



For the wind industry

PULTRUDED GLASS AND CARBON FIBRE PROFILES



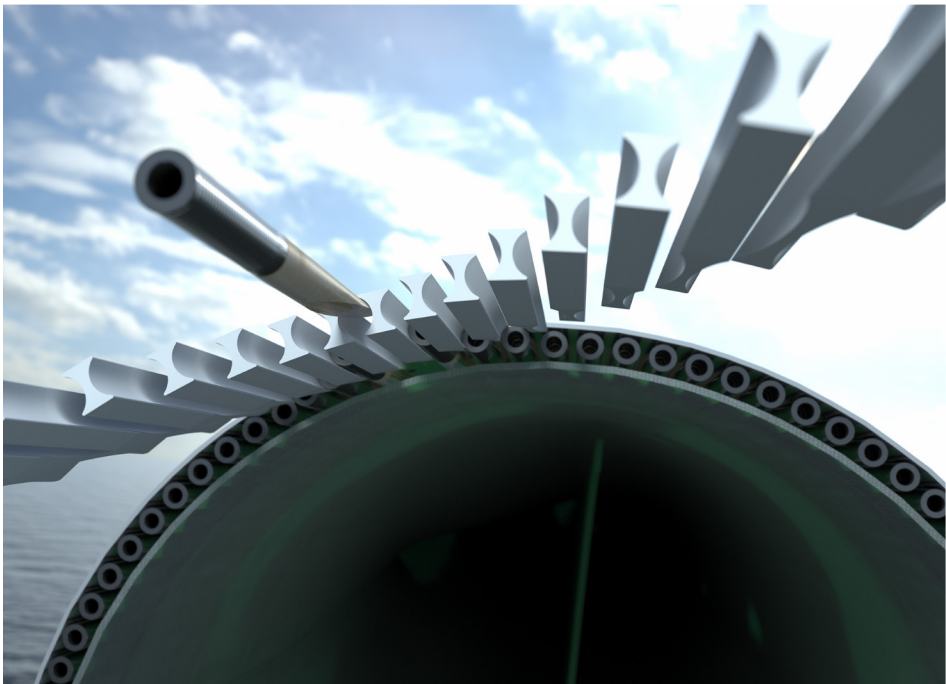
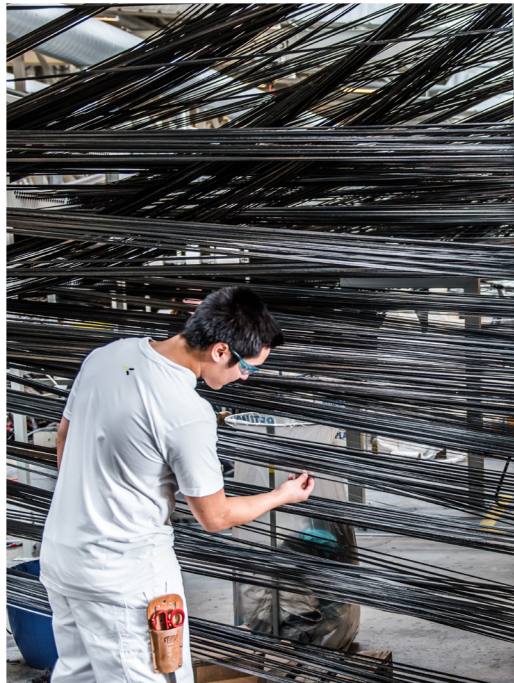
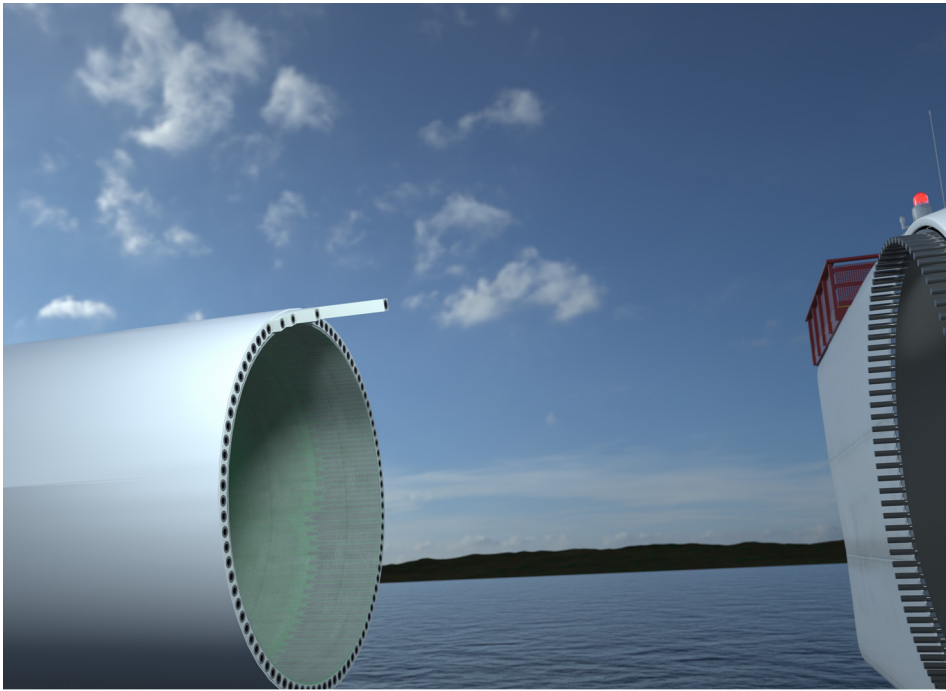
FIBERLINE
COMPOSITES

