

# **Manufactured Custom Fiberglass Pultruded Products**



## History

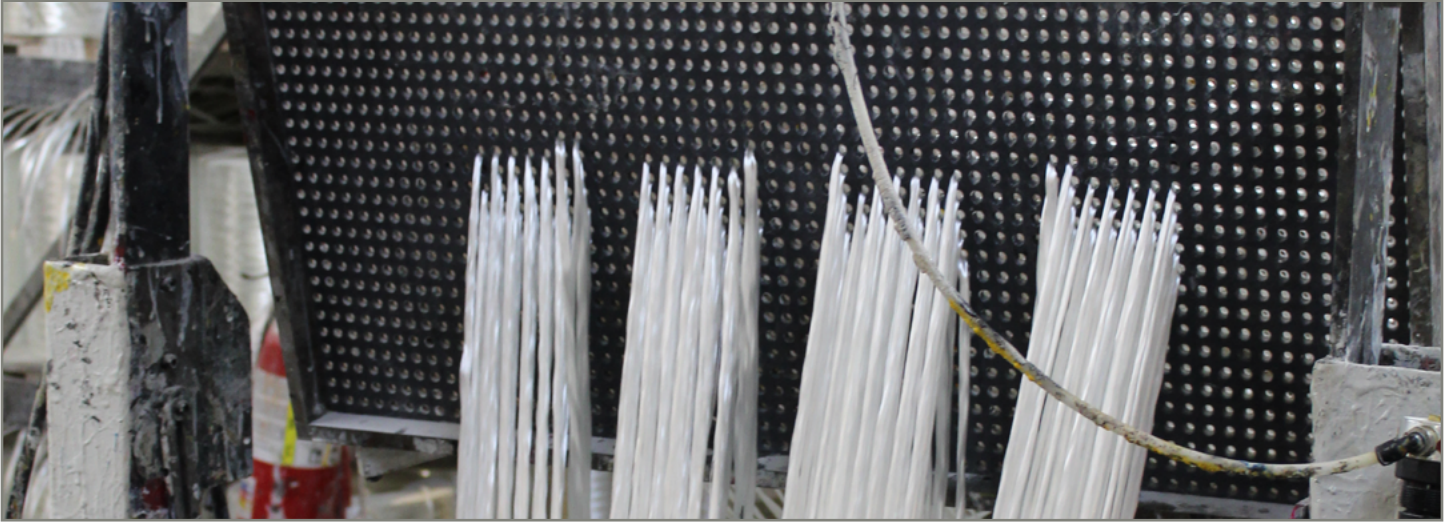
Tencom Limited was incorporated in 1997, beginning as a producer of CB antennas for the truck stop industry. In December 1999, Tencom purchased the assets of Solarcon, also a manufacturer of CB antennas, as well as a pultruder of rods and tubes.

In late 2001, Tencom redirected its strategy toward pultrusion while maintaining its position in the antenna market. At the same time, the company purchased the assets of a local pultruder, greatly expanding its customer base, equipment and total capacity for pultruded products.

During the following years, additional equipment has been added toward increasing the company's skills in pultrusion, extrusion and value-added services such as machining, drilling, chamfering, grinding and fabricating capabilities.

## Customer Centric

Everybody says so, yet in the end it's not what is said but how it is performed. Stated simply, Tencom has only one reason for being, which is "TO SERVE CUSTOMER NEEDS", The Right Product at the Right Time at the Right Price.



## Custom Fiberglass Pultrusion

At Tencom Limited, we are dedicated to custom fiberglass pultrusions, and offer the right product at the right time for the right price.

Our newly added, state-of-the-art equipment allows pultrusions of fiberglass composite material, with fiber types including E-glass, mat, carbon, and Kevlar. The polymers we work with include standard polyester, vinylester, epoxy, phenolic, and polyurethane.

Our pultrusions provide many benefits. They are lightweight and high strength, have superior dimensional stability, electrical and thermal insulation, corrosion resistance, and electromagnetic transparency, with consistent color throughout.

