APEES MARLAN PTY LTD

FIBRE COMPOSITE MATERIALS

PERFORMANCE CRITERIA

What is a Fibre Composite Material

A material of fibre reinforcement and resin manufactured using the pultrusion process.

What is Pultrusion

Pultrusion is a process whereby materials are pulled through their manufacturing process. Not to be confused with extrusion where materials are pushed through their manufacturing process.

What are fibre reinforcement

Typically, there are three forms of reinforcement, rovings, mats and fabrics.

The composition of each is generally made of the following fibres, or a combination of these fibres: Glass, Carbon or Aramide.

What are resins

Resins, for the purposes of pultrusion, are generally thermoset materials – a polymer material that irreversibly cures – such as; polyester, vinyl ester or polyurethane all of which can be combined with suitable fillers, catalysts, UV ray absorbers, fire inhibitors, mould releases and pigments to formulate the resinous matrix.

The Pultrusion Manufacturing Process

Pultrusion is a continuous moulding process using fibre reinforcement in thermosetting resin matrix.

Pre-selected reinforcement materials are drawn through a resin bath in which all reinforcing is thoroughly impregnated with a liquid thermosetting resin. A surface veil, a fabric, can be added to improve surface finishing and further protect the structural elements, fibre and resin matrix, of the product.

The impregnated fibre is formed to the desired geometric shape and pulled into a heated steel die. Once inside the die, the resin cure is initiated by controlling precise elevated temperatures. The

shape in the die now becomes a laminate as it solidifies into the exact shape of the die and as it is continuously pulled by the pultrusion machine.

