

**WAGNERS**

Composite Fiber Technologies (CFT)

# CROSSARM TECHNICAL INFORMATION GUIDE



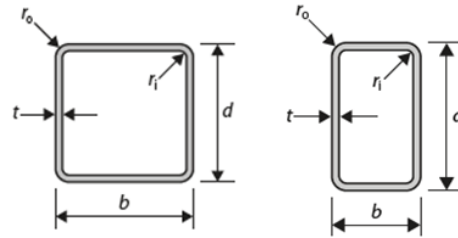
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# 1 DESIGN AND CONSTRUCTION

## 1.1 FORM AND SIZING

### 1.1.1 Profile Sizing

Wagners manufacture three standard crossarm profile sizes; 5x5 inches, 4x4 inches, and 4x3 inches. These sizes were developed to closely align with traditional timber crossarm sizes for ease of fitment into existing networks. The details of the profile sizes are as follows:



PRODUCT CODE	DIMENSIONS SECTION PROPERTIES							
	Actual Dimension			Outside Corner Radius	Inside Corner Radius	Mass per ft	External Surface Area per ft	Gross Section Area $A_g$ inches <sup>2</sup>
	Depth	Width	Thick.					
	d	b	t	$r_o$	$r_i$	lb/ft	ft <sup>2</sup> /ft	
inches	inches	inches	inches	inches				
STR-RHS-4x3x13/64	WCFT 3-15/16	2-61/64	13/64	25/64	3/16	2.16	3.58	2.449
STR-VSHS-4x4x13/64	WCFT 3-15/16	3-15/16	13/64	25/64	3/16	2.60	4.12	2.961
STR-VSHS-5x5x1/4	WCFT 4-59/64	4-59/64	1/4	25/64	3/16	4.05	5.20	4.604

## 1.2 MATERIALS

### 1.2.1 Fiber Reinforcement

Wagners use Boron-free electrical grade ECR glass rovings which are in accordance with ASTM D578 clause 4.2.4.

### 1.2.2 Resin Matrix

#### 1.2.2.1 Resin Material

Wagners use the epoxy vinyl ester resins Derakane Momentum 640-900 and Merican 30-900. No thermoplastic resins are used in the manufacture of Wagners pultrusion. The use of polyester resin in the fabrication of fiber composite crossarms is discouraged due to a lower corrosion resistance and poor fatigue qualities when compared to vinyl esters.

#### 1.2.2.2 Additives

In addition to the base vinyl ester resin, Wagners uses a collection of exclusive pultrusion additives to help enhance the final product as well as improving the manufacturing process. If required, a list of additives can be made available upon request.

### 1.2.3 Filler Material

The Wagners crossarm design is a square/rectangular hollow core section and does not include any fillers such as foam. While the Wagners crossarms do not contain filler material, the use of glued inserts as detailed in section 1.2.5.1 ensures the product is completely water tight.

### 1.2.4 Surface Treatment

All Wagners crossarms are coated with a co-extruded thermal plastic alloy that has been rigorously tested against the effects of electrical tracking and UV protection. In conjunction with the enhanced tracking and UV properties of the coating, the co-extrusion helps to improve the electrical resistance of the crossarm to ensure a long life even in the harshest of conditions.

The standard Wagners crossarm color is RAL 7001 Silver Gray in a satin finish. Other colors are available if required.

### 1.2.5 Inserts and Endcaps

#### 1.2.5.1 Inserts

Wagners crossarms come pre-fitted with anti-crush inserts at all bolt hole locations. The inserts are added to the crossarms for resistance to crushing as well as increased connection capacity and are permanently glued in place to ensure they cannot move or become dislodged during transport or throughout the life of the crossarm. The inserts are manufactured using the injection molding process and are made from lightweight and durable 50 per cent glass fiber filled thermoplastic alloy which is corrosion and pest resistant.

