CYTEC
(Formerly Advanced Composites Group)
12K HTS5631 Unidirectional
MTM45-1/HTS(12k)-145-32%RW
Qualification Material Property Data Report

FAA Special Project Number SP3505WI-Q

NCAMP Test Report Number: CAM-RP-2009-010 Rev B

Report Date: March 25, 2016

Testing Facility:
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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

CPT	cured ply thickness
ETD	elevated temperature dry
ETW	elevated temperature wet, lower wet temperature
ETW2	elevated temperature wet, higher wet temperature
Gr/Ep	graphite/epoxy
norm	normalized
RTD	room temperature dry
SACMA	Suppliers of Advanced Composite Materials Association
SRM	SACMA Recommended Method
Tply	thickness divided by the number of plies provides the thickness average per specimen
wet	specimen with an “equilibrium” moisture content
T, RH	temperature, relative humidity

1.4 NIAR NCAMP – ACG Specimen Naming Format

The NIAR specimen names can be correlated to ACG specimen names using the scheme in Figure 1-1.

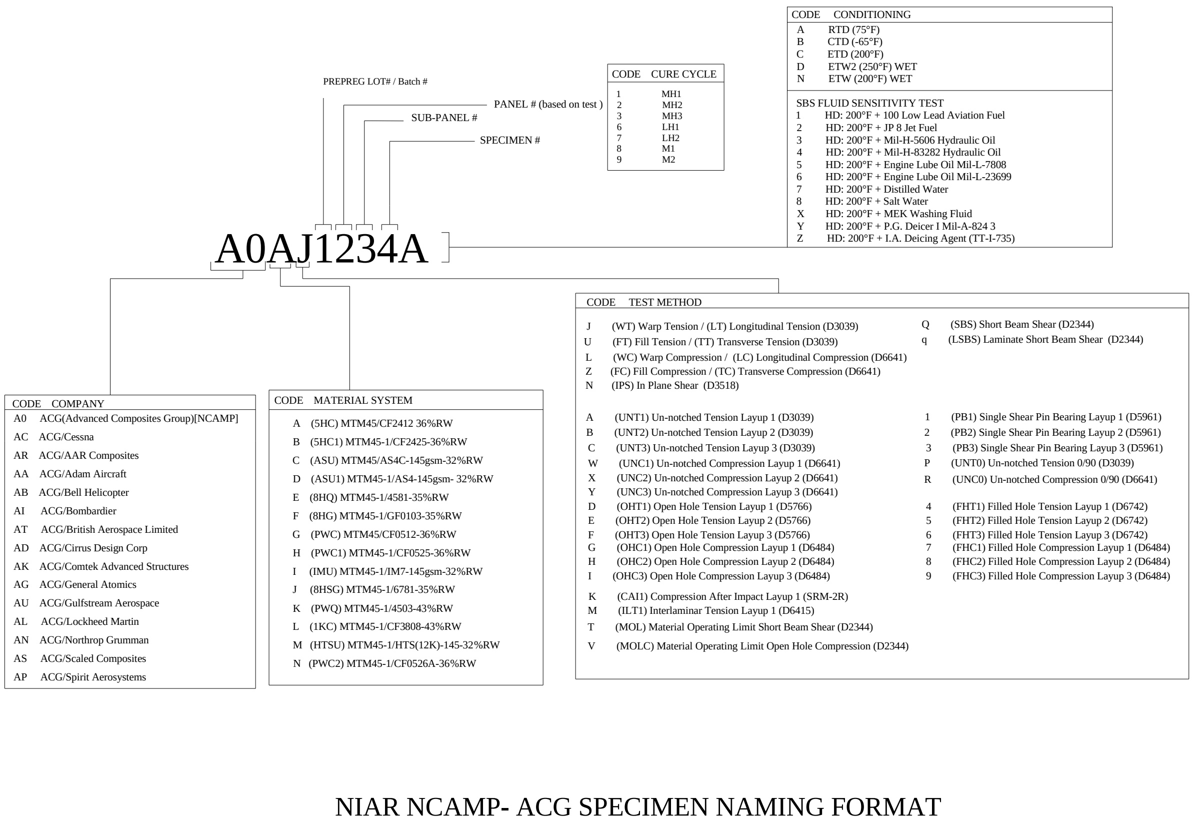


Figure 1-1: NIAR – ACG Specimen Naming Format Correlation

1.5 ASTM Standards

ASTM D 3039/D 3039M – 00^{e2} Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials

ASTM D 6641/D 6641M – 01^{e1} Standard Test Method for Determining the Compressive Properties of Polymer Matrix Composite Laminates Using a Combined Loading Compression (CLC) Test Fixture

ASTM D 3518/D 3518M – 94 (2001) Standard Test Method for In-Plane Shear Response of Polymer Matrix Composite Materials by Tensile Test of a 645° Laminate

ASTM D 2344/D 2344M – 00^{e1} Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates

ASTM D 5766/D 5766M – 02a Standard Test Method for Open Hole Tensile Strength of Polymer Matrix Composite Laminates

ASTM D 6742/D 6742M – 02 Standard Practice for Filled-Hole Tension and Compression Testing of Polymer Matrix Composite Laminates

ASTM D 6484/D 6484M – 04 Standard Test Method for Open-Hole Compressive Strength of Polymer Matrix Composite Laminates

ASTM D 5961/D 5961M – 05 Standard Test Method for Bearing Response of Polymer Matrix Composite Laminates

1.6 SACMA Standards

SACMA SRM 2R-94 SACMA Recommended Test Method for Compression After Impact Properties of Oriented Fiber-Resin Composites

1.7 Methodology

1.7.1 Process Definition

For each combination of test, batch and condition, the specimens were selected from minimum two separate panels cured separately as shown in Figure 1-2 unless otherwise specified.

If more than 2 panels were required to obtain the minimum specimens, the additional panels were labeled accordingly and an equal number of specimens were tested from each panel.

Figure 1-2: Cure Cycle Definiti on for Mechanical Test Panels

All panels were cured in accordance with ACG process specification ACGP 1001-2 Revision E.

In order to facilitate individual specimen traceability, individual specimen numbering and/or skewed lines were written or drawn across each sub-panel as shown in Figure 1-3.

Figure 1-3: Specimen Traceability Line

1.7.2 Specimen & Testing Details

1.7.2.1 Tabbing

No tabs were used for this material system.

1.7.2.2 Strain gages

Strain gages were employed for modulus on selected test methods. The callouts below are requirements of the test plan and actual strain gages used can be found in the CD accompanying this report.

ASTM D3039 tensile: CEA-XX-250UW-120 or 350 (refer to Appendix 1 for specific requirements)
ASTM D3518 in-plane shear: CEA-XX-250UW-120 or 350 (one each 0° and 90° to specimen axis) optionally CE

1.7.3 Test Matrix

Table 1-2 summarizes the lamina level tests carried out on unidirectional materials. The lay-ups chosen have been designed to produce the appropriate thickness required for the various types of tests performed. Table 1-3 summarizes the laminate level tests carried out on unidirectional materials. Lamina and Laminate stacking sequence can be obtained from page 6 of Appendix 1 of AI/TR/1392 E Appendix (or later revisions).

Layup	Test Type and Direction	Property	Number of Batches x No. Of Panels x Number of Test Specimens				
			Test Temperature/Moisture Condition				
			CTD	RTD	ETD	ETW	ETW2
[0°]n	0° Tension(1)	Modulus	3x2x3	3x2x3		3x2x3	3x2x3
[0°]n	0° Compression(1)	Modulus, Poisson's	Nu5([0s7.l .36s 2688)-1.1(x2x3)]TJ ET 68.52 4991(D7				

Table 1-2: Lamina Level Tests - Unidirectional

Table 1-3 below indicates the laminate level tests performed on the 12K unidirectional material. This table emphasizes those properties and test condition combinations believed to constitute the worst case. Additional testing at some test conditions may be necessary depending on the results contained in this document.

Layup	Test Type and Direction	Property	Number of Batches x Number of Panels x Number of Test Specimens			
			Test Temperature/Moisture Condition			
			CTD	RTD	ETW	ETW2
(25%/50%/25% - QI)	Open Hole Tension (1)	Strength	3x2x3	3x2x3	1x2x3	3x2x3
(10%/80%/10%)	Open Hole Tension (1)	Strength	3x2x3	1x2x3		1x2x3
(50%/40%/10%)	Open Hole Tension (1)	Strength	3x2x3	1x2x3		1x2x3
(25%/50%/25% - QI)	Open Hole Compression (1)	Strength		3x2x3	1x2x3	3x2x3
(10%/80%/10%)	Open Hole Compression (1)	Strength		1x2x3		3x2x3
(50%/40%/10%)	Open Hole Compression (1)	Strength		1x2x3		3x2x3
(25%/50%/25% - QI)	Un-notched Tension	Strength + modulus	3x2x3	3x2x3		1x2x3

(25%/50(5

1.7.4 Physical Testing

Physical testing was conducted at the prepreg level at ACG. See results in section 8 below. The cured physical testing results obtained by NIAR can be found in the individual summary charts in section 2.1 below.

1.7.5 Environmental Conditioning

The following tables define the range of tests and conditions were used to produce design allowable property and other screening data. Test environments are defined as:
CTD = -65±5°F, ambient moisture content dry
RTD = room temperature ambient dry
RTA = room temperature ambient – no drying required
ETD = 200±5°F dry
ETW= 200±5°F, wet (equilibrium moisture content)
ETW2=250±5°F, wet (equilibrium moisture content)

Unless otherwise specified, a tolerance of ±5°F applied to all temperature conditions specified in this document.

For dry testing, specimens were dried at 160°F±5°F for 120 to 130 hours. When drying was completed, specimens were either stored until testing in a sealed oven maintained at 85°F ± 5°F or alternately stored with desiccant in a sealed container. For wet testing, specimens were conditioned to equilibrium in a 160°F±5°F and 85% ± 5% RH environment in accordance with ASTM D 5229/D

1.7.6 Fluid Sensitivity Screening

Fluid Sensitivity was not conducted on this material.