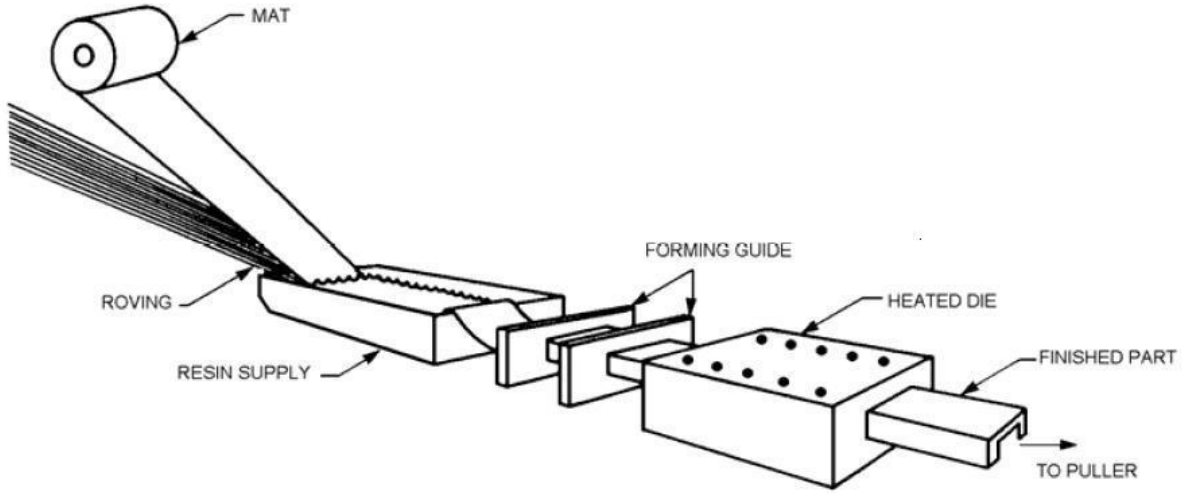

Illustration of the pultrusion process

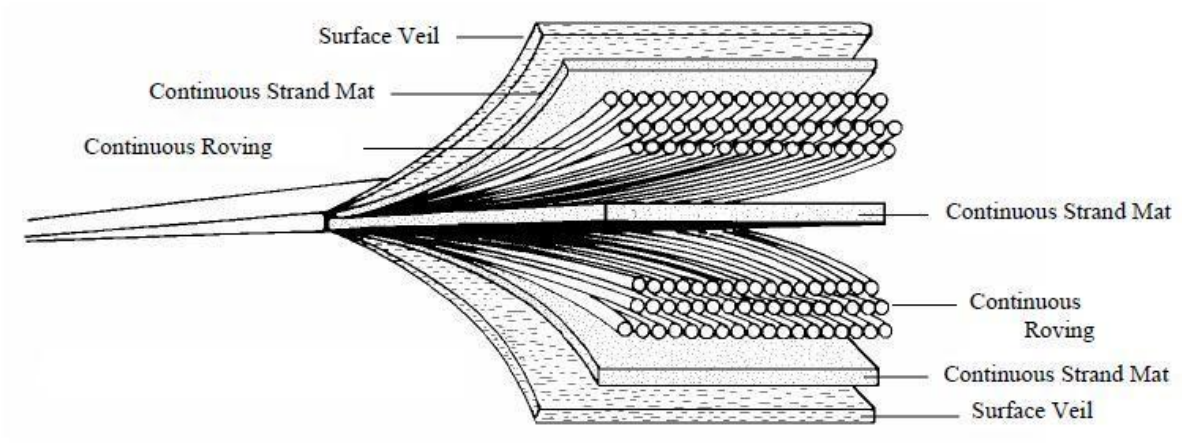

Illustration of the components of fibre composite product

The finished part being pultruded from the die

The finished part ready to be sawn to size

The advantages of the Process

Prior to commencing manufacture of a profile for an application, we assess the criteria to which the profile is to be applied. Even custom profiles can be effectively fabricated and or assembled from available standard profiles, providing for a feasible solution with minimal cost. This delivers value engineering through the early stages of the design process.

Feasibility, or cost savings, by using fibre composites can be identified by comparing the total cost of the pultrusion process with that of using traditional construction materials, such as steel, aluminium, concrete or timber. Savings are realised in lower installation and reduced freight due to the lighter weight properties as well as reduced maintenance cost.

Cost savings in the life cycle of the product should be considered with the product's original cost when marking cost comparisons.

Processing capabilities include the production of both simple and complex profiles, eliminating the need for much post-production assembly of components.

Typical characteristics of pultruded products include chemical resistance, high mechanical and electrical properties, excellent corrosion resistance, elevated service temperature capabilities, fire retardants, low smoke, low UV degradation, choice of colours and optimum surface finishes.

Selection of the type, amount and positioning of the fibre reinforcements and resins allow a product to be pultruded to meet specific criteria.

Specific strength characteristics can be designed into the composite, optimising laminate performance for a particular application by strategic placement of high performance reinforcements.

The fibreglass rovings provide the high longitudinal strength of the required product. The amount and location of these reinforcements can be determined to alter the physical properties of the product.

Continuous strand mat, layered with the rovings, provides the transverse physical properties of the product. Similarly, improved physical properties can be achieved to the required criteria by using fabrics in the laminate.

Colour is uniform throughout the cross section of the profile, eliminating the need for many painting requirements.

Features	Description	Benefits
Strength	Unit strength in tension, flexure, and compression is approximately 20 times that of steel when properties are combined on the basis of unit density	• Structural design capabilities • Optional strength in desired directions • Exceptionally high impact strengths
Lightweight	Density of Pultex® is 20% of steel and 60% of aluminum	• Higher performance at less weight • Reduced shipping costs • Reduced operational energy demands • Reduced labor expense for installations • Easily handled • Assembled and installed with ease
Corrosion Resistance	Unaffected by a wide range of corrosive chemicals and environments	• Minimal maintenance costs • Long-term safety • Installation longevity and increased service life • Outdoor storage capabilities • Lower cost performance ratio • Less need for replacements
Electrical Insulation	Structural strength and rigidity are provided with dielectric material.	• Less components for assemblies • Non-magnetic • Additional safety factors • Predictable insulation values
Part Consolidation	Many individual components can be combined into one large profile.	• Reduced assembly costs • Reduced inventory requirements • Smooth aerodynamic surfaces • Improved reliability
Dimensional Stability	Stretch-, warp-, and swell-resistant over a wide range of temperatures and physical stresses.	• No permanent set under high stress • Reduced damage to structure assemblies • Easy to repair misused parts • Close tolerances
Thermal Insulation	Low thermal conductivity rating of 1/250 of aluminum; 1/60 of steel	• Reduced insulation thickness requirements • Reduced energy operation requirements • No condensation problems

