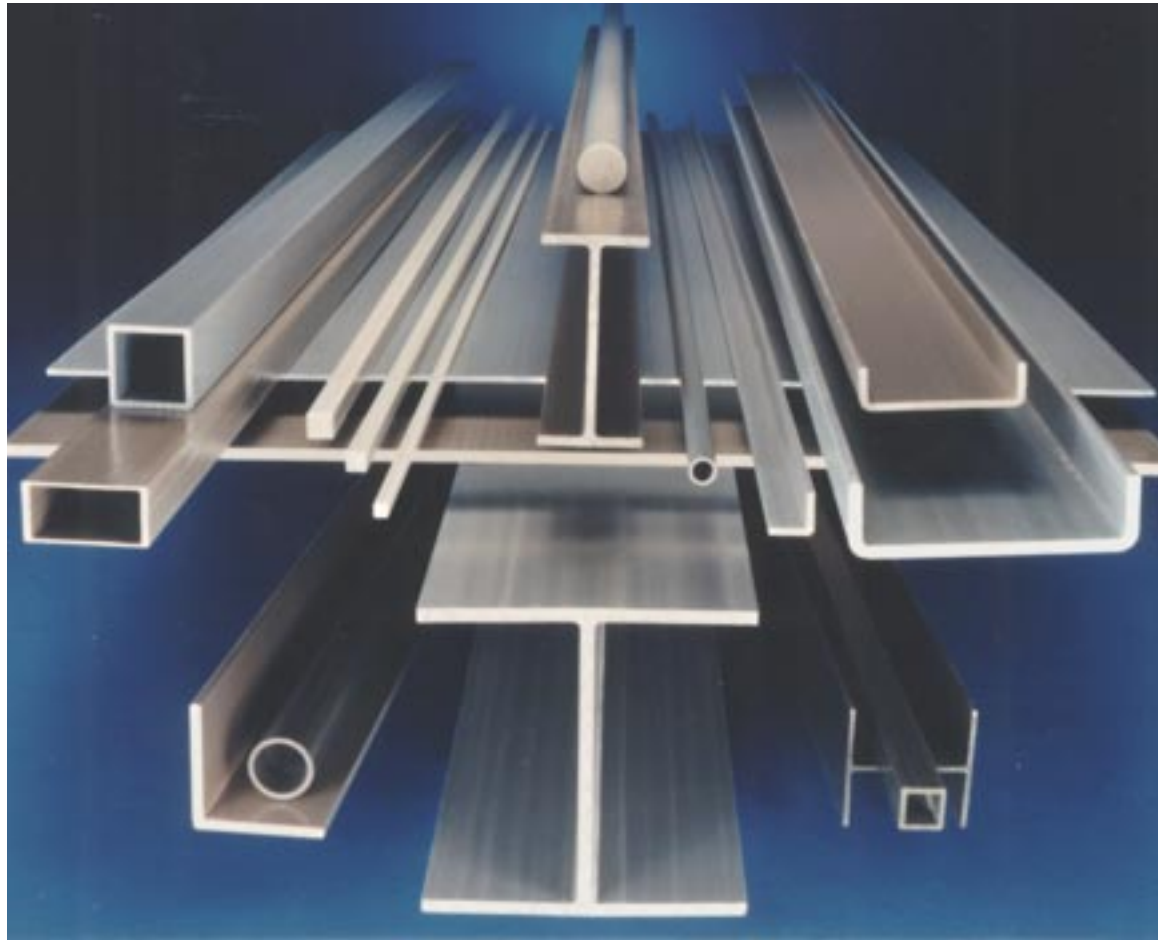


STRONGWELL

EXTREN ®

FIBERGLASS STRUCTURAL SHAPES AND PLATE



Introduction

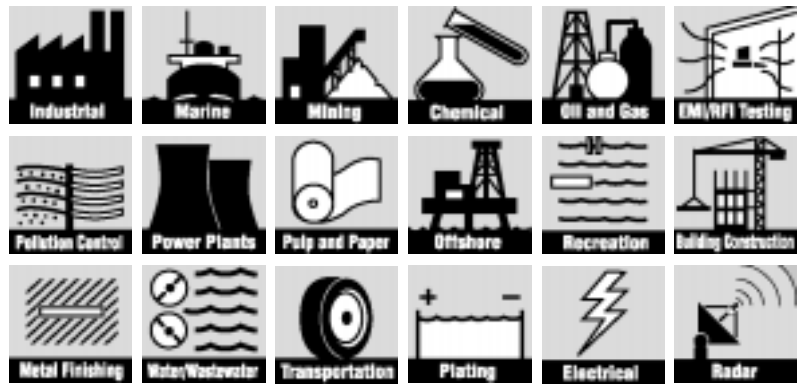
What you see below is not the erection of a steel structure. Rather, it is a structure being assembled using EXTREN® fiberglass structural members. Today, EXTREN® is replacing steel, aluminum, and wood in a wide variety of structural applications. Why? Because EXTREN® is a problem solving material. This brochure provides the reader with the basic information about the EXTREN® product line and shows many examples of how the features of EXTREN® were translated into end user benefits in a variety of markets and applications.

The features of EXTREN® fiberglass structural shapes are readily translated into user benefits:

- Corrosion Resistant
- Nonconductive — Thermally and Electrically
- Nonmagnetic — Electromagnetic Transparency
