PROCEDURES

Health and Safety in Handling Composite Materials

The materials selected for this kit are the safest, least toxic, applicable materials for this type of construction, but several simple precautions, and operating procedures should be applied for your personal well being, and satisfactory completion of the kit. As a general case, the materials in this kit are no more hazardous than many of the fluids and products that one handles in everyday life. Examples of items of similar risk are gasoline, paint and thinners, and many household-cleaning products. Just as with these substances, several safety precautions should be employed to prevent illness, physical injury, and possible adverse allergic reactions. Gloves and other protective equipment are recommended for handling any of the liquid or paste resin and adhesives. Disposable surgical gloves are often suggested for this type work, but they are very fragile, and easily torn on the glass fibres, or other sharp edges. Some of the heavier kitchen type non-porous gloves may prove more durable, and easier to use. Breathing protection should be used in cutting, grinding, or sanding any of the structural materials, or when handling any of the powder or fibrous materials. Work in well ventilated areas and clean up hands, and all spilled materials, particularly before handling any foodstuffs, or tobacco products, or any other means by which the materials might be ingested or gotten into the eyes, nose, or mouth. Smoking or eating in the composite shop area is to be vigorously discouraged. Carefully read the instructions and cautions on each new product as you encounter it during your construction progress. Quickly employ the listed medical cautions and recommended procedures, if any of these products are ingested, or are providing any undue levels of irritation or other reactions.

COMPOSITE TERMS AND PROCEDURES

Many of the same techniques and procedures apply to numerous assembly steps, so some of the more common will be covered in detail in this section to avoid cumbersome repeating through all of the individual sections.

REMOVING PEEL PLY

Most of the molded parts will be covered on the back side, with sheets of material called "peel ply". This is a cloth material that resists bonding to the resin surface and allows surplus resin to be squeezed out of the part during pressure curing. This material is left in place after fabrication since it provides protection to the part from some physical damage and contamination. This material must be removed prior to assembly, but it is suggested that this be one of the final steps just before the "dry assembly" and the mixing of resins and adhesives, to maximise the protection provided.

The peel ply usually sticks out on some place of the part, where it will look like white cloth. Where it is adhered to the part, the epoxy may give it a transparent appearance. The material is basically removed by pulling it by hand. Frequently it will tear before clearing the entire area, and a new corner will have to be lifted carefully with a utility knife. The white cotton strips running irregularly over the surface of the part must also be removed with the peel ply.

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IT IS ESPECIALLY IMPORTANT THAT ALL TRACES OF PEEL PLY BE REMOVED FROM BONDING AREAS, SINCE IT WILL TOTALLY VOID BOND STRUCTURAL INTEGRITY LEADING TO POSSIBLE STRUCTURAL FAILURE.

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BID

BID is a generally used contraction in composite construction and stands for "BI Directional" glass cloth. This is cloth woven in a manner similar to what you are used to seeing in most fabrics where there about equal numbers and sizes of strands in the longitudinal direction as in the crosswise direction. This is to differentiate between those composite fibre weaves known as unidirectional (UNI) where the primary strength is in the longitudinal direction, and only enough crosswise fibres are used to hold the material together for handling. In this kit we will only be dealing with BID for the assembly steps (in the pre-moulded factory parts UNI is used in many places to maximise required strength, but only BID is used for the final assembly steps).

The appropriate BID fabric is provided in the kit (and if you damage some, or otherwise run short please contact Tri-R for proper replacement - do not substitute with non approved materials). Most of the uses will call for bias cut strips, so it will be useful to set up the supplied cloth on a cutting table and cut out a supply of these bias cut strips. A bias cut strip is cut diagonally across the length of your fabric material at 45 degrees, such that the fibres in your resulting strip are oriented at 45 degrees to the length of the strip (see figure). This material cut in this fashion is easier to bend into or over corners and routes around the curves of any parts quite readily. This is the same reason that "bias tape" is used by tailors and seamstress to edge fabric in sewing. Some care is suggested in handling this bias strip, as pulling on the ends or edges will easily distort it in length or width. Store and handle these strips laying on clean paper or plastic to avoid this distortion. Always use caution in handling and storing these materials to avoid contamination with dirt, grease, oil, or unwanted resin residue.

