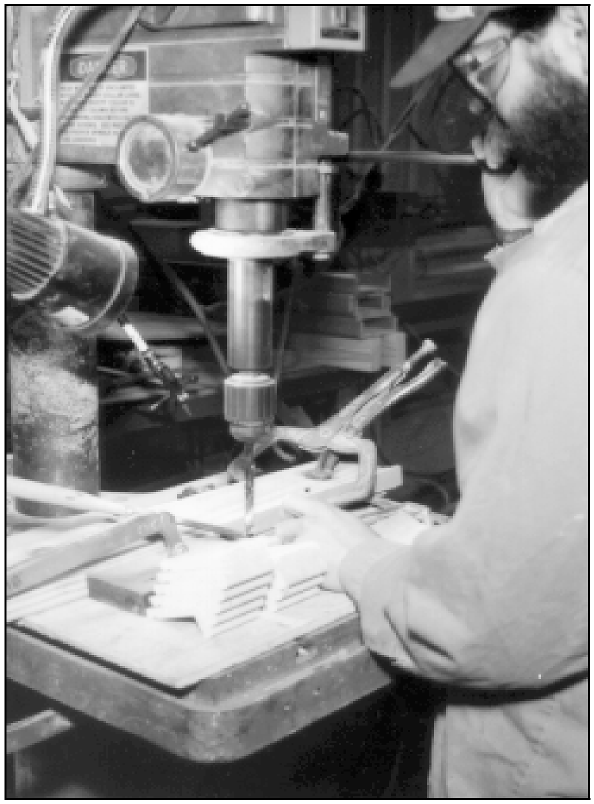
Chapter 9 Fabrication Techniques



Many profiles are pre-fabricated, making on-site installation easy.

Almost all fabricating methods currently used for wood, aluminum, steel or other materials are available for fabrication of fiber reinforced polymer pultrusions.

To fabricate Pultex® Profiles with complete success, the following techniques should be followed:

- Punches work better with a **slight shear edge**.
- Router bits should be **diamond-coated**.
- Drilling speeds should take hole size and thickness into consideration.
- Cutting speeds should be **moderately fast (3,450 rpm)**.
- Solvents, such as methylene chloride or acetone, should be used to prepare surface for bonding or coating.
- Lag screws are **not recommended** for fastening FRP to metal.
- Counter support **is necessary** when drilling hollow profiles.
- A **medium coarse** grinding wheel is preferable to the finer grades.

Each operation requires some change in technique or some modifications of equipment.

When fabricating, the most important characteristics of pultrusion are: it is a fibrous material with a grain (very much like wood); it is quite abrasive; it will bend. Although working with a fiberglass profile is similar to working with wood, it is uniquely a pultrusion and has its own characteristics. Explaining the nature of pultrusion fabrication is the purpose of this section of the manual.

Fabrication Of Pultex® Structural Profiles

Before fabricating Pultex® Profiles, several characteristics of the product itself should be recognized. These considerations apply to every phase of each operation.

1. Fiberglass is extremely abrasive. Tools, such as saw blades, router bits or punches, will wear quickly. Production problems will occur unless this problem is anticipated.
    - Frequent tool sharpening is common.
    - Diamond-coated edges and blades are the best.
    - Some re-tooling is common for heavy production.
    - Maintaining an at-hand inventory of saw blades, punches and other cutting tools is recommended.
2. Fiberglass is dusty during fabrication.
    - Minor health problems, such as skin irritation, may be experienced by some workers.
    - Wear dusk masks or respirators, long-sleeved shirts or coats.
    - Machines, such as saws, should have totally enclosed dustproof motors or better.
    - Machines, their supports and their general vicinities should be cleaned frequently. Dust and glass particles will build and become abrasive; and the machine will become damaged.
    - Vacuum hoses or vents should be placed near fabricating areas for dust collection.
3. Fiberglass, though strong, is also elastic. Pultex® is typically produced in 20-foot lengths. Because of its greater length, increase in elasticity, warpage or twist may be experienced.
    - Rigid support is needed for **all** fabrication procedures.
    - Clamps, tie-downs, and vices should be incorporated **before and after** a section is to be cut.
    - Process designers should individualize clamp and support systems for each profile for each fabrication procedure. What is typical for aluminum is not necessarily appropriate for pultruded profiles. Rigidity is mandatory.
4. Fiberglass will degrade if exposed to friction. Ragged edges and material splits could result.
    - Always use appropriate machine speeds in each operation.
    - The greater the thickness, the slower the cutting or drilling speed.
5. Exposed fibers will absorb more moisture or other contaminants than resin-coated fibers. When

fabricating, the surface coating of resin is broken and fibers are exposed; therefore, it is always a good practice to coat fabricated areas with resin to prevent attack from the elements, whether it be corrosive agents or simple weathering.

6. All fastening procedures should be carefully appraised. Prototype testing should be included in the decision process.

    - Experience has demonstrated that mechanical fasteners and a good adhesive bond are the best procedures.

    - Choosing the correct adhesive is mandatory; bonding surfaces should be carefully prepared.

    - Process engineering should know the final product application and environment when considering fastening systems.

    - Fiberglass is a composite in which many variables are operating, such as ultra-violet exposure, chemical and temperature factors, and mechanical requirements. All fastening systems should take these variables into account.

    - Never assume that what works with aluminum, bronze, or wood will suffice for FRP. Concurrently, never assume that it won't. It is best to check first.

7. Pultex® Profiles are composites that are engineered into laminate sections. **Do not** rigidly impose the fabrication requirements of homogenous materials, such as aluminum or cold rolled steel, on FRP, without first considering the composite characteristics of Pultex®.

    - Properly understood, FRP will fabricate as well as any other material.

    - Tolerances, punch clearances and hole sizing should be gauged to the fibrous characteristics of FRP.

