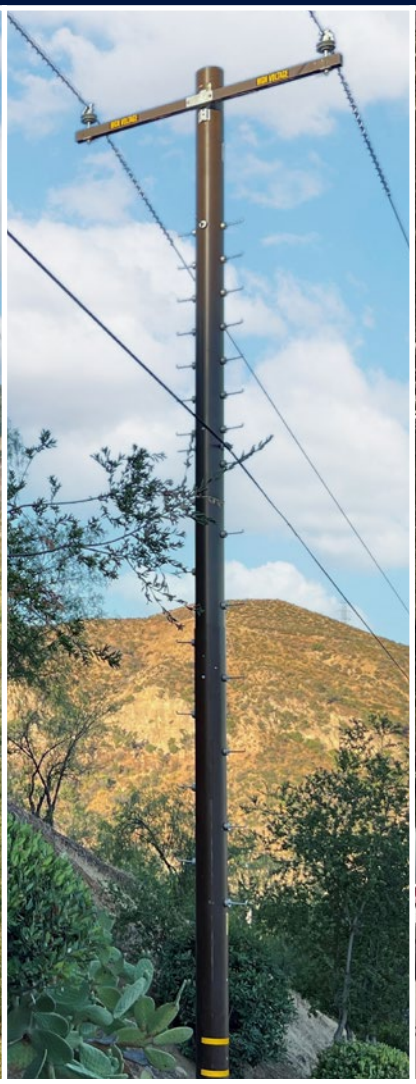
CREATIVE COMPOSITES GROUP

StormStrong® Composite Poles

Transmission & Distribution, Light & Telecom Poles Engineered To Outperform

StormStrong®
COMPOSITE POLES

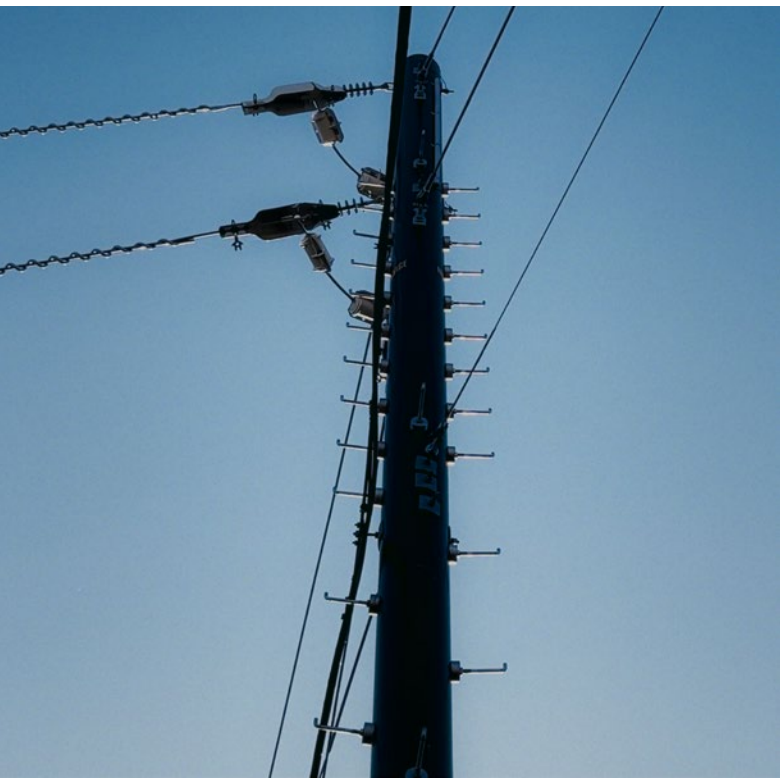
Presenting Our Full Product Line of

Transmission Poles

StormStrong transmission poles are manufactured with a toughened polyester resin and reinforced with high-strength electrical grade glass fiber matrix. Our transmission poles are engineered for both standard use and grid-hardening applications.

CCG provides custom-fabricated composite utility poles to meet your strength and stiffness requirements. We offer transmission poles ranging from Class 1 through H6, in various lengths. Our poles are classified as ANSI O5.1 wood equivalent poles and are backed by more than three decades of data on their success and reliability.

FRP poles feature a low coefficient of variation and high reliability compared to traditionally treated wood poles. Most customers choose our poles over wood, steel or concrete since our poles do not rot, rust, spall, succumb to termites or woodpeckers, leach chemicals or additives into the environment or water table that could harm humans.



Distribution Poles

CCG provides pultruded composite utility poles, custom fabricated to meet your strength and stiffness requirements. We offer FRP composite distribution poles ranging from Class 10 through 1, up to 80 feet in length. The poles are classified as ANSI O5.1 wood equivalent poles.

CCG's full-line of utility poles are round and with a constant cross section. Pole diameters range from 8" up to 18" with a wall thickness ranging from ¼" up to ¾".

Composite utility poles are manufactured with fire retardant additives for optimal performance in the event the pole is exposed to fire. StormStrong poles will self-extinguish once the fuel source of the fire has been eliminated. In fact, the poles self-extinguished in less than eight seconds during full section fire testing performed by Southwest Research. All standard utility poles manufactured by CCG will pass UL94 with a V0 rating, ASTM E84 with a Class A rating and ASTM D635 with a "Self-Extinguishing" rating.

StormStrong Composite Poles

Light Poles

CCG manufactures direct burial light poles with added features, including hand holes and adaptors for National Electrical Manufacturer Association (NEMA) standard electrical boxes. Our light poles are engineered to withstand extreme weather, have high reliability compared to other light poles and are ideal for coastal regions. The hollow light poles are available in multiple lengths and are strength-rated based on the ANSI O5.1 pole classification.

The poles have inherent fire-retardant attributes and are considered self-extinguishing per ASTM D635 with a flammability classification of V0 per UL94. The 10" diameter by 3/8" wall (TU440) pultruded round pole weighs just 10.3 lbs/ft.

The direct burial poles can be backfilled with concrete, pole set foam, soil or gravel. Surface-mounted National Cooperative Highway Research Program (NCHRP) approved break-away and standard bases are available upon request. The poles are available in multiple colors: brown-gray, light gray and brown - custom colors are available and minimum quantities and color match charges apply to custom color orders.

Telecommunications Poles

CCG manufactures telecommunications poles with features including hand holes and adaptors for National Electrical Manufacturer Association (NEMA) standard electrical boxes. Our telecommunications poles are engineered to withstand extreme weather, have high reliability and are ideal for storm-prone coastal regions and areas like the Midwest and Northeast exposed to deicing salts.

All FRP poles are approved for direct burial. The will never rot or corrode. Our poles have inherent fire-retardant attributes and are considered self-extinguishing per ASTM D635 with a flammability classification of (V0) per UL94.

The poles can be backfilled with concrete, pole-set foam, soil or gravel. We offer surface-mounted options that align with the Surface-mounted National Cooperative Highway Research Program (NCHRP). Break-away and standard bases are available upon request. The poles are available in multiple colors: brown-gray, light gray and brown. Custom colors are available upon request. Minimum quantities and color match charges apply to custom color orders.

Sectional Poles

CCG has FRP splices available to use StormStrong poles as sectional (2)+ module poles. The splices are available for all round pole profiles and will be delivered with the splice attached to (1) of the StormStrong pole modules. Designed to transfer 100% of the moment capacity of the corresponding pole profile, sectional pole systems are advantageous for remote access and dense urban environment installations. For more information regarding sectional poles, please contact your CCG outside sales representative. Sectional pole assemblies can be individually designed to fit your specific utility or telecom application.

H-Frame Structures

CCG has designed and manufactured H-Frame structures for utility companies across the United States. The StormStrong round 16" x ½" TU460 and StormStrong round 18" x ¾" TU466 profiles are suitable for transmission line loads and H-Frame Structures. These pole profiles are available in software libraries such as PLS pole to design H-Frame structures and CCG offers H-Frame structure design recommendations for specific loading scenarios. CCG also has pultruded crossarms and X-bracing systems to be used in an H-Frame system. If you are interested in more information regarding H-Frame structures, please contact your CCG outside sales representative.

CCG StormStrong Pole libraries are available for PLS Pole, O-Calc Pro, Poleforeman, DDS and other pole design software. Libraries can be downloaded via software company websites, the CCG website or by contacting CCG directly.

FireStrong™ Self-Monitoring Composite Pole System

The FireStrong high fire risk StormStrong pole is protected by a highly fire-retardant round sleeve that covers the standard fire-resistant CCG StormStrong utility pole. The engineered sleeve, consisting of a custom patented composite fire barrier system, protects the base FRP pole from excessive heat generated during a typical chaparral fire.

Why Is This Important?

A typical right-of-way fire, on the west coast, is caused by burning grasses, brush or trees during the dry season. It is estimated that a typical wildfire can create a temperature profile between 1600°F and 2100°F for up to three minutes dependent upon the amount of fuel and the speed of the fire.

If the pultruded composite pole is shielded from heat more than that slightly above the glass transition temperature, no permanent loss of strength is observed, meaning the pole can be kept in service and will be structurally sound.

How Do We Know The Temperature The Pole Reached During A Fire Event?

A permanent irreversible temperature monitoring system is placed against the standard Stormstrong pole and under the fire protection insulating sleeve. The system constantly monitors the temperature and permanently records the highest temperature observed on the surface of the StormStrong pole during a fire event.

The irreversible temperature recorder can be visually inspected post fire and the max temperature of the FireStrong utility pole, protected by the insulating fire-resistant sleeve, can be observed.

The maximum recorded temperature is evaluated against a temperature vs strength retention chart specific to the standard StormStrong pole. Based on the temperature induced during the fire event, the pole strength retention is determined. The utility can decide to repair the insulating composite sleeve and keep the pole in service or replace the entire pole structure. The decision can be made based on the strength retention which is directly related to the recorded temperature.

Fire Resistant Pole System being tested.

Post Fire Inspection Irreversible Temperature Measuring Device Access Cover Plate.

How Does The Utility Inspect The Pole?

The utility will remove one or all four access covers, which house irreversible temperature recorders. The recorders are positioned approximately two feet above the ground line which coincides with the maximum moment location. The recorders are visually evaluated to determine the maximum recorded temperature.

Irreversible Temperature Measuring Device after fire exposure, viewed through the fire protection sleeve.

The uncompromised FRP pole after the charred outer sleeve has been removed post-fire.

A technology that protects the Fiberglass Reinforced Polymer (FRP) Pole from fire damage and allows the utility to determine what the strength retention of the pole is after a fire event

Why Choose StormStrong Composite Poles?

Advanced Materials Like FRP Provide Advantages Over Traditional Poles

Although much newer than wood, FRP utility poles are a mature product well beyond first-generation technology, backed by more than three decades of data on its success and reliability. FRP poles are more available than wood utility poles and should be considered superior to wood for many other reasons. StormStrong utility poles offer superior strength and resiliency as well as the ability to be produced sustainably on-demand with shorter delivery times.

RESILIENCY

FRP poles are ideal for grid reliability enhancement. They are resilient in terms of being able to take a significant load during a major event and returning to their normal state. Very high strength and moderate modulus of elasticity values equate to significant area under the load vs displacement curve. The area under the curve is a direct indicator of the toughness or work energy absorbing capacity of a material. FRP poles can absorb about 10x more impact energy than a similar steel pole and 2x more than a wood pole.

ENVIRONMENTAL PRODUCT DECLARATION

StormStrong poles have achieved a cradle-to-gate Environment Product Declaration (EPD) from BRE Global. The parameters of this cradle-to-gate EPD include primary energy use as well as resource-use including, materials, fuels and water. BRE Global is internationally recognized for its expertise in Life Cycle Assessment (LCA). Having worked closely with industry to develop the Green Guide and Environmental Profiles Certification Scheme.

THE STRENGTH OF FRP

Unlike wood poles, our StormStrong poles are an engineered composite product with a low coefficient of strength variation. Pultruded FRP utility poles feature high reliability when compared to standard treated wood poles. The National Electric Safety Code recognized FRP materials in 2007. The NESC strength factors for FRP poles are the same as steel for Grade B and C construction. Additionally, CCG offers advanced features like StormStrong, FireStrong and ShieldStrong™ to enhance your grid even further.

LONG SERVICE LIFE

The projected service life for our utility and telecommunications poles is 75 years. Composite utility poles will not rot, spall or corrode due to the environment. Wood poles have been known to lose a significant amount of their strength when exposed to harsh wet environments. Our StormStrong FRP poles are engineered to maintain most of their original strength and stiffness throughout their service life.

