COMPOSITE FIBRE TECHNOLOGIES (CFT)

CROSSARM TECHNICAL INFORMATION GUIDE

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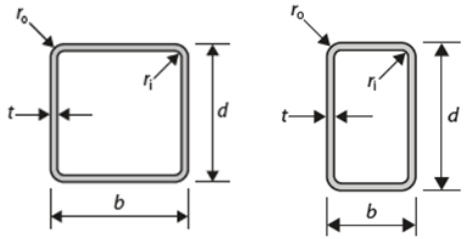
1 DESIGN AND CONSTRUCTION

1.1 FORM AND SIZING

1.1.1 Profile Sizing

Wagners manufacture three standard crossarm profile sizes; 125×125 mm, 100×100 mm, and 100×75 mm. 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								
	Designation				Outside Corner Radius	Inside Corner Radius	Mass	External Surface Area	Gross Section Area
		Depth	Width	Thick.					
		d	b	t	r_o	r_i	per m	per m	A_g
		mm	mm	mm	mm	mm	kg/m	m^2/m	mm^2
STR-RHS-100x75x5	WCFT	100	75	5.0	10.0	4.75	3.21	0.333	1580
STR-VSHS-100x100x5.2	WCFT	100	100	5.2	10.0	4.75	3.87	0.383	1910
STR-VSHS-125x125x6.4	WCFT	125	125	6.4	10.0	4.75	6.03	0.483	2970

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1.2 MATERIALS

1.2.1 Fibre 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 only uses an epoxy vinyl ester resin matrix in the manufacture of our pultrusion material. No thermoplastic resins are used in the manufacture of Wagners pultrusion. The use of polyester resin in the fabrication of fibre 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 colour is RAL 7001 Silver Grey in a satin finish. Other colours 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 moulding process and are made from lightweight and durable 50 per cent glass fibre 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 3 mm) 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 of the product.

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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 fibre 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 fibre 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; 16 mm, 20 mm, and 24 mm. 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	± 0.4 mm
Concavity of wall	< 0.3 mm
Dimension of external form	< 0.4 mm
Degree of flatness	≤ 0.8% with 0.5 mm min.
Degree of squareness	±1°
Degree of curve	≤ 0.1% of total length
Weight	± 0.1 kg/m

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 fibre 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 fibre 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.

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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 regarding 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 finalisation 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 Labelling

As standard, Wagners crossarms are wrapped and packed with an opaque protective plastic film to help minimise 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
- Pack size and quantity
- Manufactured date
- Wagners work order number

2 PERFORMANCE AND TESTING

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 utilisation of Wagners composite fibre components are:

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

2.1.1 Mechanical Properties

PROPERTY	RESULT	UOM	STANDARD
Tensile Strength – Longitudinal	610	MPa	ISO 527-4
Tensile Modulus of Elasticity – Longitudinal	36300	MPa	ISO 527-4
Tensile Strength – Transverse	55	MPa	ISO 527-4
Tensile Modulus of Elasticity – Transverse	10800	MPa	ISO 527-4
Compressive Strength – Longitudinal	485	MPa	ASTM D6641
Compressive Modulus of Elasticity – Longitudinal	33300	MPa	ASTM D6641
Compressive Strength – Transverse	120	MPa	ASTM D6641
Compressive Modulus of Elasticity – Transverse	11600	MPa	ASTM D6641
In-Plane Shear Strength – Longitudinal	84	MPa	ASTM D7078
In-Plane Shear Modulus of Elasticity – Longitudinal	4280	MPa	ASTM D7078
Interlaminar Shear Strength	44	MPa	ASTM D2344

2.1.2 Physical Properties

PROPERTY	RESULT	UOM	STANDARD
Density	2030	kg/m^3	ASTM D792
Barcol Hardness	60	-	ASTM D2583
Water Absorption	0.2	%	ISO 62
Glass Transition Temperature	130	°C	ASTM D7028
Fibre Mass Fraction	77.4	%	ISO 1172
Fibre Volume Fraction	57.7	%	ISO 1172
Coefficient of Thermal Expansion – Longitudinal	$5.03x10^{-6}$	/°C	ISO 11359-2

2.1.3 Crossarm Component Testing

PROPERTY	PROFILE	RESULT	UOM	TEST
Bending Moment	100x100	17.73	kNm	Three-Point Bend
	125x125	33.84	kNm	
Sudden Load Release	100x100	5.317	kN	ENA DOC 012
	125x125	9.791	kN	
Bolted Shear Capacity (all bolt holes sizes)	100x100	103.82	kN	Bolted Connection Capacity
	125x125	125.00	kN	
Maximun Allowable Torque	16 mm dia bolt	162	Nm	Crush Resistance
	20 mm dia bolt	190	Nm	
	24 mm dia bolt	300	Nm	

2 PERFORMANCE AND TESTING

2.2 ELECTRICAL TESTING

PROPERTY	TEST CONDITIONS	RESULT	STANDARD
Basic Insulation Level (BIL)	15+ & 15- polarity lightning pulse over 312 mm	210 kV (673kV/m)	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	1.07 x10^9 Ω	IEC 60383 (AS 2947.1)
Power Frequency Voltage (Dry)	120 kV for 60 s at 50 Hz over 305 mm	Withstood	IEC 60383 (AS 2947.1)
Inclined Plane Tracking	250 V increments until 25 mm 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*. 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 minimises the amount of air voids (typically 1% or less) in the composite, thus minimising 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 offers very good resistivity to moisture absorption and excellent product durability.

2 PERFORMANCE AND TESTING

2.3.5 Extreme Temperature

Fibre 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 150 °C. For any relaxation (loss of stiffness) to be seen the temperature of the element must be elevated above 150 °C.

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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