

## DEFECT DETECTION IN WIND TURBINE BLADE COMPOSITE BY USING INFRARED THERMOGRAPHY

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**Abstract:** this study was conducted to investigate the nondestructive infrared-thermography assessment of composite materials for wind power blades, by simulating defects likely to occur during the manufacture and operation of blades and designing artificial quantitative-sized defects.

Through the optical-infrared thermography, this study was able to detect void defects and even inclusion defects inside GFRP, a blade material.

**Keywords:** Suggest 4-5 keywords.

### 1. INTRODUCTION

Recently, for the purpose of low-carbon green growth, various types of eco-friendly industries have been promoted and propagated in the electricity generation field. In Korea at present, wind power generation and photovoltaic power generation mostly lead the electricity generation field. As for the wind turbine generator, it is difficult to operate, maintain and repair due to the wind effect and noise during the operation, and especially since most of the power turbine generators in Korea are installed near the seashore, they are mostly operated in poor environments. Therefore, most wind power blades are made of composite materials that sustain lightweight high-stiffness and doesn't cost high.

During the production or operation of wind power blades, there are various defects occurring. At present they are usually found through visual inspection, acoustic emission-based operability test or ultrasonic C-scan test, but it takes lots of time to detect small defects from wide-ranged materials, and the application of ultrasonic waves may decrease depending on the quality and defect characters of composite materials. To actively cope with such a problem, therefore, this study was conducted to investigate the nondestructive infrared-thermography assessment of composite materials for wind power blades, by simulating defects likely to occur during the manufacture and operation of blades and designing artificial quantitative-sized defects.

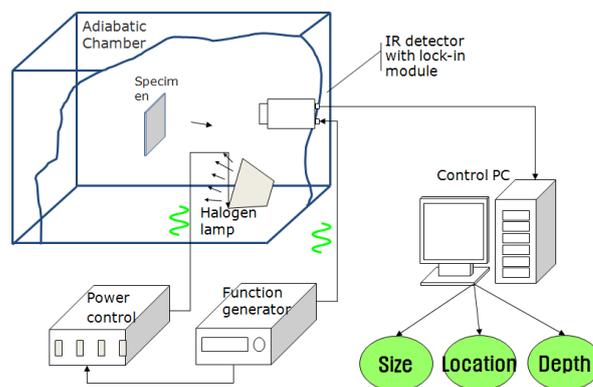
### 2. OPTIC INFRARED THERMOGRAPHY METHOD

The methods of detecting composite material defects by using infrared thermography are largely divided into passive methods and active methods, and unlike passive ones, the active measure methods measure the defect size by taking a particular source of stimuli as its harmonic function,

delivering it to objects and processing the response signals of objects.

By taking the heat source of infrared rays as its harmonic function, shooting the beam to objects and then processing response signals, the lock-in optimal-infrared thermography technique can obtain the change of phase and amplitude. Generally, photo, ultrasound, vibration and eddy current are used as source of stimuli since they are easy to control with harmonic function, depending on the kinds of defects.[1, 2]

The infrared thermography device is composed of a heating device of light source and an infrared thermography camera, and to minimize the heat exchange with exterior heat source during the test, a testing apparatus was installed inside the insulation chamber as shown in Fig. 1. An light-source lamp with 1kW in output and 1m in distance was used, and the infrared camera was Silver 480m Model (NEDT: 25 mK) made by French Cedip. For a better detection sensitivity of the infrared camera, the surface of wind blade was coated with matt black paint to satisfy the same condition as absolute black body with 1 of emissivity.



**Fig. 1** System config of Optical infrared thermography

A wind power blade used for this study was manufactured in a form of NREL (National Renewable Energy Laboratory) S82X-series airfoil, applicable to a rotor 15~40 m in diameter and used GFRP as a reinforced material for the blade and epoxy resin as a glue, and the core was made of PVC foam and balsa wood. As artificial defects, the specimen were manufactured including inclusion defects with a copper sheet and a teflon film

inserted into each layer, void defects existing in parts where part are connected to each other.