Adhesives/Bonding

Consult Creative Pultrusions for adhesive recommendations for your needs. Adhesives are an integral factor in fastening Pultex® Profiles. As has been detailed, adhesives should be used in combination with other fastening devices whenever possible.

Thousands of formula for adhesives exist; the basic ones used with Pultex® are:

1. Epoxies
2. Acrylics
3. Polyesters

Advantages Of Adhesives

- Distribute stress more uniformly.

- Permit fabrication at a lower cost and weight for structures that are mechanically equivalent to or stronger than conventional assemblies.

Advantages of Adhesives (cont'd)

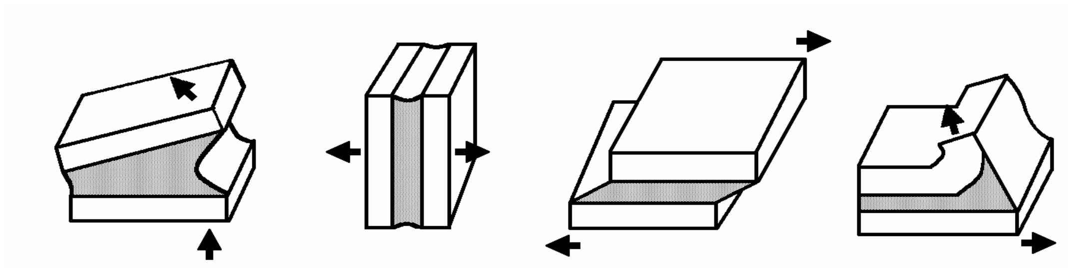
- Bond thin sections to thick sections; thus, make use of the full strength of each section.
- Produce smooth surfaces.
- Eliminate defacing of exposed surfaces.
- Reduce weight.
- Join dissimilar materials.
- Accommodate differences in thermal expansion.
- Permit profile movement with flexible adhesives.
- Seal surfaces and joints.
- Accommodate thin or fragile profiles.

Bonded Shear Joint Concepts

The behavior of bonded joints is further challenged by several significant variables which requires an understanding of the mechanics of configuration necessary for efficient and successful design.

Four basic stresses are associated with joint behavior: **tensile, shear, cleavage and peel**. **Cleavage and peel stresses** are both special cases of **tensile stresses** involving large stress gradients through the joint. Joints developing direct tension or shear stresses are stronger and more reliable than joints subjected to cleavage and peel stresses.

Joint Stresses



Cleavage **Tensile** **Shear** **Peel**

Symmetry of load transfer through a joint is to be held in highest esteem. (This axiom is also true for any material and connectors, such as bolts or welds.) **Non-symmetrical joints** induce couples, which must be resisted by cleavage or peel stresses.

With adhesive joints, flexibility of either the adhesive or the joined components is an advantage because it permits the connecting elements to rotate into alignment with the applied forces, thereby reducing the couple effect in the glue line. The geometric design of the joint can be used to improve strength and efficiency; for example, where a single lap joint is a very inefficient joint, it can be improved by using a low-modulus adhesive or beveling the joined elements to introduce some flexibility. The eccentricity of the joint may also be reduced by using a scarf type lap. (CAUTION: The desired stiffness of the joint must be observed if a joint is designed to maximize flexibility. Both cannot be achieved at the same time.)

The strength of a single lap (or any other nonsymmetrical joint) is not proportional to its size due to the stress concentration at the edges. The usual mechanism of failure in an adhesive joint is a crack propagation process initiating at points of high tensile stress; thus, failure is progressive and limited to a very small localized region at any given time, indicating that the overall size of the joint may be irrelevant to the total strength of the joint. Anything done to avoid the stress concentration will improve the integrity of the joint. The use of mechanical fasteners in cleavage stress regions, and void or crack-free glue lines, are methods in which joints can be strengthened.

Surface Preparations

The bond strength of an adhesive can be no better than the lap sheer strength of the interlaminate material itself; in other words, surface is bonded to surface, resin to resin. The fiberglass reinforcement has little to do with achieving the bond strength.

The major fact in bonding Pultex® Profiles is this: **because the profiles have been manufactured with a formulated mold-release, many adhesives will not react properly.**

Mold release agents rise to the surface of the profile during the manufacturing process. By removing this outer layer through proper surface preparation, the overly smooth surface can be abraded. Also, the majority of mold release agents will be removed. The procedures for surface preparation in painting can also apply.

Guidelines For Surface Preparations

1. Wipe contaminated surfaces with a solvent---styrene, toluene or methyl alcohol.
2. Wipe surface dry.
3. Remove surface film by sanding or light sand-blasting. Surface gloss should be removed.
4. Air blast the surface to remove any remaining dust. (Avoid recontamination by re-handling!)
5. Mix and apply adhesive 3 to 5 mils thick. Be certain that all surfaces and any glass fibers have been covered.
6. Clamp, screw and/or fasten the bonded surface.
7. Allow for proper cure time:
    - Ovens will shorten the cure time.
    - A minimum of 20 to 24 hours is an average length of time for many adhesives to bond.
    - A structure should not be exposed to its designed load limit until 48 hours have passed.
8. Always follow the adhesive manufacturer's recommendations.