#### 1.2.5.2 Endcaps

Pre-fitted to the crossarms are two types of endcaps; standard and flush. The standard endcaps protrude beyond the outer surfaces of the pultrusion (to a maximum of 1/8") to protect the structural integrity of the crossarm should it be dropped during installation. The standard endcaps are Wagners' preferred option for this reason, to help increase the impact resistance

# 1 DESIGN AND CONSTRUCTION

of the product. All endcaps are secured using a high UV-resistant Sikaflex in conjunction with the clips that are part of the endcap design. These two measures help to ensure the endcap is secure for the entirety of the design life, including transportation and installation.

## 1.3 CONSTRUCTION PROCESS

### 1.3.1 Process

Wagners use the pultrusion method to manufacture the fiber composite members used in the production of crossarms. The pultrusion method in conjunction with the stringent Quality Assurance (QA) testing regime (refer section 3) ensures consistency of the manufactured product including the high fiber volume and low void content of the Wagners product.

### 1.3.2 Bolt Holes

Our crossarms have the availability for bolt holes in a variety of sizes. The typical bolt diameters that are included on crossarm designs are; 5/8", 3/4", and 15/16". As discussed in section 1.2.5.1 all Wagners crossarms will be supplied with anti-crush inserts that have been glued in place using a high strength polyurethane adhesive.

### 1.3.3 Tolerances

The following manufacturing tolerances are used as part of the Wagners quality control conformance criteria for acceptance of pultrusion into full crossarm production.

TYPE OF TOLERANCE OBSERVED	TOLERANCE VALUE
Wall thickness	$\pm 1/64"$
Concavity of wall	$< 1/64"$
Dimension of external form	$< 1/64"$
Degree of flatness	$\leq 0.8\%$ with $1/64"$ min.
Degree of squareness	$\pm 1^\circ$
Degree of curve	$\leq 0.1\%$ of total length
Weight	$\pm 0.07$ lb/ft

### 1.3.4 Appearance

Wagners crossarms are coated as standard with a co-extruded thermal plastic alloy. The co-extruded coating has a satin finish and is designed to be very resilient to damage. If damage occurs to the surface coating, Wagners have developed work instructions for identifying and categorising repairable damage and the methods of fixing the damage.

### 1.3.5 In-Field Workability

Although it has been found that it is not generally necessary, Wagners crossarms can be drilled on-site providing an anti-crush insert is installed at all hole locations. Prior to drilling and inserting, design checks will also need to be undertaken by Wagners to establish if the additional hole is acceptable and if a glued insert is necessary.

Cutting of Wagners fiber composite crossarms can also be completed on-site if necessary. Freshly drilled holes and on-site cuts must be properly sealed using approved resin. The Safety Data Sheet (SDS) for Wagners composite fiber pultrusion can be supplied upon request which advises of precautions to be taken when cutting or drilling composite sections and has considered any dust generated from on-site works completed.

## 1.4 DESIGN LIFE

There are five durability parameters to be considered when investigating the design life of a product and/or material.

- Resistance to attack by physical agents
- Form and dimensional stability
- Permanence of adhesives and mechanical fastening systems
- Resistance to corrosion
- Resistance to fire damage

The Wagners crossarm performs extremely well with regards to all the above factors which leads to a typical design life of 40 years for most locations and environments. The design life of a Wagners crossarm may change depending on the above durability parameters specific to their installed location and should be confirmed prior to finalization of the design.

## 1.5 IDENTIFICATION AND MARKING

### 1.5.1 Visual Identification

Depending on supplier requirements, Wagners crossarms can include (but not limited to) the following identification information:

- Wagners name and/or logo
- Batch number
- Month and year of manufacture
- Weight

- Length
- Supplier store codes

There are no metallic identification methods used for Wagners crossarms.

### 1.5.2 Traceability

Wagners supply all crossarms with batch numbers permanently engraved on all endcaps (which are secured for their design life). These batch numbers are used to help trace back all relevant data including, but not limited to, the raw material purchases (and relevant Certificate of Analysis), quality control batch testing results, completed QA forms and documents, client purchase orders, etc.

