1	АВ	С	D	E	F	G	Н	I	J	K	L	ΜN
1	7.7.4	TIADD	-i	C	. T							+
2			oject (#3) - Analysis of			L		20201	******************************	nancenenenenenenenenenenenenen	·~~~	-
3	SE-16		ce Structural Analysis, Univers	ity of Califor	nıa, San Diego (Cop)	yrıght J.	ь. Kosmatka	, 2020)			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
5	-	Version:	Winter, 2020 (v2)									_
7	P	Proiect Title:	03-06-2020 Test Case - 6 ply exte	ension-shear c	arbon/epoxy laminate	subject	ed to Nx and I	Vxv. Common	in propeller an	d wind turbine	S.	-
8		loject ritie.	os do Este case o pry exe	ension silear c	агвопу сроку папппасс	Jubject	cu to IIX and I	ixy. common	in propener un	a wina tarbine	J.	
9		Variable	Description	Value	Units				Units Re			
10		iInput	Input Units	1	1 = US				US	SI	******	
11		iOutput	Output Units	1	1 = US, 2 = SI			F	10 <sup>3</sup> lb/in <sup>2</sup>	MPa		_
12								E, G	10 6 lb/in 2	GPa 3		-
13				**********		-	************	ρ	lb/in <sup>3</sup>	kg/m <sup>3</sup>	*******	_
15	Х	Part 1:	Weight Properties									-
16			g									
17		Fiber Proper									******	
18		Variable	Description	Value	Units							
19 20		-	Material Name:	1M7 40.03	Msi		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		******************	***************************************	~~~~~~~~~~	
21		-	Young's Modulus (Longitudinal) Young's Modulus (Transverse)	2.76	Msi							-
22	-		Shear Modulus (L-T plane)	3.92	Msi						*************	
23			Shear Modulus (T-T plane)	1.02	Msi							
24			Poisson ratio (L-T plane)	0.2								
25			Poisson ratio (T-T plane)	0.2								
26			Weight Density	0.0643	lb/in <sup>3</sup>		*************		***************************************		******	
27			Tension strength	751.3	Ksi							-
28	-	r <sub>FC</sub>	Compression strength	-464.1	Ksi	-					erananananananananananananan	-
30	-	Resin Prope	rties									-
31		Variable	Description	Value	Units							
32	ļ		Material Name:	3501-6								-
33			Young's Modulus Shear Modulus	0.631 0.232	Msi Msi							-
35	-		Poisson ratio	0.36	IVISI							-
36			Weight Density	0.0469	lb/in <sup>3</sup>					***************************************		-
37			Tension strength	8.08	Ksi							
38		F <sub>mc</sub>	Compression strength	-17.18	Ksi							
39		F <sub>ms</sub>	Shear Strength	12.61	Ksi					*****************	*****	
40	Х	Part 2:	MicroMechanics									-
42		rait 2.	Micromechanics									
43		Variable	Description	Value	Units							
44		iAFW	Areal Fiber Weight Units:	2	$1 = oz/yd^2$ , $2 = g/m^2$							
45 46		AFW RC	Areal Fiber Weight: Resin Content (by weight)	150 30	oz/yd <sup>2</sup> or g/m <sup>2</sup>			***************************************		\*************************************	***********	_
47		AC.	Resili Content (by weight)	30	70				**********************	********************************	~~~~~~~~~~~~~~~~~	
48				nenenenenenenenenenenenenenenen			nenenenenenenenenenenenenenenenene		encococococococococococococococococococo	nenenenenenenenenenenenenenenenenen	warenenenenenenenenene	
49	Х	Part 3:	Lamina Behavior									
50		Variable	Description	Value	l luite		***************************************			***************************************		-