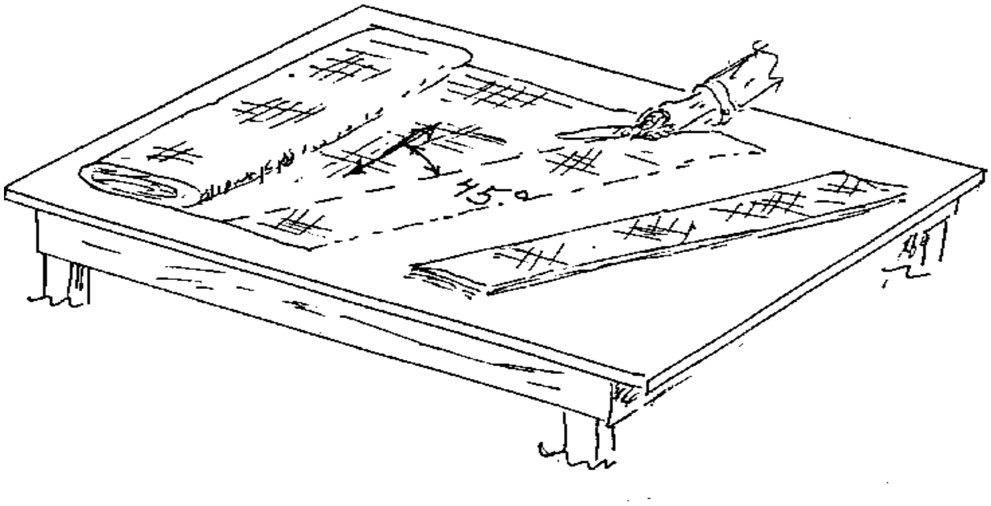

FIGURE - Sketch of bias cutting

If the plans call for a given number of BID layers in a strip of specified width, it may be useful to pre prepare this strip on a plastic sheet. This will allow more accurate trimming of the. strip, and easier, low mess handling of the material. The proper number of dry strips should be readied, a little bit oversize in both directions. Lay out the proper number of layers of the dry cloth on a sheet of thin plastic (garbage bag material will work). Wet out these layers with the resin, using a brush trimmed back for "stippling" the resin into the cloth. Wet thoroughly all layers, and work any air bubbles out by "stippling" and/or sqeegeeing in the direction of the fibres (45 degrees). Thoroughly saturated cloth will take on a transparent look. when the bubbles have been satisfactorily dispatched, a second layer of plastic material can be placed over wet resin. Additional air can be squeezed out by pressing on, and working the top plastic surface. When the cloth is properly wetted out, the section can be cut to size by trimming through the "sandwich" of plastic and wet cloth. The strip can then be easily handled and transported to the part where it is to be placed. Removed the plastic from one surface, and place that wet surface in place upon the part. The plastic on the other surface will help you position the saturated cloth, and you can pat or squeegee on this surface to assure good bonding and elimination of bubbles. The plastic helps avoid distorting the bias cut cloth, but in some cases deliberate distortion can be used to get a better fit to the bonding strip (stretching it will make it narrower and working it to make it shorter will make it wider).

PREPARATION FOR BONDING

The structural integrity of your completed aircraft, and your personal safety, are dependent on bond joints that you make in assembling this kit. For this reason,, the preparation of these bond areas to assure clean, properly prepared surfaces is extremely important.

MOULDED SURFACES

The "outer" surfaces of your remoulded parts are very smooth where they were adhered to the mould during the pressure curing cycle. These surfaces also will have some residual material known as "parting agent" that was use to keep the parts from sticking to the mould. Both this very smooth surface, and the "parting agent" will conspire to keep you from obtaining a good bond on any of these surfaces where you will be joining to adjacent parts. These areas must be prepared by roughing the surface (providing "tooth" for the bond), and cleaning away any "parting agent", dirt, dust, oil, or grease, and even your fingerprints. The surface should be lightly but thoroughly sanded with about an 80 grit abrasive paper until there is no sign of the shiny smooth surface in any of the area where you will be bonding (do not sand through any of the cloth fibres in the laminate). This surface should then be wiped clean with acetone to remove the dust and any contamination.