- Lightweight — Weighs 80% less than Steel
- High Strength
- Dimensional Stability
- Low Maintenance
- Custom Colors



Product Line



EXTREN® is a proprietary combination of fiberglass reinforcements and thermosetting polyester or vinyl ester resin systems. It is produced in more than 100 standard shapes. All EXTREN® shapes have a surface veil to protect against glass fibers penetrating the resin surface in service and to increase corrosion and UV resistance. EXTREN® is offered in three series designed for different environments and applications.

EXTREN® 500

An all-purpose series utilizing an isophthalic polyester resin system with a UV inhibitor.

Color: olive green

EXTREN® 525

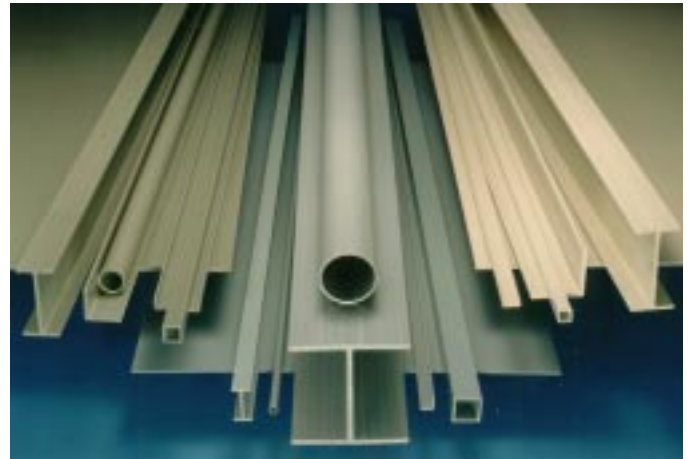
An all-purpose series utilizing a fire retardant isophthalic polyester resin system with a UV inhibitor.

Color: slate gray (plus certain handrail and fixed-ladder components in yellow)

