

**BOEING PROPRIETARY**

**THE BOEING COMPANY**

**2.8 BMS 8-139**

**2.8.1 BMS 8-139, Type 120, Class I or II**

This specification applies to solid glass laminates and glass laminate faced honeycomb sandwich details using a autoclave process (350°F).

Type 120: BMS 9-3, Type D, Style 120 Glass Fabric.

**Reference:** Coordination Sheet STRU-BY92B-C90-A195, "BMS 8-139 Fiberglass Test Results and Update on BMS 8-79 Fiberglass Test Program.

**Contents:**

Table 2.8.1-1 Ply Properties



**BOEING PROPRIETARY**

THE BOEING COMPANY

Table 2.8.1-1 Ply Properties

TABLE 2.8.1-1		PLY PROPERTIES						
PREPREG MATERIAL SPECIFICATION: BMS 8-139, TYPE 120, CLASS I or II								
RESIN CONTENT:		42 (% WT)						
CURED PLY THICKNESS:		.0045 (In)						
PROCESS SPECIFICATION:		BAC 5317, BAC 5578						
PROPERTY		UNIT	ENVIRONMENTAL CONDITION					
			-75° F		70° F		130° F	160° F
			DRY	WET	DRY	WET	WET	DRY
MODULUS ②	E 1 ①	msi	3.0					
	E 2 ①	msi	3.0					
	G 12	msi			0.54		0.42	0.37
	G 13	msi			0.54		0.42	0.37
	G 23	msi			0.54		0.42	0.37
POISSON'S RATIO	V 12	----	.12					
COEFFICIENTS OF LINEAR THERMAL EXPANSION ③	α 1	In/In ° F	5.5 x 10 <sup>-6</sup>					5.5 x 10 <sup>-6</sup>
	α 2	In/In ° F	5.5 x 10 <sup>-6</sup>					5.5 x 10 <sup>-6</sup>
COEFFECIENTS OF LINEAR MOISTURE EXPANSION ④	β 1	In/In %M	N/A					
	β 2	In/In %M	N/A					
THERMAL CONDUCTIVITY	κ 1	BTU/(hr ft °F)						
	κ 2	BTU/(hr ft °F)						
	κ 3	BTU/(hr ft °F)						

① E<sub>1</sub> & E<sub>2</sub> are the average of tension and compression moduli.

② Modulus values are secant values at a strain level of 4000 μ in/in. For special analyses use modulus versus strain curves to determine secant values at the desired strain level.

③ CLTE values are for expansion between -75° F and 70° F, and 70° F and 180° F.

④ %M = Percent absorbed moisture by weight.

DG-100-588

THE BOEING COMPANY

This specification applies to solid glass laminates and glass laminate faced honeycomb sandwich details using an autoclave process (350°F).

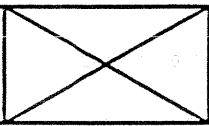
Type 7781: BMS 9-3, Type H-3, Style 181-77 Glass Fabric.

## Contents:

Table 2.8.2-1      Ply Properties

**BOEING PROPRIETARY**  
**THE BOEING COMPANY**

Table 2.8.2-1 Ply Properties

TABLE 2.8.2-1		PLY PROPERTIES						
PREPREG MATERIAL SPECIFICATION: BMS 8-139, TYPE 1581 OR 7781, CLASS I OR II								
RESIN CONTENT:		36 (% WT)						
CURED PLY THICKNESS:		.01 (In)						
PROCESS SPECIFICATION:		BAC 5317, BAC 5578						
PROPERTY		UNIT	ENVIRONMENTAL CONDITION					
			-75° F		70° F		130° F	160° F
			DRY	WET	DRY	WET	WET	DRY
MODULUS ②	E <sub>1</sub> ①	msi	3.5					
	E <sub>2</sub> ①	msi	3.5					
	G <sub>12</sub>	msi			0.62		0.52	0.48
	G <sub>13</sub>	msi			0.62		0.52	0.48
	G <sub>23</sub>	msi			0.62		0.52	0.48
POISSON'S RATIO	ν <sub>12</sub>	----	.12					
COEFFICIENTS OF LINEAR THERMAL EXPANSION ③	α <sub>1</sub>	In/In ° F	5.5 x 10 <sup>-6</sup>			5.5 x 10 <sup>-6</sup>		
	α <sub>2</sub>	In/In ° F	5.5 x 10 <sup>-6</sup>			5.5 x 10 <sup>-6</sup>		
COEFFECIENTS OF LINEAR MOISTURE EXPANSION ④	β <sub>1</sub>	In/In %M	N/A					
	β <sub>2</sub>	In/In %M	N/A					
THERMAL CONDUCTIVITY	κ <sub>1</sub>	BTU/(hr ft °F)						
	κ <sub>2</sub>	BTU/(hr ft °F)						
	κ <sub>3</sub>	BTU/(hr ft °F)						

① E<sub>1</sub> & E<sub>2</sub> are the average of tension and compression modull.

② Modulus values are secant values at a strain level of 4000 μ In/In. For special analyses use modulus versus strain curves to determine secant values at the desired strain level.

③ CLTE values are for expansion between -75° F and 70° F, and 70° F and 180° F.

④ %M = Percent absorbed moisture by weight.

October 10, 1990  
RU-BY92B-C90-A195

To: John Doherty 9R-62  
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Jack Winchester 6N-30  
Ron Zabora 9R-62

cc: M.M. Spencer 7Y-89 (cover only)

Subject: BMS 8-139 Fiberglass test results, and  
update on BMS 8-79 Fiberglass test program

Reference: EWA #AC0700, Design Guide Development

#### BMS 8-139 Fiberglass Test Results

Phase 2 of BMS 8-139 Fiberglass testing has been completed by Stress Methods and Allowables (SMA). Preliminary design values were obtained for ply properties ( $E_{11}$ ,  $G_{12}$ ,  $V_{12}$ ), tension and compression strain to failure, notch and environmental lockdown factors, and bearing strengths. These results are attached.

Phase 3 of the BMS 8-139 test program is being initiated at this time, and it will develop firm allowables for BMS 8-139 Fiberglass suitable for inclusion in the Boeing Design Manual.

#### BMS 8-79 Fiberglass Testing Update

The first phase of BMS 8-79 Fiberglass testing has been completed and a results package is due out in approximately 1-2 weeks from the date of this coordination sheet. Results from this phase of testing will be preliminary.

Phase 2 of the BMS 8-79 test program will begin soon, and will generate firm allowables and design values suitable for inclusion in the Boeing Design Manual.

Any questions concerning either of the above mentioned test programs should be directed to the undersigned.

*Tom Sandifur* MS 7

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*B. F. Backman*

B. F. Backman  
Org. B-Y92B, MS 7W-23  
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# BMS 8-139 FIBERGLASS (RTD)

