

COUPON PROPERTIES

TEMPERATURE AND WEATHERING

Design Considerations for Fiberglass Pultrusion When Exposed to Continuous High Temperatures

Property loss is experienced in Fire Retardant (FR), Polyester, and Vinylester Fiberglass pultrusion when exposed to continuous high temperatures. The loss of properties should be considered during the designing stages. The following table shows the percentage of property retention at certain continuous temperatures.

	TEMPERATURE	FR/POLYESTER	VINYLESTER
ULTIMATE STRESS	100° F (37°C)	85%	90%
	125° F (51°C)	70%	80%
	150° F (65°C)	50%	80%
	175° F (79°C)	NOT RECOMMENDED	75%
	200° F (93°C)	NOT RECOMMENDED	50%
MODULUS OF ELASTICITY	100° F (37°C)	100%	100%
	125° F (51°C)	90%	95%
	150° F (65°C)	85%	90%
	175° F (79°C)	NOT RECOMMENDED	88%
	200° F (93°C)	NOT RECOMMENDED	85%

Weathering

After exposure to outdoor weathering, almost all plastics undergo some degradation in surface appearance.

The surface of pultrusions typically have good water and ambient temperature resistance, but are attacked by ultraviolet light.

Ultraviolet light is the light spectrum 290 to 400 nanometers. The light has higher energy and can significantly degrade polymers by breaking chemical bonds or starting chemical reactions that lead to polymer degradation. Fire retardant polyester formulations, which contain a halogen, are typically more susceptible to ultraviolet light degradation, due to the halogen additive.

Ultraviolet light will cause the surface of the pultrusion to fade (yellow) and lose gloss. Over a longer period of time, fiberglass closest to the surface will be exposed. This condition is known as fiberbloom. Physical Properties are not affected by this surface degradation.

Bedford Reinforced Plastics, Inc. adds a UV stabilizer to our resin mix formulation. This slows the affects of UV degradation. We also incorporate a layer of polyester veil directly to the surface of the pultrusion during processing. This veil gives a resin rich surface and acts as a barrier between the surface and the top layer of fiberglass reinforcement. Pigments used in our resin formulations also slow the affects of weathering. The best method to protect the pultrusion from the affects of outdoor weathering is to apply a protective coating. Urethane based paints can be used.

TYPICAL COUPON PROPERTIES

Below are test results for typical coupon properties of Bedford Reinforced Plastics' structural fiberglass profiles (Standard, Fire Retardant, & Vinylester shapes). Properties are derived per the ASTM test method shown. Synthetic surfacing veil and ultraviolet inhibitors are standard.

MECHANICAL PROPERTIES	ASTM	ENGLISH		METRIC	
		Units	Value	Units	Value
Tensile Stress, LW	D-638	psi	30,000	MPa	206.8
Tensile Stress, CW	D-638	psi	7,000	MPa	48.2
Tensile Modulus, LW	D-638	10 ⁶ psi	2.5	GPa	17.2
Tensile Modulus, CW	D-638	10 ⁶ psi	.8	GPa	5.5
Compressive Stress, LW	D-695	psi	30,000	MPa	206.8
Compressive Stress, CW	D-695	psi	15,000	MPa	103.4
Compressive Modulus, LW	D-695	10 ⁶ psi	2.5	GPa	17.2
Compressive Modulus, CW	D-695	10 ⁶ psi	1.0	GPa	6.9
Flexural Stress, LW	D-790	psi	30,000	MPa	206.8
Flexural Stress, CW	D-790	psi	10,000	MPa	68.9
Flexural Modulus, LW	D-790	10 ⁶ psi	1.8	GPa	12.4
Flexural Modulus, CW	D-790	10 ⁶ psi	.8	GPa	5.5
Modulus of Elasticity, E	Full Section	10 ⁶ psi	2.8	GPa	19.3
Shear Modulus	—	10 ⁶ psi	0.450	GPa	3.1
Short Beam Shear	D-2344	psi	4,500	MPa	31.0
Punch Shear	D-732	psi	10,000	MPa	68.9
Notched Izod Impact, LW	D-256	ft.-lbs./in.	25	J/mm	1.33
Notched Izod Impact, CW	D-256	ft.-lbs./in.	4	J/mm	.21
PHYSICAL PROPERTIES					
Barcol Hardness	D-2583	—	45	—	45
24 Hour Water Absorbtion	D-570	% max.	0.45	% max.	0.45
Density	D-792	lbs./in. ³	.062-.070	g/cc	1.72-1.94
Coefficient of Thermal Expansion, LW	D-696	10 ⁶ in./in./°F	4.4	10 ⁶ cm./cm./°C	8
ELECTRICAL PROPERTIES					
Arc Resistance, LW	D-495	seconds	120	seconds	120
Dielectric Strength, LW	D-149	kv./in.	35	kv./mm	1.37
Dielectric Strength, PF	D-149	volts/mil.	200	volts/mil.	200
Dielectric Constant, PF	D-150	@60hz	5	@60hz	5