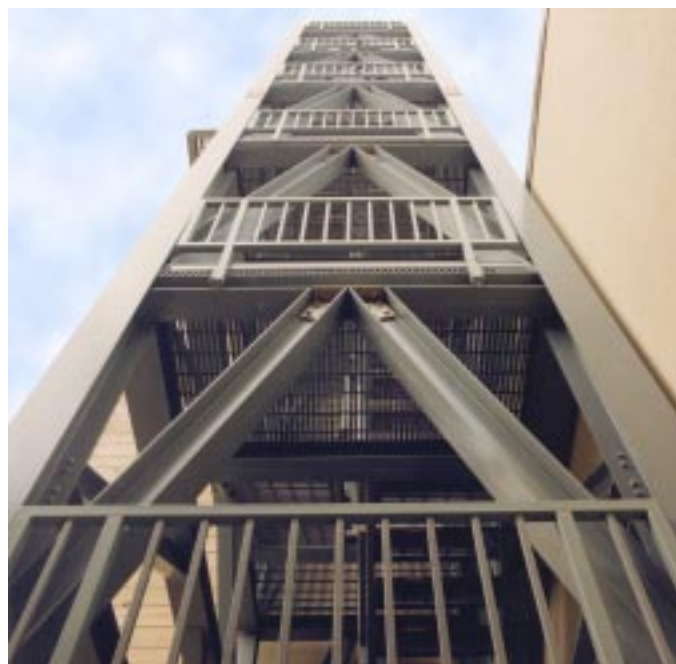
EXTREN® 625

A premium series — both fire retardant and highly corrosion resistant — utilizing a vinyl ester resin system with a UV inhibitor.

Color: beige



The three EXTREN® series: (left to right) 500, 525 and 625.



63' high freestanding fiberglass stairtower at Ft. Story Army Base, Virginia Beach, Virginia.



10' x 250' EXTREN® platform for a petrochemical complex.



One of four three-story turrets constructed of EXTREN® to house communications equipment atop the Sun Bank building in Orlando, Florida.

Markets

- Transportation
- Electrical/Electrical Utility
- Chemical Processing
- Cellular Communications
- Consumer/Recreation
- Building Construction
- Food and Beverage
- Pulp and Paper
- Oil and Gas
- Water/Wastewater
- Air Pollution Control
- Aeronautical Defense
- Plating
- Agricultural
- Appliance/Equipment



Bridges at the Sea Life Park in Waimanolo, Hawaii, use fiberglass structural supports over saltwater dolphin tanks.



Lightweight and RFI/EMI transparent, EXTREN® provides support structures for Cellular One of Ohio antennae installed on building roofs and towers.



35' high platforms over tanks at Moffat Filter Plant in Denver, Colorado were constructed of EXTREN® structural shapes.



Above: 24" EXTREN® fiberglass I-beams span 62' wide rigid gables that support siding and roof of an all-fiberglass building used for computer testing.

Below: All-fiberglass tank loading platform uses multiple EXTREN® sections.



High strength EXTREN® was used to fabricate fiberglass floating docks for seepage pits at this landfill in Snohomish County, Washington.



Nonconductive feeder beams made of EXTREN® prevent power outages.



This Well Bay Platform was easy to install requiring no heavy equipment, cutting torches or welding to make field modifications, thereby saving the cost of shutting wells down.

Designing with EXTREN®



Design By Strongwell

Strongwell has on staff registered professional engineers experienced in the design of fiberglass structures and systems for custom design requirements. Strongwell's extensive experience in fabrication procedures, joint design and stress analysis of composite assemblies combined with the use of Strongwell fiberglass products, results in structures of superior, cost-effective design and structural integrity. Clear, straightforward drawings of structures are provided to the customer for approval before fabrication begins, unless customer drawings are provided.

Design It Yourself

The EXTREN® *Design Manual*, developed by Strongwell, is the most complete reference guide in the industry and is used by more engineers and architects than any other FRP engineering guide. With over 300 pages of engineering data, it includes properties of materials, beam and column load tables, empirical design equations and sample calculations, connection details, and FRP product and fabrication specifications. It is based on years of extensive product testing with EXTREN® fiberglass structural shapes and years of experience in monitoring applications.



WARNING!

Fiberglass reinforced thermoset plastic composites are a nonhomogenous material (i.e., their strengths and behavior are dependent upon the design of the composite and reinforcement). Other fiberglass structural shapes, with a similar exterior appearance to EXTREN® shapes, are likely not equal in any other way including glass content, glass placement, glass type, wet out, resin mixture or pull speed. Do not use the EXTREN® *Design Manual* to design a structure unless you assure that only EXTREN® structurals are used.



EXTREN® Product Logo

A product logo identification program has been implemented by Strongwell after designers and specifiers of EXTREN® learned that problems were occurring because sellers or contractors were substituting look-alike shapes.

