. Recommended values are NEVER estimates. Only B-basis values that meet all requirements of CMH-17 Vol 1 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 Vol 1 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 from CMH-17 STATS 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 CTA-RTA-ETA1 trend of the basis values is not consistent with the CTA-RTA-ETA1 trend of the average values), then the B-basis values will not be recommended.

NCAMP Recommended B-Basis Values for
Toray Cetex® TC1225 (LM PAEK) T700GC 145 gsm 34% RC Unsized Fiber Unidirectional Slit Tape (0.25 inch)
All B-Basis Values in this Table Meet the Standards for Publication in the CMH-17 Volume 1 Handbook
Values Are for Normalized Data Unless Noted

Lamina Strength Tests

Environment	Statistic	LT	TT*	LC from UNC0***	TC*	UNC0	IPS* 0.2% Offset Strength	IPS* Strength at 5% Strain	90FLEX	DNS*	SBS*
CTA (-65°F)	B-basis	334.3	14.57	209.0	35.67	112.8	7.026	12.41		16.08	18.31
	Mean	385.9	16.32	231.7	40.47	125.0	7.798	13.74		17.60	20.27
	CV	6.859	6.509	6.475	6.000	6.475	6.000	6.000		6.252	6.000
RTA (70°F)	B-basis	NA: A	12.32	188.3	28.97	101.5	5.552	9.028	NA: A	12.65	13.45
	Mean	393.9	14.07	210.8	32.86	113.5	6.320	10.36	21.92	14.16	15.40
	CV	6.808	6.000	6.089	6.000	6.089	6.000	6.000	13.81	6.000	6.000
ETA1 (275°F)	B-basis	320.2	6.916**	143.6	14.98	76.39	2.599	4.729		7.174	7.565
	Mean	379.6	7.274	165.9	16.99	88.41	2.994	5.365		8.692	8.594
	CV	7.922	2.409	6.520	6.000	6.520	6.777	6.000		6.000	6.065

Notes:
The modified CV B-basis value is recommended when available.
The CV provided corresponds with the B-basis value given.
ETA2 and ETW were excluded from this table because recommended values were not computed for those environmental conditions.
NA implies that tests were run but data did not meet NCAMP's recommended requirements.
"NA: A" indicates ANOVA with 3 batches.
Shaded empty boxes indicate that test data is not available for that property and condition.
* Data is as measured rather than normalized
** Indicates the single-point B-basis value is greater than 90% of the mean values. We allow the recommended values to be more than 90% when the data is pooled.
***Derived from cross-ply using backout factor.

Table 3-1: NCAMP Recommended B-Basis Values for Lamina Test Data

NCAMP Recommended B-Basis Values for
Toray Cetex® TC1225 (LM PAEK) T700GC 145 gsm 34% RC Unsized Fiber Unidirectional Slit Tape
(0.25 inch)
All B-Basis Values in this Table Meet the Standards for Publication in the CMH-17 Volume 1 Handbook
Values Are for Normalized Data Unless Noted

Laminate Strength Tests

Layup	Environment	Statistic	OHT	OHC	UNT	UNC	FHT	FHC	SBS*	DNS*	SSB Proc. C	
											2% Offset Strength	Ultimate Strength
25/50/25	CTA (-65°F)	B-basis	NA: A		134.5		75.42					
		Mean	74.44		154.7		83.80					
		CV	5.195		6.626		6.000					
	RTA (70°F)	B-basis	NA: A	43.83	NA: A	77.02	68.35	69.94	12.87	11.39	113.6	126.6
		Mean	72.32	48.46	152.3	86.27	76.73	77.48	14.16	12.92	126.7	140.8
		CV	6.015	6.000	5.567	7.055	6.000	6.000	6.000	6.000	6.000	6.000
	ETA1 (275°F)	B-basis	NA: A	30.67	NA: A	56.45	66.69	51.71	7.853	6.602	91.82	104.1
		Mean	70.01	35.31	138.2	65.71	75.07	59.25	9.143	7.503	104.9	118.4
		CV	7.020	6.000	5.415	6.000	6.057	6.000	6.000	6.083	6.466	6.000
10/80/10	CTA (-65°F)	B-basis	52.30		79.53		58.69					
		Mean	57.90		88.07		64.79					
		CV	6.000		6.000		6.000					
	RTA (70°F)	B-basis	48.95	41.00	74.18	53.20	52.33	52.21			108.8	130.5
		Mean	54.55	45.38	82.73	58.81	58.42	59.22			120.8	144.8
		CV	6.000	6.000	6.000	6.000	6.000	6.000			6.000	6.000
	ETA1 (275°F)	B-basis	39.23	28.09	58.63	37.35	41.44	38.28			84.55	100.3
		Mean	44.83	32.47	67.18	42.99	47.53	43.57			96.50	114.5
		CV	6.000	6.275	6.198	6.000	6.000	6.149			6.000	6.000
50/40/10	CTA (-65°F)	B-basis	NA: A		NA: A		95.53					
		Mean	106.1		220.0		109.0					
		CV	7.620		6.041		6.706					
	RTA (70°F)	B-basis	NA: A	51.78	NA: A	102.9	91.50	87.67			111.1	129.2
		Mean	103.4	57.56	225.1	113.6	105.0	97.14			123.3	143.2
		CV	8.335	6.244	5.748	6.000	7.113	6.000			6.000	6.000
	ETA1 (275°F)	B-basis	NA: A	38.94	NA: A	74.59	NA: A	65.20			85.90	98.32
		Mean	108.1	44.72	214.8	85.16	107.6	74.67			98.08	112.4
		CV	7.567	6.000	6.496	6.000	6.291	6.000			6.000	6.000

Notes: The modified CV B-basis value is recommended when available.
The CV provided corresponds with the B-basis value given.
ETA2 and ETW were excluded from this table because recommended values were not computed for those environmental conditions.
NA implies that tests were run but data did not meet NCAMP's recommended requirements.
"NA: A" indicates ANOVA with 3 batches.
Shaded empty boxes indicate that test data is not available for that property and condition.
* Data is as measured rather than normalized.

Table 3-2: NCAMP Recommended B-Basis Values for Laminate Test Data

3.2 Lamina and Laminate Summary Tables

Prepreg Material: Toray Cetex® TC1225 (LM PAEK) T700GC 145 gsm 34% RC Unsized Fiber (0.25 inch)
Material Specification: NMS 122/2
Process Specification: NPS 81225 AFP
Fiber: T700GC-12K **Resin:** TC1225 LMPAEK

Toray Cetex® TC1225 (LM PAEK) T700GC 145 gsm 34% RC Unsized Fiber Unidirectional Slit Tape (0.25 inch) Lamina Properties Summary

Tg(ambient): 291.2°F **DSC Tg (ambient):** 292.7°F **Tg METHOD:** DMA (ASTM D7028) & DSC (ASTM D3418)
Tg(wet): 271.5°F **SC, Melting Temperature (Peak):** 590.6°F
DSC, Hot Crystallization Temperature (Peak): 501.5°F

	Lot 1	Lot 2	Lot 3
Date of fiber manufacture	4/5/2024	1/23/2023	1/20/2024
Date of resin manufacture	3/20/2023	03/12/23	03/27/23
Date of prepreg manufacture	5/16/2024	4/17/2024	5/13/2024
Date of composite manufacture		7/17/2024-1/23/2025	
Date of testing		10/17/2024 to 7/2/2025	
Date of data submittal		7/2/2025	
Date of analysis		07/13/2025 to 11/12/2025	

LAMINA MECHANICAL PROPERTY B-BASIS SUMMARY
Data reported: As-Measured Followed by Normalized Values in Parentheses. Normalizing CPT: 0.005400 in
Values Shown in Shaded Boxes do not Meet CMH-17 Volume 1 Requirements and are Estimates Only
These Values may not be Used for Certification Unless Specifically Allowed by the Certifying Agency

Test Condition	CTA (-65°F)			RTA (70°F)			ETA1(275°F)			ETA2 (400°F)			ETW (275°F)		
Property	**B-Basis**	**Modified CV B-basis**	**Mean**	**B-Basis**	**Modified CV B-basis**	**Mean**	**B-Basis**	**Modified CV B-basis**	**Mean**	**B-Basis**	**Modified CV B-basis**	**Mean**	**B-Basis**	**Modified CV B-basis**	**Mean**
F_1^{tu}	334.0	331.0	388.6	242.1	NA	400.0	314.4	314.4	383.0	277.3	230.6	304.4	293.0	279.9	369.4
(ksi)	(342.9)	(334.3)	(385.9)	(283.9)	NA	(393.9)	(320.8)	(320.2)	(379.6)	(264.8)	(232.0)	(306.1)	(270.5)	(270.5)	(371.5)
E_1^t			19.57			19.65			20.12			18.34			19.35
(Msi)			(19.45)			(19.38)			(19.95)			(18.44)			(19.44)
ν_{12}^t			0.3226			0.3499			0.3305			0.5682			0.3602
F_2^{tu} (ksi)	14.70	14.57	16.32	13.25	12.32	14.07	6.916	NA	7.274	2.985	2.489	3.200	5.463	4.736	6.251
E_2^t (Msi)			1.410			1.316			1.100			0.2808			0.8440
F_1^{cu} from UNC0*	210.7	206.0	228.9	190.7	186.2	208.8	118.0	142.0	164.5	34.71	34.71	48.97	126.9	NA	163.3
(ksi)	(214.9)	(209.0)	(231.7)	(194.2)	(188.3)	(210.8)	(149.3)	(143.6)	(165.9)	(35.52)	(35.52)	(50.03)	(147.4)	NA	(162.4)
E_1^c			17.69			17.44			17.87			18.97			17.18
(Msi)			(17.95)			(17.66)			(18.09)			(19.17)			(17.25)
ν_{12}^c			0.3596			0.3389			0.3550			0.5176			0.3104
F_2^{cu} (ksi)	38.75	35.67	40.47	27.06	28.97	32.86	15.74	14.98	16.99	4.932	4.932	7.281	15.51	12.19	16.09
E_2^c (Msi)			1.439			1.386			1.206			0.3180			1.059
(0/90) UNC0 Strength	113.7	111.3	123.6	102.8	100.4	112.6	62.92	75.62	87.71	17.64	17.64	24.89	67.32	NA	86.63
(ksi)	(115.9)	(112.8)	(125.0)	(104.6)	(101.5)	(113.5)	(79.51)	(76.39)	(88.41)	(18.05)	(18.05)	(25.43)	(78.18)	NA	(86.12)
(0/90) UNC0 Modulus			9.456			9.348			9.652			9.564			9.409
(Msi)			(9.569)			(9.430)			(9.743)			(9.773)			(9.356)
$F_{12}^{s0.2\%}$ (ksi)	7.268	7.026	7.798	5.643	5.552	6.320	2.670	2.599	2.994	0.7969	0.6800	0.8975	2.143	1.750	2.310
$F_{12}^{s5\%}$ (ksi)	13.43	12.41	13.74	10.05	9.028	10.36	5.055	4.729	5.365	1.803	1.520	2.006	4.497	3.480	4.593
G_{12}^s (Msi)			0.6923			0.6157			0.3030			0.06281			0.2168
90FLEX Strength				5.807	NA	21.62									
(ksi)				(4.604)	NA	(21.92)									
90FLEX Modulus						1.433									
(Msi)						(1.457)									
DNS (ksi)	14.91	16.08	17.60	13.52	12.65	14.16	8.050	7.174	8.692				6.196	5.733	7.566
SBS (ksi)	19.55	18.31	20.27	14.68	13.45	15.40	6.712	7.565	8.594				7.313	5.776	7.623

*Derived from cross-ply using backout factor.

Table 3-3: Lamina Tests Summary of Results

Prepreg Material:	Toray Cetex® TC1225 (LM PAEK) T700GC 145 gsm 34% RC Unsized Fiber (0.25 inch)
Material Specification:	NMS 122/2
Process Specification:	NPS 81225 AFP
Fiber:	T700GC-12K
Resin:	TC1225 LMPAEK
Tg(ambient):	291.2°F
Tg(wet):	271.5°F
DSC Tg (ambient):	292.7°F
DSC, Melting Temperature (Peak):	590.6°F
DSC, Hot Crystallization Temperature (Peak):	501.5°F
Tg METHOD:	DMA (ASTM D7028) & DSC (ASTM D3418)

Toray Cetex® TC1225 (LM PAEK) T700GC 145 gsm 34% RC Unsized Fiber Unidirectional Slit Tape (0.25 inch) Lamina Properties

	Lot 1	Lot 2	Lot 3
Date of fiber manufacture	4/5/2024	1/23/2023	1/20/2024
Date of resin manufacture	3/20/2023	03/12/23	03/27/23
Date of prepreg manufacture	5/16/2024	4/17/2024	5/13/2024
Date of composite manufacture		7/17/2024-1/23/2025	
Date of testing		10/17/2024 to 7/2/2025	
Date of data submittal		7/2/2025	
Date of analysis		07/13/2025 to 11/12/2025	

LAMINATE MECHANICAL PROPERTY B-BASIS SUMMARY
Data reported: Normalized unless noted. Normalizing CPT: 0.005400 in

Values Shown in Shaded Boxes do not Meet CMH-17 Volume 1 Requirements and are Estimates Only
These Values may not be Used for Certification Unless Specifically Allowed by the Certifying Agency

Test	Property	Test Condition	Unit (Layup:)	Quasi Isotropic 25/50/25 B-value	Quasi Isotropic 25/50/25 Mod. CV B-value	Quasi Isotropic 25/50/25 Mean	"Soft" 10/80/10 B-value	"Soft" 10/80/10 Mod. CV B-value	"Soft" 10/80/10 Mean	"Hard" 50/40/10 B-value	"Hard" 50/40/10 Mod. CV B-value	"Hard" 50/40/10 Mean
OHT	Strength	CTA (-65°F)	(ksi)	48.87	NA	74.44	53.55	52.30	57.90	53.50	NA	106.1
		RTA (70°F)		42.78	NA	72.32	42.68	48.95	54.55	44.07	NA	103.4
		ETA1 (275°F)		36.35	NA	70.01	38.85	39.23	44.83	55.02	NA	108.1
		ETA2 (400°F)		56.95	46.11	60.85						
		ETW (275°F)		63.48	50.24	66.30						
OHC	Strength	RTA (70°F)	(ksi)	46.71	43.83	48.46	40.30	41.00	45.38	43.11	51.78	57.56
		ETA1 (275°F)		29.47	30.67	35.31	26.76	28.09	32.47	42.92	38.94	44.72
		ETA2 (400°F)		11.14	11.14	20.41						
		ETW (275°F)		30.08	26.01	34.33						
UNT	Strength	CTA (-65°F)	(ksi)	111.8	134.5	154.7	74.20	79.53	88.07	128.8	NA	220.0
	Modulus		(Msi)			7.256			4.680			11.21
	Strength	RTA (70°F)	(ksi)	94.17	NA	152.3	63.89	74.18	82.73	135.2	NA	225.1
	Modulus		(Msi)			7.106			4.516			11.15
	Strength	ETA1 (275°F)	(ksi)	90.92	NA	138.2	61.03	58.63	67.18	130.3	NA	214.8
	Modulus		(Msi)			6.855			3.920			11.06
	Strength	ETA2 (400°F)	(ksi)	96.72	78.12	100.4						
	Modulus		(Msi)			6.280						
	Strength	ETW (275°F)	(ksi)	122.5	99.66	131.5						
	Modulus		(Msi)			6.511						
UNC	Strength	RTA (70°F)	(ksi)	61.71	77.02	86.27	55.34	53.20	58.81	90.84	102.9	113.6
	Modulus		(Msi)			6.720			4.449			10.38
	Strength	ETA1 (275°F)	(ksi)	60.65	56.45	65.71	39.50	37.35	42.99	79.22	74.59	85.16
	Modulus		(Msi)			6.736			4.191			10.51
	Strength	ETA2 (400°F)	(ksi)	13.28	13.28	28.63						
	Modulus		(Msi)			6.038						
	Strength	ETW (275°F)	(ksi)	54.51	47.24	62.35						
	Modulus		(Msi)			6.488						
FHT	Strength	CTA (-65°F)	(ksi)	65.98	75.42	83.80	53.27	58.69	64.79	78.37	95.53	109.0
		RTA (70°F)		56.62	68.35	76.73	45.10	52.33	58.42	70.47	91.50	105.0
		ETA1 (275°F)		55.04	66.69	75.07	39.12	41.44	47.53	67.59	NA	107.6
		ETA2 (400°F)		61.23	48.21	63.63						
		ETW (275°F)		69.75	54.76	72.28						
FHC	Strength	RTA (70°F)	(ksi)	72.92	69.94	77.48	56.67	52.21	59.22	90.63	87.67	97.14
		ETA1 (275°F)		49.10	51.71	59.25	34.02	38.28	43.57	70.94	65.20	74.67
		ETA2 (400°F)		10.84	10.84	31.58						
		ETW (275°F)		53.84	46.13	60.88						

*When FHC>UNC, FHC data is for informational purposes only and may not be substantial enough to be used for design.

Table 3-4: Laminate Tests Summary of Results – Part A

Test	Property	Test Condition	Unit	Quasi Isotropic 25/50/25			"Soft" 10/80/10			"Hard" 50/40/10		
			Layup:	B-value	Mod. CV B-value	Mean	B-value	Mod. CV B-value	Mean	B-value	Mod. CV B-value	Mean
SBS*	Strength	RTA (70°F)	(ksi)	13.66	12.87	14.16						
		ETA1 (275°F)		7.464	7.853	9.143						
		ETA2 (400°F)		5.229	4.497	5.935						
		ETW (275°F)		6.860	6.335	8.361						
DNS*	Strength	RTA (70°F)	(ksi)	12.06	11.39	12.92						
		ETA1 (275°F)		6.362	6.602	7.503						
		ETA2 (400°F)		2.609	2.609	3.380						
		ETW (275°F)		6.400	5.205	6.870						
SSB Proc. C	2% Offset Strength	RTA (70°F)	(ksi)	103.3	113.6	126.7	102.3	108.8	120.8	115.4	111.1	123.3
		ETA1 (275°F)		78.99	91.82	104.9	89.74	84.55	96.50	90.20	85.90	98.08
		ETA2 (400°F)		50.26	44.92	59.28						
		ETW (275°F)		90.43	80.33	106.0						
	Ultimate Strength	RTA (70°F)	(ksi)	134.5	126.6	140.8	137.6	130.5	144.8	137.7	129.2	143.2
		ETA1 (275°F)		112.0	104.1	118.4	107.3	100.3	114.5	106.8	98.32	112.4
		ETA2 (400°F)		72.88	57.73	76.20						
		ETW (275°F)		98.41	90.45	119.4						
	Chord Stiffness	RTA (70°F)	(Msi)			1.917			1.369			2.056
		ETA1 (275°F)				1.813			1.194			1.941
		ETA2 (400°F)				1.384						
		ETW (275°F)				1.732						
CAI	Strength	RTA (70°F)	(ksi)			45.53						
		ETA1 (275°F)				35.42						
		ETA2 (400°F)				15.95						
		ETW (275°F)				37.68						

* Data as-mesured rather than normalized.

Table 3-5: Laminate Tests Summary of Results – Part B

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 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 to be 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 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 Vol 1, found in the *Modified Coefficient Of Variation Approach* section of the Handbook.

4.1 Longitudinal Tension (LT)

Longitudinal Tension data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength and modulus tests were conducted in the following environmental conditions: CTA, RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with six specimens, therefore only estimates were computed for those conditions.

The results are identical for the normalized and as-measured datasets. The RTA condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for RTA. The single point normal method was used for the remaining conditions. Applying the modified CV, the RTA condition still failed the ADK test, therefore modified CV basis values were not computed for RTA and the normal method for modified CV was used for the remaining conditions. For the normalized dataset, the ETW condition has an original CV that is greater than 8%, therefore estimates using the original CV and modified CV are the same. For this reason, only the original CV line is visible in the batch plot of normalized values.

There were no statistical outliers.

Statistics, estimates, and basis values are given for the LT strength data in Table 4-1 and Table 4-2 and for the modulus data in Table 4-3 and Table 4-4. The normalized data, B-estimates, and B-basis values are shown graphically in Figure 4-1.

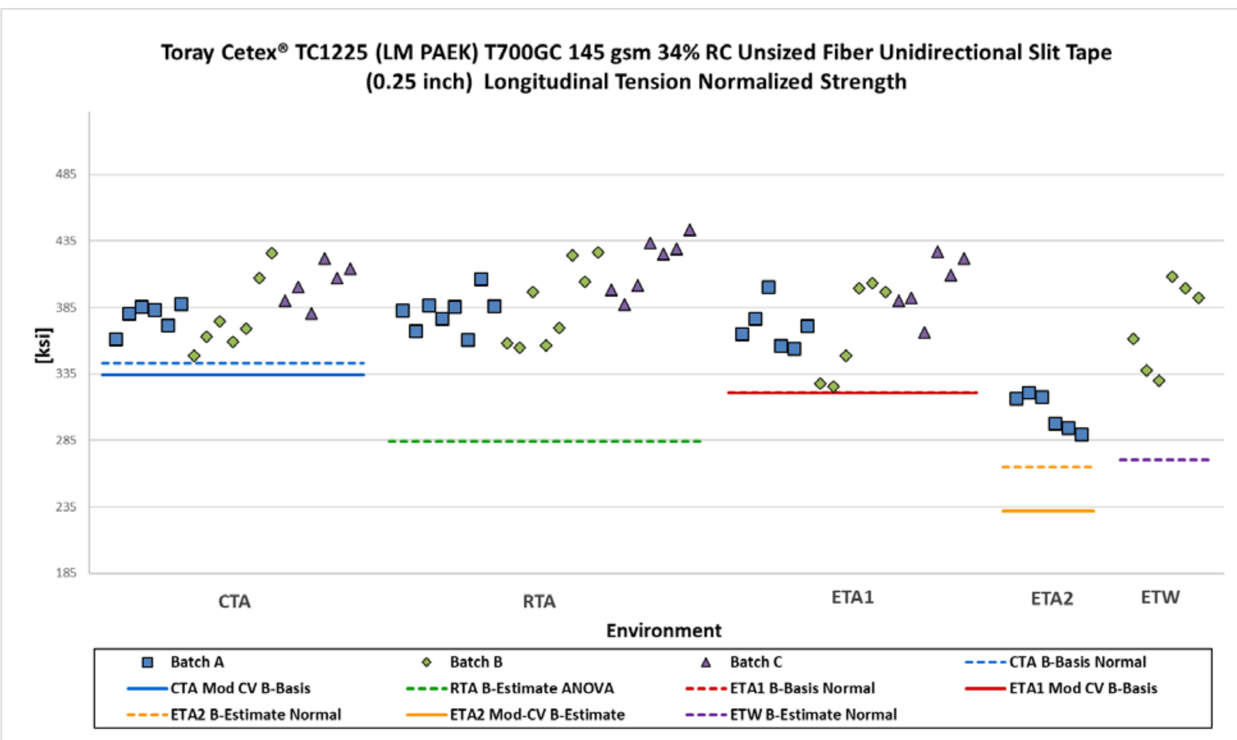

Figure 4-1: Batch Plot for LT Normalized Strength

Normalized Longitudinal Tension (LT) Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	385.9	393.9	379.6	306.1	371.5
Stdev	22.06	26.82	29.77	13.67	33.33
CV	5.717	6.808	7.844	4.464	8.972
Mod CV	6.859	7.404	7.922	8.000	8.972
Min	348.5	354.8	325.6	289.5	329.8
Max	426.0	443.3	426.8	321.0	408.4
No. Batches	3	3	3	1	1
No. Spec.	19	23	18	6	6
Basis Values and Estimates					
B-Basis Value	342.9		320.8		
B-Estimate		283.9		264.8	270.5
A-Estimate	312.4	205.4	279.2	235.3	198.7
Method	Normal	ANOVA	Normal	Normal	Normal
Modified CV Basis Values and Estimates					
B-Basis Value	334.3	NA	320.2		
B-Estimate				232.0	270.5
A-Estimate	297.7		278.2	179.2	198.7
Method	Normal		Normal	Normal	Normal

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

As-Measured Longitudinal Tension (LT) Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	388.6	400.0	383.0	304.4	369.4
Stdev	28.00	34.75	34.75	8.934	25.21
CV	7.205	8.686	9.074	2.935	6.825
Mod CV	7.602	8.686	9.074	8.000	8.000
Min	354.9	360.6	332.5	291.6	337.2
Max	443.1	475.6	456.0	313.2	399.6
No. Batches	3	3	3	1	1
No. Spec.	19	23	18	6	6
Basis Values and Estimates					
B-Basis Value	334.0		314.4		
B-Estimate		242.1		277.3	293.0
A-Estimate	295.3	129.3	265.8	258.1	238.7
Method	Normal	ANOVA	Normal	Normal	Normal
Modified CV Basis Values and Estimates					
B-Basis Value	331.0	NA	314.4		
B-Estimate				230.6	279.9
A-Estimate	290.1		265.8	178.2	216.2
Method	Normal		Normal	Normal	Normal

Table 4-2: Statistics and Basis Values for LT As-Measured Strength Data

Normalized Longitudinal Tension (LT) Modulus Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	19.45	19.38	19.95	18.44	19.44
Stdev	0.5554	0.4373	0.6931	1.138	0.5705
CV	2.855	2.257	3.474	6.171	2.935
Min	18.76	18.35	18.46	16.94	18.77
Max	20.40	20.07	20.96	19.72	20.24
No. Batches	3	3	3	1	1
No. Spec.	19	19	18	6	6

Table 4-3: Statistics for LT Normalized Modulus Data

As-Measured Longitudinal Tension (LT) Modulus Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	19.57	19.65	20.12	18.34	19.35
Stdev	0.4986	0.5661	0.7611	1.170	0.3547
CV	2.548	2.881	3.783	6.377	1.832
Min	18.73	18.71	18.09	16.53	18.85
Max	20.79	20.83	21.24	19.84	19.72
No. Batches	3	3	3	1	1
No. Spec.	19	19	18	6	6

Table 4-4: Statistics for LT As-Measured Modulus Data

4.2 Longitudinal Compression (LC)

Longitudinal Compression data is normalized by cured ply thickness. LC strength values were computed using the method detailed in section 2.4 Both normalized and as-measured results are provided. Strength and modulus tests were conducted in the following environmental conditions: CTA, RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with six specimens, therefore only estimates were computed for those conditions.

For the normalized dataset, the CTA, RTA and ETA1 conditions met all the requirements for pooling. The ETW condition failed the normality test but the Weibull distribution was a good fit. The single point normal method was used for ETA2. Applying the modified CV, the CTA, RTA and ETA1 conditions met all the requirements for pooling, the ETW condition failed the normality test, therefore modified CV basis value estimates were not computed for ETW and the normal method for modified CV was used for ETA2. The ETA2 condition has an original CV that is greater than 8%, therefore estimates using the original CV and modified CV are the same. For this reason, only the original CV line is visible in the batch plot of normalized values.

