AN OVERVIEW ON

GFRP COMPOSITES AND PULTRUSION TECHNOLOGY

For engineers and industry leaders who have questions about pultrusion technology and glass fiber-reinforced polymer (GFRP) composites.

Technical comparison data included.

pultron® COMPOSITES

Welcome

At Pultron Composites, we've been constantly evolving pultrusion technology.
We are the global specialists in the development and manufacture of high-performance, fiber-reinforced polymer (FRP) composites using the pultrusion process.

As more companies are looking to pultrusion composite technology to solve a problem, we believe providing important information for people to make informed decisions will help the next customer and make our industry stronger.

pultron®
COMPOSITES

The Pultrusion Process

Pultrusion is an automated process for the continuous production of fiber-reinforced profiles with a constant cross-section. There are four main types of fibers used in pultrusion: Glass (GFRP), Carbon (CFRP), Aramid (AFRP) and Basalt (BFRP). Each kind of fiber has its advantages and disadvantages.

At Pultron, our specialty is glass fiber-reinforced polymer (GFRP) composites which are cost-effective, high performing and durable.

ADVANTAGES OF THE PULTRUSION PROCESS

Quicker and more economical to produce: The process is faster and more economical than ever before. Continuous improvement has made mass production more efficient and bought down the manufacturing cost.

Accuracy and consistency: Resin and fiber content in a profile can be accurately controlled, delivering consistent quality with strict tolerances.

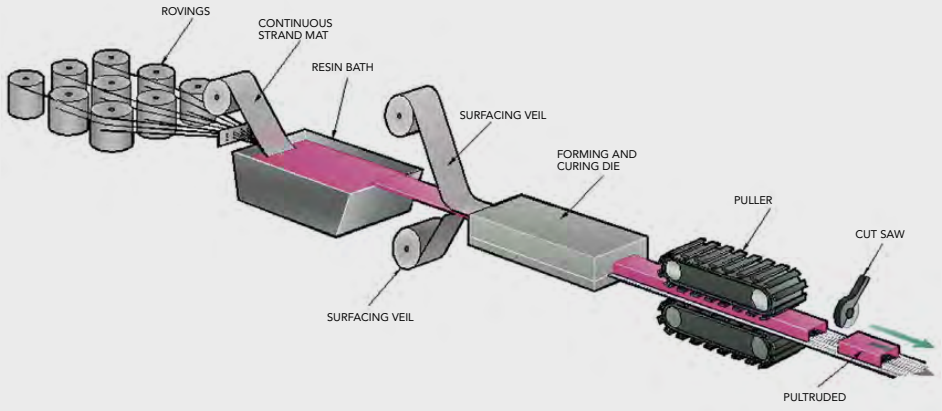
Low energy process: The manufacturing process is a low-energy process requiring no water and minimal power.

HOW IT WORKS?

The pultrusion manufacturing process begins with the fibers (glass, aramid, carbon, basalt or other fibers) being pulled into an impregnation bath.

Once the raw fiber has been impregnated with liquid resin (polyester, vinyl ester, polyurethane, epoxy, hybrid resins), it is pulled into a forming and curing die (mold), where it is heated and cured in its final shape.

The reinforced and cured material is continuously pulled through a flying cut-off saw, which cuts the profiles to the desired length.



The Essential Quality Tests

At Pultron, we run 18 different quality testing methods. Some of these are specifically designed for our customers who have critical parts that require the highest performance and safety standards in industries as diverse as infrastructure and sporting goods.

When choosing a pultrusion manufacturer, we highly recommend you find out if they use the following **on-site** test methods – as an absolute minimum requirement:

Every year, we perform over 250,000 conformance tests and run 'in-process' conformance quality checks.

DIFFERENTIAL SCANNING CALORIMETER (DSC)

DSC measures consistency in resin quality, glass transition temperature (Tg) and checks for full cure of the resin.

Why is this important? If a full cure is not achieved it leads to early failures or breakages through the loss of strength, stiffness and poor resistance to chemical attack.