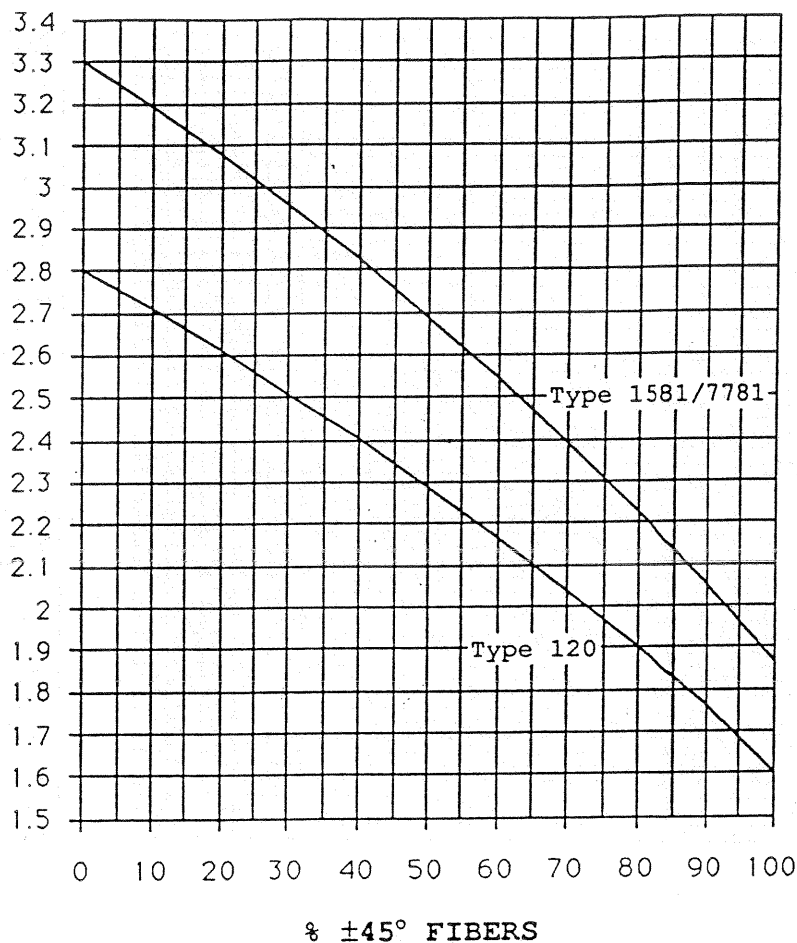
$E_x^C, E_y^C$

PRELIMINARY DATA ONLY

FABRIC:  $E_x^C = E_y^C$

LAMINATE MODULI

$E_x^C, E_y^C$  (msi)



1	Type 1581/7781
$E_{11}$	3.3 msi
$E_{22}$	3.3 msi
$G_{12}$	.62 msi
$\nu_{12}$	.124
$t_n$	.01 in

1	Type 120
$E_{11}$	2.8 msi
$E_{22}$	2.8 msi
$G_{12}$	.535 msi
$\nu_{12}$	.129
$t_n$	.0045 in

1 INPUTS TO LAMINATED PLATE THEORY

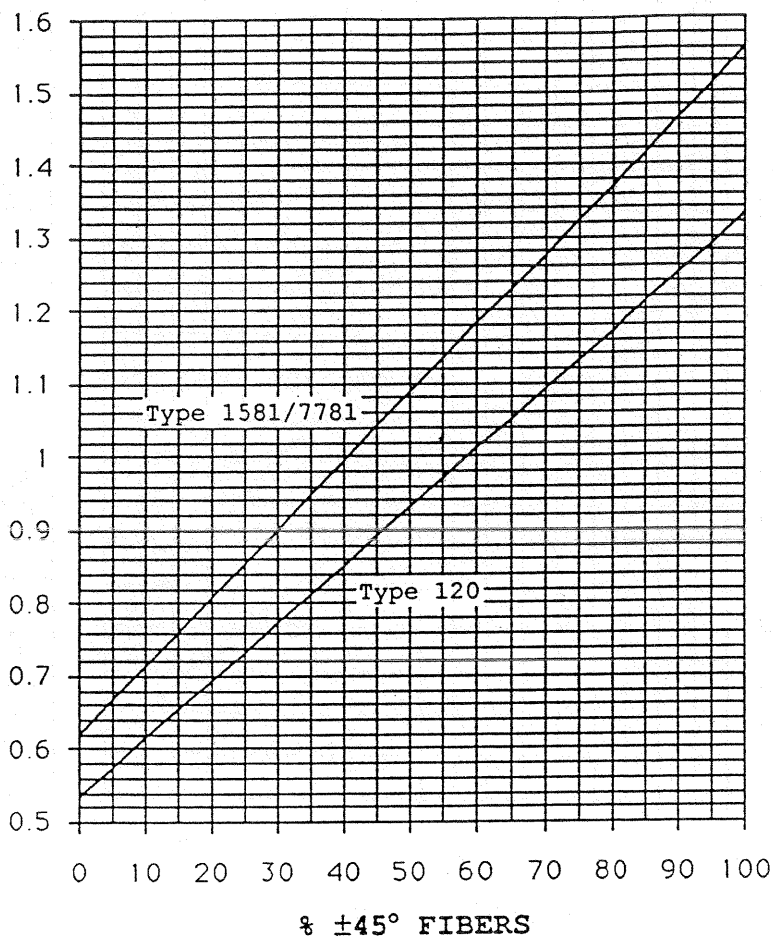
ENGR	T. SANDIFUR	REVISED	BMS 8-139 FIBERGLASS	
CHECK			COMPRESSION MODULI	
APR			BOEING	

# BMS 8-139 FIBERGLASS (RTD)

$G_{xy}$

PRELIMINARY DATA ONLY

LAMINATE MODULI  
 $G_{xy}$  (msi)



1	Type 1581/7781
$E_{11}$	3.5 msi
$E_{22}$	3.5 msi
$G_{12}$	.62 msi
$\nu_{12}$	.124
$t_n$	.01 in

1	Type 120
$E_{11}$	3.0 msi
$E_{22}$	3.0 msi
$G_{12}$	.535 msi
$\nu_{12}$	.129
$t_n$	.0045 in

1 INPUTS TO LAMINATED PLATE THEORY

ENGR	T. SANDIFUR	REVISED	BMS 8-139 FIBERGLASS	
CHECK			SHEAR MODULUS	
APR			BOEING	



# BMS 8-139 FIBERGLASS

## DEFINITION OF TERMS

$E_{x,y}^A$	Laminate Average Modulus in x- or y-direction
$E_{x,y}^C$	Laminate Compression Modulus in x- or y-direction
$G_{xy}$	Laminate Shear Modulus
$\nu_{xy}$	Laminate Poisson's Ratio
$t_n$	Nominal Ply Thickness
$F_{UN}^T$	Unnotched Tension - Stress to Failure
$\epsilon_{UN}^T$	Unnotched Tension - Strain to Failure
$F_{UN}^C$	Unnotched Compression - Stress to Failure
$\epsilon_{UN}^C$	Unnotched Compression - Strain to Failure
$\epsilon_{OH}^{C,T}$	Open Hole (Notched) Strain to Failure
$C_N$	Notch Correction Factor
$C_T$	Environmental Correction Factor
$F_{bru}$	Bearing Strength - Ultimate
$G_{Ic}$	Mode I Toughness
$G_{IIc}$	Mode II Toughness

# BMS 8-139 FIBERGLASS (RTD)

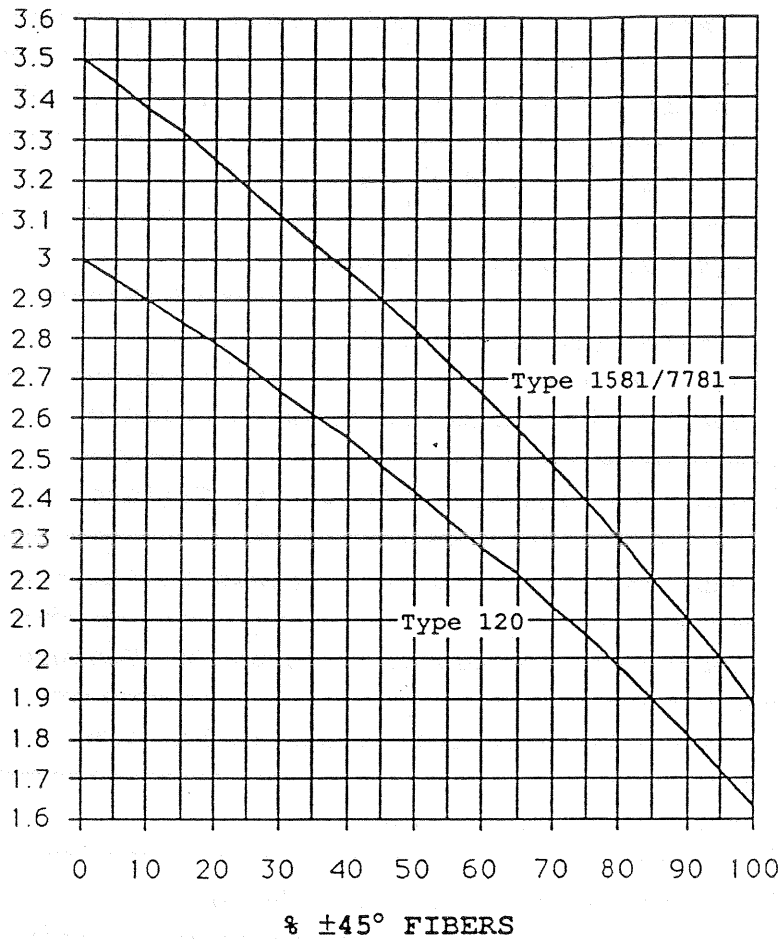
$E_X^A, E_Y^A$

PRELIMINARY DATA ONLY

FABRIC:  $E_X^A = E_Y^A$

LAMINATE MODULI

$E_X^A, E_Y^A$  (msi)