51 52	-	Variable $\theta_z$	<b>Description</b> Orientation Angle	Value 20	Units degrees		***********************	***************************************		*************************	******	-
53	-	V Z			8.000	-					*****	-
54												
55	Х		Laminate Behavior*					1				
56 57		note: the lan	ninate is a 12-ply maximum where	tne Iay-up ML	osi be symmetric						******************	-
58		Variable	Description	Value	Units	1 1	Laminate	Definition	Vancous and an			+
59		n	Number of plies (12 max)	6			(#)	$\theta_{\rm i}$ (degree)				
60		t ply	ply thickness	0.02	inch		12					
61		$N_x$	Inplane x-direction load	5000	lb/inch		11					4
62	-	N <sub>y</sub>	Inplane y-direction load	0	lb/inch	ļļ	10					+
63 64		N <sub>xy</sub> SF	Inplane shear load Safety Factor:	-1000 1.5	lb/inch	ļļ	9 8					+
65		D.I.	sarcty ructor.	1.5		1	7					+
66						+	6	0				
67				***************************************			5	0			******************	
68 69	-						3	15 15				-
70							2	0				+
71							1	0	tool surface			T
72						1						
73 74	-					-						
75 (	)	END OF FI	LE									

-	В	С	D	E	F	G	Н	1	1	K	- 1	ΜN
1		Ü	2			- C		·				1
2	MA'	TIARP	roject (#3) - Analysis of Composit	o I aminatos								+
						2020)						-
3	SE-16	UA Aerosp	ace Structural Analysis, University of Californ	ia, San Diego (Copy	rignt J.B. Kosmatка,	2020)						-
5		Version:	Winter, 2020 (v2) - Input: US, Output: US/SI									
6												П
7			John Kosmatka									
8	S	tudent ID:	A0123456789									
9												+
10	Pr	oject Title:	03-06-2020 Test Case - 6 ply extension-shear car	bon/epoxy laminate :	subjected to Nx and N	xy. Common in prope	ller and wind	urbines.	li .	li .		4
11 12	INDIT	ECHO:										
13		LCIIO.										
14		Variable	Description	Value	Units				Units Re	eference		+
15		ilnput	Input Units	1	1 = US				US	SI		77
16		iOutput	Output Units	1	1 = US, 2 = SI			F	10 <sup>3</sup> lb/in <sup>2</sup>	MPa		Т
17		,	·					E, G	10 6 lb/in 2	GPa		_
18		Fiber Prope	ortios					ρ	lb/in <sup>3</sup>	kg/m <sup>3</sup>		+
19		Variable	Description	Value	Units			P				+-
20			Material Name:	IM7								
21		E <sub>fL</sub>		40.03	Msi							П
22			Young's Modulus (Transverse)	2.76	Msi							Ħ
23		G <sub>fLT</sub>	Shear Modulus (L-T plane)	3.92	MSi							T
24		G <sub>fTT</sub>	Shear Modulus (T-T plane)	1.02	Msi							T
25		V <sub>fLT</sub>	Poisson ratio (L-T plane)	0.2								П
26		V <sub>fTT</sub>	Poisson ratio (T-T plane)	0.2								T/
27		$\rho_{f}$	Weight Density	0.0643	Ksi		_					П
28				751.3	Ksi							Ш
29		F <sub>FC</sub>	Compression strength	-464.1	Ksi							Ш
30												Ш
31		Resin Prope		W-1	4444							4
32		Variable	Description Material Name:	Value	Units							+
33 34		r	Material Name: Young's Modulus	3501-6 0.631	Msi							+
35		E <sub>m</sub>	Young's Modulus Shear Modulus	0.631	Msi							+
36			Poisson ratio	0.36	14131							+
37			Weight Density	0.0469	lb/in^3							+
38			Tension strength	8.08	Ksi							+
39			Compression strength	-17.18	Ksi							+
40			Shear Strength	12.61	Ksi							+
41												+
42		MicroMech	nanics									_
43		Variable	Description	Value	Units							Т
44		iAFW	Areal Fiber Weight Units:	2								
45		AFW	Areal Fiber Weight:	150	g/m^2							
46		RC	Resin Content (by weight)	30				Definition				
47							(#)	$\theta_i$ (degree)				Ш.
