



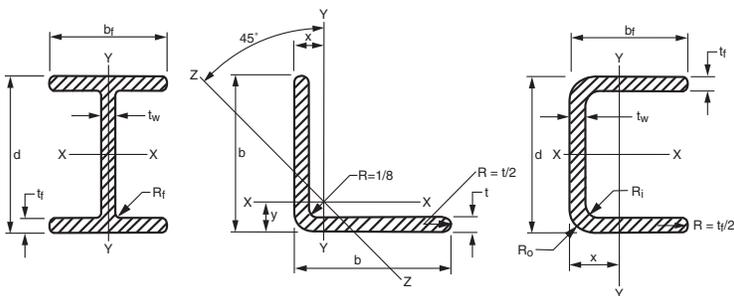
GEF Incorporated
Innovative Solutions in Fiberglass

EXTREN®

FIBERGLASS STRUCTURAL SHAPES AND PLATE

EXCLUSIVELY
 **MADE IN THE USA**

- » Corrosion Resistant
- » High Strength-to-Weight
- » Easy Installation
- » Cost Effective
- » Low Maintenance
- » Low Conductivity
- » Dimensionally Stable



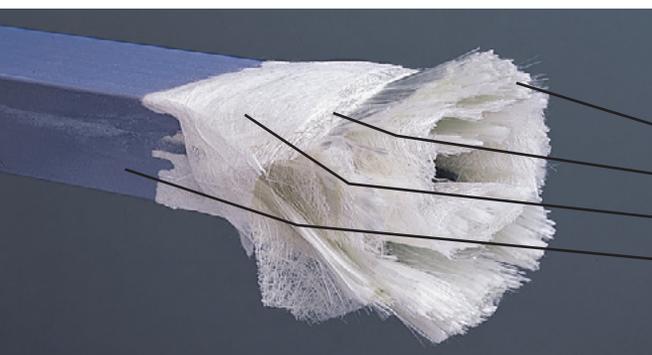
EXTREN® FIBERGLASS STRUCTURAL SHAPES AND PLATE



This entire rooftop structure was built using EXTREN®, to take advantage of its transparency to RF and cellular signals.



EXTREN® structural shapes have become an ideal alternative for traditional wood in cooling tower construction.



What is EXTREN®?

EXTREN® replaces steel, aluminum, and wood in a wide variety of structural applications. EXTREN® is a durable, lightweight, cost saving structural material. This brochure provides basic information about the EXTREN® product line and shows many examples of how EXTREN® provides solutions for end users in a variety of markets and applications.

EXTREN® is:

- Corrosion Resistant
- Structurally Strong
- Impact Resistant
- Lightweight
- Easy to Field Fabricate
- Low in Thermal and Electrical Conductivity

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 world leader of the pultrusion process with more than 60 pultrusion machines in four plant locations across North America.

Why Use EXTREN®?

EXTREN® is the result of decades of experience in manufacture, design, and fabrication. EXTREN® offers the following advantages:

- **Corrosion Resistance** - Superior resistance to a broad range of chemicals. Unaffected by moisture or immersion in water when sealed. Will not rust like metal and will not rot like wood.
- **High Strength-to-Weight** - Pound-for-pound, EXTREN® pultruded fiberglass structural shapes are stronger than steel in lengthwise direction. Strongwell FRP weighs up to 75% less than steel and 30% less than aluminum - ideal when maximum performance is required but every pound counts.
- **Easy Installation** - Can be field fabricated using simple carpenter tools and is easily lifted into place during installation with less equipment or specialized labor vs. steel.
- **Cost Effective** - Because installation of Strongwell FRP is much simpler and quicker than steel, structures built using Strongwell's pultruded products can cost as much as 15% less than carbon steel, 30% less than galvanized steel, and as much as 50% less than stainless steel.
- **Virtually Maintenance Free** - Will not permanently deform under impact. Corrosion resistance eliminates need for constant painting and upkeep. Provides long-term, cost effective solutions with lower life cycle costs.
- **Durability & Weatherability** - Resists impact, non-denting and hard to break. Pigmented resin, surfacing veil, and UV-Inhibitors prevent moisture absorption, warping, fiber bloom, and delays fading.