DYNAMIC MECHANICAL THERMAL ANALYZER (DMTA)

DMTA analyzes viscoelastic responses, glass transition temperature and the cure of finished pultruded products. DMTA provides details of the material's stability over a wide range of temperatures as the resin system and other ingredients are specific for the application.

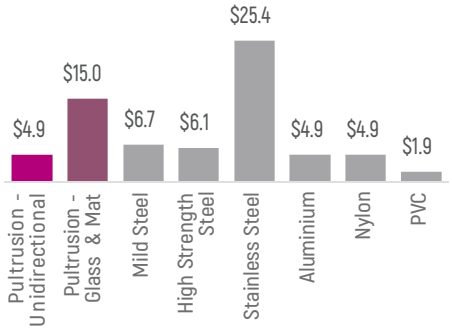
Why is this important? Full cure of the resin matrix is critical to ensure maximum life-cycle for the product. The DMTA is also beneficial to our R&D team for product development, gathering special data during the development process. It is also helpful to our QA team who are able to perform long term monitoring of incoming materials.

Both test methods are essential and form an important part of any pultrusion quality control program.

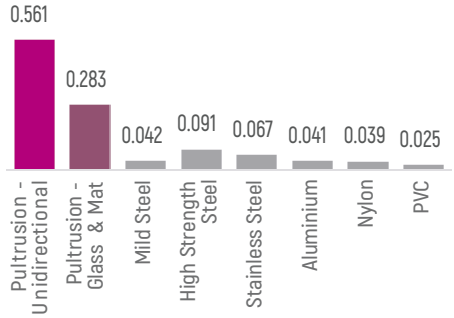
Material Comparisons

$ in US currency

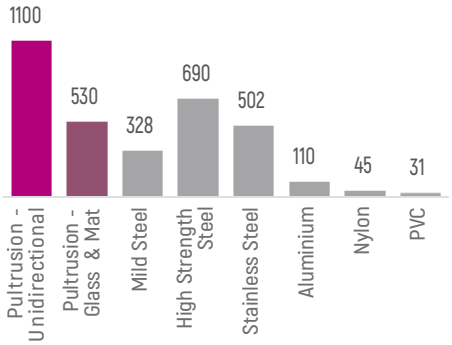
PRICE PER VOLUME ($000's/m^3)



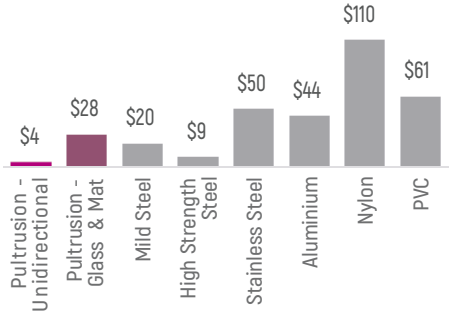
SPECIFIC TENSILE STRENGTH (MPa.m^3/kg)



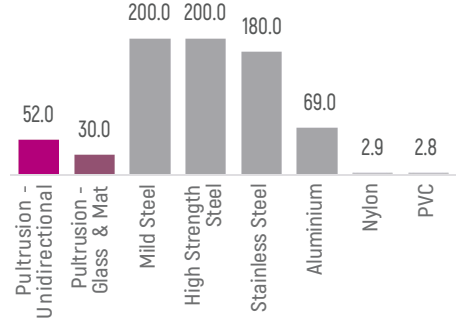
TENSILE STRENGTH (MPa)



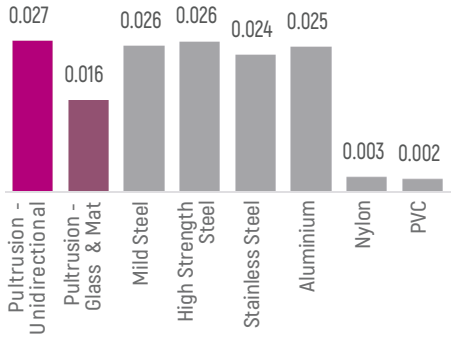
PRICE SPECIFIC TENSILE STRENGTH vol. ($/MPa.m^3)