1.7.8 Conformity

All laminates and specimens for design allowable property and fluid sensitivity screening were inspected for conformance with the requirements of this document and appendices 1 and 2. For all materials requiring FAA approval, the conformance was verified by an FAA approved designated airworthiness representative (DAR). Test setup and methods were approved and witnessed by the FAA or authorized designated engineering representative (DER) as required. Conformity documentation can be obtained in PDF file entitled Conformity_Final and is included on the CD accompanying this report.

1.7.9 Material Pedigree Information

The PMC Data collection template includes the material pedigree information required, such as material and batch information, as well as environmental conditioning and test results. This template is included in this report.

2.2 Laminate Level Test Summary

Prepreg Material:	Advanced Composites Group - MTM45-1 HTS(12K) Unitape ACGM 1001-14 or NMS 451/14 Material Specification						
Fiber	Tenax-E HTS40 F13 12K 800tex		Resin	MTM45-1			
Tg(dry)	397.40° F	Tg(wet)	332.59° F			Tg METHOD	DMA (SRM 18-94)
PROCESSING:	ACGP 1001-02 Process Specification "MH" Cure Cycle						

2.3 Individual Test Summaries

2.3.1 Longitudinal Tension Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW					Tension, 1-axis Gr/ Ep ACG MTM45-1/HTS(12K)-145gsm-32%RW [0]16			
Resin content:	40.69% vol		Comp. densi t	1.53 [g/cc]					
Fiber volume:	59.31% vol								
Ply thickness:	0.0053 - 0.0058								
Ply count:	16								
Test method:	ASTM D3039-00		Modulus calculation:	1000 to 3000 microstrain					
Normalized by:	0.0055								
		CTD		RTD		ETW		ETW2	
Test Temperature [°F]		-65		75		200		250	
Moisture Conditioning		dry		dry		equilibrium		equilibrium	
Equilibrium at T, RH						160 F,85%		160 F,85%	
Source code		ABMJX X1XB		ABMJX X1XA		ABMJX X1XN		ABMJX X1XD	
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
E_1^t (Msi)	Mean	19.07	18.80	19.00	18.76	19.66	19.38	20.16	19.90
	Minimum	18.70	18.15	17.39	17.71	18.81	18.37	19.29	18.63
	Maximum	19.40	19.26	19.66	19.62	22.17	22.43	21.64	20.97
	C.V.(%)	1.04	1.58	2.82	3.12	3.54	4.47	3.47	3.55
	No. Specimens	19		19		19		19	
	No. Prepreg Lots	3		3		3		3	
n_{21}^t	Mean	0.322		0.318		0.332		0.338	
	No. Specimens	19		19		19		19	
	No. Prepreg Lots	3		3		3		3	

*LT modulus values used to calculate final UNT0 strength utlizing the backout formula

2.3.2 Transverse Tension Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW		
Resin content:	41.20% vol	Comp. density:	
Fiber volume:	58.58% vol		
Ply thickness:	0.0054 - 0.0058		
Ply count:	16		
Test method:	ASTM D3039-00	Modulus calculation:	linear fit from 1000 to 3000 micro in/in
Normalized by:	NA		

Test Temperature [°F]		-65		75					
Moisture Conditioning		dry		dry					
Equilibrium at T, RH									
Source code									
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
	Mean		8.91		8.72		4.56		4.36
	Minimum		7.97		7.24		3.92		3.38
	Maximum		9.66		10.24		5.04		4.72
F_2^{tu} (ksi)	C.V.(%)		5.13		7.27		8.02		9.05
	No. Specimens								
	No. P .0lw [(Nio03Tm (2)Tj o0.)40.(Nio03Tm (2)Tj og.)40. .MeMaan								

2.3.3 Longitudinal Compression Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%					Compression, 1-axis Gr/ Ep ACG MTM45-1/HTS(12K)-145gsm-32%RW			
Resin content:	43.80% vol		Comp. density:	1.52 [g/cc]					
Fiber volume:	56.20% vol								
Ply thickness:	0.0047 - 0.0061								
Ply count:	16								
Test method:	ASTM D6641-01		Modulus calculation:	linear fit from 1000 to 3000 micro in/in					
Normalized by:	0.0055								
		CTD		RTD		ETW		ETW2	
Test Temperature [°F]		-65		75		200		250	
Moisture Conditioning		dry		dry		equilibrium		equilibrium	
Equilibrium at T, RH						160 F,85%		160 F,85%	
Source code		ABMLX X1XB		ABMLX X1XA		ABMLX X1XN		ABMLX X1XD	
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
	Mean	17.24	17.01	17.02	17.20	17.50	17.26	17.50	17.32
	Minimum	16.15	16.32	15.16	16.15	16.47	16.60	16.30	16.01
	Maximum	19.32	18.34	19.22	18.16	18.53	17.86	19.76	19.73
E_1^c	C.V.(%)	5.19	3.68	6.15	3.43	3.29	2.28	4.62	5.73
(Msi)									
	No. Specimens	19		19		19		20	
	No. Prepreg Lots	3		3		3		3	
	Mean	0.365		0.350		0.326		0.396	
Q_2^c	No. Specimens	19		19		19		20	
	No. Prepreg Lots	3		3		3		3	

*LC modulus values used to calculate the final UNC0 strength utilizing the backout formula

2.3.4 Transverse Compression Properties

Compression, 2-axis
Gr/ Ep
ACG- MTM45-1/HTS(12K)-145gsm-32%RW
[90]16

Material:	Advanced Composites Group - MTM45-1/HTS(12K)-145gsm-32%RW
Resin content:	41.30% vol — Comp. densi t 1.53 [g/cc]
Fiber volume:	58.70% vol
Ply thickness:	0.0052 - 0.0057
Ply count:	16
Test method:	ASTM D3039-00 — Modulus calculation: 1000 to 3000 microstrain
Normalized by:	NA

		CTD		RTD		ETW		ETW2	
Test Temperature [°F]		-65		75		200		250	
Moisture Conditioning		dry		dry		equilibrium		equilibrium	
Equilibrium at T, RH						160 F,85%		160 F,85%	
Source code		ABMUX X1XB		ABMUX X1XA		ABMUX X1XN		ABMUX X1XD	
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
	Mean		36.64		28.29		17.36		14.27
	Minimum		30.85		26.19		16.56		13.65
	Maximum		40.73		30.29		18.13		15.33
F_2^{tu} (ksi)	C.V.(%)		7.96		4.16		2.86		3.35
	No. Specimens	22		19		19		20	
	No. Prepreg Lots	3		3		3		3	
	Mean		1.33		1.26		1.15		1.07
	Minimum		1.22		1.17		1.11		0.98
	Maximum		1.45		1.40		1.25		1.17
E_2^t (Msi)	C.V.(%)		4.72		4.55		3.24		5.37
	No. Specimens	22		19		19		20	
	No. Prepreg Lots	3		3		3		3	
	Mean	0.025		0.025		0.020		0.022	
Q^c	No. Specimens	22		19		19		19	
	No. Prepreg Lots	3		3		3		3	

2.3.7 Unnotched Tension 1 Properties

Material:

2.3.8 Unnotched Tension 2 Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW					
Resin content:	41.26% vol	Comp. density: 1.53 [g/cc]				
Fiber volume:	58.74% vol					
Ply thickness:	0.0055 - 0.0057					
Ply count:	20					
Test method:	ASTM D3039-00	Modulus calculation: linear fit from 1000 to 3000 micro in/in				
Normalized by:	0.0055					
		CTD		RTD		ETW2
Test Temperature [°F]		-65		75		250
Moisture Conditioning		dry		dry		equilibrium
Equilibrium at T, RH						160 F,85%
Source code		ABMBX X1XB		ABMBX X1XA		ABMBX X1XD
		Normalized	Measured	Normalized	Measured	Normalized	Measured
UNT2 Strength (ksi)	Mean	73.34	72.58	66.22	65.24	52.11	51.33
	Minimum	71.07	70.18	64.55	62.48	49.92	49.08
	Maximum	75.60	74.29	68.00	66.65	54.61	53.87
	C.V.(%)	2.08	2.02	1.97	2.26	3.26	3.31
	No. Specimens	8		7		7	
	No. Prepreg Lots	1		1		1	
UNT2 Modulus (Msi)	Mean	4.69	4.64	4.65	4.59	3.95	3.89
	Minimum	4.58	4.55	4.49	4.46	3.85	3.77
	Maximum	4.88	4.78	4.83	4.78	4.12	4.04
	C.V.(%)	2.16	1.84	2.71	2.95	2.23	2.17
	No. Specimens	8		6		7	
	No. Prepreg Lots	1		1		1	

2.3.9 Unnotched Tension 3 Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW		
Resin content:	41.23% vol	Comp. density:	1.53 [g/cc]
Fiber volume:	58.77% vol		
Ply thickness:	0.0055 - 0.0056		
Ply count:	20		
Test method:	ASTM D3039-00	Modulus calculation:	1000 to 3000 mircrostrain
Normalized by:	0.0055		

Test Temperature [°F]		-65		75		250	
Moisture Conditioning		dry		dry		equilibrium	
Equilibrium at T, RH						160 F,85%	
Source code							
		Normalized	Measured	Normalized	Measured	Normalized	Measured
	Mean	184.13	182.25	188.29	186.43	181.51	179.79
	Minimum	172.29	169.02	185.02	182.36	175.82	172.81
	Maximum	191.77	188.06	191.60	190.13	192.27	192.01
UNT3	C.V.(%)	3.70	3.84	1.35	1.57	2.99	3.63
Strength (ksi)							
	No. Specimens						
	No. Prepreg Lots						
	Mean	11.68	11.56	11.29	11.18	11.24	11.13
	Minimum	11.45	11.24	11.01	10.93	10.58	10.57
	Maximum	12.00	11.78	11.59	11.59MaTD .755(12)7372>Tj /TT15 14k7.7(1)-.6(.59)-5723.9		