48		Lamina Bel					12					
49		Variable	Description	Value	Units		11					
50 51		$\theta_z$	Orientation Angle	20	degrees		10 9					_
52		Laminate B	Sehavior				8					+-
53		Variable	Description	Value	Units		7					+-
54		n	Number of plies (12 max)	6			6	0				+
55		t ply	ply thickness	0.02	inch		5	0				Ħ
56			Inplane x-direction load	5000	lb/in		4	15				T
57		N <sub>y</sub>	Inplane y-direction load	0	lb/in		3	15				П
58		N <sub>xy</sub>	Inplane shear load	-1000	lb/in		2	0				П
59		SF	Safety Factor:	1.5			1	0	tool surface			П
60						'////			///////////////////////////////////////	///.		Ц
61	01:=											Ц
62 63	OUTP	uI:										H
64	Х	Part 1	Weight Properties							l		Н
65	^	rait i:	g.it i 10poi 1103									Н
66												+
67		Variable	Description	Value	Units							Ħ
68		Vf	Volume Fraction (Fiber)	0.62989								T
69			Volume Fraction (Resin)	0.37011								П
70			Weight Fraction (Fiber)	0.70000							-	Ц
71	-		Weight Fraction (Resin)	0.30000	II- /' A.2							4
72 73		ρ <sub>c</sub>	Composite density	0.05786 0.00527	lb/in^3 inch							+
74	-	t <sub>ply</sub>	Cured ply thickness	0.00527	IIICII							+
75	Х	Part 2	MicroMechanics		1							Ч
76		. u.t Z.										Н
77		Variable	Description	Value	Units							+
78			Young's Modulus (Longitudinal)	25.4481	Msi							T
79			Young's Modulus (Transverse)	1.2274	Msi							Ħ
80			Shear Modulus (L-T plane)	0.5695	Msi							Ħ
81			Shear Modulus (T-T plane)	0.4873	Msi							T
82			Poisson ratio (L-T plane)	0.2592								T
83			Poisson ratio (T-T plane)	0.2592								J
84				477.6214								П
85		F <sub>2t</sub>	Tension Strength (Transverse)	7.0593	Ksi	<u> </u>						<b>⊥</b>

A   B   C   D   E   F   G   H   I   J	K L
Compression Strength (Fiber Failure)   -292.3331 Ksi	
R8	
Compression Strength (Delamination)	
90	
90	
91   F <sub>56</sub>   Shear Strength (1-2 plane)   10.6671   Ksi	
92	
93   X   Part 3: Lamina Behavior	
94	
95   2-D material reduced stiffness [Q]:   2.55309E+01   3.19185E-01   0.00000E+00   Msi   units     97	
96     3.19185E-01   1.23134E+00   0.0000E+00   Msi   units     97     0.0000E+00   0.0000E+00   5.69483E-01       98     99   2-D material reduced compliance [S]:   3.92956E-02   -1.01861E-02   0.00000E+00   1/Msi   units     100   -1.01861E-02   8.14763E-01   0.0000E+00   1/Msi   units     101   0.00000E+00   0.00000E+00   1.75598E+00       102   103   Orientation Angle (θz):   20   degrees       104   105   Transformation matrix [T <sub>1</sub> ']   8.83022E-01   1.16978E-01   6.42788E-01       106   1.16978E-01   8.83022E-01   -6.42788E-01       107   -3.21394E-01   3.21394E-01   7.66044E-01       109   Transformation matrix [T <sub>2</sub> ']   8.83022E-01   1.16978E-01   6.42788E-01       109   Transformation matrix [T <sub>2</sub> ']   8.83022E-01   1.16978E-01   6.42788E-01       109   Transformation matrix [T <sub>2</sub> ']   8.83022E-01   1.6978E-01   6.42788E-01       110   1.16978E-01   8.83022E-01   7.66044E-01       120   1.16978E-01   8.83022E-01   7.66044E-01       121   1.16978E-01   3.21394E-01   7.66044E-01       122   133   2-D material reduced stiffness [Q-bar]:   2.02252E+01   2.78232E+00   6.84031E+00	