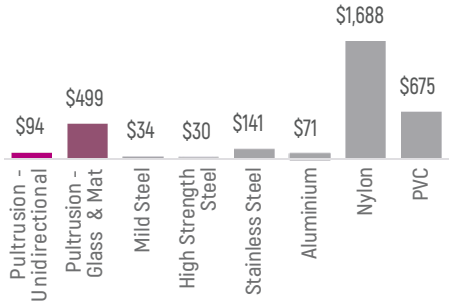
YOUNGS MODULUS (GPa)



SPECIFIC MODULUS (GPa.m^3/kg)



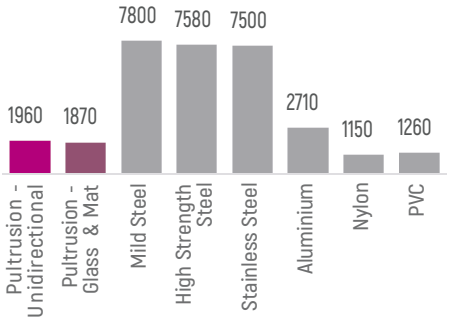
PRICE SPECIFIC MODULUS vol. ($/GPa.m^3)



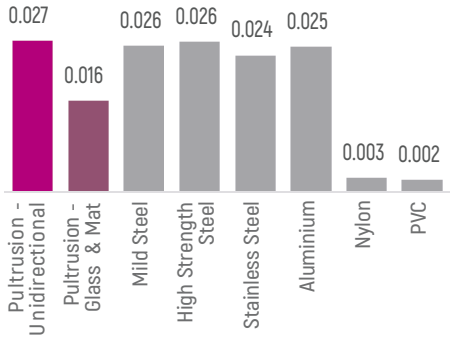
Material Comparisons

$ in US currency

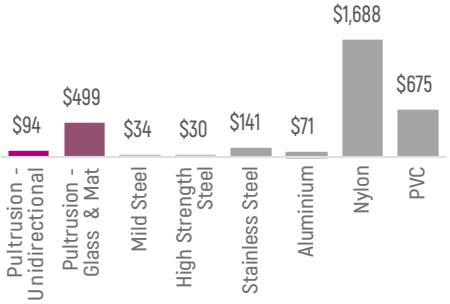
DENSITY (kg/m ^{3})



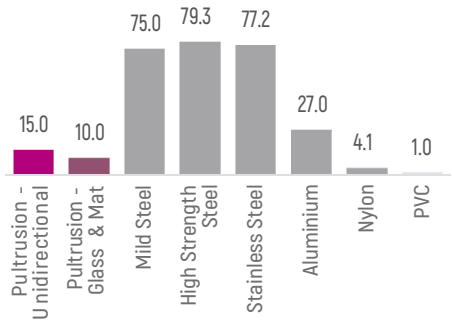
SPECIFIC MODULUS (GPa.m ^{3}/kg)



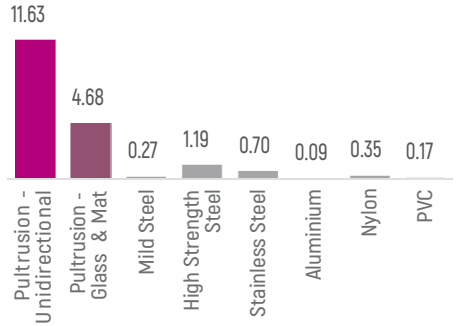
PRICE SPECIFIC MODULUS vol. ($/GPa.m^3)



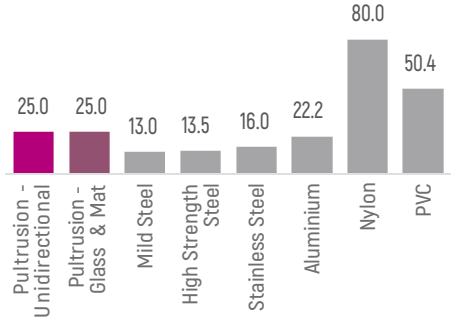
SHEAR MODULUS (GPa)



