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## **1. Introduction**



*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 NMS 122/1.*


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## **2. Background**

### **2.1 CMH17 STATS Statistical Formulas and Computations**

#### **2.1.1 Basic Descriptive Statistics**



$$b_B f \frac{\sqrt{f}}{\sqrt{f}} \frac{f}{f} \frac{f\sqrt{f}}{f\sqrt{f}}$$

Equation 10

$$c_B f \frac{\sqrt{f}}{\sqrt{f}} \frac{f}{f} \frac{f\sqrt{f}}{f\sqrt{f}}$$

Equation 11

$$b_A f \frac{\sqrt{f}}{\sqrt{f}} \frac{f}{f} \frac{f\sqrt{f}}{f\sqrt{f}}$$

Equation 12

$$\frac{\sqrt{f}}{\sqrt{f}}$$

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$$\begin{aligned} a & \quad g \quad k \quad \quad \quad g \quad S \\ b & \quad g \quad k \quad Tk \quad g \quad T \quad S \quad T \quad g \\ c & \quad T \quad g \quad k \quad T \quad g \quad k \quad T \quad S \quad T \\ d & \quad T \quad k \quad Tk \\ S & \quad \begin{matrix} k \\ \hline i \quad n_i \end{matrix} \\ T & \quad \begin{matrix} n \\ \hline i \quad i \end{matrix} \\ g & \quad \begin{matrix} n & n \\ \hline i & j \quad i \quad n \quad i \quad j \end{matrix} \end{aligned}$$

**2.1.8 Levene’s Test for Equality of Coefficient of Variation**

$$w_{ij} = |y_{ij} - \bar{y}_i|$$

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

**Equation 32**

**2.1.9 Distribution Tests**

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

$$\frac{1}{\sqrt{n}}$$

$k_B$

$n$

$/n$

**Equation 33**

$$\frac{n}{n} \quad \sum_{i=1}^n x_i \quad \frac{\sum_{i=1}^n x_i}{n}$$

$$V_B$$

$$n \frac{\quad}{n}$$

Equation 45



**2.1.10.2 Non-parametric Basis Values for small samples**

$$B \quad x_r \frac{x}{x_r}^k$$

**Equation 50**

$$A \quad x_n \frac{x}{x_n}^k$$

**Equation 51**



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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

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### **2.1.11.1 Calculation of basis values using ANOVA**

$$u \frac{MSB}{MSE}$$

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### **3. Summary of Results**

#### **3.1 NCAMP Recommended B-basis Values**

**Lamina Strength Tests**

					<b>0.2% Offset</b>	<b>5% Strain</b>				
B-basis	168.3	304.4	34.81	NA:A	6.159	11.58	15.34	210.7		91.28
Mean	188.5	358.9	39.49	15.29	6.834	13.14	16.77	232.2		102.2
CV	7.130	7.875	6.000	7.959	6.000	6.000	6.000	6.000		7.130
B-basis	157.5	285.3	27.12	12.08	4.763	8.379	12.67	179.6	NA:A	85.31
Mean	177.8	336.8	30.76	13.68	5.437	9.505	14.10	201.1	20.56	96.29
CV	6.479	8.842	6.000	6.000	6.000	6.000	6.000	6.303	7.201	6.479
B-basis	108.0	NA:A	15.21	5.951	1.519	4.025	6.727	116.8		57.81
Mean	128.2	364.6	17.20	6.750	1.800	4.565	8.161	138.3		68.78
CV	6.913	8.556	6.000	6.000	8.106	6.000	6.000	6.802		6.913

Notes: The modified CV B-basis value is recommended when available.  
 The CV provided corresponds with the B-basis value given.  
 NA implies that tests were run but data did not meet NCAMP recommended requirements.  
 "NA: A" indicates ANOVA with 3 batches, "NA: I" indicates insufficient data,







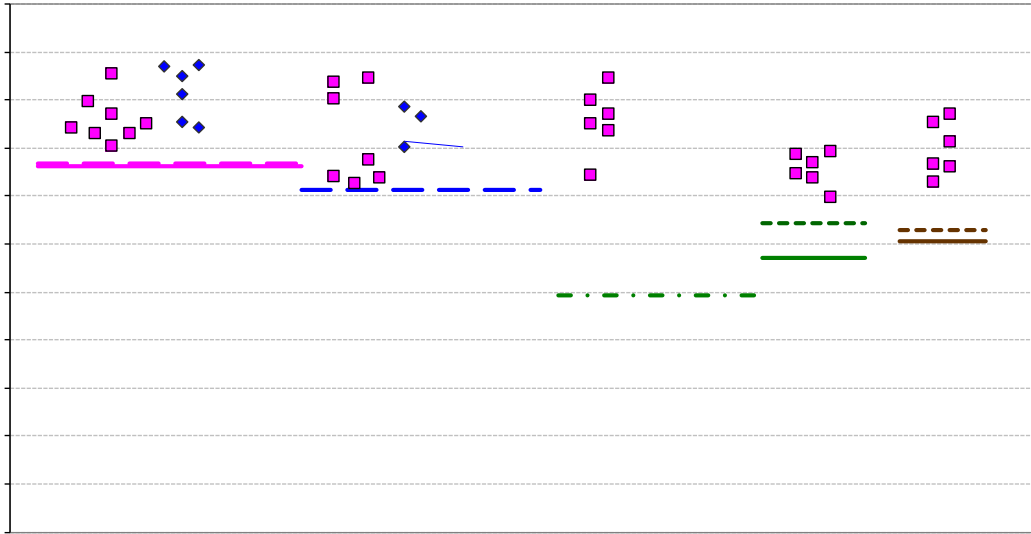


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#### **4. Test Results, Statistics, Basis Values, and Graphs**

## 4.1 Longitudinal Tension (LT)



Longitudinal Tension Modulus Statistics										
Env	Normalized					As-measured				
	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)
Mean	18.49	18.10	17.93	18.33	17.27	19.14	18.93	18.36	18.86	18.43
Stdev	0.5709	0.6202	0.6770	0.4136	0.2053	0.4001	0.4288	0.4488	0.3967	0.3645
CV	3.088	3.427	3.776	2.256	1.188	2.090	2.265	2.445	2.104	1.978
Mod CV	6.000	6.000	6.000	8.000	8.000	6.000	6.000	6.000	8.000	8.000
Min	17.33	16.92	16.70	17.80	17.12	18.61	18.41	17.54	18.38	17.78
Max	19.56	19.28	19.02	18.82	17.60	19.90	20.02	19.04	19.39	18.77
No. Batches	3	3	3	1	1	3	3	3	1	1
No. Spec.	18	18	18	6	6	18	18	18	6	6

Table 4-2: Statistics from LT Modulus data

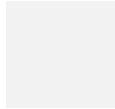
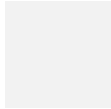


Env	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)
Mean	15.29	13.68	6.750	3.093	5.916
Stdev	1.217	0.5464	0.2050	0.07420	0.08599
CV	7.959	3.995	3.037	2.399	1.454
Mod CV	7.979	6.000	6.000	8.000	8.000
Min	12.01	12.26	6.368	3.013	5.802
Max	16.85	14.59	7.196	3.191	6.030
No. Batches	3	3	3	1	1
No. Spec.	19	19	18	7	6
B-estimate	8.702	11.06	5.850	2.887	5.655
A-estimate	4.000	9.186	5.208	2.742	5.470
Method	ANOVA	ANOVA	ANOVA	Normal	Normal
B-basis Value		12.08	5.951		
B-estimate				2.410	4.490