1	Type 1581/7781
$E_{11}$	3.5 msi
$E_{22}$	3.5 msi
$G_{12}$	.62 msi
$\nu_{12}$	.124
$t_n$	.01 in

1	Type 120
$E_{11}$	3.0 msi
$E_{22}$	3.0 msi
$G_{12}$	.535 msi
$\nu_{12}$	.129
$t_n$	.0045 in

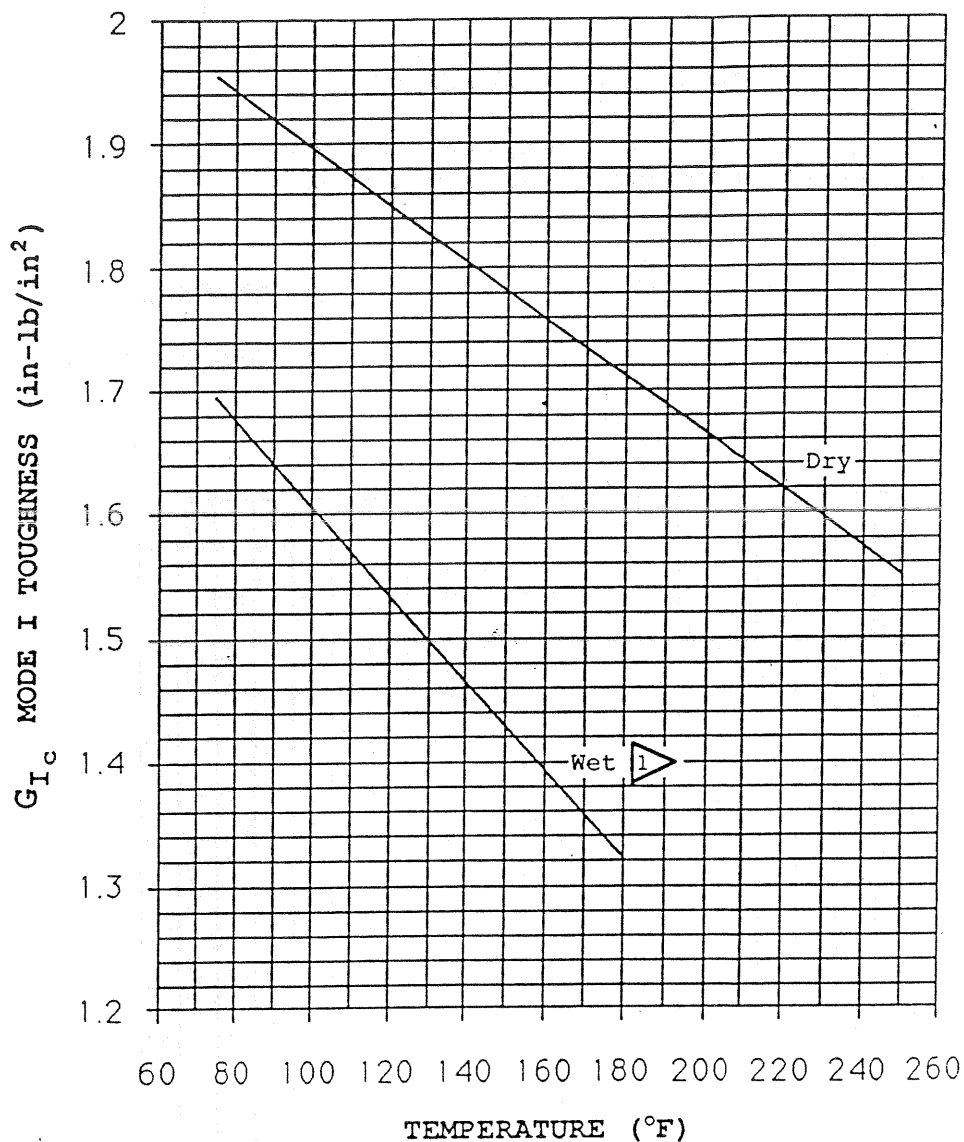
1 INPUTS TO LAMINATED PLATE THEORY

ENGR	T. SANDIFUR	REVISED	BMS 8-139 FIBERGLASS	
CHECK			AVERAGE MODULI	
APR			BOEING	

# BMS 8-139 FIBERGLASS (RTD)

$G_{Ic}$

PRELIMINARY DATA ONLY



1 "WET" SPECIMENS WERE CONDITIONED AT 170°F AND 85% R.H. TO EQUILIBRIUM WEIGHT GAIN.

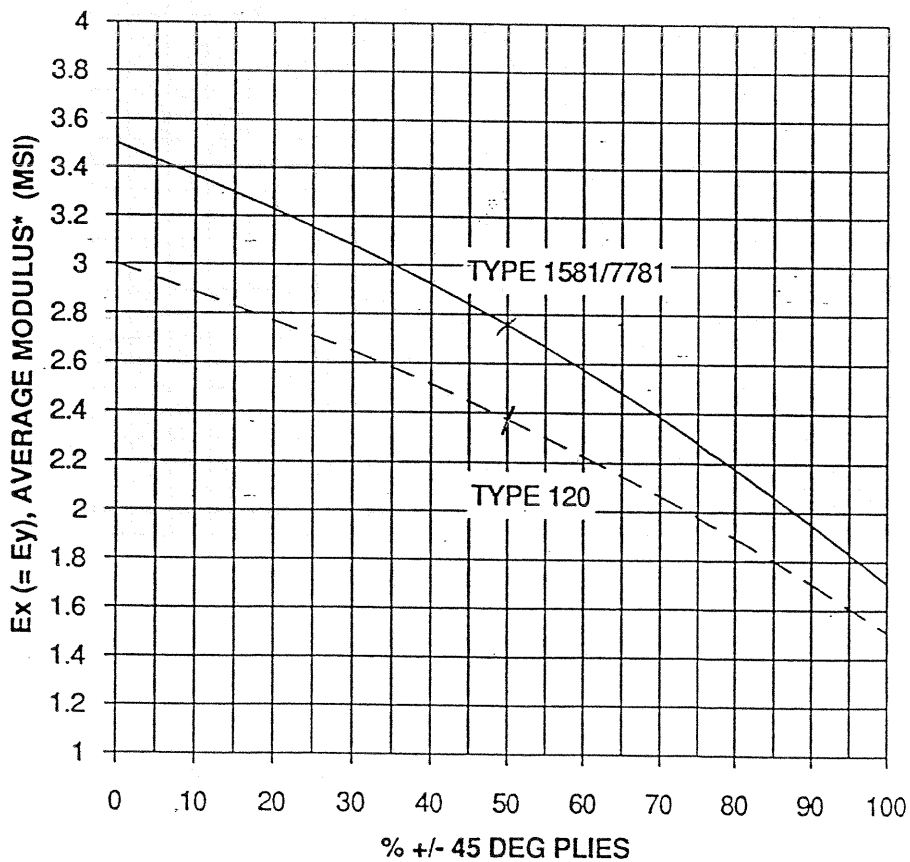
ENGR	T. SANDIFUR	REVISED	BMS 8-139 FIBERGLASS	
CHECK			MODE I TOUGHNESS-TYPICAL VALUES	
APR			<b>BOEING</b>	