We offer custom fiberglass pultrusions up to 15" wide and up to 6" high, with tightness tolerances as high as  $\pm 0.005"$ . Our services can be performed in almost any profile, from solid to conductor rods, from tubes to oval solids, channels to tees, and any other custom profile imaginable.

We produce prototypes to large scale production runs. In addition to our specialization in fiberglass reinforced pultrusions, we offer quality drilling, grinding, sand blasting, and chamfering services.

Everything we do is completed with a customer-centric attitude, attention to industry and quality standards, and done by the "nicest in the country," a moniker we take pride in. To learn how Tencom's expertise and offerings can help you accomplish your goals, contact us.

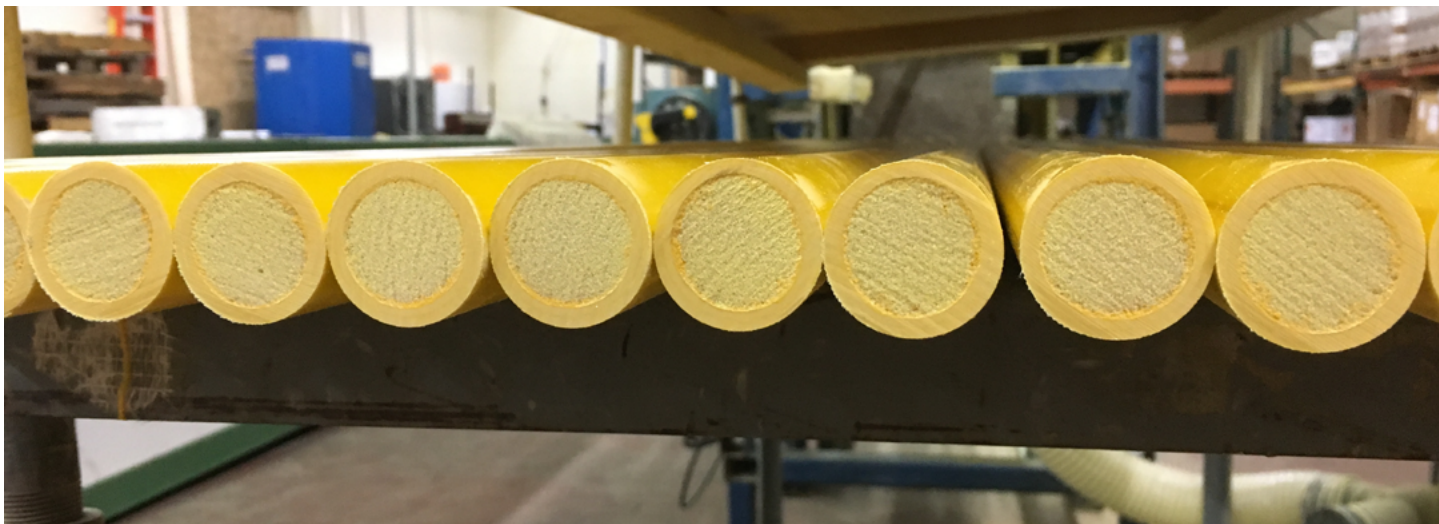
## Capabilities

|                                   |   |
|-----------------------------------|---|
| Fiberglass Reinforced Pultrusions | Custom Pultrusions  |
| Materials                         | Fiberglass Composite  |
| Fiber Type                        | E-Glass<br>E-Glass & Mat<br>Carbon<br>Kevlar  |
| Resin Systems                     | Standard<br>Polyester<br>Vinylester<br>Epoxy<br>Phenolic<br>Polyurethane  |
| Components                        | Resin<br>High Strength<br>Superior Dimensional Stability<br>Electrical Insulation<br>Thermal Insulation<br>Corrosion Resistance<br>Electromagnetic Transparency<br>Consistent Cross Section<br>Inherent Color<br>Part Consolidation<br>Ease of Fabrication and Installation |
| Colors                            | White, Black, Custom  |
| Shapes                            | Solid Rods<br>Conductor Rods<br>Tubes<br>Custom Profiles<br>Bar Stock (Rectangle & Square)<br>Oval Solids<br>Channels<br>Half Rounds<br>Tees<br>Almost Any Profile  |
| Process                           | Roving<br>Mat / Roving<br>Resin Bath<br>Heated Die<br>In-Die Heat Cure<br>Cut to Length   |
| Width                             | Up to 15 in   |
| Height                            | Up to 6 in  |
| Tolerance                         | .005 in   |
| Additional Services               | Drilling<br>Grinding<br>Sand Blasting<br>Chamfering   |
| Production Volume                 | Prototype to Large Scale Production   |
| Lead Time                         | 3 to 4 weeks  |