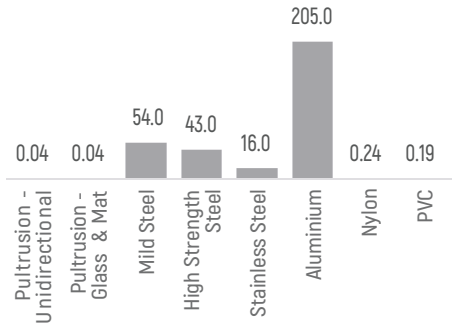
STRAIN ENERGY (kJ)



THERMAL EXPANSION K $^{-1}$



THERMAL CONDUCTIVITY W/m.K



Why GFRP Composites?

Pultruded GFRP composites are replacing traditional materials like steel, aluminum, stainless steel and timber, to name a few.

The physical advantages of GFRP composites offer an excellent starting point for engineers looking for an innovative solution for their unique challenges.

PULTRUDED COMPOSITES CAN BE OPTIMIZED FOR APPLICATION

Through research and development, a GFRP composite can be customized for a particular application. For example, we can optimize resin formulations, increase creep resistant, engineer in flex or stiffness – and with the addition of finishing technology, mechanical and physical traits can be engineered into the final product.

GFRP COMPOSITE ADVANTAGES

Corrosion resistant: they will never rust or corrode.

Highly chemical resistant: exceptionally resistant to chemicals including acids, alkalis, wastewater and salt water.

Lightweight: approximately ¼ weight steel and 70% that of aluminum.

Highly durable: More than 100 years retention of strength in corrosive environments*.

Competitively priced: GFRP composites are offer an excellent price-performance ratio with reduced lifetime costs.

Non-magnetic: no interference to sensitive magnetic apparatus such as compass calibration areas or MRI scanners.

Non-electrically conductive: no interference with electromagnetic fields and an excellent electrical insulator.

Low thermal conductivity: useful for energy efficiency buildings.

Low environmental impact: GFRP composites have a 15% lower carbon footprint than steel**.

* Based on test methods developed by the American Concrete Institute.
**Comparison based on the manufacturer of steel rebar.

Are GFRP Composites Sustainable?

Yes, GFRP composites are sustainable and do not leach or corrode into the environment.

RAW MATERIALS

GFRP composites have a 15% lower carbon footprint than steel**.

THE MANUFACTURING PROCESS

Minimal heat and energy is used in the pultrusion process resulting in lower CO_2 emmissions. The pultrusion process is accurate, resulting in minimal wastage. No water is used in the process.

DISTRIBUTION

GFRP composites are lightweight (¼ that of steel). Less fuel is required for transport.

USE

The long life-cycle is one of the biggest advantage when it comes to sustainability. For example, using GFRP composite concrete reinforcement, has shown to increase asset life-cycle by as much as four times, with no maintenance requirements.