**BMS 8-79 FIBERGLASS  
PRELIMINARY  
DESIGN VALUES**

**LAMINATE AVERAGE MODULUS  
TYPICAL VALUES  
CLASS III, GRADE 1, TYPE 120 AND/OR 1581/7781  
ROOM TEMPERATURE AMBIENT (RTA)**

TYPE 120:  $E_x = E_y = 3.00 - 1.11E-2*(\%45'S) - 2.15E-5*(\%45'S)^2 - 1.76E-7*(\%45'S)^3$

TYPE 1581/7781:  $E_x = E_y = 3.50 - 1.29E-2*(\%45'S) - 2.87E-5*(\%45'S)^2 - 2.12E-7*(\%45'S)^3$

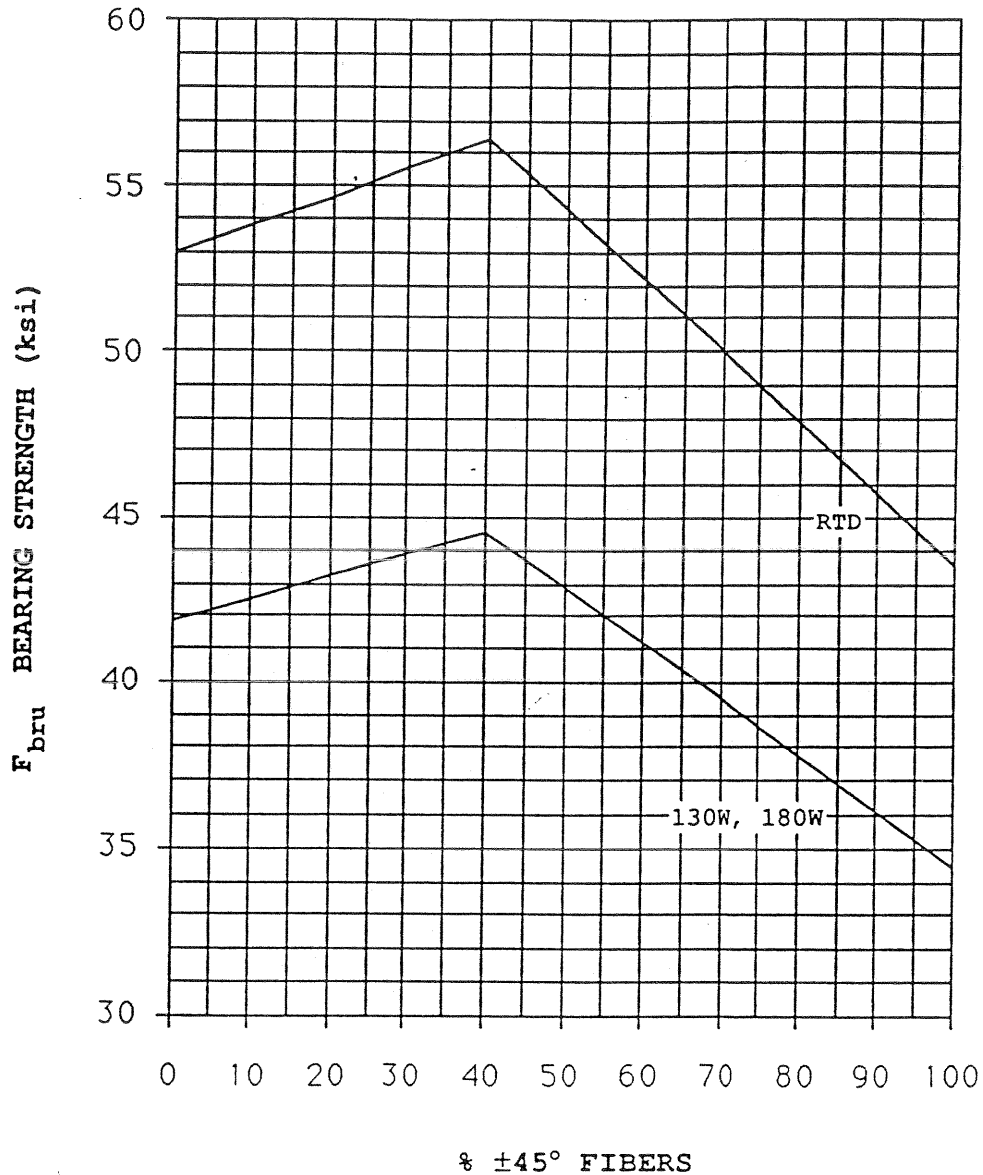


\* Compression Modulus = Average Modulus

# BMS 8-139 FIBERGLASS (RTD) DESIGN VALUES

$F_{bru}$   
Type 120

PRELIMINARY DATA ONLY



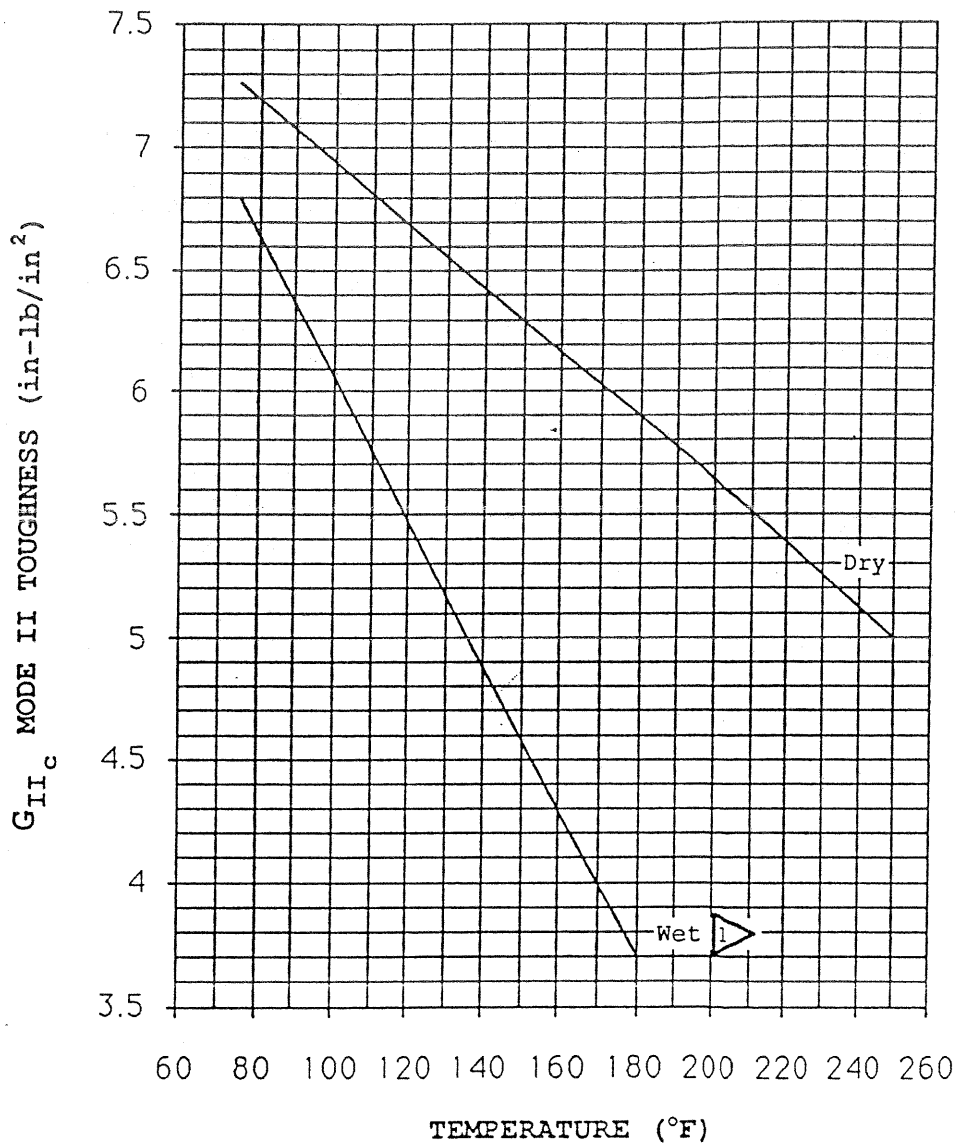
ENGR	T. SANDIFUR	REVISED	BMS 8-139 FIBERGLASS	
CHECK			BEARING STRENGTH - TYPE 120	
APR			<b>BOEING</b>	



# BMS 8-139 FIBERGLASS (RTD)

$G_{IIc}$

PRELIMINARY DATA ONLY



1 "WET" SPECIMENS WERE CONDITIONED AT 170°F AND 85% R.H. TO EQUILIBRIUM WEIGHT GAIN.