NO DANGEROUS PESTICIDES OR PRESERVATIVES

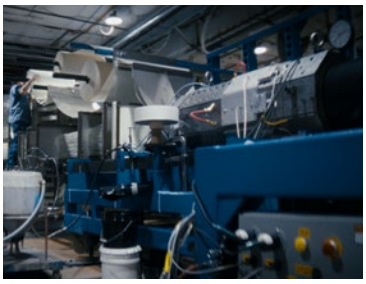
StormStrong utility and telecom poles help communities support their sustainability goals by protecting the environment. Unlike treated wood poles, composite utility poles contain no dangerous pesticides or chemicals that will leach into the environment or cause occupational hazards. Ideal for school yard, downtown, highly occupied areas, aquifer and watershed applications.

COMPOSITE POLE SAFETY

Composite poles are one of the safest types of poles for workers to transport, install and maintain due to the lightweight properties of FRP. The lighter weight of FRP allows for ease of handling and installation. According to (OSHA Standard 65997-17-3) dust from cutting FRP utility poles does not present a health hazard. The particles produced when drilling or cutting FRP in the field are too large to cause respiratory problems for utility workers.

ENGINEERED POLES

CCG's utility poles are an engineered product. The engineered Stormstrong poles are manufactured in a production plant and exhibit a strength coefficient of variation of 5% or less when tested per ANSI O5.1. CCG's pultrusion production facility is ISO 9001:2015 certified for production and design.



PEST PROTECTION

StormStrong FRP poles are unaffected by termites, woodpeckers & bees. Animals in remote areas do more harm to wood poles than people realize and they can do a lot of damage very fast. Woodpeckers bore holes in poles to get at the termites within and bees can make homes in the holes left behind. Since FRP is resistant to vermin–this advantage pays for itself by reducing the frequency of replacements and lowering future installation costs.

LIGHTWEIGHT POLES

StormStrong poles engineered to be strong and lightweight. They are ideal for transporting into areas with limited ground access and remote installations like helicopter sets. Each 45-ft Class 2 StormStrong Pole weighs under 500 lbs. and can be carried by a group of linemen into areas that would otherwise be inaccessible for a wooden utility pole. FRP Poles are approved through RUS on a case-by-case basis per installation. Consult CCG for assistance with application for RUS approval.

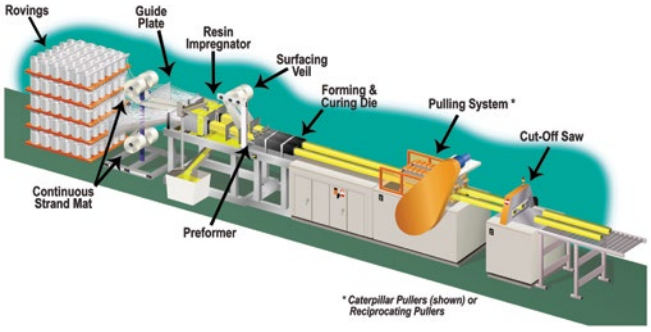
COLOR & UV PROTECTION

The distribution and transmission poles are manufactured in standard low gloss Brown RAL8014 or Light Gray RAL7044 color options. All utility, light and telecommunications poles include ShieldStrong the most advanced UV protection in the in the industry. ShieldStrong UV coating is permanently bonded to our poles increasing durability. Custom colors for StormStrong poles are available upon request. Consult your Sales Representative or Inside Account Manager for details or customization questions.

Pole Construction

High Quality Pultrusion Manufacturing

StormStrong poles are manufactured by pultrusion. Pultrusion is a continuous manufacturing process utilized to make composite profiles with constant cross-sections whereby fiberglass reinforcements, in the form of roving continuous filament and engineered fabric mats, are saturated with resin and guided into a heated die. Once in the die, the polymerization process takes place and the profile exits the die in a solid state and in the form of the desired cross-section.



1. E-glass Reinforcements

All composite utility poles are manufactured with electrical grade E-glass reinforcements in the form of unidirectional roving, Continuous Filament Mat (CFM) and stitched fabric mats. All E-glass reinforcements meet a minimum tensile strength of 290 ksi per ASTM D2343.

2. Resin/Matrix

The FRP poles are manufactured with a high-performance thermoset resin system exhibiting superior strength, toughness and fire-resistant properties. Thermoset resins used for the manufacturing process of StormStrong poles are typically of vinyl ester or polyester chemistry. FireStrong poles, designed for high fire prone areas, are typically manufactured with vinyl ester chemistry.

3. ShieldStrong UV Protection

CCG's composite utility poles contain three layers of UV protection. First, CCG adds light stabilizers to each pole. The light stabilizers are mixed into the thermoset resin, prior to production and function as long term thermal and light stability promoters. Second, the composite utility poles are encapsulated with a 10-mil polyester surfacing veil. The 10-mil veil creates a resin rich surface and protects the glass reinforcements from fiber blooming. Third, the poles are UV protected with ShieldStrong, an advanced UV coating developed specifically to maximize the service life of poles installed in high UV radiation zones.

4. HDPE Pole Cap

The flat HDPE pole cap has been engineered to prevent rodent and insect infestation in the pole. The UV resistant thermoplastic FRP caps are custom molded to snugly fit the poles. They provide foundation support to keep the hollow pole from shearing into the soil. The caps can be easily removed and reassembled in the event you need to access the pole interior to pull ground wire or add ballast to the bottom of the pole to offset the center of gravity.

Pole Testing

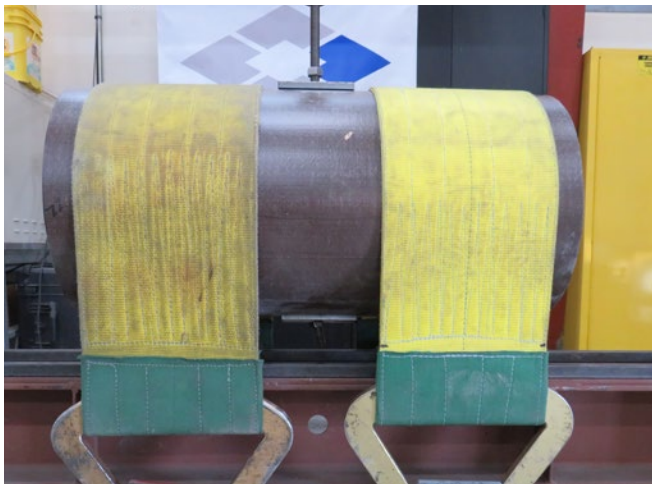
In addition to full section pole testing, other tests have been conducted to determine the pin bearing, washer pull through and guy attachment capacities. The capacities are published based on a 5% Lower Exclusion Limit (LEL). The 5% lower exclusion limit is a statistical term used to describe the lower limit of a given population. One could conclude, in general terms, if 100 poles were tested, 95 out of 100 poles would break at or above the load that is published.

The composite utility poles are tested both in house and at EDM International, Fort Collins, Colorado, in accordance with the principles set forth in the ASTM D1036 test procedure. Poles are tested in a horizontal cantilever arrangement with the butt-end placed inside a rigid test frame and held in position by 12-inch-wide nylon slings. The load cable is attached approximately two feet from the pole tip using a nylon strap. The load is applied at a constant rate of deformation using a winch. The winch is mounted on a trolley that moves along a track to keep the load perpendicular to the original pole axis. CCG's and EDM's test facilities are equipped with a pole holding fixture, loading system, electronic calibrated load and deflection measuring sensors and a calibrated computerized data acquisition system.

Pole & Connection Testing at EDM International, Fort Collins, CO

Guy Testing at EDM International

Bolt Bearing Testing at EDM International



Bolt Pull Through Testing at EDM International

The Following Charts Have Been Developed For Proper Pole Selection Based On Your Specific Requirements.

StormStrong Round Pole (Light) Mechanical & Physical Properties

Mechanical Properties	Round Pultruded Pole TU470 8"x1/4" Metric (203mm x 6.35mm)		Round Pultruded Pole TU440 10"x3/8" Metric (254mm x 9.52mm)		Round Pultruded Pole TU443 14"x0.410" Metric (356mm x 10.4mm)	
Flexural Strength per ASTM D1036 psi (Mpa) [3]	55,849	(385)	59,585	(411)	50,824	(350)
Compression Strength per ASTM D1036 psi (Mpa) [3]	55,849	(385)	59,585	(411)	50,824	(350)
Axial Compression Strength psi (Mpa) [3]	55,849	(385)	59,585	(411)	50,824	(350)
Ultimate Axial Compression Capacity (Short Column) lbf (kg) [3]	340,681	(154,530)	675,634	(306,462)	889,420	(403,434)
Average Modulus of Elasticity psi (Gpa) [4]	5.24E+06	(36.1)	6.31E+06	(43.5)	5.25E+06	(36.2)
Bending Stiffness (EI) per ASTM D1036 lbs▪in^2 (kg▪mm^2)	2.40E+08	(70E+09)	8.33E+08	(244E+09)	2.12E+09	(621E+09)
Ultimate Moment Capacity per ASTM D1036 lb-ft (kN▪m) [3]	53,231	(72)	130,590	(177)	204,751	(278)
Max. Bolt Torque lb▪ft (N▪m) [1]	50	(67.8)	50	(67.8)	50	(67.8)
Ultimate Pole Torque Strength, Calculated (lb▪ft) (N▪m)	19,655	(26,649)	45,739	(62,013)	99,120	(134,389)
Ultimate Pin Bearing Strength Lengthwise psi (Mpa) [2,3]	19,621	(135.3)	27,755	(191.4)	19,354	(133.4)
Ultimate Pin Bearing Strength Crosswise psi (Mpa) [2,3]	13,414	(92.5)	16,577	(114.3)	14,991	(103.4)
Ultimate Washer Pull Through Strength kips (kg) [3,5]	5.7	(2,585)	15.8	(7,157)	15.3	(6,944)
Ultimate Shear Capacity, Calculated (lbs) (kN) [3]	30,500	(136)	56,828	(253)	87,500	(389)
In-Plane Shear Strength per ASTM D5379 psi (Mpa) [3]	10,000	(68.9)	10,058	(69.3)	10,000	(68.9)
Physical Properties						
Moment of Inertia in^4 (mm^4)	46	(1.90E+07)	132	(5.49E+07)	404	(1.68E+08)
Section Modulus in^3 (mm^3)	11.4	(1.87E+05)	26.3	(4.31E+05)	58.0	(9.50E+05)
Radius of Gyration in (mm)	2.74	(69.6)	3.41	(86.6)	4.74	(120.40)
Weight lbs/ft (N/m)	5.6	(81.7)	10.3	(150.3)	15.1	(220.4)
Wall Thickness in (mm)	0.25	(6.35)	0.375	(9.53)	0.41	(10.41)
Coefficient of Thermal Expansion (CTE) Lengthwise in/in/°F	5.00E-06		5.00E-06		5.00E-06	
Water Absorption ASTM D570 (max)	<1.0% (24 hrs)		<1.0% (24 hrs)		<1.0% (24 hrs)	
Fiber Volume Fraction %	≥50%		≥50%		≥50%	
Cross Sectional Area in^2 (mm^2)	6.1	(3,935)	11.3	(7,290)	17.5	(11,290)
Surface Area ft^2/ft (m^2/m)	2.1	(0.64)	2.6	(0.79)	3.7	(1.12)
Fire Properties						
Flame Rating (UL 94)	V0 Self Extinguishing		V0 Self Extinguishing		V0 Self Extinguishing	
Flame Spread ASTM E-84	Class A 25 or less		Class A 25 or less		Class A 25 or less	
Electrical Properties						
ASTM F711 (100 kVAC per foot - 5 minutes dry)	Passed		Passed		Passed	
IEEE978 (75 kVAC per foot - 1 minute wet)	Passed		Passed		Passed	

Notes:
1. Max torque based on utilizing oversized steel washers.
2. Capacity based on testing conducted with 5/8" hardware for the TU470 and 3/4" hardware for all others.
3. Values have been factored based on a 5% Lower Exclusion Limit (LEL) per NESC 2007 requirements.
4. Modulus of elasticity value obtained from ASTM D3039 testing for TU440 & TU443. MOE value obtained from ASTM D1036 for TU470.
5. Capacity based on testing conducted with 4" x 3/8" square/radius washer for the TU470, 6"x3/8" square/radius washer for the TU440 and 6"x1/2" square/radius washer for the TU443.
6. Shear Values for TU470 & TU443 listed as conservative estimates.

