



# FABRICATION & INSTALLATION MANUAL



# INTRODUCTION

PROForms® and PROPlate® Structural Shapes, PROGrid® Molded Grating and PROGrate® Pultruded Grating are designed to provide superior mechanical properties and corrosion resistance.

This manual presents some of the fabrication techniques that are used when working with fiberglass reinforced polymer (FRP). The content of this manual is general in nature, but should provide you with a variety of useful information. Almost all fabrication methods currently used for wood, aluminum and steel are available for the fabrication of our FRP building materials.

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# FABRICATION & INSTALLATION



### **SUGGESTED HAND TOOLS**

Bedford recommends having the following tools on hand when doing light fabrication:

**DRILL / CIRCULAR SAW / JIG SAW / RECIPROCATING SAW / HAND GRINDER**

### **RECOMMENDED FABRICATION PRACTICES**

1. Always follow common safety practices. Eye protection is a must.
2. FRP is dusty during fabrication. Wear a dust mask or a respirator and a long-sleeve shirt or coat.
3. FRP is extremely abrasive. Tools will wear rapidly, and frequent tool sharpening is common.
4. Diamond-coated router bits and saw blades are best for this application.
5. Always use appropriate machine speeds for each operation. The greater the thickness, the slower the cutting or drilling speed.
6. Avoid excessive pressure when sawing, drilling, routing, etc. Using too much force can rapidly dull the tool.
7. For adhesive fastening, prepare the surface properly for bonding.
8. Machines should be cleaned frequently. Dust and glass particles will build and become abrasive.
9. Mechanical fasteners and a good adhesive bond will provide the strongest connections.

## MACHINING OPERATIONS

### Cutting or Sawing

When performing any cutting operation, use light, evenly applied pressure. Excessive pressure tends to clog the blade with dust particles, and this will shorten the life of the blade. Cutting speed is very important. Cutting too fast will fray the edge of the material and may cause it to turn black.

You will need to provide adequate support to keep the material from shifting as you make the cut. If the material is not supported properly, chipping will occur. A common masonry blade will work for small jobs.

### Straight Cuts and Ripping

For small-volume work, a hand-held circular saw is good for on-site fabrication. A table saw is recommended for volume ripping and will provide a more accurate cut when equipped with the proper blade. A diamond-coated blade will produce the best results and helps ensure longer blade life. A radial-arm saw is good for large or thick sections.



### Circular or Curved Cuts

Good results can be obtained using a saber saw or a band saw for small-volume cutting. Diamond-coated blades will increase production and lengthen the life of the blade. A hand router can also be used to cut curves and circles. When properly done, this method can produce excellent results, but it will remove considerably more stock. Carbide grit saw blades are recommended for jig saws or reciprocating saws.

### Cutting Bar Stock or Rod

A hand-variety hacksaw is good for doing a limited number of cuts. A blade with 24 to 32 teeth per inch is effective, and light strokes should be used. A power hacksaw is better for cutting large quantities. Diamond abrasive blades or tungsten carbide blades will provide the best results; however, a chop saw with a diamond abrasive blade will also produce good results.





### **Drilling**

Drilling FRP profiles is an easy, routine operation. Any standard high-speed steel drill bit can be used, but it will require frequent sharpening. Properly sharpened brad-point bits provide excellent results.

When drilling FRP, keep these tips in mind:

- The drill speed should be equivalent to those used for drilling hardwood.
- Carbide-tipped drills are recommended when drilling large quantities.
- Holes drilled in FRP are generally .002" under size.
- For large holes, a wood backup plate will reduce breakout on the back side of the hole.

### **Routing**

A CNC router is typically used in the fabrication shop to quickly perform highly repetitive standard routing operations. A typical CNC unit can be programmed electronically to produce exact repetitive routing operations. Most routing is done with diamond-coated bits.

Routers can be used to make straight cuts and angle cuts, as well as radius cuts. Both hand-held and table routers deliver excellent results, as router cuts tend to be smooth and even.

Rotary file bits (either tungsten-carbide or diamond-coated) perform best when routing large quantities. Wood bits can be used, but they will require frequent sharpening and will wear out quickly.

Light pressure should be used when making a cut. Forcing the bit causes the FRP to heat and soften, damaging the material. Forcing the cut can also damage the bit.



