Laminate Construction Guide

Polyester Resins:
Structural Lay-Up, Isophthalic, Laminating Bond Coat B

The majority of all fiberglass parts are constructed using polyester resins. Polyester resins are easy to use, fast curing, tolerant of temperature and catalyst extremes, cost less that epoxies and vinyl ester resins and can be used with gel coat. For general purpose parts, made by hand lay-up, TAP's Structural Lay-Up resin is ideal. Lay-Up resin is drain-resistant (thixotropic), has a moderately low heat build-up (exotherm), wets out quickly, and cures fast after the laminating is done.

Vinyl Ester Resin

Vinyl ester resin is typically used when high durability, thermal stability, and high corrosion resistance are needed. Vinyl ester is often used to produce and repair fiberglass boat hulls to reduce blistering and osmotic problems. Vinyl ester falls between polyester and epoxy on price and physical properties. Vinyl ester does exceed both polyester and epoxy in corrosion resistance, temperature resistance and toughness.

Epoxy Resins

Epoxy is 1.5 to 2 times the cost of polyester resins but offers higher strength to weight ratios and less shrinkage for close tolerance work. Epoxy has tenacious adhesive properties. TAP's Premium Marine Grade Epoxy system has a choice of three hardeners for curing 314 resin. The three hardeners offer different cure times, viscosities and physical properties. Purchase 314 resin in bulk and keep all three hardeners on hand for any project.

Reinforcement

Reinforcements are selected based on the needs of the finished part. List your needs, lightweight, stiffness, abrasion resistance, damage tolerance, cost and ease of lay-up. Compare your list to the descriptions listed below.

Mat

Mat is a sheet form of fiberglass. Mat is the weakest reinforcement but mat has multi-directional strength. Mat is made up of chopped glass strands up to 2 inches long, held together with a binder soluble in polyester resin. Mat is used to inexpensively build up stiffness. Epoxy is not recommended for mat. Mat readily conforms to compound curves. One gallon of resin will wet out 20 sq. ft. of mat.

Woven Roving

Roving is a glass woven in a coarse weave. It offers better tensile and flexural strength than mat. Roving has a loose weave and this conforms to contours well. Its strength is bidirectional like cloth, so often multiple plies are laid at different angles to each other. Woven Roving is often used on large parts like boat hulls and auto bodies. One gallon of resin will wet out 15 sq. ft. of woven roving.

Glass Cloth (E-Glass)

Cloth is the most expensive form of fiberglass and the strongest woven material on an equivalent weight basis. Cloth is used as a finishing layer for better appearance or in a light weight high strength laminate. One gallon of resin will wet out 40 sq. ft. of cloth.

Core Materials

When parts need stiffness and strength without significant increases in weight, core materials are sandwiched between layers of fiberglass. These core materials may be honeycomb, wood, foam, etc.

TAP sells BaltekMat. BaltekMat is a low-density, nonwoven continuous-strand mat containing 45% by volume of micro-balloons. One gallon of resin will wet out 30 sq. ft. of Baltek Mat.

Aramids (Kevlar)

Aramid fabrics are twice as strong as E glass fabrics. Temperatures, chemicals and moisture have little or no effect on aramid fibers. Laminates made with aramid fabrics provide superior resistance to damage from fatigue, vibration, and impact. Aramids are used for structures requiring high abrasion resistance and light weight. Current applications include lightweight kayaks, canoes, boats and racecars. Aramids are difficult to use and require technique that takes time to develop. One gallon of resin will wet out 50 sq. ft. of Aramid.

Carbon

Carbon fabrics, sometimes called graphite, are one of the strongest and stiffest reinforcements available. Carbon fabric composites can achieve the strength and stiffness of metals at significant weight savings. One gallon of resin will wet out 50 sq. ft. of Carbon.

Knytex

Knytex represent a new, sophisticated technology, one that offers light weight, smooth-surfaces, improved impact strength and lower resin percentage. Knytex fabrics are a series of unidirectional fabrics held together by a knitting process. Knitted fibers lie in a flat plane that carry loads more efficiently It also increases fiber density reducing a laminate's resin content. One gallon of resin will wet out 20 sq. ft. of Knytex.

S-Cloth

S-Glass fiber is the commercial outgrowth of the high strength fiber developed by Owens-Corning for military missile applications. When compared to E-Glass, laminates made with S-Glass show improvements in strength, stiffness, impact resistance, toughness, and service temperature. S-Glass is used for high-performance surf and sailboards. One gallon of resin will wet out 50 sq. ft. of S-glass.

Laminate Thickness/Layers Of Glass Reinforcement

Layers of reinforcement are laminated one on top of each other. The first layer is normally a mat. Mat helps prevent air pockets from forming behind the gel coat and it helps hide woven patterns from the surface. Succeeding layers should alternate mat with woven roving or cloth. It is not usually good practice to face two heavy woven layers because of poor inter laminate bond and a higher chance for air bubble entrapment. Nine total ounces of mat per square foot will result in a 1/4 inch thick laminate that's about 30% glass content. Using woven fabrics with mat will increase glass content and strength. Where the highest physical properties are important use less bulk reinforcements like mat and woven roving, and use glass cloth, Knytex, S-Glass and coring materials. Hybrid lay-ups benefit by bringing together physical properties of more than one type of material.

Chart

REINFORCEMENT	LAYERS	%GLASS CONTENT	LAMINATE THICKNESS
1.5 oz mat	1	36	.041
7.5 oz cloth	1	41	.017
	2	55	.031
	3	59	.045
24 oz. roving	1	54	.043
mat/cloth/mat	3	30	.106

Please view this guide as the first step in your learning process. Please read the free resources on our website and consider purchasing one or two of the books and videos we have available. We recommend doing small projects before tackling anything large. After you get familiar with the techniques, you'll be more comfortable with the process and be able to customize the process to achieve the results you desire. Before starting any project be sure to read the hazardous precautions for the materials you are using. Fiberglass can be handled safety, but proper precautions must be taken to do so.