Fire Retardant Polyester and Fire Retardant Vinylester Structural Profiles:

FLAMMABILITY PROPERTIES	ASTM	Units	Value
Tunnel Test	E-84	Flame Spread	25 max.
Flammability	D-635	—	Nonburning
UL	94	VO	
NBS Smoke Chamber	E-662	Smoke Density	600-700

LW = Lengthwise

CW = Crosswise

PF = Perpendicular to Laminate Face



TYPICAL PROPERTIES OF THREADED ROD / NUTS

Bedford Reinforced Plastics' threaded rod and nuts are manufactured using premium vinylester resin containing UV inhibitors. The properties listed below are the result of the ASTM test method indicated.

PROPERTIES	ASTM	UNITS English <i>Metric</i>	VALUE (Diameter - Threads Per Inch (UNC))				
			3/8-16 <i>9.5mm</i>	1/2-13 <i>12.7mm</i>	5/8-11 <i>15.9mm</i>	3/4-10 <i>19.0mm</i>	1-8 <i>25.4mm</i>
Ultimate Transverse Shear (Double Shear)	B-565	lb. <i>Newton</i>	4,200 <i>18,680</i>	6,800 <i>30,240</i>	10,000 <i>44,480</i>	13,400 <i>59,600</i>	24,000 <i>106,750</i>
Longitudinal Compressive Strength	D-695	psi <i>MPa</i>	50,000 <i>344</i>	50,000 <i>344</i>	50,000 <i>344</i>	50,000 <i>344</i>	50,000 <i>344</i>
Flexural Strength	D-790	psi <i>MPa</i>	70,000 <i>482</i>	70,000 <i>482</i>	70,000 <i>482</i>	70,000 <i>482</i>	70,000 <i>482</i>
Flexural Modulus	D-790	psi x 10 ⁶ <i>GPa</i>	2.5 <i>17.2</i>	2.5 <i>17.2</i>	2.5 <i>17.2</i>	2.5 <i>17.2</i>	2.5 <i>17.2</i>
Flammability	D-635	Self-extinguishing for all					
Fire Retardant	E-84	Class 1					
Water Absorption (24 hr. immersion)	D-570	% max.	0.8	0.8	0.8	0.8	0.8
Longitudinal Coefficient of Thermal Expansion	D-696	10 ⁻⁶ in./in./°F <i>10⁻⁶ mm/mm/°C</i>	6 <i>11</i>	6 <i>11</i>	6 <i>11</i>	6 <i>11</i>	6 <i>11</i>
Ultimate Thread Shear using fiberglass nut	--	lb. <i>Newton</i>	1,200 <i>5,337</i>	2,400 <i>10,670</i>	3,600 <i>16,010</i>	4,000 <i>17,790</i>	8,200 <i>36,470</i>
Ultimate Torque Strength fiberglass nut lubricated with SAE 10W30 motor oil		ft.-lb. <i>NewtonMeter</i>	8 <i>10</i>	16 <i>21</i>	35 <i>47</i>	50 <i>67</i>	110 <i>149</i>
Rod Weight	--	lb./ft. <i>Kg./m</i>	0.07 <i>0.104</i>	0.14 <i>0.119</i>	0.2 <i>0.297</i>	0.3 <i>0.447</i>	0.5 <i>0.789</i>
Nut Weight	--	lb. <i>grams</i>	0.01 <i>4.5</i>	0.02 <i>9.1</i>	0.04 <i>18.1</i>	0.06 <i>27.2</i>	0.14 <i>63.6</i>
Nut Dimensions	--	in. (square) x in. (thick) <i>mm. (square) x mm. (thick)</i>	.68 x .45 <i>17.2x11.4</i>	.86 x .56 <i>21.8x14.2</i>	1.06 x .69 <i>26.9x17.5</i>	1.24 x .82 <i>31.5x20.8</i>	1.63 x 1.1 <i>41.4x27.9</i>
Color	Gray						

