



About Reinforcements

The physical properties of composites are fiber dominant. This means that when the resin and fiber are combined, their performance remains most like the individual fiber properties. Test data shows that the fibrous reinforcement is the component carrying the majority of the load. For this reason, fabric selection is critical when designing composite structures.

Begin the process by determining the type of reinforcement needed in the project. The average fabricator has a choice of three types of materials. These are fiberglass, carbon fiber, and Kevlar®. Fiberglass tends to be the all-purpose choice, while carbon fiber offers high stiffness and Kevlar® high abrasion resistance. Our revised "The Fundamentals of Fiberglass" brochure includes extra fabric selection information if it is necessary. For customers requiring specific testing information, we have prepared the following laminate comparison table. This table should help you select the proper material when the stress loads of your parts are known in advance. Also, if a single fabric type won't work, they may be combined in the laminate forming a hybrid lay-up with the benefits of more than one type of material.

Once the family of fabric has been determined, select the weight and weave style which suits the demands of the job. The lighter the ounce weight of the fabric, the easier it will be to drape over highly contoured surfaces. Lightweights also use less resin so the entire laminate remains lighter. As the fabrics become heavier, they begin to become less flexible. The medium weights retain enough flexibility to drape over most contours and they begin to contribute significantly to the strength of the part. 6, 7.5, and 10 ounce fabrics are our most popular. They are very economical and produce strong and lightweight parts used in automotive, marine, and industrial applications. Woven roving is the heaviest reinforcement and is typically used in boat building and mold construction.

The way the fabric is woven is considered its pattern or style. There are three main types to choose from. Plain weave styles are the least expensive and least pliable, but they hold together well when cut. The frequent over/under crossings of the threads reduces the strength of the plainweaves, although they are still adequate for all but the highest performance applications.

Satin fabrics and Twill weaves are highly pliable and stronger than the plain weaves. In a satin weave, one filling yarn floats over three to seven other warp threads before being stitched under another warp fiber. Threads run straighter much longer in this loosely woven type, maintaining the theoretical strengths of the fiber. Twill weaves offer a compromise between satin and plain types, as well as an often desirable herringbone cosmetic finish.

Specifications	Fiberglass Fabric w/System 2000/2060 Epoxy	Graphite Fabric w/System 2000/2060 Epoxy	Kevlar® Fabric w/Syste 2000/2060 Epoxy
Fabric Specifica- tions	Style 7781, 9 oz., E-Glass	5.6 oz., 3K Graphite	5 oz. Kevlar®
Laminate Construction	10 Plies Glass	10 Plies Carbon	10 Plies Kevlar®
Laminate/Resin Content	50% Resin/50% Glass	56% Graphite/44% Resin	51% Kevlar®/49% Resin
Elongation @ Break %	1.98%	0.91%	1.31%
Tensile Strength, PSI	45,870 PSI	75,640 PSI	45,400 PSI
Tensile Modulus, PSI	2,520,000 PSI	8,170,000 PSI	3,770.000 PSI
Flexural Strength, PSI	66,667 PSI	96,541 PSI	34,524 PSI
Flexural Modulus PSI	3,050,000 PSI	6,480,000 PSI	2,500,000 PSI

Tech Tip #1 - To increase the pliability of any fabric, cut it off the roll on a bias of 45 degrees. Even the coarsest fabric will drape better over contours when cut this way.

Tech Tip #2 - A separate pair of scissors should always be used to cut Kevlar® because glass fabrics wear scissors at a different cutting angle than Kevlar®. The same pair of scissors can be used to cut both glass and graphite.

Kevlar® Aramid Reinforcements

This was one of the first high strength synthetic fibers to gain acceptance in the reinforced plastic industry. Unlike the previous synthetic reinforcing fibers, Kevlar® has a considerably higher tensile strength and modulus than fiberglass. Kevlar® is usually used for structures requiring good stiffness, high abrasion resistance, and light weight. Current applications include lightweight boat hulls such as kayaks and canoes, aircraft fuselage panels and pressure vessels. May be used with epoxy or vinylester resins.

Carbon Fiber/Graphite Reinforcements

Graphite fibers contain up to 95% carbon and yield the highest tensile strength in the FRP industry. These fibers woven together form graphite fabric. These fabrics offer higher strength and stiffness-to-weight ratios than any other commonly available reinforcements. While there are hundreds of types to choose from, we have selected three styles of standard modulus carbon fiber which are suitable for use in racing, aircraft, competition marine, and light industrial applications.

To maximize the fiber properties we recommend using only epoxy or vinyl ester resin, although polyesters will bond to the fabrics. Pre-weigh the fabric before use, and mix only the same weight resin for laminating. This will encourage low or proper resin content within the part. Our experience has also proven that a flexible rubber squeegee is the most effective applicator for distributing the resin.