HexPEKK® Material Qualification Material Allowables Statistical Analysis Report

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1. Introduction

This report contains statistical analysis of the Additively Manufactured HexPEKK®-100 Polymer Material qualification material property data published in NCAMP Test Report CAM-RP-2023-007 Rev N/C not released yet. The lamina and laminate material property data have been generated with NCAMP oversight in accordance with NSP 100 NCAMP Standard Operating Procedures; the test specimens have been inspected by NCAMP Authorized Inspection Representatives (AIR) and the testing has been witnessed by NCAMP Authorized Engineering Representatives (AER). However, the data may not fulfill all the needs of any specific company's program; specific properties, environments, laminate architecture, and loading situations may require additional testing.

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 800 Rev N/C 10-25-21. NCAMP Material Specification NMS 800/1 Rev N/C 10-25-21 was created at later date as a supplement material specification for HexPEKK®-100 powder.

Basis numbers are labeled as ‘values’ when the data meets all the requirements of CMH-17-1G. 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 or estimate is noted for each basis value or estimate 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-17-1G).

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

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

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

Part fabricators that wish to utilize the material property data, allowables, and specifications may be able to do so by demonstrating the capability to reproduce the original material properties; a process known as equivalency. More information about this equivalency process including the test statistics and its limitations can be found in Section 6 of DOT/FAA/AR-03/19 and Section 8.4.1 of CMH-17-1G. The applicability of equivalency process must be evaluated on program-by-program basis by the applicant and certifying agency. The applicant and certifying agency must agree that the equivalency test plan along with the equivalency process described in Section 6 of DOT/FAA/AR-03/19 and Section 8.4.1 of CMH-17-1G are adequate for the given program.

Aircraft companies should not use the data published in this report without specifying NCAMP Material Specification NMS 800/1. NMS 800/1 has additional requirements for 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 800/1*. NMS 800/1 is a free, publicly available, non-proprietary aerospace industry material specification.

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1.1 Symbols and Abbreviations

Test Method	Abbreviation
Compression Prism	C
Dogbone Tension	T
Flex	F
Filled-Hole Compression	FHC
Filled-Hole Tension	FHT
Open-Hole Compression	OHC
Open-Hole Tension	OHT
Punch Shear Hole	PSH
Single-Shear Bearing	SSB

Table 1-1: Test Method Abbreviations

Environmental Condition	Abbreviation	Temperature
Cold Temperature Ambient	CTA	−65˚±5˚F
Room Temperature Ambient	RTA	70˚±10˚F
Elevated Temperature Ambient 1	ETA1	180˚±5˚F
Elevated Temperature Ambient 2	ETA2	250˚±5˚F
Elevated Temperature Wet	ETW	250˚±5˚F

Table 1-2: Environmental Conditions Abbreviations

Detailed information about the test methods and conditions used is given in NCAMP Test Report CAM-RP-2023-007 Rev N/C not yet released.

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.

2. Background

Statistical computations are performed with CMH17 STATS. Pooling across environments will be used whenever it is permissible according to CMH-17-1G 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-17-1G 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.: $$S_p = \sqrt{\frac{\sum_{i=1}^{k}(n_i - 1)S_i^2}{\sum_{i=1}^{k}(n_i - 1)}}$$ **Equation 4**

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

2.1.2.2 Pooled Coefficient of Variation

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

Pooled Coefficient of Variation $$= \frac{S_p}{1} = S_p$$ **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: $$A - basis = \overline{X} - K_a S$$ $$B - basis = \overline{X} - K_b S$$ **Equation 6**

2.1.3.1 K-factor computations

K_a and K_b are computed according to the methodology documented in section 8.3.5 of CMH-17-1G. The approximation formulas are given below:

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

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

Where

r = the number of environments being pooled together

n_j = number of data values for environment j

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

$f = N - r$

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

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

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

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

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

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 Determination of Outliers

All outliers are identified in text and graphics. If an outlier is removed from the dataset, it will be specified and the reason why will be documented in the text. Outliers are identified using the Maximum Normed Residual Test for Outliers as specified in section 8.3.3 of CMH-17-1G.

$$MNR = \frac{\max_{all\ i} \left| X_i - \bar{X} \right|}{S}, \; i = 1 \ldots n \qquad \textbf{Equation 14}$$

$$C = \frac{n-1}{\sqrt{n}} \sqrt{\frac{t^2}{n - 2 + t^2}} \qquad \textbf{Equation 15}$$

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.

2.1.5 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:

$$ADK = \frac{n-1}{n^2(k-1)} \sum_{i=1}^{k} \left[\frac{1}{n_i} \sum_{j=1}^{L} h_j \frac{\left(nF_{ij} - n_i H_j\right)^2}{H_j\left(n - H_j\right) - \frac{nh_j}{4}} \right]$$ **Equation 16**

Where

n_i = the number of test specimens in each batch

$n = n_1 + n_2 + \ldots + n_k$

h_j = the number of values in the combined samples equal to $z_{(j)}$

H_j = the number of values in the combined samples less than $z_{(j)}$ plus ½ the number of values in the combined samples equal to $z_{(j)}$

F_{ij} = the number of values in the i^{th} group which are less than $z_{(j)}$ plus ½ the number of values in this group which are equal to $z_{(j)}$.

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

$$ADC = 1 + \sigma_n \left[z_\alpha + \frac{0.678}{\sqrt{k-1}} - \frac{0.362}{k-1} \right]$$ **Equation 17**

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

$$\sigma_n^2 = VAR(ADK) = \frac{an^3 + bn^2 + cn + d}{(n-1)(n-2)(n-3)(k-1)^2}$$ **Equation 18**

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.

2.1.6 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:

$$F(x) = \int_a^b \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} dx \qquad \textbf{Equation 19}$$

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

$$z_{(i)} = \frac{x_{(i)} - \bar{x}}{s}, \quad \text{for i = 1,…,n} \qquad \textbf{Equation 20}$$

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

The Anderson Darling test statistic (AD) is:

$$AD = \sum_{i=1}^{n} \frac{1-2i}{n} \left\{ \ln\left[F_0(z_{(i)})\right] + \ln\left[1 - F_0\left(z_{(n+1-i)}\right)\right]\right\} - n \qquad \textbf{Equation 21}$$

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

$$OSL = \frac{1}{1 + e^{-0.48+0.78\ln(AD^*)+4.58AD^*}}, \quad AD^* = \left(1 + \frac{4}{n} - \frac{25}{n^2}\right) AD \qquad \textbf{Equation 22}$$

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.

2.1.7 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:

$$F = \frac{\sum_{i=1}^{k} n_i \left(\bar{w}_i - \bar{w}\right)^2 / (k-1)}{\sum_{i=1}^{k} \sum_{j=1}^{n_i} {}_i\left(w_{ij} - \bar{w}_i\right)^2 / (n-k)} \qquad \textbf{Equation 23}$$

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.

2.1.8 Distribution Tests

In addition to testing for normality using the Anderson-Darling test (see 2.1.6), 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 $x_1, \ldots, x_n$, and the sample observations ordered from least to greatest by $x_{(1)}, \ldots, x_{(n)}$.

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

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

$$k_B \approx 1.282 + \exp\{0.958 - 0.520\ln(n) + 3.19/n\} \qquad \textbf{Equation 24}$$

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

2.1.8.2 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 noncentrality parameter $2.326\sqrt{n}$ and n − 1 degrees of freedom (Reference

11). Since this is not a calculation that Excel can handle easily, the following approximation to the k_A values is used:

$$k_A \approx 2.326 + \exp\{1.34 - 0.522\ln(n) + 3.87/n\} \qquad \textbf{Equation 25}$$

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

2.1.8.3 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

$$e^{-\left(a/\alpha\right)^{\beta}} - e^{-\left(b/\alpha\right)^{\beta}} \qquad \textbf{Equation 26}$$

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 2.1.8.3.1). Calculations specific to the goodness-of-fit test for the Weibull distribution are provided in section 2.1.8.3.2.

2.1.8.3.1 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:

$$\hat{\alpha}\hat{\beta}\mathrm{n} - \frac{\hat{\beta}}{\hat{\alpha}^{\hat{\beta}-1}}\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{x}_{\mathrm{i}}^{\hat{\beta}} = 0 \qquad \textbf{Equation 27}$$

$$\frac{n}{\hat{\beta}} - n\ln\hat{\alpha} + \sum_{i=1}^{n}\ln x_i - \sum_{i=1}^{n}\left[\frac{x_i}{\hat{\alpha}}\right]^{\hat{\beta}}\left(\ln x_i - \ln\hat{\alpha}\right) = 0 \qquad \textbf{Equation 28}$$

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

2.1.8.3.2 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 2.1.8.3.1, let

$$z_{(i)} = \left[x_{(i)}/\hat{\alpha}\right]^{\hat{\beta}}, \quad \text{for } i = 1,\ldots,n \qquad \textbf{Equation 29}$$

The Anderson-Darling test statistic is

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

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 31**

where

$$AD^{*} = \left(1+\frac{0.2}{\sqrt{n}}\right)AD$$ **Equation 32**

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.

2.1.8.3.3 Basis value calculations for the Weibull distribution

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

$$B = \hat{q}e^{\left(-V/\hat{\beta}\sqrt{n}\right)}$$ **Equation 33**

where

$$\hat{q} = \hat{\alpha}\left(0.10536\right)^{1/\hat{\beta}}$$ **Equation 34**

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

$$\hat{q} = \hat{\alpha}(0.01005)^{1/\beta}$$ **Equation 35**

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.

$$V_B \approx 3.803 + \exp\left[1.79 - 0.516\ln(n) + \frac{5.1}{n-1}\right]$$ **Equation 36**

$$V_A \approx 6.649 + \exp\left[2.55 - 0.526\ln(n) + \frac{4.76}{n}\right]$$ **Equation 37**

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

2.1.8.4 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.

2.1.8.4.1 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 2.1.6. 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 38**

where $x_{(i)}$ is the ith 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 ≤ 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.

2.1.8.4.2 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.

2.1.9 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.

2.1.9.1 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:

$$r_B = \frac{n}{10} - 1.645\sqrt{\frac{9n}{100}} + 0.23 \qquad \textbf{Equation 39}$$

For A-Basis values:

$$r_A = \frac{n}{100} - 1.645\sqrt{\frac{99n}{10,000}} + 0.29 + \frac{19.1}{n} \qquad \textbf{Equation 40}$$

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.

2.1.9.2 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:

$$B = x_{(r)} \left[\frac{x_{(1)}}{x_{(r)}} \right]^k \qquad \textbf{Equation 41}$$

The A-basis value is:

$$A = x_{(n)} \left[\frac{x_{(1)}}{x_{(n)}} \right]^k \qquad \textbf{Equation 42}$$

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-17-1G, 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

2.1.10 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 2.1.7). 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.

2.1.10.1 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 2.1.5) 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 $\left(n_i, \bar{x}_i, s_i^2\right)$ 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:

$$SSB = \sum_{i=1}^{k} n_i \bar{x}_I^2 - n\bar{x}^2 \qquad \textbf{Equation 43}$$

$$SST = \sum_{i=1}^{k} \sum_{j=1}^{n_i} x_{ij}^2 - n\bar{x}^2 \qquad \textbf{Equation 44}$$

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

$$SSE = SST - SSB \qquad \textbf{Equation 45}$$

Next, the mean sums of squares are computed:

$$MSB = \frac{SSB}{k-1} \qquad \textbf{Equation 46}$$

$$MSE = \frac{SSE}{n-k} \qquad \textbf{Equation 47}$$

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

$$n' = \frac{n - \frac{1}{n}\sum_{i=1}^{k} n_i^2}{k-1} \qquad \textbf{Equation 48}$$

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

$$S = \sqrt{\frac{MSB}{n'} + \left(\frac{n'-1}{n'}\right) MSE} \qquad \textbf{Equation 49}$$

Two k-factors are computed using the methodology of section 8.3.5 of CMH-17-1G 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

$$u = \frac{MSB}{MSE} \quad \textbf{Equation 50}$$

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

$$T = \frac{k_0 - \frac{k_1}{\sqrt{n'}} + \left(k_1 - k_0\right)\sqrt{\frac{u}{u + n' - 1}}}{1 - \frac{1}{\sqrt{n'}}} \quad \textbf{Equation 51}$$

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

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.

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-17-1G. 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-17-1G are shown in shaded boxes and labeled as estimates.

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-17-1G are recommended.
2. Only normalized basis values are given for properties that are normalized.
3. ANOVA B-basis values are not recommended since only three batches of material are available and CMH-17-1G recommends that no less than five batches be used when computing basis values with the ANOVA method.
4. 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 CMH17 STATS when the B-basis value is 90% or more of the average value. Such values will be indicated.

If the data appear questionable (e.g. when the CTD-RTD-ETW trend of the basis values is not consistent with the CTD-RTD-ETW trend of the average values), then the B-basis values will not be recommended.

3.2 Lamina and Laminate Summary Tables

NCAMP Recommended B-basis Values for
HexPEKK®-100 Polymer Material

All B-basis values in this table meet the standards for publication in CMH-17G Handbook

Test Condition			CTA (–65˚ F)		RTA (70˚ F)		ETA2 (250˚ F)		ETW (250˚ F)	
Test Method	Orientation	Property	B-Basis	Mean	B-Basis	Mean	B-Basis	Mean	B-Basis	Mean
Dogbone Tension	XY	Strength [ksi]	13.11	16.56	14.56	15.78	8.979	9.919	7.654	8.593
		0.2% Offset Strength [ksi]					7.394	8.157		
	ZX	Strength [ksi]	8.680	10.66	9.276	11.25	7.488	8.326		
		0.2% Offset Strength [ksi]					5.346	7.393	5.648	6.068
Compression Prism	XY	Strength [ksi]	33.76	35.12	25.02	25.92	15.93	16.94	15.97	17.30
		2% Offset Strength [ksi]			24.91	25.80			13.38	14.61
	ZX	Strength [ksi]			24.86	25.89	15.98	17.30	15.61	17.32
		2% Offset Strength [ksi]			24.77	25.64			13.96	14.66
FHT	XY	Strength [ksi]	14.60	16.75	13.77	14.62	8.770	9.615	7.136	7.980
	ZX	Strength [ksi]	9.090	11.12	9.262	11.28	5.337	7.675	6.155	6.511
OHT	XY	Strength [ksi]	8.677	10.06	7.914	8.712	6.273	7.079	5.572	6.379
	ZX	Strength [ksi]	6.444	7.324	5.796	6.676	4.726	5.606	4.476	5.356
PSH	XY	Max. Shear Strength [ksi]	15.86	16.91			8.744	9.707	8.236	8.944
	ZX	Max. Shear Strength [ksi]	14.76	15.79	11.92	12.95	8.410	9.027	7.688	8.532
FLEX	XY	Strength [ksi]	23.97	28.11	22.99	27.11	18.41	20.00		
		0.2% Offset Strength [ksi]							12.34	13.74
	ZX	Strength [ksi]	13.11	15.76	14.24	16.86	12.13	13.88	12.36	13.88
		0.2% Offset Strength [ksi]					9.791	12.12	10.10	11.40
SSB	XY	2% Offset Strength [ksi]							27.68	30.57
		Ultimate Strength [ksi]			27.68	31.77			32.45	34.86
	ZX	Ultimate Strength [ksi]			21.09	25.48			21.98	28.24

Table 3-1 : NCAMP Recommended B-basis values

NCAMP Properties Summary

HexPEKK®-100 Polymer Material

Values shown in shaded boxes do not meet CMH-17G 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 (180° F)		ETA2 (250° F)		ETW (250° F)	
Test Method	Orientation	Property	B-Basis	Mean	B-Basis	Mean	B-Basis	Mean	B-Basis	Mean	B-Basis	Mean
Dogbone Tension	XY	Strength [ksi]	13.11	16.56	14.56	15.78	11.74	13.16	8.979	9.919	7.654	8.593
		0.2% Offset Strength [ksi]	14.93	16.39	11.26	12.10	9.375	10.23	7.394	8.157	6.384	7.020
		Modulus [Msi]		1.014		0.9685		0.9522		0.9316		0.8115
	XZ	Strength [ksi]	10.97	15.37	15.02	16.28					7.821	8.612
		0.2% Offset Strength [ksi]	13.98	15.34	12.32	12.88					6.550	6.990
		Modulus [Msi]		1.062		0.9184						0.7895
	YX	Strength [ksi]	9.992	14.40	13.14	15.34					7.711	8.294
		0.2% Offset Strength [ksi]	NA	15.30	11.01	11.66					6.688	6.836
		Modulus [Msi]		0.9648		0.8758						0.7515
	ZX	Strength [ksi]	8.680	10.66	9.276	11.25	8.876	10.61	7.488	8.326	5.733	7.041
		0.2% Offset Strength [ksi]	9.672	11.75	9.489	10.32	8.992	9.525	5.346	7.393	5.648	6.068
		Modulus [Msi]		0.8872		0.7114		0.6673		0.6538		0.6194
	ZX45	Strength [ksi]	8.813	10.36	9.905	11.86					6.714	7.455
		0.2% Offset Strength [ksi]			10.56	11.35					5.078	6.240
		Modulus [Msi]		0.9380		0.7534						0.6565
Compression Prism	XY	Strength [ksi]	33.76	35.12	25.02	25.92	18.43	20.60	15.93	16.94	15.97	17.30
		2% Offset Strength [ksi]	31.66	34.56	24.91	25.80			15.02	16.18	13.38	14.61
		Modulus [Msi]		1.089		1.019		0.9763		0.9387		0.9076
	YX	Strength [ksi]	33.14	34.53	23.55	25.35					13.43	17.47
		2% Offset Strength [ksi]	32.62	34.05	23.65	25.09					13.29	14.00
		Modulus [Msi]		1.008		0.9310						0.8337
	ZX	Strength [ksi]	32.66	35.95	24.86	25.89	18.85	20.19	15.98	17.30	15.61	17.32
		2% Offset Strength [ksi]	32.45	35.58	24.77	25.64	18.62	19.85	15.59	16.13	13.96	14.66
		Modulus [Msi]		0.9442		0.8708		0.8213		0.7931		0.7695
	ZX45	Strength [ksi]	32.96	34.05	24.06	25.06					13.70	18.73
		2% Offset Strength [ksi]	32.87	33.56	23.69	24.92					13.69	14.11
		Modulus [Msi]		0.9639		0.8816						0.7905
FHC	XY	0.2% Offset Strength [ksi]			13.37	16.66					9.580	11.62
	XZ	0.2% Offset Strength [ksi]			10.88	15.09					8.525	11.15
	YX	0.2% Offset Strength [ksi]			11.24	14.90						
	ZX	0.2% Offset Strength [ksi]			14.90	17.94					9.923	11.96
	ZX45	0.2% Offset Strength [ksi]			11.83	15.09						
FHT	XY	Strength [ksi]	14.60	16.75	13.77	14.62			8.770	9.615	7.136	7.980
	XZ	Strength [ksi]	13.27	16.06	13.88	14.92					6.818	7.660
	YX	Strength [ksi]	14.03	16.62	12.96	14.60					6.861	7.509
	ZX	Strength [ksi]	9.090	11.12	9.262	11.28			5.337	7.675	6.155	6.511
	ZX45	Strength [ksi]	9.040	13.19	11.58	13.17					6.269	6.687
OHC	XY	0.2% Offset Strength [ksi]			11.64	14.40					8.438	10.04
		1% Offset Strength [ksi]									10.99	12.06
		Modulus [Msi]				0.9865						0.9179
	XZ	0.2% Offset Strength [ksi]			12.43	14.35					8.597	9.562
		1% Offset Strength [ksi]									10.02	11.31
		Modulus [Msi]				0.8699						0.8347
	YX	0.2% Offset Strength [ksi]									8.619	9.308
		1% Offset Strength [ksi]									10.11	11.30
		Modulus [Msi]										0.7601
	ZX	0.2% Offset Strength [ksi]			12.24	14.18					9.708	10.32
		1% Offset Strength [ksi]			NA	18.58					10.76	11.71
		Modulus [Msi]				0.7362						0.7284
	ZX45	0.2% Offset Strength [ksi]			6.768	14.60					8.512	9.448
		1% Offset Strength [ksi]			NA	17.50					9.833	11.01
		Modulus [Msi]				0.6661						0.7077
OHT	XY	Strength [ksi]	8.677	10.06	7.914	8.712			6.273	7.079	5.572	6.379
	XZ	Strength [ksi]	8.274	9.660	7.033	8.783					5.475	6.704
	YX	Strength [ksi]	8.474	8.959	7.186	8.028					5.549	6.397
	ZX	Strength [ksi]	6.444	7.324	5.796	6.676			4.726	5.606	4.476	5.356
	ZX45	Strength [ksi]	7.178	8.942	6.754	7.854					5.376	6.011
PSH	XY	Max. Shear Strength [ksi]	15.86	16.91	11.76	13.57	10.44	11.24	8.744	9.707	8.236	8.944
	ZX	Max. Shear Strength [ksi]	14.76	15.79	11.92	12.95	9.596	10.55	8.410	9.027	7.688	8.532
	ZX45	Max. Shear Strength [ksi]	12.92	15.73	12.01	13.11					8.306	8.740
FLEX	XY	Strength [ksi]	23.97	28.11	22.99	27.11	19.39	23.90	18.41	20.00	16.74	18.45
		0.2% Offset Strength [ksi]	20.59	29.34	19.49	25.19	18.86	20.69	9.551	14.52	12.34	13.74
		Modulus [Msi]		0.9249		0.8249		0.7376		0.8568		0.8134
	XZ	Strength [ksi]	17.57	20.60	21.59	22.93					14.74	16.80
		0.2% Offset Strength [ksi]			20.01	22.19					9.135	12.18
		Modulus [Msi]		0.8335		0.7135						0.7172
	YX	Strength [ksi]	23.88	29.87	24.51	27.54					17.02	18.13
		0.2% Offset Strength [ksi]	NA	30.83	23.34	24.77					11.27	12.99
		Modulus [Msi]		0.8479		0.7717						0.8028
	ZX	Strength [ksi]	13.11	15.76	14.24	16.86	12.03	15.63	12.13	13.88	12.36	13.88
		0.2% Offset Strength [ksi]			NA	18.81	NA	17.59	9.791	12.12	10.10	11.40
		Modulus [Msi]		0.6612		0.5937		0.5789		0.5843		0.5745
	ZX45	Strength [ksi]	14.37	17.06	15.66	20.34					11.99	15.21
		0.2% Offset Strength [ksi]			17.37	20.60					9.099	11.41
		Modulus [Msi]		0.6511		0.6163						0.6091
SSB	XY	2% Offset Strength [ksi]					NA	36.93	30.30	33.67	27.68	30.57
		Ultimate Strength [ksi]			27.68	31.77	20.64	33.70	8.143	37.73	32.45	34.86
	XZ	2% Offset Strength [ksi]									24.73	30.04
		Ultimate Strength [ksi]			24.84	31.47					25.50	32.88
	YX	2% Offset Strength [ksi]									29.23	29.82
		Ultimate Strength [ksi]			25.45	31.67					31.98	33.78
	ZX	2% Offset Strength [ksi]							27.30	31.60	24.32	27.17
		Ultimate Strength [ksi]			21.09	25.48	NA	29.03	18.62	27.84	21.98	28.24
	ZX45	2% Offset Strength [ksi]									24.89	27.70
		Ultimate Strength [ksi]			24.46	29.58					22.55	30.79

Table 3-2: Summary of basis values

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

All the statistics included in the tables and graphs are based in as-measured data. Test failures, outliers and explanations regarding computational choices were noted in the accompanying text for each test.

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

When a dataset fails the Anderson-Darling k-sample (ADK) test for batch-to-batch variation, an ANOVA analysis is required. In order for B-basis values 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.

4.1 Compression Prism XY Orientation

This test method was performed for 2.0% offset strength, compressive strength and modulus properties in the CTA, RTA, ETA1, ETA2 and ETW environments. There were insufficient specimens tested in the ETA1 condition to compute A- and B-basis values publishable in CMH17, so only estimates can be provided for that environmental condition. There were insufficient specimens that had a 0.2% Offset strength property in the CTA and ETA2 conditions, so only estimates could be provided for that property in those conditions

For 2% offset strength, CTA data failed ADK test, so ANOVA was used to compute design values. Since there are less than 5 batches, the result for ANOVA method is a B-estimate rather than B-basis.Values for the ETA1 2.0% offset data is not reported because failure occurred prior to the 2% offset. For conditions RTA, ETA2 and ETW, Weibull test was passed, so Weibull method was used. For compressive strength, conditions CTA, ETA1 and ETA2 passed normality test, so normal method was used. Condition RTA passed Weibull test, so Weibull method was used and ETW failed all three distribution goodness-of-fit tests, so a non-parametric method was used.

Three specimens were statistical outliers for at least one property. .The lowest value in batch one of the RTA condition was an outlier for the RTA condition but not for batch one. The lowest value in batch three of the RTA condition was an outlier for batch three but not for the RTA condition. Both of the outlier in the RTA condition were outliers for both 2.0% offset and for strength. The lowest value in batch three of the ETW condition was an outlier for the 2.0% offset strength property only in batch three only. It was not an outlier for the ETW condition or for the strength property. All outliers were retained for this analysis.

Statistics are given for the 2.0% offset strength data in Table 4-1, for compressive strength data in Table 4-2 and for modulus data in Table 4-3. The data for 2% offset strength are shown graphically in Fig 4-1 and for compressive strength in Fig 4-2.

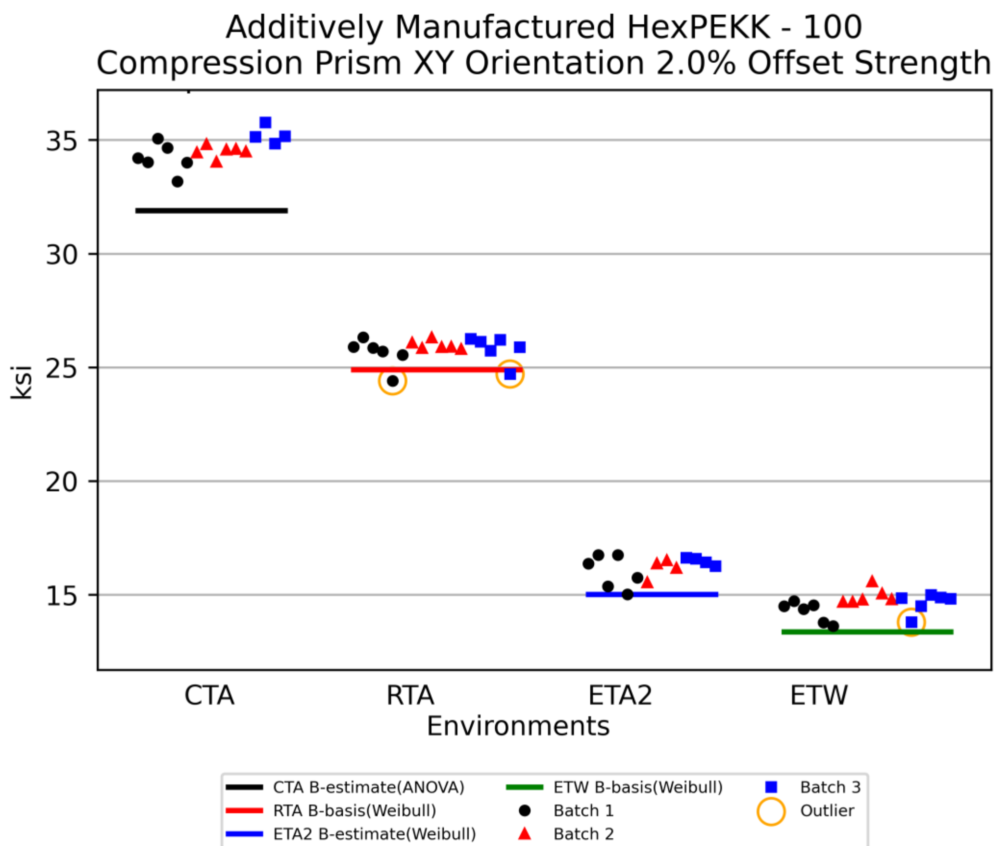

Figure 4-1: Batch plot for Compression Prism XY Orientation 2% Offset Strength

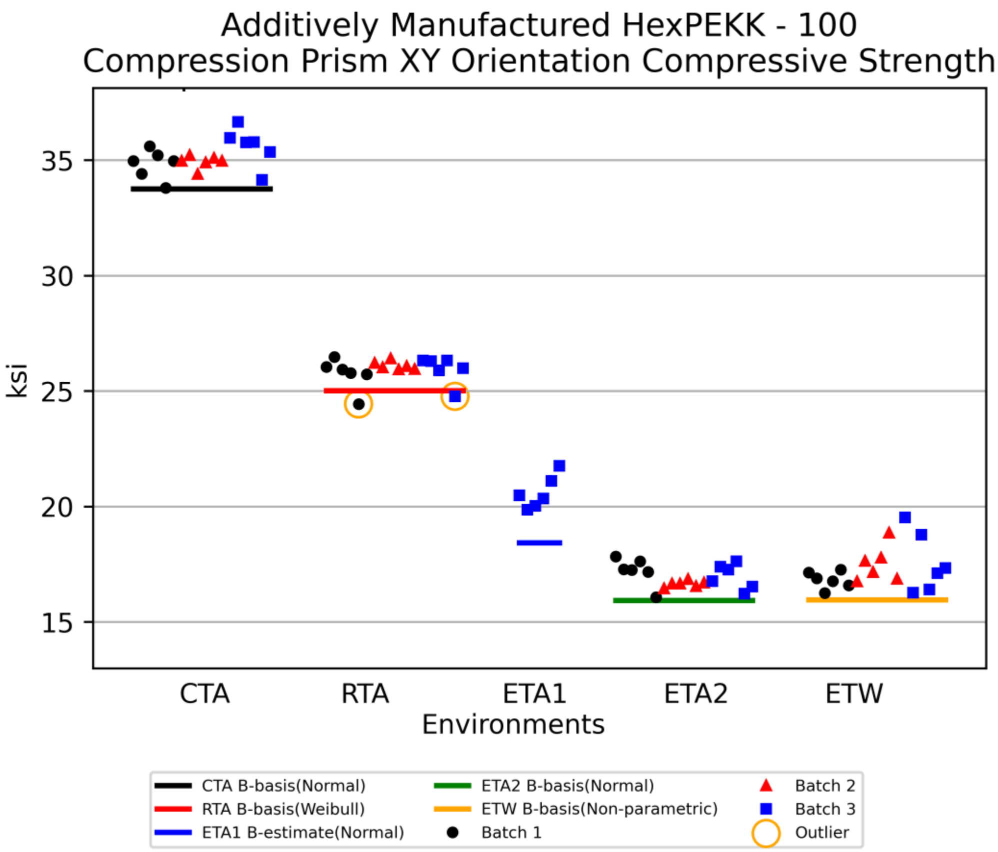

Figure 4-2: Batch plot for Compression Prism XY Orientation Compressive Strength

Compression Prism XY Orientation Basis Values and Statistics				
	2.0% Offset Strength [ksi]			
Env	CTA(-65°F)	RTA(70°F)	ETA2(250°F)	ETW(250°F)
Mean	34.56	25.80	16.18	14.61
Stdev	0.6051	0.5061	0.5439	0.4808
CV	1.751	1.961	3.362	3.291
Min	33.18	24.41	15.02	13.63
Max	35.77	26.32	16.76	15.58
No. Batches	3	3	3	3
No. Spec.	16	18	14	18
Basis Values and Estimates				
B-Basis		24.91		13.38
B-Estimate	31.66		15.02	
A-Estimate	29.60	23.89	13.79	12.11
Method	ANOVA	Weibull	Weibull	Weibull

Table 4-1: Statistics for Compression Prism XY Orientation 2% Offset Strength

Compression Prism XY Orientation Basis Values and Statistics					
	Compressive Strength [ksi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	35.12	25.92	20.60	16.94	17.30
Stdev	0.6903	0.5273	0.7173	0.5089	0.9203
CV	1.965	2.034	3.482	3.005	5.319
Min	33.80	24.44	19.86	16.07	16.26
Max	36.66	26.48	21.77	17.83	19.53
No. Batches	3	3	1	3	3
No. Spec.	18	18	6	18	18
Basis Values and Estimates					
B-Basis	33.76	25.02		15.93	15.97
B-Estimate			18.43		
A-Estimate	32.79	23.99	16.88	15.22	12.36
Method	Normal	Weibull	Normal	Normal	Non-parametric

Table 4-2: Statistics for Compression Prism XY Orientation Compressive Strength

Compression Prism XY Orientation Statistics					
	Modulus [Msi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	1.089	1.019	0.9763	0.9387	0.9076
Stdev	0.03534	0.02697	0.01582	0.03203	0.01990
CV	3.244	2.646	1.621	3.413	2.192
Min	1.019	0.9627	0.9460	0.8770	0.8557
Max	1.193	1.077	0.9887	1.002	0.9297
No. Batches	3	3	1	3	3
No. Spec.	18	18	6	18	18

Table 4-3: Statistics for Compression Prism XY Orientation Modulus

4.2 Compression Prism YX Orientation

This test method was performed for 2.0% offset strength, compressive strength and modulus properties and CTA, RTA and ETW environments. There were insufficient specimens tested to compute A- and B-basis values publishable in CMH17, so only estimates can be provided. For 2% offset strength, all conditions passed normality test, so normal method was used for computing design values. Similarly, for compressive strength, all conditions passed normality test, so normal method was used.

No outliers were detected for this test method.

Statistics are given for the 2.0% offset strength data in Table 4-4, for compressive strength data in Table 4-5 and for modulus data in Table 4-6. The data for 2% offset strength are shown graphically in Fig 4-3 and for compressive strength in Fig 4-4.