## Additional Information

|                       |   |
|-----------------------|---|
| Industry Focus        | Electrical<br>Utility<br>Consumer<br>Recreation Sporting Goods<br>Construction<br>Telecommunications  |
| Intended Applications | Plant and Tree Stakes<br>Duct Rod<br>Transformer Spacers<br>Isolation Rods<br>Cable Support Rod<br>Corrosion Resistant Equipment<br>Food Processing Machines<br>Tent Poles<br>ATV Whips<br>Soccer Poles<br>Window Shades<br>Flag Poles<br>Driveway Markers<br>Retaining Wall Pins<br>Advertising Panels<br>Antennas |
| Industry Standards    | ASTM  |
| File Formats          | AutoCAD, Inventor, Solidworks   |





## Hot Line Tool Handles

Tencom Limited was contracted by an Electrical Utility company to fabricate fiber-glass poles known as “hot line sticks” for their workers. These sticks are used on high voltage electrical power lines in different capacities.

It is important that these poles do not conduct electricity, so as to protect the worker from shock and also to avoid damaging the power lines. This is a specialized process that only a couple of manufacturers in the country have the ability to produce. The pole was composed of vinylester resin and special electrical glass.

This custom profile was formulated and pultruded using our proprietary techniques, holding tolerances of  $\pm 0.030$ ” on the diameter.

The high voltage hot stick is available in lengths of 3’ to 20’, with diameters of 1”,

1-1/4”, 1-1/2”, 2” and 2-1/2”. Built to withstand 100 KV per foot, it is durable as well as impervious to moisture.

Colored yellow according to customer specifications. Tested to meet the ASTM F-711 standard. Turnaround time for this project was 4 -5 weeks. For more information about this project or our other capabilities please see the table below or contact us directly.

## Highlights

|   |  |
|---|--|
| Product Description                               | High voltage hot stick tool handles.   |
| Custom Pultrusion Capabilities Applied/ Processes | Primary: Pultrusion  |
| Overall Part Dimensions                           | Material Thickness: 1", 1 1/4", 1 1/2", 2", 2 1/2" diameters<br>Product Length: 3 to 20 feet |
| Tightest Tolerances                               | +/-0.030" on the diameter  |
| Material Used                                     | Vinyl Ester Resin & Special Electrical Glass   |
| Material Finish                                   | Color: Yellow  |
| Additional Facts                                  | Withstand 100KV per foot. Not Absorb Moisture. Durable.                                      |
| In process testing/inspection performed           | Tested to meet ASTM F-711  |
| Industry for Use                                  | Electrical Utility   |
| Delivery/Turnaround Time                          | 4 to 5 weeks   |
| Standards Met                                     | Customer Specifications<br>ASTM F-711  |
| Product Name                                      | Hot Line Sticks  |



## Manufactured Fiberglass with Specialty Resins

Tencom Limited is constantly seeking to update our value added services and find new ways to innovate the fiberglass industry. Drawing from extensive knowledge and experience, we have formulated specialty resin systems to manufacture reinforced fiberglass for certain results, such as enhanced fire retarding, or super strength.

Resins used in our formulations include epoxy, high temperature vinylester, fire retardant polyester, fire retardant vinylester, and polyurethanes. The materials are then pultruded using our exclusive process and equipment.