Since July 1, 1993, all EXTREN® fiberglass structural shapes and plate have been imprinted with the EXTREN® logo every three feet down the length of the part. Square and round tubes have the logo imprinted inside the shape. Small and unobtrusive, the logo assures customers that they are getting EXTREN® properties backed by corrosion, mechanical and structural testing as conducted by Strongwell.

Fabricating with EXTREN®



Bolts and adhesives are used for efficient connections in EXTREN® structures.



Strongwell has trained personnel at two fabrication facilities to take your drawings and/or design to whatever prefabrication stage you choose.



Prefabrication of support beams can include bonding predrilled angles and plate for connections.



Beams are prepped before bonding connections together.



EXTREN® may be painted for better protection against long-term exposure to the sun.

In addition to being the world's largest producer of pultruded parts, Strongwell is also the largest fabricator of structures utilizing pultruded components.

Typical fabrications include beam, column and plate structures, all-fiberglass buildings using foam core panels, platforms and other custom fabrications involving grating and handrail. Specialized OEM-type structures such as flue gas desulfurization components, over-the-horizon-radar space frames and wastewater structures can also be accommodated. Hand lay-up capabilities complement the corporation's structural fabrication capability.

Joining

EXTREN® can be fastened mechanically with screws, bolts or rivets. FIBREBOLT® fiberglass studs and hex nuts (available from Strongwell) can also be used with

EXTREN®. EXTREN® can be joined by adhesives. The strongest connections can be made by using a combination of mechanical fasteners with adhesives. Suggested fabrication techniques for EXTREN® are covered in Strongwell's *EXTREN® Fabrication and Repair Manual*.

Material Preparation

EXTREN® shapes and plate can be sawed, drilled, routed and turned on a lathe or other machine tool. Punching should be limited to thicknesses of 3/16" and under. Carbide or diamond-tipped saw blades and tool bits are recommended for faster speeds and longer-tool life. Cut edges should always be sealed. EXTREN® cannot be bent, rolled or pressed as can steel.



EXTREN® sections can be joined mechanically or with adhesives.

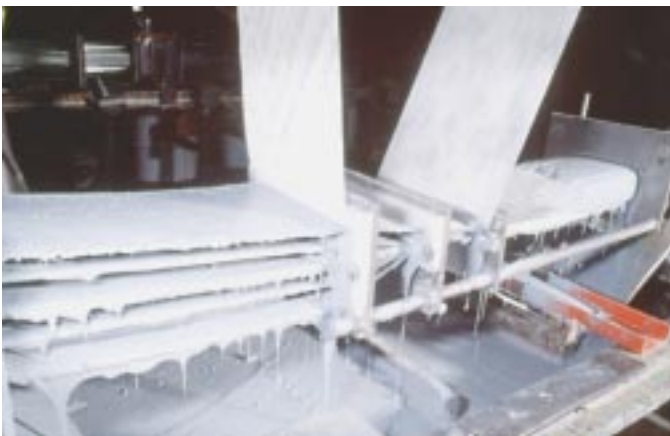
Process



Strongwell's 350,000 sq. ft. Bristol, Virginia facility is the world's largest pultrusion operation.



EXTREN® is manufactured by the pultrusion process. In its simplest terms, pultrusion is the process of pulling fiberglass (or other) reinforcements through a "bath" of thermosetting resin and into a heated forming-and-curing die to produce composite structural shapes. Reinforcement placement, resin formulation, catalyst levels, die temperature and pull speed are critical process parameters. Strongwell is one of the pioneers of the pultrusion process with over 50 pultrusion machines in several plant locations across the United States.



Quality and Availability

Quality for EXTREN® is defined as "conformance to published specifications". A "first article" series of tests on each EXTREN® production run is designed to assure the end user that the structural members meet or exceed published minimum criteria. Increasingly, both incoming materials and manufacturing processes are subjected to QA/QC techniques involving statistical process control. While distributors stock the most popular shapes of EXTREN® for immediate delivery to their customers, Strongwell also maintains a large inventory to service distributors and prevent long lead times to end users.



Left: Strongwell's strict quality assurance program requires all raw materials to be tested before being accepted for processing.