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WARNING acetone and similar solvents are toxic, and highly flammable. Perform these operations with good ventilation well away from any sparks or flames, and avoid breathing the vapours.

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First wash the area with a clean cloth or paper towel wet with the solvent, and follow by drying the surface before it dries with another clean cloth or paper towel. If the surface is allowed to dry before wiping, some of the dissolved contaminates will be re-deposited on the part.

PEEL PLY SURFACES

Many of the areas where you will be bonding will be surfaces where the "peel ply" was used in fabricating the part. The first step in these areas is a careful inspection to make sure that all fragments of the peel ply material have been totally removed in zones to be bonded. Again, it is important to remember that peel ply is designed to **NOT** stick, and will leave a completely non-bonded area where ever it has been missed, and you had failed to remove it. Once the peel ply has been totally removed an adequate bond could be made, but it is strongly recommended that the same procedure of abrading the surface with 80 grit paper, and subsequent cleaning with acetone be employed in these areas also.

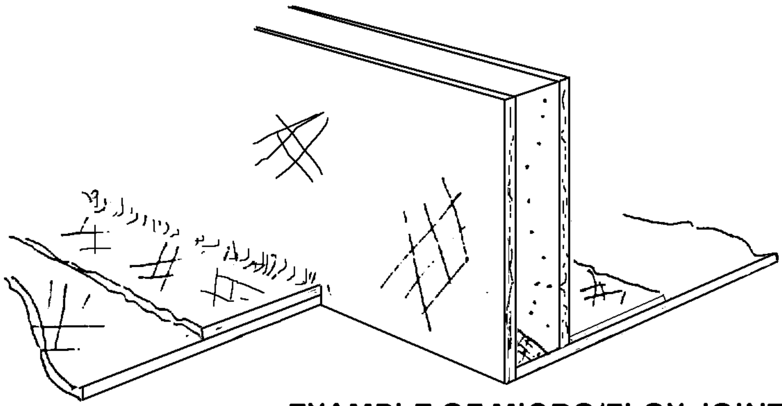
MICRO and FLOX

MICRO and FLOX are terms use to describe two common types of filler material used with epoxy resin systems. Both of these materials are provided with the kit, and are identified by name.

MICRO is a shortened description for micro-balloons, which are tiny hollow spheres of either glass or phenolic plastic. These spheres are so tiny that it is a powder almost as fine as flour. These can be mixed with epoxy resin to make it thicker and easier to use as filler. For general purpose, enough MICRO is added to the resin to make it a thick paste about like putty. This would be thick enough to squeegee a thin layer on a vertical surface and not have it "run" or sag. For bonding or laminating to foam surfaces (covered in more detail later), MICRO is mixed as slurry, which is about like a thick creamy paint. In some composite constructions you will see reference to "dry MICRO", and this is a thicker mix which will appear almost dry, but will have enough resin content to be compacted together and adhere to clean surfaces (about like a snowball). MICRO will result in a structure that is significantly lighter than solid resin, and will be less brittle, though not really stronger. MICRO mixes are frequently used in adhesive applications, where the thickened "paste" can fill voids, and not run out of the joint as straight resin would be apt to do.

FLOX is the term applied to finely chopped fibres (generally cotton) which also is frequently mixed into the epoxy resin to make it thicker and more “pasty", for use as a filler and/or adhesive. With this filler also, the usual mix will be thickened to almost a putty consistency (generally FLOX is used a bit wetter than MICRO). The fibres add structural integrity, and avoid the brittle nature of unfilled solid sections of cured resin. The FLOX mix is heavier than MICRO mix, and is not as easy to use as a filler, and is significantly stronger. Chopped glass fibres have been used in a similar fashion on occasion, but they are heavier and more difficult to work with.

In this kit, frequent use is made of a mixture of roughly half and half of these two filler materials with the resin system, and this will be called a MICRO/FLOX mix. This usage provides a compromise between the characteristics of the two filler materials, and combines some strength improvement of the FLOX with the lighter weight of the MICRO. A typical use is in what is called a "FLOX/MICRO joint" where a layer of glass crosses the edge of another glass layer, and structural integrity is desired in the joint between the two. The attached sketch shows how the foam is "chamfered" out to make a triangular recess which is filled with the FLOX/MICRO paste. For a higher level of structural strength, the same technique is used but with a straight FLOX mix.



