SGRE Blade Repairs: UV Curing Laminate Repair System
Winterwind 2020

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Blade Facts

- Blades have a direct impact on the quantity as well as the cost of the MWh your turbines produce.
- Blades are the most expensive components of a wind turbine.
- They face extreme loads and changing weather conditions.
- They are subject to bird strikes; lightning strikes; leading edge erosion – trailing edge damage; and material fatigue; plus surface erosion from rain, hail, ice and insects. Even without actual damage, surface roughness caused by minor pitting and particle accretion can spoil the aerodynamic efficiency of the blades, detracting from turbine productivity.
- With a growing number of blades now in service - many well outside their warranty periods - rotor blade maintenance is becoming a major issue.

Optimal blade condition and performance is key and requires state-of-the-art maintenance. Thus professional care is crucial.

Siemens Gamesa
Blade Service products

Blade inspections: Reporting and assessment

Blade repairs

Blade Integrity Management

Blade upgrades and updates

Hermes artificial intelligence

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Keep your rotor blades healthy

- The Siemens Gamesa Blade Integrity Management service module offers a thorough assessment of the condition of the blade by our experts. It can minimize downtime and improve turbine performance. BIM comes in two different variations:

- **BIM I (Inspection):** Following a comprehensive inspection plan, Siemens Gamesa issues a validated status report on the condition of the blades including an assessment and prioritization of blade repairs that will be necessary in the future.

- **BIM R&M (Repairs and Monitoring):** We observe the performance of the blade in response to the conditions during inspections and any implemented repair. This includes the planning and prioritization of necessary tasks, the execution of repair work, and further monitoring of non-critical findings.

Closely monitor the blades

Cold facts: The effective blade repair solution

Winter has come: both technically and logistically,
cold weather makes blade repair a challenge.

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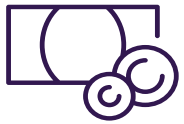
The innovative Siemens Gamesa UV Curing Laminate Repair System.

Why is it of benefit?

- Can be installed in high humidity and low temperatures
- Substantial reduction in processing time compare to wet lamination method
- No handling and mixing of liquid resin systems
- Improved repeatability and process control of the lamination



How does it work?

- The pre-consolidated solution is prepared on-site
- The pregreg laminate stack (patch) is applied with the adhesive paste to the repair area
- The laminate is then cured for 2-5 minutes with the UV lamp that is developed by SGRE

SGRE Innovation:

- Optimized UV light source development
- A special adhesion paste is defined and added to the process
- The field solution process with promoter is developed

Basic features on application

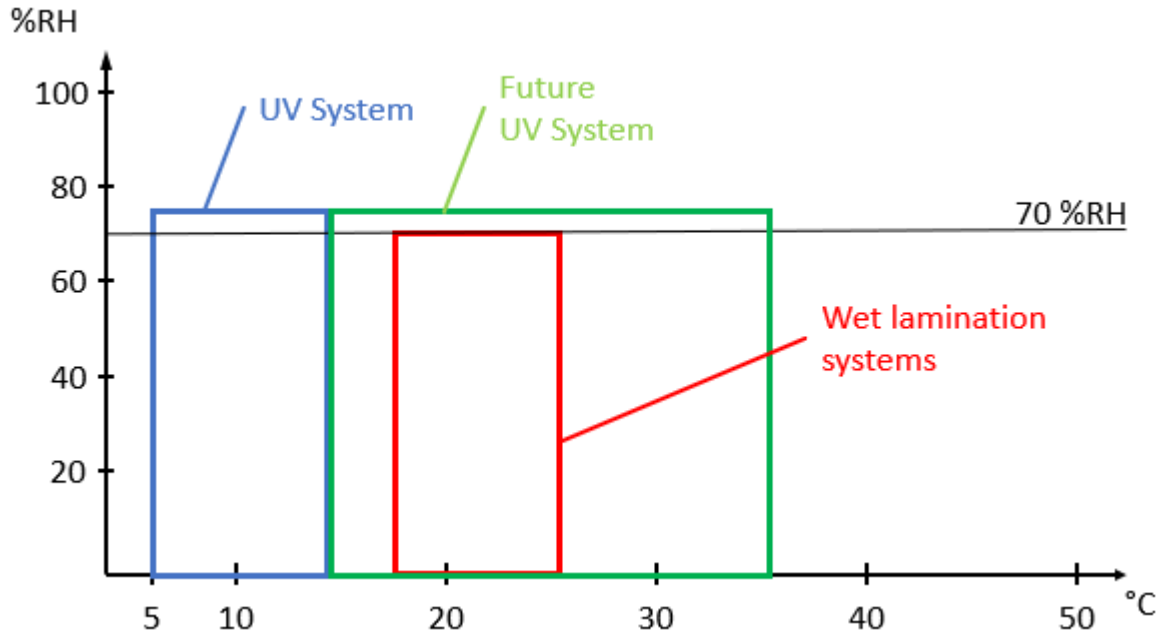
Processing climate window substantially changed.