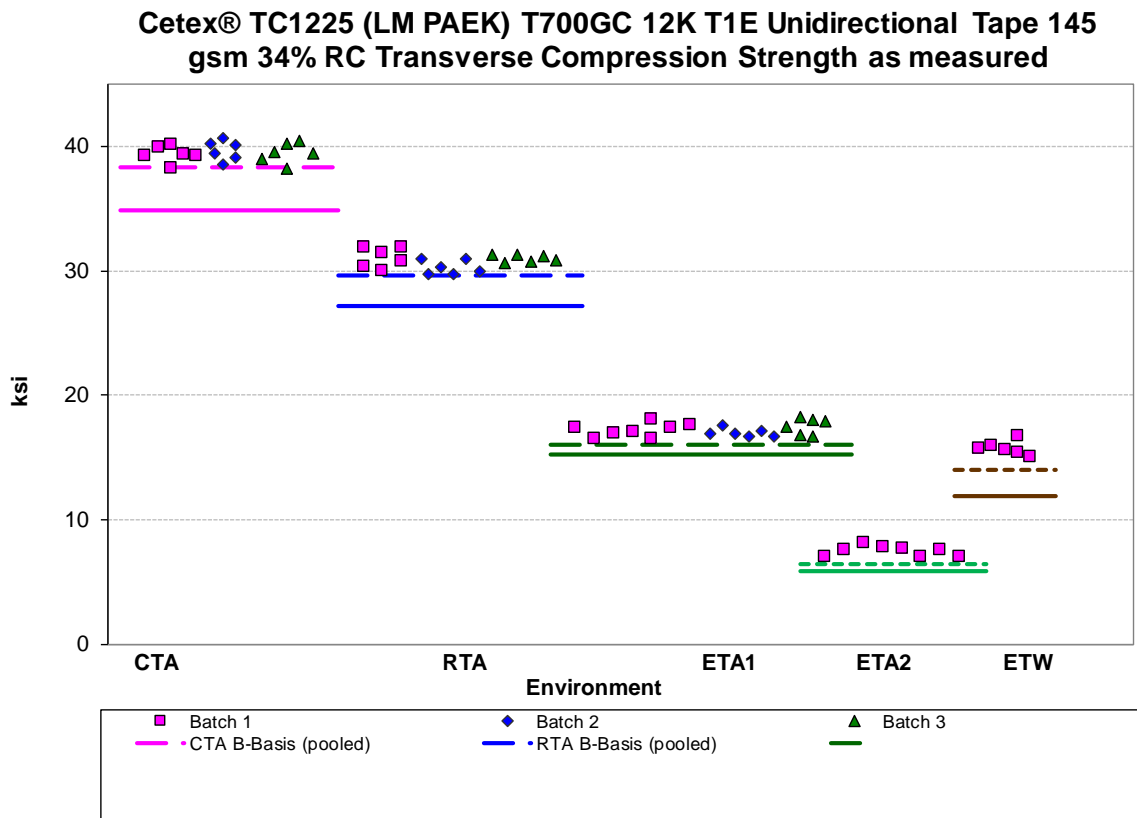




Env	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)
Mean	188.5	177.8	128.2	48.93	120.9	192.9	181.3	129.1	48.10	119.4
Stdev	11.80	8.816	7.473	3.007	14.77	10.57	7.771	6.216	2.821	15.17
CV	6.259	4.958	5.827	6.144	12.21	5.482	4.287	4.816	5.864	12.70
Mod CV	7.130	6.479	6.913	8.000	12.21	6.741	6.143	6.408	8.000	12.70
N .	1422		V		202					



### 4.4 Transverse Compression (TC)



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Env	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)
Mean	39.49	30.76	17.20	7.435	15.70

## **4.5 Lamina Short-Beam Strength (SBS)**



### 4.7 0° Flexural Test (0FLEX, Proc. A)



Env	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	ETW (275 F)
Mean	232.2	201.1	138.3	111.1
Stdev	5.770	9.265	7.752	1.959
CV	2.485	4.607	5.605	1.763
Modified CV	6.000	6.303	6.802	8.000
Min	224.8	183.9	120.1	107.8
Max	245.1	215.8	149.0	113.7



