Carpet Plots — High Strength Graphite/Epoxy

This package contains “carpet plots” that allow the determination of elastic, physical, and strength properties of a High Strength Graphite/Epoxy composite laminate. These plots are applicable for a “lay-up” such that plies are oriented in a combination of $[0_n/\pm 45_n/90_p]_s$. This is a balanced and symmetric laminate with $m$ number of plies at $0^\circ$ orientation, $n$ plies each at $+45^\circ$ and $-45^\circ$, and $p$ plies at $90^\circ$. The $s$ subscript indicates that the lay-up is symmetric about the mid-plane of the laminate. The total number of plies is then $2 \times (m + 2n + p)$.

1. Elastic Moduli
   
   $(E_x$ and $E_y)$

2. Shear Modulus
   
   $(G_{xy})$

3. Poisson’s Ratio
   
   $(\nu_{xy}$ and $\nu_{yx})$

4. Coefficient of Thermal Expansion
   
   $(\alpha_x$ and $\alpha_y)$

5. Ultimate Tensile Strengths
   
   $(F_x^{tu}$ and $F_y^{tu})$

6. Ultimate Compressive Strengths
   
   $(F_x^{cu}$ and $F_y^{cu})$

7. Ultimate Shear Strength
   
   $(F_{xy}^{cu})$

Source: Original version of the Advanced Composite Design Guide

Use these plots for your RMS Arm Boom Design and Analysis group term project. Additional information not contained in the plots:

- ply thickness, $h = 0.005$ inch
- density, $\rho = 0.06$ lbm/in$^3$

Note: to conduct dynamic calculations in U.S. Customary System (UCSC) units (a.k.a. English units), you need to convert mass-related quantities into a consistent force-length-time system. This can be done using the slug unit of mass: 1 slug = 32.2 lbm = 1 lbf s$^2$/ft. Thus, the conversion of density is:

$$0.06 \text{ lbm} \times \frac{1 \text{lbf} \cdot \text{s}^2}{32.2 \text{ ft} \cdot \text{lbm}} \times \frac{1 \text{ ft}}{12 \text{ in}} = 0.155 \cdot 10^{-3} \frac{\text{lbf} \cdot \text{s}^2}{\text{in}^4}$$

In this form, when multiplied by volume (in$^3$) to get mass, and then by acceleration (in/s$^2$), the unit of force (lbf) is recovered.
FIGURE 1.2.2-13. ULTIMATE TENSILE STRENGTH $F_y^{tu}$ - RT
HIGH-STRENGTH GRAPHITE/EPOXY - $[0/\pm45/90_k]$ FAMILY

FIGURE 1.2.2-14. ULTIMATE TENSILE STRENGTH $F_x^{tu}$ - 350°F
HIGH-STRENGTH GRAPHITE/EPOXY - $[0/\pm45/90_k]$ FAMILY
FIGURE 1.2.2-15. ULTIMATE COMPRESSIVE STRENGTH $F_{cu}^c$ - RT
HIGH-STRENGTH GRAPHITE/EPOXY - $[0_1/\pm 45/90_k]$ FAMILY

FIGURE 1.2.2-16. ULTIMATE COMPRESSIVE STRENGTH $F_{cu}^c$ - 350°F
HIGH-STRENGTH GRAPHITE/EPOXY - $[0_1/\pm 45/90_k]$ FAMILY
FIGURE 1.2.2-17. ULTIMATE SHEAR STRENGTH $F_{xy}^{u}$ - RT AND 350°F
HIGH-STRENGTH GRAPHITE/EPOXY - [0, ±45]_K" FAMILY
Figure 1.2.3-18. Extensional Modulus $E_x$ - RT
High-Strength Graphite/Epoxy - $[0_1/\pm45/90_k]$ Family

Figure 1.2.2-19. Extensional Modulus $E_x$ - 350°F
High-Strength Graphite/Epoxy - $[0_1/\pm45/90_k]$ Family
Figure 1.2.2-20. Shear modulus $G_{xy}$ - RT and 350°F
High-Strength Graphite/Epoxy - [$0/±45°/90_k$] Family
**Figure 1.2.2-21. Poisson's Ratio $\nu_{xy}$ - RT**

High-Strength Graphite/Epoxy - $[0_i/\pm 45_j/90_k]$ Family

**Figure 1.2.2-22. Poisson's Ratio $\nu_{xy}$ - 350°F**

High-Strength Graphite/Epoxy - $[0_i/\pm 45_j/90_k]$ Family
FIGURE 1.2.2-23. LONGITUDINAL COEFFICIENT OF THERMAL EXPANSION, RT
HIGH-STRENGTH GRAPHITE/EPoxy - $[0_{145}/90_k]$ FAMILY

FIGURE 1.2.2-24. LONGITUDINAL COEFFICIENT OF THERMAL EXPANSION, 350°F
HIGH-STRENGTH GRAPHITE/EPoxy - $[0_{145}/90_k]$ FAMILY

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20