Table 9-1 Adhesive Comparison Guide Used With Pultex® Standard Structural and Pultex® SuperStructural Profiles

Important Details	Epoxies	Acrylics
Product Advantages	Strongest average lap shear can be approximately 1200 psi Adheres to many surfaces	Lower cost Impurity tolerant
Substrates	Many use clean surfaces	Metals, glass, plastics, ceramics
Resistant to	Moisture, acids, bases, salts	Moisture, solvents, acids
Dispensing Methods	Meter mixing Hand mixing	Meter mixing Hand mixing
Strength	Strength to 6000 psi Average 1200 psi	Strength to 4000 psi Average 700 psi
Cure time	Varies	Varies
Formula available	Thousands	Many
Upper temperature range	Service Range -40°F and +160°F	250°F Maximum
Cost relative to other adhesives	Moderate	Moderate

Table 9-2 Comparison of Joining Techniques

	Mechanical Bonds	Adhesive Bonds
Seal (water tightness)	No	Yes
Thermal insulation	No	Yes
Electrical insulation	No	Yes
Stress concentration at joint	High	Medium
Strength/weight ratio	Low	Medium
Aesthetics (smooth joints)	Poor	Good
Fatigue endurance	Poor	Good
Inspection	Easy	Difficult
Skill required of fabricator	Low	High
Sensitivity to peel loading	No	Yes
Time to develop strength	Immediate	Varies
Disassembly	Possible	Impossible

Cutting/Sawing

The most common cuts are: (1) straight lines, (2) 20°-80° angles, (3) ripping, and (4) concentric cuts. Different saws are not required for cutting profiles of different resin systems; however, adequate support is necessary for **all** cutting procedures. Clamps are the preferred method for the hold-down function. These clamps can be either air cylinder hold-downs or the wide range of welding clamps such as the De-Sta-Co type. Precise cuts can be made if the profile is fastened on each side of the cut-line. Because dust will obscure the cutting marks and the heat of the saw may burn the material, it is advisable to use water-cooled blades for heavy production cutting. Parameter for cutting: Anything can be cut; thickness is not an issue, shape is.

Table 9-3 Machining Operations

Type of Saw	Application	Comments
Circular Power Saw	Straight cuts and ripping	a) The hand model is good for on-site fabrication with small to moderate numbers of cuts. b) The table saw is a better model for accuracy and support use, and is recommended for volume slitting or cutting when equipped with the proper blade.
Radial Arm Saw	Straight cuts and ripping	a) Good for large or thick sections. Water-cooled for large production. Blade sizes can be varied.
Saber Saw/Band Saw	Curved cuts	a) Adequate for very small quantities. Diamond-coated blades will increase production.
Hand Router	Curved cuts	a) Better for large production. Often the slot cut by the router bit will be wider or deeper than needed. It is a good practice to try the bit before designing fixtures; however, if properly done, this will yield precise results.
Radial Arm Saw with Swivel Head	20°-80° angle cuts	a) Can be used for mitering; 3,450 rpm recommended.
Hack Saw	Cutting rod stock	a) Hand variety good for limited cuts ---.94 – 1.25 teeth per mm. Power hack saw is better for large production. Tungsten carbide or diamond abrasive blades recommended. Keep plenty on hand as breakage is a problem.

Cutting Procedures

1. Blades should always be diamond or carbide-coated for large production; diamond blades should be 30 to 40 mesh.

2. Tolerances should be no less than ± 1/16 inches for large productions.

3. Very often another more precise cutting is needed as a secondary procedure.

4. Precision cuts are also made with a (diamond-tipped) jig saw.

5. When mitering an end-cut, permit 1/2 to 1 inch waste area.

6. Infrequent circular cuts could use a metal cutting blade, although it will be dull after one cut.

7. Carbide-coated masonry blades are recommended for on-site fabrication.

8. For large section cuts, use the following:
   a) begin with a power band saw for multiple cuts
   b) use a circular saw and then invert material to finish the cuts

Operating Tips

1. When the edges begin to fray, reduce the saw speed.

2. If pultruded profiles are covered with nico or veil material, cut the visible side face-up.

Operating Tips (cont'd)

3. **Use a light, even touch!**

4. The thicker the profile, the slower the cut. Time must be taken and a saw with adequate horsepower used.

5. **Excessively high speed** will make the edges ragged and the diamonds will peel off the saw blade.

Design Note

For hollow sections with thin walls (.080 inches and under), counter supports may have to be designed to fit into the cavity. Or, you may need to purposely schedule a second-cut procedure. Unique custom profiles often require unique cut-off operations and equipment.

Drilling

Drilling Pultex® Profiles is an easy, routine operation. Re-design of equipment is generally unnecessary. Standard twist drills are more than adequate for low production, but cobalt-bits are best for high production. Carbide-tipped bits are **not** required.

Parameters for Drilling

Drilling of Pultex® Profiles is standard for sections with thicknesses of .187 inches or thicker.

Holes drilled in Pultex® Profiles are generally undersized by .002 inches to .005 inches. A 1/8-inch drill bit will not make a hole large enough for a 1/8-inch rivet. A No. 30 bit is **necessary**. Oversize the drill bit in order to compensate for any shrinkage variation in fastener dimensions.

1. Drill Pultex® Profiles as you would drill hard wood.

2. Feed drills slowly, even with higher speeds.

3. For profiles with surfacing veils, drill from the visible side to the non-visible side.

4. Off-centering can be a problem in mass production; use bushings for this procedure.

5. For riveting holes, use supplier's recommended clearance.

6. For larger holes, a back-up plate of wood or receiving bushing will prohibit fracturing or "breakouts" on the backside of the material.

Design Note

For round, hollow profiles and custom, hollow profiles, use sturdy counter-supports from within the hollow sections.

Grinding

Grinding of Pultex® Profiles is not generally recommended; however, it is necessary for the following operations:

1. Notching

2. Recessing an internal wall in order to accommodate a flush fitting with another surface

3. Mounting secondary accessories or parts

4. Correcting inaccuracies in primary or secondary cuts (fragments, splinters)

5. Touching up edges

Parameters for Grinding

Grinding may be used for any thickness; results may vary.

Grinding Equipment

- Use any standard grinder. Air-powered equipment is preferred.

- Use carbide grinding wheels---especially for medium and coarse grit surfaces. (Fine surfaces will quickly clog.)

- Provide constant attention to the wheel surface. Grinding wheels need to be "dressed" or cleaned regularly.

- Operate at fairly high speeds. (1500 rpm plus)

- Centerless grinding for tubes and rods is very accurate.

- Use light pressure.