EXAMPLE OF MICRO/FLOX JOINT

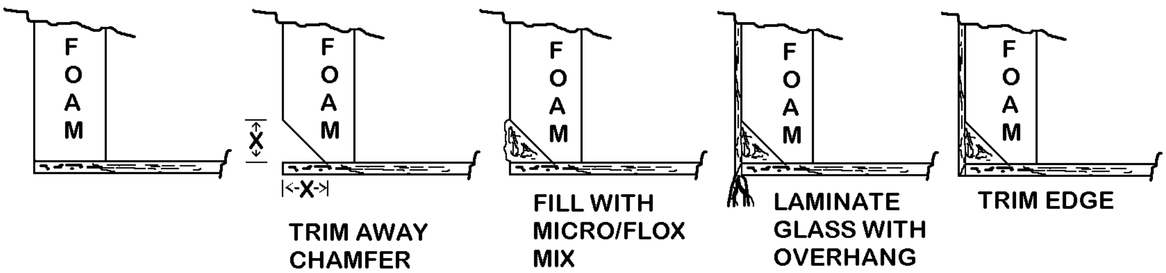


FIGURE - Sketch of a FLOX or MICRO/FLOX joint

The resulting fillet of the filled epoxy resin provides the required structural connection between the intersecting glass layers, and avoids trapping weakening air bubbles in the structure. Frequently a size will be specified for the MICRO/FLOX joint, and that dimension refers to the legs of the triangular cut-out in the same fashion as for a chamfer specification on an engineering drawing.

BONDING AND LAMINATING TO FOAM

The raw surface of most foam core materials is rough and somewhat porous in both appearance and fact. Using straight epoxy resin for bonding to this surface will produce a heavy joint with rather spotty performance. Invariably some of the resin in the bond area will run, or "wick" away leaving bubbles and unbonded areas. Also the large amount of resin used in an attempt to fill the surface of the foam will add a lot of unnecessary weight in the structure. The solution to this problem is to "prime" the foam surface with a MICRO slurry before laminating the cloth to this surface. A "slurry", as the name suggests, is a little wetter than the paste or putty consistency discussed with MICRO and FLOX. The thickening effect of the MICRO will make the mixture stay in place better than straight resin, and the MICRO balloons will significantly reduce the weight of this mixture. The weakening effect of the MICRO fill is not an issue in this application, since it is still many times stronger than the foam substrate to which it is bonding, the slurry is applied to the surface with a squeegee, basically filling the surface to it's top of the roughness. Some builders allow this filler to cure, and then sand it smooth, but the most common, and quite effective technique, is to lay the glass cloth on the wet uncured surface and add straight resin to the surface of the cloth, brushing and stippling the resin into the weave. As in all laminating of glass cloth, squeegee away the extra surface resin to make a surface which has no bubbles, but the weave is plainly visible. Surplus resin only adds weight - not strength.