### 4.8 90° Flexural Test (90FLEX, Proc. A)

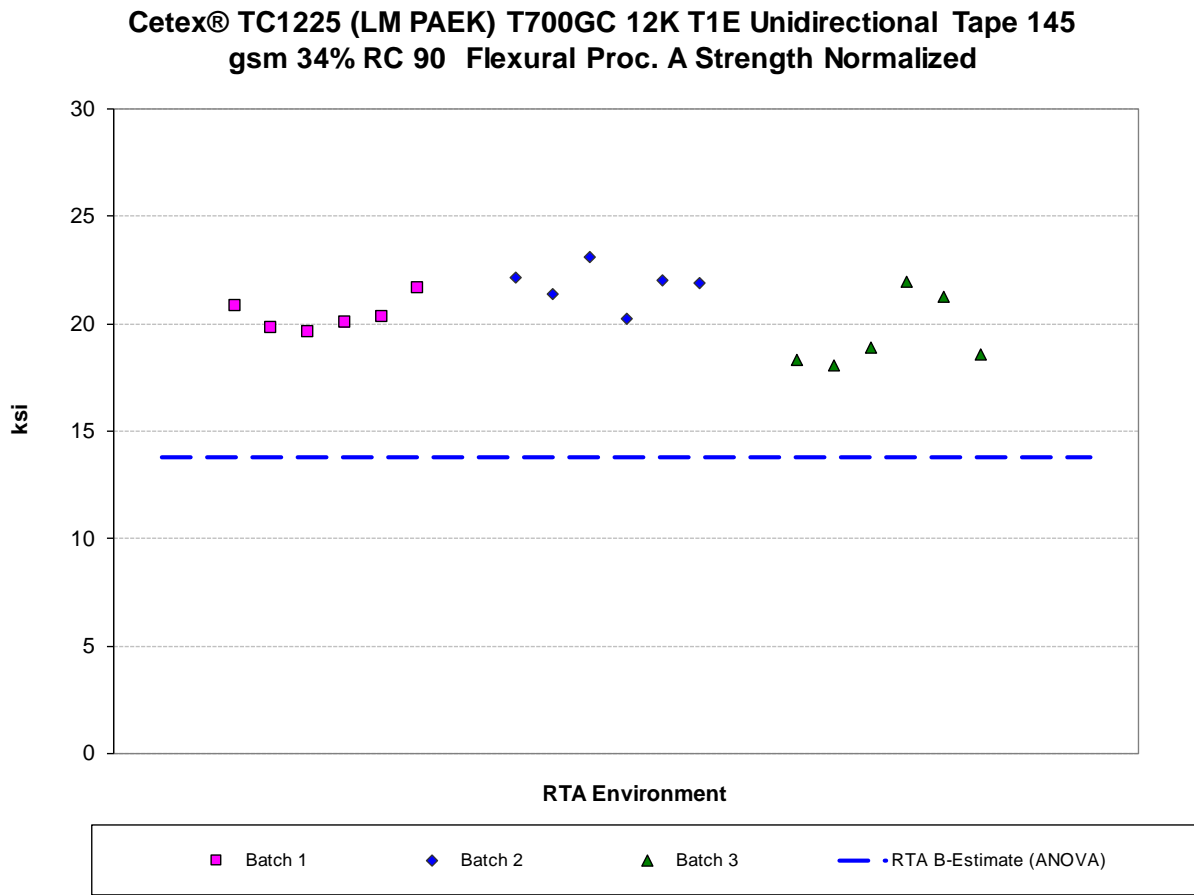


Figure 4-6: Batch plot for 90FLRie

<b>RTA (70 F)</b>	<b>Normalized</b>	<b>As-Measured</b>
<b>Mean</b>	20.56	21.24
<b>Stdev</b>	1.480	1.416
<b>CV</b>	7.201	6.664
<b>Modified CV</b>	7.601	7.332
<b>Min</b>	18.07	19.06
<b>Max</b>	23.12	23.79
<b>No. Batches</b>	3	3
<b>No. Spec.</b>	18	18
<b>B-basis Value</b>		18.45
<b>B-estimate</b>	13.79	
<b>A-estimate</b>	8.972	16.47

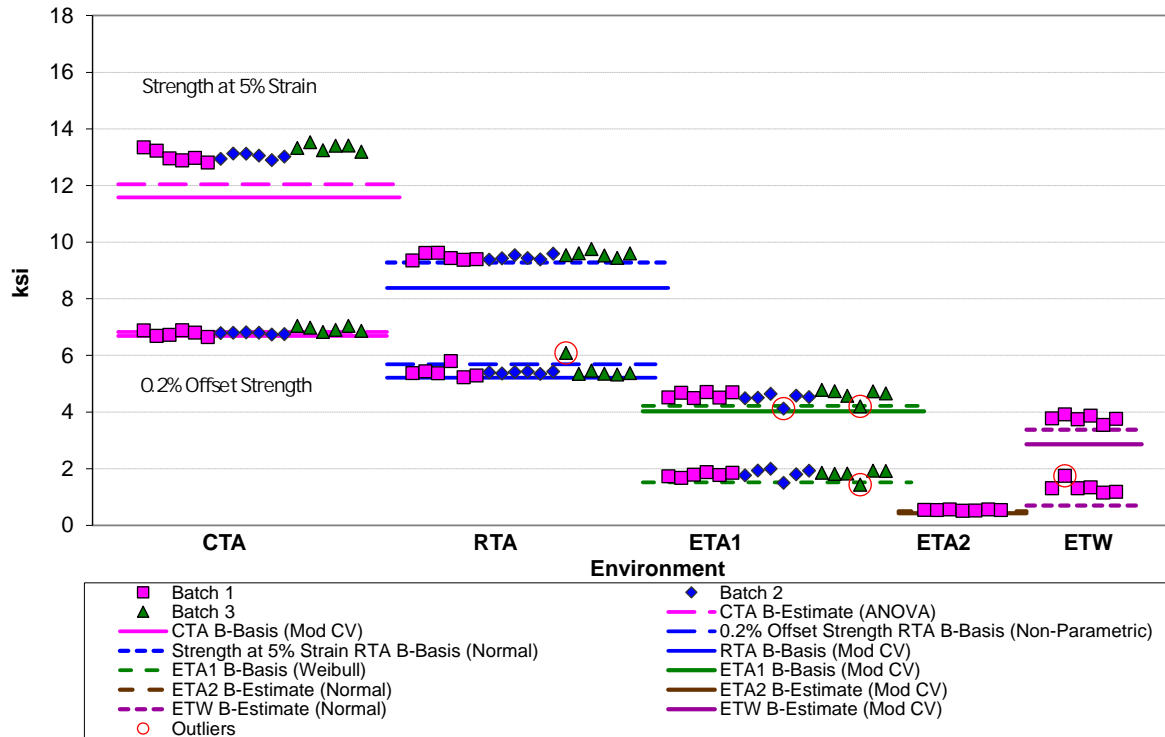


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## 4.9 In-Plane Shear (IPS)

**Cetex® TC1225 (LM PAEK) T700GC 12K T1E Unidirectional Tape 145 gsm 34% RC In-Plane Shear Strength as measured**



**Figure 4-7: Batch plot for IPS for 0.2% Offset Strength and Strength at 5% Strain as-measured**

Env	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	ETW (275 F)
Mean	6.834	5.437	1.800	0.5403	1.341	13.14	9.505	4.565	3.770
Stdev	0.1099	0.1988	0.1459	0.01707	0.2120	0.2097	0.1142	0.1757	0.1310
CV	1.609	3.656	8.106	3.160	15.81	1.596	1.201	3.849	3.476
Mod CV	6.000	6.000	8.106	8.000	15.81	6.000	6.000	6.000	8.000
Min	6.650	5.231	1.436	0.5162	1.151	12.81	9.353	4.120	3.541
Max	7.044	6.089	1.994	0.5635	1.745	13.53	9.760	4.781	3.921
No. Batches	3	3	3	1	1	3	3	3	1
No. Spec.	18	18	18	7	6	18	18	18	6
B-basis Value		5.179	1.519				9.280	4.218	
B-estimate	6.270			0.4929	0.6990	12.0	99i403V	1.60	asis

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## **4.10 In-Plane (Interlaminar) Shear Double Notch (Round) Shear Strength**



#### **4.11 Laminate In-Plane Shear (Interlaminar) Double Notch (Round) Shear Strength (DNS1)**



Env	RTA (70 F)	ETA1 (275 F)	ETW (275 F)
Mean	12.09	6.964	6.265
Stdev	0.4804	0.3927	0.2343
CV	3.972	5.638	3.739
Mod CV	6.000	6.819	8.000
Min	11.02	6.262	5.911
Max	12.73	7.874	6.525
No. Batches	3	3	1
No. Spec.	18	19	6
<b>B-basis Value</b>		6.244	
<b>B-estimate</b>	9.960		5.555
<b>A-estimate</b>	8.440	5.785	5.051
<b>Method</b>	ANOVA	Lognormal	Normal
<b>B-basis Value</b>	10.984	5.862	
<b>B-estimate</b>			4.755
<b>A-estimate</b>	10.232	5.108	3.722
<b>Method</b>	pooled	pooled	Norma





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#### **4.13 “10/80/10” Unnotched Tension 2 (UNT2)**



4.14 “50/40/10” Unnotched Tension 3 (UNT3)