TYPICAL PROPERTIES OF ROD, BAR, AND FLATSTRIP

Below are test results for typical coupon properties of Bedford Reinforced Plastics' Rod, Bar, and Flatstrip reinforced with all unidirectional longitudinal fiberglass roving. Properties are derived per the ASTM test method shown.

MECHANICAL PROPERTIES	ASTM	UNITS	ROD	BAR	FLATSTRIP
Tensile Stress	D-638	psi <i>MPa</i>	90,000 <i>620.5</i>	80,000 <i>165.5</i>	90,000 <i>620.5</i>
Tensile Modulus	D-638	10 ⁶ psi <i>GPa</i>	5.0 <i>34.7</i>	4.0 <i>27.6</i>	5.0 <i>34.7</i>
Compressive Stress	D-695	psi <i>MPa</i>	60,000 <i>413.7</i>	50,000 <i>344.7</i>	50,000 <i>344.7</i>
Flexural Stress	D-790	psi <i>MPa</i>	100,000 <i>689.5</i>	90,000 <i>620.5</i>	100,000 <i>689.5</i>
Flexural Modulus	D-790	10 ⁶ psi <i>GPa</i>	6.0 <i>41.4</i>	4.5 <i>31.0</i>	4.5 <i>31.0</i>
Barcol Hardness	D-2583		60	60	60
Izod Impact	D-256	ft-lbs/in <i>J/mm</i>	40 <i>2.14</i>	40 <i>2.14</i>	40 <i>2.14</i>
Density	D-792	lbs/in ³ <i>gr/cc</i>	.065-.075 <i>1.80-2.07</i>	.065-.075 <i>1.80-2.07</i>	.065-.075 <i>1.80-2.07</i>
Water Absorption (24 hour) D-570	%	0.2	0.2	0.2	

TYPICAL COUPON PROPERTIES OF FLAT SHEET

Below are test results for typical coupon properties of Bedford Reinforced Plastics' Standard, Fire Retardant and Vinylester Flat Sheet. Properties are derived per the ASTM test method shown. Synthetic surfacing veil and ultraviolet inhibitors are standard.

