Coefficient of Thermal Expansion

Large temperature gradients can be detrimental to the gel coat of FRP booms. Major swings in environmental conditions of the boom can lead to cold cracking in the gel coat and in some cases into the resin itself. The coefficient of thermal expansion, α, for a linear approximation is given by the below equation where ΔT is the thermal gradient, Li the original length, and ΔL the change in length due to thermal expansion.

$$\alpha = \frac{\Delta L}{L_i \Delta T}$$

Waco Boom uses fiber reinforced epoxy resin and polyester gel coat in our manufacturing process. Table 1 shows the thermal expansion coefficients of both of these base materials. It should be noted that the polyester gel coat is expected to increase over three times more than the fiber reinforced epoxy since the original length and temperature gradient will be constant for both materials. Therefore α can be directly compared to represent the difference in the increase of length of the two materials and shows to be much larger for polyester than for the reinforced epoxy (2-5 times greater). The number further skews when fiber orientation is considered.

Material	**α**	
	in/in/°F x 10^{-6}	**cm/cm/°C x 10^{-5}**
E-glass	2.8	0.5
Epoxy w/E glass reinforced longitudinally	3.7	0.66
Epoxy w/E glass reinforced transversely	16.7	3.0
Epoxy Resin	45-65	8.1-11.7
Thermoset Polyester	55-100	10.0-18.0
Stainless Steel	5.7-9.6	1.2-1.72

Table 1 – Coefficient of thermal expansion of typical plastics[1]

[1] Callister, William. "Materials Science and Engineering, an Introduction." Wiley Publishing, 7th edition. Pages A17-A20