Montana Advanced Composites

Specific suggestions for machining cured NorPLY™ Fiberglass Reinforced Plastic Composites and general recommendations for fabrication and machining of cured fiberglass reinforced plastics

MILLING

Tool material: Carbide (Carbology Grade 999)

Coolant: Water at flow rates to completely flood tool 80 SFPM 9"/min. feed depth of cut up to 1/2", 10 point cutter
Typical surface finish 63 to 125
Machining characteristics greatly influenced by orientation of glass filaments and rigidity of parts
Tool life is relatively short due to abrasiveness of glass

BAND SAWING

BandType: Segmented Diamond Edge, Heavy Duty

BandThickness: 0.035 inch

Band Grit: 3 5/40 Mesh Grit Diamond

Band Width: 1 inch

Band Velocity: 4,000 RPM

Coolant: Water

Rate of Feed: 20 square in/min.

DRILLING

DrillType: Carbide

Feeds: Up to 25/32 diameter 0.006"/Rev.
Above 25/32 diameter 0.009"/Rev.

Speeds: 13/32 dia. or less 60 SFPM 25/32 dia. 90 SFPM
17/32 dia. or less 80 SFPM 29/32 dia. 100 SFPM
21/32 dia. or less 85 SFPM 1-1/32 dia. 125 SPFM

Coolant: Water

Fabrication Suggestions for Cured Reinforced Plastics

Ordinary hand or power tools may be used in some cased. When fabricating large structures or large quantities, special tools such as carbide or diamond tipped saw blades are recommended for longer tool life and faster cutting speeds.

Recommended General Fabricating Practices

1. Observe common safety precautions. For example, the operator of a circular power saw should wear a face mask to protect the operators' lungs and safety glasses for the eyes.
2. A coverall or shop coat will add to the operator's comfort during the sawing, machining or sanding operations. Although the dust created is non-toxic and presents no serious health hazard, it can cause skin irritation.The amount of irritation will vary from person to person and can be reduced or eliminated by use of a protective cream.
3. Machine ways and other friction-producing areas should be cleaned frequently.The combination of grease and fiber glass chips can become a damaging abrasive if allowed to accumulate.
4. Avoid excessive pressure when sawing, drilling, routing, etc.Too much force can rapidly dull the tool.
5. Do not generate excessive heat in any machining operation. Excessive heat softens the bonding resin in the fiber glass-- resulting in a ragged rather than a clean-cut edge.
6. Support the fiber glass material rigidly during cutting operations. Shifting may cause chipping and/or delamination at the cut edges.
7. Carefully consider the use and design of fastening devices for mechanical connections.
8. For adhesive fastening **prepare the surface properly for bonding** prior to the application of the adhesive.
9. The strongest connections of high reliability can be made by using a combination of mechanical fasteners with adhesives.

Machining Cured Fiberglass Reinforced Plastic Composites

SAWING OR CUTTING

Always provide adequate support to keep the material from shifting when making a cut. Without adequate support fiber glass reinforced shapes or profiles will chip and/or delaminate.

In cutting operations, use light evenly applied pressure. Heavy pressure tends to clog the blade teeth with dust particles, and thus the cutting life of the blades is shortened.

Water cooling is desirable when many pieces or when thick cross sections are being sawed. With cooling, cutting speeds increase, smoother cuts result, and dust is largely eliminated.

For infrequent cutting on a circular power saw, a metal blade with coarse, offset teeth can be used.

For frequent cutting, a masonry saw blade – preferably carbide tipped – will give you accurate cuts and reasonably long blade life. For production cutting, use a 60 to 80 grit diamond tipped blade for best results.

Circular or curvature sawing – Good results can be obtained by using a saber saw or band saw on small quantity cutting. Neither machine is particularly recommended for production sawing unless carbide or diamond tipped blades are used to avoid excessive blade replacement.

A hand router with rotary bit can also be used to cut circles and curves – but it removes considerably more stock.

In cutting rod or bar stock, a hacksaw may be convenient to use. A blade with 24 to 32 teeth per inch is effective for hand cutting and light rapid strokes should be used.

Abrasive blades (carbide or diamond), which may have become clogged because of overheating or too much pressure, may be cleaned by cutting a common brick.

SHEARING

Shearing is not recommended unless your shear is equipped with a specially shaped blade that allows only a small portion of the cutting edge to penetrate the material at any one time. Even then, shearing will not be as precise as sawing. Do not shar shapes over 3/32" thick.