Turning

Pultex® Profiles can be “turned” with standard metal working equipment on either a limited or a large-production basis.

Parameters For Turning

Dimensional tolerance for turning Pultex® Profiles should be equated with cold rolled steel tolerances. Operation feed and speed limits should be geared as if for brass or aluminum.

Equipment

- For short production, steel tool cutters, with a single or multiple point, are satisfactory.

- For large or multiple production, carbide tool bits are a necessity.

- Round-nose lathe tools are best for good finishes.

Turning (cont'd)

- Use water coolants.
- Use climb cutting, not under cutting.
- For round-nose lathe tools, observe these pointers:
- The tool should display tight tolerance.
- Single points may tear the material, with sharp corners being rounded instead.
- The surface speeds must be regulated according to the desired finish.
- The speed must be geared to the hardness of the material and the type of cutting.
- The material should be fed continuously and steadily.
- Stopping and starting will noticeably mark the fiberglass.
- The cutters should be set slightly above the center of the material when lathing.

Design Note

Fiberglass is a composite material; turning it should be executed only after ample experimentation. Get to know the tolerances and the degree of hardness of each profile. Gauge the turning procedures to a medium range derived from that experiment.

Routing

A router can cut a straight line or any angle. With a special bit, routers can be used for cutting radii, keyways and milling profiles. The router cuts tend to be smooth and even which makes this an excellent choice. Frayed edges may then be avoided.

Thickness

Routing is done on parts that are 1/8 to 1/2 inches thick.

Equipment

Two types of routing machines are used:

- A hand-held air-powered model of 0 - 4,500 rpms
- A medium-sized table model of 4500 - 10,000 rpms

Tungsten-carbide coated rotary file bits are adequate for moderate production; however, the self-cleaning diamond-tipped, channeled or fluted bits serve even better for a routing operation.

Routing (cont'd)

Procedures

1. A coarser bit (36 mesh) will generally cut faster. Routing greatly improves when performed at a higher speed; however, with a 1/2-inch-thick profile, the pultrusion material will cause a great deal of friction. Caution should be exercised to avoid over-heating.

2. Use very light pressure when making router cuts. Forcing the bit could damage the material.

Design Note

A wide variety of router bits is available. As pultrusion gains the design flexibility of aluminum extrusions, routing will take on great significance. The versatility of the process adapts quite well to profile customization.

Punching

Fiberglass punches better than metal because it will spring back rather than bend. The amount of tonnage for punching is also somewhat less than aluminum, especially on a thinner profile.

Punching is one of the most common fabrication methods. It is very important for a number of secondary processes, such as fastening. If the inherent qualities of fiberglass are taken into account, punching can be effortless. If not taken into account, problems may arise.

It is also important to note that many basic rules applicable to metal are **not applied** when punching Pultex® Profiles. Some differences to keep in mind are:

- The clearances between the punch and the die are not as generous with pultrusion.
- Hole sizing in pultrusion is typically "oversized" by as much as .002 to .030 inches.
- The standard 15% rule regarding die clearance and material thickness of metal **does not apply** to fiberglass.
- Standard metal punching equipment is **often** inadequate for pultrusion punching. The equipment must be realigned and/or fitted.

Procedure

1. The abrasiveness of pultrusion must be compensated for in the method of punching:
   - The punches need to be sharpened often.
   - The dies will need to be replaced or sharpened.
   - The overall tooling life may be shorter than the equivalent for metal punching.
   - It is common for punched holes to be drilled again in a secondary procedure when dictated by tight tolerances.

Punching (cont'd)

2. The fiberglass material will make dust and chips.

    - A clearance of .001 inches is not adequate. Dust will clog the female die almost instantly; thus, a punch would quickly be off-center.

    - The minimum clearance should always begin at .005 inches. For high-production lines or thicker sections of 3/16 inch or more, there is often a clearance of .010 to .020 inches.

3. All plastics are **not** the same.

    - Extremely close tolerances can be maintained for some thermoplastics.

    - Polyester, vinyl ester and epoxy thermosets are **not** as predictably tight; tolerances often have to be generous.

    - Mat-reinforced pultrusion (thermoset) **can** be punched to closer tolerances than those containing high roving.

4. Reinforced fiberglass is resilient.

    - The hold-down systems should be designed very carefully to compensate for this resiliency.

    - Strippers are mandatory.

    - Lubrication will gather the fiber and dust particles, thus quickly jamming the punch. A clean machine and work area at all times should eliminate this problem.

5. Pultex® Profiles can deviate from specified tolerances regarding thickness, warpage, twist and straightness. Though the deviation may not extend beyond acceptable limits, punching accuracy and alignment may be affected.

    - System designers must take into account the degree of variance from specified tolerances.

    - System flexibility should be designed into the punching system.

    - Due to the flexibility of a pultruded profile, proper clamp-down systems can alleviate most of the problems associated with profile deviations.

Press Tonnage Requirements

Test results illustrate the shear strength values for Pultex® Profiles.

The samples below were taken from one production run. The sample dimensions were circular coupons.

Thickness	=	0.130 inches
Circumference	=	3.132 inches

Results

Sample #1 Break	=	7,400 lbs.
	=	18,175 psi
Sample #2 Break	=	6,800 lbs.
	=	16,701 psi
Sample #3 Break	=	7,200 lbs.
	=	17,683 psi

- The average shear value for Pultex® Profiles is 17,520 psi. Converted to pounds, the total is7,133 lbs.
- The press tonnage required to punch fiberglass: .130 inches thick = 3.56 tons.
- Punching a 15/16-inch diameter hole in 10-gauge half-hard 1/4-inch thick aluminum requires 3.80 tons.

To determine the press tonnage values to punch Pultex® Profiles, follow this procedure:

Multiply the profile material thickness by the hole circumference to be punched by the shear value.