StormStrong Round Pole (Heavy) Mechanical & Physical Properties

Mechanical Properties	Round Pultruded Pole TU450 12"x1/2" Metric (305mm x 12.7mm)		Round Pultruded Pole TU460 16"x1/2" Metric (406mm x 12.7mm)		Round Pultruded Pole TU466 18"x3/4" Metric (457mm x 19.1mm)	
Flexural Strength per ASTM D1036 psi (Mpa) [3]	58,825	(406)	50,984	(352)	62,182	(429)
Compression Strength per ASTM D1036 psi (Mpa) [3]	58,825	(406)	50,984	(352)	62,182	(429)
Axial Compression Strength psi (Mpa) [3]	58,825	(406)	50,984	(352)	62,182	(429)
Ultimate Axial Compression Capacity (Short Column) lbf (kg) [3]	1,064,732	(482,954)	1,238,911	(561,961)	2,524,589	(1,145,134)
Average Modulus of Elasticity psi (Gpa)	5.84E+06	(40.2)	5.52E+06	(38.0)	4.94E+06	(34.0)
Bending Stiffness (EI) per ASTM D1036 lbs▪in^2 (kg▪mm^2)	1.75E+09	(.511E+12)	4.04E+09	(1.18E+12)	7.48E+09	(2.19E+12)
Ultimate Moment Capacity per ASTM D1036 lb-ft (kN▪m) [3]	244,124	(331)	388,752	(527)	872,066	(1,182)
Max. Bolt Torque lb▪ft (N▪m) [1]	50	(67.8)	50	(67.8)	50	(67.8)
Ultimate Pole Torque Strength, Calculated (lb▪ft) (N▪m)	82,662	(112,075)	185,343	(251,291)	277,525	(376,273)
Ultimate Pin Bearing Strength Lengthwise psi (Mpa) [2,3]	24,585	(169.5)	20,087	(138.5)	29,974	(206.7)
Ultimate Pin Bearing Strength Crosswise psi (Mpa) [2,3]	14,063	(97.0)	12,399	(85.5)	14,000	(96.5)
Ultimate Washer Pull Through Strength kips (kg) [3,5]	18.9	(8,573)	20.2	(9,163)	25.0	(11,340)
Ultimate Shear Capacity, Calculated (lbs) (kN) [3]	86,428	(384)	143,212	(637)	192,850	(858)
In-Plane Shear Strength per ASTM D5379 psi (Mpa) [3]	9,550	(65.8)	11,787	(81.3)	9,500	(65.5)
Physical Properties						
Moment of Inertia in^4 (mm^4)	299	(1.24E+08)	732	(3.05E+08)	1515	(6.31E+08)
Section Modulus in^3 (mm^3)	49.8	(8.16E+05)	91.5	(1.50E+06)	168.3	(2.76E+06)
Radius of Gyration in (mm)	4.07	(103.38)	5.48	(139.19)	6.10	(154.94)
Weight lbs/ft (N/m)	15.6	(227.7)	21	(306.5)	35.6	(519.5)
Wall Thickness in (mm)	0.5	(12.70)	0.5	(12.70)	0.75	(19.05)
Coefficient of Thermal Expansion (CTE) Lengthwise in/in/°F	5.00E-06		5.00E-06		5.00E-06	
Water Absorption ASTM D570 (max)	<1.0% (24 hrs)		<1.0% (24 hrs)		<1.0% (24 hrs)	
Fiber Volume Fraction %	≥50%		≥50%		≥50%	
Cross Sectional Area in^2 (mm^2)	18.1	(11,677)	24.3	(15,677)	40.6	(26,193)
Surface Area ft^2/ft (m^2/m)	3.1	(0.94)	4.2	(1.28)	4.7	(1.44)
Fire Properties						
Flame Rating (UL 94)	V0 Self Extinguishing		V0 Self Extinguishing		V0 Self Extinguishing	
Flame Spread ASTM E-84	Class A 25 or less		Class A 25 or less		Class A 25 or less	
Electrical Properties						
ASTM F711 (100 kVAC per foot - 5 minutes dry)	Passed		Passed		Passed	
IEEE978 (75 kVAC per foot - 1 minute wet)	Passed		Passed		Passed	

Notes:
1. Max torque based on utilizing 6"x1/2" steel washers.
2. Capacity based on testing conducted with 3/4" hardware.
3. Values have been factored based on a 5% Lower Exclusion Limit (LEL) per NESC 2007 requirements.
4. Modulus of elasticity value obtained from ASTM D3039 testing for TU450 & TU460. MOE value obtained from ASTM D1036 for TU466.
5. Capacity based on testing conducted with 6"x1/2" square/radius steel washers.
6. TU466 coupon testing values are listed as equivalents to TU450 due to similar glass fiber volume fractions within laminate.

Distribution & Light Pole Selection Guide

Load Chart Based on the 2007 NESC Code

Pole Strength Classification	Pole Length: FT		25	30	35
	Moment Length: FT		18.0	22.5	27.5
	POLE CLASS	Tip Load: lbs	Moment lb-ft	Moment lb-ft	Moment lb-ft
ANSI O5.1	5	1900	34200	42750	52250
Wood Pole with NESC .85 Strength Reduction Factor (Grade C)	5	1615	29070	36338	44413
Wood Pole with NESC .65 Strength Reduction Factor (Grade B)	5	1235	22230	27788	33963
ANSI O5.1	4	2400	43200	54000	66000
Wood Pole with NESC .85 Strength Reduction Factor (Grade C)	4	2040	36720	45900	56100
Wood Pole with NESC .65 Strength Reduction Factor (Grade B)	4	1560	28080	35100	42900
ANSI O5.1	3	3000	54000	67500	82500
Wood Pole with NESC .85 Strength Reduction Factor (Grade C)	3	2550	45900	57375	70125
Wood Pole with NESC .65 Strength Reduction Factor (Grade B)	3	1950	35100	43875	53625
ANSI O5.1	2	3700	66600	83250	101750
Wood Pole with NESC .85 Strength Reduction Factor (Grade C)	2	3145	56610	70763	86488
Wood Pole with NESC .65 Strength Reduction Factor (Grade B)	2	2405	43290	54113	66138
ANSI O5.1	1	4500	81000	101250	123750
Wood Pole with NESC .85 Strength Reduction Factor (Grade C)	1	3825	68850	86063	105188
Wood Pole with NESC .65 Strength Reduction Factor (Grade B)	1	2925	52650	65813	80438
ANSI O5.1	H1	5400	97200	121500	148500
Wood Pole with NESC .85 Strength Reduction Factor (Grade C)	H1	4590	82620	103275	126225
Wood Pole with NESC .65 Strength Reduction Factor (Grade B)	H1	3510	63180	78975	96525

Round Pole Section	X-sectional Area (in^2)	Average Ultimate Moment Capacity (lb-ft)	NESC 5% LEL Moment Capacity	Weight lbs/ft of pole	Moment of Inertia (in^4)
8 in Dia. x 1/4" Round Pole TU470 (See Note 4.0)	6.1	57,812	53,231	5.6	46
Pole Tip Deflection (inches) per Every 1000 lbs Applied at Pole Tip			16	31	55
10 in Dia. x 3/8" Round Pole TU440	11.3	144,041	130,590	10.3	132
Pole Tip Deflection (inches) per Every 1000 lbs Applied at Pole Tip			5	9	16
14 in Dia. x 0.410" Wall Round Pole TU443	17.5	244,729	204,751	15.1	404.5
Pole Tip Deflection (inches) per Every 1000 lbs Applied at Pole Tip			2	4	6
Refer to the Heavy Distribution & Transmission Pole Selection Chart					

Notes:
1.0 Charts are based on pole tip load/bending strength. Serviceability may control pole selection.
2.0 The ANSI O5.1 row is compared against the average ultimate strength of an FRP pole.
3.0 The Grade B and Grade C equivalency rows are compared against the 5% LEL strength of an FRP pole.
4.0 Larger Transmission poles can be selected for the poles identified in the white boxes.

The Distribution & Light Pole and Heavy Distribution & Transmission Load Charts are based upon ANSI O5.1 wood pole class strength requirements. The pole classes range from 5 to 1 (Distribution & Light Poles) and 1 to H6 (Heavy Distribution & Transmission), with H6 being more stringent. The poles are classified by the class number. The class number is based upon the strength rating of the pole in terms of the ultimate tip load that will cause the pole to fail. The tip location is defined as a location two feet below the top of the pole. The pole is considered to be buried in the ground at a level that represents 10% of the pole length plus an additional 2 ft. The ultimate moment capacity is based upon the moment arm length and the tip load. For example, a 45′ pole has an effective moment arm of 36.5′ derived as 45′-[(45x10%)+2′+2′] = 36.5′.

The FRP poles have been classed the same as wood for simplicity. However, FRP poles are much more reliable than wood poles and should be selected based on reliability. The FRP poles are an engineered product and when tested exhibit a low coefficient of variation, less than 5%. Wood poles exhibit a coefficient of variation of 20%. Fiberglass poles and crossarms have been added to the NESC as having the same reliability as steel and prestressed-concrete poles.

The resulting strength factor is 1.0 as described in Table 261-1 of the NESC. Wood requires a strength factor of .65 and .85 for grade B and C construction respectively. What does this mean to the Utility Engineer? An FRP pole with lower pole class strengths can be selected that will have the same reliability or better than a wood pole. In order to directly compare wood poles to FRP poles the NESC code should be utilized and the coefficient of variations between the wood and FRP poles should be considered.

The Distribution & Light Pole and Heavy Distribution & Transmission Charts contain three lines per Pole Class within the Pole Strength Classification column. The top line contains the tip load and class requirement when comparing an average strength FRP pole directly to an average strength wood pole without any consideration to reliability. The second and third lines consider the wood pole tip load requirements with a .85 and .65 strength reduction factor respectively. The

40	45	50	55
32.0	36.5	41.0	45.5
Moment lb-ft	Moment lb-ft	Moment lb-ft	Moment lb-ft
60800	69350	77900	86450
51680	58948	66215	73483
39520	45078	50635	56193
76800	87600	98400	109200
65280	74460	83640	92820
49920	56940	63960	70980
96000	109500	123000	136500
81600	93075	104550	116025
62400	71175	79950	88725
118400	135050	151700	168350
100640	114793	128945	143098
76960	87783	98605	109428
144000	164250	184500	204750
122400	139613	156825	174038
93600	106763	119925	133088
172800	197100	221400	245700
146880	167535	188190	208845
112320	128115	143910	159705

Section Modulus (in^3)	Radius of Gyration (in)	Modulus of Elasticity (psi)	5% LEL Bending Stress at Failure (psi)
11.4	2.74	5.24E+06	55,849
86	126	178	
26.3	3.41	6.31E+06	59,585
25	36	51	69
58	4.81	5.25E+06	50,824
10	14	20	27

equivalent FRP pole capacities for lines two and three, within each pole class, have been published based on 5% LEL values. According to the NESC code, the FRP pole should be selected based on the classification of construction grade. For example, a Class Three FRP to wood equivalent pole for grade B construction only needs a tip capacity of 1,950 lbs to have the same reliability as a class three wood pole which requires a tip capacity of 3,000 lbs.

In the event you do not know your grade of construction, the grade C reduction factor of .85 should be applied to wood pole strength requirement in order to economically select a FRP pole.

The columns within the spreadsheet are set up based on various pole lengths. The proper FRP pole should be selected based on the color and the moment described in each cell. The pole selected should have a pole class moment lower than the 5% LEL moment published in the Round Pole Section Table located at the bottom of the chart. The section properties, moment capacities and 5% LEL bending strengths have been noted at the bottom of the chart. If additional information is required, please reference the StormStrong Round Pole Mechanical & Physical Properties on Page 12 and 13.

Please note that serviceability and or connection capacities may dictate the appropriate pole selection.