### 1.5.3 Packaging and Labeling

As standard, Wagners crossarms are wrapped and packed with an opaque protective plastic film to help minimize any potential damage to the crossarms due to transport and handling. Typically, the crossarms are packed in bundles of 50 and are strapped to pallets or dunnage for ease of handling. Custom made cardboard dividers are used to separate each crossarm to ensure no rubbing occurs during transport. The design life of the crossarm begins once exposed to UV, maintaining the wrapping of packed crossarms during storage will ensure the longevity of the crossarm in service.

Wagners crossarm packs are supplied with identification labels which include critical information including:

- Items included in pack
- Manufactured date
- Pack size and quantity
- Wagners work order number

## 2.1 MECHANICAL TESTING

The following mechanical tests were undertaken to verify the design properties and capacities of Wagners crossarms and their various individual elements. The results for mechanical properties are shown as a “Characteristic Value” which takes into consideration testing results and standard deviation.

In conjunction with section 2.3.3.2 of the Eurocomp Design Guide, Wagners applies material reduction factors for short-term and long-term loading cases. Maximum utilization of Wagners composite fiber components are:

- Short term loads: 79%
- Long term loads: 32%

### 2.1.1 Mechanical Properties

PROPERTY	RESULT	UOM	STANDARD
Tensile Strength – Longitudinal	88.5	ksi	ISO 527-4
Tensile Modulus of Elasticity – Longitudinal	5265.9	ksi	ISO 527-4
Tensile Strength – Transverse	8.0	ksi	ISO 527-4
Tensile Modulus of Elasticity – Transverse	1566.4	ksi	ISO 527-4
Compressive Strength – Longitudinal	70.3	ksi	ASTM D6641
Compressive Modulus of Elasticity – Longitudinal	4829.8	ksi	ASTM D6641
Compressive Strength – Transverse	17.4	ksi	ASTM D6641
Compressive Modulus of Elasticity – Transverse	1682.4	ksi	ASTM D6641
In-Plane Shear Strength – Longitudinal	12.2	ksi	ASTM D7078
In-Plane Shear Strength – Longitudinal	620.8	ksi	ASTM D7078
Interlaminar Shear Strength	6.4	ksi	ASTM D2344

### 2.1.2 Physical Properties

PROPERTY	RESULT	UOM	STANDARD
Density	126.7	lb/ft <sup>3</sup>	ASTM D792
Barcol Hardness	60	-	ASTM D2583
Water Absorption	0.2	%	ISO 62
Glass Transition Temperature	166	°F	ASTM D7028
Fiber Mass Fraction	77.4	%	ISO 1172
Fiber Volume Fraction	57.7	%	ISO 1172
Coefficient of Thermal Expansion – Longitudinal	9.054x10 <sup>-6</sup>	/°F	ISO 11359-2

### 2.1.3 Crossarm Component Testing

PROPERTY	PROFILE	RESULT	UOM	TEST
Bending Moment	4x4	13077	lb-ft	Three-Point Bend
	5x5	25697	lb-ft	
Sudden Load Release	4x4	1.2	kip	ENA DOC 012
	5x5	2.2	kip	
Bolted Shear Capacity (all bolt holes sizes)	4x4	23.3	kip	Bolted Connection Capacity
	5x5	28.1	kip	
Maximun Allowable Torque	5/8" dia bolt	119	ft-lbs	Crush Resistance
	3/4" dia bolt	140	ft-lbs	
	1" dia bolt	221	ft-lbs	

## 2.2 ELECTRICAL TESTING

PROPERTY	TEST CONDITIONS	RESULT	STANDARD
Basic Insulation Level (BIL)	15+ & 15- polarity lightning pulse over 312 mm (1ft)	210 kV (17.5 kV/in)	IEC 60383 (AS 2947.1)
Power Arc Test	20 kA for 1s at 6.8 kV	Withstood	IEC 1109 (AS 4435.1)
DC Electrical Resistance	5 kV over a minimum distance of 305 mm (1ft)	1.07 x10 <sup>9</sup> Ω	IEC 60383 (AS 2947.1)
Power Frequency Voltage (Dry)	120 kV for 60 s at 50 Hz over 305mm (1ft)	Withstood	IEC 60383 (AS 2947.1)
Inclined Plane Tracking	250 V increments until 25 mm (1in.) tracking reached	3.00 kV	IEC 60587 ASTM D2303