Right: Strongwell's SATEC Microprocessor-Based Automatic Testing System is a physical testing workhorse.

Bottom: Strongwell's laboratory and research facility is large, well-equipped and professionally staffed.



Properties

PROPERTIES	TEST METHOD ⑦	UNITS/VALUE	SERIES	SERIES	SERIES 500/525 PLATE ⑤			SERIES 625 PLATE ⑤		
			500/525 SHAPES	625 SHAPES	1/8"	3/16" - 1/4"	3/8" - 1"	1/8"	3/16" - 1/4"	3/8" - 1"
MECHANICAL										
Tensile Stress, LW	D638	psi MPa	30,000 207	30,000 207	20,000 138	20,000 138	20,000 138	20,000 138	20,000 138	20,000 138
Tensile Stress CW	D638	psi MPa	7,000 48	7,000 48	7,500 51	10,000 68	10,000 68	7,500 51	10,000 68	10,000 68
Tensile Modulus, LW	D638	10 ⁶ psi MPa	2.5 17250	2.6 17940	1.8 12420	1.8 12420	1.8 12420	1.8 12420	1.8 12420	1.8 12420
Tensile Modulus, CW	D638	10 ⁶ psi MPa	0.8 5520	0.8 5520	0.7 4830	0.9 6210	1.4 9660	1.0 6900	1.0 6900	1.4 6900
Compressive Stress, LW	D695	psi MPa	30,000 207	30,000 207	24,000 165	24,000 165	24,000 165	24,000 165	24,000 165	24,000 165
Compressive Stress, CW	D695	psi MPa	15,000 103	16,000 109	15,500 106	16,500 113	20,000 137	16,500 113	17,500 120	17,500 120
Compressive Modulus, LW	D695	10 ⁶ psi MPa	2.5 17250	2.6 17940	1.8 12420	1.8 12420	1.8 12420	1.8 12420	1.8 12420	1.8 12420
Compressive Modulus CW	D695	10 ⁶ psi MPa	1.0 6900	1.0 6900	1.0 6900	1.0 6900	1.0 6900	1.0 6900	1.0 6900	1.0 6900
Flexural Stress, LW	D790	psi MPa	30,000 207	30,000 207	35,000 241	35,000 241	30,000 207	35,000 241	35,000 241	30,000 207
Flexural Stress, CW	D790	psi MPa	10,000 69	10,000 69	13,000 89	15,000 103	18,000 124	13,000 89	15,000 103	18,000 124
Flexural Modulus, LW	D790	10 ⁶ psi MPa	1.6 11040	1.6 11040	1.8 12420	2 13800	2 13800	1.8 12420	2 13800	2 13800
Flexural Modulus, CW	D790	10 ⁶ psi MPa	0.8 5520	0.8 5520	0.9 6210	1.1 7590	1.4 9660	1.0 6900	1.1 7590	1.4 9660
Modulus of Elasticity, Ex or Ey ⑥	full section	10 ⁶ psi MPa	2.6 17940	2.8 19320						
Modulus of Elasticity, W & I shapes > 4"	full section	10 ⁶ psi	2.5	2.5						
Compressive Shear Stress, LW ②	D3846	psi MPa	3,000 20	3,000 20						
Shear Modulus, LW ③ (Nominal)	—	10 ⁶ psi MPa	0.425 2932	0.425 2932						
Short Beam Shear, LW	D2344	psi MPa	4,500 31	4,500 31						
Bearing Stress, LW	D953	psi MPa	30,000 207	30,000 207	32,000 220	32,000 220	32,000 220	32,000 220	32,000 220	32,000 220
Poisson's Ratio, LW (Nominal)	D3039	in/in	0.33	0.33	0.31	0.31	0.31	0.32	0.32	0.32
Notched Izod Impact, LW	D256	ft-lbs/in N-m/m	25 1334	25 1334	18.5 987	20 1067	20 1067	18.5 987	20 1067	20 1067
Notched Izod Impact, CW	D256	ft-lbs/in N-m/m	4 213	4 213	5 266	5 266	5 266	5 266	5 266	5 266
PHYSICAL										
Barcol Hardness	D2583	—	45 ④	45 ④	40	40	40	40	40	40
24 hr Water Absorption	D570	% Max	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Density	D792	lbs/in ³ kg/m ³	.062-.070 1716-1937	.062-.070 1716-1937	.060-.068 1660-1882	.060-.068 1660-1882	.060-.068 1660-1882	.060-.068 1660-1882	.060-.068 1660-1882	.060-.068 1660-1882
Coefficient of Thermal Expansion (Nominal)	D696	10 ⁻⁶ in/in/°F — 10 ⁻⁶ in/in/°C	4.4 8.0	4.4 8.0	4.4 8.0	4.4 8.0	4.4 8.0	4.4 8.0	4.4 8.0	4.4 8.0
Thermal Conductivity (Nominal)	C177	BTU-in/ft ² Hr/°F w/(m *k)	4 .58	4 .63						