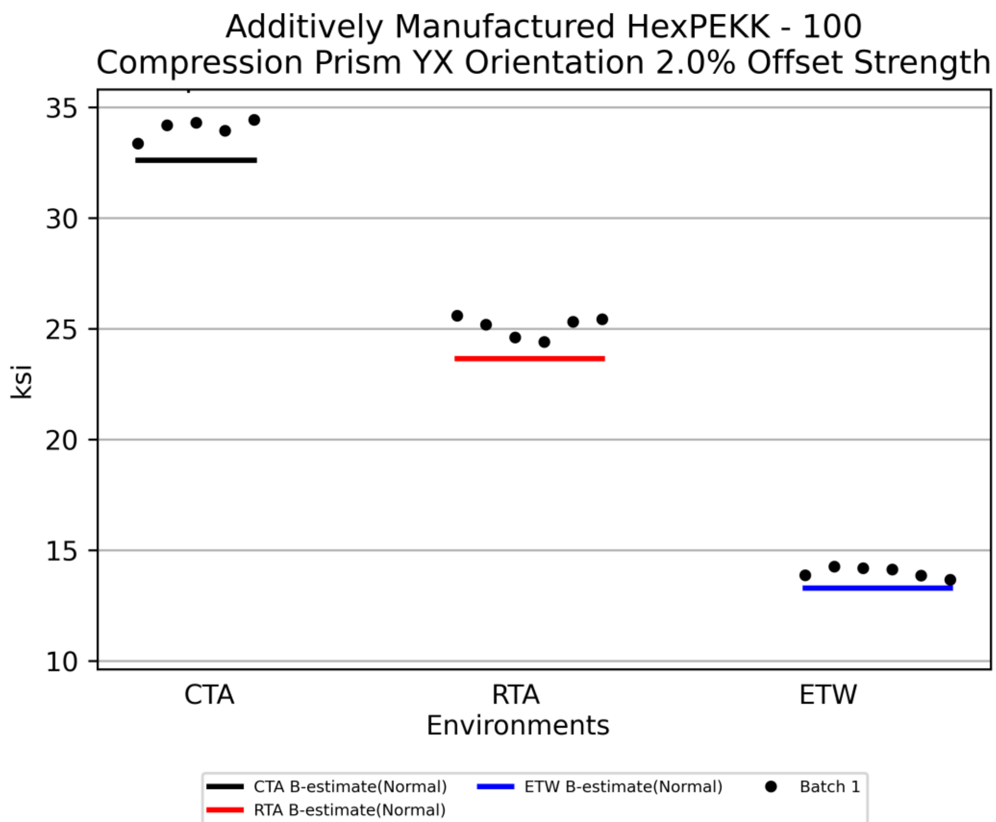

Figure 4-3: Batch Plot for Compression Prism YX Orientation 2.0% Offset Strength

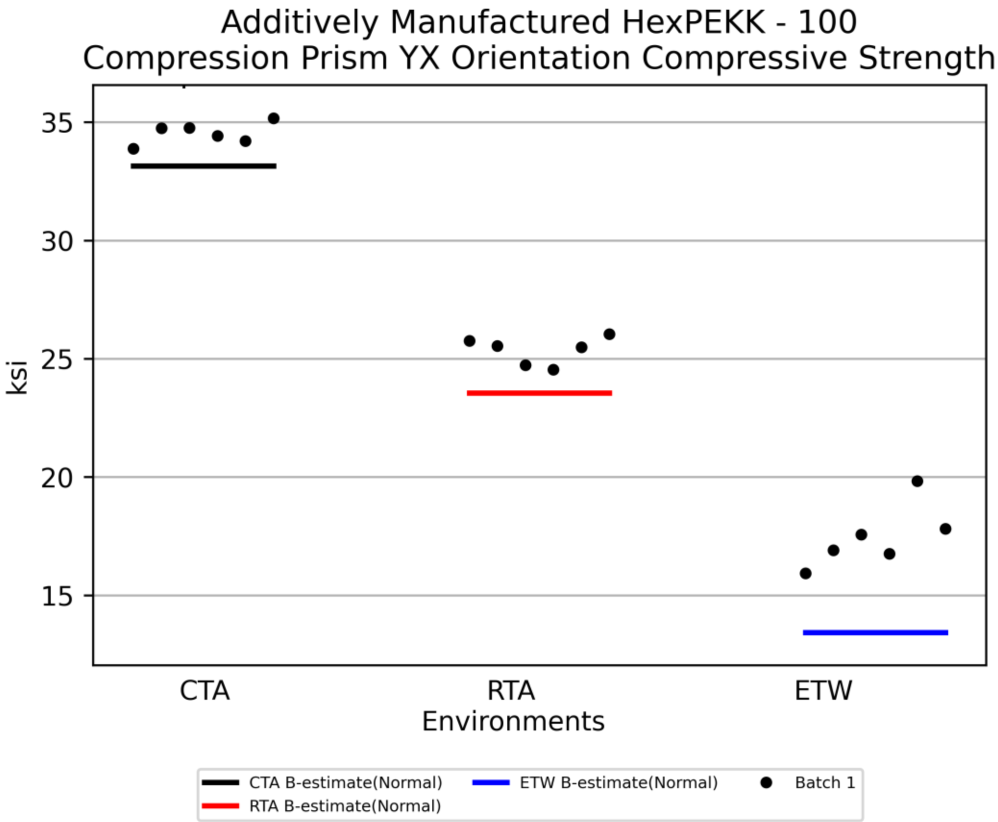

Figure 4-4: Batch Plot for Compression Prism YX Orientation Compressive Strength

Compression Prism YX Orientation Basis Values and Statistics			
	2.0% Offset Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	34.05	25.09	14.00
Stdev	0.4182	0.4735	0.2338
CV	1.228	1.887	1.671
Min	33.37	24.41	13.67
Max	34.43	25.58	14.26
No. Batches	1	1	1
No. Spec.	5	6	6
Basis Values and Estimates			
B-Estimate	32.62	23.65	13.29
A-Estimate	31.58	22.63	12.79
Method	Normal	Normal	Normal

Table 4-4: Statistics and Basis Values for Compression Prism YX Orientation 2.0% Offset

Compression Prism YX Orientation Basis Values and Statistics			
	Compressive Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	34.53	25.35	17.47
Stdev	0.4579	0.5938	1.332
CV	1.326	2.342	7.625
Min	33.88	24.54	15.94
Max	35.17	26.04	19.83
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	33.14	23.55	13.43
A-Estimate	32.16	22.27	10.56
Method	Normal	Normal	Normal

Table 4-5: Statistics and Basis Values for Compression Prism YX Orientation Strength

Compression Prism YX Orientation Statistics			
	Modulus [Msi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	1.008	0.9310	0.8337
Stdev	0.02125	0.01613	0.007528
CV	2.109	1.733	0.9030
Min	0.9795	0.9140	0.8257
Max	1.031	0.9566	0.8456
No. Batches	1	1	1
No. Spec.	6	6	6

Table 4-6: Statistics for Compression Prism YX Orientation Modulus

4.3 Compression Prism ZX Orientation

This test method was performed for 2.0% offset strength, compressive strength and modulus properties and CTA, RTA, ETA1, ETA2 and ETW environments. There were insufficient specimens tested in the ETA1 condition to compute A- and B-basis values publishable in CMH17, so only estimates can be provided for that environmental condition. There were insufficient specimens that had a 0.2% Offset strength property in the CTA and ETA2 conditions, so only estimates could be provided for that property in those conditions.

For 2% offset strength, all conditions passed normality test, so normal method was used for computing design values, except for CTA condition, which fails ADK test, so ANOVA method was used. For compressive strength, RTA, ETA1, ETA2 and ETW conditions passed ADK and normality tests, so normal method was used, while CTA failed ADK test, so ANOVA method was used. For ANOVA method, whenever there are less than 5 batches, the results are only B-estimates rather than B-basis values.

There was one statistical outlier. The largest strength value in batch one of the ETW condition was an outlier for batch one but not for the ETW condition and not for the 2.0% Offset strength property. It was retained for this analysis.
Statistics are given for the 2.0% offset strength data in Table 4-7, for compressive strength data in Table 4-8 and for modulus data in Table 4-9. The data for 2% offset strength are shown graphically in Fig 4-5 and for compressive strength in Fig 4-6.

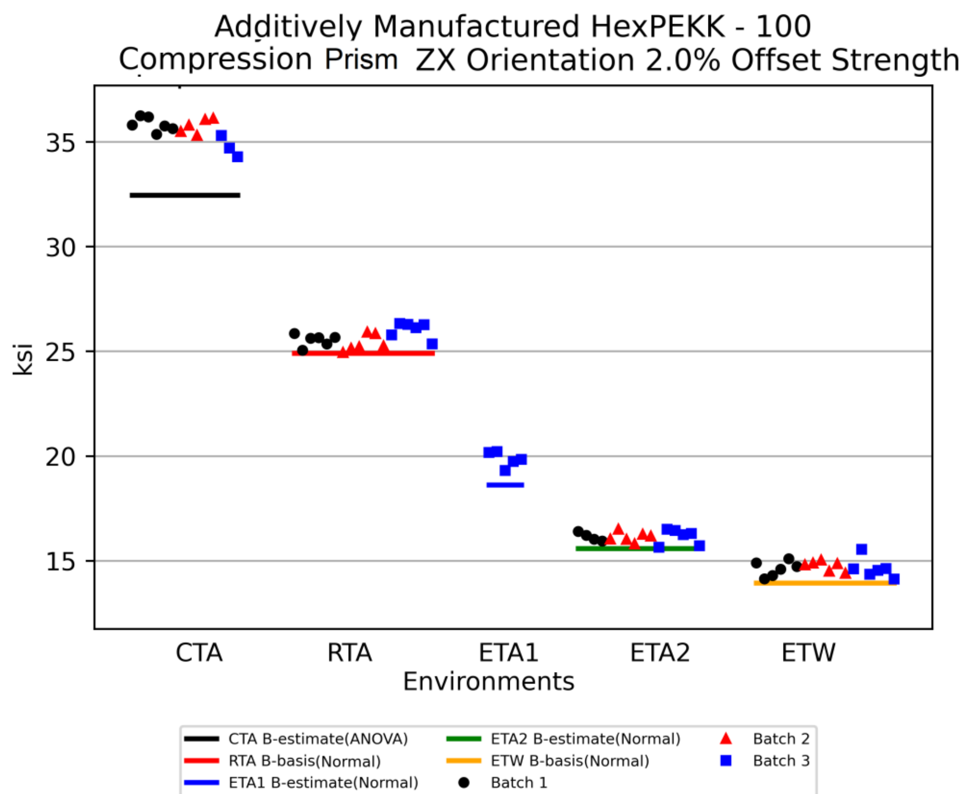

Figure 4-5: Batch Plot for Compression Prism ZX Orientation 2.0% Offset Strength

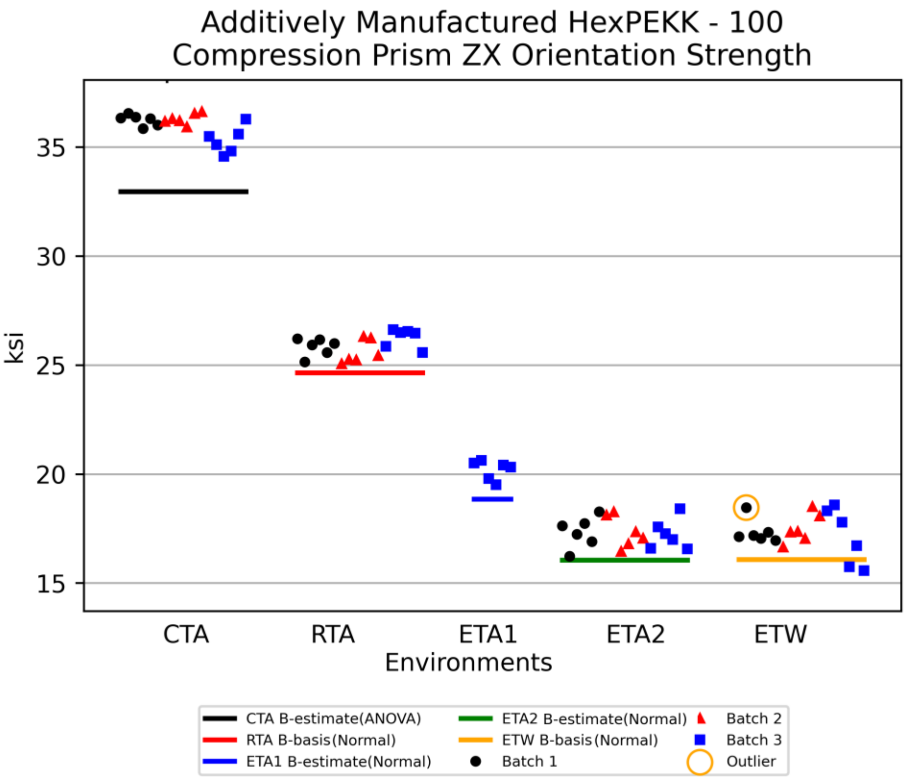

Figure 4-6: Batch Plot for Compression Prism ZX Orientation Compressive Strength

Compression Prism ZX Orientation Basis Values and Statistics					
	2.0% Offset Strength [ksi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	35.58	25.64	19.85	16.13	14.66
Stdev	0.5633	0.4401	0.3615	0.2694	0.3580
CV	1.583	1.716	1.821	1.670	2.442
Min	34.29	24.94	19.31	15.64	14.12
Max	36.25	26.32	20.20	16.49	15.54
No. Batches	3	3	1	3	3
No. Spec.	14	18	5	16	18
Basis Values and Estimates					
B-Basis		24.77			13.96
B-Estimate	32.45		18.62	15.59	
A-Estimate	30.23	24.16	17.72	15.20	13.45
Method	ANOVA	Normal	Normal	Normal	Normal

Table 4-7: Statistics and Basis Values for Compression Prism ZX Orientation 2.0% Offset

Compression Prism ZX Orientation Basis Values and Statistics					
	Strength [ksi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	35.95	25.89	20.19	17.30	17.32
Stdev	0.6022	0.5236	0.4438	0.6688	0.8671
CV	1.675	2.022	2.198	3.866	5.006
Min	34.58	25.04	19.51	16.23	15.58
Max	36.62	26.62	20.63	18.40	18.59
No. Batches	3	3	1	3	3
No. Spec.	18	18	6	18	18
Basis Values and Estimates					
B-Basis		24.86		15.98	15.61
B-Estimate	32.66		18.85		
A-Estimate	30.32	24.12	17.89	15.04	14.40
Method	ANOVA	Normal	Normal	Normal	Normal

Table 4-8: Statistics and Basis Values for Compression Prism ZX Orientation Strength

Compression Prism ZX Orientation Statistics					
	Modulus [Msi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	0.9442	0.8708	0.8213	0.7931	0.7695
Stdev	0.02015	0.01394	0.01741	0.009540	0.01165
CV	2.134	1.601	2.120	1.203	1.513
Min	0.9119	0.8407	0.8004	0.7685	0.7484
Max	0.9932	0.8890	0.8494	0.8038	0.7850
No. Batches	3	3	1	3	3
No. Spec.	18	18	6	18	18

Table 4-9: Statistics for Compression Prism ZX Orientation Modulus

4.4 Compression Prism ZX45 Orientation

This test method was performed for 2.0% offset strength, compressive strength, and modulus properties and CTA, RTA and ETW environments. There were insufficient specimens tested to compute A- and B-basis values publishable in CMH17, so only estimates can be provided. For 2% offset strength, all conditions passed normality test, so normal method was used for computing design values. For compressive strength, CTA, RTA and ETW conditions passed normality test, so normal method was used.

No outliers were detected for this test method.

Statistics are given for the 2.0% offset strength data in Table 4-10, for compressive strength data in Table 4-11, and for modulus data in Table 4-12. The data for 2% offset strength are shown graphically in Fig 4-7 and for compressive strength in Fig 4-8.

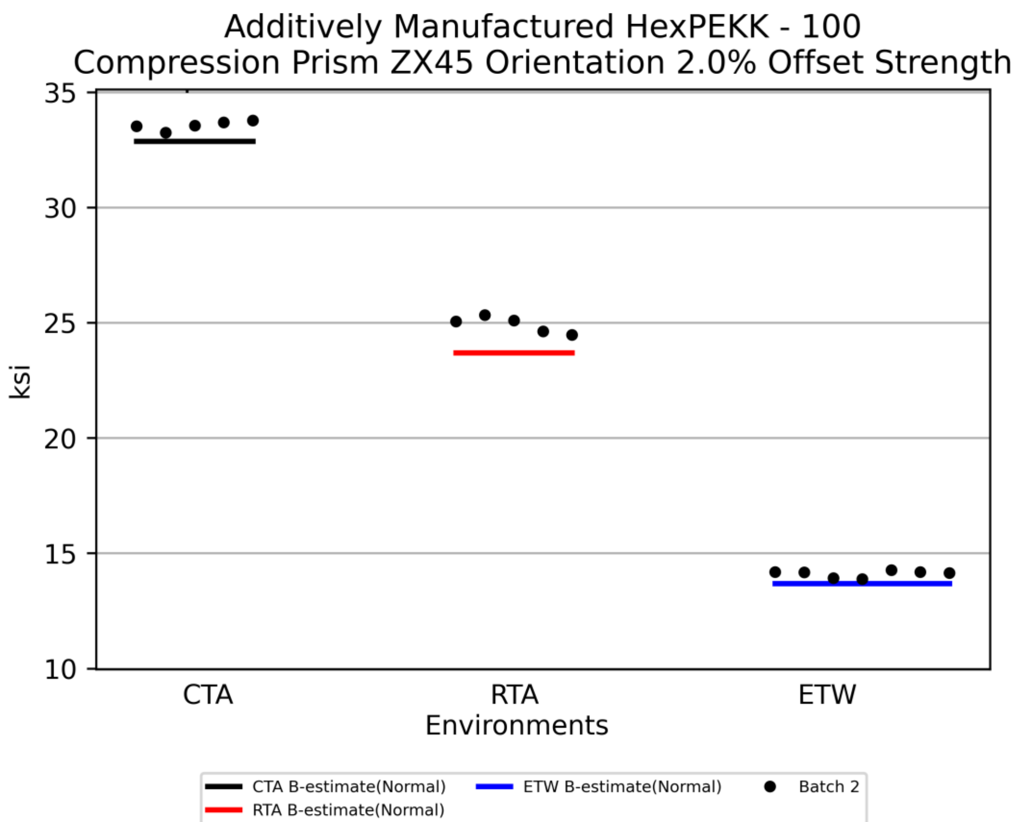

Figure 4-7: Batch Plot for Compression Prism ZX45 Orientation 2.0% Offset Strength

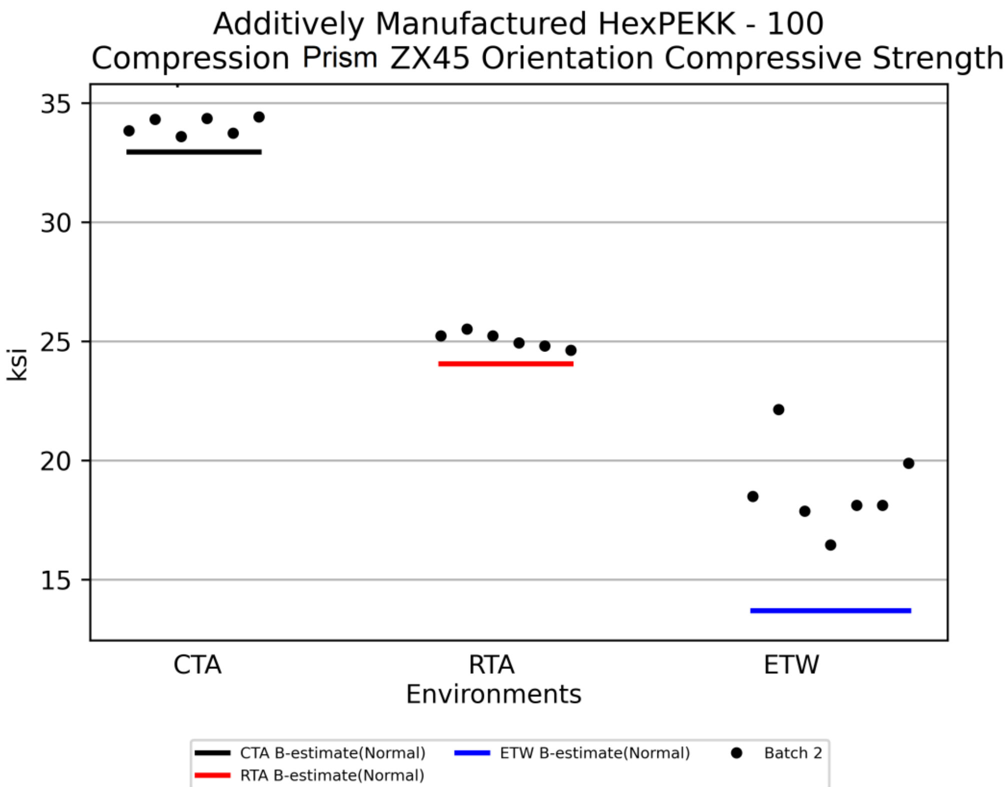

Figure 4-8: Batch Plot for Compression Prism ZX45 Orientation Compressive Strength

Compression Prism ZX45 Orientation Basis Values and Statistics			
	2.0% Offset Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	33.56	24.92	14.11
Stdev	0.2014	0.3593	0.1522
CV	0.6003	1.442	1.078
Min	33.25	24.47	13.87
Max	33.77	25.34	14.28
No. Batches	1	1	1
No. Spec.	5	5	7
Basis Values Estimates			
B-Estimate	32.87	23.69	13.69
A-Estimate	32.37	22.80	13.39
Method	Normal	Normal	Normal

Table 4-10: Statistics and Basis Values for Compression Prism ZX45 Orientation 2.0% Offset

Compression Prism ZX45 Orientation Basis Values and Statistics			
	Compressive Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	34.05	25.06	18.73
Stdev	0.3601	0.3286	1.813
CV	1.058	1.312	9.678
Min	33.59	24.63	16.45
Max	34.42	25.52	22.14
No. Batches	1	1	1
No. Spec.	6	6	7
Basis Values and Estimates			
B-Estimate	32.96	24.06	13.70
A-Estimate	32.18	23.36	10.15
Method	Normal	Normal	Normal

Table 4-11: Statistics and Basis Values for Compression Prism ZX45 Orientation Strength

Compression Prism ZX45 Orientation Statistics			
	Modulus [Msi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	0.9639	0.8816	0.7905
Stdev	0.01926	0.01193	0.01013
CV	1.998	1.353	1.281
Min	0.9317	0.8644	0.7766
Max	0.9863	0.8966	0.8081
No. Batches	1	1	1
No. Spec.	6	6	7

Table 4-12: Statistics for Compression Prism ZX45 Orientation Modulus

4.5 Dogbone Tension XY Orientation

This test method was performed for 0.2% offset yield strength, tensile strength and modulus properties and all five environments CTA, RTA, ETA1, ETA2, and ETW. There were insufficient specimens tested in the ETA1 condition to compute A- and B-basis values publishable in CMH17, so only estimates can be provided for that environmental condition. There were insufficient specimens that had a 0.2% Offset strength property in the CTA and ETW conditions, so only estimates could be provided for that property in those conditions.

For 0.2% offset yield strength, CTA and ETA1 passed normality test, so normal method was used to compute design values. ETA2 and ETW failed normality but passed Weibull test, so Weibull method was used. RTA failed ADK test, so ANOVA method was used. Since the number of batches is less than 5, ANOVA method produces B-estimate rather than B-basis. For tensile strength, RTA, ETA1, ETA2 and ETW passed normality test, so normal method was used. CTA failed all tests, so non-parametric method was used.

There were four statistical outliers, three for the 0.2% offset strength property and one for the strength property. A higher condition outlier for 0.2% offset strength in batch three and condition CTA. A lower condition outlier for 0.2% offset strength in batch one and condition ETA2. A lower batch and condition outlier for 0.2% offset strength in batch two and condition ETW. The lowest value for strength in batch three of the CTA condition was an outlier for batch three but not for the CTA condition. All outliers were retained for this analysis.
Statistics, basis values and estimates are given for 0.2% offset yield strength data in Table 4-13, for tensile strength data in Table 4-14 and modulus data in Table 4-15. The 0.2% offset yield strength data are shown graphically in Figure 4-9 and the tensile strength data in Figure 4-10.

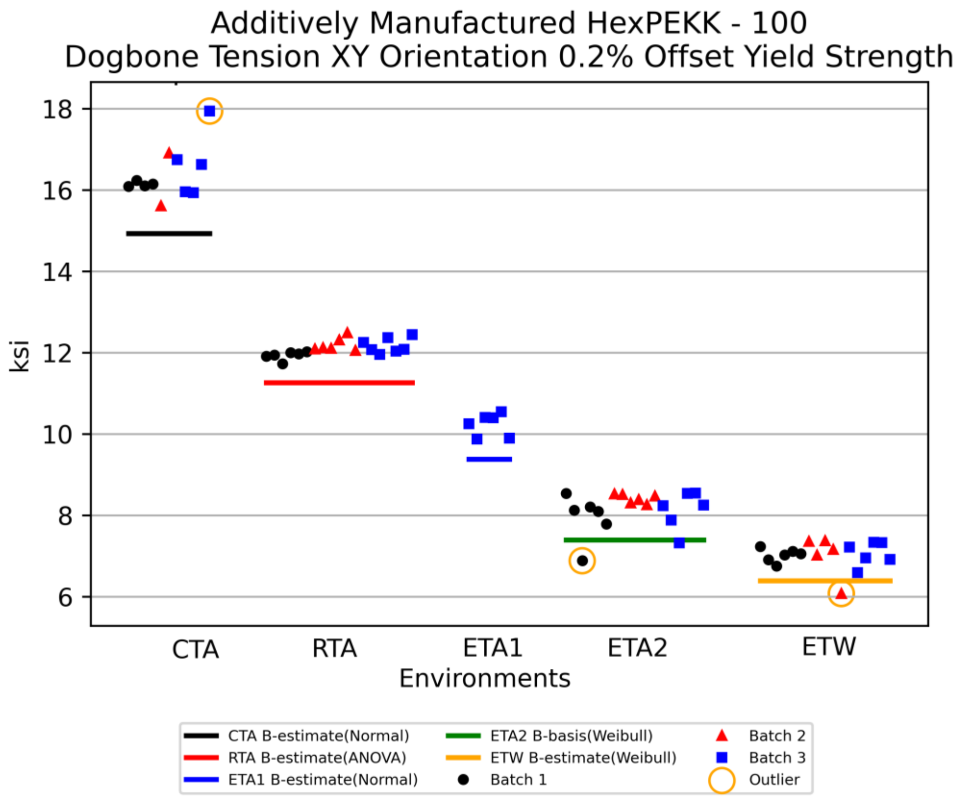

Figure 4-9: Batch plot for Dogbone Tension XY Orientation 0.2% Offset Yield Strength

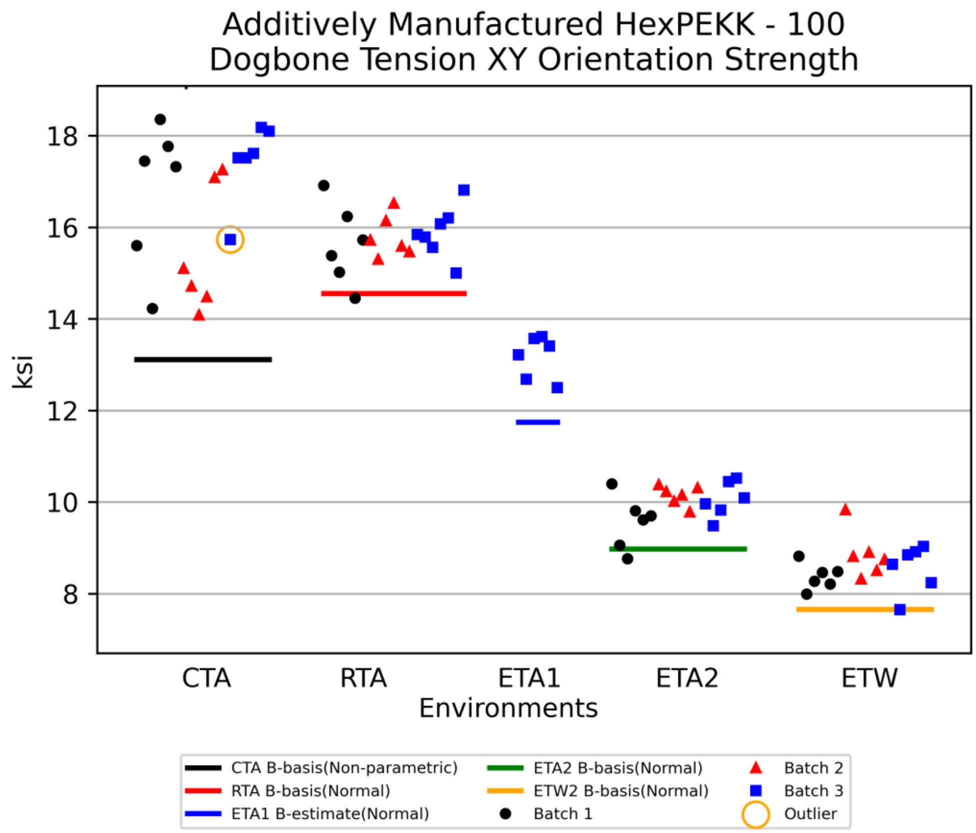

Figure 4-10: Batch plot for Dogbone Tension XY Orientation Strength

Dogbone Tension XY Orientation Basis Values and Statistics					
	0.2% Offset Yield Strength [ksi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	16.39	12.10	10.23	8.157	7.020
Stdev	0.6406	0.1921	0.2809	0.4502	0.3287
CV	3.909	1.588	2.747	5.519	4.683
Min	15.61	11.73	9.874	6.879	6.072
Max	17.94	12.48	10.54	8.542	7.371
No. Batches	3	3	1	3	3
No. Spec.	11	19	6	18	17
Basis Values and Estimates					
B-Basis				7.394	
B-Estimate	14.93	11.26	9.375		6.384
A-Estimate	13.90	10.66	8.770	6.591	5.723
Method	Normal	ANOVA	Normal	Weibull	Weibull

Table 4-13: Statistics and Basis Values for Dogbone Tension XY Orientation 0.2% Offset Strength

Dogbone Tension XY Orientation Basis Values and Statistics					
	Strength [ksi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	16.56	15.78	13.16	9.919	8.593
Stdev	1.489	0.6248	0.4690	0.4762	0.4756
CV	8.993	3.961	3.562	4.801	5.534
Min	14.09	14.46	12.50	8.767	7.649
Max	18.35	16.91	13.61	10.52	9.830
No. Batches	3	3	1	3	3
No. Spec.	18	19	6	18	18
Basis Values and Estimates					
B-Basis	13.11	14.56		8.979	7.654
B-Estimate			11.74		
A-Estimate	9.479	13.69	10.73	8.313	6.989
Method	Non-parametric	Normal	Normal	Normal	Normal

Table 4-14: Statistics and Basis Values for Dogbone Tension XY Orientation Tensile Strength

Dogbone Tension XY Orientation Statistics					
	Modulus [Msi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	1.014	0.9685	0.9522	0.9316	0.8115
Stdev	0.03787	0.02456	0.06313	0.03356	0.03510
CV	3.733	2.536	6.630	3.602	4.325
Min	0.9186	0.9214	0.8594	0.8865	0.7273
Max	1.073	1.014	1.031	1.022	0.8843
No. Batches	3	3	1	3	3
No. Spec.	18	19	6	18	18

Table 4-15: Statistics for Dogbone Tension XY Orientation Modulus

4.6 Dogbone Tension XZ Orientation

This test method was performed for 0.2% offset yield strength, tensile strength, and modulus properties and environments CTA, RTA and ETW. There were insufficient specimens tested to compute A- and B-basis values publishable in CMH17, so only estimates can be provided. For 0.2% offset yield strength, all conditions passed normality test, so normal method was used to compute design values. For tensile strength, all conditions passed normality test, so normal method was used.

No statistical outliers were detected in the data.

Statistics, basis values, and estimates are given for 0.2% offset yield strength data in Table 4-16, for tensile strength data in Table 4-17, and modulus data in Table 4-18. The 0.2% offset yield strength data are shown graphically in Figure 4-11 and the tensile strength data in Figure 4-12.

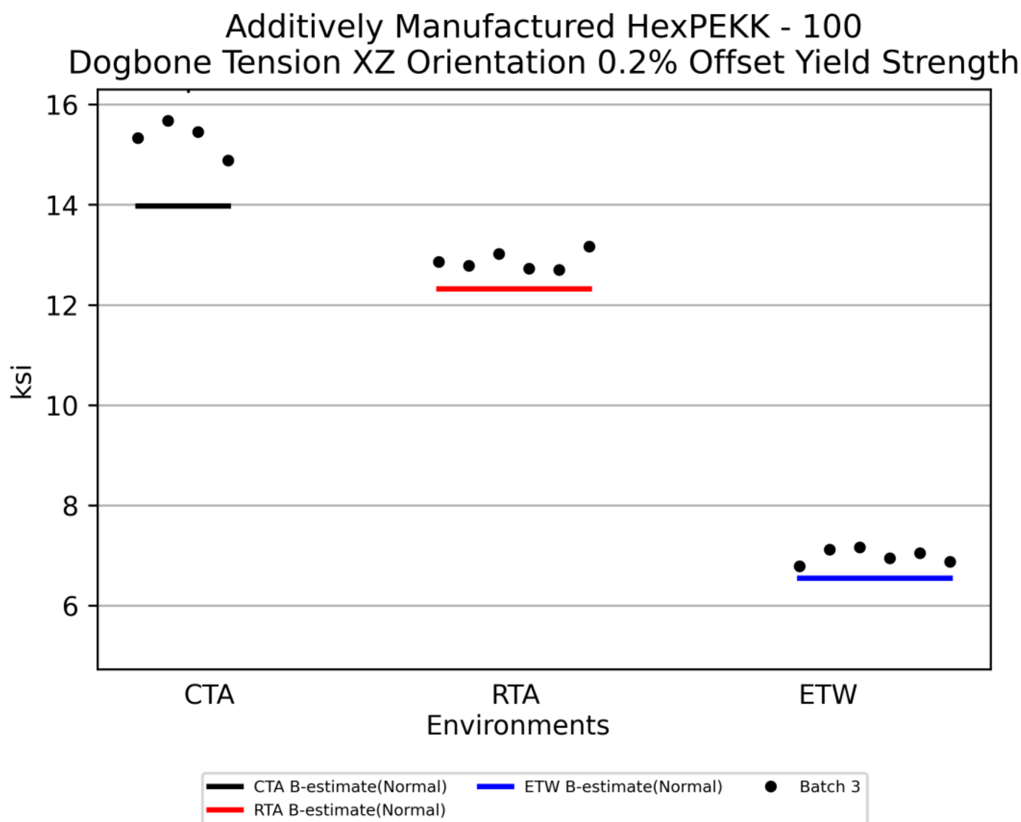

Figure 4-11: Batch plot for Dogbone Tension XZ Orientation 0.2% Offset Yield Strength

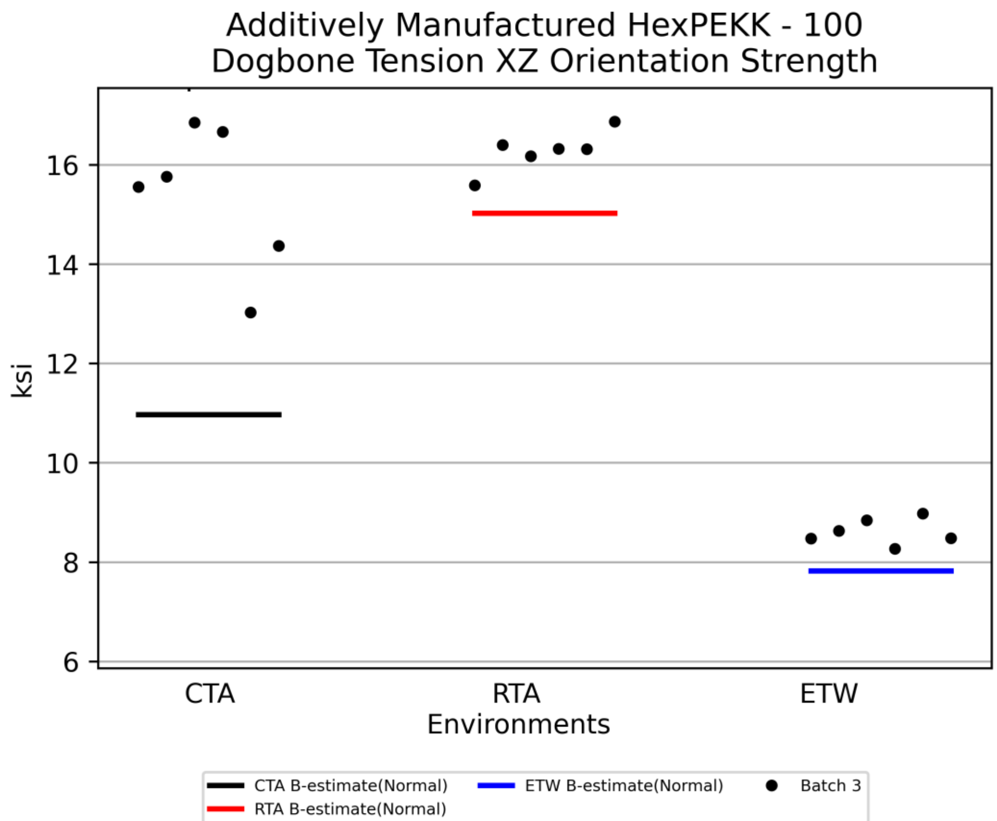

Figure 4-12: Batch plot for Dogbone Tension XZ Orientation Strength

Dogbone Tension XZ Orientation Basis Values and Statistics			
	0.2% Offset Yield Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	15.34	12.88	6.990
Stdev	0.3316	0.1822	0.1451
CV	2.162	1.415	2.076
Min	14.89	12.70	6.787
Max	15.67	13.16	7.165
No. Batches	1	1	1
No. Spec.	4	6	6
Basis Values and Estimates			
B-Estimate	13.98	12.32	6.550
A-Estimate	12.95	11.93	6.238
Method	Normal	Normal	Normal

Table 4-16: Statistics and Basis Values for Dogbone Tension XZ Orientation 0.2% Offset Strength

Dogbone Tension XZ Orientation Basis Values and Statistics			
	Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	15.37	16.28	8.612
Stdev	1.452	0.4139	0.2609
CV	9.447	2.543	3.030
Min	13.03	15.59	8.271
Max	16.85	16.87	8.978
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	10.97	15.02	7.821
A-Estimate	7.844	14.13	7.260
Method	Normal	Normal	Normal

Table 4-17: Statistics and Basis Values for Dogbone Tension XZ Orientation Tensile Strength

Dogbone Tension XZ Orientation Statistics			
	Modulus [Msi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	1.062	0.9184	0.7895
Stdev	0.02212	0.01001	0.02671
CV	2.082	1.090	3.383
Min	1.026	0.9068	0.7517
Max	1.085	0.9312	0.8249
No. Batches	1	1	1
No. Spec.	6	6	6

Table 4-18: Statistics for Dogbone Tension XZ Orientation Modulus

4.7 Dogbone Tension YX Orientation

This test method was performed for 0.2% offset yield strength, tensile strength and modulus properties and environments CTA, RTA and ETW. There were insufficient specimens tested to compute A- and B-basis values publishable in CMH17, so only estimates can be provided. For 0.2% offset yield strength, condition CTA has too few specimens, so design values are not available (NA). RTA and ETW conditions passed normality test, so normal method was used to compute design values. For tensile strength, all conditions passed normality test, so normal method was used.