### Punching

FRP is an easy material to punch, depending on the thickness of the material. FRP will punch better than metal because it will spring back, whereas metal will bend. The tonnage required for punching FRP will vary depending on the material thickness, the size of the hole being punched, and the number of holes being punched at one time.

#### Procedure

It is important to note that dust will clog up the die almost instantly. To prevent this from happening, the clearance between the punch and the die – especially on thicker materials – will need to be between .010" and .020". It is normal for fibers to spring back after the hole is punched, and this will partially close the hole. For this reason, the hole sizing in FRP is typically oversized by as much as .020" to .030".

Due to the abrasiveness of FRP, the punching method must compensate for several things:

- The punches will need to be sharpened often.
  - The dies will need to be sharpened or replaced.
- The overall life of the tooling may be shorter than the equivalent for punching metal.
- It is common practice for punched holes in FRP to be drilled out in a secondary operation when tight tolerances are required.

#### All plastics are NOT the same!

- It is possible to maintain extremely tight tolerances for some thermoplastics.
- Vinyl ester, polyester and epoxy thermoplastics are not as predictably tight. Tolerances often have to be generous.
- Mat-reinforced FRP can be punched to tighter tolerances than those containing high roving.

#### FRP is resilient.

- The hold-down system will need to be designed to compensate for the resiliency of the material.
- Strippers may be required.
- Silicones or graphite are sometimes used to lubricate the punches. Lubrication will gather dust and fiber particles, and this will cause the punches to jam.



### Shearing

Shearing is possible, but is only recommended on material 3/16" or thinner. The shear blade should be designed so only a small portion of the cutting edge will penetrate the material at any one time. If a precise cut is needed, sawing the material will yield much better results than shearing can provide. All shearing should be done perpendicular to any continuous fibers.

### Grinding

Grinding — although not generally recommended — is necessary for some operations, such as notching and touching up edges. During grinding operations, the dust tends to load the stone and stop the grinding process. Grinding may be used on any thickness of material, but a medium or coarse carbide grinding wheel will yield the best results. Keep in mind that the grinding wheel will need to be cleaned regularly. Any standard grinder may be used, although air-powered equipment is preferred. Use light pressure when grinding to prevent burning the part.

### Sanding

Sanding works best when using an open-grit sandpaper (40 to 80 grit) on a high-speed sanding wheel. Do not force the sander; simply use light pressure against the FRP surface. Heavy pressure may heat up the FRP to the point where it may soften the resin. Air-powered equipment is readily available and provides good results.

### Turning

FRP can be turned using standard metal working equipment. Carbide tool bits work best for large production runs. Standard tool steel cutters can be used for small-run machining operations. Round-nose lathe tools work best for a good finish. Single-point tools may tear the material.

Dimensional tolerances should be comparable to cold-rolled steel tolerances. Feed and speed should compare to that used for aluminum or brass. Climb cutting will give the best-machined finish.

Undercutting increases the tearing action when machining FRP. Adjust the surface speed depending on the hardness of the material for the desired finish. A continuous, steady rate of feed will give the best results; stopping and starting will leave the material noticeably marked.

### Tapping and Threading

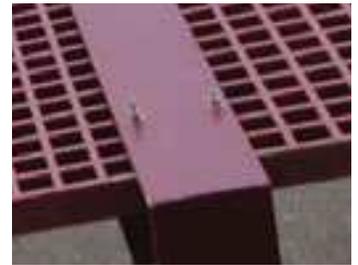
Threaded connections in FRP are satisfactory only when strength is not an important consideration. Threading is not recommended when high strength is required. An adhesive bond will greatly improve the strength of a threaded connection. Standard taps and dies can be used. When tapping blind holes, be sure to allow adequate clearance at the bottom of the hole to prevent the tap from bottoming out, as this will quickly damage the threads.



## MECHANICAL FASTENING

There are many ways to fasten FRP to FRP or FRP to other materials. Below are a few examples of the different methods that may be used.