Example: a 13/16-inch hole in a pultruded profile .077 inches thick is .077 inches (thickness) x 2.553 inches (circumference) x 17,000 psi (punch shear) = 3,342 lbs. pressure.

If 15 holes were going to be simultaneously punched, the number of holes would be multiplied by 3,342 pounds. In the above example, 50,130 pounds, or 25 tons of pressure, would be necessary for the multiple punch machine.

Always use the 17,520 psi (120.8 MPa) shear value in the calculation.

Equipment

The following punching equipment is used routinely at Creative Pultrusions:

Equipment	**Application**
(1) 3 Ton Press	1 to 6,000 pounds
(1) 5 1/2 Ton Press	Punching profiles of 1/8-inch thickness or smaller profiles from 1/8-3/16 inch thickness
(1) 13 Ton Brake Press	Punching profiles from 3/16 - 1/2 inch thickness

Design Note

Most fabrication shops are already equipped to punch aluminum sheet metal and cold rolled steel. Their machinery can be used for punching Pultex® Profiles, if the punches are appropriate for fiberglass. Hold-down and support equipment should be evaluated for appropriateness, i.e., extra support.

Shear Angle in Punching

Rule: Optimum benefits for punching will be achieved when the punch is specially designed. **Only a small portion of the cutting edge should penetrate the material at any given time.**

During the punching cycle, the goal is to subject the minimum amount of fiberglass to the smallest fraction of cutting edge **on an even basis**. The punch should function as much like a scissor edge as possible.

To design shear angle into a punch, the following criteria can be observed:

- Shear strength of material
- Thickness
- Degree of resiliency
- Production needs
- Amount of hole clearance for fasteners
- Type of fasteners (if any)

Round, flat-headed punches **without shear edges** are routinely used in punching small round holes on an industry-wide basis with success.

Shear angle should be incorporated, if optimum benefits are desired. A shear angle that is equal to the material thickness will reduce the required tonnage by **one-third**.

Providing a **slighter** shear angle is the most effective method. Shear angles are used, not only to reduce tonnage, but to obtain a cleaner punch hole.

Doubling the shear angle to twice the material thickness of the profile is the recommended maximum angle. Shear angle should not exceed that limit.


Routing is one of many techniques used in fabrication.

Other Useful Guidelines for Punching

1. Some useful parameters are:

   - Oversize all holes by .020 to .030 inches.
   - The punched holes will range from .010 to .020 inches **smaller** than the punching die.
   - The larger the hole, the "cleaner" the punch.
   - Material thickness to be punched will range from .070 to .187 inches.

2. For **riveting**, punched holes occasionally have to be redrilled especially in parts with thickness of 1/8 inch or thicker.

3. Material Differences:

   - Mat-reinforced materials can be punched with exactness, especially when bushings are used.
   - Profiles with surfacing veils are punched from the non-visible to visible side.

4. A laminate .070 inches thick by 43 feet long, with a hole punched every 2 inches, has been punched successfully.

5. For materials 3/16-inch thick, rivet holes can be placed every 6-8 inches; for bolting, the holes should be 8-12 inches (203.2 mm – 304.8 mm).

6. The depth of a punch should be twice the thickness of the laminate.

7. When punching hollow profiles, use strong counter supports, such as mandrels or bottom carriage rests.

Shearing

Similar to punching, shearing is possible with Pultex® Profiles. Profiles of 3/16-inch or thinner have been sheared successfully in production.

Shearing is very useful for large production, particularly in very thin laminates (.070 to .090 inches). Thicker profiles (.125 to .187 inches) can be sheared on flat sections, but shearing of profiles with multiple contours are best cut with a saw.

The rules for punching also apply to shearing, especially those rules referring to angles.

All shearing should be done perpendicular to any continuous fibers in the laminate.

Shearing should be perpendicular to the longitudinal reinforcements. Cuts must be clean.

Consideration of the shear angle should be of primary importance before specifying this procedure. Small profiles with a thickness not exceeding 3/16 inches can be sheared if the punch and profile are designed together.

Painting

For most applications, internal coloration and a variety of surface treatments eliminate the need for secondary coating operations. Situations exist, however, when paints are used to improve the weathering properties or the appearance of a pultruded profile.

For improved weathering, urethane coatings are recommended as they have superior ultraviolet resistance and adhere well to the pultruded substrate. Urethane-coated Pultex® Profiles have been exposed to advanced weathering, equivalent to 30 years of exposure, with no loss in insulation properties and only a slight loss in mechanical properties. Non-skid coatings are available for slip resistant surfaces. These coatings are available from several suppliers and in a wide range of colors.

Surface Preparation

Due to the fact that the pultrusion process requires internal mold releases, it is essential that, prior to any painting or coating, the surface be properly prepared. The mold releases are a form of wax that creates a film on the surface of the profile to be removed. It can be accomplished with several methods:

- Solvent-wiping is the simplest method of surface preparation. Several solvents will attack the mold release films. Some of these are toluene, xylene, acetone, or styrene.