2.3.11 Unnotched Compression 1 Properties

Material: MTM45-1/HTS(12K)-145gsm-32%RW

Resin content: 41.92% vol Comp. density: 1.52 [g/cc]
Fiber volume: 58.08% vol
Ply thickness: 0.0055 - 0.0058
Ply count: 24

Test method: ASTM D6641-01[E1] Modulus calculation: 1000 to 3000 microstrain

Normalized by: 0.0055

		RTD		ETW		ETW2	
Test Temperature [°F]							
Moisture Conditioning							
Equilibrium at T, RH							
Source code							
		Normalized	Measured	Normalized	Measured	Normalized	Measured
UNC1 Strength (ksi)	Mean	88.02	86.60	74.68	74.13	61.81	60.97
	Minimum	81.72	80.75	69.84	69.20	52.11	50.24
	Maximum	93.16	92.64	79.79	79.00	71.78	71.83
	C.V.(%)	3.52	3.79	4.96	4.77	8.61	9.09
	No. Specimens	19		7		22	
	No. Prepreg Lots	3		1		3	
UNC1 Modulus (Msi)	Mean	6.64	6.54	6.72	6.67	6.42	6.33
	Minimum	6.35	6.15	6.41	6.40	6.02	5.88
	Maximum	6.91	6.87	6.84	6.77	6.80	6.77
	C.V.(%)	2.22	2.65	2.28	1.95	3.37	3.82
	No. Specimens	19		7		20	
	No. Prepreg Lots	3		1		3	
QUNC1	Mean	0.340		0.338		0.312	
	No. Specimens	19		7		20	
	No. Prepreg Lots	3		1		3	

2.3.12 Unnotched Compression 2 Properties

Material: MTM45-1/HTS(12K)-145gsm-32%RW

Resin content: 40.78% vol Comp. density: 1.53 [g/cc]
Fiber volume: 59.22% vol
Ply thickness: 0.0053 - 0.0055
Ply count: 20

Test method: ASTM D6641-01[E1] Modulus calculation: 1000 to 3000 microstrain

Normalized by: 0.0055

		RTD		ETW2			
Test Temperature [°F]		75 F		250 F			
Moisture Conditioning				equilibrium			
Equilibrium at T, RH		dry		160 F,85%			
Source code		ABMXX X1XA		ABMXX X1XD			
		Normalized	Measured	Normalized	Measured	Normalized	Measured
	Mean	58.30	58.51	41.81	41.67		
	Minimum	53.40	55.15	37.15	36.98		
	Maximum	62.36	62.00	48.73	48.49		
UNC2 Strength (ksi)	C.V.(%)	5.72	5.16	8.77	8.80		
	No. Specimens	7		7			
	No. Prepreg Lots	1		1			
	Mean	4.29	4.30	3.88	3.86		
	Minimum	4.12	4.12	3.80	3.78		
	Maximum	4.38	4.45	4.02	4.00		
UNC2 Modulus (Msi)	C.V.(%)	1.87	2.59	1.93	1.91		
	No. Specimens	7		7			
	No. Prepreg Lots	1		1			
	Mean			0.504			
QUNC2	No. Specimens	7		7			
	No. Prepreg Lots						

2.3.13 Unnotched Compression 3 Properties

Material:

2.3.14 Laminate Short Beam Strength Properties

Material: MTM45-1/HTS(12K)-145gsm-32%RW

Resin content: See UNC1 Comp. density: See UNC1
Fiber volume: See UNC1
Ply thickness: 0.055 - 0.0057
Ply count: 24

Test method: ASTM D2344-00[E1]

Normalized by: NA

		RTD				ETW2	
Test Temperature [°F]				200			
Moisture Conditioning				equilibrium			
Equilibrium at T, RH							
Source code				ABMqX XXXN		ABMqX XXXD	
		Normalized	Measured	Normalized	Measured	Normalized	Measured
	Mean		11.22		6.74		5.91
	Minimum		10.18		6.45		5.41
	Maximum		12.24		7.03		6.24
LSBS (ksi)	C.V.(%)		5.48		3.37		3.30
	No. Specimens						
	No. Prepreg Lots						

2.3.15 Lamina Short B eam Strength Properties

Material: MTM45-1/HTS(12K)-145gsm-32%RW

Resin content: See WC Comp. density: See WC
Fiber volume: See WC
Ply thickness: 0.0053 - 0.0060
Ply count: 16

Test method: ASTM D2344-00[E1]

Normalized by: NA

				RTD		ETD		ETW			
Test Temperature [°F]						195		200			
Moisture Conditioning						dry		equilibrium			
Equilibrium at T, RH								160 F,85%			
Source code											
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
	Mean		19.55		14.52		10.74		8.47		6.98
	Minimum		17.64		13.51		10.49		8.20		6.58
	Maximum		21.38		15.17		10.94		8.91		7.39
SBS Strength (ksi)	C.V.(%)		5.57		2.99		1.24		2.62		3.37
	No. Specimens		19		19		19		20		19
	No. Prepreg Lots								3		3

2.3.16 Open Hole Tension 1 Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW						Open Hole Tension 1 Gr/ Ep MTM45-1/HTS(12K)-145gsm-32%RW [45,0,-45,90]3S		
Resin content:	41.78% vol		Comp. densi t	1.52 [g/cc]					
Fiber volume:	58.22% vol								
Ply thickness:	0.0055 - 0.0057								
Ply count:	24								
Test method:	ASTM D5766-02a								
Normalized by:	0.0055								
		CTD		RTD		ETW		ETW2	
Test Temperature [°F]		-65		75		200		250	
Moisture Conditioning		dry		dry		equilibrium		equilibrium	
Equilibrium at T, RH						160 F,85%		160 F,85%	
Source code		ABMDX X1XB		ABMDX X1XA		ABMDX X1XN		ABMDX X1XD	
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
	Mean	61.17	60.27	60.47	59.56	63.47	62.28	62.64	61.77
	Minimum	56.42	55.42	58.73	56.60	60.14	59.41	60.72	59.52
	Maximum	64.05	64.15	62.04	61.43	68.23	67.18	64.19	63.85
OHT1	C.V.(%)	2.73	3.31	1.62	2.26	4.32	4.22	1.67	2.24
Strength (ksi)									
	No. Specimens	19		19		7		19	
	No. Prepreg Lots	3		3		1		3	

2.3.17 Open Hole Tension 2 Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW		
Resin content:	41.82% vol	Comp. den s	1.52 [g/cc]
Fiber volume:	58.18% vol		
Ply thickness:	0.0055 - 0.0058		
Ply count:	20		
Test method:			

2.3.19 Filled Hole Tension 1 Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW		
Resin content:	41.08% vol	Comp. density:	1.53 [g/cTw b 1) 1(%)-32.3(4)-55.797tu.797tT 1):

2.3.20 Filled Hole Tension 2 Properties

Material: MTM45-1/HTS(12K)-145gsm-32%RW

Resin content: 41.58% vol   Comp. density: 1.53 [g/cc]
Fiber volume: 58.42% vol
Ply thickness: 0.0055 - 0.0056
Ply count: 20

Test method: ASTM D6742-02

Normalized by: 0.0055 in. CPT

Test Temperature [°F]
Moisture Conditioning
Equilibrium at T, RH
Source code

			Normalized	Measured	Normalized	Measured	Normalized	Measured
	Mean		47.97	47.30	43.54	42.91	38.07	37.51
	Minimum		46.95	46.16	42.16	41.57	37.29	36.93
	Maximum		49.14	48.34	44.42	43.87	39.20	38.47
FHT2	C.V.(d7	37.51						

2.3.21 Filled Hole Tension 3 Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW		
Resin content:	40.59% vol	Comp. density:	1.53 [g/cc]

2.3.22 Open Hole Compression 1 Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW		
Resin content:	41.18% vol	Comp. density	1.52 [g/cc]
Fiber volume:	58.82% vol		
Ply thickness:	0.0054 - 0.0058		
Ply count:	24		
Test method:	ASTM D6484-04		
Normalized by:	0.0055		

2.3.23 Open Hole Compression 2 Properties

Material: MTM45-1/HTS(12K)-145gsm-32%RW

Resin content: 41.48% vol Comp. density 1.52 [g/cc]
Fiber volume: 58.52% vol
Ply thickness: 0.0054 - 0.0058
Ply count: 20

Test method: ASTM D6484-04

Normalized by: 0.0055

Test Temperature [°F]							
Moisture Conditioning							
Equilibrium at T, RH							
Source code							
		Normalized	Measured	Normalized	Measured	Normalized	Measured
	Mean	38.93	38.49	27.87	27.56		
	Minimum	38.05	37.13	26.16	26.28		
	Maximum	39.93	39.64	29.03	28.65		
OHC2	C.V.(%)	1.67	2.13	2.52	2.47		
Strength (ksi)							
	No. Specimens						

2.3.25 Filled-Hole Compression 1 Properties

Material:	Advanced Composites Group - MTM45-1/HTS(12K)-145gsm-32%RW				Filled Hole Compression 1 Gr/ Ep MTM45-1/HTS(12K)-145gsm-32%RW [45,0,-45,90]3S		
Resin content:	41.7% vol	Comp. density	1.52 [g/cc]				
Fiber volume:	58.3% vol						
Ply thickness:	0.0055 - 0.0058						
Ply count:	24						
Test method:	ASTM D6742-02						
Normalized by:	0.0055						
		RTD		ETW2			
Test Temperature [°F]		75		250			
Moisture Conditioning		dry		equilibrium			
Equilibrium at T, RH				160 F,85%			
Source code		ABM7X X1XA		ABM7X X1XD			
		Normalized	Measured	Normalized	Measured	Normalized	Measured
FHC1 Strength (ksi)	Mean	66.64	65.30	46.16	45.32		
	Minimum	61.50	59.84	40.85	39.92		
	Maximum	72.48	71.29	55.07	54.05		
	C.V.(%)	7.13	7.71	7.78	7.72		
	No. Specimens	7		19			
	No. Prepreg Lots	1		3			