Materials of Construction

EXTREN® is an engineered composite consisting of:

- Fiberglass rovings for increased strength
- Continuous strand mat for crosswise strength and impact resistance
- Synthetic surfacing veil for corrosion and UV protection
- Resin (specified by Series)

THE EXTREN® SERIES

EXTREN® is pultruded structural composite profiles and plate produced exclusively by Strongwell with the EXTREN® logo embedded in the surfacing veil. It meets or exceeds the minimum published mechanical, physical, electrical, flammability, and corrosive properties of the respective Series published in the *Strongwell Design Manual*.



EXTREN® Series 500

Premium Polyester Resin, UV inhibitor added
Standard Color: olive green
A general purpose resin with excellent corrosion properties



EXTREN® Series 525

Premium Polyester Resin, UV inhibitor added, Flame retardant additives
Standard Color: slate gray
A general purpose resin with excellent corrosion properties and improved fire performance



EXTREN® Series 600

Premium Vinyl Ester Resin, UV inhibitor added
Standard Color: light gray
For harsher corrosive environments and higher temperature applications



EXTREN® Series 625

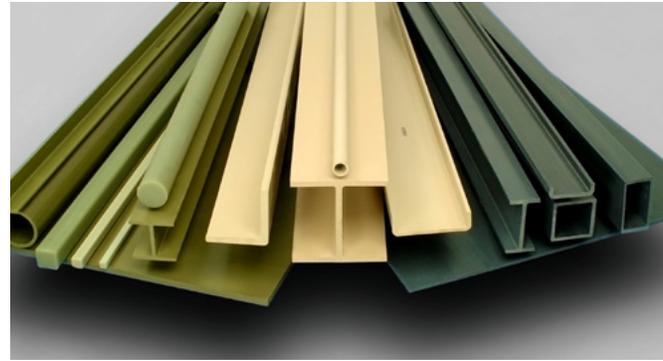
Premium Vinyl Ester Resin, UV inhibitor added, Flame retardant additives
Standard Color: beige
For harsher corrosive environments, higher temperature applications, with improved fire performance

EXTREN® Series 900

In addition to the above EXTREN® products, Strongwell manufactures custom pultrusions. These pultrusions vary from EXTREN® in either shape, resin type, or reinforcement (type, amount, location and/or orientation). Designers may choose to vary one or all of these parameters to improve strength, temperature resistance, corrosion resistance, machinability, or some other characteristic. Consult Strongwell with specific needs or questions.

E23

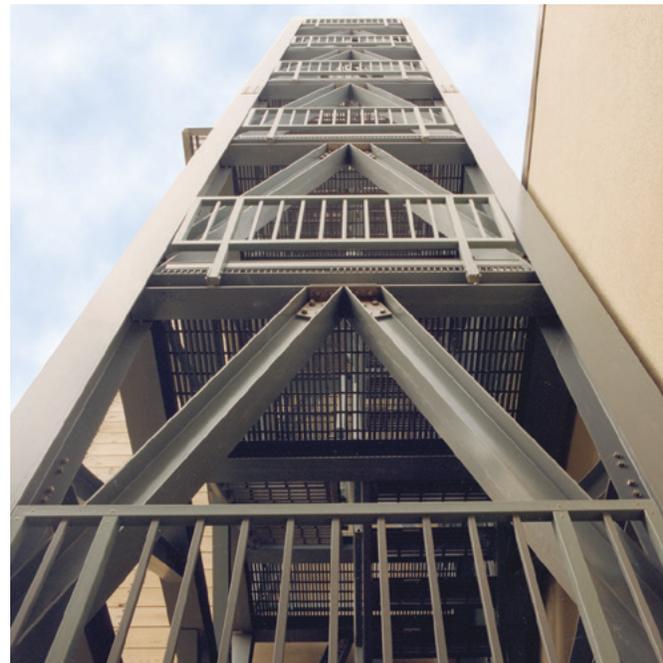
All standard EXTREN® products meet and/or exceed the structural requirements of E17 European standards. EXTREN® can be manufactured upon request to meet the mechanical and physical properties of BS EN 13706 (E23) European standards.



EXTREN® Series: (left to right) 500, 625, and 525.



EXTREN® structural shapes were used in a SXEW copper refinery because of the highly corrosive environment.



A 63' (19.2m) high freestanding fiberglass stair tower at Ft. Story Army Base, Virginia Beach, Virginia.