ENGR	T. SANDIFUR	REVISED	BMS 8-139 FIBERGLASS	
CHECK			MODE II TOUGHNESS-TYPICAL VALUES	
APR			BOEING	



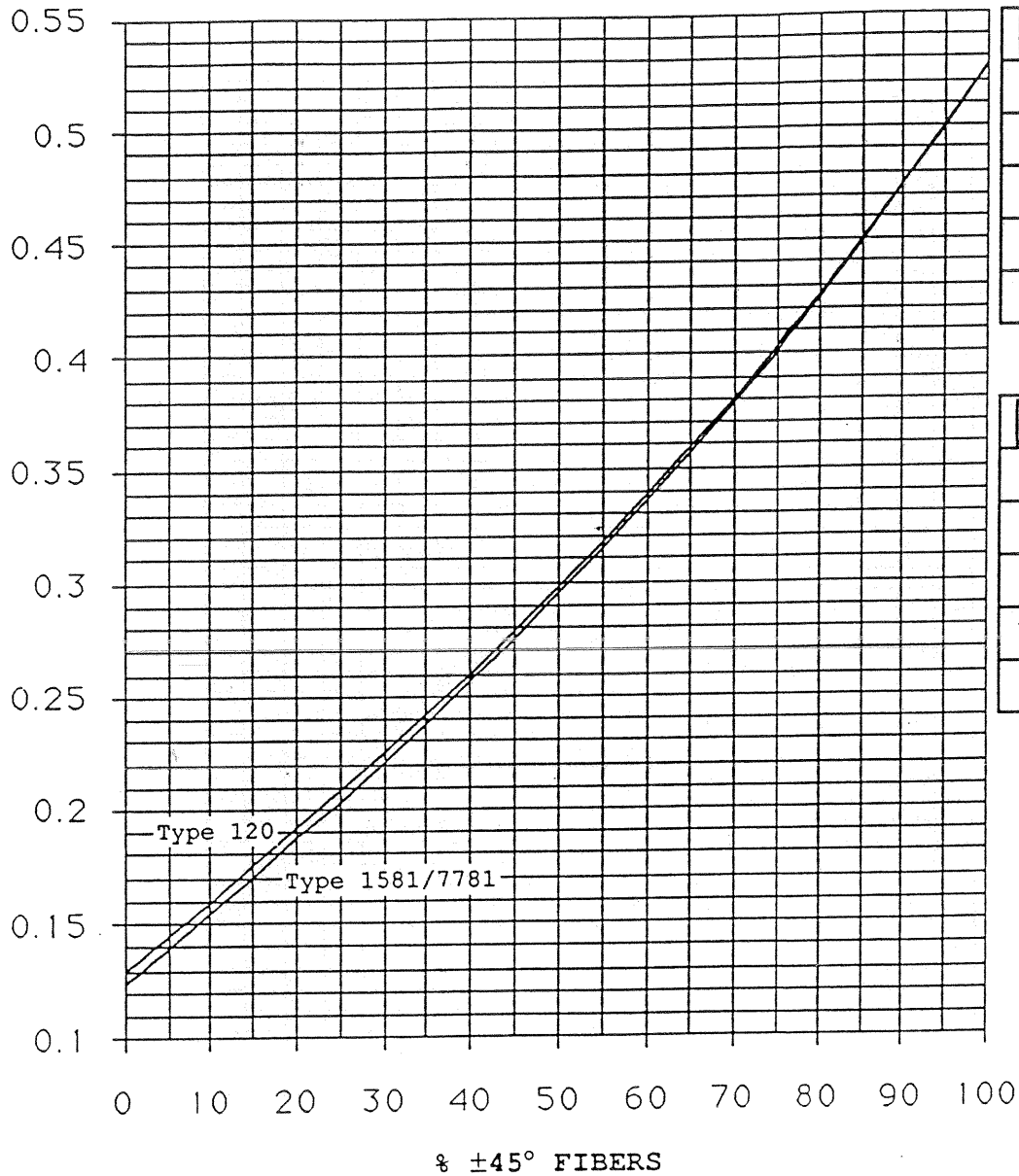


# BMS 8-139 FIBERGLASS (RTD)

$v_{xy}$

PRELIMINARY DATA ONLY

POISSON'S RATIO  
 $v_{xy}$



1	Type 1581/7781
$E_{11}$	3.5 msi
$E_{22}$	3.5 msi
$G_{12}$	.62 msi
$v_{12}$	.124
$t_n$	.01 in

1	Type 120
$E_{11}$	3.0 msi
$E_{22}$	3.0 msi
$G_{12}$	.535 msi
$v_{12}$	.129