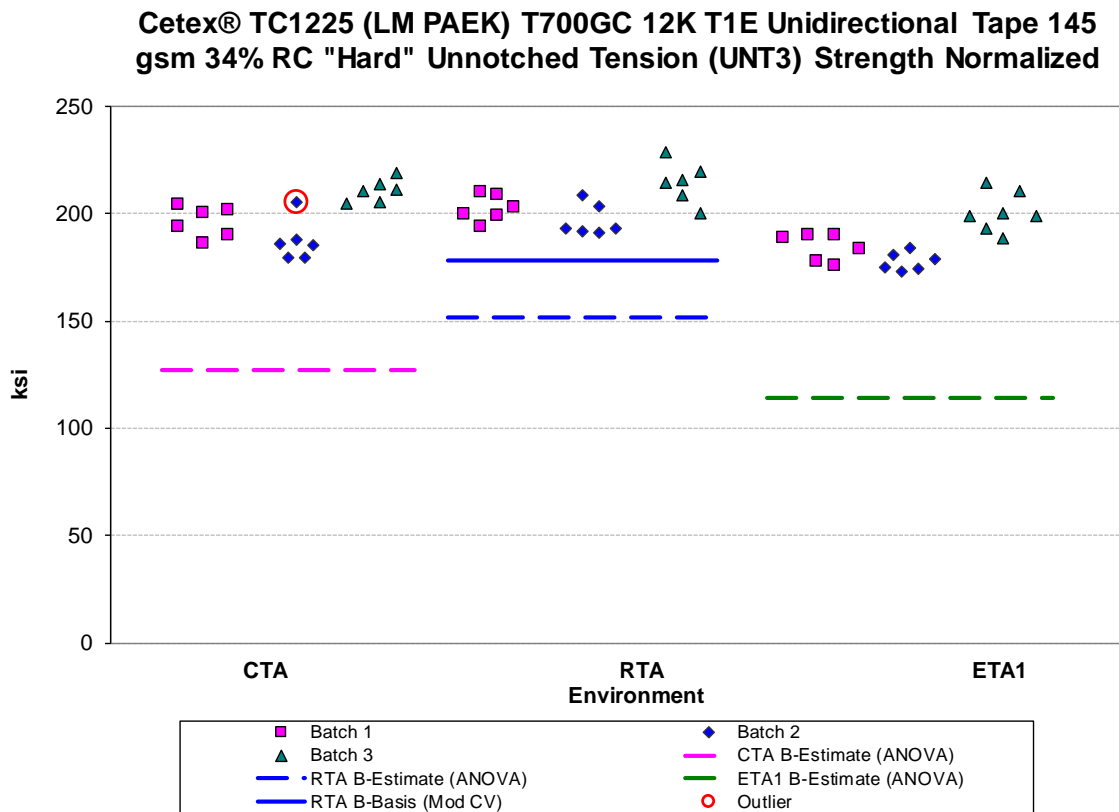
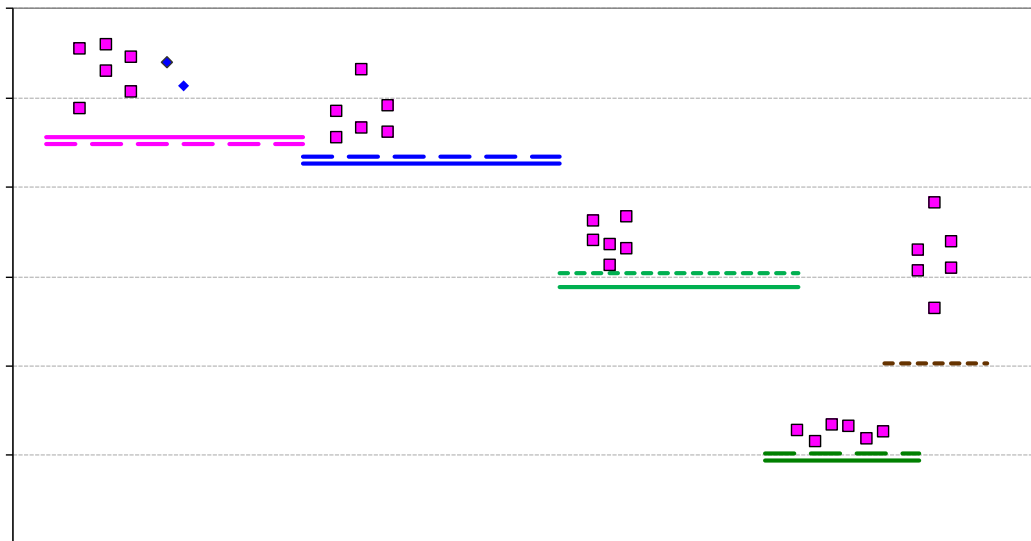


Figure 4-12: Batch Plot for UNT3 Strength normalized

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### 4.15 “50/0/50” Unnotched Compression 0/90 (UNC0)

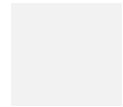
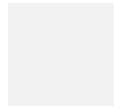




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Env	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)
Mean	102.2	96.29	68.78	24.99	64.27	104.2	97.68	68.93	24.54	63.30



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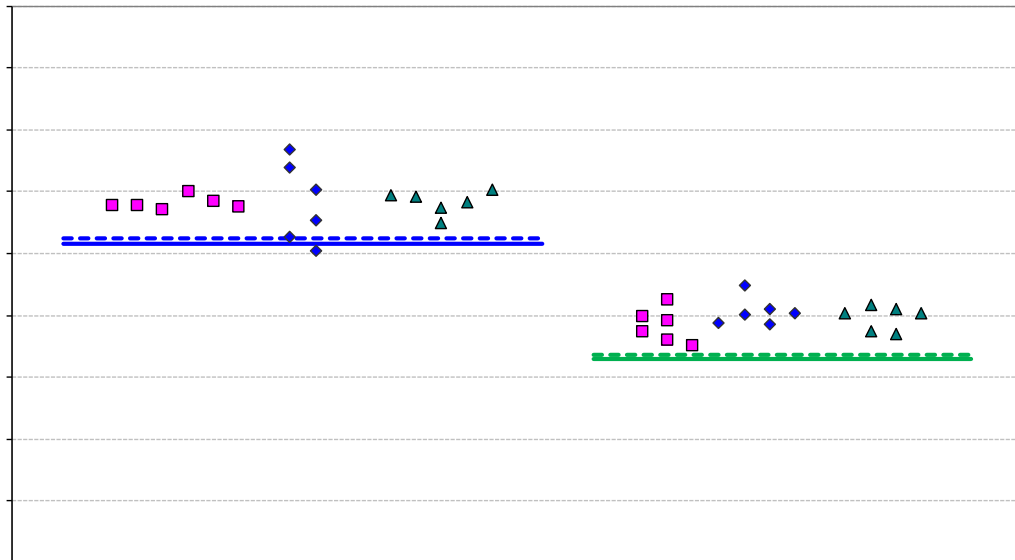
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#### **4.16 “25/50/25” Unnotched Compression 1 (UNC1)**

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### 4.17 “10/80/10” Unnotched Compression 2 (UNC2)