- 1. Riveted Connections** – Rivets are available in many sizes, types and head styles. Options include nylon, aluminum, stainless steel, steel, copper, etc. The hole for the rivet must be drilled slightly larger than the rivet itself.
- 2. Screwed Connections** – Self-tapping screws work well in conjunction with adhesives. They will hold the material together until the adhesive has time to cure. Screws may be used alone, but will not provide a high-strength connection.
- 3. Bolt and Nut Connections** – This is a common method of connecting profiles. It is best to use flat washers on both sides of the bolted connection whenever possible, as this will help distribute the load. The strength of this connection will increase when an adhesive is applied to properly prepared mating surfaces. Threaded FRP rod and molded FRP nuts work well for corrosive applications.
- 4. Bolts and Threaded Holes** – FRP threads will wear quickly, so for best results, threaded metal inserts should be bonded in place.
- 5. Lag Screws** – These work well for fastening profiles to wood, but are not recommended when attaching FRP to FRP.



Adhesives can provide a very strong bond between two FRP shapes or between FRP shapes and many other structural materials. For best results, the mating surfaces must be properly prepared, and the recommended type of adhesive must be used. Adhesive should also be applied in a controlled environment, as air temperature and humidity can adversely affect the cure.



Many types of adhesive work well with FRP materials. When choosing an adhesive, consider the open time and the clamp or fixture time that will work best for your application. Bedford has experienced excellent results with epoxy, methacrylate and urethane adhesives. For additional information, contact Bedford. The Material Safety Data Sheets should always be followed when working with adhesives.



Proper preparation of the bonding surfaces is essential to ensure proper adhesion. Contaminated surfaces should be cleaned with a solvent, such as methyl alcohol, and wiped dry with a clean cloth prior to sanding. It is necessary to remove the surface veil by sanding the mating surfaces. An 80-grit sandpaper works well for this process. You will then need to remove any remaining dust from the surfaces to be bonded by wiping them with a clean, dry rag. Do not use a solvent-dampened rag, as this will contaminate your bonding surfaces and may cause your bond to fail.



Follow the manufacturer's recommendations when mixing the adhesive. When applying the adhesive, you will need to spread a thin film of adhesive to both surfaces that are to be joined. Make certain the entire surface that is to be bonded is covered with adhesive. It will then be necessary to hold the bonded joints in position until the adhesive has time to cure. The clamp time will vary with the type of adhesive being used. Always follow the manufacturer's recommendations.



Mechanical fasteners, such as self-tapping screws, rivets and/or bolts, can be used to maintain the bond pressure and hold freshly bonded joints in place when possible. In some instances, using mechanical fasteners may allow you to proceed with fabrication without waiting for the joint to cure. The use of clamps or weight alone will require you to allow time for the joint to cure before proceeding with fabrication or assembly.

## REPAIR PROCEDURE FOR MISLOCATED HOLES

One of the most common problems in fabrication is a hole in the wrong location. There are several reasons why this may occur, including an error on the print, a change in the design or shop errors. The following procedure will work well to repair the hole, as long as the new hole or holes do not intersect the plugged holes.

### Plugging Holes Using FRP Threaded Rod

1. Determine the smallest threaded rod size that will work to plug the hole and tap the hole for that size of threaded rod. In some cases, you may need to drill the mislocated hole larger for the tap to fit.
2. You will then need to apply adhesive to both the threaded rod and the tapped hole.
3. Screw the threaded rod into the hole and cut it off as close to the material as possible.
4. Grind any excess rod off flush to the part.
5. After the adhesive has cured, seal the area with resin



Working with Bedford PROGrate® and PROGrid® products is similar to working with wood, metals and plastics when it comes to tasks such as sawing, grinding, drilling and machining.

For maximum accuracy, we recommend on-site fabrication. Remember to allow for saw kerf (usually 3/16") on take-offs and layouts. To ensure the best appearance on your installation, cut panels to align with the bars on adjoining panels and leave a solid bar on all sides.

### Suggested Tools

- Power saw with a masonry or diamond blade
- Circular saw for straight cuts
- Jig saw for circular cuts
- Diamond grit blade for large fabrication jobs
- Sawhorses or platform support for cutting
- Tape measure
- Straightedge
- Chalk-line or felt-tip pen for marking cuts
- Sealing kit to seal cut edges