Heavy Distribution & Transmission Pole Selection Guide

Load Chart Based on the 2007 NESC Code

Pole Strength Classification	Pole Length: FT		50	55	60
	Moment Length: FT		41.0	45.5	50.0
	POLE CLASS	Tip Load: lbs	Moment lb-ft	Moment lb-ft	Moment lb-ft
ANSI O5.1	1	4500	184500	204750	225000
Wood Pole with NESC .85 Strength Reduction Factor (Grade C)	1	3825	156825	174038	191250
Wood Pole with NESC .65 Strength Reduction Factor (Grade B)	1	2925	119925	133088	146250
ANSI O5.1	H1	5400	221400	245700	270000
Wood Pole with NESC .85 Strength Reduction Factor (Grade C)	H1	4590	188190	208845	229500
Wood Pole with NESC .65 Strength Reduction Factor (Grade B)	H1	3510	143910	159705	175500
ANSI O5.1	H2	6400	262400	291200	320000
Wood Pole with NESC .85 Strength Reduction Factor (Grade C)	H2	5440	223040	247520	272000
Wood Pole with NESC .65 Strength Reduction Factor (Grade B)	H2	4160	170560	189280	208000
ANSI O5.1	H3	7500	307500	341250	375000
Wood Pole with NESC .85 Strength Reduction Factor (Grade C)	H3	6375	261375	290063	318750
Wood Pole with NESC .65 Strength Reduction Factor (Grade B)	H3	4875	199875	221813	243750
ANSI O5.1	H4	8700	356700	395850	435000
Wood Pole with NESC .85 Strength Reduction Factor (Grade C)	H4	7395	303195	336473	369750
Wood Pole with NESC .65 Strength Reduction Factor (Grade B)	H4	5655	231855	257303	282750
ANSI O5.1	H5	10000	410000	455000	500000
Wood Pole with NESC .85 Strength Reduction Factor (Grade C)	H5	8500	348500	386750	425000
Wood Pole with NESC .65 Strength Reduction Factor (Grade B)	H5	6500	266500	295750	325000
ANSI O5.1	H6	11400	467400	518700	570000
Wood Pole with NESC .85 Strength Reduction Factor (Grade C)	H6	9690	397290	440895	484500
Wood Pole with NESC .65 Strength Reduction Factor (Grade B)	H6	7410	303810	337155	370500

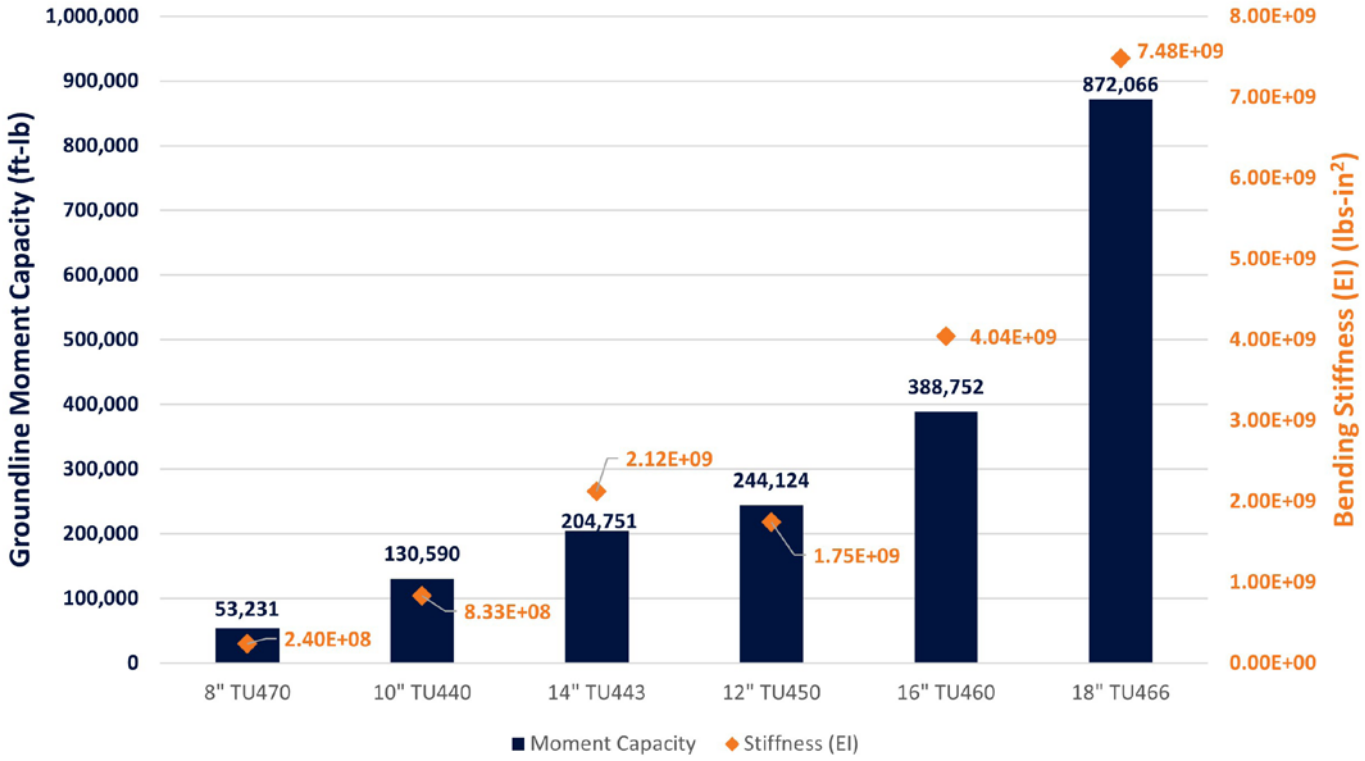
Round Pole Section		X-sectional Area (in^2)	Average Ultimate Moment Capacity (lb-ft)	NESC 5% LEL Moment Capacity	Weight lbs/ft of pole
14 in Dia. x .410" Wall Round Pole TU443		17.5	244,729	204,751	15.1
Pole Tip Deflection (inches) per Every 1000 lbs Applied at Pole Tip			20	27	36
12 in Dia. x 1/2" Round Pole TU450		18.1	262,009	244,124	15.9
Pole Tip Deflection (inches) per Every 1000 lbs Applied at Pole Tip			24	33	44
16 in Dia. x 1/2" Round Pole TU460		24.3	400,368	388,752	21.3
Pole Tip Deflection (inches) per Every 1000 lbs Applied at Pole Tip			11	14	19
18 in Dia. X 3/4" Wall Round Pole TU466		40.6	1,042,339	872,066	35.6
Pole Tip Deflection (inches) per Every 1000 lbs Applied at Pole Tip			6	8	10

Notes:
1.0 Charts are based on pole tip load/bending strength. Serviceability may control pole selection.
2.0 The ANSI O5.1 row is compared against the average ultimate strength of an FRP pole.
3.0 The Grade B and Grade C equivalency rows are compared against the 5% LEL strength of an FRP pole.

65	70	75	80	85	90	95	100
54.5	59.0	63.5	68.0	72.5	77.0	81.5	86.0
Moment lb-ft	Moment lb-ft	Moment lb-ft	Moment lb-ft	Moment lb-ft	Moment lb-ft	Moment lb-ft	Moment lb-ft
245250	265500	285750	306000	326250	346500	366750	387000
208463	225675	242888	260100	277313	294525	311738	328950
159413	172575	185738	198900	212063	225225	238388	251550
294300	318600	342900	367200	391500	415800	440100	464400
250155	270810	291465	312120	332775	353430	374085	394740
191295	207090	222885	238680	254475	270270	286065	301860
348800	377600	406400	435200	464000	492800	521600	550400
296480	320960	345440	369920	394400	418880	443360	467840
226720	245440	264160	282880	301600	320320	339040	357760
408750	442500	476250	510000	543750	577500	611250	645000
347438	376125	404813	433500	462188	490875	519563	548250
265688	287625	309563	331500	353438	375375	397313	419250
474150	513300	552450	591600	630750	669900	709050	748200
403028	436305	469583	502860	536138	569415	602693	635970
308198	333645	359093	384540	409988	435435	460883	486330
545000	590000	635000	680000	725000	770000	815000	860000
463250	501500	539750	578000	616250	654500	692750	731000
354250	383500	412750	442000	471250	500500	529750	559000
621300	672600	723900	775200	826500	877800	929100	980400
528105	571710	615315	658920	702525	746130	789735	833340
403845	437190	470535	503880	537225	570570	603915	637260

Moment of Inertia (in^4)	Section Modulus (in^3)	Radius of Gyration (in)	Modulus of Elasticity (psi)	5% LEL Bending Stress at Failure (psi)			
404	58.0	4.74	5.25E+06	50,824			
46	59	73	89				
299	49.8	4.07	5.84E+06	58,825			
56	71	88	108	131	156	185	
732	91.5	5.48	5.52E+06	50,984			
24	31	38	47	57	68	80	94
1515	168.3	6.11	4.94E+06	62,182			
13	17	21	25	31	37	43	51

StormStrong Utility Pole Moment Capacity & Stiffness Chart



The above chart shows each StormStrong composite pole and the pole's corresponding groundline moment capacity (based on 5% lower exclusion limit strength values) and bending stiffness (based on average modulus of elasticity values). This chart provides a graphical representation of the wide range of CCG's current StormStrong composite pole offerings.

Guying FRP Poles

The guy capacity of StormStrong FRP poles is dictated by the pin bearing strength of the FRP material, the wall thickness and the diameter of the bolt(s) being utilized in the connection.

The Utility Engineer is encouraged to use the pole guy charts below for determining the optimal pole guy connection for the guy load scenario.

The charts are set up for general guy loads ranging from 5,000 lb to 20,000 lb per connection. The guy angle is an important consideration that influences the diameter and number of fasteners required for the connection. In the event that a particular guy scenario does not fit the chart parameters, a custom design can be detailed based on the pin bearing strengths dictated in the mechanical and physical property sheets and by following the recommended edge distances spelled out in the Bolted Connections section on Page 22.

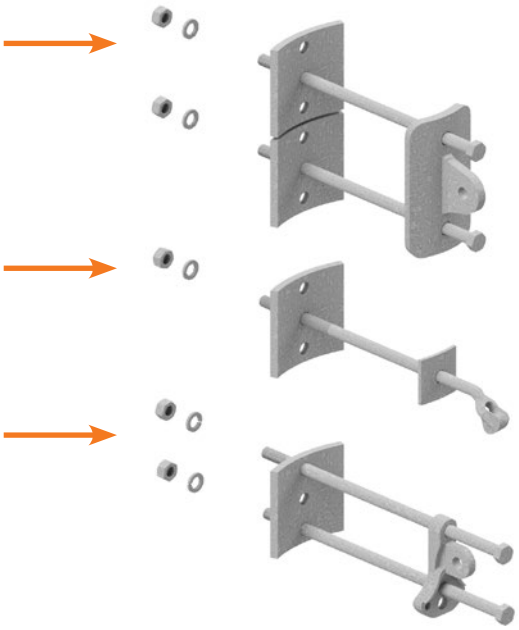
StormStrong Distribution and Light Pole Guy Chart

Guy Load per attachment (lbs)	Guy Angle Ø	Guy Attachment Vertical Component Load (lbs)	8 in Dia. x 1/4" Round Pole TU470		10 in Dia. x 3/8" Round Pole TU440		14 in Dia. x 0.410" Round Pole TU443	
			Number of 5/8" Bolts Required in Attachment	Number of 3/4" Bolts Required in Attachment	Number of 5/8" Bolts Required in Attachment	Number of 3/4" Bolts Required in Attachment	Number of 5/8" Bolts Required in Attachment	Number of 3/4" Bolts Required in Attachment
5,000	15	4,830	1.6	1.3	0.7	0.6	1.0	0.8
5,000	30	4,330	1.4	1.2	0.7	0.6	0.9	0.7
5,000	45	3,536	1.2	1.0	0.5	0.5	0.7	0.6
7,500	15	7,244	2.4	2.0	1.1	0.9	1.5	1.2
7,500	30	6,495	2.1	1.8	1.0	0.8	1.3	1.1
7,500	45	5,303	1.7	1.4	0.8	0.7	1.1	0.9
10,000	15	9,659	3.2	2.6	1.5	1.2	1.9	1.6
10,000	30	8,660	2.8	2.4	1.3	1.1	1.7	1.5
10,000	45	7,071	2.3	1.9	1.1	0.9	1.4	1.2
15,000	15	14,489	4.7	3.9	2.2	1.9	2.9	2.4
15,000	30	12,990	4.2	3.5	2.0	1.7	2.6	2.2
15,000	45	10,607	3.5	2.9	1.6	1.4	2.1	1.8

StormStrong Heavy Distribution & Transmission Pole Guy Chart

Guy Load per attachment (lbs)	Guy Angle Ø	Guy Attachment Vertical Component Load (lbs)	12 in Dia. x 1/2" Round Pole TU450		16 in Dia. x 1/2" Round Pole TU460		18 in Dia. x 3/4" Round Pole TU466	
			Number of 5/8" Bolts Required in Attachment	Number of 3/4" Bolts Required in Attachment	Number of 5/8" Bolts Required in Attachment	Number of 3/4" Bolts Required in Attachment	Number of 5/8" Bolts Required in Attachment	Number of 3/4" Bolts Required in Attachment
7,500	15	7,244	0.9	0.8	1.1	0.9	0.5	0.4
7,500	30	6,495	0.8	0.7	1.0	0.8	0.5	0.4
7,500	45	5,303	0.7	0.6	0.8	0.7	0.4	0.3
10,000	15	9,659	1.3	1.0	1.5	1.3	0.7	0.6
10,000	30	8,660	1.1	0.9	1.3	1.1	0.6	0.5
10,000	45	7,071	0.9	0.8	1.1	0.9	0.5	0.4
15,000	15	14,489	1.9	1.6	2.3	1.9	1.0	0.9
15,000	30	12,990	1.7	1.4	2.0	1.7	0.9	0.8
15,000	45	10,607	1.4	1.2	1.7	1.4	0.8	0.6
20,000	15	19,319	2.5	2.1	3.0	2.5	1.4	1.1
20,000	30	17,321	2.3	1.9	2.7	2.2	1.2	1.0
20,000	45	14,142	1.8	1.5	2.2	1.8	1.0	0.8

StormStrong 3-Hole Curved Washer & Guy Hardware



6" Spacing Guy Attachment BOM:
(1) FAB887 - Dead End Tee
(2) 20" x 3/4" Bolt A325 or 5 SAE Grade
(2) FAB186 - 3/4" Nuts A325 or 5 SAE Grade
(2) FAB187 - 3/4" Lock/Spring Washers
(4) FAB449 - 6" x 5.75" x 1/2" Curved Washer

Single Bolt Guy Attachment BOM:
(1) Bent Thimble Bolt, 3/4" Diameter
(1) 3" Square Curved washer
(1) FAB186 - 3/4" Nuts A325 or 5 SAE Grade
(1) FAB187 - 3/4" Lock/Spring Washers
(2) FAB449 - 6" x 5.75" x 1/2" Curved Washer

4" Spacing Guy Attachment BOM:
(1) Pole Eye Plate
(2) 20" x 3/4" Bolt A325 or 5 SAE Grade
(2) FAB186 - 3/4" Nuts A325 or 5 SAE Grade
(2) FAB187 - 3/4" Lock/Spring Washers

NOTE: Detail shown for clarification purposes only. Hardware lengths and sizes are selected according to pole diameter and hardware dimensions. Consult manufacturer for alternate hardware availability.

