

ProBlade™ Ultra

Superior
leading edge
protection



Excellent
erosion resistance



Increased
asset value



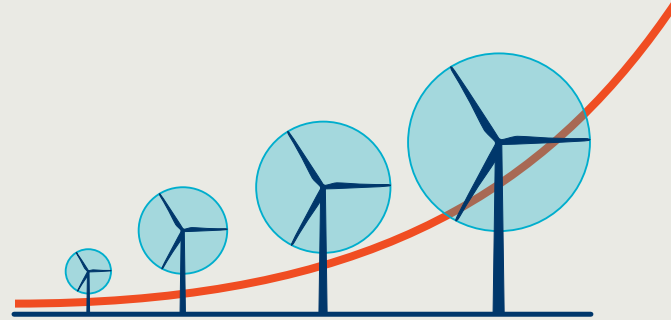
Easy & fast
application

ProBlade™ Ultra is the answer to leading edge erosion

WHY PROBLADE ULTRA?

Increasing blade lengths, faster tip speeds and harsh weather conditions make leading edge degradation the biggest contributor to blade repair costs and lost revenue from turbine downtime. ProBlade™ Ultra allows turbine manufacturers and asset owners to safeguard their assets, maintain an optimal Annual Energy Production (AEP) and lower the levelized cost of energy (LCoE).

ProBlade™ Ultra is an innovative leading edge protection (LEP) comprising a resilient elastomeric polymer and a pressure sensitive adhesive.



LEADING EDGE EROSION: AN AEP AND COST ISSUE

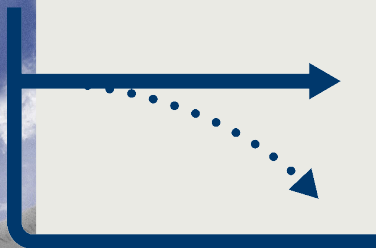
Leading edge erosion repairs account for more than half of the blade repairs, constituting a very large portion of repair costs and lost revenue from downtime.

ProBlade™ Ultra is a superior solution offering a long lasting and reliable leading edge protection while limiting vastly its impact on AEP - compared to gelcoat and other existing leading edge protection solutions on the market.



Excellent erosion resistance

Your leading edge remains intact for longer



Increased asset value

Increased lifetime, lower maintenance costs and sustained AEP



Easy and fast installation

Wide application window and drastically reduced downtime



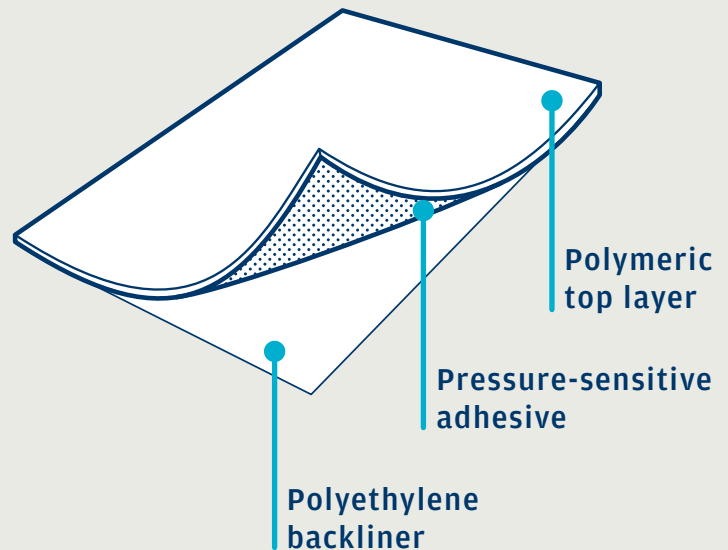
Better performance by design

ROBUST & RELIABLE

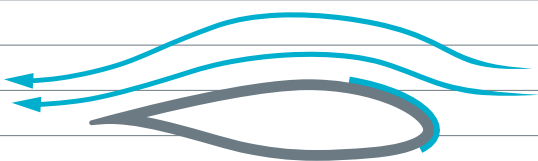
The molecular structure of ProBlade™ Ultra is the secret behind its excellent erosion resistance, outstanding low temperature flexibility and exceptional resistance to microbial degradation.