PROPERTIES

	ASTM TEST METHOD	UNITS/VALUE	SERIES 500/525 SHAPES	SERIES 600/625 SHAPES	SERIES 500/525 PLATE ④			SERIES 600/625 PLATE ④		
					1/8" 3.175mm	3/16" - 3/8" 4.76-9.5mm	1/2" - 1" 9.5-25.4mm	1/8" 3.175mm	3/16" - 1/4" 4.76-6.35mm	3/8" - 1" 9.5-25.4mm
MECHANICAL										
Tensile Stress, LW	D638	psi N/mm ²	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 N/mm ²	7,000 48.3	7,000 48.3	7,500 51.7	10,000 68.9	10,000 68.9	7,500 51.7	10,000 68.9	10,000 68.9
Tensile Modulus, LW	D638	10 ⁶ psi 10 ³ N/mm ²	2.5 17.2	2.6 17.9	1.8 12.4	1.8 12.4	1.8 12.4	1.8 12.4	1.8 12.4	1.8 12.4
Tensile Modulus, CW	D638	10 ⁶ psi 10 ³ N/mm ²	0.8 5.52	0.8 5.52	0.7 4.83	0.9 6.21	1.0 6.89	1.0 6.89	1.0 6.89	1.0 6.89
Compressive Stress, LW	D695	psi N/mm ²	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 N/mm ²	15,000 103	16,000 110	15,500 107	16,500 114	20,000 138	16,500 114	17,500 121	17,500 121
Compressive Modulus, LW	D695	10 ⁶ psi 10 ³ N/mm ²	2.5 17.2	2.6 17.9	1.8 12.4	1.8 12.4	1.8 12.4	1.8 12.4	1.8 12.4	1.8 12.4
Compressive Modulus, CW	D695	10 ⁶ psi N/mm ²	0.8 5.52	0.8 5.52	0.7 4.83	0.9 6.21	1.0 6.89	1.0 6.89	1.0 6.89	1.0 6.89
Flexural Stress, LW	D790	psi N/mm ²	30,000 207	30,000 207	24,000 165	24,000 165	24,000 165	24,000 165	24,000 165	24,000 165
Flexural Stress, CW	D790	psi N/mm ²	10,000 68.9	10,000 68.9	10,000 68.9	13,000 89.6	17,000 117	10,000 68.9	13,000 89.6	17,000 117
Flexural Modulus, LW	D790	10 ⁶ psi 10 ³ N/mm ²	1.6 11.0	1.6 11.0	1.1 7.58	1.1 7.58	1.4 9.65	1.1 7.58	1.1 7.58	1.4 9.65
Flexural Modulus, CW	D790	10 ⁶ psi 10 ³ N/mm ²	0.8 5.52	0.8 5.52	0.8 5.51	0.8 5.51	1.3 8.96	0.8 5.51	0.9 6.21	1.3 8.96
Modulus of Elasticity ①	full section	10 ⁶ psi 10 ³ N/mm ²	2.6 17.9	2.8 19.3	LW: 2.0 CW: 0.8 LW: 13.7 CW: 5.51	2.0 0.8 13.7 5.51	2.0 1.3 13.7 8.96	2.0 0.8 13.7 5.51	2.0 0.9 13.7 6.21	2.0 1.3 13.7 8.95
Modulus of Elasticity:	W & I shapes > 4" W & I shapes > 102mm	full section 10 ⁶ psi 10 ³ N/mm ²	2.5 17.2	2.5 17.2	- -	- -	- -	- -	- -	- -
Shear Modulus, LW ②③	D5379	10 ⁶ psi 10 ³ N/mm ²	0.425 2.93	0.425 2.93	- -	- -	- -	- -	- -	- -
Short Beam Shear, LW ④⑤	D2344	psi N/mm ²	4,500 31.0	4,500 31.0	- -	- -	- -	- -	- -	- -
Ultimate Bearing Stress, LW	D953	psi N/mm ²	30,000 207	30,000 207	32,000 221	32,000 221	32,000 221	32,000 221	32,000 221	32,000 221
Poisson's Ratio, LW ⑥	D3039	in/in mm/mm	0.33 0.33	0.33 0.33	0.31 0.31	0.31 0.31	0.31 0.31	0.32 0.32	0.32 0.32	0.32 0.32
Poisson's Ratio, CW ⑥	D3039	in/in mm/mm	- -	- -	0.29 0.29	0.29 0.29	0.29 0.29	0.24 0.24	0.24 0.24	0.24 0.24
Notched Izod Impact, LW	D256	ft-lbs/in J/mm	25 1.33	25 1.33	15 0.801	10 0.533	10 0.533	15 0.801	10 0.533	10 0.533
Notched Izod Impact, CW	D256	ft-lbs/in J/mm	4 0.214	4 0.214	5 0.267	5 0.267	5 0.267	5 0.267	5 0.267	5 0.267