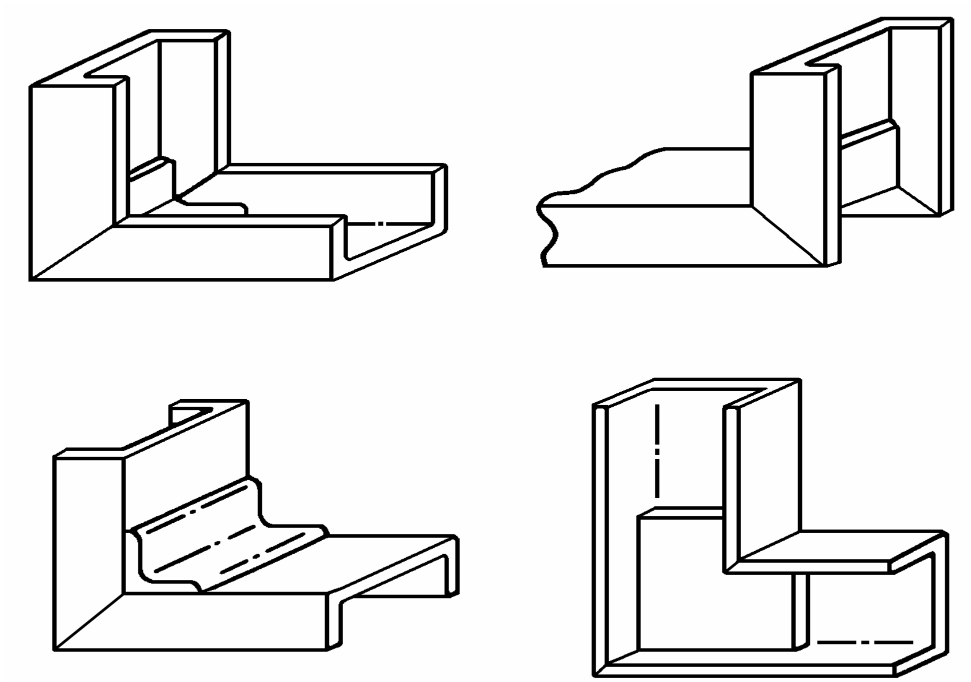
- Sanding will also adequately prepare the surface; however, when you break the surface at times, you will expose minor imperfections that become quite visible when paint is applied. A sand and fill primer can be applied to help this situation.

Sand-blasting can be used as a surface preparation technique, but exhibits the same problems as sanding.

It is best to follow the paint manufacturer's recommendations for the application of any type of coating.

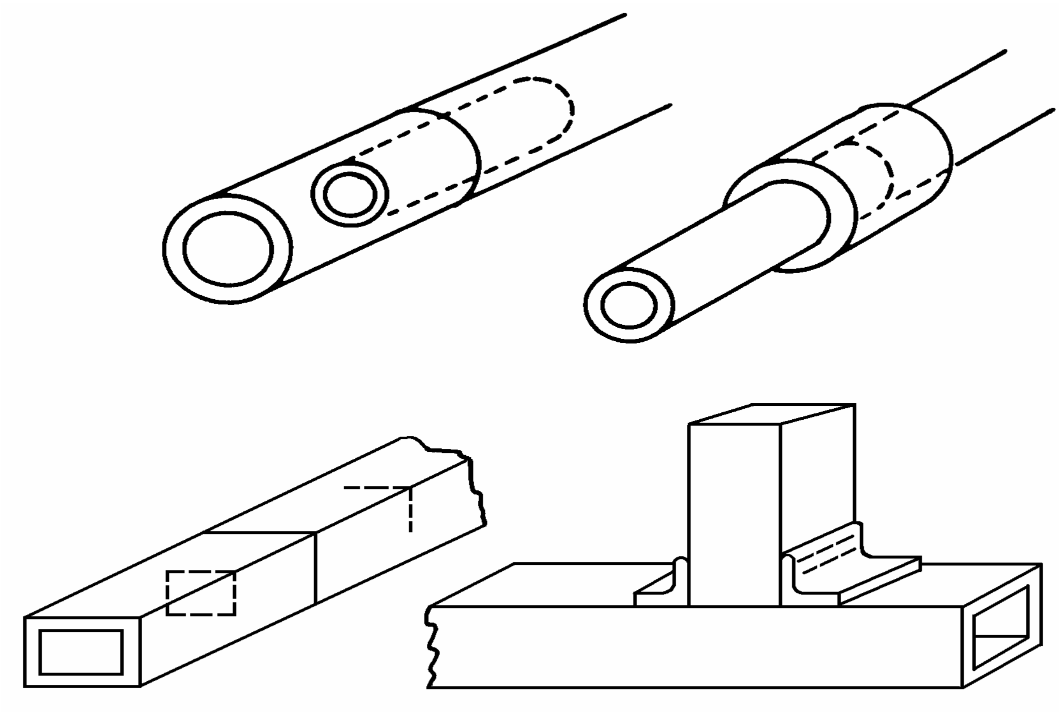
Joining Pultex® Structural Profiles

Channel Joints

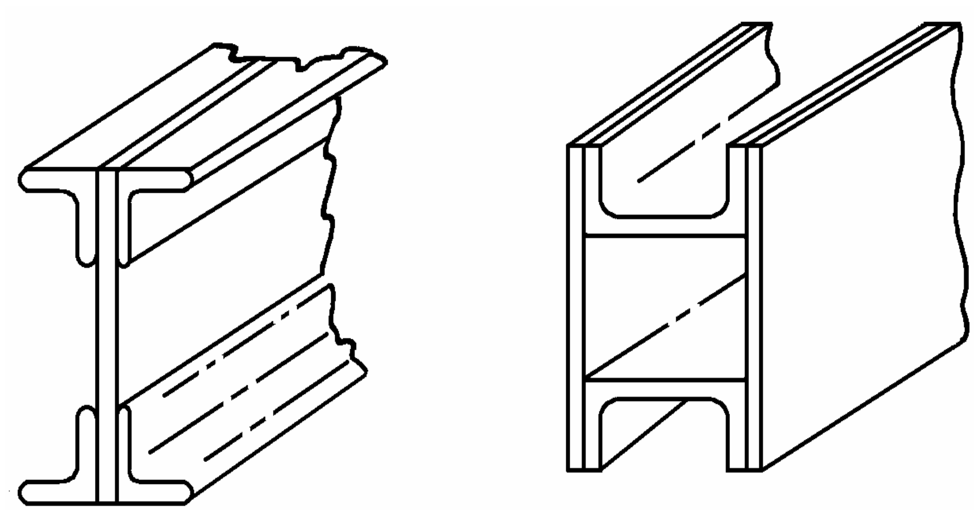


Joining Pultex® Structural Profiles (cont'd)