Our unique reinforced fiberglass is available in lengths of 3" to continuous spools, in thicknesses of 0.080" to 2", in variable widths, and a tolerable temperature range of

-50°F to 450°F. The turnaround time for products made with specialty resins are 6 - 8 weeks for tooling, 3 - 4 weeks for production.

The applications for this type of reinforced fiberglass are virtually unlimited. For more information about our manufactured reinforced fiberglass or our other offerings please see the table below or contact us directly.



## Highlights

|   |   |
|---|---|
| Product Description                                   | Special Bonding Resins Adding Unique Properties to Fiberglass Reinforcements  |
| Reinforced Fiberglass Capabilities Applied/ Processes | Primary: Pultrusion   |
| Equipment Used to Manufacture Part                    | Proprietary custom made equipment   |
| Overall Part Dimensions                               | Thickness: 0.075" - 2"<br>Product Width: Varies<br>Length: 5" to Continuous Spools<br>Temperature Range: -50° to 450°F  |
| Tightest Tolerances                                   | ± 0.005"  |
| Material Used   | Epoxy, High temperature Vinyl Ester, Fire Retardant Polyester, Fire Retardant Vinyl Ester, Polyurethanes.   |
| Additional Facts                                      | <p><b>High Temp Vinyl Ester Resin System:</b><br/>Fiberglass produced with Tencom's high temp resin system can be used in applications up to 200 degrees centigrade. Providing temperature resistance far higher than then standard PE and VE resin systems.</p> <p><b>Fire Retardant Polyester Resin System:</b><br/>Fiberglass produced with Tencom's FR PE adds low smoke and low spread FR capabilities to standard PE resin system while maintaining standard PE strengths.</p> <p><b>Fire Retardant Vinyl Ester Resin System:</b><br/>Combining the higher corrosion resistance and higher strength of vinyl ester resins with FR additives.</p> <p><b>Super High Strength Epoxies:</b><br/>Provide very high mechanical properties and fatigue resistance. Tooling cost similar to PE and VE, but higher material costs.</p> <p><b>Super High Strength Polyurethanes:</b><br/>Provide very high mechanical properties and fatigue resistance with lower material costs than Epoxies but higher tooling costs."</p> |
| Industry for Use                                      | Many  |
| Delivery/Turnaround Time                              | 6 - 12 weeks for Tooling, 3 - 4 weeks for Production  |
| Delivery Location                                     | FOB Holland, Ohio   |
| Standards Met   | Customer Specifications   |
| Product Name  | Fiberglass Reinforced with Specialty Resins   |



## Manufacturer of Fiberglass Window Reinforcements for the Construction Industry

A customer in the construction industry needed fiberglass reinforcements to structurally strengthen their vinyl windows. This was necessary in order to meet stringent standards of various cities. Tencom Limited took on this project, performing all work at our modern facility utilizing our proprietary pultrusion process and equipment. Tight tolerances of  $\pm 0.005"$  was held throughout the fabrication process.

The finished product was 3" to 20' in length, with a thickness range of 0.075" to 0.250". This material can withstand temperatures from -50°F to 300°F. Fiberglass is quickly gaining popularity in construction due to its high strength to weight ratio and low thermal conductivity. Tencom will work with customers to design structural replacements in an economical manner, maintaining or improving upon the strength and stability of original parts. The turnaround time for a project of this type is typically

6 - 12 weeks for tooling, and 2 - 4 weeks for production. For more information about this fiberglass window reinforcement project or our other custom structural fiberglass capabilities please see the table below or contact us directly.