	ASTM TEST METHOD	UNITS/VALUE	SERIES 500/525 SHAPES	SERIES 600/625 SHAPES	SERIES 500/525 PLATE ④			SERIES 600/625 PLATE ④		
					1/8" 3.175mm	3/16" - 3/8" 4.76-9.5mm	1/2" - 1" 9.5-25.4mm	1/8" 3.175mm	3/16" - 1/4" 4.76-6.35mm	3/8" - 1" 9.5-25.4mm
PHYSICAL *										
Barcol Hardness	D2583	-	45	45	40	40	40	40	40	40
24 hr Water Absorption ⑥	D570	% Max	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Density	D792	lbs/in ³	0.062-0.070	0.062-0.070	0.060-0.068	0.060-0.068	0.060-0.068	0.060-0.068	0.060-0.068	0.060-0.068
		10 ⁻³ g/mm ³	1.72-1.94	1.72-1.94	1.66-1.88	1.66-1.88	1.66-1.88	1.66-1.88	1.66-1.88	1.66-1.88
Coefficient of Thermal Expansion, LW ⑧	D696	10 ⁻⁶ in/in/°F	7	7	8	8	8	8	8	8
		10 ⁻⁶ mm/mm/°C	12	12	14.5	14.5	14.5	14.5	14.5	14.5
Coefficient of Thermal Expansion, CW ⑧	D696	10 ⁻⁶ in/in/°F	16	16	-	-	-	-	-	-
		10 ⁻⁶ mm/mm/°C	28.8	28.8	-	-	-	-	-	-
Thermal Conductivity ⑧	C177	BTU-in/ft ² /hr/°F	4	4	-	-	-	-	-	-
		W(m * °K)	0.58	0.58	-	-	-	-	-	-

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

ELECTRICAL

Arc Resistance, LW ⑧	D495	seconds	120	120	-	-	-	-	-	-
Dielectric Strength, LW ⑧	D149	KV/in	35	35	35	35	35	35	35	35
		KV/mm	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
Dielectric Strength, PF ⑧	D149	volts/mil	200	200	200	-	-	250	-	-

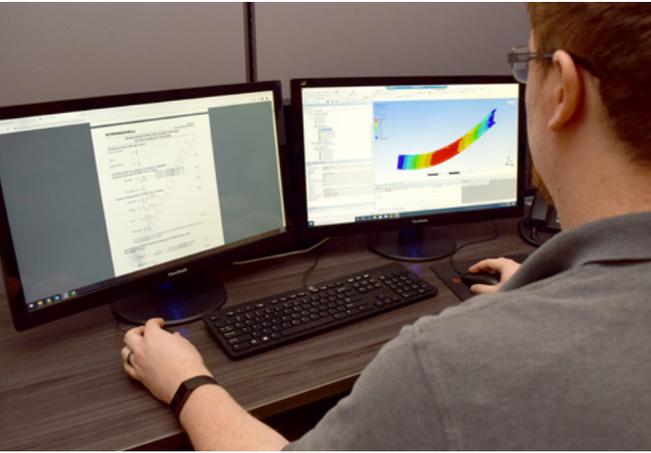
FLAMMABILITY ⑤

Flammability Classification	UL 94	V-0								
Tunnel Test	E84	25 Max								
NBS Smoke Chamber	E662	650-700 (Typical)								
Flammability	D635	Self Extinguishing								
UL Thermal Index	Generic	266°F								
		130°C								
British Fire Test	BS 476-7	Class 1								

- ① This value is determined from full section simple beam bending of EXTREN® structural shapes.
- ② The Shear Modulus value has been determined from tests with full sections of EXTREN® structural shapes. (See Strongwell's *Design Manual* for further information.)
- ③ Value would be 50 if the surfacing veil were not there.
- ④ Plate compressive stress/modulus measured edgewise and flexural stress/modulus measured flatwise.
- ⑤ Values apply to Series 525 and 625 (≥ 1/8" thickness).
- ⑥ Measured as a percentage maximum by weight.
- ⑦ Span to depth ratio of 3:1; EXTREN® angles will have a minimum value of 4000 psi and the I/W shapes are tested in the web.
- ⑧ Typical values.