Characteristics comparison of standard Composite structural profiles, Pultex, with some traditional materials

Pultex and Steel

Characteristic Pultex® Standard Structural Profiles		Steel A-36 Carbon
Corrosion Resistance	Various resin systems to meet corrosion requirements Painting suggested when exposed to UV rays	Subject to oxidation and corrosion Painting or galvanizing required
Weight	Lightweight: 75% lighter than steel - zero to minimal lifting equipment	Reduced installation and shipping cost.
Electrical Conductivity	Non-conductive Low Thermal Conductivity 4 (BTU/SF/HR/F°/IN)	Conducts electricity; grounding potential Thermal Conductivity 260-460 (BTU/SF/HR/F°/IN)
Strength	High strength-to-weight ratio; stronger than some steels in lengthwise direction Ultimate flexural strength (Fu) LW = 30 x 10^3 PSI, CW = 10 x 10^3 PSI	Homogeneous material
Stiffness	Flexural modulus LW - 2.5 x 10^6 PSI, CW = .8 x 10^6 PSI No permanent deformity under working load	Yield strength (Fy) 36,000 PSI Flexural modulus 20 x 10^6 PSI
Impact Resistance	Glass mat distributes impact load to prevent surface damage. No permanent deformity under impact.	Can permanently deform under impact
EMI/RFI Transparency	Transparent to EMI/RFI transmissions	Can interfere with EMI/RFI transmissions
Versatility	Pigments provide inherent color; special colors available	Must be painted for color To maintain color and corrosion resistance, repainting may be required.
Ease of Fabrication	Field fabricated with simple hand tools Lightweight for easier erection and installation.	Requires welding and cutting torches Heavier material requires special handling equipment to erect and install
Cost	Lower installation and maintenance costs equals lower lifecycle costs	Expensive to install and maintain.

*LW = Lengthwise; CW = Crosswise

Pultex and Aluminium

Characteristic Pultex® Standard Structural Profiles		Aluminum
Corrosion Resistance	Superior resistance to broad range of chemicals Surfacing veil and UV additives improve weatherability	Causes galvanic corrosion; Increase resistance through anodizing or other coatings
Weight	Lightweight - 30% lighter than aluminum	Lightweight - about 1/3 the weight of copper or steel
Electrical Conductivity	Non-conductive; high dielectric capability (i.e. ASTM standard)	Conducts electricity; grounding potential
Thermal Properties	Low thermal conductivity, 4 BTU/SF/HR/F°/IN; low thermal coefficient of expansion 4.4 (in/in/F°) 10^{-6}.	Heat conductor - high thermal conductivity, 150 BTU/SF/HR/F°/IN; thermal coefficient of expansion 11-13 (in/in/F°) 10^{-6}
Strength	Ultimate flexural strength (Fu) LW = 30 x 10^3 PSI, CW = 10 x 10^3 86% of the yield strength of aluminum and stronger than aluminum in the lengthwise direction	Flexural Strength (Fu) 35 x 10^3 PSI Homogeneous material
Finishing and Color	Pigments provide inherent color; special colors available.	Silver color; other colors require prefinishes, anodic coatings and paints; Mechanical, chemical and electro-plated finishes can be applied
EMI/RFI Transparency	Electromagnetically transparent; used for radar and antennae enclosures and supports	Highly reflective
Fabrication	Field-fabricated with simple hand tools; adhesive bonding and/or mechanical joining. No torches or welding required.	Good machinability - welding, brazing, soldering or mechanical joining required
Cost	Slightly higher tooling costs; price per lineal foot marginally higher	Inexpensive tooling; part price comparable or slightly lower
Impact Resistance	Glass mat distributes impact load to prevent surface damage. No permanent deformity under impact.	Easily deforms under impact