For the as-measured dataset, the CTA and RTA conditions met all the requirements for pooling. The ETA1 condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for ETA1. The ETW condition failed all the distributions tests, therefore the non-parametric was used for ETW and the single point normal method was used for ETA2. Applying the modified CV, the CTA, RTA and ETA1 conditions met all the requirements for pooling, the ETW condition failed the normality test, therefore modified CV basis value estimates were not computed for ETW and the normal method for modified CV was used for ETA2. The ETA2 condition has an original CV that is greater than 8%, therefore estimates using the original CV and modified CV are the same.

There was one statistical outlier. The lowest value of the ETW condition was an outlier in the single batch tested in both the normalized and as-measured datasets. It was retained for this analysis.

Statistics, basis values and estimates are given for the LC strength data in Table 4-5 and Table 4-6 and for the modulus data in Table 4-7 and Table 4-8. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-2.

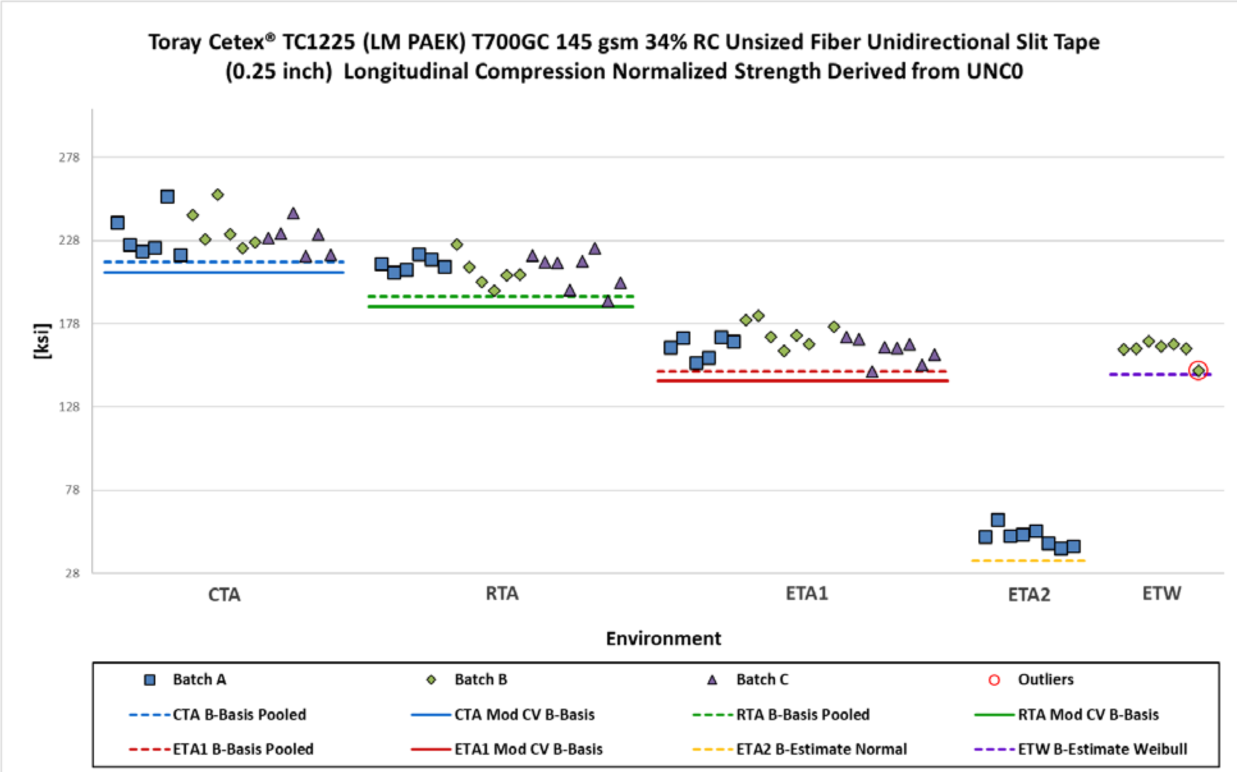

Figure 4-2: Batch Plot for LC Normalized Strength

Normalized Longitudinal Compression (LC) Strength from UNC0 Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	231.7	210.8	165.9	50.03	162.4
Stdev	11.47	8.807	8.363	5.583	5.779
CV	4.950	4.178	5.040	11.16	3.559
Mod CV	6.475	6.089	6.520	11.16	8.000
Min	218.7	191.8	149.2	43.05	149.9
Max	255.5	225.6	182.8	60.32	167.6
No. Batches	3	3	3	1	1
No. Spec.	18	20	21	8	7
Basis Values and Estimates					
B-Basis Value	214.9	194.2	149.3		
B-Estimate				35.52	147.4
A-Estimate	203.7	182.9	138.1	25.36	133.1
Method	Pooled	Pooled	Pooled	Normal	Weibull
Modified CV Basis Values and Estimates					
B-Basis Value	209.0	188.3	143.6		NA
B-Estimate				35.52	
A-Estimate	193.9	173.2	128.4	25.36	
Method	Pooled	Pooled	Pooled	Normal	

Table 4-5: Statistics and Basis Values for LC Normalized Strength Data Derived from UNC0

As-Measured Longitudinal Compression (LC) Strength from UNC0 Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	228.9	208.8	164.5	48.97	163.3
Stdev	11.71	8.273	9.574	5.487	5.941
CV	5.116	3.962	5.820	11.21	3.638
Mod CV	6.558	6.000	6.910	11.21	8.000
Min	215.5	191.4	143.0	41.95	150.6
Max	258.4	227.2	183.9	58.95	169.6
No. Batches	3	3	3	1	1
No. Spec.	18	20	21	8	7
Basis Values and Estimates					
B-Basis Value	210.7	190.7			
B-Estimate			118.0	34.71	126.9
A-Estimate	198.3	178.4	84.80	24.73	95.94
Method	Pooled	Pooled	ANOVA	Normal	Non-Parm.
Modified CV Basis Values and Estimates					
B-Basis Value	206.0	186.2	142.0		NA
B-Estimate				34.71	
A-Estimate	190.9	171.0	126.8	24.73	
Method	Pooled	Pooled	Pooled	Normal	

Table 4-6: Statistics and Basis Values for LC As-Measured Strength Data Derived from UNC0

Normalized Longitudinal Compression (LC) Modulus Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	17.95	17.66	18.09	19.17	17.25
Stdev	0.7198	0.4570	0.4941	1.600	0.2187
CV	4.009	2.587	2.731	8.344	1.267
Min	16.92	16.99	17.21	18.07	17.03
Max	19.06	18.41	18.67	22.60	17.58
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	7	6

Table 4-7: Statistics for LC Normalized Modulus Data

As-Measured Longitudinal Compression (LC) Modulus Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	17.69	17.44	17.87	18.97	17.18
Stdev	0.5730	0.2893	0.3469	1.466	0.2341
CV	3.240	1.659	1.941	7.728	1.362
Min	16.78	17.03	17.22	17.32	16.93
Max	19.00	18.08	18.35	21.67	17.51
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	7	6

Table 4-8: Statistics for LC As-Measured Modulus Data

4.3 0/90 Unnotched Compression (UNC0)

UNC0 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength and modulus tests were conducted in the following environmental conditions: CTA, RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with six specimens, therefore only estimates were computed for those conditions.

For the normalized dataset, the CTA, RTA and ETA1 conditions met all the requirements for pooling. The ETW condition failed the normality test but the Weibull distribution was a good fit. The single point normal method was used for ETA2. Applying the modified CV, the CTA, RTA and ETA1 conditions met all the requirements for pooling, the ETW condition failed the normality test, therefore modified CV basis value estimates were not computed for ETW and the normal method for modified CV was used for ETA2. The ETA2 condition has an original CV that is greater than 8%, therefore estimates using the original CV and modified CV are the same. For this reason, only the original CV line is visible in the batch plot of normalized values.

For the as-measured dataset, the CTA and RTA conditions met all the requirements for pooling. The ETA1 condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for ETA1. The ETW condition failed all the distributions tests, therefore the non-parametric was used for ETW and the single point normal method was used for ETA2. Applying the modified CV, the CTA, RTA and ETA1 conditions met all the requirements for pooling, the ETW condition failed the normality test, therefore modified CV basis value estimates were not computed for ETW and the normal method for modified CV was used for ETA2. The ETA2 condition has an original CV that is greater than 8%, therefore estimates using the original CV and modified CV are the same.

There was one statistical outlier. The lowest value of the ETW condition was an outlier in the normalized and as-measured datasets. It was retained for this analysis.

Statistics, basis values and estimates are given for the UNC0 strength data in Table 4-9 and Table 4-10 and for the modulus data in Table 4-11 and Table 4-12. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-3.

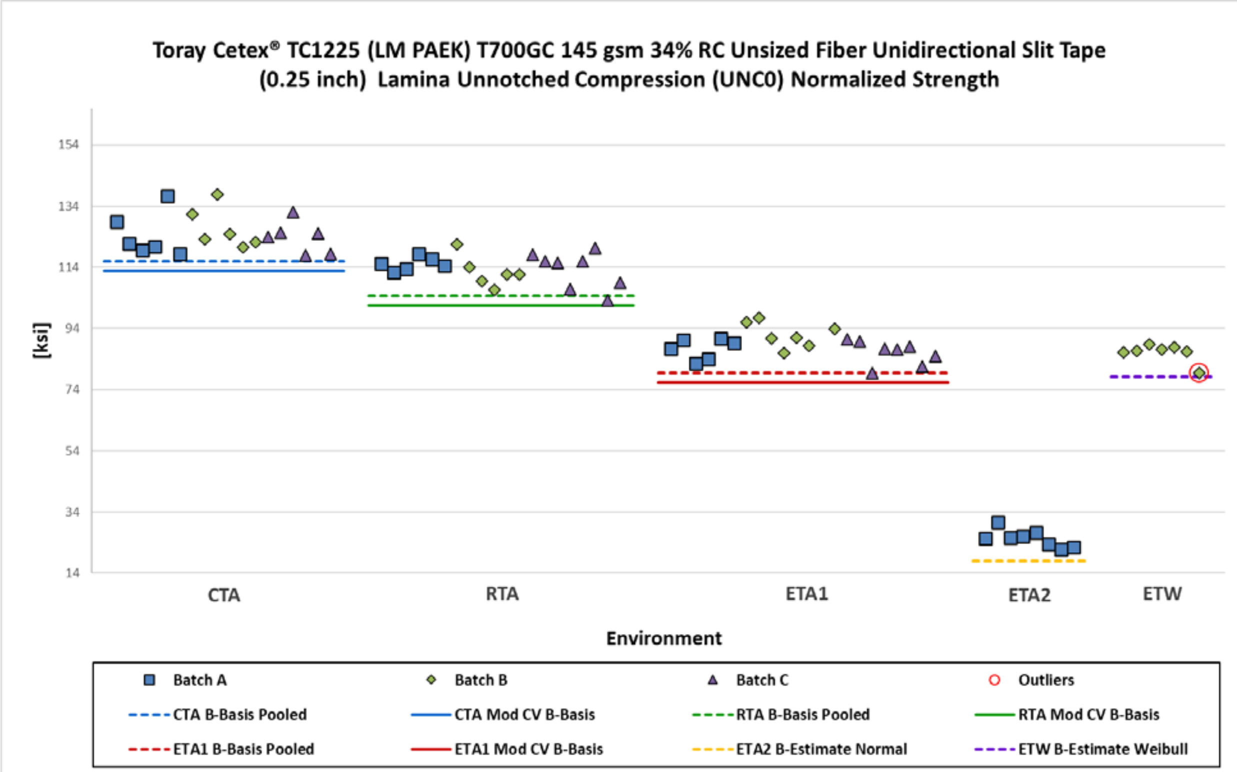

Figure 4-3: Batch Plot for UNC0 Normalized Strength

Normalized Lamina Unnothced Compression (UNC0) Strength Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	125.0	113.5	88.41	25.43	86.12
Stdev	6.186	4.744	4.456	2.837	3.065
CV	4.950	4.178	5.040	11.16	3.559
Mod CV	6.475	6.089	6.520	11.16	8.000
Min	118.0	103.3	79.51	21.88	79.48
Max	137.8	121.5	97.39	30.65	88.90
No. Batches	3	3	3	1	1
No. Spec.	18	20	21	8	7
Basis Values and Estimates					
B-Basis Value	115.9	104.6	79.51		
B-Estimate				18.05	78.18
A-Estimate	109.9	98.58	73.47	12.89	70.57
Method	Pooled	Pooled	Pooled	Normal	Weibull
Modified CV Basis Values and Estimates					
B-Basis Value	112.8	101.5	76.39		NA
B-Estimate				18.05	
A-Estimate	104.7	93.34	68.25	12.89	
Method	Pooled	Pooled	Pooled	Normal	

Table 4-9: Statistics and Basis Values for UNC0 Normalized Strength Data

As-Measured Lamina Unnothced Compression (UNC0) Strength Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	123.6	112.6	87.71	24.89	86.63
Stdev	6.321	4.460	5.105	2.789	3.152
CV	5.116	3.962	5.820	11.21	3.638
Mod CV	6.558	6.000	6.910	11.21	8.000
Min	116.4	103.2	76.23	21.32	79.88
Max	139.5	122.5	98.05	29.97	89.99
No. Batches	3	3	3	1	1
No. Spec.	18	20	21	8	7
Basis Values and Estimates					
B-Basis Value	113.7	102.8			
B-Estimate			62.92	17.64	67.32
A-Estimate	107.1	96.14	45.22	12.57	50.90
Method	Pooled	Pooled	ANOVA	Normal	Non-Parm.
Modified CV Basis Values and Estimates					
B-Basis Value	111.3	100.4	75.62		NA
B-Estimate				17.64	
A-Estimate	103.1	92.24	67.44	12.57	
Method	Pooled	Pooled	Pooled	Normal	

Table 4-10: Statistics and Basis Values for UNC0 As-Measured Strength Data

Normalized Lamina Unnotched Compression (UNC0) Modulus Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	9.569	9.430	9.743	9.773	9.356
Stdev	0.4856	0.3286	0.3171	0.8597	0.1217
CV	5.075	3.484	3.255	8.797	1.301
Min	8.776	8.555	9.169	8.419	9.162
Max	10.90	9.875	10.31	10.57	9.510
No. Batches	3	3	3	1	1
No. Spec.	18	20	20	8	6

Table 4-11: Statistics for UNC0 Normalized Modulus Data

As-Measured Lamina Unnotched Compression (UNC0) Modulus Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	9.456	9.348	9.652	9.564	9.409
Stdev	0.3699	0.2990	0.2678	0.8159	0.1467
CV	3.912	3.199	2.774	8.531	1.559
Min	8.870	8.547	9.144	8.237	9.208
Max	10.42	9.901	10.24	10.27	9.595
No. Batches	3	3	3	1	1
No. Spec.	18	20	20	8	6

Table 4-12: Statistics for UNC0 As-Measured Modulus Data

4.4 Transverse Tension (TT)

Transverse Tension data is not normalized. Strength and modulus tests were conducted in the following environmental conditions: CTA, RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with seven or less specimens, therefore only estimates were computed for those conditions.

The RTA condition failed the normality test, but the Weibull distribution was a good fit for the dataset. The ETA1 condition failed all the distributions tests, therefore the single point non-parametric method was used for ETA1. The single point normal method was used for CTA, ETA2, and ETW. Applying the modified CV, pooling the CTA, RTA and ETA1 conditions was not possible because the pooled dataset failed the Levene's test for equality of variances. However, the CTA and RTA conditions met all requirements for pooling. The ETA1 condition failed the normality test, therefore modified CV basis values were not computed for ETA1 and the normal method for modified CV was used for ETA2 and ETW.

There was one statistical outlier. The lowest value in batch B of the RTA condition was a condition outlier. It was retained for this analysis.

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

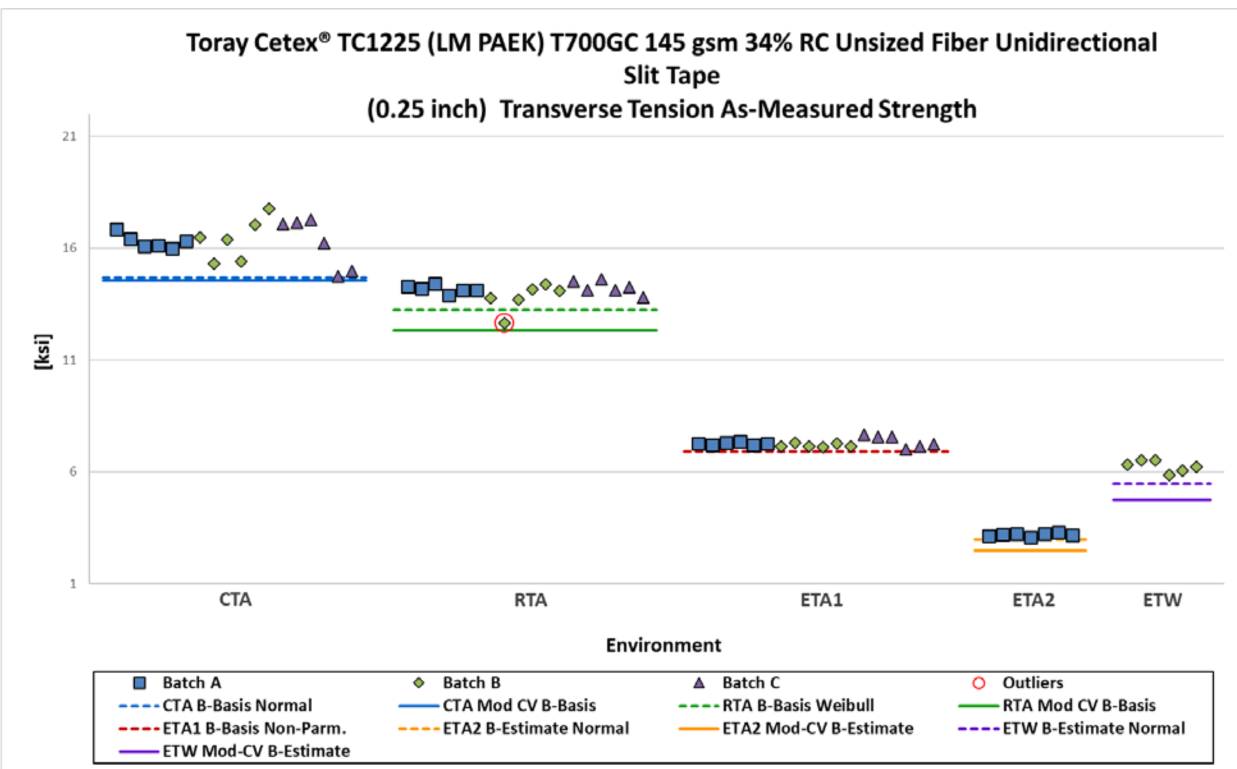

Figure 4-4: Batch Plot for TT As-Measured Strength

As-Measured Transverse Tension (TT) Strength Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	16.32	14.07	7.274	3.200	6.251
Stdev	0.8187	0.4352	0.1752	0.07712	0.2600
CV	5.018	3.093	2.409	2.410	4.160
Mod CV	6.509	6.000	6.000	8.000	8.000
Min	14.75	12.64	7.001	3.061	5.863
Max	17.76	14.63	7.661	3.292	6.523
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	7	6
Basis Value Estimates					
·Basis Value	14.70	13.25	6.916		
B-Estimate				2.985	5.463
A-Estimate	13.55	12.36	6.117	2.835	4.903
Method	Normal	Weibull	Non-Parm.	Normal	Normal
Modified CV Basis Values and Estimates					
B-Basis Value	14.57	12.32			
B-Estimate			NA	2.489	4.736
A-Estimate	13.38	11.13		1.989	3.659
Method	Pooled	Pooled		Normal	Normal

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

As-Measured Transverse Tension (TT) Modulus Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	1.410	1.316	1.100	0.2808	0.8440
Stdev	0.04960	0.04392	0.05339	0.01106	0.02748
CV	3.517	3.338	4.854	3.940	3.256
Min	1.328	1.240	0.9958	0.2685	0.8059
Max	1.483	1.396	1.179	0.3016	0.8820
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	7	6

Table 4-14: Statistics for TT Modulus Data

4.5 Transverse Compression (TC)

Transverse Compression data is not normalized. Strength and modulus tests were conducted in the following environmental conditions: CTA, RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with six specimens, therefore only estimates were computed for those conditions.

The RTA condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for RTA. The single point normal method was used for the remaining conditions. Applying the modified CV, pooling the CTA, RTA and ETA1 conditions was not possible because the pooled dataset failed the Levene's test for equality of variances. The normal method for modified CV was used for all conditions. The ETA2 condition has an original CV that is greater than 8%, therefore estimates using the original CV and modified CV are the same. For this reason, only the original CV line is visible in the batch plot of as-measured values.

There was one statistical outlier. The lowest value in batch B of the ETA1 condition was a condition outlier. It was retained for this analysis.

Statistics, basis values and estimates are given for the TC 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 4-5.

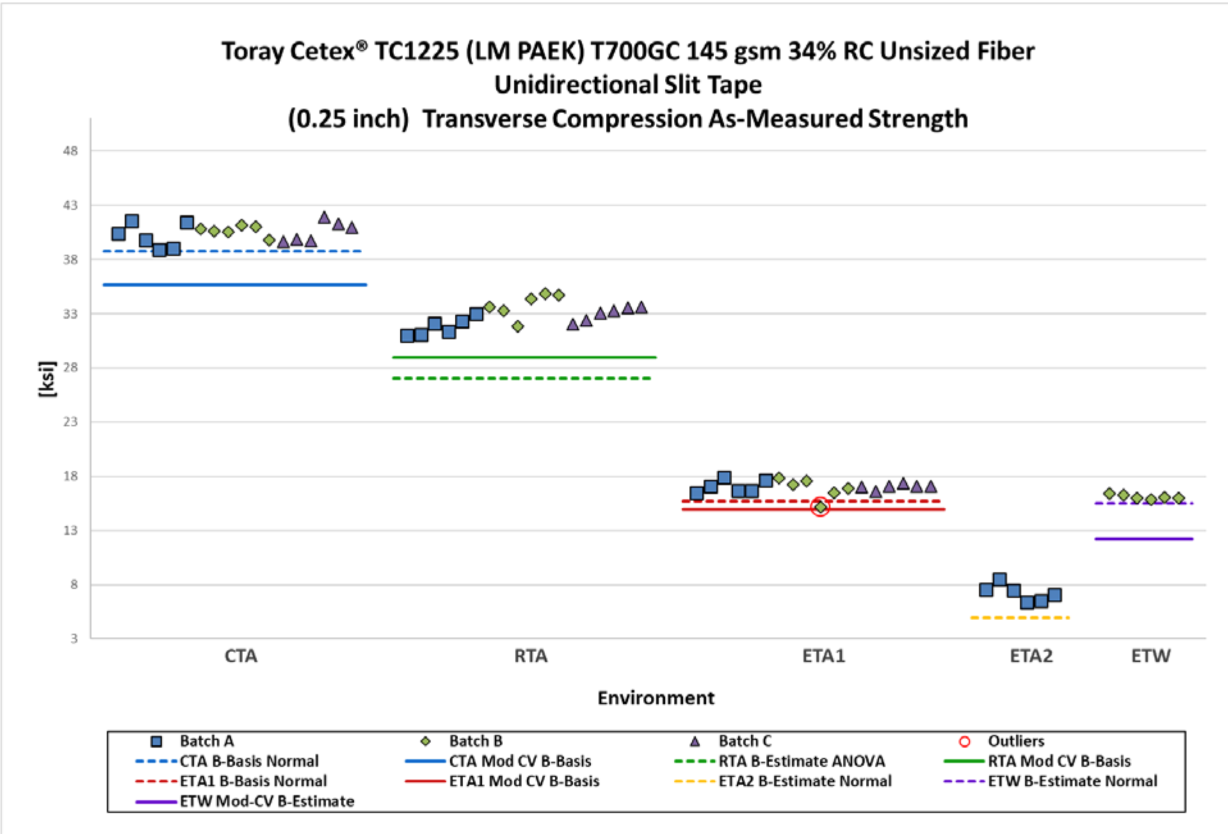

Figure 4-5: Batch Plot for TC As-Measured Strength

As-Measured Transverse Compression (TC) Strength Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	40.47	32.86	16.99	7.281	16.09
Stdev	0.8713	1.167	0.6326	0.7756	0.1904
CV	2.153	3.551	3.723	10.65	1.183
Mod CV	6.000	6.000	6.000	10.65	8.000
Min	38.88	31.02	15.14	6.426	15.85
Max	41.93	34.85	17.90	8.530	16.38
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	6	6
Basis Value Estimates					
Basis Value	38.75		15.74		
B-Estimate		27.06		4.932	15.51
A-Estimate	37.53	22.93	14.86	3.261	15.10
Method	Normal	ANOVA	Normal	Normal	Normal
Modified CV Basis Values and Estimates					
B-Basis Value	35.67	28.97	14.98		
B-Estimate				4.932	12.19
A-Estimate	32.28	26.21	13.55	3.261	9.417
Method	Normal	Normal	Normal	Normal	Normal

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

As-Measured Transverse Compression (TC) Modulus Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	1.439	1.386	1.206	0.3180	1.059
Stdev	0.04155	0.03847	0.07223	0.01292	0.02179
CV	2.887	2.775	5.987	4.062	2.056
Min	1.341	1.338	0.9872	0.2984	1.036
Max	1.504	1.471	1.317	0.3311	1.101
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	6	6

Table 4-16: Statistics for TC Modulus Data

4.6 In-Plane Shear (IPS)

In Plane Shear data is not normalized. 0.2% offset strength, strength at 5% strain and modulus tests were conducted in the following environmental conditions: CTA, RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with six specimens, therefore only estimates were computed for those conditions.

For the 0.2% Offset Strength dataset, the CTA and RTA conditions failed the ADK test for batch equivalency. ANOVA was used to computes estimates for CTA and RTA and the single point normal method was used for the remaining conditions. Applying the modified CV, pooling CTA, RTA and ETA1 was not possible because the pooled dataset failed the Levene's test for equality of variances. However, the CTA and RTA conditions met all the requirements for pooling, and the normal method for modified CV was used for the remaining conditions.

For the Strength at 5% strain dataset, the CTA, RTA and ETA1 conditions met all the requirements for pooling and the single point normal method was used for ETA2 and ETW. Applying the modified CV, pooling the CTA, RTA and ETA1 conditions was not possible because the pooled dataset failed the Levene's test for equality of variances. However, the CTA and RTA conditions met all the requirements for pooling. The normal method for modified CV was used for the remaining conditions.

There were no statistical outliers.

Statistics, basis values and estimates are given for the IPS strength data in Table 4-17 and Table 4-18 and for the modulus data in Table 4-19. The as-measured data, B-basis values and B-estimates are shown graphically for 0.2% offset strength in Figure 4-6 and for strength at 5% strain in Figure 4-7.