## FABRICATION PROCEDURES FOR GRATING

### Recommended Fabrication Practices

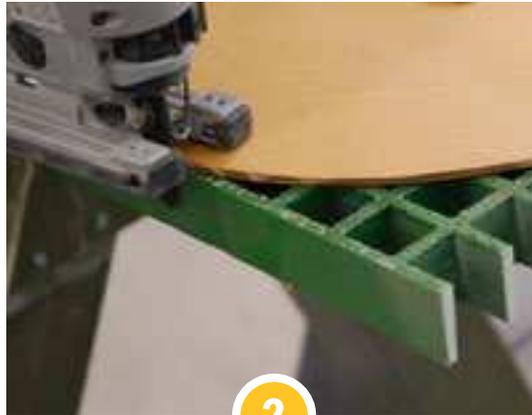
1. Allow a minimum of 1-1/2" of support around all edges.
2. Use the recommended hold-down clips (see illustration at the end of this section), with a minimum of four clips per panel spaced a maximum of every 48".
3. Be sure to support the panel securely to prevent flexing or shifting during cutting.
4. Mark cuts clearly and carefully. Avoid splitting 1/4" and 5/16" bars.
5. Cut from the smooth side (bottom) of a grit-top panel.
6. Use steady, even pressure when cutting. Excessive pressure may cause heat and/or ragged edges. Replace dull blades to prevent heat buildup.
7. Use a sealing kit to coat all cut or sanded surfaces to prevent corrosive chemicals from reaching exposed glass fibers. Carefully read and follow the instructions included with the sealing kit.

## FABRICATION STEPS



1

Marking



2

Cutting



3

Sealing

**PROGrid®/PROGrate® Fastening Methods**

**Support Around Cutout Areas**

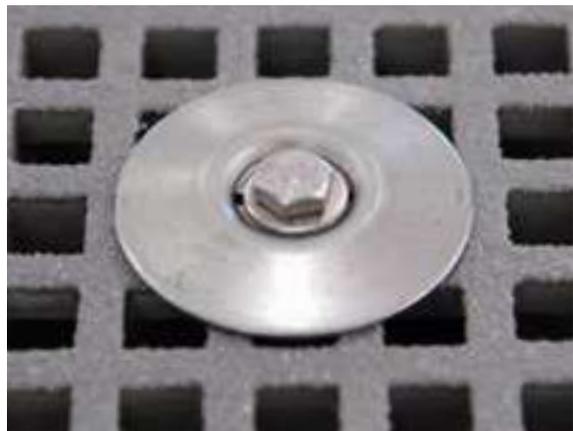
It may be necessary to add additional super-structural supports around the cleanout area to support grating bearing bar ends.

If it is not possible to add super-structural supports around the cutout area, the alternate method shown here is recommended. Position hold-downs on two uncut bearing bars beyond the cutout area. (The distance between hold-downs determines the required support bar length.)

Secure hold-downs to the support bar.



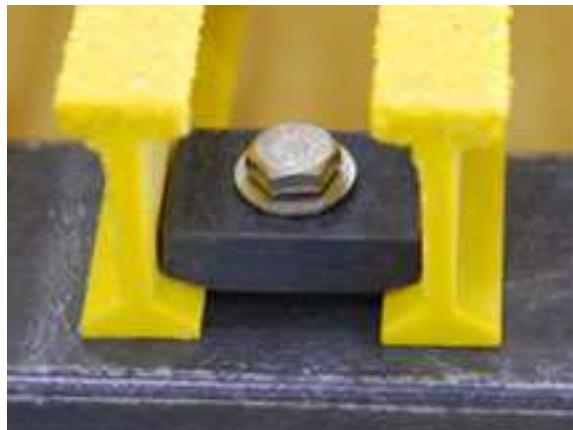
Saddle Clip



Washer



M Clip



T Clip



## EXPLORE OUR FULL LINE OF FRP SOLUTIONS

Bedford offers a wide variety of structural products made of fiberglass-reinforced polymer, including PROForms® shapes, PROGrid® molded grating and PROGrate® pultruded grating. Our staff of skilled engineering, design and manufacturing professionals is dedicated to helping our customers maximize the benefits of FRP.

### PRODUCTS

- Structural shapes
- Grating
- Decking
- Stairs and handrails
- Ladders and cages
- Fabricated structures

### SERVICES

- Engineering
- Design and drafting
- Fabrication, including CNC machining and assembly
- Secondary coating and painting
- In-house testing



When you receive a ready-to-ship date from Bedford, it's **GUARANTEED\***. If we miss the promised ship date, we pay significant penalties back to you. We also offer Express Response options with shorter, guaranteed lead times.

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