Round Pole - TU460 16" dia.

3-Hole Curved Washers

Corresponding StormStrong Pole	Radius	Hole Dia.	Height	Width	Thickness	Part #
TU440 (10" dia)	5"	13/16"	5 3/4"	6"	3/8"	FAB549
TU440 (10" dia)	5"	11/16"	5 3/4"	6"	3/8"	FAB886
TU450 (12" dia)	6"	13/16"	5 3/4"	6"	1/2"	FAB448
TU450 (12" dia)	6"	11/16"	5 3/4"	6"	1/2"	FAB884
TU443 (14" dia)	7"	13/16"	5 3/4"	6"	1/2"	FAB896
TU443 (14" dia)	7"	11/16"	5 3/4"	6"	1/2"	FAB903
TU460 (16" dia)	8"	13/16"	5 3/4"	6"	1/2"	FAB449
TU460 (16" dia)	8"	11/16"	5 3/4"	6"	1/2"	FAB885
TU466 (18" dia)	9"	13/16"	5 3/4"	6"	1/2"	FAB897

Contact CCG for Autocad and Inventor part files

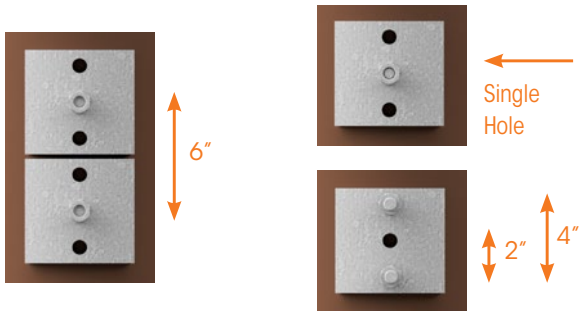
Galvanized Steel Wire Strengths

Nominal Dia. (in)	Construction	Minimum Breaking Load (lbs)	
		Utilities Grade	Extra High Strength Grade
9/32	1 x 7	4,600	8,950
5/16	1 x 7	6,000	11,200
3/8	1 x 7	11,500	15,400
7/16	1 x 7	18,000	20,800
1/2	1 x 7	25,000	26,900

Represents typical strengths

The 3-hole curved washer system allows for attachment of traditional guy hardware to StormStrong Utility Poles with vertical hole spacings of 2", 4" and 6". For hardware with hole spacings exceeding 6", best practice is to match-fit the spacing with washer center-holes. The 6"x 5.75"x 1/2" curved washers are mounted on the pole face opposite to guy attachments to distribute applied loads across the pole surface.

A single curved washer can be used to accommodate attachments that require only (1) center hole or 2" and 4" hole spacings. Two curved washers can be used to accommodate attachments with 6" and greater hole spacings. All curved washers are composed of Grade 50 steel or equivalent and galvanized in accordance with ASTM A123.

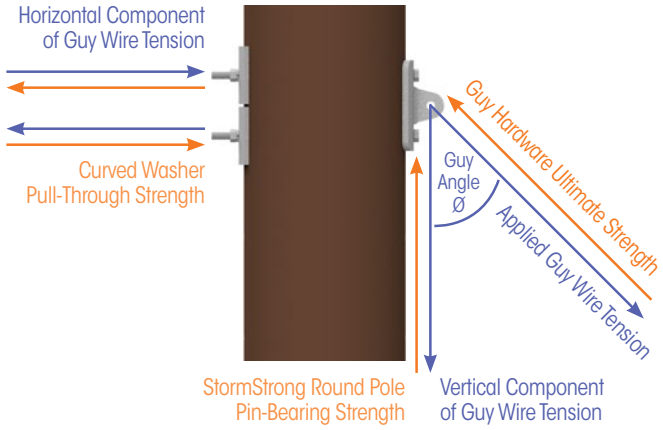


Guy wires are used in the utility industry to counteract horizontal forces that utility poles experience in the field. This is achieved by mounting guy hardware to a utility pole at an angle (Ø), typically between 15° and 45°. When designing pole hardware to resist an applied guy wire tension, there are 3 component forces to consider:

1. Guy Hardware Ultimate Strength must be stronger than an applied guy wire tension. This strength is typically provided by the hardware manufacturer.

2. Curved Washer Pull-Through Strength must be stronger than the horizontal component of an applied guy wire tension at an angle (Ø). CCG's curved washers are engineered to distribute these horizontal forces across the pole surface evenly and must be used on the backside of any mounted guy hardware.

3. StormStrong Round Pole Pin-Bearing Strength must be stronger than the vertical component of an applied guy wire tension at an angle (Ø). The pin-bearing strength of a pole dictates the maximum guy wire tension that can be applied to mounted guy hardware. Thru-bolt quantity directly correlates with the pin bearing capacity of a pole, so hardware with multiple bolts can withstand greater wire tensions.



The **"Characteristic Strength of Bolted Guy Hardware"** table below shows the maximum guy wire tension that can be applied to guy hardware at varying angles. Multiple hardware articles can be used together to increase the capacity of a guying system.

Characteristic Strength of Bolted Guy Hardware

Guy Hardware	Number of Thru Bolts	Bolt Diameter (in)	Guy Angle Ø	Hardware Ultimate Strength (lbf)	Maximum Applied Guy Wire Tension (lbf)				
					10 in Dia. x 3/8" Round Pole TU440	12 in Dia. x 1/2" Round Pole TU450	14 in Dia. x .410" Round Pole TU443	16 in Dia. x 1/2" Round Pole TU460	18 in Dia. x 3/4" Round Pole TU466
FAB887 DE Tee bracket	2	3/4	15	30,000	16,100	19,000	12,300	15,500	30,000
	2	3/4	30		18,000	21,200	13,700	17,300	30,000
	2	3/4	45		22,000	26,000	16,800	21,300	30,000
Pole Eye Plate	2	5/8	15	21,000	13,400	15,900	10,200	12,900	21,000
	2	5/8	30		15,000	17,700	11,400	14,400	21,000
	2	5/8	45		18,300	21,700	14,000	17,700	21,000
Bent Thimble Eye Bolt (5/8")	1	5/8	15	13,550	6,700	7,900	5,100	6,400	13,550
	1	5/8	30		7,500	8,800	5,700	7,200	13,550
	1	5/8	45		9,100	10,800	7,000	8,800	13,550
Bent Thimble Eye Bolt (3/4")	1	3/4	15	20,050	8,000	9,500	6,100	7,700	17,400
	1	3/4	30		9,000	10,600	6,800	8,600	19,400
	1	3/4	45		11,000	13,000	8,400	10,600	20,050

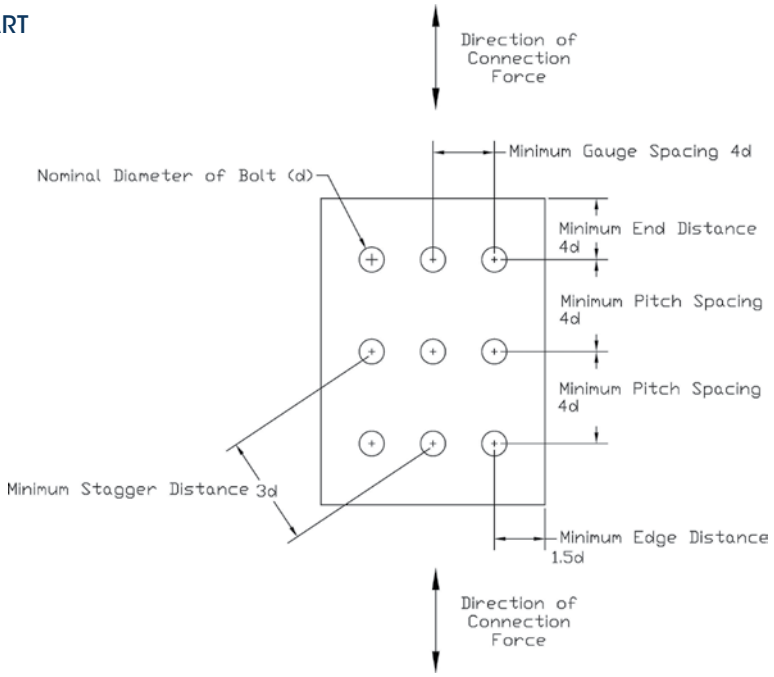
Notes:
Clearance hole 1/16" over nominal bolt diameter.
Characteristic strength is based on the 5% LEL lengthwise pin bearing strength. (Safety Factors are required to be applied)
Lengthwise pin bearing strength controls design over 6"x5.75"x3/8" washer pull-through strength & Guy Attachment Strength for 10" - 16" poles
Hardware Ultimate Strength controls in most loading scenarios for the 18"TU466 pole. Consult CCG engineering for specific loading scenarios
Hardware with a FAB # can be purchased directly through CCG - all other hardware can be purchased via utility hardware distributors

Connections

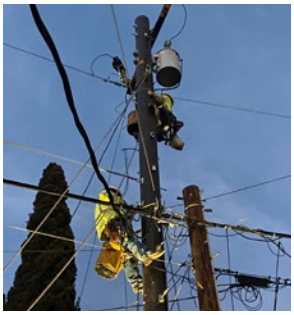
Bolted Connections

Proper bolt hole location limits are depicted in this Edge Distance Chart. This chart describes the minimum edge, gauge, pitch end and stagger distances for holes being drilled into the composite utility poles. The distances are based on a 1/16" oversized holes above the nominal bolt diameters. In general terms, avoid placing holes a distance closer than four times the bolt diameter to each other.

EDGE DISTANCE CHART



The bolted connection charts have been set up for 5/8", 3/4" and 1" diameter bolts for connections with forces acting parallel to the pole. Parallel connections include all loads applied no greater than ±5° off 0°, when 0° is defined as parallel to the pole axis. Examples of connections exhibiting forces parallel to the pole include transformers, tangent signaling wire, tangent communication wires and crossarms. Consult the factory for assistance designing load transferred into the pole at an angle greater than 5°. Note the strengths within the table are characteristic 5% LEL values and require appropriate safety factors to be applied by the design engineer.



Characteristic Strength of a Bolted Connection for Forces Applied Parallel to the Pole

Round Pole	Single 5/8" Bolt	Two 5/8" Bolts	Single 3/4" Bolt	Two 3/4" Bolts	Single 1" Bolt	Two 1" Bolts
TU470 8"x1/4" (203mm x 6.35mm)	3,066	6,132	3,679	7,358	4,905	9,811
TU440 10"x3/8" (254mm x 9.52mm)	6,505	13,010	7,806	15,612	10,408	20,816
TU443 14"x0.410" (356mm x 10.4mm)	4,959	9,919	5,951	11,903	7,935	15,870
TU450 12"x1/2" (305mm x 12.7mm)	7,683	15,366	9,219	18,439	12,293	24,585
TU460 16"x1/2" (406mm x 12.7mm)	6,277	12,554	7,533	15,065	10,044	20,087
TU466 18"x3/4" (457mm x 19.1mm)	14,050	28,101	16,860	33,721	22,481	44,961

Notes:
Clearance hole 1/16" over nominal bolt diameter.
Characteristic strength is based on the 5% LEL lengthwise pin bearing strength.

Washer Pull Through

The washer pull through charts depict the washer pull through ultimate and 5% LEL characteristic load capacities. The washer pull through loads represent tension loads that are applied through a bolt into properly sized washers. The loads translate into punch shear and pole crush stresses. As composite utility poles are hollow and possess thin walls, connection details are important in the design. Due to the modulus of elasticity and shear strength of composite poles compared to solid wood or hollow steel poles it is recommended that oversized washers be used for loads with high horizontal component forces. The oversized washers dissipate point loads over a larger area thus decreasing the stress levels. Stormstrong pole hardware is available upon request. We will work with your standards group to aid in the specification of necessary hardware and in the development of hardware that may be necessary for any unique connection situations.