2.3.26 Filled-Hole Compression 2 Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW		
Resin content:	41.65% vol	Comp. densit y	1.52 [g/cc]
Fib	]		

2.3.28 Pin Bearing 1 Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW		
Resin content:	41.55% vol	Comp. density:	1.52 [g/cc]
Fiber volume:	58.45% vol		
Ply thickness:	0.0055 - 0.0058		
Ply count:	24		
Test method:	ASTM D5961-08		
Normalized by:	0.00550		

Test Temperature [°F]				
Moisture Conditioning				
Equilibrium at T, RH				
Source code				
	Normalized	Measured	Normalized	Measured

2.3.29 Pin Bearing 2 Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW			Pin Bearing 2 Gr/ Ep MTM45-1/HTS(12K)-145gsm-32%RW [45,-45,0,45,-45,90,45,-45,45,-45]S	
Resin content:	41.31% vol	Comp. density: 1.52 [g/cc]			
Fiber volume:	58.69% vol				
Ply thickness:	0.0055 - 0.0057				
Ply count:	20				
Test method:	ASTM D5961-08				
Normalized by:	0.0055				
		RTD		ETW2	
Test Temperature [°F]		75		250	
Moisture Conditioning		dry		equilibrium	
Equilibrium at T, RH				160 F,85%	
Source code		ABM2XX1XA		ABM2XX1XD	
		Normalized	Measured	Normalized	Measured
	Mean	109.32	107.47	86.68	85.59
	Minimum	105.26	102.30	79.40	77.82
	Maximum	112.65	111.07	101.62	100.66
PB2	C.V.(%)	2.63	2.79	5.98	6.08
2% offset Strength					
(ksi)	No. Specimens	7		19	
	No. Prepreg Lots	1		3	

2.3.30 Pin Bearing 3 Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW		
Resin content:	41.38% vol	Comp. density:	1.52 [g/cc]
Fiber volume:	58.62% vol		
Ply thickness:	0.0055 - 0.0057		
Ply count:	20		
Test method:	ASTM D5961-08		
Normalized by:	0.0055		

Pin Bearing 3
Gr/ Ep
MTM45-1/HTS(12K)-145gsm-32%RW
[0,0,45,0,90,-45,0,45,0,-45]S

		RTD		ETW2	
Test Temperature [°F]		75		250	
Moisture Conditioning		dry		equilibrium	
Equilibrium at T, RH				160 F,85%	
Source code		ABM3X X1XA		ABM3X X1XD	
		Normalized	Measured	Normalized	Measured
	Mean	112.19	110.62	86.37	85.46
	Minimum	100.89	99.31	77.70	76.74
	Maximum	120.99	119.79	96.91	95.77
PB3	C.V.(%)	5.86	6.01	6.24	6.24
2% offset Strength					
(ksi)	No. Specimens	7		19	
	No. Prepreg Lots	1		3	

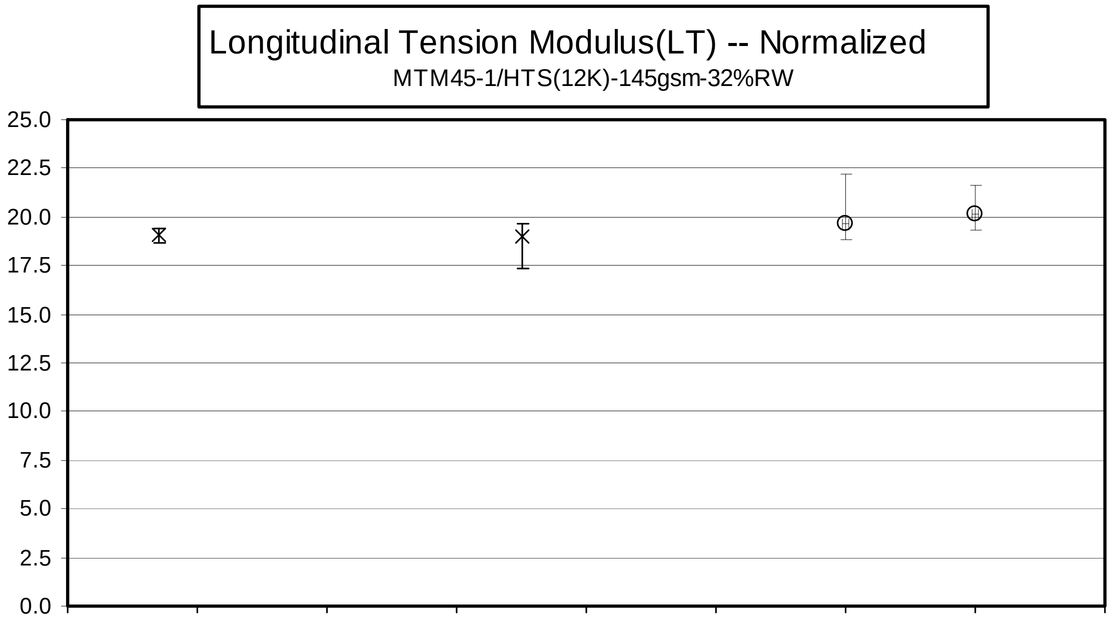
2.3.32 Compression after Impact Properties

Material:	MTM45-1/HTS(12K)-145gsm-32%RW			Compression After Impact Gr/ Ep MTM45-1/HTS(12K)-145gsm-32%RW [0,45,90,-45]4S		
Resin content:	42.15% vol	Comp. density:	1.52 [g/cc]			
Fiber volume:	57.85% vol					
Ply thickness:	0.0056					
Ply count:	32					
Test method:	SACMA SRM 2R-94					
Normalized by:	0.0055					
	RTD					
Test Temperature [°F]	75					
Moisture Conditioning	dry					
Equilibrium at T, RH						
Source code	AMBKXXXA					
	Normalized	Measured	Normalized	Measured	Normalized	Measured
CAI Strength (ksi) Mean	35.30	34.79				
Minimum	31.84	31.37				
Maximum	38.53	38.12				
C.V.(%)	6.47	6.74				
No. Specimens	7					
No. Prepreg Lots	1					

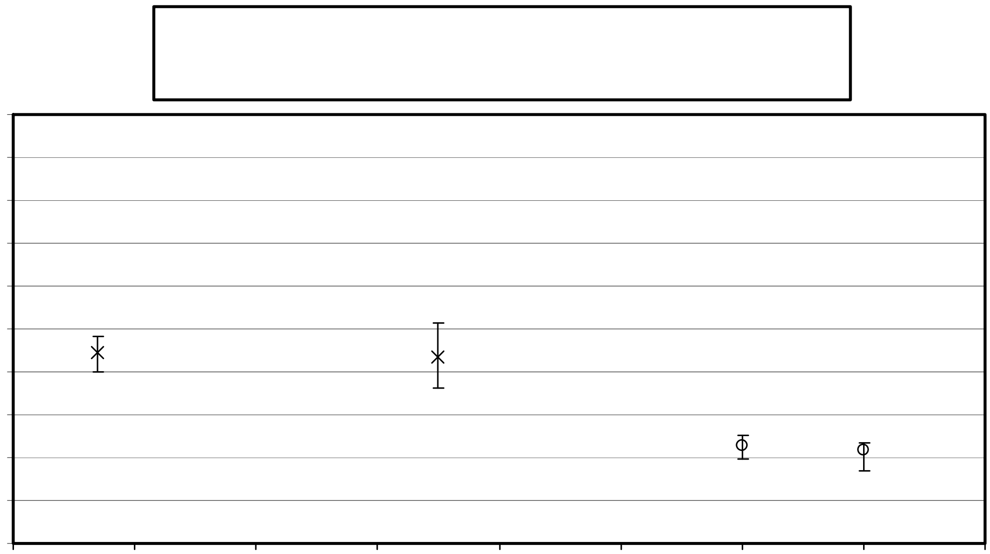
3. Individual Test Charts

These charts combine all three batches of data and plot the minimum and maximum modulus and strength range based on the test temperature.