It is lined with an ultra strong, pressure-sensitive adhesive which bonds to different surfaces and secures that the leading edge remains protected throughout the turbine's operational life.

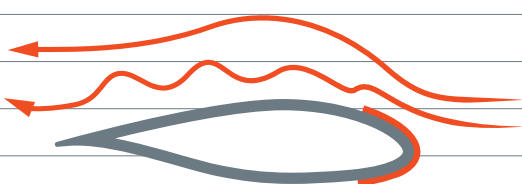
Finally, a polyethylene backliner ensures the storage life of ProBlade™ Ultra, as well as its integrity during the application procedures.



PBU's asymmetric profile



Symmetric LEP



INNOVATIVE AERODYNAMICS

Our aerodynamics experts have performed sensitivity studies to arrive at an optimized application zone. Asymmetric application demonstrates superior performance and adds to the benefits by delaying tripping of the boundary layer, thereby keeping the AEP impact to a bare minimum and significantly increasing the power output compared to eroded blades.

3X

PROBLADE™ ULTRA'S
ASYMMETRIC PROFILE
IS 3 TIMES MORE EFFICIENT

In the lab and field: proven superiority

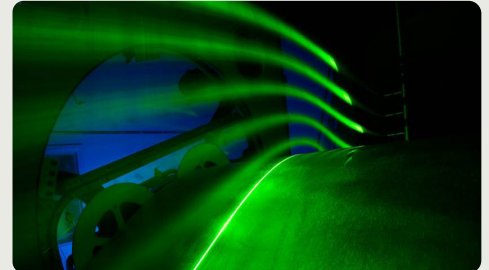
ADVANCED TESTING CAPABILITIES

In our Technology Center of Lunderskov, Denmark, the development of ProBlade™ Ultra has benefited from state-of-the-art testing equipment:

Our Wind Tunnel has allowed us to validate the aerodynamic modelling of ProBlade™ Ultra with asymmetric application & wind speeds up to 105m/s.

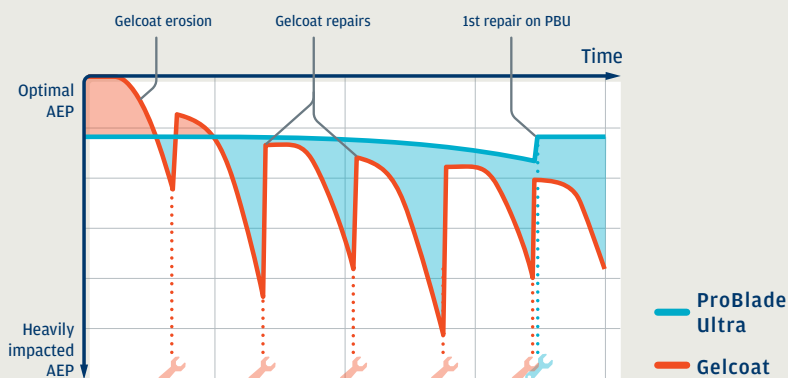
Our Rain erosion test rig supported to verify the lifetime of ProBlade™ Ultra under a selection of rainfall intensity, droplet sizes and at varying tip speeds.

All of LM Wind Power's testing procedures are in compliance with the DNVGL-RP-0573 industry standard.

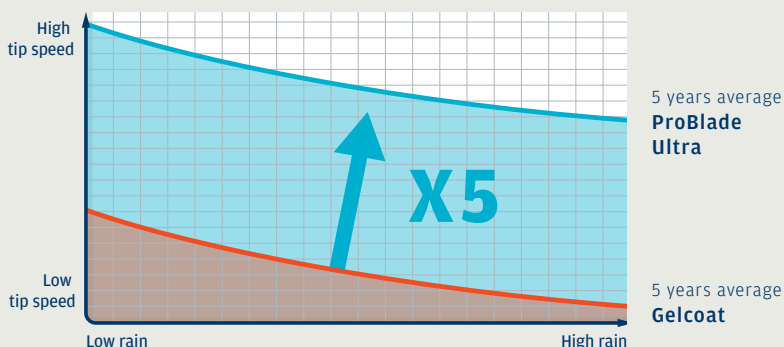


Top: Airflow analysis in our wind tunnel
Bottom: Our in-house rain erosion test rig

ProBlade™ Ultra vs. Gelcoat: AEP evolution



ProBlade™ Ultra vs. Gelcoat lifetime comparison



5X MORE RESISTANT THAN GELCOAT

Problade™ Ultra on average lasts 5 times longer than gelcoat, while drastically reducing the need for maintenance. Its impact on performance is proven to be minimal, validated through wind tunnel tests across different blade types and site conditions.