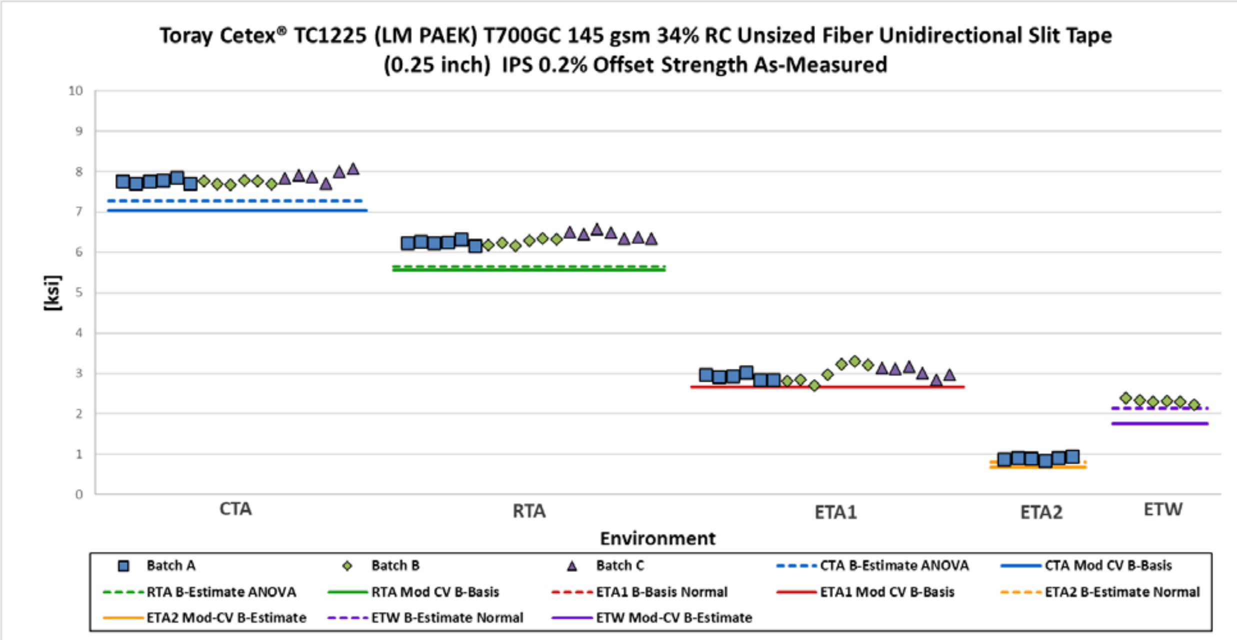

Figure 4-6: Batch Plot for IPS 0.2% Offset Strength As-Measured

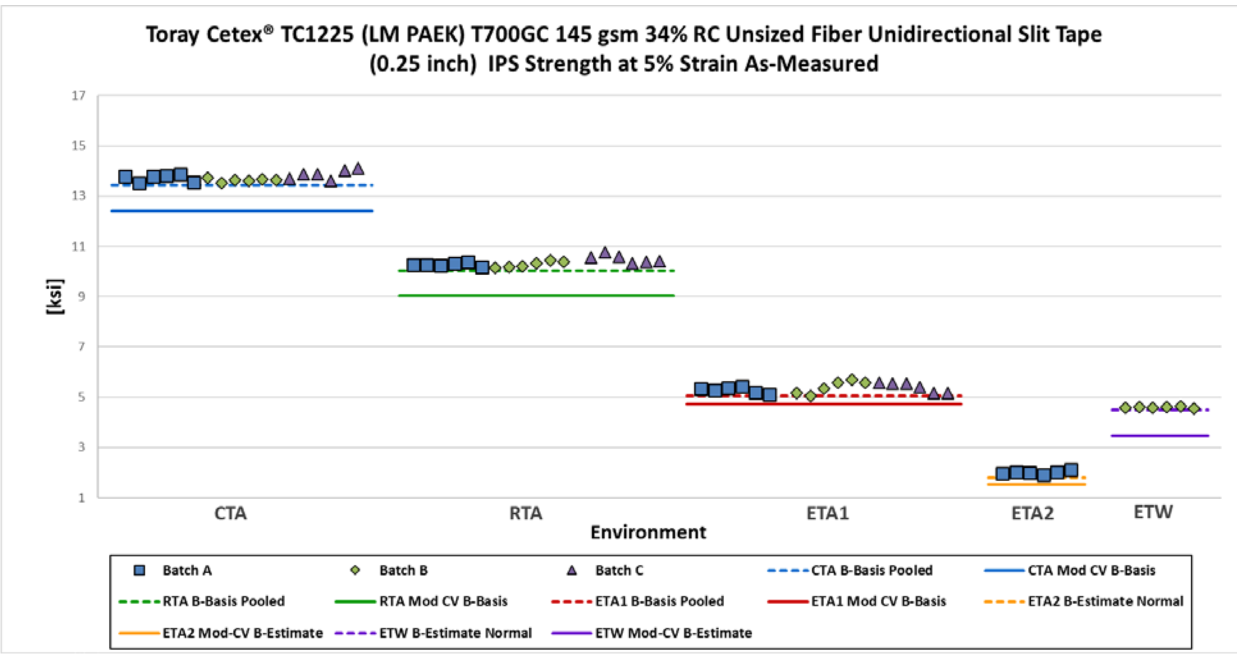

Figure 4-7: Batch Plot for IPS Strength at 5% Strain As-Measured

In Plane Shear Strength Basis Values and Statistics					
0.2% Offset Strength					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	7.798	6.320	2.994	0.8975	2.310
Stdev	0.1109	0.1175	0.1663	0.03319	0.05512
CV	1.422	1.859	5.553	3.698	2.387
Mod CV	6.000	6.000	6.777	8.000	8.000
Min	7.678	6.164	2.703	0.8487	2.220
Max	8.074	6.575	3.309	0.9475	2.387
No. Batches	3	3	3	1	1
No. Spec.	18	19	19	6	6
Basis Values and Estimates					
B-Basis Value			2.670		
B-Estimate	7.268	5.643		0.7969	2.143
A-Estimate	6.891	5.160	2.440	0.7254	2.024
Method	ANOVA	ANOVA	Normal	Normal	Normal
Modified CV Basis Values and Estimates					
B-Basis Value	7.026	5.552	2.599		
B-Estimate				0.6800	1.750
A-Estimate	6.502	5.027	2.318	0.5254	1.352
Method	Pooled	Pooled	Normal	Normal	Normal

Table 4-17: Statistics and Basis Values for IPS 0.2% Offset Strength Data

In Plane Shear Strength Basis Values and Statistics					
Strength at 5% Strain					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	13.74	10.36	5.365	2.006	4.593
Stdev	0.1645	0.1632	0.1951	0.06707	0.03154
CV	1.197	1.575	3.636	3.342	0.6868
Mod CV	6.000	6.000	6.000	8.000	8.000
Min	13.53	10.14	5.052	1.904	4.541
Max	14.12	10.78	5.704	2.110	4.628
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	6	6
Basis Values and Estimates					
B-Basis Value	13.43	10.05	5.055		
B-Estimate				1.803	4.497
A-Estimate	13.23	9.842	4.849	1.659	4.429
Method	Pooled	Pooled	Pooled	Normal	Normal
Modified CV Basis Values and Estimates					
B-Basis Value	12.41	9.028	4.729		
B-Estimate				1.520	3.480
A-Estimate	11.51	8.123	4.279	1.175	2.688
Method	Pooled	Pooled	Normal	Normal	Normal

Table 4-18: Statistics and Basis for IPS Strength at 5% Strain Data

In Plane Shear As-Measured Modulus Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	0.6923	0.6157	0.3030	0.06281	0.2168
Stdev	0.01220	0.01301	0.02126	0.002054	0.007720
CV	1.762	2.112	7.017	3.270	3.560
Min	0.6739	0.5961	0.2646	0.05955	0.2071
Max	0.7159	0.6396	0.3444	0.06575	0.2294
No. Batches	3	3	3	1	1
No. Spec.	18	19	19	6	6

Table 4-19: Statistics for IPS Modulus Data

4.7 90 Flexural (90FLX)

The 90FLX data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength and modulus tests were conducted in the following environmental conditions: RTA.

The results were identical for the normalized and as-measured datasets. The RTA condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates. Applying the modified CV, the RTA condition failed the ADK test, therefore modified CV values were not computed.

There were no statistical outliers.

Statistics and estimates are given for the 90FLX strength data in Table 4-20 and for the modulus data in Table 4-21. The normalized data and B-estimate are shown graphically in Figure 4-8.

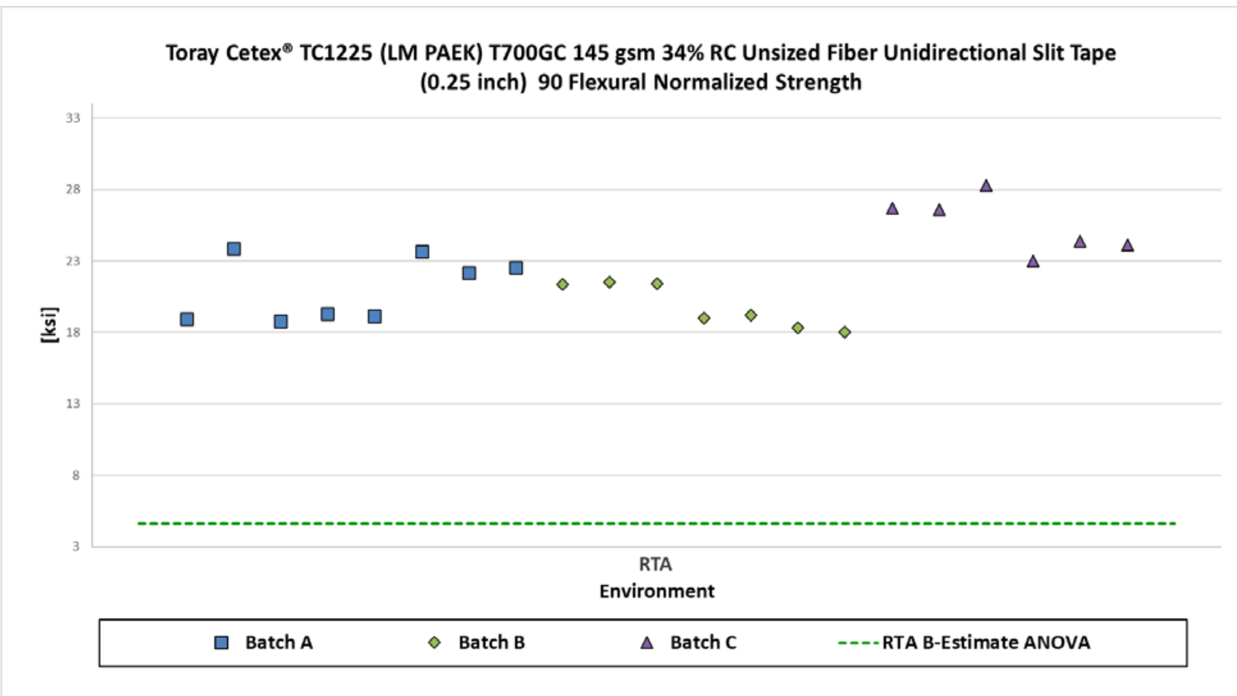

Figure 4-8: Batch Plot for 90FLX Strength As-Measured

Fill Flexural Strength (90FLX)		
RTA		
Environment	Normalized	As-Measured
Mean	21.92	21.62
Stdev	3.027	3.318
CV	13.81	15.35
Mod CV	13.81	15.35
Min	18.01	16.27
Max	28.31	27.02
No. Batches	3	3
No. Spec.	21	21
Basis Value Estimates		
B-Estimate	4.604	5.807
A-Estimate	0.000	0.000
Method	ANOVA	ANOVA

Table 4-20: Statistics and Basis Value Estimates for 90FLX Strength Data

Fill Flexural Modulus (90FLX)		
RTA		
Environment	Normalized	As-Measured
Mean	1.457	1.433
Stdev	0.05584	0.07608
CV	3.832	5.309
Min	1.367	1.334
Max	1.522	1.564
No. Batches	3	3
No. Spec.	21	21

Table 4-21: Statistics for 90FLX Modulus Data

4.8 Lamina Double-Notch Shear (DNS)

The DNS data is not normalized. Strength tests were conducted in the following environmental conditions: CTA, RTA, ETA1, and ETW.

The ETW condition consists of a single batch with six specimens, therefore only estimates were computed for that condition.

The CTA condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for CTA. The RTA and ETA1 conditions met all the requirements for pooling and the single point normal method was used for ETW. Applying the modified CV, the CTA, RTA, and ETA1 conditions met all the requirements for pooling and the normal method for modified CV was used for ETW.

There were two statistical outliers. The lowest value in batch B of the CTA condition was a batch and condition outlier. The lowest value in batch B of the RTA condition was a batch outlier. They were retained for this analysis.

Statistics, B-Basis values and B-Estimates are given for the DNS strength data in Table 4-22. The as-measured data, B-Basis values and B-estimates are shown graphically in Figure 4-9

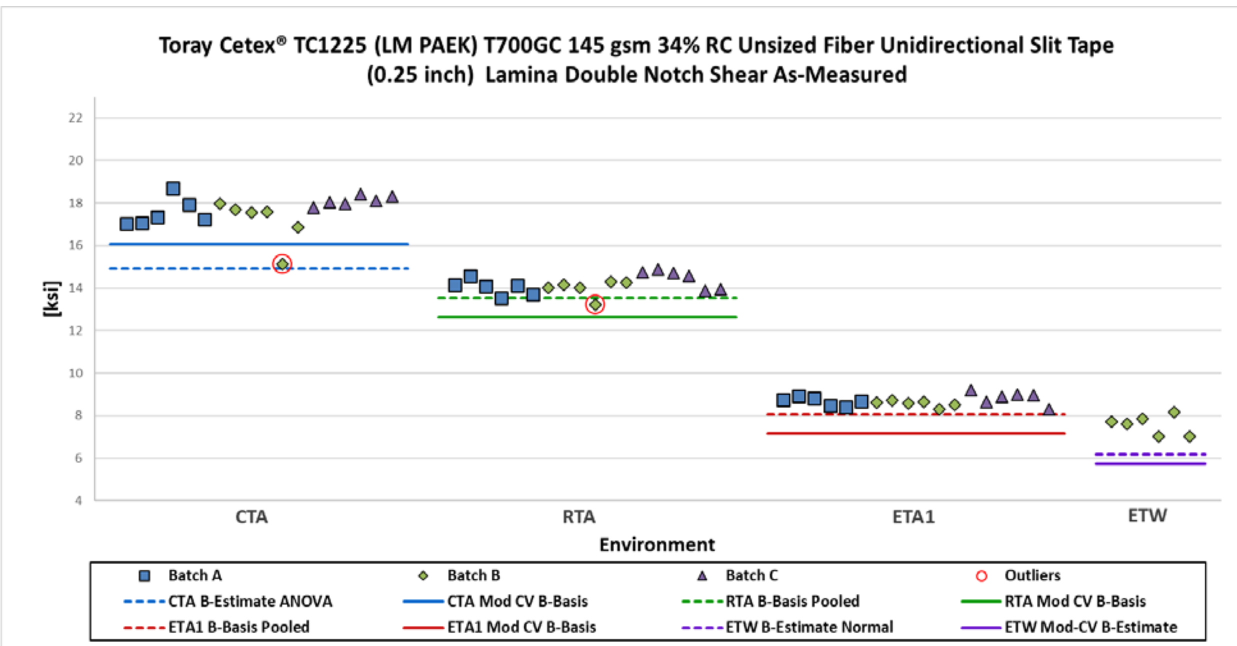

Figure 4-9: Batch Plot for DNS Strength As-Measured

Lamina Double Notch Shear (DNS) As-Measured Basis Values and Statistics				
Environment	CTA	RTA	ETA1	ETW
Mean	17.60	14.16	8.692	7.566
Stdev	0.7927	0.4320	0.2487	0.4523
CV	4.504	3.050	2.862	5.977
Mod CV	6.252	6.000	6.000	8.000
Min	15.13	13.23	8.292	7.030
Max	18.69	14.88	9.195	8.158
No. Batches	3	3	3	1
No. Spec.	18	18	18	6
Basis Values and Estimates				
B-Basis Value		13.52	8.050	
B-Estimate	14.91			6.196
A-Estimate	13.00	13.08	7.613	5.222
Method	ANOVA	Pooled	Pooled	Normal
Modified CV Basis Values and Estimates				
B-Basis Value	16.08	12.65	7.174	
B-Estimate				5.733
A-Estimate	15.07	11.63	6.161	4.429
Method	Pooled	Pooled	Pooled	Normal

Table 4-22: Statistics and Basis Values for DNS Strength Data

4.9 Lamina Short-Beam Strength (SBS)

The Short Beam Strength data is not normalized. Tests were conducted in the following environmental conditions: CTA, RTA, ETA1, and ETW.

The ETW condition consists of a single batch with six specimens, therefore only estimates were computed for that condition.

The CTA and RTA conditions met all the requirements for pooling. The ETA1 condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for ETA1 and the single point normal method was used for ETW. Applying the modified CV, pooling the CTA, RTA and ETA1 conditions was not possible because the pooled dataset failed the Levene's test for equality of variances. However, the CTA and RTA conditions met all the requirements for pooling. The normal method for modified CV was used for ETA1 and ETW.

There were no statistical outliers.

Statistics, basis values and estimates are given for the SBS data in Table 4-23. The as-measured data, B-estimates and B-basis values are shown graphically in Figure 4-10.

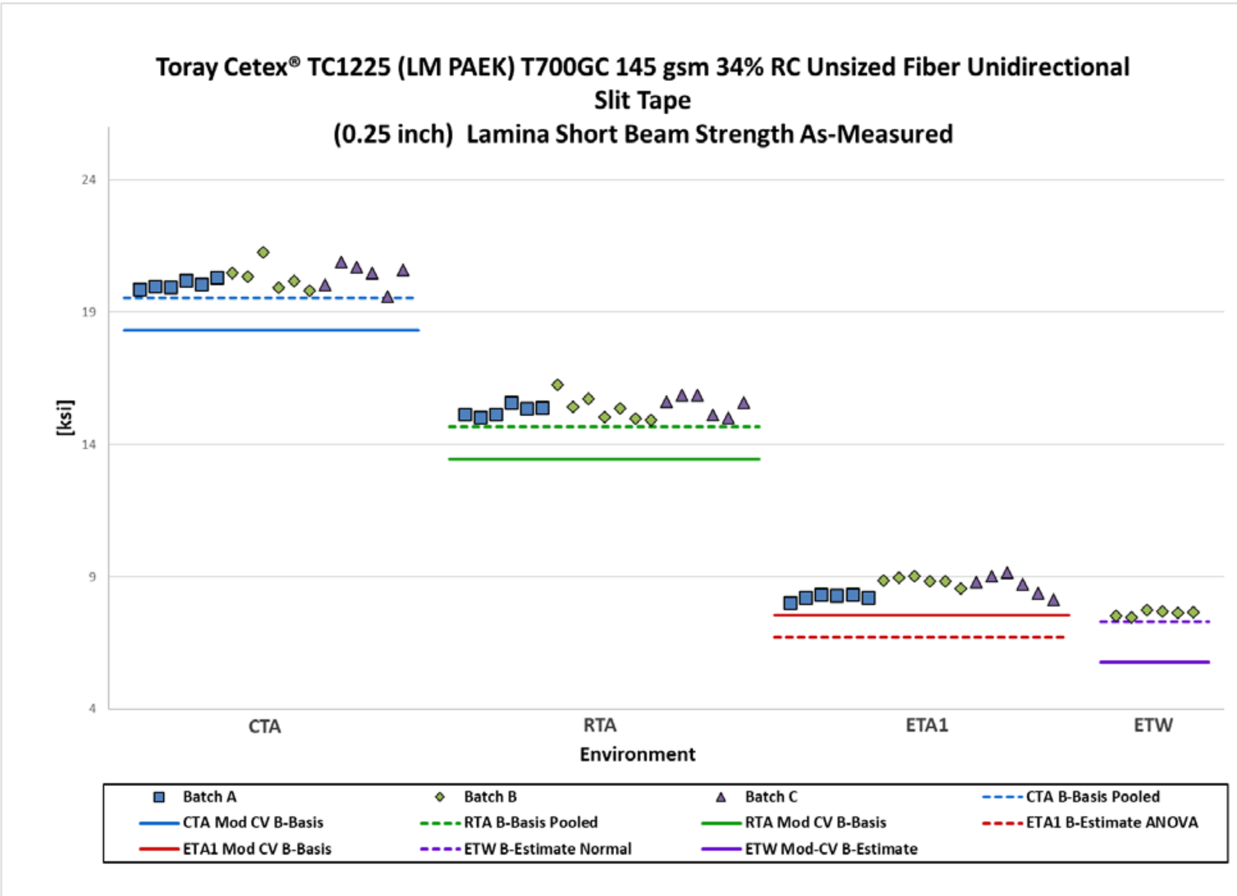

Figure 4-10: Batch Plot for SBS As-Measured

Lamina Short Beam Strength (SBS) As-Measured Basis Values and Statistics				
Environment	CTA	RTA	ETA1	ETW
Mean	20.27	15.40	8.594	7.623
Stdev	0.4189	0.3705	0.3549	0.1024
CV	2.067	2.406	4.129	1.344
Mod CV	6.000	6.000	6.065	8.000
Min	19.61	14.92	8.029	7.479
Max	21.27	16.27	9.162	7.758
No. Batches	3	3	3	1
No. Spec.	18	19	18	6
Basis Values and Estimates				
B-Basis Value	19.55	14.68		
B-Estimate			6.712	7.313
A-Estimate	19.06	14.19	5.369	7.092
Method	Pooled	Pooled	ANOVA	Normal
Modified CV Basis Values and Estimates				
B-Basis Value	18.31	13.45	7.565	
B-Estimate				5.776
A-Estimate	16.98	12.12	6.836	4.463
Method	Pooled	Pooled	Normal	Normal

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

4.10 “25/50/25” Unnotched Tension 1 (UNT1)

The UNT1 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength and modulus tests were conducted in the following environmental conditions: CTA, RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with seven specimens or less, therefore only estimates were computed for those conditions.

For the normalized dataset, the CTA, RTA and ETA1 conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for those conditions. The single point normal method was used for ETA2 and ETW. Applying the modified CV, the RTA and ETA1 conditions failed the ADK test, therefore modified CV basis values were not computed for those conditions. The normal method for modified CV was used for the remaining conditions.

For the as-measured dataset, the CTA, RTA and ETA1 conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for those conditions. The single point normal method was used for ETA2 and ETW. Applying the modified CV, the ETA1 condition failed the ADK test, therefore modified CV basis values were not computed for ETA1. The CTA and RTA conditions met all the requirement for pooling and the normal method was used for ETA2 and ETW.

There were four statistical outliers. The lowest value in batch B of the ETA1 condition was a batch outlier in the normalized and as-measured datasets. The highest values in batch A of the ETA2 condition was an outlier in the normalized dataset. The lowest value in batch B of the ETW condition was an outlier in the normalized dataset. The lowest value in batch C of the ETA1 condition was a batch outlier in the as-measured dataset. They were retained for this analysis.

Statistics, basis values and estimates are given for the UNT1 strength data in Table 4-24 and Table 4-25 and for the modulus data in Table 4-26 and Table 4-27. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-11.

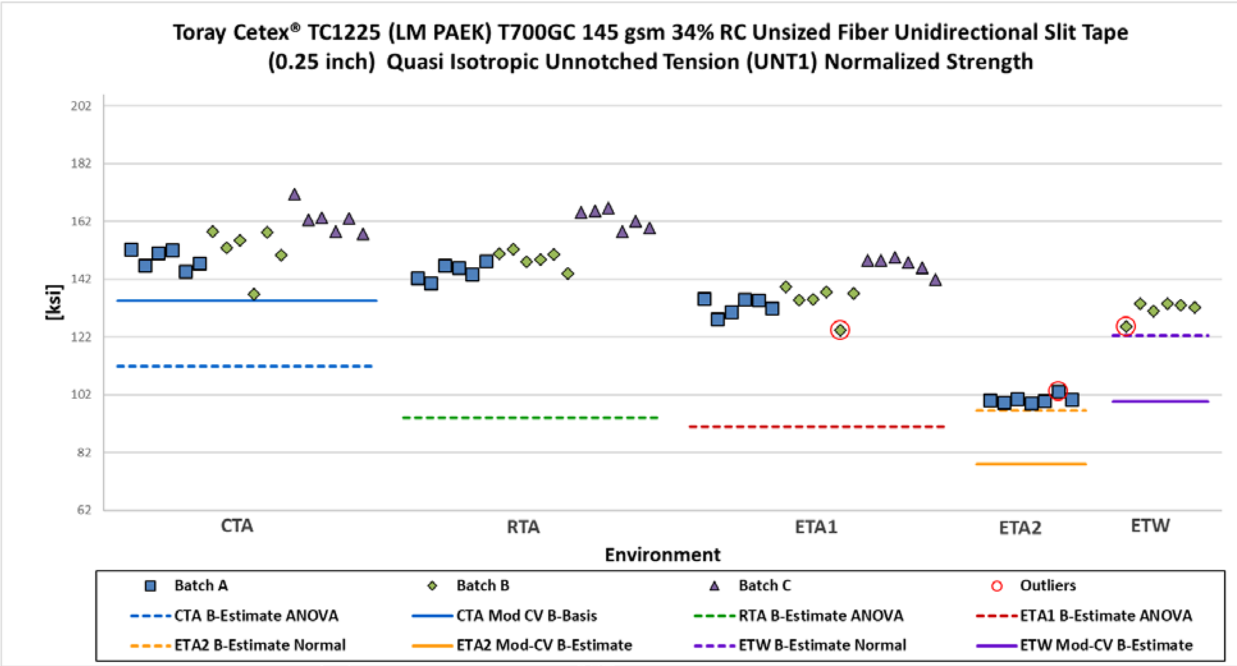

Figure 4-11: Batch Plot for UNT1 Normalized Strength

Normalized Quasi Unnotched Tension (UNT1) Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	154.7	152.3	138.2	100.4	131.5
Stdev	8.126	8.477	7.483	1.336	2.984
CV	5.252	5.567	5.415	1.330	2.269
Mod CV	6.626	6.783	6.708	8.000	8.000
Min	136.8	140.8	124.5	99.13	125.8
Max	171.5	166.6	149.7	103.2	133.6
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	7	6
Basis Value Estimates					
B-Estimate	111.8	94.17	90.92	96.72	122.5
A-Estimate	81.25	52.68	57.19	94.11	116.1
Method	ANOVA	ANOVA	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates					
B-Basis Value	134.5	NA	NA		
B-Estimate				78.12	99.66
A-Estimate	120.1			62.43	77.00
Method	Normal			Normal	Normal

Table 4-24: Statistics and Basis Values for UNT1 Normalized Strength Data

As-Measured Quasi Unnotched Tension (UNT1) Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	152.6	150.0	136.2	98.93	131.4
Stdev	6.972	7.206	6.319	3.058	2.395
CV	4.568	4.805	4.640	3.091	1.823
Mod CV	6.284	6.402	6.320	8.000	8.000
Min	136.4	136.1	124.0	95.70	127.0
Max	164.8	160.1	144.1	104.0	134.1
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	7	6
Basis Value Estimates					
B-Estimate	121.4	104.6	102.3	90.44	124.2
A-Estimate	99.17	72.20	78.15	84.46	119.0
Method	ANOVA	ANOVA	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates					
B-Basis Value	135.2	132.5	NA		
B-Estimate				76.95	99.58
A-Estimate	123.3	120.6		61.49	76.94
Method	Pooled	Pooled		Normal	Normal

Table 4-25: Statistics and Basis Values for UNT1 As-Measured Strength Data

Normalized Quasi Unnotched Tension (UNT1) Modulus Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	7.256	7.106	6.855	6.280	6.511
Stdev	0.2162	0.2443	0.2825	0.1280	0.1207
CV	2.979	3.438	4.121	2.038	1.853
Min	6.955	6.730	6.388	6.114	6.364
Max	7.628	7.601	7.363	6.479	6.666
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	7	6

Table 4-26: Statistics for UNT1 Normalized Modulus Data

As-Measured Quasi Unnotched Tension (UNT1) Modulus Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	7.161	7.000	6.757	6.185	6.507
Stdev	0.1947	0.2242	0.2650	0.1874	0.1620
CV	2.719	3.203	3.922	3.031	2.489
Min	6.730	6.504	6.186	5.923	6.328
Max	7.359	7.255	7.089	6.402	6.694
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	7	6

Table 4-27: Statistics for UNT1 As-Measured Modulus Data

4.11 “10/80/10” Unnotched Tension 2 (UNT2)

The UNT2 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength and modulus tests were conducted in the following environmental conditions: CTA, RTA, and ETA1.