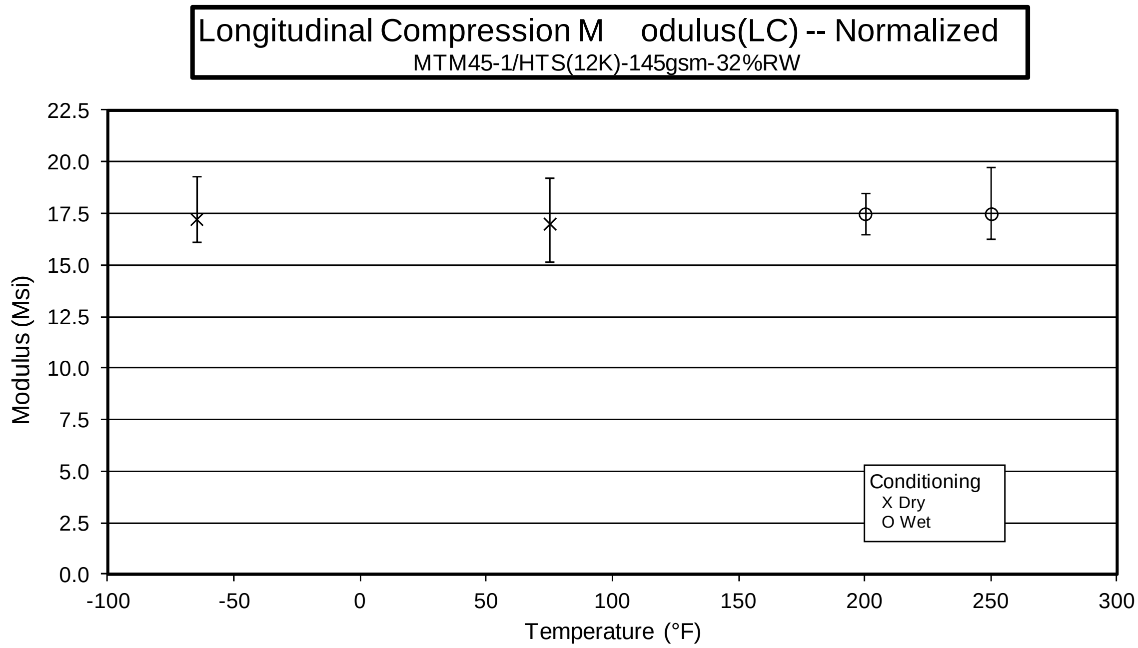
3.1 Longitudinal Tension Properties



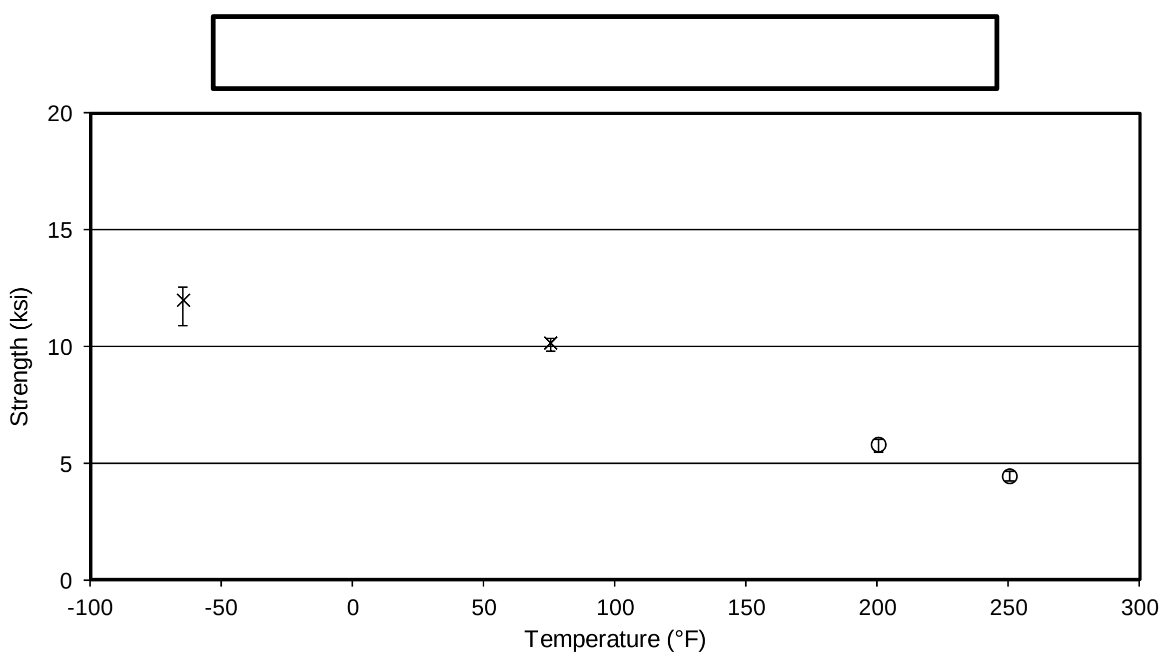
3.2 Transverse Tension Properties

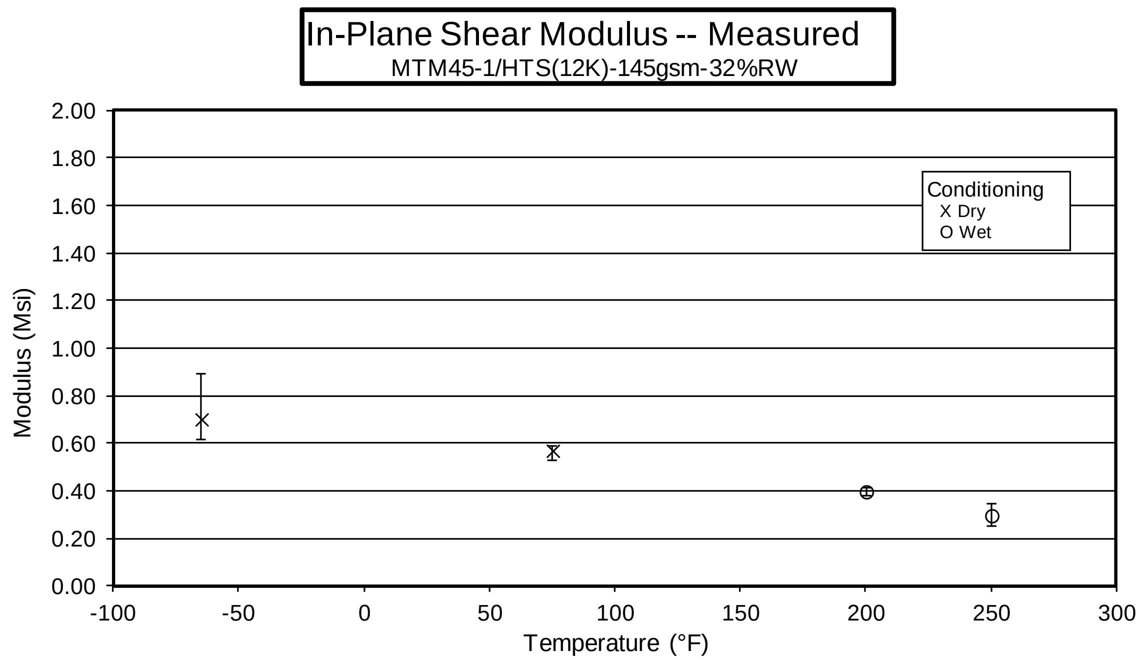


3.3 Longitudinal Compression Properties

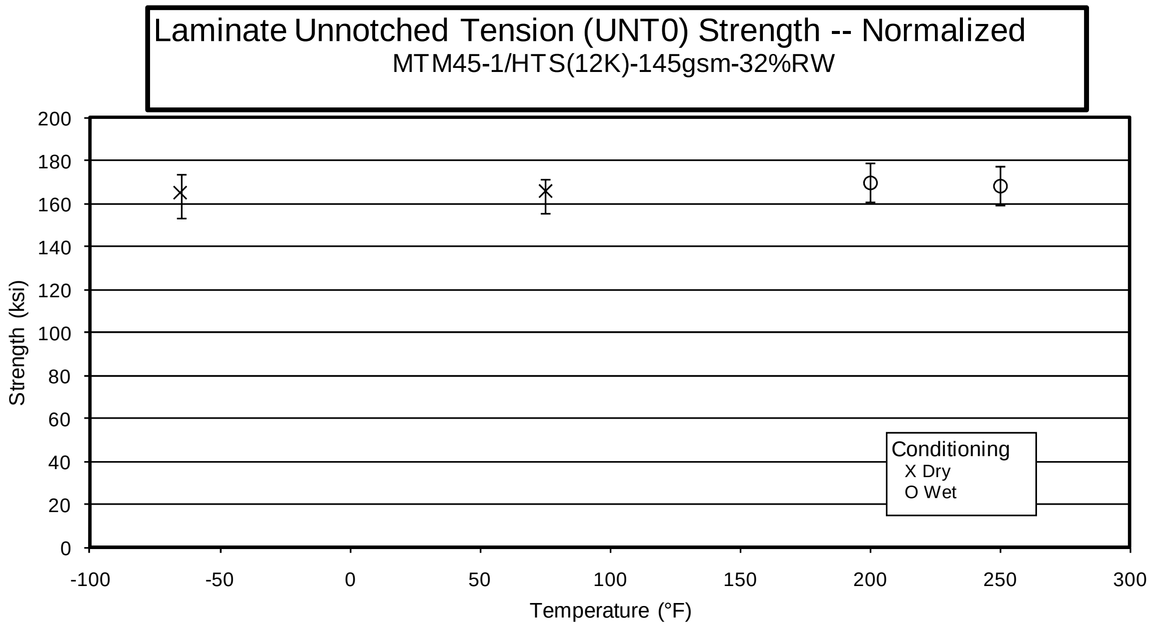


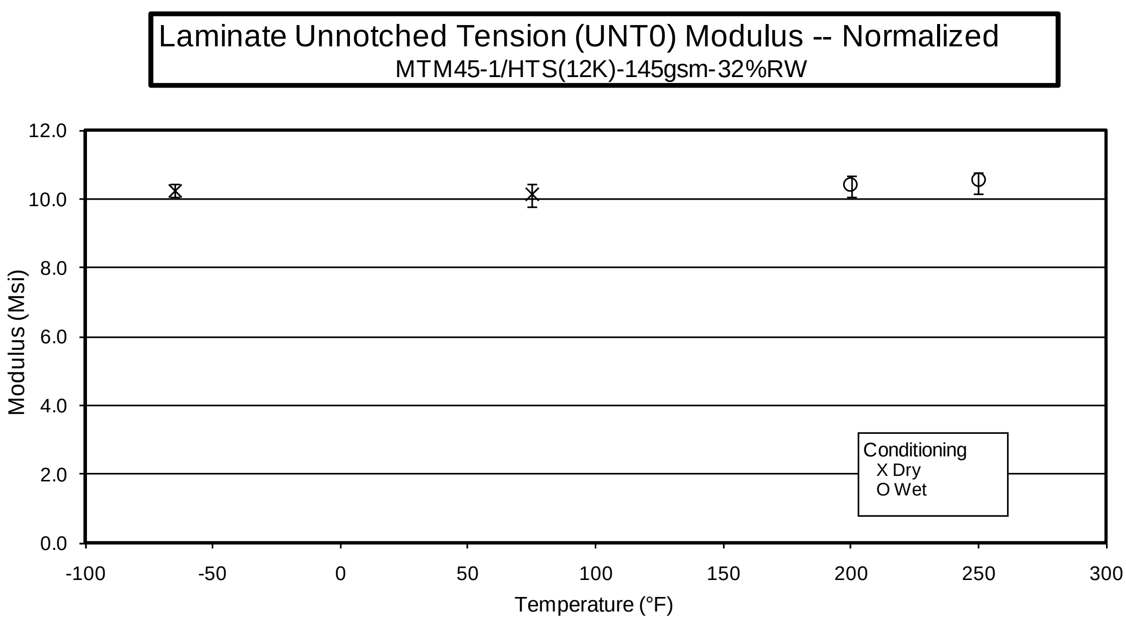
3.4 In-Plane Shear Properties




In-Plane Shear Modulus -- Measured
MTM45-1/HTS(12K)-145gsm-32%RW
Modulus (Msi)
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-100
-50
0
50
100
150
200
250
300
Temperature (°F)
Conditioning
X Dry
O Wet