**Sustained
AEP advantage**



**Reduced
maintenance**

VALIDATED IN THE FIELD

After 3 years in operation, ProBlade™ Ultra has proven to withstand tough weather conditions and remains intact with no sign of failure.

Field inspection results have proven ProBlade™ Ultra's resistance to erosion on two of our customer sites placed in the harshest environments, exposed to monsoon climate and rainforest conditions. Blades equipped with ProBlade™ Ultra showed no sign of leading edge damage compared to other blades on the same sites using other leading edge protection solutions.

PBU was validated on

360

prototype blades



Increased lifetime



Highly UV resistant



No peel-off



Brazil

Rainforest and nearshore site

- large droplets, offshore conditions
- 5000mm cumulated rainfall
- exposure to rainforest contamination and sand
- 3 years in operation, equivalent to 82,000 hours

NO
VISIBLE
DAMAGE



India

Monsoon-exposed site

- large droplets
- 15000mm cumulated rainfall, equivalent to 15 years lifetime on onshore sites
- 3 years in operation, equivalent to 150,000 hours

NO
VISIBLE
DAMAGE

Annual rainfall
(mm)

0-124

125-274

275-474

475-1474

1475-2474

2475-4974

>4975

1 Product

2 Application environments

ProBlade™ Ultra is available in two different shapes which are optimized for its points of application



1. ON-SITE APPLICATION

One meter precut segments tailored for field use make it easy to apply ProBlade™ Ultra through rope access, cherry pickers or any platforms.

The large temperature window at which ProBlade™ Ultra is installed (+8°C to +38°C) ensures limited downtime and faster return to operation. In addition, Installation is free of sealant and specialized tools.