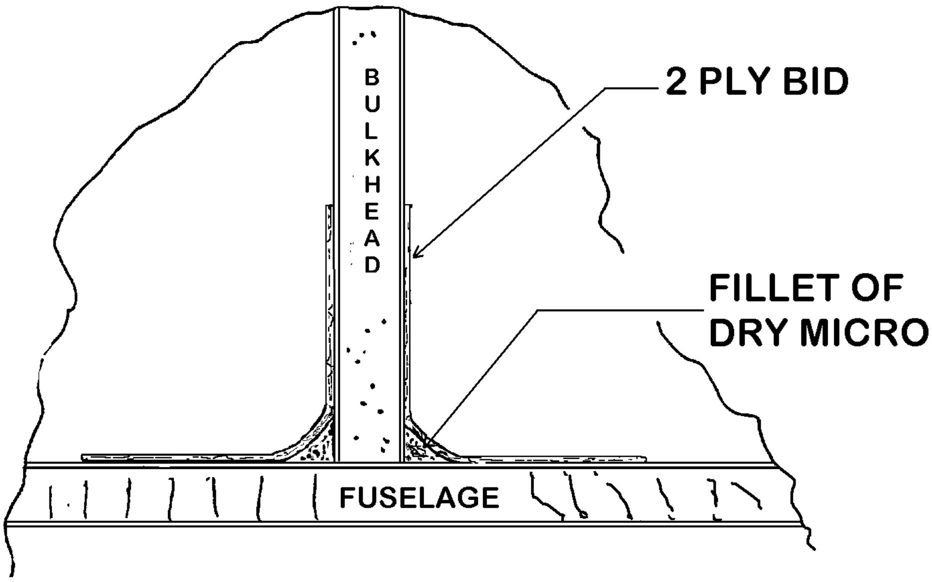


FIGURE - Fillet joint with MICRO/FLOX

GREEN TRIMMING

A technique which is frequently use when laminating parts with the BID cloth is called "green trimming". When laying the wet cloth on shaped parts, the only way of assuring complete coverage is for the edges of the wet cloth to overhang the edge of the part. It is good practice to use generous amounts of this overhang to assure that the cloth is properly wet out up to the edge of the part below. During the cure process, epoxy resin goes through a stage where it is described as "green", where it will have a rubbery character with about the strength of beeswax. At this point it is fairly easy to trim the overhanging cloth with a sharp utility knife or razor blade. Determining the time to do this trimming is a trial and error proposition, and will vary primarily with the ambient temperature. With working in the cool evening you might end up losing some sleep to hit this proper trimming time. Test frequently with the point of your knife to see when this rubbery stage is reached, since if you wait too long your alternative will be to saw and grind back this edge. As mentioned above the time to reach this point will vary from not much more than an hour in hot weather to several hours in cool temperatures.

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CAUTION
When doing this cutting, be aware that the epoxy is quite short of ifs eventual bond strength, so use care in handling and working with the part. Position the part and the knife such that the cutting pressure is toward the part, and not tending to peel the cloth away from the part (always be sure also - that if the knife slips neither you nor the part will be injured). Do not attempt to use "green trimming" to neaten up the edges of glass tape laid as seam strengthening on the pre-moulded parts, as the point of the knife will damage the fibres in the structural part beneath the cut at the "trim line" and lead to potential failure.

FOR THIS REASON NEVER CUT AGAINST STRUCTURAL COMPOSITE MATERIAL
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DIMENSIONS AND STATIONS SYSTEM

The dimensioning systems used in aircraft are usually described with such terms as "'Stations"', "Butt Lines", and "Water Lines". Since this dimensioning system will be used in locating important elements in the assembly, it is important to understand these "call outs" without confusion, or ambiguous interpretations. The figure below should help you in becoming familiar with the aircraft dimensioning nomenclature.