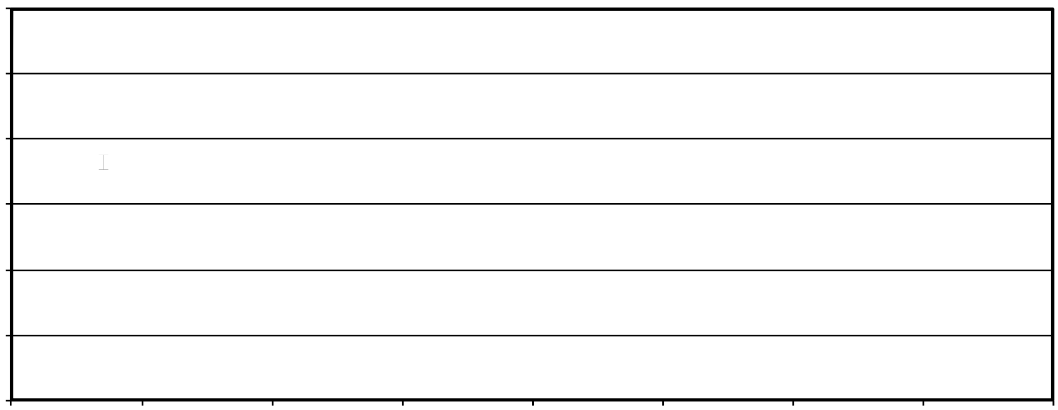
3.5 Unnotched Tension 0 Properties



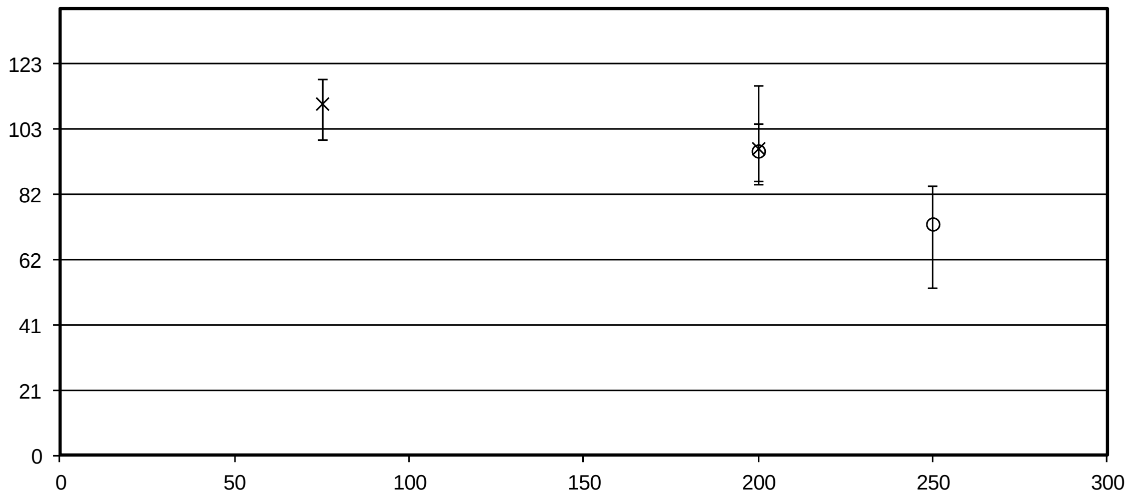


3.6 Unnotched Tension 1 Properties

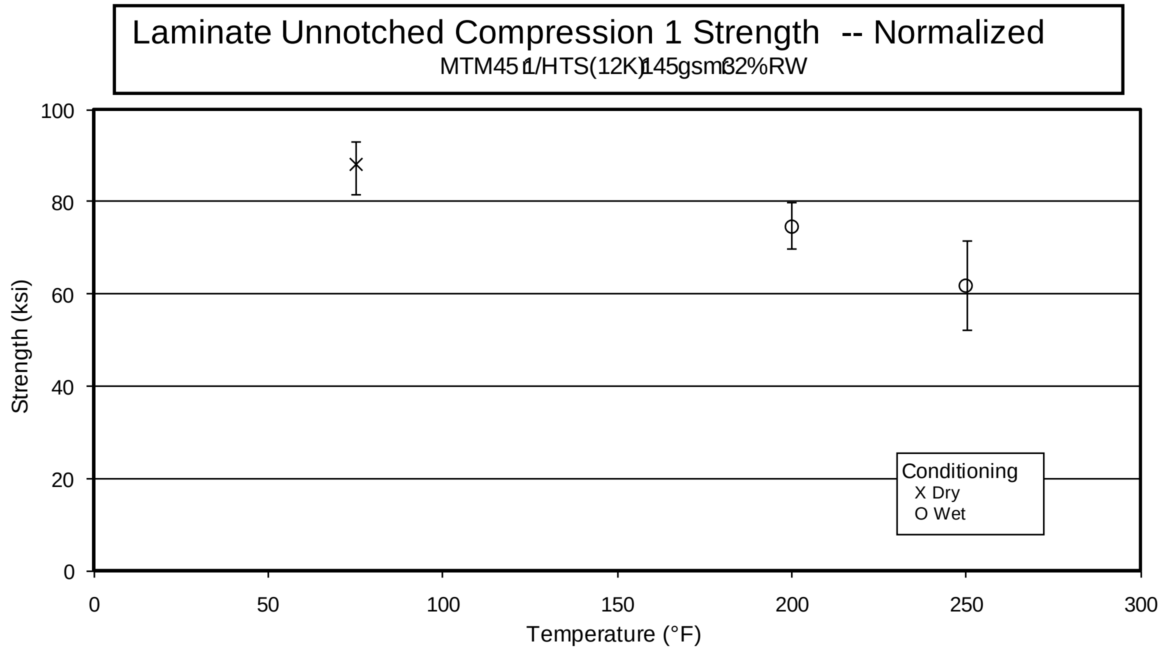
3.7 Unnotched Tension 2 Properties

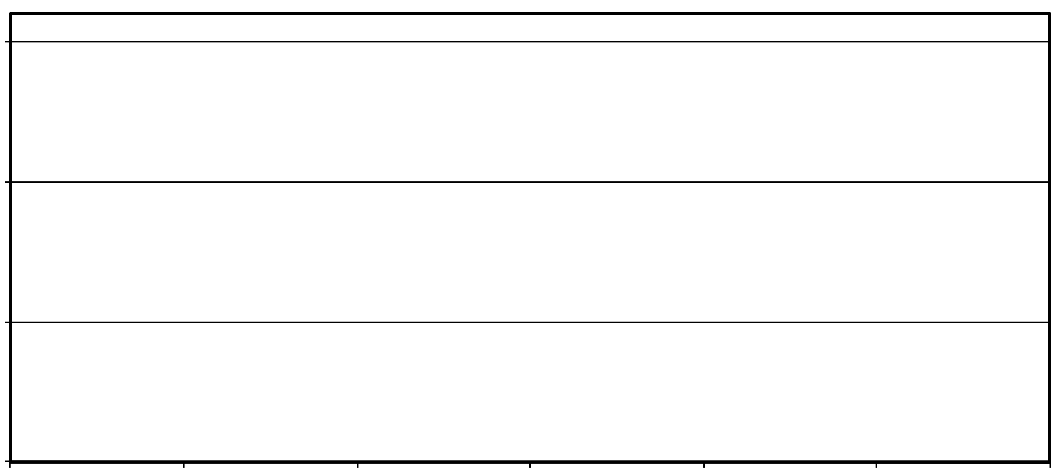


3.9 Unnotched Compression 0 Properties

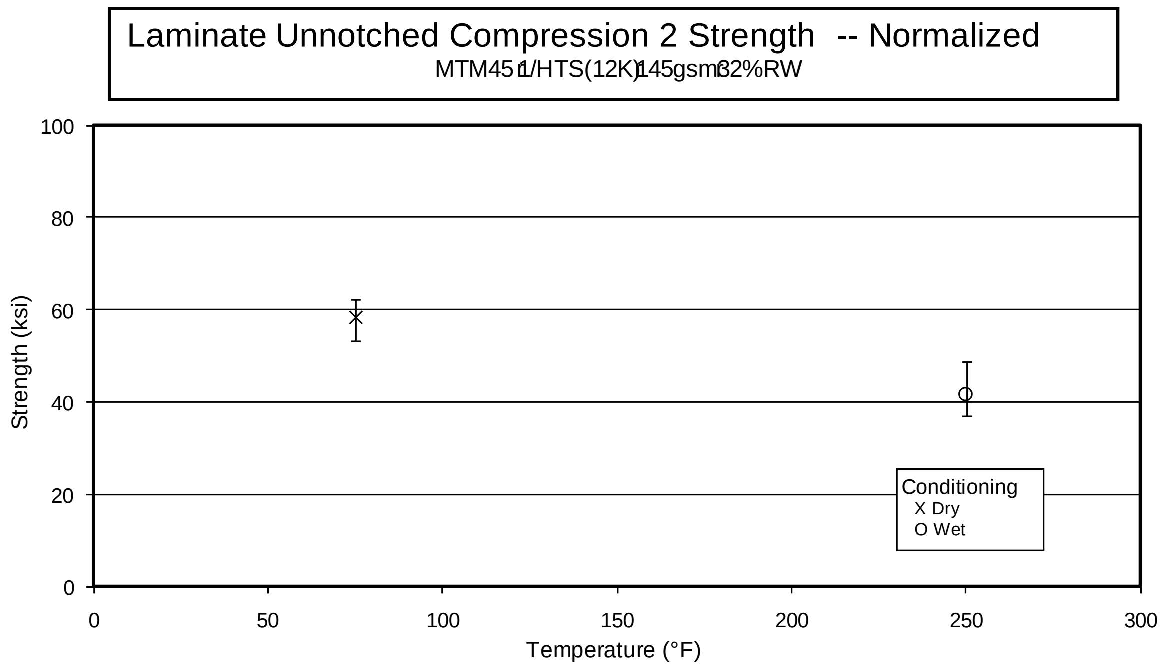


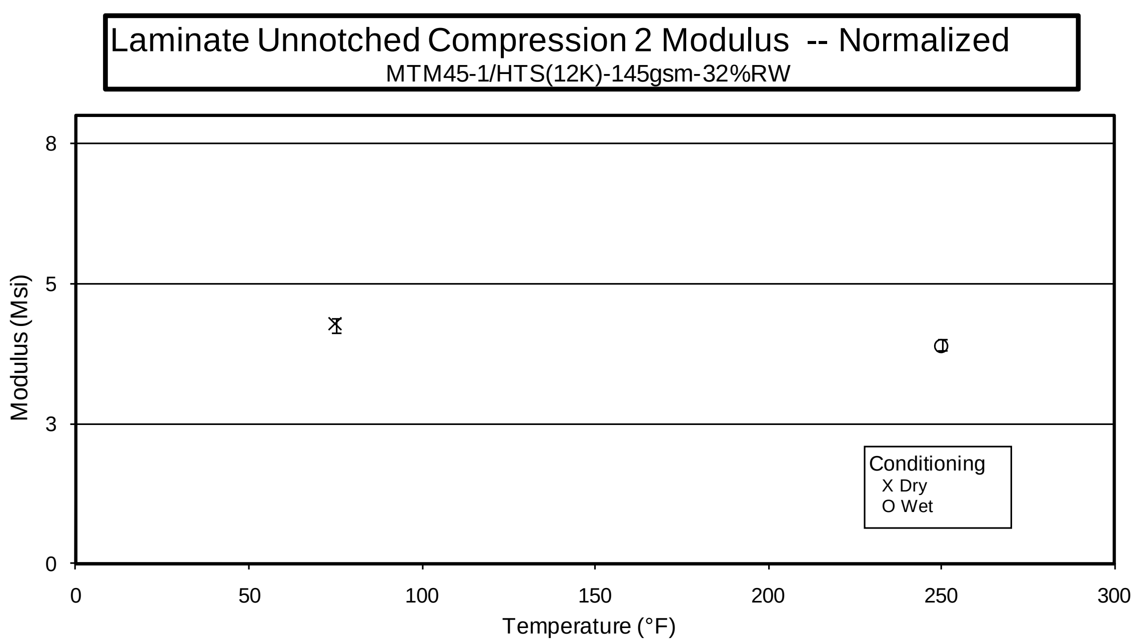
3.10 Unnotched Compression 1 Properties



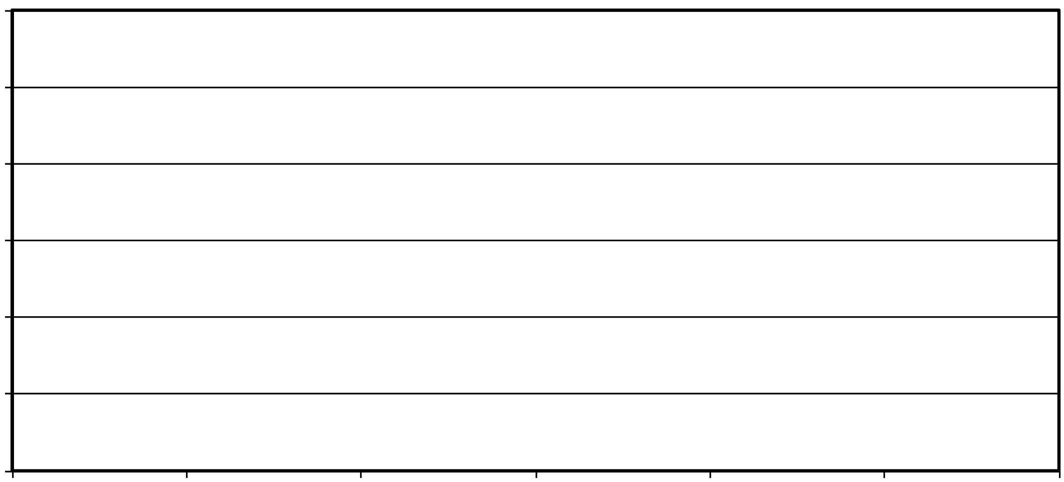


3.11 Unnotched Compression 2 Properties



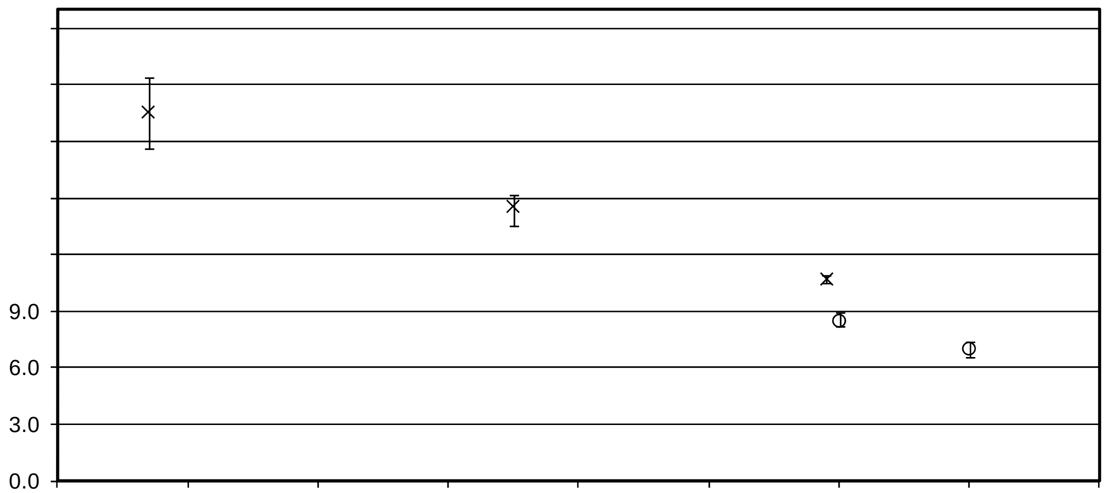


3.12 Unnotched Compression 3 Properties



3.13 Laminate Short Beam Strength Properties

3.14 Lamina Short Beam Strength Properties

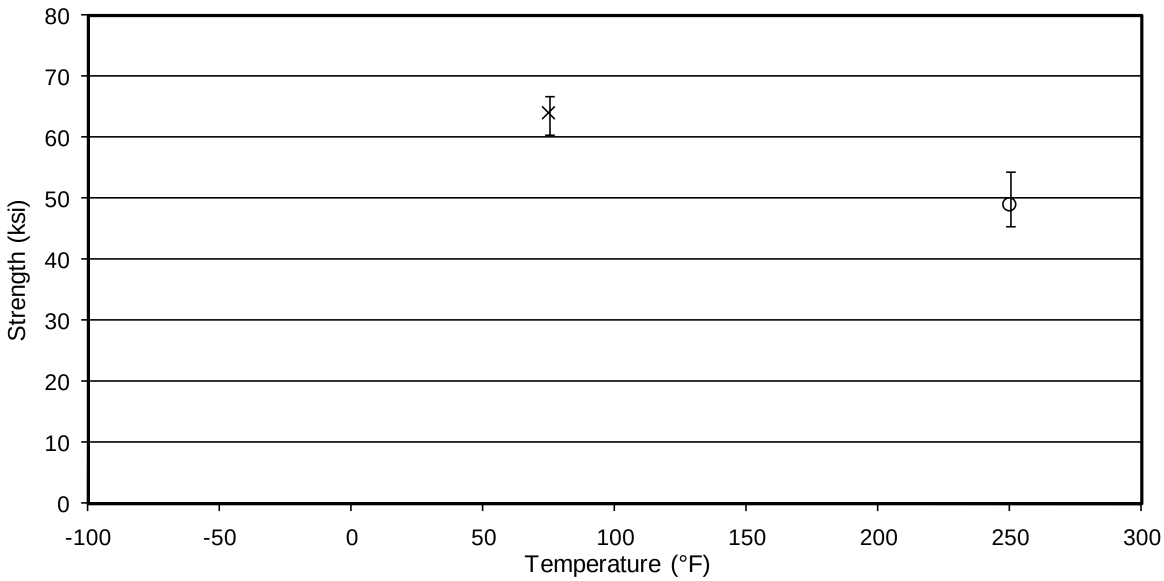


3.18 Filled-Hole Tension 1 Properties

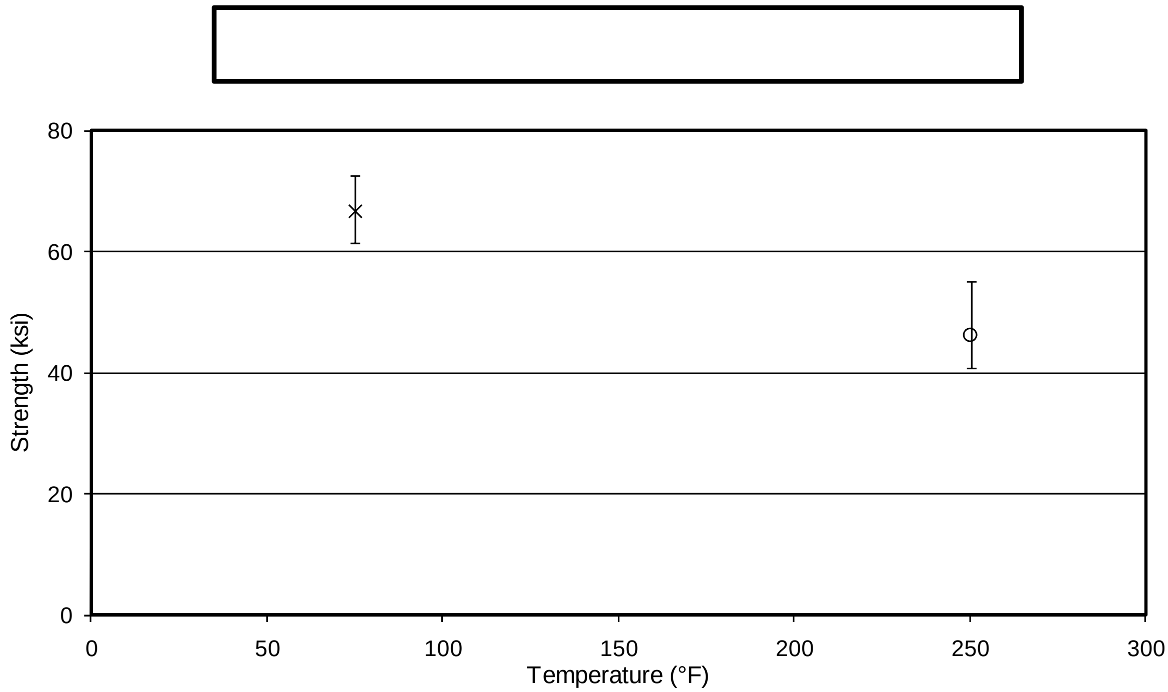
3.20 Filled-Hole Tension 3 Properties

3.21 Open Hole Compression 1 Properties

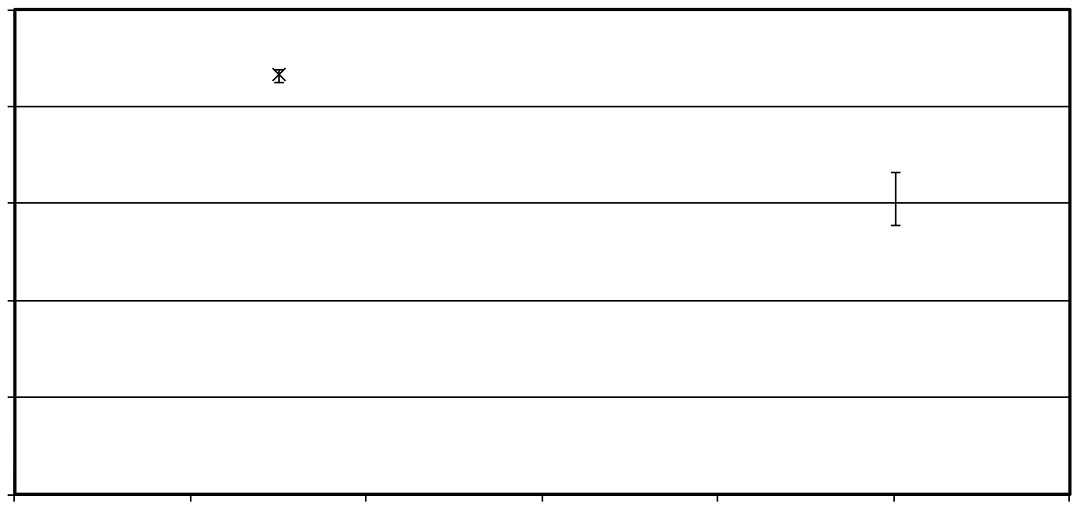