Washer Pull Through Capacity	5% LEL Ultimate Strength
TU470 8"x1/4" (203mm x 6.35mm)	5,770
TU440 10"x3/8" (254mm x 9.52mm)	15,778
TU443 14"x0.410" (356mm x 10.4mm)	15,309
TU450 12"x1/2" (305mm x 12.7mm)	18,944
TU460 16"x1/2" (406mm x 12.7mm)	20,223
TU466 18"x3/4" (457mm x 19.1mm)	25,000

Notes:
TU440 based on a 6"x5.75" x3/8" square washer. TU470 based on 4"x4"x3/8" square washer. All others based on a 6"x5.75" x1/2" square washer.
Allowable load based on 5% LEL with an applied safety factor.

Column Loads

The compression capacity of pultruded poles can be determined based on both short and long column behavior. The ultimate column load shall be determined by the lesser value of the two equations. Euler buckling governs the capacity of the long column poles.

$$F_{cr} = \sigma_c - 1/7\frac{KL}{r}$$

Where:

F_{cr} = Critical compression stress
σ_c = Axial compression strength
K = Effective Length Factor
L = Laterally unbraced length of member
r = radius of gyration about the axis of buckling

$$F_{cr} = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2}$$

Where:

F_{cr} = Critical compression stress
E = Modulus of elasticity
K = Effective Length Factor
L = Laterally unbraced length of member
r = radius of gyration about the axis of buckling

The column load charts have been set up based on the short and long column equations presented. Reference Pultex® Pultrusion Design Manual. The column load tables are based on poles that have been installed by direct burial methods. The column height is considered to be the length out of the ground to the applied compression load. The effective length factor "K" is equal to 2 based on rotation and translation free end conditions. K factors can be adjusted dependent upon the end conditions specific to your application.

A pultruded column will fail in either short or long column mode. The long column capacity follows Euler buckling and is influenced by the modulus of elasticity and the radius of gyration.

The loads depicted in the column charts are un-factored ultimate load capacities. A safety factor of three is recommended.

Distribution & Light Pole Column Load Chart

Column Capacity Based on a K=2.0 (Rotation and Translation Free)		Ultimate Column Capacity, lbf (kgf)								
Pole Length, Above Ground, ft	Pole Length, Above Ground, m	Round Pole TU470 8"x1/4"		Kn	Round Pole TU440 10"x3/8"		Kn	Round Pole TU443 14"x0.410"		Kn
22	6.71	3,327	1,509	14.8	10,962	4,972	49	28,076	12,735	125
24	7.31	2,986	1,354	13.3	9,838	4,463	44	25,198	11,430	112
26	7.92	2,695	1,222	12.0	8,879	4,028	39	22,741	10,315	101
28	8.53	2,444	1,109	10.9	8,054	3,653	36	20,627	9,356	92
30	9.14	2,227	1,010	9.9	7,338	3,329	33	18,794	8,525	84
32	9.75	2,038	924	9.1	6,714	3,045	30	17,196	7,800	76
34	10.36	1,871	849	8.3	6,166	2,797	27	15,793	7,163	70
36	10.97	1,725	782	7.7	5,683	2,578	25	14,554	6,602	65
38	11.58	1,595	723	7.1	5,254	2,383	23	13,456	6,104	60
40	12.19	1,479	671	6.6	4,872	2,210	22	12,478	5,660	56
42	12.80	1,375	624	6.1	4,530	2,055	20	11,603	5,263	52
44	13.41	1,282	581	5.7	4,223	1,916	19	10,816	4,906	48
46	14.02	1,198	543	5.3	3,946	1,790	18	10,107	4,585	45
48	14.63	1,122	509	5.0	3,696	1,676	16	9,466	4,294	42
50	15.24	1,053	477	4.7	3,468	1,573	15	8,883	4,029	40

Heavy Distribution & Transmission Pole Column Load Chart

Column Capacity Based on a K=2.0 (Rotation and Translation Free)		Ultimate Column Capacity, lbf (kgf)								
Pole Length, Above Ground, ft	Pole Length, Above Ground, m	Round Pole TU450 12"x1/2"		Kn	Round Pole TU460 16"x1/2"		Kn	Round Pole TU466 18"x3/4"		Kn
36	10.97	23,150	10,501	103	53,257	24,157	237	98,926	44,872	440
38	11.58	20,777	9,424	92	47,799	21,681	213	88,787	40,273	395
40	12.19	18,752	8,506	83	43,139	19,567	192	80,130	36,346	356
42	12.80	17,008	7,715	76	39,128	17,748	174	72,680	32,967	323
44	13.41	15,497	7,029	69	35,652	16,171	159	66,223	30,038	295
46	14.02	14,179	6,431	63	32,619	14,796	145	60,590	27,483	270
48	14.63	13,022	5,907	58	29,957	13,588	133	55,646	25,241	248
50	15.24	12,001	5,444	53	27,609	12,523	123	51,283	23,262	228
52	15.85	11,096	5,033	49	25,526	11,578	114	47,414	21,507	211
54	16.46	10,289	4,667	46	23,670	10,737	105	43,967	19,943	196
56	17.07	9,567	4,340	43	22,009	9,983	98	40,883	18,544	182
58	17.68	8,919	4,045	40	20,518	9,307	91	38,112	17,287	170
60	18.29	8,334	3,780	37	19,173	8,697	85	35,613	16,154	158
62	18.90	7,805	3,540	35	17,956	8,145	80	33,353	15,129	148
64	19.51	7,325	3,323	33	16,851	7,643	75	31,301	14,198	139
66	20.12	6,888	3,124	31	15,845	7,187	70	29,432	13,350	131
68	20.73	6,488	2,943	29	14,927	6,771	66	27,727	12,577	123

Serviceability & Key Considerations

Serviceability

Composite utility poles are extremely strong. However, they exhibit a lower modulus of elasticity than steel. Therefore, serviceability limits, such as deflection, need to be scrutinized. The combination of transformer, conductor, light, telecommunications, other attachments, wind and ice all transfer moments into the pole. The combination of moments should be quantified and compared against the pole strength and deflection limitations as set forth by the utility or applicable codes.

Deflection calculations can be conducted on the pultruded poles very simply. Specifically, the constant cross sections enable traditional mechanics of materials equations to be utilized for predicting strength and serviceability limits. Like wood structure design, the shear modulus of elasticity should be considered for short pole applications if deflection is critical. For span to depth ratios above 20:1, it is common to neglect the shear portion of the total deflection and to rely solely on the flexural deflection. This simplifies the calculations while allowing for a deflection calculation which still has a high degree of certainty.

It is common practice to utilize the average modulus of elasticity when performing serviceability calculations. When comparing the deflection of a StormStrong pole directly to the deflection of an equivalent wood pole, the 5% LEL modulus of elasticity may be considered for both materials. This practice can be further reviewed by referencing Load and Resistance Factor Design (LRFD) for Pultruded Fiber Reinforced Polymer (FRP) Structures, ASCE/SEI 74-23.

Key Considerations

The following information is being provided due to the complexity of the various design methodologies that utilities utilize around the globe.

The pultrusion industry, in combination with American Society of Civil Engineers (ASCE), has developed a standard for Load and Resistant Factor Design of Pultruded Fiber Reinforced Polymer Structures. The standard permits a reliability-based design methodology to be utilized for pultruded members. In the electrical distribution and transmission industry, the NESC governs most design aspects. The NESC code heavily factors the load side of design and states that the 5% LEL values should be published for the structure material properties.

In terms of allowable stress design, for pultruded structures with sustained loads, the normal service factors applied to the pultruded pole material properties are 2.5 for flexure and compression due to bending and 3 for connections, shear and compression buckling. Once all design loads have been tabulated the engineer should verify that the sustained load recommended service factors are being met.

Unlike steel and akin to wood composite materials are typically anisotropic. Pultruded utility structures exhibit strength and stiffness properties that are directional dependent. For example, the lengthwise and crosswise material properties differ since composites are made up of mats and roving that exhibit different mechanical characteristics in lengthwise and crosswise direction. The Engineer needs to recognize this distinct difference while designing systems and setting up work instructions.

Pultruded utility structures are structurally reliable over a long service life. However, due to the modulus of elasticity and the fact that the poles are hollow, special precaution needs to take place when designing connections and evaluating loads that are concentrated and of high magnitude. An example of such loading is bolt torque, guying and conductor termination. CCG is providing the necessary information for the Utility Engineer to comfortably put together the correct specifications and standards for a long service life. Specifying the correct hardware and making sure that the correct hardware is being utilized by the utility is critical for the long-term performance.

Hardware Options

Injection Molded Caps

Round pole caps are made of UV stabilized thermoplastic. They are field removable for access into the interior of the pole.

Part Number	Description	Weight
UTL018	8" HDPE Pole Cap (Fits TU470)	1.2 lb.
UTL013	10" HDPE Pole Cap (Fits TU440)	1.7 lb.
UTL012	12" HDPE Pole Cap (Fits TU450)	2.4 lb.
UTL016	14" HDPE Pole Cap (Fits TU443)	3.0 lb.
UTL014	16" HDPE Pole Cap (Fits TU460)	4.0 lb.
FAB529.0020	18" HDPE Machined Pole Cap (Fits TU466)	7.8 lb.

FAB529

UTL018/UTL013/UTL012/
UTL016/UTL014

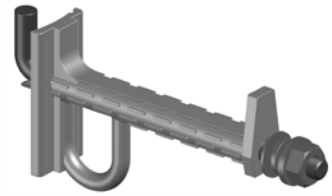
Hole Plugs

Part Number	Description	Weight
FAB300	5/8" Poly Hole Plug	.1 lb.
FAB389	11/16" Poly Hole Plug	.1 lb.
FAB301	13/16" Poly Hole Plug	.1 lb.
FAB407	15/16" Poly Hole Plug	.1 lb.
FAB470	1" Poly Hole Plug	.1 lb.
FAB362	1-1/8" Poly Hole Plug	.1 lb.
FAB458	1-3/8" Poly Hole Plug	.1 lb.
UTL003	1" Stainless Steel Hole Plug	.1 lb.

FAB300/FAB389/FAB301/
FAB407/FAB470/
FAB362/FAB458

Pole Step Hardware

CCG has a variety of options for round pole step hardware that is compatible with StormStrong and FireStrong Poles. Pictured are some examples of pole steps utility companies have used with StormStrong poles in the past. Also pictured is the VAF1002 and the VAF1027 removable pole steps which CCG recommends for most pole stepping applications (CCG ordering part number: FAB853 & FAB904). Consult your outside sales representative for recommendations on step hardware and questions concerning unique step hardware compatibility.



FAB853 - VAF1002

FAB904 - VAF1027

Clips

Part Number	Description	Weight
PTK014	FAB375 - ¼" stainless steel cushioned loop clamp for #4 and #6 AWG solid copper wire; Fastenal part number 0777616	.025 lb.
	FAB376 - #10-16 x 1" Hex - Unslotted Drive Hex Washer Head 1000 Hour Coating #3 Point 410 Stainless Steel Self-Drilling Screw; Fastenal part number 1131952	.007 lb.

FAB375

FAB376

Guying Brackets & Adapters

Part Number	Description	Weight
FAB887	Deadend Tee Bracket for 10" – 18" poles (All holes 13/16")	9.2 lb.
FAB888	Sidewalk Guy Pole End Plate for 10" round pole (11/16" holes)	8.7 lb.
FAB889	Sidewalk Guy Pole End Plate for 12" round pole (11/16" holes)	8.6 lb.
FAB890	Sidewalk Guy Pole End Plate for 14" round pole (11/16" holes)	8.6 lb
FAB891	Sidewalk Guy Pole End Plate for 16" round pole (11/16" holes)	8.5 lb.
FAB892	Aerial Cable Clamp Washer for 10" – 18" poles (Adapts Aerial Messenger Cable Clamp, holes for 3/4" & 5/8" Hardware)	4.0 lb.
FAB899	Guy Hook Bracket Washer (Adapts cleated guy hook hardware, 11/16" hole)	1.8 lb.