All values are minimum ultimate properties from coupon tests except as noted.

- ① This value is determined from full section simple beam bending of EXTREN® structural shapes.
- ② The shear stress test results will change radically if the notched orientation is altered. The value in this chart represents the test configuration where the notches are machined parallel to the reinforcing mat. For notches machined perpendicular to the reinforcing mat, this value would be two to three times larger.
- ③ The Shear Modulus value has been determined from tests with full sections of EXTREN® structural shapes. (See Strongwell's EXTREN® Design Manual for further information.)
- ④ Value would be 50 if the surfacing veil were not there.
- ⑤ Plate compressive stress/modulus measured edgewise and flexural stress/modulus measured flatwise.
- ⑥ Values apply to Series 525 and 625.
- ⑦ All listings beginning with a 'D' or 'E' are ASTM tests.

LW = Lengthwise or parallel to the rovings PF = Tested perpendicular to laminate face
 CW = Crosswise or perpendicular to laminate face N.T. = Not Tested
 MPa = Megapascals

PROPERTIES	TEST METHOD ①	UNITS/ VALUE	SERIES 500/525 SHAPES	SERIES 625 SHAPES	SERIES 500/525 PLATE ②			SERIES 625 PLATE ③		
					1/8"	3/16" - 1/4"	3/8" - 1"	1/8"	3/16" - 1/4"	3/8" - 1"

ELECTRICAL

Dielectric Strength, LW	D149	KV/in	35	35						
Dielectric Strength, PF	D149	volts/mil	200	200						
Volume Resistivity (Nominal)	D257	ohms-cm	1x10 ¹³	1x10 ¹³	1x10 ¹³	1x10 ¹³	1x10 ¹³	1x10 ¹³	1x10 ¹³	1x10 ¹³

FLAMMABILITY ⑥

Flammability Classification (1/16")	UL 94	VO
Tunnel Test	E-84	25 Max
NBS Smoke Chamber	E-662	650-700 (Typical)
Flammability	D635	Self Extinguishing
UL Thermal Index	Generic	130°C
British Fire Test	B5 476-7	Class 1

ASTM SPECIFICATIONS

- ASTM D3917 "Standard Specification for Dimensional Tolerance of Thermosetting Glass-Reinforced Plastic Pultruded Shapes".
- ASTM D3918 "Standard Definition of Terms Relating to Reinforced Plastic Pultruded Products".
- ASTM D3647 "Standard Practice for Classifying Reinforced Plastic Pultruded Shapes According to Composition".
- ASTM D4385 "Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products".

Options

Strongwell offers a broad range of fiberglass industrial products. Two other products often used with EXTREN® are SAFPLATE® and FIBREBOLT®. A brief description of each is given here. Full-color brochures are available for each product.

SAFPLATE®

SAFPLATE® fiberglass gritted plate, is a tough, corrosion resistant floor plate. A unique combination of pultruded fiberglass plate and anti-skid grit surface provides a textured solid sheet flooring that is ideal for both wet and dry applications. Used in a variety of applications, such as trench covers to contain vapors and fumes, or pedestrian bridge walkways for sure footing, SAFPLATE® provides a long lasting maintenance free alternative to steel plate for severe, corrosive environments.