3.23 Open Hole Compression 3 Properties



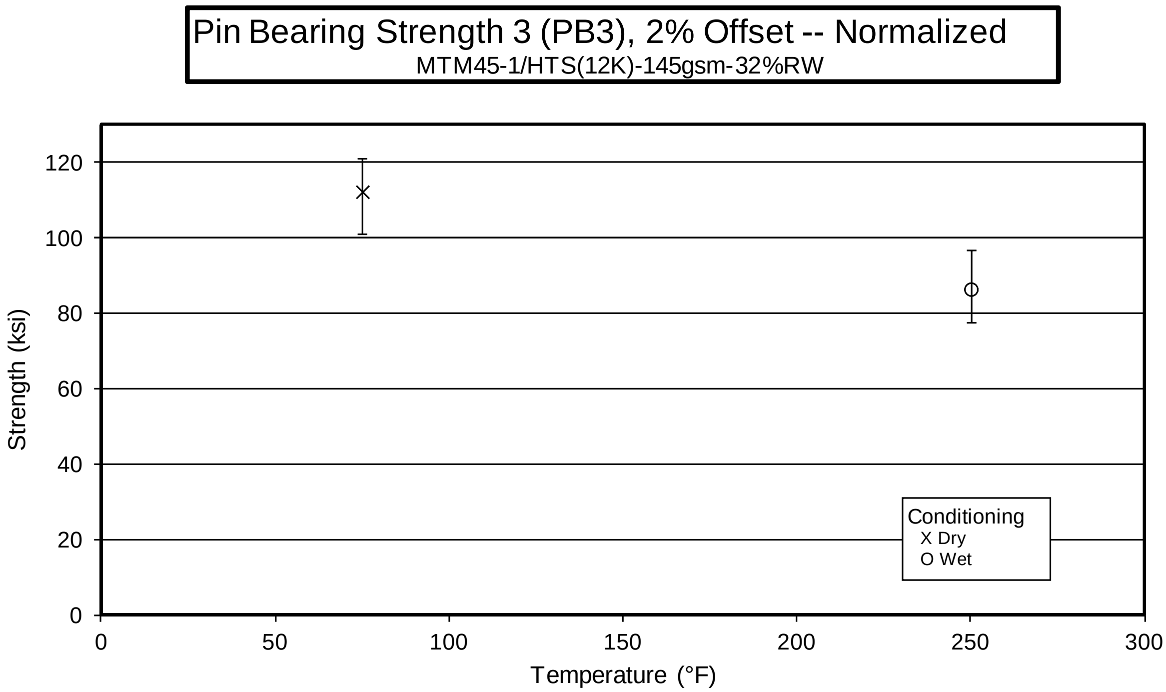
3.24 Filled-Hole Compression 1 Properties



3.26 Filled-Hole Compression 3 Properties



3.29 Pin Bearing 3 Properties



4. Raw Data

4.1 Longitudinal Tens ion Properties

	normalizing t_{ply} [in]
	0.0055

Specimen Number	ACG Batch #	ACG Cure Cycle	Prepreg Lot #	Cure Cycle #	Modulus [Msi]	Poisson's Ratio	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]	$Modulus_{norm}$ [Msi]
ABMJA116B	A	MH1	1	1	18.963	0.312	0.089	16	0.0055	19.117
ABMJA117B	A	MH1	1	1	19.164	0.311	0.089	16	0.0056	19.379
ABMJA118B	A	MH1	1	1	19.130	0.327	0.089	16	0.0055	19.256
ABMJA215B	A	MH2	1	1	18.799	0.327	0.090	16	0.0056	19.209
ABMJA216B	A	MH2	1	2	18.712	0.328	0.089	16	0.0056	18.929
ABMJA217B	A	MH2	1	2	18.450	0.314	0.092	16	0.0057	19.243
ABMJA218B	A	MH2	1	2	19.058	0.327	0.088	16	0.0055	19.086
ABMJB115B	B	MH1	2	1	18.744	0.312	0.090	16	0.0056	19.188
