McGill University

Mechanics of Composite Materials

MECH 530

Assignment 4

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October 21, 2014

Ply orientation list

```
Orientation [degrees] :
[0, 0, 25, -25, 0, 0, 0, 0, -25, 25, 0, 0]
```

Number of plies

```
12
```

Material properties

```
Graphite/Thermoplastic
'          ID :                     5  [-]'
'fiber/matrix :              AS4/PEEK  [-]'
'        name : Graphite/Thermoplastic  [-]'
'          ex :              134.0000  [GPA]'
'          ey :                8.9000  [GPA]'
'          es :                5.1000  [GPA]'
'         nux :                0.2800  [-]'
'          xt :             2130.0000  [MPA]'
'          xc :             1100.0000  [MPA]'
'          yt :               80.0000  [MPA]'
'          yc :              200.0000  [MPA]'
'          sc :              160.0000  [MPA]'
'          h0 :                0.1250  [mm]'
'         nuy :                0.0186  [-]'
```

Thickness

```
Total thickness : 0.011500 [m]
Ply thickness   : 0.001500 [m]
```

On-axis Modulus and Compliance matrices -- [Q] and [S]

```
S_on [1/GPa] :
[[   0.0075   -0.0021    0.0000]
 [  -0.0021    0.1124    0.0000]
 [   0.0000    0.0000    0.1961]]
U's for S [1/GPa]
U1 :  0.0689
U2 : -0.0524
U3 : -0.0090
U4 : -0.0111
U5 :  0.1600

Q_on [GPa] :
[[ 134.7014    2.5050    0.0000]
 [   2.5050    8.9466    0.0000]
 [   0.0000    0.0000    5.1000]]
U's for Q [GPa]
U1 : 57.0443
U2 : 62.8774
U3 : 14.7797
U4 : 17.2848
U5 : 19.8797
```

In-plane Modulus and Compliance -- [A] and [a]

```
A [GN/m] :
[[   0.1821    0.0124    0.0000]
 [   0.0124    0.0160    0.0000]
 [   0.0000    0.0000    0.0163]]
a [m/GN] :
[[   5.7979   -4.5109   -0.0000]
 [  -4.5109   66.0994   -0.0000]
 [   0.0000    0.0000   61.2628]]
```

Flexural Modulus and Compliance -- [D] and [d]

```
D [kNm] :
[[   5.2718    0.3594    0.0130]
 [   0.3594    0.4622    0.0032]
 [   0.0130    0.0032    0.4720]]
d [1/MNm] :
[[ 200.3143 -155.6995   -4.4529]
 [-155.6995 2284.5488  -11.2113]
 [  -4.4529  -11.2113 2118.8941]]
```

Loads

```
M [N] :
[-2869.4250    0.0000    0.0000]

N [N/m] :
[0, 0, 0]
```

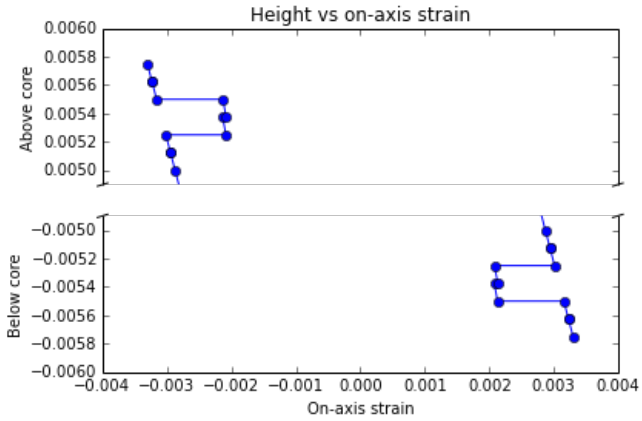
Curvature

```
K [1/m] :
[  -0.5748    0.4468    0.0128]
```

Results

```
See Appendix A
```

Strain distribution



Maximum strain and deflection

```
Maximum deflection [cm] : 1.2952
Maximum allowable  [cm] : 0.5000
Too large!
----------------------------------------
Maximum strain    [-]  : 0.0033
Maximum allowable [-]  : 0.0020
Too large!
```

Appendix A

Table 1: Strains and stresses. Stresses are in [GPa].