$t_n$	.0045 in

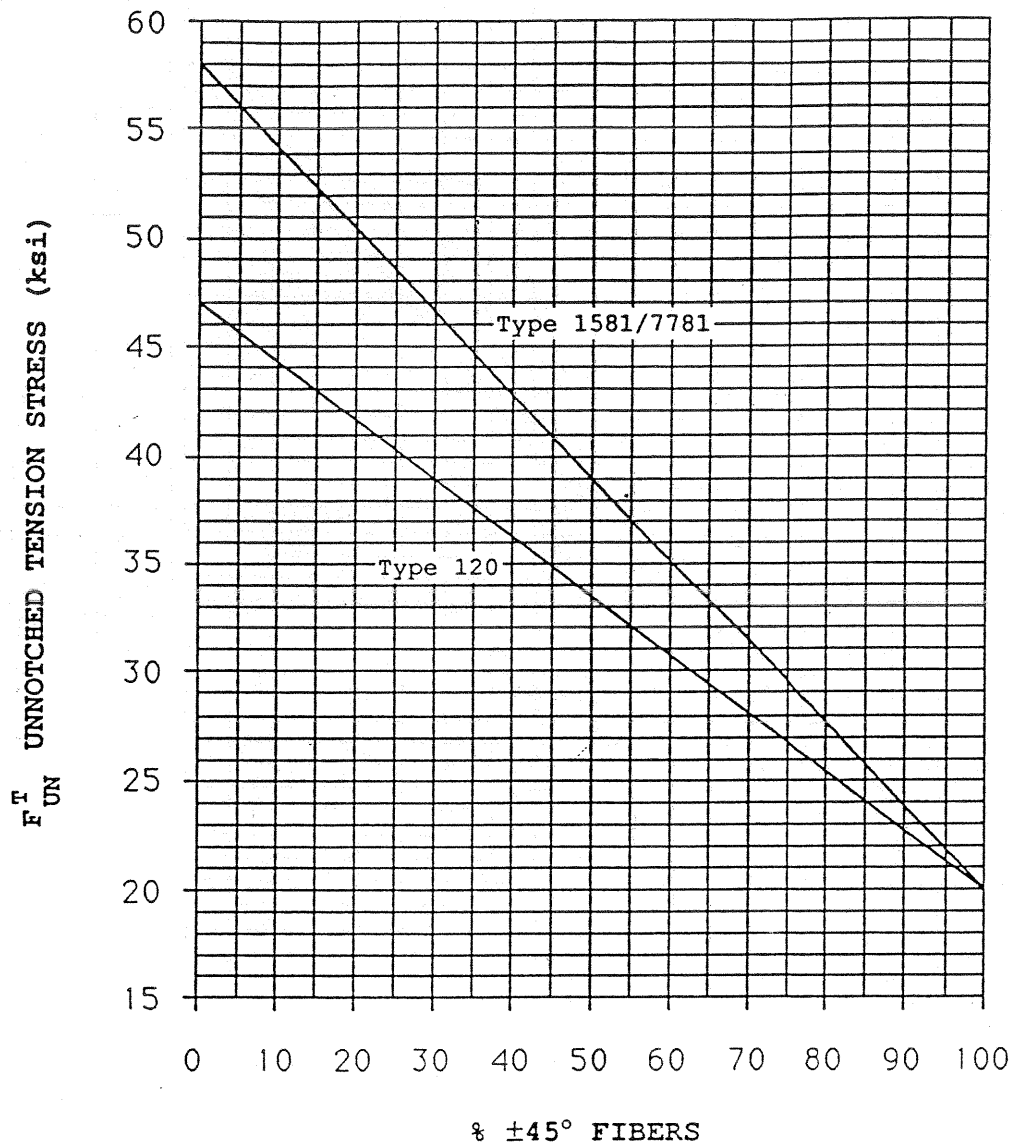
1 INPUTS TO LAMINATED PLATE THEORY

ENGR	T. SANDIFUR	REVISED	BMS 8-139 FIBERGLASS	
CHECK			POISSON'S RATIO	
APR			BOEING	

# BMS 8-139 FIBERGLASS(RTD) DESIGN VALUES

$F_{UN}^T$

PRELIMINARY DATA ONLY



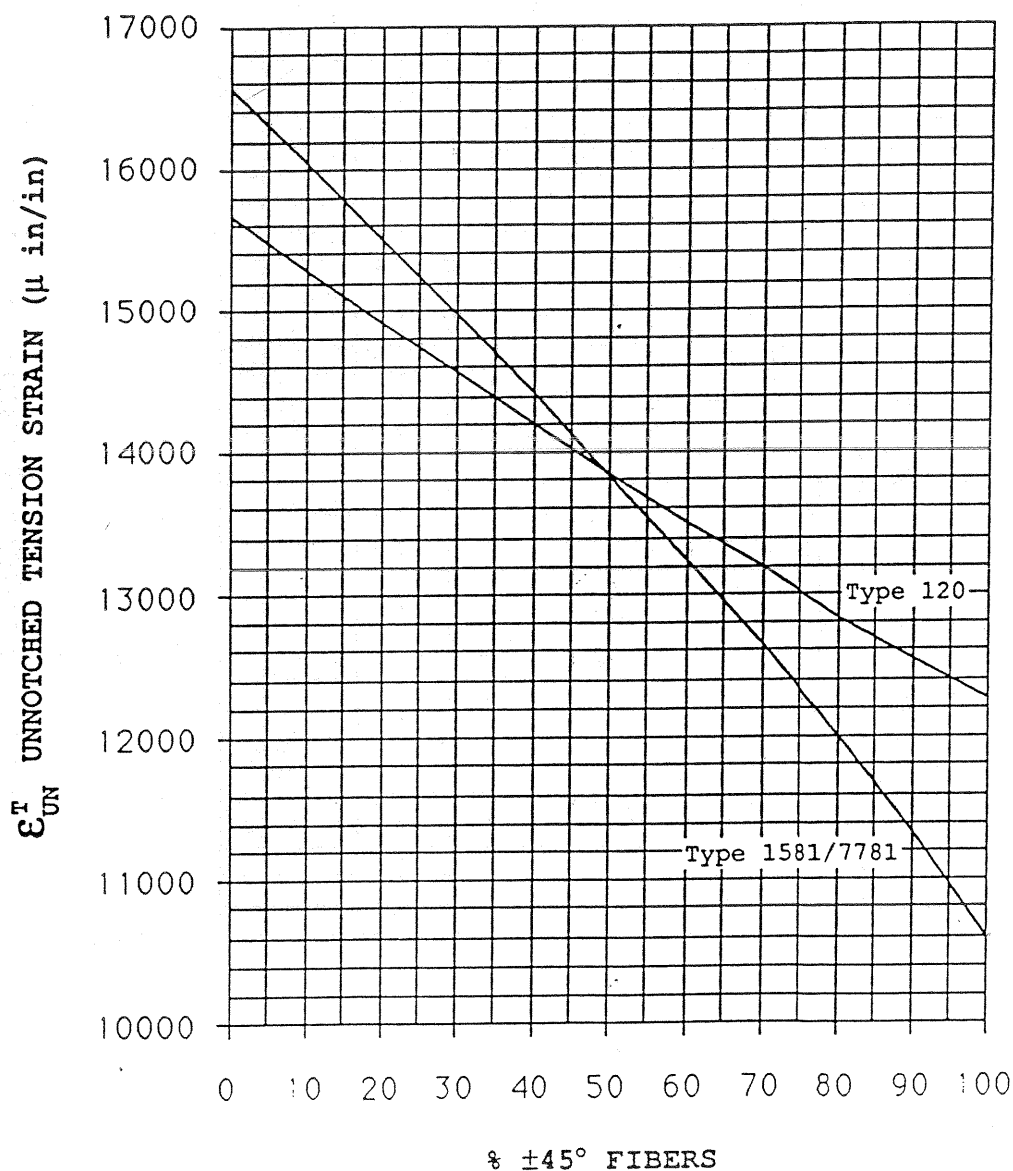
ENGR	T. SANDIFUR	REVISED	BMS 8-139 FIBERGLASS	
CHECK			UNNOTCHED TENSION - STRESS	
APR			<b>BOEING</b>	