## 2.3 ENVIRONMENTAL ELEMENT TESTING

### 2.3.1 Ultraviolet (UV) Resistance

TEST	WITHSTOOD	STANDARD
QUV-B Accelerated Weathering	41,000+ hours	ASTM G154-02

### 2.3.2 Resistance to Chemical Attack

Wagners pultrusion is made from the Derakane family of vinyl ester resins. Derakane produce a guide which contains information on corrosion resistance based on case studies. The guide can be found at [www.derakane.com](http://www.derakane.com). Vinyl ester resins provide the best corrosion performance in both acidic and alkaline environments and can easily deal with the standard atmospheric conditions it is expected to encounter when used as a crossarm.

### 2.3.3 Resistance to Fire Damage

TEST	RESULT	STANDARD
Flammability Resistance	Pass	ASTM D635
Flame Spread Index	25	ASTM E84
Smoke Developed Index	560	ASTM E84
Smoke Generation	Pass	ASTM E662

### 2.3.4 Moisture Ingress

Exposed moisture ingress in composites generally occurs through areas of air voids, which can weaken the FRP materials in areas of high stress. The pultrusion process minimizes the amount of air voids (typically 1% or less) in the composite, thus minimizing water entry. Wagners have tested the square hollow section pultrusion for moisture absorption, with results listed in the following table.

TIME	SAMPLE A	SAMPLE B	SAMPLE C	SAMPLE D
Original Weight	344.24	338.73	338.02	341.15
12 hours drying	344.02	338.51	337.79	340.94
Water 6 hours	344.25	338.69	338.03	341.12
Water 24 hours	344.30	338.80	338.02	341.20
Water 48 hours	344.40	339.10	338.34	341.40
24 hour % increase	0.081%	0.086%	0.068%	0.076%

The results observed indicate that Wagners' pultrusion offer very good resistivity to moisture absorption and excellent product durability.



## 2.3.5 Extreme Temperature

Fiber composite components can experience loss of stiffness when their temperature rises above their "Heat Distortion Temperature" or HDT. The HDT of a composite is based on the resin type used, and the treatment that the resin has undergone. Wagners pultrusion process occurs at a temperature of 300 °F. For any relaxation (loss of stiffness) to be seen the temperature of the element must be elevated above 300 °F.

Whilst the effect of low temperatures does not directly affect the strength of Wagners sections, low temperatures have the potential to cause "freeze-thaw" issues on many structural elements. Freeze-thaw becomes an issue for a material when that material is able to absorb moisture. Water expands by 9% when frozen, which applies tremendous force to any material attempting to confine it. In this way the best method to prevent degradation from freeze-thaw is to prevent moisture ingress.

The test results in section 2.3.4 show Wagners members absorb very little moisture, aiding in the resistance to freeze-thaw actions. Wagners have performed 22 weeks of freeze-thaw testing (1 cycle per day) for bridge applications, with the result being no loss of strength over that period.



# 3 QUALITY ASSURANCE

Wagners place pride in producing the highest level of products and services which is evident in the continuous certification of the company under ISO 9001. Quality control documents and tests in conjunction with a production Inspection and Test Plan (ITP) have been developed in-house to create a stringent QA system to ensure the highest level of manufacturing quality in all Wagners products.

The ITP is used to define the following information for production of all pultrusion profiles, manufactured crossarms, as well as inspections and testing for incoming goods:

- Testing frequency
- Determination of low and high confidence levels
- Pass/fail criteria
- Corrective action
- Test methods (work instructions)
- Test result records (forms)
- Quality Check (QC) responsibility





# 4 MAINTENANCE

It is not expected that any maintenance is required on the Wagners crossarm over its design life. Many years of research and development in the design and manufacture of a Wagners crossarm ensures a product that is durable with no maintenance required throughout its service life. Damage to the crossarm caused by outlying environmental and human factors such as fire, storms, transport damage may be repairable.



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