LW - Lengthwise
 CW - Crosswise
 PF - Perpendicular to laminate face

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, when combined with the use of Strongwell fiberglass products, results in structures of superior, cost-effective design and structural integrity. Strongwell provides drawings of any of its designed-in-house structures for approval before fabrication begins.

Design It Yourself

The Strongwell Design Manual, developed by Strongwell, is the most complete reference guide in the industry for designing FRP structures and is used by more engineers and architects than any other FRP engineering guide. With more than 400 pages of engineering data, the Design Manual includes properties of materials, beam and column load tables, empirical design equations and sample calculations, connection details, and FRP product and fabrication specifications. Strongwell's Design Manual can be found online at www.strongwell.com. It is based upon years of extensive product testing and experience in monitoring applications of EXTREN® fiberglass structural shapes, fiberglass grating, handrail and other proprietary pultruded products.

Pick document type: Imperial | Metric

DESIGN MANUAL >

TITLE	DATE MODIFIED	
Preface	5/16/13 @ 11:43pm	>
1-The Basics	4/26/19 @ 8:58am	>
2-Introduction to EXTREN	4/02/19 @ 2:52pm	>
3-Properties of EXTREN	7/25/19 @ 8:31am	>
4-Availability List	3/09/15 @ 10:07am	>
5-Tolerances	5/16/13 @ 11:49pm	>
6-Elements of Sections	4/10/17 @ 3:20pm	>
7-Safety Factors	5/16/13 @ 10:08pm	>
8-Flexural Members		
9-Compression Members		
10-Fiberglass Plate		
11-FIBREBOLT		

PLEASE SIGN-IN TO CONTINUE

Strongwell Login

Username or Email: _____

Password: _____

Remember Me

SIGN IN

FORGOT PASSWORD?

REGISTER FOR STRONGWELL DESIGN TOOLS

Strongwell's Design Manual is found online at www.strongwell.com for easy 24-hour access to the most up-to-date design information. Register your email address and information; you'll receive access immediately via email.

WARNING!

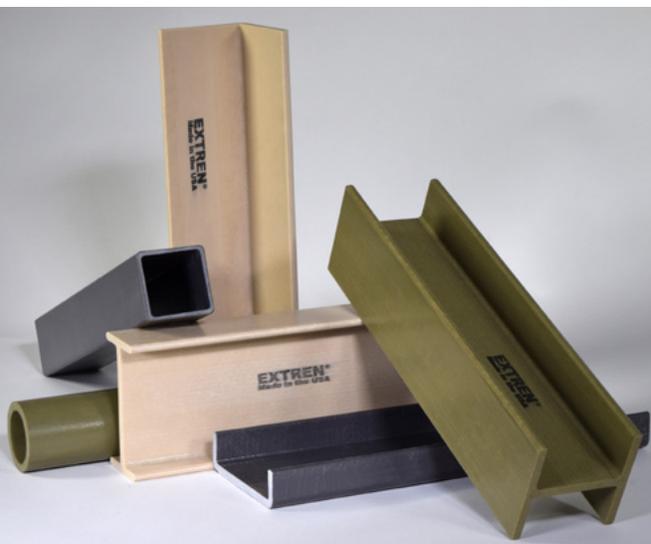
Fiberglass reinforced thermoset plastic composites are non-homogenous materials (i.e., their strengths and behavior are dependent upon the design of the composite and reinforcement). Other fiberglass structural shapes with a similar exterior appearance to EXTREN® shapes are likely not equal in any other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

EXTREN® Product Logo

Since July 1, 1993, all EXTREN® fiberglass structural shapes and plate have been imprinted with the "EXTREN® Made in the USA" 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.

Fabrication

Working with EXTREN® is somewhat similar to working with wood, but there are some differences in cutting and fastening. These differences are presented in detail in the *EXTREN® Fabrication and Repair Manual*. This manual also presents the cleaning, inspection, maintenance, and repair of EXTREN® structural shapes.



QUALITY AND AVAILABILITY

Strongwell manufacturing facilities are ISO 9001 certified. This ensures the highest quality standards for every piece of EXTREN® used in the field. A “first article” series of tests on each EXTREN® production run assures that the structural members meet or exceed published minimum criteria.

With a 10,000 square-foot on-site R&D laboratory and full-time R&D staff, Strongwell can perform most testing procedures, material qualifications, and quality experiments in house. These resources provide Strongwell, its customers, and suppliers unmatched technical expertise.