DRILLING

Any standard twist drill is an excellent tool for working fiber glass shapes. Carbide tipped drills are recommended as a minimum when cutting large quantities. Drill speeds should be roughly equivalent to those used for drilling hardwood. When drilling large holes, a backup plate of wood will prevent the hole from breaking out on the sides.

Important Note for Close Tolerance Work: Holes drilled are generally 0.002" - 0.004" undersize. A 1/8" drill will **not** produce a hole large enough to admit a 1/8" expanding rivet; a No. 30 drill must be used.

ROUTING

Both handheld and bench type routers give excellent results. Rotary file bits – preferably carbide tipped – are best when you're doing a large amount of routing. Two-fluted wood bits can also be used, but they require frequent sharpening and are therefore practical only for occasional routing.

Caution: Use light pressure when making a cut. Forcing the routing operation causes the fiber glass resin to heat up and soften – and you may damage the bit if it becomes clogged.

TURNING

Most metal working machine tools can be used in working with fiber glass shapes. Tool steel cutters – single or multiple point – are entirely satisfactory for short run machining operations on small quantities of material.

Carbide tool bits such as Carbaloy 999 are recommended whenever a great deal of machining is to be done.

In general, dimensional tolerances should match cold rolled steel tolerances; feeds and speeds should match those used for brass or aluminum.

The best machine finish can be obtained by climb-cutting instead of under cutting. Reason: climb-cutting reduces the tearing action on the glass fibers. A water coolant will aid in giving a good machined finish too.

Round nose lathe tools also provide good finishes. The tool should have very little clearance. A single point tool tends to tear the material and also results in round corners rather than sharp corners. Surface speeds should be adjusted to give the desired finish and will be dependent on the hardness of the material and the type of cutting tool in use. The work should be fed continuously and steadily, for if the too is stopped in the middle of a pass, the material will be noticeably marked.

When turning fiber glass on a lathe, set the cutter slightly above center to reduce tearing action on the fibers.

THREADING AND TAPPING

Threading of fiber glass reinforced material is not recommended as a means of mechanical fastening where high strength is required and should be avoided in the design of fabricated components whenever possible. This is because the threading operation cuts the continuity of the glass fibers and leaves only the shear strength of the resin component to provide the strength of the thread.

GRINDING

Centerless grinding of tubes and rod can be done satisfactorily if this specialized equipment is available. In ordinary grinding operations, the dust tends to load the stone and stop the grinding action. If grinding is required, use an open grit wheel and water as a coolant.

SANDING

Open grit sandpaper on a high-speed sanding wheel gives best results. Use very light pressure – do **not** force the sander against the fiber glass surface because heavy pressure may heat-up and soften the resin. Wet sandpaper applied by hand or with an orbital sander will produce a high gloss finish.

MECHANICAL FASTENING

Nailed Connections – Nailing is a satisfactory way of fastening fiber glass shapes to wood and to other materials that provide enough grip to hold the nail. Common nails can be driven through 1/32" thick fiber glass without predrilling holes – tempered nails will go through 5/16" thick material. Fiber glass heavier than 5/16" requires predrilled holes, slightly oversize, to admit the nail and to allow for expansion and contraction between the fiber glass and the material to which it is nailed. It is also advisable to pre-drill slightly oversized holes before nailing long lengths of lighter fiber glass sections. **Never nail fiber glass to fiber glass.**

Screwed Connections – Self-tapping screws have been used successfully in application involving mechanical connection where high strength fastenings are not required. A better use of self-tapping screws is in combination with adhesives. In this application the screws can serve to hold the adhesive bonded surfaces of the two parts together while the adhesive cures in addition to contributing limited mechanical strength to the connection. Appropriately sized pilot holes should be provided for the screws. In corrosive environments, stainless steel or monel screws should be used – unless a suitable coating of polyester or epoxy can be applied to the exposed screw heads to prevent discoloration of the area due to rusting.

Lag screws are not recommended because they do not take a good bite in the fiber glass.

Bolted Connections – A very satisfactory connection can be made with fiber glass components by using standard bolts, nuts and washers. Since fiber glass materials can fail under high localized stress conditions, such as those encountered around a bolt, the tighter the bolt is in the hole, the more effective it will be.

The strongest joint between pieces of fiber glass shapes is obtained by using a combination of properly fitted bolts with adhesives applied to the properly prepared mating surfaces.