For the normalized dataset, the CTA and RTA condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for CTA and RTA. The ETA1 condition failed the normality test, but the Weibull distribution was a good fit for the ETA1 dataset. Applying the modified CV, there were no diagnostic test failures, so all conditions were pooled.

For the as-measured dataset, the CTA and RTA condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for CTA and RTA. The ETA1 condition failed all the distributions tests, therefore the single point non-parametric method was used for ETA1. Applying the modified CV, there were no diagnostic test failures, so all conditions were pooled.

There were two statistical outliers. The lowest value in batch B of the ETA1 condition was a condition outlier in the normalized and as-measured datasets. The highest value in batch C of the ETA1 condition was a batch outlier in the normalized dataset. They were retained for this analysis.

Statistics, basis values and estimates are given for the UNT2 strength data in Table 4-28 and for the modulus data in Table 4-29. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-12.

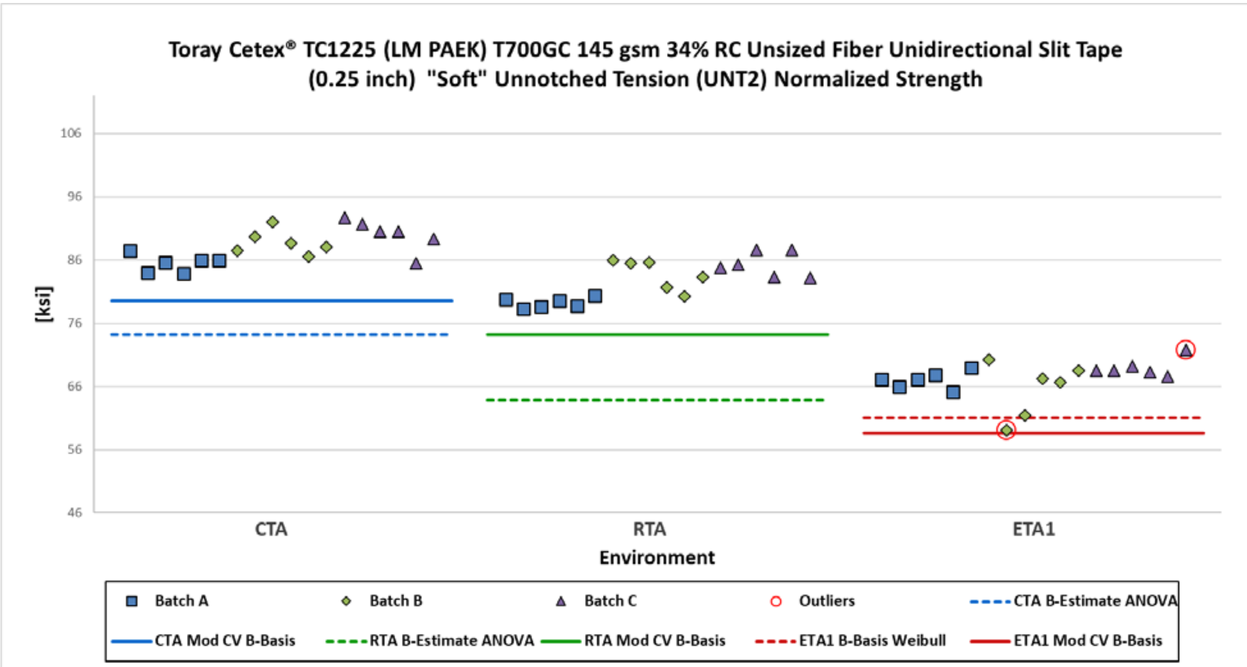

Figure 4-12: Batch Plot for UNT2 Normalized Strength

Soft Unnotched Tension (UNT2) Basis Values and Statistics						
	Normalized			As-Measured		
Environment	CTA	RTA	ETA1	CTA	RTA	ETA1
Mean	88.07	82.73	67.18	87.16	81.79	66.51
Stdev	2.711	3.140	2.953	2.458	2.564	3.343
CV	3.078	3.795	4.396	2.820	3.135	5.027
Mod CV	6.000	6.000	6.198	6.000	6.000	6.514
Min	83.92	78.29	59.13	83.43	78.17	56.99
Max	92.72	87.59	71.80	92.31	87.00	70.30
No. Batches	3	3	3	3	3	3
No. Spec.	18	18	18	18	18	18
Basis Values and Estimates						
B-Basis Value			61.03			53.66
B-Estimate	74.20	63.89		76.32	66.74	
A-Estimate	64.30	50.45	54.69	68.60	56.01	41.63
Method	ANOVA	ANOVA	Weibull	ANOVA	ANOVA	Non-Parm.
Modified CV Basis Values and Estimates						
B-Basis Value	79.53	74.18	58.63	78.60	73.22	57.94
A-Estimate	73.82	68.48	52.93	72.88	67.51	52.23
Method	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled

Table 4-28: Statistics and Basis Values for UNT2 Strength Data

Soft Unnotched Tension (UNT2) Modulus Statistics						
	Normalized			As-Measured		
Environment	CTA	RTA	ETA1	CTA	RTA	ETA1
Mean	4.680	4.516	3.920	4.633	4.467	3.881
Stdev	0.09285	0.06989	0.1095	0.1382	0.1124	0.1466
CV	1.984	1.547	2.793	2.984	2.517	3.776
Min	4.523	4.407	3.675	4.368	4.230	3.542
Max	4.871	4.677	4.236	4.818	4.642	4.207
No. Batches	3	3	3	3	3	3
No. Spec.	18	18	18	18	18	18

Table 4-29: Statistics for UNT2 Modulus Data

4.12 "50/40/10" Unnotched Tension 3 (UNT3)

The UNT3 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength and modulus tests were conducted in the following environmental conditions: CTA, RTA, and ETA1 conditions.

The results are identical for the normalized and as-measured datasets. All the conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for all conditions. Applying the modified CV, all conditions failed the ADK so modified CV basis values were not computed for any condition.

There was one statistical outlier. The lowest value in batch B of the CTA condition was a batch outlier in the normalized dataset. It was retained for this analysis.

Statistics, basis values and estimates are given for the UNT3 strength data in Table 4-30 and for the modulus data in Table 4-31. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-13.

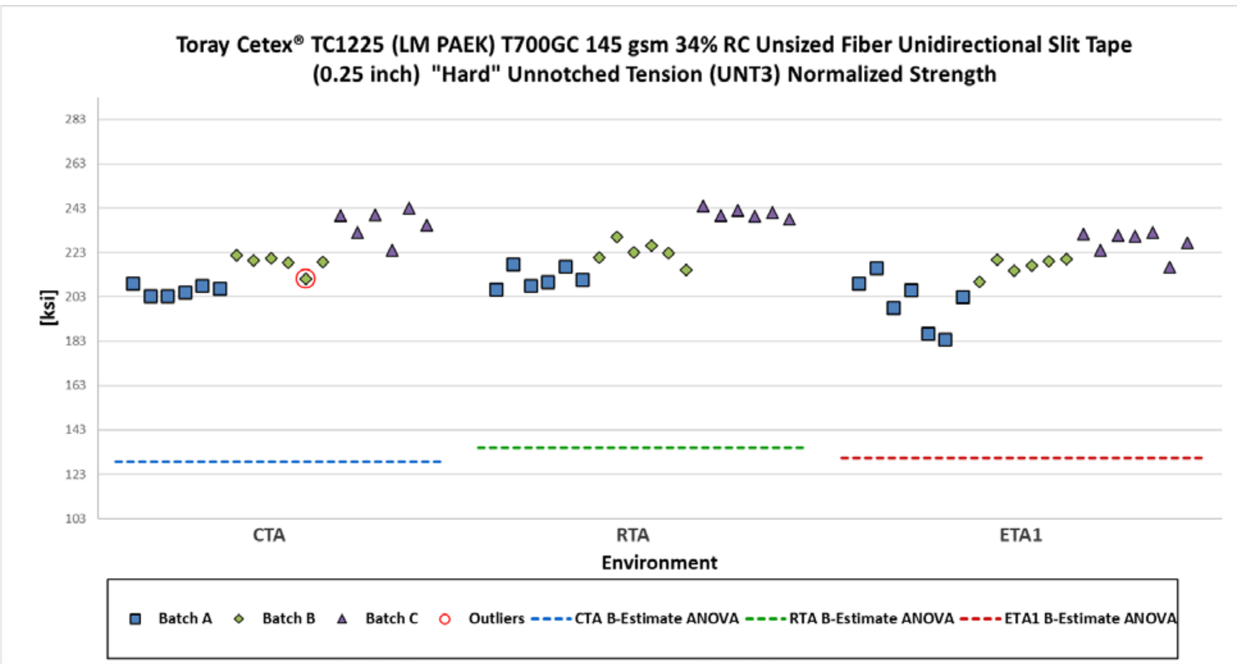

Figure 4-13: Batch Plot for UNT3 Normalized Strength

Hard Unnotched Tension (UNT3) Basis Values and Statistics						
	Normalized			As-Measured		
Environment	CTA	RTA	ETA1	CTA	RTA	ETA1
Mean	220.0	225.1	214.8	217.9	223.5	212.5
Stdev	13.29	12.94	13.95	13.55	13.37	13.87
CV	6.041	5.748	6.496	6.217	5.985	6.528
Mod CV	7.020	6.874	7.248	7.109	6.992	7.264
Min	203.3	206.3	183.9	197.8	200.2	184.6
Max	242.9	244.0	232.1	240.2	243.7	230.7
No. Batches	3	3	3	3	3	3
No. Spec.	18	18	20	18	18	20
Basis Values and Estimates						
B-Estimate	128.8	135.2	130.3	127.8	133.7	124.3
A-Estimate	63.65	70.96	69.88	63.52	69.63	61.30
Method	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA

Table 4-30: Statistics and Basis Values for UNT3 Strength Data

Hard Unnotched Tension (UNT3) Modulus Statistics						
	Normalized			As-Measured		
Environment	CTA	RTA	ETA1	CTA	RTA	ETA1
Mean	11.21	11.15	11.06	11.10	11.07	10.94
Stdev	0.2280	0.2657	0.2950	0.2539	0.3070	0.3526
CV	2.034	2.383	2.668	2.286	2.774	3.223
Min	10.96	10.82	10.45	10.69	10.51	10.14
Max	11.66	11.60	11.53	11.66	11.65	11.49
No. Batches	3	3	3	3	3	3
No. Spec.	18	18	20	18	18	20

Table 4-31: Statistics for UNT3 Modulus Data

4.13 “25/50/25” Unnotched Compression 1 (UNC1)

The UNC1 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength and modulus tests were conducted in the following environmental conditions: RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with six specimens, therefore only estimates were computed for those conditions.

For the normalized dataset, the RTA condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for RTA. The single point normal method was used for the remaining conditions. Applying the modified CV, the RTA and ETA1 conditions met all the requirements for pooling, and the normal method for modified CV was used for ETA2 and ETW. The ETA2 condition has an original CV that is greater than 8%, therefore original CV and modified CV results are the same. For this reason, only the original CV line is visible in the batch plot of normalized values.

For the as-measured dataset, the RTA condition failed the normality test, but the Weibull distribution was a good fit for the data. The single point normal method was used for the remaining conditions. Applying the modified CV, the RTA and ETA1 conditions could not be pooled because the pooled dataset failed the normality test. The normal method for modified CV was used for all the conditions. The ETA2 condition has an original CV that is greater than 8%, therefore original CV and modified CV results are the same.

There was one statistical outlier. The lowest value in batch C of the RTA condition was a batch outlier in the as-measured dataset. It was retained for this analysis.

Statistics, basis values and estimates are given for the UNC1 strength data in Table 4-32 and Table 4-33 for the modulus data in Table 4-34. The normalized data and B-basis values are shown graphically in Figure 4-14.

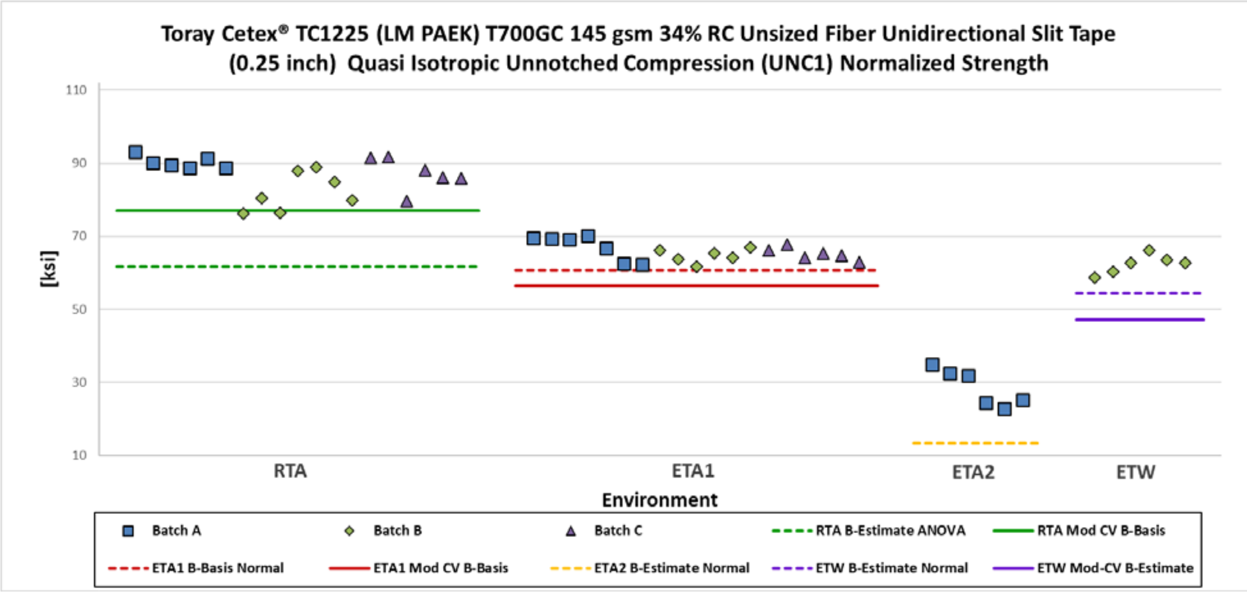

Figure 4-14: Batch Plot for UNC1 Normalized Strength

Normalized Quasi Unnotched Compression (UNC1) Basis Values and Statistics				
Environment	RTA	ETA1	ETA2	ETW
Mean	86.27	65.71	28.63	62.35
Stdev	5.271	2.593	5.068	2.588
CV	6.110	3.947	17.70	4.150
Mod CV	7.055	6.000	17.70	8.000
Min	76.19	61.81	22.81	58.74
Max	93.11	70.10	34.92	66.16
No. Batches	3	3	1	1
No. Spec.	19	19	6	6
Basis Values and Estimates				
B-Basis Value		60.65		
B-Estimate	61.71		13.28	54.51
A-Estimate	44.20	57.06	2.370	48.94
Method	ANOVA	Normal	Normal	Normal
Modified CV Basis Values and Estimates				
B-Basis Value	77.02	56.45		
B-Estimate			13.28	47.24
A-Estimate	70.70	50.14	2.370	36.50
Method	Pooled	Pooled	Normal	Normal

Table 4-32: Statistics and Basis Values for UNC1 Normalized Strength Data

As-Measured Quasi Unnotched Compression (UNC1) Basis Values and Statistics				
Environment	RTA	ETA1	ETA2	ETW
Mean	86.04	65.66	28.11	63.93
Stdev	3.853	2.141	4.832	1.986
CV	4.478	3.261	17.19	3.107
Mod CV	6.239	6.000	17.19	8.000
Min	78.43	61.56	22.59	61.22
Max	90.31	68.76	34.14	66.87
No. Batches	3	3	1	1
No. Spec.	19	19	6	6
Basis Values and Estimates				
B-Basis Value	78.52	61.49		
B-Estimate			13.48	57.91
A-Estimate	70.57	58.52	3.069	53.64
Method	Weibull	Normal	Normal	Normal
Modified CV Basis Values and Estimates				
B-Basis Value	75.58	57.98		
B-Estimate			13.48	48.44
A-Estimate	68.15	52.53	3.069	37.42
Method	Normal	Normal	Normal	Normal

Table 4-33: Statistics and Basis Values for UNC1 As-Measured Strength Data

Quasi Unnotched Compression (UNC1) Modulus Statistics								
	Normalized				As-Measured			
Environment	RTA	ETA1	ETA2	ETW	RTA	ETA1	ETA2	ETW
Mean	6.720	6.736	6.038	6.488	6.700	6.739	5.932	6.653
Stdev	0.2799	0.3107	0.2455	0.1381	0.1727	0.2022	0.2296	0.07114
CV	4.165	4.613	4.067	2.129	2.578	3.000	3.871	1.069
Min	6.184	6.072	5.770	6.313	6.448	6.316	5.716	6.579
Max	7.246	7.319	6.382	6.649	6.997	7.175	6.255	6.770
No. Batches	3	3	1	1	3	3	1	1
No. Spec.	18	18	6	6	18	18	6	6

Table 4-34: Statistics for UNC1 Modulus Data

4.14 “10/80/10” Unnotched Compression 2 (UNC2)

The UNC2 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength and modulus tests were conducted in the following environmental conditions: RTA and ETA1.

The results were identical for the normalized and as-measured datasets. There were no diagnostic test failures, therefore both conditions were pooled using the original CV and the modified CV.

There were no statistical outliers.

Statistics, basis values and estimates are given for the UNC2 strength data in Table 4-35 and for the modulus data in Table 4-36. The normalized data and B-basis values are shown graphically in Figure 4-15.

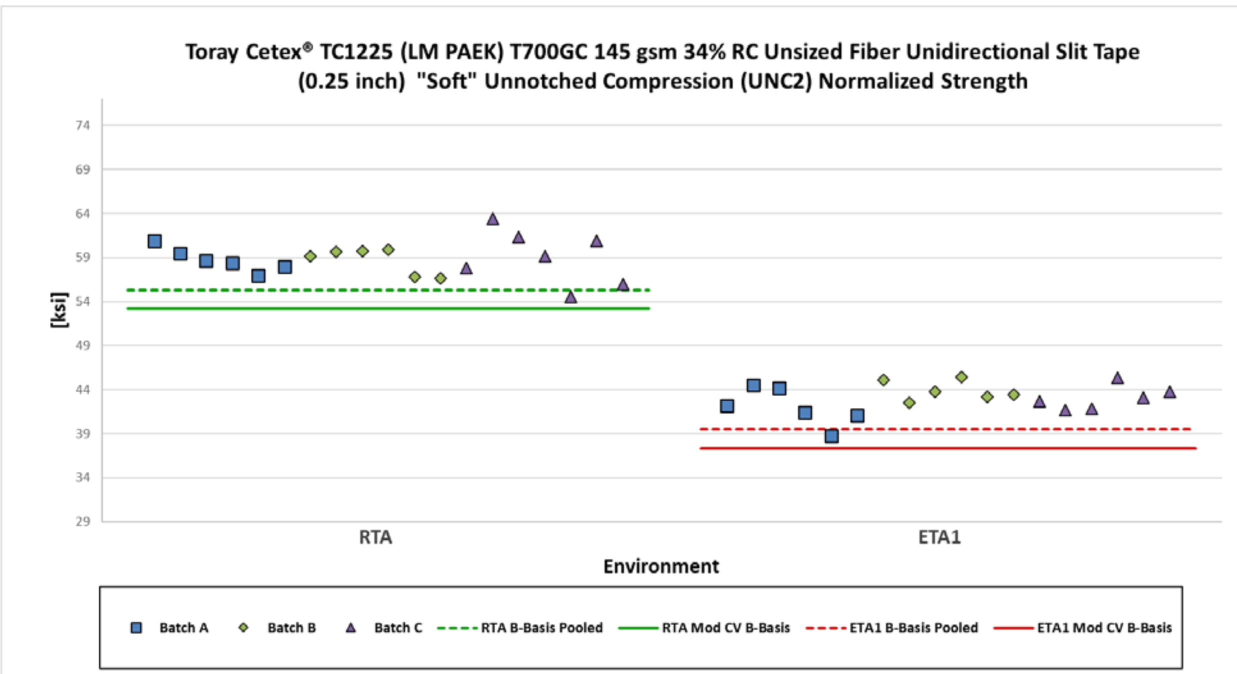

Figure 4-15: Batch Plot for UNC2 Normalized Strength

Soft Unnotched Compression (UNC2) Basis Values and Statistics				
	Normalized		As-Measured	
Environment	RTA	ETA1	RTA	ETA1
Mean	58.81	42.99	58.21	42.48
Stdev	2.109	1.701	2.349	1.516
CV	3.586	3.957	4.035	3.569
Mod CV	6.000	6.000	6.018	6.000
Min	54.51	38.73	53.44	38.93
Max	63.42	45.41	63.15	44.96
No. Batches	3	3	3	3
No. Spec.	19	18	19	18
Basis Values and Estimates				
B-Basis Value	55.34	39.50	54.61	38.87
A-Estimate	52.96	37.13	52.15	36.42
Method	Pooled	Pooled	Pooled	Pooled
Modified CV Basis Values and Estimates				
B-Basis Value	53.20	37.35	52.64	36.89
A-Estimate	49.36	33.52	48.84	33.09
Method	Pooled	Pooled	Pooled	Pooled

Table 4-35: Statistics and Basis Values for UNC2 Strength Data

Soft Unnotched Compression (UNC2) Modulus Statistics				
	Normalized		As-Measured	
Environment	RTA	ETA1	RTA	ETA1
Mean	4.449	4.191	4.403	4.143
Stdev	0.1158	0.1610	0.1314	0.1733
CV	2.602	3.840	2.983	4.183
Min	4.293	3.963	4.163	3.832
Max	4.859	4.519	4.746	4.431
No. Batches	3	3	3	3
No. Spec.	19	18	19	18

Table 4-36: Statistics for UNC2 Modulus Data

4.15 "50/40/10" Unnotched Compression 3 (UNC3)

The UNC3 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength and modulus tests were conducted in the following environmental conditions: RTA and ETA1.

The results were identical for the normalized and as-measured datasets. The RTA condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for RTA and the single point normal method was used for ETA1. Applying the modified CV, there were no diagnostic test failures, therefore both conditions were pooled.

There were no statistical outliers.

Statistics, basis values and estimates are given for the UNC3 strength data in Table 4-37 and for the modulus data in Table 4-38. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-16.

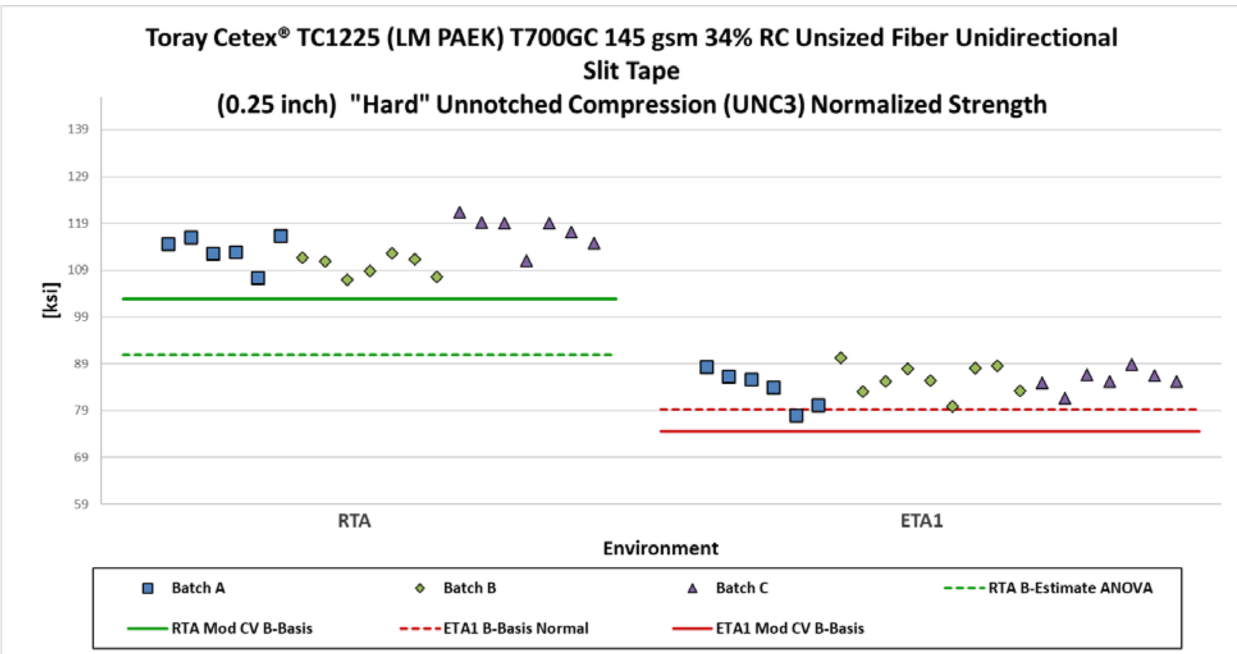

Figure 4-16: Batch Plot for UNC3 Normalized Strength

Hard Unnotched Compression (UNC3) Basis Values and Statistics				
	Normalized		As-Measured	
Environment	RTA	ETA1	RTA	ETA1
Mean	113.6	85.16	112.3	84.18
Stdev	4.283	3.145	4.210	2.840
CV	3.771	3.693	3.750	3.374
Mod CV	6.000	6.000	6.000	6.000
Min	106.9	78.08	106.0	78.84
Max	121.4	90.22	120.5	89.31
No. Batches	3	3	3	3
No. Spec.	20	22	20	22
Basis Values and Estimates				
B-Basis Value		79.22		78.83
B-Estimate	90.84		90.80	
A-Estimate	74.62	74.99	75.48	75.00
Method	ANOVA	Normal	ANOVA	Normal
Modified CV Basis Values and Estimates				
B-Basis Value	102.9	74.59	101.7	73.74
A-Estimate	95.64	67.29	94.54	66.52
Method	Pooled	Pooled	Pooled	Pooled

Table 4-37: Statistics and Basis Values for UNC3 Strength Data

Hard Unnotched Compression (UNC3) Modulus Statistics				
	Normalized		As-Measured	
Environment	RTA	ETA1	RTA	ETA1
Mean	10.38	10.51	10.25	10.39
Stdev	0.2496	0.2195	0.2439	0.2763
CV	2.404	2.088	2.378	2.659
Min	9.901	10.17	9.849	9.812
Max	10.86	10.90	10.65	10.75
No. Batches	3	3	3	3
No. Spec.	18	18	18	18

Table 4-38: Statistics for UNC3 Modulus Data

4.16 “25/50/25” Open-Hole Tension 1 (OHT1)

The OHT1 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength tests were conducted in the following environmental conditions: CTA, RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with six specimens, therefore only estimates were computed for those conditions.