No statistical outliers were detected.

Statistics, basis values and estimates are given for 0.2% offset yield strength data in Table 4-19, for tensile strength data in Table 4-20 and modulus data in Table 4-21. The 0.2% offset yield strength data are shown graphically in Figure 4-13 and the tensile strength data in Figure 4-14.

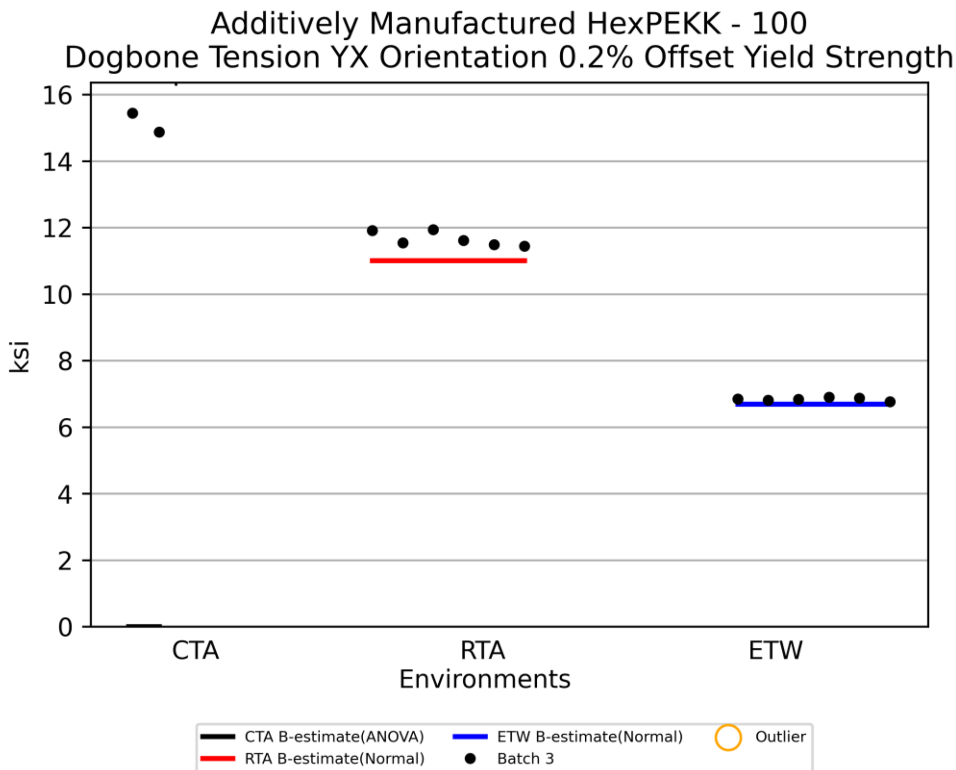

Figure 4-13: Batch plot for Dogbone Tension YX Orientation 0.2% Offset Yield Strength

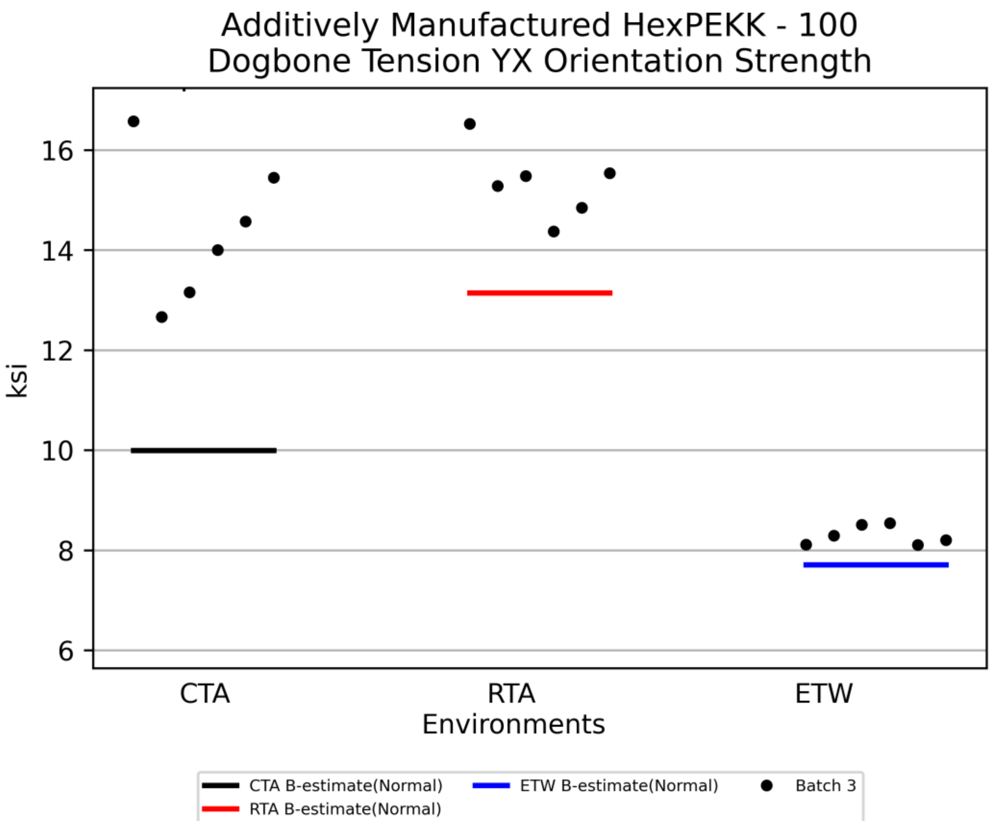

Figure 4-14: Batch plot for Dogbone Tension YX Orientation Strength

Dogbone Tension YX Orientation Basis Values and Statistics			
	0.2% Offset Yield Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	15.30	11.66	6.836
Stdev	0.6059	0.2144	0.04879
CV	3.959	1.840	0.7137
Min	14.88	11.44	6.762
Max	15.73	11.94	6.903
No. Batches	1	1	1
No. Spec.	2	6	6
Basis Values and Estimates			
B-Estimate	NA	11.01	6.688
A-Estimate		10.54	6.583
Method		Normal	Normal

Table 4-19: Statistics and Basis Values for Dogbone Tension YX Orientation 0.2% Offset Strength

Dogbone Tension YX Orientation Basis Values and Statistics			
	Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	14.40	15.34	8.294
Stdev	1.456	0.7256	0.1926
CV	10.11	4.730	2.322
Min	12.66	14.38	8.104
Max	16.58	16.52	8.540
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	9.992	13.14	7.711
A-Estimate	6.856	11.58	7.296
Method	Normal	Normal	Normal

Table 4-20: Statistics and Basis Values for Dogbone Tension YX Orientation Tensile Strength

Dogbone Tension YX Orientation Statistics			
	Modulus [Msi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	0.9648	0.8758	0.7515
Stdev	0.01902	0.02254	0.008968
CV	1.971	2.574	1.193
Min	0.9306	0.8423	0.7352
Max	0.9849	0.9095	0.7622
No. Batches	1	1	1
No. Spec.	6	6	6

Table 4-21: Statistics for Dogbone Tension YX Orientation Modulus

4.8 Dogbone Tension ZX Orientation

This test method was performed for 0.2% offset yield strength, tensile strength, and modulus properties and environments CTA, RTA, ETA1, ETA2 and ETW. There were insufficient specimens tested in the ETA1 condition to compute A- and B-basis values publishable in CMH17 so only estimates can be provided for that environmental condition. There were insufficient specimens that had a 0.2% Offset strength property in the CTA and RTA conditions, so only estimates could be provided for that property in those conditions.

For 0.2% offset yield strength, all conditions, except ETA2, passed normality test, so normal method was used to compute design values for these. ETA2 condition failed standard distributions test, so non-parametric method was used to compute design values. For tensile strength, CTA and RTA passed ADK and normality tests, so pooling method was used. ETA1 passed normality test, so normal method was used for this. For ETA2 condition, normality test failed but Weibull test passed, so Weibull method was used. For ETW, ADK test failed, so ANOVA method was used. Since number of batches is less than 5, ANOVA produces a B-estimate value rather than a B-basis value.

Three statistical outliers were detected. A lower condition and batch outlier for 0.2% offset yield strength in condition ETA2 batch one. A lower condition outlier for strength in condition RTA batch two. A lower batch outlier for strength in condition ETA2 batch three. All outliers were retained for this analysis. All outliers were retained for this analysis.

Statistics, basis values, and estimates are given for 0.2% offset yield strength data in Table 4-22, for tensile strength data in Table 4-23, and modulus data in Table 4-24. The 0.2% offset yield strength data are shown graphically in Figure 4-15 and the tensile strength data in Figure 4-16.

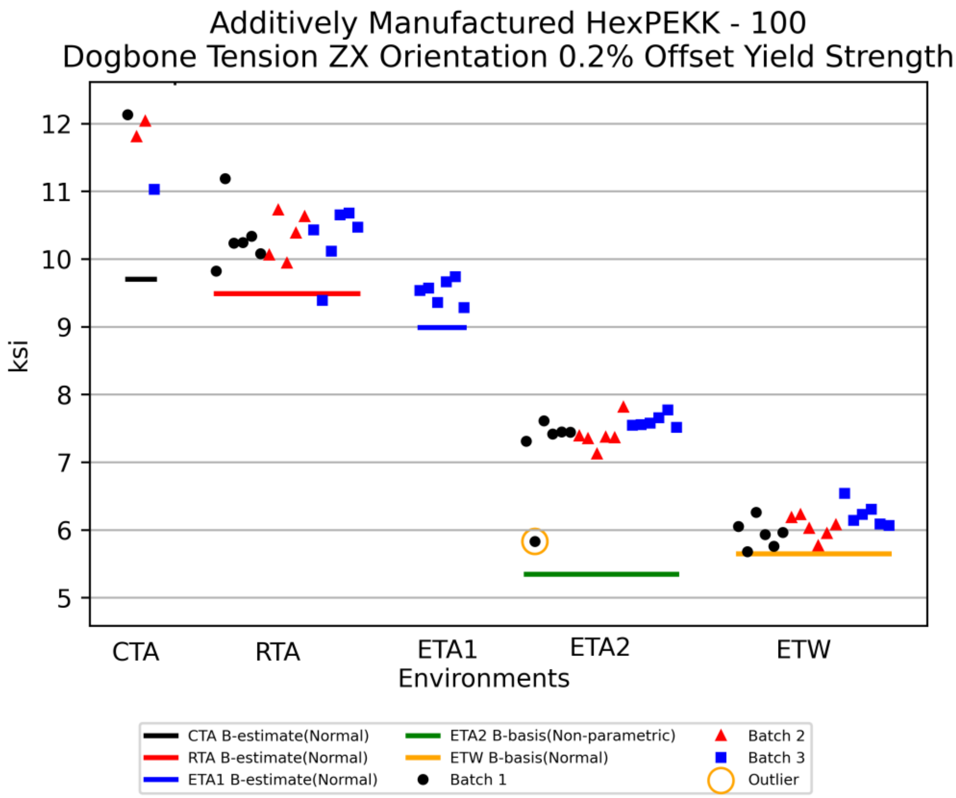

Figure 4-15: Batch plot for Dogbone Tension ZX Orientation 0.2% Offset Strength

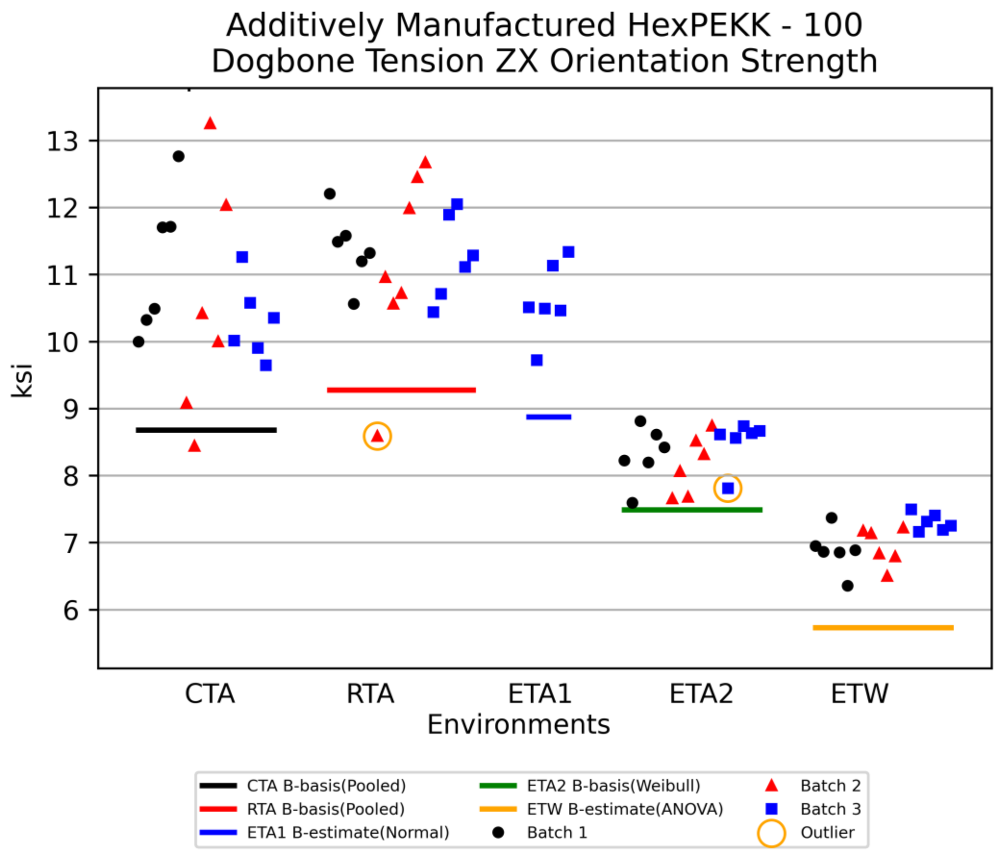

Figure 4-16: Batch plot for Dogbone Tension ZX Orientation Strength

Dogbone Tension ZX Orientation Basis Values and Statistics					
	0.2% Offset Yield Strength [ksi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	11.75	10.32	9.525	7.393	6.068
Stdev	0.4990	0.4128	0.1760	0.4246	0.2128
CV	4.247	4.002	1.847	5.744	3.507
Min	11.03	9.387	9.280	5.830	5.681
Max	12.13	11.19	9.740	7.810	6.540
No. Batches	3	3	1	3	3
No. Spec.	4	17	6	18	18
Basis Values and Estimates					
B-Basis				5.346	5.648
B-Estimate	9.672	9.489	8.992		
A-Estimate	8.235	8.905	8.613	3.763	5.350
Method	Normal	Normal	Normal	Non-parametric	Normal

Table 4-22: Statistics and Basis Values for Dogbone Tension ZX Orientation 0.2% Offset Strength

Dogbone Tension ZX Orientation Basis Values and Statistics					
	Strength [ksi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	10.66	11.25	10.61	8.326	7.041
Stdev	1.242	0.9283	0.5718	0.4070	0.3087
CV	11.64	8.251	5.390	4.889	4.384
Min	8.440	8.587	9.719	7.596	6.358
Max	13.25	12.67	11.34	8.812	7.495
No. Batches	3	3	1	3	3
No. Spec.	18	19	6	18	18
Basis Values and Estimates					
B-Basis	8.680	9.276		7.488	
B-Estimate			8.876		5.733
A-Estimate	7.333	7.927	7.645	6.624	4.801
Method	Pooled	Pooled	Normal	Weibull	ANOVA

Table 4-23: Statistics and Basis Values for Dogbone Tension ZX Orientation Strength

Dogbone Tension ZX Orientation Statistics					
	Modulus [Msi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	0.8872	0.7114	0.6673	0.6538	0.6194
Stdev	0.07375	0.03764	0.01632	0.03211	0.03842
CV	8.312	5.291	2.446	4.912	6.203
Min	0.7886	0.6627	0.6445	0.5682	0.5529
Max	1.133	0.8070	0.6881	0.6927	0.7101
No. Batches	3	3	1	3	3
No. Spec.	18	19	6	18	18

Table 4-24: Statistics for Dogbone Tension ZX Orientation Modulus

4.9 Dogbone Tension ZX45 Orientation

This test method was performed for 0.2% offset yield strength, tensile strength, and modulus properties and environments CTA, RTA, and ETW. There were insufficient specimens tested to compute A- and B-basis values publishable in CMH17, so only estimates can be provided. For 0.2% offset yield strength, CTA has no data since specimens failed before 0.2% offset. RTA condition passed normality test, so normal method was used to compute design values for this. ETW condition failed standard distributions tests, so non-parametric method was used to compute design values. For tensile strength, conditions CTA, RTA, and ETW passed normality test, so normal method was used for these.

One statistical outlier was detected. The lowest value in the ETW condition for 0.2% Offset yield was an outlier. It was retained for this analysis.
Statistics, basis values, and estimates are given for 0.2% offset strength data in Table 4-25, for tensile strength data in Table 4-26, and modulus data in Table 4-27. The 0.2% offset yield strength data are shown graphically in Figure 4-17 and the tensile strength data in Figure 4-18.

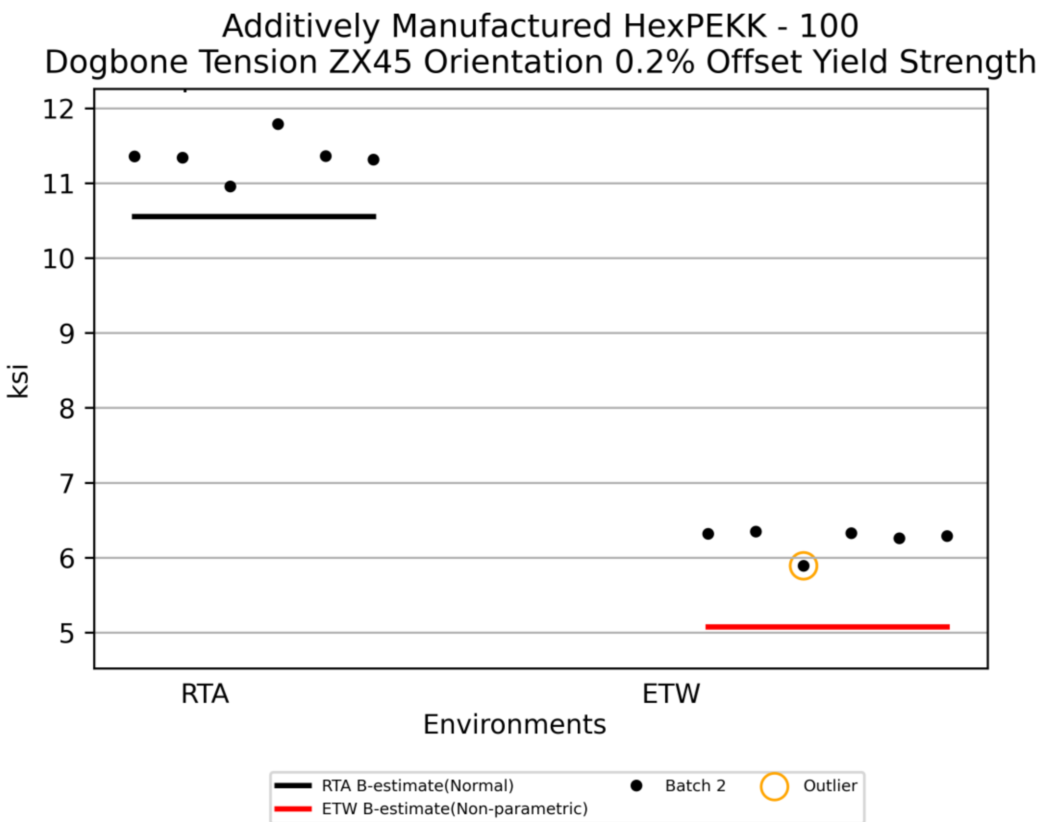

Figure 4-17: Batch plot for Dogbone Tension ZX45 Orientation 0.2% Offset Strength

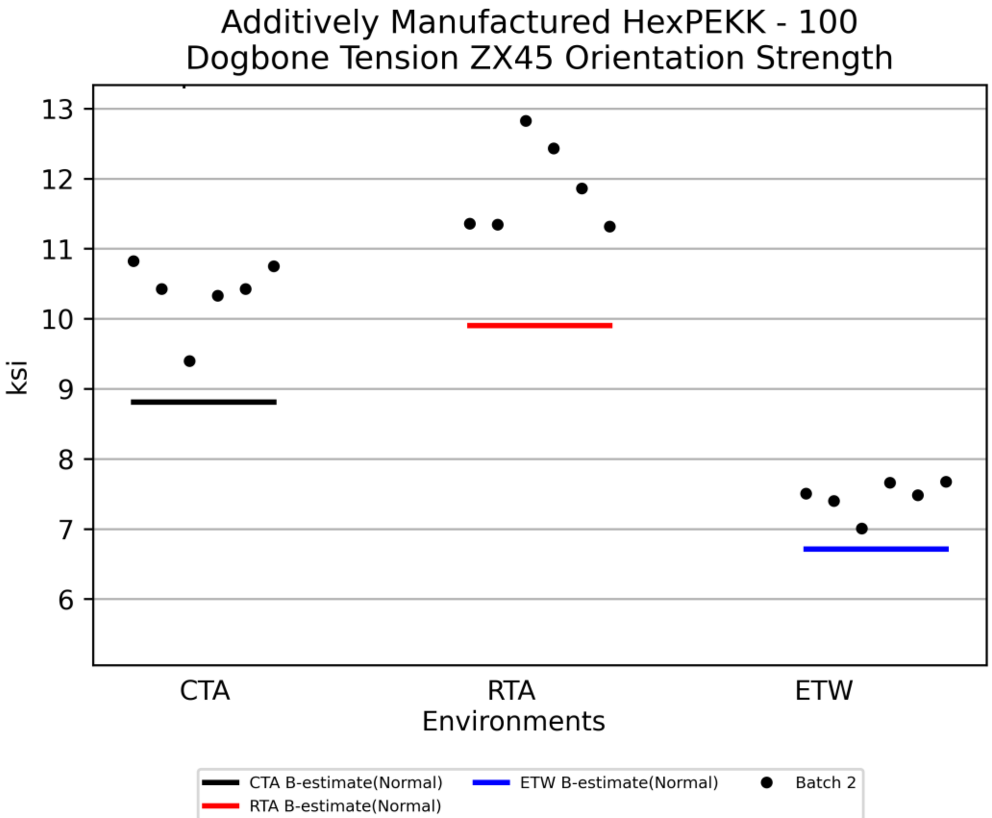

Figure 4-18: Batch plot for Dogbone Tension ZX45 Orientation Strength

Dogbone Tension ZX45 Orientation Basis Values and Statistics		
	0.2% Offset Yield Strength [ksi]	
Env	RTA(70°F)	ETW(250°F)
Mean	11.35	6.240
Stdev	0.2636	0.1740
CV	2.322	2.788
Min	10.96	5.891
Max	11.79	6.350
No. Batches	1	1
No. Spec.	6	6
Basis Values and Estimates		
B-Estimate	10.56	5.078
A-Estimate	9.988	4.178
Method	Normal	Non-parametric

Table 4-25: Statistics and Basis Values for Dogbone Tension ZX45 Orient. 0.2% Offset Strength

Dogbone Tension ZX45 Orientation Basis Values and Statistics			
	Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	10.36	11.86	7.455
Stdev	0.5104	0.6441	0.2447
CV	4.927	5.432	3.283
Min	9.398	11.32	7.005
Max	10.82	12.82	7.674
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	8.813	9.905	6.714
A-Estimate	7.713	8.518	6.187
Method	Normal	Normal	Normal

Table 4-26: Statistics and Basis Values for Dogbone Tension ZX45 Orientation Strength

Dogbone Tension ZX45 Orientation Statistics			
	Modulus [Msi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	0.9380	0.7534	0.6565
Stdev	0.05266	0.01564	0.02459
CV	5.614	2.075	3.746
Min	0.8965	0.7338	0.6126
Max	1.032	0.7740	0.6772
No. Batches	1	1	1
No. Spec.	6	6	6

Table 4-27: Statistics for Dogbone Tension ZX45 Orientation Modulus

4.10 Filled-Hole Compression (FHC) XZ Orientation

This test method was performed for 0.2% offset strength and environments RTA and ETW. Both conditions passed normality test, so normal method was used to compute design values. Since the data has a low number of specimens, the results are B-estimates rather than B-values.

No statistical outliers were detected.

Statistics, basis values and estimates are given for 0.2% offset strength data in Table 4-28. The 0.2% offset strength data are shown graphically in Figure 4-19.

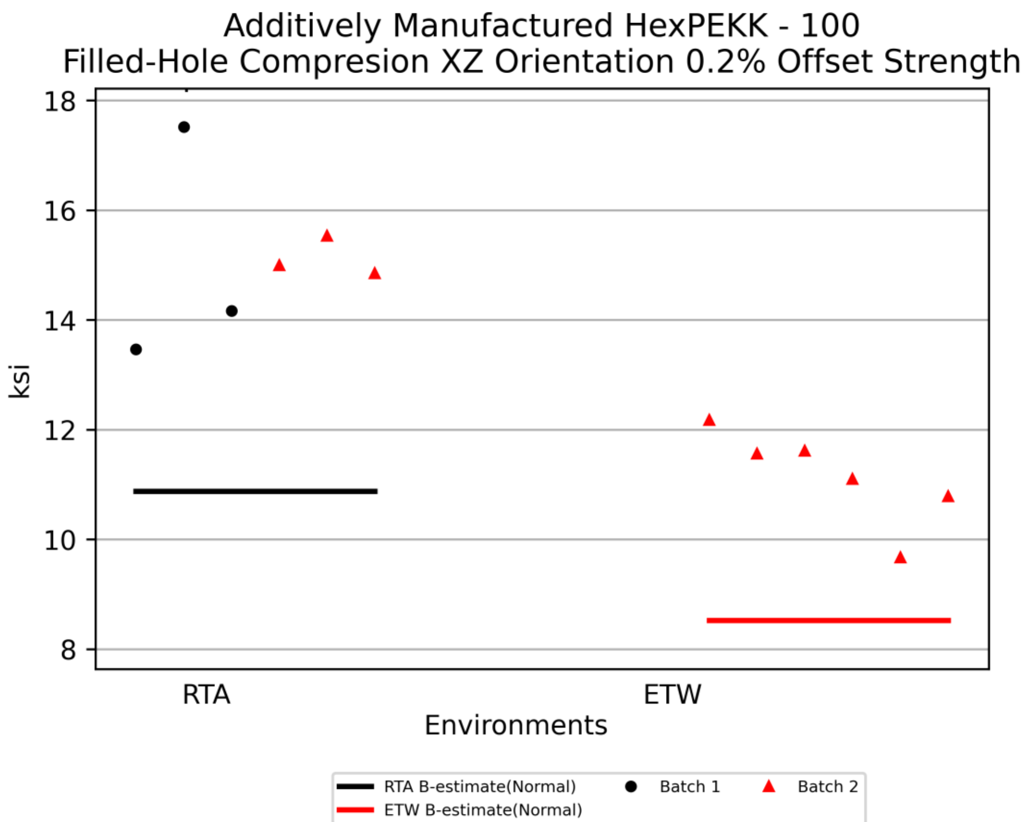

Figure 4-19: Batch plot for FHC XZ Orientation 0.2% Offset Strength

FHC XZ Orientation Basis Values and Statistics		
	0.2% Offset Strength [ksi]	
Env	RTA(70°F)	ETW(250°F)
Mean	15.09	11.15
Stdev	1.390	0.8674
CV	9.210	7.778
Min	13.46	9.670
Max	17.52	12.18
No. Batches	2	1
No. Spec.	6	6
Basis Values and Estimates		
B-Estimate	10.88	8.525
A-Estimate	7.886	6.657
Method	Normal	Normal

Table 4-28: Statistics for Filled-Hole Compression XZ Orientation 0.2% Offset Strength

4.11 Filled-Hole Compression (FHC) ZX Orientation

This test method was performed for 0.2% offset strength property in environments RTA and ETW. Both conditions passed normality test, so normal method was used to compute design values. Since the data has a low number of specimens, the results are B-estimates rather than B-values.

No statistical outliers were detected.

Statistics, basis values and estimates are given for 0.2% offset strength data in Table 4-29. The 0.2% offset strength data are shown graphically in Figure 4-20.

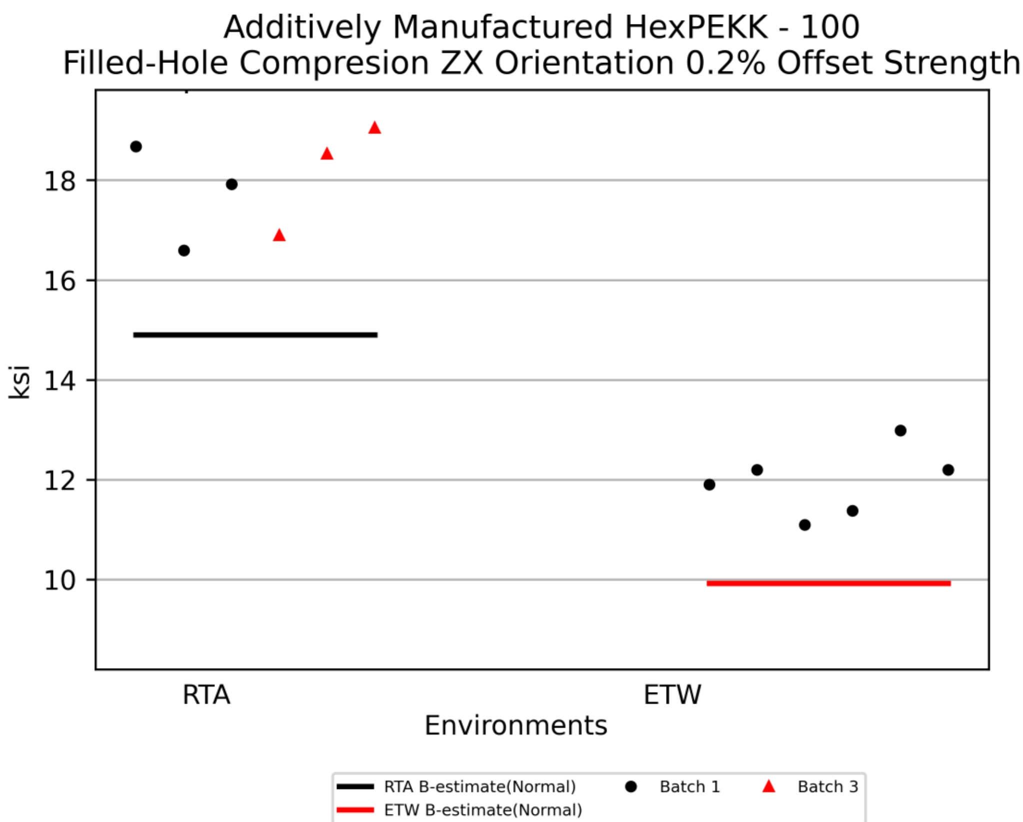

Figure 4-20: Batch plot for FHC ZX Orientation 0.2% Offset Strength

Filled-Hole Compresion ZX Orientation Basis Values and Statistics		
	0.2% Offset Strength [ksi]	
Env	RTA(70°F)	ETW(250°F)
Mean	17.94	11.96
Stdev	1.003	0.6721
CV	5.590	5.620
Min	16.59	11.09
Max	19.05	12.99
No. Batches	2	1
No. Spec.	6	6
Basis Values and Estimates		
B-Estimate	14.90	9.923
A-Estimate	12.74	8.475
Method	Normal	Normal

Table 4-29: Statistics for FHC ZX Orientation 0.2% Offset Strength

4.12 Filled-Hole Compression (FHC) ZX45 Orientation

This test method was performed for 0.2% offset strength property in environment RTA only. The data passed normality test, so normal method was used to compute design values. Since the data has a low number of specimens, the results are B-estimates rather than B-values.

No statistical outliers were detected.

Statistics, basis values and estimates are given for 0.2% offset strength data in Table 4-30. The 0.2% offset strength data are shown graphically in Figure 4-21.