# BMS 8-139 FIBERGLASS (RTD) DESIGN VALUES

$\epsilon_{UN}^T$

PRELIMINARY DATA ONLY

$$\epsilon_{UN}^T = \frac{F_{UN}^T}{E^A}$$



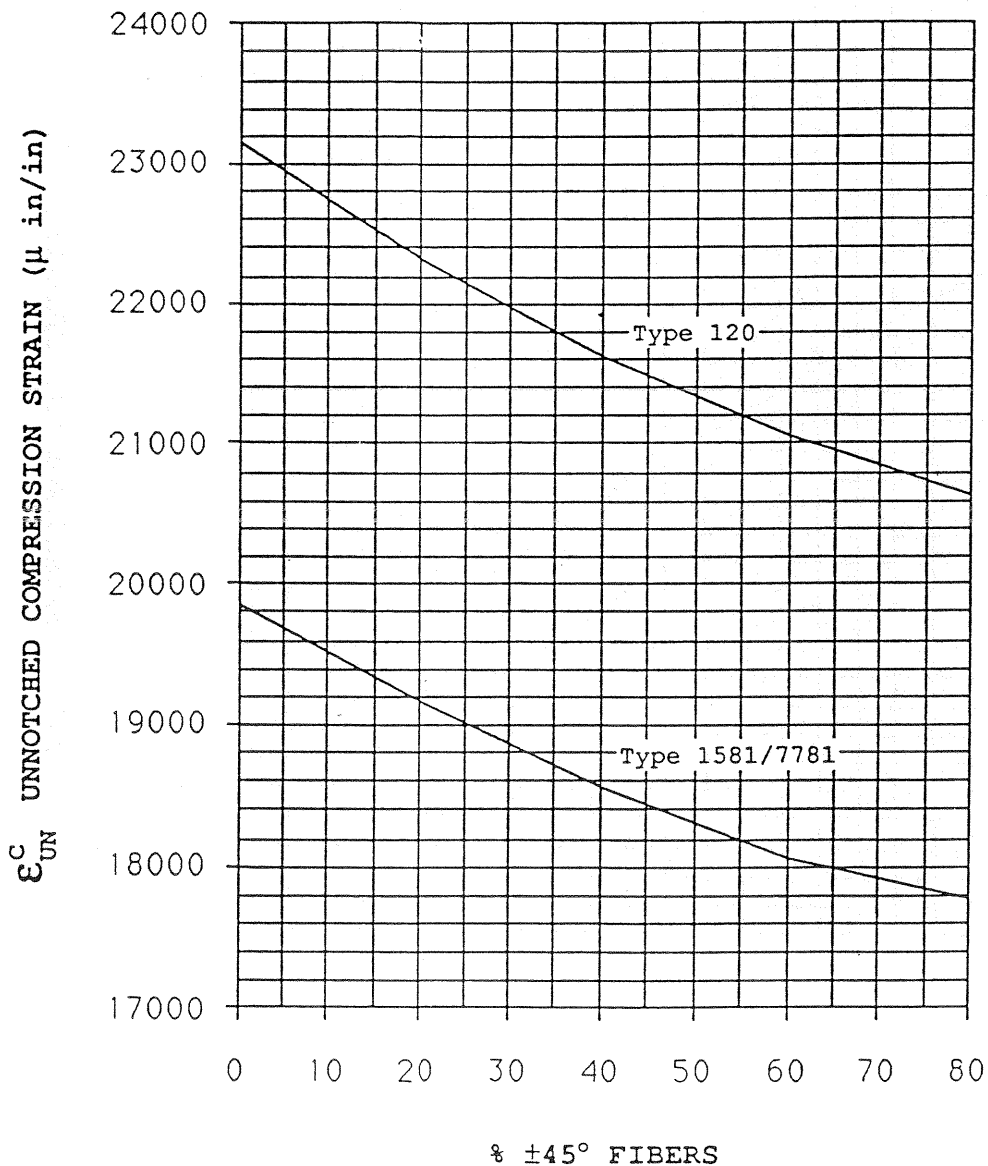
ENGR	T. SANDIFUR	REVISED	BMS 8-139 FIBERGLASS UNNOTCHED TENSION - STRAIN	
CHECK				
APR			BOEING	

# BMS 8-139 FIBERGLASS (RTD) DESIGN VALUES

$\epsilon_{UN}^C$

PRELIMINARY DATA ONLY

$$\epsilon_{UN}^C = \frac{F_{UN}^C}{E^A}$$



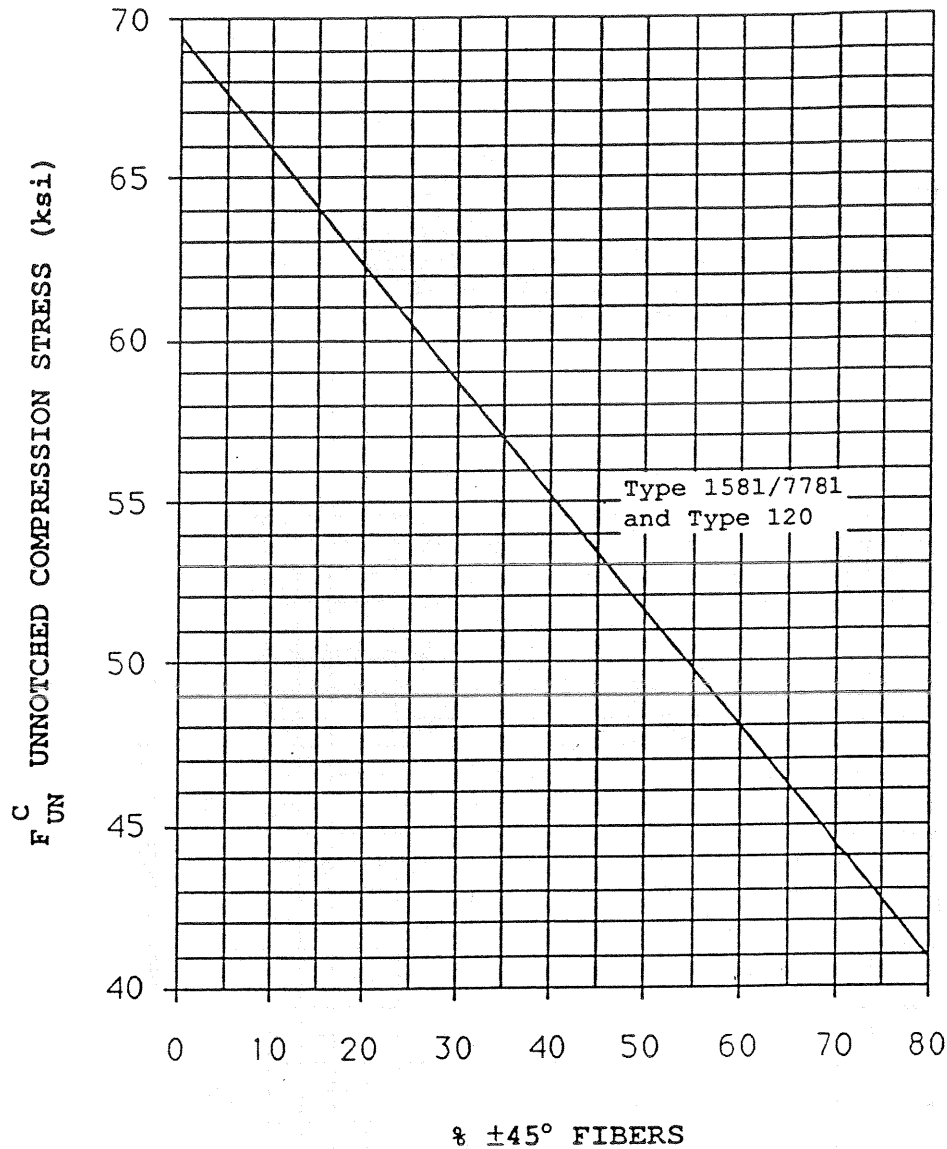
%  $\pm 45^\circ$  FIBERS

ENGR	T. SANDIFUR	REVISED	BMS 8-139 FIBERGLASS	
CHECK			UNNOTCHED COMPRESSION - STRAIN	
APR			BOEING	

# BMS 8-139 FIBERGLASS (RTD) DESIGN VALUES

$F_{UN}^C$

PRELIMINARY DATA ONLY



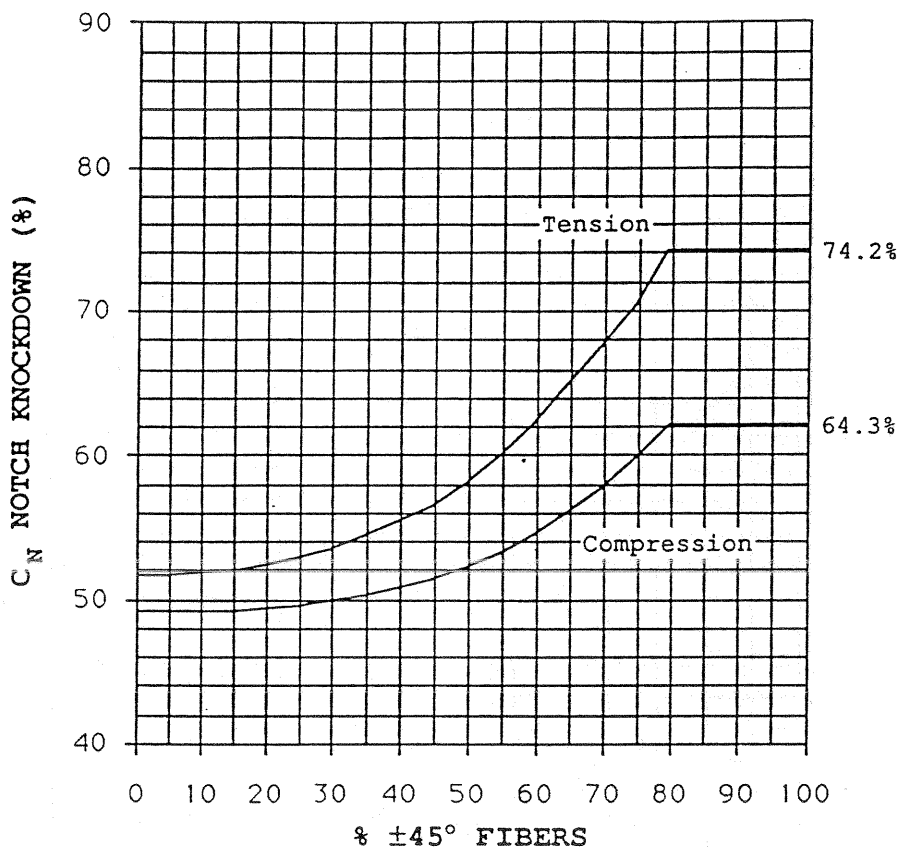
ENGR	T. SANDIFUR	REVISED	BMS 8-139 FIBERGLASS	
CHECK			UNNOTCHED COMPRESSION - STRESS	
APR			<b>BOEING</b>	