FAB887

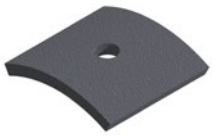
FAB888/FAB889/FAB890/FAB891

FAB892

FAB899

Washers

Part Number	Description	Weight
FAB895	4" x 4" Curved Square Washer for 8" round pole (3/8" thick – 13/16" hole	1.7 lb.
FAB902	4" x 4" Curved Square Washer for 8" round pole (3/8" thick – 11/16" hole	1.7 lb.
FAB469	4" x 4" Curved Square Washer for 12" round pole (1/4" thick - 13/16" hole)	1 lb.
FAB549	6" x 5.75" 3-Hole Curved Washer for 10" round pole (3/8" thick - 13/16" hole)	3.6 lb.
FAB448	6" x 5.75" 3-Hole Curved Washer for 12" round pole (1/2" thick - 13/16" hole)	4.7 lb.
FAB896	6" x 5.75" 3-Hole Curved Washer for 14" round pole (1/2" thick - 13/16" hole)	4.7 lb.
FAB449	6" x 5.75" 3-Hole Curved Washer for 16" round pole (1/2" thick - 13/16" hole)	4.7 lb.
FAB897	6" x 5.75" 3-Hole Curved Washer for 18" round pole (1/2" thick - 13/16" hole)	4.7 lb.
FAB886	6" x 5.75" 3-Hole Curved Washer for 10" round pole (3/8" thick - 11/16" hole)	4.7 lb.
FAB884	6" x 5.75" 3-Hole Curved Washer for 12" round pole (1/2" thick - 11/16" hole)	4.7 lb.
FAB893	6" x 5.75" 3-Hole Curved Washer for 14" round pole (1/2" thick - 11/16" hole)	4.7 lb.
FAB885	6" x 5.75" 3-Hole Curved Washer for 16" round pole (1/2" thick - 11/16" hole)	4.7 lb.



FAB895/FAB902/FAB469

FAB549/FAB448/FAB896/
FAB449/FAB897/FAB886/
FAB884/FAB893/FAB885

Note: Washers and plates are a structural grade steel galvanized in accordance with ASTM A123.

Work Instructions

1. TRANSPORTATION AND HANDLING

StormStrong poles are shipped via flatbed truck in bundles to ease the unloading process. A typical package scheme weighs less than 5,000 lbs. and consists of a bundle of 3 to 5 poles. The package is designed to be lifted with a tow motor. However, the package can be picked with a crane or boom truck using a nylon sling. Special shipping requirements must be prearranged with the factory.

When receiving products, all items should be inspected for damage prior to acceptance. If damage has occurred, the user should immediately notify the delivering carrier and complete the necessary freight damage claims. The damage report should indicate what types and level of damage has occurred to the poles. The manufacturer must be notified to discuss the reported damage and help assess the structural integrity of the material for its intended use.

2. STORAGE

Composite utility poles can be stored outdoors or indoors. Poles are delivered in bundles to assist in yard storage and minimize pole handling and movement prior to actual delivery to job location. If it is necessary to unpack the poles from the original shipping crates, separate the poles from one another using a similar timber cribbing plan to avoid unnecessary damage to the pole surface. The timber cribbing should also keep the pole high enough above the ground to allow nylon lifting straps to be easily slipped under and around the pole.

3. HANDLING INSTRUCTIONS

The identification tag contains the estimated weight of the pole. Composite utility poles can be loaded/moved/unloaded using a forklift positioned perpendicular to the longitudinal axis of the pole and with the load in balance. Care should also be taken in handling to prevent puncturing or cracking a pole with the forklift and to prevent damaging the UV protective surface. It is important to fully position the forklift under the load and lift the pole(s) rather than “slide” the forklift across the surface of the pole while in a lifting action. All composite utility poles can be handled utilizing single pick points. The center of gravity on an unframed pole is typically at mid-point of the overall length due to its non-taper design. Significant hardware installations will affect the balance and location of pick when moving a pole. The user should evaluate these weights and adjust the pick point accordingly. Nylon slings should always be used in lieu of chains, cables or other metal hardware when lifting composite utility poles.

The minimal weight of the pole should eliminate the need to drag or skid the pole for any significant distance. If dragging of the pole is necessary for extended lengths due to difficult terrain, the butt of the pole should be protected to avoid excessive damage to the FRP materials and base plug. The pole should be lifted so that only the butt of the pole is in contact

3. HANDLING INSTRUCTIONS (CONTINUED)

with the ground when dragging the pole is necessary. Pole hand carts are ideal for applications in which poles need to be moved over a greater distance.

Composite utility poles are NOT solid in cross section. Care should be taken in the lowering of the pole to the ground to facilitate the removal of the handling slings. Poles should not be dropped from distances or freely dumped from transportation trailers. Poles should be rested to a firm surface with clearance allowed to easily remove the supporting slings.

For short distances, pole dollies and other pole handling vehicles can be used. If pole dollies are used, nylon straps should be used in lieu of metal chains to secure the pole. Because composite utility poles are lightweight, some distribution size poles can be manually carried short distances between the staging area and the installation site. Craft persons using shorter nylon slings can carry the pole manually. Pole climbing hardware is also a means of "handling" a pole for manual carry.

4. FRAMING

Most standard, non-cleat line hardware can be used on composite utility poles with conventional fasteners and practices. In general, the poles will accept most of the hardware that is used on wood, steel or concrete poles. However, washers that conform to the pole surface should be used beneath the bolt head and nut. CCG recommends washers matching the contour of the poles be used for all installations. Washer sizes should be selected by reviewing the Washer Pull Through Capacity charts on Page 23.

The preferred method of attachment is with through bolts. There is no need to over torque the nuts as the dimensional characteristics of the composite utility pole will not change significantly due to moisture or temperature. The maximum torque applied is recommended not to exceed 50 ft-lbs. A good rule of thumb is that a lineman should hand tighten the nut and then turn the nut half to one complete turn for proper bolt tension. If over tightening occurs, the pole will oval shape and structural failure could occur.

The following hardware features are not compatible with the CCG composite utility poles:

- Lag bolts: Use a through bolt instead
- Teeth: Hardware that is drawn into a wood pole should not be used on a composite utility pole. In almost every case, a similar piece of hardware exists that does not have teeth
- Nails and Staples: Use self-tapping screws

5. FIELD DRILLING HOLES AND CUTTING POLES

CCG will pre-drill holes per customer specifications in the production plant with Computer Numerical Control (CNC) equipment. Holes can be drilled in the field with either hardened high-speed steel (HSS) twist drills, carbide tipped twist drills or self-centering hole-saws. Diamond coated hole saws, carbide tipped twist drill bits and brad-point HSS twist drills perform best. The number of holes needed determines drill selection. Carbide or diamond type drills are recommended for quantities above 20. CCG recommends Milwaukee SHOCKWAVE Impact Duty™ Lineman's Fiberglass Drill Bits, for applications that require multiple holes in a short period of time. The carbide tip reduces friction, helping you to make faster, cleaner cuts while maintaining best life. Minimum hole spacing shall be selected by referencing the Edge Distance Chart on Page 22.

StormStrong poles can be cut with circular saws and Sawzalls. CCG recommends Milwaukee Diamond Premium Turbo or Segmented circular saw blades and any Milwaukee Sawzall blade with carbide teeth.

REGULATION AND RECOMMENDED PRACTICES FOR WORKPLACE EXPOSURE TO GLASS FIBER DUST

Inhalation of the dust from cutting or drilling a composite pole can cause irritation of the respiratory system. OSHA considers these dusts to be "Inert/Nuisance Dusts" or "Particulates Not Otherwise Regulated (PNOR)" and has established a workplace Permissible Exposure Limit (PEL) of 5 mg/m3 for the PNOR respirable fraction and 15 mg/m3 for PNOR as total dust.[1]

For dust comprised of the continuous filament glass fibers used to manufacture composite poles, the American Conference of Governmental Industrial Hygienists has established a Threshold Limit Value (TLV, a recommended workplace exposure limit) of 1 fiber/cm3 for respirable fibers and 5 mg/m3 for inhalable glass fiber dust.[2] Cal-OSHA has adopted the TLV in their state plan as a state permissible exposure limit.[3]

Glass fiber potentially contained in FRP dust can cause irritation or itching if it is in contact with skin or mucus membranes. This is due to mechanical abrasion and is not an allergic effect.[4]

RECOMMENDED PPE

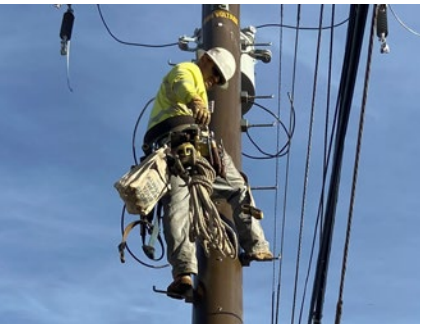
When cutting and drilling composite poles, composite utility pole manufacturers recommend use of the following personal protective equipment (PPE): A particle mask, safety glasses, gloves, long sleeve shirt and long pants, safety footwear and a hard hat.

1 OSHA Occupational Chemical Database: Fibrous Glass Dust; https://www.osha.gov/chemicaldata/805; see note in Exposure Limits table: "For General Industry, please see 29 CFR 1910.1000 Table Z-3, Mineral Dusts for Inert or Nuisance Dust". Also see OSHA Occupational Chemical Database: Particulates Not Otherwise Regulated, Total and Respirable Dust; https://www.osha.gov/chemicaldata/801.

2 https://www.acgih.org/synthetic-vitreous-fibers/.

3 Table AC-1. https://www.dir.ca.gov/title8/5155table_ac1.html.

4 "Continuous Filament Glass Fibre and Human Health", Glass Fibre Europe. https://www.glassfibreeurope.eu/wp-content/uploads/2022/09/GFE_leaflet-Human-Health-November-2021.pdf



6. CLIMBING

Climbing provisions are available as permanent or removable steps. CCG offers an array of step options that can be viewed in the Hardware Options Section of this brochure. Climbing positions are usually vertically spaced every 15 to 18 inches and are oriented at 180 degrees (each side of a pole) to each other. "Stepping" positions and "working" positions (steps at the same elevation) can be specified by the user at the time of order. The holes can then be factory drilled and steps attached prior to delivery of the poles.

7. ERECTION

Composite utility poles are generally faster and safer to install than wood, steel or concrete poles. Conventional equipment and practices can be used as required for the terrain and site conditions. They can be erected using a single pick point as determined by the weight of the pole and any framed hardware. Nylon chokers should be used by the method of "choking the pole" to secure the pole to the lifting cable; this practice avoids scratching and gouging the pole finish. Never use a chain or steel choker to pick or unload a composite utility pole. A nylon strap, preferably with a neoprene skin, is preferred. CCG recommends Bashlin industries grip slings as the slings' rubber belting allows for a secure grip to composite poles in dry and wet conditions alike. The bottom cap can be removed and stone or other ballast material can be used to offset the center of gravity of the pole. This technique can be performed if you need to pick the pole at a lower elevation to avoid conductor and boom interference.

8. DIRECT EMBEDMENT

CCG composite utility poles have been designed to be directly embedded in the ground in the same manner as wood poles. Composite utility poles are inert. Therefore, the poles will not adversely affect the environment, nor do they require special protective coatings or treatments before being embedded. Composite utility poles can be directly embedded using the same burial depth as would be used for most other types of poles unless special loading or soil conditions dictate otherwise. Once the pole is placed in the hole, the hole can be backfilled with any material normally used, such as native soil, crushed aggregate, concrete or structural foam. Backfill tools and techniques for CCG composite utility poles are typically the same as those used for wood poles. Care should be taken to avoid impacting the pole wall with tools during backfill and tamping operations. Like all tubular poles, a bottom plug is provided to prevent further settling after the composite utility pole has been installed.

9. POLE GROUNDING

Ground wires can be fastened to the pole with copper ground clips and self-tapping screws. Plastic wire molding strips can also be used to secure the ground wire to the pole. These strips contain the ground wire and are easily secured to the pole with a self-tapping screw. Ground wires can also be positioned inside of the pole to discourage theft.

10. END OF SERVICE LIFE DISPOSAL

CCG composite utility poles have several disposal options, including:

- Recycle
- Repurpose
- Landfill (Toxicity Characteristic Leaching Procedure or TCLP) will not leach

Inspection

Visual

Visual inspection is a reliable method for surface damage assessment of a composite utility pole. It can roughly map out an area of surface damage but will not necessarily reveal information about any underlying damage. Visual inspection of FRP structures by maintenance personnel should include inspection for the following:

- Tracking on material surface
- Lightning damage
- Damage from vandalism
- Mechanical impact damage
- Delamination or cracking evidence of composite

Items such as scratches, minor nicks and discoloration may be visually evident, but are not considered to have an impact on the structural integrity of the structure.

Tap Test

A tap test can be used as a routine test to further check for any suspected localized damage. The test requires an inspector to use a small hammer to tap all around the area of suspected damage. This is a fast, inexpensive and easy way to roughly evaluate the condition of the material and locate suspected delaminations or cracks. Any area of the composite utility pole that has suffered an impact and has internal damage will be evident by a low, shallow sound given off by a tap test. Adversely, areas that are unaffected and structurally sound will be evident by a high pitch sound given by a tap test.