For the normalized dataset, the CTA, RTA and ETA1 conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for those conditions. The single point normal method was used for ETA2 and ETW. Applying the modified CV, the CTA, RTA and ETA1 conditions failed the ADK test, therefore modified CV basis values were not computed for those conditions. The normal method for modified CV was used for ETA2 and ETW.

For the as-measured dataset, the CTA, RTA and ETA1 conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for those conditions. The single point normal method was used for ETA2 and ETW. Applying the modified CV, the ETA1 condition failed the ADK test, therefore modified CV basis values were not computed for ETA1. The CTA and RTA conditions met all the requirements for pooling. The normal method for modified CV was used for ETA2 and ETW.

There were no statistical outliers.

Statistics, basis values and estimates are given for the OHT1 strength data in Table 4-39 and Table 4-40. The normalized data, B-basis values and B-estimates are shown graphically in Figure 4-17.

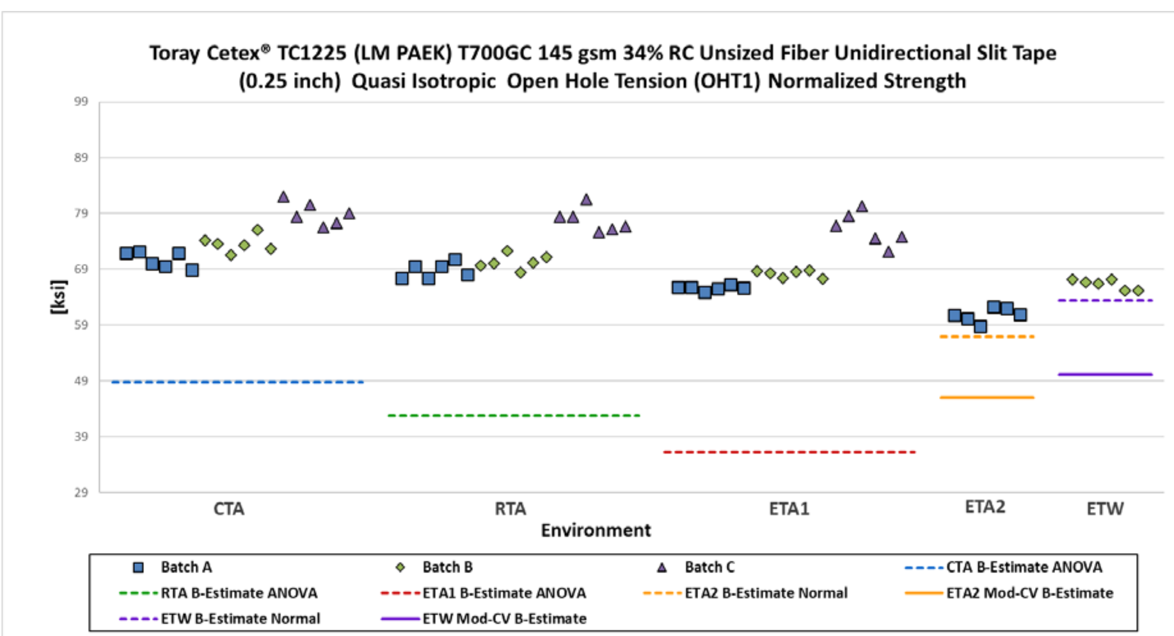

Figure 4-17: Batch Plot for OHT1 Normalized Strength

Normalized Quasi Open Hole Tension (OHT1) Strength Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	74.44	72.32	70.01	60.85	66.30
Stdev	3.867	4.350	4.915	1.286	0.9330
CV	5.195	6.015	7.020	2.114	1.407
Mod CV	6.598	7.008	7.510	8.000	8.000
Min	68.93	67.40	64.90	58.85	65.14
Max	82.09	81.54	80.34	62.37	67.21
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	6	6
Basis Value Estimates					
B-Estimate	48.87	42.78	36.35	56.95	63.48
A-Estimate	30.62	21.69	12.33	54.18	61.47
Method	ANOVA	ANOVA	ANOVA	Normal	Normal
Modified CV Basis Value Estimates					
B-Basis Value	NA	NA	NA		
B-Estimate				46.11	50.24
A-Estimate				35.62	38.81
Method				Normal	Normal

Table 4-39: Statistics and Basis Values for OHT1 Normalized Strength Data

As-Measured Quasi Open Hole Tension (OHT1) Strength Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	73.46	71.24	68.97	60.66	66.25
Stdev	3.029	3.494	3.977	2.601	0.9987
CV	4.124	4.904	5.767	4.287	1.507
Mod CV	6.062	6.452	6.884	8.000	8.000
Min	68.37	65.37	62.90	57.23	64.71
Max	78.50	78.03	77.55	63.90	67.57
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	6	6
Basis Value Estimates					
B-Estimate	53.97	50.56	43.18	52.79	63.23
A-Estimate	40.05	35.81	24.77	47.18	61.08
Method	ANOVA	ANOVA	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates					
B-Basis Value	65.22	63.00	NA		
B-Estimate				45.96	50.20
A-Estimate	59.61	57.39		35.51	38.78
Method	Pooled	Pooled		Normal	Normal

Table 4-40: Statistics and Basis Values for OHT1 As-Measured Strength Data

4.17 “10/80/10” Open-Hole Tension 2 (OHT2)

The OHT2 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength tests were conducted in the following environmental conditions: CTA, RTA, and ETA1.

The results are identical for the normalized and as-measured datasets. The RTA and ETA1 conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for those conditions. The single point normal method was used for CTA. Applying the modified CV, there were no diagnostic test failures, therefore all conditions were pooled.

For the as-measured dataset, there was one statistical outlier. The lowest value in batch C of the RTA condition was a batch outlier. This outlier cannot be seen in the graph because the graph is for normalized values. It was retained for this analysis.

Statistics, basis values and estimates are given for the OHT2 strength data in Table 4-41. The normalized data and B-basis values are shown graphically in Figure 4-18.

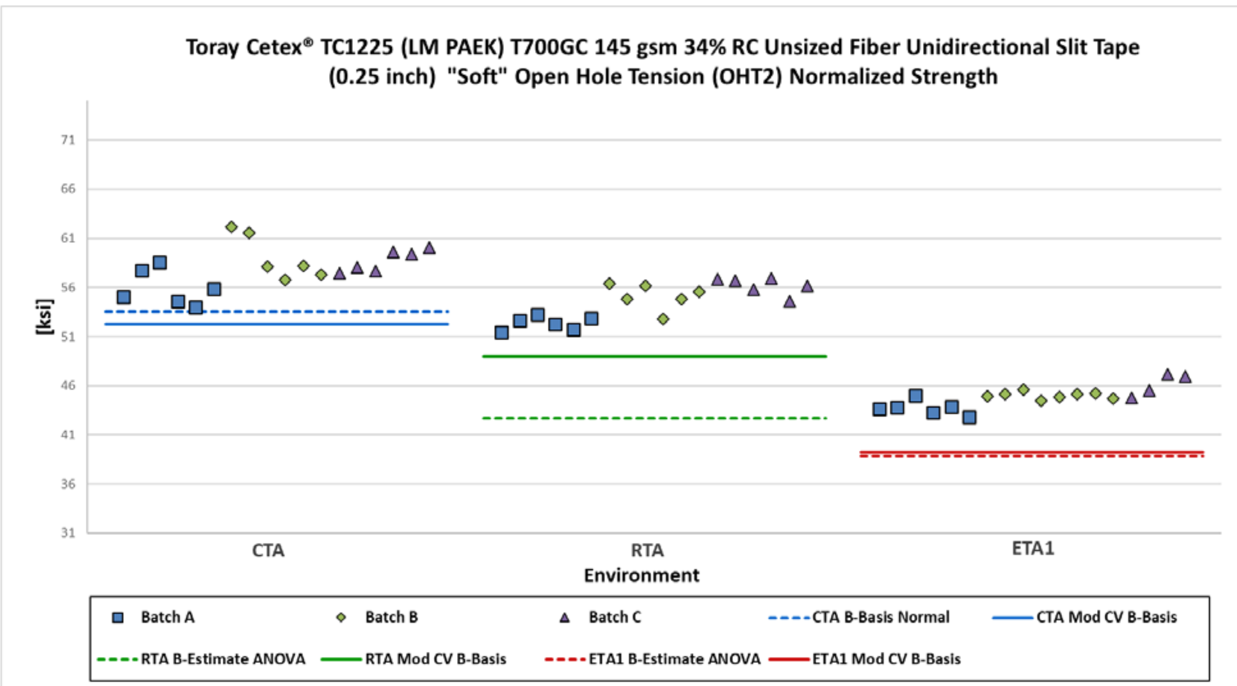

Figure 4-18: Batch Plot for OHT2 Normalized Strength

Soft Open Hole Tension (OHT2) Strength Basis Values and Statistics						
	Normalized			As-Measured		
Environment	CTA	RTA	ETA1	CTA	RTA	ETA1
Mean	57.90	54.55	44.83	57.21	53.94	44.32
Stdev	2.200	1.884	1.119	1.818	1.751	1.040
CV	3.800	3.454	2.495	3.177	3.246	2.347
Mod CV	6.000	6.000	6.000	6.000	6.000	6.000
Min	54.03	51.48	42.81	53.68	51.31	42.52
Max	62.15	56.89	47.15	59.54	56.72	46.54
No. Batches	3	3	3	3	3	3
No. Spec.	18	18	18	18	18	18
Basis Values and Estimates						
B-Basis Value	53.55			53.62		
B-Estimate		42.68	38.85		43.32	38.80
A-Estimate	50.48	34.21	34.58	51.08	35.75	34.87
Method	Normal	ANOVA	ANOVA	Normal	ANOVA	ANOVA
Modified CV Basis Values and Estimates						
B-Basis Value	52.30	48.95	39.23	51.67	48.40	38.78
A-Estimate	48.56	45.21	35.49	47.98	44.71	35.09
Method	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled

Table 4-41: Statistics and Basis Values for OHT2 Strength Data

4.18 "50/40/10" Open-Hole Tension 3 (OHT3)

The OHT3 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength tests were conducted in the following environmental conditions: CTA, RTA, and ETA1.

The results are identical for the normalized and as-measured datasets. All the conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for all conditions. Applying the modified CV, all the conditions failed the ADK test, therefore modified CV basis values were not computed for any condition.

There were two statistical outliers. The highest value in batch B of the RTA condition was a batch outlier in the normalized dataset. The lowest value in batch B of the ETA1 condition was a batch outlier in the normalized dataset. They were retained for this analysis.

Statistics, basis values and estimates are given for the OHT3 strength data in Table 4-42. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-19.

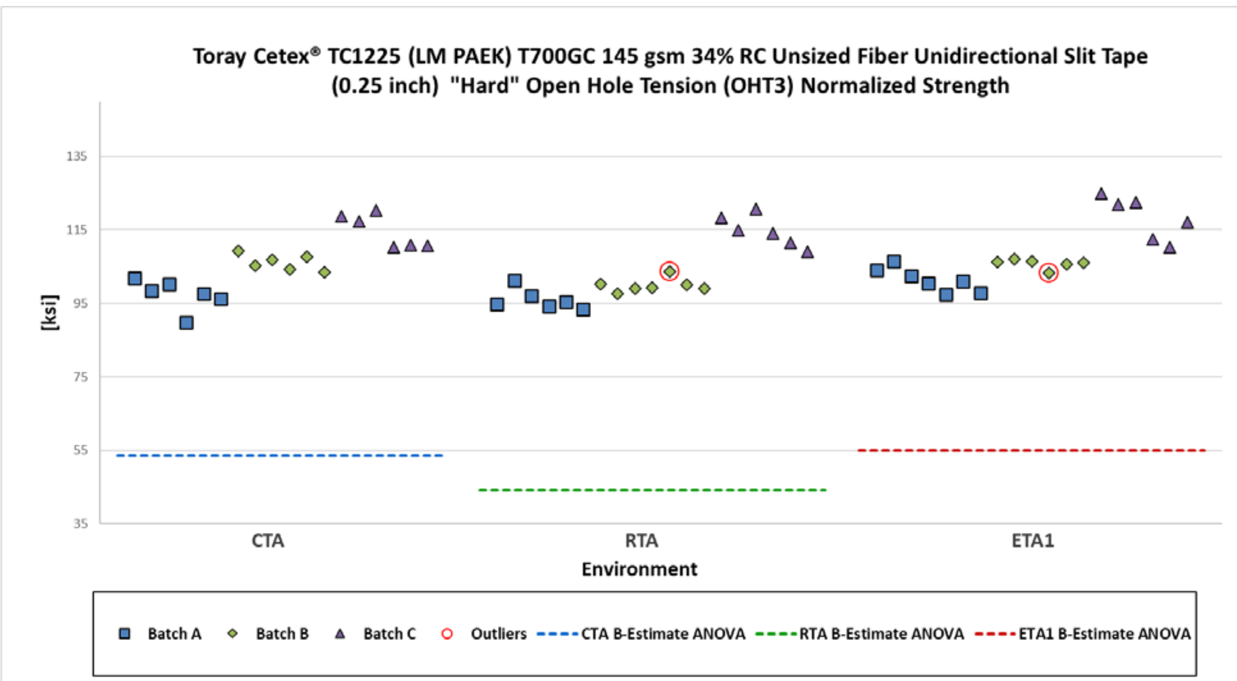

Figure 4-19: Batch Plot for OHT3 Normalized Strength

Open Hole Tension 3 (OHT3) Strength Basis Values and Statistics						
	Normalized			As-Measured		
Environment	CTA	RTA	ETA1	CTA	RTA	ETA1
Mean	106.1	103.4	108.1	104.7	101.9	106.4
Stdev	8.083	8.615	8.178	8.101	8.508	8.201
CV	7.620	8.335	7.567	7.737	8.350	7.705
Mod CV	7.810	8.335	7.784	7.869	8.350	7.852
Min	89.89	93.49	97.41	90.46	91.71	96.63
Max	120.2	120.6	124.9	119.3	119.8	124.0
No. Batches	3	3	3	3	3	3
No. Spec.	18	19	19	18	19	19
Basis Value Estimates						
B-Estimate	53.50	44.07	55.02	51.44	43.83	53.07
A-Estimate	15.96	1.749	17.14	13.41	2.381	14.97
Method	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA

Table 4-42: Statistics and Basis Values for OHT3 Strength Data

4.19 "25/50/25" Filled-Hole Tension 1 (FHT1)

The FHT1 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength tests were conducted in the following environmental conditions: CTA, RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with six specimens, therefore only estimates were computed for those conditions.

The results were identical for the normalized and as-measured datasets. The CTA, RTA, and ETA1 conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for those conditions and the single point normal method was used for ETA2 and ETW. Applying the modified CV, the CTA, RTA and ETA1 conditions met all the requirements for pooling and the normal method for modified CV was used for ETA2 and ETW.

There were two statistical outliers. The highest value in batch B of the ETA1 condition was a batch outlier in the normalized dataset. The lowest value in batch A of the ETA2 condition was an outlier in the normalized and as-measured datasets. They were retained for this analysis.

Statistics, basis values and estimates are given for the FHT1 strength data in Table 4-43 and Table 4-44. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-20.

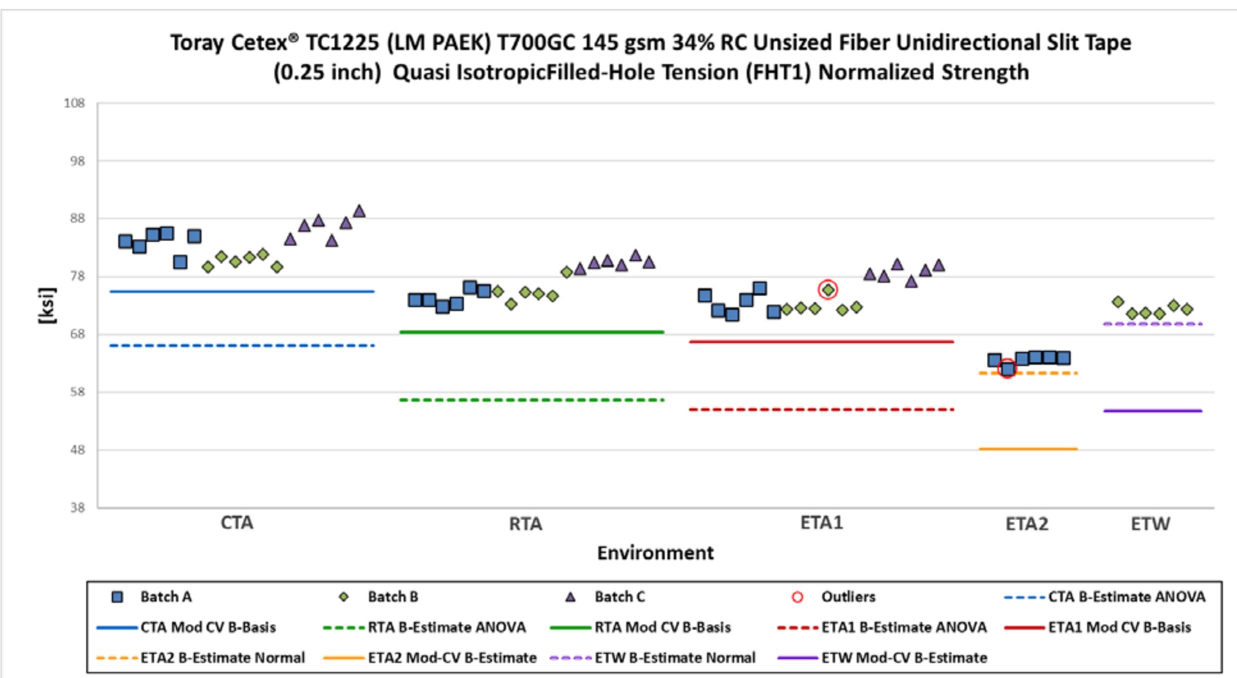

Figure 4-20: Batch Plot for FHT1 Normalized Strength

Normalized Quasi Filled Hole Tension (FHT1) Strength Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	83.80	76.73	75.07	63.63	72.28
Stdev	2.927	3.057	3.088	0.7909	0.8333
CV	3.492	3.984	4.114	1.243	1.153
Mod CV	6.000	6.000	6.057	8.000	8.000
Min	79.66	72.81	71.39	62.08	71.52
Max	89.34	81.74	80.19	64.16	73.59
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	6	6
Basis Value Estimates					
B-Estimate	65.98	56.62	55.04	61.23	69.75
A-Estimate	53.27	42.27	40.75	59.53	67.96
Method	ANOVA	ANOVA	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates					
B-Basis Value	75.42	68.35	66.69		
B-Estimate				48.21	54.76
A-Estimate	69.83	62.76	61.10	37.25	42.31
Method	Pooled	Pooled	Pooled	Normal	Normal

Table 4-43: Statistics and Basis Values for FHT1 Normalized Strength Data

As-Measured Quasi Filled Hole Tension (FHT1) Strength Basis Values and Statistics					
Environment	CTA	RTA	ETA1	ETA2	ETW
Mean	82.21	75.39	73.85	62.27	71.76
Stdev	2.686	2.845	2.842	0.6474	1.252
CV	3.267	3.773	3.848	1.040	1.744
Mod CV	6.000	6.000	6.000	8.000	8.000
Min	77.73	71.83	70.18	61.04	70.13
Max	87.44	79.91	79.24	62.83	72.90
No. Batches	3	3	3	1	1
No. Spec.	18	18	18	6	6
Basis Value Estimates					
B-Estimate	68.55	58.56	57.41	60.30	67.97
A-Estimate	58.81	46.54	45.68	58.91	65.27
Method	ANOVA	ANOVA	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates					
B-Basis Value	74.01	67.19	65.65		
B-Estimate				47.18	54.37
A-Estimate	68.53	61.71	60.17	36.45	42.00
Method	Pooled	Pooled	Pooled	Normal	Normal

Table 4-44: Statistics and Basis Values for FHT1 As-Measured Strength Data

4.20 "10/80/10" Filled-Hole Tension 2 (FHT2)

The FHT2 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength tests were conducted in the following environmental conditions: CTA, RTA, and ETA1.

The results were identical for the normalized and as-measured datasets. The three conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for all conditions. Applying the modified CV, there were no diagnostic test failures, therefore all conditions were pooled.

There were no statistical outliers.

Statistics, basis values and estimates are given for the FHT2 strength data in Table 4-45. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-21.

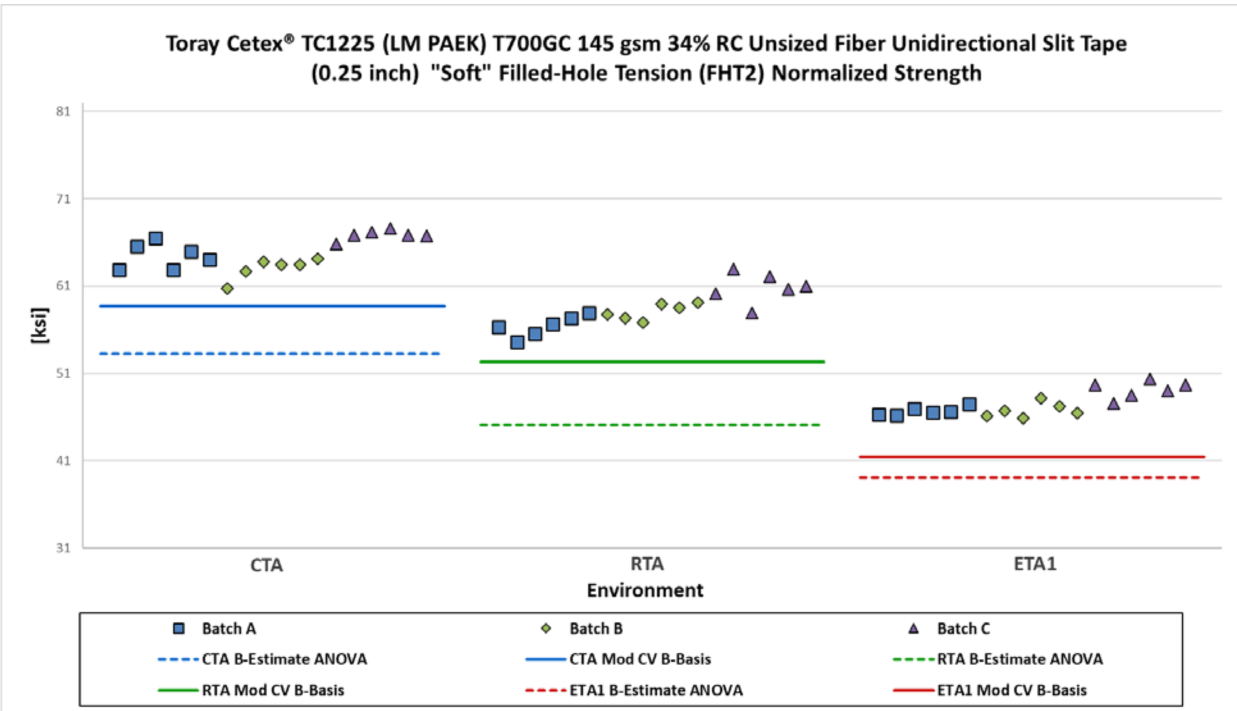

Figure 4-21: Batch plot for FHT2 Normalized Strength

Soft Filled Hole Tension (FHT2) Strength Basis Values and Statistics						
	Normalized			As-Measured		
Environment	CTA	RTA	ETA1	CTA	RTA	ETA1
Mean	64.79	58.42	47.53	64.32	57.83	47.18
Stdev	1.940	2.234	1.389	1.600	2.063	1.139
CV	2.994	3.824	2.923	2.488	3.567	2.415
Mod CV	6.000	6.000	6.000	6.000	6.000	6.000
Min	60.77	54.60	45.85	60.88	54.00	45.72
Max	67.58	62.94	50.36	66.50	61.77	49.41
No. Batches	3	3	3	3	3	3
No. Spec.	18	18	18	18	18	18
Basis Value Estimates						
B-Estimate	53.27	45.10	39.12	56.07	45.43	40.99
A-Estimate	45.04	35.60	33.12	50.18	36.58	36.57
Method	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA
Modified CV Basis Values and Estimates						
B-Basis Value	58.69	52.33	41.44	58.27	51.79	41.14
A-Estimate	54.63	48.26	37.37	54.24	47.76	37.10
Method	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled

Table 4-45: Statistics and Basis Values for FHT2 Strength Data

4.21 "50/40/10" Filled-Hole Tension 3 (FHT3)

The FHT3 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength tests were conducted in the following environmental conditions: CTA, RTA, and ETA1.

For the normalized dataset, the three conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for all conditions. Applying the modified CV, the ETA1 condition failed the ADK test, therefore modified CV basis values were not computed for ETA1. The CTA and RTA conditions met all the requirements for pooling.

For the as-measured dataset, the three conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for all conditions. Applying the modified CV, the three conditions failed the ADK test, therefore modified CV basis values were not computed for any condition.

There were no statistical outliers.

Statistics, basis values and estimates are given for the FHT3 strength data in Table 4-46. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-22.