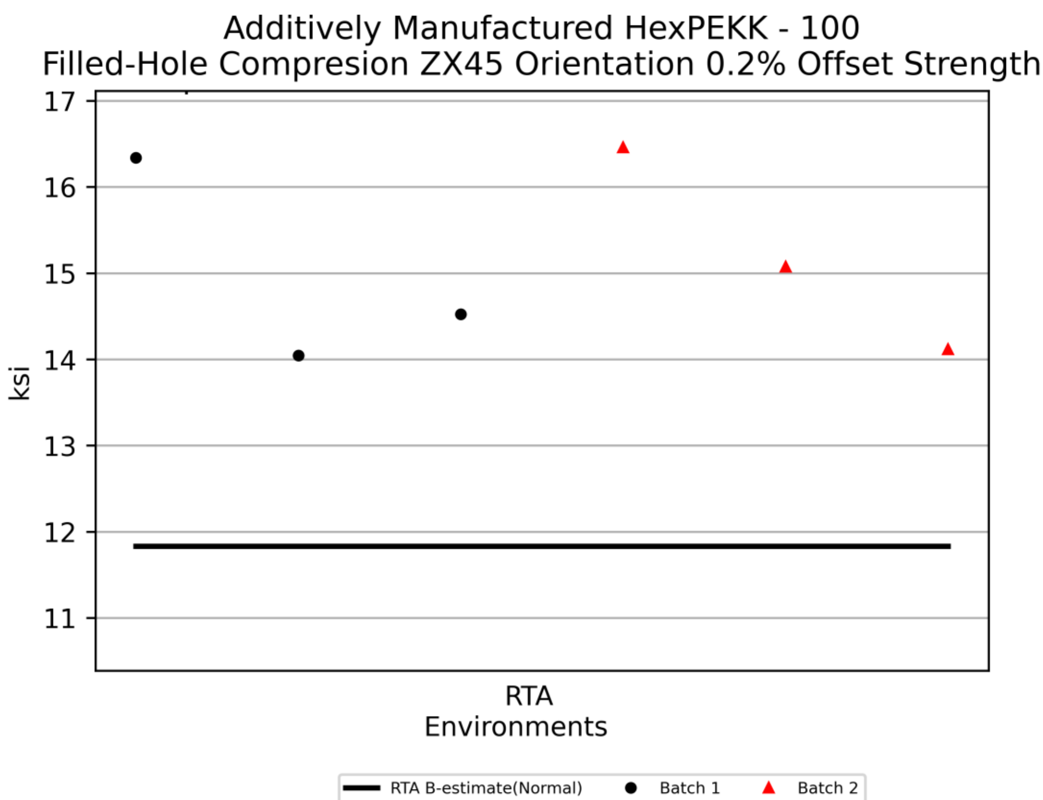

Figure 4-21: Batch plot for FHC ZX45 Orientation 0.2% Offset Strength

FHC ZX45 Orientation Basis Values and Statistics	
0.2% Offset Strength [ksi]	
Env	RTA(70°F)
Mean	15.09
Stdev	1.076
CV	7.133
Min	14.04
Max	16.46
No. Batches	2
No. Spec.	6
Basis Values and Estimates	
B-Estimate	11.83
A-Estimate	9.512
Method	Normal

Table 4-30: Statistics for FHC ZX45 Orientation 0.2% Offset Strength

4.13 Filled-Hole Compression (FHC) XY Orientation

This test method was performed for 0.2% offset strength property in environments RTA and ETW. Both environments passed normality test, so normal method was used to compute design values. Since the data has a low number of specimens, the results are B-estimates rather than B-values.

No statistical outliers were detected.

Statistics, basis values and estimates are given for 0.2% offset strength data in Table 4-31. The 0.2% offset strength data are shown graphically in Figure 4-22.

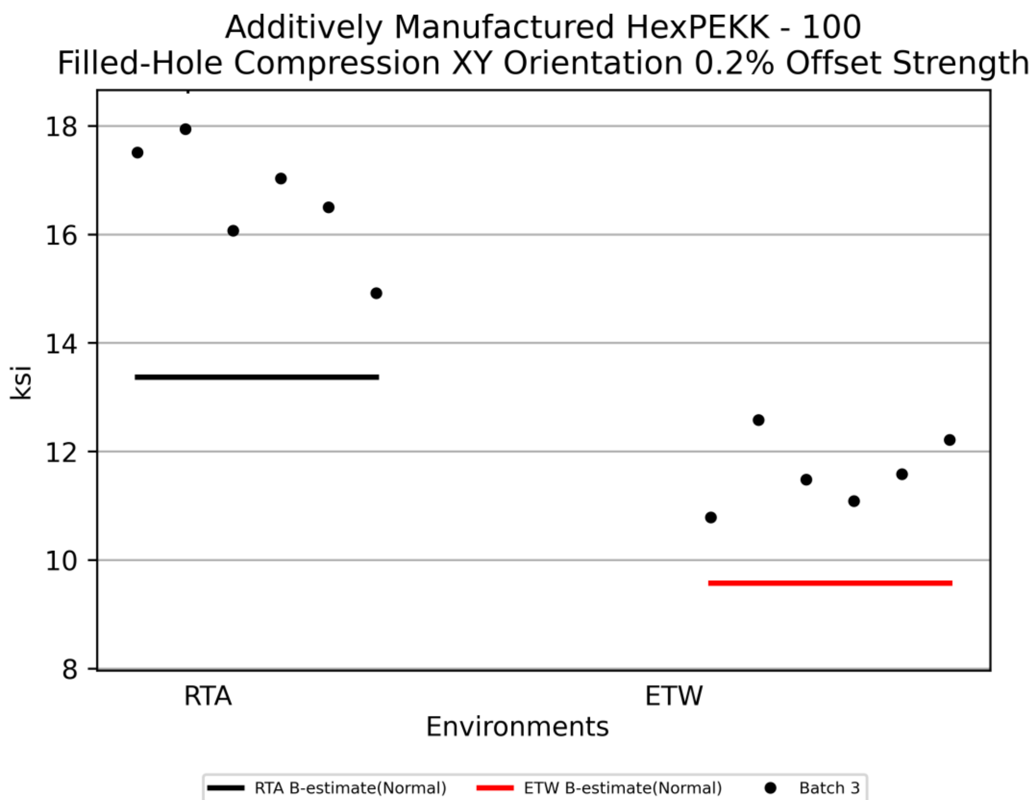

Figure 4-22: Batch plot for FHC XY Orientation 0.2% Offset Strength

Filled-Hole Compression XY Orientation Basis Values and Statistics		
	0.2% Offset Strength [ksi]	
Env	RTA(70°F)	ETW(250°F)
Mean	16.66	11.62
Stdev	1.087	0.6743
CV	6.523	5.802
Min	14.92	10.78
Max	17.94	12.58
No. Batches	1	1
No. Spec.	6	6
Basis Values and Estimates		
B-Estimate	13.37	9.580
A-Estimate	11.03	8.127
Method	Normal	Normal

Table 4-31: Statistics for FHC XY Orientation 0.2% Offset Strength

4.14 Filled-Hole Compression (FHC) YX Orientation

This test method was performed for 0.2% offset strength property in environment RTA. The data passed normality test, so normal method was used to compute design values. Since the data has a low number of specimens, the result is a B-estimate rather than a B-value.

No statistical outliers were detected.

Statistics, basis values and estimates are given for 0.2% offset strength data in Table 4-32. The 0.2% offset strength data are shown graphically in Figure 4-23.

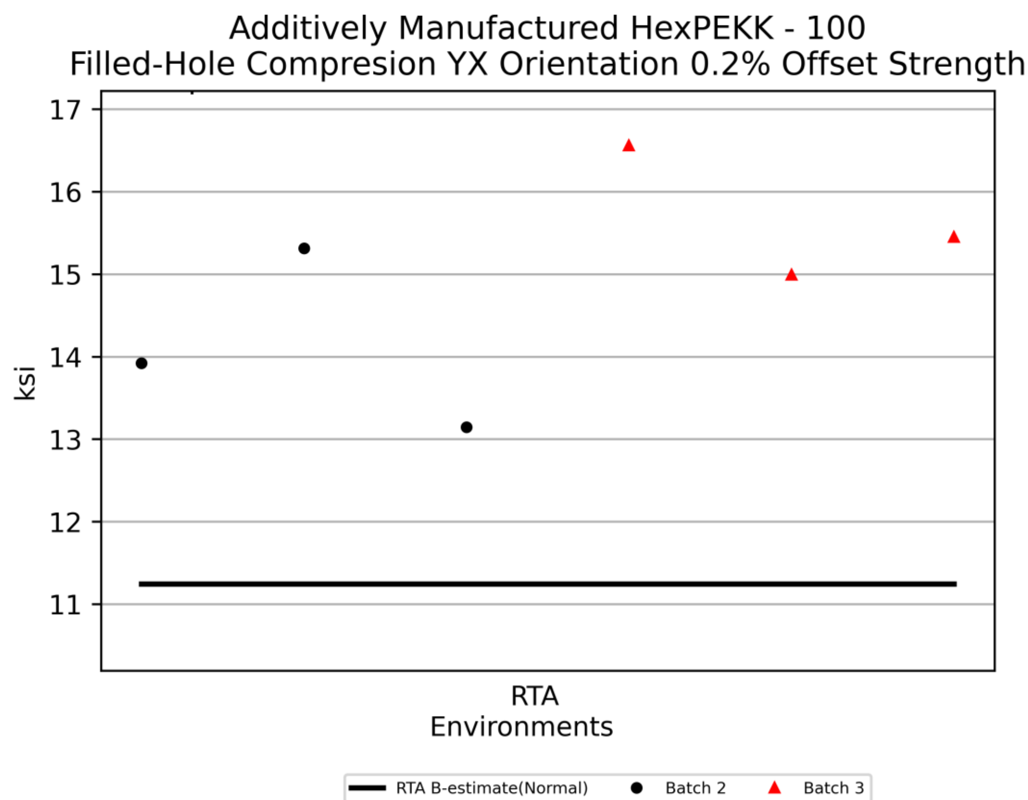

Figure 4-23: Batch plot for FHC XY Orientation 0.2% Offset Strength

Filled-Hole Compresion YX Orientation Basis Values and Statistics	
0.2% Offset Strength	
Env	RTA(70)
Mean	14.90
Stdev	1.206
CV	8.094
Min	13.14
Max	16.56
No. Batches	2
No. Spec.	6
Basis Values Estimates	
B-Estimate	11.24
A-Estimate	8.647
Method	Normal

Table 4-32: Statistics for FHC XY Orientation 0.2% Offset Strength

4.15 Filled-Hole Tension (FHT) XY Orientation

This test method was performed for tensile strength property in environments CTA, RTA, ETA2 and ETW. Environments RTA, ETA2, and ETW passed pooling tests, so pooling method was used to compute design values for these. Environment CTA failed normality test but passed Weibull distribution test, so Weibull method was used.

Two statistical outliers were detected. A lower condition and batch outlier for strength property in condition CTA batch two. A higher batch outlier for strength property in condition ETA2 batch one. Both outliers were retained for this analysis.

Statistics, basis values and estimates for tensile strength data are given in Table 4-33. The strength data are shown graphically in Figure 4-24.

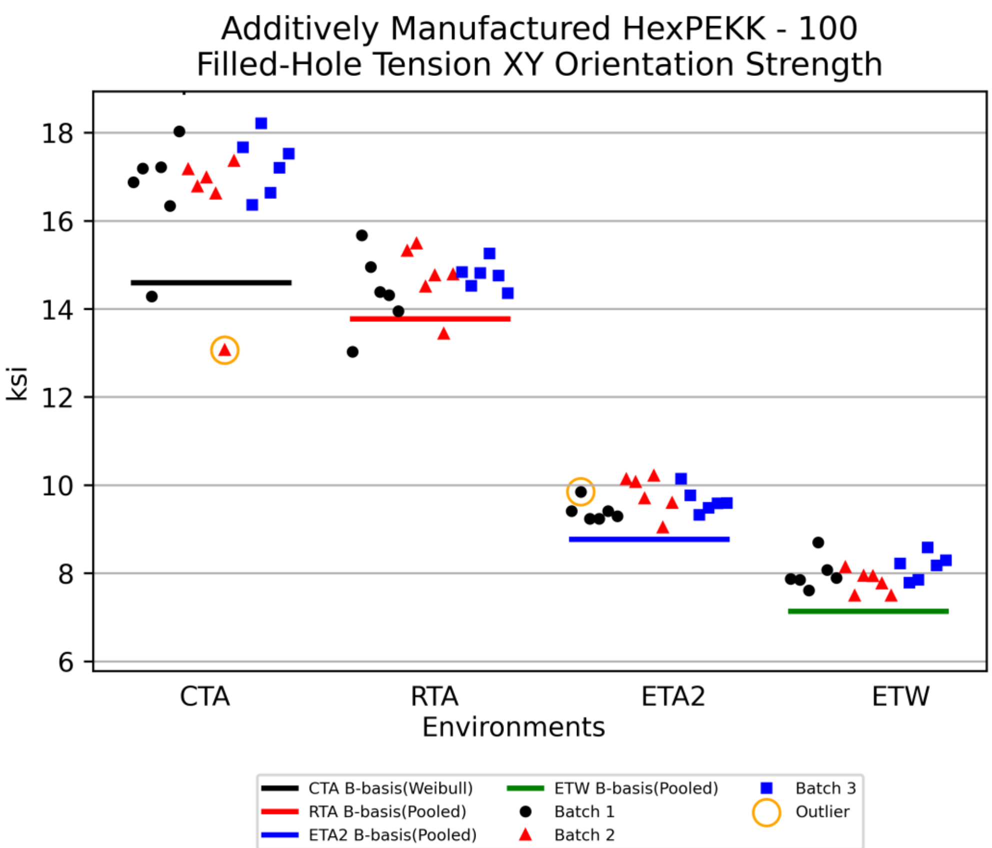

Figure 4-24: Batch plot for FHT XY Orientation Strength

Filled-Hole Tension XY Orientation Basis Values and Statistics				
	Strength [ksi]			
Env	CTA(-65°F)	RTA(70°F)	ETA2(250°F)	ETW(250°F)
Mean	16.75	14.62	9.615	7.980
Stdev	1.248	0.6700	0.3511	0.3318
CV	7.450	4.584	3.652	4.158
Min	13.06	13.02	9.037	7.485
Max	18.21	15.67	10.21	8.701
No. Batches	3	3	3	3
No. Spec.	18	18	18	18
Basis Values and Estimates				
B-Basis	14.60	13.77	8.770	7.136
A-Estimate	12.45	13.21	8.207	6.572
Method	Weibull	Pooled	Pooled	Pooled

Table 4-33: Statistics for FHT XY Orientation Strength

4.16 Filled-Hole Tension (FHT) XZ Orientation

This test method was performed for tensile strength property in environments CTA, RTA, and ETW. All three environments passed normality test, so normal method was used to compute design values for these. Since the number of specimens is less than 18, the results are B-estimates rather than B-basis.

No statistical outlier was detected.

Statistics, basis values, and estimates for tensile strength data are given in Table 4-34. The strength data are shown graphically in Figure 4-25.

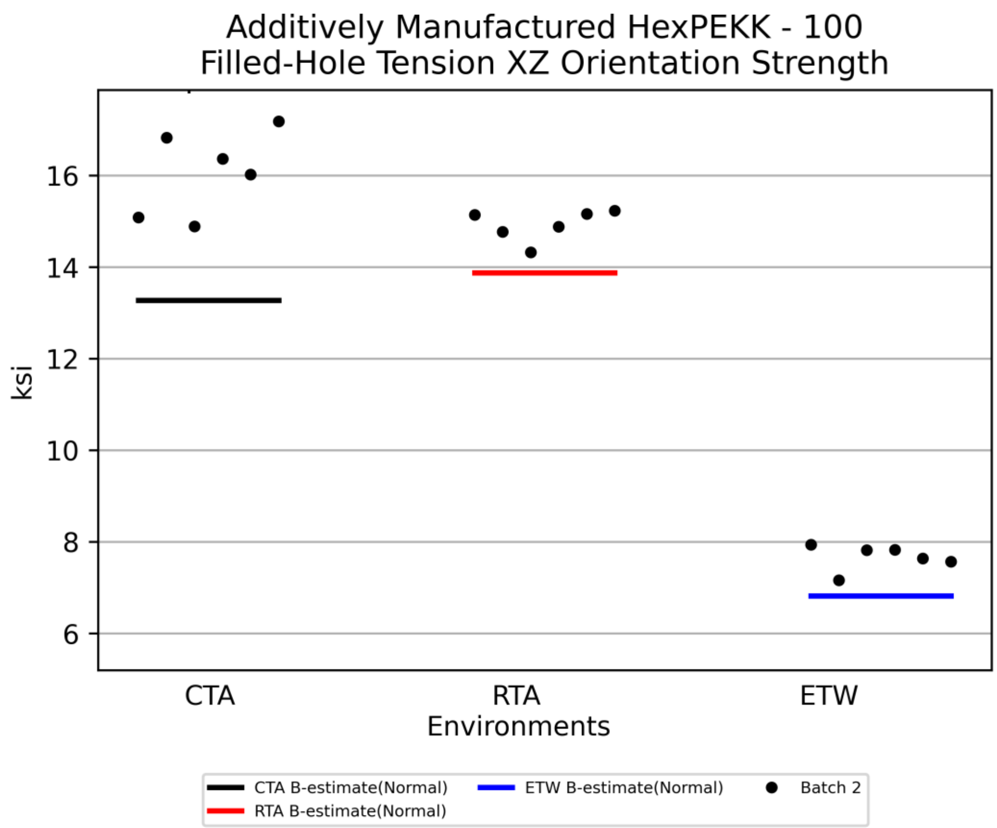

Figure 4-25: Batch plot for FHT XZ Orientation Strength

Filled-Hole Tension XZ Orientation Basis Values and Statistics			
	Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	16.06	14.92	7.660
Stdev	0.9211	0.3436	0.2779
CV	5.736	2.303	3.629
Min	14.89	14.32	7.163
Max	17.18	15.23	7.936
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Estimates			
B-Estimate	13.27	13.88	6.818
A-Estimate	11.29	13.14	6.219
Method	Normal	Normal	Normal

Table 4-34: Statistics for FHT XZ Orientation Strength

4.17 Filled-Hole Tension (FHT) YX Orientation

This test method was performed for tensile strength property in environments CTA, RTA, and ETW. All three environments passed normality test, so normal method was used to compute design values for these. Since the number of specimens is less than 18, the results are B-estimates rather than B-basis.

No statistical outlier was detected.

Statistics and basis value estimates for tensile strength data are given in Table 4-35. The strength data are shown graphically in Figure 4-26.

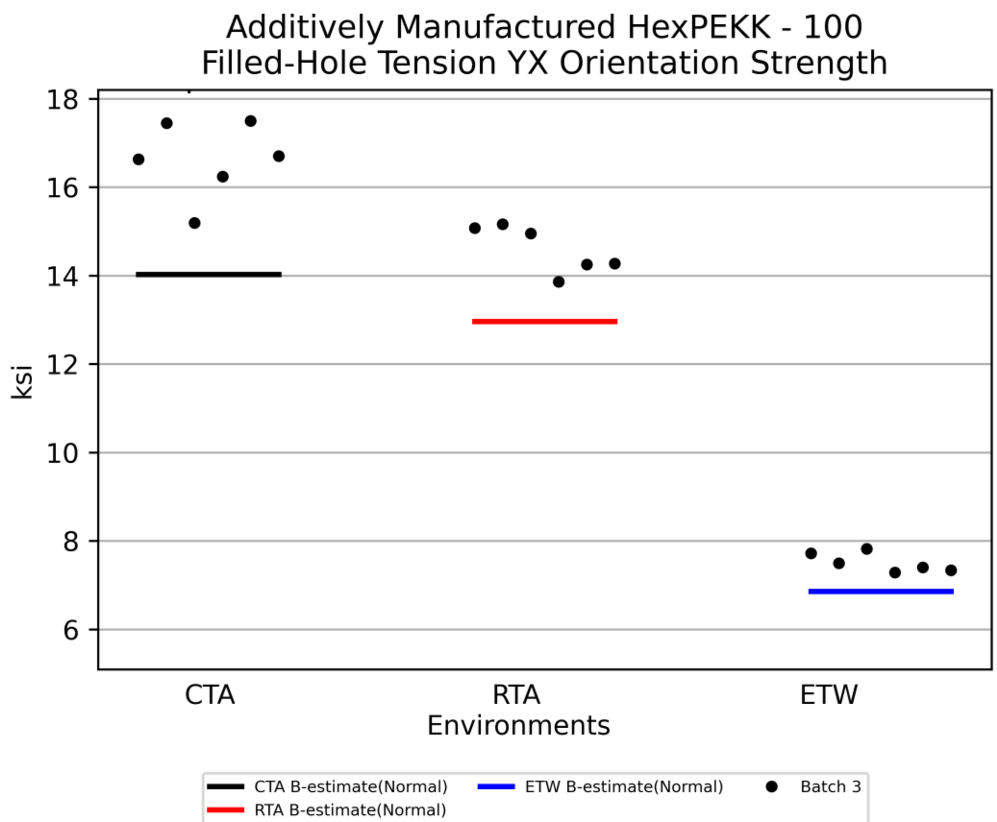

Figure 4-26: Batch plot for FHT YX Orientation Strength

Filled-Hole Tension YX Orientation Basis Values and Statistics			
	Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	16.62	14.60	7.509
Stdev	0.8544	0.5383	0.2139
CV	5.142	3.688	2.849
Min	15.19	13.86	7.288
Max	17.50	15.16	7.818
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	14.03	12.96	6.861
A-Estimate	12.19	11.81	6.400
Method	Normal	Normal	Normal

Table 4-35: Statistics for FHT YX Orientation Strength

4.18 Filled-Hole Tension (FHT) ZX Orientation

This test method was performed for tensile strength property in environments CTA, RTA, ETA2, and ETW. Environments CTA and RTA passed pooling tests, so pooling method was used to compute design values for these. ETA2 failed the standard distributions tests, so non-parametric method was used. ETW passed normality test, so normal method was used for this.

Three statistical outliers were detected. A lower batch outlier for strength property in condition RTA batch two. A lower condition outlier for strength property in condition ETA2 batch one. A lower batch outlier for strength property in condition ETA2 batch two. All outliers were retained for this analysis.

Statistics, basis values and estimates for tensile strength data are given in Table 4-36. The strength data are shown graphically in Figure 4-27.

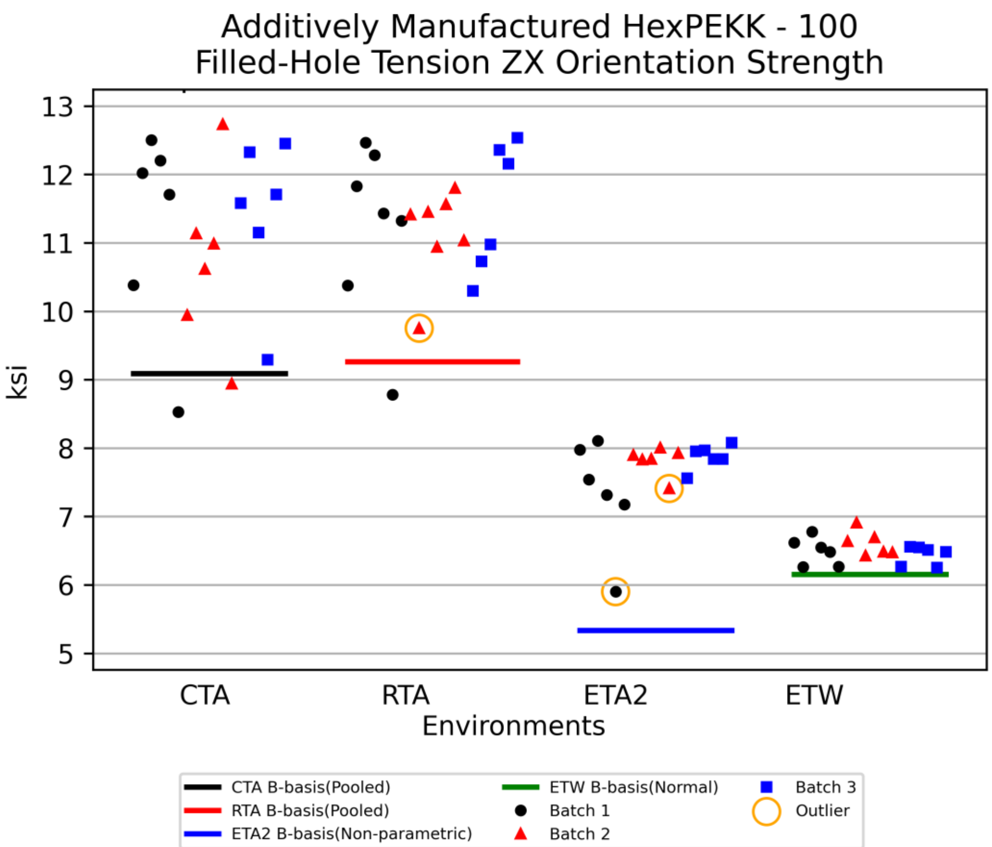

Figure 4-27: Batch plot for FHT ZX Orientation Strength

Filled-Hole Tension ZX Orientation Basis Values and Statistics				
	Strength [ksi]			
Env	CTA(-65°F)	RTA(70°F)	ETA2(250°F)	ETW(250°F)
Mean	11.12	11.28	7.675	6.511
Stdev	1.275	0.9621	0.5178	0.1803
CV	11.46	8.533	6.746	2.770
Min	8.529	8.781	5.901	6.255
Max	12.73	12.54	8.108	6.908
No. Batches	3	3	3	3
No. Spec.	18	20	18	18
Basis Values and Estimates				
B-Basis	9.090	9.262	5.337	6.155
A-Estimate	7.712	7.879	3.668	5.902
Method	Pooled	Pooled	Non-parametric	Normal

Table 4-36: Statistics for FHT ZX Orientation Strength

4.19 Filled-Hole Tension (FHT) ZX45 Orientation

This test method was performed for tensile strength property in environments CTA, RTA, and ETW. All three environments passed normality test, so normal method was used for computing design values. Since the number of specimens is less than 18, the results are B-estimates rather than B-basis.

One statistical outlier was detected. The lowest value in the CTA condition was an outlier. It was retained for this analysis.
Statistics, basis values and estimates for tensile strength data are given in Table 4-37. The strength data are shown graphically in Figure 4-28.

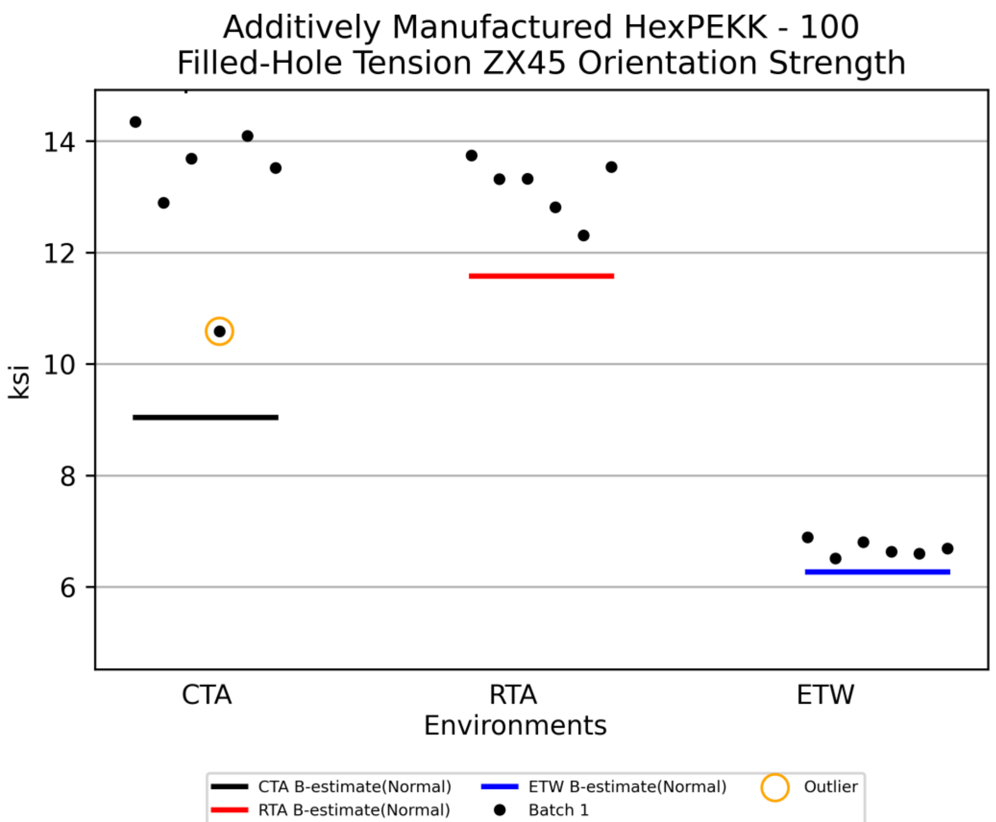

Figure 4-28: Batch plot for FHT ZX45 Orientation Strength

Filled-Hole Tension ZX45 Orientation Basis Values and Statistics			
	Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	13.19	13.17	6.687
Stdev	1.369	0.5267	0.1379
CV	10.38	3.998	2.062
Min	10.59	12.31	6.514
Max	14.35	13.75	6.888
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Estimates			
B-Estimate	9.040	11.58	6.269
A-Estimate	6.091	10.44	5.972
Method	Normal	Normal	Normal

Table 4-37: Statistics for FHT ZX45 Orientation Strength

4.20 Flexural Properties XY Orientation

This test method was performed for three properties: 0.2% offset yield strength, flexural strength, and modulus in conditions CTA, RTA, ETA1, ETA2, and ETW. There were insufficient specimens tested in the ETA1 condition to compute A- and B-basis values publishable in CMH17 so only estimates can be provided for that environmental condition. There were insufficient specimens that had a 0.2% Offset strength property in the CTA condition, so only estimates could be provided for that property in the CTA condition.

For 0.2% offset yield strength, conditions CTD, ETA1, and ETW passed ADK test and normality test, so normal method was used for computing basis values for these. Since the number of specimens is less than 18, normal method produces B-estimates rather than B-basis values. For conditions RTA and ETA2, ADK test failed, so ANOVA method was used. Since the number of batches is less than 5, ANOVA method produces B-estimates rather than B-basis values. For flexural strength, CTA and RTA conditions passed pooling tests, so pooling method was used for these. For ETA1 and ETA2, normality test was passed, so normal method was used. Lastly, for ETW condition, ADK test failed, so ANOVA method was used.

Four statistic outliers were detected. A lower batch outlier for 0.2% offset yield strength in condition RTA batch three. A lower batch outlier for flexural strength in condition RTA batch two. A lower batch outlier for flexural strength in condition ETA2 batch one. A lower batch outlier for flexural strength in condition ETA2 batch three. All outliers were retained for this analysis.

Statistics and design values for the 0.2% offset yield strength property data are given in Table 4-38, for strength data in Table 4-39, and for modulus data in Table 4-40. The data and B-values for 0.2% offset strength data are shown graphically in Table 4-29 and for strength in Figure 4-30.

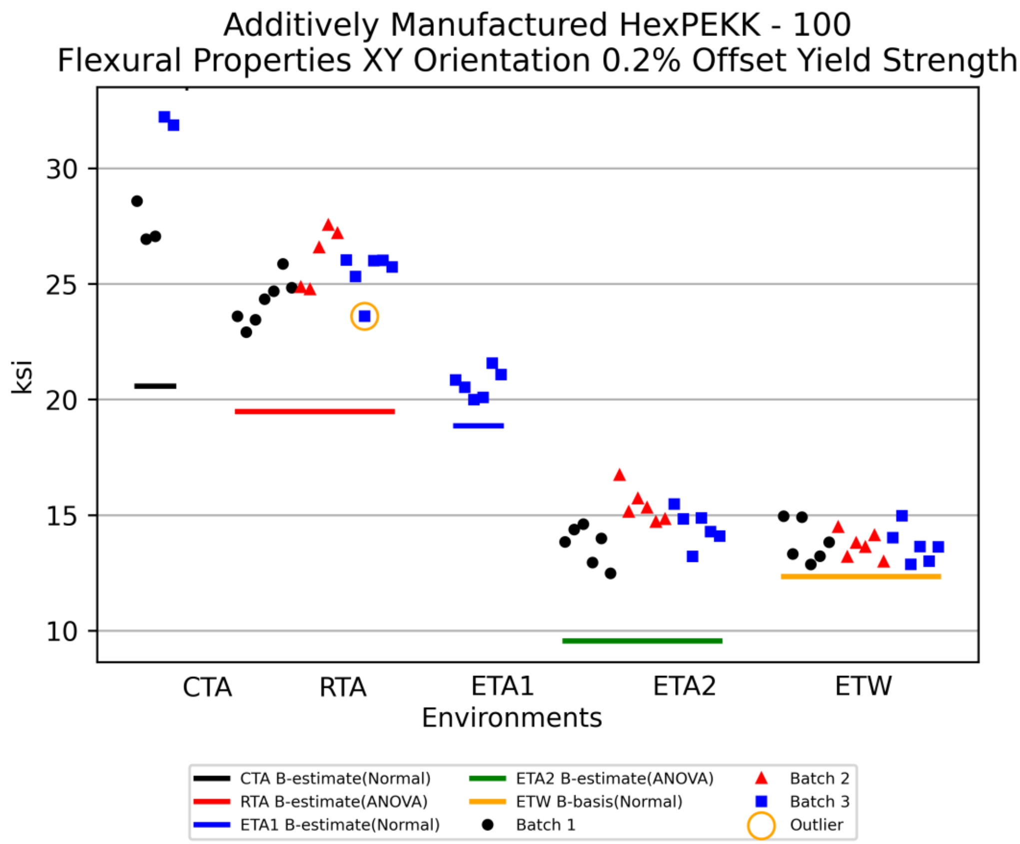

Figure 4-29: Plot for Flex XY Orientation 0.2% Offset Yield Strength

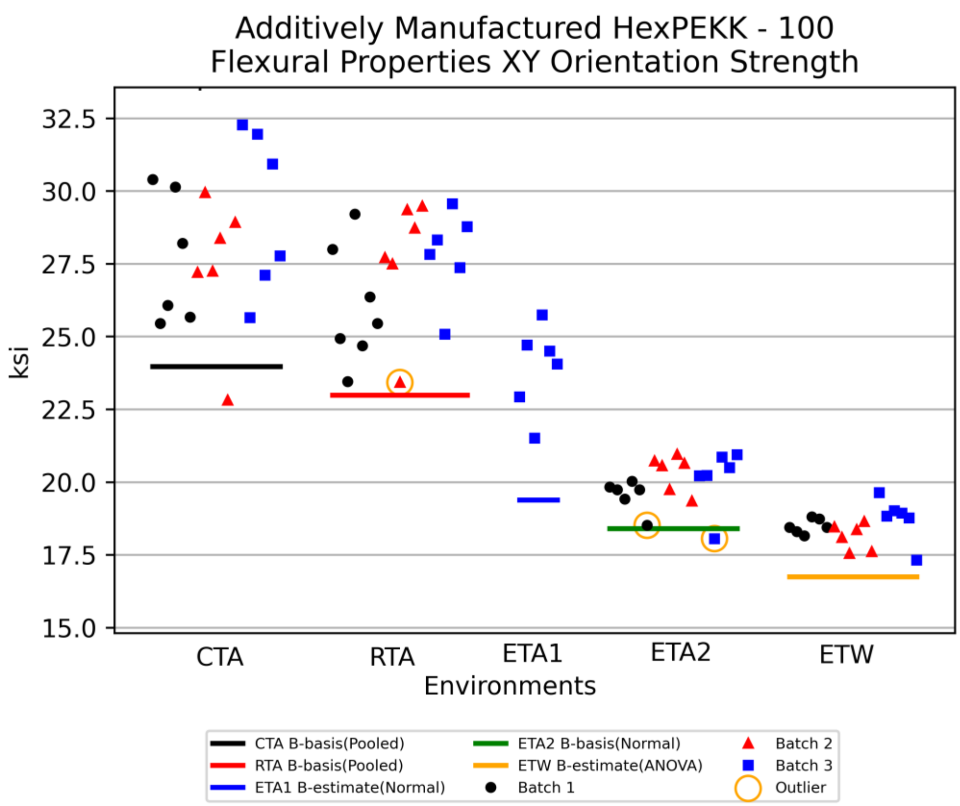

Figure 4-30: Plot for Flex XY Orientation Strength

Flexural Properties XY Orientation Basis Values and Statistics					
	0.2% Offset Yield Strength [ksi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	29.34	25.19	20.69	14.52	13.74
Stdev	2.560	1.304	0.6019	1.024	0.7088
CV	8.725	5.178	2.910	7.052	5.157
Min	26.94	22.91	19.99	12.49	12.87
Max	32.23	27.55	21.57	16.72	14.96
No. Batches	2	3	1	3	3
No. Spec.	5	18	6	18	18
Basis Values and Estimates					
B-Basis					12.34
B-Estimate	20.59	19.49	18.86	9.551	
A-Estimate	14.23	15.43	17.57	6.006	11.35
Method	Normal	ANOVA	Normal	ANOVA	Normal

Table 4-38: Statistics for Flex XY Orientation 0.2% Offset Yield Strength

Flexural Properties XY Orientation Basis Values and Statistics					
	Strength [ksi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	28.11	27.11	23.90	20.00	18.45
Stdev	2.514	2.038	1.490	0.8066	0.5685
CV	8.943	7.517	6.235	4.033	3.082
Min	22.81	23.42	21.50	18.06	17.32
Max	32.27	29.55	25.74	20.94	19.63
No. Batches	3	3	1	3	3
No. Spec.	18	19	6	18	18
Basis Values and Estimates					
B-Basis	23.97	22.99		18.41	
B-Estimate			19.39		16.74
A-Estimate	21.15	20.17	16.18	17.28	15.53
Method	Pooled	Pooled	Normal	Normal	ANOVA

Table 4-39: Statistics for Flex XY Orientation Strength

Flexural Properties XY Orientation Statistics					
	Modulus [Msi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	0.9249	0.8249	0.7376	0.8568	0.8134
Stdev	0.04851	0.03460	0.02301	0.04923	0.05147
CV	5.245	4.194	3.119	5.746	6.328
Min	0.8464	0.7660	0.7058	0.7749	0.7355
Max	1.022	0.8929	0.7572	0.9251	0.9119
No. Batches	3	3	1	3	3
No. Spec.	18	19	6	18	18

Table 4-40: Statistics for Flex XY Orientation Modulus

4.21 Flexural Properties XZ Orientation

This test method was performed for three properties: 0.2% offset yield strength, flexural strength, and modulus in conditions CTA, RTA, and ETW. For 0.2% offset yield strength, CTA data is not reported due to specimen failure occurring before 0.2% offset strain. Conditions RTA and ETW passed normality test, so normal method was used for computing basis values for these. For flexural strength, CTA, RTA, and ETW conditions passed normality test, so normal method was used for these. Since the number of specimens is less than 18, normal method produces B-estimates rather than B-basis values.