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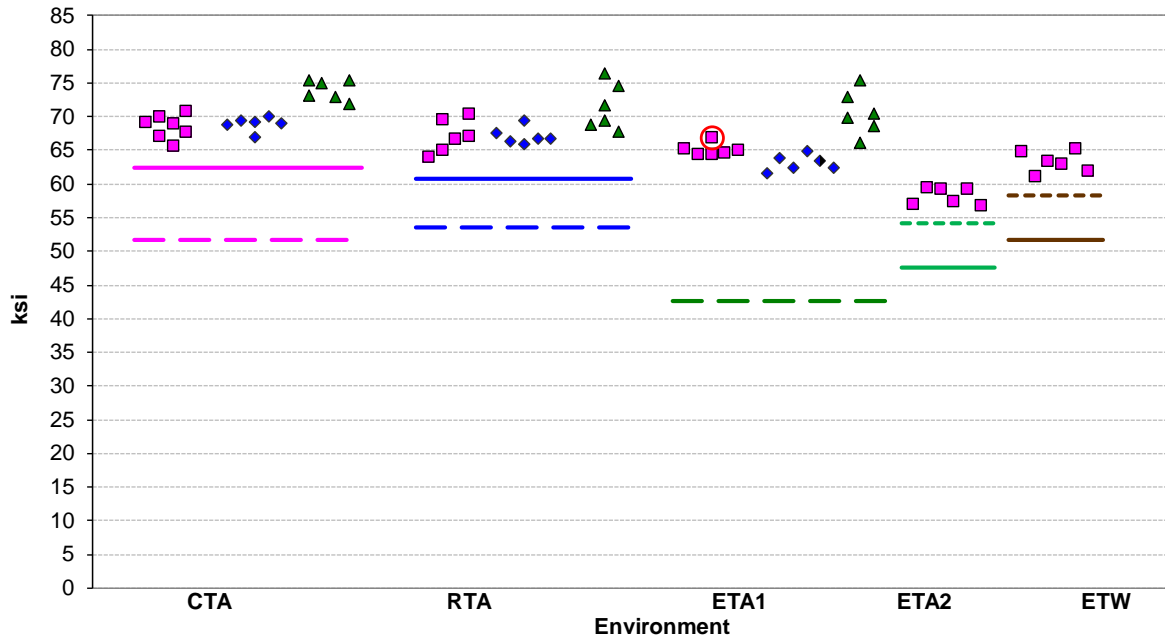
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#### **4.18 “50/40/10” Unnotched Compression 3 (UNC3)**

Env	RTA (70 F)	ETA1 (275 F)	RTA (70 F)	ETA1 (275 F)
Mean	98.06	74.81	102.8	78.41
Stdev	5.584	3.541	4.412	3.002
CV	5.695	4.733	4.291	3.829
Modified CV	6.847	6.367	6.146	6.000
Min	90.95	68.94	94.82	71.87
Max	109.1	82.81	110.9	82.81
No. Batches	3	3	3	3
No. Spec.	18	18	18	18

### 4.19 “25/50/25” Open-Hole Tension 1 (OHT1)

Cetex® TC1225 (LM PAEK) T700GC 12K T1E Unidirectional Tape 145 gsm





Open-Hole Tension (OHT1) Strength Basis Values and Statistics										
Env	Normalized					As-measured				
	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)
Mean	70.30	68.52	66.18	58.03	63.11	71.72	69.82	67.24	60.12	65.00
Stdev	2.931	3.227	3.836	1.281	1.608	3.903	4.287	5.125	1.623	1.759
CV	4.169	4.710	5.796	2.208	2.547	5.442	6.141	7.623	2.700	2.706
Modified CV	6.084	6.355	6.898	8.000	8.000	6.721	7.070	7.811	8.000	8.000
Min	65.42	63.82	61.50	56.55	60.97	66.24	63.21	59.29	57.80	63.12
Max	75.35	76.45	75.44	59.29	65.01	78.42	78.29	77.38	62.74	67.61
No. Batches	3	3	3	1	1	3	3	3	1	1
No. Spec.	19	18	18	6	6	19	18	18	6	6
Basis Values and Estimates										
B-estimate	51.62	53.57	42.54	54.15	58.24	45.99	44.84	34.56	55.20	59.68
A-estimate	38.28	42.90	25.68	51.39	54.77	27.62	27.02	11.24	51.71	55.89
Method	ANOVA	ANOVA	ANOVA	Normal	Normal	ANOVA	ANOVA	ANOVA	Normal	Normal
Modified CV Basis Values and Estimates										
B-basis Value	62.49	60.68	NA			NA	NA	NA		
B-estimate				44.04	47.90				45.63	49.34
A-estimate	57.16	55.35		34.47	37.49				35.72	38.62
Method	pooled	pooled	Normal	Normal	Normal	Normal				

Table 4-30: Statistics and Basis Values for OHT1 Strength data

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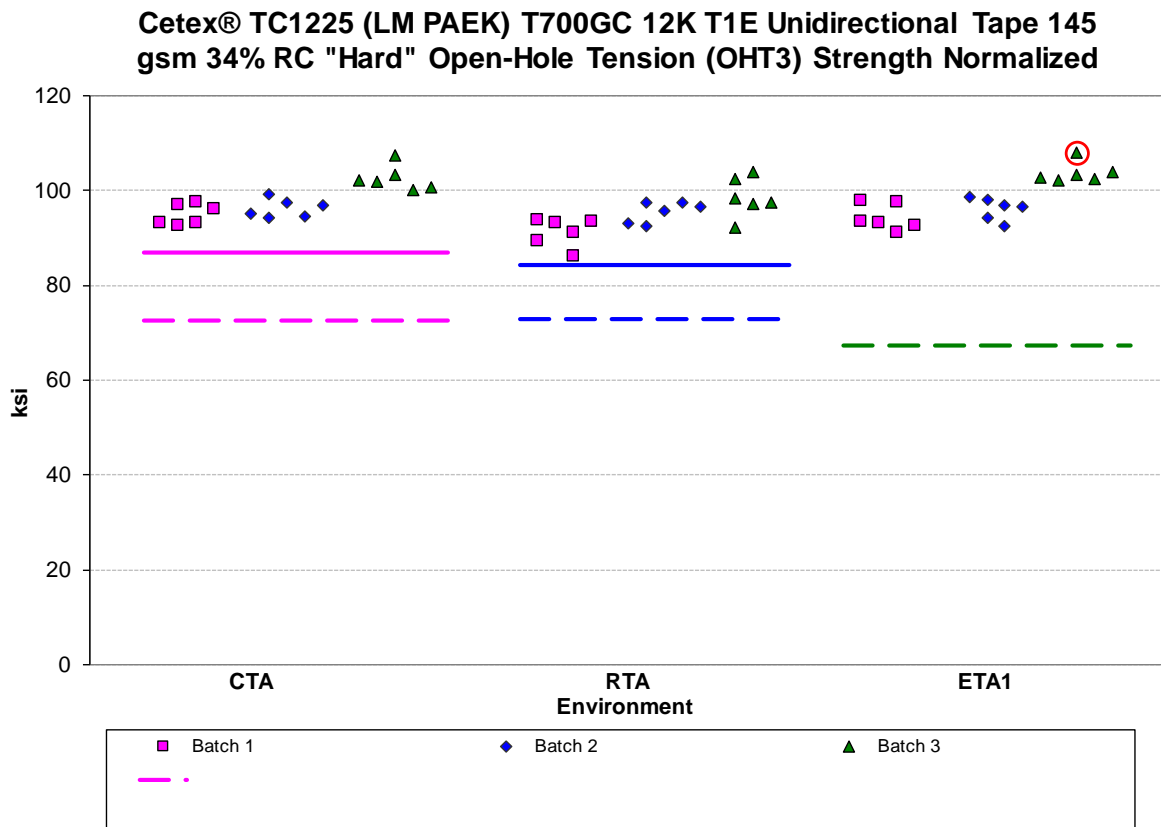
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## **4.20 “10/80/10” Open-Hole Tension 2 (OHT2)**