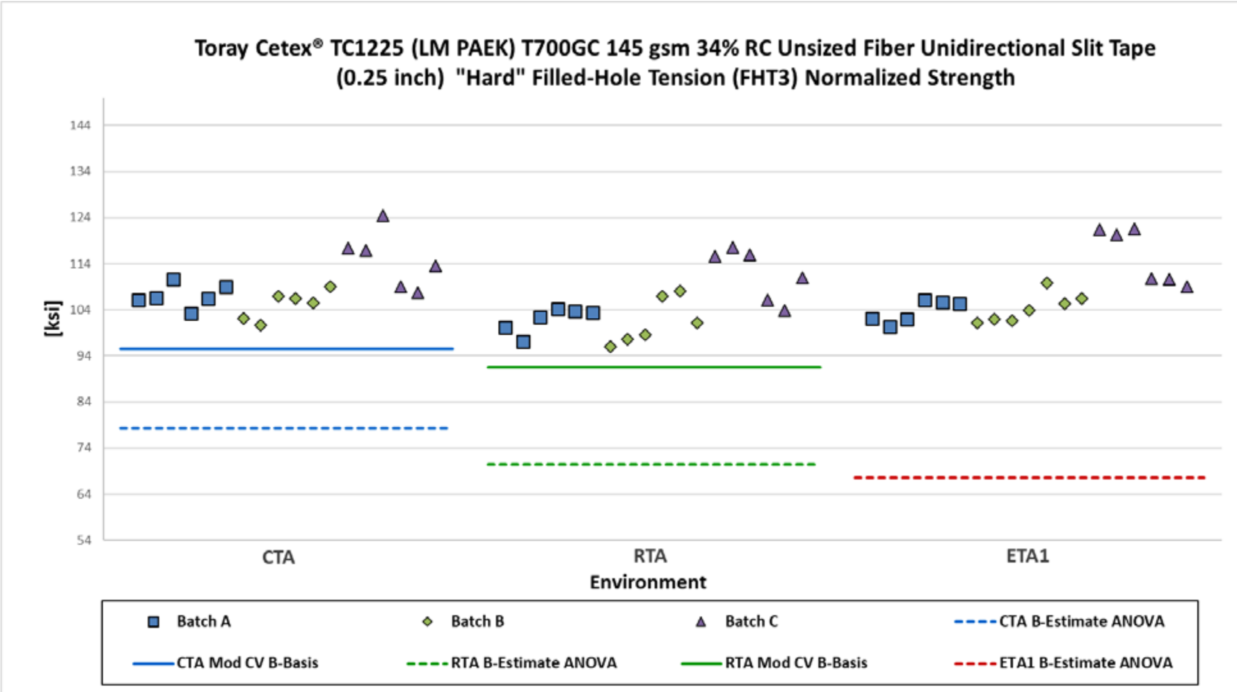

Figure 4-22: Batch plot for FHT3 Normalized Strength

Hard Filled Hole Tension (FHT3) Strength Basis Values and Statistics						
	Normalized			As-Measured		
Environment	CTA	RTA	ETA1	CTA	RTA	ETA1
Mean	109.0	105.0	107.6	107.0	103.0	105.8
Stdev	5.900	6.535	6.772	6.356	6.891	7.177
CV	5.413	6.226	6.291	5.938	6.690	6.785
Mod CV	6.706	7.113	7.145	6.969	7.345	7.392
Min	100.6	96.08	100.3	97.71	92.71	97.86
Max	124.5	117.5	121.5	121.2	114.2	118.6
No. Batches	3	3	3	3	3	3
No. Spec.	18	18	19	18	18	19
Basis Value Estimates						
B-Estimate	78.37	70.47	67.59	67.13	59.35	56.05
A-Estimate	56.53	45.86	38.99	38.66	28.18	20.55
Method	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA
Modified CV Basis Values and Estimates						
B-Basis Value	95.53	91.50	NA	NA		
A-Estimate	86.38	82.35				
Method	Pooled	Pooled				

Table 4-46: Statistics and Basis Values for FHT3 Strength Data

4.22 "25/50/25" Open-Hole Compression 1 (OHC1)

The OHC1 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength tests were conducted in the following environmental conditions: RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with six specimens, therefore only estimates were computed for those conditions.

The results are identical for the normalized and as-measured datasets. The ETA1 condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for ETA1. The single point normal method was used for the remaining conditions. Applying the modified CV, the RTA and ETA1 conditions met all the requirements for pooling. The normal method for modified CV was used for ETA2 and ETW. The ETA2 condition has a original CV larger than 8%, therefore the original CV and modified CV results are identical. For this reason, only the original CV results can be observed in the batch plot of normalized values.

There were no statistical outliers.

Statistics, basis values and estimates are given for the OHC1 strength data in Table 4-47 and Table 4-48. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-23.

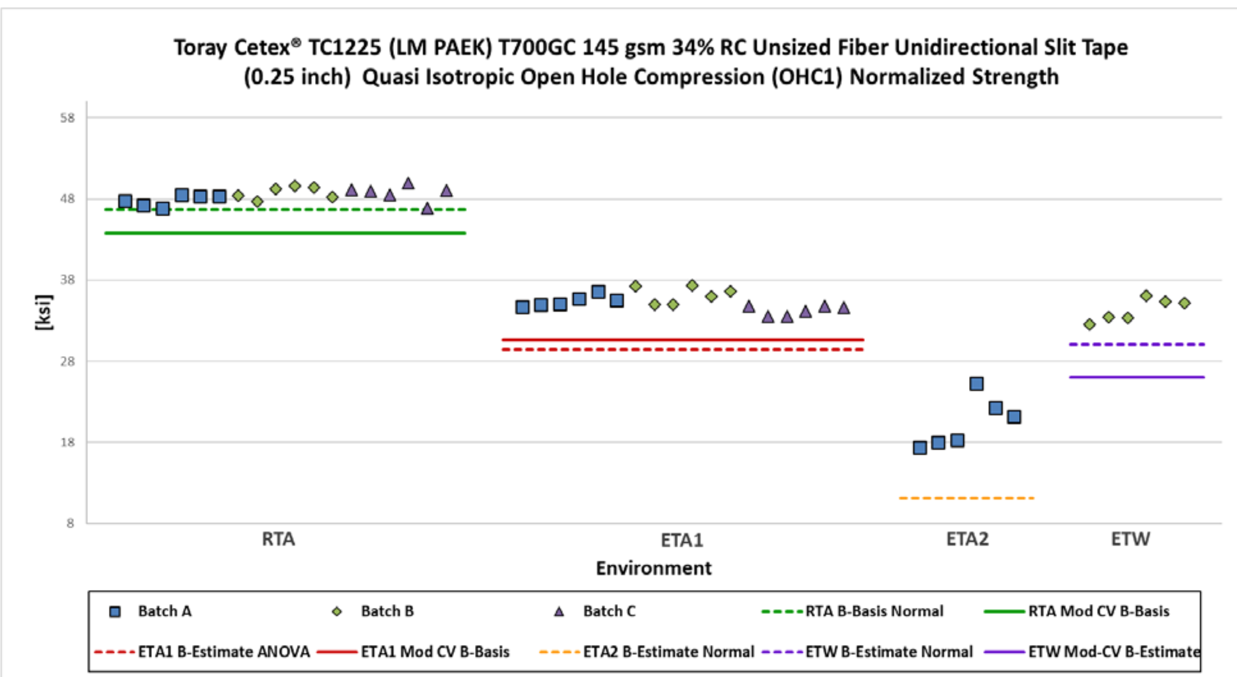

Figure 4-23: Batch Plot for OHC1 Normalized Strength

Normalized Quasi Open Hole Compression (OHC1) Strength Basis Values and Statistics				
Environment	RTA	ETA1	ETA2	ETW
Mean	48.46	35.31	20.41	34.33
Stdev	0.8912	1.114	3.060	1.402
CV	1.839	3.155	14.99	4.085
Mod CV	6.000	6.000	14.99	8.000
Min	46.90	33.57	17.36	32.58
Max	49.96	37.32	25.26	36.13
No. Batches	3	3	1	1
No. Spec.	18	18	6	6
Basis Values and Estimates				
B-Basis Value	46.71			
B-Estimate		29.47	11.14	30.08
A-Estimate	45.46	25.30	4.550	27.06
Method	Normal	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates				
B-Basis Value	43.83	30.67		
B-Estimate			11.14	26.01
A-Estimate	40.68	27.52	4.550	20.09
Method	Pooled	Pooled	Normal	Normal

Table 4-47: Statistics and Basis Values for OHC1 Normalized Strength Data

As-Measured Quasi Open Hole Compression (OHC1) Strength Basis Values and Statistics				
Environment	**RTA**	**ETA1**	**ETA2**	**ETW**
Mean	47.86	34.84	20.34	33.58
Stdev	0.8967	1.044	2.943	0.7380
CV	1.873	2.995	14.47	2.198
Mod CV	6.000	6.000	14.47	8.000
Min	46.04	32.98	17.37	32.50
Max	49.56	37.20	25.05	34.78
No. Batches	3	3	1	1
No. Spec.	18	18	6	6
Basis Values and Estimates				
B-Basis Value	46.09			
B-Estimate		29.08	11.43	31.35
A-Estimate	44.84	24.98	5.091	29.76
Method	Normal	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates				
B-Basis Value	43.29	30.26		
B-Estimate			11.43	25.44
A-Estimate	40.18	27.15	5.091	19.66
Method	Pooled	Pooled	Normal	Normal

Table 4-48: Statistics and Basis Values for OHC1 As-Measured Strength Data

4.23 “10/80/10” Open-Hole Compression 2 (OHC2)

The OHC2 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength tests were conducted in the following environmental conditions: RTA and ETA1.

For the normalized dataset, both conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for both conditions. Applying the modified CV, there were not diagnostic test failures, therefore both conditions were pooled.

For the as-measured dataset, the RTA and ETA1 conditions could not be pooled because the pooled dataset failed the Levene’s test for equality of variances. The single point normal method was used for both conditions. Applying the modified CV, there were no diagnostic test failures, therefore both conditions were pooled.

There were two statistical outliers. The highest value in batch B of the ETA1 condition was a batch outlier in the normalized and as-measured datasets. The highest value in batch C of the ETA1 condition was a batch outlier in the as-measured dataset. They were retained for this analysis.

Statistics, basis values and estimates are given for the OHC2 strength data in Table 4-49. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-24.

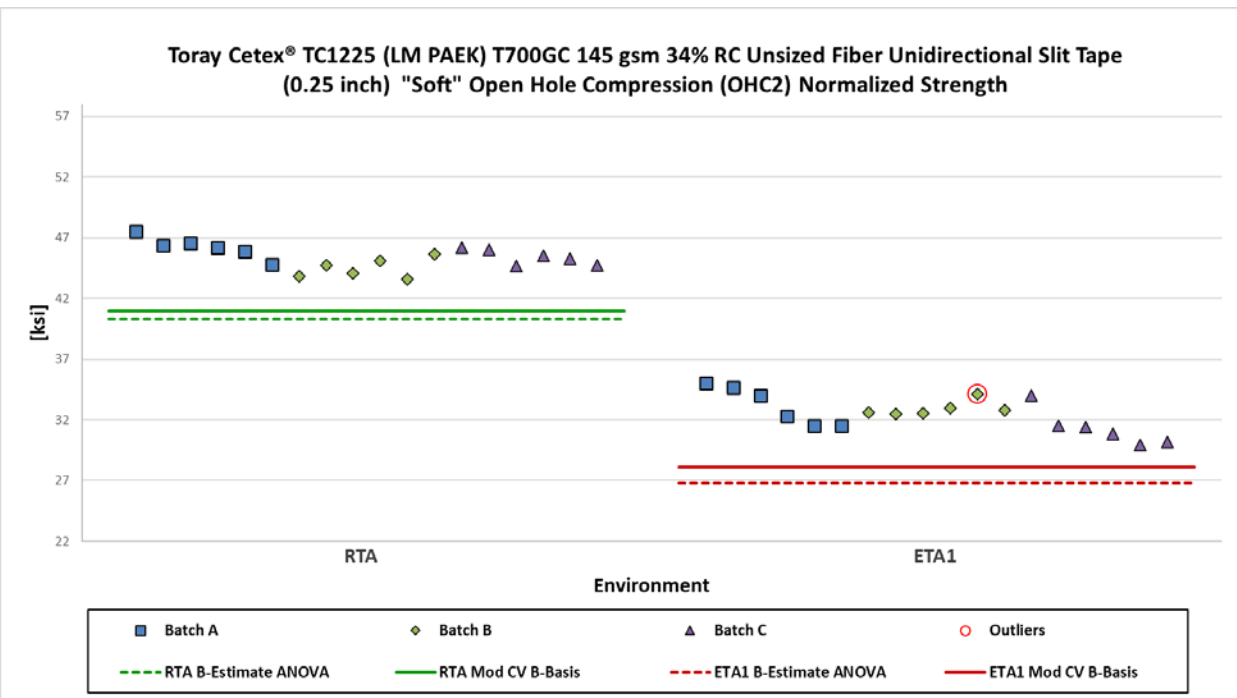

Figure 4-24: Batch Plot for OHC2 Normalized Strength

Soft Open Hole Compression (OHC2) Strength Basis Values and Statistics				
	Normalized		As-Measured	
Environment	RTA	ETA1	RTA	ETA1
Mean	45.38	32.47	45.30	32.41
Stdev	1.026	1.478	0.6436	1.309
CV	2.262	4.551	1.421	4.037
Mod CV	6.000	6.275	6.000	6.019
Min	43.61	29.97	44.09	30.33
Max	47.50	35.02	46.18	34.41
No. Batches	3	3	3	3
No. Spec.	18	18	18	18
Basis Values and Estimates				
B-Basis Value			44.03	29.83
B-Estimate	40.30	26.76		
A-Estimate	36.68	22.69	43.13	28.00
Method	ANOVA	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates				
B-Basis Value	41.00	28.09	40.99	28.10
A-Estimate	38.02	25.11	38.06	25.17
Method	Pooled	Pooled	Pooled	Pooled

Table 4-49: Statistics and Basis Values for OHC2 Strength Data

4.24 “50/40/10” Open-Hole Compression 3 (OHC3)

The OHC3 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength tests were conducted in the following environmental conditions: RTA and ETA1.

For the normalized dataset, the RTA condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for RTA. The single point normal method was used for ETA1. Applying the modified CV, there were no diagnostic test failures, therefore both conditions were pooled.

For the as-measured dataset, the RTA condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for RTA. The single point normal method was used for ETA1. Applying the modified CV, both conditions could not be pooled because the pooled dataset failed the normality test. The ETA1 condition failed the normality test, therefore modified CV basis values were not computed for ETA1. The normal method for modified CV was used for RTA.

There were no statistical outliers.

Statistics, basis values and estimates are given for the OHC3 strength data in Table 4-50. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-25.

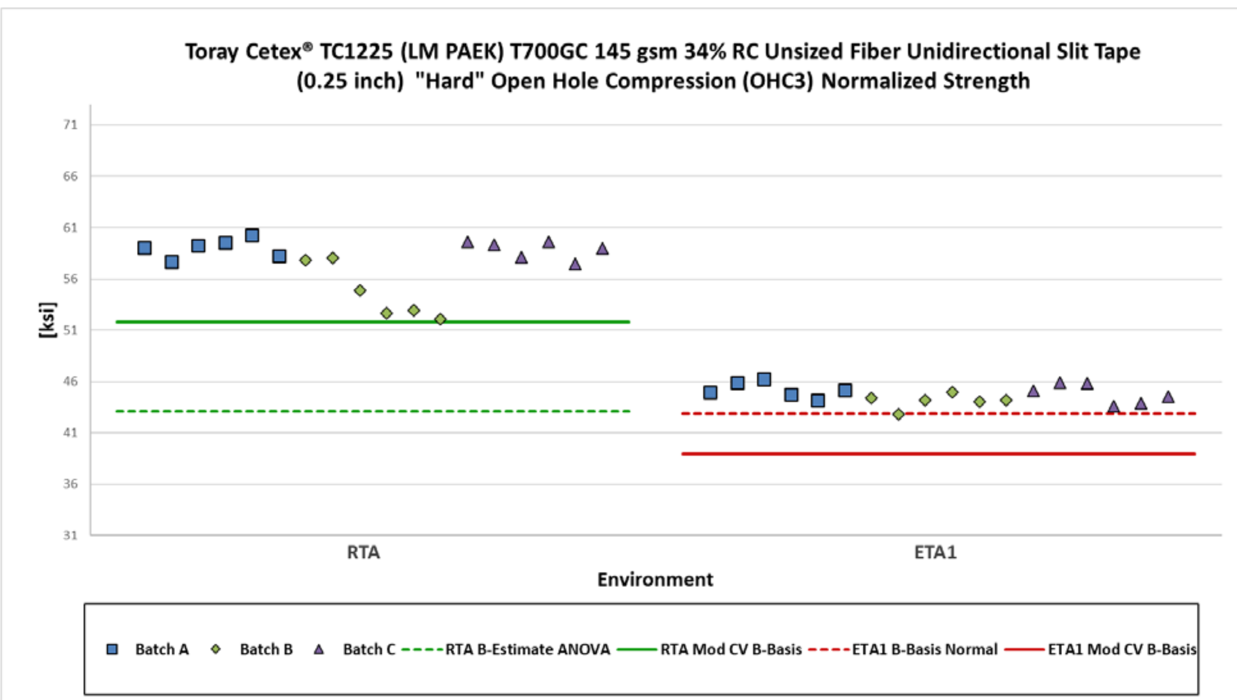

Figure 4-25: Batch Plot for OHC3 Normalized Strength

Hard Open Hole Compression (OHC3) Strength Basis Values and Statistics				
	Normalized		As-Measured	
Environment	RTA	ETA1	RTA	ETA1
Mean	57.56	44.72	56.54	44.14
Stdev	2.583	0.9131	1.383	1.313
CV	4.488	2.042	2.446	2.975
Mod CV	6.244	6.000	6.000	6.000
Min	52.10	42.80	54.09	42.13
Max	60.29	46.29	58.59	46.56
No. Batches	3	3	3	3
No. Spec.	18	18	18	18
Basis Values and Estimates				
B-Basis Value		42.92		41.54
B-Estimate	43.11		49.86	
A-Estimate	32.80	41.64	45.09	39.71
Method	ANOVA	Normal	ANOVA	Normal
Modified CV Basis Values and Estimates				
B-Basis Value	51.78	38.94	49.85	NA
B-Estimate				
A-Estimate	47.85	35.01	45.10	
Method	Pooled	Pooled	Normal	

Table 4-50: Statistics and Basis Values for OHC3 Strength Data

4.25 “25/50/25” Filled-Hole Compression 1 (FHC1)

The FHC1 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength tests were conducted in the following environmental conditions: RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with six specimens, therefore only estimates were computed for those conditions.

The results were identical for the normalized and as-measured datasets. The ETA1 condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for ETA1. The single point normal method was used for the remaining conditions. The ETA2 A-Estimate was set to zero because the result was negative. Applying the modified CV, the RTA and ETA1 conditions met all the requirements for pooling and the normal method for modified was used for ETA2 and ETW. The ETA2 condition has an original CV that is greater than 8%, therefore estimates using the original CV and modified CV are the same. For this reason, only the original CV line is visible in the batch plot of normalized values.

There were no statistical outliers.

Statistics, basis values and estimates are given for the FHC1 strength data in Table 4-51 and Table 4-52. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-26.

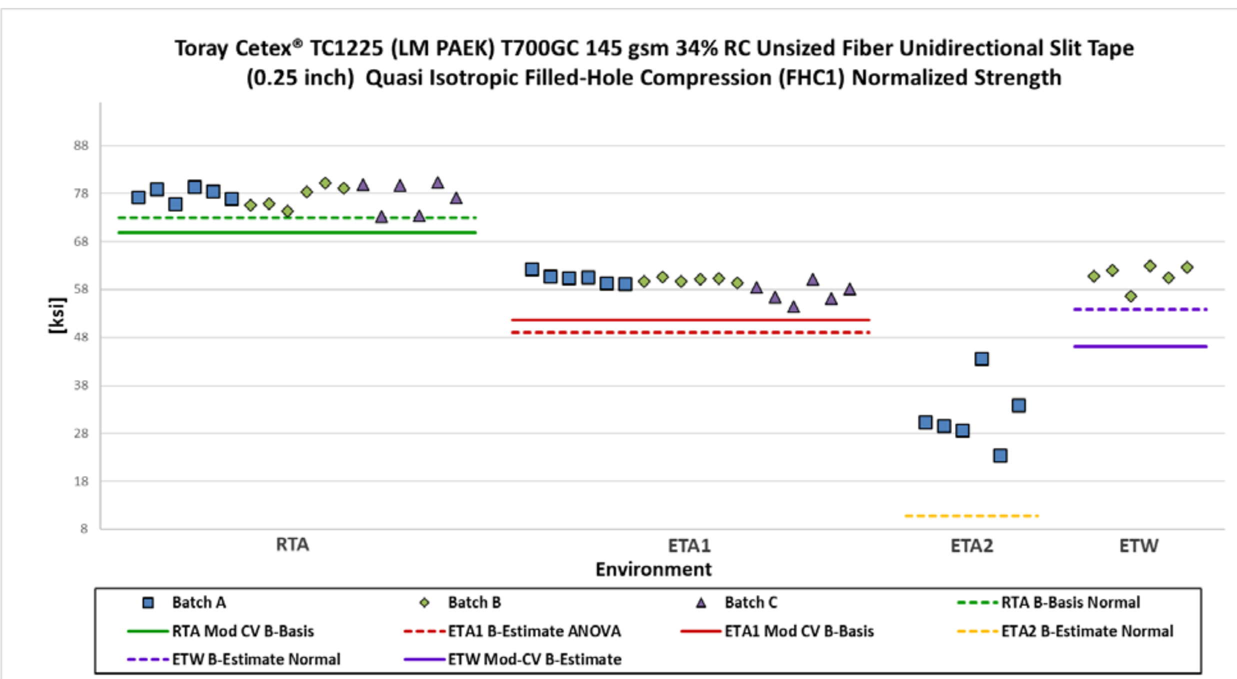

Figure 4-26: Batch plot for FHC1 Normalized Strength

Normalized Quasi Filled Hole Compression (FHC1) Strength Basis Values and Statistics				
Environment	RTA	ETA1	ETA2	ETW
Mean	77.48	59.25	31.58	60.88
Stdev	2.305	1.919	6.849	2.325
CV	2.976	3.240	21.69	3.819
Mod CV	6.000	6.000	21.69	8.000
Min	73.30	54.40	23.36	56.57
Max	80.32	62.34	43.70	62.96
No. Batches	3	3	1	1
No. Spec.	18	18	6	6
Basis Values and Estimates				
B-Basis Value	72.92			
B-Estimate		49.10	10.84	53.84
A-Estimate	69.70	41.86	0.000	48.83
Method	Normal	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates				
B-Basis Value	69.94	51.71		
B-Estimate			10.84	46.13
A-Estimate	64.81	46.58	0.000	35.64
Method	Pooled	Pooled	Normal	Normal

Table 4-51: Statistics and Basis Values for FHC1 Normalized Strength Data

As-Measured Quasi Filled Hole Compression (FHC1) Strength Basis Values and Statistics				
Environment	RTA	ETA1	ETA2	ETW
Mean	76.58	58.56	31.52	59.87
Stdev	1.960	2.283	6.774	2.090
CV	2.559	3.899	21.49	3.491
Mod CV	6.000	6.000	21.49	8.000
Min	72.42	53.51	23.17	56.69
Max	79.16	62.54	43.42	62.42
No. Batches	3	3	1	1
No. Spec.	18	18	6	6
Basis Values and Estimates				
B-Basis Value	72.71			
B-Estimate		46.39	11.00	53.54
A-Estimate	69.97	37.70	0.000	49.03
Method	Normal	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates				
B-Basis Value	69.13	51.11		
B-Estimate			11.00	45.36
A-Estimate	64.07	46.04	0.000	35.04
Method	Pooled	Pooled	Normal	Normal

Table 4-52: Statistics and Basis Values for FHC1 As-Measured Strength Data

4.26 “10/80/10” Filled-Hole Compression 2 (FHC2)

The FHC2 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength tests were conducted in the following environmental conditions: RTA and ETA1.

The results were identical for the normalized and as-measured datasets. The ETA1 condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for ETA1 and the single point normal method was used for RTA. Applying the modified CV, both conditions could not be pooled because the pooled dataset failed the normality test. The normal method for modified CV was used for both conditions.

There were no statistical outliers.

Statistics are given for the FHC2 strength data in Table 4-53. The normalized specimen data are shown graphically in Figure 4-27.

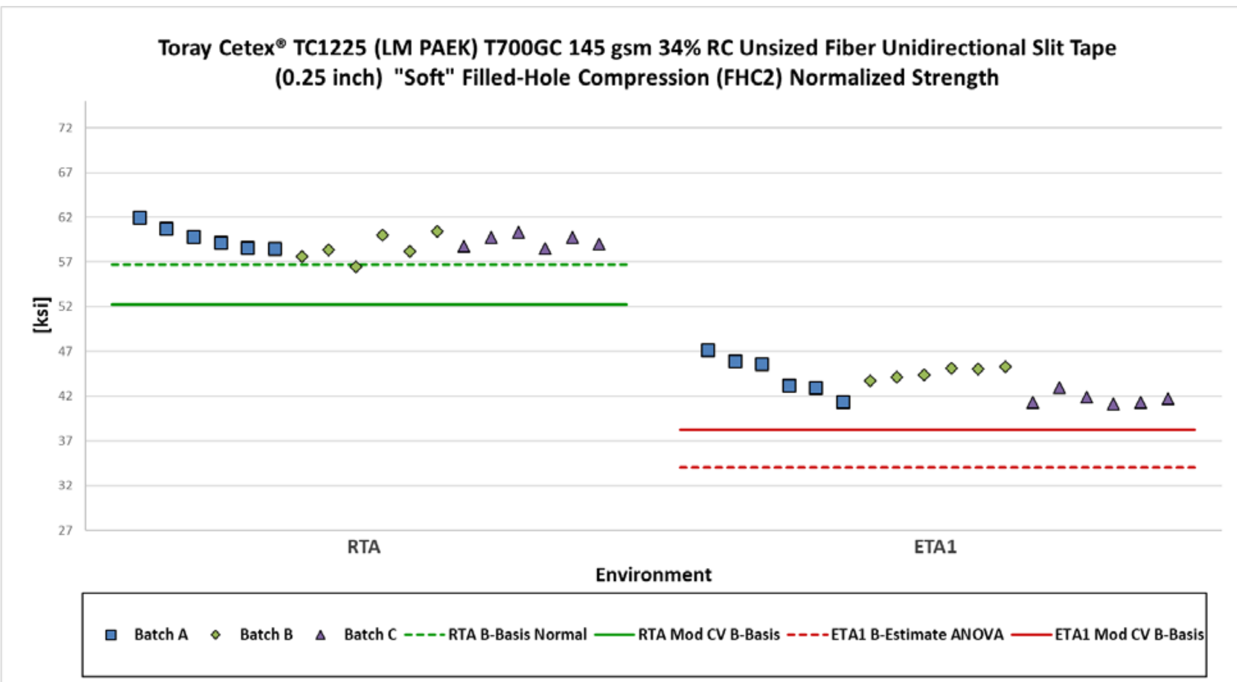

Figure 4-27: Batch plot for FHC2 Normalized Strength

Soft Filled Hole Compression (FHC2) Strength Basis Values and Statistics				
	Normalized		As-Measured	
Environment	RTA	ETA1	RTA	ETA1
Mean	59.22	43.57	59.29	43.59
Stdev	1.294	1.872	1.049	1.681
CV	2.185	4.297	1.770	3.857
Mod CV	6.000	6.149	6.000	6.000
Min	56.46	41.11	57.36	41.02
Max	62.02	47.16	61.11	45.91
No. Batches	3	3	3	3
No. Spec.	18	18	18	18
Basis Values and Estimates				
B-Basis Value	56.67		57.21	
B-Estimate		34.02		34.12
A-Estimate	54.86	27.22	55.75	27.36
Method	Normal	ANOVA	Normal	ANOVA
Modified CV Basis Values and Estimates				
B-Basis Value	52.21	38.28	52.26	38.43
A-Estimate	47.23	34.53	47.29	34.77
Method	Normal	Normal	Normal	Normal

Table 4-53: Statistics and Basis Values for FHC2 Strength Data

4.27 "50/40/10" Filled-Hole Compression 3 (FHC3)

The FHC3 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength tests were conducted in the following environmental conditions: RTA and ETA1.