RECYCLE

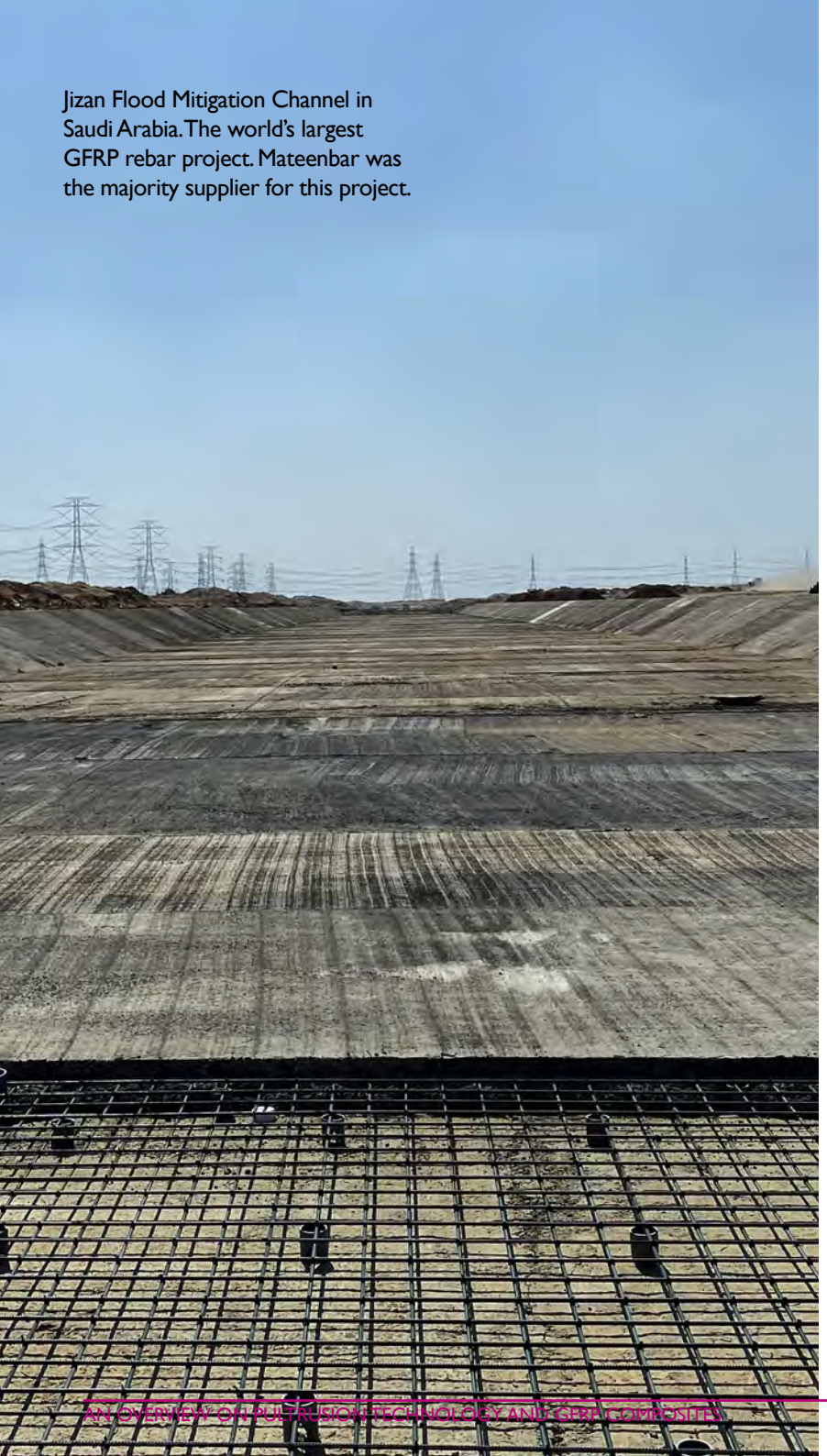
GFRP composites can be crushed up and used as aggregate in concrete.

Projects

We work closely with our customers to develop GFRP composites products and profiles that solve their unique challenges.

Our customers come from a diverse range of industries, which only goes to show the versality of what can be achieved with leading pultrusion technology.

Here's a sample of some of the projects we work on with our customers:



Jizan Flood Mitigation Channel in Saudi Arabia. The world's largest GFRP rebar project. Mateenbar was the majority supplier for this project.

Infrastructure

Mateenbar™, the future of lasting infrastructure

CHALLENGE

The cost of corrosion to the economy and ratepayer is ongoing. The impact on society and the environment is also a price to pay. Corrosion affects the safety and reliability of its application – leading to ongoing maintenance, repairs, and, ultimately a shortened life cycle.

With a long and costly history of corrosion worldwide, steel is no longer viewed as a cost-effective option in aggressive environments.