*LW = Lengthwise; CW = Crosswise

Pultex and Timber

Characteristic Pultex® Standard Structural Profiles		Structural Timber - Douglas Fir
Corrosion Resistance	Superior resistance to broad chemcial range. Unaffected by moisture or immersion in water with sealed ends. Surfacing veil and UV additives create excellent weatherability	Warp, rot and decay potential from moisture, water and chemicals; coatings or preservatives rrequired to increase corrosion or rot resistance can create hazardous waste and/ or high maintenance.
Insect resistance	Resists damage by insects	Susceptible to insect attack (marine borers, termites); coatings increase resistance to insects and are environmentally hazardous
Strength	Greater flexural strength than timber; Ultimate flexural strength (Fu) LW = 30 x 10^3 PSI; CW = 10 x 10^3 PSI Compression strength is 30,000 PSI	Extreme fiber bending = up to 2800 PSI Compression parallel to grain = up to 1800 PSI*
Stiffness	1.5-3.3 times as rigid as wood; Modulus of elasticity LW = 2.5 x 10^6 PSI, CW = .8 x 10^6 PSI	Modulus of elasticity = up to 1.8 x 10^6 PSI
Electrical Conductivity	Non-conductive; high dielectric capability	Conductive when wet
Weight	Specific gravity = 1.7 with significantly higher strength-to-weight ratio	Specific gravity = .51 (oven dried).*
Finishing and Color	Pigments provide inherent color; special colors available.	Must be primed and painted for color; painting may be required
Cost	Lower maintenance; longer product life equals lower lifecycle costs	Lower initial cost replacements necessary
		**Surface dry at 19% max moisture content Design Values for Wood Construction, National Design Specification for Wood Construction.*

*LW = Lengthwise; CW = Crosswise

Property comparison of standard Composite structural profiles, Pultex, with some traditional materials

	Pultex® 1500/1525	Pultex® 1625	Pultex® Solid Rod & Bar	Carbon Steel (M1020)	316 Stainless Steel	Aluminum 6061-T6 T651	Ponderosa Pine	Rigid PVC	Rigid PVC 10% Glass	Fiberglass Compression Molding (SMC)	Spray-Up (30-50% Glass)
MECHANICAL											
Tensile Strength (psi x 10^3)											
LW	30	30	100	35	30-35	45	8.4	6.2	7.8	8-20	9-18
CW	7	7	-	35	30-35	45	--	6.2	7.8	8-20	9-18
Tensile Modulus (psi x 10^6)											
LW	2.5	2.6	6	30	28	10	-	.39	.47	1.6-2.5	.8-1.8
CW	.8	1	-	30	28	10	-	.39	.47	1.6-2.5	.8-1.8
Flexural Strength (psi x 10^3)											
LW	30	30	100	35	30-35	45	15.4	11	11.7	18-30	16-28
CW	10	10	-	35	30-35	45	9.4	11	11.7	18-30	16-28
Flexural Modulus (psi x 10^6)											
LW	2	2.2	6	30	28	10	1	.35	.45	1.3-1.8	1-1.2
CW	.8	.8	-	30	28	10	-	.35	.45	1.3-1.8	1-1.2
Izod Impact (Ft.-Lbs./in.)											
LW	25	25	40	N/A	8.5-11	--	--	1.6	1.6	10-20	4-12
CW	4	4	--	N/A	--	--	--	1.6	1.6	10-20	4-12
Specific Gravity	1.7	1.7	2	7.8	7.92	2.5	.52	1.38	1.39	1.5-1.7	1.4-1.6
PHYSICAL											
Density (Lbs./$in.^3$)	.062-.07	.062-.07	.072-.076	.284	.29	.092	.019	.052	.052	.054-.061	.05-.059
Coefficient of Thermal Expansion (10^{-6}in./in.°F)	5.2	5.2	3	6-8	9-10	13.5	1.7	37	23	10-18	12-20
Thermal Conditions (BTU-in./$Ft.^2$/HR/°F)	4	4	5	260-460	96-185	1200	.08	1.3	--	1.3-1.7	1.2-1.6

LW = Longitudinal/CW = Transverse
Pultex® 1500,1525 and 1625 standard 40 to 45% glass
Values are minimum ultimate properties from coupons
Specific Heat (cal./°C/gm) = .25

For more information on the Fibre Reinforced Polymer materials and all of our products, please visit our website:

www.apeesmarlan.com

PRODUCTS ARE PROVIDED BY

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