For the normalized dataset, both conditions could not be pooled because the pooled dataset failed the Levene's test for equality of variances. The single point normal method was used for both conditions. Applying the modified CV, there were no diagnostic test failures, therefore both conditions were pooled.

For the as-measured dataset, there were no diagnostic test failures using the original CV and the modified CV, therefore both conditions were pooled.

There were no statistical outliers.

Statistics, basis values and estimates are given for the FHC3 strength data in Table 4-54. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-28.

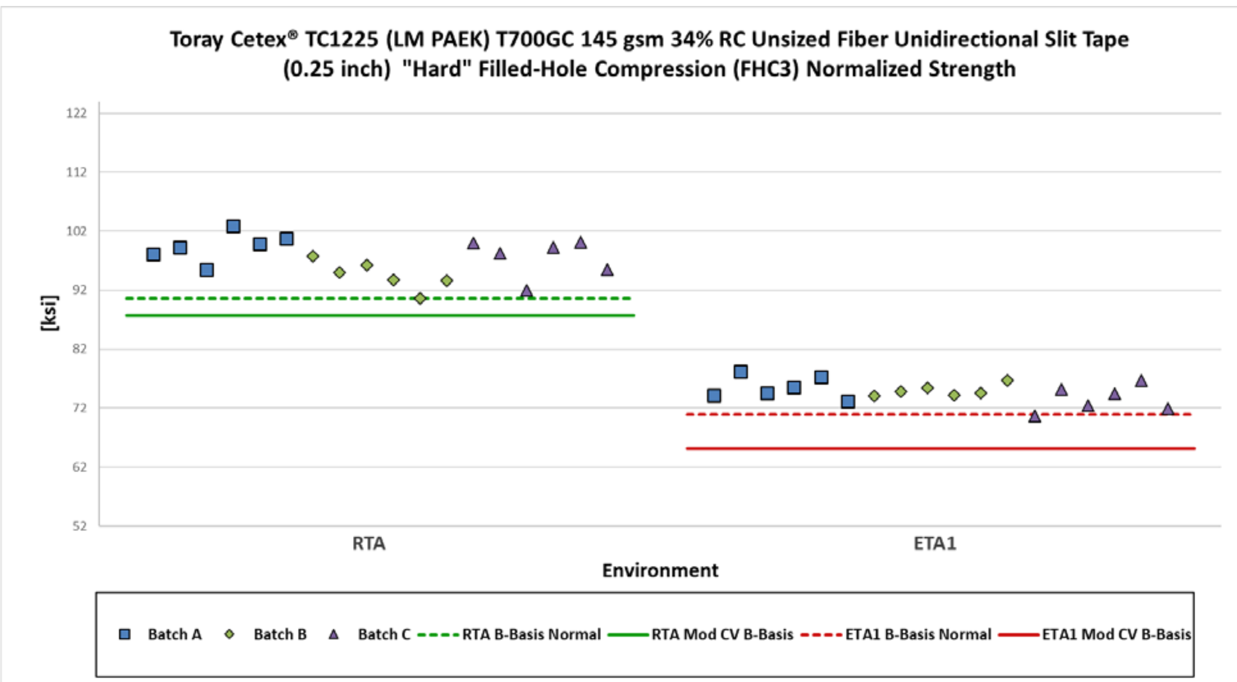

Figure 4-28: Batch Plot for FHC3 Normalized Strength

Hard Filled Hole Compression (FHC3) Strength Basis Values and Statistics				
	Normalized		As-Measured	
Environment	RTA	ETA1	RTA	ETA1
Mean	97.14	74.67	95.86	73.73
Stdev	3.299	1.887	2.129	2.673
CV	3.396	2.527	2.221	3.626
Mod CV	6.000	6.000	6.000	6.000
Min	90.66	70.70	90.43	69.26
Max	102.9	78.18	98.83	79.41
No. Batches	3	3	3	3
No. Spec.	18	18	18	18
Basis Values and Estimates				
B-Basis Value	90.63	70.94	91.46	69.33
A-Estimate	86.01	68.30	88.46	66.33
Method	Normal	Normal	Pooled	Pooled
Modified CV Basis Values and Estimates				
B-Basis Value	87.67	65.20	86.51	64.38
A-Estimate	81.23	58.76	80.15	58.03
Method	Pooled	Pooled	Pooled	Pooled

Table 4-54: Statistics and Basis Values for FHC3 Strength Data

4.28 Laminate Double-Notch Shear 1 (DNS1)

The DNS1 data is not normalized. Strength tests were conducted in the following environmental conditions: RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with seven or less specimens, therefore only estimates were computed for those conditions.

The ETA1 condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for ETA1. The single point normal method was used for the remaining conditions. Applying the modified CV, ETA1 passed the ADK test, the RTA and ETA1 conditions could not be pooled because the pooled dataset failed the Levene's test for equality of variances. The normal method for modified CV was used for all conditions. The ETA2 condition has an original CV that is greater than 8%, therefore the original and modified CV results are identical. For this reason only the original CV line is visible in the batch plot.

There were no statistical outliers.

Statistics, B-Basis values and estimates are given for DNS1 strength data in Table 4-55. The as-measured data, B-estimates and B-basis values are shown graphically in Figure 4-29.

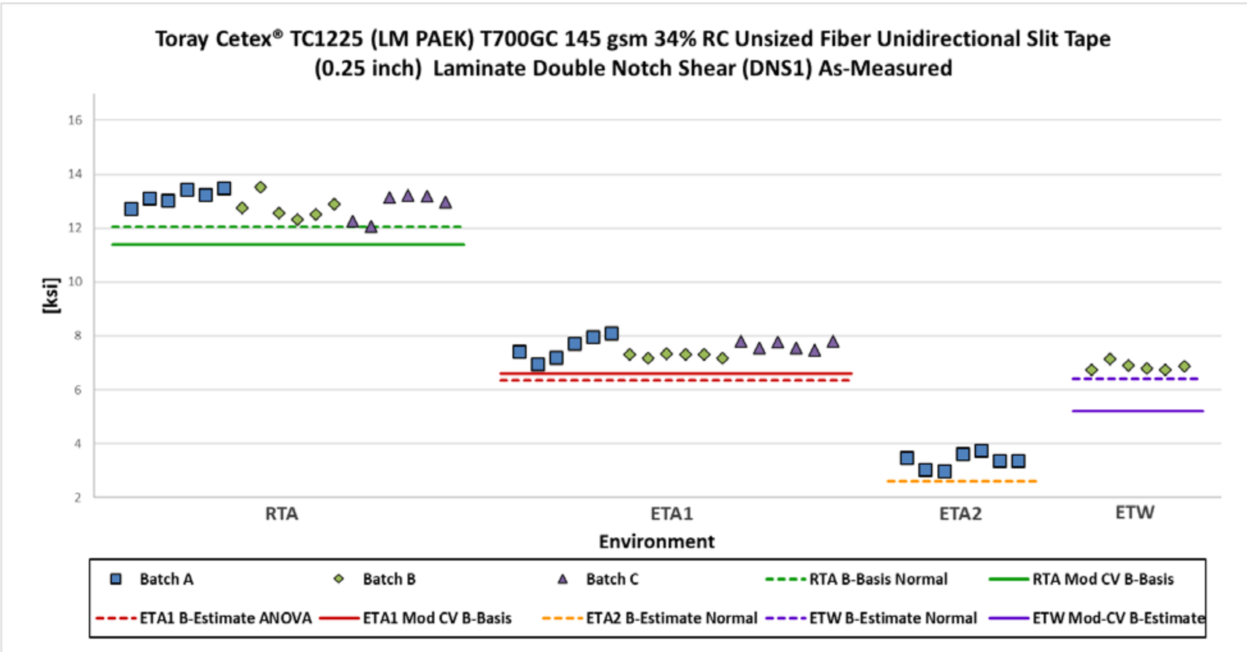

Figure 4-29: Batch Plot for DNS1 As-Measured Strength

Laminate Double Notch Shear (DNS1) As-Measured Basis Values and Statistics				
Environment	RTA	ETA1	ETA2	ETW
Mean	12.92	7.503	3.380	6.870
Stdev	0.4349	0.3126	0.2774	0.1550
CV	3.368	4.166	8.209	2.257
Mod CV	6.000	6.083	8.209	8.000
Min	12.08	6.961	2.999	6.740
Max	13.51	8.121	3.750	7.152
No. Batches	3	3	1	1
No. Spec.	18	18	7	6
Basis Values and Estimates				
B-Basis Value	12.06			
B-Estimate		6.362	2.609	6.400
A-Estimate	11.45	5.549	2.067	6.066
Method	Normal	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates				
B-Basis Value	11.39	6.602		
B-Estimate			2.609	5.205
A-Estimate	10.30	5.963	2.067	4.021
Method	Normal	Normal	Normal	Normal

Table 4-55: Statistics and Basis Values for DNS1 Strength Data

4.29 Laminate Short-Beam Shear 1 (SBS1)

The SBS1 data is not normalized. Strength tests were conducted in the following environmental conditions: RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consists of a single batch with six specimens, therefore only estimates were computed for those conditions.

The ETA1 conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for ETA1. The single point normal method was used for the remaining conditions. Applying the modified CV, the RTA and ETA1 conditions met all the requirements for pooling. The normal method for modified CV was used for ETA2 and ETW.

There were no statistical outliers.

Statistics, basis values and estimates are given for the SBS1 data in Table 4-56. The as-measured data, B-estimates and B-basis values are shown graphically in Figure 4-30.

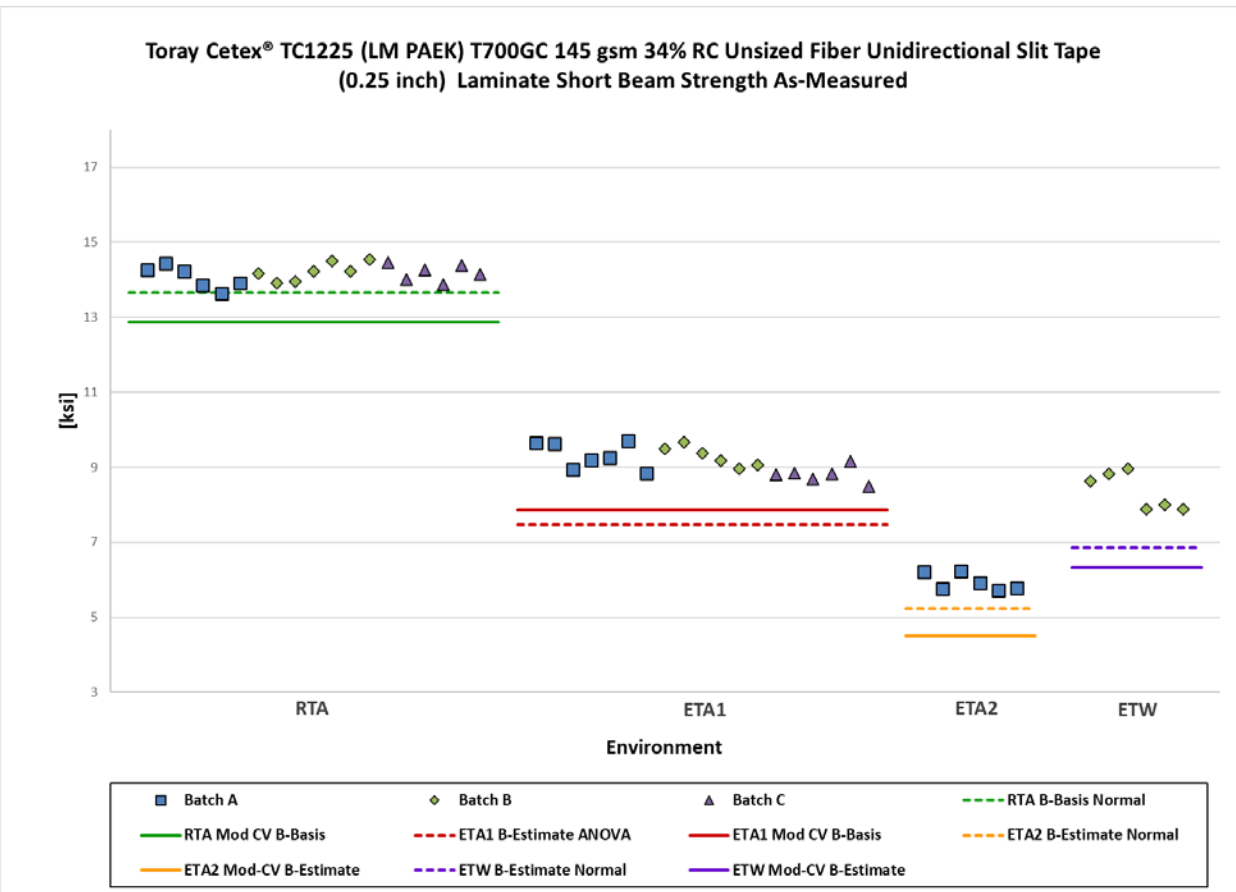

Figure 4-30: Batch Plot for SBS1 As-Measured Strength

Laminate Short Beam Strength 1 (SBS1) As-Measured Basis Values and Statistics				
Environment	RTA	ETA1	ETA2	ETW
Mean	14.16	9.143	5.935	8.361
Stdev	0.2536	0.3641	0.2332	0.4957
CV	1.792	3.982	3.929	5.929
Mod CV	6.000	6.000	8.000	8.000
Min	13.64	8.490	5.710	7.877
Max	14.54	9.709	6.225	8.959
No. Batches	3	3	1	1
No. Spec.	19	19	6	6
Basis Values and Estimates				
B-Basis Value	13.66			
B-Estimate		7.464	5.229	6.860
A-Estimate	13.31	6.266	4.726	5.792
Method	Normal	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates				
B-Basis Value	12.87	7.853		
B-Estimate			4.497	6.335
A-Estimate	11.98	6.973	3.474	4.894
Method	Pooled	Pooled	Normal	Normal

Table 4-56: Statistics and Basis Values for SBS1 Strength Data

4.30 "25/50/25" Single-Shear Bearing 1 Proc. C (SSB1)

The SSB1 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. 2% offset strength, ultimate strength and stiffness tests were conducted in the following environmental conditions: RTA, ETA1, ETA2, and ETW.

The ETA2 and ETW conditions consist of a single batch with six specimens, therefore only estimates were computed for those conditions.

For both strength properties, the results are identical for the normalized and as-measured dataset.

For 2% offset strength, the RTA and ETA1 conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for those conditions. The single point normal method was used for ETA2 and ETW. Applying the modified CV, the RTA and ETA1 conditions met all the requirements for pooling. The normal method for modified CV was used for ETA2 and ETW.

For ultimate strength, the results are identical using the original CV and the modified CV. The RTA and ETA1 conditions met all the requirements for pooling. The normal method was used for ETA2 and ETW.

There were no statistical outliers.

Statistics, basis values and estimates are given for the SSB1 strength data in Table 4-57 and Table 4-58, and for stiffness data in Table 4-59. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-31 and Figure 4-32.

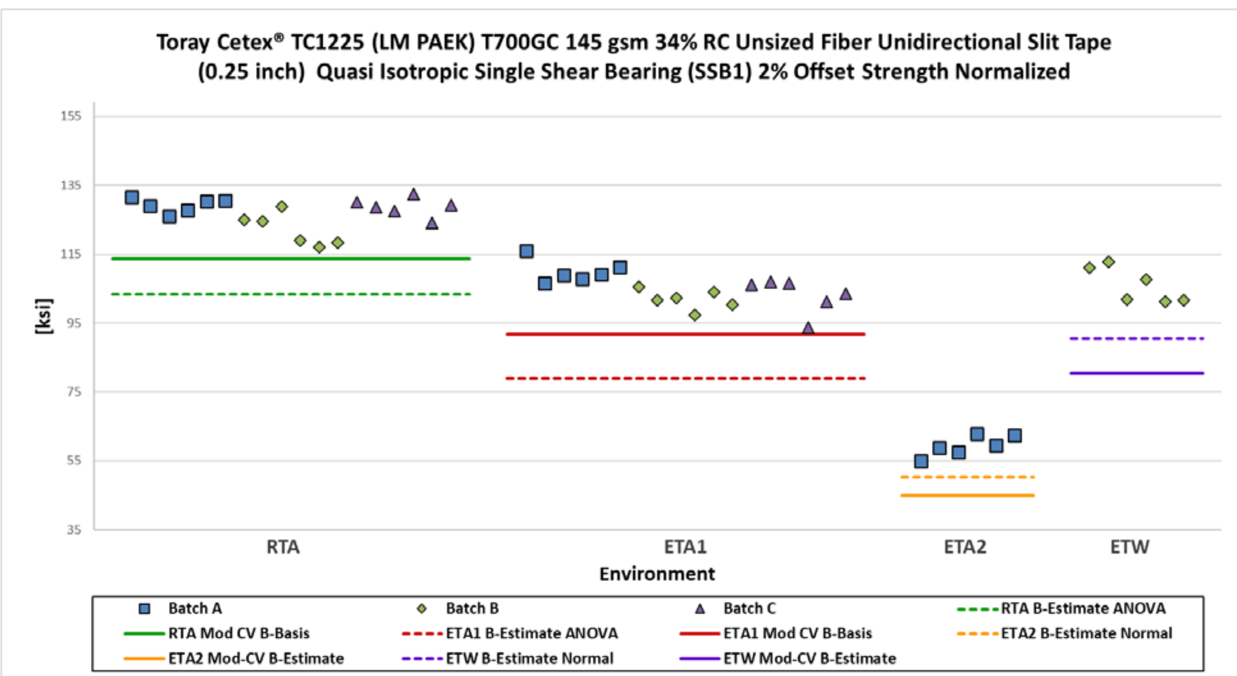

Figure 4-31: Batch Plot for SSB1 Normalized 2% Offset Strength

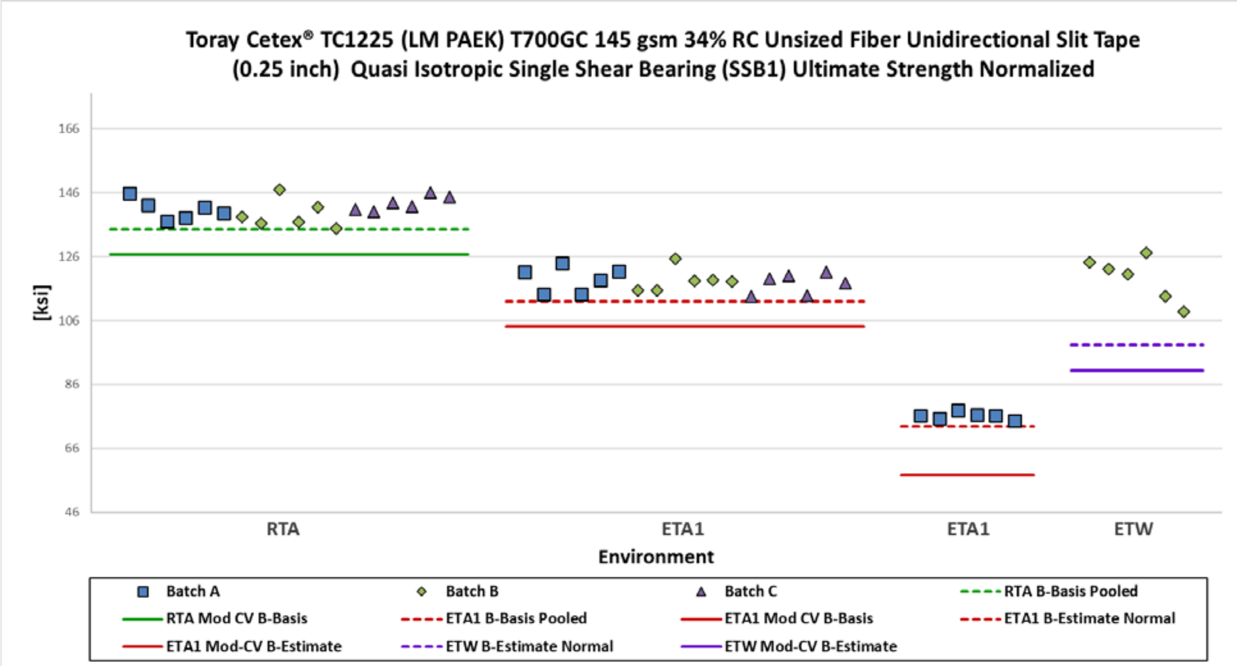

Figure 4-32: Batch Plot for SSB1 Normalized Ultimate Strength

Normalized Quasi Single Shear Bearing (SSB1) Strength Basis Values and Statistics								
Property	2% Offset Strength				Ultimate Strength			
Environment	RTA	ETA1	ETA2	ETW	RTA	ETA1	ETA2	ETW
Mean	126.7	104.9	59.28	106.0	140.8	118.4	76.20	119.4
Stdev	4.562	5.176	2.978	5.149	3.521	3.468	1.096	6.922
CV	3.601	4.933	5.023	4.856	2.500	2.930	1.439	5.798
Mod CV	6.000	6.466	8.000	8.000	6.000	6.000	8.000	8.000
Min	117.2	93.73	54.93	101.2	134.8	113.6	74.69	108.8
Max	132.4	116.0	62.78	112.8	147.0	125.4	77.97	127.2
No. Batches	3	3	1	1	3	3	1	1
No. Spec.	18	18	6	6	18	18	6	6
Basis Values and Estimates								
B-Basis Value					134.5	112.0		
B-Estimate	103.3	78.99	50.26	90.43			72.88	98.41
A-Estimate	86.61	60.49	43.85	79.34	130.1	107.7	70.52	83.51
Method	ANOVA	ANOVA	Normal	Normal	Pooled	Pooled	Normal	Normal
Modified CV Basis Values and Estimates								
B-Basis Value	113.6	91.82			126.6	104.1		
B-Estimate			44.92	80.33			57.73	90.45
A-Estimate	104.6	82.89	34.70	62.07	117.0	94.47	44.61	69.88
Method	Pooled	Pooled	Normal	Normal	Pooled	Pooled	Normal	Normal

Table 4-57: Statistics and Basis Values for SSB1 Normalized Strength Data

As-Measured Quasi Single Shear Bearing (SSB1) Strength Basis Values and Statistics								
Property	2% Offset Strength				Ultimate Strength			
Environment	RTA	ETA1	ETA2	ETW	RTA	ETA1	ETA2	ETW
Mean	125.1	103.5	58.37	105.2	139.1	116.8	75.01	118.4
Stdev	4.395	5.226	3.163	4.710	3.300	3.562	0.9553	6.496
CV	3.513	5.048	5.418	4.478	2.372	3.051	1.274	5.486
Mod CV	6.000	6.524	8.000	8.000	6.000	6.000	8.000	8.000
Min	116.2	91.04	53.60	100.5	134.4	110.7	74.14	108.5
Max	131.6	114.1	61.87	111.2	145.1	124.0	76.52	126.6
No. Batches	3	3	1	1	3	3	1	1
No. Spec.	18	18	6	6	18	18	6	6
Basis Values and Estimates								
B-Basis Value					132.8	110.5		
B-Estimate	104.3	81.01	48.79	90.90			72.12	98.74
A-Estimate	89.39	64.95	41.98	80.76	128.6	106.3	70.06	84.75
Method	ANOVA	ANOVA	Normal	Normal	Pooled	Pooled	Normal	Normal
Modified CV Basis Values and Estimates								
B-Basis Value	112.1	90.52			125.1	102.7		
B-Estimate			44.22	79.68			56.83	89.72
A-Estimate	103.3	81.68	34.17	61.56	115.5	93.18	43.91	69.32
Method	Pooled	Pooled	Normal	Normal	Pooled	Pooled	Normal	Normal

Table 4-58: Statistics and Basis Values for SSB1 As-Measured Strength Data

Quasi Single Shear Bearing (SSB1) Stiffness Statistics								
	Normalized				As-Measured			
Environment	RTA	ETA1	ETA2	ETW	RTA	ETA1	ETA2	ETW
Mean	1.917	1.813	1.384	1.732	1.893	1.788	1.362	1.718
Stdev	0.07893	0.08406	0.02113	0.06225	0.07429	0.07744	0.02474	0.06039
CV	4.118	4.637	1.527	3.594	3.924	4.330	1.816	3.515
Min	1.788	1.663	1.357	1.639	1.773	1.649	1.324	1.617
Max	2.047	1.941	1.411	1.806	2.030	1.906	1.400	1.780
No. Batches	3	3	1	1	3	3	1	1
No. Spec.	18	18	6	6	18	18	6	6

Table 4-59: Statistics for SSB1 Stiffness Data

4.31 “10/80/10” Single-Shear Bearing 2 Proc. C (SSB2)

The SSB2 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. 2% offset strength, ultimate strength and stiffness tests were conducted in the following environmental conditions: RTA and ETA1.

For the normalized datasets, for the 2% offset strength property, the RTA condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for RTA. The single point normal method was used for ETA1. Applying the modified CV, there were no diagnostic test failures, therefore both conditions were pooled. For the ultimate strength property, there were no diagnostic test failures using the original CV and the modified CV, therefore both conditions were pooled.

For the as-measured datasets, for the 2% offset strength property, there were no diagnostic test failures using the original CV and the modified CV, therefore both conditions were pooled. For the ultimate strength property, both conditions failed the ADK test for batch equivalency. ANOVA was used to compute estimates for both conditions. Applying the modified CV, there were no diagnostic test failures, therefore both conditions were pooled.

There were three statistical outliers. For the 2% offset strength property, the lowest value in batch A of the RTA condition was a batch outlier in the normalized and as-measured datasets. For the 2% offset strength property, the lowest value in batch B of the RTA condition was a condition outlier in the normalized and as-measured datasets. For the ultimate strength property, the lowest value in batch C of the ETA1 condition was a batch outlier in the as-measured dataset. They were retained for this analysis,.

Statistics, basis values and estimates are given for the SSB2 strength data in Table 4-60 and for the stiffness data in Table 4-61. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-33 and Figure 4-34.