Ply	ϵ_1	ϵ_2	ϵ_6	ϵ_x	ϵ_y	ϵ_s	σ_x	σ_y	σ_s
0 (0°) - Bot	0.0033	-0.0026	-0.0001	0.0033	-0.0026	-0.0001	0.4388	-0.0147	-0.0004
0 (0°) - Top	0.0032	-0.0025	-0.0001	0.0032	-0.0025	-0.0001	0.4292	-0.0144	-0.0004
1 (0°) - Bot	0.0032	-0.0025	-0.0001	0.0032	-0.0025	-0.0001	0.4292	-0.0144	-0.0004
1 (0°) - Top	0.0032	-0.0025	-0.0001	0.0032	-0.0025	-0.0001	0.4197	-0.0141	-0.0004
2 (25°) - Bot	0.0032	-0.0025	-0.0001	0.0021	-0.0014	-0.0043	0.2835	-0.0074	-0.0222
2 (25°) - Top	0.0031	-0.0024	-0.0001	0.0021	-0.0014	-0.0043	0.2770	-0.0073	-0.0217
3 (-25°) - Bot	0.0031	-0.0024	-0.0001	0.0021	-0.0014	0.0042	0.2840	-0.0076	0.0212
3 (-25°) - Top	0.0030	-0.0023	-0.0001	0.0021	-0.0014	0.0041	0.2774	-0.0074	0.0207
4 (0°) - Bot	0.0030	-0.0023	-0.0001	0.0030	-0.0023	-0.0001	0.4006	-0.0134	-0.0003
4 (0°) - Top	0.0029	-0.0023	-0.0001	0.0029	-0.0023	-0.0001	0.3911	-0.0131	-0.0003
5 (0°) - Bot	0.0029	-0.0023	-0.0001	0.0029	-0.0023	-0.0001	0.3911	-0.0131	-0.0003
5 (0°) - Top	0.0029	-0.0022	-0.0001	0.0029	-0.0022	-0.0001	0.3815	-0.0128	-0.0003
6 (0°) - Bot	-0.0029	0.0022	0.0001	-0.0029	0.0022	0.0001	-0.3815	0.0128	0.0003
6 (0°) - Top	-0.0029	0.0023	0.0001	-0.0029	0.0023	0.0001	-0.3911	0.0131	0.0003
7 (0°) - Bot	-0.0029	0.0023	0.0001	-0.0029	0.0023	0.0001	-0.3911	0.0131	0.0003
7 (0°) - Top	-0.0030	0.0023	0.0001	-0.0030	0.0023	0.0001	-0.4006	0.0134	0.0003
8 (-25°) - Bot	-0.0030	0.0023	0.0001	-0.0021	0.0014	-0.0041	-0.2774	0.0074	-0.0207
8 (-25°) - Top	-0.0031	0.0024	0.0001	-0.0021	0.0014	-0.0042	-0.2840	0.0076	-0.0212
9 (25°) - Bot	-0.0031	0.0024	0.0001	-0.0021	0.0014	0.0043	-0.2770	0.0073	0.0217
9 (25°) - Top	-0.0032	0.0025	0.0001	-0.0021	0.0014	0.0043	-0.2835	0.0074	0.0222
10 (0°) - Bot	-0.0032	0.0025	0.0001	-0.0032	0.0025	0.0001	-0.4197	0.0141	0.0004
10 (0°) - Top	-0.0032	0.0025	0.0001	-0.0032	0.0025	0.0001	-0.4292	0.0144	0.0004
11 (0°) - Bot	-0.0032	0.0025	0.0001	-0.0032	0.0025	0.0001	-0.4292	0.0144	0.0004
11 (0°) - Top	-0.0033	0.0026	0.0001	-0.0033	0.0026	0.0001	-0.4388	0.0147	0.0004