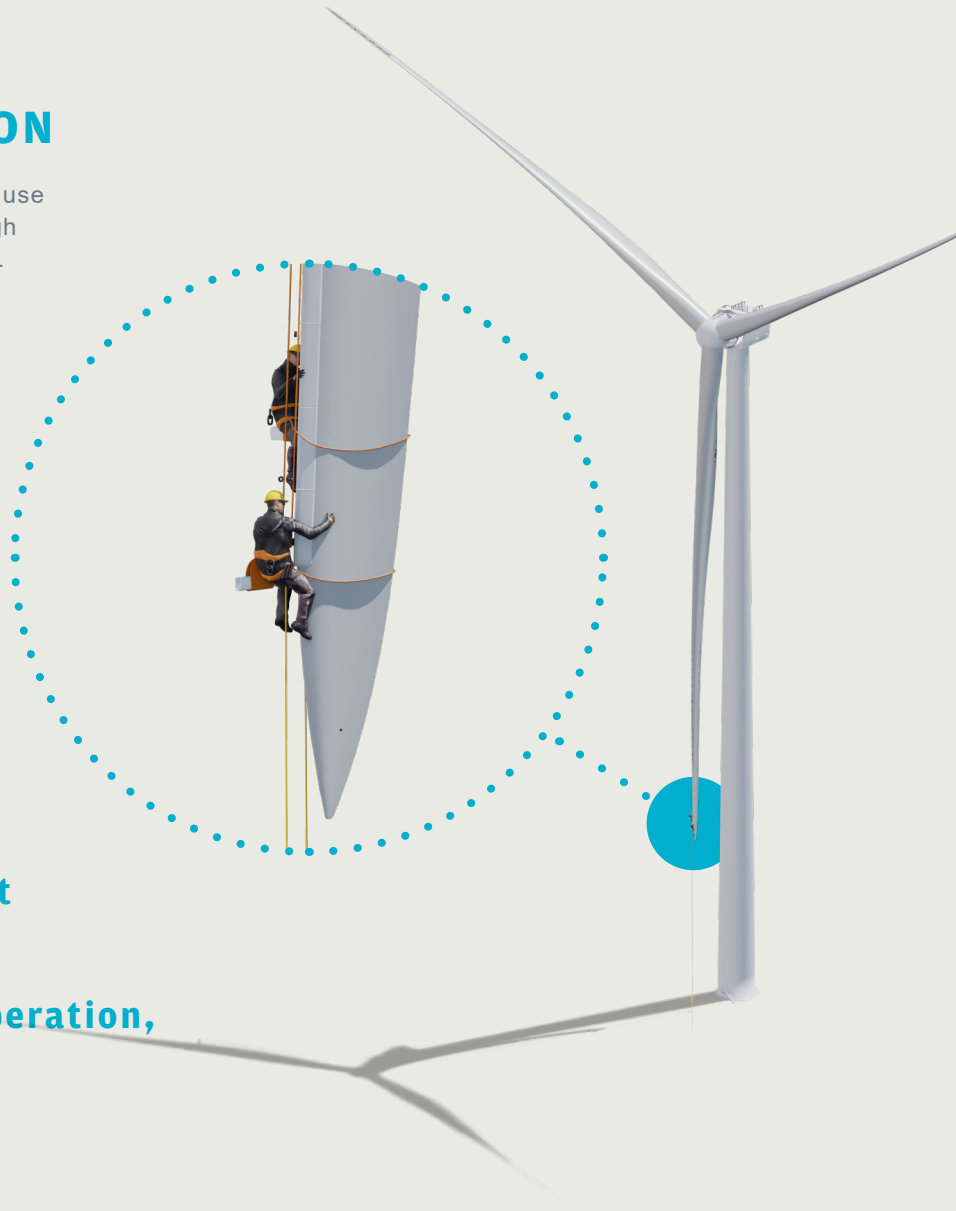
Wide application window



No need for sealant



Faster return to operation, less downtime



2. FACTORY APPLICATION

In addition to field application, ProBlade™ Ultra is also applied in our factories on new blades. The material comes in continuous rolls making it easier to handle and install in a temperature controlled environment without humidity constraints.

Your blades can thus benefit from a seamless layer of protection that further optimizes your AEP and maximizes ProBlade™ Ultra's lifetime.



Flexible application environment



Parallel process, same throughput



A comprehensive product-service solution

OUTSTANDING VALUE PROPOSITION



**Excellent erosion
resistance**



Highly UV resistant



No peel-off



**Increased
asset value**



Increased lifetime
5x superior to gelcoat
on average



Sustained AEP advantage



Reduced maintenance



**Easy and fast
installation**



Wide application window
No humidity constraints
Temperature: 8°C to 38°C



No need for sealant



**Parallel process,
same throughput**

LM WIND POWER: YOUR RELIABLE SERVICE PARTNER

- More than 4 decades experience in blade manufacturing
- Efficient blade add-ons
- Intricate blade repairs and upgrades
- Blade monitoring and inspections
- GWO certified

GLOBAL REACH

- 6 service hubs worldwide
- 100+ highly skilled professionals
- Efficient on-site repair solution



TRAINED TO PROTECT YOUR BLADES

Working several meters above the ground to service and repair blades requires a trained crew. Our highly-skilled and capable technicians are able to carry out the most intricate procedures expertly and safely.

All LM Wind Power service technicians receive extensive, customized training and courses to continuously refresh their knowledge and further improve their skills. In addition to training in new products and repair methods, our customized training programs include safe pass training, working at heights and rescuing, a first aid and medical test, working in confined spaces and fire extinguishing. The globally-coordinated training ensures our service technicians receive the same high level of skills no matter where in the world they are trained and stationed.



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We Know Blades, and how to protect them

LM Wind Power is a leading global partner for design, manufacture and service of wind turbine blades. We have a global manufacturing footprint and are a valued partner in established and emerging markets all over the world.

We work closely with our customers to reduce the cost of energy and continue to invest in research and development. In addition to our own wind tunnel, our technology center ensures that your turbines continue to generate ever more power.

LM Wind Power represents the state-of-the-art in blade technology. Since 1978, we have produced over 260,000 blades from 5 to 107 meters and we continue to establish our position among the world leaders in the growing wind power industry.

LM Wind Power became the first carbon neutral wind business in 2018, and we continue to balance our impact on the planet every year.