SOLUTION

Mateenbar™ was developed at Pultron by a team with decades of product development experience in construction, mining, and infrastructure composites. Possessing a deep understanding of these industries, the team developed a fiberglass rebar to meet the highest standards required by leading engineering bodies and transportation departments worldwide.

Mateenbar™ provides a massive leap forward in how issues of corrosion in infrastructure and extended life-cycles can be addressed. The lightweight traits make it **more economical to transport and has proven to be quicker and easier to install**, resulting in less worker fatigue. It is **ideal for use in challenging and corrosive environments** and has been used on as reinforcement on mega-projects globally.

Mateenbar is now a company in its own right, with manufacturing facilities in North Carolina, USA and Dammam, Saudi Arabia.

Mining & Tunnels

The One-Step Mining Rockbolt

CHALLENGE

Rockbolts are used in mines and tunnels to reinforce wall strata and provide stability. For years, steel was the material of choice for its strength, but its downside was significant. When the time came to remove the bolts they were difficult to cut and any sparks created a potentially fatal health hazard. Alternatively, forcibly extracting the bolts risked a catastrophic cave-in.

The team at Hilti asked us to explore a rock bolt solution that could be installed in a single process using customized pultrusions.

SOLUTION

We developed a self-drilling One-Step composite rock bolting system that, after multiple tests at Hilti's R&D tunnel site in Switzerland, was found to be superior in every way to steel. The advantages of GFRP composites had the **same strength but with corrosion-resistant properties** that eliminated the risk of premature bolt failure.

High resistance to shock loading and outstanding torsional and shear strength meant it was easier and faster to install – even where there were unstable seams.

And importantly, safety requirements were exceeded for miners as GFRP rock bolts could be easily cut through without any risk to equipment or danger of sparks.

Testing at Hilti's Swiss Research and Development test site.

Marine

Revolutionizing the Floating Dock Marina

CHALLENGE

Stainless steel is expensive and steel corrodes quickly in marine environments, polluting the water. A marina environment also suffers continual movement from the tide and the wake of boat traffic, both of which put a huge strain on any construction materials.

SOLUTION

In collaboration with our client, Bellingham Marine, we developed a GFRP thru-rod and nut system that would be stronger than steel, lightweight and much longer lasting. Custom CNC grinder technology was developed to add an **accurate thread to the rods, including a self-locking nut for minimal maintenance**. Resistance to both creep and fatigue were major advantages of this GFRP innovation, reducing maintenance and associated costs, as well as having zero impact on the environment with no rust or chemicals entering the waterways. The end result is viewed as **the biggest innovation in marina design in 25 years**.

The FRP thru-rod and nut system is a patented technology, proudly shown here at the newly upgraded Marina Del Rey Marina in California.

Image: Marina Del Rey, California. The USA's first fully composite marina

Sports & Recreation

Improving Snowmobile Resilience and Performance

CHALLENGE

Nothing tests the limits of steel more than extreme temperatures as well as constant bending and flexing when traveling over rough terrain. But for years steel was used in snowmobile tracks and eventually that same material would break. Not a great thing to happen to a snowmobile driver travelling at high speed in the wilderness, or miles from anywhere.

What our customer needed was a bespoke GFRP solution with the ability to flex and bend back to shape when under extreme strain.

SOLUTION

At Pultron, the team came up with the answer – a D-shaped composite rod with a unique resin formulation to deliver **ultra-high shear and extremely high flex and fatigue resistance**, whilst incorporating a specialized fine end-bevel finish.

Our customer now has a snowmobile track with **increased durability and reduced maintenance requirements,** plus they run faster and are quieter – a better user experience for the end-user by far.

Our new finishing technology, which we developed specifically for this project, allowed for **mass production at low cost.**

FORTUNE 500 COMPANY

Pultron's composite solutions are everywhere...

We love a challenge!

Have a project in mind that could benefit from world-class R&D
to deliver a customized pultrusion solution?

We'll be happy to help, so get in touch:
pultrusionexperts@pultron.com

pultron®
COMPOSITES