No outliers were detected in the data.

Statistics and design values for the 0.2% offset yield strength property data are given in Table 4-41, for strength data in Table 4-42 and for modulus data in Table 4-43. The data and B-values for 0.2% offset strength data are shown graphically in Table 4-31 and for strength in Figure 4-32.

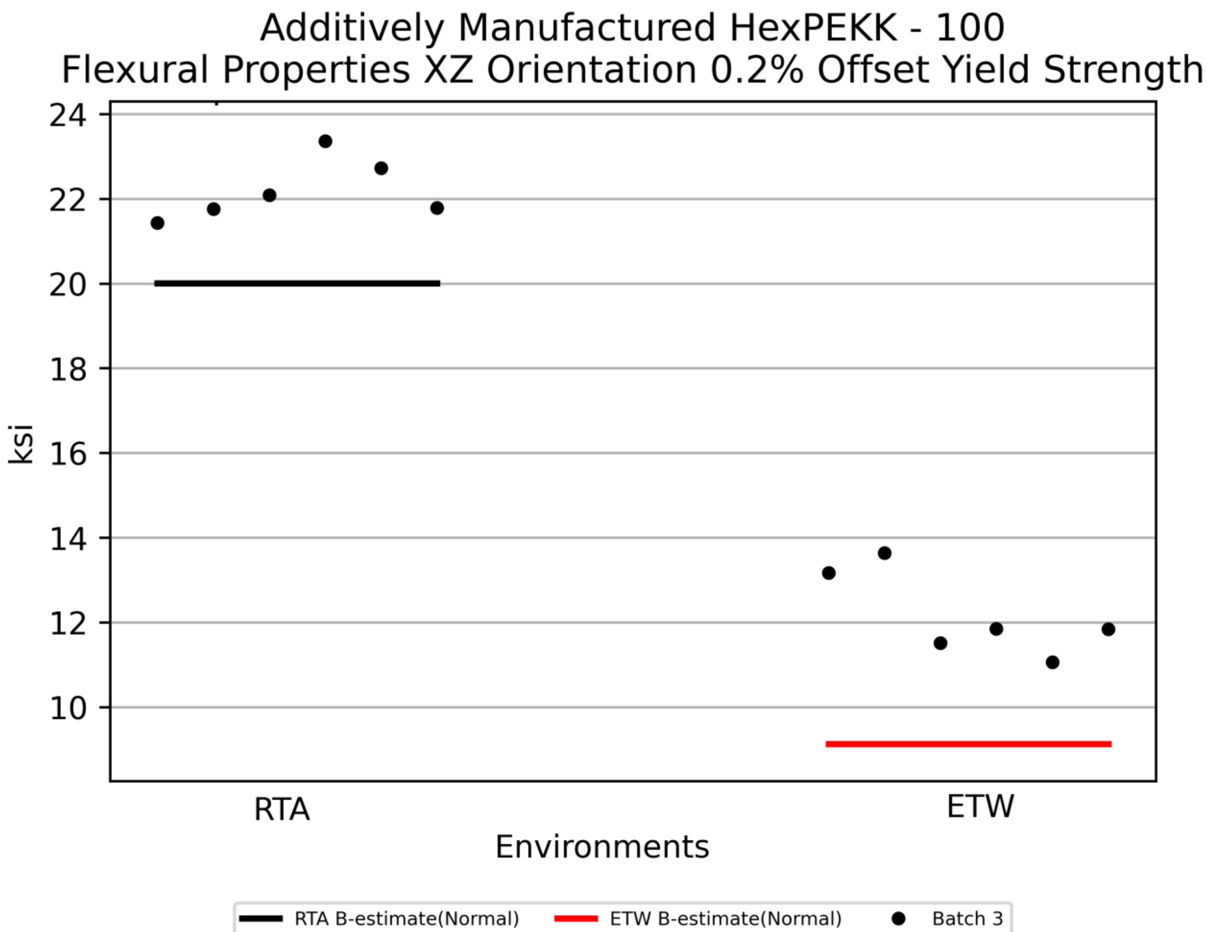

Figure 4-31: Plot for Flex XZ Orientation 0.2% Offset Yield Strength

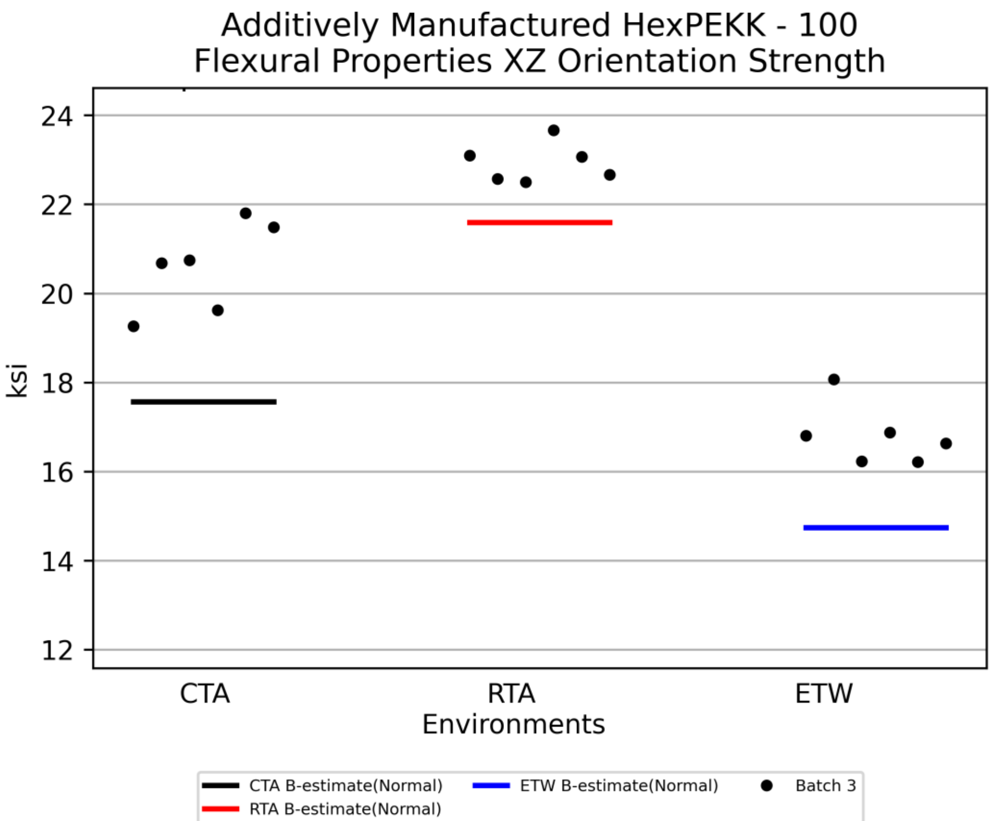

Figure 4-32: Plot for Flex XZ Orientation Strength

Flexural Properties XZ Orientation Basis Values and Statistics		
0.2% Offset Yield Strength [ksi]		
Env	RTA(70°F)	ETW(250°F)
Mean	22.19	12.18
Stdev	0.7207	1.005
CV	3.248	8.250
Min	21.43	11.06
Max	23.36	13.64
No. Batches	1	1
No. Spec.	6	6
Basis Values and Estimates		
B-Estimate	20.01	9.135
A-Estimate	18.46	6.971
Method	Normal	Normal

Table 4-41: Statistics for Flex XZ Orientation 0.2% Offset Yield Strength

Flexural Properties XZ Orientation Basis Values and Statistics			
	Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	20.60	22.93	16.80
Stdev	1.001	0.4410	0.6805
CV	4.860	1.923	4.049
Min	19.26	22.50	16.21
Max	21.80	23.67	18.07
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	17.57	21.59	14.74
A-Estimate	15.41	20.64	13.28
Method	Normal	Normal	Normal

Table 4-42: Statistics for Flex XZ Orientation Strength

Flexural Properties XZ Orientation Statistics			
	Modulus [Msi]		
Env	CTA(70°F)	RTA(70°F)	ETW(250°F)
Mean	0.8335	0.7135	0.7172
Stdev	0.04584	0.02638	0.02480
CV	5.500	3.697	3.458
Min	0.7609	0.6851	0.6951
Max	0.8865	0.7514	0.7630
No. Batches	1	1	1
No. Spec.	6	6	6

Table 4-43: Statistics for Flex XZ Orientation Modulus

4.22 Flexural Properties YX Orientation

This test method was performed for three properties: 0.2% offset yield strength, flexural strength, and modulus in conditions CTA, RTA, and ETW. For 0.2% offset yield strength, CTA condition has insufficient data, so design values are not available (NA). RTA and ETW conditions passed normality test, so normal method was used for computing basis values for these. Since the number of specimens is less than 18, normal method produces B-estimates rather than B-basis values. For flexural strength, all three conditions passed normality test, so normal method was used for these.

No outliers were detected in the data.

Statistics and design values for the 0.2% offset yield strength data are given in Table 4-44, for flexural strength data are given in Table 4-45 and for modulus data in Table 4-46. The data and B-values for 0.2% offset strength data are shown graphically in Table 4-33 and for strength in Figure 4-34.

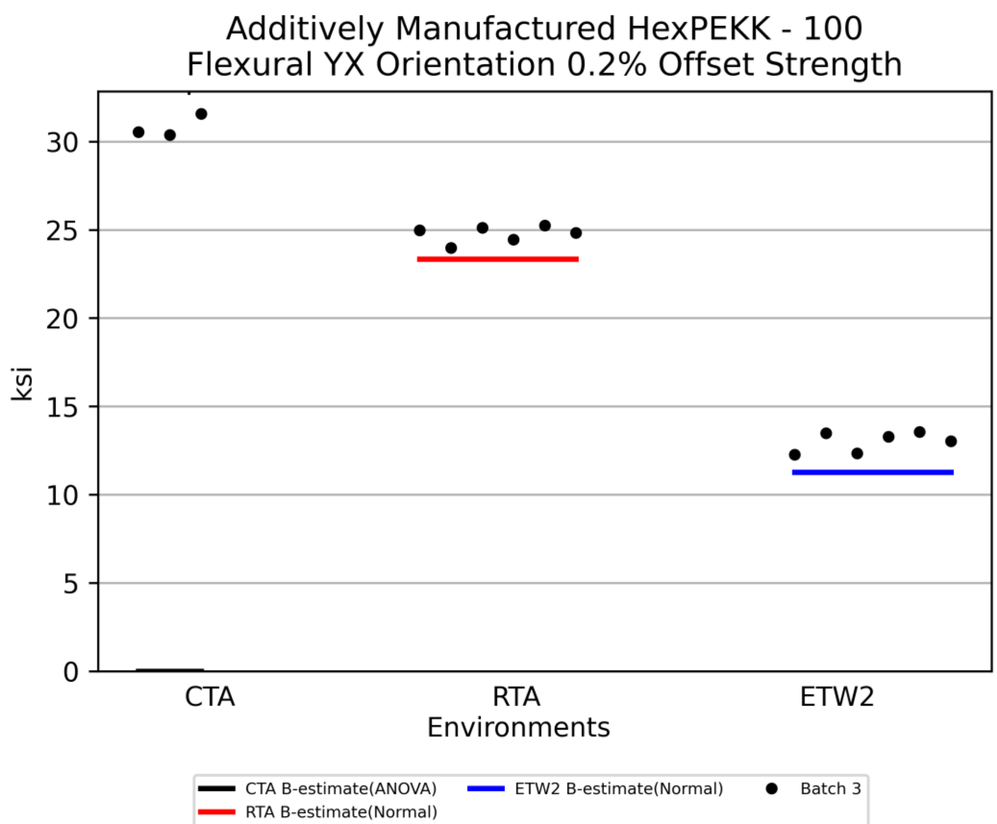

Figure 4-33: Plot for Flex YX Orientation 0.2% Offset Yield Strength

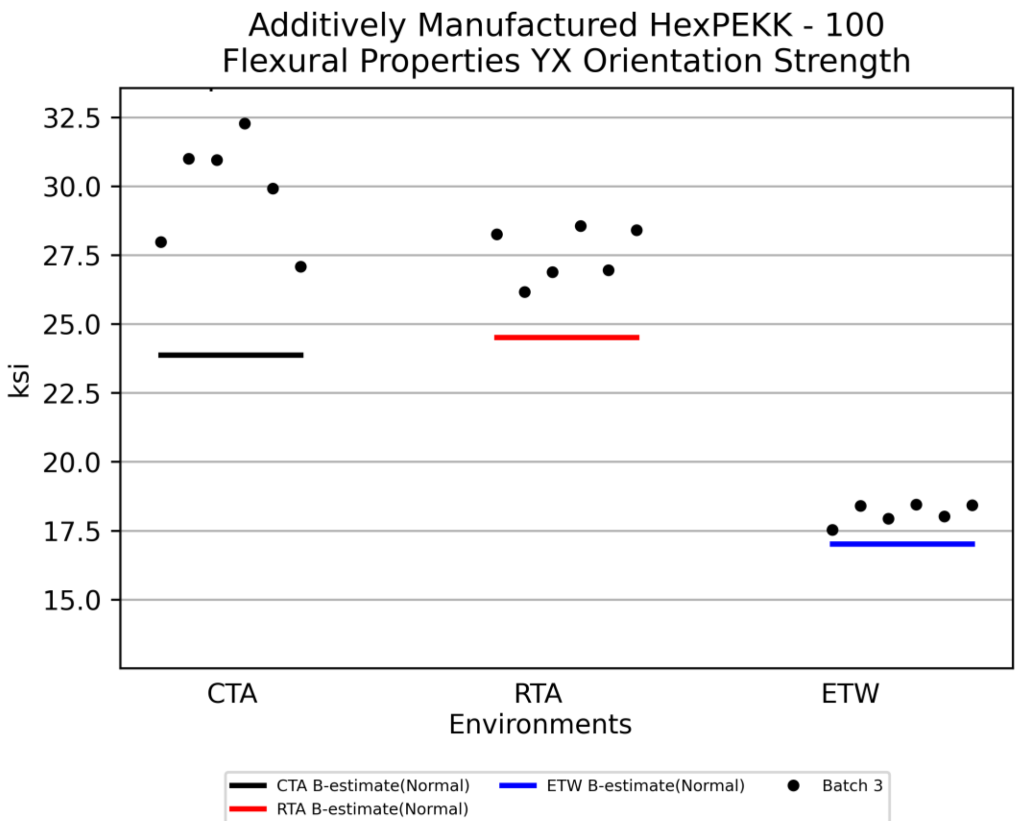

Figure 4-34: Plot for Flex YX Orientation Strength

Flexural YX Orientation Basis Values and Statistics			
	0.2% Offset Strength		
Env	CTA(-65)	RTA(70)	ETW2(250)
Mean	30.83	24.77	12.99
Stdev	0.6539	0.4719	0.5660
CV	2.121	1.905	4.357
Min	30.37	23.98	12.26
Max	31.58	25.24	13.56
No. Batches	1	1	1
No. Spec.	3	6	6
Basis Values Estimates			
B-Estimate	NA	23.34	11.27
A-Estimate		22.32	10.06
Method		Normal	Normal

Table 4-44: Statistics for Flex YX Orientation 0.2% Offset Strength

Flexural YX Orientation Basis Values and Statistics			
	Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	29.87	27.54	18.13
Stdev	1.978	0.9986	0.3662
CV	6.622	3.626	2.020
Min	27.08	26.16	17.54
Max	32.28	28.56	18.45
No. Batches/Machines	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	23.88	24.51	17.02
A-Estimate	19.62	22.36	16.23
Method	Normal	Normal	Normal

Table 4-45: Statistics for Flex YX Orientation Strength

Flexural Properties YX Orientation Statistics			
	Modulus [Msi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	0.8479	0.7717	0.8028
Stdev	0.02430	0.01825	0.01785
CV	2.865	2.365	2.223
Min	0.8232	0.7483	0.7890
Max	0.8795	0.7999	0.8379
No. Batches	1	1	1
No. Spec.	6	6	6

Table 4-46: Statistics for Flex YX Orientation Modulus

4.23 Flexural Properties ZX Orientation

This test method was performed for three properties: 0.2% offset yield strength, flexural strength, and modulus in conditions CTA, RTA, ETA1, ETA2, and ETW. For 0.2% offset yield strength, CTA has no data because failure occurred before 0.2% offset. RTA and ETA1 conditions have too few specimens, so design values are not available (NA). ETA2 and ETW passed normality test, so normal method was used. For flexural strength, conditions CTA and RTA passed pooling tests, so pooling method was used for these. Conditions ETA1, ETA2 and ETW passed normality test, so normal method was used. There were insufficient specimens that had a 0.2% offset yield strength property in the CTA, RTA and ETA conditions for any basis values or estimates to be provided for that property.

One statistical outlier was detected in the data. A lower batch outlier for flexural strength in condition ETW batch two. It was retained for this analysis.

Statistics and design values for the 0.2% offset yield strength data are given in Table 4-47, for flexural strength data are given in Table 4-48 and for modulus data in Table 4-49. The data and B-values for 0.2% offset strength data are shown graphically in Table 4-35 and for strength in Figure 4-36.

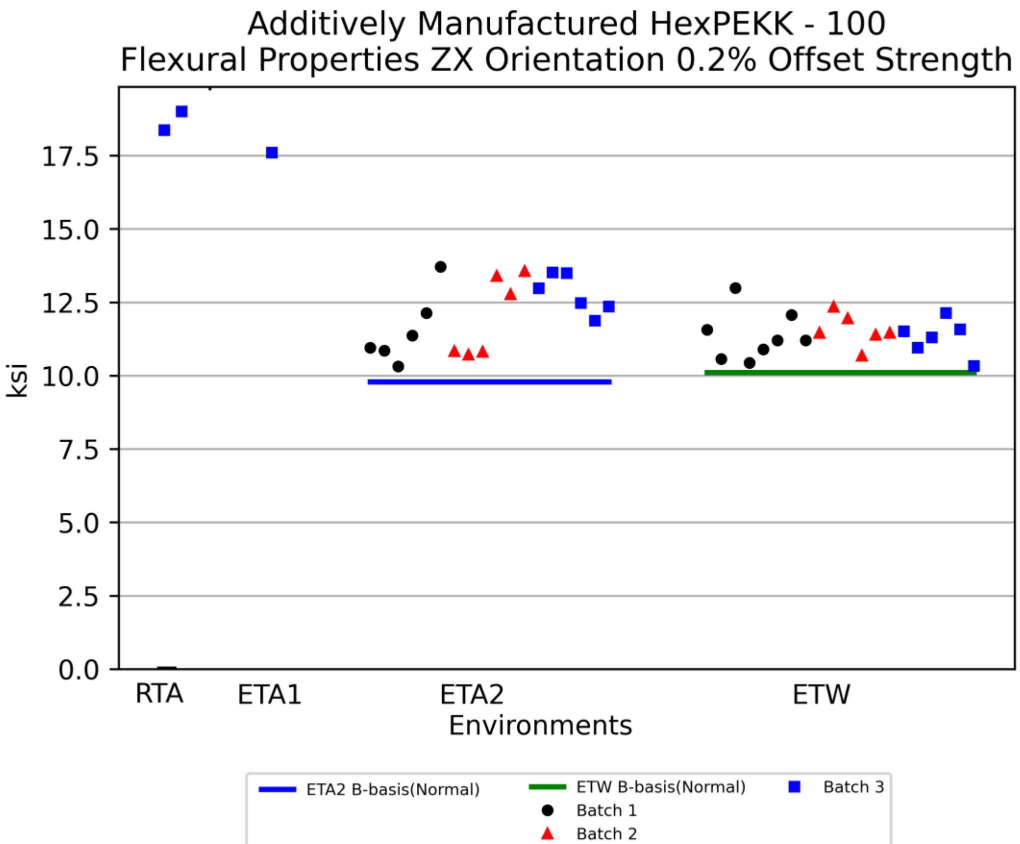

Figure 4-35: Plot for Flex ZX Orientation 0.2% Offset Yield Strength

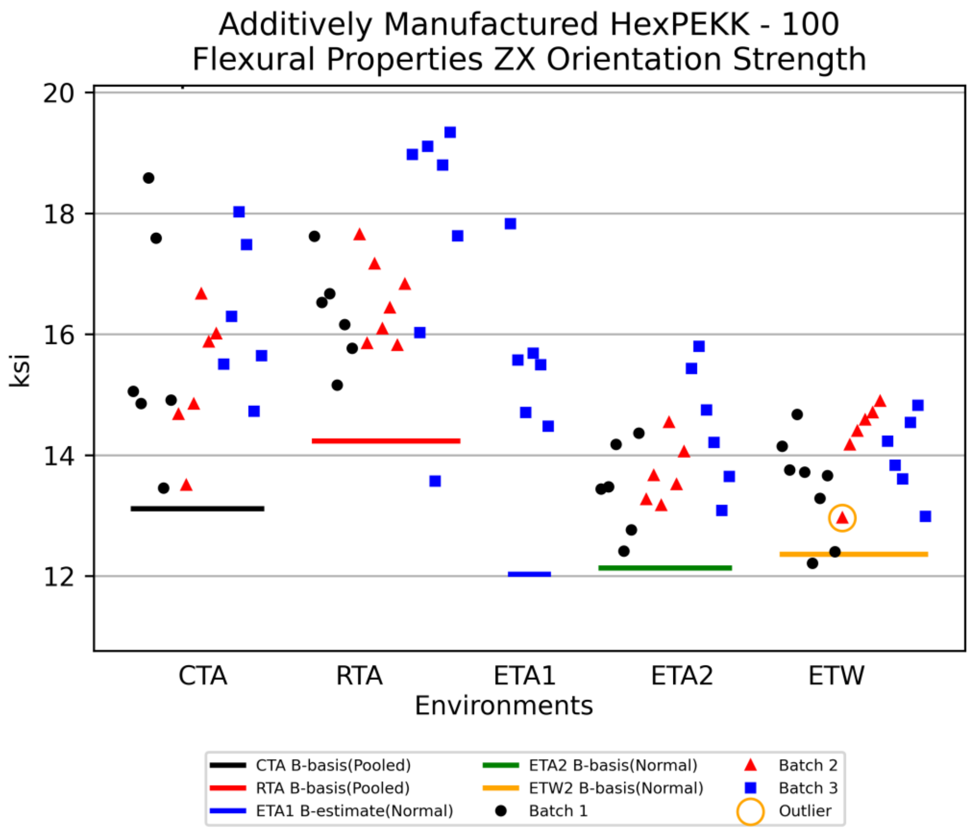

Figure 4-36: Plot for Flex ZX Orientation Strength

Flexural Properties ZX Orientation Basis Values and Statistics				
	0.2% Offset Strength [ksi]			
Env	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	18.81	17.59	12.12	11.40
Stdev	0.3828	NA	1.178	0.6731
CV	2.035	NA	9.724	5.904
Min	18.54	17.59	10.32	10.33
Max	19.08	17.59	13.71	12.99
No. Batches	1	1	3	3
No. Spec.	2	1	18	20
Basis Values and Estimates				
B-Basis	NA	NA	9.791	10.10
A-Estimate			8.142	9.182
Method			Normal	Normal

Table 4-47: Statistics for Flex ZX Orientation 0.2% Offset Strength

Flexural ZX Orientation Basis Values and Statistics					
	Strength [ksi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	15.76	16.86	15.63	13.88	13.88
Stdev	1.460	1.459	1.187	0.8828	0.7885
CV	9.266	8.656	7.593	6.362	5.681
Min	13.46	13.57	14.48	12.42	12.21
Max	18.59	19.34	17.83	15.80	14.89
No. Batches	3	3	1	3	3
No. Spec.	18	20	6	18	20
Basis Values and Estimates					
B-Basis	13.11	14.24		12.13	12.36
B-Estimate			12.03		
A-Estimate	11.32	12.44	9.477	10.90	11.28
Method	Pooled	Pooled	Normal	Normal	Normal

Table 4-48: Statistics for Flex ZX Orientation Strength

Flexural Properties ZX Orientation Statistics					
	Modulus [Msi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	0.6612	0.5937	0.5789	0.5843	0.5745
Stdev	0.05618	0.03880	0.04644	0.05194	0.03368
CV	8.498	6.537	8.022	8.889	5.864
Min	0.5585	0.5324	0.5272	0.5011	0.5122
Max	0.7654	0.6745	0.6424	0.6708	0.6280
No. Batches	3	3	1	3	3
No. Spec.	18	20	6	18	20

Table 4-49: Statistics for Flex ZX Orientation Modulus

4.24 Flexural Properties ZX45 Orientation

This test method was performed for three properties: 0.2% offset yield strength, flexural strength and modulus in conditions CTA, RTA, and ETW. For 0.2% offset yield strength, CTA has no data due to failure before reaching 0.2% offset strength. RTA and ETW conditions passed normality test, so normal method was used for computing design values. For flexural strength, conditions CTA, RTA, and ETW passed normality test, so normal method was used. Since the number of specimens is less than 18, the results are B-estimates rather than B-basis values. There were insufficient specimens that had a 0.2% offset yield strength property in the CTA, condition for any basis values or estimates to be provided for that property.

No statistical outliers were detected in the data.

Statistics and design values for the 0.2% offset yield strength data are given in Table 4-48, for flexural strength data are given in Table 4-49, and for modulus data in Table 4-50. The data and B-values for 0.2% offset strength data are shown graphically in Figure-36 and for strength in Figure 4-37.

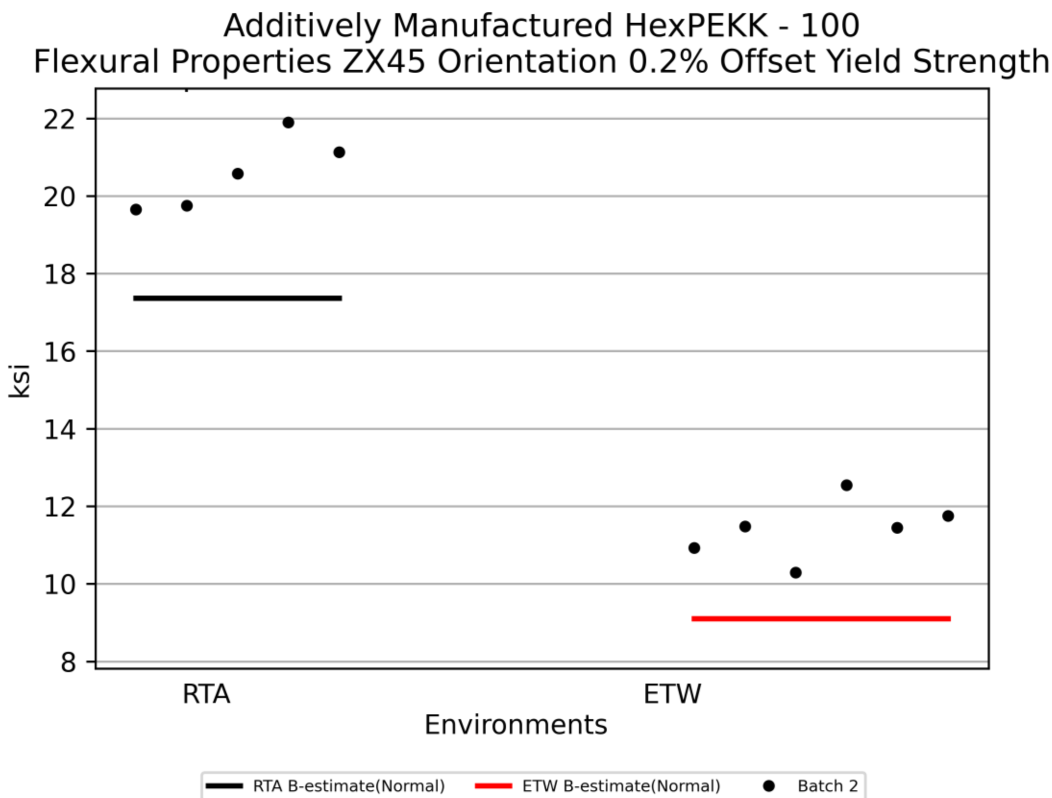

Figure 4-36: Plot for Flex ZX45 Orientation 0.2% Offset Yield Strength

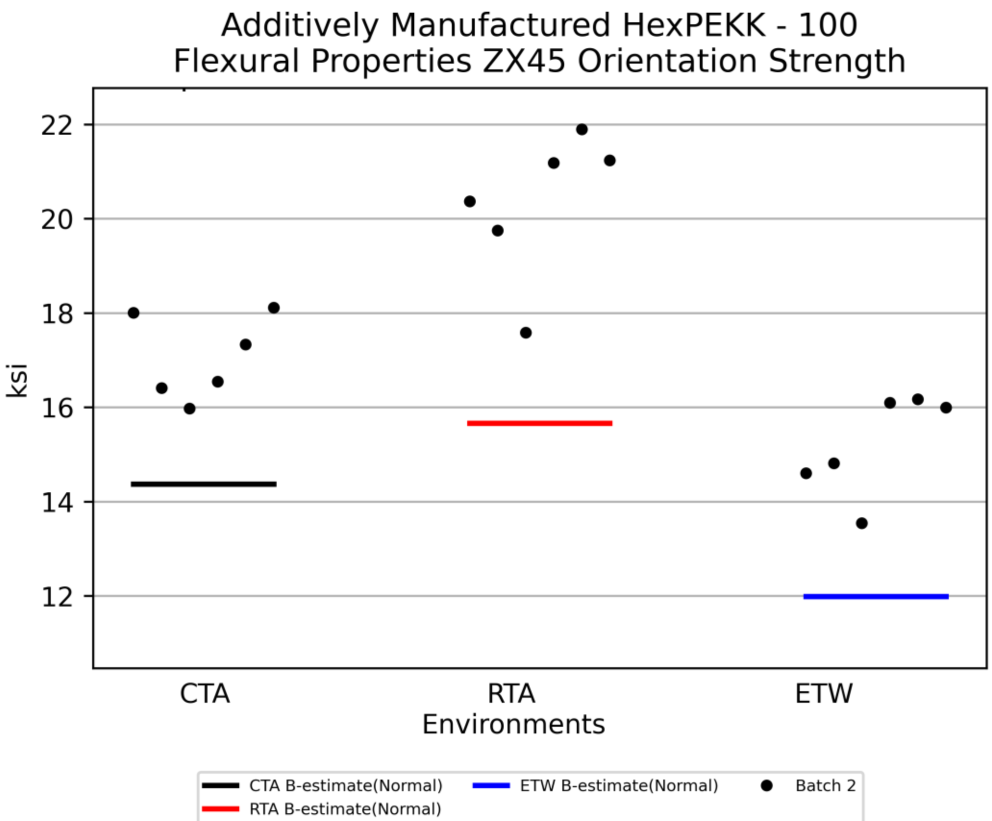

Figure 4-37: Plot for Flex ZX45 Orientation Strength

Flexural Properties ZX45 Orientation Basis Values and Statistics		
0.2% Offset Yield Strength [ksi]		
Env	RTA(70°F)	ETW(250°F)
Mean	20.60	11.41
Stdev	0.9458	0.7616
CV	4.591	6.677
Min	19.65	10.29
Max	21.90	12.55
No. Batches	1	1
No. Spec.	5	6
Basis Values and Estimates		
B-Estimate	17.37	9.099
A-Estimate	15.02	7.459
Method	Normal	Normal

Table 4-48: Statistics for Flex ZX45 Orientation 0.2% Offset Strength

Flexural Properties ZX45 Orientation Basis Values and Statistics			
	Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	17.06	20.34	15.21
Stdev	0.8881	1.543	1.061
CV	5.204	7.586	6.977
Min	15.98	17.58	13.54
Max	18.11	21.90	16.17
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	14.37	15.66	11.99
A-Estimate	12.46	12.34	9.707
Method	Normal	Normal	Normal

Table 4-49: Statistics for Flex ZX45 Orientation Strength

Flexural Properties ZX45 Orientation Statistics			
	Modulus [Msi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	0.6511	0.6163	0.6091
Stdev	0.01576	0.03365	0.04452
CV	2.420	5.459	7.309
Min	0.6254	0.5673	0.5594
Max	0.6692	0.6617	0.6710
No. Batches	1	1	1
No. Spec.	6	6	6

Table 4-50: Statistics for Flex ZX45 Orientation Modulus

4.25 Open-Hole Compression (OHC) XY Orientation

This test method was performed for three properties: 0.2% offset strength, 1% offset strength, and modulus in conditions RTA and ETW. For 0.2% offset yield strength, RTA and ETW conditions passed normality test, so normal method was used for computing design values. For 1% offset strength, RTA has no data because failure before reaching 1% offset strength. Condition ETW passed normality test, so normal method was used. Since the number of specimens is less than 18, the results are B-estimates rather than B-basis values.

No statistical outliers were detected in the data.

Statistics and design values for the 0.2% offset strength data are given in Table 4-51, for 1% offset strength data are given in Table-52 and for modulus data in Table 4-53. The data and B-values for 0.2% offset strength data are shown graphically in Figure-38 and for strength in Figure 4-39.