## Highlights

|   |   |
|---|---|
| Product Description                               | Fiberglass Window Reinforcements  |
| Custom Pultrusion Capabilities Applied/ Processes | <b>Design/Engineering:</b><br>Tencom can help customers design fiberglass parts to replace their aluminum and steel reinforcements and maintain the same stiffness and strength.<br>Pultrusion" |
| Overall Part Dimensions                           | <b>Thickness:</b> from 0.060" - 0.250"<br><b>Length:</b> 3" - 20'<br><b>Width:</b> Varies<br><b>Temperature Range:</b> -50° - 300°F"  |
| Tightest Tolerances                               | ± 0.005"  |
| Material Used                                     | Fiberglass  |
| Additional Facts                                  | Fiberglass has become the go to option for high structural strength and stiffness combined with low thermal conductivity.   |
| Industry for Use                                  | Construction  |
| Delivery/Turnaround Time                          | 6 - 12 weeks for Tooling<br>2 - 4 weeks for Production"   |
| Standards Met                                     | Customer Specifications   |
| Product Name                                      | Fiberglass Reinforcements for Vinyl Windows   |



## Custom Pultruded, Coiled Fiberglass Rods

Tencom Limited was contracted to manufacture coiled fiberglass rods to a customer's specifications. All of the work was done on-site, using our state-of-the-art, specially enhanced pultrusion equipment.

Developed by our team of experts, this proprietary equipment was designed to increase the efficiency and cost effectiveness of the pultrusion process. It is not available at any other company.

Materials used for this product include Polyester, Vinyl Ester, Epoxy, and Urethane. Finished lengths for the fiberglass rods range from 100' to 2,000', with available diameters of 1/8", 3/16", 1/4", 5/16", and 3/8". The resin mix can be changed according to customer needs, to meet expectations for specific product requirements.

This fiberglass rod can also be produced as a conductor rod. Some applications for this product include fabric frame, guy wire, cable strength core, and fish tape. The turnaround time for a project of this type is typically 3 - 4 weeks.

Tencom is dedicated to making strides in the pultrusion industry, offering consistently high quality products at competitive prices. We are serious about customer service, and operate according to stringent industry standards of quality.

For more information about this custom coiled fiberglass process, or to learn more about our other capabilities, please see the table below or contact us directly.

## Highlights

|   |  |
|---|--|
| Product Description                               | A variety of applications including fiberglass duct rods (fish tapes) and cable reinforcements.                  |
| Custom Pultrusion Capabilities Applied/ Processes | <b>Primary:</b> Pultrusion   |
| Equipment Used to Manufacture Part                | Proprietary custom made equipment  |
| Overall Part Dimensions                           | <b>Product Length:</b> 100 to 2,000 feet<br><b>Material Thickness:</b> 1/8", 3/16", 1/4", 5/16", 3/8" diameters" |
| Material Used                                     | Polyester, Vinyl Ester, Epoxy, Urethane  |
| Additional Facts                                  | Available in different resin types. Can be produced with a conductor rod(s).                                     |
| Industry for Use                                  | Fabric Frame, Guy Wire, Cable Strength Core, Fish Tape   |
| Delivery/Turnaround Time                          | 3 to 4 weeks   |
| Delivery Location                                 | FOB Holland, Ohio  |
| Standards Met                                     | Customer Specifications  |
| Product Name                                      | Fiberglass Rod   |



