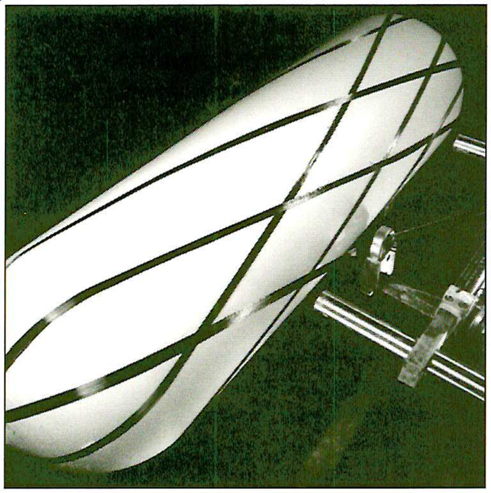
AMALGA COMPOSITES, INC.

FILAMENT WOUND COMPOSITE STRUCTURES



TEXTBOOK DEFINITION:
A composite material is a macroscopic combination of two or more distinct materials, having a recognizable interface between them.

PRACTICAL DEFINITION:

A versatile solution to today's design problems.

Amalga Composites offers a variety of light weight and high strength structures that can solve your design challenges.

A wide variety of properties can be achieved through proper selection of fiber type, fiber orientation and resin matrix of the composite structure required for your application. Strong and stiff fibers carry loads imposed on the composite while the resin matrix distributes the loads across the fibers.

Resin Matrix

Amalga Composites has the technical background and experience to engineer a variety of resin systems for filament wound thermoset plastics.

The proven composite structures described on this page have been fabricated with anhydride cured epoxy systems.

Anhydride cured epoxy systems offer the following advantages: high strength/stiffness properties, low shrinkage, excellent corrosion resistance, impact and abrasion resistance.

Typical room temperature properties of the unfilled anhydride cured epoxy resin system.

Tensile Strength, psi	12,300
Tensile Modulus, psi	450,000
Elongation %	6%
Flexural Strength, psi	12,000
Flexural Modulus, psi	425,000
Heat Distortion Temperature	265°F
Service Temperature	225°F or 325°F

Fiber Types

In the composite industry, over 90% of all fibers used are glass. Electrical or E-glass is the most commonly used and the most economical glass fiber while structural or S-type glass has slightly higher strength and corrosion resistance. Advanced fibers such as carbon and Kevlar exhibit higher tensile strengths and stiffness than glass fibers. Due to the higher cost of these fibers, they are typically reserved for applications demanding exceptional performance.

Typical room temperature properties of E-glass, S-glass and commercial carbon fibers.

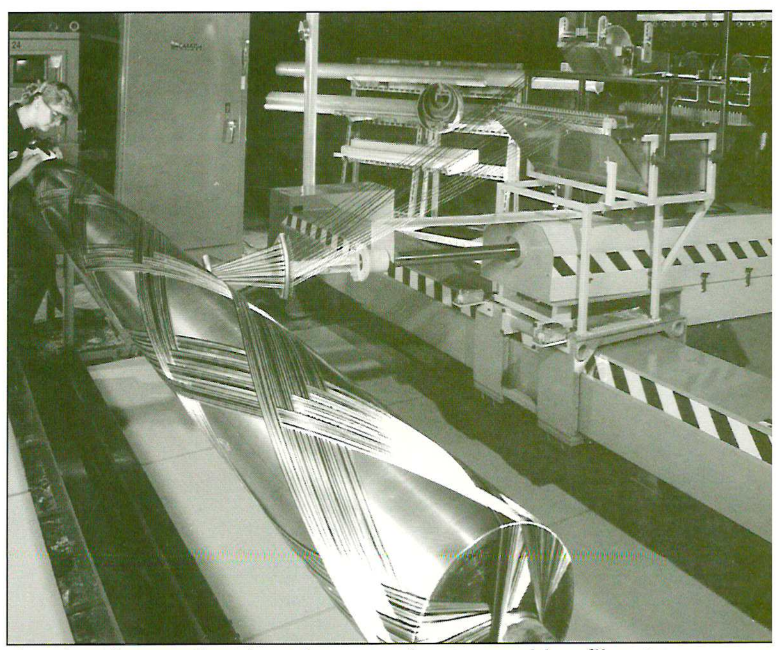
Properties	E-glass	S-glass	Commercial Carbon
Tensile Strength, ksi	500	665	650
Young's Modulus, x 10^6 psi	11.8	12.9	34.0
Elongation %	4.8	5.7	1.9
Volume Resistivity Ohm Mx10^{15}	0.402	0.905	conductive
Dielectric Strength V/mil	262	330	conductive
Dissipation Factor @ 60Hz	0.003	0.013	conductive

Fiber Orientation

Orientation is the basis of the fiber architecture of the composite structure. Orientation refers to the fiber direction in the laminate - typically near parallel (15°) to circumferential (85°) to the centerline of the part. Combining various fiber orientations with the available resins and fiber types creates a wide range of structural properties that can be manufactured by Amalga Composites.