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### 4.21 "50/40/10" Open-Hole Tension 3 (OHT3)



Env	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)
Mean	97.90	95.06	98.05	104.5	102.8	105.2
Stdev	4.107	4.363	4.844	4.276	4.398	5.117
CV	4.195	4.590	4.940	4.091	4.279	4.863
Modified CV	6.097	6.295	6.470	6.045	6.140	6.431
Min	92.48	86.06	90.90	99.05	94.24	98.64
Max	107.6	103.9	108.0	114.9	112.6	114.6
No. Batches	3	3	3	3	3	3
No. Spec.	18	18	18	18	18	18
B-estimate	72.66	72.97	67.26	77.83	79.47	72.05
A-estimate	54.64	57.21	45.29	58.78	62.84	48.38
Method	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA	ANOVA
B-basis Value	87.01	84.18		93.04	91.28	
A-estimate	79.61	76.77		85.21	83.45	
Method	pooled	pooled		pooled	pooled	

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#### **4.23 “10/80/10” Filled-Hole Tension 2 (FHT2)**



Env	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)
Mean	61.81	53.66	44.55	63.41	55.37	45.93
Stdev	1.974	2.878	1.862	2.154	2.654	1.913
CV	3.193	5.363	4.180	3.397	4.793	4.165
Modified CV	6.000	6.682	6.090	6.000	6.396	6.082



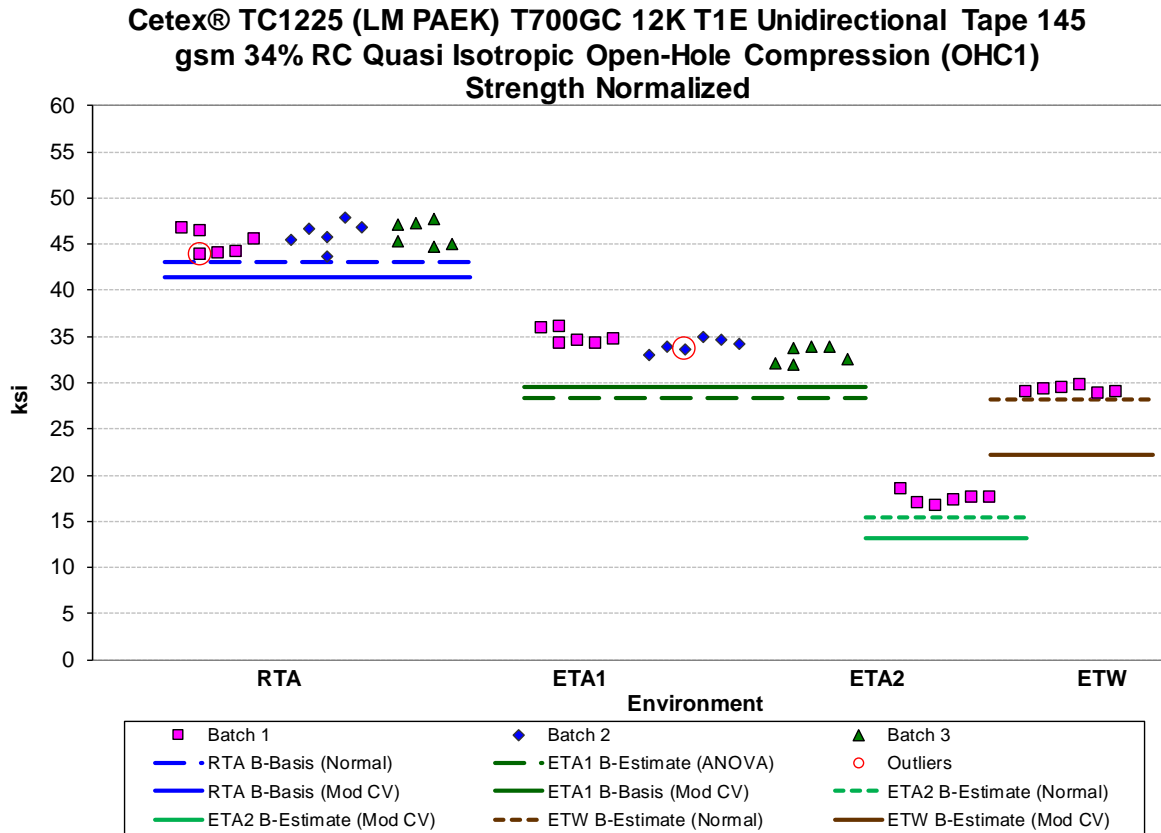
Env	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)	CTA (-65 F)	RTA (70 F)	ETA1 (275 F)
Mean	97.61	93.20	95.04	103.0	99.81	102.1
Stdev	4.924	4.402	4.452	6.088	5.012	5.680
CV	5.044	4.723	4.684	5.912	5.022	5.564
Modified CV	6.522	6.362	6.342	6.956	6.511	6.782
Min	89.75	85.87	90.15	93.40	91.29	95.09
Max	106.6	102.3	103.8	114.8	110.4	111.2
No. Batches	3	3	3	3	3	3
No. Spec.	18	18	18	18	18	18



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#### **4.25 “25/50/25” Open-Hole Compression 1 (OHC1)**



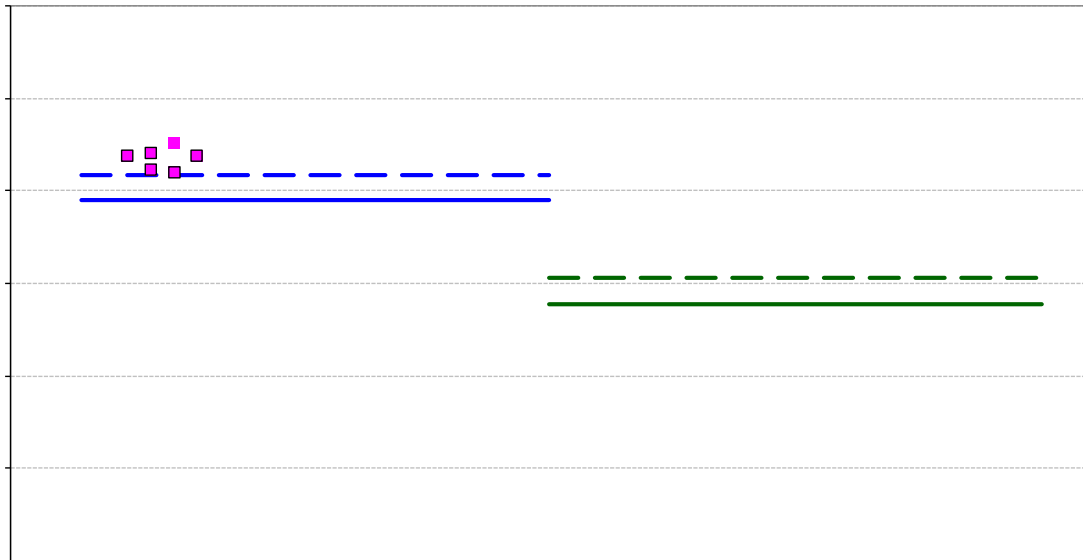
**Figure 4-23: Batch plot for OHC1 Strength normalized**