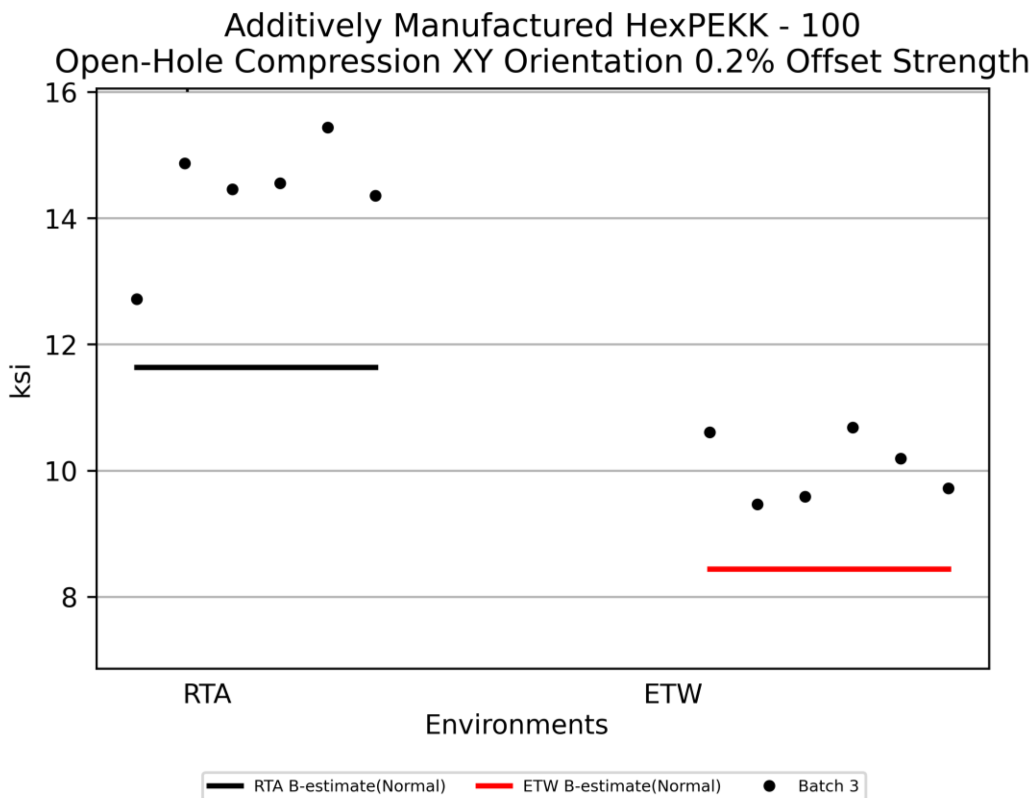

Figure 4-38: Plot for OHC XY Orientation 0.2% Offset Yield Strength

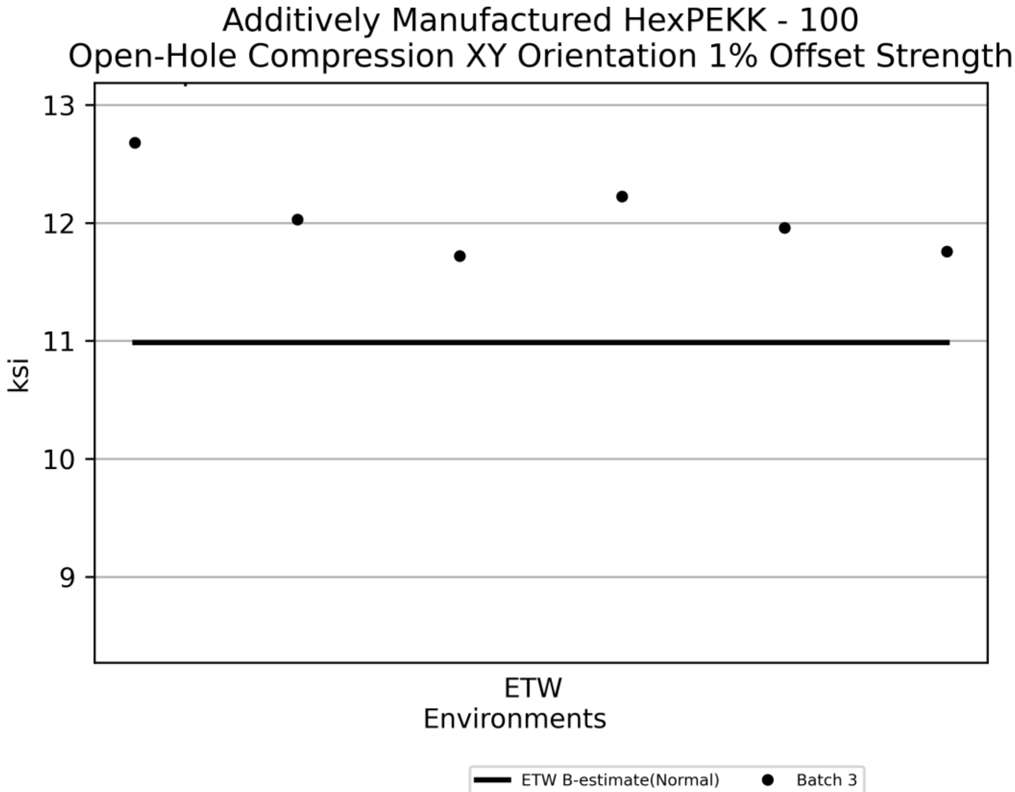

Figure 4-39: Plot for OHC XY Orientation 1% Offset Strength

Open-Hole Compression XY Orientation Basis Values and Statistics		
	0.2% Offset Strength [ksi]	
Env	RTA(70°F)	ETW(250°F)
Mean	14.40	10.04
Stdev	0.9120	0.5291
CV	6.334	5.269
Min	12.72	9.463
Max	15.44	10.68
No. Batches	1	1
No. Spec.	6	6
Basis Value Estimates		
B-Estimate	11.64	8.438
A-Estimate	9.673	7.299
Method	Normal	Normal

Table 4-51: Statistics for OHC XY Orientation 0.2% Offset Strength

Open-Hole Compression XY Orientation Basis Values and Statistics	
	1% Offset Strength [ksi]
Env	ETW(250°F)
Mean	12.06
Stdev	0.3548
CV	2.942
Min	11.72
Max	12.68
No. Batches	1
No. Spec.	6
Basis Value Estimates	
B-Estimate	10.99
A-Estimate	10.22
Method	Normal

Table 4-52: Statistics for OHC XY Orientation 1% Offset Strength

Open-Hole Compression XY Orientation Statistics		
	Modulus [Msi]	
Env	RTA(70°F)	ETW(250°F)
Mean	0.9865	0.9179
Stdev	0.1413	0.09986
CV	14.33	10.88
Min	0.7749	0.7955
Max	1.179	1.031
No. Batches	1	1
No. Spec.	6	6

Table 4-53: Statistics for OHC XY Orientation Modulus

4.26 Open-Hole Compression (OHC) XZ Orientation

This test method was performed for three properties: 0.2% offset strength, 1% offset strength, and modulus in conditions RTA and ETW. For 0.2% offset yield strength, RTA and ETW conditions passed normality test, so normal method was used for computing design values for these. For 1% offset strength, RTA condition has no data because of failure before reaching 1% offset strength. Condition ETW passed normality test, so normal method was used. Since the number of specimens is less than 18, the results are B-estimates rather than B-basis values.

No statistical outliers were detected in the data.

Statistics and design values for the 0.2% offset strength data are given in Table 4-54, for 1% offset strength data are given in Table 4-55, and modulus data in Table 4-56. The data and B-values for 0.2% offset strength data are shown graphically in Figure 4-40 and for 1% offset strength in Figure 4-41.

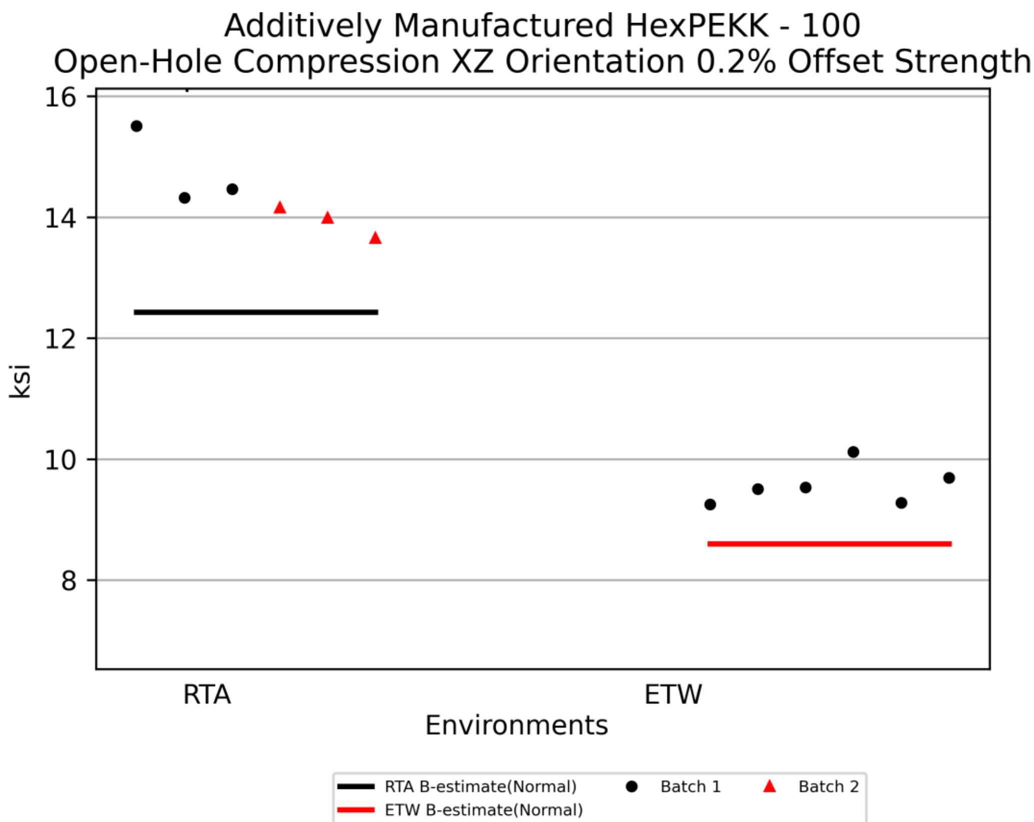

Figure 4-40: Plot for OHC XZ Orientation 0.2% Offset Yield Strength

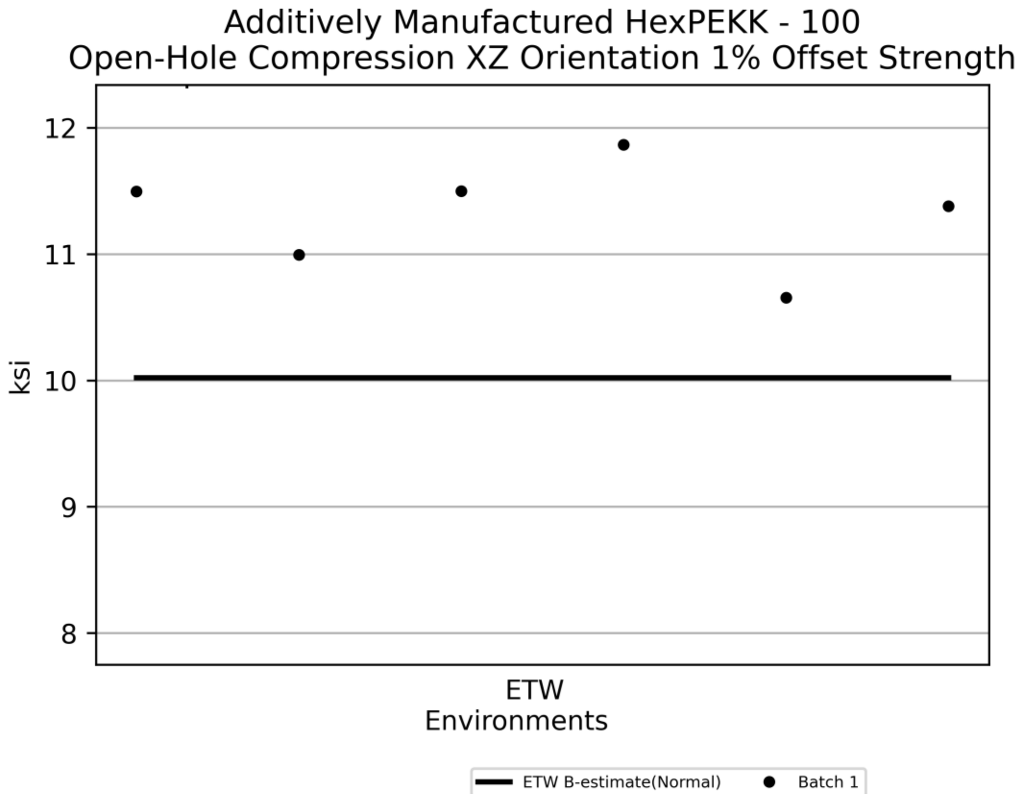

Figure 4-41: Plot for OHC XZ Orientation 1% Offset Strength

Open-Hole Compression XZ Orientation Basis Values and Statistics		
	0.2% Offset Strength [ksi]	
Env	RTA(70°F)	ETW(250°F)
Mean	14.35	9.562
Stdev	0.6334	0.3186
CV	4.415	3.331
Min	13.65	9.251
Max	15.51	10.12
No. Batches	2	1
No. Spec.	6	6
Basis Values and Estimates		
B-Estimate	12.43	8.597
A-Estimate	11.07	7.911
Method	Normal	Normal

Table 4-54: Statistics for OHC XZ Orientation 0.2% Offset Strength

Open-Hole Compression XZ Orientation Basis Values and Statistics	
1% Offset Strength [ksi]	
Env	ETW(250°F)
Mean	11.31
Stdev	0.4268
CV	3.772
Min	10.65
Max	11.86
No. Batches	1
No. Spec.	6
Basis Values and Estimates	
B-Estimate	10.02
A-Estimate	9.102
Method	Normal

Table 4-55: Statistics for OHC XZ Orientation 1% Offset Strength

Open-Hole Compression XZ Orientation Statistics		
	Modulus [Msi]	
Env	RTA(70°F)	ETW(250°F)
Mean	0.8699	0.8347
Stdev	0.02842	0.05440
CV	3.267	6.518
Min	0.8445	0.7502
Max	0.9221	0.8836
No. Batches	2	1
No. Spec.	6	6

Table 4-56: Statistics for OHC XZ Orientation Modulus

4.27 Open-Hole Compression (OHC) YX Orientation

This test method was performed for three properties: 0.2% offset strength, 1% offset strength, and modulus in condition ETW only. For both 0.2% offset yield strength and 1% offset strength, ETW condition passed normality test, so normal method was used for computing design values for this. Since the number of specimens is less than 18, the results are B-estimates rather than B-basis values.

No statistical outliers were detected in the data.

Statistics and design values for the 0.2% offset strength and 1% offset strength data are given in Table 4-57 and for modulus data in Table 4-58. The data and B-values for 0.2% offset strength data are shown graphically in Figure 4-42 and for 1% offset strength in Figure 4-43.

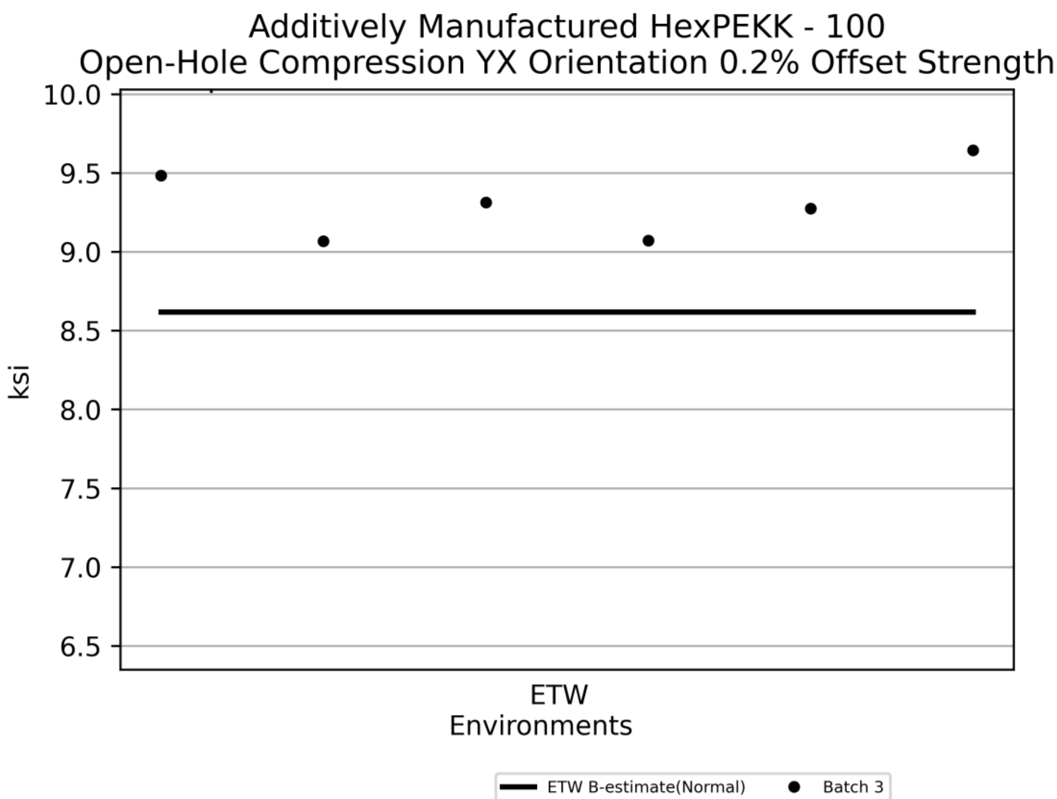

Figure 4-42: Plot for OHC YX Orientation 0.2% Offset Yield Strength

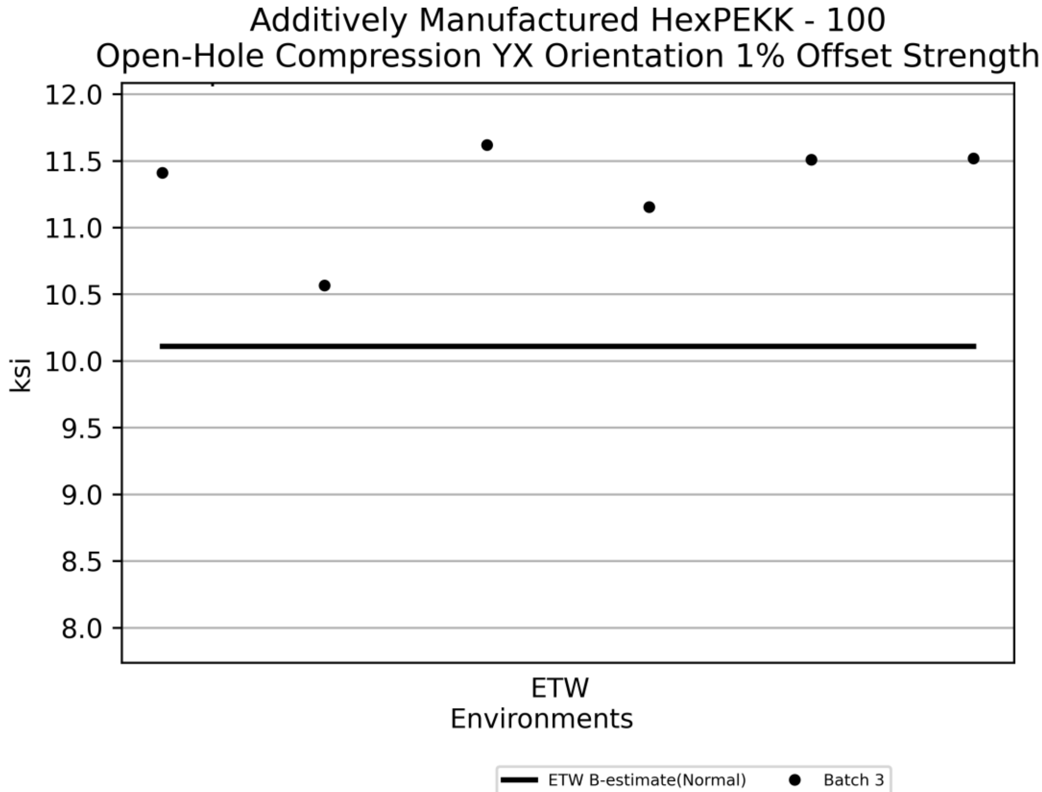

Figure 4-43: Plot for OHC YX Orientation 1% Offset Strength

Open-Hole Compression YX Orientation Basis Values and Statistics		
	0.2% Offset Strength [ksi]	1% Offset Strength [ksi]
Env	ETW(250°F)	ETW(250°F)
Mean	9.308	11.30
Stdev	0.2276	0.3912
CV	2.446	3.463
Min	9.066	10.57
Max	9.644	11.62
No. Batches	1	1
No. Spec.	6	6
Basis Value Estimates		
B-Estimate	8.619	10.11
A-Estimate	8.128	9.268
Method	Normal	Normal

Table 4-57: Statistics for OHC YX Orientation 0.2% & 1% Offset Strength

Open-Hole Compression YX Orientation Statistics	
	Modulus [Msi]
Env	ETW(250°F)
Mean	0.7601
Stdev	0.06943
CV	9.134
Min	0.6941
Max	0.8586
No. Batches	1
No. Spec.	6

Table 4-58: Statistics for OHC YX Orientation Modulus

4.28 Open-Hole Compression (OHC) ZX Orientation

This test method was performed for three properties: 0.2% offset strength, 1% offset strength and modulus in conditions RTA and ETW. For 0.2% offset yield strength, RTA and ETW conditions passed normality test, so normal method was used for computing design values for these. For 1% offset strength, condition RTA has insufficient data so design values are not available (NA), while condition ETW passed normality test, so normal method was used. Since the number of specimens is less than 18, the results are B-estimates rather than B-basis values.

No statistical outliers were detected in the data.

Statistics and design values for the 0.2% offset strength and 1% offset strength data are given in Table 4-59 and for modulus data in Table 4-60. The data and B-values for 0.2% offset strength data are shown graphically in Figure 4-44 and for 1% offset strength in Figure 4-45.

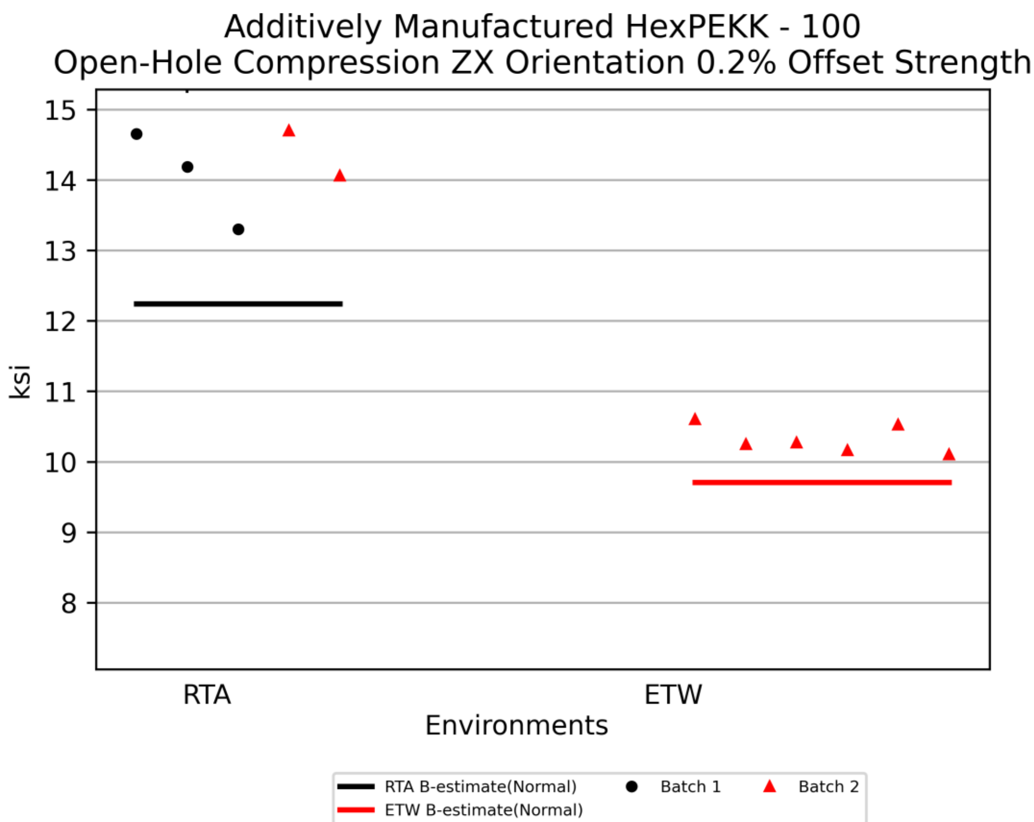

Figure 4-44: Plot for OHC ZX Orientation 0.2% Offset Yield Strength

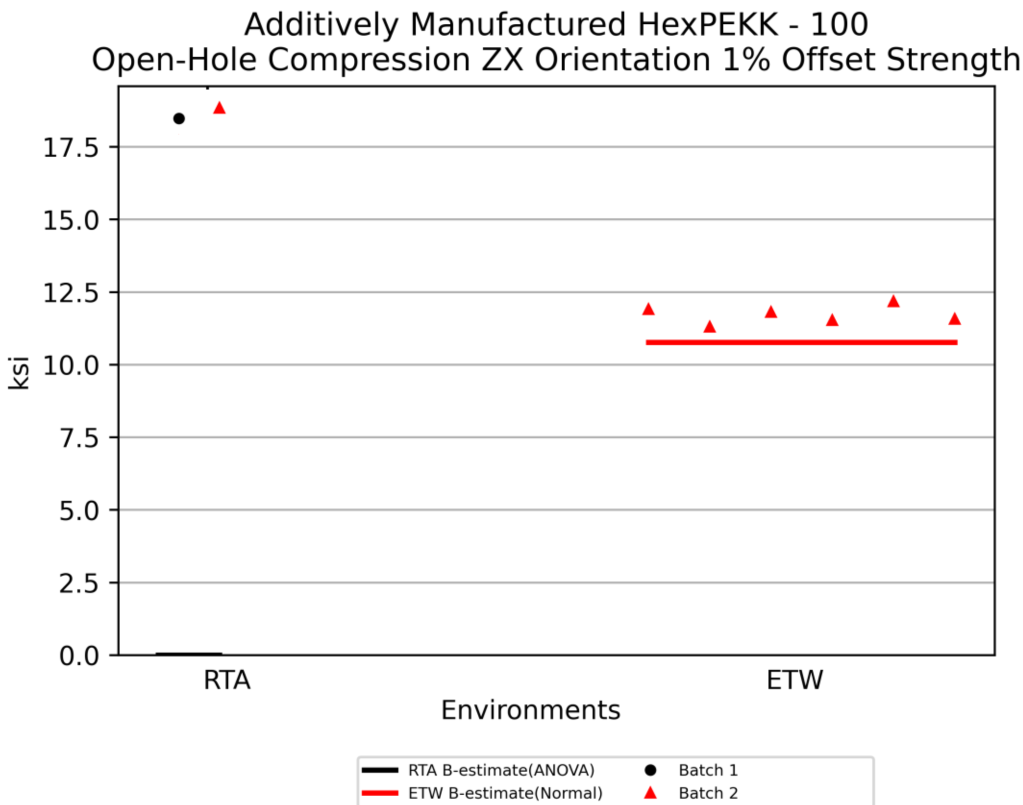

Figure 4-45: Plot for OHC ZX Orientation 1% Offset Strength

Open-Hole Compression ZX Orientation Basis Values and Statistics				
	0.2% Offset Strength [ksi]		1% Offset Strength [ksi]	
Env	RTA(70°F)	ETW(250°F)	RTA(70°F)	ETW(250°F)
Mean	14.18	10.32	18.58	11.71
Stdev	0.5663	0.2014	0.3524	0.3114
CV	3.994	1.952	1.896	2.660
Min	13.30	10.10	18.34	11.29
Max	14.70	10.60	18.83	12.17
No. Batches	2	1	2	1
No. Spec.	5	6	2	6
Basis Values and Estimates				
B-Estimate	12.24	9.708	NA	10.76
A-Estimate	10.84	9.274		10.09
Method	Normal	Normal		Normal

Table 4-59: Statistics for OHC ZX Orientation 0.2% & 1% Offset Strength

Open-Hole Compression ZX Orientation Statistics		
	Modulus [Msi]	
Env	RTA(70°F)	ETW(250°F)
Mean	0.7362	0.7284
Stdev	0.06510	0.02182
CV	8.842	2.995
Min	0.6406	0.6994
Max	0.7903	0.7562
No. Batches	2	1
No. Spec.	5	6

Table 4-60: Statistics for OHC ZX Orientation Modulus

4.29 Open-Hole Compression (OHC) ZX45 Orientation

This test method was performed for three properties: 0.2% offset strength, 1% offset strength, and modulus in conditions RTA and ETW. For 0.2% offset yield strength, RTA and ETW conditions passed normality test, so normal method was used for computing design values. For 1% offset strength, condition RTA has insufficient data so design values are not available (NA), while condition ETW passed normality test, so normal method was used. Since the number of specimens is less than 18, the results are B-estimates rather than B-basis values.

No statistical outliers were detected in the data.

Statistics and design values for the 0.2% offset strength and 1% offset strength data are given in Table 4-61 and for modulus data in Table 4-62. The data and B-values for 0.2% offset strength data are shown graphically in Figure 4-46 and for 1% offset strength in Figure 4-47.

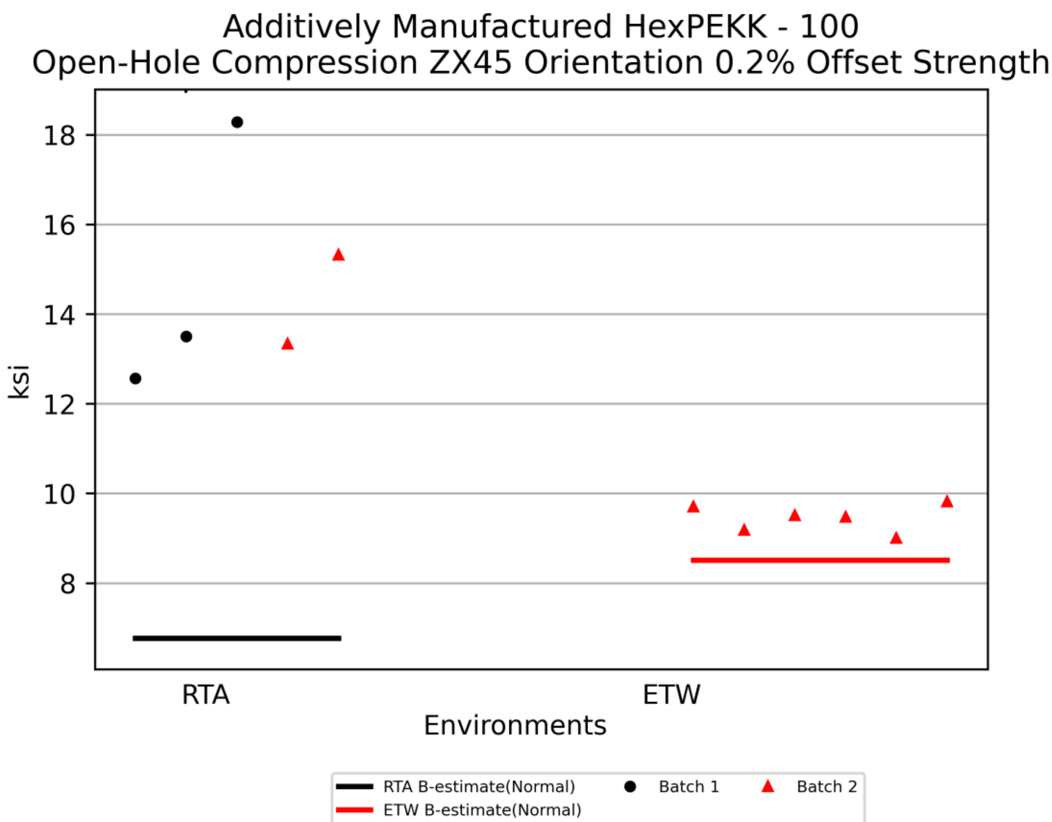

Figure 4-46: Plot for OHC ZX45 Orientation 0.2% Offset Yield Strength

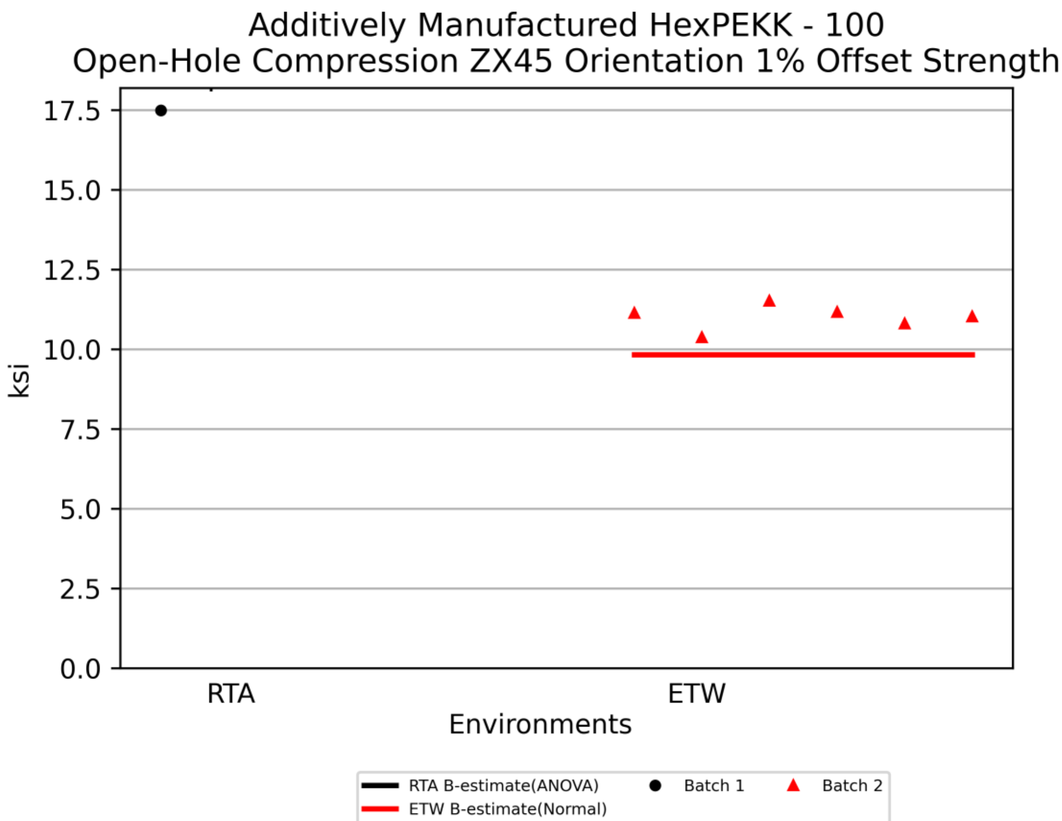

Figure 4-47: Plot for OHC ZX45 Orientation 1% Offset Strength

Open-Hole Compression ZX45 Orientation Basis Values and Statistics				
	0.2% Offset Strength [ksi]		1% Offset Strength [ksi]	
Env	RTA(70°F)	ETW(250°F)	RTA(70°F)	ETW(250°F)
Mean	14.60	9.448	17.50	11.01
Stdev	2.292	0.3090	NA	0.3871
CV	15.70	3.270	NA	3.517
Min	12.57	9.002	17.50	10.37
Max	18.28	9.820	17.50	11.52
No. Batches	2	1	1	1
No. Spec.	5	6	1	6
Basis Values and Estimates				
B-Estimate	6.768	8.512	NA	9.833
A-Estimate	1.078	7.846		8.999
Method	Normal	Normal		Normal

Table 4-61: Statistics for OHC ZX45 Orientation 0.2% & 1% Offset Strength

Open-Hole Compression ZX45 Orientation Statistics		
	Modulus [Msi]	
Env	RTA(70°F)	ETW(250°F)
Mean	0.6661	0.7077
Stdev	0.01657	0.05135
CV	2.487	7.256
Min	0.6470	0.6575
Max	0.6822	0.7721
No. Batches	2	1
No. Spec.	5	6

Table 4-62: Statistics for OHC ZX45 Orientation Modulus

4.30 Open-Hole Tension (OHT) XY Orientation

This test method was performed for one property: tensile strength in conditions CTA, RTA, ETA2, and ETW. CTA condition passed normality test, so normal method was used for computing design values. Conditions RTA, ETA2, and ETW passed pooling tests, so pooling method was used.