Based on over thirty years of successful product development, Amalga offers standard laminate constructions for most common applications (see back page).

Custom design of laminates incorporating complex fiber orientation, hybrid fibers and exotic resins are available for your most demanding applications.



Amalga Composites has the expertise to combine fiber type, fiber orientation and resin matrix to create a filament wound structure that is lightweight, superior in strength and stiffness, and corrosion, impact and abrasion resistant.

Innovative
Composite Structures
Since 1966

FILAMENT WOUND COMPOSITE STRUCTURES

AMALGA COMPOSITES, INC.

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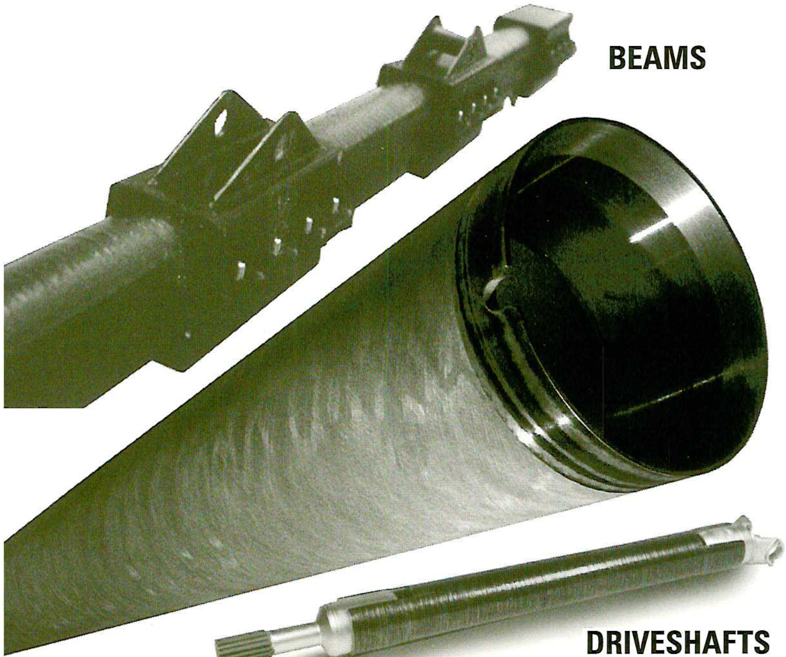
STANDARD LAMINATE CONSTRUCTIONS

BEAM STRUCTURES *Built for maximum stiffness.*

Material Properties	E-Glass	Commercial Carbon	High Modulus Carbon	Applications
Flexural Modulus Longitudinal, x 10^6 psi	5.5	14.0	21.0	PROCESS ROLLERS
Flexural Modulus Circumferential, x 10^6 psi	1.1	5.0	7.5	
Tensile Strength Longitudinal, psi	115,000	130,000	130,000	BOOMS
Tensile Strength Circumferential, psi	44,000	40,000	36,000	MASTS
Compressive Strength Longitudinal, psi	57,000	130,000	130,000	BEAMS
Compressive Strength Circumferential, psi	26,000	50,000	50,000	COLUMNS
Shear Modulus, x 10^6 psi	1.0	1.8	2.2	HIGH STIFFNESS
Shear Strength, psi	8,000	8,000	8,000	
CTE Circumferential, x 10^{-6} in/in/°F	8.6	7.1	6.4	
CTE Longitudinal, x 10^{-6} in/in/°F	4.8	0.17	-43.6	
Poisson's ratio, NUxy	0.27	0.24	0.69	
Density, Lb/in^3	0.072	0.058	0.058	



TORQUE APPLICATIONS *Built for maximum torque transmission*

Material Properties	E-glass	Commercial Carbon	Applications
Flexural Modulus Longitudinal, x 10^6 psi	2.7	3.0	
Flexural Modulus Circumferential, x 10^6 psi	2.7	3.0	AUTOMOTIVE DRIVESHAFTS
Tensile Strength Longitudinal, psi	22,000	20,000	
Tensile Strength Circumferential, psi	22,000	20,000	MARINE DRIVESHAFTS
Compressive Strength Longitudinal, psi	26,000	23,000	
Compressive Strength Circumferential, psi	26,000	23,000	COOLING TOWER DRIVESHAFTS
Shear Modulus, x 10^6 psi	1.8	5.5	
Shear Strength, psi	8,000	8,000	COUPLINGS
CTE Circumferential, x 10^{-6} in/in/°F	6.4	1.1	UNDERWATER HOUSINGS
CTE Longitudinal, x 10^{-6} in/in/°F	6.4	1.1	
Poisson's ratio, NUxy	0.47	0.7	
Density, Lb/in^3	0.072	0.058	