- Opening the repair window at low temperaure
- Enabling repairs at higher humidities

Operator efficiency

- Prepregs can be applied directly to the prepared blade.
- No resin mixing
- No distribution of resin
- No infusion

Only liquid handled is the new adhesive applied to the substrate. Blue box is for the cold climate glue for arctic and offshore climate.



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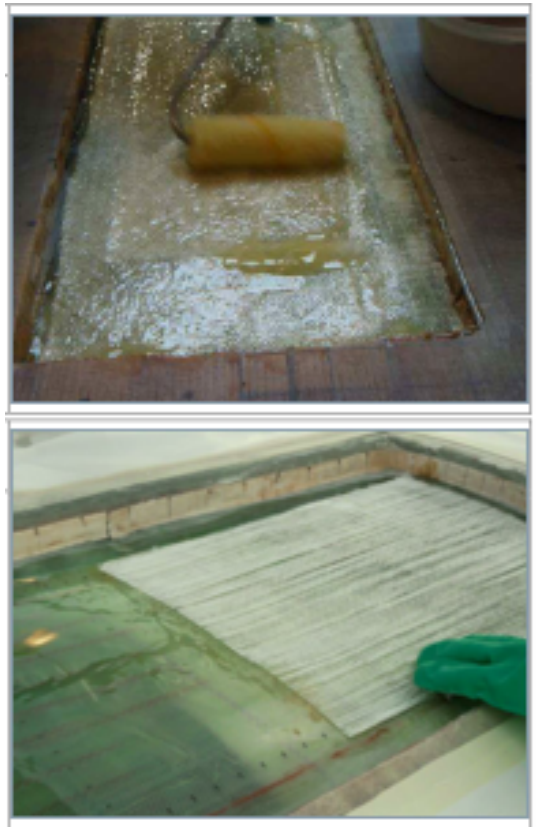
Limitations of current repair systems

Wet Lamination Repair

- Wet resin systems typically used for blade repairs today need to be applied at temperatures above 15°C
- Wet systems need to be accurately mixed and tend to generate high levels of waste.
- Chance of wet resin somehow getting onto synthetic ropes, something that leads to ropes having to be discarded.
- Epoxy requires curing for long durations around 5 hours
- Technicians in contact with chemical material for long time, causing EHS issues

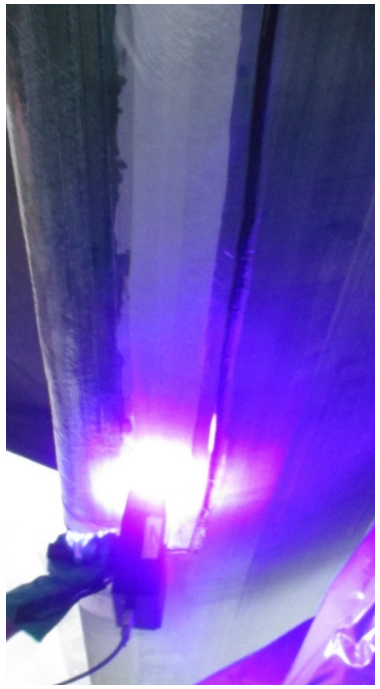


New UV laminate application process

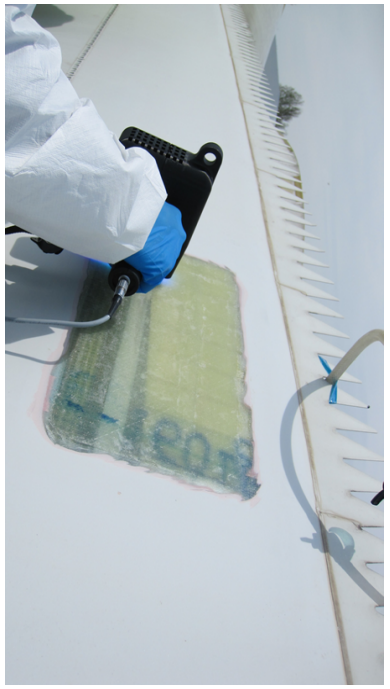
Off-blade consolidation of ply stack.

Application of ply stack to blade laminate.

Initial UV-cure under vacuum



Final cure after removing ancilary materials.