No statistical outliers were detected in the data.

Statistics and design values for the strength data are given in Table 4-63. The data and B-values for strength data are shown graphically in Figure 4-48.

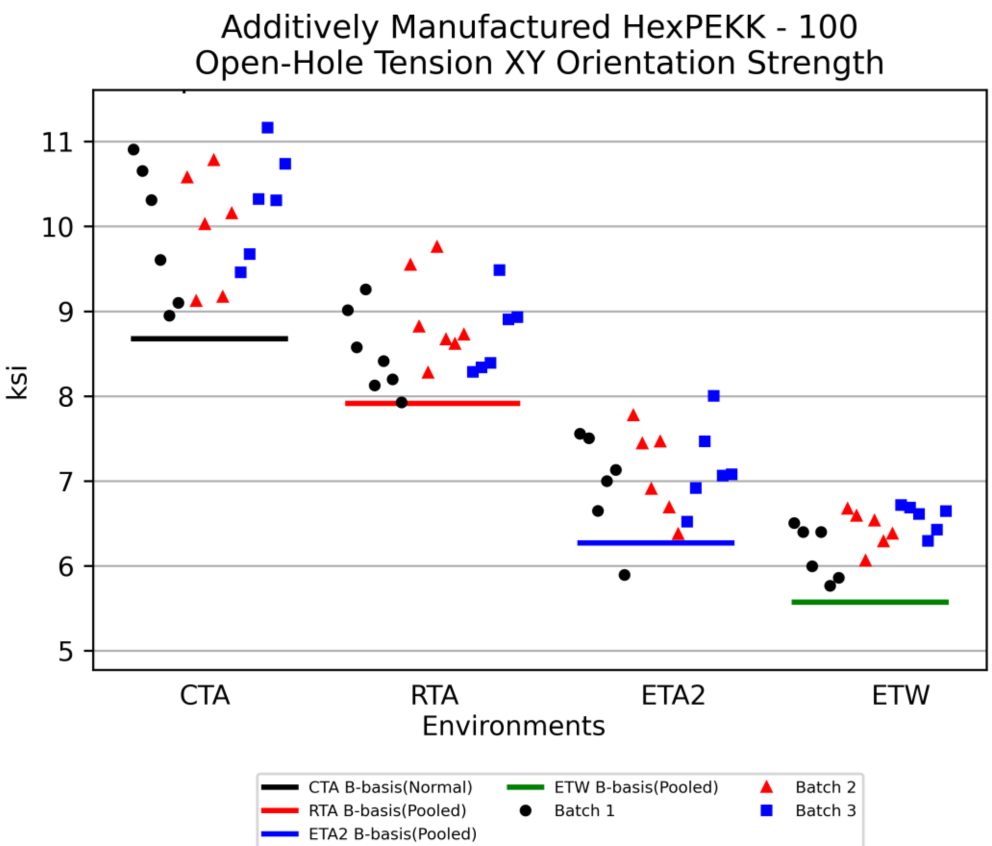

Figure 4-48: Plot for OHT XY Orientation Strength

Open-Hole Tension XY Orientation Basis Values and Statistics				
	Strength [ksi]			
Env	CTA(-65°F)	RTA(70°F)	ETA2(250°F)	ETW(250°F)
Mean	10.06	8.712	7.079	6.379
Stdev	0.6981	0.5043	0.5308	0.2880
CV	6.943	5.788	7.498	4.515
Min	8.950	7.928	5.894	5.766
Max	11.16	9.757	8.003	6.717
No. Batches	3	3	3	3
No. Spec.	18	20	18	18
Basis Values and Estimates				
B-Basis	8.677	7.914	6.273	5.572
A-Estimate	7.701	7.376	5.736	5.036
Method	Normal	Pooled	Pooled	Pooled

Table 4-63: Statistics for OHT XY Orientation Strength

4.31 Open-Hole Tension (OHT) XZ Orientation

This test method was performed for one property: tensile strength in conditions CTA, RTA, and ETW. All three conditions passed normality test, so normal method was used for computing design values. Since the number of specimens is less than 18, the results are B-estimates rather than B-basis values.

No statistical outliers were detected in the data.

Statistics and design values for the strength data are given in Table 4-64. The data and B-values for strength data are shown graphically in Figure 4-49.

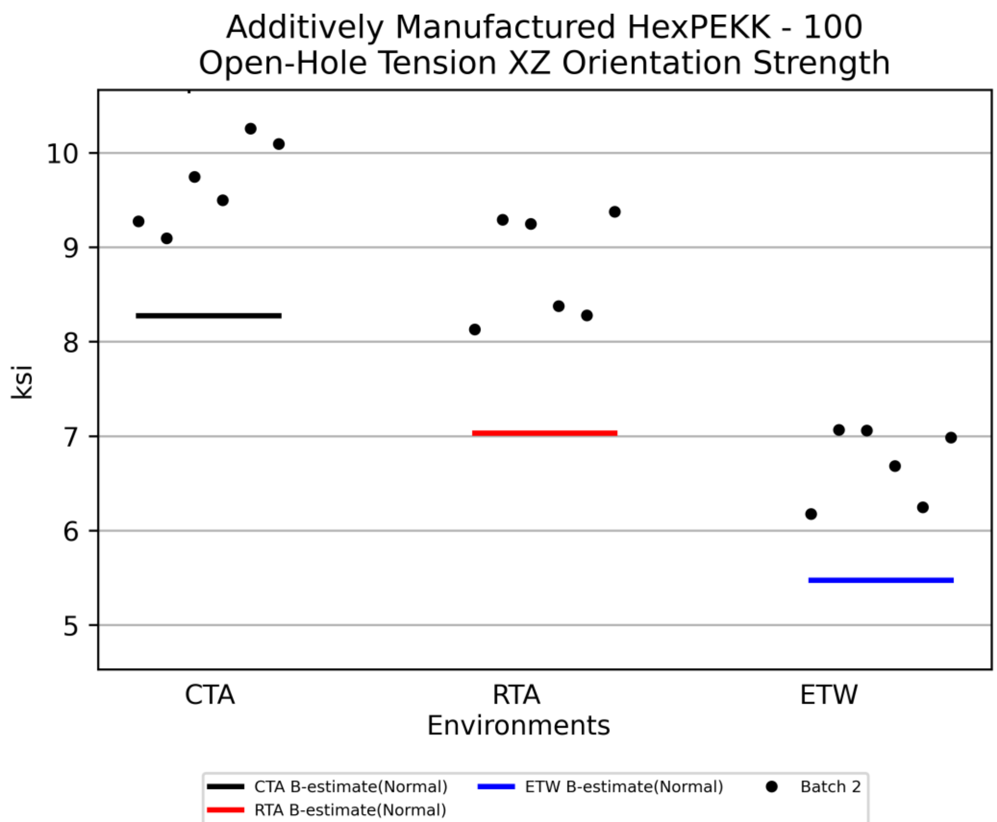

Figure 4-49: Plot for OHT XZ Orientation Strength

Open-Hole Tension XZ Orientation Basis Values and Statistics			
	Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	9.660	8.783	6.704
Stdev	0.4575	0.5779	0.4055
CV	4.736	6.580	6.049
Min	9.094	8.129	6.178
Max	10.26	9.375	7.067
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	8.274	7.033	5.475
A-Estimate	7.289	5.788	4.602
Method	Normal	Normal	Normal

Table 4-64: Statistics for OHT XZ Orientation Strength

4.32 Open Hole Tension (OHT) YX Orientation

This test method was performed for one property: tensile strength in conditions CTA, RTA, and ETW. All three conditions passed normality test, so normal method was used for computing design values. Since the number of specimens is less than 18, the results are B-estimates rather than B-basis values.

No statistical outliers were detected in the data.

Statistics and design values for the strength data are given in Table 4-65. The data and B-values for strength data are shown graphically in Figure 4-50.

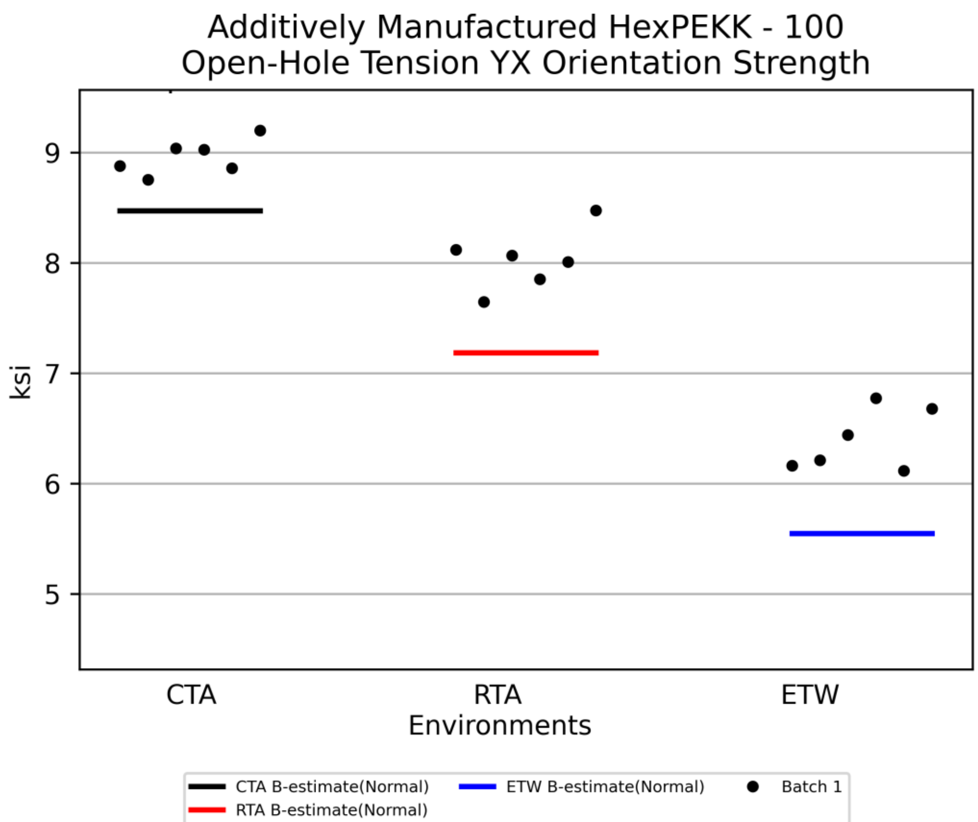

Figure 4-50: Plot for OHT YX Orientation Strength

Open-Hole Tension YX Orientation Basis Values and Statistics			
	Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	8.959	8.028	6.397
Stdev	0.1602	0.2779	0.2799
CV	1.788	3.461	4.376
Min	8.752	7.646	6.115
Max	9.200	8.474	6.773
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	8.474	7.186	5.549
A-Estimate	8.129	6.588	4.946
Method	Normal	Normal	Normal

Table 4-65: Statistics for OHT YX Orientation Strength

4.33 Open-Hole Tension (OHT) ZX Orientation

This test method was performed for one property: tensile strength in conditions CTA, RTA, ETA2, and ETW. All conditions passed the pooling tests, so pooling method was used for computing design values.

Two statistical outliers were detected in the data. A condition and batch lower outlier for strength property in condition CTA batch three. A batch lower outlier for strength property in condition RTA batch three. Both outliers were retained for this analysis.

Statistics and design values for the strength data are given in Table 4-66. The data and B-values for strength data are shown graphically in Figure 4-51.

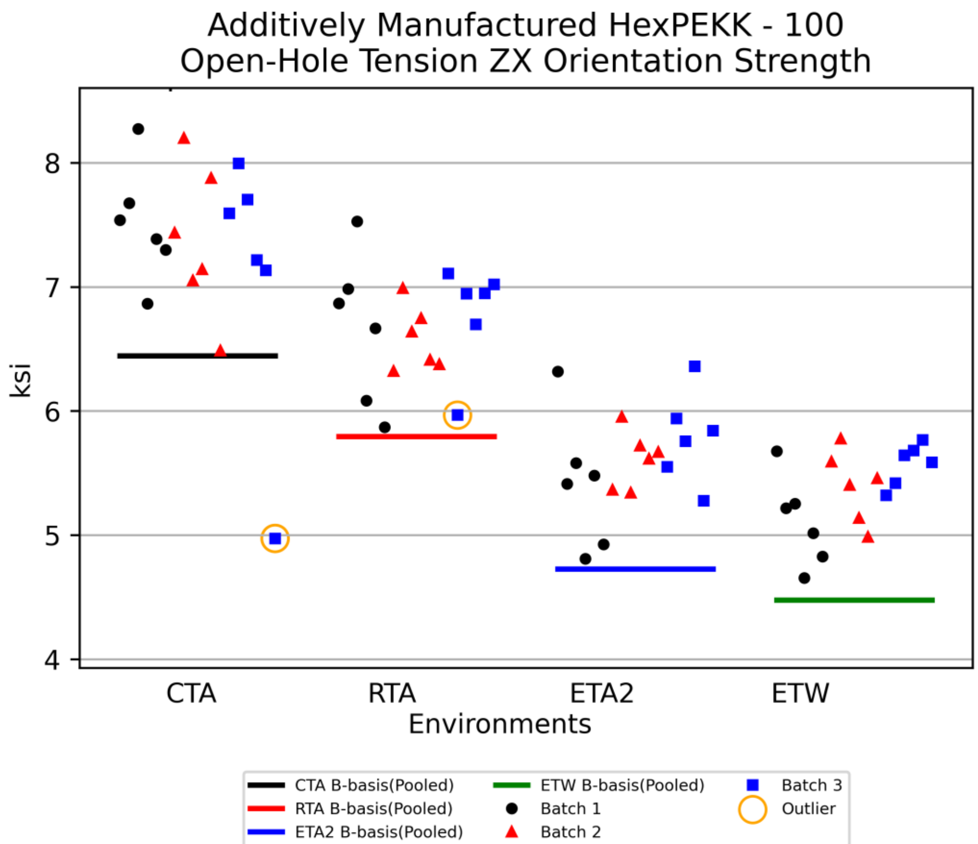

Figure 4-51: Plot for OHT ZX Orientation Strength

Open-Hole Tension ZX Orientation Basis Values and Statistics				
	Strength [ksi]			
Env	CTA(-65°F)	RTA(70°F)	ETA2(250°F)	ETW(250°F)
Mean	7.324	6.676	5.606	5.356
Stdev	0.7445	0.4341	0.4055	0.3315
CV	10.16	6.503	7.233	6.190
Min	4.973	5.870	4.808	4.654
Max	8.273	7.529	6.359	5.777
No. Batches	3	3	3	3
No. Spec.	18	18	18	18
Basis Values and Estimates				
B-Basis	6.444	5.796	4.726	4.476
A-Estimate	5.864	5.216	4.146	3.896
Method	Pooled	Pooled	Pooled	Pooled

Table 4-66: Statistics for OHT ZX Orientation Strength

4.34 Open-Hole Tension ZX45 Orientation

This test method was performed for one property: tensile strength in conditions CTA, RTA, and ETW. All conditions passed normality test, so normal method was used for computing design values. Since the number of specimens is less than 18, the results are B-estimates rather than B-basis values.

No statistical outliers were detected in the data.

Statistics and design values for the strength data are given in Table 4-67. The data and B-values for strength data are shown graphically in Figure 4-52.

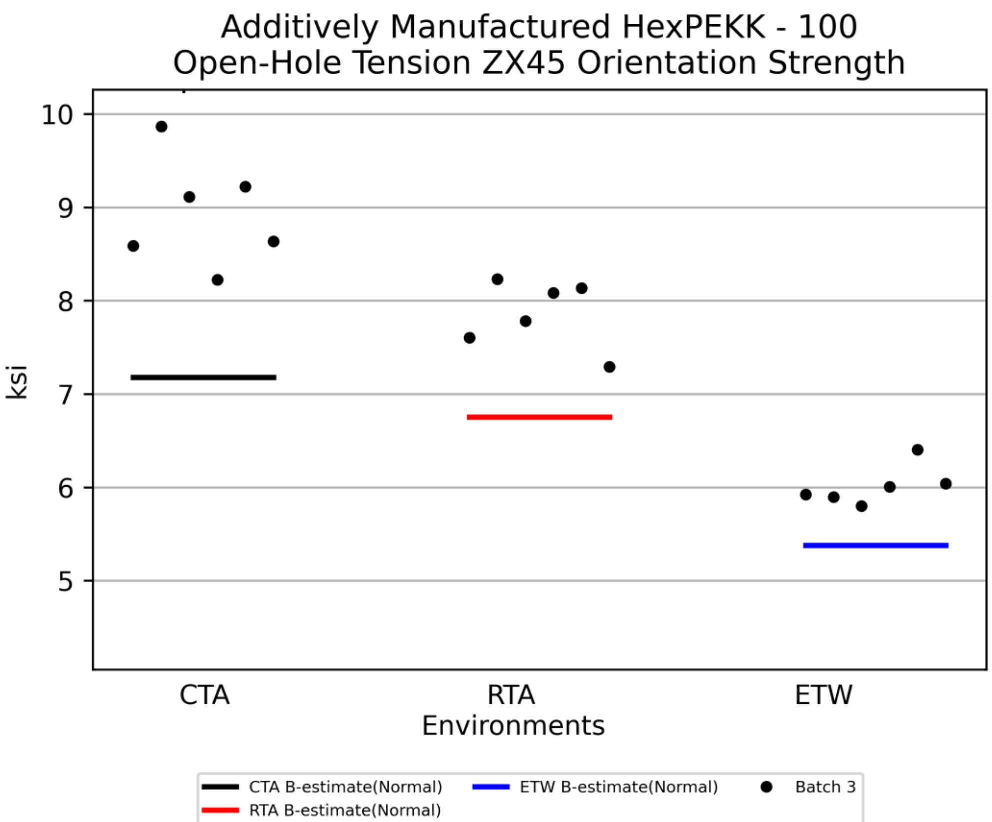

Figure 4-52: Plot for OHT ZX45 Orientation Strength

Open-Hole Tension ZX45 Orientation Basis Values and Statistics			
	Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	8.942	7.854	6.011
Stdev	0.5824	0.3631	0.2096
CV	6.513	4.623	3.486
Min	8.225	7.291	5.800
Max	9.867	8.231	6.402
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	7.178	6.754	5.376
A-Estimate	5.924	5.972	4.925
Method	Normal	Normal	Normal

Table 4-67: Statistics for OHT ZX45 Orientation Strength

4.35 Punch Shear Hole (PSH) XY Orientation

This test method was performed for one property: maximum shear strength in conditions CTA, RTA, ETA1, ETA2, and ETW. For maximum shear strength, all conditions but RTA passed normality test, so normal method was used for computing design values. RTA condition failed ADK test, so ANOVA method was used. Since RTA condition has less than 5 batches, ANOVA method produces a B-estimate rather than a B-basis value. There were insufficient specimens tested in the ETA1 condition to compute A- and B-basis values publishable in CMH17, so only estimates can be provided for that environmental condition.

One statistical outlier was detected in the data. A batch lower outlier for maximum shear strength property in condition ETA2 batch two. It was retained for this analysis.

Statistics and design values for the strength data are given in Table 4-68. The data and B-values for strength data are shown graphically in Figure 4-53.

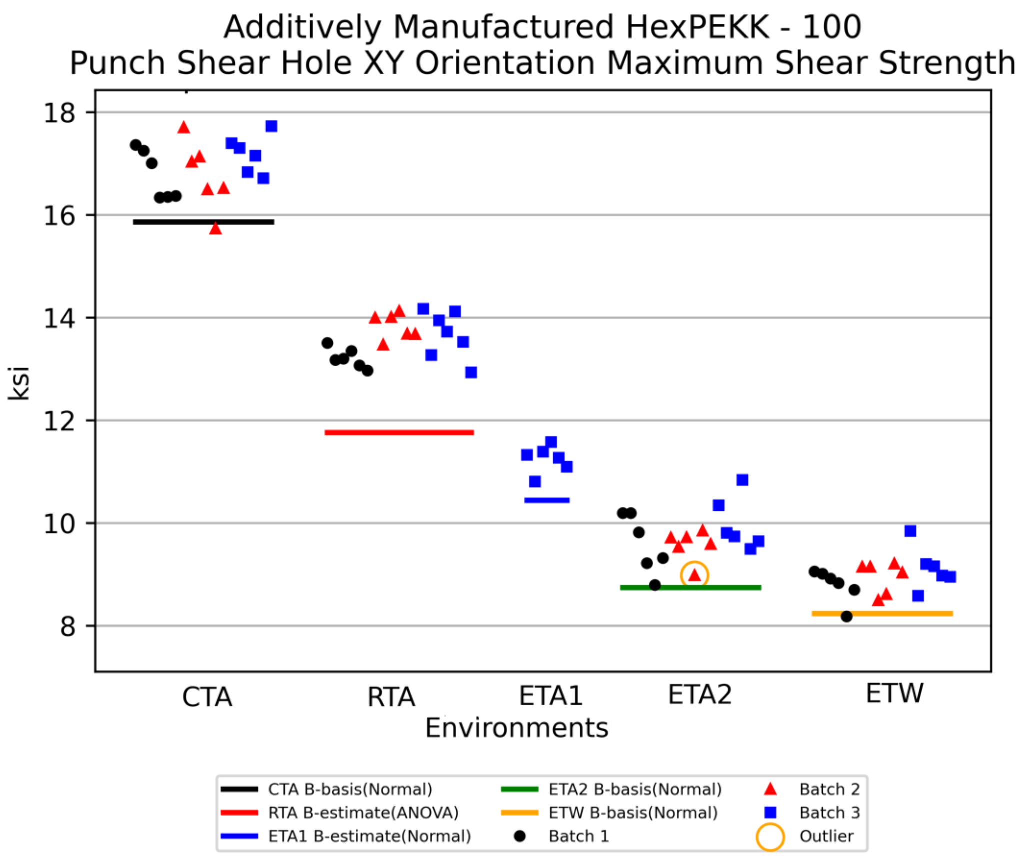

Figure 4-53: Plot for PSH XY Orientation Maximum Shear Strength

Punch Shear Hole XY Orientation Basis Values and Statistics					
	Maximum Shear Strength [ksi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	16.91	13.57	11.24	9.707	8.944
Stdev	0.5314	0.4075	0.2643	0.4878	0.3587
CV	3.143	3.003	2.352	5.026	4.011
Min	15.73	12.93	10.81	8.790	8.179
Max	17.72	14.17	11.57	10.83	9.838
No. Batches	3	3	1	3	3
No. Spec.	18	19	6	18	18
Basis Values and Estimates					
B-Basis	15.86			8.744	8.236
B-Estimate		11.76	10.44		
A-Estimate	15.12	10.46	9.870	8.061	7.734
Method	Normal	ANOVA	Normal	Normal	Normal

Table 4-68: Statistics for PSH XY Orientation Maximum Shear Strength

4.36 Punch Shear Hole (PSH) ZX Orientation

This test method was performed for one property: maximum shear strength in conditions CTA, RTA, ETA1, ETA2, and ETW. For maximum shear strength, CTA and RTA passed pooling tests, so pooling method was used for computing design values. ETA1, ETA2, and ETW passed normality test, so normal method was used. Since ETA1 condition has less than 18 specimens, normal method produces a B-estimate rather than a B-basis value.

One statistical outlier was detected in the data. A batch higher outlier for maximum shear strength property in condition RTA2 batch one. It was retained for this analysis.

Statistics and design values for the strength data are given in Table 4-69. The data and B-values for strength data are shown graphically in Figure 4-54.

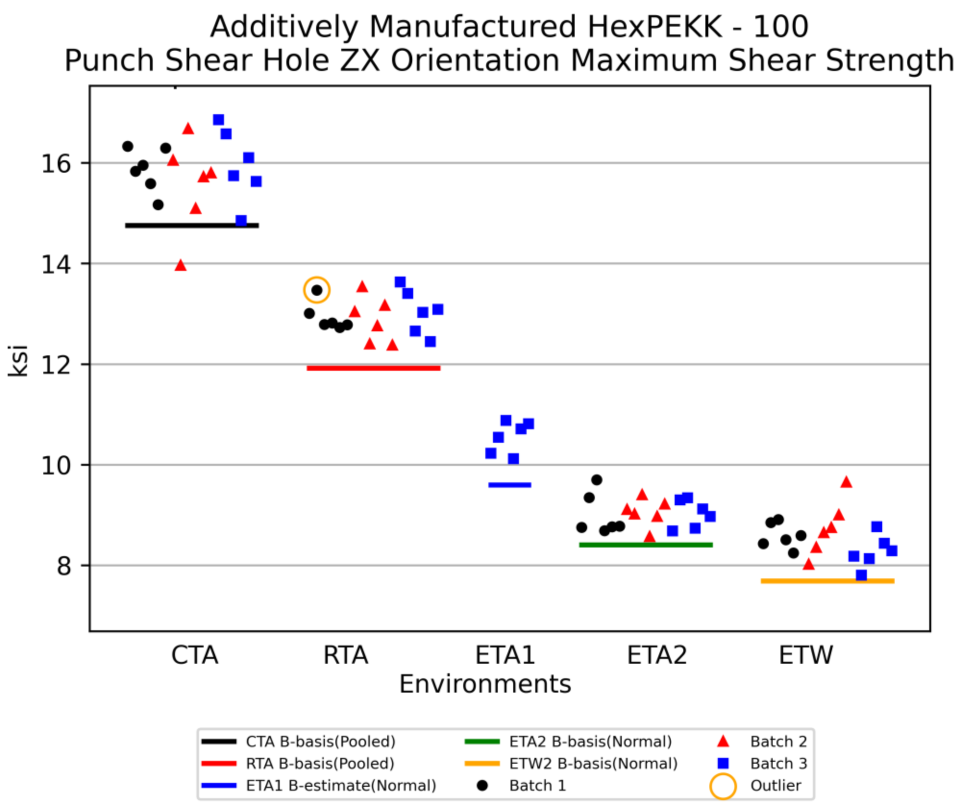

Figure 4-54: Plot for PSH ZX Orientation Maximum Shear Strength

Punch Shear Hole ZX Orientation Basis Values and Statistics					
	Maximum Shear Strength [ksi]				
Env	CTA(-65°F)	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW2(250°F)
Mean	15.79	12.95	10.55	9.027	8.532
Stdev	0.7052	0.3838	0.3144	0.3126	0.4276
CV	4.466	2.963	2.980	3.463	5.011
Min	13.96	12.38	10.12	8.568	7.802
Max	16.86	13.63	10.88	9.699	9.650
No. Batches	3	3	1	3	3
No. Spec.	18	18	6	18	18
Basis Values and Estimates					
B-Basis	14.76	11.92		8.410	7.688
B-Estimate			9.596		
A-Estimate	14.05	11.21	8.919	7.972	7.090
Method	Pooled	Pooled	Normal	Normal	Normal

Table 4-69: Statistics for PSH ZX Orientation Maximum Shear Strength

4.37 Punch Shear Hole (PSH) ZX45 Orientation

This test method was performed for one property: maximum shear strength in conditions CTA, RTA, and ETW. For maximum shear strength, all three conditions passed normality test, so normal method was used. Since each condition has less than 18 specimens, normal method produces a B-estimate rather than a B-basis value.

No statistical outlier was detected in the data.

Statistics and design values for the strength data are given in Table 4-70. The data and B-values for strength data are shown graphically in Figure 4-55.

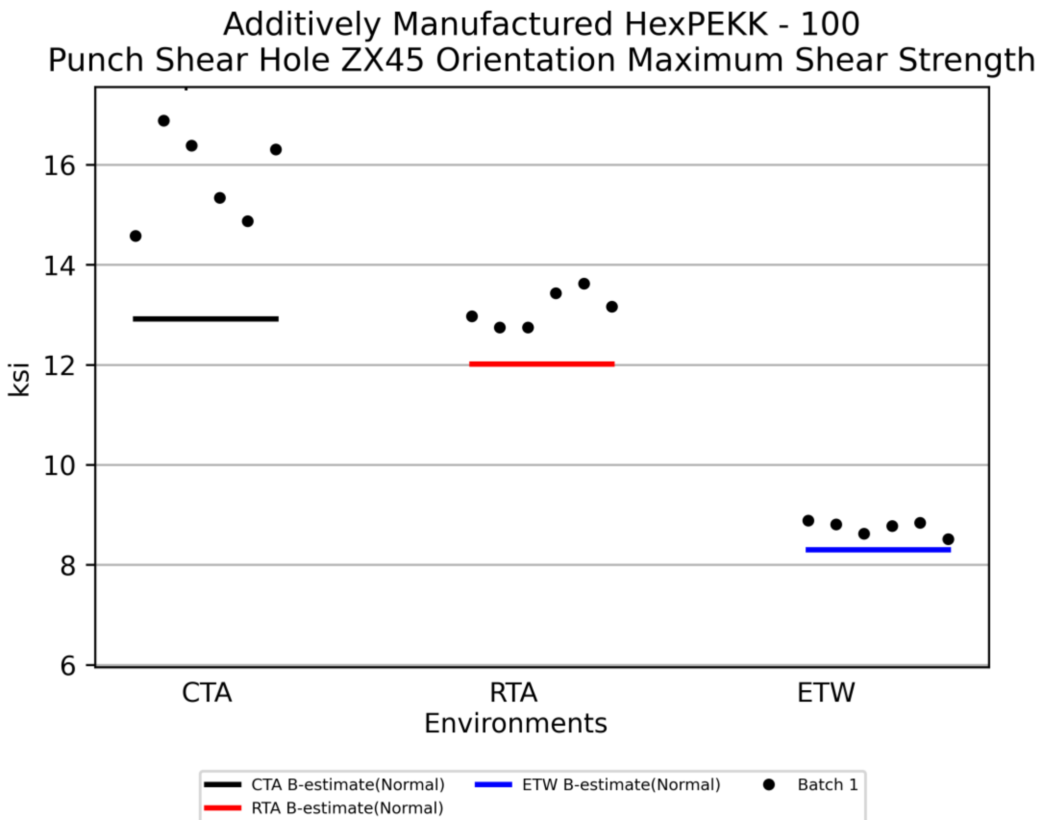

Figure 4-55: Plot for PSH ZX45 Orientation Maximum Shear Strength

Punch Shear Hole ZX45 Orientation Basis Values and Statistics			
	Maximum Shear Strength [ksi]		
Env	CTA(-65°F)	RTA(70°F)	ETW(250°F)
Mean	15.73	13.11	8.740
Stdev	0.9276	0.3624	0.1433
CV	5.898	2.764	1.640
Min	14.58	12.74	8.511
Max	16.88	13.62	8.883
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	12.92	12.01	8.306
A-Estimate	10.92	11.23	7.997
Method	Normal	Normal	Normal

Table 4-70: Statistics for PSH ZX45 Orientation Maximum Shear Strength

4.38 Single-Shear Bearing (SSB) XY Orientation

This test method was performed for 2% offset strength and ultimate strength properties in RTA, ETA1, ETA2 and ETW conditions. For 2% offset strength, RTA condition has no data because failure occurred before 2% offset strength. ETA1 condition has too few specimens, so design values are not available (NA), while ETA2 and ETW passed normality test, so normal method was used. Since ETA2 has less than 18 specimens, it produces a B-estimate rather than B-basis value. For ultimate strength, RTA, ETA1, and ETW conditions passed normality test, so normal method was used, while ETA2 failed ADK test, so ANOVA method was used. Since ETA2 condition has less than 5 batches, it produces a B-estimate rather than a B-basis value.

Two statistical outliers were detected. A condition and batch higher outlier for ultimate strength property in condition ETA1 and batch 3. A batch higher lower for ultimate strength property in condition ETA2 and batch 2.

Statistics are given for the 2% offset strength property in Table 4-71 and for ultimate strength property in Table 4-72. The data for 2% offset strength property are shown graphically in Figure 4-56 and for ultimate strength in Figure 4-57.

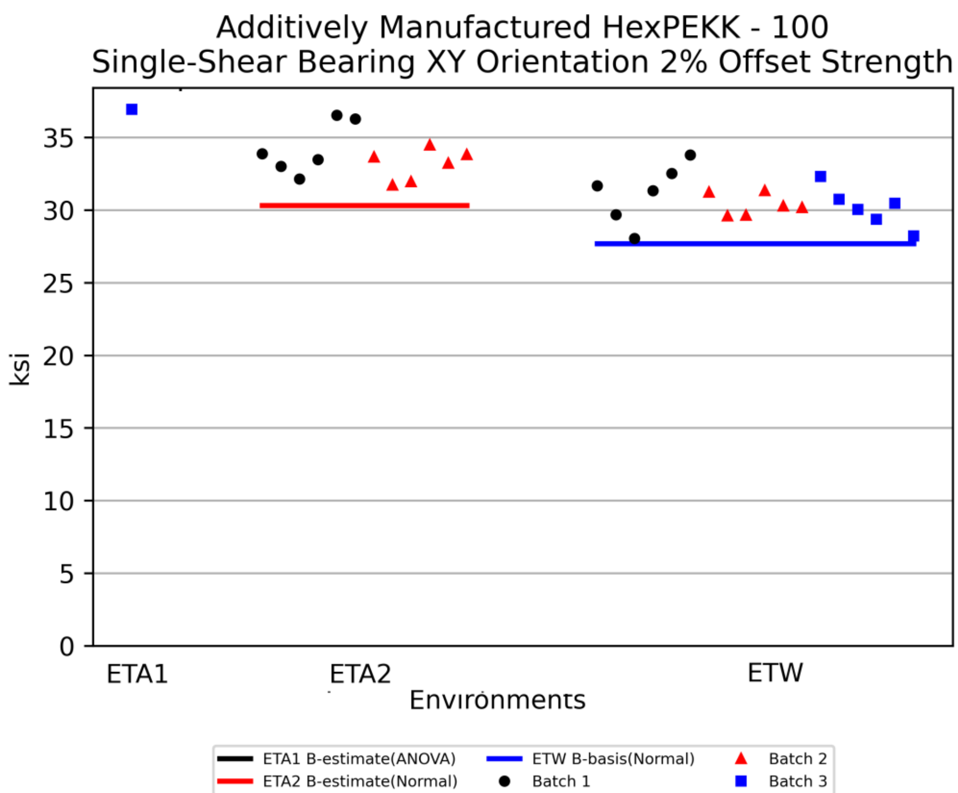

Figure 4-56: Plot for SSB XY Orientation 2% Offset Strength

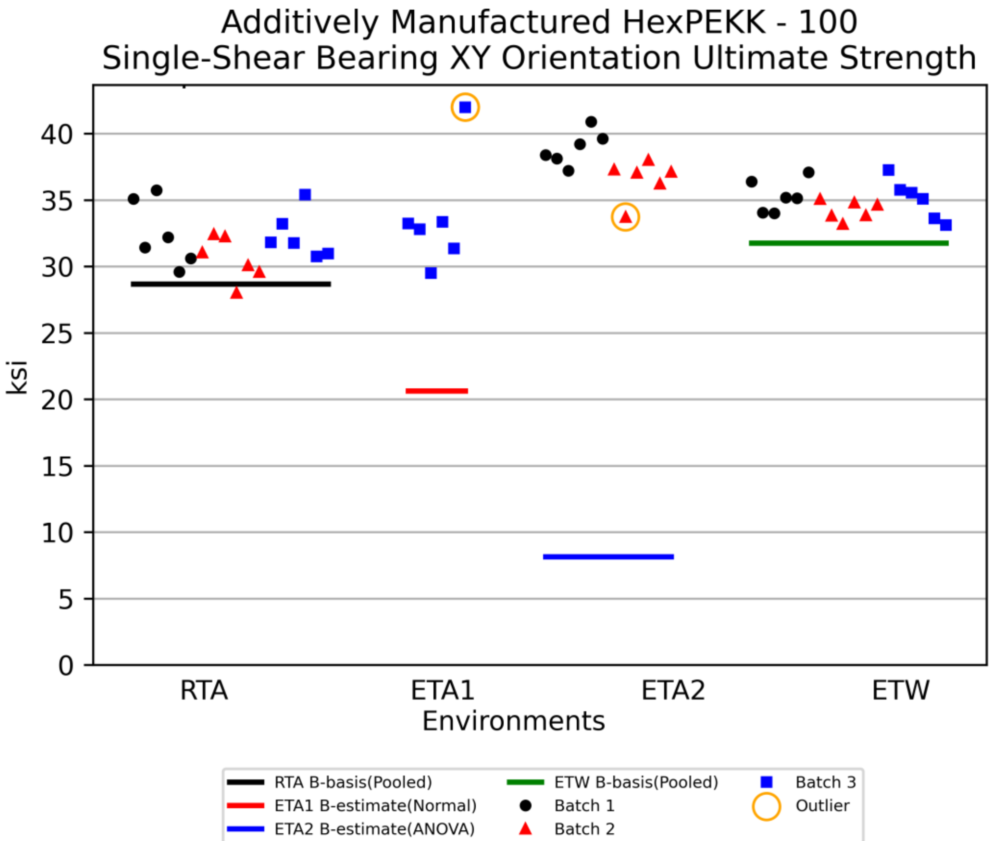

Figure 4-57: Plot for SSB XY Orientation Ultimate Strength

Single-Shear Bearing XY Orientation Basis Values and Statistics			
	2% Offset Strength [ksi]		
Env	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	36.93	33.67	30.57
Stdev	NA	1.520	1.465
CV	NA	4.514	4.792
Min	36.93	31.71	28.04
Max	36.93	36.51	33.78
No. Batches	1	2	3
No. Spec.	1	12	18
Basis Values and Estimates			
B-Basis	NA		27.68
B-Estimate		30.30	
A-Estimate		27.95	25.63
Method		Normal	Normal

Table 4-71: Statistics for SSB XY Orientation 2% Offset Strength

Single-Shear Bearing XY Orientation Basis Values and Statistics				
	Ultimate Strength [ksi]			
Env	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW(250°F)
Mean	31.77	33.70	37.73	34.86
Stdev	2.074	4.313	1.813	1.224
CV	6.528	12.80	4.804	3.512
Min	27.99	29.50	33.72	33.12
Max	35.74	41.99	40.90	37.26
No. Batches	3	1	2	3
No. Spec.	18	6	12	18
Basis Values and Estimates				
B-Basis	27.68			32.45
B-Estimate		20.64	8.143	
A-Estimate	24.78	11.35	NA	30.73
Method	Normal	Normal	ANOVA	Normal

Table 4-72: Statistics for SSB XY Orientation Ultimate Strength

4.39 Single-Shear Bearing (SSB) XZ Orientation

This test method was performed for 2% offset strength and ultimate strength properties in RTA and ETW conditions. For 2% offset strength, RTA condition has no data because failure occurring before reaching 2% offset strength. ETW passed normality test, so normal method was used for computing design values. For ultimate strength, RTA and ETW conditions passed normality test, so normal method was used. All the above conditions have less than 18 specimens, so the computation produces B-estimate values rather than B-basis values.