“We Know How”.



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1. Pultruded profiles

TRUSTED SUPPLIER FOR THE NEXT GENERATION

To support our customers' global manufacturing strategies, Fiberline will extend its production footprint around the world.

Having already manufacturing sites in Denmark since 1979 and in China since 2009, we will start up new facilities in India 2022 and in Mexico and the United Kingdom in 2023.





As a carbon fibre and glass fibre specialist, Fiberline has been a trusted supplier to the wind industry for the past 30 years.

The primary focus for Fiberline's involvement in the wind industry is to strengthen turbine blade parts such as root sections inserts and profiles for spar caps and webs.

In close collaboration with our customers, we push the boundaries for our composites, to achieve optimised solutions for the next generation wind turbine blades and profitable growth for the producers.





2. Engineered to purpose

7 ADVANTAGES OF FIBERLINE PULTRUDED PROFILES



Joint development

In close collaboration with our customers, we push the boundaries for our composites. All technology and development projects are undertaken in accordance with the APQP4Wind standard.



Great strength

The continuous pultrusion process ensures unique fibre alignment and consistently high quality. A superior strength-weight ratio also ensures material savings on the final solution.



Stiffness

With unparalleled levels of stiffness, our pultruded carbon fibre profiles help to strengthen constructions in some of the world's longest wind turbine blades.



CE marking

Our structural profiles have a number of international and highly sought-after certifications, which is your guarantee of consistently high quality.



Minimal maintenance

Our profiles have unrivalled durability and a long life, even in demanding conditions. This results in minimal maintenance and low operating costs throughout the entire lifetime.



Carbon footprint

By using an energy-efficient production process and operating close to our customers, we can facilitate our customers' increasing demands for sustainable growth.



Sustainable manufacturing process

Low-energy manufacturing process and ISO 50001 energy certification pave the way for sustainable end products.



AV

MULTIBRID M5000

A
AREVA



3. Consistently, high quality

APQP4WIND FOR QUALITY ASSURANCE

Our project development stage gate model has fully embedded the APQP4Wind standard, as a key enabler to ensure customer alignment at all levels in the project development phases.

The APQP4Wind standard is strongly supporting our preventive approach to Quality, in terms of shifting mindset from QC to QA. When we understand the specification, the associated critical parameters and the expectations then we have a sound foundation to fulfill and even exceed customer expectations. The detailed planning and deliverables described in the APQP4Wind manual ensures that risks and challenges are communicated and managed on time.