MECHANICAL PROPERTIES	ASTM	UNITS	THICKNESS (ENGLISH - METRIC)					
			STD & FR			VE		
			1/8" - 3.2	3/16"-1/4" - 4.8 - 6.4	3/8"-1" - 9.5-25.4	1/8" - 3.2	3/16"-1/4" - 4.80-6.4	3/8"-1" - 9.5-25.4
Tensile Stress, LW	D-638	psi - MPa	24,000 - 165.5	24,000 - 165.5	24,000 - 165.5	24,000 - 165.5	24,000 - 165.5	24,000 - 165.5
Tensile Stress, CW	D-638	psi - MPa	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	D-638	10 ⁶ psi - GPa	2.0 - 13.8	2 - 13.8	2.0 - 13.8	2.0 - 13.8	2.0 - 13.8	2.0 - 13.8
Tensile Modulus, CW	D-638	10 ⁶ psi - GPa	1.0 - 6.9	1.1 - 7.6	1.4 - 9.6	1.0 - 6.9	1.1 - 7.6	1.4 - 9.6
Compressive Stress, LW	D-695	psi - MPa	24,000 - 165.5	24,000 - 165.5	24,000 - 165.5	24,000 - 165.5	24,000 - 165.5	24,000 - 165.5
Compressive Stress, CW	D-695	psi - MPa	15,500 - 106.9	16,500 - 113.8	16,500 - 113.8	16,500 - 113.8	17,500 - 120.7	17,500 - 120.7
Compressive Modulus, LW	D-695	10 ⁶ psi - GPa	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	D-695	10 ⁶ psi - GPa	1.0 - 6.9	1.0 - 6.9	1.0 - 6.9	1.0 - 6.9	1.0 - 6.9	1.0 - 6.9
Flexural Stress, LW	D-790	psi - MPa	35,000 - 241.3	35,000 - 241.3	30,000 - 206.8	35,000 - 241.3	35,000 - 241.3	30,000 - 206.8
Flexural Stress, CW	D-790	psi - MPa	15,000 - 103.4	15,000 - 103.4	18,000 - 124.1	15,000 - 103.4	15,000 - 103.4	18,000 - 124.1
Flexural Modulus, LW	D-790	10 ⁶ psi - GPa	1.6 - 11.0	2.0 - 13.8	2.0 - 13.8	1.6 - 11.0	2.0 - 13.8	2.0 - 13.8
Flexural Modulus, CW	D-790	10 ⁶ psi - GPa	0.9 - 6.2	1.1 - 7.6	1.4 - 9.6	0.9 - 6.2	1.1 - 7.6	1.4 - 9.6
Perpendicular Shear Stress, LW	D-3846	psi - MPa	6,000 - 41.3	6,000 - 41.3	6,000 - 41.3	6,000 - 41.3	6,000 - 41.3	6,000 - 41.3
Perpendicular Shear Stress, CW	D-3846	psi - MPa	6,000 - 41.3	6,000 - 41.3	6,000 - 41.3	6,000 - 41.3	6,000 - 41.3	6,000 - 41.3
Bearing Stress, LW	D-953	psi - MPa	32,000 - 220.6	32,000 - 220.6	32,000 - 220.6	32,000 - 220.6	32,000 - 220.6	32,000 - 220.6
Notched Izod Impact, LW	D-256	ft-lbs/in-J/mm	18.5 - 0.99	20 - 1.1	20 - 1.1	18.5 - 1.0	20 - 1.1	20 - 1.06
Notched Izod Impact, CW	D-256	ft-lbs/in-J/mm	5 - 0.27	5 - 0.3	5 - 0.3	5 - 0.3	5 - 0.3	5 - 0.27
PHYSICAL PROPERTIES								
Barcol Hardness	D-2583	----	40.0	40.0	40.0	40.0	40.0	40.0
24 Hour Water Absorption	D-570	% max.	0.6	0.6	0.6	0.6	0.6	0.6
Density	D-792	lbs./in. ³ g/cc	.062-.070 1.72-1.94	.062-.070 1.72-1.94	.062-.070 1.72-1.94	.062-.070 1.72-1.94	.062-.070 1.72-1.94	.062-.070 1.72-1.94
Coefficient Thermal Expansion, LW	D-696	10 ⁻⁶ in./in./F	4.4	4.4	4.4	4.4	4.4	4.4
Coefficient Thermal Expansion, CW	D-696	10 ⁻⁶ mm/mm/°C	8.0	8.0	8.0	8.0	8.0	8.0
ELECTRICAL PROPERTIES								
Arc Resistance, LW	D-495	seconds seconds	120.0 120.0	120.0 120.0	120.0 120.0	120.0 120.0	120.0 120.0	120.0 120.0
Dielectric Strength, LW	D-149	kv./in. kv./mm	35 1.37	35 1.37	35 1.37	35 1.37	35 1.37	35 1.37
Dielectric Strength, PF	D-149	volts/mil. volts/mil.	200.0 200.0	200.0 200.0	200.0 200.0	200.0 200.0	200.0 200.0	200.0 200.0
FLAMMABILITY PROPERTIES FOR FR & VE								
Tunnel Test	E-84	Flame Spread 25 max.						
Flammability	D-635	Nonburning						
UL	94	VO						
NBS Smoke Chamber	E-662	Smoke Density 600-700						

LW = Lengthwise

CW = Crosswise

PF = Perpendicular to Laminate Face