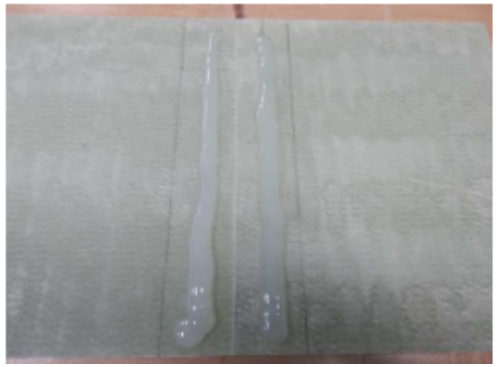


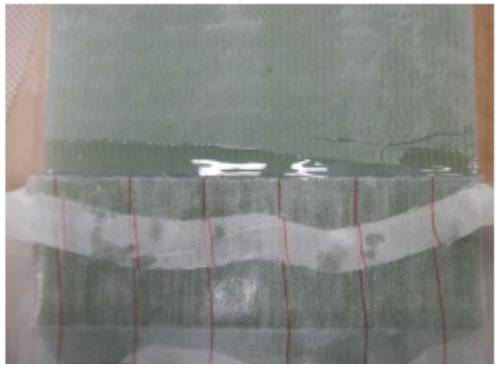
Limitations of supplier solution

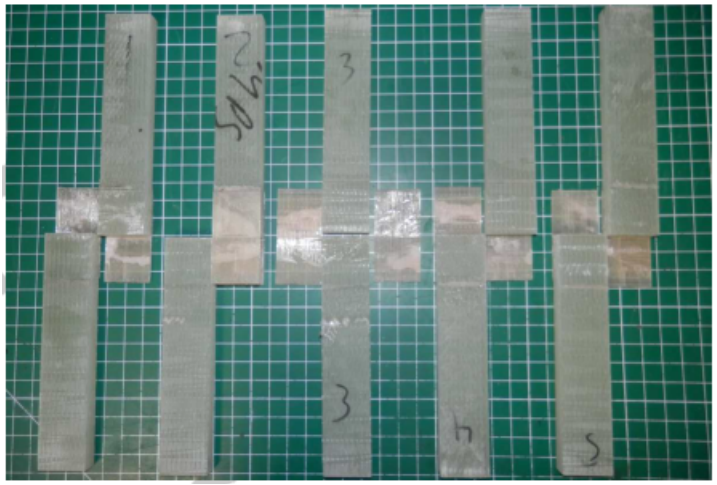
RENUVO with MPS adhesive

- The MPS in its current formulation cannot be approved for field application by SGRE due to its handling and processing characteristics.
- MPS provided low lap shear strength, therefore mechanical properties were not up to the task.

Double lap shear test proved low lap shear strength which is not acceptable by SGRE standards







Test parameters

- Laminate fatigue
- Double lap shear
- Interface fatigue

- Bond line thickness
- Climate variations
- Salt contamination
- Blade bearing grease contamination

Basic features on structural performance

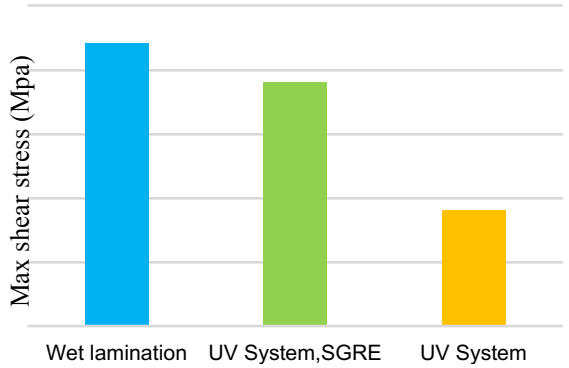
Shear performance

- Fully acceptable with the SGRE solution
- ONLY with the SGRE interface adhesive

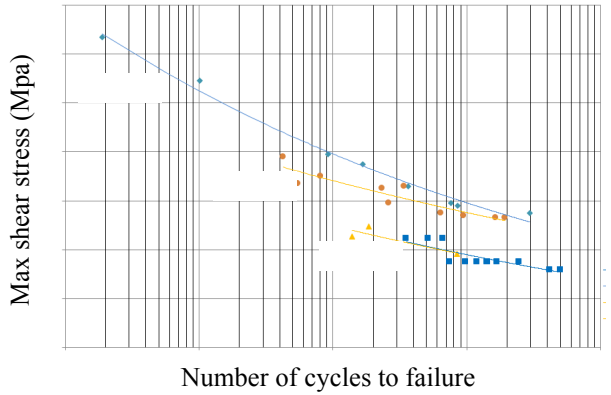
Fatigue performance

- Matching the current wet lamination system
- Two repairs take through full scale blade test
- Ply-drop zone verified