Competitive solutions

To guarantee highly competitive solutions and reduce risks on delivery and quality for our customers all procurements are based on a dual sourcing strategy. Furthermore, all development projects are led by project managers and supported by in-house category management teams that have in-depth knowledge on both component and application level.





Our quality assurance system covers all stages of our production process, from orders and raw materials to the end product when it reaches the customer.



4. Pultrusion: The most effective way

SUSTAINABLE MANUFACTURING PROCESS

Our production process is the most cost effective way of converting fibres into profiles while ensuring products with a minimum of variation. Furthermore, the mechanical properties allow our customers to save significant amounts of material. We can supply the profiles in customized resin systems such as polyester, vinylester, or epoxy.

Supports sustainable growth

At Fiberline, we are keen to facilitate our customers' increasing demands for sustainable growth. By using an energy-efficient production process and operating close to our customers, we can be part of a sustainable value chain. Our pultrusion lines run 24/7 and we have a capacity of several thousand tons a year on our factories in Denmark and China.



Our glass and carbon fibre profiles are manufactured in an enclosed process, which effectively limits the evaporation of solvents and keeps energy consumption low.





5. Close collaboration for profitable growth

JOINT DEVELOPMENT

We have an organisation dedicated to this industry and an in-house setup that allows us to embark on technology and development journeys with our customers.

In close collaboration, we constantly seek to push the limits for our product performance to create end solutions that facilitate profitable growth and reduce risks.

With more than 30 years' experience and strong process engineering and material knowledge, we know how to exploit the unique opportunities of our glass and carbon fibre composites. Therefore, we are well positioned to advise our customers on both material choices and solution design.

All development projects follow the APQP4Wind standardisation, which reduce time to market and increase efficiency. By following this process we ensure to do things right and develop the best possible composite solutions for our customers.





6. Superior mechanical properties

CARBON SPAR CAPS

The pultruded carbon spar caps have superior mechanical properties due to unique fibre alignment. The profiles allows quality inspection on component level and the surface is prepared for excellent adhesion. Our leading edge and trailing edge reinforcement profiles are engineered to purpose and since our pultrusion process leaves no wrinkles the mechanical properties are second to none.

Advantages:

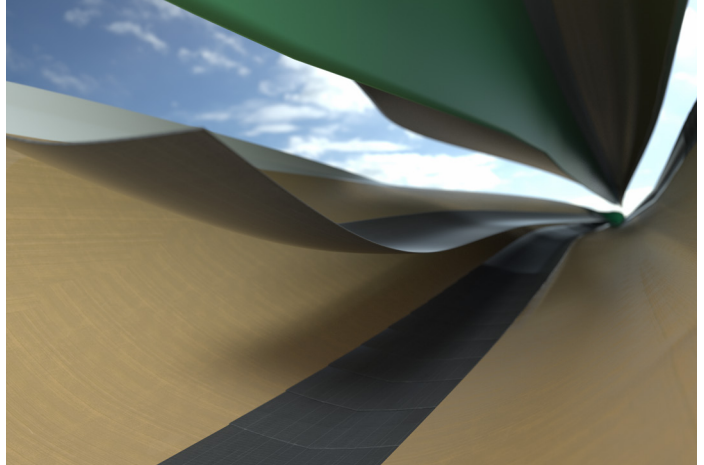
- Unique fibre alignment
- Customized resin system in either vinylester or epoxy
- High and consistent quality
- No wrinkles
- Fast layup

Additional possibilities:

- Chamfered ends of the profile for reduced stress concentrations.
- Peel ply for secondary bonding in the blade moulding process.

Partial properties with vinylester resin (avg.)

| | |
|-------------------------------|-----------------------------|
| Density | 1,53-1,58 g/cm ³ |
| Fiber volume fraction | 60-67 % |
| Tensile E-modulus | 138-154 GPa |
| Tensile strain to failure | 1,5 % |
| Compressive E-modulus | 126-140 GPa |
| Compressive strain to failure | 1,5 % |
| Tensile transverse strength | 55 MPa |
| Interlaminar shear strength | 74 MPa |



Reinforcement profiles for blades with consistent longitudinal strength. Profiles are available in carbon fibre (CFRP), Glass fibre (GFRP), or a combination.