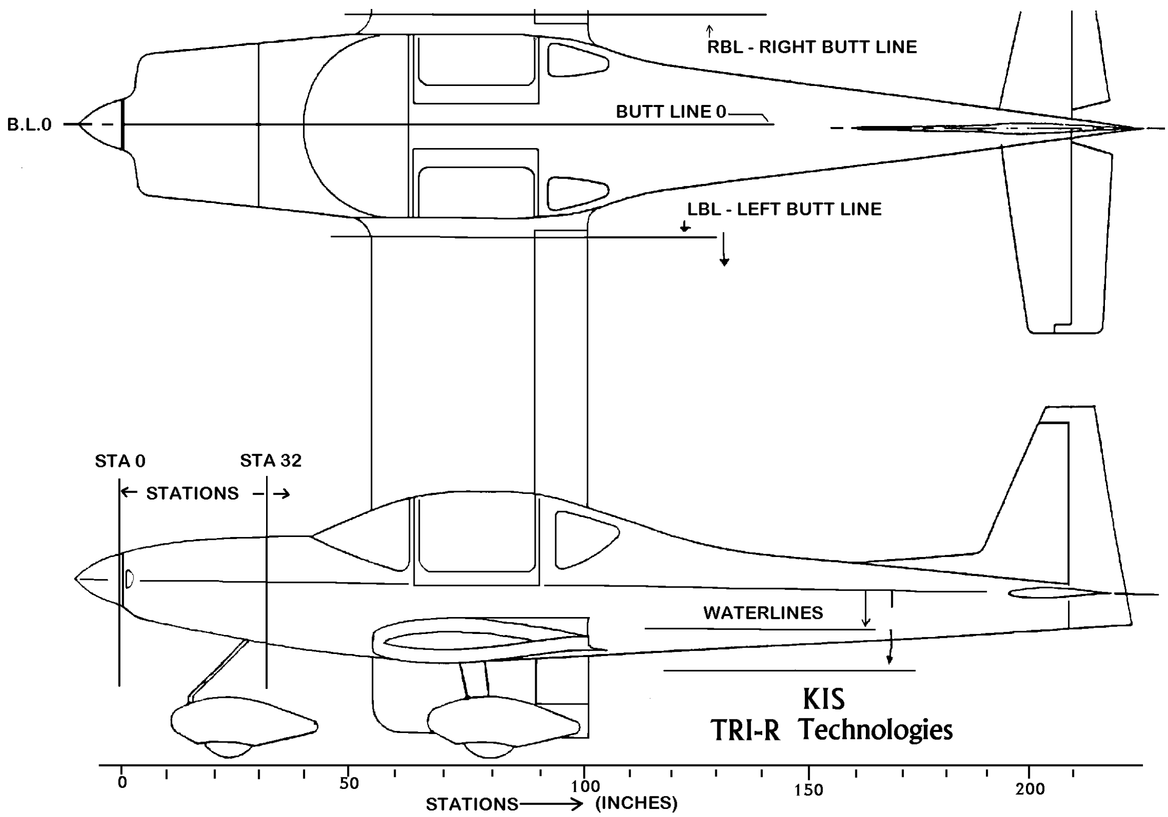

FIGURE - Aircraft dimensioning system.

STATIONS

The longitudinal locations on an aircraft are described as stations, and the station dimensions are generally in inches as measured aft of the reference station. Negative station locations are for those locations which are forward of this reference point. Various builders and designers use different techniques for establishing the reference "zero" station location. In some cases this may be an imaginary vertical plane completely in space in front of the aircraft. For the KIS aircraft the zero station is located at the aft surface of the propeller spinner. A reference station at STATION 32 will be established during the fuselage assembly at the moulded in "joggle" which provides clearance for the aft edge of the cowling. All components added to this assembly will be located based on this station reference plane.. The station locations will continue to be of importance after the assembly of the aircraft is completed, particularly in weight and balance determinations. Station locations of major components are required for computations of weight and balance to assure safe loading of any aircraft. Typical locations of moveable/removable weight (such a fuel, passengers, and baggage, will be catalogued for the completed plane, and will be use in these calculations.

BUTT LINE

The next most important location parameter is the distance of the various features on each side of the aircraft centreline. The KIS aircraft uses the most common form of notation for Butt line locations 9 with the zero plane being along the axial centreline of the fuselage. Left Butt Line values (L.B.L XX.X) would be measured out from the centreline on the left side (pilots left side). Obviously the Right Butt Lines (R.B.L XX.X) are measured out on the right side from the zero centreline. The very first component to be assembled (Horizontal stabiliser) uses B.L. dimensions extensively in locating cut edges and rib locations. Most portions of the aircraft design are symmetrical about the aeroplane longitudinal centre, but some features require notable exception to this fact. Be particularly careful with those components that are assembled upside down, to avoid confusion between right and left Butt line dimensions.

WATERLINE

Waterline, (W.L.) dimensions are much less frequently used than the other two. The vertical locations on an aircraft are known as waterline locations. This is apparently a holdover from marine applications in "lofting" hull shapes, and these lofting techniques were carried over for layout of the aerodynamic shapes of aircraft components. It is not unusual for the zero reference Water Line (W.L.0.0) to be located at some imaginary horizontal plane below the aircraft, such that all W.L. call-outs will be positive numbers. The use of W.L. dimensions in this kit assembly procedure is less frequent than the other measurements, but will be used from time to time, the belt line joint between the fuselage halves must be level and square with the world for the joining operations, and that will be the most frequent use of waterline dimensions.