

# Design Guide For Composite Enclosures

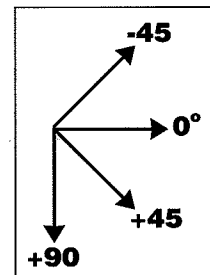
## basic material design properties

	Standard Modulus Carbon Epoxy Tape	High Modulus Carbon Epoxy Tape	Standard Modulus Carbon Epoxy Fabric	Glass Epoxy Fabric	Kevlar Epoxy Fabric	Aluminium 6061
Density (lbs/cu.in)	0.058	0.058	0.058	0.073	0.052	0.098
Elastic Modulus ( $E_{11}$ ) (MSI)	18.0	27.0	7.3	3.4	4.0	10.1
Elastic Modulus ( $E_{22}$ ) (MSI)	1.2	1.1	7.3	3.4	4.0	10.1
Shear Modulus ( $G_{12}$ ) (MSI)	0.3	0.3	0.3	0.6	0.33	3.8
Poisson Ratio ( $\nu_{12}$ )	0.3	0.3	0.048	0.085	0.046	0.3
Tensile Strength ( $\sigma_{11T}$ ) (KSI)	170.0	190.0	75.0	65.0	70.0	45.0

## material properties of common laminate orientations

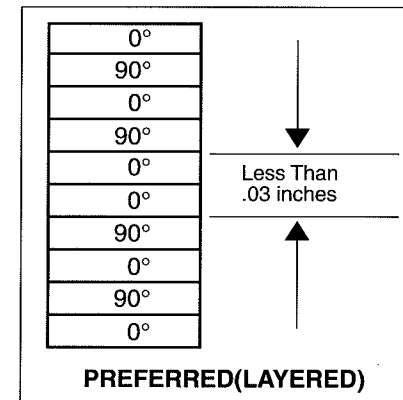
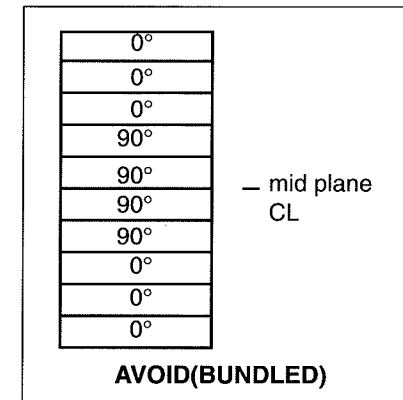
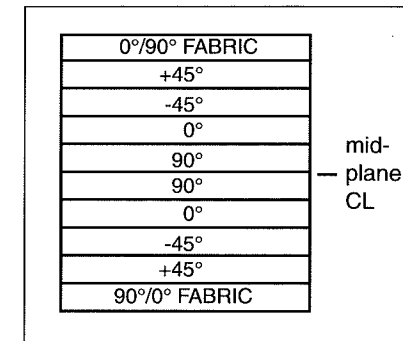
Using lamination theory the basic material properties are used to calculate the mechanical property of a laminate. The figure below shows how laminate properties vary with percent of fiber flow in each direction.

Percent Fiber Orientation				Ex (MSI)	Ey (MSI)	Gxy	$\sigma_x$ (KSI)	$\sigma_y$ (KSI)	$\sigma_{xy}$
%0°	%+45°	%-45°	%90°						
50	0	0	50	9.2	9.2	0.6	84	84	10
25	25	25	25	6.8	6.8	2.6	65	65	28
0	50	50	0	2.4	2.4	4.5	20	20	50
60	15	15	10	11.5	4.1	1.8	109	40	20
50	25	25	0	9.8	3.1	2.6	95	18	28
0	25	25	50	3.1	9.8	2.6	18	95	28



laminate coordinate system

## laminate design

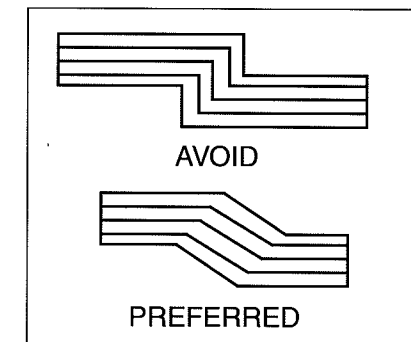


- Laminate stacking sequence should be symmetrical (mirrored about mid-plane) and balanced (equal number of +45° and -45° plies).

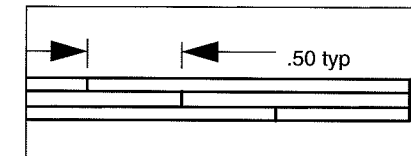
- When possible, a woven fabric ply is used on the laminate surface to increase damage tolerance.

- Bundled laminates greater than .03" thick should be layered to minimize matrix cracking.

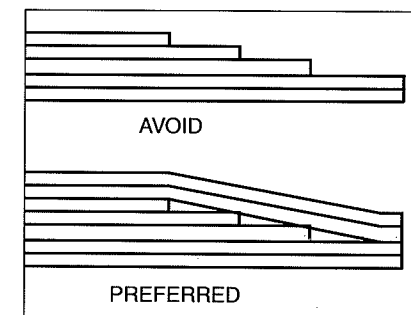
- Splice joints in plies should be staggered through the laminate thickness.



## molded joggles

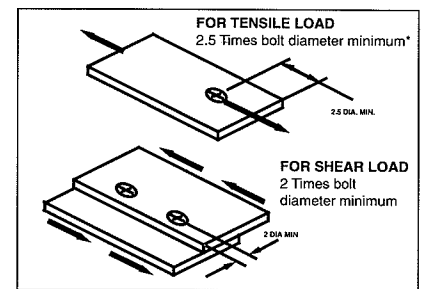


## splice joints

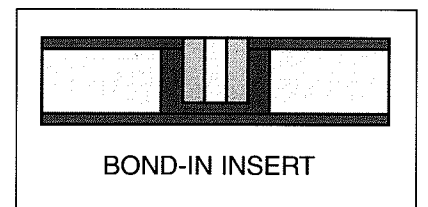


## interspacing laminate plies

## edge distance



## inserts



## galvanic corrosion

- Stainless steel and titanium hardware preferred
- Do not use cadmium plated bolts
- Aluminum must be isolated from Carbon/Epoxy laminate
  - Glass/Epoxy scrim ply cloth cured to laminate
  - Adhesive layer isolation
- Avoid contact with elements more anodic than Monel