**Open-Hole Compression (OHC1) Strength Basis Values and Statistics**

Env	Normalized				As-measured			
	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)
Mean	45.79	34.00	17.38	29.19	47.33	34.96	17.77	29.93
Stdev	1.380	1.111	0.6432	0.3394	1.235	1.261	0.7136	0.6402
CV	3.014	3.268	3.701	1.163	2.610	3.607	4.015	2.139
Modified CV	6.000	6.000	8.000	8.000	6.000	6.000	8.000	8.000
Min	43.64	31.95	16.64	28.83	44.99	33.02	17.28	28.98
Max	47.95	35.99	18.47	29.72	48.95	37.47	19.19	30.74
No. Batches	3	3	1	1	3	3	1	1
No. Spec.	18	18	6	6	18	18	6	6
<b>Basis Values and Estimates</b>								
B-basis Value	43.07				44.89			
B-estimate		28.35	15.43	28.17		27.74	16.40	27.99
A-estimate	41.14	24.32	14.05	27.43	43.16	22.58	10.72	26.61
Method	Normal	ANOVA	Normal	Normal	Normal	ANOVA	Non-Parametric	Normal
B-basis Value	41.39	29.59			42.78	30.41		
B-estimate			13.19	22.16				22.72
A-estimate	38.39	26.59	10.33	17.34	39.69	27.32		17.78
Method	pooled	pooled	Normal	Normal	pooled	pooled		Normal

### 4.26 "10/80/10" Open-Hole Compression 2 (OHC2)

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#### **4.27 “50/40/10” Open-Hole Compression 3 (OHC3)**



Env	RTA (70 F)	ETA1 (275 F)	RTA (70 F)	ETA1 (275 F)
Mean	55.04	40.82	57.59	42.47
Stdev	1.038	0.8034	0.8612	1.448
CV	1.886	1.968	1.496	3.409
Modified CV	6.000	6.000	6.000	6.000
Min	52.64	39.19	56.16	40.35
Max	56.50	42.54	59.23	45.09
No. Batches	3	3	3	3
No. Spec.	18	18	18	18
B-basis Value			55.89	
B-estimate	50.19	36.16		32.57
A-estimate	46.73	32.84	54.68	25.50

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#### **4.28 “25/50/25” Filled-Hole Compression 1 (FHC1)**

Env	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)
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#### **4.29 “10/80/10” Filled-Hole Compression 2 (FHC2)**



4.30 “50/40/10” Filled-Hole Compression 3 (FHC3)

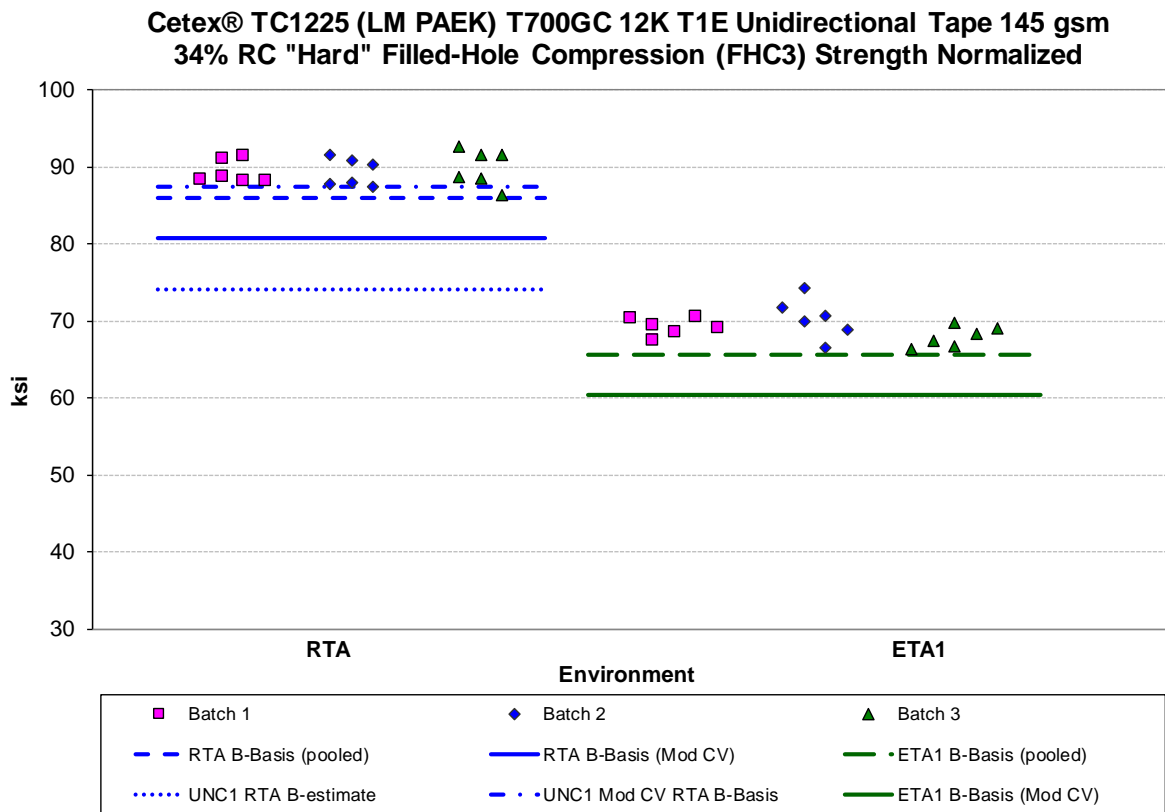


Figure 4-28: Batch plot for FHC3 Strength normalized



3

' 6LQJOH 6KEDU %66% 3URF &

7KH 66% GDWD LV QRUPDOLJHG 'DWD L2IIVHWR6WUHQRVW  
8OWLPDWH 6WUHQRVW 2QO\ RQH EDWFKWRG PD:WHQYLIDURQDW  
FRQGLWLRQV VREDOVHYDOLXPHDWDKIRDMDFRQGLWLRQV