No statistical outliers were detected.

Statistics are given for the strength properties in Table 4-73. The data for 2% offset strength property are shown graphically in Figure 4-58 and for ultimate strength in Figure 4-59.

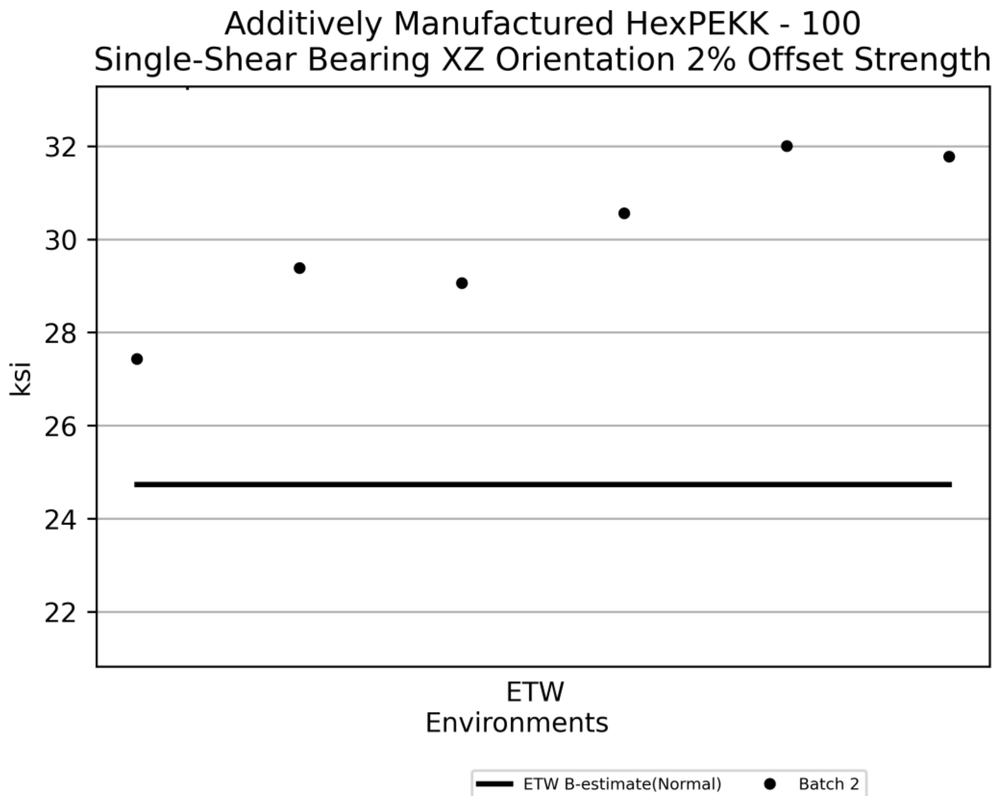

Figure 4-58: Plot for SSB XZ Orientation 2% Offset Strength

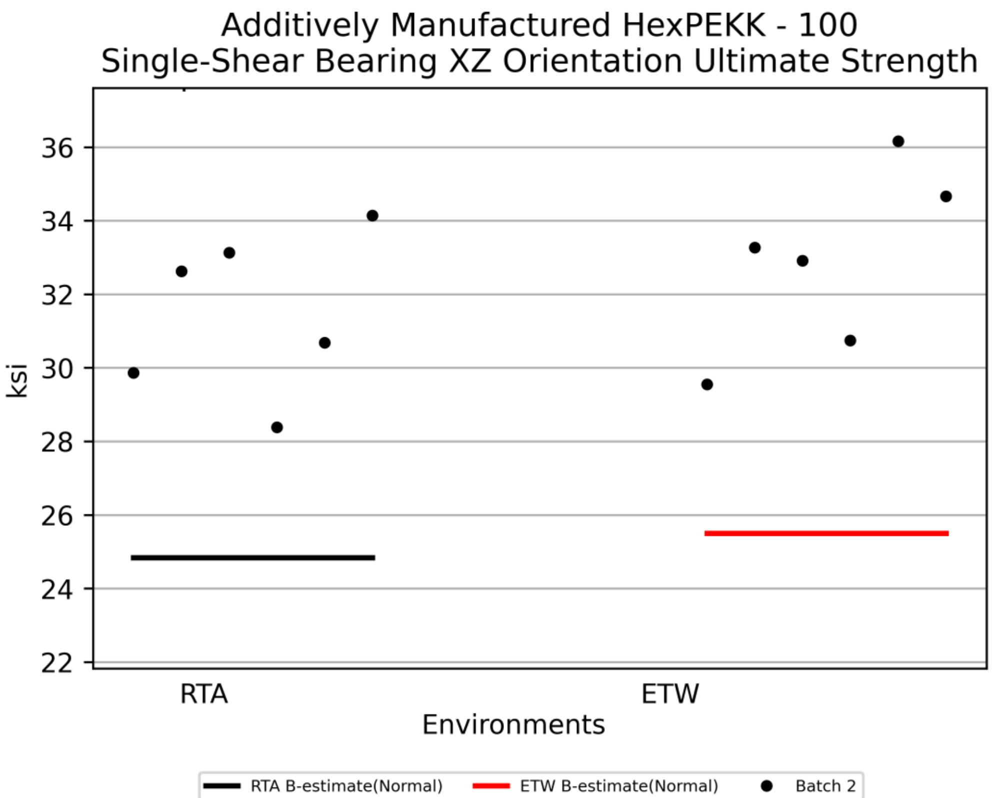

Figure 4-59: Plot for SSB XZ Orientation Ultimate Strength

Single-Shear Bearing XZ Orientation Basis Values and Statistics			
	2% Offset Strength [ksi]	Ultimate Strength [ksi]	
Env	ETW(250°F)	RTA(70°F)	ETW(250°F)
Mean	30.04	31.47	32.88
Stdev	1.751	2.189	2.439
CV	5.830	6.956	7.416
Min	27.43	28.38	29.56
Max	32.00	34.14	36.16
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	24.73	24.84	25.50
A-Estimate	20.96	20.12	20.24
Method	Normal	Normal	Normal

Table 4-73: Statistics for SSB XZ Orientation Strength Properties

4.40 Single-Shear Bearing (SSB) YX Orientation

This test method was performed for 2% offset strength and ultimate strength properties in RTA and ETW conditions. For 2% offset strength, RTA condition has no data because failure occurred before reaching 2% offset strength. ETW passed normality test, so normal method was used for computing design values. For ultimate strength, RTA and ETW conditions passed normality test, so normal method was used. All the above conditions have less than 18 specimens, so the computation produces B-estimate values rather than a B-basis values.

No statistical outliers were detected.

Statistics are given for the strength properties in Table 4-74. The data for 2% offset strength property are shown graphically in Figure 4-60 and for ultimate strength in Figure 4-61.

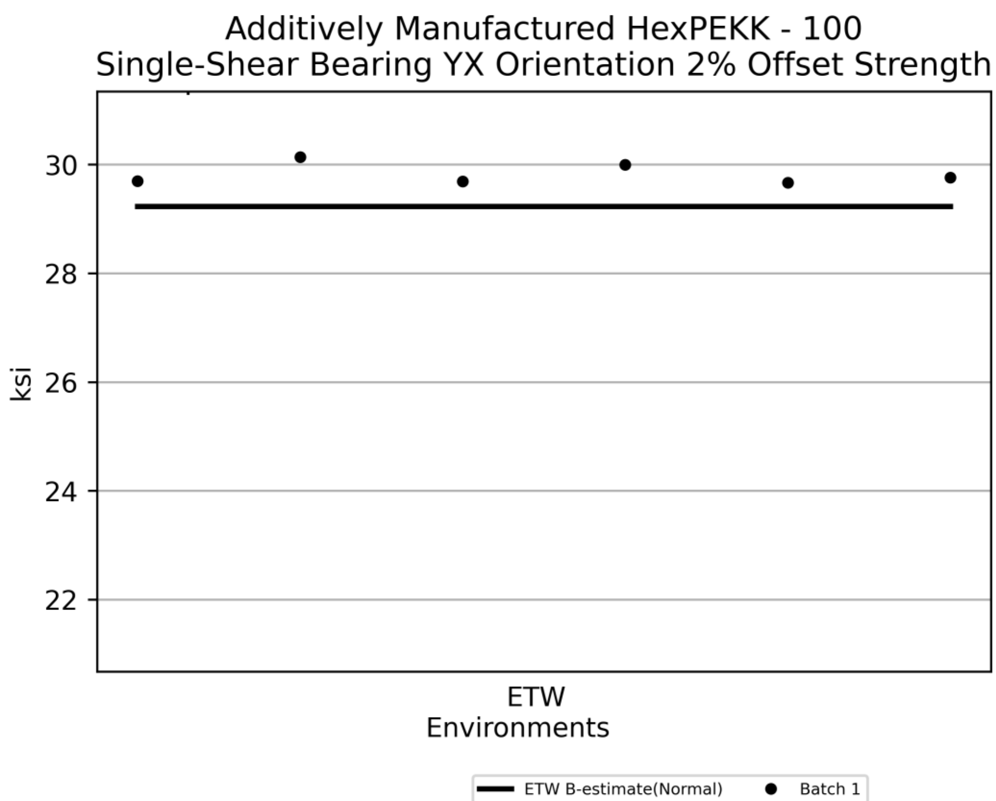

Figure 4-60: Plot for SSB YX Orientation 2% Offset Strength

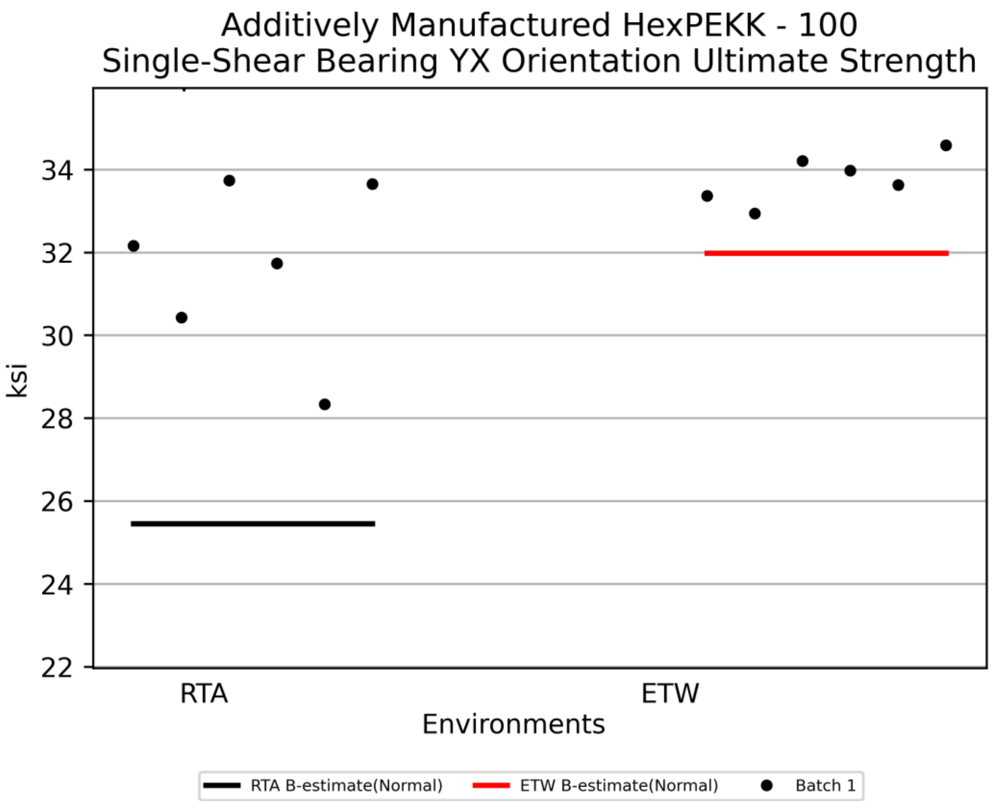

Figure 4-61: Plot for SSB YX Orientation Ultimate Strength

Single-Shear Bearing YX Orientation Basis Values and Statistics			
	2% Offset Strength [ksi]	Ultimate Strength [ksi]	
Env	ETW(250°F)	RTA(70°F)	ETW(250°F)
Mean	29.82	31.67	33.78
Stdev	0.1967	2.053	0.5956
CV	0.6595	6.482	1.763
Min	29.66	28.34	32.94
Max	30.14	33.73	34.58
No. Batches	1	1	1
No. Spec.	6	6	6
Basis Values and Estimates			
B-Estimate	29.23	25.45	31.98
A-Estimate	28.80	21.03	30.70
Method	Normal	Normal	Normal

Table 4-74: Statistics for SSB YX Orientation Strength Properties

4.41 Single-Shear Bearing (SSB) ZX Orientation

This test method was performed for 2% offset strength and ultimate strength properties in RTA, ETA1, ETA2, and ETW conditions. For 2% offset strength, RTA and ETA1 conditions have no data because failure occurred before reaching 2% offset strength. Conditions ETA2 and ETW passed normality test, so normal method was used for computing design values. For ultimate strength, conditions RTA, ETA2, and ETW passed normality test, so normal method was used, while condition ETA1 has insufficient data, so design values are not available (NA). When the condition has less than 18 specimens, the computation produces a B-estimate value rather than a B-basis value.

One statistical outlier was detected. A batch higher outlier for 2% offset strength in condition ETW and batch one. It was retained for this analysis.

Statistics are given for the 2% offset strength in Table 4-75 and for ultimate strength in Table 4-76. The data for 2% offset strength are shown graphically in Figure 4-62 and for ultimate strength in Figure 4-63.

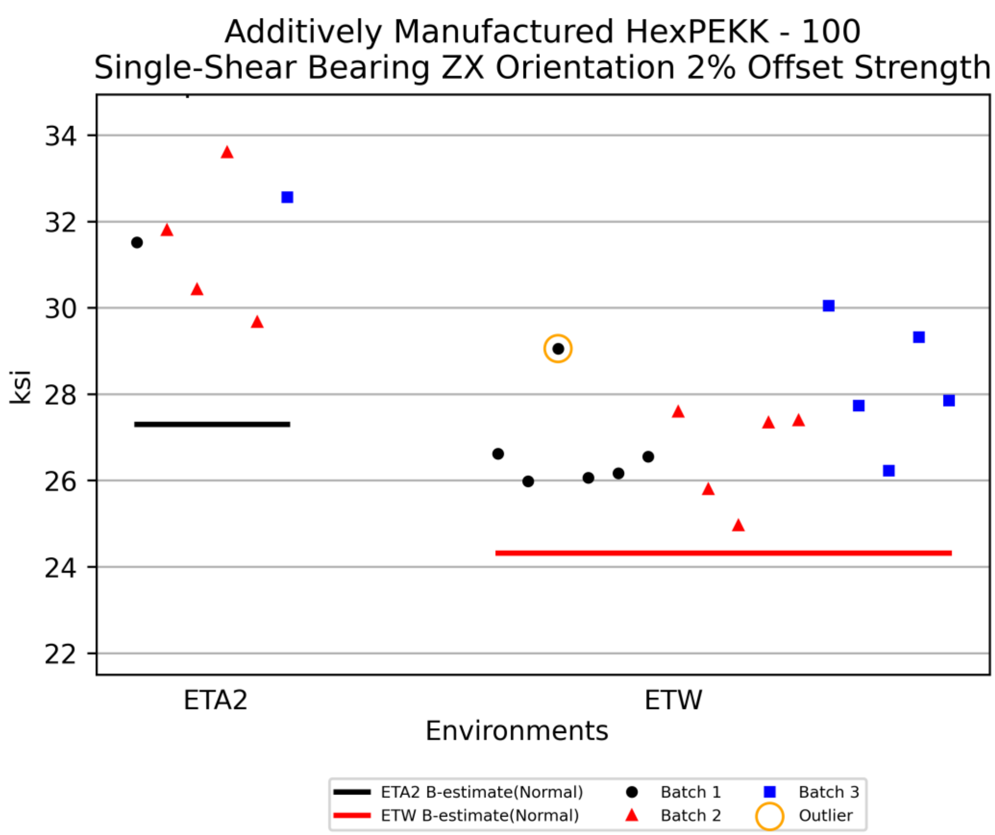

Figure 4-62: Plot for SSB ZX Orientation 2% Offset Strength

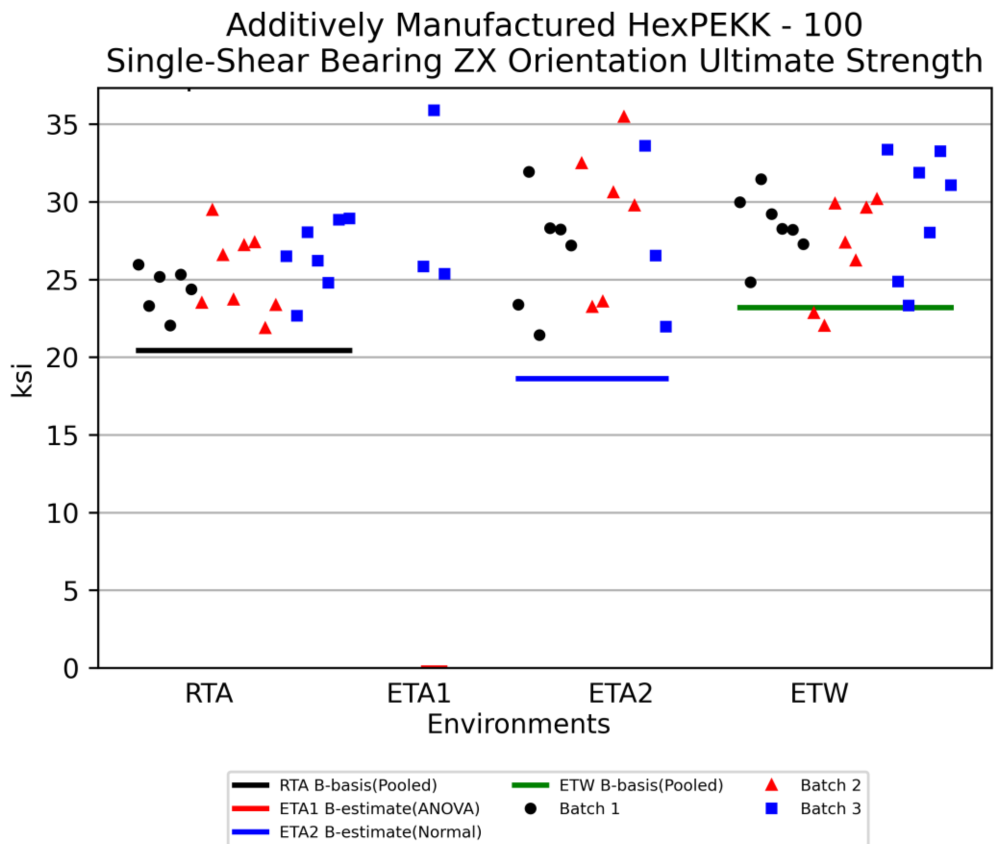

Figure 4-63: Plot for SSB ZX Orientation Ultimate Strength

Single-Shear Bearing ZX Orientation Basis Values and Statistics		
	2% Offset Strength [ksi]	
Env	ETA2(250°F)	ETW(250°F)
Mean	31.60	27.17
Stdev	1.418	1.402
CV	4.489	5.159
Min	29.67	24.96
Max	33.60	30.05
No. Batches	3	3
No. Spec.	6	16
Basis Values and Estimates		
B-Estimate	27.30	24.32
A-Estimate	24.24	22.30
Method	Normal	Normal

Table 4-75: Statistics for SSB ZX Orientation 2% Offset Strength

Single-Shear Bearing ZX Orientation Basis Values and Statistics				
	Ultimate Strength [ksi]			
Env	RTA(70°F)	ETA1(180°F)	ETA2(250°F)	ETW2(250°F)
Mean	25.48	29.03	27.84	28.24
Stdev	2.304	5.953	4.457	3.288
CV	9.043	20.51	16.01	11.64
Min	21.86	25.36	21.43	22.00
Max	29.46	35.90	35.46	33.36
No. Batches	3	1	3	3
No. Spec.	21	3	15	21
Basis Values and Estimates				
B-Basis	21.09	NA		21.98
B-Estimate			18.62	
A-Estimate	17.96		12.12	17.51
Method	Normal		Normal	Normal

Table 4-76: Statistics for SSB ZX Orientation Ultimate Strength

4.42 Single-Shear Bearing (SSB) ZX45 Orientation

This test method was performed for 2% offset strength and ultimate strength properties in RTA and ETW conditions. For 2% offset strength, condition RTA has no data because failure occurred before reaching 2% offset strength. Conditions ETW passed normality test, so normal method was used for computing design values. For ultimate strength, conditions RTA and ETW passed normality test, so normal method was used. Since the conditions above have less than 18 specimens, the computation produces B-estimate values rather than a B-basis values.

One statistical outlier was detected. A condition and batch lower outlier for ultimate strength in condition ETW and batch three. It was retained for this analysis.

Statistics are given for the 2% offset strength and ultimate strength data in Table 4-77. The data for 2% offset strength are shown graphically in Figure 4-64 and for ultimate strength in Figure 4-65.

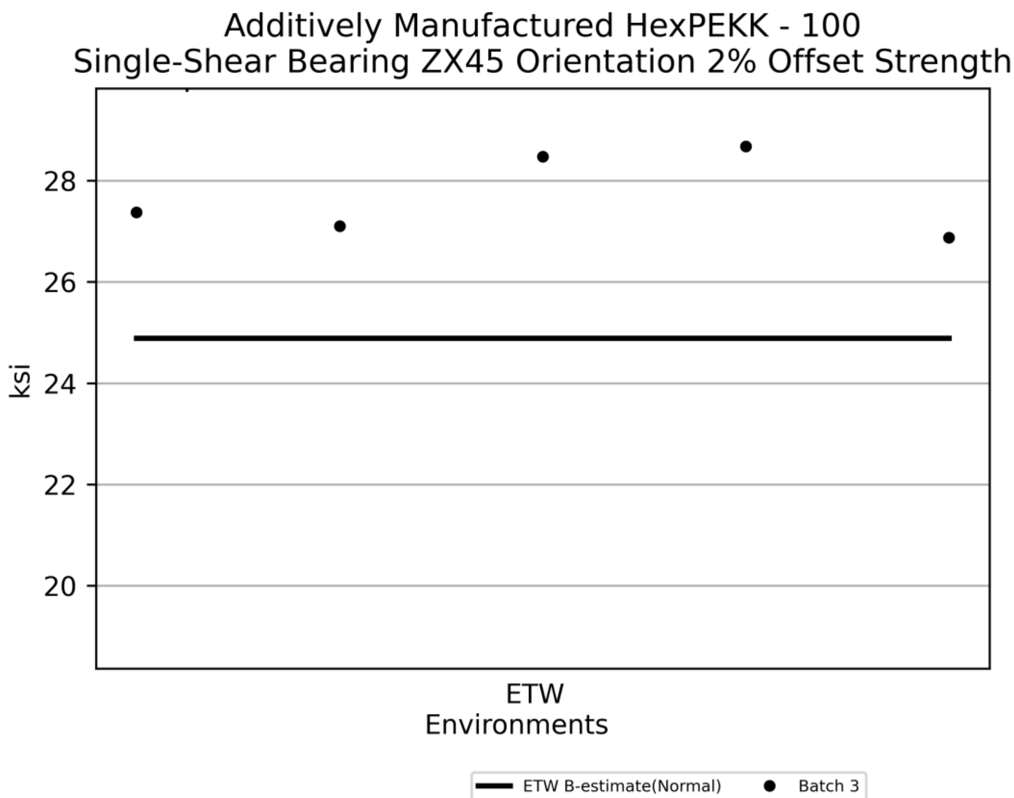

Figure 4-64: Plot for SSB ZX45 Orientation 2% Offset Strength

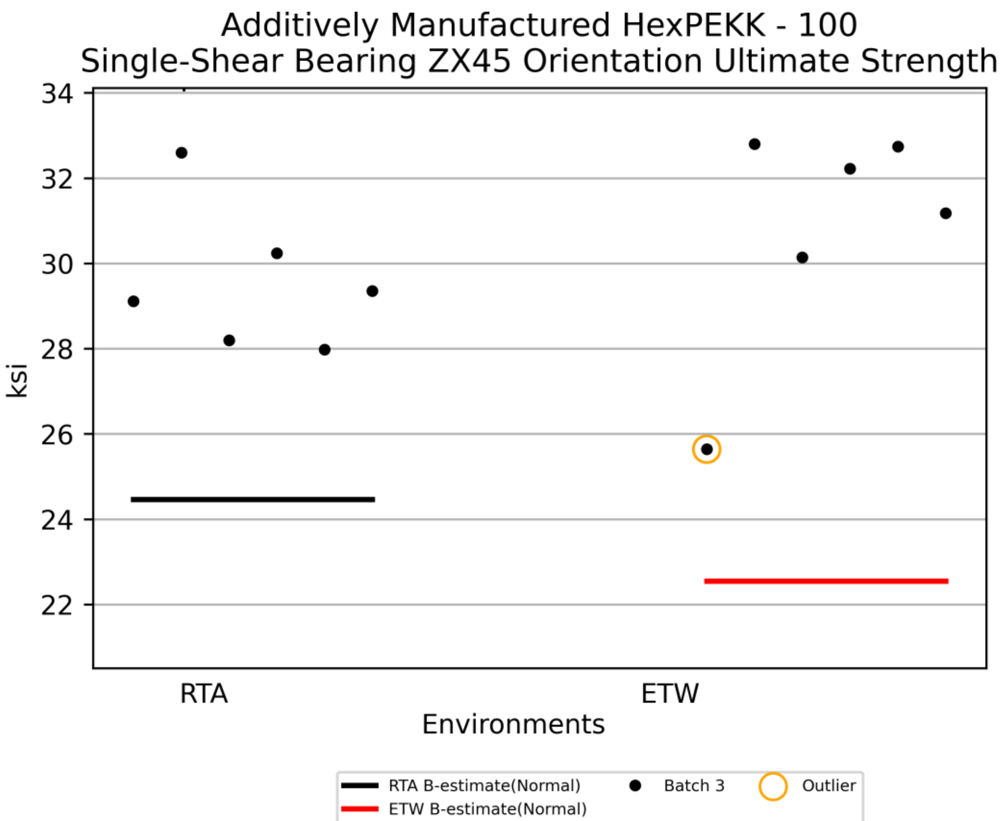

Figure 4-65: Plot for SSB ZX45 Orientation Ultimate Strength

Single-Shear Bearing ZX45 Orientation Basis Values and Statistics			
	2% Offset Strength [ksi]	Ultimate Strength [ksi]	
Env	ETW(250°F)	RTA(70°F)	ETW(250°F)
Mean	27.70	29.58	30.79
Stdev	0.8214	1.690	2.720
CV	2.965	5.714	8.834
Min	26.87	27.98	25.64
Max	28.67	32.60	32.80
No. Batches	1	1	1
No. Spec.	5	6	6
Basis Values and Estimates			
B-Estimate	24.89	24.46	22.55
A-Estimate	22.85	20.82	16.69
Method	Normal	Normal	Normal

Table 4-77: Statistics for SSB ZX45 Orientation 2% Offset & Ultimate Strength

5. Outliers

Outliers were identified according to the standards documented in section 2.1.4, which are in accordance with the guidelines developed in section 8.3.3 of CMH-17-1G. A specimen may be an outlier for the batch only (before pooling the batches within a condition together) or for the condition (after pooling the 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 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 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-2023-007 Rev N/C.

Outliers for which no causes could be identified are listed in Table 5-1. These outliers were included in the analysis for their respective test properties.

Test Method	Orien-tation	Property	Condi-tion	Batch	Specimen Number	Value	High/Low	Batch Outlier	Condition Outlier
C	XY	2.0% Offset	RTA	1	HL-A-R2-13-XYC-2T-RTA-4	24.41	Low	No	Yes
C	XY	Strength	RTA	1	HL-A-R2-13-XYC-2T-RTA-4	24.44	Low	No	Yes
C	XY	2.0% Offset	RTA	3	HL-C-R10-5-XYC-3T-RTA-3	24.71	Low	Yes	No
C	XY	Strength	RTA	3	HL-C-R10-5-XYC-3T-RTA-3	24.77	Low	Yes	No
C	XY	2.0% Offset	ETW	3	HL-C-R11-6-XYC-3T-ETW-3	13.79	Low	Yes	No
C	ZX	Strength	ETW	1	HL-A-R17-11-ZXC-1T-ETW-17	18.46	High	Yes	No
FLEX	XY	Strength	RTA	2	HL-B-R15-18-XYF-1T-RTA-6	23.42	Low	Yes	No
FLEX	XY	Strength	ETA2	1	HL-A-R5-15-XYF-3T-ETA2-5	18.51	Low	Yes	No
FLEX	XY	Strength	ETA2	3	HL-C-R10-5-XYF-4T-ETA2-6	18.06	Low	Yes	No
FLEX	XY	0.2% Offset	RTA	3	HL-C-R7-4-XYF-4T-RTA-6	23.60	Low	Yes	No
FLEX	ZX	Strength	ETW	2	HL-B-R15-18-ZXF-2T-ETW-11	12.96	Low	Yes	No
DT	XY	0.2% Offset	CTA	3	HL-C-R7-4-XYT-5T-CTA-5	17.94	High	No	Yes
DT	XY	0.2% Offset	ETA2	1	HL-A-R16-10-XYT-5T-ETA2-6	6.879	Low	No	Yes
DT	XY	0.2% Offset	ETW	2	HL-B-R6-8-XYT-5T-ETW-6	6.072	Low	Yes	Yes
DT	XY	Strength	CTA	3	HL-C-R1-1-XYT-2B-CTA-1	15.73	Low	Yes	No
DT	ZX45	0.2% Offset	ETW	2	HL-B-R13-9-ZX45T-2T-ETW-19	5.891	Low	One batch	One batch
DT	ZX	0.2% Offset	ETA2	1	HL-A-R16-10-ZXT-5T-ETA2-12	5.830	Low	Yes	Yes
DT	ZX	Strength	RTA	2	HL-B-R15-18-ZXT-5B-RTA-10	8.587	Low	No	Yes
DT	ZX	Strength	ETA2	3	HL-C-R11-6-ZXT-3T-ETA2-18	7.809	Low	Yes	No
FHT	XY	Strength	CTA	2	HL-B-R4-7-XYFHT-5B-CTA-3	13.06	Low	Yes	Yes
FHT	XY	Strength	ETA2	1	HL-A-R18-12-XYFHT-4B-ETA2-4	9.848	High	Yes	No
FHT	ZX	Strength	RTA	2	HL-B-R14-17-ZXFHT-5T-RTA-11	9.752	Low	Yes	No
FHT	ZX	Strength	ETA2	1	HL-A-R3-14-ZXFHT-3B-ETA2-7	5.901	Low	No	Yes
FHT	ZX	Strength	ETA2	2	HL-B-R9-16-ZXFHT-5T-ETA2-12	7.409	Low	Yes	No
FHT	ZX45	Strength	CTA	1	HL-A-R18-12-ZX45FHT-4B-CTA-16	10.59	Low	One batch	One batch
OHT	ZX	Strength	CTA	3	HL-C-R7-4-ZXOHT-1T-CTA-9	4.973	Low	Yes	Yes
OHT	ZX	Strength	RTA	3	HL-C-R10-5-ZXOHT-4T-RTA-12	5.966	Low	Yes	No
PSH	XY	Maximum Shear	ETA2	2	HL-B-R9-16-XYPSH-1T-ETA2-3	8.978	Low	Yes	No
PSH	ZX	Maximum Shear	RTA	1	HL-A-R17-11-ZXPSH-1B-RTA-7	13.47	High	Yes	No
SSB	XY	Ultimate Strength	ETA1	3	HL-C-R7-4-XYSSB-1T-ETA1-6	41.99	High	Yes	Yes
SSB	XY	Ultimate Strength	ETA2	2	HL-B-R13-9-XYSSB-3T-ETA2-3	33.72	Low	Yes	No
SSB	ZX	2% Offset	ETW	1	HL-A-R17-11-ZXSSB-1T-ETW-9	29.06	High	Yes	No
SSB	ZX45	Ultimate Strength	ETW	3	HL-C-R1-1-ZX45SSB-3B-ETW-14	25.64	Low	One batch	One batch

Table 5-1: List of Outliers

6. References

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