Strongwell maintains a large inventory of many commonly-used EXTREN® structural shapes and plate. Refer to the *Strongwell Availability List* for more details.



Clockwise from Above: Strongwell's Instron 5984 Materials Testing Machine with Environmental Chamber is a state-of-the-art piece of equipment.

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

Rheology/DMA to determine glass transition temperature and other viscoelastic properties of resin mixes as well as solid composites.

Strongwell can perform incoming resin tests to verify the suppliers' conformance to specified requirements.

Differential Scanning Calorimetry (DSC) for profiling the cure characteristics of resin mixes.

Below: Strongwell maintains a large inventory of many commonly-used EXTREN® structural shapes and plate. Refer to the *Strongwell Availability List* for more details.



MARKETS

Strongwell works every day to provide solutions to tough engineering and design challenges like the examples shown here. As engineers become aware of the features and benefits of pultrusion, the range of applications for composite materials continues to grow.



Architectural

Strongwell manufactures numerous products used in the architectural market, including walkways and handrail, to fully customized shapes like the one above, Strongwell's fiberglass pultrusions are strong, lightweight, corrosion resistant, and durable.



Building / Construction

The EXTREN® line includes over 100 standard shapes, and Strongwell manufactures hundreds of other profiles used in building and construction, which have been used to save weight, increase corrosion resistance, provide aesthetic beauty, and reduce maintenance costs.



Cellular

EXTREN® is often an ideal material for building anywhere that electro-magnetic (EMI) or radio frequency interference (RFI) is a concern. Strongwell FRP has been used extensively for applications ranging from architectural screening to entire structures - FRP is nearly invisible to cellular and radio frequencies.



Coastal / Marine

Fiberglass handrail, pultruded grating, decking, and EXTREN® from Strongwell offer an attractive, low-maintenance and long-lasting alternative to steel and wood in corrosive marine and freshwater environments.



Electric Utility

The high strength to weight ratio, low electrical conductivity and proven durability of Strongwell's FRP make it an attractive option for electric utilities seeking to upgrade or install new materials.



Hotel / Motel

Constant maintenance at hotel and motel facilities have driven many operators to select Strongwell FRP to replace traditional materials, especially in exterior handrail, stairways, walkways, and water play areas.



Chemical Processing

The superior corrosion resistance of Strongwell FRP makes it an excellent choice around most harsh chemicals in a variety of environments. In addition, Strongwell offers a vast Corrosion Resistance Guide to help end users determine the expected performance of FRP in their application(s).



Infrastructure

Strongwell is actively involved in the advancement of FRP technology for civil infrastructure applications. These efforts include the research and development of new products as well as in the establishment of engineering and performance standards.



Transportation

Incorporating FRP into structures and designs reduces the overall structure weight and foundational requirements. Installation can also be much faster and less complicated, reducing congestion in work zones and improving safety.



Mining

Engineers and end users are replacing traditional materials with FRP in corrosive mining environments. FRP provides lower life cycle costs, offers outstanding performance and provides superior quality.



Air Pollution Control

Odor control covers made with traditional materials weigh significantly more than those made with FRP. Strongwell's odor control covers weigh up to 75% less than steel and 30% less than aluminum, and offer superior corrosion resistance in the chemical-laden wastewater processing setting.



Food & Beverage

The processing of many foods and beverages creates significant corrosion and food safety challenges for end users. Many Strongwell products can be manufactured to meet NSF-61 certification for hot and cold, while offering exceptional corrosion performance in most food processing environments.



Water / Wastewater

Strongwell offers a wide range of fiberglass products for the water and wastewater treatment industries, including NSF compliant structures for use in potable water systems. For example, EXTREN® structural shapes are often used with FRP baffles for an all-FRP system.



Oil & Gas

Strongwell's structural composites have proven to be an effective long-term solution in the Oil and Gas market. Weight savings, durability, and resistance to salt air and seawater are just a few of the benefits which fiberglass composites provide over steel.



Parks & Recreation

Strongwell's pultruded fiberglass materials can replace wood and metal to help reduce maintenance costs, reduce downtime and increase the beauty of parks and recreational areas, especially in areas which currently require frequent maintenance.

Innovative Solutions in Fiberglass



GEF INCORPORATED

6497 Winfield Rd
Winfield, WV 25213
(Office) 304-755-1600
(Toll Free) 800-784-0529
(Fax) 304-755-3150
www.gefinc.com