96     3.19185E-01   1.23134E+00   0.0000E+00   Msi   units     97     0.00000E+00   0.00000E+00   5.69483E-01       98   99   2-D material reduced compliance [S]:   3.92956E-02   -1.01861E-02   0.00000E+00       100   -1.01861E-02   8.14763E-01   0.00000E+00   1/Msi   units     101   0.00000E+00   0.00000E+00   1.75598E+00       102   0.00000E+00   0.00000E+00   1.75598E+00       103   Orientation Angle (θz):   20   degrees       104	
97   0.00000E+00   0.00000E+00   5.69483E-01   98   99   2-D material reduced compliance [S]: 3.92956E-02   -1.01861E-02   0.00000E+00   1/Msi   units   101   0.00000E+00   0.00000E+00   1.75598E+00   102   0.00000E+00   0.00000E+00   1.75598E+00   103   0.00000E+00   0.00000E+00   0.00000E+00   1.75598E+00   103   0.00000E+00   0.00000E+00   0.00000E+00   0.00000E+00   0.0000E+00   0.00000E+00   0.0000E+00   0.000	
98	
99   2-D material reduced compliance [S]:   3.92956E-02   -1.01861E-02   0.00000E+00   1/Msi   units	
1.01861E-02	
101	
102	
103	
104	
105   Transformation matrix [T <sub>1</sub> ']   8.83022E-01   1.16978E-01   6.42788E-01   1.16978E-01   8.83022E-01   -6.42788E-01   1.16978E-01   8.83022E-01   -6.42788E-01   1.16978E-01   7.66044E-01   1.16978E-01   7.66044E-01   1.16978E-01   7.66044E-01   1.16978E-01   8.83022E-01   6.42788E-01   1.16978E-01   8.83022E-01   6.42788E-01   1.16978E-01   7.66044E-01   1.16978E-01   1.16978E-01   7.66044E-01   1.16978E-01   1.16978E-01   7.66044E-01   1.16978E-01   1.	
1.16978E-01   8.83022E-01   -6.42788E-01	1
1.16978E-01   8.83022E-01   -6.42788E-01	1
107     3.21394E-01   3.21394E-01   7.66044E-01	
108     8.83022E-01     1.16978E-01     -6.42788E-01       109     Transformation matrix [T₂']     8.83022E-01     1.16978E-01     -6.42788E-01       110     1.16978E-01     8.83022E-01     6.47788E-01       111     3.21394E-01     -3.21394E-01     7.66044E-01       112	<del></del>
109 Transformation matrix [T <sub>2</sub> '] 8.83022E-01 1.16978E-01 -6.42788E-01 110 1.16978E-01 8.83022E-01 6.42788E-01 111 3.21394E-01 -3.21394E-01 7.66044E-01 112 2 113 2-D material reduced stiffness [Q-bar]: 2.02252E+01 2.78232E+00 6.84031E+00	
110     1.16978E-01     8.83022E-01     6.42788E-01       111     3.21394E-01     -3.21394E-01     7.66044E-01       112     2-D material reduced stiffness [Q-bar]:     2.02252E+01     2.78232E+00     6.84031E+00	
111	
112       113       2-D material reduced stiffness [Q-bar]:       2.02252E+01       2.78232E+00       6.84031E+00	
113 2-D material reduced stiffness [Q-bar]: 2.02252E+01 2.78232E+00 6.84031E+00	
113 2-D material reduced stiffness [Q-bar]: 2.02252E+01 2.78232E+00 6.84031E+00	
125	
116	
117   2-D material reduced compliance [S-bar]:   2.21067E-01   -1.01245E-01   -4.66269E-01	