Tube Joints

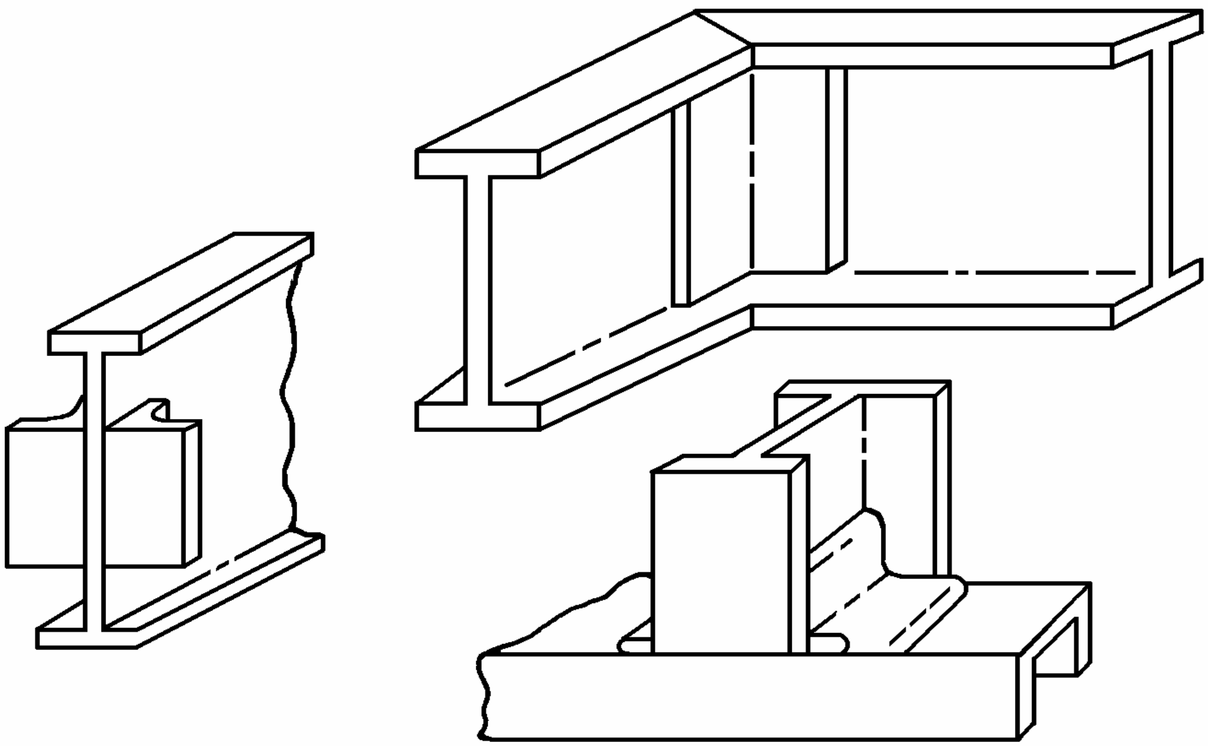


Fabricated Beams

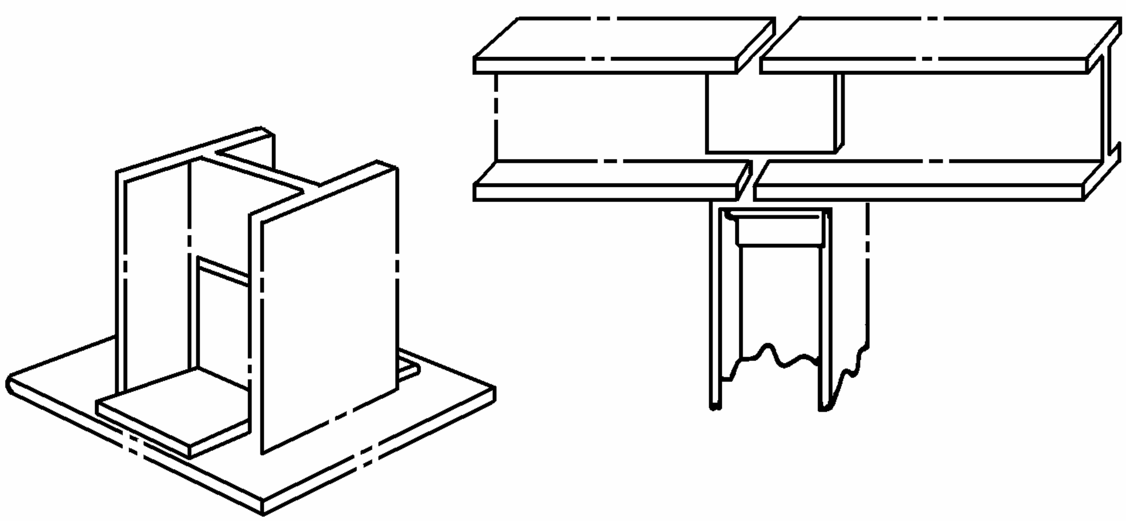


Joining Pultex® Structural Profiles (cont'd)

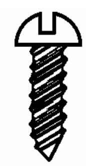
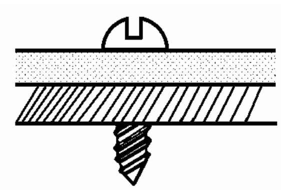
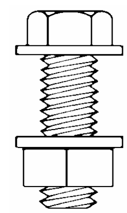
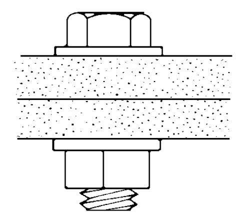
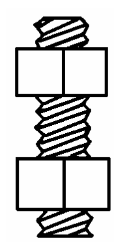
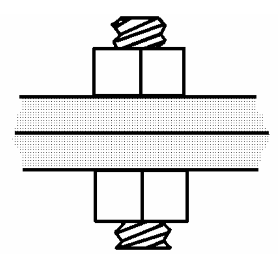
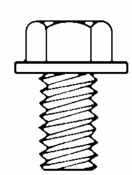
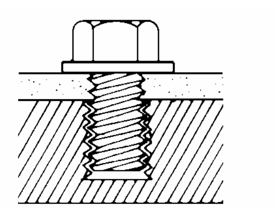
I-Beam Joints



