Wind turbine blade inspection

With FlawExplorer Laser Shearography system

Introduction

The high demand for Green Energy is causing a rapid increase in the production rate of turbine blades. The wide range of wind power solutions and blade sizes requires a higher and faster production rate. These requirements are generating a need for improved and faster quality inspection which can be accomplished by optical measurement technologies such as Shearography.

Image 1 – Wind turbine blade

Complex structures

Wind turbine blades are highly sophisticated products, composed of a variety of materials and composites. They are safety relevant components and, therefore, 100% quality control has to be assured. Each turbine blade is manufactured as a composite, with wood forming the core of the blade, covered with one or more layers of glass fibre plastics on the outside. Various design features strengthen the structure of the blade so that blade lengths of more than 50 metres can be achieved. The high demand on larger and highly efficient blades leads to a high-tech product where weight and quality is the key to success.

100%-inspection required

The production of these turbine blades follows a rather complicated and complex procedure and, consequently, nearly 100% inspection of the blades is required after production. The new FlawExplorer Laser Shearography system

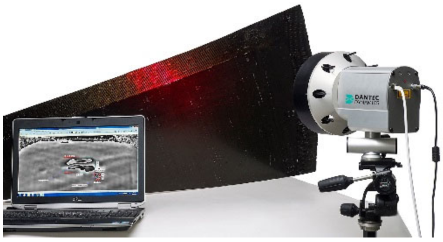

Image 2 – FlawExplorer Laser Shearography system

is used to define the parameters for an upcoming fully automatic inspection system.

The huge dimensions of the blades require a fast and reliable inspection technology which can cover several square metres in a very short time.
Furthermore, the shape of the blade requires a non-contact and full field measurement system. The varying curvatures and surface conditions must be covered by the system without any modification.

Image 3 – Wind turbine

The increase in production rate causes a higher risk of production variations which must be recognised by such a new technology.

The shearography system can detect these variations and can display defects, such as wrinkles, delaminations, debondings and kissing bondings.

Excitation of turbine blade

The excitation technique will be determined during the initial test phase by the R&D department. The thermal excitation has already proven to successfully detect wrinkles in highly stressed areas of the blade. The verification of the vacuum loading will also be a part of the evaluation process where the most practical method will be determined.

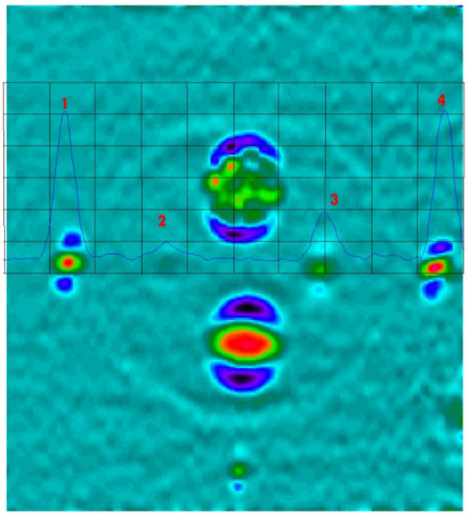

Image 4 – Results from shearography inspection

Shearography sensor

The FlawExplorer Laser Shearography system consists of eight Diode lasers mounted to the sensor housing. The sensor is connected to a controller which is linked to the evaluation PC. The complete system set-up takes less than 5

Image 5 – size of a turbine blade

minutes to be ready for the first measurement. The sensor allows a variable field of view by positioning it at different distances from the object surface.
This provides maximum flexibility to the operator and the best set-up in relation to the detectable defects can easily be verified. This principle is used to provide parameters for the design of the automatic inspection system.

Laser illumination

The inspection areas are illuminated by the Diode lasers mounted on the sensor head. They provide light to illuminate an area of 200 x 300 mm which already allows for a faster inspection than current technologies can provide.

Easy and fast operation

The complete system is operated by the user friendly software. The software offers full control of all measurement specific tools including camera gain, shear angle adjustment, image evaluation parameters, defect sizing, calibration of the field of view, Realtime Phase Image Display and automatic image storing.

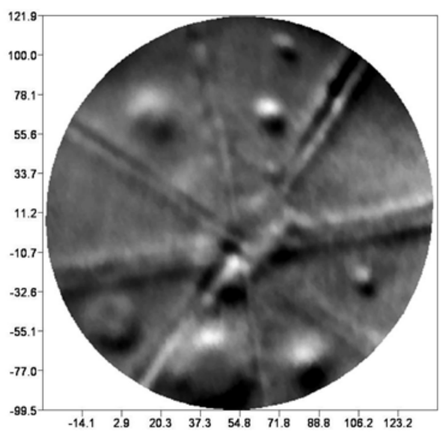

Image 6 – Realtime Phase Image Display

Outlook to the automatic system

The goal of the pre-evaluation in the R&D department is to define the best practice and the parameters for the production unit. This unit has to be fully automatic to cover the high production rate of the blades. The unit will use a gantry system to move the sensor system from one inspection area to the other. The gantry as well as the operation of the shearography system will be controlled by a single software platform which can be a steep learning curve during the training. Therefore, positioning of the sensor, image acquisition and evaluation will be done automatically based on the pre-defined parameters.

Image 7 – Wind turbine blades

The software will allow for automatic defect detection and any potential deviation is automatically registered in the report. The final operator review will offer a re-test of specific areas, acceptance of the deviation or rejection of the blade. An automatic test report is included so operator input is kept to minimum.

Defect display

The results of the measurement are displayed in realtime to the operator which displays a continuous view of the surface response due to the excitation. The operator can easily detect any variation or anomaly in the field of view and with one 'click', all images are stored automatically. These images can later be reviewed in a repository where the best image is selected to be used for e.g. reporting.

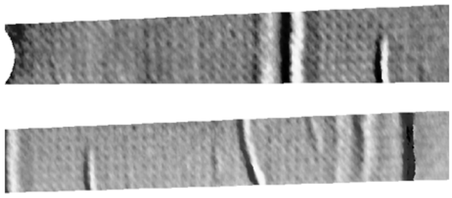

Image 8 – Typical results of wrinkles in a laminate

Conclusion

In comparison to existing inspection technologies, Shearography has proven to be faster, easier to operate and capable of ensuring the high quality of the production turbine blades required, even under higher production rates and shorter inspection cycles.

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