ABMJB116B	B	MH1	2	1	18.590	0.312	0.091	16	0.0057	19.175
ABMJB117B	B	MH1	2	1	18.892	0.326	0.090	16	0.0056	19.404
ABMJB215B	B	MH2	2	2	18.420	0.342	0.091	16	0.0057	18.968
ABMJB216B	B	MH2	2	2	18.389	0.339	0.091	16	0.0057	18.978
ABMJB217B	B	MH2	2	2	18.151	0.345	0.091	16	0.0057	18.729
ABMJC115B	C	MH1	3	1	18.717	0.333	0.089	16	0.0056	18.936
ABMJC116B	C	MH1	3	1	18.895	0.321	0.089	16	0.0055	19.049
ABMJC117B	C	MH1	3	1	18.919	0.329	0.087	16	0.0054	18.704
ABMJC215B	C	MH2	3	2	19.048	0.298	0.088	16	0.0055	19.066
ABMJC216B	C	MH2	3	2	19.265	0.319	0.087	16	0.0054	19.086
ABMJC217B	C	MH2	3	2	18.988	0.300	0.087	16	0.0054	18.776

	Modulus	Poisson's Ratio		Avg. t_{ply}	$Modulus_{norm}$
Average	18.805	0.322	$Average_{norm}$	0.0056	19.067
Standard Dev.	0.298	0.013	$Standard Dev._{norm}$		0.199
Coeff. of Var. [%]	1.584	4.018	$Coeff. of Var. [\%]_{norm}$		1.043
Min.	18.151	0.298		0.0054	18.704
Max.	19.265	0.345		0.0057	19.404
Number of Spec.	19	19			19