SAFPLATE® is available as solid plate or bonded to DURADEK® or DURAGRID® grating. The grit surfaces can be fine, medium or coarse. It is available in 4' x 8' panels in all standard EXTREN® plate thicknesses: 1/8", 3/16", 1/4", 3/8", 1/2" and 3/4". The standard SAFPLATE® is fiberglass reinforced polyester with fire retardant in a gray color. Other resin systems and custom colors are available upon request.

FIBREBOLT®

FIBREBOLT® fiberglass studs and nuts are ideal for applications requiring mechanical fasteners that must be non-corrosive, non-conductive and/or transparent to electromagnetic waves. FIBREBOLT® studs are machined from pultruded fiberglass vinyl ester rods. The hex shaped nut is thermoplastic. They are easily assembled with a standard six point socket wrench.

FIBREBOLT® studs and hex nuts are available in diameters of 3/8", 1/2", 5/8", 3/4" and 1" for immediate delivery. Four foot bolt lengths are standard, with custom lengths and partial length threading available on request. Brown is the standard color. The studs and nuts have UV inhibitors to provide resistance to ultraviolet degradation and corrosion.



SAFPLATE®, a solid anti-skid flooring, helps reduce worker slips and falls in both wet and dry applications.



FIBREBOLT® is widely used as a replacement for metallic fasteners in structures that must be non-conductive and/or transparent to electromagnetic waves.

Availability List

STOCKED

NONSTOCKED

Equal Leg Angles

1 x 1/8
1-1/4 x 3/16
1-1/2 x 3/16
1-1/2 x 1/8
1-1/2 x 1/4
2 x 3/16
2 x 1/4
3 x 1/4
3 x 3/8
4 x 1/4
4 x 3/8
4 x 1/2
6 x 1/2

1-1/4 x 1/8
2 x 1/8
5 x 1/2
6 x 1/4 (Stock S- 525)
6 x 3/8

Unequal Leg Angles

1-3/4 x 1-1/4 x 1/4

Channels

2 x 9/16 x 1/8
3 x 7/8 x 1/4
4 x 1-3/8 x 3/16
4 x 1-1/8 x 1/4
5 x 1-3/8 x 1/4
6 x 1-5/8 x 1/4
8 x 2-3/16 x 3/8
10 x 2-3/4 x 1/2 (24' lg.)

1-1/2 x 1 x 3/16
1-1/2 x 1-1/2 x 1/4 (Stock S-625)
2 x 7/8 x 1/4
2-5/8 x 1/8 x 1-1/4 x 3/16
3 x 1 x 3/16
3-1/2 x 2 x 7/32
4 x 1-1/16 x 1/8
6 x 1-11/16 x 3/8 (Stock S-500)
8 x 2-3/16 x 1/4
14 x 3-1/2 x 3/4
18 x 2-3/16 x 3/16
24 x 3 x .260

I-Beams

3 x 1-1/2 x 1/4
4 x 2 x 1/4
8 x 4 x 3/8
2 x 1 x 1/8
6 x 3 x 1/4
6 x 3 x 3/8
6 x 4 x 1/4
8 x 4 x 1/2
10 x 5 x 3/8
10 x 5 x 1/2
12 x 6 x 1/2 (Stock S-525)
18 x 3/8 x 4-1/2 x 1/2
24 x 3/8 x 7-1/2 x 3/4

Wide Flange Beams

3 x 1/4
4 x 1/4
6 x 1/4
6 x 3/8
8 x 3/8
10 x 3/8 (32' lg.)