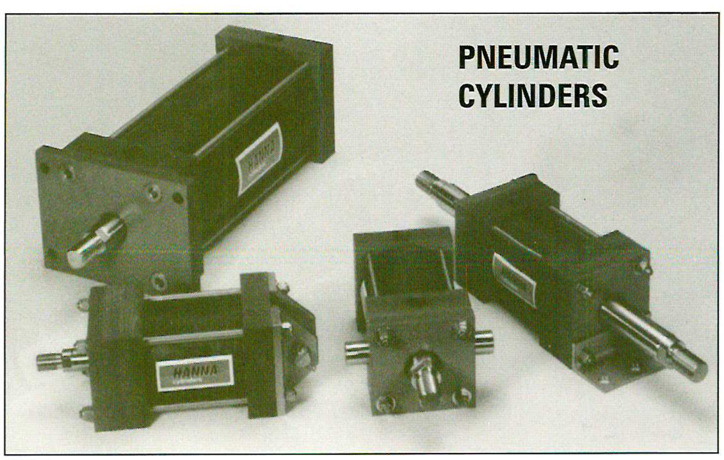
ELECTRICAL APPLICATIONS

Choose from fiber orientations listed on this page for mechanical properties.

Electrical Properties		E-glass	Applications
Dissipation Factor		0.015 max	FUSES
Power Factor 1MHz (ASTM D 150-64T)	60cps	0.30%	
	1mc	0.15%	LIGHTNING ARRESTORS
Dielectric Strength (ASTM D 149-61)			
Short Term Perpendicular Volts/mil	@ 60 Hz	500.00	INSULATED HOUSINGS
Step by Step Perpendicular Volts/mil	@ 60 Hz	400.00	
Dielectric Constant (ASTM D 150-64T)	60 cps.	4.70	INSULATED BUSHINGS
	1 mc.	4.50	
Arc Resistance (ASTM 495-61)		150.00 seconds	
Insulation Resistance (ASTM 257-61)			
96 HRS @ 35°C 2 x 10^7 meg ohms.		90.00% RH	
Water Absorption 24 hrs.		0.01% max	
Thermal Conductivity BTU/in/hr/ft^2/°F		2.50	

BLACK AMALGON® *Built for maximum internal pressure under a compressive load.*

Material Properties	E-glass	Commercial Carbon	Applications
Flexural Modulus Longitudinal, x 10^6 psi	1.3	2.5	PNEUMATIC & HYDRAULIC CYLINDERS
Flexural Modulus Circumferential, x 10^6 psi	3.6	8.7	
Tensile Strength Longitudinal, psi	16,000	12,000	
Tensile Strength Circumferential, psi	40,000	58,000	
Compressive Strength Longitudinal, psi	27,000	37,000	VALVE ACTUATORS
Compressive Strength Circumferential, psi	37,000	35,000	
Shear Modulus, x 10^6 psi	1.8	5.0	
Shear Strength, psi	8,000	8,000	PUMP HOUSINGS
CTE Circumferential, x 10^{-6} in/in/°F	4.6	-0.81	
CTE Longitudinal, x 10^{-6} in/in/°F	8.8	4.4	
Poisson's ratio, NUxy	0.35	0.43	MARINE CYLINDERS
Density, Lb/in^3	0.072	0.058	



OVERWRAP REINFORCEMENTS *Additional strength from overwrapping.*

Material Properties	E-glass	Commercial Carbon	Applications
Flexural Modulus Longitudinal, x 10^6 psi	1.2	1.3	
Flexural Modulus Circumferential, x 10^6 psi	8.0	19.0	HIGH SPEED ROTORS
Tensile Strength Longitudinal, psi	5,000	6,000	
Tensile Strength Circumferential, psi	210,000	210,000	REINFORCED TANKS
Compressive Strength Longitudinal, psi	17,000	35,000	
Compressive Strength Circumferential, psi	138,000	185,000	ANTI-CORROSION COVERS
Shear Modulus, x 10^6 psi	0.8	1.0	
Shear Strength, psi	8,000	8,000	CATHODES
CTE Circumferential, x 10^{-6} in/in/°F	3.7	-0.09	
CTE Longitudinal, x 10^{-6} in/in/°F	13.3	11.9	IMPACT PROTECTION
Poisson's ratio, NUxy	0.08	0.02	
Density, Lb/in^3	0.072	0.058	