7KH QRUPDOLJHG 2IIVHW 6WUHQRVWDLGELV DWKHW\$RQHWKRQ  
VDPSOH WHVW \$. WHVW IRU EDWFK WR EDWFK YDULDE



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Single Shear Bearing (SSB1 Proc. C) 2% Offset Strength Basis Values and Statistics								
Env	Normalized				As-measured			
	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)
Mean	100.9	84.98	50.58	88.12	107.2	89.28	52.32	91.08
Stdev	7.969	5.031	3.323	4.552	7.308	5.142	2.921	5.390
CV	7.900	5.920	6.569	5.166	6.820	5.759	5.582	5.918
Modified CV	7.950	6.960	8.000	8.000	7.410	6.880	8.000	8.000
Min	87.04	71.88	47.01	79.51	92.64	75.08	48.19	81.38
Max	113.8	94.02	55.75	92.57	119.5	96.56	56.36	96.52
No. Batches	3	3	1	1	3	3	1	1
No. Spec.	18	18	6	6	18	18	6	6
Basis Values and Estimates								
B-basis Value		75.05			95.65	77.77		
B-estimate	68.72		40.52	74.33			43.47	74.75
A-estimate	45.80	68.01	33.36	64.53	87.82	69.94	37.18	63.14
Method	ANOVA	Normal	Normal	Normal	pooled	pooled	Normal	Normal
Modified CV Basis Values and Estimates								
B-basis Value	88.05	72.15			94.23	76.35	39.71	69.13
B-estimate			38.39	66.88				
A-estimate	79.32	63.41	30.05	52.35	85.44	67.55	31.08	54.11
Method	pooled	pooled	Normal	Normal	pooled	pooled	Normal	Normal

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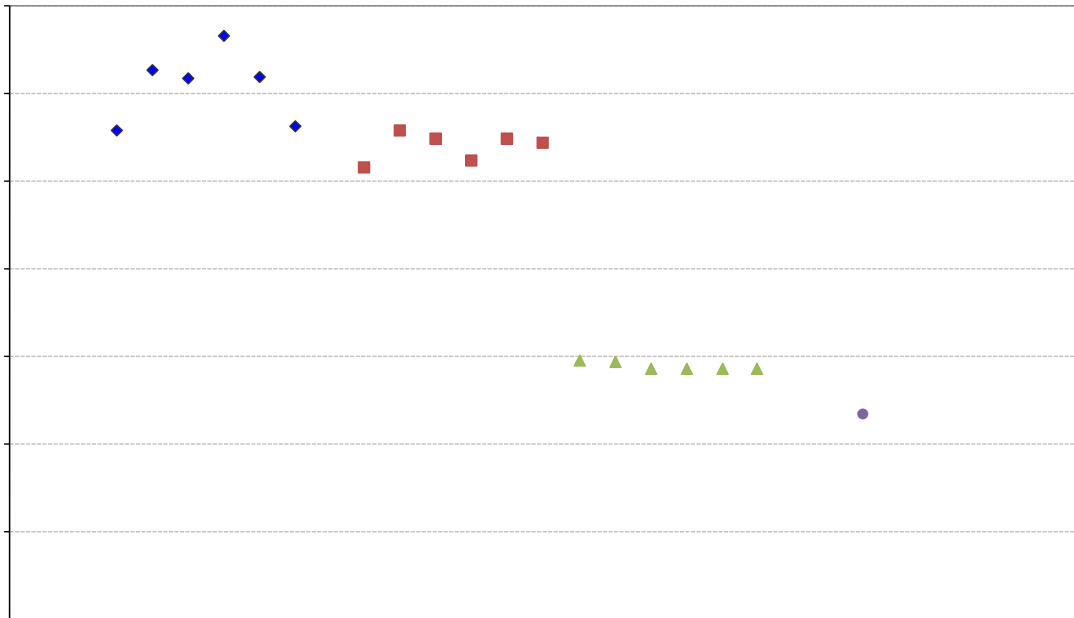
### **4.32 “10/80/10” Single-Shear Bea**







#### **4.34 Interlaminar Tension and Curved Beam Strength (ILT and CBS)**





4.35 “25/50/25” Compression After Impact 1 (CAI1)

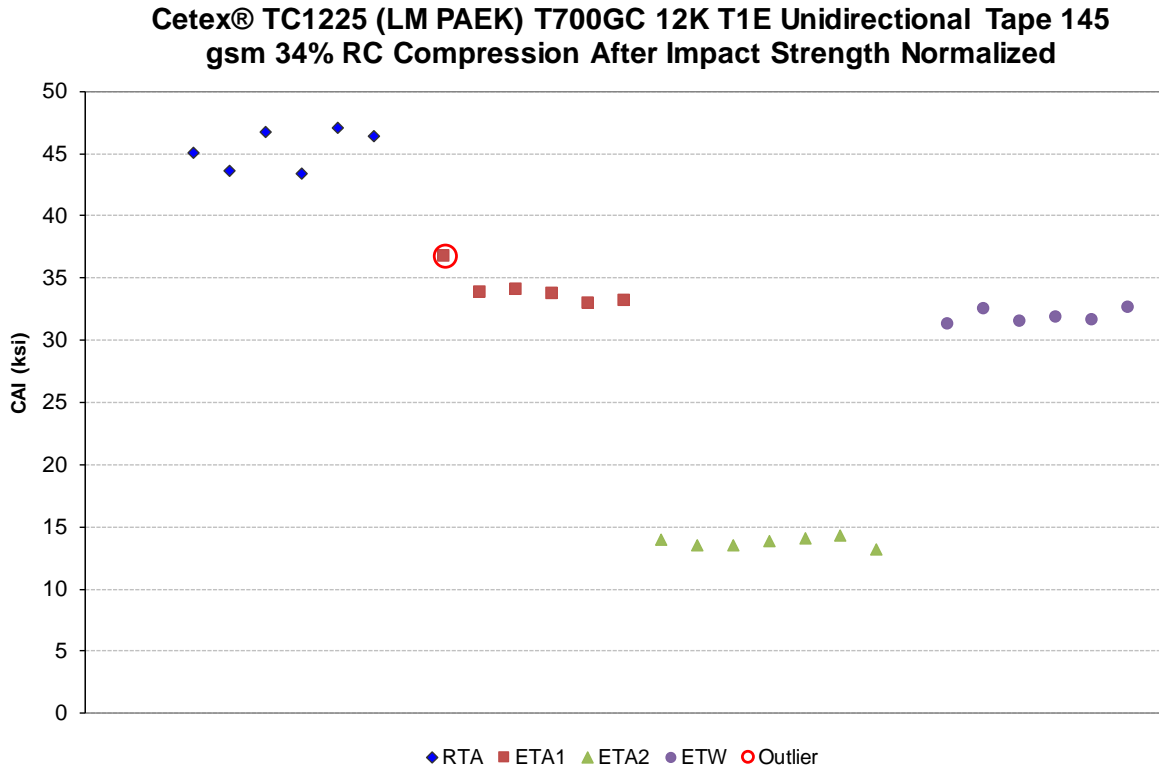


Figure 4-35: Plot for CAI1 Strength normalized

Env	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)	RTA (70 F)	ETA1 (275 F)	ETA2 (400 F)	ETW (275 F)
Mean	45.38	34.04	13.77	31.86	46.10	34.44	14.14	32.56
Stdev	1.609	1.374	0.3824	0.5476	1.719	1.404	0.4658	0.4867
CV	3.544	4.035	2.777	1.719	3.730	4.077	3.295	1.495
Min	43.39	32.94	13.17	31.25	43.65	33.25	13.37	32.07
Max	47.10	36.71	14.29	32.60	48.06	37.13	14.76	33.13
No. Batches	1	1	1	1	1	1	1	1
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## 5. Outliers

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Test	Condition	Batch	Specimen Number	Normalized Strength	Strength As- measured	High/ Low	Batch Outlier	Condition Outlier
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## 6. References

*Statistical Methods*

*Technometrics*