2 x 1/8
8 x 1/2
10 x 1/2
12 x 1/2

Plate

1/8"
3/16"
1/4"
3/8"
1/2"
3/4"

5/8"
1"

Round Tube

1 x 1/8
1-1/4 x 1/8
1-1/2 x 1/8
1-1/2 x 1/4
2 x 1/8
2 x 1/4
2-1/2 x 1/4
3 x 1/4

3/4 x 3/16
1-1/4 x 3/16
1-3/8 x 3/16
1-3/4 x 1/8
1-3/4 x 1/4
2-3/4 x 1/4
2-3/4 x 3/8
3 x 1/8
3-1/2 x .140
3-1/2 x 1/2
4 x 1/8
4 x 1/4
5 x 1/8
5 x 1/4
6 x 1/8
6 x .156
6 x 1/4
8 x 3/16
10 x 3/16

FIBREBOLT® Studs and Nuts

Stocked in 4' lengths
Size: 3/8", 1/2", 5/8",
3/4", 1"

Rectangular Tube

4 x 1/8 x 2 x 1/4
2-1/2 x 1-5/8 x 1/8
3-1/4 x 2-1/2 x .160
6-1/2 x 1/4 x 2 x 1/2
7 x 4 x 1/4

Square Tube

1 x 1/8
1-1/2 x 1/8
2 x 1/8
2 x 1/4
2 x 1/4 (Yellow; Series 525)
3 x 1/4
4 x 1/4

1-1/4 x 1/8
1-1/2 x 1/4
1-3/4 x 1/8 **
1-3/4 x 1/4 **
2-1/2 x 1/4 (Stock Yellow; S-525)
3 x 1/8
3 x 3/8
4 x 3/8
6 x 3/8

Square Bar - Thermal Cure Clear

1/2"
5/8"
3/4"
1"
1-1/4"
1-1/2"

Rod - Thermal Cure Clear

1/4"
3/8"
1/2"
5/8"
3/4"
13/16"
7/8"
1"
1-1/8"
1-1/4"
1-1/2"
1-7/8"
2"

Special Pultruded Shapes

Corner Post

3-1/4 x 1/4

Curb Angle

1 x 1-1/2
1-1/2 x 1-1/2
2 x 1-1/2
(stocked at
Chatfield Division)

F-Section

5-1/2 x 1 x 1/4
6 x 1-1/2 x 1/4

Flat Bar

.25 x .25
.25 x .75
.25 x .812

Flat Strips

1 x 1/4
2 x 3/16 (Stock Yellow; S-525)
2 x 1/4
3 x 3/16
3 x 1/2

Flight Channel

5-1/4 x 1/8 x 2-1/2 x 3/16
7-1/8 x 1/8 x 2-1/2 x 3/16

Foam Core Planks

4 x 2
5 x 2
6 x 2
8 x 2

Framing Angle

2 x 2 x 1/4

Custom Pultrusions

Strongwell produces custom pultrusions in many shapes and materials for hundreds of customers. The listing on this page is only a partial listing of dies owned by Strongwell.

Additional Sections are frequently added and modifications to existing sections may be possible. For special needs contact your EXTREN® distributor.

H-Section

3-1/2 x 1-9/16 x 1-1/2 x 1/4

Hat Section

3-1/2 x 1-7/8 x 2 x 1/8

Square Tube w/Round Hole

1" sq. with 3/4" round hole
1" sq. with 5/8" round hole
1-1/2" sq. with 1" round hole

Stair Riser

8 x 1-1/2 x 1/8

Top Rail

2 x 1/4 modified rd. tube

Z-Section

1-1/4 x 2-1/2 x 1/8

Kick Plate

4 x 1/2 x 3/16
(Yellow; S-525)

Slide Guide

2-1/2 x 2-1/4 x 1/4
(White; S-500)

Square Tube

2 x .156 (Yellow; S-625)

Strut

1-5/8 x 1-5/8 x 5/32
(Gray; S-525)

**1-3/4 x 1/8 and 1-3/4 x 1/4 Square Tubes are undersized to allow telescoping.

NOTE: All EXTREN® Series 500 products can be produced to meet NSF potable water standards in minimum mill run quantities. Only products bearing the NSF logo are certified.



BRISTOL DIVISION*

400 Commonwealth Ave., P. O. Box 580, Bristol, VA 24203-0580 USA
(540) 645-8000 Fax (540) 645-8132

*EXTREN® manufacturing location

CHATFIELD DIVISION

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(507) 867-3479 Fax (507) 867-4031

www.strongwell.com

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