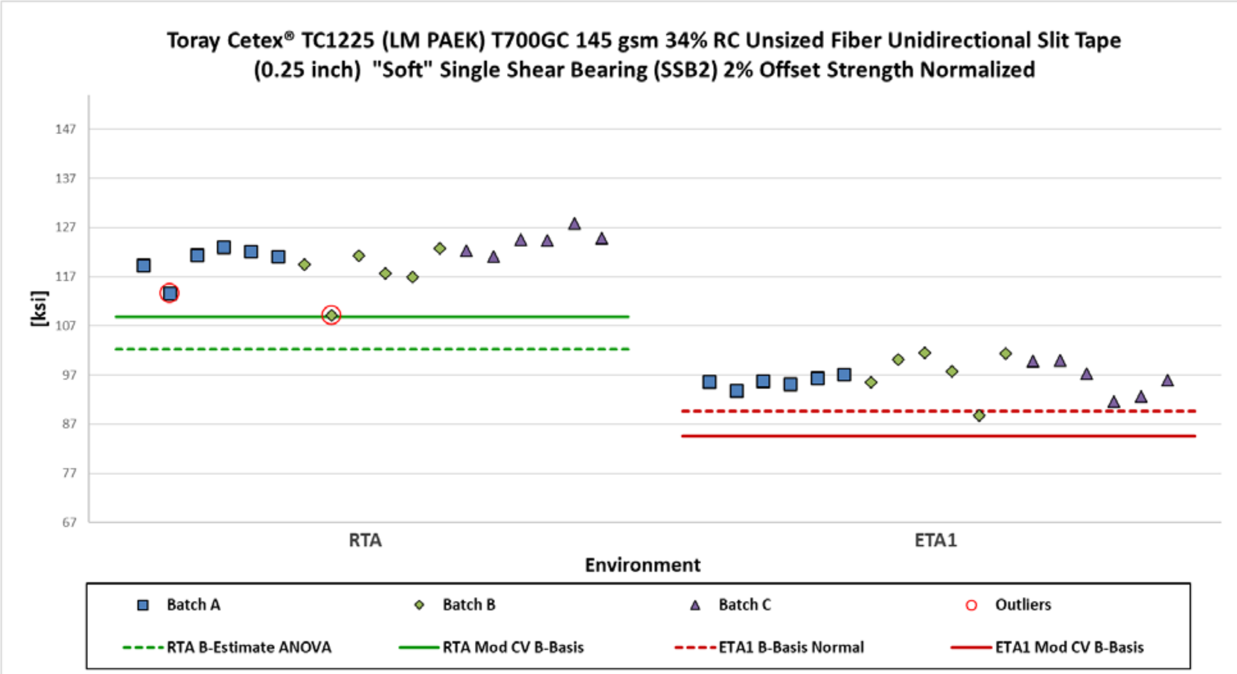

Figure 4-33: Batch Plot for SSB2 Normalized 2% Offset Strength

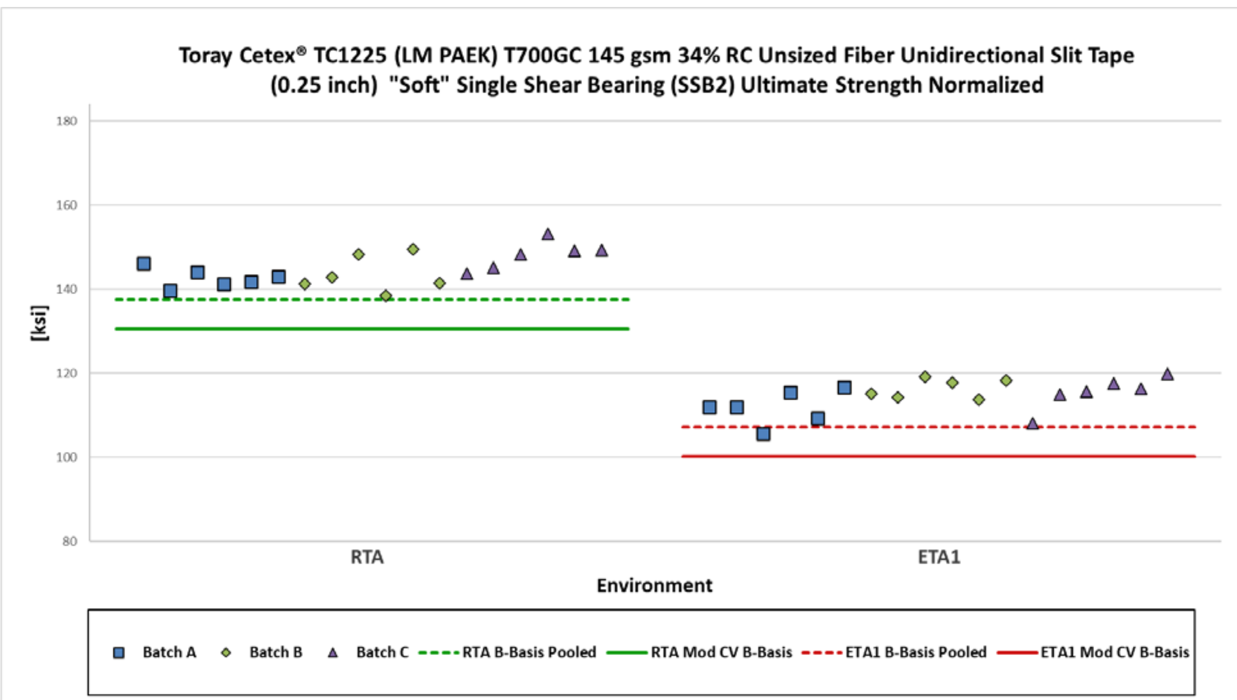

Figure 4-34: Batch Plot for SSB2 Normalized Ultimate Strength

Soft Single Shear Bearing (SSB2) Strength Basis Values and Statistics								
	Normalized				As-Measured			
Property	2% Offset Strength		Ultimate Strength		2% Offset Strength		Ultimate Strength	
Environment	RTA	ETA1	RTA	ETA1	RTA	ETA1	RTA	ETA1
Mean	120.8	96.50	144.8	114.5	119.5	95.75	143.3	113.6
Stdev	4.353	3.422	4.061	3.875	3.741	4.243	4.069	4.340
CV	3.605	3.546	2.804	3.383	3.131	4.431	2.839	3.818
Mod CV	6.000	6.000	6.000	6.000	6.000	6.215	6.000	6.000
Min	109.2	88.74	138.5	105.6	109.2	88.19	137.0	105.3
Max	127.8	101.6	153.2	119.9	124.8	103.4	150.1	121.3
No. Batches	3	3	3	3	3	3	3	3
No. Spec.	18	18	18	18	18	18	18	18
Basis Values and Estimates								
B-Basis Value		89.74	137.6	107.3	112.2	88.47		
B-Estimate	102.3						126.6	93.67
A-Estimate	89.20	84.95	132.7	102.4	107.2	83.51	114.7	79.43
Method	ANOVA	Normal	Pooled	Pooled	Pooled	Pooled	ANOVA	ANOVA
Modified CV Basis Values and Estimates								
B-Basis Value	108.8	84.55	130.5	100.3	107.5	83.75	129.2	99.51
A-Estimate	100.7	76.42	120.8	90.57	99.31	75.59	119.5	89.90
Method	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled

Table 4-60: Statistics and Basis Values for SSB2 Strength Data

Soft Single Shear Bearing (SSB2) Stiffness Statistics				
	Normalized		As-Measured	
Environment	RTA	ETA1	RTA	ETA1
Mean	1.369	1.194	1.354	1.184
Stdev	0.03897	0.06968	0.02660	0.06599
CV	2.847	5.836	1.964	5.572
Min	1.299	1.018	1.302	1.011
Max	1.425	1.273	1.390	1.262
No. Batches	3	3	3	3
No. Spec.	18	18	18	18

Table 4-61: Statistics for SSB2 Stiffness Data

4.32 “50/40/10” Single-Shear Bearing 3 Proc. C (SSB3)

The SSB3 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. 2% offset strength, ultimate strength and stiffness tests were conducted in the following environmental conditions: RTA and ETA1.

For the normalized datasets, the results were identical for both strength properties. There were no diagnostic test failures using the original CV and the modified CV, therefore both condition were pooled.

For the as-measured datasets, for the 2% offset strength property, the RTA condition failed the ADK test for batch equivalency. ANOVA was used to compute estimates for RTA and the single point normal method was used for ETA1. Applying the modified CV, there were no diagnostic test failures, therefore both conditions were pooled. For the ultimate strength property, the RTA condition failed the normality test, but the lognormal distribution was a good fit for the dataset. The single point normal method was used for ETA1. Applying the modified CV, there were no diagnostic test failures, therefore both conditions were pooled.

There was one statistical outlier. For the ultimate strength property, the highest value in batch C of the RTA condition was a condition outlier in the as-measured dataset. It was retained for this analysis.

Statistics, basis values and estimates are given for the SSB3 strength data in Table 4-62 and for the stiffness data in Table 4-63. The normalized data, B-estimates and B-basis values are shown graphically in Figure 4-35 and Figure 4-36.

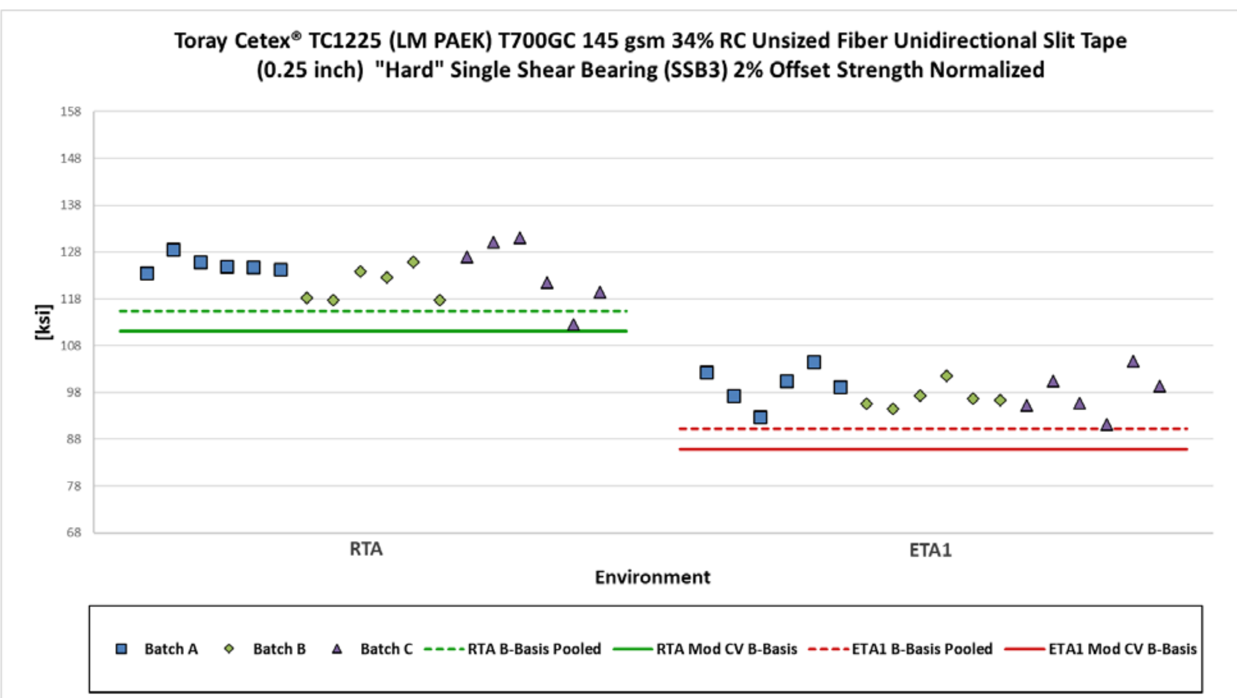

Figure 4-35: Batch Plot for SSB3 Normalized 2% Offset Strength

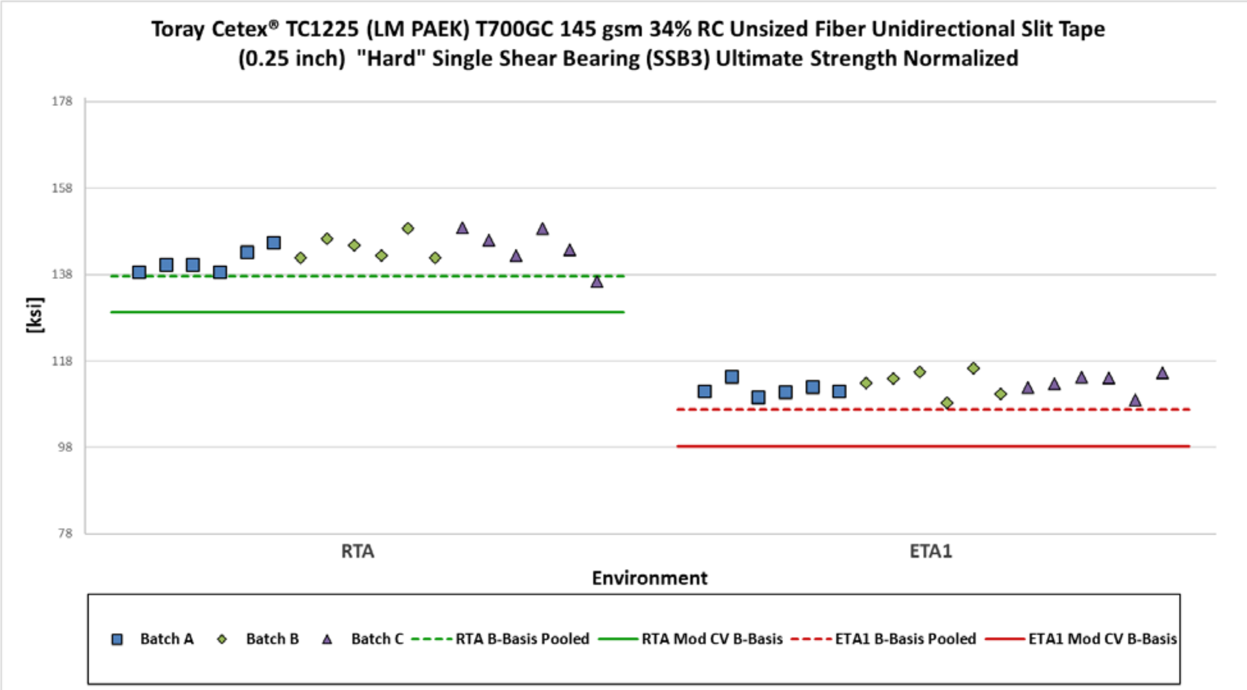

Figure 4-36: Batch Plot for SSB3 Normalized Ultimate Strength

Single Shear Bearing 3 (SSB3) Strength Basis Values and Statistics								
	Normalized				As-Measured			
Property	2% Offset Strength		Ultimate Strength		2% Offset Strength		Ultimate Strength	
Environment	RTA	ETA1	RTA	ETA1	RTA	ETA1	RTA	ETA1
Mean	123.3	98.08	143.2	112.4	121.5	96.66	141.2	110.8
Stdev	4.799	3.798	3.645	2.332	4.347	4.359	4.089	3.196
CV	3.892	3.872	2.545	2.075	3.577	4.510	2.897	2.885
Mod CV	6.000	6.000	6.000	6.000	6.000	6.255	6.000	6.000
Min	112.5	91.18	136.4	108.3	113.9	92.11	135.4	105.2
Max	131.0	104.8	148.8	116.2	127.5	107.5	152.6	118.0
No. Batches	3	3	3	3	3	3	3	3
No. Spec.	18	18	18	18	18	18	18	18
Basis Values and Estimates								
B-Basis Value	115.4	90.20	137.7	106.8		88.06	133.4	104.5
B-Estimate					102.3			
A-Estimate	110.1	84.84	133.9	103.0	88.69	81.96	128.2	99.98
Method	Pooled	Pooled	Pooled	Pooled	ANOVA	Normal	Log Normal	Normal
Modified CV Basis Values and Estimates								
B-Basis Value	111.1	85.90	129.2	98.32	109.3	84.47	127.3	96.90
A-Estimate	102.8	77.62	119.6	88.75	101.0	76.17	117.9	87.46
Method	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled

Table 4-62: Statistics and Basis Values for SSB3 Strength Data

Hard Single Shear Bearing (SSB3) Stiffness Statistics				
	Normalized		As-Measured	
Environment	RTA	ETA1	RTA	ETA1
Mean	2.056	1.941	2.026	1.913
Stdev	0.06551	0.06974	0.07266	0.08450
CV	3.187	3.593	3.586	4.417
Min	1.928	1.841	1.866	1.796
Max	2.182	2.070	2.152	2.121
No. Batches	3	3	3	3
No. Spec.	18	18	18	18

Table 4-63: Statistics for SSB3 Stiffness Data

4.33 "25/50/25" Compression After Impact 1 (CAI1)

The CAI1 data is normalized by cured ply thickness. Both normalized and as-measured results are provided. Strength tests were done in the following environmental conditions: RTA, ETA1, ETA2, and ETW. Basis values were not computed for CAI1 strength data.

Summary statistics are presented in Table 4-64 and the normalized data are displayed graphically in Figure 4-37.

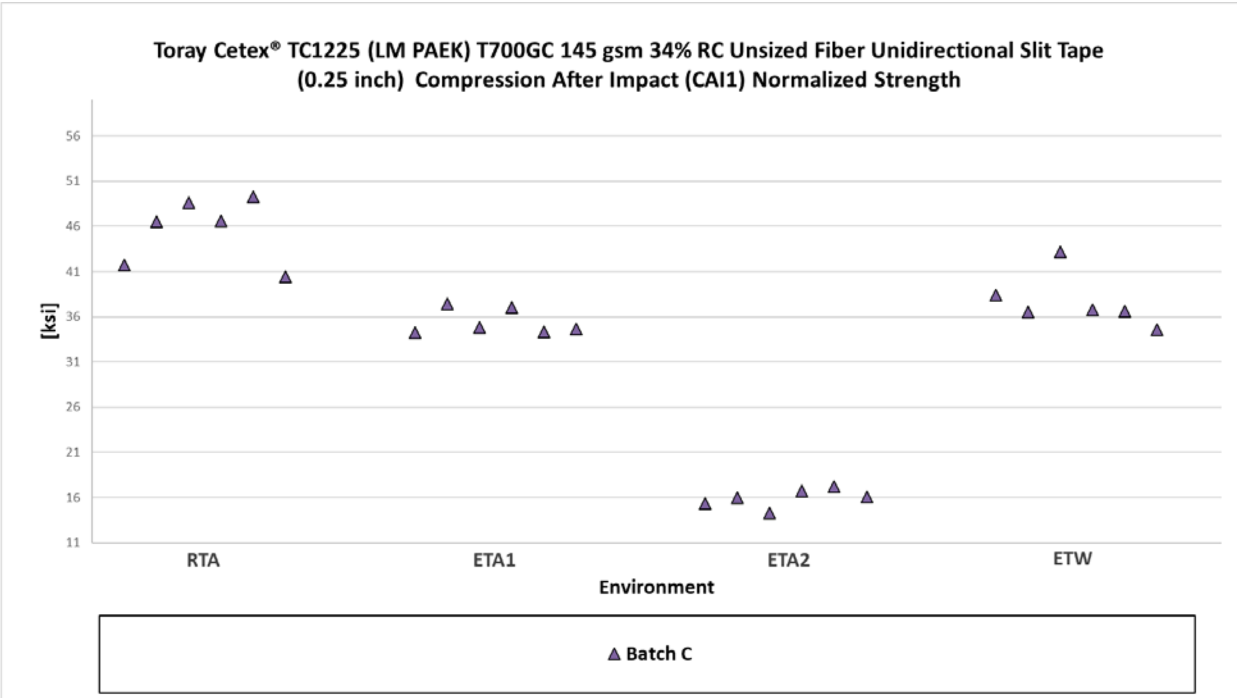

Figure 4-37: Batch Plot for Compression After Impact Normalized Strength

Compression After Impact (CAI1) Strength [ksi] Statistics								
	Normalized				As-Measured			
Environment	RTA	ETA1	ETA2	ETW	RTA	ETA1	ETA2	ETW
Mean	45.53	35.42	15.95	37.68	44.87	34.11	15.42	37.28
Stdev	3.664	1.421	1.052	2.940	3.596	1.293	1.004	2.934
CV	8.047	4.011	6.597	7.801	8.015	3.789	6.511	7.872
Mod CV	8.047	8.000	8.000	8.000	8.015	8.000	8.000	8.000
Min	40.39	34.30	14.28	34.62	39.92	32.95	13.82	34.21
Max	49.30	37.46	17.25	43.17	48.61	36.05	16.62	42.80
No. Batches	1	1	1	1	1	1	1	1
No. Spec.	6	6	6	6	6	6	6	6

Table 4-64: Statistics for Compression After Impact 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 the *Detecting Outliers* section of the CMH-17 Vol 1 Handbook. 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-2025-016 Rev A. Outliers for which no causes could be identified are listed in Table 5-1 and Table 5-2. These outliers were included in the analysis for their respective test properties.

Lamina Test	Condition	Batch	Specimen No.	Value	Type	Outlier		
						High/Low	Batch	Condition
LC from UNC0	ETW	B	NTP1226Q1-TC-WEB-NIAR-T25-MST4-B-C2-1-UNC0-ETW-3	149.9	Normalized	Low	Single Batch	
				150.6	As-Measured			
UNC0				79.48	Normalized	Low	Single Batch	
				79.88	As-Measured			
TT	RTA	B	NTP1226Q1-TC-WEB-NIAR-T25-MST2-B-C1-1-TT-RTA-2	12.64	As-Measured	Low	No	Yes
TC	ETA1	B	NTP1226Q1-TC-WEB-NIAR-T25-MST3-B-C2-1-TC-ETA1-1	15.14	As-Measured	Low	No	Yes
DNS	CTA	B	NTP1226Q1-TC-WEB-NIAR-T25-MST6-B-C2-1-DNS-CTA-2	15.13	As-Measured	Low	Yes	Yes
	RTA	B	NTP1226Q1-TC-WEB-NIAR-T25-MST6-B-C2-1-DNS-RTA-1	13.23	As-Measured	Low	Yes	No

Table 5-1: Lamina Tests List of Outliers

Laminate Test	Condition	Batch	Specimen No.	Value	Type	Outlier		
						High/Low	Batch	Condition
UNT1	ETA1	B	NTP1226Q1-TC-WEB-NIAR-T25-MST7-B-C2-1-UNT1-ETA1-2	124.5	Normalized	Low	Yes	No
				124.0	As-Measured			
	ETA2	A	NTP1226Q1-TC-WEB-NIAR-T25-MST7-A-C2-1-UNT1-ETA2-2	103.2	Normalized	High	Single Batch	
	ETW	B	NTP1226Q1-TC-WEB-NIAR-T25-MST7-B-C1-1-UNT1-ETW-1	125.8	Normalized	Low	Single Batch	
	ETA1	C	NTP1226Q1-TC-NIAR-NIAR-T25-MST7-C-C2-1-UNT1-ETA1-3	138.9	As-Measured	Low	Yes	No
UNT2	ETA1	B	NTP1226Q1-TC-WEB-NIAR-T25-MST12-B-C1-1-UNT2-ETA1-2	59.13	Normalized	Low	No	Yes
				56.99	As-Measured			
		C	NTP1226Q1-TC-NIAR-NIAR-T25-MST12-C-C2-1-UNT2-ETA1-3	71.80	Normalized	High	Yes	No
UNT3	CTA	B	NTP1226Q1-TC-WEB-NIAR-T25-MST15-B-C2-1-UNT3-CTA-2	211.2	Normalized	Low	Yes	No
UNC1	RTA	C	NTP1226Q1-TC-NIAR-NIAR-T25-MST9-C-C1-1-UNC1-RTA-3	78.43	As-Measured	Low	Yes	No
OHT2	RTA	C	NTP1226Q1-TC-NIAR-NIAR-T25-MST12-C-C2-1-OHT2-RTA-2	53.95	As-Measured	Low	Yes	No
OHT3	RTA	B	NTP1226Q1-TC-WEB-NIAR-T25-MST15-B-C2-1-OHT3-RTA-1	103.6	Normalized	High	Yes	No
	ETA1	B	NTP1226Q1-TC-WEB-NIAR-T25-MST15-B-C2-1-OHT3-ETA1-1	103.3	Normalized	Low	Yes	No
FHT1	ETA1	B	NTP1226Q1-TC-WEB-NIAR-T25-MST8-B-C2-1-FHT1-ETA1-1	75.69	Normalized	High	Yes	No
	ETA2	A	NTP1226Q1-TC-WEB-NIAR-T25-MST8R-A-C1-1-FHT1-ETA2-2	62.08	Normalized	Low	Single Batch	
				61.04	As-Measured			
OHC2	ETA1	B	NTP1226Q1-TC-WEB-NIAR-T25-MST14-B-C2-1-OHC2-ETA1-2	34.11	Normalized	High	Yes	No
				34.41	As-Measured			
		C	NTP1226Q1-TC-NIAR-NIAR-T25-MST14-C-C1-1-OHC2-ETA1-1	34.12	As-Measured	High	Yes	No
SSB2 2% Offset Strength	RTA	A	NTP1226Q1-TC-WEB-NIAR-T25-MST13-A-C1-1-SSB2-RTA-2	113.7	Normalized	Low	Yes	No
				112.7	As-Measured			
		B	NTP1226Q1-TC-WEB-NIAR-T25-MST13-B-C1-1-SSB2-RTA-2	109.2	Normalized	Low	No	Yes
				109.2	As-Measured			
SSB2 Ultimate Strength	ETA1	C	NTP1226Q1-TC-NIAR-NIAR-T25-MST13-C-C1-1-SSB2-ETA1-1	106.1	As-Measured	Low	Yes	No
SSB3 Ultimate Strength	RTA	C	NTP1226Q1-TC-NIAR-NIAR-T25-MST16-C-C2-1-SSB3-RTA-1	152.6	As-Measured	High	No	Yes

Table 5-2: Laminate Tests List of Outliers

6. References

1. Snedecor, G.W. and Cochran, W.G., *Statistical Methods*, 7th ed., The Iowa State University Press, 1980, pp. 252-253.
2. Stefansky, W., "Rejecting Outliers in Factorial Designs," *Technometrics*, Vol. 14, 1972, pp. 469-479.
3. Scholz, F.W. and Stephens, M.A., “K-Sample Anderson-Darling Tests of Fit,” *Journal of the American Statistical Association*, Vol. 82, 1987, pp. 918-924.
4. Lehmann, E.L., *Testing Statistical Hypotheses*, John Wiley & Sons, 1959, pp. 274-275.
5. Levene, H., “Robust Tests for Equality of Variances,” in *Contributions to Probability and Statistics*, ed. I. Olkin, Palo, Alto, CA: Stanford University Press, 1960.
6. Lawless, J.F., *Statistical Models and Methods for Lifetime Data*, John Wiley & Sons, 1982, pp. 150, 452-460.
7. *Metallic Materials and Elements for Aerospace Vehicle Structures*, MIL-HDBK-5E, Naval Publications and Forms Center, Philadelphia, Pennsylvania, 1 June 1987, pp. 9-166,9-167.
8. Hanson, D.L. and Koopmans, L.H., "Tolerance Limits for the Class of Distribution with Increasing Hazard Rates," *Annals of Math. Stat.*, Vol 35, 1964, pp. 1561-1570.
9. Vangel, M.G., “One-Sided Nonparametric Tolerance Limits,” *Communications in Statistics: Simulation and Computation*, Vol. 23, 1994, p. 1137.
10. Vangel, M.G., "New Methods for One-Sided Tolerance Limits for a One-Way Balanced Random Effects ANOVA Model," *Technometrics*, Vol 34, 1992, pp. 176-185.
11. Odeh, R.E. and Owen, D.B., *Tables of Normal Tolerance Limits, Sampling Plans and Screening*, Marcel Dekker, 1980.
12. Tomblin, John and Seneviratne, Waruna, *Laminate Statistical Allowable Generation for Fiber-Reinforced Composites Material: Lamina Variability Method,* U.S. Department of Transportation, Federal Aviation Administration, May 2006.
13. Tomblin, John, Ng, Yeow and Raju, K. Suresh, *Material Qualification and Equivalency for Polymer Matrix Composite Material Systems: Updated Procedure,* U.S. Department of Transportation, Federal Aviation Administration, September 2003.
14. CMH-17 Rev H, Volume 1, 2022. SAE International, 400 Commonwealth Drive, Warrendale, PA 15096