Shear performance
Repair laminate to blade laminate

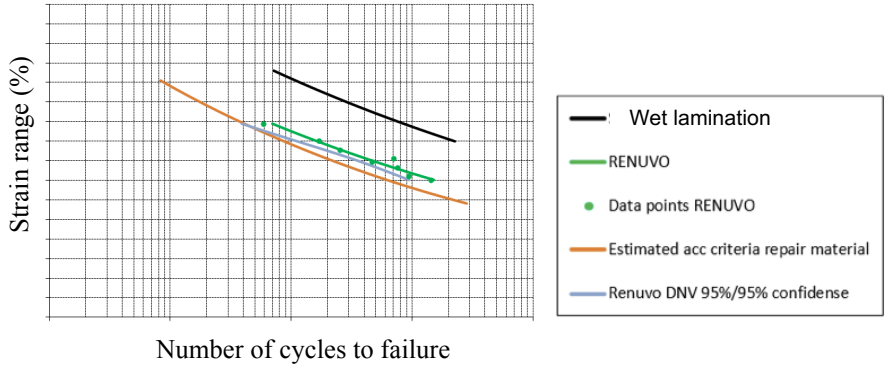


Comparison of the shear fatigue performance



WL: wet lamination

Comparison of the fatigue performance

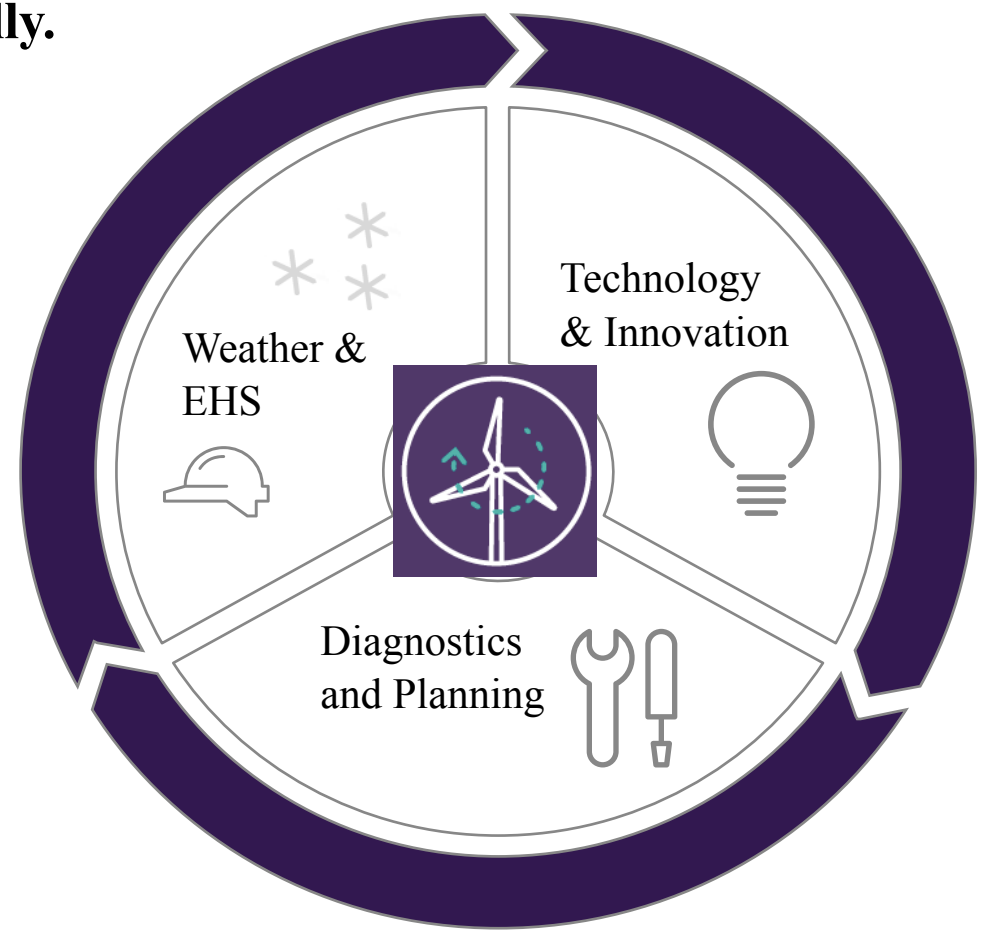


An innovative, cost and time-efficient repair solution that helps to keep your turbine blades operating optimally.

Blade repair season opened for lower temperatures and higher humidities.

Repair cost reductions of 20-30%, (1×1m, 3 ply deep).

Safe operation and greatly simplified logistic setup thanks to lamination with less operator dependancy



Thank you!

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