## Pultrusions vs. Structural Timber

|                                | Pultruded Fiberglass<br>Structural Shapes  | Structural Timber Douglas Fir  |
|--------------------------------|--|--|
| <b>Corrosion Resistance</b>    | <p>Superior resistance to a broad range of chemicals.</p> <p>Unaffected by moisture or immersion in water if ends are properly sealed.</p> <p>Surfacing veil and UV additives create excellent weatherability.</p> | <p>Can warp, rot and decay from exposure to moisture, water and chemicals.</p> <p>Coatings or preservatives required to increase corrosion or rot resistance can create hazardous waste and/or high maintenance.</p> |
| <b>Insect Resistance</b>       | Unaffected by insects.   | <p>Susceptible to insect attack (marine borers, termites, etc.).</p> <p>Coatings to increase resistance to insects can be environmentally hazardous.</p>   |
| <b>Strength</b>                | <p>Pultruded fiberglass is stronger, and has higher flexural strength than timber. Ultimate flexural strength (Fu)</p> <p>LW = 30,000 psi,<br/>CW = 10,000 psi.</p> <p>Compression strength is 30,000 psi.</p>     | <p>Extreme fiber bending = up to 2800 psi.</p> <p>Compression parallel to grain = up to 1800 psi.</p>  |
| <b>Stiffness</b>               | Pultruded fiberglass is approximately 1-1/2 times as rigid as wood. Modulus of Elasticity LW = 2.9 x 10 <sup>6</sup> psi. CW = 1.2 x 10 <sup>6</sup> psi.  | Modulus of Elasticity = up to 1.8 x 10 <sup>6</sup> psi.   |
| <b>Electrical Conductivity</b> | Non-conductive - high dielectric capability.   | Timber can be conductive when it is wet  |
| <b>Weight</b>                  | Specific Gravity = 1.7<br>Pultruded fiberglass has significantly higher strength-to-weight ratio.  | Specific Gravity = 0.51 (oven dried).  |
| <b>Finishing and Color</b>     | Pigments added to the resin provide color throughout the part. Special colors available. Composite design can be customized for required finishes.   | Must be primed and painted for colors. To maintain color, repainting may be required.  |
| <b>Cost</b>                    | Lower maintenance, longer product life often equals lower overall costs.   | Lower initial cost   |

## Engineering Features

Pultruded fiberglass is a highly versatile material that is rapidly displacing steel, aluminum, wood and other plastics as the primary structural component in a variety of applications ranging from consumer products to aerospace. By capitalizing on the inherent strengths of structural fiberglass it is possible to significantly reduce production cost, while providing a final produce that exhibits superior performance characteristics and a lower life cycle cost.

### Design Flexibility

The Pultrusion process facilitates the production of highly complex cross sections In virtually unlimited lengths. It also makes it easy to achieve specific physical properties of a given application. Design variables effecting the nature and appearance of the final include: percentage of glass roving and mat, resin system, surface veil, UV coating, pigments and additives.

### Strength

Load bearing capacity can be tailored to the application by modifying the glass content, fiber orientation and combination of mat and roving reinforcement. On average, structural fiberglass provides 50% higher tensile strength than hot roll steel and possesses greater impact resistance.

### Dimensional Stability

Expansion and contraction are 24% less than aluminum and 50% less than hot rolled steel. It can be consistently manufactured to tolerances as high as  $\pm .005$ " ensuring easy assembly and greater efficiency in applications such as door jams and window frames.

### Thermal Conductivity

Low thermal conductivity reduces or eliminates the need for thermal barriers or insulation and prevents the formation or condensation.

### Electrical Conductivity

Structural fiberglass both nonmagnetic and electrically non-conductive. It provides predictable insulation values for greater safety area where electrical hazards are present.

## Corrosion Resistance

Structural fiberglass is particularly well suited to highly corrosive environments. It offers extended service life without periodic maintenance and minimizes replacement costs.

## Weather Resistance

The material is not subject to rot or oxidation and can be coated to prevent deterioration due to UV exposure.

## Flame Retardation

Agent can be added to the resin system to satisfy required safety standards.

## Coloration

Structurals can be produced in any color by adding pigments to resin. The color is constant throughout the material. Structural fiberglass may also be painted with any high quality urethane, oil base, acrylic or latex.

## Weight

Lighter and less dense than aluminum, structural fiberglass is easy to handle and economical to ship.

## EMI/RFI Transparency

Transparent to radio waves, EMI/RA transmissions, used for radar and antennae enclosures and supports.

## Fabrication

Cutting and machining can be performed with a diamond tipped router or abrasive cutting wheel. Component sections may be joined mechanically with bolts, screws and pop rivets or bonded with two part epoxy.