118 -1.01245E-01 8.15109E-01 -3.21919E-02 1/Msi units	
-4.66269E-01 -3.21919E-02 1.39174E+00	
120	
121	
122 Variable Description Value Units	
1223 E <sub>J</sub> Young's Modulus (x-direction) 4.5235 Msi	+
124 E <sub>y</sub> Young's Modulus (y-direction) 1.2268 Msi	
125 G <sub>sy</sub> Shear Modulus (x-y plane) 0.7185 Msi	
126 v <sub>xy</sub> Poisson Ratio (x-y plane) 0.4580	
127 η <sub>x,yy</sub> Extension-Shear coupling (x-direction, x-y plane) -2.1092	
128 η <sub>γ,xγ</sub> Extension-Shear coupling (γ-direction, x-γ plane) -0.0395	
130 F* 17 Allowable Fiber Direction Tension Strength 318.4143 Ksi	
131 F* 1C Allowable Fiber Direction Compression Strength -105.0833 Ksi	
132 F* 27 Allowable Matrix Direction Tension Strength 4.7062 Ksi	
133 F* 2c Allowable Matrix Direction Compression Strength -10.0065 Ksi	
1334 F*s Allowable Shear Strength 7.1114 Ksi	
	<del></del>
135	
136	
137 X Part 4: Laminate Behavior	
138	
139 In-Plane Stiffness Relationship [A]	
140 $N_{\rm X}$ 2.93898E+06 9.79170E+04 2.24754E+05 $\varepsilon_{\rm XXO}$ units	
141   N <sub>y</sub> = 9.79170E+04 1.53257E+05 1.82418E+04   \$\varepsilon_{yyo}\$   \$\text{lb/in}\$	
	+
142   N <sub>xy</sub>   2.24754E+05   1.82418E+04   1.27953E+05   7 <sub>xy</sub>   143	
	<del></del>
144	
145 Inverse In-Plane Stiffness Relationship	
[A*]	
147	
	ch/inch
149   7 <sub>xyo</sub>   -6.73533E-07	
150	
151	
152 Equivalent Laminate Stiffness Properties (In-Plane Analysis)	
1222 Equivalent Calinias a Troperties (in France Alian) 333 Variable Description Value Units	<del></del>
154 I I Laminate Thickness 0.12 inch	
155 E <sub>x</sub> Young's Modulus (x-direction) 20.9616 Msi	
156 E , Young's Modulus (y-direction) 1.2413 Msi	
157	
158 V <sub>xy</sub> Poisson Ratio (applied x, measured y) 0.4373	
159 $\eta_{x,xy}$ Extension-Shear Coupling (x, xy) -1.6942	
160 $\eta_{y,xy}$ Extension-Shear Coupling $(y,xy)$ -0.0971	
161   Iso-Check   In-plane Isotropic Check (1.00)   4.213345395	
162	
163	
164 Ply stresses Ply Depth inch Global Stresses (x,y frame) Ksi Local Stresses (1	1,2 frame) Ksi
	$\sigma_{22}$ $\tau_{12}$
165 Ply (#) Ply Angle (degree) Bottom Top $\sigma_{xx}$ $\sigma_{yy}$ $\tau_{xy}$ $\sigma_{11}$	-
166 12	
166         12           167         11	
166     12       167     11       168     10	
166     12       167     11       168     10       169     9	
166     12       167     11       168     10	

1	В	С	D	E	F	G	Н	1	J	K	L	ΜN
172		6	0	0.04	0.06	67.876	0.582	-7.095	67.876	0.582	-7.095	
173		5	0	0.02	0.04	67.876	0.582	-7.095	67.876	0.582	-7.095	
174		4	15	6.93889E-18	0.02	-10.752	-1.164	-10.810	-15.514	3.599	-6.964	
175		3	15	-0.02	6.93889E-18	-10.752	-1.164	-10.810	-15.514	3.599	-6.964	
176		2	0	-0.04	-0.02	67.876	0.582	-7.095	67.876	0.582	-7.095	
177		1	0	-0.06	-0.04	67.876	0.582	-7.095	67.876	0.582	-7.095	
178	2		tool surface									
179												
180												
181	End o	f Output										