# BMS 8-139 FIBERGLASS DESIGN VALUES

$C_N, C_T$

PRELIMINARY DATA ONLY

$$\epsilon_{OH}^{T,C} = \epsilon_{UN}^{T,C} \times C_N \times C_T$$



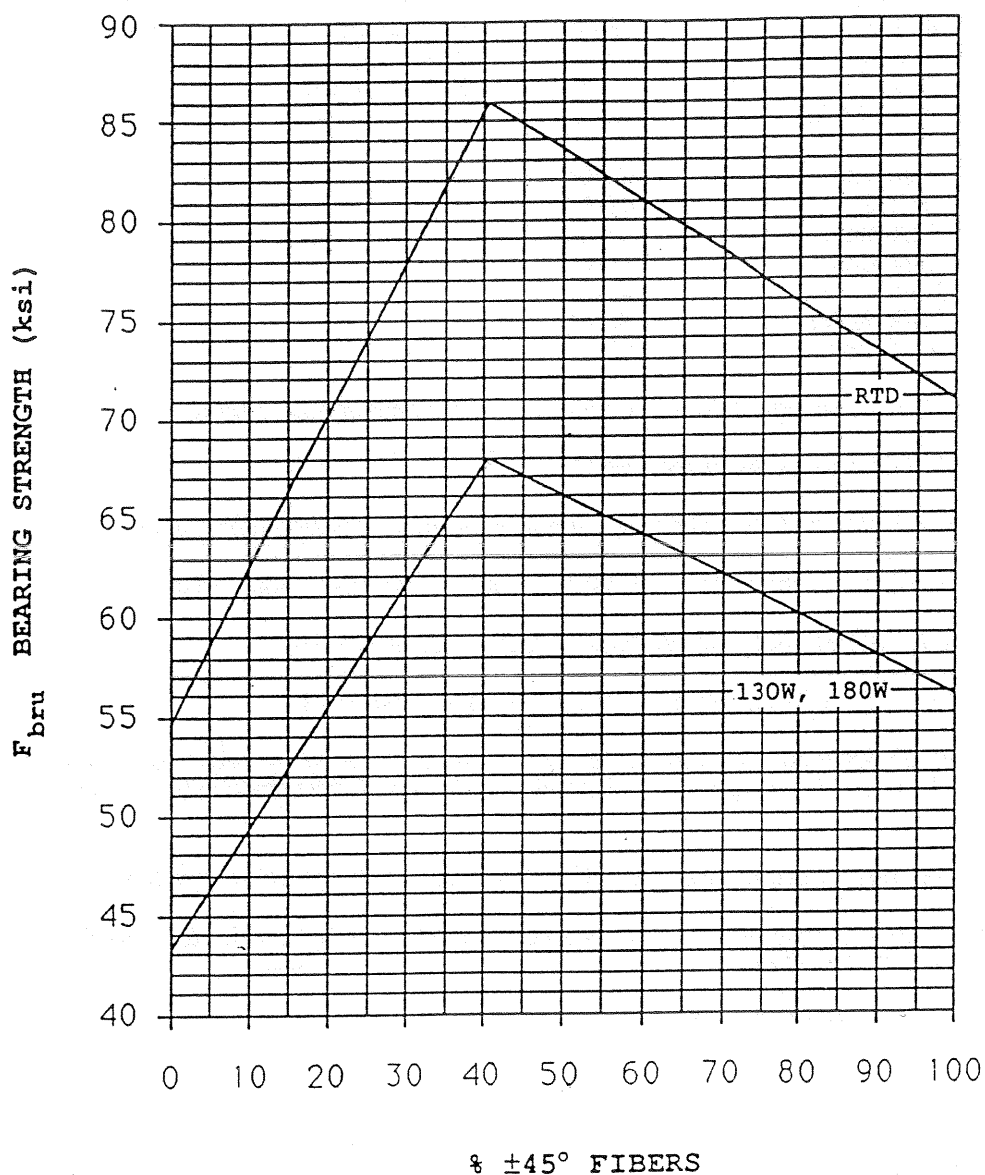
$C_T$ ENVIRONMENTAL FACTORS		
	TYPE	
	120	1581/7781
TENSION		
RTD	1.0	1.0
130°F Wet	.67	.67
180°F Wet	.54	.54
COMPRESSION		
RTD	1.0	1.0
130°F Wet	.73	.66
180°F Wet	.64	.60

ENGR	T. SANDIFUR	REVISED	BMS 8-139 FIBERGLASS	
CHECK			NOTCH & ENVIRONMENTAL FACTORS	
APR			BOEING	

# BMS 8-139 FIBERGLASS (RTD) DESIGN VALUES

$F_{bru}$   
Type  
1581/7781

PRELIMINARY DATA ONLY



ENGR	T. SANDIFUR	REVISED	BMS 8-139 FIBERGLASS	
CHECK			BEARING STRENGTH-TYPE 1581/7781	
APR			BOEING	

February 4, 1993  
BY1NU-RFW-M93-031

To:	Michael J. Tovey	48-05	John Dohert	48-30
	Ken Wilson	48-33	Roy Ostergren	6F-HH
	Dan Wilson	48-02	Steve Ward	48-02
	Ernie Dost	6K-19	Bud James	4F-01
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	Pat Meyers	48-02	Kevin Johnson	6K-KA
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	M. Thould	48-30
	K. Schreiber	48-33
	J. Simmons	48-05
	J. Kent	48-02
	J. Winchester	6F-KF
	L. Thomson	6F-HJ

Subject: BMS 8-79 Design Values, Supporting 777 Empennage Structures

From: 777 Empennage Allowables/SMA

Ref. A: EWA W81000-A53, "777 Empennage Allowables Development Support"

Ref. B: Coordination Sheet STRU-BY92B-C90-A231, BMS 8-79 Test Results

Ref. C: EWA W81067-A22, Rev.A, "Design Values for BMS 8-79"

Ref. D: EWA W81067A22, Rev.B, "Design Values for BMS 8-79"

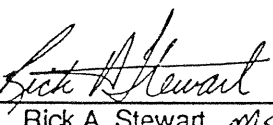
- Enclosed is the updated design values for BMS 8-79. The updated values are based on coupon data collected from REF. A, B, C and D to support 777 Empennage Design. Environmental testing still pending under REF. D.

It should be stressed that these numbers are only PRELIMINARY, and should be treated as such.


The fiberglass used to support these design values was purchased through HEXCEL and FIBERITE per BMS 8-79, Class III, Grade 1, Type 7781.

Any questions should be directed to the undersigned.

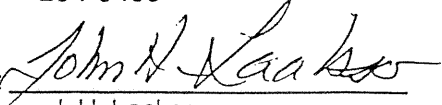
Prepared by:

  
Rick A. Stewart  
BY91B,  
234-3439

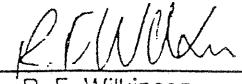
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