7. Cost-effective lamination process

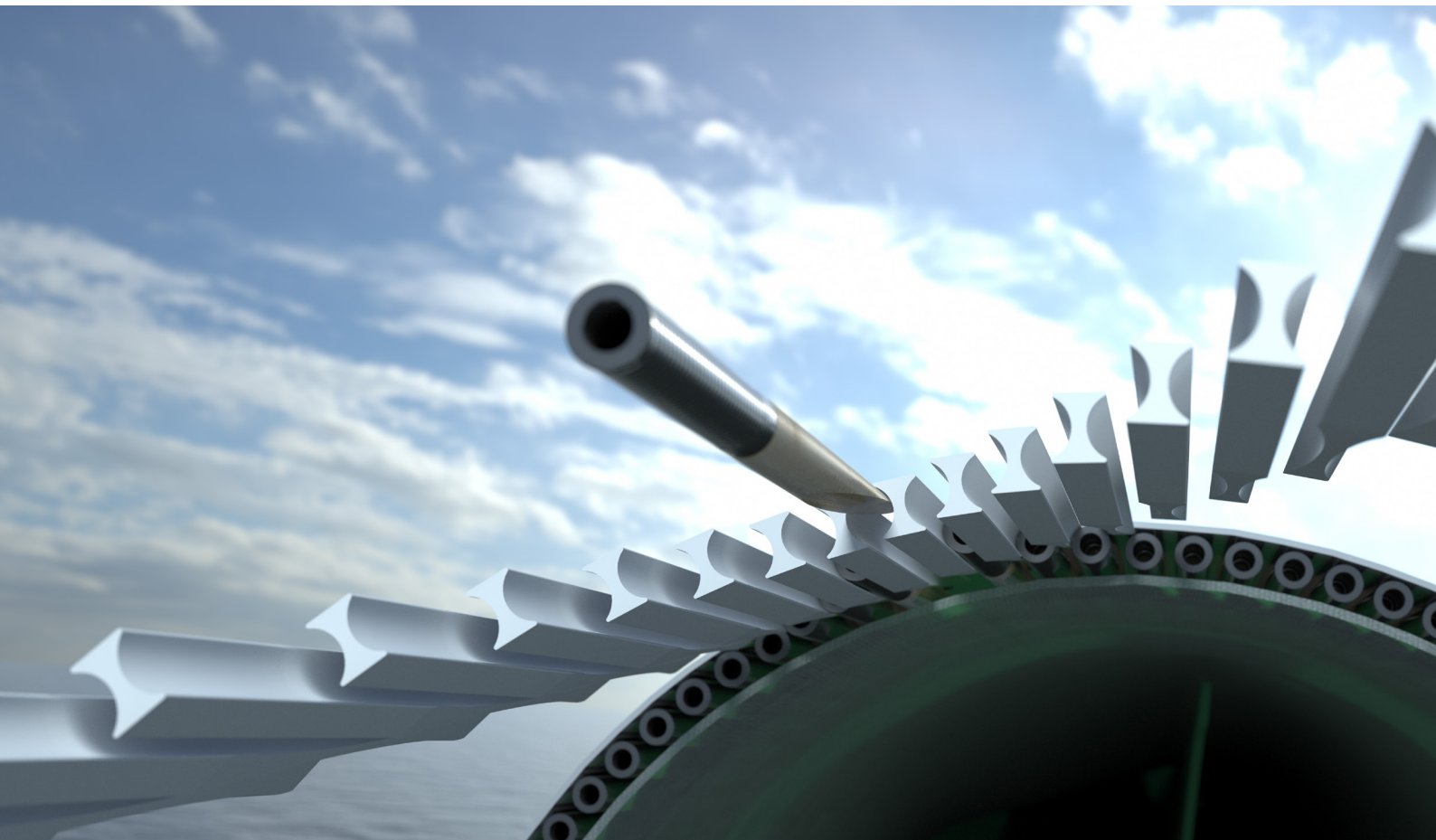
BLADE ROOT REINFORCEMENTS

Our pultruded blade root elements enables our customers to produce cost effective high strength blade roots.