Bolting intoTapped Holes – Mechanical fastening can be done by using bolts screwed into tapped holes. However, as stated earlier, the properties of tapped holes are not good and the connection will not be particularly strong. For removable cover plates, sheet metal screws can be used. Strength of the connection can be improved by use of threaded inserts bonded into place with suitable adhesives.

When removable bolts are required:Threaded metal inserts or fasteners should be installed in the fiber glass and preferable bonded in place with a suitable adhesive. Fiber glass threads will wear out quickly and may not give sufficient holding strength. Many types of metal inserts and fasteners are commercially available, for example: “Molly” nuts, “Tee” nuts, “Dzus” fasteners, “Rivnuts” and “Helicoils”. Some types need to be bonded in place, while others can be mechanically fastened.

Another way of installing removable bolts is by tapping the fiber glass, applying epoxy or polyester adhesive in the hole and inserting the bolt after covering the threads and shank with grease or some other releasing agent. The bolt can be withdrawn after the adhesive has formed and hardened around the treads. This method is **not** recommended when an exceptionally strong connectionism required.

When bolts are to be installed permanently: A tight connection is easily made by tapping the fiber glass and applying epoxy or polyester adhesive to the hole just before inserting the bolts.

Riveted Connections – "Pop" rivets are very effective in joining fiber glass sections. These rivets are available in various sizes and head styles in aluminum, steel, Monel, copper and stainless steel. Other types of rivets, such as Drive Rivets, those formed by a rivet gun or the conventional rivet formed with a ball peen hammer, can produce an effective mechanical connection. The strength of the connection can also be improved with suitable adhesives. Backup washers are recommended for distributing load stresses. As in drilling operations, it is necessary to use a slightly larger drill than the exact diameter of the rivet. For a 1/8" rivet, use a No. 30 drill rather than a 1/8" drill.

ADHESIVE FASTENING

Adhesives can provide strong and durable bonds. Satisfactory bonds will be obtained if the joint is designed to avoid excessive peeling stresses, if the mating surfaces are properly prepared and if the recommended types of adhesives are used. Epoxy adhesives are preferred.

Design

Joints between two structural members may be designed to carry loads by stressing the joint in pure compression or tension, in compressive or tensile shear, in peel or in some combination thereof. In pure compression or tension the joint is subjected to stresses only at right angles to the plane of the joint. Adhesive joints are strongest under these circumstances. In compressive or tensile shear the joint is subjected to stresses in a direction that is parallel to the plane of the joint. Adhesive joints are not quite as strong under these shear stresses but are quite adequate for most structural requirements. In peel the joint is subjected to stresses at some angle that is intermediate between the two cases mentioned above which results in a prying or peeling effect at one edge of the joint. Adhesive joints are weakest in peel and this type of stress should be avoided wherever possible. If peel stresses cannot be avoided, the adhesive joint should be supplemented with a mechanical fastener.

Surface Preparation

Before fiberglass shapes can be bonded or glued, the surface must be properly prepared to insure proper adhesion.

Contaminated surfaces should be thoroughly cleansed by wiping with a clean rag dampened with a solvent such as acetone, toluol, or methyl alcohol. Wipe dry with clean cloth. Do not immerse or soak the part in these solvents.

Note: When using solvents it is essential that proper precautionary measures for handling such materials be observed.

Making the Adhesive Joint

1. Remove surface film left during manufacture by sanding both mating surfaces using 120 grit sandpaper. Sanding is adequate when surface gloss has been removed. On large surfaces, coarser grit sandpaper may be more practicable to use. Sandblasting can also be utilized for improved efficiency on large areas.
2. Remove any dust remaining on surface to be bonded from sanding operation by using an air blast or wiping with a clean dry rag. Avoid recontamination of the surface by handling.

Adhesives

Typical epoxy adhesives for bonding include the following:

FM 94K – a one part film type adhesive which cures at 250°F

Curing the Adhesive Joint

Freshley bonded joints should be held in position with clamps or weights until the adhesive cures. Joints bonded with epoxy adhesives generally can be handled with reasonable care after 8 hours. It is desirable to leave the clamps or maintain the bonding pressure on the joints over night or for a total of 20 to 40 hours. If an oven is available, the curing time can be lessened considerably by heating moderately. The structure should not be expected to carry its design load until the adhesive joints have cured a minimum of 48 hours at 70°F. Lower temperatures will require longer.

Product Information Source:
Safety Data Sheet or address below.