Repairing A Damaged Pole

For moderate scuffs and cosmetic damage caused by severe abrasion or light impacts in which there is less than 15% wall thickness loss over a six inch by six square section, Bullseye UV light activated fiberglass reinforced self-adhesive protective patches can be applied directly to the surface of the fiberglass pole.

Fiberglass wrap systems can be used for structural and aggressive cosmetic repairs. Osmose moisture activated fiberglass pole wrap systems or BullsEye fiberglass UV cure pole wraps can be applied to the pultruded fiberglass poles. Severe damage resulting in splintering, cracking, delaminations and section loss of the pole caused by vehicle impacts or other incidents will require a structural splint. Damage due to vehicle impact is inevitable. The extent of damage will determine if the pole should be replaced or if the pole can be repaired. Consult CCG's Stormstrong pole owners manual for additional inspection and repair information.

Specifying

This specification is intended to define composite utility poles for the Power Distribution Utility and Telecommunication Companies for procurement purposes.

1.0 SCOPE

This specification covers the minimum mechanical, physical, quality, structural, manufacturing and performance requirements for non-tapered self-supporting and or guyed direct burial pultruded Fiberglass Reinforced Polymer (FRP) utility poles intended for use as electrical distribution and transmission tangent and deadend electric utility pole structures. Installation and inspection and repair procedures are to be covered in the vendors installation, inspection and repair manuals.

Applicable Standards and Documents

The latest revisions of the following documents in effect on the date of invitation apply to the extent specified herein, except in the case of specifically dated documents, in which case those revisions shall apply:

- ASTM A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- American Architectural Manufacturers Association (AAMA) 623 specification Voluntary Specification, Performance Requirements and Test Procedures for Organic Coatings on Fiber Reinforced Thermoset Profiles
- American National Standards Institute (ANSI)ANSI 05.1 American National Standard for Wood Pole Specifications and Dimensions
- ASTM G154, Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials
- ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- ASTM D8069-17a, Standard Test Method for Determining Flexural Modulus of Full Section Pultruded Fiber Reinforced Polymer (FRP) Composite Members with Doubly Symmetric Cross Sections under Bending
- ASTM D638, Standard Test Method for Tensile Properties of Plastics
- ASTM D6641, Standard Test Method for Compressive Properties of Polymer Matrix Composite Materials Using a Combined Loading Compression (CLC) Test Fixture
- ASTM E-84, Standard Test Method for Surface Burning Characteristics of Building Materials
- ASTM D4541-09, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- ASCE Manuals and Reports on Engineering Practice No. 111 Reliability Based Design of Utility Pole Structures
- California Public Utilities Commission General Order No. 95 Rules for Overhead Line Construction “Rules for Overhead Line Construction”
- ASTM D1036, Standard Test Methods of Static Tests of Wood Poles
- ASTM D3917, Standard Specification for Dimensional Tolerance of Thermosetting Glass-Reinforced Plastic Pultruded Shapes
- ASTM D4385, Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products
- IEEE C135.1-1999, Standard for Zinc-Coated Steel Bolts and Nuts for Overhead Line Construction
- UL94, Standard for Safety of Flammability of Plastic Materials for Parts in Devices and Appliances

2.0 CONSTITUENT MATERIAL REQUIREMENTS UTILIZED IN PULTRUDED POLES

2.1 The pultruded poles shall be constructed by the pultrusion process using a thermoset resin with fire retardant additives.

2.2 All composite utility poles shall be manufactured with pultrusion grade electrical grade E-glass reinforcements in the form of unidirectional roving, Continuous Filament Mat (CFM) and or stitched fabric mats.

2.3 Sizing chemistry applied to the E-glass reinforcements shall be compatible with the vendors resin formulation.

2.4 The resin shall contain color additives in the form of pigment that corresponds to the utilities choice of color.

3.0 FIRE PERFORMANCE

All pultruded composite utility poles shall be pultruded with a high-performance thermoset resin providing fire retardant properties that permit the pole to be classified as "self-extinguishing" per UL94, when tested in the vertical direction, with a (V0) rating. The flame spread shall be class I per ASTM E-84 with a Flame Spread Index (FSI) of 25 or less.

4.0 QUV AND WEATHERING

4.1 All pultruded utility poles shall contain Ultraviolet (UV) Light Absorbers that shall be mixed into the thermoset resin prior to production and shall function as long-term light stability promoter.

4.2 All pultruded utility poles shall be encompassed with a thermoplastic10-mil synthetic surfacing veil. The 10-mil synthetic veil shall create a resin rich surface and protect the glass reinforcements from fiber blooming.

4.3 For long term protection from UV light, all pultruded utility poles shall be coated with a 3 mil (wet) high performance UV resistant coating meeting the mechanical requirements of the American Architectural Manufacturers Association (AAMA) 623 specification.

4.4 The UV coating adhesion to the pultruded pole, when tested per ASTM D4541-09, shall exhibit a minimum bond strength of 1,000 psi.

4.5 After representative samples have been exposed to a minimum of 8,000 hours of accelerated weather testing, per ASTM G154, a visual inspection shall be performed. The aged samples shall show no signs of fiber bloom. After UV testing, the same samples shall be subjected to tension and in-plane shear testing. The results comparing the control at 0 hours shall demonstrate less than a 25% reduction in strength after 8,000 hours of exposure.

5.0 POLE STRENGTH AND STIFFNESS

5.1 All pultruded utility pole nominal resistant strengths shall be published per the National Electric Safety Code (NESC) and General Order 95 requirements and shall be published based on a 5% lower exclusion limit (LEL).

5.2 The nominal resistant strengths of all connection related design values shall be published based on a 5% LEL. ASCE-111 may be used for providing information for determining the 5% LEL strength.

5.3 Pole strength shall be documented in terms of the 5% LEL nominal strength and/or moment capacity calculated at the pole ground line by applying load to the pole tip as determined by physical cantilever testing in accordance with the principles set forth in ASTM D1036.

5.4 The Modulus of Elasticity (MOE) shall be determined and published as the average modulus based on full section testing to ASTM D 8069-17a or as the lesser of the tensile or compression modulus when tested per ASTM D638 or ASTM D6641 respectively.

5.5 When steps are utilized, the pole wall shall be capable of supporting a 3,000-pound load applied onto the pole step (centered one inch away from the pole wall) without permanent damage. A minimum of three tests shall be conducted for each style of step furnished by the utility.

6.0 VISUAL AND FINISH

6.1 The surface of the pultruded utility pole shall exemplify a UV resistant, resin rich, smooth and aesthetically pleasing finish uniform along the entire pole length.

6.2 The composite utility poles shall be manufactured and visually inspected in accordance with ASTM D4385.

6.3 The poles shall be _____ in color.

7.0 HOLES, HARDWARE AND ACCESSORIES

7.1 Holes: The composite utility pole shall be predrilled as requested in accordance with customer specifications for steps and attachments.

7.2 Pole wall and designated step to support a minimum of 750 pounds (340 kg) of vertical loading at the furthest location of the step adjacent to the pole face. In addition, the pole wall and step shall be capable of supporting a 3,000-pound load applied onto the pole step (centered one inch away from the pole wall) without permanent damage.

7.3 The composite utility pole shall be supplied with a removable top cap matching the pole profile geometry securely attached for shipment and delivery. The caps shall be UV stable for the service life of the pole.

7.4 The composite utility pole shall be supplied with an installed base plug. Pole base plug to be no smaller than the outside utility pole geometry with an intermittent interference fit with a 1" diameter hole to a allow moisture to egress from pole interior.

7.5 All mounting brackets shall be welded per AWSD1.1 recommendation.

7.6 The steel shall be grade 50 and shall be galvanized per ASTM A123.

7.7 When supplied by the vendor, the DA bolts shall meet the requirements of IEEE C135.1-1999 and or ASTM A153.

8.0 FABRICATION TOLERANCES AND DIMENSIONS

8.1 Pole Length ± 2" (50 mm)

8.2 Squareness of end cut: 1/4" (6.35 mm)

8.3 Hole Diameter: ± 1/32" (0.8 mm)

8.4 Hole Location between through holes (opposite sides): ±1/8" (3.2 mm)

8.5 Hole location centered across flats (Octagonal poles only): ± 1/16" (1.5 mm)

8.6 Hole Location within a group of holes: ± 1/16" (1.5 mm)

8.7 Hole Location between groups: ±1" (25 mm)

8.8 Hole location from top of pole for the first grouping of holes: ±2" (50 mm)

8.9 All hardware assemblies must be bolted with at least one full nut engaged into the threads.

8.10 Pole profile dimensions per ASTM D3917.

8.11 Straightness: .030"/ft. (2.5mm/m) measured with weight minimizing.

8.12 Weight: ±10%

9.0 IDENTIFICATION

9.1 Each composite utility pole shall be provided with a permanent stainless-steel identification tag. It shall contain the customer's name, manufacturer's name, pole serial number, month and year of manufacture, class and height of the pole and weight. The tag shall be installed with stainless steel rivets at a distance from pole butt as specified by the utility.

10.0 SHIPPING

10.1 Crated composite utility poles shall be individually protected in cardboard or equivalent protective material in areas in which dunnage contacts poles.

10.2 Composite utility poles shall be crated in bundles for ease of handling and transfer without damage to the poles by lifting equipment.

10.3 Vendor shall create packaging drawings and specs. in relation to utility receiving requirements.

11.0 QUALITY CONTROL

11.0 Quality Assurance shall be performed as described in the organization's quality plan, as approved by the utility.

11.1 Manufacturer shall inspect the pultruded FRP poles as outlined in their ISO 9001:2015 requirements to the extent that the poles meet or exceed the published 5% LEL values, visual, dimensional and workmanship requirements referenced in this specification.

ELECTRIC PROPERTIES

FRP Utility poles have inherent, non-conductive behavior however they are not designed or intended to be used as insulators.

VENDOR REQUIREMENTS

Each FRP utility pole manufacturer shall have an established Quality Control (QC) and Quality Assurance (QA) Plan. FRP utility pole production shall be performed as described in the manufacturer's quality control plan. Certificates of Conformance for raw materials are recommended to be retained by the FRP utility pole manufacturer to ensure product traceability. At a minimum, a comprehensive quality plan includes visual, dimensional and validation of the mechanical properties of the products offered by the manufacturer. Vendor shall be certified ISO 9001:2015 with a scope of Design and Manufacture of FRP Structural Components and Systems.

Ordering Part Number System

CP	55	01	TU450	3	D1	10	FR
Type	**Pole Length** *(ft)*	**Pole Class (ANSI O5.1)[1]**	**Pole Section[2]**	**Resin**	**Pole Color[3]**	**No. of Holes Drilled in Pole**	**Features**
CP = Round Pole	20 25 30 35 40 45 50 55 60 65 70 Etc.	06 = 1,500 lbs 05 = 1,900 lbs 04 = 2,400 lbs 03 = 3,000 lbs 02 = 3,700 lbs 01 = 4,500 lbs H1 = 5,400 lbs H2 = 6,400 lbs H3 = 7,500 lbs H4 = 8,700 lbs H5 = 10,000 lbs H6 = 11,400 lbs NA = Not Applicable	TU440 TU443 TU455 TU450 TU460 TU466 TU470	2 2 3 3 3 3 2	02 = Light Gray RAL 7044 D1 = Brown RAL 8014		FR = FireStrong SE = Sectional Leave Blank for Standard Poles

Notes:
1.0 Use NA when Pole Class is not defined.
2.0 Reference Pole Load Charts to Select the Proper Pole Section.
3.0 Finish color is the exterior coating color of the pole.

Creative Composites Group is the Largest Manufacturer of Pultruded Composite Poles for Utility, Telecom & Lighting Applications

Your Single Source for Innovative Telecom & Utility Poles Using Fiber Reinforced Polymer Composites

We have a history of technical innovation that has led to the development of a full-line of the industry's most advanced structural FRP utility and telecommunication poles.

Advance your products and projects beyond the limitations of traditional concrete, steel and wood by leveraging highly-engineered FRP products that harden against storms, hurricanes and fire.

Our StormStrong poles are pre-engineered to exceed industry standards. We manufacture our composite products to high-quality standards to assure our customers of the superior performance in their respective applications including: grass fires, high winds, corrosive environments, woodpecker-prone areas, hurricanes and areas that require ground water protection measures.

CCG is Your Custom Engineered FRP Provider

We're much more than a material supplier – we provide proven engineering processes, end-to-end collaboration, service and support resources. CCG works alongside your team to design and engineer pultruded FRP solutions that meet the most demanding grid-hardening requirements and environmental considerations.

Creative Composites Group, we can help you create structural FRP products of any size or shape — for projects of any ambition or vision. We are the single source for the broadest range of engineered FRP solutions to build your ideal projects.

Have a project that you think engineered FRP is right for?
We'd be thrilled to discuss it with you.

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