The fact that bushings can be placed closer together makes a reduced blade root diameter possible compared to a conventional T-bolt solution. Full-scale components have been tested in tensile loading – both in static and fatigue loading. For the blade manufacturer a reduced in-mould time is possible due to:

- Less material to be placed in blade mould
- Fast installation of bushings
- Reduced infusion and curing time

The profiles are custom-made and ensure a quicker and more cost-effective high quality lamination process.



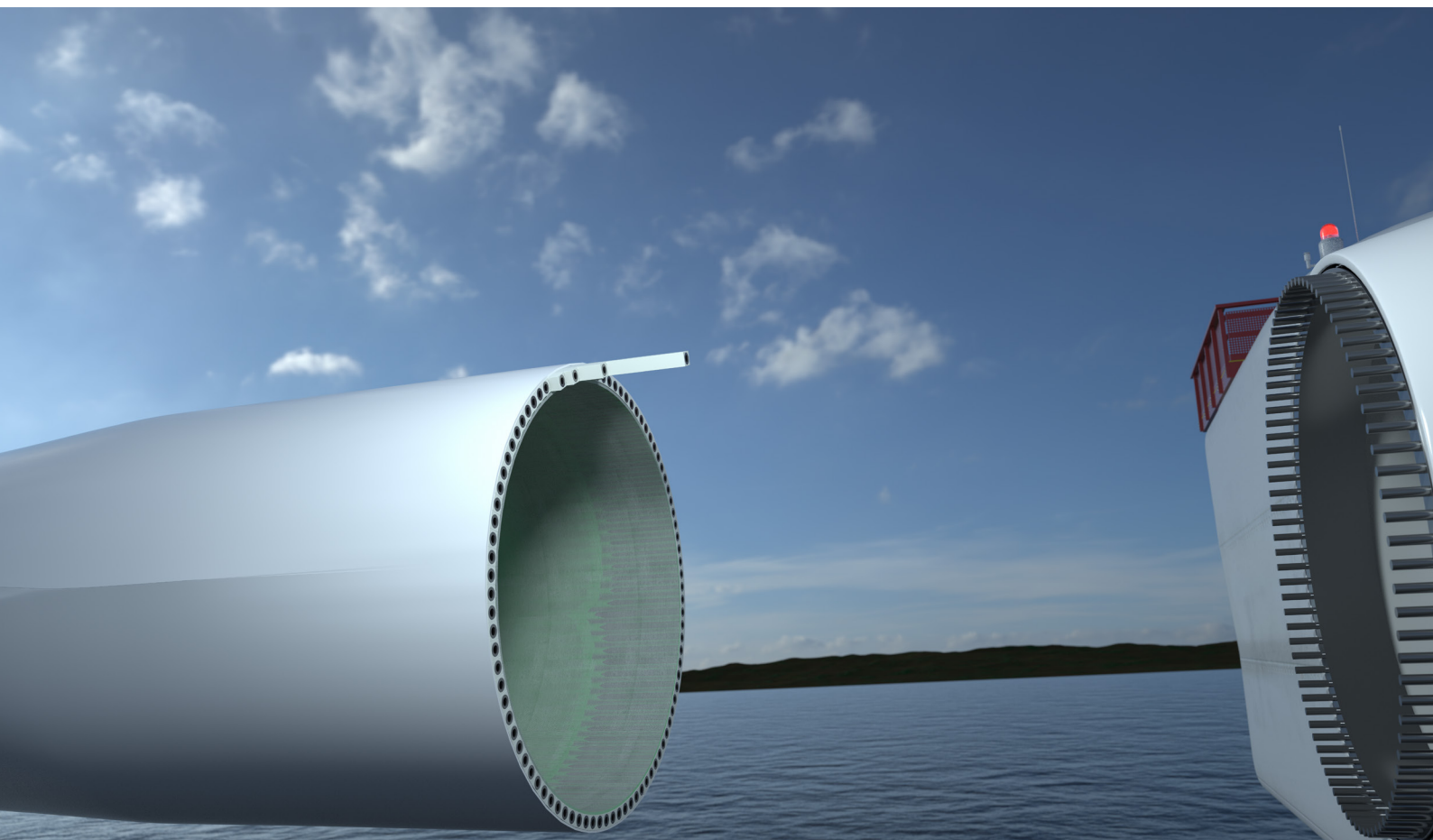
Typical mechanical properties for the pultruded inserts