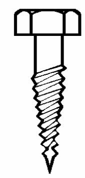
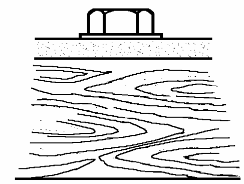
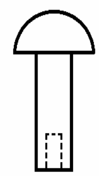
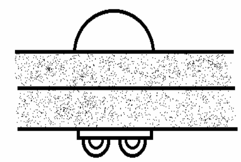
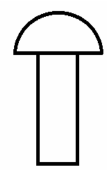
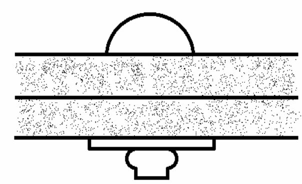
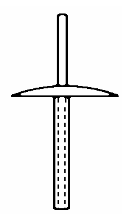
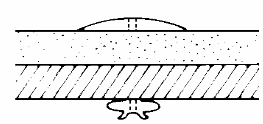
Platform Supports



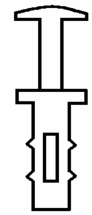
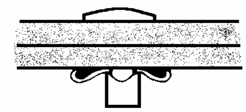
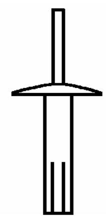
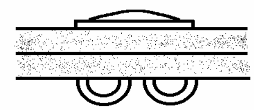
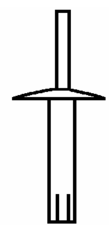
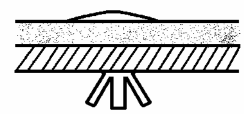
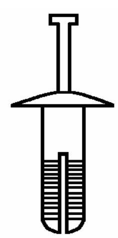
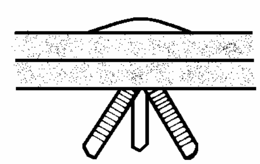
Mechanical Fastenings

Application	Fastener	Engaged
SCREW Used for fastening Pultex® profiles to metal. Use metal as backup to fiberglass.		
BOLT AND NUT Used for fastening profiles together. Best to use washers to distribute load whenever possible. Steel, galvanized, silicon, bronze, nylon, polyester and other materials available for a wide range of applications. Check with your supplier.		
SUPERSTUD!™/NUTS! Threaded fiberglass rods with molded fiberglass nuts. Good for highly corrosion applications. Good shear values.		
BOLTS AND THREADED HOLE Possible assembly technique; however, special construction of Pultex® Profile required. Fiberglass nuts above are made by this technique. Epoxies or other adhesives greatly improve joint strength.		

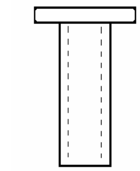
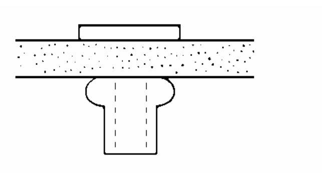
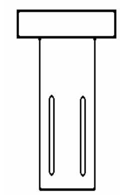
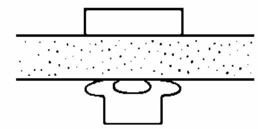
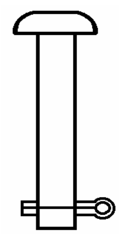
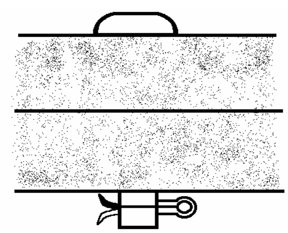
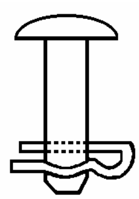
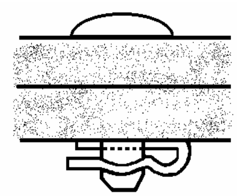
Mechanical Fastenings (cont'd)

Application	Fastener	Engaged
LAG SCREW Can be used to attach profiles to wood. Washer should be used to distribute load. Not recommended for attaching fiberglass to fiberglass.		
TUBULAR RIVET Used in conjunction with washer or metal backup plate. Stronger than pop-rivets because of solid shank. Requires accessibility from both sides of profile.		
SOLID RIVET Use with backup plate or washer. Must have accessibility to both sides of profile.		
BLIND RIVET Pull-up mandrel. Special tool required. Assembly from one side only. Good for fiberglass to metal or with washer backup. Steel or aluminum.		

Mechanical Fastenings (cont'd)

Application	Fastener	Engaged
NYLON RIVET Crimp type rivet. Requires special tool for installation. Good for insulating in mildly corrosive environment.		
T-RIVET (Aluminum) Good for metal to fiberglass or fiberglass to fiberglass with backup plate. Wide expansion provides good load distribution and prevents tear.		
DRIVE RIVET (Aluminum) Good for fiberglass to metal. Can be installed with hammer. Can also be removed from one side by driving out mandrel.		
DRIVE RIVET (Nylon) Installed with hammer. Same as above. Lower shear value than metal. Center core stays in place.		

Mechanical Fastenings (cont'd)

Application	Fastener	Engaged
BLIND THREAD INSERTS Applies metal threads to profile. Good for products for which disassembly is required. Hexagon shape available to prevent twist. Special tool required.		
BLIND THREAD INSERTS Better torque and shear strength. Loads are more evenly spread on back surface.		
CLEVIS AND PIN (Metal) Can be used for some installations. Not normally a very tight fit.		
CLEVIS AND PIN (Nylon) Used in some installations. Electrical insulating properties.		

Notes