## Pultrusions vs. Aluminum

|                                | Pultruded Fiberglass<br>Structural Shapes   | Aluminum<br>Extruded Shapes   |
|--------------------------------|---|---|
| <b>Corrosion Resistance</b>    | <p>Superior resistance to a broad range of chemicals.</p> <p>Surfacing veil and UV additives create excellent weatherability.</p>   | <p>Can cause galvanic corrosion</p> <p>Corrosion resistance can be increased through anodizing or other coatings.</p>                             |
| <b>Weight</b>                  | Very lightweight - about 70% the weight of aluminum on a density basis.   | Lightweight - about 1/3 that of copper or steel.  |
| <b>Electrical Conductivity</b> | Non-conductive - high dielectric capability.  | Conducts electricity - grounding potential.   |
| <b>Thermal Conductivity</b>    | Insulates - low thermal conductivity, 4 Btu/ft <sup>2</sup> /hr/°F/in; low thermal coefficient of expansion 4.4 x 10 <sup>-6</sup> in/in/°F   | Heat conductor - high thermal conductivity. 150 Btu/ft <sup>2</sup> /hr/°F/in; thermal coefficient of expansion 11-13 x 10 <sup>-6</sup> in/in/°F |
| <b>Strength</b>                | <p>Ultimate flexural strength (Fu)<br/>LW = 30 ksi.<br/>CW = 10 ksi.</p> <p>Pultruded fiberglass has 86% of the yield strength of aluminum and is pound-for-pound stronger than aluminum in the lengthwise direction.</p> | <p>Flexural strength (Fu) 35 ksi.<br/>Homogeneous material</p>  |
| <b>Finishing and Color</b>     | Pigments added to the resin provide color throughout the part. Special colors available. Composite design can be customized for required finishes.  | Silver color. Other colors require prefinishes, anodic coatings and paints. Mechanical, chemical and electroplated finishes can be applied.       |
| <b>EMI/RFI Transparency</b>    | Transparent to radio waves, EMI/RFI transmissions, used for radar and antennae enclosures and supports.   | Highly reflective.  |
| <b>Fabrication</b>             | Easy field fabrication with simple carpenter tools - utilizes adhesive bonding and/or mechanical joining. No torches or welding.  | Good machinability - welding, brazing, soldering or mechanical joining.   |
| <b>Cost</b>                    | Slightly higher tooling costs; price per lineal foot marginally higher.   | Extrusion tooling is relatively inexpensive. Part price comparable or slightly lower.   |
| <b>Impact Resistance</b>       | Will not permanently deform under impact.   | Easily deforms under impact.  |

## Physical Properties

### High Strength

Stronger than structural steel on a pound-for-pound basis. Has been used to form the superstructures of multistory buildings, walkways, sub-floors and platforms.

### Lightweight

Pultrusions are 20-25% the weight of steel and 70% the weight of aluminum. Pultruded products are easily transported, handled and lifted into place. Total structures can often be preassembled and shipped to the job site ready for installation.

### Corrosion/Rot Resistant

Pultruded products will not rot and are impervious to a broad range of corrosive elements. This feature makes pultrusions a natural selection for indoor or outdoor structures in pulp and paper mills, chemical plants, water and sewage treatment plants, structures near salt water and other corrosive environments.

### Non-Conductive

Glass reinforced pultrusions have low thermal conductivity and are electrically non-conductive.

### Electro-Magnetic Transparency

Pultruded products are transparent to radio waves, microwaves and other electromagnetic frequencies.

### Dimensional Stability

The coefficient of thermal expansion of pultruded products is slightly less than steel and significantly less than aluminum.

### Parts Consolidation

Custom designed pultrusions allow multiple discrete parts to be designed and fabricated into a single part thus reducing the number of fabricated parts and the need to join these parts together.



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## Low Temperature Capabilities

Glass fiber reinforced pultrusions exhibit excellent mechanical properties at very low temperatures, even  $-70^{\circ}\text{F}$ . Tensile strength and impact strengths are greater at  $-70^{\circ}\text{F}$  than at  $+80^{\circ}\text{F}$ .

## Aesthetics

Pultruded profiles are pigmented throughout the thickness of the part and can be made to virtually any desired custom color. Special surfacing veils are also available to create special surface appearances such as wood grain, marble, granite, etc.