This study manufactured all the specimen by putting them into a chamber after laminating and molding prepreg through the vacuum processing. By using optical-infrared thermography and lock-in signal processing technique, this study carried out the detection of artificial defects prepared in each part of the blade. (Fig. 2 shows a shape of the specimen)

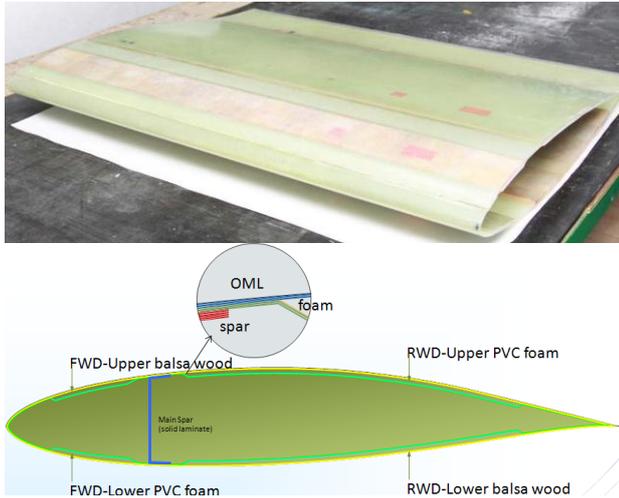


Fig. 2 Wind blade specimen

### 3. RESULTS OF THE EXPERIMENT

Fig. 3 is the results of infrared thermography for the frontal part of the blade, showing images of detected void defects existing inside the blade. In case of GFRP, defects may be seen with naked eyes, but in case of an actual blade, since the coating work is done in the final stage, it is impossible to detect inner defects with naked eyes. Although the coating work was not done in this experiment as it is done in an actual case, this study was able to detect void defects by spreading matt black paint on the material with infrared thermography, which are actually difficult to detect by spreading silver paint with infrared thermography.

The parts where defects exist are lead-edge parts where detecting defects is not easy with ultrasonic waves due to the characteristics of curvature, and especially during the operation, it is more difficult to detect defects.

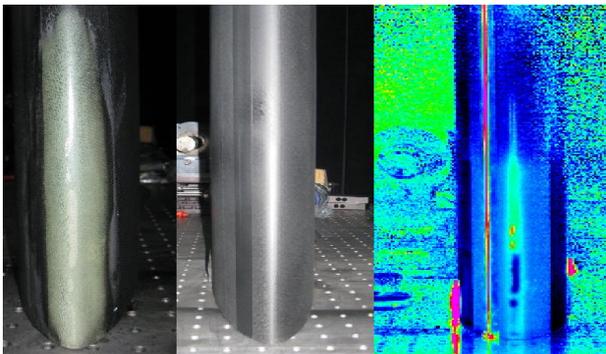


Fig. 3 Void defect of blade lead edge

Fig. 4 shows a thermal image of the part where a copper sheet was inserted. Actually, the image of the surface part where matt black paint was spread was obtained through infrared thermography, and it was possible to detect inclusion defects that a copper sheet was inserted. Manufacturing artificial defects by using a copper sheet is a method that Boeing Company applies at present, and it is known to help grasp defects qualitatively and manufacture inner delamination as well. As a result of the infrared thermography, this study obtained thermal images regarding the growth ring of balsa wood and the adhesive state of resin, which would help confirm the adhesive condition of composite materials with balsa wood used as the core in the future.

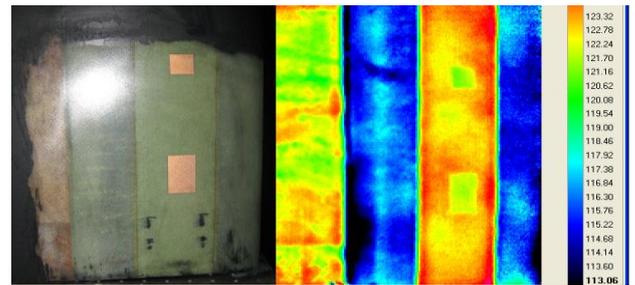


Fig. 4 Inclusion defect of blade

### 4. CONCLUSION

Through the optical-infrared thermography, this study was able to detect void defects and even inclusion defects inside GFRP, a blade material. Especially, it was possible to detect defects in a form that ultrasonic detection of defects cannot be applied.

Especially, as a non-contact defect detection method, the infrared thermography technique is considered to detect various kinds of defects when applied to detecting defects of a wind power blade in operation.

### ACKNOWLEDGEMENTS

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