Homework # 9

Exercises for Section 10.2, Exercise 1 (p. 403)

Using the stresses in each layer due to a unit axial load, from Table 1 of Exercise 1 in the Exercises for Section 9.2, in eq. 10.38 leads to the analogs of eq. 10.45, 10. 49. and 10.53. Solving for the roots, p, from each of the three equations results in the following table, which is the analog of Table 10.4:

Table 1: Summary of loads p (kN) to cause failure in $[\pm 30/0_3]_S$ tube: Tsai-Wu criterion

	+ 30° layers		- 30° layers		0° layers	
	p=-193.6	p=+339	p=-193.6	p=+339	p=-113.4	p=+254
σ_1,MPa	-564	+989	-564	+989	-623	+1392
σ_2,MPa	+23.6	-41.4	+23.6	-41.4	+31.3	-70.0
τ_{12},MPa	+49.8	-87.2	-49.8	+87.2	0	0
$F_1\sigma_1$	0.0752	-0.1318	0.0752	-0.1318	0.0830	-0.1856
$F_2\sigma_2$	0.354	-0.621	0.354	-0.621	0.470	-1.051
$F_{11}\sigma_1^2$	0.1697	0.521	0.1697	0.521	0.207	1.034
$F_{22}\sigma_2^2$	0.0558	0.1713	0.0558	0.1713	0.0981	0.490
$F_{66}\tau_{12}^2$	0.248	0.761	0.248	0.761	0	0
$-\sqrt{F_{11}F_{22}}\sigma_1\sigma_2$	0.0973	0.299	0.0973	0.299	0.1424	0.712
Total	1.000	1.000	1.000	1.000	1.000	1.000

Failure due to +P: p = +254 kN. Failure is due to tension in the fiber direction in the 0° layers. Failure due to -P: p = -113.4 kN. Failure is due to a combination of tension perpendicular to the fibers ($F_2\sigma_2$ = 0.470) and compression in the fiber direction ($F_{11}\sigma_1^2$ = 0.207) in the 0° layers.

These numbers are lower in magnitude than the predictions of the maximum stress criterion, Exercise 1 in the Exercises for Section 9.2. Also, the load capacity of the $[\pm 30/0_3]_S$ tube is less than the load capacity of the $[\pm 20/0_3]_S$ tube, in both tension and compression. For additional information, the values of A, D, and F in eq. 10.46 for the three layers are given in the table below.

Table 2: Values of A, D, and F in eq. 10.46 for $[\pm 30/0_3]_S$ tube

Layer	A	D	F
+30°	+0.1522x10^{-10}	-22200x10^{-10}	-1
-30°	+0.1522x10^{-10}	-22200x10^{-10}	-1
0°	+0.348x10^{-10}	-48700x10^{-10}	-1