Coupon tests for characterization of the composite material surrounding the bushing*

Longitudinal stiffness 38 GPa

Longitudinal strength 600 MPa

*additional test data are available upon request





8. Material savings on shear web

WEB-PROFILES

A pultruded assembly flange – connecting the shear web to the spar cap – can be designed to purpose. It will allow a modular build up of the shear web.

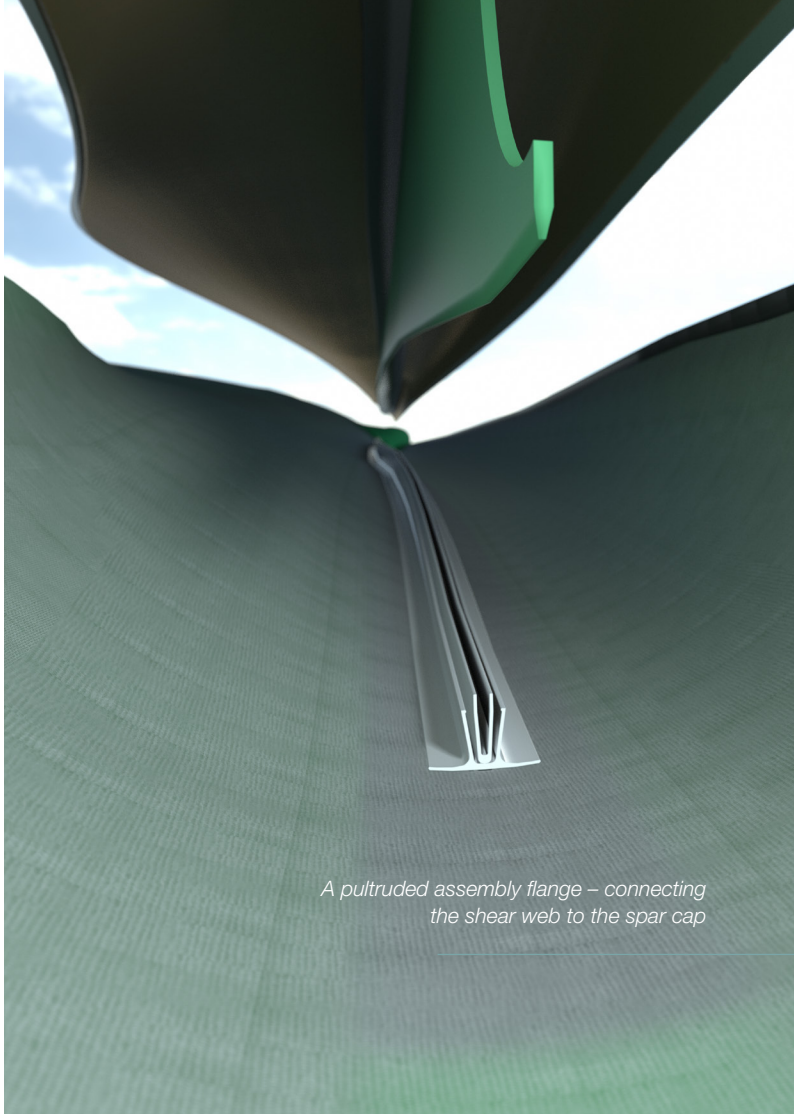
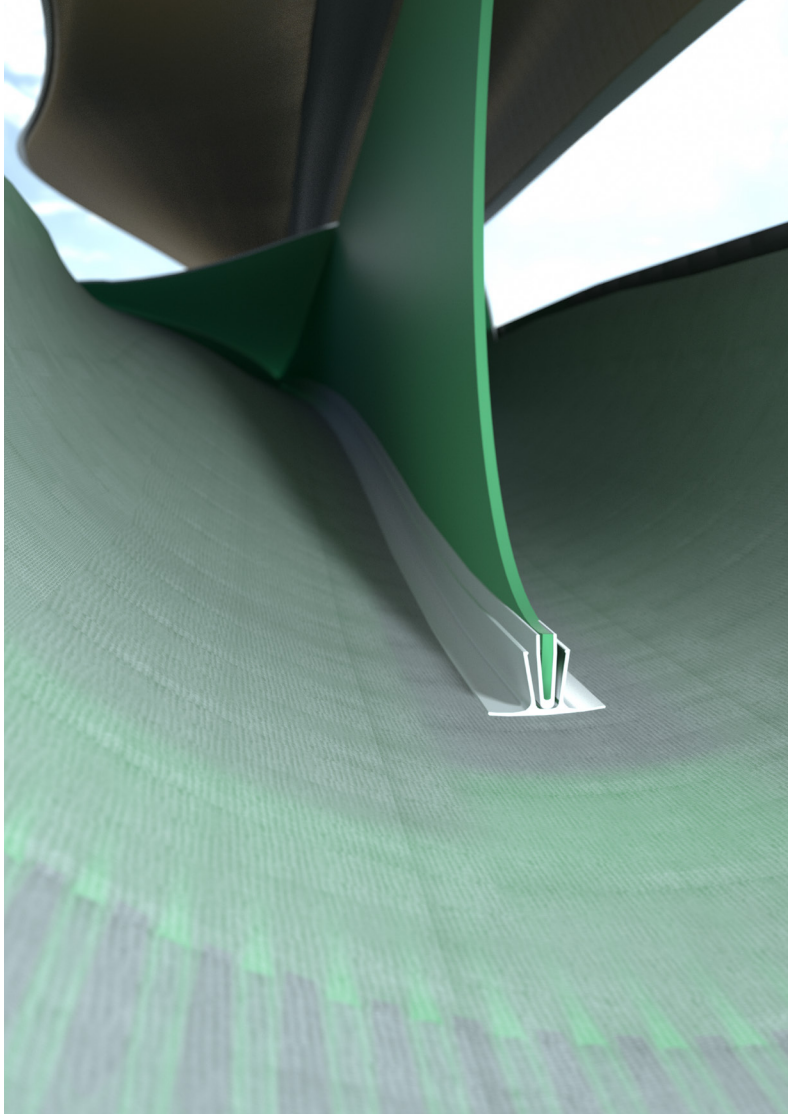
Due to unique fibre alignment and minimal variation in the pultrusion process, the assembly flange have superior mechanical properties. Also a superior strength-weight ratio and customised design ensures material savings on the final solution.

Advantages:

- Unique fibre alignment
- Material savings on final solution
- Design freedom
- Prepared for excellent adhesion
- High and consistent quality

Typical properties with vinylester resin (avg.)

| | |
|-----------------------------|---------|
| Fiber volume | 50-60% |
| Tensile strength | 370 MPa |
| Tensile modulus | 25 GPa |
| Compression strength | 330 MPa |
| Compression modulus | 23 GPa |
| Shear strength | 100 MPa |
| Shear modulus | 12 GPa |
| Interlaminar shear strength | 35 MPa |





4. Danish manufacturer

CLOSE TO OUR CUSTOMERS

Our iconic building in Middelfart, which houses our head office and production, is located just in the middle of Denmark. From here, our products can quickly reach our customers and partners all over the world. Our technology centre is also in Middelfart, and it is here that we develop and test new products before they are produced.

Close to our wind customers

In order to serve the global wind sector, we opened a factory in Tianjin, China's third-largest urban area, in 2009. Production has been consolidated here using the same know-how and stringent quality requirements as in Denmark. In 2019, we moved to a new factory in Tianjin in order to meet the increasing demand for our products.



The Fiberline plant in Tianjin, China

*The Fiberline plant
Barmstedt Allé 5 in Middelfart, Denmark*



